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Self-Certification Training – Structural Basics

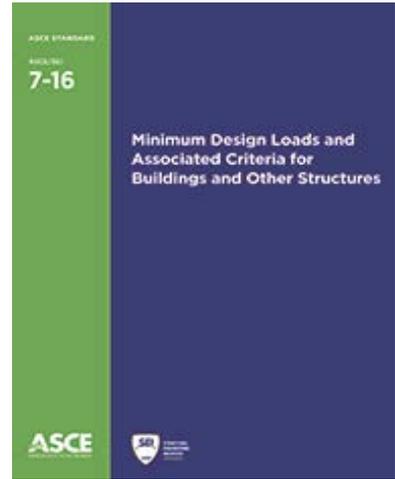
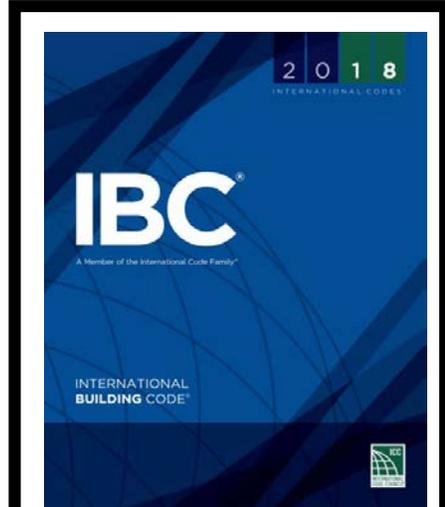
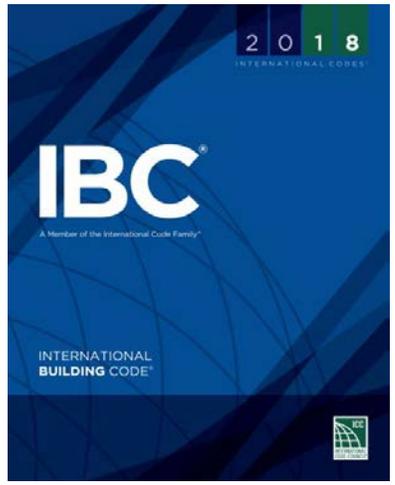
**John-Jozef “JJ” Proczka
Structural Plans Engineer**

Structural Codes



Admin → Load
and Scope

Material Specific Resistance



We will only be covering admin and loading items in this presentation

Complete Construction Documents



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Structural Drawings

- ✓ General Structural Notes
- ✓ Foundation Plan
- ✓ Floor Framing Plan
- ✓ Roof Framing Plan
- ✓ Structural Details

Supporting Documents

- ✓ Structural Calculations
- ✓ Geotechnical Report
- ✓ Geotechnical Special Inspection Certificate
- ✓ Structural Special Inspection Certificate
- ✓ Structural Observation Certificate

General Structural Notes Contents



- Building Code
- Design Live Loads
- Roof Rain Intensity
- Wind Design Data
- Earthquake Design Data
- Geotechnical Report Number and Date
- Soil Bearing Values
- Statement of special inspections
- Structural Observations
- Deferred Submittals
- Material Specifications
- **Make sure the notes actually apply to this project**

Frequently Confused Structural Options



Deferred Designs

- Identified before a permit is issued, but
- Performed and submitted after a permit is issued

Delegated Designs

- Performed and submitted before a permit is issued

Deferred Designs



LIMITED ITEMS CAN BE DEFERRED

- See the Phoenix deferred submittal policy document

https://www.phoenix.gov/pddsite/Documents/TRT/dsd_trt_pdf_00469.pdf

Do not defer:

- Stairs
- Guards (Guardrails)
- Structural Connections

Deferred Designs



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The construction permit drawings should:

- Identify all deferred design items,
- Show deferred items on the plans and in the details,
- Specify the design loads for the deferred items,
- Lay out the deferred items within the construction,
- Detail the supports for the deferred items.

Each deferred submittal is required to be reviewed and approved by the design team before they get to the field for construction (or to the office for an office review).

Delegated Designs

Any portion of the structural design may be delegated to another qualified licensed engineer by the engineer of record.

-----HOWEVER-----

The complete delegated design drawings shall be included as an integral part of the construction documents.



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Delegated Designs



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The engineer of record is responsible for each delegated design, and shall provide:

- The design loads required for the delegated design,
- The design for the supports of the delegated design,
- The review and coordination of the delegated design.

Delegated Design drawings need to be regular design drawings and are not shop drawings!

Pre-Engineered Metal Buildings and Precast Concrete



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Pre-Engineered Metal Buildings and Precast Concrete Structures are an example of a DELEGATED DESIGN

Check:

- Are the drawings sealed with an ARIZONA seal?
- Are the drawings labelled “FOR CONSTRUCTION”?
- Do the drawings appear complete? Notes, Plans, Details
- Do the drawings look like this project?

Post-Tensioned Concrete Slab



Post-Tensioned Concrete Slabs may be a DELEGATED DESIGN

- PT Slabs are typically designed by the E.O.R. using standard design procedures and typical material parameters
- The construction drawings show the tendon layout and specify the design assumptions and material parameters used.
- Contractor submits sealed adjusted tendon placement drawings and calculations to E.O.R., using specific, tested, tendon properties, to meet the original E.O.R. design.



Coordination

- Check the architectural drawings for compatibility with the structural drawings

Common Load Issues



Live Loads:

- Too low in assembly areas and corridors that serve them. IBC Table 1607.1.
- Live loads over 50 psf are posted in a conspicuous location. IBC 106.1

Dead Loads:

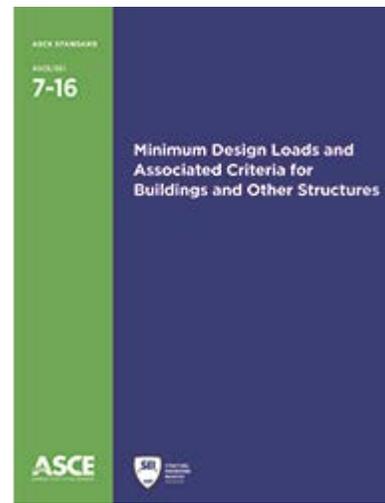
- Not coordinated with actual finishes and construction shown on architectural drawings.
 - Frequent mismatch between roof covering and number of layers of gypsum wallboard.

Wind Loads:

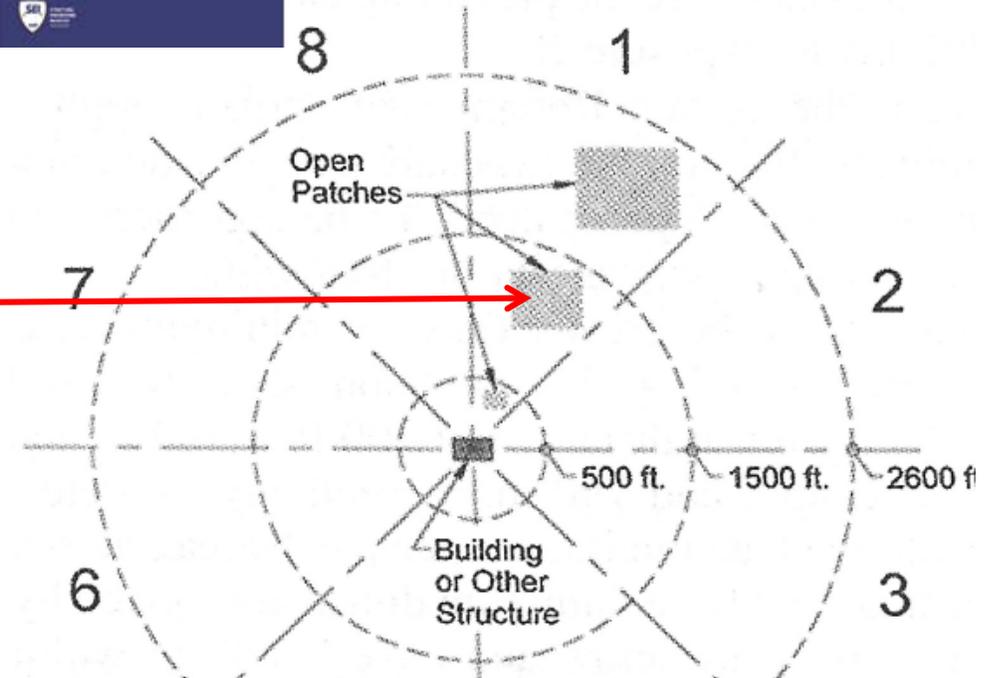
- Exposure Category B chosen arbitrarily over Exposure Category C resulting in approximately 30% missing wind load.
- Missing parapet and overhang wind loads

Wind Exposure Category

- Frequently misunderstood and misapplied
- Result of confusion is Exposure Category B being used in inappropriate locations, resulting in less safe buildings.
- What ASCE 7 says:
 - For each wind direction the exposure *Surface Roughness* is to be determined by the worst case 45° sector.
 - What?
 - Surface Roughness* describes one area.
 - Exposure Category describes the result of all of the *Surface Roughness* areas in the two quadrants over the required distance from the structure.
 - Many areas of Phoenix that are not developed are *Surface Roughness C*.
- Where Exposure Category B is used it is best to perform an analysis of the percentages of open spaces to confirm.



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North direction Exposure Category is determined by worst case of quadrants 8 and 1

Wind Exposure Category Cont.



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Surface Roughness B: Urban and suburban areas with numerous, closely spaced obstructions that have the size of single-family dwellings or larger

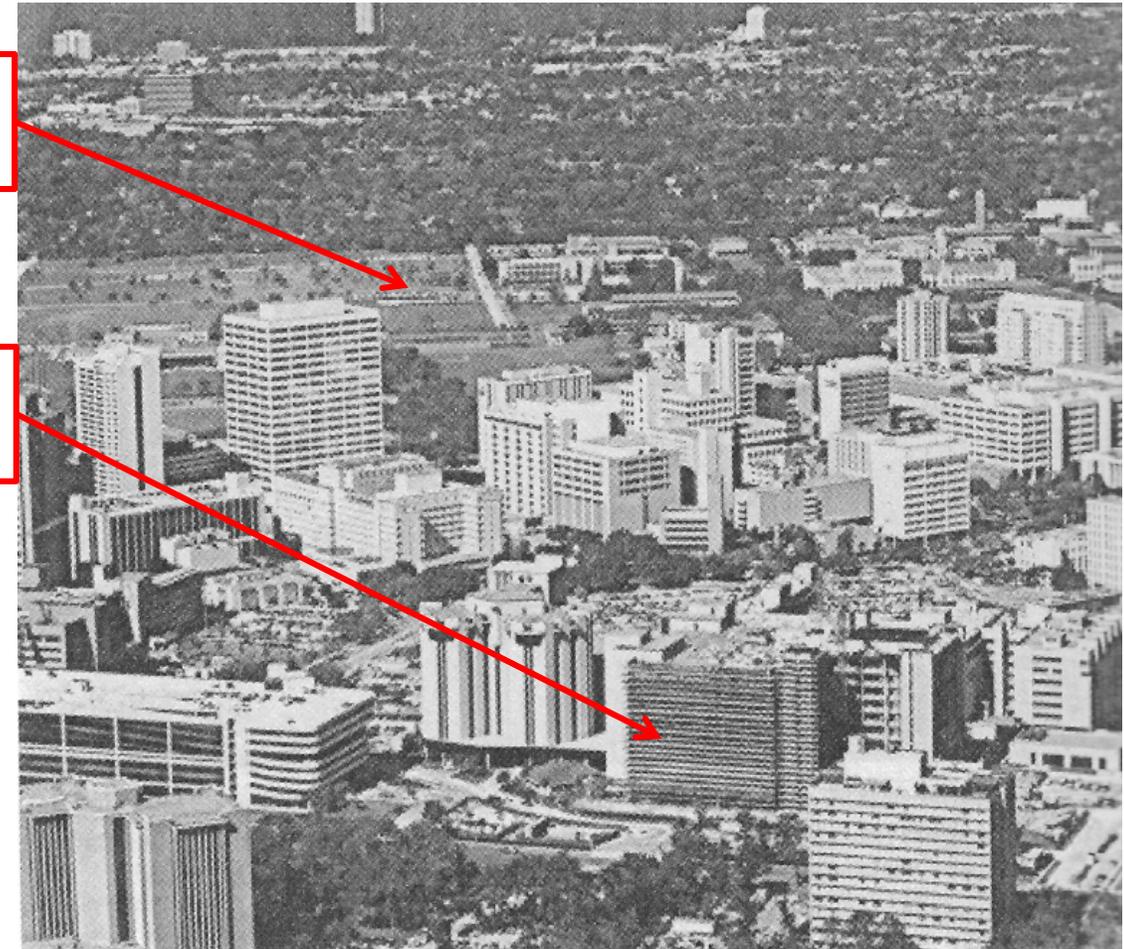


Roughness
C

Surface Roughness C:
Open terrain with scattered obstructions that have heights generally less than 30 feet.



Roughness
B



Wind Exposure Category Cont.



Phoenix is *Surface Roughness C* where not developed!



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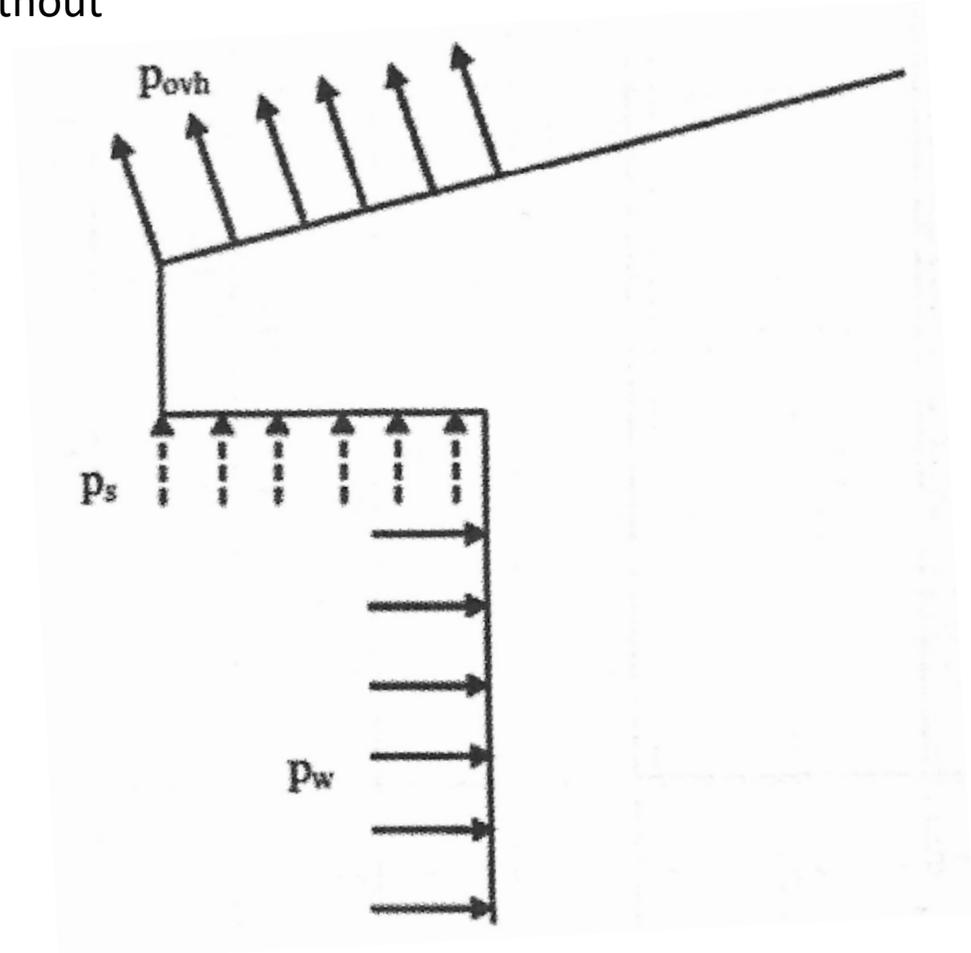
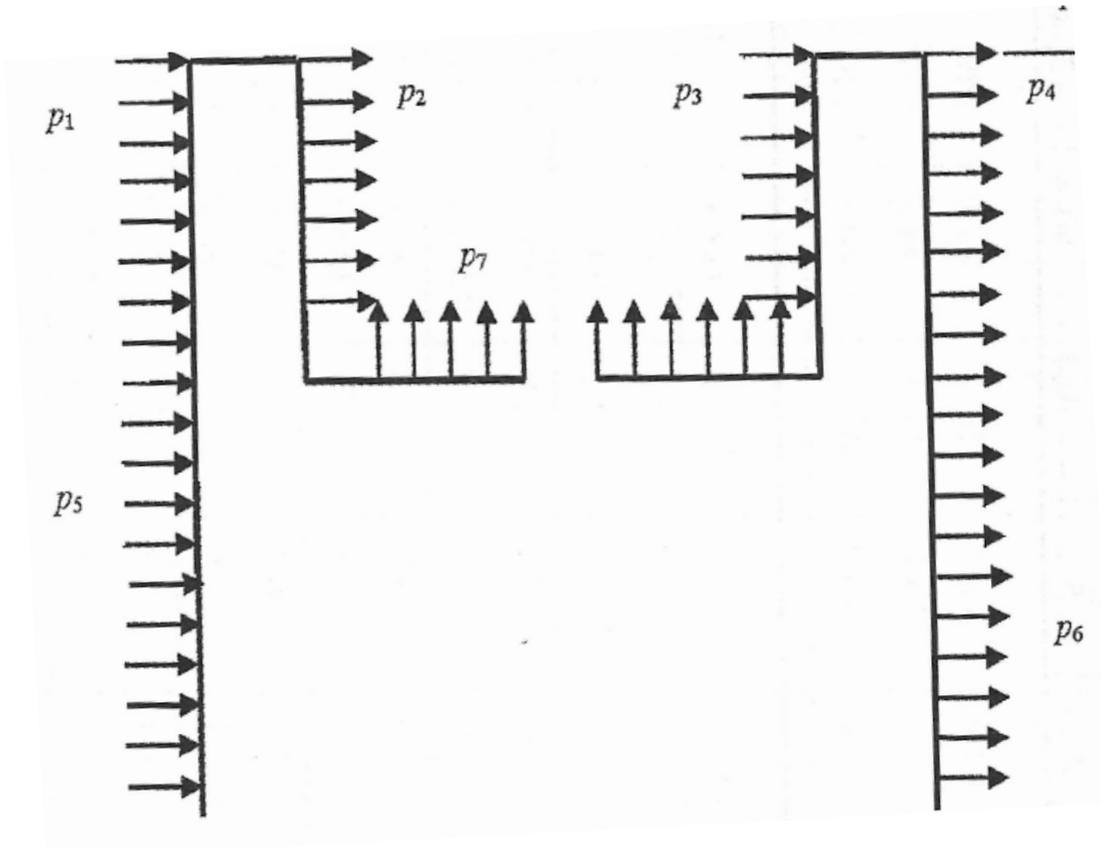


Wind on Parapets and Overhangs



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- Parapets and overhangs have high wind loads as the wind pushes on one side while it pulls on the other side.
- Buildings with parapets have much higher wind load than those without



Common Load Issues Continued



Earthquake Loads:

- Soil site class C chosen arbitrarily resulting in approximately 20% missing earthquake load
 - Sometimes dramatically large missing load if resulting Seismic Design Category is A instead of correctly B.
- Structure separation for earthquake pounding is not provided

Rain Loads:

- Rain ponding potential ignored or incorrectly checked only with strength and not stiffness.
 - ASCE 7-16 updated its definitions of susceptible bays to clarify where its required to check.
 - From 2007 to 2017 rain load building damage losses in Texas and Arizona were nearly equal to snow load losses in New England

Earthquake Building Pounding



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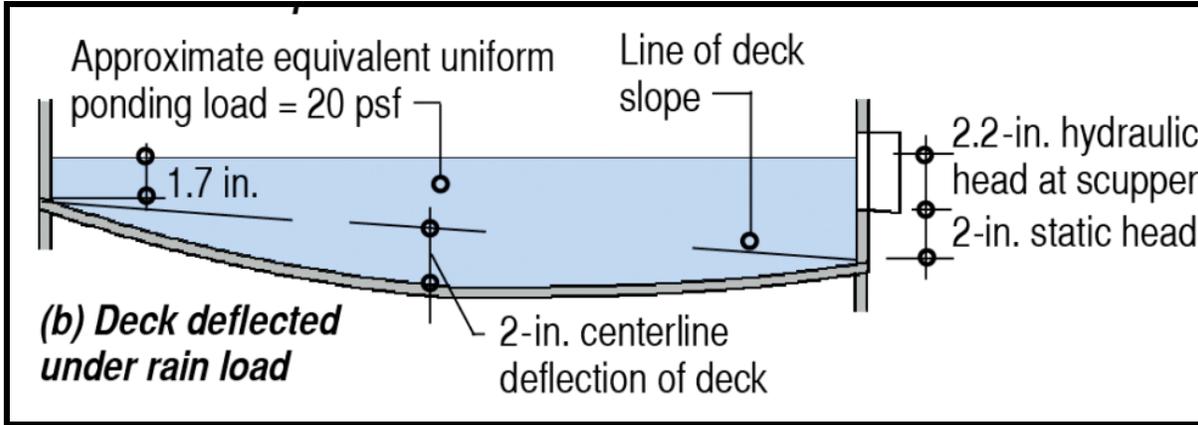
- Building pounding occurs when two adjacent buildings collide.
- Earthquakes cause pounding when adjacent buildings have little or no separation.
- Can be extremely severe if impact takes place between floor levels
- Phoenix is lucky that its earthquake chances and motion are low, but they are not zero
- Only way to design for pounding is with separation.



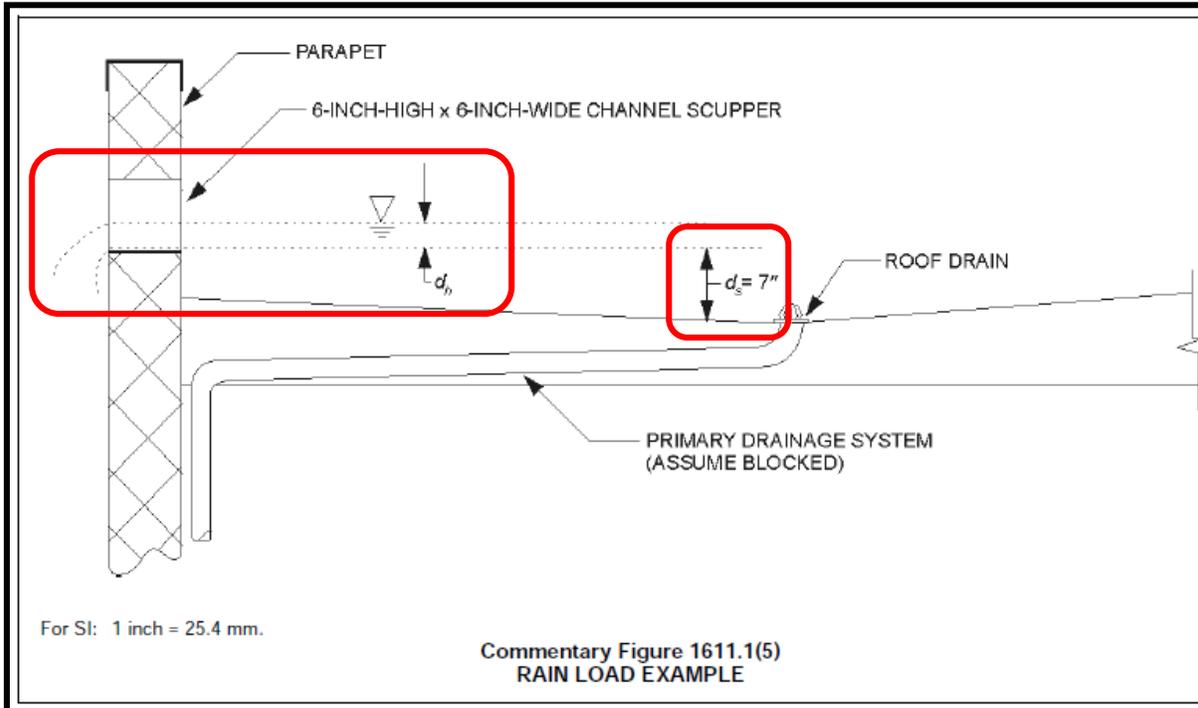
Roof Rain Load and Ponding



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- Rain causes mild pond
- Roof deflects
- More water ponds
- Roof deflections more
- Continues until failure or equilibrium from stiffness



For SI: 1 inch = 25.4 mm.

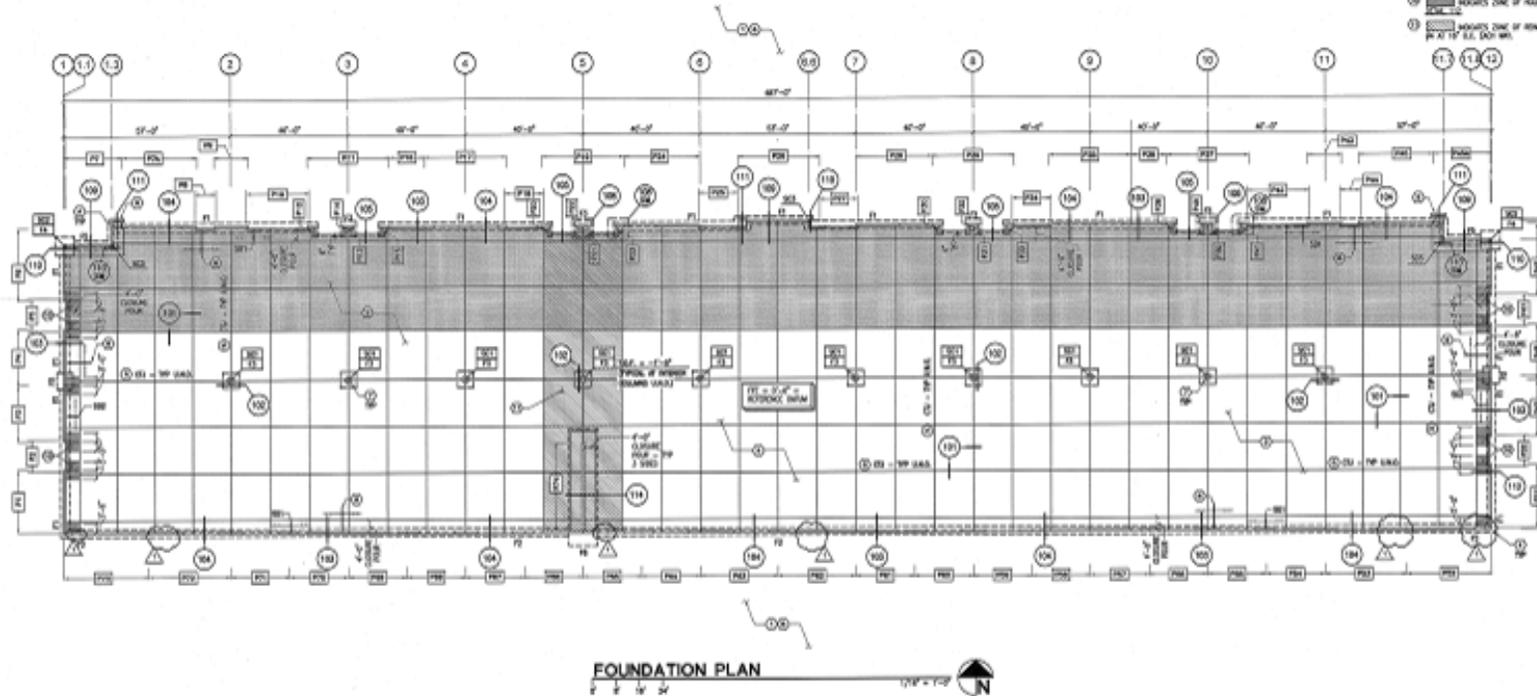
Commentary Figure 1611.1(5)
 RAIN LOAD EXAMPLE



Foundation Plan



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- FOUNDATION PLAN A**
- 1. SEE FOUNDATION REPORT FOR ALL DETAILS OF FOUNDATION REQUIREMENTS.
 - 2. ADVANCE OUR SHOP DRAWINGS TO THE ARCHITECT FOR REVIEW AND APPROVAL.
 - 3. SEE FOUNDATION REPORT FOR TYPICAL FOUNDATION REQUIREMENTS.
 - 4. ALL HORIZONTAL REINFORCEMENT IS TO BE CONFORMING BARS AS SHOWN ON THE FOUNDATION REPORT.
 - 5. ALL REINFORCEMENT SHALL BE CONFORMING BARS AS SHOWN ON THE FOUNDATION REPORT.
 - 6. ALL REINFORCEMENT SHALL BE CONFORMING BARS AS SHOWN ON THE FOUNDATION REPORT.
 - 7. ALL REINFORCEMENT SHALL BE CONFORMING BARS AS SHOWN ON THE FOUNDATION REPORT.
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 - 11. ALL REINFORCEMENT SHALL BE CONFORMING BARS AS SHOWN ON THE FOUNDATION REPORT.
 - 12. ALL REINFORCEMENT SHALL BE CONFORMING BARS AS SHOWN ON THE FOUNDATION REPORT.

FOUNDATION PLAN
 1/4" = 1'-0"

FOUNDATION SCHEDULES

FOOTING (F) SCHEDULE

NO.	SECTION	FOOTING REINFORCEMENT	REMARKS
F1	2'-0" x 2'-0"	1 #4 @ 12" O.C.	SEE SHEET 1
F2	2'-0" x 2'-0"	1 #4 @ 12" O.C.	---
F3	2'-0" x 2'-0"	1 #4 @ 12" O.C.	---
F4	2'-0" x 2'-0"	1 #4 @ 12" O.C.	---
F5	2'-0" x 2'-0"	1 #4 @ 12" O.C.	---
F6	2'-0" x 2'-0"	1 #4 @ 12" O.C.	---

STEEL COLUMN (SC) SCHEDULE

NO.	TYPE AND SIZE	SECTION	REMARKS
SC1	12" x 12" x 1/2"	12" x 12" x 1/2"	---
SC2	12" x 12" x 1/2"	12" x 12" x 1/2"	---
SC3	12" x 12" x 1/2"	12" x 12" x 1/2"	---

SLAB DOWEL (SD) SCHEDULE

NO.	TYPE AND SIZE	SECTION	REMARKS
SD1	1/2" x 1/2"	1/2" x 1/2"	---
SD2	1/2" x 1/2"	1/2" x 1/2"	---
SD3	1/2" x 1/2"	1/2" x 1/2"	---

FOUNDATION DEPTH (N) SCHEDULE

NO.	SECTION	FOUNDATION DEPTH	REMARKS
N1	1/2" x 1/2"	1/2" x 1/2"	---
N2	1/2" x 1/2"	1/2" x 1/2"	---
N3	1/2" x 1/2"	1/2" x 1/2"	---

Contents:

- Foundation sizes
- Rebar size and spacing
- Column sizes
- Wall sizes
- Shear Walls / Braced Frames / Moment Frames Identified
- Cut Details

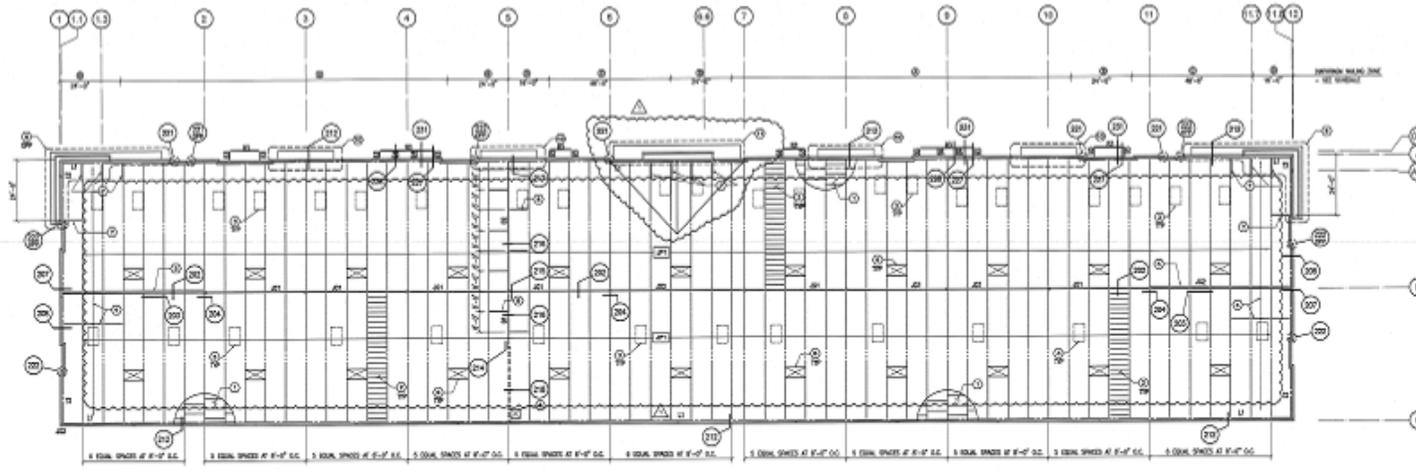
Roof Framing Plan



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FRAMING PLAN NOTES:

- 1. 1/2" THICK ROOF SHEETING SHALL BE USED AND MANUFACTURED BY JOHNSON, SEE SECTION 05 11 00 FOR GENERAL SPECIFICATIONS.
- 2. 2x6 RAFTERS TO BE SPACED AT 24" O.C. WITH SPACED JOISTS (DIMENSIONS SHOWN) AT EACH END - TYPICAL THROUGHOUT THIS AREA.
- 3. JOISTS FOR ALL MECHANICAL, ELEC. AND TEL. ARE NOT TO BE MANUFACTURED BY JOHNSON. 2x10-1000-SPACED AND JOIST BRIMS, TYPICAL, JOISTS SHALL BE SPACED PER TYPICAL DETAILS TO SUPPORT FLOOR WORKING. USE BOLD.
- 4. ROOF OF 2x6 OR 2x8 SPACED AND JOISTS PER SECTION 05 11 00. SEE 2x6 RAFTERS PER THIS AREA - TYPICAL IF NOT SHOWN.
- 5. PROVIDE 2x8 BRIMS IN ROW OF JOIST BRIMS WITH JOIST JOIST BRIMS AT END END OF BRIMS. WITH BRIMS - SEE SECTION 05 11 00 FOR GENERAL SPECIFICATIONS.
- 6. CHECK FOR INTERFERENCES WITH OR ADJACENT TO USE. EXCEPT EXISTING WORK COVERED WITH APPROXIMATE DIMENSIONS. SEE SECTION 05 11 00 FOR FRAME AS SHOWN.
- 7. STEEL PURLIN BRIMS PER SECTION 05 11 00.
- 8. STEEL JOIST BRIMS AT 4'-0" O.C. ALTERNATE BRIMS PER SECTION 05 11 00.
- 9. SEE 1 ON SHEET 032 FOR ENLARGED CHORDY FRAMING THIS AREA.
- 10. SEE 2 ON SHEET 032 FOR ENLARGED CHORDY FRAMING THIS AREA.
- 11. SEE 3 ON SHEET 032 FOR ENLARGED CHORDY FRAMING THIS AREA.



ROOF FRAMING PLAN

FRAMING SCHEDULES

JOIST GRIDER (JG) SCHEDULE					
MARK	SPACING	DEPTH	MANUFACTURER	NO. CONNECTIONS	REMARKS
JG1	24"	11.5"	---	---	SEE SECTION 05 11 00
JG2	24"	11.5"	---	---	SEE SECTION 05 11 00
JG3	24"	11.5"	---	---	SEE SECTION 05 11 00

JOIST PURLIN (JP) SCHEDULE					
MARK	SPACING	DEPTH	MANUFACTURER	NO. CONNECTIONS	REMARKS
JP1	24"	11.5"	---	---	SEE SECTION 05 11 00

ROOF DIAPHRAGM NAILING SCHEDULE					
MARK	DIAPHRAGM TYPE	DIAPHRAGM SIZE	DIAPHRAGM POSITION	DIAPHRAGM ORIENTATION	REMARKS
D1	---	---	---	---	---

LEDGER (L) SCHEDULE					
MARK	DEPTH	SPACING	MANUFACTURER	NO. CONNECTIONS	REMARKS
L1	---	---	---	---	---

STEEL BEAM (SB) SCHEDULE					
MARK	BEAM SIZE	SPACING	MANUFACTURER	NO. CONNECTIONS	REMARKS
SB1	---	---	---	---	---

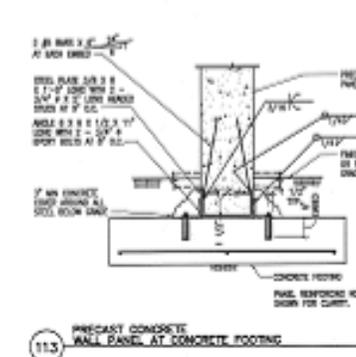
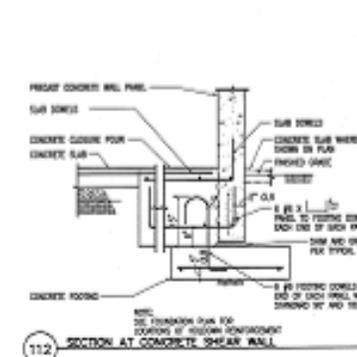
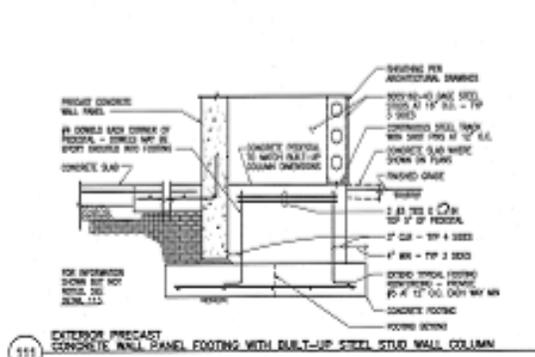
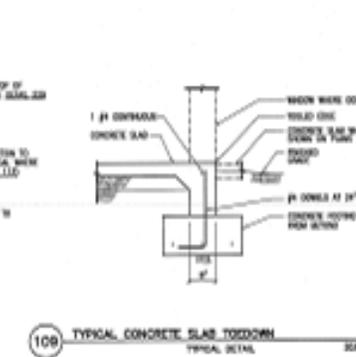
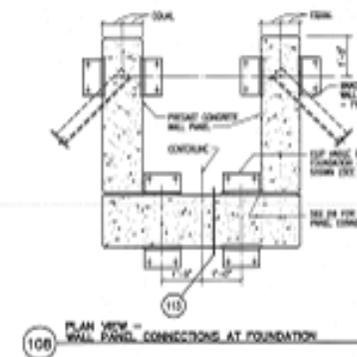
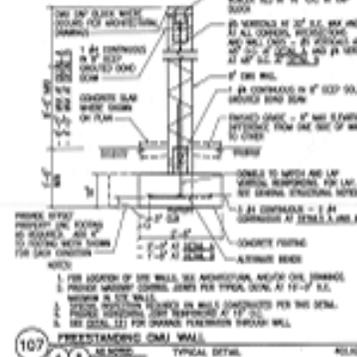
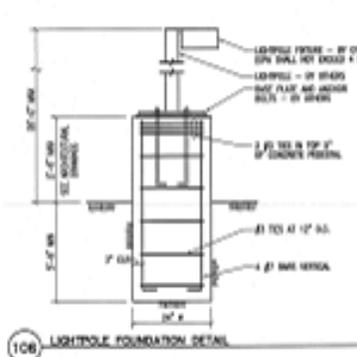
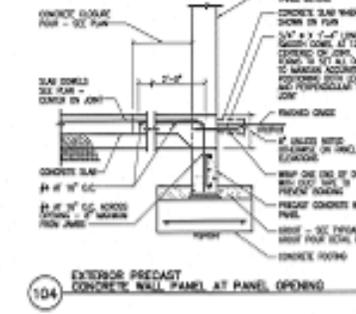
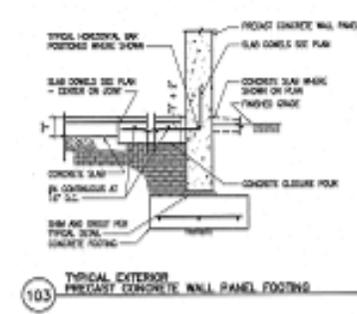
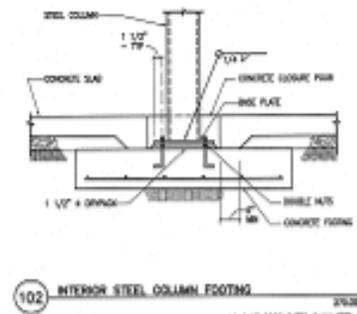
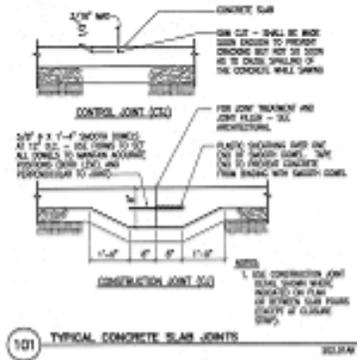
Check Contents:

- Rooftop Unit Weights are shown
- Repetitive framing sizes
- Beam sizes
- Diaphragm collectors
- Diaphragm chords
- Roofs with parapets have roof drains

Details



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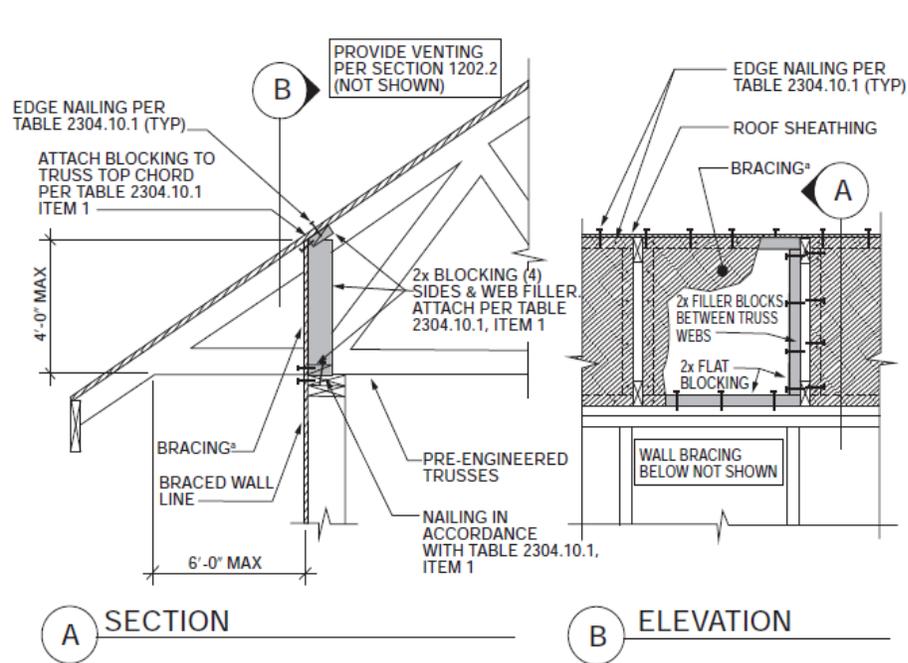
Check Contents:

- Beam to column connections
- Repetitive framing to beam connections
- Repetitive framing to wall connections
- Foundation to column connections
- Foundation to wall connections
- Window and Door opening details
- Diaphragm to shear wall connections
- Shear wall chords and holdowns
- Diaphragm continuity at corridors

Lateral Load Detailing



- Loads in the roof and floor diaphragms have a path to reach the shear walls
- Large openings in diaphragms and shear walls have reinforcement



a. Methods of bracing shall be as described in Table 2308.6.3(1) DWB, WSP, SFB, GB, PBS, PCP or HPS.

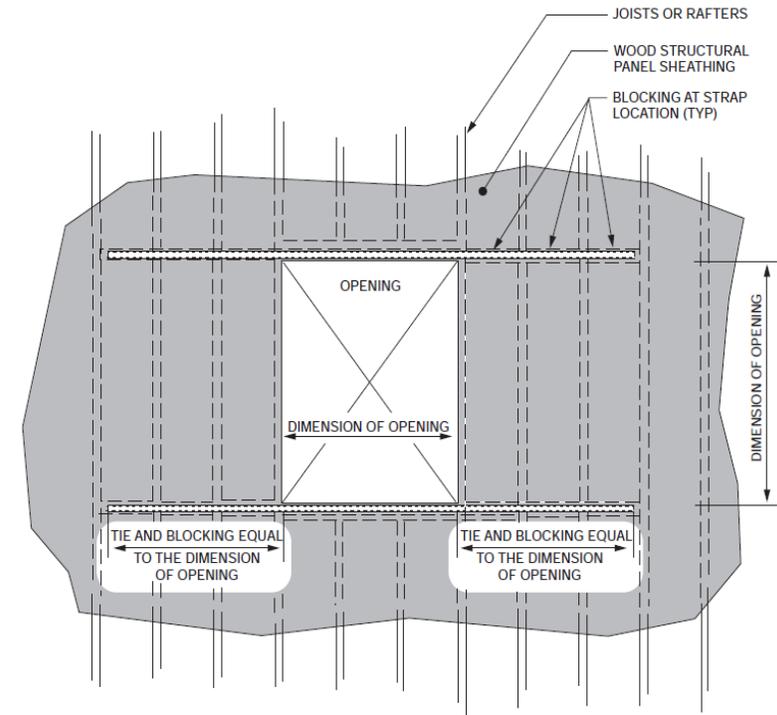


FIGURE 2308.4.4.1(1)
OPENINGS IN FLOOR AND ROOF DIAPHRAGMS

04.8 mm.

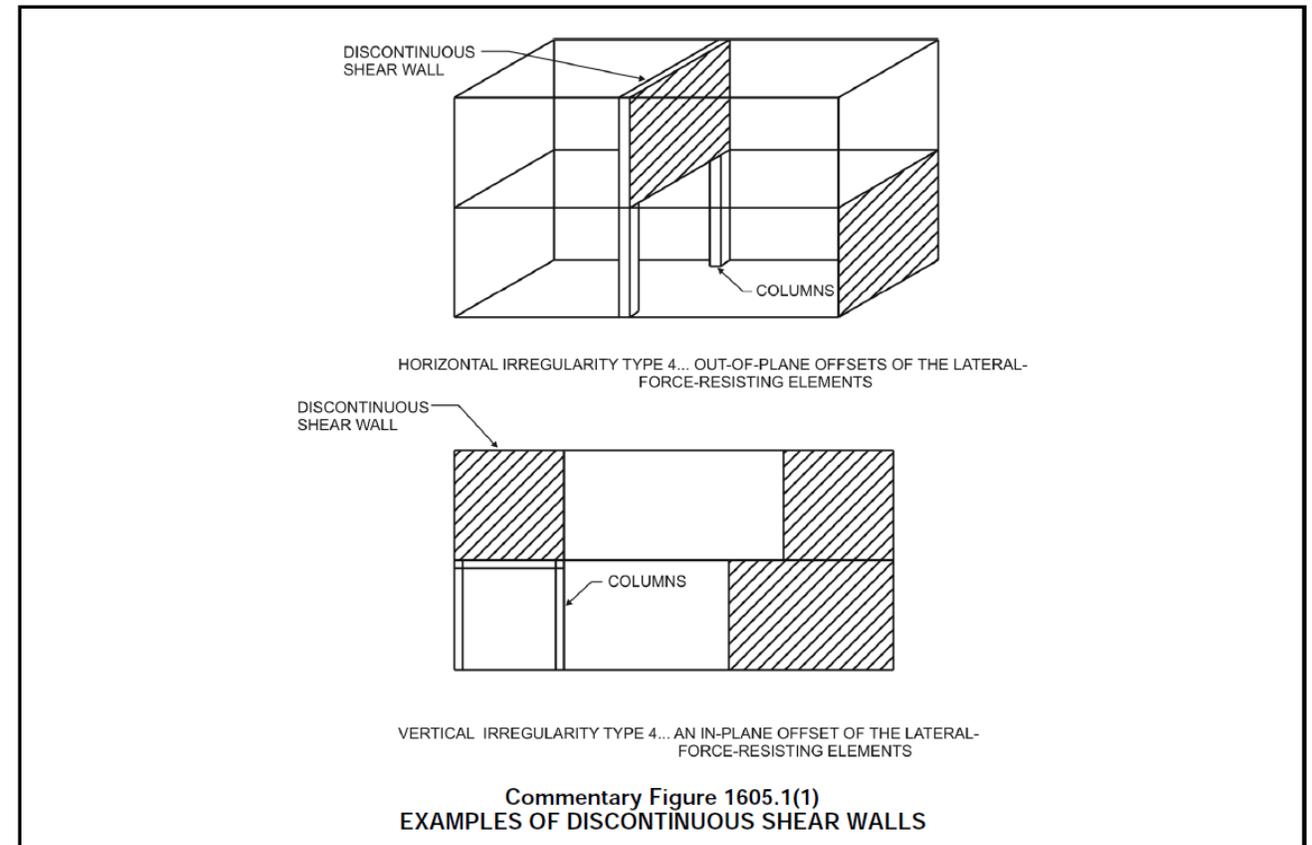
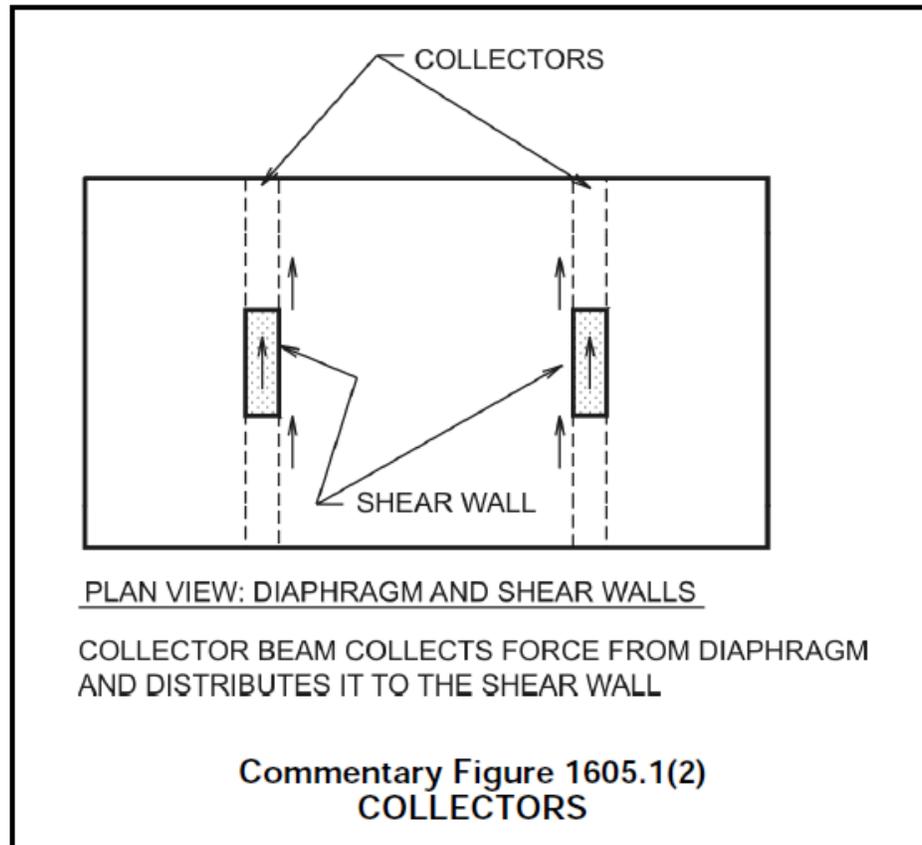
FIGURE 2308.6.7.2(2)
BRACED WALL PANEL TOP PLATE CONNECTION

Lateral Load Detailing



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- Diaphragms have collectors provided so force can reach a shear wall
- Discontinuous shear walls have adequate detailing to transfer forces. This can get very complicated if you offset walls.



Structural Checklist



City of Phoenix
PLANNING AND DEVELOPMENT DEPARTMENT

Plan Review Checklist Structural

STRUCTURAL DRAWINGS

Sealed by either a structural or civil engineer registered in the State of Arizona.

1. IBC 1603 General Structural Notes

- Design Dead Loads.
- Design Live Loads.
- IBC 106.1 and 1607.7.5 Live loads posted. – Storage – light and heavy. Parking Garages 1607.7.5
- Wind Design Data-1603.1.4, ASCE 7-10, Chapter 6 (wind exposure category- type B, parapets, components and cladding).
- IBC 1604.5 – Risk Category.
- Seismic Design Data – 1603.1.5
- Special Loads (if applicable) that are specified by the code.
- IBC 107.3.4.1 Identify all Deferred Submittal Items such as joists, trusses, alternate stairs.
- IBC 1705 Identify all Special Inspection and Structural Observation requirements.
- Material Specifications (fire cover for concrete if applies, fire treated wood if applies, etc.)
- IBC 2304.3.3 Shrinkage specs for wood framing over 3 stories.
- Geotechnical Information, i.e. Soils Class, Allowable Bearing Pressure, Reference to Geotechnical.
- Investigation Report or IBC Table 1806.2, other information pertaining to the design.

2. Foundation Plan

- Indicate shear wall and hold down locations.
- Include separate sheets for "mirrored" plans.
- Footing bearing or top of footing elevations.
- Anchor size and placements.
- PT slabs stamped per IBC 1907.2. Note: This is a PHX amendment.
- Plaza decks adjacent to high-rise buildings designed per IBC 1607.6 **IF REQUIRED.**

3. Floor Framing Plan

- Indicate shear wall and hold down locations.
- Include separate sheets for "mirrored" plans.
- Framing floor layout and sizes.
- Section and detail cuts.
- Stairs and railings when required.

4. Roof Framing Plan

- Framing roof layout and sizes- include loading and reactions for deferred elements per 107.3.4.2.
- Section and detail cuts.
- Mechanical loads shown and designed for per IBC 1607.12.
- Roof slopes match architectural plans – ponding design per IBC 1611.2.
- Drag elements at re-entrant corners and flexible diaphragms designed per ASCE 7-10.
- Parapets are designed and detailed per ASCE 7-10.

5. Wall Framing Information and Details

6. Structural Details

- General structural details, connection details and all cut structural details called out from structural.
- Foundation / framing plans.

Page 1 of 2

This publication can be made available in alternate formats (Braille, large print or digital media) upon request.
Contact Planning & Development at (602) 262-7811 voice or (602) 534-5500 TTY.

S:\Plan Review Checklist, Structural
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Rev. 7/13

City of Phoenix Planning and Development Department Plan Review Checklist, Structural – Page 2 of 2

TRT/DOC/00706

7. Calculations

- One copy of Structural calculations that includes vertical and lateral structural analysis and sealed by the structural engineer of record.
- Computer Calculations shall include design input load summary, output summary and explicit cross references to supplemental calculations as well as the plans.
- Sketched detailed layout of Lateral Force Resistance System members.
- Hand calculations to validate design input loads, output data, connection details, etc. (such as stair and railings).

8. Geotechnical Investigation Report

- Provide one copy of soil report sealed by the geotechnical engineer of record or include site soil classification & allowable bearing and cite the source.

9. Prefabricated Metal Building

- Provide separate manufacturer's construction drawings and calculations that are sealed by the structural engineer of record for the prefabricated metal building.

10. Post-Tension Slab-on-Ground Plans

- Slab/beam geometry; length, width, thickness, overlapping regions based on simplified analysis for complex geometries, thickened sections if used, dimensions of tumdowns.
- Slab type per PTI guide- type I, II, III, or IV.
- Minimum concrete strength at 28 days and minimum concrete strength at jacking.
- Em, Ym, coefficient of subgrade friction, soil subgrade modulus.
- Strand specifications; strand grade and diameter, clearances, drape if used.
- Post tendons' jacking force, assumed losses, anchor set, edge distance to first strand, edge moisture variation. Plans shall graphically show all locations of strand tendons with dimensioned spacing requirements.
- Mild reinforcing associated with stress concentrations (re-entrant corners, etc.)
- Provide the following loading data in Post-Tension Slab-on-Ground calculation: concentrated loads from framing elements; posts and columns, fire places, heavy equipment, etc. and perimeter line loading.
- Plans shall reference the correct vital soil report information for design: the company and their report number, allowable soil bearing capacities and at what depth and any compacted fill requirements in addition to items noted above. All calculations shall be based and coordinated with this soil report.
- Strand elongation.
- Post tension hardware supplier assumptions; i.e., proprietary data from supplier used in analysis assumptions.

11. Remodels and Alterations

- Provide structural evaluation/calculations addressing code compliance.

12. Special Inspections

- One copy of Special Structural Inspection Certificate and Special Geotechnical Inspection Certificate if applicable.

13. Overlapping information with architectural details

- 705 – Fire walls – Structural independence.
- 707 – Shaft walls – 707.7.1 no structural penetrations.
- 704.2, 704.3 – Individual protection of structural members
- 721 – Prescriptive and calculated fire resistance



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https://www.phoenix.gov/pdds/Docs/Documents/TRT/dsd_trt_pdf_00706.pdf

Questions?



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