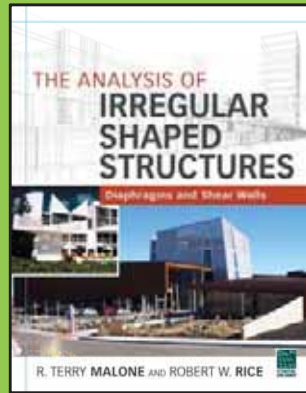


Part 2-Offset Shear Walls

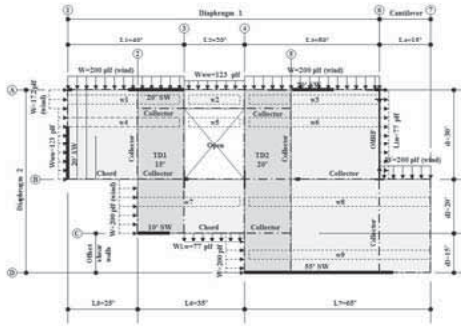
Excerpts From:



Presentation updated to 2012 IBC, ASCE 7-10
Copyright McGraw-Hill, ICC

By: R. Terry Malone, PE, SE
Senior Technical Director
Architectural & Engineering
Solutions

terrym@woodworks.org



Example Complex Diaphragm

Copyright Materials

This presentation is protected by US and International Copyright laws. Reproduction, distribution, display and use of the presentation without written permission of the speaker is prohibited.

© The Wood Products Council 2014

“The Wood Products Council” is a Registered Provider with The American Institute of Architects Continuing Education Systems (AIA/CES), Provider #G516.

Credit(s) earned on completion of this course will be reported to AIA CES for AIA members. Certificates of Completion for both AIA members and non-AIA members are available upon request.

This course is registered with AIA CES for continuing professional education. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the AIA of any material of construction or any method or manner of handling, using, distributing, or dealing in any material or product.

Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

Course Description

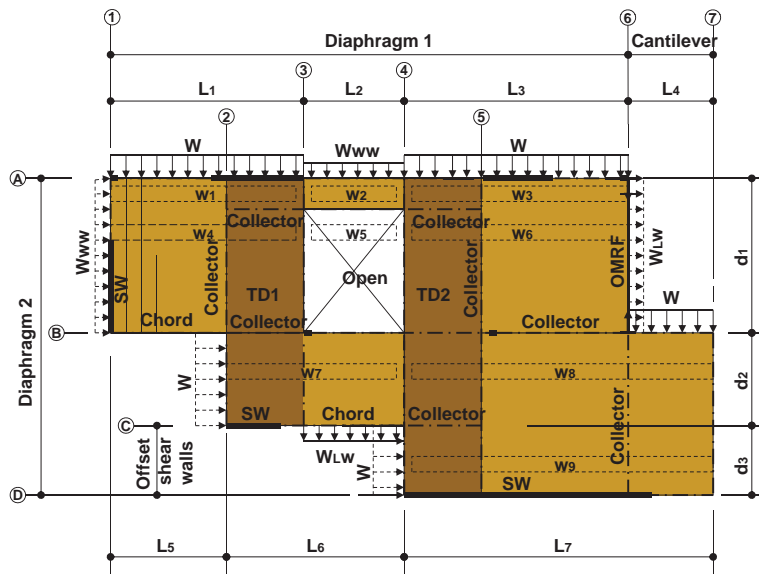
A continuation from Part 1, this session will cover how to conduct a preliminary breakdown of a complex diaphragm to better understand the distribution of forces within the diaphragm and assure that complete load paths are being established. Examples will be provided illustrating how to analyze in-plane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

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.



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



Presentation Assumptions

Flexible wood sheathed or un-topped steel deck diaphragms

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

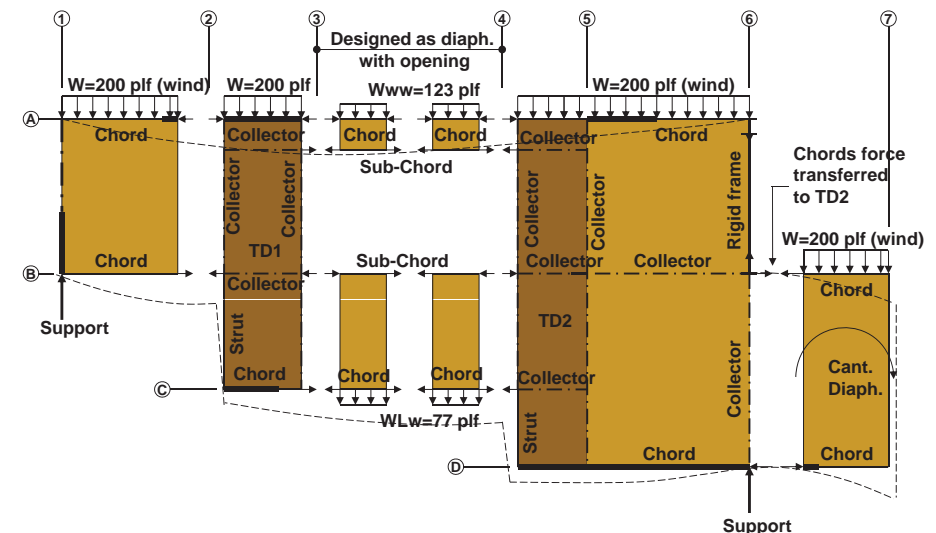
- Loads to diaphragms and shear walls
 - Strength level or allowable stress design
 - Wind or seismic forces (UNO).
- The loads are already factored for the appropriate load combination.

Code References:

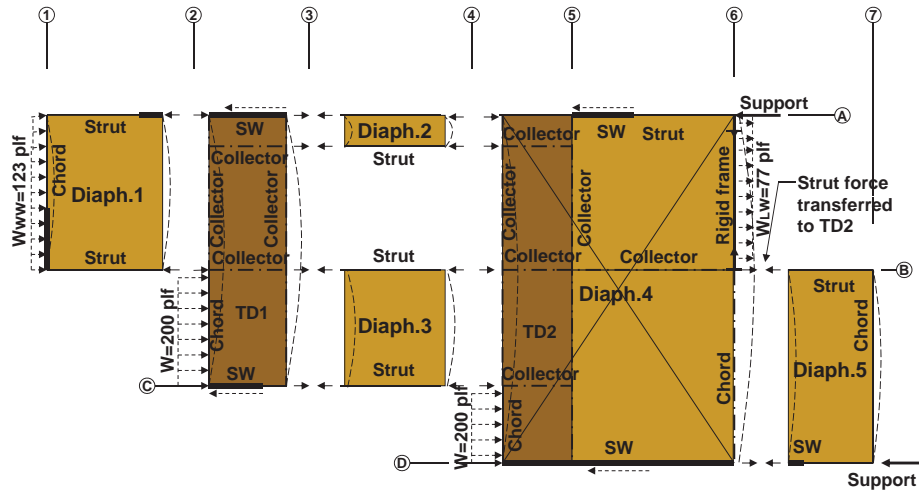
- ASCE 7-10 "Minimum Design Loads for Buildings and Other Structures"
- 2012 IBC

Design references:

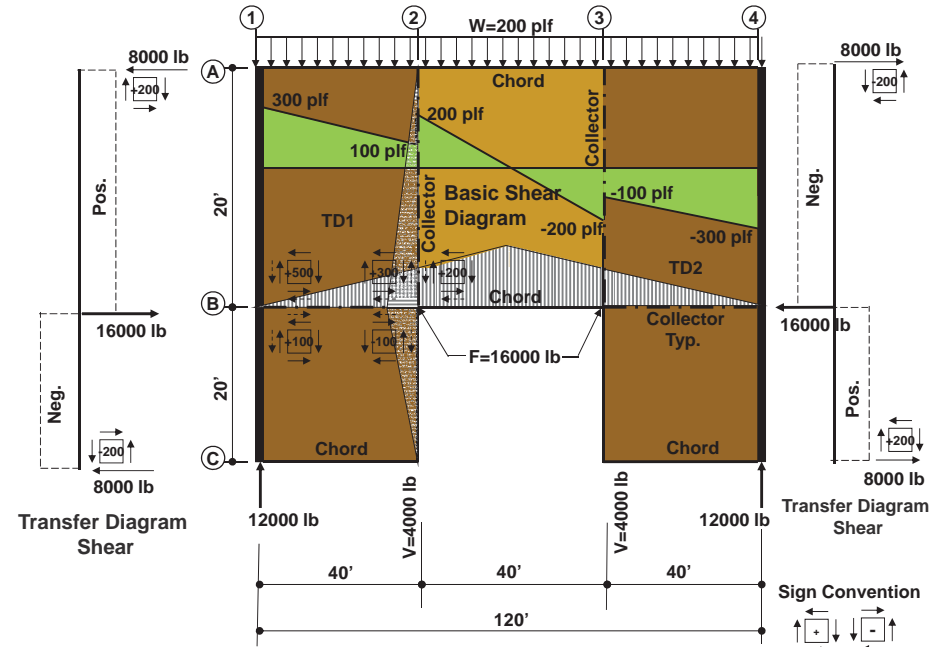
- The Analysis of Irregular Shaped Structures: Diaphragms and Shear Walls- Malone, Rice
- Design of Wood Structures- Breyer, Fridley, Pollock, Cobeen
- SEAOC Seismic Design Manual, Volume 2
- Wood Engineering and Construction Handbook-Faherty, Williamson
- Guide to the Design of Diaphragms, Chords and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



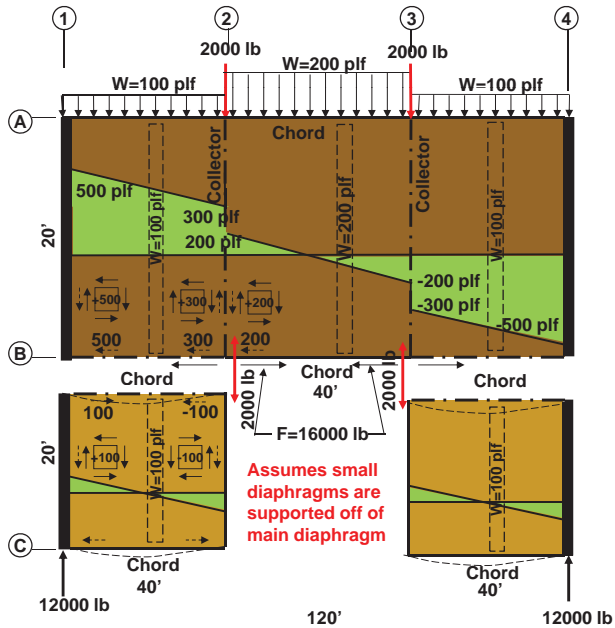
Segmentation of the Diaphragm for Transverse Loading



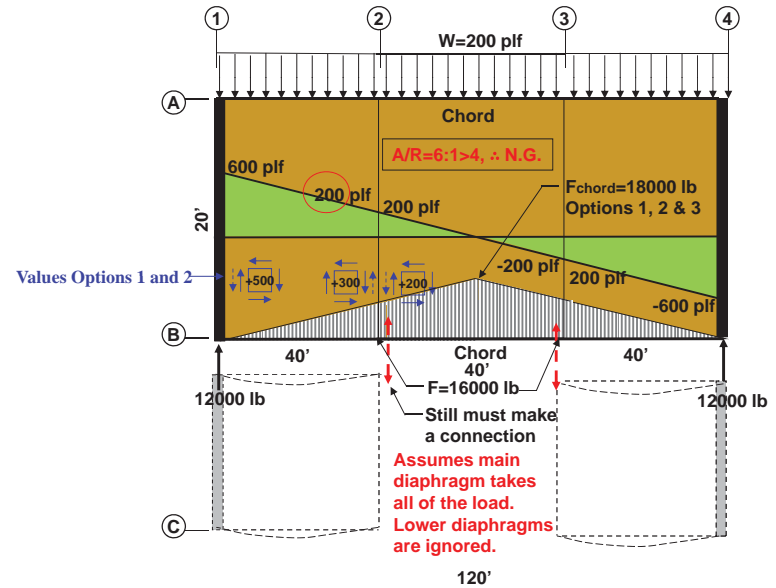
Segmentation of the Diaphragm for Longitudinal Loading



Analysis Option 1-Analyze as Diaphragm with Intermediate offset

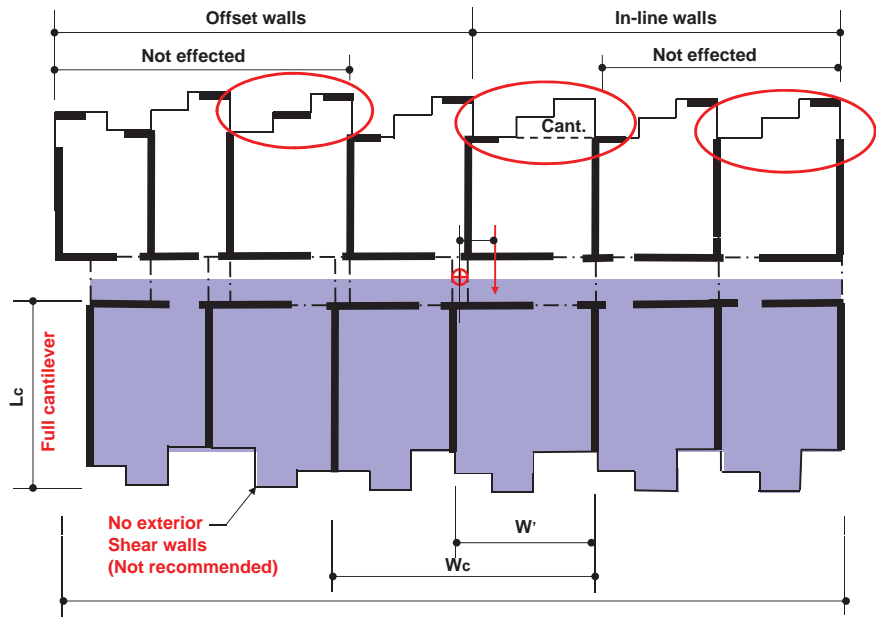


Analysis Option 2-Analyzing as separate diaphragms

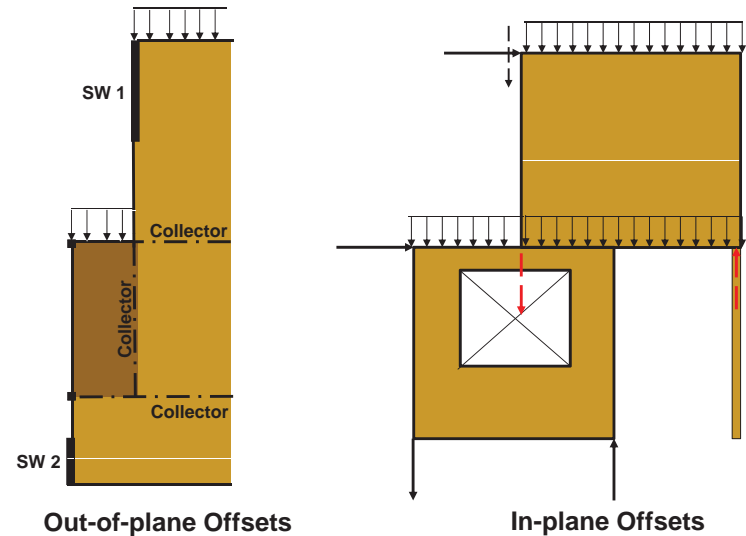


Analysis Option 3-Ignoring lower diaphragm sections

Transverse Loading Semi-Rigid

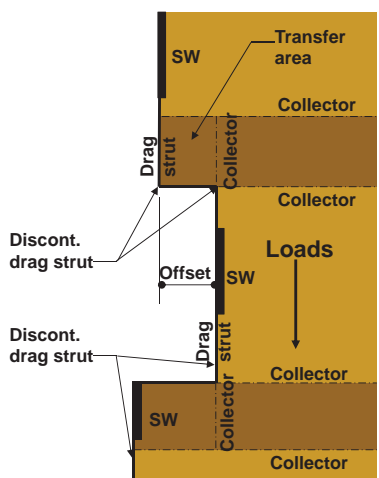


Offset Shear Walls



Out-of-Plane Offset Shear Walls

Assumed to act in the Same Line of Resistance



- 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)

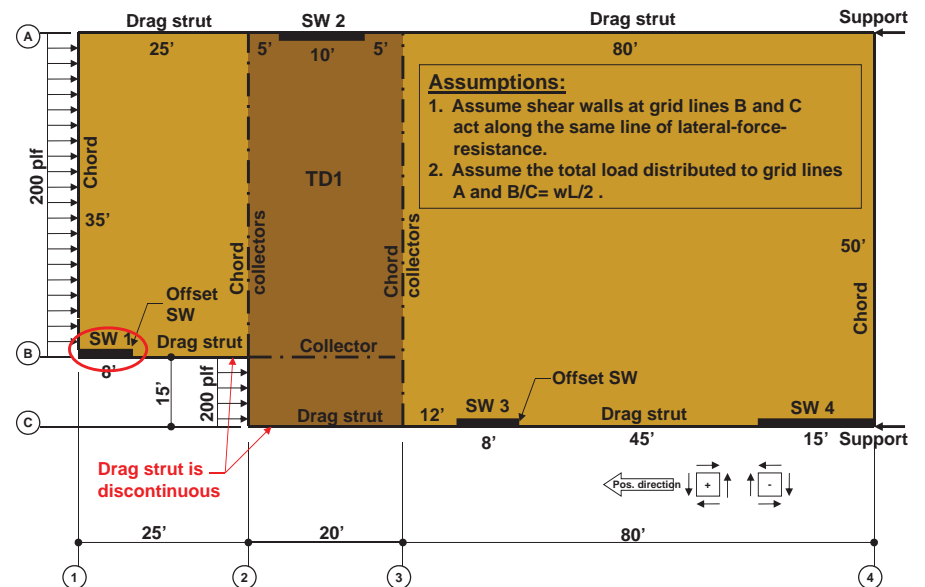
ASCE 7-10 Section 12.10.1-At diaphragm discontinuities such as openings and re-entrant corners, the design shall assure that the dissipation or transfer of edge (chord) forces combined with other forces in the diaphragm is within shear and tension capacity of the diaphragm.

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

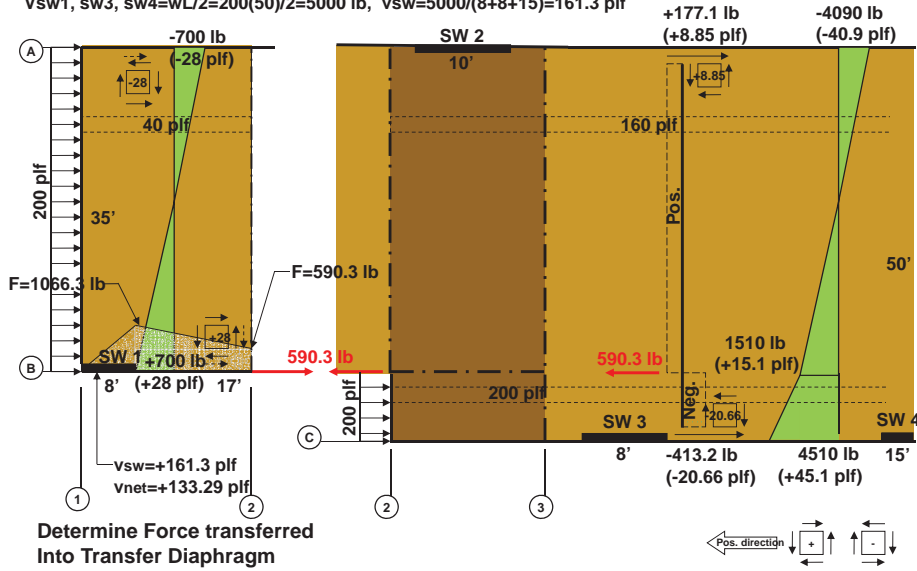


Typical mid-rise multi-family structure at exterior wall line

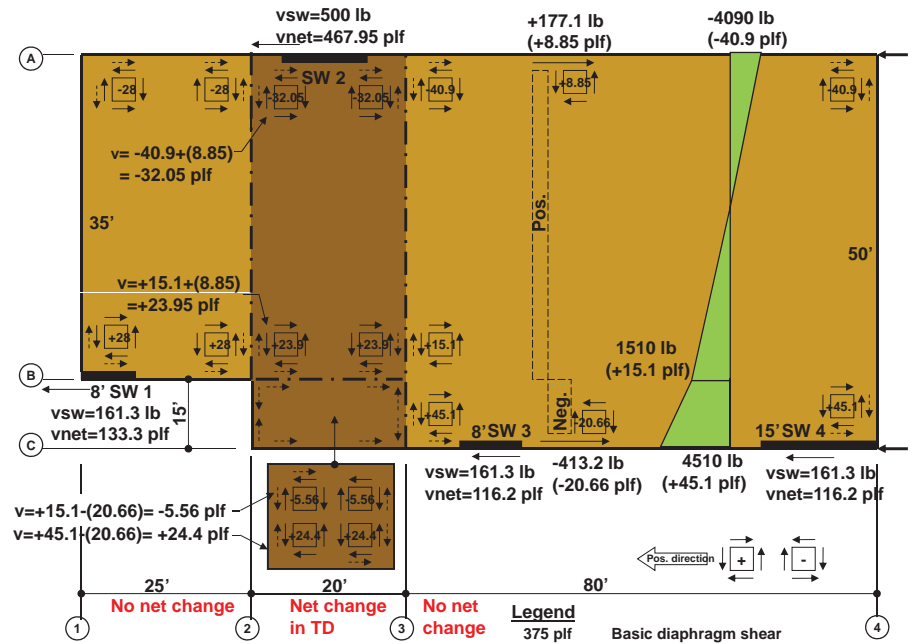
Total Shear to Shear Walls (Assumed)

$V_{sw2} = wL/2 = 200(50)/2 = 5000 \text{ lb}$, $v_{sw2} = 5000/10 = 500 \text{ plf}$

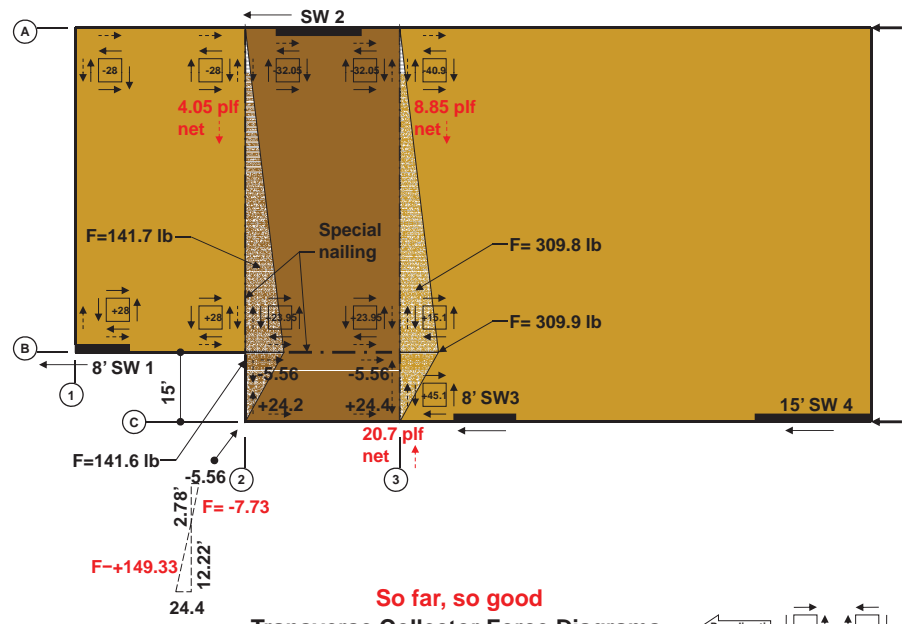
$V_{sw1, sw3, sw4} = wL/2 = 200(50)/2 = 5000 \text{ lb}$, $v_{sw} = 5000/(8+8+15) = 161.3 \text{ plf}$



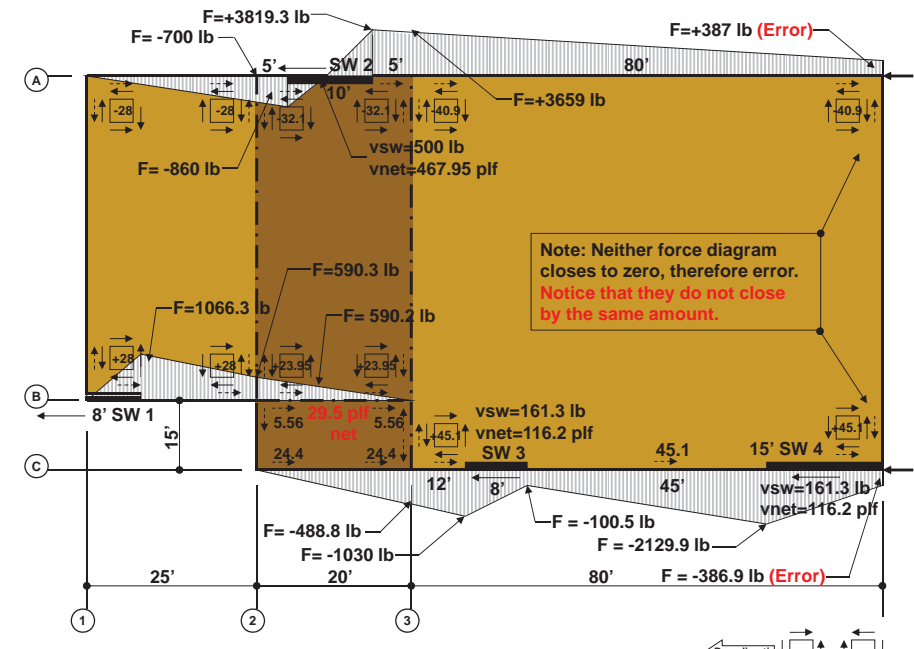
Basic Diaphragm Shears and Transfer Diaphragm Shear



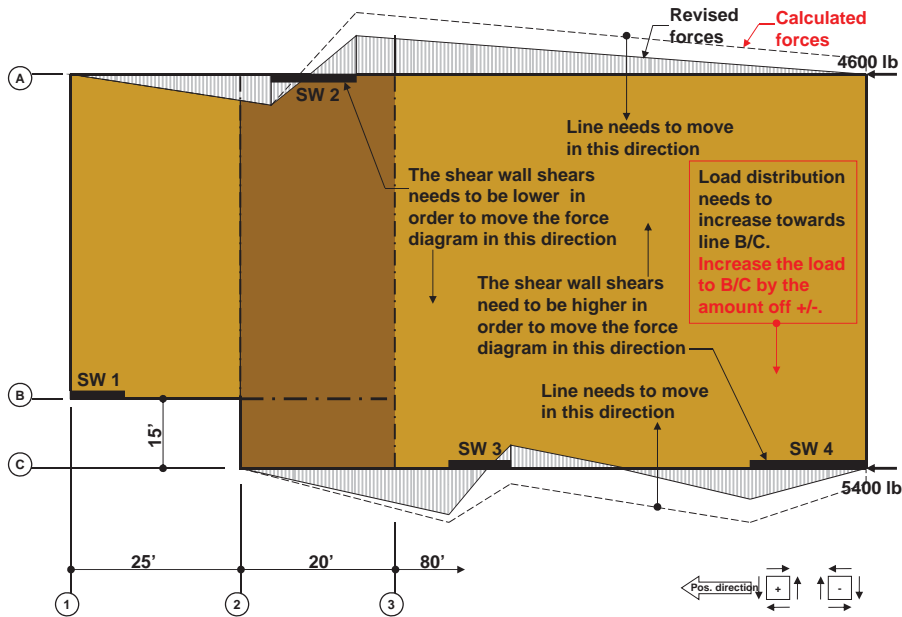
Net Diaphragm Shears



Transverse Collector Force Diagrams

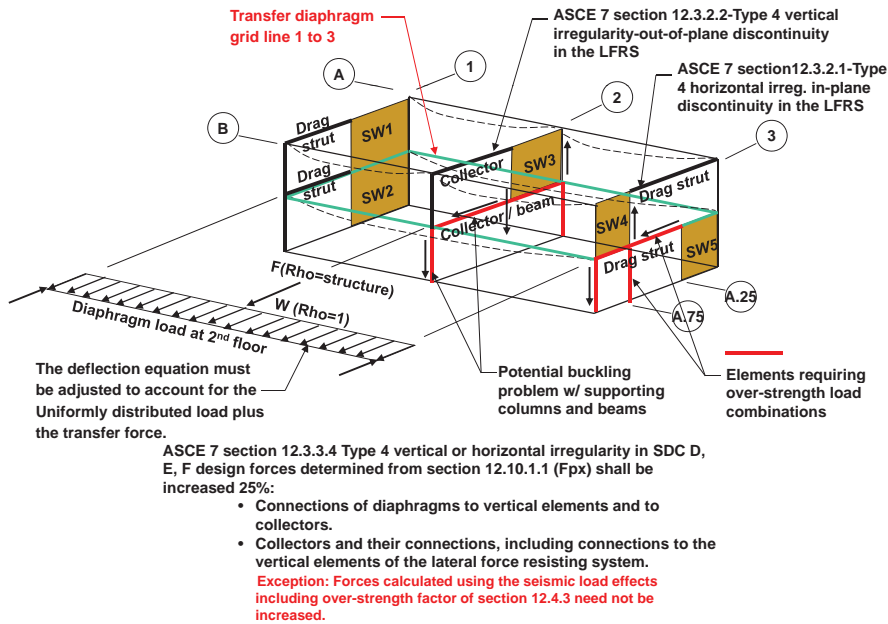
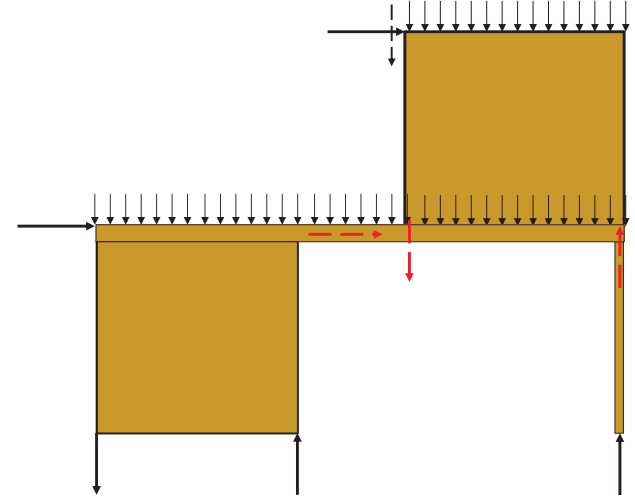


Longitudinal Strut Force Diagrams



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



The deflection equation must be adjusted to account for the Uniformly distributed load plus the transfer force.

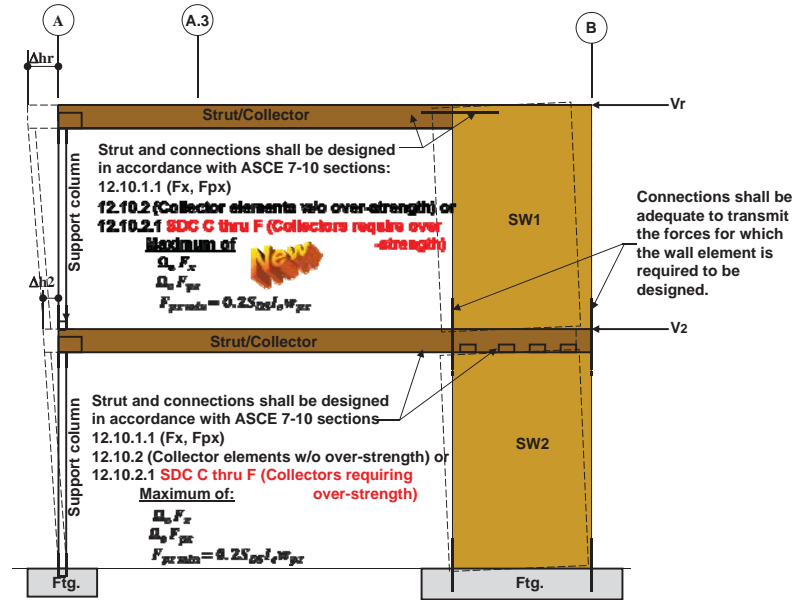
ASCE 7 section 12.3.3.4 Type 4 vertical or horizontal irregularity in SDC D, E, F design forces determined from section 12.10.1.1 (F_{px}) shall be increased 25%:

- 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.

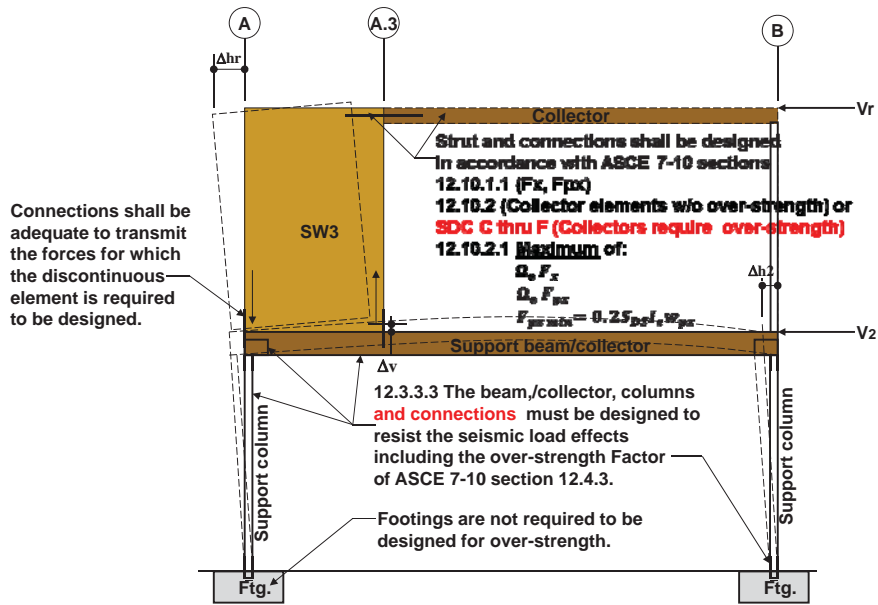
Exception: Forces calculated using the seismic load effects including over-strength factor of section 12.4.3 need not be increased.

ASCE 7 section 12.3.3.3

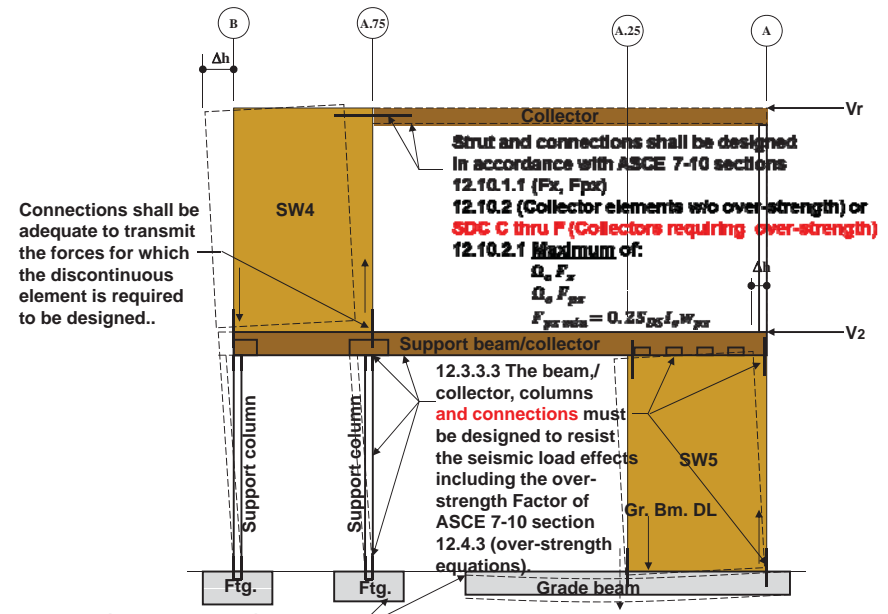
Elements supporting discontinuous walls and frames (Rho required if SDC D thru F)



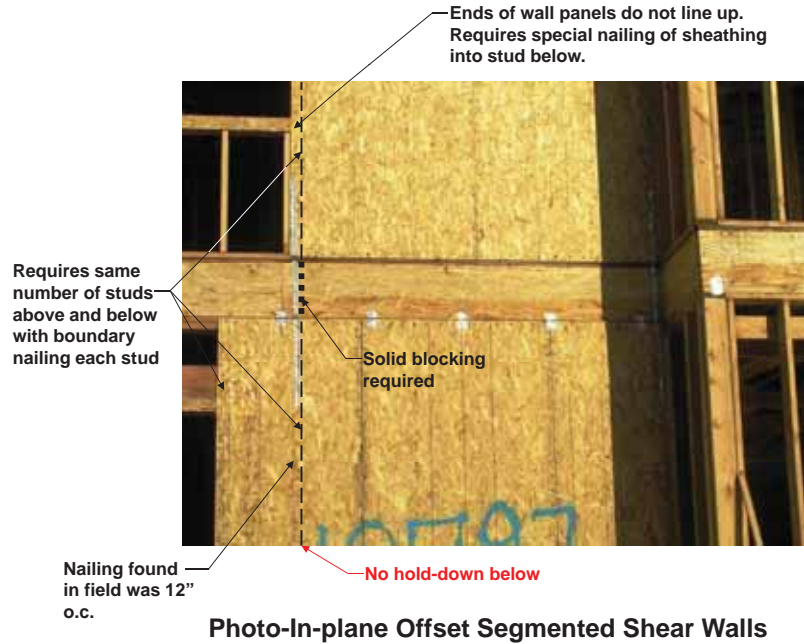
Shear wall system at grid line 1-vertically aligned



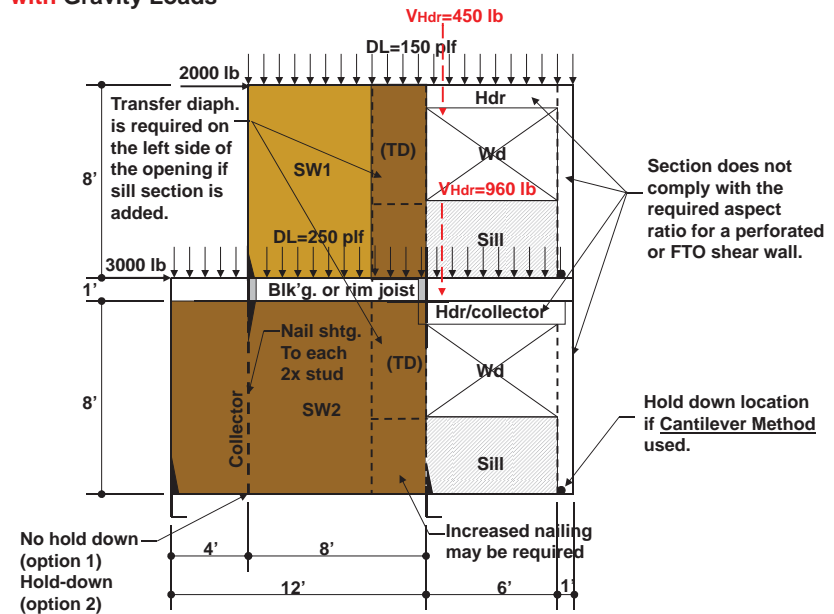
Shear wall system at grid line 2
Elements supporting discontinuous walls or frames

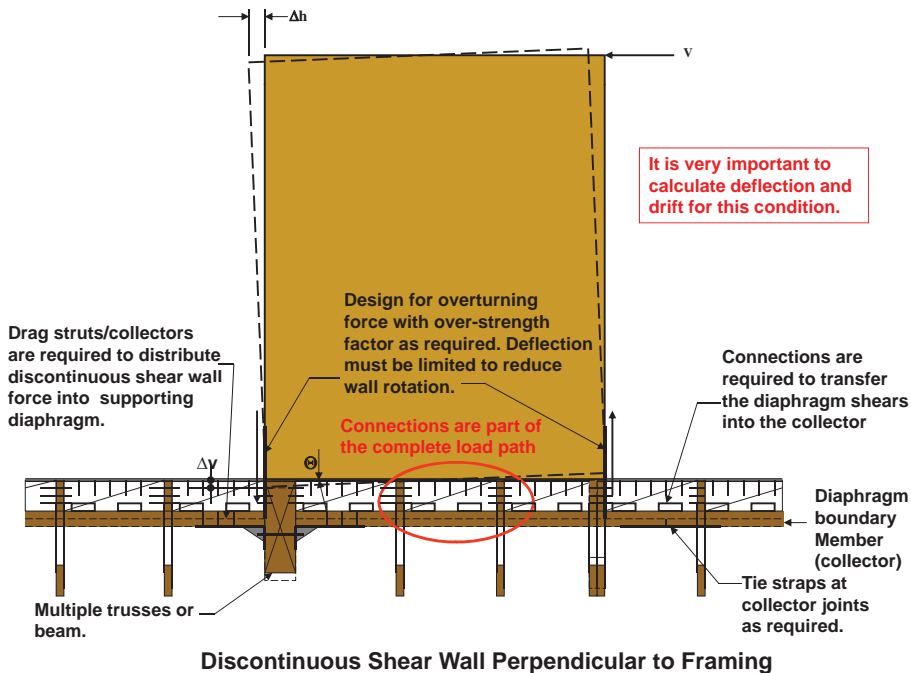
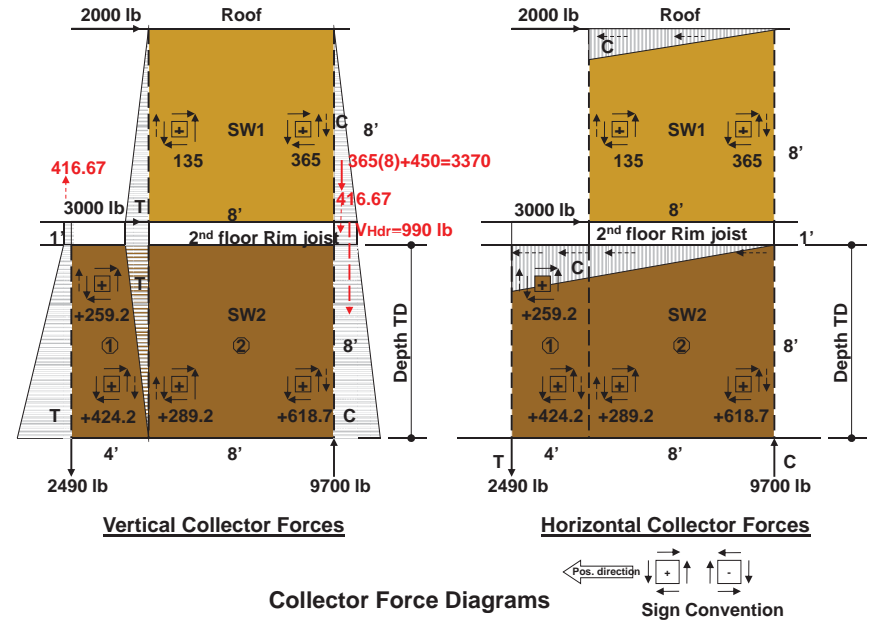
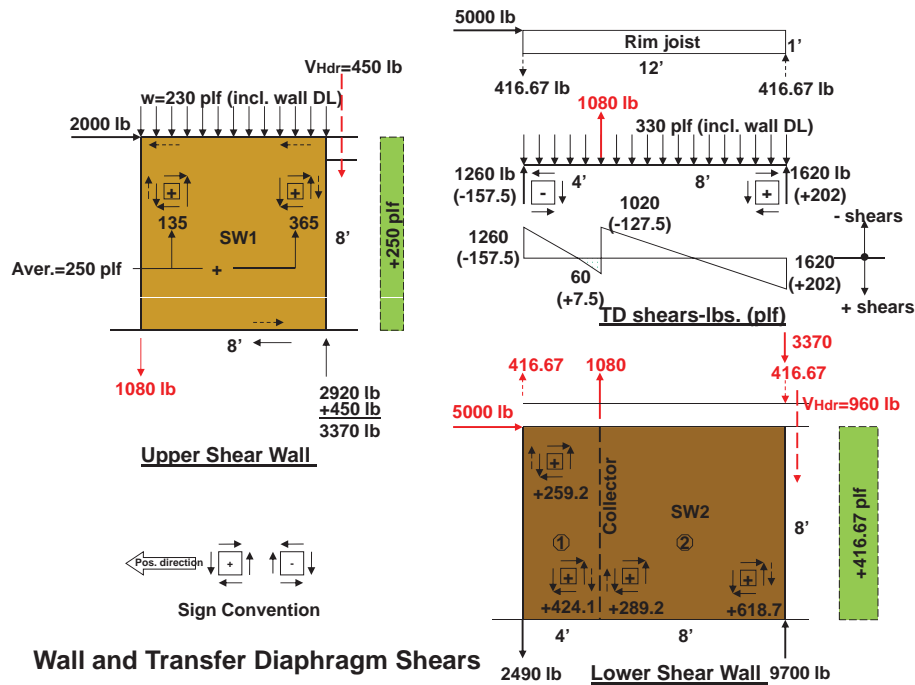


Shear wall system at grid line 3-Type4 Horiz.



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





Questions?

This concludes

The AIA Part 2-Presentation on Offset Shear Walls

R. Terry Malone, P.E., S.E.
Senior Technical Director
WoodWorks.org
Prescott Valley, Arizona

Contact Information:
terrym@woodworks.org

WoodWorks
woodworks.org
Events/Presentation Archives (slide handouts)-free