318-11 vs. 318-14
Overview of Presentation

- A brief history of ACI 318
- The rationale for reorganization
- How 318-14 is organized and was built
- 318-14 style
- Available resources
History

- Founded in 1904
- HQ in Farmington Hills, Michigan, USA
I. General.

1. The term "Reinforced Concrete" shall be understood to mean an approved concrete which has been reinforced by metal in some form so as to develop the compressive strength of the concrete.

2. Reinforced concrete may be used for all classes of buildings if the design is in accordance with good engineering practice and stresses are figured as indicated in these regulations.

3. There shall be no limit upon the height of buildings of reinforced concrete except as limited by the requirements in these regulations.

4. Before permission is granted by the Building Department to erect any reinforced concrete building, complete plans, accompanied by specifications, signed by the engineer and architect, must be filed with the Building Department and remain on file for public inspection until the building is completed.

5. The Building Department shall have access to the computations, which shall give the loads assumed separately, such as dead and live loads, wind and impact, if any, and the resulting stresses.

6. The specifications shall state the qualities of the materials to be used for making the concrete, and the proportions in which they are to be mixed.
Goal: Life Safety
Code of Hammurabi (Circa 1772 B.C.)

“If a builder builds a house for someone, and does not construct it properly, and the house which he built falls in and kills its owner, then the builder shall be put to death.”

“If the owner's son dies, then the builder's son shall be put to death.”
Code of Hammurabi

Musée du Louvre

c.1772 B.C.
Code of Hammurabi

ACI Committee 318 shall reorganize the Code in 2014...

c.1772 B.C.
History

Building Code Requirements for Structural Concrete 318-14

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Advancing concrete knowledge
History

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

- Structural provisions assumed a working stress limit through 1956


- ACI 318 organization based on behavior of cast-in-place reinforced concrete
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
History

- 1971 Code had 750 provisions
- 2011 Code has more than 2,500 provisions

ACI 318-11 compared to ACI 318-71
ACI 318 Committee

Contractor  Structural Engineer  ACI 318 Chair

Building Official  Materials Engineer  University Researcher
ACI 318-14 Reorganization Process

- In 2003, committee 318 began discussion on code organization
- In 2006, ACI surveyed users about experience using 318
E-Survey Results

Question: How do you use the Code?

Percentage of Respondents

- Designing Buildings: 80
- As Reference Material: 60
- Repair/Strengthening: 50
- Non-building Structures: 40
- Resolving Field...: 30
- Writing Project...: 20
- Educational Use: 10
- Evaluation -- Existing...: 5
- Litigation Activities: 5
- Other: 0
ACI 318-14 Reorganization Process

**Survey feedback:**

- Engineers want all related information for a member’s design and detailing easily located
- Engineers want the Code to be more closely related to how they design members
318 Organization Since 1971

- Chapters 7 - 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)
Need to find a tool?
ACI 318-14 Reorganization Process

- 2003: committee began discussion
- 2006: surveyed users, held focus groups / workshops
  - Engineers want all related information for a member’s design and detailing easily located
  - Engineers want the code to be configured parallel to how they design members
- 2007: outline developed
- 2008: committee approved effort
Major goals of reorganizing 318

- Find the information you need quickly
- Increase certainty that a design fully meets the Code
- “Organize the Garage!”
And so the reorganization began...
Need to find a tool?
The beginning of a marathon...
The end of a marathon...
What does 318-14 look like?
ACI 318-14 Code Structure

- General
- Analysis
- Member Design
- Joints, Connections, and Anchoring to Concrete
- Seismic Design
- Material Properties for Design
- Strength and Serviceability
- General Reinforcement Details
- Construction Requirements
- Existing Structures
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American Concrete Institute
Always advancing
## 318 Code Contents

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ACI 318-14 Organization

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

General Chapters

- Scope, Application, and Principles of interpretation
- Notation and Terminology
- Referenced Standards
ACI 318-14 Organization

Systems Chapter
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

4.9 Sustainability

- LDP permitted to specify sustainability requirements in addition to strength, serviceability, and durability requirements
- Strength, serviceability, and durability requirements take precedence over sustainability requirements
ACI 318-14 Organization

System Chapters

- Structural Systems (new) Chapter 4
- Loads and Load Combinations
- Structural Analysis
- Earthquake Resistant Structures
ACI 318-14 Organization

- General
- Systems
- Members
- Joints and Connections
- Toolbox
- Construction

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ACI 318-14 Organization

Members Chapters

- One-Way Slabs
- Two-Way Slabs
- Beams
- Columns
- Walls

- Diaphragms (new)
- Foundations
- Plain Concrete Members
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
### ACI 318-14 Organization

#### Example:

<table>
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<th>Chapter 9 - Beams</th>
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<td>9.1 Scope</td>
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<td>10.2 General</td>
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<tr>
<td>10.3 Design Limits</td>
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<tr>
<td>10.4 Required Strength</td>
<td>9.4 Required Strength</td>
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<tr>
<td>10.5 Design Strength</td>
<td>9.5 Design Strength</td>
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<tr>
<td>10.6 Reinforcement Limits</td>
<td>9.6 Reinforcement Limits</td>
</tr>
<tr>
<td>10.7 Reinforcement Detailing</td>
<td>9.7 Reinforcement Detailing</td>
</tr>
</tbody>
</table>
ACI 318-14
Organization

Anchorage, Ch. 9
Flexure, Ch. 9
Shear, Ch. 9
Deflection, Ch. 9
Diaphragms and Collectors (Chapter 12)

- **Diaphragm**
- **Collector**
- **Transfer Slab/Diaphragm**
- **In-Plane Inertial Loads**
- **Out-of-Plane Wind Pressure or Inertial Loads**
- **Inclined Column**
- **Shear Transfer in Diaphragm**
- **Distributor**
- **Below Grade Soil Pressure**

[Diagram showing the components and forces in a diaphragm and collector system]
Stiffness assumptions

Any set of reasonable and consistent assumptions are permitted. (Most diaphragms can be modeled as rigid in their plane.)
Diaphragm components (chords)

(a) Plan

(b) Simple beam idealization

(c) Internal moment and shear resistance
Collectors (drags, struts)

(a) Plan

- Collector spread into slab
- Collector same width as wall

(b) Collector actions

\[ v_u \]
\[ C_{u,\text{max}} \]
\[ T_{u,\text{max}} \]
ACI 318-14 Organization

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

Joints / Connections

- Beam-column and slab-column joints
- Connections between members
- Anchoring to concrete
ACI 318-14 Organization

- General
- Systems
- Members
- Joints and Connections
- Toolbox
- Construction

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**Toolbox Chapters**

- Strength Reduction Factors
- Sectional Strength
- Strut-and-Tie
- Serviceability
- Reinforcement Details
Member Chapter

9.5 — Design strength
9.5.2 — Moment
9.5.2.1 — If \( P_u < 0.10f'_c A_g \), \( \phi M_n \) shall be calculated in accordance with 22.3.
If \( P_u \geq 0.10f'_c A_g \), \( \phi M_n \) 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 AND INSPECTION

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

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.
26.4.7 - Joints in concrete

26.4.7.1 - Design information:

(a) Locations and details of construction, isolation and contraction joints if required by the design.

(b) Provisions required for transfer of shear and other forces through construction joints.

(c) Surface preparation requirements including intentional roughening.
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>
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<tbody>
<tr>
<td>$&lt; 4000$</td>
<td>All</td>
<td>$4d_b$</td>
</tr>
<tr>
<td>$\geq 4000$</td>
<td>$\leq 0.5$ in.</td>
<td>1-3/4 in.</td>
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<tr>
<td></td>
<td>0.6 in.</td>
<td>2 in.</td>
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</tbody>
</table>
ACI 318-11 Style

Chapter 18 - Prestressed Concrete

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
Technical Changes in ACI 318-14

- Diaphragms
- Columns of special moment frames
- Beam-column joints of special moment frames
- Special structural walls
ing Off The Presses
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 improve speed of understanding

Consistent language in text

Single idea for each requirement
ACI 318-14

Variety of formats, including:
- Printed copy
- Enhanced PDF
- EPUB, MOBI

Versions:
- English
- Spanish
- Chinese
- In.-lb units
- SI units
## Transition Keys

Where did that provision go/come from?

ACI 318-11 ↔ ACI 318-14

Free PDF from ACI Store

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<th>Description</th>
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<td>Heading: Standard hooks</td>
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<tr>
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<tr>
<td>25.3.2</td>
<td>~</td>
<td>Revised so that standard hooks meet seismic hook requirements</td>
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<td>25.3.4</td>
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Design Handbook

15 chapters

Explanatory text

Design aids
318-14 Resource Center

ACI 318-14 Building Code Requirements for Structural Concrete is available! To aid your transition to the new edition, the American Concrete Institute has several resources available -- transition keys, articles, papers, presentations, seminars, and videos can be found on this page. A new ACI 318-14: "Reorganized for Design" On-line Learning Course is now available. A new Reinforced Concrete Design Manual is coming soon.

ACI 318 Transition Keys

TRANSITION KEY: 318-11 TO 318-14

TRANSITION KEY: 318-14 TO 318-15
uclean Effort:

150,000 man-hours

70 man-years

Over $14 million in volunteer time
Questions?