ACI Code Change Proposals ICC Group B

Code change proposals have been developed and submitted for the Group B cycle of International Code Council code development process to modify the 2018 edition of the I-codes. The proposals clarify, remove transcriptions, remove requirements that are also addressed in referenced ACI documents and include ACI documents as reference standards.

International Code Council IBC and IEBC	
Section(s)	Concept
***International Building Code* (IBC) Chapter 17—Special Inspection and Tests**	
1703.1.3	Adds qualifications for special inspectors including **ACI Concrete Construction Special Inspector**
1704.2.6	Adds requirements for testing and technicians by referencing **ACI 311.6-18:** *Specification for Ready Mixed Concrete Testing Services*
1705.1	Replaces requirements for special inspection by referencing **ACI 311.7-18:** *Specification for Inspection of Concrete Construction*
IBC Chapter—18 Soils and Foundations	
1808.8.1	Removes requirements for **foundation compressive strength** because strengths are addressed in ACI 318
1808.8.1	Removes restrictive and antiquated requirements for **funnel placement**.
1808.8.1	Removes restrictive and antiquated requirements for **pumpable concrete**.
1808.8.2	Removes requirements for **cover of reinforcement** in foundations because cover is addressed in ACI 318
1808.2 1808.3	Removes requirements for **concrete piles** because piles are addressed in ACI 318 based on coordination with ASCE[1]
1810.3.2.7	Removes requirements for **allowable compressive strengths** of concrete piles because strengths are addressed in ACI 318.
1810.3.11	Removes requirements for **pile caps** where pile cap criteria are addressed in ACI 318.
1810.3.12 1810.3.13	Removes requirements for **grade beams** and **seismic ties** because these grade beams and seismic ties are addressed in ACI 318.
IBC Chapter 19—Concrete	
1901.2	Clarifies provisions for **detailed plain concrete structural walls** and removes unnecessary transcription from ACI 318
1901.2	Removes requirements for **precast diaphragms** because precast diaphragms are addressed in ACI 318.
1901.3	Adds provisions to permit **screw anchors** per ACI 318
1901.5	Removes abridged list of **construction document** requirements in favor of requirements in ACI 318.
1901.7	Adds provision for construction tolerances by referencing **ACI 117-10**: *Specification for Tolerances for Concrete Construction and Materials* and **ITG-7-09**: *Specification for Tolerances for Precast Concrete*
1902	Clarifies the **coordination of terms** between the IBC, ASCE 7[1] and ACI 318, specifically design displacement and special structural wall.
1903.1	Removes references to **cement standards** to eliminate duplication and to clarify that other cementitious materials are permitted in accordance with ACI 318.
1905.1	Clarifies requirements for **seismic design** and removes provisions addressed in ACI 318.
1906	Reorganizes and clarifies requirements for **anchors** in concrete.
1906.1	Reorganizes and clarifies provisions **for anchorage of light-frame construction** to concrete.
1907	Reorganizes and clarifies provisions for **slabs-on-ground**
1908	Removes antiquated requirements for **shotcrete** in favor of provisions in ACI 318.
IBC Chapter 35—Reference Standards	
ACI	Update reference to **ACI 318-19**: *Building Code Requirements for Structural Concrete.*
International Existing Building Code	
303.4	Permits the use of **ACI 562-19**: *Code Requirements for Assessment, Repair, and Rehabilitation of Existing Concrete Structures*

[1]American Society of Civil Engineers *Minimum Design Loads and Associated Criteria for Buildings and Other Structures* (ASCE 7)

ACI IBC 17 02/03 1703.1 Certified Inspectors

IBC: 1703.1.3

Proponent: Stephen Szoke, American Concrete Institute, representing American Concrete Institute (steve.szoke@concrete.org); Scott Campbell, National Ready Mixed Concrete Association, representing National Ready Mixed Concrete Association (scampbell@nrmca.org)

2018 International Building Code

Revise as follows:

1703.1.3 Personnel. An *approved agency* shall employ experienced personnel educated in conducting, supervising and evaluating tests and *special inspections*.
1703.1.3.1 Structural concrete special inspector. Individuals with current credentials demonstrating that the requirements of ACI Concrete Construction Special Inspector or ICC Reinforced Concrete Special Inspector have been satisfied shall be permitted to act as special inspectors for structural concrete construction.

Reason Statement: This code change proposal provides the criteria for personnel to be considered qualified to conduct special inspections of structural concrete. The American Concrete Institute Committee C630 - Construction Inspector Certification has developed a rigorous program to certify individuals as qualified to perform special inspection of concrete construction. This code change proposal does not alter any existing criteria of other individuals qualified as special inspectors, but adds provisions for individuals who are ACI or ICC certified concrete construction special inspectors to be permitted to satisfy the code criteria as special inspectors for concrete construction. This proposal provides the criteria, but does not require individuals to be certified as an ACI Concrete Construction Special Inspector. The ACI requirements are provided in the attached file, cpp-6301-15.pdf, or may be found at:
https://www.concrete.org/Portals/0/Files/PDF/cpp_6301-15.pdf.
Jurisdictions are adding these requirements to their codes. As a model code, this requirement should be inlcuded in the IBC to assist the jurisidcitons in having the language properly incorporated into their respective codes. For example, the Georgia Building Code now incudes certified inspectors. See pages 12 through 15 of the attached file, 2014-ibcamendments.pdf.

The American Concrete Institute. as a professional society whose mission includes working to facilitate the use and adoption of current concrete technology to assure the desired performance for the benefit of the public, encourages the committee to approve of this code change as submitted.

Cost Impact: The code change proposal will not increase or decrease the cost of construction
This code change will not increase of decrease the cost of consturciton.

ACI IBC 17 03/03 Inspection and Tests

IBC: 1704.2.6 (New), ACI Chapter 35 (New)

Proponent: Stephen Szoke, American Concrete Institute, representing American Concrete Institute (steve.szoke@concrete.org); Scott Campbell, National Ready Mixed Concrete Association, representing National Ready Mixed Concrete Association (scampbell@nrmca.org)

2018 International Building Code

Add new text as follows:

1704.2.6 Concrete tests. Unless otherwise required by the authority having jurisdiction, field and laboratory technicians qualifications shall comply with ACI 311.6.

Add new standard(s) follows:

ACI

American Concrete Institute
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Farmington Hills MI 48331

1: ACI 311.6-18 Specification for Ready Mixed Concrete Testing Services

Reason Statement: Proper sampling, specimen preparation and acceptance testing of concrete delivered to construction projects is crucial for assuring proper performance of structural concrete. Inaccurate test results and the negative implications on the performance of concrete occur far too frequently. When field testing, preparation of samples and laboratory testing are not conducted properly there may be significant expenses and delays added to the cost of construction, such as extracting cores of hardened concrete to verify concrete strength. Improper sampling, preparation and testing often cause project delays, further increasing costs.
On many projects the qualifications for technicians are included in the construction documents. There is a need to assure cast-in-place concrete is properly sampled, prepared and tested. Cast-in-place concrete is one of the few building materials provided to the construction site in a condition other than its final state. Verification of properties should only be performed by qualified individuals.

Local jurisdictions have already begun to address this concern. In 2014 the Georgia Building Code included an amendment to the IBC which added ACI Concrete Field Testing Technician with Grade 1 certification: https://dca.ga.gov/sites/default/files/2014_ibcamendments.pdf. In 2018 the Georgia Building Code included another amendment to the IBC which added American Concrete Institute (ACI) Strength Testing Technician: https://dca.ga.gov/sites/default/files/2018_ibcamendments.pdf. This demonstrates the need to more clearly communicate the necessary qualifications for technicians conduction sampling, specimen preparation and testing of concrete.

ACI, a technical professional society, recommends that the committee approve this code change proposal as submitted to 1) improve the quality assurance processes for structural concrete, 2) reduce project cost increases due to inappropriate sampling, preparation and testing, 3) reduce the frequency of related construction delays, and 4) help assure that the concrete being used in structural elements will provide the life safety and property protection necessary to satisfy the intent of the code.

Cost Impact: The code change proposal will not increase or decrease the cost of construction
There is no cost increase for this code change proposals, as for most projects these requirements are included in the contract documents between the owners, designers, and contractors. This code change proposal helps to assure that these requirements are included for structural concrete.

ACI IBC 17 01/03 ACI 311.7

IBC: 1705.3, 1705.3.1, 1705.3.2, 1705.3.3 (New), TABLE 1705.3, ACI Chapter 35 (New)

Proponent: Stephen Szoke, American Concrete Institute, representing American Concrete Institute (steve.szoke@concrete.org); Scott Campbell, National Ready Mixed Concrete Association, representing National Ready Mixed Concrete Association (scampbell@nrmca.org)

2018 International Building Code

Revise as follows:

1705.3 Concrete construction. *Special inspections* and tests of concrete construction shall be performed in accordance with this section and ~~Table 1705.3.~~ACI 311.7.

Exception 1: *Special inspections* and tests shall not be required for:

1. Isolated spread concrete footings of buildings three stories or less above *grade plane* that are fully supported on earth or rock.
2. Continuous concrete footings supporting walls of buildings three stories or less above *grade plane* that are fully supported on earth or rock where:
   2.1. The footings support walls of light-frame construction.
   2.2. The footings are designed in accordance with Table ~~1809.7.~~1809.7.
   2.3. The structural design of the footing is based on a specified compressive strength, f'_c, not more than 2,500 pounds per square inch (psi) (17.2 MPa), regardless of the compressive strength specified in the *approved construction documents* or used in the footing construction.
3. Nonstructural concrete slabs supported directly on the ground, including prestressed slabs on grade, where the effective prestress in the concrete is less than 150 psi (1.03 MPa).
4. Concrete foundation walls constructed in accordance with Table ~~1807.1.6.2.~~1807.1.6.2.
5. Concrete patios, driveways and sidewalks, on grade.

Exception 2: Special inspection for welding reinforcing bars shall be in accordance with section 1705.3.1.
Exception 3: Continuous special inspection is required for placement of reinforcing steel for special moment frames, boundary elements of special walls, and coupling beams.

1705.3.1 Welding of reinforcing bars. *Special inspection* of welding of reinforcing bars shall be as follows:
1. Special inspections of welding and qualifications of special inspectors for reinforcing bars shall be in accordance with the requirements of AWS D1.4 for *special inspection* and of AWS D1.4 for special inspector qualification.

2. Perform continuous special inspection for welding of reinforcing steel for special moment frames, boundary elements of special structural walls, and coupling beams.

3. Perform periodic inspection for all other welds.

4. Verify weldability of reinforcing bars other than ASTM A706

1705.3.2 Material tests. In the absence of sufficient data or documentation providing evidence of conformance to quality standards for materials in Chapters 19 and 20 of ACI 318, the *building official* shall require testing of materials in accordance with the appropriate standards and criteria for the material in Chapters 19 and 20 of ACI 318.

Add new text as follows:

1705.3.3 Post-installed anchors installation. Specific requirements for special inspection of post-installed anchors shall be included in the research report for the anchor issued by an approved source in accordance with Section 5.1 in ACI 311.7, or other qualification procedures. Where specific requirements are not provided, special inspection requirements shall be specified by the registered design professional and shall be approved by the building official prior to the commencement of the work.

Delete without substitution:

~~**TABLE 1705.3**~~
~~**REQUIRED SPECIAL INSPECTIONS AND TESTS OF CONCRETE CONSTRUCTION**~~

TYPE	CONTINUOUS SPECIAL INSPECTION	PERIODIC SPECIAL INSPECTION	REFERENCEDSTANDARD[a]	IBCREFERENCE
1. Inspect reinforcement, including prestressing tendons, and verify placement.	—	X	ACI 318: Ch. 20, 25.2, 25.3, 26.6.1-26.6.3	1908.4
2. Reinforcing bar welding: a. Verify weldability of reinforcing bars other than ASTM A706; b. Inspect single-pass fillet welds, maximum $^{5}/_{16}$"; and c. Inspect all other welds.	— X	 X X	 AWS D1.4 ACI 318: 26.6.4	—
3. Inspect anchors cast in concrete.	—	X	ACI 318: 17.8.2	—
4. Inspect anchors post-installed in hardened concrete members.[b] a. Adhesive anchors installed in horizontally or upwardly inclined orientations to resist sustained tension loads. b. Mechanical anchors and adhesive anchors not defined in 4.a.	X	X	 ACI 318: 17.8.2.4 ACI 318: 17.8.2	—
5. Verify use of required design mix.	—	X	ACI 318: Ch. 19, 26.4.3, 26.4.4	1904.1, 1904.2, 1908.2, 1908.3
6. Prior to concrete placement, fabricate speci-mens for strength tests, perform slump and air content tests, and determine the temperature of the concrete.	X	—	ASTM C172 ASTM C31 ACI 318: 26.5, 26.12	1908.10
7. Inspect concrete and shotcrete placement for proper application techniques.	X	—	ACI 318: 26.5	1908.6, 1908.7, 1908.8
8. Verify maintenance of specified curing tem-perature and techniques.	—	X	ACI 318: 26.5.3-26.5.5	1908.9
9. Inspect prestressed concrete for:a.Application of prestressing forces; andb.Grouting of bonded prestressing tendons.	X X	——	ACI 318: 26.10	—
10. Inspect erection of precast concrete members.	—	X	ACI 318: 26.9	—
11. Verify in-situ concrete strength, prior to stress-ing of tendons in post-tensioned concrete and prior to removal of shores and forms from beams and structural slabs.	—	X	ACI 318: 26.11.2	—
12. Inspect formwork for shape, location and dimensions of the concrete member being formed.	—	X	ACI 318: 26.11.1.2(b)	—

For SI: 1 inch = 25.4 mm.

a. Where applicable, see Section 1705.12, Special inspections for seismic resistance.
b. Specific requirements for special inspection shall be included in the research report for the anchor issued by an approved source in accordance with 17.8.2 in ACI 318, or other qualification procedures. Where specific requirements are not provided, special inspection requirements shall be specified by the registered design professional and shall be approved by the building official prior to the commencement of the work.

Add new standard(s) follows:

ACI

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311.7-18: Specification for Inspection of Concrete Construction

Reason Statement: The list of criteria in the current Code is not as comprehensive as the list required by ACI 318. ACI 311.7 is written to the inspector and complies with the requirements of ACI 318. This code change simplifies this code, references ACI 311.7 on special inspection and removes conflicts with the requirements of ACI 318.
1) ACI 311.7 is added as a reference with modification to language to align 2018 IBC, ACI 318-19, and ACI 311.7 language.

2) Table 1705.3 is deleted to avoid conflicts between Table1705.3 and ACI 318.

3) As not to lose pertinent information provided in footnote b to the Table 1705.3, new section 1705.3.3 Anchor installation is added and more appropriately references the applicable section of ACI 311.7.

The criteria in the IBC is not as accurate, complete, and extensive as the criteria in ACI 311.7. ACI 311.7 is aligned with ACI 318 more than Table 1705.3. Further Table 1705.3 does not include all the special inspection requirements of ACI 318. The omissions of criteria in ACI 318 suggest that the additional special inspections required by ACI 318 are not necessary. The result is that the lack of the special inspections as identified in ACI 318 could pose life safety issues. Coordinating and maintaining duplicate lists is always challenging and tends to lead to omissions and errors. The solution, as recommended by this code change proposal, is to comply with the requirements of ACI 311.7. If for some reason it is important for the building code officials to have a partial list of the inspection criteria, such as that in the 2018 edition of the IBC, then this abridged list would be more appropriate as commentary to the IBC.

Differences between IBC Table 1705.3 and ACI 311.7 are:

· Item 1 – exception 2 is added to comply with ACI 318-19 for special moment frame, boundary elements of special structural walls, and coupling beams

· Item 2 – necessary language is retained in Section 1705.3.1 for reinforcing steel and to modify provisions of the IBC and ACI 311.7 to comply with ACI 318-19 for special moment frames, boundary elements of special structural walls and coupling beams.

· Item 3 – no difference

· Item 4 – ACI 311.7 includes a reference to ACI 355.4 *Qualification of Post-Installed Adhesive Anchors in Concrete*, a standard that prescribes the qualifications for adhesive anchors. This standard was developed by ACI to fill a void that exists due to the absence of an ASTM Standard on adhesive anchor qualifications. Without this reference there are no requirements for qualifying adhesive anchors. ACI 311.7 also requires compliance with both Sections 17.1.2 and 17.8.2 for mechanical anchors whereas the IBC only requires compliance with 17.8.2. ACI 318 Section 17.1.2 prescribes the minimum age of the concrete for anchoring adhesive anchors to concrete. This is crucial criteria necessary to achieve the performance of the adhesive anchors.

· Item 5 - IBC requires compliance with 26.4.3 of ACI 318, but this section does not provide compliance criteria. Chapter 19 of the IBC requires concrete comply with ACI 318 so this specific reference is not required in the table; and IBC requires compliance with 26.4.4 of ACI 318, however ACI 311.7 provides more specific direction to the use. The compliance requirement appropriate for special inspections are specifically included in ACI 318 Section 26.4.4.1, as cited in ACI 311.7.

· Item 6 - Where the IBC only cites compliance with ASTM C31 and C172, ACI 311.6 Specification for Ready Mixed Concrete Testing Services, referenced in ACI 311.7, also provides for compliance with:

C39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens,

C138 Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete,

C143 Standard Test Method for Slump of Hydraulic-Cement Concrete,

C173 Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method,

C231 Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method,

C511 Standard Specification for Mixing Rooms, Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes, and

C1064 Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete

· Item 7 – no difference, ACI 311.7 reference more precise.

· Item 8 – no difference.

· Item 9 – ACI 311.7 more precisely identifies the ACI 318 Section for compliance requirements. ACI 311.7, consistent with ACI 318 also includes compliance with ACI 318 Section 26.13.2:

(a) Placement of concrete.

(b) Tensioning of prestressing steel and grouting of bonded tendons.

(c) Installation of adhesive anchors in horizontal or upwardly inclined orientations to resist sustained tension loads in accordance with 17.8.2.4 and where required as a condition of the anchor assessment in accordance with ACI 355.4.

(d) Reinforcement for special moment frames.

· Item 10 – no difference.

· Item 11 – § ACI 311.7 more precisely identifies the ACI 318 Section for compliance requirements. ACI 311.7, consistent with ACI 318 also includes compliance with ACI 318 Section 26.13.3.3(e): *"Verification of in-place concrete strength before stressing post-tensioned reinforcement and before removal of shores and formwork from beams and structural slabs."*

· Item 12 – no difference

In addition, ACI 311.7 is written specifically for special inspectors and provides the necessary direction to aid special inspectors determining compliance. ACI 311.7 also includes references to specifications necessary to properly conduct special inspections for specific elements, ACI 355.4 for post-installed anchors and ACI 311.6 for testing of ready-mixed concrete.

This code change avoids confusion for compliance with the intent of both the IBC and ACI 318. It also addresses items omitted from the IBC but required in ACI 318. Proper special inspection should be in accordance with ACI 311.7 and not only the truncated list in the IBC. Without this code change items crucial for life safety could be omitted from special inspection as the IBC criteria supersede the criteria of referenced standards. The omissions in the IBC suggest to the user that the additional criteria of ACI documents are not required.

ACI, a technical professional society, recommends approval of this code change proposal as submitted to avoid confusion and conflicts between the IBC and ACI 318 and to help assure that all items identified as warranting special inspection in ACI 318 are addressed as compliance criteria where special inspection of concrete is required in the IBC.

Cost Impact: The code change proposal will not increase or decrease the cost of construction
There is no increase in the initial cost of construction. Design and construction professionals adhering to the requirements of ACI 318, would being complying with these special inspections requirements as proposed herein and required by Chapter 19 of the IBC. Code change avoids confusion for compliance with both the IBC and ACI documents.

ACI IBC 18 04 1808.8.1 Compressive Strength

IBC: 1808.8.1, TABLE 1808.8.1

Proponent: Stephen Szoke, American Concrete Institute, representing American Concrete Institute (steve.szoke@concrete.org); Scott Campbell, representing National Ready Mixed Concrete Association (scampbell@nrmca.org)

2018 International Building Code

Revise as follows:

1808.8.1 Concrete or grout strength and mix proportioning. Concrete or grout in foundations shall have a specified compressive strength (f'_c) not less than the largest applicable value indicated in Table ~~1808.8.1.~~19.2.1.1 of ACI 318.

Where concrete is placed through a funnel hopper at the top of a deep foundation element, the concrete mix shall be designed and proportioned so as to produce a cohesive workable mix having a slump of not less than 4 inches (102 mm) and not more than 8 inches (204 mm). Where concrete or grout is to be pumped, the mix design including slump shall be adjusted to produce a pumpable mixture.

Delete without substitution:

~~**TABLE 1808.8.1**~~
~~**MINIMUM SPECIFIED COMPRESSIVE STRENGTH f'_c OF CONCRETE OR GROUT**~~

~~**FOUNDATION ELEMENT OR CONDITION**~~	~~**SPECIFIED COMPRESSIVE STRENGTH, f'_c**~~
~~1.Foundations for structures assigned to *Seismic Design Category* A, B or C~~	~~2,500 psi~~
~~2a.Foundations for Group R or U occupancies of light-frame construction, two stories or less in height, assigned to *Seismic Design Category* D, E or F~~	~~2,500 psi~~
~~2b. Foundations for other structures assigned to *Seismic Design Category* D, E or F~~	~~3,000 psi~~
~~3. Precast nonprestressed driven piles~~	~~4,000 psi~~
~~4. Socketed drilled shafts~~	~~4,000 psi~~
~~5. Micropiles~~	~~4,000 psi~~
~~6.Precast prestressed driven piles~~	~~5,000 psi~~

~~For SI: 1 pound per square inch = 0.00689 MPa.~~

Reason Statement: Removes the table for compressive strength requirements for the 2018 IBC and directs the user to ACI 318 Table 19.2.1.1 Limits for f'_c. The user is already required to use information from ACI 318 for foundations. For example. Table 1808.8.2 Minimum Concrete Cover directs the user to the requirements of Section 20.6 of ACI 318. By not having information in two places will reduce confusion, avoid unintended differences and reduce the potential for errors. Rather than having criteria in two locations this change places criteria on one reference and helps assure that other applicable provisions of ACI 318 as required by 2018 IBC Chapter 19 are not overlooked. Table 1 below shows the comparison of criteria in 2018 IBC and ACI 318. It is noteworthy that, consistent with the overall methodology throughout ACI 318, the user is directed to one section for all relevant criteria. Note that Table 19.2.1.1 has all limits for specified compressive strength in one location. This improves the user-friendliness provided by ACI 318. Further with criteria in two documents that user is required to refer to both to identify potential differences which can be a cumbersome process.

TABLE 1

Comparison of IBC AND ACI 318 MIN. COMPRESSIVE STRENGTH OF CONCRETE OR GROUT

2018 IBC	**ACI 318**	**2018 IBC**	**ACI 318**
Foundation Element of Condition		**Specified Compressive Strength f'_c**	**Minimum f'_c, psi**
1. Foundations for structures assigned to Seismic Design Category A, B or C	1. General	2,500	2,500
2a. Foundations for two stories or less in height,	2. Special Moment Frames		

assigned to Seismic Design Category D, E or F 2b. Foundations for other structures assigned to Seismic Design Category D, E or F2	2a. Special structural walls with Grade 60 or 80 reinforcement 2b. Special Structural walls with Grade 100 reinforcement	2,500 3,000	3,000[1] 5,000
3. Precast nonprestressed driven piles		4,000 psi	4,000
4. Socketed drilled shafts		4,000 psi	4,000
5. Micropiles		4,000 psi	4,000
6. Precast prestressed driven piles		5,000 psi	5,000

[1] The f'_c for lightweight concrete in special moment frames and special structural walls shall not exceed 5000psi. The limit is permitted to be exceeded where demonstrated by experimental evidence that members made with lightweight concrete provide strength and toughness equal to or exceeding those of comparable members made with normalweight concrete of the same strength.

[2]Does not include foundations for stud bearing wall construction two stories or less.

ACI, a professional technical society, recommends the deletion of the specified compressive strength criteria form the IBC to better assure that all applicable requirements of ACI 318 are properly considered for design and construction of concrete foundations. ACI encourages the committee to approve this code change as submitted.

Cost Impact: The code change proposal will not increase or decrease the cost of construction
Technical criteria remain unchanged and thus no cost impact.

ACI IBC 18 01/07 1808.8.1 Funnel Placement

IBC: 1808.8.1

Proponent: Stephen Szoke, American Concrete Institute, representing American Concrete Institute (steve.szoke@concrete.org); Scott Campbell, National Ready Mixed Concrete Association, representing National Ready Mixed Concrete Association (scampbell@nrmca.org)

2018 International Building Code

Revise as follows:

1808.8.1 Concrete or grout strength and mix proportioning. Concrete or grout in foundations shall have a specified compressive strength (f'_c) not less than the largest applicable value indicated in Table 1808.8.1. ~~Where concrete is placed through a funnel hopper at the top of a deep foundation element, the concrete mix shall be designed and proportioned so as to produce a cohesive workable mix having a slump of not less than 4 inches (102 mm) and not more than 8 inches (204 mm).~~

Where concrete or grout is to be pumped, the mix design including slump shall be adjusted to produce a pumpable mixture.

Reason Statement: This code change removes outdated requirements from the IBC. Current concrete mixes are commonly designed with admixtures to better improve and assure placement using funnel hopper and this set of criteria specifying slump is no longer required in the code. The information in IBC Section 1808.1 is outdated as the slump criteria is only applicable for concrete mix designs not containing admixtures used for proper placement. Where such admixtures are used the slump requirement is likely not to be satisfied.

ACI, a professional technical society, recommends the deletion of this outdated criteria and encourages the committee to approve this code change as submitted.

Cost Impact: The code change proposal will not increase or decrease the cost of construction

This code change eliminates antiquated prescriptive crtieria, allowing admixtures to acheive necessary properties and increase affordability.

ACI IBC 18 02/07 1808.8.1 Pumpable Concrete

IBC: 1808.8.1

Proponent: Stephen Szoke, American Concrete Institute, representing American Concrete Institute (steve.szoke@concrete.org); Scott Campbell, National Ready Mixed Concrete Association, representing National Ready Mixed Concrete Association (scampbell@nrmca.org)

2018 International Building Code

Revise as follows:

1808.8.1 Concrete or grout strength and mix proportioning. Concrete or grout in foundations shall have a specified compressive strength (f'_c) not less than the largest applicable value indicated in Table 1808.8.1.
Where concrete is placed through a funnel hopper at the top of a deep foundation element, the concrete mix shall be designed and proportioned so as to produce a cohesive workable mix having a slump of not less than 4 inches (102 mm) and not more than 8 inches (204 mm).

~~Where concrete or grout is to be pumped, the mix design including slump shall be adjusted to produce a pumpable mixture.~~

Reason Statement: This code change removes an inappropriate requirement. Grout to be pumped needs to satisfy more requirements than just those required to facilitate pumping. The consistency of the concrete must also satisfy other requirements including but not limited to workability, durability and structural performance requirements. ACI 301 *Specifications for Structural Concrete* provides that: "*4.2.2.2 Slump—Unless otherwise specified, select a target slump or slump flow at the point of delivery for all concrete mixtures. Selected target slump shall not exceed 9 in. Selected target slump flow shall not exceed 30 in. Concrete shall not show visible signs of segregation. The target slump or slump flow value shall be enforced for the duration of the project*." Current concrete technology provides for both concrete slump and flow as applicable for concrete placement and performance.
ACI 318 *Building Code Requirements for Structural Concrete* which is a reference in the IBC references ACI 301 for concrete mix design criteria. Thus the appropriate criteria are applicable for concrete are requirements of the IBC by reference. This text should be deleted to assure the appropriate criteria for concrete slump and flow are satisfied regardless of delivery methods. ACI, a technical professional society, recommends the committee approve this code change proposal as submitted.

Cost Impact: The code change proposal will not increase or decrease the cost of construction
In general, this code change will not increase nor decrease the cost of construction except there may be cost savings due to the use of admixtures that improve pumpability of concrete while retaining the other necessary properites of the concrete.

ACI IBC 18 03/07 1808.8.2 Cover

IBC: 1808.8.2, 1808.2.1 (New), TABLE 1808.8.2

Proponent: Stephen Szoke, American Concrete Institute, representing American Concrete Institute (steve.szoke@concrete.org); Scott Campbell, representing National Ready Mixed Concrete Association (scampbell@nrmca.org)

2018 International Building Code

Revise as follows:

1808.8.2 Concrete cover. The concrete cover ~~provided for prestressed and nonprestressed reinforcement in~~ for all concrete deep foundations shall be ~~not less than the largest applicable value specified in Table 1808.8.2. Longitudinal bars spaced less than 1½ inches (38 mm) clear distance apart shall be considered to be bundled bars for which the concrete cover provided shall be not less than that required by Section 20.6.1.3.4 of ACI 318. Concrete cover shall be measured from the concrete surface to the outermost surface of the steel to which the cover requirement applies. Where concrete is placed in a temporary or permanent casing or a mandrel, the inside face of the casing or mandrel shall be considered to be the concrete surface.~~ in accordance with ACI 318 Section 20.5.1.3.4 and this section.

Add new text as follows:

1808.2.1 Structural steel deep foundations. The concrete cover for structural steel cores within a steel pipe, tube or permanent casing shall not be less than 2 inches.

Delete without substitution:

~~**TABLE 1808.8.2**~~
~~**MINIMUM CONCRETE COVER**~~

~~FOUNDATION ELEMENT OR CONDITION~~	~~MINIMUM COVER~~
~~1.Shallow foundations~~	~~In accordance with Section 20.6 of ACI 318~~
~~2. Precast nonprestressed deep foundation elementsExposed to seawater Not manufactured under plant conditionsManufactured under plant control conditions~~	~~3 inches2 inchesIn accordance with Section 20.6.1.3.3 of ACI 318~~
~~3. Precast prestressed deep foundation elementsExposed to seawater Other~~	~~2.5 inchesIn accordance with Section 20.6.1.3.3 of ACI 318~~
~~4. Cast-in-place deep foundation elements not enclosed by a steel pipe, tube or permanent casing~~	~~2.5 inches~~
~~5. Cast-in-place deep foundation elements enclosed by a steel pipe, tube or permanent casing~~	~~1 inch~~
~~6. Structural steel core within a steel pipe, tube or permanent casing~~	~~2 inches~~
~~7. Cast-in-place drilled shafts enclosed by a stable rock socket~~	~~1.5 inches~~

~~For SI: 1 inch = 25.4 mm.~~

Reason Statement: This code change removes the requirements in IBC Section 1808.2 and Table 1808.2 on concrete cover for foundations to avoid confusion and conflicts between the IBC and ACI 318. Plus, the references are no longer correct, as concrete cover requirements for deep foundations are addressed in Section 20.5.1.3.4 and Table 20.5.1.3.4 of ACI 318. The 2018 IBC incorrectly directs the user to Section 20.6.1.3.3 of ACI 318.
The 2018 IBC advises that ACI 318 is to be followed in addition to any requirements in the IBC by the reference to Chapter 19 of the IBC:

"1808.8 Concrete foundations. The design, materials and construction of concrete foundations shall comply with Sections 1808.8.1 through 1808.8.6 and the provisions of Chapter 19."

and Chapter 19 of the 2018 IBC reads:

" 1901.2 Plain and reinforced concrete. Structural concrete shall be designed and constructed in accordance with the requirements of this chapter and ACI 318..."

There is no reason to duplicate requirements of ACI 318 in the IBC.

With regard to removal of text, there are two provisions in the text of IBC Section 1808.2.

1. There are criteria for longitudinal reinforcement and bundled bars, but the requirements in the IBC refer the user to ACI 318 Section 20.6.1.3.4. This is unnecessary language due to the IBC language in Section 1808.8 and 1901.2 as shown above.

2. The IBC language provides a definition for concrete cover which is already addressed in ACI 318: “distance between the outermost surface of embedded reinforcement and the closest outer surface of the concrete.” note that concrete cover is a specified dimension. Thus, where concrete is placed inside casings or mandrels the closest outer surface of the concrete is clearly the inside of the casing or mandrel.

With regard to the criteria in Table 1808.2, the requirements are shown as a side-by-side comparison in the Table below. The requirements remain identical for all concrete cover requirements for foundations except as follows:

1. Concrete cover for precast elements exposed to seawater is permitted to be 2 inches in ACI 318 where the 2018 IBC requires 3 inches and 2-1/2 inches for precast nonprestressed and prestressed, respectively. This modification recognizes the performance of centrifugally manufacturers precast concrete piles, which were probably not a consideration when the cover provisions were introduced into the 2018 IBC. Where additional information on cover requirements as related to manufacturing process and materials the commentary of ACI 318 directs the user to ACI 543R *Guide to Design, Manufacture, and Installation of Concrete Piles*. Now that centrifugally are becoming more commonplace, the code would be remiss in not providing for the minimum requirement that reflect current practice and materials. This lowers costs by recognizing the performance of piles manufactured using zero-slump concrete.

2. Where the 2018 IBC permits cover to be a little as 2.5 inches for deep foundations not enclosed by a steel pipe, tube or permanent casing, ACI 318 finds that the ability to assure proper cover in deep foundations is more challenging than that required for shallow foundations. ACI 318 requires the minimum cover to remain the same for deep foundations as that required for shallow foundations, 3 inches.

3. ACI 318 does not differentiate the minimum concrete cover requirements between deep foundations enclosed within a steel pipe, tube or permanent casing whether there is a structural steel core. Further ACI 318 does not consider the requirements for structural steel deep foundations to be with their purview. Section 1808.2 is retained to include the provisions for these deep foundation systems.

4. Research considered by ACI Committee 318 and Subcommittee 318-0F on Foundations showed comparable performance for cover of precast elements regardless of whether manufactured at a plant or site cast.

ACI, a 501.C.3 professional society recommends approval as submitted to reflect current concrete technology and to assure appropriate minimum requirements are provided for the protection of reinforcement.

Cost Impact: The code change proposal will not increase or decrease the cost of construction
There is no significant increase in cost of construction. Cost is decreased for precast prestressed concrete piles by reducing cover and providing for acceptable performance of new technologies and materials. There may be a slight increase in costs where deep foundations are cast without casings or tubes because the cover is increased from 2-1/2 inches to 3 inches.

ACI IBC 18 06 1810.1 Deep Foundations

IBC: 1810.2.4.1, 1810.3.2.1, 1810.3.2.1.1, 1810.3.2.1.2, 1810.3.2.2, 1810.3.8, 1810.3.8.1, 1810.3.8.2, 1810.3.8.2.1, 1810.3.8.2.2, 1810.3.8.2.3, 1810.3.8.3, 1810.3.8.3.1, , 1810.3.8.3.3, 1810.3.8.3.4, 1810.3.9, 1810.3.9.1, 1810.3.9.2, 1810.3.9.4.1, 1810.3.9.4.2, 1810.3.9.4.2.1, 1810.3.9.4.2.2

Proponent: Stephen Szoke, representing American Concrete Institute (steve.szoke@concrete.org)

2018 International Building Code

Revise as follows:

1810.2.4.1 Seismic Design Categories D through F. For structures assigned to *Seismic Design Category* D, E or F, deep foundation elements on *Site Class* E or F sites, as determined in Section 1613.2.2, shall be designed and constructed to withstand maximum imposed curvatures from earthquake ground motions and structure response. Curvatures shall include free-field soil strains modified for soil-foundation-structure interaction coupled with foundation element deformations associated with earthquake loads imparted to the foundation by the structure.

Exception: Deep foundation elements that satisfy the following additional detailing requirements shall be deemed to comply with the curvature capacity requirements of this section.

1. Precast prestressed concrete piles detailed in accordance with Section ~~1810.3.8.3.3~~ 18.13.5.10.5 in ACI 318.
2. Cast-in-place deep foundation elements with a minimum longitudinal reinforcement ratio of 0.005 extending the full length of the element and detailed in accordance with ~~Sections 18.7.5.2, 18.7.5.3 and 18.7.5.4 of ACI 318 as required by Section 1810.3.9.4.2.2~~ Section 18.13.5.5 of ACI 318.

1810.3.2.1 Concrete. Concrete materials shall conform to ACI 318.
1810.3.2.1.1 Concrete cast in steel pipe. Where concrete is cast in a steel pipe or where an enlarged base is formed by compacting concrete, the maximum size for coarse aggregate shall be 3/4 inch (19.1 mm). Concrete to be compacted shall have a zero slump.

Delete without substitution:

~~**1810.3.2.1.1 Seismic hooks.** For structures assigned to *Seismic Design Category* C, D, E or F, the ends of hoops, spirals and ties used in concrete deep foundation elements shall be terminated with seismic hooks, as defined in ACI 318, and shall be turned into the confined concrete core.~~

~~**1810.3.2.1.2 ACI 318 Equation (25.7.3.3).** Where this chapter requires detailing of concrete deep foundation elements in accordance with Section 18.7.5.4 of ACI 318, compliance with Equation (25.7.3.3) of ACI 318 shall not be required.~~

~~**1810.3.2.2 Prestressing steel.** Prestressing steel shall conform to ASTM A416.~~

Revise as follows:

1810.3.8 Precast concrete piles. Precast concrete piles shall be designed and detailed in accordance with ~~Sections 1810.3.8.1 through 1810.3.8.3.~~ACI 318.

Delete without substitution:

~~**1810.3.8.1 Reinforcement.** Longitudinal steel shall be arranged in a symmetrical pattern and be laterally tied with steel ties or wire spiral spaced center to center as follows:~~

1. ~~At not more than 1 inch (25 mm) for the first five ties or spirals at each end; then~~
2. ~~At not more than 4 inches (102 mm), for the remainder of the first 2 feet (610 mm) from each end; and then~~
3. ~~At not more than 6 inches (152 mm) elsewhere.~~

~~The size of ties and spirals shall be as follows:~~

1. ~~For piles having a least horizontal dimension of 16 inches (406 mm) or less, wire shall not be smaller than 0.22 inch (5.6 mm) (No. 5 gage).~~
2. ~~For piles having a least horizontal dimension of more than 16 inches (406 mm) and less than 20 inches (508 mm), wire shall not be smaller than 0.238 inch (6 mm) (No. 4 gage).~~
3. ~~For piles having a least horizontal dimension of 20 inches (508 mm) and larger, wire shall not be smaller than~~

~~1/4 inch (6.4 mm) round or 0.259 inch (6.6 mm) (No. 3 gage).~~

~~**1810.3.8.2 Precast nonprestressed piles.** Precast nonprestressed concrete piles shall comply with the requirements of Sections 1810.3.8.2.1 through 1810.3.8.2.3.~~

~~**1810.3.8.2.1 Minimum reinforcement.** Longitudinal reinforcement shall consist of not fewer than four bars with a minimum longitudinal reinforcement ratio of 0.008.~~

~~**1810.3.8.2.2 Seismic reinforcement in *Seismic Design Categories* C through F.** For structures assigned to *Seismic Design Category* C, D, E or F, precast nonprestressed piles shall be reinforced as specified in this section. The minimum longitudinal reinforcement ratio shall be 0.01 throughout the length. Transverse reinforcement shall consist of closed ties or spirals with a minimum 3/8 inch (9.5 mm) diameter. Spacing of transverse reinforcement shall not exceed the smaller of eight times the diameter of the smallest longitudinal bar or 6 inches (152 mm) within a distance of three times the least pile dimension from the bottom of the pile cap. Spacing of transverse reinforcement shall not exceed 6 inches (152 mm) throughout the remainder of the pile.~~

~~**1810.3.8.2.3 Additional seismic reinforcement in *Seismic Design Categories* D through F.** For structures assigned to *Seismic Design Category* D, E or F, transverse reinforcement shall be in accordance with Section 1810.3.9.4.2 .~~

~~**1810.3.8.3 Precast prestressed piles.** Precast prestressed concrete piles shall comply with the requirements of Sections 1810.3.8.3.1 through 1810.3.8.3.3.~~

~~**1810.3.8.3.1 Effective prestress.** The effective prestress in the pile shall be not less than 400 psi (2.76 MPa) for piles up to 30 feet (9144 mm) in length, 550 psi (3.79 MPa) for piles up to 50 feet (15 240 mm) in length and 700 psi (4.83 MPa) for piles greater than 50 feet (15 240 mm) in length.~~
~~Effective prestress shall be based on an assumed loss of 30,000 psi (207 MPa) in the prestressing steel. The tensile stress in the prestressing steel shall not exceed the values specified in ACI 318.~~

Revise as follows:

~~**1810.3.8.3.2 Seismic reinforcement in Seismic Design Category C.**~~ **Exception:** For structures assigned to *Seismic Design Category* C, ~~precast prestressed piles shall have transverse reinforcement in accordance with this section. The volumetric ratio of spiral reinforcement shall not be less than the amount required by the following formula for the upper 20 feet (6096 mm) of the pile.~~

$$\rho_s = 0.04(f'_c / f_{yh})[2.8 + 2.34Pf f'_c A_g)]$$ ~~**(Equation 18-5)**~~

~~where:~~

~~A_g = Pile cross-sectional area square inches (mm^2).~~

~~f'_c = Specified compressive strength of concrete, psi (MPa).~~

~~f_{yh} = Yield strength of spiral reinforcement £ 85,000 psi (586 MPa).~~

~~P = Axial load on pile, pounds (kN), as determined from Equations 16-5 and 16-7.~~

~~ρ_s =~~ Spiral reinforcement index or volumetric ratio (vol. spiral/vol. core).

~~Not less than one-half the volumetric ratio required by Equation 18-5 shall be provided below the upper 20 feet (6096 mm) of the pile.~~

~~**Exception:** The~~
D, E, or F, the minimum spiral reinforcement index required by

~~Equation 18-5~~
Sections 18.13.5.10.4 or 18.13.5.10.5 of ACI 318 shall not apply in cases where the design includes full consideration of load combinations specified in ASCE 7, Section 2.3.6 and the applicable overstrength factor,

~~Ω.~~
Ω0. In such cases, minimum spiral reinforcement index shall be as specified in Section

~~1810.3.8.1.~~
13.4.5.6 of ACI 318.

Delete without substitution:

1810.3.8.3.3 Seismic reinforcement in *Seismic Design Categories* D through F. For structures assigned to *Seismic Design Category* D, E or F, precast prestressed piles shall have transverse reinforcement in accordance with the following:

1. Requirements in ACI 318, Chapter 18, need not apply, unless specifically referenced.
2. Where the total pile length in the soil is 35 feet (10 668 mm) or less, the lateral transverse reinforcement in the ductile region shall occur through the length of the pile. Where the pile length exceeds 35 feet (10 668 mm), the ductile pile region shall be taken as the greater of 35 feet (10 668 mm) or the distance from the underside of the pile cap to the point of zero curvature plus three times the least pile dimension.
3. In the ductile region, the center-to-center spacing of the spirals or hoop reinforcement shall not exceed one-fifth of the least pile dimension, six times the diameter of the longitudinal strand or 8 inches (203 mm), whichever is smallest.
4. Circular spiral reinforcement shall be spliced by lapping one full turn and bending the end of each spiral to a 90-degree hook or by use of a mechanical or welded splice complying with Section 25.5.7 of ACI 318.
5. Where the transverse reinforcement consists of circular spirals, the volumetric ratio of spiral transverse reinforcement in the ductile region shall comply with the following:

$$\rho_s = 0.06(f'_c / f_{yh})[2.8 + 2.34P/f'_c A_g)] \qquad \textbf{(Equation 18-6)}$$

but not exceed:

$$\rho_s = 0.021 \qquad \textbf{(Equation 18-7)}$$

where:

A_g = Pile cross-sectional area, square inches (mm^2).

f'_c = Specified compressive strength of concrete, psi (MPa).

f_{yh} = Yield strength of spiral reinforcement = 85,000 psi (586 MPa).

P = Axial load on pile, pounds (kN), as determined from Equations 16-5 and 16-7.

ρ_s = Volumetric ratio (vol. spiral/vol. core).
This required amount of spiral reinforcement is permitted to be obtained by providing an inner and outer spiral.

> **Exception:** The minimum spiral reinforcement required by Equation 18-6 shall not apply in cases where the design includes full consideration of load combinations specified in ASCE 7, Section 2.3.6 and the applicable overstrength factor, Ω_0. In such cases, minimum spiral reinforcement shall be as specified in Section 1810.3.8.1.

6. Where transverse reinforcement consists of rectangular hoops and cross ties, the total cross-sectional area of lateral transverse reinforcement in the ductile region with spacing, s, and perpendicular dimension, h_c, shall conform to:

$$A_{sh} = 0.3s\, h_c\, (f'_c / f_{yh})(A_g / A_{ch} - 1.0) \, [0.5 + 1.4P/(f'_c A_g)] \qquad \textbf{(Equation 18-8)}$$

but not less than:

$$A_{sh} = 0.12s\, h_c\, (f'_c / f_{yh})\, [0.5 + 1.4P/(f'_c A_g)] \qquad \textbf{(Equation 18-9)}$$

where:

f_{yh} = yield strength of transversereinforcement ≤70,000 psi (483 MPa).

h_c = Cross-sectional dimension of pile core measured center to center of hoop reinforcement, inch (mm).

s = Spacing of transverse reinforcement measured along length of pile, inch (mm).

A_{sh} = Cross-sectional area of tranverse reinforcement, square inches (mm^2).

~~f'_c = Specified compressive strength of concrete, psi (MPa).~~
~~The hoops and cross ties shall be equivalent to deformed bars not less than No. 3 in size. Rectangular hoop ends shall terminate at a corner with seismic hooks.~~

~~Outside of the length of the pile requiring transverse confinement reinforcing, the spiral or hoop reinforcing with a volumetric ratio not less than one-half of that required for transverse confinement reinforcing shall be provided.~~

~~**1810.3.8.3.4 Axial load limit in Seismic Design Categories C through F.** For structures assigned to *Seismic Design Category* C, D, E, or F, the maximum factored axial load on precast prestressed piles subjected to a combination of seismic lateral force and axial load shall not exceed the following values:~~

1. ~~$0.2f'_c A_g$ for square piles~~
2. ~~$0.4f'_c A_g$ for circular or octagonal piles~~

Revise as follows:

1810.3.9 Cast-in-place deep foundations. Cast-in-place deep foundation elements shall be designed and detailed in accordance with Sections 1810.3.9.1 through ~~1810.3.9.6.~~1810.3.9.4.

Delete without substitution:

~~**1810.3.9.1 Design cracking moment.** The design cracking moment (ΦM_n) for a cast-in-place deep foundation element not enclosed by a structural steel pipe or tube shall be determined using the following equation:~~

$$\phi M_n = 3\sqrt{f'_c}S_m$$ ~~**(Equation 18-10)**~~

~~For SI:~~

$$\phi M_n = 0.25\sqrt{f'_c}S_m$$

~~where:~~

~~f'_c = Specified compressive strength of concrete or grout, psi (MPa).~~

~~S_m = Elastic section modulus, neglecting reinforcement and casing, cubic inches (mm^3).~~

~~**1810.3.9.2 Required reinforcement.** Where subject to uplift or where the required moment strength determined using the load combinations of Section 1605.2 exceeds the design cracking moment determined in accordance with Section 1810.3.9.1 , cast-in-place deep foundations not enclosed by a structural steel pipe or tube shall be reinforced.~~

Revise as follows:

~~**1810.3.9.3**~~**1810.3.9.1 Placement of reinforcement.** Reinforcement where required shall be assembled and tied together and shall be placed in the deep foundation element as a unit before the reinforced portion of the element is filled with concrete.

Exceptions:

1. Steel dowels embedded 5 feet (1524 mm) or less shall be permitted to be placed after concreting, while the concrete is still in a semifluid state.
2. For deep foundation elements installed with a hollow-stem auger, tied reinforcement shall be placed after elements are concreted, while the concrete is still in a semifluid state. Longitudinal reinforcement without lateral ties shall be placed either through the hollow stem of the auger prior to concreting or after concreting, while the concrete is still in a semifluid state.
3. For Group R-3 and U occupancies not exceeding two stories of light-frame construction, reinforcement is permitted to be placed after concreting, while the concrete is still in a semifluid state, and the concrete cover requirement is permitted to be reduced to 2 inches (51 mm), provided that the construction method can be demonstrated to the satisfaction of the *building official*.

~~**1810.3.9.4**~~**1810.3.9.2 Seismic reinforcement.** Where a structure is assigned to *Seismic Design Category* C, ~~reinforcement shall be provided in accordance with Section 1810.3.9.4.1 . Where a structure is assigned to *Seismic Design Category* D, E, or F, reinforcement shall be provided in accordance with Section 1810.3.9.4.2.~~18.13.5.7 of ACI 318.

Exceptions:

1. Isolated deep foundation elements supporting posts of Group R-3 and U occupancies not exceeding two

stories of light-frame construction shall be permitted to be reinforced as required by rational analysis but with not less than one No. 4 bar, without ties or spirals, where detailed so the element is not subject to lateral loads and the soil provides adequate lateral support in accordance with Section 1810.2.1 .

2. Isolated deep foundation elements supporting posts and bracing from decks and patios appurtenant to Group R-3 and U occupancies not exceeding two stories of light-frame construction shall be permitted to be reinforced as required by rational analysis but with not less than one No. 4 bar, without ties or spirals, where the lateral load, E, to the top of the element does not exceed 200 pounds (890 N) and the soil provides adequate lateral support in accordance with Section 1810.2.1.
3. Deep foundation elements supporting the concrete foundation wall of Group R-3 and U occupancies not exceeding two stories of light-frame construction shall be permitted to be reinforced as required by rational analysis but with not less than two No. 4 bars, without ties or spirals, where the design cracking moment determined in accordance with ~~Section 1810.3.9.1~~ ACI 318 exceeds the required moment strength determined using the load combinations with overstrength factor in Section 2.3.6 or 2.4.5 of ASCE 7 and the soil provides adequate lateral support in accordance with Section 1810.2.1.
4. Closed ties or spirals where required by Section ~~1810.3.9.4.2~~ 18.3.5.7.1 of ACI 318 shall be permitted to be limited to the top 3 feet (914 mm) of deep foundation elements 10 feet (3048 mm) or less in depth supporting Group R-3 and U occupancies of *Seismic Design Category* D, not exceeding two stories of light-frame construction.

Delete without substitution:

~~**1810.3.9.4.1 Seismic reinforcement in *Seismic Design Category* C.** For structures assigned to *Seismic Design Category* C, cast-in-place deep foundation elements shall be reinforced as specified in this section. Reinforcement shall be provided where required by analysis.~~
~~Not fewer than four longitudinal bars, with a minimum longitudinal reinforcement ratio of 0.0025, shall be provided throughout the minimum reinforced length of the element as defined in this section starting at the top of the element. The minimum reinforced length of the element shall be taken as the greatest of the following:~~

1. ~~One-third of the element length.~~
2. ~~A distance of 10 feet (3048 mm).~~
3. ~~Three times the least element dimension.~~
4. ~~The distance from the top of the element to the point where the design cracking moment determined in accordance with Section 1810.3.9.1 exceeds the required moment strength determined using the load combinations of Section 1605.2.~~

~~Transverse reinforcement shall consist of closed ties or spirals with a minimum 3/8 inch (9.5 mm) diameter. Spacing of transverse reinforcement shall not exceed the smaller of 6 inches (152 mm) or 8 longitudinal bar diameters, within a distance of three times the least element dimension from the bottom of the pile cap. Spacing of transverse reinforcement shall not exceed 16 longitudinal bar diameters throughout the remainder of the reinforced length.~~

~~**Exceptions:**~~

1. ~~The requirements of this section shall not apply to concrete cast in structural steel pipes or tubes.~~
2. ~~A spiral welded metal casing of a thickness not less than the manufacturer's standard No. 14 gage (0.068 inch) is permitted to provide concrete confinement in lieu of the closed ties or spirals. Where used as such, the metal casing shall be protected against possible deleterious action due to soil constituents, changing water levels or other factors indicated by boring records of site conditions.~~

~~**1810.3.9.4.2 Seismic reinforcement in Seismic Design Categories D through F.** For structures assigned to *Seismic Design Category* D, E or F, cast-in-place deep foundation elements shall be reinforced as specified in this section. Reinforcement shall be provided where required by analysis.~~
~~Not fewer than four longitudinal bars, with a minimum longitudinal reinforcement ratio of 0.005, shall be provided throughout the minimum reinforced length of the element as defined in this section starting at the top of the element. The minimum reinforced length of the element shall be taken as the greatest of the following:~~

1. ~~One-half of the element length.~~
2. ~~A distance of 10 feet (3048 mm).~~
3. ~~Three times the least element dimension.~~
4. ~~The distance from the top of the element to the point where the design cracking moment determined in accordance with Section 1810.3.9.1 exceeds the required moment strength determined using the load combinations of Section 1605.2.~~

~~Transverse reinforcement shall consist of closed ties or spirals not smaller than No. 3 bars for elements with a least dimension up to 20 inches (508 mm), and No. 4 bars for larger elements. Throughout the remainder of the reinforced length outside the regions with transverse confinement reinforcement, as specified in Section 1810.3.9.4.2.1 or 1810.3.9.4.2.2, the spacing of transverse reinforcement shall not exceed the least of the following:~~

1. ~~12 longitudinal bar diameters.~~
2. ~~One-half the least dimension of the element.~~
3. ~~12 inches (305 mm).~~

~~Exceptions:~~

1. ~~The requirements of this section shall not apply to concrete cast in structural steel pipes or tubes.~~
2. ~~A spiral-welded metal casing of a thickness not less than manufacturer's standard No. 14 gage (0.068 inch) is permitted to provide concrete confinement in lieu of the closed ties or spirals. Where used as such, the metal casing shall be protected against possible deleterious action due to soil constituents, changing water levels or other factors indicated by boring records of site conditions.~~

~~1810.3.9.4.2.1 Site Classes A through D.~~ ~~For *Site Class* A, B, C or D sites, transverse confinement reinforcement shall be provided in the element in accordance with Sections 18.7.5.2, 18.7.5.3 and 18.7.5.4 of ACI 318 within three times the least element dimension of the bottom of the pile cap. A transverse spiral reinforcement ratio of not less than one-half of that required in Section 18.7.5.4(a) of ACI 318 shall be permitted.~~

~~1810.3.9.4.2.2 Site Classes E and F.~~ ~~For *Site Class* E or F sites, transverse confinement reinforcement shall be provided in the element in accordance with Sections 18.7.5.2, 18.7.5.3 and 18.7.5.4 of ACI 318 within seven times the least element dimension of the pile cap and within seven times the least element dimension of the interfaces of strata that are hard or stiff and strata that are liquefiable or are composed of soft- to medium-stiff clay.~~

Reason Statement: This Code change includes revisions and additions to the Code in an effort to eliminate conflicting provisions in ACI 318-14, ASCE 7-16 and IBC-2018 regarding design of deep foundations for earthquake resistant structures. Subcommittee F, Foundations, of ACI 318 has coordinated efforts with members from ASCE 7 to bring the concrete material design requirements for foundations to one location. ASCE 7 started this effort in their cycle ending in 2016. The changes to ACI 318 shown here is the continuation of that effort. A side-by-side comparison is provided, however, difficult to follow with all the changes and dissimilar format. For a more comprehensive look at the changes in ACI 318, please review the public comment version available at
https://www.concrete.org/publications/standards/upcomingstandards.aspx
Summary of code change proposals:

· Section 1810.2.4.1 is updated to the latest version of ACI 318.

· The sections in Materials for the design and detailing of deep foundations were updated to the latest edition of ACI 318.

o Section 1810.3.2.1: A general reference to ACI 318 is made and the existing requirement is moved to 1810.3.2.1.1 as it is not covered in ACI 318.

o Section 1810.3.2.1.1: Is covered by Section 18.13.5.4 in ACI 318.

o Section 1810.3.2.1.2: Is covered by Section 25.7.3.3 in ACI 318.

o Section 1810.3.2.2: Is covered by Section 20.3 in ACI 318.

· Section 18.10.3.8, Precast Concrete pile, was adopted by ACI 318. The exception for minimum spiral reinforcement was retained from Sections 1810.3.8.3.2 and 1810.3.8.3.3 with the appropriate references to ACI 318. The requirements for 18.10.3.8 mostly went to Section 13.4.5 and 18.3.5 of ACI 318. A comparison is provided but for a full review please reference the public comment version of ACI 318.

o Section 1810.3.8.1→13.4.5.2 and 13.4.5.6

o Section 1810.3.8.2.1→13.4.5.3

o Section 1810.3.8.2.2→18.13.5.10.2

§ Exception remains

o Section 1810.3.8.2.3→18.13.5.10.3

§ Exception remains

o Section 1810.3.8.3.1→13.4.5.4 and 13.4.5.5

o Section 1810.3.8.3.2→18.13.5.10.4

o Section 1810.3.8.3.3→18.13.5.10.5

o Section 1810.3.8.3.4→18.13.5.10.6

· Section 18.10.3.9, Cast-in-place deep foundation, was adopted by ACI 318.

o Section 1810.3.9.1→13.4.4

o Section 1810.3.9.2→13.4.4

o Section 1810.3.9.3→Remains

o Section 1810.3.9.4→Remains, update reference

o Section 1810.3.9.4.1→18.13.5.7

§ Exception→18.13.5.8

o Section 1810.3.9.4.2→18.13.5.7

§ Exception→18.13.5.8

o Section 1810.3.9.4.2.1→18.13.5.5

o Section 1810.3.9.4.2.2→18.13.5.5

IBC 2018	ACI 318
1810.3.2.1.1 Seismic hooks. For structures assigned to Seismic Design Category C, D, E or F, the ends of hoops, spirals and ties used in concrete deep foundation elements shall be terminated with seismic hooks, as defined in ACI 318, and shall be turned into the confined concrete core.	**18.13.5.4** For structures assigned to SDC C, D, E, or F, hoops, spirals, and ties in deep foundation members shall be terminated with seismic hooks.
1810.3.2.1.2 ACI 318 Equation (25.7.3.3). Where this chapter requires detailing of concrete deep foundation elements in accordance with Section 18.7.5.4 of ACI 318, compliance with Equation (25.7.3.3) of ACI 318 shall not be required.	**25.7.3.3** Except for transverse reinforcement in deep foundations, the volumetric spiral reinforcement ratio ρ_s shall satisfy Eq. (25.7.3.3).
1810.3.2.2 Prestressing steel. Prestressing steel shall conform to ASTM A416.	**20.3** Prestressing strands, wires, and bars **20.3.1** Material properties **20.3.1.1** Except as required in 20.3.1.3 for special moment frames and special structural walls, prestressing reinforcement shall conform to (a), (b), (c), or (d): (a) ASTM A416 – strand (b) ASTM A421 – wire

(c) ASTM A421 – low-relaxation wire including Supplementary Requirement S1, “Low-Relaxation Wire and Relaxation Testing”

(d) ASTM A722 – high-strength bar

1810.3.8 Precast concrete piles. Precast concrete piles shall be designed and detailed in accordance with Sections 1810.3.8.1 through 1810.3.8.3.

1810.3.8.1 Reinforcement. Longitudinal steel shall be arranged in a symmetrical pattern and be laterally tied with steel ties or wire spiral spaced center to center as follows:

1. At not more than 1 inch (25 mm) for the first five ties or spirals at each end; then

2. At not more than 4 inches (102 mm), for the remainder of the first 2 feet (610 mm) from each end; and then

3. At not more than 6 inches (152 mm) elsewhere.

The size of ties and spirals shall be as follows:

1. For piles having a least horizontal dimension of 16 inches (406 mm) or less, wire shall not be smaller than 0.22 inch (5.6 mm) (No. 5 gage).

2. For piles having a least horizontal dimension of more than 16 inches (406 mm) and less than 20 inches (508 mm), wire shall not be smaller than 0.238 inch (6 mm) (No. 4 gage).

3. For piles having a least horizontal dimension of 20 inches (508 mm) and larger, wire shall not be smaller than 1/4 inch (6.4 mm) round or 0.259 inch (6.6 mm) (No. 3 gage).

1810.3.8.2 Precast nonprestressed piles. Precast nonprestressed concrete piles shall comply with the requirements of Sections 1810.3.8.2.1 through 1810.3.8.2.3.

1810.3.8.2.1 Minimum reinforcement. Longitudinal reinforcement shall consist of not fewer than four bars with a minimum longitudinal reinforcement ratio of 0.008.

...

1810.3.8.3 Precast prestressed piles. Precast prestressed concrete piles shall comply with the requirements of Sections 1810.3.8.3.1 through 1810.3.8.3.3

1810.3.8.3.1 Effective prestress. The effective prestress in the pile shall be not less than 400 psi (2.76 MPa) for piles up to 30 feet (9144 mm) in length, 550 psi (3.79 MPa) for piles up to 50 feet (15 240 mm) in length and 700 psi (4.83 MPa) for piles greater than 50 feet (15 240 mm) in length. Effective prestress shall be based on an assumed loss of 30,000 psi (207 MPa) in the prestressing steel. The tensile stress in the prestressing steel shall not exceed the values specified in ACI 318.

13.4.5 Precast concrete piles

13.4.5.1 Precast concrete piles supporting buildings assigned to SDC A or B shall satisfy the requirements of 13.4.5.2 through 13.4.5.6.

13.4.5.2 Longitudinal reinforcement shall be arranged in a symmetrical pattern.

13.4.5.3 For precast nonprestressed piles, longitudinal reinforcement shall be provided according to (a) and (b):

(a) Minimum of 4 bars

(b) Minimum area of $0.008A_g$

13.4.5.4 For precast prestressed piles, the effective prestress in the pile shall provide a minimum average compressive stress in the concrete in accordance with Table 13.4.5.4.

Table 13.4.5.4 Minimum compressive stress in precast prestressed piles

Pile length (ft)	Minimum compressive stress (psi)
Pile length ≤ 30	400
30 < Pile length ≤ 50	550
Pile length > 50	700

13.4.5.5 For precast prestressed piles, the effective prestress in the pile shall be calculated based on an assumed total loss of 30,000 psi in the prestressed reinforcement.

13.4.5.6 The longitudinal reinforcement shall be enclosed by transverse reinforcement according to Table 13.4.5.6(a) and shall be spaced according to Table 13.4.5.6(b):

Table 13.4.5.6(a) Minimum transverse reinforcement size

Least horizontal pile dimension-h (in.)	Minimum wire size transverse reinforcement[1]
h ≤ 16	W4, D4
16 < h < 20	W4.5, D5
h ≥ 20	W5.5, D6

	[1] If bars are used, minimum of #3 bar applies to all values of h **Table 13.4.4.6(b)** Maximum transverse reinforcement spacing Reinforcement location in the pile: Maximum center-to-center spacing (in.) First five ties or spirals at each end of pile: 1 24 in. from each end of pile: 4 Remainder of pile: 6
1810.3.9 Cast-in-place deep foundations. Cast-in-place deep foundation elements shall be designed and detailed in accordance with Sections 1810.3.9.1 through 1810.3.9.6. **1810.3.9.1** Design cracking moment. The design cracking moment (ϕM_n) for a cast-in-place deep foundation element not enclosed by a structural steel pipe or tube shall be determined using the following equation: $\phi M_n = 3\sqrt{f_c'}S_m$ (Equation 18-10) For SI: $0.25\sqrt{f_c'}S_m$ where: f_c' = Specified compressive strength of concrete or grout, psi (MPa). S_m = Elastic section modulus, neglecting reinforcement and casing, cubic inches (mm^3). **1810.3.9.2** Required reinforcement. Where subject to uplift or where the required moment strength determined using the load combinations of Section 1605.2 exceeds the design cracking moment determined in accordance with Section 1810.3.9.1, cast-in-place deep foundations not enclosed by a structural steel pipe or tube shall be reinforced.	**13.4.4** Cast-in-place deep foundations **13.4.4.1** Cast-in-place deep foundations that are subject to uplift or where M_u is greater than 0.4 M_{cr} shall be reinforced, unless enclosed by a structural steel pipe or tube. Note $f_{cr} = 7.5\sqrt{f_c'}$
1810.3.9.4.1 Seismic reinforcement in Seismic Design Category C. For structures assigned to Seismic Design Category C, cast-in-place deep foundation elements shall be reinforced as specified in this section. Reinforcement shall be provided where required by analysis. Not fewer than four longitudinal bars, with a minimum longitudinal reinforcement ratio of 0.0025, shall be provided throughout the minimum reinforced length of the element as defined in this section starting at the top of the element. The minimum reinforced length of the element shall be taken as the greatest of the following: 1. One-third of the element length. 2. A distance of 10 feet (3048 mm). 3. Three times the least element dimension.	**18.13.5** Deep Foundations **18.13.5.1** This section shall apply to the following types of deep foundations (a) uncased cast-in-place concrete drilled or augered piles (b) metal cased concrete piles (c) concrete filled pipe piles (d) precast concrete piles **18.13.5.2** For structures assigned to SDC C, D, E, or F, piles, piers, or caissons resisting tension loads shall have continuous longitudinal reinforcement over their length resisting to resist design tension forces.

4. The distance from the top of the element to the point where the design cracking moment determined in accordance with Section 1810.3.9.1 exceeds the required moment strength determined using the load combinations of Section 1605.2.

Transverse reinforcement shall consist of closed ties or spirals with a minimum 3/8 inch (9.5 mm) diameter. Spacing of transverse reinforcement shall not exceed the smaller of 6 inches (152 mm) or 8- longitudinal-bar diameters, within a distance of three times the least element dimension from the bottom of the pile cap. Spacing of transverse reinforcement shall not exceed 16 longitudinal bar diameters throughout the remainder of the reinforced length.

Exceptions:

1. The requirements of this section shall not apply to concrete cast in structural steel pipes or tubes.

2. A spiral-welded metal casing of a thickness not less than the manufacturer's standard No. 14 gage (0.068 inch) is permitted to provide concrete confinement in lieu of the closed ties or spirals. Where used as such, the metal casing shall be protected against possible deleterious action due to soil constituents, changing water levels or other factors indicated by boring records of site conditions.

1810.3.9.4.2 Seismic reinforcement in Seismic Design Categories D through F. For structures assigned to Seismic Design Category D, E or F, cast-in-place deep foundation elements shall be reinforced as specified in this section. Reinforcement shall be provided where required by analysis. Not fewer than four longitudinal bars, with a minimum longitudinal reinforcement ratio of 0.005, shall be provided throughout the minimum reinforced length of the element as defined in this section starting at the top of the element. The minimum reinforced length of the element shall be taken as the greatest of the following:

1. One-half of the element length.

2. A distance of 10 feet (3048 mm).

3. Three times the least element dimension.

4. The distance from the top of the element to the point where the design cracking moment determined in accordance with Section 1810.3.9.1 exceeds the required moment strength determined using the load combinations of Section 1605.2.

Transverse reinforcement shall consist of closed ties or spirals not smaller than No. 3 bars for elements with a least dimension up to 20 inches (508 mm), and No. 4 bars for larger elements. Throughout the remainder of the reinforced length outside the regions with transverse confinement reinforcement, as specified in Section 1810.3.9.4.2.1 or 1810.3.9.4.2.2, the spacing of transverse reinforcement shall not exceed the least of the following:

1. 12 longitudinal bar diameters.

18.13.5.3 For structures assigned to SDC C, D, E, or F, the minimum longitudinal and transverse reinforcement required by 18.13.5.7 through 18.13.5.10 shall be extended over the entire unsupported length for the portion of pile in air or water, or in soil that is not capable of providing adequate lateral restraint to prevent buckling throughout this length.

18.13.5.4 For structures assigned to SDC C, D, E, or F, hoops, spirals, and ties in deep foundation members shall be terminated with seismic hooks.

18.13.5.5 For structures assigned to SDC D, E, or F or located in Site Class E or F, concrete piles shall have transverse reinforcement in accordance with 18.7.5.2, 18.7.5.3, and Table 18.7.5.4(e) within seven pile diameters above and below the interfaces between strata that are hard or stiff and strata that are liquefiable or soft.

18.13.5.6 For structures assigned to SDC D, E, or F, in foundations supporting one- and two-story stud bearing wall construction, concrete piles, piers or caissons, and foundation ties are exempt from the transverse reinforcement requirements of 18.13.5.3 through 18.13.5.5.

18.13.5.7 Uncased cast-in-place drilled or augered concrete piles or piers

18.13.5.7.1 For structures assigned to SDC C, D, E, or F, reinforcement shall be provided in uncased cast-in-place drilled or augered concrete piles where required by analysis and in accordance with the requirements in Table 18.13.5.7.1.

18.13.5.7.2 Minimum longitudinal and transverse reinforcement shall be provided along minimum reinforced lengths measured from the top of the pile in accordance with Table 18.13.5.7.1.

18.13.5.7.3 Longitudinal reinforcement shall extend at least the development length in tension beyond the flexural length of the pile, which is defined in Table 18.13.5.7.1 as the distance from the bottom of the pile cap to where $0.4M_{cr} > M_u$.

18.13.5.8 Metal-cased concrete piles

18.13.5.8.1 For structures assigned to SDC C, D, E, or F, longitudinal reinforcement requirements and minimum reinforced lengths for metal-cased concrete piles shall be the same as for uncased concrete piles in 18.13.5.7

18.13.5.8.2 Metal-cased concrete piles shall have a spiral-welded metal casing of a thickness not less than 0.0747 in. (No. 14 gauge) that is adequately protected from possible deleterious action due to soil constituents, changing water levels, or other factors indicated by boring records of site conditions.

2. One-half the least dimension of the element. 3. 12 inches (305 mm). Exceptions: 1. The requirements of this section shall not apply to concrete cast in structural steel pipes or tubes. 2. A spiral-welded metal casing of a thickness not less than manufacturer's standard No. 14 gage (0.068 inch) is permitted to provide concrete confinement in lieu of the closed ties or spirals. Where used as such, the metal casing shall be protected against possible deleterious action due to soil constituents, changing water levels or other factors indicated by boring records of site conditions. **1810.3.9.4.2.1** Site Classes A through D. For Site Class A, B, C or D sites, transverse confinement reinforcement shall be provided in the element in accordance with Sections 18.7.5.2, 18.7.5.3 and 18.7.5.4 of ACI 318 within three times the least element dimension of the bottom of the pile cap. A transverse spiral reinforcement ratio of not less than one-half of that required in Section 18.7.5.4(a) of ACI 318 shall be permitted. **1810.3.9.4.2.2** Site Classes E and F. For Site Class E or F sites, transverse confinement reinforcement shall be provided in the element in accordance with Sections 18.7.5.2, 18.7.5.3 and 18.7.5.4 of ACI 318 within seven times the least element dimension of the pile cap and within seven times the least element dimension of the interfaces of strata that are hard or stiff and strata that are liquefiable or are composed of soft- to medium-stiff clay.	**18.13.5.9** Concrete-filled pipe piles **18.13.5.9.1** For structures assigned to SDC C, D, E or F, concrete-filled pipe piles shall have longitudinal reinforcement in the top of the pile with a total area of at least $0.01A_g$ and with a minimum length within the pile equal to two times the required embedment length into the pile cap, but not less than the development length in tension of the reinforcement.

Table 18.13.5.7.1 Minimum reinforcement for uncased cast-in-place or augered concrete piles or pier:

Minimum Reinforcement	**SDC C – All Site Classes**	**SDC D, E, and F – Site Class A, B, C, and D**	**SDC D, E, and F – Site Class E and F**
Minimum Longitudinal Reinforcement Ratio (minimum number of bars)	0.0025 (minimum number of bars in accordance with 10.7.3.1)	0.005 (minimum number of bars in accordance with 10.7.3.1)	0.005 (minimum number of bars in accordance with 10.7.3.1)
Minimum Reinforced Pile Length	Longest of (a) through (d): (a) 1/3 pile length (b) 10 ft. (c) 3 times the pile diameter (d) flexural length of pile - distance from bottom of pile	Longest of (a) through (d): (a) ½ pile length (b) 10 ft. (c) 3 times the pile diameter (d) flexural length of pile - distance from	Full length of pile except in accordance with [1] or [2].

		cap to where 0.4$\mathbf{M_{cr}}$ exceeds $\mathbf{M_u}$.	bottom of pile cap to where 0.4$\mathbf{M_{cr}}$ exceeds $\mathbf{M_u}$.	
Transverse Confinement Reinforcement Zone	Length of Reinforcement Zone	3 times the pile diameter from the bottom of the pile cap	3 times the pile diameter from the bottom of the pile cap.	7 times the pile diameter from the bottom of the pile cap.
	Type of Transverse Reinforcement	Closed ties or spirals with a minimum 3/8 in. diameter.	Minimum of No. 3 closed tie or 3/8 in. diameter spiral for piles ≤ 20 in. diameter. Minimum No. 4 closed tie or 1/2 in. diameter spiral for piles > 20 in. diameter.	
			In accordance with 18.7.5.2	
	Spacing and Amount of Transverse Reinforcement	Spacing shall not exceed lesser of 6 in. or 8 longitudinal bar diameters	In accordance with 18.7.5.3 and not less than one-half the requirement of Table 18.7.5.4(e)	In accordance with 18.7.5.3 and not less than the requirement of Table 18.7.5.4(e).
Transverse Reinforcement in Remainder of Reinforced Pile Length	Type of Transverse Reinforcement	Closed ties or spirals with minimum 3/8 in. diameter.	Minimum of No. 3 closed tie or 3/8 in. diameter spiral for piles ≤ 20 in. diameter. Minimum of No. 4 closed tie or 1/2 in. diameter spiral for piles > 20 in. diameter.	
			In accordance with 18.7.5.2	
	Spacing and Amount of Transverse Reinforcement	Maximum spacing of 16 longitudinal bar diameters.	Spacing shall not exceed the least of (a) through (c): (a) 12 longitudinal bar diameters (b) ½ the pile diameter (c) 12 in.	

[1] For piles sufficiently embedded in firm soil or rock, reinforcement shall be permitted to be terminated a length above the tip equal to the lesser of 5 percent of the pile length and 33 percent of the length of the pile within rock or firm soil.

[2] In lieu of providing full length minimum flexural reinforcement, the deep foundation element shall be designed to withstand maximum imposed curvatures from the earthquake ground motions and structural response. Curvatures shall include free-field soil strains modified for soil-foundation-structure interaction coupled with foundation element deformations associated with earthquake loads imparted to the foundation by the structure. Minimum reinforced length shall not be less than the requirement for SDC D, E, or F; Site Class D.

1810.3.8.2 Precast nonprestressed piles. **…** **1810.3.8.2.2** Seismic reinforcement in Seismic Design Categories C through F. For structures assigned to Seismic Design Category C, D, E or F, precast nonprestressed piles shall be reinforced as specified in this section. The minimum longitudinal reinforcement ratio shall be 0.01 throughout the length. Transverse reinforcement shall consist of closed ties or spirals with a minimum 3/8 inch (9.5 mm) diameter. Spacing of transverse reinforcement shall not exceed the smaller of eight times the diameter of the smallest longitudinal bar or 6 inches (152 mm) within a distance of three times the least pile dimension from the bottom of the pile cap. Spacing of transverse reinforcement shall not exceed 6 inches (152 mm) throughout the remainder of the pile.	**18.13.5.10** Precast concrete piles **18.13.5.10.1** For precast concrete driven piles, the length of transverse reinforcement provided shall be sufficient to account for potential variations in the elevation of pile tips. **18.13.5.10.2** Precast nonprestressed concrete piles for structures assigned to SDC C shall satisfy (a) through (d): (a) Minimum longitudinal steel reinforcement ratio shall be 0.01 (b) Longitudinal reinforcement shall be enclosed within a minimum of No. 3 closed ties or 3/8-in. diameter spirals, for up to 20-in. diameter piles, and No. 4 closed

1810.3.8.2.3 Additional seismic reinforcement in Seismic Design Categories D through F. For structures assigned to Seismic Design Category D, E or F, transverse reinforcement shall be in accordance with Section 1810.3.9.4.2.

...

1810.3.8.3 Precast prestressed piles.

...

1810.3.8.3.2 Seismic reinforcement in Seismic Design Category C. For structures assigned to Seismic Design Category C, precast prestressed piles shall have transverse reinforcement in accordance with this section. The volumetric ratio of spiral reinforcement shall not be less than the amount required by the following formula for the upper 20 feet (6096 mm) of the pile.

$\rho_s = 0.04(f_c'/f_{yh})[2.8 + 2.34P/ f_c'A_g)]$ (Equation 18-5)

where:

A_g = Pile cross-sectional area square inches (mm^2).

f_c'= Specified compressive strength of concrete, psi (MPa).

f_{yh} = Yield strength of spiral reinforcement ≤ 85,000 psi (586 MPa).

P = Axial load on pile, pounds (kN), as determined from Equations 16-5 and 16-7.

ρ_s = Spiral reinforcement index or volumetric ratio (vol. spiral/vol. core).

Not less than one-half the volumetric ratio required by Equation 18-5 shall be provided below the upper 20 feet (6096 mm) of the pile.

Exception: The minimum spiral reinforcement index required by Equation 18-5 shall not apply in cases where the design includes full consideration of load combinations specified in ASCE 7, Section 2.3.6 and the applicable overstrength factor, Ω_0. In such cases, minimum spiral reinforcement index shall be as specified in Section 1810.3.8.1.

1810.3.8.3.3 Seismic reinforcement in Seismic Design Categories D through F. For structures assigned to Seismic Design Category D, E or F, precast prestressed piles shall have transverse reinforcement in accordance with the following:

1. Requirements in ACI 318, Chapter 18, need not apply, unless specifically referenced.

2. Where the total pile length in the soil is 35 feet (10 668 mm) or less, the lateral transverse reinforcement in the ductile region shall occur through the length of the pile. Where the pile length exceeds 35 feet (10 668 mm), the ductile pile region shall be taken as the greater of 35 feet (10 668 mm) or the distance from the underside of the pile cap to the point of zero

ties or ½-in. diameter spirals, for larger diameter piles

(c) Spacing of transverse reinforcement within a distance of 3 times the least cross-sectional dimension of the pile from the bottom of the pile cap shall not exceed the lesser of 8 times the diameter of the smallest longitudinal bar and 6 in.

(d) Transverse reinforcement shall be provided throughout the length of the pile at a spacing not exceeding 6 in.

18.13.5.10.3 For structures assigned to SDC D, E, or F, precast nonprestressed concrete piles shall satisfy the requirements of 18.13.5.10.2 and the requirements for uncased cast-in-place or augered concrete piles in SDC D, E, or F in Table 18.13.5.7.1.

18.13.5.10.4 For structures assigned to SDC C, precast prestressed concrete piles shall satisfy (a) and (b):

(a) If the transverse reinforcement consists of spirals or circular hoops, the volumetric ratio of transverse reinforcement, ρ_s, in the upper 20 ft shall not be less than that calculated by Eq. (18.13.5.10.4a) or calculated from a more detailed analysis by Eq. (18.13.5.10.4b):

$0.15(f_c'/f_{yt})$ (18.13.5.10.4a)

$0.04(f_c'/f_{yt})[2.8 + 2.3P_u/ f_c'A_g)]$ (18.13.5.10.4b)

and f_{yt} shall not be taken greater than 100,000 psi

(b) A minimum of one-half of the volumetric ratio of spiral reinforcement required by Eq. (18.13.5.10.4a) or Eq. (18.13.5.10.4b) shall be provided for the remaining length of the pile.

18.13.5.10.5 For structures assigned to SDC D, E, or F, precast prestressed concrete piles shall satisfy (a) through (e) and the ductile pile region shall be defined as the length of pile measured from the bottom of the pile cap to the point of zero curvature plus 3 times the least pile dimension, but not less than 35 ft. If the total pile length in the soil is 35 ft or less, the ductile pile region shall be taken as the entire length of the pile:

(a) In the ductile pile region, the center-to-center spacing of spirals or hoop reinforcement shall not exceed the least of 0.2 times the least pile dimension, 6 times the diameter of the longitudinal strand, and 6 in.

(b) Spiral reinforcement shall be spliced by lapping one full turn, by welding, or by the use of a mechanical splice. If spiral reinforcement is lap spliced, the ends of the spiral shall terminate in a seismic hook. Mechanical and welded splices of deformed bars shall comply with 25.5.7.

curvature plus three times the least pile dimension.

3. In the ductile region, the center-to-center spacing of the spirals or hoop reinforcement shall not exceed one-fifth of the least pile dimension, six times the diameter of the longitudinal strand or 8 inches (203 mm), whichever is smallest.

4. Circular spiral reinforcement shall be spliced by lapping one full turn and bending the end of each spiral to a 90-degree hook or by use of a mechanical or welded splice complying with Section 25.5.7 of ACI 318.

5. Where the transverse reinforcement consists of circular spirals, the volumetric ratio of spiral transverse reinforcement in the ductile region shall comply with the following:

$\rho_s = 0.06(f_c'/f_{yh})[2.8 + 2.34P/ f_c'A_g)]$ (Equation 18-6) but not exceed: $\rho_s = 0.021$ (Equation 18-7)

where:

A_g = Pile cross-sectional area, square inches (mm2).

f_c' = Specified compressive strength of concrete, psi (MPa).

f_{yh} = Yield strength of spiral reinforcement ≤ 85,000 psi (586 MPa).

P = Axial load on pile, pounds (kN), as determined from Equations 16-5 and 16-7.

ρ_s = Volumetric ratio (vol. spiral/vol. core).

This required amount of spiral reinforcement is permitted to be obtained by providing an inner and outer spiral.

Exception: The minimum spiral reinforcement required by Equation 18-6 shall not apply in cases where the design includes full consideration of load combinations specified in ASCE 7, Section 2.3.6 and the applicable overstrength factor, Ω_0. In such cases, minimum spiral reinforcement shall be as specified in Section 1810.3.8.1.

6. Where transverse reinforcement consists of rectangular hoops and cross ties, the total cross-sectional area of lateral transverse reinforcement in the ductile region with spacing, s, and perpendicular dimension, h_c, shall conform to:

$A_{sh} = 0.3sh_c(f_c'/f_{yh})(A_g/A_{ch} - 1.0)[0.5 + 1.4P/(f_c'A_g)]$ (Equation 18-8)

but not less than:

$A_{sh} = 0.12sh_c(f_c'/f_{yh}) [0.5 + 1.4P/(f_c'A_g)]$ (Equation 18-9)

where:

f_{yh} = yield strength of transverse reinforcement ≤ 70,000 psi (483 MPa).

h_c = Cross-sectional dimension of pile core measured center to

(c) If the transverse reinforcement consists of spirals, or circular hoops, the volumetric ratio of transverse reinforcement, ρ_s, in the ductile pile region shall not be less than that calculated by Eq. (18.13.5.10.5a) or calculated from a more detailed analysis by Eq. (18.13.5.10.5b), and the required volumetric ratio shall be permitted to be obtained by providing an inner and outer spiral.

$0.2(f_c'/f_{yt})$ (18.13.5.10.5a)

$0.06(f_c'/f_{yt})[2.8 + 2.3P_u/ f_c'A_g)]$ (18.13.5.10.5b)

and f_{yt} shall not be taken as greater than 100,000 psi

(d) Outside of the ductile pile region, spiral or hoop reinforcement shall be provided with a volumetric ratio not less than one-half of that required within the ductile pile region, and the maximum spacing shall be in accordance with Table 13.4.4.6(b).

(e) If transverse reinforcement consists of rectangular hoops and crossties, the total cross-sectional area of lateral transverse reinforcement in the ductile region shall be the greater of Eq. (18.13.5.10.5c) and Eq. (18.13.5.10.5d). The hoops and crossties shall be equivalent to deformed bars not less than No. 3 in size, and rectangular hoop ends shall terminate at a corner with seismic hooks.

$A_{sh} = 0.3sb_c (f_c'/f_{yt})(A_g/A_{ch} - 1.0)[0.5 + 1.4P_u/(f_c'A_g)]$ (18.13.5.10.5c)

$A_{sh} = 0.12sb_c (f_c'/f_{yh}) [0.5 + 1.4P_u/(f_c'A_g)]$ (18.13.5.10.5d)

and f_{yt} shall not be taken as greater than 100,000 psi

18.13.5.10.6 For structures assigned to SDC C, D, E, or F, the maximum factored axial load for precast prestressed piles subjected to a combination of earthquake lateral force and axial load shall not exceed the following values:

(a) $0.2\ f_c'A_g$ for square piles

(b) $0.4f_c'A_g$ for circular or octagonal piles

center of hoop reinforcement, inch (mm). s = Spacing of transverse reinforcement measured along length of pile, inch (mm). A_{sh} = Cross-sectional area of transverse reinforcement, square inches (mm2). f_c' = Specified compressive strength of concrete, psi (MPa). The hoops and cross ties shall be equivalent to deformed bars not less than No. 3 in size. Rectangular hoop ends shall terminate at a corner with seismic hooks. Outside of the length of the pile requiring transverse confinement reinforcing, the spiral or hoop reinforcing with a volumetric ratio not less than one-half of that required for transverse confinement reinforcing shall be provided. **1810.3.8.3.4** Axial load limit in Seismic Design Categories C through F. For structures assigned to Seismic Design Category C, D, E, or F, the maximum factored axial load on precast prestressed piles subjected to a combination of seismic lateral force and axial load shall not exceed the following values: 1. $0.2f_c'A_g$ for square piles 2. $0.4f_c'A_g$ for circular or octagonal piles	

Cost Impact: The code change proposal will not increase or decrease the cost of construction
There is no cost increase or decrease associated with this code change proposal with eliminates requirements addressed in ACI 318 from the IBC to avoid confusion and potenital conflicts.

ACI IBC 18 05/07 1810.3.2.6 Allowable Capacity

IBC: 1810.3.2.7, TABLE 1810.3.2.6

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2018 International Building Code

Delete without substitution:

~~**1810.3.2.7 Increased allowable compressive stress for cased mandrell-driven cast-in-place elements.** The allowable compressive stress in the concrete shall be permitted to be increased as specified in Table 1810.3.2.6 for those portions of permanently cased cast-in-place elements that satisfy all of the following conditions:~~

1. ~~The design shall not use the casing to resist any portion of the axial load imposed.~~
2. ~~The casing shall have a sealed tip and be mandrel driven.~~
3. ~~The thickness of the casing shall be not less than manufacturer's standard gage No.14 (0.068 inch) (1.75 mm).~~
4. ~~The casing shall be seamless or provided with seams of strength equal to the basic material and be of a configuration that will provide confinement to the cast-in-place concrete.~~
5. ~~The ratio of steel yield strength (F_y) to specified compressive strength (f'_c) shall be not less than six.~~
6. ~~The nominal diameter of the element shall not be greater than 16 inches (406 mm).~~

Revise as follows:

TABLE 1810.3.2.6
ALLOWABLE STRESSES FOR MATERIALS USED IN DEEP FOUNDATION ELEMENTS

MATERIAL TYPE AND CONDITION	MAXIMUM ALLOWABLE STRESS[a]
1. Concrete or grout in compression	In accordance with ACI 318
2. Nonprestressed reinforcement in compression	In accordance with aCI 318
3. Steel in compression Cores within concrete-filled pipes or tubesPipes, tubes or H-piles, where justified in accordance with Section 1810.3.2.8Pipes or tubes for micropilesOther pipes, tubes or H-pilesHelical piles	0.5 F_y ≤ 32,000 psi 0.5 F_y ≤ 32,000 psi0.4 F_y ≤ 32,000 psi0.35 F_y ≤ 16,000 psi0.6 F_y ≤ 0.5 F_u
4. Nonprestressed reinforcement in tensionWithin micropilesOther conditions	0.6 f_y 0.5 f_y ≤ 24,000 psi
5. Steel in tensionPipes, tubes or H-piles, where justified in accordance with Section 1810.3.2.8 Other pipes, tubes or H-pilesHelical piles	0.5F_y ≤ 32,000 psi0.35 F_y ≤ 16,000 psi0.6 F_y ≤ 0.5 F_u
6. Timber	In accordance with the ANSI/AWC NDS

~~a. f'_c is the specified compressive strength of the concrete or grout; f_{pc} is the compressive stress on the gross concrete section due to effective prestress forces only; f_y is the specified yield strength of reinforcement;~~

aF_y is the specified minimum yield stress of steel; F_u is the specified minimum tensile stress of structural steel.

~~b.The stresses specified apply to the gross cross-sectional area within the concrete surface. Where a temporary or permanent casing is used, the inside face of the casing shall be considered to be the concrete surface.~~

Reason Statement: This proposed code change makes four modifications to the 2018 IBC:
1. In Section 1810.3.2.6, ACI 318 is added to Item 1 as the method for design and construction of concrete deep foundations. This aligns the code with the methodology in ACI 318. A comparison of the provisions removed from the 2018 IBC and the requirements in ACI 318 are shown in Table 1.

2. In Section 1810.3.2.7, all text is deleted as this information is provided in ACI 318. Comparison of the text in 2018 IBC and ACI 318 is shown in Table 2. Requirements are identical, except ACI 318 language more clearly communicates that there are other permissible design and construction methods in accordance with Chapter 10 of ACI 318.

Table 1

Comparison of 2018 IBC and ACI 318 Requirements

2018 IBC	ACI 318
1810.3.2.7 Increased allowable compressive stress for cased mandrell-driven cast-in-place elements. The allowable compressive stress in the concrete shall be permitted to be increased as specified in Table 1810.3.2.6 for those portions of permanently cased cast-in-place elements that satisfy all of the following conditions: 1. The design shall not use the casing to resist any portion of the axial load imposed. 2. The casing shall have a sealed tip and be mandrel driven. 3. The thickness of the casing shall be not less than manufacturer's standard gage No.14 (0.068 inch) (1.75 mm). 4. The casing shall be seamless or provided with seams of strength equal to the basic material and be of a configuration that will provide confinement to the cast-in-place concrete. 5. The ratio of steel yield strength (Fy) to specified compressive strength (f 'c) shall be not less than six. 6. The nominal diameter of the element shall not be greater than 16 inches (406 mm).	13.4.2 Allowable axial capacity 13.4.2.1 Where concrete deep foundation elements are laterally supported for the entire height and the applied forces cause bending moments no greater than those resulting from accidental eccentricities, structural design of the element using unfactored loads and the allowable capacities specified in Table 13.4.2.2 is permitted. Otherwise, the structural design of concrete deep foundation elements shall be in accordance with Chapter 10. 13.4.2.2 The maximum allowable axial capacity of deep foundation members shall be in accordance with Table 13.4.2.2. 13.4.2.2.1 The allowable axial capacity for permanently cased cast-in-place concrete deep foundation members that satisfy (a) through (f) shall be permitted to be increased to the value given in Table 13.4.2.2: (a) The design shall not use the casing to resist any portion of the axial load imposed. (b) The casing shall have a sealed tip and be mandrel-driven. (c) The thickness of the casing shall not be less than manufacturer's standard gage No.14 (0.068 inch). (d) The casing shall be seamless or provided with seams of strength equal to the basic material and be of a configuration that will provide confinement to the cast-in-place concrete. (e) The ratio of steel yield strength of the casing to f'_c shall be not less than six. (f) The nominal diameter of the element shall be not greater than 16-in.

Table 2 Comparison of 2018 IBC TABLE 1810.3.2.6 and ACI 13.4.2.2

ALLOWABLE STRESSES FOR MATERIALS USED IN DEEP FOUNDATION ELEMENTS

Material Type and Condition	IBC 2018 Maximum allowable Stress	ACI 318 MAXIMUM CAPACITY
1. Concrete or grout in compression	$0.4\ f'_c$	$P_n = 0.4f'_cA_g$
Cast-in-place with a permanent casing in accordance with Section 1810.3.2.7	$0.33\ f'_c$	$P_n = 0.33f'_cA_g+0.4f_yA_s$
Cast-in-place in a pipe, tube, other permanent casing or rock	$0.3\ f'_c$	$P_n = 0.3f'_cA_g+0.4f_yA_s$
Cast-in-place without a permanent casing	$0.33\ f'_c$	$P_n = 0.33f'_cA_g+0.4f_yA_s$
Precast nonprestressed	$0.33\ f'_c - 0.27\ f_{pc}$	$P_n = (0.33f'_c - 0.27f'_{pe})A_g$
Precast prestressed		

The reference to ACI 318 is not a new concept for obtaining information for deep foundations. The IBC currently refers to the American Wood Council for provisions for deep timber foundations.

ACI, a professional technical society, supports these revisions to better align the IBC with current design and construction methodologies addressed in ACI 318 and to better communicate to the user that there additional methods that could result in lower initial costs and for conditions not addressed in 2018 IBC. ACI recommends that the committee approve this code change as submitted.

Cost Impact: The code change proposal will not increase or decrease the cost of construction
There is no increase in cost of construction. This proposal aligns the IBC with the methods used for concrete design and construction in accordance with ACI 318.

ACI IBC 18 07 1810.3.11 Pile Caps

IBC: 1810.3.11, 1810.3.11.1

Proponent: Stephen Szoke, representing American Concrete Institute (steve.szoke@concrete.org)

2018 International Building Code

Revise as follows:

1810.3.11 Pile caps. Pile caps shall conform with ACI 318 and this section. Pile caps shall be of reinforced concrete, and shall include all elements to which vertical deep foundation elements are connected, including grade beams and mats. The soil immediately below the pile cap shall not be considered as carrying any vertical load, with the exception of a combined pile raft. The tops of vertical deep foundation elements shall be embedded not less than 3 inches (76 mm) into pile caps and the caps shall extend not less than 4 inches (102 mm) beyond the edges of the elements. The tops of elements shall be cut or chipped back to sound material before capping.

Delete without substitution:

~~**1810.3.11.1 Seismic Design Categories C through F.** For structures assigned to *Seismic Design Category* C, D, E or F, concrete deep foundation elements shall be connected to the pile cap by embedding the element reinforcement or field-placed dowels anchored in the element into the pile cap for a distance equal to their development length in accordance with ACI 318. It shall be permitted to connect precast prestressed piles to the pile cap by developing the element prestressing strands into the pile cap provided that the connection is ductile. For deformed bars, the development length is the full development length for compression, or tension in the case of uplift, without reduction for excess reinforcement in accordance with Section 25.4.10 of ACI 318. Alternative measures for laterally confining concrete and maintaining toughness and ductile-like behavior at the top of the element shall be permitted provided that the design is such that any hinging occurs in the confined region.~~
~~The minimum transverse steel ratio for confinement shall be not less than one-half of that required for columns.~~

~~For resistance to uplift forces, anchorage of steel pipes, tubes or H-piles to the pile cap shall be made by means other than concrete bond to the bare steel section. Concrete-filled steel pipes or tubes shall have reinforcement of not less than 0.01 times the cross-sectional area of the concrete fill developed into the cap and extending into the fill a length equal to two times the required cap embedment, but not less than the development length in tension of the reinforcement.~~

Revise as follows:

~~**1810.3.11.2**~~**1810.3.11.1 Seismic Design Categories D through F.** For structures assigned to *Seismic Design Category* D, E or F, deep foundation element resistance to uplift forces or rotational restraint shall be provided by anchorage into the pile cap, designed considering the combined effect of axial forces due to uplift and bending moments due to fixity to the pile cap. Anchorage shall develop not less than 25 percent of the strength of the element in tension. Anchorage into the pile cap shall comply with the following:

1. In the case of uplift, the anchorage shall be capable of developing the least of the following:
   1.1. The nominal tensile strength of the longitudinal reinforcement in a concrete element.
   1.2. The nominal tensile strength of a steel element.
   1.3. The frictional force developed between the element and the soil multiplied by 1.3.

   Exception: The anchorage is permitted to be designed to resist the axial tension force resulting from the seismic load effects including overstrength factor in accordance with Section 2.3.6 or 2.4.5 of ASCE 7.
2. In the case of rotational restraint, the anchorage shall be designed to resist the axial and shear forces, and moments resulting from the seismic load effects including overstrength factor in accordance with Section 2.3.6 or 2.4.5 of ASCE 7 or the anchorage shall be capable of developing the full axial, bending and shear nominal strength of the element.

Where the vertical lateral-force-resisting elements are columns, the pile cap flexural strengths shall exceed the column flexural strength. The connection between batter piles and pile caps shall be designed to resist the nominal strength of the pile acting as a short column. Batter piles and their connection shall be designed to resist forces and moments that result from the application of seismic load effects including overstrength factor in accordance with Section 2.3.6 or 2.4.5 of ASCE 7.

Reason Statement: This Code change includes revisions and additions to the Code in an effort to eliminate conflicting

provisions in ACI 318-14, ASCE 7-16 and IBC-2018 regarding design of deep foundations for earthquake resistant structures. Subcommittee F, Foundations, of ACI 318 has coordinated efforts with members from ASCE 7 to bring the concrete material design requirements for foundations to one location. ASCE 7 started this effort in their cycle ending in 2016. The changes to ACI 318 shown here is the continuation of that effort. A side-by-side comparison is provided, however, difficult to follow with all the changes and dissimilar format. For a more comprehensive look at the changes in ACI 318, please review the public comment version available at
https://www.concrete.org/publications/standards/upcomingstandards.aspx
ACI, a 501(c)3 professional technical society, recommends approval as submitted to help avoid confusion and potential conflicts where similar requirements exist in both the IBC and ACI 318.

IBC 2018	ACI 318
1810.3.11.1 Seismic Design Categories C through F. For structures assigned to Seismic Design Category C, D, E or F, concrete deep foundation elements shall be reinforcement or field-placed dowels anchored in the element into the pile cap for a distance equal to their development length in accordance with ACI 318. It shall be permitted to connect precast prestressed piles to the pile cap by developing the element prestressing strands into the pile cap provided that the connection is ductile. For deformed bars, the development length is the full development length for compression, or tension in the case of uplift, without reduction for excess reinforcement in accordance with Section 25.4.10 of ACI 318. Alternative measures for laterally confining concrete and maintaining toughness and ductile-like behavior at the top of the element shall be permitted provided that the design is such that any hinging occurs in the confined region. The minimum transverse steel ratio for confinement shall be not less than one-half of that required for columns. For resistance to uplift forces, anchorage of steel pipes, tubes or H-piles to the pile cap shall be made by means other than concrete bond to the bare steel section. Concrete-filled steel pipes or tubes shall have reinforcement of not less than 0.01 times the cross-sectional area of the concrete fill developed into the cap and extending into the fill a length equal to two times the required cap embedment, but not less than the development length in tension of the reinforcement	**18.13.6** Anchorage of piles, piers, and caissons **18.13.6.1** For structures assigned to SDC C, D, E, or F, the longitudinal reinforcement in piles, piers, or caissons resisting tension loads shall be detailed to transfer tension forces within the pile cap to supported structural members. **18.13.6.2** For structures assigned to SDC C, D, E, or F, concrete piles and concrete filled pipe piles shall be connected to the pile cap by embedding the pile reinforcement in the pile cap a distance equal to the development length or by the use of field-placed dowels anchored in the concrete pile. For deformed bars, the compression development length is used if the pile is in compression. In the case of uplift, the tension development length is used without reduction in length for excess reinforcement. **18.13.6.3** For structures assigned to SDC D, E, or F, if tension forces induced by earthquake effects are transferred between pile cap or mat foundation and precast pile by reinforcing bars grouted or post-installed in the top of the pile, the grouting system shall have been demonstrated by testing to develop at least $1.25f_y$ of the bar.

Cost Impact: The code change proposal will not increase or decrease the cost of construction
The is not cost increase or decrease, as the technical requirements remain essential unchanged. The proposal eliinates content from the IBC that is addressed in ACI 318.

ACI IBC 18 08 1810.3.12-13 Grade Beams - Seismic Ties

IBC: 1810.3.12, 1810.3.13

Proponent: Stephen Szoke, representing American Concrete Institute (steve.szoke@concrete.org)

2018 International Building Code

Revise as follows:

1810.3.12 Grade beams. ~~For structures assigned to *Seismic Design Category* D, E or F, grade~~ Grade beams shall comply with the provisions ~~in Section 18.13.3~~ of ACI ~~318 for grade beams, except where they are~~ 318.
Exception: Grade beams designed to resist the seismic load effects including overstrength factor in accordance with Section 2.3.6 or 2.4.5 of ASCE 7.

1810.3.13 Seismic ties. ~~For structures assigned to~~ Seismic ~~Design Category C, D, E or F, individual deep foundations shall be interconnected by ties. Unless it can be demonstrated that equivalent restraint is provided by reinforced concrete beams within slabs on grade or reinforced concrete slabs on grade or confinement by competent rock, hard cohesive soils or very dense granular soils, ties shall be capable of carrying, in tension or compression, a force equal to the lesser of the product of the larger pile cap or column design gravity load times the seismic coefficient, SDS, divided by 10, and 25 percent of the smaller pile or column design gravity load.~~ties shall comply with the provisions of ACI 318.

> **Exception:** In Group R-3 and U occupancies of light-frame construction, deep foundation elements supporting foundation walls, isolated interior posts detailed so the element is not subject to lateral loads or exterior decks and patios are not subject to interconnection where the soils are of adequate stiffness, subject to the approval of the *building official*.

Cost Impact: The code change proposal will not increase or decrease the cost of construction
There is no increase or decrease in cost of consturction. Provisions of ACI 318 are applicable and code change proposal removes requirements from IBC that are also addressed in ACI 318.

ACI IBC 19-01 1901.2 Detailed Plain Wall

IBC: 1901.2, 1905.1.1, 202, 202, 202, 202, 1901.2.1, [BS] 202

Proponent: Stephen Szoke, American Concrete Institute, representing American Concrete Institute (steve.szoke@concrete.org); Scott Campbell, representing National Ready Mixed Concrete Association (scampbell@nrmca.org)

2018 International Building Code

Revise as follows:

1901.2 Plain and reinforced concrete. Structural concrete shall be designed and constructed in accordance with the requirements of this chapter and ACI 318 ~~as amended in Section 1905 of this code.~~. Except for the provisions of Sections 1904 and 1907, the design and construction of slabs on grade shall not be governed by this chapter unless they transmit vertical loads or lateral forces from other parts of the structure to the soil. Precast concrete diaphragms in buildings assigned to *Seismic Design Category* C, D, E or F shall be designed in accordance with the requirements of ASCE 7, Section 14.2.4.

1905.1.1 ACI 318, Section 2.3. Modify existing definitions and add the following definitions to ACI 318, Section 2.3.

Delete without substitution:

~~**DETAILED PLAIN CONCRETE STRUCTURAL WALL.** A wall complying with the requirements of Chapter 14, including 14.6.2.~~

~~**ORDINARY PRECAST STRUCTURAL WALL.** A precast wall complying with the requirements of Chapters 1 through 13, 15, 16 and 19 through 26.~~

~~**ORDINARY REINFORCED CONCRETE STRUCTURAL WALL.** A *cast-in-place* wall complying with the requirements of Chapters 1 through 13, 15, 16 and 19 through 26.~~

~~**ORDINARY STRUCTURAL PLAIN CONCRETE WALL.** A wall complying with the requirements of Chapter 14, *excluding 14.6.2.*~~

Revise as follows:

~~**1905.1.6**~~**1901.2.1** ~~**ACI 318, Section 14.6.**~~**Detailed plain concrete structural wall.** ~~Modify ACI 318, Section 14.6 by adding new Section 14.6.2 to read as follows:14.6.2 –~~
Detailed plain concrete structural

~~walls.~~
~~14.6.2.1 – Detailed plain concrete structural walls are walls conforming to the requirements of ordinary structural plain concrete walls and 14.6.2.2.~~
~~14.6.2.2 – Reinforcement shall be~~
walls shall comply with the requirements of Chapter 14 of ACI 318 with reinforcement provided as follows:

(a) Vertical reinforcement of at least 0.20 square inch (129 mm^2) in cross-sectional area shall be provided continuously from support to support at each corner, at each side of each opening and at the ends of walls. The continuous vertical bar required beside an opening is permitted to substitute for one of the two No. 5 bars required by ~~14.6.1.~~Section 14.6.1 of ACI 318.

(b) Horizontal reinforcement at least 0.20 square inch (129 mm^2) in cross-sectional area shall be provided:

1. Continuously at structurally connected roof and floor levels and at the top of walls.
2. At the bottom of load-bearing walls or in the top of foundations where doweled to the wall.
3. At a maximum spacing of 120 inches (3048 mm).

Reinforcement at the top and bottom of openings, where used in determining the maximum spacing specified in Item 3 above, shall be continuous in the wall.

Delete without substitution:

~~**[BS] DETAILED PLAIN CONCRETE STRUCTURAL WALL.** See Section 1905.1.1.~~

~~**[BS] ORDINARY PRECAST STRUCTURAL WALL.** See Section 1905.1.1.~~

~~**[BS] ORDINARY REINFORCED CONCRETE STRUCTURAL WALL.** See Section 1905.1.1.~~

~~**[BS] ORDINARY STRUCTURAL PLAIN CONCRETE WALL.** See Section 1905.1.1.~~

Reason Statement: There is no technical change to the requirements for design and construction of structural concrete. This change improves the clarity of the code and the coordination with ACI 318 by:
1) removing redundant language that advises concrete shall be in accordance with "this chapter" and "Section 1905" where the latter is part of the chapter.

2) relocating the provisions for detailed plain concrete structural wall from IBC Section 1905.1.6 to new Section 1901.2.1 for clarity and to facilitate use.

3) removing definition of ordinary precast concrete wall which has the same definition as ordinary reinforced concrete wall and not differentiated in ACI 318 or in the IBC.

4) removing definitions for other walls systems defined in ACI 318 and transcribed from ACI 318 simply to have all wall system definitions in one place when adding a definition for "detailed plain concrete structural wall."

In addition, because the current language is presented as a modification, it portrays that criteria in ACI 318 for such walls are being modified. ACI Committee 318 does not recognize and thus does not address detailed plain concrete structural walls. This should not be presented as a modification to ACI 318, but included as specific language that permits detailed plain concrete structural walls in the IBC.

Deletion of "as amended in Section 1905 of this code." In Section 1901.2 "as amended in Section 1905 of this code" is removed because it is redundant. The same sentence where this text occurs advises that "structural concrete be designed and constructed in accordance with the requirements of this chapter and ACI 318." There is no need for the superfluous language: "as amended in Section 1905 of this code." Language already advises that both ACI 318 and Chapter 19 shall be satisfied and IBC administration sections advise that Chapter 19 shall governor over ACI 318.

Detailed plain concrete structural wall. The current organization forces the user to flip back and forth between the IBC and ACI 318, only to discover the differences in the two are only applicable to "detailed plain concrete structural walls" which are not addressed in ACI 318. The new proposed language makes it clear to the use the provisions only where "detailed plain concrete structural walls" are being used in the project. This code change proposal removed redundant and superfluous language and clarifies the code. This change removes text transcribed from ACI simply to have all definitions in one place.

The technical requirements (text) is moved from Section 1905.1.6 new Section 1901.2.1 titled "detailed plain concrete structural wall" with minor editorial modifications necessary to accommodate the relocation.

Ordinary precast concrete wall. The definition for "ordinary precast structural wall" is deleted. The definition is identical to that for ordinary reinforced concrete structural wall and ACI does not differentiate between ordinary reinforced and precast structural walls. The language in the 2018 edition of the IBC creates confusion because the definition in the IBC encourages the user to seek specific language and criteria identified for ordinary precast concrete wall where it does not exist in ACI 318. ACI 318 is clear that both are addressed in ACI 318 Chapter 11. ACI 318 Section 11.1. Scope states:

"11.1.1 This chapter shall apply to the design of nonprestressed and prestressed walls including (a) through (c):

(a) Cast-in-place

(b) Precast in-plant

(c) Precast on-site including tilt-up"

Removal of repetitive definitions in the IBC. Several definitions in the 2018 IBC are similar to those in ACI 318. Continuation of carrying definitions in both documents requires additional coordination in Sections of ACI 318. The transcription of these definitions in the IBC was to have all structural wall definitions together when the IBC was simply adding criteria for "detailed plain concrete structural wall." Having the new Section 1901.2.1 addresses "detailed plain concrete structural wall" and eliminates potential confusion on the definitions and applicable section of ACI 318. This will reduce the need for subsequent code change proposals simply to coordinate ACI 318 and the IBC. The definitions in both documents are show in the table below.

Removal of points called definitons in Section 202. Pointers are removed from Section 202 for the definitons being removed from Section 1905.1.1

2018 IBC 1905.1.1	**ACI 318**
Definition for "structural wall: is absent from the 2018 IBC. DETAILED PLAIN CONCRETE STRUCTURAL WALL. A wall complying with the requirements of Chapter 14, including 14.6.2. ORDINARY PRECAST STRUCTURAL WALL. A precast wall complying with the requirements of Chapters 1 through 13, 15, 16 and 19 through 26. ORDINARY REINFORCED CONCRETE STRUCTURAL WALL. A cast-in-place wall complying with the requirements of Chapters 1 through 13, 15, 16 and 19 through 26. ORDINARY STRUCTURAL PLAIN CONCRETE WALL. A wall complying with the requirements of Chapter 14, excluding 14.6.2. SPECIAL STRUCTURAL WALL. A cast-in-place or precast wall complying with the requirements of 18.2.4 through 18.2.8, 18.10 and 18.11, as applicable, in addition to the requirements for ordinary reinforced concrete structural walls or ordinary precast structural walls, as applicable. Where ASCE 7 refers to a special reinforced concrete structural wall," it shall be deemed to mean a "special structural wall." IBC has no provisions for **intermediate precast walls**.	**structural wall**—wall proportioned to resist combinations of shears, moments, and axial forces in the plane of the wall; a shear wall is a structural wall. **Detailed plain concrete structural walls** are not addressed in ACI 318. IBC text is moved from Section 1905.1.6 to new section 1901.2.1. Commentary to the IBC should be added to indicate that detailed plain concrete structural walls are not recognized by ACI Committee 318 and thus not addressed in ACI 318 *Building Code Requirements for Structural Concrete*. **Ordinary precast structural wall.** ACI 318 does not differentiate between ordinary precast structural walls and ordinary reinforced structural walls. Note that the definitions in the IBC are identical for both Ordinary Precast Structural Wall and Ordinary Reinforced concrete structural Wall **structural wall, ordinary reinforced concrete**—a wall complying with Chapter 11. **Structural wall, ordinary plain concrete**—a wall complying with Chapter 14. Section 14.6.2 does not exist in ACI 318 and is a modification to ACI 318 in IBC Section 1905.1.6 which provides new Section 14.6.2. This is very confusing. Text from 1905.1.6 identifying and adding a non-existing Section 14.6.2 in ACI 318 is revised to eliminate reference to ACI 318 and moves to new Section 1901.2.1 **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. **structural wall, intermediate precast**—a wall complying with 18.5.

ACI, a 501.C.3 professional technical society, encourages the approval of this code change proposal to improve the IBC by more clearly advising the user that there are provisions in the IBC for "detailed plain concrete structural walls" which are not addressed in ACI 318. The change removes transcription from ACI 318 and eliminates the need for frequent code change proposals to coordinate referenced ACI sections cited in the IBC.

Cost Impact: The code change proposal will not increase or decrease the cost of construction
No change to technical requirements

ACI IBC 19-02 1901.2 Precast diaphragm

IBC: 1901.2

Proponent: Stephen Szoke, American Concrete Institute, representing American Concrete Institute (steve.szoke@concrete.org); Jason Krohn, Precast/Prestressed Concrete Institute, representing Precast/Prestressed Concrete Institute (jkrohn@pci.org)

2018 International Building Code

Revise as follows:

1901.2 Plain and reinforced concrete. Structural concrete shall be designed and constructed in accordance with the requirements of this chapter and ACI 318 as amended in Section 1905 of this code. Except for the provisions of Sections 1904 and 1907, the design and construction of slabs on grade shall not be governed by this chapter unless they transmit vertical loads or lateral forces from other parts of the structure to the soil. ~~Precast concrete diaphragms in buildings assigned to *Seismic Design Category* C, D, E or F shall be designed in accordance with the requirements of ASCE 7, Section 14.2.4.~~

Reason Statement: This information has been coordinated between ASCE 7 and ACI 318. ACI 318-19 now contains duplicate provisions as Section 14.2.4 of ASCE 7-16. Future versions of ASCE 7 plan to remove the duplicate language. Therefore, ACI 318 should be the design reference for precast concrete diaphragms in buildings assigned to Seismic Design Category C, D, E or F.
ACI, a 501.C.3, professional technical society, encourages the approval of this code change proposal to improve the IBC by avoiding unnecessary duplication of text in code and referenced standards.

Cost Impact: The code change proposal will not increase or decrease the cost of construction
Design and construction requirements are unaltered, change only removes text that is no longer necessary.

ACI IBC 19-03 1901.3 Adds Screws

IBC: 1901.3

Proponent: Stephen Szoke, American Concrete Institute, representing American Concrete Institute (steve.szoke@concrete.org); Scott Campbell, representing National Ready Mixed Concrete Association (scampbell@nrmca.org)

2018 International Building Code

Revise as follows:

1901.3 Anchoring to concrete. Anchoring to concrete shall be in accordance with ACI 318 as amended in Section 1905, and applies to cast-in (headed bolts, headed studs and hooked J- or L-bolts)~~,~~; post-installed expansion (torque-controlled and displacement-controlled)~~,~~; undercut and adhesive; and screw anchors.

Reason Statement: This code change adds screws conforming to the requirements of ACI 318 as permissible anchoring devices. This make the IBC more current and reflects technological advancements integrated into standardization. Further the use of screws adds flexibility for design and construction.
ACI, a 501.C.3 professional society encourages the approval of this code change proposal to improve the IBC by adding increased flexibility by adding screws as acceptable elements for anchoring to concrete.

Cost Impact: The code change proposal will increase the cost of construction
While there is no quantitative data, the addition of another method of anchorage improves flexibility in design and construction which may reduce initial cost. The addition of screws as a method for attachment will not increase cost.

ACI IBC 19-04 1905.1 Construction Documents

IBC: 1901.5

Proponent: Stephen Szoke, American Concrete Institute, representing American Concrete Institute (steve.szoke@concrete.org); Scott Campbell, National Ready Mixed Concrete Association, representing National Ready Mixed Concrete Association (scampbell@nrmca.org); Amy Trygestad, representing Concrete Reinforcing Steel Institute (atrygestad@crsi.org)

2018 International Building Code

Delete without substitution:

~~**1901.5 Construction documents.** The *construction documents* for structural concrete construction shall include:~~

1. ~~The specified compressive strength of concrete at the stated ages or stages of construction for which each concrete element is designed.~~
2. ~~The specified strength or grade of reinforcement.~~
3. ~~The size and location of structural elements, reinforcement and anchors.~~
4. ~~Provision for dimensional changes resulting from creep, shrinkage and temperature.~~
5. ~~The magnitude and location of prestressing forces.~~
6. ~~Anchorage length of reinforcement and location and length of lap splices.~~
7. ~~Type and location of mechanical and welded splices of reinforcement.~~
8. ~~Details and location of contraction or isolation joints specified for plain concrete.~~
9. ~~Minimum concrete compressive strength at time of posttensioning.~~
10. ~~Stressing sequence for posttensioning tendons.~~
11. ~~For structures assigned to *Seismic Design Category* D, E or F, a statement if slab on grade is designed as a structural diaphragm.~~

Reason Statement: This code change proposal removes an incomplete list of criteria necessary for the construction documents applicable to structural concrete. The list in the IBC is not as comprehensive as the list in referenced ACI documents. Many of the omissions from the IBC list are shown in the table below. Since the IBC supersedes referenced ACI documents the partial list in the IBC is all that would be required although ACI documents have significantly more extensive requirements. If the list in the IBC is to indicate what may be of particular importance to the building code official, then that list might be best included in the commentary to the IBC, but not provided as the applicable requirements for construction documents. Further maintaining duplicate lists becomes problematic and results code change proposals that would not alter the requirements. The list in the IBC is outdate and many important items recently added to ACI documents are not addressed, in particular note the requirements for anchors and qualifications for personnel.

IBC Requirements	ACI Requirements
	Loads used in design
	Design work delegated to contractor
	Cementitious materials and combinations
	Water cement ratio
	Aggregates
	Mixing water
	Admixtures
	If water reducing – amount of modification
	If retarding – modification in setting time
	Where expansive cements are used – admixture compatibility
	Steel fiber reinforcement
Compressive strength of concrete	Compressive strength of concrete
	Test age for compressive strengths
	Maximum water cement ratio
	Maximum size of aggregate
	Exposure Category F – air content

	Exposure Class C – chloride ion limits
	Exposure Class S – types of cement
	Density of lightweight aggregate
	Volumetric fracture of aggregates where required in design
	Where used for shear – requirements for steel-fiber reinforced concrete
	Exposure class at option of engineer
	Compressive strength as various phases at option of engineer.
	Concrete mix proportions
	Material storage
	Concrete batching, mixing, and transport/delivery
	Pump pipe requirements
	Concrete placement
	Vertical lift requirements
	Field cured specimens if required
	Temperature of high early strength concrete
	Accelerated curing requirements if employed
	Protection and curing concrete
	Cold weather concrete procedures if applicable
	Hot weather concrete procedures if applicable
	Locations where slab column interfaces are integrated
	Locations where steel-fiber reinforcement is required
	Saw cutting locations
Strength or grade of reinforcement	Designation and grade of reinforcement
Size and location of elements	Size and location of members
	Tolerance of members
Size and location of reinforcement	Size and location of reinforcement
	Tolerances for reinforcement
	Designation of protective coatings
	Mill reports
	Field bending of reinforcement
Provisions for dimensional change	Provisions for dimensional change
	Qualifications of anchors
	Type, size, location requirements, effective embedment depth, and installation requirements for anchors
	For adhesive anchors, minimum age of concrete, concrete temperature range, moisture condition of concrete at time of installation, type of lightweight concrete if applicable, and requirements for hole drilling and preparation
	Qualifications for anchor installers
	Corrosion protect for exposed anchors
	Type, size, details, and location of embedments
	Details of lifting devices, embedments, and related reinforcement required to resist temporary loads from handling, storage, transportation, and erection, where designed by the licensed design professional.
Magnitude and location of	Magnitude and location of prestressing forces

prestressing forces	
Anchor and lap splice lengths	Anchor and lap splice lengths
Type and location of welded and mechanical splices	Type and location of welded and mechanical splices
	Type and location of end-bearing splices
Details and location of construction joints	Details and location of construction joints
	Design of construction joints
	Surface preparation
	Shear transfer where required
Minimum compressive strength for post-tensioning	Minimum compressive strength for post-tensioning
Post-tensioning stressing sequence	Post-tensioning stressing sequence
	Tolerances for tendons
	Materials and details of corrosion protection for tendons, couplers, end fittings, post-tensioning anchorages, and anchorage regions.
	Requirements for grouting of bonded tendons, including maximum water-soluble chloride ion
	Formwork, including removal
	Qualifications of filed technicians
	Qualifications of inspectors
	Qualifications of testing agency and technicians
Slab on grade resisting seismic forces.	Identify if a slab-on-ground is designed as a structural diaphragm or part of the seismic-force-resisting system

ACI, a 501.C.3. professional technical society, recommends approval of this code change as submitted to assure that all relevant requirements for structural concrete as included on construction documents and to reduce confusion and eliminate the need to maintain duplicate lists.

Cost Impact: The code change proposal will not increase or decrease the cost of construction
This code change proposal removes potential conflicts between the IBC and ACI requirements for consturciton documents.

ACI IBC 19-12 Tolerances

IBC: 1901.7 (New), 1901.7.1 (New), 1901.7.2 (New), ACI Chapter 35 (New)

Proponent: Stephen Szoke, representing American Concrete Institute (steve.szoke@concrete.org)

2018 International Building Code

Add new text as follows:

1901.7 Tolerances for structural concrete Where not indicated in construction documents, structural tolerances for concrete structural elements shall be in accordance with this section.

1901.7.1 Cast-in-place concrete tolerances. Structural tolerances for cast-in-place concrete structural elements shall be in accordance with ACI 117.
Exception: The requirements of ACI 117 are not applicable for for single-family residential construction or shotcrete.

1901.7.2 Precast concrete tolerances. Structural tolerances for precast concrete structural elements shall be in accordance with ACI ITG-7.
Exception: The requirements of ACI ITG-7 are not applicable for single-family residential construction.

ACI

American Concrete Institute
38800 Country Club Drive
Farmington Hills MI 48331

117-10: Specification for Tolerances for Concrete Construction and Materials

ACI

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Farmington Hills MI 48331

ITG-7-09: Specification for Tolerances for Precast Concrete

Reason Statement: ACI staff receive frequent technical inquiries regarding the allowable tolerances of structural concrete elements when tolerances are not indicated in construction documents. Adding these reference standards to the IBC provides the user with the information necessary for structural elements to perform as intended.
ACI, a 501(c)3 professional technical society, recommends approval as submitted to help assure that the appropriate tolerances for structural concrete elements appplicable where not included in construction documents.

Cost Impact: The code change proposal will not increase or decrease the cost of construction
There is no cost change associated with these requirements which are routinely cited in construction docments.

ACI IBC 19-06 1902 (New) Terms

IBC: SECTION 1902, 1902.1, 202, 202, [BS] 202

Proponent: Stephen Szoke, American Concrete Institute, representing American Concrete Institute (steve.szoke@concrete.org); Scott Campbell, representing National Ready Mixed Concrete Association (scampbell@nrmca.org); Amy Trygestad, representing Concrete Reinforcing Steel Institute (atrygestad@crsi.org)

2018 International Building Code

Revise as follows:

SECTION 1902
~~DEFINITIONS~~COORDINATION OF TERMS

1902.1 General. ~~The words and terms defined in ACI 318 shall, for the purposes of this chapter and as used elsewhere in this code for concrete construction, have the meanings shown in ACI 318 as modified by Section 1905.1.1.~~Coordination of terminology used in ACI 318 and ASCE 7 shall be as follows:

~~**DESIGN DISPLACEMENT.**~~**1902.1.1 Design displacement.** ~~Total~~ Design displacement shall be the total lateral displacement expected for the design-basis earthquake, *as specified by Section 12.8.6 of ASCE 7.*

~~**SPECIAL STRUCTURAL WALL.**~~**1902.1.2 Special structural wall.** ~~A~~ Special structural walls made of cast-in-place or precast ~~wall complying~~ concrete shall comply with the requirements of Sections 18.2.4 through 18.2.8, 18.10 and 18.11 of ACI 318, as applicable, in addition to the requirements for ordinary reinforced concrete structural walls *or ordinary precast structural walls, as applicable. Where ASCE 7 refers to a "special reinforced concrete* ~~structural~~ *shear wall," it shall be deemed to mean a "special structural wall."*

Delete without substitution:

~~**[BS] DESIGN DISPLACEMENT.** See Section 1905.1.1.~~

~~**[BS] SPECIAL STRUCTURAL WALL.** See Section 1905.1.1.~~

Reason Statement: There is no change to the requirements for design and construction of structural concrete. This change improves the clarity of the code and the coordination with ACI 318 by:
1) removing redundant language that advises concrete shall be in accordance with “this chapter” and “Section 1905” where the latter is part of the chapter.

2) relocating the provisions for "design displacement" from IBC Section 1905.1.6 to new Section 1901.2.1 for clarity and to facilitate use. This appropriately removes criteria from a definiton andplaces the criteria in a section.

3) relocating the provisions for "special structural wall" from IBC Section 1905.1.6 to new Section 1901.2.1 for clarity and to facilitate use. This appropriately removes criteria from a definiton andplaces the criteria in a section. The definition and crtieria for special structural wall in the IBC and ACI 318 are shown in Table 1

Deletion of “as amended in Section 1905 of this code.” In Section 1901.2 “as amended in Section 1905 of this code” is removed because it is redundant. The same sentence where this text occurs advises that “structural concrete be designed and constructed in accordance with the requirements of this chapter and ACI 318.” There is no need for the superfluous language: “as amended in Section 1905 of this code.” Language already advises that both ACI 318 and Chapter 19 shall be satisfied and IBC administration sections advise that Chapter 19 shall governor over ACI 318.

Removal of repetitive definitions in the IBC. Several definitions in the 2018 IBC are similar to those in ACI 318. This will reduce the need for subsequent code change proposals simply to coordinate ACI 318 and the IBC.

Elimination of pointers. Unnecessary pointers in Section 202 Definitions are removed.

Table 1 - Comparison of IBC and ACI 318 definitions and crtieria for special structural walls.

2018 IBC 1905.1.1	**ACI 318**
SPECIAL STRUCTURAL WALL. A cast-in-place or precast wall complying with the requirements of 18.2.4 through 18.2.8, 18.10 and 18.11, as applicable, in addition to	**structural wall, special**—a cast-in-place structural wall in accordance

the requirements for ordinary reinforced concrete structural walls or ordinary precast structural walls, as applicable. Where ASCE 7 refers to a special reinforced concrete structural wall," it shall be deemed to mean a "special structural wall."	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.
IBC has no provisions for **intermediate precast walls**.	**structural wall, intermediate precast**—a wall complying with 18.5.

ACI, a 501.C.3 professional technical society, encourages the approval of this code change proposal to improve the IBC by more clearly advising the user that there are provisions in the IBC for "detailed plain concrete structural walls" which are not addressed in ACI 318. The change removes transcription from ACI 318 and eliminates the need for frequent code change proposals to coordinate referenced ACI sections cited in the IBC.

Cost Impact: The code change proposal will not increase or decrease the cost of construction
This change does not alter design or consturciton crtieria but makes the code more user friendly, reducing the potential for errors or conflicts.

ACI IBC 19-05 1903.1 Cement Standards

IBC: 1903.1

Proponent: Stephen Szoke, American Concrete Institute, representing American Concrete Institute (steve.szoke@concrete.org); Scott Campbell, representing National Ready Mixed Concrete Association (scampbell@nrmca.org)

2018 International Building Code

Revise as follows:

1903.1 General. Materials used to produce concrete, concrete itself and testing thereof shall comply with the applicable standards listed in ACI 318.

~~**Exception:** The following standards as referenced in Chapter 35 shall be permitted to be used.~~

~~1. ASTM C150~~
~~2. ASTM C595~~
~~3. ASTM C1157~~

Reason Statement: This language was introduced when there was concern that reference to the re-formatted edition of ACI 318-14 might not be approved for inclusion as a referenced standard in the 2015 edition of the International Building Code (IBC). The re-formatted edition of ACI 318 was included in the IBC and thus these cement standards, as referenced in ACI 318, are part of the IBC because language in Chapter 19 advises that:
1901.2 Plain and reinforced concrete*. Structural concrete shall be designed and constructed in accordance with the requirements of this chapter and ACI 318 as amended in Section 1905 of this code.*

Further, ACI 318 permits other cementitious materials and the exception has implied to some users that these are the only cementitious materials permitted for concrete. All permissible cement standard specifications are listed in ACI 318:

C150/C150M-12—Standard Specification for Portland Cement

C595/C595M-14—Standard Specification for Blended Hydraulic Cements

C618-12a—Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete

C845/C845M-12—Standard Specification for Expansive Hydraulic Cement

C989/C989M-13—Standard Specification for Slag Cement for Use in Concrete and Mortars

C1157/C1157M-11—Standard Performance Specification for Hydraulic Cement

C1240-14—Standard Specification for Silica Fume Used in Cementitious Mixtures

ACI, a 501.C.3 professional society, encourages the approval of this code change proposal as submitted to remove redundant and potentially misleading language.

Cost Impact: The code change proposal will not increase or decrease the cost of construction
This code change proposal continues to permit the use of cement cited in the the 2018 editon of the IBC, and may reduce costs on specific projects by expanding the acceptable types of cement in accordance with those permitted in ACI 318.

ACI IBC 19-07 1905.1 Seismic Design

IBC: 1905 (New), 1905.1, 1905.1.1, 1905.1.3, 1905.1.6, 1905.1.7, 1905.1.8

Proponent: Stephen Szoke, American Concrete Institute, representing American Concrete Institute (steve.szoke@concrete.org); Scott Campbell, representing National Ready Mixed Concrete Association (scampbell@nrmca.org); Amy Trygestad, representing Concrete Reinforcing Steel Institute (atrygestad@crsi.org)

2018 International Building Code

Add new text as follows:

1905
SEISMIC DESIGN REQUIREMENTS

Revise as follows:

~~**1905.1.1**~~**1905.1 ~~ACI 318, Section 2.3.~~Seismic design category requirements.** ~~Modify existing definitions and add the following definitions to ACI 318, Section 2.3.~~The requirements of this section shall govern the design and construction of structural concrete elements subjected to seismic forces.

~~**1905.1.2**~~**1905.1.1 ~~ACI 318, Section 18.2.1.~~Seismic design category A** ~~Modify ACI 318 Sections 18.2.1.2 and 18.2.1.6 to read as follows:18.2.1.2 –~~
Structures assigned to Seismic Design Category A shall not be required to satisfy the requirements of Chapter 18 of ACI 318.

1905.1.2 Seismic design categories B, C, D, E, and F. ~~Chapters 1 through 17 and 19 through 26; *Chapter 18 does not apply.*~~ Structures assigned to *Seismic Design Category* B, C, D, E or F shall satisfy 18.2.1.3 through 18.2.1.7 of ACI 318, as applicable. ~~*Except for structural elements of plain concrete complying with Section 1905.1.7 of the International Building Code, structural elements of plain concrete are prohibited in structures assigned to Seismic Design Category C, D, E or F.*~~

1905.1.4 Seismic force resisting systems. ~~18.2.1.6 –~~ Structural systems designated as part of the seismic force-resisting system shall be restricted to those *permitted by ASCE 7.*~~7.~~ Except for *Seismic Design Category* A, for which Chapter 18 of ACI 318 does not apply, the following provisions shall be satisfied for each structural system designated as part of the seismic force-resisting system, regardless of the *seismic design category*:

(a) Ordinary moment frames shall satisfy ~~18.3.~~Section 18.3 of ACI 318.
(b) Ordinary reinforced concrete structural walls *and ordinary precast structural walls* need not satisfy any provisions in Chapter ~~18.~~18 of ACI 318.
(c) Intermediate moment frames shall satisfy ~~18.4.~~Section 18.4 of ACI 318.
(d) Intermediate precast *structural* walls shall satisfy ~~18.5.~~Section 18.5 of ACI 318.
(e) Special moment frames shall satisfy Sections 18.6 through ~~18.9.~~18.9 of ACI 318.
(f) Special structural walls shall satisfy ~~18.10.~~Section 18.10 of ACI 318.
(g) Special structural walls constructed using precast concrete shall satisfy ~~18.11.~~Section 18.11 of ACI 318.

1905.1.5 Special structural elements. Special moment frames and special structural walls shall also satisfy Sections 18.2.4 through

~~18.2.8.~~
18.2.8 of ACI 318.

~~**1905.1.7**~~**1905.1.3 ~~ACI 318, Section 14.1.4.~~Structural plain concrete.** ~~Delete ACI 318, Section 14.1.4 and replace with the following:~~
~~14.1.4 – Plain concrete in structures assigned to *Seismic Design Category* C, D, E or F.~~
~~14.1.4.1 – Structures~~
Structural elements of of p*lain concrete are prohibited in structures assigned to Seismic Design Category C, D, E or F*

~~shall not have elements of structural plain concrete~~
, except as follows:

(a) Structural plain concrete basement, foundation or other walls below the base as defined in ASCE 7 are permitted in detached one- and two-family dwellings three stories or less in height constructed with stud-

bearing walls. In dwellings assigned to Seismic Design Category D or E, the height of the wall shall not exceed 8 feet (2438 mm), the thickness shall be not less than $7^1/_2$ inches (190 mm), and the wall shall retain no more than 4 feet (1219 mm) of unbalanced fill. Walls shall have reinforcement in accordance with 14.6.1.

(b) Isolated footings of plain concrete supporting pedestals or columns are permitted, provided the projection of the footing beyond the face of the supported member does not exceed the footing thickness.

***Exception:** In detached one- and two-family dwellings three stories or less in height, the projection of the footing beyond the face of the supported member is permitted to exceed the footing thickness.*

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

Exceptions:

1. In *Seismic Design Categories* A, B and C, detached one- and two-family dwellings three stories or less in height constructed with stud-bearing walls are permitted to have plain concrete footings without longitudinal reinforcement.
2. For foundation systems consisting of a plain concrete footing and a plain concrete stemwall, a minimum of one bar shall be provided at the top of the stemwall and at the bottom of the footing.
3. Where a slab on ground is cast monolithically with the footing, one No. 5 bar is permitted to be located at either the top of the slab or bottom of the footing.

~~**1905.1.4**~~**1905.1.6 ~~ACI 318, Section 18.11.~~Precast special structural concrete walls.** ~~Modify ACI 318, Section 18.11.2.1 to read as follows:18.11.2.1 –~~
Special structural walls constructed using precast concrete shall satisfy all the requirements of Sections 18.10 *for cast-in-place special structural walls*

~~in addition to 18.5.2.~~
add Section 18.5.2 of ACI 318.

~~**1905.1.5**~~**1905.1.7 ~~ACI 318, Section 18.13.1.1.~~Seismic force resisting foundations.** ~~Modify ACI 318, Section 18.13.1.1 to read as follows:18.13.1.1 –~~
Foundations resisting earthquake-induced forces or transferring earthquake-induced forces between a structure and ground shall comply with the requirements of 18.13 and other applicable provisions of ACI 318 *unless modified by Chapter 18 of the* International Building Code.

~~**1905.1.3**~~**1905.1.8 ~~ACI 318, Section 18.5.~~Connections** Connections shall satisfy the requirements of this section.

1905.1.8.1 Connections designed to yield.

~~Modify ACI 318, Section 18.5 by adding new Section 18.5.2.2 and renumbering existing Sections 18.5.2.2 and 18.5.2.3 to become 18.5.2.3 and 18.5.2.4, respectively.~~

~~18.5.2.2 –~~*Connections that are designed to yield shall be capable of maintaining 80 percent of their design strength at the deformation induced by the design displacement or shall use Type 2 mechanical splices.*
~~18.5.2.3 –~~**1905.1.8.2 Elements of connections not designed to yield.** Elements of the connection that are not designed to yield shall develop at least 1.5 S_y.
~~18.5.2.4 –~~**1905.1.9 Wall Piers.** In structures assigned to SDC D, E or F, wall piers shall be designed in accordance with ACI 318 Section 18.10.8 or ~~18.14 in ACI 318.~~18.14.

Reason Statement: These proposed revisions do not alter the criteria in the IBC, but instead make it clear to the user what systems and applications are being addressed. Rather than having the user read sections 14.1.4, 14.1.4.1 etc., the revisions clearly advise the user what is being addressed in the section. The user can more easily determine if the criteria are applicable to the project.
Modifications shown as new section 1906.1. The Chapter already requires compliance with applicable sections of ACI 318. The change removes superfluous language included to simply advise the user that the requirements of Chapter 18 are not applicable in SDC A.

Modifications shown as new section 1906.1.2. Retains the criteria for structures assigned to SDC B, C, D, E, and F. but clearly identifies that criteria as only being applicable to those SDCs. This change makes the code more user friendly, especially where used for project sin SDC A.

Modifications shown as new section 1906.1.3. This revision more clearly presents the requirements and exceptions for plain concrete used in seismic design categories in an appropriately identified section. The criteria of section 1905.1.7 is moved to new section 1906.1.3. This also eliminates a pointer to other sections of the code.

Modifications shown as new section 1906.1.4. This revision identifies the section topic as "Seismic force resisting systems" in lieu of ACI 318 Section "18.2.1.6." This provides clarity and improves direction to the user.

Modifications shown as new section 1906.1.5, This revision identifies the section topic as "Special structural elements." and not as ACI 318, Section 18.11. This provides clarity and improves direction to the user

Modification shown as new section 1906.1.6. This revision identifies the section as "Precast special structural concrete walls." in lieu of 1905.1.4 ACI 318, Section 18.11. This provide clarity and direction to the user. This revision makes it clear that the user need not be concerned with these criteria where projects do not involve precast concrete.

Modification shown as new section 1906.1.7. This revision identifies the section as "Seismic force-resisting foundations." in lieu of "ACI 318, Section 18.13.1.1." This provide clarity and direction to the user. This revision makes it clear that the user need not be concerned with these criteria where projects do not involve seismic force-resisting foundations.

Modification shown as new section 1906.1.8, This revision identifies the section as "Connections" in lieu of "ACI 318, Section 18.5." This provide clarity and direction to the user. This revision makes it clear that the user need not be concerned with these criteria are applicable to connections and further clearly delineates between elements designed to yield and those not designed to yield.

Modification shown as new section 1906.1.9. This revision identifies the section as "Wall piers" in lieu of "ACI "18.5.2.4." To the user it is unclear whether to search IBC or ACI 318 for Section 18.5.2.4. Further, if wall piers are not employed on the project, the user can easily identify that these requirements may not be applicable. Finally, the revised language makes it clearer that the cited references are both in ACI 318

ACI, a 501.C.3 professional technical society, encourages the approval of this code change proposal to improve the IBC by more clearly advising the user that the provisions addressed in this section are related to seismic design category requirements, reduces transcription/duplication of language in IBC and ACI 318, reduces confusion by eliminating multiple indicators that are solely section numbers from ACI 318.

Cost Impact: The code change proposal will not increase or decrease the cost of construction
Requriemetns are not changed. Text is reorganized and presented in a more clear manner identifying specifcaly what crtieria to which crtieria pertain rather than jus tlisting seciton number of ACI 318 which is very confusing. Could result in cost reductions by reducitng confusion as presente din the 2018 IBC.

ACI IBC 19-08 Anchors to Concrete

IBC: SECTION 1906 ANCHORS TO CONCRETE

Proponent: Stephen Szoke, American Concrete Institute, representing American Concrete Institute (steve.szoke@concrete.org); Scott Campbell, representing National Ready Mixed Concrete Association (scampbell@nrmca.org)

2018 International Building Code

Revise as follows:

~~**1905.1.8**~~**SECTION 1906 ANCHORS TO CONCRETE** ~~**ACI 318, Section 17.2.3.**~~**1906.1 General** ~~Modify ACI 318 Sections 17.2.3.4.2, 17.2.3.4.3(d) and 17.2.3.5.2 to read as follows:17.2.3.4.2 – Where the tensile component of the strength-level earthquake force applied to anchors exceeds 20 percent of the total factored anchor tensile force associated with the same load combination, anchors and their attachments~~
Anchors to concrete shall be designed and installed in accordance with

~~17.2.3.4.3. The anchor design tensile strength shall be determined in accordance with 17.2.3.4.4.~~
Chapter 17 of ACI 318 and the provisions of this section.:

1906.1.1 Anchors resisting out-of-plane forces

~~**Exception:**~~
Anchors designed to resist wall out-of-plane forces with design strengths equal to or greater than the force determined in accordance with ASCE 7 Equation 12.11-1 or 12.14-10 shall be deemed to satisfy Section 17.2.3.4.3(d) of ACI 318.

1906.1.2 Anchorage of lightframe walls to concrete.

~~.17.2.3.4.3(d) – The anchor or group of anchors shall be designed for the maximum tension obtained from design load combinations that include **E**, with **E** increased by Ω. The anchor design tensile strength shall *be calculated from 17.2.3.4.4.*~~
~~17.2.3.5.2 – Where the shear component of the strength-level earthquake force applied to anchors exceeds 20 percent of the total factored anchor shear force associated with the same load combination, anchors and their attachments shall be designed in accordance with 17.2.3.5.3. The anchor design shear strength for resisting earthquake forces shall be determined in accordance with 17.5.~~

~~**Exceptions:**~~

~~1.~~
For the calculation of the in-plane shear strength of anchor bolts attaching wood sill plates or cold-formed steel track of bearing or nonbearing walls of light-frame

~~wood~~
structures to foundations or foundation stem walls, the in-plane shear strength in accordance with 17.5.2 and 17.5.3 of ACI 318 need not be computed and 17.2.3.5.3 of ACI 318 shall be deemed to be satisfied

~~provided all of the following are met: 1.1.~~
where the requirements of sections 1906.1.2.1 or 1906.1.2.2 are met.

1906.1.2.1 Wood lightframe walls. For anchor bolts attaching wood sill plates of lightframe wood walls to to foundations or foundation stem walls:

1. The allowable in-plane shear strength of the anchor is determined in accordance with ANSI/AWC NDS Table 12E for lateral design values parallel to grain.

~~1.2.~~

2. The maximum anchor nominal diameter is $^5/_8$ inch (16 mm).

~~1.3.~~

3. Anchor bolts are embedded into concrete a minimum of 7 inches (178 mm).

~~1.4.~~

4. Anchor bolts are located a minimum of $1^3/_4$ inches (45 mm) from the edge of the concrete parallel to the length of the wood sill plate.

~~1.5.~~

5. Anchor bolts are located a minimum of 15 anchor diameters from the edge of the concrete perpendicular to the length of the wood sill plate.

~~1.6.~~

6. The sill plate is 2-inch (51 mm) or 3-inch (76 mm) nominal thickness.

~~2.For the calculation of the in-plane shear strength of~~
1906.1.2.2 Cold-formed steel lightframe walls. For anchor bolts attaching cold-formed steel track

~~of bearing or nonbearing walls~~
of light-frame construction to foundations or foundation stem

~~walls, the in-plane shear strength in accordance with 17.5.2 and 17.5.3 need not be computed and 17.2.3.5.3 shall be deemed to be satisfied provided all of the following are met: 2.1.~~
walls.

1. The maximum anchor nominal diameter is $^5/_8$ inch (16 mm).

~~2.2.~~

2. Anchors are embedded into concrete a minimum of 7 inches (178 mm).

~~2.3.~~

3. Anchors are located a minimum of $1^3/_4$ inches (45 mm) from the edge of the concrete parallel to the length of the track.

~~2.4.~~

4. Anchors are located a minimum of 15 anchor diameters from the edge of the concrete perpendicular to the length of the track.

~~2.5.~~

5. The track is 33 to 68 mil (0.84 mm to 1.73 mm) designation thickness.

~~*Allowable in-plane shear strength of exempt anchors, parallel to the edge of concrete, shall be permitted to be determined in accordance with AISI S100 Section E3.3.1.*~~

~~3.~~
1906.1.2.3 Anchors 1 inch (25mm) or less in diameter. In light-frame construction bearing or nonbearing walls, shear strength of concrete anchors less than or equal to 1 inch [25 mm] in diameter attaching sill plate or track to foundation or foundation stem wall need not satisfy

~~17.2.3.5.3~~
17.10.6.3 (a) through (c) of ACI 318 when the design strength of the anchors is determined in accordance with

~~17.5.2.1~~
17.7.2.1(c)

.
of ACI 318.

Reason Statement: This code change proposal:
1) More clearly identifies the subject matter as anchors to concrete.

2) Removes duplicative text transcribed from ACI 318 to which the chapter already requires compliance. Deleted text from the IBC is shown with text in ACI 318 in the table below.

3) More clearly indicates where exceptions for light-frame anchorage to concrete are applicable and that the exceptions are only applicable to light-frame.

4) Moves anchor requirement in one section.

2018 IBC	**ACI 318**
17.2.3.4.2 – Where the tensile component of the strength-level earthquake force applied to anchors exceeds 20 percent of the total factored anchor tensile force associated with the same load combination, anchors and their attachments shall be designed in accordance with 17.2.3.4.3. The anchor design tensile strength shall be determined in accordance with 17.2.3.4.4.	17.2.3.4.2 Where the tensile component of the strength level earthquake force applied to anchors exceeds 20 percent of the total factored anchor tensile force associated with the same load combination, anchors and their attachments shall be designed in accordance with 17.2.3.4.3. The anchor design tensile strength shall be determined in accordance with 17.2.3.4.4. *Comment: Criteria are the same and text is recommended for deletion from IBC. Further such a change avoids routine code change proposals to coordinate section of ACI 318 referenced in the IBC.*
17.2.3.4.3(d) – The anchor or group of anchors shall be designed for the maximum tension obtained from design load combinations that include E, with E increased by □0. The anchor design tensile strength shall be calculated from 17.2.3.4.4.	(d) The anchor or group of anchors shall be designed for the maximum tension obtained from design load combinations that include E, with the horizontal component of E increased by Ωo. The anchor design tensile strength shall satisfy the tensile strength requirements of 17.2.3.4.4 *Comment: Criteria are the same and text is recommended for deletion from IBC. Further such a change avoids routine code change proposals to coordinate section of ACI 318 referenced in the IBC.*
17.2.3.5.2 – Where the shear component of the strength-level earthquake force applied to anchors exceeds 20 percent of the total factored anchor shear force associated with the same load combination, anchors and their attachments shall be designed in accordance with 17.2.3.5.3. The anchor design shear strength for resisting earthquake forces shall be determined in accordance with 17.5	17.2.3.5.2 Where the shear component of the strength level earthquake force applied to anchors exceeds 20 percent of the total factored anchor shear force associated with the same load combination, anchors and their attachments shall be designed in accordance with 17.2.3.5.3. The anchor design shear strength for resisting earthquake forces shall be determined in accordance with 17.5 *Comment: Criteria are the same and text is recommended for deletion from IBC. Further such a change avoids routine code change proposals to coordinate section of ACI 318 referenced in the IBC.*

This code change also removes unnecessary transcription from ACI 318 to further inprove clarity.

ACI, a 501.C.3 professional technical society, encourages the approval of this code change proposal to improve the IBC by removing transcription from ACI 318, as the transcription makes the user think there is something different that must be addressed when the chapter already requires compliance with ACI 318. Further this proposed revision places anchor requirements in one section.

Cost Impact: The code change proposal will not increase or decrease the cost of construction
This code change does not alter any technical requirements, but make the code more user-firendly by clearly communicating where deviations form aCI 318 are permitted.

ACI IBC 19-09 1906 Footings for Lightframe

IBC: SECTION 1906, 1906.1

Proponent: Stephen Szoke, American Concrete Institute, representing American Concrete Institute (steve.szoke@concrete.org); Scott Campbell, representing National Ready Mixed Concrete Association (scampbell@nrmca.org)

2018 International Building Code

Revise as follows:

SECTION 1906
~~STRUCTURAL PLAIN CONCRETE~~FOOTINGS FOR LIGHTFRAME CONSTRUCTION

1906.1 ~~Scope.~~Plain concrete footings. ~~The design and construction of structural plain concrete, both cast-in-place and precast, shall comply with the minimum requirements of ACI 318, as modified in Section 1905.~~ **Exception:** For Group R-3 occupancies and buildings of other occupancies less than two stories above grade plane of light-frame construction, the required

~~footing~~
thickness of

~~ACI 318~~
plain concrete footings is permitted to be reduced to 6 inches (152 mm), provided that the footing does not extend more than 4 inches (102 mm) on either side of the supported wall.

Reason Statement: This code change removes unnecessary text and clearly indicate to the user that the provisions of this sections are restricted to light-frame construction. Sections 1905 and 1901 already advise that structural plain concrete must follow the ACI 318 and the appropriate sections of the IBC. This redundant language is eliminated. Further text is editorially modified to alter language presented as an “exception” to be presented as an appropriate provision. ACI, a 501.C.3 professional technical society, encourages the approval of this code change proposal to improve the IBC by more clearly advising the user that these provisions are only applicable footing supporting light-frame construction.

Cost Impact: The code change proposal will not increase or decrease the cost of construction
No change to criteria, improved language for clarify and direction.

ACI IBC 19-10 Slabs-on-Ground

IBC: 1901.2, SECTION 1907, 1907.1

Proponent: Stephen Szoke, American Concrete Institute, representing American Concrete Institute (steve.szoke@concrete.org); Scott Campbell, representing National Ready Mixed Concrete Association (scampbell@nrmca.org)

2018 International Building Code

Revise as follows:

1901.2 Plain and reinforced concrete. Structural concrete shall be designed and constructed in accordance with the requirements of this chapter and ACI 318 as amended in Section 1905 of this code. ~~Except for the provisions of Sections 1904 and 1907, the design and construction of slabs on grade shall not be governed by this chapter unless they transmit vertical loads or lateral forces from other parts of the structure to the soil.~~ Precast concrete diaphragms in buildings assigned to *Seismic Design Category* C, D, E or F shall be designed in accordance with the requirements of ASCE 7, Section 14.2.4.

SECTION 1907
~~MINIMUM SLAB PROVISIONS~~SLABS-ON-GROUND

1907.1 General. Slabs-on-ground not transmitting vertical loads or lateral forces from other parts of the structure to the soil shall be designed and constructed in accordance with section 1904 and this section.
1907.1.1 Slabs-on-ground transmitting loads. Where slabs-on-ground transmit vertical loads or lateral forces from other parts of the structure to the soil all provisions in this Chapter shall be applicable.

1907.2 Thickness. The thickness of concrete floor slabs supported directly on the ground shall be not less than $3^1/_2$ inches (89 mm).

1907.3 Vapor retarder. A polyethylene vapor retarder having a minimum 6-mil (0.006 inch; 0.15 mm) ~~polyethylene vapor retarder~~ thickness and with joints lapped not less than 6 inches (152 mm) shall be placed between the base course or subgrade and the concrete floor slab, or other *approved* equivalent methods or materials shall be used to retard vapor transmission through the floor slab.

Exception: A vapor retarder is not required:

1. For detached structures accessory to occupancies in Group R-3, such as garages, utility buildings or other unheated facilities.
2. For unheated storage rooms having an area of less than 70 square feet (6.5 m^2) and carports attached to occupancies in Group R-3.
3. For buildings of other occupancies where migration of moisture through the slab from below will not be detrimental to the intended occupancy of the building.
4. For driveways, walks, patios and other flatwork that will not be enclosed at a later date.
5. Where *approved* based on local site conditions.

Reason Statement: Reason: The current language is not clear. First the provisions are only applicable to slabs on ground and this should be more clearly stated. Further it is generally understood that all provisions of the IBC are minimum requirements. This code change places all provisions uniquely applicable to slabs-on-ground in one section rather than having provisions in sections 1901.2 and 1907.
Modifications shown as new section 1907.1.1. This portion of the proposed revision is editorial, deleting slab-on-ground provisions from Section 1901.2 (shown above as deleted text) and moving the provisions to the more appropriate section, 1907. This places provisions for concrete slabs-on-ground in one section.

Modifications shown as new section 1907.1.2. This portion of the proposed revision is editorial and clarifies that thickness criteria are for concrete slabs-on-ground.

Modifications shown as new section 1907.1.3. This portion of the proposed revision is editorial and appropriately assigns provisions for vapor retarders to vapor retarders and not to slabs-on-ground.

ACI, a 501.C.3 professional society, encourages the approval of this code change proposal to improve the IBC by more clearly advising the user that these provisions are only applicable to slabs-on-ground and relocates slab-on-ground

provisions in one section.

Cost Impact: The code change proposal will not increase or decrease the cost of construction
No change to cost of design or consturciton, change places slab related crtieria in one section.

ACI IBC 19-11 Shotcrete

IBC: SECTION 1908, 1908.1, 1908.2, 1908.3, 1908.4, 1908.4.1, 1908.4.2, 1908.4.3, 1908.4.4, 1908.5, 1908.6, 1908.7, 1908.8, 1908.9, 1908.9.1, 1908.9.2, 1908.9.3, 1908.10, 1908.10.1, 1908.10.2, 1908.10.3

Proponent: Stephen Szoke, American Concrete Institute, representing American Concrete Institute (steve.szoke@concrete.org); Charles Hanskat, American Shotcrete Association, representing American Shotcrete Association (charles.hanskat@shotcrete.org); Scott Campbell, representing National Ready Mixed Concrete Association (scampbell@nrmca.org)

2018 International Building Code

SECTION 1908
SHOTCRETE

Revise as follows:

1908.1 General. Shotcrete ~~is mortar or concrete that is pneumatically projected at high velocity onto a surface. Except as specified in this section, shotcrete shall conform to the requirements of this chapter for plain or reinforced concrete.~~shall be designed and constructed in accordance with the requirements of ACI 318.

Delete without substitution:

~~**1908.2 Proportions and materials.** Shotcrete proportions shall be selected that allow suitable placement procedures using the delivery equipment selected and shall result in finished in-place hardened shotcrete meeting the strength requirements of this code.~~

~~**1908.3 Aggregate.** Coarse aggregate, if used, shall not exceed $^{3}/_{4}$ inch (19.1 mm).~~

~~**1908.4 Reinforcement.** Reinforcement used in shotcrete construction shall comply with the provisions of Sections 1908.4.1 through 1908.4.4.~~

~~**1908.4.1 Size.** The maximum size of reinforcement shall be No. 5 bars unless it is demonstrated by preconstruction tests that adequate encasement of larger bars will be achieved.~~

~~**1908.4.2 Clearance.** Where No. 5 or smaller bars are used, there shall be a minimum clearance between parallel reinforcement bars of $2^{1}/_{2}$ inches (64 mm). When bars larger than No. 5 are permitted, there shall be a minimum clearance between parallel bars equal to six diameters of the bars used. Where two curtains of steel are provided, the curtain nearer the nozzle shall have a minimum spacing equal to 12 bar diameters and the remaining curtain shall have a minimum spacing of six bar diameters.~~

> ~~**Exception:** Subject to the approval of the *building official*, required clearances shall be reduced where it is demonstrated by preconstruction tests that adequate encasement of the bars used in the design will be achieved.~~

~~**1908.4.3 Splices.** Lap splices of reinforcing bars shall utilize the noncontact lap splice method with a minimum clearance of 2 inches (51 mm) between bars. The use of contact lap splices necessary for support of the reinforcing is permitted where *approved* by the *building official*, based on satisfactory preconstruction tests that show that adequate encasement of the bars will be achieved, and provided that the splice is oriented so that a plane through the center of the spliced bars is perpendicular to the surface of the shotcrete.~~

~~**1908.4.4 Spirally tied columns.** Shotcrete shall not be applied to spirally tied columns.~~

~~**1908.5 Preconstruction tests.** Where preconstruction tests are required by Section 1908.4, a test panel shall be shot, cured, cored or sawn, examined and tested prior to commencement of the project. The sample panel shall be representative of the project and simulate job conditions as closely as possible. The panel thickness and reinforcing shall reproduce the thickest and most congested area specified in the structural design. It shall be shot at the same angle, using the same nozzleman and with the same concrete mix design that will be used on the project. The equipment used in preconstruction testing shall be the same equipment used in the work requiring such testing, unless substitute equipment is *approved* by the *building official*. Reports of preconstruction tests shall be submitted to the *building official* as specified in Section 1704.5.~~

~~**1908.6 Rebound.** Any rebound or accumulated loose aggregate shall be removed from the surfaces to be covered prior to placing the initial or any succeeding layers of shotcrete. Rebound shall not be used as aggregate.~~

~~**1908.7 Joints.** Except where permitted herein, unfinished work shall not be allowed to stand for more than 30 minutes~~

~~unless edges are sloped to a thin edge. For structural elements that will be under compression and for construction joints shown on the *approved construction documents*, square joints are permitted. Before placing additional material adjacent to previously applied work, sloping and square edges shall be cleaned and wetted.~~

~~**1908.8 Damage.** In-place shotcrete that exhibits sags, sloughs, segregation, honeycombing, sand pockets or other obvious defects shall be removed and replaced. Shotcrete above sags and sloughs shall be removed and replaced while still plastic.~~

~~**1908.9 Curing.** During the curing periods specified herein, shotcrete shall be maintained above 40°F (4°C) and in moist condition.~~

~~**1908.9.1 Initial curing.** Shotcrete shall be kept continuously moist for 24 hours after shotcreting is complete or shall be sealed with an *approved* curing compound.~~

~~**1908.9.2 Final curing.** Final curing shall continue for seven days after shotcreting, or for three days if high-early-strength cement is used, or until the specified strength is obtained. Final curing shall consist of the initial curing process or the shotcrete shall be covered with an *approved* moisture-retaining cover.~~

~~**1908.9.3 Natural curing.** Natural curing shall not be used in lieu of that specified in this section unless the relative humidity remains at or above 85 percent, and is authorized by the *registered design professional* and *approved* by the *building official*.~~

~~**1908.10 Strength tests.** Strength tests for shotcrete shall be made by an *approved agency* on specimens that are representative of the work and that have been water soaked for not fewer than 24 hours prior to testing. Where the maximum-size aggregate is larger than $^{3}/_{8}$ inch (9.5 mm), specimens shall consist of not less than three 3-inch-diameter (76 mm) cores or 3-inch (76 mm) cubes. Where the maximum-size aggregate is $^{3}/_{8}$ inch (9.5 mm) or smaller, specimens shall consist of not less than 2-inch-diameter (51 mm) cores or 2-inch (51 mm) cubes.~~

~~**1908.10.1 Sampling.** Specimens shall be taken from the in-place work or from test panels, and shall be taken not less than once each shift, but not less than one for each 50 cubic yards (38.2 m^3) of shotcrete.~~

~~**1908.10.2 Panel criteria.** Where the maximum-size aggregate is larger than $^{3}/_{8}$ inch (9.5 mm), the test panels shall have minimum dimensions of 18 inches by 18 inches (457 mm by 457 mm). Where the maximum-size aggregate is $^{3}/_{8}$ inch (9.5 mm) or smaller, the test panels shall have minimum dimensions of 12 inches by 12 inches (305 mm by 305 mm). Panels shall be shot in the same position as the work, during the course of the work and by the nozzlemen doing the work. The conditions under which the panels are cured shall be the same as the work.~~

~~**1908.10.3 Acceptance criteria.** The average compressive strength of three cores from the in-place work or a single test panel shall equal or exceed 0.85 f'_c with no single core less than 0.75 f'_c. The average compressive strength of three cubes taken from the in-place work or a single test panel shall equal or exceed f'_c with no individual cube less than 0.88 f'_c. To check accuracy, locations represented by erratic core or cube strengths shall be retested.~~

Reason Statement: The current criteria in the International Building Code (IBC) is based on American Concrete Institute (ACI) *Guide to Fiber-Reinforced Shotcrete* (ACI 506.1R). The guide was last updated in 2008 and much of the information in the current edition of the IBC is based on recommendations published in the 1998 edition of ACI 506.1R. The current criteria in the IBC is for the most part archaic and does not reflect shotcrete that is readily available today. Mandatory criteria for the design and construction of shotcrete is now integrated into ACI *Building Code Requirements for Structural Concrete and Commentary* (ACI 318). ACI 318 includes shotcrete along with plain and reinforced cast-in-place concrete and precast and prestressed concrete:
“4.2.1.1 Design properties of shotcrete shall conform to the requirements for concrete except as modified by specific provisions of the Code.”

The provisions unique to shotcrete as shown below under “Shotcrete provisions included in ACI 318,” demonstrating a fully comprehensive effort by ACI Committee 318 to integrate shotcrete into ACI 318 *Building Code Requirements for Structural Concrete.* These provisions are in addition to all exiting applicable provisions of ACI 318. Among the significant differences between the current language in the 2018 edition of the IBC and ACI 318 are:

1) New durability requirements added to Chapter 19

2) Criteria that allow for additional spacings of reinforcement to improve economy added to Chapter 25.

3) Additional criteria for reinforcement and splices to better assure life safety and desired performance added to Chapter 25.

4) Criteria for inspection and quality assurance specific to shotcrete added to ACI 318 Chapter 26.

With ACI 318 being the premier document for design and construction of structural concrete, this inclusion elevates the overall acceptance of shotcrete thereby providing owners, developers, and designers with increased confidence when using shotcrete. This in turn allows owners, developers and designers to more readily use the most economical concrete solutions for their projects. Inclusion in ACI 318 also provides all relevant design and construction criteria in mandatory language required for design and construction of shotcrete to assure an acceptable level of life safety and performance while more appropriately addressing current industry practice.

Further ACI 318 is referenced as applicable to plain and reinforced concrete in Section 1901.2: "Structural concrete shall be designed and constructed in accordance with the requirements of this chapter and ACI 318..." Since shotcrete may be a type of structural concrete, the removal of the criteria in the IBC, in addition to updating the requirements to current technology and practice, will help remove confusion and eliminate errors.

This code change proposal:

1) Replaces general language in Section 1908.1 and simply directs the user to ACI 318.

2) Removes archaic criteria from the IBC in favor of current criteria applicable to current shotcrete products, design, construction, and inspection as addressed in ACI 318.

3) Removes pointers for inspection from Table 1705.3 Required Special Inspections and Tests of Concrete Construction, as these pointers are no longer required where compliance is in accordance with ACI 318.

4) Adds ACI 318 as a reference to Section 1908 of the IBC.

As a not-for-profit professional society, ACI recommends approval of this code change proposal as submitted to reflect current products and design and construction practices for the benefit of the pubic and to improve design and construction flexibility and lower costs.

Shotcrete provisions included in ACI 318

Chapter 2 – Notation and Terminology

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.
shotcrete — mortar or 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.

Chapter 4 – Structural System Requirements

4.2—Materials

4.2.1.1 Design properties of shotcrete shall conform to the requirements for concrete except as modified by specific provisions of the Code.

Chapter 19—Concrete: Design and Durability Requirements

19.3.3.3 Wet-mix shotcrete subject to freezing-and-thawing Exposure Classes F1, F2, or F3 shall be air entrained. Dry-mix shotcrete subject to freezing-and thawing Exposure Class F3 shall be air entrained. Except as permitted in 19.3.3.6, air content shall conform to Table 19.3.3.3.

Table 19.3.3.3—Total air content for shotcrete exposed to cycles of freezing and thawing.

Mixture Type	Target air content, percent		

	F1	F2	F3
Wet-mix shotcrete, before placement	5.0	6.0	6.0
Dry-mix shotcrete (in place)	N/A	N/A	4.5

19.3.3.4 Wet-mix shotcrete shall be sampled in accordance with ASTM C172, and air content shall be measured in accordance with ASTM C231 or ASTM C173.

19.3.3.5 Dry-mix shotcrete shall be sampled and air content shall be measured as directed by the licensed design professional.

19.3.3.6 For f'_c exceeding 5000 psi, reduction of air content indicated in Tables 19.3.3.1 and 19.3.3.3 by 1.0 percentage point is permitted.

Chapter 25—Reinforcement Details

25.2—Minimum spacing of reinforcement

25.2.7 For parallel nonprestressed reinforcement in shotcrete members, the clear spacing shall be in accordance with (a) or (b):

(a) The clear spacing between bars shall be at least the greater of $\mathbf{6}\boldsymbol{d_b}$ and 2½ in.

(b) If two curtains of reinforcement are provided, the clear spacing between bars in the curtain nearer the nozzle shall be at least $\mathbf{12}\boldsymbol{d_b}$. The clear spacing between bars in the remaining curtain shall conform to (a).

25.2.7.1 It shall be permitted to use a clear spacing that does not meet 25.2.7(a) or 25.2.7(b) provided shotcrete mockup panels are used to demonstrate proper reinforcement encasement in accordance with (a) and (b):

(a) The shotcrete mockup panels shall be representative of the most complex reinforcement configurations to be encountered.

(b) The licensed design professional shall specify the shotcrete mock-up panel quantity, frequency of shooting per nozzleman and member type, and panel thickness to verify reinforcement encasement.

25.2.8 For prestressed strands in shotcrete members, minimum center-to-center spacing s shall satisfy 25.2.4, except as permitted in 25.2.6.

25.2.9 For prestressed wire in shotcrete members, minimum center-to-center spacing s shall satisfy the requirements for wire in 25.2.5, except as permitted in and 25.2.6.

25.2.10 For ties, hoops, and spiral reinforcement in columns to be placed with shotcrete, minimum clear spacing shall be 3 in.

25.2.10.1 It shall be permitted to use a clear spacing other than 3 in. provided shotcrete mockup panels are used to demonstrate proper encasement of the reinforcement in accordance with 25.2.7.1

25.5—Splices

25.5.1.6 Non-contact lap splices for reinforcement in shotcrete shall have clear spacing in accordance with (a) or (b):

(a) For No. 6 and smaller bars, the clear spacing between bars shall be at least the greater of $\mathbf{6}\boldsymbol{d_b}$ and 2½ in.

(b) For. No. 7 and larger bars, the clear spacing shall be established using a shotcrete mockup panel to demonstrate that the reinforcement is properly encased.

25.5.1.7 Contact lap splices for reinforcement in shotcrete shall be oriented with the plane of the spliced bars perpendicular to the surface of the shotcrete and approved by the licensed design professional based on a shotcrete mockup panel to demonstrate that the reinforcement is properly encased.

Chapter 26 – Construction Documents and Inspection

26.3—Member information

26.3.1 (b) Members to be constructed using shotcrete

26.3.2(a) Use of shotcrete for structural members not identified in the construction documents as required to be placed by shotcrete shall be permitted in accordance with the project contract documents.

26.4—Concrete materials and mixture requirements

26.4.1.2.1 Compliance requirements:

(c) For shotcrete, the aggregate gradation shall comply with ASTM C1436.

26.4.1.4 Admixtures

26.4.1.4.1 Compliance requirements:

(e) Admixtures used in shotcrete shall conform to ASTM C1141.

26.4.1.6 Packaged, pre-blended, dry, combined materials for shotcrete

26.4.1.6.1 Compliance requirements:

(a) Packaged, pre-blended, dry, combined materials for shotcrete shall conform to ASTM C1480.

26.4.2 Concrete mixture requirements

26.4.2.1 Design information:

(a)(17) For shotcrete, the nominal maximum size of coarse aggregate shall not exceed 1/2 in.

26.4.3 Proportioning of concrete mixtures

26.4.3.1 Compliance requirements:

(e) Shotcrete mixture proportions shall be established so that shotcrete satisfies (1) through (3):

(1) Can be placed without segregation and fully encase reinforcement.

(2) Meets durability requirements given in the construction documents.

(3) Conforms to strength test requirements for shotcrete.

26.4.4 Documentation of concrete mixture characteristics

26.4.4.1 Compliance requirements:

(d) Documentation of shotcrete mixture characteristics shall be submitted for review by the licensed design professional before the mixture is used and before making changes to mixtures already approved. Evidence of the ability of the proposed shotcrete mixture to comply with the concrete mixture requirements in the construction documents shall be included in the documentation.

26.5.2 Concrete placement and consolidation

26.5.2.1 Compliance requirements:

(j) Prior to placement of a new layer of shotcrete, rebound and overspray from adjacent placements shall be removed.

(k) Cuttings and rebound shall not be incorporated into the Work.

(l) Shotcrete surfaces intended to receive subsequent shotcrete placement shall be roughened to a full amplitude of

approximately ¼-in. before the shotcrete has reached final set.

(m) Before placing additional material onto hardened shotcrete, laitance shall be removed, joints shall be cleaned, and the surface dampened.

(n) In-place fresh shotcrete that exhibits sags, sloughs, segregation, honeycombing, or sand pockets shall be removed and replaced.

(o) A certified shotcrete nozzle operator shall place all shotcrete.

(p) If a project-specific shotcrete mockup panel is required, each nozzle operator shall have demonstrated the ability to shoot an approved shotcrete mockup panel.

26.5.3 Curing

26.5.3.2 Compliance requirements:

(f) Shotcrete shall be cured in accordance with (1) through (3).

1. For 24 hours from completion of placement, initial curing shall be provided by one of the following methods:

i. Ponding, fogging, or continuous sprinkling;

ii. Absorptive mat, fabric, or other protective covering kept continuously moist;

iii. Application of a membrane-forming curing compound.

2. After 24 hours from completion of placement, final curing shall be provided by one of the following methods:

i. Same method used in the initial curing process;

ii. Sheet materials;

iii. Other moisture-retaining covers kept continuously moist.

3. Final curing shall be maintained for a minimum duration of not less than the following:

i. 7 days,

ii. 3 days if high-early-strength cement or an accelerating admixture is used.

26.5.6 Construction, contraction, and isolation joints

26.5.6.1 Design information:

26.5.6.1(f) For shotcrete, location of construction joints for which square joints are permitted.

26.5.6.2 Compliance information:

26.5.6.2 (g) For shotcrete, construction joint surfaces shall be cut at a 45-degree angle to the finished surface, unless a square joint is designated in the construction documents.

26.5.6.2(h) For shotcrete, construction joints proposed at locations not shown on the construction documents shall be submitted to the licensed design professional for approval prior to shotcrete placement.

26.12—Concrete evaluation and acceptance

26.12.1 General

26.12.1.1 Compliance requirements:

(b) For shotcrete, a strength test shall be the average strengths of at least three 3-in. diameter cores taken from a test panel prepared in accordance with ASTM C1140 and tested at 28 days from time of placement or at test age designated for f'_c.

26.12.2 Frequency of testing

26.12.2.1 Compliance requirements:

(d) For shotcrete, prepare a shotcrete test panel for each mixture and each nozzle operator at least once per day or for every 50 yd^3 placed, whichever results in the greater number of panels

26.12.4 Acceptance for shotcrete

26.12.4.1 Compliance requirements:

(a) Specimens for acceptance tests shall be in accordance with (1) and (2):

(1) Test panels shall be prepared in the same orientation and by the same nozzle operator placing shotcrete.

(2) Cores shall be obtained, conditioned, and tested in accordance with ASTM C1604.

(b) Strength level of a shotcrete mixture shall be acceptable if (1) and (2) are satisfied:

(1) Every arithmetic average of the strengths from three consecutive test panels equals or exceeds f'_c.

(2) The average compressive strength of three cores from a single test panel is not less than 0.85 f'_c with no core having a strength less than 0.75 f'_c.

(c) If either of the requirements of 26.12.4.1(b) are not satisfied, steps shall be taken to increase the average of subsequent strength results.

(d) Requirements for investigating low strength-test results shall apply if the requirements of 26.12.4.1(b)(2) are not met.

Table 1 - Comparison of 2018 IBC and ACI 318 Provisions

2018 IBC Provisions	***ACI 318-19 Provisions***
	Chapter 2 – Notation and Terminology **shotcrete** — mortar or 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.
1908.2 Proportions and materials. Shotcrete proportions shall be selected that allow suitable placement procedures using the delivery equipment selected and shall result in finished in-place hardened shotcrete meeting the strength requirements of this code.	**Chapter 4 – Structural System Requirements** 4.2—Materials 4.2.1.1 Design properties of shotcrete shall conform to the requirements for concrete except as modified by specific provisions of the Code.
	26.4.3 Proportioning of concrete mixtures 26.4.3.1 Compliance requirements:

	(e) Shotcrete mixture proportions shall be established so that shotcrete satisfies (1) through (3): (1) Can be placed without segregation and fully encase reinforcement. (2) Meets durability requirements given in the construction documents. (3) Conforms to strength test requirements for shotcrete. 26.4.4.1 Compliance requirements: (d) Documentation of shotcrete mixture characteristics shall be submitted for review by the licensed design professional before the mixture is used and before making changes to mixtures already approved ~~in use~~. Evidence of the ability of the proposed shotcrete mixture to comply with the concrete mixture requirements in the construction documents shall be included in the documentation.
Comment: ACI 318-19 addresses durability in addition to strength and placement.	
1908.3 Aggregate. Coarse aggregate, if used, shall not exceed 3/4 inch (19.1 mm).	26.4.2 Concrete mixture requirements 26.4.2.1 Design information: (a)(17) For shotcrete, the nominal maximum size of coarse aggregate shall not exceed 1/2 in.
Comment: The ACI 318-19 provisions more appropriately limit the maximum aggregate size for shotcrete to ½ inch in lieu of ¾ inch as allowed in the IBC.	
1908.4 Reinforcement. Reinforcement used in shotcrete construction shall comply with the provisions of Sections 1908.4.1 through 1908.4.4. 1908.4.1 Size. The maximum size of reinforcement shall be No. 5 bars unless it is demonstrated by preconstruction tests that adequate encasement of larger bars will be achieved.	**Chapter 25—Reinforcement Details** 25.2—Minimum spacing of reinforcement 25.2.7 For parallel nonprestressed reinforcement in shotcrete members, the clear spacing shall be in accordance with (a) or (b): (a) The clear spacing between bars shall be at least the greater of $\mathbf{6}\boldsymbol{d_b}$ and 2½ in. (b) If two curtains of reinforcement are provided, the clear spacing between bars in the curtain nearer the nozzle shall be at least $\mathbf{12}\boldsymbol{d_b}$. The clear spacing between bars in the remaining curtain shall conform to (a). 25.2.7.1 It shall be permitted to use a clear spacing that does not meet 25.2.7(a) or 25.2.7(b) provided shotcrete mockup panels are used to demonstrate proper reinforcement encasement in accordance with (a) and (b): (a) The shotcrete mockup panels shall be representative of the most complex reinforcement configurations to be encountered.

	(b) The licensed design professional shall specify the shotcrete mock-up panel quantity, frequency of shooting per nozzleman and member type, and panel thickness to verify reinforcement encasement.
Comment: To reflect current state-of-the art, minimum bar sizes are No. 6 in ACI 318-19.	
	25.2.8 For prestressed strands in shotcrete members, minimum center-to-center spacing s shall satisfy 25.2.4, except as permitted in 25.2.6. 25.2.9 For prestressed wire in shotcrete members, minimum center-to-center spacing s shall satisfy the requirements for wire in 25.2.5, except as permitted in and 25.2.6.
Comment: ACI 318-19 appropriately addresses prestressing strand and wire use in shotcrete members.	
1908.5 Preconstruction tests. Where preconstruction tests are required by Section 1908.4, a test panel shall be shot, cured, cored or sawn, examined and tested prior to commencement of the project. The sample panel shall be representative of the project and simulate job conditions as closely as possible. The panel thickness and reinforcing shall reproduce the thickest and most congested area specified in the structural design.	**panel, shotcrete test**—a shotcrete specimen prepared in accordance with ASTM C1140 for evaluation of shotcrete. **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. 26.5.2 Concrete placement and consolidation 26.5.2.1 Compliance requirements: (o) A certified shotcrete nozzle operator shall place all shotcrete. (p) If a project-specific shotcrete mockup panel is required, each nozzle operator shall have demonstrated the ability to shoot an approved shotcrete mockup panel.
Comment: ACI 318-19 uses the current terminology of mockup panel versus sample panel. ACI 318-19 has clear language addressing size and detailing of reinforcement.	
	26.12—Concrete evaluation and acceptance 26.12.1 General 26.12.1.1 Compliance requirements: (b) For shotcrete, a strength test shall be the average strength~~s~~ of at least three 3-in. diameter cores taken from a test panel prepared in accordance with ASTM C1140 and tested at 28 days from time of placement or at test age designated for f'_c.
Comment: ACI 318-19 has specific requirements for sampling and testing cores	
It shall be shot at the same angle, using the same nozzleman and with the same concrete mix design that will be used on the project. The equipment used in preconstruction testing shall be the same equipment used in the work requiring such testing, unless substitute equipment is approved by the building official.	26.12.4.1 Compliance requirements: (a) Specimens for acceptance tests shall be in accordance with (1) and (2): (1) Test panels shall be prepared in the same orientation and by the same nozzle operator placing shotcrete.

	(2) Cores shall be obtained, conditioned, and tested in accordance with ASTM C1604.
Comment: ACI 318-19 adds requirements for placement of shotcrete to be performed by the same nozzle operator doing the work.	
Reports of preconstruction tests shall be submitted to the building official as specified in Section 1704.5.	
Comment: ACI 318-18 contains more specific requirements including but not limited to frequency of tests.	
1908.4.2 Clearance. Where No. 5 or smaller bars are used, there shall be a minimum clearance between parallel reinforcement bars of 21/2 inches (64 mm). When bars larger than No. 5 are permitted, there shall be a minimum clearance between parallel bars equal to six diameters of the bars used. Where two curtains of steel are provided, the curtain nearer the nozzle shall have a minimum spacing equal to 12 bar diameters and the remaining curtain shall have a minimum spacing of six bar diameters **Exception**: Subject to the approval of the building official, required clearances shall be reduced where it is demonstrated by preconstruction tests that adequate encasement of the bars used in the design will be achieved.	25.2.10 For ties, hoops, and spiral reinforcement in columns to be placed with shotcrete, minimum clear spacing shall be 3 in. 25.2.10.1 It shall be permitted to use a clear spacing other than 3 in. provided shotcrete mockup panels are used to demonstrate proper encasement of the reinforcement in accordance with 25.2.7.1
1908.4.3 Splices. Lap splices of reinforcing bars shall utilize the noncontact lap splice method with a minimum clearance of 2 inches (51 mm) between bars. The use of contact lap splices necessary for support of the reinforcing is permitted where approved by the building official, based on satisfactory preconstruction tests that show that adequate encasement of the bars will be achieved, and provided that the splice is oriented so that a plane through the center of the spliced bars is perpendicular to the surface of the shotcrete.	25.5—Splices 25.5.1.6 Non-contact lap splices for reinforcement in shotcrete shall have a clear spacing in accordance with (a) or (b): (a) For No. 6 and smaller bars, the clear spacing between bars shall be at least the greater of $\mathbf{6}\boldsymbol{d_b}$ and 2½ in. (b) For. No. 7 and larger bars, the clear spacing shall be established using a shotcrete mockup panel to demonstrate that the reinforcement is properly encased. 25.5.1.7 Contact lap splices for reinforcement in shotcrete shall be oriented with the plane of the spliced bars perpendicular to the surface of the shotcrete and approved by the licensed design professional based on a shotcrete mockup panel to demonstrate that the reinforcement is properly encased.
1908.4.4 Spirally tied columns. Shotcrete shall not be applied to spirally tied columns.	25.2.10 For ties, hoops, and spiral reinforcement in columns to be placed with shotcrete, minimum clear spacing shall be 3 in. 25.2.10.1 It shall be permitted to use a clear spacing other than 3 in. provided shotcrete mockup panels are used to demonstrate proper encasement of the reinforcement in accordance with 25.2.7.1
	Chapter 19—Concrete: Design and Durability Requirements 19.3.3.4 Wet-mix shotcrete shall be sampled in accordance with ASTM C172, and air content shall be measured in accordance with ASTM C231 or ASTM C173.

	19.3.3.5 Dry-mix shotcrete shall be sampled and air content shall be measured as directed by the licensed design professional.
Comment: ACI 318-19 includes specific requirements for sampling wet-mix and dry-mix shotcrete	
	19.3.3.6 For f'c exceeding 5000 psi, reduction of air content indicated in Tables 19.3.3.1 and 19.3.3.3 by 1.0 percentage point is permitted.
Comment: ACI 318-19 reflects the durability and performance of higher strength concrete by relaxing the requirements for air content.	
1908.6 Rebound. Any rebound or accumulated loose aggregate shall be removed from the surfaces to be covered prior to placing the initial or any succeeding layers of shotcrete. Rebound shall not be used as aggregate.	26.5.2 Concrete placement and consolidation 26.5.2.1 Compliance requirements: (j) Prior to placement of a new layer of shotcrete, rebound and overspray from adjacent placements shall be removed. (k) Cuttings and rebound shall not be incorporated into the Work.
Comment: ACI 318-19 clearly address overspray, rebound and cuttings.	
	26.5.2 Concrete placement and consolidation 26.5.2.1 Compliance requirements: (l) Shotcrete surfaces intended to receive subsequent shotcrete placement shall be roughened to a full amplitude of approximately ¼-in. before the shotcrete has reached final set.
Comment: ACI 318-19 includes requirements for placement of subsequent concrete not addressed in the 2018 IBC.	
1908.7 Joints. Except where permitted herein, unfinished work shall not be allowed to stand for more than 30 minutes unless edges are sloped to a thin edge. For structural elements that will be under compression and for construction joints shown on the approved construction documents, square joints are permitted. Before placing additional material adjacent to previously applied work, sloping and square edges shall be cleaned and wetted.	26.5.6 Construction, contraction, and isolation joints 26.5.6.1 Design information: 26.5.6.1(f) For shotcrete, location of construction joints for which square joints are permitted. 26.5.6.2 Compliance information: 26.5.6.2 (g) For shotcrete, construction joint surfaces shall be cut at a 45-degree angle to the finished surface, unless a square joint is designated in the construction documents. 26.5.6.2(h) For shotcrete, construction joints proposed at locations not shown on the construction documents shall be submitted to the licensed design professional for approval prior to shotcrete placement.
1908.7 Joints. Except where permitted herein, unfinished work shall not be allowed to stand for more than 30 minutes unless edges are sloped to a thin edge. For structural elements that will be under compression and for construction joints shown on the approved construction documents, square joints are permitted. Before placing additional material adjacent to previously applied work, sloping and square edges shall be cleaned and wetted.	26.5.2 Concrete placement and consolidation 26.5.2.1 Compliance requirements: (m) Before placing additional material onto hardened shotcrete, laitance shall be removed, joints shall be cleaned, and the surface dampened.
1908.8 Damage. In-place shotcrete that exhibits sags, sloughs, segregation, honeycombing, sand pockets or other obvious defects shall be removed and replaced. Shotcrete above sags and sloughs	26.5.2 Concrete placement and consolidation 26.5.2.1 Compliance requirements:

shall be removed and replaced while still plastic.	(n) In-place fresh shotcrete that exhibits sags, sloughs, segregation, honeycombing, or sand pockets shall be removed and replaced.
1908.9 Curing. During the curing periods specified herein, shotcrete shall be maintained above 40°F (4°C) and in moist condition.	
Comment: This requirement in ACI 318-19 is applicable to all concrete and not specifically called out for shotcrete.	
1908.9.1 Initial curing. Shotcrete shall be kept continuously moist for 24 hours after shotcreting is complete or shall be sealed with an approved curing compound.	26.5.3 Curing concrete and shotcrete 26.5.3.2 Compliance requirements: (f) Shotcrete shall be cured in accordance with (1) through (3). 1. For 24 hours from completion of placement, initial curing shall be provided by one of the following methods: i. Ponding, fogging, or continuous sprinkling; ii. Absorptive mat, fabric, or other protective covering kept continuously moist; iii. Application of a membrane-forming curing compound. 2. After 24 hours from completion of placement, final curing shall be provided by one of the following methods: i. Same method used in the initial curing process; ii. Sheet materials; iii. Other moisture-retaining covers kept continuously moist.
Comment: ACI 318-19 reflects specific requirements addressed in the appropriate ASTM product specifications for shotcrete.	
1908.9.2 Final curing. Final curing shall continue for seven days after shotcreting, or for three days if high early-strength cement is used, or until the specified strength is obtained. Final curing shall consist of the initial curing process or the shotcrete shall be covered with an approved moisture-retaining cover.	26.5.3 Curing concrete and shotcrete 26.5.3.2 Compliance requirements: 3. Final curing shall be maintained for a minimum duration of not less than the following: i. 7 days, ii. 3 days if high-early-strength cement or an accelerating admixture is used.
Comment: ACI 318-19 provides time-period for curing but appropriately defers to the ASTM specifications for methods.	
1908.9.3 Natural curing. Natural curing shall not be used in lieu of that specified in this section unless the relative humidity remains at or above 85 percent, and is authorized by the registered design professional and approved by the building official.	
Comment: ACI 318-19 appropriately defers curing methods as provided in the applicable ASTM product specifications.	
1908.10 Strength tests. Strength tests for shotcrete shall be made by an approved agency on specimens that are representative of the work and that have been water soaked for not fewer than 24	Cores shall be obtained, conditioned, and tested in accordance with ASTM C1604

hours prior to testing. Where the maximum size aggregate is larger than 3/8 inch (9.5 mm), specimens shall consist of not less than three 3-inch-diameter (76 mm) cores or 3-inch (76 mm) cubes. Where the maximum-size aggregate is 3/8 inch (9.5 mm) or smaller, specimens shall consist of not less than 2-inch-diameter (51 mm) cores or 2-inch (51 mm) cubes.	26.12.4 Acceptance for shotcrete 26.12.4.1 Compliance requirements: (a) Specimens for acceptance tests shall be in accordance with (1) and (2): (1) Test panels shall be prepared in the same orientation and by the same nozzle operator placing shotcrete. (2) Cores shall be obtained, conditioned, and tested in accordance with ASTM C1604. (b) Strength level of a shotcrete mixture shall be acceptable if (1) and (2) are satisfied: (1) Every arithmetic average of the strengths from three consecutive test panels equals or exceeds f'_c. (2) The average compressive strength of three cores from a single test panel is not less than 0.85 f'_c with no core having a strength less than 0.75 f'_c. (c) If either of the requirements of 26.12.4.1(b) are not satisfied, steps shall be taken to increase the average of subsequent strength results. (d) Requirements for investigating low strength-test results shall apply if the requirements of 26.12.4.1(b)(2) are not met. 19.3.3.3 Wet-mix shotcrete subject to freezing-and-thawing Exposure Classes F1, F2, or F3 shall be air entrained. Dry-mix shotcrete subject to freezing-and thawing Exposure Class F3 shall be air entrained. Except as permitted in 19.3.3.6, air content shall conform to Table 19.3.3.3
Comment: ACI 318-19 appropriately references ASTM C1604 Obtaining and Testing Drilled Cores of Shotcrete for sampling and testing shotcrete cores.	
1908.10.1 Sampling. Specimens shall be taken from the in-place work or from test panels, and shall be taken not less than once each shift, but not less than one for each 50 cubic yards (38.2 m3) of shotcrete.	26.12.2 Frequency of testing 26.12.2.1 Compliance requirements: (d) For shotcrete, prepare a shotcrete test panel for each mixture and each nozzle operator at least once per day or for every 50 yd^3 placed, whichever results in the greater number of panels
1908.10.2 Panel criteria. Where the maximum-size aggregate is larger than 3/8 inch (9.5 mm), the test panels shall have minimum dimensions of 18 inches by 18 inches (457 mm by 457 mm). Where the maximum-size aggregate is 3/8 inch (9.5 mm) or smaller, the test panels shall have minimum dimensions of 12 inches by 12 inches (305 mm by 305 mm).	
Comment: ACI 318-19 appropriately references ASTM C1140 Standard Practice for Preparing and Testing Specimens from Shotcrete Test Panel.	
Panels shall be shot in the same position as the work, during the course of the work and by the nozzlemen doing the work	26.12.4.1 Compliance requirements:

	(a) Specimens for acceptance tests shall be in accordance with (1) and (2): (1) Test panels shall be prepared in the same orientation and by the same nozzle operator placing shotcrete.
The conditions under which the panels are cured shall be the same as the work.	
Comment: ACI 318-19 appropriately references ASTM C1140 Standard Practice for Preparing and Testing Specimens from Shotcrete Test Panel.	
1908.10.3 Acceptance criteria. The average compressive strength of three cores from the in-place work or a single test panel shall equal or exceed 0.85 f'_c with no single core less than 0.75 f'_c. The average compressive strength of three cubes taken from the in-place work or a single test panel shall equal or exceed f'_c with no individual cube less than 0.88 f'_c. To check accuracy, locations represented by erratic core or cube strengths shall be retested.	26.12.1 General 26.12.1.1 Compliance requirements: (b) For shotcrete, a strength test shall be the average strength~~s~~ of at least three 3-in. diameter cores taken from a test panel prepared in accordance with ASTM C1140 and tested at 28 days from time of placement or at test age designated for f'_c. 26.12.4 Acceptance for shotcrete 26.12.4.1 Compliance requirements: (a) Specimens for acceptance tests shall be in accordance with (1) and (2): (1) Test panels shall be prepared in the same orientation and by the same nozzle operator placing shotcrete. (2) Cores shall be obtained, conditioned, and tested in accordance with ASTM C1604. (b) Strength level of a shotcrete mixture shall be acceptable if (1) and (2) are satisfied: (1) Every arithmetic average of the strengths from three consecutive test panels equals or exceeds f'_c. (2) The average compressive strength of three cores from a single test panel is not less than 0.85 f'_c with no core having a strength less than 0.75 f'_c. (c) If either of the requirements of 26.12.4.1(b) are not satisfied, steps shall be taken to increase the average of subsequent strength results. (d) Requirements for investigating low strength-test results shall apply if the requirements of 26.12.4.1(b)(2) are not met. 19.3.3.3 Wet-mix shotcrete subject to freezing-and-thawing Exposure Classes F1, F2, or F3 shall be air entrained. Dry-mix shotcrete subject to freezing-and thawing Exposure Class F3 shall be air entrained. Except as permitted in 19.3.3.6, air content shall conform to Table 19.3.3.3.

Comment: ACI 318-19 provides general requirements and appropriately references ASTM C1140 Standard Practice for Preparing and Testing Specimens from Shotcrete Test Panel	
	Chapter 26 – Construction Documents and Inspection 26.3—Member information 26.3.1 (b) Members to be constructed using shotcrete 26.3.2(a) Use of shotcrete for structural members not identified in the construction documents as required to be placed by shotcrete shall be permitted in accordance with the project contract documents.
	26.4—Concrete materials and mixture requirements 26.4.1.2.1 Compliance requirements: (~~c~~e) For shotcrete, the aggregate gradation shall comply with ASTM C1436. 26.4.1.4 Admixtures 26.4.1.4.1 Compliance requirements: (e) Admixtures used in shotcrete shall conform to ASTM C1141. 26.4.1.6 Packaged, pre-blended, dry, combined materials for shotcrete 26.4.1.6.1 Compliance requirements: (a) Packaged, pre-blended, dry, combined materials for shotcrete shall conform to ASTM C1480. (d) Documentation of shotcrete mixture characteristics shall be submitted for review by the licensed design professional before the mixture is used and before making changes to mixtures already in use. Evidence of the ability of the proposed shotcrete mixture to comply with the concrete mixture requirements in the construction documents shall be included in the documentation.
Comment: ACI 318-19 includes material and mixture requirements not addressed in the 2018 IBC.	

Cost Impact: The code change proposal will not increase or decrease the cost of construction
No increase to initial cost of construction. This change removes antiquated criteria for the International Building Code (IBC) and simply refers to updated, but comparable, criteria in American Concrete Institute Building Code Requirements for Structural Concrete and Commentary (ACI 318). The provisions of ACI 318 are more inclusive of design and construction methods conditions and provide increase flexibility for designers and contractors. In many instances this increased flexibility has the potential to reduce costs.

ACI IBC 35-01 ACI 318-19

IBC: ACI Chapter 35

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2018 International Building Code

ACI

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~~318—14~~318—19: Building Code Requirements for Structural Concrete

722.2.4.3, 1604.3.2, 1616.2.1, 1616.3.1, 1704.5, Table 1705.3, 1705.3.2, 1808.8.2, Table 1808.8.2, 1808.8.5, 1808.8.6, 1810.1.3, 1810.2.4.1, 1810.3.2.1.1, 1810.3.2.1.2, 1810.3.8.3.1, 1810.3.8.3.3, 1810.3.9.4.2.1, 1810.3.9.4.2.2, 1810.3.10.1, 1810.3.11.1, 1810.3.12, 1901.2, 1901.3, 1902.1, 1903.1, 1904.1, 1904.2, 1905.1, 1905.1.1, 1905.1.2, 1905.1.3, 1905.1.4, 1905.1.5, 1905.1.6, 1905.1.7, 1905.1.8, 1906.1, 2108.3, 2206.1

Reason Statement: There is no cost imapct as this change updates the IBC to reference the current editon of ACI 318. The ACI 318-19 Public Discussion Draft is available at: https://www.concrete.org/publications/standards/upcomingstandards.aspx. The License Key is: concrete

Cost Impact: The code change proposal will not increase or decrease the cost of construction
There is no cos timpact, this change updates the IBC to reference the current editon of ACI 318.

ACI IEBC 03-01/01 Add 562

IEBC: 303.4 (New); IBC: ACI Chapter 35 (New)

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2018 International Existing Building Code

Add new text as follows:

303.4 Concrete evaluation and design procedures. Evaluation and design of repairs of structural concrete in compliance with ACI 562 and this code shall be permitted.

Exception 1. ACI 562 shall not be used to comply with provisions of this code that involve the classification of earthquake

damage or the evaluation or retrofit of structures using load combinations that include earthquake load effects.

Exception 2. The following Sections of ACI 562 are not adopted:

1.3.8 for seismic resistance

4.1.4 for determining the rehabilitation category of work

4.7 for additions

4.8 for alterations

4.9 for change in occupancy

2018 International Building Code

Add new standard(s) follows:

ACI

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562-19: Code Requirements for Assessment, Repair, and Rehabilitation of Existing Concrete Structures

Reason Statement: Concept – This code change proposal adds ACI 562: *Code Requirements for Assessment, Repair, and Rehabilitation of Existing Concrete Structures*, to establish minimum requirements for the design, construction, repair, and rehabilitation of concrete structural elements in buildings for various levels of desired performance as deemed appropriate for the project. In addition to improved life safety, the requirements clearly define objectives and anticipated performance for the code official, owners, designers, contractors and installers. The proposed language is permissive, allowing other methods to be used to comply with the intent of the building code. Further Section 104.11 of the IEBC allows for alternative design methods:
"104.11Alternative materials, design and methods of construction, and equipment. The provisions of this code are not intended to prevent the installation of any material or to prohibit any design or method of construction not specifically prescribed by this code, provided that any such alternative has been approved. An alternative material, design, or method of construction shall be approved where the code official finds that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method, or work offered is, for the purpose intended, not less than the equivalent of that prescribed in this code in quality, strength, effectiveness, fire resistance, durability and safety. Where the alternative material, design or method of construction is not approved, the code official shall respond in writing, stating the reasons why the alternative was not approved."

The pulbic discussion version of this standards is available at:
www.concrete.org/publications/standards/upcomingstandards.aspx

Background – In 2006, the repair industry approached ACI asking for a concrete repair and rehabilitation code that would improve the overall quality of concrete repairs by establishing common requirements and establishing clear responsibilities between owners, designers, and contractors. This code would also provide building code officials with a reference by which to evaluate rehabilitated concrete structures. ACI, following its rigorous American National Standards Institute accredited standards development process assembled a code committee with balanced representation and produced the first official code in 2012. The committee members reviewed and considered numerous reports and publications related to concrete repair and rehabilitation to identify and develop requirements consistent with current industry practice. The committee has received feedback from users of the code and are now completing their third version of this code, ACI 562-19.

Scope – ACI 562-19 complements the IEBC by providing specific direction on how to design concrete repairs and how to handle the unique construction problems associated with repair. This standard helps the designer assess the existing structure in accordance with the IEBC. The standard then provides the requirements that bridge the inconsistencies and gaps in acceptable criteria that occur from the two following situations that a designer must solve: one, repairing a structure according to the original building code used at the time it was built using today's construction methods and materials; or, repairing a structure built according to an older building code but repaired according to the latest building code. Note that ACI 562 does not directly address the evaluation of lateral-force resisting systems in high seismic areas. ASCE 41 is the appropriate standard for this situation as stated in the IEBC and ACI 562.

Benefits – There are many benefits that ACI 562 provides for the designer, owner, contractor, materials providers,

building code official and the public. A few of these benefits are:

- Provides a level of expectation of life safety to the public in buildings where repairs or rehabilitation is performed on concrete structural elements.
- Provides clearly defined, uniform requirements aimed at extending the service life of existing structures.
- Provides minimum requirements for safety and quality of concrete repair.
- Establishes clear responsibilities between owners, designers, and contractors.
- Provides building code officials with a means to evaluate rehabilitation designs.
- Provides specific repair requirements that often result in less costly repairs compared to repairs required to meet only new construction requirements.

Flexibility – ACI 562 permits flexibility in evaluation, design, construction and repair materials to provide economies while establishing expected performance for the service-life of the rehabilitation or repairs.

Resources – Also, there many resources that complement ACI 562. Among these are:

- *Concrete Repair Manual: Fourth Edition 2013*
- ACI 563-18, *Specifications for Repair of Structural Concrete in Buildings*
- MNL-3(16) *Guide to the Code for Assessment, Repair, and Rehabilitation of Existing Concrete Structures*

These resources are readily available to provide greater understanding of assessment, repair and rehabilitation of concrete structural elements. ACI MNL-3 provides case studies demonstrating the ease of use of ACI 562. Numerous technical notes, reports, guides, and specifications that provide background information and technical support are available through other organizations, such as American Society of Civil Engineers, British Research Establishment, Concrete Society, International Concrete Repair Institute, National Association of Corrosion Engineers, Post-Tensioning Institute, Society for Protective Coatings, and US Army Corps of Engineers. Many of these organizations publications related to concrete repair can be found in the Concrete Repair Manual.

Sustainability - Reference of ACI 562 in the IEBC will help improve the confidence of owners, builders, and developers regarding effective repairs, upgrades, and reuse of existing buildings in lieu of demolition and replacement. Typically, extending the life of existing buildings is substantially more sustainable than demolition and new construction. Adoption of ACI 562 by reference is needed to help facilitate efforts that conserve energy and resources while maintaining a minimum level of requirements to ensure reasonable levels of life safety, and welfare are afforded to the public.

State and Local Adoptions – Jurisdictions see the need for these requirements. As the model for state and local adoptions, the IEBC should include this reference with appropriate charging language. ACI 562 is already being used in several jurisdictions:

Hawaii: Hawaii was the first state to adopt ACI 562 by reference. The following provisions are included in the State Building Code Council HAWAII STATE BUILDING CODE, which became effective on November 13, 2018:

“3401.6 Alternative compliance.

1) Work performed in accordance with the International Existing Building Code shall be deemed to comply with the provisions of this chapter.

2) Work performed in accordance with the 2016 version of the American Concrete Institute Committee 562, “Code Requirements for Assessment, Repair, and Rehabilitation of Existing Concrete Structures” shall be deemed to comply with this chapter when used as a supplement to the requirements of this chapter or the International Existing Building Code. Wherever the term International Existing Building Code (IEBC) is used in ACI 562-16, it shall mean International Existing Building Code or Chapter 34 of the International Building Code.”

Ohio: The Ohio Board of Building Standards Ohio adopted rule changes identified as Amendments Group 95. Included in this group is:

3401.6 Concrete evaluation and design procedures. Evaluation and design of structural concrete repairs and rehabilitation shall be in compliance with Chapter 34 and ACI 562.

ACI, a professional technical society, has developed this standard in response to industry needs and to help assure minimum levels of life safety results where repairs and rehabilitation are associated with concrete structural elements. For this reason and the other benefits identified in this reason statement, ACI recommends this code change proposal for

committee approval as submitted.

New York City: The New York City Buildings Department issued *BUILDINGS BULLETIN 2015-017* in December 2017 Conditions of Acceptance for Fiber Reinforced Cementitious Matrix strengthening systems.

FRCM shall comply with the NYC Construction Codes and the following applicable provisions:

A. Design

1. FRCM system shall be designed in accordance with the ACI 549.4R-132 Guide for the Design and Construction of Externally Bonded Fabric-Reinforced Cementitious Matrix (FRCM) Systems for Repair and Strengthening Concrete and Masonry Structures with properties used for design obtained from tests performed in accordance with AC 434. Fire-resistance-rating and interior finish requirements shall be in accordance with the NYC Construction Codes, manufacturer's recommendations and the conditions of the required listing.

2. For repairs and upgrade achieved with unprotected external FRCM, the increase in flexural or shear strength provided by the external reinforcing system shall not exceed 50% of the existing structural capacity of the member prior to strengthening. This increase should be checked before applying the strength reduction factor.

3. Careful consideration should be given to determine reasonable strengthening limits. These limits are imposed to guard against collapse of the structure should bond or other failure of the FRCM system occur due to damage, vandalism, or other causes. The required strength of a structure without repair should be as specified in in accordance with ACI 562 *Code Requirements for Assessment, Repair, and Rehabilitation of Existing Concrete Structures* Section 5.5.

Recommendation – ACI, a professional technical society, has developed this ACI 562 in response to industry needs and to help assure minimum levels of life safety, health, and welfare for the public. For this reason and the other benefits identified in this reason statement, ACI recommends this code change proposal for committee approval as submitted.

Bibliography: Concrete Repair Manual - 4th Edition: 2-Volume Set, ACI and ICRI, 2013, 2093 pp.
https://www.concrete.org/store/productdetail.aspx?ItemID=RPMN13PACK&Format=HARD_COPY

Guide to the Code for Assessment, Repair, and Rehabilitation of Existing Concrete Buildings, ACI and ICRI, 2016, 176 pp.

https://www.concrete.org/store/productdetail.aspx?ItemID=MNL316&Language=English

Cost Impact: The code change proposal will not increase or decrease the cost of construction
The use of this referenced standard should in many cases reduce the cost of repair. Too often in the process of repair, there is insufficient information to determine acceptance criteria that is amicable to both the owner and the building code official. The result is the determination that the repair must meet the latest building code requirements for new construction. This standard increases the options available for repair and provides the acceptance criteria necessary to permit these options. A case study that illustrates this point: "ACI 562 has been referenced in expert reports for litigation cases, resulting in significantly reduced financial settlements. Denver-based J. R. Harris & Company recently used the code as a standard in several litigation reports assessing damages in existing concrete structures. As an approved consensus standard, according to American National Standards Institute (ANSI) procedures, ACI 562-13 has been accepted as the source standard to use for damage assessment and repair on individual projects by Greenwood Village and Pikes Peak Regional Building Departments in Colorado. Based on this acceptance, the consulting engineer was able to cite the code in their recommendation for structural remediation and determination of damages. In one case involving rehabilitation work on four buildings with faulty construction, J.R. Harris was able to reduce the repair costs from $12 million to $3 million, with a repair plan based on the lesser of the demand-capacity ratio based on either the original or current building code per ACI 562."