

Implications of the IRC Seismic Requirements on Brick Veneer Construction

October 14, 2021

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AIA Provider: 505119857



Course Description

This presentation reviews the implications of the 2018 International Residential Code (IRC) seismic regulations on brick veneer construction in the United States. The primary focus is on those areas assigned to Seismic Design Category D_0 or above. The issues are whether the prescriptive requirements for brick veneer enhance the safety of the structure and whether they are justified when the seismic risk is compared to other risks.

Design loads for wind and seismic risks are compared. Wind loads are typically higher than seismic for design. Wind values are higher without the consideration of weather events such as tornadoes. Still, the design earthquake remains at 2,475 years, which is roughly the same likelihood of occurrence as a tornado in parts of the country. All risks need to be considered and weighed appropriately.

The IRC assigns a damping value for wood framed construction of 5%. Wood frame construction, the most common for residential construction, will typically have damping values higher than this. With increased damping values the discrepancy between wind and seismic loads becomes even greater. When proper ties and fasteners are used, brick veneer construction can perform well under seismic conditions. Brick veneer can be inadvertently penalized by increased seismic requirements despite the added benefits of brick in a more likely event such as fire and wind-borne debris

Learning Objectives

- Requirements by Seismic Design Category (SDC) C, D, and E
- Risk posed by seismic events
- Differences between San Andreas and New Madrid fault zones
- Current rulings and amendments in the state of Tennessee
- Moving Forward

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Seismic Requirements by Category

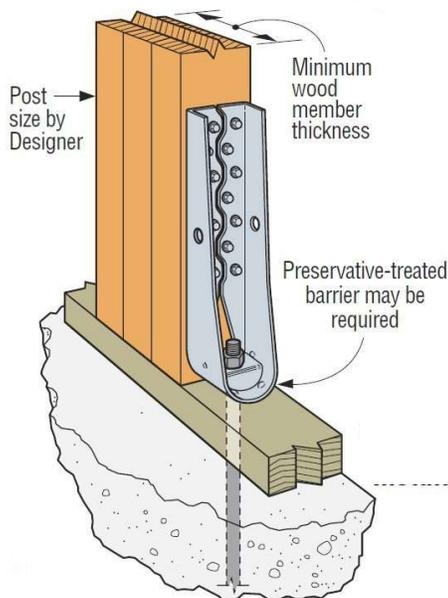
- Category C:
 - Isolate sides and top of veneer walls. (R606.12.2.2.2)
- Category D:
 - Brick on 2nd story limited to one side only or 25% of floor area. (R602.10.6.5)
 - Brick veneer over one story requires hold downs. (R603.9.5.1)
 - Allowable Tie Area reduced by 75%. (R703.8.4.1)
 - Use ring shank nails or #10 screws for ties. (Table R703.8.4(1))
 - Mortar Type M or S (R606.2.8.3)
 - Townhouses must be engineered. (R602.10.6.5)
 - Masonry chimneys require special considerations. (R1001.3)
- Category E:
 - All restrictions for category C and D still apply
 - Brick veneer limited to one story. (IBC 2308.6.10.2)
 - Isolate each story. (TMS 402 12.2.2.10.3)
 - Designed to resist seismic loads in accordance with the IBC (R301.2.2)

*Engineered design can be used, but that comes at a cost.

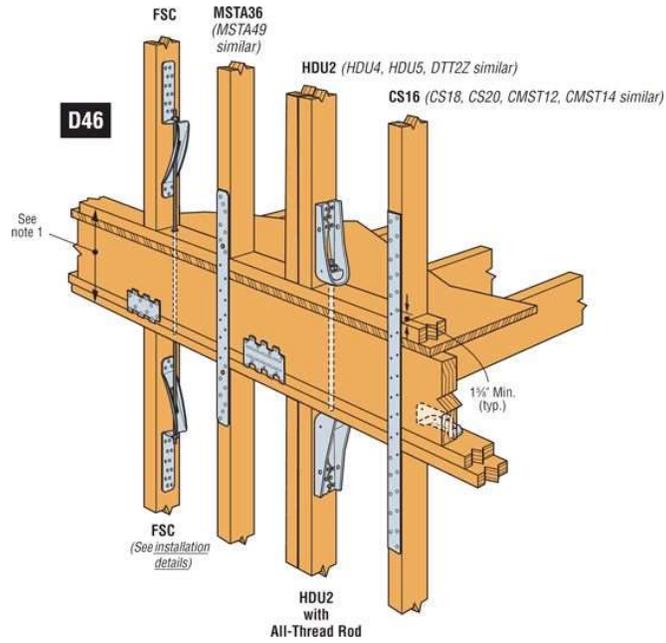
2018 IRC Seismic Summary – If Adopted

- If the new code is adopted it will have major implications for areas moving into higher SDC
 - Large impact on residential construction
 - Brick limited to 1-story max in (SDC E)
 - Without additional considerations and engineered design
 - Second story brick limited to one side only or 25% of floor area (SDC D₀, D₁, and D₂)
 - Without additional considerations and engineered design
 - Number of Brick Ties increased in (SDC D₀, D₁, and D₂)
 - Maximum veneer weight drops to 40 psf (SDC D₀, D₁) and 30 psf (SDC D₂)
 - Homes over one story will require hold downs

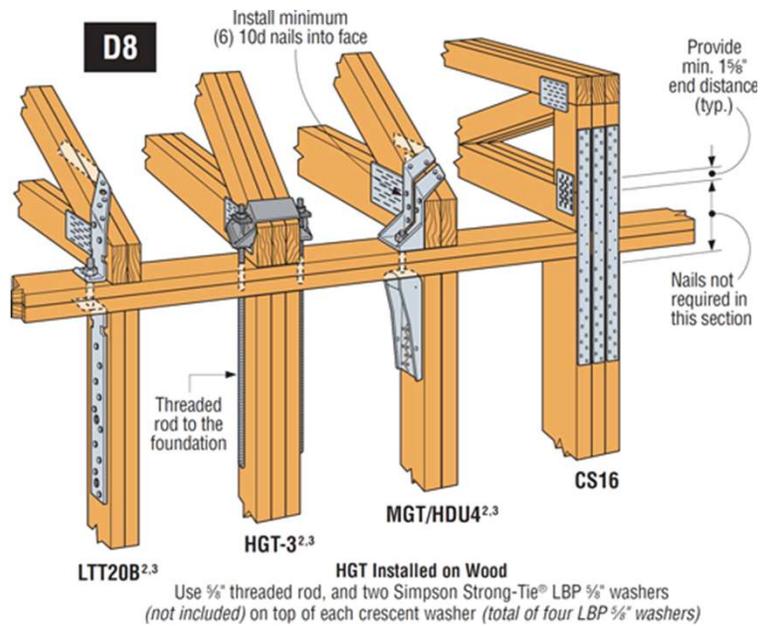
Foundation Hold Downs



Floor to Floor Hold Downs



Roof Hold Downs



We have been making our case since 2000

IRC 2000 Included the 1st major seismic changes in TN

- Wind loads typically govern
- Designs are not made based on tornados, yet the return period for a design earthquake and tornado is roughly the same
- Wood frame construction has higher damping values than 5%
- Brick is a superior cladding for resistance to fire and windborne debris



IMPLICATIONS OF THE IRC SEISMIC REQUIREMENTS ON BRICK VENEER CONSTRUCTION IN THE SOUTHEAST

Richard M. Bennett¹ and Jim Bryja²

Abstract

The implications of the 2000 International Residential Code seismic regulations on brick veneer construction in the southeastern United States are discussed. The primary focus is on those areas assigned to Seismic Design Category D_s or above. The basic issue is whether the prescriptive requirements for brick veneer enhance the safety of the structure, and whether they are justified when the seismic risk is compared to other risks.

Wind and seismic risks and design loads are compared. Typically, wind will result in a higher design load than seismic. In addition, the design wind loads do not consider extreme events, such as tornados. Yet the new design earthquake (2475 year return period) has about the same chance of occurring as a tornado.

Other issues in the IRC code are examined. These include the prescriptive joint reinforcement required in veneer, which has been shown to be unnecessary. The seismic design forces are also based on an assumed 5% damping while residential structures will typically have higher damping values.

Increased seismic requirements can penalize a type of construction, brick veneer, which is advantageous in reducing other risks, such as fire and windborne debris. These other risks are more likely to occur than an earthquake.

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Seismic Map 2018 IRC

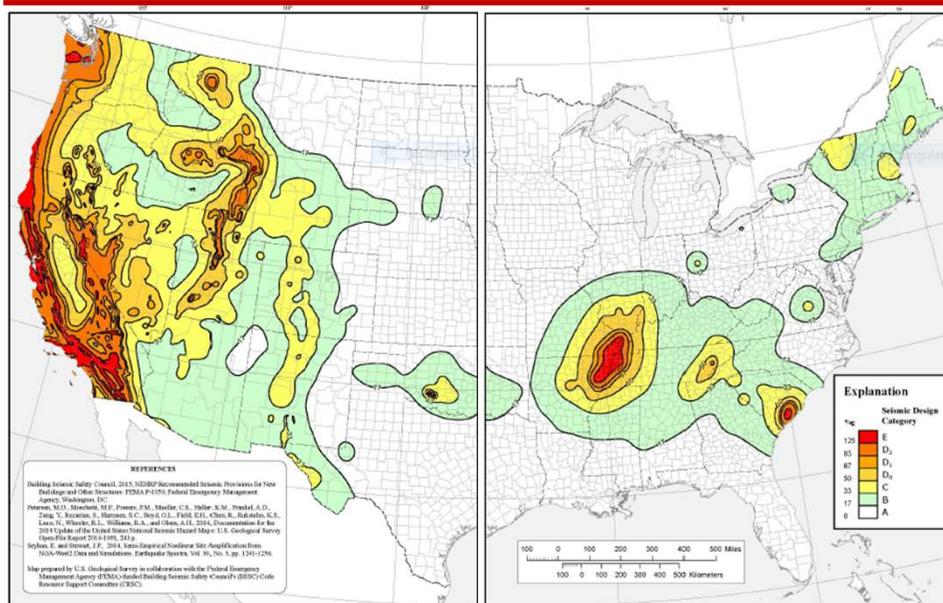


FIGURE R301.2(2) SEISMIC DESIGN CATEGORIES

FIGURE R301.2(2) - continued SEISMIC DESIGN CATEGORIES

Annual Causes of Death (USA-2019)

Earthquake	2 (total from 2000 -2012)
Severe Weather	534
Fires	2,692
Vehicle Accidents	39,107

Seismic Loads Typically Don't Govern the Design

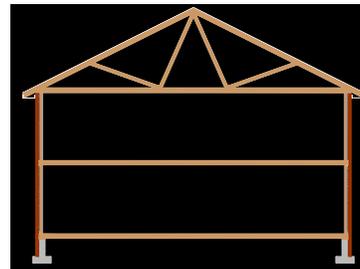
Seismic Load

SDC	Load (lbs)
C	11,016
D ₂	27,612
E	33,453

Wind Load

Wind Speed (mph)	Load (lbs)
105	30,386
115	36,450
150	62,020

*Vast majority of the United States has a design wind speed of 105 mph or higher

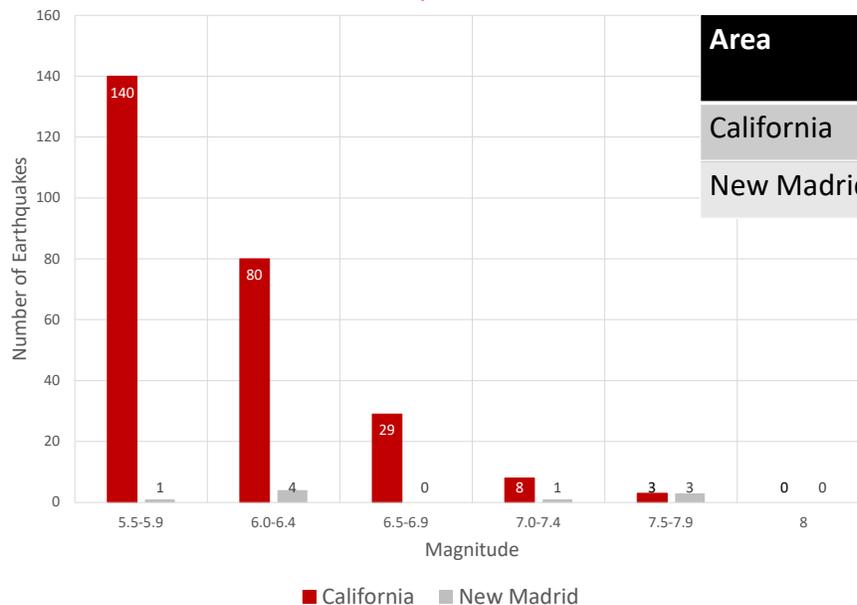


Assumptions

- 30' x 45' two-story light frame wood structure with attic
- Fully sheathed with wood structural panels (R = 6.5)
- Mean roof height = 30'
- Gable roof angle = 30°
- Anchored brick veneer (3" nominal) over all surfaces
- Seismic load reduced by 10% due to damping benefits of wood framing

West Coast vs Memphis

Number of Earthquakes Since 1800



Area	Total 5.5+ Magnitude
California	260
New Madrid	9

Arguments For Reduced Seismic Load/Restrictions

- Wind loads typically govern
- Severe Weather and Fire Risks are much more frequent and probable
- While brick is not being directly targeted, new requirements could lead to a reduction in the use of brick.
 - Brick is a leading product for: Fire Resistance, Wind and Projectile Resistance, and Thermal Mass
- Seismic philosophy is based on West Coast conditions and behavior.
 - New Madrid is a different animal
 - These two seismic zones produce different types of earthquakes at substantially different rates of activity.

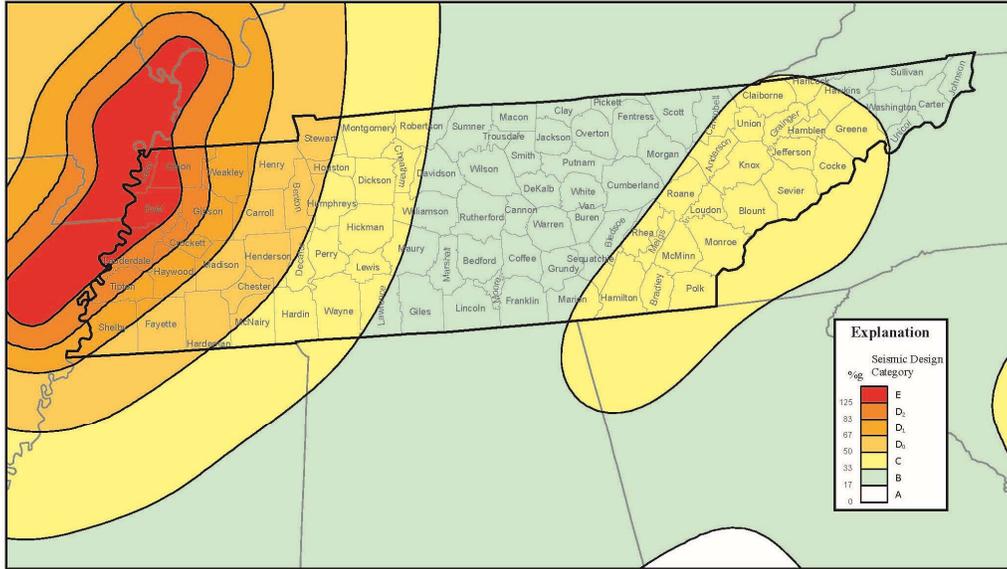
Arguments For Reduced Seismic Load/Restrictions

- IRC design basis earthquake:
 - 2% probability exceedance in 50 years (return period = 2475 years)
 - This should also include tornado
 - Return Period = 2564 years (East TN and Western NC, Simiu and Scanlan (1986))
- New Madrid should be:
 - 10% probability exceedance in 50 years (return period = 475 years)
 - New Madrid Fault movement = 0.2 mm/year.
 - San Andreas Fault movement = 37mm/year

Arguments For Reduced Seismic Load/Restrictions

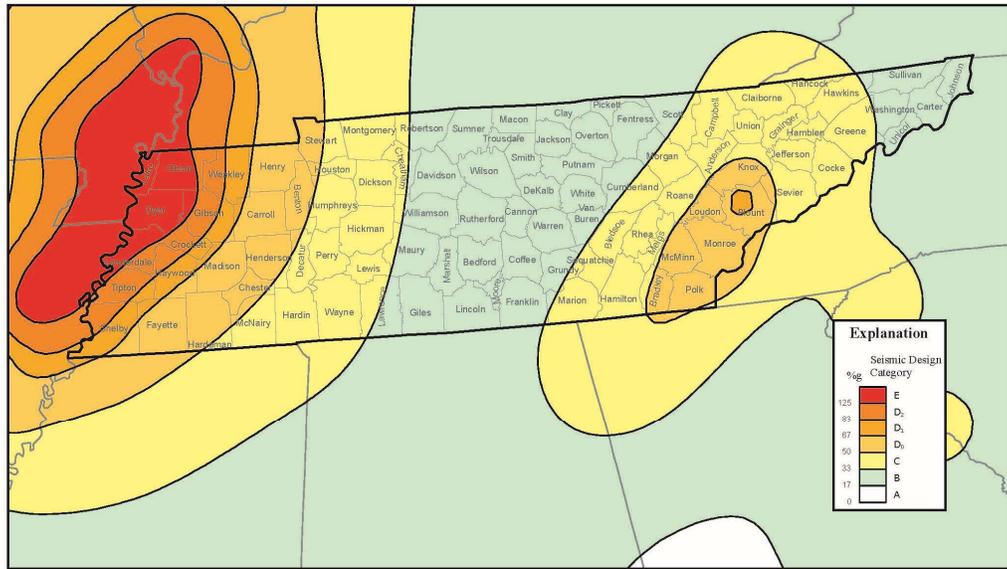
- Risk category I & II Structures Importance Factor = 1.0
Recommend 10% probability exceedance in 50 years (return period = 475 years)
- Risk category III Structures Importance Factor = 1.25
Risk category IV Structures Importance Factor = 1.50
Recommend 2% probability exceedance in 50 years (return period = 2475 years)
- IRC based on 5% damping. Wood frame construction more appropriate at 7% damping which reduces seismic load by 10%
- Brick veneer can resist in plane seismic load

Seismic Map 2015 IRC



IRC Seismic Design Categories - Site Class D
2015/2012

Seismic Map 2018 IRC



IRC Seismic Design Categories - Site Class D
2018

Tennessee State Fire Marshal Ruling

Amendment
Chapter 0780-02-23
One and Two Family Dwellings and Townhouses

0780-02-23-.02 ADOPTION BY REFERENCE.

- (1) Unless otherwise provided by applicable law or the provisions of this chapter, the required minimum codes and standards for the construction of one (1) and two (2) family dwellings, townhouses, and additions thereto of thirty (30) square feet or more of interior space in the State of Tennessee shall be those prescribed in the following publications:
- (a) International Residential Code (IRC), 2018 edition, published by the International Code Council, Inc. (ICC), 500 New Jersey Avenue Northwest, 6th Floor, Washington, D.C., 20001, and Appendix Q except that:
1. Section R313 Automatic Fire Sprinkler Systems is not mandatory, pursuant to T.C.A. § 68-120-101(a)(8).
 2. Chapters 34-43 relating to Electrical Installations are deleted and electrical standards adopted in 0780-02-01 Electrical Installations shall apply.
 3. **Figure R301.2(2) Seismic Design Categories is deleted and replaced with Figure R301.2(2) Seismic Design Categories Site Class D from 2015 IRC.**
 4. Section R314.6 Power Source relating to Smoke Alarms is amended to create Exception 3 that shall read:
Exception 3. Interconnection and hardwiring of smoke alarms in existing areas shall not be required where the alterations or repairs do not result in the removal of interior walls or ceiling finishes exposing the structure.
 5. Section N1102.4.1.2 (R402.4.1.2) Testing is replaced with Section N1102.4.2.1 Testing Option and Section N1102.4.2.2 Visual Inspection from 2009 IRC.
 6. Section N1103.3.3 (R403.3.3) Duct Testing (Mandatory) and Section N1103.3.4 (R403.3.4) Duct Leakage (Prescriptive) are optional.
 7. Table N1102.1.2 (R402.1.2) Insulation and Fenestration Requirement by Component and Table N1102.1.4 (R402.1.4) Equivalent U-Factors from 2018 IRC are replaced with Table N1102.1 Insulation and Fenestration Requirements by Component and Table N1102.1.2 Equivalent U-Factor from 2009 IRC.
 8. Section N1102.4.4 (R402.4.4) Rooms Containing Fuel-Burning Appliances is deleted in its entirety.

SS-7039 (October 2016)

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RDA 1693

Ever since the 2000 Code was published the TN Fire Marshall office has accepted our argument and East TN has remained as Category C

Fire Marshalls like brick.

Shelby County Amendment (2015 IRC)

R301.2.2 Seismic provisions. The seismic provisions of this code shall apply as follows:

1. Townhouses in Seismic Design Categories C, D₀, D₁, and D₂
2. Detached one and two family dwellings in Seismic Design Categories D₀, D₁, and D₂
3. Townhouses and detached one and two family dwellings shall be allowed to follow Section R301.2.2.3.8 as an alternative compliance method for meeting the structural requirements of this code's seismic provisions.

Shelby County Amendment (2015 IRC)

R301.2.2.3.8 Alternative compliance method for structural requirements. In addition to meeting all the structural requirements for Seismic Design Category C and sections R301.2.2.3.1, R301.2.2.3.6, and R301.2.2.3.7 an alternative compliance method for meeting structural requirements when wood framing is used shall include compliance code structural requirements, the more stringent will apply.

Shelby County Amendment (2015 IRC)

R301.2.2.3.8.11 Brick Veneer.

1. Exterior brick veneer shall not exceed 25 feet (7620 mm) in height above non-combustible foundation. Brick at gable peaks shall not exceed 40 feet (12 192 mm) in height above non-combustible foundation.
2. Exterior brick veneer shall comply with all other applicable Chapter 7 IRC requirements.
3. Interior brick veneer and masonry chimneys shall comply with Chapter 7 IRC requirements.

Shelby County Amendment

Puts restrictions in place regardless of cladding material.

Current amendment:

- Alternative compliance method for structural requirements
- Anchoring exterior walls
- Anchoring interior structural walls
- Max stud spacing = 16 inches
- Minimum thickness exterior sheathing = 7/16 inch
- Interior structural wall sheathing $\geq \frac{1}{2}$ inch
- Roof Framing Connections
- Shearwall holddowns

Moving Forward

- The same arguments are still being made.
- The USGS maps are continually changing which leads to confusion in design.
- Fire and severe weather are much more frequent than earthquakes. We shouldn't take a fire resistant material off a building for the sake of a low probability event. (Look at what has taken place in recent years)
- If new regulations are eventually adopted simple design aides for builders would be helpful.
- Main locations of impact are West TN and South Carolina.

This concludes The American Institute of Architects Continuing Education
Systems Course



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