Are you ready?
The Reorganized ACI 318-14 Code
Are you ready?
American Concrete Institute
Always advancing
The Reorganized ACI 318-14 Code
- Are You Ready?

Neal S. Anderson, P.E., S.E.
Staff Consultant
Simpson Gumpertz & Heger, Chicago, Illinois
NSAnderson@sgh.com

Member ACI 318 – Structural Concrete Bldg. Code,
Chair 318B – Anchorage & Reinforcement
Really a Story about Cheese
“Cheese” – a metaphor for what we want to have in life, whether it is a job, a relationship, money, a big house, freedom, health, recognition, spiritual peace, or even an activity like jogging or golf.

Each of us has our own idea of what **Cheese** is, and we pursue it because we believe it makes us happy. If we get it, we often become attached to it *(perhaps 318-11)*.

And if we lose it, or it’s taken away, it can be traumatic *(new 318-14)*.
Our Cheese . . .

Ultimate Strength Design

Chapter Layout
As an engineer...

The more important your cheese is to you, the more you want to hold onto it.
Our Current Cheese . . .

- Most of us know where everything is . . .
- Chapter, section & provision (*Chapter, line & verse*)
- **318**: *Smell the cheese often so you know when it is getting old*. . .
Movement in a new direction helps you find new cheese.

Old beliefs do not lead you to new cheese.
So we moved the cheese . . .
The quicker you let go of old cheese (318-11), the sooner you find new cheese (318-14).

When you move beyond your fear of change, you feel free.
Move With The Cheese & Enjoy ACI 318-14!
Our new cheese . . .
Overview of Reorganization

• A brief history of ACI 318
• The rationale for reorganization
• How 318-14 is organized
• 318-14 style
• Timetable and available resources
History

• **1910** – first code published: “*Standard Building Regulations for the Use of Reinforced Concrete*”

• Structural provisions assumed a working stress limit through 1956

• “Ultimate Strength” approach firmly established in 1971 edition.

• **ACI 318** organization based on behavior of cast-in-place reinforced concrete
Goal: Life Safety
History

• **1971** Code had 750 provisions

• **2011** Code has more than 2,500 provisions

**ACI 318-11 compared to ACI 318-71**
Significant changes (since 1971)

- Development lengths
- Torsional strength
- Seismic design and detailing
- Integrity reinforcement
- Concrete exposure classes
- Strain-based strength reduction factors
- Anchoring to concrete
Overview of Reorganization

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318 Organization (since 1971)

• Chapters 7 to 12 are central to organization
  – Analysis
  – Serviceability (deflections, crack control, etc.)
  – Strength (flexure, shear, etc.)
  – Related Reinforcement Details
318-11 Organization (since 1971)

- Specialty Chapters
  - Two-way Slabs (Ch 13)
  - Footings (Ch 15)
  - Precast (Ch 16)
  - Prestressed (Ch 18)
  - Seismic (Ch 21)
  - Strut & Tie (Appendix A)
  - Anchoring to Concrete (Appendix D)
ACI 318-11
Organization

Shear Strength, Chapter 11
Flexural and Axial Strength, Chapter 10
Strength Reduction Factors, \( \phi \), Chapter 9
Lap Splice, 12.15-12.17
Ties in Joint, 11.10.2
Slope, 7.8.1.1
Ties, 7.10.5
Cover, 7.7
Need to find a tool?
ACI 318-14 Reorganization Process

2003: Committee discussion

2006: User survey, focus groups / workshops – engineers want:
  – Member design and detailing easily located
  – Code to be configured parallel to how members designed

2007: 2-day workshop in Chicago

2008: SC outline developed & effort approved by 318 Committee

2014
Major goals of reorganizing 318

• Find the information you need quickly
• Increase certainty that a design fully meets the Code
• Ability to add new topics easily

• “Clean out the Garage!”
And so the reorganization began...
Sometimes it wasn’t real smooth.....

2008 ................................. 2014
But we got there. Need to find a tool?
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- A brief history of ACI 318
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- Timetable and available resources
What does the reorganized 318-14 look like?
ACI 318-14 Organization - Groups

- General
- Systems
- Members
- Joints and Connections
- Toolbox
- Construction
ACI 318-14 Organization

• General Chapters
  – General – Scope, Application, Interpretation [1]
  – Notation and Terminology [2]
  – Referenced Standards [3]
    • Concrete Design Properties
    • Steel Design Properties
    • ASTMs, etc.
ACI 318-14 Organization

- General
- Systems
- Members
- Joints and Connections
- Toolbox
- Construction
ACI 318-14 Organization

• System Chapters
  – Structural Systems [new]
  – Loads and Load Combinations
  – Structural Analysis
  – Earthquake Resistant Structures
Chapter 4: Structural System Requirements

- Slabs
- Beams
- Columns
- Walls
- Foundation
- Diaphragms
- Seismic systems
- Loads
- Analysis
ACI 318-14 Organization

Chapter 4 – Structural System Requirements

4.1 Scope
4.2 Materials
4.3 Design loads
4.4 Structural system and load paths
4.5 Structural analysis
4.6 Strength
4.7 Serviceability
ACI 318-14 Organization

Chapter 4 – Structural System Requirements

4.8 Durability
4.9 Sustainability
4.10 Structural integrity
4.11 Fire resistance
4.12 Requirements for specific types of construction
4.13 Quality assurance, construction, and inspection
4.14 Strength evaluation of existing structures
ACI 318-14 Organization

• System Chapters
  – Structural Systems [new]
  – Loads and Load Combinations [5]
  – Structural Analysis [6]
  – Earthquake Resistant Structures [18]
### Chapter 6 - Structural Analysis

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>6.9 — Acceptability of finite element analysis</strong></td>
<td><strong>R6.9 — Acceptability of finite element analysis</strong></td>
</tr>
<tr>
<td><strong>6.9.1</strong></td>
<td>Finite element analysis to determine load effects shall be permitted.</td>
</tr>
<tr>
<td><strong>R6.9.1</strong></td>
<td>This section was introduced in the 2014 Code to explicitly recognize a widely used analysis method.</td>
</tr>
<tr>
<td><strong>6.9.2</strong></td>
<td>The finite element model shall be appropriate for its intended purpose.</td>
</tr>
<tr>
<td><strong>R6.9.2</strong></td>
<td>The licensed design professional should ensure that an appropriate analysis model is used for the particular problem of interest. …</td>
</tr>
<tr>
<td><strong>6.9.3</strong></td>
<td>For inelastic analysis, a separate analysis shall be performed for each factored load combination.</td>
</tr>
<tr>
<td><strong>R6.9.3</strong></td>
<td>For inelastic finite element analysis, the rules of linear superposition do not apply. …</td>
</tr>
<tr>
<td><strong>6.9.4</strong></td>
<td>The licensed design professional shall confirm that the results are appropriate for the purposes of the analysis.</td>
</tr>
<tr>
<td><strong>6.9.5</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>6.9.6</strong></td>
<td>Redistribution of moments calculated by an inelastic analysis shall not be permitted.</td>
</tr>
</tbody>
</table>
ACI 318-14 Organization

- General
- Systems
- Members
- Joints and Connections
- Toolbox
- Construction
ACI 318-14 Organization

Member Chapters

• One-Way Slabs [7]
• Two-Way Slabs [8]
• Beams [9]
• Columns [10]

• Walls [11]
• Diaphragms [new – 12]
• Foundations [13]
• Plain Concrete Members [14]
Punching shear crack is not intercepted by reinforcement, substantially reducing punching shear strength.

Possible Punching Shear Problem in Podium Slabs
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
## Example:

<table>
<thead>
<tr>
<th>Chapter 10 – Columns</th>
<th>Chapter 12 – Diaphragms</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.1 Scope</td>
<td>12.1 Scope</td>
</tr>
<tr>
<td>10.2 General</td>
<td>12.2 General</td>
</tr>
<tr>
<td>10.3 Design Limits</td>
<td>12.3 Design Limits</td>
</tr>
<tr>
<td>10.4 Required Strength</td>
<td>12.4 Required Strength</td>
</tr>
<tr>
<td>10.5 Design Strength</td>
<td>12.5 Design Strength</td>
</tr>
<tr>
<td>10.6 Reinforcement Limits</td>
<td>12.6 Reinforcement Limits</td>
</tr>
<tr>
<td>10.7 Reinforcement Detailing</td>
<td>12.7 Reinforcement Detailing</td>
</tr>
</tbody>
</table>
ACI 318-14 Organization

- General
- Systems
- Members
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ACI 318-14 Organization

• Joint / Connection Chapters
  – Beam-column and slab-column joints [15]
  – Connections between members [16]
  – Anchoring to concrete [17]
ACI 318-14 Organization

- General
- Systems
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- Toolbox
- Construction
ACI 318-14 Organization

• Toolbox Chapters
  – Strength Reduction Factors [21]
  – Sectional Strength [22]
  – Strut-and-Tie [23]
  – Serviceability [24]
  – Reinforcement Details [25]
ACI 318-14 Organization

Member Chapter

9.5 — Design strength

9.5.2 — Moment
9.5.2.1 — If $P_u < 0.10f'_cA_g$, $M_n$ shall be calculated in accordance with 22.3.
9.5.2.2 — If $P_u \geq 0.10f'_cA_g$, $M_n$ shall be calculated in accordance with 22.4.

Toolbox Chapter

22.3 — Moment strength...

22.4 — Axial strength or combined moment and axial strength...
ACI 318-14 Organization

- General
- Systems
- Members
- Joints and Connections
- Toolbox
- **Construction**
ACI 318-14 Organization

Chapter 26 – Construction Documents & Inspection

• **318-11** construction requirements
  ▶ *located with the design requirement*

• **318-14** construction requirements
  ▶ *gathered in Chapter 26*

• 318 written to engineer, not contractor

• Construction requirements on / in the construction documents
21.9.9 — **Construction joints**
All construction joints in structural walls shall conform to 6.4 and contact surfaces shall be roughened as in 11.6.9.

6.4.3 — Construction joints shall be so made and located as not to impair the strength of the structure. Provision shall be made for transfer of shear and other forces through construction joints. See 11.6.9.

11.6.9 — When concrete is placed against previously hardened concrete, the interface for shear transfer shall be clean and free of laitance. If \( \mu \) is assumed equal to 1.0\( \lambda \), interface shall be roughened to a full amplitude of approximately 1/4 in.
26.5.6 Construction, contraction, & isolation joints

26.5.6.1 Design information:
(a) If required by the design, locations and details of construction, isolation, and contraction joints.
(b) Details required for transfer of shear and other forces through construction joints.
(c) Surface preparation, including intentional roughening of hardened concrete surfaces where concrete is to be placed against previously hardened concrete.
(d) Locations . . . .
1. The Contractor shall detail all bar bends in accordance with ACI 318-14.
2. The Contractor shall provide lap splices in conformance with ACI 318-14.
3. The Contractor shall provide lap splices in conformance with ACI 318-14.

It is **NOT** intended that the Contractor will need to read and interpret the 318 Code.
Overview of Reorganization

• A brief history of ACI 318
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7.6.7.1—Center-to-center spacing of pretensioning tendons at each end of a member shall be not less than $4d_b$ for strands, or $5d_b$ for wire, except that if specified compressive strength of concrete at time of initial prestress, $f_{ci}'$, is 4000 psi or more, minimum center-to-center spacing of strands shall be 1-3/4 in. for strands of 1/2 in. nominal diameter or smaller and 2 in. for strands of 0.6 in. nominal diameter. See also 3.3.2.
### Table 25.2.4 — Minimum center-to-center spacing of pretensioned strands at ends of members

<table>
<thead>
<tr>
<th>$f'_{ci}$, psi</th>
<th>Nominal strand diameter in.</th>
<th>Minimum s</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 4000</td>
<td>All</td>
<td>$4d_b$ (a)</td>
</tr>
<tr>
<td>≥ 4000</td>
<td>≤ 0.5 in.</td>
<td>1-3/4 in. (b)</td>
</tr>
<tr>
<td></td>
<td>0.6 in.</td>
<td>2 in. (c)</td>
</tr>
</tbody>
</table>
18.1.2 — All provisions of this Code not specifically excluded, and not in conflict with provisions of Chapter 18, shall apply to prestressed concrete.

18.1.3 — The following provisions of this Code shall not apply to prestressed concrete, except as specifically noted:

Sections 6.4.4, 7.6.5, 8.12.2, 8.12.3, 8.12.4, 8.13, 10.5, 10.6, 10.9.1, and 10.9.2; Chapter 13; and Sections 14.3, 14.5, and 14.6, except that certain sections of 10.6 apply as noted in 18.4.4.
ACI 318-14 Style

• 9.6 — Reinforcement limits
  9.6.1 — Minimum flexural reinforcement in nonprestressed beams
  9.6.2 — Minimum flexural reinforcement in prestressed beams

• 9.7 — Reinforcement detailing
  9.7.3 — Flexural reinforcement in nonprestressed beams
  9.7.4 — Flexural reinforcement in prestressed beams
Benefits of ACI 318-14

- Organized from a designer’s perspective
- Easier to find specific requirements
- Intuitive location of information
- Reduced cross references
Benefits of ACI 318-14

- Tables simplify understanding of a provision
- Consistent language in text
- Format allows inclusion of new code topics and information
- Single idea for each requirement
Overview of Reorganization

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Timetable

• **318-14** is now available
  – We welcome errata
• Reference in IBC 2015
• Adoption dependent on local jurisdiction
Publication

• ACI 318-14 will be published in:
  – English
  – Spanish

• ACI 318-14 will be published in:
  – US Customary units
  – SI units
Publication

• It will be available in an variety of formats, including:
  – Printed copy
  – Enhanced PDF
  – EPUB, MOBI
Additional Resources

- Transition key – maps:
  - ACI 318-11 to ACI 318-14
  - ACI 318-14 to ACI 318-11

- Articles in *Concrete International*

- ACI *Reinforced Concrete Design Manual* will be consistent with 318-14

- Seminars, online learning, etc.
The Master Key

ACI 318-11 to ACI 318-14 and ACI 318.2-14
Building Code
Requirements for
Structural Concrete

ACI 318-14 and ACI 318.2-14 to ACI 318-11
Building Code
Requirements for
Structural Concrete

American Concrete Institute
Always advancing
318-14 Resource Center

ACI 318-14 Building Code Requirements for Structural Concrete is now available! To aid your transition to the 2014 edition, the American Concrete Institute has several resources available - transition keys, articles, papers, presentations, and videos are available now on this page. Seminars, webinars, and a new Reinforced Concrete Design Manual, are coming soon.

ACI 318 Transition Keys
- TRANSITION KEY: 318-11 TO 318-14
- TRANSITION KEY: 318-14 TO 318-11

ACI 318-14 Articles and Papers

ACI REINFORCED CONCRETE DESIGN MANUAL
Explorations, analyses, examples, and design aids for reinforced concrete structures - an invaluable companion to the new ACI 318-14 (Available 2014)
### Transition Key: 318-14 to 318-11

† = Heading, scope statement, introduction, or pointer to another section  
～ = Technical change  
BLANK = Editorial or no change  

#### Technical changes made to more than 200 individual provisions

<table>
<thead>
<tr>
<th>318-14</th>
<th>318-11</th>
<th>Note</th>
<th>Staff Comment</th>
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<tr>
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<tr>
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<tr>
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<td></td>
<td>†</td>
<td>Scope of chapter</td>
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<td>General</td>
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<td>1.2.1</td>
<td>New</td>
<td>~</td>
<td>CR015: Definition of &quot;this Code&quot;</td>
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<td>1.1.1</td>
<td></td>
<td></td>
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<tr>
<td>1.2.3</td>
<td>New</td>
<td>~</td>
<td>CR015: English version is the precedent for code interpretation</td>
</tr>
<tr>
<td>1.2.4</td>
<td>New</td>
<td>~</td>
<td>CR015: This is the official version for code interpretation</td>
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<tr>
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<td>1.1.1</td>
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<td>CR015: Provides the minimum requirements for safety and health of public</td>
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<td>1.3.2</td>
<td>New</td>
<td>~</td>
<td>CR015: Code can not anticipate all design issues</td>
</tr>
<tr>
<td>1.3.3</td>
<td>New</td>
<td>~</td>
<td>CR015: Does not cover construction means and methods</td>
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<td></td>
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<td>Applicability</td>
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<tr>
<td>1.4.1</td>
<td>New</td>
<td>~</td>
<td>CR015: Applies to the design and construction of concrete structures</td>
</tr>
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</table>
What do you think?

• **60 – 65**
  – I can’t wait until RETIREMENT so I don’t have to learn this !! . . .

• **20 – 25**
  – I don’t know any better, so I’ll learn it . . .

• **25 – 60**
  – You are likely used to ACI 318-11 (<) . . .
  – You are going to have to get used to the **new cheese** . . .
Questions?

Thank you

NSAnderson@sgh.com