

PROPOSAL 4-2 (2009)

SCOPE: Sec. 14.2 Concrete Sec. 14.2.2 Modifications to ACI 318

PROPOSAL FOR CHANGE:

Revise Sec. 14.2.2 of the 2009 *Provisions* as follows:

14.2.2 Modifications to ACI 318. The text of ACI 318 shall be modified as indicated in Sections 14.2.2.1 through 14.2.2.9~~18~~. Italics are used for text within Sections 14.2.2.1 through 14.2.2.9~~18~~ to indicate provisions that differ from ACI 318.

14.2.2.1 ACI 318, Section 7.10. Modify Section 7.10 by revising Section 7.10.5.6 to read as follows:

7.10.5.6 – Where anchor bolts are placed in the top of columns or pedestals, the bolts shall be enclosed by lateral reinforcement that also surrounds at least four vertical bars of the column or pedestal. The lateral reinforcement shall ~~also~~ be distributed within 5 in. of the top of the column or pedestal, and shall consist of at least two No.4 or three No.3 bars. *In structures assigned to Seismic Design Categories C, D, E or F, the ties shall have a hook on each free end that complies with 7.1.4.*

~~**14.2.2.2 ACI 318, Section 10.5.** Modify Section 10.5, by adding anew Section 10.5.5 to read as follows:~~

~~**10.5.5** *In structures assigned to Seismic Design Category B, flexural members of ordinary moment frames forming part of the seismic force-resisting system shall have at least two main flexural bars continuously top and bottom throughout the beams, through or developed within exterior columns or boundary elements.*~~

~~**14.2.2.3 ACI 318-05, Section 11.11.** Modify Section 11.11, by changing its title to read as shown in the following text, and by adding a new Section 11.11.3 to read as follows:~~

~~**11.11** *Special Provisions for Columns*~~

~~**11.11.3** *In structures assigned to Seismic Design Category B, columns of ordinary moment frames having a clear height to maximum plan dimension ratio of five or less shall be designed for shear in accordance with 21.12.3*~~

14.2.2.24 Definitions. Add the following definitions to Section 2.2 ~~21.1~~.

DETAILED PLAIN CONCRETE STRUCTURAL WALL: *A wall complying with the*

1 requirements of Chapter 22, including 22.6.7.

2 ~~**ORDINARY STRUCTURAL PLAIN CONCRETE WALL:** A wall complying with the~~
3 ~~requirements of Chapter 22, excluding 22.6.7.~~

4 ~~**ORDINARY PRECAST STRUCTURAL WALL;** A precast wall complying with the~~
5 ~~requirements of Chapters 1 through 18.~~

6 ~~**ORDINARY REINFORCED CONCRETE STRUCTURAL WALL:** A cast in place wall~~
7 ~~complying with the requirements of Chapters 1 through 18.~~

8
9 ~~**WALL PIER:** A wall segment with a horizontal length-to-thickness ratio of at least 2.5, but~~
10 ~~not exceeding 6, whose clear height is at least two times its horizontal length.~~

11
12 **14.2.2.3 5 Scope.** Modify Section 21.1.1.3 Sections 21.2.1.2 through 21.2.1.4 to read as follows:

13
14 **21.1.1.3** All members shall satisfy requirements of Chapters 1 to 19 and 22. Structures assigned
15 to SDC B, C, D, E, or F also shall satisfy 21.1.1.4 through 21.1.1.8, as applicable, except as
16 modified by the requirements of Chapters 14 and 15 of this document.

17
18 ~~**21.2.1.2** For structures assigned to Seismic Design Category A or B, the provisions of Chapters~~
19 ~~1 through 18 and 22 shall apply except as modified by the requirements of Chapters 14 and 15 of~~
20 ~~ASCE 7. Where design seismic loads are computed using provisions for intermediate or special~~
21 ~~concrete systems, the requirements of Chapter 21 for intermediate or special systems, as~~
22 ~~applicable, shall be satisfied.~~

23
24 ~~**21.2.1.3** For structures assigned to Seismic Design Category C, intermediate or special moment~~
25 ~~frames, or ordinary, intermediate, or special reinforced concrete structural walls, or intermediate~~
26 ~~or special precast structural walls shall be used to resist forces induced by earthquake motions~~
27 ~~except as modified by the requirements of Chapter 15 of ASCE 7. Where design seismic loads are~~
28 ~~computed using provisions for special concrete systems, the requirements of Chapter 21 for~~
29 ~~special systems, as applicable, shall be satisfied.~~

30
31 ~~**21.2.1.4** For structures assigned to Seismic Design Category D, E or F, special moment frames,~~
32 ~~special structural walls, diaphragms, trusses and foundations complying with Sections 21.2~~
33 ~~through 21.10, or intermediate precast structural walls complying with 21.13, shall be used to~~
34 ~~resist earthquake motions. Members not proportioned to resist earthquake forces shall comply~~
35 ~~with Section 21.11.~~

36
37 ~~**14.2.2.6 Reinforcement in Members Resisting Earthquake Induced Forces.** Modify Section~~
38 ~~21.2.5 by renumbering as Section 21.2.5.1 and adding new Section 21.2.5.2, to read as follows:~~

39
40 ~~**21.2.5 Reinforcement in Members Resisting Earthquake Induced Forces**~~

41
42 ~~**21.2.5.1** Deformed reinforcement resisting earthquake induced flexural and axial forces in frame~~
43 ~~members and in wall boundary elements shall comply with ASTM A706. ASTM A615 Grades~~
44 ~~40 and 60 reinforcement shall be permitted in these members if:~~

1 a. The actual yield strength based on mill tests does not exceed the specified yield strength by
2 more than 18,000 psi (retests shall not exceed this value by more than an additional 3,000 psi);
3 and

4
5 b. The ratio of the actual tensile strength to the actual yield strength is not less than 1.25.

6
7 ~~21.2.5.2 Prestressing steel resisting earthquake induced flexural and axial loads in frame~~
8 ~~members shall comply with ASTM A 421 or ASTM A 722. The average prestress, f_{pe} , calculated~~
9 ~~for an area equal to the member's shortest cross sectional dimension multiplied by the~~
10 ~~perpendicular dimension shall be the lesser of 700 psi (4.83 MPa) or $f'_c/6$ at plastic hinge~~
11 ~~regions.~~

12
13 ~~14.2.2.7 Anchorages for Unbonded Posttensioning Tendons.~~ Modify Section 21.2 by adding
14 a new Section 21.2.9 to read as follows:

15
16 ~~21.2.9 Anchorages for Unbonded Posttensioning Tendons.~~

17 ~~21.2.9 Anchorages for unbonded posttensioning tendons resisting earthquake induced forces in~~
18 ~~structures in regions of moderate or high seismic risk, or assigned to intermediate or high~~
19 ~~seismic performance or design categories shall withstand, without failure, 50 cycles of loading~~
20 ~~ranging between 40 percent and 85 percent of the specified tensile strength of the prestressing~~
21 ~~steel.~~

22
23 ~~14.2.2.8 Flexural Members of Special Moment Frames.~~ Modify Section 21.3 by adding a new
24 Section 21.3.2.5 to read as follows:

25 ~~—21.3.2.5—Unless the special moment frame is qualified for use through structural testing as~~
26 ~~required by 21.6.3, for flexural members prestressing steel shall not provide more than one~~
27 ~~quarter of the strength for either positive or negative moment at the critical section in a plastic~~
28 ~~hinge location and shall be anchored at or beyond the exterior face of a joint.~~

29
30 ~~14.2.2.4 9 Wall Piers and Wall Segments.~~ Modify Section ~~21.9~~ 21.7 by adding a new Section
31 ~~21.9.10~~ 21.7.10 to read as follows:

32
33 ~~21.9.7.10 Wall Piers and Wall Segments.~~

34
35 ~~21.9.7.10.1 Wall piers not designed as a part of a special moment-resisting frame shall have~~
36 ~~transverse reinforcement designed to satisfy the requirements in Section 21.9.7.10.2.~~

37
38 **Exceptions:**

- 39 1. Wall piers that satisfy Section 21.13.11.
40 2 Wall piers along a wall line within a story where other shear wall segments provide lateral
41 support to the wall piers, and such segments have a total stiffness of at least six times the sum
42 of the in-plane stiffnesses of all the wall piers.

43
44 ~~21.9.7.10.2 Transverse reinforcement with seismic hooks at both ends shall be designed to resist~~
45 ~~the shear forces determined from Section 21.6.5.1~~ 21.4.5.1. Spacing of transverse reinforcement

1 shall not exceed 6 in. (152 mm). Transverse reinforcement shall be extended beyond the pier
2 clear height for at least 12 in. (304 mm).

3
4 **21.9.7.10.3** Wall segments with a horizontal length-to-thickness ratio less than 2.5 shall be
5 designed as columns

6
7 **14.2.2.5.10 Special Precast Structural Walls.** Modify Section ~~21.10.2~~ ~~21.8.4~~ to read as
8 follows:

9
10 ~~21.10.28.4~~ Special structural walls constructed using precast concrete shall satisfy all the
11 requirements of Section 21.9 in addition to 21.4 as modified in Section 14.2.2.8.2 and 21.4.3.

12
13 **14.2.2.6.11 Foundations.** Modify Section 21.12.10.1.1 to read as follows:

14
15 ~~21.12.10.1.1~~ Foundations resisting earthquake-induced forces or transferring earthquake-induced
16 forces between structure and ground shall comply with requirements of Section 21.12.10 and
17 other applicable code provisions unless modified by Sections 12.1.5, 12.13 or 14.2 of ASCE 7-05.

18
19 ~~14.2.2.6.12 Members Not Designated as Part of the Lateral Force-Resisting System.~~ Modify
20 Section ~~21.13.3.2~~ ~~21.11.2.2~~ to read as follows:

21
22 ~~21.13.11~~ ~~Members Not Designated As Part of the Lateral Force-Resisting System~~

23
24 ~~21.11.2.2~~ Members with factored gravity axial forces exceeding $(A_g f'_c/10)$ shall satisfy Sections
25 21.4.3, 21.4.4.1 (e), 21.4.4.3 and 21.4.5. The maximum longitudinal spacing of ties shall be s_o
26 for the full column height. The spacing s_o shall not be more than six diameters of the smallest
27 longitudinal bar enclosed or 6 in. (152 mm), whichever is smaller. ~~Lap splices of longitudinal~~
28 ~~reinforcement in such members need not satisfy Section 21.4.3.2 in structures where the seismic~~
29 ~~force-resisting system does not include special moment frames.~~

30
31 ~~14.2.2.13 Columns Supporting Reactions from Discontinuous Stiff Members.~~ Modify
32 Section 21.12.5, by adding a new Section 21.12.5.6 to read as follows:

33
34 ~~21.12.5.6~~ Columns supporting reactions from discontinuous stiff members, such as walls, shall
35 be designed for the special load combinations of Section 12.4.3 of ASCE 7, and shall be
36 provided with transverse reinforcement at the spacing, s_o , as defined in 21.12.5.2 over the full
37 height beneath the level at which the discontinuity occurs. This transverse reinforcement shall
38 be extended above and below the column as required in 21.4.4.5.

39
40 **14.2.2.7.14 Intermediate Precast Structural Walls:** Modify Section 21.4.13 by renumbering
41 Section 21.4.3.13.3 to Section 21.4.4.13.4 and adding new Sections 21.4.3.13.3 and 21.4.5.13.5,
42 to read as follows:

43
44 ~~21.4.3.13.3~~ Connections that are designed to yield shall be capable of maintaining 80% of their
45 design strength at the deformation induced by design displacement, or shall use type 2
46 mechanical splices.

1 ~~21.4.4~~ ~~13.4~~ Elements of the connection that are not designed to yield shall develop at least 1.5
2 S_y .

3 ~~21.4.5~~ ~~13.5~~ Wall piers not designed as part of a moment frame shall have transverse
4 reinforcement designed to resist the shear forces determined from Section 21.3.3 ~~12.3~~. Spacing
5 of transverse reinforcement shall not exceed 8 in. Transverse reinforcement shall be extended
6 beyond the pier clear height for at least 12 in.

7
8 **Exceptions:** The preceding requirement need not apply in the following situations:

- 9 1. Wall piers that satisfy Section 21.13 ~~11~~.
- 10
- 11 2. Wall piers along a wall line within a story where other shear wall segments provide
12 lateral support to the wall piers and such segments have a total stiffness of at least six
13 times the sum of the in-plane stiffnesses of all the wall piers.

14
15 Wall segments with a horizontal length-to-thickness ratio less than 2.5 shall be designed
16 as columns

17
18 **14.2.2.8** ~~15~~ **Detailed Plain Concrete Shear Walls.** Modify Section 22.6 by adding a new
19 Section 22.6.7 to read:

20
21 **22.6.7 Detailed Plain Concrete Shear Walls.**

22
23 **22.6.7.1** - Detailed plain concrete shear walls are walls conforming to the requirements for
24 ordinary plain concrete shear walls and 22.6.7.2

25
26 **22.6.7.2** Reinforcement shall be provided as follows:

- 27
- 28 a. Vertical reinforcement of at least 0.20 in.^2 (129 mm^2) in cross-sectional area shall be
29 provided continuously from support to support at each corner, at each side of each
30 opening, and at the ends of walls. The continuous vertical bar required beside an opening
31 is permitted to substitute for ~~one of the two~~ No. 5 bars required by Section 22.6.6.5.
- 32
- 33 b. Horizontal reinforcement at least 0.20 in.^2 (129 mm^2) in cross-sectional area shall be
34 provided:
- 35
- 36 1. Continuously at structurally connected roof and floor levels and at the top of walls.
- 37 2. At the bottom of load-bearing walls or in the top of foundations where doveled to the
38 wall
- 39 3. At a maximum spacing of 120 in. (3048 mm).

40
41 Reinforcement at the top and bottom of openings, where used in determining the maximum
42 spacing specified in Item 3 in the preceding text, shall be continuous in the wall.

43
44 ~~14.2.2.16 Plain Concrete in Structures Assigned to Seismic Design Category C, D, E, or F.~~
45 ~~Delete Section 22.10 and replace with the following:~~

1 ~~22.10 Plain concrete structures assigned to Seismic Design Category C, D, E, or F~~

2
3 ~~22.10.1 Structures assigned to Seismic Design Category C, D, E or F shall not have elements of~~
4 ~~structural plain concrete, except as follows:~~

5
6 ~~a. Structural plain concrete basement, foundation, or other walls below the base are~~
7 ~~permitted in detached one and two family dwellings three stories or less in height~~
8 ~~constructed with stud bearing walls. In dwellings assigned to Seismic Design Category D~~
9 ~~or E, the height of the wall shall not exceed 8 ft., the thickness shall not be less than 7.5~~
10 ~~in., and the wall shall retain no more than 4 ft. of unbalanced fill. Walls shall have~~
11 ~~reinforcement in accordance with Section 22.6.6.5.~~

12
13 ~~b. Isolated footings of plain concrete supporting pedestals or columns are permitted~~
14 ~~provided the projection of the footing beyond the face of the supported member does not~~
15 ~~exceed the footing thickness.~~

16
17 ~~**EXCEPTION:** In detached one and two family dwellings three stories or less in height,~~
18 ~~the projection of the footing beyond the face of the supported member is permitted to~~
19 ~~exceed the footing thickness.~~

20
21 ~~c. Plain concrete footings supporting walls are permitted provided the footings have not less~~
22 ~~than two continuous longitudinal reinforcing bars. Bars shall not be smaller than No. 4~~
23 ~~and shall have a total area of not less than 0.002 times the gross cross sectional area of~~
24 ~~the footing. For footings that exceed 8 in. (203 mm) in thickness, a minimum of one bar~~
25 ~~shall be provided at the top and bottom of the footing. Continuity of reinforcement shall~~
26 ~~be provided at corners and intersections.~~

27
28 ~~**EXCEPTIONS:**~~

- 29 ~~1. In detached one and two family dwellings three stories or less in height and constructed~~
30 ~~with stud bearing walls, plain concrete footings supporting walls and without~~
31 ~~longitudinal reinforcement are permitted.~~
32 ~~2. For foundation systems consisting of a plain concrete footing and a plain concrete~~
33 ~~stemwall, a minimum of one bar shall be provided at the top of the stemwall and at the~~
34 ~~bottom of the footing.~~
35 ~~3. Where a slab on ground is cast monolithically with the footing, one No. 5 bar is~~
36 ~~permitted to be located at either the top or bottom of the footing.~~

37
38 ~~14.2.2.17 General Requirements for Anchoring to Concrete.~~ Modify Section D.3.3 by
39 ~~deleting Sections D.3.3.2 through D.3.3.5 and replace with the following:~~

40 ~~D.3.3.2 In structures assigned to Seismic Design Category C, D, E, or F, post installed~~
41 ~~structural anchors for use under Section D.2.3 shall have passed the Simulated Seismic Tests of~~
42 ~~ACI 355.2.~~

43 ~~D.3.3.3 In structures assigned to Seismic Design Category C, D, E, or F, the design strength of~~
44 ~~anchors shall be taken as $0.75\phi N_n$ and $0.75\phi V_n$, where ϕ is given in Sections D.4.4 or in D.4.5,~~
45 ~~and N_n and V_n are determined in accordance with Section D.4.1.~~

1 ~~D.3.3.4—In structures assigned to Seismic Design Category C, D, E, or F, anchors shall be~~
2 ~~designed to be governed by tensile or shear strength of a ductile steel element, unless Section~~
3 ~~D.3.3.5 is satisfied.~~

4 ~~D.3.3.5—Instead of Section D.3.3.4, the attachment that the anchor is connecting to the~~
5 ~~structure shall be designed so that the attachment undergoes ductile yielding at a load level~~
6 ~~corresponding to anchor forces no greater than the design strength of anchors specified in~~
7 ~~Section D.3.3.3, or the minimum design strength of the anchors shall be at least 2.5 times the~~
8 ~~factored forces transmitted by the attachment.~~

9
10 **14.2.2.9~~18~~ Strength Requirements for Anchors:** Modify Section D.4 by adding a new
11 exception at the end of Section D.4.2.2 to read as follows:

12
13 **EXCEPTION:** *If N_b is determined using Eq. D-7, the concrete breakout strength of*
14 *Section D.4.2 shall be considered satisfied by the design procedure of Sections D.5.2 and*
15 *D.6.2 without the need for testing regardless of anchor bolt diameter and tensile*
16 *embedment.*

17
18
19 **REASON FOR PROPOSAL:**

20
21 To eliminate many of the exceptions to ACI 318-05 contained within ASCE/SEI 7-05 Sec. 14.2
22 as a result of the change in the Reference Document from ACI 318-05 to ACI 318-08. The
23 proposal is needed because ACI 318-08 includes provisions specifically addressing the
24 exceptions that have been eliminated.

25
26 **TS-4 VOTE:** In a ballot canvassed 12/14/2007 TS-4 voted as follows on the first draft
27 of this proposal.

28 YES=6 Yes with Reservations= 1 No= 3 Not Voting= 1

29 There was also an editorial comment.

30
31 The proposal was revised by eliminating the exception for lap splices that was initially in
32 14.2.2.6 and reinstating an exception for special shear walls in a revised 14.2.2.6. With those
33 three changes the No voters withdrew their No votes.