c. Connections that accommodate story drift by bending of threaded rods shall satisfy Eq. (13.5-1):

$$(L/d)/D_{pI} \geq 6.0 \text{ [1/in.]}; \quad (13.5\text{-}1)$$

$$(L/d)/D_{pI} \geq 0.24 \text{ [1/mm]}; \quad (13.5\text{-}1.si)$$

where:

L = clear length of rod between nuts or threaded plates [in. (mm.)];

d = rod diameter [in. (mm)]; and

D_{pI} = relative seismic displacement that the connection must be designed to accommodate [in. (mm)].

~~c.~~ 3. Unchanged

~~d.~~ 4. See discussion in the next section of this publication

~~e.~~ 5. Unchanged

Analysis and Significance

Part b has been replaced by Item 2 for connections accommodating drifts through sliding mechanisms or bending of threaded steel rods to incorporate information from the recent seismic testing. The section includes specific requirements on acceptable threaded rod materials, the length to diameter ratios of the rods, and the size of the slots or oversized holes (if used). The new specific provisions replace the general requirements from Section 13.5.3(b) in ASCE 7-10. The commentary to Section 13.5.3 contains a discussion on the new requirements.

References:

Pantoli, E., Chen, M., Hutchinson, T., Underwood, G., and Hildebrand, M., "Shake Table Testing of a Full-Scale Five-Story Building: Seismic Performance of Precast Concrete Cladding Panels," 4th ECCOMAS Thematic Conference on Computational Methods in Structural Dynamics and Earthquake Engineering (COMPDYN 2013), Kos Island, Greece, 12 -14 June 2013.

Trautner, C., Hutchinson, T., Grosser, P., "Cyclic Behavior of Structural Base Plate Connections with Ductile Fastening Failure: Component Test Results," Tenth U.S. National Conference on Earthquake Engineering, Anchorage, Alaska, July 2014, 11 pp.

Full-Scale Structural and Nonstructural Building System Performance During Earthquakes and Post-Earthquake Fire – UC San Diego Shake Table Test Specimen

Exterior Nonstructural Connections

Modification

13.5.3 Item 4, Table 13.5-1

At a Glance

A reference to the overstrength factor, Ω_0, is added to Section 13.5.3 Item 4 (which replaced Section 13.5.3 Item d) and the overstrength values in Table 13.5-1 are revised.

2016 Standard

Table 13.5-1 Coefficients for Architectural Components

Architectural Component	a_p[a]	R_p	Ω_0[c]
(Table entries not shown are unchanged)			
Exterior Nonstructural Wall Elements and Connections[b]			
Wall Element	1	2 ½	~~2 ½~~ NA
Body of wall panel connections	1	2 ½	~~2 ½~~ NA
Fasteners of the connecting system	1 ¼	1	~~1 ½~~ 1

13.5.3 Exterior Nonstructural Wall Elements and Connections.

(Text of section not shown is unchanged)

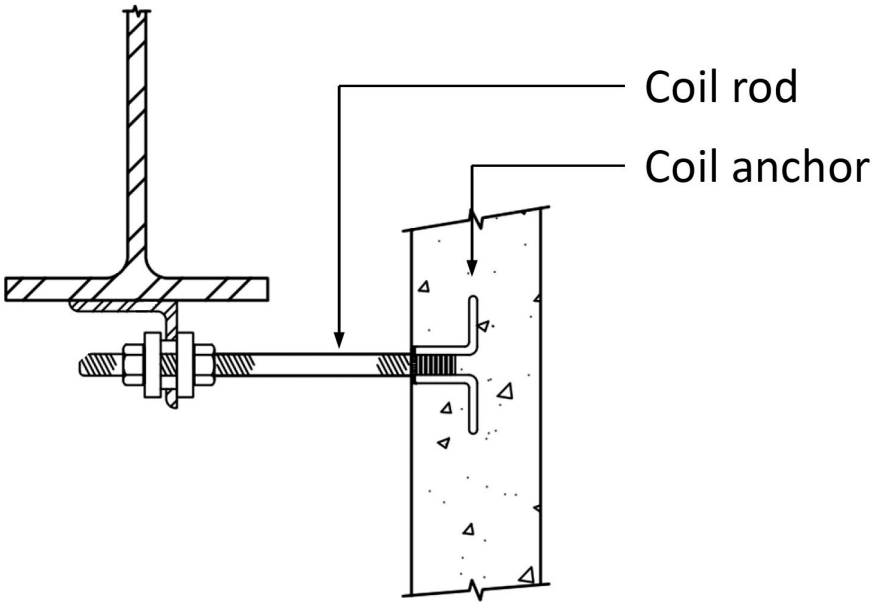
~~c.~~*13.5.3.4.* All fasteners in the connecting system such as bolts, inserts, welds, and dowels, and the body of the connectors shall be designed for the force (F_p) determined by Section 13.3.1 with values of a_p , R_p , and Ω_0 taken from Table 13.5-1 applied at the center of mass of the panel. The connecting system shall include both the connections between the wall panels or elements and the structure and the interconnections between wall panels or elements.

Analysis and Significance

The overstrength factor was introduced in Supplement 1 to ASCE 7-10 for anchorage forces to ensure that brittle elements remain elastic under seismic loading. Anchorage forces are determined by Section 13.3.1 and include the overstrength factor only for anchorage to concrete and masonry. Setting the overstrength factor to 1.0 and the component amplification factor to 1.25 ensures a consistent seismic design force for fastener elements regardless of whether they are anchored to concrete and masonry or not.

Wall elements and body of the wall panel connections are not associated with anchorage to concrete and therefore the values of overstrength are replaced with NA (not applicable).

Glazed Curtain Wall lements and body of the wall panel connections are not associated with anchorage to concrete and therefore the values of overstrength are replaced with NA (not applicable).



Bolted Tieback from PCI – DN–32
Connections for Architectural Precast Concrete

Glass in Glazed Curtain Walls and Storefronts

Addition

13.5.4

At a Glance

Additional language clarifies the application of Section 13.5.9 and adds a list of references to a number of ASTM standards for the use of structural sealant glazing.

2016 Standard

13.5.4 Glass. Glass in glazed curtain walls and storefronts shall be designed and installed to accommodate without breakage or dislodgement the relative displacement requirement of ~~in accordance with~~ Section 13.5.9.

Where glass is secured to the window system framing by means of structural sealant glazing, the requirements contained in the reference standards listed in Table 13.5-2 shall also apply.

Table 13.5-2 Reference Standards for Structural Sealant Glazing

ASTM
C1087-00 *Test Method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems*
C1135-00 *Test Method for Determining Tensile Adhesion Properties of Structural Sealants*
C1184-14 *Specification for Structural Silicone Sealants*
C1265-94 *Test Method for Determining the Tensile Properties of an Insulating Glass Edge Seal for Structural Glazing Applications*
C1294-07 *Test Method for Compatibility of Insulating Glass Edge Sealants with Liquid-Applied Glazing Materials*
C1369-07 *Specification for Secondary Edge Sealants for Structurally Glazed Insulating Glass Units*

Analysis and Significance

The additional language in reference to Section 13.5.9 clarifies that the relative displacement requirements of that section apply. The new Table 13.5-2 includes a list of ASTM standards that contain additional requirements for the use of structural silicone sealants in window systems where imposed loads are transferred from the glass to the support system through the adhesive bond of the sealant.

Glazed Curtain Wall

Acoustical Tile and Lay-in Panel Ceilings in Seismic Design Categories D though F

Modification

13.5.6.2.2

At a Glance

The requirements for perimeter support of acoustical tile or lay-in panel ceilings are revised to allow the use of qualified perimeter supporting clips.

2016 Standard

13.5.6.2.2 Seismic Design Categories D through F.

Acoustical tile or lay-in panel ceilings in structures assigned to Seismic Design Categories D, E, and F shall be designed and installed in accordance with ASTM C635, ASTM C636, and ASTM E580, Section 5—Seismic Design Categories D, E, and F as modified by this section.

Acoustical tile or lay-in panel ceilings shall also comply with the following:

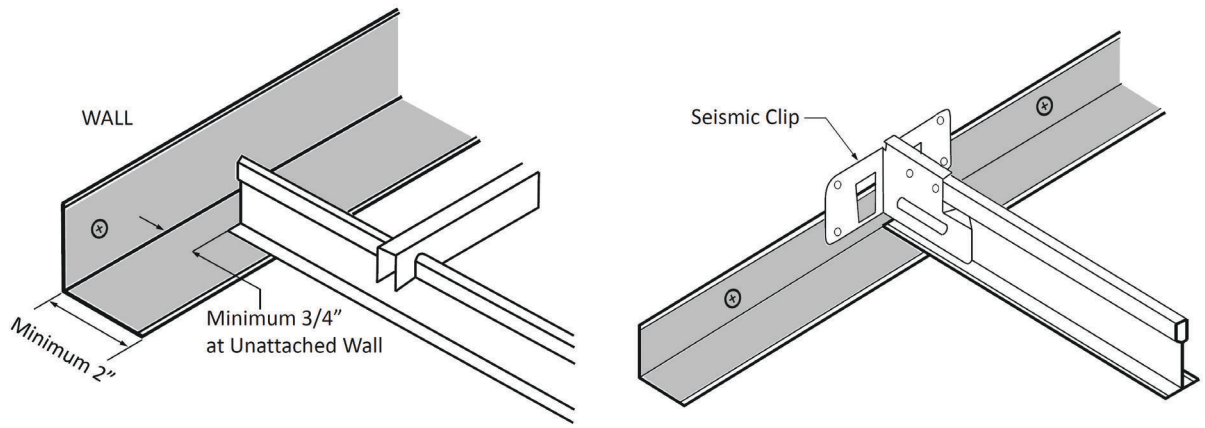
a. The width of the perimeter supporting closure angle or channel shall be not less than 2.0 in. (50 mm) unless qualified perimeter supporting clips are used. Closure angles or channels shall be screwed or otherwise positively attached to wall studs or other supporting structure. ~~Where perimeter~~ Perimeter supporting clips ~~are used, they~~ shall be qualified in accordance with approved test criteria per Section 13.2.5. Perimeter supporting clips shall be attached to the supporting closure angle or channel with a minimum of two screws per clip, and shall be installed around the entire ceiling perimeter. In each orthogonal horizontal direction, one end of the ceiling grid shall be attached to the closure angle~~, or~~ channel or perimeter supporting clip. The other end of the ceiling grid in each horizontal direction shall have a minimum 0.75 in. (19 mm) clearance from the wall and shall rest upon and be free to slide on a closure angle~~, or~~ channel or perimeter supporting clip.

b. *Unchanged, except for a minor editorial revision.*

Analysis and Significance

The requirements of Section 13.5.6.2.2(a) are intended to ensure vertical support of the ceiling and to minimize damage to the ceiling system during and after a seismic event. The requirements for perimeter support of acoustical tile or lay-in panel ceilings are revised to make it clear that there are two options, 1) a perimeter supporting closure angle or channel with a width of 2 in. or more or 2) qualified perimeter supporting clips. Option 2 is added to allow the use of proprietary (or otherwise qualified per Section 13.2.5) supporting clips. The use of perimeter supporting clips has become standard construction practice and the revisions are intended to make it easier to use appropriate, qualified clips.

Additionally, closure angles or channels are now required to be positively attached to the supporting structure and, where used, perimeter supporting clips must be attached to the supporting angle or channel with 2 screws per clip around the entire ceiling perimeter.



Perimeter Supporting Angle without and with Seismic Clips
Courtesy: S. K. Ghosh Associates Inc.

Egress Stairs and Ramps

Addition

13.5.10, Table 13.5-1

At a Glance

New section on egress stairs and ramp supports is added.

2016 Standard

13.5.10 Egress Stairs and Ramps.

Egress stairs and ramps not part of the seismic force-resisting system of the structure to which they are attached shall be detailed to accommodate the seismic relative displacements, D_{pI}, defined in Section 13.3.2 including diaphragm deformation. The net relative displacement shall be assumed to occur in any horizontal direction. Such elements shall be supported by means of positive and direct structural supports or by mechanical connections and fasteners in accordance with the following requirements:

a. Sliding connections with slotted or oversize holes, sliding bearing supports with keeper assemblies or end stops, and connections that permit movement by deformation of metal attachments, shall accommodate a displacement D_{pI}, but not less than 0.5 in. (13 mm), without loss of vertical support or inducement of displacement-related compression forces in the stair.

b. Sliding bearing supports without keeper assemblies or end stops shall be designed to accommodate a displacement $1.5D_{pI}$, but not less than 1.0 in. (25 mm) without loss of vertical support. Break-away restraints are permitted if their failure does not lead to loss of vertical support.

c. Metal supports shall be designed with rotation capacity to accommodate seismic relative displacements as defined in item b. above. The strength of such metal supports shall not be limited by bolt shear, weld fracture or other brittle modes.

d. All fasteners and attachments such as bolts, inserts, welds, and dowels and anchors shall be designed for the seismic design forces determined in accordance with Section 13.3.1 with R_p, a_p, and Ω_0 as given in Table 13.5-1.

EXCEPTION: If sliding or ductile connections are not provided to accommodate seismic relative displacements, the stiffness and strength of the stair or ramp structure shall be included in the building structural model of Section 12.7.3 and the stair shall be designed with Ω_0 corresponding to the seismic force-resisting system but not less than 2-1/2.

TABLE 13.5-1 Coefficients for Architectural Components

Architectural Component	a_p[a]	R_p[b]	Ω_0[c]
(Table entries not shown are unchanged)			
Other Flexible Components			
(Table entries not shown are unchanged)			
Egress stairways not part of the building ~~structure~~ seismic force-resisting system	1	2 ½	~~2 ½~~ 2
Egress stairs and ramp fasteners and attachments	2 ½	2 ½	2 ½

Analysis and Significance

Section 13.5.10 for egress stairs and ramps is added to introduce provisions for seismic relative displacements according to Section 13.3.2 and seismic forces on attachments according to Section 13.3.1. In addition, a new entry for fasteners and attachments of egress stairs and ramps is added to Table 13.5-1. Existing requirements to consider relative seismic displacements in Section 13.3.2 cover stair design. However, due to the critical nature of egress stairs after a seismic event, special design and detailing provisions are warranted and are added. The main intent of the new requirements is to ensure vertical support during and after a seismic event.

In addition, it is clarified that where stairs are rigidly attached to the structure, they must be included as part of the structural model.

Egress Stairs