

PHRC Webinar Series | Tuesday, January 12, 2016 @ 1pm

## 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.



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### 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.



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## Outline

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



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## 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?



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## Examples of Failures

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



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**Two Main Categories**

- 1. Structural**
- 2. Building Envelope**

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**Structural Failures**

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

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STRUCTURAL FAILURE

**Design Example**

- Basement beam to column connection (bearing)**
- Considerations**
  - Load accumulation
  - Column compression and buckling
  - Beam compression perpendicular to grain

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STRUCTURAL FAILURE

### Construction Example

- **Modification and installation of wood structural components**
- **Considerations**
  - Manufacturer guidelines
  - Joist hole and notch guidelines
  - General jobsite safety



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**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.

13 International Code Council (ICC). (2008). 2009 International Residential Code, Country Club Hill, Ill.

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### 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.**

FLOOR JOIST—CENTER CUTS

International Code Council (ICC). (2008). 2009 International Residential Code, Country Club Hill, Ill.

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### 2009 IRC Requirements

- **R502.8.2 Engineered wood products.**
  - Cuts, notches and holes bored in trusses, structural composite lumber, structural glue-laminated members or I-joists 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.

25 International Code Council (ICC). (2008). 2009 International Residential Code, Country Club Hill, Ill.

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## 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 1 1/2 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 1 1/2 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.

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International Code Council (ICC). (2008). 2009 International Residential Code, Country Club Hill, Ill.




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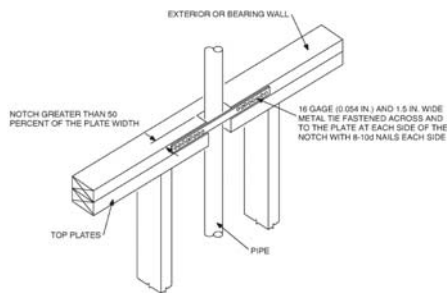
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## 2009 IRC Requirements



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International Code Council (ICC). (2008). 2009 International Residential Code, Country Club Hill, Ill.




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### STRUCTURAL FAILURE

## Materials/Systems Example

- **Wood structural member durability**
- **Considerations**
  - Moisture exposure
  - Bearing conditions
  - General maintenance

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**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 AWPAC 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.

31 International Code Council (ICC). (2008). 2009 International Residential Code, Country Club Hill, Ill.

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**STRUCTURAL FAILURE**

**Space Usage Example**

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

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### 2009 IRC Requirements

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

USE	LIVE LOAD
Attics without storage <sup>b</sup>	10
Attics with limited storage <sup>b, c</sup>	20
Habitable attics and attics w/ fixed stairs	30
Balconies (exterior) and decks <sup>a</sup>	40
Fire escapes	40
Guardrails and handrails <sup>d</sup>	200 <sup>e</sup>
Guardrail in-fill components <sup>f</sup>	50 <sup>g</sup>
Passenger vehicle garages <sup>a</sup>	50 <sup>g</sup>
Rooms other than sleeping room	40
Sleeping rooms	30
Stairs	40 <sup>g</sup>

International Code Council (ICC). (2008). 2009 International Residential Code, Country Club Hill, Ill.

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### Building Envelope Failures

- Potential causes:**
  - Assembly design
  - Construction
  - Material specification
  - Changing boundary conditions

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ENCLOSURE FAILURE

## Assembly Design Example

- Exterior plaster tear-offs
- Considerations
  - Water-resistive barrier selection
  - Assembly design
  - Flashing details
  - Above-code options

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## 2009 IRC Requirements

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

39 International Code Council (ICC). (2008). *2009 International Residential Code*, Country Club Hill, Ill. 

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## 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/m<sup>2</sup>) 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).

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International Code Council (ICC). (2003). *2003 International Residential Code*, Country Club Hill, Ill.



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ENCLOSURE FAILURE

## Construction Example

- Bulk moisture intrusion
- Considerations
  - Flashing detail design
  - Flashing detail execution
  - Flashing material selection

SEE SECTION DETAIL THIS PAGE



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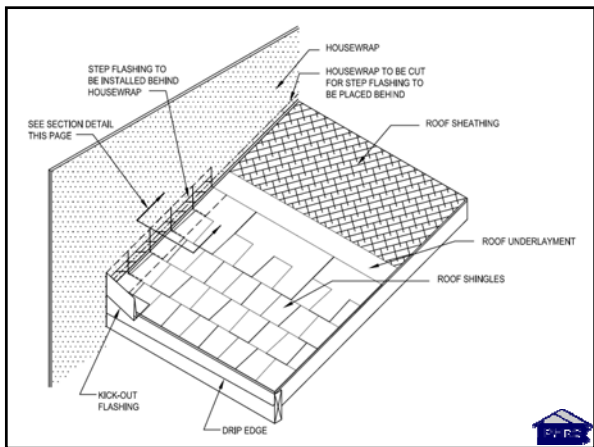
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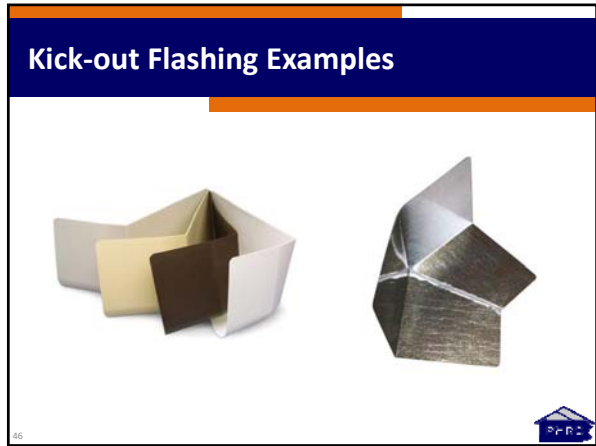
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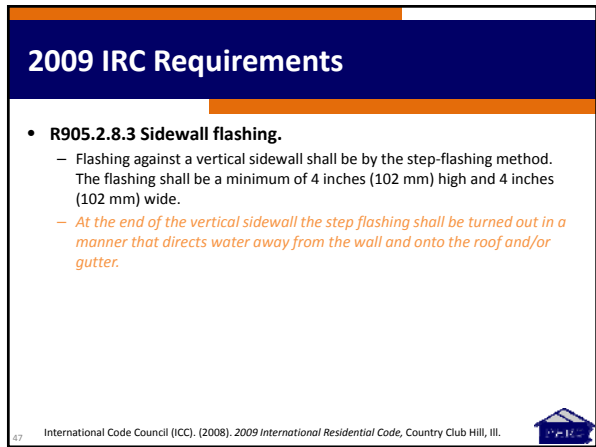
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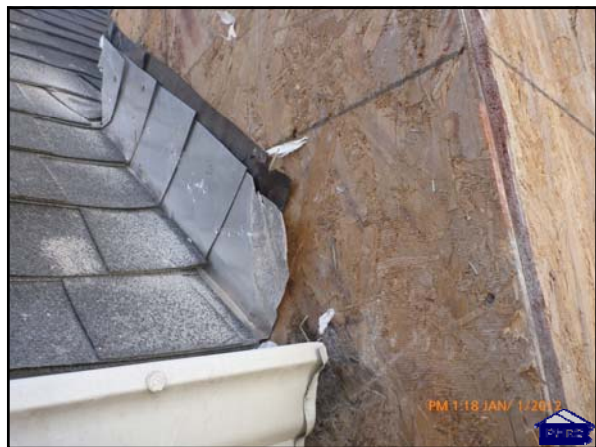
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**How Does This Affect the Industry?**

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

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## 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.”
  - Federal Trade Commission – Consumer Information ([www.consumer.ftc.gov](http://www.consumer.ftc.gov))
- **Typical duration**
  - General workmanship and materials = 1 year
  - MEP = 2 years
  - Structural = 10 years

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## 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?

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## 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.*

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## 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).

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## 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

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