ACI 332-20
Residential Concrete

Code Influence on Foundations

International Residential Code
National Standard
Chapter 4, 2021 Edition
Basic prescriptive standards
Requirements standardized for a broad market
Limited Design Variety

ACI 332 Standard
Referenced by the International Residential Code (IRC)
“...or comply with the applicable standards of ACI 318 or ACI 332...”
Section R402.2 (Materials)
Section R403.1 (Footings)
Section R404 (Walls)
Chs. SPS 320-325; Wisconsin Uniform Dwelling Code

- Statewide building code for one- and two-family dwellings
- Structures built since June 1, 1980.
- The Industry Services Division provides consultation and education concerning UDC construction standards and inspection procedures.
- Building materials are evaluated for conformance with standards.
- UDC inspection and contractor credentials are administered.
- The UDC is enforced in all Wisconsin municipalities.
- 2018 version > ACI 332-14 for concrete prescription

ACI 332

Advantages

References for:
- Cold weather placement
- Footing excavations
- Wall jumps – footing discontinuity
- Footing spans
- Integrated footings
- Consolidation of wall requirements
- Increased design flexibility
- and more...

Committee 332 – Residential Concrete Work

- Who we are
- 50 members:
  - 43 voting
  - 7 consulting

MEMBER INTEREST EDIT

<table>
<thead>
<tr>
<th>Interest</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic/Educator</td>
<td>2%</td>
</tr>
<tr>
<td>Consultant</td>
<td>15%</td>
</tr>
<tr>
<td>Contractor</td>
<td>5%</td>
</tr>
<tr>
<td>Designer</td>
<td>23%</td>
</tr>
<tr>
<td>General Interest</td>
<td>12%</td>
</tr>
<tr>
<td>Producer</td>
<td>30%</td>
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<tr>
<td>Researcher</td>
<td>2%</td>
</tr>
<tr>
<td>User</td>
<td>7%</td>
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We’ve been doing this for a while

- Code
- Mandatory language
- 2004 – 26 pages
- 2008 – 31 pages
- 2010 – 34 pages
- 2014 – 58 pages
- 2020 – 74 pages

- Guide
- Not mandatory language
- 1984 – 38 pages
- 2006 – 52 pages
- 2018 – 68 pages
Intent of Codes

R101.3 Intent. ...to establish minimum requirements to safeguard the public safety, health and general welfare through affordability, structural integrity, means of egress facilities, stability, sanitation, light and ventilation, energy conservation and safety to life and property from fire and other hazards attributed to the built environment, and to provide safety to fire fighters and emergency responders during emergency operations.

2020 Code Scope

- Most Significant Changes
- Concrete requirements
- Design of structural concrete
  - Footings
  - Foundation walls
  - Above-grade walls
  - Lintels
- Complements the prescriptive design

Material Interaction: Rebar Contaminants

- 4.2.4 Surface conditions of reinforcement—At the time concrete is placed, deformed bar and welded wire reinforcement shall be free of materials deleterious to development of bond strength between the reinforcement and the concrete.

Table 5.1.1—Exposure categories and classes

<table>
<thead>
<tr>
<th>Category</th>
<th>Exposure Conditions</th>
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<tbody>
<tr>
<td>RF</td>
<td>Concrete not exposed to freezing-thawing cycles</td>
</tr>
<tr>
<td>Moderate</td>
<td>Concrete exposed to moisture but not likely to be in a saturated condition when exposed to freezing-thawing cycles</td>
</tr>
<tr>
<td>Severe</td>
<td>Reinforced concrete exposed to moisture and with the potential of being saturated when exposed to freezing-thawing cycles</td>
</tr>
<tr>
<td>Very Severe</td>
<td>Plate concrete exposed to moisture and freezing-thawing cycles with the potential of being saturated when exposed to freezing-thawing cycles</td>
</tr>
<tr>
<td>Most Severe</td>
<td>Reinforced concrete exposed to moisture and freezing-thawing cycles with the potential of being saturated when exposed to freezing-thawing cycles</td>
</tr>
</tbody>
</table>

R4.2.4 Common surface contaminants such as concrete splatter, rust, form oil, or other release agents have been found not to be deleterious to bond.
Cold weather means the need for protection and the opportunity for better quality concrete.

Code Influence: Material Performance

- **6.6.1** During anticipated ambient temperature conditions of 35 °F or less, concrete temperature shall be maintained above a frozen state until a concrete compressive strength of 500 psi has been reached.

- **Frozen concrete wall (MN)**

- **6.6.2** Concrete materials, reinforcement, forms, and any earth with which concrete is to come in contact shall be free from ice, snow and frost.

- **6.6.3** Frozen materials or materials containing ice shall not be used.
Snow Insulates?
Contractor felt the snow would be melted from the forms...instead, it was pushed to one mound.

Cold Weather Research
- Referenced by ACI 332
- Referenced by ACI 306
- Only research specifically conducted on residential concrete foundation walls
- Validates mix design options
- Encourages use of Maturity

ACI 332 – Lateral Soil Load
- The definition and classification of soil materials shall be in accordance with ASTM D2487.
- Design lateral soil loads are given for moist conditions for the specified soils at their optimum densities. Actual field conditions shall govern. Submerged or saturated soil pressures shall include the weight of the buoyant soil plus the hydrostatic loads.
- For relatively rigid walls, as when braced by floors, the design lateral soil load shall be increased for sand and gravel type soils to 60 psf per foot of depth. Basement walls extending not more than 10 ft below grade and supporting light floor systems are not considered as being relatively rigid walls.
- Unsuitable as backfill material.
Foundation Systems
Several components and products must work together to have an effective system.

Footing Design & Construction
Isolated pads, continuous strip, trench, integrated slab, piers and pilings...a complicated system.

ACI 332-20: Tables 8.6.1.a – f
ACI 332 8.2.4 – Unsupported Footings

- 8.2.4.1 Trenches under footings shall be backfilled to prevent movement of the adjacent soil. Trenches should be 1 ft deep or less to match the adjacent soil conditions.

- 8.2.4.2 Where an unsupported wall footing section does not exceed a 3 ft span, at least two No. 4 reinforcing bars shall be securely positioned in the bottom of the footing and extend at least 18 in. into the supported sections on both sides. Reinforcing bars shall have a cover as specified in 5.6.4.

Continuous Footings:

- IRC – R403.1 – All exterior walls shall be supported on continuous solid concrete footings.

- ACI 332 – 8.2.5
ACI 332-20
Footing Requirements

8.2.5 Maximum length of discontinuity
- 4 feet

The walls must be designed for the span
The footing around the discontinuity shall bear on at least 4 feet of undistributed soil

Typical additional discontinuity wall reinforcement:
- 2 - #4 reinforcement bars across the bottom
- 1 - #4 reinforcement bars across the top

ACI 332-14
Foundation Wall Structure:

9.2.7 - Horizontal Reinforcement
- All walls must have horizontal reinforcement.
- Vertical rebar is placed on the inside.
- 3 horizontal bars are needed if the wall is 8 feet or less in height
- 4 horizontal bars if the wall is more than 8 feet high
- 1 bar in the upper 24 in. and 1 bar in lower 24 in., except SDC D, E and F (2 in upper 24 in.)

ACI 332 – Wall Design Tables

- Combined tables for plain and reinforced originated in 2004 edition
- Ten (10) tables for concrete strengths from 2,500 psi to 4,500 psi at steel strengths of 40 and 60 ksi
- Significant departure from IRC design tables
- Wall heights up to 10-ft.
ACI 332 -20
Wall Detailing

Reduced Wall Thickness:
Getting brick to grade for the homeowner.

ACI 332-14

- Increasing Reduced Wall Thickness Height

Backfill:

9.7.4.1 – Before backfill
- The top and bottom restraint shall be in place before backfill
- Temporary lateral restraint shall be permitted.

R404.1.7 – Shall not be placed until sufficient strength is obtained to
anchor it, at least 6 inches from grade against damage. Except ≤ 4 feet unbalanced
Surface Irregularities:

9.7.3 – fins or projections greater than 0.5 in. shall be removed to prevent interference with waterproofing systems or interior finishes.

R9.7.3 Remove fins or other projections

• to prevent interference with dampproofing and waterproofing systems
• to prevent interference with interior finish systems where the wall surface encloses occupied space.

IRC does not address irregularities.

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Final Questions?