2021 Virginia Construction Code

CHAPTER 16 STRUCTURAL DESIGN

SECTION 1607
LIVE LOADS

1607.1 General.

Live loads are those loads defined in Chapter 2 of this code.

TABLE 1607.1
MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS, L_o, AND MINIMUM CONCENTRATED LIVE LOADS

	OCCUPANCY OR USE		UNIFORM (psf)	CONCENTRATED (pounds)	ALSO SEE SECTION
1.	Apartments (see residential)		—	—	—
2.	Access floor systems	Office use	50	2,000	—
		Computer use	100	2,000	—
3.	Armories and drill rooms		150[b]	—	—
4.	Assembly areas	Fixed seats (fastened to floor)	60[a]	—	—
		Follow spot, projections and control rooms	50		
		Lobbies	100[a]		
		Movable seats	100[a]		
		Stage floors	150[b]		
		Platforms (assembly)	100[a]		
		Bleachers, folding and telescopic seating and grandstands	100[a] (See Section 1607.19)		
		Stadiums and arenas with fixed seats (fastened to the floor)	60[a] (See Section 1607.19)		
		Other assembly areas	100[a]		
5.	Balconies and decks		1.5 times the live load for the area served, not required to exceed 100	—	—
6.	Catwalks for maintenance and service access		40	300	—
7.	Cornices		60	—	—
8.	Corridors	First floor	100	—	—
		Other floors	Same as occupancy served except as indicated		
9.	Dining rooms and restaurants		100[a]	—	—
10.	Dwellings (see residential)		—	—	—
11.	Elevator machine room and control room grating (on area of 2 inches by 2 inches)		—	300	—
12.	Finish light floor plate construction (on area of 1 inch by 1 inch)		—	200	—
13.	Fire escapes		100	—	—
		On single-family dwellings only	40		

Copyright © 2024 International Code Council, Inc., or its licensors (ALL RIGHTS RESERVED).
Accessed by Venkatesh Shanmugam on 11/14/2024 pursuant to License Agreement with ICC. No further reproduction or distribution authorized. Any Unauthorized reproduction or distribution is a violation of the federal copyright, and subject to civil and criminal penalties thereunder.

PDF from: http://codes.iccsafe.org/content/VACC2021P1/chapter-16-structural-design#VACC2021P1_Ch16_Sec1607

14.	Fixed ladders		See Section 1607.17		—
15.	Garages	Passenger vehicles only	40[c]	See Section 1607.7	—
		Trucks and buses	See Section 1607.8		
16.	Handrails, guards and grab bars		See Section 1607.9		—
17.	Helipads		See Section 1607.6		—
18.	Hospitals	Corridors above first floor	80	1,000	—
		Operating rooms, laboratories	60	1,000	
		Patient rooms	40	1,000	
19.	Hotels (see residential)		—	—	—
20.	Libraries	Corridors above first floor	80	1,000	—
		Reading rooms	60	1,000	—
		Stack rooms	150[b]	1,000	Section 1607.18
21.	Manufacturing	Heavy	250[b]	3,000	—
		Light	125[b]	2,000	
22.	Marquees, except one- and two-family dwellings		75	—	—
23.	Office buildings	Corridors above first floor	80	2,000	—
		File and computer rooms shall be designed for heavier loads based on anticipated occupancy	—	—	
		Lobbies and first-floor corridors	100	2,000	
		Offices	50	2,000	
24.	Penal institutions	Cell blocks	40	—	—
		Corridors	100		
25.	Recreational uses	Bowling alleys, poolrooms and similar uses	75[a]	—	—
		Dance halls and ballrooms	100[a]		
		Gymnasiums	100[a]		
		Ice skating rinks	250[b]		
		Roller skating rinks	100[a]		
26.	Residential	One- and two-family dwellings:		—	Section 1607.22
		Uninhabitable attics without storage	10		
		Uninhabitable attics with storage	20		
		Habitable attics and sleeping areas	30		
		Canopies, including marquees	20		
		All other areas	40		
		Hotels and multifamily dwellings:			
		Private rooms and corridors serving them	40		
		Public rooms[a] and corridors serving them	100		

Copyright © 2024 International Code Council, Inc., or its licensors (ALL RIGHTS RESERVED).
Accessed by Venkatesh Shanmugam on 11/14/2024 pursuant to License Agreement with ICC. No further reproduction or distribution authorized. Any Unauthorized reproduction or distribution is a violation of the federal copyright, and subject to civil and criminal penalties thereunder.

PDF from: http://codes.iccsafe.org/content/VACC2021P1/chapter-16-structural-design#VACC2021P1_Ch16_Sec1607

27.	Roofs	Ordinary flat, pitched, and curved roofs (that are not occupiable)	20	—	Section 1607.14.2
		Roof areas used for assembly purposes	100[a]	—	
		Roof areas used for occupancies other than assembly	Same as occupancy served	—	
		Vegetative and landscaped roofs:		—	
		Roof areas not intended for occupancy	20	—	
		Roof areas used for assembly purposes	100[a]	—	
		Roof areas used for other occupancies	Same as occupancy served	—	
		Awnings and canopies:		—	
		Fabric construction supported by a skeleton structure	5[a]	—	
		All other construction, except one- and two-family dwellings	20	—	
		Primary roof members exposed to a work floor:			Section 1607.15.2
		Single panel point of lower chord of roof trusses or any point along primary structural members supporting roofs over manufacturing, storage warehouses, and repair garages	—	2,000	
		All other primary roof members	—	300	
		All roof surfaces subject to maintenance workers	—	300	
28.	Schools	Classrooms	40	1,000	—
		Corridors above first floor	80	1,000	
		First-floor corridors	100	1,000	
29.	Scuttles, skylight ribs and accessible ceilings		—	200	—
30.	Sidewalks, vehicular driveways and yards, subject to trucking		250[b]	8,000	Section 1607.20
31.	Stairs and exits	One- and two-family dwellings	40	300	Section 1607.21
		All other	100	300	Section 1607.21
32.	Storage areas above ceilings		20	—	—
33.	Storage warehouses (shall be designed for heavier loads if required for anticipated storage)	Heavy	250[b]	—	—
		Light	125[b]		
34.	Stores	Retail:			—
		First floor	100	1,000	
		Upper floors	75	1,000	
		Wholesale, all floors	125[b]	1,000	
35.	Vehicle barriers		See Section 1607.10		—

Copyright © 2024 International Code Council, Inc., or its licensors (ALL RIGHTS RESERVED).
Accessed by Venkatesh Shanmugam on 11/14/2024 pursuant to License Agreement with ICC. No further reproduction or distribution authorized. Any Unauthorized reproduction or distribution is a violation of the federal copyright, and subject to civil and criminal penalties thereunder.

PDF from: http://codes.iccsafe.org/content/VACC2021P1/chapter-16-structural-design#VACC2021P1_Ch16_Sec1607

36.	Walkways and elevated platforms (other than exitways)	60	—	—
37.	Yards and terraces, pedestrian	100[a]	—	—

For SI: 1 inch = 25.4 mm, 1 square inch = 645.16 mm^2, 1 square foot = 0.0929 m^2, 1 pound per square foot = 0.0479 kN/m^2, 1 pound = 0.004448 kN, 1 pound per cubic foot = 16 kg/m^3.

a. Live load reduction is not permitted.
b. Live load reduction is only permitted in accordance with Section 1607.12.1.2 or Item 1 of Section 1607.12.2.
c. Live load reduction is only permitted in accordance with Section 1607.12.1.3 or Item 2 of Section 1607.12.2.

1607.2 Loads not specified.

For occupancies or uses not designated in Section 1607, the *live load* shall be determined in accordance with a method *approved* by the *building official*.

1607.3 Uniform live loads.

The *live loads* used in the design of buildings and *other structures* shall be the maximum loads expected by the intended use or occupancy but shall not be less than the minimum uniformly distributed *live loads* given in Table 1607.1.

1607.4 Concentrated live loads.

Floors, roofs and other similar surfaces shall be designed to support the uniformly distributed *live loads* prescribed in Section 1607.3 or the concentrated *live loads*, given in Table 1607.1, whichever produces the greater *load effects*. Unless otherwise specified, the indicated concentration shall be assumed to be uniformly distributed over an area of $2^1/_2$ feet by $2^1/_2$ feet (762 mm by 762 mm) and shall be located so as to produce the maximum *load effects* in the structural members.

1607.5 Partition loads.

In office buildings and in other buildings where partition locations are subject to change, provisions for partition weight shall be made, whether or not partitions are shown on the construction documents, unless the specified *live load* is 80 psf (3.83 kN/m^2) or greater. The partition *load* shall be not less than a uniformly distributed *live load* of 15 psf (0.72 kN/m^2).

1607.6 Helipads.

Helipads shall be designed for the following *live loads*:

1. A uniform *live load*, *L*, as specified in Items 1.1 and 1.2. This *load* shall not be reduced.
   1.1. 40 psf (1.92 kN/m^2) where the design basis helicopter has a maximum take-off weight of 3,000 pounds (13.35 kN) or less.
   1.2. 60 psf (2.87 kN/m^2) where the design basis helicopter has a maximum take-off weight greater than 3,000 pounds (13.35 kN).
2. A single concentrated *live load*, *L*, of 3,000 pounds (13.35 kN) applied over an area of 4.5 inches by 4.5 inches (114 mm by 114 mm) and located so as to produce the maximum *load effects* on the structural elements under consideration. The concentrated *load* is not required to act concurrently with other uniform or concentrated *live loads*.
3. Two single concentrated *live loads*, *L*, 8 feet (2438 mm) apart applied on the landing pad (representing the helicopter's two main landing gear, whether skid type or wheeled type), each having a magnitude of 0.75 times the maximum take-off weight of the helicopter, and located so as to produce the maximum *load effects* on the structural elements under consideration. The concentrated loads shall be applied over an area of 8 inches by 8 inches (203 mm by 203 mm) and are not required to act concurrently with other uniform or concentrated *live loads*.

Landing areas designed for a design basis helicopter with maximum take-off weight of 3,000 pounds (13.35 kN) shall be identified with a 3,000-pound (13.34 kN) weight limitation. The landing area weight limitation shall be indicated by the numeral "3" (kips) located in the bottom right corner of the landing area as viewed from the primary approach path. The indication for the landing area weight limitation shall be a minimum 5 feet (1524 mm) in height.

1607.7 Passenger vehicle garages.

Copyright © 2024 International Code Council, Inc., or its licensors (ALL RIGHTS RESERVED).
Accessed by Venkatesh Shanmugam on 11/14/2024 pursuant to License Agreement with ICC. No further reproduction or distribution authorized. Any Unauthorized reproduction or distribution is a violation of the federal copyright, and subject to civil and criminal penalties thereunder.

PDF from: http://codes.iccsafe.org/content/VACC2021P1/chapter-16-structural-design#VACC2021P1_Ch16_Sec1607

Floors in garages or portions of a building used for the storage of motor vehicles shall be designed for the uniformly distributed *live loads* indicated in Table 1607.1 or the following concentrated *load*:

1. For garages restricted to passenger vehicles accommodating not more than nine passengers, 3,000 pounds (13.35 kN) acting on an area of 4.5 inches by 4.5 inches (114 mm by 114 mm).
2. For mechanical parking structures without slab or deck that are used for storing passenger vehicles only, 2,250 pounds (10 kN) per wheel.

1607.8 Heavy vehicle loads.

Floors and other surfaces that are intended to support vehicle *loads* greater than a 10,000-pound (4536 kg) gross vehicle weight rating shall comply with Sections 1607.8.1 through 1607.8.5.

1607.8.1 Loads.

Where any structure does not restrict access for vehicles that exceed a 10,000-pound (4536 kg) gross vehicle weight rating, those portions of the structure subject to such *loads* shall be designed using the vehicular *live loads*, including consideration of impact and fatigue, in accordance with the codes and specifications required by the jurisdiction having authority for the design and construction of the roadways and bridges in the same location of the structure.

1607.8.2 Fire truck and emergency vehicles.

Where a structure or portions of a structure are accessed and loaded by fire department access vehicles and other similar emergency vehicles, the structure shall be designed for the greater of the following *loads*:

1. The actual operational *loads*, including outrigger reactions and contact areas of the vehicles as stipulated and *approved* by the *building official*.
2. The live loading specified in Section 1607.8.1.

1607.8.3 Heavy vehicle garages.

Garages designed to accommodate vehicles that exceed a 10,000-pound (4536 kg) gross vehicle weight rating, shall be designed using the live loading specified by Section 1607.8.1. For garages the design for impact and fatigue is not required.

Exception: The vehicular *live loads* and *load* placement are allowed to be determined using the actual vehicle weights for the vehicles allowed onto the garage floors, provided that such *loads* and placement are based on rational engineering principles and are approved by the building official, but shall be not less than 50 psf (2.9 kN/m^2). This *live load* shall not be reduced.

1607.8.4 Forklifts and movable equipment.

Where a structure is intended to have forklifts or other movable equipment present, the structure shall be designed for the total vehicle or equipment *load* and the individual wheel *loads* for the anticipated vehicles as specified by the owner of the facility. These *loads* shall be posted in accordance with Section 1607.8.5.

1607.8.4.1 Impact and fatigue.

Impact loads and fatigue loading shall be considered in the design of the supporting structure. For the purposes of design, the vehicle and wheel *loads* shall be increased by 30 percent to account for impact.

1607.8.5 Posting.

The maximum weight of vehicles allowed into or on a garage or other structure shall be posted by the *owner* or the *owner's* authorized agent.

1607.9 Loads on handrails, guards, grab bars and seats.

Handrails and *guards* shall be designed and constructed for the structural loading conditions set forth in Section 1607.9.1. Grab bars, shower seats and accessible benches shall be designed and constructed for the structural loading conditions set forth in Section 1607.9.2.

1607.9.1 Handrails and guards.

Handrails and *guards* shall be designed to resist a linear *load* of 50 pounds per linear foot (plf) (0.73 kN/m) in accordance with Section 4.5.1.1 of ASCE 7. Glass *handrail* assemblies and *guards* shall comply with Section 2407.

Exceptions:

1. For one- and two-family dwellings, only the single concentrated *load* required by Section 1607.9.1.1 shall be applied.
2. In Group I-3, F, H and S occupancies, for areas that are not accessible to the general public and that have an *occupant load* less than 50, the minimum *load* shall be 20 pounds per foot (0.29 kN/m).

1607.9.1.1 Concentrated load.

Handrails and *guards* shall be designed to resist a concentrated *load* of 200 pounds (0.89 kN) in accordance with Section 4.5.1 of ASCE 7.

Copyright © 2024 International Code Council, Inc., or its licensors (ALL RIGHTS RESERVED).
Accessed by Venkatesh Shanmugam on 11/14/2024 pursuant to License Agreement with ICC. No further reproduction or distribution authorized. Any Unauthorized reproduction or distribution is a violation of the federal copyright, and subject to civil and criminal penalties thereunder.

PDF from: http://codes.iccsafe.org/content/VACC2021P1/chapter-16-structural-design#VACC2021P1_Ch16_Sec1607

1607.9.1.2 Guard component loads.

Balusters, panel fillers and guard infill components, including all rails except the handrail and the top rail, shall be designed to resist a concentrated load of 50 pounds (0.22 kN) in accordance with Section 4.5.1.2 of ASCE 7.

1607.9.2 Grab bars, shower seats and accessible benches.

Grab bars, shower seats and accessible benches shall be designed to resist a single concentrated *load* of 250 pounds (1.11 kN) applied in any direction at any point on the grab bar, shower seat, or seat of the accessible bench so as to produce the maximum *load effects*.

1607.10 Vehicle barriers.

Vehicle barriers for passenger vehicles shall be designed to resist a concentrated *load* of 6,000 pounds (26.70 kN) in accordance with Section 4.5.3 of ASCE 7. Garages accommodating trucks and buses shall be designed in accordance with an *approved* method that contains provisions for traffic railings.

1607.11 Impact loads.

The *live loads* specified in Sections 1607.3 through 1607.10 shall be assumed to include adequate allowance for ordinary impact conditions. Provisions shall be made in the structural design for uses and loads that involve unusual vibration and impact forces.

1607.11.1 Elevators.

Members, elements and components subject to dynamic *loads* from elevators shall be designed for *impact loads* and deflection limits prescribed by ASME A17.1/CSA B44.

1607.11.2 Machinery.

For the purpose of design, the weight of machinery and moving *loads* shall be increased as follows to allow for impact:

1. Light machinery, shaft- or motor-driven, 20 percent.
2. Reciprocating machinery or power-driven units, 50 percent.

Percentages shall be increased where specified by the manufacturer.

1607.11.3 Elements supporting hoists for façade access and building maintenance equipment.

In addition to any other applicable *live loads*, structural elements that support hoists for façade access and building maintenance equipment shall be designed for a *live load* of 2.5 times the rated *load* of the hoist or the stall *load* of the hoist, whichever is larger.

1607.11.4 Fall arrest, lifeline, and rope descent system anchorages.

In addition to any other applicable *live loads*, fall arrest, lifeline, and rope descent system anchorages and structural elements that support these anchorages shall be designed for a *live load* of not less than 3,100 pounds (13.8 kN) for each attached line, in any direction that the *load* can be applied.

Anchorages of horizontal lifelines and the structural elements that support these anchorages shall be designed for the maximum tension that develops in the horizontal lifeline from these *live loads*.

1607.12 Reduction in uniform live loads.

Except for uniform *live loads* at roofs, all other minimum uniformly distributed *live loads*, L_o, in Table 1607.1 are permitted to be reduced in accordance with Section 1607.12.1 or 1607.12.2. Uniform *live loads* at roofs are permitted to be reduced in accordance with Section 1607.14.2.

1607.12.1 Basic uniform live load reduction.

Subject to the limitations of Sections 1607.12.1.1 through 1607.12.1.3 and Table 1607.1, members for which a value of $K_{LL}A_T$ is 400 square feet (37.16 m^2) or more are permitted to be designed for a reduced uniformly distributed *live load*, L, in accordance with the following equation:

$$L = L_o\left(0.25 + \frac{15}{\sqrt{K_{LL}A_T}}\right)$$

$$\text{For SI: } L = L_o\left(0.25 + \frac{4.57}{\sqrt{K_{LL}A_T}}\right) \qquad \textbf{(Equation 16-7)}$$

where:

L = Reduced design *live load* per square foot (m^2) of area supported by the member.

L_o = Unreduced design *live load* per square foot (m^2) of area supported by the member (see Table 1607.1).

K_{LL} = *Live load* element factor (see Table 1607.12.1).

A_T = Tributary area, in square feet (m^2).

L shall be not less than $0.5L_o$ for members supporting one floor and L shall be not less than $0.4L_o$ for members

Copyright © 2024 International Code Council, Inc., or its licensors (ALL RIGHTS RESERVED).
Accessed by Venkatesh Shanmugam on 11/14/2024 pursuant to License Agreement with ICC. No further reproduction or distribution authorized. Any Unauthorized reproduction or distribution is a violation of the federal copyright, and subject to civil and criminal penalties thereunder.

PDF from: http://codes.iccsafe.org/content/VACC2021P1/chapter-16-structural-design#VACC2021P1_Ch16_Sec1607

supporting two or more floors.

TABLE 1607.12.1
LIVE LOAD ELEMENT FACTOR, K_{LL}

ELEMENT	K_{LL}
Interior columns	4
Exterior columns without cantilever slabs	4
Edge columns with cantilever slabs	3
Corner columns with cantilever slabs	2
Edge beams without cantilever slabs	2
Interior beams	2
Members not previously identified including: Edge beams with cantilever slabs Cantilever beams One-way slabs Two-way slabs Members without provisions for continuous shear transfer normal to their span	1

1607.12.1.1 One-way slabs.
The tributary area, A_T, for use in Equation 16-7 for one-way slabs shall not exceed an area defined by the slab span times a width normal to the span of 1.5 times the slab span.

1607.12.1.2 Heavy live loads.
Live loads that exceed 100 psf (4.79 kN/m^2) shall not be reduced.

Exceptions:

1. The *live loads* for members supporting two or more floors are permitted to be reduced by not greater than 20 percent, but the *live load* shall be not less than *L* as calculated in Section 1607.12.1.
2. For uses other than storage, where *approved*, additional *live load* reductions shall be permitted where shown by the *registered design professional* that a rational approach has been used and that such reductions are warranted.

1607.12.1.3 Passenger vehicle garages.
The *live loads* shall not be reduced in passenger vehicle garages.

Exception: The *live loads* for members supporting two or more floors are permitted to be reduced by not greater than 20 percent, but the *live load* shall be not less than *L* as calculated in Section 1607.12.1.

1607.12.2 Alternative uniform live load reduction.
As an alternative to Section 1607.12.1 and subject to the limitations of Table 1607.1, uniformly distributed *live loads* are permitted to be reduced in accordance with the following provisions. Such reductions shall apply to slab systems, beams, girders, columns, piers, walls and foundations.

1. A reduction shall not be permitted where the *live load* exceeds 100 psf (4.79 kN/m^2) except that the design *live load* for members supporting two or more floors is permitted to be reduced by not greater than 20 percent.

   Exception: For uses other than storage, where *approved*, additional *live load* reductions shall be permitted where shown by the *registered design professional* that a rational approach has been used and that such reductions are warranted.
2. A reduction shall not be permitted in passenger vehicle parking garages except that the *live loads* for members supporting two or more floors are permitted to be reduced by not greater than 20 percent.
3. For *live loads* not exceeding 100 psf (4.79 kN/m^2), the design *live load* for any structural member supporting 150 square feet (13.94 m^2) or more is permitted to be reduced in accordance with Equation 16-8
4. For one-way slabs, the area, *A*, for use in Equation 16-8 shall not exceed the product of the slab span and a width normal to the span of 0.5 times the slab span.

$$R = 0.08(A - 150)$$

For SI: $R = 0.861(A - 13.94)$ **(Equation 16-8)**

Such reduction shall not exceed the smallest of:

Copyright © 2024 International Code Council, Inc., or its licensors (ALL RIGHTS RESERVED).
Accessed by Venkatesh Shanmugam on 11/14/2024 pursuant to License Agreement with ICC. No further reproduction or distribution authorized. Any Unauthorized reproduction or distribution is a violation of the federal copyright, and subject to civil and criminal penalties thereunder.

PDF from: http://codes.iccsafe.org/content/VACC2021P1/chapter-16-structural-design#VACC2021P1_Ch16_Sec1607

1. 40 percent for members supporting one floor.
2. 60 percent for members supporting two or more floors.
3. R as determined by the following equation:

$$R = 23.1(1 + D/L_o)$$

where: **(Equation 16-9)**

A = Area of floor supported by the member, square feet (m^2).

D = *Dead load* per square foot (m^2) of area supported.

L_o = Unreduced *live load* per square foot (m^2) of area supported.

R = Reduction in percent.

1607.13 Distribution of floor loads.

Where uniform floor *live loads* are involved in the design of structural members arranged so as to create continuity, the minimum applied loads shall be the full *dead loads* on all spans in combination with the floor *live loads* on spans selected to produce the greatest *load effect* at each location under consideration. Floor *live loads* are permitted to be reduced in accordance with Section 1607.12 .

1607.14 Roof loads.

The structural supports of roofs and marquees shall be designed to resist wind and, where applicable, tornado, snow and earthquake loads, in addition to the dead load of *construction* and the appropriate live loads as prescribed in this section, or as set forth in Table 1607.1. The live loads acting on a sloping surface shall be assumed to act vertically on the horizontal projection of that surface.

1607.14.1 Distribution of roof loads.

Where uniform roof live *loads* are reduced to less than 20 psf (0.96 kN/m^2) in accordance with Section 1607.14.2.1 and are applied to the design of structural members arranged so as to create continuity, the reduced roof *live load* shall be applied to adjacent spans or to alternate spans, whichever produces the most unfavorable *load effect*. See Section 1607.14.2 for reductions in minimum roof *live loads* and Section 7.5 of ASCE 7 for partial snow loading.

1607.14.2 Reduction in uniform roof live loads.

The minimum uniformly distributed *live loads* of roofs and *marquees*, L_o, in Table 1607.1 are permitted to be reduced in accordance with Section 1607.14.2.1.

1607.14.2.1 Ordinary roofs, awnings and canopies.

Ordinary flat, pitched and curved roofs, and *awnings* and canopies other than of fabric construction supported by a skeleton structure, are permitted to be designed for a reduced uniformly distributed *roof live load*, L_r, as specified in the following equations or other controlling combinations of *loads* as specified in Section 1605, whichever produces the greater *load effect*.

In structures such as *greenhouses*, where special scaffolding is used as a work surface for workers and materials during maintenance and repair operations, a lower roof *load* than specified in the following equations shall not be used unless *approved* by the *building official*. Such structures shall be designed for a minimum roof live *load* of 12 psf (0.58 kN/m^2).

$$L_r = L_o R_1 R_2$$

where: $12 \le L_r \le 20$ **(Equation 16-10)**

For SI: $L_r = L_o R_1 R_2$

where: $0.58 \le L_r \le 0.96$

L_o = Unreduced *roof live load* per square foot (m^2) of horizontal projection supported by the member (see Table 1607.1).

L_r = Reduced *roof live load* per square foot (m^2) of horizontal projection supported by the member.

The reduction factors R_1 and R_2 shall be determined as follows:

$$R_1 = 1 \text{ for } A_t \le 200 \text{ square feet } (18.58\ m^2)$$

$$R_1 = 1.2 - 0.001A_t \text{ for } 200 \text{ square feet} < A_t < 600 \text{ square feet}$$ **(Equation 16-11)**

For SI: $1.2 - 0.011A_t$ for 18.58 square meters $< A_t <$ 55.74 square meters **(Equation 16-12)**

$$R_1 = 0.6 \text{ for } A_t \ge 600 \text{ square feet } (55.74\ m^2)$$

where: **(Equation 16-13)**

Copyright © 2024 International Code Council, Inc., or its licensors (ALL RIGHTS RESERVED).
Accessed by Venkatesh Shanmugam on 11/14/2024 pursuant to License Agreement with ICC. No further reproduction or distribution authorized. Any Unauthorized reproduction or distribution is a violation of the federal copyright, and subject to civil and criminal penalties thereunder.

PDF from: http://codes.iccsafe.org/content/VACC2021P1/chapter-16-structural-design#VACC2021P1_Ch16_Sec1607

A_t = Tributary area (span length multiplied by effective width) in square feet (m^2) supported by the member, and

$R_2 = 1$ for $F \leq 4$

$R_2 = 1.2 - 0.05F$ for $4 < F < 12$ **(Equation 16-14)**

$R_2 = 0.6$ for $F \geq 12$ **(Equation 16-15)**

where: **(Equation 16-16)**

F = For a sloped roof, the number of inches of rise per foot (for SI: $F = 0.12 \times$ slope, with slope expressed as a percentage), or for an arch or dome, the rise-to-span ratio multiplied by 32.

1607.14.2.2 Occupiable roofs.

Areas of roofs that are occupiable, such as *vegetative roofs*, landscaped roofs or for assembly or other similar purposes, and *marquees* are permitted to have their uniformly distributed *live loads* reduced in accordance with Section 1607.12.

1607.14.3 Awnings and canopies.

Awnings and canopies shall be designed for uniform live loads as required in Table 1607.1 as well as for snow loads and wind and tornado loads as specified in Sections 1608 and 1609.

1607.14.4 Photovoltaic panel systems.

Roof structures that provide support for *photovoltaic panel systems* shall be designed in accordance with Sections 1607.14.4.1 through 1607.14.4.5, as applicable.

1607.14.4.1 Roof live load.

Roof structures that support *photovoltaic panel systems* shall be designed to resist each of the following conditions:

1. Applicable uniform and concentrated roof *loads* with the *photovoltaic panel system dead loads*.

   Exception: *Roof live loads* need not be applied to the area covered by *photovoltaic panels* where the clear space between the panels and the roof surface is 24 inches (610 mm) or less.

2. Applicable uniform and concentrated roof loads without the *photovoltaic panel system* present.

1607.14.4.2 Photovoltaic panels or modules.

The structure of a roof that supports solar *photovoltaic panels* or modules shall be designed to accommodate the full solar *photovoltaic panels* or modules and ballast *dead load*, including concentrated *loads* from support frames in combination with the *loads* from Section 1607.14.4.1 and other applicable *loads*. Where applicable, snow drift *loads* created by the *photovoltaic panels* or modules shall be included.

1607.14.4.3 Photovoltaic panels installed on open grid roof structures.

Structures with open grid framing and without a *roof deck* or sheathing supporting *photovoltaic panel systems* shall be designed to support the uniform and concentrated *roof live loads* specified in Section 1607.14.4.1, except that the uniform *roof live load* shall be permitted to be reduced to 12 psf (0.57 kN/m^2).

1607.14.4.4 Ground-mounted photovoltaic (PV) panel systems.

Ground-mounted photovoltaic (PV) panel systems that are independent structures and do not have accessible/occupied space underneath are not required to accommodate a roof photovoltaic *live load*. Other *loads* and combinations in accordance with Section 1605 shall be accommodated.

1607.14.4.5 Ballasted photovoltaic panel systems.

Roof structures that provide support for ballasted *photovoltaic panel systems* shall be designed, or analyzed, in accordance with Section 1604.4; checked in accordance with Section 1604.3.6 for deflections; and checked in accordance with Section 1611 for ponding.

1607.15 Crane loads.

The crane *live load* shall be the rated capacity of the crane. Design *loads* for the runway beams, including connections and support brackets, of moving bridge cranes and monorail cranes shall include the maximum wheel *loads* of the crane and the vertical impact, lateral and longitudinal forces induced by the moving crane.

1607.15.1 Maximum wheel load.

The maximum wheel *loads* shall be the wheel *loads* produced by the weight of the bridge, as applicable, plus the sum of the rated capacity and the weight of the trolley with the trolley positioned on its runway at the location where the resulting *load effect* is maximum.

1607.15.2 Vertical impact force.

The maximum wheel *loads* of the crane shall be increased by the following percentages to account for the effects of

Copyright © 2024 International Code Council, Inc., or its licensors (ALL RIGHTS RESERVED).
Accessed by Venkatesh Shanmugam on 11/14/2024 pursuant to License Agreement with ICC. No further reproduction or distribution authorized. Any Unauthorized reproduction or distribution is a violation of the federal copyright, and subject to civil and criminal penalties thereunder.

PDF from: http://codes.iccsafe.org/content/VACC2021P1/chapter-16-structural-design#VACC2021P1_Ch16_Sec1607

vertical impact or vibration:

Monorail cranes (powered)	25 percent
Cab-operated or remotely operated bridge cranes (powered)	25 percent
Pendant-operated bridge cranes (powered)	10 percent
Bridge cranes or monorail cranes with hand-geared bridge, trolley and hoist	0 percent

1607.15.3 Lateral force.

The lateral force on crane runway beams with electrically powered trolleys shall be calculated as 20 percent of the sum of the rated capacity of the crane and the weight of the hoist and trolley. The lateral force shall be assumed to act horizontally at the traction surface of a runway beam, in either direction perpendicular to the beam, and shall be distributed with due regard to the lateral stiffness of the runway beam and supporting structure.

1607.15.4 Longitudinal force.

The longitudinal force on crane runway beams, except for bridge cranes with hand-geared bridges, shall be calculated as 10 percent of the maximum wheel *loads* of the crane. The longitudinal force shall be assumed to act horizontally at the traction surface of a runway beam, in either direction parallel to the beam.

1607.16 Interior walls and partitions.

Interior walls and partitions that exceed 6 feet (1829 mm) in height, including their finish materials, shall have adequate strength and stiffness to resist the *loads* to which they are subjected but not less than a horizontal *load* of 5 psf (0.240 kN/m^2).

1607.16.1 Fabric partitions.

Fabric partitions that exceed 6 feet (1829 mm) in height, including their finish materials, shall have adequate strength and stiffness to resist the following *load* conditions:

1. The horizontal distributed *load* need only be applied to the partition framing. The total area used to determine the distributed *load* shall be the area of the fabric face between the framing members to which the fabric is attached. The total distributed *load* shall be uniformly applied to such framing members in proportion to the length of each member.
2. A concentrated *load* of 40 pounds (0.176 kN) applied to an 8-inch-diameter (203 mm) area [50.3 square inches (32 452 mm^2)] of the fabric face at a height of 54 inches (1372 mm) above the floor.

1607.16.2 Fire walls.

In order to meet the structural stability requirements of Section 706.2 where the structure on either side of the wall has collapsed, *fire walls* and their supports shall be designed to withstand a minimum horizontal allowable stress *load* of 5 psf (0.240 kN/m^2).

1607.17 Fixed ladders.

Fixed ladders with rungs shall be designed to resist a single concentrated *load* of 300 pounds (1.33 kN) in accordance with Section 4.5.4 of ASCE 7. Where rails of fixed ladders extend above a floor or platform at the top of the ladder, each side rail extension shall be designed to resist a single concentrated *load* of 100 pounds (0.445 kN) in accordance with Section 4.5.4 of ASCE 7. Ship's ladders shall be designed to resist the *stair loads* given in Table 1607.1.

1607.18 Library stack rooms.

The live loading indicated in Table 1607.1 for library stack rooms applies to stack room floors that support nonmobile, double-faced library book stacks, subject to the following limitations:

1. The nominal book stack unit height shall not exceed 90 inches (2290 mm).
2. The nominal shelf depth shall not exceed 12 inches (305 mm) for each face.
3. Parallel rows of double-faced book stacks shall be separated by aisles not less than 36 inches (914 mm) in width.

1607.19 Seating for assembly uses.

Bleachers, *folding and telescopic seating* and *grandstands* shall be designed for the *loads* specified in ICC 300. Stadiums and arenas with fixed seats shall be designed for the horizontal sway *loads* in Section 1607.19.1.

1607.19.1 Horizontal sway loads.

The design of stadiums and arenas with fixed seats shall include horizontal swaying forces applied to each row of seats as follows:

1. 24 pounds per linear foot (0.35 kN/m) of seat applied in a direction parallel to each row of seats.
2. 10 pounds per linear foot (0.15 kN/m) of seat applied in a direction perpendicular to each row of seats.

The parallel and perpendicular horizontal swaying forces are not required to be applied simultaneously.

Copyright © 2024 International Code Council, Inc., or its licensors (ALL RIGHTS RESERVED).
Accessed by Venkatesh Shanmugam on 11/14/2024 pursuant to License Agreement with ICC. No further reproduction or distribution authorized. Any Unauthorized reproduction or distribution is a violation of the federal copyright, and subject to civil and criminal penalties thereunder.

PDF from: http://codes.iccsafe.org/content/VACC2021P1/chapter-16-structural-design#VACC2021P1_Ch16_Sec1607

1607.20 Sidewalks, vehicular driveways, and yards subject to trucking.

The live loading indicated in Table 1607.1 for sidewalks, vehicular driveways, and yards subject to trucking shall comply with the requirements of this section.

1607.20.1 Uniform loads.

In addition to the *loads* indicated in Table 1607.1, other uniform *loads* in accordance with an approved method that contains provisions for truck loading shall be considered where appropriate.

1607.20.2 Concentrated loads.

The concentrated wheel *load* indicated in Table 1607.1 shall be applied on an area of $4^1/_2$ inches by $4^1/_2$ inches (114 mm by 114 mm).

1607.21 Stair treads.

The concentrated *load* indicated in Table 1607.1 for *stair* treads shall be applied on an area of 2 inches by 2 inches (51 mm by 51 mm). This *load* need not be assumed to act concurrently with the uniform *load*.

1607.22 Residential attics.

The *live loads* indicated in Table 1607.1 for *attics* in residential occupancies shall comply with the requirements of this section.

1607.22.1 Uninhabitable attics without storage.

In residential occupancies, uninhabitable *attic* areas without storage are those where the maximum clear height between the joists and rafters is less than 42 inches (1067 mm), or where there are not two or more adjacent trusses with web configurations capable of accommodating an assumed rectangle 42 inches (1067 mm) in height by 24 inches (610 mm) in width, or greater, within the plane of the trusses. The *live load* in Table 1607.1 need not be assumed to act concurrently with any other *live load* requirement.

1607.22.2 Uninhabitable attics with storage.

In residential occupancies, uninhabitable attic areas with storage are those where the maximum clear height between the joist and rafter is 42 inches (1067 mm) or greater, or where there are two or more adjacent trusses with web configurations capable of accommodating an assumed rectangle 42 inches (1067 mm) in height by 24 inches (610 mm) in width, or greater, within the plane of the trusses. The live load in Table 1607.1 need only be applied to those portions of the joists or truss bottom chords where both of the following conditions are met:

1. The attic area is accessed from an opening not less than 20 inches (508 mm) in width by 30 inches (762 mm) in length that is located where the clear height in the attic is not less than 30 inches (762 mm).
2. The slope of the joists or truss bottom chords is not greater than 2 units vertical in 12 units horizontal.

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 (0.48 kN/m^2).

1607.22.3 Attics served by stairs.

Attic spaces served by *stairways* other than the pull-down type shall be designed to support the minimum *live load* specified for habitable *attics* and sleeping rooms.

Copyright © 2024 International Code Council, Inc., or its licensors (ALL RIGHTS RESERVED).
Accessed by Venkatesh Shanmugam on 11/14/2024 pursuant to License Agreement with ICC. No further reproduction or distribution authorized. Any Unauthorized reproduction or distribution is a violation of the federal copyright, and subject to civil and criminal penalties thereunder.

PDF from: http://codes.iccsafe.org/content/VACC2021P1/chapter-16-structural-design#VACC2021P1_Ch16_Sec1607