Fundamentals of Structural Engineering

...for Building Officials

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Course Objectives

- ***The intent of this course is to...***
  1. To better understand the importance of ensuring a complete gravity and lateral load path.
  2. To get a general understanding of key referenced structural standards.
  3. To understand some of the key structural elements to review in relation to wood, steel, concrete, and masonry structures.

2

Seminar Format

Day 1: Load Paths & Wood-Framed Construction

1) Introduction
2) Load Paths
3) Wood-Framed Construction

Day 2: Steel, Concrete & Masonry Construction

4) Concrete Construction
5) Masonry Construction
6) Steel Construction

3

PART 1
Introduction

4

Introduction

- ***What items need to be reviewed?***
  - Use & Occupancy
  - Type of Construction
  - Fire-rated Construction
  - Fire protection Systems
  - Means of Egress
  - Accessibility
  - Energy Efficiency
  - Structural Design
  - Mechanical
  - Plumbing
  - Electrical
  - …

5

Certifications

- When you get certified as a building plans examiner, a commercial building inspector, or building official, how many questions do you have from Chapters 16-23?
- What types of questions are they?
- Is that what we should be looking at during a structural plan review or when performing inspections?

6

Course Intent

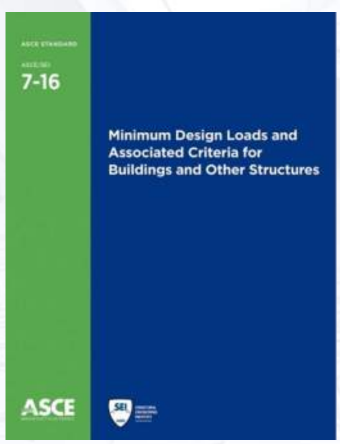
- To learn how to perform a structural plan review or structural inspections for simple- to moderate-sized commercial or residential projects.
- The course assumes attendees have a solid code background.

111. S Main, Salt Lake City, Utah

7

Codes/Standards

International Code Council, 2021 IBC©



American Society of Civil Engineers, ASCE 7-16

8

Resources

SEAOC, International Code Council & NCSEA ©

9

Resources

- ❑ ***2020 NEHRP Design Examples***
  - Free from FEMA's website
  - https://www.fema.gov/sites/default/files/documents/fema_nehrp_design-examples-training-materials_volume-1.pdf

FEMA P-2192-V1, Design Examples©

10

Resources

- **_SEAW & WABO White papers:_**
  - https://www.seaw.org/codeswhite-papers
  - SEAW:
    - Cross-Laminated Timber Diaphragms
    - Voluntary Use of Multi-Period Response Spectra
    - ASCE 7 Triggers for Requiring Wind Tunnel
    - ASCE 7 Site Specific Exposure Determination
    - ASCE 7 Special Wind Regions in Washington State

SEAW Wind Engineering Committee | WHITE PAPER WEC #3-2023

ASCE 7 Special Wind Regions in Washington State | Date: February 3, 2023

ABSTRACT: | Task Group Members:

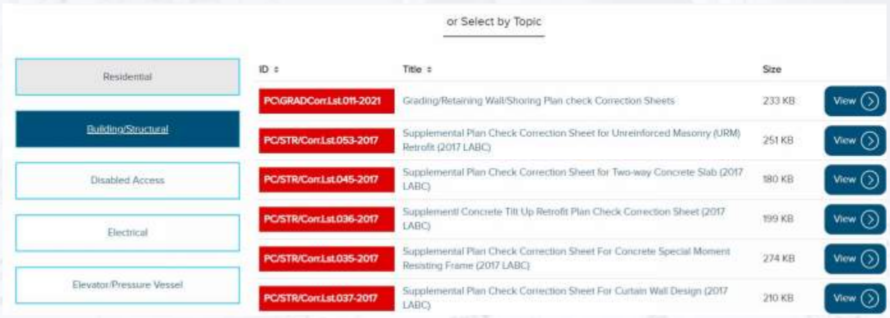
COMMITTEE MISSION STATEMENT:

Resources

- **_SEAW & WABO White papers:_**
  - WABO/SEAW:
    - Structural Plan Review Philosophy*
    - Wet Sealing & Signing of Structural Submittals
    - Structural Permit Submittal Guidelines*
    - Phased Approvals in Permitting
    - Deferred Submittals
    - Seismic Design & Gravity Support Requirements for Non-Structural Components
    - Guidelines for Determining Snow Loads in Washington State*
    - Threaded Rod Holdown Systems in Wood Framed Buildings*
    - Guards and Connections
    - Heavy Vehicle Load Provisions

Resources

- **LADBS Standard Plan Check Correction Lists**
  - https://www.ladbs.org/forms-publications/forms/standard-correction-list



or Select by Topic

Residential
Building/Structural
Disabled Access
Electrical
Elevator/Pressure Vessel

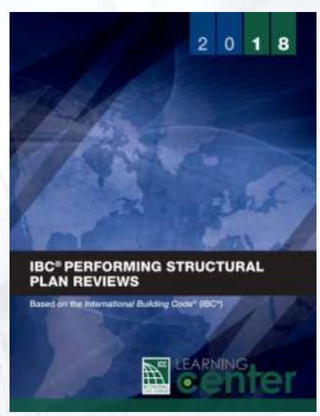
ID	Title	Size	
PC\GRADCorr.Lst.011-2021	Grading/Retaining Wall/Shoring Plan check Correction Sheets	233 KB	View
PC/STR/Corr.Lst.053-2017	Supplemental Plan Check Correction Sheet for Unreinforced Masonry (URM) Retrofit (2017 LABC)	251 KB	View
PC/STR/Corr.Lst.045-2017	Supplemental Plan Check Correction Sheet for Two-way Concrete Slab (2017 LABC)	180 KB	View
PC/STR/Corr.Lst.036-2017	Supplementl Concrete Tilt Up Retrofit Plan Check Correction Sheet (2017 LABC)	199 KB	View
PC/STR/Corr.Lst.035-2017	Supplemental Plan Check Correction Sheet For Concrete Special Moment Resisting Frame (2017 LABC)	274 KB	View
PC/STR/Corr.Lst.037-2017	Supplemental Plan Check Correction Sheet For Curtain Wall Design (2017 LABC)	210 KB	View

13

Resources

ICC Performing Structural Plan Reviews

- ***"The purpose of a structural plan review is to determine that building structures…"***
  - Comply with applicable standards of construction.
  - Use appropriate materials and methods.
  - Are safe for people and property.
  - Comply with code requirements.



International Code Council©

14

Questioning an Engineer

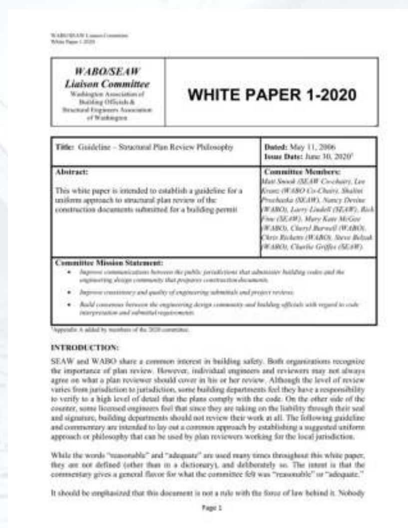
- ❑ ***How many of you are comfortable questioning an engineer?***

15

Plan Review Philosophy

- ❑ ***WABO/SEAW: Structural Plan Review Philosophy***

https://www.seaw.org/codeswhite-papers



WABO/SEAW Liaison Committee

WHITE PAPER 1-2020

16

Plan Review Philosophy

Collaborative Effort:

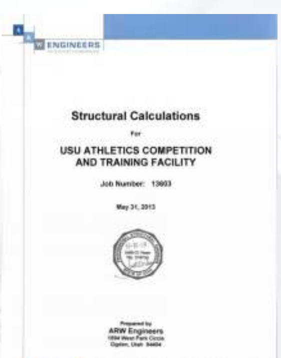
- "Given the respective roles and responsibilities of the designer and reviewer, the process of ensuring a building conforms to the code should be a collaborative effort between the two."

17

Plan Review Philosophy

Scope of Review:

- "… it should not necessarily be the reviewers primary focus to check the mathematical accuracy of the submitted calculations."


ENGINEERS

Structural Calculations

For

USU ATHLETICS COMPETITION
AND TRAINING FACILITY

Job Number: 13603

May 31, 2013

Prepared by
ARW Engineers

18

Plan Review Philosophy

SHEET TITLE
ENGINEERING
JUDGEMENT

Engineering Judgment:

- "…if the design engineer is able to give a reasonable explanation, the reviewer should defer to the engineer's judgment, particularly if the issue under discussion is not directly addressed in the code."
- "Design engineers' responses… should address the concerns expressed and promote a collaborative effort."

d. Please learn engineering. The calculations show 1#4 cont at the roof line on sheet 42. That is why the details 1 and 2 call for 2#4 continuous at the anchors to the ledgers. The design is correct as submitted.

19

Plan Review Philosophy

Engineering Judgment:

- "It is appropriate for a reviewer to ask an engineer to justify a design that directly contradicts a code requirement. For example, a reinforced concrete column that does not have ties or spirals at the code-required spacing should be questioned."

20

Plan Review Philosophy

Plan Reviewer Judgment:

- "He or she should avoid delving into the minutiae of details and losing sight of the primary life-safety issues."

  #4 @17 5/8" O.C.(EA.FACE)

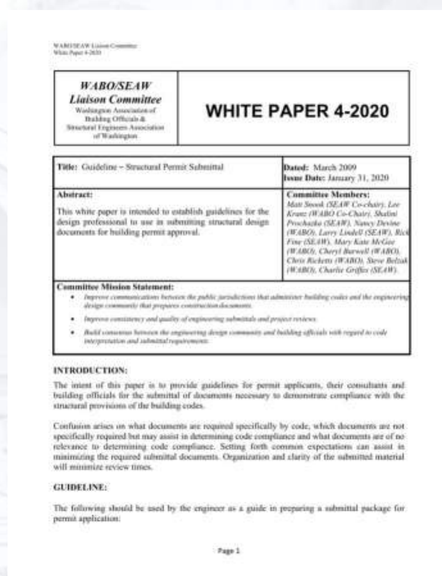
- "In exercising his/her judgment the plan reviewer should refrain from imposing his/her own idea of what constitutes 'best practices' on the design engineer."

21

Submittal Guidelines

WABO/SEAW: Structural Permit Submittal Guidelines

https://www.seaw.org/codeswhite-papers



WABO/SEAW Liaison Committee
White Paper 4-2020

WABO/SEAW Liaison Committee Washington Association of Building Officials & Structural Engineers Association of Washington	WHITE PAPER 4-2020
Title: Guideline – Structural Permit Submittal	**Dated:** March 2009 **Issue Date:** January 31, 2020
Abstract: This white paper is intended to establish guidelines for the design professional to use in submitting structural design documents for building permit approval.	**Committee Members:** *Matt Steeck (SEAW Co-chair), Lee Kranz (WABO Co-Chair), Shalini Prochazka (SEAW), Nancy Devine (WABO), Larry Lindell (SEAW), Rick Fine (SEAW), Mary Kate McGee (WABO), Cheryl Burwell (WABO), Chris Ricketts (WABO), Steve Belzak (WABO), Charlie Griffes (SEAW).*

Committee Mission Statement:

- *Improve communications between the public jurisdictions that administer building codes and the engineering design community that prepares construction documents.*
- *Improve consistency and quality of engineering submittals and project reviews.*
- *Build consensus between the engineering design community and building officials with regard to code interpretation and submittal requirements.*

INTRODUCTION:

The intent of this paper is to provide guidelines for permit applicants, their consultants and building officials for the submittal of documents necessary to demonstrate compliance with the structural provisions of the building codes.

Confusion arises on what documents are required specifically by code, which documents are not specifically required but may assist in determining code compliance and what documents are of no relevance to determining code compliance. Setting forth common expectations can assist in minimizing the required submittal documents. Organization and clarity of the submitted material will minimize review times.

GUIDELINE:

The following should be used by the engineer as a guide in preparing a submittal package for permit application:

Page 1

22

Submittal Guidelines

Construction Documents:

- "…complete as necessary to verify code compliance and inspection in the field."

Design Criteria & Construction Materials:

- "Specific items should be noted on the plans as specified in various code sections including Chapters 1, 16, 17, and 18. At a minimum this should include material specifications, loading criteria, and special inspection requirements."

23

Submittal Guidelines

Accessory Documents:

- "Additional documents such as a design narrative, calculations, studies and reports should be provided to the extent necessary to clarify code compliance."

Deferred Submittals:

- "Items not included but intended for later submittal to the building department should be clearly be noted on the Drawings."

24

Submittal Guidelines

Structural Calculations:

- ❑ Provide table of contents
- ❑ Include narrative
- ❑ Include design criteria summary
- ❑ Provide linkage between drawings & calculations
- ❑ And more…

25

PART 2
Load Paths

26

Load Paths

Newton's 3rd Law:

- ❑ "To every action there is an equal and opposite reaction."

Load Path:

- ❑ How the loads are transferred from the point of origin to where they are resisted.

27

Load Paths

What causes vertical loads?

- ❑ Gravity

What causes lateral loads?

- ❑ Wind
- ❑ Seismic

What resists these loads?

- ❑ Ground

28

Parts of a Structure

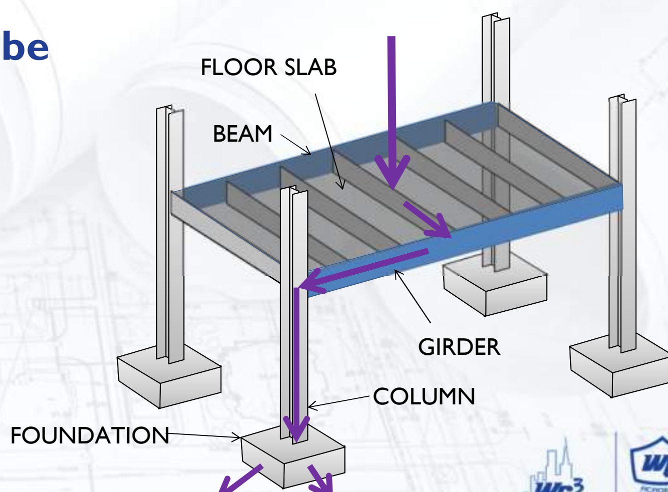
- ❑ Beams, Headers, Columns, Bearing Walls
- ❑ Diaphragms (i.e., Floor or Roof)
- ❑ Vertical Lateral-Force-Resisting Elements
- ❑ Footings & Foundations
- ❑ Anything else?

29

Gravity Load Path

What loads need to be considered?

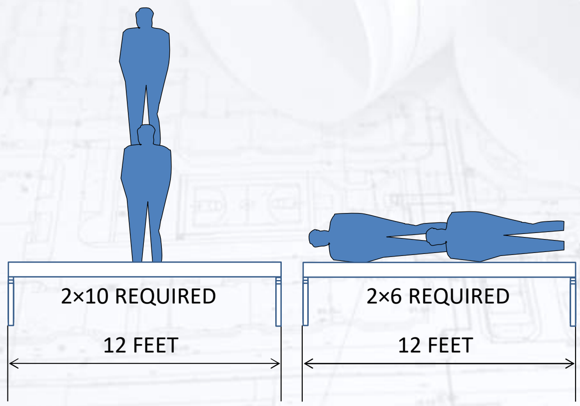
- ❑ Dead loads
- ❑ Live loads
- ❑ Snow loads
- ❑ Soil loads
- ❑ Hydrostatic loads
- ❑ Rain loads
- ❑ Flood loads



30

Gravity Load Path

Concentrated vs. Uniform Loads



31

Gravity Load Path

The gravity load path is easy to follow.

- ❑ What are some common problems?

32

Lateral Load Path

Not as easily understood

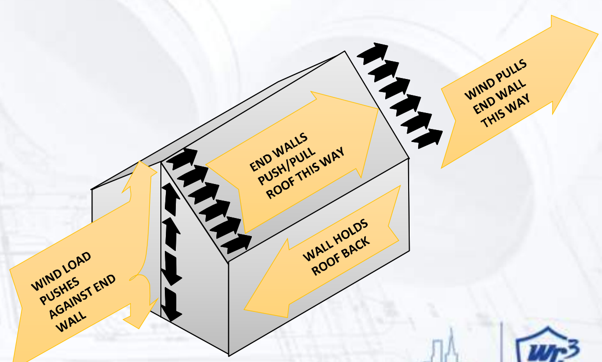
- What loads need to be considered?
  - Wind
  - Seismic

33

Lateral Load Path

Wind:

- Wind acts against the sides of a building like the sail on a boat.
- The majority of forces are transferred up into the roof/floor and the rest into the foundation.

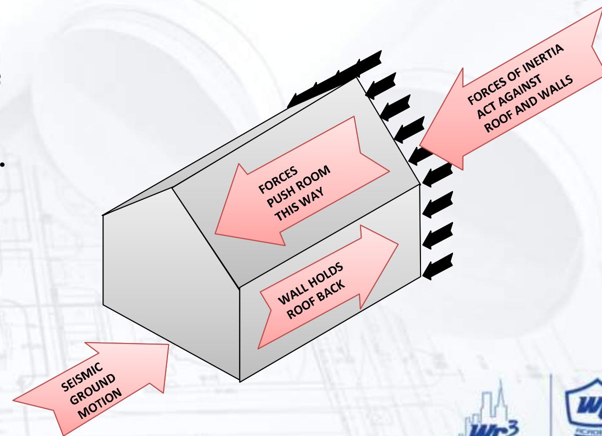


34

Lateral Load Path

Seismic:

- ❑ Ground shaking causes the structure's mass to be accelerated back and forth.
- ❑ Forces are developed where the structures mass is the largest.



35

Lateral Load Path

Lateral-Resisting Elements:

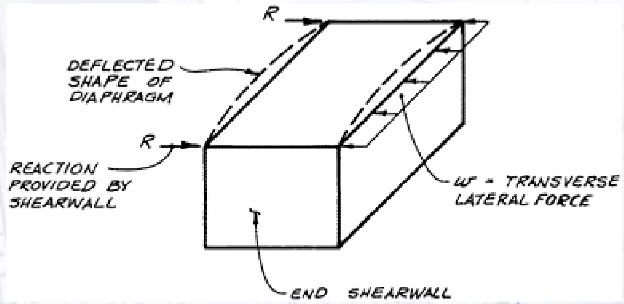
- ❑ **Vertical (LFRS):**
  - Shear Walls
  - Braced Frames
  - Moment Frames
  - Cantilevered Columns
  - Many types of each!

36

Lateral Load Path

Lateral-Resisting Elements:

- **Horizontal:**
  - Floor/Roof Diaphragm
  - §202: **DIAPHRAGM** – *A horizontal or sloped system acting to transmit lateral forces to vertical elements of the lateral force-resisting system.*



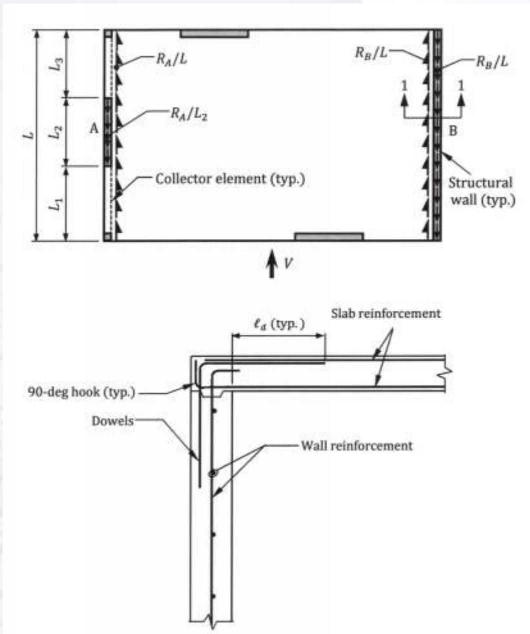
37

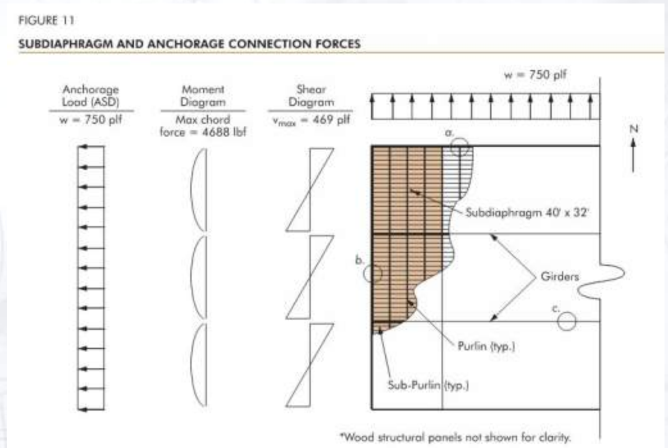
Lateral Load Path

Lateral-Resisting Elements:

- **Diaphragm Components** *(ASCE 7)***:**
  - ***Boundary*** – A location where shear is transferred into or out of the diaphragm element. Transfer is either to a boundary element or to another force-resisting element.
  - ***Collector*** *(drag strut, tie, subdiaphragm strut)* – A diaphragm or shear wall boundary element parallel to the applied load that collects and transfers diaphragm shear forces to the vertical elements of the LFRS or distributes forces within the diaphragm or shear wall.
  - ***Subdiaphragm*** – A portion of a diaphragm used to transfer wall anchorage forces to diaphragm crossties.

38





Form No. L350A – © 2007 APA – The Engineered Wood Association

39

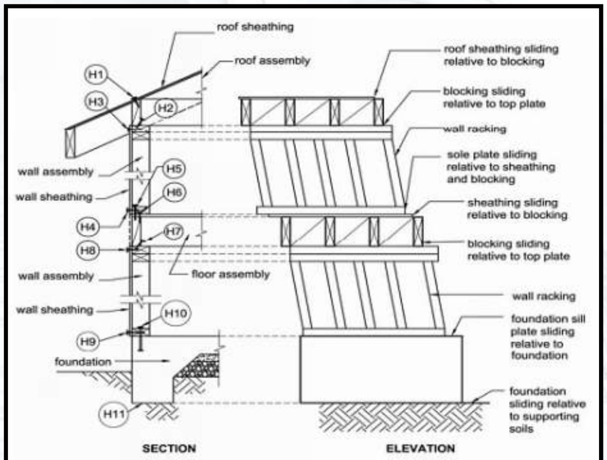
Lateral Load Path

Structures must be designed to resist…

40

Lateral Load Path

Horizontal Load Path:



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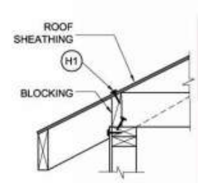
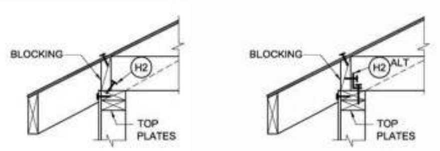
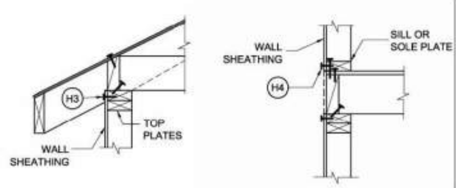
41

Table 2-1 Load Path Connections for Horizontal Sliding

Item	Minimum Fastening per *IRC* Table R602.3(1) and Discussion	Illustration
H1	**Sheathing**[a] **Nailing**[b] 5/16" to ½" 8d common @ 6" 19/32" to 1" 8d common @ 6" $1^1/_8$" to $1^1/_4$" 10d common @ 6" • Resists roof sheathing sliding with respect to blocking below. • Six-inch nail spacing applies to supported sheathing edges and blocking. Twelve-inch spacing applies at other panel supports. • Rafter blocking is not always required by *IRC*; however, sheathing should be nailed to blocking where blocking is provided.	
H2	Three 8d box (0.113"x$2^1/_2$") or three 8d common (0.131x$2^1/_2$") toenails each block. • Resists rafter blocking sliding with respect to wall top plate. • **Use of angle clips in lieu of toenails is a recommended above-code measure.** • Rafter blocking is not always required by *IRC*; however, it should be fastened where provided.	
H3 & H4	**Sheathing**[a] **Nailing**[b] 5/16" to ½" 6d common @ 6" 19/32" to 1" 8d common @ 6" $1^1/_8$" to $1^1/_4$" 10d common @ 6" • Provides wall racking resistance. • Six-inch nail spacing applies to sheathing edges. Twelve-inch spacing applies at other studs.	

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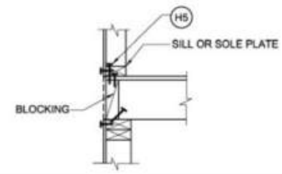
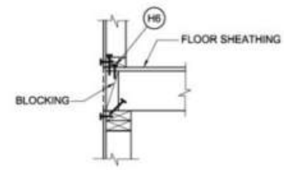
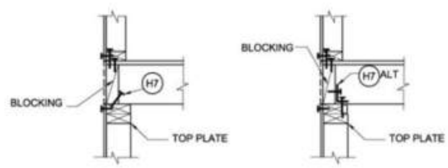
42

Item	Minimum Fastening per *IRC* Table R602.3(1) and Discussion	Illustration
H5	**At Braced Wall Panels** Three 16d box (0.135"x3 1/2") or three 16d sinker (0.148x3 1/4") face nails each 16 inches on center (space evenly). **Between Braced Wall Panels** One 16d box (0.135"x3 1/2") or one 16d sinker (0.148x3 1/4") face nail at 16 inches on center. • Resists wall sole plate sliding with respect to sheathing and blocking or rim joist below.	
H6	**Sheathing**[a] **Nailing**[b] 5/16" to ½" 6d common @ 6" 19/32" to 1" 8d common @ 6" 1 1/8" to 1 1/4" 10d common @ 6" • Resists floor sheathing sliding with respect to blocking below. • Six-inch nail spacing applies to supported sheathing edges and blocking. Twelve-inch spacing applies at other panel supports.	
H7	Three 8d box (0.113"x2 1/2") or three 8d common (0.131x2 1/2") toenails each block. • Resists joist blocking sliding with respect to wall top plate. • **Use of angle clips in lieu of toenails is a recommended above-code measure.**	

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43

Lateral Load Path

Need to pay attention at interior shear walls!

44

Lateral Load Path

Overturning Load Path:

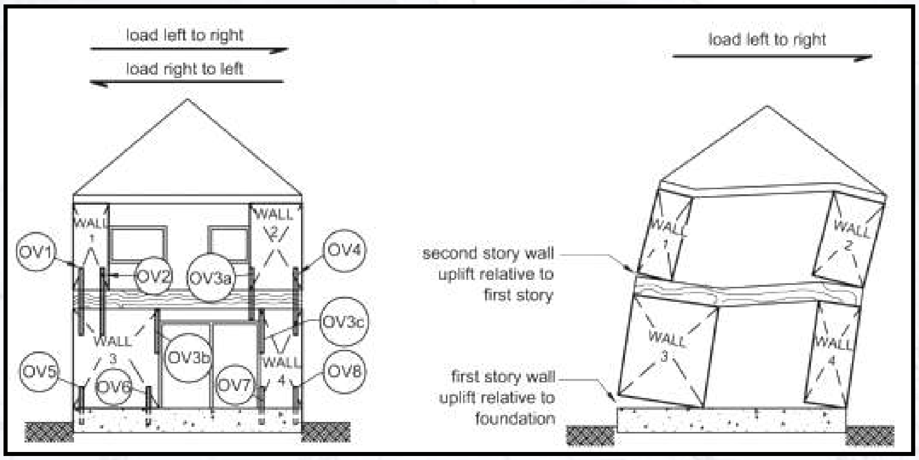

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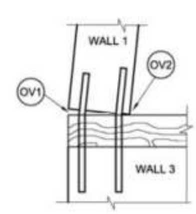
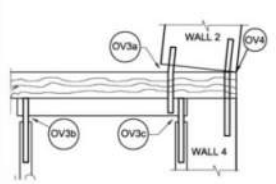
Table 2-2 Load Path Connections for Overturning

Item	Overturning Load Path Description and Discussion	Illustration
OV1	When Wall 1 is loaded from left to right, the wall tries to overturn causing the lower left corner to uplift. This illustration shows a hold-down strap restraining this uplift. The hold-down strap carries tension from an end post or studs in the second-story wall to an end post or studs in the first-story wall, which in turn must be anchored to the foundation (OV5)	
OV2	When Wall 1 is loaded from left to right and an uplift load occurs at OV1, an approximately equal downward load occurs at OV2. This load will be in the post or studs at the end of the wall and will push down on the floor framing and first-story wall. This load will be transmitted through a first-story post to the foundation. When Wall 1 is loaded from right to left, there is an uplift load in the hold-down strap at OV2. Because this end of the wall is not aligned with a wall end in the first story, attention is needed to make sure that a post is added in the first-story wall for strap nailing. The first-story post can have edge nailing to the wall sheathing and transfer the uplift into the first-story wall or, alternatively, can be anchored directly to the foundation with an additional hold-down anchor. One or the other of these anchorage methods is needed to complete the load path.	
OV3	When Wall 2 is loaded from left to right, the wall tries to overturn causing the lower left corner to uplift. The location of OV3 over a first-story header makes the load path more complex than OV1. Hold-down strap OV3a carries the uplift load from the Wall 2 end post to the first-story header. Because the uplift load can be larger than the minimum load on the header, straps OV3b and OV3c are shown tying the header down to the first-story posts or studs. If this is not done, it might be possible for the header to pull up. When Wall 2 is loaded from right to left, a downward load occurs at OV3a. This downward load adds to the load already in the header and the studs supporting the header. When Wall 2 extends more than a foot over the header, the condition is considered an irregularity and is subject to limitations in SDC D_1 and D_2.	
OV4	When Wall 2 is loaded from left to right and an uplift load occurs at OV3a, an approximately equal downward load occurs at OV4. This load will be in the post or studs at the end of the wall and will push down on the floor framing and first-story wall. This load will be transmitted through a first-story post to the foundation.	

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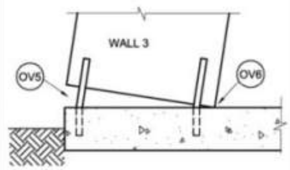
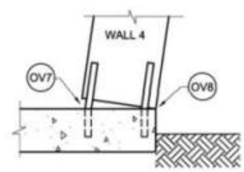
Item	Overturning Load Path Description and Discussion	Illustration
OV5	When Wall 3 is loaded from left to right, the wall tries to overturn causing the lower left corner to uplift. This illustration shows a hold-down strap restraining this uplift. The hold-down strap carries tension from an end post or studs in the first-story wall to the foundation. The uplift load in the first-story end post or studs is a combination of the second-story uplift load from OV1 and the uplift load accumulated over the height of the first story. Hold-downs anchored to the foundation should be used only where substantial continuous foundations are provided. Hold-downs anchored to existing foundations that are weak or that do not meet current dimensional requirements require engineering guidance. Hold-downs anchored to isolated footings require engineering guidance.	
OV6	When Wall 3 is loaded from left to right and an uplift load occurs at OV5, an approximately equal downward load occurs at OV6. This load will be in the post or studs at the end of the wall and will push down on the foundation. This load will be a combination of the downward load OV2 from Wall 1 and the load accumulated over the height of Wall 3. An exact engineering calculation would adjust this downward load based on the narrower width of Wall 2 and the uplift from the hold-down at OV3b.	
OV7	When Wall 4 is loaded from left to right, the wall tries to overturn causing the lower left corner to uplift. This illustration shows a hold-down strap restraining this uplift. The hold-down strap carries tension from an end post or studs in the first-story wall to the foundation. The uplift load in the first-story end post or studs is a combination of the second-story uplift load from OV3c and the uplift load accumulated over the height of the first story.	
OV8	When Wall 4 is loaded from left to right and an uplift load occurs at OV7, an approximately equal downward load occurs at OV8. This load will be in the post or studs at the end of the wall and will push down on the foundation. This load will be a combination of the downward load OV4 from Wall 2 and the load accumulated over the height of Wall 4.	

FEMA 232: "Homebuilder's Guide to Earthquake Resistant Design and Construction"

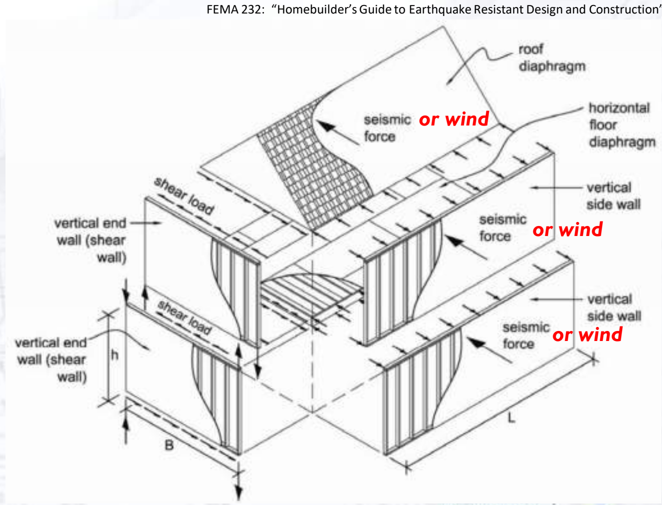
47

Lateral Load Path

FEMA 232: "Homebuilder's Guide to Earthquake Resistant Design and Construction"

Load Transfer Between Components

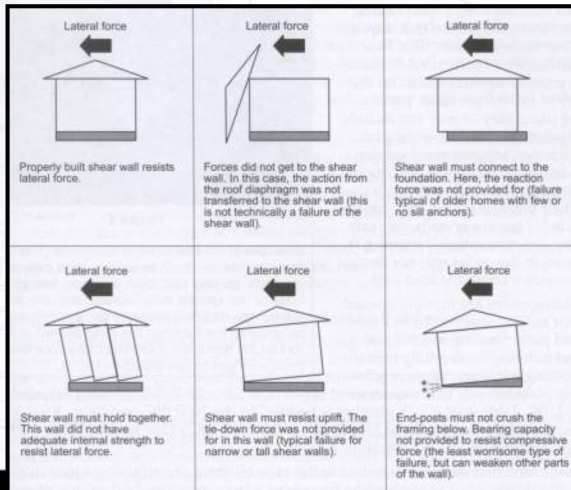
- IBC 1604.4
- Section 12.1.3



48

Lateral Load Path

Connections – Connections – Connections



49

Lateral Load Path

50

Lateral Load Path

- ***Connections – Applies to all construction types***

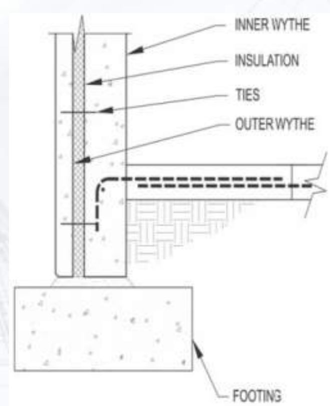
1994 Northridge Earthquake, Tilt-up wall anchorage failure,
https://www.seaoc.org/news/416622/Revisiting-Earthquake-Lessons--Wall-Anchorage-to-Flexible-Diaphragms.htm

51

Lateral Load Path

- ***Connections – Applies to all construction types***

Example Review Comment:
The project calls for tilt-up panels to be directly connected to the floor slab, with no physical connection to the footing. Please provide calculations showing that the portion of the floor slab that is used is capable of transferring the required forces to the supporting soils. In addition, please provide a check of the panel-to-slab connection for side-edge concrete breakout.



52

Load Path Summary

Design must consider three load cases:

- ❑ Gravity design
- ❑ Lateral in one direction
- ❑ Lateral in opposite direction

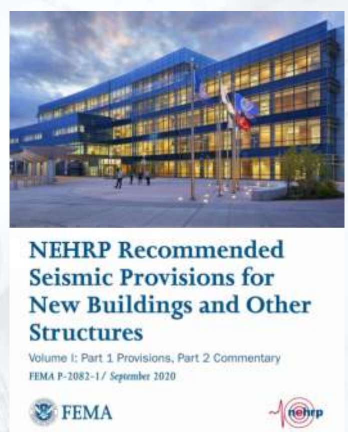
- Load capacity of each building element and their connections must be calculated to resist all three and adequately transfer them to…

53

NEHRP Provisions

Serve as basis of IBC seismic provisions:

- ❑ Main purpose is to prevent serious injury and life loss
- ❑ Focuses on collapse prevention
- ❑ "The degree to which these goals can be achieved depends on a number of factors including ***structural framing type***, ***building configuration***, ***materials***, ***as-built details*** and ***overall quality of design***."



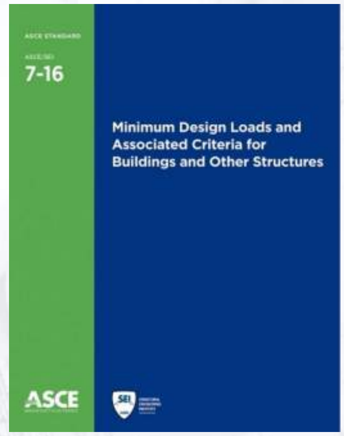
National Earthquakes Hazard Reduction Program (NEHRP), FEMA P-2082-1, 2020

54

Structural Framing Type

ASCE 7-16 →Table 12.2-1:

- ❑ Only structures in SDC 'A' are exempt from seismic design requirements.
- ❑ Per Section 11.7, these structures must still be designed for general integrity including load-path connections, lateral forces, connections to supports, and anchorages to walls.



American Society of Civil Engineers, ASCE 7-16

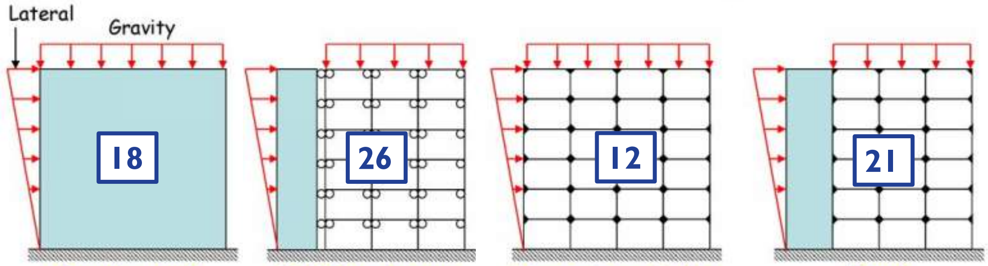
55

Table 12.2-1 Design Coefficients and Factors for Seismic Force-Resisting Systems

Seismic Force-Resisting System	ASCE 7 Section Where Detailing Requirements Are Specified	Response Modification Coefficient, R^a	Overstrength Factor, Ω_0^b	Deflection Amplification Factor, C_d^c	Structural System Limitations Including Structural Height, h_n (ft) Limits[d] — Seismic Design Category: B	C	D[e]	E[e]	F[f]
A. BEARING WALL SYSTEMS									
1. Special reinforced concrete shear walls[g,h]	14.2	5	2½	5	NL	NL	160	160	100
2. Ordinary reinforced concrete shear walls[g]	14.2	4	2½	4	NL	NL	NP	NP	NP
3. Detailed plain concrete shear walls[g]	14.2	2	2½	2	NL	NP	NP	NP	NP
4. Ordinary plain concrete shear walls[g]	14.2	1½	2½	1½	NL	NP	NP	NP	NP
5. Intermediate precast shear walls[g]	14.2	4	2½	4	NL	NL	40[i]	40[i]	40[i]
6. Ordinary precast shear walls[g]	14.2	3	2½	3	NL	NP	NP	NP	NP
7. Special reinforced masonry shear walls	14.4	5	2½	3½	NL	NL	160	160	100
8. Intermediate reinforced masonry shear walls	14.4	3½	2½	2¼	NL	NL	NP	NP	NP
9. Ordinary reinforced masonry shear walls	14.4	2	2½	1¾	NL	160	NP	NP	NP
10. Detailed plain masonry shear walls	14.4	2	2½	1¾	NL	NP	NP	NP	NP
11. Ordinary plain masonry shear walls	14.4	1½	2½	1¼	NL	NP	NP	NP	NP
12. Prestressed masonry shear walls	14.4	1½	2½	1¾	NL	NP	NP	NP	NP
13. Ordinary reinforced AAC masonry shear walls	14.4	2	2½	2	NL	35	NP	NP	NP
14. Ordinary plain AAC masonry shear walls	14.4	1½	2½	1½	NL	NP	NP	NP	NP
15. Light-frame (wood) walls sheathed with wood structural panels rated for shear resistance	14.5	6½	3	4	NL	NL	65	65	65
16. Light-frame (cold-formed steel) walls sheathed with wood structural panels rated for shear resistance or steel sheets	14.1	6½	3	4	NL	NL	65	65	65
17. Light-frame walls with shear panels of all other materials	14.1 and 14.5	2	2½	2	NL	NL	35	NP	NP
18. Light-frame (cold-formed steel) wall systems using flat strap bracing	14.1	4	2	3½	NL	NL	65	65	65
B. BUILDING FRAME SYSTEMS									
1. Steel eccentrically braced frames	14.1	8	2	4	NL	NL	160	160	100
2. Steel special concentrically braced frames	14.1	6	2	5	NL	NL	160	160	100
3. Steel ordinary concentrically braced frames	14.1	3¼	2	3¼	NL	NL	35[j]	35[j]	NP[j]
4. Special reinforced concrete shear walls[g,h]	14.2	6	2½	5	NL	NL	160	160	100
5. Ordinary reinforced concrete shear walls[g]	14.2	5	2½	4½	NL	NL	NP	NP	NP
6. Detailed plain concrete shear walls[g]	14.2 and	2	2½	2	NL	NP	NP	NP	NP

American Society of Civil Engineers, ASCE 7-16

56



8 others!
85 total

Bearing wall

- Supports all gravity and lateral loads
- Lack redundancy
- R-value varies from 2.8 to 5.5

Building frame

- Frame carries gravity (i.e. gravity frame
- Shear walls or braced frames carry lateral load
- Need to consider deformation compatibility
- R-value varies from 5.5 to 7.0

Moment-resisting frame

- Specially detailed frame to support both gravity and lateral loads
- High level of ductility and redundancy
- R-value varies from 3.5 to 8.5

Dual system

- Similar to building frame system except the gravity frame also provide secondary lateral force resistance.
- R-value varies from 4.2 to 8.5

57

Structural Framing Type

- ❑ I have a building with special reinforced concrete shear walls, and I would like to classify it as a building frame (R=6) rather than a bearing wall (R=5). What is the difference between a building frame and a bearing wall?

58

Structural Framing Type

- ❑ ***Different design values for each system as well.***
- ❑ ***Example: Reinforced Masonry Shear Walls***
  - Ordinary → R = 2.0 ← **40% of special**
  - Intermediate → R = 3.5 ← **57% of special**
  - Special → R = 5.0 ← **Required for high seismic**

7. Special reinforced masonry shear walls	14.4	5	2½	3½	NL	NL	160	160	100
8. Intermediate reinforced masonry shear walls	14.4	3½	2½	2¼	NL	NL	NP	NP	NP
9. Ordinary reinforced masonry shear walls	14.4	2	2½	1¾	NL	160	NP	NP	NP

Design Lateral Load (C_s) = ($\frac{S_{DS}}{R / Ie}$) * Weight of building

59

Structural Framing Type

- ❑ ***Is there a problem with this?***

3.4 LFRS – Cantilevered Columns

Steel Cantilevered Column			
Lateral Loads (per column)			
Wind (ASD)	=	312.817021213318 lb	Refer to lateral analysis
Seismic (ASD)	=	262.14743482906 lb	Refer to lateral analysis
Primary response coeff.	R =	6.5	Refer to lateral analysis
Cantilevered column			
Height	H =	14.5 ft	
Cantilevered column size	=	HSS6X6X1/2	

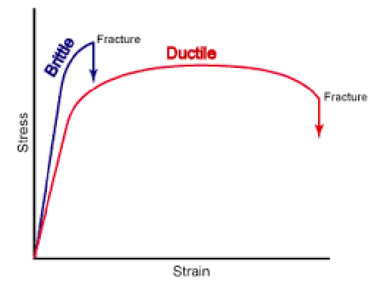
G. CANTILEVERED COLUMN SYSTEMS DETAILED TO CONFORM TO THE REQUIREMENTS FOR:	12.2.5.2	
1. Steel special cantilever column systems	14.1	2½
2. Steel ordinary cantilever column systems	14.1	1¼
3. Special reinforced concrete moment frames[m]	12.2.5.5 and 14.2	2½
4. Intermediate reinforced concrete moment frames	14.2	1½
5. Ordinary reinforced concrete moment frames	14.2	1
6. Timber frames	14.5	1½

60

Structural Framing Type

Three key design values in Table 12.2-1:

- **Response Modification Factor (R):**
  - This describes whether system is **brittle** (i.e. ,stiff) or **ductile** (i.e. ,flexible).
  - Higher R-value → lower design loads & more detailing expense
  - Lower R-value → higher design loads & less detailing expense
  - Are you comfortable with the R-value used?



61

Structural Framing Type

Three key design values in Table 12.2-1 (cont.):

- **Overstrength Factor (Ω_0):**
  - An amplification factor applied to forces in certain components of the lateral load path.
  - Includes collector elements, some foundation elements, and more.
- **Deflection Amplification Factor (C_d):**
  - Used to determine inelastic story drift due to ground motions.
  - Elastic drift → due to wind (linear behavior)

62

Structural Framing Type

- **Combinations**
  - **In Different Directions** *(§12.2.2)*:
    - Respective R, C_d and Ω_0 shall be used.
  - **In Same Direction** *(§12.2.3)*:
    - Most stringent R, C_d and Ω_0 shall be used.
  - **Vertical Combinations** *(§12.2.3.1)*:
    - Lower system < R: Upper coefficients should be used for both
    - Lower system > R: Separate values used but upper system forces shall be multiplied by the ratio of the higher to the lower "R".

Simpson Strong-Tie, https://www.strongtie.com/

63

Structural Framing Type

- ***Two-Stage Analysis:***
  - Allowed if flexible upper portion and rigid lower portion and…
  - Stiffness of lower ≥ 10 * upper
  - Period (T) of entire structure ≤ 1.1 * period of upper
  - Upper portion designed as separate structure
  - Lower portion designed as separate structure + amplified reaction from upper
  - Lower uses ELF procedure

64

Building Configuration

- ***Structural Irregularities***
  - Regular structures dissipate an earthquake's energy uniformly throughout the structure resulting in light, but relatively well-distributed damage.
  - Irregularities tend to concentrate earthquake forces in one, or a few, locations resulting in extreme local damage.

65

Building Configuration

Structural Irregularities (cont.):

Table 2-1 Structural Irregularities in U.S. Codes and their Treatment in this Report

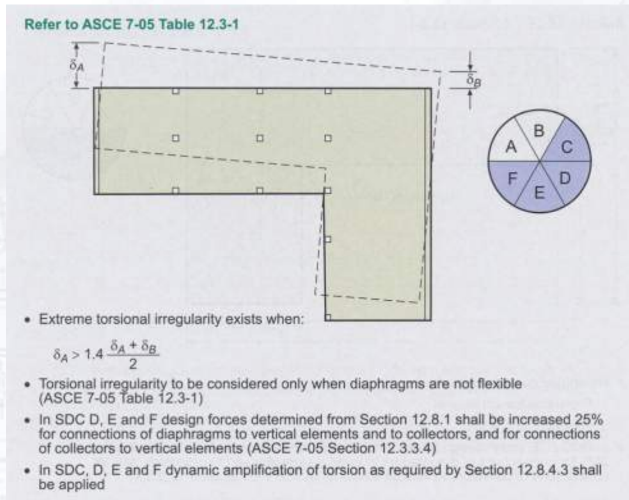
Structural Irregularities	Codified in	Treatment in this Report
H1. Torsional (stiffness) irregularity	ASCE/SEI 7-16	Analysis
H2. Reentrant corner irregularity	ASCE/SEI 7-16	Discussion
H3. Diaphragm discontinuity irregularity	ASCE/SEI 7-16	Discussion
H4. Out-of-plane offset irregularity	ASCE/SEI 7-16	Discussion
H5. Nonparallel system irregularity	ASCE/SEI 7-16	Discussion
H6.[1] Torsional strength irregularity	ASCE/SEI 41-17	Analysis
V1. Soft story irregularity	ASCE/SEI 7-16	Analysis
V2. Weight (mass) irregularity	ASCE/SEI 7-16	Analysis
V3. Vertical geometric irregularity	ASCE/SEI 7-16	Discussion
V4. In-plane discontinuity … irregularity	ASCE/SEI 7-16	Discussion
V5. Weak story irregularity	ASCE/SEI 7-16	Analysis
V6.[1] Story mechanism: weak-column/strong-beam	ACI 318-14, ANSI/AISC 341-16	Analysis
V7.[1] Gravity-induced lateral demand		Analysis
V8.[1] Wall discontinuity		Limited analysis

FEMA P-2012: "Assessing Seismic Performance of Buildings with Configuration Irregularities"

66

Building Configuration

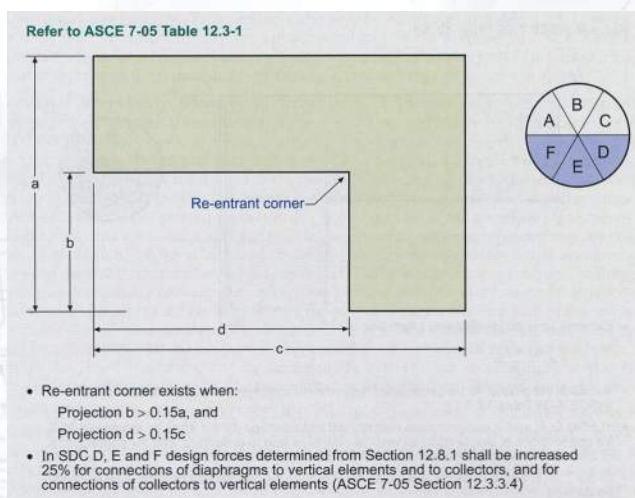
- ***H1 – Torsional:***
  - Irregular > 1.2
  - Extreme > 1.4



67

Building Configuration

- ***H2 – Re-entrant Corners:***
  - Both plan projections > 15%
  - Projecting wings of the floor may respond somewhat independently

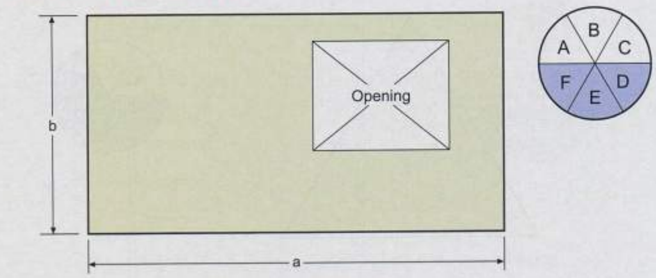


68

Building Configuration

- **H3 – Diaphragm Discontinuity:**

Refer to ASCE 7-05 Table 12.3-1

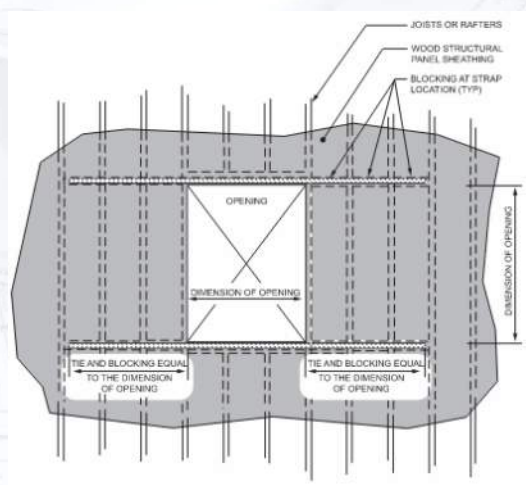


- Diaphragm discontinuity exists when:
  Area of opening > 0.5ab or
  Effective diaphragm stiffness changes more than 50% from one story to the next
- In SDC D, E and F, design forces determined from Section 12.8.1 shall be increased 25% for connections of diaphragms to vertical elements and to collectors, and for connections of collectors to vertical elements (ASCE 7-05 Section 12.3.3.4)

69

Building Configuration

- ***Diaphragm openings** (§2308.4.4.1):*
- ***Openings > 4-feet***
  - Metal ties and blocking per Figure 2308.4.4.1(1).
  - Metal ties ≥ 16 gage x 1.5-inches in width
  - Blocking shall extend not less than the dimension of the opening in the direction of the tie and blocking.
  - SDC 'D-F': Length ≤ 50% distance between LFRS or ≤ 25% diaphragm area



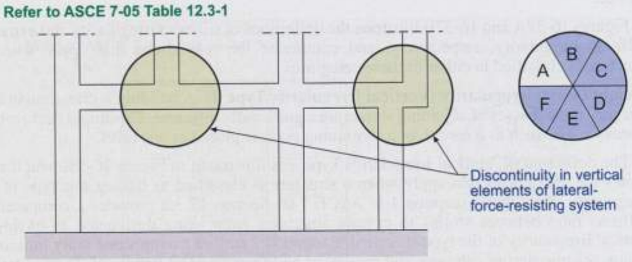
International Code Council, 2018 IBC©

70

Building Configuration

- ❑ ***H4 – Out-of-Plane Offset:***
  - Discontinuity in LFR path

Refer to ASCE 7-05 Table 12.3-1



- Required strength of columns supporting discontinuous vertical elements (ASCE 7-05 Section 12.3.3.3):

  Load combinations with overstrength factor (ASCE 7-05 Section 12.4.3.2)

  $(1.2 + 0.2S_{DS})D + \Omega_0 Q_E + L + 0.2S$

  $(0.9 - 0.2S_{DS})D + \Omega_0 Q_E + L + 1.6H$
- Note special detailing requirements in materials chapters.
- In SDC D, E and F, design forces determined from Section 12.8.1 shall be increased 25% for connections of diaphragms to vertical elements and to collectors, and for connections of collectors to vertical elements (ASCE 7-05 Section 12.3.3.4).

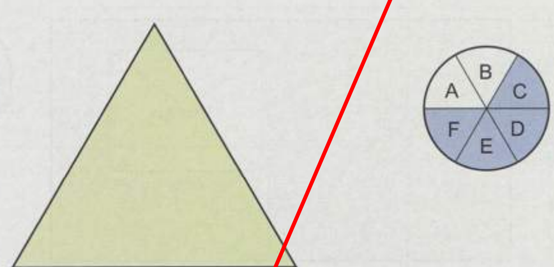
71

Building Configuration

- ❑ ***H5 – Nonparallel System:***

100% forces in one direction and 30% of forces in perpendicular direction

Refer to ASCE 7-05 Table 12.3-1



- Design to consider:

  SDC C, D, E and F structures are required to include effects of orthogonal ground motions as per ASCE 7-05 Section 12.5.3

72

Building Configuration

- ❑ ***Do horizontal irregularities exist?***
  - Types 1a, 1b, 2, 3 & 4

Example Review Comment:
The proposed structure includes ___________ irregularities as defined by Table 12.3-1 of ASCE 7-16. Please confirm that the requisite forces were increased as required by Section 12.3.3.4 of ASCE 7.

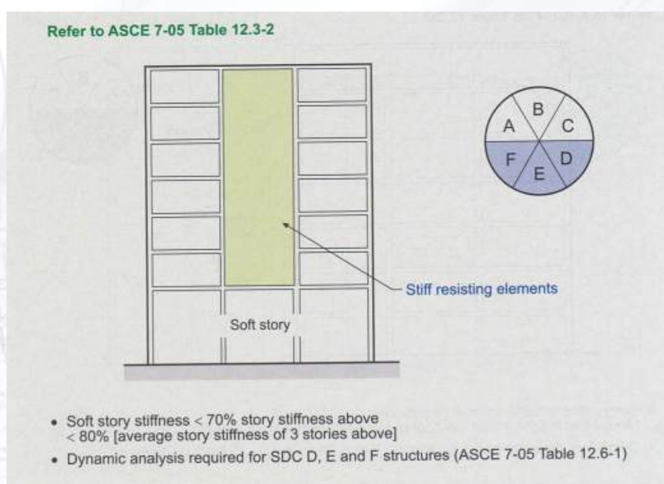
  - Type 5

Example Review Comment:
The proposed structure includes nonparallel system irregularities as defined by Table 12.3-1 of ASCE 7-16. Please confirm that the orthogonal combination procedures defined in Section 12.5.3 of ASCE 7-16 have been incorporated.

73

Building Configuration

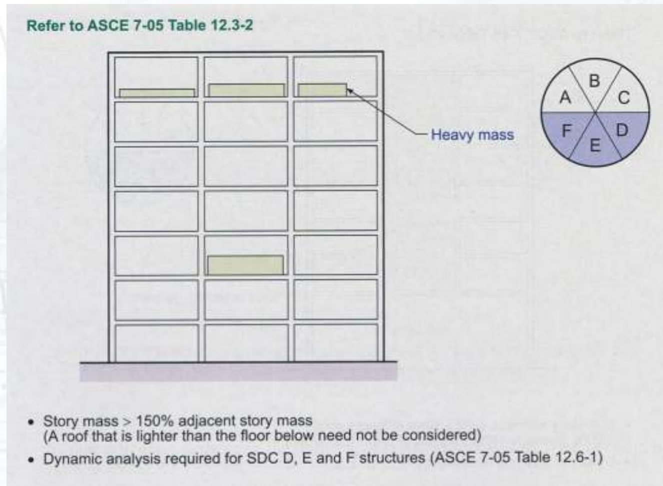
- ❑ ***VI – Soft Story:***
  - SF Mandatory Soft Story Program



74

Building Configuration

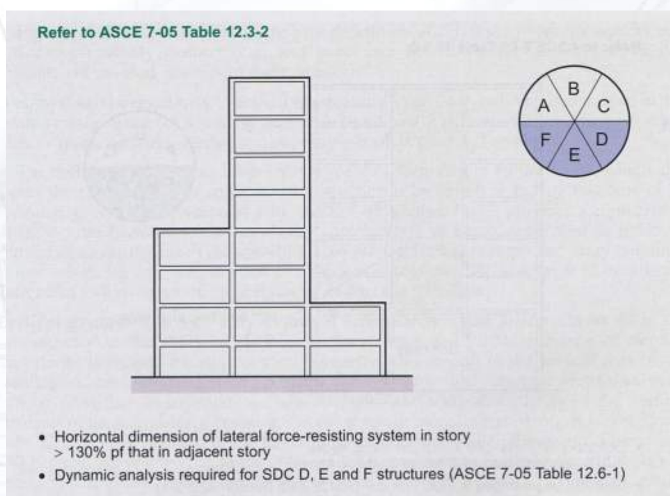
- ***V2 – Weight (Mass):***
  - Effective mass of any story > 150% of adjacent story



75

Building Configuration

- ***V3 – Vertical Geometric:***

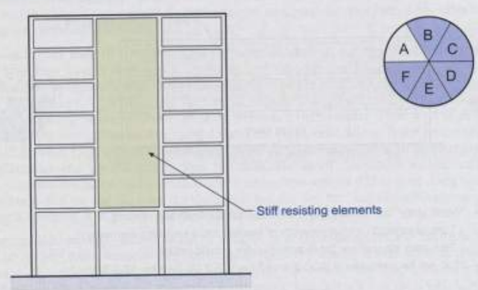


76

Building Configuration

- **V4 – In-Plane Discontinuity:**
  - In-plane offset of vertical SFR element resulting in overturning demands on supporting elements

Refer to ASCE 7-05 Table 12.3-2



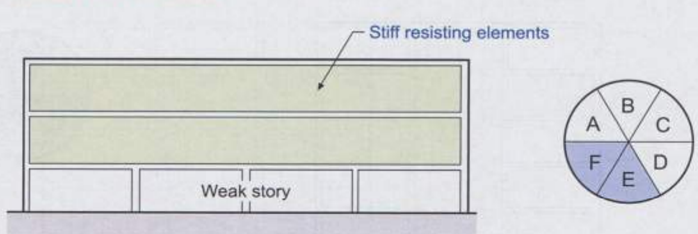
- In-plane offset of lateral-force-resisting elements > lengths of those elements or reduction in stiffness of resisting elements in story below
- Required strength of columns supporting discontinuous vertical elements (ASCE 7-05 Section 12.3.3.3):
  - Load combinations with overstrength factor (ASCE 7-05 Section 12.4.3.2) must be used
  - $(1.2 + 0.2S_{DS})D + \Omega_0 Q_E + L + 0.2S$
  - $(0.9 - 0.2S_{DS})D + \Omega_0 Q_E + L + 1.6H$
- Note special detailing requirements in materials chapters.
- In SDC D, E and F design forces determined from Section 12.8.1 shall be increased 25% for connections of diaphragms to vertical elements and to collectors, and for connectors of collector to vertical elements (ASCE 7-50 Section 12.3.3.4)

77

Building Configuration

- **V5 – Weak Story:**

Refer to ASCE 7-05 Table 12.3-2



- "Weak story" lateral strength < 80% laterals strength above story
  - Lateral strength = total strength of seismic force-resisting elements
  - Shearing story shear for direction under consideration
- Shall not be permitted in SDC E and F (ASCE 7-05 Section 12.3.3.1)

78

Building Configuration

- ***Do vertical irregularities exist?***
  - Types 1a, 1b, 2 & 3 → Dynamic analysis required
  - Type 4

Example Review Comment:
The proposed structure includes in-plane discontinuity irregularity as defined by Table 12.3-2 of ASCE 7-16. Please confirm that the requisite forces were increased as required by Section 12.3.3.4 of ASCE 7-16.

  - Type 5a → Not allowed in SDC 'E-F'
  - Type 5b → Not allowed in SDC 'D-F' & limited to 2 stories

79

Building Configuration

- ***Redundancy:***
  - If a structure's lateral resistance is concentrated in only one or a few elements, the structure will not have any residual strength if these elements are seriously damaged, and it could collapse.
  - If a structure is redundant, a relatively large number of elements participate in providing lateral resistance and, if only a few are badly damaged, the remaining elements may have adequate residual strength to prevent collapse.
  - Redundancy (ρ) is either 1.0 or 1.3 and must be considered in each of two orthogonal directions.

80

Building Configuration

- ***Redundancy (cont.):***
  - There are several conditions for which the redundancy factor, ρ, is permitted to be taken as 1.0, including for structures in SDC B and C, for drift calculations, for non-structural component forces, collectors, overstrength load combinations, and diaphragms.
  - For structures assigned to ***SDC D-F***, ρ must be taken as ***1.3*** unless one of two conditions are met. If one of the conditions is met, ρ is permitted to be taken as ***1.0***.

81

Building Configuration

- ***Redundancy (cont.):***
  - **Method 1:** Removing an individual element (brace, beam-to-column connection, shear wall or wall pier, and cantilever column) of the SFRS does not decrease the story strength by more than ***33%*** and does not trigger an extreme torsional irregularity.
  - **Method 2:** The structure must have ***two bays*** of SFRS perimeter framing ***on each side*** of the structure in each orthogonal direction. This method is only permitted for structures with no horizontal irregularities.

82

Building Configuration

- ***A comment was made noting that forces needed to be increased for a vertical irregularity. This was the response that was provided. Is the response acceptable?***

S4. 12.3.3.3 and 12.3.3.4 in the ASCE 7-16 states for shear forces to be increased by 25% for vertical structural irregularity connections. Our calcs increase the shear forces by 30% due to our redundancy factor 1.30 (see page 7 of the structural calculations package). Thus, the shear forces for offset walls have already been increased.

83

Materials

That will be most of this course.

3) Wood
4) Concrete
5) Masonry
6) Steel

84

Construction Documents

- ❑ ***IBC 107.2.1:*** *"…shall be of sufficient clarity to indicate the location, nature and extent of the work proposed and show in detail that it will conform to the provisions of this code… as determined by the B.O."*

85

Construction Documents

- ❑ Shall show size, section & relative location of structural members with floor levels, column centers and offsets dimensioned. (IBC 1603.1)
- ❑ ***Load information*** must be provided.

GENERAL

1 **Building Code: International Building Code (IBC), 2018 Edition.**
Material Codes:
ASCE 7-16, "Minimum Design Loads and Associated Criteria for Buildings and Other Structures"
AISC 360-16, "Specification for Structural Steel Buildings"
AISC 341-16, "Seismic Provisions for Structural Steel Buildings"
ACI 318-14, "Building Code Requirements for Structural Concrete and Commentary"
ACI 530, 2013 ed. "Building Code Requirements and Specification for Masonry Structures"

2 **Design Gravity Loads:**
Roof Dead Load = 16 psf
Roof Live Load (Reducible) = 20 psf
Floor Live Load = 100 psf
Assumed Construction Live Load = 50 psf

3 **Design Wind Loads:**
Ultimate Design Wind Speed (V_{ULT}) = 103 mph
Nominal Design Wind Speed (V_{ASD}) = 80 mph
Risk Category = II
Wind Exposure Category = C
Internal Pressure Coeff, GC_{pi} = +/-0.18

Components and Cladding:
Refer Components and Cladding Diagram and Schedule

4 **Design Snow Loads:**
Ground Snow Load, p_g= 28 psf
Flat Roof Snow Load, p_f = 20 psf
Snow Exposure Factor, c_e = 0.9
Snow Load Importance Factor, I = 1.0
Thermal Factor, c_t = 1.0

5 **Design Seismic Loads:**
Seismic Importance Factor, I = 1.0
Risk Category = II
5% Damped Spectral Response Acceleration Parameter, S_S = 1.027
1-sec Period Spectral Response Acceleration Parameter, S_1 = 0.910
Site Class = F
5% Damped Spectral Response Coefficient, S_{DS} = 0.685
1-sec Period Spectral Response Coefficient, S_{D1} = 1.517
Seismic Design Category = D
Seismic Force Resisting System = Bearing Wall, Intermediate Precast Shear Walls
Response Modification Factor, R = 4
Seismic Force Resisting System = Steel Special Concentrically Braced Frames
Response Modification Factor, R = 6
Seismic Response Coefficient, C_s = 0.171 (for R=4)
Analysis Method = Equivalent Lateral Force Procedure
Design Base Shear (V) = 0.171 W (0.120 W Service)

86

Construction Documents

IBC 1603.1.1 & 1603.1.2: Floor/Roof Live Loads

- Verify live loads based on use → IBC Table 1607.1

TABLE 1607.1
MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS, L_o, AND MINIMUM CONCENTRATED LIVE LOADS

	OCCUPANCY OR USE		UNIFORM (psf)	CONCENTRATED (pounds)	ALSO SEE SECTION
1.	Apartments (see residential)		—	—	—
2.	Access floor systems	Office use	50	2,000	—
		Computer use	100	2,000	—
3.	Armories and drill rooms		150[b]	—	—
4.	Assembly areas	Fixed seats (fastened to floor)	60[a]	—	—
		Follow spot, projections and control rooms	50		
		Lobbies	100[a]		
		Movable seats	100[a]		
		Stage floors	150[b]		
		Platforms (assembly)	100[a]		
		Bleachers, folding and telescopic seating and grandstands	100[a] (See Section 1607.19)		
		Stadiums and arenas with fixed seats (fastened to the floor)	60[a] (See Section 1607.19)		
		Other assembly areas	100[a]		
5.	Balconies and decks		1.5 times the live load for the area served, not required to exceed 100	—	—

87

Construction Documents

Compare to architectural plans…

88

Construction Documents

Risk Category:

- ❑ IBC Table 1604.5
- ❑ Table 1.5-2, ASCE 7-16

Table 1.5-2 Importance Factors by Risk Category of Buildings and Other Structures for Snow, Ice, and Earthquake Loads

Risk Category from Table 1.5-1	Snow Importance Factor, I_s	Ice Importance Factor—Thickness, I_i	Ice Importance Factor—Wind, I_w	Seismic Importance Factor, I_e
I	0.80	0.80	1.00	1.00
II	1.00	1.00	1.00	1.00
III	1.10	1.15	1.00	1.25
IV	1.20	1.25	1.00	1.50

TABLE 1604.5
RISK CATEGORY OF BUILDINGS AND OTHER STRUCTURES

RISK CATEGORY	NATURE OF OCCUPANCY
I	Buildings and other structures that represent a low hazard to human life in the event of failure, including but not limited to: • Agricultural facilities. • Certain temporary facilities. • Minor storage facilities.
II	Buildings and other structures except those listed in Risk Categories I, III and IV.

III	Buildings and other structures that represent a substantial hazard to human life in the event of failure, including but not limited to:
	• Buildings and other structures whose primary occupancy is public assembly with an occupant load greater than 300.
	• Buildings and other structures containing one or more public assembly spaces, each having an occupant load greater than 300 and a cumulative occupant load of the public assembly spaces of greater than 2,500.
	• Buildings and other structures containing Group E or Group I-4 occupancies or combination thereof, with an occupant load greater than 250.
	• Buildings and other structures containing educational occupancies for students above the 12th grade with an occupant load greater than 500.
	• Group I-2, Condition 1 occupancies with 50 or more care recipients.
	• Group I-2, Condition 2 occupancies not having emergency surgery or emergency treatment facilities.
	• Group I-3 occupancies.
	• Any other occupancy with an occupant load greater than 5,000.[a]
	• Power-generating stations, water treatment facilities for potable water, wastewater treatment facilities and other public utility facilities not included in Risk Category IV.
	• Buildings and other structures not included in Risk Category IV containing quantities of toxic or explosive materials that:
	  • Exceed maximum allowable quantities per control area as given in Table 307.1(1) or 307.1(2) or per outdoor control area in accordance with the *International Fire Code*; and
	  • Are sufficient to pose a threat to the public if released.[b]

IV	Buildings and other structures designated as essential facilities, including but not limited to:
	• Group I-2, Condition 2 occupancies having emergency surgery or emergency treatment facilities.
	• Ambulatory care facilities having emergency surgery or emergency treatment facilities.
	• Fire, rescue, ambulance and police stations and emergency vehicle garages
	• Designated earthquake, hurricane or other emergency shelters.
	• Designated emergency preparedness, communications and operations centers and other facilities required for emergency response.
	• Power-generating stations and other public utility facilities required as emergency backup facilities for Risk Category IV structures.
	• Buildings and other structures containing quantities of highly toxic materials that:
	  • Exceed maximum allowable quantities per control area as given in Table 307.1(2) or per outdoor control area in accordance with the *International Fire Code*; and
	  • Are sufficient to pose a threat to the public if released.[b]
	• Aviation control towers, air traffic control centers and emergency aircraft hangars.
	• Buildings and other structures having critical national defense functions.
	• Water storage facilities and pump structures required to maintain water pressure for fire suppression.

89

Construction Documents

Risk Category: What is the risk category for a…?

- ❑ Elementary school
- ❑ Retail greenhouse
- ❑ Restaurant
- ❑ Warehouse
- ❑ Single-family home
- ❑ Apartment complex

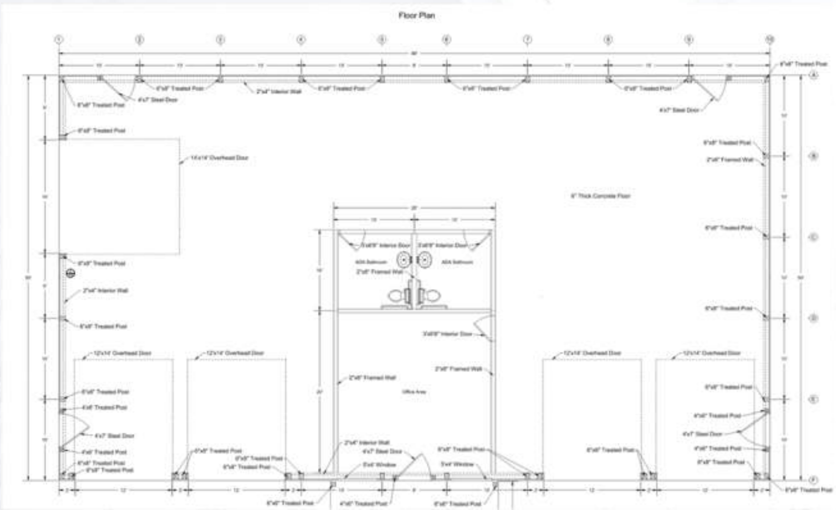
What would this apply to?

Risk Category = 1.5

90

Risk Category 1- Low Risk
Type of Construction: VB

Total Square Footage: 4400 Sq. Ft.
Shop Area Square Footage: 3800 Sq. Ft. — Occupancy Classification F-1 — Occupant Load 38
Office Area Square Footage: 600 Sq. Ft. — Occupancy Classification B — Occupant Load 4



91

Construction Documents

IBC 1603.1.3: Snow Loads

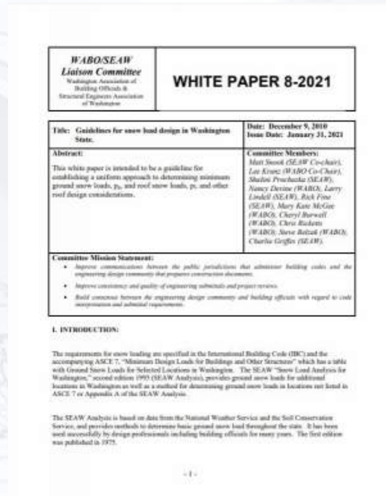
- The following should be provided:
  - Ground Snow Load (P_g)
  - Flat-roof Snow Load (P_f)
  - Snow Exposure Factor (C_e)
  - Thermal factor (C_t)
  - Snow Importance Factor (I_s)
  - Drift Surcharge Loads (P_d) and width (w)

92

Construction Documents

WABO/SEAW White Paper:

- SEAW *"Snow Load Analysis for Washington"*, 1995, 2d Edition, or…
- ASCE 7
- Low-Lying Areas of Western Washington
  - o P_f = 25psf min.
  - o Snow drift analysis not required
  - o Rain on snow should be considered

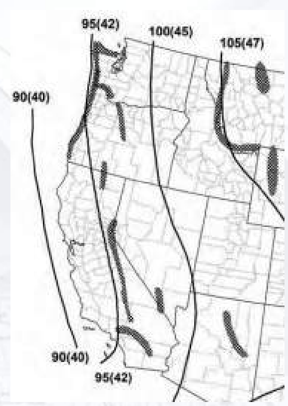


93

Construction Documents

IBC 1603.1.4: Wind Design Data

- The following should be provided:
  - o Basic Wind Speed
  - o Risk Category
  - o Wind Exposure
  - o Internal Pressure Coefficient
  - o Component & Cladding Pressures & ***Applicable Zones with Dimensions***



International Code Council, 2021 IBC©

94

Construction Documents

WABO/SEAW White Paper:

- SEAW *"ASCE 7 Special Wind Regions in Washington State"*, 2023

Risk Category (MRI)	Basic Ultimate Wind Speed (mph)
I (100 years)	115
II (700 years)	120
III (1700 years)	130
IV (3000 years)	140

Table 1 –Recommended SWR Wind Speeds Along Washington's Pacific Coast

Figure 2 – Recommended Washington State SWR Boundary

95

Construction Documents

IBC 1603.1.5: Earthquake Design Data

- The following should be provided:
  - Risk Category
  - Seismic Importance Factor (I_e)
  - Mapped Accelerations (S_S, S_1)
  - Soil Site Class*
  - Design Accelerations (S_{DS}, S_{D1})*
  - Seismic Design Category

2001 Nisqually Earthquake

96

Construction Documents

❑ *Soil Site Class*

- IBC 202: *"A classification assigned to a site based on the types of soils present and their engineering properties as defined in Section 1613.2.2."*
- IBC 1613.2.2: *"The site shall be classified as Site Class A, B, C, D, E or F in accordance with Chapter 20 of ASCE 7."*

Table 20.3-1 Site Classification

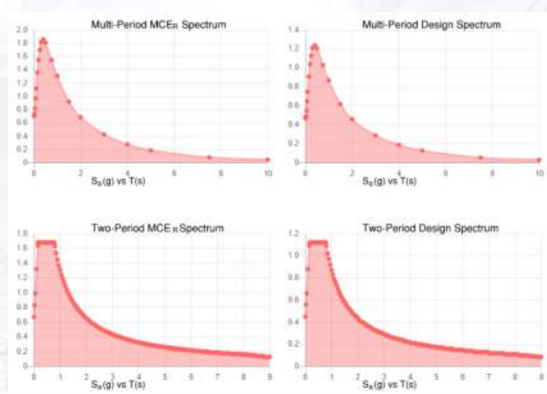
Site Class	$\bar{v}_s$	$\bar{N}$ or $\bar{N}_{ch}$	$\bar{s}_u$
A. Hard rock	>5,000 ft/s	NA	NA
B. Rock	2,500 to 5,000 ft/s	NA	NA
C. Very dense soil and soft rock	1,200 to 2,500 ft/s	>50 blows/ft	>2,000 lb/ft²
D. Stiff soil	600 to 1,200 ft/s	15 to 50 blows/ft	1,000 to 2,000 lb/ft²
E. Soft clay soil	<600 ft/s	<15 blows/ft	<1,000 lb/ft²
	Any profile with more than 10 ft of soil that has the following characteristics: — Plasticity index $PI > 20$, — Moisture content $w \geq 40\%$, — Undrained shear strength $\bar{s}_u < 500$ lb/ft²		
F. Soils requiring site response analysis in accordance with Section 21.1	See Section 20.3.1		

97

Construction Documents

WABO/SEAW White Paper:

- SEAW *"Voluntary Use of Multi-Period Response Spectra for Determination of Seismic Hazard"*, 2022
- Sections 1613.4.3 – 1613.4.6 of amendments
- Follows ASCE 7-22 provisions



98

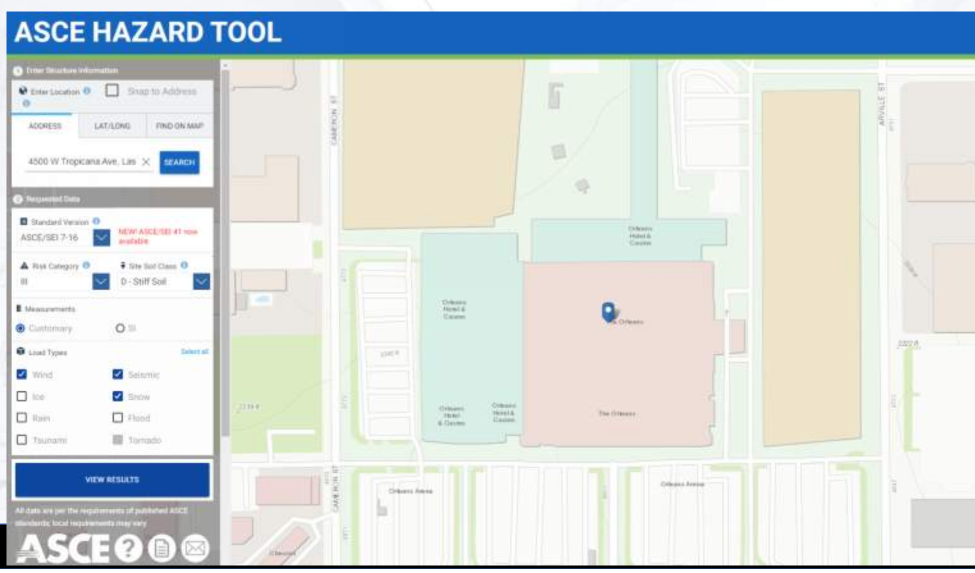
Construction Documents

- ***How many of you verify ground motions, wind, or snow?***
  - Multiple options, such as …
    - ATC Hazards by Location (seismic, wind, snow, tornado)
    - SEAOC Seismic Design Map Tool (seismic only)
    - ASCE 7 Hazard Tool (seismic, wind, rain, flood, ice, snow & tsunami
  - The others are fading out with the introduction of ASCE 7-22.
  - For that reason, we will use the ***ASCE 7 Hazard Tool*** as an example.

https://ascehazardtool.org

99

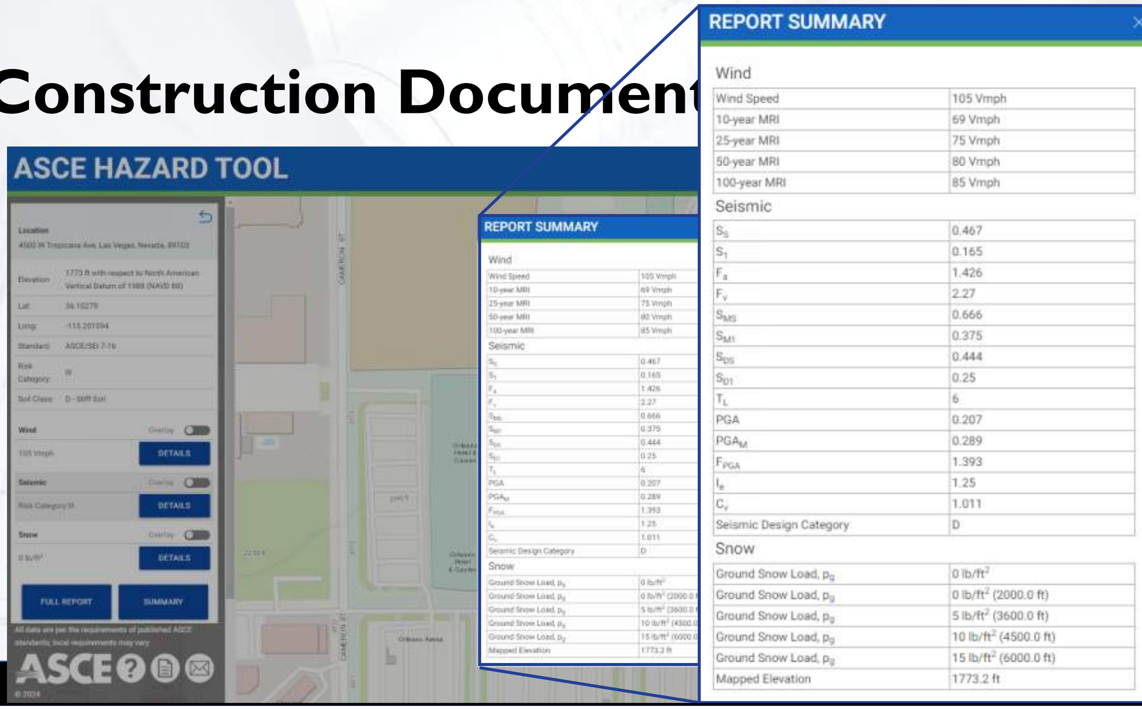
Construction Documents



https://ascehazardtool.org

100

Construction Documents



Construction Documents

IBC 1603.1.5: Earthquake Design Data (cont.)

- Additional items…
  - Basic Seismic Force-Resisting System(s)
  - Design Base Shear(s)
  - Seismic Response Coefficient(s), C_S
  - Response Modification Coefficient(s), R
  - Analysis Procedure Used
  - ***Are all systems listed?***

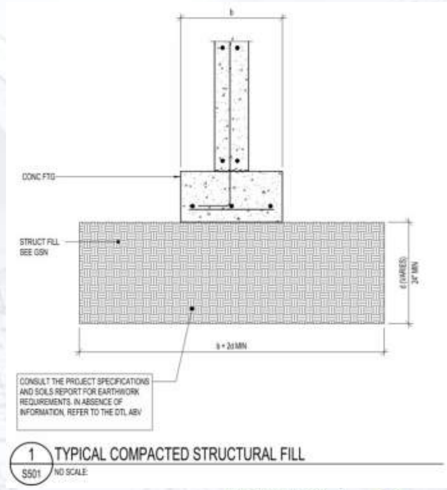
5 **Design Seismic Loads:**
Seismic Importance Factor, I = 1.0
Risk Category = II
5% Damped Spectral Response Acceleration Parameter, S_S = 1.027
1-sec Period Spectral Response Acceleration Parameter, S_1 = 0.910
Site Class = F
5% Damped Spectral Response Coefficient, S_{DS} = 0.685
1-sec Period Spectral Response Coefficient, S_{D1} = 1.517
Seismic Design Category = D
Seismic Force Resisting System = Bearing Wall, Intermediate Precast Shear Walls
Response Modification Factor, R = 4
Seismic Force Resisting System = Steel Special Concentrically Braced Frames
Response Modification Factor, R = 6
Seismic Response Coefficient, C_s = 0.171 (for R=4)
Analysis Method = Equivalent Lateral Force Procedure
Design Base Shear (V) = 0.171 W (0.120 W Service)

102

Construction Documents

- ❑ ***IBC 1603.1.6: Geotechnical Information***
  - Do the plans properly reference the geotechnical report and all applicable addendums?
  - If significant foundation preparation is required, is it also noted clearly on the plans?

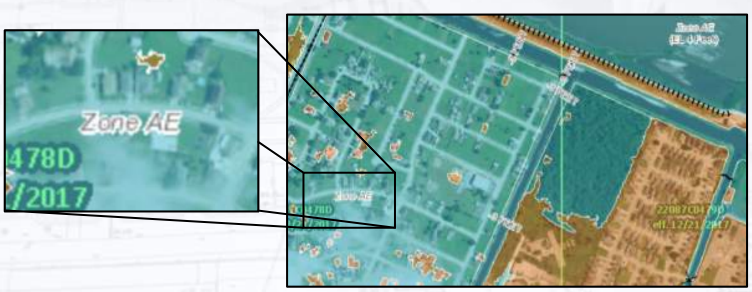
We should take the time to review the geotechnical report carefully!



103

Construction Documents

- ❑ ***IBC 1603.1.7: Flood Design Data***
  - Is the project located within a flood hazard area?
    - Flood Zones A or V → Within FHA
  - Is all appropriate flood documentation provided?



104

Construction Documents

IBC 1603.1.8: Special Loads

- This could include items such as…
  - PV systems
  - Machinery
  - Pools/spas
  - Etc.

105

Construction Documents

- ***IBC 1603.1.9: Rain Load Data***
  - The rain intensity (in/hr) must be listed regardless of whether rain loads govern the design.

106

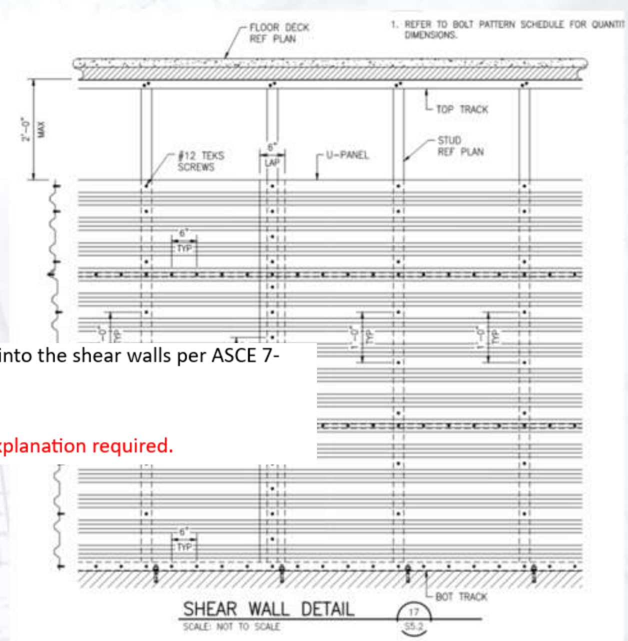
Summary

- ❑ ***Gravity Load Path***
  - Need to verify all appropriate loads are considered.
  - Are there any special load conditions?
  - Is a complete gravity load path provided?
- ❑ ***Lateral Load Path***
  - Connections-Connections-Connections!
  - Are all LFRS defined and appropriately considered?
  - Are there structural irregularities?
  - Is redundancy provided?

107

Summary

- ❑ ***What do you think of these?***



II. Please provide a complete lateral load path from the floor into the shear walls per ASCE 7-16 §12.1.3.

Lateral load path defined in design calculations. No further explanation required.

108

PART 3
Wood-Framed Construction

109

Codes/Standards

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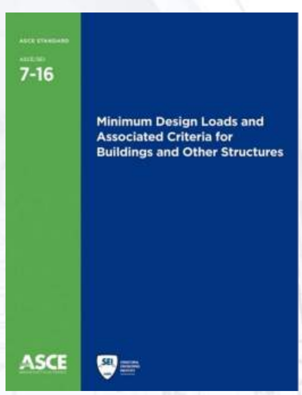
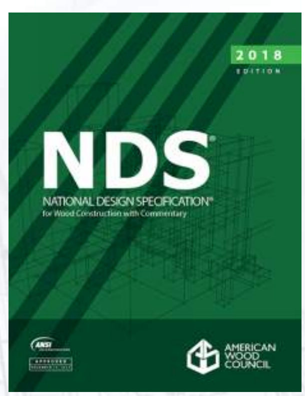


American Society of Civil Engineers, ASCE 7-16©



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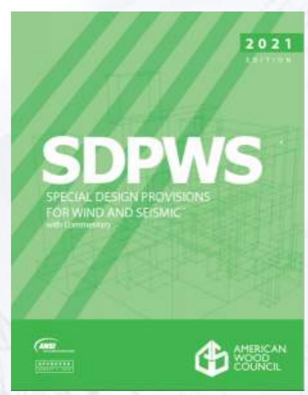

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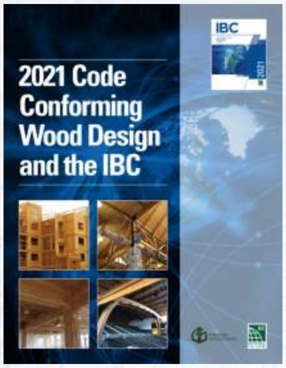
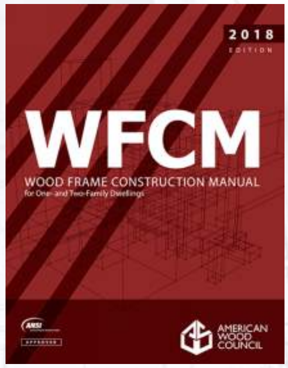
110

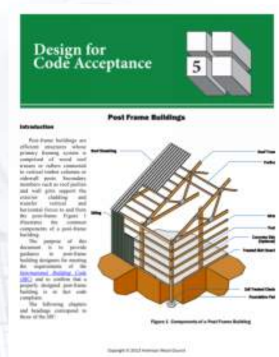
Resources



American Wood Council, 2021 Code Conforming Wood Design©



American Wood Council, 2018 WFCM Guide©



American Wood Council, 2013 DCA 5©

FEMA P-2192-V1, Design Examples©

111

IBC Requirements

- ***IBC Chapter 23***
  - Provides requirements for wood materials, wood design, construction and quality of wood members and their fasteners.
  - **Compliance Paths** *(IBC 2302.1)***:**
    - Allowable Stress Design (ASD)
    - Load & Resistance Factor Design (LRFD)
    - Conventional Light-Frame Construction
    - AWC Wood Frame Construction Manual (WFCM)
    - ICC 400 for Log Structures

International Code Council, 2021 IBC©

112

IBC Requirements

❑ *IBC 2303 – Material Specifications*

- Provides manufacturing standards, specification criteria, and use applications for wood products.
- **Includes:**
  - Structural sawn lumber
  - End-jointed lumber
  - I-joists
  - Glued-laminated timber
  - Cross-laminated timber
  - Wood structural panels
  - Fiberboard sheathing
  - Hardboard siding
  - Particleboard
  - Preservative-treated
  - Fire-retardant-treated
  - Structural log members
  - Structural composite lumber
  - Timber poles and piles
  - Rim board
  - Wood trusses
  - Joist hangers
  - Nails & staples

113

IBC Requirements

❑ *IBC 2303.2 – Fire-Retardant-Treated Wood*

- Must be tested per ASTM E84 or UL 723
- The use of paints, coating, stains, or surface treatments are not approved
- Strength adjustment is required!

Table 3: Flame Tech Treated Lumber Adjustment Factors When Used at or Near Room Temperatures

Property	Lumber Treatment Adjustment Factors [1,2]			
	SPF	Southern Pine	Douglas Fir	Other Wood Species
Bending MOR	0.95	0.82	1.00	0.82
Bending MOE	1.00	0.87	0.99	0.87
Tension Parallel to Grain	0.95	0.98	1.00	0.98
Shear Parallel to Grain	1.00	0.95	1.00	0.95
Compression Parallel to Grain	0.96	0.96	0.96	0.96
Compression Perpendicular to Grain [3]	0.95	0.95	0.96	0.95
Fasteners / connectors [4]	0.90	0.90	0.90	0.90

FlameTech™, Fire-Retardant-Treated Wood

114

Must be labeled *(IBC 2303.2.4)*

Code Compliant Fire Retardant Wood Stamps

Interior Fire Retardants | **Exterior Fire Retardants**

Interior:

1. FR product name/logo
2. Treating manufacturer
3. Wood species
4. Drying method
5. Approved inspection agency name or logo
6. Flame spread/smoke developed index rating
7. Referenced standard

Exterior:

1. FR product name/logo
2. Treating manufacturer
3. Wood species
4. Drying method
5. Approved inspection agency name or logo
6. Flame spread/smoke developed index rating
7. Referenced standard
8. Referenced rain test

Western Wood Preserver's Institute, www.fireresistant wood.org

115

IBC Requirements

- ***IBC 2304.10.1 – Connection Fire-Resistance Rating***
  - This only applies to Type IV-A, IV-B, and IV-C
  - Connection should be part of fire-resistance assembly test, or…
  - Engineering analysis showing that the temperature rise is not more than…
    - 250°F on average for duration of rating, and…
    - 325°F maximum for duration of rating
    - Must consider connectors, fasteners, and wood members that are part of connection in the analysis

116

IBC Requirements


West Coast Code Consultants, Inc.©

❑ *IBC 2304 – General Requirements*

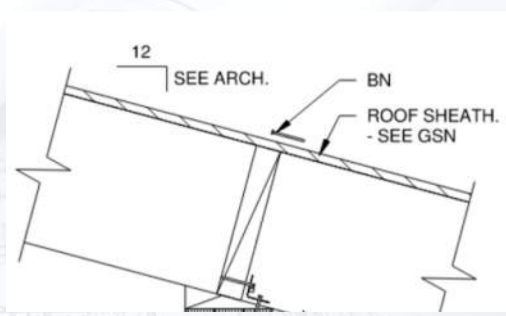
- Wall & floor framing should comply with IBC 2308.
- Bottom plates → Minimum 2x and same width as studs
- Framing over openings → Adequate size to transfer loads to vertical members
- Connectors in preservative-treated or fire-retardant → galvanized, stainless steel, silicone bronze or copper. *(Staples shall be stainless steel.)*
- Load path *(IBC 2304.10.6)* → Members shall be secured
- Wood columns and posts shall have full end bearing and shall resist lateral and uplift forces.

117

IBC Requirements

❑ *Nailing Definitions*

- Face Nail
- Toenail
- End Nail
- Edge Nailing
- Field Nailing
- Boundary Nailing



118

Exterior sheathing attachment

TABLE 2304.6.1
MAXIMUM ALLOWABLE STRESS DESIGN WIND SPEED, V_{asd} PERMITTED FOR WOOD STRUCTURAL PANEL WALL SHEATHING USED TO RESIST WIND PRESSURES[a, b, c]

MINIMUM NAIL		MINIMUM WOOD STRUCTURAL PANEL SPAN RATING	MINIMUM NOMINAL PANEL THICKNESS (inches)	MAXIMUM WALL STUD SPACING (inches)	PANEL NAIL SPACING		MAXIMUM ALLOWABLE STRESS DESIGN WIND SPEED, V_{asd}[d] (MPH)		
							Wind exposure category		
Size	Penetration (inches)				Edges (inches o.c.)	Field (inches o.c.)	B	C	D
6d common (2.0″ × 0.113″)	1.5	24/0	3/8	16	6	12	110	90	85
		24/16	7/16	16	6	12	110	100	90
						6	150	125	110
8d common (2.5″ × 0.131″)	1.75	24/16	7/16	16	6	12	130	110	105
						6	150	125	110
				24	6	12	110	90	85
						6	110	90	85

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119

Diaphragm sheathing

TABLE 2304.8(3)
ALLOWABLE SPANS AND LOADS FOR WOOD STRUCTURAL PANEL SHEATHING AND SINGLE-FLOOR GRADES CONTINUOUS OVER TWO OR MORE SPANS WITH STRENGTH AXIS PERPENDICULAR TO SUPPORTS[a]

SHEATHING GRADES		ROOF[b]				FLOOR[c]
Panel span rating roof/ floor span	Panel thickness (inches)	Maximum span (inches)		Load[d](psf)		Maximum span (inches)
		With edge support[e]	Without edge support	Total load	Live load	
16/0	3/8	16	16	40	30	0
20/0	3/8	20	20	40	30	0
24/0	3/8, 7/16, 1/2	24	20[f]	40	30	0
24/16	7/16, 1/2	24	24	50	40	16
32/16	15/32, 1/2, 5/8	32	28	40	30	16[g]
40/20	19/32, 5/8, 3/4, 7/8	40	32	40	30	20[g, h]
48/24	23/32, 3/4, 7/8	48	36	45	35	24
54/32	7/8, 1	54	40	45	35	32
60/32	7/8, 1 1/8	60	48	45	35	32
SINGLE FLOOR GRADES		**ROOF[b]**				**FLOOR[c]**
Panel span rating	**Panel thickness (inches)**	**Maximum span (inches)**		**Load[e](psf)**		**Maximum span (inches)**
		With edge support[e]	**Without edge support**	**Total load**	**Live load**	
16 o.c.	1/2, 19/32, 5/8	24	24	50	40	16[g]
20 o.c.	19/32, 5/8, 3/4	32	32	40	30	20[g, h]
24 o.c.	23/32, 3/4	48	36	35	25	24
32 o.c.	7/8, 1	48	40	50	40	32
48 o.c.	1 3/32, 1 1/8	60	48	50	40	48

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120

Roof sheathing

TABLE 2304.8(5)
ALLOWABLE LOAD (PSF) FOR WOOD STRUCTURAL PANEL ROOF SHEATHING CONTINUOUS OVER TWO OR MORE SPANS AND STRENGTH AXIS PARALLEL TO SUPPORTS
(Plywood structural panels are five-ply, five-layer unless otherwise noted)[a]

PANEL GRADE	THICKNESS (inch)	MAXIMUM SPAN (inches)	LOAD AT MAXIMUM SPAN (psf)	
			Live	Total
Structural I sheathing	$^{7}/_{16}$	24	20	30
	$^{15}/_{32}$	24	35[b]	45[b]
	$^{1}/_{2}$	24	40[b]	50[b]
	$^{19}/_{32}$, $^{5}/_{8}$	24	70	80
	$^{23}/_{32}$, $^{3}/_{4}$	24	90	100
Sheathing, other grades covered in DOC PS 1 or DOC PS 2	$^{7}/_{16}$	16	40	50
	$^{15}/_{32}$	24	20	25
	$^{1}/_{2}$	24	25	30
	$^{19}/_{32}$	24	40[b]	50[b]
	$^{5}/_{8}$	24	45[b]	55[b]
	$^{23}/_{32}$, $^{3}/_{4}$	24	60[b]	65[b]

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121

41 connections defined

TABLE 2304.10.2
FASTENING SCHEDULE

DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a]	SPACING AND LOCATION
	Roof	
1. Blocking between ceiling joists, rafters or trusses to top plate or other framing below	4-8d box ($2^{1}/_{2}$" x 0.113"); or 3-8d common ($2^{1}/_{2}$" × 0.131"); or 3-10d box (3" × 0.128"); or 3-3" × 0.131" nails; or 3-3" 14 gage staples, $^{7}/_{16}$" crown	Each end, toenail
Blocking between rafters or truss not at the wall top plate, to rafter or truss	2-8d common ($2^{1}/_{2}$" × 0.131") 2-3" × 0.131" nails 2-3" 14 gage staples	Each end, toenail
	2-16 d common ($3^{1}/_{2}$" × 0.162") 3-3" × 0.131" nails 3-3" 14 gage staples	End nail
Flat blocking to truss and web filler	16d common ($3^{1}/_{2}$" × 0.162") @ 6" o.c. 3" × 0.131" nails @ 6" o.c. 3" × 14 gage staples @ 6" o.c	Face nail
2. Ceiling joists to top plate		
3. Ceiling joist not attached to parallel r… over partitions (no thrust) (see Sectio… Table 2308.7.3.1)		
4. Ceiling joist attached to parallel rafter (heel joint) (see Section 2308.7.3.1, Table 2308.7.3.1)	Per Table 2308.7.3.1	Face nail

Remember the load path!
#1: Eave blocking to top plate, toenail (3-8d)
#12: Top plate to top plate, face nail (16d @ 16"o.c.)
#15: Bottom plate to blocking, face nail (2-16d)

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122

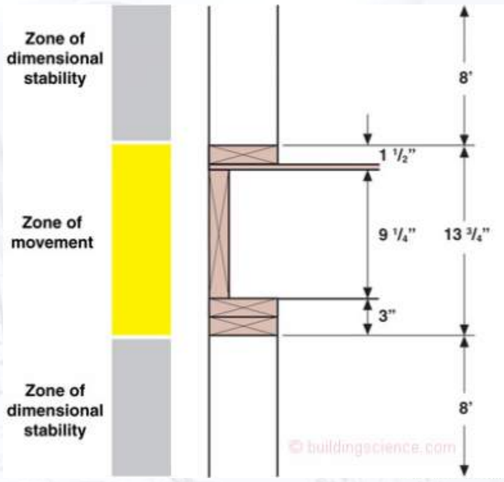
IBC Requirements

- ***IBC 2304.3.3 – Shrinkage:***
  - Wood walls supporting > two floors and a roof must provide an analysis of the potential shrinkage.

123

IBC Requirements

- ***IBC 2304.3.3 – Shrinkage:***
  - The analysis should show that the shrinkage will not cause an adverse effect on the…
    - Structure
    - MEP equipment and systems
    - Roof drainage



124

IBC Requirements

❑ *IBC 2304.3.3 – Shrinkage:*

<u>Example Review Comment:</u>
No calculations were included for the analysis of wood shrinkage in the proposed structure. Per IBC 2304.3.3, a wood-framed structure supporting the framing of more than two floors and a roof must provide an adequate shrinkage analysis to the building official. Please provide a satisfactory analysis.

- Shrinkage Calculators:
  http://www.strongtie.com/webapps/woodshrinkage/
  http://www.cwc.ca/dimensioncalc/

125

IBC Requirements

WABO/SEAW White Paper:

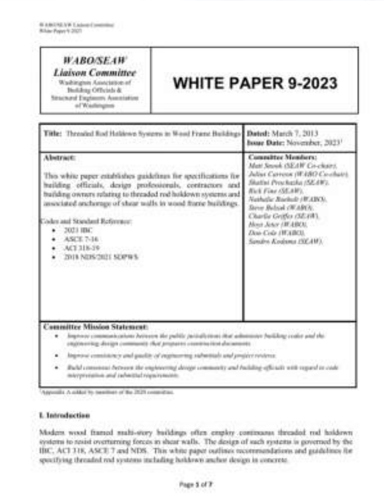
- SEAW *"Threaded Rod Holdown Systems in Wood Frame Buildings"*, 2023

For <u>performance criteria</u>, the following list of items must be provided on the plans:

1. Plan view locations of shear walls and holdowns.
2. Cumulative tension loads per story.
3. Compression loads per story, including lumber grade and story wall heights.
4. Building shrinkage and consolidation allowances per story to determine the amount of travel required by the shrinkage compensating devices.
5. Rod system deformation limit (if required).
6. A requirement for the holdown submittal to be stamped by a registered design professional.

For <u>holdown specific system criteria</u>, the following list of items must be provided on the plans:

1. Plan view locations of shear walls and holdowns.
2. Specify the holdown system and approved alternates.
3. Specify rod diameters and steel material grade.
4. Specify bearing plate requirements.
5. Specify compression posting.
6. Specify shrinkage devices and couplers.
7. Rod system deformation limit (if required).
8. Fire-Retardant Wood Treatment (FRT) design value adjustment factors


WABO/SEAW Liaison Committee

WHITE PAPER 9-2023

Title: Threaded Rod Holdown Systems in Wood Frame Buildings

Dated: March 7, 2013
Issue Date: November, 2023

Abstract:

This white paper establishes guidelines for specifications for building officials, design professionals, contractors and building owners relating to threaded rod holdown systems and associated anchorage of shear walls in wood frame buildings.

Codes and Standard Reference:
- 2021 IBC
- ASCE 7-16
- ACI 318-19
- 2018 NDS/2021 SDPWS

Committee Members:

Committee Mission Statement:

I. Introduction

Modern wood framed multi-story buildings often employ continuous threaded rod holdown systems to resist overturning forces in shear walls. The design of such systems is governed by the IBC, ACI 318, ASCE 7 and NDS. This white paper outlines recommendations and guidelines for specifying threaded rod systems including holdown anchor design in concrete.

Page 1 of 7

126

IBC Requirements

- ***IBC 2304.11 – Heavy Timber***
  - Minimum dimensions per Table 2304.11
  - Columns shall be continuous or superimposed throughout all stories and appropriately connected.
  - Approved wall plate boxes or hangers shall be used for members resting on concrete or masonry walls.
  - Exterior walls may consist of 4-inch CLT. ***(WA - 3.5")***
  - Interior walls: Solid wood, 4-inch CLT, or 1-hour construction ***(WA - 3.5")***
  - Floors and roofs shall not have concealed spaces.
  - 4-inch CLT floors and 3-inch CLT roofs are permitted. ***(WA - 3.5" & 2.5")***

127

Minimum Dimensions

TABLE 2304.11
MINIMUM DIMENSIONS OF HEAVY TIMBER STRUCTURAL MEMBERS

		MINIMUM NOMINAL SOLID SAWN SIZE		MINIMUM GLUED-LAMINATED NET SIZE		MINIMUM STRUCTURAL COMPOSITE LUMBER NET SIZE	
SUPPORTING	HEAVY TIMBER STRUCTURAL ELEMENTS	Width, inch	Depth, inch	Width, inch	Depth, inch	Width, inch	Depth, inch
Floor loads only or combined floor and roof loads	Columns; Framed sawn or glued-laminated timber arches that spring from the floor line; Framed timber trusses	8	8	$6^3/_4$	$8^1/_4$	7	$7^1/_2$
	Wood beams and girders	6	10	5	$10^1/_2$	$5^1/_4$	$9^1/_2$
Roof loads only	Columns (roof and ceiling loads); Lower half of: wood-frame or glued-laminated arches that spring from the floor line or from grade	6	8	5	$8^1/_4$	$5^1/_4$	$7^1/_2$
	Upper half of: wood-frame or glued-laminated arches that spring from the floor line or from grade	6	6	5	6	$5^1/_4$	$5^1/_2$
	Framed timber trusses and other roof framing;[a] Framed or glued-laminated arches that spring from the top of walls or wall abutments	4[b]	6	3[b]	$6^7/_8$	$3^1/_2$[b]	$5^1/_2$

128

IBC Requirements

❑ ***IBC 2304.12 – Naturally Durable or Preservative-Treated***

- Joists & Girders: 18-inches & 12-inches from exposed ground
- Exterior Foundation Walls: < 8-inches from exposed earth
- Sleepers & Sills: Sleepers or sills on slab in contact with earth
- Wood Siding: < 6-inch clear of earth, or < 2-inch clear to concrete
- Posts or columns supported by concrete in direct contact with earth
- Structural supports exposed to weather.
- Structural members supporting moisture-permeable floors*
- Heavy termite hazard → crawlspace floors and decks/balconies

129

IBC Requirements

❑ ***IBC 2304.12.2.5 – Supporting Members of Permeable Floors***

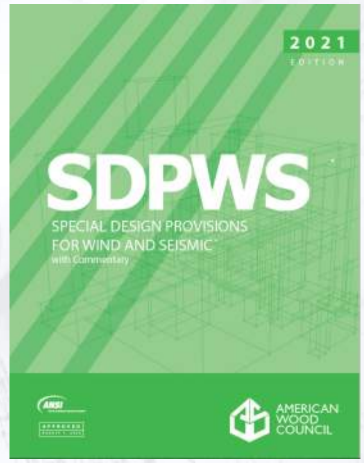
- Lumber reduction for incised lumber
- Fasteners shall be galvanized or stainless steel
- Required unless impervious floor covering

West Coast Code Consultants, Inc.©

130

IBC Requirements

- ***IBC 2305 – Lateral Force-Resisting Systems***
  - Designed per AWC SDPWS
  - Also provides optional diaphragm and shear wall deflection calculations for staples.



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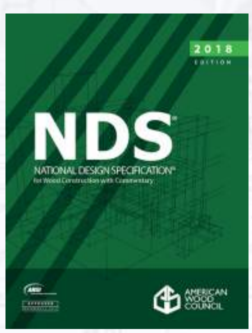
131

IBC Requirements

- ***IBC 2306 – Allowable Stress Design***
- ***IBC 2307 – Load & Resistance Factor Design***
  - Per AWC NDS and AWC SDPWS



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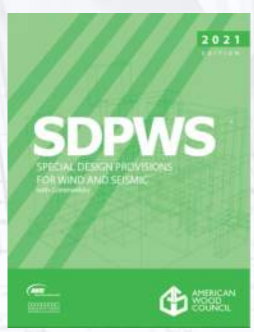

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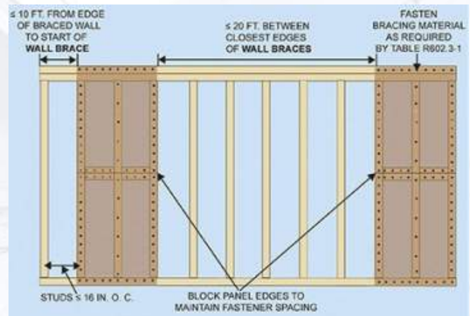
132

IBC Requirements

- ***IBC 2308 – Conventional Light-Frame Construction***
  - Remember 2304 refers to 2308 for wall and floor framing provisions
  - Includes story and allowable floor-to-floor height limitations
  - Provides braced wall provisions, but numerous limitations.



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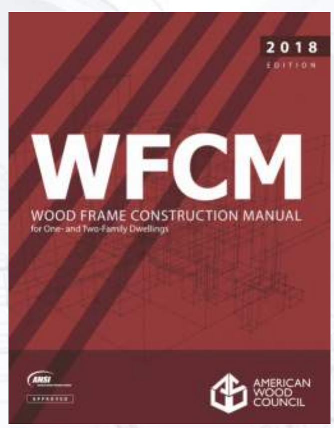
133

IBC Requirements

- ***IBC 2309 – Wood Frame Construction Manual***
  - Alternative to SDPWS and IBC 2308
  - Limited to Risk Category I or II only
  - Several limitations and load assumptions included



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134

IBC Requirements

- ***IBC Chapter 17 – Special Inspections***
  - Should be included in Statement of Special Inspections *(IBC 1704.3)*
  - What information must be provided in an SSI?
  - Wood Construction *(IBC 1705.3)*:
    - High-load diaphragms
    - Trusses spanning > 60-feet
    - Mass timber construction (IBC Table 1705.5.3)
  - Structural Wood *(IBC 1705.12.1 & 1705.13.2)*:
    - Shear walls, diaphragms, braces & holdowns (≤4"o.c.)
  - Sealing of Mass Timber *(IBC 1705.20)*

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135

IBC Requirements

TABLE 1705.5.3
REQUIRED SPECIAL INSPECTIONS OF MASS TIMBER CONSTRUCTION

	TYPE		CONTINUOUS SPECIAL INSPECTION	PERIODIC SPECIAL INSPECTION
1.	Inspection of anchorage and connections of mass timber construction to timber deep foundation systems.		—	X
2.	Inspect erection of mass timber construction.		—	X
3.	Inspection of connections where installation methods are required to meet design loads.			
	Threaded fasteners	Verify use of proper installation equipment.	—	X
		Verify use of pre-drilled holes where required.	—	X
		Inspect screws, including diameter, length, head type, spacing, installation angle and depth.	—	X
	Adhesive anchors installed in horizontal or upwardly inclined orientation to resist sustained tension loads.		X	—
	Adhesive anchors not defined in preceding cell.		—	X
	Bolted connections.		—	X
	Concealed connections.		—	X

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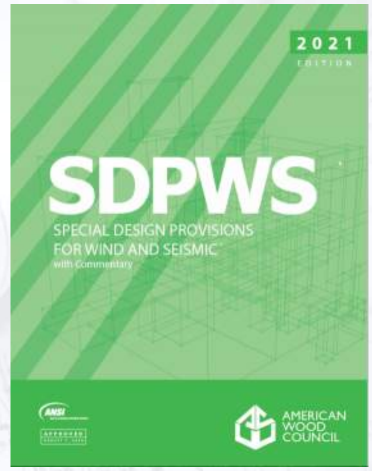
136

SDPWS Requirements

- ***Standard Layout***
  - Chapter 1 – Designer Flowchart
  - Chapter 2 – General Design Requirements
  - Chapter 3 – Members & Connections
  - ***Chapter 4 – LFRS *****
  - Appendix A – Fastener Provisions



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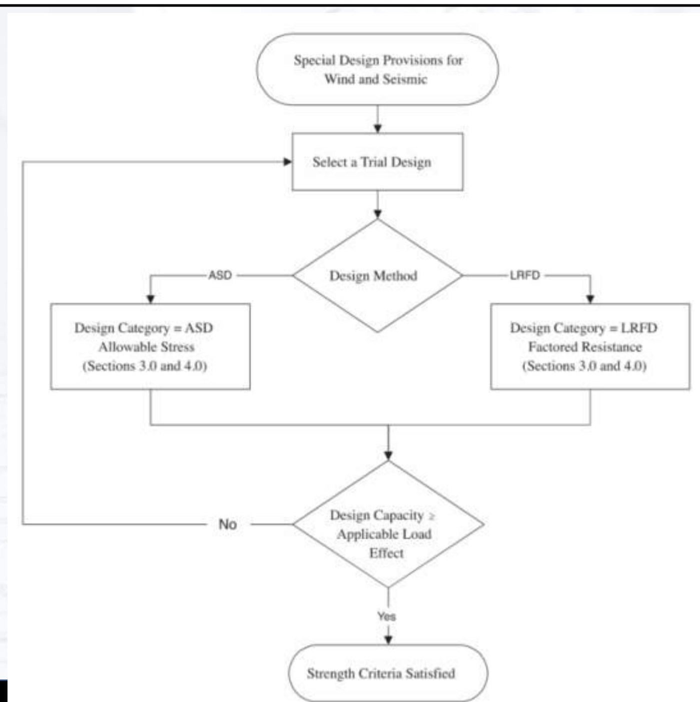
https://awc.org/publications/2021-sdpws/

137



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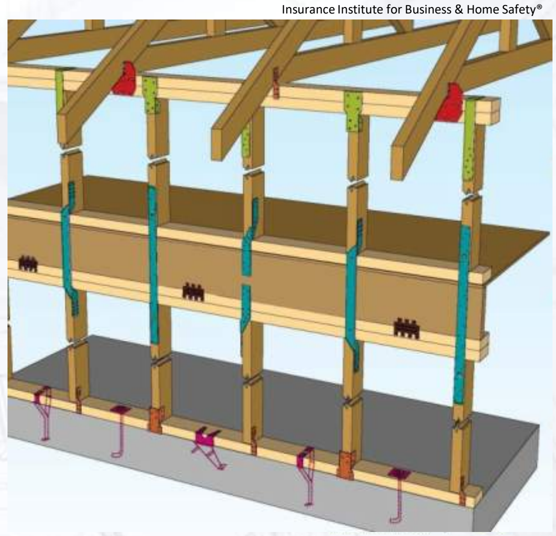
138

SDPWS Requirements

Insurance Institute for Business & Home Safety®

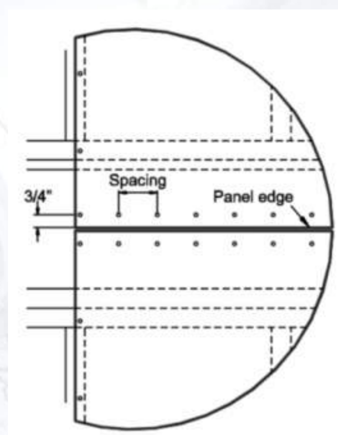


- **_Uplift Load Path (§3.4):_**
  - A continuous load path, or paths, with adequate strength and stiffness shall be provided to transfer all forces from the point of application to the final point of resistance.
- **_§4.1.1 repeats this requirements for the lateral load path._**

139

SDPWS Requirements

- **_General Lateral Provisions (§4.1)_**
  - Shall meet applicable drift, deflection, and deformation requirements of the IBC.
  - Shear Capacity:
    - Seismic → §4.1.4.1
    - Wind → §4.1.4.2
  - Shear Walls & Diaphragms:
    - **_Diaphragms → §4.2_** _(CLT → §4.5)_
    - **_Shear Walls → §4.3_** _(CLT → §4.6)_
    - Shear Walls where sheathing resists uplift → §4.4

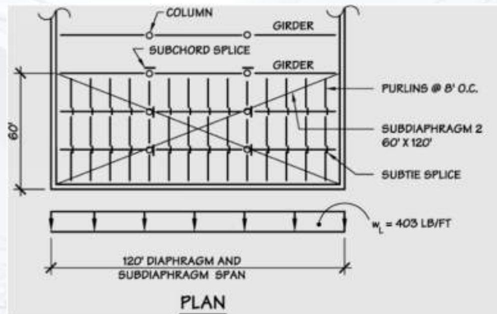


140

SDPWS Requirements

❑ ***General Lateral Provisions (cont.)***

- Deformation of each element shall be compatible with other LFRS elements. Boundary elements required to transfer shear wall and diaphragm forces.
- Wood-frame systems should not be used to resist seismic forces from masonry or concrete walls over 1-story.
- Anchorage of concrete or masonry walls to wood diaphragms → Provided with continuous ties or struts between diaphragm chords to distribute the wall anchorage forces.

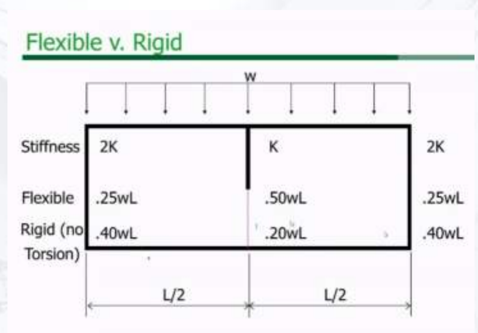


141

SDPWS Requirements

❑ ***General Lateral Provisions (cont.)***

- **Horizontal Distribution:**
- Flexible
  - Diaphragm loads distributed to shear walls by tributary area
- Rigid
  - Diaphragm load is distributed to vertical LFR elements based on their stiffness
- Semi-rigid
  - Distributed based on relative stiffness of diaphragm and vertical LFR elements



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142

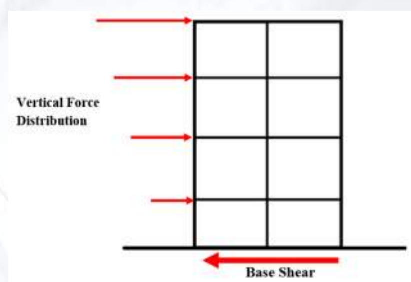
SDPWS Requirements

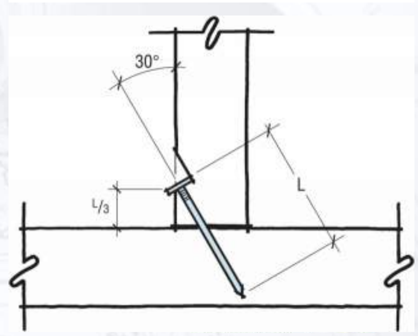
- ***General Lateral Provisions (cont.)***
  - **ASCE 7-16 provisions (§ 12.3.1):**
  - Flexible assumption allowed if…
    - Steel or concrete frames
    - Concrete, masonry, or steel shear walls
    - One- and two-family dwellings
    - Light-frame construction and…
      - Topping is limited to 1.5-inches
      - Vertical LFRS comply with allowable story drift
  - Rigid assumption allowed if concrete slabs or concrete-filled metal deck with span-to-depth ratio of 3 or less and no horizontal irregularities.

143

SDPWS Requirements

- ***General Lateral Provisions (cont.)***
  - Vertical distribution of shear
  - Shear wall and diaphragm boundary elements shall be provided to transfer lateral forces.
  - Toe-nailed connections shall not be used in SDC "D-F" for > 150plf (ASD)





144

SDPWS Requirements

- ***Wood-Frame Diaphragms (§4.2)***
  - **Aspect Ratio:**

Table 4.2.2 Maximum Diaphragm Aspect Ratios
(Flat or Sloped Diaphragms)

Sheathed Wood-Frame Diaphragm Assemblies	Maximum L/W Ratio
Wood structural panel, unblocked	3:1
Wood structural panel, blocked	4:1
Single-layer horizontally-sheathed lumber	2:1
Single-layer diagonally-sheathed lumber	3:1
Double-layer diagonally-sheathed lumber	4:1

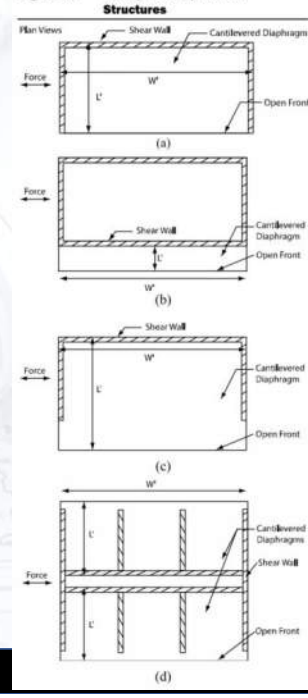
145

SDPWS Requirements

- ***Wood-Frame Diaphragms (§4.2)***
  - **Open Front Structures:**
  - L' / W' ratio limited to 1.5:1.0
  - Loading parallel to open side → modelled as rigid or semi-rigid
  - Cantilevered diaphragm length ≤ 35-feet
  - *Exception:* 6-foot cantilever allowed

Example Review Comment:
Please verify that the requirements of Section 4.2.6 in AWC SDPWS for "open front structures" have been met at locations where the roof diaphragm cantilevers beyond the lateral resisting elements.

Figure 4A Examples of Open Front Structures



146

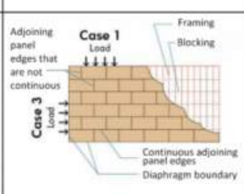
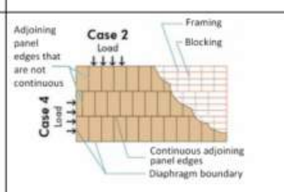
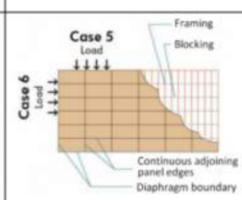
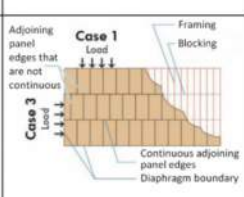
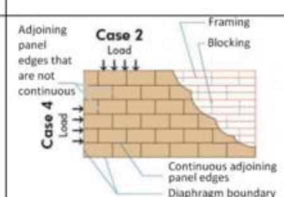
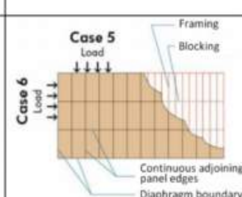
SDPWS Requirements

- ❑ ***Wood-Frame Diaphragms (§4.2)***
  - **General:**
    - Panels ≥ 4’x8’ except at boundaries & changes in framing
    - Panel minimum dimension ≥ 24-inches unless edges are supported
    - Nails shall be ≥ 3/8-inch from panel edges
    - Nailing:
      - Edge spacing ≤ 6-inches (same at intermediate framing members & blocking)
      - Field spacing ≤ 12-inches (6-inches if support spacing 48-inches)
  - Unblocked → Table 4.2C
  - Blocked → Table 4.2A
  - High-Load → Table 4.2B & Figure 4C

147

Diaphragm Cases

Capacity is not dependent on panel orientation, but on loading direction and direction of framing.

	Cases 1&3: Continuous Adjoining Panel Edges Perpendicular to Framing	**Cases 2&4:** Continuous Adjoining Panel Edges Parallel to Framing	**Cases 5&6:** Continuous Adjoining Panel Edges Perpendicular and Parallel to Framing
Long Panel Direction Perpendicular to Supports			
Long Panel Direction Parallel to Supports			

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148

Unblocked Diaphragms

→Assume 7/16-inch OSB Structural I roof sheathing is specified

Table 4.2C Nominal Unit Shear Values for Sheathed Wood-Frame Diaphragms

Unblocked Wood Structural Panel Diaphragms[1,2,3,4,6]

Sheathing Grade	Common Nail Size[5] Length (in.) x Shank diameter (in.) x Head diameter (in.)	Minimum Nail Bearing Length in Framing Member, ℓ_m (in.)	Minimum Nominal Panel Thickness (in.)	Minimum Nominal Width of Nailed Face at Adjoining Panel Edges and Boundaries (in.)	6 in. Nail Spacing at diaphragm boundaries and supported panel edges: Case 1 v_n (plf)	Case 1 G_a (kips/in) OSB	Case 1 G_a (kips/in) PLY	Cases 2,3,4,5,6 v_n (plf)	Cases 2,3,4,5,6 G_a (kips/in) OSB	Cases 2,3,4,5,6 G_a (kips/in) PLY
Structural I	6d (2 x 0.113 x 0.266)	1-1/4	5/16	2	460	9.0	7.0	350	6.0	4.5
				3	520	7.0	6.0	390	4.5	4.0
	8d (2-1/2 x 0.131 x 0.281)	1-3/8	3/8	2	670	8.5	7.0	505	6.0	4.5
				3	740	7.5	6.0	560	5.0	4.0
	10d (3 x 0.148 x 0.312)	1-1/2	15/32	2	800	14	10	600	9.5	7.0
				3	895	12	9.0	670	8.0	6.0
Sheathing and Single-Floor	6d (2 x 0.113 x 0.266)	1-1/4	5/16	2	420	9.0	6.5	310	6.0	4.0
				3	475	7.0	5.5	350	5.0	3.5
			3/8	2	460	7.5	5.5	350	5.0	4.0
				3	520	6.0	4.5	390	4.0	3.0
	8d (2-1/2 x 0.131 x 0.281)	1-3/8	3/8	2	600	9.0	6.5	450	6.0	4.5
				3	670	7.5	5.5	505	5.0	3.5
			[illegible]	2	645	8.5	6.0	475	5.5	4.0
			[illegible]							
	10d (3 x 0.148 x 0.312)	1-1/2	[illegible]							
			[illegible]							

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Values listed are "nominal".

- ***ASD →Dividing by 2.8 (Seismic); 2.0 (Wind)***
- ***LRFD →Multiplying by 0.50 (Seismic); 0.80 (Wind)***

149

Blocked Diaphragms

→Assume 15/32-inch blocked OSB Structural I roof sheathing

Blocked Wood Structural Panel Diaphragms[1,2,3,4,6]

Nail Spacing (in.) at diaphragm boundaries (all cases), at continuous panel edges parallel to load (Cases 3 & 4), and at all panel edges (Cases 5 & 6): 6 / 4 / 2-1/2 / 2. Nail Spacing (in.) at other panel edges (Cases 1,2,3, & 4): 6 / 6 / 4 / 3.

Sheathing Grade	Common Nail Size[5] Length (in.) x Shank diameter (in.) x Head diameter (in.)	Minimum Nail Bearing Length in Framing Member or Blocking, ℓ_m (in.)	Minimum Nominal Panel Thickness (in.)	Minimum Nominal Width of Nailed Face at Adjoining Panel Edges and Boundaries (in.)	6/6 v_n (plf)	6/6 G_a (kips/in.) OSB	6/6 G_a PLY	4/6 v_n (plf)	4/6 G_a OSB	4/6 G_a PLY	2-1/2/4 v_n (plf)	2-1/2/4 G_a OSB	2-1/2/4 G_a PLY	2/3 v_n (plf)	2/3 G_a OSB	2/3 G_a PLY
Structural I	6d (2 x 0.113 x 0.266)	1-1/4	5/16	2	520	15	12	700	8.5	7.5	1050	12	10	1175	20	15
				3	590	12	9.5	785	7.0	6.0	1175	9.5	8.5	1330	17	13
	8d (2-1/2 x 0.131 x 0.281)	1-3/8	3/8	2	755	14	11	1010	9.0	7.5	1485	13	10	1680	21	15
				3	840	12	10	1120	7.5	6.5	1680	10	9.0	1890	18	13
	10d (3 x 0.148 x 0.312)	1-1/2	15/32	2	895	24	17	1190	15	12	1790	20	15	2045	31	21
				3	1010	20	15	1345	12	9.5	2015	16	13	2295	26	18
Sheathing and Single-Floor	6d (2 x 0.113 x 0.266)	1-1/4	5/16	2	475	15	10	630	9.0	7.0	940	13	9.5	1065	21	13
				3	530	12	9.0	700	7.0	6.0	1065	10	8.0	1205	17	12
			3/8	2	520	13	9.5	700	7.0	6.0	1050	10	8.0	1175	18	12
				3	590	10	8.0	785	5.5	5.0	1175	8.5	7.0	1330	14	10
	8d (2-1/2 x 0.131 x 0.281)	1-3/8	3/8	2	670	15	11	895	9.5	7.5	1345	13	9.5	1525	21	13
				3	755	12	9.5	1010	7.5	6.0	1510	11	8.5	1710	18	12
			7/16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
			15/32													
	10d (3 x 0.148 x 0.312)	1-1/2	15/32													
			19/32													

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Values listed are "nominal".

- ***ASD →Dividing by 2.8 (Seismic); 2.0 (Wind)***
- ***LRFD →Multiplying by 0.50 (Seismic); 0.80 (Wind)***

150

High Load Diaphragms → *IBC 1705.5.1 requires special inspection of these diaphragms*

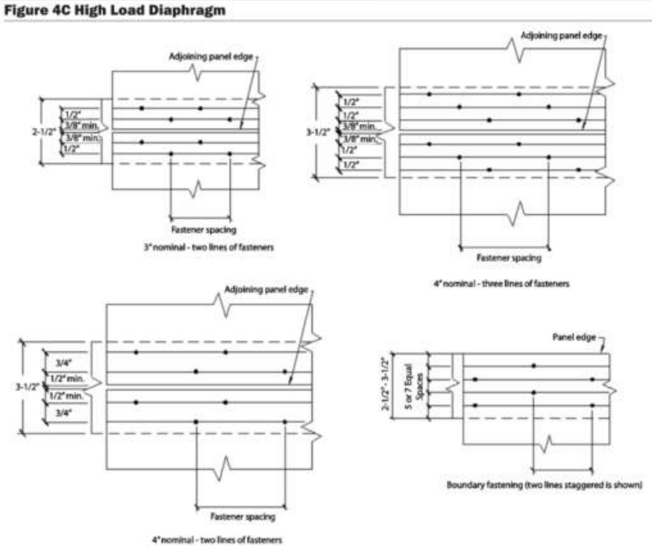
Blocked Wood Structural Panel Diaphragms Utilizing Multiple Rows of Fasteners (High Load Diaphragms) [1,2,3,4,6]

Sheathing Grade	Common Nail Size[5] Length (in.) x Shank diameter (in.) x Head diameter (in.)	Minimum Nail Bearing Length in Framing Member or Blocking, ℓ_m (in.)	Minimum Nominal Panel Thickness (in.)	Minimum Nominal Width of Nailed Face at Adjoining Panel Edges and Boundaries (in.)	Lines of Nails	Nail Spacing (in.) at diaphragm boundaries (all cases), at continuous panel edges parallel to load (Cases 3 & 4), and at all panel edges (Cases 5 & 6)											
						4			4			2-1/2			2-1/2		
						Nail Spacing (in.) at other panel edges (Cases 1, 2, 3, & 4)											
						6			4			4			3		
						v_n (plf)	G_a (kips/in.)		v_n (plf)	G_a (kips/in.)		v_n (plf)	G_a (kips/in.)		v_n (plf)	G_a (kips/in.)	
							OSB	PLY		OSB	PLY		OSB	PLY		OSB	PLY
Structural I	10d (3 x 0.148 x 0.312)	1-1/2	15/32	3	2	1695	40	24	2280	53	28	2450	50	27	3220	56	29
				4	2	1960	33	21	2560	48	27	2815	44	25	3610	51	28
				4	3	2450	50	27	3415	61	30	3600	59	30	3905	70	32
			19/32	3	2	1875	36	23	2465	52	29	2700	47	27	3515	54	29
				4	2	2185	29	20	2770	46	27	3110	40	25	4030	48	27
				4	3	2700	47	27	3695	60	31	3935	57	30	5010	64	32
			23/32	3	2	2045	33	22	2675	50	29	2940	45	27	3820	53	30
				4	2	2395	26	19	2995	43	27	3390	37	24	4380	45	27
				4	3	2940	45	27	4005	59	32	4270	56	31	5040	68	34
Sheathing and Single-Floor	10d (3 x 0.148 x 0.312)	1-1/2	15/32	3	2	1470	43	21	2030	55	23	2140	53	23	2830	58	24
				4	2	1695	36	19	2280	50	22	2450	46	21	3095	55	23
				4	3	2140	53	23	3040	62	24	3165	61	24	3345	72	26
			19/32	3	2	1820	34	19	2410	49	23	2620	45	22	3430	52	23
				4	2	2115	27	16	2700	43	21	3025	37	20	3835	46	22
				4	3	2620	45	22	3610	57	24	3820	55	24	4160	68	26
			23/32	3	2	1990	30	18	2620	46	23	2855	42	22	3740	50	24
				4	2	2310	24	16	2940	40	21	3290	34	20	4045	45	23
				4	3	2855	42	22	3920	56	25	4145	53	25	4380	71	28

151

High Load Diaphragms

Figure 4C High Load Diaphragm



Note: Space adjoining panel edges 1/8" apart. Minimum spacing between lines of fasteners is 3/8".

152

SDPWS Requirements

- ***Wood-Frame Shear Walls (§4.3)***
  - **General:**
    - All framing members and blocking shall be ≥ 2x
    - Framing members, blocking, and connections shall extend into the shear wall a sufficient distance to develop the force transferred into the shear wall.
    - Boundary elements shall be provided to transmit the design tension and compression forces.

Model No.	Ga.	Dimensions (in.)					Fasteners (in.)		Minimum Wood Member Size (in.)	Allowable Tension Loads (160)		
		W	H	B	CL	SO	Anchor Bolt Dia. (in.)	Wood Fasteners		DF/SP	SPF/HF	Deflection at Allowable Load (in.)
HDU2-SDS2.5	14	3	8 11/16	3 1/4	1 5/16	1 3/8	5/8	(6) 1/4 x 2 1/2 SDS	3 x 3 1/2	3,075	2,215	0.088
HDU4-SDS2.5	14	3	10 15/16	3 1/4	1 5/16	1 3/8	5/8	(10) 1/4 x 2 1/2 SDS	3 x 3 1/2	4,565	3,285	0.114
HDU5-SDS2.5	14	3	13 3/16	3 1/4	1 5/16	1 3/8	5/8	(14) 1/4 x 2 1/2 SDS	3 x 3 1/2	5,645	4,340	0.115
HDU8-SDS2.5	10	3	16 5/8	3 1/2	1 3/8	1 1/2	7/8	(20) 1/4 x 2 1/2 SDS	3 x 3 1/2	6,765	5,820	0.11
									3 1/2 x 3 1/2	6,970	5,995	0.116
									3 1/2 x 4 1/2	7,870	6,580	0.113
HDU11-SDS2.5	10	3	22 1/4	3 1/2	1 3/8	1 1/2	1	(30) 1/4 x 2 1/2 SDS	3 1/2 x 5 1/2	9,535	8,030	0.137
									3 1/2 x 7 1/4	11,175	9,610	0.137
HDU14-SDS2.5	7	3	25 11/16	3 1/2	1 9/16	1 9/16	1	(36) 1/4 x 2 1/2 SDS	3 1/2 x 5 1/2	10,770	9,260	0.122
									3 1/2 x 7 1/4	14,390	12,375	0.177
									5 1/2 x 5 1/2	14,445	12,425	0.172

Simpson Strong-Tie; https://www.strongtie.com/

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153

SDPWS Requirements

- ***Wood-Frame Shear Walls (§4.3)***
  - **General:**
    - Anchor Bolts: 0.229" x 3" x 3", shall extend to within 1/2-inches of wall sheathing where nominal shear capacity is > 400plf for wind or seismic
    - Panels ≥ 4'x8' except at boundaries & changes in framing
    - Nails shall be ≥ 3/8-inch from panel edges
    - Nailing:
      - Edge spacing ≤ 6-inches (same at intermediate framing members & blocking)
      - Field spacing ≤ 6-inches (12-inches if > 7/16-inch sheathing or studs < 24"o.c.)

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154

SDPWS Requirements

- ❑ ***Wood-Frame Shear Walls (§4.3)***
  - **General** *(cont.)***:**
    - 3x if…
      - 2-inch edge nailing
      - 10d nails & 3-inch edge nailing
      - > 980plf nominal shear capacity in SDC "D-F"
    - Double 2x allowed *(Stitched together → 16d @ 24"o.c.)*
    - Framing at 24"o.c. maximum

155

Structural Sheathing

→Assume 7/16-inch OSB Structural 1 wall sheathing

Table 4.3A Nominal Unit Shear Capacities for Sheathed Wood-Frame Shear Walls [1,3,6]

Wood-based Panels [4]

Sheathing Material	Minimum Nominal Panel Thickness (in.)	Minimum Nail Bearing Length in Framing Member or Blocking, ℓ_m (in.)	Nail Type & Size [9] Length (in.) x Shank diameter (in.) x Head diameter (in.)	Panel Edge Nail Spacing (in.) 6: v_n (plf)	6: G_a (kips/in.) OSB	6: G_a PLY	4: v_n (plf)	4: G_a (kips/in.) OSB	4: G_a PLY	3: v_n (plf)	3: G_a (kips/in.) OSB	3: G_a PLY	2: v_n (plf)	2: G_a (kips/in.) OSB	2: G_a PLY
Wood Structural Panels - Structural I [4,5]	5/16	1-1/4	6d common nail (2 x 0.113 x 0.266) [8]	560	13	10	840	18	13	1090	23	16	1430	35	22
	3/8 [2]	1-3/8	8d common nail (2-1/2 x 0.131 x 0.281) [8]	645	19	14	1010	24	17	1290	30	20	1710	43	24
	7/16 [2]			715	16	13	1105	21	16	1415	27	19	1875	40	24
	15/32			785	14	11	1205	18	14	1540	24	17	2045	37	23
	15/32	1-1/2	10d common nail (3 x 0.148 x 0.312) [8,10]	950	22	16	1430								
					13	9.5	755								
					11	8.5	840								
					17	12	895								
					15	11	980								
					13	10	1065								
					22	14	1290								
					19	13	1430								

Values listed are "nominal".
- ***ASD → Dividing by 2.8 (Seismic); 2.0 (Wind)***
- ***LRFD → Multiplying by 0.50 (Seismic); 0.80 (Wind)***

If 4"o.c. edge nailing…
- ***Are plate washers required to be within 1/2-inch?***
- ***Are 3x framing members required?***

156

Over Gypsum

Table 4.3B Nominal Unit Shear Capacities for Sheathed Wood-Frame Shear Walls [1,2,5,6]

Wood Structural Panels installed over 1/2" or 5/8" Gypsum Wallboard or Gypsum Sheathing Board

Sheathing Material	Minimum Nominal Panel Thickness (in.)	Minimum Nail Bearing Length in Framing Member or Blocking, ℓ_m (in.)	Nail Type & Size [8]: Length (in.) x Shank diameter (in.) x Head diameter (in.)	Panel Edge Nail Spacing (in.): 6			4			3			2		
				v_n (plf)	G_a (kips/in.) OSB	PLY	v_n (plf)	G_a (kips/in.) OSB	PLY	v_n (plf)	G_a (kips/in.) OSB	PLY	v_n (plf)	G_a (kips/in.) OSB	PLY
Wood Structural Panels - Structural I [3,4]	5/16	1-1/4	8d common nail (2-1/2 x 0.131 x 0.281) [7]	560	13	10	840	18	13	1090	23	16	1430	35	22
	3/8, 7/16, 15/32	1-3/8	10d common nail (3x0.148x0.312) [7]	785	14	11	1205	18	14	1540	24	17	2045	37	23
Wood Structural Panels - Sheathing [3,4]	5/16	1-1/4	8d common nail (2-1/2 x 0.131 x 0.281) [7]	505	13	9.5	755	18	12	980	24	14	1260	37	18
	3/8			560	11	8.5	840	15	11	1090	20	13	1430	32	17
	3/8, 7/16, 15/32	1-3/8	10d common nail (3x0.148x0.312) [7]	730	13	10	1065	19	13	1370	25	15	1790	39	20
Plywood Siding	5/16	1-1/4	8d galv.[6] casing nail (2-1/2 x 0.113 x 0.142)	390	13		590	16		770	17		1010	21	
	3/8	1-3/8	10d galv.[6] casing nail (3 x 0.128 x 0.155)	450	16		670	18		870	20		1150	22	

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157

Gypsum Shear Walls *→ Not allowed in SDC "E-F"*

Table 4.3C Nominal Unit Shear Capacities for Sheathed Wood-Frame Shear Walls [1]

Gypsum Board, Gypsum Lath and Plaster, and Portland Cement Plaster

Sheathing Material	Material Thickness	Fastener Type & Size [2]	Max. Fastener Spacing [3] (in.)	Max. Stud Spacing (in.)		v_n (plf)	G_a (kips/in.)
Gypsum wallboard, gypsum base for veneer plaster, or water-resistant gypsum backing board	1/2"	5d cooler (0.086" x 1-5/8" long, 15/64" head) or wallboard nail (0.086" x 1-5/8" long, 9/32" head) or 0.120" nail x 1-1/2" long, min 3/8" head	7	24	unblocked	150	4.0
			4	24	unblocked	220	6.0
			7	16	unblocked	200	5.5
			4	16	unblocked	250	6.5
			7	16	blocked	250	6.5
			4	16	blocked	300	7.5
		No. 6 Type S or W drywall screws 1-1/4" long	8/12	16	unblocked	120	3.5
			4/16	16	blocked	320	8.0
			4/12	24	blocked	310	8.0
			8/12	16	blocked	140	4.0
			6/12	16	blocked	180	5.0
	5/8"	6d cooler (0.092" x 1-7/8" long, 1/4" head) or wallboard nail (0.0915" x 1-7/8" long, 19/64" head) or 0.120" nail x 1-3/4" long, min 3/8" head	7	24	unblocked	230	6.0
			4	24	unblocked	290	7.5
			7	16	blocked	290	7.5
			4	16	blocked	350	8.5
		No. 6 Type S or W drywall screws 1-1/4" long	8/12	16	unblocked	140	4.0
			8/12	16	blocked	180	5.0
	5/8" (Two-Ply)	Base ply--6d cooler (0.092" x 1-7/8" long, 1/4" head) or wallboard nail (0.0915" x 1-7/8" long, 19/64" head) or 0.120"nail x 1-3/4" long, min 3/8" head; Face ply--8d cooler (0.113" x 2-3/8" long, 0.281" head) or wallboard nail (0.113" x 2-3/8" long, 3/8" head) or 0.120" nail x 2-3/8" long, min 3/8" head	Base: 9 Face: 7	16	blocked	500	11

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158

SDPWS Requirements

- ❑ ***Wood-Frame Shear Walls (§4.3)***
  - **Aspect Ratio:**
    - Size & shape limited to Table 4.3.3

Table 4.3.3 Maximum Shear Wall Aspect Ratios

Sheathed Wood-Frame Shear Wall System	Maximum h/b Ratio
Wood structural panels, unblocked	2:1
Wood structural panels, blocked	3.5:1
Particleboard, blocked	2:1
Diagonally-sheathed lumber	2:1
Gypsum wallboard	2:1[1,2]
Portland cement plaster	2:1[1]
Structural Fiberboard	3.5:1

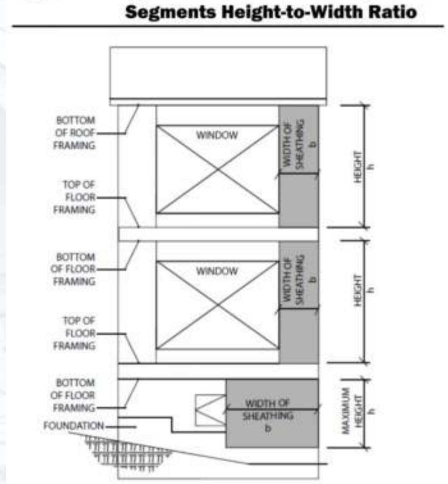
159

SDPWS Requirements

Segmented Shear Walls:

- While Table 4.3.3 allows a 3.5:1 aspect ratio, walls with ratios > 2:1 have reduced capacity
- $(WSP) = 1.25 - 0.125h/b$
- **Example:** 9-foot wall
  - 2:1 → 4.5 feet
  - 3.5:1 → 2.57 feet
  - ***43% reduction in capacity!***

Figure 4D Typical Individual Full-Height Wall Segments Height-to-Width Ratio



160

SDPWS Requirements

Segmented Shear Walls:

- Collectors shall transfer shear forces between the diaphragms and the individual full-height wall segments.

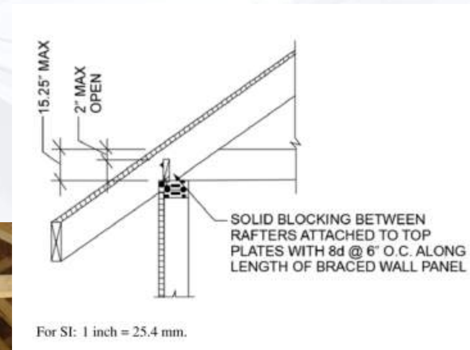


FIGURE R602.10.8.2(1)
BRACED WALL PANEL CONNECTION TO PERPENDICULAR RAFTERS

161

SDPWS Requirements

Segmented Shear Walls:

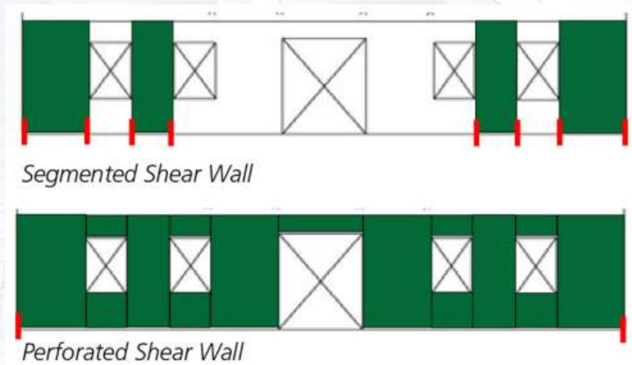
Example Review Comment:
There are numerous shear walls that appear to exceed an aspect ratio of 2:1. Please confirm that no walls exceed an aspect ratio of 3.5:1 and that these walls have been checked for a reduced capacity in accordance with Section 4.3.3.2 of AWC SDPWS.

Example Review Comment:
Multiple shear wall types are shown along the same line in some instances. Per Section 4.3.5.5 of AWC SDPWS shear walls on the same line shall be of similar construction unless forces are distributed according to rigidity.

162

SDPWS Requirements

Perforated Shear Walls:

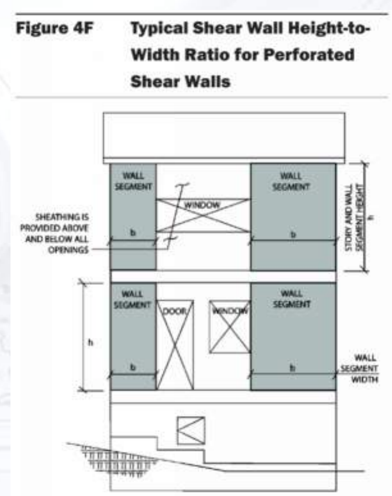


163

SDPWS Requirements

Perforated Shear Walls:

- Not designed for force transfer around opening
- Aspect ratio → 3.5:1
- Segment required at each end
- Nominal shear capacity ≤ 2,435plf
- Out-of-plane offsets not allowed
- Full-length collectors
- Uniform top and bottom of wall
- 20-foot maximum height



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164

Shear Capacity Adjustment

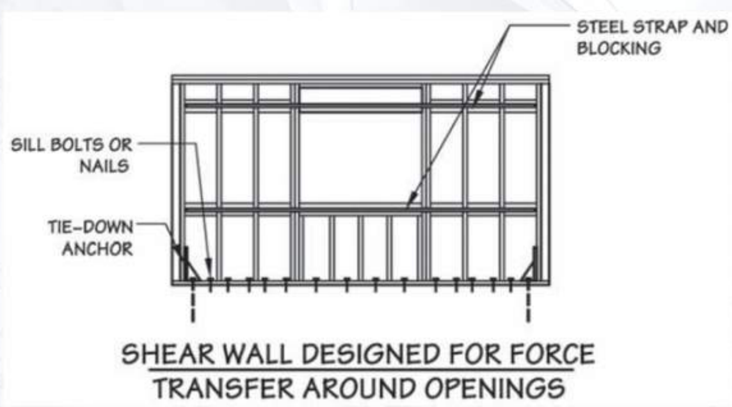
Table 4.3.5.6 Shear Capacity Adjustment Factor, C_o[1]

Percent Full-Height Sheathing (A_{fhs}/A_{wall})	Percentage Wall Area Openings (A_o / A_{wall})									
	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%
	Shear Capacity Ratio, C_o									
10%	1.00	1.00	1.00	1.00	0.77	0.63	0.53	0.45	0.40	0.36
20%	1.00	1.00	1.00	0.91	0.71	0.59	0.50	0.43	0.38	-
30%	1.00	1.00	1.00	0.83	0.67	0.56	0.48	0.42	-	-
40%	1.00	1.00	1.00	0.77	0.63	0.53	0.45	-	-	-
50%	1.00	1.00	0.91	0.71	0.59	0.50	-	-	-	-
60%	1.00	1.00	0.83	0.67	0.56	-	-	-	-	-
70%	1.00	1.00	0.77	0.63	-	-	-	-	-	-
80%	1.00	0.91	0.71	-	-	-	-	-	-	-
90%	1.00	0.83	-	-	-	-	-	-	-	-
100%	1.00	-	-	-	-	-	-	-	-	-

165

SDPWS Requirements

Force-Transfer Around Openings (FTAO) Shear Walls:



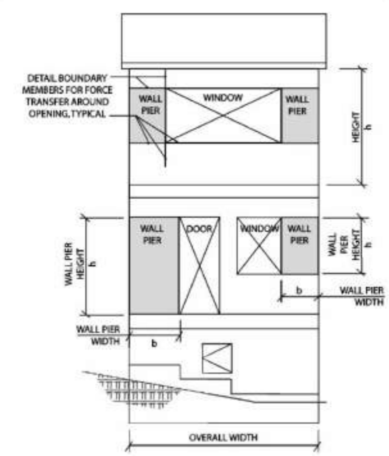
166

SDPWS Requirements

Force-Transfer Shear Walls:

- Each wall pier ≥ 2-feet
- Aspect Ratio → 3.5:1
- Full-height wall segment at each end
- No out-of-plane offsets
- Collectors between diagrams and shear wall shall be the full length of FTAO shear wall

Figure 4E **Typical Shear Wall Height-to-Width Ratio for Shear Walls Designed for Force Transfer Around Openings (FTAO)**



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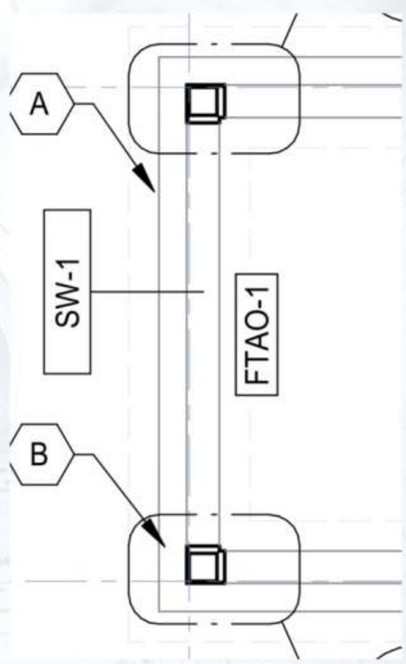
167

SDPWS Requirements

Force-Transfer Shear Walls:

- Real-world project…
- Called out as FTAO shear wall
- Piers are only 7-inches wide
- Does this work?
- Are there any alternatives?



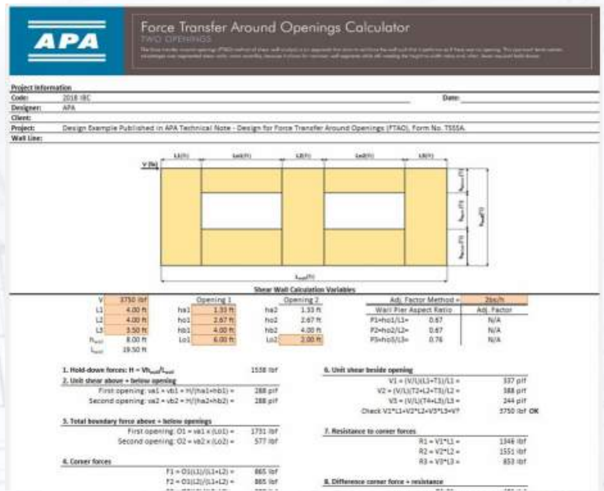
168

SDPWS Requirements

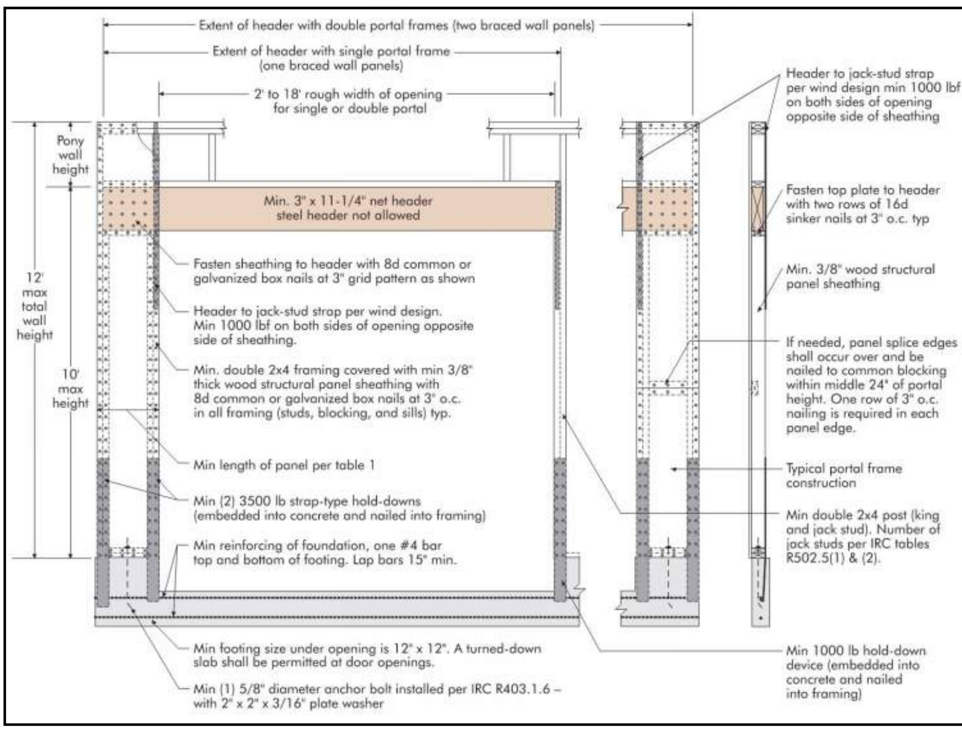
Force-Transfer Shear Walls:

- Requires rational analysis
- Must define blocking, straps and holdowns
- **Example:**
  - o https://www.apawood.org/ftao

Engineered Wood Association (APA), FTAO Calculator ©



169



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170

APA Technical Topics

TT-100H MAY 2020

A Portal Frame with Hold Downs for Engineered Applications

The APA portal-frame design, as shown in Figure 1, was envisioned primarily for use as bracing in conventional light-frame construction. However, it can also be used in engineered applications, as described in this technical topic. The portal frame is not actually a narrow shear wall because it transfers shear by means of a semi-rigid, moment-resisting frame. The extended header is integral in the function of the portal frame, thus, the effective frame width is more than just the wall segment, but includes the header length that extends beyond the wall segment. For this shear transfer mechanism, the wall aspect ratio requirements of the code do not apply to the wall segment of the APA portal frame.

FIGURE 1

CONSTRUCTION DETAILS FOR APA PORTAL-FRAME DESIGN WITH HOLD DOWNS

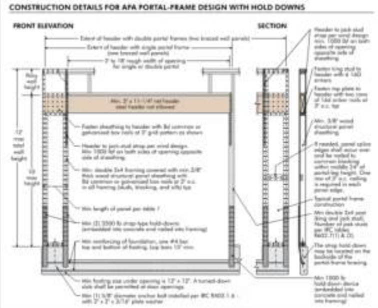


TABLE 1

RECOMMENDED ALLOWABLE DESIGN VALUES FOR A SINGLE LEG OF AN APA PORTAL FRAME USED ON A RIGID-BASE FOUNDATION FOR WIND OR SEISMIC LOADING[a,b,c,d]

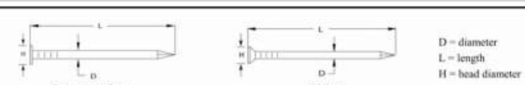
Minimum Portal Width (in.)	Maximum Portal Height (ft)	Allowable Design (ASD) Values per Frame Segment: Shear[e,f] (lbf)	Allowable Design (ASD) Values per Frame Segment: Deflection (in.)	Load Factor
16	8	850	0.33	3.09
	10	625	0.44	2.97
24	8	1,675	0.38	2.88
	10	1,125	0.51	3.42

SDPWS Requirements

Fasteners:

- Model Codes have specified "common" nails for more than 40 years.
- Most gun nails are box nails *(also cooler & sinker)*
- 8d common → 0.131 shank; 8d box → 0.113 shank
- ≈ ***15%*** reduction in shank

Table A1 Standard Common, Box, and Sinker Nails[1]



Type		6d	7d	8d	10d	12d	16d	20d	30d	40d	50d	60d
		Pennyweight										
Common	L	2"	2-1/4"	2-1/2"	3"	3-1/4"	3-1/2"	4"	4-1/2"	5"	5-1/2"	6"
	D	0.113"	0.113"	0.131"	0.148"	0.148"	0.162"	0.192"	0.207"	0.225"	0.244"	0.263"
	H	0.266"	0.266"	0.281"	0.312"	0.312"	0.344"	0.406"	0.438"	0.469"	0.5"	0.531"
Box	L	2"	2-1/4"	2-1/2"	3"	3-1/4"	3-1/2"	4"	4-1/2"	5"	-	-
	D	0.099"	0.099"	0.113"	0.128"	0.128"	0.135"	0.148"	0.148"	0.162"	-	-
	H	0.266"	0.266"	0.297"	0.312"	0.312"	0.344"	0.375"	0.375"	0.406"	-	-
Sinker	L	1-7/8"	2-1/8"	2-3/8"	2-7/8"	3-1/8"	3-1/4"	3-3/4"	4-1/4"	4-3/4"	-	5-3/4"
	D	0.092"	0.099"	0.113"	0.12"	0.135"	0.148"	0.177"	0.192"	0.207"	-	0.244"
	H	0.234"	0.250"	0.266"	0.281"	0.312"	0.344"	0.375"	0.406"	0.438"	-	0.5"

SDPWS Requirements

45 pages and a bit overwhelming!

- ***ESR-1539 – Power-Driven Staples & Nails***

TABLE 6—ALLOWABLE SHEAR FOR WIND OR SEISMIC LOADING FOR WOOD STRUCTURAL PANEL HORIZONTAL DIAPHRAGMS WITH FRAMING OF DOUGLAS FIR-LARCH OR SOUTHERN PINE AND STRUCTURAL I SHEATHING (plf)[1,2,3,4,5,6,7,8,9]

NOMINAL NAIL DIAMETER (inch) or STAPLE GAGE (Nails must be smooth or deformed, and must be carbon steel (bright or galvanized).)	MINIMUM REQUIRED FASTENER LENGTH (inches)	MINIMUM WIDTH OF FRAMING MEMBER (inches)	BLOCKED DIAPHRAGMS: FASTENER SPACING (inch) AT DIAPHRAGM BOUNDARIES (ALL CASES), AT CONTINUOUS PANEL EDGES PARALLEL TO LOAD (CASES 3, 4), AND AT ALL PANEL EDGES (CASES 5 & 6)								UNBLOCKED DIAPHRAGMS: FASTENERS SPACED 6" MAX. AT DIAPHRAGM BOUNDARIES AND ALL SUPPORTED EDGES			
			6		4		2½		2		Case 1		All other configurations (Cases 2, 3, 4, 5 & 6)	
			Nail spacing at other panel edges (Cases 1, 2, 3 & 4): 6		6		4		3					
			Seismic	Wind	Seismic	Wind	Seismic	Wind	Seismic	Wind	Seismic	Wind	Seismic	Wind
⅜-inch Nominal Panel Thickness														
0.131	1¾	2 3	270 300	375 420	360 400	505 560	530 600	740 840	600 675	840 945	240 265	335 370	180 200	255 280
0.120	1¾	2 3	230 255	320 360	305 340	435 480	455 510	635 720	515 580	720 810	200 225	290 320	150 170	220 240
0.113	1¾	2 3	205 230	290 325	275 305	390 430	410 460	570 645	465 520	645 725	180 205	260 285	135 155	200 215
14, 15, 16 Gage	1½ Leg Length	2 3	175 200	245 280	235 265	330 370	350 395	490 550	400 450	560 630	155 175	215 245	115 130	160 180

International Staple, Nail and Tool Association (ISANTA), ICC-ES ESR-1539

173

Equivalency Chart

TABLE 14—SUMMARY OF ALTERNATIVE FASTENING DESIGNS DESCRIBED IN TABLES 11 THROUGH 13[1,2,3,4]

CONNECTION	NAIL SIZE (DIAMETER X LENGTH) (inches): 3½ x 0.162	3¼ x 0.148	3 x 0.148	3½ x 0.135	3¼ x 0.131	3 x 0.131	2½ x 0.131	3¼ x 0.120	3 x 0.120	2½ x 0.113	2⅜ x 0.113	2 x 0.113	2¼ x 0.099
Wall Framing													
Double studs (face nail) Typical	24" o.c.	16" o.c.	16" o.c.	16" o.c.	16" o.c.	16" o.c.	8" o.c.	8" o.c.	8" o.c.				
At braced walls	16" o.c.	12" o.c.	12" o.c.	12" o.c.	12" o.c.	12" o.c.		8" o.c.	8" o.c.				
Abutting studs at corners and intersections Typical	12" o.c.	12" o.c.	12" o.c.	12" o.c.	8" o.c.	8" o.c.	8" o.c.	8" o.c.	8" o.c.				
At braced walls	12" o.c.	12" o.c.	12" o.c.	12" o.c.	12" o.c.	12" o.c.		8" o.c.	8" o.c.				
Built up header 2" to 2" w/ ½" spacer	12" o.c.	8" o.c.	8" o.c.	12" o.c.	8" o.c.	8" o.c.		8" o.c.	8" o.c.				
Continuous header to stud (toe nail)	3	4	4	4	4	4	4	5	5	6	6		
Adjacent full-height stud to end of header (toe-nail)	3	4	4	4	4	4		5	5				
Double top plates to each other (face nail)	16" o.c.	12" o.c.	12" o.c.	12" o.c.	12" o.c.	12" o.c.	8" o.c.	8" o.c.	8" o.c.				
Top plate to top plate at end joint (lap splice) (each side of joint)	8	12	12	12	12	12							
For 2015 IRC Connection 13b	10	12	12	12									
Top plate overlap at corners and intersections (face nail)	2	3	3	3	3	3		4	4				
Sole plate to joist or blocking not at braced wall panels	16" o.c.	12" o.c.	12" o.c.	12" o.c.	12" o.c.	12" o.c.		8" o.c.	8" o.c.				
Sole Plate to joist or blocking at braced wall panel	2 @ 16" o.c.	3 @ 16" o.c.	3 @ 16" o.c.	3 @ 16" o.c.	4 @ 16" o.c.	4 @ 16" o.c.		4 @ 16" o.c.	5 @ 16" o.c.				
Top or sole plate to stud (end nail)	3	3	3	3	4	4	4	4	4				

International Staple, Nail and Tool Association (ISANTA), ICC-ES ESR-1539

174

Plan Review Items

- ❑ ***Remember the WABO white paper***
- ❑ ***What should be included in a comment?***
- ❑ ***What should not?***
- ❑ ***How do we begin?***
- ❑ ***How much of our time should be spent reviewing…***
  - The plans?
  - The structural calculations?
  - Anything else?

175

Plan Review Items

Structural General Notes:

- Are materials requirements specified?
  - IBC 2303, AWC NDS, TPI, DOC
- Do specific installations meet code?
  - Is treated lumber and appropriate fasteners called out?
- Is extraneous information listed?
- Are there any deferred submittals?
  - Are the allowed?
- Are any special inspections noted?
  - Is a special inspection agreement form required?

176

Plan Review Items

Are all members called out?

Are all items on schedules included on the plans?

Floor & Roof Framing Plans:

- Beam & joist sizes, spans, and spacing
- Column & post sizes
- Wall framing (stud size & spacing)
- Shear walls (sheathing, nailing, blocking, are interior walls addressed?)
- Load path connections (holdowns, anchor bolts, sill plates, collectors, drag elements, blocking, etc.)
- Connection callouts (correct detail references)
- Diaphragm requirements (sheathing, nailing, blocking, etc.)

177

Plan Review Items

Sections & Details:

- ***Structural Connections:***
  - Framing details
  - Foundation details
  - Joist-to-Beam
  - Beam-to-Beam
  - Beam-to-Column
  - Column-to-Foundation

This is the opportunity to verify that a complete load path is provided!

178

Plan Review Items

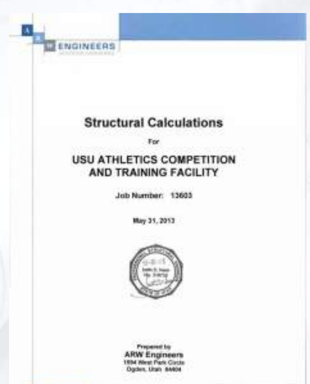
What if the plans say this?

PROGRESS PRINT (NOT FOR CONSTRUCTION)

These drawings have been released at the request of the client and are not intended for the purposes of bidding, permitting, or construction.

179

Plan Review Items



ENGINEERS

Structural Calculations

For

USU ATHLETICS COMPETITION AND TRAINING FACILITY

Job Number: 13603

May 31, 2013

Prepared by

ARW Engineers

Structural Calculations:

- Majority of time should be spent reviewing the plans.
- Remember, it is not our responsibility to verify the mathematical accuracy of the calculations.
- When reviewing plans, note significant structural members and make sure that a calculation is included.

Example Review Comment:

Please provide supporting calculations for the following…

A. The GB7 grade beam specified on sheet S1.02.

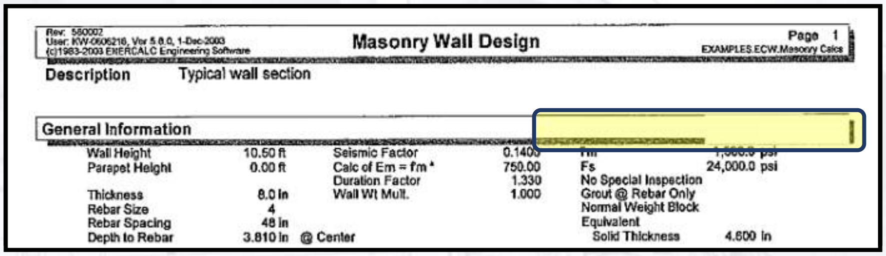
B. The footings and retaining walls at ramps shown on sheet S1.04.

C. The retaining walls in the elevator pit area shown on sheet S1.05.

180

Plan Review Items

Structural Calculations:

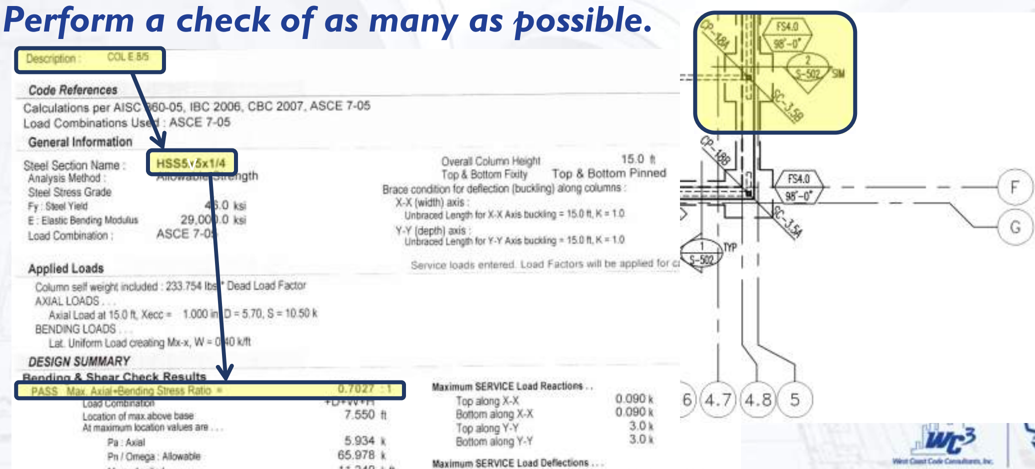


Example Review Comment:
Many of the calculations were performed in reference to outdated building codes and standards. Please confirm that calculations meet the requirements of the 2021 IBC and its referenced standards as listed in Chapter 35.

181

Plan Review Items

- ***Perform a check of as many as possible.***

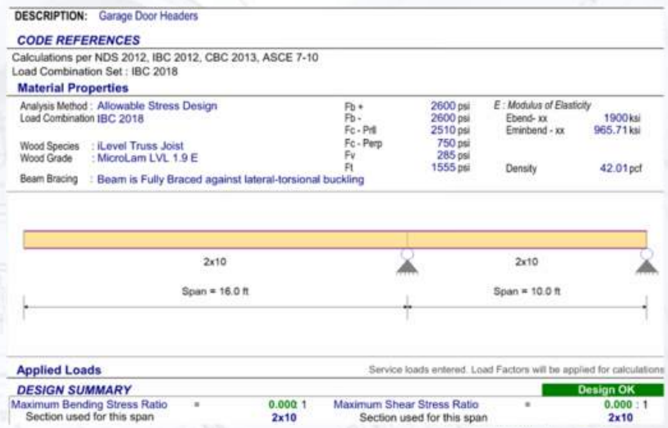


182

Plan Review Items

Perform a check of as many as possible:

- This is a garage door header calculation.
- No loads are applied (stress ratio of 0.00).
- It is shown as a cantilevered condition instead of the simple span called for on the plans.
- It is a completely different header size than the drawings show.



183

Plan Review Items

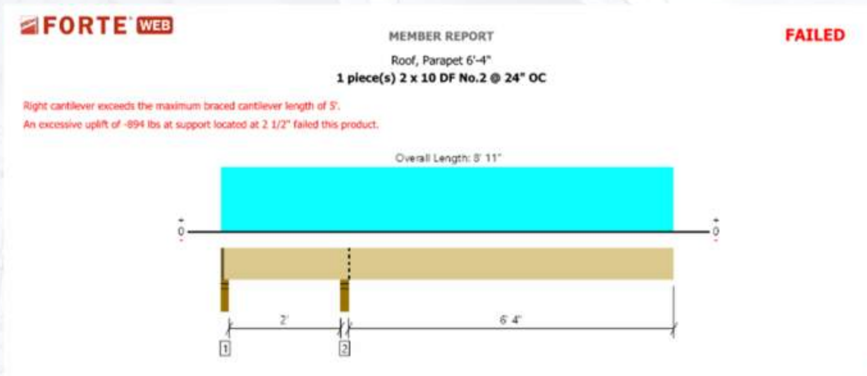
Perform a check of as many as possible:

- The calculation called for (4) 1.75"x14" LVLs while the schedule on the plans called for (3) 1.75"x11.875" LVLs.

184

Plan Review Items

Perform a check of as many as possible:



185

Plan Review Items

What do you even say regarding these? 280 # > 1,330 #

Design Output					
LOAD CASES		fc psi	fb psi	**S.R.**	L / Δ
Gravity	DL + LL	941	483	2.49	-
	DL + SL	297	207	0.79	-
	DL + 0.75LL + 0.75SL	780	207	2.06	-
With Wind	DL+0.6WL(OUT)	297	307	0.99	1142
	DL+0.6WL(IN)	297	307	0.99	3379
	DL+0.75(LL+0.6WL(OUT)+SL)	780	489	4.10	715
	DL+0.75(LL+0.6WL(IN) +SL)	780	489	4.10	1063
	0.6DL+0.6WL(OUT)	178	225	0.35	1559
	0.6DL+0.6WL(IN)	178	225	0.35	-14442
With Seismic	DL+0.7EQ	297	324	1.01	625
	DL+0.75(LL+0.7EQ+SL)	780	540	4.08	384
	0.6DL+0.7EQ	178	241	0.35	869

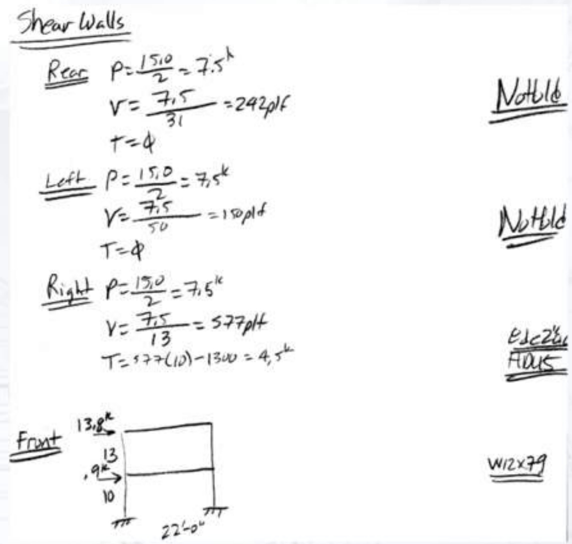
Design is insufficient

186

Plan Review Items

Do the calculations appear to be adequate?

- This is the entire lateral analysis for 3-story residence with wood shear walls and a moment frame.

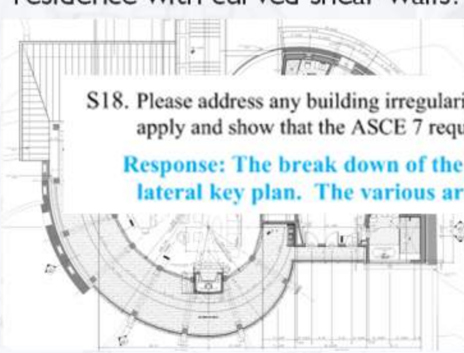


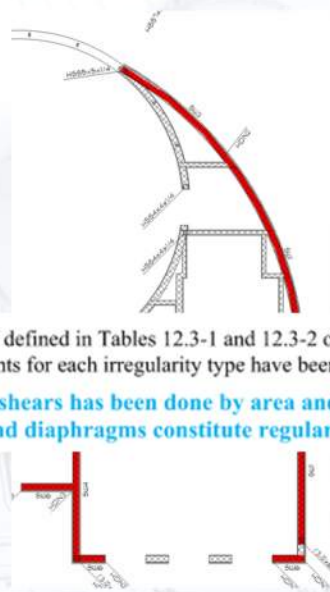
187

Plan Review Items

Not every structure is the same.

- What should you verify for this residence with curved shear walls?





S18. Please address any building irregularities as defined in Tables 12.3-1 and 12.3-2 of ASCE 7-16 that may apply and show that the ASCE 7 requirements for each irregularity type have been met.

Response: The break down of the base shears has been done by area and is shown on the lateral key plan. The various areas and diaphragms constitute regular areas.

188

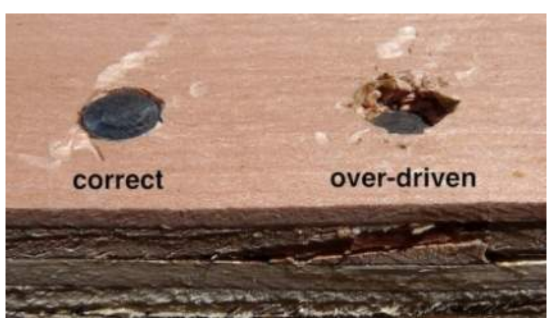
Inspection Items

- No matter how good the review, inspection issues will arise.
- IBC 110 lists when inspections are required.
- Are approved plans onsite?
- Is a complete gravity, lateral, and uplift load path provided?
- Do member sizes match the approved plans?

189

Overdriven Fasteners

- *IBC 2304.10.2:*
  - Nails "*…shall be driven so that their head or crown is flush with the surface of the sheathing.*"



190

Overdriven Fasteners

- ***APA TT-012C:***
  - Reduction in capacity is not required if…
    - If all are overdriven ≤ ***1/16”*** in dry conditions
    - If ≤ ***20%*** of edge fasteners are overdriven ≤ ***1/8”***
    - If panels used are thicker than required


APA Technical Topics
TT-012C APRIL 2020

Effect of Overdriven Fasteners on Shear Capacity

The following is a suggested guideline for determining if overdriven fasteners will affect the shear capacity of diaphragm or shear wall construction.

1. If any case described below is met, no reduction in shear capacity needs to be taken.

a. If all nails are overdriven into panels by no greater than 1/16 inch during construction under dry conditions (moisture content less than 16 percent).

191

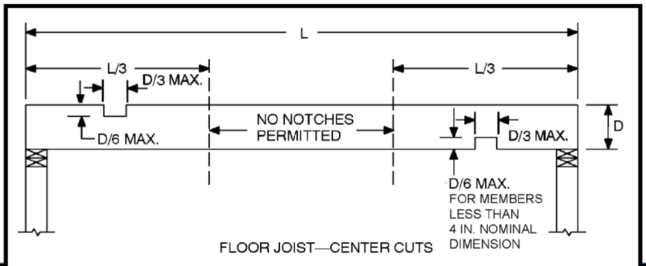
Overdriven Fasteners

- ***APA TT-012C:***
  - If ***> 20%*** are overdriven by ***> 1/16”***, or…
  - If any are overdriven by ***> 1/8”***, then…
  - One additional fastener must be driven for each two overdriven.
  - If nails were originally used and are spaced too close for additional nails, approved staples should be used to reduce the potential for splitting.

192

Notches / Holes

- ***Joists & Beams*** *(IBC 2308.4.2.4)****:***
  - Not exceed 1/6 of member depth
  - Not be longer than 1/3 of member depth
  - Not be located in middle 1/3 of span
  - Notches at ends shall not exceed 1/4 of member depth

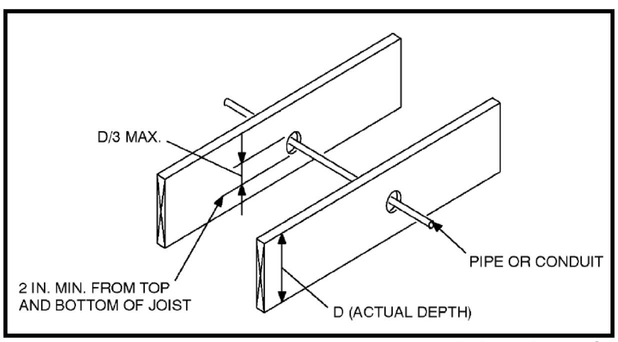


International Code Council, 2021 IRC ©

193

Notches / Holes

- ***Joists & Beams*** *(cont.)****:***
  - Not exceed 1/3 of member depth
  - Not be closer than 2" from bottom of member or any other hole or notch



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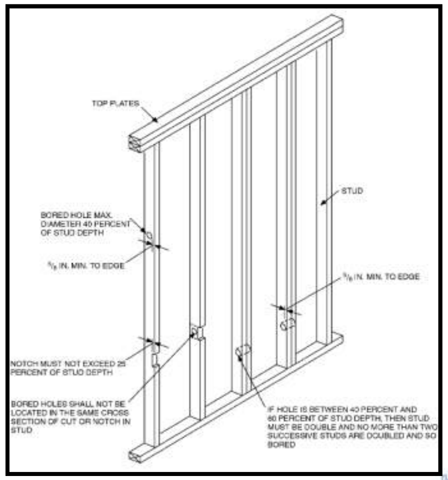
194

Notches / Holes

- ***Notching** (IBC 2308.5.9):*
  - Exterior ≤ 25% width
  - Bearing ≤ 25% width
  - Partition ≤ 40% width
- ***Holes** (IBC 2308.5.10):*
  - Edge ≥ 5/8"
  - ∅ ≤ 40% width (single)
  - ∅ ≤ 60% width (double)



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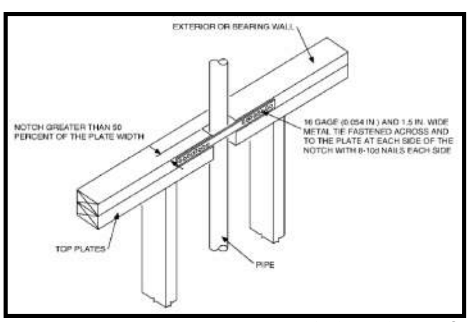
195

Notches / Holes

- ***Cutting of Plate** (IBC 2308.5.8):*
  - Provide a 1.5" wide x 16ga. galvanized metal tie
  - Fasten to either side w/ (6) 16d nails



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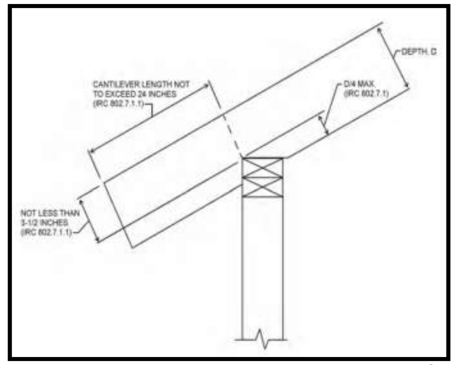
196

Notches / Holes

- ❑ ***Rafters*** *(IBC 2308.7.4):*
  - At ends → No more than 1/4 the depth
  - In top or bottom → No more than 1/6 the depth and not within middle third
  - Holes cannot be within 2-inches of edges nor within middle third



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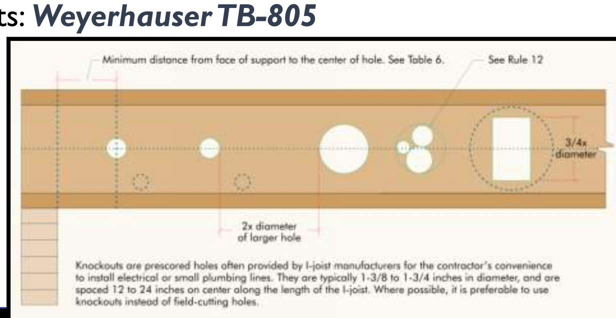
197

Notches / Holes

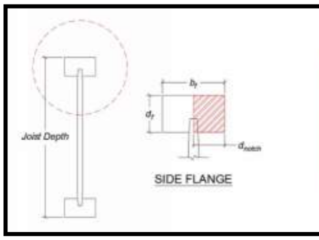
- ❑ ***Notches & Holes:***
  - I-Joists: ***APA – Form No. Z725F***
  - Notch in Top Flange: ***Weyerhauser TB-818***
  - Holes Near Bearing: ***Weyerhauser TB-817***
  - Rafter Cuts: ***Weyerhauser TB-805***



198

Notches / Holes

- ❑ ***I-Joists: Weyerhauser TB-818***
  - Original joists are properly designed
  - Adjacent joists are undamaged
  - Uniform loads
  - One side-flange notch



TJI® JOIST FLANGE DIMENSIONS

Product	b_f	d_f
TJI® 110	1 ¾"	1 ¼" - 1 ⅜"
TJI® 210	2 1/16"	1 ¼" - 1 ⅜"
TJI® 230	2 5/16"	1 ¼" - 1 ⅜"
TJI® 360	2 5/16"	1 ⅜"
TJI® 560	3 ½"	1 ⅜"

Weyerhauser, Technical Bulletin, TB-818©

199

Notches / Holes

- ❑ ***I-Joists: Weyerhauser TB-817***

CONTINUOUS WEB BACKER:
5/8" thick for TJI® 110
7/8" (net) thick for TJI® 210
1" (net) thick for TJI® 230, 360
1 1/2" thick for TJI® 560

USE CONSTRUCTION ADHESIVE ON ALL CONTACT SURFACES

FASTENING SCHEDULE:
WEB-2 rows of 10d pneumatic nails @ 4" o.c.
FLANGE-2 rows of 10d pneumatic nails @ 4" o.c.
- Use 16d pneumatic nails for TJI® 560
- Clinch as necessary

TABLE 1: MAXIMUM JOIST SPANS[1][2][3]

Joist Depth	Max Hole Diameter	TJI® Joist Series	Max o.c. Spacing	Max Joist Span (40 PSF Live) 10 PSF (Dead)	Max Joist Span (40 PSF Live) 20 PSF (Dead)
9½"	3⅜"	110, 210, 230, & 360	16"	16'-6"	15'-3"
			24"	13'-8"	12'-5"
11⅞"	4⅜"	110, 210, 230, & 360	16"	18'-11"	17'-3"
			24"	15'-5"	14'-0"
		560	16"	26'-3"	26'-3"
			24"	21'-10"	20'-11"
14"	5½"	110, 210, 230, & 360	16"	20'-6"	18'-9"
			24"	16'-9"	14'-9"
		560	16"	29'-9"	29'-9"
			24"	24'-3"	20'-11"
16"	6½"	210, 230, & 360	16"	24'-1"	22'-0"
			24"	19'-5"	16'-2"
		560	16"	32'-11"	31'-6"
			24"	25'-2"	20'-11"

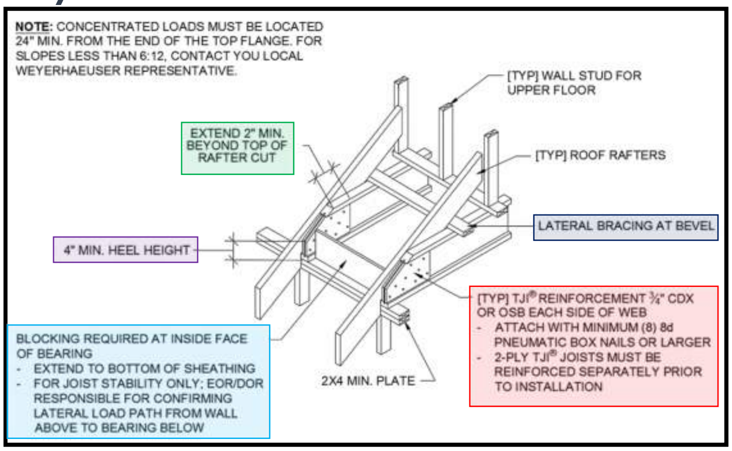
[1] Span table and repair detail shown applies to holes placed in the first 12" from end bearing of joist.

Weyerhauser, Technical Bulletin, TB-817©

200

Notches / Holes

- ***I-Joists:* *Weyerhauser TB-805***

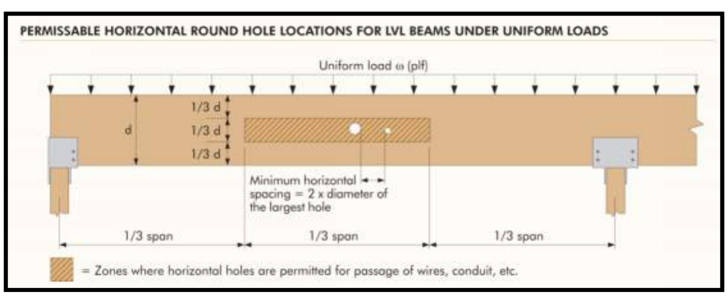


Weyerhauser, Technical Bulletin, TB-805©

201

Notches / Holes

- ***Notches & Holes:***
  - LVL's: ***APA – Form No. EWS G535A***
  - GLB's: ***APA – Form No. EWS S560H***



The Engineered Wood Association, Form No. EWS G535A©

202

Holdown Straps

- ***Case 1: Improper locations***
  - Engineered specified retrofit anchor required.

Holdown Straps

- ***Case 2: Spalling at embed straps***
  - If < 1", load capacity is not affected.
  - If < 4", holdown capacity is reduced by 10%. ???
  - If > 4", Engineered retrofit holdown is required.

Holdown Straps

- ❑ ***Case 3: Offsets (Creates slack in the line.)***
  - Only a 5/8” offset is permitted.
  - If over sheathing, slightly notching the panel edge will keep strap from bulging and wall movement to a minimum.
  - More than a ***single*** 90° bend is not allowed.

205

Holdown Straps

- ❑ ***Case 4: Holdowns at Rim Joists***
  - Is proper holdown being used at rim joists?
  - The holdown will need to be replaced.

206

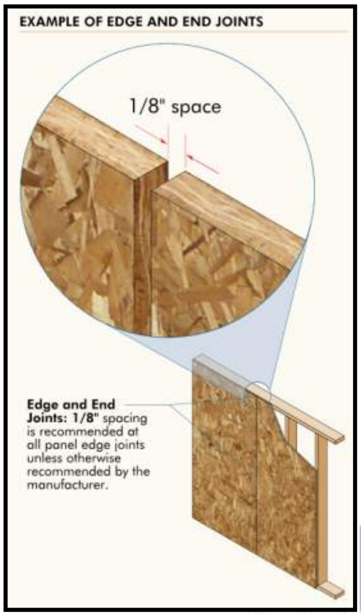
Holdown Straps

- ***Case 5: Improper Holdown Used***
  - Plans often state *"Simpson xxx, or approved equal"*
  - Is the replacement holdown equivalent?
  - Has the replacement holdown been approved by the EOR?
  - Does it have a current ICC-ES report?

207

Gaps in Sheathing

- ***APA recommends a minimum 1/8-inch gap between sheathing panels***

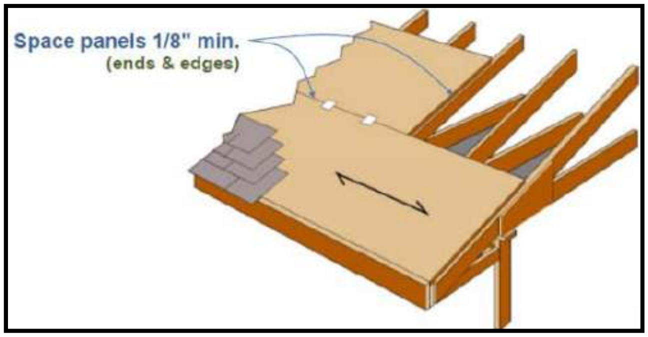


Engineered Wood Association, Form No. M300S ©

208

Gaps in Sheathing

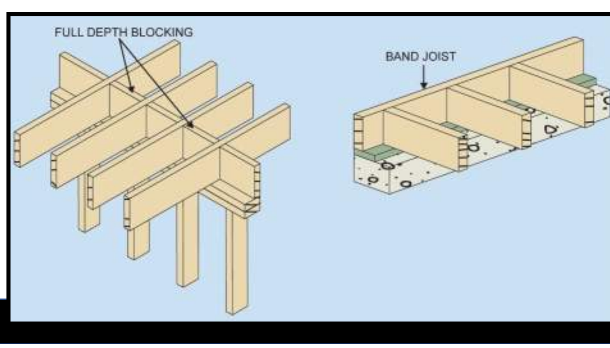
- ***APA's spacing hint:***
  - Use 10d box nail to gauge 1/8-inch spacing between panels.
  - Spacer-type panel clips may be used for roof sheathing applications.



209

Full-Depth Blocking

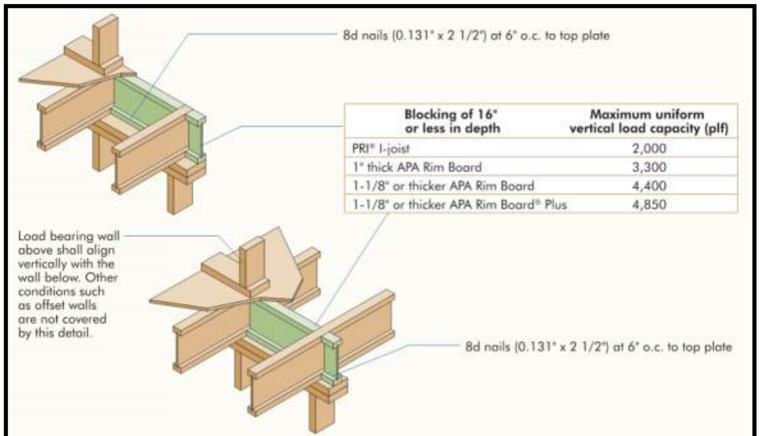
- ***Shall be provided at…***
  - Ends of joists
  - Intermediate supports
  - At 8-feet on center (> 2"x12" dimension lumber)



210

Full-Depth Blocking

- ❑ ***Same for I-joists…***



Engineered Wood Association, Form No. A750A ©

211

APA I-Joist Blocking

- ❑ ***Web Stiffeners:***
  - Where web is in jeopardy of ***buckling*** out-of-plane
  - ***Heavy loads*** that cause web to knife through flange
  - Support ***hanger*** does not extend to top flange

STIFFENER SIZE REQUIREMENTS

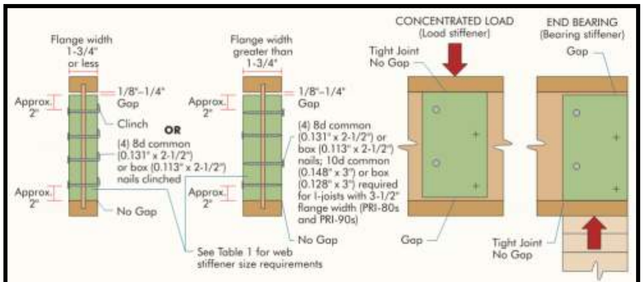
APA PRI Flange Width (in.)	Web Stiffener Size Each Side of Web (in.)
1-1/2	15/32 x 2-5/16 minimum width
1-3/4	19/32 x 2-5/16 minimum width
2-5/16	1 x 2-5/16 minimum width
2-1/2	1 x 2-5/16 minimum width
3-1/2	1-1/2 x 2-5/16 minimum width

Engineered Wood Association, Form No. A745C ©

212

APA I-Joist Blocking

- ***Web Stiffeners (cont.)***
  - ***Bearing stiffeners***: Located at the reactions, both interior and exterior, when required
  - ***Load stiffeners***: Located between supports where significant point loads are applied to top flange

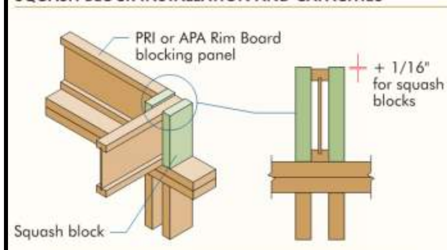


213

APA I-Joist Blocking

- ***Squash Blocks:***
  - Purpose is to carry a point load that would otherwise be carried by the joist.

SQUASH BLOCK INSTALLATION AND CAPACITIES



Pair of Squash Blocks	Vertical load transfer capacity per pair of squash blocks (lbf)[a]	
	3-1/2" wide	5-1/2" wide
2x lumber	3800	5900
1-1/8" APA Rim Board, Rim Board Plus, C1 or better,[b] or Rated Sturd-I-Floor 48 oc	2600	4000
1" APA Rim Board, C2 or better,[b] or Rated Sturd-I-Floor 32 oc	1900	3000

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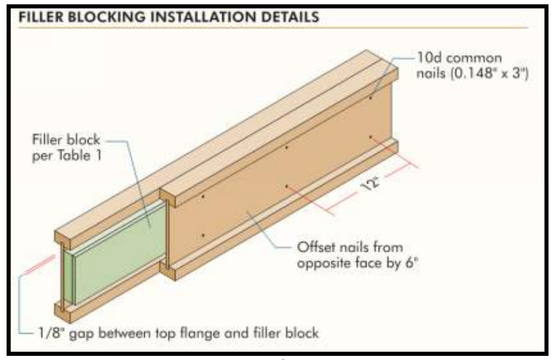
214

APA I-Joist Blocking

- ***Filler Blocks:***
  - Used to fill space between a pair of I-joists acting as a single bending member.
  - Helps to transfer load from one member to the next.
  - Must be placed the full length of the I-joist.



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215

Truss Package

- ***Inconsistencies are common between the initial design and the truss package.***
- ***What are some common issues that arise?***
- ***When do you review the truss package?***

216

item 15_ comment S2: Please submit the deferred submittal agreement listing all deferred items.

response: Deferred submittal agreement will be submitted by contractor at a later date.

Truss Package

- ❑ ***Deferred Submittal (IBC 107.3.4.1)***
  - Required for structural components in which the structural design has not been submitted.
  - Must be allowed by jurisdiction.
  - Must be listed on the construction documents.
  - Prior to submittal to the city, designs must be submitted to, and approved by, the EOR.
  - None of the deferred submittal items shall be installed until submittal is approved by the AHJ.

217

Truss Package

- ❑ ***What is included? (IBC 2303.4.1.1)***
  - Design per ANSI/TPI 1
  - Placement diagram & individual truss drawings
  - Design professional → where required
  - Permanent individual truss member restraint (PITMR)
    - Who is responsible for specifying?

218

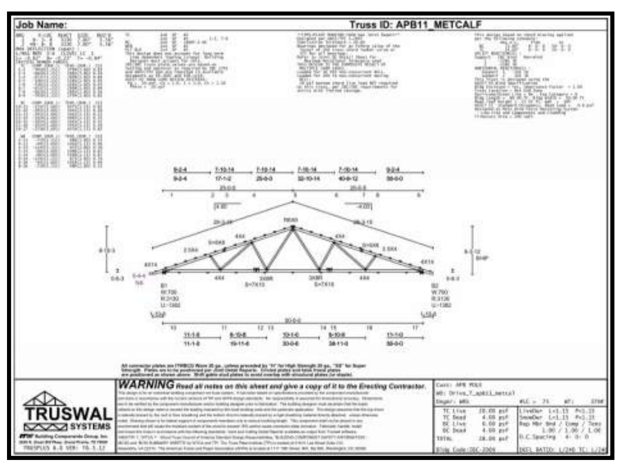
Truss Package

- ***Truss Design Drawings (IBC 2303.4.1.1)***
  - Slope/depth, span and spacing;
  - Locations of all joints;
  - Required bearing widths;
  - Design loads;
  - Adjustments for conditions of use;
  - Each reaction force and direction;
  - Joint connector type, size, etc.;
  - Lumber size, species & grade of wood; …

219

Truss Package

- ***Truss Design Drawings (cont.)***
  - Truss connections *(truss-to-girder, ply-to-ply, splices)*;
  - Calculated and allowable deflections;
  - Maximum axial and tension forces;
  - Permanent bracing locations, methods & details



220

Truss Bracing

- ***Trusses require lateral support in order to perform in the manner they are intended.***
- ***Very narrow in relation to their depth and span.***
- ***Bracing…***
  - Prevents out-of-plane buckling
  - Maintains spacing
  - Resists and transfers lateral loads

221

Truss Bracing

- ***Locations shown on individual truss drawings***

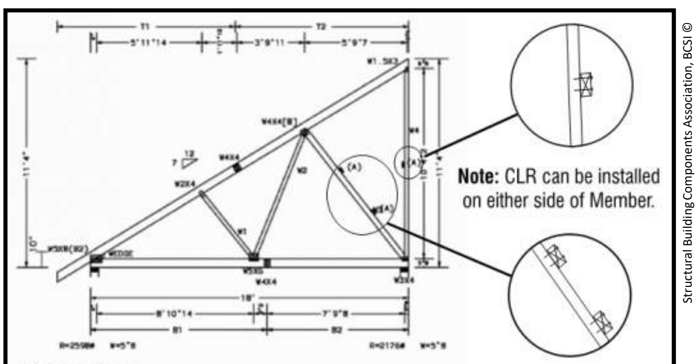
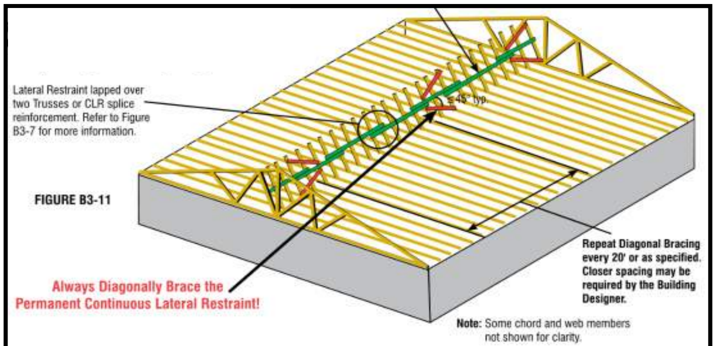


FIGURE B3-9

222

Truss Bracing

- ❑ ***2021 IBC clarifies what is already required:***
  - Member restraint (PITMR) in "***green***"
  - Diagonal bracing (PITMDB) at each PITMR in "***red***"



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223

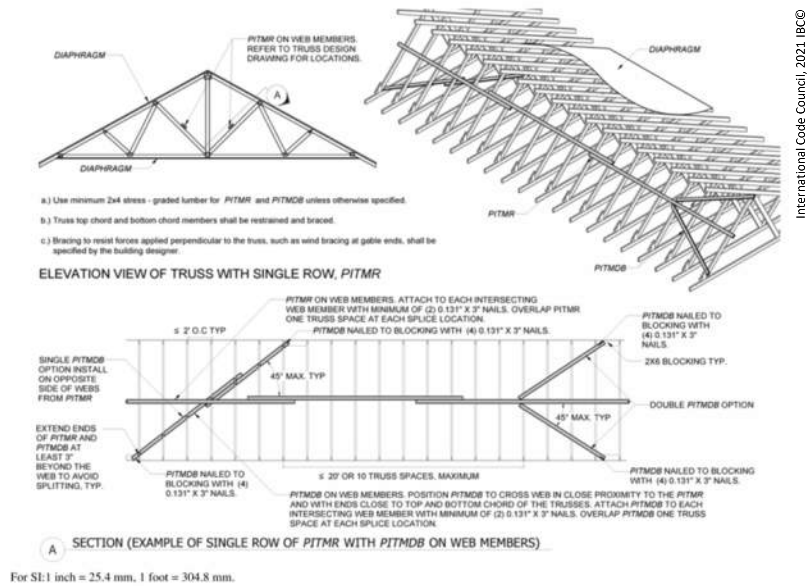
Truss Bracing

- ❑ ***IBC 2303.4.1.2: PITMR & PITMDB***
  - When the truss plans call for PITMR, it must be provided by one of following…

1. PITMR & PITMDB shall be provided using standard industry lateral restraint and diagonal bracing details ***per TPI***, ***accepted engineering practice***, or ***Figures 2303.4.1.2(1), (3), and (5).***
2. Buckling reinforcement is added to individual truss ***per truss drawings***, or ***per Figures 2303.4.1.2 (2) and (4)***.
3. ***Project-specific*** PITMR and PITMDB design by EOR.

ADDED

224



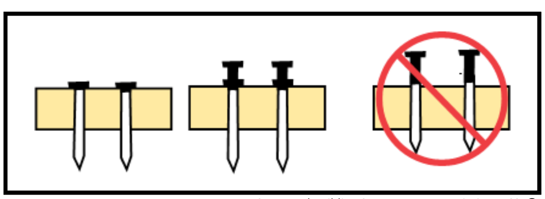
International Code Council, 2021 IBC©

FIGURE 2303.4.1.2 (1)
PITMR AND PITMDB FOR TRUSS WEB MEMBERS REQUIRING ONE ROW OF PITMR

225

Truss Bracing

- ***Bracing Installation:***
  - Minimum size member → 2x4
  - Continuous bracing to overlap 2-feet.
  - Use at least two 10d, 12d, or 16d nails into each truss
  - Nails to be flush or double-headed for easy removal



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226

Miscellaneous Items

- **Decks**
  - IBC 1604.8.3: Positively attached for vertical & lateral loads
  - AWC DCA 6
- **Post Frame Buildings**
  - AWC DCA 5
- **Log Structures**
  - ICC 400

227

Quiz

- What AWC standards govern the design of wood structures in addition to the IBC and ASCE 7?
- Describe three components of the lateral load path?
- When are 3x framing members required at shear walls?
- When are special inspections required for wood framing?
- When is a shrinkage analysis required?
- What are things to look for if force-transfer shear walls are used?
- What should be looked at in relation to the diaphragm?

228

Any Questions?

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229