2024

NORTH CAROLINA STATE BUILDING CODE: RESIDENTIAL CODE

(2021 IRC®, IMC®, IFGC® AND IPC® WITH NORTH CAROLINA AMENDMENTS)

ICC INTERNATIONAL CODE COUNCIL®

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PREFACE

Introduction

The *International Residential Code*® (IRC®) establishes minimum requirements for one- and two family dwellings and townhouses using prescriptive provisions. It is founded on broad-based principles that make possible the use of new materials and new building designs. This 2021 edition is fully compatible with all of the International Codes® (I-Codes®) published by the International Code Council (ICC), including the *International Building Code*® (IBC®), *International Energy Conservation Code*® (IECC®), *International Existing Building Code*® (IEBC®), *International Fire Code*® (IFC®), *International Fuel Gas Code*® (IFGC®), *International Green Construction Code*® (IgCC®), *International Mechanical Code*® (IMC®), *International Plumbing Code*® (IPC®), *International Private Sewage Disposal Code*® (IPSDC®), *International Property Maintenance Code*® (IPMC®), *International Swimming Pool and Spa Code*® (ISPSC®), *International Wildland-Urban Interface Code*® (IWUIC®), *International Zoning Code*® (IZC®) and *International Code Council Performance Code*® (ICCPC®).

The I-Codes, including the IRC, are used in a variety of ways in both the public and private sectors. Most industry professionals are familiar with the I-Codes as the basis of laws and regulations in communities across the US and in other countries. However, the impact of the codes extends well beyond the regulatory arena, as they are used in a variety of nonregulatory settings, including:

- Voluntary compliance programs such as those promoting sustainability, energy efficiency and disaster resistance.
- The insurance industry, to estimate and manage risk, and as a tool in underwriting and rate decisions.
- Certification and credentialing of individuals involved in the fields of building design, construction and safety.
- Certification of building and construction-related products.
- US federal agencies, to guide construction in an array of government-owned properties.
- Facilities management.
- “Best practices” benchmarks for designers and builders, including those who are engaged in projects in jurisdictions that do not have a formal regulatory system or a governmental enforcement mechanism.
- College, university and professional school textbooks and curricula.
- Reference works related to building design and construction.

In addition to the codes themselves, the code development process brings together building professionals on a regular basis. It provides an international forum for discussion and deliberation about building design, construction methods, safety, performance requirements, technological advances and innovative products.

Development

This 2021 edition presents the code as originally issued, with changes reflected in the 2003 through 2018 editions and further changes approved by the ICC Code Development Process through 2019. Residential electrical provisions are based on the 2020 National Electrical Code® (NFPA 70). A new edition such as this is promulgated every 3 years.

Fuel gas provisions have been included through an agreement with the American Gas Association (AGA). Electrical provisions have been included through an agreement with the NFPA.

This code is founded on principles intended to establish provisions consistent with the scope of a residential code that adequately protects public health, safety and welfare; provisions that do not unnecessarily increase construction costs; provisions that do not restrict the use of new materials, products or methods of construction; and provisions that do not give preferential treatment to particular types or classes of materials, products or methods of construction.

Maintenance

The IRC is kept up to date through the review of proposed changes submitted by code enforcement officials, industry representatives, design professionals and other interested parties. Proposed changes are carefully considered through an open code development process in which all interested and affected parties may participate.

The ICC Code Development Process reflects principles of openness, transparency, balance, due process and consensus, the principles embodied in OMB Circular A-119, which governs the federal government's use of private-sector standards. The ICC process is open to anyone; there is no cost to participate, and people can participate without travel cost through the ICC's cloud-based app, cdpAccess®. A broad cross section of interests are represented in the ICC Code Development Process. The codes, which are updated regularly, include safeguards that allow for emergency action when required for health and safety reasons.

In order to ensure that organizations with a direct and material interest in the codes have a voice in the process, the ICC has developed partnerships with key industry segments that support the ICC's important public safety mission. Some code development committee members were nominated by the following industry partners and approved by the ICC Board:

- National Association of Home Builders (NAHB)
- National Council of Structural Engineers Association (NCSEA)

The code development committees evaluate and make recommendations regarding proposed changes to the codes. Their recommendations are then subject to public comment and council-wide votes. The ICC's governmental members—public safety officials who have no financial or business interest in the outcome—cast the final votes on proposed changes.

The contents of this work are subject to change through the code development cycles and by any governmental entity that enacts the code into law. For more information regarding the code development process, contact the Codes and Standards Development Department of the ICC.

The maintenance process for the fuel gas provisions is based on the process used to maintain the IFGC, in conjunction with the AGA. The maintenance process for the electrical provisions is undertaken by the NFPA.

While the I-Code development procedure is thorough and comprehensive, the ICC, its members and those participating in the development of the codes disclaim any liability resulting from the publication or use of the I-Codes, or from compliance or noncompliance with their provisions. The ICC does not have the power or authority to police or enforce compliance with the contents of this code.

Marginal Markings

Solid vertical lines in the margins within the body of the code indicate a technical change from the requirements of the 2018 IRC edition. Deletion indicators in the form of an arrow (➡) are provided in the margin where an entire section, paragraph, exception or table has been deleted or an item in a list of items or a row of a table has been deleted from the 2018 IRC. Double vertical lines in the margins within the body of the code indicate North Carolina Building Code Council amendments to the base code. An open deletion arrow (>) in the margin indicates North Carolina deletions from the *International Residential Code.*

Coordination of the International Codes

The coordination of technical provisions is one of the strengths of the ICC family of model codes. The codes can be used as a complete set of complementary documents, which will provide users with full integration and coordination of technical provisions. Individual codes can also be used in subsets or as stand-alone documents. To make sure that each individual code is as complete as possible, some technical provisions that are relevant to more than one subject area are duplicated in some of the model codes. This allows users maximum flexibility in their application of the I-Codes.

Italicized Terms

Terms italicized in code text, other than document titles, are defined in Chapter 2. The terms selected to be italicized have definitions that the user should read carefully to better understand the code. Where italicized, the Chapter 2 definition applies. If not italicized, common-use definitions apply.

Adoption

The ICC maintains a copyright in all of its codes and standards. Maintaining copyright allows the ICC to fund its mission through sales of books, in both print and electronic formats. The ICC welcomes adoption of its codes by jurisdictions that recognize and acknowledge the ICC's copyright in the code, and further acknowledge the substantial shared value of the public/private partnership for code development between jurisdictions and the ICC.

The ICC also recognizes the need for jurisdictions to make laws available to the public. All I-Codes and I-Standards, along with the laws of many jurisdictions, are available for free in a nondownloadable form on the ICC's website. Jurisdictions should contact the ICC at adoptions@iccsafe.org to learn how to adopt and distribute laws based on the IRC in a manner that provides necessary access, while maintaining the ICC's copyright.

Effective Use of the International Residential Code

The IRC was created to serve as a complete, comprehensive code regulating the construction of single-family houses, two-family houses (duplexes) and buildings consisting of three or more townhouse units. All buildings within the scope of the IRC are limited to three stories above grade plane. For example, a four-story single-family house would fall within the scope of the IBC, not the IRC. The benefits of devoting a separate code to residential construction include the fact that the user need not navigate through a multitude of code provisions that do not apply to residential construction in order to locate that which is applicable. A separate code also allows for residential and nonresidential code provisions to be distinct and tailored to the structures that fall within the appropriate code's scopes.

The IRC contains coverage for all components of a house or townhouse, including structural components, fireplaces and chimneys, thermal insulation, mechanical systems, fuel gas systems, plumbing systems and electrical systems.

The IRC is a prescriptive-oriented (specification) code with some examples of performance code language. It has been said that the IRC is the complete cookbook for residential construction. Section R301.1, for example, is written in performance language, but states that the prescriptive requirements of the code will achieve such performance.

It is important to understand that the IRC contains coverage for what is conventional and common in residential construction practice. While the IRC will provide all of the needed coverage for most residential construction, it might not address construction practices and systems that are atypical or rarely encountered in the industry. Sections such as R301.1.3, R301.2.2.1.1, R320.1, M1301.1, G2401.1 and P2601.1 refer to other codes either as an alternative to the provisions of the IRC or where the IRC lacks coverage for a particular type of structure, design, system, appliance or method of construction. In other words, the IRC is meant to be all inclusive for typical residential construction and it relies on other codes only where alternatives are desired or where the code lacks coverage for the uncommon aspect of residential construction. Of course, the IRC constantly evolves to address new technologies and construction practices that were once uncommon, but are now common.

The IRC is unique in that much of it, including Chapters 3 through 9 and Chapters 34 through 43, is presented in an ordered format that is consistent with the normal progression of construction, starting with the design phase and continuing through the final trim-out phase. This is consistent with the "cookbook" philosophy of the IRC.

ARRANGEMENT AND FORMAT OF THE 2021 IRC

The IRC is divided into nine main parts, specifically: Part I—Administrative, Part II—Definitions, Part III—Building Planning and Construction, Part IV—Energy Conservation, Part V—Mechanical, Part VI—Fuel Gas, Part VII—Plumbing, Part VIII—Electrical and Part IX—Referenced Standards.

The following provides a brief description of the content of each chapter and appendix of the IRC:

Chapter 1 Scope and Administration

This chapter contains provisions for the application, enforcement and administration of subsequent requirements of the code. In addition to establishing the scope of the code, Chapter 1 identifies which buildings and structures come under its purview. Chapter 1 is largely concerned with maintaining "due process of law" in enforcing the building criteria contained in the body of the code. Only through careful observation of the administrative provisions can the building official reasonably expect to demonstrate that "equal protection under the law" has been provided.

Chapter 2 Definitions

Terms defined in the code are listed alphabetically in Chapter 2. It is important to note that three chapters have their own definitions sections: Chapter 11 for the defined terms unique to energy conservation, Chapter 24 for the defined terms unique to fuel gas and Chapter 35 for the terms applicable to electrical Chapters 34 through 43. Where Chapter 24 or 35 defines a term differently than it is defined in Chapter 2, the definition applies in that chapter only. Chapter 2 definitions apply in all other locations in the code.

Where understanding a term's definition is key to or necessary for understanding a particular code provision, the term is shown in italics where it appears in the code. This is true only for those terms that have a meaning that is unique to the code. In other words, the generally understood meaning of a term or phrase might not be sufficient or consistent with the meaning prescribed by the code; therefore, it is essential that the code-defined meaning be known.

Guidance regarding not only tense, gender and plurality of defined terms, but also terms not defined in this code, is provided.

Chapter 3 Building Planning

Chapter 3 provides guidelines for a minimum level of structural integrity, life safety, fire safety and livability for inhabitants of dwelling units regulated by this code. Chapter 3 is a compilation of the code requirements specific to the building planning sector of the design and construction process. This chapter sets forth code requirements dealing with light, ventilation, sanitation, minimum room size, ceiling height and environmental comfort. Chapter 3 establishes life-safety provisions including limitations on glazing used in hazardous areas, specifications on stairways, use of guards at elevated surfaces, window and fall protection, and rules for means of egress. Snow, wind and seismic design live and dead loads and flood-resistant construction, as well as solar energy systems, and swimming pools, spas and hot tubs, are addressed in this chapter.

Chapter 4 Foundations

Chapter 4 provides the requirements for the design and construction of foundation systems for buildings regulated by this code. Provisions for seismic load, flood load and frost protection are contained in this chapter. A foundation system consists of two interdependent components: the foundation structure itself and the supporting soil.

The prescriptive provisions of this chapter provide requirements for constructing footings and walls for foundations of wood, masonry, concrete and precast concrete. In addition to a foundation's ability to support the required design loads, this chapter addresses several other factors that can affect foundation performance. These include controlling surface water and subsurface drainage, requiring soil tests where conditions warrant and evaluating proximity to slopes and minimum depth requirements. The chapter also provides requirements to minimize adverse effects of moisture, decay and pests in basements and crawl spaces.

Chapter 5 Floors

Chapter 5 provides the requirements for the design and construction of floor systems that will be capable of supporting minimum required design loads. This chapter covers four different types: wood floor framing, wood floors on the ground, cold-formed steel floor framing and concrete slabs on the ground. Allowable span tables are provided that greatly simplify the determination of joist, girder and sheathing sizes for raised floor systems of wood framing and cold-formed steel framing. This chapter also contains prescriptive requirements for wood-framed exterior decks and their attachment to the main building.

Chapter 6 Wall Construction

Chapter 6 contains provisions that regulate the design and construction of walls. The wall construction covered in Chapter 6 consists of five different types: wood framed, cold-formed steel framed, masonry, concrete and structural insulated panel (SIP). The primary concern of this chapter is the structural integrity of wall construction and transfer of all imposed loads to the supporting structure. This chapter provides the requirements for the design and construction of wall systems that are capable of supporting the minimum design vertical loads (dead, live and snow loads) and lateral loads (wind or seismic loads). This chapter contains the prescriptive requirements for wall bracing and/or shear walls to resist the imposed lateral loads due to wind and seismic activity.

Chapter 6 also regulates exterior windows and doors installed in walls. This chapter contains criteria for the performance of exterior windows and doors and includes provisions for testing and labeling, garage doors, windborne debris protection and anchorage details.

Chapter 7 Wall Covering

Chapter 7 contains provisions for the design and construction of interior and exterior wall coverings. This chapter establishes the various types of materials, materials standards and methods of application permitted for use as interior coverings, including interior plaster, gypsum board, ceramic tile, wood veneer paneling, hardboard paneling, wood shakes and wood shingles. Chapter 7 also contains requirements for the use of vapor retarders for moisture control in walls.

Exterior wall coverings provide the weather-resistant exterior envelope that protects the building's interior from the elements. Chapter 7 provides the requirements for wind resistance and water-resistive barrier for exterior wall coverings. This chapter prescribes the exterior wall coverings as well as the water-resistive barrier required beneath the exterior materials. Exterior wall coverings regulated by this section include aluminum, stone and masonry veneer, wood, hardboard, particleboard, wood structural panel siding, wood shakes and shingles, exterior plaster, steel, vinyl, fiber cement and exterior insulation finish systems.

Chapter 8 Roof-ceiling Construction

Chapter 8 regulates the design and construction of roof-ceiling systems. This chapter contains two roof-ceiling framing systems: wood framing and cold-formed steel framing. Allowable span tables are provided to simplify the selection of rafter and ceiling joist size for wood roof framing and cold-formed steel framing. Chapter 8 also provides requirements for the application of ceiling finishes, the proper ventilation of concealed spaces in roofs (e.g., enclosed attics and rafter spaces), unvented attic assemblies and attic access.

Chapter 9 Roof Assemblies

Chapter 9 regulates the design and construction of roof assemblies. A roof assembly includes the roof deck, vapor retarder, substrate or thermal barrier, insulation, vapor retarder and roof covering. This chapter provides the requirement for wind resistance of roof coverings.

The types of roof covering materials and installation regulated by Chapter 9 are: asphalt shingles, clay and concrete tile, metal roof shingles, mineral-surfaced roll roofing, slate and slate-type shingles, wood shakes and shingles, built-up roofs, metal roof panels, modified bitumen roofing, thermoset and thermoplastic single-ply roofing, sprayed polyurethane foam roofing, liquid applied coatings and photovoltaic shingles. Chapter 9 also provides requirements for roof drainage, flashing, above deck thermal insulation, rooftop-mounted photovoltaic systems and recovering or replacing an existing roof covering.

Chapter 10 Chimneys and Fireplaces

Chapter 10 contains requirements for the safe construction of masonry chimneys and fireplaces and establishes the standards for the use and installation of factory-built chimneys, fireplaces and masonry heaters. Chimneys and fireplaces constructed of masonry rely on prescriptive requirements for the details of their construction; the factory-built type relies on the listing and labeling method of approval. Chapter 10 provides the requirements for seismic reinforcing and anchorage of masonry fireplaces and chimneys.

Chapter 11 [RE] Energy Efficiency

The purpose of Chapter 11 [RE] is to provide minimum design requirements that will promote efficient utilization of energy in buildings. The requirements are directed toward the design of building envelopes with adequate thermal resistance and low air leakage, and toward the design and selection of mechanical, water heating, electrical and illumination systems that promote effective use of depletable energy resources. The provisions of Chapter 11 [RE] are duplicated from the *International Energy Conservation Code—Residential Provisions*, as applicable for buildings which fall under the scope of the IRC.

For ease of use and coordination of provisions, the corresponding IECC—Residential Provisions section number is indicated following the IRC section number [e.g., N1102.1 (R402.1)].

Chapter 12 Mechanical Administration

Chapter 12 establishes the limits of applicability of the code and describes how the code is to be applied and enforced. A mechanical code, like any other code, is intended to be adopted as a legally enforceable document and it cannot be effective without adequate provisions for its administration and enforcement. The provisions of Chapter 12 establish the authority and duties of the code official appointed by the jurisdiction having authority and also establish the rights and privileges of the design professional, contractor and property owner. It also relates this chapter to the administrative provisions in Chapter 1.

Chapter 13 General Mechanical System Requirements

Chapter 13 contains broadly applicable requirements related to appliance listing and labeling, appliance location and installation, appliance and systems access, protection of structural elements and clearances to combustibles, among others.

Chapter 14 Heating and Cooling Equipment and Appliances

Chapter 14 is a collection of requirements for various heating and cooling appliances, dedicated to single topics by section. The common theme is that all of these types of appliances use energy in one form or another, and the improper installation of such appliances would present a hazard to the occupants of the dwellings, due to either the potential for fire or the accidental release of refrigerants. Both situations are undesirable in dwellings that are covered by this code.

Chapter 15 Exhaust Systems

Chapter 15 is a compilation of code requirements related to residential exhaust systems, including kitchens and bathrooms, clothes dryers and range hoods. The code regulates the materials used for constructing and installing such duct systems. Air brought into the building for ventilation, combustion or makeup purposes is protected from contamination by the provisions found in this chapter.

Chapter 16 Duct Systems

Chapter 16 provides requirements for the installation of ducts for supply, return and exhaust air systems. This chapter contains no information on the design of these systems from the standpoint of air movement, but is concerned with the structural integrity of the systems and the overall impact of the systems on the fire-safety performance of the building. This chapter regulates the materials and methods of construction which affect the performance of the entire air distribution system.

Chapter 17 Combustion Air

Complete combustion of solid and liquid fuel is essential for the proper operation of appliances, control of harmful emissions and achieving maximum fuel efficiency. If insufficient quantities of oxygen are supplied, the combustion process will be incomplete, creating dangerous byproducts and wasting energy in the form of unburned fuel (hydrocarbons). The byproducts of incomplete combustion are poisonous, corrosive and combustible, and can cause serious appliance or equipment malfunctions that pose fire or explosion hazards.

The combustion air provisions in this code from previous editions have been deleted from Chapter 17 in favor of a single section that directs the user to NFPA 31 for oil-fired appliance combustion air requirements and the manufacturer's installation instructions for solid fuel-burning appliances. If fuel gas appliances are used, the provisions of Chapter 24 must be followed.

Chapter 18 Chimneys and Vents

Chapter 18 regulates the design, construction, installation, maintenance, repair and approval of chimneys, vents and their connections to fuel-burning appliances. A properly designed chimney or vent system is needed to conduct the flue gases produced by a fuel-burning appliance to the outdoors. The provisions of this chapter are intended to minimize the hazards associated with high temperatures and potentially toxic and corrosive combustion gases. This chapter addresses factory-built and masonry chimneys, vents and venting systems used to vent oil-fired and solid fuel-burning appliances.

Chapter 19 Special Appliances, Equipment and Systems

Chapter 19 regulates the installation of fuel-burning appliances that are not covered in other chapters, such as ranges and ovens, sauna heaters, fuel cell power plants and hydrogen systems. Because the subjects in this chapter do not contain the volume of text necessary to warrant individual chapters, they have been combined into a single chapter. The only commonality is that the subjects use energy to perform some task or function. The intent is to provide a reasonable level of protection for the occupants of the dwelling.

Chapter 20 Boilers and Water Heaters

Chapter 20 regulates the installation of boilers and water heaters. Its purpose is to protect the occupants of the dwelling from the potential hazards associated with such appliances. A water heater is any appliance that heats potable water and supplies it to the plumbing hot water distribution system. A boiler either heats water or generates steam for space heating and is generally a closed system.

Chapter 21 Hydronic Piping

Hydronic piping includes piping, fittings and valves used in building space conditioning systems. Applications include hot water, chilled water, steam, steam condensate, brines and water/antifreeze mixtures. Chapter 21 regulates installation, alteration and repair of all hydronic piping systems to ensure the reliability, serviceability, energy efficiency and safety of such systems.

Chapter 22 Fuel Oil Piping and Storage Systems

Chapter 22 regulates the design and installation of fuel oil storage and piping systems. The regulations include reference to construction standards for above-ground and underground storage tanks, material standards for piping systems (both above-ground and underground) and extensive requirements for the proper assembly of system piping and components. The purpose of this chapter is to prevent fires, leaks and spills involving fuel oil storage and piping systems, whether inside or outside structures and above or underground.

Chapter 23 Solar Thermal Energy Systems

Chapter 23 contains requirements for the construction, alteration and repair of all systems and components of solar thermal energy systems used for space heating or cooling, and domestic hot water heating or processing. The provisions of this chapter are limited to those necessary to achieve installations that are relatively hazard free.

A solar thermal energy system can be designed to handle 100 percent of the energy load of a building, although this is rarely accomplished. Because solar energy is a low-intensity energy source and dependent on the weather, it is usually necessary to supplement a solar thermal energy system with traditional energy sources.

As our world strives to find alternate means of producing power for the future, the requirements of this chapter will become more and more important over time.

Chapter 24 Fuel Gas

Chapter 24 regulates the design and installation of fuel gas distribution piping and systems, appliances, appliance venting systems and combustion air provisions. The definition of “Fuel gas” includes natural, liquefied petroleum and manufactured gases and mixtures of these gases.

The purposes of this chapter are to establish the minimum acceptable level of safety and to protect life and property from the potential dangers associated with the storage, distribution and use of fuel gases and the byproducts of combustion of such fuels. This code also protects the personnel who install, maintain, service and replace the systems and appliances addressed herein.

Chapter 25 Plumbing Administration

The requirements of Chapter 25 do not supersede the administrative provisions of Chapter 1. Rather, the administrative guidelines of Chapter 25 pertain to plumbing installations that are best referenced and located within the plumbing chapters. This chapter addresses how to apply the plumbing provisions of this code to specific types or phases of construction. This chapter also outlines the responsibilities of the applicant, installer and inspector with regard to testing plumbing installations.

Chapter 26 General Plumbing Requirements

The content of Chapter 26 is often referred to as "miscellaneous," rather than general plumbing requirements. This is the only chapter of the plumbing chapters of the code whose requirements do not interrelate. If a requirement cannot be located in another plumbing chapter, it should be located in this chapter. Chapter 26 contains safety requirements for the installation of plumbing systems and includes requirements for the identification of pipe, pipe fittings, traps, fixtures, materials and devices used in plumbing systems. If specific provisions do not demand that a requirement be located in another chapter, the requirement is located in this chapter.

Chapter 27 Plumbing Fixtures

Chapter 27 requires fixtures to be of the proper type, approved for the purpose intended and installed properly to promote usability and safe, sanitary conditions. This chapter regulates the quality of fixtures and faucets by requiring those items to comply with nationally recognized standards. Because fixtures must be properly installed so that they are usable by the occupants of the building, this chapter contains the requirements for the installation of fixtures.

Chapter 28 Water Heaters

Chapter 28 regulates the design, approval and installation of water heaters and related safety devices. The intent is to minimize the hazards associated with the installation and operation of water heaters. Although this chapter does not regulate the size of a water heater, it does regulate all other aspects of the water heater installation such as temperature and pressure relief valves, safety drip pans and connections. Where a water heater also supplies water for space heating, this chapter regulates the maximum water temperature supplied to the water distribution system.

Chapter 29 Water Supply and Distribution

This chapter regulates the supply of potable water from both public and individual sources to every fixture and outlet so that it remains potable and uncontaminated by cross connections. Chapter 29 also regulates the design of the water distribution system, which will allow fixtures to function properly. Because it is critical that the potable water supply system remain free of actual or potential sanitary hazards, this chapter has the requirements for providing backflow protection devices.

Chapter 30 Sanitary Drainage

The purpose of Chapter 30 is to regulate the materials, design and installation of sanitary drainage piping systems as well as the connections made to the system. The intent is to design and install sanitary drainage systems that will function reliably, are neither undersized nor oversized and are constructed from materials, fittings and connections whose quality is regulated by this section. This chapter addresses the proper use of fittings for directing the flow into and within the sanitary drain piping system. Materials and provisions necessary for servicing the drainage system are also included in this chapter.

Chapter 31 Vents

Venting protects the trap seal of each trap. The vents are designed to limit differential pressures at each trap to 1 inch of water column (249 Pa). Because waste flow in the drainage system creates pressure fluctuations that can negatively affect traps, the sanitary drainage system must have a properly designed venting system. Chapter 31 covers the requirements for vents and venting. All of the provisions set forth in this chapter are intended to limit the pressure differentials in the drainage system to a maximum of 1 inch of water column (249 Pa) above or below atmospheric pressure (i.e., positive or negative pressures).

Chapter 32 Traps

Traps prevent sewer gas from escaping from the drainage piping into the building. Water seal traps are the simplest and most reliable means of preventing sewer gas from entering the interior environment. This chapter lists prohibited trap types and specifies the minimum trap size for each type of fixture.

Chapter 33 Storm Drainage

Deleted.

Chapter 34 General Requirements

Deleted. See the *North Carolina Electrical Code*.

Chapter 35 Electrical Definitions

Deleted. See the *North Carolina Electrical Code*.

Chapter 36 Services

Deleted. See the *North Carolina Electrical Code*.

Chapter 37 Branch Circuit and Feeder Requirements

Deleted. See the *North Carolina Electrical Code*.

Chapter 38 Wiring Methods

Deleted. See the *North Carolina Electrical Code*.

Chapter 39 Power and Lighting Distribution

Deleted. See the *North Carolina Electrical Code*.

Chapter 40 Devices and Luminaires

Deleted. See the *North Carolina Electrical Code*.

Chapter 41 Appliance Installation

Deleted. See the *North Carolina Electrical Code*.

Chapter 42 Swimming Pools

Deleted. See the *North Carolina Electrical Code*.

Chapter 43 Class 2 Remote-control, Signaling and Power-limited Circuits

Deleted. See the *North Carolina Electrical Code*.

Chapter 44 Referenced Standards

The code contains numerous references to standards that are used to regulate materials and methods of construction. Chapter 44 contains a comprehensive list of all standards that are referenced in the code. The standards are part of the code to the extent of the reference to the standard. Compliance with the referenced standard is necessary for compliance with this code. By providing specifically adopted standards, the construction and installation requirements necessary for compliance with the code can be readily determined. The basis for code compliance is, therefore, established and available on an equal basis to the code official, contractor, designer and owner.

Chapter 44 is organized in a manner that makes it easy to locate specific standards. It lists all of the referenced standards, alphabetically, by acronym of the promulgating agency of the standard. Each agency's standards are then listed in either alphabetical or numeric order based upon the standard identification. The list also contains the title of the standard; the edition (date) of the standard referenced; any addenda included as part of the ICC adoption; and the section or sections of this code that reference the standard.

Chapter 45 High Wind Zones

This chapter applies to buildings constructed in North Carolina high wind zones. These provisions shall be in addition to or in lieu of the requirements of Chapters 1 through 10.

Chapter 46 Coastal and Flood Plain Standards

The requirements of this chapter apply to all construction located within areas identified by a governmental agency (state and federal) as coastal high hazard area, ocean hazard areas, the regulatory flood plain areas, and all areas designated as 150 miles per hour (67 m/s) wind zone.

Appendix AA Sizing and Capacities of Gas Piping

This appendix is informative and not part of the code. It provides design guidance, useful facts and data and multiple examples of how to apply the sizing tables and sizing methodologies of Chapter 24.

Appendix AB Sizing of Venting Systems Serving Appliances Equipped with Draft Hoods, Category I Appliances, and Appliances Listed for Use with Type B Vents

This appendix is informative and not part of the code. It contains multiple examples of how to apply the vent and chimney tables and methodologies of Chapter 24.

Appendix AC Exit Terminals of Mechanical Draft and Direct-vent Venting Systems

This appendix is informative and not part of the code. It consists of a figure and notes that visually depict code requirements from Chapter 24 for vent terminals with respect to the openings found in building exterior walls.

Appendix AD Recommended Procedure for Safety Inspection of an Existing Appliance Installation

This appendix is informative and not part of the code. It provides recommended procedures for testing and inspecting an appliance installation to determine if the installation is operating safely and if the appliance is in a safe condition.

Appendix AE Manufactured Housing Used as Dwellings

Deleted.

Appendix AF Radon Control Methods

Radon comes from the natural (radioactive) decay of the element radium in soil, rock and water and finds its way into the air. Appendix AF contains requirements to mitigate the transfer of radon gases from the soil into the dwelling. The provisions of this appendix regulate the design and construction of radon-resistant measures intended to reduce the entry of radon gases into the living space of residential buildings.

Appendix AG Piping Standards for Various Applications

Appendix AG provides standards for various types of plastic piping products. This appendix is informative and is not part of the code.

Appendix AH Patio Covers

Deleted.

Appendix AI Private Sewage Disposal

Deleted.

Appendix AJ Existing Buildings and Structures

Deleted.

Appendix AK Sound Transmission

Appendix AK regulates the sound transmission of wall and floor-ceiling assemblies separating dwelling units and townhouse units. Airborne sound insulation is required for walls. Airborne sound insulation and impact sound insulation are required for floor-ceiling assemblies. The provisions in Appendix AK set forth a minimum Sound Transmission Class (STC) rating for common walls and floor-ceiling assemblies between dwelling units. In addition, a minimum Impact Insulation Class (IIC) rating is also established to limit structureborne sound through common floor-ceiling assemblies separating dwelling units.

Appendix AL Permit Fees

Deleted.

Appendix AM Home Day Care—Occupancy

Deleted.

Appendix AN Venting Methods

Because venting of sanitary drainage systems is a difficult concept to understand, and Chapter 31 uses only words to describe venting requirements, illustrations can offer greater insight into what the words mean. Appendix AN has a number of illustrations for commonly installed sanitary drainage systems in order for the reader to gain a better understanding of this code's venting requirements.

Appendix AO Automatic Vehicular Gates

Appendix AO provides the requirements for the design and construction of automatic vehicular gates. The provisions are for where automatic gates are installed for use at a vehicular entrance or exit on the lot of a one- or two-family dwelling. The requirements provide protection for individuals from potential entrapment between an automatic gate and a stationary object or surface.

Appendix AP Sizing of Water Piping System

Appendix AP provides two recognized methods for sizing the water service and water distribution piping for a building. The method under Section AP103 provides friction loss diagrams that require the user to "plot" points and read values from the diagrams in order to perform the required calculations and necessary checks. This method is the most accurate of the two presented in this appendix. The method under Section AP201 is known to be conservative; however, very few calculations are necessary in order to determine a pipe size that satisfies the flow requirements of any application.

Appendix AQ Tiny Houses

For dwelling units that are 400 square feet (37 m^2) or less in floor area, excluding lofts, Appendix AQ provides relaxed provisions as compared to those in the body of the code. These provisions primarily address reduced ceiling heights for loft areas and specific stair and ladder detail requirements that allow for more compact designs where accessing lofts.

Appendix AR Light Straw-clay Construction

Deleted.

Appendix AS Strawbale Construction

Deleted.

Appendix AT Solar-ready Provisions—Detached One- and Two-family Dwellings and Townhouses

Deleted.

Appendix AU Cob Construction (Monolithic Adobe)

Deleted.

Appendix AV Board of Appeals

Deleted.

Appendix AW 3D-printed Building Construction

Appendix AW provides for the design, construction and inspection of buildings, structures and building elements fabricated by 3D-printed construction techniques.

Appendix AX Zero Energy Residential Building Provisions

Deleted.

Appendix NCA Swimming Pools, Spas and Hot Tubs

This appendix provides informational guidance.

Appendix NCB Discontinuous Footing Details

This appendix provides adopted code details.

Appendix NCC Basic Load Estimating

This appendix provides adopted code information.

Appendix NCD Foam Plastic Diagrams

This appendix provides adopted code information.

Appendix NCE

This appendix provides additional information for compliance with the energy conservation residential requirements of this code.

TABLE OF CONTENTS

Part I—Administrative

CHAPTER 1
SCOPE AND ADMINISTRATION

PART 1—SCOPE AND APPLICATION

SECTION R101
SCOPE AND GENERAL REQUIREMENTS

R101.1 Title. These provisions shall be known as the *North Carolina Residential Code for One- and Two-family Dwellings*, and shall be cited as such and will be referred to herein as "this code." These regulations were adopted by the North Carolina Building Code Council on September 12, 2023 to be effective July 1, 2025. References to the International Codes shall mean the *North Carolina State Building Code*.

R101.2 Scope. The provisions of this code shall apply to the construction, *alteration*, movement, enlargement, replacement, *repair*, equipment, use and occupancy, location, removal, and demolition of one or more detached one- and two-family dwellings and *townhouses* located on a parcel and not more than three stories above *grade plane* in height with a separate means of egress and their *accessory structures* not more than three stories above *grade plane* in height. Single family dwellings otherwise permitted by this Code shall include *bed and breakfast* homes.

Exception: *Live/work units* complying with the requirements of Section 508.5 of the *International Building Code* shall be permitted to be built as one- and two-family dwellings or townhouses. Fire suppression required by Section 508.5.7 of the *International Building Code* where constructed under the *International Residential Code for One- and Two-family Dwellings* shall conform to Section P2904 of the *International Residential Code for One- and Two-family Dwellings*.

R101.2.1 Accessory buildings. *Accessory buildings* with any dimension greater than 12 feet (3658 mm) shall meet the provisions of this code. *Accessory buildings* are permitted to be constructed without a masonry or concrete foundation, except in *coastal high hazard* or *ocean hazard areas*, provided all of the following conditions are met:

1. The *accessory building* shall not exceed 400 square feet (37 m^2) or one story in height;
2. The building is supported on a wood foundation of minimum 2-inch by 6-inch (51-mm by 152-mm) or 3-inch by 4-inch (76-mm by 102-mm) mudsill of approved wood in accordance with Section R317;
3. The building is anchored to resist overturning and sliding by installing a minimum of one ground anchor at each corner of the building. The total resisting force of the anchors shall be equal to 20 psf (958 Pa) times the plan area of the building.

R101.2.2 Accessory structures. Only the following *accessory structures* shall meet the provisions of this code.

1. Decks, see Chapter 47,
2. Gazebos,
3. Retaining walls, see Section R404.4,
4. Detached masonry chimneys located less than 10 feet (3048 mm) from other buildings or lot lines,
5. Swimming pools and spas, see Appendix NCA,
6. Detached carports,

   Exception: Portable, lightweight carports not exceeding 400 square feet (37 m^2) or 12 feet (3658 mm) mean roof height.
7. *Docks, piers, bulkheads*, and waterway structures, see Section R331,
8. Ground mounted photovoltaic system, see Section R324.7.

R101.3 Purpose. The purpose of this code is to establish minimum requirements to provide a reasonable level of safety, health and general welfare through affordability, structural strength, means of egress, stability, sanitation, light and ventilation, energy conservation and safety to life and property from fire and other hazards attributed to the built environment.

SECTION R102
APPLICABILITY

R102.1 General. Where there is a conflict between a general requirement and a specific requirement, the specific requirement shall be applicable. Where, in any specific case, different sections of this code specify different materials, methods of construction or other requirements, the most restrictive shall govern.

R102.2 Other laws. The provisions of this code shall not be deemed to nullify any provisions of local, state or federal law.

R102.3 Application of references. References to chapter or section numbers, or to provisions not specifically identified by number, shall be construed to refer to such chapter, section or provision of this code.

R102.4 Referenced codes and standards. The codes and standards referenced in this code shall be considered part of the requirements of this code to the prescribed extent of each

such reference and as further regulated in Sections R102.4.1 and R102.4.2.

Exception: Where enforcement of a code provision would violate the conditions of the *listing* of the *equipment* or *appliance*, the conditions of the *listing* and manufacturer's instructions shall apply.

R102.4.1 Conflicts. Where conflicts occur between provisions of this code and referenced codes and standards, the provisions of this code shall apply.

R102.4.2 Provisions in referenced codes and standards. Where the extent of the reference to a referenced code or standard includes subject matter that is within the scope of this code, the provisions of this code, as applicable, shall take precedence over the provisions in the referenced code or standard.

R102.5 Appendices. Provisions in the appendices shall not apply unless specifically referenced in the code text.

R102.6 Partial invalidity. In the event any part or provision of this code is held to be illegal or void, this shall not have the effect of making void or illegal any of the other parts or provisions.

R102.7 Existing structures. For requirements of existing structures, refer to the *North Carolina Administrative Code and Policies* and the *North Carolina Existing Building Code*.

R102.7.1 Additions, alterations or repairs. *Additions*, *alterations* or repairs to any structure shall conform to the requirements for a new structure without requiring the existing structure to comply with the requirements of this code, unless otherwise stated. *Additions*, *alterations*, repairs and relocations shall not cause an existing structure to become less compliant with the provisions of this code than the existing building or structure was prior to the *addition*, *alteration* or *repair*. Where the *alteration* causes the use or occupancy to be changed to one not within the scope of this code, the provisions of the *International Existing Building Code* shall apply.

PART 2—ADMINISTRATION AND ENFORCEMENT

See the North Carolina Administrative Code and Policies for the administration and enforcement of the North Carolina State Building Codes as adopted by the Building Code Council and enforced by State and local code enforcement officials.

Part II—Definitions

CHAPTER 2
DEFINITIONS

SECTION R201
GENERAL

R201.1 Scope. Unless otherwise expressly stated, the following words and terms shall, for the purposes of this code, have the meanings indicated in this chapter.

R201.2 Interchangeability. Words used in the present tense include the future; words in the masculine gender include the feminine and neuter; the singular number includes the plural and the plural, the singular.

R201.3 Terms defined in other codes. Where terms are not defined in this code such terms shall have the meanings ascribed in other code publications of the International Code Council.

R201.4 Terms not defined. Where terms are not defined through the methods authorized by this section, such terms shall have ordinarily accepted meanings such as the context implies.

SECTION R202
DEFINITIONS

ABOVE-GRADE WALL. A wall more than 50 percent above grade and enclosing conditioned space. This includes between-floor spandrels, peripheral edges of floors, roof and basement knee walls, dormer walls, gable end walls, walls enclosing a mansard roof and skylight shafts.

ACCEPTED ENGINEERING PRACTICE. Practice that conforms to accepted principles, tests or standards of nationally recognized technical or scientific authorities.

ACCESS COVER. A removable plate, usually secured by bolts or screws, to permit access to a pipe or pipe fitting for the purposes of inspection, repair or cleaning.

ACCESS (TO). That which enables a device, an *appliance* or equipment to be reached by *ready access* or by a means that first requires the removal or movement of a panel, door or similar obstruction.

ACCESSIBLE. Signifies access that requires the removal of an access panel or similar removable obstruction. For energy purposes, *accessible* means admitting close approach as a result of not being guarded by locked doors, elevation or other effective means (see "*Accessible, readily*").

ACCESSORY BUILDING. A building that does not contain a sleeping room, the use of which is appurtenant to that of the dwelling, that is detached and located on the same lot as the dwelling and is roofed over with more than 50 percent of its exterior walls enclosed.

ACCESSORY STRUCTURE. A detached structure that is appurtenant to the dwelling and not defined as an accessory building. Examples of accessory structures are fencing, decks, gazebos, arbors, retaining walls, barbecue pits, detached chimneys, playground equipment, yard art, docks, piers, etc.

ADAPTER FITTING. An *approved* connecting device that suitably and properly joins or adjusts pipes and fittings that do not otherwise fit together.

ADDITION. An extension or increase in floor area, number of stories or height of a building or structure. For energy purposes, an extension or increase in the conditioned space floor area or height of a building or structure.

ADHERED STONE OR MASONRY VENEER. Stone or masonry veneer secured and supported through the adhesion of an *approved* bonding material applied to an *approved* backing.

AIR, EXHAUST. Air being removed from any space or piece of *equipment* or *appliance* and conveyed directly to the atmosphere by means of openings or ducts. Relief air is classified as *exhaust air*.

AIR, MAKEUP. Any combination of outdoor and transfer air intended to replace exhaust air and exfiltration.

AIR, OUTDOOR. Ambient air that enters a building through a ventilation system, through intentional openings for natural ventilation, or by infiltration.

AIR, TRANSFER. Air moved from one indoor space to another.

AIR ADMITTANCE VALVE. A one-way valve designed to allow air into the plumbing drainage system where a negative pressure develops in the piping. This device shall close by gravity and seal the terminal under conditions of zero differential pressure (no flow conditions) and under positive internal pressure. The purpose of an air admittance valve is to provide a method of allowing air to enter the plumbing drainage system without the use of a vent extended to open air and to prevent *sewer* gases from escaping into a building.

AIR BREAK (DRAINAGE SYSTEM). An arrangement where a discharge pipe from a fixture, *appliance* or device drains indirectly into a receptor below the flood-level rim of the receptor and above the trap seal.

AIR CIRCULATION, FORCED. A means of providing space conditioning utilizing movement of air through ducts or plenums by mechanical means.

AIR CONDITIONER, GAS-FIRED. A gas-burning, automatically operated *appliance* for supplying cooled air, dehumidified air, or both, or chilled liquid.

AIR CONDITIONING. The treatment of air so as to control simultaneously the temperature, humidity, cleanness and distribution of the air to meet the requirements of a *conditioned space*.

AIR-CONDITIONING SYSTEM. A system that consists of heat exchangers, blowers, filters, supply, exhaust and return-air systems, and shall include any apparatus installed in connection therewith.

AIR GAP, DRAINAGE SYSTEM. The unobstructed vertical distance through free atmosphere between the outlet of a waste pipe and the flood-level rim of the fixture or receptor into which it is discharging.

AIR GAP, WATER-DISTRIBUTION SYSTEM. The unobstructed vertical distance through free atmosphere between the lowest opening from a water supply discharge to the flood-level rim of a plumbing fixture.

AIR-HANDLING UNIT. A blower or fan used for the purpose of distributing supply air to a room, space or area.

AIR-IMPERMEABLE INSULATION. An insulation having an air permeance equal to or less than 0.02 L/s-m^2 at 75 Pa pressure differential tested according to ASTM E283 or E2178 at the thickness applied.

ALTERATION. Any construction, retrofit or renovation to an existing structure other than *repair* or *addition* that requires a *permit*. Also, a change in a building, electrical, gas, mechanical or plumbing system that involves an extension, *addition* or change to the arrangement, type or purpose of the original installation that requires a *permit*.

ALTERNATE ON-SITE NONPOTABLE WATER. Nonpotable water from other than public utilities, on-site surface sources and subsurface natural freshwater sources. Examples of such water are gray water, on-site reclaimed water, collected rainwater, captured condensate and rejected water from reverse osmosis systems.

ALTERNATING TREAD DEVICE. A device that has a series of steps between 50 and 70 degrees (0.87 and 1.22 rad) from horizontal, usually attached to a center support rail in an alternating manner so that the user does not have both feet on the same level at the same time.

ALTERNATIVE ENGINEERED DESIGN. A plumbing system that performs in accordance with the intent of Chapters 29 through 33 and provides an equivalent level of performance for the protection of public health, safety and welfare. The system design is not specifically regulated by Chapters 29 through 33.

ANCHORED STONE OR MASONRY VENEER. Stone or masonry veneer secured with *approved* mechanical fasteners to an *approved* backing.

ANCHORS. See "*Supports*."

ANODELESS RISER. A transition assembly in which plastic *piping* is installed and terminated above ground outside of a building.

ANTISIPHON. A term applied to valves or mechanical devices that eliminate siphonage.

APPLIANCE. A device or apparatus that is manufactured and designed to utilize energy and for which this code provides specific requirements.

APPLIANCE, AUTOMATICALLY CONTROLLED. *Appliances* equipped with an automatic *burner* ignition and safety shut-off device and other automatic devices, that accomplish complete turn-on and shut-off of the gas to the *main burner* or *burners*, and graduate the gas supply to the *burner* or *burners*, but do not affect complete shut-off of the gas.

APPLIANCE, FAN-ASSISTED COMBUSTION. An *appliance* equipped with an integral mechanical means to either draw or force products of combustion through the combustion chamber or heat exchanger.

APPLIANCE, UNVENTED. An *appliance* designed or installed in such a manner that the products of combustion are not conveyed by a vent or *chimney* directly to the outside atmosphere.

APPLIANCE, VENTED. An *appliance* designed and installed in such a manner that all of the products of combustion are conveyed directly from the *appliance* to the outside atmosphere through an *approved chimney* or vent system.

APPROVED. Acceptable to the *building official*.

APPROVED AGENCY. An established and recognized agency that is regularly engaged in conducting tests, furnishing inspection services or furnishing product certification, and has been *approved* by the building official.

APPROVED SOURCE. An independent person, firm or corporation, *approved* by the *building official*, who is competent and experienced in the application of engineering principles to materials, methods or systems analyses.

AREA DRAIN. A receptacle designed to collect surface or storm water from an open area.

ASPECT RATIO. The ratio of longest to shortest perpendicular dimensions, or for wall sections, the ratio of height to length.

ASPIRATOR. A fitting or device supplied with water or other fluid under positive pressure that passes through an integral orifice or constriction, causing a vacuum. Aspirators are also referred to as suction apparatus, and are similar in operation to an ejector.

ATMOSPHERIC PRESSURE. The pressure of the weight of air and water vapor on the surface of the earth, approximately 14.7 pounds per square inch (psia) (101 kPa absolute) at sea level.

ATTIC. The unfinished space between the ceiling assembly and the *roof assembly*.

ATTIC, HABITABLE. A finished or unfinished *habitable space* within an attic.

ATTIC STORAGE. A floored area, regardless of size, within an attic space that is served by an attic access.

Exception: A floor walkway not less than 24 inches (610 mm) wide or greater than 48 inches (1219 mm) wide that serves as an access for the service of utilities or equipment, and a level service space not less than 30 inches (762 mm) deep or greater than 48 inches (1219 mm) deep and not less than 30 inches (762 mm) wide or greater than 48 inches (1219 mm) wide at the front or service side of the appliance, shall not be considered as attic storage.

Such floored area shall be labeled at the attic access opening, "NOT FOR STORAGE." The lettering shall be a minimum of 2 inches (51 mm) in height.

AUTOMATIC. Self-acting, operating by its own mechanism when actuated by some impersonal influence, as, for example, a change in current strength, pressure, temperature or mechanical configuration (see "*Manual*").

AUTOMATIC IGNITION. Ignition of gas at the *burner(s)* when the gas controlling device is turned on, including reignition if the flames on the *burner(s)* have been extinguished by means other than by the closing of the gas controlling device.

BACKFLOW, DRAINAGE. A reversal of flow in the drainage system.

BACKFLOW, WATER DISTRIBUTION. The flow of water or other liquids into the potable water-supply piping from any sources other than its intended source. Backsiphonage is one type of backflow.

BACKFLOW CONNECTION. Any arrangement whereby backflow is possible.

BACKFLOW PREVENTER. A backflow prevention assembly, a backflow prevention device or other means or method to prevent backflow into the potable water supply.

BACKFLOW PREVENTER, REDUCED-PRESSURE-ZONE TYPE. A backflow-prevention device consisting of two independently acting check valves, internally force loaded to a normally closed position and separated by an intermediate chamber (or zone) in which there is an automatic relief means of venting to atmosphere internally loaded to a normally open position between two tightly closing shutoff valves and with means for testing for tightness of the checks and opening of relief means.

BACKPRESSURE. Pressure created by any means in the water distribution system that by being in excess of the pressure in the water supply mains causes a potential backflow condition.

BACKPRESSURE, LOW HEAD. A pressure less than or equal to 4.33 psi (29.88 kPa) or the pressure exerted by a 10-foot (3048 mm) column of water.

BACKSIPHONAGE. The flowing back of used or contaminated water from piping into a potable water-supply pipe due to a negative pressure in such pipe.

BACKWATER VALVE. A device or valve installed in the *building drain* or *sewer* pipe where a *sewer* is subject to backflow, and that prevents drainage or waste from backing up into a lower level or fixtures and causing a flooding condition.

BALANCED VENTILATION. Any combination of concurrently operating mechanical exhaust and mechanical supply whereby the total mechanical exhaust airflow rate is within 10 percent of the total mechanical supply airflow rate.

BALANCED VENTILATION SYSTEM. A ventilation system where the total supply airflow and total exhaust airflow are simultaneously within 10 percent of their averages. The balanced ventilation system airflow is the average of the supply and exhaust airflows.

BALCONY, EXTERIOR. An exterior floor projecting from and supported by a structure without additional independent supports.

BAROMETRIC DRAFT REGULATOR. A balanced *damper* device attached to a *chimney*, vent *connector*, breeching or flue gas manifold to protect combustion *appliances* by controlling *chimney draft*. A double-acting *barometric draft regulator* is one whose balancing *damper* is free to move in either direction to protect combustion *appliances* from both excessive *draft* and backdraft.

BASE FLOOD ELEVATION (BFE) The elevation of surface water resulting from a flood that has a 1 percent chance of equaling or exceeding that level in any given year.

BASEMENT. A *story* that is not a *story above grade plane* (see "*Story above grade plane*").

BASEMENT WALL. The opaque portion of a wall that encloses one side of a basement and has an average below grade wall area that is 50 percent or more of the total opaque and nonopaque area of that enclosing side. For energy purposes, a wall 50 percent or more below grade and enclosing conditioned space.

BASIC WIND SPEED. Three-second gust speed at 33 feet (10 058 mm) above the ground in Exposure C (see Section R301.2.1) as given in Tables R301.2(4) and R301.2(5).

BATHROOM. A room containing a bathtub, shower, spa or similar bathing fixture (see also "*Toilet room*").

BATHROOM GROUP. A group of fixtures, including or excluding a bidet, consisting of a water closet, lavatory, and bathtub or shower. Such fixtures are located together on the same floor level.

BATTERY OF FIXTURES. Any group of two or more similar adjacent fixtures that discharge into a common horizontal waste or soil branch.

BED AND BREAKFAST HOME. A detached single-family *dwelling* occupied by the *dwelling* owner and containing eight or fewer guest rooms for rent for a period of less than one week.

BEDROOM. *Sleeping room*.

BEND. A drainage fitting, designed to provide a change in direction of a drain pipe of less than the angle specified by the amount necessary to establish the desired slope of the line (see "*Elbow*" and "*Sweep*").

BOAT SLIP. A berthing place for one or two watercraft where the watercraft can be securely moored to cleats, piling, or other devices while the boats are in the water. Boat slips are commonly configured as "side-ties" or as single- or double-loaded "U" shaped berths.

BOILER. A self-contained *appliance* from which hot water is circulated for heating purposes and then returned to the boiler, and that operates at water pressures not exceeding 160 pounds per square inch gage (psig) (1102 kPa gauge) and at water temperatures not exceeding 250°F (121°C).

BOILER, LOW-PRESSURE. A self-contained *appliance* for supplying steam or hot water.

Hot water heating boiler. A boiler in which no steam is generated, from which hot water is circulated for heating purposes and then returned to the boiler, and that operates at water pressures not exceeding 160 pounds per square inch gauge (psig) (1100 kPa gauge) and at water temperatures not exceeding 250°F (121°C) at or near the boiler outlet.

Hot water supply boiler. A boiler, completely filled with water, which furnishes hot water to be used externally to itself, and that operates at water pressures not exceeding 160 psig (1100 kPa gauge) and at water temperatures not exceeding 250°F (121°C) at or near the boiler outlet.

Steam heating boiler. A boiler in which steam is generated and that operates at a steam pressure not exceeding 15 psig (100 kPa gauge).

BOND BEAM. A horizontal grouted element within masonry in which reinforcement is embedded.

BONDING JUMPER. A conductor installed to electrically connect metallic gas *piping* to the grounding electrode system.

BRACED WALL LINE. A straight line through the building plan that represents the location of the lateral resistance provided by the wall bracing.

BRACED WALL LINE, CONTINUOUSLY SHEATHED. A *braced wall line* with structural sheathing applied to all sheathable surfaces including the areas above and below openings.

BRACED WALL PANEL. A full-height section of wall constructed to resist in-plane shear loads through interaction of framing members, sheathing material and anchors. The panel's length meets the requirements of its particular bracing method, and contributes toward the total amount of bracing required along its *braced wall line* in accordance with Section R602.10.1.

BRANCH. Any part of the piping system other than a riser, main or stack.

BRANCH, FIXTURE. See "*Fixture branch, drainage.*"

BRANCH, HORIZONTAL. See "*Horizontal branch, drainage*."

BRANCH, MAIN. A water-distribution pipe that extends horizontally off a main or riser to convey water to branches or fixture groups.

BRANCH, VENT. A vent connecting two or more individual vents with a vent stack or stack vent.

BRANCH INTERVAL. A distance along a soil or waste stack corresponding, in general, to a story height, but not less than 8 feet (2438 mm) within which the horizontal branches from one floor or story of a structure are connected to the stack. Measurements are taken down the stack from the highest horizontal branch connection.

BRAZED JOINT. A gas-tight joint obtained by the joining of metal parts with metallic mixtures or alloys that melt at a temperature above 1,000ºF (538ºC), but lower than the melting temperature of the parts to be joined.

BRAZING. A metal-joining process wherein coalescence is produced by the use of a nonferrous filler metal having a melting point above 1,000°F (538°C), but lower than that of the base metal being joined. The filler material is distributed between the closely fitted surfaces of the joint by capillary action.

BREAKAWAY WALL. A wall that is not part of the structural support of the building and is intended through its design and construction to collapse under specific lateral loading forces, without causing damage to the elevated portion of the building or supporting foundation system. Any walls below the lowest floor in a building in a V Zone should give way under wind and water loads without causing collapse, displacement, or other damage to the elevated portion of the building or the supporting pilings or columns.

BROILER. A general term including salamanders, barbecues and other appliances cooking primarily by radiated heat, excepting toasters.

BTU. Abbreviation for British thermal unit, which is the quantity of heat required to raise the temperature of 1 pound (454 g) of water 1°F (0.56°C) (1 *Btu* = 1055 J).

BTU/H. The *listed* maximum capacity of an *appliance*, absorption unit or burner expressed in British thermal units input per hour.

BUILDING. Any one- or two-family dwelling or *townhouse*, or portion thereof, used or intended to be used for human habitation, for living, sleeping, cooking or eating purposes, or any combination thereof, or any *accessory building*.

BUILDING, EXISTING. Existing building is a building erected prior to the adoption of this code, or one for which a legal building *permit* has been issued.

BUILDING DRAIN. The lowest piping that collects the discharge from all other drainage piping inside the house and extends to 10 feet (3048 mm) beyond the exterior walls of the building and conveys the drainage to the *building sewer*.

Exception: Drain lines connecting to septic tanks within 25 feet (7620 mm) of the building foundation wall for one- and two-family dwellings with 4 water closets or less shall be considered to be building drain with a minimum size of 3 inches (76.2 mm).

BUILDING LINE. The line established by law, beyond which a building shall not extend, except as specifically provided by law.

BUILDING OFFICIAL. The officer or other designated authority charged with the administration and enforcement of this code, or a duly authorized representative.

BUILDING SEWER. That part of the drainage system that extends from the end of the *building drain* and conveys its discharge to a public sewer, private sewer, individual sewage-disposal system or other point of disposal.

Sanitary. A *building sewer* that conveys sewage only.

Storm. A *building sewer* that conveys storm water or other drainage, but not sewage.

BUILDING SITE. A continguous area of land that is under the ownership or control of one entity.

BUILDING SUBDRAIN. That portion of a drainage system that does not drain by gravity into the *building sewer*.

BUILDING THERMAL ENVELOPE. The basement walls, exterior walls, floor, roof and any other building element that enclose conditioned spaces. This boundary also includes the boundary between conditioned space and any exempt or unconditioned space.

BUILDING-INTEGRATED PHOTOVOLTAIC PRODUCT. A building product that incorporates *photovoltaic modules* and functions as a component of the building envelope.

BUILDING-INTEGRATED PHOTOVOLTAIC ROOF PANEL (BIPV Roof Panel). A *photovoltaic panel* that functions as a component of the building envelope.

BUILT-UP ROOF COVERING. Two or more layers of felt cemented together and surfaced with a cap sheet, mineral aggregate, smooth coating or similar surfacing material.

BURNER. A device for the final conveyance of the gas, or a mixture of gas and air, to the combustion zone.

Induced-draft. A *burner* that depends on *draft* induced by a fan that is an integral part of the *appliance* and is located downstream from the *burner*.

Power. A *burner* in which gas, air or both are supplied at pressures exceeding, for gas, the line pressure, and for air, atmospheric pressure, with this added pressure being applied at the *burner*.

CAP PLATE. The top plate of the double top plates used in *structural insulated panel* (SIP) construction. The cap plate is cut to match the *panel thickness* such that it overlaps the wood structural panel facing on both sides.

CARBON MONOXIDE ALARM. A single- or multiple-station alarm intended to detect carbon monoxide gas and alert occupants by a distinct audible signal. It incorporates a sensor, control components and an alarm notification appliance in a single unit.

CARBON MONOXIDE DETECTOR. A device with an integral sensor to detect carbon monoxide gas and transmit an alarm signal to a connected alarm control unit.

CEILING HEIGHT. The clear vertical distance from the finished floor to the finished ceiling.

CEMENT PLASTER. A mixture of Portland or blended cement, Portland cement or blended cement and hydrated lime, masonry cement or plastic cement and aggregate and other *approved* materials as specified in this code.

CHANGE OF OCCUPANCY. A change in the use of a building or portion of a building that involves a change in the application of the requirements of this code.

CHIMNEY. A primary vertical structure containing one or more flues, for the purpose of carrying gaseous products of combustion and air from a fuel-burning *appliance* to the outside atmosphere.

Factory-built chimney. A *listed* and *labeled* chimney composed of factory-made components, assembled in the field in accordance with manufacturer's instructions and the conditions of the listing.

Masonry chimney. A field-constructed chimney composed of solid masonry units, bricks, stones or concrete.

CHIMNEY CONNECTOR. A pipe that connects a fuel-burning *appliance* to a chimney.

CHIMNEY TYPES.

Residential-type appliance. An *approved* chimney for removing the products of combustion from fuel-burning, residential-type *appliances* producing combustion gases not in excess of 1,000°F (538°C) under normal operating conditions, and capable of producing combustion gases of 1,400°F (760°C) during intermittent forces firing for periods up to 1 hour. All temperatures shall be measured at the *appliance* flue outlet. Residential-type *appliance* chimneys include masonry and factory-built types.

CIRCUIT VENT. A vent that connects to a horizontal drainage branch and vents two traps to not more than eight traps or trapped fixtures connected into a battery.

CIRCULATING HOT WATER SYSTEM. A specifically designed water distribution system where one or more pumps are operated in the service hot water piping to circulate heated water from the water-heating equipment to fixtures and back to the water-heating equipment.

CISTERN. A small covered tank for storing water for a home or farm. Generally, this tank stores rainwater to be utilized for purposes other than in the potable water supply, and such tank is placed underground in most cases.

CLADDING. The exterior materials that cover the surface of the building envelope that is directly loaded by the wind.

CLEANOUT. An access opening in the drainage system utilized for the removal of obstructions. Types of cleanouts include a removable plug or cap, and a removable fixture or fixture trap.

CLEARANCE. The minimum distance through air measured between the heat-producing surface of the mechanical *appliance*, device or *equipment* and the surface of the *combustible material* or assembly.

CLIMATE ZONE. A geographical region based on climatic criteria as specified in this code. >

CLOSED CRAWLSPACE. A foundation without wall vents that uses air sealed walls, ground and foundation moisture control, and mechanical drying potential to control crawl space moisture. Insulation may be located at the floor level or at the exterior walls.

CLOSET. A small room or chamber used for storage.

CLOTHES DRYER. An *appliance* used to dry wet laundry by means of heated air.

Type 1. Factory-built package, multiple production. Primarily used in the family living environment. Usually the smallest unit physically and in function output.

COASTAL HIGH HAZARD AREA. An area of special flood hazard extending from offshore to the inland limit of a primary frontal dune along an open coast and any other area subject to high velocity wave action from storms or seismic sources. The coastal high hazard area is identified as either V Zone or Coastal A Zone on Flood Insurance Rate Maps (FIRMs).

CODE. These regulations, subsequent amendments thereto, or any emergency rule or regulation that the administrative authority having *jurisdiction* has lawfully adopted.

CODE OFFICIAL. The officer or other designated authority charged with the administration and enforcement of this code, or a duly authorized representative.

COLLAPSIBLE SOILS. Soils that exhibit volumetric reduction in response to partial or full wetting under load.

COLLECTION PIPE. Unpressurized pipe used within the collection system that drains on-site nonpotable water or rainwater to a storage tank by gravity.

COMBINATION FIXTURE. A fixture combining one sink and laundry tray or a two- or three-compartment sink or laundry tray in one unit.

COMBINATION WASTE AND VENT SYSTEM. A specially designed system of waste piping embodying the horizontal wet venting of one or more sinks, lavatories or floor drains by means of a common waste and vent pipe adequately sized to provide free movement of air above the flow line of the drain.

COMBUSTIBLE ASSEMBLY. Wall, floor, ceiling or other assembly constructed of one or more component materials that are not defined as noncombustible.

COMBUSTIBLE MATERIAL. Any material not defined as noncombustible.

COMBUSTION. In the context of this code, refers to the rapid oxidation of fuel accompanied by the production of heat or heat and light.

COMBUSTION AIR. Air necessary for complete combustion of a fuel, including theoretical air and excess air.

COMBUSTION CHAMBER. The portion of an *appliance* within which combustion occurs.

COMBUSTION PRODUCTS. Constituents resulting from the combustion of a fuel with the oxygen of the air, including the inert gases, but excluding excess air.

COMMON VENT. A vent connecting at the junction of two *fixture drains* or to a fixture *branch* and serving as a vent for both fixtures.

COMPRESSIBLE SOILS. Soils that exhibit volumetric reduction in response to the application of load even in the absence of wetting or drying.

CONCEALED LOCATION. A location that cannot be accessed without damaging permanent parts of the building structure or finish surface. Spaces above, below or behind readily removable panels or doors shall not be considered as concealed.

CONCEALED PIPING. *Piping* that is located in a *concealed location* (see "*Concealed location*").

CONDENSATE. The liquid that separates from a gas due to a reduction in temperature; for example, water that condenses from flue gases and water that condenses from air circulating through the cooling coil in air conditioning equipment.

CONDENSING APPLIANCE. An *appliance* that condenses water generated by the burning of fuels.

CONDITIONED AIR. Air treated to control its temperature, relative humidity or quality.

CONDITIONED CRAWL SPACE. A conditioned crawl space is a foundation without wall vents that encloses an intentionally heated or cooled space. Insulation is located at the exterior walls.

CONDITIONED FLOOR AREA. The horizontal projection of the floors associated with *conditioned space*.

CONDITIONED SPACE. A space within a building that is provided with heating or cooling equipment or systems capable of maintaining, through design or heat loss/gain, 50°F (10°C) during the heating season or 85°F (29°C) during the cooling season, or communicates directly with a conditioned space. Spaces within the building thermal envelope are considered conditioned space.

CONNECTOR, APPLIANCE (Fuel). Rigid metallic *pipe* and fittings, semirigid metallic *tubing* and fittings or a *listed* and *labeled* device that connects an *appliance* to the *gas piping system*.

CONNECTOR, CHIMNEY OR VENT. The *pipe* that connects an *appliance* to a chimney or vent.

CONSTRUCTION DOCUMENTS. Written, graphic and pictorial documents prepared or assembled for describing the design, location and physical characteristics of the elements of a project necessary for obtaining a building *permit*. Construction drawings shall be drawn to an appropriate scale.

CONTAMINATION. A hazard impairment of the quality of the potable water that creates an actual hazard to the public health through poisoning or through the spread of disease by sewage, industrial fluids or waste. <

CONTINUOUS INSULATION (ci). Insulating material that is continuous across all structural members without thermal bridges other than fasteners and service openings. It is installed on the interior or exterior or is integral to any opaque surface of the building envelope.

CONTINUOUS WASTE. A drain from two or more similar adjacent fixtures connected to a single trap.

CONTROL. A manual or automatic device designed to regulate the gas, air, water or electrical supply to, or operation of, a mechanical system.

CONTROL, LIMIT. An automatic control responsive to changes in liquid flow or level, pressure, or temperature for limiting the operation of an *appliance*.

CONTROL, PRIMARY SAFETY. A safety control responsive directly to flame properties that senses the presence or absence of flame and, in event of ignition failure or unintentional flame extinguishment, automatically causes shutdown of mechanical equipment.

CONVECTOR. A system incorporating a heating element in an enclosure in which air enters an opening below the heating element, is heated and leaves the enclosure through an opening located above the heating element.

CONVERSION BURNER. A unit consisting of a *burner* and its *controls* for installation in an *appliance* originally utilizing another fuel.

COPPER ALLOY. A homogeneous mixture of not less than two metals where not less than 50 percent of the finished metal is copper.

CORE. The lightweight middle section of a *structural insulated panel*, composed of foam plastic insulation, that provides the link between the two facing shells.

CORROSION RESISTANCE. The ability of a material to withstand deterioration of its surface or its properties where exposed to its environment.

CORROSION RESISTANCE AREA. Areas within hurricane prone regions defined as that area east of the Intracoastal Waterway from the North Carolina/South Carolina state line north to Beaufort Inlet and from that point to include the barrier islands to the North Carolina/Virginia state line.

COURT. A space, open and unobstructed to the sky, located at or above *grade* level on a *lot* and bounded on three or more sides by walls or a building.

CRAWL SPACE. An underfloor space that is not a *basement*.

CRAWL SPACE WALL. The opaque portion of a wall that encloses a crawl space and is partially or totally below grade.

CRIPPLE WALL. A framed wall extending from the top of the foundation to the underside of the floor framing of the first *story above grade plane*.

CRIPPLE WALL CLEAR HEIGHT. The vertical height of a *cripple wall* from the top of the foundation to the underside of floor framing above.

CRITICAL LEVEL (C-L). An elevation (height) reference point that determines the minimum height at which a backflow preventer or vacuum breaker is installed above the *flood level rim* of the fixture or receptor served by the device. The critical level is the elevation level below which there is a potential for backflow to occur. If the critical level marking is not indicated on the device, the bottom of the device shall constitute the critical level.

CROSS CONNECTION. Any physical connection or arrangement between two otherwise separate piping systems, one of which contains potable water and the other either water of unknown or questionable safety or steam, gas or chemical, whereby there exists the possibility for flow from one system to the other, with the direction of flow depending on the pressure differential between the two systems (see "*Backflow*").

CROSS-LAMINATED TIMBER. A prefabricated engineered wood product consisting of not less than three layers of solid-sawn lumber or *structural composite lumber* where the adjacent layers are cross-oriented and bonded with structural adhesive to form a solid wood element.

CUBIC FOOT. The amount of gas that occupies 1 cubic foot (0.02832 m^3) when at a temperature of 60°F (16°C), saturated with water vapor and under a pressure equivalent to that of 30 inches of mercury (101 kPa).

DALLE GLASS. A decorative composite glazing material made of individual pieces of glass that are embedded in a cast matrix of concrete or epoxy.

DAMPER. A manually or automatically controlled device to regulate *draft* or the rate of flow of air or combustion gases.

DAMPER, VOLUME. A device that will restrict, retard or direct the flow of air in any duct, or the products of combustion of heat-producing equipment, vent connector, vent or chimney.

DAMPPROOFING. A coating or the application of coatings applied to retard the penetration of water vapor and moisture through or into walls or into interior spaces.

DEAD END. A *branch* leading from a soil, waste or vent pipe; a *building drain*; or a *building sewer*, and terminating at a *developed length* of 2 feet (610 mm) or more by means of a plug, cap or other closed fitting.

DEAD LOADS. The weight of the materials of construction incorporated into the building, including but not limited to walls, floors, roofs, ceilings, *stairways*, built-in partitions, finishes, cladding, and other similarly incorporated architectural and structural items, and fixed service equipment.

DECK. An exterior floor system supported on at least two opposing sides by an adjoining structure or posts, piers, or other independent supports.

DECORATIVE APPLIANCE, VENTED. A *vented appliance* wherein the primary function lies in the aesthetic effect of the flames.

DECORATIVE APPLIANCES FOR INSTALLATION IN VENTED FIREPLACES. A *vented appliance* designed for installation within the fire chamber of a vented *fireplace*, wherein the primary function lies in the aesthetic effect of the flames.

DECORATIVE GLASS. A carved, leaded or Dalle glass or glazing material with a purpose that is decorative or artistic, not functional; with coloring, texture or other design qualities or components that cannot be removed without destroying the glazing material; and with a surface, or assembly into which it is incorporated, that is divided into segments.

DEMAND. The maximum amount of gas input required per unit of time, usually expressed in cubic feet per hour, or *Btu*/h (1 *Btu*/h = 0.2931 W).

DEMAND RECIRCULATION WATER SYSTEM. A water distribution system where pump(s) prime the service hot water piping with heated water upon a demand for hot water.

DESIGN FLOOD ELEVATION. The elevation of the "design flood," including wave height, relative to the datum specified on the community's legally designated flood hazard map. In areas designated as Zone AO, the *design flood elevation* shall be the elevation of the highest existing grade of the *building's* perimeter plus the depth number (in feet) specified on the flood hazard map. In areas designated as Zone AO where a depth number is not specified on the map, the depth number shall be taken as being equal to 2 feet (610 mm).

DESIGN PROFESSIONAL. See "*Registered design professional*."

DESIGN WORKING PRESSURE. The maximum allowable working pressure for which a specific part of a system is designed.

DEVELOPED LENGTH. The length of a pipeline measured along the center line of the pipe and fittings.

DIAMETER. Unless specifically stated, the term "diameter" is the nominal diameter as designated by the *approved* material standard.

DIAPHRAGM. A horizontal or nearly horizontal system acting to transmit lateral forces to the vertical resisting elements. Where the term "*diaphragm*" is used, it includes horizontal bracing systems.

DILUTION AIR. Air that enters a draft hood or draft regulator and mixes with flue gases.

DIRECT SYSTEM. A solar thermal system in which the gas or liquid in the solar collector loop is not separated from the load.

DIRECT-VENT APPLIANCE. A fuel-burning *appliance* with a sealed combustion system that draws all air for combustion from the outside atmosphere and discharges all flue gases to the outside atmosphere.

DISCHARGE PIPE. A pipe that conveys the discharge from plumbing fixtures or appliances.

DISCRETE PRODUCT. Products that are noncontinuous, individual, distinct pieces such as, but not limited to, electrical, plumbing and mechanical products and duct straps, duct fittings, duct registers and pipe hangers.

DOCK. A structure extending alongshore or out from the shore into a body of water, usually accommodating multiple boat slips, to which boats may be moored in order to load or unload people or cargo.

DRAFT. The pressure difference existing between the *appliance* or any component part and the atmosphere, that causes a continuous flow of air and products of combustion through the gas passages of the *appliance* to the atmosphere.

Induced draft. The pressure difference created by the action of a fan, blower or ejector, that is located between the *appliance* and the chimney or vent termination.

Natural draft. The pressure difference created by a vent or chimney because of its height, and the temperature difference between the flue gases and the atmosphere.

DRAFT HOOD. A device built into an *appliance*, or a part of the vent connector from an *appliance*, that is designed to provide for the ready escape of the flue gases from the *appliance* in the event of no draft, backdraft or stoppage beyond the draft hood; prevent a backdraft from entering the *appliance*; and neutralize the effect of stack action of the chimney or gas vent on the operation of the *appliance*.

DRAFT REGULATOR. A device that functions to maintain a desired draft in the *appliance* by automatically reducing the draft to the desired value.

DRAFT STOP. A material, device or construction installed to restrict the movement of air within open spaces of concealed areas of building components such as crawl spaces, floor-ceiling assemblies, roof-ceiling assemblies and *attics*.

DRAIN. Any pipe that carries soil and waterborne wastes in a building drainage system.

DRAIN-BACK SYSTEM. A solar thermal system in which the fluid in the solar collector loop is drained from the collector into a holding tank under prescribed circumstances.

DRAINAGE FITTING. The type of fitting or fittings utilized in the drainage system. Drainage fittings are similar to cast-iron fittings, except that instead of having a bell and spigot, drainage fittings are recessed and tapped to eliminate ridges on the inside of the installed pipe.

DRAINAGE SYSTEM. Piping within a *public* or *private* premise that conveys sewage, rainwater or other liquid waste to a point of disposal. A drainage system does not include the mains of a *public sewer* system or a private or public sewage treatment or disposal plant.

Building gravity. A drainage system that drains by gravity into the *building sewer*.

Sanitary. A drainage system that carries sewage and excludes storm, surface and ground water**.**

Storm. A drainage system that carries rainwater, surface water, subsurface water and similar liquid waste.

DRIP. The container placed at a low point in a system of *piping* to collect *condensate* and from which the *condensate* is removable.

DUCT. A tube or conduit utilized for conveying air. The air passages of self-contained systems are not to be construed as air ducts.

DUCT FURNACE. A warm-air *furnace* normally installed in an air distribution duct to supply warm air for heating. This definition shall apply only to a warm-air heating *appliance* that depends for air circulation on a blower not furnished as part of the *furnace*.

DUCT SYSTEM. A continuous passageway for the transmission of air that, in addition to ducts, includes duct fittings, dampers, plenums, fans and accessory air-handling *equipment* and *appliances*.

DUCTLESS MINI-SPLIT SYSTEM. A heating and cooling system that is comprised of one or multiple indoor evaporator/air-handling units and an outdoor condensing unit that is connected by refrigerant piping and electrical wiring. A ductless mini-split system is capable of cooling or heating one or more rooms without the use of a traditional ductwork system.

DURHAM FITTING. A special type of drainage fitting for use in the durham systems installations in which the joints are made with recessed and tapered threaded fittings, as opposed to bell and spigot lead/oakum or solvent/cemented or soldered joints. The tapping is at an angle (not 90 degrees) to provide for proper slope in otherwise rigid connections.

DURHAM SYSTEM. A term used to describe soil or waste systems where all piping is of threaded pipe, tube or other such rigid construction using recessed drainage fittings to correspond to the types of piping.

DWELLING. Any building that contains one or two *dwelling units* (duplex) on the same parcel of land, used, intended, or designed to be built, used, rented, leased, let or hired out to be occupied, or that are occupied for living purposes.

DWELLING UNIT. A single unit providing complete independent living facilities for a single family, including permanent provisions for living, sleeping, eating, cooking and sanitation. For the definition applicable in Chapter 11, see Section N1101.6.

DWV. Abbreviated term for drain, waste and vent piping as used in common plumbing practice.

EFFECTIVE OPENING. The minimum cross-sectional area at the point of water-supply discharge, measured or expressed in terms of diameter of a circle and if the opening is not circular, the diameter of a circle of equivalent cross-sectional area. (This is applicable to *air gap*.)

EGRESS ROOF ACCESS WINDOW. A *skylight* or roof window designed and installed to satisfy the emergency escape and rescue opening requirements in Section R310.2.

ELBOW. A pressure pipe fitting designed to provide an exact change in direction of a pipe run. An elbow provides a sharp turn in the flow path (see "Bend" and "Sweep").

ELECTRIC HEATING APPLIANCE. An *appliance* that produces heat energy to create a warm environment by the application of electric power to resistance elements, refrigerant compressors or dissimilar material junctions.

EMERGENCY ESCAPE AND RESCUE OPENING. An operable exterior window, door or other similar device that provides for a means of escape and access for rescue in the event of an emergency. (See also "*Grade floor emergency escape and rescue opening*.")

ENERGY ANALYSIS. A method for estimating the annual energy use of the *proposed design* and *standard reference design* based on estimates of energy use.

ENERGY COST. The total estimated annual cost for purchased energy for the building functions regulated by this code, including applicable demand charges.

ENERGY RECOVERY VENTILATION SYSTEM. Systems that employ air-to-air heat exchangers to recover energy from or reject energy to *exhaust air* for the purpose of preheating, pre-cooling, humidifying or dehumidifying outdoor *ventilation air* prior to supplying such air to a space, either directly or as part of an HVAC system.

ENERGY SIMULATION TOOL. An *approved* software program or calculation-based methodology that projects the annual energy use of a building.

ENERGY STORAGE SYSTEMS (ESS). One device or multiple devices, assembled together, capable of storing electrical energy to be supplied at a future time.

ENGINEERED WOOD RIM BOARD. A full-depth *structural composite lumber*, wood structural panel, structural glued laminated timber or prefabricated wood I-joist member designed to transfer horizontal (shear) and vertical (compression) loads, provide attachment for *diaphragm* sheathing, siding and exterior deck ledgers and provide lateral support at the ends of floor or roof joists or rafters.

ENVIRONMENTAL AIR. Air that is conveyed to or from occupied areas through ducts that are not part of the heating or air-conditioning system, such as ventilation for human usage, domestic kitchen range exhaust, bathroom exhaust, domestic clothes dryer exhaust and parking garage exhaust.

EQUIPMENT. Piping, ducts, vents, control devices and other components of systems other than *appliances* that are permanently installed and integrated to provide control of environmental conditions for buildings. This definition shall also include other systems specifically regulated in this code.

EQUIPMENT, EXISTING. Any *equipment* regulated by this code which was legally installed prior to the effective date of this code, or for which a permit to install has been issued.

EQUIVALENT LENGTH. For determining friction losses in a piping system, the effect of a particular fitting equal to the friction loss through a straight piping length of the same nominal diameter.

ERI REFERENCE DESIGN. A version of the rated design that meets the minimum requirements of the 2006 *International Energy Conservation Code*.

ESCARPMENT. With respect to topographic wind effects, a cliff or steep slope generally separating two levels or gently sloping areas.

ESSENTIALLY NONTOXIC TRANSFER FLUIDS. Fluids having a Gosselin rating of 1, including propylene glycol; mineral oil; polydimethylsiloxane; hydrochlorofluorocarbon, chlorofluorocarbon and hydrofluorocarbon refrigerants; and FDA-approved boiler water additives for steam boilers.

ESSENTIALLY TOXIC TRANSFER FLUIDS. Soil, water or graywater and fluids having a Gosselin rating of 2 or more including ethylene glycol, hydrocarbon oils, ammonia refrigerants and hydrazine.

EVAPORATIVE COOLER. A device used for reducing air temperature by the process of evaporating water into an airstream.

EXCESS AIR. Air that passes through the combustion chamber and the *appliance* flue in excess of what is theoretically required for complete combustion.

EXCESS FLOW VALVE (EFV). A valve designed to activate when the fuel gas passing through it exceeds a prescribed flow rate.

EXFILTRATION. Uncontrolled outward air leakage from conditioned spaces through unintentional openings in ceilings, floors and walls to unconditioned spaces or the outdoors caused by pressure differences across these openings resulting from wind, the stack effect created by temperature differences between indoors and outdoors, and imbalances between supply and exhaust airflow rates.

EXHAUST HOOD, FULL OPENING. An exhaust hood with an opening not less than the diameter of the connecting vent.

EXHAUST SYSTEM. An assembly of connected ducts, *plenums*, fittings, registers, grilles and hoods through which air is conducted from the space or spaces and exhausted to the outdoor atmosphere.

EXISTING INSTALLATIONS. Any plumbing system regulated by this code that was legally installed prior to the effective date of this code, or for which a *permit* to install has been issued.

EXPANSIVE SOILS. Soils that exhibit volumetric increase or decrease (swelling or shrinking) in response to partial or full wetting or drying under load.

EXTERIOR INSULATION AND FINISH SYSTEMS (EIFS). EIFS are nonstructural, nonload-bearing exterior wall cladding systems that consist of an insulation board attached either adhesively or mechanically, or both, to the substrate; an integrally reinforced base coat; and a textured protective finish coat.

EXTERIOR INSULATION AND FINISH SYSTEMS (EIFS) WITH DRAINAGE. An EIFS that incorporates a means of drainage applied over a *water-resistive barrier*.

EXTERIOR MASONRY CHIMNEYS. Masonry chimneys exposed to the outdoors on one or more sides below the roof line.

EXTERIOR WALL. An above-grade wall that defines the exterior boundaries of a building. Includes between-floor spandrels, peripheral edges of floors, roof and *basement* knee walls, dormer walls, gable end walls, walls enclosing a mansard roof and *basement walls* with an average below-grade wall area that is less than 50 percent of the total opaque and nonopaque area of that enclosing side.

EXTERIOR WALL COVERING. A material or assembly of materials applied on the exterior side of exterior walls for the purpose of providing a weather-resistive barrier, insulation or for aesthetics, including but not limited to, veneers, siding, exterior insulation and finish systems, architectural *trim* and embellishments such as cornices, soffits, and fascias.

FACING. The wood structural panel facings that form the two outmost rigid layers of the *structural insulated panel*.

FACTORY-BUILT CHIMNEY. A *listed* and *labeled* chimney composed of factory-made components assembled in the field in accordance with the manufacturer's instructions and the conditions of the *listing*.

FACTORY-MADE AIR DUCT. A *listed and labeled* duct manufactured in a factory and assembled in the field in accordance with the manufacturer's instructions and conditions of the *listing*.

FAMILY. Family is an individual, two or more persons related by blood, marriage or law, or a group of not more than any eight persons living together in a dwelling unit. Servants having common housekeeping facilities with a family consisting of an individual, or more persons related by blood, marriage or law, are a part of the family for this code.

FARM BUILDING. Any building not used for sleeping purposes that is not accessed by the general public and is used primarily for a farm purpose. Farm purposes includes structures or buildings for equipment, storage and processing of agricultural products or commodities such as: crops, fruits, vegetables, ornamental or flowering plants, dairy, timber, livestock, poultry and all other such forms of agricultural products by the specific farm on which the structure or building is located. Farm purposes do not include structures or buildings for uses such as education facilities, research facilities, or aircraft hangers. Limited use of farm buildings for public and private events is permitted by law in accordance with N.C.G.S. 143-138 (b4)(1a) and 160D-903(a).

FAUCET. A valve end of a water pipe through which water is drawn from or held within the pipe.

FENESTRATION. Products classified as either vertical fenestration or *skylights and sloped glazing*, installed in such a manner as to preserve the weather-resistant barrier of the wall or roof in which they are installed. Fenestration includes products with glass or other transparent or translucent materials.

FENESTRATION, VERTICAL. Windows that are fixed or movable, opaque doors, glazed doors, glazed block and combination opaque and glazed doors installed in a wall at > less than 15 degrees (0.26 rad) from vertical.

FENESTRATION PRODUCT, SITE-BUILT. A fenestration designed to be made up of field-glazed or fieldassembled units using specific factory cut or otherwise factory-formed framing and glazing units.

FIBER-CEMENT (BACKERBOARD, SIDING, SOFFIT, TRIM AND UNDERLAYMENT) PRODUCTS. Manufactured thin section composites of hydraulic cementitious matrices and discrete nonasbestos fibers.

FILL VALVE. A water supply valve, opened or closed by means of a float or similar device, utilized to supply water to a tank. An antisiphon fill valve contains an antisiphon device in the form of an *approved air gap* or vacuum breaker that is an integral part of the fill valve unit and that is positioned on the discharge side of the water supply control valve.

FIRE SEPARATION DISTANCE. The distance measured from the building face to one of the following:

1. To the closest interior *lot line*.
2. To the centerline of a street, an alley or public way.
3. To an imaginary line between two buildings on the *lot*.

The distance shall be measured at a right angle from the face of the wall.

FIREBLOCKING. Building materials or materials *approved* for use as fireblocking, installed to resist the free passage of flame to other areas of the building through concealed spaces.

FIREPLACE. An assembly consisting of a hearth and fire chamber and smoke chamber, beginning at the hearth and ending at the top of the smoke chamber, of *noncombustible material* and provided with a chimney, for use with solid fuels.

Factory-built fireplace. A listed and labeled fireplace and chimney system composed of factory-made components, and assembled in the field in accordance with manufacturer's instructions and the conditions of the listing.

Masonry fireplace. A field-constructed fireplace composed of solid masonry units, bricks, stones or concrete.

FIREPLACE STOVE. A free-standing, chimney-connected solid-fuel-burning heater designed to be operated with the fire chamber doors in either the open or closed position.

FIREPLACE THROAT. The opening between the top of the firebox and the smoke chamber.

FIRE-RETARDANT-TREATED WOOD. Wood products that, when impregnated with chemicals by a pressure process or other means during manufacture, exhibit reduced surface burning characteristics and resist propagation of fire.

Other means during manufacture. A process where the wood raw material is treated with a fire-retardant formulation while undergoing creation as a finished product.

Pressure process. A process for treating wood using an initial vacuum followed by the introduction of pressure above atmospheric.

FIXTURE. See "*Plumbing fixture*."

FIXTURE BRANCH, DRAINAGE. A drain serving two or more fixtures that discharges into another drain or to a *stack*.

FIXTURE BRANCH, WATER-SUPPLY. A water-supply pipe between the fixture supply and a main water-distribution pipe or fixture group main.

FIXTURE DRAIN. The drain from the trap of a fixture to the junction of that drain with any other drain pipe.

FIXTURE FITTING.

Supply fitting. A fitting that controls the volume or directional flow or both of water and that is either attached to or accessed from a fixture or is used with an open or atmospheric discharge.

Waste fitting. A combination of components that conveys the sanitary waste from the outlet of a fixture to the connection of the sanitary drainage system.

FIXTURE GROUP, MAIN. The main water-distribution pipe (or secondary branch) serving a plumbing fixture grouping such as a bath, kitchen or laundry area to which two or more individual fixture branch pipes are connected.

FIXTURE SUPPLY. The water-supply pipe connecting a fixture or fixture fitting to a *branch* water supply pipe or directly to a main water supply pipe branch.

FIXTURE UNIT, DRAINAGE (d.f.u.). A measure of probable discharge into the drainage system by various types of plumbing fixtures, used to size DWV piping systems. The drainage fixture-unit value for a particular fixture depends on its volume rate of drainage discharge, on the time duration of a single drainage operation and on the average time between successive operations.

FIXTURE UNIT, WATER-SUPPLY (w.s.f.u.). A measure of the probable hydraulic demand on the water supply by various types of plumbing fixtures used to size water-piping systems. The water-supply fixture-unit value for a particular fixture depends on its volume rate of supply, on the time duration of a single supply operation and on the average time between successive operations.

FLAME SAFEGUARD. A device that will automatically shut off the fuel supply to a *main burner* or group of *burners* when the means of ignition of such *burners* becomes inoperative, and when flame failure occurs on the *burner* or group of *burners*.

FLAME SPREAD. The propagation of flame over a surface.

FLAME SPREAD INDEX. A comparative measure, expressed as a dimensionless number, derived from visual measurements of the spread of flame versus time for a material tested in accordance with ASTM E84 or UL 723.

FLASHBACK ARRESTOR CHECK VALVE. A device that will prevent the backflow of one gas into the supply system of another gas and prevent the passage of flame into the gas supply system.

FLEXIBLE AIR CONNECTOR. A conduit for transferring air between an air duct or plenum and an air terminal unit, an air inlet or an air outlet. Such conduit is limited in its use, length and location.

FLIGHT. A continuous run of rectangular treads or *winders* or combination thereof from one landing to another.

FLOOD HAZARD AREA. For definition, see Section R322.

FLOOD PLAIN. Land below base flood elevation, which of record has in the past been flooded by storm water-surface runoffs, or tidal influx, and as defined by the Corps of Engineers' maps, the Federal Emergency Management Agency maps.

FLOOD-LEVEL RIM. The edge of the receptor or fixture from which water overflows.

FLOOR DRAIN. A plumbing fixture for recess in the floor having a floor-level strainer intended for the purpose of the collection and disposal of wastewater used in cleaning the floor and for the collection and disposal of accidental spillage to the floor.

FLOOR FURNACE. A completely self-contained *furnace* suspended from the floor of the space being heated, taking air for combustion from outside such space and with means for observing flames and lighting the *appliance* from such space.

Fan type. A floor furnace equipped with a fan that provides the primary means for circulating air.

Gravity type. A floor furnace depending primarily on circulation of air by gravity. This classification shall also include floor furnaces equipped with booster-type fans that do not materially restrict free circulation of air by gravity flow when such fans are not in operation.

FLOW PRESSURE. The static pressure reading in the water-supply pipe near the faucet or water outlet while the faucet or water outlet is open and flowing at capacity.

FLUE. See "*Vent*."

FLUE, APPLIANCE. The passages within an *appliance* through which combustion products pass from the combustion chamber to the flue collar.

FLUE COLLAR. The portion of a fuel-burning *appliance* designed for the attachment of a draft hood, vent connector or venting system.

FLUE CONNECTION (BREECHING). A passage for conducting the products of *combustion* from a fuel-fired *appliance* to the vent or *chimney* (see also "*Chimney connector*" and "*Vent connector*").

FLUE GASES. Products of combustion plus excess air in *appliance* flues or heat exchangers.

FLUE LINER (LINING). A system or material used to form the inside surface of a flue in a *chimney* or vent, for the purpose of protecting the surrounding structure from the effects of *combustion products* and for conveying *combustion products* without leakage to the atmosphere.

FLUSH VALVE. A device located at the bottom of a flush tank that is operated to flush water closets.

FLUSHOMETER TANK. A device integrated within an air accumulator vessel that is designed to discharge a predetermined quantity of water to fixtures for flushing purposes.

FLUSHOMETER VALVE. A valve attached to a pressurized water supply pipe and so designed that when activated it opens the line for direct flow into the fixture at a rate and quantity to operate the fixture properly, and then gradually closes to reseal fixture traps and avoid water hammer.

FOAM BACKER BOARD. Foam plastic used in siding applications where the foam plastic is a component of the siding.

FOAM PLASTIC INSULATION. A plastic that is intentionally expanded by the use of a foaming agent to produce a reduced-density plastic containing voids consisting of open or closed cells distributed throughout the plastic for thermal insulating or acoustic purposes and that has a density less than 20 pounds per cubic foot (320 kg/m^3) unless it is used as interior *trim*.

FOAM PLASTIC INTERIOR TRIM. Exposed foam plastic used as picture molds, chair rails, crown moldings, baseboards, *handrails*, ceiling beams, door *trim* and window *trim* and similar decorative or protective materials used in fixed applications.

FUEL CELL POWER SYSTEM, STATIONARY. A stationary energy generation system that converts the chemical energy of a fuel and oxidant to electric energy (DC or AC electricity) by an electrochemical process.

Field-fabricated fuel cell power system. A *stationary fuel cell power system* that is assembled at the job site and is not a preengineered or prepackaged factory-assembled fuel cell power system.

Preengineered fuel cell power system. A *stationary fuel cell power system* consisting of components and modules that are produced in a factory, and shipped to the job site for assembly.

Prepackaged fuel cell power system. A *stationary fuel cell power system* that is factory assembled as a single, complete unit and shipped as a complete unit for installation at the job site.

FUEL GAS. A natural gas, manufactured gas, *liquefied petroleum gas* or mixtures of these gases.

FUEL OIL. Kerosene or any hydrocarbon oil having a flash point not less than 100ºF (38ºC).

FUEL-OIL PIPING SYSTEM. A closed piping system that connects a combustible liquid from a source of supply to a fuel-oil-burning *appliance*.

FUEL-PIPING SYSTEM. All piping, tubing, valves and fittings used to connect fuel utilization equipment to the point of fuel delivery.

FULL-OPEN VALVE. A water control or shutoff component in the water supply system piping that, where adjusted for maximum flow, the flow path through the component's closure member is not a restriction in the component's through-flow area.

FULLWAY VALVE. A valve that in the full open position has an opening cross-sectional area that is not less than 85 percent of the cross-sectional area of the connecting pipe.

FURNACE. A vented heating *appliance* designed or arranged to discharge heated air into a *conditioned space* or through a duct or ducts.

FURNACE, CENTRAL. A self-contained *appliance* for heating air by transfer of heat of *combustion* through metal to the air, and designed to supply heated air through ducts to spaces remote from or adjacent to the *appliance* location.

FURNACE, ENCLOSED. A specific heating, or heating and ventilating, furnace incorporating an integral total enclosure and using only outside air for combustion.

FURNACE PLENUM. An air compartment or chamber to which one or more ducts are connected and that forms part of an air distribution system.

FURNACE ROOM. A room primarily utilized for the installation of fuel-burning, space-heating and water-heating *appliances* other than boilers (see also "*Boiler room"*).

FUSIBLE PLUG. A device arranged to relieve pressure by operation of a fusible member at a predetermined temperature.

GAS CONVENIENCE OUTLET. A permanently mounted, manually operated device that provides the means for connecting an *appliance* to, and disconnecting an *appliance* from, the supply *piping.* The device includes an integral, manually operated valve with a nondisplaceable valve member and is designed so that disconnection of an *appliance* only occurs when the manually operated valve is in the closed position.

GAS PIPING. An installation of pipe, valves or fittings installed on a premises or in a building and utilized to convey fuel gas.

GLASS MAT GYPSUM PANEL. A gypsum panel consisting of a noncombustible core primarily of gypsum, surfaced with glass mat partially or completely embedded in the core.

GLAZING AREA. The interior surface area of all glazed fenestration, including the area of sash, curbing or other framing elements, that enclose *conditioned space*. Includes the area of glazed fenestration assemblies in walls bounding conditioned *basements*.

GRADE. The finished ground level adjoining the building at all exterior walls.

GRADE, PIPING. See "*Slope*."

GRADE FLOOR EMERGENCY ESCAPE AND RESCUE OPENING. An emergency escape and rescue opening located such that the bottom of the clear opening is not more than 44 inches (1118 mm) above or below the finished ground level adjacent to the opening. (See also "*Emergency escape and rescue opening*.")

GRADE PLANE. A reference plane representing the average of the finished ground level adjoining the building at all exterior walls. Where the finished ground level slopes away from the exterior walls, the reference plane shall be established by the lowest points within the area between the building and the *lot line* or, where the *lot line* is more than 6 feet (1829 mm) from the building between the structure and a point 6 feet (1829 mm) from the building.

GRAYWATER. Waste discharged from lavatories, bathtubs, showers, clothes washers and laundry trays.

GRIDDED WATER DISTRIBUTION SYSTEM. A water distribution system where every water distribution pipe is interconnected so as to provide two or more paths to each fixture supply pipe.

GROSS AREA OF EXTERIOR WALLS. The normal projection of all *exterior walls*, including the area of all windows and doors installed therein.

GROUND-SOURCE HEAT PUMP LOOP SYSTEM. Piping buried in horizontal or vertical excavations or placed in a body of water for the purpose of transporting heat transfer liquid to and from a heat pump. Included in this definition are closed loop systems in which the liquid is recirculated and open loop systems in which the liquid is drawn from a well or other source.

GUARD. A building component or a system of building components located near the open sides of elevated walking surfaces that minimizes the possibility of a fall from the walking surface to the lower level.

GUESTROOM. Any room or rooms used or intended to be used by one or more guests for living or sleeping purposes.

GYPSUM BOARD. The generic name for a family of sheet products consisting of a noncombustible core primarily of gypsum with paper surfacing. Gypsum wallboard, gypsum sheathing, gypsum base for gypsum *veneer* plaster, exterior gypsum soffit board, predecorated gypsum board and water-resistant gypsum backing board complying with the standards listed in Section R702.3 and Part IX of this code are types of gypsum board.

GYPSUM PANEL PRODUCT. The general name for a family of sheet products consisting essentially of gypsum.

GYPSUM SHEATHING. Gypsum panel products specifically manufactured with enhanced water resistance for use as a substrate for exterior surface materials.

GYPSUM WALLBOARD. A gypsum board used primarily as interior surfacing for building structures.

HABITABLE SPACE. A space in a building for living, sleeping, eating or cooking. Bathrooms, toilet rooms, closets, halls, storage or utility spaces and similar areas are not considered *habitable spaces.*

HANDRAIL. A horizontal or sloping rail intended for grasping by the hand for guidance or support.

HANGERS. See "*Supports*."

HAZARDOUS LOCATION. Any location considered to be a fire hazard for flammable vapors, dust, combustible fibers or other highly combustible substances.

HAZARDOUS LOCATION, GLAZING. See Section R308.4.

HEAT PUMP. An *appliance* having heating or heating and cooling capability and that uses refrigerants to extract heat from air, liquid or other sources.

HEAT TRANSFER LIQUID. The operating or thermal storage liquid in a mechanical system, including water or other liquid base, and additives at the concentration present under operating conditions used to move heat from one location to another. Refrigerants are not included as heat transfer liquids.

HEATED SLAB. Slab-on-grade construction in which the heating elements, hydronic tubing, or hot air distribution system is in contact with, or placed within or under, the slab.

HEIGHT, BUILDING. The vertical distance from *grade plane* to the average height of the highest roof surface.

HEIGHT, STORY. The vertical distance from top to top of two successive tiers of beams or finished floor surfaces; and, for the topmost *story*, from the top of the floor finish to the top of the ceiling joists or, where there is not a ceiling, to the top of the roof rafters.

HIGH-EFFICACY LAMPS. Compact fluorescent lamps, T-8 or smaller diameter linear fluorescent lamps, or lamps with a minimum efficacy of:

1. 60 lumens per watt for lamps over 40 watts;
2. 50 lumens per watt for lamps over 15 watts to 40 watts; and
3. 40 lumens per watt for lamps 15 watts or less.

HIGH-TEMPERATURE (H.T.) CHIMNEY. A high-temperature chimney complying with the requirements of UL 103. A Type H.T. chimney is identifiable by the markings "Type H.T." on each chimney pipe section.

HILL. With respect to topographic wind effects, a land surface characterized by strong relief in any horizontal direction.

HISTORIC BUILDING. A building or structure that is one or more of the following:

1. Listed, or certified as eligible for listing, by the State Historic Preservation Officer or the Keeper of the National Register of Historic Places in the National Register of Historic Places.
2. Designated as historic under an applicable state or local law.
3. Certified as a contributing resource within a National Register-listed, or a state-designated or locally designated historic district.

HOOD, FULL OPENING. An exhaust hood with an opening not less than the diameter of the connecting vent.

HORIZONTAL BRANCH, DRAINAGE. A drainage *branch* pipe extending laterally from a soil or waste *stack* or *building drain*, with or without vertical sections or *branches*, that receives the discharge from two or more *fixture drains* or *branches* and conducts the discharge to the soil or waste *stack* or to the *building drain*.

HORIZONTAL PIPE. Any pipe or fitting that makes an angle of less than 45 degrees (0.79 rad) with the horizontal.

HOT WATER. Water at a temperature greater than 120ºF (49ºC).

HOUSE PIPING. See "*Piping system*."

HUMIDISTAT. A regulatory device, actuated by changes in humidity, used for automatic control of relative humidity.

HURRICANE-PRONE REGIONS. Areas vulnerable to hurricanes, defined as the US Atlantic Ocean and Gulf of Mexico coasts where the ultimate design wind speed, V_{ult}, is greater than 115 miles per hour (51 m/s), and Hawaii, Puerto Rico, Guam, Virgin Islands and America Samoa.

HYDROGEN-GENERATING APPLIANCE. A self-contained package or factory-matched packages of integrated systems for generating gaseous hydrogen. Hydrogen-generating *appliances* utilize electrolysis, reformation, chemical or other processes to generate hydrogen.

IGNITION PILOT. A *pilot* that operates during the lighting cycle and discontinues during *main burner* operation.

IGNITION SOURCE. A flame, spark or hot surface capable of igniting flammable vapors or fumes. Such sources include *appliance* burners, burner ignitions and electrical switching devices.

IMPACT PROTECTIVE SYSTEM. Construction that has been shown by testing to withstand the impact of test missiles and that is applied, attached, or locked over exterior glazing.

INDIRECT SYSTEM. A solar thermal system in which the gas or liquid in the solar collector loop circulates between the solar collector and a heat exchanger and such gas or liquid is not drained from the system or supplied to the load during normal operation.

INDIRECT WASTE PIPE. A waste pipe that discharges into the drainage system through an *air gap* into a trap, fixture or receptor.

INDIRECT WASTE RECEPTOR. A plumbing fixture designed to collect and dispose of liquid waste from other plumbing fixtures, plumbing equipment or appliances that are required to discharge to the drainage system through an air gap. The following types of fixtures fall within the classification of indirect liquid waste receptors: floor sinks, mop receptors, service sinks and standpipe drains with integral air gaps.

INDIVIDUAL SEWAGE DISPOSAL SYSTEM. A system for disposal of sewage by means of a septic tank or mechanical treatment, designed for use apart from a public sewer to serve a single establishment or building.

INDIVIDUAL VENT. A pipe installed to vent a single *fixture* trap that connects with the vent system above the fixture served or terminates in the open air.

INDIVIDUAL WATER SUPPLY. A water supply that serves one or more families, and that is not an *approved* public water supply.

INFILTRATION. The uncontrolled inward air leakage into a building caused by the pressure effects of wind or the effect of differences in the indoor and outdoor air density or both.

INFRARED RADIANT HEATER. A heater that directs a substantial amount of its energy output in the form of infrared radiant energy into the area to be heated. Such heaters are of either the vented or unvented type.

INSULATED SIDING. A type of continuous insulation, with manufacturer-installed insulating material as an integral part of the cladding product, having a minimum *R*-value of R-2.

INSULATED VINYL SIDING. A vinyl cladding product, with manufacturer-installed foam plastic insulating material as an integral part of the cladding product, having a thermal resistance of not less than R-2.

INSULATING CONCRETE FORM (ICF). A concrete forming system using stay-in-place forms of rigid foam plastic insulation, a hybrid of cement and foam insulation, a hybrid of cement and wood chips, or other insulating material for constructing cast-in-place concrete walls.

INSULATING SHEATHING. A rigid panel or board insulation material having a thermal resistance of not less than R-2 of the core material with properties suitable for use on walls, floors, roofs or foundations.

INTERLOCK. A device actuated by another device with which it is directly associated, to govern succeeding operations of the same or allied devices. A circuit in which a given action cannot occur until after one or more other actions have taken place.

INTERMODAL SHIPPING CONTAINER. A six-sided steel unit originally constructed as a general cargo container used for the transport of goods and materials.

JOINT.

Expansion. A loop, return bend or return offset that provides for the expansion and contraction in a piping system and is utilized in tall buildings or where there is a rapid change of temperature, as in power plants, steam rooms and similar occupancies.

Flexible. Any joint between two pipes that permits one pipe to be deflected or moved without movement or deflection of the other pipe.

Mechanical. See "*Mechanical joint.*"

Slip. A type of joint made by means of a washer or a special type of packing compound in which one pipe is slipped into the end of an adjacent pipe.

JOINT, FLANGED. A joint made by bolting together a pair of flanged ends.

JOINT, FLARED. A metal-to-metal compression joint in which a conical spread is made on the end of a tube that is compressed by a flare nut against a mating flare.

JOINT, MECHANICAL. A general form of gastight joints obtained by the joining of metal parts through a positive-holding mechanical construction, such as a press-connect joint, flanged joint, threaded joint, flared joint or compression joint.

JOINT, PLASTIC ADHESIVE. A joint made in thermoset plastic *piping* by the use of an adhesive substance that forms a continuous bond between the mating surfaces without dissolving either one of them.

JOINT, PLASTIC HEAT FUSION. A joint made in thermoplastic piping by heating the parts sufficiently to permit fusion of the materials when the parts are pressed together.

JOINT, PLASTIC SOLVENT CEMENT. A joint made in thermoplastic piping by the use of a solvent or solvent cement that forms a continuous bond between the mating surfaces.

JOINT, SOLDERED. A gas-tight joint obtained by the joining of metal parts with metallic mixtures of alloys that melt at temperatures between 400ºF (204ºC) and 1,000ºF (538ºC).

JOINT, WELDED. A gas-tight joint obtained by the joining of metal parts in molten state.

JURISDICTION. The governmental unit that has adopted this code.

KITCHEN. An area used, or designated to be used, for the preparation of food.

LABEL. An identification applied on a product by the manufacturer that contains the name of the manufacturer, the function and performance characteristics of the product or material, and the name and identification of an *approved agency* and that indicates that the representative sample of the product or material has been tested and evaluated by an *approved agency*. (See also "*Manufacturer's designation*" and "*Mark*.")

LABELED. Equipment, appliances, materials or products to which have been affixed a *label*, seal, symbol or other identifying *mark* of a nationally recognized testing laboratory, *approved* inspection agency or other organization as approved by the North Carolina Building Code Council concerned with product evaluation that maintains periodic inspection of the production of such *labeled* items and whose labeling indicates either that the *equipment*, appliances, material or product meets identified standards or has been tested and found suitable for a specified purpose.

LAUNDRY TRAY. A fixed tub with running water and drainpipe for washing clothes and other household linens, also called set tub.

LAVATORY. A hand-washing plumbing fixture located in a bathroom, or toilet room.

LEAD-FREE PIPE AND FITTINGS. Containing not more than a weighted average of 0.25-percent lead when used with respect to the wetted surfaces of pipes, pipe fittings, plumbing fittings, and fixtures.

LEAD-FREE SOLDER AND FLUX. Containing not more than 0.2-percent lead**.**

LEADER. An exterior drainage pipe for conveying storm water from roof or gutter drains to an *approved* means of disposal.

LIQUEFIED PETROLEUM GAS or LPG (LP-GAS). *Liquefied petroleum gas* composed predominately of propane, propylene, butanes or butylenes, or mixtures thereof that is gaseous under normal atmospheric conditions, but is capable of being liquefied under moderate pressure at normal temperatures.

LEAK CHECK. An operation performed on a gas *piping system* to verify that the system does not leak.

LIGHT-FRAME CONSTRUCTION. Construction whose vertical and horizontal structural elements are primarily formed by a system of repetitive wood or cold-formed steel framing members.

LISTED. Equipment, appliances, materials, products or services included in a list published by an organization acceptable to the code official and concerned with evaluation of products or services that maintains periodic inspection of production of *listed equipment* or materials or periodic evaluation of services and whose listing states either that the *equipment*, appliances, material, product or service meets identified standards or has been tested and found suitable for a specified purpose.

LIVE LOADS. Those loads produced by the use and occupancy of the building or other structure and do not include construction or environmental loads such as wind load, snow load, rain load, earthquake load, flood load or dead load.

LIVE/WORK UNIT. A *dwelling unit* in which more than 10 percent and less than 50 percent of the space includes a nonresidential use that is operated by the tenant.

LIVING SPACE. Space within a *dwelling unit* utilized for living, sleeping, eating, cooking, bathing, washing and sanitation purposes.

LOCAL EXHAUST. An exhaust system that uses one or more fans to exhaust air from a specific room or rooms within a dwelling.

LOCKING-TYPE TAMPER-RESISTANT CAP. A cap designed to be unlocked by a specially designed tool or key to prevent removal of the cap by means of hand-loosening or by commonly available tools.

LODGING HOUSE. A one-family dwelling where one or more occupants are primarily permanent in nature, and rent is paid for guestrooms.

LOG LIGHTER. A manually operated solid-fuel ignition *appliance* for installation in a vented solid-fuel-burning *fireplace*.

LOT. A measured portion or parcel of land considered as a unit having fixed boundaries.

LOT LINE. The line that bounds a plot of ground described as a lot in the title to the property.

LOW-PRESSURE HOT-WATER-HEATING BOILER. A boiler furnishing hot water at pressures not exceeding 160 psi (1103 kPa) and at temperatures not exceeding 250ºF (121ºC).

LOW-PRESSURE STEAM-HEATING BOILER. A boiler furnishing steam at pressures not exceeding 15 psi (103 kPa).

LOW-VOLTAGE LIGHTING. Lighting equipment powered through a transformer such as a cable conductor, a rail conductor and track lighting.

LOWEST FLOOR. The lowest floor of the lowest enclosed area (including basement). An unfinished or flood-resistant enclosure, usable solely for parking of vehicles, building access or storage in an area other than a basement area is not considered a building's lowest floor, provided that unenclosed areas below the lowest floor of elevated buildings be free of obstructions and that enclosed areas be enclosed by open lattice-work, insect screening or non-supporting breakaway walls in accordance with the National Flood Insurance Program located in *coastal high hazard areas*.

MACERATING TOILET SYSTEMS. A system comprised of a sump with macerating pump and with connections for a water closet and other plumbing fixtures, that is designed to accept, grind and pump wastes to an *approved* point of discharge.

MAIN. The principal pipe artery to which branches may be connected.

MAIN BURNER. A device or group of devices essentially forming an integral unit for the final conveyance of gas or a mixture of gas and air to the combustion zone, and on which combustion takes place to accomplish the function for which the *appliance* is designed.

MAIN SEWER. See "*Public sewer*."

MANIFOLD WATER DISTRIBUTION SYS-TEMS. A fabricated piping arrangement in which a large supply main is fitted with multiple branches in close proximity in which water is distributed separately to fixtures from each branch.

MANUAL. Capable of being operated by personal intervention (see "*Automatic*").

MANUFACTURED HOME. A structure, transportable in one or more sections, that in the traveling mode is 8 body feet (2438 body mm) or more in width or 40 body feet (12 192 body mm) or more in length, or, where erected on site, is 320 square feet (30 m^2) or more, and that is built on a permanent chassis and designed to be used as a *dwelling* with or without a permanent foundation where connected to the required utilities, and includes the plumbing, heating, air-conditioning and electrical systems contained therein; except that such term shall include any structure that meets all the requirements of this paragraph except the size requirements and with

respect to which the manufacturer voluntarily files a certification required by the secretary (HUD) and complies with the standards established under this title. For mobile homes built prior to June 15, 1976, a *label* certifying compliance to the Standard for Mobile Homes, NFPA 501, in effect at the time of manufacture is required. For the purpose of these provisions, a mobile home shall be considered to be a *manufactured home*.

MANUFACTURER'S DESIGNATION. An identification applied on a product by the manufacturer indicating that a product or material complies with a specified standard or set of rules. (See also "*Mark*" and "*Label*.")

MANUFACTURER'S INSTALLATION INSTRUCTIONS. Printed instructions included with equipment as part of the conditions of their *listing* and *labeling*.

MARK. An identification applied on a product by the manufacturer indicating the name of the manufacturer and the function of a product or material. (See also "*Manufacturer's designation*" and "*Label*.")

MASONRY, SOLID. Masonry consisting of *solid masonry* units laid contiguously with the joints between the units filled with mortar.

MASONRY CHIMNEY. A field-constructed chimney composed of *solid masonry* units, bricks, stones or concrete.

MASONRY HEATER. A masonry heater is a solid fuel burning heating *appliance* constructed predominantly of concrete or *solid masonry* having a mass of not less than 1,100 pounds (500 kg), excluding the chimney and foundation. It is designed to absorb and store a substantial portion of heat from a fire built in the firebox by routing exhaust gases through internal heat exchange channels in which the flow path downstream of the firebox includes not less than one 180-degree (3.14-rad) change in flow direction before entering the chimney and that deliver heat by radiation through the masonry surface of the heater.

MASONRY UNIT. Brick, tile, stone, architectural cast stone, glass block or concrete block conforming to the requirements specified in Section 2103 of the *International Building Code*.

Clay. A building unit larger in size than a brick, composed of burned clay, shale, fire clay or mixtures thereof.

Concrete. A building unit or block larger in size than 12 inches by 4 inches by 4 inches (305 mm by 102 mm by 102 mm) made of cement and suitable aggregates.

Glass. Nonload-bearing masonry composed of glass units bonded by mortar.

Hollow. A *masonry unit* with a net cross-sectional area in any plane parallel to the loadbearing surface that is less than 75 percent of its gross cross-sectional area measured in the same plane.

Solid. A *masonry unit* with a net cross-sectional area in every plane parallel to the loadbearing surface that is 75 percent or more of its cross-sectional area measured in the same plane.

MEAN ROOF HEIGHT. The average of the roof eave height and the height to the highest point on the roof surface, except that eave height shall be used for roof angle of less than or equal to 10 degrees (0.18 rad).

MECHANICAL DRAFT SYSTEM. A venting system designed to remove flue or vent gases by mechanical means, that consists of an induced draft portion under nonpositive static pressure or a forced draft portion under positive static pressure.

Forced draft venting system. A portion of a venting system using a fan or other mechanical means to cause the removal of flue or vent gases under positive static pressure.

Induced draft venting system. A portion of a venting system using a fan or other mechanical means to cause the removal of flue or vent gases under nonpositive static vent pressure.

Power venting system. A portion of a venting system using a fan or other mechanical means to cause the removal of flue or vent gases under positive static vent pressure.

MECHANICAL EXHAUST SYSTEM. A system for removing air from a room or space by mechanical means.

MECHANICAL JOINT.

1. A connection between pipes, fittings or pipes and fittings that is not welded, brazed, caulked, soldered, solvent cemented or heat fused.
2. A general form of gastight or liquid-tight connections obtained by the joining of parts through a positive holding mechanical construction such as, but not limited to, flanged, screwed, clamped or flared connections.

MECHANICAL SYSTEM. A system specifically addressed and regulated in this code and composed of components, devices, *appliances* and *equipment*.

METAL ROOF PANEL. An interlocking metal sheet having an installed weather exposure of not less than 3 square feet (0.28 m^2) per sheet.

METAL ROOF SHINGLE. An interlocking metal sheet having an installed weather exposure less than 3 square feet (0.28 m^2) per sheet.

METER. The instrument installed to measure the volume of gas delivered through it or a measuring device used to collect data and indicate water usage.

MEZZANINE. An intermediate level or levels between the floor and ceiling of any *story*.

MODIFIED BITUMEN ROOF COVERING. One or more layers of polymer modified asphalt sheets. The sheet materials shall be fully adhered or mechanically attached to the substrate or held in place with an *approved* ballast layer.

MODULATING. Modulating or throttling is the action of a *control* from its maximum to minimum position in either predetermined steps or increments of movement as caused by its actuating medium.

MSL. Mean Sea Level as defined by National Geodetic Vertical Datum.

MULTIPLE-STATION SMOKE ALARM. Two or more single-station alarm devices that are capable of interconnection such that actuation of one causes all integral or separate audible alarms to operate.

NAILABLE SUBSTRATE. A product or material such as framing, sheathing or furring, composed of wood or wood-based materials, or other materials and fasteners providing equivalent fastener withdrawal resistance.

NATURAL DRAFT SYSTEM. A venting system designed to remove flue or vent gases under nonpositive static vent pressure entirely by natural draft.

NATURAL VENTILATION. The movement of air into and out of a space through intentionally provided openings, such as windows and doors, or through nonpowered ventilators.

NATURALLY DURABLE WOOD. The heartwood of the following species with the exception that an occasional piece with corner sapwood is permitted if 90 percent or more of the width of each side on which it occurs is heartwood.

Decay resistant. Redwood, cedar, black locust and black walnut.

Termite resistant. Alaska yellow cedar, redwood, Eastern red cedar and Western red cedar including all sapwood of Western red cedar.

NONCOMBUSTIBLE MATERIAL. A material that passes ASTM E136.

NOSING. The leading edge of treads of stairs and of landings at the top of *stairway* flights.

OCCUPIABLE SPACE. An enclosed space intended for human activities, excluding those spaces intended primarily for other purposes, such as storage rooms and *equipment* rooms, that are only intended to be occupied occasionally and for short periods of time.

OCCUPIED SPACE. The total area of all buildings or structures on any *lot* or parcel of ground projected on a horizontal plane, excluding permitted projections as allowed by this code.

OCEAN HAZARD AREA. An area, as identified by the North Carolina Coastal Resources Commission, near the shoreline of the Atlantic Ocean that has been identified as subject to at least one of the following hazards: (A) Historical or predicted future trends of long-term erosion, (B) erosion expected to occur during a coastal storm reaching the base flood elevation, or (C) shoreline fluctuations due to tidal inlets.

OFFSET. A combination of fittings that makes two changes in direction, bringing one section of the pipe out of line and into a line parallel with the other section.

OFFSET (VENT). A combination of *approved* bends that make two changes in direction bringing one section of the vent out of line, but into a line parallel with the other section.

ON-SITE NONPOTABLE WATER REUSE SYSTEMS. Water systems for the collection, treatment, storage, distribution, and reuse of nonpotable water generated on site, including but not limited to graywater systems. This definition does not include rainwater harvesting systems.

OUTDOOR AIR. Air taken from the outdoors, and therefore not previously circulated through the system.

OUTDOOR OPENING. A door, window, louver or skylight openable to the outdoor atmosphere.

OUTLET. The point at which a gas-fired *appliance* connects to the gas *piping system*.

OWNER. Any person, agent, firm or corporation having a legal or equitable interest in the property.

OXYGEN DEPLETION SAFETY SHUTOFF SYSTEM (ODS). A system designed to act to shut off the gas supply to the main and *pilot burners* if the oxygen in the surrounding atmosphere is reduced below a predetermined level.

PAN FLASHING. Corrosion-resistant flashing at the base of an opening that is integrated into the building exterior wall to direct water to the exterior and is premanufactured, fabricated, formed or applied at the job site.

PANEL HEATING. A method of radiant space heating in which heat is supplied by large heated areas of room surfaces. The heating element usually consists of warm water piping, warm air ducts, or electrical resistance elements embedded in or located behind ceiling, wall or floor surfaces.

PANEL THICKNESS. Thickness of core plus two layers of structural wood panel facings.

PELLET FUEL-BURNING APPLIANCE. A closed combustion, vented *appliance* equipped with a fuel feed mechanism for burning processed pellets of solid fuel of a specified size and composition.

PELLET VENT. A vent *listed* and *labeled* for use with a *listed* pellet fuel-burning *appliance*.

PERFORMANCE CATEGORY. A designation of wood structural panels as related to the panel performance used in Chapters 4, 5, 6 and 8.

PERMIT. An official document or certificate issued by the *building official* that authorizes performance of a specified activity.

PERSON. An individual, heirs, executors, administrators or assigns, and a firm, partnership or corporation, its or their successors or assigns, or the agent of any of the aforesaid.

PHOTOVOLTAIC MODULE. A complete, environmentally protected unit consisting of solar cells, optics and other components, exclusive of a tracker, designed to generate DC power where exposed to sunlight.

PHOTOVOLTAIC PANEL. A collection of *photovoltaic modules* mechanically fastened together, wired, and designed to provide a field-installable unit.

PHOTOVOLTAIC PANEL SYSTEM. A system that incorporates discrete photovoltaic panels that convert solar radiation into electricity, including rack support systems.

PHOTOVOLTAIC SHINGLES. A *roof covering* that resembles shingles and that incorporates *photovoltaic modules*.

PIER. An elevated deck structure, usually pile supported, extending out into the water from the shore.

PILOT. A small flame that is utilized to ignite the gas at the *main burner* or *burners*.

PIPE SIZES. For the purposes of determining the minimum size of pipe required, cross-sectional areas are the essential characteristic, not the pipe diameter. When the Code instructs to "increase by one pipe size," some pipe sizes may not be commercially available. The following pipe sizes are presumed to be commercially available: $^1/_2$, $^3/_4$, 1, $1^1/_4$, $1^1/_2$, 2, $2^1/_2$, 3, $3^1/_2$, 4, $4^1/_2$, 5, 6, 7, 8, 9, 10.

PIPING. Where used in this code, "*piping*" refers to either *pipe* or *tubing*, or both.

Pipe. A rigid conduit of iron, steel, copper, copper-alloy or plastic.

Tubing. Semirigid conduit of copper, copper-alloy, aluminum, plastic or steel.

PIPING SYSTEM. The fuel *piping*, valves and fittings from the outlet of the *point of delivery* to the outlets of the *appliance* shutoff valves.

PITCH. See "*Slope*."

PLANS. Construction documents.

PLASTIC, THERMOPLASTIC. A plastic that is capable of being repeatedly softened by increase of temperature and hardened by decrease of temperature.

PLASTIC COMPOSITE. A generic designation that refers to wood-plastic composites and plastic lumber.

PLATFORM CONSTRUCTION. A method of construction by which floor framing bears on load bearing walls that are not continuous through the *story* levels or floor framing.

PLENUM. An enclosed portion of the building structure, other than an *occupiable space* being conditioned, that is designed to allow air movement, and thereby serve as part of an air distribution system.

PLUMBING. The practice, materials and fixtures utilized in the installation, maintenance, extension and alteration of all piping, fixtures, plumbing appliances and plumbing appurtenances, within or adjacent to any structure, in connection with sanitary drainage or storm drainage facilities; venting systems; and public or private water supply systems. For the purpose of this code, plumbing refers to those installations, repairs, maintenance and *alterations* regulated by Chapters 25 through 33.

PLUMBING APPLIANCE. An energized household *appliance* with plumbing connections, such as a dishwasher, food waste disposer, clothes washer or water heater. These devices have their operation or control dependent on one or more energized components, such as motors, controls or heating elements. Such devices are manually adjusted or controlled by the owner or operator, or are operated automatically through one or more of the following actions: a time cycle, a temperature range, a pressure range, a measured volume or weight.

PLUMBING APPURTENANCE. A manufactured device, prefabricated assembly or on-the-job assembly of component parts that is an adjunct to the basic piping system and plumbing fixtures. An appurtenance demands no additional water supply and does not add any discharge load to a fixture or to the drainage system. Examples include filters, relief valves and aerators.

PLUMBING FIXTURE. A receptacle or device that is either permanently or temporarily connected to the water distribution system of the premises and demands a supply of water therefrom; or discharges wastewater, liquid-borne waste materials or sewage either directly or indirectly to a drainage system of the premises; or requires both a water supply connection and a discharge to the drainage system of the premises.

PLUMBING SYSTEMS. Includes the water distribution pipes; plumbing fixtures and traps; water-treating or water-using equipment; soil, waste and vent pipes; and building drains; in addition to their respective connections, devices and appurtenances within a structure or premises; and the water service, building sewer and building storm sewer serving such structure or premises.

POINT OF DELIVERY. For natural gas systems, the *point of delivery* is the outlet of the service meter assembly or the outlet of the service regulator or service shutoff valve where a meter is not provided. Where a system shutoff valve is provided after the outlet of the service meter assembly, such valve shall be considered to be downstream of the *point of delivery*. For undiluted liquefied petroleum gas systems, the *point of delivery* shall be considered to be the outlet of the first regulator that reduces pressure.

POLLUTION. An impairment of the quality of the potable water to a degree that does not create a hazard to the public health and that does adversely and unreasonably affect the aesthetic qualities of such potable water for domestic use.

POLYPROPYLENE SIDING. A shaped material, made principally from polypropylene homopolymer, or copolymer, that in some cases contains fillers or reinforcements, that is used to clad exterior walls or buildings.

PORTABLE-FUEL-CELL APPLIANCE. A fuel cell generator of electricity that is not fixed in place. A portable-fuel-cell *appliance* utilizes a cord and plug connection to a grid-isolated load and has an integral fuel supply.

POSITIVE ROOF DRAINAGE. The drainage condition in which consideration has been made for the loading deflections of the *roof deck*, and additional slope has been provided to ensure drainage of the roof within 48 hours of precipitation.

POTABLE WATER. Water free from impurities present in amounts sufficient to cause disease or harmful physiological effects and conforming in bacteriological and chemical qual-

ity of the Public Health Service Drinking Water Standards or to the regulations of the public health authority having *jurisdiction*.

PRECAST CONCRETE. A structural concrete element cast elsewhere than its final position in the structure.

PRECAST CONCRETE FOUNDATION WALLS. Preengineered, *precast concrete* wall panels that are designed to withstand specified stresses and used to build below-*grade* foundations.

PRESS-CONNECT JOINT. A permanent mechanical joint incorporating an elastomeric seal or an elastomeric seal and corrosion-resistant grip or bite ring. The joint is made with a pressing tool and jaw or ring approved by the fitting manufacturer.

PRESSURE DROP. The loss in pressure due to friction or obstruction in pipes, valves, fittings, *regulators* and *burners*.

PRESSURE-RELIEF DEVICE. A pressure-actuated valve or rupture member designed to relieve excessive pressure automatically.

PRESSURE TEST. An operation performed to verify the gastight integrity of *gas piping* following its installation or modification.

PRESSURE-RELIEF VALVE. A pressure-actuated valve held closed by a spring or other means and designed to automatically relieve pressure at the pressure at which it is set.

PRIMARY STRUCTURAL FRAME. The primary structural frame shall include all of the following structural members:

1. The columns.
2. Structural members having direct connections to the columns, including girders, beams, trusses and spandrels.
3. Members of the floor construction and roof construction having direct connections to the columns.
4. Members that are essential to the vertical stability of the *primary structural frame* under gravity loading.

PRIVATE POND. A body of water owned entirely by a single property owner and located on the same parcel of land as a detached single-family dwelling.

PROPOSED DESIGN. A description of the proposed building used to estimate annual energy use for determining compliance based on total building performance.

PROTECTIVE ASSEMBLY (REDUCED CLEARANCE). Any noncombustible assembly that is *labeled* or constructed in accordance with Table M1306.2 and is placed between combustible materials or assemblies and mechanical *appliances*, devices or *equipment*, for the purpose of reducing required airspace *clearances*. Protective assemblies attached directly to a combustible assembly shall not be considered as part of that combustible assembly.

PUBLIC SEWER. A common sewer directly controlled by public authority.

PUBLIC WATER MAIN. A water-supply pipe for public use controlled by public authority.

PUBLIC WAY. Any street, alley or other parcel of land open to the outside air leading to a public street, that has been deeded, dedicated or otherwise permanently appropriated to the public for public use and that has a clear width and height of not less than 10 feet (3048 mm).

PURGE. To clear of air, gas or other foreign substances.

PUSH-FIT JOINTS. A type of mechanical joint consisting of elastomeric seals and corrosion-resistant tube grippers. Such joints are permanent or removable depending on the design.

QUICK-CLOSING VALVE. A valve or faucet that closes automatically where released manually or controlled by mechanical means for fast-action closing.

RADIANT HEATER. A heater designed to transfer heat primarily by direct radiation.

RAINWATER. Water from natural precipitation.

RAMP. A walking surface that has a running slope steeper than 1 unit vertical in 20 units horizontal (5-percent slope).

RATED DESIGN. A description of the proposed building, used to determine the energy rating index.

READY ACCESS (TO). That which enables a device, *appliance* or equipment to be directly reached, without requiring the removal or movement of any panel, door or similar obstruction.

RECEPTOR. A fixture or device that receives the discharge from indirect waste pipes.

RECLAIMED WATER. Nonpotable water that has been derived from the treatment of wastewater by a facility or system licensed or permitted to produce water meeting the *jurisdiction's* water requirements for its intended uses. Also known as "recycled water."

REDUCED PRESSURE PRINCIPLE BACKFLOW PREVENTION ASSEMBLY. A backflow prevention device consisting of two independently acting check valves, internally force-loaded to a normally closed position and separated by an intermediate chamber (or zone) in which there is an automatic relief means of venting to the atmosphere, internally loaded to a normally open position between two tightly closing shutoff valves and with a means for testing for tightness of the checks and opening of the relief means.

REFRIGERANT. A substance used to produce refrigeration by its expansion or evaporation.

REFRIGERANT COMPRESSOR. A specific machine, with or without accessories, for compressing a given refrigerant vapor.

REFRIGERATING SYSTEM. A combination of interconnected parts forming a closed circuit in which refrigerant is circulated for the purpose of extracting, then rejecting, heat.

A direct refrigerating system is one in which the evaporator or condenser of the refrigerating system is in direct contact with the air or other substances to be cooled or heated. An indirect refrigerating system is one in which a secondary coolant cooled or heated by the refrigerating system is circulated to the air or other substance to be cooled or heated.

REGISTERED DESIGN PROFESSIONAL. An individual who is registered or licensed to practice their respective design profession as defined by the statutory requirements of the professional registration laws of the state or *jurisdiction* in which the project is to be constructed. Design by a registered design professional is not required where exempt under North Carolina general statutes or licensure laws.

REGULATOR, LINE GAS PRESSURE. A device placed in a gas line between the *service pressure regulator* and the *appliance* for controlling, maintaining or reducing the pressure in that portion of the *piping system* downstream of the device.

REGULATOR, MEDIUM-PRESSURE (MP Regulator). A line *pressure regulator* that reduces gas pressure from the range of greater than 0.5 psig (3.4 kPa) and less than or equal to 5 psig (34.5 kPa) to a lower pressure.

REGULATOR, MONITORING. A pressure regulator set in series with another pressure regulator for the purpose of preventing an overpressure in the downstream piping system.

REGULATOR, PRESSURE. A device placed in a gas line for reducing, controlling and maintaining the pressure in that portion of the *piping system* downstream of the device.

REGULATOR, SERVICE PRESSURE. For natural gas systems, a device installed by the serving gas supplier to reduce and limit the service line pressure to delivery pressure. For undiluted liquefied petroleum gas systems, the regulator located upstream from all line gas pressure regulators, where installed, and downstream from any first stage or a high pressure regulator in the system.

RELIEF OPENING. The opening provided in a *draft hood* to permit the ready escape to the atmosphere of the flue products from the *draft hood* in the event of no *draft*, backdraft or stoppage beyond the *draft hood*, and to permit air into the *draft hood* in the event of a strong chimney updraft.

RELIEF VALVE (DEVICE). A safety valve designed to forestall the development of a dangerous condition by relieving either pressure, temperature or vacuum in the hot water supply system.

RELIEF VALVE, PRESSURE. An *automatic valve* that opens and closes a relief vent, depending on whether the pressure is above or below a predetermined value.

RELIEF VALVE, TEMPERATURE.

Manual reset type. A valve that automatically opens a *relief* vent at a predetermined temperature and that must be manually returned to the closed position.

Reseating or self-closing type. An *automatic valve* that opens and closes a relief vent, depending on whether the temperature is above or below a predetermined value.

RELIEF VALVE, VACUUM. A device to prevent excessive buildup of vacuum in a pressure vessel.

RELIEF VENT. A vent whose primary function is to provide circulation of air between drainage and vent systems.

REPAIR. The reconstruction, replacement or renewal of any part of an existing building for the purpose of its maintenance or to correct damage.

REROOFING. The process of recovering or replacing an existing *roof covering*. See "*Roof recover*."

RETURN AIR. Air removed from an *approved conditioned space* or location and recirculated or exhausted.

RETURN AIR SYSTEM. An assembly of connected ducts, *plenums*, fittings, registers and grilles through which air from the space or spaces to be heated or cooled is conducted back to the supply unit (see also "*Supply air system*").

RIDGE. With respect to topographic wind effects, an elongated crest of a *hill* characterized by strong relief in two directions.

RIM. An unobstructed open edge of a fixture.

RISER (PLUMBING). A water pipe that extends vertically one full *story* or more to convey water to branches or to a group of fixtures.

RISER (STAIR). The vertical component of a step or *stair*.

RISER, GAS. A vertical *pipe* supplying fuel gas.

ROOF ASSEMBLY. A system designed to provide weather protection and resistance to design loads. The system consists of a *roof covering* and *roof deck* or a single component serving as both the *roof covering* and the *roof deck*. A *roof assembly* can include an underlayment, thermal barrier, ignition barrier, insulation or a vapor retarder.

ROOF COATING. A fluid-applied, adhered coating used for roof maintenance or *roof repair*, or as a component of a *roof covering* system or *roof assembly*.

ROOF COVERING. The covering applied to the *roof deck* for weather resistance, fire classification or appearance.

ROOF COVERING SYSTEM. See "*Roof assembly*."

ROOF DECK. The flat or sloped surface not including its supporting members or vertical supports.

ROOF RECOVER. The process of installing an additional *roof covering* over an existing roof covering without removing the existing roof covering.

ROOF REPAIR. Reconstruction or renewal of any part of an existing roof for the purposes of its maintenance.

ROOF REPLACEMENT. The process of removing the existing *roof covering*, repairing any damaged substrate and installing a new *roof covering*.

ROOM HEATER. A free-standing heating *appliance* installed in the space being heated and not connected to ducts.

ROOM HEATER, UNVENTED. See "*Unvented room heater*."

ROOM HEATER, VENTED. A free-standing heating unit used for direct heating of the space in and adjacent to that in which the unit is located. (See "*Vented room heater*.")

ROUGH-IN. The installation of the parts of the plumbing system that must be completed prior to the installation of fixtures. This includes DWV, water supply and built-in fixture supports.

RUNNING BOND. The placement of *masonry units* such that head joints in successive courses are horizontally offset not less than one-quarter the unit length.

SAFETY SHUTOFF DEVICE. See "*Flame safeguard*."

SANITARY SEWER. A sewer that carries sewage and excludes storm, surface and groundwater.

SCREEN ENCLOSURE. A building or part thereof, in whole or in part self-supporting, and having walls of insect screening with or without removable vinyl or acrylic wind break panels 10 mil or less with a Class A Flame Spread, and a roof.

SCUPPER. An opening in a wall or parapet that allows water to drain from a roof.

SEISMIC DESIGN CATEGORY (SDC). A classification assigned to a structure based on its occupancy category and the severity of the design earthquake ground motion at the site.

SELF-CONTAINED EQUIPMENT. Complete, factory-assembled and tested, heating, air-conditioning or refrigeration *equipment* installed as a single unit, and having all working parts, complete with motive power, in an enclosed unit of said machinery.

SEPTIC TANK. A watertight receptor that receives the discharge of a building sanitary drainage system and is constructed so as to separate solids from the liquid, digest organic matter through a period of detention, and allow the liquids to discharge into the soil outside of the tank through a system of open joint or perforated piping or a seepage pit.

SERVICE METER ASSEMBLY. The meter, valve, regulator, piping, fittings and equipment installed by the service gas supplier before the *point of delivery*.

SERVICE WATER HEATING. Supply of hot water for purposes other than comfort heating.

SEWAGE. Any liquid waste containing animal matter, vegetable matter or other impurity in suspension or solution. Any liquid waste containing animal or vegetable matter in suspension or solution, including liquids containing chemicals in solution.

SEWAGE EJECTOR. A device for lifting sewage by entraining the sewage in a high-velocity jet of steam, air or water.

SEWAGE PUMP. A permanently installed mechanical device for removing sewage or liquid waste from a sump.

SEWER.

Building sewer. See "*Building sewer*."

Public sewer. That part of the drainage system of pipes, installed and maintained by a city, township, county, public utility company or other public entity, and located on public property, in the street or in an approved dedicated easement of public or community use.

Sanitary sewer. A *sewer* that carries sewage and excludes storm, surface and ground water.

Storm sewer. A *sewer* that conveys rainwater, surface water, subsurface water and similar liquid wastes**.**

SHAFT. An enclosed space extending through one or more stories of a building, connecting vertical openings in successive floors, or floors and the roof.

SHAFT ENCLOSURE. The walls or construction forming the boundaries of a shaft.

SHALL. The term, where used in the code, is construed as mandatory.

SHEAR WALL. A general term for walls that are designed and constructed to resist racking from seismic and wind by use of masonry, concrete, cold-formed steel or wood framing in accordance with Chapter 6 of this code and the associated limitations in Section R301.2 of this code.

SHINGLE FASHION. A method of installing roof or wall coverings, *water-resistive barriers*, flashing or other building components such that upper layers of material are placed overlapping lower layers of material to provide drainage and protect against water intrusion at unsealed penetrations and joints or in combination with sealed joints.

SIDE VENT. A vent connecting to the drain pipe through a fitting at an angle less than 45 degrees (0.79 rad) to the horizontal.

SINGLE-PLY MEMBRANE. A roofing membrane that is field applied using one layer of membrane material (either homogeneous or composite) rather than multiple layers.

SINGLE-STATION SMOKE ALARM. An assembly incorporating the detector, control equipment and alarm sounding device in one unit that is operated from a power supply either in the unit or obtained at the point of installation.

SKYLIGHT. Glass or other transparent or translucent glazing material installed at a slope of less than 60 degrees (1.05 rad) from horizontal. Glazing material in skylights, including unit skylights, solariums, sunrooms, roofs and sloped walls is included in this definition.

SKYLIGHT, UNIT. A factory assembled, glazed fenestration unit, containing one panel of glazing material, that allows for natural daylighting through an opening in the *roof assembly* while preserving the weather-resistant barrier of the roof.

SKYLIGHTS AND SLOPED GLAZING. Glass or other transparent or translucent glazing material installed at a slope of 15 degrees (0.26 rad) or more from vertical. *Unit skylights*, *tubular daylighting devices* and glazing materials in solariums, *sunrooms*, roofs and sloped walls are included in this definition.

SLEEPING ROOM. A room designated as sleeping or bedroom on the plans and permit application.

SLEEPING UNIT. A single unit that provides rooms or spaces for one or more persons, includes permanent provisions for sleeping and can include provisions for living, eating and either sanitation or kitchen facilities but not both. Such rooms and spaces that are also part of a *dwelling unit* are not sleeping units.

SLIP JOINT. A mechanical-type joint used primarily on fixture traps. The joint tightness is obtained by compressing a friction-type washer such as rubber, nylon, neoprene, lead or special packing material against the pipe by the tightening of a (slip) nut.

SLOPE. The fall (pitch) of a line of pipe in reference to a horizontal plane. In drainage, the slope is expressed as the fall in units vertical per units horizontal (percent) for a length of pipe.

SMOKE-DEVELOPED INDEX. A comparative measure, expressed as a dimensionless number, derived from measurements of smoke obscuration versus time for a material tested in accordance with ASTM E84 or UL 723.

SOIL STACK OR PIPE. A pipe that conveys sewage containing fecal material to the *building drain* or *building sewer*.

SOLAR ENERGY SYSTEM. A system that converts solar radiation to usable energy, including *photovoltaic panel systems* and *solar thermal systems*.

SOLAR HEAT GAIN COEFFICIENT (SHGC). The ratio of the solar heat gain entering the space through the fenestration assembly to the incident solar radiation. Solar heat gain includes directly transmitted solar heat and absorbed solar radiation that is then reradiated, conducted or convected into the space. This value is related to the shading coefficient (SC) by the formula SHGC = 0.87 × SC.

SOLAR THERMAL COLLECTOR. Components in a *solar thermal system* that collect and convert solar radiation to thermal energy.

SOLAR THERMAL SYSTEM. A system that converts solar radiation to thermal energy for use in heating or cooling.

SOLID MASONRY. Load-bearing or nonload-bearing construction using *masonry units* where the net cross-sectional area of each unit in any plane parallel to the bearing surface is not less than 75 percent of its gross cross-sectional area. *Solid masonry* units shall conform to ASTM C55, C62, C73, C145 or C216.

SPECIFIC GRAVITY. As applied to gas, *specific gravity* is the ratio of the weight of a given volume to that of the same volume of air, both measured under the same condition.

SPLINE. A strip of wood structural panel cut from the same material used for the panel facings, used to connect two structural insulated panels. The strip (spline) fits into a groove cut into the vertical edges of the two structural insulated panels to be joined. Splines are used behind each facing of the structural insulated panels being connected as shown in Figure R610.8.

STACK. A general term for any vertical line of soil, waste, vent or inside conductor piping that extends through at least one story with or without offsets as directly as possible to its vent terminal.

STACK BOND. The placement of *masonry units* in a bond pattern is such that head joints in successive courses are vertically aligned. For the purpose of this code, requirements for stack bond shall apply to all masonry laid in other than *running bond*.

STACK VENT. The extension of soil or waste stack above the highest horizontal drain connected.

STACK VENTING. A method of venting a fixture or fixtures through the soil or waste *stack*.

STAIR. A change in elevation, consisting of one or more *risers*.

STAIRWAY. One or more flights of stairs, either interior or exterior, with the necessary landings and connecting platforms to form a continuous and uninterrupted passage from one level to another.

STAIRWAY, SPIRAL. A stairway with a plan view of closed circular form and uniform section-shaped treads radiating from a minimum-diameter circle.

STANDARD REFERENCE DESIGN. A version of the proposed design that meets the minimum requirements of this code and is used to determine the maximum annual energy use requirement for compliance based on total building performance.

STANDARD TRUSS. Any construction that does not permit the roof-ceiling insulation to achieve the required *R*-value over the exterior walls.

STATIONARY FUEL CELL POWER PLANT. A self-contained package or factory-matched packages that constitute an automatically operated assembly of integrated systems for generating useful electrical energy and recoverable thermal energy that is permanently connected and fixed in place.

STEAM-HEATING BOILER. A boiler operated at pressures not exceeding 15 psi (103 kPa) for steam.

STORM SEWER, DRAIN. A pipe used for conveying rainwater, surface water, subsurface water and similar liquid waste.

STORM SHELTER. A building, structure or portion thereof, constructed in accordance with ICC 500 and designated for use during a severe wind storm event, such as a hurricane or tornado.

STORY. That portion of a building included between the upper surface of a floor and the upper surface of the floor or roof next above. A flood-resistant enclosure, designed to break away so as not to cause collapse, shall not be considered as a story when determining height.

STORY ABOVE GRADE PLANE. Any *story* having its finished floor surface entirely above *grade plane*, except that a *basement* shall be considered as a *story above grade plane* where the finished surface of the floor above the *basement* meets any one of the following:

1. More than 6 feet (1829 mm) above *grade plane.*
2. More than 12 feet (3658 mm) above the finished ground level at any point.
3. More than 6 feet (1829 mm) above the finished ground level for more than 50 percent of the total building perimeter.

STRUCTURAL COMPOSITE LUMBER. Structural members manufactured using wood elements bonded together with exterior adhesives.

Examples of structural composite lumber are:

Laminated strand lumber (LSL). A composite of wood strand elements with wood fibers primarily oriented along the length of the member, where the least dimension of the wood strand elements is 0.10 inch (2.54 mm) or less and their average lengths are not less than 150 times the least dimension of the wood strand elements.

Laminated veneer lumber (LVL). A composite of wood veneer elements with wood fibers primarily oriented along the length of the member, where the veneer element thicknesses are 0.25 inch (6.4 mm) or less.

Oriented strand lumber (OSL). A composite of wood strand elements with wood fibers primarily oriented along the length of the member, where the least dimension of the wood strand elements is 0.10 inch (2.54 mm) or less and their average lengths are not less than 75 times and less than 150 times the least dimension of the wood strand elements.

Parallel strand lumber (PSL). A composite of wood strand elements with wood fibers primarily oriented along the length of the member, where the least dimension of the wood strand elements is 0.25 inch (6.4 mm) or less and their average lengths are not less than 300 times the least dimension of the wood strand elements.

STRUCTURAL INSULATED PANEL (SIP). A structural sandwich panel that consists of a lightweight foam plastic core securely laminated between two thin, rigid wood structural panel facings.

STRUCTURE. That which is built or constructed.

SUBSOIL DRAIN. A drain that collects subsurface water or seepage water and conveys such water to a place of disposal.

SUMP. A tank or pit that receives sewage or waste, located below the normal *grade* of the gravity system and that must be emptied by mechanical means.

SUMP PUMP. An automatic water pump powered by an electric motor for the removal of drainage, except raw sewage, from a sump, pit or low point. The pump is selected for the specific head and volume of the load and is usually operated by level controllers.

SUMP PUMP, SINGLE POINT-OF-USE. An automatic water pump powered by an electric motor for the removal of drainage, except raw sewage, from a single fixture trap. The pump is selected for the specific head and volume of the load and is usually operated by level controllers.

SUMP VENT. A vent from pneumatic sewage ejectors, or similar equipment, that terminates separately to the open air.

SUNROOM. A one-*story* structure attached to a *dwelling* with a *glazing area* in excess of 40 percent of the gross area of the structure's *exterior walls* and roof.

SUPPLY AIR. That air delivered to each or any space supplied by the air distribution system or the total air delivered to all spaces supplied by the air distribution system, which is provided for ventilating, heating, cooling, humidification, dehumidification and other similar purposes.

SUPPLY AIR SYSTEM. An assembly of connected ducts, *plenums*, fittings, registers and grilles through which air, heated or cooled, is conducted from the supply unit to the space or spaces to be heated or cooled (see also "*Return air system*").

SUPPORTS. Devices for supporting, hanging and securing pipes, fixtures and equipment.

SWEEP. A drainage fitting designed to provide a change in direction of a drain pipe of less than the angle specified by the amount necessary to establish the desired slope of the line. Sweeps provide a longer turning radius than bends and a less turbulent flow pattern (see "*Bend*" and "*Elbow*"). Sweeps can be plastic or metal.

SYSTEM SHUTOFF. A valve installed after the *point of delivery* to shut off the entire piping system.

TEMPERATURE- AND PRESSURE-RELIEF (T AND P) VALVE. A combination relief valve designed to function as both a temperature-relief and pressure-relief valve.

TEMPERATURE-RELIEF VALVE. A temperature-actuated valve designed to discharge automatically at the temperature at which it is set.

TEMPERED WATER. Water having a temperature range between 85°F (29°C) and 110°F (43°C).

TERMITE-RESISTANT MATERIAL. Pressure-preservative-treated wood in accordance with the AWPA standards in Section R317.1, naturally durable termite-resistant wood, steel, concrete, masonry or other *approved* material.

THERMAL ISOLATION. Physical and space conditioning separation from *conditioned space(s)* consisting of existing or new walls, doors or windows. The *conditioned space(s)* shall be controlled as separate zones for heating and cooling or conditioned by separate *equipment.*

THERMAL RESISTANCE, *R*-VALUE. See "*R-value*."

THERMAL TRANSMITTANCE, *U*-FACTOR. See "*U-factor*."

THERMOSTAT. (See types that follow.)

Electric switch type. A device that senses changes in temperature and controls electrically, by means of sepa-

rate components, the flow of gas to the *burner(s)* to maintain selected temperatures.

Integral gas valve type. An automatic device, actuated by temperature changes, designed to control the gas supply to the *burner(s)* in order to maintain temperatures between predetermined limits, and in which the thermal actuating element is an integral part of the device.

1. Graduating thermostat. A thermostat in which the motion of the valve is approximately in direct proportion to the effective motion of the thermal element induced by temperature change.
2. Snap-acting thermostat. A thermostat in which the thermostatic valve travels instantly from the closed to the open position, and vice versa.

THIRD-PARTY CERTIFICATION AGENCY. An *approved* agency operating a product or material certification system that incorporates initial product testing, assessment and surveillance of a manufacturer's quality control system.

THIRD-PARTY CERTIFIED. Certification obtained by the manufacturer indicating that the function and performance characteristics of a product or material have been determined by testing and ongoing surveillance by an *approved* third-party certification agency. Assertion of certification is in the form of identification in accordance with the requirements of the third-party certification agency.

TOILET, GAS-FIRED. A packaged and completely assembled *appliance* containing a toilet that incinerates refuse instead of flushing it away with water.

TOWNHOUSE. A single-family dwelling unit constructed in a group of two or more attached units separated by property lines, or three or more attached units separated by assumed property lines based on the location of the double wall or common wall in which each unit extends from foundation to roof and with a yard or public way on not less than two sides.

TOWNHOUSE UNIT. A single-family *dwelling unit* in a *townhouse* that extends from foundation to roof and that has a *yard* or *public way* on not less than two sides.

TRANSITION FITTINGS, PLASTIC TO STEEL. An adapter for joining plastic *pipe* to steel *pipe*. The purpose of this fitting is to provide a permanent, pressure-tight connection between two materials that cannot be joined directly one to another.

TRAP. A fitting, either separate or built into a fixture, that provides a liquid seal to prevent the emission of sewer gases without materially affecting the flow of sewage or wastewater through it.

TRAP ARM. That portion of a *fixture drain* between a trap weir and the vent fitting.

TRAP PRIMER. A device or system of piping to maintain a water seal in a trap, typically installed where infrequent use of the trap would result in evaporation of the trap seal, such as floor drains.

TRAP SEAL. The trap seal is the maximum vertical depth of liquid that a trap will retain, measured between the crown weir and the top of the dip of the trap.

TRIM. Picture molds, chair rails, baseboards, *handrails*, door and window frames, and similar decorative or protective materials used in fixed applications.

TRUSS DESIGN DRAWING. The graphic depiction of an individual truss, that describes the design and physical characteristics of the truss.

TUBULAR DAYLIGHTING DEVICE (TDD). A nonoperable fenestration unit primarily designed to transmit daylight from a roof surface to an interior ceiling via a tubular conduit. The basic unit consists of an exterior glazed weathering surface, a light-transmitting tube with a reflective interior surface, and an interior-sealing device such as a translucent ceiling panel. The unit may be factory assembled, or field assembled from a manufactured kit.

TYPE L VENT. A *listed* and *labeled* vent conforming to UL 641 for venting oil-burning *appliances listed* for use with Type L vents or with gas *appliances listed* for use with Type B vents.

***U*-FACTOR (THERMAL TRANSMITTANCE).** The coefficient of heat transmission (air to air) through a building component or assembly, equal to the time rate of heat flow per unit area and unit temperature difference between the warm side and cold side air films ($Btu/h \cdot ft^2 \times °F$)[$W/(m^2 K)$].

UNDERLAYMENT. One or more layers of felt, sheathing paper, nonbituminous saturated felt, or other *approved* material over which a roof covering, with a slope of 2 units vertical in 12 units horizontal (17-percent slope) or greater, is applied.

UNIT HEATER.

Fuel Gas. A self-contained, automatically controlled, vented, fuel-gas-burning, space-heating *appliance*, intended for installation in the space to be heated without the use of ducts, and having integral means for circulation of air.

Other. A self-contained *appliance* of the fan type, designed for the delivery of warm air directly into the space in which the *appliance* is located.

UNVENTED ROOM HEATER. An unvented heating *appliance* designed for stationary installation and utilized to provide comfort heating. Such *appliances* provide radiant heat or convection heat by gravity or fan circulation directly from the heater and do not utilize ducts.

VACUUM. Any pressure less than that exerted by the atmosphere.

VACUUM BREAKER. A device that prevents backsiphonage of water by admitting atmospheric pressure through ports to the discharge side of the device.

VALVE. A device used in *piping* to control the gas supply to any section of a system of *piping* or to an *appliance*.

Appliance shutoff. A *valve* located in the *piping system*, used to isolate individual *appliances* for purposes such as service or replacement.

Automatic. An automatic or semiautomatic device consisting essentially of a *valve* and an operator that control the gas supply to the *burner(s)* during operation of an *appliance*. The operator shall be actuated by applica-

tion of gas pressure on a flexible diaphragm, by electrical means, by mechanical means or by other *approved* means.

Automatic gas shutoff. A *valve* used in conjunction with an automatic gas shutoff device to shut off the gas supply to a water-heating system. It shall be constructed integrally with the gas shutoff device or shall be a separate assembly.

Individual main burner. A *valve* that controls the gas supply to an individual *main burner*.

Main burner control. A *valve* that controls the gas supply to the *main burner* manifold.

Manual main gas-control. A manually operated *valve* in the gas line for the purpose of completely turning on or shutting off the gas supply to the *appliance*, except to *pilot* or pilots that are provided with independent shutoff.

Manual reset. An automatic shutoff valve installed in the gas supply *piping* and set to shut off when unsafe conditions occur. The device remains closed until manually reopened.

Service shutoff. A valve, installed by the serving gas supplier between the source of supply and the *point of delivery*, to shut off the entire *piping system*.

VAPOR DIFFUSION PORT. An assembly constructed or installed within a *roof assembly* at an opening in the *roof deck* to convey water vapor from an unvented attic to the outside atmosphere.

VAPOR PERMEABLE. The property of having a moisture vapor permeance rating of 5 perms (2.9×10^{-10} kg/Pa × s × m^2) or greater, where tested in accordance with Procedure A or Procedure B of ASTM E96. A vapor permeable material permits the passage of moisture vapor.

VAPOR RETARDER CLASS. A measure of the ability of a material or assembly to limit the amount of moisture that passes through that material or assembly. Vapor retarder class shall be defined using the desiccant method with Procedure A of ASTM E96 as follows:

Class I: ≤ 0.1 perm rating

Class II: > 0.1 to ≤ 1.0 perm rating

Class III: > 1.0 to ≤ 10 perm rating

VENT. A *pipe* or other conduit composed of factory-made components, containing a passageway for conveying *combustion products* and air to the atmosphere, *listed* and *labeled* for use with a specific type or class of *appliance*.

Special gas vent. A vent *listed* and *labeled* for use with *listed* Category II, III and IV gas *appliances*.

Type B vent. A vent *listed* and *labeled* for use with *appliances* with *draft hoods* and other Category I *appliances* that are *listed* for use with Type B vents.

Type BW vent. A vent *listed* and *labeled* for use with wall *furnaces*.

Type L vent. A vent *listed* and *labeled* for use with *appliances* that are *listed* for use with Type L or Type B vents.

VENT COLLAR. See "*Flue collar*."

VENT CONNECTOR. That portion of a venting system that connects the flue collar or draft hood of an *appliance* to a vent.

VENT DAMPER DEVICE, AUTOMATIC. A device intended for installation in the venting system, in the outlet of an individual, automatically operated fuel-burning *appliance* and that is designed to open the venting system automatically where the *appliance* is in operation and to close off the venting system automatically where the *appliance* is in a standby or shutdown condition.

VENT GASES. Products of combustion from fuel-burning *appliances*, plus excess air and dilution air, in the venting system above the draft hood or draft regulator.

VENT PIPE. See "*Vent system*."

VENT PIPING.

Breather. *Piping* run from a pressure-regulating device to the outdoors, designed to provide a reference to *atmospheric pressure*. If the device incorporates an integral pressure *relief* mechanism, a breather vent can also serve as a *relief* vent.

Relief. *Piping* run from a pressure-regulating or pressure-limiting device to the outdoors, designed to provide for the safe venting of gas in the event of excessive pressure in the *gas piping system*.

VENT STACK. A vertical vent pipe installed to provide circulation of air to and from the drainage system and that extends through one or more stories.

VENT SYSTEM. A pipe or pipes installed to provide a flow of air to or from a plumbing drainage system, or to provide a circulation of air within such system to protect trap seals from siphonage and backpressure.

VENTED APPLIANCE CATEGORIES. *Appliances* that are categorized for the purpose of vent selection are classified into the following four categories:

Category I. An *appliance* that operates with a nonpositive vent static pressure and with a vent gas temperature that avoids excessive *condensate* production in the vent.

Category II. An *appliance* that operates with a nonpositive *vent* static pressure and with a vent gas temperature that is capable of causing excessive *condensate* production in the vent.

Category III. An *appliance* that operates with a positive vent static pressure and with a vent gas temperature that avoids excessive *condensate* production in the vent.

Category IV. An *appliance* that operates with a positive vent static pressure and with a vent gas temperature that is capable of causing excessive *condensate* production in the vent.

VENTED ROOM HEATER. A vented self-contained, free-standing, nonrecessed *appliance* for furnishing warm air to the space in which it is installed, directly from the heater without duct connections.

VENTED WALL FURNACE. A self-contained vented *appliance* complete with grilles or equivalent, designed for incorporation in or permanent attachment to the structure of a

building, mobile home or travel trailer, and furnishing heated air circulated by gravity or by a fan directly into the space to be heated through openings in the casing. This definition shall exclude *floor furnaces*, *unit heaters* and *central furnaces* as herein defined.

VENTILATION. The natural or mechanical process of supplying conditioned or unconditioned air to, or removing > such air from, any space.

VENTILATION AIR. That portion of supply air that comes from the outside (outdoors), plus any recirculated air that has been treated to maintain the desired quality of air within a designated space.

VENTING. Removal of combustion products to the outdoors.

VENTING SYSTEM. A continuous open passageway from the *flue collar* or *draft hood* of an *appliance* to the outdoor atmosphere for the purpose of removing flue or vent gases. A venting system is usually composed of a vent or a chimney and *vent connector*, if used, assembled to form the open passageway.

Forced draft venting system. A portion of a venting system using a fan or other mechanical means to cause the removal of flue or vent gases under positive static vent pressure.

Induced draft venting system. A portion of a venting system using a fan or other mechanical means to cause the removal of flue or vent gases under nonpositive static vent pressure.

Mechanical draft venting system. A venting system designed to remove flue or vent gases by mechanical means, that consists of an induced draft portion under nonpositive static pressure or a forced draft portion under positive static pressure.

Natural draft venting system. A venting system designed to remove flue or vent gases under nonpositive static vent pressure entirely by natural draft.

VERTICAL PIPE. Any pipe or fitting that makes an angle of 45 degrees (0.79 rad) or more with the horizontal.

VINYL SIDING. A shaped material, made principally from rigid polyvinyl chloride (PVC), that is used to cover exterior walls of buildings.

VISIBLE TRANSMITTANCE (VT). The ratio of visible light entering the space through the fenestration product assembly to the incident visible light. Visible transmittance includes the effects of glazing material and frame and is expressed as a number between 0 and 1.

WALL, ABOVE-GRADE. A wall more than 50 percent above-grade and enclosing *conditioned space*. This includes between-floor spandrels, peripheral edges of floors, roof and basement knee walls, dormer walls, gable end walls, walls enclosing a mansard roof and skylight shafts.

WALL, CRAWLSPACE. The opaque portion of a wall that encloses a crawl space and is partially or totally below grade.

WALL, RETAINING. A wall not laterally supported at the top, that resists lateral soil load and other imposed loads.

WALL HEATER, UNVENTED TYPE. A room heater of the type designed for insertion in or attachment to a wall or partition. Such heater does not incorporate concealed venting arrangements in its construction and discharges all products of *combustion* through the front into the room being heated.

WALL VENTED CRAWL SPACE. A foundation that uses foundation wall vents as a primary means to control space moisture. Insulation is located at the floor level.

WALLS. Walls shall be defined as follows:

Load-bearing wall. A wall supporting any vertical load in addition to its own weight.

Nonbearing wall. A wall which does not support vertical loads other than its own weight.

WASTE. Liquidborne waste that does not contain fecal matter.

WASTE PIPE OR STACK. Piping that conveys only liquid sewage not containing fecal material.

WASTE RECEPTOR. A floor sink, standpipe, hub drain or a floor drain that receives the discharge of one or more indirect waste pipes.

WATER DISTRIBUTION SYSTEM. Piping that conveys water from the service to the plumbing fixtures, *appliances*, appurtenances, equipment, devices or other systems served, including fittings and control valves.

WATER HEATER. Any heating *appliance* or equipment that heats potable water and supplies such water to the potable hot water distribution system.

WATER MAIN. A water supply pipe or system of pipes, installed and maintained by a city, township, county, public utility company or other public entity, on public property, in the street or in an approved dedicated easement of public or community use.

WATER OUTLET. A discharge opening through which water is supplied to a fixture, into the atmosphere, such as a hose bibb, (except into an open tank that is part of the water supply system), to a boiler or heating system, or to any devices or equipment requiring water to operate but which are not part of the plumbing system.

WATER PIPE.

Riser. A water supply pipe that extends one full story or more to convey water to *branches* or to a group of fixtures.

Water distribution pipe. A pipe within the structure or on the premises that conveys water from the water service pipe, or from the meter when the meter is at the structure, to the points of utilization.

Water service pipe. The pipe from the water main or other source of potable water supply, or from the meter when the meter is at the public right of way, to the water

distribution system of the building served. Water service pipe shall terminate 5 feet (1524 mm) outside the foundation wall.

WATER SUPPLY SYSTEM. The water service pipe, the water-distributing pipes and the necessary connecting pipes, fittings, control valves and appurtenances in or adjacent to the building or premises.

WATER-HAMMER ARRESTOR. A device utilized to absorb the pressure surge (water hammer) that occurs when water flow is suddenly stopped in a water supply system.

WATER-RESISTIVE BARRIER. A material behind an exterior wall covering that is intended to resist liquid water that has penetrated behind the exterior covering from further intruding into the exterior wall assembly.

WEIGHTED AVERAGE LEAD CONTENT. The weighted average lead content of a pipe, pipe fitting, plumbing fitting, or fixture shall be calculated by using the following formula: For each wetted component, the percentage of lead in the component shall be multiplied by the ratio of the wetted surface area of that component to the total wetted surface area of the entire product to arrive at the weighted percentage of lead of the component. The weighted percentage of lead of each wetted component shall be added together, and the sum of these wetted percentages shall constitute the weighted average lead content of the product. For lead content of materials that are provided as a range, the maximum content of the range shall be used.

WET VENT. A vent that receives the discharge of wastes from other fixtures.

WHIRLPOOL BATHTUB. A plumbing appliance consisting of a bathtub fixture that is equipped and fitted with a circulating piping system designed to accept, circulate and discharge bathtub water upon each use.

WHOLE-HOUSE MECHANICAL VENTILATION SYSTEM. An exhaust system, supply system, or combination thereof that is designed to mechanically exchange indoor air for outdoor air where operating continuously or through a programmed intermittent schedule to satisfy the whole-house ventilation rate.

WINDBORNE DEBRIS REGION. Areas within *hurricane-prone regions* defined as that area east of the Intracoastal Waterway from the North Carolina/South Carolina state line north to Beaufort Inlet and from that point to include the barrier islands to the North Carolina/Virginia state line.

WINDER. A tread with nonparallel edges.

WOOD STRUCTURAL PANEL. A panel manufactured from veneers; or wood strands or wafers; bonded together with waterproof synthetic resins or other suitable bonding systems. Examples of wood structural panels are plywood, orientated strand board (OSB) or composite panels.

YARD. An open space, other than a court, unobstructed from the ground to the sky, except where specifically provided by this code, on the *lot* on which a building is situated.

YARD HYDRANT. A freeze proof yard hydrant is an outdoor water supply outlet that has a valve and outlet above ground and a drain opening below the frost level.

ZONE. A space or group of spaces within a building with heating or cooling requirements that are sufficiently similar so that desired conditions can be maintained throughout using a single controlling device.

Part III—Building Planning and Construction

CHAPTER 3
BUILDING PLANNING

SECTION R301
DESIGN CRITERIA

R301.1 Application. Buildings and structures, and parts thereof, shall be constructed to safely support all loads, including dead loads, *live loads*, roof loads, flood loads, snow loads, wind loads and seismic loads as prescribed by this code. The construction of buildings and structures in accordance with the provisions of this code shall result in a system that provides a complete load path that meets the requirements for the transfer of loads from their point of origin through the load-resisting elements to the foundation. Buildings and structures constructed as prescribed by this code are deemed to comply with the requirements of this section.

R301.1.1 Alternative provisions. As an alternative to the requirements in Section R301.1, the following standards are permitted subject to the limitations of this code and the limitations therein. Where engineered design is used in conjunction with these standards, the design shall comply with the *International Building Code*.

1. AWC *Wood Frame Construction Manual* (WFCM).
2. AISI *Standard for Cold-Formed Steel Framing—Prescriptive Method for One- and Two-Family Dwellings* (AISI S230).
3. ICC *Standard on the Design and Construction of Log Structures* (ICC 400).
4. Sunrooms complying with AAMA/NPEA/NSA 2100.

R301.1.2 Construction systems. The requirements of this code are based on platform and balloon-frame construction for light-frame buildings. The requirements for concrete and masonry buildings are based on a balloon framing system. Other framing systems must have equivalent detailing to ensure force transfer, continuity and compatible deformations.

R301.1.3 Engineered design. Where a building of otherwise conventional construction contains structural elements exceeding the limits of Section R301 or otherwise not conforming to this code, these elements shall be designed in accordance with accepted engineering practice. The extent of such design need only demonstrate compliance of nonconventional elements with other applicable provisions and shall be compatible with the performance of the conventional framed system. Engineered design in accordance with the *International Building Code* is permitted for buildings and structures, and parts thereof, included in the scope of this code.

R301.1.4 Intermodal shipping containers. Intermodal shipping containers that are repurposed for use as buildings or structures shall be designed in accordance with the structural provisions in Section 3115 of the *International Building Code*.

R301.2 Climatic and geographic design criteria. Buildings shall be constructed in accordance with the provisions of this code as limited by the provisions of this section. Additional criteria shall be established by the local *jurisdiction* and set forth in Table R301.2.

R301.2.1 Wind design criteria. Buildings and portions thereof shall be constructed in accordance with the wind provisions of this code using the ultimate design wind speed in Tables R301.2 as determined from Tables R301.2(4) and R301.2(5). Where different construction methods and structural materials are used for various portions of a building, the applicable requirements of this section for each portion shall apply. Where not otherwise specified, the wind loads listed in Tables R301.2.1(1) and R301.2(6) adjusted for height and exposure using Table R301.2.1(2) shall be used to determine design load performance requirements for wall coverings, curtain walls, roof coverings, exterior windows, skylights, garage doors and exterior doors. Asphalt shingles shall be designed for wind speeds in accordance with Section

TABLE R301.2
CLIMATIC AND GEOGRAPHIC DESIGN CRITERIA

ROOF LOAD (psf)	WIND SPEED (mph)	SEISMIC DESIGN CATEGORY	SUBJECT TO DAMAGE FROM			WINTER DESIGN TEMP	ICE BARRIER UNDER-LAYMENT REQUIRED	FLOOD HAZARDS[b]	AIR FREEZING INDEX	MEAN ANNUAL TEMP
			Weathering[a]	Frost line depth[d]	Termite[c]					
20	Tables R301.2(4) & (5)	Table R301.2(7)	Moderate	Minimum 12 inches	Moderate-Heavy	Local	Local	Local	Local	Local

For SI: 1 pound per square foot = 0.0479 kPa, 1 mile per hour = 0.447 m/s.

a. Weathering may require a higher strength concrete or grade of masonry than necessary to satisfy the structural requirements of this code. The grade of masonry units shall be determined from ASTM C34, C55, C62, C73, C90, C129, C145, C216 or C652.

b. The jurisdiction shall fill in this part of the table with (a) the date of the jurisdiction's entry into the National Flood Insurance Program (date of adoption of the first code or ordinance for management of flood hazard areas), (b) the date(s) of the currently effective FIRM and FBFM or other flood hazard map adopted by the community, as may amended.

c. Protection is required in all of North Carolina in accordance with Section R318

d. Check with local jurisdiction for frost line depth.

R905.2.4. Metal roof shingles shall be designed for wind speeds in accordance with Section R905.4.4. A continuous load path shall be provided to transmit the applicable uplift forces in Section R802.11 from the *roof assembly* to the foundation. Where ultimate design wind speeds in Figure R301.2(2) are less than the lowest wind speed indicated in the prescriptive provisions of this code, the lowest wind speed indicated in the prescriptive provisions of this code shall be used.

Exception: Openings for exterior balconies, decks, or porches under roofs enclosed with screen or removable vinyl or acrylic wind break panels shall be exempt from the loads listed in Table R301.2(2) and the height and exposure factors listed in Table R301.2(3). Vinyl and acrylic glazed panels shall be removable. Removable panels shall be identified as removable by a decal. The identification decal shall state "Removable panel SHALL be removed when wind speeds exceed 75 mph (34 m/s)." Decals shall be placed such that the decal is visible when the panel is installed.

R301.2.1.1 Wind limitations and wind design required. Construction in regions where the ultimate wind speeds from Tables R301.2(4) and R301.2(5) equal or exceed 130 miles per hour (58 m/s) shall be designed in accordance with one of the following:

1. AWC *Wood Frame Construction Manual* (WFCM).
2. ICC *Standard for Residential Construction in High-Wind Regions* (ICC 600).
3. ASCE *Minimum Design Loads and Associated Criteria for Buildings and Other Structures* (ASCE 7).
4. Deleted.
5. *International Building Code*.
6. Concrete construction shall be designed in accordance with the provisions of this code.
7. Structural insulated panel (SIP) walls shall be designed in accordance with the provisions of this code.
8. Chapters 45 and 46.

The elements of design not addressed by the methods in Items 1 through 5 shall be in accordance with the provisions of this code.

Where ASCE 7 or the *International Building Code* is used for the design of the building, the wind speed map and exposure category requirements as specified in ASCE 7 and the *International Building Code* shall be used.

R301.2.1.1.1 Sunrooms. Deleted.

R301.2.1.2 Protection of openings. Exterior glazing in buildings located in *windborne debris regions* shall be protected from windborne debris. Glazed opening protection for windborne debris shall meet the requirements of the Large Missile Test of ASTM E1886 and ASTM E1996 as modified in Section 301.2.1.2.1. Garage door glazed opening protection for windborne debris shall meet the requirements of an *approved* impact-resisting standard or ANSI/DASMA 115.

Exception:

1. *Wood structural panels* with a thickness of not less than $^{7}/_{16}$ inch (11 mm) and a span of not more than 8 feet (2438 mm) shall be permitted for opening protection. Panels shall be precut and attached to the framing surrounding the opening containing the product with the glazed opening. Panels shall be predrilled as required for the anchorage method and shall be secured with the attachment hardware provided. Attachments shall be designed to resist the component and cladding loads determined in accordance with either Table R301.2.1(1) or ASCE 7, with the permanent corrosion-resistant attachment hardware provided and anchors permanently installed on the building. Attachment in accordance with Table R301.2.1.2 is permitted for buildings with a mean roof height of 45 feet (13 728 mm) or less where the ultimate design wind speed, V_{ult}, is 180 mph (290 kph) or less.
2. Openings for exterior balconies, decks, or porches under roofs enclosed with screen or removable vinyl or acrylic wind break panels shall not be required to be protected, provided the spaces are separated from the building interior by a wall and all openings in the wall separating the unit from the balcony, deck or porch are protected in accordance with this section. Vinyl and acrylic glazed panels shall be removable. Removable panels shall be identified as removable by a decal. The identification decal shall state "Removable panel SHALL be removed when wind speeds exceed 75 mph (34 m/s)." Decals shall be placed such that the decal is visible when the panel is installed.

R301.2.1.2.1 Application of ASTM E1996. The text of Section 2.2 of ASTM E1996 shall be substituted as follows:

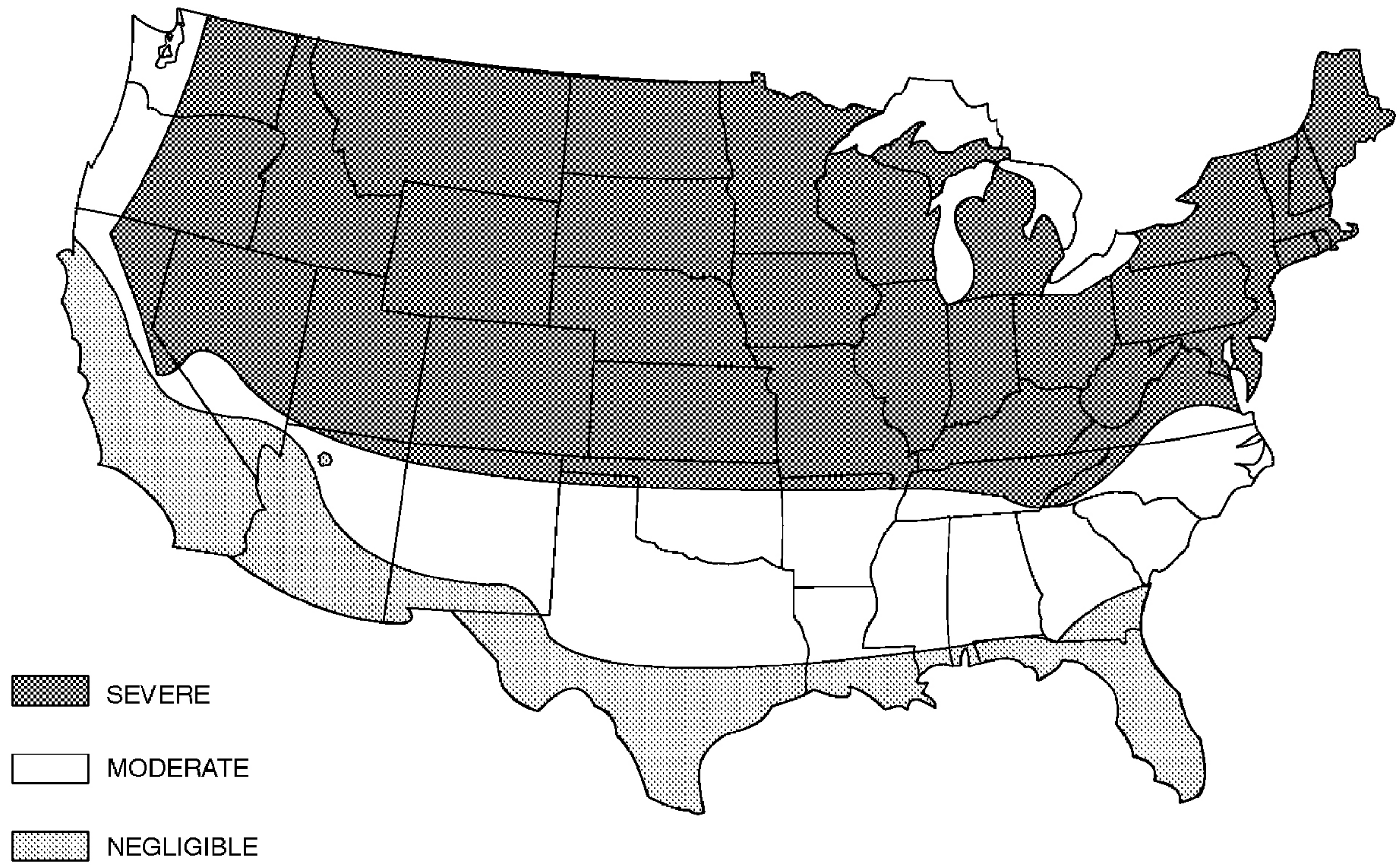
2.2 ASCE Standard:

ASCE 7-10 American Society of Civil Engineers *Minimum Design Loads for Buildings and Other Structures*

The text of Section 6.2.2 of ASTM E1996 shall be substituted as follows:

6.2.2 Unless otherwise specified, select the wind zone based on the ultimate design wind speed, V_{ult}, as follows:

6.2.2.1 Wind Zone 1–130 mph ≤ ultimate design wind speed, V_{ult} < 140 mph.



a. Alaska and Hawaii are classified as severe and negligible, respectively.

b. Lines defining areas are approximate only. Local conditions may be more or less severe than indicated by region classification. A sever classification is where weather conditions result in significant snowfall combined with extended periods during which there is little or no natural thawing, causing deicing salts to be used extensively.

FIGURE R301.2(1)
WEATHERING PROBABILITY MAP FOR CONCRETE[a, b]

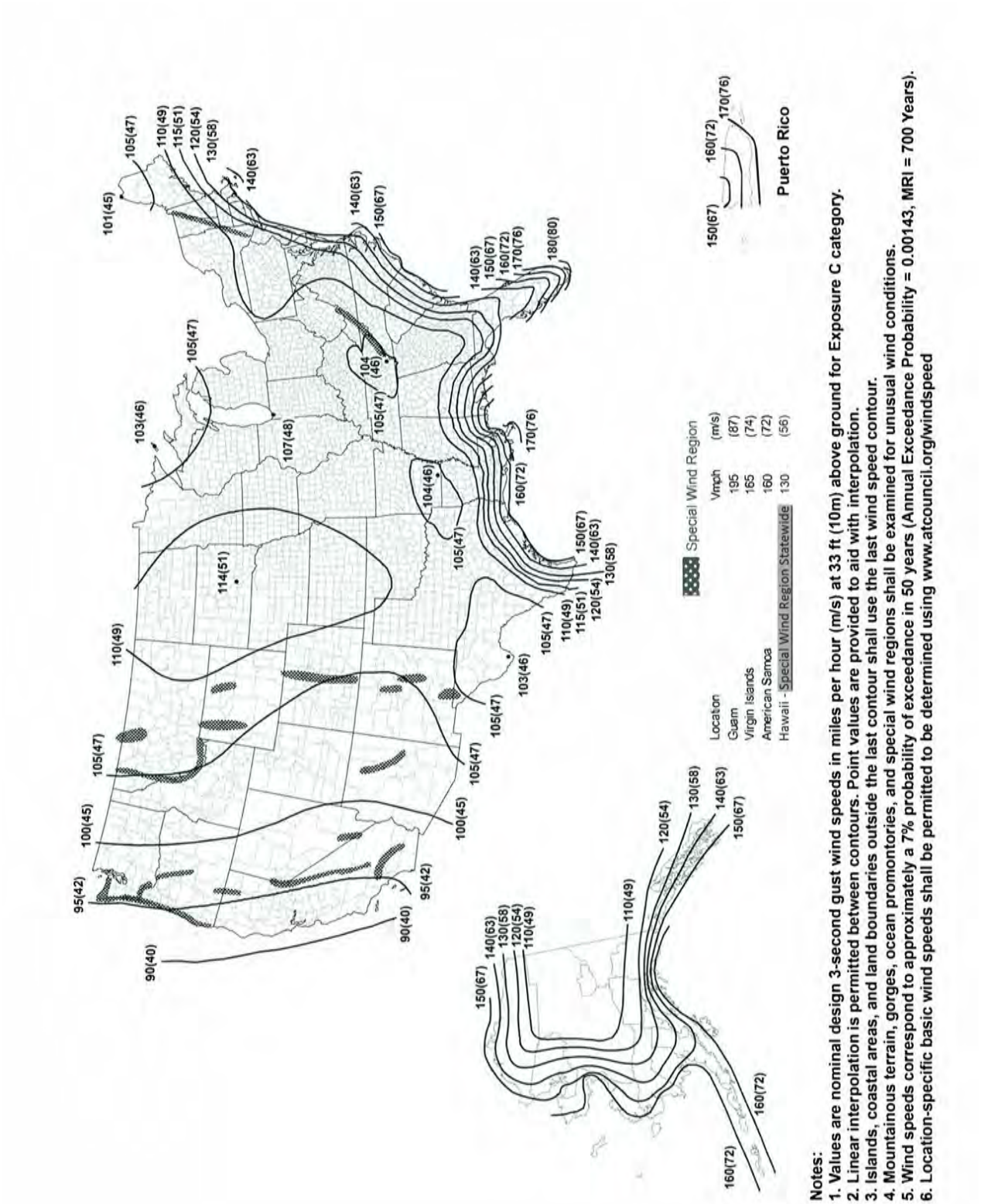


FIGURE R301.2(2)
ULTIMATE DESIGN WIND SPEEDS

For SI:1 foot = 34.8 mm, 1 pound per square foot =0.0479 kPa, 1 mile =1.61 km.

a. In CS areas, site-specific case studies are required to establish ground snow loads. Extreme local variations in ground snow loads in these areas preclude mapping at this scale.

b. Numbers in parentheses represent the upper elevation limits in feet for the ground snow load values presented below. Site-specific case studies are required to establish ground snow loads at elevations not covered.

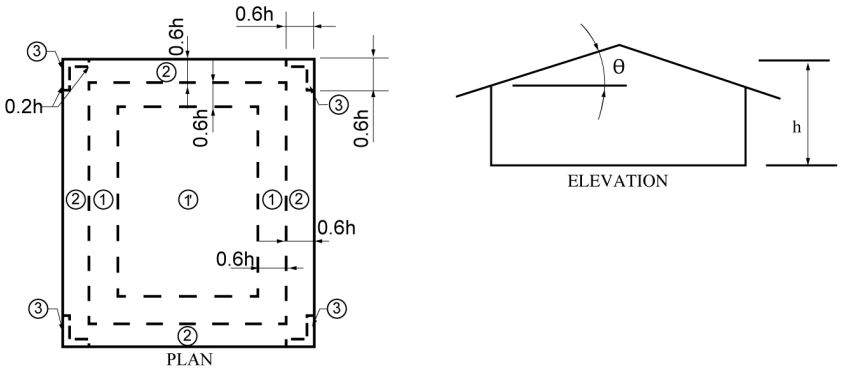
FIGURE R301.2(3)
GROUND SNOW LOADS, P_g, FOR THE UNITED STATES (lb/ft^2)

For SI: 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa, 1 mile = 1.61 km.

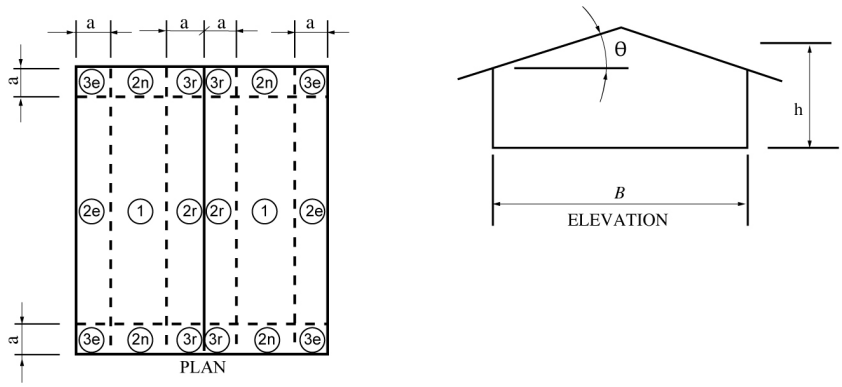
a. In CS areas, site-specific case studies are required to establish ground snow loads. Extreme local variations in ground snow loads in these areas preclude mapping at this scale.

b. Numbers in parentheses represent the upper elevation limits in feet for the ground snow load values presented below. Site-specific case studies are required to establish ground snow loads at elevations not covered.

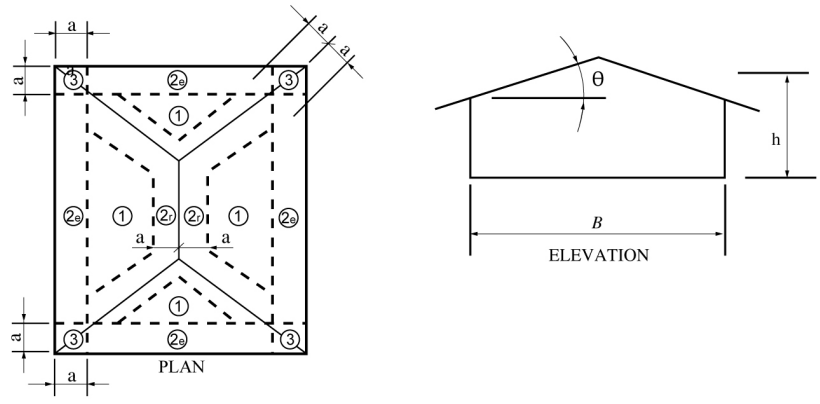
FIGURE R301.2(4)
GROUND SNOW LOADS, P_g, FOR THE UNITED STATES (lb/ft^2)



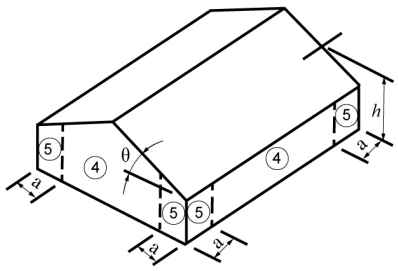
Gable and Flat Roofs $\theta \leq 7^o$



Gable and Flat Roofs $7^o < \theta \leq 45^o$



Hip Roofs $7^o < \theta \leq 45^o$



Walls

For SI: 1 foot = 304.8 mm, 1 degree = 0.0175 rad.
Note: a = 4 feet in all cases.

FIGURE R301.2.1
COMPONENT AND CLADDING PRESSURE ZONES

TABLE R301.2.1(1)
COMPONENT AND CLADDING LOADS FOR A BUILDING WITH A MEAN ROOF HEIGHT OF 30 FEET LOCATED IN EXPOSURE B (ASD) (psf)[a, b, c, d, e, f, g, h]

	ZONE	EFFECTIVE WIND AREAS (square feet)	ULTIMATE DESIGN WIND SPEED, V_{ult}																									
			90.0		95.0		100.0		105.0		110.0		115.0		120.0		130.0		140.0		150.0		160.0		170.0		180.0	
			Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg
Flat and gable roof 0 to 7 degrees	1	10.0	3.6	-13.9	4.0	-15.5	4.4	-17.2	4.8	-19.0	5.3	-20.8	5.8	-22.7	6.3	-24.8	7.4	-29.1	8.6	-33.7	9.9	-38.7	11.2	-44.0	12.7	-49.7	14.2	-55.7
	1	20.0	3.3	-13.0	3.7	-14.5	4.1	-16.0	4.5	-17.7	5.0	-19.4	5.4	-21.2	5.9	-23.1	7.0	-27.1	8.1	-31.4	9.3	-36.1	10.5	-41.1	11.9	-46.4	13.3	-52.0
	1	50.0	3.0	-11.8	3.4	-13.1	3.8	-14.5	4.1	-16.0	4.5	-17.6	5.0	-19.2	5.4	-20.9	6.3	-24.5	7.4	-28.4	8.4	-32.6	9.6	-37.1	10.8	-41.9	12.2	-47.0
	1	100.0	2.8	-10.8	3.1	-12.1	3.5	-13.4	3.8	-14.7	4.2	-16.2	4.6	-17.7	5.0	-19.2	5.9	-22.6	6.8	-26.2	7.8	-30.0	8.9	-34.2	10.0	-38.6	11.3	-43.3
	2	10.0	3.6	-18.4	4.0	-20.5	4.4	-22.7	4.8	-25.0	5.3	-27.4	5.8	-30.0	6.3	-32.7	7.4	-38.3	8.6	-44.5	9.9	-51.0	11.2	-28.1	12.7	-65.6	14.2	-73.5
	2	20.0	3.3	-17.2	3.7	-19.2	4.1	-21.2	4.5	-23.4	5.0	-25.7	5.4	-28.1	5.9	-30.6	7.0	-35.9	8.1	-41.6	9.3	-47.8	10.5	-54.3	11.9	-61.4	13.3	-68.8
	2	50.0	3.0	-15.6	3.4	-17.4	3.8	-19.3	4.1	-21.3	4.5	-23.3	5.0	-25.5	5.4	-27.8	6.3	-32.6	7.4	-37.8	8.4	-43.4	9.6	-49.4	10.8	-55.8	12.2	-62.5
	2	100.0	2.8	-14.4	3.1	-16.1	3.5	-17.8	3.8	-19.7	4.2	-21.6	4.6	-23.6	5.0	-25.7	5.9	-30.1	6.8	-35.0	7.8	-40.1	8.9	-45.7	10.0	-51.5	11.3	-57.8
	3	10.0	3.6	-25.0	4.0	-27.9	4.4	-30.9	4.8	-34.1	5.3	-37.4	5.8	-40.9	6.3	-44.5	7.4	-52.2	8.6	-60.6	9.9	-69.6	11.2	-79.1	12.7	-89.4	14.2	-100.2
	3	20.0	3.3	-22.6	3.7	-25.2	4.1	-28.0	4.5	-30.8	5.0	-33.8	5.4	-37.0	5.9	-40.3	7.0	-47.2	8.1	-54.8	9.3	-62.9	10.5	-71.6	11.9	-80.8	13.3	-90.6
	3	50.0	3.0	-19.4	3.4	-21.7	3.8	-24.0	4.1	-26.5	4.5	-29.0	5.0	-31.7	5.4	-34.6	6.3	-40.6	7.4	-47.0	8.4	-54.0	9.6	-61.4	10.8	-69.4	12.2	-77.8
	3	100.0	2.8	-17.4	3.1	-19.0	3.5	-21.0	3.8	-23.2	4.2	-25.5	4.6	-27.8	5.0	-30.3	5.9	-35.6	6.8	-41.2	7.8	-47.3	8.9	-53.9	10.0	-60.8	11.3	-68.2
Gable roof > 7 to 20 degrees	1, 2e	10.0	5.4	-16.2	6.0	-18.0	6.7	-19.9	7.4	-22.0	8.1	-24.1	8.8	-26.4	9.6	-28.7	11.3	-33.7	13.1	39.1	15.0	44.9	17.1	-51.0	19.3	-57.6	21.6	-64.6
	1, 2e	20.0	4.9	-16.2	5.4	-18.0	6.0	-19.9	6.6	-22.0	7.2	-24.1	7.9	-26.4	8.6	-28.7	10.1	-33.7	11.7	-39.1	13.5	-44.9	15.3	-51.0	17.3	-57.6	19.4	-64.6
	1, 2e	50.0	4.1	-9.9	4.6	-11.0	5.1	-12.2	5.6	-13.4	6.1	-14.7	6.7	-16.1	7.3	-17.5	8.6	-20.6	10.0	-23.8	11.4	-27.4	13.0	-31.1	14.7	-35.2	16.4	-39.4
	1, 2e	100.0	3.6	-5.0	4.0	-5.6	4.4	-6.2	4.8	-6.9	5.3	-7.5	5.8	-8.2	6.3	-9.0	7.4	-10.5	8.6	-12.2	9.9	-14.0	11.2	-15.9	12.7	-18.0	14.2	-20.2
	2n, 2r, 3e	10.0	5.4	-23.6	6.0	-26.3	6.7	-29.1	7.4	-32.1	8.1	-35.2	8.8	-38.5	9.6	-41.9	11.3	-49.2	13.1	-57.0	15.0	-65.4	17.1	-74.5	19.3	-84.1	21.6	-94.2
	2n, 2r, 3e	20.0	4.9	-20.3	5.4	-22.7	6.0	-25.1	6.6	-27.7	7.2	-30.4	7.9	-33.2	8.6	-36.2	10.1	-42.4	11.7	-49.2	13.5	-56.5	15.3	-64.3	17.3	-72.6	19.4	-81.4
	2n, 2r, 3e	50.0	4.1	-16.0	4.6	-17.9	5.1	-19.8	5.6	-21.8	6.1	-24.0	6.7	-26.2	7.3	-28.5	8.6	-33.5	10.0	-38.8	11.4	-44.6	13.0	-50.7	14.7	-57.2	16.4	-64.2
	2n, 2r, 3e	100.0	3.6	-12.8	4.0	-14.3	4.4	-15.8	4.8	-17.4	5.3	-19.1	5.8	-20.9	6.3	-22.8	7.4	-26.7	8.6	-31.0	9.9	-35.6	11.2	-40.5	12.7	-45.7	14.2	-51.3
	3r	10.0	5.4	-28.0	6.0	-30.2	6.7	-34.6	7.4	-38.1	8.1	-41.8	8.8	-45.7	9.6	-49.8	11.3	-58.4	13.1	-67.8	15.0	-77.8	17.1	-88.5	19.3	-99.9	21.6	-112.0
	3r	20.0	4.9	-24.0	5.4	-26.7	6.0	-29.6	6.6	-32.7	7.2	-35.9	7.9	-39.2	8.6	-42.7	10.1	-50.1	11.7	-58.1	13.5	-66.7	15.3	-75.9	17.3	-85.6	19.4	-96.0
	3r	50.0	4.1	-18.7	4.6	-20.8	5.1	-23.1	5.6	-25.4	6.1	-27.9	6.7	-30.5	7.3	-33.2	8.6	-39.0	10.0	-45.2	11.4	-51.9	13.0	-59.0	14.7	-66.6	16.4	-74.7
	3r	100.0	3.6	-14.7	4.0	-16.3	4.4	-18.1	4.8	-20.0	5.3	-21.9	5.8	-24.0	6.3	-26.1	7.4	-30.6	8.6	-35.5	9.9	-40.8	11.2	-46.4	12.7	-52.3	14.2	-58.7
Gable roof > 20 to 27 degrees	1, 2e	10.0	6.5	-12.4	7.3	-13.9	8.0	-15.4	8.9	-16.9	9.7	-18.6	10.6	-20.3	11.6	-22.1	13.6	-26.0	15.8	-30.1	18.1	-34.6	20.6	-39.3	23.3	-44.4	26.1	-49.9
	1, 2e	20.0	5.6	-12.4	6.3	-13.9	7.0	-15.4	7.7	-16.9	8.4	-18.6	9.2	-20.3	10.0	-22.1	11.7	-26.0	13.6	-30.1	15.6	-34.6	17.8	-39.3	20.1	-44.4	22.5	-49.8
	1, 2e	50.0	4.4	-10.6	5.0	-11.8	5.5	-3.1	6.1	-14.4	6.6	-15.8	7.3	-17.3	7.9	-18.8	9.3	-22.1	10.8	-25.6	12.3	-29.4	14.0	-33.5	15.9	-37.8	17.8	-42.4
	1, 2e	100.0	3.6	-9.1	4.0	-10.2	4.4	-11.3	4.8	-12.4	5.3	-13.6	5.8	-14.9	6.3	-16.2	7.4	-19.0	8.6	-22.1	9.9	-25.3	11.2	-28.8	12.7	-32.5	14.2	-36.5
	2n, 2r, 3e	10.0	6.5	-19.9	7.3	-22.1	8.0	-24.5	8.9	-27.0	9.7	-29.7	10.6	-32.4	11.6	-35.3	13.6	-41.4	15.8	-48.0	18.1	-55.2	20.6	-62.8	23.3	-70.8	26.1	-79.4
	2n, 2r, 3e	20.0	5.6	-17.4	6.3	-19.4	7.0	-21.5	7.7	-23.7	8.4	-26.0	9.2	-28.4	10.0	-31.0	11.7	-36.3	13.6	-42.1	15.6	-48.4	17.8	-55.0	20.1	-62.1	22.5	-69.6
	2n, 2r, 3e	50.0	4.4	-14.2	5.0	-15.8	5.5	-17.5	6.1	-19.3	6.6	-21.1	7.3	-23.1	7.9	-25.2	9.3	-29.5	10.8	-34.2	12.3	-39.3	14.0	-44.7	15.9	-50.5	17.8	-56.6
	2n, 2r, 3e	100.0	3.6	-11.7	4.0	-13.0	4.4	-14.5	4.8	-15.9	5.3	-17.5	5.8	-19.1	6.3	-20.8	7.4	-24.4	8.6	-28.3	9.9	-32.5	11.2	-37.0	12.7	-41.8	14.2	-46.8
	3r	10.0	6.5	-23.6	7.3	-26.3	8.0	-29.1	8.9	-32.1	9.7	-35.2	10.6	-38.5	11.6	-41.9	13.6	-49.2	15.8	-57.0	18.1	-65.4	20.6	-74.5	23.3	-84.1	26.1	-94.2
	3r	20.0	5.6	-19.9	6.3	-22.1	7.0	-24.5	7.7	-27.0	8.4	-29.7	9.2	-32.4	10.0	-35.3	11.7	-41.4	13.6	-48.0	15.6	-55.2	17.8	-62.8	20.1	-70.8	22.5	-79.4
	3r	50.0	4.4	-14.7	5.0	-16.3	5.5	-18.1	6.1	-20.0	6.6	-21.9	7.3	-24.0	7.9	-26.1	9.3	-30.6	10.8	-35.5	12.3	-40.8	14.0	-46.4	15.9	-52.3	17.8	-58.7
	3r	100.0	3.6	-14.7	4.0	-16.3	4.4	-18.1	4.8	-20.0	5.3	-21.9	5.8	-24.0	6.3	-26.1	7.4	-30.6	8.6	-35.5	9.9	-40.8	11.2	-46.4	12.7	-52.3	14.2	-58.7

(continued)

TABLE R301.2.1(1)—continued
COMPONENT AND CLADDING LOADS FOR A BUILDING WITH A MEAN ROOF HEIGHT OF 30 FEET LOCATED IN EXPOSURE B (ASD) (psf) [a, b, c, d, e, f, g]

	ZONE	EFFECTIVE WIND AREAS (square feet)	ULTIMATE DESIGN WIND SPEED, V_{ult}																									
			90.0		95.0		100.0		105.0		110.0		115.0		120.0		130.0		140.0		150.0		160.0		170.0		180.0	
			Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg
Gable roof > 27 to 45 degrees	1, 2e, 2r	10.0	8.0	-14.7	8.9	-16.3	9.9	-18.1	10.9	-20.0	12.0	-21.9	13.1	-24.0	14.2	-26.1	16.7	-30.6	19.4	-35.5	22.2	-40.8	25.3	-16.4	28.5	-52.3	32.0	-58.7
	1, 2e, 2r	20.0	7.1	-12.4	7.9	-13.9	8.8	-15.4	9.7	-16.9	10.6	-18.6	11.6	-20.3	12.6	-22.1	14.8	-26.0	17.2	-30.1	19.8	-34.6	22.5	-39.3	25.4	-44.4	28.5	-49.8
	1, 2e, 2r	50.0	5.9	-9.5	6.6	-10.6	7.3	-11.7	8.1	-12.9	8.9	-14.2	9.7	-15.5	10.5	-16.9	12.4	-19.8	14.3	-22.9	16.5	-26.3	18.7	-30.0	21.1	-33.8	23.7	-37.9
	1, 2e, 2r	100.0	5.0	-7.3	5.6	-8.1	6.2	-9.0	6.9	-9.9	7.5	-10.8	8.2	-11.9	9.0	-12.9	10.5	-15.1	12.2	-17.6	14.0	-20.2	15.9	-22.9	18.0	-25.9	20.2	-29.0
	2n, 3r	10.0	8.0	-16.2	8.9	-18.0	9.9	-19.9	10.9	-22.0	12.0	-24.1	13.1	-26.4	-14.2	-28.7	16.7	-33.7	19.4	-39.1	22.2	-44.9	25.3	-51.0	28.5	-57.6	32.0	-64.6
	2n, 3r	20.0	7.1	-14.4	7.9	-16.1	8.8	-17.8	9.7	-19.7	10.6	-21.6	11.6	-23.6	12.6	-25.7	14.8	-30.1	17.2	-34.9	19.8	-40.1	22.5	-45.6	25.4	-51.5	28.5	-57.8
	2n, 3r	50.0	5.9	-12.2	6.6	-13.5	7.3	-15.0	8.1	-16.5	8.9	-18.2	9.7	-19.9	10.5	-21.6	12.4	-25.4	14.3	-29.4	16.5	-33.8	18.7	-38.4	21.1	-43.4	23.7	-48.6
	2n, 3r	100.0	5.0	-10.4	5.6	-11.6	6.2	-12.9	6.9	-14.2	7.5	-15.6	8.2	-17.1	9.0	-18.6	10.5	-21.8	12.2	-25.3	14.0	-29.0	15.9	-33.0	18.0	-37.3	20.0	-41.8
	3e	10.0	8.0	-19.9	8.9	-22.1	9.9	-24.5	10.9	-27.0	12.0	-29.7	13.1	-32.4	14.2	-35.3	16.7	-41.4	19.4	-48.0	22.2	-55.2	25.3	-62.8	28.8	-70.8	32.0	-79.4
	3e	20.0	7.1	-17.6	7.9	-19.6	8.8	-21.8	9.7	-24.0	10.6	-26.3	11.6	-28.8	12.6	-31.3	14.8	-36.8	17.2	-42.7	19.8	-49.0	22.5	-55.7	25.4	-62.9	28.5	-70.5
	3e	50.0	5.9	-14.7	6.6	-16.3	7.3	-18.1	8.1	-20.0	8.9	-21.9	9.7	-24.0	10.5	-26.1	12.4	-30.6	14.3	-35.5	16.6	-40.8	18.7	-46.4	21.1	-52.3	23.7	-58.7
	3e	100.0	5.0	-12.4	5.6	-13.9	6.2	-15.4	6.9	-16.9	7.5	-18.6	8.2	-20.3	9.0	-22.1	10.5	-26.0	12.2	-30.1	14.0	-34.6	15.9	-39.3	18.0	-44.4	20.2	-49.8
Hipped roof > 7 to 20 degrees[g]	1	10.0	6.5	-14.7	7.3	-16.3	8.0	-18.1	8.9	-20.0	9.7	-21.9	10.6	-24.0	11.6	-26.1	13.6	-30.6	15.8	-35.5	18.1	-40.8	20.6	-46.4	23.3	-52.3	26.1	-58.7
	1	20.0	5.6	-14.7	6.3	-16.3	7.0	-18.1	7.7	-20.0	8.4	-21.9	9.2	-24.0	10.0	-26.1	11.7	-30.6	13.6	-35.5	15.6	-40.8	17.8	-46.4	20.1	-52.3	22.5	-58.7
	1	50.0	4.4	-11.3	5.0	-12.6	5.5	-14.0	6.1	-15.4	6.6	-16.9	7.3	-18.5	7.9	-20.2	9.3	-23.7	10.8	-27.4	12.3	-31.5	14.0	-35.8	15.9	-40.4	17.8	-45.3
	1	100.0	3.6	-8.7	4.0	-9.7	4.4	-10.8	4.8	-11.9	5.3	-13.1	5.8	-14.3	6.3	-15.5	7.4	-18.2	8.6	-21.2	9.9	-24.3	11.2	-27.6	12.7	-31.2	14.2	-35.0
	2r	10.0	6.5	-19.1	7.3	-21.3	8.0	-23.6	8.9	-26.0	9.7	-28.6	10.6	-31.2	11.6	-34.0	13.6	-39.9	15.8	-46.3	18.1	-53.1	20.6	-60.4	23.3	-68.2	26.1	-76.5
	2r	20.0	5.6	-17.2	6.3	-19.2	7.0	-21.3	7.7	-23.4	8.4	-25.7	9.2	-28.1	10.0	-30.6	11.7	-35.9	13.6	-41.7	15.6	-47.9	17.8	-54.4	20.1	-61.5	22.5	-68.9
	2r	50.0	4.4	-14.7	5.0	-16.4	5.5	-18.2	6.1	-20.0	6.6	-22.0	7.3	-24.0	7.9	-26.1	9.3	-30.7	10.8	-35.6	12.3	-40.9	14.0	-46.5	15.9	-52.5	17.8	-58.8
	2r	100.0	3.6	-12.8	4.0	-14.3	4.4	-15.8	4.8	-17.4	5.3	-19.1	5.8	-20.9	6.3	-22.8	7.4	-26.7	8.6	-31.0	9.9	-35.6	11.2	-40.5	12.7	-45.7	14.2	-51.3
	2e, 3	10.0	6.5	-20.6	7.3	-22.9	8.0	-25.4	8.9	-28.0	9.7	-30.8	10.6	-33.6	11.6	-36.6	13.6	-43.0	15.8	-49.8	18.1	-57.2	20.6	-65.1	23.3	-73.5	26.1	-82.4
	2e, 3	20.0	5.6	-18.5	6.3	-20.6	7.0	-22.9	7.7	-25.2	8.4	-27.7	9.2	-30.3	10.0	-32.9	11.7	-38.7	13.6	-44.8	15.6	-51.5	17.8	-58.6	20.1	-66.1	22.5	-74.1
	2e, 3	50.0	4.4	-15.8	5.0	-17.6	5.5	-19.5	6.1	-21.5	6.6	-23.6	7.3	-25.8	7.9	-28.0	9.3	-32.9	10.8	-38.2	12.3	-43.8	14.0	-49.9	15.9	-56.3	17.8	-63.1
	2e, 3	100.0	3.6	-13.7	4.0	-15.3	4.0	-16.9	4.8	-18.7	5.3	-20.5	5.8	-22.4	6.3	-24.4	7.4	-28.6	8.6	-33.2	9.9	-38.1	11.2	-43.3	12.7	-48.9	14.2	-54.8
Hipped roof > 20 to 27 degrees	1	10.0	6.5	-11.7	7.3	-13.0	8.0	-14.5	8.9	-15.9	9.7	-17.5	10.6	-19.1	11.6	-20.8	13.6	-24.4	15.8	-28.3	18.1	-32.5	20.6	-37.0	23.3	-41.8	26.1	-46.8
	1	20.0	5.6	-10.4	6.3	-11.6	7.0	-12.8	7.7	-14.1	8.4	-15.5	9.2	-16.9	10.0	-18.4	11.7	-21.6	13.6	-25.1	15.6	-28.8	17.8	-32.8	20.1	-37.0	22.5	-41.5
	1	50.0	4.4	-8.6	5.0	-9.6	5.5	-10.6	6.1	-11.7	6.6	-12.8	7.3	-14.0	7.9	-15.3	9.3	-17.9	10.8	-20.8	12.3	-23.9	14.0	-27.2	15.9	-30.7	17.8	-34.4
	1	100.0	3.6	-7.3	4.0	-8.1	4.4	-9.0	4.8	-9.9	5.3	-10.8	5.8	-11.9	6.3	-12.9	7.4	-15.1	8.6	-17.6	9.9	-20.2	11.2	-22.9	12.7	-25.9	14.2	-29.0
	2e, 2r, 3	10.0	6.5	-16.2	7.3	-18.0	8.0	-19.9	8.9	-22.0	9.7	-24.1	10.6	-26.4	11.6	-28.7	13.6	-33.7	15.8	-39.1	18.1	-44.9	20.6	-51.0	23.3	-57.6	26.1	-64.6
	2e, 2r, 3	20.0	5.6	-14.4	6.3	-16.1	7.0	-17.8	7.7	-19.7	8.4	-21.6	9.2	-23.6	10.0	-25.7	11.7	-30.1	13.6	-34.9	15.6	-40.1	17.8	-45.6	20.1	-51.5	22.5	-57.8
	2e, 2r, 3	50.0	4.4	-12.2	5.0	-13.5	5.5	-15.0	6.1	-16.5	6.6	-18.2	7.3	-19.9	7.9	-21.6	9.3	-25.4	10.8	-29.4	12.3	-33.8	14.0	-38.4	15.9	-43.4	17.8	-48.6
	2e, 2r, 3	100.0	3.6	-10.4	4.0	-11.6	4.4	-12.9	4.8	-14.2	5.3	-15.6	5.8	-17.1	6.3	-18.6	7.4	-21.8	8.6	-25.3	9.9	-29.0	11.2	-33.0	12.7	-37.3	14.2	-41.8

(continued)

TABLE R301.2.1(1)—continued
COMPONENT AND CLADDING LOADS FOR A BUILDING WITH A MEAN ROOF HEIGHT OF 30 FEET LOCATED IN EXPOSURE B (ASD) (psf) [a, b, c, d, e, f, g]

	ZONE	EFFECTIVE WIND AREAS (square feet)	ULTIMATE DESIGN WIND SPEED, V_{ult}																									
			90.0		95.0		100.0		105.0		110.0		115.0		120.0		130.0		140.0		150.0		160.0		170.0		180.0	
			Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg
Hipped roof > 27 to 45 degrees	1	10.0	6.2	-12.4	6.9	-13.9	7.7	-15.4	8.5	-16.9	9.3	-18.6	10.2	-20.3	11.1	-22.1	13.0	-26.0	15.1	-30.1	17.3	-34.6	19.7	-39.3	22.2	-44.4	24.9	-49.8
	1	20.0	5.4	-11.0	6.0	-12.3	6.7	-13.6	7.4	-15.0	8.1	-16.5	8.9	-18.0	9.6	-19.6	11.3	-23.0	13.1	-26.7	15.1	-30.7	17.1	-34.9	19.4	-39.4	21.7	-44.2
	1	50.0	4.4	-9.2	4.9	-10.2	5.4	-11.3	5.9	-12.5	6.5	-13.7	7.1	-15.0	7.7	-16.3	9.1	-19.2	10.5	-22.2	12.1	-25.5	13.8	-29.0	15.5	-32.8	17.4	-36.7
	1	100.0	3.6	-7.8	4.0	-8.7	4.4	-9.6	4.8	-10.6	5.3	-11.6	5.8	-12.7	6.3	-13.8	7.4	-16.2	8.6	-18.8	9.9	-21.6	11.2	-24.6	12.7	-27.8	14.2	-31.1
	2e	10.0	6.2	-14.8	6.9	-16.5	7.7	-18.3	8.5	-20.2	9.3	-22.1	10.2	-24.2	11.1	-26.3	13.0	-30.9	15.1	-35.9	17.3	-41.2	19.7	-46.8	22.2	-52.9	24.9	-59.3
	2e	20.0	5.4	-11.7	6.0	-13.0	6.7	-14.5	7.4	-15.9	8.1	-17.5	8.9	-19.1	9.6	-20.8	11.3	-24.4	13.1	-28.3	15.1	-32.5	17.1	-37.0	19.4	-41.8	21.7	-46.8
	2e	50.0	4.4	-7.3	4.9	-8.1	5.4	-9.0	5.9	-9.9	6.5	-10.8	7.1	-11.9	7.7	-12.9	9.1	-15.1	10.5	-17.6	12.1	-20.2	13.8	-22.9	15.5	-25.9	17.4	-29.0
	2e	100.0	3.6	-7.3	4.0	-8.1	4.4	-9.0	4.8	-9.9	5.3	-10.8	5.8	-11.9	6.3	-12.9	7.4	-15.1	8.6	-17.6	9.9	-20.2	11.2	-22.9	12.7	-25.9	14.2	-29.0
	2r	10.0	6.2	-18.7	6.9	-20.9	7.7	-23.1	8.5	-25.5	9.3	-28.0	10.2	-30.6	11.1	-33.3	13.0	-39.1	15.1	-45.4	17.3	-52.1	19.7	-59.2	22.2	-66.9	24.9	-75.0
	2r	20.0	5.4	-15.7	6.0	-17.5	6.7	-19.4	7.4	-21.4	8.1	-23.5	8.9	-25.7	9.6	-28.0	11.3	-32.8	13.1	-38.1	15.1	-43.7	17.1	-49.8	19.4	-56.2	21.7	-63.0
	2r	50.0	4.4	-11.7	4.9	-13.1	5.4	-14.5	5.9	-16.0	6.5	-17.5	7.1	-19.2	7.7	-20.9	9.1	-24.5	10.5	-28.4	12.1	-32.6	13.8	-37.1	15.5	-41.9	17.4	-47.0
	2r	100.0	3.6	-8.7	4.0	-9.7	4.4	-10.8	4.8	-11.9	5.3	-13.1	5.8	-14.3	6.3	-15.5	7.4	-18.2	8.6	-21.2	9.9	-24.3	11.2	-27.6	12.7	-31.2	14.2	-35.0
	3	10.0	6.2	-20.0	6.9	-22.3	7.7	-24.7	8.5	-27.2	9.3	-29.9	10.2	-32.7	11.1	-35.6	13.0	-41.7	15.1	-48.4	17.3	-55.6	19.7	-63.2	22.2	-71.4	24.9	-80.0
	3	20.0	5.4	-15.0	6.0	-16.8	6.7	-18.6	7.4	-20.5	8.1	-22.5	8.9	-24.6	9.6	-26.7	11.3	-31.4	13.1	-36.4	15.1	-41.8	17.1	-47.5	19.4	-53.7	21.7	-60.2
	3	50.0	4.4	-8.7	4.9	-9.7	5.4	-10.8	5.9	-11.9	6.5	-13.1	7.1	-14.3	7.7	-15.5	9.1	-18.2	10.5	-21.2	12.1	-24.3	13.8	-27.6	15.5	-31.2	17.4	-35.0
	3	100.0	3.6	-8.7	4.0	-9.7	4.4	-10.8	4.8	-11.9	5.3	-13.1	5.8	-14.3	6.3	-15.5	7.4	-18.2	8.6	-21.2	9.9	-24.3	11.2	-27.6	12.7	-31.2	14.2	-35.0
Wall	4	10.0	8.7	-9.5	9.7	-10.6	10.8	-11.7	11.9	-12.9	13.1	-14.2	14.3	-15.5	15.5	-16.9	18.2	-19.8	21.2	-22.9	24.3	-26.3	27.6	-30.0	31.2	-33.8	35.0	-37.9
	4	20.0	8.3	-9.1	9.3	-10.1	10.3	-11.2	11.4	-12.4	12.5	-13.6	13.6	-14.8	14.8	-16.2	17.4	-19.0	20.2	-22.0	23.2	-25.3	26.4	-28.7	29.8	-32.4	33.4	-36.4
	4	50.0	7.8	-8.6	8.7	-9.5	9.7	-10.6	10.7	-11.7	11.7	-12.8	12.8	-14.0	13.9	-15.2	16.3	-17.9	18.9	-20.7	21.7	-23.8	24.7	-27.1	27.9	-30.6	31.3	-34.3
	4	100.0	7.4	-8.2	8.3	-9.1	9.2	-10.1	10.1	-11.1	11.1	-12.2	12.1	-13.3	13.2	-14.5	15.5	-17.1	18.0	-19.8	20.6	-22.7	23.5	-25.8	26.5	-29.2	29.7	-32.7
	4	500.0	6.5	-7.3	7.3	-8.1	8.0	-9.0	8.9	-9.9	9.7	-10.8	10.6	-11.9	11.6	-12.9	13.5	-15.1	15.8	-17.6	18.1	-20.2	20.6	-22.9	23.3	-25.9	26.1	-29.0
	5	10.0	8.7	-11.7	9.7	-13.0	10.8	-14.5	11.9	-15.9	13.1	-17.5	14.3	-19.1	15.5	-20.8	18.2	-24.4	21.2	-28.3	24.3	-32.5	27.6	-37.0	31.2	-41.8	35.0	-46.8
	5	20.0	8.3	-10.9	9.3	-12.2	10.3	-13.5	11.4	-14.9	12.5	-16.3	13.6	-17.8	14.8	-19.4	17.4	-22.8	20.2	-26.4	23.2	-30.3	26.4	-34.5	29.8	-39.0	33.4	-43.7
	5	50.0	7.8	-9.9	8.7	-11.0	9.7	-12.2	10.7	-13.4	11.7	-14.7	12.8	-16.1	13.9	-17.5	16.3	-20.6	18.9	-23.9	21.7	-27.4	24.7	-31.2	27.9	-35.2	31.3	-39.5
	5	100.0	7.4	-9.1	8.3	-10.1	9.2	-11.2	10.1	-12.4	11.1	-13.6	12.1	-14.8	13.2	-16.1	15.5	-19.0	18.0	-22.0	20.6	-25.2	23.5	-28.7	26.5	-32.4	29.7	-36.3
	5	500.0	6.5	-7.3	7.3	-8.1	8.0	-9.0	8.9	-9.9	9.7	-10.8	10.6	-11.9	11.6	-12.9	13.6	-15.1	15.8	-17.6	18.1	-20.2	20.6	-22.9	23.3	-25.9	26.1	-29.0

For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m^2, 1 mile per hour = 0.447 m/s, 1 pound per square foot = 0.0479 kPa.

a. The effective wind area shall be equal to the span length multiplied by an effective width. This width shall be not less than one-third the span length. For cladding fasteners, the effective wind areas shall not be greater than the area that is tributary to an individual fastener.

b. For effective areas between those given, the load shall be interpolated or the load associated with the lower effective areas shall be used.

c. Table values shall be adjusted for height and exposure by multiplying by the adjustment coefficient in Table R301.2.1(2).

d. See Figure R318.4 for locations of termite infestation probability zones.

e. Plus and minus signs signify pressures acting toward and away from the building surfaces.

f. Positive and negative design wind pressures shall not be less than 10 psf.

g. Where the ratio of the building mean roof height to the building length or width is less than 0.8, uplift loads shall be permitted to be calculated in accordance with ASCE 7.

h. Openings for exterior balconies, decks, or porches under roofs enclosed with screen or removable vinyl or acrylic wind break panels shall be exempt from the loads listed in Table R301.2(2) and the height and exposure factors listed in Table R301.2(3). Vinyl and acrylic glazed panels shall be removable. Removable panels shall be identified as removable by a decal. The identification decal shall state “Removable panel SHALL be removed when wind speeds exceed 75 mph (34 m/s).” Decals shall be placed such that the decal is visible when the panel is installed.

6.2.2.2 Wind Zone 2–140 mph ≤ ultimate design wind speed, V_{ult} < 150 mph at greater than 1 mile (1.6 km) from the coastline. The coastline shall be measured from the mean high-water mark.

6.2.2.3 Wind Zone 3–150 mph (67 m/s) ≤ ultimate design wind speed, V_{ult} ≤ 170 mph (76 m/s), or 140 mph (54 m/s) ≤ ultimate design wind speed, V_{ult} ≤ 170 mph (76 m/s) and within 1 mile (1.6 km) of the coastline. The coastline shall be measured from the mean high-water mark.

6.2.2.4 Wind Zone 4–ultimate design wind speed, V_{ult} > 170 mph (76 m/s).

R301.2.1.3 Wind speed conversion. Where referenced documents are based on nominal design wind speeds and do not provide the means for conversion between ultimate design wind speeds and nominal design wind speeds, the ultimate design wind speeds, V_{ult}, of Figure R301.2(2) shall be converted to nominal design wind speeds, V_{asd}, using Table R301.2.1.3.

R301.2.1.4 Exposure category. For each wind direction considered, an exposure category that adequately reflects the characteristics of ground surface irregularities shall be determined for the site at which the building or structure is to be constructed. For a site located in the transition zone between categories, the category resulting in the largest wind forces shall apply. Account shall be taken of variations in ground surface roughness that arise from natural topography and vegetation as well as from constructed features. For a site where multiple detached one- and two-family *dwellings*, townhouses or other structures are to be constructed as part of a subdivision or master-planned community, or are otherwise designated as a developed area by the authority having *jurisdiction*, the exposure category for an individual structure shall be based on the site conditions that will exist at the

TABLE R301.2.1(2)
HEIGHT AND EXPOSURE ADJUSTMENT COEFFICIENTS FOR TABLE R301.2.1(1)

MEAN ROOF HEIGHT	EXPOSURE		
	B	C	D
15	0.82	1.21	1.47
20	0.89	1.29	1.55
25	0.94	1.35	1.61
30	1.00	1.40	1.66
35	1.05	1.45	1.70
40	1.09	1.49	1.74
45	1.12	1.53	1.78
50	1.16	1.56	1.81
55	1.19	1.59	1.84
60	1.22	1.62	1.87

TABLE R301.2.1.2
WINDBORNE DEBRIS PROTECTION FASTENING SCHEDULE FOR WOOD STRUCTURAL PANELS[a, b, c, d]

FASTENER TYPE	FASTENER SPACING (inches)[a, b]		
	Panel span ≤ 4 feet	4 feet < panel span ≤ 6 feet	6 feet < panel span ≤ 8 feet
No. 8 wood screws	16	10	8
No. 10 wood screws	16	12	9
$^1/_4$-inch lag screws	16	16	16

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound = 4.448 N, 1 mile per hour = 0.447 m/s.

a. This table is based on 180 mph ultimate design wind speeds, V_{ult}, and a 45-foot mean roof height.

b. Fasteners shall be installed at opposing ends of the wood structural panel. Fasteners shall be located not less than 1 inch from the edge of the panel.

c. Fasteners shall penetrate through the exterior wall covering with an embedment length of not less than 2 inches into the building frame. Fasteners shall be located not less than $2^1/_2$ inches from the edge of concrete block or concrete.

d. Panels attached to masonry or masonry/stucco shall be attached using vibration-resistant anchors having an ultimate withdrawal capacity of not less than 1,500 pounds.

TABLE R301.2.1.3
WIND SPEED CONVERSIONS[a]

V_{ult}	110	115	120	130	140	150	160	170	180	190	200
V_{asd}	85	89	93	101	108	116	124	132	139	147	155

For SI: 1 mile per hour = 0.447 m/s.

a. Linear interpolation is permitted.

TABLE R301.2(4)
ULTIMATE DESIGN WIND SPEEDS BY COUNTY (mph)

Counties not listed	115		
Alleghany	special mountain region	Johnston	120
Ashe	special mountain region	Jones	140
Avery	special mountain region	Lenoir	130
Beaufort	130	Madison	special mountain region
Bertie	120	Martin[f]	120/130
Bladen[a]	130/140	Mitchell	special mountain region
Brunswick	150	New Hanover	150
Buncomb	115	Onslow[g]	140/150
Camden	130	Pamlico	140
Carteret	150	Pasquotank	130
Chowan	130	Pender[h]	140/150
Columbus	140	Perquimans	130
Craven	140	Pitt	130
Cumberland[b]	120/130	Richmond	120
Currituck	130	Robeson	130
Dare[c]	130/140	Sampson	130
Duplin[d]	130/140	Scotland	120
Gates	120	Swain	special mountain region
Graham	special mountain region	Tyrell	130
Greene	130	Washington	130
Harnett	120	Watauga	special mountain region
Haywood	special mountain region	Wayne	130
Hoke	120	Wilson	120
Hyde[e]	130/140	Yancey	special mountain region
Jackson	115		

For SI: 1 foot = 304.8, 1 mile per hour = 0.44 m/s.

a. Bladen County – 130 mph zone west of Hwy. 701, 140 mph zone east of Hwy. 701.
b. Cumberland County – 120 mph zone west of I-95, 130 mph zone east of I-95.
c. Dare County - 130 mph zone west of U.S. Route 264, 140 mph zone east of U.S. Route 264.
d. Duplin County - 130 mph zone west of U.S. Route 41, 140 mph zone east of U.S. Route 41
e. Hyde County – 130 mph zone west of U.S. Route 264, 140 mph zone east of U.S. Route 264.
f. Martin County – 120 mph zone west of Hwy. 17, 130 mph zone east of Hwy 17.
g. Onslow County – 150 mph zone in the Township of Swansboro and Stump Sound, 150 mph zone east of the Intracoastal Waterway, 140 mph zone in the remainder of the county.
h. Pender County – 150 mph zone in the Township of Topsail, 140 mph zone in the remainder of the county.

TABLE R301.2(5)
ULTIMATE DESIGN WIND SPEED FOR MOUNTAIN REGIONS

FIRST FLOOR FINISH ELEVATION (feet)	ULTIMATE DESIGN WIND SPEED (mph)
Less than 2,700	115
2,700 to less than 3,000	120
3,000 to less than 3,500	130
3,500 to less than 4,500	140
4,500 or greater	150

For SI: 1 foot = 304.8, 1 mile per hour = 0.44 m/s.

TABLE R301.2(6)
DESIGN PRESSURES FOR DOORS AND WINDOWS [a,b,c,d,e]
POSITIVE AND NEGATIVE (psf)

VELOCITY (mph)	MEAN ROOF HEIGHT (feet)		
	15	25	35
115	16	18	20
120	17	20	22

For SI: 1 foot = 304.8, 1 mile per hour = 0.44 m/s.

a. Alternative design pressures may be determined by using *North Carolina Building Code*, ASCE-7, or the *International Building Code*.
b. If window or door is more than 4 feet (1219 mm) from a corner, the pressure from this table shall be permitted to be multiplied by 0.87. This adjustment does not apply to garage doors.
c. For windows and doors in structures with a roof slope of 10 degrees (0.0745 rad) or less (2:12) from the table may be multiplied by 0.90.
d. Design pressure ratings based on standards listed in Section R609 are adequate documentation of capacity to resist pressures from the table.
e. Design pressures are for windows and doors located in Exposure Category B.

TABLE R301.2(7)
COUNTIES IN SEISMIC DESIGN CATEGORY C

Transylvania	Jackson
Madison	Macon
Cherokee	Henderson
Clay	Buncombe
Graham	Swain
Haywood	

Note: Counties not listed are in Seismic Design Category A or B.

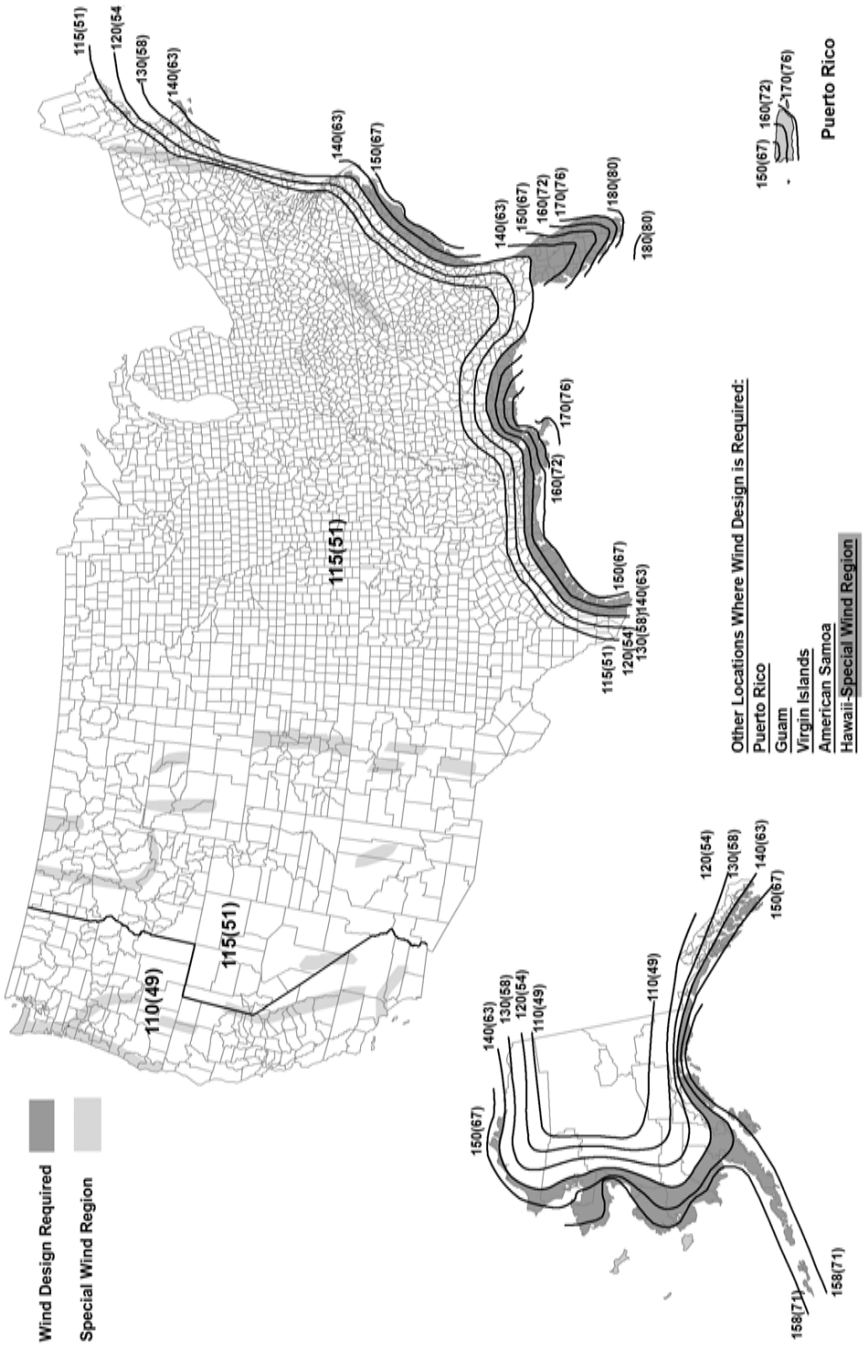


FIGURE R301.2.1.1
REGIONS WHERE WIND DESIGN IS REQUIRED

time when all adjacent structures on the site have been constructed, provided that their construction is expected to begin within 1 year of the start of construction for the structure for which the exposure category is determined. For any given wind direction, the exposure in which a specific building or other structure is sited shall be assessed as being one of the following categories:

1. Exposure B. Urban and suburban areas, wooded areas or other terrain with numerous closely spaced obstructions having the size of single-family *dwellings* or larger. Exposure B shall be assumed unless the site meets the definition of another type exposure.
2. Exposure C. Open terrain with scattered obstructions, including surface undulations or other irregularities, having heights generally less than 30 feet (9144 mm) extending more than 1,500 feet (457 m) from the building site in any quadrant. This exposure shall apply to any building located within Exposure B type terrain where the building is directly adjacent to open areas of Exposure C type terrain in any quadrant for a distance of more than 600 feet (183 m). This category includes flat, open country and grasslands.
3. Exposure D. Flat, unobstructed areas exposed to wind flowing over open water, smooth mud flats, salt flats and unbroken ice for a distance of not less than 5,000 feet (1524 m). This exposure shall apply only to those buildings and other structures exposed to the wind coming from over the unobstructed area. Exposure D extends downwind from the edge of the unobstructed area a distance of 600 feet (183 m) or 20 times the height of the building or structure, whichever is greater.

R301.2.1.5 Topographic wind effects. Deleted.

R301.2.1.5.1 Simplified topographic wind speed-up method. Deleted.

R301.2.2 Townhouse seismic provisions. *Townhouses* in Seismic Design Category C shall be constructed in accordance with the requirements of this section and other seismic requirements of this code.

R301.2.2.1 Determination of seismic design category. Buildings shall be assigned a seismic design category in accordance with Table R301.2(7).

R301.2.2.1.1 Alternate determination of seismic design category. Deleted.

R301.2.2.1.2 Alternative determination of Seismic Design Category E. Deleted.

R301.2.2.2 Weights of materials. Average dead loads shall not exceed 15 pounds per square foot (720 Pa) for the combined roof and ceiling assemblies (on a horizontal projection) or 10 pounds per square foot (480 Pa) for floor assemblies, except as further limited by Section R301.2.2. Dead loads for walls above *grade* shall not exceed:

1. Fifteen pounds per square foot (720 Pa) for exterior light-frame wood walls.
2. Deleted.
3. Ten pounds per square foot (480 Pa) for interior light-frame wood walls.
4. Deleted.
5. Eighty pounds per square foot (3830 Pa) for 8-inch-thick (203 mm) masonry walls.
6. Eighty-five pounds per square foot (4070 Pa) for 6-inch-thick (152 mm) concrete walls.
7. Ten pounds per square foot (480 Pa) for SIP walls.

Exceptions:

1. Deleted.
2. Light-frame walls with stone or masonry veneer shall be permitted in accordance with the provisions of Sections R702.1 and R703.
3. Fireplaces and chimneys shall be permitted in accordance with Chapter 10.

R301.2.2.3 Stone and masonry veneer. Anchored stone and masonry veneer shall comply with the requirements of Sections R702.1 and R703.

R301.2.2.4 Masonry construction. Masonry construction shall comply with the requirements of Section R606.12.

R301.2.2.5 Concrete construction. *Townhouses* with exterior above-*grade* concrete walls shall comply with PCA 100 or shall be designed in accordance with ACI 318.

Exception: Deleted.

R301.2.2.6 Irregular townhouses. The seismic provisions of this code shall not be used for structures, or portions thereof, located in *Seismic Design Category* C and considered to be irregular in accordance with this section. A building or portion of a building shall be considered to be irregular where one or more of the conditions defined in Items 1 through 8 occur. Irregular structures, or irregular portions of structures, shall be designed in accordance with accepted engineering practice to the extent the irregular features affect the performance of the remaining structural system. Where the forces associated with the irregularity are resisted by a structural system designed in accordance with accepted engineering practice, the remainder of the building shall be permitted to be designed using the provisions of this code.

1. ***Shear wall* or braced wall offsets out of plane.** Conditions where exterior *shear wall* lines or *braced wall panels* are not in one plane vertically from the foundation to the uppermost story in which they are required.

Exception: For wood *light-frame construction*, floors with cantilevers or setbacks not exceeding four times the nominal depth of the wood floor joists are permitted to support *braced wall panels* that are out of plane with *braced wall panels* below provided that all of the following are satisfied:

1. Floor joists are nominal 2 inches by 10 inches (51 mm by 254 mm) or larger and spaced not more than 16 inches (406 mm) on center.
2. The ratio of the back span to the cantilever is not less than 2 to 1.
3. Floor joists at ends of *braced wall panels* are doubled.
4. For wood-frame construction, a continuous rim joist is connected to ends of cantilever joists. Where spliced, the rim joists shall be spliced using a galvanized metal tie not less than 0.058 inch (1.5 mm) (16 gage) and $1^1/_2$ inches (38 mm) wide fastened with six 16d nails on each side of the splice; or a block of the same size as the rim joist and of sufficient length to fit securely between the joist space at which the splice occurs, fastened with eight 16d nails on each side of the splice.
5. Gravity loads carried at the end of cantilevered joists are limited to uniform wall and roof loads and the reactions from headers having a span of 8 feet (2438 mm) or less.

2. **Lateral support of roofs and floors.** Conditions where a section of floor or roof is not laterally supported by *shear walls* or *braced wall lines* on all edges.

   Exception: Portions of floors that do not support *shear walls*, *braced wall panels* above, or roofs shall be permitted to extend not more than 6 feet (1829 mm) beyond a *shear wall* or *braced wall line*.

3. ***Shear wall* or braced wall offsets in plane.** Conditions where the end of a *braced wall panel* occurs over an opening in the wall below and extends more than 1 foot (305 mm) horizontally past the edge of the opening. This provision is applicable to *shear walls* and *braced wall panels* offset in plane and to *braced wall panels* offset out of plane in accordance with the exception to Item 1.

   Exception: For wood light-frame wall construction, one end of a *braced wall panel* shall be permitted to extend more than 1 foot (305 mm) over an opening not more than 8 feet (2438 mm) in width in the wall below provided that the opening includes a header in accordance with all of the following:

   1. The building width, loading condition and framing member species limitations of Table R602.7(1) shall apply.
   2. The header is composed of:
      2.1. Not less than one 2 × 12 or two 2 × 10 for an opening not more than 4 feet (1219 mm) wide.
      2.2. Not less than two 2 × 12 or three 2 × 10 for an opening not more than 6 feet (1829 mm) in width.
      2.3. Not less than three 2 × 12 or four 2 × 10 for an opening not more than 8 feet (2438 mm) in width.
   3. The entire length of the *braced wall panel* does not occur over an opening in the wall below.

4. **Floor and roof opening.** Conditions where an opening in a floor or roof exceeds the lesser of 12 feet (3658 mm) or 50 percent of the least floor or roof dimension.
5. **Floor level offset.** Conditions where portions of a floor level are vertically offset.

   Exceptions:

   1. Framing supported directly by continuous foundations at the perimeter of the building.
   2. For wood *light-frame construction*, floors shall be permitted to be vertically offset where the floor framing is lapped or tied together as required by Section R502.6.1.

6. **Perpendicular *shear wall* and wall bracing.** Conditions where *shear walls* and *braced wall lines* do not occur in two perpendicular directions.
7. **Wall bracing in stories containing masonry or concrete construction.** Conditions where stories above *grade plane* are partially or completely braced by wood wall framing in accordance with Section R602 or cold-formed steel wall framing in accordance with Section R603 include masonry or concrete construction. Where this irregularity applies, the entire story shall be designed in accordance with accepted engineering practice.

   Exception: Fireplaces, chimneys and masonry veneer in accordance with this code.

8. **Hillside *light-frame construction*.** Conditions in which all of the following apply:

8.1. The grade slope exceeds 1 unit vertical in 5 units horizontal where averaged across the full length of any side of the dwelling.

8.2. The tallest cripple wall clear height exceeds 7 feet (2134 mm), or where a post and beam system occurs at the dwelling perimeter, the post and beam system tallest post clear height exceeds 7 feet (2134 mm).

8.3. Of the total plan area below the lowest framed floor, whether open or enclosed, less than 50 percent is living space having interior wall finishes conforming to Section R702.

Where Item 8 is applicable, design in accordance with accepted engineering practice shall be provided for the floor immediately above the cripple walls or post and beam system and all structural elements and connections from this diaphragm down to and including connections to the foundation and design of the foundation to transfer lateral loads from the framing above.

Exception: *Light-frame construction* in which the lowest framed floor is supported directly on concrete or masonry walls over the full length of all sides except the downhill side of the dwelling need not be considered an irregular dwelling under Item 8.

R301.2.2.7 Height limitations. Wood-framed buildings shall be limited to three *stories* above *grade plane* or the limits given in Table R602.10.3(3). *Mezzanines* as defined in Section R202 that comply with Section R325 shall not be considered as *stories*. *Structural insulated panel* buildings shall be limited to two *stories* above *grade plane*.

R301.2.2.8 Cold-formed steel framing in Seismic Design Categories D_0, D_1 and D_2. Deleted.

R301.2.2.9 Masonry chimneys. Deleted.

R301.2.2.10 Anchorage of water heaters. Deleted.

R301.2.3 Snow loads. Deleted.

R301.2.4 Floodplain construction. Buildings and structures constructed in whole or in part in flood hazard areas (including A or V Zones) as established in Table R301.2, and substantial improvement and *repair* of substantial damage of buildings and structures in flood hazard areas, shall be designed and constructed in accordance with Section R322. Buildings and structures that are located in more than one flood hazard area shall comply with the provisions associated with the most restrictive flood hazard area. Buildings and structures located in whole or in part in identified floodways shall be designed and constructed in accordance with ASCE 24.

R301.2.4.1 Alternative provisions. As an alternative to the requirements in Section R322, ASCE 24 is permitted subject to the limitations of this code and the limitations therein.

R301.3 Story height. The wind and seismic provisions of this code shall apply to buildings with *story heights* not exceeding the following:

1. For wood wall framing, the *story height* shall not exceed 11 feet 7 inches (3531 mm) and the laterally unsupported bearing wall stud height permitted by Table R602.3(5).

   Exception: A *story height* not exceeding 13 feet 7 inches (4140 mm) is permitted provided that the maximum wall stud clear height does not exceed 12 feet (3658 mm), the wall studs are in accordance with Exception 2 or 3 of Section R602.3.1 or an engineered design is provided for the wall framing members, and wall bracing for the building is in accordance with Section R602.10. Studs shall be laterally supported at the top and bottom plate in accordance with Section R602.3.

2. Deleted.
3. For masonry walls, the *story height* shall be not more than 13 feet 7 inches (4140 mm) and the bearing wall clear height shall be not more than 12 feet (3658 mm).

   Exception: An additional 8 feet (2438 mm) of bearing wall clear height is permitted for gable end walls.

4. For insulating concrete form walls, the maximum *story height* shall not exceed 11 feet 7 inches (3531 mm) and the maximum unsupported wall height per *story* as permitted by Section R608 tables shall not exceed 10 feet (3048 mm).
5. For structural insulated panel (SIP) walls, the *story height* shall be not more than 11 feet 7 inches (3531 mm) and the bearing wall height per *story* as permitted by Section R610 tables shall not exceed 10 feet (3048 mm).

For walls other than wood-framed walls, individual walls or wall studs shall be permitted to exceed these limits as permitted by Chapter 6, provided that the *story heights* of this section are not exceeded. An engineered design shall be provided for the wall or wall framing members where the limits of Chapter 6 are exceeded. Where the *story height* limits of this section are exceeded, the design of the building, or the noncompliant portions thereof, to resist wind and seismic loads shall be in accordance with the *International Building Code*.

R301.4 Dead load. The actual weights of materials and construction shall be used for determining dead load with consideration for the dead load of fixed service equipment.

R301.5 Live load. The minimum uniformly distributed *live load* shall be as provided in Table R301.5.

R301.6 Roof load. The roof shall be designed for the *live load* indicated Table R301.2.

TABLE R301.5
MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS (in pounds per square foot)

USE	UNIFORM LOAD (psf)	CONCENTRATED LOAD (lb)
Uninhabitable attics without storage[b]	10	—
Uninhabitable attics with limited storage[b, g]	20	—
Habitable attics and attics served with fixed stairs	30	—
Balconies (exterior) and decks[e]	40	—
Fire escapes	40	—
Guards	—	200[h, i]
Guard in-fill components[f]	—	50[h]
Handrail[d]	—	200[h]
Passenger vehicle garages	50	2,000[a]
Areas other than sleeping areas	40	—
Sleeping areas	30	—
Stairs	40[c]	300[c]

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa, 1 square inch = 645 mm^2, 1 pound = 4.45 N.

a. Elevated garage floors shall be capable of supporting the uniformly distributed live load or a 2,000-pound concentrated load applied on an area of $4^1/_2$ inches by $4^1/_2$ inches, whichever produces the greater stresses.

b. Uninhabitable attics without storage are those where the clear height between joists and rafters is not more than 42 inches, or where there are not two or more adjacent trusses with web configurations capable of accommodating an assumed rectangle 42 inches in height by 24 inches in width, or greater, within the plane of the trusses. This live load need not be assumed to act concurrently with any other live load requirements.

c. Individual stair treads shall be capable of supporting the uniformly distributed live load or a 300-pound concentrated load applied on an area of 2 inches by 2 inches, whichever produces the greater stresses.

d. A single concentrated load applied in any direction at any point along the top. For a guard not required to serve as a handrail, the load need not be applied to the top element of the guard in a direction parallel to such element.

e. See Chapter 47 for decks attached to exterior walls.

f. Guard in-fill components (all those except the handrail), balusters and panel fillers shall be designed to withstand a horizontally applied normal load of 50 pounds on an area equal to 1 square foot. This load need not be assumed to act concurrently with any other live load requirement.

g. Uninhabitable attics with limited storage are those where the clear height between joists and rafters is 42 inches or greater, or where there are two or more adjacent trusses with web configurations capable of accommodating an assumed rectangle 42 inches in height by 24 inches in width, or greater, within the plane of the trusses.

The live load need only be applied to those portions of the joists or truss bottom chords where all of the following conditions are met:

1. The attic area is accessed from an opening not less than 20 inches in width by 30 inches in length that is located where the clear height in the attic is not less than 30 inches.
2. The slopes of the joists or truss bottom chords are not greater than 2 units vertical in 12 units horizontal.
3. Required insulation depth is less than the joist or truss bottom chord member depth.

The remaining portions of the joists or truss bottom chords shall be designed for a uniformly distributed concurrent live load of not less than 10 pounds per square foot.

h. Glazing used in handrail assemblies and guards shall be designed with a load adjustment factor of 4. The load adjustment factor shall be applied to each of the concentrated loads applied to the top of the rail, and to the load on the in-fill components. These loads shall be determined independent of one another, and loads are assumed not to occur with any other live load.

i. Where the top of a guard system is not required to serve as a handrail, the single concentrated load shall be applied at any point along the top, in the vertical downward direction and in the horizontal direction away from the walking surface. Where the top of a guard is also serving as the handrail, a single concentrated load shall be applied in any direction at any point along the top. Concentrated loads shall not be applied concurrently.

R301.7 Deflection. The allowable deflection of any structural member under the *live load* listed in Sections R301.5 and R301.6 or wind loads determined by Section R301.2.1 shall not exceed the values in Table R301.7.

R301.8 Nominal sizes. For the purposes of this code, dimensions of lumber specified shall be deemed to be nominal dimensions unless specifically designated as actual dimensions.

SECTION R302
FIRE-RESISTANT CONSTRUCTION

R302.1 Exterior walls. Construction, projections, openings and penetrations of exterior walls of *dwellings* and accessory buildings shall comply with Table R302.1(1); or *dwellings* equipped throughout with an *automatic sprinkler system* installed in accordance with Section P2904 shall comply with Table R302.1(2).

TABLE R301.7
ALLOWABLE DEFLECTION OF STRUCTURAL MEMBERS[b, c]

STRUCTURAL MEMBER	ALLOWABLE DEFLECTION
Rafters having slopes greater than 3:12 with finished ceiling not attached to rafters	*L*/180
Interior walls and partitions	*H*/180
Floors	*L*/360[f]
Ceilings with brittle finishes (including plaster and stucco)	*L*/360
Ceilings with flexible finishes (including gypsum board)	*L*/240
All other structural members	*L*/240
Exterior walls—wind loads[a] with plaster or stucco finish	*H*/360
Exterior walls—wind loads[a] with other brittle finishes	*H*/240
Exterior walls—wind loads[a] with flexible finishes	*H*/120[d]
Lintels supporting masonry veneer walls[e]	*L*/600

Note: *L* = span length, *H* = span height.

a. For the purpose of the determining deflection limits herein, the wind load shall be permitted to be taken as 0.7 times the component and cladding (ASD) loads obtained from Table R301.2.1(1).

b. For cantilever members, *L* shall be taken as twice the length of the cantilever.

c. For aluminum structural members or panels used in roofs or walls of sunroom additions or patio covers, not supporting edge of glass or sandwich panels, the total load deflection shall not exceed *L*/60. For continuous aluminum structural members supporting edge of glass, the total load deflection shall not exceed *L*/175 for each glass lite or *L*/60 for the entire length of the member, whichever is more stringent. For sandwich panels used in roofs or walls of sunroom additions or patio covers, the total load deflection shall not exceed *L*/120.

d. Deflection for exterior walls with interior gypsum board finish shall be limited to an allowable deflection of *H*/180.

e. Refer to Section R703.8.2. The dead load of supported materials shall be included when calculating the deflection of these members.

f. When floor spans exceed 20 feet, joists, built-up beams and trusses shall not be spaced greater than 24 inches and deflection shall not exceed L/480.

Exceptions:

1. Walls, projections, openings or penetrations in walls perpendicular to the line used to determine the *fire separation distance*. *Townhouse* eave projections shall comply with Sections R302.2.7 and R302.2.8.
2. Walls of *individual dwelling units* and their *accessory structures* located on the same *lot*.
3. Detached tool sheds and storage sheds, playhouses and similar structures exempted from *permits* are not required to provide wall protection based on location on the *lot*. Projections beyond the exterior wall shall not extend over the *lot line*.
4. Detached garages accessory to a *dwelling* located within 3 feet (915 mm) of a *lot line* are permitted to have non-fire-resistance rated roof eave projections not exceeding 16 inches (407 mm).
5. Foundation vents installed in compliance with this code are permitted.

TABLE R302.1(2)
EXTERIOR WALLS--DWELLINGS WITH FIRE SPRINKLERS
DELETED

R302.1.1 Soffit protection. In construction using vinyl or aluminum soffit material, the following application shall apply. Soffit assemblies located on buildings with less than a 5 feet (1524 mm) fire separation distance shall be securely attached to framing members and applied over fire-retardant-treated wood, $^{23}/_{32}$-inch (18.3 mm) wood sheathing or $^{5}/_{8}$-inch (15.9 mm) exterior grade or moisture resistant gypsum board. Venting requirements shall be provided in both soffit and underlayments. Vents shall be either nominal 2-inch (51 mm) continuous or equivalent intermittent and shall not exceed the minimum net free air requirements established in Section R806.2 by more than 50 percent. *Townhouse* construction shall meet the additional requirements of Sections R302.2.7 and R302.2.8.

Exceptions:

1. Any portion of soffits having 5 feet (1524 mm) or more *fire separation distance*.
2. Roof rake lines where the soffit does not communicate to the attic are not required to be protected in accordance with this section.
3. Soffits with less than 3 feet (914 mm) *fire separation distance* shall meet the projection fire rating requirements of Table R302.1.
4. Soffits between buildings located on the same lot.

R302.1.2 Flame spread. Vinyl siding and vinyl soffit materials shall have a flame spread index of 25 or less as tested in accordance with ASTM E84.

R302.2 Townhouses. Walls separating *townhouse units* shall be constructed in accordance with Section R302.2.1 or R302.2.2 and shall comply with Sections R302.2.3 through R302.2.5.

R302.2.1 Double walls. Each *townhouse unit* shall be separated from other *townhouse units* by two 1-hour fire-resistance-rated wall assemblies tested in accordance with ASTM E119, UL 263 or Section 703.2.2 of the 2024 *North Carolina Building Code.*

R302.2.2 Common walls. Common walls separating *townhouse units* shall be assigned a fire-resistance rating in accordance with Item 1 or 2 and shall be rated for fire

TABLE R302.1
EXTERIOR WALLS

EXTERIOR WALL ELEMENT		MINIMUM FIRE-RESISTANCE RATING	MINIMUM FIRE SEPARATION DISTANCE
Walls	Fire-resistance rated	1 hour—tested in accordance with ASTM E119, UL 263 or Section 703.3 of the *International Building Code* with exposure from both sides	< 3 feet < 5 feet[c]
	Not fire-resistance rated	0 hours	≥ 3 feet > 5 feet[c]
Projections	Fire-resistance rated	1 hour on the underside, or heavy timber, or fire-retardant-treated wood[a, b]	< 3 feet < 5 feet[c]
	Not fire-resistance rated	0 hours	> 3feet > 5 feet[c]
Openings in walls	Not allowed	NA	< 3 feet < 5 feet[c]
	Unlimited	0 hours	3 feet > 5 feet[c]
Penetrations	All	Comply with Section R302.4	< 3 feet < 5 feet[c]
		None required	3 feet > 5 feet[c]

For SI: 1 foot = 304.8 mm.

NA = Not Applicable.

a. The fire-resistance rating shall be permitted to be reduced to 0 hours on the underside of the eave overhang if fireblocking is provided from the wall top plate to the underside of the roof sheathing.

b. The fire-resistance rating shall be permitted to be reduced to 0 hours on the underside of the rake overhang where gable vent openings are not installed.

c. Fire separation distance requirement for multiple dwellings on a single parcel.

exposure from both sides. Common walls shall extend to and be tight against the exterior sheathing of the exterior walls, or the inside face of exterior walls without stud cavities, and the underside of the roof sheathing. The common wall shared by two *townhouse units* shall be constructed without plumbing or mechanical equipment, ducts or vents, other than water-filled fire sprinkler piping in the cavity of the common wall. Penetrations of the membrane of common walls for electrical outlet boxes shall be in accordance with Section R302.4.

1. Where an automatic sprinkler system in accordance with Section P2904 is provided, the common wall shall be not less than a 1-hour fire-resistance-rated wall assembly tested in accordance with ASTM E119, UL 263 or Section 703.2.2 of the *International Building Code*.
2. Where an automatic sprinkler system in accordance with Section P2904 is not provided, the common wall shall be not less than a 2-hour fire-resistance-rated wall assembly tested in accordance with ASTM E119, UL 263 or Section 703.2.2 of the *International Building Code*.

Exception: Common walls are permitted to extend to and be tight against the inside of the exterior walls if the cavity between the end of the common wall and the exterior sheathing is filled with a minimum of two 2-inch nominal thickness wood studs.

R302.2.3 Continuity. The fire-resistance-rated wall or assembly separating *townhouse units* shall be continuous from the foundation to the underside of the roof sheathing, deck or slab. The fire-resistance rating shall extend the full length of the wall or assembly from exterior sheathing to exterior sheathing, including wall extensions through and separating attached enclosed *accessory structures*.

R302.2.4 Parapets for townhouses. Parapets constructed in accordance with Section R302.2.5 shall be constructed for *townhouses* as an extension of exterior walls or common walls separating *townhouse units* in accordance with the following:

1. Where roof surfaces adjacent to the wall or walls are at the same elevation, the parapet shall extend not less than 30 inches (762 mm) above the roof surfaces.
2. Where roof surfaces adjacent to the wall or walls are at different elevations and the higher roof is not more than 30 inches (762 mm) above the lower roof, the parapet shall extend not less than 30 inches (762 mm) above the lower roof surface.

Exception: A parapet is not required in the preceding two cases where the roof covering complies with a minimum Class C rating as tested in accordance with ASTM E108 or UL 790 and the roof decking or sheathing is of *noncombustible materials* or fire-retardant-

treated wood for a distance of 4 feet (1219 mm) on each side of the wall or walls, or one layer of $^5/_8$-inch (15.9 mm) Type X gypsum board is installed directly beneath the roof decking or sheathing, supported by not less than nominal 2-inch (51 mm) ledgers attached to the sides of the roof framing members, for a distance of not less than 4 feet (1219 mm) on each side of the wall or walls and any openings or penetrations in the roof are not within 4 feet (1219 mm) of the common walls. Fire-retardant-treated wood shall meet the requirements of Sections R802.1.5 and R803.2.1.2.

3. A parapet is not required where roof surfaces adjacent to the wall or walls are at different elevations and the higher roof is more than 30 inches (762 mm) above the lower roof. The common wall construction from the lower roof to the underside of the higher *roof deck* shall have not less than a 1-hour fire-resistance rating. The wall shall be rated for exposure from both sides.

R302.2.5 Parapet construction. Parapets shall have the same fire-resistance rating as that required for the supporting wall or walls. On any side adjacent to a roof surface, the parapet shall have noncombustible faces for the uppermost 18 inches (457 mm), to include counterflashing and coping materials. Where the roof slopes toward a parapet at slopes greater than 2 units vertical in 12 units horizontal (16.7-percent slope), the parapet shall extend to the same height as any portion of the roof within a distance of 3 feet (914 mm), and the height shall be not less than 30 inches (762 mm).

R302.2.6 Structural independence. Each *townhouse unit* shall be structurally independent.

Exceptions:

1. Foundations supporting exterior walls or common walls.
2. Structural roof and wall sheathing from each unit fastened to the common wall framing.
3. Nonstructural wall and roof coverings.
4. Flashing at termination of roof covering over common wall.
5. *Townhouse units* separated by a common wall as provided in Section R302.2.2, Item 1 or 2.
6. *Townhouse units* protected by a fire sprinkler system complying with Section P2904 or NFPA 13D.

R302.2.7 Townhouse eave protection. In *townhouse* construction projections extending into the fire separation distance shall have not less than 1-hour fire-resistive-construction on the underside. Soffit material beyond the fire separation distance shall be securely attached to framing members and shall be constructed using either noncombustible soffit material; fire-retardant-treated soffit material; vinyl soffit installed over $^3/_4$-inch (19 mm) wood sheathing or $^5/_8$-inch (15.9 mm) gypsum board; or aluminum soffit installed over $^3/_4$-inch (19 mm) wood sheathing or $^5/_8$-inch (15.9 mm) gypsum board. Venting requirements shall be provided in both soffit and underlayments. Vents shall be either nominal 2-inch (51 mm) continuous or equivalent intermittent and shall not exceed the minimum net free air requirements established in Section R806.2 by more than 50 percent. Vents in soffit are not allowed within 4 feet (1219 mm) of fire walls or property lines.

R302.2.8 Townhouse eave projections. Overhang projections not exceeding 12 inches (305 mm) shall be allowed to extend beyond the property line in *townhouse* buildings provided all the following conditions are met:

1. Required fire-resistant-rated wall assembly is tight to roof deck;
2. Eaves shall be protected with roof decking and fascia of noncombustible materials or approved fire-retardant-treated wood; and
3. Eaves shall have not less than one layer of 5/8-inch (15.9 mm) Type X gypsum board or equivalent fire resistive construction on the underside.

R302.2.9 Sound transmission. See Appendix K.

R302.3 Two-family dwellings. *Dwelling units* in two-family dwellings shall be separated from each other by wall and floor assemblies having not less than a 1-hour fire-resistance rating where tested in accordance with ASTM E119, UL 263 or Section 703.2.2 of the *International Building Code*. Such separation shall be provided regardless of whether a *lot line* exists between the two dwelling units or not. Fire-resistance-rated floor/ceiling and wall assemblies shall extend to and be tight against the exterior wall, and wall assemblies shall extend from the foundation to the underside of the roof sheathing.

Exceptions:

1. A fire-resistance rating of $^1/_2$ hour shall be permitted in buildings equipped throughout with an automatic sprinkler system installed in accordance with Section P2904.
2. Wall assemblies need not extend through attic spaces where the ceiling is protected by not less than $^5/_8$-inch (15.9 mm) Type X gypsum board, an attic draft stop constructed as specified in Section R302.12.1 is provided above and along the wall assembly separating the *dwellings* and the structural framing supporting the ceiling is protected by not less than $^1/_2$-inch (12.7 mm) gypsum board or equivalent.

R302.3.1 Supporting construction. Where floor assemblies are required to be fire-resistance rated by Section R302.3, the supporting construction of such assemblies shall have an equal or greater fire-resistance rating.

R302.4 Dwelling unit rated penetrations. Penetrations of wall or floor-ceiling assemblies required to be fire-resistance rated in accordance with Section R302.2 or R302.3 shall be protected in accordance with this section.

R302.4.1 Through penetrations. Through penetrations of fire-resistance-rated wall or floor assemblies shall comply with Section R302.4.1.1 or R302.4.1.2.

Exceptions:

1. Where the penetrating items are steel, ferrous or copper pipes, tubes or conduits, the annular space shall be protected as follows:
    1.1. In concrete or masonry wall or floor assemblies, concrete, grout or mortar shall be permitted where installed to the full thickness of the wall or floor assembly or the thickness required to maintain the fire-resistance rating, provided that both of the following are complied with:
        1.1.1. The nominal diameter of the penetrating item is not more than 6 inches (152 mm).
        1.1.2. The area of the opening through the wall does not exceed 144 square inches (92 900 mm^2).
    1.2. The material used to fill the annular space shall prevent the passage of flame and hot gases sufficient to ignite cotton waste where subjected to ASTM E119 or UL 263 time temperature fire conditions under a positive pressure differential of not less than 0.01 inch of water (3 Pa) at the location of the penetration for the time period equivalent to the fire-resistance rating of the construction penetrated.
2. The annular space created by the penetration of water-filled fire sprinkler piping, provided that the annular space is filled using a material complying with Item 1.2 of Exception 1.

R302.4.1.1 Fire-resistance-rated assembly. Penetrations shall be installed as tested in the *approved* fire-resistance-rated assembly.

R302.4.1.2 Penetration firestop system. Penetrations shall be protected by an *approved* penetration firestop system installed as tested in accordance with ASTM E814 or UL 1479, with a positive pressure differential of not less than 0.01 inch of water (3 Pa) and shall have an F rating of not less than the required fire-resistance rating of the wall or floor-ceiling assembly penetrated.

R302.4.2 Membrane penetrations. Membrane penetrations shall comply with Section R302.4.1. Where walls are required to have a fire-resistance rating, recessed fixtures shall be installed so that the required fire-resistance rating will not be reduced.

Exceptions:

1. Membrane penetrations of not more than 2-hour fire-resistance-rated walls and partitions by steel electrical boxes that do not exceed 16 square inches (0.0103 m^2) in area provided that the aggregate area of the openings through the membrane does not exceed 100 square inches (0.0645 m^2) in any 100 square feet (9.29 m^2) of wall area. The annular space between the wall membrane and the box shall not exceed $^1/_8$ inch (3.1 mm). Such boxes on opposite sides of the wall shall be separated by one of the following:
    1.1. By a horizontal distance of not less than 24 inches (610 mm) where the wall or partition is constructed with individual noncommunicating stud cavities.
    1.2. By a horizontal distance of not less than the depth of the wall cavity where the wall cavity is filled with cellulose loose-fill, rockwool or slag mineral wool insulation.
    1.3. By solid fireblocking in accordance with Section R302.11.
    1.4. By protecting both boxes with *listed* putty pads.
    1.5. By other *listed* materials and methods.
2. Membrane penetrations by *listed* electrical boxes of any materials provided that the boxes have been tested for use in fire-resistance-rated assemblies and are installed in accordance with the instructions included in the *listing*. The annular space between the wall membrane and the box shall not exceed $^1/_8$ inch (3.1 mm) unless *listed* otherwise. Such boxes on opposite sides of the wall shall be separated by one of the following:
    2.1. By the horizontal distance specified in the *listing* of the electrical boxes.
    2.2. By solid fireblocking in accordance with Section R302.11.
    2.3. By protecting both boxes with *listed* putty pads.
    2.4. By other *listed* materials and methods.
3. The annular space created by the penetration of a fire sprinkler or water-filled fire sprinkler piping, provided that the annular space is covered by a metal escutcheon plate.
4. Ceiling membrane penetrations by *listed* luminaires or by luminaires protected with *listed* materials that have been tested for use in fire-resistance-rated assemblies and are installed in accordance with the instructions included in the *listing*.

R302.5 Dwelling-garage opening and penetration protection. Openings and penetrations through the walls or ceilings separating the *dwelling* from the garage shall be in accordance with Sections R302.5.1 through R302.5.3.

R302.5.1 Opening protection. Openings from a private garage directly into a room used for sleeping purposes shall not be permitted. Other openings between the garage and residence shall be equipped with solid wood doors not less than $1^3/_8$ inches (35 mm) in thickness, solid or honeycomb-core steel doors not less than $1^3/_8$ inches (35 mm) thick, or 20-minute fire-rated doors.

Exception: A disappearing/pull-down stairway to uninhabited attic space with minimum $^3/_8$-inch (9.53 mm) (nominal) fire-retardant-treated structural panel is equivalent to the separation requirement from attics in Table R302.6.

R302.5.2 Duct penetration. Ducts in the garage and ducts penetrating the walls or ceilings separating the *dwelling* from the garage shall be constructed of a minimum No. 26 gage (0.48 mm) sheet steel or other *approved* material and shall not have openings into the garage.

R302.5.3 Other penetrations. Penetrations through the separation required in Section R302.6 shall be protected as required by Section R302.11, Item 4.

R302.6 Dwelling-garage fire separation. The garage shall be separated as required by Table R302.6. Openings in garage walls shall comply with Section R302.5. Attachment of gypsum board shall comply with Table R702.3.5. The wall separation provisions of Table R302.6 shall not apply to garage walls that are perpendicular to the adjacent *dwelling unit* wall.

R302.7 Under-stair protection. Enclosed accessible space under stairs shall have walls, under-stair surface and any soffits protected on the enclosed side with $^1/_2$-inch (12.7 mm) gypsum board.

R302.8 Foam plastics. For requirements for foam plastics, see Section R316.

R302.8.1 Interior finish. Foam plastics used as interior finishes shall comply with Section R316.5.10.

R302.9 Flame spread index and smoke-developed index for wall and ceiling finishes. Flame spread and smoke-developed indices for wall and ceiling finishes shall be in accordance with Sections R302.9.1 through R302.9.4.

R302.9.1 Flame spread index. Wall and ceiling finishes shall have a flame spread index of not greater than 200.

Exception: Flame spread index requirements for finishes shall not apply to *trim* defined as picture molds, chair rails, baseboards and *handrails*; to doors and windows or their frames; or to materials that are less than $^1/_{28}$ inch (0.91 mm) in thickness cemented to the surface of walls or ceilings if these materials exhibit flame spread index values not greater than those of paper of this thickness cemented to a noncombustible backing.

R302.9.2 Smoke-developed index. Wall and ceiling finishes shall have a *smoke-developed index* of not greater than 450.

R302.9.3 Testing. Tests shall be made in accordance with ASTM E84 or UL 723.

R302.9.4 Alternative test method. As an alternative to having a flame spread index of not greater than 200 and a *smoke-developed index* of not greater than 450 where tested in accordance with ASTM E84 or UL 723, wall and ceiling finishes shall be permitted to be tested in accordance with NFPA 286. Materials tested in accordance with NFPA 286 shall meet the following criteria:

The interior finish shall comply with the following:

1. During the 40 kW exposure, flames shall not spread to the ceiling.
2. The flame shall not spread to the outer extremity of the sample on any wall or ceiling.
3. Flashover, as defined in NFPA 286, shall not occur.
4. The peak heat release rate throughout the test shall not exceed 800 kW.
5. The total smoke released throughout the test shall not exceed 1,000 m^2.

R302.9.5 High-density polyethylene (HDPE) and polypropylene (PP). Where high-density polyethylene or polypropylene is used as an interior finish material, it shall be tested in accordance with NFPA 286 and comply with the criteria in Section R302.9.4.

R302.10 Flame spread index and smoke-developed index for insulation. Flame spread and *smoke-developed index* for

TABLE R302.6
DWELLING-GARAGE SEPARATION[b]

SEPARATION	MATERIAL
From the residence and attics	Not less than $^1/_2$-inch gypsum board or equivalent applied to the garage side
From habitable rooms above the garage[a]	Not less than $^5/_8$-inch Type X gypsum board or equivalent
Structure(s) supporting floor/ceiling assemblies used for separation required by this section	Not less than $^1/_2$-inch gypsum board or equivalent
Garages located less than 3 feet from a dwelling unit on the same lot	Not less than $^1/_2$-inch gypsum board or equivalent applied to the interior side of exterior walls that are within this area

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

a. For dwelling units constructed prior to the 2012 *North Carolina Residential Code* edition, $^1/_2$ inch or greater existing gypsum board on the bottom side of the garage ceiling shall be acceptable. Joints shall be taped.

b. Residential aircraft hangar shall comply with *North Carolina Building Code* Section 412.4.

insulation shall be in accordance with Sections R302.10.1 through R302.10.5.

R302.10.1 Insulation. Insulating materials installed within floor-ceiling assemblies, roof-ceiling assemblies, wall assemblies, crawl spaces and *attics* shall comply with the requirements of this section. They shall exhibit a flame spread index not to exceed 25 and a *smoke-developed index* not to exceed 450 where tested in accordance with ASTM E84 or UL 723. Insulating materials, where tested in accordance with the requirements of this section, shall include facings, where used, such as vapor retarders, *vapor permeable* membranes and similar coverings.

Exceptions:

1. Where such materials are installed in concealed spaces, the flame spread index and *smoke-developed index* limitations do not apply to the facings, provided that the facing is installed in substantial contact with the unexposed surface of the ceiling, floor or wall finish.
2. Cellulose fiber loose-fill insulation that is not spray applied and that complies with the requirements of Section R302.10.3 shall not be required to meet the flame spread index requirements but shall be required to meet a *smoke-developed index* of not more than 450 where tested in accordance with CAN/ULC S102.2.
3. Foam plastic insulation shall comply with Section R316.

R302.10.2 Loose-fill insulation. Loose-fill insulation materials that cannot be mounted in the ASTM E84 or UL 723 apparatus without a screen or artificial supports shall comply with the flame spread and smoke-developed limits of Section R302.10.1 where tested in accordance with CAN/ULC S102.2.

Exception: Cellulosic fiber loose-fill insulation shall not be required to be tested in accordance with CAN/ULC S102.2, provided that such insulation complies with the requirements of Sections R302.10.1 and R302.10.3.

R302.10.3 Cellulosic fiber loose-fill insulation. Cellulosic fiber loose-fill insulation shall comply with CPSC 16 CFR, Parts 1209 and 1404. Each package of such insulating material shall be clearly *labeled* in accordance with CPSC 16 CFR, Parts 1209 and 1404.

R302.10.4 Exposed attic insulation. Exposed insulation materials installed on attic floors shall have a critical radiant flux of not less than 0.12 watt per square centimeter.

R302.10.5 Testing. Tests for critical radiant flux shall be made in accordance with ASTM E970.

R302.11 Fireblocking. In combustible construction, fireblocking shall be provided to cut off both vertical and horizontal concealed draft openings and to form an effective fire barrier between stories, and between a top story and the roof space.

Fireblocking shall be provided in wood-framed construction in the following locations:

1. In concealed spaces of stud walls and partitions, including furred spaces and parallel rows of studs or staggered studs, as follows:
   1.1. Vertically at the ceiling and floor levels.
   1.2. Horizontally at intervals not exceeding 10 feet (3048 mm) in furred spaces, parallel rows of studs, or staggered studs.
2. At interconnections between concealed vertical and horizontal spaces such as occur at soffits, drop ceilings and cove ceilings.
3. In concealed spaces between stair stringers at the top and bottom of the run. Enclosed spaces under stairs shall comply with Section R302.7.
4. At openings around vents, pipes, ducts, cables and wires at ceiling and floor level, with an *approved* material to resist the free passage of flame and products of combustion. The material filling this annular space shall not be required to meet the ASTM E136 requirements.
5. For the fireblocking of chimneys and fireplaces, see Section R1003.19.
6. Fireblocking of cornices of a two-family *dwelling* is required at the line of *dwelling unit* separation.

R302.11.1 Fireblocking materials. Except as provided in Section R302.11, Item 4, fireblocking shall consist of the following materials.

1. Two-inch (51 mm) nominal lumber.
2. Two thicknesses of 1-inch (25.4 mm) nominal lumber with broken lap joints.
3. One thickness of $^{23}/_{32}$-inch (18.3 mm) *wood structural panels* with joints backed by $^{23}/_{32}$-inch (18.3 mm) *wood structural panels.*
4. One thickness of $^{3}/_{4}$-inch (19.1 mm) particleboard with joints backed by $^{3}/_{4}$-inch (19.1 mm) particleboard.
5. One-half-inch (12.7 mm) gypsum board.
6. One-quarter-inch (6.4 mm) cement-based millboard.
7. Batts or blankets of mineral wool or glass fiber or other *approved* materials installed in such a manner as to be securely retained in place.
8. Cellulose insulation installed as tested in accordance with ASTM E119 or UL 263, for the specific application.

R302.11.1.1 Batts or blankets of mineral or glass fiber. Batts or blankets of mineral or glass fiber or other *approved* nonrigid materials shall be permitted for compliance with the 10-foot (3048 mm) horizontal

fireblocking in walls constructed using parallel rows of studs or staggered studs.

R302.11.1.2 Unfaced fiberglass. Unfaced fiberglass batt insulation used as fireblocking shall fill the entire cross section of the wall cavity to a height of not less than 16 inches (406 mm) measured vertically. Where piping, conduit or similar obstructions are encountered, the insulation shall be packed tightly around the obstruction.

R302.11.1.3 Loose-fill insulation material. Loose-fill insulation material shall not be used as a fireblock unless specifically tested in the form and manner intended for use to demonstrate its ability to remain in place and to retard the spread of fire and hot gases.

R302.11.2 Fireblocking integrity. The integrity of fireblocks shall be maintained.

R302.12 Draftstopping. In combustible construction where there is usable space both above and below the concealed space of a floor-ceiling assembly, draftstops shall be installed so that the area of the concealed space does not exceed 1,000 square feet (92.9 m^2). Draftstopping shall divide the concealed space into approximately equal areas. Where the assembly is enclosed by a floor membrane above and a ceiling membrane below, draftstopping shall be provided in floor-ceiling assemblies under the following circumstances:

1. Ceiling is suspended under the floor framing.
2. Floor framing is constructed of truss-type open-web or perforated members.

R302.12.1 Materials. Draftstopping materials shall be not less than $^1/_2$-inch (12.7 mm) gypsum board, $^3/_8$-inch (9.5 mm) *wood structural panels* or other *approved* materials adequately supported. Draftstopping shall be installed parallel to the floor framing members unless otherwise *approved* by the *building official*. The integrity of the draftstops shall be maintained.

R302.13 Fire protection of floors. Deleted.

R302.14 Combustible insulation clearance. Combustible insulation shall be separated not less than 3 inches (76 mm) from recessed luminaires, fan motors and other heat-producing devices.

Exception: Where heat-producing devices are *listed* for lesser clearances, combustible insulation complying with the listing requirements shall be separated in accordance with the conditions stipulated in the listing.

Recessed luminaires installed in the *building thermal envelope* shall meet the requirements of Section N1102.4.5 of this code.

SECTION R303
LIGHT, VENTILATION AND HEATING

R303.1 Habitable rooms. Habitable rooms shall have an aggregate glazing area of not less than 8 percent of the floor area of such rooms. Natural *ventilation* shall be through windows, skylights, doors, louvers or other *approved* openings to the outdoor air. Such openings shall be provided with ready access or shall otherwise be readily controllable by the building occupants. The openable area to the outdoors shall be not less than 4 percent of the floor area being ventilated.

Exceptions:

1. For habitable rooms, the glazed areas need not be openable where the opening is not required by Section R310 and a whole-house mechanical *ventilation* system is installed in accordance with Section M1507.
2. For kitchens, the glazed areas need not be openable where the opening is not required by Section R310 and a local exhaust system is installed in accordance with Section M1507.
3. The glazed areas need not be installed in rooms where Exception 1 is satisfied and artificial light is provided that is capable of producing an average illumination of 6 footcandles (65 lux) over the area of the room at a height of 30 inches (762 mm) above the floor level.
4. Use of *sunroom* and patio covers, as defined in Section R202, shall be permitted for natural *ventilation* if in excess of 40 percent of the exterior *sunroom* walls are open, or are enclosed only by insect screening.

R303.2 Adjoining rooms. For the purpose of determining light and *ventilation* requirements, rooms shall be considered to be a portion of an adjoining room where not less than one-half of the area of the common wall is open and unobstructed and provides an opening of not less than one-tenth of the floor area of the interior room and not less than 25 square feet (2.3 m^2).

Exception: Openings required for light or *ventilation* shall be permitted to open into a *sunroom* with thermal isolation or a patio cover, provided that there is an openable area between the adjoining room and the *sunroom* or patio cover of not less than one-tenth of the floor area of the interior room and not less than 20 square feet (2 m^2). The minimum openable area to the outdoors shall be based on the total floor area being ventilated.

R303.3 Bathrooms. Bathrooms, water closet compartments and other similar rooms shall be provided with aggregate glazing area in windows of not less than 3 square feet (0.3 m^2), one-half of which shall be openable.

Exception: The glazed areas shall not be required where artificial light and a local exhaust system are provided. The minimum local exhaust rates shall be determined in accordance with Section M1507. Exhaust air from the space shall be exhausted directly to the outdoors.

R303.4 Mechanical ventilation. Buildings and dwelling units complying with Section N1102.4.1 shall be provided with mechanical ventilation in accordance with Section M1507, or with other approved means of ventilation.

R303.5 Opening location. Outdoor intake and exhaust openings shall be located in accordance with Sections R303.5.1 and R303.5.2.

R303.5.1 Intake openings. Mechanical and gravity outdoor air intake openings shall be located not less than 10 feet (3048 mm) from any hazardous or noxious contaminant, such as vents, chimneys, plumbing vents, streets, alleys, parking lots and loading docks.

For the purpose of this section, the exhaust from *dwelling unit* toilet rooms, bathrooms and *kitchens* shall not be considered as hazardous or noxious.

Exceptions:

1. The 10-foot (3048 mm) separation is not required where the intake opening is located 3 feet (914 mm) or greater below the contaminant source.
2. Vents and chimneys serving fuel-burning *appliances* shall be terminated in accordance with the applicable provisions of Chapters 18 and 24.
3. Clothes dryer exhaust ducts shall be terminated in accordance with Section M1502.3.

R303.5.2 Exhaust openings. Exhaust air shall not be directed onto walkways.

R303.6 Outside opening protection. Air exhaust and intake openings that terminate outdoors shall be protected with corrosion-resistant screens, louvers or grilles having an opening size of not less than $^1/_4$ inch (6 mm) and a maximum opening size of $^1/_2$ inch (13 mm), in any dimension. Openings shall be protected against local weather conditions. Outdoor air exhaust and intake openings shall meet the provisions for exterior wall opening protectives in accordance with this code.

R303.7 Interior stairway illumination. Interior *stairways* shall be provided with an artificial light source to illuminate the landings and treads. The light source shall be capable of illuminating treads and landings to levels of not less than 1 footcandle (11 lux) as measured at the center of treads and landings. There shall be a wall switch at each floor level to control the light source where the *stairway* has six or more *risers*.

Exception: A switch is not required where remote, central or automatic control of lighting is provided.

R303.8 Exterior stairway illumination. Exterior *stairways* shall be provided with an artificial light source located at the top landing of the *stairway*. Exterior *stairways* providing access to a *basement* from the outdoor *grade* level shall be provided with an artificial light source located at the bottom landing of the *stairway*.

R303.9 Required glazed openings. Required glazed openings shall open directly onto a street or public alley, or a *yard* or court located on the same *lot* as the building.

Exceptions:

1. Required glazed openings that face into a roofed porch where the porch abuts a street, *yard* or court and the longer side of the porch is not less than 65 percent unobstructed and the ceiling height is not less than 7 feet (2134 mm).
2. Eave projections shall not be considered as obstructing the clear open space of a *yard* or court.
3. Required glazed openings that face into the area under a deck, balcony, bay or floor cantilever where a clear vertical space not less than 36 inches (914 mm) in height is provided.

R303.9.1 Sunroom additions. Required glazed openings shall be permitted to open into *sunroom additions* or patio covers that abut a street, *yard* or court if in excess of 40 percent of the exterior *sunroom* walls are open, or are enclosed only by insect screening, and the ceiling height of the *sunroom* is not less than 7 feet (2134 mm).

R303.10 Required heating. Where the winter design temperature in Table R301.2 is below 60°F (16°C), every *dwelling unit* shall be provided with heating facilities capable of maintaining a room temperature of not less than 68°F (20°C) at a point 3 feet (914 mm) above the floor and 2 feet (610 mm) from exterior walls in habitable rooms at the design temperature. The installation of one or more portable space heaters shall not be used to achieve compliance with this section.

Exception: Unconditioned *sunrooms* that are thermally isolated from the dwelling.

SECTION R304
MINIMUM ROOM AREAS

R304.1 Minimum area. Habitable rooms shall have a floor area of not less than 70 square feet (6.5 m^2).

Exception: Kitchens.

R304.2 Minimum dimensions. Habitable rooms shall be not less than 7 feet (2134 mm) in any horizontal dimension.

Exception: Kitchens.

R304.3 Height effect on room area. Portions of a room with a sloping ceiling measuring less than 5 feet (1524 mm) or a furred ceiling measuring less than 7 feet (2134 mm) from the finished floor to the finished ceiling shall not be considered as contributing to the minimum required habitable area for that room.

SECTION R305
CEILING HEIGHT

R305.1 Minimum height. *Habitable space*, hallways and portions of *basements* containing these spaces shall have a ceiling height of not less than 7 feet (2134 mm). Bathrooms, toilet rooms and laundry rooms shall have a ceiling height of not less than 6 feet 8 inches (2032 mm).

Exceptions:

1. For rooms with sloped ceilings, the required floor area of the room shall have a ceiling height of not less than 5 feet (1524 mm) and not less than 50

percent of the required floor area shall have a ceiling height of not less than 7 feet (2134 mm).

2. The ceiling height above bathroom and toilet room fixtures shall be such that the fixture is capable of being used for its intended purpose. A shower or tub equipped with a showerhead shall have a ceiling height of not less than 6 feet 8 inches (2032 mm) above an area of not less than 30 inches (762 mm) by 30 inches (762 mm) at the showerhead.
3. Beams, girders, ducts or other obstructions in *basements* containing *habitable space* shall be permitted to project to within 6 feet 4 inches (1931 mm) of the finished floor.
4. Beams and girders spaced apart not less than 36 inches (914 mm) in clear finished width shall project not more than 78 inches (1981 mm) from the finished floor.

R305.1.1 Basements. Portions of *basements* that do not contain *habitable space* or hallways shall have a ceiling height of not less than 6 feet 8 inches (2032 mm).

Exception: At beams, girders, ducts or other obstructions, the ceiling height shall be not less than 6 feet 4 inches (1931 mm) from the finished floor.

SECTION R306
SANITATION

R306.1 Toilet facilities. Every *dwelling unit* shall be provided with a water closet, lavatory, and a bathtub or shower.

R306.2 Kitchen. Each *dwelling unit* shall be provided with a kitchen area and every kitchen area shall be provided with a sink.

R306.3 Sewage disposal. Plumbing fixtures shall be connected to a sanitary sewer or to an *approved* private sewage disposal system.

R306.4 Water supply to fixtures. Plumbing fixtures shall be connected to an *approved* water supply. Kitchen sinks, lavatories, bathtubs, showers, bidets, laundry tubs and washing machine outlets shall be provided with hot and cold water.

SECTION R307
TOILET, BATH AND SHOWER SPACES

R307.1 Space required. Fixtures shall be spaced in accordance with Figure R307.1, and in accordance with the requirements of Section P2705.1.

R307.2 Bathtub and shower spaces. Bathtub and shower floors and walls above bathtubs with installed shower heads and in shower compartments shall be finished with a nonabsorbent surface. Such wall surfaces shall extend to a height of not less than 6 feet (1829 mm) above the floor.

SECTION R308
GLAZING

R308.1 Identification. Except as indicated in Section R308.1.1 each pane of glazing installed in hazardous locations as defined in Section R308.4 shall be provided with a manufacturer's designation specifying who applied the designation, the type of glass and the safety glazing standard with which it complies, and that is visible in the final installation. The designation shall be acid etched, sandblasted, ceramic-fired, laser etched, embossed, or be of a type that once applied cannot be removed without being destroyed. A *label* shall be permitted in lieu of the manufacturer's designation.

Exceptions:

1. For other than tempered glass, manufacturer's designations are not required provided that the *building official* approves the use of a certificate,

TABLE R308.3.1(1)
MINIMUM CATEGORY CLASSIFICATION OF GLAZING USING CPSC 16 CFR 1201

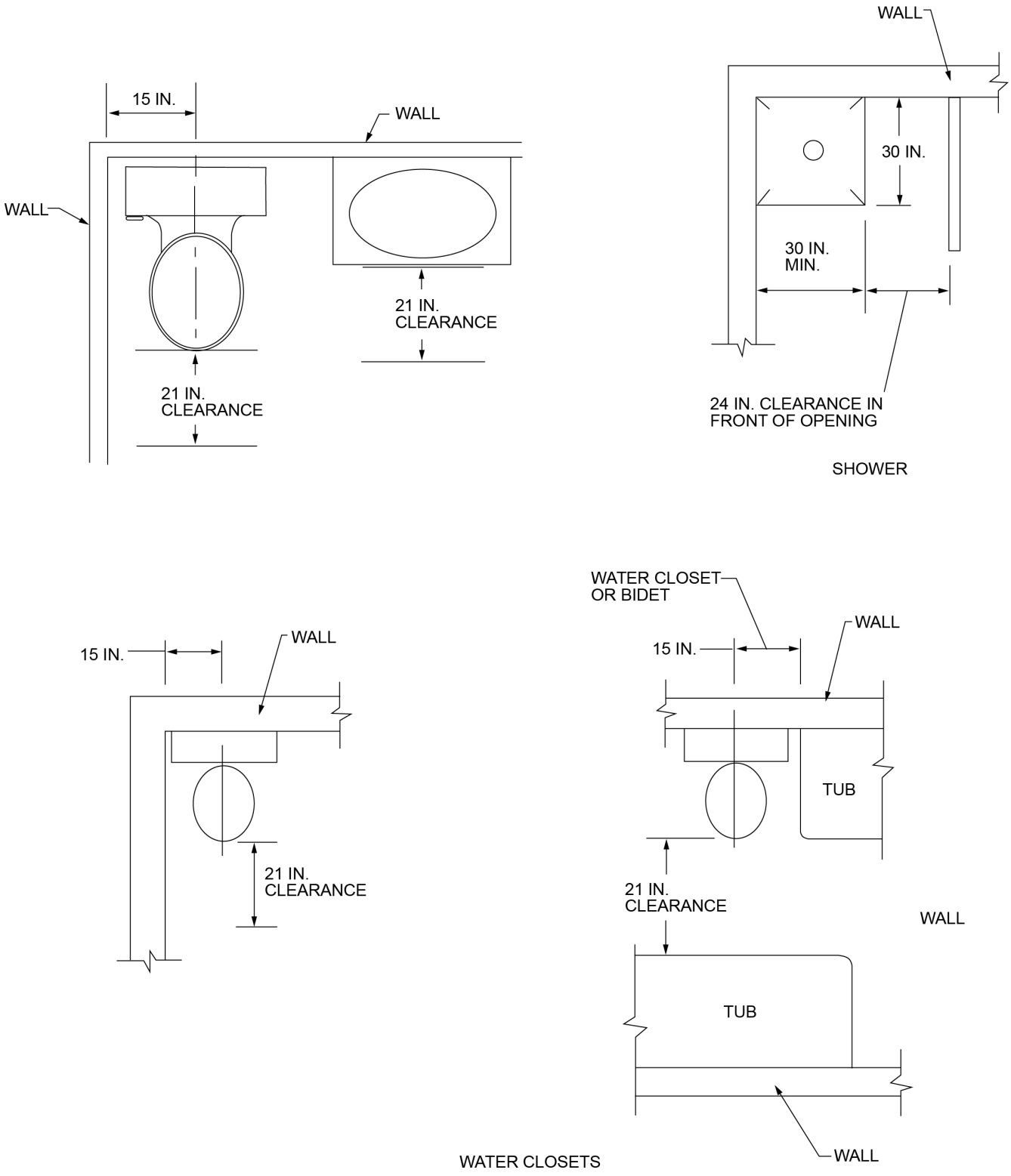
EXPOSED SURFACE AREA OF ONE SIDE OF ONE LITE	GLAZING IN STORM OR COMBINATION DOORS (Category Class)	GLAZING INDOORS (Category Class)	GLAZED PANELS REGULATED BY SECTION R308.4.3 (Category Class)	GLAZED PANELS REGULATED BY SECTION R308.4.2 (Category Class)	GLAZING INDOORS AND ENCLOSURES REGULATED BY SECTION 308.4.5 (Category Class)	SLIDING GLASS DOORS PATIO TYPE (Category Class)
9 square feet or less	I	I	NR	I	II	II
More than 9 square feet	II	II	II	II	II	II

For SI: 1 square foot = 0.0929 m^2.
NR = No Requirement.

TABLE R308.3.1(2)
MINIMUM CATEGORY CLASSIFICATION OF GLAZING USING ANSI Z97.1

EXPOSED SURFACE AREA OF ONE SIDE OF ONE LITE	GLAZED PANELS REGULATED BY SECTION R308.4.3 (Category Class)	GLAZED PANELS REGULATED BY SECTION R308.4.2 (Category Class)	DOORS AND ENCLOSURES REGULATED BY SECTION R308.4.5[a] (Category Class)
9 square feet or less	No requirement	B	A
More than 9 square feet	A	A	A

For SI: 1 square foot = 0.0929 m^2.
a. Use is permitted only by the exception to Section R308.3.1.



For SI: 1 inch = 25.4 mm.

FIGURE R307.1
MINIMUM FIXTURE CLEARANCES

affidavit or other evidence confirming compliance with this code.

2. Tempered spandrel glass is permitted to be identified by the manufacturer with a removable paper designation.

R308.1.1 Identification of multiple assemblies. Multipane assemblies having individual panes not exceeding 1 square foot (0.09 m^2) in exposed area shall have not less than one pane in the assembly identified in accordance with Section R308.1. Other panes in the assembly shall be *labeled* "CPSC 16 CFR 1201" or "ANSI Z97.1" as appropriate.

R308.2 Louvered windows or jalousies. Regular, float, wired or patterned glass in jalousies and louvered windows shall be not less than nominal $^3/_{16}$ inch (5 mm) thick and not more than 48 inches (1219 mm) in length. Exposed glass edges shall be smooth.

R308.2.1 Wired glass prohibited. Wired glass with wire exposed on longitudinal edges shall not be used in jalousies or louvered windows.

R308.3 Human impact loads. Individual glazed areas, including glass mirrors in hazardous locations such as those indicated as defined in Section R308.4, shall pass the test requirements of Section R308.3.1.

Exceptions:

1. Louvered windows and jalousies shall comply with Section R308.2.
2. Mirrors and other glass panels mounted or hung on a surface that provides a continuous backing support.
3. Glass unit masonry complying with Section R607.

R308.3.1 Impact test. Where required by other sections of the code, glazing shall be tested in accordance with CPSC 16 CFR 1201. Glazing shall comply with the test criteria for Category II unless otherwise indicated in Table R308.3.1(1).

Exception: Glazing not in doors or enclosures for hot tubs, whirlpools, saunas, steam rooms, bathtubs and showers shall be permitted to be tested in accordance with ANSI Z97.1. Glazing shall comply with the test criteria for Class A unless otherwise indicated in Table R308.3.1(2).

R308.4 Hazardous locations. The locations specified in Sections R308.4.1 through R308.4.7 shall be considered to be specific hazardous locations for the purposes of glazing.

R308.4.1 Glazing in doors. Glazing in fixed and operable panels of swinging, sliding and bifold doors shall be considered to be a hazardous location.

Exceptions:

1. Glazed openings of a size through which a 3-inch-diameter (76 mm) sphere is unable to pass.
2. Decorative glazing.

R308.4.2 Glazing adjacent to doors. Glazing in an individual fixed or operable panel in the same plane as the door shall be considered to be a hazardous location where the bottom exposed edge of the glazing is less than 60 inches (1524 mm) above the floor or walking surface and it meets either of the following conditions:

1. Where the glazing is within 24 inches (610 mm) of either side of the door in the plane of the door in a closed position.
2. Deleted.

Exceptions:

1. Decorative glazing.
2. Where there is an intervening wall or other permanent barrier between the door and the glazing.
3. Where access through the door is to a closet or storage area 3 feet (914 mm) or less in depth. Glazing in this application shall comply with Section R308.4.3.
4. Glazing that is adjacent to the fixed panel of patio doors.

R308.4.3 Glazing in windows. Glazing in an individual fixed or operable panel that meets all of the following conditions shall be considered to be a hazardous location:

1. The exposed area of an individual pane is larger than 9 square feet (0.836 m^2).
2. The bottom edge of the glazing is less than 18 inches (457 mm) above the floor.
3. The top edge of the glazing is more than 36 inches (914 mm) above the floor.
4. One or more walking surfaces are within 36 inches (914 mm), measured horizontally and in a straight line, of the glazing.

Exceptions:

1. Decorative glazing.
2. Where glazing is adjacent to a walking surface and a horizontal rail is installed 34 to 38 inches (864 to 965 mm) above the walking surface. The rail shall be capable of withstanding a horizontal load of 50 pounds per linear foot (730 N/m) without contacting the glass and have a cross-sectional height of not less than $1^1/_2$ inches (38 mm).
3. Outboard panes in insulating glass units and other multiple glazed panels where the bottom edge of the glass is 25 feet (7620 mm) or more above *grade*, a roof, walking surfaces or other horizontal [within 45 degrees (0.79 rad) of horizontal] surface adjacent to the glass exterior.

R308.4.4 Glazing in guards and railings. Glazing in *guards* and railings, including structural baluster panels and nonstructural in-fill panels, regardless of area or height above a walking surface shall be considered to be a hazardous location.

R308.4.4.1 Structural glass baluster panels. *Guards* with structural glass baluster panels shall be installed with an attached top rail or *handrail*. The top rail or *handrail* shall be supported by not less than three glass baluster panels, or shall be otherwise supported to remain in place should one glass baluster panel fail.

Exception: An attached top rail or *handrail* is not required where the glass baluster panels are laminated glass with two or more glass plies of equal thickness and of the same glass type.

R308.4.5 Glazing and wet surfaces. Glazing in walls, enclosures or fences containing hot tubs, spas, whirlpools, saunas, steam rooms, bathtubs, showers and indoor or outdoor swimming pools where the bottom exposed edge of the glazing is less than 60 inches (1524 mm) measured vertically above any standing or walking surface shall be considered to be a hazardous location. This shall apply to single glazing and each pane in multiple glazing.

Exception: Glazing that is more than 60 inches (1524 mm), measured horizontally, from the water's edge.

R308.4.6 Glazing adjacent to stairs and ramps. Glazing where the bottom exposed edge of the glazing is less than 36 inches (914 mm) above the plane of the adjacent walking surface of *stairways*, landings between flights of stairs and *ramps* shall be considered to be a hazardous location.

Exceptions:

1. Where glazing is adjacent to a walking surface and a horizontal rail is installed at 34 to 38 inches (864 to 965 mm) above the walking surface. The rail shall be capable of withstanding a horizontal load of 50 pounds per linear foot (730 N/m) without contacting the glass and have a cross-sectional height of not less than $1^1/_2$ inches (38 mm).
2. Glazing 36 inches (914 mm) or more measured horizontally from the walking surface.
3. Where a change in elevation is $8^1/_4$ inches (210 mm) or less at an exterior door.

R308.4.7 Glazing adjacent to the bottom stair landing. Glazing adjacent to the landing at the bottom of a *stairway* where the glazing is less than 36 inches (914 mm) above the landing and within a 60-inch (1524 mm) horizontal arc less than 180 degrees (3.14 rad) from the bottom tread *nosing* shall be considered to be a hazardous location. (See Figure R308.4.7.)

Exception: Where the glazing is protected by a *guard* complying with Section R312 and the plane of the glass is more than 18 inches (457 mm) from the *guard*.

R308.5 Site-built windows. Site-built windows shall comply with Section 2404 of the *International Building Code*.

R308.6 Skylights and sloped glazing. *Skylights and sloped glazing* shall comply with the following sections.

R308.6.1 Definitions. The following terms are defined in Chapter 2:

SKYLIGHT, UNIT.

SKYLIGHTS AND SLOPED GLAZING.

TUBULAR DAYLIGHTING DEVICE (TDD).

R308.6.2 Materials. Glazing materials shall be limited to the following:

1. Laminated glass with not less than a 0.015-inch (0.38 mm) polyvinyl butyral interlayer for glass panes 16 square feet (1.5 m^2) or less in area located such that the highest point of the glass is not more than 12 feet (3658 mm) above a walking surface; for higher or larger sizes, the interlayer thickness shall be not less than 0.030 inch (0.76 mm).
2. Fully tempered glass.
3. Heat-strengthened glass.
4. Wired glass.
5. *Approved* rigid plastics.

R308.6.3 Screens, general. For fully tempered or heat-strengthened glass, a retaining screen meeting the requirements of Section R308.6.7 shall be installed below the glass, except for fully tempered glass that meets Condition 1 or 2 listed in Section R308.6.5.

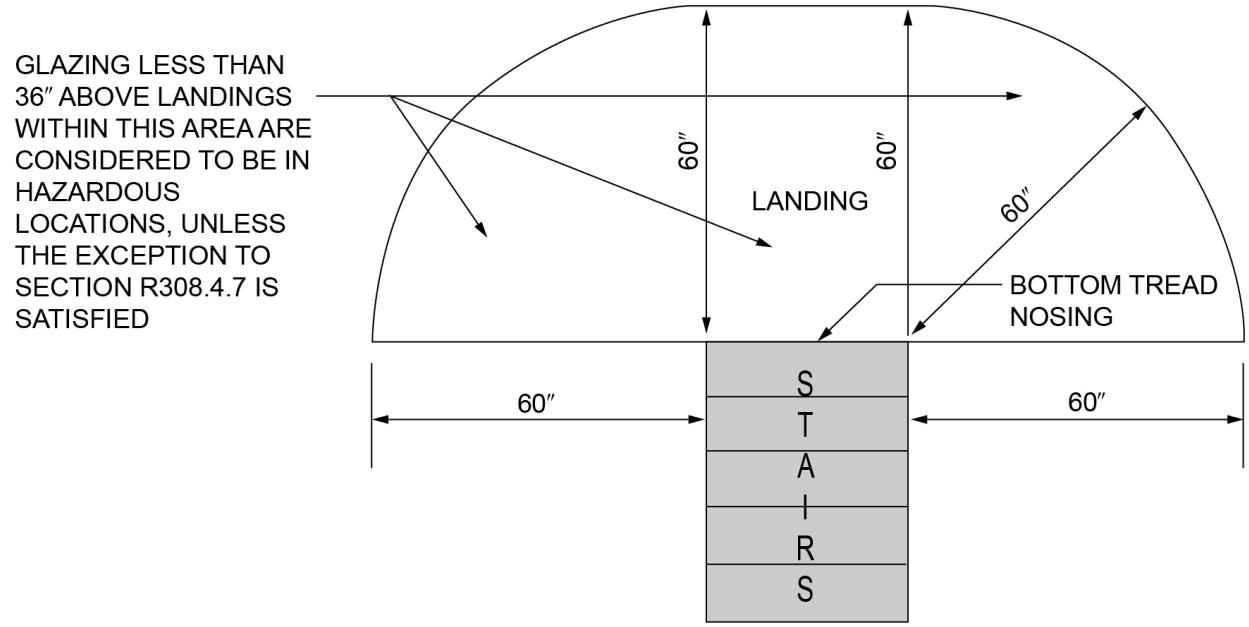
R308.6.4 Screens with multiple glazing. Where the inboard pane is fully tempered, heat-strengthened or wired glass, a retaining screen meeting the requirements of Section R308.6.7 shall be installed below the glass, except for Condition 1 or 2 listed in Section R308.6.5. Other panes in the multiple glazing shall be of any type listed in Section R308.6.2.

R308.6.5 Screens not required. Screens shall not be required where laminated glass complying with Item 1 of Section R308.6.2 is used as single glazing or the inboard pane in multiple glazing. Screens shall not be required where fully tempered glass is used as single glazing or the inboard pane in multiple glazing and either of the following conditions is met:

1. The glass area is 16 square feet (1.49 m^2) or less; the highest point of glass is not more than 12 feet (3658 mm) above a walking surface; the nominal glass thickness is not more than $^3/_{16}$ inch (4.8 mm); and for multiple glazing only the other pane or panes are fully tempered, laminated or wired glass.
2. The glass area is greater than 16 square feet (1.49 m^2); the glass is sloped 30 degrees (0.52 rad) or less from vertical; and the highest point of glass is not more than 10 feet (3048 mm) above a walking surface.

R308.6.6 Glass in greenhouses. Any glazing material is permitted to be installed without screening in the sloped areas of greenhouses, provided that the greenhouse height at the ridge does not exceed 20 feet (6096 mm) above *grade*.

R308.6.7 Screen characteristics. The screen and its fastenings shall: be capable of supporting twice the



For SI: 1 inch = 25.4 mm.

FIGURE R308.4.7
HAZARDOUS GLAZING LOCATIONS AT BOTTOM STAIR LANDINGS

weight of the glazing; be firmly and substantially fastened to the framing members; be installed within 4 inches (102 mm) of the glass; and have a mesh opening of not greater than 1 inch by 1 inch (25 mm by 25 mm).

R308.6.8 Curbs for skylights. *Unit skylights* installed in a roof with a pitch of less than 3 units vertical in 12 units horizontal (25-percent slope) shall be mounted on a curb extending not less than 4 inches (102 mm) above the plane of the roof, unless otherwise specified in the manufacturer's installation instructions.

R308.6.9 Testing and labeling. *Unit skylights* and *tubular daylighting devices* shall be tested by an *approved* independent laboratory, and bear a *label* identifying manufacturer, performance grade rating and *approved* inspection agency to indicate compliance with the requirements of AAMA/WDMA/CSA 101/I.S.2/A440.

R308.6.9.1 Comparative analysis for glass-glazed unit skylights. Structural wind load design pressures for glass-glazed *unit skylights* different than the size tested in accordance with Section R308.6.9 shall be permitted to be different than the design value of the tested unit where determined in accordance with one of the following comparative analysis methods:

1. Structural wind load design pressures for glass-glazed *unit skylights* smaller than the size tested in accordance with Section R308.6.9 shall be permitted to be higher than the design value of the tested unit provided that such higher pressures are determined by accepted engineering analysis. Components of the smaller unit shall be the same as those of the tested unit. Such calculated design pressures shall be validated by an additional test of the glass-glazed *unit skylight* having the highest allowable design pressure.
2. In accordance with WDMA I.S.11.

SECTION R309
GARAGES AND CARPORTS

R309.1 Floor surface. Garage floor surfaces shall be of *approved noncombustible material*.

The area of floor used for parking of automobiles or other vehicles shall be sloped to facilitate the movement of liquids to a drain or toward the main vehicle entry doorway.

R309.2 Carports. Carports shall be open on not less than two sides. Carport floor surfaces shall be of *approved noncombustible material*. Carports not open on two or more sides shall be considered to be a garage and shall comply with the provisions of this section for garages.

The area of floor used for parking of automobiles or other vehicles shall be sloped to facilitate the movement of liquids to a drain or toward the main vehicle entry doorway.

Exception: Asphalt surfaces shall be permitted at ground level in carports.

R309.3 Flood hazard areas. Garages and carports located in flood hazard areas as established by Table R301.2 shall be constructed in accordance with Section R322.

R309.4 Automatic garage door openers. Automatic garage door openers, if provided, shall be *listed* and *labeled* in accordance with UL 325.

R309.5 Fire sprinklers. Deleted.

SECTION R310
EMERGENCY ESCAPE AND RESCUE OPENINGS

R310.1 Emergency escape and rescue opening required. *Basements, habitable attics* and every sleeping room shall have not less than one operable *emergency escape and rescue opening*. Where *basements* contain one or more sleeping rooms, an *emergency escape and rescue opening* shall be required in each sleeping room. *Emergency escape and rescue openings* shall open directly into a *public way*, or to a *yard* or court having a minimum width of 36 inches (914 mm) that opens to a *public way*.

Exceptions:

1. *Storm shelters* and *basements* used only to house mechanical *equipment* not exceeding a total floor area of 200 square feet (18.58 m^2).
2. Where the *dwelling unit* or *townhouse unit* is equipped with an automatic sprinkler system installed in accordance with Section P2904, sleeping rooms in *basements* shall not be required to have *emergency escape and rescue openings* provided that the *basement* has one of the following:
   2.1. One means of egress complying with Section R311 and one *emergency escape and rescue opening*.
   2.2. Two means of egress complying with Section R311.
3. A yard shall not be required to open directly into a public way where the yard opens to an unobstructed path from the yard to the public way. Such path shall have a width of not less than 36 inches (914 mm).

R310.1.1 Operational constraints and opening control devices. *Emergency escape and rescue openings* shall be operational from the inside of the room without the use of keys, tools or special knowledge. Window opening control devices and fall prevention devices complying with ASTM F2090 shall be permitted for use on windows serving as a required *emergency escape and rescue opening*.

R310.2 Emergency escape and rescue openings. *Emergency escape and rescue openings* shall have minimum dimensions in accordance with Sections R310.2.1 through R310.2.4.

R310.2.1 Minimum size. *Emergency escape and rescue openings* shall have a minimum net clear openable area of 4 square feet (0.372 m^2) and must have a minimum total glazing area of not less than 5 square feet (0.465 m^2) in the case of a ground floor level window and not less than 5.7 square feet (0.530 m^2) in the case of an upper story window.

R310.2.2 Minimum dimensions. The minimum net clear opening height dimension shall be 22 inches (559 mm). The minimum net clear opening width dimension shall be 20 inches (508 mm). The net clear opening dimensions shall be the result of normal operation of the opening.

R310.2.3 Maximum height from floor. Emergency escape and rescue openings shall have the bottom of the clear opening not greater than 44 inches (1118 mm) above the finished floor.

R310.2.4 Emergency escape and rescue openings under decks, porches and cantilevers. *Emergency escape and rescue openings* installed under decks, porches and cantilevers shall be fully openable and provide a path not less than 36 inches (914 mm) in height and 36 inches (914 mm) in width to a *yard* or court.

R310.2.5 Egress roof access window. Egress roof access windows shall be deemed to meet the requirements of Section R310 where installed such that the bottom of the opening is not more than 44 inches (1118 mm) above the floor, provided the egress roof access window complies with the minimum opening area requirements of Section R310.2.1.

R310.3 Emergency escape and rescue doors. Where a door is provided as the required *emergency escape and rescue opening*, it shall be a side-hinged door or a sliding door.

R310.3.1 Minimum door opening size. The minimum net clear height opening for any door that serves as an emergency and escape rescue opening shall be 22 inches (559 mm). The minimum net clear opening width dimension shall be 20 inches (508 mm).

R310.4 Area wells. An *emergency escape and rescue opening* where the bottom of the clear opening is below the adjacent grade shall be provided with an area well in accordance with Sections R310.4.1 through R310.4.4.

R310.4.1 Minimum size. The horizontal area of the area well shall be not less than 9 square feet (0.9 m^2), with a horizontal projection and width of not less than 36 inches (914 mm). The size of the area well shall allow the *emergency escape and rescue opening* to be fully opened.

Exception: The ladder or steps required by Section R310.4.2 shall be permitted to encroach not more than 6 inches (152 mm) into the required dimensions of the area well.

R310.4.2 Ladder and steps. Area wells with a vertical depth greater than 44 inches (1118 mm) shall be equipped with an approved, permanently affixed ladder or steps. The ladder or steps shall not be obstructed by the emergency escape and rescue opening where the window or door is in the open position. Ladders or steps required by this section shall not be required to comply with Section R311.7.

R310.4.2.1 Ladders. Ladders and rungs shall have an inside width of not less than 12 inches (305 mm), shall project not less than 3 inches (76 mm) from the wall and shall be spaced not more than 18 inches (457 mm) on center vertically for the full height of the area well.

R310.4.2.2 Steps. Steps shall have an inside width of not less than 12 inches (305 mm), a minimum tread depth of 5 inches (127 mm) and a maximum riser height of 18 inches (457 mm) for the full height of the area well.

R310.4.3 Drainage. Area wells shall be designed for proper drainage.

Exception: A drainage system for area wells is not required where the foundation is on well-drained soil or sand-gravel mixture soils in accordance with the United Soil Classification System, Group I Soils, as detailed in Table R405.1.

R310.4.4 Bars, grilles, covers and screens. Where bars, grilles, covers, screens or similar devices are placed over *emergency escape and rescue openings*, bulkhead enclosures or area wells that serve such openings, the minimum net clear opening size shall comply with Sections R310.2 through R310.2.2 and R310.4.1. Such devices shall be releasable or removable from the inside without the use of a key or tool or force greater than that required for the normal operation of the escape and rescue opening.

R310.5 Replacement windows for emergency escape and rescue openings. Replacement windows installed in buildings meeting the scope of this code shall be exempt from Sections R310.2 and R310.4.4, provided that the replacement window meets the following conditions:

1. The replacement window is the manufacturer's largest standard size window that will fit within the existing frame or existing rough opening.
2. The replacement window is of the same operating style as the existing window or a style that provides for an equal or greater window opening area than the existing window.
3. The rough opening has not been reconstructed or modified in any manner. If the opening is reconstructed or modified in any manner, then the opening must comply with the current code requirements for emergency escape and rescue openings.

R310.6 Dwelling additions. Where *dwelling additions* contain sleeping rooms, an *emergency escape and rescue opening* shall be provided in each new sleeping room. Where *dwelling additions* have *basements*, an *emergency escape and rescue opening* shall be provided in the new *basement*.

Exceptions:

1. An *emergency escape and rescue opening* is not required in a new *basement* that contains a sleeping room with an *emergency escape and rescue opening*.
2. An *emergency escape and rescue opening* is not required in a new *basement* where there is an *emergency escape and rescue opening* in an existing *basement* that is *accessed* from the new *basement*.

R310.7 Alterations or repairs of existing basements. New sleeping rooms created in an existing *basement* shall be provided with *emergency escape and rescue openings* in accordance with Section R310.1. Other than new sleeping rooms, where existing basements undergo alterations or repairs, an *emergency escape and rescue opening* is not required.

SECTION R311
MEANS OF EGRESS

R311.1 Means of egress. *Dwellings and accessory buildings* shall be provided with a means of egress in accordance with this section. The means of egress shall provide a continuous and unobstructed path of vertical and horizontal egress travel from all portions of the *dwelling and accessory buildings* to the required egress door without requiring travel through a garage. The required egress door shall open directly into a *public way* or to a *yard* or court that opens to a *public way*.

Exceptions:

1. Equipment service platforms may be served by ladders constructed in accordance with Section R310.4.2.1
2. Detached garages and storage buildings.

R311.2 Egress door. Not less than one egress door shall be provided for each *dwelling unit*. The egress door shall be side-hinged, and shall provide a clear width of not less than 32 inches (813 mm) where measured between the face of the door and the stop, with the door open 90 degrees (1.57 rad). The clear height of the door opening shall be not less than 78 inches (1981 mm) in height measured from the top of the threshold to the bottom of the stop. Other doors shall not be required to comply with these minimum dimensions. All interior egress doors and a minimum of one exterior egress door shall be readily openable from the side from which egress is to be made without the use of a key or special knowledge or effort.

R311.3 Floors and landings at exterior doors. There shall be a landing or floor on each side of each exterior door. The width of each landing shall be not less than the door served. Landings shall have a dimension of not less than 36 inches (914 mm) measured in the direction of travel. The slope at exterior landings shall not exceed $^1/_4$ unit vertical in 12 units horizontal (2 percent).

Exception: Exterior balconies less than 60 square feet (5.6 m^2) and only *accessed* from a door are permitted to have a landing that is less than 36 inches (914 mm) measured in the direction of travel.

R311.3.1 Floor elevations at the required egress doors. Landings or finished floors at the required egress door shall be not more than $1^1/_2$ inches (38 mm) lower than the top of the threshold.

Exception: The landing or floor on the exterior side shall be not more than $8^1/_4$ inches (210 mm) below the top of the threshold provided that the door does not swing over the landing or floor.

Where exterior landings or floors serving the required egress door are not at *grade*, they shall be provided with access to *grade* by means of a *ramp* in accordance with Section R311.8 or a *stairway* in accordance with Section R311.7.

R311.3.2 Floor elevations at other exterior doors. Doors other than the required egress door shall be

provided with landings or floors not more than $8^1/_4$ inches (210 mm) below the top of the threshold.

Exception: A top landing is not required where a *stairway* of not more than two *risers* is located on the exterior side of the door, provided that the door does not swing over the *stairway*.

R311.3.3 Storm and screen doors. Storm and screen doors shall be permitted to swing over exterior stairs and landings.

R311.4 Vertical egress. Egress from habitable levels including habitable attics and *basements* that are not provided with an egress door in accordance with Section R311.2 shall be by a *ramp* in accordance with Section R311.8 or a *stairway* in accordance with Section R311.7.

R311.5 Landing, deck, balcony and stair construction and attachment. Exterior landings, decks, balconies, stairs and similar facilities shall be positively anchored to the primary structure to resist both vertical and lateral forces or shall be designed to be self-supporting. Attachment shall not be accomplished by use of toenails or nails subject to withdrawal.

R311.6 Hallways. The width of a hallway shall be not less than 3 feet (914 mm) measured from the finished surface of the walls.

R311.6.1 Interior egress doors. All doors providing egress from habitable rooms shall have nominal dimensions of 2 feet 6 inches (782 mm) width by 6 feet 8 inches (2032 mm) height. Interior egress doors shall be readily openable from the side from which egress is to be made without the use of a key or special knowledge or effort.

R311.7 Stairways. Where required by this code or provided, *stairways* shall comply with this section.

Exceptions:

1. Stairways not within or serving a building, porch or deck.
2. Stairways leading to nonhabitable attics.
3. Stairways leading to *crawl spaces*.

R311.7.1 Width. *Stairways* shall be not less than 36 inches (914 mm) in clear width at all points above the permitted *handrail* height and below the required headroom height. The clear width of *stairways* at and below the *handrail* height, including treads and landings, shall be not less than $31^1/_2$ inches (787 mm) where a *handrail* is installed on one side and 27 inches (698 mm) where *handrails* are installed on both sides.

Exceptions:

1. The width of *spiral stairways* shall be in accordance with Section R311.7.10.1.
2. Stairways not required for egress shall be permitted to be a minimum width of 26 inches (660 mm).

R311.7.2 Headroom. The headroom in *stairways* shall be not less than 6 feet 8 inches (2032 mm) measured vertically from the sloped line adjoining the tread *nosing* or from the floor surface of the landing or platform on that portion of the *stairway*.

Exceptions:

1. Where the *nosings* of treads at the side of a flight extend under the edge of a floor opening through which the *stair* passes, the floor opening shall not project horizontally into the required headroom more than $4^3/_4$ inches (121 mm).
2. The headroom for spiral *stairways* shall be in accordance with Section R311.7.10.1.

R311.7.3 Vertical rise. A flight of stairs shall not have a vertical rise greater than 12 feet 7 inches (3835 mm) between floor levels or landings.

R311.7.4 Walkline. The walkline across *winder* treads shall be concentric to the curved direction of travel through the turn and located 12 inches (305 mm) from the side where the winders are narrower. The 12 inch (305 mm) dimension shall be measured from the widest point of the clear stair width at the walking surface of the winder. If winders are adjacent within the flight, the point of the widest clear stair width of the adjacent winders shall be used.

R311.7.5 Stair treads and risers. *Stair* treads and *risers* shall meet the requirements of this section. For the purposes of this section, dimensions and dimensioned surfaces shall be exclusive of carpets, rugs or runners.

R311.7.5.1 Risers. The *riser* height shall be not more than $8^1/_4$ inches (210 mm). The *riser* height shall be measured vertically between leading edges of the adjacent treads. The greatest *riser* height within any flight of stairs shall not exceed the smallest by more than $^3/_8$ inch (9.5 mm). At open *risers*, openings located more than 30 inches (762 mm), as measured vertically, to the floor or *grade* below shall not permit the passage of a 4-inch-diameter (102 mm) sphere. The top and bottom riser of interior stairs shall not exceed the smallest riser within that stair run by more than $^3/_4$ inch (19 mm). The height of the top and bottom riser of the interior stairs shall be measured from the permanent finished surface (carpet excluded). Where the bottom riser of an exterior stair adjoins an exterior walk, porch, driveway, patio, garage floor, or finish grade, the height of the riser may be less than the height of the adjacent risers.

Exceptions:

1. The opening between adjacent treads is not limited on *spiral stairways*.
2. The *riser* height of *spiral stairways* shall be in accordance with Section R311.7.10.1.

R311.7.5.2 Treads. The tread depth shall be not less than 9 inches (229 mm). The tread depth shall be measured horizontally between the vertical planes of the foremost projection of adjacent treads and at a right angle to the tread's leading edge. The greatest tread

depth within any flight of stairs shall not exceed the smallest by more than $^3/_8$ inch (9.5 mm).

R311.7.5.2.1 Winder treads. *Winder treads* shall have a tread depth of not less than 9 inches (229 mm) measured as above a point 12 inches (305 mm) from the side where the treads are narrower. Winder treads shall have a tread depth of not less than 4 inches (102 mm) at any point. Within any flight of stairs, the greatest winder tread depth at the 12 inch (305 mm) walkline shall not exceed the smallest by more than $^3/_8$ inch (9.5 mm). Consistently shaped winders at the walkline shall be allowed within the same flight of stairs as rectangular treads and shall not be required to be within $^3/_8$ inch (9.5 mm) of the rectangular tread depth.

Exception: The tread depth at *spiral stairways* shall be in accordance with Section R311.7.10.1.

R311.7.5.3 Nosings. *Nosings* at treads, landings and floors of *stairways* shall have a radius of curvature at the *nosing* not greater than $^9/_{16}$ inch (14 mm) or a bevel not greater than $^1/_2$ inch (12.7 mm). A *nosing* projection not less than $^3/_4$ inch (19 mm) and not more than $1^1/_4$ inches (32 mm) shall be provided on *stairways*. The greatest *nosing* projection shall not exceed the smallest *nosing* projection by more than $^3/_8$ inch (9.5 mm) within a *stairway*.

Exception: A *nosing* projection is not required where the tread depth is not less than 11 inches (279 mm).

R311.7.5.4 Exterior plastic composite stair treads. *Plastic composite* exterior stair treads shall comply with the provisions of this section and the requirements of ASTM D7032 -2017.

R311.7.6 Landings for stairways. There shall be a floor or landing at the top and bottom of each *stairway*. A flight of stairs shall not have a vertical rise larger than 12 feet 7 inches (3734 mm) between floor levels or landings. The width of each landing shall not be less than the width of the stairway served. Every landing shall have a minimum dimension of 36 inches (914 mm) measured in the direction of travel.

Exception: A floor or landing is not required at the top of an interior flight of stairs, including stairs in an enclosed garage, provided that a door does not swing over the stairs.

R311.7.7 Stairway walking surface. The walking surface of treads and landings of *stairways* shall be sloped not steeper than 1 unit vertical in 48 units horizontal (2-percent slope).

R311.7.8 Handrails. *Handrails* shall be provided on not less than one side of each flight of stairs with four or more *risers*.

R311.7.8.1 Height. *Handrail* height, measured vertically from the sloped plane adjoining the tread *nosing*, or finish surface of ramp slope, shall be not less than 34 inches (864 mm) and not more than 38 inches (965 mm).

Exceptions:

1. The use of a volute, turnout, starting easing or starting newel shall be allowed over the lowest tread.
2. Where *handrail* fittings or bendings are used to provide continuous transition between flights, transitions at *winder* treads, the transition from *handrail* to *guard*, or used at the start of a flight, the *handrail* height at the fittings or bendings shall be permitted to exceed 38 inches (965 mm).

R311.7.8.2 Handrail projection. *Handrails* shall not project more than $4^1/_2$ inches (114 mm) on either side of the *stairway*.

Exception: Where *nosings* of landings, floors or passing flights project into the *stairway* reducing the clearance at passing *handrails*, *handrails* shall project not more than $6^1/_2$ inches (165 mm) into the *stairway*, provided that the stair width and *handrail* clearance are not reduced to less than that required.

R311.7.8.3 Handrail clearance. *Handrails* adjacent to a wall shall have a space of not less than $1^1/_2$ inches (38 mm) between the wall and the *handrails*.

R311.7.8.4 Continuity. *Handrails* shall be continuous for the full length of the flight, from a point directly above the top riser of the flight to a point directly above the lowest riser of the flight. *Handrail* ends shall be returned toward a wall, guard walking surface continuous to itself, or terminate to a post.

Exceptions:

1. *Handrail* continuity shall be permitted to be interrupted by a newel post at a turn in a flight with winders, at a landing, or over the lowest tread.
2. A volute, turnout or starting easing shall be allowed to terminate over the lowest tread and over the top landing.
3. Two or more separate rails shall be considered continuous if the termination of the rails occurs within 6 inches (152 mm) of each other. If transitioning between a wall-mounted handrail and a guardrail/handrail, the wall-mounted rail shall return into the wall.

R311.7.8.5 Grip size. Required *handrails* shall be of one of the following types or provide equivalent graspability.

1. Type I. *Handrails* with a circular cross section shall have an outside diameter of not less than $1^1/_4$ inches (32 mm) and not greater than 2 inches (51 mm). If the *handrail* is not circular, it shall have a perimeter of not less than 4 inches (102 mm) and not greater than $6^1/_4$ inches (160 mm) and a cross section of not

more than $2^1/_4$ inches (57 mm). Edges shall have a radius of not less than 0.01 inch (0.25 mm).

2. Type II. *Handrails* with a perimeter greater than $6^1/_4$ inches (160 mm) shall have a graspable finger recess area on both sides of the profile. The finger recess shall begin within $^3/_4$ inch (19 mm) measured vertically from the tallest portion of the profile and have a depth of not less than $^5/_{16}$ inch (8 mm) within $^7/_8$ inch (22 mm) below the widest portion of the profile. This required depth shall continue for not less than $^3/_8$ inch (10 mm) to a level that is not less than $1^3/_4$ inches (45 mm) below the tallest portion of the profile. The width of the *handrail* above the recess shall be not less than $1^1/_4$ inches (32 mm) and not more than $2^3/_4$ inches (70 mm). Edges shall have a radius of not less than 0.01 inch (0.25 mm).

Exception: Exterior handrails (garages and areas exposed to the weather) shall not be more than $3^1/_2$ inches (89 mm) in cross-section dimension.

R311.7.8.6 Exterior plastic composite handrails. *Plastic composite* exterior *handrails* shall comply with the requirements of ASTM D7032.

R311.7.9 Illumination. *Stairways* shall be provided with illumination in accordance with Sections R303.7 and R303.8.

R311.7.10 Special stairways. *Spiral stairways* and bulkhead enclosure *stairways* and bowed tread stairways shall comply with the requirements of Section R311.7 except as specified in Sections R311.7.10.1 and R311.7.10.3.

R311.7.10.1 Spiral stairways. The clear width at and below the *handrails* at *spiral stairways* shall be not less than 26 inches (660 mm) and the walkline radius shall be not greater than $24^1/_2$ inches (622 mm). Each tread shall have a depth of not less than $6^3/_4$ inches (171 mm) at the walkline. Treads shall be identical, and the rise shall be not more than $9^1/_2$ inches (241 mm). Headroom shall be not less than 6 feet 6 inches (1982 mm).

R311.7.10.2 Bulkhead enclosure stairways. *Stairways* serving bulkhead enclosures, not part of the required building egress, providing access from the outside *grade* level to the *basement* shall be exempt from the requirements of Sections R311.3 and R311.7 where the height from the *basement* finished floor level to *grade* adjacent to the *stairway* is not more than 8 feet (2438 mm) and the *grade* level opening to the *stairway* is covered by a bulkhead enclosure with hinged doors or other *approved* means.

R311.7.10.3 Bowed tread stairways. Bowed tread stairways are permitted provided they are uniform in bowed tread depth along the entire width of the tread with not more than $^3/_8$-inch (9.5 mm) variance from greatest to smallest tread in the stairway flight. At no point shall the tread be less than 9 inches (229 mm) with a nosing as listed in Sections R311.7.5.2 and R311.7.5.3, respectively.

R311.7.10.3.1 Standard stairway application. The bottom three treads in a standard straight run stairway application as listed under Section R311.7.5.2 are permitted to bow provided that, at no point along the width of the tread, they are less than 9 inches (229 mm) as measured under Section R311.7.5.2 and each bowed tread is uniform with other bowed treads with no more than $^3/_8$-inch (9.5 mm) variance from greatest to least. Nosing is required as listed in Section R311.7.5.3.

R311.7.10.3.2 Bowed tread circular stairways. Bowed treads in a circular stairway are permitted provided they are uniform, as per winder treads as listed in Section 311.7.5.2.1, measured at a point 12 inches (305 mm) from the side where the treads are narrower. At this walk line, bowed treads must be uniform with other circular stairway treads with the greatest tread not to exceed the smallest by more than $^3/_8$ inch (9.5 mm). Nosing is required as listed in Section R311.7.5.3.

R311.7.11 Alternating tread devices. Deleted.

R311.7.12 Ship's ladders. Ship's ladders shall not be used as an element of a means of egress. Ship's ladders shall be permitted provided that a required means of egress *stairway* or *ramp* serves the same space at each adjoining level or where a means of egress is not required. The clear width at and below the *handrails* shall be not less than 20 inches (508 mm).

Exception: Ship's ladders are allowed to be used as an element of a means of egress for lofts, *mezzanines* and similar areas of 200 gross square feet (18.6 m^2) or less that do not provide exclusive access to a kitchen or bathroom.

R311.7.12.1 Treads of ship's ladders. Treads shall have a depth of not less than 5 inches (127 mm). The tread shall be projected such that the total of the tread depth plus the *nosing* projection is not less than $8^1/_2$ inches (216 mm). The *riser* height shall be not more than $9^1/_2$ inches (241 mm).

R311.7.12.2 Handrails of ship's ladders. *Handrails* shall be provided on both sides of ship's ladders and shall comply with Sections R311.7.8.2 through R311.7.8.6. *Handrail* height shall be uniform, not less than 30 inches (762 mm) and not more than 34 inches (864 mm).

R311.8 Ramps. Where required by this code or provided, *ramps* shall comply with this section.

Exception: *Ramps* not within or serving a building, porch or deck.

R311.8.1 Maximum slope. *Ramps* serving the egress door required by Section R311.2 shall have a slope of not more than 1 unit vertical in 12 units horizontal (8.3-percent slope).

Other *ramps* shall have slope of not more than 1 unit vertical in 8 units horizontal (12.5 percent).

Exception: Where it is technically infeasible to comply because of site constraints, *ramps* shall have a slope of not more than 1 unit vertical in 8 units horizontal (12.5 percent).

R311.8.2 Landings required. There shall be a floor or landing at the top and bottom of each *ramp*, where doors open onto *ramps*, and where *ramps* change directions. The width of the landing perpendicular to the *ramp* slope shall be not less than the width of the *ramp*. The depth of the landing in the direction of the ramp slope shall be not less than 36 inches (914 mm).

R311.8.3 Handrails required. *Handrails* shall be provided on not less than one side of *ramps* exceeding a slope of 1 unit vertical in 12 units horizontal (8.33-percent slope).

R311.8.3.1 Height. *Handrail* height, measured above the finished surface of the *ramp* slope, shall be not less than 34 inches (864 mm) and not more than 38 inches (965 mm).

R311.8.3.2 Grip size. *Handrails* on *ramps* shall comply with Section R311.7.8.5.

R311.8.3.3 Continuity. *Handrails* where required on *ramps* shall be continuous for the full length of the *ramp*. *Handrail* ends shall be returned or shall terminate in newel posts or safety terminals. *Handrails* adjacent to a wall shall have a space of not less than $1^1/_2$ inches (38 mm) between the wall and the *handrails*.

SECTION R312
GUARDS AND WINDOW FALL PROTECTION

R312.1 Guards. *Guards* shall be provided in accordance with Sections R312.1.1 through R312.1.4.

R312.1.1 Where required. *Guards* shall be provided for those portions of open-sided walking surfaces, including floors, stairs, *ramps* and landings that are located more than 30 inches (762 mm) measured vertically to the floor or *grade* below at any point within 36 inches (914 mm) horizontally to the edge of the open side. Insect screening shall not be considered as a *guard*.

R312.1.2 Height. Required *guards* at open-sided walking surfaces, including stairs, porches, balconies or landings, shall be not less than 36 inches (914 mm) in height as measured vertically above the adjacent walking surface or the line connecting the *nosings*.

Exceptions:

1. *Guards* on the open sides of stairs shall have a height of not less than 34 inches (864 mm) measured vertically from a line connecting the *nosings*.
2. Where the top of the *guard* serves as a *handrail* on the open sides of stairs, the top of the *guard* shall be not less than 34 inches (864 mm) and not more than 38 inches (965 mm) as measured vertically from a line connecting the *nosings*.

R312.1.3 Opening limitations. Required *guards* shall not have openings from the walking surface to the required *guard* height that allow passage of a sphere 4 inches (102 mm) in diameter.

Exceptions:

1. The triangular openings at the open side of *stair*, formed by the *riser*, tread and bottom rail of a *guard*, shall not allow passage of a sphere 6 inches (153 mm) in diameter.
2. *Guards* on the open side of stairs shall not have openings that allow passage of a sphere $4^3/_8$ inches (111 mm) in diameter.

R312.1.4 Exterior plastic composite guards. *Plastic composite* exterior *guards* shall comply with the requirements of Section R317.4.

R312.2 Window fall protection. Window fall protection shall be provided in accordance with Sections R312.2.1 and R312.2.2.

R312.2.1 Window opening height. In *dwelling units*, where the bottom of the clear opening of an operable window opening is located less than 24 inches (610 mm) above the finished floor and greater than 72 inches (1829 mm) above the finished *grade* or other surface below on the exterior of the building, the operable window shall comply with one of the following:

1. Operable window openings will not allow a 4-inch-diameter (102 mm) sphere to pass through where the openings are in their largest opened position.
2. Operable windows are provided with window opening control devices or fall prevention devices that comply with ASTM F2090.

R312.2.2 Emergency escape and rescue openings. Where an operable window serves as an emergency escape and rescue opening, a window opening control device or fall prevention device, after operation to release the control device or fall prevention device allowing the window to fully open, shall not reduce the net clear opening area of the window unit to less than the area required by Sections R310.2.1 and R310.2.2.

SECTION R313
AUTOMATIC FIRE SPRINKLER SYSTEMS
DELETED

SECTION R314
SMOKE ALARMS

R314.1 General. Smoke alarms shall comply with NFPA 72 and Section R314.

R314.1.1 Listings. Smoke alarms shall be *listed* in accordance with UL 217. Combination smoke and carbon monoxide alarms shall be *listed* in accordance with UL 217 and UL 2034.

R314.2 Where required. Smoke alarms shall be provided in accordance with this section.

R314.2.1 New construction. Smoke alarms shall be provided in *dwelling units.*

R314.2.2 Alterations, repairs and additions. Where *alterations*, *repairs* or *additions* requiring a building *permit* occur, the individual *dwelling unit* shall be equipped with smoke alarms located as required for new *dwellings.*

Exceptions:

1. Work involving the exterior surfaces of *dwellings*, such as the replacement of roofing or siding, the addition or replacement of windows or doors, or the addition of a porch or deck.
2. Installation, *alteration* or repairs of plumbing or mechanical systems.

R314.3 Location. Smoke alarms shall be installed in the following locations:

1. In each sleeping room.
2. Outside each separate sleeping area in the immediate vicinity of the bedrooms.
3. On each additional story of the *dwelling*, including *basements* and *habitable attics* and not including crawl spaces and uninhabitable *attics*. In *dwellings* or *dwelling units* with split levels and without an intervening door between the adjacent levels, a smoke alarm installed on the upper level shall suffice for the adjacent lower level provided that the lower level is less than one full *story* below the upper level.
4. Not less than 3 feet (914 mm) horizontally from the door or opening of a bathroom that contains a bathtub or shower unless this would prevent placement of a smoke alarm required by this section.
5. Deleted.

R314.3.1 Installation near cooking appliances. Smoke alarms shall not be installed in the following locations unless this would prevent placement of a smoke alarm in a location required by Section R314.3.

1. Ionization smoke alarms shall not be installed less than 20 feet (6096 mm) horizontally from a permanently installed cooking *appliance*.
2. Ionization smoke alarms with an alarm-silencing switch shall not be installed less than 10 feet (3048 mm) horizontally from a permanently installed cooking *appliance*.
3. Photoelectric smoke alarms shall not be installed less than 6 feet (1828 mm) horizontally from a permanently installed cooking *appliance*.
4. Deleted.

R314.4 Interconnection. Where more than one smoke alarm is required to be installed within an individual *dwelling unit* in accordance with Section R314.3, the alarm devices shall be interconnected in such a manner that the actuation of one alarm will activate all of the alarms in the individual *dwelling unit*. Physical interconnection of smoke alarms shall not be required where *listed* wireless alarms are installed and all alarms sound upon activation of one alarm.

R314.5 Combination alarms. Combination smoke and carbon monoxide alarms shall be permitted to be used in lieu of smoke alarms.

R314.6 Power source. Smoke alarms shall receive their primary power from the building wiring where such wiring is served from a commercial source and, where primary power is interrupted, shall receive power from a battery. Wiring shall be permanent and without a disconnecting switch other than those required for overcurrent protection.

Exceptions:

1. Smoke alarms shall be permitted to be battery operated where installed in buildings without commercial power.
2. Smoke alarms installed in accordance with Section R314.2.2 shall be permitted to be battery powered.

R314.7 Fire alarm systems. Fire alarm systems shall be permitted to be used in lieu of smoke alarms and shall comply with Sections R314.7.1 through R314.7.4.

R314.7.1 General. Fire alarm systems shall comply with the provisions of this code and the household fire warning equipment provisions of NFPA 72. Smoke detectors shall be *listed* in accordance with UL 268.

R314.7.2 Location. Smoke detectors shall be installed in the locations specified in Section R314.3.

R314.7.3 Permanent fixture. Where a household fire alarm system is installed, it shall become a permanent fixture of the occupancy, owned by the homeowner.

R314.7.4 Combination detectors. Combination smoke and carbon monoxide detectors shall be permitted to be installed in fire alarm systems in lieu of smoke detectors, provided that they are *listed* in accordance with UL 268 and UL 2075.

SECTION R315
CARBON MONOXIDE ALARMS

R315.1 General. Carbon monoxide alarms shall comply with Section R315.

R315.1.1 Listings. Carbon monoxide alarms shall be *listed* in accordance with UL 2034. Combination carbon monoxide and smoke alarms shall be *listed* in accordance with UL 217 and UL 2034.

R315.2 Where required. Carbon monoxide alarms shall be provided in accordance with Sections R315.2.1 and R315.2.2.

R315.2.1 New construction. For new construction, carbon monoxide alarms shall be provided in *dwelling units* where either or both of the following conditions exist.

1. The *dwelling unit* contains a fuel-fired *appliance* or fireplace.

2. The *dwelling unit* has an attached garage with an opening that communicates with the *dwelling unit*.

R315.2.2 Alterations, repairs and additions. Where *alterations*, *repairs* or *additions* requiring a building *permit* occur, or where one or more *sleeping rooms* are added or created in *existing dwellings*, or where fuel-fired appliances or fireplaces are added or replaced, shall be equipped with carbon monoxide alarms located as required for new *dwellings*.

Exceptions:

1. Work involving the exterior surfaces of *dwellings*, such as the replacement of roofing or siding, or the addition or replacement of windows or doors, or the addition of a porch or deck or the installation of a fuel-fired appliance that cannot introduce carbon monoxide to the interior of the dwelling.
2. Deleted.
3. Deleted.

R315.3 Location. Carbon monoxide alarms in *dwelling units* shall be installed outside of each separate sleeping area in the immediate vicinity of the bedrooms. Where a fuel-burning *appliance* is located within a bedroom or its attached bathroom, a carbon monoxide alarm shall be installed within the bedroom.

R315.4 Combination alarms. Combination carbon monoxide and smoke alarms shall be permitted to be used in lieu of carbon monoxide alarms.

R315.5 Interconnectivity. Where more than one carbon monoxide alarm is required to be installed within an individual *dwelling unit* in accordance with Section R315.3, the alarm devices shall be interconnected in such a manner that the actuation of one alarm will activate all of the alarms in the individual *dwelling unit*. Physical interconnection of carbon monoxide alarms shall not be required where *listed* wireless alarms are installed and all alarms sound upon activation of one alarm.

Exception: Interconnection of carbon monoxide alarms in existing areas shall not be required where *alterations* or *repairs* do not result in removal of interior wall or ceiling finishes exposing the structure, unless there is an attic, *crawl space* or *basement* available that could provide access for interconnection without the removal of interior finishes.

R315.6 Power source. Carbon monoxide alarms shall receive their primary power from the building wiring where such wiring is served from a commercial source and, where primary power is interrupted, shall receive power from a battery. Wiring shall be permanent and without a disconnecting switch other than those required for overcurrent protection.

Exceptions:

1. Carbon monoxide alarms shall be permitted to be battery operated where installed in buildings without commercial power.
2. Carbon monoxide alarms installed in accordance with Section R315.2.2 shall be permitted to be battery powered.

R315.7 Carbon monoxide detection systems. Carbon monoxide detection systems shall be permitted to be used in lieu of carbon monoxide alarms and shall comply with Sections R315.7.1 through R315.7.4.

R315.7.1 General. Household carbon monoxide detection systems shall comply with NFPA 72. Carbon monoxide detectors shall be *listed* in accordance with UL 2075.

R315.7.2 Location. Carbon monoxide detectors shall be installed in the locations specified in Section R315.3. These locations supersede the locations specified in NFPA 72.

R315.7.3 Permanent fixture. Where a household carbon monoxide detection system is installed, it shall become a permanent fixture of the occupancy and owned by the homeowner.

R315.7.4 Combination detectors. Combination carbon monoxide and smoke detectors installed in carbon monoxide detection systems in lieu of carbon monoxide detectors shall be *listed* in accordance with UL 268 and UL 2075.

SECTION R316
FOAM PLASTIC

R316.1 General. The provisions of this section shall govern the materials, design, application, construction and installation of foam plastic materials.

R316.2 Labeling and identification. Packages and containers of foam plastic insulation and foam plastic insulation components delivered to the job site shall bear the *label* of an *approved agency* showing the manufacturer's name, the product listing, product identification and information sufficient to determine that the end use will comply with the requirements.

R316.3 Surface burning characteristics. Unless otherwise allowed in Section R316.5, foam plastic, or foam plastic cores used as a component in manufactured assemblies, used in building construction shall comply with Section R316.3.1 or R316.3.2. Loose-fill-type foam plastic insulation shall be tested as board stock for the flame spread index and *smoke-developed index*.

Exception: Spray foam plastic insulation more than 4 inches (102 mm) in thickness shall have a flame spread index of not more than 25 and a smoke-developed index of not more than 450 where tested at a thickness of 4 inches (102 mm) and at the density intended for use. Such spray foam plastic shall be separated from the interior of a building by $^1/_2$-inch (12.7 mm) gypsum wallboard or by a material that has been tested in accordance with NFPA 275, and shall meet the acceptance criteria of both the Temperature Transmission Fire Test and the Integrity Fire Test.

R316.3.1 Foam plastic insulation 4 inches thick or less. Foam plastic insulation installed at 4 inches (102 mm) in thickness or less shall have a flame spread index of not more than 75 and a smoke-developed index of not more than 450 where tested in the maximum thickness and density intended for use in accordance with ASTM E84 or UL 723.

R316.3.2 Foam plastic insulation more than 4 inches thick. Foam plastic insulation installed at more than 4 inches (102 mm) in thickness shall have a flame spread index of not more than 75 and a smoke-developed index of not more than 450 where tested at a thickness of 4 inches (102 mm) in accordance with ASTM E84 or UL 723, provided that the end use is approved in accordance with Section R316.6 using the thickness and density intended for use.

R316.4 Thermal barrier. Unless otherwise allowed in Section R316.5, foam plastic shall be separated from the interior of a building by an *approved* thermal barrier of not less than $^{1}/_{2}$-inch (12.7 mm) gypsum wallboard, $^{23}/_{32}$-inch (18.2 mm) *wood structural panel* or a material that is tested in accordance with and meets the acceptance criteria of both the Temperature Transmission Fire Test and the Integrity Fire Test of NFPA 275.

R316.5 Specific requirements. The following requirements shall apply to these uses of foam plastic unless specifically *approved* in accordance with Section R316.6 or by other sections of the code or the requirements of Sections R316.2 through R316.4 have been met.

R316.5.1 Masonry or concrete construction. The thermal barrier specified in Section R316.4 is not required in a masonry or concrete wall, floor or roof where the foam plastic insulation is separated from the interior of the building by not less than a 1-inch (25 mm) thickness of masonry or concrete.

R316.5.2 Roofing. The thermal barrier specified in Section R316.4 is not required where the foam plastic in a roof assembly or under a roof covering is installed in accordance with the code and the manufacturer's instructions and is separated from the interior of the building by one of the following:

1. Tongue-and-groove wood planks
2. *Wood structural panel* sheathing, in accordance with Section R803, that is not less than $^{15}/_{32}$ inch (11.9 mm) thick bonded with exterior glue, identified as Exposure 1 and with edges supported by blocking or tongue-and-groove joints or an equivalent material.

The *smoke-developed index* for roof applications shall not be limited.

R316.5.3 Attics. The thermal barrier specified in Section R316.4 is not required where all of the following apply:

1. *Attic* access is required by Section R807.1.
2. The space is entered only for purposes of repairs or maintenance.
3. The foam plastic insulation has been tested in accordance with Section R316.6 or the foam plastic insulation is protected against ignition using one of the following ignition barrier materials:
   - 3.1. $1^{1}/_{2}$-inch-thick (38 mm) mineral fiber insulation.
   - 3.2. $^{1}/_{4}$-inch-thick (6.4 mm) *wood structural panels*.
   - 3.3. $^{3}/_{8}$-inch (9.5 mm) particleboard.
   - 3.4. $^{1}/_{4}$-inch (6.4 mm) hardboard.
   - 3.5. $^{3}/_{8}$-inch (9.5 mm) gypsum board.
   - 3.6. Corrosion-resistant steel having a base metal thickness of 0.016 inch (0.406 mm).
   - 3.7. $1^{1}/_{2}$-inch-thick (38 mm) cellulose insulation.
   - 3.8. $^{1}/_{4}$-inch (6.4 mm) fiber-cement panel, soffit or backer board.

The ignition barrier is not required where the foam plastic insulation has been tested in accordance with Section R316.6.

R316.5.4 Crawl spaces. The thermal barrier specified in Section R316.4 is not required where all of the following apply:

1. *Crawl space* access is required by Section R408.8 and Section R409.1.2.
2. Entry is made only for purposes of repairs or maintenance.
3. The foam plastic insulation has been tested in accordance with Section R316.6 or the foam plastic insulation is protected against ignition using one of the following ignition barrier materials:
   - 3.1. $1^{1}/_{2}$-inch-thick (38 mm) mineral fiber insulation.
   - 3.2. $^{1}/_{4}$-inch-thick (6.4 mm) *wood structural panels*.
   - 3.3. $^{3}/_{8}$-inch (9.5 mm) particleboard.
   - 3.4. $^{1}/_{4}$-inch (6.4 mm) hardboard.
   - 3.5. $^{3}/_{8}$-inch (9.5 mm) gypsum board.
   - 3.6. Corrosion-resistant steel having a base metal thickness of 0.016 inch (0.406 mm).
   - 3.7. $^{1}/_{4}$-inch (6.4 mm) fiber-cement panel, soffit or backer board.

R316.5.5 Foam-filled exterior doors. Foam-filled exterior doors are exempt from the requirements of Sections R316.3 and R316.4.

R316.5.6 Foam-filled garage doors. Foam-filled garage doors in attached or detached garages are exempt from the requirements of Sections R316.3 and R316.4.

R316.5.7 Foam backer board. The thermal barrier specified in Section R316.4 is not required where siding backer board foam plastic insulation has a thickness of not more than 0.5 inch (12.7 mm) and a potential heat of not more than 2000 Btu per square foot (22 720 kJ/m^2)

when tested in accordance with NFPA 259 and it complies with one or more of the following:

1. The foam plastic insulation is separated from the interior of the building by not less than 2 inches (51 mm) of mineral fiber insulation.
2. The foam plastic insulation is installed over existing exterior wall finish in conjunction with re-siding.
3. The foam plastic insulation has been tested in accordance with Section R316.6.

R316.5.8 Re-siding. The thermal barrier specified in Section R316.4 is not required where the foam plastic insulation is installed over existing exterior wall finish in conjunction with re-siding provided that the foam plastic has a thickness of not more than 0.5 inch (12.7 mm) and a potential heat of not more than 2000 Btu per square foot (22 720 kJ/m^2) when tested in accordance with NFPA 259.

R316.5.9 Interior trim. The thermal barrier specified in Section R316.4 is not required for exposed foam plastic interior *trim*, provided that all of the following are met:

1. The density is not less than 20 pounds per cubic foot (320 kg/m^3).
2. The thickness of the *trim* is not more than 0.5 inch (12.7 mm) and the width is not more than 8 inches (204 mm).
3. The interior *trim* shall not constitute more than 10 percent of the aggregate wall and ceiling area of any room or space.
4. The flame spread index does not exceed 75 when tested in accordance with ASTM E84 or UL 723. The *smoke-developed index* is not limited.

R316.5.10 Interior finish. Foam plastics used as interior finishes shall comply with Section R316.6 and shall meet the flame spread index and *smoke-developed index* requirements of Sections R302.9.1 and R302.9.2.

R316.5.11 Sill plates and headers. Foam plastic spray applied to sill plates and headers or installed in the perimeter joist space without the thermal barrier specified in Section R316.4 shall comply with all of the following:

1. The thickness of the foam plastic shall be not more than $3^1/_4$ inches (83 mm).
2. The density of the foam plastic shall be in the range of 0.5 to 2.0 pounds per cubic foot (8 to 32 kg/m^3).
3. The foam plastic shall have a flame spread index of 25 or less and an accompanying *smoke-developed index* of 450 or less when tested in accordance with ASTM E84 or UL 723.

R316.5.12 Sheathing. Foam plastic insulation used as sheathing shall comply with Section R316.3 and Section R316.4. Where the foam plastic sheathing is exposed to the *attic* space at a gable or kneewall, the provisions of Section R316.5.3 shall apply. Where foam plastic insulation is used as exterior wall sheathing on framed wall assemblies, it shall comply with Section R316.8.

R316.5.13 Floors. The thermal barrier specified in Section R316.4 is not required to be installed on the walking surface of a structural floor system that contains foam plastic insulation where the foam plastic is covered by not less than a nominal $^1/_2$-inch-thick (12.7 mm) *wood structural panel* or equivalent. The thermal barrier specified in Section R316.4 is required on the underside of the structural floor system that contains foam plastic insulation where the underside of the structural floor system is exposed to the interior of the building.

R316.6 Specific approval. Foam plastic not meeting the requirements of Sections R316.3 through R316.5 shall be specifically *approved* on the basis of one of the following *approved* tests: NFPA 286 with the acceptance criteria of Section R302.9.4, FM 4880, UL 1040 or UL 1715, or fire tests related to actual end-use configurations. Approval shall be based on the actual end-use configuration and shall be performed on the finished foam plastic assembly in the maximum thickness intended for use. Assemblies tested shall include seams, joints and other typical details used in the installation of the assembly and shall be tested in the manner intended for use.

R316.7 Termite damage. The use of foam plastics in areas of "moderate-heavy" termite infestation probability shall be in accordance with Section R318.4.

R316.8 Wind resistance. Foam plastic insulation complying with ASTM C578 and ASTM C1289 and used as exterior wall sheathing on framed wall assemblies shall comply with SBCA FS 100 for wind pressure resistance unless installed directly over a sheathing material that is separately capable of resisting the wind load or otherwise exempted from the scope of SBCA FS 100.

SECTION R317
PROTECTION OF WOOD AND WOOD-BASED PRODUCTS AGAINST DECAY

R317.1 Location required. Protection of wood and wood-based products from decay shall be provided in the following locations by the use of *naturally durable wood* or wood that is preservative-treated in accordance with AWPA U1.

1. In crawl spaces or unexcavated areas located within the periphery of the building foundation, wood joists or the bottom of a wood structural floor where closer than 18 inches (457 mm) to exposed ground, wood girders where closer than 12 inches (305 mm) to exposed ground.
2. Wood framing members that rest on concrete or masonry exterior foundation walls and are less than 8 inches (203 mm) from the exposed ground.
3. Sills and sleepers on a concrete or masonry slab that is in direct contact with the ground unless separated from such slab by an impervious moisture barrier.

4. The ends of wood girders entering exterior masonry or concrete walls having clearances of less than $^1/_2$ inch (12.7 mm) on tops, sides and ends.
5. Wood siding, sheathing and wall framing on the exterior of a building having a clearance of less than 6 inches (152 mm) from the ground or less than 2 inches (51 mm) measured vertically from concrete steps, porch slabs, patio slabs and similar horizontal surfaces exposed to the weather.
6. Wood structural members supporting moisture-permeable floors or roofs that are exposed to the weather, such as concrete or masonry slabs, unless separated from such floors or roofs by an impervious moisture barrier.
7. Wood furring strips or other wood framing members attached directly to the interior of exterior masonry walls or concrete walls below *grade* except where an *approved* vapor retarder is applied between the wall and the furring strips or framing members.
8. All portions of a porch, screen porch or deck from the bottom of the header down, including posts, guardrails, pickets, steps, and floor structure. Coverings that would prevent moisture or water accumulation on the surface or at joints between members are allowed.

   Exception: Columns complying with Section R317.1.3, Exception 3.

R317.1.1 Field treatment. Deleted.

R317.1.2 Ground contact. All wood in contact with the ground, embedded in concrete in direct contact with the ground or embedded in concrete exposed to the weather that supports permanent structures intended for human occupancy shall be *approved* pressure-preservative-treated wood suitable for ground contact use, except that untreated wood used entirely below groundwater level or continuously submerged in fresh water shall not be required to be pressure-preservative treated.

R317.1.3 Wood columns. Wood columns shall be *approved* wood of natural decay resistance or *approved* pressure-preservative-treated wood.

Exceptions:

1. Columns in basements when supported by a concrete floor with an approved impervious moisture barrier installed between the slab and earth.
2. Columns exposed to the weather when all of the following conditions are met:
   a. The column is supported by piers or metal pedestals projecting 1 inch (25.4 mm) above a concrete floor or 6 inches (152 mm) above exposed earth and the earth is covered by an approved impervious moisture barrier;
   b. There are no joints in or between structural members (from the header to the base of the column);
   c. The column is protected from exposure to surface moisture at the top by a roof, eave, or overhang; and
   d. The exterior surface of the column is full sealed (paint, sealer, etc.) against moisture intrusion.
3. Columns in enclosed crawl spaces or unexcavated areas located within the periphery of the building when supported by a concrete pier or metal pedestal at a height more than 8 inches (203 mm) from exposed earth and the earth is covered by an impervious moisture barrier.

R317.2 Quality mark. Lumber and plywood required to be pressure-preservative treated in accordance with Section R317.1 shall bear the quality *mark* of an *approved* inspection agency that maintains continuing supervision, testing and inspection over the quality of the product and that has been *approved* by an accreditation body that complies with the requirements of the American Lumber Standard Committee treated wood program.

R317.2.1 Required information. The required quality *mark* on each piece of pressure-preservative-treated lumber or plywood shall contain the following information:

1. Identification of the treating plant.
2. Type of preservative.
3. The minimum preservative retention.
4. End use for which the product was treated.
5. Standard to which the product was treated.
6. Identity of the *approved* inspection agency.
7. The designation “Dry,” if applicable.

Exception: Quality *mark*s on lumber less than 1 inch (25 mm) nominal thickness, or lumber less than nominal 1 inch by 5 inches (25 mm by 127 mm) or 2 inches by 4 inches (51 mm by 102 mm) or lumber 36 inches (914 mm) or less in length shall be applied by stamping the faces of exterior pieces or by end labeling not less than 25 percent of the pieces of a bundled unit.

R317.3 Fasteners and connectors in contact with preservative-treated and fire-retardant-treated wood. Fasteners, including nuts and washers, and connectors in contact with preservative-treated wood and fire-retardant-treated wood shall be in accordance with this section. The coating weights for zinc-coated fasteners shall be in accordance with ASTM A153. Stainless steel driven fasteners shall be in accordance with the material requirements of ASTM F1667.

R317.3.1 Fasteners for preservative-treated wood. Fasteners, including nuts and washers, for preservative-treated wood shall be of hot-dipped, zinc-coated galvanized steel, stainless steel, silicon bronze or copper. Staples shall be of stainless steel. Coating types and weights for connectors in contact with preservative-treated wood shall be in accordance with the connector manufacturer’s recommendations. In the absence of manufacturer’s recommendations, not less than ASTM

A653 type G185 zinc-coated galvanized steel, or equivalent, shall be used.

Exceptions:

1. $^1/_2$-inch-diameter (12.7 mm) or greater steel bolts.
2. Fasteners other than nails, staples and timber rivets shall be permitted to be of mechanically deposited zinc-coated steel with coating weights in accordance with ASTM B695, Class 55 minimum.
3. Plain carbon steel fasteners in SBX/DOT and zinc borate preservative-treated wood in an interior, dry environment shall be permitted.

R317.3.2 Fastenings for wood foundations. Fastenings, including nuts and washers, for wood foundations shall be as required in AWC PWF.

R317.3.3 Fasteners for fire-retardant-treated wood used in exterior applications or wet or damp locations. Fasteners, including nuts and washers, for fire-retardant-treated wood used in exterior applications or wet or damp locations shall be of hot-dipped, zinc-coated galvanized steel, stainless steel, silicon bronze or copper. Fasteners other than nails, staples and timber rivets shall be permitted to be of mechanically deposited zinc-coated steel with coating weights in accordance with ASTM B695, Class 55 minimum.

R317.3.4 Fasteners for fire-retardant-treated wood used in interior applications. Fasteners, including nuts and washers, for fire-retardant-treated wood used in interior locations shall be in accordance with the manufacturer's recommendations. In the absence of the manufacturer's recommendations, Section R317.3.3 shall apply.

R317.4 Plastic composites. *Plastic composite* exterior deck boards, stair treads, *guards* and *handrails* containing wood, cellulosic or other biodegradable materials shall comply with the requirements of Section ASTM D7032.

SECTION R318
PROTECTION AGAINST SUBTERRANEAN TERMITES

R318.1 Subterranean termite control methods. In areas subject to damage from termites as indicated by Table R301.2, protection shall be by one, or a combination, of the following methods:

1. Chemical termiticide treatment in accordance with Section R318.2.
2. Termite-baiting system installed and maintained in accordance with the *label* and according to the rules adopted by the North Carolina Structural Pest Control Committee (02 NCAC 34).
3. Pressure-preservative-treated wood in accordance with AWPA U1.
4. Naturally durable termite-resistant wood.
5. Deleted.
6. Deleted.

R318.1.1 Quality mark. Lumber and plywood required to be pressure-preservative treated in accordance with Section R318.1 shall bear the quality *mark* of an *approved* inspection agency that maintains continuing supervision, testing and inspection over the quality of the product and that has been *approved* by an accreditation body that complies with the requirements of the American Lumber Standard Committee treated wood program.

R318.1.2 Field treatment. Deleted.

R318.2 Chemical termiticide treatment. Chemical termiticide treatment shall include soil treatment or field-applied wood treatment. The concentration, rate of application and method of treatment of the chemical termiticide shall be in strict accordance with the termiticide *label* and applied according to the rules adopted by the North Carolina Structural Pest Control Committee (02 NOAC 34).

R318.3 Barriers. Deleted.

R318.4 Foam plastic protection. This section shall apply to both treated and untreated foam plastic.

R318.4.1 Foundation walls. All foam plastic shall be a minimum of 8 inches (203 mm) above grade. See Appendix NCD.

Exception: Foam plastic less than 8 inches (203 mm) above or in contact with grade shall be installed in accordance with Section 318.4.5 and Appendix NCD.

R318.4.2 Termite control. When foam plastic is in contact with the ground, subterranean termite control shall be in accordance with Section 318.1.

R318.4.3 Slab on grade (nonstructural). Foam plastic shall be installed along the vertical edge and underneath the slab as specified in Section R318.4.5.

R318.4.4 Slab on grade (structural). All slabs that distribute the wall loads to the foundation shall be insulated as specified in this section. Foam plastic shall be installed along the vertical edge and underneath grade as specified in Appendix NCD, Figure NCD-3.

R318.4.5 Foam plastic in contact with ground. Foam plastic in contact with the ground shall comply with Sections R318.4.5.1 through R318.4.5.4.

R318.4.5.1 Inspection and treatment gaps. Foam plastic in contact with the ground shall not be continuous to the bottom of the weather-resistant siding. A clear and unobstructed 2-inch (51 mm) minimum inspection gap shall be maintained from the bottom of the weather-resistant siding to the top of any foam plastic. A minimum 4-inch (102 mm) treatment gap shall be provided beginning not more than 6 inches (152 mm) below grade. The top and bottom edges of the foam plastic installed between the inspection gap and the treatment gap shall be cut at a 45-degree (0.79 rad) angle. See Appendix NCD.

Exception: For additional requirements for insulating concrete form (ICF) foundations see Section R404.1.3.3.6.1.

R318.4.5.2 Protection of exposed foam plastic. Exposed foam plastic shall be protected from physical

damage. The required inspection gap foam plastic and treatment gap shall be on the exterior with a cementitious coating that extends at least 2 inches (51 mm) below the foam plastic onto the surface of the foundation wall. See Appendix NCD.

R318.4.5.3 Waterproofing foam plastic between inspection gap and treatment gap. Waterproofing shall be installed over the required cementitious coating from 6 inches (152 mm) above grade to the treatment gap in accordance with manufacturer's installation instructions.

R318.4.5.4 Dampproofing of below grade walls. Any foam plastic applied below the treatment gap shall be installed after required foundation wall dampproofing is in place. See Section R406 and Appendix NCD.

SECTION R319
SITE ADDRESS

R319.1 Address identification. Buildings shall be provided with *approved* address identification. The address identification shall be legible and placed in a position that is visible from the street or road fronting the property. Address identification characters shall contrast with their background. Address numbers shall be Arabic numbers or alphabetical letters. Numbers shall not be spelled out. Each character shall be not less than 4 inches (102 mm) in height with a stroke width of not less than 0.5 inch (12.7 mm). Where required by the fire code official, address identification shall be provided in additional *approved* locations to facilitate emergency response. Where access is by means of a private road and the building address cannot be viewed from the *public way*, a monument, pole or other sign or means shall be used to identify the structure. Address identification shall be maintained.

SECTION R320
ACCESSIBILITY

R320.1 Scope. Where there are four or more *dwelling units* or *sleeping units* in a single structure, the provisions of Chapter 11 of the *International Building Code* for Group R-3 shall apply.

Exception: Owner-occupied lodging houses with eight or fewer guestrooms are not required to be accessible.

R320.2 Live/work units. In *live/work units*, the nonresidential portion shall be accessible in accordance with Sections 508.5.9 and 508.5.11 of the *International Building Code*. In a structure where there are four or more live/work units, the dwelling portion of the *live/work unit* shall comply with Section 1108.6.2.1 of the *International Building Code*.

SECTION R321
ELEVATORS AND PLATFORM LIFTS

R321.1 Elevators. Where provided, passenger elevators, limited-use and limited-application elevators or private residence elevators shall comply with ASME A17.1/CSA B44.

R321.1.1 Clearance between hoistways doors and car doors or gates The clearance between the hoistway doors or gates and the hoistway edge of the landing sill shall not exceed $^3/_4$ inch (19 mm). The distance between the hoistway face of the landing door or gate and the car door or gate shall not exceed 4 inches (101.6 mm) as follows:

1. Horizontal sliding car doors and gates shall be designed and installed to withstand a force of 75 pounds applied horizontally on an area 4 inches by 4 inches (101.6 mm by 101.6 mm) at right angles to and at any location on the car door without permanent deformation. The deflection may not exceed $^3/_4$ inch (19 mm) and may not displace the door from its guides or tracks. The force must be applied while the door is in the fully closed position.
2. Folding car doors shall be designed and installed to withstand a force of 75 pounds applied horizontally using a 4-inch-diameter (101.6 mm) sphere at any location within the folds on the car door without permanent deformation. The deflection may not exceed $^3/_4$ inch (19 mm) and may not displace the door from its guides. The force must be applied while the door is in the fully closed position.

Exception: A permanent installation of a nonremovable, hoistway door space guard, a full height door baffle or door baffle that is at least $31^3/_4$ inches (806 mm) in height is allowed. The door space guard, full height door baffle or $31^3/_4$ inches (806 mm) door baffle must be designed and installed to withstand a force of 75 pounds applied horizontally using a 4-inch-diameter (101.6 mm) sphere at any location of the space guard without permanent deformation while allowing no more than $^3/_4$ inch (19 mm) sill.

R321.2 Platform lifts. Where provided, platform lifts shall comply with ASME A18.1.

R321.3 Accessibility. Deleted.

R321.4 Certification. The installer shall certify that the following conditions have been met.

1. The elevator or platform lift has been installed in accordance with the manufacturer's installation instructions.
2. The elevator meets the requirements of ASME A17.1/CSA B44.
3. The elevator or platform lift meets the requirements of the *North Carolina Electrical Code*. Before a certificate of occupancy is issued, the permit holder shall provide the code enforcement official a letter of certification from the installer, evidencing compli-

ance with the above conditions. Any maintenance requirements required by the manufacturer must be stated and affixed to the component.

SECTION R322
FLOOD-RESISTANT CONSTRUCTION

R322.1 General. Buildings and structures constructed in whole or in part in flood hazard areas, including A or V Zones and Coastal A Zones, as established in Table R301.2, and substantial improvement and *repair* of substantial damage of buildings and structures in flood hazard areas, shall be designed and constructed in accordance with the provisions contained in this section. Buildings and structures that are located in more than one flood hazard area shall comply with the provisions associated with the most restrictive flood hazard area. Buildings and structures located in whole or in part in identified floodways shall be designed and constructed in accordance with ASCE 24. See additional provisions in Chapter 46.

R322.1.1 Alternative provisions. As an alternative to the requirements in Section R322, ASCE 24 is permitted subject to the limitations of this code and the limitations therein.

R322.1.2 Structural systems. Structural systems of buildings and structures shall be designed, connected and anchored to resist flotation, collapse or permanent lateral movement due to structural loads and stresses from flooding equal to the design flood elevation.

R322.1.3 Flood-resistant construction. Buildings and structures erected in areas prone to flooding shall be constructed by methods and practices that minimize flood damage.

R322.1.4 Establishing the design flood elevation. The design flood elevation shall be used to define flood hazard areas. At a minimum, the design flood elevation shall be the higher of the following:

1. The base flood elevation at the depth of peak elevation of flooding, including wave height, that has a 1-percent (100-year flood) or greater chance of being equaled or exceeded in any given year.
2. The elevation of the design flood associated with the area designated on a flood hazard map adopted by the community, or otherwise legally designated.

R322.1.4.1 Determination of design flood elevations. If design flood elevations are not specified, the *building official* is authorized to require the applicant to comply with either of the following:

1. Obtain and reasonably use data available from a federal, state or other source.
2. Determine the design flood elevation in accordance with accepted hydrologic and hydraulic engineering practices used to define special flood hazard areas. Determinations shall be undertaken by a *registered design professional* who shall document that the technical methods used reflect currently accepted engineering practice. Studies, analyses and computations shall be submitted in sufficient detail to allow thorough review and *approval*.

R322.1.4.2 Determination of impacts. In riverine flood hazard areas where design flood elevations are specified but floodways have not been designated, the applicant shall demonstrate that the effect of the proposed buildings and structures on design flood elevations, including fill, when combined with other existing and anticipated flood hazard area encroachments, will not increase the design flood elevation more than 1 foot (305 mm) at any point within the *jurisdiction*.

R322.1.5 Lowest floor. The lowest floor shall be the lowest floor of the lowest enclosed area, including *basement*, and excluding any unfinished flood-resistant enclosure that is useable solely for vehicle parking, building access or limited storage provided that such enclosure is not built so as to render the building or structure in violation of this section.

R322.1.6 Protection of mechanical, plumbing and electrical systems. Electrical systems, *equipment* and components; heating, ventilating, air-conditioning; plumbing *appliances* and plumbing fixtures; *duct systems*; and other service *equipment* shall be located at or above the elevation required in Section R322.2 or R322.3. If replaced as part of a substantial improvement, electrical systems, *equipment* and components; heating, ventilating, air-conditioning and plumbing *appliances* and plumbing fixtures; *duct systems*; and other service *equipment* shall meet the requirements of this section. Systems, fixtures, and *equipment* and components shall not be mounted on or penetrate through walls intended to break away under flood loads.

Exception: Locating electrical systems, *equipment* and components; heating, ventilating, air-conditioning; plumbing *appliances* and plumbing fixtures; *duct systems*; and other service *equipment* is permitted below the elevation required in Section R322.2 or R322.3 provided that they are designed and installed to prevent water from entering or accumulating within the components and to resist hydrostatic and hydrodynamic loads and stresses, including the effects of buoyancy, during the occurrence of flooding to the required elevation in accordance with ASCE 24. Electrical wiring systems are permitted to be located below the required elevation provided that they conform to the provisions of the electrical part of this code for wet locations.

R322.1.7 Protection of water supply and sanitary sewage systems. New and replacement water supply systems shall be designed to minimize or eliminate infiltration of floodwaters into the systems in accordance with the plumbing provisions of this code. New and replacement sanitary sewage systems shall be designed to minimize or eliminate infiltration of floodwaters into

systems and discharges from systems into floodwaters in accordance with the plumbing provisions of this code and Chapter 3 of the *International Private Sewage Disposal Code*.

R322.1.8 Flood-resistant materials. Building materials and installation methods used for flooring and interior and exterior walls and wall coverings below the elevation required in Section R322.2 or R322.3 shall be flood damage-resistant materials that conform to the provisions of FEMA TB-2.

R322.1.9 Manufactured homes. Deleted.

R322.1.10 As-built elevation documentation. A *registered design professional* shall prepare and seal documentation of the elevations specified in Section R322.2 or R322.3.

R322.2 Flood hazard areas (including A Zones). Areas that have been determined to be prone to flooding and that are not subject to high-velocity wave action shall be designated as flood hazard areas. Flood hazard areas that have been delineated as subject to wave heights between $1^1/_2$ feet (457 mm) and 3 feet (914 mm) or otherwise designated by the *jurisdiction* shall be designated as Coastal A Zones and are subject to the requirements of Section R322.3. Buildings and structures constructed in whole or in part in flood hazard areas shall be designed and constructed in accordance with Sections R322.2.1 through R322.2.4.

R322.2.1 Elevation requirements.

1. Buildings and structures in flood hazard areas, not including flood hazard areas designated as Coastal A Zones, shall have the lowest floors elevated to or above the base flood elevation plus 1 foot (305 mm), or the design flood elevation, whichever is higher.
2. In areas of shallow flooding (AO Zones), buildings and structures shall have the lowest floor (including *basement*) elevated to a height above the highest adjacent *grade* of not less than the depth number specified in feet (mm) on the FIRM plus 1 foot (305 mm), or not less than 3 feet (915 mm) if a depth number is not specified.
3. *Basement* floors that are below *grade* on all sides shall be elevated to or above base flood elevation plus 1 foot (305 mm), or the design flood elevation, whichever is higher.
4. Garage and carport floors shall comply with one of the following:
    4.1. They shall be elevated to or above the elevations required in Item 1 or Item 2, as applicable.
    4.2. They shall be at or above *grade* on not less than one side. Where a garage or carport is enclosed by walls, the garage or carport shall be used solely for parking, building access or storage.

Exception: Enclosed areas below the elevation required in this section, including *basements* with floors that are not below *grade* on all sides, shall meet the requirements of Section R322.2.2.

R322.2.2 Enclosed area below required elevation. Enclosed areas, including *crawl spaces*, that are below the elevation required in Section R322.2.1 shall:

1. Be used solely for parking of vehicles, building access or storage.
2. Be provided with flood openings that meet the following criteria and are installed in accordance with Section R322.2.2.1:
    2.1. The total net area of nonengineered openings shall be not less than 1 square inch (645 mm^2) for each square foot (0.093 m^2) of enclosed area where the enclosed area is measured on the exterior of the enclosure walls, or the openings shall be designed as engineered openings and the *construction documents* shall include a statement by a *registered design professional* that the design of the openings will provide for equalization of hydrostatic flood forces on exterior walls by allowing for the automatic entry and exit of floodwaters as specified in Section 2.7.2.2 of ASCE 24.
    2.2. Openings shall be not less than 3 inches (76 mm) in any direction in the plane of the wall.
    2.3. The presence of louvers, blades, screens and faceplates or other covers and devices shall allow the automatic flow of floodwater into and out of the enclosed areas and shall be accounted for in the determination of the net open area.

R322.2.2.1 Installation of openings. The walls of enclosed areas shall have openings installed such that:

1. There shall be not less than two openings on different sides of each enclosed area; if a building has more than one enclosed area, each area shall have openings.
2. The bottom of each opening shall be not more than 1 foot (305 mm) above the higher of the final interior grade or floor and the finished exterior grade immediately under each opening.
3. Openings shall be permitted to be installed in doors and windows; doors and windows without installed openings do not meet the requirements of this section.

R322.2.3 Foundation design and construction. Foundation walls for buildings and structures erected in flood hazard areas shall meet the requirements of Chapter 4.

Exception: Unless designed in accordance with Section R404:

1. The unsupported height of 6-inch (152 mm) plain masonry walls shall be not more than 3 feet (914 mm).

2. The unsupported height of 8-inch (203 mm) plain masonry walls shall be not more than 4 feet (1219 mm).
3. The unsupported height of 8-inch (203 mm) reinforced masonry walls shall be not more than 8 feet (2438 mm).

For the purpose of this exception, unsupported height is the distance from the finished *grade* of the under-floor space to the top of the wall.

R322.2.4 Tanks. Deleted.

R322.3 Coastal high-hazard areas (including V Zones and Coastal A Zones, where designated). See Chapter 46.

R322.3.1 Location and site preparation. Deleted.

R322.3.2 Elevation requirements. Deleted.

R322.3.3 Foundations. Deleted.

R322.3.4 Concrete slabs. Deleted.

R322.3.5 Walls below required elevation. Deleted.

R322.3.6 Enclosed areas below required elevation. Deleted.

R322.3.7 Stairways and ramps. Deleted.

R322.3.8 Decks and porches. Deleted.

R322.3.9 Construction documents. Deleted.

R322.3.10 Tanks. Deleted.

SECTION R323
STORM SHELTERS

R323.1 General. This section applies to *storm shelters* where constructed as separate detached buildings or where constructed as safe rooms within buildings for the purpose of providing refuge from storms that produce high winds, such as tornados and hurricanes. In addition to other applicable requirements in this code, storm shelters shall be constructed in accordance with ICC 500.

R323.1.1 Sealed documentation. The *construction documents* for all structural components and *impact protective systems* of the *storm shelter* shall be prepared and sealed by a *registered design professional* indicating that the design meets the criteria of ICC 500.

Exception: Storm shelters, structural components and impact-protective systems that are *listed* and *labeled* to indicate compliance with ICC 500.

SECTION R324
SOLAR ENERGY SYSTEMS

R324.1 General. Solar energy systems shall comply with the provisions of this section.

R324.2 Solar thermal systems. Solar thermal systems shall be designed and installed in accordance with Chapter 23.

R324.3 Photovoltaic systems. Photovoltaic (PV) systems shall be designed and installed in accordance with Sections R324.3.1 through R324.7.1 and the manufacturer's installation instructions. The electrical portion of solar PV systems shall be designed and installed in accordance with NFPA 70.

R324.3.1 Equipment listings. *Photovoltaic panels* and modules shall be *listed* and *labeled* in accordance with UL 1703 or with both UL 61730-1 and UL 61730-2. Inverters shall be *listed* and *labeled* in accordance with UL 1741. Systems connected to the utility grid shall use inverters *listed* for utility interaction. Mounting systems *listed* and *labeled* in accordance with UL 2703 shall be installed in accordance with the manufacturer's installation instructions and their listings.

R324.4 Rooftop-mounted photovoltaic systems. Rooftop-mounted *photovoltaic panel systems* installed on or above the roof covering shall be designed and installed in accordance with this section.

R324.4.1 Structural requirements. Rooftop-mounted *photovoltaic panel systems* shall be designed to structurally support the system and withstand applicable gravity loads in accordance with Chapter 3. The roof on which these systems are installed shall be designed and constructed to support the loads imposed by such systems in accordance with Chapter 8.

R324.4.1.1 Roof load. Portions of roof structures not covered with *photovoltaic panel systems* shall be designed for dead loads and roof loads in accordance with Sections R301.4 and R301.6. Portions of roof structures covered with *photovoltaic panel systems* shall be designed for the following load cases:

1. Dead load (including *photovoltaic panel* weight) plus roof load in accordance with Table R301.2.
2. Dead load (excluding *photovoltaic panel* weight) plus roof *live load*, whichever is greater, in accordance with Section R301.6.

R324.4.1.2 Wind load. Rooftop-mounted *photovoltaic panel* or *module* systems and their supports shall be designed and installed to resist the component and cladding loads specified in Table R301.2.1(1), adjusted for height and exposure in accordance with Table R301.2.1(2).

R324.4.2 Fire classification. Rooftop-mounted *photovoltaic panel systems* shall have the same fire classification as the *roof assembly* required in Section R902.

R324.4.3 Roof penetrations. Roof penetrations shall be flashed and sealed in accordance with Chapter 9.

R324.5 Building-integrated photovoltaic systems. Building-integrated photovoltaic (BIPV) systems that serve as roof coverings shall be designed and installed in accordance with Section R905.

R324.5.1 Photovoltaic shingles. Photovoltaic shingles shall comply with Section R905.16.

R324.5.2 Fire classification. *Building-integrated photovoltaic systems* shall have a fire classification in accordance with Section R902.3.

R324.5.3 BIPV roof panels. BIPV roof panels shall comply with Section R905.17.

R324.6 Roof access and pathways. Roof access, pathways and setback requirements shall be provided in accordance with Sections R324.6.1 through R324.6.2.1. Access and minimum spacing shall be required to provide emergency access to the roof, to provide pathways to specific areas of the roof, provide for smoke ventilation opportunity areas, and to provide emergency egress from the roof.

Exceptions:

1. Detached, nonhabitable structures, including but not limited to detached garages, parking shade structures, carports, solar trellises and similar structures, shall not be required to provide roof access.
2. Roof access, pathways and setbacks need not be provided where the code official has determined that rooftop operations will not be employed.
3. These requirements shall not apply to roofs with slopes of 2 units vertical in 12 units horizontal (17-percent slope) or less.
4. BIPV systems listed in accordance with Section 690.12(B)(2) of NFPA 70, where the removal or cutting away of portions of the BIPV system during fire-fighting operations has been determined to not expose a fire fighter to electrical shock hazards.

R324.6.1 Pathways. Not fewer than two pathways, on separate roof planes from lowest roof edge to ridge and not less than 36 inches (914 mm) wide, shall be provided on all buildings. Not fewer than one pathway shall be provided on the street or driveway side of the roof. For each roof plane with a photovoltaic array, a pathway not less than 36 inches wide (914 mm) shall be provided from the lowest roof edge to ridge on the same roof plane as the photovoltaic array, on an adjacent roof plane, or straddling the same and adjacent roof planes. Pathways shall be over areas capable of supporting fire fighters accessing the roof. Pathways shall be located in areas with minimal obstructions such as vent pipes, conduit, or mechanical equipment.

R324.6.2 Setback at ridge. For photovoltaic arrays occupying not more than 33 percent of the plan view total roof area, not less than an 18-inch (457 mm) clear setback is required on both sides of a horizontal ridge. For photovoltaic arrays occupying more than 33 percent of the plan view total roof area, not less than a 36-inch (914 mm) clear setback is required on both sides of a horizontal ridge.

R324.6.2.1 Alternative setback at ridge. Where an automatic sprinkler system is installed within the dwelling in accordance with NFPA 13D or Section P2904, setbacks at ridges shall comply with one of the following:

1. For photovoltaic arrays occupying not more than 66 percent of the plan view total roof area, not less than an 18-inch (457 mm) clear setback is required on both sides of a horizontal ridge.
2. For photovoltaic arrays occupying more than 66 percent of the plan view total roof area, not less than a 36-inch (914 mm) clear setback is required on both sides of a horizontal ridge.

R324.6.3 Emergency escape and rescue openings. Panels and modules installed on dwellings shall not be placed on the portion of a roof that is below an *emergency escape and rescue opening*. A pathway not less than 36 inches (914 mm) wide shall be provided to the emergency escape and rescue opening.

Exception: BIPV systems listed in accordance with Section 690.12(B)(2) of NFPA 70, where the removal or cutting away of portions of the BIPV system during fire-fighting operations has been determined to not expose a fire fighter to electrical shock hazards.

R324.7 Ground-mounted photovoltaic systems. Ground-mounted photovoltaic systems shall be designed and installed in accordance with Section R301.

R324.7.1 Fire separation distances. Ground-mounted photovoltaic systems shall be subject to the *fire separation distance* requirements determined by the local *jurisdiction*.

SECTION R325
MEZZANINES

R325.1 General. *Mezzanines* shall comply with Sections R325 through R325.5.

R325.2 Mezzanines. The clear height above and below *mezzanine* floor construction shall be not less than 7 feet (2134 mm).

R325.3 Area limitation. The aggregate area of a *mezzanine* or *mezzanines* shall be not greater than one-third of the floor area of the room or space in which they are located. The enclosed portion of a room shall not be included in a determination of the floor area of the room in which the *mezzanine* is located.

Exception: The aggregate area of a *mezzanine* located within a *dwelling unit* equipped with an automatic sprinkler system in accordance with Section P2904 shall not be greater than one-half of the floor area of the room, provided that the *mezzanine* meets all of the following requirements:

1. Except for enclosed closets and bathrooms, the *mezzanine* is open to the room in which such *mezzanine* is located.
2. The opening to the room is unobstructed except for walls not more than 42 inches (1067 mm) in height, columns and posts.
3. The exceptions to Section R325.5 are not applied.

R325.4 Means of egress. The means of egress for *mezzanines* shall comply with the applicable provisions of Section R311.

R325.5 Openness. *Mezzanines* shall be open and unobstructed to the room in which they are located except for walls not more than 36 inches (914 mm) in height, columns and posts.

Exceptions:

1. *Mezzanines* or portions thereof are not required to be open to the room in which they are located, provided that the aggregate floor area of the enclosed space is not greater than 10 percent of the *mezzanine* area.
2. In buildings that are not more than two stories above *grade plane* and equipped throughout with an automatic sprinkler system in accordance with Section R313, a *mezzanine* shall not be required to be open to the room in which the *mezzanine* is located.

SECTION R326
HABITABLE ATTICS

R326.1 General. Habitable attics shall comply with Sections R326.2 and R326.3.

R326.2 Minimum dimensions. A habitable attic shall have a floor area in accordance with Section R304 and a ceiling height in accordance with Section R305.

R326.3 Story above grade plane. A habitable attic shall be considered a story above grade plane.

Exceptions: A habitable attic shall not be considered to be a story above *grade plane* provided that the habitable attic meets all the following:

1. The aggregate area of the habitable attic is either of the following:
   1.1. Not greater than 50 percent of the floor area of the story below.
2. The occupiable space is enclosed by the roof assembly above, knee walls, if applicable, on the sides and the floor-ceiling assembly below.
3. The floor of the habitable attic does not extend beyond the exterior walls of the story below.

R326.4 Means of egress. The means of egress for habitable attics shall comply with the applicable provisions of Section R311.

SECTION R327
SWIMMING POOLS, SPAS AND HOT TUBS

R327.1 General. The design and construction of pools and spas shall comply with Appendix NCA.

SECTION R328
ENERGY STORAGE SYSTEMS

R328.1 General. *Energy storage systems* (ESS) shall comply with the provisions of this section.

Exceptions:

1. *ESS listed* and *labeled* in accordance with UL 9540 and marked "For use in residential dwelling units" where installed in accordance with the manufacturer's instructions and NFPA 70.
2. ESS less than 1 kWh (3.6 megajoules).

R328.2 Equipment listings. *Energy storage systems* (ESS) shall be listed and labeled in accordance with UL 9540.

Exception: Where approved, repurposed unlisted battery systems from electric vehicles are allowed to be installed outdoors or in detached sheds located not less than 5 feet (1524 mm) from exterior walls, property lines and public ways.

R328.3 Installation. ESS shall be installed in accordance with the manufacturer's instructions and their *listing*.

R328.3.1 Spacing. Individual units shall be separated from each other by not less than 3 feet (914 mm) except where smaller separation distances are documented to be adequate based on large-scale fire testing complying with UL 9540A.

R328.4 Locations. ESS shall be installed only in the following locations:

1. Detached garages and detached accessory structures.
2. Attached garages separated from the dwelling unit living space in accordance with Section R302.6.
3. Outdoors or on the exterior side of exterior walls located not less than 3 feet (914 mm) from doors and windows directly entering the dwelling unit.
4. Enclosed utility closets, basements, storage or utility spaces within dwelling units with finished or noncombustible walls and ceilings. Walls and ceilings of unfinished wood-framed construction shall be provided with not less than $^{5}/_{8}$-inch (15.9 mm) Type X gypsum wallboard.

ESS shall not be installed in sleeping rooms, or closets or spaces opening directly into sleeping rooms.

R328.5 Energy ratings. Individual ESS units shall have a maximum rating of 20 kWh. The aggregate rating of the ESS shall not exceed:

1. 40 kWh within utility closets, basements and storage or utility spaces.
2. 80 kWh in attached or detached garages and detached accessory structures.
3. 80 kWh on exterior walls.
4. 80 kWh outdoors on the ground.

R328.6 Electrical installation. ESS shall be installed in accordance with NFPA 70. Inverters shall be listed and

labeled in accordance with UL 1741 or provided as part of the UL 9540 listing. Systems connected to the utility grid shall use inverters listed for utility interaction.

R328.7 Fire detection. Rooms and areas within dwelling units, basements and attached garages in which ESS are installed shall be protected by smoke alarms in accordance with Section R314. A heat detector, listed and interconnected to the smoke alarms, shall be installed in locations within dwelling units and attached garages where smoke alarms cannot be installed based on their listing.

R328.8 Protection from impact. ESS installed in a location subject to vehicle damage shall be protected by approved barriers.

R328.9 Ventilation. Indoor installations of ESS that produce hydrogen or other flammable gases during charging shall be provided with mechanical ventilation in accordance with Section M1307.4.

R328.10 Electric vehicle use. The temporary use of an owner or occupant's electric-powered vehicle to power a dwelling unit while parked in an attached or detached garage or outdoors shall comply with the vehicle manufacturer's instructions and NFPA 70.

R328.11 Documentation and labeling. The following information shall be provided:

1. A copy of the manufacturer's installation, operation, maintenance and decommissioning instructions shall be provided to the owner or placed in a conspicuous location near the ESS equipment.
2. A label on the installed system containing the contact information for the qualified maintenance and service providers.

SECTION R329
STATIONARY ENGINE GENERATORS

R329.1 General. Stationary engine generators shall be listed and labeled in accordance with UL 2200 and shall comply with this section. The connection of stationary engine generators to the premise wiring system shall be by means of a listed transfer switch.

R329.2 Installation. The installation of stationary engine generators shall be in an approved location and in accordance with the listing, the manufacturer's installation instructions and Chapters 34 through 43.

SECTION R330
STATIONARY FUEL CELL POWER SYSTEMS DELETED

SECTION R331
DOCKS, PIERS, BULKHEADS AND WATERWAY STRUCTURES

R331.1 General. Docks, piers, bulkheads and waterway structures shall be constructed in accordance with Chapter 36 of the *North Carolina Building Code*.

Exception: Structures complying with the following are not required to meet the provisions of this code.

1. Docks and piers built over private ponds.
2. Fixed in place walkways, docks, and piers not covered in Exception 1 and not exceeding 144 square feet (13.4 m^2) for single family dwelling.
3. Minor repairs to existing docks, piers and waterway structures.

SECTION R332
LICENSED RESIDENTIAL CARE

R332.1 General. Buildings in which more than three people are harbored for medical, charitable or other care or treatment shall be classified as residential care facilities. The state agency having jurisdiction shall classify the facility as a residential care home, small residential care facility or small nonambulatory care facility.

R332.1.1 Fire extinguishers. Fire extinguishers shall be installed in licensed residential care facilities in accordance with the North Carolina Fire Code.

R332.1.2 Means of egress. Where two means of egress exits are required, the exits or exit access doors shall be so located and constructed to minimize the possibility that both may be blocked by any one fire or other emergency condition.

R332.2 Residential care facilities. Homes keeping no more than six adults or six unrestrained children who are able to respond and evacuate the facility without verbal or physical assistance, determined by the state agency having jurisdiction to be licensable, shall be classified as Single-Family Residential and comply with the requirements of this section.

R332.2.1 Means of egress. Each normally occupied story of the facility shall have two remotely located means of egress exits. The exits or exit access doors shall be so located and constructed to minimize the possibility that both may be blocked by any one fire or other emergency condition.

R332.2.2 Smoke detection systems. Smoke detectors shall be provided on all levels.

R332.2.3 Interior finishes. Interior wall and ceiling finishes shall be Class A, B or C.

R332.2.4 Heating appliances. Unvented fuel-fired heaters and portable electric heaters shall be prohibited.

R332.3 Licensed small residential care facilities. The following facilities when determined by the State Agency having jurisdiction to be licensable, shall be classified as Single-Family Residential and comply with the requirements of this section.

1. Residential care facilities keeping no more than six adults or six unrestrained children with no more than three who are unable to respond and evacuate without verbal or physical assistance.
2. Residential care facilities keeping no more than five adults or five children who are unable to respond and evacuate without verbal or physical assistance, when certifiable for Medicaid reimbursement, and when staffed 24-hours per day with at least two staff awake at all times.
3. Residential care facilities keeping no more than nine adults or nine children who are able to respond and evacuate without verbal or physical assistance.

R332.3.1 Fire-resistance construction. The building shall be of 1-hour fire-resistant-rated construction including all walls, partitions, floors and ceilings. Bedroom doors shall be 1.75 inches (44.4 mm) solid wood core.

Exception: No rating shall be required if the building is NFPA 13D sprinklered with a wet pipe system with a 30-minute water supply. Bathrooms, toilets, closets, pantries, storage spaces, attached garages, and utility spaces shall be sprinklered. The sprinkler system shall be monitored in accordance with *North Carolina Fire Code*, Section 903.4 (Section 903.4, Exception 1 is not applicable in this occupancy).

R332.3.2 Building height and area. Buildings shall not exceed two stories in height and shall not exceed 7,000 square feet (650 m^2) per story for dwellings applying the exception in Section R332.3.1 and 12,000 square feet (1114.8 m^2) per story for all other dwellings. For purposes of this section, attics and basements used as habitable spaces shall be considered as stories.

R332.3.3 Quantity of exits. Each normally occupied story of the facility shall have two remotely located exits. The exit doors shall be so located and constructed to minimize the possibility that both may be blocked by any one fire or other emergency condition.

R332.3.4 Egress stairs. Required facility egress stairways shall be either exterior unenclosed or interior enclosed on each level with 1-hour fire-resistant-rated construction and self-closing 20-minute labeled doors. Other interior stairways shall be enclosed on one floor level with 1-hour fire-resistant walls and self-closing 20-minute labeled doors.

R332.3.5 Smoke and heat detectors. Smoke detectors shall be provided on all levels. Heat detectors shall be installed in all attic spaces. The heat detectors shall be connected to the fire alarm and detection system.

R332.3.6 Incidental accessory occupancies. Any incidental use area, as defined by *North Carolina Building Code*, Table 509.1, shall be enclosed with 1-hour fire-resistant-rated construction and self-closing 20-minute labeled door or provided with an automatic sprinkler system and smoke-resistant separation from other areas.

R332.3.7 Fire alarm systems. A building fire alarm system shall be provided in accordance with NFPA 72. Provisions shall be made to activate the internal evacuation alarm at all required exits.

R332.3.8 Interior finishes. Interior wall and ceiling membranes shall be gypsum wallboard, plaster or other noncombustible material.

R332.3.9 Heating appliances. Unvented fuel-fired heaters, floor furnaces, and portable electric heaters shall not be installed.

R332.3.10 Occupants. Occupants younger than six-years of age shall sleep on the level of exit discharge with adult supervision.

R332.4 Small nonambulatory care facilities. Facilities keeping no more than six adults or six children who are unable to respond and evacuate without verbal or physical assistance, when determined by the State Agency having jurisdiction to be licensable shall comply with the requirements of Section R332.3 for Licensed Small Residential Care Facilities.

R332.4.1 Automatic sprinkler systems. The building shall be sprinklered with a wet pipe system in accordance with NFPA 13D with a 30-minute water supply including bathrooms, toilets, closets, pantries, storage spaces, attached garages, and utility spaces. The sprinkler system shall be monitored in accordance with *North Carolina Fire Code*, Section 903.4. *North Carolina Fire Code*, Section 903.4, Exception 1 shall not apply to this section.

SECTION R333
LICENSED ADULT AND CHILD DAY CARE

R333.1 Means of egress.

R333.1.1 Location. Rooms where occupants receive care shall be on the level of exit discharge.

R333.1.2 Quantity of exits. Adult and child day care facilities shall have two or more remote means of egress.

Exception: A room where occupants receive care and comply with all of the following:

a. Located on the level of exit discharge, and
b. Has an exit door directly to the exterior.

R333.1.3 Walls and ceilings. All walls and ceilings in rooms which are used for day care purposes and are part of an egress (exiting) path shall have interior membranes of noncombustible construction such as, but not limited to, plaster or gypsum wallboard or shall comply with Section 803 of the *North Carolina Building Code*.

R333.2 Portable fire extinguishers. At least one 2-A:10-B:C fire extinguisher shall be provided per floor with a maximum of 40 feet (12 192 mm) travel distance to the extinguisher.

SECTION R334
DEMOLITION

R334.1 Demolition. Where a building or structure regulated by this code has been demolished or removed, the lot shall not create a new hazard to the site or to adjoining properties. All utilities shall be properly terminated.

CHAPTER 4
FOUNDATIONS

SECTION R401
GENERAL

R401.1 Application. The provisions of this chapter shall control the design and construction of the foundation and foundation spaces for buildings. In addition to the provisions of this chapter, the design and construction of foundations in flood hazard areas as established by Table R301.2 shall meet the provisions of Section R322. Wood foundations shall be designed and installed in accordance with AWC PWF.

Exception: The provisions of this chapter shall be permitted to be used for wood foundations only in the following situations:

1. In buildings that have not more than two floors and a roof.
2. Where interior *basement* and foundation walls are constructed at intervals not exceeding 50 feet (15 240 mm).

Wood foundations in Seismic Design Category D_0, D_1 or D_2 shall be designed in accordance with accepted engineering practice.

R401.2 Requirements. Foundation construction shall be capable of accommodating all loads in accordance with Section R301 and of transmitting the resulting loads to the supporting soil. Fill soils that support footings and foundations shall be designed, installed and tested in accordance with accepted engineering practice.

R401.3 Drainage. Surface drainage shall be diverted to a storm sewer conveyance or other *approved* point of collection that does not create a hazard. *Lots* shall be graded to drain surface water away from foundation walls. The *grade* shall fall not fewer than 6 inches (152 mm) within the first 10 feet (3048 mm).

Exception: Where *lot lines*, walls, slopes or other physical barriers prohibit 6 inches (152 mm) of fall within 10 feet (3048 mm), drains or swales shall be constructed to ensure drainage away from the structure. Impervious surfaces within 10 feet (3048 mm) of the building foundation shall be sloped not less than 2 percent away from the building.

R401.4 Soil tests. Where quantifiable data created by accepted soil science methodologies indicate *expansive soils, compressible soils*, shifting soils or other questionable soil characteristics are likely to be present, the *building official* shall determine whether to require a soil test to determine the soil's characteristics at a particular location. This test shall be done by an *approved agency* using an *approved* method.

R401.4.1 Geotechnical evaluation. The load bearing values greater than 2000 psf (95.8 kPa) in Table R401.4.1 require an engineering evaluation.

TABLE R401.4.1
PRESUMPTIVE LOAD-BEARING VALUES OF FOUNDATION MATERIALS[a]

CLASS OF MATERIAL	LOAD-BEARING PRESSURE (pounds per square foot)
Crystalline bedrock	12,000
Sedimentary and foliated rock	6,000
Sandy gravel and/or gravel (GW and GP)	5,000
Sand, silty sand, clayey sand, silty gravel and clayey gravel (SW, SP, SM, SC, GM and GC)	3,000
Clay, sandy, silty clay, clayey silt, silt and sandy siltclay (CL, ML, MH and CH)	2,000[b]

For SI: 1 pound per square foot = 0.0479 kPa.

a. Where soil tests are required by Section R401.4, the allowable bearing capacities of the soil shall be part of the recommendations.

b. Where the building official determines that in-place soils with an allowable bearing capacity of less than 2,000 psf are likely to be present at the site, the allowable bearing capacity shall be determined by a soils investigation.

R401.4.2 Compressible or shifting soil. Instead of a complete geotechnical evaluation, where top or subsoils are compressible or shifting, they shall be removed to a depth and width sufficient to ensure stable moisture content in each active zone and shall not be used as fill or stabilized within each active zone by chemical, dewatering or presaturation.

SECTION R402
MATERIALS

R402.1 Wood foundations. Wood foundation systems shall be designed and installed in accordance with the provisions of this code.

R402.1.1 Fasteners. Fasteners used below *grade* to attach plywood to the exterior side of exterior *basement* or crawl-space wall studs, or fasteners used in knee wall construction, shall be of Type 304 or 316 stainless steel. Fasteners used above *grade* to attach plywood and all lumber-to-lumber fasteners except those used in knee wall construction shall be of Type 304 or 316 stainless steel, silicon bronze, copper, hot-dipped galvanized (zinc coated) steel nails, or hot-tumbled galvanized (zinc coated) steel nails. Electro-galvanized steel nails and galvanized (zinc coated) steel staples shall not be permitted.

R402.1.2 Wood treatment. Lumber and plywood shall be pressure-preservative treated and dried after treatment in accordance with AWPA U1 (Commodity Specification A, Special Requirement 4.2), and shall bear the *label* of an accredited agency. Where lumber or plywood is cut or drilled after treatment, the treated surface shall be field

treated with copper naphthenate, the concentration of which shall contain not less than 2-percent copper metal, by repeated brushing, dipping or soaking until the wood cannot absorb more preservative.

R402.2 Concrete. Concrete shall have a minimum specified compressive strength of f'_c, as shown in Table R402.2. Concrete subject to moderate or severe weathering as indicated in Table R301.2 shall be air entrained as specified in Table R402.2. The maximum weight of fly ash, other pozzolans, silica fume, slag or blended cements that is included in concrete mixtures for garage floor slabs and for exterior porches, carport slabs and steps that will be exposed to deicing chemicals shall not exceed the percentages of the total weight of cementitious materials specified in Section 19.3.3.4 of ACI 318. Materials used to produce concrete and testing thereof shall comply with the applicable standards listed in Chapters 19 and 20 of ACI 318 or ACI 332.

R402.2.1 Materials for concrete. Materials for concrete shall comply with the requirements of Section R608.5.1.

R402.3 Precast concrete. *Precast concrete* foundations shall be designed in accordance with Section R404.5 and shall be installed in accordance with the provisions of this code and the manufacturer's instructions.

R402.3.1 Precast concrete foundation materials. Materials used to produce *precast concrete* foundations shall meet the following requirements:

1. All concrete used in the manufacture of *precast concrete* foundations shall have a minimum compressive strength of 5,000 psi (34 470 kPa) at 28 days. Concrete exposed to a freezing and thawing environment shall be air entrained with a minimum total air content of 5 percent.
2. Structural reinforcing steel shall meet the requirements of ASTM A615, A706M or A996M. The minimum yield strength of reinforcing steel shall be 40,000 psi (Grade 40) (276 MPa). Steel reinforcement for *precast concrete foundation walls* shall have a minimum concrete cover of $^3/_4$ inch (19.1 mm).
3. Panel-to-panel connections shall be made with Grade II steel fasteners.
4. The use of nonstructural fibers shall conform to ASTM C1116.
5. Grout used for bedding precast foundations placed on concrete footings shall meet ASTM C1107.

R402.4 Masonry. Masonry systems shall be designed and installed in accordance with this chapter and shall have a minimum specified compressive strength of 1,500 psi (10.3 MPa).

TABLE R402.2
MINIMUM SPECIFIED COMPRESSIVE STRENGTH OF CONCRETE

TYPE OR LOCATION OF CONCRETE CONSTRUCTION	MINIMUM SPECIFIED COMPRESSIVE STRENGTH[a] (f'_c)		
	Weathering Potential[b]		
	Negligible	Moderate	Severe
Basement walls, foundations and other concrete not exposed to the weather	2,500	2,500	2,500[c]
Basement slabs and interior slabs on grade, except garage floor slabs	2,500	2,500	2,500[c]
Basement walls, foundation walls, exterior walls and other vertical concrete work exposed to the weather	2,500	3,000[d]	3,000[d]
Porches, carport slabs and steps exposed to the weather, and garage floor slabs	2,500	3,000[d, e, f]	3,500[d, e, f]

For SI: 1 pound per square inch = 6.895 kPa.

a. Strength at 28 days psi.
b. See Table R301.2 for weathering potential.
c. Concrete in these locations that is subject to freezing and thawing during construction shall be air-entrained concrete in accordance with Note d.
d. Concrete shall be air-entrained. Total air content (percent by volume of concrete) shall be not less than 5 percent or more than 7 percent.
e. See Section R402.2 for maximum cementitious materials content.
f. For garage floors with a steel-troweled finish, reduction of the total air content (percent by volume of concrete) to not less than 3 percent is permitted if the specified compressive strength of the concrete is increased to not less than 4,000 psi.

SECTION R403
FOOTINGS

R403.1 General. All exterior walls shall be supported on continuous solid or fully grouted masonry or concrete footings, crushed stone footings, wood foundations, or other *approved* structural systems that shall be of sufficient design to accommodate all loads according to Section R301 and to transmit the resulting loads to the soil within the limitations as determined from the character of the soil. Footings shall be supported on undisturbed natural soils or engineered fill. Concrete footing shall be designed and constructed in accordance with the provisions of Section R403 or in accordance with ACI 332. Discontinuous footings shall be permitted to be constructed in accordance with ACI 332 for concrete foundation walls and Appendix NCB for masonry foundation walls.

R403.1.1 Minimum size. The minimum width, W, and thickness, T, for concrete footings shall be in accordance with Table R403.1(1) and Figure R403.1(1), but not less than 12 inches (305 mm) in width and 6 inches (152 mm) in depth. The footing width shall be based on the load-bearing value of the soil in accordance with Table R401.4.1. Footing projections, P, shall be not less than 2 inches (51 mm) and shall not exceed the thickness of the footing. Footing thickness and projection for fireplaces shall be in accordance with Section R1001.2. The size of footings supporting piers and columns shall be based on the tributary load in accordance with Table R403.1(2). Footings for wood foundations shall be in accordance with the details set forth in Section R403.2, and Figures R403.1(2) and R403.1(3). Footings for precast foundations shall be in accordance with the details set forth in Section R403.4, Table R403.4, and Figures R403.4(1) and R403.4(2).

TABLE R403.1(1)[a, b, c, d]
MINIMUM WIDTH OF CONCRETE, PRECAST OR MASONRY FOOTINGS (INCHES)

	LOAD-BEARING VALUE OF SOIL (psf)			
	1,500	2,000	3,000	4,000
	Light-frame wood construction			
1 story—slab-on-grade	12	12	12	12
1 story—crawl space	14	12	12	12
1 story—plus basement wall	17	13	12	12
2 story—slab-on-grade	13	12	12	12
2 story—crawl space	18	13	12	12
2 story—plus basement wall	21	16	12	12
3 story—slab-on-grade	16	12	12	12
3 story—crawl space	21	16	12	12
3 story—plus basement wall	24	18	12	12
	Light-frame wood construction with brick veneer or 8-inch hollow concrete masonry			
1 story—slab-on-grade	12	12	12	12
1 story—crawl space	17	13	12	12
1 story—plus basement wall	20	15	12	12
2 story—slab-on-grade	19	14	12	12
2 story—crawl space	24	18	12	12
2 story—plus basement wall	27	20	14	12
3 story—slab-on-grade	25	19	13	12
3 story—crawl space	30	23	15	12
3 story—plus basement wall	33	25	17	13
	8-inch grout-filled concrete masonry			
1 story—slab-on-grade	15	12	12	12
1 story—crawl space	20	15	12	12
1 story—plus basement wall	23	17	12	12
2 story—slab-on-grade	23	18	12	12
2 story—crawl space	28	21	14	12
2 story—plus basement wall	31	24	16	12
3 story—slab-on-grade	32	24	16	12
3 story—crawl space	37	28	19	14
3 story—plus basement wall	40	30	20	15

The table is based on the following conditions and loads:
Building width: 36 feet; Wall height: 9 feet; Crawl space wall height: 10 feet; Basement wall height: 10 feet;
Dead loads: 20 psf roof and ceiling assembly, 10 psf floor assembly, 15 psf wall assembly;
Roof Live load: 20 psf;
Live Load: 40 psf first floor, 30 psf second and third floor each.

a. The table assumed a clear-span roof, such as a truss.
b. The table assumed a center-bearing wall carrying the load with floor tributary length no more than 9 feet.
c. Linear interpolation of footing width is permitted between the soil bearing pressures in the table. Extrapolation is not permitted.
d. Table does not include habitable attic floor load.

TABLE R403.1(2)
PIER[a] AND FOOTING[b] SIZES FOR SUPPORT OF GIRDERS

AREA[e]	1 (ONE) STORY		2 (TWO) STORY		$2^1/_2$ (TWO & ONE HALF) STORY	
	Pier[c, d]	Footing	Pier[c, d]	Footing	Pier[c, d]	Footing
50	8″ × 16″	1′ -4″ × 2′ -0″ × 8″	8″ × 16″	1′ -4″ × 2′ -6″ × 8″	8″ × 16″	1′ -4″ × 2′ -6″ × 8″
100	8″ × 16″	1′ -4″ × 2′ -0″ × 8″	8″ × 16″	2′ -0″ × 2′ -0″ × 10″	16″ × 16″	2′ -6″ × 2′ -6″ × 10″
150	8″ × 16″	2′ -0″ × 2′ -0″ × 8″	16″ × 16″	2′ -8″ × 2′ -8″ × 10″	16″ × 16″	3′ -0″ × 3′ -0″ × 10″
200	8″ × 16″	2′ -4″ × 2′ -4″ × 10″	16″ × 16″	3′ -0″ × 3′ -0″ × 10″	16″ × 16″	4′ -0″ × 4′ -0″ × 1′ -0″
250	—	—	16″ × 16″	3′ -4″ × 3′ -4″ × 1′ -0″	16″ × 24″	4′ -0″ × 4′ -0″ × 1′ -0″
300	—	—	16″ × 16″	3′ -8″ × 3′ -8″ × 1′ -0″	16″ × 24″	4′ -6″ × 4′ -6″ × 1′ -0″

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa

a. Pier sizes are based on hollow CMU capped with 4 inches of solid masonry or concrete for 1 (one) story and 8 inches of solid masonry or concrete for 2 (two), $2^1/_2$ (two and one half) or 3 (three) story houses or shall have cavities of the top course filled with concrete or grout or other approved methods. Mortar shall be Type S. A minimum footing width of 12 inches is acceptable for monolithic slab foundations.

b. Footing sizes are based on 2000 psf allowable soil bearing and 2500 psi concrete. This table is based on the limitations of a tributary area using dimensional framing lumber only.

c. Centers of piers shall bear in the middle one-third of the footings. Girders must have full bearing on piers. Footings shall be full thickness over the entire area of the footing.

d. Pier sizes given are minimum. For height/thickness limitations see Section R606.7.

e. Area at first level supported by pier and footing in square feet.

R403.1.2 Continuous footing in Seismic Design Categories D_0, D_1 and D_2. Deleted.

R403.1.3 Footing and stem wall reinforcing in Seismic Design Categories D_0, D_1 and D_2. Deleted.

R403.1.3.1 Concrete stem walls with concrete footings. Deleted.

R403.1.3.2 Masonry stem walls with concrete footings. Deleted.

R403.1.3.3 Slabs-on-ground with turned-down footings. Deleted.

R403.1.3.4 Interior bearing and *braced wall panel* footings in Seismic Design Categories D_0, D_1 and D_2. Deleted.

R403.1.3.5 Reinforcement. Deleted.

R403.1.3.5.1 Steel reinforcement. Deleted.

R403.1.3.5.2 Location of reinforcement in wall. Deleted.

R403.1.3.5.3 Support and cover. Deleted.

R403.1.3.5.4 Lap splices. Deleted.

R403.1.3.6 Isolated concrete footings. Deleted.

R403.1.4 Minimum depth. All foundation systems and exterior footings shall extend below the frost line specified in Table R301.2(1). In no case shall the bottom of the exterior footings be less than 12 inches (305 mm) below the finished grade.

Exception: Footings and foundations erected on solid rock shall not be required to extend below the frost line.

R403.1.4.1 Frost protection. See Section R403.1.4.

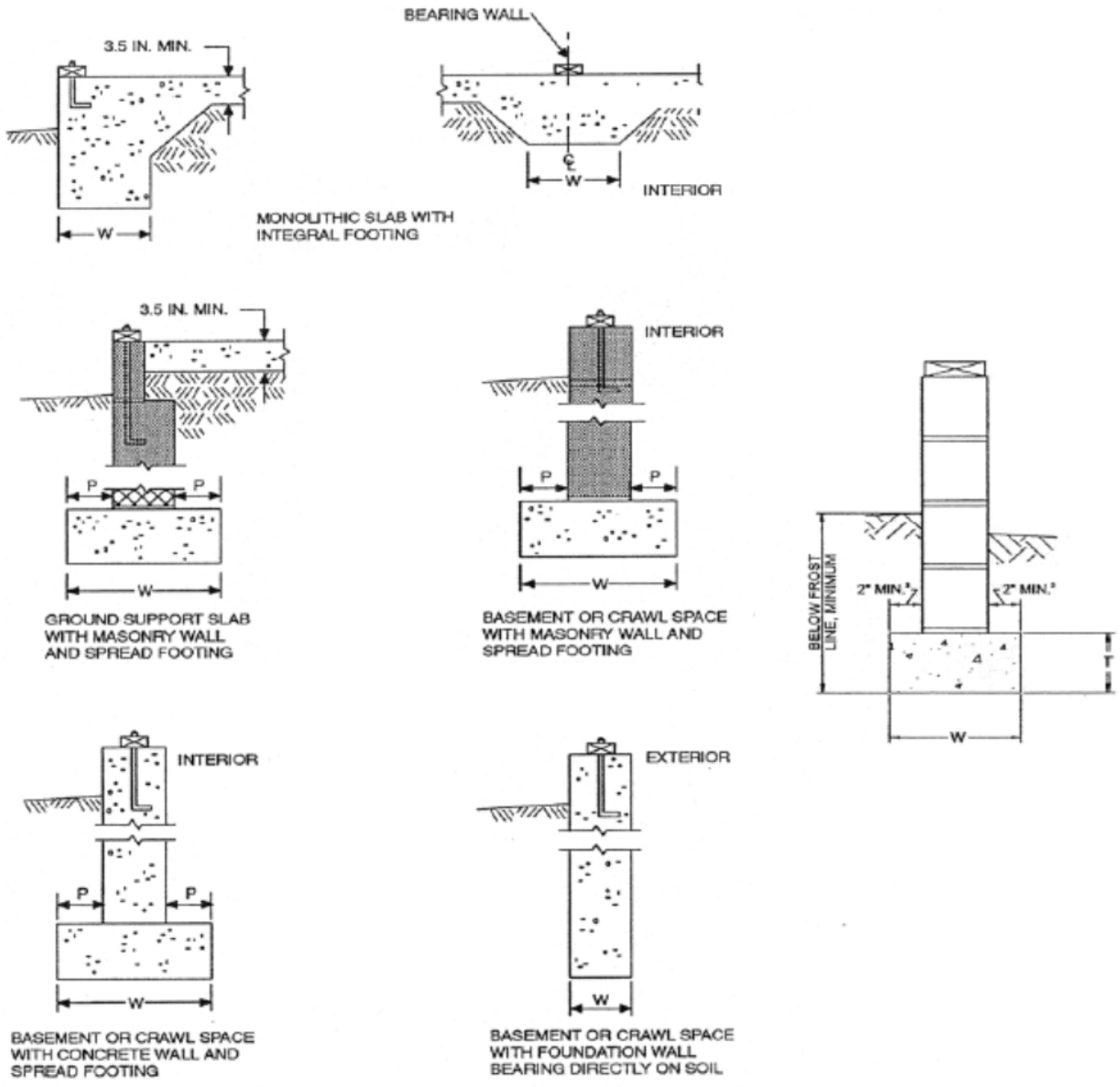
R403.1.5 Slope. The top surface of footings shall be level ($^1/_2$ inch in 10 feet) or shall be brought level, under the width of the wall, with masonry units with full mortar joints. The bottom surface of footings shall not have a slope exceeding 1 unit vertical in 10 units horizontal (10-percent slope). Footings shall be stepped where it is necessary to change the elevation of the top surface of the footings or where the slope of the bottom surface of the footings will exceed 1 unit vertical in 10 units horizontal (10-percent slope).

R403.1.6 Foundation anchorage. Wood sill plates and wood walls supported directly on continuous foundations shall be anchored to the foundation in accordance with this section.

Wood sole plates at all exterior walls on monolithic slabs, wood sole plates of *braced wall panels* at building interiors on monolithic slabs and all wood sill plates shall be anchored to the foundation with minimum $^1/_2$-inch-diameter (12.7 mm) anchor bolts spaced not greater than 6 feet (1829 mm) on center or *approved* anchors or anchor straps spaced as required to provide equivalent anchorage to $^1/_2$-inch-diameter (12.7 mm) anchor bolts. Bolts shall extend not less than 7 inches (178 mm) into concrete or grouted cells of *concrete masonry units*. The bolts shall be located in the middle third of the width of the plate. A nut and washer shall be tightened on each anchor bolt. There shall be not fewer than two bolts per plate section with one bolt located not more than 12 inches (305 mm) from the corner. Interior bearing wall sole plates on monolithic slab foundation that are not part of a *braced wall panel* shall be positively anchored with *approved* fasteners. Sill plates and sole plates shall be protected against decay and termites where required by Sections R317 and R318. Anchor bolts shall be permitted to be located while concrete is still plastic and before it has set. Where anchor bolts resist placement or the consolidation of concrete around anchor bolts is impeded, the concrete shall be vibrated to ensure full contact between the anchor bolts and concrete.

Exceptions:

1. Walls 24 inches (610 mm) total length or shorter connecting offset *braced wall panels* shall be anchored to the foundation with not



For SI: 1 inch = 25.4 mm.

W = Width of footing, T = Thickness of footing, and P = Projection in accordance with Section R403.1.1.

a. Foundations shall extend not less than 12 inches below finished grade and in no case less than the frost line depth.

b. Footing sizes are based on soil with an allowable soil pressure of 2,000 pounds per square foot. Footings on soil with a lower allowable soil pressure shall be designed in accordance with accepted engineering practice.

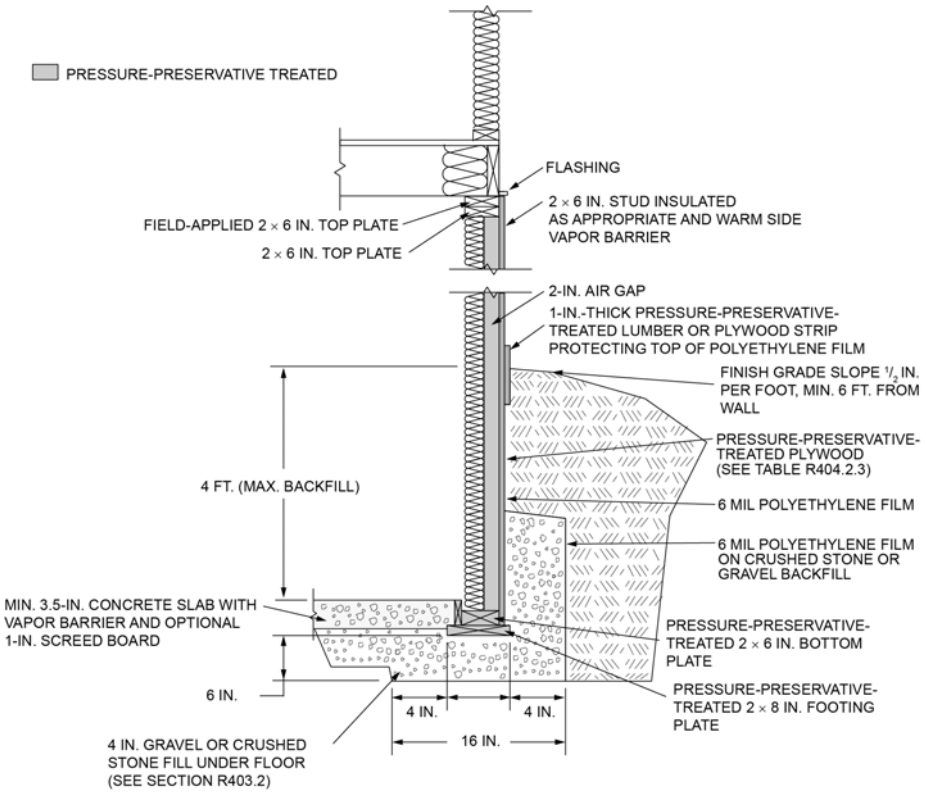
c. Footing projections shall not exceed the footing thickness.

d. For minimum footing width (W) see Table R403.1(1).

e. Minimum footing thickness (T) is: 6″ for 1 story, 8″ for 2 story and 10″ for 3 story.

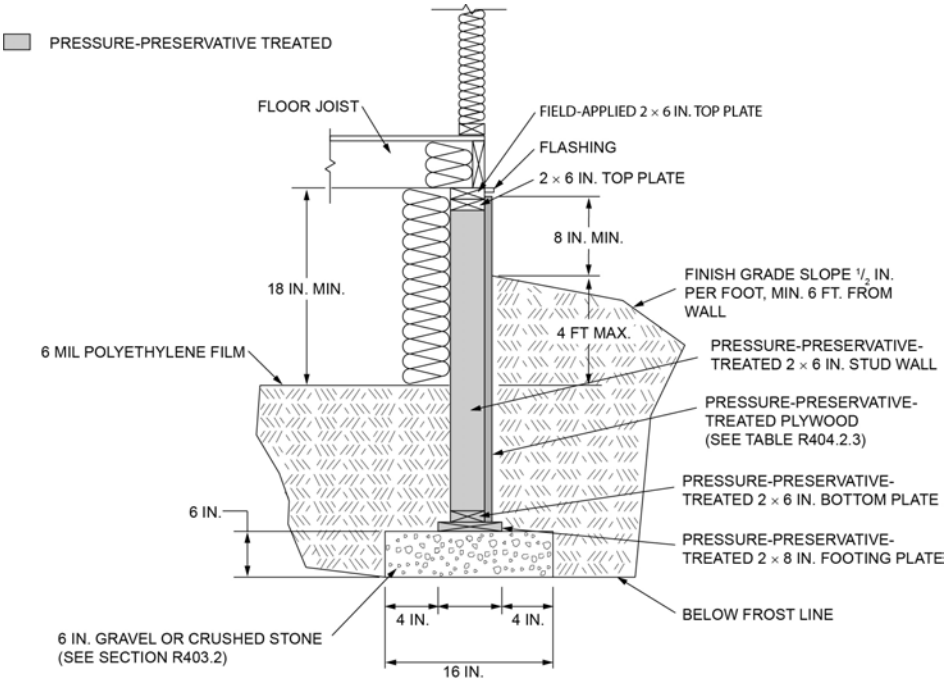
f. Install anchor bolts in accordance with Section R403.1.6.

FIGURE R403.1(1)
CONCRETE AND MASONRY FOUNDATION DETAILS[a, b, c, d, e, f]



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mil = 0.0254 mm.

FIGURE R403.1(2)
PERMANENT WOOD FOUNDATION BASEMENT WALL SECTION



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mil = 0.0254 mm.

FIGURE R403.1(3)
PERMANENT WOOD FOUNDATION CRAWL SPACE SECTION

fewer than one anchor bolt located in the center third of the plate section and shall be attached to adjacent *braced wall panels* at corners as shown in Item 9 of Table R602.3(1).

2. Connection of walls 12 inches (305 mm) total length or shorter connecting offset *braced wall panels* to the foundation without anchor bolts shall be permitted. The wall shall be attached to adjacent *braced wall panels* at corners as shown in Item 9 of Table R602.3(1).

R403.1.6.1 Foundation anchorage in Seismic Design Category C. In addition to the requirements of Section R403.1.6, the following requirements shall apply to wood light-frame *townhouses* in Seismic Design Category C.

1. Plate washers conforming to Section R602.11.1 shall be provided for all anchor bolts over the full length of required *braced wall lines* except where *approved* anchor straps are used. Properly sized cut washers shall be permitted for anchor bolts in wall lines not containing *braced wall panels*.
2. Interior braced wall plates shall have anchor bolts spaced at not more than 6 feet (1829 mm) on center and located not more than 12 inches (305 mm) from the corner.
3. Interior bearing wall sole plates shall have anchor bolts spaced at not more than 6 feet (1829 mm) on center and located not more than 12 inches (305 mm) from the corner.
4. The maximum anchor bolt spacing shall be 4 feet (1219 mm) for buildings over two *stories* in height.
5. Deleted.
6. Where continuous wood foundations in accordance with Section R404.2 are used, the force transfer shall have a capacity equal to or greater than the connections required by Section R602.11.1 or the *braced wall panel* shall be connected to the wood foundations in accordance with the *braced wall panel*-to-floor fastening requirements of Table R602.3(1).

R403.1.7 Footings on or adjacent to slopes. Deleted.

R403.1.8 Foundations on expansive soils. Deleted.

R403.1.9 Excavations near footings or foundations. Excavations shall not remove lateral support from any footing or foundation without first shoring, underpinning or protecting the footing or foundation against settlement or lateral translation. Where footings of adjacent buildings or structures are undercut by excavations measured from the bottom of the adjacent existing footing at a 45 degree angle (0.79 rad) within 10 feet (3048 mm) as shown in Figure R403.1.9, the footings shall require evaluation by a *registered design professional.*

Exception: *Accessory buildings* not exceeding 400 square feet (37 m^2) exempt from providing a masonry or concrete foundation in accordance with Section R101.2.1.

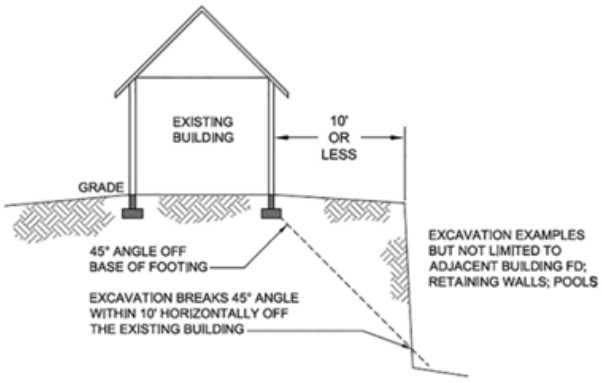


FIGURE R403.1.9
EXCAVATIONS NEAR FOOTINGS OR FOUNDATIONS

R403.2 Footings for wood foundations. Footings for wood foundations shall be in accordance with Figures R403.1(2) and R403.1(3). Gravel shall be washed and well graded. The maximum size stone shall not exceed $^3/_4$ inch (19.1 mm). Gravel shall be free from organic, clayey or silty soils. Sand shall be coarse, not smaller than $^1/_{16}$-inch (1.6 mm) grains and shall be free from organic, clayey or silty soils. Crushed stone shall have a maximum size of $^1/_2$ inch (12.7 mm).

R403.3 Frost-protected shallow foundations. Deleted.

R403.4 Footings for precast concrete foundations. Footings for *precast concrete* foundations shall comply with Sections R403.4.1 and R403.4.2.

R403.4.1 Crushed stone footings. Clean crushed stone shall be free from organic, clayey or silty soils. Crushed stone shall be angular in nature and meet ASTM C33, with the maximum size stone not to exceed $^1/_2$ inch (12.7 mm) and the minimum stone size not to be smaller than $^1/_{16}$ inch (1.6 mm). Crushed stone footings for precast foundations shall be installed in accordance with Figure R403.4(1) and Table R403.4. Crushed stone footings shall be consolidated using a vibratory plate in not greater than 8-inch (203 mm) lifts. Crushed stone footings shall be limited to *Seismic Design Categories* A, B and C.

R403.4.2 Concrete footings. Concrete footings shall be installed in accordance with Section R403.1 and Figure R403.4(2).

SECTION R404
FOUNDATION AND RETAINING WALLS

R404.1 Concrete and masonry foundation walls. Concrete foundation walls shall be selected and constructed in accordance with the provisions of Section R404.1.3. Masonry foundation walls shall be selected and constructed in accordance with the provisions of Section R404.1.2.

R404.1.1 Design required. Concrete or masonry foundation walls shall be designed in accordance with accepted

TABLE R403.4
MINIMUM DEPTH (D) AND WIDTH (W) OF CRUSHED STONE FOOTINGS[a, b] (inches)

NUMBER OF STORIES	UNIFORM WALL LOAD	DEPTH (D) AND WIDTH (W)	LOAD-BEARING VALUE OF SOIL (psf)																	
			1500			2000			2500			3000			3500			4000		
			MH, CH, CL, ML[c]			SC, GC, SM, GM, SP, SW[c]						GP, GW[c]								
			Wall width (inches)			Wall width (inches)			Wall width (inches)			Wall width (inches)			Wall width (inches)			Wall width (inches)		
			8	10	12	8	10	12	8	10	12	8	10	12	8	10	12	8	10	12
Conventional light-frame construction																				
1-story	1,100 plf	D	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
		W	13	15	17	13	15	17	13	15	17	13	15	17	13	15	17	13	15	17
2-story	1,800 plf	D	6	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
		W	15	15	17	13	15	17	13	15	17	13	15	17	13	15	17	13	15	17
3-story	2,900 plf	D	14	12	10	9	7	5	6	4	4	4	4	4	4	4	4	4	4	4
		W	25	24	24	19	19	18	15	15	17	13	15	17	13	15	17	13	15	17
4-inch brick veneer over light-frame or 8-inch hollow concrete masonry																				
1-story	1,500 plf	D	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
		W	13	15	17	13	15	17	13	15	17	13	15	17	13	15	17	13	15	17
2-story	2,700 plf	D	12	11	9	8	6	4	5	4	4	4	4	4	4	4	4	4	4	4
		W	22	23	23	18	17	17	14	15	17	13	15	17	13	15	17	13	15	17
3-story	4,000 plf	D	21	20	18	14	13	11	10	8	7	7	6	4	5	4	4	4	4	4
		W	33	34	33	25	26	25	20	20	21	17	17	17	14	15	17	13	15	17
8-inch solid or fully grouted masonry																				
1-story	2,000 plf	D	7	6	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
		W	17	17	17	13	15	17	13	15	17	13	15	17	13	15	17	13	15	17
2-story	3,600 plf	D	19	17	15	12	11	9	9	7	5	6	4	4	4	4	4	4	4	4
		W	30	30	30	22	23	23	19	19	18	15	15	17	13	15	17	13	15	17
3-story	5,300 plf	D	30	29	27	21	19	18	16	14	12	12	10	8	9	8	6	7	6	4
		W	43	44	44	33	32	33	27	27	26	22	22	22	19	20	19	17	17	17

For SI: 1 inch = 25.4 mm, 1 plf = 14.6 N/m, 1 pound per square foot = 47.9 N/m^2.

a. Linear interpolation of stone depth between wall widths is permitted within each Load-Bearing Value of Soil (psf).

b. Crushed stone must be consolidated in 8-inch lifts with a plate vibrator.

c. Soil classes are in accordance with the Unified Soil Classification System. Refer to Table R405.1.

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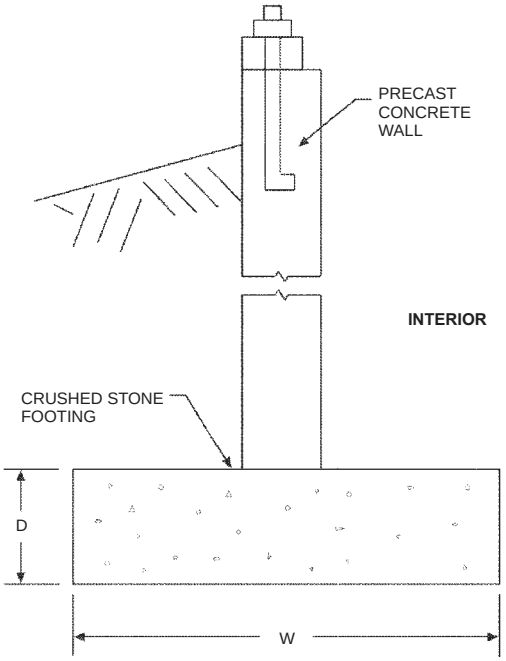


FIGURE R403.4(1)
BASEMENT OR CRAWL SPACE WITH PRECAST FOUNDATION WALL BEARING ON CRUSHED STONE

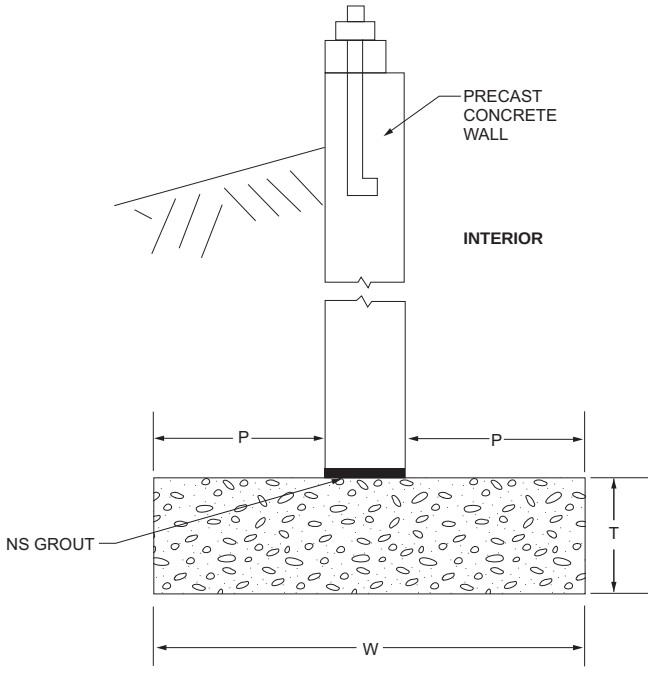


FIGURE R403.4(2)
BASEMENT OR CRAWL SPACE WITH PRECAST FOUNDATION WALL ON SPREAD FOOTING

TABLE R404.1.1(1)
PLAIN MASONRY FOUNDATION WALLS[f]

MAXIMUM UNSUPPORTED WALL HEIGHT (feet)	MAXIMUM UNBALANCED BACKFILL HEIGHT[c] (feet)	PLAIN MASONRY[a] MINIMUM NOMINAL WALL THICKNESS (inches)		
		Soil classes[b]		
		GW, GP, SW and SP	GM, GC, SM, SM-SC and ML	SC, MH, ML-CL and inorganic CL
5	4	6 solid[d] or 8	6 solid[d] or 8	6 solid[d] or 8
	5	6 solid[d] or 8	8	10
6	4	6 solid[d] or 8	6 solid[d] or 8	6 solid[d] or 8
	5	6 solid[d] or 8	8	10
	6	8	10	12
7	4	6 solid[d] or 8	8	8
	5	6 solid[d] or 8	10	10
	6	10	12	10 solid[d]
	7	12	10 solid[d]	12 solid[d]
8	4	6 solid[d] or 8	6 solid[d] or 8	8
	5	6 solid[d] or 8	10	12
	6	10	12	12 solid[d]
	7	12	12 solid[d]	Note e
	8	10 grout[d]	12 grout[d]	Note e
9	4	6 grout[d] or 8 solid[d] or 12	6 grout[d] or 8 solid[d]	8 grout[d] or 10 solid[d]
	5	6 grout[d] or 10 solid[d]	8 grout[d] or 12 solid[d]	8 grout[d]
	6	8 grout[d] or 12 solid[d]	10 grout[d]	10 grout[d]
	7	10 grout[d]	10 grout[d]	12 grout
	8	10 grout[d]	12 grout	Note e
	9	12 grout	Note e	Note e

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

a. Mortar shall be Type M or S and masonry shall be laid in running bond. Ungrouted hollow masonry units are permitted except where otherwise indicated.

b. Soil classes are in accordance with the Unified Soil Classification System. Refer to Table R405.1.

c. Unbalanced backfill height is the difference in height between the exterior finish ground level and the lower of the top of the concrete footing that supports the foundation wall or the interior finish ground level. Where an interior concrete slab-on-grade is provided and is in contact with the interior surface of the foundation wall, measurement of the unbalanced backfill height from the exterior finish ground level to the top of the interior concrete slab is permitted.

d. Solid indicates solid masonry unit; grout indicates grouted hollow units.

e. Wall construction shall be in accordance with Table R404.1.1(2), R404.1.1(3) or R404.1.1(4), or a design shall be provided.

f. The use of this table shall be prohibited for soil classifications not shown.

engineering practice where either of the following conditions exists:

1. Walls are subject to hydrostatic pressure from ground water.
2. Walls supporting more than 48 inches (1219 mm) of unbalanced backfill that do not have permanent lateral support at the top or bottom.

R404.1.2 Design of masonry foundation walls. Masonry foundation walls shall be designed and constructed in accordance with the provisions of this section or in accordance with the provisions of TMS 402. Where TMS 402 or the provisions of this section are used to design masonry foundation walls, project drawings, typical details and specifications are not required to bear the seal of the architect or engineer responsible for design, unless otherwise required by the state law of the *jurisdiction* having authority.

TABLE R404.1.2(1)
MINIMUM HORIZONTAL REINFORCEMENT FOR CONCRETE BASEMENT WALLS[a, b]

MAXIMUM UNSUPPORTED WALL HEIGHT (feet)	LOCATION OF HORIZONTAL REINFORCEMENT
≤ 8	One No. 4 bar within 12 inches of the top of the wall story and one No. 4 bar near mid-height of the wall story.
> 8	One No. 4 bar within 12 inches of the top of the wall story and one No. 4 bar near third points in the wall story.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square inch = 6.895 kPa.

a. Horizontal reinforcement requirements are for reinforcing bars with a minimum yield strength of 40,000 psi and concrete with a minimum concrete compressive strength of 2,500 psi.

b. See Section R404.1.3.2 for minimum reinforcement required for foundation walls supporting above-grade concrete walls.

TABLE R404.1.1(2)
8-INCH MASONRY FOUNDATION WALLS WITH REINFORCING WHERE d ≥ 5 INCHES[a, c, f]

MAXIMUM UNSUPPORTED WALL HEIGHT	HEIGHT OF UNBALANCED BACKFILL[e]	MINIMUM VERTICAL REINFORCEMENT AND SPACING (INCHES)[b, c]		
		Soil classes and lateral soil load[d] (psf per foot below grade)		
		GW, GP, SW and SP soils 30	GM, GC, SM, SM-SC and ML soils 45	SC, ML-CL and inorganic CL soils 60
6 feet 8 inches	4 feet (or less)	#4 at 48	#4 at 48	#4 at 48
	5 feet	#4 at 48	#4 at 48	#4 at 48
	6 feet 8 inches	#4 at 48	#5 at 48	#6 at 48
7 feet 4 inches	4 feet (or less)	#4 at 48	#4 at 48	#4 at 48
	5 feet	#4 at 48	#4 at 48	#4 at 48
	6 feet	#4 at 48	#5 at 48	#5 at 48
	7 feet 4 inches	#5 at 48	#6 at 48	#6 at 40
8 feet	4 feet (or less)	#4 at 48	#4 at 48	#4 at 48
	5 feet	#4 at 48	#4 at 48	#4 at 48
	6 feet	#4 at 48	#5 at 48	#5 at 48
	7 feet	#5 at 48	#6 at 48	#6 at 40
	8 feet	#5 at 48	#6 at 48	#6 at 32
8 feet 8 inches	4 feet (or less)	#4 at 48	#4 at 48	#4 at 48
	5 feet	#4 at 48	#4 at 48	#5 at 48
	6 feet	#4 at 48	#5 at 48	#6 at 48
	7 feet	#5 at 48	#6 at 48	#6 at 40
	8 feet 8 inches	#6 at 48	#6 at 32	#6 at 24
9 feet 4 inches	4 feet (or less)	#4 at 48	#4 at 48	#4 at 48
	5 feet	#4 at 48	#4 at 48	#5 at 48
	6 feet	#4 at 48	#5 at 48	#6 at 48
	7 feet	#5 at 48	#6 at 48	#6 at 40
	8 feet	#6 at 48	#6 at 40	#6 at 24
	9 feet 4 inches	#6 at 40	#6 at 24	#6 at 16
10 feet	4 feet (or less)	#4 at 48	#4 at 48	#4 at 48
	5 feet	#4 at 48	#4 at 48	#5 at 48
	6 feet	#4 at 48	#5 at 48	#6 at 48
	7 feet	#5 at 48	#6 at 48	#6 at 32
	8 feet	#6 at 48	#6 at 32	#6 at 24
	9 feet	#6 at 40	#6 at 24	#6 at 16
	10 feet	#6 at 32	#6 at 16	#6 at 16

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot per foot = 0.157 kPa/mm.

a. Mortar shall be Type M or S and masonry shall be laid in running bond.

b. Alternative reinforcing bar sizes and spacings having an equivalent cross-sectional area of reinforcement per lineal foot of wall shall be permitted provided the spacing of the reinforcement does not exceed 72 inches in Seismic Design Categories A, B and C.

c. Vertical reinforcement shall be Grade 60 minimum. The distance, *d*, from the face of the soil side of the wall to the center of vertical reinforcement shall be not less than 5 inches.

d. Soil classes are in accordance with the Unified Soil Classification System and design lateral soil loads are for moist conditions without hydrostatic pressure. Refer to Table R405.1.

e. Unbalanced backfill height is the difference in height between the exterior finish ground level and the lower of the top of the concrete footing that supports the foundation wall or the interior finish ground level. Where an interior concrete slab-on-grade is provided and is in contact with the interior surface of the foundation wall, measurement of the unbalanced backfill height from the exterior finish ground level to the top of the interior concrete slab is permitted.

f. The use of this table shall be prohibited for soil classifications not shown.

TABLE R404.1.1(3)
10-INCH MASONRY FOUNDATION WALLS WITH REINFORCING WHERE d ≥ 6.75 INCHES[a, c, f]

MAXIMUM UNSUPPORTED WALL HEIGHT	HEIGHT OF UNBALANCED BACKFILL[e]	MINIMUM VERTICAL REINFORCEMENT AND SPACING (INCHES)[b, c]		
		Soil classes and later soil load[d] (psf per foot below grade)		
		GW, GP, SW and SP soils 30	GM, GC, SM, SM-SC and ML soils 45	SC, ML-CL and inorganic CL soils 60
6 feet 8 inches	4 feet (or less)	#4 at 56	#4 at 56	#4 at 56
	5 feet	#4 at 56	#4 at 56	#4 at 56
	6 feet 8 inches	#4 at 56	#5 at 56	#5 at 56
7 feet 4 inches	4 feet (or less)	#4 at 56	#4 at 56	#4 at 56
	5 feet	#4 at 56	#4 at 56	#4 at 56
	6 feet	#4 at 56	#4 at 56	#5 at 56
	7 feet 4 inches	#4 at 56	#5 at 56	#6 at 56
8 feet	4 feet (or less)	#4 at 56	#4 at 56	#4 at 56
	5 feet	#4 at 56	#4 at 56	#4 at 56
	6 feet	#4 at 56	#4 at 56	#5 at 56
	7 feet	#4 at 56	#5 at 56	#6 at 56
	8 feet	#5 at 56	#6 at 56	#6 at 48
8 feet 8 inches	4 feet (or less)	#4 at 56	#4 at 56	#4 at 56
	5 feet	#4 at 56	#4 at 56	#4 at 56
	6 feet	#4 at 56	#4 at 56	#5 at 56
	7 feet	#4 at 56	#5 at 56	#6 at 56
	8 feet 8 inches	#5 at 56	#6 at 48	#6 at 32
9 feet 4 inches	4 feet (or less)	#4 at 56	#4 at 56	#4 at 56
	5 feet	#4 at 56	#4 at 56	#4 at 56
	6 feet	#4 at 56	#5 at 56	#5 at 56
	7 feet	#4 at 56	#5 at 56	#6 at 56
	8 feet	#5 at 56	#6 at 56	#6 at 40
	9 feet 4 inches	#6 at 56	#6 at 40	#6 at 24
10 feet	4 feet (or less)	#4 at 56	#4 at 56	#4 at 56
	5 feet	#4 at 56	#4 at 56	#4 at 56
	6 feet	#4 at 56	#5 at 56	#5 at 56
	7 feet	#5 at 56	#6 at 56	#6 at 48
	8 feet	#5 at 56	#6 at 48	#6 at 40
	9 feet	#6 at 56	#6 at 40	#6 at 24
	10 feet	#6 at 48	#6 at 32	#6 at 24

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot per foot = 0.157 kPa/mm.

a. Mortar shall be Type M or S and masonry shall be laid in running bond.

b. Alternative reinforcing bar sizes and spacings having an equivalent cross-sectional area of reinforcement per lineal foot of wall shall be permitted provided the spacing of the reinforcement does not exceed 72 inches in Seismic Design Categories A, B and C.

c. Vertical reinforcement shall be Grade 60 minimum. The distance, *d*, from the face of the soil side of the wall to the center of vertical reinforcement shall be not less than 6.75 inches.

d. Soil classes are in accordance with the Unified Soil Classification System and design lateral soil loads are for moist conditions without hydrostatic pressure. Refer to Table R405.1.

e. Unbalanced backfill height is the difference in height between the exterior finish ground level and the lower of the top of the concrete footing that supports the foundation wall or the interior finish ground level. Where an interior concrete slab-on-grade is provided and is in contact with the interior surface of the foundation wall, measurement of the unbalanced backfill height from the exterior finish ground level to the top of the interior concrete slab is permitted.

f. The use of this table shall be prohibited for soil classifications not shown.

TABLE R404.1.1(4)
12-INCH MASONRY FOUNDATION WALLS WITH REINFORCING WHERE d ≥ 8.75 INCHES[a, c, f]

MAXIMUM UNSUPPORTED WALL HEIGHT	HEIGHT OF UNBALANCED BACKFILL[e]	MINIMUM VERTICAL REINFORCEMENT AND SPACING (INCHES)[b, c]		
		Soil classes and lateral soil load[d] (psf per foot below grade)		
		GW, GP, SW and SP soils 30	GM, GC, SM, SM-SC and ML soils 45	SC, ML-CL and inorganic CL soils 60
6 feet 8 inches	4 feet (or less)	#4 at 72	#4 at 72	#4 at 72
	5 feet	#4 at 72	#4 at 72	#4 at 72
	6 feet 8 inches	#4 at 72	#4 at 72	#5 at 72
7 feet 4 inches	4 feet (or less)	#4 at 72	#4 at 72	#4 at 72
	5 feet	#4 at 72	#4 at 72	#4 at 72
	6 feet	#4 at 72	#4 at 72	#5 at 72
	7 feet 4 inches	#4 at 72	#5 at 72	#6 at 72
8 feet	4 feet (or less)	#4 at 72	#4 at 72	#4 at 72
	5 feet	#4 at 72	#4 at 72	#4 at 72
	6 feet	#4 at 72	#4 at 72	#5 at 72
	7 feet	#4 at 72	#5 at 72	#6 at 72
	8 feet	#5 at 72	#6 at 72	#6 at 64
8 feet 8 inches	4 feet (or less)	#4 at 72	#4 at 72	#4 at 72
	5 feet	#4 at 72	#4 at 72	#4 at 72
	6 feet	#4 at 72	#4 at 72	#5 at 72
	7 feet	#4 at 72	#5 at 72	#6 at 72
	8 feet 8 inches	#5 at 72	#7 at 72	#6 at 48
9 feet 4 inches	4 feet (or less)	#4 at 72	#4 at 72	#4 at 72
	5 feet	#4 at 72	#4 at 72	#4 at 72
	6 feet	#4 at 72	#5 at 72	#5 at 72
	7 feet	#4 at 72	#5 at 72	#6 at 72
	8 feet	#5 at 72	#6 at 72	#6 at 56
	9 feet 4 inches	#6 at 72	#6 at 48	#6 at 40
10 feet	4 feet (or less)	#4 at 72	#4 at 72	#4 at 72
	5 feet	#4 at 72	#4 at 72	#4 at 72
	6 feet	#4 at 72	#5 at 72	#5 at 72
	7 feet	#4 at 72	#6 at 72	#6 at 72
	8 feet	#5 at 72	#6 at 72	#6 at 48
	9 feet	#6 at 72	#6 at 56	#6 at 40
	10 feet	#6 at 64	#6 at 40	#6 at 32

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot per foot = 0.157 kPa/mm.

a. Mortar shall be Type M or S and masonry shall be laid in running bond.

b. Alternative reinforcing bar sizes and spacings having an equivalent cross-sectional area of reinforcement per lineal foot of wall shall be permitted provided the spacing of the reinforcement does not exceed 72 inches in Seismic Design Categories A, B and C.

c. Vertical reinforcement shall be Grade 60 minimum. The distance, *d*, from the face of the soil side of the wall to the center of vertical reinforcement shall be not less than 8.75 inches.

d. Soil classes are in accordance with the Unified Soil Classification System and design lateral soil loads are for moist conditions without hydrostatic pressure. Refer to Table R405.1.

e. Unbalanced backfill height is the difference in height between the exterior finish ground level and the lower of the top of the concrete footing that supports the foundation wall or the interior finish ground levels. Where an interior concrete slab-on-grade is provided and in contact with the interior surface of the foundation wall, measurement of the unbalanced backfill height is permitted to be measured from the exterior finish ground level to the top of the interior concrete slab is permitted.

f. The use of this table shall be prohibited for soil classifications not shown.

TABLE R404.1.2(2)
MINIMUM VERTICAL REINFORCEMENT FOR 6-INCH NOMINAL FLAT CONCRETE BASEMENT WALLS[b, c, d, e, g, h, i, j, k]

MAXIMUM UNSUPPORTED WALL HEIGHT (feet)	MAXIMUM UNBALANCED BACKFILL HEIGHT[f] (feet)	MINIMUM VERTICAL REINFORCEMENT-BAR SIZE AND SPACING (inches)		
		Soil classes[a] and design lateral soil (psf per foot of depth)		
		GW, GP, SW, SP 30	GM, GC, SM, SM-SC and ML 45	SC, ML-CL and inorganic CL 60
8	4	NR	NR	NR
	5	NR	6 @ 39	6 @ 48
	6	5 @ 39	6 @ 48	6 @ 35
	7	6 @ 48	6 @ 34	6 @ 25
	8	6 @ 39	6 @ 25	6 @ 18
9	4	NR	NR	NR
	5	NR	5 @ 37	6 @ 48
	6	5 @ 36	6 @ 44	6 @ 32
	7	6 @ 47	6 @ 30	6 @ 22
	8	6 @ 34	6 @ 22	6 @ 16
	9	6 @ 27	6 @ 17	DR
10	4	NR	NR	NR
	5	NR	5 @ 35	6 @ 48
	6	6 @ 48	6 @ 41	6 @ 30
	7	6 @ 43	6 @ 28	6 @ 20
	8	6 @ 31	6 @ 20	DR
	9	6 @ 24	6 @ 15	DR
	10	6 @ 19	DR	DR

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot per foot = 0.1571 kPa^2/m, 1 pound per square inch = 6.895 kPa.

NR = Not Required.

DR = Design Required.

a. Soil classes are in accordance with the Unified Soil Classification System. Refer to Table R405.1.

b. Table values are based on reinforcing bars with a minimum yield strength of 60,000 psi concrete with a minimum specified compressive strength of 2,500 psi and vertical reinforcement being located at the centerline of the wall. See Section R404.1.3.3.7.2.

c. Vertical reinforcement with a yield strength of less than 60,000 psi and bars of a different size than specified in the table are permitted in accordance with Section R404.1.3.3.7.6 and Table R404.1.2(9).

d. Deflection criterion is *L*/240, where *L* is the height of the basement wall in inches.

e. Interpolation is not permitted.

f. Where walls will retain 4 feet or more of unbalanced backfill, they shall be laterally supported at the top and bottom before backfilling.

g. NR indicates vertical wall reinforcement is not required, except for 6-inch-nominal walls formed with stay-in-place forming systems in which case vertical reinforcement shall be No. 4@48 inches on center.

h. See Section R404.1.3.2 for minimum reinforcement required for basement walls supporting above-grade concrete walls.

i. See Table R608.3 for tolerance from nominal thickness permitted for flat walls.

j. DR means design is required in accordance with the applicable building code, or in the absence of a code, in accordance with ACI 318.

k. The use of this table shall be prohibited for soil classifications not shown.

TABLE R404.1.2(3)
MINIMUM VERTICAL REINFORCEMENT FOR 8-INCH (203 mm) NOMINAL FLAT CONCRETE BASEMENT WALLS[b, c, d, e, f, h, i, j]

MAXIMUM UNSUPPORTED WALL HEIGHT (feet)	MAXIMUM UNBALANCED BACKFILL HEIGHT[g] (feet)	MINIMUM VERTICAL REINFORCEMENT-BAR SIZE AND SPACING (inches)		
		Soil classes[a] and design lateral soil (psf per foot of depth)		
		GW, GP, SW, SP 30	GM, GC, SM, SM-SC and ML 45	SC, ML-CL and inorganic CL 60
8	4	NR	NR	NR
	5	NR	NR	NR
	6	NR	NR	6 @ 37
	7	NR	6 @ 36	6 @ 35
	8	6 @ 41	6 @ 35	6 @ 26
9	4	NR	NR	NR
	5	NR	NR	NR
	6	NR	NR	6 @ 35
	7	NR	6 @ 35	6 @ 32
	8	6 @ 36	6 @ 32	6 @ 23
	9	6 @ 35	6 @ 25	6 @ 18
10	4	NR	NR	NR
	5	NR	NR	NR
	6	NR	NR	6 @ 35
	7	NR	6 @ 35	6 @ 29
	8	6 @ 35	6 @ 29	6 @ 21
	9	6 @ 34	6 @ 22	6 @ 16
	10	6 @ 27	6 @ 17	6 @ 13

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot per foot = 0.1571 kPa^2/m, 1 pound per square inch = 6.895 kPa.
NR = Not Required.

a. Soil classes are in accordance with the Unified Soil Classification System. Refer to Table R405.1.
b. Table values are based on reinforcing bars with a minimum yield strength of 60,000 psi, concrete with a minimum specified compressive strength of 2,500 psi and vertical reinforcement being located at the centerline of the wall. See Section R404.1.3.3.7.2.
c. Vertical reinforcement with a yield strength of less than 60,000 psi and bars of a different size than specified in the table are permitted in accordance with Section R404.1.3.3.7.6 and Table R404.1.2(9).
d. NR indicates vertical reinforcement is not required.
e. Deflection criterion is *L*/240, where *L* is the height of the basement wall in inches.
f. Interpolation is not permitted.
g. Where walls will retain 4 feet or more of unbalanced backfill, they shall be laterally supported at the top and bottom before backfilling.
h. See Section R404.1.3.2 for minimum reinforcement required for basement walls supporting above-grade concrete walls.
i. See Table R608.3 for tolerance from nominal thickness permitted for flat walls.
j. The use of this table shall be prohibited for soil classifications not shown.

TABLE R404.1.2(4)
MINIMUM VERTICAL REINFORCEMENT FOR 10-INCH NOMINAL FLAT CONCRETE BASEMENT WALLS[b, c, d, e, f, h, i, j]

MAXIMUM UNSUPPORTED WALL HEIGHT (feet)	MAXIMUM UNBALANCED BACKFILL HEIGHT[g] (feet)	MINIMUM VERTICAL REINFORCEMENT-BAR SIZE AND SPACING (inches)		
		Soil classes[a] and design lateral soil (psf per foot of depth)		
		GW, GP, SW, SP 30	GM, GC, SM, SM-SC and ML 45	SC, ML-CL and inorganic CL 60
8	4	NR	NR	NR
	5	NR	NR	NR
	6	NR	NR	NR
	7	NR	NR	NR
	8	6 @ 48	6 @ 35	6 @ 28
9	4	NR	NR	NR
	5	NR	NR	NR
	6	NR	NR	NR
	7	NR	NR	6 @ 31
	8	NR	6 @ 31	6 @ 28
	9	6 @ 37	6 @ 28	6 @ 24
10	4	NR	NR	NR
	5	NR	NR	NR
	6	NR	NR	NR
	7	NR	NR	6 @ 28
	8	NR	6 @ 28	6 @ 28
	9	6 @ 33	6 @ 28	6 @ 21
	10	6 @ 28	6 @ 23	6 @ 17

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot per foot = 0.1571 kPa^2/m, 1 pound per square inch = 6.895 kPa.
NR = Not Required.

a. Soil classes are in accordance with the Unified Soil Classification System. Refer to Table R405.1.
b. Table values are based on reinforcing bars with a minimum yield strength of 60,000 psi concrete with a minimum specified compressive strength of 2,500 psi and vertical reinforcement being located at the centerline of the wall. See Section R404.1.3.3.7.2.
c. Vertical reinforcement with a yield strength of less than 60,000 psi and bars of a different size than specified in the table are permitted in accordance with Section R404.1.3.3.7.6 and Table R404.1.2(9).
d. NR indicates vertical reinforcement is not required.
e. Deflection criterion is *L*/240, where *L* is the height of the basement wall in inches.
f. Interpolation is not permitted.
g. Where walls will retain 4 feet or more of unbalanced backfill, they shall be laterally supported at the top and bottom before backfilling.
h. See Section R404.1.3.2 for minimum reinforcement required for basement walls supporting above-grade concrete walls.
i. See Table R608.3 for tolerance from nominal thickness permitted for flat walls.
j. The use of this table shall be prohibited for soil classifications not shown.

TABLE R404.1.2(5)
MINIMUM VERTICAL WALL REINFORCEMENT FOR 6-INCH WAFFLE-GRID BASEMENT WALLS[b, c, d, e, g, h, i, j]

MAXIMUM UNSUPPORTED WALL HEIGHT (feet)	MAXIMUM UNBALANCED BACKFILL HEIGHT[f] (feet)	MINIMUM VERTICAL REINFORCEMENT-BAR SIZE AND SPACING (inches)		
		Soil classes[a] and design lateral soil (psf per foot of depth)		
		GW, GP, SW, SP 30	GM, GC, SM, SM-SC and ML 45	SC, ML-CL and inorganic CL 60
8	4	4 @ 48	4 @ 46	6 @ 39
	5	4 @ 45	5 @ 46	6 @ 47
	6	5 @ 45	6 @ 40	DR
	7	6 @ 44	DR	DR
	8	6 @ 32	DR	DR
9	4	4 @ 48	4 @ 46	4 @ 37
	5	4 @ 42	5 @ 43	6 @ 44
	6	5 @ 41	6 @ 37	DR
	7	6 @ 39	DR	DR
	> 8	DR[i]	DR	DR
10	4	4 @ 48	4 @ 46	4 @ 35
	5	4 @ 40	5 @ 40	6 @ 41
	6	5 @ 38	6 @ 34	DR
	7	6 @ 36	DR	DR
	> 8	DR	DR	DR

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot per foot = 0.1571 kPa^2/m, 1 pound per square inch = 6.895 kPa.
DR = Design Required.

a. Soil classes are in accordance with the Unified Soil Classification System. Refer to Table R405.1.
b. Table values are based on reinforcing bars with a minimum yield strength of 60,000 psi concrete with a minimum specified compressive strength of 2,500 psi and vertical reinforcement being located at the centerline of the wall. See Section R404.1.3.3.7.2.
c. Maximum spacings shown are the values calculated for the specified bar size. Where the bar used is Grade 60 and the size specified in the table, the actual spacing in the wall shall not exceed a whole-number multiple of 12 inches (12, 24, 36 and 48) that is less than or equal to the tabulated spacing. Vertical reinforcement with a yield strength of less than 60,000 psi and bars of a different size than specified in the table are permitted in accordance with Section R404.1.3.3.7.6 and Table R404.1.2(9).
d. Deflection criterion is $L/240$, where L is the height of the basement wall in inches.
e. Interpolation is not permitted.
f. Where walls will retain 4 feet or more of unbalanced backfill, they shall be laterally supported at the top and bottom before backfilling.
g. See Section R404.1.3.2 for minimum reinforcement required for basement walls supporting above-grade concrete walls.
h. See Table R608.3 for thicknesses and dimensions of waffle-grid walls.
i. DR means design is required in accordance with the applicable building code, or in the absence of a code, in accordance with ACI 318.
j. The use of this table shall be prohibited for soil classifications not shown.

TABLE R404.1.2(6)
MINIMUM VERTICAL REINFORCEMENT FOR 8-INCH WAFFLE-GRID BASEMENT WALLS[b, c, d, e, f, h, i, j, k]

MAXIMUM UNSUPPORTED WALL HEIGHT (feet)	MAXIMUM UNBALANCED BACKFILL HEIGHT[g] (feet)	MINIMUM VERTICAL REINFORCEMENT-BAR SIZE AND SPACING (inches)		
		Soil classes[a] and design lateral soil (psf per foot of depth)		
		GW, GP, SW, SP 30	GM, GC, SM, SM-SC and ML 45	SC, ML-CL and inorganic CL 60
8	4	NR	NR	NR
	5	NR	5 @ 48	5 @ 46
	6	5 @ 48	5 @ 43	6 @ 45
	7	5 @ 46	6 @ 43	6 @ 31
	8	6 @ 48	6 @ 32	6 @ 23
9	4	NR	NR	NR
	5	NR	5 @ 47	5 @ 46
	6	5 @ 46	5 @ 39	6 @ 41
	7	5 @ 42	6 @ 38	6 @ 28
	8	6 @ 44	6 @ 28	6 @ 20
	9	6 @ 34	6 @ 21	DR
10	4	NR	NR	NR
	5	NR	5 @ 46	5 @ 44
	6	5 @ 46	5 @ 37	6 @ 38
	7	5 @ 38	6 @ 35	6 @ 25
	8	6 @ 39	6 @ 25	DR
	9	6 @ 30	DR	DR
	10	6 @ 24	DR	DR

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot per foot = 0.1571 kPa^2/m, 1 pound per square inch = 6.895 kPa.

NR = Not Required.

DR = Design Required.

a. Soil classes are in accordance with the Unified Soil Classification System. Refer to Table R405.1.

b. Table values are based on reinforcing bars with a minimum yield strength of 60,000 psi concrete with a minimum specified compressive strength of 2,500 psi and vertical reinforcement being located at the centerline of the wall. See Section R404.1.3.3.7.2.

c. Maximum spacings shown are the values calculated for the specified bar size. Where the bar used is Grade 60 (420 MPa) and the size specified in the table, the actual spacing in the wall shall not exceed a whole-number multiple of 12 inches (12, 24, 36 and 48) that is less than or equal to the tabulated spacing. Vertical reinforcement with a yield strength of less than 60,000 psi and bars of a different size than specified in the table are permitted in accordance with Section R404.1.3.3.7.6 and Table R404.1.2(9).

d. NR indicates vertical reinforcement is not required.

e. Deflection criterion is $L/240$, where L is the height of the basement wall in inches.

f. Interpolation shall not be permitted.

g. Where walls will retain 4 feet or more of unbalanced backfill, they shall be laterally supported at the top and bottom before backfilling.

h. See Section R404.1.3.2 for minimum reinforcement required for basement walls supporting above-grade concrete walls.

i. See Table R608.3 for thicknesses and dimensions of waffle-grid walls.

j. DR means design is required in accordance with the applicable building code, or in the absence of a code, in accordance with ACI 318.

k. The use of this table shall be prohibited for soil classifications not shown.

TABLE R404.1.2(7)
MINIMUM VERTICAL REINFORCEMENT FOR 6-INCH (152 mm) SCREEN-GRID BASEMENT WALLS[b, c, d, e, g, h, i, j]

MAXIMUM UNSUPPORTED WALL HEIGHT (feet)	MAXIMUM UNBALANCED BACKFILL HEIGHT[f] (feet)	MINIMUM VERTICAL REINFORCEMENT-BAR SIZE AND SPACING (inches)		
		Soil classes[a] and design lateral soil (psf per foot of depth)		
		GW, GP, SW, SP 30	GM, GC, SM, SM-SC and ML 45	SC, ML-CL and inorganic CL 60
8	4	4 @ 48	4 @ 48	5 @ 43
	5	4 @ 48	5 @ 48	5 @ 37
	6	5 @ 48	6 @ 45	6 @ 32
	7	6 @ 48	DR	DR
	8	6 @ 36	DR	DR
9	4	4 @ 48	4 @ 48	4 @ 41
	5	4 @ 48	5 @ 48	6 @ 48
	6	5 @ 45	6 @ 41	DR
	7	6 @ 43	DR	DR
	> 8	DR	DR	DR
10	4	4 @ 48	4 @ 48	4 @ 39
	5	4 @ 44	5 @ 44	6 @ 46
	6	5 @ 42	6 @ 38	DR
	7	6 @ 40	DR	DR
	> 8	DR	DR	DR

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot per foot = 0.1571 kPa^2/m, 1 pound per square inch = 6.895 kPa.
DR = Design Required.

a. Soil classes are in accordance with the Unified Soil Classification System. Refer to Table R405.1.
b. Table values are based on reinforcing bars with a minimum yield strength of 60,000 psi, concrete with a minimum specified compressive strength of 2,500 psi and vertical reinforcement being located at the centerline of the wall. See Section R404.1.3.3.7.2.
c. Maximum spacings shown are the values calculated for the specified bar size. Where the bar used is Grade 60 and the size specified in the table, the actual spacing in the wall shall not exceed a whole-number multiple of 12 inches (12, 24, 36 and 48) that is less than or equal to the tabulated spacing. Vertical reinforcement with a yield strength of less than 60,000 psi and bars of a different size than specified in the table are permitted in accordance with Section R404.1.3.3.7.6 and Table R404.1.2(9).
d. Deflection criterion is $L/240$, where L is the height of the basement wall in inches.
e. Interpolation is not permitted.
f. Where walls will retain 4 feet or more of unbalanced backfill, they shall be laterally supported at the top and bottom before backfilling.
g. See Sections R404.1.3.2 for minimum reinforcement required for basement walls supporting above-grade concrete walls.
h. See Table R608.3 for thicknesses and dimensions of screen-grid walls.
i. DR means design is required in accordance with the applicable building code, or in the absence of a code, in accordance with ACI 318.
j. The use of this table shall be prohibited for soil classifications not shown.

TABLE R404.1.2(8)
MINIMUM VERTICAL REINFORCEMENT FOR 6-, 8-, 10- AND 12-INCH NOMINAL FLAT BASEMENT WALLS[b, c, d, e, f, h, i, k, n, o]

MAXIMUM UNSUPPORTED WALL HEIGHT (feet)	MAXIMUM UNBALANCED BACKFILL HEIGHT[g] (feet)	MINIMUM VERTICAL REINFORCEMENT-BAR SIZE AND SPACING (inches)											
		Soil classes[a] and design lateral soil (psf per foot of depth)											
		GW, GP, SW, SP 30				GM, GC, SM, SM-SC and ML 45				SC, ML-CL and inorganic CL 60			
		Minimum nominal wall thickness (inches)											
		6	8	10	12	6	8	10	12	6	8	10	12
5	4	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	5	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
6	4	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	5	NR	NR	NR	NR	NR	NR[l]	NR	NR	4 @ 35	NR[l]	NR	NR
	6	NR	NR	NR	NR	5 @ 48	NR	NR	NR	5 @ 36	NR	NR	NR
7	4	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	5	NR	NR	NR	NR	NR	NR	NR	NR	5 @ 47	NR	NR	NR
	6	NR	NR	NR	NR	5 @ 42	NR	NR	NR	6 @ 43	5 @ 48	NR[l]	NR
	7	5 @ 46	NR	NR	NR	6 @ 42	5 @ 46	NR[l]	NR	6 @ 34	6 @ 48	NR	NR
8	4	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	5	NR	NR	NR	NR	4 @ 38	NR[l]	NR	NR	5 @ 43	NR	NR	NR
	6	4 @ 37	NR[l]	NR	NR	5 @ 37	NR	NR	NR	6 @ 37	5 @ 43	NR[l]	NR
	7	5 @ 40	NR	NR	NR	6 @ 37	5 @ 41	NR[l]	NR	6 @ 34	6 @ 43	NR	NR
	8	6 @ 43	5 @ 47	NR[l]	NR	6 @ 34	6 @ 43	NR	NR	6 @ 27	6 @ 32	6 @ 44	NR
9	4	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	5	NR	NR	NR	NR	4 @ 35	NR[l]	NR	NR	5 @ 40	NR	NR	NR
	6	4 @ 34	NR[l]	NR	NR	6 @ 48	NR	NR	NR	6 @ 36	6 @ 39	NR[l]	NR
	7	5 @ 36	NR	NR	NR	6 @ 34	5 @ 37	NR	NR	6 @ 33	6 @ 38	5 @ 37	NR[l]
	8	6 @ 38	5 @ 41	NR[l]	NR	6 @ 33	6 @ 38	5 @ 37	NR[l]	6 @ 24	6 @ 29	6 @ 39	4 @ 48[m]
	9	6 @ 34	6 @ 46	NR	NR	6 @ 26	6 @ 30	6 @ 41	NR	6 @ 19	6 @ 23	6 @ 30	6 @ 39
10	4	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	5	NR	NR	NR	NR	4 @ 33	NR[l]	NR	NR	5 @ 38	NR	NR	NR
	6	5 @ 48	NR[l]	NR	NR	6 @ 45	NR	NR	NR	6 @ 34	5 @ 37	NR	NR
	7	6 @ 47	NR	NR	NR	6 @ 34	6 @ 48	NR	NR	6 @ 30	6 @ 35	6 @ 48	NR[l]
	8	6 @ 34	5 @ 38	NR	NR	6 @ 30	6 @ 34	6 @ 47	NR[l]	6 @ 22	6 @ 26	6 @ 35	6 @ 45[m]
	9	6 @ 34	6 @ 41	4 @ 48	NR[l]	6 @ 23	6 @ 27	6 @ 35	4 @ 48[m]	DR	6 @ 22	6 @ 27	6 @ 34
	10	6 @ 28	6 @ 33	6 @ 45	NR	DR[j]	6 @ 23	6 @ 29	6 @ 38	DR	6 @ 22	6 @ 22	6 @ 28

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot per foot = 0.1571 kPa^2/m, 1 pound per square inch = 6.895 kPa.

NR = Not Required.

DR = Design Required.

a. Soil classes are in accordance with the Unified Soil Classification System. Refer to Table R405.1.

b. Table values are based on reinforcing bars with a minimum yield strength of 60,000 psi.

c. Vertical reinforcement with a yield strength of less than 60,000 psi and bars of a different size than specified in the table are permitted in accordance with Section R404.1.3.3.7.6 and Table R404.1.2(9).

d. NR indicates vertical wall reinforcement is not required, except for 6-inch nominal walls formed with stay-in-place forming systems in which case vertical reinforcement shall be No. 4@48 inches on center.

e. Allowable deflection criterion is $L/240$, where L is the unsupported height of the basement wall in inches.

f. Interpolation is not permitted.

g. Where walls will retain 4 feet or more of unbalanced backfill, they shall be laterally supported at the top and bottom before backfilling.

h. Vertical reinforcement shall be located to provide a cover of $1^1/_4$ inches measured from the inside face of the wall. The center of the steel shall not vary from the specified location by more than the greater of 10 percent of the wall thickness or $^3/_8$ inch.

i. Concrete cover for reinforcement measured from the inside face of the wall shall be not less than $^3/_4$ inch. Concrete cover for reinforcement measured from the outside face of the wall shall be not less than $1^1/_2$ inches for No. 5 bars and smaller, and not less than 2 inches for larger bars.

j. DR means design is required in accordance with the applicable building code, or in the absence of a code, in accordance with ACI 318.

k. Concrete shall have a specified compressive strength, f'_c, of not less than 2,500 psi at 28 days, unless a higher strength is required by Note l or m.

l. The minimum thickness is permitted to be reduced 2 inches, provided that the minimum specified compressive strength of concrete, f'_c, is 4,000 psi.

m. A plain concrete wall with a minimum nominal thickness of 12 inches is permitted, provided that the minimum specified compressive strength of concrete, f'_c, is 3,500 psi.

n. See Table R608.3 for tolerance from nominal thickness permitted for flat walls.

o. The use of this table shall be prohibited for soil classifications not shown.

TABLE R404.1.2(9)
MINIMUM SPACING FOR ALTERNATE BAR SIZE AND ALTERNATE GRADE OF STEEL[a, b, c]

BAR SPACING FROM APPLICABLE TABLE IN SECTION R404.1.3.2 (inches)	BAR SIZE FROM APPLICABLE TABLE IN SECTION R404.1.3.2														
	#4					#5					#6				
	Alternate bar size and alternate grade of steel desired														
	Grade 60		Grade 40			Grade 60		Grade 40			Grade 60		Grade 40		
	#5	#6	#4	#5	#6	#4	#6	#4	#5	#6	#4	#5	#4	#5	#6
	Maximum spacing for alternate bar size and alternate grade of steel (inches)														
8	12	18	5	8	12	5	11	3	5	8	4	6	2	4	5
9	14	20	6	9	13	6	13	4	6	9	4	6	3	4	6
10	16	22	7	10	15	6	14	4	7	9	5	7	3	5	7
11	17	24	7	11	16	7	16	5	7	10	5	8	3	5	7
12	19	26	8	12	18	8	17	5	8	11	5	8	4	6	8
13	20	29	9	13	19	8	18	6	9	12	6	9	4	6	9
14	22	31	9	14	21	9	20	6	9	13	6	10	4	7	9
15	23	33	10	16	22	10	21	6	10	14	7	11	5	7	10
16	25	35	11	17	23	10	23	7	11	15	7	11	5	8	11
17	26	37	11	18	25	11	24	7	11	16	8	12	5	8	11
18	28	40	12	19	26	12	26	8	12	17	8	13	5	8	12
19	29	42	13	20	28	12	27	8	13	18	9	13	6	9	13
20	31	44	13	21	29	13	28	9	13	19	9	14	6	9	13
21	33	46	14	22	31	14	30	9	14	20	10	15	6	10	14
22	34	48	15	23	32	14	31	9	15	21	10	16	7	10	15
23	36	48	15	24	34	15	33	10	15	22	10	16	7	11	15
24	37	48	16	25	35	15	34	10	16	23	11	17	7	11	16
25	39	48	17	26	37	16	35	11	17	24	11	18	8	12	17
26	40	48	17	27	38	17	37	11	17	25	12	18	8	12	17
27	42	48	18	28	40	17	38	12	18	26	12	19	8	13	18
28	43	48	19	29	41	18	40	12	19	26	13	20	8	13	19
29	45	48	19	30	43	19	41	12	19	27	13	20	9	14	19
30	47	48	20	31	44	19	43	13	20	28	14	21	9	14	20
31	48	48	21	32	45	20	44	13	21	29	14	22	9	15	21
32	48	48	21	33	47	21	45	14	21	30	15	23	10	15	21
33	48	48	22	34	48	21	47	14	22	31	15	23	10	16	22
34	48	48	23	35	48	22	48	15	23	32	15	24	10	16	23
35	48	48	23	36	48	23	48	15	23	33	16	25	11	16	23
36	48	48	24	37	48	23	48	15	24	34	16	25	11	17	24
37	48	48	25	38	48	24	48	16	25	35	17	26	11	17	25
38	48	48	25	39	48	25	48	16	25	36	17	27	12	18	25
39	48	48	26	40	48	25	48	17	26	37	18	27	12	18	26
40	48	48	27	41	48	26	48	17	27	38	18	28	12	19	27
41	48	48	27	42	48	26	48	18	27	39	19	29	12	19	27
42	48	48	28	43	48	27	48	18	28	40	19	30	13	20	28
43	48	48	29	44	48	28	48	18	29	41	20	30	13	20	29
44	48	48	29	45	48	28	48	19	29	42	20	31	13	21	29
45	48	48	30	47	48	29	48	19	30	43	20	32	14	21	30
46	48	48	31	48	48	30	48	20	31	44	21	32	14	22	31
47	48	48	31	48	48	30	48	20	31	44	21	33	14	22	31
48	48	48	32	48	48	31	48	21	32	45	22	34	15	23	32

For SI: 1 inch = 25.4 mm.

a. This table is for use with tables in Section R404.1.3.2 that specify the minimum bar size and maximum spacing of vertical wall reinforcement for foundation walls and above-grade walls. Reinforcement specified in tables in Section R404.1.3.2 is based on Grade 60 steel reinforcement.

b. Bar spacing shall not exceed 48 inches on center and shall be not less than one-half the nominal wall thickness.

c. For Grade 50 steel bars (ASTM A996, Type R), use spacing for Grade 40 bars or interpolate between Grades 40 and 60.

R404.1.2.1 Masonry foundation walls. *Concrete masonry* and *clay masonry* foundation walls shall be constructed as set forth in Table R404.1.1(1), R404.1.1(2), R404.1.1(3) or R404.1.1(4) and shall comply with applicable provisions of Section R606. Rubble stone masonry foundation walls shall be constructed in accordance with Sections R404.1.8 and R606.4.2. Rubble stone masonry walls shall not be used in *townhouses* in Seismic Design Category C.

R404.1.3 Concrete foundation walls. Concrete foundation walls that support light-frame walls shall be designed and constructed in accordance with the provisions of this section, ACI 318, ACI 332 or PCA 100. Concrete foundation walls that support above-grade concrete walls that are within the applicability limits of Section R608.2 shall be designed and constructed in accordance with the provisions of this section, ACI 318, ACI 332 or PCA 100. Concrete foundation walls that support above-grade concrete walls that are not within the applicability limits of Section R608.2 shall be designed and constructed in accordance with the provisions of ACI 318, ACI 332 or PCA 100. Where ACI 318, ACI 332, PCA 100 or the provisions of this section are used to design concrete foundation walls, project drawings, typical details and specifications are not required to bear the seal of the architect or engineer responsible for design, unless otherwise required by the state law of the *jurisdiction* having authority.

R404.1.3.1 Concrete cross section. Concrete walls constructed in accordance with this code shall comply with the shapes and minimum concrete cross-sectional dimensions required by Table R608.3. Other types of forming systems resulting in concrete walls not in compliance with this section and Table R608.3 shall be designed in accordance with ACI 318.

R404.1.3.2 Reinforcement for foundation walls. Concrete foundation walls shall be laterally supported at the top and bottom. Horizontal reinforcement shall be provided in accordance with Table R404.1.2(1). Vertical reinforcement shall be provided in accordance with Table R404.1.2(2), R404.1.2(3), R404.1.2(4), R404.1.2(5), R404.1.2(6), R404.1.2(7) or R404.1.2(8). Vertical reinforcement for flat *basement* walls retaining 4 feet (1219 mm) or more of unbalanced backfill is permitted to be determined in accordance with Table R404.1.2(9). For *basement* walls supporting above-grade concrete walls, vertical reinforcement shall be the greater of that required by Tables R404.1.2(2) through R404.1.2(8) or by Section R608.6 for the above-grade wall. In buildings assigned to Seismic Design Category D_0, D_1 or D_2, concrete foundation walls shall also comply with Section R404.1.4.2.

R404.1.3.2.1 Concrete foundation stem walls supporting above-grade concrete walls. Foundation stem walls that support above-grade concrete walls shall be designed and constructed in accordance with this section.

1. Stem walls not laterally supported at top. Concrete stem walls that are not monolithic with slabs-on-ground or are not otherwise laterally supported by slabs-on-ground shall comply with this section. Where unbalanced backfill retained by the stem wall is less than or equal to 18 inches (457 mm), the stem wall and above-grade wall it supports shall be provided with vertical reinforcement in accordance with Section R608.6 and Table R608.6(1), R608.6(2) or R608.6(3) for above-grade walls. Where unbalanced backfill retained by the stem wall is greater than 18 inches (457 mm), the stem wall and above-grade wall it supports shall be provided with vertical reinforcement in accordance with Section R608.6 and Table R608.6(1).
2. Stem walls laterally supported at top. Concrete stem walls that are monolithic with slabs-on-ground or are otherwise laterally supported by slabs-on-ground shall be vertically reinforced in accordance with Section R608.6 and Table R608.6(1), R608.6(2) or R608.6(3) for above-grade walls. Where the unbalanced backfill retained by the stem wall is greater than 18 inches (457 mm), the connection between the stem wall and the slab-on-ground, and the portion of the slab-on-ground providing lateral support for the wall shall be designed in accordance with PCA 100 or with accepted engineering practice. Where the unbalanced backfill retained by the stem wall is greater than 18 inches (457 mm), the minimum nominal thickness of the wall shall be 6 inches (152 mm).

R404.1.3.2.2 Concrete foundation stem walls supporting light-frame above-grade walls. Concrete foundation stem walls that support light-frame above-grade walls shall be designed and constructed in accordance with this section.

1. Stem walls not laterally supported at top. Concrete stem walls that are not monolithic with slabs-on-ground or are not otherwise laterally supported by slabs-on-ground and retain 48 inches (1219 mm) or less of unbalanced fill, measured from the top of the wall, shall be constructed in accordance with Section R404.1.3. Foundation stem walls that retain more than 48 inches (1219 mm) of unbalanced fill, measured from the top of the wall, shall be designed in accordance with Sections R404.1.1 and R404.4.
2. Stem walls laterally supported at top. Concrete stem walls that are monolithic with slabs-on-ground or are otherwise laterally supported by slabs-on-ground shall be constructed in accordance with

Section R404.1.3. Where the unbalanced backfill retained by the stem wall is greater than 48 inches (1219 mm), the connection between the stem wall and the slab-on-ground, and the portion of the slab-on-ground providing lateral support for the wall, shall be designed in accordance with PCA 100 or in accordance with accepted engineering practice.

R404.1.3.3 Concrete, materials for concrete, and forms. Materials used in concrete, the concrete itself and forms shall conform to requirements of this section or ACI 318.

R404.1.3.3.1 Compressive strength. The minimum specified compressive strength of concrete, f'_c, shall comply with Section R402.2 and shall be not less than 2,500 psi (17.2 MPa) at 28 days in buildings assigned to Seismic Design Category A, B or C and 3,000 psi (20.5 MPa) in buildings assigned to Seismic Design Category D_0, D_1 or D_2.

R404.1.3.3.2 Concrete mixing and delivery. Mixing and delivery of concrete shall comply with ASTM C94 or ASTM C685.

R404.1.3.3.3 Maximum aggregate size. The nominal maximum size of coarse aggregate shall not exceed one-fifth the narrowest distance between sides of forms, or three-fourths the clear spacing between reinforcing bars or between a bar and the side of the form.

Exception: Where *approved*, these limitations shall not apply where removable forms are used and workability and methods of consolidation permit concrete to be placed without honeycombs or voids.

R404.1.3.3.4 Proportioning and slump of concrete. Proportions of materials for concrete shall be established to provide workability and consistency to permit concrete to be worked readily into forms and around reinforcement under conditions of placement to be employed, without segregation or excessive bleeding. Slump of concrete placed in removable forms shall not exceed 6 inches (152 mm).

Exception: Where *approved*, the slump is permitted to exceed 6 inches (152 mm) for concrete mixtures that are resistant to segregation, and are in accordance with the form manufacturer's recommendations.

Slump of concrete placed in stay-in-place forms shall exceed 6 inches (152 mm). Slump of concrete shall be determined in accordance with ASTM C143.

R404.1.3.3.5 Consolidation of concrete. Concrete shall be consolidated by suitable means during placement and shall be worked around embedded items and reinforcement and into corners of forms. Where stay-in-place forms are used, concrete shall be consolidated by internal vibration.

Exception: Where *approved* for concrete to be placed in stay-in-place forms, self-consolidating concrete mixtures with slumps equal to or greater than 8 inches (203 mm) that are specifically designed for placement without internal vibration need not be internally vibrated.

R404.1.3.3.6 Form materials and form ties. Forms shall be made of wood, steel, aluminum, plastic, a composite of cement and foam insulation, a composite of cement and wood chips, or other *approved* material suitable for supporting and containing concrete. Forms shall be accurately positioned and secured before placing concrete and shall provide sufficient strength to contain concrete during the concrete placement operation.

Form ties shall be steel, solid plastic, foam plastic, a composite of cement and wood chips, a composite of cement and foam plastic, or other suitable material capable of resisting the forces created by fluid pressure of fresh concrete.

R404.1.3.3.6.1 Stay-in-place forms. Stay-in-place concrete forms shall comply with this section.

1. Surface burning characteristics. The flame-spread index and *smoke-developed index* of forming material, other than foam plastic, left exposed on the interior shall comply with Section R302. The surface burning characteristics of foam plastic used in *insulating concrete forms* shall comply with Section R316.3.
2. Interior covering. Stay-in-place forms constructed of rigid foam plastic shall be protected on the interior of the building as required by Section R316. Where gypsum board is used to protect the foam plastic, it shall be installed with a mechanical fastening system. Use of adhesives in addition to mechanical fasteners is permitted.
3. Exterior wall covering. Stay-in-place forms constructed of rigid foam plastics shall be protected from sunlight and physical damage by the application of an *approved* exterior wall covering complying with this code. Exterior surfaces of other stay-in-place forming systems shall be protected in accordance with this code.
4. Termite protection. Foam plastic insulation shall be permitted below grade on foundation walls in accordance with Section R318.4.
5. Flat ICF wall system forms shall conform to ASTM E2634.

R404.1.3.3.7 Reinforcement.

R404.1.3.3.7.1 Steel reinforcement. Steel reinforcement shall comply with the requirements of ASTM A615, A706M or A996. ASTM A996 bars produced from rail steel shall be Type R. In buildings assigned to Seismic Design Category A, B or C, the minimum yield strength of reinforcing steel shall be 40,000 psi (Grade 40) (276 MPa).

R404.1.3.3.7.2 Location of reinforcement in wall. The center of vertical reinforcement in *basement* walls determined from Tables R404.1.2(2) through R404.1.2(7) shall be located at the centerline of the wall. Vertical reinforcement in *basement* walls determined from Table R404.1.2(8) shall be located to provide a maximum cover of $1^1/_4$ inches (32 mm) measured from the inside face of the wall. Regardless of the table used to determine vertical wall reinforcement, the center of the steel shall not vary from the specified location by more than the greater of 10 percent of the wall thickness and $^3/_8$ inch (10 mm). Horizontal and vertical reinforcement shall be located in foundation walls to provide the minimum cover required by Section R404.1.3.3.7.4.

R404.1.3.3.7.3 Wall openings. Vertical wall reinforcement required by Section R404.1.3.2 that is interrupted by wall openings shall have additional vertical reinforcement of the same size placed within 12 inches (305 mm) of each side of the opening.

R404.1.3.3.7.4 Support and cover. Reinforcement shall be secured in the proper location in the forms with tie wire or other bar support system to prevent displacement during the concrete placement operation. Steel reinforcement in concrete cast against the earth shall have a minimum cover of 3 inches (75 mm). Minimum cover for reinforcement in concrete cast in removable forms that will be exposed to the earth or weather shall be $1^1/_2$ inches (38 mm) for No. 5 bars and smaller, and 2 inches (50 mm) for No. 6 bars and larger. For concrete cast in removable forms that will not be exposed to the earth or weather, and for concrete cast in stay-in-place forms, minimum cover shall be $^3/_4$ inch (19 mm). The minus tolerance for cover shall not exceed the smaller of one-third the required cover or $^3/_8$ inch (10 mm).

R404.1.3.3.7.5 Lap splices. Vertical and horizontal wall reinforcement shall be the longest lengths practical. Where splices are necessary in reinforcement, the length of lap splice shall be in accordance with Table R608.5.4(1) and Figure R608.5.4(1). The maximum gap between noncontact parallel bars at a lap splice shall not exceed the smaller of one-fifth the required lap length and 6 inches (152 mm) [see Figure R608.5.4(1)].

R404.1.3.3.7.6 Alternate grade of reinforcement and spacing. Where tables in Section R404.1.3.2 specify vertical wall reinforcement based on minimum bar size and maximum spacing, which are based on Grade 60 (414 MPa) steel reinforcement, different size bars or bars made from a different grade of steel are permitted provided that an equivalent area of steel per linear foot of wall is provided. Use of Table R404.1.2(9) is permitted to determine the maximum bar spacing for different bar sizes than specified in the tables or bars made from a different grade of steel. Bars shall not be spaced less than one-half the wall thickness, or more than 48 inches (1219 mm) on center.

R404.1.3.3.7.7 Standard hooks. Where reinforcement is required by this code to terminate with a standard hook, the hook shall comply with Section R608.5.4.5 and Figure R608.5.4(3).

R404.1.3.3.7.8 Construction joint reinforcement. Construction joints in foundation walls shall be made and located to not impair the strength of the wall. Construction joints in plain concrete walls, including walls required to have not less than No. 4 bars at 48 inches (1219 mm) on center by Sections R404.1.3.2 and R404.1.4.2, shall be located at points of lateral support, and not fewer than one No. 4 bar shall extend across the construction joint at a spacing not to exceed 24 inches (610 mm) on center. Construction joint reinforcement shall have not less than 12 inches (305 mm) embedment on both sides of the joint. Construction joints in reinforced concrete walls shall be located in the middle third of the span between lateral supports, or located and constructed as required for joints in plain concrete walls.

Exception: Use of vertical wall reinforcement required by this code is permitted in lieu of construction joint reinforcement provided that the spacing does not exceed 24 inches (610 mm), or the combination of wall reinforcement and No. 4 bars described in this section does not exceed 24 inches (610 mm).

R404.1.3.3.8 Exterior wall coverings. Requirements for installation of masonry veneer, stucco and other wall coverings on the exterior of concrete walls and other construction details not covered in this section shall comply with the requirements of this code.

R404.1.3.4 Requirements for Seismic Design Category C. Concrete foundation walls supporting above-grade concrete walls in *townhouses* assigned to Seismic Design Category C shall comply with ACI 318, ACI 332 or PCA 100 (see Section R404.1.3).

R404.1.4 Seismic Design Category D_0, D_1 or D_2. Deleted.

R404.1.5 Foundation wall thickness based on walls supported. The thickness of masonry or concrete foundation walls shall be not less than that required by Section R404.1.5.1 or R404.1.5.2, respectively.

R404.1.5.1 Masonry wall thickness. Masonry foundation walls shall be not less than the thickness of the wall supported, except that masonry foundation walls of not less than 8-inch (203 mm) nominal thickness shall be permitted under brick veneered frame walls and under 10-inch-wide (254 mm) cavity walls where the total height of the wall supported, including gables, is not more than 20 feet (6096 mm), provided that the requirements of Section R404.1.1 are met.

R404.1.5.2 Concrete wall thickness. The thickness of concrete foundation walls shall be equal to or greater than the thickness of the wall in the story above. Concrete foundation walls with corbels, brackets or other projections built into the wall for support of masonry veneer or other purposes are not within the scope of the tables in this section.

Where a concrete foundation wall is reduced in thickness to provide a shelf for the support of masonry veneer, the reduced thickness shall be equal to or greater than the thickness of the wall in the story above. Vertical reinforcement for the foundation wall shall be based on Table R404.1.2(8) and located in the wall as required by Section R404.1.3.3.7.2 where that table is used. Vertical reinforcement shall be based on the thickness of the thinner portion of the wall.

Exception: Where the height of the reduced thickness portion measured to the underside of the floor assembly or sill plate above is less than or equal to 24 inches (610 mm) and the reduction in thickness does not exceed 4 inches (102 mm), the vertical reinforcement is permitted to be based on the thicker portion of the wall.

R404.1.5.3 Pier and curtain wall foundations. Use of pier and curtain wall foundations shall be permitted to support *light-frame construction* not more than two *stories* in height, provided that the following requirements are met:

1. Curtain walls shall be bonded into piers and supported on concrete footings poured integrally with pier footings.
2. The minimum actual thickness of a load-bearing masonry wall shall be not less than 4 inches (102 mm) nominal or $3^3/_8$ inches (92 mm) actual thickness, and shall be bonded integrally with piers spaced in accordance with Section R606.6.4.
3. Piers shall be constructed in accordance with Sections R606.7 and R606.7.1, and shall be bonded into the load-bearing masonry wall in accordance with Section R606.13.1 or R606.13.1.1.
4. The maximum height of a pier and curtain wall foundations shall be not more than 6 feet (1829 mm).
5. Anchorage shall be in accordance with Section R403.1.6, Figure R404.1.5(1), or as specified by engineered design accepted by the *building official*.
6. The unbalanced fill for 4-inch (102 mm) foundation walls shall not exceed 24 inches (610 mm) for *solid masonry* or 16 inches (406 mm) for *hollow masonry*.
7. Pier size shall be based on Table R403.1(2).
8. See Chapter 45 for special anchorage and reinforcement in high wind zones.

R404.1.5.4 Piers. The unsupported height of masonry piers shall not exceed 10 times their least dimension. When structural clay tile or hollow concrete masonry units are used for isolated piers to support beams and girders, the cellular spaces shall be filled solidly with concrete or Type M or S mortar, except that unfilled hollow piers may be used if their unsupported height is not more than four times their least dimension. When hollow masonry units are solidly filled with concrete or Type M or S mortar, the allowable compressive stress may be increased as provided in Table R606.9.

R404.1.6 Height above finished grade. Concrete and masonry foundation walls shall extend above the finished *grade* adjacent to the foundation at all points not less than 4 inches (102 mm) where masonry veneer is used and not less than 6 inches (152 mm) elsewhere.

R404.1.7 Backfill placement. Backfill shall not be placed against the wall until the wall has sufficient strength and has been anchored to the floor above, or has been sufficiently braced to prevent damage by the backfill.

Exception: Bracing is not required for walls supporting less than 4 feet (1219 mm) of unbalanced backfill.

R404.1.8 Rubble stone masonry. Rubble stone masonry foundation walls shall have a minimum thickness of 16 inches (406 mm), shall not support an unbalanced backfill exceeding 8 feet (2438 mm) in height, shall not support a soil pressure greater than 30 pounds per square foot per foot (4.71 kPa/m), and shall not be constructed in *Seismic Design Categories* D_0, D_1, D_2 or *townhouses* in Seismic Design Category C, as established in Figure R301.2(2).

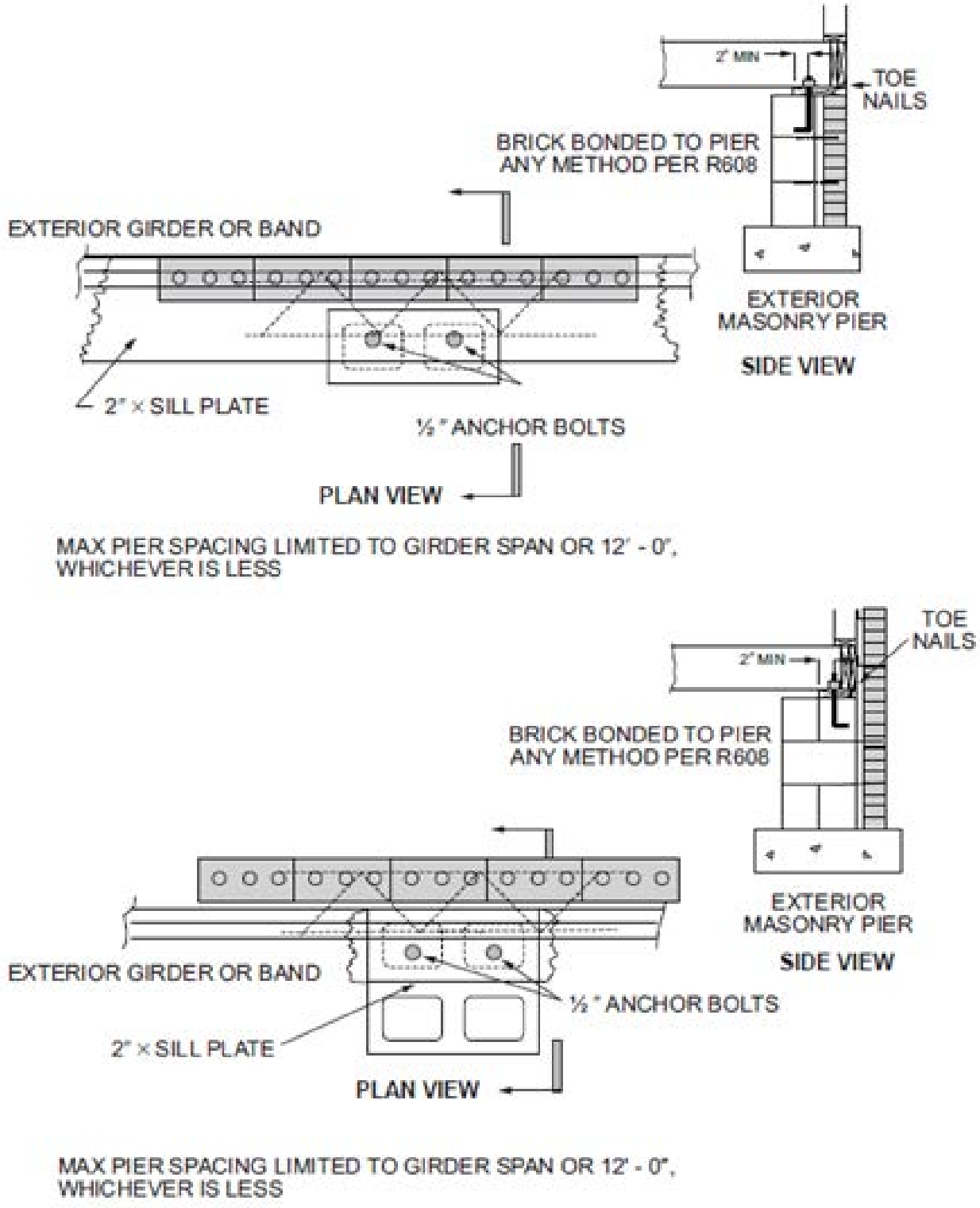


FIGURE R404.1.5(1)
ALTERNATIVE ANCHORAGE FOR MASONRY CURATIN WALL WITH CONCRETE MASONRY PIERS

R404.1.9 Isolated masonry piers. Isolated masonry piers shall be constructed in accordance with this section and the general masonry construction requirements of Section R606. *Hollow masonry* piers shall have a minimum nominal thickness of 8 inches (203 mm), with a nominal height not exceeding four times the nominal thickness and a nominal length not exceeding three times the nominal thickness. Where *hollow masonry units* are solidly filled with concrete, grout, or Type M or S mortar, piers shall be permitted to have a nominal height not exceeding ten times the nominal thickness. Footings for isolated masonry piers shall be sized in accordance with Section R403.1.1.

R404.1.9.1 Pier cap. *Hollow masonry* piers shall be capped with 4 inches (102 mm) of *solid masonry* or concrete for one story and 8 inches (203 mm) of solid masonry or concrete for two stories and two and one-half stories or shall have cavities of the top course filled with concrete or grout or Type M or S mortar. Where required, termite protection for the pier cap shall be provided in accordance with Section R318.

R404.1.9.2 Masonry piers supporting floor girders. Masonry piers supporting wood girders sized in accordance with Tables R602.7(1) and R602.7(2) shall be permitted in accordance with this section. Piers supporting girders for interior bearing walls shall have a minimum nominal dimension of 12 inches (305 mm) and a maximum height of 10 feet (3048 mm) from top of footing to bottom of sill plate or girder. Piers supporting girders for exterior bearing walls shall have a minimum nominal dimension of 12 inches (305 mm) and a maximum height of 4 feet (1220 mm) from top of footing to bottom of sill plate or girder. Girders and sill plates shall be anchored to the pier or footing in accordance with Section R403.1.6 or Figure R404.1.5(1). Floor girder bearing shall be in accordance with Section R502.6.

R404.1.9.3 Masonry piers supporting braced wall panels. Masonry piers supporting *braced wall panels* shall be designed in accordance with accepted engineering practice.

R404.1.9.4 Seismic design of masonry piers. Masonry piers in *townhouses* in Seismic Design Category C, shall be designed in accordance with accepted engineering practice.

R404.1.9.5 Masonry piers in flood hazard areas. Masonry piers for *dwellings* in flood hazard areas shall be designed in accordance with Section R322.

R404.2 Wood foundation walls. Wood foundation walls shall be constructed in accordance with the provisions of Sections R404.2.1 through R404.2.6 and with the details shown in Figures R403.1(2) and R403.1(3).

R404.2.1 Identification. Load-bearing lumber shall be identified by the grade *mark* of a lumber grading or inspection agency that has been *approved* by an accreditation body that complies with DOC PS 20. In lieu of a grade *mark*, a certificate of inspection issued by a lumber grading or inspection agency meeting the requirements of this section shall be accepted. *Wood structural panels* shall conform to DOC PS 1 or DOC PS 2 and shall be identified by a grade *mark* or certificate of inspection issued by an *approved agency*.

R404.2.2 Stud size. The studs used in foundation walls shall be 2-inch by 6-inch (51 mm by 152 mm) members. Where spaced 16 inches (406 mm) on center, a wood species with an F_b value of not less than 1,250 pounds per square inch (8619 kPa) as *listed* in ANSI AWC NDS shall be used. Where spaced 12 inches (305 mm) on center, an F_b of not less than 875 psi (6033 kPa) shall be required.

R404.2.3 Height of backfill. For wood foundations that are not designed and installed in accordance with AWC PWF, the height of backfill against a foundation wall shall not exceed 4 feet (1219 mm). Where the height of fill is more than 12 inches (305 mm) above the interior grade of a *crawl space* or floor of a *basement*, the thickness of the plywood sheathing shall meet the requirements of Table R404.2.3.

R404.2.4 Backfilling. Wood foundation walls shall not be backfilled until the *basement* floor and first floor have been constructed or the walls have been braced. For *crawl space* construction, backfill or bracing shall be installed on the interior of the walls prior to placing backfill on the exterior.

R404.2.5 Drainage and dampproofing. Wood foundation *basements* shall be drained and dampproofed in accordance with Sections R405 and R406, respectively.

R404.2.6 Fastening. *Wood structural panel* foundation wall sheathing shall be attached to framing in accordance with Table R602.3(1) and Section R402.1.1.

R404.3 Wood sill plates. Wood sill plates shall be not less than 2-inch by 4-inch (51 mm by 102 mm) nominal lumber. Sill plate anchorage shall be in accordance with Sections R403.1.6 and R602.11.

R404.4 Retaining walls. Retaining walls that meet the following shall be designed by a registered design professional.

1. Any retaining walls on a residential site that cross over adjacent property lines regardless of vertical height, or
2. Retaining walls that support buildings and their accessory structures, undercutting footings 10 feet (3048 mm) or less in accordance with Section R403.1.9 and Figure 403.1.9, or

TABLE R404.2.3
PLYWOOD GRADE AND THICKNESS FOR WOOD FOUNDATION CONSTRUCTION (30 pcf equivalent-fluid weight soil pressure)

HEIGHT OF FILL (inches)	STUD SPACING (inches)	FACE GRAIN ACROSS STUDS			FACE GRAIN PARALLEL TO STUDS		
		Grade[a]	Minimum thickness (inches)	Span rating	Grade[a]	Minimum thickness (inches)[b, c]	Span rating
24	12	B	15/32	32/16	A	15/32	32/16
					B	15/32 c	32/16
	16	B	15/32	32/16	A	15/32 c	32/16
					B	19/32 c (4, 5 ply)	40/20
36	12	B	15/32	32/16	A	15/32	32/16
					B	15/32 c (4, 5 ply)	32/16
					B	19/32 (4, 5 ply)	40/20
	16	B	15/32 c	32/16	A	19/32	40/20
					B	23/32	48/24
48	12	B	15/32	32/16	A	15/32 c	32/16
					B	19/32 c (4, 5 ply)	40/20
	16	B	19/32	40/20	A	19/32 c	40/20
					A	23/32	48/24

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

a. Plywood shall be of the following minimum grades in accordance with DOC PS 1 or DOC PS 2:
   1. DOC PS 1 Plywood grades marked:
      1.1. Structural I C-D (Exposure 1).
      1.2. C-D (Exposure 1).
   2. DOC PS 2 Plywood grades marked:
      2.1. Structural I Sheathing (Exposure 1).
      2.2. Sheathing (Exposure 1).
   3. Where a major portion of the wall is exposed above ground and a better appearance is desired, the following plywood grades marked exterior are suitable:
      3.1. Structural I A-C, Structural I B-C or Structural I C-C (Plugged) in accordance with DOC PS 1.
      3.2. A-C Group 1, B-C Group 1, C-C (Plugged) Group 1 or MDO Group 1 in accordance with DOC PS 1.
      3.3. Single Floor in accordance with DOC PS 1 or DOC PS 2.

b. Minimum thickness 15/32 inch, except crawl space sheathing shall have not less than 3/8 inch for face grain across studs 16 inches on center and maximum 2-foot depth of unequal fill.

c. For this fill height, thickness and grade combination, panels that are continuous over less than three spans (across less than three stud spacings) require blocking 16 inches above the bottom plate. Offset adjacent blocks and fasten through studs with two 16d corrosion-resistant nails at each end.

3. Individual retaining walls supporting unbalanced backfill exceeding 5 feet (1524 mm) in height within a horizontal distance of 15 feet (4572 mm) or less, or
4. Multiple retaining walls providing a cumulative vertical relief of unbalanced backfill heights greater than 5 Feet (1524 mm) within a horizontal distance of 15 feet (4572 mm) or less.

Retaining walls shall be designed for a safety factor of 1.5 against lateral sliding and overturning.

R404.5 Precast concrete foundation walls.

R404.5.1 Design. *Precast concrete* foundation walls shall be designed in accordance with accepted engineering practice. The design and manufacture of *precast concrete* foundation wall panels shall comply with the materials requirements of Section R402.3 or ACI 318. The panel design drawings shall be prepared by a *registered design professional* where required by the statutes of the *jurisdiction* in which the project is to be constructed in accordance with Section R106.1.

R404.5.2 Precast concrete foundation design drawings. *Precast concrete* foundation wall design drawings shall be submitted to the *building official* and *approved* prior to installation. Drawings shall include, at a minimum, the following information:

1. Design loading as applicable.
2. Footing design and material.
3. Concentrated loads and their points of application.
4. Soil bearing capacity.
5. Maximum allowable total uniform load.
6. Seismic design category.
7. Basic wind speed.

R404.5.3 Identification. *Precast concrete* foundation wall panels shall be identified by a certificate of inspection *label* issued by an *approved* third-party inspection agency.

SECTION R405
FOUNDATION DRAINAGE

R405.1 Concrete or masonry foundations. Exterior drains shall be provided around concrete or masonry foundations that retain 12 inches or more of earth on the exterior of the foundation wall. Drainage tiles, gravel or crushed stone drains, perforated pipe or other *approved* systems or materials shall be installed at or below the top of the footing or below the bottom of the slab and shall discharge by gravity or mechanical means into an *approved* drainage system. Gravel or crushed stone drains shall extend not less than 1 foot (305 mm) beyond the outside edge of the footing and 6 inches (152 mm) above the top of the footing and be covered with an *approved* filter membrane material. The top of open joints of drain tiles shall be protected with strips of building paper. Except where otherwise recommended by the drain manufacturer, perforated drains shall be surrounded with an *approved* filter membrane or the filter membrane shall cover the washed gravel or crushed rock covering the drain. Drainage tiles or perforated pipe shall be placed on not less than 2 inches (51 mm) of washed gravel or crushed rock not less than one sieve size larger than the tile joint opening or perforation and covered with not less than 6 inches (152 mm) of the same material.

Exception: A drainage system is not required where the foundation is installed on well-drained ground or sand-gravel mixture soils according to the Unified Soil Classification System, Group I soils, as detailed in Table R405.1.

R405.1.1 Precast concrete foundation. *Precast concrete* walls that retain earth and enclose habitable or useable space located below-*grade* that rest on crushed stone footings shall have a perforated drainage pipe installed below the base of the wall on either the interior or exterior side of the wall, not less than 1 foot (305 mm) beyond the edge of the wall. If the exterior drainage pipe is used, an *approved* filter membrane material shall cover the pipe. The drainage system shall discharge into an *approved* sewer system or to daylight.

R405.2 Wood foundations. Wood foundations enclosing habitable or usable spaces located below *grade* shall be adequately drained in accordance with Sections R405.2.1 through R405.2.3.

R405.2.1 Base. A porous layer of gravel, crushed stone or coarse sand shall be placed to a minimum thickness of 4 inches (102 mm) under the *basement* floor. Provision shall be made for automatic draining of this layer and the gravel or crushed stone wall footings.

R405.2.2 Vapor retarder. A 6-mil-thick (0.15 mm) polyethylene vapor retarder shall be applied over the porous layer with the *basement* floor constructed over the polyethylene.

R405.2.3 Drainage system. In other than Group I soils, a sump shall be provided to drain the porous layer and footings. The sump shall be not less than 24 inches (610 mm) in diameter or 20 inches square (0.0129 m^2), shall extend not less than 24 inches (610 mm) below the bottom of the *basement* floor and shall be capable of positive gravity or mechanical drainage to remove any accumulated water. The drainage system shall discharge into an *approved* sewer system or to daylight.

TABLE R405.1
PROPERTIES OF SOILS CLASSIFIED ACCORDING TO THE UNIFIED SOIL CLASSIFICATION SYSTEM

SOIL GROUP	UNIFIED SOIL CLASSIFICATION SYSTEM SYMBOL	SOIL DESCRIPTION	DRAINAGE CHARACTERISTICS[a]	FROST HEAVE POTENTIAL	VOLUME CHANGE POTENTIAL EXPANSION[b]
Group I	GW	Well-graded gravels, gravel sand mixtures, little or no fines	Good	Low	Low
	GP	Poorly graded gravels or gravel sand mixtures, little or no fines	Good	Low	Low
	SW	Well-graded sands, gravelly sands, little or no fines	Good	Low	Low
	SP	Poorly graded sands or gravelly sands, little or no fines	Good	Low	Low
	GM	Silty gravels, gravel-sand-silt mixtures	Good	Medium	Low
	SM	Silty sand, sand-silt mixtures	Good	Medium	Low
Group II	GC	Clayey gravels, gravel-sand-clay mixtures	Medium	Medium	Low
	SC	Clayey sands, sand-clay mixture	Medium	Medium	Low
	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity	Medium	High	Low
	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	Medium	Medium	Medium to Low
Group III	CH	Inorganic clays of high plasticity, fat clays	Poor	Medium	High
	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	Poor	High	High
Group IV	OL	Organic silts and organic silty clays of low plasticity	Poor	Medium	Medium
	OH	Organic clays of medium to high plasticity, organic silts	Unsatisfactory	Medium	High
	Pt	Peat and other highly organic soils	Unsatisfactory	Medium	High

For SI: 1 inch = 25.4 mm.

a. The percolation rate for good drainage is over 4 inches per hour, medium drainage is 2 inches to 4 inches per hour, and poor is less than 2 inches per hour.

b. Soils with a low potential expansion typically have a plasticity index (PI) of 0 to 15, soils with a medium potential expansion have a PI of 10 to 35 and soils with a high potential expansion have a PI greater than 20.

SECTION R406
FOUNDATION WATERPROOFING AND DAMPPROOFING

R406.1 Concrete and masonry foundation dampproofing. Foundation walls where the outside grade is higher than the inside grade shall be dampproofed from the top of the footing to the finished grade. Masonry walls shall be dampproofed in accordance with one of the following:

1. Bituminous coating.
2. Three pounds per square yard (1.63 kg/m^2) of acrylic modified cement.
3. One-eighth-inch (3.2 mm) coat of surface-bonding cement complying with ASTM C887.
4. Any material permitted for waterproofing in Section R406.2.
5. Portland cement parging applied to the exterior of the wall no less than $^3/_8$-inch (9.5 mm).
6. Other *approved* methods or materials.

Concrete walls shall be dampproofed by applying any one of the listed dampproofing materials or any one of the waterproofing materials listed in Section R406.2 to the exterior of the wall.

R406.2 Concrete and masonry foundation waterproofing. Exterior foundation walls that retain earth and enclose interior *occupiable* spaces below *grade* shall be waterproofed from the finished *grade* to the higher of the top of the footing or 6 inches (152 mm) below the top of the basement floor. Walls shall be waterproofed in accordance with one of the following:

1. Two-ply hot-mopped felts.
2. Fifty-five-pound (25 kg) roll roofing.
3. Forty-mil (1 mm) polymer-modified asphalt.
4. Sixty-mil (1.5 mm) flexible polymer cement.
5. One-eighth-inch (3 mm) cement-based, fiber-reinforced, waterproof coating.
6. Sixty-mil (1.5 mm) solvent-free liquid-applied synthetic rubber.

All joints in membrane waterproofing shall be lapped and sealed with an adhesive compatible with the membrane.

Exception: Organic-solvent-based products such as hydrocarbons, chlorinated hydrocarbons, ketones and esters shall not be used for ICF walls with expanded polystyrene form material. Use of plastic roofing cements, acrylic coatings, latex coatings, mortars and pargings to seal ICF walls is permitted. Cold-setting asphalt or hot asphalt shall conform to Type C of ASTM D449. Hot asphalt shall be applied at a temperature of less than 200°F (93°C).

R406.3 Dampproofing for wood foundations. Wood foundations enclosing habitable or usable spaces located below *grade* shall be dampproofed in accordance with Sections R406.3.1 through R406.3.4.

R406.3.1 Panel joint sealed. Plywood panel joints in the foundation walls shall be sealed full length with a caulking compound capable of producing a moistureproof seal under the conditions of temperature and moisture content at which it will be applied and used.

R406.3.2 Below-grade moisture barrier. A 6-mil-thick (0.15 mm) polyethylene film shall be applied over the below-*grade* portion of exterior foundation walls prior to backfilling. Joints in the polyethylene film shall be lapped 6 inches (152 mm) and sealed with adhesive. The top edge of the polyethylene film shall be bonded to the sheathing to form a seal. Film areas at *grade* level shall be protected from mechanical damage and exposure by a pressure-preservative treated lumber or plywood strip attached to the wall several inches above finished *grade* level and extending approximately 9 inches (229 mm) below *grade*. The joint between the strip and the wall shall be caulked full length prior to fastening the strip to the wall. Where *approved*, other coverings appropriate to the architectural treatment shall be permitted to be used. The polyethylene film shall extend down to the bottom of the wood footing plate but shall not overlap or extend into the gravel or crushed stone footing.

R406.3.3 Porous fill. The space between the excavation and the foundation wall shall be backfilled with the same material used for footings, up to a height of 1 foot (305 mm) above the footing for well-drained sites, or one-half the total backfill height for poorly drained sites. The porous fill shall be covered with strips of 30-pound (13.6 kg) asphalt paper or 6-mil (0.15 mm) polyethylene to permit water seepage while avoiding infiltration of fine soils.

R406.3.4 Backfill. The remainder of the excavated area shall be backfilled with the same type of soil as was removed during the excavation.

R406.4 Precast concrete foundation system dampproofing. Except where required by Section R406.2 to be waterproofed, *precast concrete* foundation walls enclosing habitable or useable spaces located below *grade* shall be dampproofed in accordance with Section R406.1.

R406.4.1 Panel joints sealed. *Precast concrete* foundation panel joints shall be sealed full height with a sealant meeting ASTM C920, Type S or M, Grade NS, Class 25, Use NT, M or A. Joint sealant shall be installed in accordance with the manufacturer's instructions.

SECTION R407
COLUMNS

R407.1 Wood column protection. Wood columns shall be protected against decay as set forth in Section R317.

R407.2 Steel column protection. All surfaces (inside and outside) of steel columns shall be given a shop coat of rust-inhibitive paint, except for corrosion-resistant steel and steel treated with coatings to provide corrosion resistance.

R407.3 Structural requirements. The columns shall be restrained to prevent lateral displacement at the top and bottom end. Wood columns shall be not less in nominal size than 4 inches by 4 inches (102 mm by 102 mm). Steel columns shall be not less than 3-inch-diameter (76 mm) Schedule 40 pipe manufactured in accordance with ASTM A53/A53M Grade B or *approved* equivalent.

Exception: In *Seismic Design Categories* A, B and C, columns not more than 48 inches (1219 mm) in height on a pier or footing are exempt from the bottom end lateral displacement requirement within under-floor areas enclosed by a continuous foundation.

SECTION R408
WALL VENTED CRAWL SPACES

R408.1 Space moisture vapor control. Vented crawl space foundations shall be provided with foundation vent openings through the exterior foundation walls.

R408.1.1 Foundation vent sizing. The minimum net area of ventilation openings shall be not less than 1 square foot (0.0929 m^2) for each 150 square feet (13.9 m^2) of crawl space ground area.

Exception: The total area of ventilation openings may be reduced to 1/1,500 of the under-floor area where the ground surface is treated with an approved vapor retarder material in accordance with Section R408.2 and the required openings are placed to provide cross ventilation of the crawl space. The installation of operable louvers shall not be prohibited.

R408.1.2 Foundation vent location. One foundation vent shall be within 3 feet (914 mm) of each corner of the building. To prevent rainwater entry when the crawlspace is built on a sloped site, the uphill foundation walls may be constructed without wall vent openings. Vent dams shall be provided when the bottom of the foundation vent opening is less than 4 inches (102 mm) above the finished exterior grade.

R408.1.3 Covering material. To prevent rodent entry, foundation vents shall be covered with any of the following materials provided that the ventilation holes through the covering material shall not exceed $^1/_4$ inch (6.4 mm) in any direction:

1. Perforated sheet metal plates not less than 0.070 inch (1.8 mm) thick.
2. Expanded sheet metal plates no less than 0.047 inch (1.2 mm) thick.
3. Cast iron grills or grating.
4. Extruded load-bearing brick vents.
5. Hardware cloth of 0.035 inch (0.89 mm) wire or heavier.
6. Corrosion-resistant mesh, with the least dimension being $^1/_8$ inch (3.2 mm).

R408.1.4 Drains and vent terminations. Drains (including pressure relief and drain pans) shall terminate outdoors, to crawl space floor drains or interior pumps, and shall not intentionally discharge water into the crawl space. Crawl space drains shall be separate from roof gutter drain systems and foundation perimeter drains. Dryer vents shall terminate outdoors.

R408.1.5 Space separation. Wall vented crawl spaces shall be separated from adjoining basements, porches and garages by permanent solid wall surfaces with all utility penetrations through the separating wall sealed. Latched, weather-stripped doors or access panels shall provide access between the crawl space and such adjoining spaces.

R408.2 Ground vapor retarder. When required by Section R408.1.1 Exception, a minimum 6-mil (0.15 mm) polyethylene vapor retarder or equivalent shall be installed to nominally cover all exposed earth in the crawl space, with joints lapped not less than 12 inches (305 mm). Where there is no evidence that the groundwater table can rise to within 6 inches (152 mm) of the floor of the crawl space, it is acceptable to puncture the ground vapor retarder at low spots to prevent water puddles from forming on top of the vapor retarder due to condensation.

R408.3 Wall damp proofing. Where the outside grade is higher than the inside grade, the exterior walls shall be dampproofed from the top of the footing to the finished grade as required by Section R406.1.

R408.4 Site grading. Building site shall be graded to drain water away from the crawl space foundation in accordance with the requirements of Section R401.3.

R408.5 Insulation. The thermal insulation in a wall-vented crawl space shall be placed in the floor system. Wall insulation is not allowed as the only insulation system in a wall vented crawl space. The required insulation value can be determined from Table N1102.1.

R408.6 Floor air leakage control. All plumbing, electrical, duct, plenum, phone, cable, computer wiring and other penetrations through the subfloor shall be sealed with nonporous materials, caulks, or sealants. The use of rock wool or fiberglass insulation is prohibited as an air sealant.

R408.7 Duct air leakage control. All heating and cooling ductwork located in the crawl space shall be sealed with mastic or other industry-approved duct closure systems.

R408.8 Access. A minimum access opening measuring 18 inches by 24 inches (457 mm by 610 mm) shall be provided to the crawl space. See the *North Carolina Mechanical Code* for access requirements where mechanical equipment is located under floors.

R408.9 Removal of debris. The crawl space floor shall be cleaned of all vegetation and organic material. All wood forms used for placing shall be removed before the building is occupied or used for any purpose. All construction materials shall be removed before the building is occupied or used for any purpose.

R408.10 Finished grade. The finished grade of the crawl space is permitted to be located at the bottom of the footings; however, where there is evidence that the groundwater table can rise to within 6 inches (152 mm) of the finished grade of the crawl space at the perimeter or where there is evidence that the surface water does not readily drain from the building site, the grade in the crawl space shall be as high as the outside finished grade, unless an approved drainage system is provided.

R408.11 Flood resistance. For buildings located in flood hazard areas as established in Table R301.2(1):

1. Walls enclosing the under-floor space shall be provided with flood openings in accordance with Section R322.2.2.
2. The finished ground level of the under-floor space shall be equal to or higher than the outside finished ground level on at least one side.

   Exception: Under-floor spaces that meet the requirements of FEMA/FIA TB 11-1.

SECTION R409
CLOSED CRAWL SPACES

R409.1 Air sealed walls. Closed crawl spaces shall be built to minimize the entry of outdoor air into the crawl space. Specifically prohibited are foundation wall vents and wall openings to ventilated porch foundations. When outdoor packaged heating and cooling equipment is used, solid blocking and sealants shall be used to seal gaps between the exterior wall opening and the smaller supply and return ducts that pass through the opening.

R409.1.1 Caulking and sealants. Air sealing caulk, gaskets or sealants shall be applied to the foundation wall and floor assemblies that separate the crawl space from outside and other ventilated areas such as joints around access door and frame, between foundation and sill plate,

at penetrations for plumbing, mechanical, electrical and gas lines and at duct penetrations.

R409.1.2 Access panel/door. A minimum access opening measuring 18 inches by 24 inches (457 mm by 610 mm) shall be provided to the crawl space. See the *North Carolina Mechanical Code* for access requirements where mechanical equipment is located under floors. To minimize air entry, provide a tight fitting access panel/door with a latch mechanism. Access panels or doors shall be insulated to a minimum of R-2.

R409.2 Groundwater vapor retarder. Closed crawl spaces shall be protected from water entry by the evaporation of water from the ground surface.

R409.2.1 Ground vapor retarder. A minimum 6-mil (0.15 mm) polyethylene vapor retarder or equivalent shall be installed to nominally cover all exposed earth in the crawl space, with joints lapped not less than 12 inches (305 mm). Minor pockets or wrinkles that prevent total drainage across the surface of the vapor retarder are allowed. The floor of the crawl space shall be graded so that it drains to one or more low spots. Install a drain to daylight or sump pump at each low spot. Crawl space drains shall be kept separate from roof gutter drain systems and foundation perimeter drains.

R409.2.2 Liner. The ground vapor retarder is permitted to be installed as a full interior liner by sealing the edges to the walls and beam columns and sealing the seams. Single piece liner systems are approved. The top edge of the wall liner shall terminate 3 inches (76 mm) below the top edge of the masonry foundation wall. The top edge of the liner shall be brought up the interior columns a minimum of 4 inches (102 mm) above the crawl space floor. The floor of the crawl space shall be graded so that it drains to one or more low spots. Install a drain to daylight or sump pump at each low spot. Crawl space drains shall be separate from roof gutter drain systems and foundation perimeter drains.

R409.2.2.1 Wall liner termite inspection gap. Provide a clear and unobstructed 3 inch (76 mm) minimum, 4 inch (102 mm) maximum inspection gap between the top of the wall liner and the bottom of the wood sill. This inspection gap may be ignored with regards to energy performance and is not intended to create an energy penalty.

R409.2.3 Concrete floor surfacing. Deleted.

R409.2.4 Drains and vent terminations. Drains (including pressure relief and drain pans) shall terminate outdoors, to crawl space floor drains or interior pumps and shall not intentionally discharge water into the crawl space. Crawl space drains shall be separate from roof gutter drain systems and foundation perimeter drains. Dryer vents shall terminate outdoors.

R409.3 Wall damp proofing. Where the outside grade is higher than the inside grade, the exterior walls shall be dampproofed from the top of the footing to the finished grade as required by Section R406.1.

R409.4 Site grading. Building site shall be graded to drain water away from the crawl space foundation in accordance with the requirements of Section R401.3.

R409.5 Space moisture vapor control. Closed crawl spaces shall be provided with a mechanical drying capability to control space moisture levels. The allowed methods are listed below in Sections R409.5.1 through R409.5.5. At least one method shall be provided; however, combination systems shall be allowed.

R409.5.1 Dehumidifier. A permanently installed dehumidifier shall be provided in the crawl space. The minimum rated capacity per day is 15 pints (7.1 liters). Condensate discharge shall be drained to daylight or interior condensate pump. A permanently installed dehumidifier shall be provided with an electrical outlet.

R409.5.2 Supply air. Supply air from the dwelling air conditioning system shall be ducted into the crawl space at the rate of 1 cubic foot per minute (0.5 L/s) per 30 square feet (4.6 m^2) of crawl space floor area. No return air duct from the crawl space to the dwelling air conditioning system is allowed. The crawl space supply air duct shall be fitted with a backflow damper to prevent the entry of crawl space air into the supply duct system when the system fan is not operating. An air relief vent to the outdoors may be installed. Crawl spaces with moisture vapor control installed in accordance with this section are not considered plenums.

R409.5.3 House air. House air shall be blown into the crawl space with a fan at the rate of 1 cubic foot per minute (0.5 L/s) per 50 square feet (4.6 m^2) of crawl space floor area. The fan motor shall be rated for continuous duty. No return air duct from the crawl space to the dwelling air conditioning system is allowed. An air relief vent to the outdoors may be installed. Crawl spaces with moisture vapor control installed in accordance with this section are not considered plenums.

R409.5.4 Exhaust fan. Crawl space air shall be exhausted to outside with a fan at the rate of 1 cubic foot per minute (0.5 L/s) per 50 square feet (4.6 m^2) of crawl space floor area. The fan motor shall be rated for continuous duty. There is no requirement for make-up air.

R409.5.5 Conditioned space. The crawl space shall be designed as a heated and cooled, conditioned space with wall insulation installed in accordance with the requirements of Section R409.8. Intentionally returning air from the crawl space to space-conditioning equipment that serves the dwelling shall be allowed. Foam plastic insulation located in a crawl space plenum shall be protected against ignition by an approved thermal barrier.

R409.6 Plenums. Closed crawl spaces used as supply or return plenums for distribution of heated or cooled air shall comply with the requirements of the *North Carolina Mechanical Code*. Crawl space plenums shall not contain

plumbing cleanouts, gas lines or other prohibited components. Foam plastic insulation located in a crawl space plenum shall be protected against ignition by an approved thermal barrier.

R409.7 Combustion air. The air sealing requirements of a closed crawl space may result in a foundation that cannot provide adequate combustion air for fuel-burning appliances; therefore, fuel-burning appliances located in the crawl space such as furnaces and water heaters shall obtain combustion air from outdoors as in accordance with the *North Carolina Mechanical Code*.

R409.8 Insulation. The thermal insulation in a crawl space may be located in the floor system or at the exterior walls. The required insulation value can be determined from Table N1102.1.

Exception: Insulation shall be placed at the walls when the closed crawl space is designed to be intentionally heated or cooled, conditioned space.

R409.8.1 Wall insulation. Where the floor above a crawl space is not insulated, the walls shall be insulated. Wall insulation is permitted to be located on any combination of the exterior and interior surfaces and within the structural cavities or materials of the exterior crawl space walls. Wall insulation systems require that the band joist area of the floor frame be insulated. Wall insulation shall begin 3 inches (76 mm) below the top of the masonry foundation wall and shall extend down to 3 inches (76 mm) above the top of the footing or concrete floor, 3 inches (76 mm) above the interior ground surface or 24 inches (610 mm) below the outside finished ground level, whichever is less. No insulation shall be required on masonry walls of 9 inches (229 mm) height or less.

R409.8.1.1 Inspection gap requirements for insulation. For outside walls, Section R318.4 governs applications. When expanded polystyrene, polyisocyanurate, other foam plastic insulation fiberglass, rockwool, cellulose or other porous insulation is installed on the inside surface of the exterior foundation walls, provide a clear and unobstructed 3-inch (76 mm) minimum, 4-inch (102 mm) maximum termite inspection gap between the top of the foam plastic wall insulation and the bottom of the wood sill.

R409.8.1.2 Porous insulation material. To reduce wicking potential, porous insulation ground contact is not allowed in earth floored or concrete surfaces crawl spaces. Provide a continuous 3-inch (76 mm) minimum wicking gap between the bottom edge of the porous wall insulation and the earth or concrete floor surface. Refer to Section N1102.1.7 to determine maximum allowances for insulation gaps.

R409.8.2 Foam plastic fire safety. Foam plastic insulation may be installed inside crawl spaces without a thermal cover when the insulation product has been tested in accordance with ASTM E84 to have a flame-spread rating of not more than 25 and a smoke developed rating of not more than 450. Foam plastics that have not been tested to meet these ratings shall be protected against ignition by covering them with a thermal barrier. Acceptable thermal barriers include $^1/_2$-inch (13 mm) cement board, metal foil sheets, metal foil tape, steel or aluminum metal sheets or other approved materials installed in such a manner that the foam is not exposed.

Exception: Foam plastic insulation located in closed crawl spaces used as conditioned spaces or plenums shall be protected against ignition by an approved thermal barrier.

R409.9 Floor air leakage control. All plumbing, electrical, duct, plenum, phone, cable, computer wiring and other penetrations through the subfloor shall be sealed with nonporous materials, caulks, or sealants. The use of rockwool or fiberglass insulation is prohibited as an air sealant.

R409.10 Duct air leakage control. All heating and cooling ductwork located in the crawl space shall be sealed with mastic or other industry approved duct closure systems.

R409.11 Access. A minimum access opening measuring 18 inches by 24 inches (457 mm by 610 mm) shall be provided to the crawl space. See the *North Carolina Mechanical Code* for access requirements where mechanical equipment is located under floors.

R409.12 Removal of debris. The crawl space floor shall be cleaned of all vegetation and organic material. All wood forms used for placing shall be removed before the building is occupied or used for any purpose. All construction materials shall be removed before the building is occupied or used for any purpose.

R409.13 Finished grade. The finished grade of the crawlspace is permitted to be located at the bottom of the footings; however, where there is evidence that the groundwater table can rise to within 6 inches (152 mm) of the finished grade of the crawl space at the perimeter or where there is evidence that the surface water does not readily drain from the building site, the grade in the crawl space shall be as high as the outside finished grade, unless an approved drainage system is provided.

CHAPTER 5
FLOORS

SECTION R501
GENERAL

R501.1 Application. The provisions of this chapter shall control the design and construction of the floors for buildings, including the floors of attic spaces used to house mechanical or plumbing fixtures and *equipment*.

R501.2 Requirements. Floor construction shall be capable of accommodating all loads in accordance with Section R301 and of transmitting the resulting loads to the supporting structural elements.

SECTION R502
WOOD FLOOR FRAMING

R502.1 General. Wood and wood-based products used for load-supporting purposes shall conform to the applicable provisions of this section.

R502.1.1 Sawn lumber. Sawn lumber shall be identified by a grade *mark* of an accredited lumber grading or inspection agency and have design values certified by an accreditation body that complies with DOC PS 20. In lieu of a grade *mark*, a certificate of inspection issued by a lumber grading or inspection agency meeting the requirements of this section shall be accepted.

R502.1.1.1 Preservative-treated lumber. Preservative treated dimension lumber shall be identified as required by Section R317.2.

R502.1.1.2 End-jointed lumber. *Approved* end-jointed lumber identified by a grade *mark* conforming to Section R502.1.1 shall be permitted to be used interchangeably with solid-sawn members of the same species and grade. End-jointed lumber used in an assembly required elsewhere in this code to have a fire-resistance rating shall have the designation "Heat-Resistant Adhesive" or "HRA" included in its grade *mark*.

R502.1.2 Prefabricated wood I-joists. Structural capacities and design provisions for prefabricated wood I-joists shall be established and monitored in accordance with ASTM D5055.

R502.1.3 Structural glued laminated timbers. Glued laminated timbers shall be manufactured and identified as required in ANSI A190.1, ANSI 117 and ASTM D3737.

R502.1.4 Structural log members. Structural log members shall comply with the provisions of ICC 400.

R502.1.5 Structural composite lumber. Structural capacities for *structural composite lumber* shall be established and monitored in accordance with ASTM D5456.

R502.1.6 Cross-laminated timber. Cross-laminated timber shall be manufactured and identified as required by ANSI/APA PRG 320.

R502.1.7 Engineered wood rim board. Engineered wood rim boards shall conform to ANSI/APA PRR 410 or shall be evaluated in accordance with ASTM D7672. Structural capacities shall be in accordance with ANSI/APA PRR 410 or established in accordance with ASTM D7672. Rim boards conforming to ANSI/APA PRR 410 shall be marked in accordance with that standard.

R502.2 Design and construction. Floors shall be designed and constructed in accordance with the provisions of this chapter, Figure R502.2 and Sections R317 and R318 or in accordance with ANSI AWC NDS.

R502.2.1 Framing at braced wall lines. A load path for lateral forces shall be provided between floor framing and *braced wall panels* located above or below a floor, as specified in Section R602.10.8.

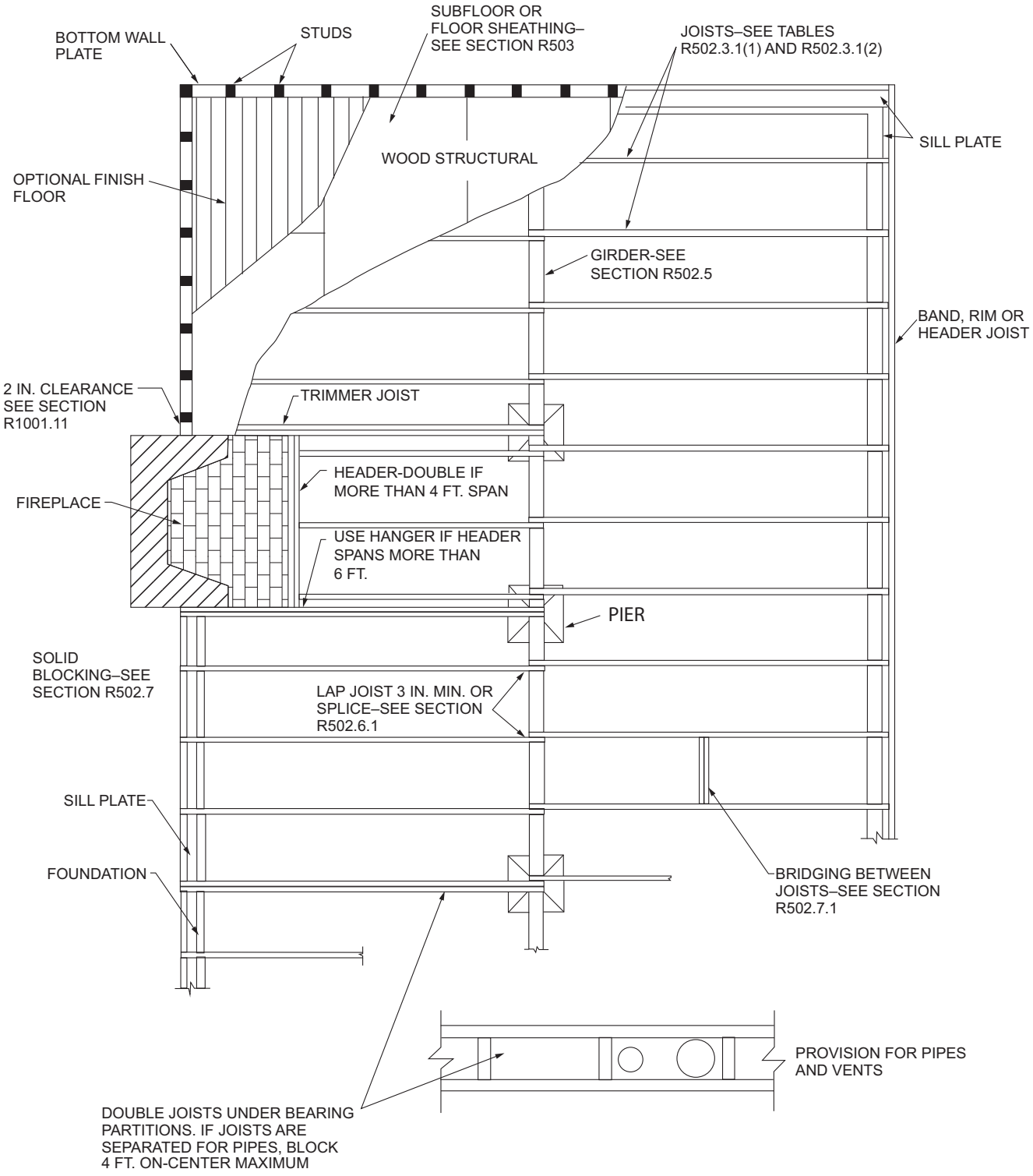
R502.2.2 Blocking and subflooring. Blocking for fastening panel edges or fixtures shall be not less than utility grade lumber. Subflooring shall be not less than utility grade lumber, No. 4 common grade boards or *wood structural panels* as specified in Section R503.2. Fireblocking shall be of any grade lumber.

R502.3 Allowable joist spans. Spans for floor joists shall be in accordance with Tables R502.3.1(1) and R502.3.1(2). For other grades and species and for other loading conditions, refer to the AWC STJR.

R502.3.1 Sleeping areas and attic joists. Table R502.3.1(1) shall be used to determine the maximum allowable span of floor joists that support sleeping areas and *attics* that are accessed by means of a fixed *stairway* in accordance with Section R311.7 provided that the design *live load* does not exceed 30 pounds per square foot (1.44 kPa) and the design dead load does not exceed 20 pounds per square foot (0.96 kPa). The allowable span of ceiling joists that support *attics* used for limited storage or no storage shall be determined in accordance with Section R802.5.

R502.3.2 Other floor joists. Table R502.3.1(2) shall be used to determine the maximum allowable span of floor joists that support other areas of the building, other than sleeping areas and *attics*, provided that the design *live load* does not exceed 40 pounds per square foot (1.92 kPa) and the design dead load does not exceed 20 pounds per square foot (0.96 kPa).

R502.3.3 Floor cantilevers. Floor cantilever spans shall not exceed the nominal depth of the wood floor joist. Floor cantilevers constructed in accordance with Table R502.3.3(1) shall be permitted where supporting a light-frame bearing wall and roof only. Floor cantilevers



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

FIGURE R502.2
FLOOR CONSTRUCTION

TABLE R502.3.1(1)
FLOOR JOIST SPANS FOR COMMON LUMBER SPECIES (Residential sleeping areas, live load = 30 psf, L/Δ = 360)[a]

JOIST SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf				DEAD LOAD = 20 psf			
			2 × 6	2 × 8	2 × 10	2 × 12	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum floor joist spans							
			(ft-in)	(ft-in)	(ft-in)	(ft-in)	(ft-in)	(ft-in)	(ft-in)	(ft-in)
12	Douglas fir-larch	SS	12-6	16-6	21-0	25-7	12-6	16-6	21-0	25-7
	Douglas fir-larch	#1	12-0	15-10	20-3	24-8	12-0	15-7	19-0	22-0
	Douglas fir-larch	#2	11-10	15-7	19-10	23-4	11-8	14-9	18-0	20-11
	Douglas fir-larch	#3	9-11	12-7	15-5	17-10	8-11	11-3	13-9	16-0
	Hem-fir	SS	11-10	15-7	19-10	24-2	11-10	15-7	19-10	24-2
	Hem-fir	#1	11-7	15-3	19-5	23-7	11-7	15-3	18-9	21-9
	Hem-fir	#2	11-0	14-6	18-6	22-6	11-0	14-4	17-6	20-4
	Hem-fir	#3	9-8	12-4	15-0	17-5	8-8	11-0	13-5	15-7
	Southern pine	SS	12-3	16-2	20-8	25-1	12-3	16-2	20-8	25-1
	Southern pine	#1	11-10	15-7	19-10	24-2	11-10	15-7	18-7	22-0
	Southern pine	#2	11-3	14-11	18-1	21-4	10-9	13-8	16-2	19-1
	Southern pine	#3	9-2	11-6	14-0	16-6	8-2	10-3	12-6	14-9
	Spruce-pine-fir	SS	11-7	15-3	19-5	23-7	11-7	15-3	19-5	23-7
	Spruce-pine-fir	#1	11-3	14-11	19-0	23-0	11-3	14-7	17-9	20-7
	Spruce-pine-fir	#2	11-3	14-11	19-0	23-0	11-3	14-7	17-9	20-7
	Spruce-pine-fir	#3	9-8	12-4	15-0	17-5	8-8	11-0	13-5	15-7
16	Douglas fir-larch	SS	11-4	15-0	19-1	23-3	11-4	15-0	19-1	23-3
	Douglas fir-larch	#1	10-11	14-5	18-5	21-4	10-8	13-6	16-5	19-1
	Douglas fir-larch	#2	10-9	14-2	17-5	20-3	10-1	12-9	15-7	18-1
	Douglas fir-larch	#3	8-7	10-11	13-4	15-5	7-8	9-9	11-11	13-10
	Hem-fir	SS	10-9	14-2	18-0	21-11	10-9	14-2	18-0	21-11
	Hem-fir	#1	10-6	13-10	17-8	21-1	10-6	13-4	16-3	18-10
	Hem-fir	#2	10-0	13-2	16-10	19-8	9-10	12-5	15-2	17-7
	Hem-fir	#3	8-5	10-8	13-0	15-1	7-6	9-6	11-8	13-6
	Southern pine	SS	11-2	14-8	18-9	22-10	11-2	14-8	18-9	22-10
	Southern pine	#1	10-9	14-2	18-0	21-4	10-9	13-9	16-1	19-1
	Southern pine	#2	10-3	13-3	15-8	18-6	9-4	11-10	14-0	16-6
	Southern pine	#3	7-11	10-0	11-1	14-4	7-1	8-11	10-10	12-10
	Spruce-pine-fir	SS	10-6	13-10	17-8	21-6	10-6	13-10	17-8	21-4
	Spruce-pine-fir	#1	10-3	13-6	17-2	19-11	9-11	12-7	15-5	17-10
	Spruce-pine-fir	#2	10-3	13-6	17-2	19-11	9-11	12-7	15-5	17-10
	Spruce-pine-fir	#3	8-5	10-8	13-0	15-1	7-6	9-6	11-8	13-6

(continued)

TABLE R502.3.1(1)—continued
FLOOR JOIST SPANS FOR COMMON LUMBER SPECIES (Residential sleeping areas, live load = 30 psf, L/Δ = 360)[a]

JOIST SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf				DEAD LOAD = 20 psf			
			2 × 6	2 × 8	2 × 10	2 × 12	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum floor joist spans							
			(ft-in)	(ft-in)	(ft-in)	(ft-in)	(ft-in)	(ft-in)	(ft-in)	(ft-in)
19.2	Douglas fir-larch	SS	10-8	14-1	18-0	21-10	10-8	14-1	18-0	21-4
	Douglas fir-larch	#1	10-4	13-7	16-9	19-6	9-8	12-4	15-0	17-5
	Douglas fir-larch	#2	10-1	13-0	15-11	18-6	9-3	11-8	14-3	16-6
	Douglas fir-larch	#3	7-10	10-0	12-2	14-1	7-0	8-11	10-11	12-7
	Hem-fir	SS	10-1	13-4	17-0	20-8	10-1	13-4	17-0	20-7
	Hem-fir	#1	9-10	13-0	16-7	19-3	9-7	12-2	14-10	17-2
	Hem-fir	#2	9-5	12-5	15-6	17-1	8-11	11-4	13-10	16-1
	Hem-fir	#3	7-8	9-9	11-10	13-9	6-10	8-8	10-7	12-4
	Southern pine	SS	10-6	13-10	17-8	21-6	10-6	13-10	17-8	21-6
	Southern pine	#1	10-1	13-4	16-5	19-6	9-11	12-7	14-8	17-5
	Southern pine	#2	9-6	12-1	14-4	16-10	8-6	10-10	12-10	15-1
	Southern pine	#3	7-3	9-1	11-0	13-1	6-5	8-2	9-10	11-8
	Spruce-pine-fir	SS	9-10	13-0	16-7	20-2	9-10	13-0	16-7	19-6
	Spruce-pine-fir	#1	9-8	12-9	15-8	18-3	9-1	11-6	14-1	16-3
	Spruce-pine-fir	#2	9-8	12-9	15-8	18-3	9-1	11-6	14-1	16-3
	Spruce-pine-fir	#3	7-8	9-9	11-10	13-9	6-10	8-8	10-7	12-4
24	Douglas fir-larch	SS	9-11	13-1	16-8	20-3	9-11	13-1	16-5	19-1
	Douglas fir-larch	#1	9-7	12-4	15-0	17-5	8-8	11-0	13-5	15-7
	Douglas fir-larch	#2	9-3	11-8	14-3	16-6	8-3	10-5	12-9	14-9
	Douglas fir-larch	#3	7-0	8-11	10-11	12-7	6-3	8-0	9-9	11-3
	Hem-fir	SS	9-4	12-4	15-9	19-2	9-4	12-4	15-9	18-5
	Hem-fir	#1	9-2	12-1	14-10	17-2	8-7	10-10	13-3	15-5
	Hem-fir	#2	8-9	11-4	13-10	16-1	8-0	10-2	12-5	14-4
	Hem-fir	#3	6-10	8-8	10-7	12-4	6-2	7-9	9-6	11-0
	Southern pine	SS	9-9	12-10	16-5	19-11	9-9	12-10	16-5	19-8
	Southern pine	#1	9-4	12-4	14-8	17-5	8-10	11-3	13-1	15-7
	Southern pine	#2	8-6	10-10	12-10	15-1	7-7	9-8	11-5	13-6
	Southern pine	#3	6-5	8-2	9-10	11-8	5-9	7-3	8-10	10-5
	Spruce-pine-fir	SS	9-2	12-1	15-5	18-9	9-2	12-1	15-0	17-5
	Spruce-pine-fir	#1	8-11	11-6	14-1	16-3	8-1	10-3	12-7	14-7
	Spruce-pine-fir	#2	8-11	11-6	14-1	16-3	8-1	10-3	12-7	14-7
	Spruce-pine-fir	#3	6-10	8-8	10-7	12-4	6-2	7-9	9-6	11-0

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

Note: Check sources for availability of lumber in lengths greater than 20 feet.

a. Dead load limits for townhouses in Seismic Design Category C and all structures in Seismic Design Categories D_0, D_1 and D_2 shall be determined in accordance with Section R301.2.2.2.

TABLE R502.3.1(2)
FLOOR JOIST SPANS FOR COMMON LUMBER SPECIES (Residential living areas, live load = 40 psf, L/Δ = 360)[b]

JOIST SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf				DEAD LOAD = 20 psf			
			2 × 6	2 × 8	2 × 10	2 × 12	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum floor joist spans							
			(ft-in)	(ft-in)	(ft-in)	(ft-in)	(ft-in)	(ft-in)	(ft-in)	(ft-in)
12	Douglas fir-larch	SS	11-4	15-0	19-1	23-3	11-4	15-0	19-1	23-3
	Douglas fir-larch	#1	10-11	14-5	18-5	22-0	10-11	14-2	17-4	20-1
	Douglas fir-larch	#2	10-9	14-2	18-0	20-11	10-8	13-6	16-5	19-1
	Douglas fir-larch	#3	8-11	11-3	13-9	16-0	8-1	10-3	12-7	14-7
	Hem-fir	SS	10-9	14-2	18-0	21-11	10-9	14-2	18-0	21-11
	Hem-fir	#1	10-6	13-10	17-8	21-6	10-6	13-10	17-1	19-10
	Hem-fir	#2	10-0	13-2	16-10	20-4	10-0	13-1	16-0	18-6
	Hem-fir	#3	8-8	11-0	13-5	15-7	7-11	10-0	12-3	14-3
	Southern pine	SS	11-2	14-8	18-9	22-10	11-2	14-8	18-9	22-10
	Southern pine	#1	10-9	14-2	18-0	21-11	10-9	14-2	16-11	20-1
	Southern pine	#2	10-3	13-6	16-2	19-1	9-10	12-6	14-9	17-5
	Southern pine	#3	8-2	10-3	12-6	14-9	7-5	9-5	11-5	13-6
	Spruce-pine-fir	SS	10-6	13-10	17-8	21-6	10-6	13-10	17-8	21-6
	Spruce-pine-fir	#1	10-3	13-6	17-3	20-7	10-3	13-3	16-3	18-10
	Spruce-pine-fir	#2	10-3	13-6	17-3	20-7	10-3	13-3	16-3	18-10
	Spruce-pine-fir	#3	8-8	11-0	13-5	15-7	7-11	10-0	12-3	14-3
16	Douglas fir-larch	SS	10-4	13-7	17-4	21-1	10-4	13-7	17-4	21-1
	Douglas fir-larch	#1	9-11	13-1	16-5	19-1	9-8	12-4	15-0	17-5
	Douglas fir-larch	#2	9-9	12-9	15-7	18-1	9-3	11-8	14-3	16-6
	Douglas fir-larch	#3	7-8	9-9	11-11	13-10	7-0	8-11	10-11	12-7
	Hem-fir	SS	9-9	12-10	16-5	19-11	9-9	12-10	16-5	19-11
	Hem-fir	#1	9-6	12-7	16-0	18-10	9-6	12-2	14-10	17-2
	Hem-fir	#2	9-1	12-0	15-2	17-7	8-11	11-4	13-10	16-1
	Hem-fir	#3	7-6	9-6	11-8	13-6	6-10	8-8	10-7	12-4
	Southern pine	SS	10-2	13-4	17-0	20-9	10-2	13-4	17-0	20-9
	Southern pine	#1	9-9	12-10	16-1	19-1	9-9	12-7	14-8	17-5
	Southern pine	#2	9-4	11-10	14-0	16-6	8-6	10-10	12-10	15-1
	Southern pine	#3	7-1	8-11	10-10	12-10	6-5	8-2	9-10	11-8
	Spruce-pine-fir	SS	9-6	12-7	16-0	19-6	9-6	12-7	16-0	19-6
	Spruce-pine-fir	#1	9-4	12-3	15-5	17-10	9-1	11-6	14-1	16-3
	Spruce-pine-fir	#2	9-4	12-3	15-5	17-10	9-1	11-6	14-1	16-3
	Spruce-pine-fir	#3	7-6	9-6	11-8	13-6	6-10	8-8	10-7	12-4

(continued)

TABLE R502.3.1(2)—continued
FLOOR JOIST SPANS FOR COMMON LUMBER SPECIES (Residential living areas, live load = 40 psf, L/Δ = 360)[b]

JOIST SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf				DEAD LOAD = 20 psf			
			2 × 6	2 × 8	2 × 10	2 × 12	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum floor joist spans							
			(ft-in)	(ft-in)	(ft-in)	(ft-in)	(ft-in)	(ft-in)	(ft-in)	(ft-in)
19.2	Douglas fir-larch	SS	9-8	12-10	16-4	19-10	9-8	12-10	16-4	19-6
	Douglas fir-larch	#1	9-4	12-4	15-0	17-5	8-10	11-3	13-8	15-11
	Douglas fir-larch	#2	9-2	11-8	14-3	16-6	8-5	10-8	13-0	15-1
	Douglas fir-larch	#3	7-0	8-11	10-11	12-7	6-5	8-2	9-11	11-6
	Hem-fir	SS	9-2	12-1	15-5	18-9	9-2	12-1	15-5	18-9
	Hem-fir	#1	9-0	11-10	14-10	17-2	8-9	11-1	13-6	15-8
	Hem-fir	#2	8-7	11-3	13-10	16-1	8-2	10-4	12-8	14-8
	Hem-fir	#3	6-10	8-8	10-7	12-4	6-3	7-11	9-8	11-3
	Southern pine	SS	9-6	12-7	16-0	19-6	9-6	12-7	16-0	19-6
	Southern pine	#1	9-2	12-1	14-8	17-5	9-0	11-5	13-5	15-11
	Southern pine	#2	8-6	10-10	12-10	15-1	7-9	9-10	11-8	13-9
	Southern pine	#3	6-5	8-2	9-10	11-8	5-11	7-5	9-0	10-8
	Spruce-pine-fir	SS	9-0	11-10	15-1	18-4	9-0	11-10	15-1	17-9
	Spruce-pine-fir	#1	8-9	11-6	14-1	16-3	8-3	10-6	12-10	14-10
	Spruce-pine-fir	#2	8-9	11-6	14-1	16-3	8-3	10-6	12-10	14-10
	Spruce-pine-fir	#3	6-10	8-8	10-7	12-4	6-3	7-11	9-8	11-3
24	Douglas fir-larch	SS	9-0	11-11	15-2	18-5	9-0	11-11	15-0	17-5
	Douglas fir-larch	#1	8-8	11-0	13-5	15-7	7-11	10-0	12-3	14-3
	Douglas fir-larch	#2	8-3	10-5	12-9	14-9	7-6	9-6	11-8	13-6
	Douglas fir-larch	#3	6-3	8-0	9-9	11-3	5-9	7-3	8-11	10-4
	Hem-fir	SS	8-6	11-3	14-4	17-5	8-6	11-3	14-4	16-10[a]
	Hem-fir	#1	8-4	10-10	13-3	15-5	7-10	9-11	12-1	14-0
	Hem-fir	#2	7-11	10-2	12-5	14-4	7-4	9-3	11-4	13-1
	Hem-fir	#3	6-2	7-9	9-6	11-0	5-7	7-1	8-8	10-1
	Southern pine	SS	8-10	11-8	14-11	18-1	8-10	11-8	14-11	18-0
	Southern pine	#1	8-6	11-3	13-1	15-7	8-1	10-3	12-0	14-3
	Southern pine	#2	7-7	9-8	11-5	13-6	7-0	8-10	10-5	12-4
	Southern pine	#3	5-9	7-3	8-10	10-5	5-3	6-8	8-1	9-6
	Spruce-pine-fir	SS	8-4	11-0	14-0	17-0	8-4	11-0	13-8	15-11
	Spruce-pine-fir	#1	8-1	10-3	12-7	14-7	7-5	9-5	11-6	13-4
	Spruce-pine-fir	#2	8-1	10-3	12-7	14-7	7-5	9-5	11-6	13-4
	Spruce-pine-fir	#3	6-2	7-9	9-6	11-0	5-7	7-1	8-8	10-1

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

Note: Check sources for availability of lumber in lengths greater than 20 feet.

a. End bearing length shall be increased to 2 inches.

b. Dead load limits for townhouses in Seismic Design Category C and all structures in Seismic Design Categories D_0, D_1, and D_2 shall be determined in accordance with Section R301.2.2.2.

supporting an exterior balcony are permitted to be constructed in accordance with Table R502.3.3(2).

R502.4 Joists under bearing partitions. Joists under parallel bearing partitions shall be of adequate size to support the load. Double joists, sized to adequately support the load, that are separated to permit the installation of piping or vents shall be full-depth solid blocked with lumber not less than 2 inches (51 mm) in nominal thickness spaced not more than 4 feet (1219 mm) on center. Bearing partitions perpendicular to joists shall not be offset from supporting girders, walls or partitions more than the joist depth unless such joists are of sufficient size to carry the additional load.

R502.5 Allowable girder and header spans. The allowable spans of girders and headers fabricated of dimension lumber shall not exceed the values set forth in Tables R602.7(1), R602.7(2) and R602.7(3).

R502.6 Bearing. The ends of each joist, beam or girder shall have not less than $1^1/_2$ inches (38 mm) of bearing on wood or metal, have not less than 3 inches of bearing (76 mm) on masonry or concrete or be supported by *approved* joist hangers. Alternatively, the ends of joists shall be supported on a 1-inch by 4-inch (25 mm by 102 mm) ribbon strip and shall be nailed to the adjacent stud. The bearing on masonry or concrete shall be direct, or a sill plate of 2-inch-minimum (51 mm) nominal thickness shall be provided under the joist, beam or girder. The sill plate shall provide a minimum nominal bearing area of 48 square inches (30 865 mm^2).

R502.6.1 Floor systems. Joists framing from opposite sides over a bearing support shall lap not less than 3 inches (76 mm) and shall be nailed together with a minimum three 10d face nails. A wood or metal splice with strength equal to or greater than that provided by the nailed lap is permitted.

R502.6.2 Joist framing. Joists framing into the side of a wood girder shall be supported by *approved* framing anchors or on ledger strips not less than nominal 2 inches by 2 inches (51 mm by 51 mm).

R502.7 Lateral restraint at supports. Joists shall be supported laterally at the ends by full-depth solid blocking not less than 2 inches (51 mm) nominal in thickness; or by attachment to a full-depth header, band or rim joist, or to an adjoining stud or shall be otherwise provided with lateral support to prevent rotation.

Exceptions:

1. Trusses, *structural composite lumber*, structural glued-laminated members and I-joists shall be supported laterally as required by the manufacturer's recommendations.
2. Deleted.

TABLE R502.3.3(1)
CANTILEVER SPANS FOR FLOOR JOISTS SUPPORTING LIGHT-FRAME EXTERIOR BEARING WALL AND ROOF ONLY[a, b, c, f, g, h]
(Floor live load ≤ 40 psf, roof live load ≤ 20 psf)

MEMBER & SPACING	MAXIMUM CANTILEVER SPAN (uplift force at backspan support in lb)[d, e]											
	Ground Snow Load											
	≤ 20 psf			30 psf			50 psf			70 psf		
	Roof Width			Roof Width			Roof Width			Roof Width		
	24 ft	32 ft	40 ft	24 ft	32 ft	40 ft	24 ft	32 ft	40 ft	24 ft	32 ft	40 ft
2 × 8 @ 12″	20″ (177)	15″ (227)	—	18″ (209)	—	—	—	—	—	—	—	—
2 × 10 @ 16″	29″ (228)	21″ (297)	16″ (364)	26″ (271)	18″ (354)	—	20″ (375)	—	—	—	—	—
2 × 10 @ 12″	36″ (166)	26″ (219)	20″ (270)	34″ (198)	22″ (263)	16″ (324)	26″ (277)	—	—	19″ (356)	—	—
2 × 12 @ 16″	—	32″ (287)	25″ (356)	36″ (263)	29″ (345)	21″ (428)	29″ (367)	20″ (484)	—	23″ (471)	—	—
2 × 12 @ 12″	—	42″ (209)	31″ (263)	—	37″ (253)	27″ (317)	36″ (271)	27″ (358)	17″ (447)	31″ (348)	19″ (462)	—
2 × 12 @ 8″	—	48″ (136)	45″ (169)	—	48″ (164)	38″ (206)	—	40″ (233)	26″ (294)	36″ (230)	29″ (304)	18″ (379)

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

a. Tabulated values are for clear-span roof supported solely by exterior bearing walls.

b. Spans are based on No. 2 Grade lumber of Douglas fir-larch, Southern pine, hem-fir and spruce-pine-fir for repetitive (three or more) members.

c. Ratio of backspan to cantilever span shall be not less than 3:1.

d. Connections capable of resisting the indicated uplift force shall be provided at the backspan support.

e. Uplift force is for a backspan to cantilever span ratio of 3:1. Tabulated uplift values are permitted to be reduced by multiplying by a factor equal to 3 divided by the actual backspan ratio provided (3/backspan ratio).

f. See Section R301.2.2.6, Item 1, for additional limitations on cantilevered floor joists for detached one- and two-family dwellings in Seismic Design Category D_0, D_1 or D_2 and townhouses in Seismic Design Category C, D_0, D_1 or D_2.

g. A full-depth rim joist shall be provided at the unsupported end of the cantilever joists. Solid blocking shall be provided at the supported end. Where the cantilever length is 24 inches or less and the building is assigned to Seismic Design Category A, B or C, solid blocking at the support for the cantilever shall not be required.

h. Linear interpolation shall be permitted for building widths and ground snow loads other than shown.

TABLE R502.3.3(2)
CANTILEVER SPANS FOR FLOOR JOISTS SUPPORTING EXTERIOR BALCONY[a, b, e, f]

MEMBER SIZE	SPACING	MAXIMUM CANTILEVER SPAN (uplift force at backspan support in lb)[c, d]		
		Ground Snow Load		
		≤ 30 psf	50 psf	70 psf
2 × 8	12″	42″ (139)	39″ (156)	34″ (165)
2 × 8	16″	36″ (151)	34″ (171)	29″ (180)
2 × 10	12″	61″ (164)	57″ (189)	49″ (201)
2 × 10	16″	53″ (180)	49″ (208)	42″ (220)
2 × 10	24″	43″ (212)	40″ (241)	34″ (255)
2 × 12	16″	72″ (228)	67″ (260)	57″ (268)
2 × 12	24″	58″ (279)	54″ (319)	47″ (330)

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa.

a. Spans are based on No. 2 Grade lumber of Douglas fir-larch, Southern pine, hem-fir, and spruce-pine-fir for repetitive (three or more) members.
b. Ratio of backspan to cantilever span shall be not less than 2:1.
c. Connections capable of resisting the indicated uplift force shall be provided at the backspan support.
d. Uplift force is for a backspan to cantilever span ratio of 2:1. Tabulated uplift values are permitted to be reduced by multiplying by a factor equal to 2 divided by the actual backspan ratio provided (2/backspan ratio).
e. A full-depth rim joist shall be provided at the unsupported end of the cantilever joists. Solid blocking shall be provided at the supported end. Where the cantilever length is 24 inches or less and the building is assigned to Seismic Design Category A, B or C, solid blocking at the support for the cantilever shall not be required.
f. Linear interpolation shall be permitted for ground snow loads other than shown.

R502.7.1 Bridging. Joists exceeding a nominal 2 inches by 12 inches (51 mm by 305 mm) shall be supported laterally by solid blocking, diagonal bridging (wood or metal), or a continuous 1-inch by 3-inch (25 mm by 76 mm) strip nailed across the bottom of joists perpendicular to joists at intervals not exceeding 8 feet (2438 mm).

Exception: Trusses, *structural composite lumber*, structural glued-laminated members and I-joists shall be supported laterally as required by the manufacturer's recommendations.

R502.8 Cutting, drilling and notching. Structural floor members shall not be cut, bored or notched in excess of the limitations specified in this section. See Figures R502.8(1) and R502.8(2).

R502.8.1 Sawn lumber. Notches in solid lumber joists, rafters and beams shall not exceed one-sixth of the depth of the member, shall not be longer than one-third of the depth of the member and shall not be located in the middle one-third of the span. Notches at the ends of the member shall not exceed one-fourth the depth of the member. The tension side of members 4 inches (102 mm) or greater in nominal thickness shall not be notched except at the ends of the members. The diameter of holes bored or cut into members shall not exceed one-third the depth of the member. Holes shall not be closer than 2 inches (51 mm) to the top or bottom of the member, or to any other hole located in the member. Where the member is notched, the hole shall not be closer than 2 inches (51 mm) to the notch.

R502.8.2 Engineered wood products. Cuts, notches and holes bored in trusses, *structural composite lumber*, structural glue-laminated members, cross-laminated timber members or I-joists are prohibited except where permitted by the manufacturer's recommendations or where the effects of such alterations are specifically considered in the design of the member by a *registered design professional*.

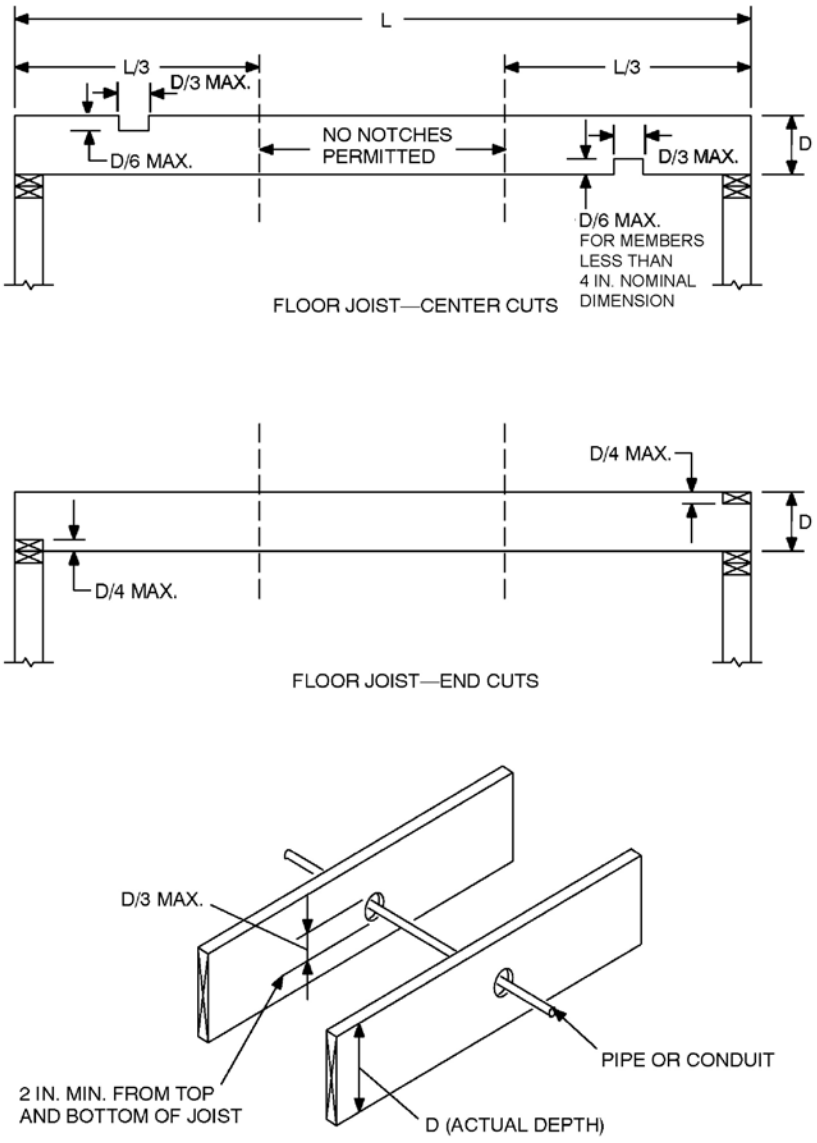
R502.9 Fastening. Floor framing shall be nailed in accordance with Table R602.3(1). Where posts and beam or girder construction is used to support floor framing, positive connections shall be provided to ensure against uplift and lateral displacement.

R502.10 Framing of openings. Openings in floor framing shall be framed with header and trimmer joists. Where the header joist span does not exceed 4 feet (1219 mm), the header joist shall be a single member the same size as the floor joist. Single trimmer joists shall be used to carry a single header joist that is located within 3 feet (914 mm) of the trimmer joist bearing. Where the header joist span exceeds 4 feet (1219 mm), the trimmer joists and the header joist shall be doubled and of sufficient cross section to support the floor joists framing into the header.

R502.11 Wood trusses.

R502.11.1 Design. Wood trusses shall be designed in accordance with *approved* engineering practice. The design and manufacture of metal-plate-connected wood trusses shall comply with ANSI/TPI 1. The *truss design drawings* shall be prepared by a *registered design professional*.

R502.11.2 Bracing. Trusses shall be braced to prevent rotation and provide lateral stability in accordance with the requirements specified in the *construction documents* for the building and on the individual *truss design drawings*. In the absence of specific bracing requirements, trusses shall be braced in accordance with accepted indus-



For SI: 1 inch = 25.4 mm.

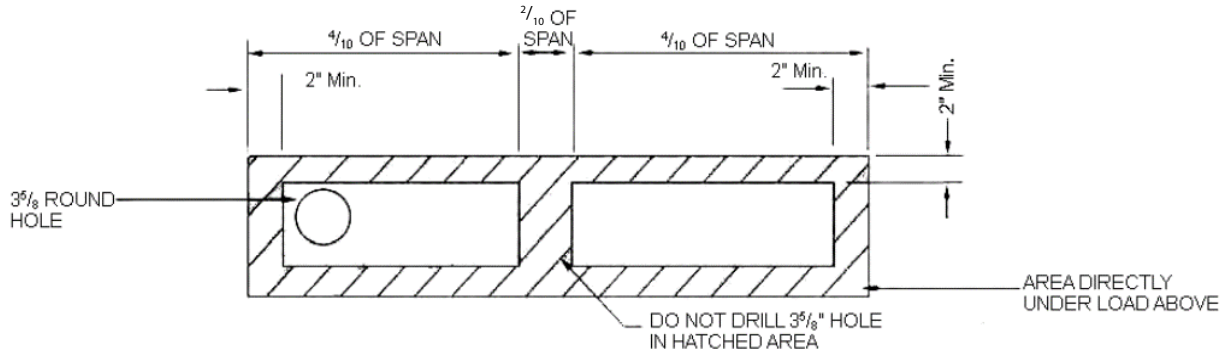
FIGURE R502.8(1)
CUTTING, NOTCHING AND DRILLING

try practices, such as the SBCA *Building Component Safety Information (BCSI) Guide to Good Practice for Handling, Installing & Bracing of Metal Plate Connected Wood Trusses.*

R502.11.3 Alterations to trusses. Truss members and components shall not be cut, notched, spliced or otherwise altered in any way without the approval of a *registered design professional*. *Alterations* resulting in the addition of load that exceeds the design load for the truss, shall not be permitted without verification that the truss is capable of supporting the additional loading.

R502.11.4 Truss design drawings. *Truss design drawings*, prepared in compliance with Section R502.11.1, shall be submitted to the *building official*. *Truss design drawings* shall be provided with the shipment of trusses delivered to the job site. *Truss design drawings* shall include, at a minimum, the information specified as follows:

1. Slope or depth, span and spacing.
2. Location of all joints.
3. Required bearing widths.
4. Design loads as applicable:
   - 4.1. Top chord *live load.*
   - 4.2. Top chord dead load.
   - 4.3. Bottom chord *live load.*



For SI: 1 inch = 24.5 mm, 1 foot = 304.8 mm.

1. Do not drill in center two-tenths of joist span.
2. Do not drill directly under load bearing walls at end.
3. Do not drill closer than 2 inch to top or bottom edge.
4. Apply 4 feet joist width × 1/2 inch CDX plywood with face grain running with joist to both sides using 6d nails or 1 1/2 inch screws 1 inch from top and bottom 4 inches o.c.
5. Holes shall not be closer than 2 inches o.c. within unhatched area only.
6. Plywood shall be attached such that 2 feet minimum of plywood is centered on each side of the hole location, except when the hole is located within 2 feet of the end of joist.

FIGURE R502.8(2)
ACCEPTABLE LOCATION OF 3 5/8-INCH DIAMETER HOLE IN 2 × 10 JOIST

4.4. Bottom chord dead load.

4.5. Concentrated loads and their points of application.

4.6. Controlling wind and earthquake loads.

5. Adjustments to lumber and joint connector design values for conditions of use.
6. Each reaction force and direction.
7. Joint connector type and description, such as size, thickness or gage, and the dimensioned location of each joint connector except where symmetrically located relative to the joint interface.
8. Lumber size, species and grade for each member.
9. Connection requirements for:
   9.1. Truss-to-girder-truss.
   9.2. Truss ply-to-ply.
   9.3. Field splices.
10. Calculated deflection ratio, maximum description for live and total load, or both.
11. Maximum axial compression forces in the truss members to enable the building designer to design the size, connections and anchorage of the permanent continuous lateral bracing. Forces shall be shown on the truss drawing or on supplemental documents.
12. Required permanent truss member bracing location.

R502.12 Draftstopping required. Draftstopping shall be provided in accordance with Section R302.12.

R502.13 Fireblocking required. Fireblocking shall be provided in accordance with Section R302.11.

SECTION R503
FLOOR SHEATHING

R503.1 Lumber sheathing. Maximum allowable spans for lumber used as floor sheathing shall conform to Tables R503.1, R503.2.1.1(1) and R503.2.1.1(2).

TABLE R503.1
MINIMUM THICKNESS OF LUMBER FLOOR SHEATHING

JOIST OR BEAM SPACING (inches)	MINIMUM NET THICKNESS	
	Perpendicular to joist	Diagonal to joist
24	11/16	3/4
16	5/8	5/8
48[a]	1 1/2 T & G	N/A
54[b]		
60[c]		

For SI: 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa.
N/A = Not Applicable.

a. For this support spacing, lumber sheathing shall have a minimum F_b of 675 and minimum E of 1,100,000 (see ANSI AWC NDS).
b. For this support spacing, lumber sheathing shall have a minimum F_b of 765 and minimum E of 1,400,000 (see ANSI AWC NDS).
c. For this support spacing, lumber sheathing shall have a minimum F_b of 855 and minimum E of 1,700,000 (see ANSI AWC NDS).

R503.1.1 End joints. End joints in lumber used as subflooring shall occur over supports unless end-matched lumber is used, in which case each piece shall bear on not less than two joists. Subflooring shall be permitted to be omitted where joist spacing does not exceed 16 inches (406 mm) and a 1-inch (25 mm) nominal tongue-and-groove wood strip flooring is applied perpendicular to the joists.

R503.2 Wood structural panel sheathing.

R503.2.1 Identification and grade. *Wood structural panel* sheathing used for structural purposes shall conform to CSA O325, CSA O437 DOC PS 1 or DOC PS 2. Panels shall be identified for grade, bond classification and Performance Category by a grade *mark* or certificate of inspection issued by an *approved* agency. The Performance Category value shall be used as the "nominal *panel thickness*" or "*panel thickness*" wherever referenced in this code.

R503.2.1.1 Subfloor and combined subfloor underlayment. Where used as subflooring or combination subfloor underlayment, *wood structural panels* shall be of one of the grades specified in Table R503.2.1.1(1). Where sanded plywood is used as combination subfloor underlayment, the grade, bond classification, and Performance Category shall be as specified in Table R503.2.1.1(2).

TABLE R503.2.1.1(2)
ALLOWABLE SPANS FOR SANDED PLYWOOD COMBINATION SUBFLOOR UNDERLAYMENT[a]

IDENTIFICATION	SPACING OF JOISTS (inches)		
	16	20	24
Species group[b]	—	—	—
1	1/2	5/8	3/4
2, 3	5/8	3/4	7/8
4	3/4	7/8	1

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa.

a. Plywood continuous over two or more spans and face grain perpendicular to supports. Unsupported edges shall be tongue-and-groove or blocked except where nominal 1/4-inch-thick wood panel-type underlayment, fiber-cement underlayment or 3/4-inch wood finish floor is used. Fiber-cement underlayment shall comply with ASTM C1288 or ISO 8336 Category C. Allowable uniform live load at maximum span based on deflection of 1/360 of span is 100 psf.

b. Applicable to all grades of sanded exterior-type plywood.

R503.2.2 Allowable spans. The maximum allowable span for *wood structural panels* used as subfloor or combination subfloor underlayment shall be as set forth in Table R503.2.1.1(1), or APA E30. The maximum span for sanded plywood combination subfloor underlayment shall be as set forth in Table R503.2.1.1(2).

R503.2.3 Installation. *Wood structural panels* used as subfloor or combination subfloor underlayment shall be attached to wood framing in accordance with Table R602.3(1).

R503.3 Particleboard.

R503.3.1 Identification and grade. Particleboard shall conform to ANSI A208.1 and shall be so identified by a grade *mark* or certificate of inspection issued by an *approved agency*.

R503.3.2 Floor underlayment. Particleboard floor underlayment shall conform to Type PBU and shall be not less than 1/4 inch (6.4 mm) in thickness.

R503.3.3 Installation. Particleboard underlayment shall be installed in accordance with the recommendations of the manufacturer and attached to framing in accordance with Table R602.3(1).

SECTION R504
PRESSURE PRESERVATIVE-TREATED WOOD FLOORS (ON GROUND)

R504.1 General. Pressure preservative-treated wood *basement* floors and floors on ground shall be designed to withstand axial forces and bending moments resulting from lateral soil pressures at the base of the exterior walls and floor live and dead loads. Floor framing shall be designed to meet joist deflection requirements in accordance with Section R301.

R504.1.1 Unbalanced soil loads. Unless special provision is made to resist sliding caused by unbalanced lateral soil loads, wood *basement* floors shall be limited to applications where the differential depth of fill on opposite exterior foundation walls is 2 feet (610 mm) or less.

R504.1.2 Construction. Joists in wood *basement* floors shall bear tightly against the narrow face of studs in the foundation wall or directly against a band joist that bears on the studs. Plywood subfloor shall be continuous over lapped joists or over butt joints between in-line joists. Sufficient blocking shall be provided between joists to transfer lateral forces at the base of the end walls into the floor system.

R504.1.3 Uplift and buckling. Where required, resistance to uplift or restraint against buckling shall be provided by interior bearing walls or properly designed stub walls anchored in the supporting soil below.

R504.2 Site preparation. The area within the foundation walls shall have all vegetation, topsoil and foreign material removed, and any fill material that is added shall be free of vegetation and foreign material. The fill shall be compacted to ensure uniform support of the pressure preservative-treated wood floor sleepers.

R504.2.1 Base. A minimum 4-inch-thick (102 mm) granular base of gravel having a maximum size of 3/4 inch (19.1 mm) or crushed stone having a maximum size of 1/2 inch (12.7 mm) shall be placed over the compacted earth.

R504.2.2 Moisture barrier. Polyethylene sheeting of minimum 6-mil (0.15 mm) thickness shall be placed over the granular base. Joints shall be lapped 6 inches (152 mm) and left unsealed. The polyethylene membrane shall be placed over the pressure preservative-treated wood sleepers and shall not extend beneath the footing plates of the exterior walls.

R504.3 Materials. Framing materials, including sleepers, joists, blocking and plywood subflooring, shall be pressure-preservative treated and dried after treatment in accordance with AWPA U1 (Commodity Specification A, Special Requirement 4.2), and shall bear the *label* of an accredited agency.

TABLE R503.2.1.1(1)
ALLOWABLE SPANS AND LOADS FOR WOOD STRUCTURAL PANELS FOR ROOF AND SUBFLOOR SHEATHING AND COMBINATION SUBFLOOR UNDERLAYMENT[a, b, c]

SPAN RATING	MINIMUM NOMINAL PANEL THICKNESS (inch)	ALLOWABLE LIVE LOAD (psf)[h, l]		MAXIMUM SPAN (inches)		LOAD (pounds per square foot, at maximum span)		MAXIMUM SPAN (inches)
		SPAN @ 16″ o.c.	SPAN @ 24″ o.c.	With edge support[d]	Without edge support	Total load	Live load	
Sheathing[e]				Roof[f]				Subfloor[j]
16/0	3/8	30	—	16	16	40	30	0
20/0	3/8	50	—	20	20	40	30	0
24/0	3/8	100	30	24	20[g]	40	30	0
24/16	7/16	100	40	24	24	50	40	16
32/16	15/32, 1/2	180	70	32	28	40	30	16[h]
40/20	19/32, 5/8	305	130	40	32	40	30	20[h, i]
48/24	23/32, 3/4	—	175	48	36	45	35	24
60/32	7/8	—	305	60	48	45	35	32
Underlayment, C-C plugged, single floor[e]				Roof[f]				Combination subfloor underlayment[k]
16 o.c.	19/32, 5/8	100	40	24	24	50	40	16[i]
20 o.c.	19/32, 5/8	150	60	32	32	40	30	20[i, j]
24 o.c.	23/32, 3/4	240	100	48	36	35	25	24
32 o.c.	7/8	—	185	48	40	50	40	32
48 o.c.	1 3/32, 1 1/8	—	290	60	48	50	40	48

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa.

a. The allowable total loads were determined using a dead load of 10 psf. If the dead load exceeds 10 psf, then the live load shall be reduced accordingly.

b. Panels continuous over two or more spans with long dimension (strength axis) perpendicular to supports. Spans shall be limited to values shown because of possible effect of concentrated loads.

c. Applies to panels 24 inches or wider.

d. Lumber blocking, panel edge clips (one midway between each support, except two equally spaced between supports where span is 48 inches), tongue-and-groove panel edges, or other approved type of edge support.

e. Includes Structural I panels in these grades.

f. Uniform load deflection limitation: 1/180 of span under live load plus dead load, 1/240 of span under live load only.

g. Maximum span 24 inches for 15/32- and 1/2-inch panels.

h. Maximum span 24 inches where 3/4-inch wood finish flooring is installed at right angles to joists.

i. Maximum span 24 inches where 1.5 inches of lightweight concrete or approved cellular concrete is placed over the subfloor.

j. Unsupported edges shall have tongue-and-groove joints or shall be supported with blocking unless minimum nominal 1/4-inch-thick wood panel-type underlayment, fiber-cement underlayment with end and edge joints offset not less than 2 inches or 1 1/2 inches of lightweight concrete or approved cellular concrete is placed over the subfloor, or 3/4-inch wood finish flooring is installed at right angles to the supports. Fiber-cement underlayment shall comply with ASTM C1288 or ISO 8336 Category C. Allowable uniform live load at maximum span, based on deflection of 1/360 of span, is 100 psf.

k. Unsupported edges shall have tongue-and-groove joints or shall be supported by blocking unless nominal 1/4-inch-thick wood panel-type underlayment, fiber-cement underlayment with end and edge joints offset not less than 2 inches or 3/4-inch wood finish flooring is installed at right angles to the supports. Fiber-cement underlayment shall comply with ASTM C1288 or ISO 8336 Category C. Allowable uniform live load at maximum span, based on deflection of 1/360 of span, is 100 psf, except panels with a span rating of 48 on center are limited to 65 psf total uniform load at maximum span.

l. Allowable live load values at spans of 16 inches on center and 24 inches on center taken from referenced standard APA E30, *APA Engineered Wood Construction Guide*. Refer to referenced standard for allowable spans not listed in the table.

SECTION R505
COLD-FORMED STEEL FLOOR FRAMING

DELETED

SECTION R506
CONCRETE FLOORS (ON GROUND)

R506.1 General. Concrete slab-on-ground floors shall be designed and constructed in accordance with the provisions of this section or ACI 332. Floors shall be a minimum 3 1/2 inches (89 mm) thick (for *expansive soils*, see Section R403.1.8). The specified compressive strength of concrete shall be as set forth in Section R402.2.

R506.2 Site preparation. The area within the foundation walls shall have all vegetation, top soil and foreign material removed.

R506.2.1 Fill. Fill material shall be free of vegetation and foreign material. The fill shall be compacted to ensure uniform support of the slab, and except where *approved*, the fill depths shall not exceed 24 inches (610 mm) for clean sand or gravel and 8 inches (203 mm) for earth.

Exception: #57 or #67 stone may be used as fill for a maximum depth of 4 feet (1219 mm) without consolidation.

R506.2.2 Base. A 4-inch-thick (102 mm) base course consisting of clean graded sand, gravel, crushed stone, crushed concrete or crushed blast-furnace slag passing a 2-inch (51 mm) sieve shall be placed on the prepared subgrade where the slab is below *grade*.

Exception: A base course is not required where the concrete slab is installed on well-drained or sand-gravel mixture soils classified as Group I according to the United Soil Classification System in accordance with Table R405.1.

R506.2.3 Vapor retarder. A minimum 6-mil (0.006 inch; 0.152 mm) vapor retarder conforming to ASTM E1745 Class A requirements with joints lapped not less than 6 inches (152 mm) shall be placed between the concrete floor slab and the base course or the prepared subgrade where a base course does not exist.

Exception: The vapor retarder is not required for the following:

1. Garages, utility buildings and other unheated *accessory structures*.
2. For unheated storage rooms having an area of less than 70 square feet (6.5 m^2) and carports.
3. Driveways, walks, patios and other flatwork not likely to be enclosed and heated at a later date.
4. Where *approved* by the *building official*, based on local site conditions.

R506.2.4 Reinforcement support. Where provided in slabs-on-ground, reinforcement shall be supported to remain in place from the center to upper one-third of the slab for the duration of the concrete placement.

SECTION R507
EXTERIOR DECKS
DELETED

See Chapter 47.

CHAPTER 6
WALL CONSTRUCTION

SECTION R601
GENERAL

R601.1 Application. The provisions of this chapter shall control the design and construction of walls and partitions for buildings.

R601.2 Requirements. Wall construction shall be capable of accommodating all loads imposed in accordance with Section R301 and of transmitting the resulting loads to the supporting structural elements.

R601.2.1 Compressible floor-covering materials. Compressible floor-covering materials that compress more than $^1/_{32}$ inch (0.8 mm) when subjected to 50 pounds (23 kg) applied over 1 inch square (645 mm) of material and are greater than $^1/_8$ inch (3.2 mm) in thickness in the uncompressed state shall not extend beneath walls, partitions or columns, which are fastened to the floor.

SECTION R602
WOOD WALL FRAMING

R602.1 General. Wood and wood-based products used for load-supporting purposes shall conform to the applicable provisions of this section.

R602.1.1 Sawn lumber. Sawn lumber shall be identified by a grade *mark* of an accredited lumber grading or inspection agency and have design values certified by an accreditation body that complies with DOC PS 20. In lieu of a grade *mark*, a certification of inspection issued by a lumber grading or inspection agency meeting the requirements of this section shall be accepted.

R602.1.2 End-jointed lumber. *Approved* end-jointed lumber identified by a grade *mark* conforming to Section R602.1 shall be permitted to be used interchangeably with solid-sawn members of the same species and grade. End-jointed lumber used in an assembly required elsewhere in this code to have a fire-resistance rating shall have the designation "Heat Resistant Adhesive" or "HRA" included in its grade *mark.*

R602.1.3 Structural glued-laminated timbers. Glued-laminated timbers shall be manufactured and identified as required in ANSI A190.1, ANSI 117 and ASTM D3737.

R602.1.4 Structural log members. Structural log members shall comply with the provisions of ICC 400.

R602.1.5 Structural composite lumber. Structural capacities for *structural composite lumber* shall be established and monitored in accordance with ASTM D5456.

R602.1.6 Cross-laminated timber. Cross-laminated timber shall be manufactured and identified as required by ANSI/APA PRG 320.

R602.1.7 Engineered wood rim board. Engineered wood rim boards shall conform to ANSI/APA PRR 410 or shall be evaluated in accordance with ASTM D7672. Structural capacities shall be in accordance with either ANSI/APA PRR 410 or established in accordance with ASTM D7672. Rim boards conforming to ANSI/APA PRR 410 shall be marked in accordance with that standard.

R602.1.8 Wood structural panels. *Wood structural panel* sheathing shall conform to DOC PS 1, DOC PS 2 or, when manufactured in Canada, CSA O325 or CSA O437. Panels shall be identified for grade, bond classification, and performance category by a grade *mark* or certificate of inspection issued by an *approved* agency.

R602.1.9 Particleboard. Particleboard shall conform to ANSI A208.1. Particleboard shall be identified by the grade *mark* or certificate of inspection issued by an *approved* agency.

R602.1.10 Fiberboard. Fiberboard shall conform to ASTM C208. Fiberboard sheathing, where used structurally, shall be identified by an *approved* agency as conforming to ASTM C208.

R602.1.11 Structural insulated panels. *Structural insulated panels* shall be manufactured and identified in accordance with ANSI/APA PRS 610.1.

R602.2 Grade. Studs shall be a minimum No. 3, standard or stud grade lumber.

Exception: Bearing studs not supporting floors and nonbearing studs shall be permitted to be utility grade lumber, provided that the studs are spaced in accordance with Table R602.3(5).

R602.3 Design and construction. Exterior walls of wood-frame construction shall be designed and constructed in accordance with the provisions of this chapter and Figures R602.3(1) and R602.3(2), or in accordance with AWC NDS. Components of exterior walls shall be fastened in accordance with Tables R602.3(1) through R602.3(4). Wall sheathing shall be fastened directly to framing members and, where placed on the exterior side of an exterior wall, shall be capable of resisting the wind pressures listed in Table R301.2.1(1) adjusted for height and exposure using Table R301.2.1(2) and shall conform to the requirements of Table R602.3(3). Wall sheathing used only for exterior wall covering purposes shall comply with Section R703.

Studs shall be continuous from support at the sole plate to a support at the top plate to resist loads perpendicular to the wall. The support shall be a foundation or floor, ceiling or roof *diaphragm* or shall be designed in accordance with accepted engineering practice.

Exception: Jack studs, trimmer studs and cripple studs at openings in walls that comply with Tables R602.7(1) and R602.7(2).

R602.3.1 Stud size, height and spacing. The size, height and spacing of studs shall be in accordance with Table R602.3(5).

Exceptions:

1. Utility grade studs shall not be spaced more than 16 inches (406 mm) on center, shall not support more than a roof and ceiling, and shall not exceed 8 feet (2438 mm) in height for exterior walls and *load-bearing walls* or 10 feet (3048 mm) for interior nonload-bearing walls.
2. Where roof loads are less than or equal to 20 pounds per square foot and the ultimate design wind speed is less than or equal to 130 mph (58.1 m/s), 2-inch by 6-inch (38 mm by 140 mm) studs supporting a roof load with not more than 6 feet (1829 mm) of tributary length shall have a maximum height of 18 feet (5486 mm) where spaced at 16 inches (406 mm) on center, or 20 feet (6096 mm) where spaced at 12 inches (305 mm) on center. Studs shall be No. 2 grade lumber or better.
3. Exterior load-bearing studs not exceeding 12 feet (3658 mm) in height provided in accordance with Table R602.3(6). The minimum number of full-height studs adjacent to openings shall be in accordance with Section R602.7.5. The building shall be located in Exposure B, and the roof *live load* shall not exceed 20 psf (0.96 kPa). Studs and plates shall be No. 2 grade lumber or better.

R602.3.2 Top plate for bearing and braced wall lines. Wood stud walls shall be capped with a double top plate installed to provide overlapping at corners and intersections with bearing partitions. End joints in top plates shall be offset not less than 24 inches (610 mm). Joints in plates need not occur over studs. Plates shall be not less than 2-inches (51 mm) nominal thickness and have a width not less than the width of the studs.

Exception: A single top plate used as an alternative to a double top plate shall comply with the following:

1. The single top plate shall be tied at corners, intersecting walls, and at in-line splices in straight wall lines in accordance with Table R602.3.2.
2. The rafters or joists shall be centered over the studs with a tolerance of not more than 1 inch (25 mm).
3. Omission of the top plate is permitted over headers where the headers are adequately tied to adjacent wall sections in accordance with Table R602.3.2.

R602.3.3 Bearing studs. Where joists, trusses or rafters are spaced more than 16 inches (406 mm) on center and the bearing studs below are spaced 24 inches (610 mm) on center, such members shall bear within 5 inches (127 mm) of the studs beneath.

Exceptions:

1. The top plates are two 2-inch by 6-inch (38 mm by 140 mm) or two 3-inch by 4-inch (64 mm by 89 mm) members.
2. A third top plate is installed.
3. Solid blocking equal in size to the studs is installed to reinforce the double top plate.

R602.3.4 Bottom (sole) plate. Studs shall have full bearing on a nominal 2-by (51 mm) or larger plate or sill having a width not less than to the width of the studs.

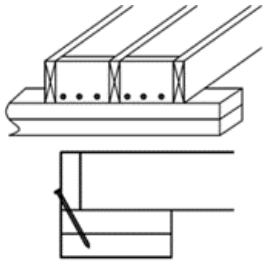
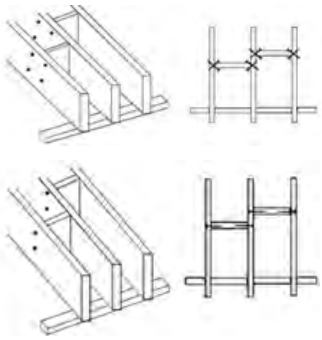
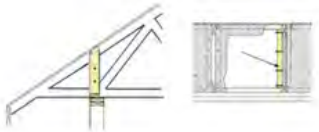
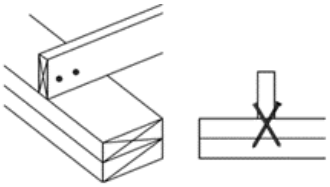
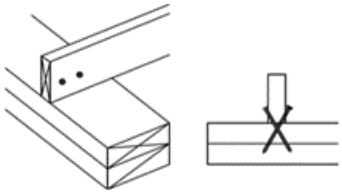
R602.3.5 Braced wall panel uplift load path. Braced wall panels located at exterior walls that support roof rafters or trusses (including stories below top story) shall have the framing members connected in accordance with one of the following:

1. Fastening in accordance with Table R602.3(1) where:
   1.1. The ultimate design wind speed does not exceed 115 mph (51 m/s), the wind exposure category is B, the roof pitch is 5:12 or greater, and the roof span is 32 feet (9754 mm) or less.
   1.2. The net uplift value at the top of a wall does not exceed 100 plf (146 N/mm). The net uplift value shall be determined in accordance with Section R802.11 and shall be permitted to be reduced by 60 plf (86 N/mm) for each full wall above.
2. Where the net uplift value at the top of a wall exceeds 100 plf (146 N/mm), installing *approved* uplift framing connectors to provide a continuous load path from the top of the wall to the foundation or to a point where the uplift force is 100 plf (146 N/mm) or less. The net uplift value shall be as determined in Item 1.2.
3. Wall sheathing and fasteners designed to resist combined uplift and shear forces in accordance with accepted engineering practice.

R602.4 Interior load-bearing walls. Interior *load-bearing walls* shall be constructed, framed and fireblocked as specified for exterior walls.

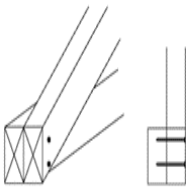
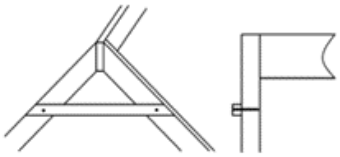
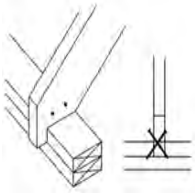
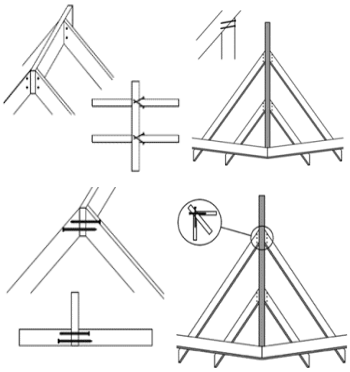
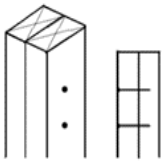
R602.5 Interior nonbearing walls. Interior *nonbearing walls* shall be permitted to be constructed with 2-inch by 3-inch (51 mm by 76 mm) studs spaced 24 inches (610 mm) on center or, where not part of a *braced wall line*, 2-inch by 4-inch (51 mm by 102 mm) flat studs spaced at 16 inches (406 mm) on center. Interior *nonbearing walls* shall be capped with not less than a single top plate. Interior *nonbearing walls* shall be fireblocked in accordance with Section R602.8.

TABLE R602.3(1)
FASTENING SCHEDULE[k, l, m, n]

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
	Roof		
1	Blocking between ceiling joists, rafters or trusses to top plate or other framing below 	4-8d box ($2^1/_2$″ × 0.113″); or 3-8d common ($2^1/_2$″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Toe nail
	Blocking between rafters or truss not at the wall top plates, to rafter or truss 	2-8d common ($2^1/_2$″ × 0.131″); or 2-3″ × 0.131″ nails	Each end toe nail
		2-16d common ($3^1/_2$″ × 0.162″); or 3-3″ × 0.131″ nails	End nail
	Flat blocking to truss and web filler 	16d common ($3^1/_2$″ × 0.162″); or 3″ × 0.131″ nails	6″ o.c. face nail
2	Ceiling joists to top plate 	4-8d box ($2^1/_2$″ × 0.113″); or 3-8d common ($2^1/_2$″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Per joist, toe nail
3	Ceiling joist not attached to parallel rafter, laps over partitions [see Section R802.5.2 and Table R802.5.2(1)] 	4-10d box (3″ × 0.128″); or 3-16d common ($3^1/_2$″ × 0.162″); or 4-3″ × 0.131″ nails	Face nail

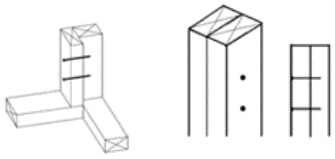
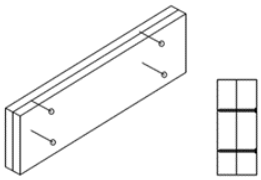
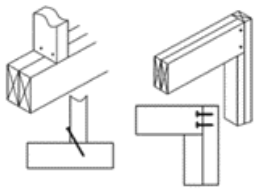
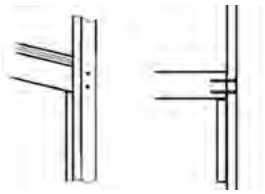
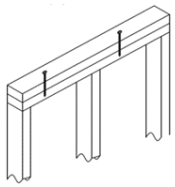
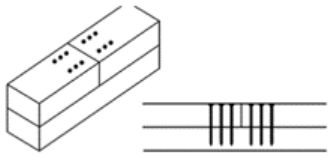
(continued)

TABLE R602.3(1)
FASTENING SCHEDULE[k, l, m, n]

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
	Roof		
4	Ceiling joist attached to parallel rafter (heel joint) [see Section R802.5.2 and Table R802.5.2(1)] 	Table R802.5.2(1)	Face nail
5	Collar tie to rafter, face nail 	4-10d box (3″ × 0.128″); or 3-10d common (3″ × 0.148″); or 4-3″ × 0.131″ nails	Face nail each rafter
6	Rafter or roof truss to plate[o] 	3-16d box ($3^1/_2$″ × 0.135″); or 3-10d common (3″ × 0.148″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	2 toe nails on one side and 1 toe nail on opposite side of each rafter or truss[i]
7	Roof rafters to ridge, valley or hip rafters or roof rafter to minimum 2″ ridge beam 	4-16d box ($3^1/_2$″ × 0.135″); or 3-10d common (3″ × 0.148″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	Toe nail
		3-16d box ($3^1/_2$″ × 0.135″); or 2-16d common ($3^1/_2$″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	End nail
	Wall		
8	Stud to stud (not at braced wall panels) 	16d common ($3^1/_2$″ × 0.162″)	24″ o.c. face nail
		10d box (3″ × 0.128″); or 3″ × 0.131″ nails	16″ o.c. face nail

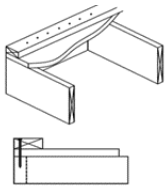
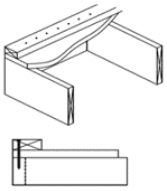
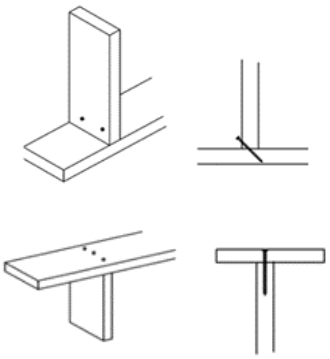
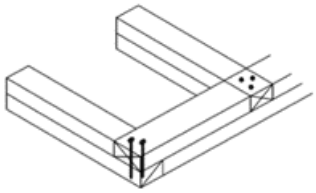
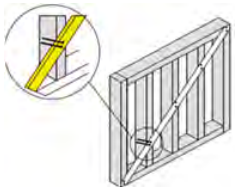
(continued)

TABLE R602.3(1)
FASTENING SCHEDULE[k, l, m, n]

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
	Wall		
9	Stud to stud and abutting studs at intersecting wall corners (at braced wall panels) 	16d box ($3^1/_2$″ × 0.135″); or 3″ × 0.131″ nails	12″ o.c. face nail
		16d common ($3^1/_2$″ × 0.162″)	16″ o.c. face nail
10	Built-up header (2″ to 2″ header with $^1/_2$″ spacer) 	16d common ($3^1/_2$″ × 0.162″)	16″ o.c. each edge face nail
		16d box ($3^1/_2$″ × 0.135″)	12″ o.c. each edge face nail
11	Continuous header to stud 	5-8d box ($2^1/_2$″ × 0.113″); or 4-8d common ($2^1/_2$″ × 0.131″); or 4-10d box (3″ × 0.128″)	Toe nail
12	Adjacent full-height stud to end of header 	4-16d box ($3^1/_2$″× 0.135″); or 3-16d common ($3^1/_2$″ × 0.162″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	End nail
13	Top plate to top plate 	16d common ($3^1/_2$″ × 0.162″)	16″ o.c. face nail
		10d box (3″ × 0.128″); or 3″ × 0.131″ nails	12″ o.c. face nail
14	Double top plate splice 	8-16d common ($3^1/_2$″ × 0.162″); or 12-16d box ($3^1/_2$″ × 0.135″); or 12-10d box (3″ × 0.128″); or 12-3″ × 0.131″ nails	Face nail on each side of end joint (minimum 24″ lap splice length each side of end joint)

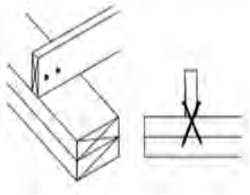
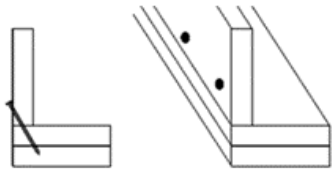
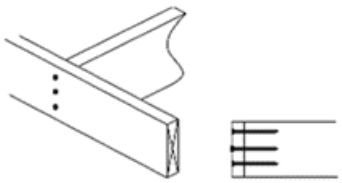
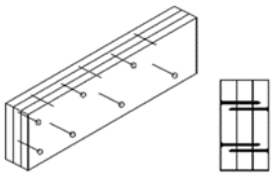
(continued)

TABLE R602.3(1)—continued
FASTENING SCHEDULE[k, l, m, n]

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
	Wall		
15	Bottom plate to joist, rim joist, band joist or blocking (not at braced wall panels) 	16d common ($3^1/_2$″ × 0.162″)	16″ o.c. face nail
		16d box ($3^1/_2$″ × 0.135″); or 3″ × 0.131″ nails	12″ o.c. face nail
	Roof		
16	Bottom plate to joist, rim joist, band joist or blocking (at braced wall panel) 	3-16d box ($3^1/_2$″ × 0.135″); or 2-16d common ($3^1/_2$″ × 0.162″); or 4-3″ × 0.131″ nails	16″ o.c. face nail
17	Top or bottom plate to stud[p] 	4-8d box ($2^1/_2$″ × 0.113″); or 3-16d box ($3^1/_2$″ × 0.135″); or 4-8d common ($2^1/_2$″ × 0.131″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	Toe nail
		3-16d box ($3^1/_2$″ × 0.135″); or 2-16d common ($3^1/_2$″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	End nail
18	Top plates, laps at corners and intersections 	3-10d box (3″ × 0.128″); or 2-16d common ($3^1/_2$″ × 0.162″); or 3-3″ × 0.131″ nails	Face nail
19	1″ brace to each stud and plate 	3-8d box ($2^1/_2$″ × 0.113″); or 2-8d common ($2^1/_2$″ × 0.131″); or 2-10d box (3″ × 0.128″); or 2-(3″ × 0.131″)	Face nail
20	1″ × 6″ sheathing to each bearing	3-8d box ($2^1/_2$″ × 0.113″); or 2-8d common ($2^1/_2$″ × 0.131″); or 2-10d box (3″ × 0.128″); or 2 staples, 1″ crown, 16 ga., $1^3/_4$″ long	Face nail

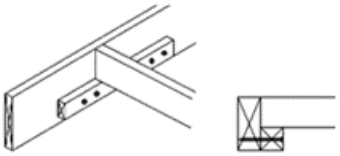
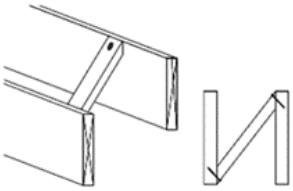
(continued)

TABLE R602.3(1)—continued
FASTENING SCHEDULE[k, l, m, n]

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
	Roof		
21	1″ × 8″ and wider sheathing to each bearing	3-8d box ($2^1/_2$″ × 0.113″); or 3-8d common ($2^1/_2$″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3 staples, 1″ crown, 16 ga., $1^3/_4$″ long	Face nail
		Wider than 1″ × 8″ 4-8d box ($2^1/_2$″ × 0.113″); or 3-8d common ($2^1/_2$″ × 0.131″); or 3-10d box (3″ × 0.128″); or 4 staples, 1″ crown, 16 ga., $1^3/_4$″ long	
	Floor		
22	Joist to sill, top plate or girder 	4-8d box ($2^1/_2$″ × 0.113″); or 3-8d common ($2^1/_2$″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Toe nail
23	Rim joist, band joist or blocking to sill or top plate (roof applications also) 	8d box ($2^1/_2$″ × 0.113″)	4″ o.c. toe nail
		8d common ($2^1/_2$″ × 0.131″); or 10d box (3″ × 0.128″); or 3″ × 0.131″ nails	6″ o.c. toe nail
24	1″ × 6″ subfloor or less to each joist	3-8d box ($2^1/_2$″ × 0.113″); or 2-8d common ($2^1/_2$″ × 0.131″); or 3-10d box (3″ × 0.128″); or 2 staples, 1″ crown, 16 ga., $1^3/_4$″ long	Face nail
25	2″ subfloor to joist or girder	3-16d box ($3^1/_2$″ × 0.135″); or 2-16d common ($3^1/_2$″ × 0.162″)	Blind and face nail
26	2″ planks (plank & beam—floor & roof)	3-16d box ($3^1/_2$″ × 0.135″); or 2-16d common ($3^1/_2$″ × 0.162″)	At each bearing, face nail
27	Band or rim joist to joist 	3-16d common ($3^1/_2$″ × 0.162″); or 4-10 box (3″ × 0.128″); or 4-3″ × 0.131″ nails; or 4-3″ × 14 ga. staples, $^7/_{16}$″ crown	End nail
28	Built-up girders and beams, 2-inch lumber layers 	20d common (4″ × 0.192″); or	Nail each layer as follows: 32″ o.c. at top and bottom and staggered.
		10d box (3″ × 0.128″); or 3″ × 0.131″ nails	24″ o.c. face nail at top and bottom staggered on opposite sides
		And: 2-20d common (4″ × 0.192″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Face nail at ends and at each splice

(continued)

TABLE R602.3(1)—continued
FASTENING SCHEDULE[k, l, m, n]

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION	
	Floor			
29	Ledger strip supporting joists or rafters 	4-16d box ($3^1/_2$″ × 0.135″); or 3-16d common ($3^1/_2$″ × 0.162″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	At each joist or rafter, face nail	
30	Bridging or blocking to joist, rafter or truss 	2-10d box (3″ × 0.128″); or 2-8d common ($2^1/_2$″ × 0.131″); or 2-3″ × 0.131″ nails	Each end, toe nail	
	Wood structural panels, subfloor, roof and interior wall sheathing to framing and particleboard wall sheathing to framing [see Table R602.3(3) for wood structural panel exterior wall sheathing to wall framing]			
31	$^3/_8$″ – $^1/_2$″	6d common or deformed (2″ × 0.113″ × 0.266″ head); or $2^3/_8$″ × 0.113″ × 0.266″ head nail (subfloor, wall)[i]	6[j]	12[j]
		8d common ($2^1/_2$″ × 0.131″) nail (roof); or RSRS-01 ($2^3/_8$″ × 0.113″) nail (roof)[b]	6[j]	6[f, j]
32	$^{19}/_{32}$″ – $^3/_4$″	8d common ($2^1/_2$″ × 0.131″) nail (subfloor, wall)	6	12
		8d common ($2^1/_2$″ × 0.131″) nail (roof); or RSRS-01; ($2^3/_8$″ × 0.113″) nail (roof)[b]	6[f, j]	6[f, j]
		Deformed $2^3/_8$″ × 0.113″ × 0.266″ head (wall or subfloor)	6	12
33	$^7/_8$″ – $1^1/_4$″	10d common (3″ × 0.148″) nail; or ($2^1/_2$″ × 0.131 × 0.281″ head) deformed nail	6	12
	Other wall sheathing[g]			
34	$^1/_2$″ structural cellulosic fiberboard sheathing	$1^1/_2$″ × 0.120″ galvanized roofing nail, $^7/_{16}$″ head diameter; or $1^1/_4$″ long 16 ga. staple with $^7/_{16}$″ or 1″ crown	3	6
35	$^{25}/_{32}$″ structural cellulosic fiberboard sheathing	$1^3/_4$″ × 0.120″ galvanized roofing nail, $^7/_{16}$″ head diameter; or $1^1/_4$″ long 16 ga. staple with $^7/_{16}$″ or 1″ crown	3	6
36	$^1/_2$″ gypsum sheathing[d]	$1^1/_2$″ × 0.120″ galvanized roofing nail, $^7/_{16}$″ head diameter, or $1^1/_4$″ long 16 ga.; staple galvanized, $1^1/_2$″ long; $^7/_{16}$″ or 1″ crown or $1^1/_4$″ screws, Type W or S	7	7
37	$^5/_8$″ gypsum sheathing[d]	$1^3/_4$″ × 0.120″ galvanized roofing nail, $^7/_{16}$″ head diameter; 16 ga.; staple galvanized, $1^1/_2$″ long; $^7/_{16}$″ or 1″ crown or $1^5/_8$″ screws, Type W or S	7	7

(continued)

TABLE R602.3(1)—continued
FASTENING SCHEDULE[k, l, m, n]

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION	
Wood structural panels, combination subfloor underlayment to framing				
38	$^3/_4$″ and less	Deformed (2″ × 0.113″) or Deformed (2″ × 0.120″) nail; or 8d common ($2^1/_2$″ × 0.131″) nail	6	12
39	$^7/_8$″ – 1"	8d common ($2^1/_2$″ × 0.131″) nail; or Deformed ($2^1/_2$″ × 0.131″); or Deformed ($2^1/_2$″ × 0.120″) nail	6	12
40	$1^1/_8$″ – $1^1/_4$″	10d common (3″ × 0.148″) nail; or Deformed ($2^1/_2$″ × 0.131″); or Deformed ($2^1/_2$″ × 0.120″) nail	6	12

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s; 1 ksi = 6.895 MPa.

a. Nails are smooth-common, box or deformed shanks except where otherwise stated. Nails used for framing and sheathing connections are carbon steel and shall have minimum average bending yield strengths as shown: 80 ksi for shank diameter of 0.192 inch (20d common nail), 90 ksi for shank diameters larger than 0.142 inch but not larger than 0.177 inch, and 100 ksi for shank diameters of 0.142 inch or less. Connections using nails and staples of other materials, such as stainless steel, shall be designed by accepted engineering practice.

b. RSRS-01 is a Roof Sheathing Ring Shank nail meeting the specifications in ASTM F1667.

c. Nails shall be spaced at not more than 6 inches on center at all supports where spans are 48 inches or greater.

d. Four-foot by 8-foot or 4-foot by 9-foot panels shall be applied vertically.

. Spacing of fasteners not included in this table shall be based on Table R602.3(2).

f. For wood structural panel roof sheathing attached to gable end roof framing and to intermediate supports within 48 inches of roof edges and ridges, nails shall be spaced at 4 inches on center where the ultimate design wind speed is greater than 130 mph in Exposure B or greater than 115 mph in Exposure C.

g. Gypsum sheathing shall conform to ASTM C1396 and shall be installed in accordance with ASTM C1280 or GA 253. Fiberboard sheathing shall conform to ASTM C208.

h. Spacing of fasteners on floor sheathing panel edges applies to panel edges supported by framing members and required blocking and at floor perimeters only. Spacing of fasteners on roof sheathing panel edges applies to panel edges supported by framing members and required blocking. Blocking of roof or floor sheathing panel edges perpendicular to the framing members need not be provided except as required by other provisions of this code. Floor perimeter shall be supported by framing members or solid blocking. Roof sheathing 7/16-inch or greater in thickness does not require perimeter blocking.

i. Where a rafter is fastened to an adjacent parallel ceiling joist in accordance with this schedule, provide two toe nails on one side of the rafter and toe nails from the ceiling joist to top plate in accordance with this schedule. The toe nail on the opposite side of the rafter shall not be required.

j. For wood structural panel roof sheathing attached to gable end roof framing and to intermediate supports within 48 inches of roof edges and ridges, nails shall be spaced at 4 inches on center where the ultimate design wind speed is greater than 130 mph in Exposure C. Roof sheathing 19/32-inch or greater in thickness shall be attached to roof framing members spaced at 24-inches on center or shall be designed by accepted engineering practice where the ultimate design wind speed is greater than 130 mph in Exposure C.

k. Fastenings listed above may also be used for other connections that are not listed but that have the same configuration and the same code requirement for fastener quantity/spacing and fastener size (pennyweight and style, e.g., 8d common, “8-penny common nail”).

l. For nominal dimensions of nails see Table R602.3(1a)

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n. Nails and staples shall conform to the requirements of ASTM F1667.

o. See Table R4508.3 in the 130, 140 and 150 mph (58 m/s, 63 m/s, 67 m/s).

p. See Table R4508.4 in the 130, 140 and 150 mph (58 m/s, 63 m/s, 67 m/s).

TABLE R602.3(1a)
NOMINAL DIMENSIONS OF NAILS LISTED IN TABLE R602.3(1)

NAILS DSCRIBED BY PENNYWEIGHT SYSTEM		
Pennyweight	**Length (inches)**	**Shank diameter (inches)**
Box		
6d	2	0.099
8d	$2^1/_2$	0.113
10d	3	0.128
Casing		
6d	$2^1/_4$	0.099
8d	$2^1/_2$	0.113
10d	3	0.128
Common		
6d	2	0.113
8d	$2^1/_2$	0.131
10d	3	0.148
16d	$3^1/_2$	0.162
20d	4	0.192
Cooler		
5d	$1^5/_8$	0.086
6d	$1^7/_8$	0.092
8d	$2^3/_8$	0.113
Deformed[a]		
3d	$1^1/_4$	0.099
4d	$1^1/_2$	0.099
6d	2	0.120
8d	$2^1/_2$	0.120
Finish		
8d	$2^1/_2$	0.099
10d	3	0.113
Siding		
6d	$1^7/_8$	0.106
8d	$2^3/_8$	0.128
Additional Recognized Nails		
Smooth shank nails	$2^1/_4$	0.092
	$2^1/_4$	0.105
	3	0.120
	$3^1/_4$	
	$1^1/_2$	0.131
	3	
	$3^1/_4$	
	$1^1/_2$	0.148
	$2^1/_2$	0.162
Deformed shank nails[a]	$2^1/_4$	0.099
	2	0.113
	$2^3/_8$	
	$2^1/_2$	0.131

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s; 1ksi = 6.895 MPa.
a. A deformed shank nail must have either a helical (screw) shank or an annular (ring) shank.

TABLE R602.3(2)
ALTERNATE ATTACHMENTS TO TABLE R602.3(1)

NOMINAL MATERIAL THICKNESS (inches)	DESCRIPTION[a, b] OF FASTENER AND LENGTH (inches)	SPACING[c] OF FASTENERS	
		Edges (inches)	Intermediate supports (inches)
Wood structural panels subfloor, roof[g] and wall sheathing to framing and particleboard wall sheathing to framing[f]			
Up to 1/2	Staple 15 ga. 1 3/4	4	8
	0.097–0.099 Nail 2 1/4	3	6
	Staple 16 ga. 1 3/4	3	6
19/32 and 5/8	0.113 Nail 2	3	6
	Staple 15 and 16 ga. 2	4	8
	0.097–0.099 Nail 2 1/4	4	8
23/32 and 3/4	Staple 14 ga. 2	4	8
	Staple 15 ga. 1 3/4	3	6
	0.097–0.099 Nail 2 1/4	4	8
	Staple 16 ga. 2	4	8
1	Staple 14 ga. 2 1/4	4	8
	0.113 Nail 2 1/4	3	6
	Staple 15 ga. 2 1/4	4	8
	0.097–0.099 Nail 2 1/2	4	8
NOMINAL MATERIAL THICKNESS (inches)	**DESCRIPTION[a, b] OF FASTENER AND LENGTH (inches)**	**SPACING[c] OF FASTENERS**	
		Edges (inches)	**Body of panel[d] (inches)**
Floor underlayment; plywood-hardboard-particleboard[f]-fiber-cement[h]			
Fiber-cement			
1/4	1 1/4 long × 0.099″ corrosion-resistant, ring shank nails (finished flooring other than tile)	3	6
	Staple 18 ga., 7/8 long, 1/4 crown (finished flooring other than tile)	3	6
	1 1/4 long × .121 shank × .375 head diameter corrosion-resistant (galvanized or stainless steel) roofing nails (for tile finish)	8	8
	1 1/4 long, No. 8 × .375 head diameter, ribbed wafer-head screws (for tile finish)	8	8
Plywood			
1/4 and 5/16	1 1/4 ring or screw shank nail-minimum 12 1/2 ga. (0.099″) shank diameter	3	6
	Staple 18 ga., 7/8, 3/16 crown width	2	5
11/32, 3/8, 15/32 and 1/2	1 1/4 ring or screw shank nail-minimum 12 1/2 ga. (0.099″) shank diameter	6	8[e]
19/32, 5/8, 23/32 and 3/4	1 1/2 ring or screw shank nail-minimum 12 1/2 ga. (0.099″) shank diameter	6	8
	Staple 16 ga. 1 1/2	6	8
Hardboard[f]			
0.200	1 1/2 long × 0.080″ ring-grooved shank underlayment nail	6	6
	1 3/8 long × 0.080″ polymer cement-coated sinker nail	6	6
	Staple 18 ga., 7/8 long (plastic coated)	3	6
Particleboard			
1/4	1 1/2 long × 0.099″ ring-grooved shank underlayment nail	3	6
	Staple 18 ga., 7/8 long, 3/16 crown	3	6
3/8	2 long × 0.120″ ring-grooved shank underlayment nail	6	10
	Staple 16 ga., 1 1/8 long, 3/8 crown	3	6
1/2, 5/8	2 long × 0.120″ ring-grooved shank underlayment nail	6	10
	Staple 16 ga., 1 5/8 long, 3/8 crown	3	6

(continued)

TABLE R602.3(2)—continued
ALTERNATE ATTACHMENTS TO TABLE R602.3(1)

For SI: 1 inch = 25.4 mm.

a. Nail is a general description and shall be permitted to be T-head, modified round head or round head.
b. Staples shall have a minimum crown width of $^{7}/_{16}$-inch except as noted.
c. Nails or staples shall be spaced at not more than 6 inches on center at all supports where spans are 48 inches or greater. Nails or staples shall be spaced at not more than 12 inches on center at intermediate supports for floors.
d. Fasteners shall be placed in a grid pattern throughout the body of the panel.
e. For 5-ply panels, intermediate nails shall be spaced not more than 12 inches on center each way.
f. Hardboard underlayment shall conform to CPA/ANSI A135.4.
g. Alternate fastening is only permitted for roof sheathing where the ultimate design wind speed is less than or equal to 110 mph, and where fasteners are installed 3 inches on center at all supports.
h. Fiber-cement underlayment shall conform to ASTM C1288 or ISO 8336, Category C.

TABLE R602.3(3)
REQUIREMENTS FOR WOOD STRUCTURAL PANEL WALL SHEATHING USED TO RESIST WIND PRESSURES[a, b, c]

MINIMUM NAIL		MINIMUM WOOD STRUCTURAL PANEL SPAN RATING	PANEL THICKNESS (inches)	MAXIMUM WALL STUD SPACING (inches)	PANEL NAIL SPACING		ULTIMATE DESIGN WIND SPEED V_{ult} (mph)		
Size	Penetration (inches)				Edges (inches o.c.)	Field (inches o.c.)	Wind exposure category		
							B	C	D
6d Common (2.0″ × 0.113″)	1.5	24/0	$^{3}/_{8}$	16	6	12	140	115	110
8d Common (2.5″ × 0.131″)	1.75	24/16	$^{7}/_{16}$	16	6	12	170	140	135
				24	6	12	140	115	110

For SI: 1 inch = 25.4 mm, 1 mile per hour = 0.447 m/s.

a. Panel strength axis parallel or perpendicular to supports. Three-ply plywood sheathing with studs spaced more than 16 inches on center shall be applied with panel strength axis perpendicular to supports.
b. Table is based on wind pressures acting toward and away from building surfaces in accordance with Section R301.2. Lateral bracing requirements shall be in accordance with Section R602.10.
c. Wood structural panels with span ratings of Wall-16 or Wall-24 shall be permitted as an alternate to panels with a 24/0 span rating. Plywood siding rated 16 o.c. or 24 o.c. shall be permitted as an alternate to panels with a 24/16 span rating. Wall-16 and Plywood siding 16 o.c. shall be used with studs spaced not more than 16 inches on center.

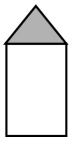
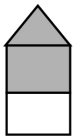
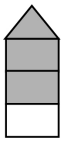
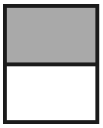
TABLE R602.3(4)
ALLOWABLE SPANS FOR PARTICLEBOARD WALL SHEATHING[a]

THICKNESS (inch)	GRADE	STUD SPACING (inches)	
		Where siding is nailed to studs	Where siding is nailed to sheathing
$^{3}/_{8}$	M-1 Exterior glue	16	—
$^{1}/_{2}$	M-2 Exterior glue	16	16

For SI: 1 inch = 25.4 mm.

a. Wall sheathing not exposed to the weather. If the panels are applied horizontally, the end joints of the panel shall be offset so that four panel corners will not meet. Panel edges must be supported. Leave a $^{1}/_{16}$-inch gap between panels and nail not less than $^{3}/_{8}$ inch from panel edges.

TABLE R602.3(5)
SIZE, HEIGHT AND SPACING OF WOOD STUDS[a]

STUD SIZE (inches)	BEARING WALLS					NONBEARING WALLS	
	Laterally unsupported stud height[a] (feet)	Maximum spacing where supporting a roof-ceiling assembly or a habitable attic assembly, only (inches)	Maximum spacing where supporting one floor, plus a roof-ceiling assembly or a habitable attic assembly (inches)	Maximum spacing where supporting two floors, plus a roof-ceiling assembly or a habitable attic assembly (inches)	Maximum spacing where supporting one floor height[a] (inches)	Laterally unsupported stud height[a] (feet)	Maximum spacing (inches)
							
2 × 3[b]	—	—	—	—	—	10	16
2 × 4	10	24[c]	16[c]	—	24	14	24
3 × 4	10	24	24	16	24	14	24
2 × 5	10	24	24	—	24	16	24
2 × 6	10	24	24	16	24	20	24

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

a. Listed heights are distances between points of lateral support placed perpendicular to the plane of the wall. Bearing walls shall be sheathed on not less than one side or bridging shall be installed not greater than 4 feet apart measured vertically from either end of the stud. Increases in unsupported height are permitted where in compliance with Exception 2 of Section R602.3.1 or designed in accordance with accepted engineering practice.

b. Shall not be used in exterior walls.

c. A habitable attic assembly supported by 2 × 4 studs is limited to a roof span of 32 feet. Where the roof span exceeds 32 feet, the wall studs shall be increased to 2 × 6 or the studs shall be designed in accordance with accepted engineering practice.

TABLE R602.3(6)
ALTERNATE WOOD BEARING WALL STUD SIZE, HEIGHT AND SPACING

STUD HEIGHT	SUPPORTING	STUD SPACING[a]	ULTIMATE DESIGN WIND SPEED					
			115 mph		130 mph[b]		140 mph[b]	
			Maximum roof/floor span[c]		Maximum roof/floor span[c]		Maximum roof/floor span[c]	
			12 ft	24 ft	12 ft	24 ft	12 ft	24 ft
11 ft	Roof only	12 in	2 × 4	2 × 4	2 × 4	2 × 4	2 × 4	2 × 4
		16 in	2 × 4	2 × 4	2 × 4	2 × 6	2 × 4	2 × 6
		24 in	2 × 6	2 × 6	2 × 6	2 × 6	2 × 6	2 × 6
	Roof and one floor	12 in	2 × 4	2 × 6	2 × 4	2 × 6	2 × 4	2 × 6
		16 in	2 × 6	2 × 6	2 × 6	2 × 6	2 × 6	2 × 6
		24 in	2 × 6	2 × 6	2 × 6	2 × 6	2 × 6	2 × 6
12 ft	Roof only	12 in	2 × 4	2 × 4	2 × 4	2 × 6	2 × 4	2 × 6
		16 in	2 × 4	2 × 6	2 × 6	2 × 6	2 × 6	2 × 6
		24 in	2 × 6	2 × 6	2 × 6	2 × 6	2 × 6	2 × 6
	Roof and one floor	12 in	2 × 4	2 × 6	2 × 6	2 × 6	2 × 6	2 × 6
		16 in	2 × 6	2 × 6	2 × 6	2 × 6	2 × 6	2 × 6
		24 in	2 × 6	2 × 6	2 × 6	2 × 6	2 × 6	DR

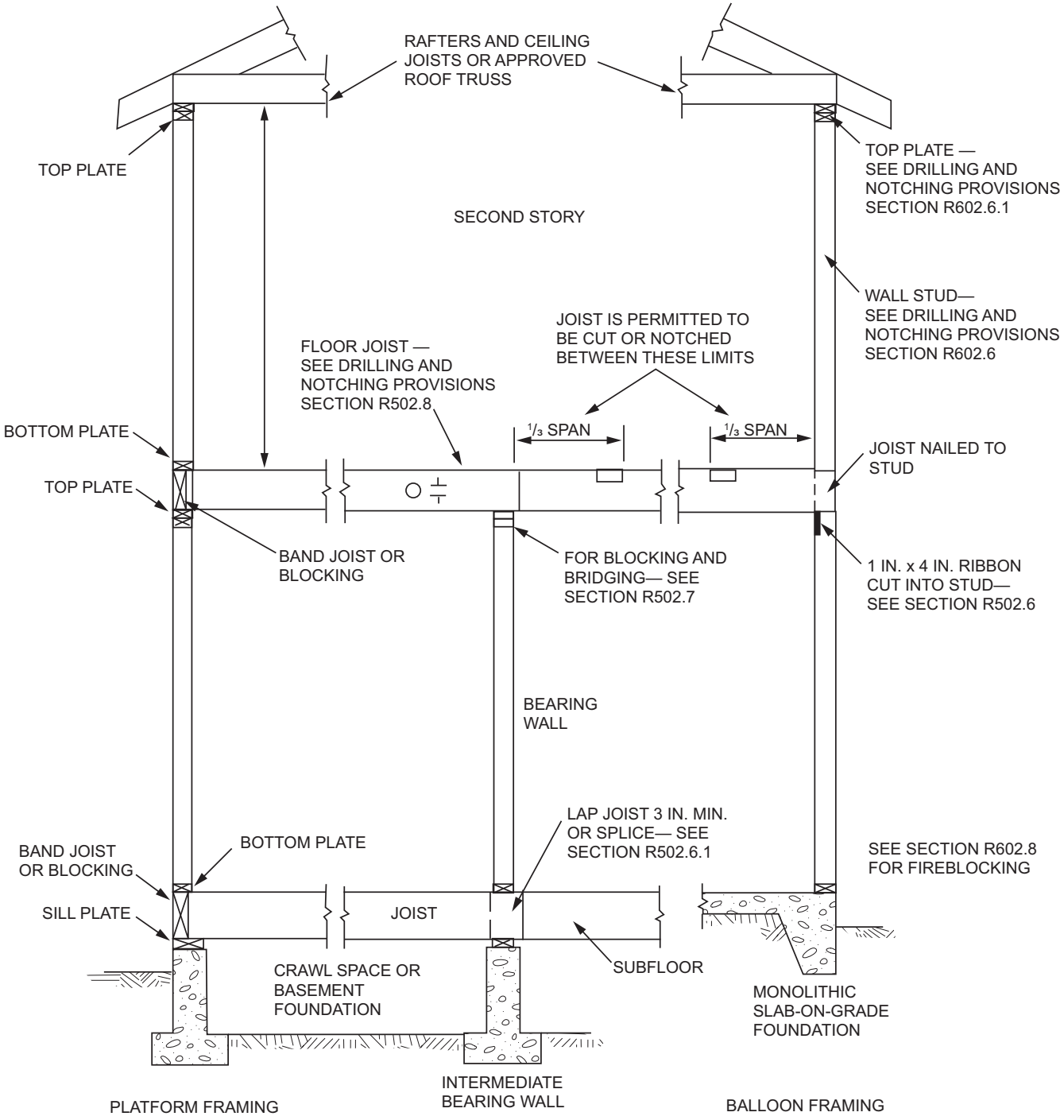
For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mph = 0.447 m/s, 1 pound = 4.448 N.

DR = Design Required.

a. Wall studs not exceeding 16 inches on center shall be sheathed with minimum $^{1}/_{2}$-inch gypsum board on the interior and $^{3}/_{8}$-inch wood structural panel sheathing on the exterior. Wood structural panel sheathing shall be attached with 8d (2.5″ × 0.131″) nails not greater than 6 inches on center along panel edges and 12 inches on center at intermediate supports, and all panel joints shall occur over studs or blocking.

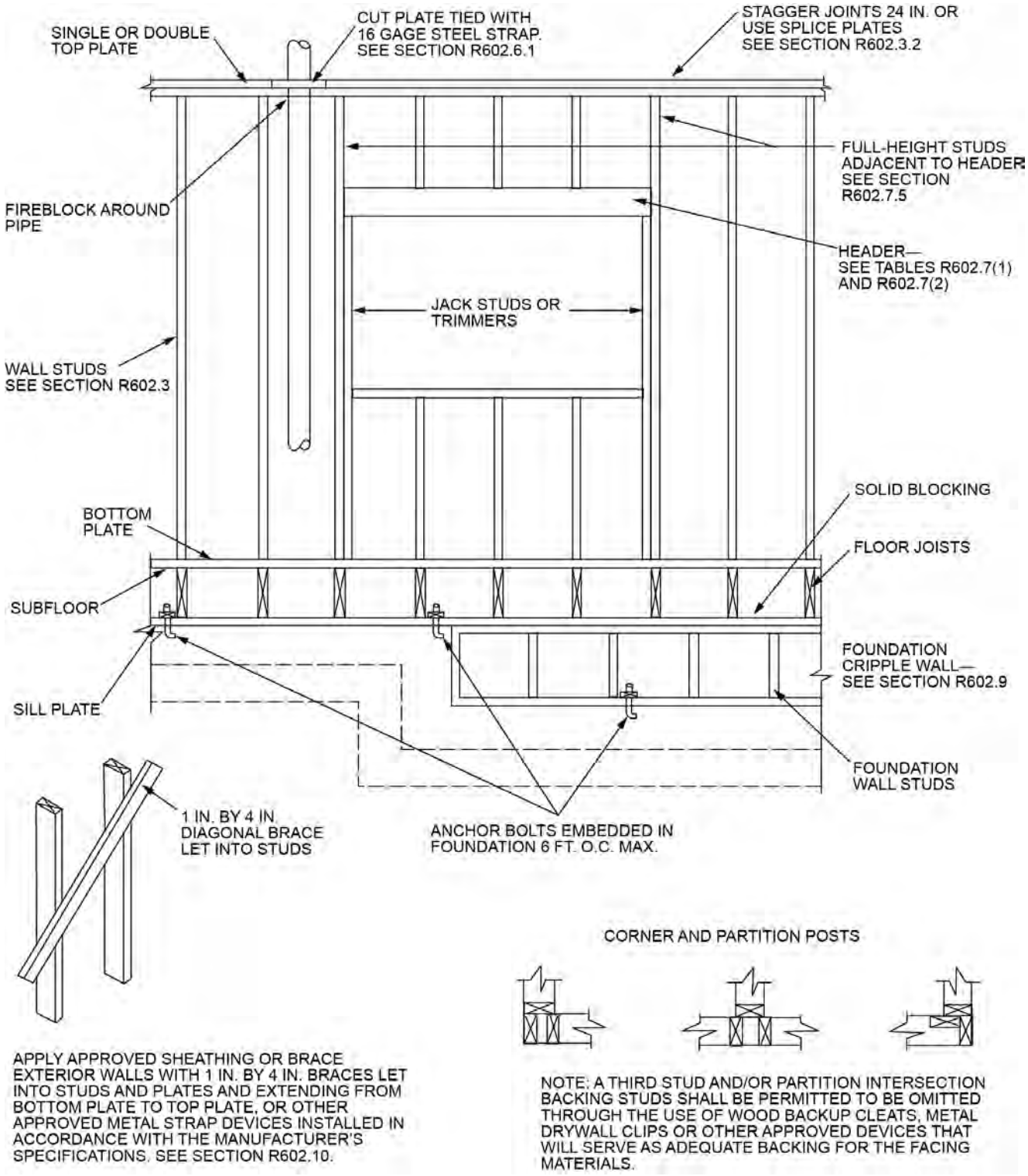
b. Where the ultimate design wind speed exceeds 115 mph, studs shall be attached to top and bottom plates with connectors having a minimum 300-pound lateral capacity.

c. The maximum span is applicable to both single- and multiple-span roof and floor conditions. The *roof assembly* shall not contain a habitable attic.



For SI: 1 inch = 25.4 mm.

FIGURE R602.3(1)
TYPICAL WALL, FLOOR AND ROOF FRAMING



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

FIGURE R602.3(2)
FRAMING DETAILS

TABLE R602.3.2
SINGLE TOP-PLATE SPLICE CONNECTION DETAILS
FOR BEARING WALLS AND BRACED WALL LINES

TOP-PLATE SPLICE LOCATION			
Corners and intersecting walls		Butt joints in straight walls	
Splice plate size	Minimum nails each side of joint	Splice plate size	Minimum nails each side of joint
3″ × 6″ × 0.036″ galvanized steel plate or equivalent	(6) 8d box ($2^1/_2$″ × 0.113″) nails	3″× 12″ × 0.036″ galvanized steel plate or equivalent	(12) 8d box ($2^1/_2$″ × 0.113″) nails

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

R602.6 Drilling and notching of studs. Drilling and notching of studs shall be in accordance with the following:

1. Notching. A stud in an exterior wall or bearing partition shall not be cut or notched to a depth exceeding 25 percent of its depth. Studs in nonbearing partitions shall not be notched to a depth exceeding 40 percent of a single stud depth. Notching of bearing studs shall be on one edge only and not to exceed one-fourth the height of the stud. Notching shall not occur in the bottom or top 6 inches (152 mm) of bearing studs.
2. Boring. The diameter of bored holes in studs shall not exceed 60 percent of the stud depth, the edge of the hole shall not be less than $^5/_8$ inch (16 mm) from the edge of the stud, and the hole shall not be closer than 6 inches (152 mm) from an adjacent hole or notch. Holes not exceeding $^3/_4$ inch (19 mm) diameter can be as close as $1^1/_2$ inches (38 mm) on center spacing. Where the diameter of a bored hole in a stud located in exterior walls or bearing partitions is between 40 percent and 60 percent of stud depth, such stud shall be doubled and not more than two successive doubled studs shall be so bored. See Figures R602.6(1) and R602.6(2).

   Exception: Where approved, stud shoes are installed in accordance with the manufacturer's instructions.
3. Cutting and notching of studs shall be permitted to be increased to 65 percent of the width of the stud in exterior and interior walls and bearing partitions, provided that one of the following conditions are met:
   (a) The wall section is reinforced with $^1/_2$-inch (13 mm) exterior grade plywood or equivalent reinforcement on the notched side of the wall. Plywood, if used, shall reach from the floor to ceiling and at least one stud further on each side of the section that has been notched or cut.
   (b) The exterior walls of a kitchen may be reinforced by placing $^1/_2$-inch (13 mm) plywood or equivalent reinforcement on the notched side of the wall. Plywood, if used, shall reach from the floor to counter-top height and at least one stud further on each side of the section that has been notched or cut.

R602.6.1 Drilling and notching of top plate. Where piping or ductwork is placed in or partly in an exterior wall or interior *load-bearing wall*, necessitating cutting, drilling or notching of the top plate by more than 50 percent of its width, a galvanized metal tie not less than 0.054 inch thick (1.37 mm) (16 ga) and $1^1/_2$ inches (38 mm) wide shall be fastened across and to the plate at each side of the opening with not less than eight 10d (0.148 inch diameter) nails having a minimum length of $1^1/_2$ inches (38 mm) at each side or equivalent. The metal tie must extend not less than 6 inches past the opening. See Figure R602.6.1.

Exception: Where the entire side of the wall with the notch or cut is covered by wood structural panel sheathing.

R602.7 Headers. For header spans, see Tables R602.7(1) and R602.7(2).

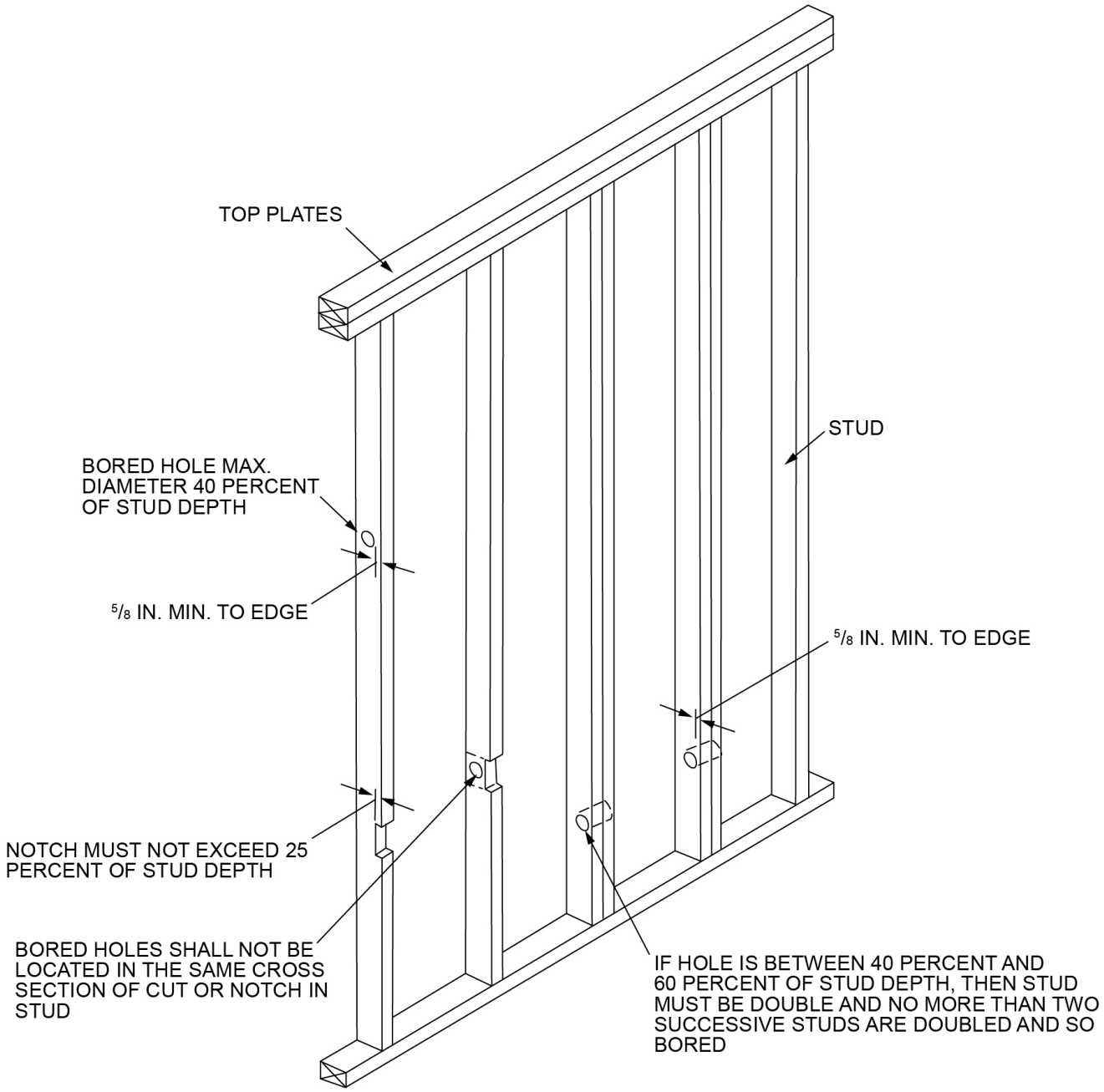
TABLE R602.7(3)
GIRDER AND HEADER SPANS[a] FOR OPEN PORCHES
DELETED

R602.7.1 Single member headers. Single headers shall be framed with a single flat 2-inch-nominal (51 mm) member or wall plate not less in width than the wall studs on the top and bottom of the header in accordance with Figures R602.7.1(1) and R602.7.1(2) and face nailed to the top and bottom of the header with 10d box nails (3 inches × 0.128 inches) spaced 12 inches on center.

R602.7.2 Rim board headers. Rim board header size, material and span shall be in accordance with Table R602.7(1). Rim board headers shall be constructed in accordance with Figure R602.7.2 and shall be supported at each end by full-height studs. The number of full-height studs at each end shall be not less than the number of studs displaced by half of the header span based on the maximum stud spacing in accordance with Table R602.3(5). Rim board headers supporting concentrated loads shall be designed in accordance with accepted engineering practice.

R602.7.3 Wood structural panel box headers. Wood structural panel box headers shall be constructed in accordance with Figure R602.7.3 and Table R602.7.3.

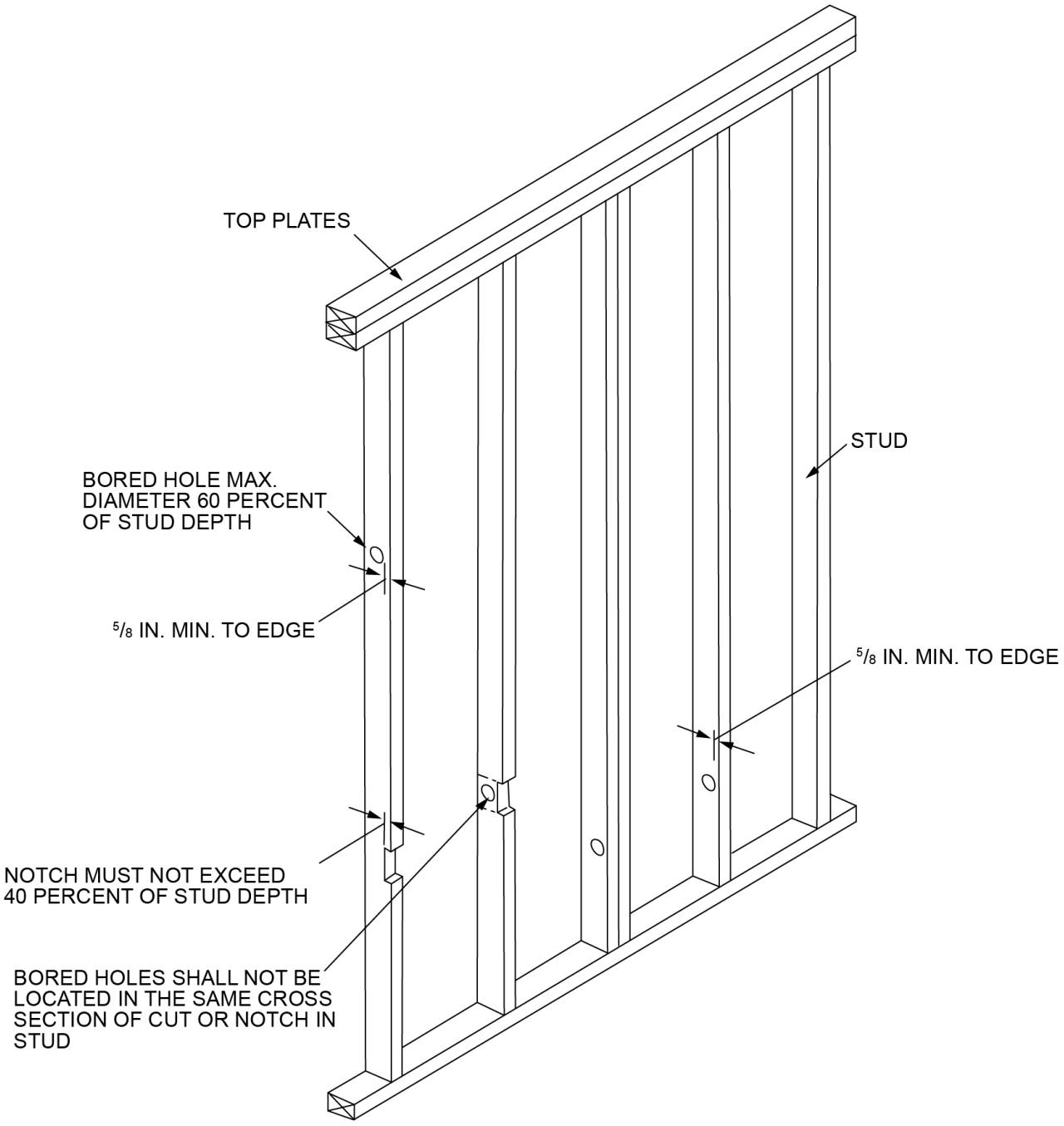
R602.7.4 Nonbearing walls. Load-bearing headers are not required in interior or exterior *nonbearing walls*. A single flat 2-inch by 4-inch (51 mm by 102 mm) member shall be permitted to be used as a header in interior or



For SI: 1 inch = 25.4 mm.

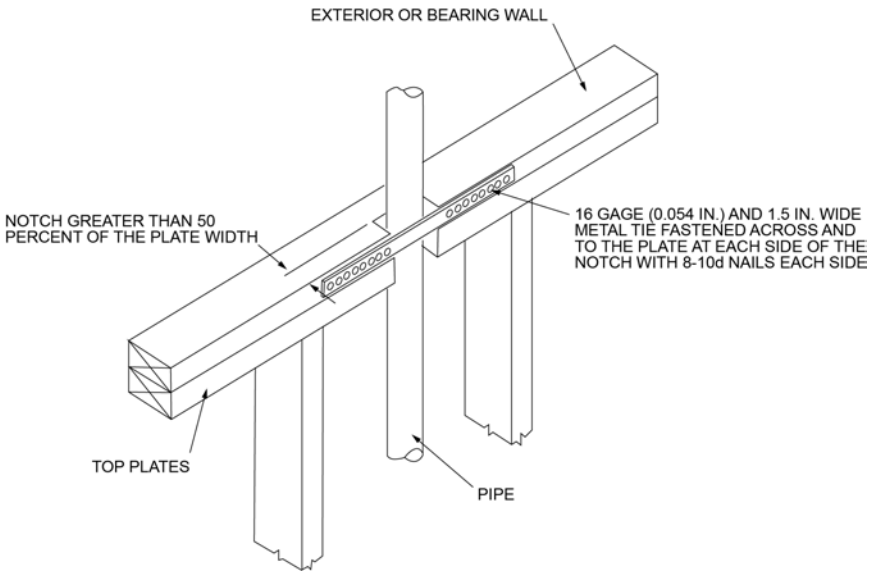
Note: Condition for exterior and bearing walls.

FIGURE R602.6(1)
NOTCHING AND BORED HOLE LIMITATIONS FOR EXTERIOR WALLS AND BEARING WALLS



For SI: 1 inch = 25.4 mm.

FIGURE R602.6(2)
NOTCHING AND BORED HOLE LIMITATIONS FOR INTERIOR NONBEARING WALLS



For SI: 1 inch = 25.4 mm.

FIGURE R602.6.1
TOP PLATE FRAMING TO ACCOMMODATE PIPING

exterior *nonbearing walls* for openings up to 8 feet (2438 mm) in width if the vertical distance to the parallel nailing surface above is not more than 24 inches (610 mm). For such nonbearing headers, cripples or blocking are not required above the header.

R602.7.5 Supports for headers. Headers shall be supported on each end with one or more jack studs or with *approved* framing anchors in accordance with Table R602.7(1) or R602.7(2). The full-height stud adjacent to each end of the header shall be end nailed to each end of the header in accordance with Table R602.3(1). The minimum number of full-height studs at each end of a header shall be in accordance with Table R602.7.5.

TABLE R602.7.5
MINIMUM NUMBER OF FULL-HEIGHT STUDS AT EACH END OF HEADERS IN EXTERIOR WALLS[a]

MAXIMUM HEADER SPAN (feet)	ULTIMATE DESIGN WIND SPEED AND EXPOSURE CATEGORY	
	< 140 mph, Exposure B or < 130 mph, Exposure C	≤ 115 mph, Exposure B[b]
4	1	1
6	2	1
8	2	1
10	3	2
12	3	2
14	3	2
16	4	2
18	4	2

For SI: 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s.

a. For header spans between those given, use the minimum number of full-height studs associated with the larger header span.

b. The tabulated minimum number of full-height studs is applicable where jack studs are provided to support the header at each end in accordance with Table R602.7(1). Where a framing anchor is used to support the header in lieu of a jack stud in accordance with Note d of Table R602.7(1), the minimum number of full-height studs at each end of a header shall be in accordance with requirements for wind speed < 140 mph, Exposure B.

R602.8 Fireblocking required. Fireblocking shall be provided in accordance with Section R302.11.

R602.9 Cripple walls. Foundation cripple walls shall be framed of studs not smaller than the studding above. Where exceeding 4 feet (1219 mm) in height, such walls shall be framed of studs having the size required for an additional story.

Exterior cripple walls with a stud height less than 14 inches (356 mm) shall be continuously sheathed on one side with wood structural panels fastened to both the top and bottom plates in accordance with Table R602.3(1), or the cripple walls shall be constructed of solid blocking.

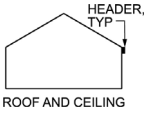
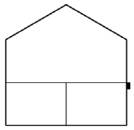
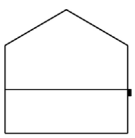
Cripple walls shall be supported on continuous foundations.

R602.10 Wall bracing. Buildings shall be braced in accordance with this section or, when applicable, Section R602.12. Where a building, or portion thereof, does not comply with one or more of the bracing requirements in this section, those portions shall be designed and constructed in accordance with Section R301.1.

R602.10.1 Braced wall lines. For the purpose of determining the amount and location of bracing required in each story level of a building, *braced wall lines* shall be designated as straight lines in the building plan placed in accordance with this section.

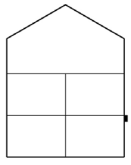
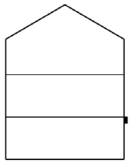
R602.10.1.1 Length of a braced wall line. The length of a *braced wall line* shall be the distance between its ends. The end of a *braced wall line* shall be the intersection with a perpendicular *braced wall line*, an

TABLE R602.7(1)
GIRDER SPANS[a] AND HEADER SPANS[a] FOR EXTERIOR BEARING WALLS
(Maximum spans for Douglas fir-larch, hem-fir, Southern pine and spruce-pine-fir[b] and required number of jack studs)

GIRDERS AND HEADERS SUPPORTING	SIZE	GROUND SNOW LOAD (psf)[e]																	
		30						50						70					
		Building width[c] (feet)																	
		12		24		36		12		24		36		12		24		36	
		Span	NJ[d]	Span	NJ[d]	Span	NJ[d]	Span	NJ[d]	Span	NJ[d]	Span	NJ[d]	Span	NJ[d]	Span	NJ[d]	Span	NJ[d]
Roof and ceiling  ROOF AND CEILING	1-2 × 6	4-0	1	3-1	2	2-7	2	3-5	1	2-8	2	2-3	2	3-0	2	2-4	2	2-0	2
	1-2 × 8	5-1	2	3-11	2	3-3	2	4-4	2	3-4	2	2-10	2	3-10	2	3-0	2	2-6	3
	1-2 × 10	6-0	2	4-8	2	3-11	2	5-2	2	4-0	2	3-4	3	4-7	2	3-6	3	3-0	3
	1-2 × 12	7-1	2	5-5	2	4-7	3	6-1	2	4-8	3	3-11	3	5-5	2	4-2	3	3-6	3
	2-2 × 4	4-0	1	3-1	1	2-7	1	3-5	1	2-7	1	2-2	1	3-0	1	2-4	1	2-0	1
	2-2 × 6	6-0	1	4-7	1	3-10	1	5-1	1	3-11	1	3-3	2	4-6	1	3-6	2	2-11	2
	2-2 × 8	7-7	1	5-9	1	4-10	2	6-5	1	5-0	2	4-2	2	5-9	1	4-5	2	3-9	2
	2-2 × 10	9-0	1	6-10	2	5-9	2	7-8	2	5-11	2	4-11	2	6-9	2	5-3	2	4-5	2
	2-2 × 12	10-7	2	8-1	2	6-10	2	9-0	2	6-11	2	5-10	2	8-0	2	6-2	2	5-2	3
	3-2 × 8	9-5	1	7-3	1	6-1	1	8-1	1	6-3	1	5-3	2	7-2	1	5-6	2	4-8	2
	3-2 × 10	11-3	1	8-7	1	7-3	2	9-7	1	7-4	2	6-2	2	8-6	1	6-7	2	5-6	2
	3-2 × 12	13-2	1	10-1	2	8-6	2	11-3	2	8-8	2	7-4	2	10-0	2	7-9	2	6-6	2
	4-2 × 8	10-11	1	8-4	1	7-0	1	9-4	1	7-2	1	6-0	1	8-3	1	6-4	1	5-4	2
	4-2 × 10	12-11	1	9-11	1	8-4	1	11-1	1	8-6	1	7-2	2	9-10	1	7-7	2	6-4	2
	4-2 × 12	15-3	1	11-8	1	9-10	2	13-0	1	10-0	2	8-5	2	11-7	1	8-11	2	7-6	2
Roof, ceiling and one center-bearing floor  ROOF, CEILING AND ONE FLOOR (CENTER BEARING)	1-2 × 6	3-3	1	2-7	2	2-2	2	3-0	2	2-4	2	2-0	2	2-9	2	2-2	2	1-10	2
	1-2 × 8	4-1	2	3-3	2	2-9	2	3-9	2	3-0	2	2-6	3	3-6	2	2-9	2	2-4	3
	1-2 × 10	4-11	2	3-10	2	3-3	3	4-6	2	3-6	3	3-0	3	4-1	2	3-3	3	2-9	3
	1-2 × 12	5-9	2	4-6	3	3-10	3	5-3	2	4-2	3	3-6	3	4-10	3	3-10	3	3-3	4
	2-2 × 4	3-3	1	2-6	1	2-2	1	3-0	1	2-4	1	2-0	1	2-8	1	2-2	1	1-10	1
	2-2 × 6	4-10	1	3-9	1	3-3	2	4-5	1	3-6	2	3-0	2	4-1	1	3-3	2	2-9	2
	2-2 × 8	6-1	1	4-10	2	4-1	2	5-7	2	4-5	2	3-9	2	5-2	2	4-1	2	3-6	2
	2-2 × 10	7-3	2	5-8	2	4-10	2	6-8	2	5-3	2	4-5	2	6-1	2	4-10	2	4-1	2
	2-2 × 12	8-6	2	6-8	2	5-8	2	7-10	2	6-2	2	5-3	3	7-2	2	5-8	2	4-10	3
	3-2 × 8	7-8	1	6-0	1	5-1	2	7-0	1	5-6	2	4-8	2	6-5	1	5-1	2	4-4	2
	3-2 × 10	9-1	1	7-2	2	6-1	2	8-4	1	6-7	2	5-7	2	7-8	2	6-1	2	5-2	2
	3-2 × 12	10-8	2	8-5	2	7-2	2	9-10	2	7-8	2	6-7	2	9-0	2	7-1	2	6-1	2
	4-2 × 8	8-10	1	6-11	1	5-11	1	8-1	1	6-4	1	5-5	2	7-5	1	5-11	1	5-0	2
	4-2 × 10	10-6	1	8-3	2	7-0	2	9-8	1	7-7	2	6-5	2	8-10	1	7-0	2	6-0	2
	4-2 × 12	12-4	1	9-8	2	8-3	2	11-4	2	8-11	2	7-7	2	10-4	2	8-3	2	7-0	2
Roof, ceiling and one clear-span floor  ROOF, CEILING AND ONE FLOOR (CLEAR SPAN)	1-2 × 6	2-11	2	2-3	2	1-11	2	2-9	2	2-1	2	1-9	2	2-7	2	2-0	2	1-8	2
	1-2 × 8	3-9	2	2-10	2	2-5	3	3-6	2	2-8	2	2-3	3	3-3	2	2-6	3	2 -2	3
	1-2 × 10	4-5	2	3-5	3	2-10	3	4-2	2	3-2	3	2-8	3	3-11	2	3-0	3	2-6	3
	1-2 × 12	5-2	2	4-0	3	3-4	3	4-10	3	3-9	3	3-2	4	4-7	3	3-6	3	3-0	4
	2-2 × 4	2-11	1	2-3	1	1-10	1	2-9	1	2-1	1	1-9	1	2-7	1	2-0	1	1-8	1
	2-2 × 6	4-4	1	3-4	2	2-10	2	4-1	1	3-2	2	2-8	2	3-10	1	3-0	2	2-6	2
	2-2 × 8	5-6	2	4-3	2	3-7	2	5-2	2	4-0	2	3-4	2	4-10	2	3-9	2	3-2	2
	2-2 × 10	6-7	2	5-0	2	4-2	2	6-1	2	4-9	2	4-0	2	5-9	2	4-5	2	3-9	3
	2-2 × 12	7-9	2	5-11	2	4-11	3	7-2	2	5-7	2	4-8	3	6-9	2	5-3	3	4-5	3
	3-2 × 8	6-11	1	5-3	2	4-5	2	6-5	1	5-0	2	4-2	2	6-1	1	4-8	2	4-0	2
	3-2 × 10	8-3	2	6-3	2	5-3	2	7-8	2	5-11	2	5-0	2	7-3	2	5-7	2	4-8	2
	3-2 × 12	9-8	2	7-5	2	6-2	2	9-0	2	7-0	2	5-10	2	8-6	2	6-7	2	5-6	3
	4-2 × 8	8-0	1	6-1	1	5-1	2	7-5	1	5-9	2	4-10	2	7-0	1	5-5	2	4-7	2
	4-2 × 10	9-6	1	7-3	2	6-1	2	8-10	1	6-10	2	5-9	2	8-4	1	6-5	2	5-5	2
	4-2 × 12	11-2	2	8-6	2	7-2	2	10-5	2	8-0	2	6-9	2	9-10	2	7-7	2	6-5	2

(continued)

TABLE R602.7(1)—continued
GIRDER SPANS[a] AND HEADER SPANS[a] FOR EXTERIOR BEARING WALLS
(Maximum spans for Douglas fir-larch, hem-fir, Southern pine and spruce-pine-fir[b] and required number of jack studs)

GIRDERS AND HEADERS SUPPORTING	SIZE	GROUND SNOW LOAD (psf)[e]																	
		30						50						70					
		Building width[c] (feet)																	
		12		24		36		12		24		36		12		24		36	
		Span	NJ[d]	Span	NJ[d]	Span	NJ[d]	Span	NJ[d]	Span	NJ[d]	Span	NJ[d]	Span	NJ[d]	Span	NJ[d]	Span	NJ[d]
Roof, ceiling and two center-bearing floors  ROOF, CEILING AND TWO FLOORS (CENTER BEARING)	1-2 × 6	2-8	2	2-1	2	1-10	2	2-7	2	2-0	2	1-9	2	2-5	2	1-11	2	1-8	2
	1-2 × 8	3-5	2	2-8	2	2-4	3	3-3	2	2-7	2	2-2	3	3-1	2	2-5	3	2-1	3
	1-2 × 10	4-0	2	3-2	3	2-9	3	3-10	2	3-1	3	2-7	3	3-8	2	2-11	3	2-5	3
	1-2 × 12	4-9	3	3-9	3	3-2	4	4-6	3	3-7	3	3-1	4	4-3	3	3-5	3	2-11	4
	2-2 × 4	2-8	1	2-1	1	1-9	1	2-6	1	2-0	1	1-8	1	2-5	1	1-11	1	1-7	1
	2-2 × 6	4-0	1	3-2	2	2-8	2	3-9	1	3-0	2	2-7	2	3-7	1	2-10	2	2-5	2
	2-2 × 8	5-0	2	4-0	2	3-5	2	4-10	2	3-10	2	3-3	2	4-7	2	3-7	2	3-1	2
	2-2 × 10	6-0	2	4-9	2	4-0	2	5-8	2	4-6	2	3-10	3	5-5	2	4-3	2	3-8	3
	2-2 × 12	7-0	2	5-7	2	4-9	3	6-8	2	5-4	3	4-6	3	6-4	2	5-0	3	4-3	3
	3-2 × 8	6-4	1	5-0	2	4-3	2	6-0	1	4-9	2	4-1	2	5-8	2	4-6	2	3-10	2
	3-2 × 10	7-6	2	5-11	2	5-1	2	7-1	2	5-8	2	4-10	2	6-9	2	5-4	2	4-7	2
	3-2 × 12	8-10	2	7-0	2	5-11	2	8-5	2	6-8	2	5-8	3	8-0	2	6-4	2	5-4	3
	4-2 × 8	7-3	1	5-9	1	4-11	2	6-11	1	5-6	2	4-8	2	6-7	1	5-2	2	4-5	2
	4-2 × 10	8-8	1	6-10	2	5-10	2	8-3	2	6-6	2	5-7	2	7-10	2	6-2	2	5-3	2
	4-2 × 12	10-2	2	8-1	2	6-10	2	9-8	2	7-8	2	6-7	2	9-2	2	7-3	2	6-2	2
Roof, ceiling, and two clear-span floors  ROOF, CEILING AND TWO FLOORS (CLEAR SPAN)	1-2 × 6	2-3	2	1-9	2	1-5	2	2-3	2	1-9	2	1-5	3	2-2	2	1-8	2	1-5	3
	1-2 × 8	2-10	2	2-2	3	1-10	3	2-10	2	2-2	3	1-10	3	2-9	2	2-1	3	1-10	3
	1-2 × 10	3-4	2	2-7	3	2-2	3	3-4	3	2-7	3	2-2	4	3-3	3	2-6	3	2-2	4
	1-2 × 12	4-0	3	3-0	3	2-7	4	4-0	3	3-0	4	2-7	4	3-10	3	3-0	4	2-6	4
	2-2 × 4	2-3	1	1-8	1	1-4	1	2-3	1	1-8	1	1-4	1	2-2	1	1-8	1	1-4	2
	2-2 × 6	3-4	1	2-6	2	2-2	2	3-4	2	2-6	2	2-2	2	3-3	2	2-6	2	2-1	2
	2-2 × 8	4-3	2	3-3	2	2-8	2	4-3	2	3-3	2	2-8	2	4-1	2	3-2	2	2-8	3
	2-2 × 10	5-0	2	3-10	2	3-2	3	5-0	2	3-10	2	3-2	3	4-10	2	3-9	3	3-2	3
	2-2 × 12	5-11	2	4-6	3	3-9	3	5-11	2	4-6	3	3-9	3	5-8	2	4-5	3	3-9	3
	3-2 × 8	5-3	1	4-0	2	3-5	2	5-3	2	4-0	2	3-5	2	5-1	2	3-11	2	3-4	2
	3-2 × 10	6-3	2	4-9	2	4-0	2	6-3	2	4-9	2	4-0	2	6-1	2	4-8	2	4-0	3
	3-2 × 12	7-5	2	5-8	2	4-9	3	7-5	2	5-8	2	4-9	3	7-2	2	5-6	3	4-8	3
	4-2 × 8	6-1	1	4-8	2	3-11	2	6-1	1	4-8	2	3-11	2	5-11	1	4-7	2	3-10	2
	4-2 × 10	7-3	2	5-6	2	4-8	2	7-3	2	5-6	2	4-8	2	7-0	2	5-5	2	4-7	2
	4-2 × 12	8-6	2	6-6	2	5-6	2	8-6	2	6-6	2	5-6	2	8-3	2	6-4	2	5-4	3

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

a. Spans are given in feet and inches.

b. Spans are based on minimum design properties for No. 2 grade lumber of Douglas fir-larch, hem-fir, Southern pine, and spruce-pine-fir.

c. Building width is measured perpendicular to the ridge. For widths between those shown, spans are permitted to be interpolated.

d. NJ = Number of jack studs required to support each end. Where the number of required jack studs equals one, the header is permitted to be supported by an approved framing anchor attached to the full-height wall stud and to the header.

e. Use 30 psf ground snow load for cases in which ground snow load is less than 30 psf and the roof live load is equal to or less than 20 psf.

TABLE R602.7(2)
GIRDER SPANS[a] AND HEADER SPANS[a] FOR INTERIOR BEARING WALLS
(Maximum spans for Douglas fir-larch, hem-fir, southern pine and spruce-pine-fir[b] and required number of jack studs)

HEADERS AND GIRDERS SUPPORTING	SIZE	BUILDING Width[c] (feet)					
		12		24		36	
		Span	NJ[d]	Span	NJ[d]	Span	NJ[d]
One floor only	2-2 × 4	4-1	1	2-10	1	2-4	1
	2-2 × 6	6-1	1	4-4	1	3-6	1
	2-2 × 8	7-9	1	5-5	1	4-5	2
	2-2 × 10	9-2	1	6-6	2	5-3	2
	2-2 × 12	10-9	1	7-7	2	6-3	2
	3-2 × 8	9-8	1	6-10	1	5-7	1
	3-2 × 10	11-5	1	8-1	1	6-7	2
	3-2 × 12	13-6	1	9-6	2	7-9	2
	4-2 × 8	11-2	1	7-11	1	6-5	1
	4-2 × 10	13-3	1	9-4	1	7-8	1
	4-2 × 12	15-7	1	11-0	1	9-0	2
Two floors	2-2 × 4	2-7	1	1-11	1	1-7	1
	2-2 × 6	3-11	1	2-11	2	2-5	2
	2-2 × 8	5-0	1	3-8	2	3-1	2
	2-2 × 10	5-11	2	4-4	2	3-7	2
	2-2 × 12	6-11	2	5-2	2	4-3	3
	3-2 × 8	6-3	1	4-7	2	3-10	2
	3-2 × 10	7-5	1	5-6	2	4-6	2
	3-2 × 12	8-8	2	6-5	2	5-4	2
	4-2 × 8	7-2	1	5-4	1	4-5	2
	4-2 × 10	8-6	1	6-4	2	5-3	2
	4-2 × 12	10-1	1	7-5	2	6-2	2

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

a. Spans are given in feet and inches.

b. Spans are based on minimum design properties for No. 2 grade lumber of Douglas fir-larch, hem-fir, Southern pine, and spruce-pine-fir.

c. Building width is measured perpendicular to the ridge. For widths between those shown, spans are permitted to be interpolated.

d. NJ = Number of jack studs required to support each end. Where the number of required jack studs equals one, the header is permitted to be supported by an approved framing anchor attached to the full-height wall stud and to the header.

>

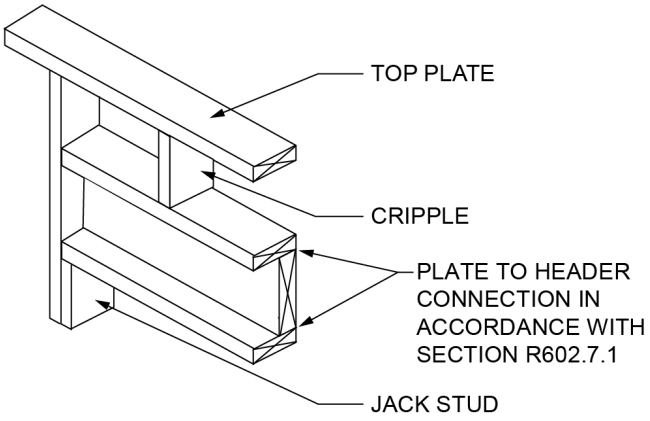


FIGURE R602.7.1(1)
SINGLE-MEMBER HEADER IN EXTERIOR BEARING WALL

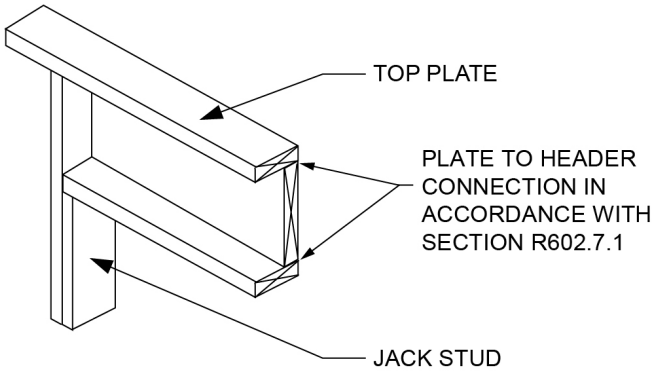
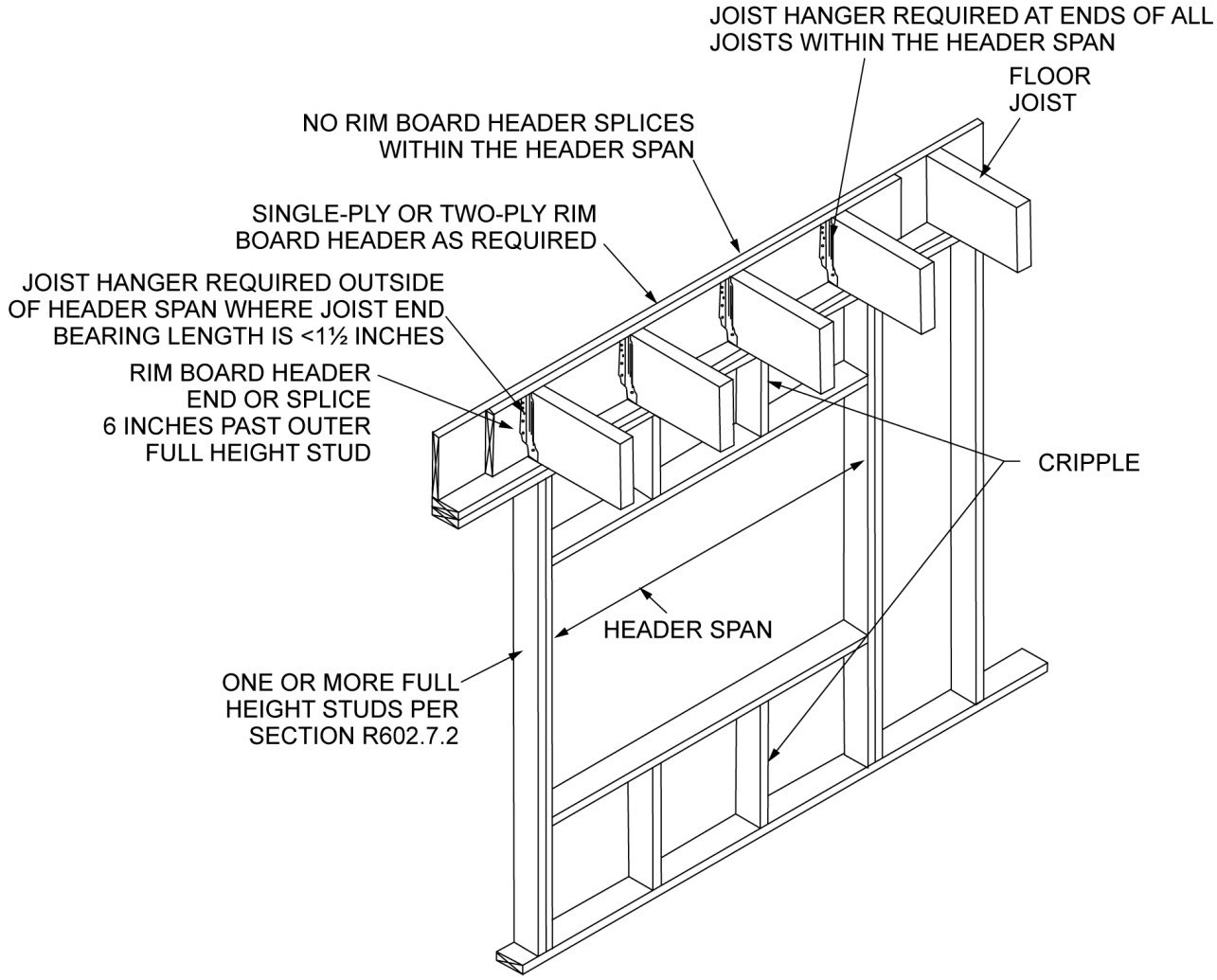


FIGURE R602.7.1(2)
ALTERNATIVE SINGLE-MEMBER HEADER WITHOUT CRIPPLE



For SI: 25.4 mm = 1 inch.

FIGURE R602.7.2
RIM BOARD HEADER CONSTRUCTION

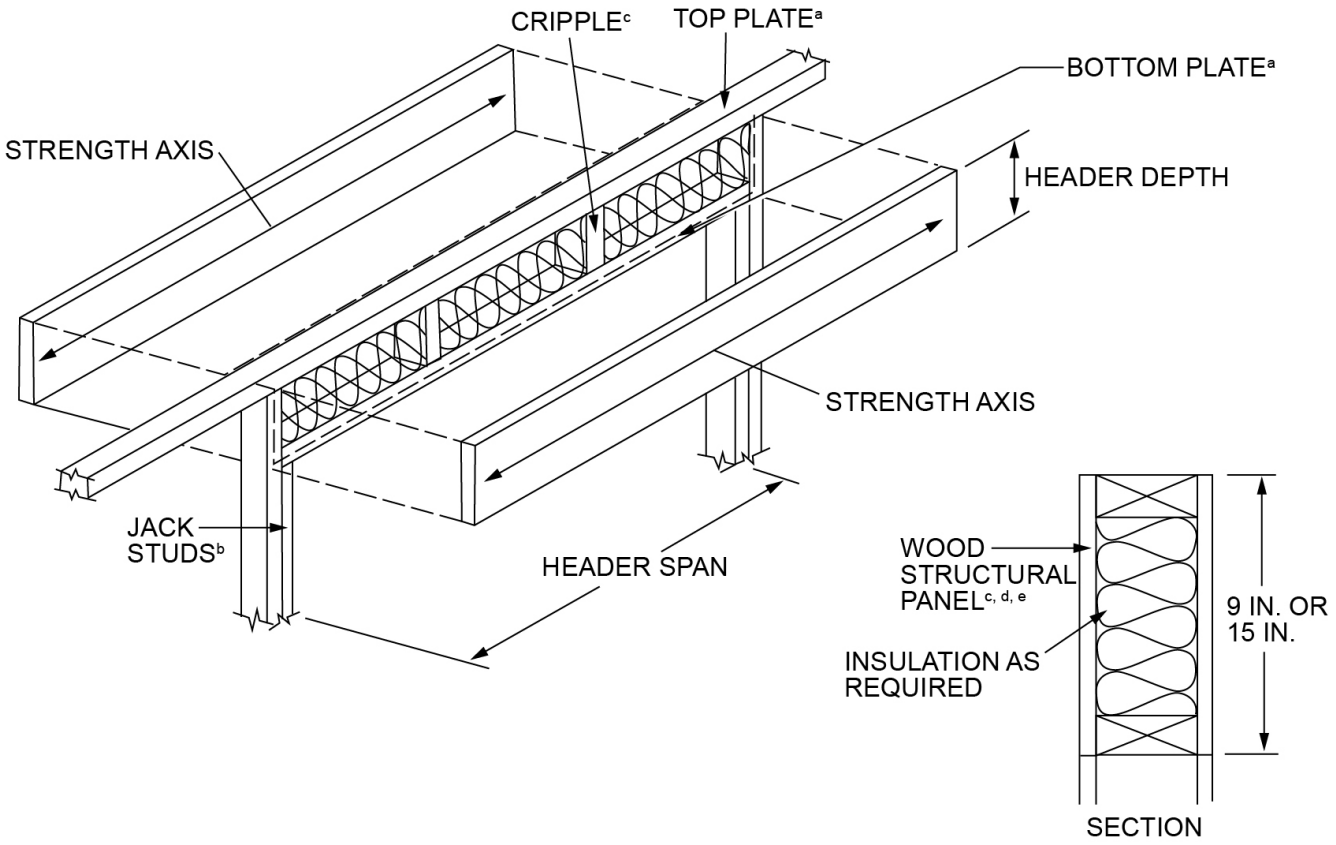
TABLE R602.7.3
MAXIMUM SPANS FOR WOOD STRUCTURAL PANEL BOX HEADERS[a]

HEADER CONSTRUCTION[b]	HEADER DEPTH (inches)	HOUSE DEPTH (feet)				
		24	26	28	30	32
Wood structural panel—one side	9	4	4	3	3	—
	15	5	5	4	3	3
Wood structural panel—both sides	9	7	5	5	4	3
	15	8	8	7	7	6

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

a. Spans are based on single story with clear-span trussed roof or two story with floor and roof supported by interior-bearing walls.

b. See Figure R602.7.3 for construction details.



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

Notes:

a. The top and bottom plates shall be continuous at header location.

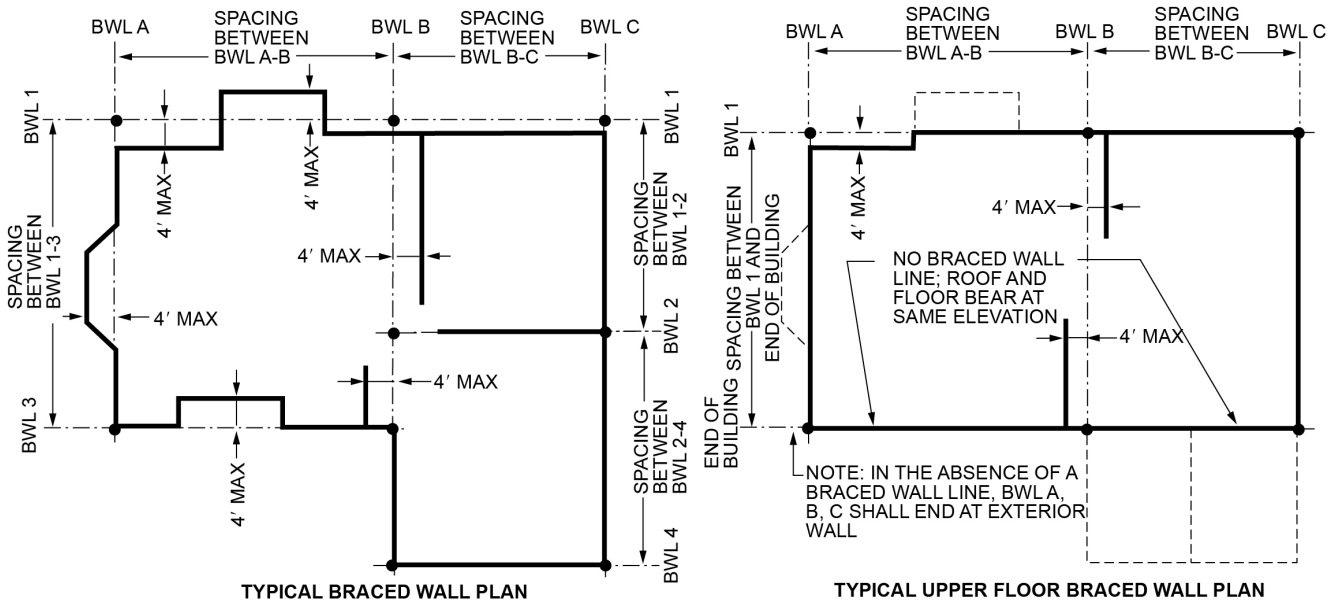
b. Jack studs shall be used for spans over 4 feet.

c. Cripple spacing shall be the same as for studs.

d. Wood structural panel faces shall be single pieces of $^{15}/_{32}$-inch-thick Exposure 1 (exterior glue) or thicker, installed on the interior or exterior or both sides of the header.

e. Wood structural panel faces shall be nailed to framing and cripples with 8d common or galvanized box nails spaced 3 inches on center, staggering alternate nails $^{1}/_{2}$ inch. Galvanized nails shall be hot-dipped or tumbled.

FIGURE R602.7.3
TYPICAL WOOD STRUCTURAL PANEL BOX HEADER CONSTRUCTION



For SI: 1 foot = 304.8 mm.

FIGURE R602.10.1.1
BRACED WALL LINES

angled *braced wall line* as permitted in Section R602.10.1.4 or an exterior wall as shown in Figure R602.10.1.1.

R602.10.1.2 Location of braced wall lines and permitted offsets. Each *braced wall line* shall be located such that no more than two-thirds of the required *braced wall panel* length is located to one side of the *braced wall line*. Braced wall panels shall be permitted to be offset up to 4 feet (1219 mm) from the designated *braced wall line*. Braced wall panels parallel to a *braced wall line* shall be offset not more than 4 feet (1219 mm) from the designated *braced wall line* location as shown in Figure R602.10.1.1.

Exterior walls parallel to a *braced wall line* shall be offset not more than 4 feet (1219 mm) from the designated *braced wall line* location as shown in Figure R602.10.1.1.

Interior walls used as bracing shall be offset not more than 4 feet (1219 mm) from a *braced wall line* through the interior of the building as shown in Figure R602.10.1.1.

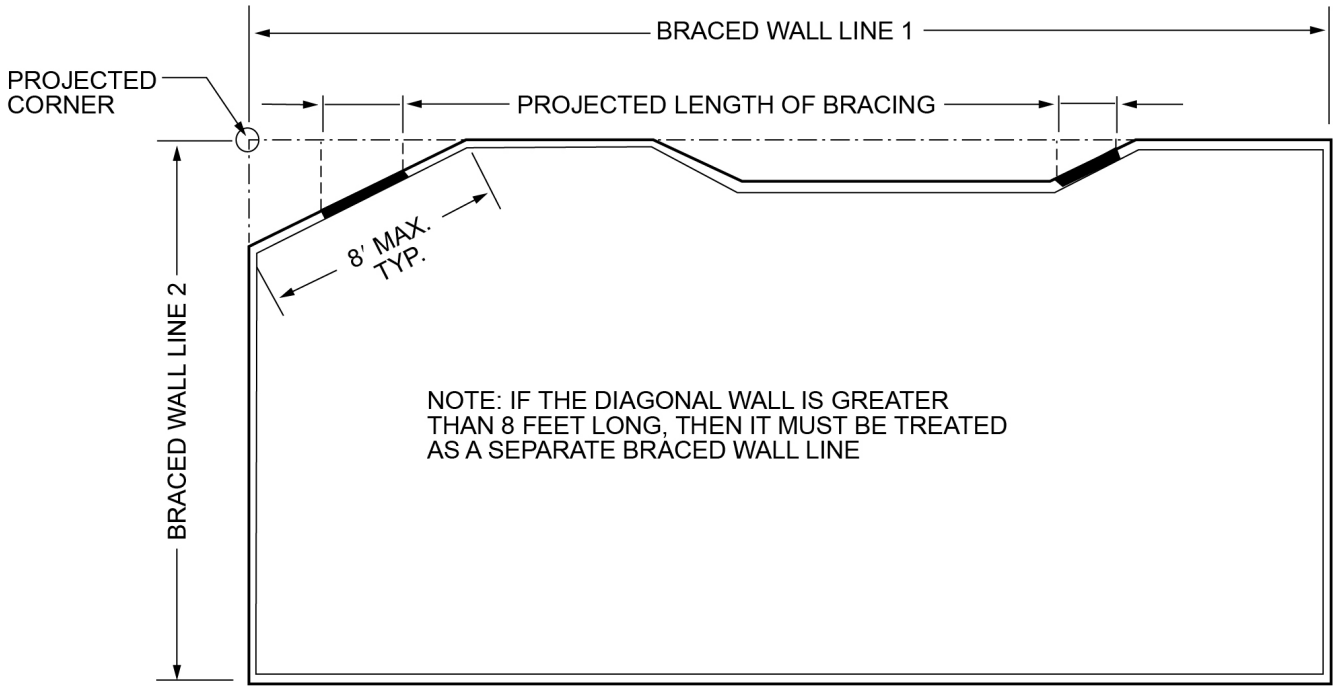
R602.10.1.3 Spacing of braced wall lines. The spacing between parallel *braced wall lines* shall be in accordance with Table R602.10.1.3. Intermediate *braced wall lines* through the interior of the building shall be permitted.

R602.10.1.4 Angled walls. Any portion of a wall along a *braced wall line* shall be permitted to angle out of plane for a maximum diagonal length of 8 feet (2438 mm). Where the angled wall occurs at a corner, the length of the *braced wall line* shall be measured from the projected corner as shown in Figure R602.10.1.4. Where the diagonal length is greater than 8 feet (2438 mm), it shall be considered to be a separate *braced wall line* and shall be braced in accordance with Section R602.10.1.

TABLE R602.10.1.3
BRACED WALL LINE SPACING

APPLICATION	CONDITION	BUILDING TYPE	BRACED WALL LINE SPACING CRITERIA	
			Maximum Spacing	Exception to Maximum Spacing
Wind bracing	Ultimate design wind speed < 140 mph	Detached, townhouse	60 feet	None
Seismic bracing	SDC A – C	Detached	Use wind bracing	
	SDC A – B	Townhouse	Use wind bracing	
	SDC C	Townhouse	35 feet	Up to 50 feet when length of required bracing per Table R602.10.3(3) is adjusted in accordance with Table R602.10.3(4).

For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m^2, 1 mile per hour = 0.447 m/s.



For SI: 1 foot = 304.8 mm.

FIGURE R602.10.1.4
ANGLED WALLS

R602.10.2 Braced wall panels. *Braced wall panel*s shall be full-height sections of wall that shall not have vertical or horizontal offsets. *Braced wall panel*s shall be constructed and placed along a *braced wall line* in accordance with this section and the bracing methods specified in Section R602.10.4.

R602.10.2.1 Braced wall panel uplift load path. The bracing lengths in Table R602.10.3(1) apply only when uplift loads are resisted in accordance with Section R602.3.5.

R602.10.2.2 Locations of braced wall panels. A *braced wall panel* shall begin within 10 feet (3810 mm) from each end of a *braced wall line* as determined in Section R602.10.1.1. The distance between adjacent edges of braced wall panels along a *braced wall line* shall be not greater than 20 feet (6096 mm) as shown in Figure R602.10.2.2.

Exceptions:

1. Deleted.
2. *Braced wall panels* with continuous sheathing in *Seismic Design Categories* A, B and C shall comply with Section R602.10.7.

R602.10.2.2.1 Location of braced wall panels in Seismic Design Categories D_0, D_1 and D_2. Deleted.

R602.10.2.3 Minimum number of braced wall panels. *Braced wall lines* with a length of 16 feet (4877 mm) or less shall have not less than two *braced wall panel*s of any length or one *braced wall panel* equal to 48 inches (1219 mm) or more. *Braced wall lines* greater than 16 feet (4877 mm) shall have not less than two *braced wall panel*s.

R602.10.3 Required length of bracing. The required length of bracing along each *braced wall line* shall be determined as follows:

1. All buildings in *Seismic Design Categories* A and B shall use Table R602.10.3(1) and the applicable adjustment factors in Table R602.10.3(2).
2. Detached buildings in *Seismic Design Category* C shall use Table R602.10.3(1) and the applicable adjustment factors in Table R602.10.3(2).
3. Townhouses in *Seismic Design Category* C shall use the greater value determined from Table R602.10.3(1) or R602.10.3(3) and the applicable adjustment factors in Table R602.10.3(2) or R602.10.3(4), respectively.
4. Deleted.

Only *braced wall panel*s parallel to the *braced wall line* shall contribute toward the required length of bracing of that *braced wall line*. *Braced wall panel*s along an angled wall meeting the minimum length requirements of Tables R602.10.5 and R602.10.5.2 shall be permitted to contribute its projected length toward the minimum required length of bracing for the *braced wall line* as

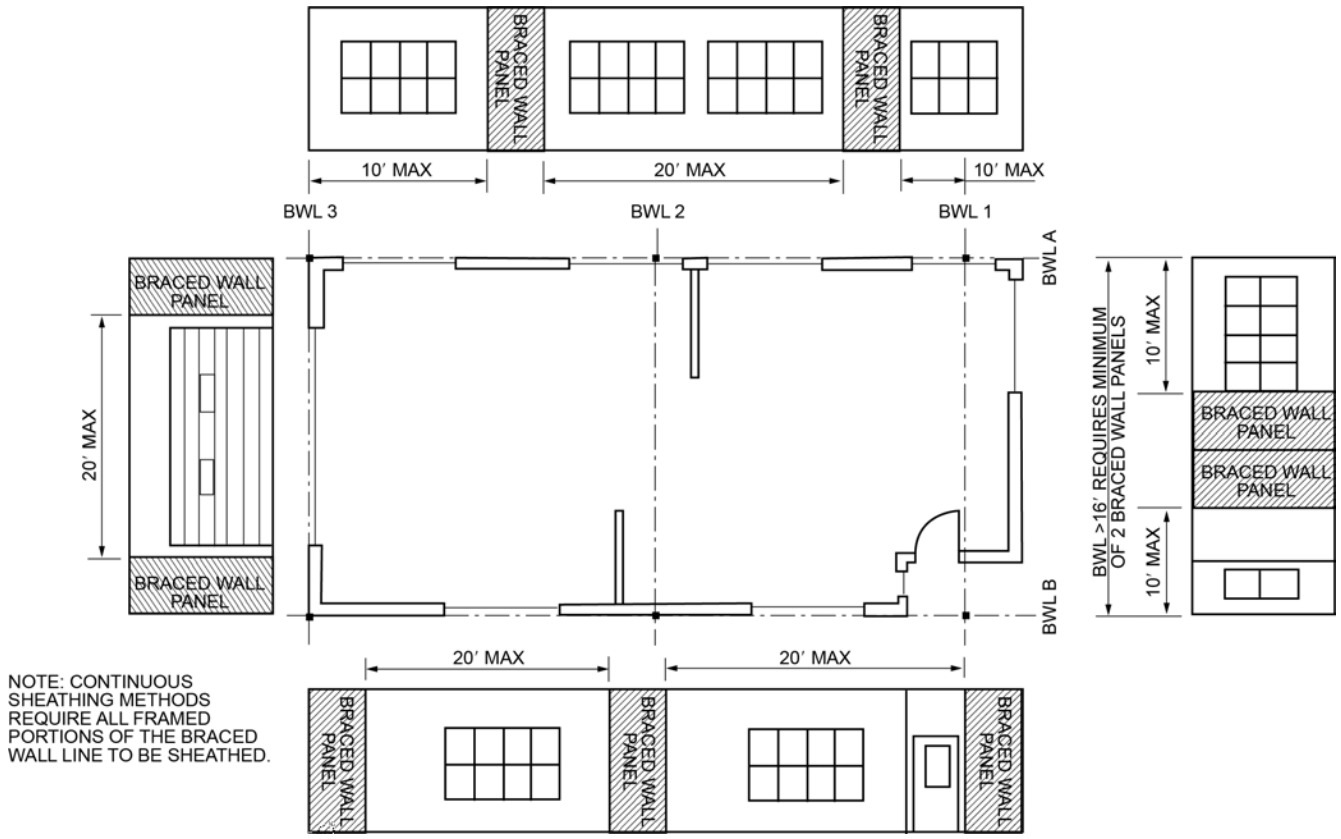
shown in Figure R602.10.1.4. Any *braced wall panel* on an angled wall at the end of a *braced wall line* shall contribute its projected length for only one of the *braced wall lines* at the projected corner.

Exception: Deleted.

R602.10.4 Construction methods for braced wall panels. Intermittent and continuously sheathed *braced wall panel*s shall be constructed in accordance with this section and the methods listed in Table R602.10.4.

R602.10.4.1 Mixing methods. Mixing of bracing methods shall be permitted as follows:

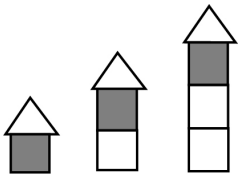
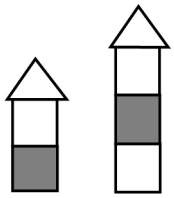
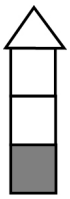
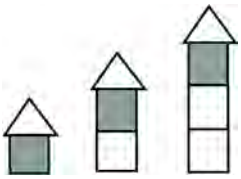
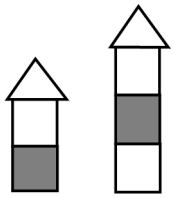
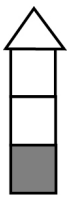
1. Mixing intermittent bracing and continuous sheathing methods from story to story shall be permitted.
2. Mixing intermittent bracing methods from *braced wall line* to *braced wall line* within a story shall be permitted. In regions within *Seismic Design Categories* A, B and C where the ultimate design wind speed is less than or equal to 130 mph (58m/s), mixing of intermittent bracing and continuous sheathing methods from *braced wall line* to *braced wall line* within a story shall be permitted.
3. Mixing intermittent bracing methods along a *braced wall line* shall be permitted in *Seismic Design Categories* A and B, and detached dwellings in *Seismic Design Category* C, provided that the length of required bracing in accordance with Table R602.10.3(1) or R602.10.3(3) is the highest value of all intermittent bracing methods used.
4. Mixing of continuous sheathing methods CS-WSP, CS-G and CS-PF along a *braced wall line* shall be permitted. Intermittent methods ABW, PFH and PFG shall be permitted to be used along a *braced wall line* with continuous sheathed methods, provided that the length of required bracing for that *braced wall line* is determined in accordance with Table R602.10.3(1) or R602.10.3(3) using the highest value of the bracing methods used.



For SI: 1 foot = 304.8 mm.

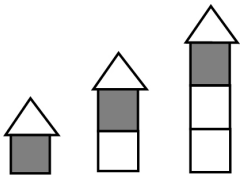
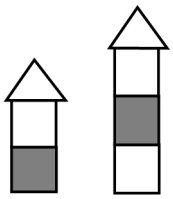
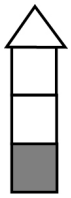
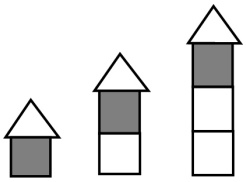
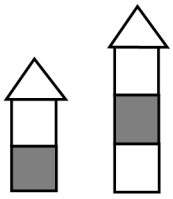
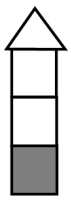
FIGURE R602.10.2.2
LOCATION OF BRACED WALL PANELS

TABLE R602.10.3(1)
BRACING REQUIREMENTS BASED ON WIND SPEED

• EXPOSURE CATEGORY B • 30-FOOT MEAN ROOF HEIGHT • 10-FOOT WALL HEIGHT • 2 BRACED WALL LINES			MINIMUM TOTAL LENGTH (FEET) OF BRACED WALL PANELS REQUIRED ALONG EACH BRACED WALL LINE[a]			
Ultimate Design Wind Speed (mph)	Story Location	Braced Wall Line Spacing[c] (feet)	Method LIB[b]	Method GB	Methods DWB, WSP, SFB, PBS, PCP, HPS, BV-WSP, ABW, PFH, PFG, CS-SFB	Methods CS-WSP, CS-G, CS-PF
≤ 115		10	3.5	3.5	2.0	2.0
		20	6.5	6.5	3.5	3.5
		30	9.5	9.5	5.5	4.5
		40	12.5	12.5	7.0	6.0
		50	15.0	15.0	9.0	7.5
		60	18.0	18.0	10.5	9.0
		10	7.0	7.0	4.0	3.5
		20	12.5	12.5	7.5	6.5
		30	18.0	18.0	10.5	9.0
		40	23.5	23.5	13.5	11.5
		50	29.0	29.0	16.5	14.0
		60	34.5	34.5	20.0	17.0
		10	NP	10.0	6.0	5.0
		20	NP	18.5	11.0	9.0
		30	NP	27.0	15.5	13.0
		40	NP	35.0	20.0	17.0
		50	NP	43.0	24.5	21.0
		60	NP	51.0	29.0	25.0
≤ 120		10	4.0	4.0	2.5	2.0
		20	7.0	7.0	4.0	3.5
		30	10.5	10.5	6.0	5.0
		40	13.5	13.5	8.0	6.5
		50	16.5	16.5	9.5	8.0
		60	19.5	19.5	11.5	9.5
		10	7.5	7.5	4.5	3.5
		20	14.0	14.0	8.0	7.0
		30	20.0	20.0	11.5	9.5
		40	25.5	25.5	15.0	12.5
		50	31.5	31.5	18.0	15.5
		60	37.5	37.5	21.5	18.5
		10	NP	11.0	6.5	5.5
		20	NP	20.5	11.5	10.0
		30	NP	29.0	17.0	14.5
		40	NP	38.0	22.0	18.5
		50	NP	47.0	27.0	23.0
		60	NP	55.5	32.0	27.0

(continued)

TABLE R602.10.3(1)—continued
BRACING REQUIREMENTS BASED ON WIND SPEED

• EXPOSURE CATEGORY B • 30-FOOT MEAN ROOF HEIGHT • 10-FOOT WALL HEIGHT • 2 BRACED WALL LINES			MINIMUM TOTAL LENGTH (FEET) OF BRACED WALL PANELS REQUIRED ALONG EACH BRACED WALL LINE[a]			
Ultimate Design Wind Speed (mph)	Story Location	Braced Wall Line Spacing[c] (feet)	Method LIB[b]	Method GB	Methods DWB, WSP, SFB, PBS, PCP, HPS, BV-WSP, ABW, PFH, PFG, CS-SFB	Methods CS-WSP, CS-G, CS-PF
≤ 130		10	4.5	4.5	2.5	2.5
		20	8.5	8.5	5.0	4.0
		30	12.0	12.0	7.0	6.0
		40	15.5	15.5	9.0	7.5
		50	19.5	19.5	11.0	9.5
		60	23.0	23.0	13.0	11.0
		10	8.5	8.5	5.0	4.5
		20	16.0	16.0	9.5	8.0
		30	23.0	23.0	13.5	11.5
		40	30.0	30.0	17.5	15.0
		50	37.0	37.0	21.5	18.0
		60	44.0	44.0	25.0	21.5
		10	NP	13.0	7.5	6.5
		20	NP	24.0	13.5	11.5
		30	NP	34.5	19.5	17.0
		40	NP	44.5	25.5	22.0
		50	NP	55.0	31.5	26.5
		60	NP	65.0	37.5	31.5
< 140		10	5.5	5.5	3.0	2.5
		20	10.0	10.0	5.5	5.0
		30	14.0	14.0	8.0	7.0
		40	18.0	18.0	10.5	9.0
		50	22.5	22.5	13.0	11.0
		60	26.5	26.5	15.0	13.0
		10	10.0	10.0	6.0	5.0
		20	18.5	18.5	11.0	9.0
		30	27.0	27.0	15.5	13.0
		40	35.0	35.0	20.0	17.0
		50	43.0	43.0	24.5	21.0
		60	51.0	51.0	29.0	25.0
		10	NP	15.0	8.5	7.5
		20	NP	27.5	16.0	13.5
		30	NP	39.5	23.0	19.5
		40	NP	51.5	29.5	25.0
		50	NP	63.5	36.5	31.0
		60	NP	75.5	43.0	36.5

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s.

NP = Not Permitted.

a. Linear interpolation shall be permitted.

b. Method LIB shall have gypsum board fastened to not less than one side with nails or screws in accordance with Table R602.3(1) for exterior sheathing or Table R702.3.5 for interior gypsum board. Spacing of fasteners at panel edges shall not exceed 8 inches.

c. Where three or more parallel braced wall lines are present and the distances between adjacent braced wall lines are different, the average dimension shall be permitted to be used for braced wall line spacing.

TABLE R602.10.3(2)
WIND ADJUSTMENT FACTORS TO THE REQUIRED LENGTH OF WALL BRACING

ITEM NUMBER	ADJUSTMENT BASED ON	STORY/SUPPORTING	CONDITION	ADJUSTMENT FACTOR[a, b] [multiply length from Table R602.10.3(1) by this factor]	APPLICABLE METHODS
1	Exposure category[d]	One-story structure	B	1.00	All methods
			C	1.20	
			D	1.50	
		Two-story structure	B	1.00	
			C	1.30	
			D	1.60	
		Three-story structure	B	1.00	
			C	1.40	
			D	1.70	
2	Roof eave-to-ridge height	Roof only	≤ 5 feet	0.70	
			10 feet	1.00	
			15 feet	1.30	
			20 feet	1.60	
		Roof + 1 floor	≤ 5 feet	0.85	
			10 feet	1.00	
			15 feet	1.15	
			20 feet	1.30	
		Roof + 2 floors	≤ 5 feet	0.90	
			10 feet	1.00	
			15 feet	1.10	
			20 feet	Not permitted	
3	Story height (Section R301.3)	Any story	8 feet	0.90	
			9 feet	0.95	
			10 feet	1.00	
			11 feet	1.05	
			12 feet	1.10	
4	Number of braced wall lines (per plan direction)[c]	Any story	2	1.00	
			3	1.30	
			4	1.45	
			≥ 5	1.60	
5	Additional 800-pound hold-down device	Top story only	Fastened to the end studs of each braced wall panel and to the foundation or framing below	0.80	DWB, WSP, SFB, PBS, PCP, HPS
6	Interior gypsum board finish (or equivalent)	Any story	Omitted from inside face of braced wall panels	1.40	DWB, WSP, SFB, PBS, PCP, HPS, CS-WSP, CS-G, CS-SFB
7	Gypsum board fastening	Any story	4 inches o.c. at panel edges, including top and bottom plates, and all horizontal joints blocked	0.7	GB
8	Horizontal blocking	Any story	Horizontal block is omitted	2.0	WSP, PBS, CS-WSP

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound = 4.48 N.

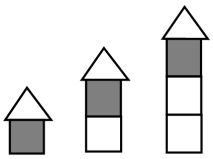
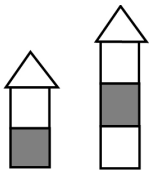
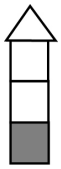
a. Linear interpolation shall be permitted.

b. The total adjustment factor is the product of all applicable adjustment factors.

c. The adjustment factor is permitted to be 1.0 when determining bracing amounts for intermediate braced wall lines provided the bracing amounts on adjacent braced wall lines are based on a spacing and number that neglects the intermediate braced wall line.

d. The same adjustment factor shall be applied to all braced wall lines on all floors of the structure, based on the worst-case exposure category.

TABLE R602.10.3(3)
BRACING REQUIREMENTS BASED ON SEISMIC DESIGN CATEGORY

• WALL HEIGHT = 10 FEET • 10 PSF FLOOR DEAD LOAD • 15 PSF ROOF/CEILING DEAD LOAD • BRACED WALL LINE SPACING ≤ 25 FEET			MINIMUM TOTAL LENGTH (FEET) OF BRACED WALL PANELS REQUIRED ALONG EACH BRACED WALL LINE[a, g]				
Seismic Design Category[b]	**Story Location**	**Braced Wall Line Length (feet)[c]**	**Method LIB[d]**	**Method GB**	**Methods DWB, SFB, PBS, PCP, HPS, CS-SFB[e]**	**Methods WSP, ABW[f], PFH[f] and PFG[e, f]**	**Methods CS-WSP, CS-G, CS-PF**
C (townhouses only)		10	2.5	2.5	2.5	1.6	1.4
		20	5.0	5.0	5.0	3.2	2.7
		30	7.5	7.5	7.5	4.8	4.1
		40	10.0	10.0	10.0	6.4	5.4
		50	12.5	12.5	12.5	8.0	6.8
		10	NP	4.5	4.5	3.0	2.6
		20	NP	9.0	9.0	6.0	5.1
		30	NP	13.5	13.5	9.0	7.7
		40	NP	18.0	18.0	12.0	10.2
		50	NP	22.5	22.5	15.0	12.8
		10	NP	6.0	6.0	4.5	3.8
		20	NP	12.0	12.0	9.0	7.7
		30	NP	18.0	18.0	13.5	11.5
		40	NP	24.0	24.0	18.0	15.3
		50	NP	30.0	30.0	22.5	19.1

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

NP = Not Permitted.

a. Linear interpolation shall be permitted.

b. Interpolation of bracing length between the S_{ds} values associated with the seismic design categories shall be permitted when a site-specific S_{ds} value is determined in accordance with Section 1613.2 of the *International Building Code*.

c. Where the braced wall line length is greater than 50 feet, braced wall lines shall be permitted to be divided into shorter segments having lengths of 50 feet or less, and the amount of bracing within each segment shall be in accordance with this table.

d. Method LIB shall have gypsum board fastened to not less than one side with nails or screws in accordance with Table R602.3(1) for exterior sheathing or Table R702.3.5 for interior gypsum board. Spacing of fasteners at panel edges shall not exceed 8 inches.

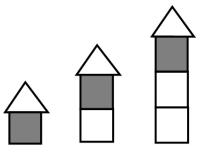
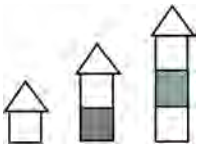
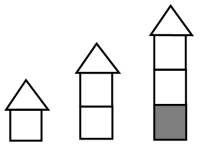
e. Deleted.

f. Methods PFH, PFG and ABW are only permitted on a single story or a first of two stories.

g. Where more than one bracing method is used, mixing methods shall be in accordance with Section R602.10.4.1.

h. Deleted.

TABLE R602.10.3(4)
SEISMIC ADJUSTMENT FACTORS TO THE REQUIRED LENGTH OF WALL BRACING

ITEM NUMBER	ADJUSTMENT BASED ON	STORY	CONDITION	ADJUSTMENT FACTOR[a, b] [Multiply length from Table R602.10.3(3) by this factor]	APPLICABLE METHODS
1	Story height (Section 301.3)	Any story	≤ 10 feet	1.0	All methods
			> 10 feet and ≤ 12 feet	1.2	
2	Braced wall line spacing, townhouses in SDC C	Any story	≤ 35 feet	1.0	
			> 35 feet and ≤ 50 feet	1.43	
4	Wall dead load	Any story	> 8 psf and < 15 psf	1.0	
			< 8psf	0.85	
5	Roof/ceiling dead load for wall supporting	1-, 2- or 3-story building	≤15 psf	1.0	
		2- or 3-story building	> 15 psf and ≤ 25 psf	1.1	
		1-story building or top story	> 15 psf and ≤ 25 psf	1.2	
6	Walls with stone or masonry veneer, townhouses in SDC C[d, e]		1.0		All methods
			1.5		
			1.5		
9	Interior gypsum board finish (or equivalent)	Any story	Omitted from inside face of braced wall panels	1.5	DWB, WSP, SFB, PBS, PCP, HPS, CS-WSP, CS-G, CS-SFB
10	Horizontal blocking	Any story	Horizontal blocking omitted	2.0	WSP, PBS, CS-WSP

For SI: 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

a. Linear interpolation shall be permitted.

b. The total length of bracing required for a given wall line is the product of all applicable adjustment factors.

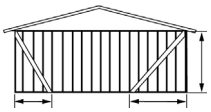
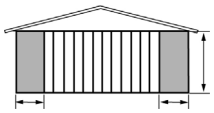
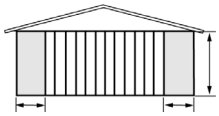
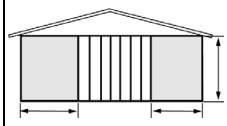
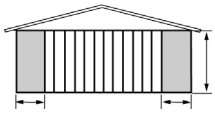
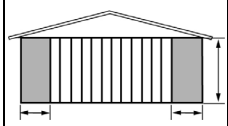
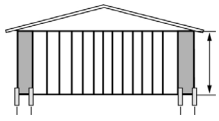
c. The length-to-width ratio for the floor/roof diaphragm shall not exceed 3:1.

d. Applies to stone or masonry veneer exceeding the first story height.

e. The adjustment factor for stone or masonry veneer shall be applied to all exterior braced wall lines and all braced wall lines on the interior of the building, backing or perpendicular to and laterally supporting veneered walls.

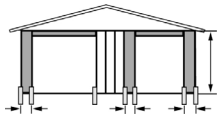
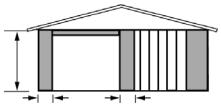
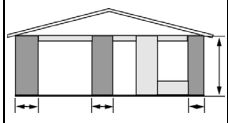
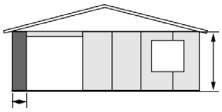
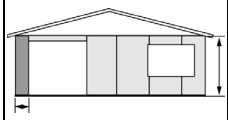
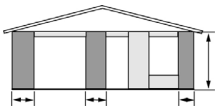
f. See Section R602.10.6.5 for requirements where stone or masonry veneer does not exceed the first-story height.

TABLE R602.10.4
BRACING METHODS

METHODS, MATERIAL		MINIMUM THICKNESS	FIGURE	CONNECTION CRITERIA[a]	
				Fasteners	Spacing
Intermittent Bracing Methods	**LIB** Let-in-bracing	1 × 4 wood or approved metal straps at 45° to 60° angles for maximum 16″ stud spacing		Wood: 2-8d common nails or 3-8d ($2^1/_2$″ long × 0.113″ dia.) nails	Wood: per stud and top and bottom plates
				Metal strap: per manufacturer	Metal: per manufacturer
	DWB Diagonal wood boards	$^3/_4$″ (1″ nominal) for maximum 24″ stud spacing		2-8d ($2^1/_2$″ long × 0.113″ dia.) nails or 2-$1^3/_4$″ long staples	Per stud
	WSP Wood structural panel (See Section R604)	$^3/_8$″		Exterior sheathing per Table R602.3(3)	6″ edges 12″ field
				Interior sheathing per Table R602.3(1) or R602.3(2)	Varies by fastener
	BV-WSP[e] Wood structural panels with stone or masonry veneer (See Section R602.10.6.5)	$^7/_{16}$″	See Figure R602.10.6.5.2	8d common ($2^1/_2$″ × 0.131) nails	4″ at panel edges 12″ at intermediate supports 4″ at braced wall panel end posts
	SFB Structural fiberboard sheathing	$^1/_2$″ or $^{25}/_{32}$″ for maximum 16″ stud spacing		$1^1/_2$″ long × 0.12″ dia. (for $^1/_2$″ thick sheathing) $1^3/_4$″ long × 0.12″ dia. (for $^{25}/_{32}$″ thick sheathing) galvanized roofing nails	3″ edges 6″ field
	GB Gypsum board	$^1/_2$″		Nails or screws per Table R602.3(1) for exterior locations	For all braced wall panel locations: 7″edges (including top and bottom plates) 7″ field
				Nails or screws per Table R702.3.5 for interior locations	
	PBS Particleboard sheathing (See Section R605)	$^3/_8$″ or $^1/_2$″ for maximum 16″stud spacing		For $^3/_8$″, 6d common (2″ long × 0.113″ dia.) nails; For $^1/_2$″, 8d common ($2^1/_2$″ long × 0.131″ dia.) nails	3″ edges 6″ field
	PCP Portland cement plaster	See Section R703.6 for maximum 16″ stud spacing		$1^1/_2$″ long, 11 gage, 0.120" dia., $^7/_{16}$″ dia. head nails or $^7/_8$″ long, 16 gage staples	6″ o.c. on all framing members
	HPS Hardboard panel siding	$^7/_{16}$″ for maximum 16″ stud spacing		0.092″ dia., 0.225″ dia. head nails with length to accommodate $1^1/_2$″ penetration into studs	4″ edges 8″ field
	ABW Alternate braced wall	$^3/_8$″		See Section R602.10.6.1	See Section R602.10.6.1

(continued)

TABLE R602.10.4—continued
BRACING METHODS

METHODS, MATERIAL		MINIMUM THICKNESS	FIGURE	CONNECTION CRITERIA[a]	
				Fasteners	Spacing
Intermittent Bracing Methods	**PFH** Portal frame with hold-downs	$^3/_8$″		See Section R602.10.6.2	See Section R602.10.6.2
	PFG Portal frame at garage	$^7/_{16}$″		See Section R602.10.6.3	See Section R602.10.6.3
Continuous Sheathing Methods	**CS-WSP** Continuously sheathed wood structural panel	$^3/_8$″		Exterior sheathing per Table R602.3(3)	6″ edges 12″ field
				Interior sheathing per Table R602.3(1) or R602.3(2)	Varies by fastener
	CS-G[b, c] Continuously sheathed wood structural panel adjacent to garage openings	$^3/_8$″		See Method CS-WSP	See Method CS-WSP
	CS-PF Continuously sheathed portal frame	$^7/_{16}$″		See Section R602.10.6.4	See Section R602.10.6.4
	CS-SFB[d] Continuously sheathed structural fiberboard	$^1/_2$″ or $^{25}/_{32}$″ for maximum 16″ stud spacing		$1^1/_2$″ long × 0.12″ dia. (for $^1/_2$″ thick sheathing) $1^3/_4$″ long × 0.12″ dia. (for $^{25}/_{32}$″ thick sheathing) galvanized roofing nails	3″ edges 6″ field

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 degree = 0.0175 rad, 1 pound per square foot = 47.8 N/m^2, 1 mile per hour = 0.447 m/s.

a. Adhesive attachment of wall sheathing, including Method GB, shall not be permitted in Seismic Design Categories C, D_0, D_1 and D_2.

> b. Applies to panels next to garage door opening where supporting gable end wall or roof load only. Shall only be used on one wall of the garage.

c. Garage openings adjacent to a Method CS-G panel shall be provided with a header in accordance with Table R602.7(1). A full-height clear opening shall not be permitted adjacent to a Method CS-G panel.

d. Deleted.

e. Deleted.

5. In *Seismic Design Categories* A and B, and for detached one- and two-family dwellings in *Seismic Design Category* C, mixing of intermittent bracing methods along the interior portion of a *braced wall line* with continuous sheathing methods CS-WSP, CS-G and CS-PF along the exterior portion of the same *braced wall line* shall be permitted. The length of required bracing shall be the highest value of all intermittent bracing methods used in accordance with Table R602.10.3(1) or R602.10.3(3) as adjusted by Tables R602.10.3(2) and R602.10.3(4), respectively. The requirements of Section R602.10.7 shall apply to each end of the continuously sheathed portion of the *braced wall line*.

R602.10.4.2 Continuous sheathing methods. Continuous sheathing methods require structural panel sheathing to be used on all sheathable surfaces on one side of a *braced wall line* including areas above and below openings and gable end walls and shall meet the requirements of Section R602.10.7.

R602.10.4.3 Braced wall panel interior finish material. *Braced wall panel*s shall have gypsum wall board installed on the side of the wall opposite the bracing material. Gypsum wall board shall be not less than $^1/_2$ inch (12.7 mm) in thickness and be fastened with nails or screws in accordance with Table R602.3(1) for exterior sheathing or Table R702.3.5 for interior gypsum wall board. Spacing of fasteners at panel edges for gypsum wall board opposite Method LIB bracing shall not exceed 8 inches (203 mm).

Exceptions:

1. Interior finish material is not required opposite wall panels that are braced in accordance with Methods GB, BV-WSP, ABW, PFH, PFG and CS-PF, unless otherwise required by Section R302.6.
2. An *approved* interior finish material with an in-plane shear resistance equivalent to gypsum board shall be permitted to be substituted, unless otherwise required by Section R302.6.
3. Except for Method LIB, gypsum wall board is permitted to be omitted provided that the required length of bracing in Tables R602.10.3(1) and R602.10.3(3) is multiplied by the appropriate adjustment factor in Tables R602.10.3(2) and R602.10.3(4), respectively, unless otherwise required by Section R302.6.

R602.10.4.4 Panel joints. Vertical joints of panel sheathing shall occur over and be fastened to common studs. Horizontal joints of panel sheathing in *braced wall panels* shall occur over and be fastened to common blocking of a thickness of $1^1/_2$ inches (38 mm) or greater.

Exceptions:

1. For methods WSP and CS-WSP, blocking of horizontal joints is permitted to be omitted when adjustment factor No. 8 of Table R602.10.3(2) or No. 9 of Table R602.10.3(4) is applied.
2. Vertical joints of panel sheathing shall be permitted to occur over double studs, where adjoining panel edges are attached to separate studs with the required panel edge fastening schedule, and the adjacent studs are attached together with two rows of 10d box nails [3 inches by 0.128 inch (76.2 mm by 3.25 mm)] at 10 inches o.c. (254 mm).
3. Blocking at horizontal joints shall not be required in wall segments that are not counted as *braced wall panels*.
4. Where Method GB panels are installed horizontally, blocking of horizontal joints is not required.

R602.10.5 Minimum length of a braced wall panel. The minimum length of a *braced wall panel* shall comply with Table R602.10.5. For Methods CS-WSP and CS-SFB, the minimum panel length shall be based on the adjacent clear opening height in accordance with Table R602.10.5 and Figure R602.10.5. Where a panel has an opening on either side of differing heights, the taller opening height shall be used to determine the panel length.

R602.10.5.1 Contributing length. For purposes of computing the required length of bracing in Tables R602.10.3(1) and R602.10.3(3), the contributing length of each *braced wall panel* shall be as specified in Table R602.10.5.

R602.10.5.2 Partial credit. For Methods DWB, WSP, SFB, PBS, PCP and HPS in *Seismic Design Categories* A, B and C, panels between 36 inches and 48 inches (914 mm and 1219 mm) in length shall be considered a *braced wall panel* and shall be permitted to partially contribute toward the required length of bracing in Tables R602.10.3(1) and R602.10.3(3), and the contributing length shall be determined from Table R602.10.5.2.

R602.10.6 Construction of Methods ABW, PFH, PFG, CS-PF and BV-WSP. Methods ABW, PFH, PFG, CS-PF and BV-WSP shall be constructed as specified in Sections R602.10.6.1 through R602.10.6.5.

R602.10.6.1 Method ABW: Alternate braced wall panels. Method ABW *braced wall panel*s shall be constructed in accordance with Figure R602.10.6.1. The hold-down force shall be in accordance with Table R602.10.6.1.

TABLE R602.10.5
MINIMUM LENGTH OF BRACED WALL PANELS

METHOD (See Table R602.10.4)		MINIMUM LENGTH[a] (inches) Wall Height					CONTRIBUTING LENGTH (inches)
		8 feet	9 feet	10 feet	11 feet	12 feet	
DWB, WSP, SFB, PBS, PCP, HPS, BV-WSP		48	48	48	53	58	Actual[b]
GB		48	48	48	53	58	Double sided = Actual Single sided = 0.5 × Actual
LIB		55	62	69	NP	NP	Actual[b]
ABW	SDC A, B and C, ultimate design wind speed < 140 mph	28	32	34	38	42	48
CS-G		24	27	30	33	36	Actual[b]
CS-WSP, CS-SFB	Adjacent clear opening height (inches)						
	≤ 64	24	27	30	33	36	Actual[b]
	68	26	27	30	33	36	
	72	27	27	30	33	36	
	76	30	29	30	33	36	
	80	32	30	30	33	36	
	84	35	32	32	33	36	
	88	38	35	33	33	36	
	92	43	37	35	35	36	
	96	48	41	38	36	36	
	100	—	44	40	38	38	
	104	—	49	43	40	39	
	108	—	54	46	43	41	
	112	—	—	50	45	43	
	116	—	—	55	48	45	
	120	—	—	60	52	48	
	124	—	—	—	56	51	
	128	—	—	—	61	54	
	132	—	—	—	66	58	
	136	—	—	—	—	62	
	140	—	—	—	—	66	
	144	—	—	—	—	72	
METHOD (See Table R602.10.4)		**Portal header height**					
		8 feet	**9 feet**	**10 feet**	**11 feet**	**12 feet**	
PFH	Supporting roof only	16	16	16	Note c	Note c	48
	Supporting one story and roof	24	24	24	Note c	Note c	
PFG		24	27	30	Note d	Note d	1.5 × Actual[b]
CS-PF	SDC A, B and C	16	18	20	Note e	Note e	1.5 × Actual[b]
	SDC D_0, D_1 and D_2	16	18	20	Note e	Note e	Actual[b]

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s.

NP = Not Permitted.

a. Linear interpolation shall be permitted.

b. Use the actual length where it is greater than or equal to the minimum length.

c. Maximum header height for PFH is 10 feet in accordance with Figure R602.10.6.2, but wall height shall be permitted to be increased to 12 feet with pony wall.

d. Maximum header height for PFG is 10 feet in accordance with Figure R602.10.6.3, but wall height shall be permitted to be increased to 12 feet with pony wall.

e. Maximum header height for CS-PF is 10 feet in accordance with Figure R602.10.6.4, but wall height shall be permitted to be increased to 12 feet with pony wall.

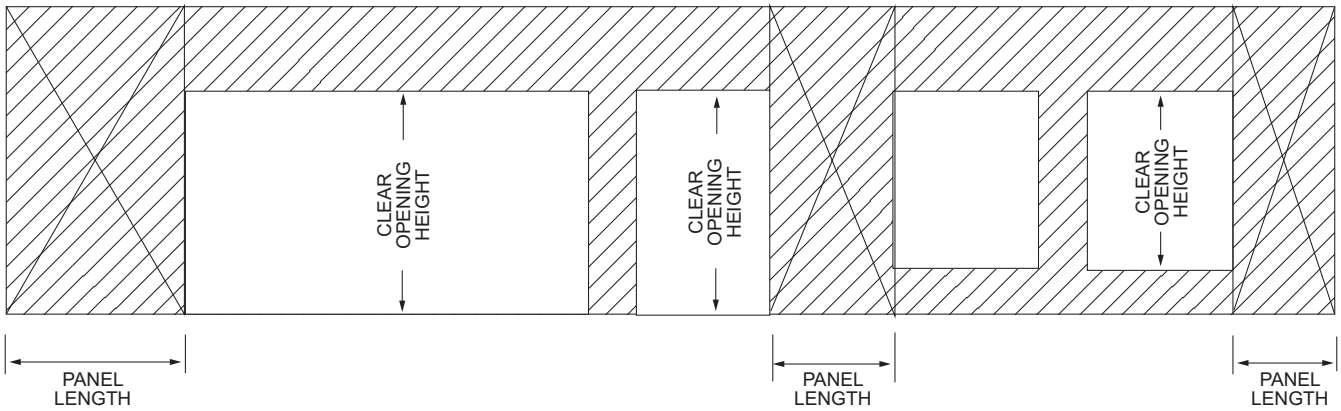


FIGURE R602.10.5

TABLE R602.10.5.2
PARTIAL CREDIT FOR BRACED WALL PANELS LESS THAN 48 INCHES IN ACTUAL LENGTH

ACTUAL LENGTH OF BRACED WALL PANEL (inches)	CONTRIBUTING LENGTH OF BRACED WALL PANEL (inches)[a]	
	8-foot Wall Height	9-foot Wall Height
48	48	48
42	36	36
36	27	NA

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

NA = Not Applicable.

a. Linear interpolation shall be permitted.

R602.10.6.2 Method PFH: Portal frame with hold-downs. Method PFH *braced wall panels* shall be constructed in accordance with Figure R602.10.6.2.

R602.10.6.3 Method PFG: Portal frame at garage door openings in Seismic Design Categories A, B and C. Where supporting a roof or one story and a roof, a Method PFG *braced wall panel* constructed in accordance with Figure R602.10.6.3 shall be permitted on either side of garage door openings.

R602.10.6.4 Method CS-PF: Continuously sheathed portal frame. Continuously sheathed portal frame *braced wall panel*s shall be constructed in accordance with Figure R602.10.6.4 and Table R602.10.6.4.

R602.10.6.5 Wall bracing for dwellings with stone and masonry veneer in Seismic Design Categories D_0, D_1 and D_2. Deleted.

TABLE R602.10.6.5.4
METHOD BV-WSP WALL BRACING REQUIREMENTS[d]
DELETED

R602.10.7 Ends of braced wall lines with continuous sheathing. Each end of a *braced wall line* with continuous sheathing shall have one of the conditions shown in Figure R602.10.7.

R602.10.8 Braced wall panel connections. *Braced wall panel*s shall be connected to floor framing or foundations as follows:

1. Where joists are perpendicular to a *braced wall panel* above or below, a rim joist, band joist or blocking shall be provided along the entire length of the *braced wall panel* in accordance with Figure R602.10.8(1). Fastening of top and bottom wall plates to framing, rim joist, band joist or blocking shall be in accordance with Table R602.3(1).
2. Where joists are parallel to a *braced wall panel* above or below, a rim joist, end joist or other parallel framing member shall be provided directly above and below the *braced wall panel* in accordance with Figure R602.10.8(2). Where a parallel framing member cannot be located directly above and below the panel, full-depth blocking at 16-inch (406 mm) spacing shall be provided between the parallel framing members to each side of the *braced wall panel* in accordance with Figure R602.10.8(2). Fastening of blocking and wall plates shall be in accordance with Table R602.3(1) and Figure R602.10.8(2).
3. Connections of *braced wall panel*s to concrete or masonry shall be in accordance with Section R403.1.6.

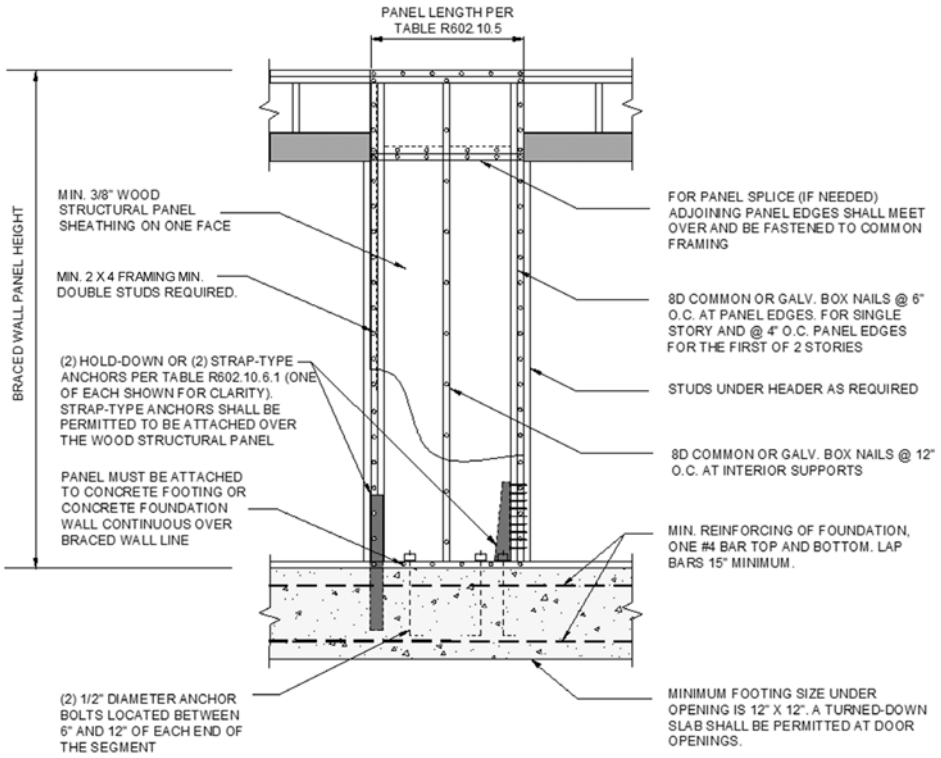
R602.10.8.1 Braced wall panel connections for Seismic Design Categories D_0, D_1 and D_2. Deleted.

R602.10.8.2 Connections to roof framing. Top plates of exterior *braced wall panels* shall be attached to rafters or roof trusses above in accordance with Table R602.3(1) and this section. Where required by this section, blocking between rafters or roof trusses shall

TABLE R602.10.6.1
MINIMUM HOLD-DOWN FORCES FOR METHOD ABW BRACED WALL PANELS

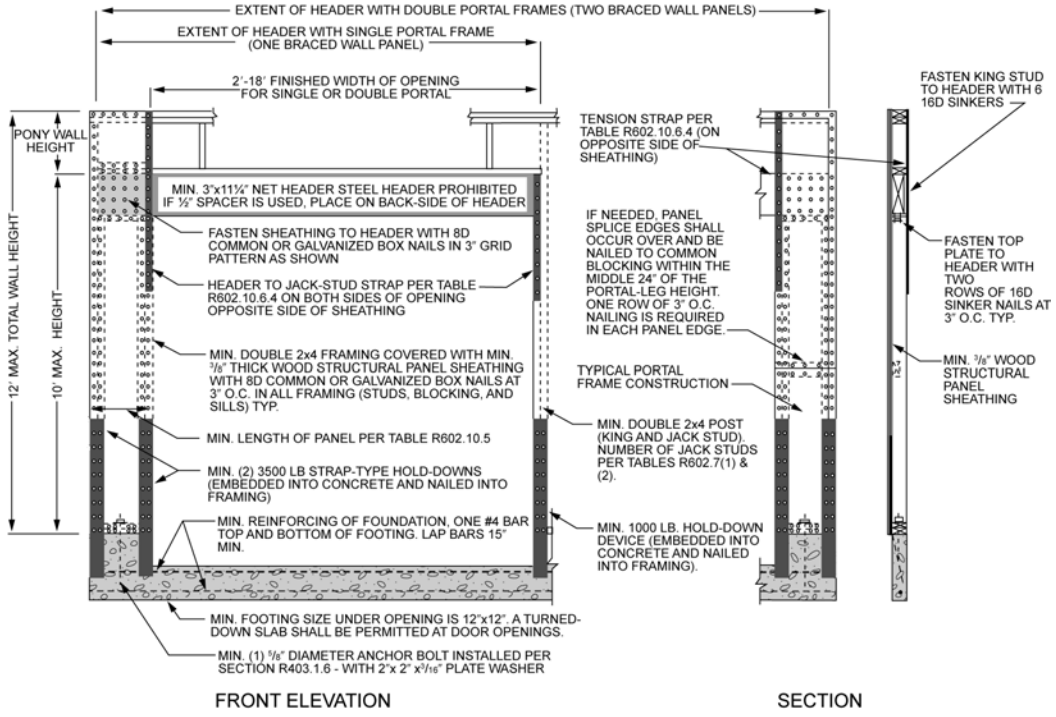
SEISMIC DESIGN CATEGORY AND WIND SPEED	SUPPORTING/STORY	HOLD-DOWN FORCE (pounds)				
		Height of Braced Wall Panel				
		8 feet	9 feet	10 feet	11 feet	12 feet
SDC A, B and C Ultimate design wind speed < 140 mph	One story	1,800	1,800	1,800	2,000	2,200
	First of two stories	3,000	3,000	3,000	3,300	3,600

For SI: 1 foot = 304.8 mm, 1 pound = 4.45 N, 1 mile per hour = 0.447 m/s.
NP = Not Permitted.



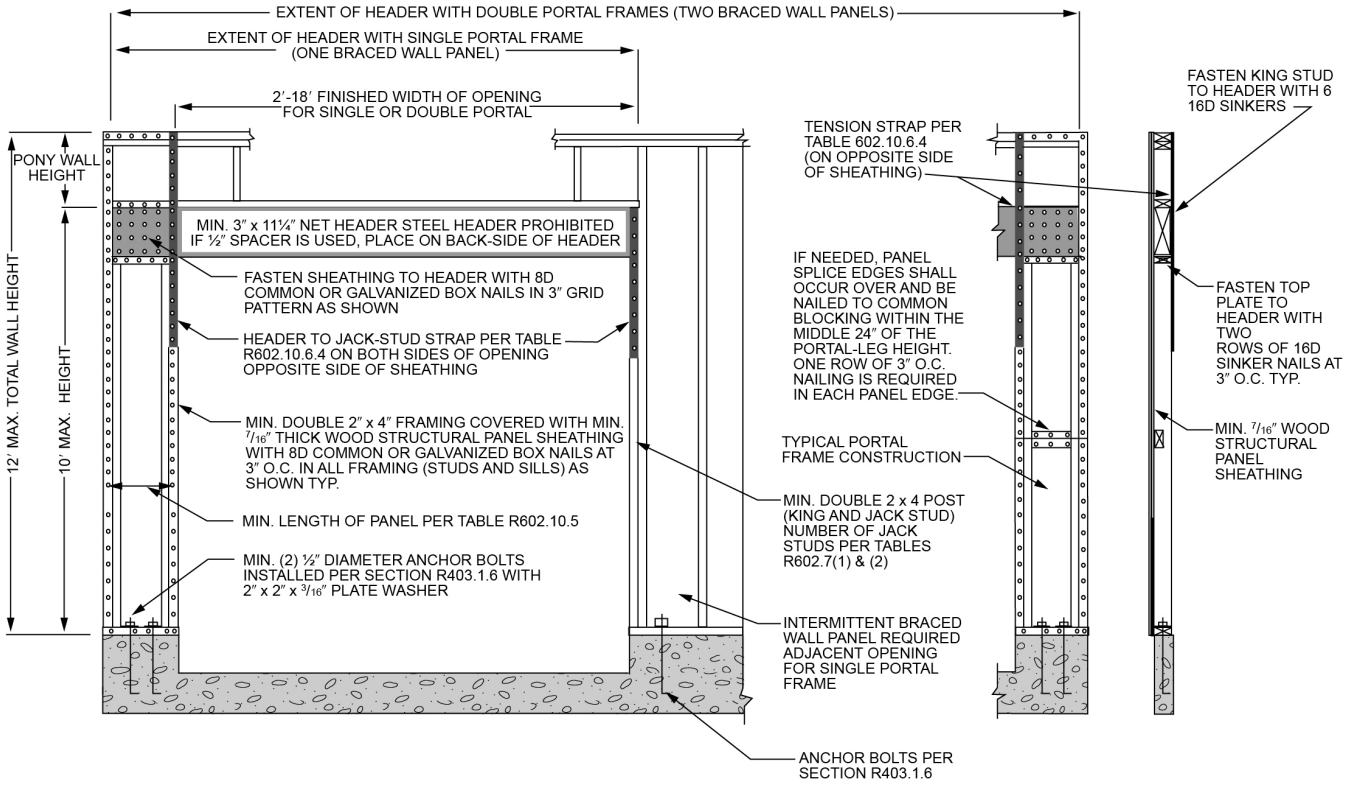
For SI: 1 inch = 25.4 mm.

FIGURE R602.10.6.1
METHOD ABW—ALTERNATE BRACED WALL PANEL



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

FIGURE R602.10.6.2
METHOD PFH—PORTAL FRAME WITH HOLD-DOWNS



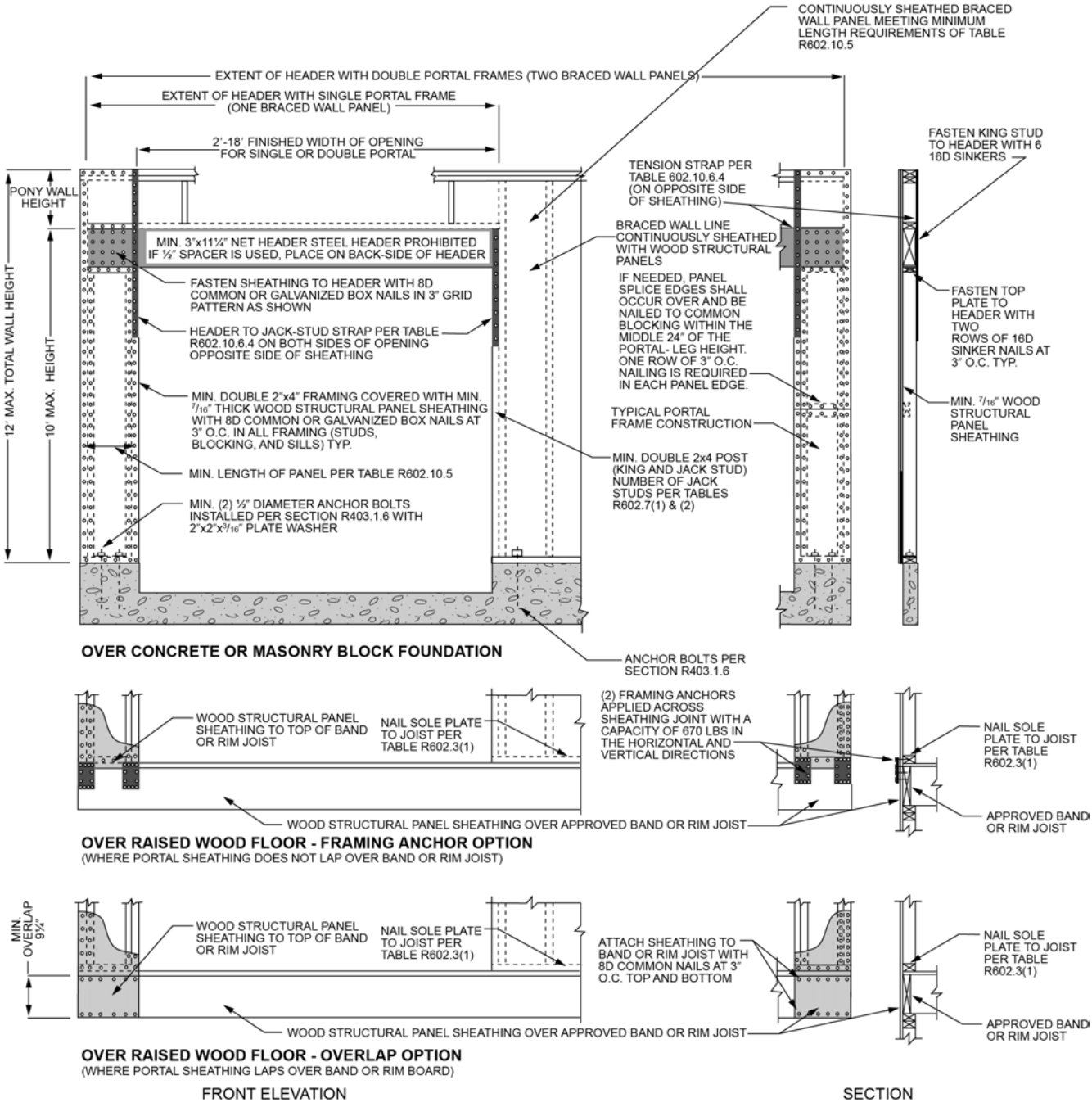
For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

FIGURE R602.10.6.3
METHOD PFG—PORTAL FRAME AT GARAGE DOOR OPENINGS IN SEISMIC DESIGN CATEGORIES A, B AND C

TABLE R602.10.6.4
TENSION STRAP CAPACITY FOR RESISTING WIND PRESSURES PERPENDICULAR TO METHODS PFH, PFG AND CS-PF BRACED WALL PANELS[a]

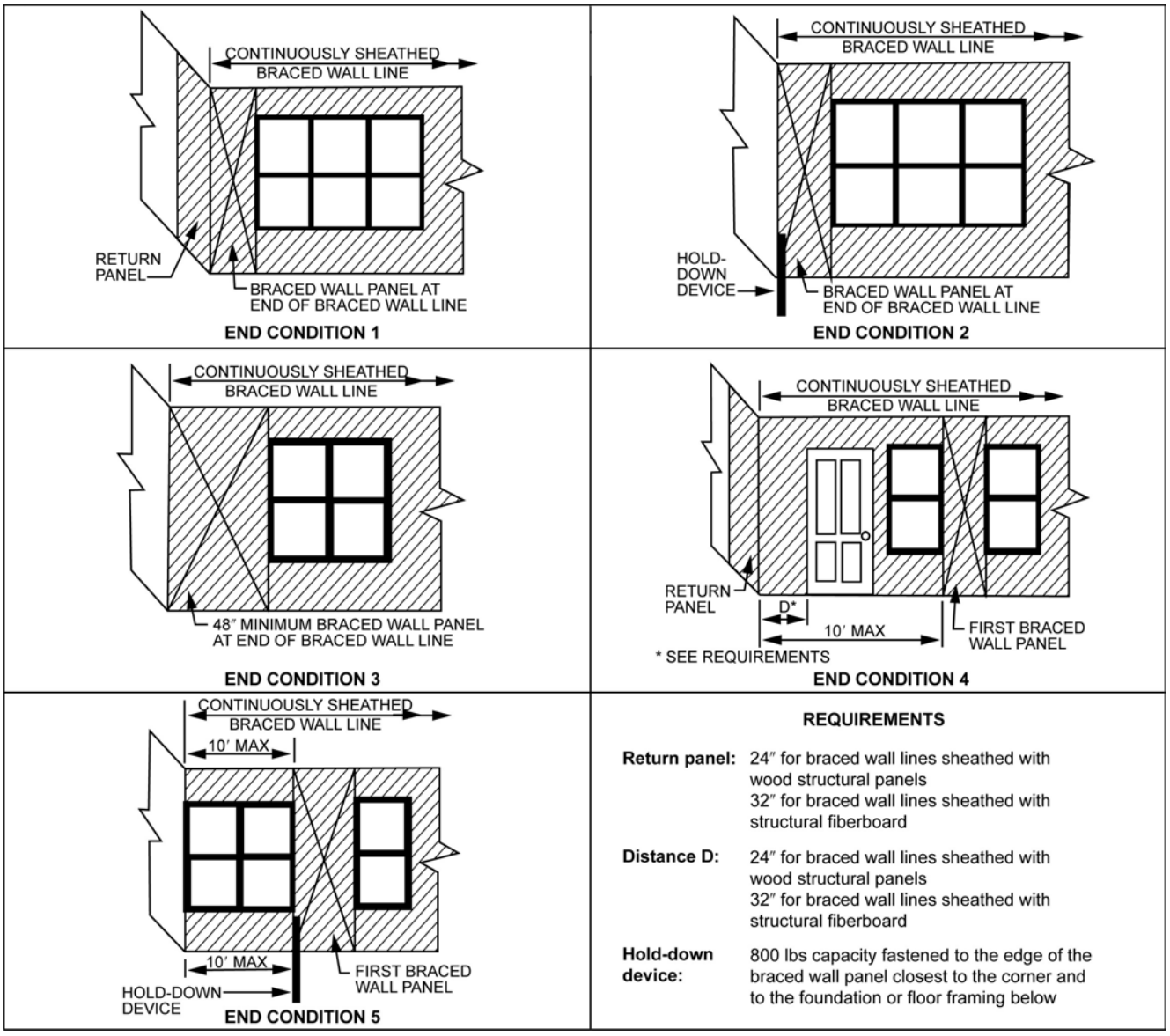
MINIMUM WALL STUD FRAMING NOMINAL SIZE AND GRADE	MAXIMUM PONY WALL HEIGHT (feet)	MAXIMUM TOTAL WALL HEIGHT (feet)	MAXIMUM OPENING WIDTH (feet)	TENSION STRAP CAPACITY REQUIRED (pounds)[a]					
				Ultimate Design Wind Speed V_{ult} (mph)					
				≤ 110	115	130	≤ 110	115	130
				Exposure B			Exposure C		
2 × 4 No. 2 Grade	0	10	18	1,000	1,000	1,000	1,000	1,000	1,050
	1	10	9	1,000	1,000	1,000	1,000	1,000	1,750
			16	1,000	1,025	2,050	2,075	2,500	3,950
			18	1,000	1,275	2,375	2,400	2,850	DR
	2	10	9	1,000	1,000	1,475	1,500	1,875	3,125
			16	1,775	2,175	3,525	3,550	4,125	DR
			18	2,075	2,500	3,950	3,975	DR	DR
	2	12	9	1,150	1,500	2,650	2,675	3,175	DR
			16	2,875	3,375	DR	DR	DR	DR
			18	3,425	3,975	DR	DR	DR	DR
	4	12	9	2,275	2,750	DR	DR	DR	DR
			12	3,225	3,775	DR	DR	DR	DR
2 × 6 Stud Grade	2	12	9	1,000	1,000	1,700	1,700	2,025	3,050
			16	1,825	2,150	3,225	3,225	3,675	DR
			18	2,200	2,550	3,725	3,750	DR	DR
	4	12	9	1,450	1,750	2,700	2,725	3,125	DR
			16	2,050	2,400	DR	DR	DR	DR
			18	3,350	3,800	DR	DR	DR	DR

For SI: 1 foot = 304.8 mm, 1 pound = 4.45 N, 1 mile per hour = 0.447 m/s.
DR = Design Required.
a. Straps shall be installed in accordance with manufacturer's recommendations.



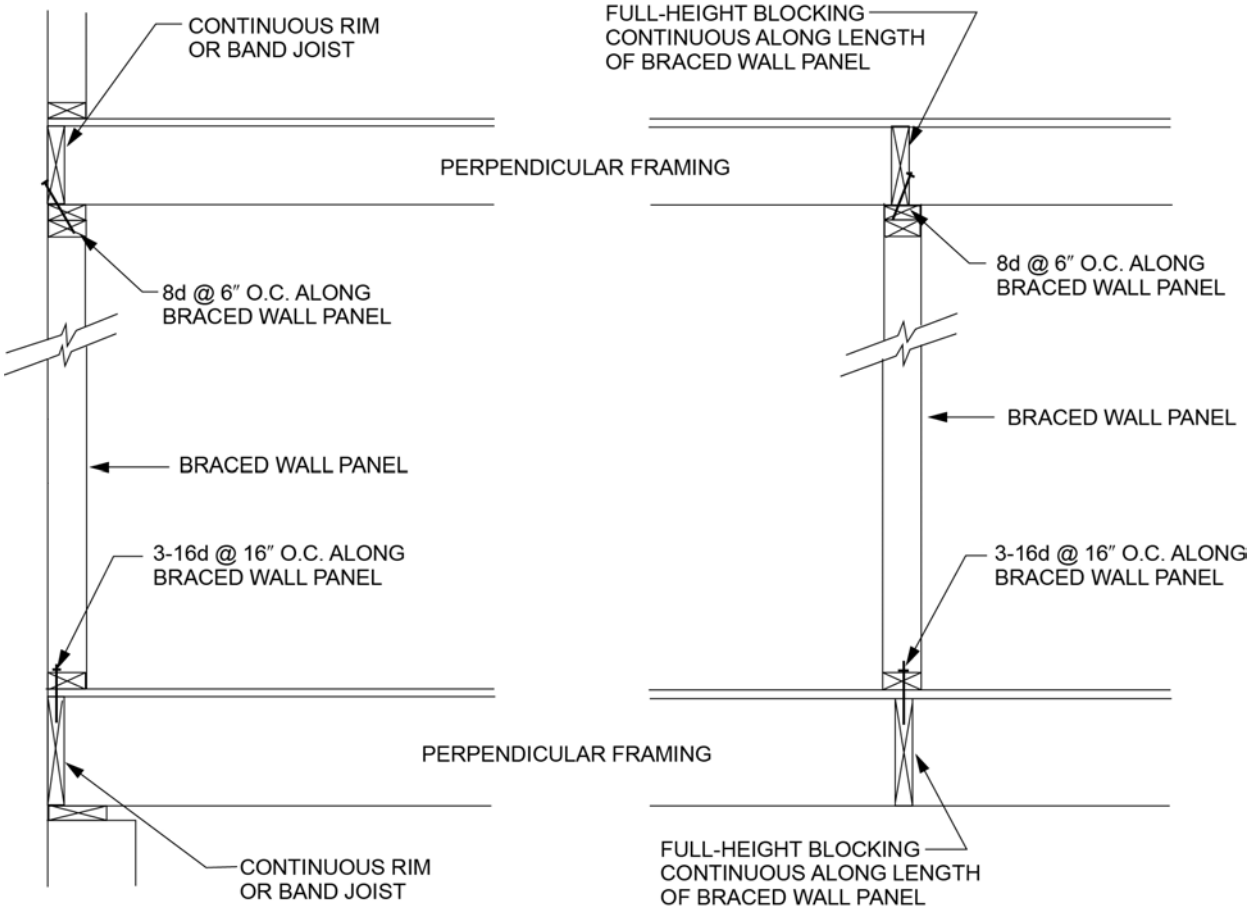
For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

FIGURE R602.10.6.4
METHOD CS-PF—CONTINUOUSLY SHEATHED PORTAL FRAME PANEL CONSTRUCTION



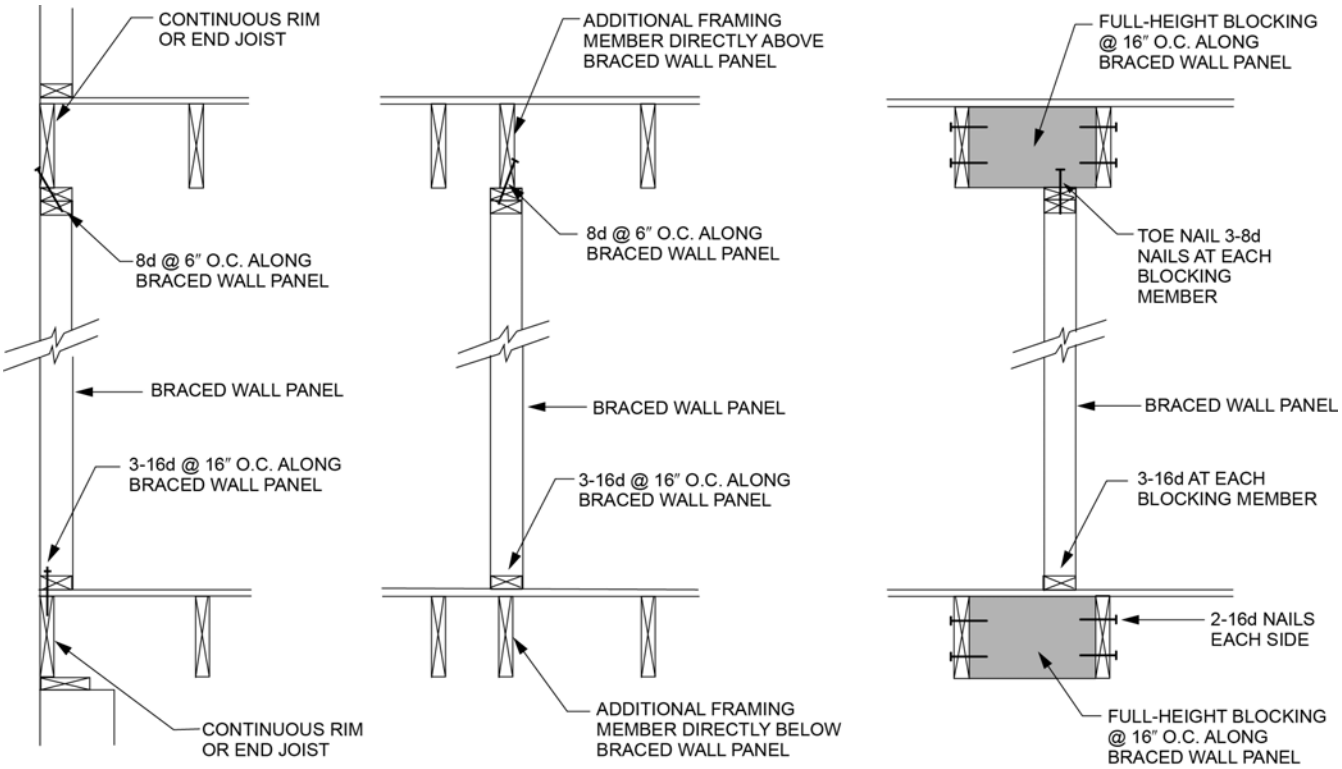
For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound = 4.45 N.

FIGURE R602.10.7
END CONDITIONS FOR BRACED WALL LINES WITH CONTINUOUS SHEATHING



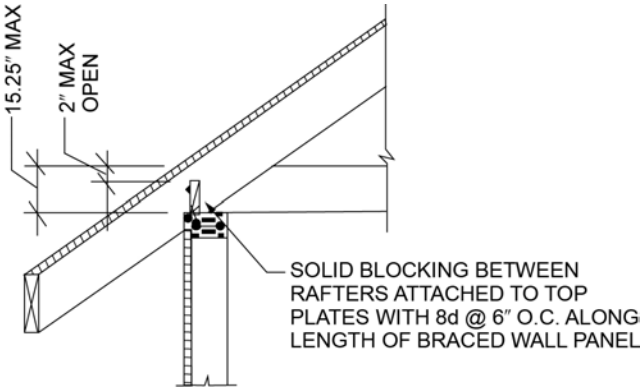
For SI: 1 inch = 25.4 mm.

FIGURE R602.10.8(1)
BRACED WALL PANEL CONNECTION WHEN PERPENDICULAR TO FLOOR/CEILING FRAMING



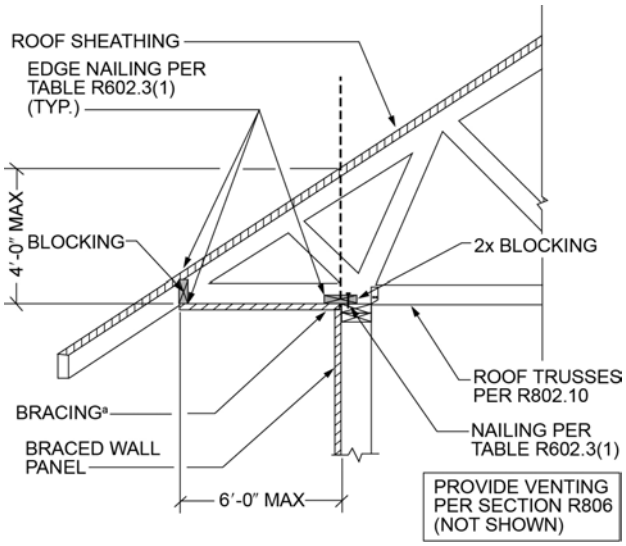
For SI: 1 inch = 25.4 mm.

FIGURE R602.10.8(2)
BRACED WALL PANEL CONNECTION WHEN PARALLEL TO FLOOR/CEILING FRAMING



For SI: 1 inch = 25.4 mm.

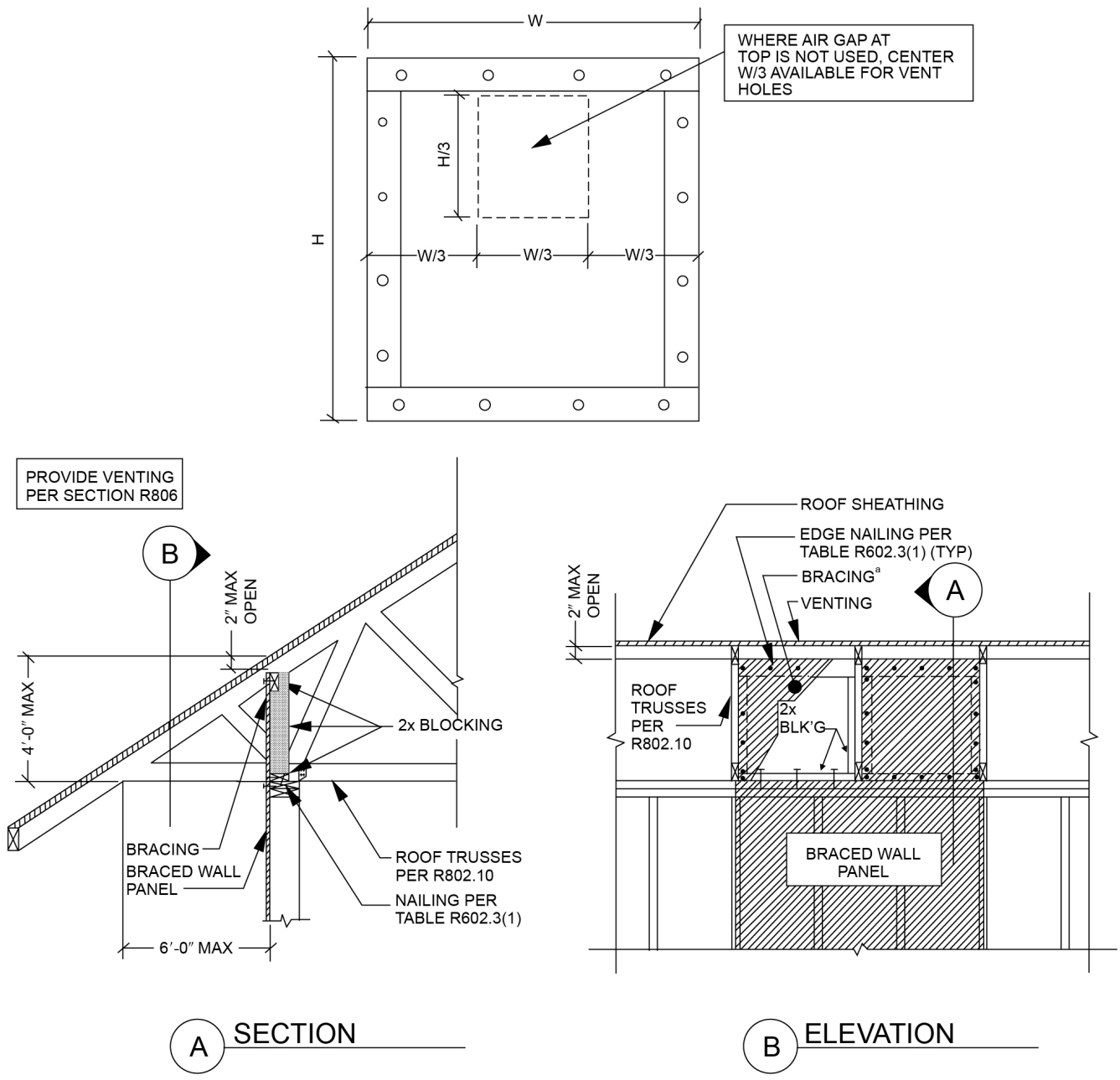
FIGURE R602.10.8.2(1)
BRACED WALL PANEL CONNECTION TO PERPENDICULAR RAFTERS



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

a. Methods of bracing shall be as described in Section R602.10.4.

FIGURE R602.10.8.2(2)
BRACED WALL PANEL CONNECTION OPTION TO PERPENDICULAR RAFTERS OR ROOF TRUSSES



For SI: 1 inch = 25.4 mm, 1 foot =304.8 mm

a. Methods of bracing shall be as described in Section R602.10.4.

FIGURE R602.10.8.2(3)
BRACED WALL PANEL CONNECTION OPTION TO PERPENDICULAR RAFTERS OR ROOF TRUSSES

be attached to top plates of *braced wall panels* and to rafters and roof trusses in accordance with Table R602.3(1). A continuous band, rim or header joist or roof truss parallel to the *braced wall panels* shall be permitted to replace the blocking required by this section. Blocking shall not be required over openings in continuously sheathed *braced wall lines*. In addition to the requirements of this section, lateral support shall be provided for rafters and ceiling joists in accordance with Section R802.8 and for trusses in accordance with Section R802.10.3. Roof *ventilation* shall be provided in accordance with Section R806.1.

1. For *Seismic Design Categories* A, B and C where the distance from the top of the *braced wall panel* to the top of the rafters or roof trusses above is $9^1/_4$ inches (235 mm) or less, blocking between rafters or roof trusses shall not be required. Where the distance from the top of the *braced wall panel* to the top of the rafters or roof trusses above is between $9^1/_4$ inches (235 mm) and $15^1/_4$ inches (387 mm), blocking between rafters or roof trusses shall be provided above the *braced wall panel* in accordance with Figure R602.10.8.2(1).

   Exception: Where the outside edge of truss vertical web members aligns with the outside face of the wall studs below, wood structural panel sheathing extending above the top plate as shown in Figure R602.10.8.2(3) shall be permitted to be fastened to each truss web with three-8d nails ($2^1/_2$ inches × 0.131 inch) and blocking between the trusses shall not be required.

2. Deleted.

3. Where the distance from the top of the *braced wall panel* to the top of rafters or roof trusses exceeds $15^1/_4$ inches (387 mm), the top plates of the *braced wall panel* shall be connected to perpendicular rafters or roof trusses above in accordance with one or more of the following methods:

   3.1. Soffit blocking panels constructed in accordance with Figure R602.10.8.2(2).

   3.2. Vertical blocking panels constructed in accordance with Figure R602.10.8.2(3).

   3.3. Blocking panels provided by the roof truss manufacturer and designed in accordance with Section R802.

   3.4. Blocking, blocking panels or other methods of lateral load transfer designed in accordance with the AWC WFCM or accepted engineering practice.

R602.10.9 Braced wall panel support. *Braced wall panel* support shall be provided as follows:

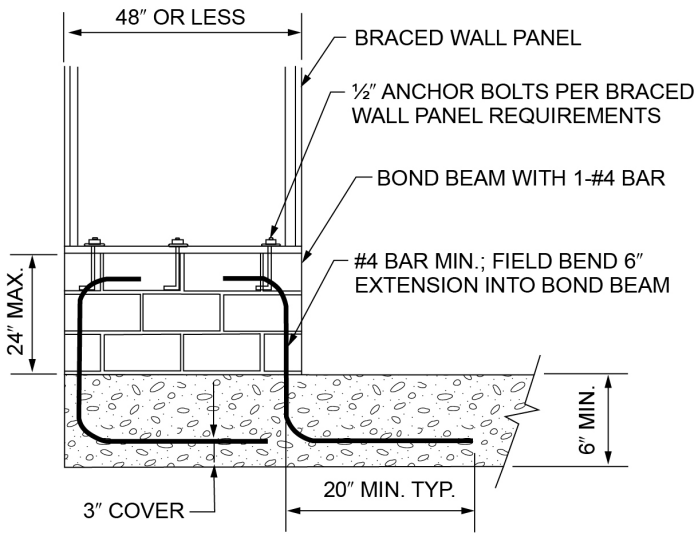
1. Cantilevered floor joists complying with Section R502.3.3 shall be permitted to support *braced wall panel*s.
2. Raised floor system post or pier foundations supporting *braced wall panel*s shall be designed in accordance with accepted engineering practice.
3. Masonry stem walls with a length of 48 inches (1219 mm) or less supporting *braced wall panel*s shall be reinforced in accordance with Figure R602.10.9. Masonry stem walls with a length greater than 48 inches (1219 mm) supporting *braced wall panel*s shall be constructed in accordance with Section R403.1 Methods ABW and PFH shall not be permitted to attach to masonry stem walls.
4. Concrete stem walls with a length of 48 inches (1219 mm) or less, greater than 12 inches (305 mm) tall and less than 6 inches (152 mm) thick shall have reinforcement sized and located in accordance with Figure R602.10.9.

R602.10.9.1 Braced wall panel support for Seismic Design Categories D_0, D_1 and D_2. Deleted.

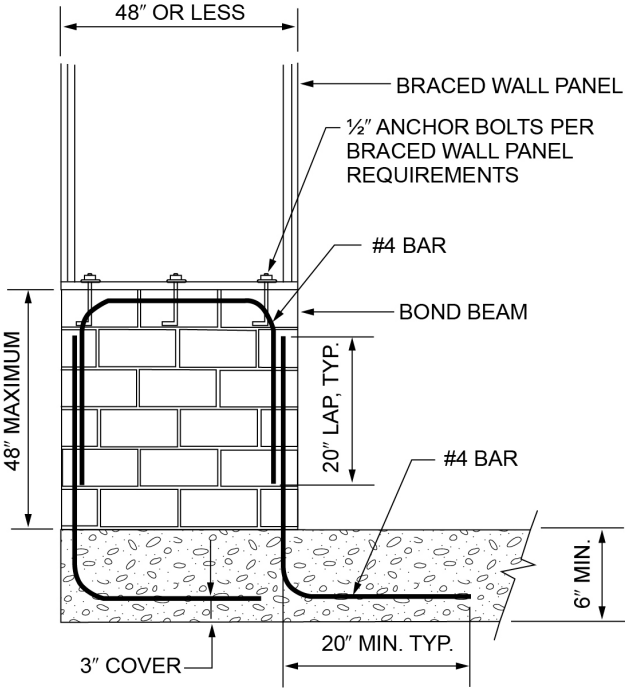
R602.10.10 Cripple wall bracing. Cripple walls shall be constructed in accordance with Section R602.9 and braced in accordance with this section. Cripple walls shall be braced with the length and method of bracing used for the wall above in accordance with Tables R602.10.3(1) and R602.10.3(3), and the applicable adjustment factors in Table R602.10.3(2) or R602.10.3(4), respectively, except that the length of cripple wall bracing shall be multiplied by a factor of 1.15. Where gypsum wall board is not used on the inside of the cripple wall bracing, the length adjustments for the elimination of the gypsum wallboard, or equivalent, shall be applied as directed in Tables R602.10.3(2) and R602.10.3(4) to the length of cripple wall bracing required. This adjustment shall be taken in addition to the 1.15 increase.

R602.10.10.1 Cripple wall bracing for townhouses in Seismic Design Category C. In addition to the requirements in Section R602.10.10, cripple wall bracing shall be limited to methods WSP and CS-WSP, and the distance between adjacent edges of *braced wall panel*s for cripple walls along a *braced wall line* shall be 14 feet (4267 mm) maximum.

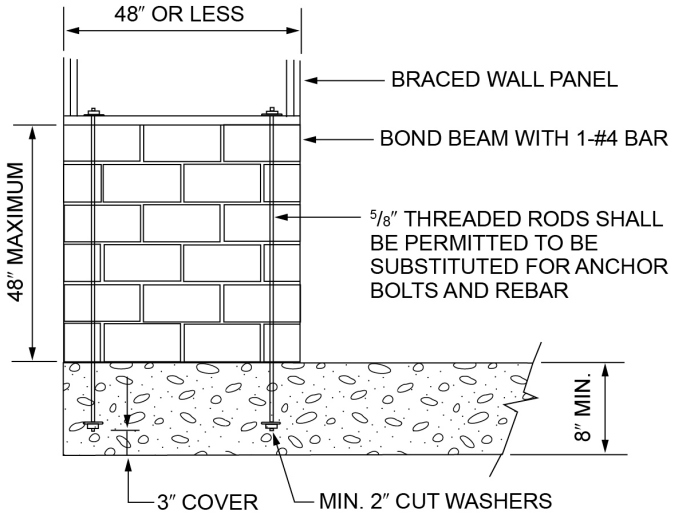
Where *braced wall lines* at interior walls are not supported on a continuous foundation below, the adjacent parallel cripple walls, where provided, shall be braced with Method WSP or Method CS-WSP in accordance with Section R602.10.4. The length of bracing required in accordance with Table R602.10.3(3) for the cripple walls shall be multiplied by 1.5. Where the cripple walls do not have sufficient length to provide the required bracing, the spacing of panel edge fasteners shall be reduced to 4 inches (102 mm) on center and the required bracing length adjusted by 0.7. If the required length can still not be



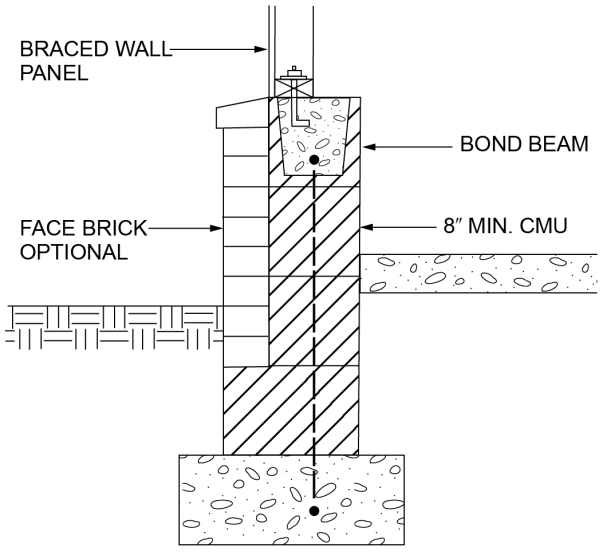
SHORT STEM WALL REINFORCEMENT



TALL STEM WALL REINFORCEMENT



OPTIONAL STEM WALL REINFORCEMENT



TYPICAL STEM WALL SECTION

NOTE: GROUT BOND BEAMS AND ALL CELLS THAT CONTAIN REBAR, THREADED RODS AND ANCHOR BOLTS.

For SI: 1 inch = 25.4 mm.

FIGURE R602.10.9
MASONRY STEM WALLS SUPPORTING BRACED WALL PANELS

provided, the cripple wall shall be designed in accordance with accepted engineering practice.

R602.10.10.2 Cripple wall bracing for Seismic Design Category D_2. Deleted.

R602.10.10.3 Redesignation of cripple walls. Where all cripple wall segments along a *braced wall line* do not exceed 48 inches (1219 mm) in height, the cripple walls shall be permitted to be redesignated as a first-*story* wall for purposes of determining wall bracing requirements. Where any cripple wall segment in a *braced wall line* exceeds 48 inches (1219 mm) in height, the entire cripple wall shall be counted as an additional *story*. If the cripple walls are redesignated, the stories above the redesignated *story* shall be counted as the second and third stories, respectively.

R602.11 Wall anchorage. *Braced wall line* sills shall be anchored to concrete or masonry foundations in accordance with Sections R403.1.6 and R602.11.1.

> **R602.11.1 Wall anchorage for townhouses in Seismic Design Category C.** Plate washers, not less than 0.229 inch by 3 inches by 3 inches (5.8 mm by 76 mm by 76 mm) in size, shall be provided between the foundation sill plate and the nut except where *approved* anchor straps are used. The hole in the plate washer is permitted to be diagonally slotted with a width of up to $^3/_{16}$ inch (5 mm) larger than the bolt diameter and a slot length not to exceed $1^3/_4$ inches (44 mm), provided a standard cut washer is placed between the plate washer and the nut.

R602.11.2 Stepped foundations in Seismic Design Categories D_0, D_1 and D_2. Deleted.

R602.12 Simplified wall bracing. Buildings meeting all of the following conditions shall be permitted to be braced in accordance with this section as an alternative to the requirements of Section R602.10. The entire building shall be braced in accordance with this section; the use of other bracing provisions of Section R602.10, except as specified herein, shall not be permitted.

1. There shall be not more than three stories above the top of a concrete or masonry foundation or basement wall. Permanent wood foundations shall not be permitted.
2. Floors shall not cantilever more than 24 inches (607 mm) beyond the foundation or bearing wall below.
3. Wall height shall not be greater than 10 feet (3048 mm).
4. The building shall have a roof eave-to-ridge height of 15 feet (4572 mm) or less.
5. Exterior walls shall have gypsum board with a minimum thickness of $^1/_2$ inch (12.7 mm) installed on the interior side fastened in accordance with Table R702.3.5.
6. The structure shall be located where the ultimate design wind speed is less than or equal to 130 mph (58 m/s), and the exposure category is B or C.
7. The structure shall be located in *Seismic Design Category* A, B or C for detached one- and two-family dwellings or *Seismic Design Category* A or B for townhouses.
8. Cripple walls shall not be permitted in three-story buildings.

R602.12.1 Circumscribed rectangle. The bracing required for each building shall be determined by circumscribing a rectangle around the entire building on each floor as shown in Figure R602.12.1. The rectangle shall surround all enclosed offsets and projections such as *sunrooms* and attached garages. Open structures, such as carports and decks, shall be permitted to be excluded. The rectangle shall not have a side greater than 60 feet (18 288 mm), and the ratio between the long side and short side shall be not greater than 3:1.

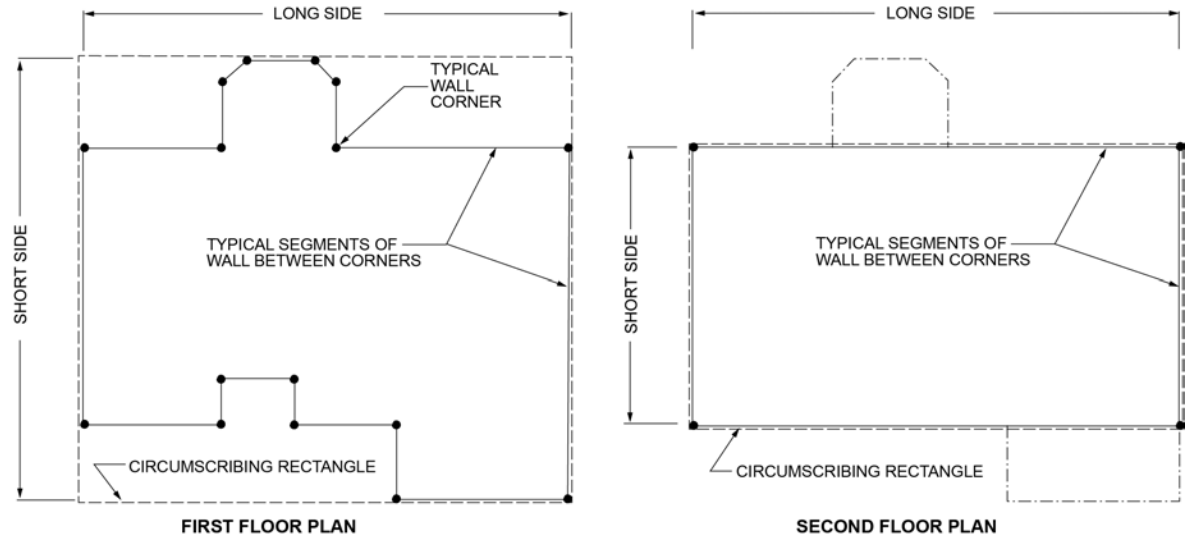


FIGURE R602.12.1
RECTANGLE CIRCUMSCRIBING AN ENCLOSED BUILDING

R602.12.2 Sheathing materials. The following sheathing materials installed on the exterior side of exterior walls shall be used to construct a bracing unit as defined in Section R602.12.3. Mixing materials is prohibited.

1. Wood structural panels with a minimum thickness of $^{3}/_{8}$ inch (9.5 mm) fastened in accordance with Table R602.3(3).
2. Structural fiberboard sheathing with a minimum thickness of $^{1}/_{2}$ inch (12.7 mm) fastened in accordance with Table R602.3(1).

R602.12.3 Bracing unit. A bracing unit shall be a full-height sheathed segment of the exterior wall without openings or vertical or horizontal offsets and a minimum length as specified herein. Interior walls shall not contribute toward the amount of required bracing. Mixing of Items 1 and 2 is prohibited on the same story.

1. Where all framed portions of all exterior walls are sheathed in accordance with Section R602.12.2, including wall areas between bracing units, above and below openings and on gable end walls, the minimum length of a bracing unit shall be 3 feet (914 mm).
2. Where the exterior walls are braced with sheathing panels in accordance with Section R602.12.2 and areas between bracing units are covered with other materials, the minimum length of a bracing unit shall be 4 feet (1219 mm).

R602.12.3.1 Multiple bracing units. Segments of wall compliant with Section R602.12.3 and longer than the minimum bracing unit length shall be considered as multiple bracing units. The number of bracing units shall be determined by dividing the wall segment length by the minimum bracing unit length. Full-height sheathed segments of wall narrower than the minimum bracing unit length shall not contribute toward a bracing unit except as specified in Section R602.12.6.

R602.12.4 Number of bracing units. Each side of the circumscribed rectangle, as shown in Figure R602.12.1, shall have, at a minimum, the number of bracing units in accordance with Table R602.12.4 placed on the parallel exterior walls facing the side of the rectangle. Bracing units shall then be placed using the distribution requirements specified in Section R602.12.5.

R602.12.5 Distribution of bracing units. The placement of bracing units on exterior walls shall meet all of the following requirements as shown in Figure R602.12.5.

1. A bracing unit shall begin not more than 12 feet (3658 mm) from any wall corner.
2. The distance between adjacent edges of bracing units shall be not greater than 20 feet (6096 mm).
3. Segments of wall greater than 8 feet (2438 mm) in length shall have not less than one bracing unit.

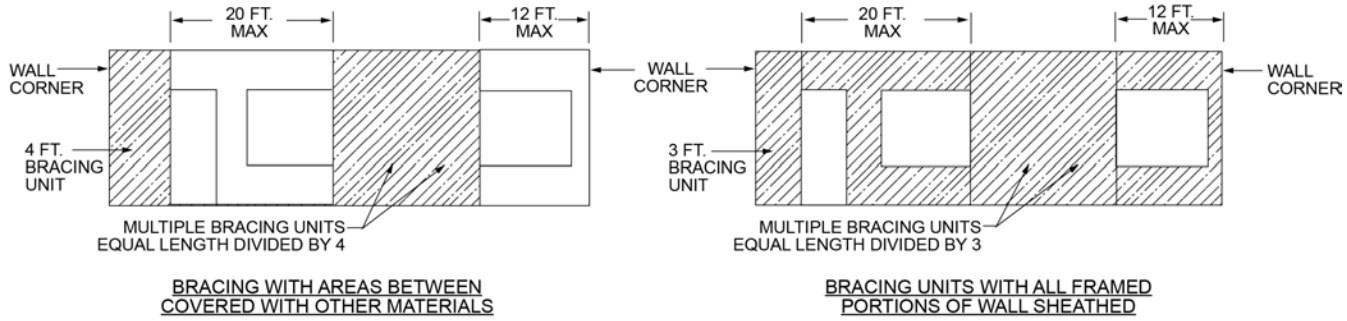
R602.12.6 Narrow panels. The bracing methods referenced in Section R602.10 and specified in Sections R602.12.6.1 through R602.12.6.3 shall be permitted where using simplified wall bracing.

R602.12.6.1 Method CS-G. *Braced wall panels* constructed as Method CS-G in accordance with Tables R602.10.4 and R602.10.5 shall be permitted for one-story garages where all framed portions of all exterior walls are sheathed with *wood structural panels*. Each CS-G panel shall be equivalent to 0.5 of a bracing unit. Segments of wall that include a Method CS-G panel shall meet the requirements of Section R602.10.4.2.

R602.12.6.2 Method CS-PF. *Braced wall panels* constructed as Method CS-PF in accordance with Section R602.10.6.4 shall be permitted where all framed portions of all exterior walls are sheathed with *wood structural panels*. Each CS-PF panel shall equal 0.75 bracing units. Segments of wall that include a Method CS-PF panel shall meet the requirements of Section R602.10.4.2.

R602.12.6.3 Methods ABW, PFH and PFG. *Braced wall panels* constructed as Method ABW, PFH and PFG shall be permitted where bracing units are constructed using *wood structural panels* applied either continuously or intermittently. Each ABW and PFH panel shall equal one bracing unit and each PFG panel shall be equal to 0.75 bracing unit.

R602.12.7 Lateral support. For bracing units located along the eaves, the vertical distance from the outside edge of the top wall plate to the roof sheathing above



For SI: 1 foot = 304.8 mm.

FIGURE R602.12.5
BRACING UNIT DISTRIBUTION

TABLE R602.12.4
MINIMUM NUMBER OF BRACING UNITS ON EACH SIDE OF THE CIRCUMSCRIBED RECTANGLE

ULTIMATE DESIGN WIND SPEED (mph)	STORY LEVEL	EAVE-TO-RIDGE HEIGHT (feet)	MINIMUM NUMBER OF BRACING UNITS ON EACH LONG SIDE[a, b, d]						MINIMUM NUMBER OF BRACING UNITS ON EACH SHORT SIDE[a, b, d]					
			Length of short side (feet)[c]						Length of long side (feet)[c]					
			10	20	30	40	50	60	10	20	30	40	50	60
115		10	1	2	2	2	3	3	1	2	2	2	3	3
			2	3	3	4	5	6	2	3	3	4	5	6
			2	3	4	6	7	8	2	3	4	6	7	8
		15	1	2	3	3	4	4	1	2	3	3	4	4
			2	3	4	5	6	7	2	3	4	5	6	7
			2	4	5	6	7	9	2	4	5	6	7	9
130		10	1	2	2	3	3	4	1	2	2	3	3	4
			2	3	4	5	6	7	2	3	4	5	6	7
			2	4	5	7	8	10	2	4	5	7	8	10
		15	2	3	3	4	4	6	2	3	3	4	4	6
			3	4	6	7	8	10	3	4	6	7	8	10
			3	6	7	10	11	13	3	6	7	10	11	13

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447m/s.

a. Interpolation shall not be permitted.

b. Cripple walls or wood-framed basement walls in a walk-out condition shall be designated as the first story and the stories above shall be redesignated as the second and third stories, respectively, and shall be prohibited in a three-story structure.

c. Actual lengths of the sides of the circumscribed rectangle shall be rounded to the next highest unit of 10 when using this table.

d. For Exposure Category C, multiply bracing units by a factor of 1.20 for a one-story building, 1.30 for a two-story building and 1.40 for a three-story building.

shall not exceed 9.25 inches (235 mm) at the location of a bracing unit unless lateral support is provided in accordance with Section R602.10.8.2.

R602.12.8 Stem walls. Masonry stem walls with a height and length of 48 inches (1219 mm) or less supporting a bracing unit or a Method CS-G, CS-PF or PFG *braced wall panel* shall be constructed in accordance with Figure R602.10.9. Concrete stem walls with a length of 48 inches (1219 mm) or less, greater than 12 inches (305 mm) tall and less than 6 inches (152 mm) thick shall be reinforced sized and located in accordance with Figure R602.10.9.

SECTION R603
COLD-FORMED STEEL WALL FRAMING
DELETED

SECTION R604
WOOD STRUCTURAL PANELS

R604.1 Identification and grade. *Wood structural panels* shall conform to DOC PS 1, DOC PS 2, ANSI/APA PRP 210, CSA O325 or CSA O437. Panels shall be identified by a grade *mark* or certificate of inspection issued by an *approved* agency.

R604.2 Allowable spans. The maximum allowable spans for wood structural panel wall sheathing shall not exceed the values set forth in Table R602.3(3).

R604.3 Installation. Wood structural panel wall sheathing shall be attached to framing in accordance with Table R602.3(1) or R602.3(3).

SECTION R605
PARTICLEBOARD

R605.1 Identification and grade. Particleboard shall conform to ANSI A208.1 and shall be so identified by a grade *mark* or certificate of inspection issued by an *approved* agency. Particleboard shall comply with the grades specified in Table R602.3(4).

SECTION R606
GENERAL MASONRY CONSTRUCTION

R606.1 General. Masonry construction shall be designed and constructed in accordance with the provisions of this section, TMS 402, TMS 403 or TMS 404.

R606.1.1 Professional registration not required. Where the empirical design provisions of Appendix A of TMS 402, the provisions of TMS 403, or the provisions of this section are used to design masonry, project drawings, typical details and specifications are not required to bear the seal of the *registered design professional* responsible for design, unless otherwise required by the state law of the *jurisdiction* having authority.

R606.2 Masonry construction materials.

R606.2.1 Concrete masonry units. *Concrete masonry units* shall conform to the following standards: ASTM C55 for concrete brick; ASTM C73 for calcium silicate face brick; ASTM C90 for load-bearing *concrete masonry units*; ASTM C744 for prefaced concrete and calcium silicate *masonry units*; or ASTM C1634 for concrete facing brick.

R606.2.2 Clay or shale masonry units. Clay or shale *masonry units* shall conform to the following standards: ASTM C34 for structural clay *load-bearing wall* tile; ASTM C56 for structural clay nonload-bearing wall tile; ASTM C62 for building brick (*solid masonry* units made from clay or shale); ASTM C126 for ceramic-glazed structural clay facing tile, facing brick and *solid masonry* units; ASTM C212 for structural clay facing tile; ASTM C216 for facing brick (*solid masonry* units made from clay or shale); ASTM C652 for hollow brick (*hollow masonry units* made from clay or shale); ASTM C1088 for solid units of thin veneer brick; or ASTM C1405 for glazed brick (single-fired solid brick units).

Exception: Structural clay tile for nonstructural use in fireproofing of structural members and in wall furring shall not be required to meet the compressive strength specifications. The fire-resistance rating shall be determined in accordance with ASTM E119 or UL 263 and shall comply with the requirements of Section R302.

R606.2.3 AAC masonry. AAC *masonry units* shall conform to ASTM C1691 and ASTM C1693 for the strength class specified.

R606.2.4 Stone masonry units. Stone *masonry units* shall conform to the following standards: ASTM C503 for marble building stone (exterior); ASTM C568 for limestone building stone; ASTM C615 for granite building stone; ASTM C616 for sandstone building stone; or ASTM C629 for slate building stone.

R606.2.5 Architectural cast stone. Architectural cast stone shall conform to ASTM C1364.

R606.2.6 Adhered manufactured stone masonry veneer units. Adhered manufactured stone masonry veneer units shall conform to ASTM C1670.

R606.2.7 Second-hand units. Second-hand *masonry units* shall not be reused unless they conform to the requirements of new units. The units shall be of whole, sound materials and free from cracks and other defects that will interfere with proper laying or use. Old mortar shall be cleaned from the unit before reuse.

Exception: Second hand units are permitted to be used for interior nonbearing conditions.

R606.2.8 Mortar. Except for mortars listed in Sections R606.2.9, R606.2.10 and R606.2.11, mortar for use in masonry construction shall meet the proportion specifications of Table R606.2.8 or the property specifications of ASTM C270. The type of mortar shall be in accordance with Sections R606.2.8.1, R606.2.8.2 and R606.2.8.3.

R606.2.8.1 Foundation walls. Mortar for masonry foundation walls constructed as set forth in Tables

TABLE R606.2.8
MORTAR PROPORTIONS[a, b]

MORTAR	TYPE	PROPORTIONS BY VOLUME (cementitious materials)							Aggregate ratio (measured in damp, loose conditions)
		Portland cement or blended cement	Mortar cement			Masonry cement			Hydrated lime[c] or lime putty	
			M	S	N	M	S	N		
Cement-lime	M	1	—	—	—	—	—	—	$^1/_4$	Not less than $2^1/_4$ and not more than 3 times the sum of separate volumes of lime, if used, and cement
	S	1	—	—	—	—	—	—	over $^1/_4$ to $^1/_2$	
	N	1	—	—	—	—	—	—	over $^1/_2$ to $1^1/_4$	
	O	1	—	—	—	—	—	—	over $1^1/_4$ to $2^1/_2$	
Mortar cement	M	1	—	—	1	—	—	—	—	
	M	—	1	—	—	—	—	—		
	S	$^1/_2$	—	—	1	—	—	—		
	S	—	—	1	—	—	—	—		
	N	—	—	—	1	—	—	—		
	O	—	—	—	1	—	—	—		
Masonry cement	M	1	—	—	—	—	—	1	—	
	M	—	—	—	—	1	—	—		
	S	$^1/_2$	—	—	—	—	—	1		
	S	—	—	—	—	—	1	—		
	N	—	—	—	—	—	—	1		
	O	—	—	—	—	—	—	1		

For SI: 1 cubic foot = 0.0283 m^3, 1 pound = 0.454 kg.

a. For the purpose of these specifications, the weight of 1 cubic foot of the respective materials shall be considered to be as follows:
Hydrated lime = 40 pounds
Lime putty (Quicklime) = 80 pounds
Masonry cement = Weight printed on bag
Mortar cement = Weight printed on bag
Portland cement = 94 pounds
Sand, damp and loose = 80 pounds of dry sand

b. Two air-entraining materials shall not be combined in mortar.

c. Hydrated lime conforming to the requirements of ASTM C207.

TABLE R606.2.12
GROUT PROPORTIONS BY VOLUME FOR MASONRY CONSTRUCTION

TYPE	PORTLAND CEMENT OR BLENDED CEMENT SLAG CEMENT	HYDRATED LIME OR LIME PUTTY	AGGREGATE MEASURED IN A DAMP, LOOSE CONDITION	
			Fine	Coarse
Fine	1	0 to 1/10	$2^1/_4$ to 3 times the sum of the volumes of the cementitious materials	—
Coarse	1	0 to 1/10	$2^1/_4$ to 3 times the sum of the volumes of the cementitious materials	1 to 2 times the sum of the volumes of the cementitious materials

R404.1.1(1) through R404.1.1(4) shall be Type M or S mortar.

R606.2.8.2 Masonry in Seismic Design Categories A, B and C. Mortar for masonry serving as the lateral force-resisting system in *Seismic Design Categories* A, B and C shall be Type M, S or N mortar.

R606.2.8.3 Masonry in Seismic Design Categories D_0, D_1 and D_2. Deleted.

R606.2.9 Surface-bonding mortar. Surface-bonding mortar shall comply with ASTM C887. Surface bonding of *concrete masonry units* shall comply with ASTM C946.

R606.2.10 Mortar for AAC masonry. Thin-bed mortar for AAC masonry shall comply with Article 2.1 C.1 of TMS 602. Mortar used for the leveling courses of AAC masonry shall comply with Article 2.1 C.2 of TMS 602.

R606.2.11 Mortar for adhered masonry veneer. Mortar for use with adhered masonry veneer shall conform to ASTM C270 Type S or Type N or shall comply with ANSI A118.4 for latex-modified Portland cement mortar.

R606.2.12 Grout. Grout shall consist of cementitious material and aggregate in accordance with ASTM C476 or the proportion specifications of Table R606.2.12. Type M or Type S mortar to which sufficient water has been added to produce pouring consistency shall be permitted to be used as grout.

R606.2.13 Metal reinforcement and accessories. Metal reinforcement and accessories shall conform to Article 2.4 of TMS 602.

R606.3 Construction requirements.

R606.3.1 Bed and head joints. Unless otherwise required or indicated on the project drawings, head and bed joints shall be $^3/_8$ inch (9.5 mm) thick, except that the thickness of the bed joint of the starting course placed over foundations shall be not less than $^1/_4$ inch (6.4 mm) and not more than $^3/_4$ inch (19.1 mm). Mortar joint thickness for load-bearing masonry shall be within the following tolerances from the specified dimensions:

1. Bed joint: + $^1/_8$ inch (3.2 mm).
2. Head joint: - $^1/_4$ inch (6.4 mm), + $^3/_8$ inch (9.5 mm).
3. Collar joints: - $^1/_4$ inch (6.4 mm), + $^3/_8$ inch (9.5 mm).

R606.3.2 Masonry unit placement. The mortar shall be sufficiently plastic and units shall be placed with sufficient pressure to extrude mortar from the joint and produce a tight joint. Deep furrowing of bed joints that produces voids shall not be permitted. Any units disturbed to the extent that initial bond is broken after initial placement shall be removed and relaid in fresh mortar. Surfaces to be in contact with mortar shall be clean and free of deleterious materials.

R606.3.2.1 Solid masonry. *Solid masonry* units shall be laid with full head and bed joints and all interior vertical joints that are designed to receive mortar shall be filled.

R606.3.2.2 Hollow masonry. For *hollow masonry units*, head and bed joints shall be filled solidly with mortar for a distance in from the face of the unit not less than the thickness of the face shell.

R606.3.3 Installation of wall ties. The installation of wall ties shall be as follows:

1. The ends of wall ties shall be embedded in mortar joints. Wall ties shall have not less than $^5/_8$-inch (15.9 mm) mortar coverage from the exposed face.
2. Wall ties shall not be bent after being embedded in grout or mortar.
3. For *solid masonry* units, solid grouted hollow units, or hollow units in anchored masonry veneer, wall ties shall be embedded in mortar bed not less than $1^1/_2$ inches (38 mm).
4. For *hollow masonry units* in other than anchored masonry veneer, wall ties shall engage outer face shells by not less than $^1/_2$ inch (13 mm).

R606.3.4 Protection for reinforcement. Bars shall be completely embedded in mortar or grout. Joint reinforcement embedded in horizontal mortar joints shall not have less than $^5/_8$-inch (15.9 mm) mortar coverage from the exposed face. Other reinforcement shall have a minimum coverage of one bar diameter over all bars, but not less than $^3/_4$ inch (19 mm), except where exposed to weather or soil, in which case the minimum coverage shall be 2 inches (51 mm).

R606.3.4.1 Corrosion protection. Minimum corrosion protection of joint reinforcement, anchor ties and wire fabric for use in masonry wall construction shall conform to Table R606.3.4.1.

R606.3.5 Grouting requirements.

R606.3.5.1 Grout placement. Grout shall be a plastic mix suitable for pumping without segregation of the constituents and shall be mixed thoroughly. Grout shall be placed by pumping or by an *approved* alternate method and shall be placed before any initial set occurs and not more than $1^1/_2$ hours after water has been added. Grout shall be consolidated by puddling or mechanical vibrating during placing and reconsolidated after excess moisture has been absorbed but before plasticity is lost. Grout shall not be pumped through aluminum pipes.

Maximum pour heights and the minimum dimensions of spaces provided for grout placement shall conform to Table R606.3.5.1. Grout shall be poured in lifts with a maximum height of 8 feet (2438 mm). Where a total grout pour exceeds 8 feet (2438 mm) in height, the grout shall be placed in lifts not exceeding 64 inches (1626 mm). If the work is stopped for 1 hour or longer, the horizontal construction joints shall be formed by stopping all tiers at the same elevation and with the grout 1 inch (25 mm) below the top.

TABLE R606.3.4.1
MINIMUM CORROSION PROTECTION

MASONRY METAL ACCESSORY	STANDARD
Joint reinforcement, interior walls	ASTM A641, Class 1
Wire ties or anchors in exterior walls completely embedded in mortar or grout	ASTM A641, Class 3
Wire ties or anchors in exterior walls not completely embedded in mortar or grout	ASTM A153, Class B-2
Joint reinforcement in exterior walls or interior walls exposed to moist environment	ASTM A153, Class B-2
Sheet metal ties or anchors exposed to weather	ASTM A153, Class B-2
Sheet metal ties or anchors completely embedded in mortar or grout	ASTM A653, Coating Designation G60
Stainless steel hardware for any exposure	ASTM A167, Type 304

TABLE R606.3.5.1
GROUT SPACE DIMENSIONS AND POUR HEIGHTS

GROUT TYPE	GROUT POUR MAXIMUM HEIGHT (feet)	MINIMUM WIDTH OF GROUT SPACES[a, b] (inches)	MINIMUM GROUT[b, c] SPACE DIMENSIONS FOR GROUTING CELLS OF HOLLOW UNITS (inches × inches)
Fine	1	0.75	1.5 × 2
	5	2	2 × 3
	12	2.5	2.5 × 3
	24	3	3 × 3
Coarse	1	1.5	1.5 × 3
	5	2	2.5 × 3
	12	2.5	3 × 3
	24	3	3 × 4

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

a. For grouting between masonry wythes.

b. Grout space dimension is the clear dimension between any masonry protrusion and shall be increased by the horizontal projection of the diameters of the horizontal bars within the cross section of the grout space.

c. Area of vertical reinforcement shall not exceed 6 percent of the area of the grout space.

R606.3.5.2 Cleanouts. Provisions shall be made for cleaning the space to be grouted. Mortar that projects more than $^1/_2$ inch (12.7 mm) into the grout space and any other foreign matter shall be removed from the grout space prior to inspection and grouting. Where required by the building official, cleanouts shall be provided in the bottom course of masonry for each grout pour where the grout pour height exceeds 64 inches (1626 mm). In solid grouted masonry, cleanouts shall be spaced horizontally not more than 32 inches (813 mm) on center. The cleanouts shall be sealed before grouting and after inspection.

R606.3.5.3 Construction. Requirements for grouted masonry construction shall be as follows:

1. Masonry shall be built to preserve the unobstructed vertical continuity of the cells or spaces to be filled. In partially grouted construction, cross webs forming cells to be filled shall be full-bedded in mortar to prevent leakage of grout. Head and end joints shall be solidly filled with mortar for a distance in from the face of the wall or unit not less than the thickness of the longitudinal face shells.
2. Vertical reinforcement shall be held in position at top and bottom and at intervals not exceeding 200 diameters of the reinforcement.
3. Cells containing reinforcement shall be filled solidly with grout.
4. The thickness of grout or mortar between *masonry units* and reinforcement shall be not less than $^1/_4$ inch (6.4 mm), except that $^1/_4$-inch (6.4 mm) bars shall be permitted to be laid in horizontal mortar joints not less than $^1/_2$ inch (12.7 mm) thick, and steel wire reinforcement shall be permitted to be laid in horizontal mortar joints not less than twice the thickness of the wire diameter.

R606.3.6 Grouted multiple-wythe masonry. Grouted multiple-wythe masonry shall conform to all the requirements specified in Section R606.3.5 and the requirements of this section.

R606.3.6.1 Bonding of backup wythe. Where all interior vertical spaces are filled with grout in multiple-wythe construction, masonry headers shall not be permitted. Metal wall ties shall be used in accordance with Section R606.13.2 to prevent spreading of the wythes and to maintain the vertical alignment of the wall. Wall ties shall be installed in accordance with Section R606.13.2 where the backup wythe in multiple-wythe construction is fully grouted.

R606.3.6.2 Grout barriers. Vertical grout barriers or dams shall be built of *solid masonry* across the grout space the entire height of the wall to control the flow of the grout horizontally. Grout barriers shall be not more than 25 feet (7620 mm) apart. The grouting of any section of a wall between control barriers shall be completed in one day without interruptions greater than 1 hour.

R606.3.7 Masonry bonding pattern. Masonry laid in running and *stack bond* shall conform to Sections R606.3.7.1 and R606.3.7.2.

R606.3.7.1 Masonry laid in running bond. In each wythe of masonry laid in *running bond*, head joints in successive courses shall be offset by not less than one-fourth the unit length, or the masonry walls shall be reinforced longitudinally as required in Section R606.3.7.2.

R606.3.7.2 Masonry laid in stack bond. In unreinforced masonry where masonry units are laid in stack bond, longitudinal reinforcement consisting of not less than two continuous wires each with a minimum aggregate cross-sectional area of 0.017 square inch (11 mm^2) shall be provided in horizontal bed joints spaced not more than 16 inches (406 mm) on center vertically.

R606.4 Thickness of masonry. The nominal thickness of masonry walls shall conform to the requirements of Sections R606.4.1 through R606.4.4.

R606.4.1 Minimum thickness. The minimum thickness of masonry bearing walls more than one story high shall be 8 inches (203 mm). *Solid masonry* walls of one-story dwellings and garages shall be not less than 6 inches (152 mm) in thickness where not greater than 9 feet (2743 mm) in height, provided that where gable construction is used, an additional 6 feet (1829 mm) is permitted to the peak of the gable. Masonry walls shall be laterally supported in either the horizontal or vertical direction at intervals as required by Section R606.6.4.

R606.4.2 Rubble stone masonry wall. The minimum thickness of rough, random or coursed rubble stone masonry walls shall be 16 inches (406 mm).

R606.4.3 Change in thickness. Where walls of masonry of hollow units or masonry-bonded hollow walls are decreased in thickness, a course of *solid masonry* or *masonry units* filled with mortar or grout shall be constructed between the wall below and the thinner wall above, or special units or construction shall be used to transmit the loads from face shells or wythes above to those below.

R606.4.4 Parapet walls. Unreinforced *solid masonry* parapet walls shall be not less than 8 inches (203 mm) thick and their height shall not exceed four times their thickness. Unreinforced hollow unit masonry parapet walls shall be not less than 8 inches (203 mm) thick, and their height shall not exceed three times their thickness. Masonry parapet walls in areas subject to wind loads of > 30 pounds per square foot (1.44 kPa) located on townhouses in *Seismic Design Category* C shall be reinforced in accordance with Section R606.12.

R606.5 Corbeled masonry. Corbeled masonry shall be in accordance with Sections R606.5.1 through R606.5.3.

R606.5.1 Units. *Solid masonry* units or masonry units filled with mortar or grout shall be used for corbeling.

R606.5.2 Corbel projection. The maximum projection of one unit shall not exceed one-half the height of the unit or one-third the thickness at right angles to the wall. The maximum corbeled projection beyond the face of the wall shall not exceed:

1. One-half of the wall thickness for multiple-wythe walls bonded by mortar or grout and wall ties or masonry headers.
2. One-half the wythe thickness for single wythe walls, masonry-bonded hollow walls, multiple-wythe walls with open collar joints and veneer walls.

R606.5.3 Corbeled masonry supporting floor or roof-framing members. Where corbeled masonry is used to support floor or roof-framing members, the top course of the corbel shall be a header course or the top course bed joint shall have ties to the vertical wall.

R606.6 Support conditions. Bearing and support conditions shall be in accordance with Sections R606.6.1 through R606.6.4.

R606.6.1 Bearing on support. Each masonry wythe shall be supported by not less than two-thirds of the wythe thickness.

R606.6.2 Support at foundation. Cavity wall or masonry veneer construction shall be permitted to be supported on an 8-inch (203 mm) foundation wall, provided the 8-inch (203 mm) wall is corbeled to the width of the wall system above with masonry constructed of *solid masonry* units or masonry units filled with mortar or grout. The total horizontal projection of the corbel shall not exceed 2 inches (51 mm) with individual corbels projecting not more than one-third the thickness of the unit or one-half the height of the unit. The hollow space behind the corbeled masonry shall be filled with mortar or grout.

R606.6.3 Beam supports. Beams, girders or other concentrated loads supported by a wall or column shall have a bearing of not less than 3 inches (76 mm) in length measured parallel to the beam on *solid masonry* not less than 4 inches (102 mm) in thickness, or on a metal bearing plate of adequate design and dimensions to distribute the load safely, or on a continuous reinforced masonry member projecting not less than 4 inches (102 mm) from the face of the wall.

R606.6.3.1 Joist bearing. Joists shall have a bearing of not less than $1^1/_2$ inches (38 mm), except as provided in Section R606.6.3, and shall be supported in accordance with Figure R606.11(1).

R606.6.4 Lateral support. Masonry walls shall be laterally supported in either the horizontal or the vertical direction. The maximum spacing between lateral supports shall not exceed the distances in Table R606.6.4. Lateral support shall be provided by cross walls, pilasters, buttresses or structural frame members where the limiting distance is taken horizontally, or by floors or roofs where the limiting distance is taken vertically.

TABLE R606.6.4
SPACING OF LATERAL SUPPORT FOR MASONRY WALLS

CONSTRUCTION	MAXIMUM WALL LENGTH TO THICKNESS OR WALL HEIGHT TO THICKNESS[a, b]
Bearing walls:	
Solid or solid grouted	20
All other	18
Nonbearing walls:	
Exterior	18
Interior	36

For SI: 1 foot = 304.8 mm.

a. Except for cavity walls and cantilevered walls, the thickness of a wall shall be its nominal thickness measured perpendicular to the face of the wall. For cavity walls, the thickness shall be determined as the sum of the nominal thicknesses of the individual wythes. For cantilever walls, except for parapets, the ratio of height to nominal thickness shall not exceed 6 for solid masonry, or 4 for hollow masonry. For parapets, see Section R606.4.4.

b. An additional unsupported height of 6 feet is permitted for gable end walls.

R606.6.4.1 Horizontal lateral support. Lateral support in the horizontal direction provided by intersecting masonry walls shall be provided by one of the methods in Section R606.6.4.1.1 or R606.6.4.1.2.

R606.6.4.1.1 Bonding pattern. Fifty percent of the units at the intersection shall be laid in an overlapping masonry bonding pattern, with alternate units having a bearing of not less than 3 inches (76 mm) on the unit below.

R606.6.4.1.2 Metal reinforcement. Interior nonload-bearing walls shall be anchored at their intersections, at vertical intervals of not more than 16 inches (406 mm) with joint reinforcement of not less than 9 gage [0.148 inch (4 mm)], or $^1/_4$-inch (6 mm) galvanized mesh hardware cloth. Intersecting masonry walls, other than interior nonload-bearing walls, shall be anchored at vertical intervals of not more than 8 inches (203 mm) with joint reinforcement of not less than 9 gage (4 mm) and shall extend not less than 30 inches (762 mm) in each direction at the intersection. Other metal ties, joint reinforcement or anchors, if used, shall be spaced to provide equivalent area of anchorage to that required by this section.

R606.6.4.2 Vertical lateral support. Vertical lateral support of masonry walls in *Seismic Design Category* A, B or C shall be provided in accordance with one of the methods in Section R606.6.4.2.1 or R606.6.4.2.2.

R606.6.4.2.1 Roof structures. Masonry walls shall be anchored to roof structures with metal strap anchors spaced in accordance with the manufacturer's instructions, $^1/_2$-inch (13 mm) bolts spaced not more than 6 feet (1829 mm) on center, or other *approved* anchors. Anchors shall be embedded not less than 16 inches (406 mm) into the masonry, or be hooked or welded to bond beam reinforcement placed not less than 6 inches (152 mm) from the top of the wall.

R606.6.4.2.2 Floor diaphragms. Masonry walls shall be anchored to floor *diaphragm* framing by metal strap anchors spaced in accordance with the manufacturer's instructions, $^1/_2$-inch-diameter (13 mm) bolts spaced at intervals not to exceed 6 feet (1829 mm) and installed as shown in Figure R606.11(1), or by other *approved* methods.

R606.7 Piers. The unsupported height of masonry piers shall not exceed 10 times their least dimension. Where structural clay tile or hollow *concrete masonry units* are used for isolated piers to support beams and girders, the cellular spaces shall be filled solidly with grout or Type M or S mortar, except that unfilled hollow piers shall be permitted to be used if their unsupported height is not more than four times their least dimension. Where *hollow masonry units* are solidly filled with grout or Type M, S or N mortar, the allowable compressive stress shall be permitted to be increased as provided in Table R606.9.

R606.7.1 Pier cap. Hollow piers shall be capped with 4 inches (102 mm) of solid masonry or concrete for one story and 8 inches (203 mm) of solid masonry or concrete for two stories and two and one-half stories or shall have cavities of the top course filled with concrete or grout or other approved methods.

R606.8 Chases. Chases and recesses in masonry walls shall not be deeper than one-third the wall thickness. The maximum length of a horizontal chase or horizontal projection shall not exceed 4 feet (1219 mm) and shall have not less than 8 inches (203 mm) of masonry in back of the chases and recesses and between adjacent chases or recesses and the jambs of openings. Chases and recesses in masonry walls shall be designed and constructed so as not to reduce the required strength or required fire resistance of the wall and shall not be permitted within the required area of a pier. Masonry directly above chases or recesses wider than 12 inches (305 mm) shall be supported on noncombustible lintels.

R606.9 Allowable stresses. Allowable compressive stresses in masonry shall not exceed the values prescribed in Table R606.9. In determining the stresses in masonry, the effects of all loads and conditions of loading and the influence of all forces affecting the design and strength of the several parts shall be taken into account.

R606.9.1 Combined units. In walls or other structural members composed of different kinds or grades of units, materials or mortars, the maximum stress shall not exceed the allowable stress for the weakest of the combination of units, materials and mortars of which the member is composed. The net thickness of any facing unit that is used to resist stress shall be not less than $1^1/_2$ inches (38 mm).

R606.10 Lintels. Masonry over openings shall be supported by steel lintels, reinforced concrete or masonry lintels or masonry arches, designed to support load imposed.

R606.11 Anchorage. Masonry walls shall be anchored to floor and roof systems in accordance with the details shown in Figure R606.11(1) or R606.11(2). Footings shall be permitted to be considered as points of lateral support.

FIGURE R606.11(3)
REQUIREMENTS FOR REINFORCED MASONRY CONSTRUCTION IN SEISMIC DESIGN CATEGORY D_0, D_1 OR D_2
DELETED

R606.12 Seismic requirements. Townhouses in *Seismic Design Category* C shall comply with the requirements of Section R606.12.2. These requirements shall not apply to glass unit masonry conforming to Section R607, anchored masonry veneer conforming to Section R703.8 or adhered masonry veneer conforming to Section R703.12.

R606.12.1 General. Masonry structures and masonry elements shall comply with the requirements of Sections R606.12.2 through R606.12.2 based on the seismic design category established in Table R301.2.1(1). Masonry structures and masonry elements shall comply with the requirements of Section R606.12 and Figures R606.11(1) and R606.11(2) or shall be designed in accordance with TMS 402 or TMS 403.

TABLE R606.9
ALLOWABLE COMPRESSIVE STRESSES FOR EMPIRICAL DESIGN OF MASONRY

CONSTRUCTION; COMPRESSIVE STRENGTH OF UNIT, GROSS AREA	ALLOWABLE COMPRESSIVE STRESSES[a] GROSS CROSS-SECTIONAL AREA[b]	
	Type M or S mortar	Type N mortar
Solid masonry of brick and other solid units of clay or shale; sand-lime or concrete brick:		
8,000 + psi	350	300
4,500 psi	225	200
2,500 psi	160	140
1,500 psi	115	100
Grouted[c] masonry, of clay or shale; sand-lime or concrete:		
4,500 + psi	225	200
2,500 psi	160	140
1,500 psi	115	100
Solid masonry of solid concrete masonry units:		
3,000 + psi	225	200
2,000 psi	160	140
1,200 psi	115	100
Masonry of hollow load-bearing units:		
2,000 + psi	140	120
1,500 psi	115	100
1,000 psi	75	70
700 psi	60	55
Hollow walls (cavity or masonry bonded[d]) solid units:		
2,500 + psi	160	140
1,500 psi	115	100
Hollow units	75	70
Stone ashlar masonry:		
Granite	720	640
Limestone or marble	450	400
Sandstone or cast stone	360	320
Rubble stone masonry:		
Coarse, rough or random	120	100

For SI: 1 pound per square inch = 6.895 kPa.

a. Linear interpolation shall be used for determining allowable stresses for masonry units having compressive strengths that are intermediate between those given in the table.

b. Gross cross-sectional area shall be calculated on the actual rather than nominal dimensions.

c. See Section R606.13.

d. Where floor and roof loads are carried on one wythe, the gross cross-sectional area is that of the wythe under load; if both wythes are loaded, the gross cross-sectional area is that of the wall minus the area of the cavity between the wythes. Walls bonded with metal ties shall be considered as cavity walls unless the collar joints are filled with mortar or grout.

R606.12.1.1 Floor and roof diaphragm construction. Floor and roof *diaphragms* shall be constructed of *wood structural panels* attached to wood framing in accordance with Table R602.3(1). Additionally, < sheathing panel edges perpendicular to framing members shall be backed by blocking, and sheathing shall be connected to the blocking with fasteners at the edge spacing. For *Seismic Design Category* C, where < the width-to-thickness dimension of the *diaphragm* exceeds 2-to-1, edge spacing of fasteners shall be 4 inches (102 mm) on center.

R606.12.2 Seismic Design Category C. Townhouses located in *Seismic Design Category* C shall comply with the requirements of this section.

R606.12.2.1 Minimum length of wall without openings. Table R606.12.2.1 shall be used to determine the minimum required solid wall length without openings at each masonry exterior wall. The provided percentage of solid wall length shall include only those wall segments that are 3 feet (914 mm) or longer. The maximum clear distance between wall segments included in determining the solid wall length shall not exceed 18 feet (5486 mm). *Shear wall* segments required to meet the minimum wall length shall be in accordance with Section R606.12.2.2.3.

R606.12.2.2 Design of elements not part of the lateral force-resisting system.

R606.12.2.2.1 Load-bearing frames or columns. Elements not part of the lateral force-resisting system shall be analyzed to determine their effect on the response of the system. The frames or columns shall be adequate for vertical load-carrying capacity and induced moment caused by the design *story* drift.

R606.12.2.2.2 Masonry partition walls. Masonry partition walls, masonry screen walls and other masonry elements that are not designed to resist vertical or lateral loads, other than those induced by their own weight, shall be isolated from the structure so that vertical and lateral forces are not imparted to these elements. Isolation joints and connectors between these elements and the structure shall be designed to accommodate the design *story* drift.

R606.12.2.2.3 Reinforcement requirements for masonry elements. Masonry elements listed in Section R606.12.2.2.2 shall be reinforced in either the horizontal or vertical direction as shown in Figure R606.11(2) and in accordance with the following:

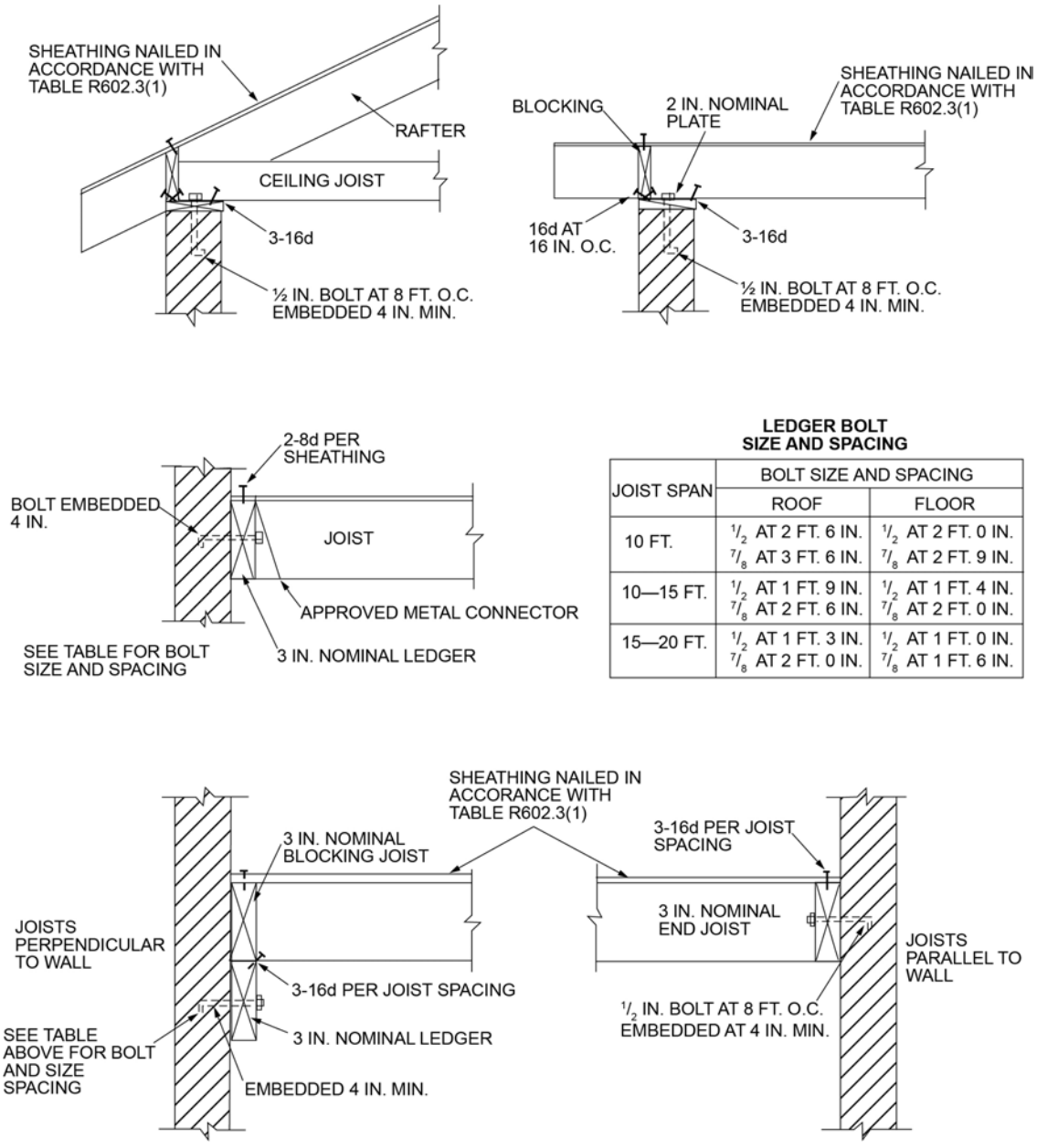
1. Horizontal reinforcement. Horizontal joint reinforcement shall consist of not less than two longitudinal W1.7 wires spaced not more than 16 inches (406 mm) for walls greater than 4 inches (102 mm) in width and not less than one longitudinal W1.7 wire spaced not more than 16 inches (406 mm) for walls not exceeding 4 inches (102 mm) in width; or not less than one No. 4 bar spaced not more than 48 inches (1219 mm). Where two longitudinal wires of

TABLE R606.12.2.1
MINIMUM SOLID WALL LENGTH ALONG EXTERIOR WALL LINES

SESIMIC DESIGN CATEGORY	MINIMUM SOLID WALL LENGTH (percent)[a]		
	One story or top story of two story	Wall supporting light-frame second story and roof	Wall supporting masonry second story and roof
> Townhouses in C	20	25	35

NP = Not Permitted, except with design in accordance with the *International Building Code*.

a. For all walls, the minimum required length of solid walls shall be based on the table percent multiplied by the dimension, parallel to the wall direction under consideration, of a rectangle inscribing the overall building plan.



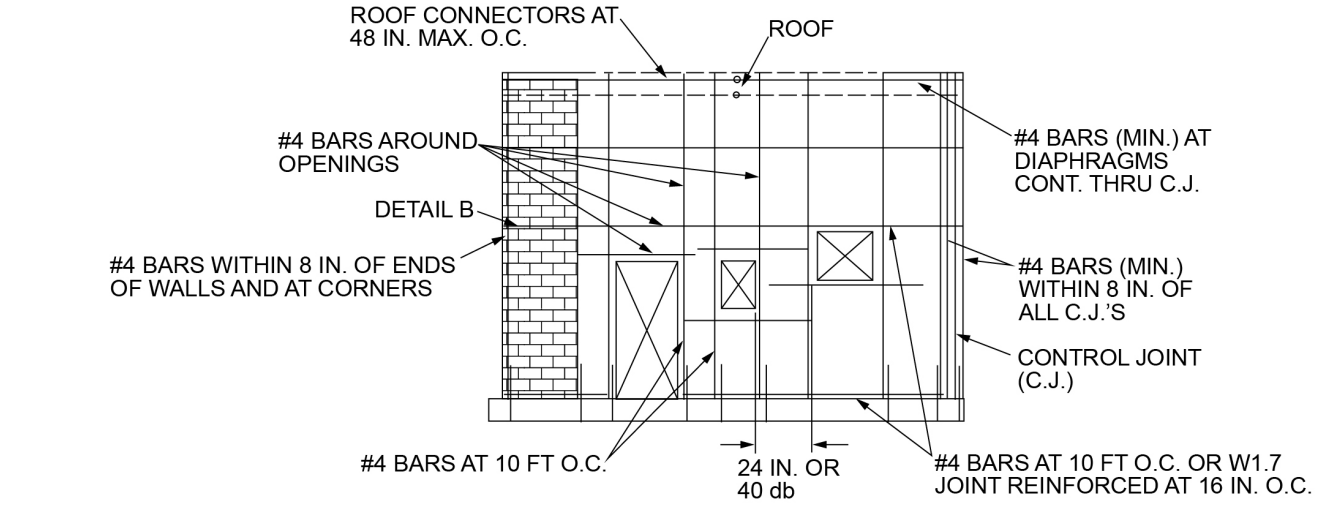
LEDGER BOLT SIZE AND SPACING

JOIST SPAN	BOLT SIZE AND SPACING	
	ROOF	FLOOR
10 FT.	1/2 AT 2 FT. 6 IN. 7/8 AT 3 FT. 6 IN.	1/2 AT 2 FT. 0 IN. 7/8 AT 2 FT. 9 IN.
10—15 FT.	1/2 AT 1 FT. 9 IN. 7/8 AT 2 FT. 6 IN.	1/2 AT 1 FT. 4 IN. 7/8 AT 2 FT. 0 IN.
15—20 FT.	1/2 AT 1 FT. 3 IN. 7/8 AT 2 FT. 0 IN.	1/2 AT 1 FT. 0 IN. 7/8 AT 1 FT. 6 IN.

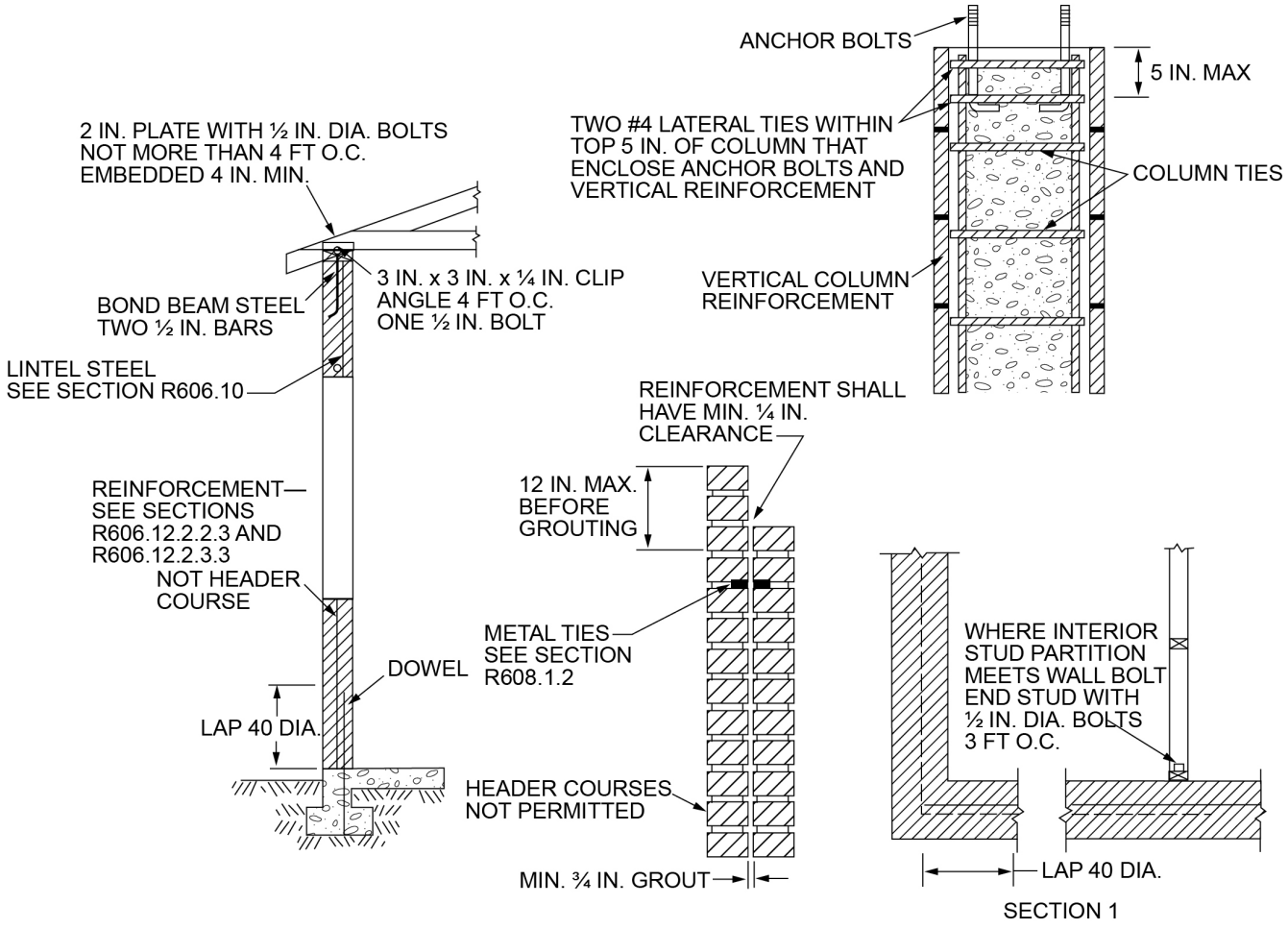
For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

Note: Where bolts are located in hollow masonry, the cells in the courses receiving the bolt shall be grouted solid.

FIGURE R606.11(1)
ANCHORAGE REQUIREMENTS FOR MASONRY WALLS LOCATED IN SEISMIC DESIGN CATEGORY A, B OR C AND WHERE WIND LOADS ARE LESS THAN 30 PSF



MINIMUM REINFORCEMENT FOR MASONRY WALLS



SECTION 1

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

FIGURE R606.11(2)
REQUIREMENTS FOR REINFORCED GROUTED MASONRY CONSTRUCTION IN SEISMIC DESIGN CATEGORY C

joint reinforcement are used, the space between these wires shall be the widest that the mortar joint will accommodate. Horizontal reinforcement shall be provided within 16 inches (406 mm) of the top and bottom of these masonry elements.

2. Vertical reinforcement. Vertical reinforcement shall consist of not less than one No. 4 bar spaced not more than 48 inches (1219 mm). Vertical reinforcement shall be located within 16 inches (406 mm) of the ends of masonry walls.

R606.12.2.3 Design of elements part of the lateral force-resisting system.

R606.12.2.3.1 Connections to masonry shear walls. Connectors shall be provided to transfer forces between masonry walls and horizontal elements in accordance with the requirements of Section 4.1.4 of TMS 402. Connectors shall be designed to transfer horizontal design forces acting either perpendicular or parallel to the wall, but not less than 200 pounds per linear foot (2919 N/m) of wall. The maximum spacing between connectors shall be 4 feet (1219 mm). Such anchorage mechanisms shall not induce tension stresses perpendicular to grain in ledgers or nailers.

R606.12.2.3.2 Connections to masonry columns. Connectors shall be provided to transfer forces between masonry columns and horizontal elements in accordance with the requirements of Section 4.1.4 of TMS 402. Where anchor bolts are used to connect horizontal elements to the tops of columns, the bolts shall be placed within lateral ties. Lateral ties shall enclose both the vertical bars in the column and the anchor bolts. There shall be not less than two No. 4 lateral ties provided in the top 5 inches (127 mm) of the column.

R606.12.2.3.3 Minimum reinforcement requirements for masonry shear walls. Vertical reinforcement of not less than one No. 4 bar shall be provided at corners, within 16 inches (406 mm) of each side of openings, within 8 inches (203 mm) of each side of movement joints, within 8 inches (203 mm) of the ends of walls, and at a maximum spacing of 10 feet (3048 mm).

Horizontal joint reinforcement shall consist of not less than two wires of W1.7 spaced not more than 16 inches (406 mm); or bond beam reinforcement of not less than one No. 4 bar spaced not more than 10 feet (3048 mm) shall be provided. Horizontal reinforcement shall be provided at the bottom and top of wall openings and shall extend not less than 24 inches (610 mm) nor less than 40 bar diameters past the opening; continuously at structurally connected roof and floor levels; and within 16 inches (406 mm) of the top of walls.

R606.12.3 Seismic Design Category D_0 or D_1. Deleted.

R606.12.4 Seismic Design Category D_2. Deleted.

R606.13 Multiple-wythe masonry. The facing and backing of multiple-wythe masonry walls shall be bonded in accordance with Section R606.13.1, R606.13.2 or R606.13.3. In cavity walls, neither the facing nor the backing shall be less than 3 inches (76 mm) nominal in thickness and the cavity shall be not more than 4 inches (102 mm) nominal in width. The backing shall not be less than the thickness of the facing.

Exception: Cavities shall be permitted to exceed the 4-inch (102 mm) nominal dimension provided that tie size and tie spacing have been established by calculation.

R606.13.1 Bonding with masonry headers. Bonding with solid or *hollow masonry* headers shall comply with Sections R606.13.1.1 and R606.13.1.2.

R606.13.1.1 Solid units. Where the facing and backing (adjacent wythes) of *solid masonry* construction are bonded by means of masonry headers, not less than 4 percent of the wall surface of each face shall be composed of headers extending not less than 3 inches (76 mm) into the backing. The distance between adjacent full-length headers shall not exceed 24 inches (610 mm) either vertically or horizontally. In walls in which a single header does not extend through the wall, headers from the opposite sides shall overlap not less than 3 inches (76 mm), or headers from opposite sides shall be covered with another header course overlapping the header below not less than 3 inches (76 mm).

R606.13.1.2 Hollow units. Where two or more hollow units are used to make up the thickness of a wall, the stretcher courses shall be bonded at vertical intervals not exceeding 34 inches (864 mm) by lapping not less than 3 inches (76 mm) over the unit below, or by lapping at vertical intervals not exceeding 17 inches (432 mm) with units that are not less than 50 percent thicker than the units below.

R606.13.2 Bonding with wall ties or joint reinforcement. Bonding with wall ties or joint reinforcement shall comply with Section R606.13.2.3.

R606.13.2.1 Bonding with wall ties. Bonding with wall ties, except as required by Section R607, where the facing and backing (adjacent wythes) of masonry walls are bonded with $^3/_{16}$-inch-diameter (5 mm) wall ties embedded in the horizontal mortar joints, there shall be not less than one metal tie for each $4^1/_2$ square feet (0.418 m^2) of wall area. Ties in alternate courses shall be staggered. The maximum vertical distance between ties shall not exceed 24 inches (610 mm), and the maximum horizontal distance shall not exceed 36 inches (914 mm). Rods or ties bent to rectangular shape shall be used with *hollow masonry units* laid with the cells vertical. In other walls, the ends of ties shall be bent to 90-degree (0.79 rad) angles to provide hooks not less than 2 inches (51 mm) long. Additional bonding ties shall be provided at all openings, spaced not more than 3 feet (914 mm) apart around the perimeter and within 12 inches (305 mm) of the opening.

R606.13.2.2 Bonding with adjustable wall ties. Where the facing and backing (adjacent wythes) of

masonry are bonded with adjustable wall ties, there shall be not less than one tie for each 2.67 square feet (0.248 m^2) of wall area. Neither the vertical nor the horizontal spacing of the adjustable wall ties shall exceed 24 inches (610 mm). The maximum vertical offset of bed joints from one wythe to the other shall be 1.25 inches (32 mm). The maximum clearance between connecting parts of the ties shall be $^1/_{16}$ inch (2 mm). Where pintle legs are used, ties shall have not less than two $^3/_{16}$-inch-diameter (5 mm) legs.

R606.13.2.3 Bonding with prefabricated joint reinforcement. Where the facing and backing (adjacent wythes) of masonry are bonded with prefabricated joint reinforcement, there shall be not less than one cross wire serving as a tie for each 2.67 square feet (0.248 m^2) of wall area. The vertical spacing of the joint reinforcement shall not exceed 16 inches (406 mm). Cross wires on prefabricated joint reinforcement shall not be smaller than No. 9 gage. The longitudinal wires shall be embedded in the mortar.

R606.13.3 Bonding with natural or cast stone. Bonding with natural and cast stone shall conform to Sections R606.13.3.1 and R606.13.3.2.

R606.13.3.1 Ashlar masonry. In ashlar masonry, bonder units, uniformly distributed, shall be provided to the extent of not less than 10 percent of the wall area. Such bonder units shall extend not less than 4 inches (102 mm) into the backing wall.

R606.13.3.2 Rubble stone masonry. Rubble stone masonry 24 inches (610 mm) or less in thickness shall have bonder units with a maximum spacing of 3 feet (914 mm) vertically and 3 feet (914 mm) horizontally, and if the masonry is of greater thickness than 24 inches (610 mm), shall have one bonder unit for each 6 square feet (0.557 m^2) of wall surface on both sides.

R606.14 Anchored and adhered masonry veneer.

R606.14.1 Anchored veneer. Anchored masonry veneer installed over a backing of wood or cold-formed steel shall meet the requirements of Section R703.8.

R606.14.2 Adhered veneer. Adhered masonry veneer shall be installed in accordance with the requirements of Section R703.12.

SECTION R607
GLASS UNIT MASONRY

R607.1 General. Panels of glass unit masonry located in load-bearing and nonload-bearing exterior and interior walls shall be constructed in accordance with this section.

R607.2 Materials. Hollow glass units shall be partially evacuated and have a minimum average glass face thickness of $^3/_{16}$ inch (5 mm). The surface of units in contact with mortar shall be treated with a polyvinyl butyral coating or latex-based paint. The use of reclaimed units is prohibited.

R607.3 Units. Hollow or solid glass block units shall be standard or thin units.

R607.3.1 Standard units. The specified thickness of standard units shall be not less than $3^7/_8$ inches (98 mm).

R607.3.2 Thin units. The specified thickness of thin units shall be not less than $3^1/_8$ inches (79 mm) for hollow units and not less than 3 inches (76 mm) for solid units.

R607.4 Isolated panels. Isolated panels of glass unit masonry shall conform to the requirements of this section.

R607.4.1 Exterior standard-unit panels. The maximum area of each individual standard-unit panel shall be 144 square feet (13.4 m^2) where the design wind pressure is 20 pounds per square foot (958 Pa). The maximum area of such panels subjected to design wind pressures other than 20 pounds per square foot (958 Pa) shall be in accordance with Figure R607.4.1. The maximum panel dimension between structural supports shall be 25 feet (7620 mm) in width or 20 feet (6096 mm) in height.

R607.4.2 Exterior thin-unit panels. The maximum area of each individual thin-unit panel shall be 85 square feet (7.9 m^2). The maximum dimension between structural supports shall be 15 feet (4572 mm) in width or 10 feet (3048 mm) in height. Thin units shall not be used in applications where the design wind pressure as stated in Table R301.2.1(1) exceeds 20 pounds per square foot (958 Pa).

R607.4.3 Interior panels. The maximum area of each individual standard-unit panel shall be 250 square feet (23.2 m^2). The maximum area of each thin-unit panel shall be 150 square feet (13.9 m^2). The maximum dimension between structural supports shall be 25 feet (7620 mm) in width or 20 feet (6096 mm) in height.

R607.4.4 Curved panels. The width of curved panels shall conform to the requirements of Sections R607.4.1, R607.4.2 and R607.4.3, except additional structural supports shall be provided at locations where a curved section joins a straight section, and at inflection points in multiple-curve walls.

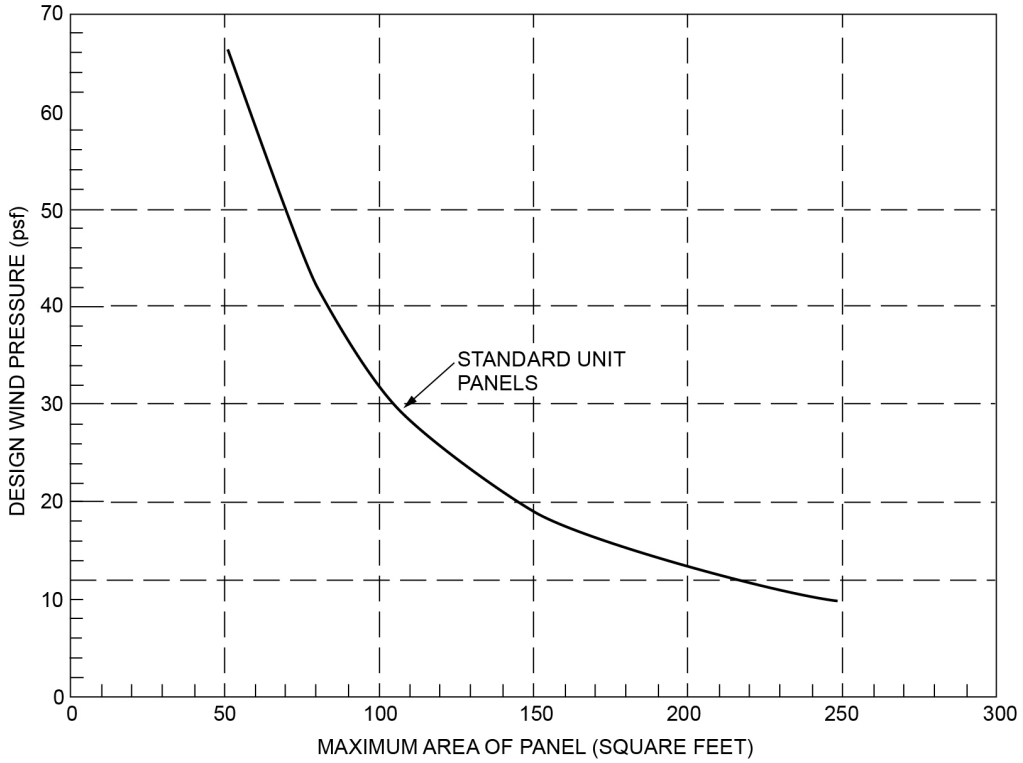
R607.5 Panel support. Glass unit masonry panels shall conform to the support requirements of this section.

R607.5.1 Deflection. The maximum total deflection of structural members that support glass unit masonry shall not exceed $^1/_{600}$.

R607.5.2 Lateral support. Glass unit masonry panels shall be laterally supported along the top and sides of the panel. Lateral supports for glass unit masonry panels shall be designed to resist not less than 200 pounds per lineal feet (2918 N/m) of panel, or the actual applied loads, whichever is greater. Except for single-unit panels, lateral support shall be provided by panel anchors along the top and sides spaced not greater than 16 inches (406 mm) on center or by channel-type restraints. Single-unit panels shall be supported by channel-type restraints.

Exceptions:

1. Lateral support is not required at the top of panels that are one unit wide.



For SI: 1 square foot = 0.0929 m^2, 1 pound per square foot = 0.0479 kPa.

FIGURE R607.4.1
GLASS UNIT MASONRY DESIGN WIND LOAD RESISTANCE

2. Lateral support is not required at the sides of panels that are one unit high.

R607.5.2.1 Panel anchor restraints. Panel anchors shall be spaced not greater than 16 inches (406 mm) on center in both jambs and across the head. Panel anchors shall be embedded not less than 12 inches (305 mm) and shall be provided with two fasteners so as to resist the loads specified in Section R607.5.2.

R607.5.2.2 Channel-type restraints. Glass unit masonry panels shall be recessed not less than 1 inch (25 mm) within channels and chases. Channel-type restraints shall be oversized to accommodate expansion material in the opening, packing and sealant between the framing restraints, and the glass unit masonry perimeter units.

R607.6 Sills. Before the bedding of glass units, the sill area shall be covered with a water-base asphaltic emulsion coating. The coating shall be not less than $^1/_8$ inch (3 mm) thick.

R607.7 Expansion joints. Glass unit masonry panels shall be provided with expansion joints along the top and sides at all structural supports. Expansion joints shall be not less than $^3/_8$ inch (10 mm) in thickness and shall have sufficient thickness to accommodate displacements of the supporting structure. Expansion joints shall be entirely free of mortar and other debris and shall be filled with resilient material.

R607.8 Mortar. Glass unit masonry shall be laid with Type S or N mortar. Mortar shall not be retempered after initial set. Mortar unused within $1^1/_2$ hours after initial mixing shall be discarded.

R607.9 Reinforcement. Glass unit masonry panels shall have horizontal joint reinforcement spaced not greater than 16 inches (406 mm) on center located in the mortar bed joint. Horizontal joint reinforcement shall extend the entire length of the panel but shall not extend across expansion joints. Longitudinal wires shall be lapped not less than 6 inches (152 mm) at splices. Joint reinforcement shall be placed in the bed joint immediately below and above openings in the panel. The reinforcement shall have not less than two parallel longitudinal wires of size W1.7 or greater, and have welded cross wires of size W1.7 or greater.

R607.10 Placement. Glass units shall be placed so head and bed joints are filled solidly. Mortar shall not be furrowed. Head and bed joints of glass unit masonry shall be $^1/_4$ inch (6.4 mm) thick, except that vertical joint thickness of radial panels shall be not less than $^1/_8$ inch (3 mm) or greater than $^5/_8$ inch (16 mm). The bed joint thickness tolerance shall be minus $^1/_{16}$ inch (1.6 mm) and plus $^1/_8$ inch (3 mm). The head joint thickness tolerance shall be plus or minus $^1/_8$ inch (3 mm).

SECTION R608
EXTERIOR CONCRETE WALL CONSTRUCTION

R608.1 General. Exterior concrete walls shall be designed and constructed in accordance with the provisions of this section or in accordance with the provisions of PCA 100, ACI 318 or ACI 332. Where PCA 100, ACI 318, ACI 332 or the provisions of this section are used to design concrete walls, project drawings, typical details and specifications are not required to bear the seal of the *registered design professional* responsible for design, unless otherwise required by the state law of the *jurisdiction* having authority.

R608.1.1 Interior construction. These provisions are based on the assumption that interior walls and partitions, both load-bearing and nonload-bearing, floors and roof/ceiling assemblies are constructed of *light-frame construction* complying with the limitations of this code and the additional limitations of Section R608.2. Design and construction of light-frame assemblies shall be in accordance with the applicable provisions of this code. Where second-story exterior walls are of *light-frame construction*, they shall be designed and constructed as required by this code.

Aspects of concrete construction not specifically addressed by this code, including interior concrete walls, shall comply with ACI 318.

R608.1.2 Other concrete walls. Exterior concrete walls constructed in accordance with this code shall comply with the shapes and minimum concrete cross-sectional dimensions of Table R608.3. Other types of forming systems resulting in concrete walls not in compliance with this section shall be designed in accordance with ACI 318.

R608.2 Applicability limits. The provisions of this section shall apply to the construction of exterior concrete walls for buildings not greater than 60 feet (18 288 mm) in plan dimensions, floors with clear spans not greater than 32 feet (9754 mm) and roofs with clear spans not greater than 40 feet (12 192 mm). Buildings shall not exceed 35 feet (10 668 mm) in mean roof height or two stories in height above grade. Floor/ceiling dead loads shall not exceed 10 pounds per square foot (479 Pa), roof/ceiling dead loads shall not exceed 15 pounds per square foot (718 Pa) and attic live loads shall not exceed 20 pounds per square foot (958 Pa). Roof overhangs shall not exceed 2 feet (610 mm) of horizontal projection beyond the exterior wall and the dead load of the overhangs shall not exceed 8 pounds per square foot (383 Pa).

Walls constructed in accordance with the provisions of this section shall be limited to buildings subjected to a maximum design wind speed of 160 mph (72 m/s) Exposure B, 136 mph (61 m/s) Exposure C and 125 mph (56 m/s) Exposure D. Walls constructed in accordance with the provisions of this section shall be limited to detached one- and two-family *dwellings* and townhouses assigned to *Seismic Design Category* A or B, and detached one- and two-family *dwellings* assigned to *Seismic Design Category* C.

Buildings that are not within the scope of this section shall be designed in accordance with PCA 100 or ACI 318.

R608.3 Concrete wall systems. Concrete walls constructed in accordance with these provisions shall comply with the

TABLE R608.3
DIMENSIONAL REQUIREMENTS FOR WALLS[a]

WALL TYPE AND NOMINAL THICKNESS	MAXIMUM WALL WEIGHT[b] (psf)	MINIMUM WIDTH, W, OF VERTICAL CORES (inches)	MINIMUM THICKNESS, T, OF VERTICAL CORES (inches)	MAXIMUM SPACING OF VERTICAL CORES (inches)	MAXIMUM SPACING OF HORIZONTAL CORES (inches)	MINIMUM WEB THICKNESS (inches)
4″ Flat[c]	50	NA	NA	NA	NA	NA
6″ Flat[c]	75	NA	NA	NA	NA	NA
8″ Flat[c]	100	NA	NA	NA	NA	NA
10″ Flat[c]	125	NA	NA	NA	NA	NA
6″ Waffle-grid	56	8[d]	5.5[d]	12	16	2
8″ Waffle-grid	76	8[e]	8[e]	12	16	2
6″ Screen-grid	53	6.25[f]	6.25[f]	12	12	NA

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa, 1 pound per cubic foot = 2402.77 kg/m^3, 1 square inch = 645.16 mm^2, 1 inch^4 = 42 cm^4.

NA = Not Applicable.

a. Width "W," thickness "T," spacing and web thickness, refer to Figures R608.3(2) and R608.3(3).

b. Wall weight is based on a unit weight of concrete of 150 pcf. For flat walls the weight is based on the nominal thickness. The tabulated values do not include any allowance for interior and exterior finishes.

c. Nominal wall thickness. The actual as-built thickness of a flat wall shall not be more than $^1/_2$ inch less or more than $^1/_4$ inch more than the nominal dimension indicated.

d. Vertical core is assumed to be elliptical-shaped. Another shape of core is permitted provided the minimum thickness is 5 inches, the moment of inertia, *I*, about the centerline of the wall (ignoring the web) is not less than 65 inch^4, and the area, *A*, is not less than 31.25 square inches. The width used to calculate *A* and *I* shall not exceed 8 inches.

e. Vertical core is assumed to be circular. Another shape of core is permitted provided the minimum thickness is 7 inches, the moment of inertia, *I*, about the centerline of the wall (ignoring the web) is not less than 200 inch^4, and the area, *A*, is not less than 49 square inches. The width used to calculate *A* and *I* shall not exceed 8 inches.

f. Vertical core is assumed to be circular. Another shape of core is permitted provided the minimum thickness is 5.5 inches, the moment of inertia, *I*, about the centerline of the wall is not less than 76 inch^4, and the area, *A*, is not less than 30.25 square inches. The width used to calculate *A* and *I* shall not exceed 6.25 inches.

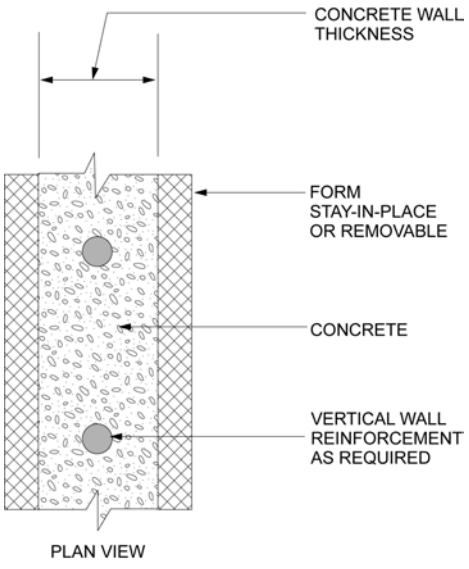
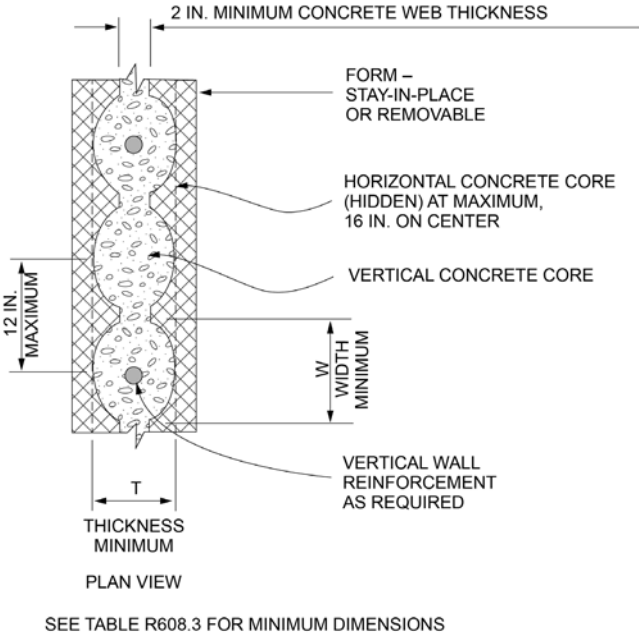


FIGURE R608.3(1)
FLAT WALL SYSTEM

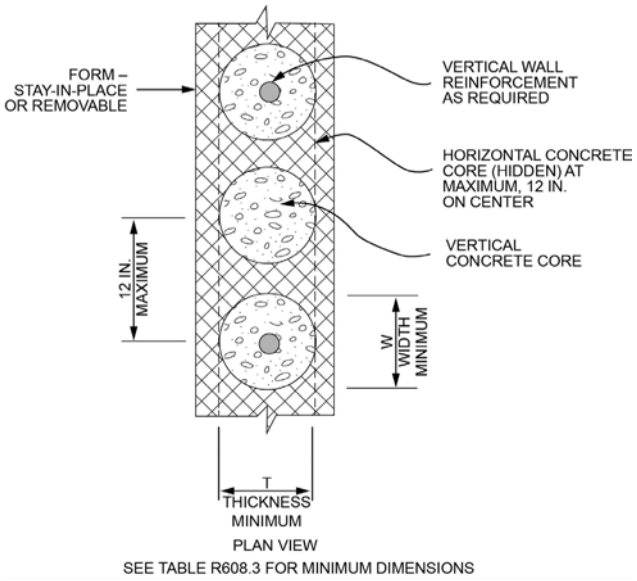


For SI: 1 inch = 25.4 mm.

FIGURE R608.3(2)
WAFFLE-GRID WALL SYSTEM

shapes and minimum concrete cross-sectional dimensions of Table R608.3.

R608.3.1 Flat wall systems. Flat concrete wall systems shall comply with Table R608.3 and Figure R608.3(1) and have a minimum nominal thickness of 4 inches (102 mm).



For SI: 1 inch = 25.4 mm.

FIGURE R608.3(3)
SCREEN-GRID WALL SYSTEM

R608.3.2 Waffle-grid wall systems. Waffle-grid wall systems shall comply with Table R608.3 and Figure R608.3(2) and shall have a minimum nominal thickness of 6 inches (152 mm) for the horizontal and vertical concrete members (cores). The core and web dimensions shall comply with Table R608.3. The maximum weight of waffle-grid walls shall comply with Table R608.3.

R608.3.3 Screen-grid wall systems. Screen-grid wall systems shall comply with Table R608.3 and Figure R608.3(3) and shall have a minimum nominal thickness of 6 inches (152 mm) for the horizontal and vertical concrete members (cores). The core dimensions shall comply with Table R608.3. The maximum weight of screen-grid walls shall comply with Table R608.3.

R608.4 Stay-in-place forms. Stay-in-place concrete forms shall comply with this section.

R608.4.1 Surface burning characteristics. The flame spread index and *smoke-developed index* of forming material, other than foam plastic, left exposed on the interior shall comply with Section R302.9. The surface burning characteristics of foam plastic used in *insulating concrete forms* shall comply with Section R316.3.

R608.4.2 Interior covering. Stay-in-place forms constructed of rigid foam plastic shall be protected on the interior of the building as required by Sections R316.4 and R702.3.4. Where gypsum board is used to protect the foam plastic, it shall be installed with a mechanical fastening system. Use of adhesives is permitted in addition to mechanical fasteners.

R608.4.3 Exterior wall covering. Stay-in-place forms constructed of rigid foam plastics shall be protected from

sunlight and physical damage by the application of an *approved* exterior wall covering complying with this code. Exterior surfaces of other stay-in-place forming systems shall be protected in accordance with this code.

Requirements for installation of masonry veneer, stucco and other finishes on the exterior of concrete walls and other construction details not covered in this section shall comply with the requirements of this code.

R608.4.4 Flat ICF wall systems. Flat ICF wall system forms shall conform to ASTM E2634.

R608.5 Materials. Materials used in the construction of concrete walls shall comply with this section.

R608.5.1 Concrete and materials for concrete. Materials used in concrete, and the concrete itself, shall conform to requirements of this section, PCA 100, ACI 318 or ACI 332.

R608.5.1.1 Cements. The following standards as referenced in Chapter 44 shall be permitted to be used:

1. ASTM C150
2. ASTM C595
3. ASTM C1157

R608.5.1.2 Concrete mixing and delivery. Mixing and delivery of concrete shall comply with ASTM C94 or ASTM C685.

R608.5.1.3 Maximum aggregate size. The nominal maximum size of coarse aggregate shall not exceed one-fifth the narrowest distance between sides of forms, or three-fourths the clear spacing between reinforcing bars or between a bar and the side of the form.

Exception: When *approved*, these limitations shall not apply where removable forms are used and workability and methods of consolidation permit concrete to be placed without honeycombs or voids.

R608.5.1.4 Proportioning and slump of concrete. Proportions of materials for concrete shall be established to provide workability and consistency to permit concrete to be worked readily into forms and around reinforcement under conditions of placement to be employed, without segregation or excessive bleeding. Slump of concrete placed in removable forms shall not exceed 6 inches (152 mm).

Exception: When *approved*, the slump is permitted to exceed 6 inches (152 mm) for concrete mixtures that are resistant to segregation, and are in accordance with the form manufacturer's recommendations.

Slump of concrete placed in stay-in-place forms shall exceed 6 inches (152 mm). Slump of concrete shall be determined in accordance with ASTM C143.

R608.5.1.5 Compressive strength. The minimum specified compressive strength of concrete, f'_c, shall comply with Section R402.2 and shall be not less than 2,500 pounds per square inch (17.2 MPa) at 28 days.

R608.5.1.6 Consolidation of concrete. Concrete shall be consolidated by suitable means during placement and shall be worked around embedded items and reinforcement and into corners of forms. Where stay-in-place forms are used, concrete shall be consolidated by internal vibration.

Exception: When *approved*, self-consolidating concrete mixtures with slumps equal to or greater than 8 inches (203 mm) that are specifically designed for placement without internal vibration need not be internally vibrated.

R608.5.2 Steel reinforcement and anchor bolts.

R608.5.2.1 Steel reinforcement. Steel reinforcement shall comply with ASTM A615, ASTM A706, or ASTM A996. ASTM A996 bars produced from rail steel shall be Type R.

R608.5.2.2 Anchor bolts. Anchor bolts for use with connection details in accordance with Figures R608.9(1) through R608.9(4) and R608.9(9) through R608.9(10) shall be bolts with heads complying with ASTM A307 or ASTM F1554. ASTM A307 bolts shall be Grade A with heads. ASTM F1554 bolts shall be Grade 36 minimum. Instead of bolts with heads, it is permissible to use rods with threads on both ends fabricated from steel complying with ASTM A36. The threaded end of the rod to be embedded in the concrete shall be provided with a hex or square nut.

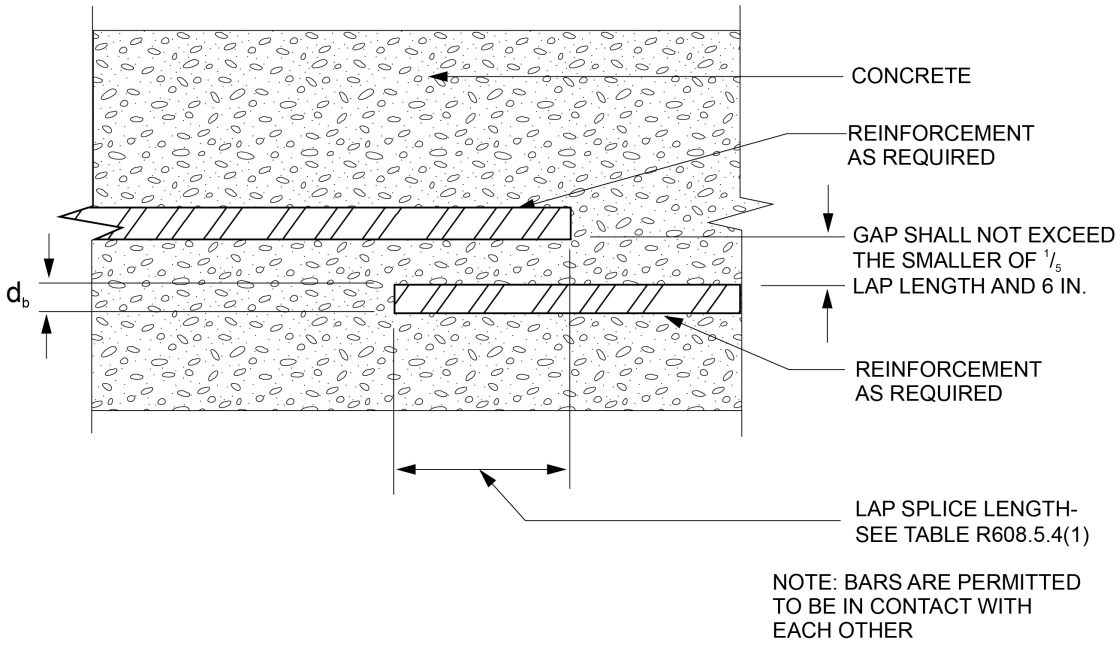
R608.5.2.3 Sheet steel angles and tension tie straps. Angles and tension tie straps for use with connection details in accordance with Figures R608.9(1) through R608.9(4) and R608.9(9) through R608.9(10) shall be fabricated from sheet steel complying with ASTM A653 SS, ASTM A792 SS, or ASTM A875 SS. The steel shall be minimum Grade 33 unless a higher grade is required by the applicable figure.

R608.5.3 Form materials and form ties. Forms shall be made of wood, steel, aluminum, plastic, a composite of cement and foam insulation, a composite of cement and wood chips, or other *approved* material suitable for supporting and containing concrete. Forms shall provide sufficient strength to contain concrete during the concrete placement operation.

Form ties shall be steel, solid plastic, foam plastic, a composite of cement and wood chips, a composite of cement and foam plastic, or other suitable material capable of resisting the forces created by fluid pressure of fresh concrete.

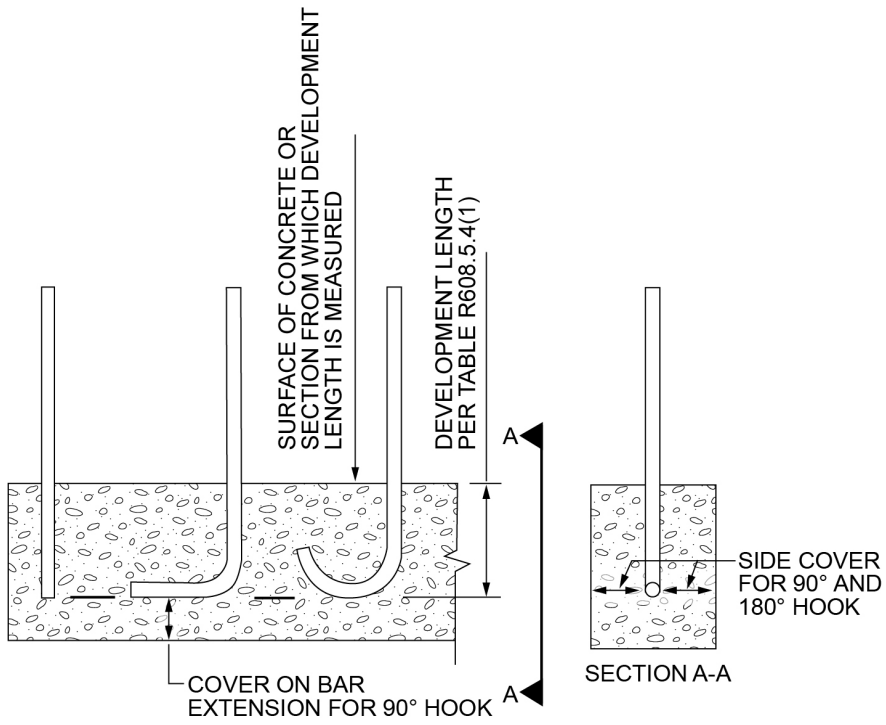
R608.5.4 Reinforcement installation details.

R608.5.4.1 Support and cover. Reinforcement shall be secured in the proper location in the forms with tie wire or other bar support system such that displacement will not occur during the concrete placement operation. Steel reinforcement in concrete cast against the earth shall have a minimum cover of 3 inches (76



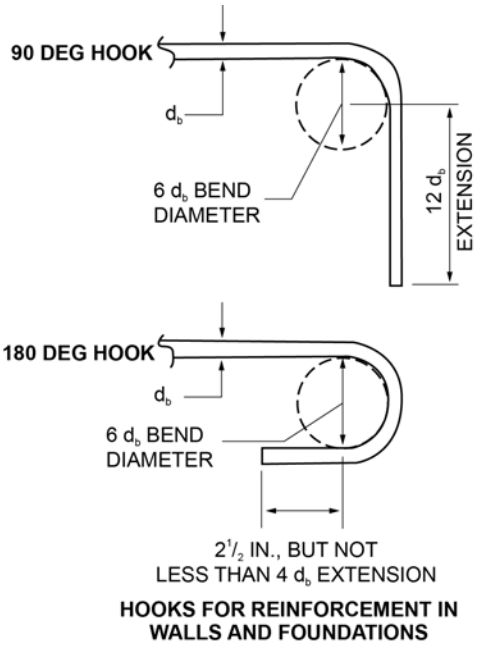
For SI: 1 inch = 25.4 mm.

FIGURE R608.5.4(1)
LAP SPLICES

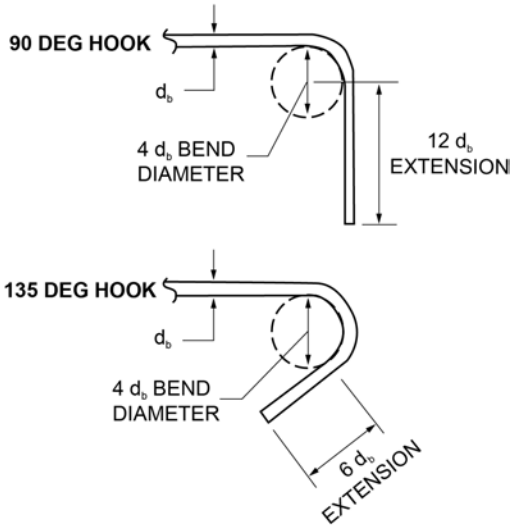


For SI: 1 degree = 0.0175 rad.

FIGURE R608.5.4(2)
DEVELOPMENT LENGTH AND COVER FOR HOOKS AND BAR EXTENSION



HOOKS FOR REINFORCEMENT IN WALLS AND FOUNDATIONS



HOOKS FOR STIRRUPS IN LINTELS

For SI: 1 inch = 25.4 mm, 1 degree = 0.0175 rad.

FIGURE R608.5.4(3)
STANDARD HOOKS

TABLE R608.5.4(1)
LAP SPLICE AND TENSION DEVELOPMENT LENGTHS

	BAR SIZE NO.	YIELD STRENGTH OF STEEL, f_y psi (MPa)	
		40,000 (280)	60,000 (420)
		Splice length or tension development length (inches)	
Lap splice length-tension	4	20	30
	5	25	38
	6	30	45
Tension development length for straight bar	4	15	23
	5	19	28
	6	23	34
Tension development length for: a. 90-degree and 180-degree standard hooks with not less than $2^1/_2$ inches of side cover perpendicular to plane of hook. b. 90-degree standard hooks with not less than 2 inches of cover on the bar extension beyond the hook.	4	6	9
	5	7	11
	6	8	13
Tension development length for bar with 90-degree or 180-degree standard hook having less cover than required in Items a and b.	4	8	12
	5	10	15
	6	12	18

For SI: 1 inch = 25.4 mm, 1 degree = 0.0175 rad, 1 pound per square inch = 6.895 kPa.

TABLE R608.5.4(2)
MAXIMUM SPACING FOR ALTERNATIVE BAR SIZE AND ALTERNATIVE GRADE OF STEEL[a, b, c]

BAR SPACING FROM APPLICABLE TABLE IN SECTION R608.6 (inches)	BAR SIZE FROM APPLICABLE TABLE IN SECTION R608.6														
	#4					#5					#6				
	Alternative bar size and alternative grade of steel desired														
	Grade 60		Grade 40			Grade 60		Grade 40			Grade 60		Grade 40		
	#5	#6	#4	#5	#6	#4	#6	#4	#5	#6	#4	#5	#4	#5	#6
	Maximum spacing for alternative bar size and alternative grade of steel (inches)														
8	12	18	5	8	12	5	11	3	5	8	4	6	2	4	5
9	14	20	6	9	13	6	13	4	6	9	4	6	3	4	6
10	16	22	7	10	15	6	14	4	7	9	5	7	3	5	7
11	17	24	7	11	16	7	16	5	7	10	5	8	3	5	7
12	19	26	8	12	18	8	17	5	8	11	5	8	4	6	8
13	20	29	9	13	19	8	18	6	9	12	6	9	4	6	9
14	22	31	9	14	21	9	20	6	9	13	6	10	4	7	9
15	23	33	10	16	22	10	21	6	10	14	7	11	5	7	10
16	25	35	11	17	23	10	23	7	11	15	7	11	5	8	11
17	26	37	11	18	25	11	24	7	11	16	8	12	5	8	11
18	28	40	12	19	26	12	26	8	12	17	8	13	5	8	12
19	29	42	13	20	28	12	27	8	13	18	9	13	6	9	13
20	31	44	13	21	29	13	28	9	13	19	9	14	6	9	13
21	33	46	14	22	31	14	30	9	14	20	10	15	6	10	14
22	34	48	15	23	32	14	31	9	15	21	10	16	7	10	15
23	36	48	15	24	34	15	33	10	15	22	10	16	7	11	15
24	37	48	16	25	35	15	34	10	16	23	11	17	7	11	16
25	39	48	17	26	37	16	35	11	17	24	11	18	8	12	17
26	40	48	17	27	38	17	37	11	17	25	12	18	8	12	17
27	42	48	18	28	40	17	38	12	18	26	12	19	8	13	18
28	43	48	19	29	41	18	40	12	19	26	13	20	8	13	19
29	45	48	19	30	43	19	41	12	19	27	13	20	9	14	19
30	47	48	20	31	44	19	43	13	20	28	14	21	9	14	20
31	48	48	21	32	45	20	44	13	21	29	14	22	9	15	21
32	48	48	21	33	47	21	45	14	21	30	15	23	10	15	21
33	48	48	22	34	48	21	47	14	22	31	15	23	10	16	22
34	48	48	23	35	48	22	48	15	23	32	15	24	10	16	23
35	48	48	23	36	48	23	48	15	23	33	16	25	11	16	23
36	48	48	24	37	48	23	48	15	24	34	16	25	11	17	24
37	48	48	25	38	48	24	48	16	25	35	17	26	11	17	25
38	48	48	25	39	48	25	48	16	25	36	17	27	12	18	25
39	48	48	26	40	48	25	48	17	26	37	18	27	12	18	26
40	48	48	27	41	48	26	48	17	27	38	18	28	12	19	27
41	48	48	27	42	48	26	48	18	27	39	19	29	12	19	27
42	48	48	28	43	48	27	48	18	28	40	19	30	13	20	28
43	48	48	29	44	48	28	48	18	29	41	20	30	13	20	29
44	48	48	29	45	48	28	48	19	29	42	20	31	13	21	29
45	48	48	30	47	48	29	48	19	30	43	20	32	14	21	30
46	48	48	31	48	48	30	48	20	31	44	21	32	14	22	31
47	48	48	31	48	48	30	48	20	31	44	21	33	14	22	31
48	48	48	32	48	48	31	48	21	32	45	22	34	15	23	32

For SI: 1 inch = 25.4 mm.

a. This table is for use with tables in Section R608.6 that specify the minimum bar size and maximum spacing of vertical wall reinforcement for foundation walls and above-grade walls. Reinforcement specified in tables in Section R608.6 is based on Grade 60 (420 MPa) steel reinforcement.

b. Bar spacing shall not exceed 48 inches on center and shall be not less than one-half the nominal wall thickness.

c. For Grade 50 (350 MPa) steel bars (ASTM A996, Type R), use spacing for Grade 40 (280 MPa) bars or interpolate between Grade 40 (280 MPa) and Grade 60 (420 MPa).

mm). Minimum cover for reinforcement in concrete cast in removable forms that will be exposed to the earth or weather shall be $1^1/_2$ inches (38 mm) for No. 5 bars and smaller, and 2 inches (50 mm) for No. 6 bars and larger. For concrete cast in removable forms that will not be exposed to the earth or weather, and for concrete cast in stay-in-place forms, minimum cover shall be $^3/_4$ inch (19 mm). The minus tolerance for cover shall not exceed the smaller of one-third the required cover and $^3/_8$ inch (10 mm). See Section R608.5.4.4 for cover requirements for hooks of bars developed in tension.

R608.5.4.2 Location of reinforcement in walls. For location of reinforcement in foundation walls and above-grade walls, see Sections R404.1.3.3.7.2 and R608.6.5, respectively.

R608.5.4.3 Lap splices. Vertical and horizontal wall reinforcement required by Sections R608.6 and R608.7 shall be the longest lengths practical. Where splices are necessary in reinforcement, the length of lap splices shall be in accordance with Table R608.5.4(1) and Figure R608.5.4(1). The maximum gap between noncontact parallel bars at a lap splice shall not exceed the smaller of one-fifth the required lap length and 6 inches (152 mm). See Figure R608.5.4(1).

R608.5.4.4 Development of bars in tension. Where bars are required to be developed in tension by other provisions of this code, development lengths and cover for hooks and bar extensions shall comply with Table R608.5.4(1) and Figure R608.5.4(2). The development lengths shown in Table R608.5.4(1) shall apply to bundled bars in lintels installed in accordance with Section R608.8.2.2.

R608.5.4.5 Standard hooks. Where reinforcement is required by this code to terminate with a standard hook, the hook shall comply with Figure R608.5.4(3).

R608.5.4.6 Webs of waffle-grid walls. Reinforcement, including stirrups, shall not be placed in webs of waffle-grid walls, including lintels. Webs are permitted to have form ties.

R608.5.4.7 Alternate grade of reinforcement and spacing. Where tables in Sections R404.1.3 and R608.6 specify vertical wall reinforcement based on minimum bar size and maximum spacing, which are based on Grade 60 (420 MPa) steel reinforcement, different size bars or bars made from a different grade of steel are permitted provided an equivalent area of steel per linear foot of wall is provided. Use of Table R608.5.4(2) is permitted to determine the maximum bar spacing for different bar sizes than specified in the tables and bars made from a different grade of steel. Bars shall not be spaced less than one-half the wall thickness, or more than 48 inches (1219 mm) on center.

R608.5.5 Construction joints in walls. Construction joints shall be made and located to not impair the strength of the wall. Construction joints in plain concrete walls, including walls required to have not less than No. 4 bars at 48 inches (1219 mm) on center by Section R608.6, shall be located at points of lateral support, and not less than one No. 4 bar shall extend across the construction joint at a spacing not to exceed 24 inches (610 mm) on center. Construction joint reinforcement shall have not less than 12 inches (305 mm) of embedment on both sides of the joint. Construction joints in reinforced concrete walls shall be located in the middle third of the span between lateral supports, or located and constructed as required for joints in plain concrete walls.

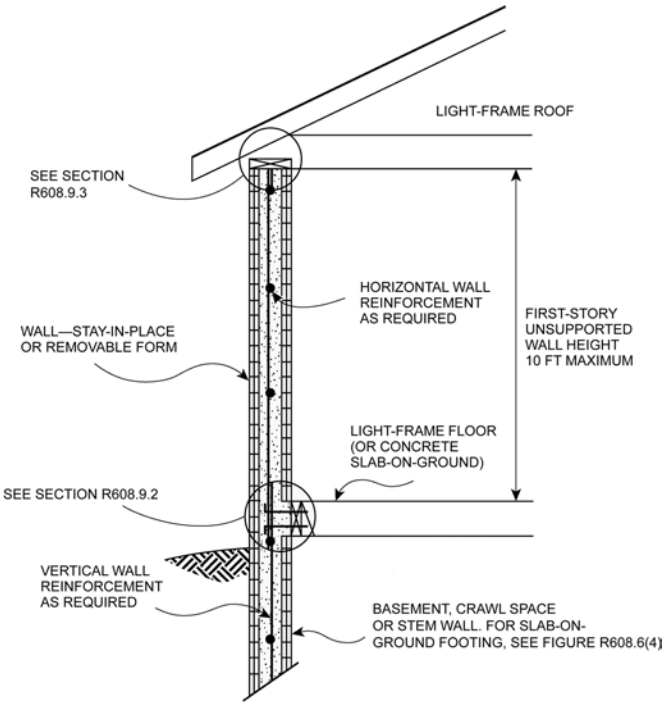
Exception: Vertical wall reinforcement required by this code is permitted to be used in lieu of construction joint reinforcement, provided the spacing does not exceed 24 inches (610 mm), or the combination of wall reinforcement and No. 4 bars described in Section R608.5.5 does not exceed 24 inches (610 mm).

R608.6 Above-grade wall requirements.

R608.6.1 General. The minimum thickness of load-bearing and nonload-bearing above-grade walls and reinforcement shall be as set forth in the appropriate table in this section based on the type of wall form to be used. The wall shall be designed in accordance with ACI 318 where the wall or building is not within the limitations of Section R608.2, where design is required by the tables in this section or where the wall is not within the scope of the tables in this section.

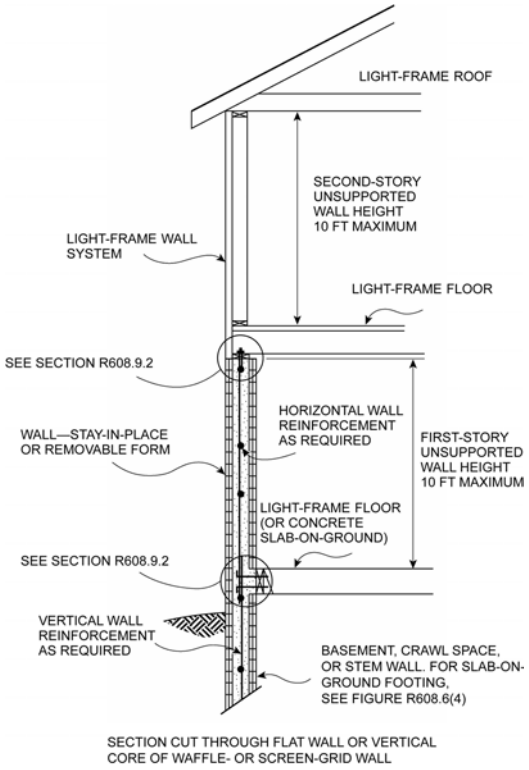
Above-grade concrete walls shall be constructed in accordance with this section and Figure R608.6(1), R608.6(2), R608.6(3) or R608.6(4). Above-grade concrete walls that are continuous with stem walls and not laterally supported by the slab-on-ground shall be designed and constructed in accordance with this section. Concrete walls shall be supported on continuous foundation walls or slabs-on-ground that are monolithic with the footing in accordance with Section R403. The minimum length of solid wall without openings shall be in accordance with Section R608.7. Reinforcement around openings, including lintels, shall be in accordance with Section R608.8. Lateral support for above-grade walls in the out-of-plane direction shall be provided by connections to the floor framing system, if applicable, and to ceiling and roof framing systems in accordance with Section R608.9. The wall thickness shall be equal to or greater than the thickness of the wall in the *story* above.

R608.6.2 Wall reinforcement for wind. Vertical wall reinforcement for resistance to out-of-plane wind forces shall be determined from Table R608.6(1), R608.6(2), R608.6(3) or R608.6(4). For the design of nonload-bearing walls, in Tables R608.6(1), R608.6(2) and R608.6(3) use the appropriate column labeled “Top.” (see Sections R608.7.2.2.2 and R608.7.2.2.3). There shall be a vertical bar at corners of exterior walls. Unless more horizontal reinforcement is required by Section R608.7.2.2.1, the minimum horizontal reinforcement shall be four No. 4 bars [Grade 40 (280 MPa)] placed as follows: top bar within 12 inches (305 mm) of the top of the wall, bottom bar within 12 inches (305 mm) of the finish floor and one



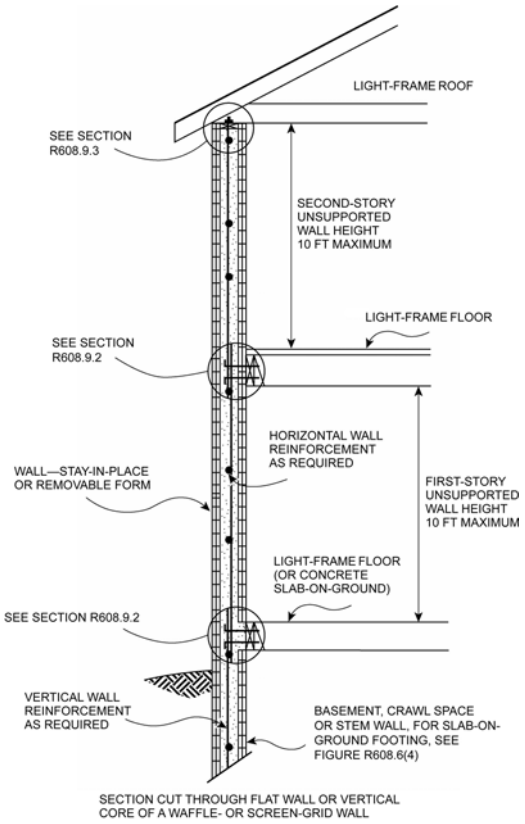
For SI: 1 foot = 304.8 mm.

FIGURE R608.6(1)
ABOVE-GRADE CONCRETE WALL CONSTRUCTION ONE STORY



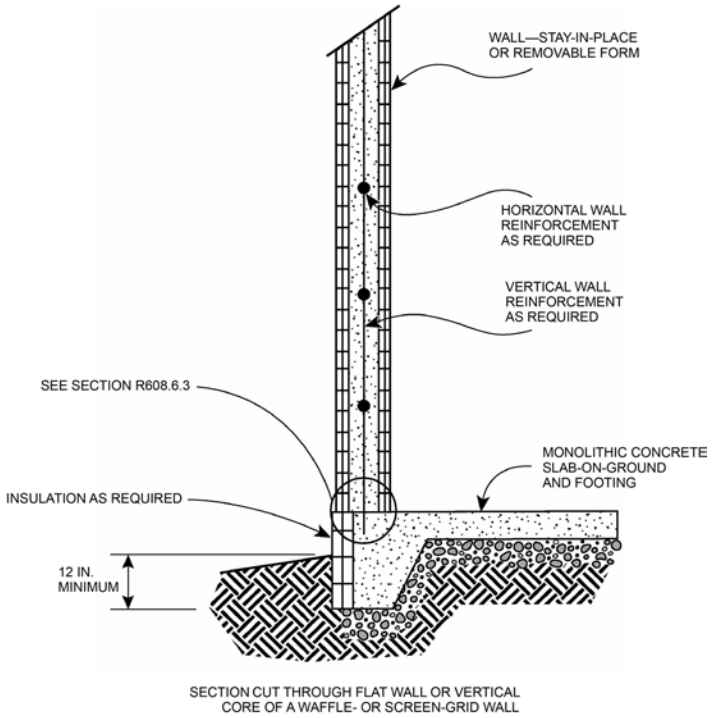
For SI: 1 foot = 304.8 mm.

FIGURE R608.6(2)
ABOVE-GRADE CONCRETE WALL CONSTRUCTION CONCRETE FIRST STORY AND LIGHT-FRAME SECOND STORY



For SI: 1 foot = 304.8 mm.

FIGURE R608.6(3)
ABOVE-GRADE CONCRETE WALL CONSTRUCTION TWO-STORY



For SI: 1 foot = 304.8 mm.

FIGURE R608.6(4)
ABOVE-GRADE CONCRETE WALL SUPPORTED ON MONOLITHIC SLAB-ON-GROUND FOOTING

TABLE R608.6(1)
MINIMUM VERTICAL REINFORCEMENT FOR FLAT ABOVE-GRADE WALLS[a, b, c, d, e]

MAXIMUM WIND SPEED (mph)			MAXIMUM UNSUPPORTED WALL HEIGHT PER STORY (feet)	MINIMUM VERTICAL REINFORCEMENT-BAR SIZE AND SPACING (inches)[f, g]							
				Nominal[h] wall thickness (inches)							
Exposure Category				4		6		8		10	
B	C	D		Top[i]	Side[i]	Top[i]	Side[i]	Top[i]	Side[i]	Top[i]	Side[i]
115	—	—	8	4@48	4@48	4@48	4@48	4@48	4@48	4@48	4@48
			9	4@48	4@39	4@48	4@48	4@48	4@48	4@48	4@48
			10	4@41	4@34	4@48	4@48	4@48	4@48	4@48	4@48
120	—	—	8	4@48	4@43	4@48	4@48	4@48	4@48	4@48	4@48
			9	4@48	4@36	4@48	4@48	4@48	4@48	4@48	4@48
			10	4@37	4@34	4@48	4@48	4@48	4@48	4@48	4@48
130	110	—	8	4@48	4@38	4@48	4@48	4@48	4@48	4@48	4@48
			9	4@39	4@34	4@48	4@48	4@48	4@48	4@48	4@48
			10	4@34	4@34	4@48	4@48	4@48	4@48	4@48	4@48
140	119	110	8	4@43	4@34	4@48	4@48	4@48	4@48	4@48	4@48
			9	4@34	4@34	4@48	4@48	4@48	4@48	4@48	4@48
			10	4@34	4@31	4@48	4@48	4@48	4@48	4@48	4@48
150	127	117	8	4@37	4@34	4@48	4@48	4@48	4@48	4@48	4@48
			9	4@34	4@33	4@48	4@48	4@48	4@48	4@48	4@48
			10	4@31	4@27	4@48	4@48	4@48	4@48	4@48	4@48
160	136	125	8	4@34	4@34	4@48	4@48	4@48	4@48	4@48	4@48
			9	4@34	4@29	4@48	4@48	4@48	4@48	4@48	4@48
			10	4@27	4@24	4@48	4@48	4@48	4@48	4@48	4@48

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s, 1 pound per square inch = 1.895 kPa, 1 square foot = 0.0929 m^2.

a. Table is based on ASCE 7 components and cladding wind pressures for an enclosed building using a mean roof height of 35 feet, interior wall area 4, an effective wind area of 10 square feet, topographic factor, K_{zt}, equal to 1.0, and Risk Category II.

b. Table is based on concrete with a minimum specified compressive strength of 2,500 psi.

c. See Section R608.6.5 for location of reinforcement in wall.

d. Deflection criterion is $L/240$, where L is the unsupported height of the wall in inches.

e. Interpolation is not permitted.

f. Where No. 4 reinforcing bars at a spacing of 48 inches are specified in the table as indicated by shaded cells, use of bars with a minimum yield strength of 40,000 psi or 60,000 psi is permitted.

g. Other than for No. 4 bars spaced at 48 inches on center, table values are based on reinforcing bars with a minimum yield strength of 60,000 psi. Vertical reinforcement with a yield strength of less than 60,000 psi or bars of a different size than specified in the table are permitted in accordance with Section R608.5.4.7 and Table R608.5.4(2).

h. See Table R608.3 for tolerances on nominal thicknesses.

i. "Top" means gravity load from roof or floor construction bears on top of wall. "Side" means gravity load from floor construction is transferred to wall from a wood ledger or cold-formed steel track bolted to side of wall. For nonload-bearing walls where floor framing members span parallel to the wall, use of the "Top" bearing condition is permitted.

TABLE R608.6(2)
MINIMUM VERTICAL REINFORCEMENT FOR WAFFLE-GRID ABOVE-GRADE WALLS[a, b, c, d, e]

MAXIMUM WIND SPEED (mph)			MAXIMUM UNSUPPORTED WALL HEIGHT PER STORY (feet)	MINIMUM VERTICAL REINFORCEMENT-BAR SIZE AND SPACING (inches)[f, g]			
				Nominal[h] wall thickness (inches)			
Exposure Category				6		8	
B	C	D		Top[i]	Side[i]	Top[i]	Side[i]
115	—	—	8	4@48	4@48	4@48	4@48
			9	4@48	5@43	4@48	4@48
			10	5@47	5@37	4@48	4@48
120	—	—	8	4@48	5@48	4@48	4@48
			9	4@48	5@40	4@48	4@48
			10	5@43	5@37	4@48	4@48
130	110	—	8	4@48	5@42	4@48	4@48
			9	5@45	5@37	4@48	4@48
			10	5@37	5@37	4@48	4@48
140	119	110	8	4@48	5@38	4@48	4@48
			9	5@39	5@37	4@48	4@48
			10	5@37	5@35	4@48	4@48
150	127	117	8	5@43	5@37	4@48	4@48
			9	5@37	5@37	4@48	4@48
			10	5@36	6@44	4@48	4@48
160	136	125	8	5@38	5@37	4@48	4@48
			9	5@37	6@47	4@48	4@48
			10	6@45	6@39	4@48	6@46

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s, 1 pound per square inch = 6.895 kPa, 1 square foot = 0.0929 m^2.

a. Table is based on ASCE 7 components and cladding wind pressures for an enclosed building using a mean roof height of 35 feet, interior wall area 4, an effective wind area of 10 square feet, topographic factor, K_{zt}, equal to 1.0, and Risk Category II.

b. Table is based on concrete with a minimum specified compressive strength of 2,500 psi.

c. See Section R608.6.5 for location of reinforcement in wall.

d. Deflection criterion is $L/240$, where L is the unsupported height of the wall in inches.

e. Interpolation is not permitted.

f. Where No. 4 reinforcing bars at a spacing of 48 inches are specified in the table as indicated by shaded cells, use of bars with a minimum yield strength of 40,000 psi or 60,000 psi is permitted.

g. Other than for No. 4 bars spaced at 48 inches on center, table values are based on reinforcing bars with a minimum yield strength of 60,000 psi. Maximum spacings shown are the values calculated for the specified bar size. Where the bar used is Grade 60 and the size specified in the table, the actual spacing in the wall shall not exceed a whole-number multiple of 12 inches such as, 12, 24, 36 and 48, that is less than or equal to the tabulated spacing. Vertical reinforcement with a yield strength of less than 60,000 psi or bars of a different size than specified in the table are permitted in accordance with Section R608.5.4.7 and Table R608.5.4(2).

h. See Table R608.3 for minimum core dimensions and maximum spacing of horizontal and vertical cores.

i. "Top" means gravity load from roof or floor construction bears on top of wall. "Side" means gravity load from floor construction is transferred to wall from a wood ledger or cold-formed steel track bolted to side of wall. For nonload-bearing walls and where floor framing members span parallel to the wall, the "top" bearing condition is permitted to be used.

TABLE R608.6(3)
MINIMUM VERTICAL REINFORCEMENT FOR 6-INCH SCREEN-GRID ABOVE-GRADE WALLS[a, b, c, d, e]

MAXIMUM WIND SPEED (mph)			MAXIMUM UNSUPPORTED WALL HEIGHT PER STORY (feet)	MINIMUM VERTICAL REINFORCEMENT-BAR SIZE AND SPACING (inches)[f, g]	
				Nominal[h] wall thickness (inches)	
Exposure Category				6	
B	C	D		Top[i]	Side[i]
115	—	—	8	4@48	4@48
			9	4@48	5@41
			10	4@48	6@48
120	—	—	8	4@48	4@48
			9	4@48	5@38
			10	5@42	6@48
130	110	—	8	4@48	5@41
			9	5@44	6@48
			10	5@35	6@48
140	119	110	8	4@48	5@36
			9	5@38	6@48
			10	6@48	6@48
150	127	117	8	5@42	6@48
			9	6@48	6@48
			10	6@48	6@42
160	136	125	8	5@37	6@48
			9	6@48	6@45
			10	6@44	6@38

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s, 1 pound per square inch = 6.895 kPa, 1 square foot = 0.0929 m^2.

a. Table is based on ASCE 7 components and cladding wind pressures for an enclosed building using a mean roof height of 35 feet, interior wall area 4, an effective wind area of 10 square feet, topographic factor, K_{zt}, equal to 1.0, and Risk Category II.

b. Table is based on concrete with a minimum specified compressive strength of 2,500 psi.

c. See Section R608.6.5 for location of reinforcement in wall.

d. Deflection criterion is $L/240$, where L is the unsupported height of the wall in inches.

e. Interpolation is not permitted.

f. Where No. 4 reinforcing bars at a spacing of 48 inches are specified in the table as indicated by shaded cells, use of bars with a minimum yield strength of 40,000 psi or 60,000 psi is permitted.

g. Other than for No. 4 bars spaced at 48 inches on center, table values are based on reinforcing bars with a minimum yield strength of 60,000 psi. Maximum spacings shown are the values calculated for the specified bar size. Where the bar used is Grade 60 and the size specified in the table, the actual spacing in the wall shall not exceed a whole-number multiple of 12 inches such as, 12, 24, 36 and 48, that is less than or equal to the tabulated spacing. Vertical reinforcement with a yield strength of less than 60,000 psi or bars of a different size than specified in the table are permitted in accordance with Section R608.5.4.7 and Table R608.5.4(2).

h. See Table R608.3 for minimum core dimensions and maximum spacing of horizontal and vertical cores.

i. "Top" means gravity load from roof or floor construction bears on top of wall. "Side" means gravity load from floor construction is transferred to wall from a wood ledger or cold-formed steel track bolted to side of wall. For nonload-bearing wall and where floor framing members span parallel to the wall, use of the "Top" bearing condition is permitted.

TABLE R608.6(4)
MINIMUM VERTICAL REINFORCEMENT FOR FLAT, WAFFLE- AND SCREEN-GRID ABOVE-GRADE WALLS DESIGNED CONTINUOUS WITH FOUNDATION STEM WALLS[a, b, c, d, e, k]

MAXIMUM WIND SPEED (mph)			HEIGHT OFSTEM WALL[h, i] (feet)	MAXIMUM DESIGN LATERAL SOIL LOAD (psf/ft)	MAXIMUM UNSUP-PORTED HEIGHT OF ABOVE-GRADE WALL (feet)	MINIMUM VERTICAL REINFORCEMENT-BAR SIZE AND SPACING (inches)[f, g]						
						Wall type and nominal thickness[j] (inches)						
Exposure Category						Flat				Waffle		Screen
B	C	D				4	6	8	10	6	8	6
115	—	—	3	30	8	4@30	4@48	4@48	4@48	4@22	4@26	4@21
					10	4@23	5@43	4@48	4@48	4@17	4@20	4@16
				60	10	4@19	5@37	4@48	4@48	4@14	4@17	4@14
			6	30	10	DR	5@21	6@35	4@48	DR	4@10	DR
				60	10	DR	5@12	6@25	6@28	DR	DR	DR
120	—	—	3	30	8	4@28	4@48	4@48	4@48	4@21	4@48	4@20
					10	4@22	5@41	4@48	4@48	4@16	4@19	4@15
				60	10	4@18	5@35	4@48	4@48	4@14	4@17	4@13
			6	30	10	DR	5@21	6@35	4@48	DR	4@10	DR
				60	10	DR	5@12	6@25	6@28	DR	DR	DR
130	110	—	3	30	8	4@25	4@48	4@48	4@48	4@18	4@22	4@18
					10	4@19	5@36	4@48	4@48	4@14	4@17	4@13
			6	60	10	4@16	5@34	4@48	4@48	4@12	4@17	4@12
				30	10	DR	5@19	6@35	4@48	DR	4@9	DR
				60	10	DR	5@12	6@24	6@28	DR	DR	DR
140	119	110	3	30	8	4@22	5@42	4@48	4@48	4@16	4@20	4@16
					10	4@17	5@34	4@48	4@48	4@21	4@17	4@12
				60	10	4@15	5@34	4@48	4@48	4@11	4@17	4@10
			6	30	10	DR	5@18	6@35	6@35	DR	4@48	DR
				60	10	DR	5@11	6@23	6@28	DR	DR	DR
150	127	117	3	30	8	4@20	5@37	4@48	4@48	4@15	4@18	4@14
					10	4@15	5@34	4@48	4@48	4@11	4@17	4@11
				60	10	4@13	5@34	4@48	4@48	4@10	4@16	4@9
			6	30	10	DR	5@17	6@33	6@32	DR	4@8	DR
				60	10	DR	DR	6@22	6@28	DR	DR	DR
160	136	125	3	30	8	4@18	5@34	4@48	4@48	4@13	4@17	4@13
					10	4@13	5@34	4@48	4@48	4@10	4@16	4@9
				60	10	4@11	5@31	6@45	4@48	4@9	4@14	4@8
			6	30	10	DR	5@15	6@31	6@30	DR	4@7	DR
				60	10	DR	DR	6@21	6@27	DR	DR	DR

(continued)

TABLE R608.6(4)—continued
MINIMUM VERTICAL REINFORCEMENT FOR FLAT, WAFFLE- AND SCREEN-GRID ABOVE-GRADE WALLS DESIGNED CONTINUOUS WITH FOUNDATION STEM WALLS[a, b, c, d, e, k]

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s, 1 pound per square inch = 6.895 kPa, 1 square foot = 0.0929 m^2.
DR = Design Required.

a. Table is based on ASCE 7 components and cladding wind pressures for an enclosed building using a mean roof height of 35 feet, interior wall area 4, an effective wind area of 10 square feet, topographic factor, K_{zt}, equal to 1.0, and Risk Category II.
b. Table is based on concrete with a minimum specified compressive strength of 2,500 psi.
c. See Section R608.6.5 for location of reinforcement in wall.
d. Deflection criterion is $L/240$, where L is the height of the wall in inches from the exterior finish ground level to the top of the above-grade wall.
e. Interpolation is not permitted. For intermediate values of basic wind speed, heights of stem wall and above-grade wall, and design lateral soil load, use next higher value.
f. Where No. 4 reinforcing bars at a spacing of 48 inches are specified in the table as indicated by shaded cells, use of bars with a minimum yield strength of 40,000 psi or 60,000 psi is permitted.
g. Other than for No. 4 bars spaced at 48 inches on center, table values are based on reinforcing bars with a minimum yield strength of 60,000 psi. Maximum spacings shown are the values calculated for the specified bar size. In waffle and screen-grid walls where the bar used is Grade 60 and the size specified in the table, the actual spacing in the wall shall not exceed a whole-number multiple of 12 inches such as, 12, 24, 36 and 48, that is less than or equal to the tabulated spacing. Vertical reinforcement with a yield strength of less than 60,000 psi and bars of a different size than specified in the table are permitted in accordance with Section R608.5.4.7 and Table R608.5.4(2).
h. Height of stem wall is the distance from the exterior finish ground level to the top of the slab-on-ground.
i. Where the distance from the exterior finish ground level to the top of the slab-on-ground is equal to or greater than 4 feet, the stem wall shall be laterally supported at the top and bottom before backfilling. Where the wall is designed and constructed to be continuous with the above-grade wall, temporary supports bracing the top of the stem wall shall remain in place until the above-grade wall is laterally supported at the top by floor or roof construction.
j. See Table R608.3 for tolerances on nominal thicknesses, and minimum core dimensions and maximum spacing of horizontal and vertical cores for waffle- and screen-grid walls.
k. Tabulated values are applicable to construction where gravity loads bear on top of wall, and conditions where gravity loads from floor construction are transferred to wall from a wood ledger or cold-formed steel track bolted to side of wall. See Tables R608.6(1), R608.6(2) and R608.6(3).

bar each at approximately one-third and two-thirds of the wall height.

R608.6.3 Continuity of wall reinforcement between stories. Vertical reinforcement required by this section shall be continuous between elements providing lateral support for the wall. Reinforcement in the wall of the *story* above shall be continuous with the reinforcement in the wall of the *story* below, or the foundation wall, if applicable. Lap splices, where required, shall comply with Section R608.5.4.3 and Figure R608.5.4(1). Where the above-grade wall is supported by a monolithic slab-on-ground and footing, dowel bars with a size and spacing to match the vertical above-grade concrete wall reinforcement shall be embedded in the monolithic slab-on-ground and footing the distance required to develop the dowel bar in tension in accordance with Section R608.5.4.4 and Figure R608.5.4(2) and lap-spliced with the above-grade wall reinforcement in accordance with Section R608.5.4.3 and Figure R608.5.4(1).

Where a construction joint in the wall is located below the level of the floor and less than the distance required to develop the bar in tension, the distance required to develop the bar in tension shall be measured from the top of the concrete below the joint. See Section R608.5.5.

Exception: Where reinforcement in the wall above cannot be made continuous with the reinforcement in the wall below, the bottom of the reinforcement in the wall above shall be terminated in accordance with one of the following:

1. Extend below the top of the floor the distance required to develop the bar in tension in accordance with Section R608.5.4.4 and Figure R608.5.4(2).
2. Lap-spliced in accordance with Section R608.5.4.3 and Figure R608.5.4(1) with a dowel bar that extends into the wall below the distance required to develop the bar in tension in accordance with Section R608.5.4.4 and Figure R608.5.4(2).

R608.6.4 Termination of reinforcement. Where indicated in Items 1 through 3, vertical wall reinforcement in the top-most *story* with concrete walls shall be terminated with a 90-degree (1.57 rad) standard hook complying with Section R608.5.4.5 and Figure R608.5.4(3).

1. Vertical bars adjacent to door and window openings required by Section R608.8.1.2.
2. Vertical bars at the ends of required solid wall segments (see Section R608.7.2.2.2).
3. Vertical bars (other than end bars, see Item 2) used as shear reinforcement in required solid wall segments where the reduction factor for design strength, R_3, used is based on the wall having horizontal and vertical shear reinforcement (see Section R608.7.2.2.3).

The bar extension of the hook shall be oriented parallel to the horizontal wall reinforcement and be within 4 inches (102 mm) of the top of the wall.

Horizontal reinforcement shall be continuous around the building corners by bending one of the bars and lap-splicing it with the bar in the other wall in accordance with Section R608.5.4.3 and Figure R608.5.4(1).

In required solid wall segments where the reduction factor for design strength, R_3, is based on the wall having horizontal and vertical shear reinforcement in accordance with Section R608.7.2.2.1, horizontal wall reinforcement shall be terminated with a standard hook

complying with Section R608.5.4.5 and Figure R608.5.4(3) or in a lap-splice, except at corners where the reinforcement shall be continuous as required.

Exception: In lieu of bending horizontal reinforcement at corners, separate bent reinforcing bars shall be permitted provided that the bent bar is lap-spliced with the horizontal reinforcement in both walls in accordance with Section R608.5.4.3 and Figure R608.5.4(1).

R608.6.5 Location of reinforcement in wall. Except for vertical reinforcement at the ends of required solid wall segments, which shall be located as required by Section R608.7.2.2.2, the location of the vertical reinforcement shall not vary from the center of the wall by more than the greater of 10 percent of the wall thickness and $^3/_8$-inch (10 mm). Horizontal and vertical reinforcement shall be located to provide not less than the minimum cover required by Section R608.5.4.1.

R608.7 Solid walls for resistance to lateral forces.

R608.7.1 Length of solid wall. Each exterior wall line in each *story* shall have a total length of solid wall required by Section R608.7.1.1. A solid wall is a section of flat, waffle-grid or screen-grid wall, extending the full *story height* without openings or penetrations, except those permitted by Section R608.7.2. Solid wall segments that contribute to the total length of solid wall shall comply with Section R608.7.2.

R608.7.1.1 Length of solid wall for wind. Buildings shall have solid walls in each exterior endwall line (the side of a building that is parallel to the span of the roof or floor framing) and sidewall line (the side of a building that is perpendicular to the span of the roof or floor framing) to resist lateral in-plane wind forces. The site-appropriate basic wind speed and exposure category shall be used in Tables R608.7.1.1(1) through (3) to determine the unreduced total length, *UR*, of solid wall required in each exterior endwall line and sidewall line. For buildings with a mean roof height of less than 35 feet (10 668 mm), the unreduced values determined from Tables R608.7.1.1(1) through (3) are permitted to be reduced by multiplying by the applicable factor, R_1, from Table R608.7.1.1(4); however, reduced values shall be not less than the minimum values in Tables R608.7.1.1(1) through (3). Where the floor-to-ceiling height of a *story* is less than 10 feet (3048 mm), the unreduced values determined from Tables R608.7.1.1(1) through (3), including minimum values, are permitted to be reduced by multiplying by the applicable factor, R_2, from Table R608.7.1.1(5). To account for different design strengths than assumed in determining the values in Tables R608.7.1.1(1) through (3), the unreduced lengths determined from Tables R608.7.1.1(1) through (3), including minimum values, are permitted to be reduced by multiplying by the applicable factor, R_3, from Table R608.7.1.1(6). The reductions permitted by Tables R608.7.1.1(4), R608.7.1.1(5) and R608.7.1.1(6) are cumulative.

The total length of solid wall segments, *TL*, in a wall line that comply with the minimum length requirements of Section R608.7.2.1 [see Figure R608.7.1.1(1)] shall be equal to or greater than the product of the unreduced length of solid wall from Tables R608.7.1.1(1) through (3), *UR* and the applicable reduction factors, if any, from Tables R608.7.1.1(4), R608.7.1.1(5) and R608.7.1.1(6) as indicated by Equation R6-1.

$$TL \geq R_1 \times R_2 \times R_3 \times UR \qquad \textbf{(Equation R6-1)}$$

where:

TL = Total length of solid wall segments in a wall line that comply with Section R608.7.2.1 [see Figure R608.7.1.1(1)].

R_1 = 1.0 or reduction factor for mean roof height from Table R608.7.1.1(4).

R_2 = 1.0 or reduction factor for floor-to-ceiling wall height from Table R608.7.1.1(5).

R_3 = 1.0 or reduction factor for design strength from Table R608.7.1.1(6).

UR = Unreduced length of solid wall from Tables R608.7.1.1(1) through (3).

The total length of solid wall in a wall line, *TL*, shall be not less than that provided by two solid wall segments complying with the minimum length requirements of Section R608.7.2.1.

To facilitate determining the required wall thickness, wall type, number and *grade* of vertical bars at each end of each solid wall segment, and whether shear reinforcement is required, use of Equation R6-2 is permitted.

$$R_3 \leq \frac{TL}{R_1 \times R_2 \times UR} \qquad \textbf{(Equation R6-2)}$$

After determining the maximum permitted value of the reduction factor for design strength, R_3, in accordance with Equation R6-2, select a wall type from Table R608.7.1.1(6) with R_3 less than or equal to the value calculated.

R608.7.2 Solid wall segments. Solid wall segments that contribute to the required length of solid wall shall comply with this section. Reinforcement shall be provided in accordance with Section R608.7.2.2 and Table R608.7.1.1(6). Solid wall segments shall extend the full story-height without openings, other than openings for the utilities and other building services passing through the wall. In flat walls and waffle-grid walls, such openings shall have an area of less than 30 square inches (19 355 mm^2) without any dimension exceeding $6^1/_4$ inches (159 mm), and shall not be located within 6 inches (152 mm) of the side edges of the solid wall segment. In screen-grid walls, such openings shall be located in the portion of the solid wall segment between horizontal and vertical cores of concrete and opening size and location are not restricted provided there is not any concrete removed.

TABLE R608.7.1.1(1)
UNREDUCED LENGTH, *UR*, OF SOLID WALL REQUIRED IN EACH EXTERIOR ENDWALL FOR WIND PERPENDICULAR TO RIDGE ONE STORY OR TOP STORY OF TWO STORY[a, c, d, e, f, g]

SIDEWALL LENGTH (feet)	ENDWALL LENGTH (feet)	ROOF SLOPE	UNREDUCED LENGTH, *UR*, OF SOLID WALL REQUIRED IN ENDWALLS FOR WIND PERPENDICULAR TO RIDGE (feet)						
			Basic Wind Speed (mph) Exposure						
			115B	120B	130B	140B	150B	160B	Minimum[b]
			—	—	110C	119C	127C	136C	
			—	—	—	110D	117D	125D	
15	15	< 1:12	1.03	1.12	1.32	1.53	1.76	2.00	0.92
		5:12	1.43	1.56	1.83	2.12	2.43	2.77	1.15
		7:12	2.00	2.18	2.56	2.97	3.41	3.88	1.25
		12:12	3.20	3.48	4.09	4.74	5.44	6.19	1.54
	30	< 1:12	1.03	1.12	1.32	1.53	1.76	2.00	0.98
		5:12	1.43	1.56	1.83	2.12	2.43	2.77	1.43
		7:12	2.78	3.03	3.56	4.13	4.74	5.39	1.64
		12:12	5.17	5.63	6.61	7.67	8.80	10.01	2.21
	45	< 1:12	1.03	1.12	1.32	1.53	1.76	2.00	1.04
		5:12	1.43	1.56	1.83	2.12	2.43	2.77	1.72
		7:12	3.57	3.88	4.56	5.28	6.07	6.90	2.03
		12:12	7.15	7.78	9.13	10.59	12.16	13.84	2.89
	60	< 1:12	1.03	1.12	1.32	1.53	1.76	2.00	1.09
		5:12	1.43	1.56	1.83	2.12	2.43	2.77	2.01
		7:12	4.35	4.73	5.55	6.44	7.39	8.41	2.42
		12:12	9.12	9.93	11.66	13.52	15.52	17.66	3.57
30	15	< 1:12	1.84	2.01	2.35	2.73	3.13	3.57	1.82
		5:12	2.56	2.78	3.27	3.79	4.35	4.95	2.23
		7:12	3.61	3.93	4.61	5.34	6.13	6.98	2.42
		12:12	5.61	6.10	7.16	8.31	9.54	10.85	2.93
	30	< 1:12	1.84	2.01	2.35	2.73	3.13	3.57	1.93
		5:12	2.56	2.78	3.27	3.79	4.35	4.95	2.75
		7:12	4.92	5.35	6.28	7.29	8.37	9.52	3.12
		12:12	8.92	9.71	11.39	13.22	15.17	17.26	4.14
	45	< 1:12	1.84	2.01	2.35	2.73	3.13	3.57	2.03
		5:12	2.56	2.78	3.27	3.79	4.35	4.95	3.26
		7:12	6.23	6.78	7.96	9.23	10.60	12.06	3.82
		12:12	12.23	13.31	15.63	18.12	20.80	23.67	5.36
	60	< 1:12	1.84	2.01	2.35	2.73	3.13	3.57	2.14
		5:12	2.56	2.78	3.27	3.79	4.35	4.95	3.78
		7:12	7.54	8.21	9.64	11.17	12.83	14.60	4.52
		12:12	15.54	16.92	19.86	23.03	26.44	30.08	6.57

(continued)

TABLE R608.7.1.1(1)—continued
UNREDUCED LENGTH, *UR*, OF SOLID WALL REQUIRED IN EACH EXTERIOR ENDWALL FOR WIND PERPENDICULAR TO RIDGE ONE STORY OR TOP STORY OF TWO STORY[a, c, d, e, f, g]

SIDEWALL LENGTH (feet)	ENDWALL LENGTH (feet)	ROOF SLOPE	UNREDUCED LENGTH, *UR*, OF SOLID WALL REQUIRED IN ENDWALLS FOR WIND PERPENDICULAR TO RIDGE (feet)						
			Basic Wind Speed (mph) Exposure						
			115B	120B	130B	140B	150B	160B	Minimum[b]
			—	—	110C	119C	127C	136C	
			—	—	—	110D	117D	125D	
60	15	< 1:12	3.42	3.72	4.36	5.06	5.81	6.61	3.63
		5:12	4.75	5.17	6.06	7.03	8.07	9.19	4.40
		7:12	6.76	7.36	8.64	10.02	11.51	13.09	4.75
		12:12	10.35	11.27	13.23	15.34	17.61	20.04	5.71
	30	< 1:12	3.42	3.72	4.36	5.06	5.81	6.61	3.83
		5:12	4.75	5.17	6.06	7.03	8.07	9.19	5.37
		7:12	9.12	9.93	11.66	13.52	15.52	17.66	6.07
		12:12	16.30	17.75	20.83	24.16	27.73	31.55	8.00
	45	< 1:12	3.55	3.87	4.54	5.27	6.05	6.88	4.03
		5:12	4.94	5.37	6.31	7.31	8.40	9.55	6.34
		7:12	11.71	12.75	14.97	17.36	19.93	22.67	7.39
		12:12	22.70	24.71	29.00	33.64	38.62	43.94	10.29
	60	< 1:12	3.68	4.01	4.71	5.46	6.27	7.13	4.23
		5:12	5.11	5.57	6.54	7.58	8.70	9.90	7.31
		7:12	14.38	15.66	18.37	21.31	24.46	27.83	8.71
		12:12	29.30	31.90	37.44	43.42	49.85	56.72	12.57

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s, 1 pound-force per linear foot = 0.146 kN/m, 1 pound per square foot = 47.88 Pa.

a. Tabulated lengths were derived by calculating design wind pressures in accordance with Figure 28.4-1 of ASCE 7 for a building with a mean roof height of 35 feet, topographic factor, K_{zt}, equal to 1.0, and Risk Category II. For wind perpendicular to the ridge, the effects of a 2-foot overhang on each endwall are included. The design pressures were used to calculate forces to be resisted by solid wall segments in each. The forces to be resisted by each wall line were then divided by the default design strength of 840 pounds per linear foot of length to determine the unreduced length, *UR*, of solid wall length required in each endwall. The actual mean roof height of the building shall not exceed the least horizontal dimension of the building.

b. Tabulated lengths in the "minimum" column are based on the requirement of Section 28.4.4 of ASCE 7 that the main windforce-resisting system be designed for a minimum pressure of 16 psf multiplied by the wall area of the building and 8 psf multiplied by the roof area of the building projected onto a vertical plane normal to the assumed wind direction. Tabulated lengths in shaded cells are less than the "minimum" value. Where the minimum controls, it is permitted to be reduced in accordance with Notes c, d and e. See Section R608.7.1.1.

c. For buildings with a mean roof height of less than 35 feet, tabulated lengths are permitted to be reduced by multiplying by the appropriate factor, R_1, from Table R608.7.1.1(4). The reduced length shall be not less than the "minimum" value shown in the table.

d. Tabulated lengths for "one story or top story of two story" are based on a floor-to-ceiling height of 10 feet. Tabulated lengths for "first story of two story" are based on floor-to-ceiling heights of 10 feet each for the first and second story. For floor-to-ceiling heights less than assumed, use the lengths in this table or Table R608.1.1(2) or (3), or multiply the value in the table by the reduction factor, R_2, from Table R608.7.1.1(5).

e. Tabulated lengths are based on the default design shear strength of 840 pounds per linear foot of solid wall segment. The tabulated lengths are permitted to be reduced by multiplying by the applicable reduction factor for design strength, R_3, from Table R608.7.1.1(6).

f. The reduction factors, R_1, R_2 and R_3, in Tables R608.7.1.1(4), R608.7.1.1(5), and R608.7.1.1(6), respectively, are permitted to be compounded, subject to the limitations of Note b. However, the minimum number and minimum length of solid wall segments in each wall line shall comply with Sections R608.7.1 and R608.7.2.1, respectively.

g. For intermediate values of sidewall length, endwall length, roof slope and basic wind speed, use the next higher value, or determine by interpolation.

TABLE R608.7.1.1(2)
UNREDUCED LENGTH, *UR*, OF SOLID WALL REQUIRED IN EACH EXTERIOR ENDWALL FOR WIND PERPENDICULAR TO RIDGE FIRST STORY OF TWO STORY[a, c, d, e, f, g]

SIDEWALL LENGTH (feet)	ENDWALL LENGTH (feet)	ROOF SLOPE	UNREDUCED LENGTH, *UR*, OF SOLID WALL REQUIRED IN ENDWALLS FOR WIND PERPENDICULAR TO RIDGE (feet)						
			Basic Wind Speed (mph) Exposure						
			115B	120B	130B	140B	150B	160B	Minimum[b]
			—	—	110C	119C	127C	136C	
			—	—	—	110D	117D	125D	
15	15	< 1:12	2.98	3.25	3.81	4.42	5.07	5.77	2.54
		5:12	4.13	4.50	5.28	6.12	7.03	8.00	2.76
		7:12	4.31	4.70	5.51	6.39	7.34	8.35	2.87
		12:12	5.51	6.00	7.04	8.16	9.37	10.66	3.15
	30	< 1:12	2.98	3.25	3.81	4.42	5.07	5.77	2.59
		5:12	4.13	4.50	5.28	6.12	7.03	8.00	3.05
		7:12	5.09	5.55	6.51	7.55	8.67	9.86	3.26
		12:12	7.48	8.15	9.56	11.09	12.73	14.49	3.83
	45	< 1:12	2.98	3.25	3.81	4.42	5.07	5.77	2.65
		5:12	4.13	4.50	5.28	6.12	7.03	8.00	3.34
		7:12	5.88	6.40	7.51	8.71	10.00	11.37	3.65
		12:12	9.46	10.30	12.09	14.02	16.09	18.31	4.51
	60	< 1:12	2.98	3.25	3.81	4.42	5.07	5.77	2.71
		5:12	4.13	4.50	5.28	6.12	7.03	8.00	3.63
		7:12	6.66	7.25	8.51	9.87	11.32	12.89	4.04
		12:12	11.43	12.45	14.61	16.94	19.45	22.13	5.19
30	15	< 1:12	5.32	5.79	6.80	7.89	9.05	10.30	5.06
		5:12	7.39	8.04	9.44	10.95	12.57	14.30	5.47
		7:12	7.94	8.65	10.15	11.77	13.51	15.37	5.65
		12:12	9.94	10.82	12.70	14.73	16.91	19.24	6.17
	30	< 1:12	5.32	5.79	6.80	7.89	9.05	10.30	5.16
		5:12	7.39	8.04	9.44	10.95	12.57	14.30	5.98
		7:12	9.25	10.07	11.82	13.71	15.74	17.91	6.35
		12:12	13.25	14.43	16.93	19.64	22.54	25.65	7.38
	45	< 1:12	5.32	5.79	6.80	7.89	9.05	10.30	5.27
		5:12	7.39	8.04	9.44	10.95	12.57	14.30	6.50
		7:12	10.56	11.50	13.50	15.65	17.97	20.45	7.06
		12:12	16.56	18.03	21.16	24.55	28.18	32.06	8.60
	60	< 1:12	5.32	5.79	6.80	7.89	9.05	10.30	5.38
		5:12	7.39	8.04	9.44	10.95	12.57	14.30	7.01
		7:12	11.87	12.93	15.17	17.60	20.20	22.98	7.76
		12:12	19.87	21.64	25.40	29.45	33.81	38.47	9.81

(continued)

TABLE R608.7.1.1(2)—continued
UNREDUCED LENGTH, *UR*, OF SOLID WALL REQUIRED IN EACH EXTERIOR ENDWALL FOR WIND PERPENDICULAR TO RIDGE FIRST STORY OF TWO STORY[a, c, d, e, f, g]

SIDEWALL LENGTH (feet)	ENDWALL LENGTH (feet)	ROOF SLOPE	UNREDUCED LENGTH, *UR*, OF SOLID WALL REQUIRED IN ENDWALLS FOR WIND PERPENDICULAR TO RIDGE (feet)						
			Basic Wind Speed (mph) Exposure						
			115B	120B	130B	140B	150B	160B	Minimum[b]
			—	—	110C	119C	127C	136C	
			—	—	—	110D	117D	125D	
60	15	< 1:12	9.87	10.74	12.61	14.62	16.79	19.10	10.10
		5:12	13.71	14.93	17.52	20.32	23.33	26.54	10.87
		7:12	15.08	16.42	19.27	22.35	25.66	29.20	11.22
		12:12	18.67	20.33	23.86	27.67	31.77	36.14	12.19
	30	< 1:12	9.87	10.74	12.61	14.62	16.79	19.10	10.30
		5:12	13.71	14.93	17.52	20.32	23.33	26.54	11.85
		7:12	17.44	18.99	22.29	25.85	29.67	33.76	12.54
		12:12	24.62	26.81	31.46	36.49	41.89	47.66	14.48
	45	< 1:12	10.27	11.18	13.12	15.21	17.47	19.87	10.50
		5:12	14.26	15.52	18.22	21.13	24.26	27.60	12.82
		7:12	20.21	22.01	25.83	29.95	34.39	39.12	13.86
		12:12	31.20	33.97	39.87	46.23	53.07	60.39	16.76
	60	< 1:12	10.64	11.59	13.60	15.77	18.11	20.60	10.70
		5:12	14.77	16.09	18.88	21.90	25.14	28.60	13.79
		7:12	23.05	25.09	29.45	34.15	39.21	44.61	15.18
		12:12	37.97	41.34	48.52	56.27	64.60	73.49	19.05

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s, 1 pound force per linear foot = 0.146 kN/m, 1 pound per square foot = 47.88 Pa.

a. Tabulated lengths were derived by calculating design wind pressures in accordance with Figure 28.4-1 of ASCE 7 for a building with a mean roof height of 35 feet, topographic factor, K_{zt}, equal to 1.0, and Risk Category II. For wind perpendicular to the ridge, the effects of a 2-foot overhang on each endwall are included. The design pressures were used to calculate forces to be resisted by solid wall segments in each endwall. The forces to be resisted by each wall line were then divided by the default design strength of 840 pounds per linear foot of length to determine the unreduced length, *UR*, of solid wall length required in each endwall. The actual mean roof height of the building shall not exceed the least horizontal dimension of the building.

b. Tabulated lengths in the "minimum" column are based on the requirement of Section 28.4.4 of ASCE 7 that the main windforce-resisting system be designed for a minimum pressure of 1016 psf multiplied by the wall area of the building and 8 psf multiplied by the roof area of the building projected onto a vertical plane normal to the assumed wind direction. Tabulated lengths in shaded cells are less than the "minimum" value. Where the minimum controls, it is permitted to be reduced in accordance with Notes c, d and e. See Section R608.7.1.1.

c. For buildings with a mean roof height of less than 35 feet, tabulated lengths are permitted to be reduced by multiplying by the appropriate factor, R_1, from Table R608.7.1.1(4). The reduced length shall be not less than the "minimum" value shown in the table.

d. Tabulated lengths for "one story or top story of two story" are based on a floor-to-ceiling height of 10 feet. Tabulated lengths for "first story of two story" are based on floor-to-ceiling heights of 10 feet each for the first and second story. For floor-to-ceiling heights less than assumed, use the lengths in this table or Table R608.7.1.1(1) or R608.7.1.1(3), or multiply the value in the table by the reduction factor, R_2, from Table R608.7.1.1(5).

e. Tabulated lengths are based on the default design shear strength of 840 pounds per linear foot of solid wall segment. The tabulated lengths are permitted to be reduced by multiplying by the applicable reduction factor for design strength, R_3, from Table R608.7.1.1(6).

f. The reduction factors, R_1, R_2 and R_3, in Tables R608.7.1.1(4), R608.7.1.1(5), and R608.7.1.1(6), respectively, are permitted to be compounded, subject to the limitations of Note b. However, the minimum number and minimum length of solid wall segments in each wall line shall comply with Sections R608.7.1 and R608.7.2.1, respectively.

g. For intermediate values of sidewall length, endwall length, roof slope and basic wind speed, use the next higher value, or determine by interpolation.

TABLE R608.7.1.1(3)
UNREDUCED LENGTH, *UR*, OF SOLID WALL REQUIRED IN EACH EXTERIOR SIDEWALL FOR WIND PARALLEL TO RIDGE[a, c, d, e, f, g]

SIDEWALL LENGTH (feet)	ENDWALL LENGTH (feet)	ROOF SLOPE	UNREDUCED LENGTH, *UR*, OF SOLID WALL REQUIRED IN SIDEWALLS FOR WIND PARALLEL TO RIDGE (feet)						
			Basic Wind Speed (mph) Exposure						
			115B	120B	130B	140B	150B	160B	Minimum[b]
			—	—	110C	119C	127C	136C	
			—	—	—	110D	117D	125D	
			First story of two story						
< 30	15	< 1:12	1.08	1.18	1.39	161	1.84	2.10	0.90
		5:12	1.29	1.40	1.65	1.91	2.19	2.49	1.08
		7:12	1.38	1.50	1.76	2.04	2.35	2.67	1.17
		12:12	1.63	1.78	2.09	2.42	2.78	3.16	1.39
	30	< 1:12	2.02	2.20	2.59	3.00	3.44	3.92	1.90
		5:12	2.73	2.97	3.48	4.04	4.64	5.28	2.62
		7:12	3.05	3.32	3.89	4.51	5.18	5.89	2.95
		12:12	3.93	4.27	5.02	5.82	6.68	7.60	3.86
	45	< 1:12	3.03	3.30	3.87	4.49	5.15	5.86	2.99
		5:12	4.55	4.96	5.82	6.75	7.74	8.81	4.62
		7:12	5.24	5.71	6.70	7.77	8.92	10.15	5.36
		12:12	7.16	7.79	9.14	10.61	12.17	13.85	7.39
	60	< 1:12	4.11	4.47	5.25	6.09	6.99	7.96	4.18
		5:12	6.78	7.39	8.67	10.05	11.54	13.13	7.07
		7:12	8.00	8.71	10.22	11.85	13.61	15.48	8.38
		12:12	11.35	12.36	14.51	16.82	19.31	21.97	12.00
60	45	< 1:12	3.17	3.46	4.06	4.70	5.40	6.14	2.99
		5:12	4.75	5.18	6.07	7.04	8.09	9.20	4.62
		7:12	5.47	5.96	6.99	8.11	9.31	10.59	5.36
		12:12	7.45	8.11	9.52	11.04	12.68	14.43	7.39
	60	< 1:12	4.41	4.81	5.64	6.54	7.51	8.54	4.18
		5:12	7.22	7.86	9.23	10.70	12.29	13.98	7.07
		7:12	8.50	9.25	10.86	12.59	14.46	16.45	8.38
		12:12	12.02	13.09	15.36	17.81	20.45	23.27	12.00
< 30	15	< 1:12	3.03	3.30	3.88	4.49	5.16	5.87	2.52
		5:12	3.24	3.52	4.14	4.80	5.51	6.26	2.70
		7:12	3.33	3.62	4.25	4.93	5.66	6.44	2.79
		12:12	3.58	3.90	4.58	5.31	6.10	6.94	3.01
	30	< 1:12	5.50	5.99	7.03	8.16	9.36	10.65	5.14
		5:12	6.21	6.76	7.93	9.20	10.56	12.01	5.86
		7:12	6.52	7.10	8.34	9.67	11.10	12.63	6.19
		12:12	7.41	8.06	9.46	10.97	12.60	14.33	7.10
	45	< 1:12	8.00	8.71	10.22	11.85	13.61	15.48	7.85
		5:12	9.52	10.37	12.17	14.11	16.20	18.43	9.48
		7:12	10.21	11.12	13.05	15.14	17.38	19.77	10.21
		12:12	12.13	13.20	15.50	17.97	20.63	23.47	12.25
	60	< 1:12	10.56	11.50	13.50	15.65	17.97	20.44	10.65
		5:12	13.24	14.41	16.91	19.62	22.52	25.62	13.54
		7:12	14.45	15.73	18.46	21.41	24.58	27.97	14.85
		12:12	17.80	19.38	22.75	26.38	30.29	34.46	18.48

(continued)

TABLE R608.7.1.1(3)—continued
UNREDUCED LENGTH, *UR*, OF SOLID WALL REQUIRED IN EACH EXTERIOR SIDEWALL FOR WIND PARALLEL TO RIDGE[a, c, d, e, f, g]

SIDEWALL LENGTH (feet)	ENDWALL LENGTH (feet)	ROOF SLOPE	UNREDUCED LENGTH, *UR*, OF SOLID WALL REQUIRED IN SIDEWALLS FOR WIND PARALLEL TO RIDGE (feet)						
			Basic Wind Speed (mph) Exposure						
			115B	120B	130B	140B	150B	160B	Minimum[b]
			—	—	110C	119C	127C	136C	
			—	—	—	110D	117D	125D	
			First story of two story						
60	45	< 1:12	8.39	9.14	10.72	12.44	14.28	16.25	7.85
		5:12	9.97	10.86	12.74	14.78	16.97	19.30	9.48
		7:12	10.69	11.64	13.66	15.84	18.19	20.69	10.21
		12:12	12.67	13.80	16.19	18.78	21.56	24.53	12.25
	60	< 1:12	11.37	12.38	14.53	16.85	19.35	22.01	10.65
		5:12	14.18	15.44	18.12	21.02	24.13	27.45	13.54
		7:12	15.46	16.83	19.75	22.91	26.29	29.92	14.85
		12:12	18.98	20.66	24.25	28.13	32.29	36.74	18.48

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s, 1 pound force per linear foot = 0.146 kN/m, 1 pound per square foot = 47.88 Pa.

a. Tabulated lengths were derived by calculating design wind pressures in accordance with Figure 28.4-1 of ASCE 7 for a building with a mean roof height of 35 feet, topographic factor, K_{zt}, equal to 1.0, and Risk Category II. The design pressures were used to calculate forces to be resisted by solid wall segments in each sidewall. The forces to be resisted by each wall line were then divided by the default design strength of 840 pounds per linear foot of length to determine the unreduced length, *UR*, of solid wall length required in each sidewall. The actual mean roof height of the building shall not exceed the least horizontal dimension of the building.

b. Tabulated lengths in the "minimum" column are based on the requirement of Section 28.4.4 of ASCE 7 that the main windforce-resisting system be designed for a minimum pressure of 16 psf multiplied by the wall area of the building and 8 psf multiplied by the roof area of the building projected onto a vertical plane normal to the assumed wind direction. Tabulated lengths in shaded cells are less than the "minimum" value. Where the minimum controls, it is permitted to be reduced in accordance with Notes c, d and e. See Section R608.7.1.1.

c. For buildings with a mean roof height of less than 35 feet, tabulated lengths are permitted to be reduced by multiplying by the appropriate factor, R_1, from Table R608.7.1.1(4). The reduced length shall be not less than the "minimum" value shown in the table.

d. Tabulated lengths for "one story or top story of two story" are based on a floor-to-ceiling height of 10 feet. Tabulated lengths for "first story of two story" are based on floor-to-ceiling heights of 10 feet each for the first and second story. For floor-to-ceiling heights less than assumed, use the lengths in this table or Table R608.7.1.1(1) or Table R608.7.1.1(2), or multiply the value in the table by the reduction factor, R_2, from Table R608.7.1.1(5).

e. Tabulated lengths are based on the default design shear strength of 840 pounds per linear foot of solid wall segment. The tabulated lengths are permitted to be reduced by multiplying by the applicable reduction factor for design strength, R_3, from Table R608.7.1.1(6).

f. The reduction factors, R_1, R_2 and R_3, in Table R608.7.1.1(4), Table R608.7.1.1(5), and Table R608.7.1.1(6), respectively, are permitted to be compounded, subject to the limitations of Note b. However, the minimum number and minimum length of solid walls segments in each wall line shall comply with Sections R608.7.1 and R608.7.2.1, respectively.

g. For intermediate values of sidewall length, endwall length, roof slope and basic wind speed, use the next higher value, or determine by interpolation.

TABLE R608.7.1.1(4)
REDUCTION FACTOR, R_1, FOR BUILDINGS WITH MEAN ROOF HEIGHT LESS THAN 35 FEET[a]

MEAN ROOF HEIGHT[b, c] (feet)	REDUCTION FACTOR R_1, FOR MEAN ROOF HEIGHT		
	Exposure category		
	B	C	D
< 15	0.96	0.84	0.87
20	0.96	0.89	0.91
25	0.96	0.93	0.94
30	0.96	0.97	0.98
35	1.00	1.00	1.00

For SI: 1 foot = 304.8 mm, 1 degree = 0.0175 rad.

a. See Section R608.7.1.1 and Note c to Table R608.7.1.1(1) for application of reduction factors in this table. This reduction is not permitted for "minimum" values.

b. For intermediate values of mean roof height, use the factor for the next greater height, or determine by interpolation.

c. Mean roof height is the average of the roof eave height and height of the highest point on the roof surface, except that for roof slopes of less than or equal to $2^1/_8$:12 (10 degrees), the mean roof height is permitted to be taken as the roof eave height.

TABLE R608.7.1.1(5)
REDUCTION FACTOR, R_2, FOR FLOOR-TO-CEILING WALL HEIGHTS LESS THAN 10 FEET[a, b]

STORY UNDER CONSIDERATION	FLOOR-TO-CEILING HEIGHT[c] (feet)	ENDWALL LENGTH (feet)	ROOF SLOPE	REDUCTION FACTOR, R_2
Endwalls—for wind perpendicular to ridge				
One story or top story of two story	8	15	< 5:12	0.83
			7:12	0.90
			12:12	0.94
		60	< 5:12	0.83
			7:12	0.95
			12:12	0.98
First story of two story	16 combined first and second story	15	< 5:12	0.83
			7:12	0.86
			12:12	0.89
		60	< 5:12	0.83
			7:12	0.91
			12:12	0.95
Sidewalls—for wind parallel to ridge				
One story or top story of two story	8	15	< 1:12	0.84
			5:12	0.87
			7:12	0.88
			12:12	0.89
		60	< 1:12	0.86
			5:12	0.92
			7:12	0.93
			12:12	0.95
First story of two story	16 combined first and second story	15	< 1:12	0.83
			5:12	0.84
			7:12	0.85
			12:12	0.86
		60	< 1:12	0.84
			5:12	0.87
			7:12	0.88
			12:12	0.90

For SI: 1 foot = 304.8 mm.

a. See Section R608.7.1.1 and Note d to Table R608.7.1.1(1) for application of reduction factors in this table.

b. For intermediate values of endwall length and roof slope, use the next higher value or determine by interpolation.

c. Tabulated values in Tables R608.7.1.1(1) and R608.7.1.1(3) for "one story or top story of two story" are based on a floor-to-ceiling height of 10 feet. Tabulated values in Tables R608.7.1.1(2) and R608.7.1.1(3) for "first story of two story" are based on floor-to-ceiling heights of 10 feet each for the first and second story. For floor to ceiling heights between those shown in this table and those assumed in Table R608.7.1.1(1), R608.7.1.1(2) or R608.7.1.1(3), use the solid wall lengths in Table R608.7.1.1(1), R608.7.1.1(2) or R608.7.1.1(3), or determine the reduction factor by interpolating between 1.0 and the factor shown in this table.

TABLE R608.7.1.1(6)
REDUCTION FACTOR FOR DESIGN STRENGTH, R_3, FOR FLAT, WAFFLE- AND SCREEN-GRID WALLS[a, c]

NOMINAL THICKNESS OF WALL (inches)	VERTICAL BARS AT EACH END OF SOLID WALL SEGMENT		VERTICAL REINFORCEMENT LAYOUT DETAIL [see Figure R608.7.1.1(2)]	REDUCTION FACTOR, R_3, FOR LENGTH OF SOLID WALL			
				Horizontal and vertical shear reinforcement provided			
				No		Yes[d]	
	Number of bars	Bar size		40,000[b]	60,000[b]	40,000[b]	60,000[b]
Flat walls							
4	2	4	1	0.74	0.61	0.74	0.50
	3	4	2	0.61	0.61	0.52	0.27
	2	5	1	0.61	0.61	0.48	0.25
	3	5	2	0.61	0.61	0.26	0.18
6	2	4	3	0.70	0.48	0.70	0.48
	3	4	4	0.49	0.38	0.49	0.33
	2	5	3	0.46	0.38	0.46	0.31
	3	5	4	0.38	0.38	0.32	0.16
8	2	4	3	0.70	0.47	0.70	0.47
	3	4	5	0.47	0.32	0.47	0.32
	2	5	3	0.45	0.31	0.45	0.31
	4	4	6	0.36	0.28	0.36	0.25
	3	5	5	0.31	0.28	0.31	0.16
	4	5	6	0.28	0.28	0.24	0.12
10	2	4	3	0.70	0.47	0.70	0.47
	2	5	3	0.45	0.30	0.45	0.30
	4	4	7	0.36	0.25	0.36	0.25
	6	4	8	0.25	0.22	0.25	0.13
	4	5	7	0.24	0.22	0.24	0.12
	6	5	8	0.22	0.22	0.12	0.08
Waffle-grid walls[e]							
6	2	4	3	0.78	0.78	0.70	0.48
	3	4	4	0.78	0.78	0.49	0.25
	2	5	3	0.78	0.78	0.46	0.23
	3	5	4	0.78	0.78	0.24	0.16
8	2	4	3	0.78	0.78	0.70	0.47
	3	4	5	0.78	0.78	0.47	0.24
	2	5	3	0.78	0.78	0.45	0.23
	4	4	6	0.78	0.78	0.36	0.18
	3	5	5	0.78	0.78	0.23	0.16
	4	5	6	0.78	0.78	0.18	0.13
Screen-grid walls[e]							
6	2	4	3	0.93	0.93	0.70	0.48
	3	4	4	0.93	0.93	0.49	0.25
	2	5	3	0.93	0.93	0.46	0.23
	3	5	4	0.93	0.93	0.24	0.16

For SI: 1 inch = 25.4 mm, 1,000 pounds per square inch = 6.895 MPa.

a. See Note e to Table R608.7.1.1(1) for application of adjustment factors in this table.

b. Yield strength in pounds per square inch of vertical wall reinforcement at ends of solid wall segments.

c. Values are based on concrete with a specified compressive strength, f'_c, of 2,500 psi. Where concrete with f'_c of not less than 3,000 psi is used, values in shaded cells are permitted to be decreased by multiplying by 0.91.

d. Horizontal and vertical shear reinforcement shall be provided in accordance with Section R608.7.2.2.

e. Each end of each solid wall segment shall have rectangular flanges. In the through-the-wall dimension, the flange shall be not less than $5^1/_2$ inches for 6-inch-nominal waffle- and screen-grid walls, and not less than $7^1/_2$ inches for 8-inch-nominal waffle-grid walls. In the in-plane dimension, flanges shall be long enough to accommodate the vertical reinforcement required by the layout detail selected from Figure R608.7.1.1(2) and provide the cover required by Section R608.5.4.1. If necessary to achieve the required dimensions, form material shall be removed or use of flat wall forms is permitted.

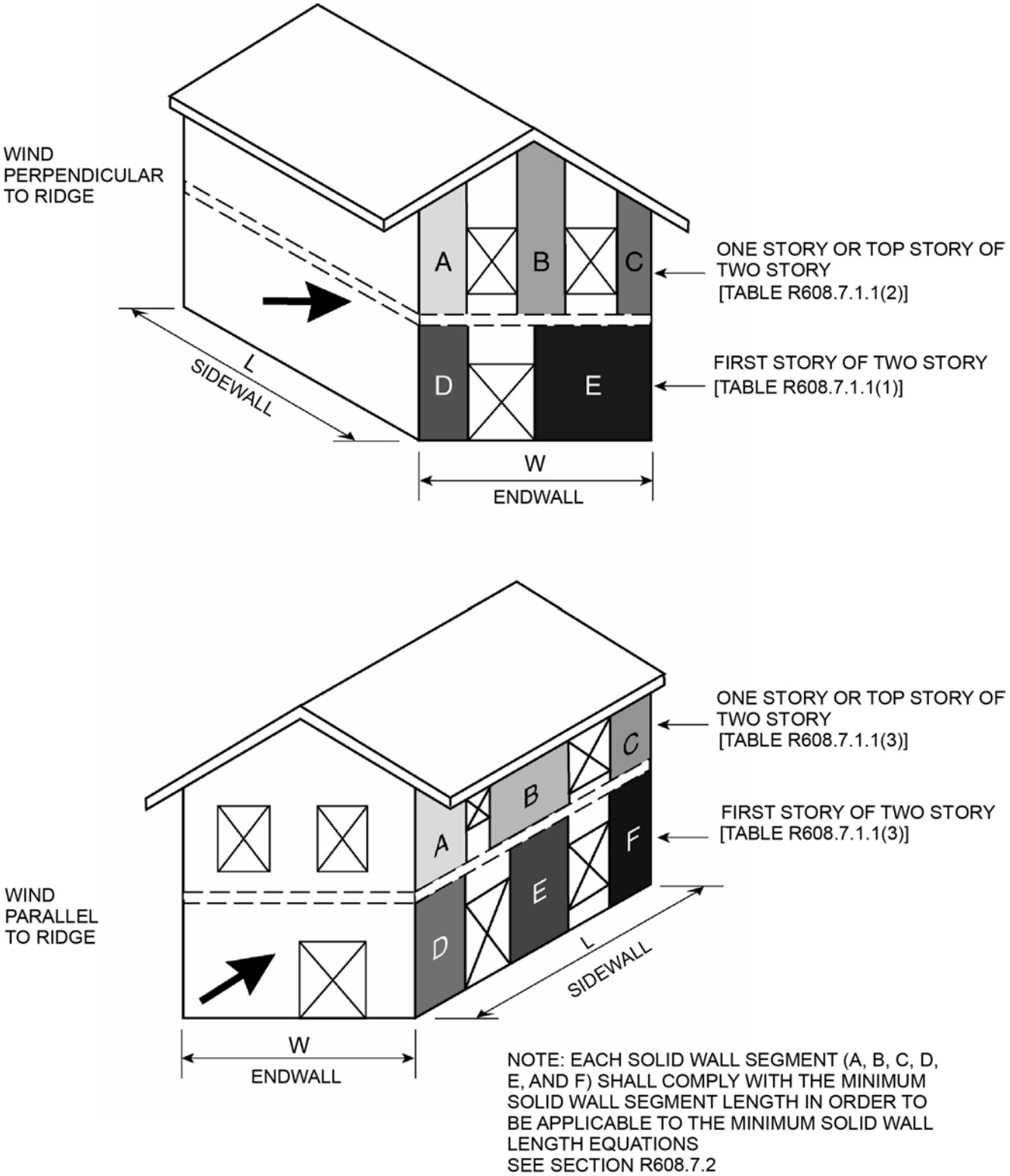
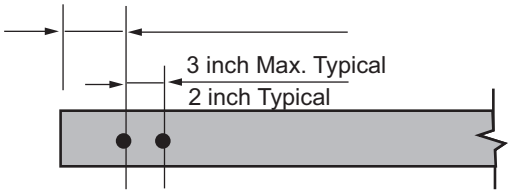
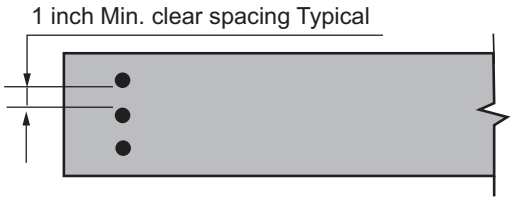
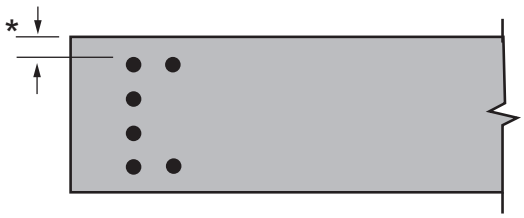


FIGURE R608.7.1.1(1)
MINIMUM SOLID WALL LENGTH

DETAIL NO.	NOM. WALL THICKNESS, IN.	REINFORCEMENT LAYOUT AT ENDS OF SOLID WALL SEGMENTS	NOTES
1	4		For SI: 1 inch = 25.4 mm. 1. See Table R608.7.1.1(6) for use of details. 2. Minimum length of solid wall segment and size and grade of reinforcement in each end of each solid wall segment shall be determined from Table R608.7.1.1(6). 3. For minimum cover requirements, see Section R608.5.4.1. 4. For details 3 - 8 where two or more bars are in the same row parallel to the end of the segment, place bars so that corner bars are as close to the sides of the wall segments as minimum cover requirements of Section R608.5.4.1 will permit. 5. For waffle- and screen-grid walls, each end of each solid wall segment shall have rectangular flanges. In the through-the-wall dimension, the flange shall be not less than 5½ inches for 6-inch nominal waffle- and screen-grid forms, and not less than 7½ inches for 8-inch nominal waffle-grid forms. In the in-plane dimension, flanges shall be long enough to accommodate the vertical reinforcement required by the layout detail selected and provide the cover required by Section R608.5.4.1. If necessary to achieve the required dimensions, form material shall be removed or flat wall forms are permitted. See Table R608.7.1.1(6), Note e.
2	4		
3	6 8 10		
4	6		
5	8		
6	8		
7	10		
8	10		

* For minimum cover see Section R608.5.4.1

FIGURE R608.7.1.1(2)
VERTICAL REINFORCEMENT LAYOUT DETAIL

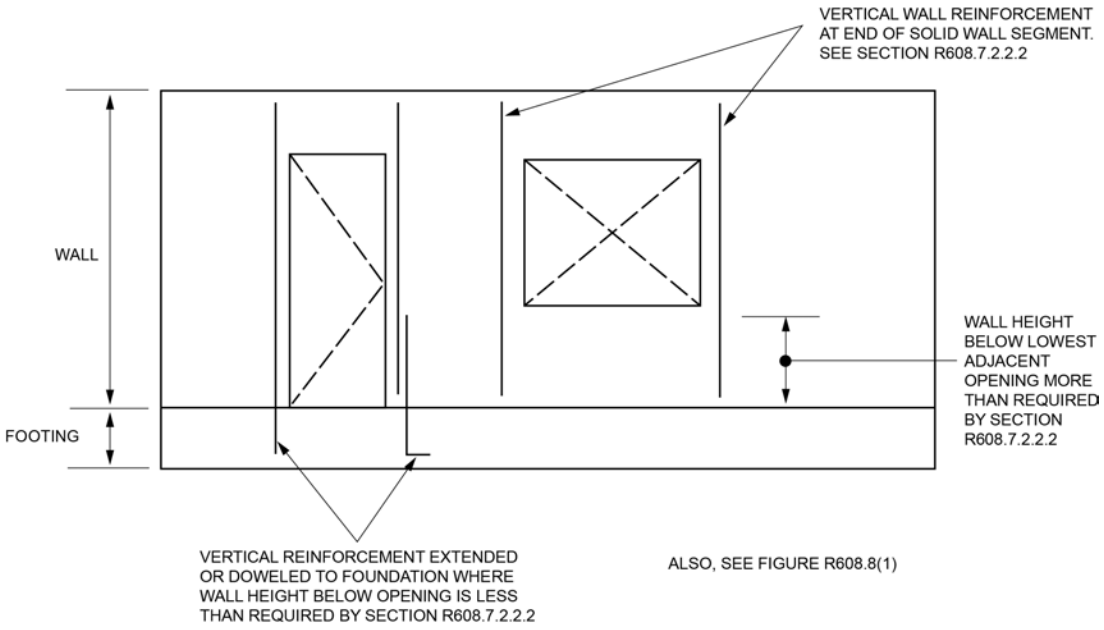


FIGURE R608.7.1.1(3)
VERTICAL WALL REINFORCEMENT ADJACENT TO WALL OPENINGS

R608.7.2.1 Minimum length of solid wall segment and maximum spacing. Only solid wall segments equal to or greater than 24 inches (610 mm) in length shall be included in the total length of solid wall required by Section R608.7.1. In addition, not more than two solid wall segments equal to or greater than 24 inches (610 mm) in length and less than 48 inches (1219 mm) in length shall be included in the required total length of solid wall. The maximum clear opening width shall be 18 feet (5486 mm). See Figure R608.7.1.1(1).

R608.7.2.2 Reinforcement in solid wall segments.

R608.7.2.2.1 Horizontal shear reinforcement. Where reduction factors for design strength, R_3, from Table R608.7.1.1(6) based on horizontal and vertical shear reinforcement being provided are used, solid wall segments shall have horizontal reinforcement consisting of minimum No. 4 bars. Horizontal shear reinforcement shall be the same grade of steel required for the vertical reinforcement at the ends of solid wall segments by Section R608.7.2.2.2.

The spacing of horizontal reinforcement shall not exceed the smaller of one-half the length of the solid wall segment, minus 2 inches (51 mm), and 18 inches (457 mm). Horizontal shear reinforcement shall terminate in accordance with Section R608.6.4.

R608.7.2.2.2 Vertical reinforcement. Vertical reinforcement applicable to the reduction factor(s) for design strength, R_3, from Table R608.7.1.1(6) that is used, shall be located at each end of each solid wall segment in accordance with the applicable detail in Figure R608.7.1.1(2). The No. 4 vertical bar required on each side of an opening by Section R608.8.1.2 is permitted to be used as reinforcement at the ends of solid wall segments where installed in accordance with the applicable detail in Figure R608.7.1.1(2). There shall be not less than two No. 4 bars at each end of solid wall segments located as required by the applicable detail in Figure R608.7.1.1(2). One of the bars at each end of solid wall segments shall be deemed to meet the requirements for vertical wall reinforcement required by Section R608.6.

The vertical wall reinforcement at each end of each solid wall segment shall be developed below the bottom of the adjacent wall opening [see Figure R608.7.1.1(3)] by one of the following methods:

1. Where the wall height below the bottom of the adjacent opening is equal to or greater than 22 inches (559 mm) for No. 4 or 28 inches (711 mm) for No. 5 vertical wall reinforcement, reinforcement around openings in accordance with Section R608.8.1 shall be sufficient.
2. Where the wall height below the bottom of the adjacent opening is less than required by Item 1, the vertical wall reinforcement adjacent to the opening shall extend into the footing far enough to develop the bar in tension in accordance with Section R608.5.4.4 and Figure R608.5.4(2), or shall be lap-spliced with a dowel that is

embedded in the footing far enough to develop the dowel-bar in tension.

R608.7.2.2.3 Vertical shear reinforcement. Where reduction factors for design strength, R_3, from Table R608.7.1.1(6) based on horizontal and vertical shear reinforcement being provided are used, solid wall segments shall have vertical reinforcement consisting of minimum No. 4 bars. Vertical shear reinforcement shall be the same grade of steel required by Section R608.7.2.2.2 for the vertical reinforcement at the ends of solid wall segments. The spacing of vertical reinforcement throughout the length of the segment shall not exceed the smaller of one third the length of the segment, and 18 inches (457 mm). Vertical shear reinforcement shall be continuous between stories in accordance with Section R608.6.3, and shall terminate in accordance with Section R608.6.4. Vertical shear reinforcement required by this section is permitted to be used for vertical reinforcement required by Table R608.6(1), R608.6(2), R608.6(3) or R608.6(4), whichever is applicable.

R608.7.2.3 Solid wall segments at corners. At all interior and exterior corners of exterior walls, a solid wall segment shall extend the full height of each wall *story*. The segment shall have the length required to develop the horizontal reinforcement above and below the adjacent opening in tension in accordance with Section R608.5.4.4. For an exterior corner, the limiting dimension is measured on the outside of the wall, and for an interior corner the limiting dimension is measured on the inside of the wall. See Section R608.8.1. The length of a segment contributing to the required length of solid wall shall comply with Section R608.7.2.1.

The end of a solid wall segment complying with the minimum length requirements of Section R608.7.2.1 shall be located not more than 6 feet (1829 mm) from each corner.

R608.8 Requirements for lintels and reinforcement around openings.

R608.8.1 Reinforcement around openings. Reinforcement shall be provided around openings in walls equal to or greater than 2 feet (610 mm) in width in accordance with this section and Figure R608.8(1), in addition to the minimum wall reinforcement required by Sections R404.1.3, R608.6 and R608.7. Vertical wall reinforcement required by this section is permitted to be used as reinforcement at the ends of solid wall segments required by Section R608.7.2.2.2 provided it is located in accordance with Section R608.8.1.2. Wall openings shall have a minimum depth of concrete over the width of the opening of 8 inches (203 mm) in flat walls and waffle-grid walls, and 12 inches (305 mm) in screen-grid walls. Wall openings in waffle-grid and screen-grid walls shall be located such that not less than one-half of a vertical core occurs along each side of the opening.

R608.8.1.1 Horizontal reinforcement. Lintels complying with Section R608.8.2 shall be provided above wall openings equal to or greater than 2 feet (610 mm) in width.

Openings equal to or greater than 2 feet (610 mm) in width shall have not less than one No. 4 bar placed within 12 inches (305 mm) of the bottom of the opening. See Figure R608.8(1).

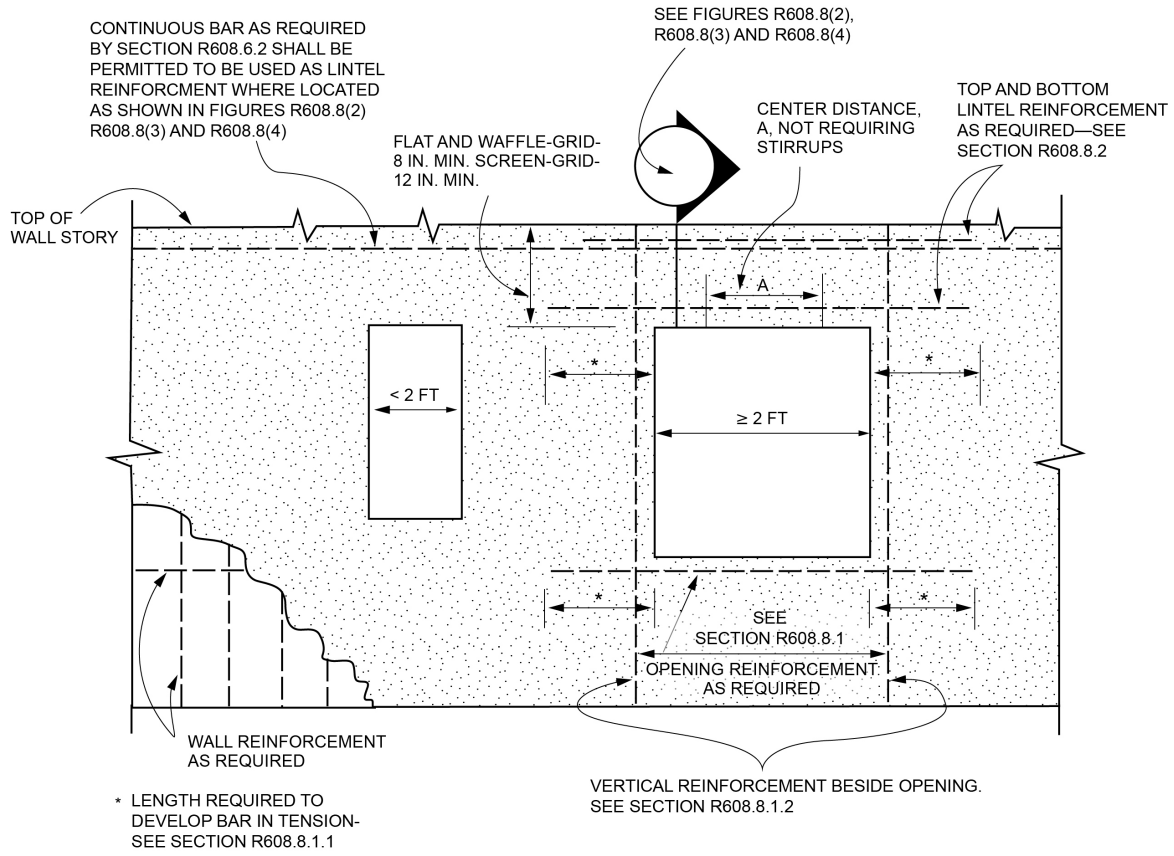
Horizontal reinforcement placed above and below an opening shall extend beyond the edges of the opening the dimension required to develop the bar in tension in accordance with Section R608.5.4.4.

Exception: Continuous horizontal wall reinforcement placed within 12 inches (305 mm) of the top of the wall *story* as required in Sections R404.1.3.2 and R608.6.2 is permitted in lieu of top or bottom lintel reinforcement required by Section R608.8.2 provided that the continuous horizontal wall reinforcement meets the location requirements specified in Figures R608.8(2), R608.8(3), and R608.8(4) and the size requirements specified in Tables R608.8(2) through R608.8(10).

R608.8.1.2 Vertical reinforcement. Not less than one No. 4 bar [Grade 40 (280 MPa)] shall be provided on each side of openings equal to or greater than 2 feet (610 mm) in width. The vertical reinforcement required by this section shall extend the full height of the wall story and shall be located within 12 inches (305 mm) of each side of the opening. The vertical reinforcement required on each side of an opening by this section is permitted to serve as reinforcement at the ends of solid wall segments in accordance with Section R608.7.2.2.2, provided it is located as required by the applicable detail in Figure R608.7.1.1(2). Where the vertical reinforcement required by this section is used to satisfy the requirements of Section R608.7.2.2.2 in waffle- and screen-grid walls, a concrete flange shall be created at the ends of the solid wall segments in accordance with Table R608.7.1.1(6), Note e. In the topmost story, the reinforcement shall terminate in accordance with Section R608.6.4.

R608.8.2 Lintels. Lintels shall be provided over all openings equal to or greater than 2 feet (610 mm) in width. Lintels with uniform loading shall conform to Sections R608.8.2.1 and R608.8.2.2, or Section R608.8.2.3. Lintels supporting concentrated loads, such as from roof or floor beams or girders, shall be designed in accordance with ACI 318.

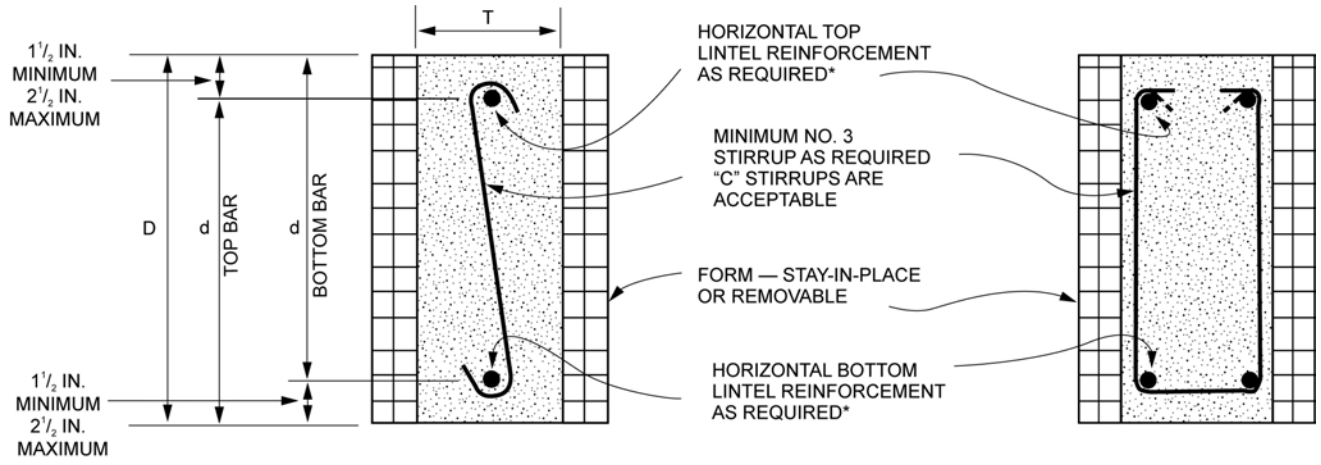
R608.8.2.1 Lintels designed for gravity load-bearing conditions. Where a lintel will be subjected to gravity load conditions 1 through 5 of Table R608.8(1), the clear span of the lintel shall not exceed that permitted by Tables R608.8(2) through R608.8(8). The maximum clear span of lintels with and without stirrups in flat walls shall be determined in accordance with Tables R608.8(2) through R608.8(5), and constructed in accordance with Figure R608.8(2). The



ELEVATION OF WALL

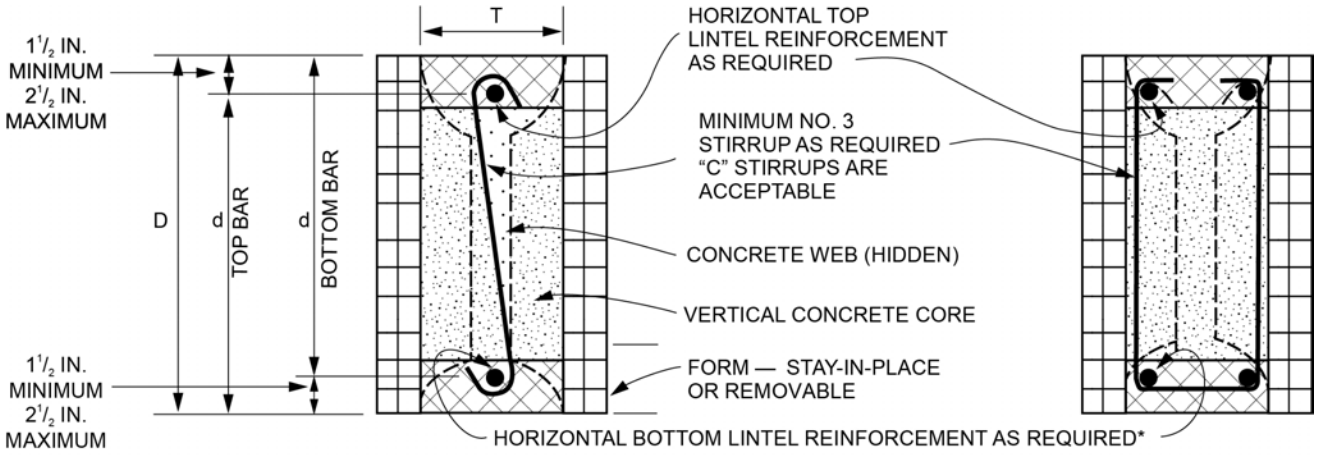
For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

FIGURE R608.8(1)
REINFORCEMENT OF OPENINGS

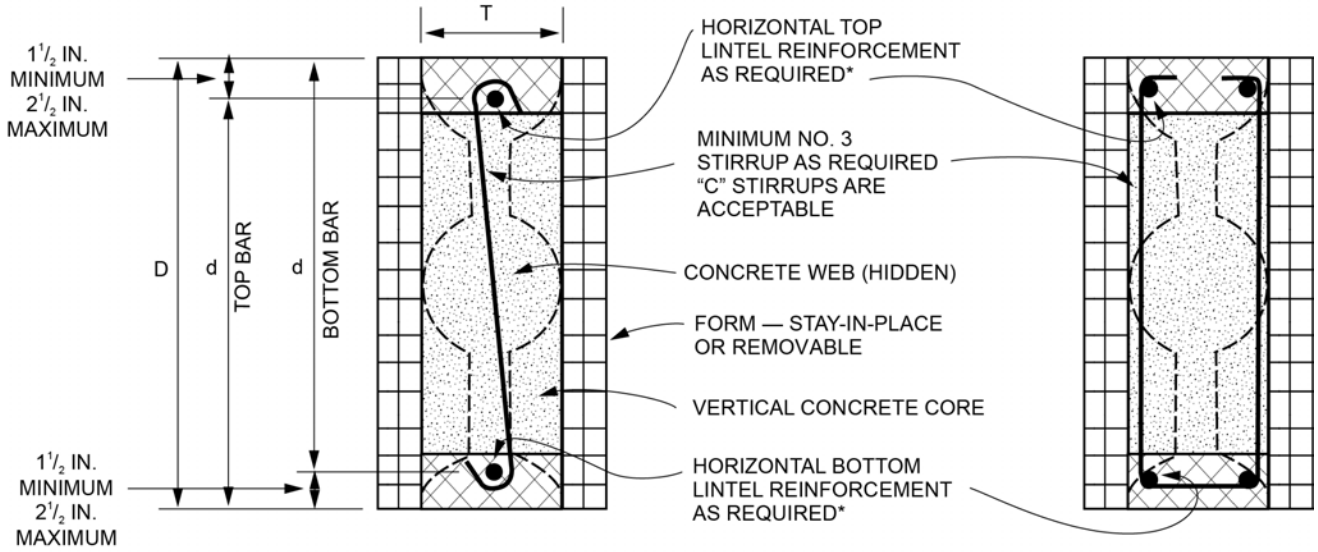


For SI: 1 inch = 25.4 mm.

FIGURE R608.8(2)
LINTEL FOR FLAT WALLS



(a) SINGLE FORM HEIGHT SECTION CUT THROUGH VERTICAL CORE OF A WAFFLE-GRID LINTEL



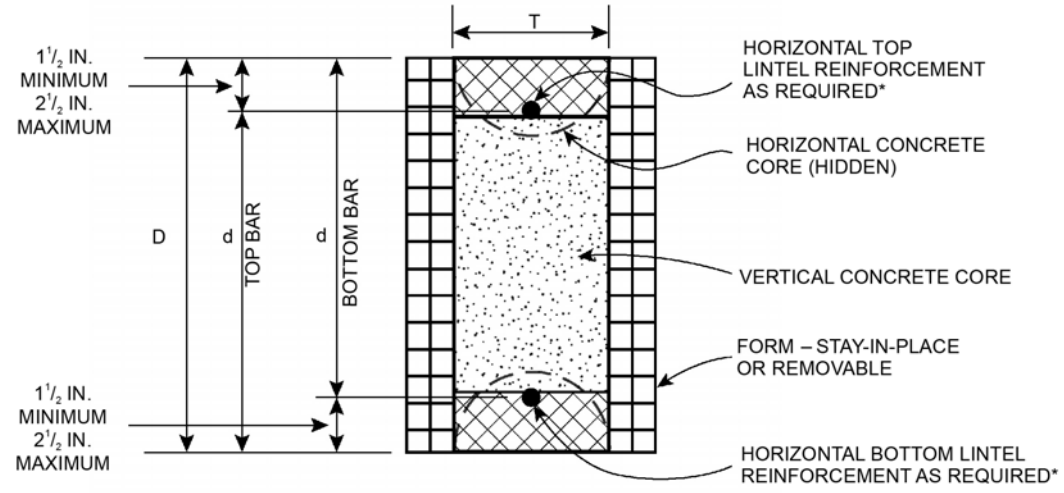
(b) DOUBLE FORM HEIGHT SECTION CUT THROUGH VERTICAL CORE OF A WAFFLE-GRID LINTEL

*FOR BUNDLED BARS, SEE SECTION R608.8.2.2.

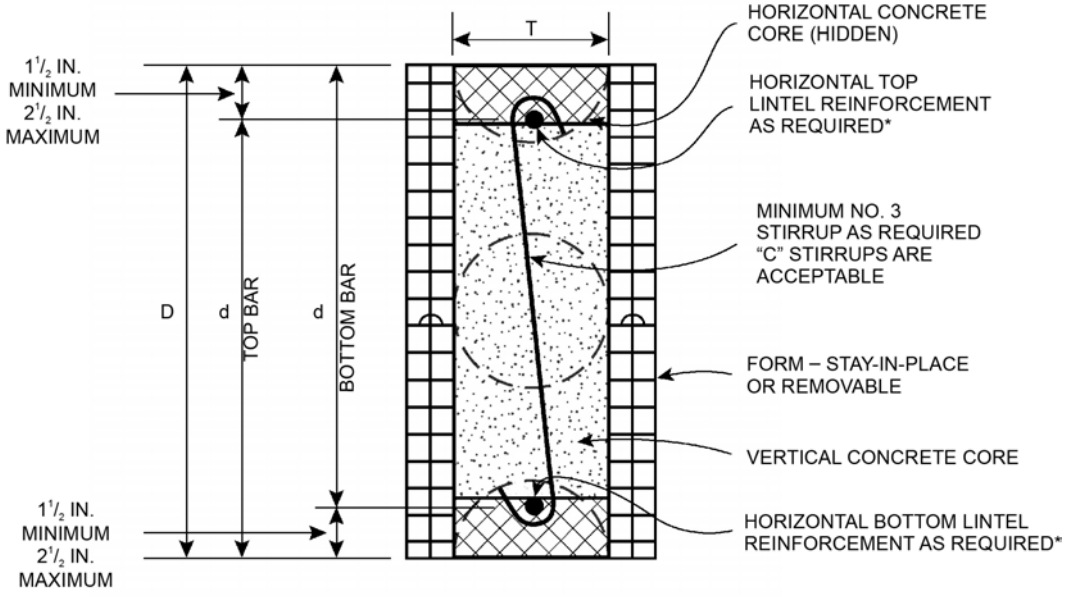
NOTE: CROSS HATCHING REPRESENTS THE AREA IN WHICH FORM MATERIAL SHALL BE REMOVED, IF NECESSARY, TO CREATE FLANGES CONTINUOUS THE LENGTH OF THE LINTEL. FLANGES SHALL HAVE A MINIMUM THICKNESS OF 3 IN., AND A MINIMUM WIDTH OF 5 IN. AND 7 IN. IN 6 IN. NOMINAL AND 8 IN. NOMINAL WAFFLE-GRID WALLS, RESPECTIVELY. SEE NOTE a TO TABLES R608.8(6) AND R608.8(10).

For SI: 1 inch = 25.4 mm.

FIGURE R608.8(3)
LINTELS FOR WAFFLE-GRID WALLS



(a) SINGLE FORM HEIGHT SECTION CUT THROUGH VERTICAL CORE OF A SCREEN-GRID LINTEL



(b) DOUBLE FORM HEIGHT SECTION CUT THROUGH VERTICAL CORE OF A SCREEN-GRID LINTEL

*FOR BUNDLED BARS, SEE SECTION R608.8.2.2

NOTE: CROSS HATCHING REPRESENTS THE AREA IN WHICH FORM MATERIAL SHALL BE REMOVED, IF NECESSARY, TO CREATE FLANGES CONTINUOUS THE LENGTH OF THE LINTEL. FLANGES SHALL HAVE A MINIMUM THICKNESS OF 2.5 IN. AND A MINIMUM WIDTH OF 5 IN. SEE NOTE a TO TABLES R608.8(8) AND R608.8(10).

For SI: 1 inch = 25.4 mm.

FIGURE R608.8(4)
LINTELS FOR SCREEN-GRID WALLS

TABLE R608.8(1)
LINTEL DESIGN LOADING CONDITIONS[a, b, d]

DESCRIPTION OF LOADS AND OPENINGS ABOVE INFLUENCING DESIGN OF LINTEL			DESIGN LOAD CONDITION[c]
Opening in wall of top story of two-story building, or first story of one-story building			
Wall supporting loads from roof, including attic floor, if applicable, and	Top of lintel equal to or less than W/2 below top of wall		2
	Top of lintel greater than W/2 below top of wall		NLB
Wall not supporting loads from roof or attic floor			NLB
Opening in wall of first story of two-story building where wall immediately above is of concrete construction, or opening in basement wall of one-story building where wall immediately above is of concrete construction			
LB ledger board mounted to side of wall with bottom of ledger less than or equal to W/2 above top of lintel, and	Top of lintel greater than W/2 below bottom of opening in story above		1
	Top of lintel less than or equal to W/2 below bottom of opening in story above, and	Opening is entirely within the footprint of the opening in the story above	1
		Opening is partially within the footprint of the opening in the story above	4
LB ledger board mounted to side of wall with bottom of ledger more than W/2 above top of lintel			NLB
NLB ledger board mounted to side of wall with bottom of ledger less than or equal to W/2 above top of lintel, or no ledger board, and	Top of lintel greater than W/2 below bottom of opening in story above		NLB
	Top of lintel less than or equal to W/2 below bottom of opening in story above, and	Opening is entirely within the footprint of the opening in the story above	NLB
		Opening is partially within the footprint of the opening in the story above	1
Opening in basement wall of two-story building where walls of two stories above are of concrete construction			
LB ledger board mounted to side of wall with bottom of ledger less than or equal to W/2 above top of lintel, and	Top of lintel greater than W/2 below bottom of opening in story above		1
	Top of lintel less than or equal to W/2 below bottom of opening in story above, and	Opening is entirely within the footprint of the opening in the story above	1
		Opening is partially within the footprint of the opening in the story above	5
LB ledger board mounted to side of wall with bottom of ledger more than W/2 above top of lintel			NLB
NLB ledger board mounted to side of wall with bottom of ledger less than or equal to W/2 above top of lintel, or no ledger board, and	Top of lintel greater than W/2 below bottom of opening in story above		NLB
	Top of lintel less than or equal to W/2 below bottom of opening in story above, and	Opening is entirely within the footprint of the opening in the story above	NLB
		Opening is partially within the footprint of the opening in the story above	1
Opening in wall of first story of two-story building where wall immediately above is of light-frame construction, or opening in basement wall of one-story building where wall immediately above is of light-frame construction			
Wall supporting loads from roof, second floor and top-story wall of light-frame construction, and	Top of lintel equal to or less than W/2 below top of wall		3
	Top of lintel greater than W/2 below top of wall		NLB
Wall not supporting loads from roof or second floor			NLB

a. LB means load bearing, NLB means nonload bearing, and W means width of opening.
b. Footprint is the area of the wall below an opening in the story above, bounded by the bottom of the opening and vertical lines extending downward from the edges of the opening.
c. For design loading condition "NLB" see Tables R608.8(9) and R608.8(10). For all other design loading conditions, see Tables R608.8(2) through R608.8(8).
d. An NLB ledger board is a ledger attached to a wall that is parallel to the span of the floor, roof or ceiling framing that supports the edge of the floor, ceiling or roof.

TABLE R608.8(2)
MAXIMUM ALLOWABLE CLEAR SPANS FOR 4-INCH-NOMINAL THICK FLAT LINTELS IN LOAD-BEARING WALLS[a, b, c, d, e, f, m]
ROOF CLEAR SPAN 40 FEET AND FLOOR CLEAR SPAN 32 FEET

LINTEL DEPTH, D[g] (inches)	NUMBER OF BARS AND BAR SIZE IN TOP AND BOTTOM OF LINTEL	STEEL YIELD STRENGTH[h], f_y (psi)	DESIGN LOADING CONDITION DETERMINED FROM Table R608.8(1)								
			1	2		3		4		5	
			Maximum ground snow load (psf)								
			—	30	70	30	70	30	70	30	70
			Maximum clear span of lintel (feet-inches)								
8	Span without stirrups[i, j]		3-2	3-4	2-4	2-6	2-2	2-1	2-0	2-0	2-0
	1-#4	40,000	5-2	5-5	4-1	4-3	3-10	3-7	3-4	2-9	2-9
		60,000	6-2	6-5	4-11	5-1	4-6	4-2	3-8	2-11	2-10
	1-#5	40,000	6-3	6-7	5-0	5-2	4-6	4-2	3-8	2-11	2-10
		60,000	DR	DR	DR	DR	DR	DR	DR	DR	DR
	Center distance A[k, l]		1-1	1-2	0-8	0-9	0-7	0-6	0-5	0-4	0-4
12	Span without stirrups[i, j]		3-4	3-7	2-9	2-11	2-8	2-6	2-5	2-2	2-2
	1-#4	40,000	6-7	7-0	5-4	5-7	5-0	4-9	4-4	3-8	3-7
		60,000	7-11	8-6	6-6	6-9	6-0	5-9	5-3	4-5	4-4
	1-#5	40,000	8-1	8-8	6-7	6-10	6-2	5-10	5-4	4-6	4-5
		60,000	9-8	10-4	7-11	8-2	7-4	6-11	6-2	4-10	4-8
	2-#4 1-#6	40,000	9-1	9-8	7-4	7-8	6-10	6-6	6-0	4-10	4-8
		60,000	DR	DR	DR	DR	DR	DR	DR	DR	DR
	Center distance A[k, l]		1-8	1-11	1-1	1-3	1-0	0-11	0-9	0-6	0-6
16	Span without stirrups[i, j]		4-7	5-0	3-11	4-0	3-8	3-7	3-4	3-1	3-0
	1-#4	40,000	6-8	7-3	5-6	5-9	5-2	4-11	4-6	3-10	3-8
		60,000	9-3	10-1	7-9	8-0	7-2	6-10	6-3	5-4	5-2
	1-#4	40,000	9-6	10-4	7-10	8-2	7-4	6-11	6-5	5-5	5-3
		60,000	11-5	12-5	9-6	9-10	8-10	8-4	7-9	6-6	6-4
	2-#4 1-#6	40,000	10-7	11-7	8-10	9-2	8-3	7-9	7-2	6-1	5-11
		60,000	12-9	13-10	10-7	11-0	9-10	9-4	8-7	6-9	6-6
	2-#5	40,000	13-0	14-1	10-9	11-2	9-11	9-2	8-2	6-6	6-3
		60,000	DR	DR	DR	DR	DR	DR	DR	DR	DR
	Center distance A[k, l]		2-3	2-8	1-7	1-8	1-4	1-3	1-0	0-9	0-8
20	Span without stirrups A[i, j]		5-9	6-5	5-0	5-2	4-9	4-7	4-4	3-11	3-11
	1-#4	40,000	7-5	8-2	6-3	6-6	5-10	5-7	5-1	4-4	4-2
		60,000	9-0	10-0	7-8	7-11	7-1	6-9	6-3	5-3	5-1
	1-#5	40,000	9-2	10-2	7-9	8-1	7-3	6-11	6-4	5-4	5-2
		60,000	12-9	14-2	10-10	11-3	10-1	9-7	8-10	7-5	7-3
	2-#4 1-#6	40,000	11-10	13-2	10-1	10-5	9-4	8-11	8-2	6-11	6-9
		60,000	14-4	15-10	12-1	12-7	11-3	10-9	9-11	8-4	8-1
	2-#5	40,000	14-7	16-2	12-4	12-9	11-4	10-6	9-5	7-7	7-3
		60,000	17-5	19-2	14-9	15-3	13-5	12-4	11-0	8-8	8-4
	2-#6	40,000	16-4	18-11	12-7	13-3	11-4	10-6	9-5	7-7	7-3
		60,000	DR	DR	DR	DR	DR	DR	DR	DR	DR
	Center distance A[k, l]		2-9	3-5	2-0	2-2	1-9	1-7	1-4	0-11	0-11

(continued)

TABLE R608.8(2)—continued
MAXIMUM ALLOWABLE CLEAR SPANS FOR 4-INCH-NOMINAL THICK FLAT LINTELS IN LOAD-BEARING WALLS[a, b, c, d, e, f, m]
ROOF CLEAR SPAN 40 FEET AND FLOOR CLEAR SPAN 32 FEET

LINTEL DEPTH, *D* [g] (inches)	NUMBER OF BARS AND BAR SIZE IN TOP AND BOTTOM OF LINTEL	STEEL YIELD STRENGTH[h], f_y (psi)	DESIGN LOADING CONDITION DETERMINED FROM Table R608.8(1)								
			1	2		3		4		5	
			Maximum ground snow load (psf)								
			—	30	70	30	70	30	70	30	70
			Maximum clear span of lintel (feet-inches)								
24	Span without stirrups[i, j]		6-11	7-9	6-1	6-3	5-9	5-7	5-3	4-9	4-8
	1-#4	40,000	8-0	9-0	6-11	7-2	6-5	6-2	5-8	4-9	4-8
		60,000	9-9	11-0	8-5	8-9	7-10	7-6	6-11	5-10	5-8
	1-#5	40,000	10-0	11-3	8-7	8-11	8-0	7-7	7-0	5-11	5-9
		60,000	13-11	15-8	12-0	12-5	11-2	10-7	9-10	8-3	8-0
	2-#4 1-#6	40,000	12-11	14-6	11-2	11-6	10-5	9-10	9-1	7-8	7-5
		60,000	15-7	17-7	13-6	13-11	12-7	11-11	11-0	9-3	9-0
	2-#5	40,000	15-11	17-11	13-7	14-3	12-8	11-9	10-8	8-7	8-4
		60,000	19-1	21-6	16-5	17-1	15-1	14-0	12-6	9-11	9-7
	2-#6	40,000	17-7	21-1	14-1	14-10	12-8	11-9	10-8	8-7	8-4
		60,000	DR	DR	DR	DR	DR	DR	DR	DR	DR
	Center distance *A*[k, l]		3-3	4-1	2-5	2-7	2-1	1-11	1-7	1-2	1-1

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kPa, Grade 40 = 280 MPa, Grade 60 = 420 MPa.

a. See Table R608.3 for tolerances permitted from nominal thickness.

b. Table values are based on concrete with a minimum specified compressive strength of 2,500 psi. See Note j.

c. Table values are based on uniform loading. See Section R608.8.2 for lintels supporting concentrated loads.

d. Deflection criterion is $L/240$, where L is the clear span of the lintel in inches, or $^1/_2$-inch, whichever is less.

e. Linear interpolation is permitted between ground snow loads and between lintel depths.

f. DR indicates design required.

g. Lintel depth, *D*, is permitted to include the available height of wall located directly above the lintel, provided that the increased lintel depth spans the entire length of the lintel.

h. Stirrups shall be fabricated from reinforcing bars with the same yield strength as that used for the main longitudinal reinforcement.

i. Allowable clear span without stirrups applicable to all lintels of the same depth, *D*. Top and bottom reinforcement for lintels without stirrups shall be not less than the least amount of reinforcement required for a lintel of the same depth and loading condition with stirrups. All other spans require stirrups spaced at not more than $d/2$.

j. Where concrete with a minimum specified compressive strength of 3,000 psi is used, clear spans for lintels without stirrups shall be permitted to be multiplied by 1.05. If the increased span exceeds the allowable clear span for a lintel of the same depth and loading condition with stirrups, the top and bottom reinforcement shall be equal to or greater than that required for a lintel of the same depth and loading condition that has an allowable clear span that is equal to or greater than that of the lintel without stirrups that has been increased.

k. Center distance, *A*, is the center portion of the clear span where stirrups are not required. This is applicable to all longitudinal bar sizes and steel yield strengths.

l. Where concrete with a minimum specified compressive strength of 3,000 psi is used, center distance, A, shall be permitted to be multiplied by 1.10.

m. The maximum clear opening width between two solid wall segments shall be 18 feet. See Section R608.7.2.1. Lintel clear spans in the table greater than 18 feet are shown for interpolation and information only.

TABLE R608.8(3)
MAXIMUM ALLOWABLE CLEAR SPANS FOR 6-INCH-NOMINAL THICK FLAT LINTELS IN LOAD-BEARING WALLS[a, b, c, d, e, f, m]
ROOF CLEAR SPAN 40 FEET AND FLOOR CLEAR SPAN 32 FEET

LINTEL DEPTH, D[g] (inches)	NUMBER OF BARS AND BAR SIZE IN TOP AND BOTTOM OF LINTEL	STEEL YIELD STRENGTH[h], f_y (psi)	DESIGN LOADING CONDITION DETERMINED FROM Table R608.8(1)								
			1	2		3		4		5	
			Maximum ground snow load (psf)								
			—	30	70	30	70	30	70	30	70
			Maximum clear span of lintel (feet-inches)								
8	Span without stirrups[i, j]		4-2	4-8	3-1	3-3	2-10	2-6	2-3	2-0	2-0
	1-#4	40,000	5-1	5-5	4-2	4-3	3-10	3-6	3-3	2-8	2-7
		60,000	6-2	6-7	5-0	5-2	4-8	4-2	3-11	3-3	3-2
	1-#5	40,000	6-3	6-8	5-1	5-3	4-9	4-3	4-0	3-3	3-2
		60,000	7-6	8-0	6-1	6-4	5-8	5-1	4-9	3-8	3-6
	2-#4 1-#6	40,000	7-0	7-6	5-8	5-11	5-3	4-9	4-5	3-8	3-6
		60,000	DR	DR	DR	DR	DR	DR	DR	DR	DR
	Center distance A[k, l]		1-7	1-10	1-1	1-2	0-11	0-9	0-8	0-5	0-5
12	Span without stirrups[i, j]		4-2	4-8	3-5	3-6	3-2	2-11	2-9	2-5	2-4
	1-#4	40,000	5-7	6-1	4-8	4-10	4-4	3-11	3-8	3-0	2-11
		60,000	7-9	8-6	6-6	6-9	6-1	5-6	5-1	4-3	4-1
	1-#5	40,000	7-11	8-8	6-8	6-11	6-2	5-7	5-2	4-4	4-2
		60,000	9-7	10-6	8-0	8-4	7-6	6-9	6-3	5-2	5-1
	2-#4 1-#6	40,000	8-11	9-9	7-6	7-9	6-11	6-3	5-10	4-10	4-8
		60,000	10-8	11-9	8-12	9-4	8-4	7-6	7-0	5-10	5-8
	2-#5	40,000	10-11	12-0	9-2	9-6	8-6	7-8	7-2	5-6	5-3
		60,000	12-11	14-3	10-10	11-3	10-1	9-0	8-1	6-1	5-10
	2-#6	40,000	12-9	14-0	10-8	11-1	9-7	8-1	7-3	5-6	5-3
		60,000	DR	DR	DR	DR	DR	DR	DR	DR	DR
	Center distance A[k, l]		2-6	3-0	1-9	1-10	1-6	1-3	1-1	0-9	0-8
16	Span without stirrups[i, j]		5-7	6-5	4-9	4-11	4-5	4-0	3-10	3-4	3-4
	1-#4	40,000	6-5	7-2	5-6	5-9	5-2	4-8	4-4	3-7	3-6
		60,000	7-10	8-9	6-9	7-0	6-3	5-8	5-3	4-4	4-3
	1-#5	40,000	7-11	8-11	6-10	7-1	6-5	5-9	5-4	4-5	4-4
		60,000	11-1	12-6	9-7	9-11	8-11	8-0	7-6	6-2	6-0
	2-#4 1-#6	40,000	10-3	11-7	8-10	9-2	8-3	7-6	6-11	5-9	5-7
		60,000	12-5	14-0	10-9	11-1	10-0	9-0	8-5	7-0	6-9
	2-#5	40,000	12-8	14-3	10-11	11-4	10-2	9-2	8-7	6-9	6-6
		60,000	15-2	17-1	13-1	13-7	12-3	11-0	10-3	7-11	7-7
	2-#6	40,000	14-11	16-9	12-8	13-4	11-4	9-8	8-8	6-9	6-6
		60,000	DR	DR	DR	DR	DR	DR	DR	DR	DR
	Center distance A[k, l]		3-3	4-1	2-5	2-7	2-1	1-9	1-6	1-0	1-0

(continued)

TABLE R608.8(3)—continued
MAXIMUM ALLOWABLE CLEAR SPANS FOR 6-INCH-NOMINAL THICK FLAT LINTELS IN LOAD-BEARING WALLS[a, b, c, d, e, f, m]
ROOF CLEAR SPAN 40 FEET AND FLOOR CLEAR SPAN 32 FEET

LINTEL DEPTH, D[g] (inches)	NUMBER OF BARS AND BAR SIZE IN TOP AND BOTTOM OF LINTEL	STEEL YIELD STRENGTH[h], f_y (psi)	DESIGN LOADING CONDITION DETERMINED FROM Table R608.8(1)								
			1	2		3		4		5	
			Maximum ground snow load (psf)								
			—	30	70	30	70	30	70	30	70
			Maximum clear span of lintel (feet-inches)								
20	Span without stirrups[i, j]		6-11	8-2	6-1	6-3	5-8	5-2	4-11	4-4	4-3
	1-#5	40,000	8-9	10-1	7-9	8-0	7-3	6-6	6-1	5-1	4-11
		60,000	10-8	12-3	9-5	9-9	8-10	8-0	7-5	6-2	6-0
	2-#4 1-#6	40,000	9-11	11-4	8-9	9-1	8-2	7-4	6-10	5-8	5-7
		60,000	13-9	15-10	12-2	12-8	11-5	10-3	9-7	7-11	7-9
	2-#5	40,000	14-0	16-2	12-5	12-11	11-7	10-6	9-9	7-11	7-8
		60,000	16-11	19-6	15-0	15-6	14-0	12-7	11-9	9-1	8-9
	2-#6	40,000	16-7	19-1	14-7	15-3	13-1	11-3	10-2	7-11	7-8
		60,000	19-11	22-10	17-4	18-3	15-6	13-2	11-10	9-1	8-9
	Center distance A[k, l]		3-11	5-2	3-1	3-3	2-8	2-2	1-11	1-4	1-3
24	Span without stirrups[i, j]		8-2	9-10	7-4	7-8	6-11	6-4	5-11	5-3	5-2
	1-#5	40,000	9-5	11-1	8-7	8-10	8-0	7-3	6-9	5-7	5-5
		60,000	11-6	13-6	10-5	10-9	9-9	8-9	8-2	6-10	6-8
	2-#4 1-#6	40,000	10-8	12-6	9-8	10-0	9-0	8-2	7-7	6-4	6-2
		60,000	12-11	15-2	11-9	12-2	11-0	9-11	9-3	7-8	7-6
	2-#5	40,000	15-2	17-9	13-9	14-3	12-10	11-7	10-10	9-0	8-9
		60,000	18-4	21-6	16-7	17-3	15-6	14-0	13-1	10-4	10-0
	2-#6	40,000	18-0	21-1	16-4	16-11	14-10	12-9	11-8	9-2	8-11
		60,000	21-7	25-4	19-2	20-4	17-2	14-9	13-4	10-4	10-0
	Center distance A[k, l]		4-6	6-2	3-8	4-0	3-3	2-8	2-3	1-7	1-6

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kPa, Grade 40 = 280 MPa, Grade 60 = 420 MPa.

a. See Table R608.3 for tolerances permitted from nominal thickness.

b. Table values are based on concrete with a minimum specified compressive strength of 2,500 psi. See Note j.

c. Table values are based on uniform loading. See Section R608.8.2 for lintels supporting concentrated loads.

d. Deflection criterion is $L/240$, where L is the clear span of the lintel in inches, or $^1/_2$ inch, whichever is less.

e. Linear interpolation is permitted between ground snow loads and between lintel depths.

f. DR indicates design required.

g. Lintel depth, D, is permitted to include the available height of wall located directly above the lintel, provided that the increased lintel depth spans the entire length of the lintel.

h. Stirrups shall be fabricated from reinforcing bars with the same yield strength as that used for the main longitudinal reinforcement.

i. Allowable clear span without stirrups applicable to all lintels of the same depth, D. Top and bottom reinforcement for lintels without stirrups shall be not less than the least amount of reinforcement required for a lintel of the same depth and loading condition with stirrups. All other spans require stirrups spaced at not more than $d/2$.

j. Where concrete with a minimum specified compressive strength of 3,000 psi is used, clear spans for lintels without stirrups shall be permitted to be multiplied by 1.05. If the increased span exceeds the allowable clear span for a lintel of the same depth and loading condition with stirrups, the top and bottom reinforcement shall be equal to or greater than that required for a lintel of the same depth and loading condition that has an allowable clear span that is equal to or greater than that of the lintel without stirrups that has been increased.

k. Center distance, A, is the center portion of the clear span where stirrups are not required. This is applicable to all longitudinal bar sizes and steel yield strengths.

l. Where concrete with a minimum specified compressive strength of 3,000 psi is used, center distance, A, shall be permitted to be multiplied by 1.10.

m. The maximum clear opening width between two solid wall segments shall be 18 feet. See Section R608.7.2.1. Lintel clear spans in the table greater than 18 feet are shown for interpolation and information only.

TABLE R608.8(4)
MAXIMUM ALLOWABLE CLEAR SPANS FOR 8-INCH-NOMINAL THICK FLAT LINTELS IN LOAD-BEARING WALLS[a, b, c, d, e, f, m]
ROOF CLEAR SPAN 40 FEET AND FLOOR CLEAR SPAN 32 FEET

LINTEL DEPTH, D[g] (inches)	NUMBER OF BARS AND BAR SIZE IN TOP AND BOTTOM OF LINTEL	STEEL YIELD STRENGTH[h], f_y (psi)	DESIGN LOADING CONDITION DETERMINED FROM Table R608.8(1)								
			1	2		3		4		5	
			Maximum ground snow load (psf)								
			—	30	70	30	70	30	70	30	70
			Maximum clear span of lintel (feet-inches)								
8	Span without stirrups[i, j]		4-4	4-9	3-7	3-9	3-4	2-10	2-7	2-1	2-0
	1-#4	40,000	4-4	4-9	3-7	3-9	3-4	2-11	2-9	2-3	2-2
		60,000	6-1	6-7	5-0	5-3	4-8	4-0	3-9	3-1	3-0
	1-#5	40,000	6-2	6-9	5-2	5-4	4-9	4-1	3-10	3-2	3-1
		60,000	7-5	8-1	6-2	6-5	5-9	4-11	4-7	3-9	3-8
	2-#4 1-#6	40,000	6-11	7-6	5-9	6-0	5-4	4-7	4-4	3-6	3-5
		60,000	8-3	9-0	6-11	7-2	6-5	5-6	5-2	4-2	4-1
	2-#5	40,000	8-5	9-2	7-0	7-3	6-6	5-7	5-3	4-2	4-0
		60,000	DR	DR	DR	DR	DR	DR	DR	DR	DR
	Center distance A[k, l]		2-1	2-6	1-5	1-6	1-3	0-11	0-10	0-6	0-6
12	Span without stirrups[i, j]		4-10	5-8	4-0	4-2	3-9	3-2	3-0	2-7	2-6
	1-#4	40,000	5-5	6-1	4-8	4-10	4-4	3-9	3-6	2-10	2-10
		60,000	6-7	7-5	5-8	5-11	5-4	4-7	4-3	3-6	3-5
	1-#5	40,000	6-9	7-7	5-9	6-0	5-5	4-8	4-4	3-7	3-6
		60,000	9-4	10-6	8-1	8-4	7-6	6-6	6-1	5-0	4-10
	2-#4 1-#6	40,000	8-8	9-9	7-6	7-9	7-0	6-0	5-8	4-7	4-6
		60,000	10-6	11-9	9-1	9-5	8-5	7-3	6-10	5-7	5-5
	2-#5	40,000	10-8	12-0	9-3	9-7	8-7	7-5	6-11	5-6	5-4
		60,000	12-10	14-5	11-1	11-6	10-4	8-11	8-4	6-7	6-4
	2-#6	40,000	12-7	14-2	10-10	11-3	10-2	8-3	7-6	5-6	5-4
		60,000	DR	DR	DR	DR	DR	DR	DR	DR	DR
	Center distance A[k, l]		3-2	4-0	2-4	2-6	2-0	1-6	1-4	0-11	0-10
16	Span without stirrups[i, j]		6-5	7-9	5-7	5-10	5-2	4-5	4-2	3-7	3-6
	1-#4	40,000	6-2	7-1	5-6	5-8	5-1	4-5	4-2	3-5	3-4
		60,000	7-6	8-8	6-8	6-11	6-3	5-5	5-1	4-2	4-0
	1-#5	40,000	7-8	8-10	6-10	7-1	6-4	5-6	5-2	4-3	4-1
		60,000	9-4	10-9	8-4	8-7	7-9	6-8	6-3	5-2	5-0
	2-#4 1-#6	40,000	8-8	10-0	7-8	8-0	7-2	6-2	5-10	4-9	4-8
		60,000	12-0	13-11	10-9	11-2	10-0	8-8	8-1	6-8	6-6
	2-#5	40,000	12-3	14-2	11-0	11-4	10-3	8-10	8-3	6-9	6-7
		60,000	14-10	17-2	13-3	13-8	12-4	10-8	10-0	7-11	7-8
	2-#6	40,000	14-6	16-10	13-0	13-5	12-1	10-1	9-2	6-11	6-8
		60,000	17-5	20-2	15-7	16-1	14-6	11-10	10-8	7-11	7-8
	Center distance A[k, l]		4-1	5-5	3-3	3-6	2-10	2-1	1-10	1-3	1-2

(continued)

TABLE R608.8(4)—continued
MAXIMUM ALLOWABLE CLEAR SPANS FOR 8-INCH-NOMINAL THICK FLAT LINTELS IN LOAD-BEARING WALLS[a, b, c, d, e, f, m]
ROOF CLEAR SPAN 40 FEET AND FLOOR CLEAR SPAN 32 FEET

LINTEL DEPTH, D[g] (inches)	NUMBER OF BARS AND BAR SIZE IN TOP AND BOTTOM OF LINTEL	STEEL YIELD STRENGTH[h], f_y (psi)	DESIGN LOADING CONDITION DETERMINED FROM Table R608.8(1)								
			1	2		3		4		5	
			Maximum ground snow load (psf)								
			—	30	70	30	70	30	70	30	70
			Maximum clear span of lintel (feet-inches)								
20	Span without stirrups[i, j]		7-10	9-10	7-1	7-5	6-7	5-8	5-4	4-7	4-6
	1-#5	40,000	8-4	9-11	7-8	8-0	7-2	6-3	5-10	4-9	4-8
		60,000	10-2	12-1	9-5	9-9	8-9	7-7	7-1	5-10	5-8
	2-#4 1-#6	40,000	9-5	11-3	8-8	9-0	8-1	7-0	6-7	5-5	5-3
		60,000	11-6	13-8	10-7	11-0	9-11	8-7	8-0	6-7	6-5
	2-#5	40,000	11-9	13-11	10-10	11-2	10-1	8-9	8-2	6-8	6-7
		60,000	16-4	19-5	15-0	15-7	14-0	12-2	11-4	9-3	9-0
	2-#6	40,000	16-0	19-0	14-9	15-3	13-9	11-10	10-10	8-3	8-0
		60,000	19-3	22-11	17-9	18-5	16-7	13-7	12-4	9-3	9-0
	Center distance A[k, l]		4-10	6-10	4-1	4-5	3-7	2-8	2-4	1-7	1-6
24	Span without stirrups[i, j]		9-2	11-9	8-7	8-11	8-0	6-11	6-6	5-7	5-6
	1-#5	40,000	8-11	10-10	8-6	8-9	7-11	6-10	6-5	5-3	5-2
		60,000	10-11	13-3	10-4	10-8	9-8	8-4	7-10	6-5	6-3
	2-#4 1-#6	40,000	10-1	12-3	9-7	9-11	8-11	7-9	7-3	6-0	5-10
		60,000	12-3	15-0	11-8	12-1	10-11	9-5	8-10	7-3	7-1
	2-#5	40,000	12-6	15-3	11-11	12-4	11-1	9-7	9-0	7-5	7-3
		60,000	17-6	21-3	16-7	17-2	15-6	13-5	12-7	10-4	10-1
	2-#6	40,000	17-2	20-11	16-3	16-10	15-3	13-2	12-4	9-7	9-4
		60,000	20-9	25-3	19-8	20-4	18-5	15-4	14-0	10-7	10-3
	Center distance A[k, l]		5-6	8-1	4-11	5-3	4-4	3-3	2-10	1-11	1-10

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kPa, Grade 40 = 280 MPa, Grade 60 = 420 MPa.

Note: Top and bottom reinforcement for lintels without stirrups, as shown in shaded cells, shall be equal to or greater than that required for lintel of the same depth and loading condition that has an allowable clear span that is equal to or greater than that of the lintel without stirrups.

a. See Table R608.3 for tolerances permitted from nominal thickness.

b. Table values are based on concrete with a minimum specified compressive strength of 2,500 psi. See Note j.

c. Table values are based on uniform loading. See Section R608.8.2 for lintels supporting concentrated loads.

d. Deflection criterion is $L/240$, where L is the clear span of the lintel in inches, or $^1/_2$ inch, whichever is less.

e. Linear interpolation is permitted between ground snow loads and between lintel depths.

f. DR indicates design required.

g. Lintel depth, D, is permitted to include the available height of wall located directly above the lintel, provided that the increased lintel depth spans the entire length of the lintel.

h. Stirrups shall be fabricated from reinforcing bars with the same yield strength as that used for the main longitudinal reinforcement.

i. Allowable clear span without stirrups applicable to all lintels of the same depth, D. Top and bottom reinforcement for lintels without stirrups shall be not less than the least amount of reinforcement required for a lintel of the same depth and loading condition with stirrups. All other spans require stirrups spaced at not more than $d/2$.

j. Where concrete with a minimum specified compressive strength of 3,000 psi is used, clear spans for lintels without stirrups shall be permitted to be multiplied by 1.05. If the increased span exceeds the allowable clear span for a lintel of the same depth and loading condition with stirrups, the top and bottom reinforcement shall be equal to or greater than that required for a lintel of the same depth and loading condition that has an allowable clear span that is equal to or greater than that of the lintel without stirrups that has been increased.

k. Center distance, A, is the center portion of the clear span where stirrups are not required. This is applicable to all longitudinal bar sizes and steel yield strengths.

l. Where concrete with a minimum specified compressive strength of 3,000 psi is used, center distance, A, shall be permitted to be multiplied by 1.10.

m. The maximum clear opening width between two solid wall segments shall be 18 feet. See Section R608.7.2.1. Lintel clear spans in the table greater than 18 feet are shown for interpolation and information only.

TABLE R608.8(5)
MAXIMUM ALLOWABLE CLEAR SPANS FOR 10-INCH-NOMINAL THICK FLAT LINTELS IN LOAD-BEARING WALLS[a, b, c, d, e, f, m]
ROOF CLEAR SPAN 40 FEET AND FLOOR CLEAR SPAN 32 FEET

LINTEL DEPTH, D[g] (inches)	NUMBER OF BARS AND BAR SIZE IN TOP AND BOTTOM OF LINTEL	STEEL YIELD STRENGTH[h], f_y (psi)	DESIGN LOADING CONDITION DETERMINED FROM Table R608.8(1)								
			1	2		3		4		5	
			Maximum ground snow load (psf)								
			—	30	70	30	70	30	70	30	70
			Maximum clear span of lintel (feet-inches)								
8	Span without stirrups[i, j]		6-0	7-2	4-7	4-10	4-1	3-1	2-11	2-3	2-2
	1-#4	40,000	4-3	4-9	3-7	3-9	3-4	2-9	2-7	2-1	2-1
		60,000	5-11	6-7	5-0	5-3	4-8	3-10	3-8	2-11	2-11
	1-#5	40,000	6-1	6-9	5-2	5-4	4-9	3-11	3-9	3-0	2-11
		60,000	7-4	8-1	6-3	6-5	5-9	4-9	4-6	3-7	3-7
	2-#4 1-#6	40,000	6-10	7-6	5-9	6-0	5-5	4-5	4-2	3-4	3-4
		60,000	8-2	9-1	6-11	7-2	6-6	5-4	5-0	4-1	4-0
	2-#5	40,000	8-4	9-3	7-1	7-4	6-7	5-5	5-1	4-1	4-0
		60,000	9-11	11-0	8-5	8-9	7-10	6-6	6-1	4-8	4-6
	2-#6	40,000	9-9	10-10	8-3	8-7	7-9	6-4	5-10	4-1	4-0
		60,000	DR	DR	DR	DR	DR	DR	DR	DR	DR
	Center distance A[k, l]		2-6	3-1	1-10	1-11	1-7	1-1	0-11	0-7	0-7
12	Span without stirrups[i, j]		5-5	6-7	4-7	4-10	4-3	3-5	3-3	2-8	2-8
	1-#4	40,000	5-3	6-0	4-8	4-10	4-4	3-7	3-4	2-9	2-8
		60,000	6-5	7-4	5-8	5-10	5-3	4-4	4-1	3-4	3-3
	1-#5	40,000	6-6	7-6	5-9	6-0	5-5	4-5	4-2	3-5	3-4
		60,000	7-11	9-1	7-0	7-3	6-7	5-5	5-1	4-2	4-0
	2-#4 1-#6	40,000	7-4	8-5	6-6	6-9	6-1	5-0	4-9	3-10	3-9
		60,000	10-3	11-9	9-1	9-5	8-6	7-0	6-7	5-4	5-3
	2-#5	40,000	10-5	12-0	9-3	9-7	8-8	7-2	6-9	5-5	5-4
		60,000	12-7	14-5	11-2	11-6	10-5	8-7	8-1	6-6	6-4
	2-#6	40,000	12-4	14-2	10-11	11-4	10-2	8-5	7-8	5-7	5-5
		60,000	14-9	17-0	13-1	13-6	12-2	10-0	9-1	6-6	6-4
	Center distance A[k, l]		3-9	4-11	2-11	3-2	2-7	1-9	1-7	1-0	1-0
16	Span without stirrups[i, j]		7-1	9-0	6-4	6-8	5-10	4-9	4-6	3-9	3-8
	1-#4	40,000	5-11	7-0	5-5	5-8	5-1	4-3	4-0	3-3	3-2
		60,000	7-3	8-7	6-8	6-11	6-3	5-2	4-10	3-11	3-10
	1-#5	40,000	7-4	8-9	6-9	7-0	6-4	5-3	4-11	4-0	3-11
		60,000	9-0	10-8	8-3	8-7	7-9	6-5	6-0	4-11	4-9
	2-#4 1-#6	40,000	8-4	9-11	7-8	7-11	7-2	5-11	5-7	4-6	4-5
		60,000	10-2	12-0	9-4	9-8	8-9	7-3	6-10	5-6	5-5
	2-#5	40,000	10-4	12-3	9-6	9-10	8-11	7-4	6-11	5-8	5-6
		60,000	14-4	17-1	13-3	13-8	12-4	10-3	9-8	7-10	7-8
	2-#6	40,000	14-1	16-9	13-0	13-5	12-2	10-1	9-6	7-0	6-10
		60,000	17-0	20-2	15-8	16-2	14-7	12-0	10-11	8-0	7-9
	Center distance A[k, l]		4-9	6-8	4-0	4-4	3-6	2-5	2-2	1-5	1-4

(continued)

TABLE R608.8(5)—continued
MAXIMUM ALLOWABLE CLEAR SPANS FOR 10-INCH-NOMINAL THICK FLAT LINTELS IN LOAD-BEARING WALLS[a, b, c, d, e, f, m]
ROOF CLEAR SPAN 40 FEET AND FLOOR CLEAR SPAN 32 FEET

LINTEL DEPTH, D[g] (inches)	NUMBER OF BARS AND BAR SIZE IN TOP AND BOTTOM OF LINTEL	STEEL YIELD STRENGTH[h], f_y (psi)	DESIGN LOADING CONDITION DETERMINED FROM Table R608.8(1)								
			1	2		3		4		5	
			Maximum ground snow load (psf)								
			—	30	70	30	70	30	70	30	70
			Maximum clear span of lintel (feet-inches)								
20	Span without stirrups[i, j]		8-7	11-4	8-1	8-5	7-5	6-1	5-9	4-10	4-9
	1-#4	40,000	6-5	7-10	6-2	6-4	5-9	4-9	4-6	3-8	3-7
		60,000	7-10	9-7	7-6	7-9	7-0	5-10	5-6	4-5	4-4
	1-#5	40,000	8-0	9-9	7-8	7-11	7-2	5-11	5-7	4-6	4-5
		60,000	9-9	11-11	9-4	9-8	8-9	7-3	6-10	5-6	5-5
	2-#4 1-#6	40,000	9-0	11-1	8-8	8-11	8-1	6-9	6-4	5-2	5-0
		60,000	11-0	13-6	10-6	10-11	9-10	8-2	7-9	6-3	6-2
	2-#5	40,000	11-3	13-9	10-9	11-1	10-0	8-4	7-10	6-5	6-3
		60,000	15-8	19-2	15-0	15-6	14-0	11-8	11-0	8-11	8-9
	2-#6	40,000	15-5	18-10	14-8	15-2	13-9	11-5	10-9	8-6	8-3
		60,000	18-7	22-9	17-9	18-5	16-7	13-10	12-9	9-5	9-2
	Center distance A[k, l]		5-7	8-4	5-1	5-5	4-5	3-1	2-9	1-10	1-9
24	Span without stirrups[i, j]		9-11	13-7	9-9	10-2	9-0	7-5	7-0	5-10	5-9
	1-#5	40,000	8-6	10-8	8-5	8-8	7-10	6-6	6-2	5-0	4-11
		60,000	10-5	13-0	10-3	10-7	9-7	8-0	7-6	6-1	6-0
	2-#4 1-#6	40,000	9-7	12-1	9-6	9-9	8-10	7-5	7-0	5-8	5-6
		60,000	11-9	14-9	11-7	11-11	10-10	9-0	8-6	6-11	6-9
	2-#5	40,000	12-0	15-0	11-9	12-2	11-0	9-2	8-8	7-1	6-11
		60,000	14-7	18-3	14-4	14-10	13-5	11-2	10-7	8-7	8-5
	2-#6	40,000	14-3	17-11	14-1	14-7	13-2	11-0	10-4	8-5	8-3
		60,000	19-11	25-0	19-7	20-3	18-4	15-3	14-5	10-10	10-7
	Center distance A[k, l]		6-3	9-11	6-1	6-6	5-4	3-9	3-4	2-2	2-1

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kPa, Grade 40 = 280 MPa, Grade 60 = 420 MPa.

Note: Top and bottom reinforcement for lintels without stirrups, as shown in shaded cells, shall be equal to or greater than that required for lintel of the same depth and loading condition that has an allowable clear span that is equal to or greater than that of the lintel without stirrups.

a. See Table R608.3 for tolerances permitted from nominal thickness.

b. Table values are based on concrete with a minimum specified compressive strength of 2,500 psi. See Note j.

c. Table values are based on uniform loading. See Section R608.8.2 for lintels supporting concentrated loads.

d. Deflection criterion is $L/240$, where L is the clear span of the lintel in inches, or $^1/_2$ inch, whichever is less.

e. Linear interpolation is permitted between ground snow loads and between lintel depths.

f. DR indicates design required.

g. Lintel depth, D, is permitted to include the available height of wall located directly above the lintel, provided that the increased lintel depth spans the entire length of the lintel.

h. Stirrups shall be fabricated from reinforcing bars with the same yield strength as that used for the main longitudinal reinforcement.

i. Allowable clear span without stirrups applicable to all lintels of the same depth, D. Top and bottom reinforcement for lintels without stirrups shall be not less than the least amount of reinforcement required for a lintel of the same depth and loading condition with stirrups. All other spans require stirrups spaced at not more than $d/2$.

j. Where concrete with a minimum specified compressive strength of 3,000 psi is used, clear spans for lintels without stirrups shall be permitted to be multiplied by 1.05. If the increased span exceeds the allowable clear span for a lintel of the same depth and loading condition with stirrups, the top and bottom reinforcement shall be equal to or greater than that required for a lintel of the same depth and loading condition that has an allowable clear span that is equal to or greater than that of the lintel without stirrups that has been increased.

k. Center distance, A, is the center portion of the clear span where stirrups are not required. This is applicable to all longitudinal bar sizes and steel yield strengths.

l. Where concrete with a minimum specified compressive strength of 3,000 psi is used, center distance, A, shall be permitted to be multiplied by 1.10.

m. The maximum clear opening width between two solid wall segments shall be 18 feet. See Section R608.7.2.1. Lintel clear spans in the table greater than 18 feet are shown for interpolation and information only.

TABLE R608.8(6)
MAXIMUM ALLOWABLE CLEAR SPANS FOR 6-INCH-THICK WAFFLE-GRID LINTELS IN LOAD-BEARING WALLS[a, b, c, d, e, f, o]
MAXIMUM ROOF CLEAR SPAN 40 FEET AND MAXIMUM FLOOR SPAN 32 FEET

LINTEL DEPTH, D[g] (inches)	NUMBER OF BARS AND BAR SIZE IN TOP AND BOTTOM OF LINTEL	STEEL YIELD STRENGTH[h], f_y (psi)	DESIGN LOADING CONDITION DETERMINED FROM Table R608.8(1)								
			1	2		3		4		5	
			Maximum ground snow load (psf)								
			—	30	70	30	70	30	70	30	70
			Maximum clear span of lintel (feet-inches)								
8[i]	Span without stirrups[k, l]		2-7	2-9	2-0	2-1	2-0	2-0	2-0	2-0	2-0
	1-#4	40,000	5-2	5-5	4-0	4-3	3-7	3-3	2-11	2-4	2-3
		60,000	5-9	6-3	4-0	4-3	3-7	3-3	2-11	2-4	2-3
	1-#5	40,000	5-9	6-3	4-0	4-3	3-7	3-3	2-11	2-4	2-3
		60,000	5-9	6-3	4-0	4-3	3-7	3-3	2-11	2-4	2-3
	2-#4 1-#6	40,000	5-9	6-3	4-0	4-3	3-7	3-3	2-11	2-4	2-3
		60,000	DR	DR	DR	DR	DR	DR	DR	DR	DR
	Center distance A[m, n]		0-9	0-10	0-6	0-6	0-5	0-5	0-4	STL	STL
12[i]	Span without stirrups[k, l]		2-11	3-1	2-6	2-7	2-5	2-4	2-3	2-1	2-0
	1-#4	40,000	5-9	6-2	4-8	4-10	4-4	4-1	3-9	3-2	3-1
		60,000	8-0	8-7	6-6	6-9	6-0	5-5	4-11	3-11	3-10
	1-#5	40,000	8-1	8-9	6-8	6-11	6-0	5-5	4-11	3-11	3-10
		60,000	9-1	10-3	6-8	7-0	6-0	5-5	4-11	3-11	3-10
	2-#4 1-#6	40,000	9-1	9-9	6-8	7-0	6-0	5-5	4-11	3-11	3-10
	Center distance A[m, n]		1-3	1-5	0-10	0-11	0-9	0-8	0-6	STL	STL
	Span without stirrups[k, l]		4-0	4-4	3-6	3-7	3-4	3-3	3-1	2-10	2-10
16[i]	1-#4	40,000	6-7	7-3	5-6	5-9	5-2	4-10	4-6	3-9	3-8
		60,000	8-0	8-10	6-9	7-0	6-3	5-11	5-5	4-7	4-5
	1-#5	40,000	8-2	9-0	6-11	7-2	6-5	6-0	5-7	4-8	4-6
		60,000	11-5	12-6	9-3	9-9	8-4	7-7	6-10	5-6	5-4
	2-#4 1-#6	40,000	10-7	11-7	8-11	9-3	8-3	7-7	6-10	5-6	5-4
		60,000	12-2	14-0	9-3	9-9	8-4	7-7	6-10	5-6	5-4
	2-#5	40,000	12-2	14-2	9-3	9-9	8-4	7-7	6-10	5-6	5-4
		60,000	DR	DR	DR	DR	DR	DR	DR	DR	DR
	Center distance A[m, n]		1-8	2-0	1-2	1-3	1-0	0-11	0-9	STL	STL
20[i]	Span without stirrups[k, l]		5-0	5-6	4-6	4-7	4-3	4-1	4-0	3-8	3-8
	1-#4	40,000	7-2	8-2	6-3	6-6	5-10	5-6	5-1	4-3	4-2
		60,000	8-11	9-11	7-8	7-11	7-1	6-8	6-2	5-2	5-0
	1-#5	40,000	9-1	10-2	7-9	8-1	7-3	6-10	6-4	5-4	5-2
		60,000	12-8	14-2	10-11	11-3	10-2	9-6	8-9	7-1	6-10
	2-#4 1-#6	40,000	10-3	11-5	8-9	9-1	8-2	7-8	7-1	6-0	5-10
		60,000	14-3	15-11	11-9	12-5	10-8	9-9	8-9	7-1	6-10
	2-#5	40,000	14-6	16-3	11-6	12-1	10-4	9-6	8-6	6-11	6-8
		60,000	DR	DR	DR	DR	DR	DR	DR	DR	DR
	Center distance A[m, n]		2-0	2-6	1-6	1-7	1-3	1-1	1-0	STL	STL

(continued)

TABLE R608.8(6)—continued
MAXIMUM ALLOWABLE CLEAR SPANS FOR 6-INCH-THICK WAFFLE-GRID LINTELS IN LOAD-BEARING WALLS[a, b, c, d, e, f, o]
MAXIMUM ROOF CLEAR SPAN 40 FEET AND MAXIMUM FLOOR SPAN 32 FEET

LINTEL DEPTH, D[g] (inches)	NUMBER OF BARS AND BAR SIZE IN TOP AND BOTTOM OF LINTEL	STEEL YIELD STRENGTH[h], f_y (psi)	DESIGN LOADING CONDITION DETERMINED FROM Table R608.8(1)								
			1	2		3		4		5	
			Maximum ground snow load (psf)								
			—	30	70	30	70	30	70	30	70
			Maximum clear span of lintel (feet-inches)								
24w[j]	Span without stirrups[k, l]		6-0	6-8	5-5	5-7	5-3	5-0	4-10	4-6	4-5
	1-#4	40,000	7-11	9-0	6-11	7-2	6-5	6-0	5-7	4-8	4-7
		60,000	9-8	10-11	8-5	8-9	7-10	7-4	6-10	5-9	5-7
	1-#5	40,000	9-10	11-2	8-7	8-11	8-0	7-6	7-0	5-10	5-8
		60,000	12-0	13-7	10-6	10-10	9-9	9-2	8-6	7-2	6-11
	2-#4 1-#6	40,000	11-1	12-7	9-8	10-1	9-1	8-6	7-10	6-7	6-5
		60,000	15-6	17-7	13-6	14-0	12-8	11-10	10-8	8-7	8-4
	2-#5	40,000	15-6	17-11	12-8	13-4	11-6	10-7	9-7	7-10	7-7
		60,000	DR	DR	DR	DR	DR	DR	DR	DR	DR
	Center distance A[m, n]		2-4	3-0	1-9	1-11	1-6	1-4	1-2	STL	STL

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kPa, Grade 40 = 280 MPa, Grade 60 = 420 MPa.

a. Where lintels are formed with waffle-grid forms, form material shall be removed, if necessary, to create top and bottom flanges of the lintel that are not less than 3 inches in depth (in the vertical direction), are not less than 5 inches in width for 6-inch-nominal waffle-grid forms and not less than 7 inches in width for 8-inch-nominal waffle-grid forms. See Figure R608.8(3). Flat form lintels shall be permitted in place of waffle-grid lintels. See Tables R608.8(2) through R608.8(5).

b. See Table R608.3 for tolerances permitted from nominal thicknesses and minimum dimensions and spacing of cores.

c. Table values are based on concrete with a minimum specified compressive strength of 2,500 psi. See Notes l and n. Table values are based on uniform loading. See Section R608.8.2 for lintels supporting concentrated loads.

d. Deflection criterion is $L/240$, where L is the clear span of the lintel in inches, or $^1/_2$ inch, whichever is less.

e. Linear interpolation is permitted between ground snow loads.

f. DR indicates design required. STL indicates stirrups required throughout lintel.

g. Lintel depth, D, is permitted to include the available height of wall located directly above the lintel, provided that the increased lintel depth spans the entire length of the lintel.

h. Stirrups shall be fabricated from reinforcing bars with the same yield strength as that used for the main longitudinal reinforcement.

i. Lintels less than 24 inches in depth with stirrups shall be formed from flat-wall forms [see Tables R608.8(2) through R608.8(5)], or, if necessary, form material shall be removed from waffle-grid forms so as to provide the required cover for stirrups. Allowable spans for lintels formed with flat-wall forms shall be determined from Tables R608.8(2) through R608.8(5).

j. Where stirrups are required for 24-inch-deep lintels, the spacing shall not exceed 12 inches on center.

k. Allowable clear span without stirrups applicable to all lintels of the same depth, D. Top and bottom reinforcement for lintels without stirrups shall be not less than the least amount of reinforcement required for a lintel of the same depth and loading condition with stirrups. All other spans require stirrups spaced at not more than $d/2$.

l. Where concrete with a minimum specified compressive strength of 3,000 psi is used, clear spans for lintels without stirrups shall be permitted to be multiplied by 1.05. If the increased span exceeds the allowable clear span for a lintel of the same depth and loading condition with stirrups, the top and bottom reinforcement shall be equal to or greater than that required for a lintel of the same depth and loading condition that has an allowable clear span that is equal to or greater than that of the lintel without stirrups that has been increased.

m. Center distance, A, is the center portion of the span where stirrups are not required. This is applicable to all longitudinal bar sizes and steel yield strengths.

n. Where concrete with a minimum specified compressive strength of 3,000 psi is used, center distance, A, shall be permitted to be multiplied by 1.10.

o. The maximum clear opening width between two solid wall segments shall be 18 feet. See Section R608.7.2.1. Lintel spans in the table greater than 18 feet are shown for interpolation and information only.

TABLE R608.8(7)
MAXIMUM ALLOWABLE CLEAR SPANS FOR 8-INCH-THICK WAFFLE-GRID LINTELS IN LOAD-BEARING WALLS[a, b, c, d, e, f, o]
MAXIMUM ROOF CLEAR SPAN 40 FEET AND MAXIMUM FLOOR CLEAR SPAN 32 FEET

LINTEL DEPTH, D[g] (inches)	NUMBER OF BARS AND BAR SIZE IN TOP AND BOTTOM OF LINTEL	STEEL YIELD STRENGTH[h], f_y (psi)	DESIGN LOADING CONDITION DETERMINED FROM Table R608.8(1)								
			1	2		3		4		5	
			Maximum ground snow load (psf)								
			—	30	70	30	70	30	70	30	70
			Maximum clear span of lintel (feet-inches)								
8[i]	Span without stirrups[k, l]		2-6	2-9	2-0	2-1	2-0	2-0	2-0	2-0	2-0
	1-#4	40,000	4-5	4-9	3-7	3-9	3-4	3-0	2-10	2-3	2-2
		60,000	5-6	6-2	4-0	4-3	3-7	3-1	2-10	2-3	2-2
	1-#5	40,000	5-6	6-2	4-0	4-3	3-7	3-1	2-10	2-3	2-2
	Center distance A[m, n]		0-9	0-10	0-6	0-6	0-5	0-4	0-4	STL	STL
12[i]	Span without stirrups[k, l]		2-10	3-1	2-6	2-7	2-5	2-3	2-2	2-0	2-0
	1-#4	40,000	5-7	6-1	4-8	4-10	4-4	3-11	3-8	3-0	2-11
		60,000	6-9	7-5	5-8	5-11	5-4	4-9	4-5	3-8	3-7
	1-#5	40,000	6-11	7-7	5-10	6-0	5-5	4-10	4-6	3-9	3-7
		60,000	8-8	10-1	6-7	7-0	5-11	5-2	4-8	3-9	3-7
	2-#4	40,000	8-8	9-10	6-7	7-0	5-11	5-2	4-8	3-9	3-7
	1-#6	60,000	8-8	10-1	6-7	7-0	5-11	5-2	4-8	3-9	3-7
	Center distance A[m, n]		1-2	1-5	0-10	0-11	0-9	0-7	0-6	STL	STL
16[i]	Span without stirrups[k, l]		3-10	4-3	3-6	3-7	3-4	3-2	3-0	2-10	2-9
	1-#4	40,000	6-5	7-2	5-6	5-9	5-2	4-8	4-4	3-7	3-6
		60,000	7-9	8-9	6-9	7-0	6-3	5-8	5-3	4-4	4-3
	1-#5	40,000	7-11	8-11	6-10	7-1	6-5	5-9	5-4	4-5	4-4
		60,000	9-8	10-11	8-4	8-8	7-10	7-0	6-6	5-2	5-1
	2-#4	40,000	9-0	10-1	7-9	8-0	7-3	6-6	6-1	5-0	4-11
	1-#6	60,000	11-5	13-10	9-2	9-8	8-3	7-2	6-6	5-2	5-1
	Center distance A[m, n]		1-6	1-11	1-2	1-3	1-0	0-10	0-8	STL	STL
20[i]	Span without stirrups[k, l]		4-10	5-5	4-5	4-7	4-3	4-0	3-11	3-7	3-7
	1-#4	40,000	7-0	8-1	6-3	6-5	5-10	5-3	4-11	4-1	3-11
		60,000	8-7	9-10	7-7	7-10	7-1	6-5	6-0	4-11	4-10
	1-#5	40,000	8-9	10-1	7-9	8-0	7-3	6-6	6-1	5-1	4-11
		60,000	10-8	12-3	9-6	9-10	8-10	8-0	7-5	6-2	6-0
	2-#4	40,000	9-10	11-4	8-9	9-1	8-2	7-4	6-10	5-8	5-7
	1-#6	60,000	12-0	13-10	10-8	11-0	9-11	9-0	8-4	6-8	6-6
	2-#5	40,000	12-3	14-1	10-10	11-3	10-2	8-11	8-1	6-6	6-4
		60,000	14-0	17-6	11-8	12-3	10-6	9-1	8-4	6-8	6-6
	Center distance A[m, n]		1-10	2-5	1-5	1-7	1-3	1-0	0-11	STL	STL

(continued)

TABLE R608.8(7)—continued
MAXIMUM ALLOWABLE CLEAR SPANS FOR 8-INCH-THICK WAFFLE-GRID LINTELS IN LOAD-BEARING WALLS[a, b, c, d, e, f, o]
MAXIMUM ROOF CLEAR SPAN 40 FEET AND MAXIMUM FLOOR CLEAR SPAN 32 FEET

LINTEL DEPTH, D[g] (inches)	NUMBER OF BARS AND BAR SIZE IN TOP AND BOTTOM OF LINTEL	STEEL YIELD STRENGTH[h], f_y (psi)	DESIGN LOADING CONDITION DETERMINED FROM Table R608.8(1)								
			1	2		3		4		5	
			Maximum ground snow load (psf)								
			—	30	70	30	70	30	70	30	70
			Maximum clear span of lintel (feet-inches)								
24[j]	Span without stirrups[k, l]		5-9	6-7	5-5	5-6	5-2	4-11	4-9	4-5	4-4
	1-#4	40,000	7-6	8-10	6-10	7-1	6-5	5-9	5-5	4-6	4-4
		60,000	9-2	10-9	8-4	8-8	7-10	7-1	6-7	5-6	5-4
	1-#5	40,000	9-5	11-0	8-6	8-10	8-0	7-2	6-8	5-7	5-5
		60,000	11-5	13-5	10-5	10-9	9-9	8-9	8-2	6-10	6-8
	2-#4 1-#6	40,000	10-7	12-5	9-8	10-0	9-0	8-1	7-7	6-3	6-2
		60,000	12-11	15-2	11-9	12-2	11-0	9-11	9-3	7-8	7-6
	2-#5	40,000	13-2	15-6	12-0	12-5	11-2	9-11	9-2	7-5	7-3
		60,000	16-3	21-0	14-1	14-10	12-9	11-1	10-1	8-1	7-11
	2-#6	40,000	14-4	18-5	12-6	13-2	11-5	9-11	9-2	7-5	7-3
	Center distance A[m, n]		2-1	2-11	1-9	1-10	1-6	1-3	1-1	STL	STL

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kPa, Grade 40 = 280 MPa, Grade 60 = 420 MPa.

a. Where lintels are formed with waffle-grid forms, form material shall be removed, if necessary, to create top and bottom flanges of the lintel that are not less than 3 inches in depth (in the vertical direction), are not less than 5 inches in width for 6-inch-nominal waffle-grid forms and not less than 7 inches in width for 8-inch-nominal waffle-grid forms. See Figure R608.8(3). Flat-form lintels shall be permitted in lieu of waffle-grid lintels. See Tables R608.8(2) through R608.8(5).

b. See Table R608.3 for tolerances permitted from nominal thicknesses and minimum dimensions and spacing of cores.

c. Table values are based on concrete with a minimum specified compressive strength of 2,500 psi. See Notes l and n. Table values are based on uniform loading. See Section R608.8.2 for lintels supporting concentrated loads.

d. Deflection criterion is $L/240$, where L is the clear span of the lintel in inches, or $^1/_2$ inch, whichever is less.

e. Linear interpolation is permitted between ground snow loads.

f. STL indicates stirrups required throughout lintel.

g. Lintel depth, D, is permitted to include the available height of wall located directly above the lintel, provided that the increased lintel depth spans the entire length of the lintel.

h. Stirrups shall be fabricated from reinforcing bars with the same yield strength as that used for the main longitudinal reinforcement.

i. Lintels less than 24 inches in depth with stirrups shall be formed from flat-wall forms [see Tables R608.8(2) through R608.8(5)], or, if necessary, form material shall be removed from waffle-grid forms so as to provide the required cover for stirrups. Allowable spans for lintels formed with flat-wall forms shall be determined from Tables R608.8(2) through R608.8(5).

j. Where stirrups are required for 24-inch-deep lintels, the spacing shall not exceed 12 inches on center.

k. Allowable clear span without stirrups applicable to all lintels of the same depth, D. Top and bottom reinforcement for lintels without stirrups shall be not less than the least amount of reinforcement required for a lintel of the same depth and loading condition with stirrups. All other spans require stirrups spaced at not more than $d/2$.

l. Where concrete with a minimum specified compressive strength of 3,000 psi is used, clear spans for lintels without stirrups shall be permitted to be multiplied by 1.05. If the increased span exceeds the allowable clear span for a lintel of the same depth and loading condition with stirrups, the top and bottom reinforcement shall be equal to or greater than that required for a lintel of the same depth and loading condition that has an allowable clear span that is equal to or greater than that of the lintel without stirrups that has been increased.

m. Center distance, A, is the center portion of the span where stirrups are not required. This is applicable to all longitudinal bar sizes and steel yield strengths.

n. Where concrete with a minimum specified compressive strength of 3,000 psi is used, center distance, A, shall be permitted to be multiplied by 1.10.

o. The maximum clear opening width between two solid wall segments shall be 18 feet. See Section R608.7.2.1. Lintel spans in the table greater than 18 feet are shown for interpolation and information only.

TABLE R608.8(8)
MAXIMUM ALLOWABLE CLEAR SPANS FOR 6-INCH-THICK SCREEN-GRID LINTELS IN LOAD-BEARING WALLS[a, b, c, d, e, f, p]
ROOF CLEAR SPAN 40 FEET AND FLOOR CLEAR SPAN 32 FEET

LINTEL DEPTH, D[g] (inches)	NUMBER OF BARS AND BAR SIZE IN TOP AND BOTTOM OF LINTEL	STEEL YIELD STRENGTH[h], f_y (psi)	DESIGN LOADING CONDITION DETERMINED FROM Table R608.8(1)								
			1	2		3		4		5	
			Maximum ground snow load (psf)								
			—	30	70	30	70	30	70	30	70
			Maximum clear span of lintel (feet-inches)								
12[i, j]	Span without stirrups		2-9	2-11	2-4	2-5	2-3	2-3	2-2	2-0	2-0
16[i, j]	Span without stirrups		3-9	4-0	3-4	3-5	3-2	3-1	3-0	2-9	2-9
20[i, j]	Span without stirrups		4-9	5-1	4-3	4-4	4-1	4-0	3-10	3-7	3-7
24[k]	Span without stirrups[l, m]		5-8	6-3	5-2	5-3	5-0	4-10	4-8	4-4	4-4
	1-#4	40,000	7-11	9-0	6-11	7-2	6-5	6-1	5-8	4-9	4-7
		60,000	9-9	11-0	8-5	8-9	7-10	7-5	6-10	5-9	5-7
	1-#5	40,000	9-11	11-2	8-7	8-11	8-0	7-7	7-0	5-11	5-9
		60,000	12-1	13-8	10-6	10-10	9-9	9-3	8-6	7-2	7-0
	2-#4 1-#6	40,000	11-2	12-8	9-9	10-1	9-1	8-7	7-11	6-8	6-6
		60,000	15-7	17-7	12-8	13-4	11-6	10-8	9-8	7-11	7-8
	2-#5	40,000	14-11	18-0	12-2	12-10	11-1	10-3	9-4	7-8	7-5
		60,000	DR	DR	DR	DR	DR	DR	DR	DR	DR
	Center distance A[n, o]		2-0	2-6	1-6	1-7	1-4	1-2	1-0	STL	STL

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kPa, Grade 40 = 280 MPa, Grade 60 = 420 MPa.

a. Where lintels are formed with screen-grid forms, form material shall be removed if necessary to create top and bottom flanges of the lintel that are not less than 5 inches in width and not less than 2.5 inches in depth (in the vertical direction). See Figure R608.8(4). Flat-form lintels shall be permitted in lieu of screen-grid lintels. See Tables R608.8(2) through R608.8(5).

b. See Table R608.3 for tolerances permitted from nominal thickness and minimum dimensions and spacings of cores.

c. Table values are based on concrete with a minimum specified compressive strength of 2,500 psi. See Notes m and o. Table values are based on uniform loading. See Section R608.7.2.1 for lintels supporting concentrated loads.

d. Deflection criterion is $L/240$, where L is the clear span of the lintel in inches, or $^1/_2$ inch, whichever is less.

e. Linear interpolation is permitted between ground snow loads.

f. DR indicates design required. STL indicates stirrups required throughout lintel.

g. Lintel depth, D, is permitted to include the available height of wall located directly above the lintel, provided that the increased lintel depth spans the entire length of the lintel.

h. Stirrups shall be fabricated from reinforcing bars with the same yield strength as that used for the main longitudinal reinforcement.

i. Stirrups are not required for lintels less than 24 inches in depth fabricated from screen-grid forms. Top and bottom reinforcement shall consist of a No. 4 bar having a yield strength of 40,000 psi or 60,000 psi.

j. Lintels between 12 and 24 inches in depth with stirrups shall be formed from flat-wall forms [see Tables R608.8(2) through R608.8(5)], or form material shall be removed from screen-grid forms to provide a concrete section comparable to that required for a flat wall. Allowable spans for flat lintels with stirrups shall be determined from Tables R608.8(2) through R608.8(5).

k. Where stirrups are required for 24-inch-deep lintels, the spacing shall not exceed 12 inches on center.

l. Allowable clear span without stirrups applicable to all lintels of the same depth, D. Top and bottom reinforcement for lintels without stirrups shall be not less than the least amount of reinforcement required for a lintel of the same depth and loading condition with stirrups. All other spans require stirrups spaced at not more than 12 inches.

m. Where concrete with a minimum specified compressive strength of 3,000 psi is used, clear spans for lintels without stirrups shall be permitted to be multiplied by 1.05. If the increased span exceeds the allowable clear span for a lintel of the same depth and loading condition with stirrups, the top and bottom reinforcement shall be equal to or greater than that required for a lintel of the same depth and loading condition that has an allowable clear span that is equal to or greater than that of the lintel without stirrups that has been increased.

n. Center distance, A, is the center portion of the span where stirrups are not required. This is applicable to all longitudinal bar sizes and steel yield strengths.

o. Where concrete with a minimum specified compressive strength of 3,000 psi is used, center distance, A, shall be permitted to be multiplied by 1.10.

p. The maximum clear opening width between two solid wall segments shall be 18 feet. See Section R608.7.2.1. Lintel spans in the table greater than 18 feet are shown for interpolation and information only.

TABLE R608.8(9)
MAXIMUM ALLOWABLE CLEAR SPANS FOR FLAT LINTELS WITHOUT STIRRUPS IN NONLOAD-BEARING WALLS[a, b, c, d, e, g]

LINTEL DEPTH, D^f (inches)	NUMBER OF BARS AND BAR SIZE	STEEL YIELD STRENGTH, f_y (psi)	NOMINAL WALL THICKNESS (inches)							
			4		6		8		10	
			Lintel Supporting							
			Concrete Wall	Light-frame Gable	Concrete Wall	Light-frame Gable	Concrete Wall	Light-frame Gable	Concrete Wall	Light-frame Gable
			Maximum Clear Span of Lintel (feet-inches)							
8	1-#4	40,000	10-11	11-5	9-7	11-2	7-10	9-5	7-3	9-2
		60,000	12-5	11-7	10-11	13-5	9-11	13-2	9-3	12-10
	1-#5	40,000	12-7	11-7	11-1	13-8	10-1	13-5	9-4	13-1
		60,000	DR	DR	12-7	16-4	11-6	14-7	10-9	14-6
	2-#4 1-#6	40,000	DR	DR	12-0	15-3	10-11	15-0	10-2	14-8
		60,000	DR	DR	DR	DR	12-2	15-3	11-7	15-3
	2-#5	40,000	DR	DR	DR	DR	12-7	16-7	11-9	16-7
		60,000	DR	DR	DR	DR	DR	DR	13-3	16-7
	2-#6	40,000	DR	DR	DR	DR	DR	DR	13-2	17-8
		60,000	DR	DR	DR	DR	DR	DR	DR	DR
12	1-#4	40,000	11-5	9-10	10-6	12-0	9-6	11-6	8-9	11-1
		60,000	11-5	9-10	11-8	13-3	10-11	14-0	10-1	13-6
	1-#5	40,000	11-5	9-10	11-8	13-3	11-1	14-4	10-3	13-9
		60,000	11-5	9-10	11-8	13-3	11-10	16-0	11-9	16-9
	2-#4 1-#6	40,000	DR	DR	11-8	13-3	11-10	16-0	11-2	15-6
		60,000	DR	DR	11-8	13-3	11-10	16-0	11-11	18-4
	2-#5	40,000	DR	DR	11-8	13-3	11-10	16-0	11-11	18-4
		60,000	DR	DR	11-8	13-3	11-10	16-0	11-11	18-4
16	1-#4	40,000	13-6	13-0	11-10	13-8	10-7	12-11	9-11	12-4
		60,000	13-6	13-0	13-8	16-7	12-4	15-9	11-5	15-0
	1-#5	40,000	13-6	13-0	13-10	17-0	12-6	16-1	11-7	15-4
		60,000	13-6	13-0	13-10	17-1	14-0	19-7	13-4	18-8
	2-#4 1-#6	40,000	13-6	13-0	13-10	17-1	13-8	18-2	12-8	17-4
		60,000	13-6	13-0	13-10	17-1	14-0	20-3	14-1	—
	2-#5	40,000	13-6	13-0	13-10	17-1	14-0	20-3	14-1	—
		60,000	DR	DR	13-10	17-1	14-0	20-3	14-1	—
20	1-#4	40,000	14-11	15-10	13-0	14-10	11-9	13-11	10-10	13-2
		60,000	15-3	15-10	14-11	18-1	13-6	17-0	12-6	16-2
	1-#5	40,000	15-3	15-10	15-2	18-6	13-9	17-5	12-8	16-6
		60,000	15-3	15-10	15-8	20-5	15-9	—	14-7	20-1
	2-#4 1-#6	40,000	15-3	15-10	15-8	20-5	14-11	—	13-10	—
		60,000	15-3	15-10	15-8	20-5	15-10	—	15-11	—
	2-#5	40,000	15-3	15-10	15-8	20-5	15-10	—	15-11	—
		60,000	15-3	15-10	15-8	20-5	15-10	—	15-11	—

(continued)

TABLE R608.8(9)—continued
MAXIMUM ALLOWABLE CLEAR SPANS FOR FLAT LINTELS WITHOUT STIRRUPS IN NONLOAD-BEARING WALLS[a, b, c, d, e, g]

LINTEL DEPTH, D[f] (inches)	NUMBER OF BARS AND BAR SIZE	STEEL YIELD STRENGTH, f_y (psi)	NOMINAL WALL THICKNESS (inches)							
			4		6		8		10	
			Lintel Supporting							
			Concrete Wall	Light-frame Gable	Concrete Wall	Light-frame Gable	Concrete Wall	Light-frame Gable	Concrete Wall	Light-frame Gable
			Maximum Clear Span of Lintel (feet-inches)							
24	1-#4	40,000	16-1	17-1	13-11	15-10	12-7	14-9	11-8	13-10
		60,000	16-11	18-5	16-1	19-3	14-6	18-0	13-5	17-0
	1-#5	40,000	16-11	18-5	16-3	19-8	14-9	18-5	13-8	17-4
		60,000	16-11	18-5	17-4	—	17-0	—	15-8	—
	2-#4	40,000	16-11	18-5	17-4	—	16-1	—	14-10	—
	1-#6	60,000	16-11	18-5	17-4	—	17-6	—	17-1	—
	2-#5	40,000	16-11	18-5	17-4	—	17-6	—	17-4	—
		60,000	16-11	18-5	17-4	—	17-6	—	17-8	—

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square inch = 6.895 kPa, Grade 40 = 280 MPa, Grade 60 = 420 MPa.
DR = Design Required.

a. See Table R608.3 for tolerances permitted from nominal thickness.
b. Table values are based on concrete with a minimum specified compressive strength of 2,500 psi. See Note e.
c. Deflection criterion is $L/240$, where L is the clear span of the lintel in inches, or $^1/_2$ inch, whichever is less.
d. Linear interpolation between lintels depths, D, is permitted provided the two cells being used to interpolate are shaded.
e. Where concrete with a minimum specified compressive strength of 3,000 psi is used, spans in cells that are shaded shall be permitted to be multiplied by 1.05.
f. Lintel depth, D, is permitted to include the available height of wall located directly above the lintel, provided that the increased lintel depth spans the entire length of the lintel.
g. The maximum clear opening width between two solid wall segments shall be 18 feet. See Section R608.7.2.1. Lintel spans in the table greater than 18 feet are shown for interpolation and information purposes only.

TABLE R608.8(10)
MAXIMUM ALLOWABLE CLEAR SPANS FOR WAFFLE-GRID AND SCREEN-GRID LINTELS WITHOUT STIRRUPS IN NONLOAD-BEARING WALLS[c, d, e, f, g]

LINTEL DEPTH[h], D (inches)	FORM TYPE AND NOMINAL WALL THICKNESS (inches)					
	6-inch Waffle-grid[a]		8-inch Waffle-grid[a]		6-inch Screen-grid[b]	
	Lintel supporting					
	Concrete Wall	Light-frame Gable	Concrete Wall	Light-frame Gable	Concrete Wall	Light-frame Gable
	Maximum Clear Span of Lintel (feet-inches)					
8	10-3	8-8	8-8	8-3	—	—
12	9-2	7-6	7-10	7-1	8-8	6-9
16	10-11	10-0	9-4	9-3	—	—
20	12-5	12-2	10-7	11-2	—	—
24	13-9	14-2	11-10	12-11	13-0	12-9

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, Grade 40 = 280 MPa, Grade 60 = 420 MPa.

a. Where lintels are formed with waffle-grid forms, form material shall be removed, if necessary, to create top and bottom flanges of the lintel that are not less than 3 inches in depth (in the vertical direction), are not less than 5 inches in width for 6-inch waffle-grid forms and not less than 7 inches in width for 8-inch waffle-grid forms. See Figure R608.8(3). Flat-form lintels shall be permitted in lieu of waffle-grid lintels. See Tables R608.8(2) through R608.8(5).
b. Where lintels are formed with screen-grid forms, form material shall be removed if necessary to create top and bottom flanges of the lintel that are not less than 5 inches in width and not less than 2.5 inches in depth (in the vertical direction). See Figure R608.8(4). Flat-form lintels shall be permitted in lieu of screen-grid lintels. See Tables R608.8(2) through R608.8(5).
c. See Table R608.3 for tolerances permitted from nominal thickness and minimum dimensions and spacing of cores.
d. Table values are based on concrete with a minimum specified compressive strength of 2,500 psi. See Note g.
e. Deflection criterion is $L/240$, where L is the clear span of the lintel in inches, or $^1/_2$ inch, whichever is less.
f. Top and bottom reinforcement shall consist of a No. 4 bar having a minimum yield strength of 40,000 psi.
g. Where concrete with a minimum specified compressive strength of 3,000 psi is used, spans in shaded cells shall be permitted to be multiplied by 1.05.
h. Lintel depth, D, is permitted to include the available height of wall located directly above the lintel, provided that the increased lintel depth spans the entire length of the lintel.

maximum clear span of lintels with and without stirrups in waffle-grid walls shall be determined in accordance with Tables R608.8(6) and R608.8(7), and constructed in accordance with Figure R608.8(3). The maximum clear span of lintels with and without stirrups in screen-grid walls shall be determined in accordance with Table R608.8(8), and constructed in accordance with Figure R608.8(4).

Where required by the applicable table, No. 3 stirrups shall be installed in lintels at a maximum spacing of $d/2$ where d equals the depth of the lintel, D, less the cover of the concrete as shown in Figures R608.8(2) through R608.8(4). The smaller value of d computed for the top and bottom bar shall be used to determine the maximum stirrup spacing. Where stirrups are required in a lintel with a single bar or two bundled bars in the top and bottom, they shall be fabricated like the letter "c" or "s" with 135-degree (2.36 rad) standard hooks at each end that comply with Section R608.5.4.5 and Figure R608.5.4(3) and installed as shown in Figures R608.8(2) through R608.8(4). Where two bars are required in the top and bottom of the lintel and the bars are not bundled, the bars shall be separated by not less than 1 inch (25 mm). The free end of the stirrups shall be fabricated with 90- or 135-degree (1.57 or 2.36 rad) standard hooks that comply with Section R608.5.4.5 and Figure R608.5.4(3) and installed as shown in Figures R608.8(2) and R608.8(3). For flat, waffle-grid and screen-grid lintels, stirrups are not required in the center distance, A, portion of spans in accordance with Figure R608.8(1) and Tables R608.8(2) through R608.8(8). See Section R608.8.2.2, Item 5, for requirement for stirrups through out lintels with bundled bars.

R608.8.2.2 Bundled bars in lintels. It is permitted to bundle two bars in contact with each other in lintels if all of the following are observed:

1. Bars equal to or less than No. 6 are bundled.
2. Where the wall thickness is not sufficient to provide not less than 3 inches (76 mm) of clear space beside bars (total on both sides) oriented horizontally in a bundle, the bundled bars shall be oriented in a vertical plane.
3. Where vertically oriented bundled bars terminate with standard hooks to develop the bars in tension beyond the support (see Section R608.5.4.4), the hook extensions shall be staggered to provide not less than 1 inch (25 mm) clear spacing between the extensions.
4. Bundled bars shall not be lap spliced within the lintel span and the length on each end of the lintel that is required to develop the bars in tension.
5. Bundled bars shall be enclosed within stirrups throughout the length of the lintel. Stirrups and the installation thereof shall comply with Section R608.8.2.1.

R608.8.2.3 Lintels without stirrups designed for nonload-bearing conditions. The maximum clear span of lintels without stirrups designed for nonload-bearing conditions of Table R608.8(1) shall be determined in accordance with this section. The maximum clear span of lintels without stirrups in flat walls shall be determined in accordance with Table R608.8(9), and the maximum clear span of lintels without stirrups in walls of waffle-grid or screen-grid construction shall be determined in accordance with Table R608.8(10).

R608.9 Requirements for connections—general. Concrete walls shall be connected to footings, floors, ceilings and roofs in accordance with this section.

R608.9.1 Connections between concrete walls and light-frame floor, ceiling and roof systems. Connec-

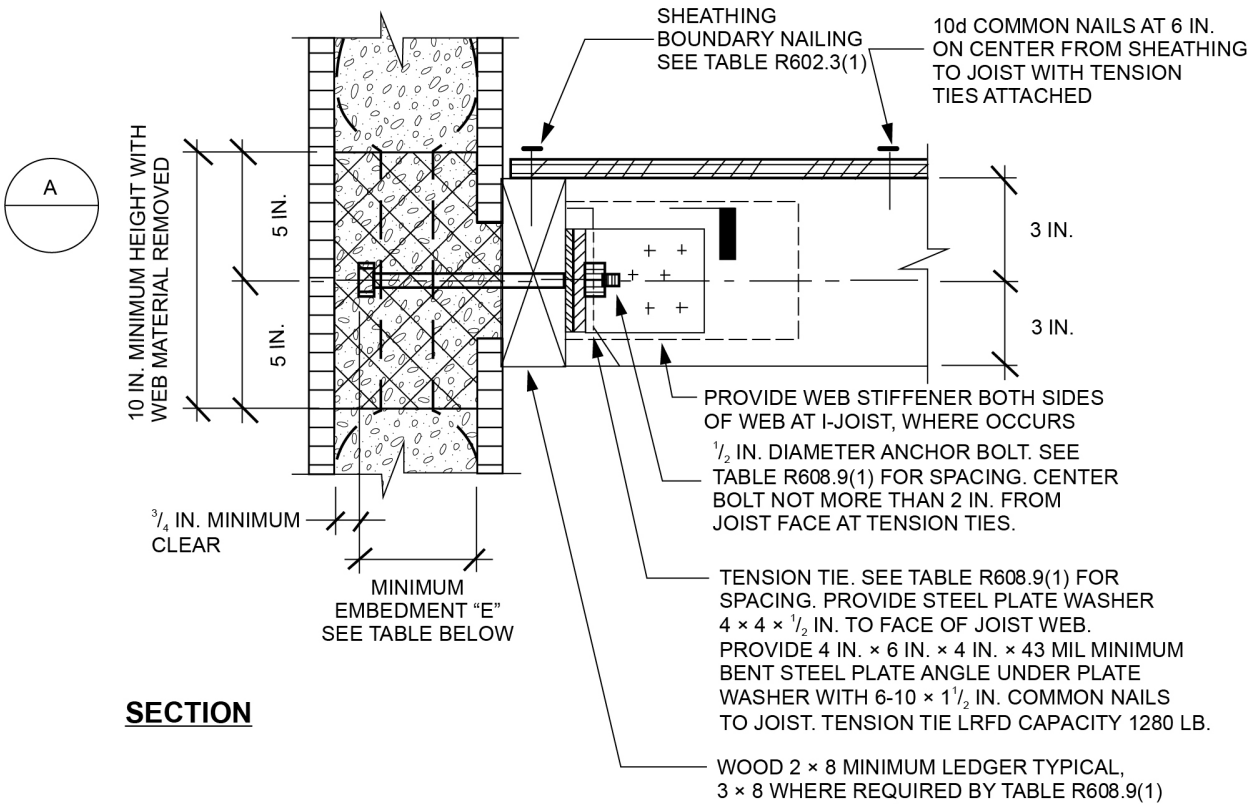
TABLE R608.9(1)
WOOD-FRAMED FLOOR TO SIDE OF CONCRETE WALL, FRAMING PERPENDICULAR[a, b]

ANCHOR BOLT SPACING (inches)	TENSION TIE SPACING (inches)	BASIC WIND SPEED (mph)					
		115B	120B	130B	140B	150B	160B
		—	—	110C	119C	127C	136C
		—	—	—	110D	117D	125D
12	12						
12	24						
12	36						
12	48						
16	16						
16	32						
16	48						
19.2	19.2						
19.2	38.4						

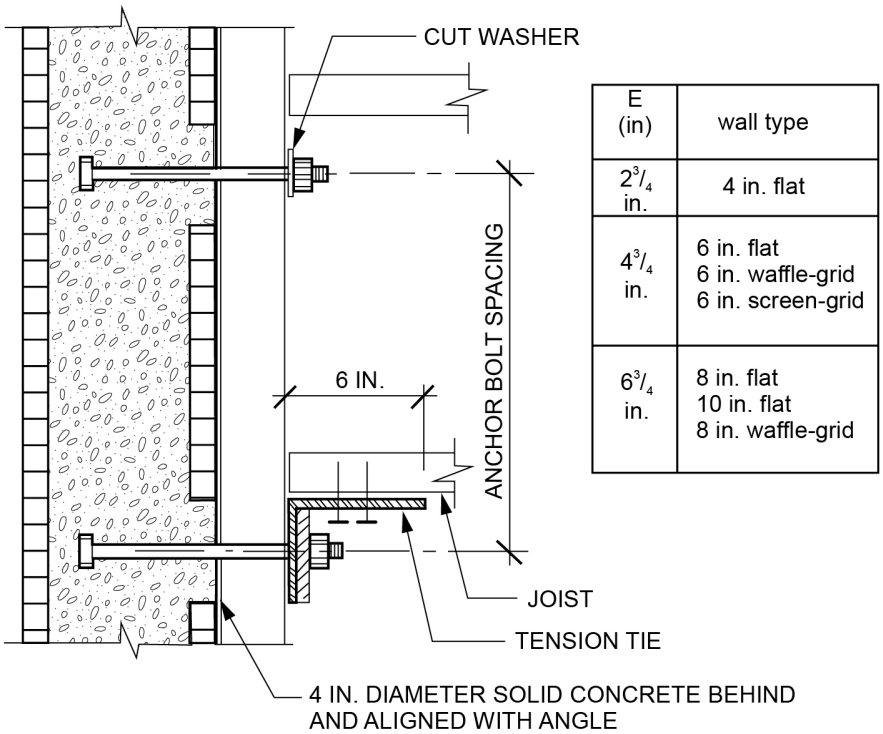
For SI:1 inch = 25.4 mm, 1 mile per hour = 0.447 m/s.

a. This table is for use with the detail in Figure R608.9(1). Use of this detail is permitted where a cell is not shaded and prohibited where shaded.

b. Wall design per other provisions of Section R608 is required.



SECTION

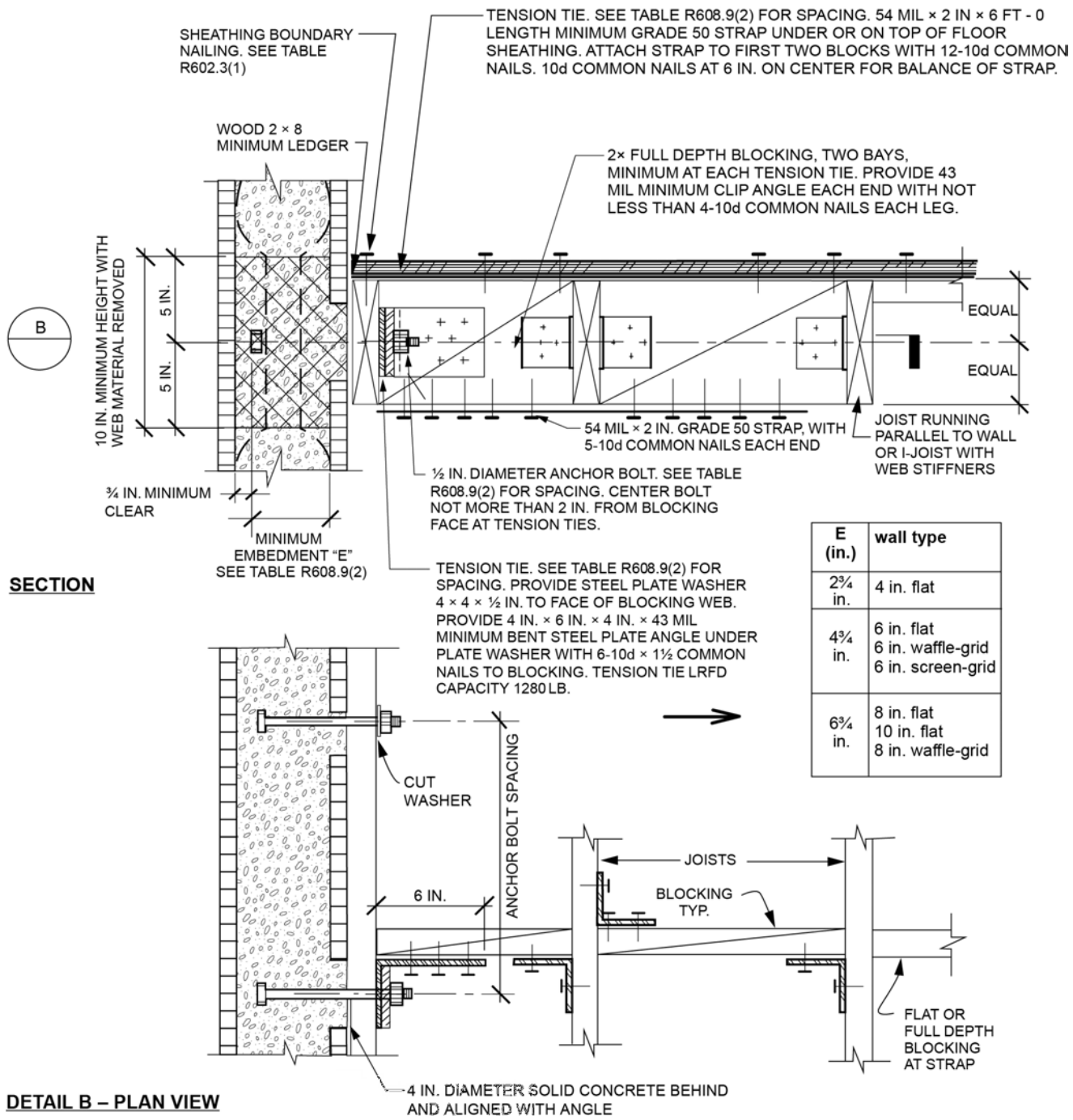


E (in)	wall type
2 3/4 in.	4 in. flat
4 3/4 in.	6 in. flat 6 in. waffle-grid 6 in. screen-grid
6 3/4 in.	8 in. flat 10 in. flat 8 in. waffle-grid

DETAIL A – PLAN VIEW

For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm, 1 pound-force = 4.448 N.

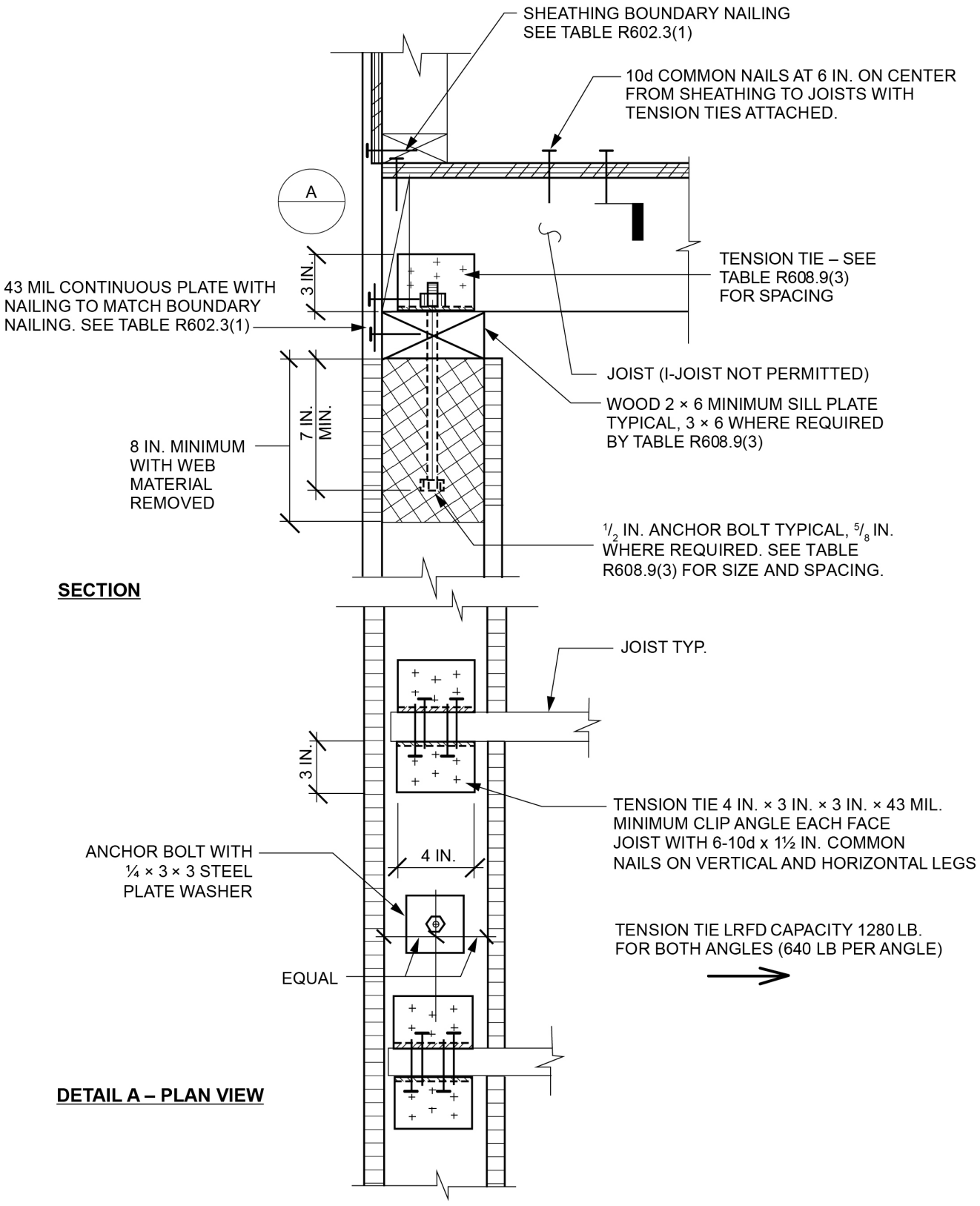
FIGURE R608.9(1)
WOOD-FRAMED FLOOR TO SIDE OF CONCRETE WALL, FRAMING PERPENDICULAR



E (in.)	wall type
2¾ in.	4 in. flat
4¾ in.	6 in. flat 6 in. waffle-grid 6 in. screen-grid
6¾ in.	8 in. flat 10 in. flat 8 in. waffle-grid

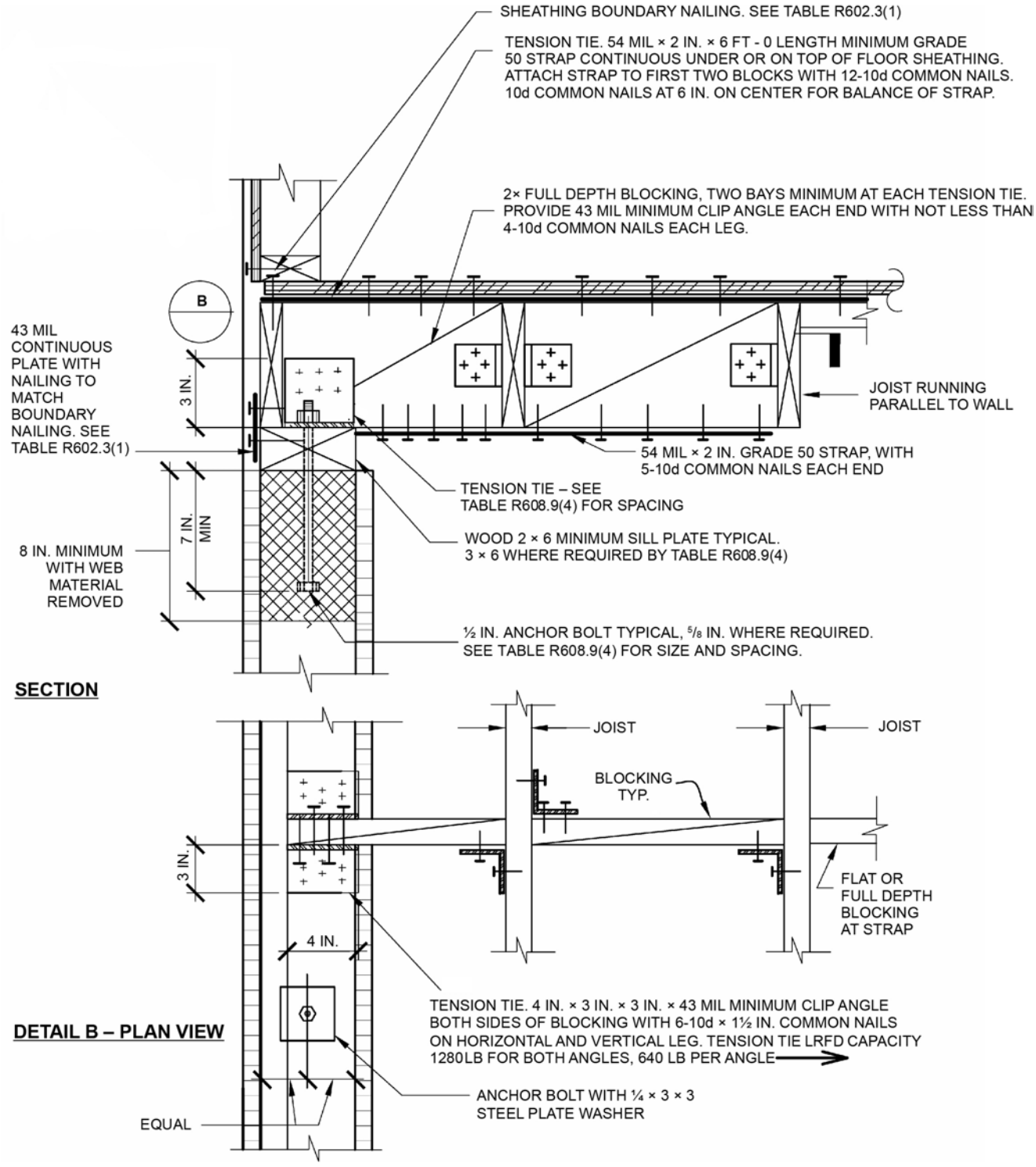
For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound-force = 4.448 N.

FIGURE R608.9(2)
WOOD-FRAMED FLOOR TO SIDE OF CONCRETE WALL, FRAMING PARALLEL



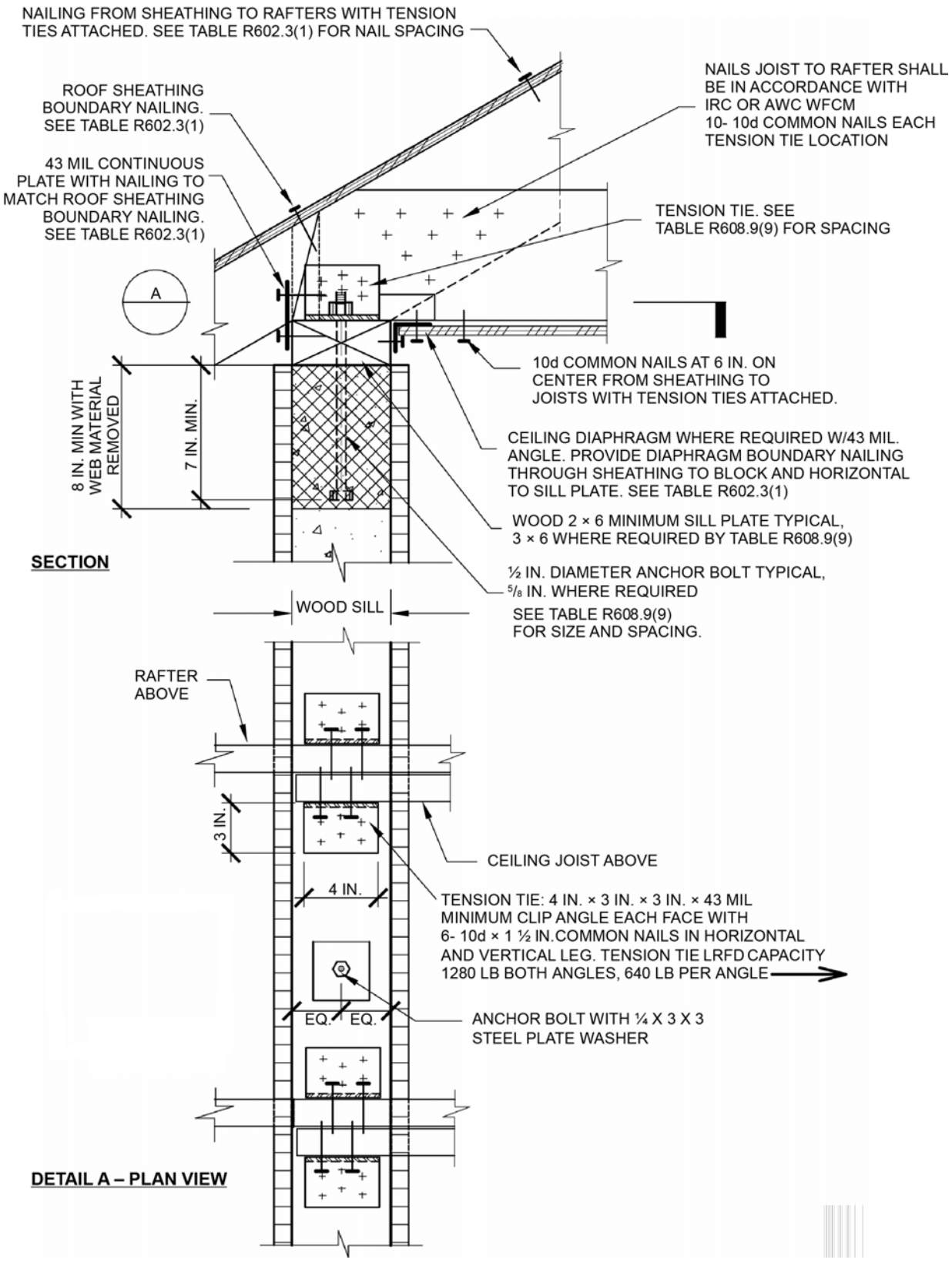
For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm, 1 pound-force = 4.448 N.

FIGURE R608.9(3)
WOOD-FRAMED FLOOR TO TOP OF CONCRETE WALL, FRAMING PERPENDICULAR



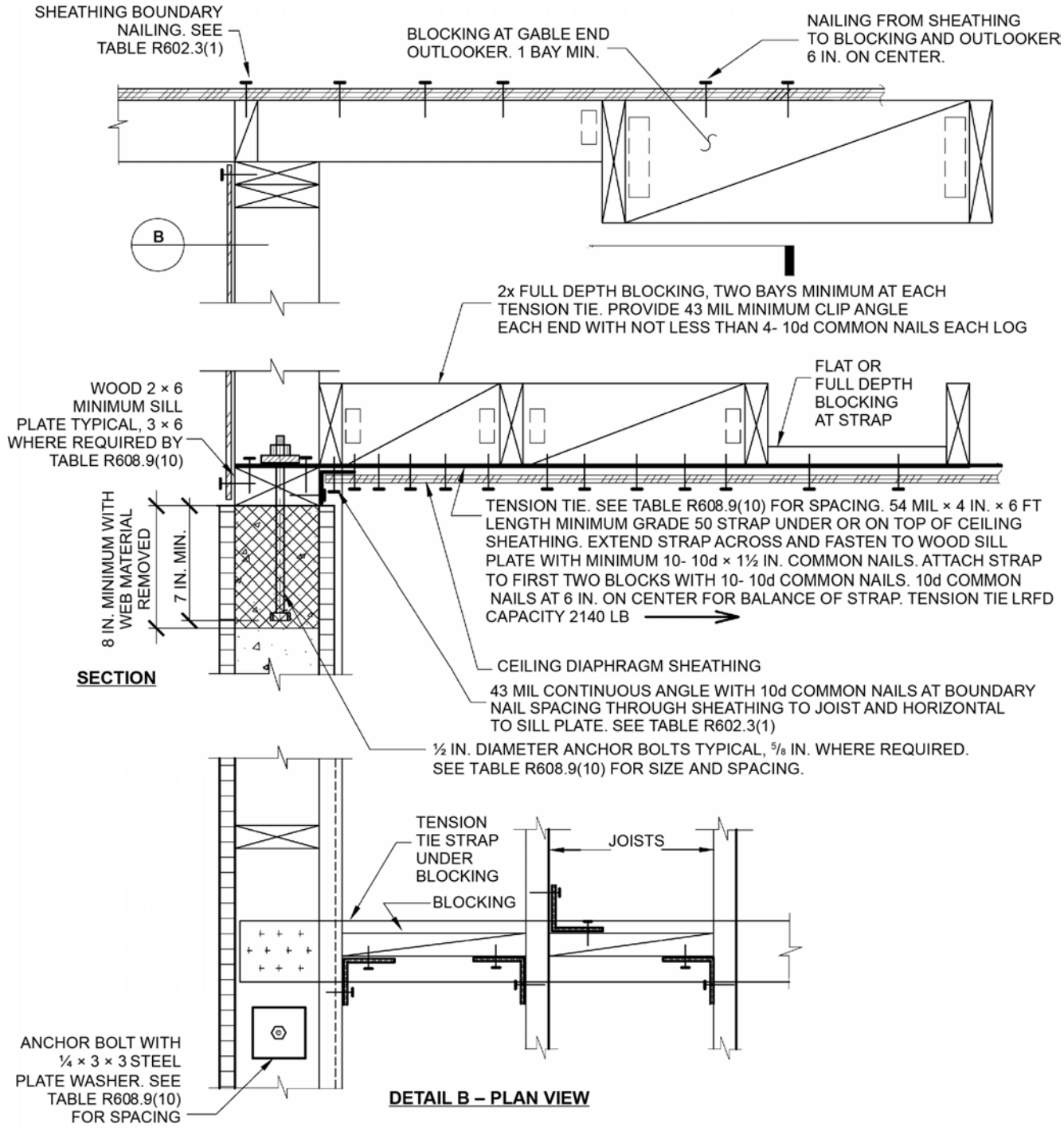
For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound-force = 4.448 N.

FIGURE R608.9(4)
WOOD-FRAMED FLOOR TO TOP OF CONCRETE WALL, FRAMING PARALLEL



For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm, 1 pound-force = 4.448 N.

FIGURE R608.9(9)
WOOD-FRAMED ROOF TO TOP OF CONCRETE WALL, FRAMING PERPENDICULAR



For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm, 1 pound-force = 4.448 N.

FIGURE R608.9(10)
WOOD-FRAMED ROOF TO TOP OF CONCRETE WALL, FRAMING PARALLEL

TABLE R608.9(2)
WOOD-FRAMED FLOOR TO SIDE OF CONCRETE WALL, FRAMING PARALLEL[a, b]

ANCHOR BOLT SPACING (inches)	TENSION TIE SPACING (inches)	BASIC WIND SPEED (mph) AND WIND EXPOSURE CATEGORY					
		115B	120B	130B	140B	150B	160B
		—	—	110C	119C	127C	136C
		—	—	—	110D	117D	125D
12	12						
12	24						
12	36						
12	48						
16	16						
16	32						
16	48						
19.2	19.2						
19.2	38.4						
24	24						
24	48						

For SI: 1 inch = 25.4 mm, 1 mile per hour = 0.447 m/s.

a. This table is for use with the detail in Figure R608.9(2). Use of this detail is permitted where a cell is not shaded and prohibited where shaded.

b. Wall design per other provisions of Section R608 is required.

TABLE R608.9(3)
WOOD-FRAMED FLOOR TO TOP OF CONCRETE WALL, FRAMING PERPENDICULAR[a, b, c, d, e]

ANCHOR BOLT SPACING (inches)	TENSION TIE SPACING (inches)	BASIC WIND SPEED (mph) AND WIND EXPOSURE CATEGORY					
		115B	120B	130B	140B	150B	160B
		—	—	110C	119C	127C	136C
		—	—	—	110D	117D	125D
12	12						6
12	24					6	6
12	36					6	6
12	48				6	6	6
16	16					6	6A
16	32				6	6	6A
16	48			6	6	6	6A
19.2	19.2				6A	6A	6B
19.2	38.4			6	6A	6A	6B
24	24			6A	6B	6B	6B
24	48		6	6A	6B	6B	8B

For SI: 1 inch = 25.4 mm, 1 mile per hour = 0.447 m/s.

a. This table is for use with the detail in Figure R608.9(3). Use of this detail is permitted where cell is not shaded.

b. Wall design per other provisions in Section R608 is required.

c. For wind design, minimum 4-inch-nominal wall is permitted in unshaded cells that do not contain a number.

d. Numbers 6 and 8 indicate minimum permitted nominal wall thickness in inches necessary to develop required strength (capacity) of connection. As a minimum, this nominal thickness shall occur in the portion of the wall indicated by the cross hatching in Figure R608.9(3). For the remainder of the wall, see Note b.

e. Letter “A” indicates that a minimum nominal 3 × 6 sill plate is required. Letter “B” indicates that a $^{5}/_{8}$-inch-diameter anchor bolt and a minimum nominal 3 × 6 sill plate are required.

TABLE R608.9(4)
WOOD-FRAMED FLOOR TO TOP OF CONCRETE WALL, FRAMING PARALLEL[a, b, c, d, e]

ANCHOR BOLT SPACING (inches)	TENSION TIE SPACING (inches)	BASIC WIND SPEED (mph) AND WIND EXPOSURE CATEGORY					
		115B	120B	130B	140B	150B	160B
		—	—	110C	119C	127C	136C
		—	—	—	110D	117D	125D
12	12						6
12	24					6	6
12	36					6	6
12	48				6	6	6
16	16					6	6A
16	32				6	6	6A
16	48			6	6	6	6A
19.2	19.2				6A	6A	6B
19.2	38.4			6	6A	6A	6B
24	24			6A	6B	6B	6B
24	48		6	6A	6B	6B	8B

For SI: 1 inch = 25.4 mm, 1 mile per hour = 0.447 m/s.

a. This table is for use with the detail in Figure R608.9(4). Use of this detail is permitted where a cell is not shaded.

b. Wall design per other provisions of Section R608 is required.

c. For wind design, minimum 4-inch-nominal wall is permitted in unshaded cells that do not contain a number.

d. Numbers 6 and 8 indicate minimum permitted nominal wall thickness in inches necessary to develop required strength (capacity) of connection. As a minimum, this nominal thickness shall occur in the portion of the wall indicated by the cross hatching in Figure R608.9(4). For the remainder of the wall, see Note b.

e. Letter "A" indicates that a minimum nominal 3 × 6 sill plate is required. Letter "B" indicates that a $^{5}/_{8}$-inch-diameter anchor bolt and a minimum nominal 3 × 6 sill plate are required.

TABLE R608.9(9)
WOOD-FRAMED ROOF TO TOP OF CONCRETE WALL, FRAMING PERPENDICULAR[a, b, c, d, e]

ANCHOR BOLT SPACING (inches)	TENSION TIE SPACING (inches)	BASIC WIND SPEED (mph) AND WIND EXPOSURE CATEGORY					
		115B	120B	130B	140B	150B	160B
		—	—	110C	119C	127C	136C
		—	—	—	110D	117D	125D
12	12						6
12	24						6
12	36					6	6
12	48				6	6	6
16	16					6	6
16	32					6	6
16	48				6	6	6
19.2	19.2					6	6
19.2	38.4				6	6	
24	24				6		
24	48			6	8B		

For SI: 1 inch = 25.4 mm, 1 mile per hour = 0.447 m/s.

a. This table is for use with the detail in Figure R608.9(9). Use of this detail is permitted where a cell is not shaded, and prohibited where shaded.

b. Wall design per other provisions of Section R608 is required.

c. For wind design, minimum 4-inch-nominal wall is permitted in unshaded cells that do not contain a number.

d. Numbers 6 and 8 indicate minimum permitted nominal wall thickness in inches necessary to develop required strength (capacity) of connection. As a minimum, this nominal thickness shall occur in the portion of the wall indicated by the cross hatching in Figure R608.9(9). For the remainder of the wall, see Note b.

e. Letter "B" indicates that a $^{5}/_{8}$-inch-diameter anchor bolt and a minimum nominal 3 × 6 sill plate are required.

TABLE R608.9(10)
WOOD-FRAMED ROOF TO TOP OF CONCRETE WALL, FRAMING PARALLEL[a, b, c, d, e]

ANCHOR BOLT SPACING (inches)	TENSION TIE SPACING (inches)	BASIC WIND SPEED (mph) AND WIND EXPOSURE CATEGORY					
		115B	120B	130B	140B	150B	160B
		—	—	110C	119C	127C	136C
		—	—	—	110D	117D	125D
12	12						6
12	24						6
12	36					6	6
12	48				6	6	6
16	16					6	6
16	32					6	6
16	48				6	6	6
19.2	19.2					6	6
19.2	38.4				6	6	
24	24				6		
24	48			6	8B		

For SI: 1 inch = 25.4 mm, 1 mile per hour = 0.447 m/s.

a. This table is for use with the detail in Figure R608.9(10). Use of this detail is permitted where a cell is not shaded, and prohibited where shaded.

b. Wall design per other provisions of Section R608 is required.

c. For wind design, minimum 4-inch-nominal wall is permitted in cells that do not contain a number.

d. Numbers 6 and 8 indicate minimum permitted nominal wall thickness in inches necessary to develop required strength (capacity) of connection. As a minimum, this nominal thickness shall occur in the portion of the wall indicated by the cross hatching in Figure R608.9(10). For the remainder of the wall, see Note b.

e. Letter “B” indicates that a $^{5}/_{8}$-inch-diameter anchor bolt and a minimum nominal 3 × 6 sill plate are required.

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tions between concrete walls and light-frame floor, ceiling and roof systems using the prescriptive details of Figures R608.9(1) through R608.9(4) and R608.9(9) through R608.9(10) shall comply with this section and Sections R608.9.2 and R608.9.3.

R608.9.1.1 Anchor bolts. Anchor bolts used to connect light-frame floor, ceiling and roof systems to concrete walls in accordance with Figures R608.9(1) through R608.9(4) and R608.9(9) through R608.9(10) shall have heads, or shall be rods with threads on both ends with a hex or square nut on the end embedded in the concrete. Bolts and threaded rods shall comply with Section R608.5.2.2. Anchor bolts with J- or L-hooks shall not be used where the connection details in these figures are used.

R608.9.1.2 Removal of stay-in-place form material at bolts. Holes in stay-in-place forms for installing bolts for attaching face-mounted wood ledger boards to the wall shall be not less than 4 inches (102 mm) in diameter for forms not greater than $1^1/_2$ inches (38 mm) in thickness, and increased 1 inch (25 mm) in diameter for each $^1/_2$-inch (12.7 mm) increase in form thickness. Holes in stay-in-place forms for installing bolts for attaching face-mounted cold-formed steel tracks to the wall shall be not less than 4 inches (102 mm) square. The wood ledger board or steel track shall be in direct contact with the concrete at each bolt location.

Exception: A vapor retarder or other material less than or equal to $^1/_{16}$ inch (1.6 mm) in thickness is permitted to be installed between the wood ledger or cold-formed track and the concrete.

R608.9.2 Connections between concrete walls and light-frame floor systems. Connections between concrete walls and light-frame floor systems shall be in accordance with one of the following:

1. For floor systems of wood-framed construction, the provisions of Section R608.9.1 and the prescriptive details of Figures R608.9(1) through R608.9(4), where permitted by the tables accompanying those figures. Portions of connections of wood-framed floor systems not noted in the figures shall be in accordance with Section R502, or AWC WFCM, if applicable. Wood framing members shall be of a species having a specific gravity equal to or greater than 0.42.
2. Deleted.
3. Proprietary connectors selected to resist loads and load combinations in accordance with Appendix A (ASD) or Appendix B (LRFD) of PCA 100.
4. An engineered design using loads and load combinations in accordance with Appendix A (ASD) or Appendix B (LRFD) of PCA 100.
5. An engineered design using loads and material design provisions in accordance with this code, or in accordance with ASCE 7, ACI 318, and AWC NDS for wood-framed construction.

R608.9.3 Connections between concrete walls and light-frame ceiling and roof systems. Connections between concrete walls and light-frame ceiling and roof systems shall be in accordance with one of the following:

1. For ceiling and roof systems of wood-framed construction, the provisions of Section R608.9.1 and the prescriptive details of Figures R608.9(9) and R608.9(10), where permitted by the tables accompanying those figures. Portions of connections of wood-framed ceiling and roof systems not noted in the figures shall be in accordance with Section R802, or AWC WFCM, if applicable. Wood framing members shall be of a species

having a specific gravity equal to or greater than 0.42.

2. Deleted.
3. Proprietary connectors selected to resist loads and load combinations in accordance with Appendix A (ASD) or Appendix B (LRFD) of PCA 100.
4. An engineered design using loads and load combinations in accordance with Appendix A (ASD) or Appendix B (LRFD) of PCA 100.
5. An engineered design using loads and material design provisions in accordance with this code, or in accordance with ASCE 7, ACI 318, and AWC NDS for wood-framed construction.

R608.10 Floor, roof and ceiling diaphragms. Floors and roofs in buildings with exterior walls of concrete shall be designed and constructed as diaphragms. Where gable-end walls occur, ceilings shall be designed and constructed as diaphragms. The design and construction of floors, roofs and ceilings of wood framing or cold-formed-steel framing serving as diaphragms shall comply with the applicable requirements of this code, or AWC WFCM, if applicable. Wood framing members shall be of a species having a specific gravity equal to or greater than 0.42.

SECTION R609
EXTERIOR WINDOWS AND DOORS

R609.1 General. This section prescribes performance and construction requirements for exterior windows and doors installed in walls. Windows and doors shall be installed in accordance with the fenestration manufacturer's written instructions. Window and door openings shall be flashed in accordance with Section R703.4. Written installation instructions shall be provided by the fenestration manufacturer for each window or door.

R609.2 Performance. Exterior windows and doors shall be capable of resisting the design wind loads specified in Table R301.2.1(1) adjusted for height and exposure in accordance with Table R301.2.1(2) or determined in accordance with ASCE 7 using the allowable stress design load combinations of ASCE 7. For exterior windows and doors tested in accordance with Sections R609.3 and R609.5, required design wind pressures determined from ASCE 7 using the ultimate strength design (USD) are permitted to be multiplied by 0.6. Design wind loads for exterior glazing not part of a labeled assembly shall be permitted to be determined in accordance with Chapter 24 of the *International Building Code*. Design wind loads for exterior glazing not part of a labeled assembly shall be permitted to be determined in accordance with Chapter 24 of the *International Building Code*.

Exception: Openings for exterior balconies, decks, or porches under roofs enclosed with screen or removable vinyl or acrylic wind break panels shall not be required to be protected provided the spaces are separated from the building interior by a wall and all openings in the wall separating the unit from the balcony, deck or porch are protected in accordance with this section. Vinyl and acrylic glazed panels shall be removable. Removable panels shall be identified as removable by a decal. The identification decal shall state "Removable panel SHALL be removed when wind speeds exceed 75 mph (34 m/s)." Decals shall be placed such that the decal is visible when the panel is installed.

R609.3 Testing and labeling. Exterior windows and sliding doors shall be tested by an *approved* independent laboratory, and bear a *label* identifying manufacturer, performance characteristics and *approved* inspection agency to indicate compliance with AAMA/WDMA/CSA 101/I.S.2/A440. Exterior side-hinged doors shall be tested and *labeled* as conforming to AAMA/WDMA/CSA 101/I.S.2/A440 or ANSI/WMA 100, or comply with Section R609.5.

Exception: Decorative glazed openings.

R609.3.1 Comparative analysis. Structural wind load design pressures for window and door units different than the size tested in accordance with Section R609.3 shall be permitted to be different than the design value of the tested unit where determined in accordance with one of the following comparative analysis methods:

1. Structural wind load design pressures for window and door units smaller than the size tested in accordance with Section R609.3 shall be permitted to be higher than the design value of the tested unit provided such higher pressures are determined by accepted engineering analysis. Components of the smaller unit shall be the same as those of the tested unit. Where such calculated design pressures are used, they shall be validated by an additional test of the window or door unit having the highest allowable design pressure.
2. In accordance with WDMA I.S.11.

R609.4 Garage doors. Garage doors shall be tested in accordance with either ASTM E330 or ANSI/DASMA 108, and shall meet the pass/fail criteria of ANSI/DASMA 108.

R609.4.1 Garage door labeling. Garage doors shall be *labeled* with a permanent *label* provided by the garage door manufacturer. The *label* shall identify the garage door manufacturer, the garage door model/series number, the positive and negative design wind pressure rating, the installation instruction drawing reference number, and the applicable test standard.

R609.5 Other exterior window and door assemblies. Exterior windows and door assemblies not included within the scope of Section R609.3 or R609.4 shall be tested in accordance with ASTM E330. Glass in assemblies covered by this section shall comply with Section R308.5.

R609.6 Windborne debris protection. Protection of exterior windows, glass doors and doors with glass in buildings located in *windborne debris regions* shall be in accordance with Section R301.2.1.2.

R609.6.1 Fenestration testing and labeling. *Fenestration* shall be tested by an *approved* independent laboratory, *listed* by an *approved* entity, and bear a *label* identifying the manufacturer, performance characteristics

and an *approved* inspection agency to indicate compliance with the requirements of the following specification(s):

1. ASTM E1886 and ASTM E1996; or
2. AAMA 506.

R609.6.2 Impact protective systems testing and labeling. *Impact protective systems* shall be tested for impact resistance by an *approved* independent laboratory for compliance with ASTM E1886 and ASTM E1996. *Impact protective systems* shall be tested for design wind pressure by an *approved* independent laboratory for compliance with ASTM E330. Required design wind pressures shall be determined in accordance with Table R301.2.1(1), adjusted for height and exposure in accordance with Table R301.2.1(2) or determined in accordance with ASCE 7. For the purposes of this section, design wind pressures determined in accordance with ASCE 7 are permitted to be multiplied by 0.6.

Impact protective systems bear a *label* identifying the manufacturer, performance characteristics and an *approved* inspection agency. *Impact protective systems* shall have a permanent *label* providing traceability to the manufacturer, product designation and performance characteristics. The permanent *label* shall be acid etched, sand blasted, ceramic fired, laser etched, embossed or of a type that, once applied, cannot be removed without being destroyed.

R609.7 Anchorage methods. The methods cited in this section apply only to anchorage of window and glass door assemblies to the main force-resisting system.

R609.7.1 Anchoring requirements. Window and glass door assemblies shall be anchored in accordance with the published manufacturer's recommendations to achieve the design pressure specified. Substitute anchoring systems used for substrates not specified by the fenestration manufacturer shall provide equal or greater anchoring performance as demonstrated by accepted engineering practice.

R609.7.2 Anchorage details. Products shall be anchored in accordance with the minimum requirements illustrated in Figures R609.7.2(1), R609.7.2(2), R609.7.2(3), R609.7.2(4), R609.7.2(5), R609.7.2(6), R609.7.2(7) and R609.7.2(8).

R609.7.2.1 Masonry, concrete or other structural substrate. Where the wood shim or buck thickness is less than $1^1/_2$ inches (38 mm), window and glass door assemblies shall be anchored through the jamb, or by jamb clip and anchors shall be embedded directly into the masonry, concrete or other substantial substrate material. Anchors shall adequately transfer load from the window or door frame into the rough opening substrate [see Figures R609.7.2(1) and R609.7.2(2)].

Where the wood shim or buck thickness is $1^1/_2$ inches (38 mm) or more, the buck is securely fastened to the masonry, concrete or other substantial substrate, and the buck extends beyond the interior face of the window or door frame, window and glass door assemblies shall be anchored through the jamb, or by jamb clip, or through the flange to the secured wood buck. Anchors shall be embedded into the secured wood buck to adequately transfer load from the window or door frame assembly [see Figures R609.7.2(3), R609.7.2(4) and R609.7.2(5)].

R609.7.2.2 Wood or other approved framing material. Where the framing material is wood or other *approved* framing material, window and glass door assemblies shall be anchored through the frame, or by frame clip, or through the flange. Anchors shall be embedded into the frame construction to adequately transfer load [see Figures R609.7.2(6), R609.7.2(7) and R609.7.2(8)].

R609.8 Mullions. Mullions shall be tested by an *approved* testing laboratory in accordance with AAMA 450, or be engineered in accordance with accepted engineering practice. Mullions tested as stand-alone units or qualified by engineering shall use performance criteria cited in Sections R609.8.1, R609.8.2 and R609.8.3. Mullions qualified by an actual test of an entire assembly shall comply with Sections R609.8.1 and R609.8.3.

R609.8.1 Load transfer. Mullions shall be designed to transfer the design pressure loads applied by the window and door assemblies to the rough opening substrate.

R609.8.2 Deflection. Mullions shall be capable of resisting the design pressure loads applied by the window and door assemblies to be supported without deflecting more than $L/175$, where L is the span of the mullion in inches.

R609.8.3 Structural safety factor. Mullions shall be capable of resisting a load of 1.5 times the design pressure loads applied by the window and door assemblies to be supported without exceeding the appropriate material stress levels. If tested by an *approved* laboratory, the 1.5 times the design pressure load shall be sustained for 10 seconds, and the permanent deformation shall not exceed 0.4 percent of the mullion span after the 1.5 times design pressure load is removed.

SECTION R610
STRUCTURAL INSULATED PANEL WALL CONSTRUCTION

R610.1 General. Structural insulated panel (SIP) walls shall be designed in accordance with the provisions of this section. Where the provisions of this section are used to design *structural insulated panel* walls, project drawings, typical details and specifications are not required to bear the seal of the architect or engineer responsible for design, unless otherwise required by the state law of the *jurisdiction* having authority.

R610.2 Applicability limits. The provisions of this section shall control the construction of exterior *structural insulated panel* walls and interior load-bearing *structural insulated panel* walls for buildings not greater than 60 feet (18 288 mm) in length perpendicular to the joist or truss span, not greater than 40 feet (12 192 mm) in width parallel to the joist

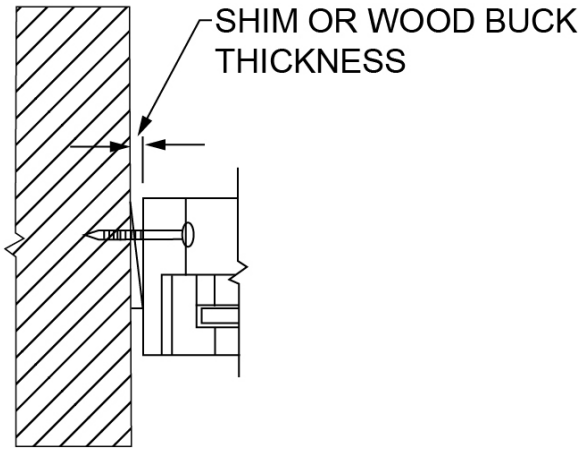


FIGURE R609.7.2(1)
THROUGH THE FRAME

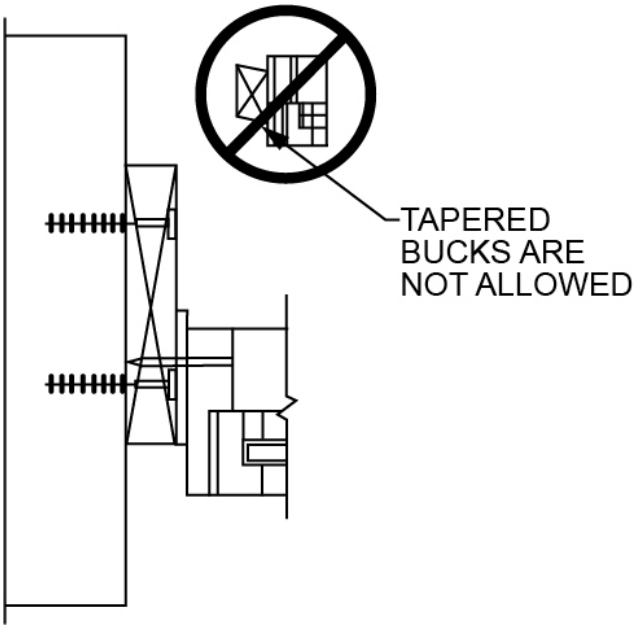


FIGURE R609.7.2(3)
THROUGH THE FRAME

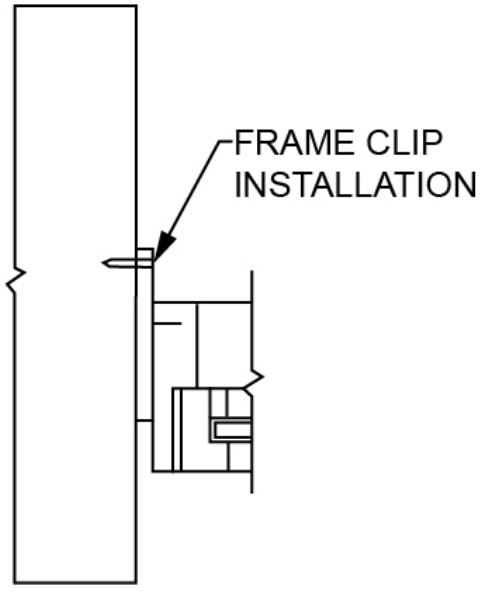


FIGURE R609.7.2(2)
FRAME CLIP

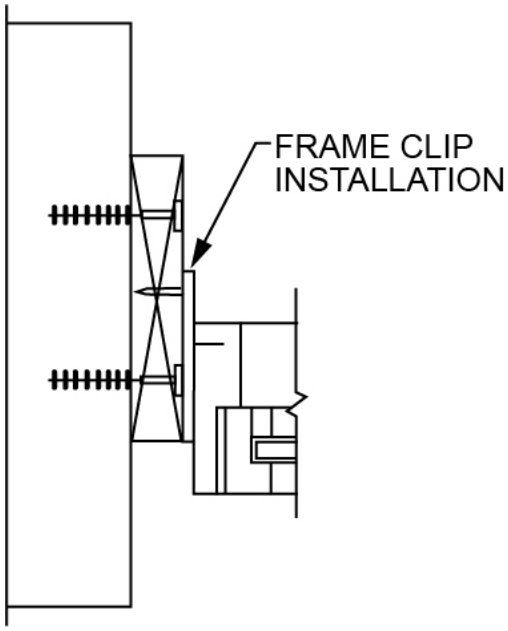


FIGURE R609.7.2(4)
FRAME CLIP

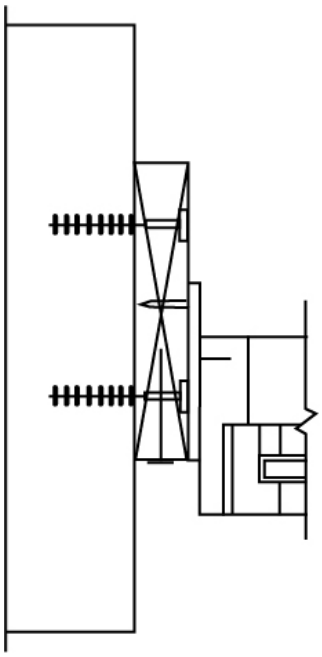


FIGURE R609.7.2(5)
THROUGH THE FLANGE

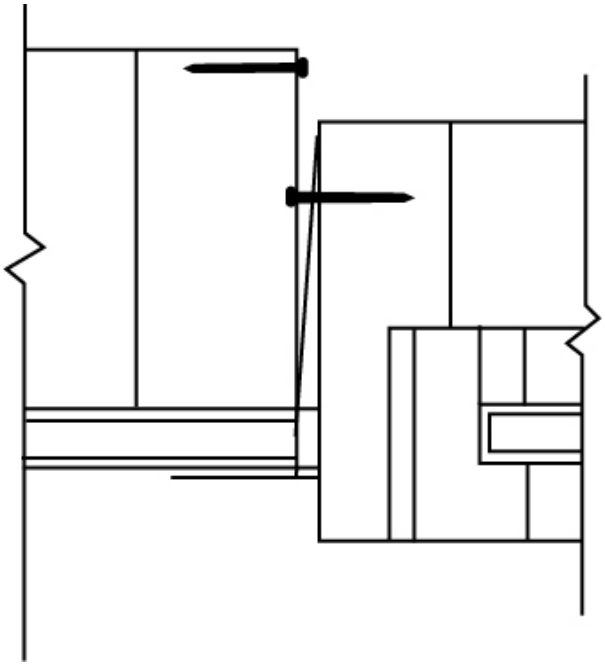


FIGURE R609.7.2(7)
FRAME CLIP

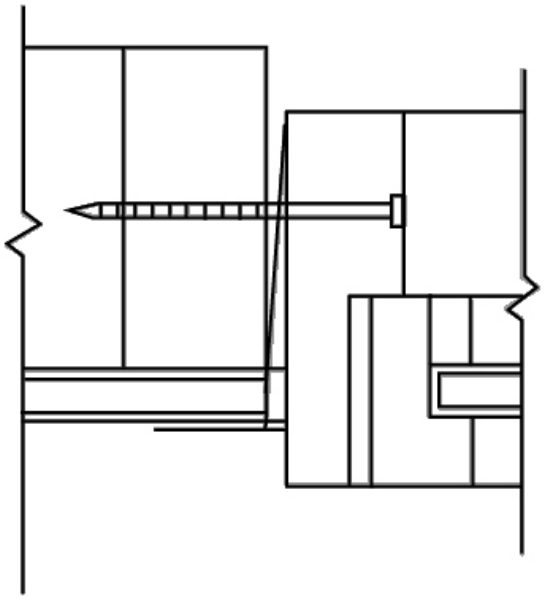


FIGURE R609.7.2(6)
THROUGH THE FLANGE

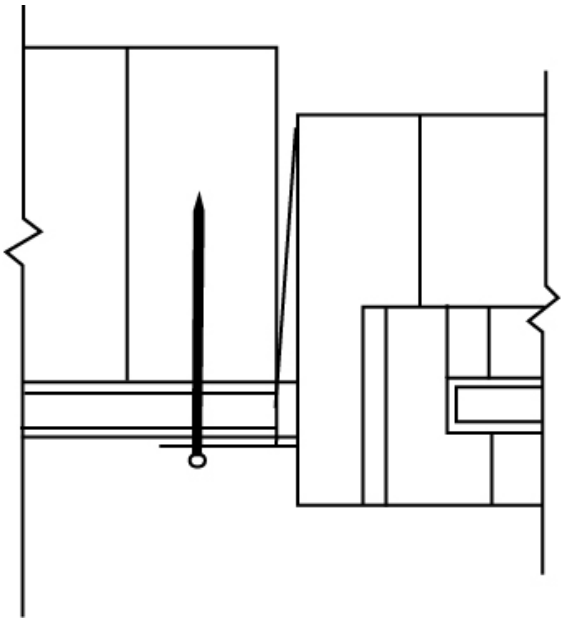


FIGURE R609.7.2(8)
THROUGH THE FLANGE

or truss span and not greater than two stories in height with each wall not greater than 10 feet (3048 mm) high. Exterior walls installed in accordance with the provisions of this section shall be considered as *load-bearing walls. Structural insulated panel* walls constructed in accordance with the provisions of this section shall be limited to sites where the ultimate design wind speed (V_{ult}) is not greater than 155 miles per hour (69 m/s) in Exposure B or 140 miles per hour (63 m/s) in Exposure C, the ground snow load is not greater than 70 pounds per square foot (3.35 kPa), and the seismic design category is A, B or C.

R610.3 Materials. SIPs shall comply with the requirements of ANSI/APA PRS 610.1.

R610.3.1 Lumber. The minimum lumber framing material used for SIPs prescribed in this document is NLGA graded No. 2 Spruce-pine-fir. Substitution of other wood species/grades that meet or exceed the mechanical properties and specific gravity of No. 2 Spruce-pine-fir shall be permitted.

R610.3.2 SIP screws. Screws used for the erection of SIPs as specified in Section R610.5 shall be fabricated from steel, shall be provided by the SIP manufacturer and shall be sized to penetrate the wood member to which the assembly is being attached by not less than 1 inch (25 mm). The screws shall be corrosion resistant and have a minimum shank diameter of 0.188 inch (4.7 mm) and a minimum head diameter of 0.620 inch (15.5 mm).

R610.3.3 Nails. Nails specified in Section R610 shall be common or galvanized box unless otherwise stated.

R610.4 SIP wall panels. SIPs shall comply with Figure R610.4 and shall have minimum *panel thickness* in accordance with Tables R610.5(1) and R610.5(2) for above-grade walls. SIPs shall be identified by grade *mark* or certificate of inspection issued by an *approved* agency in accordance with ANSI/APA PRS 610.1.

R610.5 Wall construction. Exterior walls of SIP construction shall be designed and constructed in accordance with the provisions of this section and Tables R610.5(1) and R610.5(2) and Figures R610.5(1) through R610.5(5). SIP walls shall be fastened to other wood building components in accordance with Tables R602.3(1) through R602.3(4).

Framing shall be attached in accordance with Table R602.3(1) unless otherwise provided for in Section R610.

R610.5.1 Top plate connection. SIP walls shall be capped with a double top plate installed to provide overlapping at corner, intersections and *splines* in accordance with Figure R610.5.1. The double top plates shall be made up of a single 2-by (nominal 2-inch) top plate having a width equal to the width of the panel core, and shall be recessed into the SIP below. Over this top plate a cap plate shall be placed. The cap plate width shall match the SIP thickness and overlap the facers on both sides of the panel. End joints in top plates shall be offset not less than 24 inches (610 mm).

R610.5.2 Bottom (sole) plate connection. SIP walls shall have full bearing on a sole plate having a width equal to the nominal width of the foam core. Where SIP walls are supported directly on continuous foundations, the wall wood sill plate shall be anchored to the foundation in accordance with Figure R610.5.2 and Section R403.1.

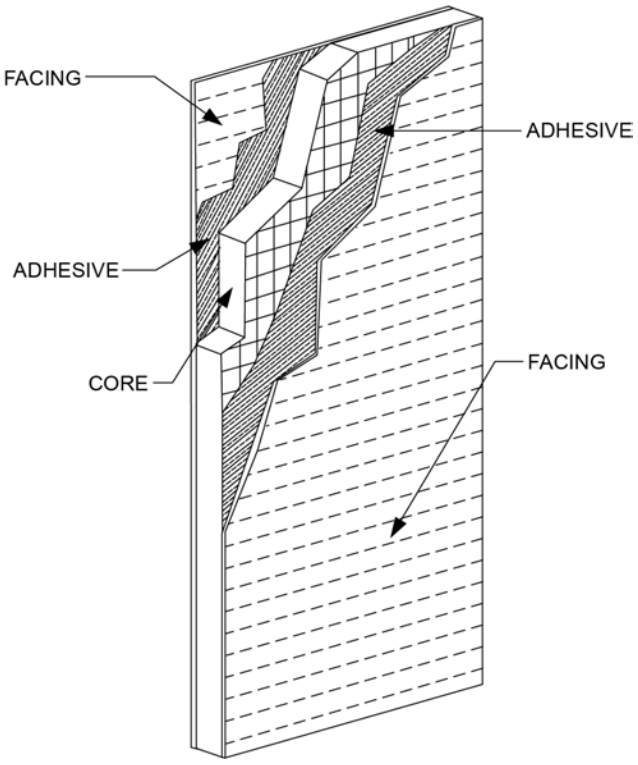


FIGURE R610.4
SIP WALL PANEL

R610.5.3 Panel-to-panel connection. SIPs shall be connected at vertical in-plane joints in accordance with Figure R610.8 or by other *approved* methods.

R610.5.4 Corner framing. Corner framing of SIP walls shall be constructed in accordance with Figure R610.5.4.

R610.5.5 Wall bracing. SIP walls shall be braced in accordance with Section R602.10. SIP walls shall be considered continuous wood structural panel sheathing (bracing Method CS-WSP) for purposes of computing required bracing. SIP walls shall meet the requirements of Section R602.10.4.2 except that SIP corners shall be fabricated as shown in Figure R610.8. Where SIP walls are used for wall bracing, the SIP bottom plate shall be attached to wood framing below in accordance with Table R602.3(1).

R610.5.6 Thermal barrier. SIP walls shall be separated from the interior of a building by an *approved* thermal barrier in accordance with Section R316.4.

R610.6 Interior load-bearing walls. Interior *load-bearing walls* shall be constructed as specified for exterior walls.

R610.7 Drilling and notching. The maximum vertical chase penetration in SIPs shall have a maximum side dimension of 2 inches (51 mm) centered in the panel. Vertical chases shall have a minimum spacing of 24 inches (610 mm) on center.

TABLE R610.5(1)
MINIMUM THICKNESS FOR SIP WALL SUPPORTING SIP OR LIGHT-FRAME ROOF ONLY (inches)[a]

BUILDING WIDTH (ft)																	
ULTIMATE DESIGN WIND SPEED V_{ult} (mph)		GROUND SNOW LOAD (psf)	24			28			32			36			40		
Exp. B	Exp. C		Wall Height (feet)			Wall Height (feet)			Wall Height (feet)			Wall Height (feet)			Wall Height (feet)		
			8	9	10	8	9	10	8	9	10	8	9	10	8	9	10
110	—	20	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
		30	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
		50	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
		70	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	6.5	4.5	4.5	6.5
115	—	20	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
		30	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
		50	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	6.5
		70	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	6.5	4.5	4.5	DR	4.5	4.5	DR
130	110	20	4.5	4.5	6.5	4.5	4.5	6.5	4.5	4.5	6.5	4.5	4.5	DR	4.5	4.5	DR
		30	4.5	4.5	6.5	4.5	4.5	6.5	4.5	4.5	DR	4.5	4.5	DR	4.5	4.5	DR
		50	4.5	4.5	DR	4.5	4.5	DR	4.5	4.5	DR	4.5	6.5	DR	4.5	DR	DR
		70	4.5	4.5	DR	4.5	DR	DR	4.5	DR	DR	4.5	DR	DR	DR	DR	DR
140	120	20	4.5	6.5	DR	4.5	6.5	DR	4.5	DR	DR	4.5	DR	DR	4.5	DR	DR
		30	4.5	6.5	DR	4.5	DR	DR	4.5	DR	DR	4.5	DR	DR	4.5	DR	DR
		50	4.5	DR	DR	4.5	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR
		70	4.5	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa, 1 mile per hour = 0.447 m/s.
DR = Design Required.

a. Design assumptions:
Maximum deflection criteria: L/240.
Maximum roof dead load: 10 psf.
Maximum roof live load: 70 psf.
Maximum ceiling dead load: 5 psf.
Maximum ceiling live load: 20 psf.
Wind loads based on Table R301.2.1(1).
Strength axis of facing material applied vertically.

Not more than two horizontal chases shall be permitted in each wall panel, one at 14 inches (360 mm) plus or minus 2 inches (51 mm) from the bottom of the panel and one at 48 inches (1220 mm) plus or minus 2 inches (51 mm) from the bottom edge of the SIP's panel. Additional penetrations are permitted where justified by analysis.

R610.8 Headers. SIP headers shall be designed and constructed in accordance with Table R610.8 and Figure R610.5.1. SIP headers shall be continuous sections without *splines*. Headers shall be not less than $11^{7}/_{8}$ inches (302 mm) deep. Headers longer than 4 feet (1219 mm) shall be constructed in accordance with Section R602.7. The strength axis of the factors on the header shall be oriented horizontally.

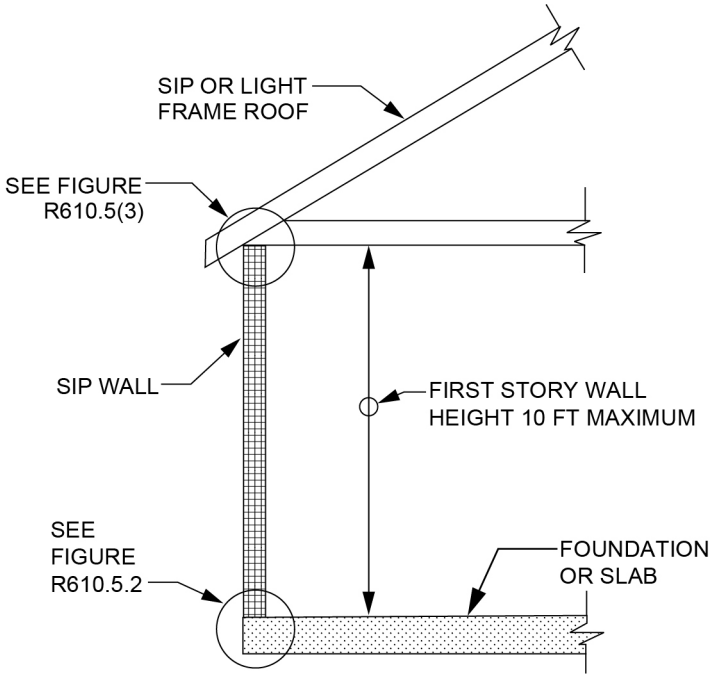
R610.8.1 Wood structural panel box headers. Wood structural panel box headers shall be allowed where SIP headers are not applicable. Wood structural panel box headers shall be constructed in accordance with Figure R602.7.3 and Table R602.7.3.

TABLE R610.5(2)
MINIMUM THICKNESS FOR SIP WALL SUPPORTING SIP OR LIGHT-FRAME ONE STORY AND ROOF ONLY (inches)[a]

BUILDING WIDTH (ft)																	
ULTIMATE DESIGN WIND SPEED V_{ult} (mph)		GROUND SNOW LOAD (psf)	24			28			32			36			40		
Exp. B	Exp. C		Wall Height (feet)			Wall Height (feet)			Wall Height (feet)			Wall Height (feet)			Wall Height (feet)		
			8	9	10	8	9	10	8	9	10	8	9	10	8	9	10
110	—	20	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	6.5	4.5	4.5	DR	4.5	4.5	DR
		30	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	6.5	4.5	4.5	DR	4.5	6.5	DR
		50	4.5	4.5	4.5	4.5	4.5	6.5	4.5	4.5	DR	4.5	DR	DR	DR	DR	DR
		70	4.5	4.5	6.5	4.5	4.5	DR	4.5	DR	DR	DR	DR	DR	DR	DR	DR
115	—	20	4.5	4.5	4.5	4.5	4.5	6.5	4.5	4.5	DR	4.5	4.5	DR	4.5	DR	DR
		30	4.5	4.5	4.5	4.5	4.5	6.5	4.5	4.5	DR	4.5	6.5	DR	4.5	DR	DR
		50	4.5	4.5	6.5	4.5	4.5	DR	4.5	DR	DR	4.5	DR	DR	DR	DR	DR
		70	4.5	4.5	DR	4.5	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR
120	—	20	4.5	4.5	6.5	4.5	4.5	DR	4.5	4.5	DR	4.5	DR	DR	4.5	DR	DR
		30	4.5	4.5	DR	4.5	4.5	DR	4.5	6.5	DR	4.5	DR	DR	DR	DR	DR
		50	4.5	4.5	DR	4.5	DR	DR	4.5	DR	DR	DR	DR	DR	DR	DR	DR
		70	4.5	DR	DR	4.5	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR
130	110	20	4.5	6.5	DR	4.5	DR	DR	4.5	DR	DR	DR	DR	DR	DR	DR	DR
		30	4.5	DR	DR	4.5	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR
		50	4.5	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR
		70	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa, 1 mile per hour = 0.447 m/s.
DR = Design Required.

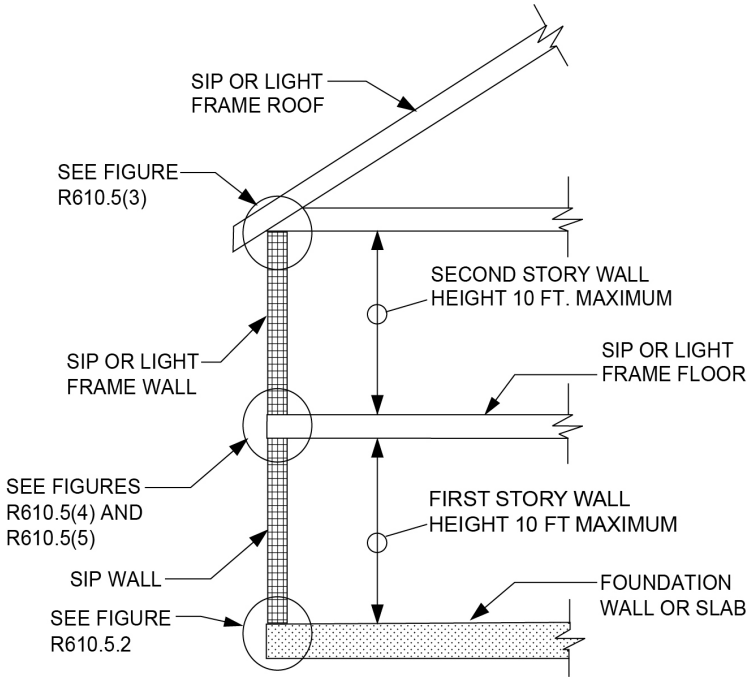
a. Design assumptions:
Maximum deflection criteria: L/240.
Maximum roof dead load: 10 psf.
Maximum roof live load: 70 psf.
Maximum ceiling dead load: 5 psf.
Maximum ceiling live load: 20 psf.
Maximum second-floor dead load: 10 psf.
Maximum second-floor live load: 30 psf.
Maximum second-floor dead load from walls: 10 psf.
Maximum first-floor dead load: 10 psf.
Maximum first-floor live load: 40 psf.
Wind loads based on Table R301.2.1(1).
Strength axis of facing material applied vertically.



For SI: 1 foot = 304.8 mm.

Note: Figure illustrates SIP-specific attachment requirements. Other connections shall be made in accordance with Tables R602.3(1) and R602.3(2), as appropriate.

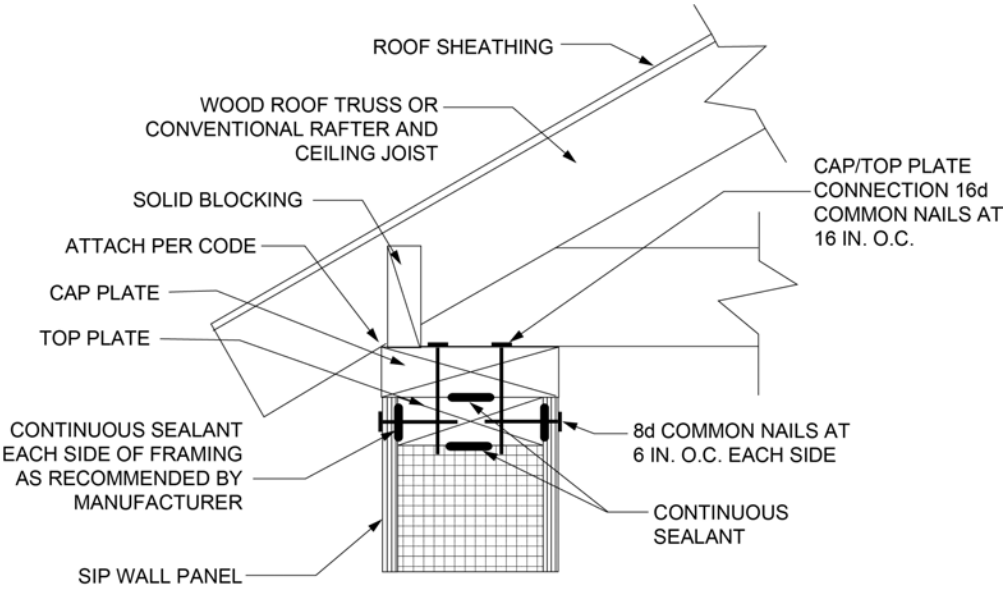
FIGURE R610.5(1)
MAXIMUM ALLOWABLE HEIGHT OF SIP WALLS



For SI: 1 foot = 304.8 mm.

Note: Figure illustrates SIP-specific attachment requirements. Other connections shall be made in accordance with Tables R602.3(1) and R602.3(2), as appropriate.

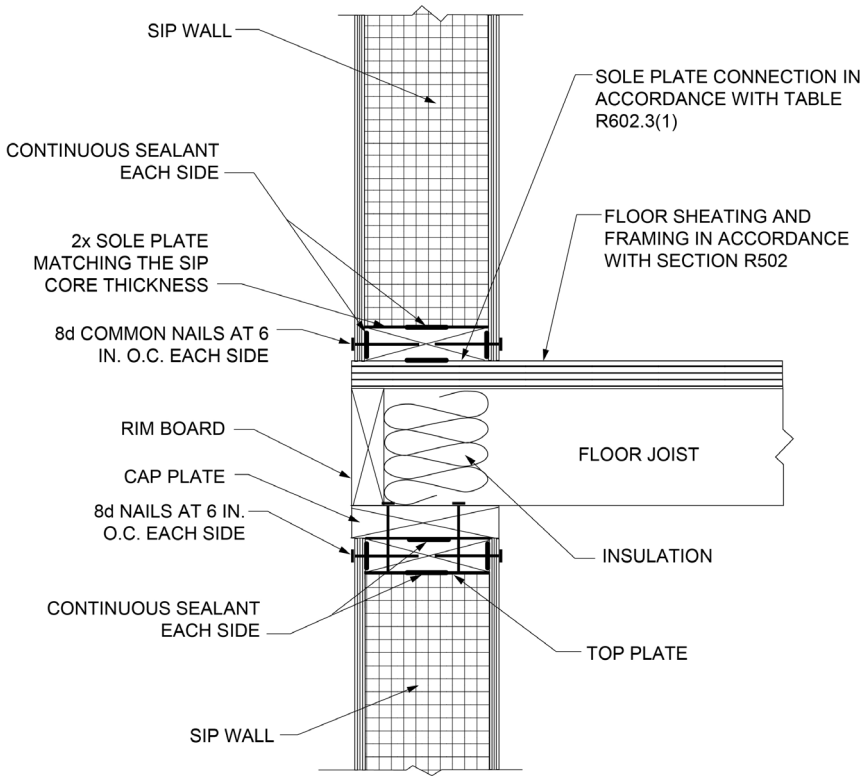
FIGURE R610.5(2)
MAXIMUM ALLOWABLE HEIGHT OF SIP WALLS



For SI: 1 inch = 25.4 mm.

Note: Figure illustrates SIP-specific attachment requirements. Other connections shall be made in accordance with Tables R602.3(1) and R602.3(2), as appropriate.

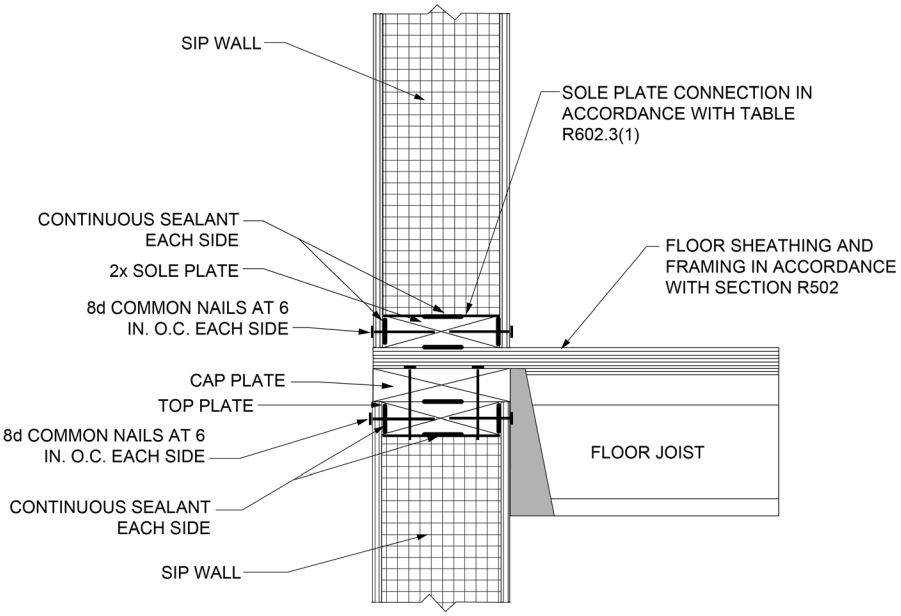
FIGURE R610.5(3)
TRUSSED ROOF TO TOP PLATE CONNECTION



For SI: 1 inch = 25.4 mm.

Note: Figure illustrates SIP-specific attachment requirements. Other connections shall be made in accordance with Tables R602.3(1) and R602.3(2), as appropriate.

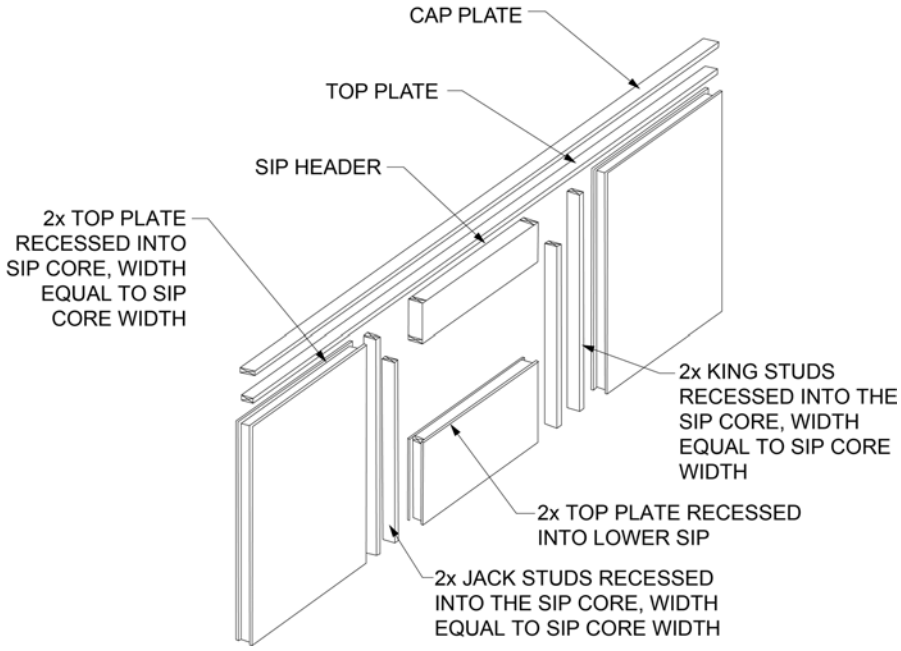
FIGURE R610.5(4)
SIP WALL-TO-WALL PLATFORM FRAME CONNECTION



For SI: 1 inch = 25.4 mm.

Note: Figure illustrates SIP-specific attachment requirements. Other connections shall be made in accordance with Tables R602.3(1) and R602.3(2), as appropriate.

FIGURE R610.5(5)
SIP WALL-TO-WALL HANGING FLOOR FRAME CONNECTION
(I-Joist floor shown for Illustration only)



For SI: 1 inch = 25.4 mm.

Notes:

1. Top plates shall be continuous over header.
2. Lower 2x top plate shall have a width equal to the SIP core width and shall be recessed into the top edge of the panel. Cap plate shall be placed over the recessed top plate and shall have a width equal to the SIP's width.
3. SIP facing surfaces shall be nailed to framing and cripples with 8d common or galvanized box nails spaced 6 inches on center.

FIGURE R610.5.1
SIP WALL FRAMING CONFIGURATION