CODE

anchor, cast-in—headed bolt, headed stud, or hooked bolt installed before placing concrete.

anchor, expansion—post-installed anchor, inserted into hardened concrete that transfers loads to or from the concrete by direct bearing or friction, or both.

anchor group—a number of similar anchors having approximately equal effective embedment depths with spacing s between adjacent anchors such that the projected areas overlap.

anchor, horizontal or upwardly inclined—Anchor installed in a hole drilled horizontally or in a hole drilled at any orientation above horizontal.

anchor, post-installed—anchor installed in hardened concrete; adhesive, expansion, screw, and undercut anchors are examples of post-installed anchors.

anchor pullout strength—the strength corresponding to the anchoring device or a major component of the device sliding out from the concrete without breaking out a substantial portion of the surrounding concrete.

anchor, screw—a post-installed threaded, mechanical anchor inserted into hardened concrete that transfers loads to the concrete by engagement of the hardened threads of the screw with the grooves that the threads cut into the sidewall of a predrilled hole during anchor installation.

anchor, undercut—post-installed anchor that develops its tensile strength from the mechanical interlock provided by undercutting of the concrete at the embedded end of the anchor. Undercutting is achieved with a special drill before installing the anchor or alternatively by the anchor itself during its installation.

anchorage device—in post-tensioned members, the hardware used to transfer force from prestressed reinforcement to the concrete.

COMMENTARY

forcing bars is generally greater than that for threaded rods. The required hole size is provided in the Manufacturer's Printed Installation Instructions (MPII).

anchor, expansion—Expansion anchors may be torque-controlled, where the expansion is achieved by a torque acting on the screw or bolt; or displacement controlled, where the expansion is achieved by impact forces acting on a sleeve or plug and the expansion is controlled by the length of travel of the sleeve or plug.

anchor group—For all potential failure modes (steel, concrete breakout, pullout, side-face blowout, and pryout), only those anchors susceptible to a particular failure mode should be considered when evaluating the strength associated with that failure mode.

anchor, horizontal or upwardly inclined—Figure R2.2 illustrates the potential hole orientations for horizontal or upwardly inclined anchors.

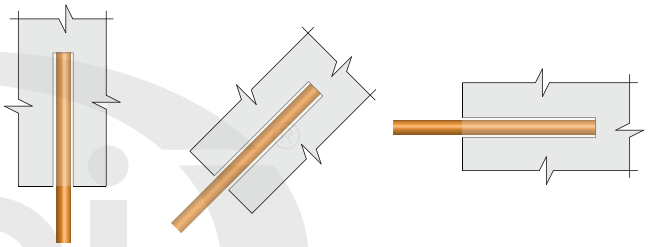

Fig. R2.2—Possible orientations of overhead, upwardly inclined, or horizontal anchors.

anchor, screw—The required predrilled hole size for a screw anchor is provided by the anchor manufacturer.

anchorage device—Most anchorage devices for post-tensioning are standard manufactured devices available from commercial sources. In some cases, non-standard details or assemblages are developed that combine various wedges and wedge plates for anchoring prestressed reinforcement. Both standard and non-standard anchorage devices may be classified as basic anchorage devices or special anchorage devices as defined in the Code and AASHTO LRFDUS.

CODE

anchorage device, basic monostrand—anchorage device used with any single strand or a single 5/8 in. or smaller diameter bar that is in accordance with 25.8.1, 25.8.2, and 25.9.3.1(a).

anchorage device, basic multistrand—anchorage device used with multiple strands, bars, or wires, or with single bars larger than 5/8 in. diameter that satisfies 25.8.1, 25.8.2 and 25.9.3.1(b).

anchorage device, special—anchorage device that satisfies tests required in 25.9.3.1(c).

anchorage zone—in post-tensioned members, portion of the member through which the concentrated prestressing force is transferred to concrete and distributed more uniformly across the section; its extent is equal to the largest dimension of the cross section; for anchorage devices located away from the end of a member, the anchorage zone includes the disturbed regions ahead of and behind the anchorage device.

attachment—structural assembly, external to the surface of the concrete, that transmits loads to or receives loads from the anchor.

B-region—portion of a member in which it is reasonable to assume that strains due to flexure vary linearly through section.

balanced strain condition—strain profile in which the extreme tension reinforcement is at the yield strain and the extreme concrete compression fiber is at a strain of 0.003.

base of structure—level at which horizontal earthquake ground motions are assumed to be imparted to a building. This level does not necessarily coincide with the ground level.

basis of design—formal document prepared by the licensed design professional expressing the performance objectives, acceptance criteria, analysis methods, and design methods to be used in the overall building design. (Appendix B)

beam—member subjected primarily to flexure and shear, with or without axial force or torsion; beams in a moment frame that forms part of the lateral-force-resisting system are predominantly horizontal members; a girder is a beam.

boundary element—portion along wall and diaphragm edge, including edges of openings, strengthened by longitudinal and transverse reinforcement.

breakout strength, concrete—strength corresponding to a volume of concrete surrounding the anchor or group of anchors separating from the member.

COMMENTARY

anchorage device, basic monostrand—Devices that are so proportioned that they can be checked analytically for compliance with bearing stress and stiffness requirements without having to undergo the acceptance-testing program required of special anchorage devices.

anchorage device, basic multistrand—Devices that are s_o proportioned that they can be checked analytically for compliance with bearing stress and stiffness requirements without having to undergo the acceptance-testing program required of special anchorage devices.

anchorage device, special—Special anchorage devices are any devices (monostrand or multistrand) that do not meet the relevant PTI or AASHTO LRFDUS bearing stress and, where applicable, stiffness requirements. Most commercially marketed multi-bearing surface anchorage devices are special anchorage devices. As provided in 25.9.3, such devices can be used only if they have been shown experimentally to be in compliance with the AASHTO requirements. This demonstration of compliance will ordinarily be furnished by the device manufacturer.

anchorage zone—In post-tensioned members, the portion of the member through which the concentrated prestressing force is transferred to the concrete and distributed more uniformly across the section. Its extent is equal to the largest dimension of the cross section. For anchorage devices located away from the end of a member, the anchorage zone includes the disturbed regions ahead of and behind the anchorage devices. Refer to Fig. R25.9.1.1b.

CODE

building official—term used to identify the Authority having jurisdiction or individual charged with administration and enforcement of provisions of the building code. Such terms as building commissioner or building inspector are variations of the title, and the term "building official" as used in this Code, is intended to include those variations, as well as others that are used in the same sense.

caisson—see drilled pier.

cementitious materials—materials that have cementing value if used in grout, mortar, or concrete, including portland cement, blended hydraulic cements, expansive cement, fly ash, raw or calcined natural pozzolan, slag cement, silica fume, and ground-glass pozzolan.

class of concrete—characterization of concrete of various qualities or usages, usually by compressive strength. (Appendix C)

collector—element that acts in axial tension or compression to transmit forces between a diaphragm and a vertical element of the lateral-force-resisting system.

column—member, usually vertical or predominantly vertical, used primarily to support axial compressive load, but that can also resist moment, shear, or torsion. Columns used as part of a lateral-force-resisting system resist combined axial load, moment, and shear. See also **moment frame**.

column capital—enlargement of the top of a concrete column located directly below the slab or drop panel that is cast monolithically with the column.

compliance requirements—construction-related code requirements directed to the contractor to be incorporated into construction documents by the licensed design professional, as applicable.

composite concrete flexural members—concrete flexural members of precast or cast-in-place concrete elements, constructed in separate placements but connected so that all elements respond to loads as a unit.

compression-controlled section—cross section in which the net tensile strain in the extreme tension reinforcement at nominal strength is less than or equal to the compression controlled strain limit.

compression-controlled strain limit—net tensile strain at balanced strain conditions.

concrete—mixture of portland cement or any other cementitious material, fine aggregate, coarse aggregate, and water, with or without admixtures.

concrete, all-lightweight—lightweight concrete containing only lightweight coarse and fine aggregates that conform to ASTM C330.

concrete-filled pipe piles—steel pipe with a closed end that is driven for its full length in contact with the surrounding soil, or a steel pipe with an open end that is driven for its full length and the soil cleaned out; for both installation procedures, the pipe is subsequently filled with reinforcement and concrete.

COMMENTARY

cementitious materials—Cementitious materials permitted for use in the Code are addressed in 26.4.1.1. Fly ash, raw or calcined natural pozzolan, slag cement, silica fume, and ground-glass pozzolan are considered supplementary cementitious materials.

compliance requirements—Although primarily directed to the contractor, the compliance requirements are also commonly used by others involved with the project.

CODE

concrete, lightweight—concrete containing lightweight aggregate and having an equilibrium density, as determined by ASTM C567, between 90 and 135 lb/ft^3.

concrete, nonprestressed—reinforced concrete with at least the minimum amount of nonprestressed reinforcement and no prestressed reinforcement; or for two-way slabs, with less than the minimum amount of prestressed reinforcement.

concrete, normalweight—concrete containing only coarse and fine aggregates that conform to ASTM C33 and having a density greater than 135 lb/ft^3.

concrete, plain—structural concrete with no reinforcement or with less than the minimum amount of reinforcement specified for reinforced concrete.

concrete, precast—structural concrete element cast elsewhere than its final position in the structure.

concrete, prestressed—reinforced concrete in which internal stresses have been introduced by prestressed reinforcement to reduce potential tensile stresses in concrete resulting from loads, and for two-way slabs, with at least the minimum amount of prestressed reinforcement.

concrete, reinforced—structural concrete reinforced with at least the minimum amounts of nonprestressed reinforcement, prestressed reinforcement, or both, as specified in this Code.

concrete, sand-lightweight—lightweight concrete containing only normalweight fine aggregate that conforms to ASTM C33 and lightweight coarse aggregate that conforms to ASTM C330.

concrete, steel fiber-reinforced—concrete containing a prescribed amount of dispersed, randomly oriented, discontinuous deformed steel fibers.

concrete strength, specified compressive, (f'_c)—compressive strength of concrete used in design and evaluated in accordance with provisions of this Code, psi; wherever the quantity f'_c is under a radical sign, the square root of numerical value only is intended, and the result has units of psi.

connection—region of a structure that joins two or more members; a connection also refers to a region that joins members of which one or more is precast.

connection, ductile—connection between one or more precast elements that experiences yielding as a result of the earthquake design displacements.

COMMENTARY

concrete, nonprestressed—Nonprestressed concrete usually contains no prestressed reinforcement. Prestressed two-way slabs require a minimum level of compressive stress in the concrete due to effective prestress in accordance with 8.6.2.1. Two-way slabs with less than this minimum level of precompression are required to be designed as nonprestressed concrete.

concrete, normalweight—Normalweight concrete typically has a density (unit weight) between 135 and 160 lb/ft^3, and is normally taken as 145 to 150 lb/ft^3.

concrete, plain—The presence of reinforcement, nonprestressed or prestressed, does not exclude the member from being classified as plain concrete, provided all requirements of Chapter 14 are satisfied.

concrete, prestressed—Classes of prestressed flexural members are defined in 24.5.2.1. Prestressed two-way slabs require a minimum level of compressive stress in the concrete due to effective prestress in accordance with 8.6.2.1. Although the behavior of a prestressed member with unbonded tendons may vary from that of members with continuously bonded prestressed reinforcement, bonded and unbonded prestressed concrete are combined with nonprestressed concrete under the generic term "reinforced concrete." Provisions common to both prestressed and nonprestressed concrete are integrated to avoid overlapping and conflicting provisions.

concrete, reinforced—Includes members satisfying the requirements for nonprestressed and prestressed concrete.

concrete, sand-lightweight—By Code terminology, sand-lightweight concrete is lightweight concrete with all of the fine aggregate replaced by sand. This definition may not be in agreement with usage by some material suppliers or contractors where the majority, but not all, of the lightweight fines are replaced by sand. For proper application of the Code provisions, the replacement limits should be stated, with interpolation if partial sand replacement is used.

CODE

connection, strong—connection between one or more precast elements that remains elastic while adjoining members experience yielding as a result of earthquake design displacements.

construction documents—written and graphic documents and specifications prepared or assembled for describing the location, design, materials, and physical characteristics of the elements of a project necessary for obtaining a building permit and construction of the project.

contraction joint—formed, sawed, or tooled groove in a concrete structure to create a weakened plane and regulate the location of cracking resulting from the dimensional change of different parts of the structure.

contractor—an entity responsible for construction of the Work as required by construction documents.

cover, specified concrete—distance between the outermost surface of embedded reinforcement and the closest outer surface of the concrete.

crosstie—a continuous reinforcing bar having a seismic hook at one end and a hook not less than 90 degrees with at least a $6d_b$ extension at the other end. The hooks shall engage peripheral longitudinal bars. The 90-degree hooks of two successive crossties engaging the same longitudinal bars shall be alternated end for end.

curtain—grid of reinforcement, usually in a vertical orientation.

cutoff point—point where reinforcement is terminated.

D-region—portion of a member within a distance h of a force discontinuity or a geometric discontinuity.

design displacement—total calculated lateral displacement expected for the design-basis earthquake.

design information—project-specific information to be incorporated into construction documents by the licensed design professional, as applicable.

design load combination—combination of factored loads and forces.

design story drift ratio—relative difference of design displacement between the top and bottom of a story, divided by the story height.

development length, nonprestressed reinforcement—length of embedded reinforcement required to develop the specified yield strength f_y or, where specifically required in this Code, $1.25f_y$ at a critical section.

COMMENTARY

design displacement—The design displacement is an index of the maximum lateral displacement expected in design for the design-basis earthquake. In documents such as ASCE/SEI 7 and the International Building Code, the design displacement is calculated using static or dynamic linear elastic analysis under code-specified actions considering effects of cracked sections, effects of torsion, effects of vertical forces acting through lateral displacements, and modification factors to account for expected inelastic response. The design displacement generally is greater than the displacement calculated from design-level forces applied to a linear-elastic model of the building.

development length, nonprestressed reinforcement—development length provisions for nonprestressed reinforcement are generally calibrated to permit the achievement of the specified yield strength at the critical section. There are also sections of the code where it is required to develop the reinforcement for more than f_y, for example, 18.10.2.3(b)

CODE

development length, prestressed reinforcement—length of embedded reinforcement required to develop f_{ps} of prestressing reinforcement at a critical section.

discontinuity—abrupt change in geometry or loading.

distance sleeve—sleeve that encases the center part of an undercut anchor, a torque-controlled expansion anchor, or a displacement-controlled expansion anchor, but does not expand.

distributed plasticity (fiber) model—component model consisting of discrete fibers explicitly representing nonlinear stress-strain or force-deformation responses. (Appendix A)

dowel—a deformed reinforcing bar intended to transmit tension, compression, or shear through a construction joint.

drilled piers or caissons—cast-in-place concrete foundation elements with or without an enlarged base (bell), constructed by excavating a hole in the ground and filling with reinforcement and concrete. Drilled piers or caissons are considered as uncased cast-in-place concrete drilled or augered piles, unless they have permanent steel casing, in which case they are considered as metal cased concrete piles.

drop panel—projection below the slab used to reduce the amount of negative reinforcement over a column or the minimum required slab thickness, and to increase the slab shear strength.

duct—conduit, plain or corrugated, to accommodate prestressing reinforcement for post-tensioning applications.

ductile coupled structural wall—see **structural wall, ductile coupled**.

durability—ability of a structure or member to resist deterioration that impairs performance or limits service life of the structure in the relevant environment considered in design.

edge distance—distance from the edge of the concrete surface to the center of the nearest anchor.

effective depth of section—distance measured from extreme compression fiber to centroid of longitudinal tension reinforcement.

effective embedment depth, anchor—overall depth through which the anchor transfers force to or from the surrounding concrete.

effective embedment depth, reinforcing bar—overall depth from the critical section through which the reinforcing

COMMENTARY

and 18.10.2.5(a). If it is desired to achieve the expected yield strength of reinforcement, the embedment length may need to be increased beyond the development length. For some cases, sectional strength may be controlled by concrete breakout even though the reinforcing bars are embedded a distance at least equal to the development length in tension.

distributed plasticity (fiber) model—Force-controlled and deformation-controlled actions are classified in A.7 for design using nonlinear analysis of concrete structures. (Appendix A)

effective embedment depth, anchor— Effective embedment depth will normally be the depth of the concrete failure surface in tension applications; for cast-in headed anchor bolts and headed studs, the effective embedment depth is measured from the bearing contact surface of the head. Effective embedment depths for a variety of anchor types are shown in Fig. R2.1. For post-installed mechanical anchors, the value h_{ef} is obtained from the ACI CODE-355.2 product evaluation report provided by the manufacturer.

effective embedment depth, reinforcing bar—Figure R2.3 illustrates effective embedment depth for the purpose

CODE

bar transfers force to or from the surrounding concrete. For straight bars, the effective embedment depth is measured from the end of the bar; for hooked reinforcement, the effective embedment is measured from the outside end of the hook, point of tangency; for headed reinforcement, effective embedment depth is measured from the bearing contact surface of the head.

effective prestress—stress remaining in prestressed reinforcement after losses in 20.3.2.6 have occurred.

effective stiffness—stiffness of a structural member accounting for cracking, creep, and other nonlinear effects.

embedment length—length of embedded reinforcement provided beyond a critical section.

COMMENTARY

of determining concrete breakout strength for various types of reinforcing bar anchorage

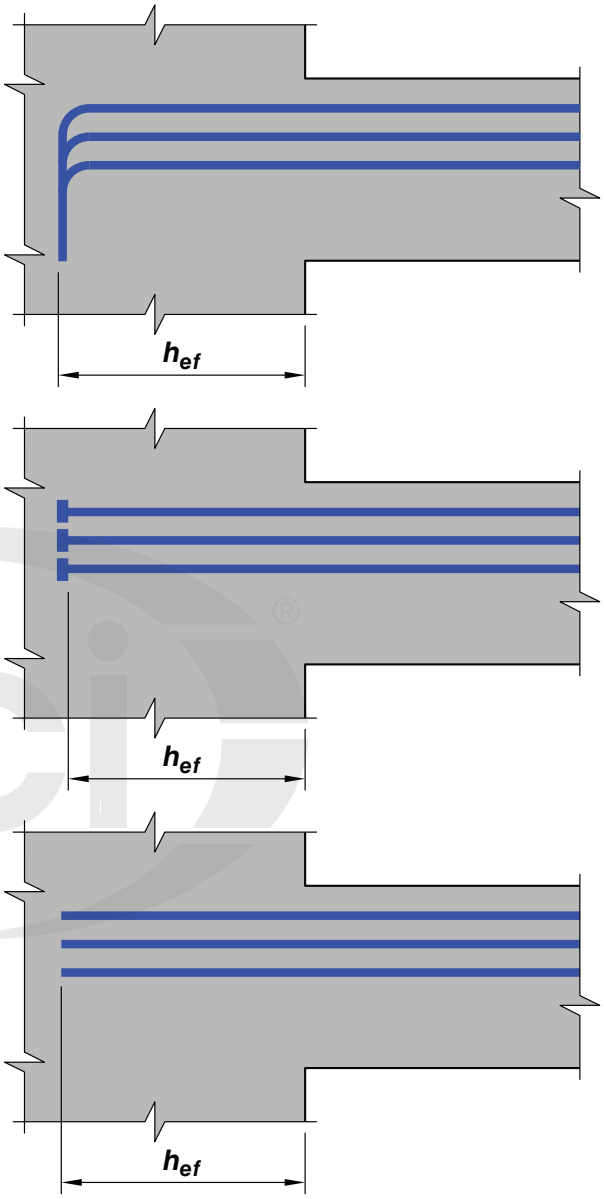

Fig. R2.3—Effective embedment depth for reinforcing bars for the purpose of determining concrete breakout strength.

CODE

embedments—items embedded in concrete, excluding reinforcement as defined in Chapter 20 and anchors as defined in Chapter 17. Reinforcement or anchors welded, bolted or otherwise connected to the embedded item to develop the strength of the assembly, are considered to be part of the embedment.

embedments, pipe—embedded pipes, conduits, and sleeves.

environmental product declaration (EPD)—declaration providing environmental data using predetermined parameters meeting the requirements of ISO 21930. (Appendix C)

equilibrium density—density of lightweight concrete determined in accordance with ASTM C567.

equivalent static wind load (ESWL)—wind load statically applied to the building, representing the wind-tunnel-determined combination of the background and resonant wind components. (Appendix B)

expansion sleeve—outer part of an expansion anchor that is forced outward by the center part, either by applied torque or impact, to bear against the sides of the predrilled hole. See also **anchor, expansion**.

expected strength, wind—strength of a member or cross section calculated in accordance with provisions and assumptions of this Code using expected material properties as contained in this Code. (Appendix B)

extreme tension reinforcement—layer of prestressed or nonprestressed reinforcement that is the farthest from the extreme compression fiber.

finite element analysis—a numerical modeling technique in which a structure is divided into a number of discrete elements for analysis.

five percent fractile—statistical term meaning 90% confidence that there is 95% probability of the actual strength exceeding the nominal strength.

foundation seismic ties—elements used to sufficiently interconnect foundations to act as a unit. Elements may consist of grade beams, slabs-on-ground, or beams within a slab-on-ground.

global warming potential (GWP)—index used to determine the energy absorption caused by the emissions of different gases associated with a product, normalized to an equivalent mass of carbon dioxide over a period of 100 years. (Appendix C)

hazard event—potential cause of damage to a structure and the magnitude or intensity associated with that cause. (Appendix C)

COMMENTARY

five percent fractile—The determination of the coefficient K_{05} associated with the 5% fractile, $\bar{x} - K_{05}s_s$ depends on the number of tests, n, used to calculate the sample mean, $\bar{x}$, and sample standard deviation, s_s. Values of K_{05} range, for example, from 1.645 for $n = \infty$, to 2.010 for $n = 40$, and 2.568 for $n = 10$. With this definition of the 5 percent fractile, the nominal strength in Chapter 17 is the same as the characteristic strength in ACI CODE-355.2 and ACI CODE-355.4.

global warming potential (GWP)—This index was developed as a single parameter to estimate the global warming impact of different gaseous emissions. (Appendix C)

hazard event—Selecting the demands for which a structure will be designed requires establishing the hazards to which the structure may be subjected and the intensities of those hazards for target risk levels. For example, a structure might be subjected to frequent earthquakes with small intensities and very infrequent earthquakes with large intensities. (Appendix C)

CODE

headed bolt—cast-in steel anchor that develops its tensile strength from the mechanical interlock provided by either a head or nut at the embedded end of the anchor.

headed deformed bars—deformed bars with heads attached at one or both ends.

headed shear stud reinforcement—reinforcement consisting of individual headed studs or groups of studs, with anchorage provided by a head at each end, or by a head at one end and a common base rail consisting of a steel plate or shape at the other end.

headed stud—a steel anchor conforming to the requirements of AWS D1.1 and affixed to a plate or similar steel attachment by the stud arc welding process before casting; also referred to as a **welded headed stud**.

hooked bolt—cast-in anchor anchored mainly by bearing of the 90-degree bend (L-bolt) or 180-degree bend (J-bolt) against the concrete, at its embedded end, and having a minimum e_h equal to $3d_a$.

hoop—continuous closed tie or continuously wound tie having seismic hooks at both ends.

inspection—observation, verification, and required documentation of the materials, installation, fabrication, erection, or placement of components and connections to determine compliance with construction documents and referenced standards.

inspection, continuous—the full-time observation, verification, and required documentation of construction being performed.

inspection, periodic—the part-time or intermittent observation, verification, and required documentation of construction being performed.

isolation joint—separation between adjoining parts of a concrete structure, usually a vertical plane at a designed location such as to interfere least with performance of the structure, yet such as to allow relative movement in three directions and avoid formation of cracks elsewhere in the concrete, and through which all or part of the bonded reinforcement is interrupted.

jacking force—in prestressed concrete, temporary force exerted by a device that introduces tension into prestressing reinforcement.

joint—portion of structure common to intersecting members

COMMENTARY

headed deformed bars—The bearing area of a headed deformed bar is, for the most part, perpendicular to the bar axis. In contrast, the bearing area of the head of headed stud reinforcement is a nonplanar spatial surface of revolution, as shown in Fig. R20.4.1. The two types of reinforcement differ in other ways. The shanks of headed studs are smooth, not deformed as with headed deformed bars. The minimum net bearing area of the head of a headed deformed bar is permitted to be as small as four times the bar area. In contrast, the minimum stud head area is not specified in terms of the bearing area, but by the total head area which must be at least 10 times the area of the shank.

hoop—Refer to 25.7.4.

joint—The effective cross-sectional area of a joint of a special moment frame, A_j, for shear strength calculations is given in 15.5.2.2.

CODE

joint, corner—joint where two non-colinear members transfer moment and terminate at the joint.

licensed design professional—an individual who is licensed to practice structural design as defined by the statutory requirements of the professional licensing laws of the state or jurisdiction in which the project is to be constructed, and who is in responsible charge for all or part of the structural design.

life cycle assessment (LCA)—compilation and evaluation of the inputs, outputs, and potential environmental impacts of a product throughout its life cycle. (Appendix C)

load—forces or other actions that result from the weight of all building materials, occupants, and their possessions, environmental effects, differential movement, and restrained dimensional changes; permanent loads are those loads in which variations over time are rare or of small magnitude; all other loads are variable loads.

load, dead—(a) the weights of the members, supported structure, and permanent attachments or accessories that are likely to be present on a structure in service; or (b) loads meeting specific criteria found in the general building code; without load factors.

load effects—forces and deformations produced in structural members by applied loads or restrained volume changes.

load, factored—load, multiplied by appropriate load factors.

load, live—(a) load that is not permanently applied to a structure, but is likely to occur during the service life of the structure (excluding environmental loads); or (b) loads meeting specific criteria found in the general building code; without load factors.

load path—sequence of members and connections designed to transfer the factored loads and forces in such combinations as are stipulated in this Code, from the point of application or origination through the structure to the final support location or the foundation.

load, roof live—a load on a roof produced: (a) during maintenance by workers, equipment, and materials, and (b) during the life of the structure by movable objects, such as planters or other similar small decorative appurtenances that are not occupancy related; or loads meeting specific criteria found in the general building code; without load factors.

load, self-weight dead—weight of the structural system, including the weight of any bonded concrete topping.

COMMENTARY

joint, corner—Roof level corner joints are sometimes referred to as knee joints.

licensed design professional—May also be referred to as "registered design professional" in other documents; a licensed design professional in responsible charge of the design is often referred to as the "engineer of record" (EOR).

load—A number of definitions for loads are given as the Code contains requirements that are to be met at various load levels. The terms "dead load" and "live load" refer to the unfactored, sometimes called "service" loads specified or defined by the general building code. Service loads (loads without load factors) are to be used where specified in the Code to proportion or investigate members for adequate serviceability. Loads used to proportion a member for adequate strength are defined as factored loads. Factored loads are service loads multiplied by the appropriate load factors for required strength except wind and earthquake which are already specified as strength loads in ASCE/SEI 7. The factored load terminology clarifies where the load factors are applied to a particular load, moment, or shear value as used in the Code provisions.

load effects—Stresses and strains are directly related to forces and deformations and are considered as load effects.

CODE

load, service—all loads, static or transitory, imposed on a structure or element thereof, during the operation of a facility, without load factors.

load, superimposed dead—dead loads other than the self-weight that are present or are considered in the design.

Manufacturer's Printed Installation Instructions (MPII)—published instructions for the correct installation of a post-installed anchor under all covered installation conditions as supplied in the product packaging.

mechanical splice—region along lengths of two reinforcing bars joined by a mechanical splicing device, including the device.

mechanical splicing device—system used to mechanically join two reinforcing bars for the purpose of transferring axial compression, axial tension, or both from one bar to the other.

metal cased concrete piles—thin-walled steel pipe, steel shell, or spiral-welded metal casing with a closed end that is driven for its full length in contact with the surrounding soil, left permanently in place, and subsequently filled with reinforcement and concrete.

modulus of elasticity—ratio of normal stress to corresponding strain for tensile or compressive stresses below proportional limit of material.

moment frame—frame in which beams, slabs, columns, and joints resist forces predominantly through flexure, shear, and axial force; beams or slabs are predominantly horizontal or nearly horizontal; columns are predominantly vertical or nearly vertical.

moment frame, intermediate—cast-in-place beam-column frame or two-way slab-column frame without beams complying with 18.4.

moment frame, ordinary—cast-in-place or precast concrete beam-column or slab-column frame complying with 18.3.

moment frame, special—cast-in-place beam-column frame complying with 18.2.3 through 18.2.8; and 18.6 through 18.8. A precast beam-column frame complying with 18.2.3 through 18.2.8 and 18.9.

net tensile strain—the tensile strain at nominal strength exclusive of strains due to effective prestress, creep, shrinkage, and temperature.

nodal zone—volume of concrete around a node that is assumed to transfer strut-and-tie forces through the node.

node—point in a strut-and-tie model where the axes of the struts, ties, and concentrated forces acting on the joint intersect.

node, curved-bar—the bend region of a continuous reinforcing bar (or bars) that defines a node in a strut-and-tie model.

COMMENTARY

mechanical splicing device—Mechanical splicing devices are most often commercially-marketed products. Features vary with the particular nature of the mechanical splicing device and may include but are not limited to coupling sleeves, filler materials of various types (such as flowable grouts), bolts, nuts, and threaded studs. Preparation of reinforcing bar ends by threading or other processes, application of friction welds, or other measures, may be required when manufacturing, fabricating, or installing the device.

CODE

one-way construction—members designed to resist out-of-plane loads through bending in a single direction. See also **two-way construction**.

panel, shotcrete mockup—a shotcrete specimen that simulates the size and detailing of reinforcement in a proposed structural member for preconstruction evaluation of the nozzle operator's ability to encase the reinforcement.

panel, shotcrete test—a shotcrete specimen prepared in accordance with ASTM C1140 for evaluation of shotcrete.

pedestal—member with a ratio of height-to-least lateral dimension less than or equal to 3 used primarily to support axial compressive load; for a tapered member, the least lateral dimension is the average of the top and bottom dimensions of the smaller side.

performance-based wind design (PBWD)—alternative design procedure to the prescriptive provisions in the general building code and referenced standards, which considers direct evaluation of the wind demand on the structure, and evaluates the building performance as it relates to occupant comfort, operational performance, and continuous occupancy, limited interruption performance objectives. (Appendix B)

performance objective—specific desired outcome for an action, element, or system of a building during or following a wind event as chosen by the project stakeholders and licensed design professionals. (Appendix B)

performance objective, continuous occupancy, limited interruption—specific desired outcome in which damage to the main wind-force-resisting system does not significantly disrupt or impair the continued operation and functionality of the structure. (Appendix B)

performance objective, occupant comfort—specific desired outcome in which the accelerations from wind-induced sway motions remain within acceptable limits for occupant comfort and for equipment to maintain the functionality of the building. (Appendix B)

performance objective, operational—specific desired outcome in which the main wind-force-resisting system remains essentially elastic and the building systems remain operational during the designated risk-category-based event. (Appendix B)

plastic hinge region—length of frame element over which flexural yielding is intended to occur due to earthquake design displacements, extending not less than a distance h from the critical section where flexural yielding initiates.

post-installed reinforcing bar—deformed bar installed with adhesive or grout in a hole drilled in hardened concrete.

COMMENTARY

one-way construction—Joists, beams, girders, and some slabs and foundations are considered one-way construction.

panel, shotcrete mockup—Shotcrete mockup panels are used for preconstruction evaluation and are either sawed or cored, or both, to evaluate if the reinforcement has been adequately encased.

panel, shotcrete test—Shotcrete test panels are typically used to evaluate a shotcrete mixture, to qualify a nozzle operator, to verify surface finish, and to provide specimens for compressive or flexural strength testing.

performance objective, continuous occupancy, limited interruption—Continued operation and functionality of the structure is implicitly achieved when the main wind-force-resisting system is designed for a wind event corresponding to the designated building risk category to achieve the target reliability for structural stability that is consistent with the building code. (Appendix B)

performance objective, occupant comfort—Although the occupant comfort performance objective is part of performance-based wind design, it is outside of the scope of Appendix B. (Appendix B)

performance objective, operational—Members in reinforced concrete structures are considered cracked when concrete tensile stresses exceed the stress corresponding to the tensile strength. Even though the force-deformation relationship becomes nonlinear immediately after cracking, when performing the lateral analysis for the operational performance objective, it is assumed that the structure is essentially elastic, and its behavior is adequately represented using the secant stiffness for peak response for the risk category-based event. (Appendix B)

CODE

post-tensioning—method of prestressing in which prestressing reinforcement is tensioned after concrete has hardened.

precast concrete piles—driven piles that may be either prestressed concrete or conventionally reinforced concrete.

precompressed tension zone—portion of a prestressed member where flexural tension, calculated using gross section properties, would occur under service loads if the prestress force was not present.

pretensioning—method of prestressing in which prestressing reinforcement is tensioned before concrete is cast.

projected area—area on the free surface of the concrete member that is used to represent the greater base of the assumed rectilinear failure surface.

projected influence area—rectilinear area on the free surface of the concrete member that is used to calculate the bond strength of adhesive anchors.

pryout strength, concrete—strength corresponding to formation of a concrete spall behind short, stiff anchors displaced in the direction opposite to the applied shear force.

reinforcement—steel element or elements embedded in concrete and conforming to 20.2 through 20.4. Prestressed reinforcement in external tendons is also considered reinforcement.

reinforcement, anchor—reinforcement used to transfer the design load in tension from the anchors into the structural member

reinforcement, bonded prestressed—pretensioned reinforcement or prestressed reinforcement in a bonded tendon.

reinforcement, deformed—deformed bars, welded bar mats, deformed wire, and welded wire reinforcement conforming to 20.2.1.3, 20.2.1.5, or 20.2.1.7, excluding plain wire.

reinforcement, nonprestressed—bonded reinforcement that is not prestressed.

reinforcement, plain—bars or wires conforming to 20.2.1.4 or 20.2.1.7 that do not conform to definition of deformed reinforcement.

reinforcement, prestressed—prestressing reinforcement that has been tensioned to impart forces to concrete.

reinforcement, prestressing—high-strength reinforcement such as strand, wire, or bar conforming to 20.3.1.

reinforcement, supplementary—reinforcement that acts to restrain the potential concrete breakout but is not designed to transfer the design load from the anchors into the structural member.

COMMENTARY

reinforcement, anchor—Anchor reinforcement is designed and detailed specifically for the purpose of transferring anchor loads in tension from the anchors into the member. Hairpins are generally used for this purpose (refer to 17.5.2.1(a) and 17.5.2.1(b)); however, other configurations that can be shown to effectively transfer the anchor load are acceptable.

reinforcement, deformed—Deformed reinforcement is defined as that meeting the reinforcement specifications in the Code. No other reinforcement qualifies. This definition permits accurate statement of development lengths. Bars or wire not meeting the deformation requirements or welded wire reinforcement not meeting the spacing requirements are "plain reinforcement," for code purposes, and may be used only for spirals.

reinforcement, supplementary—Supplementary reinforcement has a configuration and placement similar to anchor reinforcement but is not specifically designed to transfer loads from the anchors into the member. Stirrups, as used for shear reinforcement, may fall into this category.

CODE

reinforcement, welded deformed steel bar mat—mat conforming to 20.2.1.5 consisting of two layers of deformed bars at right angles to each other welded at the intersections.

reinforcement, welded wire—plain or deformed wire fabricated into sheets or rolls conforming to 20.2.1.7.

reinforcing bar group—parallel reinforcing bars connecting two members, or a member and a joint, and developed in an anchorage region defined by $A_{c,eff}$.

COMMENTARY

reinforcing bar group—Some examples are shown in Fig. R2.4.

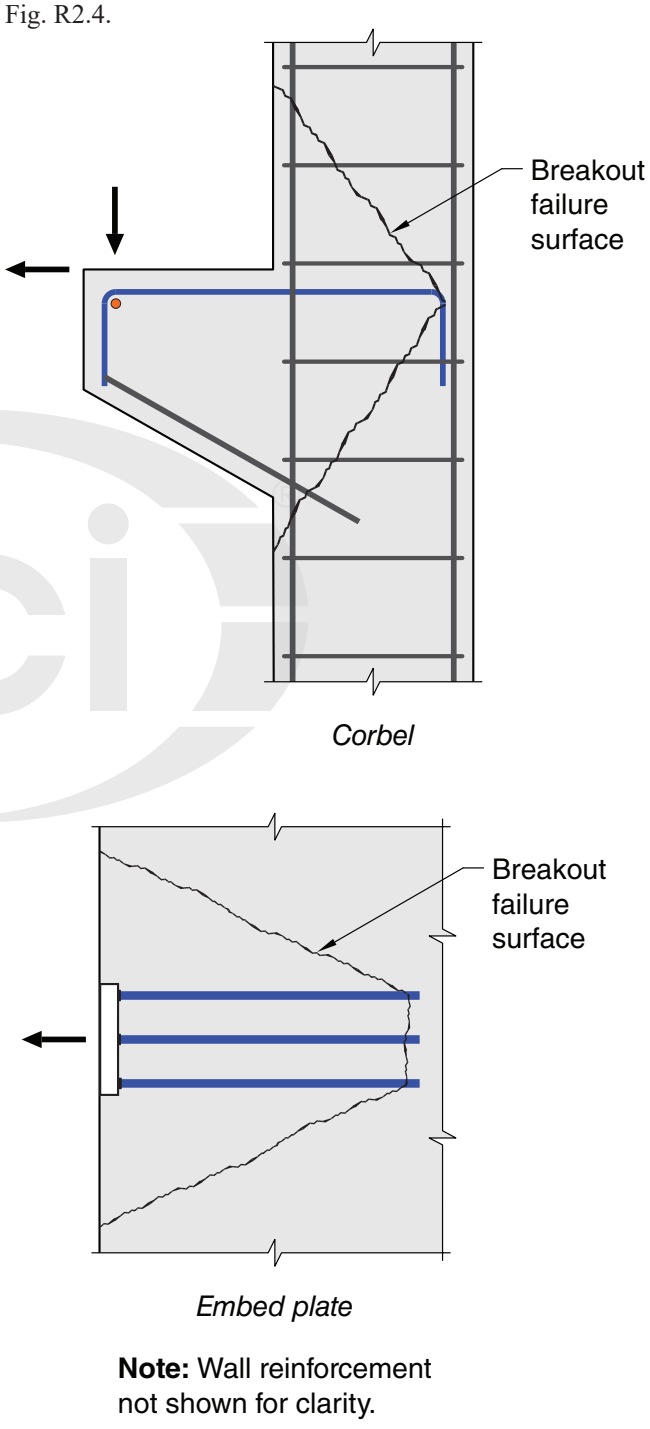

Fig. R2.4—Breakout failure of bar groups.

CODE

resilient design—design process that anticipates, addresses, and mitigates risks associated with known natural or human-caused hazards by balancing construction cost, material consumption, recovery of functionality, and potential financial loss should a particular hazard event occur. (Appendix C)

Seismic Design Category—classification assigned to a structure based on its occupancy category and the severity of the design earthquake ground motion at the site, as defined by the general building code. Also denoted by the abbreviation SDC.

seismic-force-resisting system—portion of the structure designed to resist earthquake effects required by the general building code using the applicable provisions and load combinations.

seismic hook—hook on a stirrup, hoop, or crosstie having a bend not less than 135 degrees, except that circular hoops shall have a bend not less than 90 degrees; hooks shall have an extension of at least $6d_b$, but not less than 3 in. The hooks shall engage the longitudinal reinforcement and the extension shall project into the interior of the stirrup or hoop.

shear cap—projection below the slab used to increase the slab shear strength.

shear lug—a steel element welded to an attachment base plate to transfer shear to concrete by bearing.

sheathing—material encasing prestressing reinforcement to prevent bonding of the prestressing reinforcement with the surrounding concrete, to provide corrosion protection, and to contain the corrosion-inhibiting coating.

shotcrete—concrete placed pneumatically by high velocity projection from a nozzle onto a surface.

shotcrete, dry-mix—shotcrete in which most of the mixing water is added to the concrete ingredients at the nozzle.

shotcrete, wet-mix—shotcrete in which the concrete ingredients, including water, are mixed before introduction into the delivery hose.

COMMENTARY

resilient design—The design of resilient concrete structural systems includes:

(a) Assessing the importance of the structure with respect to its functional, social, and economic roles in the community

(b) Evaluating the hazards to which the structure may be exposed (such as flood or earthquake) and the estimated magnitudes associated with target risk levels in the present and in the future

(c) Assessing the vulnerability and sensitivity of the structure to damage

(d) Assessing the consequences of damage to the structure caused by the hazard event(s)

(e) Evaluating the interdependent effects of the structure on other physical and social systems

In the context of the community of which individual structures are a part, resilience may include the community's ability to absorb disturbances while retaining the same basic structure and functionality, the capacity for self-organization, and the capacity to adapt to stress and change. The hazard design criteria and required recovery time following a hazard event should be based on the use, importance, and occupancy of the structure. (Appendix C)

sheathing—Typically, sheathing is a continuous, seamless, high-density polyethylene material extruded directly on the coated prestressing reinforcement.

shotcrete—Terms such as gunite and sprayed concrete are sometimes used to refer to shotcrete.

CODE

side-face blowout strength, concrete—strength of anchors with deep embedment and thin side-face cover such that spalling occurs on the side face around the embedded head without breakout occurring at the top concrete surface.

slab beam strip—in two-way prestressed slabs, the width of the floor system, including both the slab and beam if applicable, bounded laterally by adjacent panel centerlines for an interior slab-beam strip, or by adjacent panel centerline and slab edge for an exterior slab-beam strip.

spacing—center-to-center distance between adjacent items, such as longitudinal reinforcement, transverse reinforcement, prestressing reinforcement, or anchors.

spacing, clear—least dimension between the outermost surfaces of adjacent items.

span length—distance between supports.

special seismic systems—structural systems that use special moment frames, special structural walls, or both.

specialty engineer—a licensed design professional to whom a specific portion of the design has been delegated.

specialty insert—predesigned and prefabricated cast-in anchors specifically designed for attachment of bolted or slotted connections.

spiral reinforcement—continuously wound reinforcement in the form of a cylindrical helix.

steel element, brittle—element with a tensile test elongation of less than 14%, or reduction in area of less than 30% at failure.

steel element, ductile—element with a tensile test elongation of at least 14 percent and reduction in area of at least 30 percent; steel element meeting the requirements of ASTM A307 shall be considered ductile; except as modified by for earthquake effects, deformed reinforcing bars meeting the requirements of ASTM A615, A706, or A955 shall be considered as ductile steel elements.

stirrup—reinforcement used to resist shear and torsion in a member; deformed bar, deformed wire, or welded wire reinforcement,typically in the form of a single leg or bent into L, U, or rectangular shapes, oriented perpendicular to, or at an angle to, longitudinal reinforcement, and anchored near the extreme compression and tension surfaces of the section by bends, heads, or cross wires. See also **tie**.

structural wall panel zone—portion of a structural wall common to intersecting wall segments where forces from adjacent wall segments are resolved. (Appendix A)

strength, design—nominal strength multiplied by a strength reduction factor ϕ.

strength, nominal—strength of a member or cross section calculated in accordance with provisions and assumptions of the strength design method of this Code before application of any strength reduction factors.

COMMENTARY

specialty insert—Specialty inserts are devices often used for handling, transportation, erection, and anchoring elements; specialty inserts are not within the scope of the Code.

steel element, brittle—The 14% elongation should be measured over the gauge length specified in the appropriate ASTM standard for the steel.

steel element, ductile—The 14 percent elongation should be measured over the gauge length specified in the appropriate ASTM standard for steel. Due to concerns over fracture in cut threads, it should be verified that threaded deformed reinforcing bars satisfy the strength requirements of 25.5.7.1.

stirrup—The term "stirrup" is usually applied to transverse reinforcement in beams or slabs and the term "ties" or "hoops" to transverse reinforcement in compression members.

strength, nominal—Nominal or specified values of material strengths and dimensions are used in the calculation of nominal strength. The subscript n is used to denote the nominal strengths; for example, nominal axial load strength P_n, nominal moment strength M_n, and nominal shear strength V_n. For additional discussion on the concepts and nomenclature for strength design, refer to the Commentary of Chapter 22.

CODE

strength, required—strength of a member or cross section required to resist factored loads or related internal moments and forces in such combinations as stipulated in this Code.

stretch length—length of anchor, extending beyond concrete in which it is anchored, subject to full tensile load applied to anchor, and for which cross-sectional area is minimum and constant.

structural concrete—concrete used for structural purposes, including plain and reinforced concrete.

structural diaphragm—member, such as a floor or roof slab, that transmits forces acting in the plane of the member to vertical elements of the lateral-force-resisting system. A structural diaphragm may include chords and collectors as part of the diaphragm.

structural integrity—ability of a structure through strength, redundancy, ductility, and detailing of reinforcement to redistribute stresses and maintain overall stability if localized damage or significant overstress occurs.

structural system—interconnected members designed to meet performance requirements.

structural truss—assemblage of reinforced concrete members subjected primarily to axial forces.

structural wall—wall proportioned to resist combinations of moments, shears, and axial forces in the plane of the wall; a shear wall is a structural wall.

structural wall, ductile coupled—a seismic-force-resisting-system complying with 18.10.9.

structural wall, intermediate precast—a wall complying with 18.5.

structural wall, ordinary plain concrete—a wall complying with Chapter 14.

structural wall, ordinary reinforced concrete—a wall complying with Chapter 11.

structural wall, special—a cast-in-place structural wall in accordance with 18.2.3 through 18.2.8 and 18.10; or a precast structural wall in accordance with 18.2.3 through 18.2.8 and 18.11.

strut—compression member in a strut-and-tie model representing the resultant of a parallel or a fan-shaped compression field.

strut, boundary—strut located along the boundary of a member or discontinuity region.

COMMENTARY

strength, required—The subscript u is used only to denote the required strengths; for example, required axial load strength P_u, required moment strength M_u, and required shear strength V_u, calculated from the applied factored loads and forces. The basic requirement for strength design may be expressed as follows: design strength ≥ required strength; for example, $\phi P_n \geq P_u$; $\phi M_n \geq M_u$; $\phi V_n \geq V_u$. For additional discussion on the concepts and nomenclature for strength design, refer to the Commentary of Chapter 22.

stretch length—Length of an anchor over which inelastic elongations are designed to occur under earthquake loadings. Examples illustrating stretch length are shown in Fig. R17.2.3.4.3.

structural wall, intermediate precast—Requirements of 18.5 are intended to result in an intermediate precast structural wall having minimum strength and toughness equivalent to that for an ordinary reinforced concrete structural wall of cast-in-place concrete. A precast concrete wall not satisfying the requirements of 18.5 is considered to have ductility and structural integrity less than that for an intermediate precast structural wall.

structural wall, special—Requirements of 18.2.3 through 18.2.8 and 18.11 are intended to result in a special precast structural wall having minimum strength and toughness equivalent to that for a special reinforced concrete structural wall of cast-in-place concrete.

strut, boundary—A boundary strut is intended to apply to the flexural compression zone of a beam, wall, or other

CODE

strut, interior—strut not located along the boundary of a member or discontinuity region.

strut-and-tie model—truss model of a member or of a D-region in such a member, made up of struts and ties connected at nodes and capable of transferring the factored loads to the supports or to adjacent B-regions.

sustainable design—design process that considers the balance among social, economic, and environmental principles from the Work's conception through the end of its service life (Appendix C).

tendon—in post-tensioned members, a tendon is a complete assembly consisting of anchorages, prestressing reinforcement, and sheathing with coating for unbonded applications or ducts filled with grout for bonded applications.

tendon finishing—the trimming of tendons, installing watertight encapsulation cap, and filling stressing pockets; for bonded post-tensioning systems, it also includes installing grout caps and closure of grout vents.

tendon, bonded—tendon in which prestressed reinforcement is continuously bonded to the concrete through grouting of ducts embedded within the concrete cross section.

tendon, external—a tendon external to the member concrete cross section in post-tensioned applications.

tendon, unbonded—tendon in which prestressed reinforcement is prevented from bonding to the concrete. The prestressing force is permanently transferred to the concrete at the tendon ends by the anchorages only.

tensile strength, reinforcement—specified minimum tensile strength of reinforcement.

tension-controlled section—a cross section in which the net tensile strain in the extreme tension steel at nominal strength is greater than or equal to $\varepsilon_{ty} + 0.003$.

tie—(a) reinforcing bar or wire enclosing longitudinal reinforcement; a continuously wound transverse bar or wire in the form of a circle, rectangle, or other polygonal shape without reentrant corners enclosing longitudinal reinforcement; see also **stirrup, hoop**; (b) tension element in a strut-and-tie model.

COMMENTARY

member. Boundary struts are not subject to transverse tension and are therefore stronger than interior struts (Fig. R23.2.1).

strut, interior—Interior struts are subject to tension, acting perpendicular to the strut in the plane of the model, from shear (Fig. R23.2.1).

sustainable design—The design of sustainable concrete structural systems seeks to achieve balance between the production of concrete elements and the required performance characteristics in all phases of the structural system's life cycle. This approach includes measures to reduce the consumption of resources, including but not limited to water, aggregates, cementitious materials, reinforcing steel, and fuels; considers economic value and societal and cultural impacts; and minimizes impacts on the environment. When considering sustainable design, the Code places emphasis on the environmental impacts. Users should also consider social and economic principles of sustainable design that are not directly addressed by the Code. The principles of resilience and resilient design should be considered in sustainable design (Appendix C).

tendon, external—In new or existing post-tensioned applications, a tendon totally or partially external to the member concrete cross section, or inside a box section, and attached at the anchor device and deviation points.

CODE

transfer—act of transferring stress in prestressing reinforcement from jacks or pretensioning bed to concrete member.

transfer length—length of embedded pretensioned reinforcement required to transfer the effective prestress to the concrete.

two-way construction—members designed to resist out-of-plane loads through bending in two directions; some slabs and foundations are considered two-way construction. See also **one-way construction**.

uncased cast-in-place concrete drilled or augered piles—piles with or without an enlarged base (bell) that are constructed by either drilling a hole in the ground, or by installing a temporary casing in the ground and cleaning out the soil, and subsequently filling the hole with reinforcement and concrete.

wall—a vertical element designed to resist axial load, lateral load, or both, with a horizontal length-to-thickness ratio greater than 3, used to enclose or separate spaces.

wall pier—a vertical wall segment within a structural wall, bounded horizontally by two openings or by an opening and an edge, with ratio of horizontal length to wall thickness (ℓ_w/b_w) less than or equal to 6.0, and ratio of clear height to horizontal length (h_w/ℓ_w) greater than or equal to 2.0.

wall segment—portion of wall bounded by vertical or horizontal openings or edges.

wall segment, horizontal—segment of a structural wall, bounded vertically by two openings or by an opening and an edge.

wall segment, vertical—segment of a structural wall, bounded horizontally by two openings or by an opening and an edge; wall piers are vertical wall segments.

water-cementitious materials ratio—ratio of mass of water, excluding that absorbed by the aggregate, to the mass of cementitious materials in a mixture, stated as a decimal.

Whole Building Life Cycle Assessment (WBLCA)—life cycle assessment (LCA) of the complete building (Appendix C).

Work—the entire construction or separately identifiable parts thereof that are required to be furnished under the construction documents.

yield strength, reinforcement—specified minimum yield strength of reinforcement.

COMMENTARY

wall pier—Wall piers are vertical wall segments with dimensions and reinforcement intended to result in shear demand being limited by flexural yielding of the vertical reinforcement in the pier.

wall segment, horizontal—A horizontal wall segment is shown in Fig. R18.10.4.5.

Work—Work is capitalized throughout the Code when used in accordance with this definition.

yield strength, reinforcement—specified yield strength differs from actual yield strength, which is the measured yield strength of the reinforcement

Notes