American Concrete Institute

2022 Draft Group B Proposals

for

International Code Council model codes

I.D.	Code	Section/Title
ACI 01	IRC	Appendix AW 3-D Printed Building Construction Concept: Excludes Concrete from 3-D Printed Building Construction requirements
ACI 02	IRC	R506.1 Floors on Ground Concept: Clarifies vapor retarder provisions
ACI 03	IEBC	405.1.1 Structural - General Concept: Adds new section 405.1.1 to reference ACI 562
ACI 04	IBC	1905 Modification to ACI 318 Concept: Cleans up language and re-establishes IBC convention for Section 1905
ACI 05	IBC	1901.5 Construction Documents Concept: Removes list items to be included and defers to ACI 318
ACI 06	IBC	1907 Minimum Slab Provisions Concept: Clarifies structural versus non-structural slabs on ground
ACI 07	IBC	1907 Minimum Slab Provisions Concept: Establishes minimum requirements for vapor retarders
ACI 08	IBC	1907 Minimum Slab Provisions Concept: Aligns reinforcement placement in slabs-on-ground with IRC
NEX 09	IBC	1903.4 GFRP Bars Adds new Section to include acceptance of GFRP bars in accordance with ASTM D7957

ACI 01

SECTION AW101
GENERAL

AW101.1 Scope. Buildings, structures and building elements fabricated in whole or in part using 3D-printed construction techniques shall be designed, constructed and inspected in accordance with the provisions contained in this appendix and other applicable requirements in this code.

Exception: This Appendix shall not be applicable to 3D printed buildings constructed of concrete.

Reason:

Experience in the field of construction 3D printing of concrete and the understanding of research in that field and an understanding of the construction industry demonstrates that there is no consensus indicating that the material property tests called out in UL 3401 are representative of 3D printing technologies used for construction or that this particular standard in its current state considers all of the material properties necessary for a structural engineer to properly perform design calculations or ensure the safety of personnel during construction.

If this approach remains in the IRC, the concern is that this technology will be implemented for a short period of time, but will ultimately meet its demise due to issues in construction as there is not a consensus of construction and engineering design procedures that is addressed by construction codes. There is a lot to consider when a manufacturing method is adopted for use in construction, especially when expectations are often that structural systems that are intended to last 100 years. There are many cases in construction where lack of oversite of construction considerations, such as connection or proper building energy performance (both of which have not been addressed for 3D printed construction), have led to failures in building systems. In an industry that can’t accept failure, early adoption may lead early abandonment of the technology.

UL 3401 called out in this appendix does not incorporate for the conclusions of current research in the field of 3D printed concrete construction. In terms of cementitious materials there is consensus that the act of 3D printing results in a differences in material strength from cast materials and that this strength differs based on element orientation (Ma et al 2018, Wolfs et al 2019, Panda et al 2017, Sanjayan et al 2018). The tests called out in UL3401 only accounts for vertical loading of elements with layers perpendicular to the load direction and does not account for loading directions that may result in differences in material performance. This assumes that either this is the worst case scenario or that buildings only undergo loading direction. Not accounting for anisotropy does not provide an engineer with enough information to properly design for all loading conditions that a structure may experience.

Additionally, research has shown that material properties of printed materials are not the same as cast materials since they are extruded and not consolidated in a mold, which results in variation in materials performance. Therefore, tests like ASTM C157 Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete are not applicable, since the test requires casting and consolidation of materials so that steel studs can be embedded for placement in the measuring device. Material performance also depends on layer height and so the test specimen sizes need to be sufficient enough to account for statistical variation in material properties due to layer height or variation in specimen dimensions based on layer height. As the ASTMs referenced in the standard are intended for cast specimens, and such variations are not addressed in the standard, this material variation cannot be addressed by this proposal in its current state.

The most critical omission is that the UL 3401 does not account very early age properties of cementitious materials, which is a potential construction site or facility safety issue. The standard specifically calls out slump tests (ASTM C143 or ASTM C1611). This type of test, while widely used in the field, is not applicable to printable concrete/mortars. It does not provide measurements required for determine stability of prints. Reliance on this test will lead to materials that are not printable or result in on-site safety issues. Concrete 3D printing process can be done safely but it relies on stability of the print, as there is no formwork. This requires an understanding of the yield strength, flow characteristics, elastic modulus gain over time, and strength gain over time (Perrot 2015, Roussel 2018, Wolfs 2018, Suiker 2020, Jayathilakage 2020). The slump test does not provide the level of details required for an engineer to perform construction load and stability calculations.

While it is understood that this appendix is intended to only address the determination of material properties and printer systems, it is unclear based on the tests if design considerations were included in the determination of the material tests chosen. In general, whether cementitious or polymeric type materials, there is a lack of publically available studies or understanding in the structural load testing of representative components or systems for engineering applications found in construction that conclude that results from these tests can be used for design purposes. This applies whether these items are being used for structural or architectural applications. With this gap in research, it is unclear whether 3D printed elements or their connections using material values from this proposal can be properly designed for structural applications.

Properties being investigated by concrete industry experts include but are not limited to: analytical methods; anchorage; bond between layers; cleanouts; durability; rheology; reinforcement types, placement and positioning; shrinkage; strength; thixotropy; time to bond; time to set; use of polymers; and viscosity.

While the appendix might be appropriate for other materials, it is not appropriate for additive manufacturing using concrete. Test and evaluation techniques used for conventional cast-in-place concrete are not sufficient and may not be appropriate for additive manufacturing using concrete. 3D printing of concrete buildings should remain an alternative means and methods until such time that the concrete industry experts develop appropriate inspection, testing, design, materials, and construction practices with an understanding of properties and performance. Designs and construction using 3D printers still can comply through Section R104.11 Alternative materials, design and methods of construction and equipment.

SECTION R506
~~CONCRETE FLOORS (ON GROUND)~~
CONCRETE SLAB-ON-GROUND FLOORS

R506.1 General. Concrete slab-on-ground floors shall be designed and constructed in accordance with the provisions of this section or ACI 332. Floors shall be a minimum 31/2 inches (89 mm) thick (for *expansive soils*, see Section R403.1.8). The specified compressive strength of concrete shall be as set forth in Section R402.2.

R506.2 Site preparation. The area within the foundation walls shall have all vegetation, topsoil and foreign material removed.

R506.2.1 Fill. Fill material shall be free of vegetation and foreign material. The fill shall be compacted to ensure uniform support of the slab, and except where *approved*, the fill depths shall not exceed 24 inches (610 mm) for clean sand or gravel and 8 inches (203 mm) for earth.

R506.2.2 Base. A 4-inch-thick (102 mm) base course consisting of clean graded sand, gravel, crushed stone, crushed concrete or crushed blast-furnace slag passing a 2-inch (51 mm) sieve shall be placed on the prepared subgrade where the slab is below *grade*.

Exception: A base course is not required where the concrete slab is installed on well-drained or sand-gravel mixture soils classified as Group I according to the United Soil Classification System in accordance with Table R405.1.

R506.~~2.~~3 Vapor retarder. A vapor retarder shall be installed between the base course or subgrade and the concrete slab or between the subgrade and the base course. The vapor retarder shall be:

1) A minimum 6~~10~~-mil (0.006 ~~0.010~~ inch; 0.152 ~~0.254~~ mm) polyethylene sheet membrane,
2) Vapor retarder conforming to ASTM E1745 Class C ~~A~~ requirements, or
3) Equivalent approved vapor retarder.

Sheet membrane vapor retarders shall have ~~with~~ joints lapped not less than 6 inches (152 mm). ~~shall be placed between the concrete floor slab and the base course or the prepared subgrade where a base course does not exist.~~

Exception: The vapor retarder is not required for the following:

1. Garages, utility buildings and other unheated *accessory structures*.
2. For unheated storage rooms having an area of less than 70 square feet (6.5 m2) and carports.
3. Driveways, walks, patios and other flatwork not likely to be enclosed and heated at a later date.
4. Where *approved* by the *building official*, based on local site conditions.

R506.~~2.~~4 Reinforcement support. Where provided in slabs-on-ground, reinforcement shall be supported to remain in place from the center to upper one-third of the slab for the duration of the concrete placement.

Reason:

This code change is needed as it 1) clarifies where vapor retarders for slabs-on-ground may be placed and 2) allows vapor retarders complying with any class of ASTM E1745.

ACI 03

IEBC Chapter 4 - Repairs

Modification to 2021 Edition of IEBC – Group B

SECTION 405

STRUCTURAL

Revise text to read as follows:

405.1 General. Structural repairs shall be in compliance with this section and Section 401.2.

405.1.1 Structural concrete. In addition, assessment, design, and repairs to structural concrete shall be in accordance with ACI CODE 562. Assessment and design of repairs of seismic force-resisting concrete elements that result in changes of strength, stiffness, or ductility differing from pre-damage conditions shall be in accordance with Section 304.3.

Add new reference to Chapter 16:

ACI

American Concrete Institute
38800 Country Club Drive
Farmington Hills, MI 48331

ACI CODE 562-21: Assessment, Repair, and Rehabilitation of Existing Concrete Structures - Code Requirements

405.1

Reason:

Concept – This code change proposal adds ACI CODE 562: *Code Requirements for Assessment, Repair, and Rehabilitation of Existing Concrete Structures*, to establish minimum requirements for the evaluation, 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 project performance for the code official, owners, designers, contractors and installers. While the proposed language in mandatory, alternative means and methods remain permitted in accordance with Section 104.11 "Alternative materials, design and methods of construction, and equipment."

This addition to the IEBC is also especially important as it includes references to standard specifications for materials used to repair concrete elements that are not addressed elsewhere in the family of International Code Council Codes. AS ACI CODE 562 does not address the evaluation and design of modifications to seismic force resisting systems, the user is clearly directed to IEBC Section 304.3 "Seismic evaluation and design procedures," while retaining criteria in ACI CODE 562 for materials and making repairs.

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. Further, although ACI has made available many guides, manuals, reports and standards on concrete repairs for voluntary use, studies show that the current failure rate of repairs to structural concrete is inconsistent with ACI 562 Committee's views regarding a reasonable level of life safety. The studies show that 50 percent of repairs to structural concrete fail within 10 years and 20 percent fail within 5 years. This code provides building code officials with a reference by which to evaluate repairs and rehabilitated concrete structures. ACI, following its rigorous American National Standards Institute (ANSI) accredited standards development process assembled a code committee with balanced representation. All comments are properly adjudicated through this rigorous consensus process. As with all standards development, it is rare when all comments are considered substantial enough to be addressed by the committee as revisions to the document. 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.

Scope – ACI CODE 562 complements the IEBC by providing specific direction on how to evaluate, design and conduct concrete repairs and how to handle the unique construction problems associated with repairs to concrete elements. This standard provides more in-depth requirements needed by most entities addressing the repair of concrete structural elements than is provided in the IEBC. Further, the standard provides the requirements that bridge the inconsistencies and gaps in acceptable criteria that occur from the two following situations that a designer must solve: 1) repairing a structure according to the original building code used at the time it was built using today's construction methods and materials; or 2) repairing a structure built according to an older building code but repaired according to a more recent building code. ACI CODE 562 includes specifications and requirements for products commonly used for repairs, but not addressed elsewhere in the building codes, including but not limited to fiber-reinforced polymers and polymer concrete.

Benefits – There are many benefits that ACI CODE 562 provides for the designer, owner, contractor, materials providers, building code official and the public. A few of these benefits are:

- **Life Safety**: Provides a level of expectation of life safety to the public in buildings where repairs or rehabilitation is performed on concrete structural elements.
- **Failing Infrastructure**: Many concrete structures are in need of repair and it is crucial that repairs as remedial action for deficiencies in structural elements must be done properly and not simply be cosmetic repairs. This requires minimum levels of evaluation, design, and repair. While not unique to Pittsburgh or parking structures, there is a common theme about the need to properly rehabilitate and repair existing concrete structures.
- **Uniform Requirements**: Provides clearly defined, uniform requirements aimed at extending the service life of existing structures.
- **Quality Repairs**: Provides minimum requirements for efficiency, safety, and quality of concrete repair.
- **Clear Responsibilities**: Establishes clear responsibilities between owners, designers, and contractors.
- **Clear Path for Approval**: Provides building code officials with a means to evaluate rehabilitation designs.
- **Affordable Repairs**: Where appropriate, while helping to ensure an acceptable level of risk, permits specific repair requirements that often result in less costly repairs compared to repairs required to meet requirements for new building construction.
- **Flexibility**: 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.
- **Sustainability -** Improve owner, developer, and public confidence regarding effective repairs, upgrades, and reuse of existing buildings in lieu of demolition and replacement (energy, disposal, new materials and construction costs), by appropriately extending the life of existing buildings.
- **Consistent Language**: Several jurisdictions have adopted or are considering adoption of ACI CODE 562. These include but are not limited to Florida, Hawaii, Massachusetts, North Carolina, Ohio, and South Carolina. Inclusion of language in the model building code for existing buildings will improve consistency of language and location of the requirements with in the codes of the authorities having jurisdiction adopting ACI CODE 562 by reference.

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.

Recommendation – ACI, a professional technical society, has developed ACI CODE 562 in response to industry needs and to help assure acceptable 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.

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 CODE 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.

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
- *2020 Florida Building Code, Existing Buildings, 7th Edition* Section 301.3.4.
- *2018 Hawaii State Building* Code Item (53) Section 3401.6.
- *2017 Ohio Building Code with Aug 2018 Updates & Errata 02-08-19* Section 3401.6.
- City of Los Angeles *California Design Guide Volume 1 City of Los Angeles Mandatory Earthquake Hazard Reduction in Non-Ductile Concrete Buildings (NDC),* including Section 4.1 Retrofit Design Process.
- New York City Department of Buildings cites ACI 562 in *BUILDINGS BULLETIN 2017-015.*

Cost Impact: Generally, the use of ACI CODE 562 will reduce the cost of repair, by allowing a level of repair amicable to both the owner and the building code official, while maintain an acceptable level of safety for occupants. Without this option, often there is a demand to conduct repairs that meet the requirements of the most recent adopted building code 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 CODE 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 CODE 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."

Part I of VIII

SECTION 1905
~~MODIFICATIONS TO ACI 318~~
SEISMIC REQUIREMENTS

1905.1 General. ~~The text of ACI 318 shall be modified as indicated in Sections 1905.1.1 through 1905.1.8.~~ Chapter 18 of ACI 318 shall not apply for structures assigned to Seismic Design Category A.

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

DETAILED PLAIN CONCRETE STRUCTURAL WALL. A wall complying with the requirements of Chapter 14 of ACI 318, 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.*~~

Part II of VIII

1905.1.2 Plain concrete walls. ~~**ACI 318, Section 18.2.1.** Modify ACI 318 Sections 18.2.1.2 and 18.2.1.6 to read as follows~~:

Structural elements of plain concrete are prohibited in structures assigned to Seismic Design Category C, D, E and F.

Exception: Structural elements of plain concrete complying with Section 1905.1.7

~~• *18.2.1.2 Structures assigned to Seismic Design Category* A shall satisfy requirements of 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, 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.*~~

~~• 18.2.1.6 Structural systems designated as part of the *seismic force-resisting system* shall be restricted to those *permitted by ASCE 7*. Except for *Seismic Design Category* A, for which Chapter 18 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.~~

~~(b) *Ordinary reinforced concrete structural walls and ordinary precast structural walls* need not satisfy any provisions in Chapter 18.~~

~~(c) Intermediate moment frames shall satisfy 18.4.~~

~~(d) Intermediate precast *structural* walls shall satisfy 18.5.~~

~~(e) Special moment frames shall satisfy 18.6 through 18.9.~~

~~(f) Special structural walls shall satisfy 18.10.~~

~~(g) Special structural walls constructed using precast concrete shall satisfy 18.11.~~

~~Special moment frames and special structural walls shall also satisfy 18.2.4 through 18.2.8.~~

Part III of VIII

1905.1.3 ~~**ACI 318, Section 18.5.**~~ **Intermediate precast structural walls.** ~~Modify ACI 318, Section 18.5 by adding new Section 18.5.2.2 and renumber 18.5.2.3 and 18.5.2.4, respectively~~. Intermediate precast structural walls forming part of the seismic force resisting system shall comply with this section and Section 18.5 of ACI 318.

~~*18.5.2.2*~~ **1905.1.3.1 Connections designed to yield.** 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 Elements of the connection that are not designed to yield shall develop at least 1.5 *Sy*.~~

~~18.5.2.4 In structures assigned to SDC D, E or F, wall piers shall be designed in accordance with 18.10.8 or 18.14 in ACI 318.~~

Part IV of VIII

1905.1.4 ~~ACI 318, Section 18.11.~~ Special structural walls constructed of precast. ~~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 18.10 and ~~*for cast-in-place special structural walls* in addition to~~ 18.5.2 of ACI.

Part V of IX

1905.1.5 ~~ACI 318, Section 18.13.1.1~~. Foundations designed to resist earthquake forces. ~~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*~~.

Part VI of VIII

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

DETAILED PLAIN CONCRETE STRUCTURAL WALL. A wall complying with the requirements of Section 1905.1.6 and Chapter 14 of ACI 318, ~~including 14.6.2.~~

1905.1.6 ~~ACI 318, Section 14.6.~~ Detailed plain concrete structural walls. ~~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 for detailed plain concrete structural walls shall be provided as follows:

- Vertical reinforcement of at least 0.20 square inch (129 mm2) 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 of ACI 318.
- Horizontal reinforcement at least 0.20 square inch (129 mm2) 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.

Part VII of VIII

1905.1.7 ~~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 assigned to Seismic Design Category C, D, E or F shall not have elements of structural plain concrete, except as follows:

- 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 71/2 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.
- 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.

• 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 stem wall, 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.

Part VIII of VIII

1905.1.8 ACI 318, Section 17.2.3. Design requirements for anchors. ~~Modify ACI 318 Sections 17.10.5.2, 17.10.3(d) and 17.10.6.2 to read as follows:~~ Loading design requirements for anchors shall comply with ACI 318 and this section.

~~• 17.10.5.2 –~~ **1905.1.8.1 Where applied force does not exceed 20 percent of factored load.** 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 17.10.5.3 of ACI 318. The anchor design tensile strength shall be determined in accordance with 17.10.5.4 of ACI 318.

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 17.10.5.3(d)* of ACI 318.

• ~~17.10.5.3(d) –~~ **1905.1.8.2 Maximum tension.** *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_0. The anchor design tensile strength shall be *calculated from* 17.10.5.4 of ACI 318.

~~1905.1.8.3~~ **Where the applied force exceeds 20 percent of the factored load.** *Where* the shear component of the strength-level earthquake force applied to anchors exceeds 20 percent of factored load, the in-plane shear strength in accordance with 17.10.6.3 of ACI 318. The anchor design shear strength for resisting earthquake forces shall be determined in accordance with 17.7 of ACI 318.

Exceptions:

~~1. *For*~~ *The calculation of the in-plane shear strength of anchor bolts attaching wood sill plates of bearing or nonbearing walls of light-frame wood structures to foundations or foundation stem walls, the in-plane shear strength in accordance with 17.7.2 and 17.7.3 of ACI 318 need not be computed and 17.10.6.3 of ACI 318 shall be deemed to be satisfied provided all of the following are met:*

1.1. 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. The maximum anchor nominal diameter is 5/8 inch (16 mm).

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

1.4. Anchor bolts are located a minimum of 13/4 inches (45 mm) from the edge of the concrete parallel to the length of the wood sill plate.

1.5. 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. 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 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 17.7.2 and 17.7.3 of ACI 318 need not be computed and 17.10.6.3 of ACI 318 shall be deemed to be satisfied provided all of the following are met:*

2.1. The maximum anchor nominal diameter is 5/8 inch (16 mm).

2.2. Anchors are embedded into concrete a minimum of 7 inches (178 mm).
2.3. Anchors are located a minimum of 13/4 inches (45 mm) from the edge of the concrete.
parallel to the length of the track.
2.4. Anchors are located a minimum of 15 anchor diameters from the edge of the concrete perpendicular to the length of the track.
2.5. 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 J3.3.1.

3. *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 17.10.6.3(a) through (c) <u>of ACI 318</u> when the design strength of the anchors is determined in accordance with 17.7.2.1(c) <u>of ACI 318</u>.*

Reason Statement:

This proposal eliminates unnecessary and confusing transcription from ACI 318 and more concisely communicates contents of subsections with title rather than ACI 318 Section umbers. This proposal aligns the section with the IBC format convention and clearly communicates to the user what is different between the IBC and ACI 318. Further, additional confusion results because the proponents of the current format are not maintaining the excessive transcription from ACI 318 and errata needed to be developed for the 2021 edition of the IBC. The improved clarity and conciseness of the provisions is needed to assist in avoiding errors in design and construction of structural concrete. Finally, the clear descriptors indicating what is changed, allows the user to quickly identify if the criteria in the IBC is applicable to their project. For example, if the project does not use detailed plain structural concrete walls, the user clearly sees that those provisions do not apply for their project.
Specifically, the proposal:

- Clarifies what is contained in this section, i.e. seismic requirements.
- Communicates up front to the designer that requirements are not applicable to SDC A.
- More concisely communicates the provisions. Even with the additional words for descriptors in section and sub-section headings Parts I through IX use 24 percent fewer words to communicate the requirements of the code.
- Removes definitions that are the same as those in ACI 318. Multiple terms defined in ACI 318 are shown simply to add one term not addressed in ACI 318: “Detailed Plain Concrete Structural Wall.”
- Avoids confusion for user looking to see what is different between definitions and requirements in IBC and 318 are technically the same.
- Relocates requirements for special plain walls in a section with an appropriate descriptor.
- Eliminates text that describes renumbering sections and modifying text of ACI 318 to more clearly communicate the code requirements.
- Concisely communicates that there are prohibitions regarding the use of structural plain concrete in SDC C, D, E, and F.
- Eliminates unnecessary transcription from ACI 318.
- Clearly communicates where specific provisions are only applicable to plain structural concrete walls.
- Aligns language with ICC convention for referring the use of italics.
- Aligns language with ICC convention for descriptive section and subsection titles.
- Helps to avoid the need for errata as Section numbers in ACI 318 change. Errata needed to be issued for the 2021 Edition of the IBC.
- Removes archaic approach to code and standard use. Additional requirements in the IBC were presented as modifications to ACI 318 to allow cut-and-paste the entire section into hard copies. Most of today’s users use electronic formats and find the cut-and-paste confusing.
- In many instances there are no changes to the content in ACI 318 and text is simply transcribed. The excessive transcription increases the likelihood for the user to miss important differences between ACI 318 and the IBC.

Cost Impact:

There is no cost impact as there are no technical changes.

ACI 05

SECTION 1901
GENERAL

Delete without replacement:

~~**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:
This proposal removes truncated list of items to be cited in construction documents, thereby removing inconsistencies between ACI 318 and the IBC. Further, this proposal eliminates the problems associated with maintaining lists in both the IBC and 318.
Since IBC Section [A] 102.4.1 Conflicts. States: “Where conflicts occur between provisions of this code and referenced codes and standards, the provisions of this code shall apply,” the full list of items to appear in construction documents as required by ACI 318 is not applicable and only the truncated list in the IBC applies.
This section provides no benefit to the user, but simply creates conflicts and confusion. Except for the required related to fire performance of fireplaces in Section 2111 Masonry Fireplaces, there is no comparable list of requirements in Chapter 21 Masonry. The requirements for items to be included in the construction documents for masonry are only contained in the referenced standards: The Masonry Society 402—2016: Building Code for Masonry Structures and 602—2016: Specification for Masonry Structures, avoiding conflicts and confusion. The same should be applicable for structural concrete construction.
ACI recommends approval as submitted to avoid conflicts and confusion and to eliminate the problems of trying to maintain identical lists in multiple documents.

ACI 06

SECTION 1901
GENERAL

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.~~

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

1907.1 General. Non-structural slabs-on-ground shall comply with Section 1904 and this Section. Structural slabs-on-ground shall comply with all applicable provisions of this Chapter. Slabs-on-ground are structural where slabs-on-ground:

1) transmit loads or resist lateral forces from other parts of the structure to the soil;
2) transmit loads or resist lateral forces from other parts of the structure to other parts of the structure; or
3) resist uplift or overturning forces.

Reason:
This proposal:

1. Renames Section 1907 to “Slabs-on-Ground” as this section is not applicable to interim floor slabs or other slabs no on ground.
2. Moves all slab-on-ground requirements into one section by eliminating text in section 1901.2
3. Clarifies scenarios where slabs-on-ground are structural, adding language that addresses slabs on ground used as part of a diaphragm systems, transferring loads to micro-piles, etc. and used to resist overturning or uplift forces.

ACI 07

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

1907.1 ~~General~~ Thickness. The thickness of concrete floor slabs supported directly on the ground shall be not less than 31/2 inches (89 mm).
1907.2 Vapor Retarder: A vapor retarder shall be placed between the base course or subgrade and the concrete floor slab or between the base course and the sub-grade, The vapor retarder shall be:

1. Minimum ~~A~~ 6-mil (0.006 inch; 0.15 mm) polyethylene vapor retarder;
2. Minimum Class C vapor retarder complying with ASTM E1745; or
3. Other approved equivalent methods or materials that retard vapor transmission through the floor slab.

Sheet membrane vapor retarders shall have ~~with~~ joints lapped not less than 6 inches (152 mm).

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 m2) 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.

Add new standard:

ASTM

ASTM International
100 Barr Harbor Drive, P.O. Box C700
West Conshohocken, PA 19428

ASTM E1745-17: Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs
1907.3

Reason:
This proposal:

1. Renames Section 1907 to “Slabs-on-Ground” as this section is not applicable to interim floor slabs or other slabs no on ground.
2. Clarifies and provides options for vapor barriers by adding ASTM E1745 Class C. The new language address laps for sheet materials in a way that indicates the liquid applied vapor retarders are permissible.

ACI 08

SECTION 1907
MINIMUM SLAB PROVISIONS

Add new Section:

1907.4 Reinforcement support. Where provided in slabs-on-ground, reinforcement shall be supported to remain in place from the center to upper one-third of the slab for the duration of the concrete placement, unless otherwise specified in the construction documents.

Reason:
This proposal adds a requirement for positioning reinforcement within concrete slabs. The provision is similar to the requirement in the International Residential Code. This provision is needed to help ensure that reinforcement is properly placed in slabs-on-ground to provide the benefit of the reinforcement. This places reinforcement where it can help accommodate shrinkage and temperature movement. Reinforcement placed directly on the subgrade or base course is not fully encompassed by concrete and provides little or no benefit. It is a misconception that individuals placing concrete can be standing on the reinforcement and pull it into position with hooks or other tools. Proper placement of concrete while maintaining proper location of reinforcement required the reinforcement to be positioned before concrete placement.

Cost Impact:

ACI 08-22
IBC Chapter 19 - Concretes
Adds Glass Fiber Reinforced Polymer Rebar
Modification to 2021 Edition of IBC – Group B

Add new section as follows:

1903.3 Glass fiber-reinforced concrete. Glass fiber-reinforced concrete (GFRC) and the materials used in such concrete shall be in accordance with the PCI MNL 128 standard.

1903.4 Glass fiber reinforced polymer bars. Glass fiber reinforced polymer (GFRP) bars used as concrete reinforcement shall conform to ASTM D7957.

Add new reference standard to Chapter 35 Section ASTM International:

D7957/D7957M – 2017: Standard Specification for Solid Round Glass Fiber Reinforced Polymer Bars for Concrete Reinforcement
1903.3

Reason:
This code change adds another type of reinforcement bars, glass fiber reinforced polymer bars. This makes the IBC more current and reflects technological advancements being integrated into standards. GFRP bars are particularly beneficial where a high degree of corrosion resistance is required.

NEX is an American Concrete Institute Center of Excellence for Non-metallic Building Materials and recommends approval as submitted so that new materials currently being used in concrete construction are clearly permitted in the International Building Code.

Cost Impact: None. This code change proposal will not increase or decrease cost of construction. The proposal allows an additional type of reinforcement bars for use in concrete.