Scope of Seminar

- Significant Changes in ACI 318-14:
  - Organizational Changes
  - Technical Changes
Organizational Changes

Last major organizational change: 1971 edition
## ACI 318-11 Organization

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ACI 318-11 Organization

- Shear Strength: Chapter 11
- Flexural and Axial Strength: Chapter 10
- Lap Splice: 12.15 – 12.17
- Ties in joint: 11.10.2
- Strength Reduction Factors, Φ: Chapter 9
- Slope: 7.8.1.1
- Ties: 7.10.5
- Cover: 7.7

Major Goals of Reorganizing ACI 318

• To make it easy for designer to find information he/she needs
• To increase likelihood that a design will comply with all applicable code requirements
• “House-cleaning”
Member-Based Organization

The idea is that within each chapter devoted to a particular member type such as beam or column, the user will find all the requirements necessary to design that particular member type.

“This will eliminate the need to flip through several chapters to comply with all of the necessary design requirements for a particular structural member, as was necessary with the old organization format. The codes’ new design can be compared to a cookbook: all the ingredients for baking a cake such as eggs, flour, sugar, oil – along with the baking instructions – are in one chapter, instead of individual chapters on eggs, flour, and sugar.”

- Cary Kopczynski
Toolbox Chapters

Challenge: Where to place the design information that applies to multiple member types – such as development length requirements.

To repeat essentially the same information in multiple chapters was not the right solution.

Solution: So the decision was made to house such information in “toolbox” chapters and to reference the information from the member-based chapters.

ACI 318-14 Organization

Example:

Chapter 10 – Columns
  10.1 Scope
  10.2 General
  10.3 Design Limits
  10.4 Required Strength
  10.5 Design Strength
  10.6 Reinforcement Limits
  10.7 Reinforcement Detailing
Overall Changes

Two new chapters:
- Chapter 4 - *Structural System Requirements*
- Chapter 12 - *Diaphragms*

Two discontinued appendices:
- Appendix B - *Alternative Provisions for Reinforced and Prestressed Concrete Flexural and Compression Members*
- Appendix C - *Alternative Load and Strength Reduction Factors*

Overall Changes

Two chapters and two appendices relocated without any significant change:
- *Strength Evaluation of Existing Structures*: Chapter 20 → Chapter 27
- *Structural Plain Concrete*: Chapter 22 → Chapter 14
- *Strut-and-Tie Models*: Appendix A → Chapter 23
- *Anchoring to Concrete*: Appendix D → Chapter 17
Overall Changes

Chapter for seismic provisions remains intact, but with technical changes, and relocated:

- *Earthquake-Resistant Structures:*
  
  Chapter 21 → Chapter 18

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Overall Changes

The first three chapters also remain intact, but with technical changes

- Chapter 1: *General Requirements*, now *General*

- Chapter 2: *Notation and Definitions*, now *Notation and Terminology*

- Chapter 3: *Materials*, now *Referenced Standards*
Overall Changes

Two chapters no longer exist as separate entities, with their provisions spread over several of the new chapters:

- Chapter 16 - Precast Concrete
- Chapter 18 - Prestressed Concrete

Overall Changes

One chapter moved to a separate document:

- Shells and Folded Plates: Chapter 19 → ACI 318.2-14

ACI Committee 318, in collaboration with ACI-ASCE Committee 334, Concrete Shell Design and Construction, has developed ACI 318.2-14, the contents of which match those of ACI 318-11 Chapter 19.
Overall Changes

Logical question: Why was this document designated ACI 318.2, rather than ACI 318.1?

Answer: This is because it was initially planned that ACI 318-11 Chapter 22 on plain concrete would become a separate standard: ACI 318.1. The number was reserved for that purpose. It was later decided to place the contents of ACI 318-11 Chapter 22 in ACI 318-14 Chapter 14.

ACI 318-14 Organization

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<td>27—Strength Evaluation of Existing Structures</td>
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### Significant Changes in ACI 318-14

#### Technical Changes
Technical Changes

In view of reorganization, initial expectation was that technical changes in ACI 318-14 would be minimal. It did not end up that way.

ACI 318-14 does contain a number of significant technical changes. Some of the most important changes are found in Chapter 18, *Earthquake Resistant Structures*, and Chapter 19, *Concrete: Design and Durability Requirements*.

Chapter 1—General
1 General

General information regarding the scope and applicability of ACI 318 is provided.
A new section on interpretation is included to help users understand the ACI 318 language.

Chapter 2—Notation and Terminology
2 Terminology - Hoops

2.3 — Terminology

*hoop* — Closed tie or continuously wound tie, made up of one or several reinforcement elements, each having seismic hooks at both ends. A closed tie shall not be made up of interlocking headed deformed bars. Chapter 18.

Reason: Engineers are specifying use of interlocking headed deformed bars to form legs of hoops. This is of concern because of the possibility that heads will not be adequately interlocked and because the heads could become disengaged under complex loadings well into the inelastic range of response.
2 Terminology – Special Seismic Systems

2.3 — Terminology (Contd.)
New definition of Special Seismic Systems in order to provide consistency and clarity for reinforcement terminology throughout the reorganized code.

*special seismic systems* – Structural systems that use special moment frames, special structural walls, or both.

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Chapter 3—Referenced Standards
3 Referenced Standards

Many referenced standards updated
Some referenced standards added

Chapter 4—Structural System Requirements New!
CHAPTER 4 — Structural System Requirements

4.1- Scope
4.2- Materials
4.3- Design Loads
4.4- Structural system and load paths
  4.4.6 - Seismic-force-resisting system
  4.4.7 - Structural diaphragms and collectors
4.5- Structural analysis
4.6- Strength

CHAPTER 4 — Structural System Requirements (Contd.)

4.7- Serviceability
4.8- Durability
4.9- Sustainability
4.10- Structural integrity
4.11- Fire resistance
4.12- Requirements for specific types of construction
4.13- Construction and inspection
4.14- Strength evaluation of existing structures
New CHAPTER 4 — Structural System Requirements (Contd.)

4.9—Sustainability

4.9.1 The licensed design professional shall be permitted to specify in the construction documents sustainability requirements in addition to strength, serviceability, and durability requirements of this Code.

4.9.2 The strength, serviceability, and durability requirements of this Code shall take precedence over sustainability considerations.

New CHAPTER 4 — Structural System Requirements (Contd.)

4.11—Fire resistance

4.11.1 Structural concrete members shall satisfy the fire protection requirements of the general building code.

4.11.2 Where the general building code requires a thickness of concrete cover for fire protection greater than the concrete cover specified in 20.6.1, such greater thickness shall govern.
Chapter 5—Loads

5 Strength-Level Seismic Forces

A provision concerning service-level seismic forces was included following the strength design load combinations in Chapter 9 of ACI 318-11 and prior editions.

That provision has been discontinued in Chapter 5 of ACI 318-14.
5, 7 Secondary Moments due to Prestress

ACI 318-11 18.10.3 — Moments used to compute required strength shall be the sum of the moments due to reactions induced by prestressing (with a load factor of 1.0) and the moments due to factored loads. Adjustment of the sum of these moments shall be permitted as allowed in 18.10.4.

Reason: A requirement to include secondary moments was properly included in the ACI 318-11 on moment redistribution, but was not included anywhere else. Since secondary moments are significant considerations as a member is being designed, including when moments are not redistributed, they should be included in the member chapters. Also, the effects of reactions induced by prestressing include more than just secondary moments, so the language is modified to reflect this.
5, 7 Secondary Moments due to Prestress

5.3.11 — Required strength $U$ shall include internal load effects due to reactions induced by prestressing with a load factor of 1.0.

7.4.1.3 — For prestressed slabs, effects of reactions induced by prestressing shall be considered in accordance with 5.3.11. (Similar statements appear in other member-based chapters.)

Chapter 6—Structural Analysis
6 Rigid Joints

ACI 318-11 8.9.2 — In analysis of frames or continuous construction for determination of moments, span length shall be taken as the distance center-to-center of supports.

ACI 318-14 6.6.2.3 —

(b) For frames or continuous construction, it shall be permitted to assume the intersecting member regions are rigid

6 Finite Element Analysis

Minimum requirements for an acceptable finite element analysis for structural concrete members are now given in Chapter 6.
6 Finite Element Analysis

Reason: The new provisions are intended to explicitly allow the use of FEA.

The goal is not to provide guidance for the selection and use of FEA software; this is available in technical literature.

The new Chapter 12 on Diaphragms and Collectors makes explicit reference to use of FEA. So it becomes important to have the code recognize the acceptability of its use.

6 Finite Element Analysis

6.9 — Acceptability of finite element analysis

6.9.1 — Finite element analysis to determine load effects shall be permitted.

6.9.2 — The finite element model shall be appropriate for its intended purpose.

6.9.3 — For inelastic analysis, a separate analysis shall be performed for each factored load combination.
6 Finite Element Analysis

6.9.4—The licensed design professional shall confirm that the results are appropriate for the purposes of the analysis.

6.9.5—The cross-sectional dimensions of each member used in an analysis shall be within 10 percent of the specified member dimensions in construction documents or the analysis shall be repeated.

6.9.6—Redistribution of moments calculated by an inelastic analysis shall not be permitted.

Chapter 7—One-Way Slabs

No new content
Chapter 8—Two-Way Slabs

8 Minimum Bonded Reinforcement

ACI 318-11 18.9.1 — A minimum area of bonded reinforcement shall be provided in all flexural members with unbonded tendons as required by 18.9.2 and 18.9.3.
8 Minimum Bonded Reinforcement

8.6.2.3 — For prestressed slabs, a minimum area of bonded deformed longitudinal reinforcement, \( A_{s,\text{min}} \), shall be provided in the precompressed tensile zone in the direction of the span under consideration in accordance with Table 8.6.2.3.

8 Structural Integrity of P/T Slabs

ACI 318-11 18.12.6 — Except as permitted in 18.12.7, in slabs with unbonded tendons, a minimum of two 1/2 in. diameter or larger, seven-wire post-tensioned strands shall be provided ….
8 Structural Integrity of P/T Slabs

8.7.5 Flexural reinforcement in prestressed slabs
8.7.5.6 Structural integrity

8.7.5.6.1 — Except as permitted in 8.7.5.6.3, at least two tendons with 1/2 in. diameter or larger strand shall be placed ….

Chapter 9—Beams
9 Slender Precast Spandrels

An acceptable alternative design procedure for slender spandrel beams of precast concrete is now given in Chapter 9.

9.5.4.7—For solid precast sections with an aspect ratio $h/b_t \geq 4.5$, it shall be permitted to use an alternative design procedure and open web reinforcement, provided the adequacy of the procedure and reinforcement have been shown by analysis and substantial agreement with results of comprehensive tests. The minimum reinforcement requirements of 9.6.4 and detailing requirements of 9.7.5 and 9.7.6.3 need not be satisfied.

$b_t =$ width of that part of cross section containing the closed stirrups resisting torsion, in.
Reason: It was demonstrated through an extensive experimental and analytical research program at NC State that properly designed open web reinforcement is a safe, effective, and efficient alternative to traditional closed stirrups for precast slender spandrels.

A simple, rational design procedure was developed. This proposed procedure significantly reduces reinforcement congestion, especially in the end regions of slender spandrels, while maintaining a desired level of safety.
Chapter 10—Columns
No new content

Chapter 11—Walls
No new content
Chapter 12—Diaphragms New!

New CHAPTER 12 — Diaphragms and Collectors

12.1 – Scope
12.2 – General
12.3 – Design limits
12.4 – Required strength
12.5 – Design strength
12.6 – Reinforcement limits
12.7 – Reinforcement detailing
Chapter 13—Foundations

No new content

Chapter 14—Plain Concrete

Former Chapter 22

No new content
Chapter 15—Beam-Column and Slab-Column Joints
No new content

Chapter 16—Connection between Members
No new content
Chapter 17—Anchoring to Concrete
Former Appendix D
No new content

Chapter 18—Earthquake-Resistant Structures
18 Nonprestressed Reinforcement in Specially Detailed Structural Members

For ASTM A615 Grade 60 bars used as longitudinal reinforcement in special moment frames and special shear walls, ACI 318-14 now requires the same minimum elongation as ASTM A706 reinforcement (Section 18.2.6.1).

18 Confinement of SMF Columns

Confinement requirements for columns of special moment frames and columns not designated as part of the seismic-force-resisting system in structures assigned to SDC D, E, or F with high axial load \((P_u > 0.3A_g f'c)\) or high concrete compressive strength \((f'c > 10,000 \text{ psi})\) are significantly different.
18 Confinement of SMF Columns

18.7.5.2 — Transverse reinforcement shall be in accordance with (a) through (f):

(f) Where $P_u > 0.3A_g f_c$ or $f_c > 10,000$ psi in columns with rectilinear hoops, every longitudinal bar or bundle of bars around the perimeter of the column core shall have lateral support provided by the corner of a hoop or by a seismic hook, and the value of $h_x$ shall not exceed 8 in.

$P_u$ shall be the largest value in compression consistent with factored load combinations including $E$.

18 Columns of Special Moment Frames—Rectangular Hoop Reinforcement

$h_x = \text{max. value of } x \text{ on all column faces}$

Note: $h_x$ previously referred to the distance between legs of hoops or crossties. In the 2014 edition of the Code, $h_x$ refers to the distance between longitudinal bars supported by those hoops or crossties.
### 18 Confinement of SMF Columns

#### 18.7.5.4

Amount of transverse reinforcement shall be in accordance with Table 18.7.5.4.

The concrete strength factor, $k_f$, and confinement effectiveness factor, $k_n$, are calculated by (a) and (b).

\[
k_f = \frac{f_c'}{25,000} + 0.6 \geq 1.0 \quad (18.7.5.4a)
\]

\[
k_n = \frac{n_l}{n_l - 2} \quad (18.7.5.4b)
\]

where $n_l$ is the number of longitudinal bars or bar bundles around the perimeter of a column core with rectilinear hoops that are laterally supported by the corner of hoops or by seismic hooks.

<table>
<thead>
<tr>
<th>Transverse reinforcement $A_{sh} / s d_c$ for rectilinear hoop</th>
<th>Conditions</th>
<th>Applicable expressions</th>
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<tbody>
<tr>
<td>$P_u \leq 0.3A_g f'_c$ and $f_r' \leq 10,000$ psi</td>
<td>Greater of (a) and (b)</td>
<td>$0.3 \left( \frac{A_g}{A_{ch}} - 1 \right) \frac{f'<em>c}{f</em>{yt}}$ (a)</td>
</tr>
<tr>
<td>$P_u &gt; 0.3A_g f'_c$ or $f_r' &gt; 10,000$ psi</td>
<td>Greater of (a), (b) and (c)</td>
<td>$0.09 \frac{f'<em>c}{f</em>{yt}}$ (b)</td>
</tr>
<tr>
<td>$0.2k_f k_n \frac{P_u}{f_{yt} A_{ch}}$ (c)</td>
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</table>
18 Confinement of SMF Columns

18.7.5.4 —

\[ k_f = \frac{f'_c}{25,000} + 0.6 \geq 1.0 \]  

(18.7.5.4a)

<table>
<thead>
<tr>
<th>( f'_c ) (ksi)</th>
<th>( k_f )</th>
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<tr>
<td>10,000</td>
<td>1.00</td>
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<tr>
<td>12,500</td>
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<tr>
<td>15,000</td>
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<td>17,500</td>
<td>1.3</td>
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<td>20,000</td>
<td>1.4</td>
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<td>1.5</td>
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<tr>
<td>25,000</td>
<td>1.6</td>
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\[ n = \frac{n_l}{n_l - 2} \]

where \( n_l \) is the number of longitudinal bars or bar bundles around the perimeter of a column core with rectilinear hoops that are laterally supported by the corner of hoops or by seismic hooks.

<table>
<thead>
<tr>
<th>( n_l )</th>
<th>4</th>
<th>6</th>
<th>8</th>
<th>10</th>
<th>12</th>
<th>14</th>
<th>16</th>
<th>18</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>( k_n )</td>
<td>2.00</td>
<td>1.50</td>
<td>1.33</td>
<td>1.25</td>
<td>1.20</td>
<td>1.17</td>
<td>1.14</td>
<td>1.13</td>
<td>1.11</td>
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18 SMF Beam-Column Joints

For beam-column joints of special moment frames, restrictions on joint aspect ratio, clarification of development length of beam longitudinal reinforcement that is hooked, and requirements for joints with headed longitudinal reinforcement are new.

ACI 318 joint design provisions are based on the assumption that joint shear strength is provided mainly by a compression strut that develops diagonally across the joint. Joint transverse reinforcement confines the concrete strut, enabling it to resist shear under force reversals. The strut is most effective if the joint aspect ratio $h_{beam}/h_{column}$ is close to 1.0.
18 SMF Beam-Column Joints: Aspect Ratio Limitation

18.8.2.4 – Depth $h$ of the joint shall not be less than one-half of depth $h$ of any beam framing into the joint and generating joint shear as part of the seismic-force-resisting system.

$$\frac{h_{beam}}{h_{column}} \leq 2$$

18 SMF Beam-Column Joints: Hooked Reinforcement

The tail of 90-degree hooks is now required to be bent into the joint (Section 18.8.5.1).
18 SMF Beam-Column Joints: Headed Reinforcement

18.8.3.4 – Where beam negative moment reinforcement is provided by headed deformed bars that terminate in the joint, the column shall extend above the top of the joint a distance at least the depth $h$ of the joint.

Alternatively, the beam reinforcement shall be enclosed by additional vertical joint reinforcement providing equivalent confinement to the top face of the joint.

18 SMF Beam-Column Joints: Headed Reinforcement

18.8.5.2 — For headed deformed bars satisfying 20.2.1.5, development in tension shall be in accordance with 21.4.4, except clear spacing between bars shall be permitted to be at least $3d_b$. 
18 Design of Special Shear Walls

Design requirements for special shear walls have changed in significant ways in view of lessons learned from the Chile earthquake of 2010.

18.10.2.2 — At least two curtains of reinforcement shall be used in a wall if \( V_u > 2A_{cv}\lambda \sqrt{f_c'} \) or \( h_w/\ell_w \geq 2.0 \) in which \( h_w \) and \( \ell_w \) refer to height and length of entire wall, respectively.

R18.10.2 …The requirement for two layers of vertical reinforcement in more slender walls is to improve lateral stability of the compression zone under cyclic loads following yielding of vertical reinforcement in tension.
18 Design of Special Shear Walls

18.10.6.2 — Walls or wall piers with $h_w/l_w \geq 2.0$ that are effectively continuous from the base of structure to top of wall and are designed to have a single critical section for flexure and axial loads shall satisfy (a) and (b) or shall be designed by 18.10.6.3:

(a) Compression zones shall be reinforced with special boundary elements where

$$c \geq \frac{l_w}{600(1.5\delta_u / h_w)}$$

and corresponds to the largest neutral axis depth calculated for the factored axial force and nominal moment strength consistent with the direction of the design displacement. Ratio $\delta_u/h_w$ shall not be taken less than $0.007$ to $0.005$. 
18 Design of Special Shear Walls

18.10.6.4 — Where special boundary elements are required by 18.10.6.2 or 18.10.6.3, (a) through (e)(g) shall be satisfied:

(b) Width of flexural compression zone \( b \) over the horizontal distance calculated by 18.10.6.4(a), including flange if present, shall be at least \( h_u / 16 \);
18 Design of Special Shear Walls

18.10.6.4 —
(c) For walls or wall piers with $h_w/l_w \geq 2.0$ that are effectively continuous from the base of structure to top of wall, designed to have a single critical section for flexure and axial loads, and with $c/l_w \geq 3/8$, width of the flexural compression zone $b$ over the length calculated in 18.10.6.4(a) shall be greater than or equal to 12 in.

A value of $c/l_w \geq 3/8$ is used to define a wall critical section that is not tension-controlled according to 21.2.2. A minimum wall thickness of 12 in. is imposed to reduce the likelihood of lateral instability of the compression zone after spalling of cover concrete.
18 Design of Special Shear Walls

18.10.6.4 —

(e) The boundary element transverse reinforcement shall satisfy 18.7.5.2 (a) through (e) and 18.7.5.3, except the value \( h_x \) in 18.7.5.2 shall not exceed the lesser of 14 in. and two-thirds of the boundary element thickness, and the transverse reinforcement spacing limit of 18.7.5.3(a) shall be one-third of the least dimension of the boundary element.

---

18 Design of Special Shear Walls

R18.10.6.4 —

…The limits on \( h_x \) are intended to provide more uniform spacing of hoops and crossties for thin walls.

\[ h_x = \text{max. value of } x \text{ on all column faces} \]

Alternate 90-deg hooks

\[ 6d_b \geq 3 \text{ in.} \]

\[ 6d_b \text{ extension} \]

Provide add. trans. reinf. if thickness > 4 in.
18 Design of Special Shear Walls

18.10.6.4 —

(f) The amount of transverse reinforcement shall be in accordance with Table 18.10.6.4(f).

<table>
<thead>
<tr>
<th>Transverse reinforcement</th>
<th>Applicable expressions</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\frac{A_{sh}}{s D_c}$ for rectilinear hoop</td>
<td>Greater of (a) and (b)</td>
</tr>
<tr>
<td></td>
<td>$0.3 \left( \frac{A_g}{A_{sh}} - 1 \right) \frac{f'<em>c}{f</em>{yt}}$ (a)</td>
</tr>
<tr>
<td></td>
<td>$0.09 \frac{f'<em>c}{f</em>{yt}}$ (b)</td>
</tr>
</tbody>
</table>

Table 18.10.6.4(f) – Transverse reinforcement for special boundary elements

18 Design of Special Shear Walls

ACI 318-11 21.9.6.4 —

(c) The boundary element transverse reinforcement shall satisfy the requirements of 21.6.4.2 through 21.6.4.4, except Eq. (21-4) need not be satisfied and the transverse reinforcement spacing limit of 21.6.4.3(a) shall be one-third of the least dimension of the boundary element;
18 Design of Special Shear Walls

18.10.6.4 —

(f) The amount of transverse reinforcement shall be in accordance with Table 18.10.6.4(f).

<table>
<thead>
<tr>
<th>Transverse reinforcement</th>
<th>Applicable expressions</th>
</tr>
</thead>
<tbody>
<tr>
<td>$A_{sh}$ ( \frac{s}{b_c} ) for rectilinear hoop</td>
<td>Greater of (a) and (b)</td>
</tr>
<tr>
<td></td>
<td>$0.3 \left( \frac{A_g}{A_{ch}} - 1 \right) \frac{f_y'}{f_{yt}}$ (a)</td>
</tr>
<tr>
<td></td>
<td>$0.09 \frac{f_y'}{f_{yt}}$ (b)</td>
</tr>
</tbody>
</table>

Table 18.10.6.4(f) – Transverse reinforcement for special boundary elements

R18.10.6.4 —

For wall special boundary elements having rectangular cross section, $A_g$ and $A_{ch}$ in expressions (a) and (c) in Table 18.10.6.4(f) are defined as $A_g = \ell_{be} b$ and $A_{ch} = b_{c1} b_{c2}$, where dimensions are shown in Fig.R18.10.6.4.1. This considers that concrete spalling is likely to occur only on the exposed faces of the confined boundary element.
18 Design of Special Shear Walls

R18.10.6.4 —

Fig. R18.10.6.4.1 - Development of wall horizontal reinforcement in confined boundary element.

18.10.6.5 — Where special boundary elements are not required by 18.10.6.2 or 18.10.6.3, (a) and (b) shall be satisfied:

(a) If the longitudinal reinforcement ratio at the wall boundary exceeds $400/f_y$, boundary transverse reinforcement shall satisfy 18.7.5.2 over the distance calculated in accordance with 18.10.6.4(a).
18 Design of Special Shear Walls

18.10.6.5 —

(a) … The longitudinal spacing of transverse reinforcement at the wall boundary shall not exceed the lesser of 8 in. and $8d_b$ of the smallest primary flexural reinforcing bars, except the spacing shall not exceed the lesser of 6 in. and $6d_b$ within a distance equal to the greater of $l_w$ and $M_u/4V_u$ above and below critical sections where yielding of longitudinal reinforcement is likely to occur as a result of inelastic lateral displacements.

18 Slab-Column Joints (18.14.5)
18 Slab-Column Joints

Flat plate-column joints in buildings assigned to SDC D, E, or F shall be permitted to be without punching shear reinforcement only if interstory drift is acceptably low and/or punching shear due to gravity is acceptably low.

18 Slab-Column Joints (18.14.5)

ACI 318-11 21.13.6 — For slab-column connections of two-way slabs without beams, slab shear reinforcement satisfying the requirements of 11.11.3 and 11.11.5 and providing $V_s$ not less than $3.5\sqrt{f_c' b_{od}}$ shall extend at least four times the slab thickness from the face of the support, unless either (a) or (b) is satisfied:

(a) The requirements of 11.11.7 using the design shear $V_{ug}$ and the induced moment transferred between the slab and column under the design displacement;

(b) The design story drift ratio does not exceed the larger of 0.005 and $[0.035 - 0.05(V_{ug}/\phi V_c)]$. 

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Chapter 19—Concrete: Design and Durability Requirements

19 Durability of Concrete

Substantive changes have been made in concrete durability requirements, which are now located in Chapter 19.
Chapter 20—Steel Reinforcement Properties, Durability, and Embedments

20 Yield Strength of Reinforcement

The definition of yield strength of high-strength reinforcement ($f_y > 60,000$ psi) in Chapter 20 is now, for the first time, the same as that in ASTM specifications.

![Stress-strain diagrams showing methods of yield stress determination](image-url)

*a) Yield Point Method
b) Offset Method
c) Extension Under Load Method

*Figure 1. Stress-strain diagrams showing methods of yield stress determination*
20 Yield Strength of Reinforcement

ACI 318-11 3.5.3.2 — … for bars with $f_y$ less than 60,000 psi, the yield strength shall be taken as the stress corresponding to a strain of 0.5 percent and for bars with $f_y$ at least 60,000 psi, the yield strength shall be taken as the stress corresponding to a strain of 0.35 percent.

20 Yield Strength of Reinforcement

20.2.1.2 — Yield strength of nonprestressed bars and wires shall be determined by either (a) or (b):
(a) The offset method, using an offset of 0.2 percent
(b) The yield point by the halt-of-force method, provided the nonprestressed bar or wire has a sharp-kneed or well-defined type of yield point
Chapter 21—Strength Reduction Factors

No new content

Chapter 22—Sectional Strength
22 Compressive Strength of Prestressed Columns at Zero Eccentricity

New! 22.4.2.3 — Compressive strength of prestressed columns at zero eccentricity

New! 22.4.3.1— Nominal axial tensile strength of a nonprestressed, composite, or prestressed member

22 Punching Shear Strength

In 318-11, the nominal two-way shear strength of a slab-column connection that is subjected to concentric axial load only was expressed in terms of force \( (V_n) \), while the nominal two-way shear strength of a slab-column connection that is subjected to axial load and moment was expressed in terms of stress \( (\nu_n) \). In the two-way shear provisions for 318-14, the provisions are unified and expressed in terms of stress.
Chapter 23—Strut and Tie Models
Former Appendix A
No new content

Chapter 24—Serviceability Requirements
No new content
Chapter 25—Reinforcement Details

25 Standard Hook Geometry for Stirrups, Ties, and Hoops

Table 25.3.2 — Minimum inside bend diameters and standard hook geometry for stirrups, ties, and hoops

<table>
<thead>
<tr>
<th>Type of standard hook</th>
<th>Bar size</th>
<th>Minimum inside bend diameter, in.</th>
<th>Straight extension, $\ell_{\text{ext}}$, in.</th>
<th>Type of standard hook</th>
</tr>
</thead>
<tbody>
<tr>
<td>90-degree hook</td>
<td>No. 3 through No. 5</td>
<td>4$d_b$</td>
<td>Greater of 6$d_b$ and 3 in.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No. 6 through No. 8</td>
<td>6$d_b$</td>
<td>12$d_b$</td>
<td></td>
</tr>
<tr>
<td>135-degree hook</td>
<td>No. 3 through No. 5</td>
<td>4$d_b$</td>
<td>Greater of 6$d_b$ and 3 in.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No. 6 through No. 8</td>
<td>6$d_b$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
25 Mechanical or Welded Splices

Mechanical or welded splices with strengths below 125% of the yield strength of the spliced reinforcing bars are no longer permitted (Chapter 25). The associated stagger requirements have been deleted. Thus there is no longer a need to specify “full” mechanical or “full” welded splices.

Chapter 26—Construction Documents and Inspection
26 Construction Documents and Inspection

- 318 is written for the engineer, not the contractor.
- Construction requirements must be communicated on the construction documents.
- In 318-11, construction requirements were often with the design requirements.
- In 318-14, all construction requirements are gathered together in Chapter 26.

The construction requirements are designated either as “design information” or “compliance requirements.”

ACI 318-14, for the first time, includes inspection requirements in Chapter 26.

The inspection requirements are adapted from the 2015 IBC.
26 Deformed Steel Fiber Reinforcement

ACI 318-11 3.5 — Steel reinforcement

Discontinuous deformed steel fibers shall be permitted only for resisting shear under conditions specified in 11.4.6.1(f).

ACI 318-11 language has restricted other applications in which discontinuous deformed steel fibers could potentially be used. This was unintended.

Provision has been rephrased to indicate that ACI 318 so far only addresses its use for shear.

Other applications are not prohibited, but rather fall under Section 1.10 (Approval of special systems of design, construction, or alternative construction materials).
26 Deformed Steel Fiber Reinforcement

26.4.1.5 – Steel fiber reinforcement

26.4.1.5 – Compliance requirements:

(a) Steel fiber-reinforced concrete used for shear resistance shall satisfy (1) and (2):

(1) Conform to ASTM C1116

(2) Contain at least 100 lb of deformed steel fibers per cubic yard of concrete.

26 Mixture Proportioning

ACI 318-11 Sections 5.3 — Proportioning on the basis of field experience or trial mixtures, or both, 5.4 — Proportioning without field experience or trial mixtures, and 5.5 — Average compressive strength reduction contained prescriptive requirements for mixture proportioning.

These requirements are no longer found in ACI 318-14.

Instead, ACI 301-10, Specifications for Structural Concrete, is referenced (Section 26.4.3).
26 Mixture Proportioning

**Reason:** Many concrete producers are capable of using their quality control processes to develop appropriate mixtures without following the prescriptive procedures.

The prescriptive requirements on mixture proportioning were directed to the contractor. ACI 301 is the proper document for them.

ACI 318 need only provide the acceptance criteria for the concrete, which are now given in Section 26.4.2.

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**Further Information**

318-14 Resource Center

Transition Key: 318-11 to 318-14
Transition Key: 318-14 to 318-11
and other resources.
Thank You!!

For more information…

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