POST-FRAME BARNDOMINIUMS STRUCTURAL DESIGN BUILDING CODE ANALYSIS



Timothy R Royer, PE
Timber Tech Engineering, Inc
Chairman, Technical and Research Committee
National Frame Building Association (NFBA)

57 ANNUAL
NFBA FRAME BUILDING EXPO

WHAT IS THE T&R COMMITTEE?

NFBA TECHNICAL AND RESEARCH COMMITTEE

May 2019 NFBA T&R Committee Meeting - Madison, Wisconsin

- The Committee shall serve as an advisory committee to the Board of Directors relative to technical issues facing the Association and Post-Frame Industry.
- The committee is charged with overseeing and conducting a broad range of technical and research activities for the benefit of the post frame industry and members of the association.

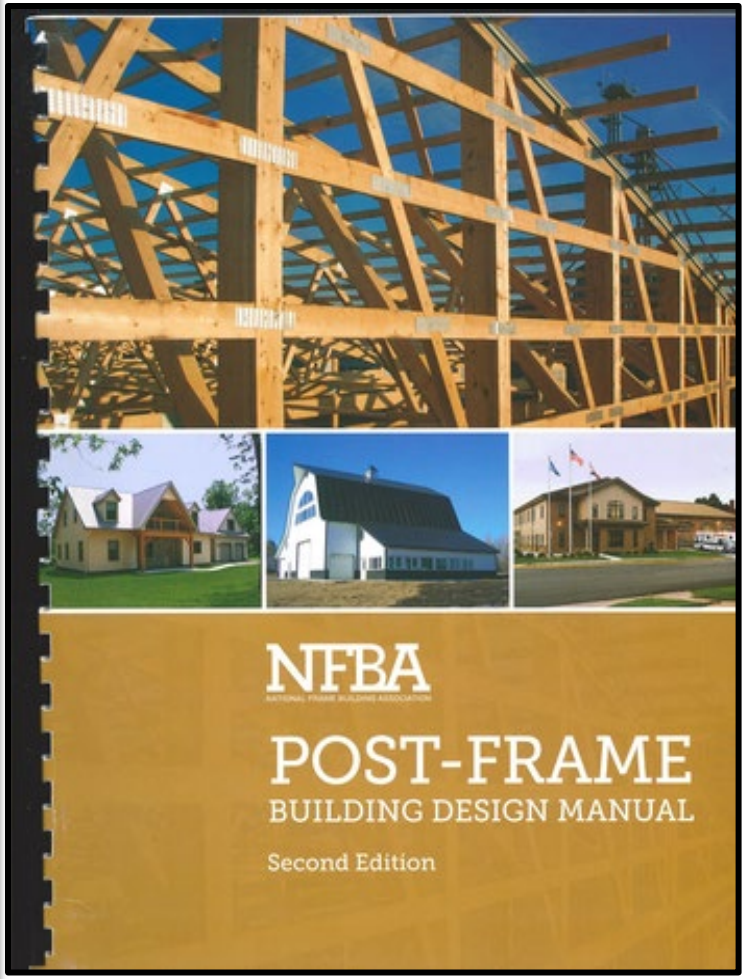
THE T & R COMMITTEE RESPONSIBILITIES:

- Identifying technical concerns/issues facing the Association and Post-Frame Industry
- Establishing NFBA's technical research agenda
- Developing and maintaining NFBA's technical educational program
- Establishing and maintaining policies related to technical issues
- Recommending standards (as sanctioned by the Board of Directors) for the post frame industry and members of the association.
- Responding to technical questions submitted by NFBA members
- Recommending strategies to achieve NFBA's technical objectives

Are you willing to serve on the committee?

RESOURCES

PFBDM (2015)



Post-Frame Building Design Manual is the ultimate resource for post-frame design. Eight chapters, 200 pages and hundreds of photos, diagrams, illustrations and design tables cover everything you need to know about designing with post frame.

POST-FRAME STRUCTURAL DESIGN

- The same procedure as any post-frame building.

  Post Frame Building Design Manual

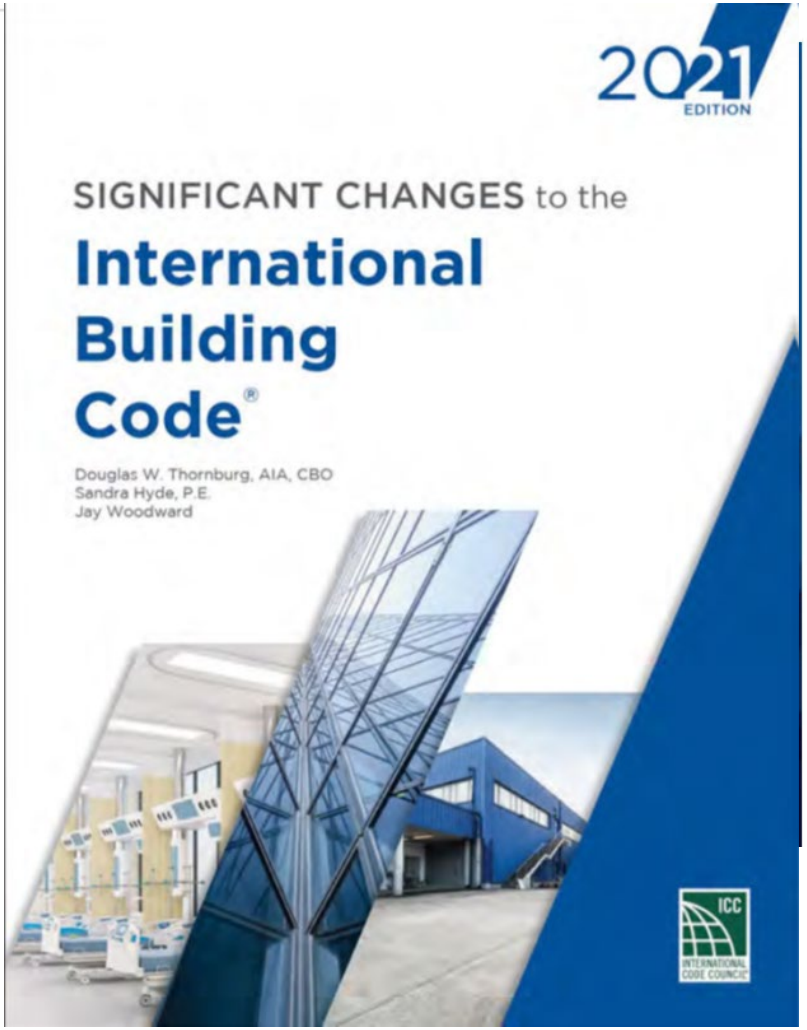
  - Chapter 2 - Building Regulations
  - Chapter 3 - Structural Load and Deflection Criteria
  - Chapter 4- Structural Design Overview
  - Chapter 5 - Post and Pier Foundation Design
  - Chapter 6 - Diaphragm Design
  - Chapter 7 - Metal-Clad Wood-Frame Diaphragm Properties
  - Chapter 8 - Post Design

  New chapters: Purlins and Girts, Mechanically laminated posts, Trusses, Connections and Design Calculation Examples

REFERENCE MATERIALS

REFERENCED CODES AND STANDARDS

- IBC Chapter 35
- List of referenced standards
  - Agency that writes the standard
  - Identification and title of the standard
  - Referenced edition by year



2021 ASABE CODE REFERENCES

Chapter 35 – Referenced Standards

ASABE

American Society of Agricultural and Biological Engineers
2950 Niles Road
St. Joseph, MI 49085

EP 484.3 DEC2017 (R2022)	Diaphragm Design of Metal-clad, Wood-frame Rectangular Buildings	1807.3, 2306.1
EP 486.3 SEP2017 (R2021)	Shallow-post and Pier Foundation Design	1807.3, 2306.1
EP 559.1 AUG2010 (R2019)	Design Requirements and Bending Properties for Mechanically Laminated Wood Assemblies	2306.1

Section 2306 – Allowable Stress Design

TABLE 2306.1

STANDARDS FOR DESIGN AND CONSTRUCTION OF WOOD ELEMENTS IN STRUCTURES USING ALLOWABLE STRESS DESIGN

STANDARDS PROMULGATOR	STANDARD	TITLE
American Wood Council		
	ANSI/AWC NDS	National Design Specification for Wood Construction
	SDPWS	Special Design Provisions for Wind and Seismic
American Society of Agricultural and Biological Engineers		
	ASABE EP 484.3	Diaphragm Design of Metal-clad, Wood-Frame Rectangular Buildings
	ASABE EP 486.3	Shallow Post and Pier Foundation Design
	ASABE EP 559.1	Design Requirements and Bending Properties for Mechanically Laminated Wood Assemblies

2024 CODE CHANGES

-Post Frame Foundation requirements also listed in Ch. 18

Chapter 18 Soils and Foundations

Fullscreen

1807.3 Embedded posts and poles. INSIGHTS

Designs to resist both axial and lateral *loads* employing posts or poles as columns embedded in earth or in concrete footings in earth shall be in accordance with Sections 1807.3.1 through 1807.3.3 or ASABE EP 486.3.

INSIGHTS (2)

Code Change Details | Hearing Videos

1807.3.1 Limitations.

The design procedures outlined in this section are subject to the following limitations:

1. The frictional resistance for structural walls and slabs on silts and clays shall be limited to one-half of the normal force imposed on the soil by the weight of the footing or slab.
2. Posts embedded in earth shall not be used to provide lateral support for structural or nonstructural materials such as plaster, masonry or concrete unless bracing is provided that develops the limited deflection required.

Wood poles shall be treated in accordance with AWPA U1 for sawn timber posts (Commodity Specification A, Use Category 4B) and for round timber posts (Commodity Specification B, Use Category 4B).

Other resources from NFBA

As a Member of the NFBA, you are granted special access to the American Society of Agricultural and Biological Engineers Technical Library

The ASABE Technical Library is a collection of over 1,500 technical papers, journal articles, textbooks, and standards related to agricultural and biological engineering. **The four IBC code reference standards that are directly linked to NFBA are found in this library**:

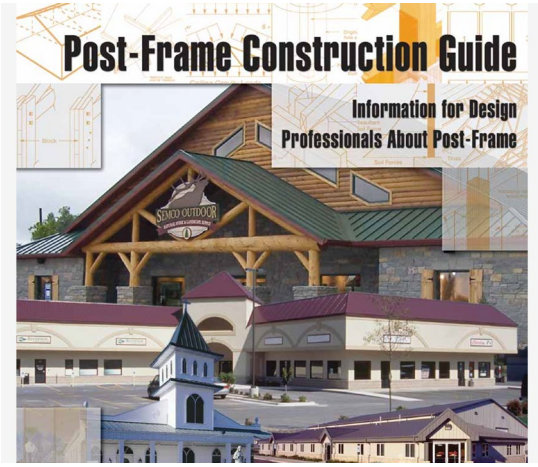
- ANSI/ASAE/NFBA EP484.3 DEC2017 (R2022) Diaphragm Design of Metal-Clad, Wood-Frame Rectangular Buildings
- ANSI/ASAE/NFBA EP486.3 SEP2017 (R2021) Shallow Post and Pier Foundation Design
- ANSI/ASAE/NFBA EP559.2 FEB2023 Design Requirements and Engineering Properties for Mechanically-Laminated Wood (Mechlam) Assemblies
- ANSI/ASABE/NFBA S618 DEC2010 (R2020) Post Frame Building System Nomenclature

Education Resources

Join us for our upcoming NFBA Webinars presented by Dr. Dan Hindman and Dr. Joe Zulovich

Click Here for All Session Descriptions!

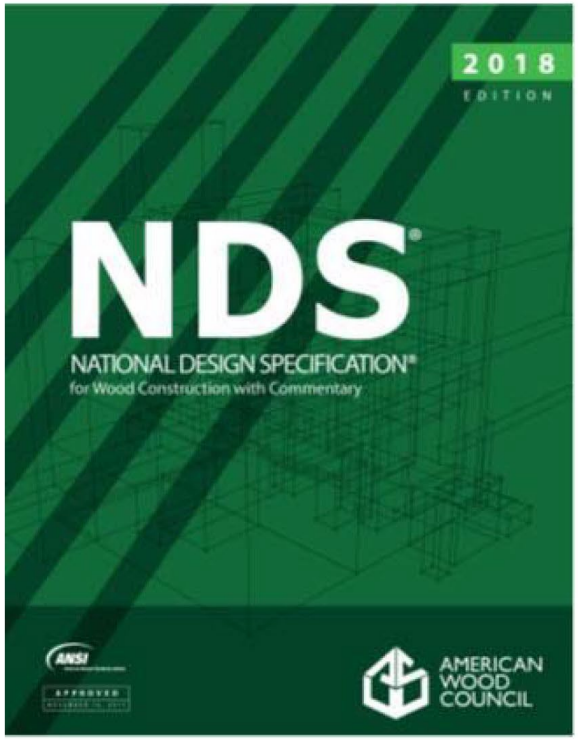
See below for the 2024 NFBA Webinar Schedule & Registration Links



REFERENCE MATERIALS

STANDARDS

- American Wood Council (AWC) Standards, referenced in the International Building Code (IBC)
- 2018 National Design Specification® (NDS®-2018) for Wood Construction with 2018 Supplement
- 2018 Special Design Provisions for Wind and Seismic (SDPWS-2018)
- 2018 Wood Frame Construction Manual (WFCM-2018) for One- and Two-Family Dwellings
- 2018 AWC Span Tables for Joists and Rafters (STJR-2018)



POST-FRAME BARNDOMINIUMS STRUCTURAL DESIGN & BUILDING CODE ANALYSIS

Do we design according to IBC (International Building Code) or IRC (International Residential Code)??

Structural design per **IBC** since **post frame design is non-prescriptive.** Other aspects of the residential design are according to the **IRC**.

R301.1.3 Engineered design.
Where a building of otherwise conventional construction contains structural elements exceeding the limits of Section R301 or otherwise not conforming to this code, these elements shall be designed in accordance with accepted engineering practice. The extent of such design need only demonstrate compliance of nonconventional elements with other applicable provisions and shall be compatible with the performance of the conventional framed system. Engineered design in accordance with the International Building Code is permitted for buildings and structures, and parts thereof, included in the scope of this code.

POST-FRAME BARNDOMINIUMS STRUCTURAL DESIGN & BUILDING CODE ANALYSIS

Stock plan vs Code conforming Plans

What's Not Included

The following items are **NOT** included:

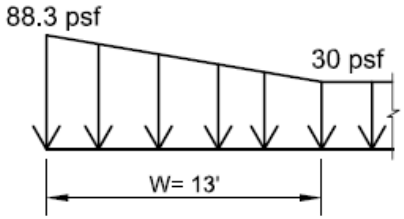
- Architectural or Engineering Stamp - handled locally if required. We can help you find a structural engineer locally
- Site Plan - handled locally when required
- Energy calculations - handled locally when required

SITE-SPECIFIC DESIGNS

- Site-specific designs are essential for structurally sound, code-compliant buildings.
  - The geographic location of the building will change the requirements for snow loads, wind loads and even vertical and lateral soil bearing capacities.
  - Consult local codes for specific variations or additions to the IRC or IBC.

Design Requirements

1. Governing Code: IRC 2015
   Including, not limited to: IBC 2018 (structural design)
   A. Risk Category II
2. Dead Loads:
   A. Roof 10 psf
   B. Floor 10 psf
   C. Other n/a psf
3. Live Loads:
   A. Roof 30 psf
   B. Floor 40 psf
   C. Other n/a psf
4. Truss Loads:
   A. Top Chord Live 37 psf
   B. Top Chord Dead 5 psf
   C. Bottom Chord Live 0 psf
   D. Bottom Chord Dead 5 psf
5. Snow Loads: (Roof live load may control)
   A. Ground Snow (Pg) 37 psf
   B. Flat Roof Snow (Pf) 29 psf
   C. Snow Exposure Factor (Ce) 1.0
   D. Snow Load Risk Factor (I) 1.0
   E. Thermal (Ct) 1.1
   F. Min. Balance Roof Snow Load 29 psf
   G. Unbalanced Snow
      i. Windward roof 9 psf
      ii. Leeward roof 51 psf 10' from ridge, then 29 psf
6. Wind Load (ASCE 7-16)
   A. Ultimate Wind Speed (V) 115 mph
   B. Wind Exposure Category C
   C. Enclosure Classification Enclosed
7. Lateral Soil Loads:
   A. Equivalent Fluid Density (EFD) n/a ps/ft
8. Lateral Stored Material Loads:
   A. Equivalent Fluid Density (EFD) n/a ps/ft
9. Earthquake Design Data:
   (Analysis Based on Equivalent Lateral Force Procedure)
   A. Spectral Response Acceleration S_1 0.1190
   B. Spectral Response Acceleration S_S 0.351
   C. Seismic Design Category B
   D. Seismic Risk Factor, I_e 1.0
   E. Site Class D
   F. Basic Structural System
      Light Framed Walls with Shear Panels
   G. Response Modification Factor (R) 2.5
   H. Deflection Amplification Factor (Cd) 2.5



Snow Drift Load on Lower Roof

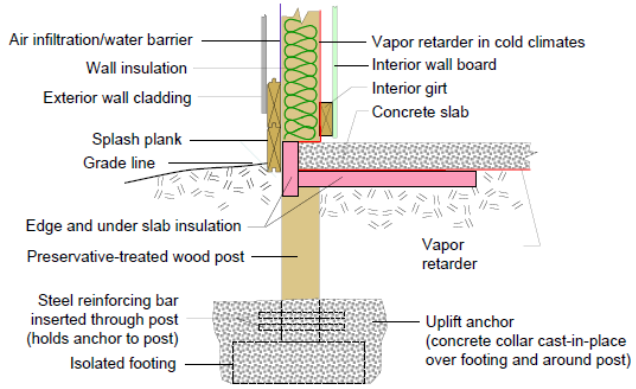
POST-FRAME STRUCTURAL DESIGN

Some unique details:

- Foundation design
- Second floor design and detailing.
- Roof to side wall connection
- Gable end framing
- Porches Roof connections to main structure.
- Snow load on a lower roof
- Use of exposed timber for architectural effect.

FOUNDATION DESIGN

Foundation design of barndominiums should be reflective of the site conditions and building loads.



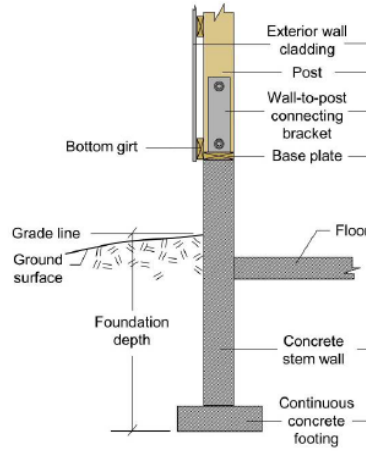
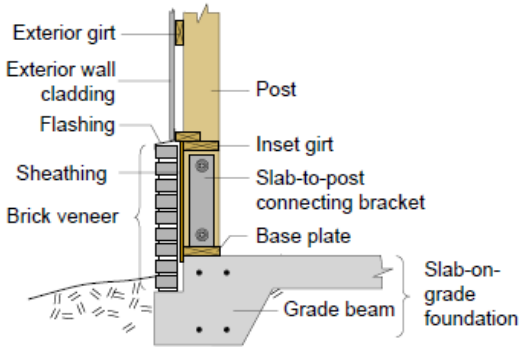
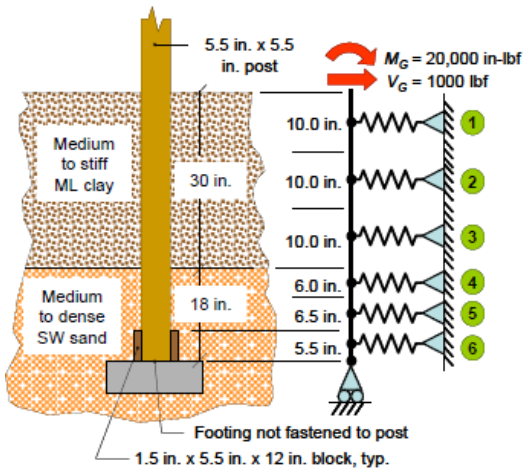


Figure 1-25. Stem wall foundation.





POST DESIGN

- Post and truss spacing will vary, with larger truss spacings more common in the mid-western parts of the country. A typical post spacing in post-frame design is 8 feet on center

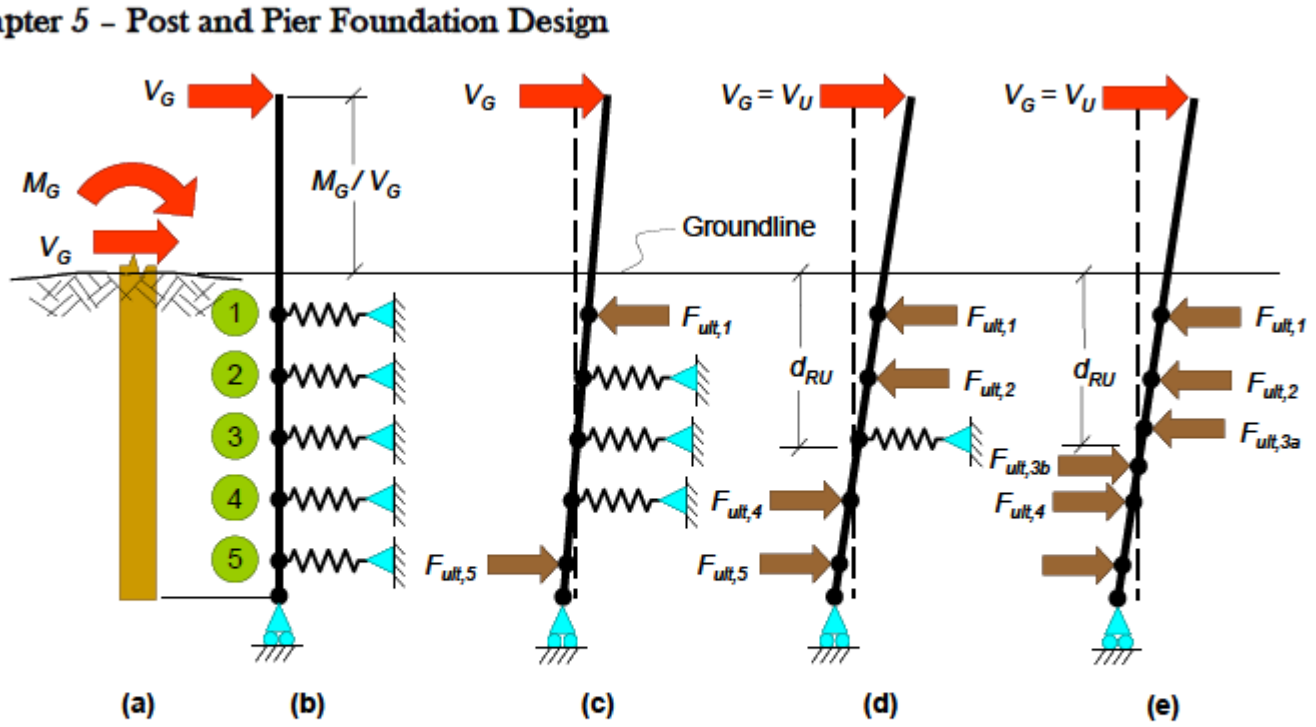


Figure 5-34. (a) Groundline shear V_G and groundline bending moment M_G, (b) equivalent load applied to spring model of foundation, (c) soil springs yield under increased load, (d) ultimate capacity of foundation is reached when all but one soil spring reaches its ultimate strength, (e) spring that doesn't reach its ultimate load is replaced by two opposing forces that represent force applied by soil yielding on both sides of the foundation.

Post & Pier Foundation Design Aid (January 2018)

Shallow Post & Pier Foundation Design Workbook (January 2022)

This Workbook

This workbook facilitates the application of major portions of the third revision to ASABE's engineering practice (EP) for the design of shallow post and pier foundations. The third revision is designated as ASAE EP486.3 and was released in September, 2017. ASAE EP486.3 is designated by ANSI as an American National Standard.

Workbook Cell Color Identifiers

The cell colors in this workbook denote the type of content in the cells. For example, any cell that is yellow is an unlocked cell that requires an input value from the user.

Worksheet Cell Color	Worksheet Cell Content
Blue	Column Headings
Green	Units
Yellow	Input Values
Orange	Calculated Values
Red	Alerts
White	Fixed Values and Basic Information

Purpose of ASAE EP486.3

ASAE EP486.3 contains procedures for determining the adequacy of shallow, isolated post and pier foundations in resisting applied structural loads. The EP helps ensure that soil and backfill are not overloaded, foundation elements have adequate strength, frost heave is minimized, and lateral movements are not excessive.

Scope of ASAE EP486.3

ASAE EP486.3 contains safety factors and other provisions for allowable stress design (ASD) which is also known as working stress design, and for load and resistance factor design (LRFD) which is also known as strength design. It also contains properties and procedures for modeling soil deformation for use in structural building frame analyses.

DESIGN AID FOR SHALLOW POST AND PIER FOUNDATIONS



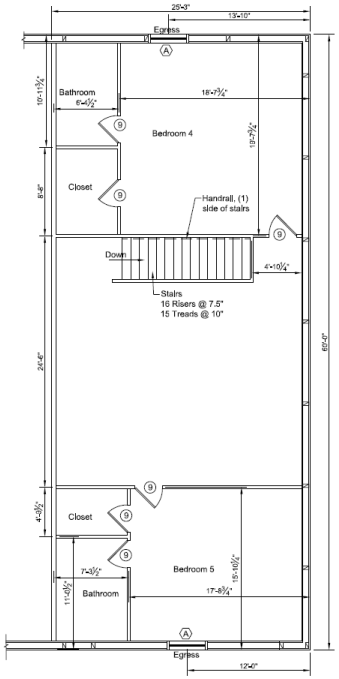
Joseph M. (Joe) Zulovich, Ph.D., P.E.
Extension Agricultural Engineer - Agricultural Systems Technology –
Division of Plant Science and Technology; University of Missouri
University of Missouri Extension

Consultant to the National Frame Building Association (NFBA)

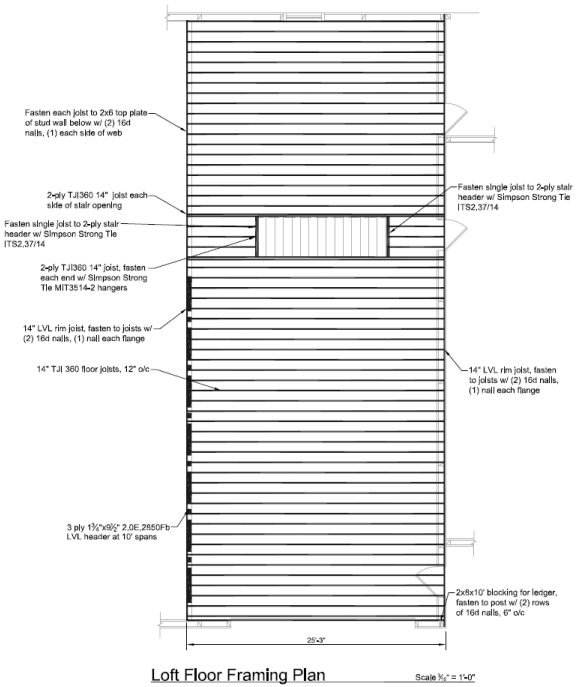
NFBA
POST-FRAME ADVANTAGE

SECOND FLOOR DESIGN CONSIDERATIONS

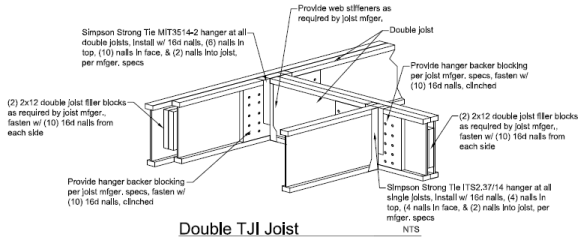
SECOND FLOOR DESIGN AND DETAILING.



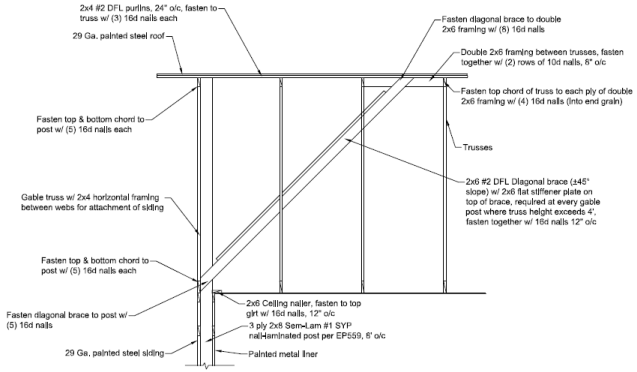
Loft Floor Plan Scale ⅜" = 1'-0"



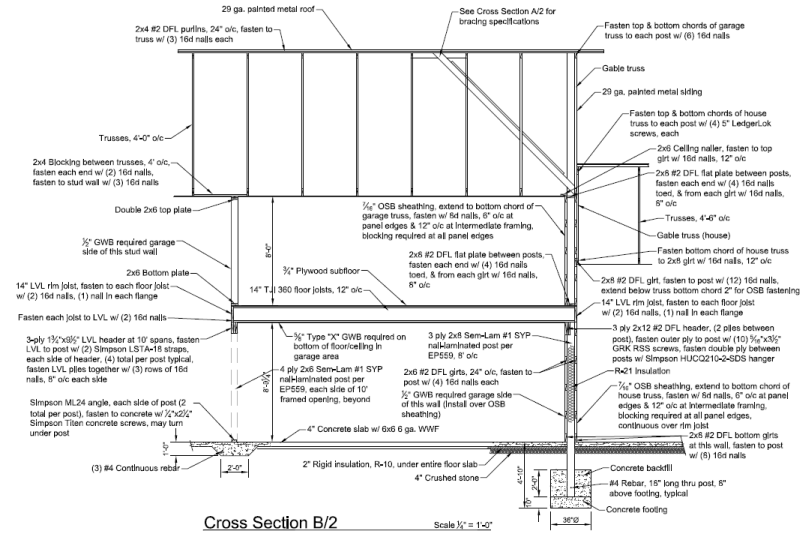
Loft Floor Framing Plan Scale ⅜" = 1'-0"



Double TJI Joist Connection Detail NTS



Cross Section A/2 Scale ⅜" = 1'-0"



Cross Section B/2 Scale ½" = 1'-0"

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West 408 S Main Street, PO Box 539 Kouts, IN 46347
Ph: 219-766-2499 Fax 219-766-2394
www.timbertecheng.com
a creative engineering firm, providing solutions and building relationships

IMPORTANT NOTE:
This plan is approved for structural design of this building.

Timothy R. Royer UT Eng. Cert # 203754
Expiration Date: 03-31-2023

CONTRACTOR:

DRAWING TITLE:
Loft Plan
Loft Framing Plan
Cross Section A/2
Cross Section B/2
Double TJI Joist Connection Detail

PROJECT:
40'x72'x12' Post Frame House w/ Attached 60'x72'x18' Post Frame Garage for:
Ken McGinnis
655 Spotted Pony Trail
Kanab, UT 84741

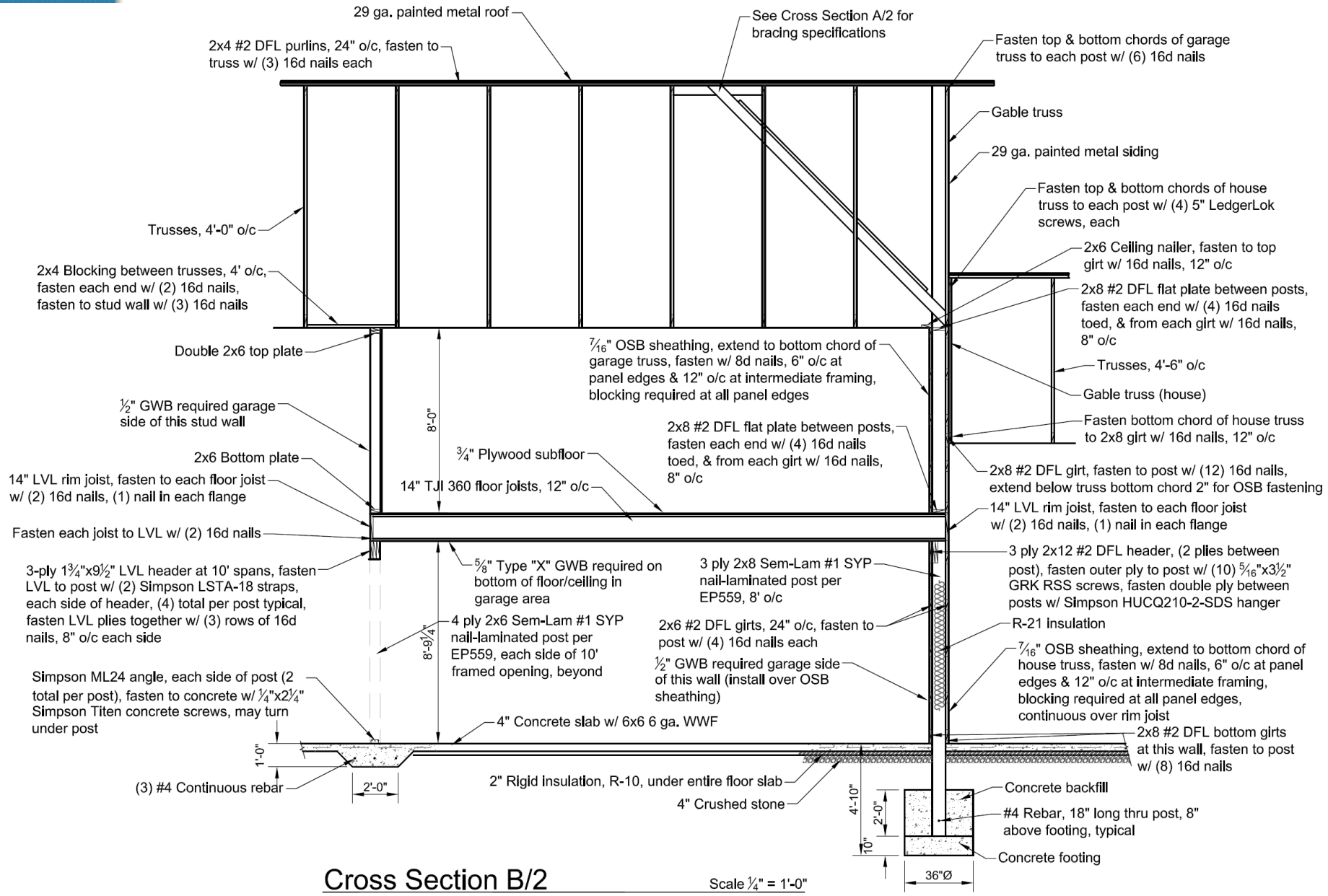
PROJECT START DATE: 2-7-2022

PROGRESS PRINT DATE: 3-30-2022

REVISIONS:	DATE:	BY:

ENGINEERED BY:
E.Wrigglesworth
DRAFTED BY:
A.Stauffer
DRAWING NUMBER: E034-22
PAGE: 2 of 5

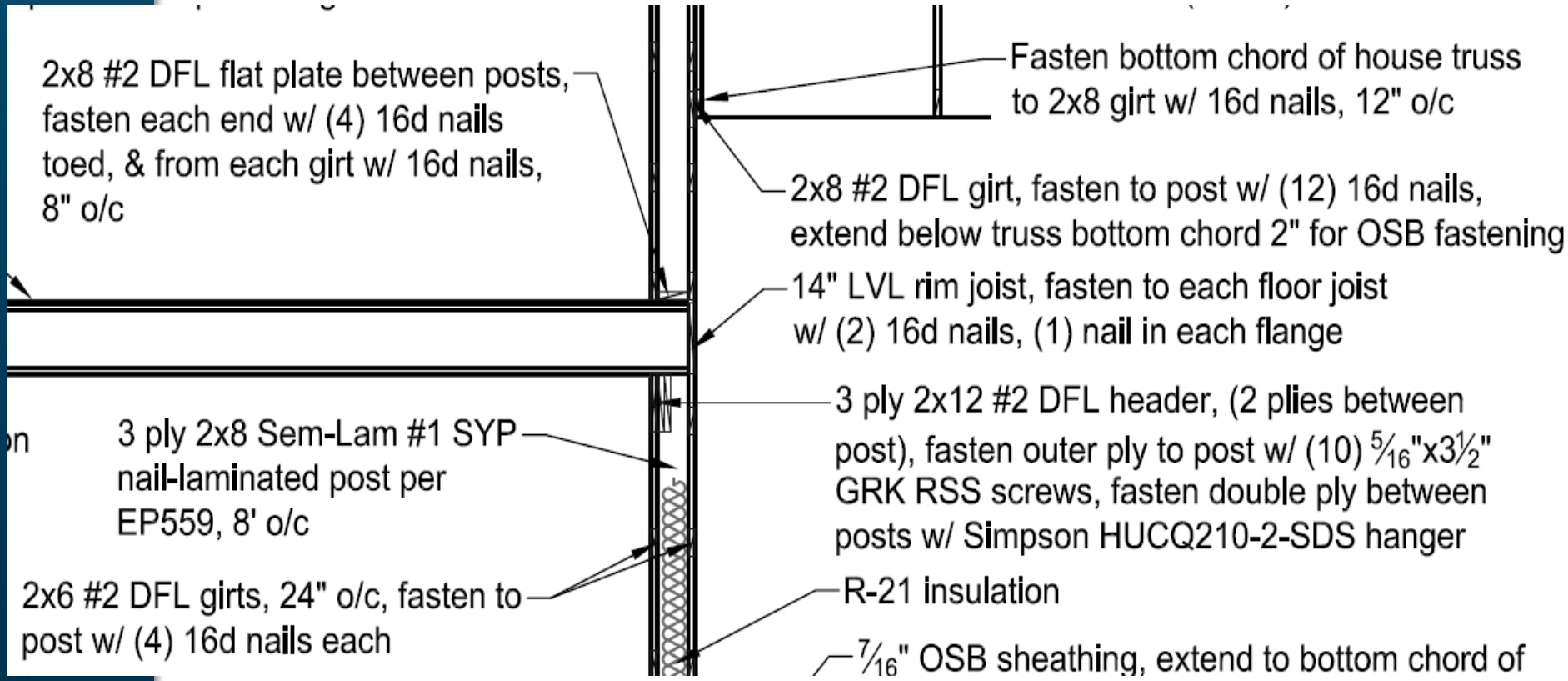
SECOND FLOOR DESIGN AND DETAILING.



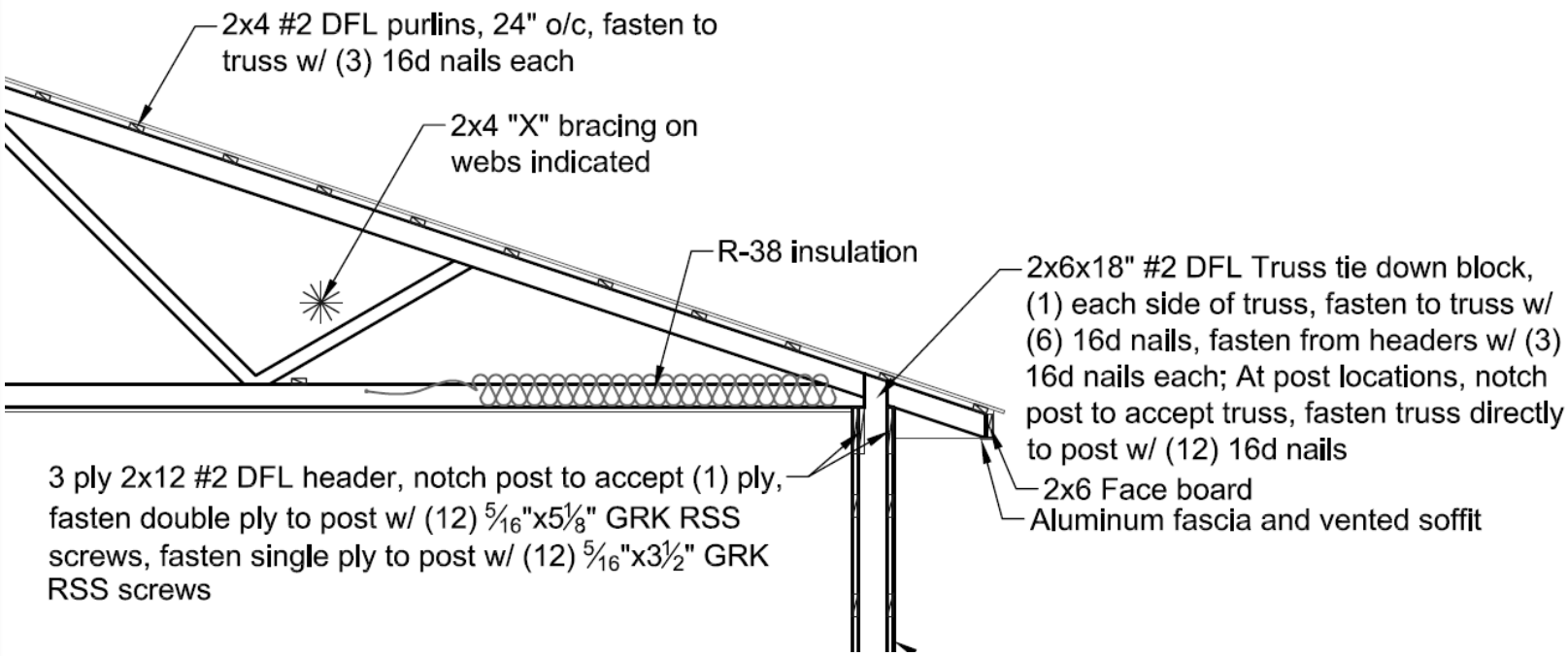
Cross Section B/2

Scale 1/4" = 1'-0"

SECOND FLOOR DESIGN AND DETAILING.

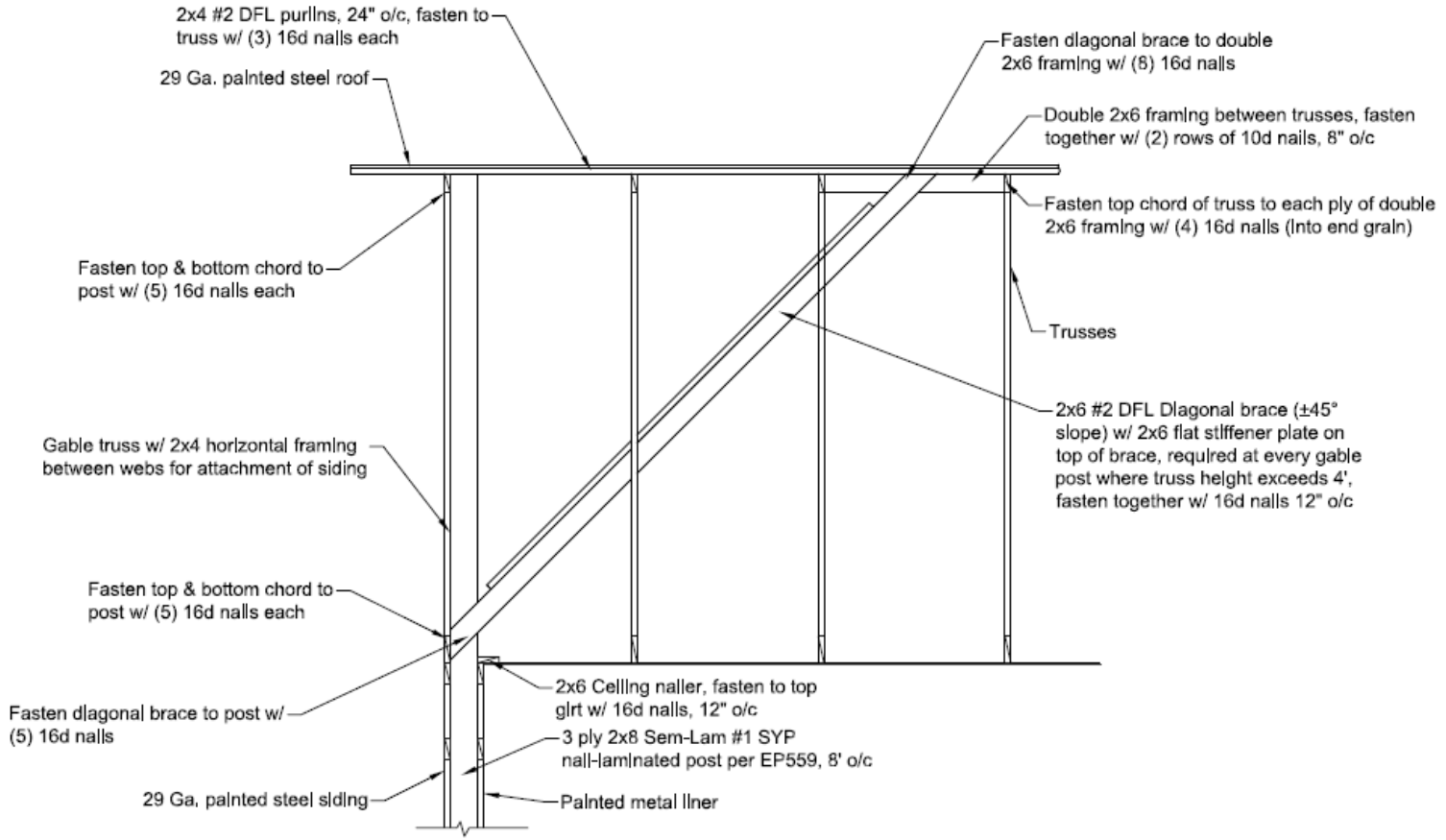


ROOF TO SIDE WALL CONNECTION



GABLE END FRAMING

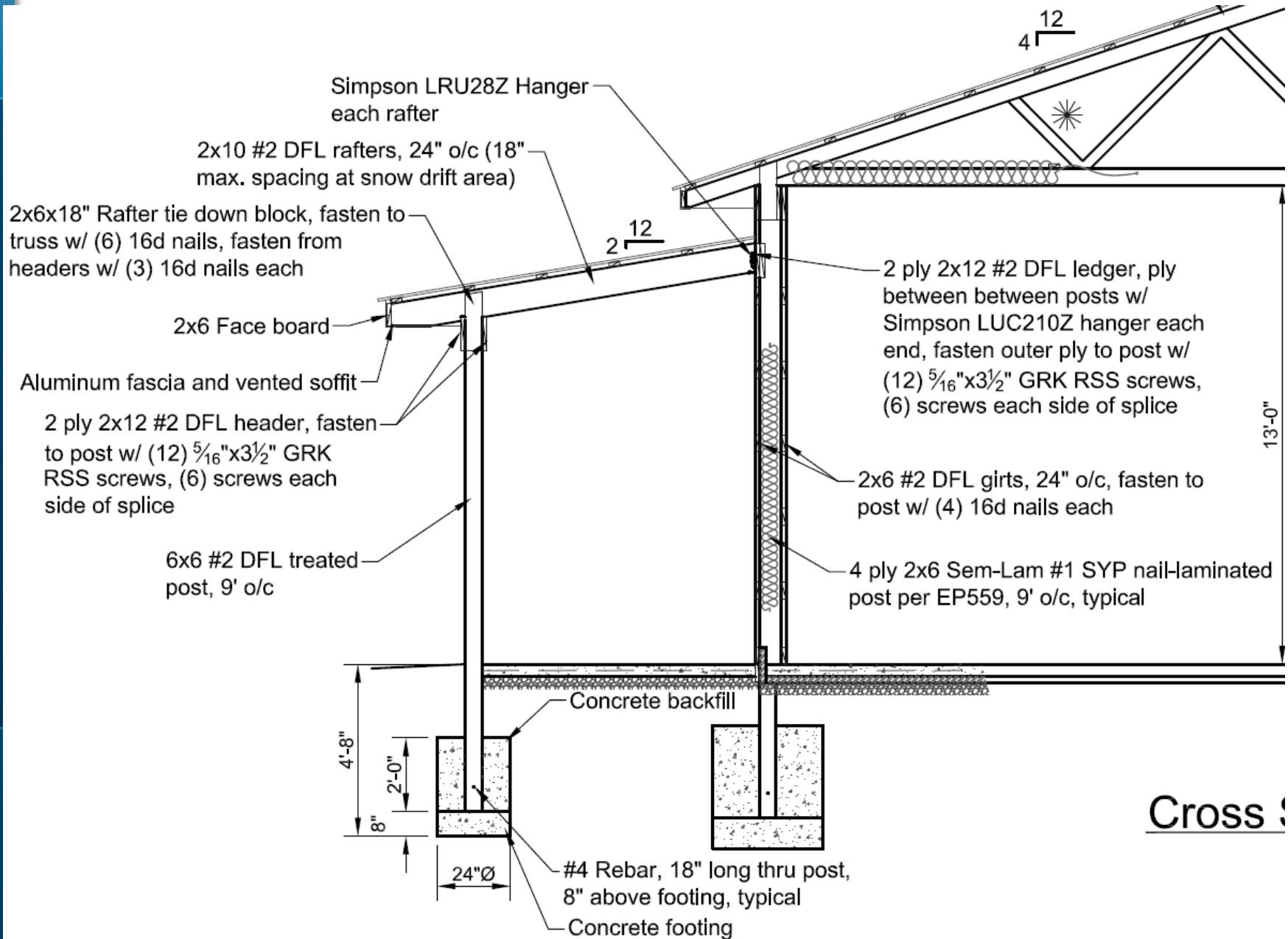
GABLE END FRAMING



Cross Section A/2 Scale 3/8" = 1'-0"

PORCH ROOF CONNECTIONS TO MAIN STRUCTURE.

PORCH AND DECK CONNECTIONS TO MAIN STRUCTURE.

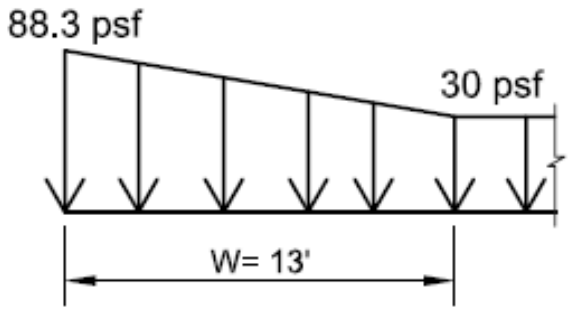


SNOW LOAD ON LOWER ROOF

SNOW LOAD ON LOWER ROOF

Design Requirements

1. Governing Code: IRC 2015
   Including, not limited to: IBC 2018 (structural design)
   A. Risk Category II
2. Dead Loads:
   - A. Roof 10 psf
   - B. Floor 10 psf
   - C. Other n/a psf
3. Live Loads:
   - A. Roof 30 psf
   - B. Floor 40 psf
   - C. Other n/a psf
4. Truss Loads:
   - A. Top Chord Live 37 psf
   - B. Top Chord Dead 5 psf
   - C. Bottom Chord Live 0 psf
   - D. Bottom Chord Dead 5 psf
5. Snow Loads: (Roof live load may control)
   - A. Ground Snow (Pg) 37 psf
   - B. Flat Roof Snow (Pf) 29 psf
   - C. Snow Exposure Factor (Ce) 1.0
   - D. Snow Load Risk Factor (I) 1.0
   - E. Thermal (Ct) 1.1
   - F. Min. Balance Roof Snow Load 29 psf
   - G. Unbalanced Snow
     - i. Windward roof 9 psf
     - ii. Leeward roof 51 psf 10' from ridge, then 29 psf
6. Wind Load (ASCE 7-16)
   - A. Ultimate Wind Speed (V) 115 mph
   - B. Wind Exposure Category C
   - C. Enclosure Classification Enclosed
7. Lateral Soil Loads:



Snow Drift Load on Lower Roof

EXPOSED STRUCTURAL TIMBER

EXPOSED STRUCTURAL TIMBER

SOME IRC CODE CONSIDERATIONS

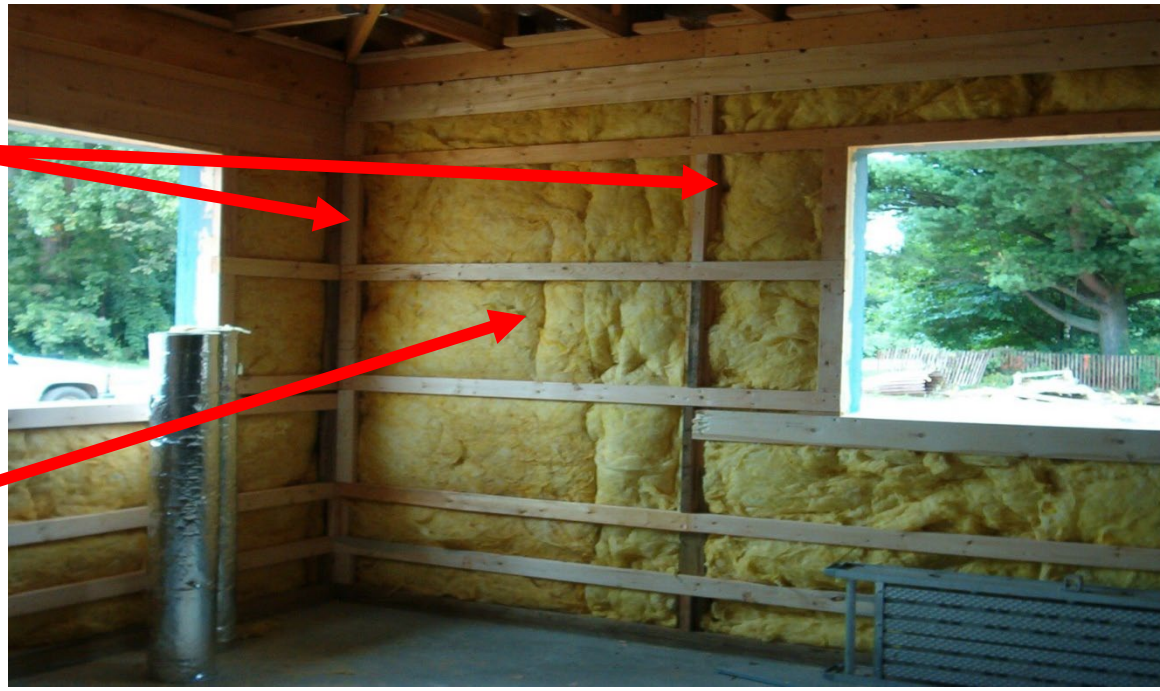
Emergency escape and rescue openings from sleeping areas

- size requirements and the operational requirements for egress.
- An egress window is required to have a minimum net clear opening of not less than 5.7 square feet, opening width of 20 inches and height of 24 inches.
- The bottom of the opening shall not be located more than 44 inches above the floor.
- The window must be operational from inside the room.

CHAPTER 11 ENERGY EFFICIENCY

Wall and roof framing members typically spaced 4 to 16 ft. o.c.

Fewer breaks in thermal insulation barrier



INSULATION REQUIREMENTS

- The climate zone will determine the insulation requirements for the building. REScheck software can be used to determine the building envelope compliance, or the prescriptive method can be used by meeting the values for each building component listed in the tables in the energy code.

(access REScheck at *www.energycodes.gov/rescheck* on web)

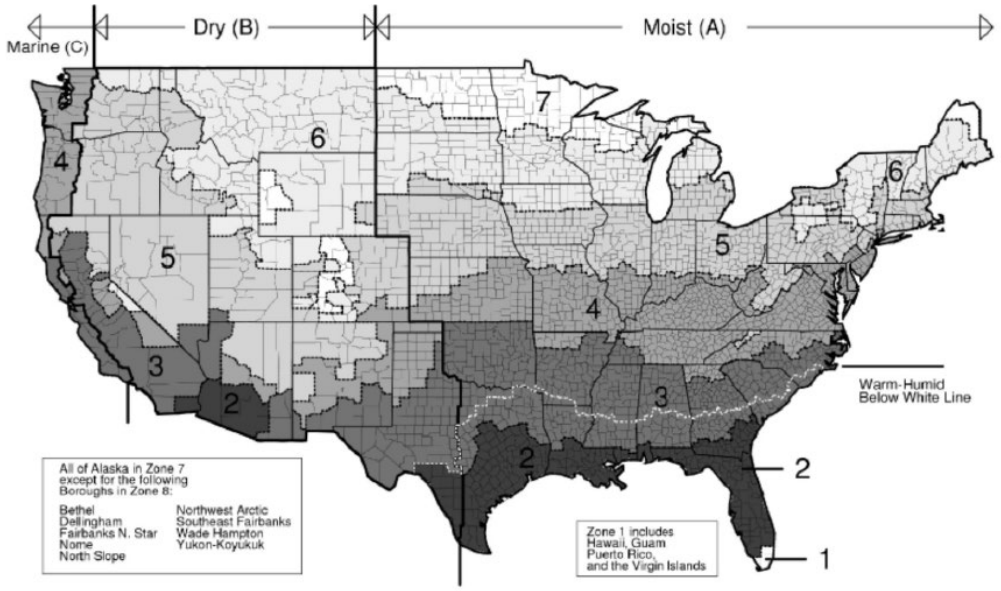


FIGURE ~~N1101.10~~ N1101.7 (R301.1)

CLIMATE ZONES

FIRE BARRIER REQUIREMENTS

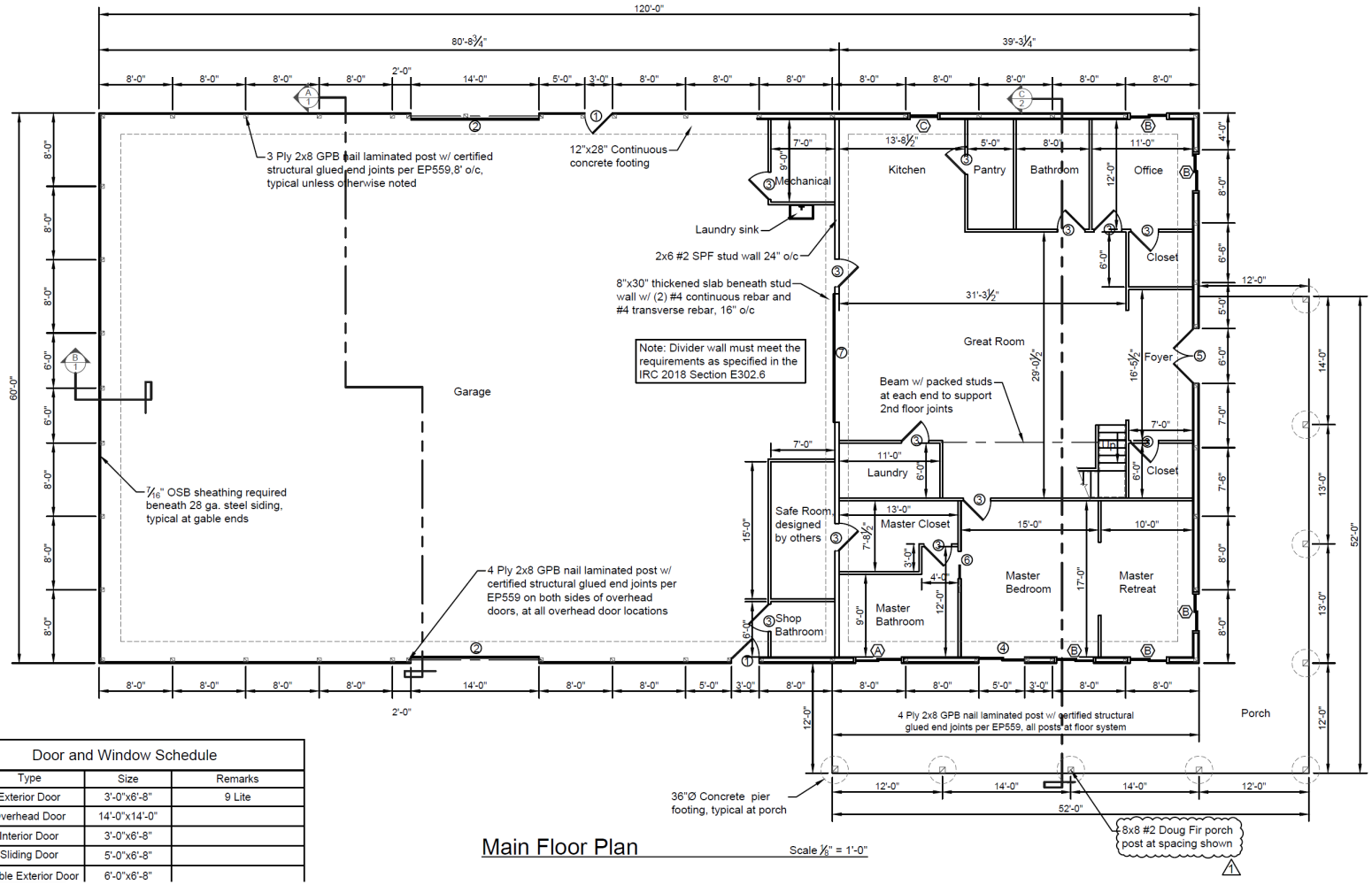
- Proximity to the lot line will determine if the exterior wall of the barndominium will need to be fire-resistance rated. If the distance between the building and the lot line is less than five feet, a 1-hour fire-resistant rating with exposure from both sides is required.
- Separation of the dwelling area from the garage in IRC 2021 per Table R302.6 (See Figure 1) is required. This table does not provide an hourly rating requirement like the table for exterior wall ratings, nor does it specify that the separation must be a UL tested assembly.

TABLE R302.6
DWELLING-GARAGE SEPARATION

SEPARATION	MATERIAL
From the residence and attics	Not less than $^1/_2$-inch gypsum board or equivalent applied to the garage side
From habitable rooms above the garage	Not less than $^5/_8$-inch Type X gypsum board or equivalent
Structure(s) supporting floor/ceiling assemblies used for separation required by this section	Not less than $^1/_2$-inch gypsum board or equivalent
Garages located less than 3 feet from a dwelling unit on the same lot	Not less than $^1/_2$-inch gypsum board or equivalent applied to the interior side of exterior walls that are within this area

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

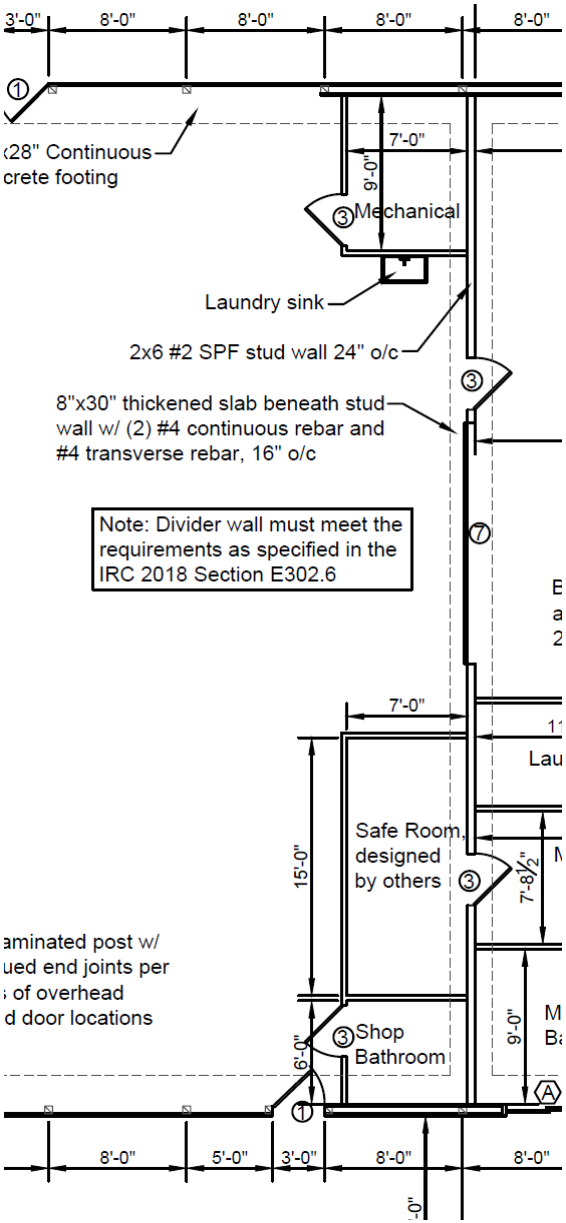
FIRE BARRIERS



Main Floor Plan Scale ⅛" = 1'-0"

Door and Window Schedule			
ID	Type	Size	Remarks
1	Exterior Door	3'-0"x6'-8"	9 Lite
2	Overhead Door	14'-0"x14'-0"	
3	Interior Door	3'-0"x6'-8"	
4	Sliding Door	5'-0"x6'-8"	
5	Double Exterior Door	6'-0"x6'-8"	

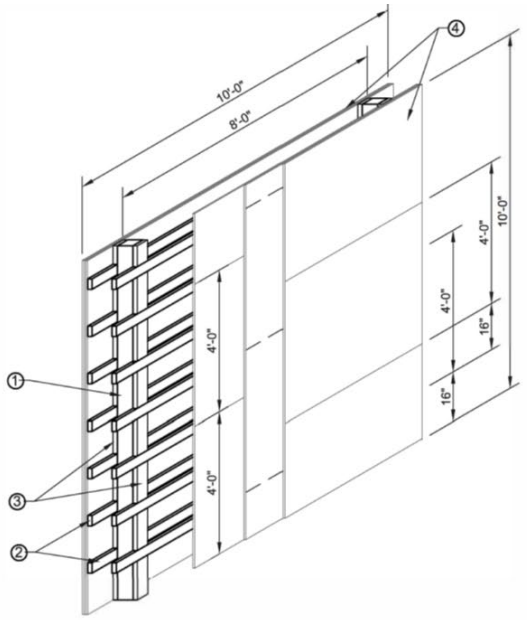
FIRE BARRIERS



UL-APPROVED FIRE-RESISTANCE RATED POST-FRAME WALL

Rated Assemblies

- Post Frame Fire Wall:
  - UL Design V304



1. 5 Ply 2x6 nail-laminated column, 8' o/c
2. 2x4 Nailers, 16" o/c, attached to column w/ (2) 16d ring shank nails.
3. 2x6 Vertical blocking between nailers at post locations, fasten to column w/ 16d ring shank nails.
4. Three layers $\frac{5}{8}$" Type X GWB each side. First layer attached to nailers w/ 2" Type W, coarse threaded screws, 8" o/c. Second layer attached to nailers w/ $2\frac{1}{2}$" Type W, coarse threaded screws, 8" o/c. Third layer attached to nailers w/ 3" Type W, coarse threaded screws, 8" o/c.

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QUESTIONS???