Simplified Structural Plan Review

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Course Objectives

- ***The intent of this course is to...***
  1. To learn how to perform a structural plan review of simple commercial or residential projects.
  2. To know how to interpret the EOR/SER design assumptions.
  3. To confirm that a complete lateral and gravity load path are provided.

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Course Intent

- ***This course is for simple projects such as residential and small-to-moderately sized commercial only. Larger projects may require a more detailed review that should be performed by a licensed professional.***

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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
  - …

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Introduction

- ***The mission of all building departments is to…***
- ***What areas of the code are primary to "life safety"?***
- ***What areas are secondary?***
- ***Are we focusing our attention on the primary items?***

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Introduction

- This class is focused on the 2021 IBC and not the structural requirements outlined in the IRC.
- **IRC R301.1.3:**

  "When a building of otherwise conventional construction contains structural elements exceeding the limits of… (the IRC), these elements shall be designed in accordance with accepted engineering practice."

International Code Council, 2021 IBC©

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Introduction

- ***CRC structural limitations include…***
  - Wind speed ≤ 140mph
  - Weights of materials
  - Ground snow loads ≤ 70psf
  - Structural irregularities
    - Out-of-plane offsets
    - Floors/roofs w/out lateral support
    - Large diaphragm openings
    - Vertical offsets
    - Irregular wall lines

International Code Council, 2021 IRC©

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Seminar Format

- ***Plan Review Process***
- ***Load Paths***
- ***Design Criteria***
- ***Hazard Review***
- ***Construction Plans***
- ***Structural Calculations***
- ***Specifications***

Actual Structural Review

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PART A
Plan Review Process

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Codes/Standards

International Code Council, 2021 IBC©

American Society of Civil Engineers, ASCE 7-16

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Certifications

- ***When you get certified as a building plans examiner, 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?***

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Resources

SEAOC, International Code Council & NCSEA ©

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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©

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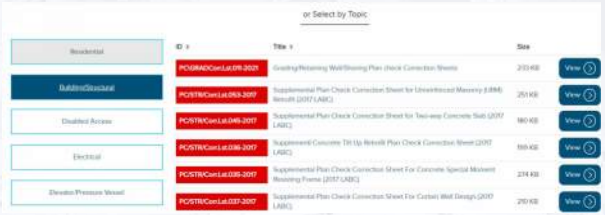
Resources

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



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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©

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Study Guides

1. Hazard Review
2. Construction Document Review
3. Calculations & Specifications Review
4. Components & Materials Review

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Structural Review

- ***Suggested Breakdown:***
  1. Hazard Review (30%)
  2. Construction Plans (60%)
  3. Structural Calculations (8%)
  4. Specifications (2%)
- This break-down only applies to simple projects. More complicated projects may require an extensive review of the calculations and reports by a licensed professional.

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Questioning an Engineer

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

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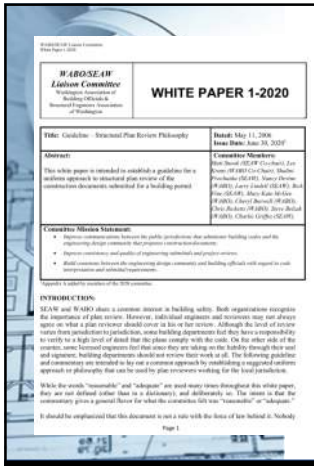

WABO/SEAW Liaison Committee

WHITE PAPER 1-2020

Plan Review Philosophy

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

http://www.wabo.org/waboseaw-white-papers

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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."*

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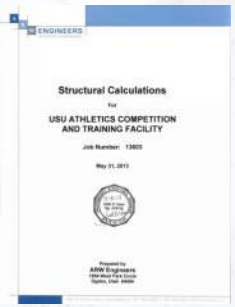
Plan Review Philosophy

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


Structural Calculations
For
USU ATHLETICS COMPETITION AND TRAINING FACILITY

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Plan Review Philosophy

- ***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."*

SHEET TITLE
ENGINEERING JUDGEMENT

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.

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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."*

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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."*

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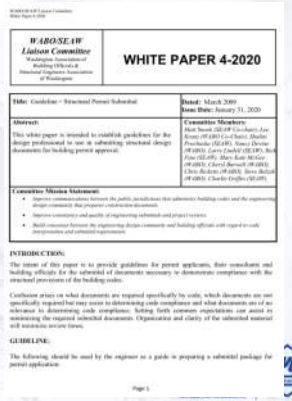
Submittal Guidelines

- ***WABO/SEAW:*** ***Structural Permit Submittal Guidelines***

http://www.wabo.org/waboseaw-white-papers



WABO/SEAW Liaison Committee

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:

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

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Submittal Guidelines

- ***Construction Documents:***
  - *"…complete as necessary to verify code compliance and inspection in the field."*
- ***Drawing List:***
  - *"A list of drawings should be included on the plans to ensure the reviewer has a complete package when reviewing the application."*

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Submittal Guidelines

- ***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****."*

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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 noted on the Drawings."*

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Submittal Guidelines

Structural Calculations:

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

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PART B
Load Paths

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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.

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Load Paths

What causes vertical loads?

- ❑ Gravity

What causes lateral loads?

- ❑ Wind
- ❑ Seismic

What resists these loads?

- ❑ Ground

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Parts of a Structure

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

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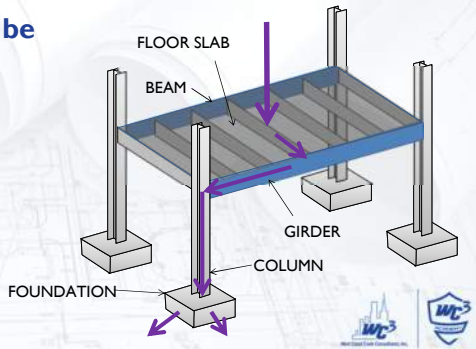
Gravity Load Path

What loads need to be considered?

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



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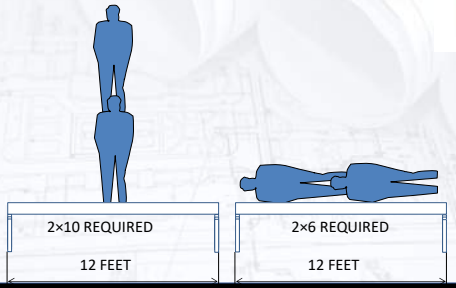
Gravity Load Path

Concentrated vs. Uniform Loads



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Gravity Load Path

The gravity load path is pretty easy to follow.

- ❑ What are some common problems?

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Lateral Load Path

Not as easily understood

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

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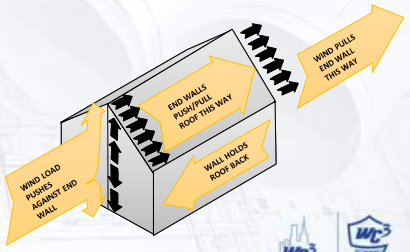
Lateral Load Path

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 while the rest into the foundation.



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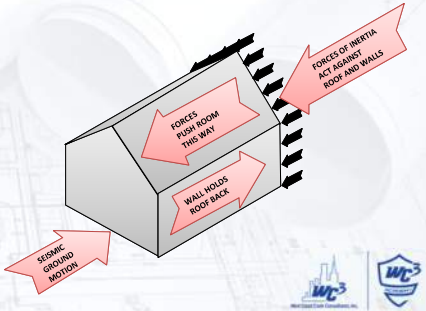
Lateral Load Path

Seismic:

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



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Lateral Load Path

Lateral-Resisting Elements:

- ❑ **Vertical (LFRS):**
  - Shear Walls
  - Braced Frames
  - Moment Frames
  - Cantilevered Columns
  - Numerous versions of each

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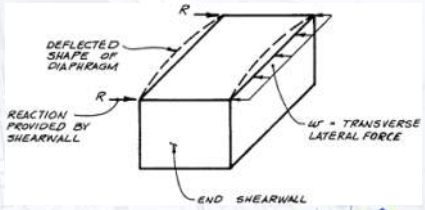
Lateral Load Path

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.*



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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.

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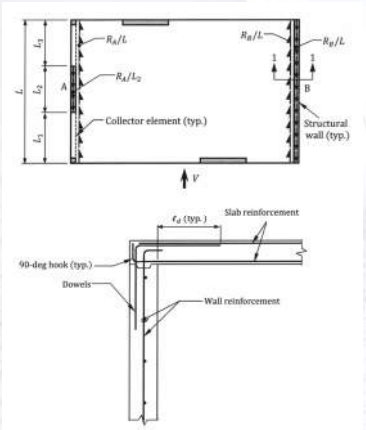

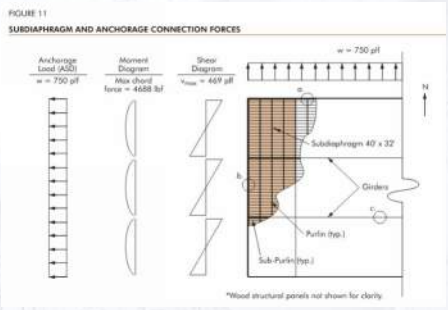

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Lateral Load Path

Structures must be designed to resist…

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Lateral Load Path

Horizontal Load Path:

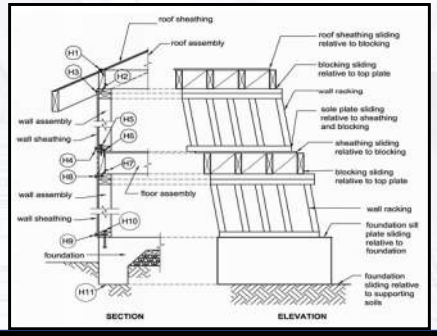

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Table 2-1 Load Path Connections for Horizontal Sliding

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.	ROOF SHEATHING, H1, BLOCKING
H2	Three 8d box (0.113"x2 1/2") or three 8d common (0.131x2 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.	BLOCKING, H2, TOP PLATES; BLOCKING, H2 ALT, TOP PLATES
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.	H3, TOP PLATES, WALL SHEATHING; WALL SHEATHING, H4, SILL OR SOLE PLATE

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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.	H5, SILL OR SOLE PLATE, BLOCKING
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.	H6, FLOOR SHEATHING, BLOCKING
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.**	BLOCKING, H7, TOP PLATE; BLOCKING, H7 ALT, TOP PLATE

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Lateral Load Path

Need to pay attention at interior shear walls!

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Lateral Load Path

Overturning Load Path:

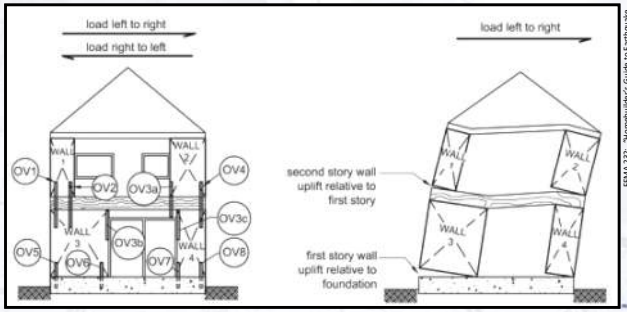

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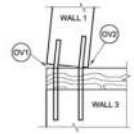
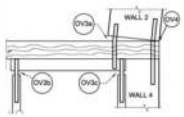
Table 2-2 Load Path Connections for Overturning

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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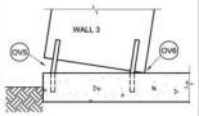
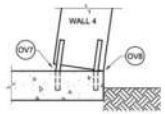
Item	Overturning Load Path Description and Discussion	Illustration
OV5	When Wall 3 is loaded from left to right, the wall tries to overturn causing the lower left corner to uplift. This illustration shows a hold-down strap restraining this uplift. The hold-down strap carries tension from an end post 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.	

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Lateral Load Path

Load Transfer Between Components

- IBC 1604.4
- Section 12.1.3

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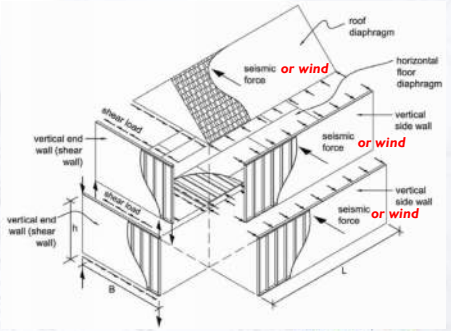

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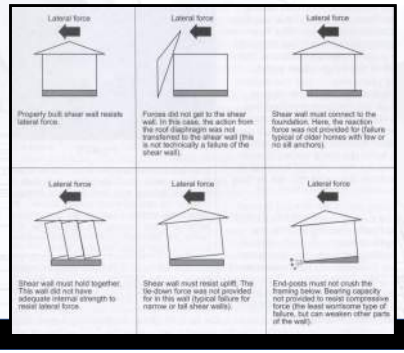
Lateral Load Path

Connections – Connections – Connections



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Lateral Load Path

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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

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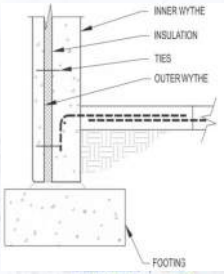
Lateral Load Path

❑ ***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.



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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 loads and adequately transfer them to…

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PART C
Design Criteria


DESIGN CRITERIA

CODES AND STANDARDS

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Design Criteria

❑ ***Key items to keep in mind…***

1) Floor/Roof Live Loads
2) Risk Category
3) Snow Loads
4) Design Wind Speed
5) Wind Exposure
6) Soil Site Class
7) Ground Motions
8) Flood Design Data

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1) Floor/Roof Live Loads

IBC 1603.1.1 & 1603.1.2: Floor/Roof Live Loads

- Verify live loads based on use → IBC Table 1607.1

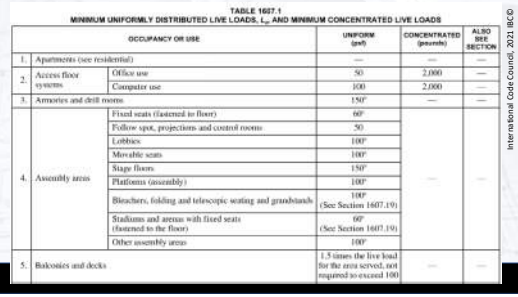
TABLE 1607.1
MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS, L_o, AND MINIMUM CONCENTRATED LIVE LOADS

	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[e]	—	—
4.	Assembly areas	Fixed seats (fastened to floor)	60[f]		
		Follow spot, projections and control rooms	50		
		Lobbies	100[f]		
		Movable seats	100[f]		
		Stage floors	150[f]		
		Platforms (assembly)	100[f]	—	—
		Bleachers, folding and telescopic seating and grandstands	100[f] (See Section 1607.19)		
		Stadiums and arenas with fixed seats (fastened to the floor)	60[f] (See Section 1607.19)		
		Other assembly areas	100[f]		
5.	Balconies and decks		1.5 times the live load for the area served, not required to exceed 100	—	—

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1) Floor/Roof Live Loads

Compare to architectural plans…

61

2) Risk Category

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

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2) Risk Category

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

63

3) Snow Loads

IBC 1603.1.3: Snow Loads

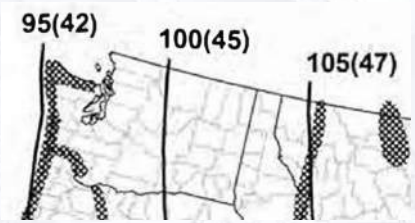
- The following should be provided:
  - Ground Snow Load (P_g)
  - Flat-roof Snow Load (P_f)
  - Snow Exposure Factor (C_e)
  - Thermal factor (C_t)
  - Snow Importance Factor (I_s)
  - Drift Surcharge Loads (P_d) and width (w)

American Society of Civil Engineers, ASCE 7-16

64

4) Design Wind Speed

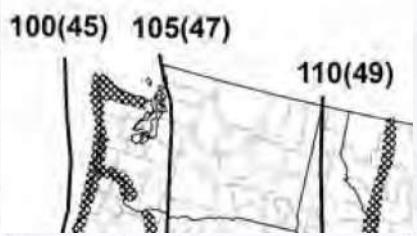
- *Risk Category II: IBC Figure 1609.3(1)*



65

4) Design Wind Speed

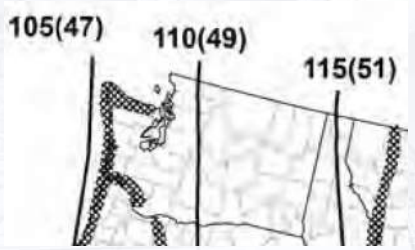
- *Risk Category III: IBC Figure 1609.3(2)*



66

4) Design Wind Speed

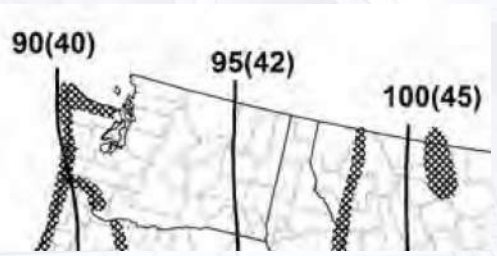
- *Risk Category IV: IBC Figure 1609.3(3)*



67

4) Design Wind Speed

- *Risk Category I: IBC Figure 1609.3(4)*



68

4) Design Wind Speed

- ***Basic Design Wind Speed (V)***
  - I_W is incorporated into the design wind speed.
  - If V is *"…determined by the local jurisdiction shall be in accordance with Section 26.5.1 of ASCE 7."*
  - Adjustment must be based upon…
    - Meteorological data, and…
    - An estimated basic wind speed per Section 26.5.3.

This is very involved!

69

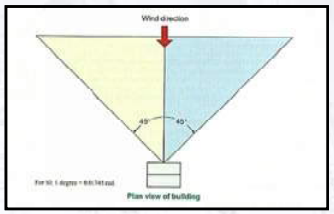
5) Wind Exposure

- ***If someone were to call and ask, what wind exposure would you specify for your jurisdiction?***

70

5) Wind Exposure

- ***§1609.4.2:*** *"A ground surface roughness within each 45° sector shall be determined upwind of the site… for the purpose of assigning an exposure…"*



71

5) Wind Exposure

- ***Surface Roughness B:***
  - *"Urban and suburban areas, wooded or other terrain with numerous closely spaced obstructions having the size of a single-family dwelling or greater."*

72

5) Wind Exposure

- ***Surface Roughness C:***
  - *"Open terrain with scattered obstructions having heights generally less than 30 feet."*

73

5) Wind Exposure

- ***Surface Roughness D:***
  - *"Flat, unobstructed areas and water surfaces."*

74

5) Wind Exposure

- ***Exposure B:***
  - Buildings ≤ 30 feet: Surface Roughness B for 1,500'
  - Buildings > 30 feet: Surface Roughness B for 2,600' or 20*building height, whichever is greater.
- ***Exposure C:***
  - Shall apply to all cases where Exposure 'B' or 'D' do not apply.

75

5) Wind Exposure

- ***Exposure D:***
  - Surface Roughness D for 5,000' or 20*building height, whichever is greater.
  - If Exposure B or C exist upwind and the site is within 600', or 20*building height, from an Exposure D condition.

76

5) Wind Exposure

- ***What Wind Exposure applies to this lot?***

77

6) Soil Site Class

- Classifications moved to ASCE 7-16.
- ***Based upon upper 100-feet***
  - Site Class A: Hard rock
  - Site Class B: Rock
  - Site Class C: Very dense soil and soft rock
  - Site Class D: Stiff soil
  - Site Class E: Soft clay soil
  - Site Class F: Soils requiring site response analysis

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5) Soil Site Class

- ***If not defined, what should we assume?***
- ***IBC 1613.2.2: Site Class Definitions***
  - "Where the soil properties are not known in sufficient detail to determine the site class, Site Class D, subjected to the requirements of Section 1613.2.3, shall be used unless the building official or geotechnical data determines that Site Class E or F soils are present at the site."

79 79

6) Soil Site Class

- ***§ 20.3.1: Site Class F***
  - Soils vulnerable to potential failure or collapse under seismic loading (i.e., liquefiable or collapsible soils)
  - Peats or highly organic clays
  - Very high plasticity clays (PI > 75)
  - Very thick soft/medium clays (H > 120 ft)
- ***§ 20.3.2: Site Class E***
  - Where it does not qualify as Site Class F and…
  - Total thickness of soft clay > 10 ft.

80

7) Ground Motions

- ***How many of you verify ground motions?***
  - 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

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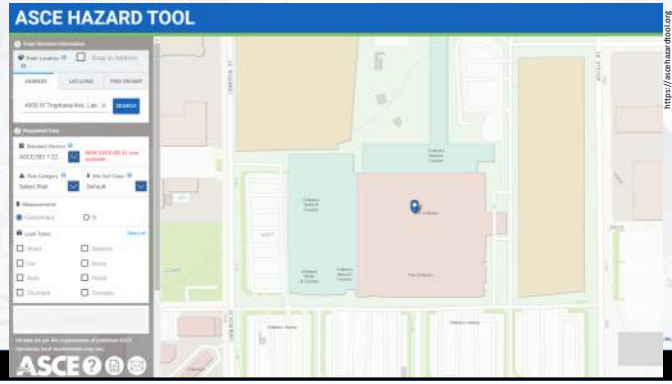
7) Ground Motions



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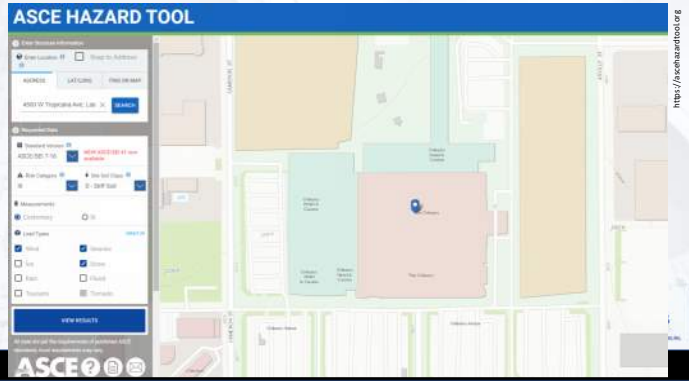
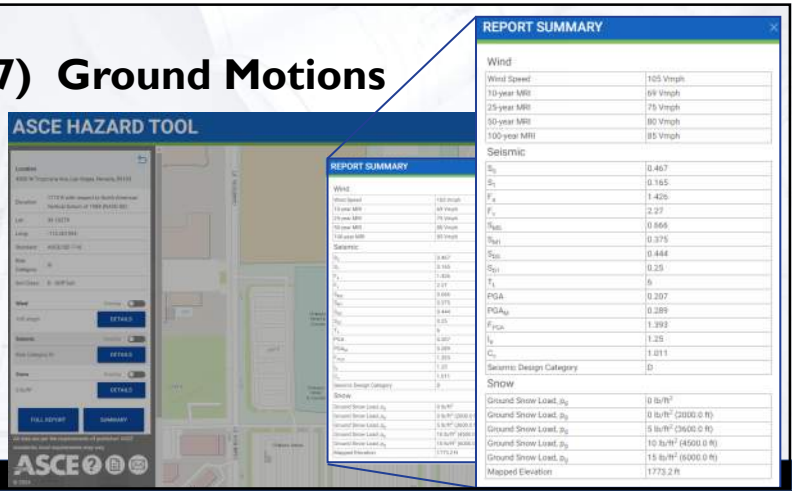
7) Ground Motions



83

7) Ground Motions



8) Flood Design Data

- ***Is there a flooding risk in your jurisdiction?***

85

8) Flood Design Data

- ***Flood Hazard Areas (FHA)*** are established by the local jurisdiction based upon the FEMA Flood Insurance Rate Map (FIRM), Flood Boundary and Floodway Map (FBFM), and other supporting data.
- Flood hazard documentation must be prepared and sealed by a registered design professional.

86

8) Flood Design Data

- ***IBC 1612.4: Flood Documentation***
- ***Not*** subject to high-velocity wave action:
  - Elevation of lowest floor, including basement
  - Fully enclosed areas below flood elevation → Statement that design will allow for equalization of flood waters per ASCE 24
  - Dry floodproofing → Statement that complies with ASCE 24

87

8) Flood Design Data

- ***IBC 1612.4: Flood Documentation***
- ***Subject*** to high-velocity wave action:
  - Elevation of lowest horizontal structural member
  - Statement that building is designed in accordance with ASCE 24, including…
    - Pile & column foundations
    - Structure anchored to resist flotation, collapse or lateral movement with wind and flood loads acting simultaneously
  - Statement that breakaway walls are designed per ASCE 24

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PART D
Hazard Review

89

Hazard Review (30%)

1. Verify Project Location
2. Verify Ground Motions
3. Verify Snow Loads
4. Review Geotechnical Report
5. Review Geologic Hazards
6. Review Adopted Flood Maps
7. Perhaps most important part of structural review!

90

1. Project Location

- ❑ Use Google Earth or other mapping software to verify project location.
- ❑ Make sure location matches what is shown in the geotechnical report and site plan.
- ❑ Note the following items:
  - Existing structures
  - Sloping site?
  - Appropriate Wind Exposure
  - Other Items?

91

1. Project Location

92

2. Ground Motions

REPORT SUMMARY

Seismic

S_S	0.568
S_1	0.253
F_a	1.345
F_v	N/A
S_{MS}	0.765
S_{M1}	N/A
S_{DS}	0.51
S_{D1}	N/A
T_L	12
PGA	0.238
PGA_M	0.325
F_{PGA}	1.362
I_e	1.25
C_v	1.079
NO SEISMIC SPECTRUM	Design and MCE_R spectrum data not available for this location
Note	Ground motion hazard analysis may be required. See ASCE/SEI 7-16 Section 11.4.8.

Site Class 'D'
S_{DS} = 0.51g
S_{D1} = N/A
SDC = ???

93

3. Snow Loads

- ***Verify Ground (Pg) and Flat Roof (Pf)***
  - What is the ground snow load?
  - What is the importance factor?
  - What is the exposure factor?
  - What is the thermal factor?

94

4. Geotechnical Report

- ***Is a soils report required? (IBC 1803)***
  - Questionable & expansive soils
  - High water table
  - Deep foundations
  - Variable rock
  - Excavations near foundations
  - Structural fill or CLSM
  - S.D.C.'C' or above.

95

4. Geotechnical Report

Basis of Investigation (IBC 1803.3)

- *"…the number and types…shall be determined by a registered design professional."*
- Are 2 borings acceptable for the following?

96

4. Geotechnical Report

- ***Basis of Investigation (IBC 1803.3)***
  - Civil + Structural Engineer Magazine, Dec. 2019
    - *"But with no universal standard governing how much data must be collected during the investigation and written into the final report, the geotechnical engineer and owner are left to negotiate what should be included."*
    - *"The geotechnical engineer wants the most thorough investigation possible and the owner wants to keep the cost of all geotechnical work as low as possible."*
  - ***Bottom line…*** It is okay for us to question the number of borings performed during the investigation.

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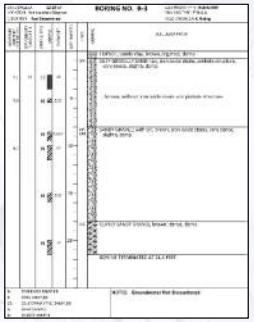
4. Geotechnical Report

- ***IBC 1803.6: Report should provide…***
  - A plot showing locations of borings
  - Complete record of soil borings
  - Record of soil profile
  - Elevation of water table
  - Recommendations for…
    - Foundation type
    - Bearing capacity
    - Mitigation measures for expansive soils
  - Expected total & differential settlement
  - Compacted fill properties



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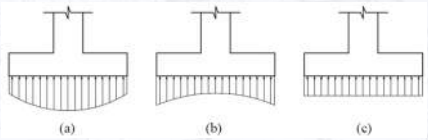
4. Geotechnical Report

- ***Allowable Bearing Pressure:***
  - The allowable bearing pressure is dependent upon…
    - Types of foundations
    - Applied loads
    - Soil type
    - Expected settlement



99

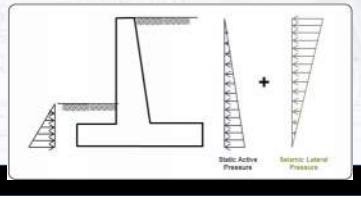
4. Geotechnical Report

- ***Total & Differential Settlement:***
  - Total = maximum settlement beneath footings
  - Differential = the uneven settlement that occurs
  - Allowable bearing pressure typically considers…
    - ***Total settlement = 1-inch maximum***
    - ***Differential settlement = ½-inch maximum***
  - Geotech may also specify minimum footing dimensions or additional reinforcing to limit expected settlement.

100

4. Geotechnical Report

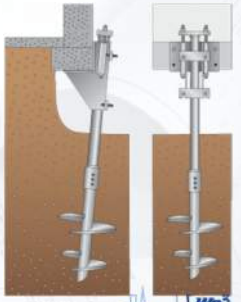
- ***IBC 1803.5.12: Additional items for SDC 'D-F'…***
  - Seismic lateral earth pressure → ***6-feet***
  - Potential for liquefaction
  - Quantify consequences of liquefaction
  - Liquefaction mitigation measures



101

4. Geotechnical Report

- ***IBC 1803.5.5: Deep Foundations***
  - Recommended deep foundation types
  - Recommended center-to-center spacing
  - Driving criteria
  - Installation procedures
  - Field inspection & reporting procedures
  - Load test requirements
  - Reductions for group action



102

4. Geotechnical Report

- ***Is it okay to assume Soil Site Class 'D'?***
  - 'D' = stiff soil
  - 'E' = soft clay
  - 'F' = liquefiable/collapsible

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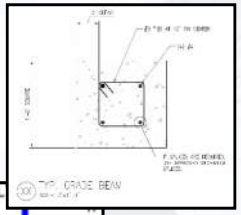
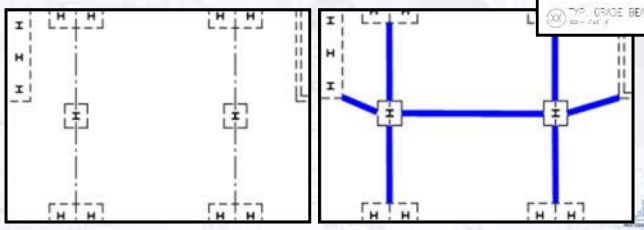
4. Geotechnical Report

- Site Class E & F soils in high seismic regions require all footings to have "seismic ties" (IBC 1809.13).





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4. Geotechnical Report

- ***Durability*** *(IBC 1904)*
  - Shall conform to ACI 318-19 *(Exception: R-2 & R-3 ≤ 3-stories)*
  - Section 19.3.1 of ACI 318-19:
    - Freezing (F0, F1, F2, & F3)
    - Sulfate (S0, S1, S2, & S3)
    - Permeability (P0, P1, P2, & P3)
    - Corrosive (C0, C1, & C2)

    - 0 = Not applicable
    - 1 = Moderate
    - 2 = Severe
    - 3 = Very severe

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4. Geotechnical Report

- ***Durability*** *(cont.)*
  - Section 19.3.1.1 of ACI 318-19: *"Licensed design professional shall assign exposure classes in accordance with the severity of the anticipated exposures…"*

CONCRETE ELEMENT:	STRENGTH:	EXPOSURE CLASS:
FOOTINGS & FOUNDATION WALLS:	4000 PSI	(F1, S0, W0, C1)
TILT-UP CONCRETE WALL PANELS	4500 PSI	(F2, S0, W1, C1)
INTERIOR SLABS ON GRADE:	3500 PSI	(F0, S0, W0, C0)
SITE CONCRETE:	4500 PSI	(F3, S0, W1, C2)

Example Review Comment:
Section 19.3.1.1 of ACI 318-19 requires the design professional to assign exposure classes to structural concrete members in accordance with Table 19.3.1.1. Please address.

106

4. Geotechnical Report

- Does the site plan match the project location?
- How old is the report?
- Is the Soil Site Class specified?
- Should "footing seismic ties" be required? (Site Class 'E' or 'F' only; see IBC 1809.13)
- Are foundations required to span a certain distance per the report recommendations?
- Are their special drainage requirements that should be noted on the plans?

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5. Geologic Hazards

- ***Are their other geologic hazards at your site?***

108

5. Geologic Hazards

- ***Footings on Slopes:***
  - IBC Figure 1808.7.1

  or…
  - Ascending Slopes (IBC 1808.7.1)
  - Descending Slopes (IBC 1808.7.2)

  or...
  - Alternate setbacks & clearances (IBC 1808.7.5)

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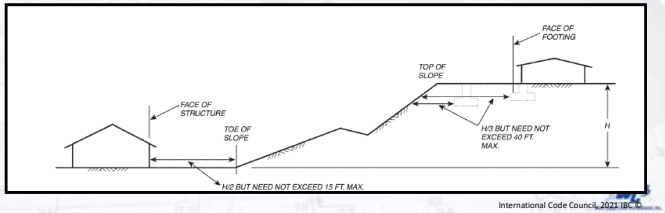
5. Geologic Hazards

- ***IBC Figure 1808.7.1***
  - Descending: H/3, but not greater than 40-feet
  - Ascending: H/2, but not greater than 15-feet



International Code Council, 2021 IBC ©

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5. Geologic Hazards

- ***Ascending Slopes (IBC 1808.7.1)***
  - Clearance = "…sufficient distance from the slope to provide protection from slope drainage, erosion and shallow failures."

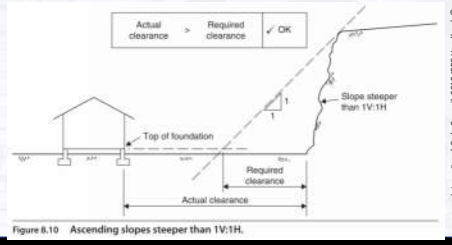

Figure 8.10 Ascending slopes steeper than 1V:1H.

International Code Council, 2018 IEBC Handbook ©

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5. Geologic Hazards

- ***Descending Slopes (IBC 1808.7.2)***
  - Setback = "…set back from the slope surface sufficient to provide vertical and lateral support for the footing without detrimental settlement."

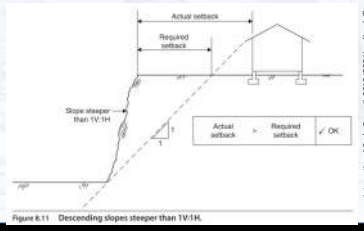

Figure 8.11 Descending slopes steeper than 1V:1H.

International Code Council, 2018 IEBC Handbook ©

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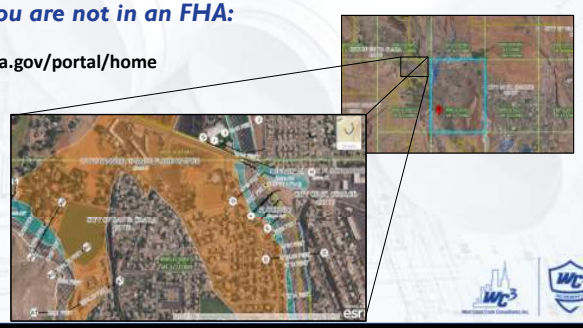
6. Flood Maps

- ***Verify that you are not in an FHA:***

https://msc.fema.gov/portal/home



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6. Flood Maps

- ***Verify that you are not in an FHA:***
  - Flood Zones A or V → Within FHA
  - Flood Zones B or shaded X → moderate flood hazard
  - Flood Zones C or unshaded X → minimal flood hazard

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Sample Comments

Ground Motions:
When checking the ASCE Hazard Tool the design ground motions per the 2021 IBC appear to be S_{DS}=1.763g and S_{D1}=0.794g. The value noted on the plans and in the calculations is S_{DS}=1.45g. This is significantly less than noted above. Please address.

Flood Hazard Area:
The project is located within a flood hazard area as shown on the City's current Flood Insurance Rate Map (FIRM). Please provide all necessary flood hazard documentation as outlined in IBC 1612.4.

Snow Loads:
The design roof snow load is greater than 30psf. Please confirm that a percentage of the snow was considered in the seismic weight of the structure as required by the load combinations of ASCE 7 or IBC 1605.2.

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Sample Comments

Geotechnical Report #1:
The City requires that geotechnical reports submitted for review be dated no more than two years from the submittal date. Please provide an update letter from a geotechnical engineer stating that the recommendations in the report are still valid or stating what items may have changed.

Geotechnical Report #2:
The geotechnical report states that all concrete which is to come into contact with the site soils are to meet the ACI requirements for "Moderate" sulfate exposure. This requires a minimum f'c = 4,000psi, maximum w/c = 0.5, and Type II cement per IBC 1904.1. Please note these requirements on the plans.

Geotechnical Report #3:
The geotechnical report classifies the site soils as Site Class 'E'. As such all individual spread footings must be interconnected by means of seismic ties in accordance with IBC 1809.13. Please address.

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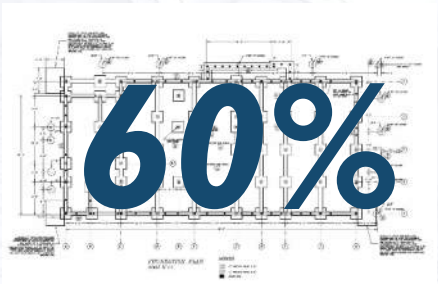
PART E
Construction Plans



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Construction Plans (60%)

- ❑ Civil, Architectural, MEP Perusal
- ❑ General Structural Notes
- ❑ Footing & Foundation Plan
- ❑ Floor Framing Plan(s)
- ❑ Roof Framing Plan(s)
- ❑ Sections & Details
- ❑ Miscellaneous

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1. Civil, Architectural, MEP

- ❑ ***What items need to be considered by SER/EOR?***
  - Retaining walls
  - Dimensions
  - Canopies
  - Mechanical unit weights
  - Suspended elements
  - Check uses → appropriate live loads?
  - Snow drift areas
  - "See Structural"

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2. General Structural Notes

A. Design Criteria
B. Material Requirements
C. Statement of Special Inspections
D. Deferred Submittals

A very important part of structural review!

120

2.A. Design Criteria

Let's look at two examples…
1. Roof Loads
2. Heavy Vehicle Loads

- ***IBC 1603.1.1: 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	—	—
4.	Assembly areas	Fixed seats (fastened to floor)	60		
		Follow spot, projections and control rooms	50		
		Lobbies	100		
		Movable seats	100		
		Stage floors	150		
		Platforms (assembly)	100	—	—
		Bleachers, folding and telescopic seating and grandstands	100 (See Section 1607.19)		
		Stadiums and arenas with fixed seats (fastened to the floor)	60 (See Section 1607.19)		
		Other assembly areas	100		
5.	Balconies and decks		1.5 times the live load for the area served, not required to exceed 100	—	—

121

2.A. Design Criteria

- Accessible Roofs: What live load is appropriate?

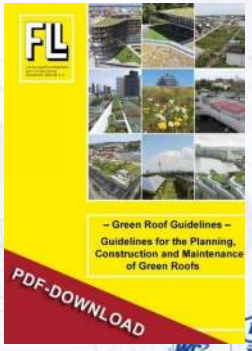
TABLE 1607.1—continued
MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS, L_o, AND MINIMUM CONCENTRATED LIVE LOADS

OCCUPANCY OR USE			UNIFORM (psf)	CONCENTRATED (pounds)	ALSO SEE SECTION
27.	Roofs	Ordinary flat, pitched, and curved roofs (that are not occupiable)	20	—	Section 1607.15.2
		Roof areas used for assembly purposes	100	—	
		Roof areas used for occupancies other than assembly	Same as occupancy served	—	
		Vegetative and landscaped roofs:		—	
		Roof areas not intended for occupancy	20	—	
		Roof areas used for assembly purposes	100	—	
		Roof areas used for other occupancies	Same as occupancy served	—	
		Awnings and canopies:		—	
		Fabric construction supported by a skeleton structure	5	—	
		All other construction, except one- and two-family dwellings	20	—	
		Primary roof members exposed to a work floor:			Section 1607.15.2
		Single panel point of lower chord of roof trusses or any point along primary structural members supporting roofs over manufacturing, storage warehouses, and repair garages	—	2,000	
		All other primary roof members	—	300	
		All roof surfaces subject to maintenance workers	—	300	

122

2.A. Design Criteria

- ***IBC 1607.1 & IBC 1606.5:*** Vegetative & Landscaped Roofs
  - Live Load = 20psf
  - Dead Load = weight of "saturated" materials
  - Is 80pcf dead load sufficient?



123

2.A. Design Criteria

124

2.A. Design Criteria

- Heavy Vehicles: What live load is appropriate?

13.	Fire escapes		100	—	—
		On single-family dwellings only	40		
14.	Fixed ladders		See Section 1607.17		—
15.	Garages	Passenger vehicles only	40[f]	See Section 1607.7	—
		Trucks and buses	See Section 1607.8		
16.	Handrails, guards and grab bars		See Section 1607.9		—
17.	Helipads		See Section 1607.6		—

125

2.A. Design Criteria

- ***IBC 1607.8: Heavy Vehicle Loads***
  - IBC 1607.8.1 – Loads
  - IBC 1607.8.2 – Fire truck and emergency vehicles
  - IBC 1607.8.3 – Heavy vehicle garages
  - IBC 1607.8.4 – Forklifts and movable equipment
  - IBC 1607.8.5 – Posting

126

2.A. Design Criteria

- ***Heavy Vehicles =*** Gross Vehicle Weight Rating (GVWR) > 10,000#
- ***GVWR =*** Maximum allowable weight a vehicle can carry including itself.

127

128

2.A. Design Criteria

- ***IBC 1607.8.2: Fire Trucks***
- Must be designed for the greater of…
  - Actual operational loads, including outrigger reactions
  - Live load specified in IBC 1607.7.1

129

2.A. Design Criteria

- ***IBC 1607.8.3:*** Heavy Vehicle Garages
  - Rational analysis allowed, but LL shall not be < 50psf
- ***IBC 1607.8.5:*** Max weight of vehicles allowed into a parking garage or other structure shall be posted.

130

2.A. Design Criteria

- ***IBC 1607.8.4:*** Forklifts and movable equipment
  - *"…structure shall be designed for the total vehicle or equipment loads… These loads shall be posted…"*

131

2.A. Design Criteria

- ***Compare to architectural plans…***

132

2.A. Design Criteria

- ***IBC 1603.1.3: Snow Loads***
  - This was checked as part of the "Hazard Review". Now we simply verify that the values noted on the plans are correct.
    - 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)

133

2.A. Design Criteria

- ***IBC 1603.1.4: Wind Design Data***
  - This was checked as part of the "Hazard Review". Now we simply verify that the values noted on the plans are correct.
    - Basic Wind Speed
    - Wind Exposure
    - Internal Pressure Coefficient
    - Component & Cladding Pressures & Applicable Zones

134

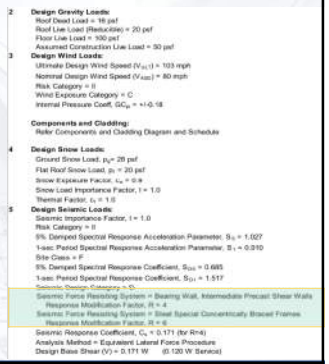
2.A. Design Criteria

- ***IBC 1603.1.5: Earthquake Design Data***
  - This was checked as part of the "Hazard Review". Now we simply verify that the values noted on the plans are correct.
    - 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

135

2.A. Design Criteria

- ***IBC 1603.1.5: Earthquake Design Data***
  - Additional items…
    - Analysis Procedure Used
    - Basic Seismic Force-Resisting System(s) → R
    - Are all systems listed?


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 = 25 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 = 0.310
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)

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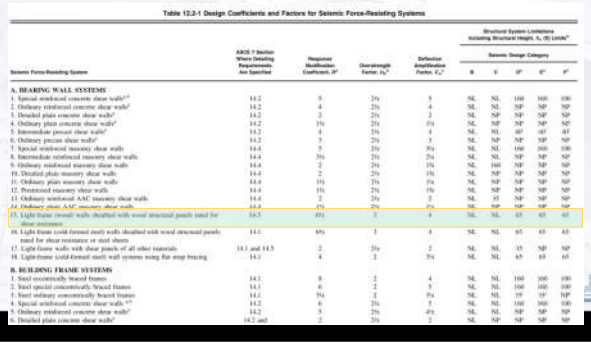
2.A. Design Criteria

Table 12.2-1 of ASCE 7-16:



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137

2.A. Design Criteria

- *IBC 1603.1.5: Earthquake Design Data*
  - **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

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2.A. Design Criteria

- *IBC 1603.1.6: Geotechnical Information*
- *IBC 1603.1.7: Flood Design Data*
  - This was checked as part of the "Hazard Review". Now we simply verify that the values noted on the plans are correct.

139

2.A. Design Criteria

- *IBC 1603.1.8: Special Loads*
  - This could include items such as…
    - PV systems
    - Machinery
    - Pools/spas
    - Etc.

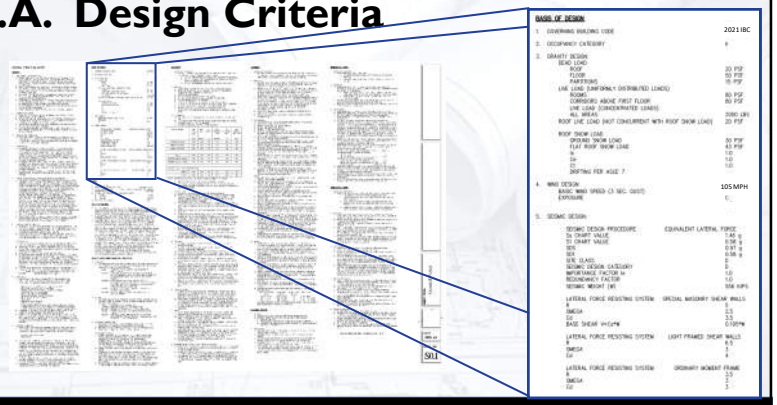
140

2.A. Design Criteria

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

141

2.A. Design Criteria



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2.B. Material Requirements

- ***Wood, Concrete, Masonry, Steel, etc.***
  - Are design/construction standards specified?

Main 2021 IBC Structural Standards

Standard	Version	Description
ACI 318	2019	Structural Concrete
AISC 341	2016	Structural Steel Buildings - Seismic Provisions
AISC 360	2016	Structural Steel Buildings - Specifications
ASCE 7	2016	Minimum Design Loads for Buildings
AWC NDS	2018	National Design Specification for Wood
AWC SDPWS	2021	Special Design Provisions for Wind & Seismic
TMS 402	2016	Masonry Structures - Provisions
TMS 602	2016	Masonry Structures - Specifications

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2.B. Material Requirements

- ***Wood, Concrete, Masonry, Steel, etc.***
  - Are materials and design strengths specified?
    - Concrete per IBC 1901.3, etc.
  - Do specific installations meet code?
    - Is concrete cover being met?
    - Is treated lumber and preservative fasteners called out?
  - Is extraneous information listed?

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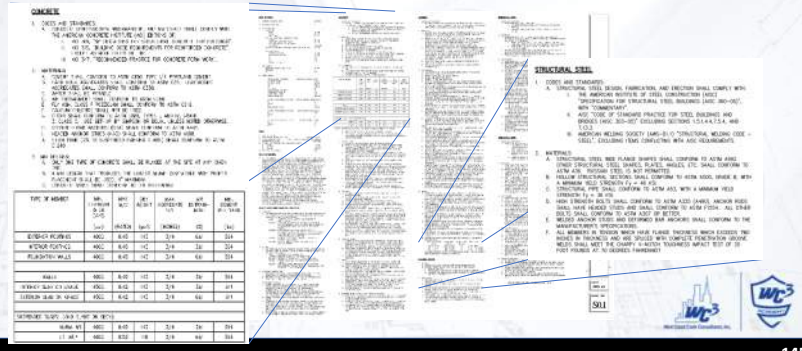
2.B. Material Requirements



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2.C. Special Inspections

- ***History of Special Inspections***
  - Inspections of structural components were included in first edition of the UBC (1927)
  - Term "Special Inspections" appeared in the 1961 UBC
  - BOCA first introduced special inspection requirements in 1988.
  - The 2000 IBC merged the UBC and BOCA special inspection provisions into Chapter 17.
  - The requirements keep growing!

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2.C. Special Inspections

- Can the architect or SER act as the special inspector?
- Where are special inspection requirements typically provided?
- Do only structural elements require special inspections?

147

2.C. Special Inspections

- ***IBC 1704.3: Statement of Special Inspections (SSI)***
  - Shall be prepared by the Registered Design Professional in Responsible Charge.
  - Shall identify the following:
    - Work required to have special inspections or testing
    - Type & extent of special inspection or testing
    - Frequency → continuous or periodic

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2.C. Special Inspections

- ***Continuous:***
  - Full-time observation
  - *"100% of the work must be inspected and it must be inspected as the work is being performed."*
- ***Periodic:***
  - Part-time or intermittent observation
  - *"The registered design professional… should indicate the frequency of inspection that is required. The frequency varies depending on the size and complexity of the project."* - Structure Magazine, May 2006

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2.C. Special Inspections

- ***Bad Example:***
  - Large single-story retail shell → CMU construction
  - Original plans provided the following:

Special Inspection: Special inspection is required in accordance with IBC 1701.

A. All concrete masonry units and reinforcing.
B. Field welding.
C. Epoxy bolts.

150

2.C. Special Inspections

- ***Bad Example:***
  - Our initial review comment stated the following:

The "special inspection" portion of sheet Sxxx does not meet the requirements for a "Statement of Special Inspections" as required by IBC 1704.3. Not only should the items requiring special inspection/testing be noted, but the extent of the inspections/tests should be defined and the frequency (i.e. continuous or periodic) noted. Additional items requiring special inspection may include soils, concrete, etc. Please address.

151

2.C. Special Inspections

- ***Bad Example:***
  - Revision #1 was as follows:

Special Inspection: Special inspection is required in accordance with IBC 1701.

A. All concrete masonry units and reinforcing, level II, periodic.
B. Field welding. Periodic
C. Epoxy bolts. If apply. During installation.
D. Inspection of soil as noted on soil report. Periodic.

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2.C. Special Inspections

- ❑ See Handout for an example of what we should be seeing in relation to a Statement of Special Inspections.

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2.C. Special Inspections

- ❑ ***Exemptions:***
  - Not required for construction of minor nature.
  - Group U occupancies accessory to R-3.
  - Construction per conventional construction provisions.
  - Approved fabricators (Certificate of Compliance)
  - Isolated footings supporting 3-stories or less.
  - Continuous footings supporting 3-stories or less of light-frame construction and designed using a concrete strength (f'c) of 2,500psi.
  - Nonstructural slabs on grade, driveways, and sidewalks

154

2.C. Special Inspections

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2.D. Deferred Submittals

- ❑ Required for structural components in which the structural design has not been submitted.
- ❑ Does the B.O. have to allow them?
- ❑ 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 city.

156

2.D. Deferred Submittals

- ***Should the following items be accepted as deferred submittals?***
  - Concrete mix designs
  - Deep foundation systems
  - Tilt-up panel lifting design
  - Open web steel joists
  - Prefabricated metal buildings

157

2.D. Deferred Submittals

- ***IBC 107.3.4.1:*** *"..shall be submitted to the registered design professional in responsible charge who shall review them and forward them to the building official with a notation indicating that the deferred submittal documents have been reviewed for general conformance to the design of the building."*

SHOP DRAWING / SUBMITTAL REVIEW

☐ APPROVED ☐ APPROVED WITH CHANGES NOTED
☐ REVISE AND RESUBMIT ☐ REJECTED

SUBMITTAL WAS REVIEWED FOR DESIGN CONFORMITY AND GENERAL CONFORMANCE TO CONTRACT DOCUMENTS ONLY. THE CONTRACTOR IS RESPONSIBLE FOR CONFIRMING AND CORRELATING DIMENSIONS AT JOB SITES FOR TOLERANCES, CLEARANCES, QUANTITIES, FABRICATION PROCESSES AND TECHNIQUES OF CONSTRUCTION, COORDINATION OF HIS WORK WITH OTHER TRADES AND FULL COMPLIANCE WITH THE CONTRACT DOCUMENTS.

BY_____ DATE_____

YOUR COMPANY NAME
Your City, State

158

2.D. Deferred Submittals


YOUR LOGO HERE

DEFERRED SUBMITTAL AGREEMENT

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2. General Structural Notes

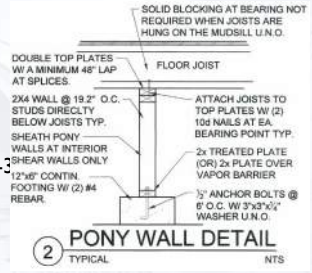
A. Design Criteria
B. Material Requirements
C. Statement of Special Inspections
D. Deferred Submittals

A very important part of structural review!

160

3. Foundation Plan

- ***Minimum Dimensions:***
  - Minimum depth = 12-inches
  - Minimum width = 12-inches
  - Extend to below frost line
  - Plain concrete thickness = 8-inches (Group R-3)



161

3. Foundation Plan

- ***Frost Protection:***
  - Verify footings meet required frost depth.

162

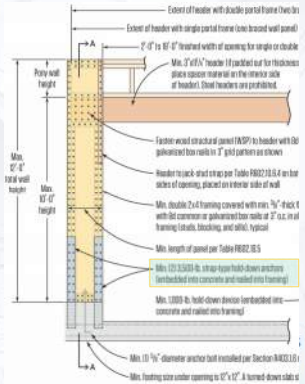
Foundation Plan

- ***Footing Thickness:***
  - Plain Concrete ≥ 8-inches (IBC 1809.8)
    - Same in §14.3.2.1 of ACI 318-19
  - Reinforced ≥ 10-inches
    - §13.3.1.2 of ACI 318-19 → 6" min. to bottom reinforcement
    - Diameter of reinforcing
    - Concrete cover
  - §14.1.4 of ACI 318-19 limits plain concrete in SDC 'D' or above.

163

Foundation Plan

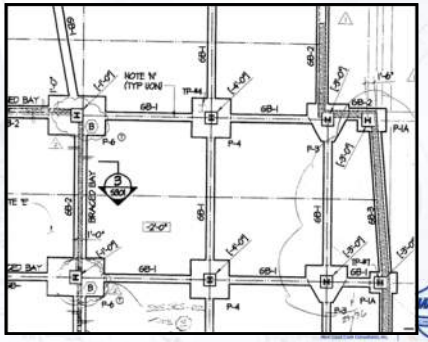
- ***Holdown Sizes and Locations:***



164

Foundation Plan

- ***Footing Seismic Ties?***
  - Site Class 'E' or 'F', and…
  - SDC 'D or above'



165

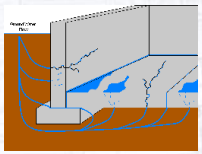
Foundation Plan

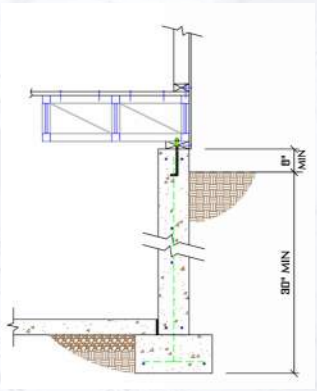
- ***IBC Table 1808.8.1: Footing Concrete Strength***
  - F'cmin = 2,500psi (Light-framed, ≤ 2 stories)
  - F'cmin = 3,000psi (All others)
- ***Footing & Foundation Prep:***
  - Are the requirements of the geotechnical report clear on the plans?
    - Engineered Fill
    - Mitigation measures

166

Foundation Plan

- ***Foundation Walls:***
  - Are they restrained?
  - Is appropriate backfill material specified?
  - Is foundation wall drainage provided?





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Foundation Plan

- ***Footings on Slopes:***

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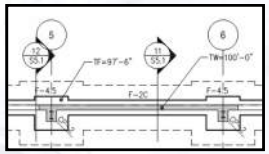
Foundation Plan



- ☒ Footings specified on plan?
- ☒ Proper Reinforcement?
- ☒ Calculations Provided?

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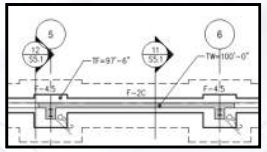
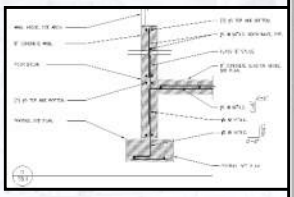
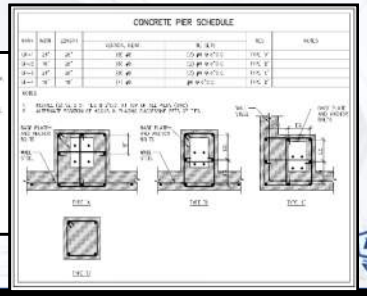
Foundation Plan



- ☒ Check Details
- ☒ Verify Piers on Table





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4. Floor Framing

- ❑ Beam & joist sizes, spans, and spacing
- ❑ Column sizes
- ❑ Wall framing (stud size & spacing, reinforcement)
- ❑ Shear walls (sheathing, nailing, blocking, masonry)
- ❑ Uplift floor ties (holdowns, anchor bolts, sill plates, boundary reinforcement, etc.)
- ❑ Connection callouts (correct detail references)
- ❑ Diaphragm requirements (sheathing, nailing, blocking, steel deck, HSA's, reinforcement, etc.)

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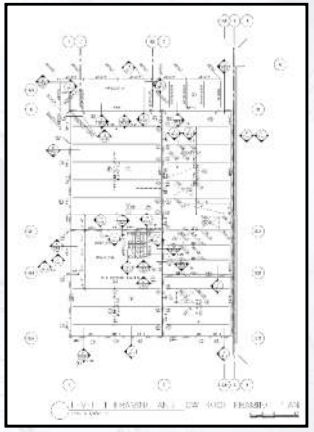
4. Floor Framing

- ❑ Verify Trusses/Beams
- ❑ Locate Shear Walls and Verify Shear Transfer Details
- ❑ Verify Holdowns
- ❑ Verify that Snow Loads are Shown on Low Roof Plans



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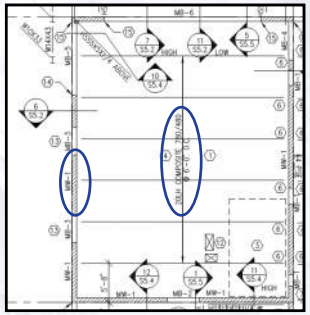
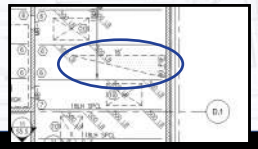
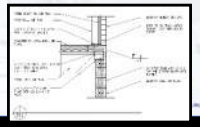
4. Floor Framing

- ☒ Verify Trusses/Beams
- ☒ Locate Shear Walls and Verify Shear Transfer Details
- ☒ Verify Holdowns
- ☒ Verify that Snow Loads are Shown on Low Roof Plans







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5. Roof Framing

- ❑ Beam & joist sizes, spans, and spacing
- ❑ Column sizes
- ❑ Assumed truss layout
- ❑ Design loads (i.e. unbalanced, sliding, & drift snow)
- ❑ Connection callouts (verify detail references)
- ❑ Diaphragm requirements (i.e. sheathing, nailing, blocking)
- ❑ Rooftop units and other projections

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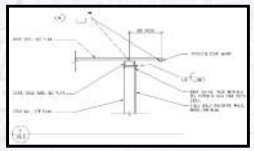
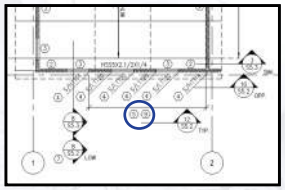
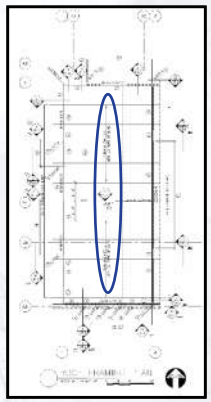
5. Roof Framing

- ☒ Verify Trusses/Beams
- ☒ Locate Shear Walls
- ☒ Verify Details
- ☒ Special Loads







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6. Sections & Details

- ❑ ***Connections, Connections, Connections!***
  - Primary Structural
    - Framing details
    - Foundation details
    - Joist-to-Beam
    - Beam-to-Beam
    - Beam-to-Column
    - Column-to-Foundation
    - Moment & Braced Frame Elevations
  - Secondary Structural
    - Canopies
    - Parapets
    - Fascias

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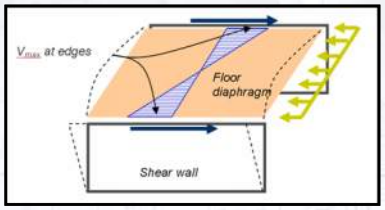
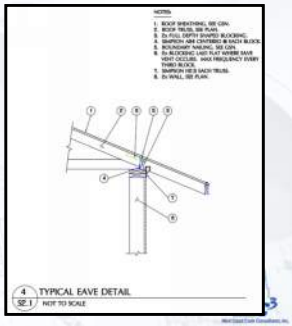
6. Sections & Details

Eave Blocking:





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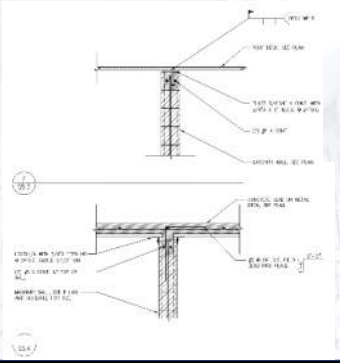
6. Sections & Details



Interior Shear Walls:

- Direct connection *(load path)*
- Parallel to truss
  - As in detail
  - Engineered girder truss
- Perpendicular to truss
  - Shear wall panels
  - Truss blocking

178

179

6. Sections & Details

Concentrated Loads:

- Watch for specific point loads

180

6. Sections & Details

Gable Wall Bracing:

- Knee bracing or ceiling bracing at hinge points in gable walls.

181

6. Sections & Details

❑ ***Specific Material Requirements:***

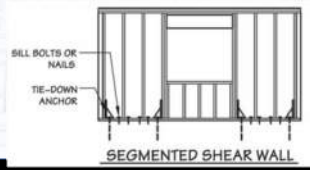
A. Wood Construction
B. Concrete Construction
C. Masonry Construction
D. Steel Construction

182

6.A. Wood Construction

❑ ***Shear Walls:***

- All panels shall have 2x blocking
  - 3x required when edge nailing is 2"o.c., or…
  - 10d nails and 3"o.c., or…
  - Panels applied to each face, and they are not offset

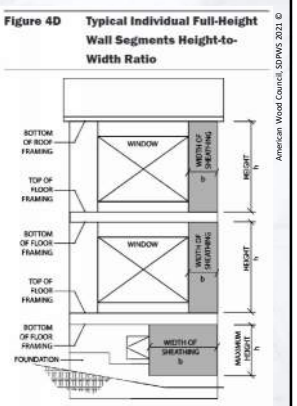


183

6.A. Wood Construction

❑ ***Segmented Shear Walls:***

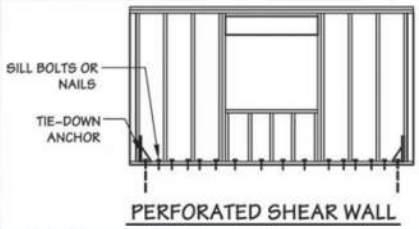
- Allowable aspect ratios
  - Seismic → 2:1 (3.5:1 if reduced)
  - Wind → 3.5:1 (e.g., 8'-0" x 2'-3")
- Example: 9-foot wall
  - 2:1 → 4.5 feet
  - 3.5:1 → 2.57 feet
  - 43% reduction in capacity!



184

6.A. Wood Construction

❑ ***Perforated Shear Walls:***

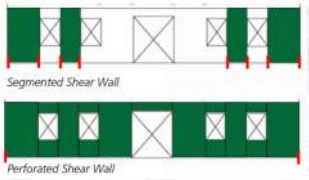


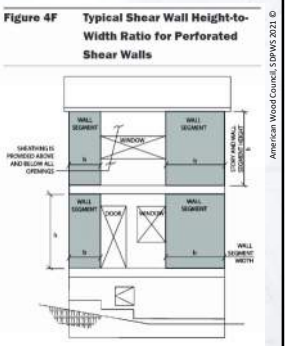
185

6.A. Wood Construction

❑ ***Perforated Shear Walls:***

- Allowable aspect ratios
  - Seismic & Wind → 3.5:1
- Example: https://www.structuremag.org/?p=11564





186

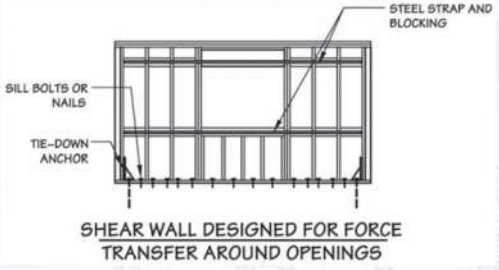
6.A. Wood Construction

Wall Height (h)	Maximum Opening Height Ratio & Height				
	h/3	h/2	2h/3	5h/6	h
8′-0″	2′-8″	4′-0″	5′-4″	6′-8″	8′-0″
10′-0″	3′-4″	5′-0″	6′-8″	8′-4″	10′-0″
% Full-Height Sheathing	**Shear Capacity Adjustment Factor**				
10%	1.00	0.69	0.53	0.43	0.36
20%	1.00	0.71	0.56	0.45	0.38
30%	1.00	0.74	0.59	0.49	0.42
40%	1.00	0.77	0.63	0.53	0.45
50%	1.00	0.80	0.67	0.57	0.50

187

6.A. Wood Construction

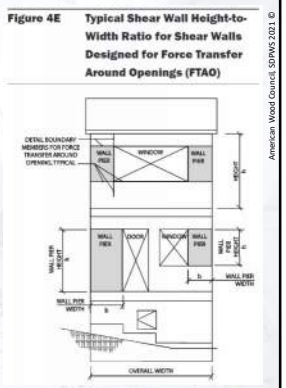
❑ ***Force-Transfer Shear Walls:***



188

6.A. Wood Construction

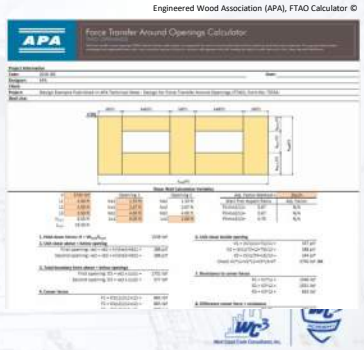
- ***Force-Transfer Shear Walls:***
  - Allowable aspect ratios
    - Same as segmented, but…
  - Design & Detailing:
    - Each wall pier ≥ 2-feet
    - Full-height segment at each end
    - No out-of-plane offsets
    - Collectors shall be full length



189

6.A. Wood Construction

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



190

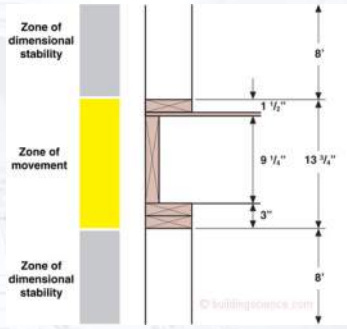
6.A. Wood Construction

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

191

6.A. Wood Construction

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



192

6.A. Wood Construction

- ***Shrinkage:***
  - Structure Magazine – June 2011: https://www.structuremag.org/wp-content/uploads/2014/08/C-ConstrIssues-Howe-June111.pdf
  - Western Wood Products Association – Tech Note: https://www.wwpa.org/resources/?id=shrinkage-calculations-for-multistory-wood-frame-construction
  - Shrinkage Calculators: http://www.strongtie.com/webapps/woodshrinkage/ http://www.cwc.ca/dimensioncalc/

193

6.B. Concrete Construction

- ***Concrete Cover:***
  - How comfortable are you with concrete cover requirements?

American Concrete Institute, ACI 318-19 ©

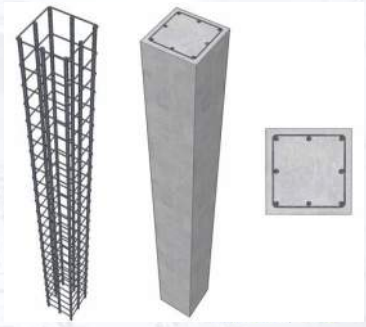
Table 20.5.1.3.1—Specified concrete cover for cast-in-place nonprestressed concrete members

Concrete exposure	Member	Reinforcement	Specified cover, in.
Cast against and permanently in contact with ground	All	All	3
Exposed to weather or in contact with ground	All	No. 6 through No. 18 bars	2
		No. 5 bar, W31 or D31 wire, and smaller	1-1/2
Not exposed to weather or in contact with ground	Slabs, joists, and walls	No. 14 and No. 18 bars	1-1/2
		No. 11 bar and smaller	3/4
	Beams, columns, pedestals, and tension ties	Primary reinforcement, stirrups, ties, spirals, and hoops	1-1/2

194

6.B. Concrete Construction

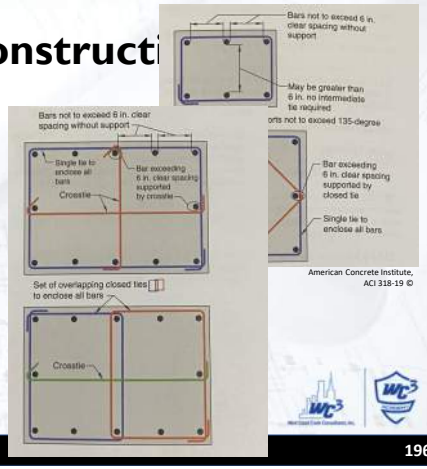
- ***Column Ties:***
  - § 25.7.2 of ACI 318-14 requires…
  - Minimum Bar Size
    - < #11 vertical bar → ***#3 ties minimum***
    - #11, 14 or 18 → ***#4 tie minimum***
  - Maximum Vertical Spacing
    - 16db vertical bars (e.g. #5 bars = 10")
    - 48db tie bars (e.g. #3 ties = 18")
    - Least dimension of compression member



195

6.B. Concrete Construct

- ***Column Ties:***
  - § 25.7.2.3 of ACI 318-19…
  - *"Every corner or alternate longitudinal bar shall have lateral support provided by the corner of a tie... No bar shall be further than **6" clear**… from such a laterally supported bar."*

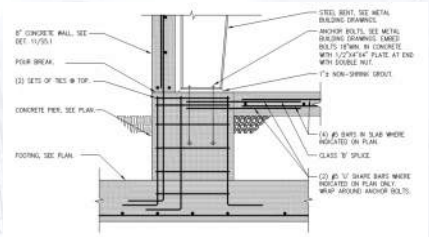


196

6.B. Concrete Construction

❑ ***Column Ties:***

- § 10.7.6.1.6 of ACI 318-19…
- Anchor bolts placed in the top of column or pedestal shall be enclosed by ties surrounding at least four vertical bars.
- Ties shall consist of…
  - (2) #4 or (3) #3 ties
  - Distributed within top 5"



197

B. Concrete Construction

Footings:

- § 13.3 of ACI 318-19 requires compliance with Chapter 7
- § 7.6.1.1 of ACI 318-19 → $A_{s,min} = 0.0018*A_g$
- What does that mean?
- Example: 42" wide x 12" thick wall footing w/ (3) #5 bars
  - $A_g = 504\ in^2$
  - $A_s = 0.60\ in^2$
  - Ratio = 0.00119 < 0.0018 ***No Good!***

198

B. Concrete Construction

Footings:

- Take some time to review the footing schedule

Footings							
Width	Depth	A_{conc}	Bar	#	A_{steel}	Rho	
12	12	144	4	1	0.20	0.00139	No Good!
42	12	504	4	3	0.60	0.00119	No Good!
54	12	648	4	6	1.20	0.00185	
60	14	840	5	5	1.55	0.00185	
60	12	720	4	7	1.40	0.00194	
72	16	1152	5	7	2.17	0.00188	
96	20	1920	6	9	3.96	0.00206	

Footing Reinforcement:
Footings F-2 and F-5 do not appear to meet the minimum reinforcing requirements of ACI 318-19 Sections 13.3 and 7.6.1.1. Please address.

199

6.B. Concrete Construction

❑ ***Concrete Piers:***

- **SDC 'D':** IBC 1810.3.9.4.2 requires…
  - At least 4 vertical bars
  - ρmin = 0.005

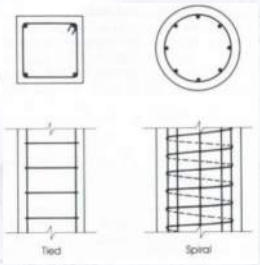
ρ = 0.005
#4 ≤ 14"Ø
#5 ≤ 17"Ø
#6 ≤ 21"Ø
#7 ≤ 24"Ø

200

6.B. Concrete Construction

- ***Concrete Piers:***
  - Enclosed Ties
    - #3 bar if ≤ 20"Ø
    - Otherwise #4 bar
    - Spacing shall be least of…
      - 12db vertical bar;
      - 1/2 least dimension of compression member; and…
      - 12 inches

#4 → 6"
#5 → 7.5"
#6 → 9"
#7 → 10.5"



201

6.B. Concrete Construction

- ***Concrete Piers:***
  - Exceptions:
    - Not required in Groups R-3 or U of 2-stories or less when…
    - Element is not subject to lateral loads, or…
    - Only supports posts from decks and patios and the calculated lateral does not exceed 200#
    - In these cases a single #4 vertical bar must be provided without ties or spirals

202

C. Masonry Construction

- ***Materials:***
  - CMU: 1,500psi min, 4,000psi max
  - Grout: ≥ CMU, but not less than 2,000psi
  - § 5.3.1.4: Similar tie requirements as for concrete…
    - Spacing ≤ 16bd longitudinal or 48bd of tie
    - ≤ 6-inch clearance from laterally supported bar

Tied Bars:
Please review the lateral tie requirements shown in the masonry column details. Vertical bars should be tied in such a fashion as to ensure the maximum distance between laterally tied bars is less than or equal to 6-inches. See Section 5.3.1.4 of TMS 402-16.

203

C. Masonry Construction

- ***Masonry Walls:***
  - Based on SDC
  - Table CC-7.3.2-1 refers to requirements

TABLE CC-7.3.2-1 Requirements for Masonry Shear Walls Based on Shear Wall Designation[1]

Shear wall Designation	Design Methods	Reinforcement Requirements	Permitted In
Empirical Design of Masonry Shear Walls	Section A.3	None	SDC A
Ordinary Plain (Unreinforced) Masonry Shear Walls	Section 8.2 or Section 9.2	None	SDC A and B
Detailed Plain (Unreinforced) Masonry Shear Walls	Section 8.2 or Section 9.2	Section 7.3.2.3.1	SDC A and B
Ordinary Reinforced Masonry Shear Walls	Section 8.3 or Section 9.3	Section 7.3.2.3.1	SDC A, B, and C
Intermediate Reinforced Masonry Shear Walls	Section 8.3 or Section 9.3	Section 7.3.2.5	SDC A, B, and C
Special Reinforced Masonry Shear Walls	Section 8.3 or Section 9.3	Section 7.3.2.6	SDC A, B, C, D, E, and F
Ordinary Plain (Unreinforced) AAC Masonry Shear Walls	Section 11.2	Section 7.3.2.7.1	SDC A and B
Detailed Plain (Unreinforced) AAC Masonry Shear Walls	Section 11.2	Section 7.3.2.8.1	SDC A and B
Ordinary Reinforced AAC Masonry Shear Walls	Section 11.3	Section 7.3.2.9	SDC A, B, C, D, E, and F
Ordinary Plain (Unreinforced) Prestressed Masonry Shear Walls	Chapter 10	None	SDC A and B
Intermediate Reinforced Prestressed Masonry Shear Walls	Chapter 10	Section 7.3.2.11	SDC A, B, and C
Special Reinforced Prestressed Masonry Shear Walls	Chapter 10	Section 7.3.2.12	SDC A, B, C, D, E, and F

[1] Section and Chapter references in this table refer to Code Sections and Chapters.

204

C. Masonry Construction

- ***Special Reinforced Example:***
  - § 7.3.2.6 of TMS 402-16
  - Maximum reinforcement spacing
    - 1/3 length of wall, or…
    - 1/3 height of wall, or…
    - 48"o.c.

EXAMPLE

Given: 9-foot walls

- **25'/3 = 8.33'**
- **9'/3 = 3.0'**
- **48"**

205

6.C. Masonry Construction

- ***Reinforcing:***
  - Ratio of reinforcing
    - ρmin ≥ 0.0007 in each direction (ρ_h & ρ_v)
    - ρtotal ≥ 0.002 ($\rho_h + \rho_v$)
  - Plan Review Cheat Sheet…

Actual Reinforcing Steel Ratio (ρ_{act})

	A_g (in²)	#4 bars (A_s=0.20in²)					#5 bars (A_s=0.31in²)				
		8"o.c.	16"o.c.	24"o.c.	32"o.c.	48"o.c.	8"o.c.	16"o.c.	24"o.c.	32"o.c.	48"o.c.
4" block	43.5	0.00690	0.00345	0.00230	0.00172	0.00115	0.01069	0.00534	0.00356	0.00267	0.00178
6" block	67.5	0.00444	0.00222	0.00148	0.00111	0.00074	0.00689	0.00344	0.00230	0.00172	0.00115
8" block	91.5	0.00328	0.00164	0.00109	0.00082	0.00055	0.00508	0.00254	0.00169	0.00127	0.00085
10" block	115.5	0.00260	0.00130	0.00087	0.00065	0.00043	0.00403	0.00201	0.00134	0.00101	0.00067
12" block	139.5	0.00215	0.00108	0.00072	0.00054	0.00036	0.00333	0.00167	0.00111	0.00083	0.00056

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6.C. Masonry Construction

- ***Nonparticipating Elements:***
  - If not intended to resist lateral forces…
  - Must be isolated in their own plane per §7.3.1 of TMS 402-16

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6.C. Masonry Construction

- ***Masonry Veneer:***
  - Height Limitations
    - Wood backing ≤ 30-feet above noncombustible foundation (38-feet at gables)
    - Metal stud backing ≤ 30-feet above noncombustible foundation (Can be supported above this height)

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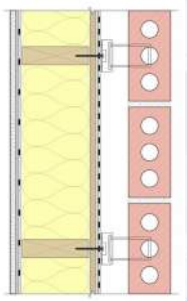
6.C. Masonry Construction

- ***Masonry Veneer:***
  - Attachment Requirements
    - Provide at least one anchor for every 2ft² of wall area
    - Space anchors at max. 32" horizontally and 25" vertically
    - Continuous #9 wire reinforcement at 18"o.c. to which anchors are attached is no longer required.



209

6.D. Steel Construction

- ***Protected Zones:***
  - Areas of expected yielding
  - Fabrication discontinuities are repaired
  - Detrimental attachments are not permitted
  - ***AISC 341-16*** requires drawings to show protected zones for…
    - Special Steel Moment Frames
    - Intermediate Steel Moment Frames
    - Special Concentrically Braced Frames
    - Eccentrically Braced Frames
    - Buckling Restrained Braced Frames

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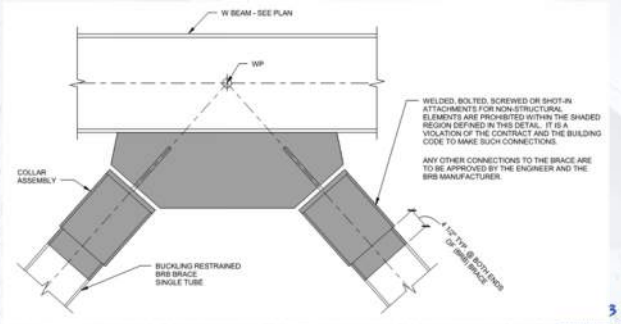
6.D. Steel Construction



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6.D. Steel Construction

- ***Demand Critical Welds:***
  - These are welds that…
    - Are subject to yield-level stresses, and…
    - Could cause catastrophic results if they fail
  - AISC 341 requires that drawings show the demand critical welds for…
    - Special Steel Moment Frames
    - Intermediate Steel Moment Frames
    - Special Concentrically Braced Frames
    - Eccentrically Braced Frames
    - Column Splices
    - Column Anchorages

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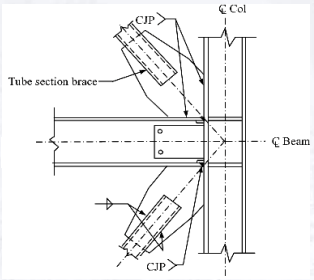
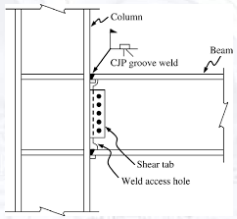
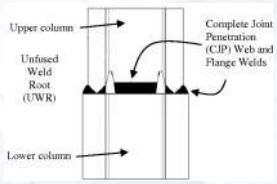
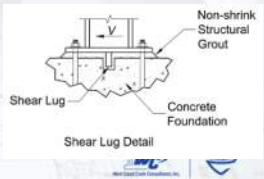
6.D. Steel Construction









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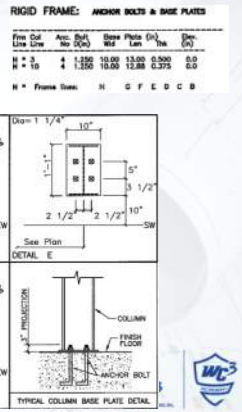
6.D. Steel Construction

- ***Demand Critical Welds:***
  - The plans must clearly identify the following…
    - Weld Filler Metal: CVN of 20ft-lbs at -20°F
    - Ultrasonic testing is required

214

6.D. Steel Construction

- ***Steel Columns:***
  - Bolt embedment
  - Bolt diameter
  - Bolt spacing requirements
  - Non-shrink grout
  - Column-to-plate weld
  - Base plate thickness



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7. Miscellaneous

- Verify that structural drawings are consistent with architectural and MEP.
- Ensure dimensions are provided.
- Verify proper code references.
- Verify each sheet bears the seal of an appropriate design professional.
- Do structural irregularities exist?

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Sample Comments

General Notes #1:
Please list all deferred submittal items on the cover sheet and note that they are to be reviewed by the Design Professional in Responsible Charge and that they are not to be installed until approval has been obtained from the building official in accordance with IBC 107.3.4.1.

General Notes #2:
The "special inspection" portion of sheet S001 does not meet the requirements for a "Statement of Special Inspections" as required by IBC 1704.3. All elements requiring special inspection must be noted, the extent of the inspection and testing listed, and the frequency (e.g. continuous or periodic) specified.

General Notes #3:
Please provide the material strength and specific construction requirements for the various construction materials. As an example, the block, mortar and grout strengths should be provided within the masonry notes.

Sample Comments

General Notes #4:
Please add a note to the plans stating that all fasteners (i.e. nails, screws, anchor bolts, etc.) which are to be installed in preservative treated wood (i.e., sill plates) shall meet the requirements of IBC 2304.10.5.

Foundation Plan:
No details or notes are provided for endwall blocking at the floor joists which run parallel to the foundation walls. Please provide a detail showing the blocking requirements as required by Section 12.11.2.2 of ASCE 7-16.

Roof Framing Plans:
Sheet SF103: The calculated snow drift loads are not shown at the roof. Per IBC 2207.2 these loads should be shown for the fabricator to consider in the final design of the roof joists. Please address.

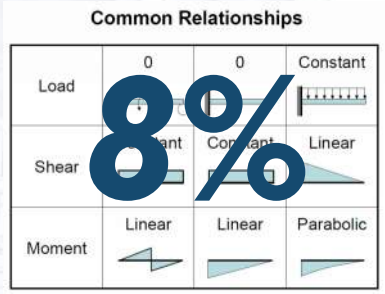
Sample Comments

Wood Shrinkage:
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.

Column Ties:
Please review the lateral tie requirements shown in detail _____. Vertical bars should be tied in such a fashion as to ensure the maximum distance between laterally tied bars is less than or equal to 6-inches (see Section 7.10.5.3 of ACI 318).

Protected Zones:
Per IBC 2205.2.2, structural steel structures located within high seismic regions shall be designed and detailed in accordance with AISC 341. AISC 314 requires that drawings define and show protected zones. Protected zone requirements could not be found on the plans. Please address.

PART F
Structural Calculations



Calculations (8%)

1. Proper Code References
2. Wind Design
3. Seismic Design
4. Flood Design
5. Snow Loads
6. Do Calculations Match Plans?

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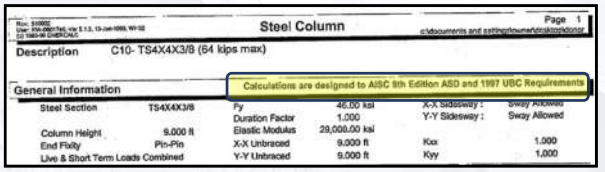
1. Proper References



Steel Column

Description C10- TS4X4X3/8 (64 kips max)

General Information — Calculations are designed to AISC 9th Edition ASD and 1997 UBC Requirements

Steel Section	TS4X4X3/8	Fy	46.00 ksi	X-X Sidesway :	Sway Allowed
		Duration Factor	1.000	Y-Y Sidesway :	Sway Allowed
Column Height	9.000 ft	Elastic Modulus	29,000.00 ksi		
End Fixity	Pin-Pin	X-X Unbraced	9.000 ft	Kxx	1.000
Live & Short Term Loads Combined		Y-Y Unbraced	9.000 ft	Kyy	1.000

Structural Calculation Note #1:
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.

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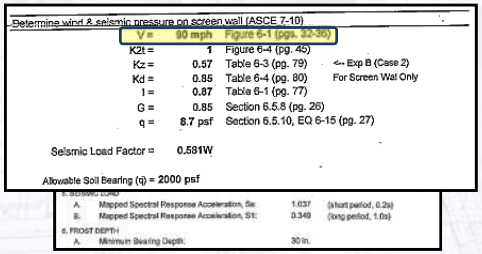
2. Wind Design

We already checked this as part of the "Hazard Review" and when checking the design criteria on the structural general notes.



Determine wind & seismic pressure on screen wall (ASCE 7-10)

V =	90 mph	Figure 6-1 (pgs. 32-36)
Kzt =	1	Figure 6-4 (pg. 45)
Kz =	0.57	Table 6-3 (pg. 79) <-- Exp B (Case 2)
Kd =	0.85	Table 6-4 (pg. 80) For Screen Wal Only
I =	0.87	Table 6-1 (pg. 77)
G =	0.85	Section 6.5.8 (pg. 26)
q =	8.7 psf	Section 6.5.10, EQ 6-15 (pg. 27)

Seismic Load Factor = 0.581W

Allowable Soil Bearing (q) = 2000 psf

A.	Mapped Spectral Response Acceleration, Ss:	1.037	(short period, 0.2s)
B.	Mapped Spectral Response Acceleration, S1:	0.349	(long period, 1.0s)

6. FROST DEPTH

A.	Minimum Bearing Depth:	30 in.

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3. Seismic Design

- We already checked this as part of the "Hazard Review" and when checking the design criteria on the structural general notes.
- Verify that the appropriate S_{DS} and SDC are used in the lateral calculations.

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4. Flood Design

- ❑ We already checked this as part of the "Hazard Review" and when checking the design criteria on the structural general notes.
- ❑ If within a flood hazard area, flood hazard documentation must be provided per IBC 1612.4.

Flood Emergency Management Agency (FEMA), Standard Flood Hazard Determination Form

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5. Snow Loads

- ❑ Verify that drift and sliding snow calculations have been provided.
- ❑ Perform a spot check that they match the loads shown on the plans.
- ❑ Overhangs shall be capable of supporting Ice Dams along the eaves. (2*Pf)

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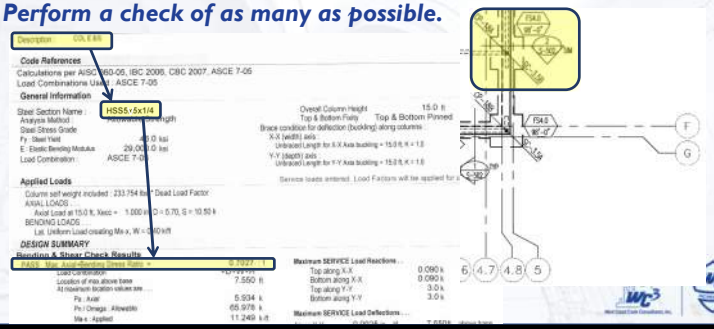
6. Do They Match Plans

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



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PART G
Specifications

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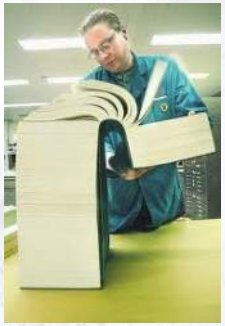
Specifications (2%)

- ❑ Do they comply with the structural plans, structural calculations, and geotechnical report?



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Summary

- ❑ Simplified approach for small to moderate projects.
- ❑ Are complete load paths provided?
- ❑ Are appropriate dead & live loads considered?
- ❑ Is the design criteria correct?
- ❑ Are there any local hazards to consider?
- ❑ Is the current code and standard being used?
- ❑ Are all elements considered & specified?

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Any Questions?

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