Defining Failures in Residential Construction

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Description

• The word "failure" is one of the more subjective terms in the field of residential construction and design, yet this term appears in a multitude of design guides, best practice documents, and other literature. This webinar will take a step back to look at what the term failure may mean in different settings. The viewpoints of various construction industry stakeholders will be used to understand the differences in perspective and how they determine the applicability and severity of building failures. Case studies will be used to understand this concept further. Each case study will analyze the role of building codes in the overall situation.

Learning Objectives

• Analyze the various definitions of the term failure as it is viewed from the perspective of various stakeholders, including homeowners, builders, and design professionals.
• Understand the impact that failures can have on the local and national residential construction industry through analysis of various case studies.
• Examine the impact of past failures on the future of occupant safety, building codes, and construction costs.
• Develop methods for mitigating risks of failure throughout the design, construction, and occupancy of residential structures.
Outline

- Definitions
- Case Studies / Examples
- Impacts on Stakeholders & Risk Mitigation

What is Failure?

- **Structural Failure:**
  - The inability of a structure or structural member to perform its intended function, perhaps caused by collapse or excessive deformation.
  - DictionaryofConstruction.com

- Do homes experience non-structural failures?

Examples of Failures

- Inadequate HVAC system
- Excessive deflection in floor joists
- Burst water lines due to inadequate installation
- OSB rot due to moisture intrusion
Two Main Categories

1. Structural
2. Building Envelope

Structural Failures

- Potential causes:
  1. Design
  2. Construction
  3. Materials/systems
  4. Space usage

Design Example

- Basement beam to column connection (bearing)

Considerations
- Load accumulation
- Column compression and buckling
- Beam compression perpendicular to grain
Modification and installation of wood structural components

Considerations
- Manufacturer guidelines
- Joist hole and notch guidelines
- General jobsite safety
2009 IRC Requirements

- R802.10.3 Bracing.
  - Trusses shall be braced to prevent rotation and provide lateral stability in accordance with the requirements specified in the construction documents for the building and on the individual truss design drawings. In the absence of specific bracing requirements, trusses shall be braced in accordance with the Building Component Safety Information (BCSI 1-03) Guide to Good Practice for Handling, Installing & Bracing of Metal Plate Connected Wood Trusses.
2009 IRC Requirements

- **R502.8 Drilling and notching.**
  - Structural floor members shall not be cut, bored or notched in excess of the limitations specified in this section. See Figure R502.8.
- **R502.8.1 Sawn lumber.**

![Diagram of R502.8](image)
2009 IRC Requirements

• RS02.8.2 Engineered wood products.
  - Cuts, notches and holes bored in trusses, structural composite lumber, structural glue-laminated members or I-joints are prohibited except where permitted by the manufacturer’s recommendations or where the effects of such alterations are specifically considered in the design of the member by a registered design professional.
2009 IRC Requirements

- R602.6.1 Drilling and notching of top plate.
  - When piping or ductwork is placed in or partly in an exterior wall or interior load-bearing wall, necessitating cutting, drilling or notching of the top plate by more than 50 percent of its width, a galvanized metal tie not less than 0.054 inch thick (1.37 mm) (16 ga) and 11/2 inches (38 mm) wide shall be fastened across and to the plate at each side of the opening with not less than eight 10d (0.148 inch diameter) having a minimum length of 11/2 inches (38 mm) at each side or equivalent. The metal tie must extend a minimum of 6 inches past the opening. See Figure R602.6.1.
2009 IRC Requirements

- SECTION R317
  - PROTECTION OF WOOD AND WOOD BASED PRODUCTS AGAINST DECAY

- R317.1 Location required.
  - Protection of wood and wood based products from decay shall be provided in the following locations by the use of naturally durable wood or wood that is preservative-treated in accordance with AWPA U1 for the species, product, preservative and end use...
  - 2. All wood framing members that rest on concrete or masonry exterior foundation walls and are less than 8 inches (203 mm) from the exposed ground.

Space Usage Example

- Overloaded floor system
- Considerations
  - Design load selection
  - Product durability
  - Factor of safety
  - Communication of occupancy limits
2009 IRC Requirements

• **R301.5 Live load.**
  
  The minimum uniformly distributed live load shall be as provided in Table R301.5.

<table>
<thead>
<tr>
<th>USE</th>
<th>SAFE LOAD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attics without storage</td>
<td>30 p.s.f.</td>
</tr>
<tr>
<td>Attics with limited storage</td>
<td>20 p.s.f.</td>
</tr>
<tr>
<td>Habitable attic and closets</td>
<td>10 p.s.f.</td>
</tr>
<tr>
<td>Stairs</td>
<td>40 p.s.f.</td>
</tr>
<tr>
<td>Balconies</td>
<td>40 p.s.f.</td>
</tr>
<tr>
<td>Guardrails and handrails</td>
<td>20 p.s.f.</td>
</tr>
<tr>
<td>Guardrail in-fill components</td>
<td>50 p.s.f.</td>
</tr>
<tr>
<td>Passenger vehicle garages</td>
<td>60 p.s.f.</td>
</tr>
<tr>
<td>Habitable attic that projects into sleeping windows</td>
<td>40 p.s.f.</td>
</tr>
<tr>
<td>Sleeping rooms</td>
<td>40 p.s.f.</td>
</tr>
</tbody>
</table>

**TABLE R301.5 MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS (in pounds per square foot)**


Building Envelope Failures

• **Potential causes:**
  
  — Assembly design
  — Construction
  — Material specification
  — Changing boundary conditions
ENCLOSURE FAILURE

Assembly Design Example

• Exterior plaster tear-offs

• Considerations
  — Water-resistant barrier selection
  — Assembly design
  — Flashing details
  — Above-code options

2009 IRC Requirements

• R703.6.3 Water-resistant barriers.
  — Water-resistant barriers shall be installed as required in Section R703.2
    and, where applied over wood-based sheathing, shall include a water-resistant
    vapor-permeable barrier with a performance at least equivalent to
    two layers of Grade D paper.

  — Exception: Where the water-resistant barrier that is applied over wood-
    based sheathing has a water resistance equal to or greater than that of 60
    minute Grade D paper and is separated from the stucco by an intervening,
    substantially non-water-absorbing layer or designed drainage space.
One Layer vs. Two

- **2003 International Residential Code**
  - R703.2 Weather-resistant sheathing paper.
    - Asphalt-saturated felt free from holes and breaks, weighing not less than 14 pounds per 100 square feet (0.683 kg/m²) and complying with ASTM D 226 or other approved weather-resistant material shall be applied over studs or sheathing of all exterior walls as required by Table R703.4. Such felt or material shall be applied horizontally, with the upper layer lapped over the lower layer not less than 2 inches (51 mm). Where joints occur, felt shall be lapped not less than 6 inches (152 mm).


**ENCLOSURE FAILURE**

**Construction Example**

- Bulk moisture intrusion

- Considerations
  - Flashing detail design
  - Flashing detail execution
  - Flashing material selection
Kick-out Flashing Examples

2009 IRC Requirements

- R005.2.8.3 Sidewall flashing.
  - Flashing against a vertical sidewall shall be by the step-flashing method. The flashing shall be a minimum of 4 inches (102 mm) high and 4 inches (102 mm) wide.
  - At the end of the vertical sidewall the step flashing shall be turned out in a manner that directs water away from the wall and onto the roof and/or gutter.
How Does This Affect the Industry?

- Builders:
  - Warranties
  - Insurance
  - HIC License
  - Statute of repose (PA)
Builder Warranties

• “Warranties for newly built homes generally offer limited coverage on workmanship and materials relating to various components of the home, such as windows, heating, ventilation and air conditioning (HVAC), plumbing, and electrical systems for specific periods.”

• Typical duration
  — General workmanship and materials = 1 year
  — MEP = 2 years
  — Structural = 10 years

Insurance

• Insurance may provide protection against lawsuits and other financial liabilities
  — General Liability Insurance
  — Errors & Omissions Insurance

• Considerations:
  — How much?
  — Subcontractor liability?
  — What does my insurance cover?

HIC License

• PA Home Improvement Consumer Protection Act (HICPA)
  — Requires all contractors who perform $5,000 or more in home improvement work in a year to register with the PA Attorney General
  — (ix) Proof of liability insurance covering personal injury in an amount not less than $50,000 and insurance covering property damage caused by the work of a home improvement contractor in an amount not less than $50,000.
Statute of Repose

- PA Title 42 – Chapter 55 – Limitation of Time
  - § 5536. Construction projects.
  - (a) General rule. Except as provided in subsection (b), a civil action or proceeding brought against any person lawfully performing or furnishing the design, planning, supervision or observation of construction, or construction of any improvement to real property must be commenced within 12 years after completion of construction of such improvement to recover damages for:
    1. Any deficiency in the design, planning, supervision or observation of construction or construction of the improvement.
    2. Injury to property, real or personal, arising out of any such deficiency.
    3. Injury to the person or for wrongful death arising out of any such deficiency.
    4. Contribution or indemnity for damages sustained on account of any injury mentioned in paragraph (2) or (3).

Summary

- Failure can be defined in many ways from many different perspectives
- How can builders and contractors reduce their risk?
  - Understand regulations and their liability
  - Communicate with design team and subcontractors
  - Incorporate best practices and above-code practices where necessary