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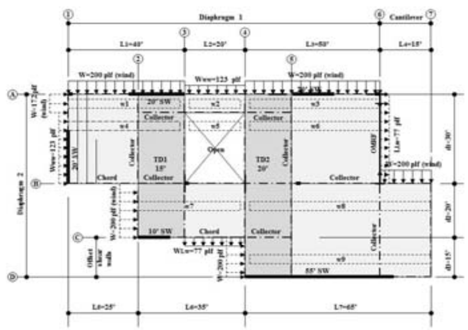
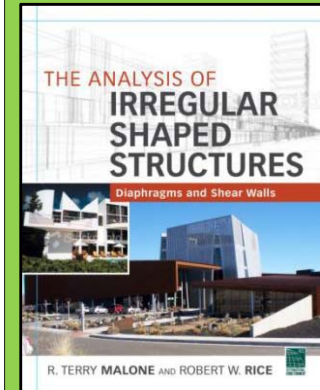
Part 2-Offset Shear Walls



Example-Complex Diaphragm

Excerpts From:



Presentation updated to 2012 IBC, ASCE 7-10

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Course Description

A continuation from Part 1, this session will cover how to conduct a preliminary breakdown of a complex diaphragm to better understand the distribution of forces within the diaphragm and assure that complete load paths are being established. Examples will be provided illustrating how to analyze in-plane and out-of-plane offset shear walls that are typically created by these diaphragms.

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Learning Objectives

- **Segmentation of a Complex Diaphragm**

  Discuss methods of breaking down and analyzing complex diaphragms into manageable segments.

- **In-plane and Out-of-plane Offset Shear Walls**

  Discuss the various types of offset shear wall conditions.

- **Out-of-plane Offset Shear Walls**

  Examine the method of analyzing a diaphragm with offset shear walls with loading in the longitudinal direction.

- **In-plane Offset Shear Walls**

  Examine a two story offset shear wall with varying widths.

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Presentation Assumptions

<u>Flexible</u> wood sheathed or un-topped steel deck diaphragms

The method of analysis is also relevant to internal load path analysis within semi-rigid diaphragms.

- **Loads to diaphragms and shear walls**
  - **Strength level or allowable stress design**
  - **Wind or seismic forces (UNO).**
- **The loads are already factored for the appropriate load combination.**

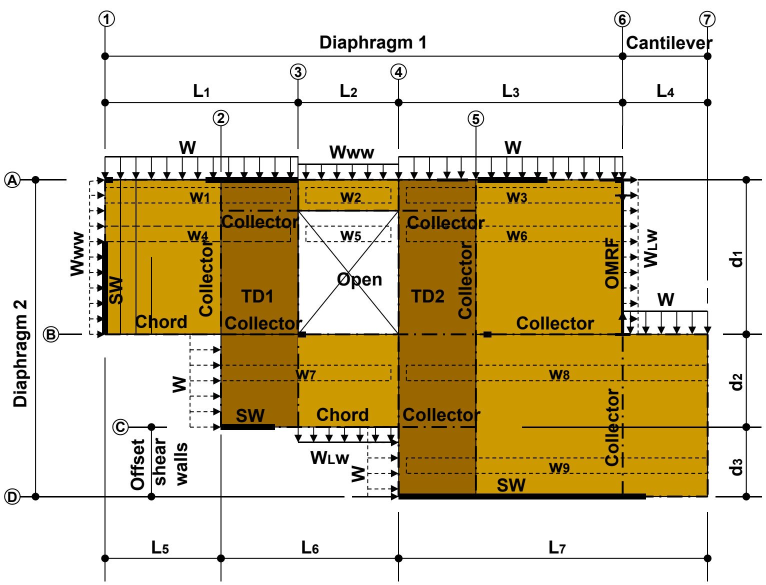
Code References:

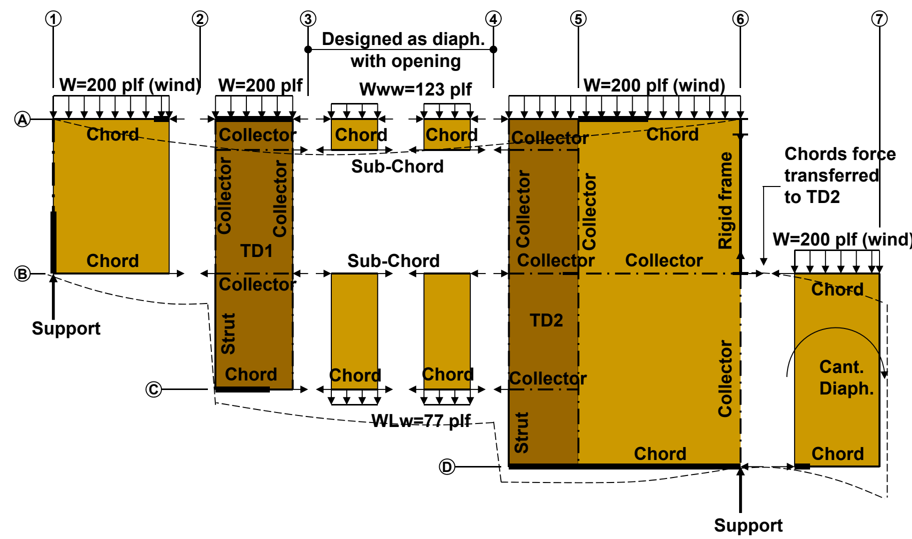
- ASCE 7-10 “Minimum Design Loads for Buildings and Other Structures”
- 2012 IBC

Design references:

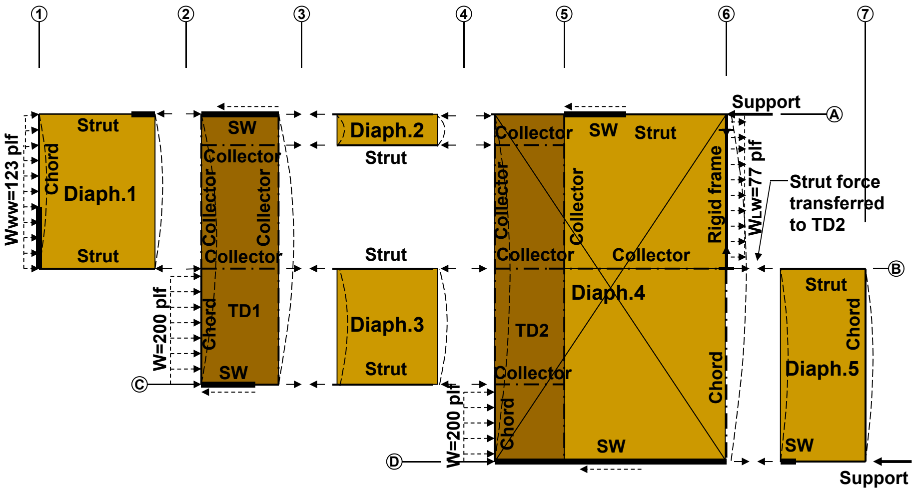
- The Analysis of Irregular Shaped Structures: Diaphragms and Shear Walls- Malone, Rice
- Design of Wood Structures- Breyer, Fridley, Pollock, Cobeen
- SEAOC Seismic Design Manual, Volume 2
- Wood Engineering and Construction Handbook-Faherty, Williamson
- Guide to the Design of Diaphragms, Chords and Collectors-NCSEA, Mays

A Quick Note on Segmenting and analyzing Complex Diaphragms-Ch.8

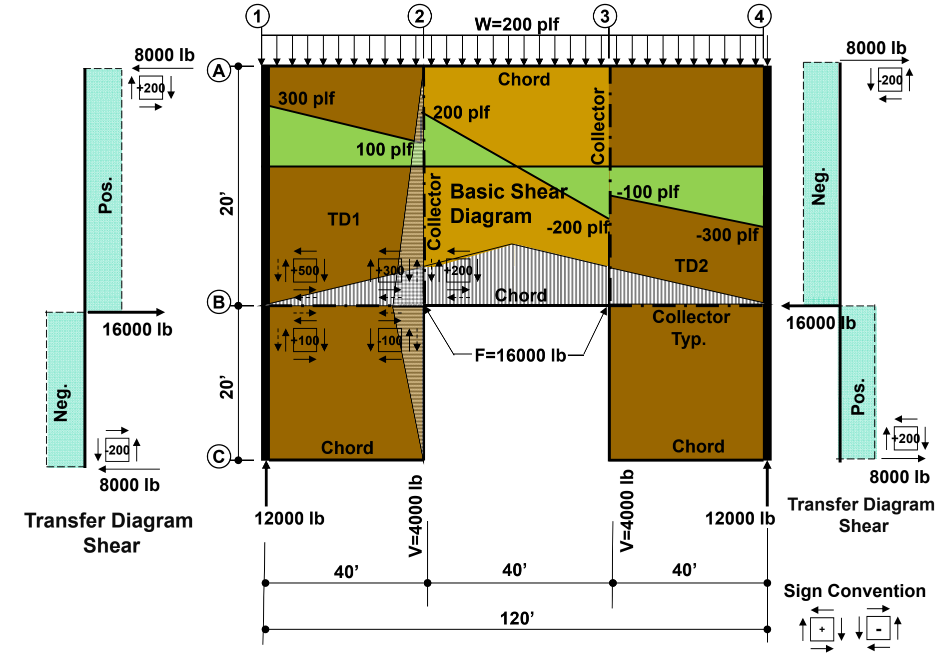




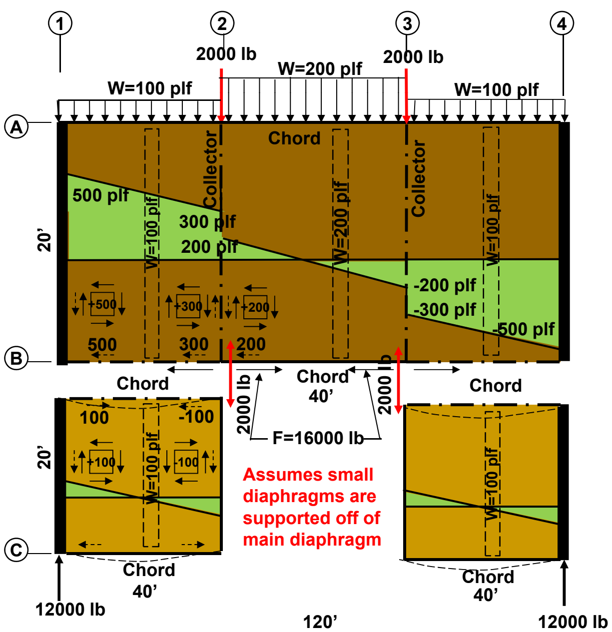
Segmentation of the Diaphragm for Transverse Loading



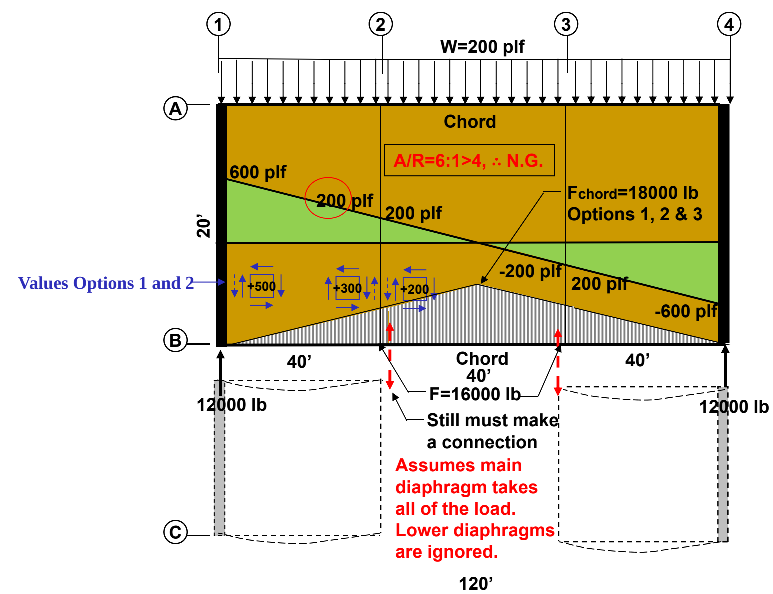
Segmentation of the Diaphragm for Longitudinal Loading



Analysis Option 1-Analyze as Diaphragm with Intermediate offset

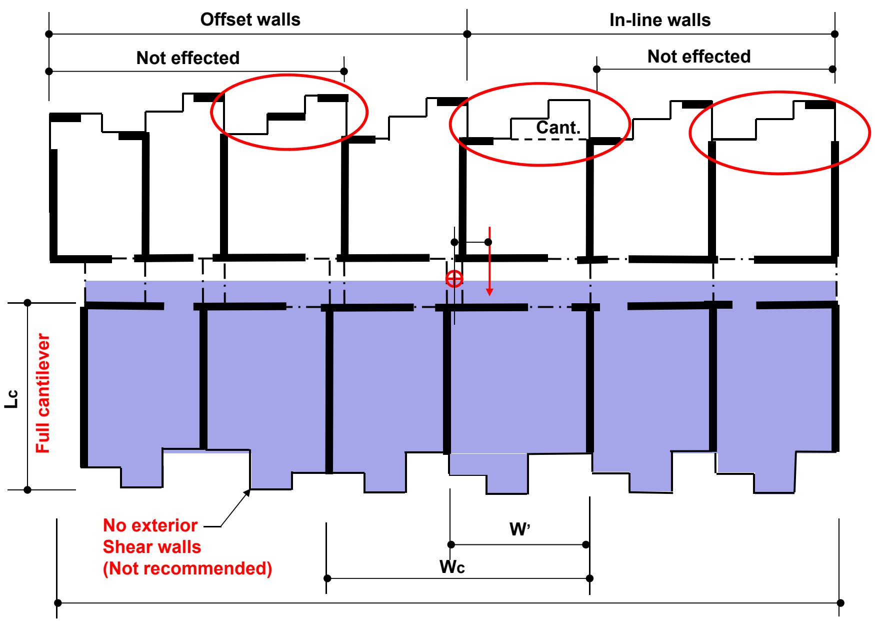


Analysis Option 2-Analyzing as separate diaphragms

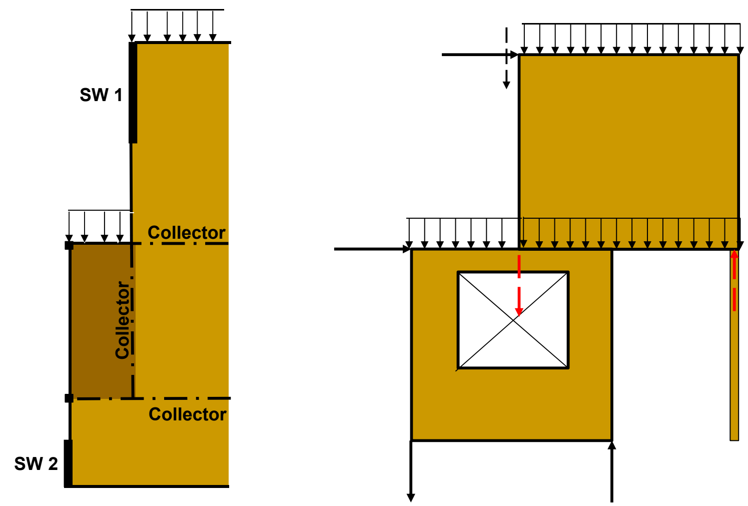


Analysis Option 3-Ignoring lower diaphragm sections

Transverse Loading Semi-Rigid



Offset Shear Walls

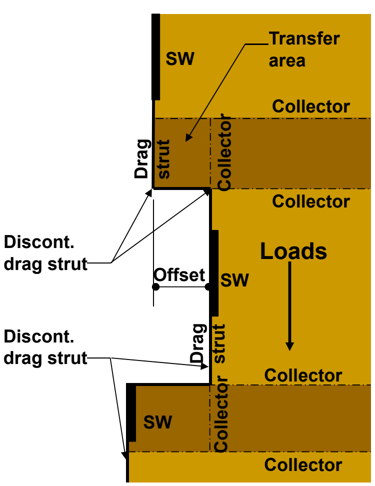


Out-of-plane Offsets

In-plane Offsets

Out-of-Plane Offset Shear Walls

Assumed to act in the Same Line of Resistance



Typical mid-rise multi-family structure at exterior wall line

- Whenever there are offset walls, they are typically assumed to act in the same line of lateral-force-resistance.
- Calculations are rarely provided showing how the walls are interconnected to act as a unit, or to verify that a complete lateral load path has been provided.
- Collectors are rarely installed to transfer the disrupted forces across the offsets.

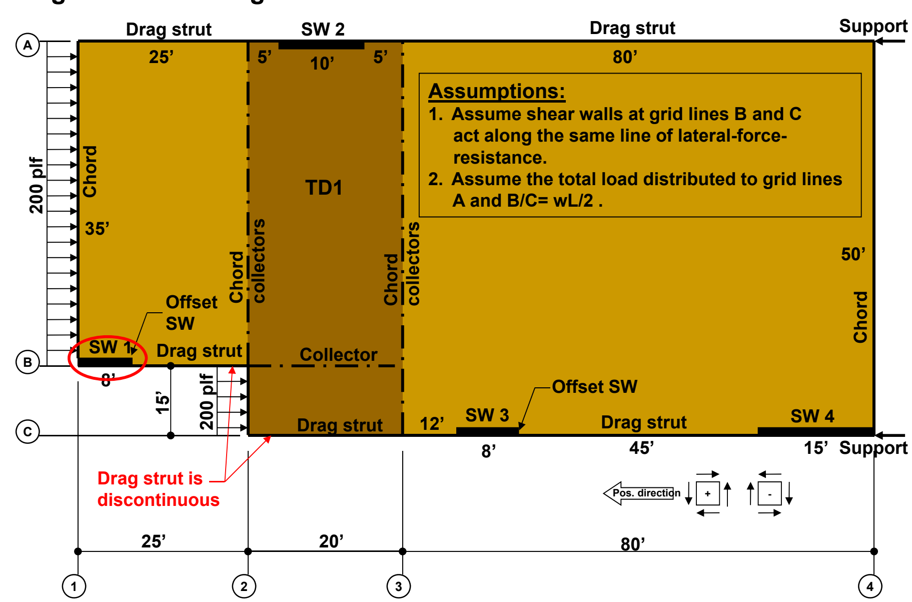
ASCE 7-10, Section 12.1.3
A continuous load path shall be provided to transfer all forces from their point of origin to the lateral force resisting elements (includes members and their connections and splices)

ASCE 7-10 Section 12.10.1-At diaphragm discontinuities such as openings and re-entrant corners, the design shall assure that the dissipation or transfer of edge (chord) forces combined with other forces in the diaphragm is within shear and tension capacity of the diaphragm.

ASCE 7-10 Section 14.5.2
Where offset walls occur in the wall line, portions of the shear wall on each side of the offset shall be considered as separate shear walls unless provisions for force transfer around the offset are provided.

Example 3-Diaphragm with Horizontal End Offset

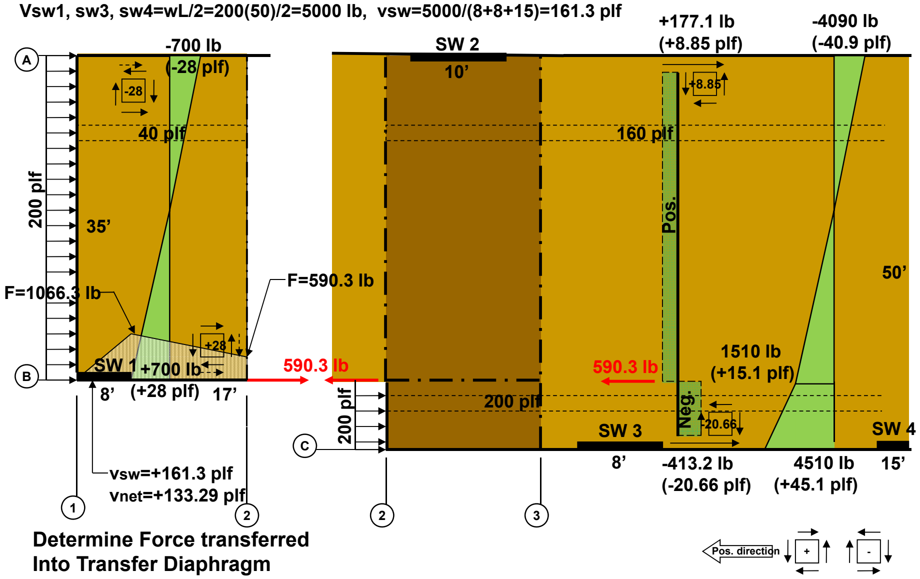
Longitudinal Loading-Offset Shear Walls



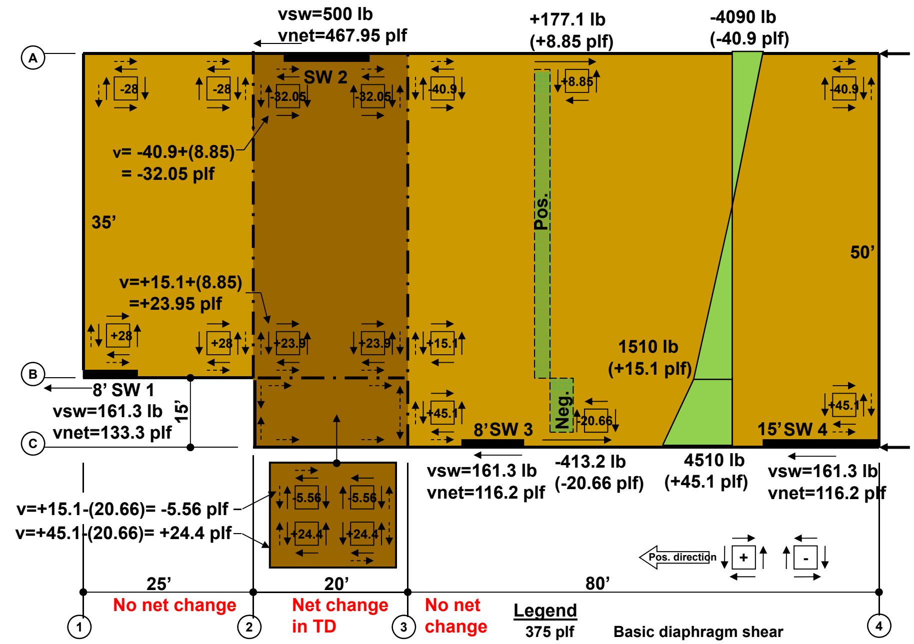
Total Shear to Shear Walls (Assumed)

Vsw2=wL/2=200(50)/2=5000 lb, vsw2=5000/10=500 plf

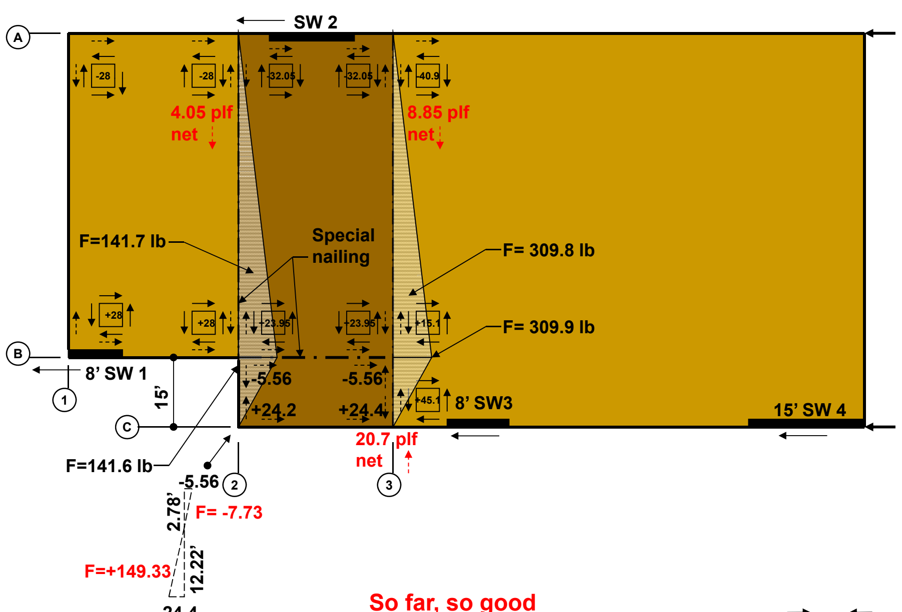
Vsw1, sw3, sw4=wL/2=200(50)/2=5000 lb, vsw=5000/(8+8+15)=161.3 plf



Basic Diaphragm Shears and Transfer Diaphragm Shear

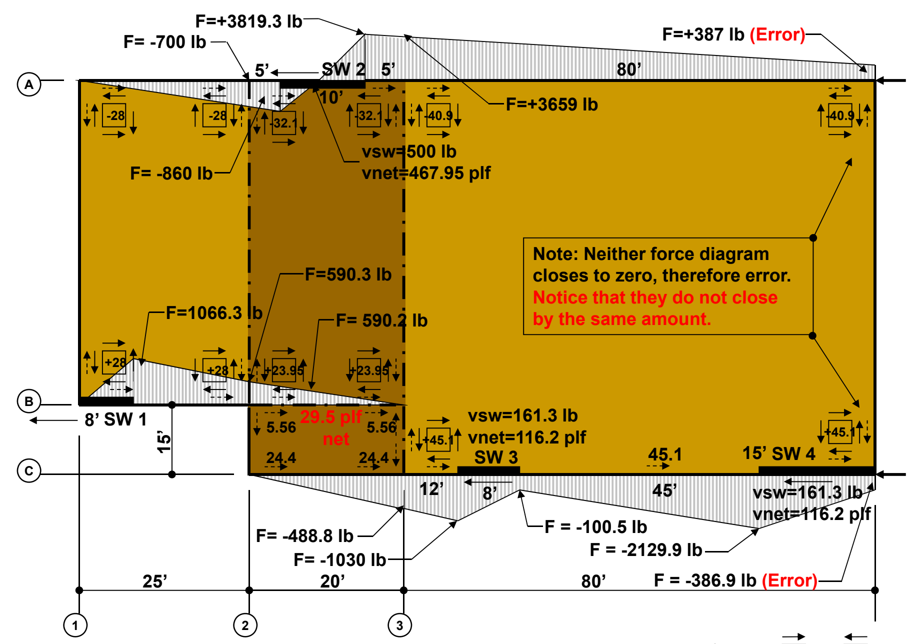


Net Diaphragm Shears

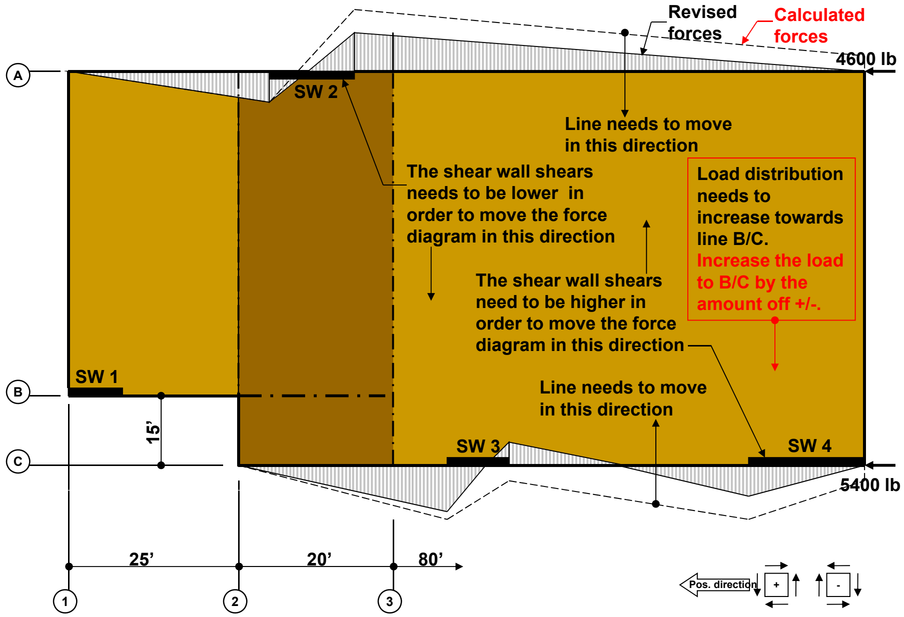


So far, so good

Transverse Collector Force Diagrams



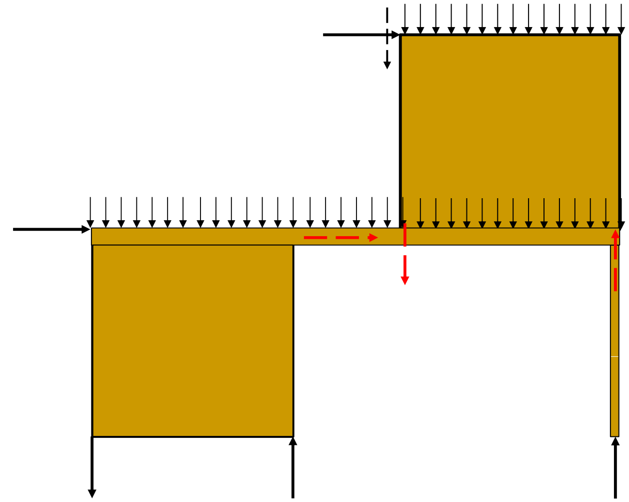
Longitudinal Strut Force Diagrams

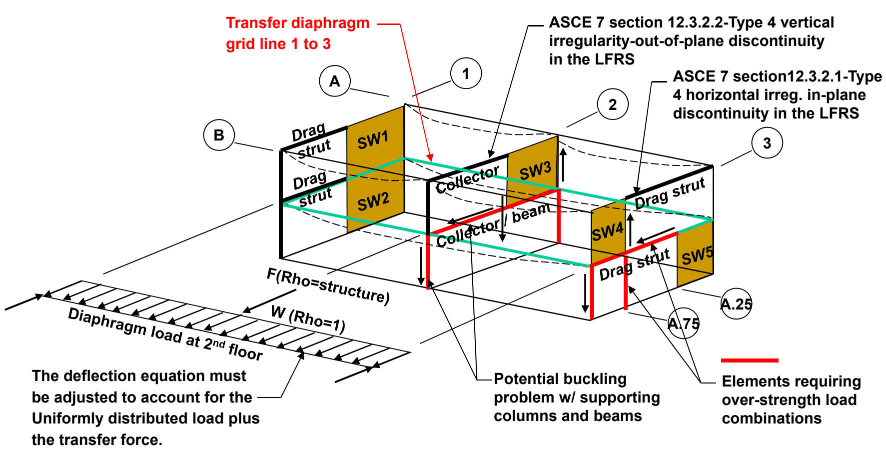


Adjusted Longitudinal Strut Force Diagrams (8% increase to B/C)

[Amount shifted to B/C depends on the offset to span ratio of the transfer diaphragm]

In-plane Offset Shear Walls





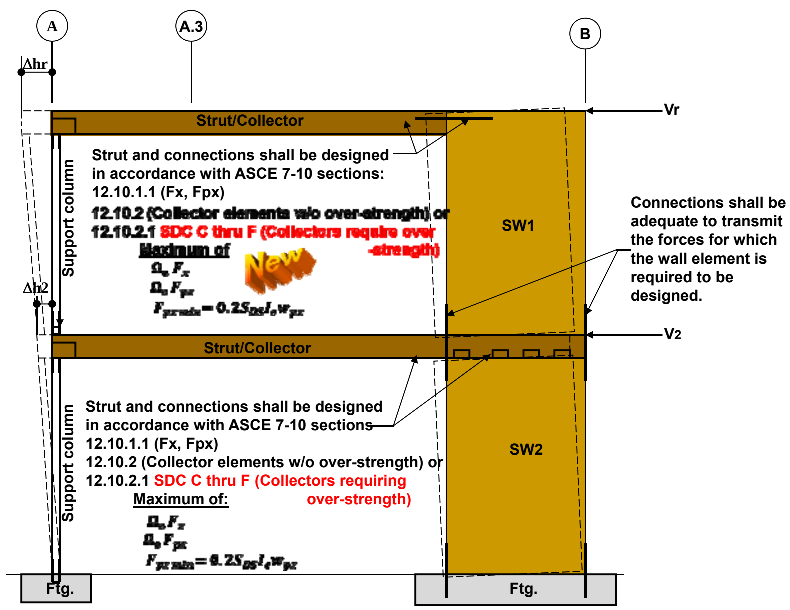
ASCE 7 section 12.3.3.4 Type 4 vertical or horizontal irregularity in SDC D, E, F design forces determined from section 12.10.1.1 (Fpx) shall be increased 25%:

- Connections of diaphragms to vertical elements and to collectors.
- Collectors and their connections, including connections to the vertical elements of the lateral force resisting system.

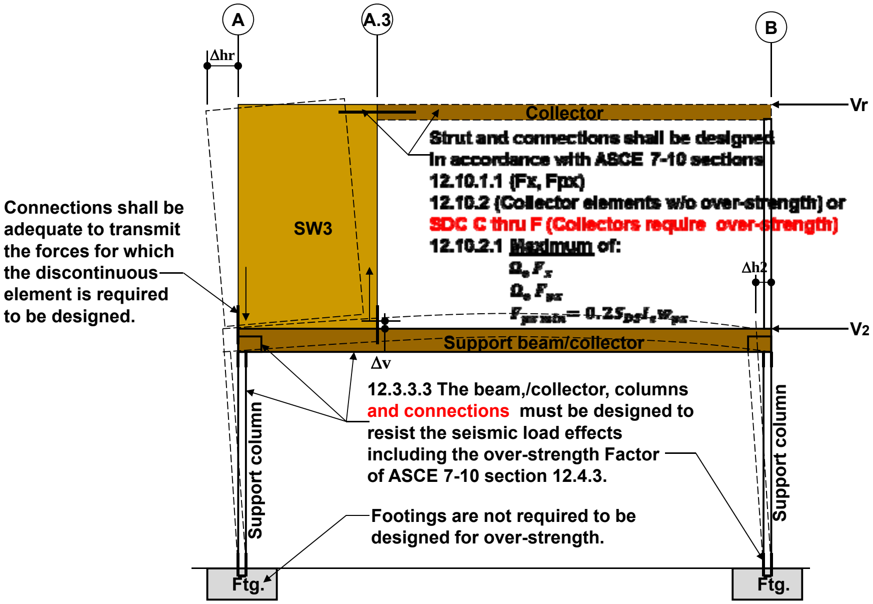
Exception: Forces calculated using the seismic load effects including over-strength factor of section 12.4.3 need not be increased.

ASCE 7 section 12.3.3.3

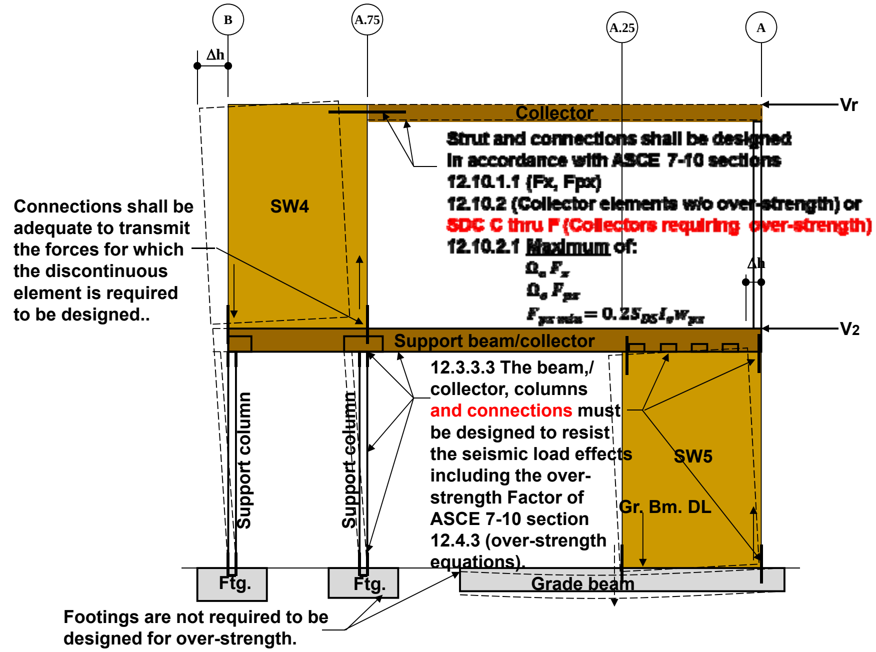
Elements supporting discontinuous walls and frames (Rho required if SDC D thru F)



Shear wall system at grid line 1-vertically aligned



Shear wall system at grid line 2
Elements supporting discontinuous walls or frames



Shear wall system at grid line 3-Type4 Horiz.

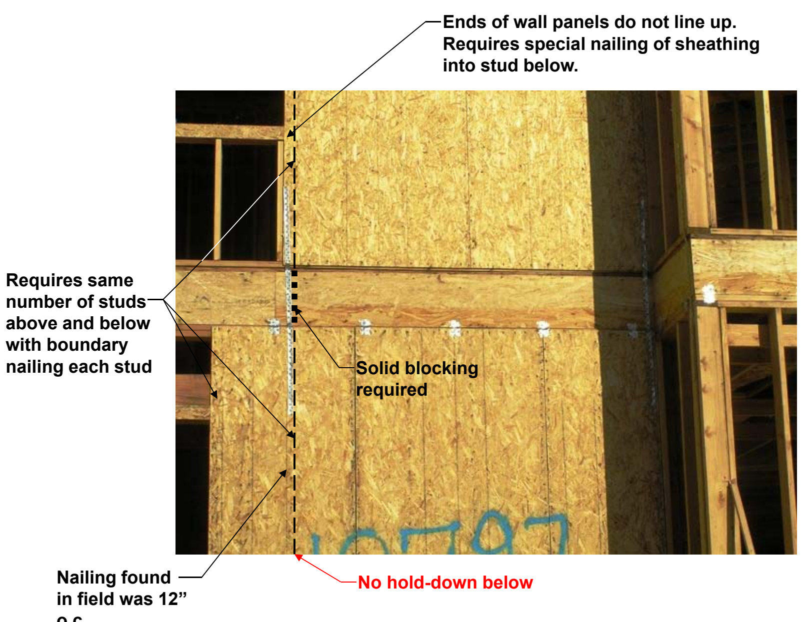
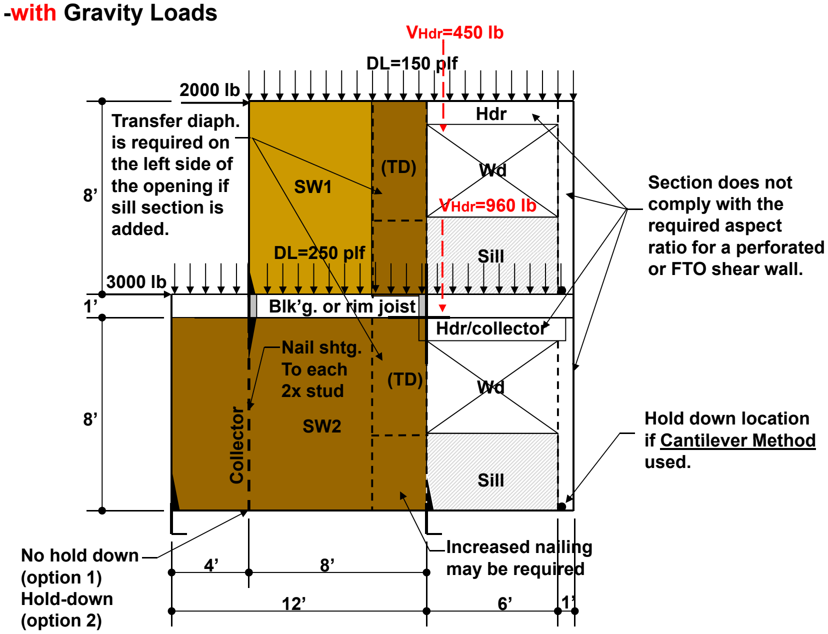
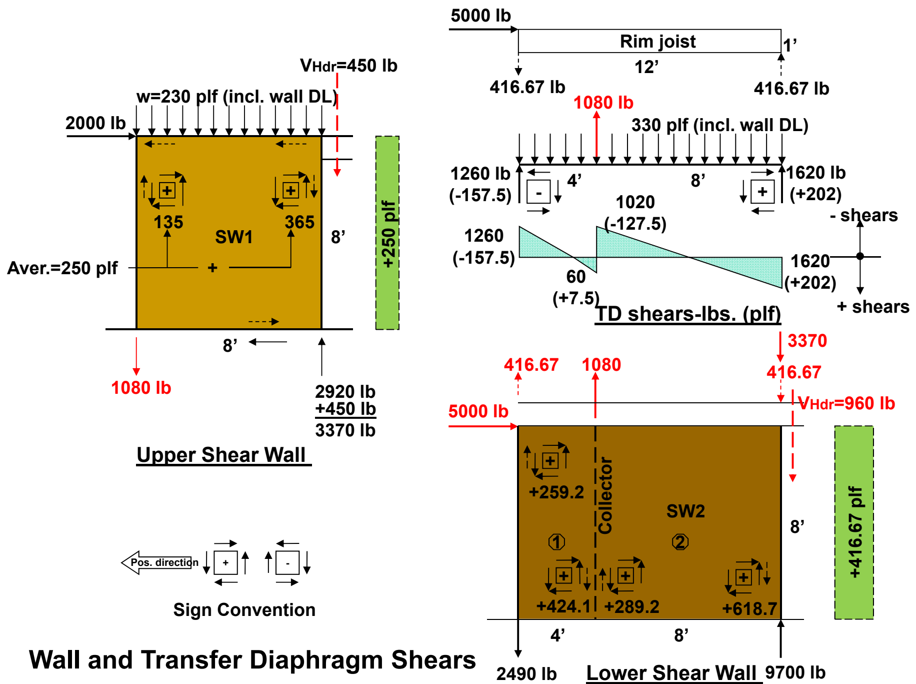


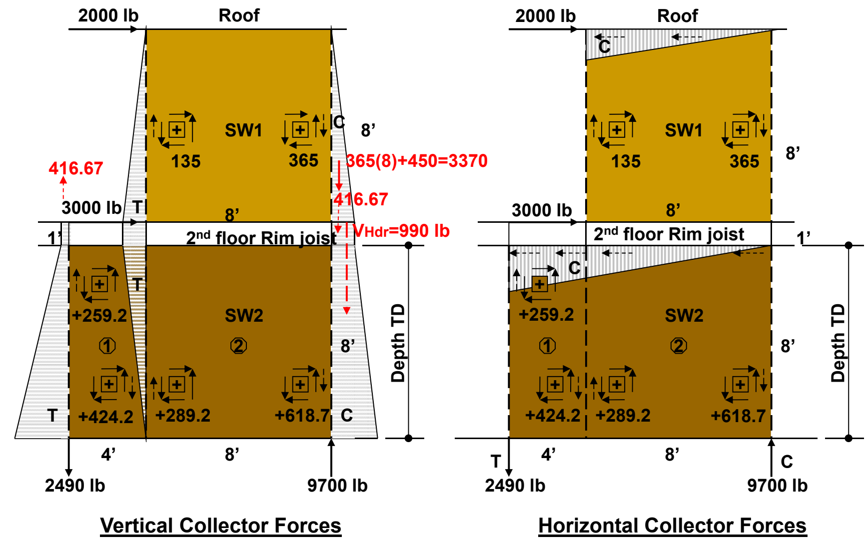
Photo-In-plane Offset Segmented Shear Walls

Example 4-In-plane Offset Segmented Shear Wall
-with Gravity Loads

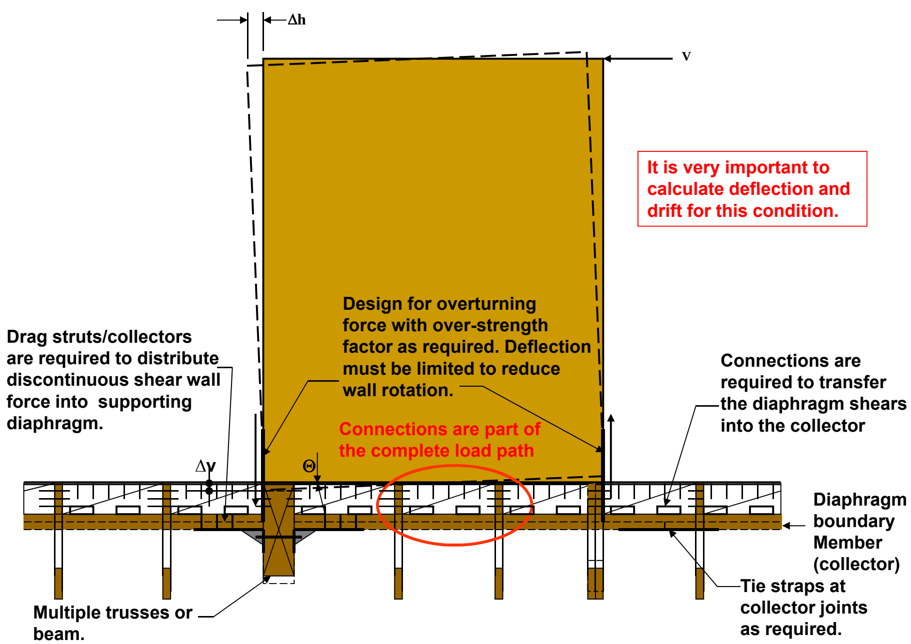


Wall and Transfer Diaphragm Shears





Collector Force Diagrams



Discontinuous Shear Wall Perpendicular to Framing

Questions?

This concludes

The AIA Part 2-Presentation on Offset Shear Walls

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