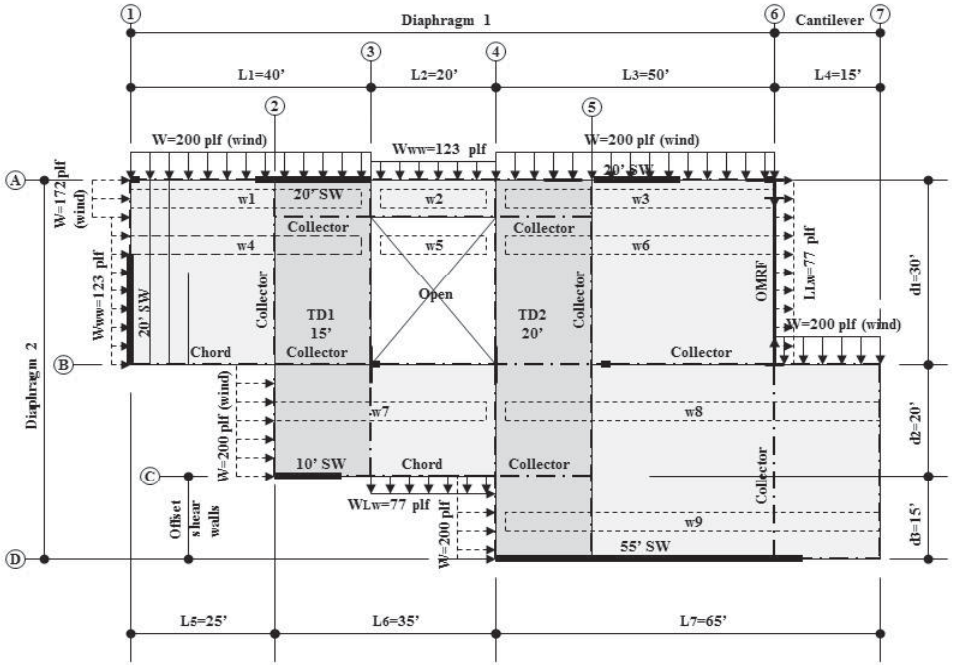
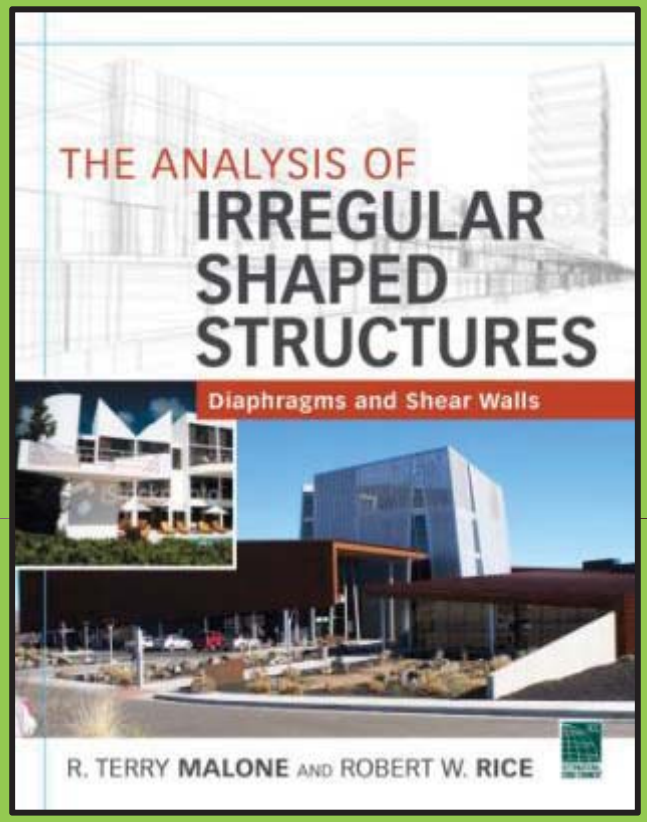
WoodWorks

Part 2-Offset Shear Walls



Example-Complex Diaphragm

Based on:



Presentation updated to 2012 IBC, ASCE 7-10

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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 for loading in the longitudinal direction.

- **In-plane Offset Shear Walls**

  Examine a two story offset shear wall with varying width.

Presentation Assumptions

Flexible wood sheathed or un-topped steel deck diaphragms

(Also applies to 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.**

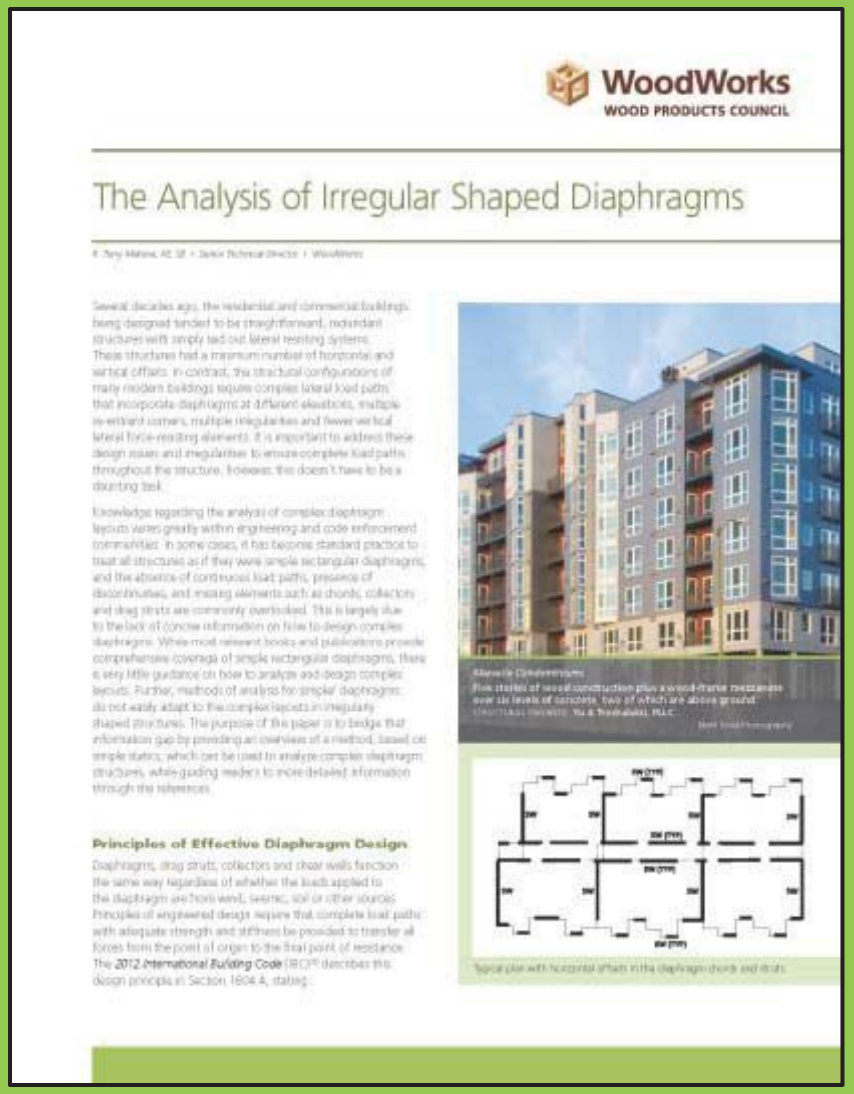
Code References:

- **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**

Complete Example with narrative and calculations



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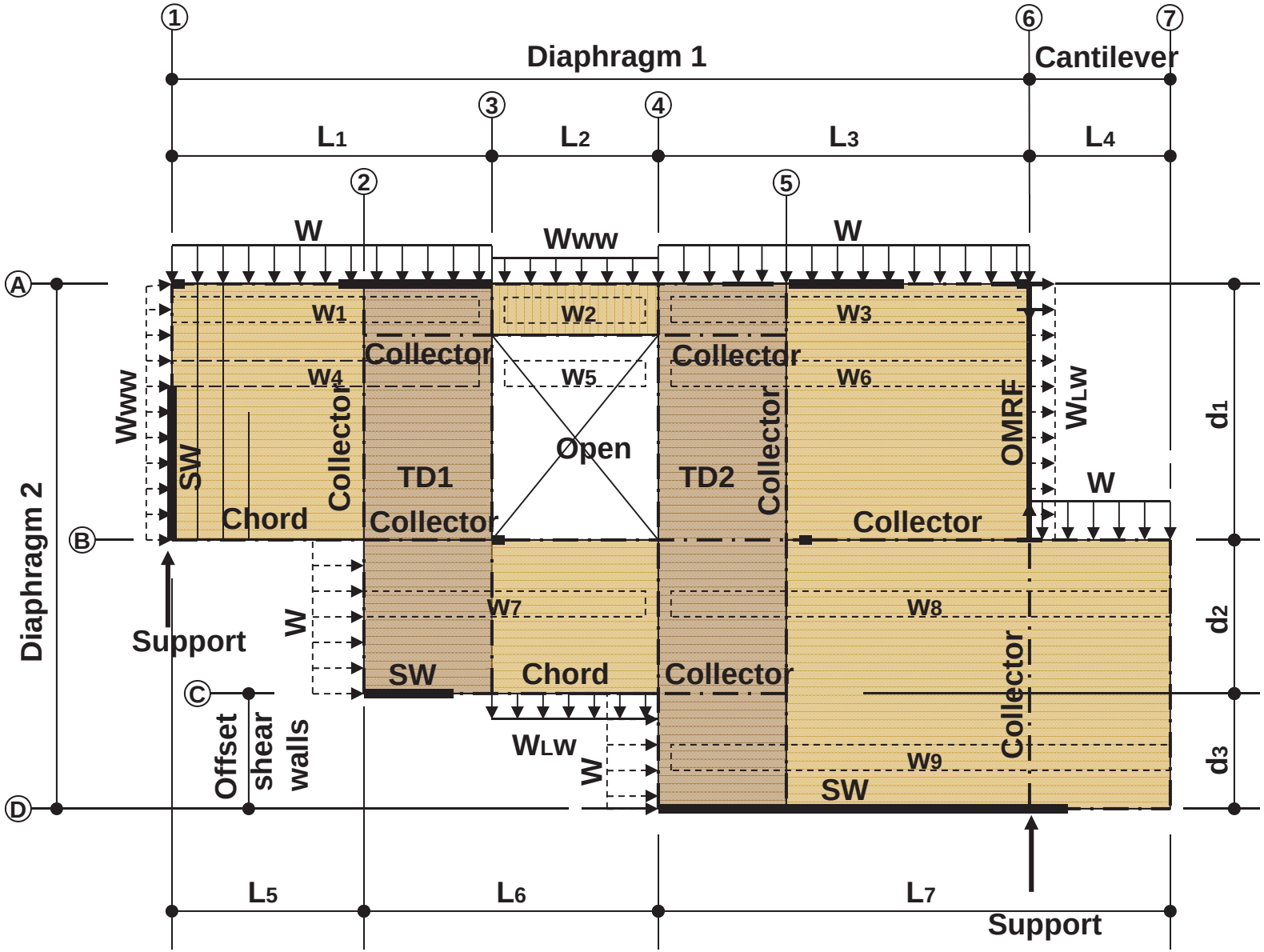
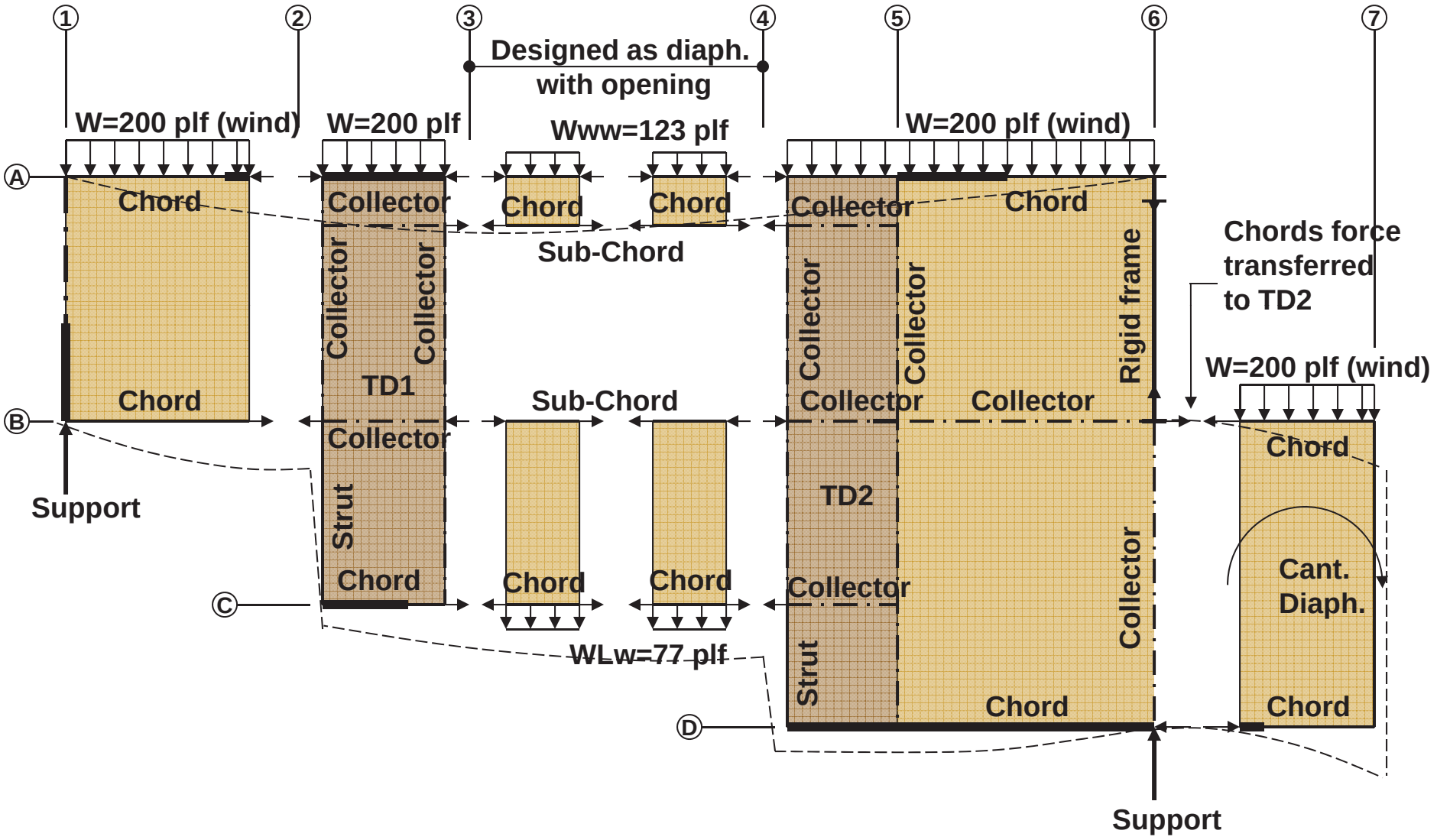
The Analysis of Irregular Shaped Diaphragms

Principles of Effective Diaphragm Design

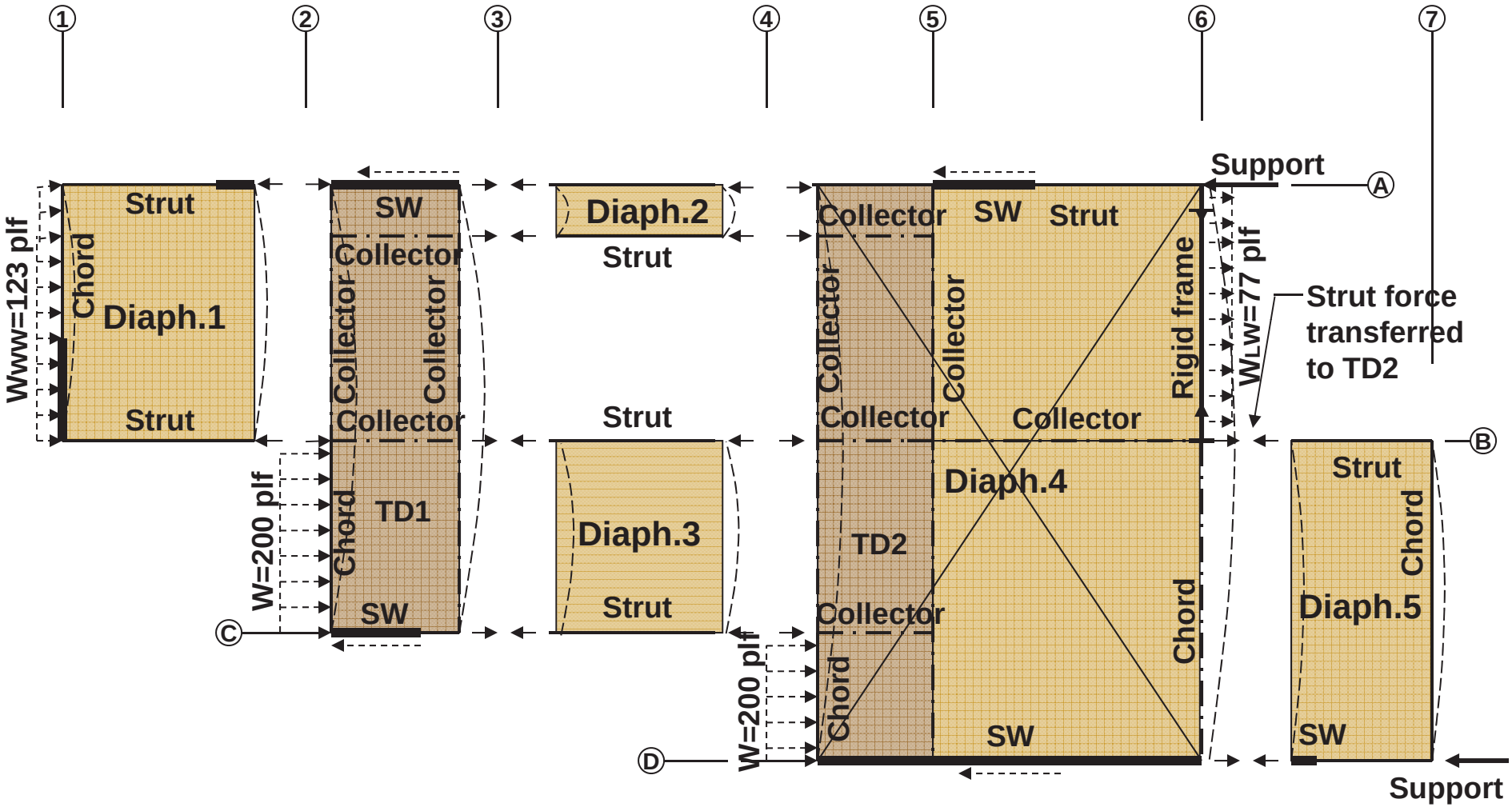
http://www.woodworks.org/education-publications/research-papers/#

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



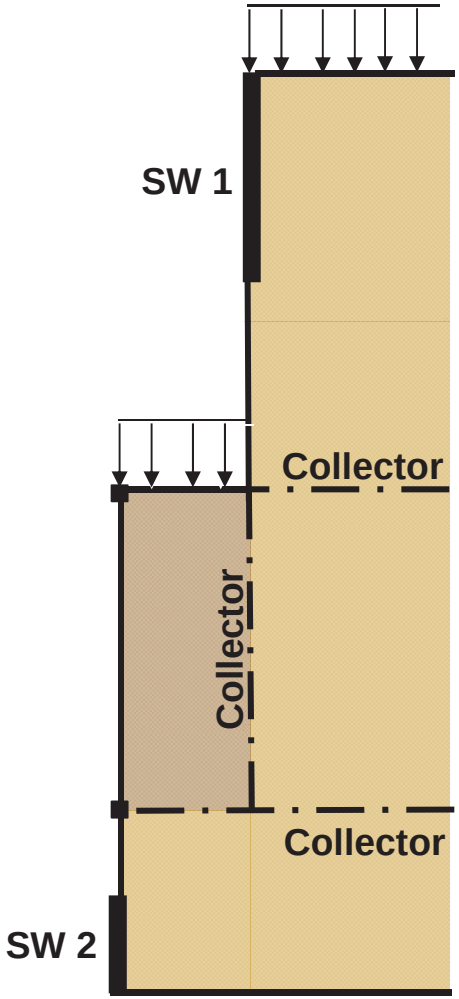


Segmentation of the Diaphragm for Transverse Loading

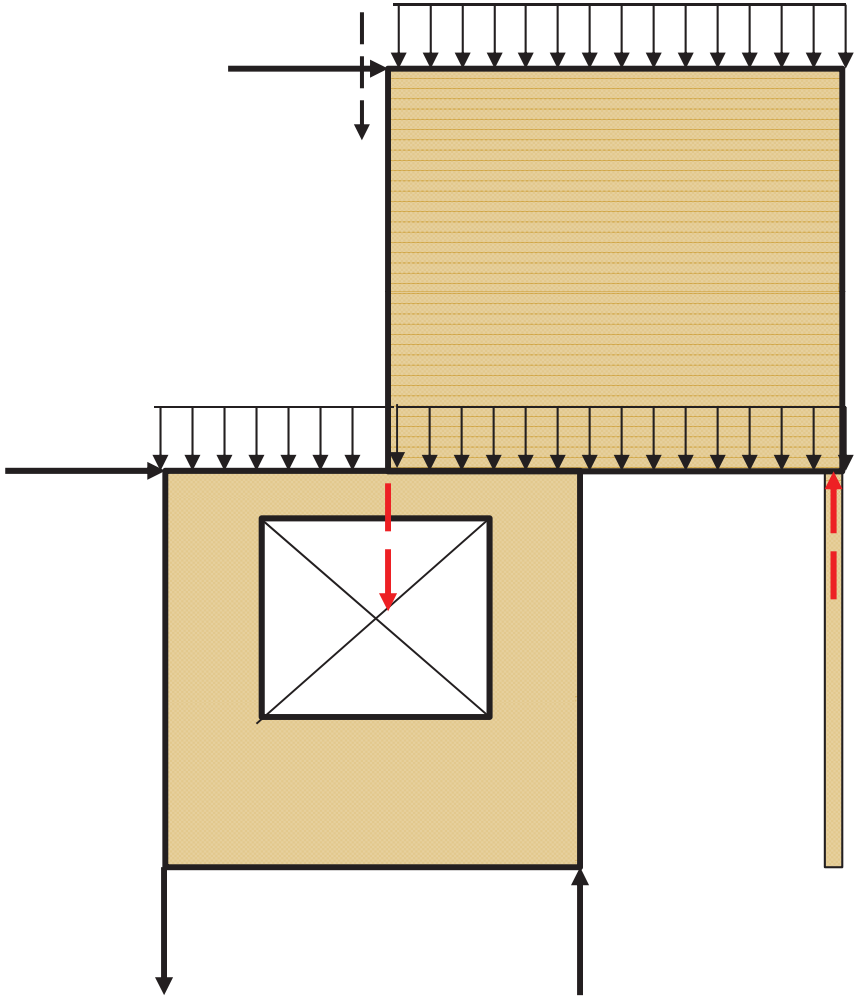


Segmentation of the Diaphragm for Longitudinal Loading

Offset Shear Walls



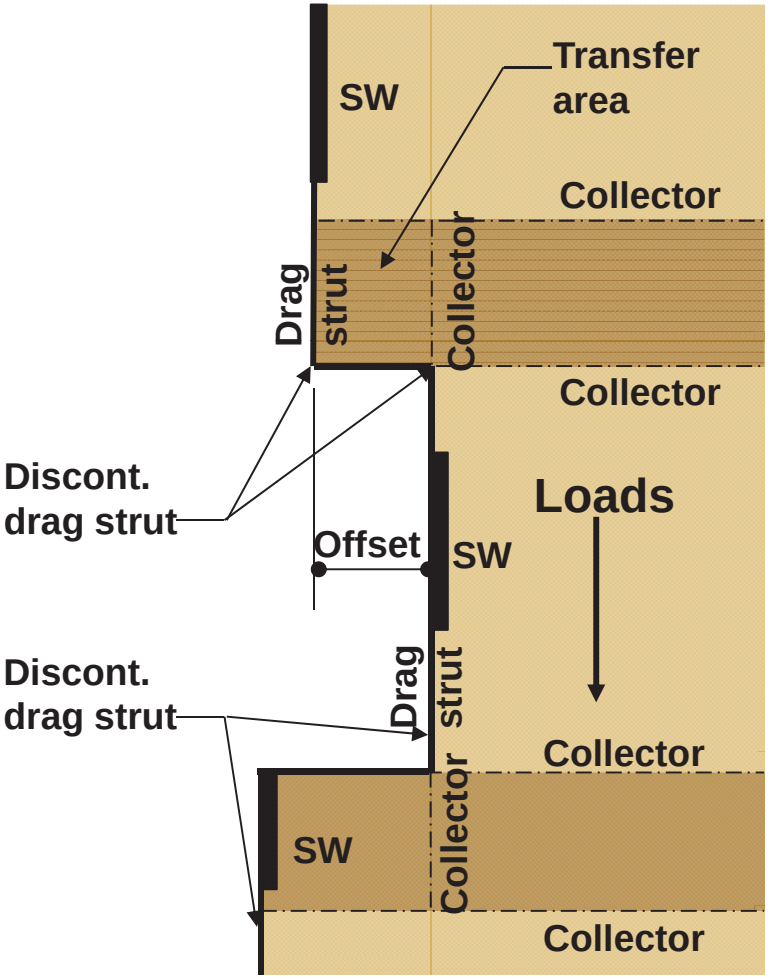
Out-of-plane Offsets



In-plane Offsets

Out-of-Plane Offset Shear Walls

Assumed to act in the Same Line of Resistance

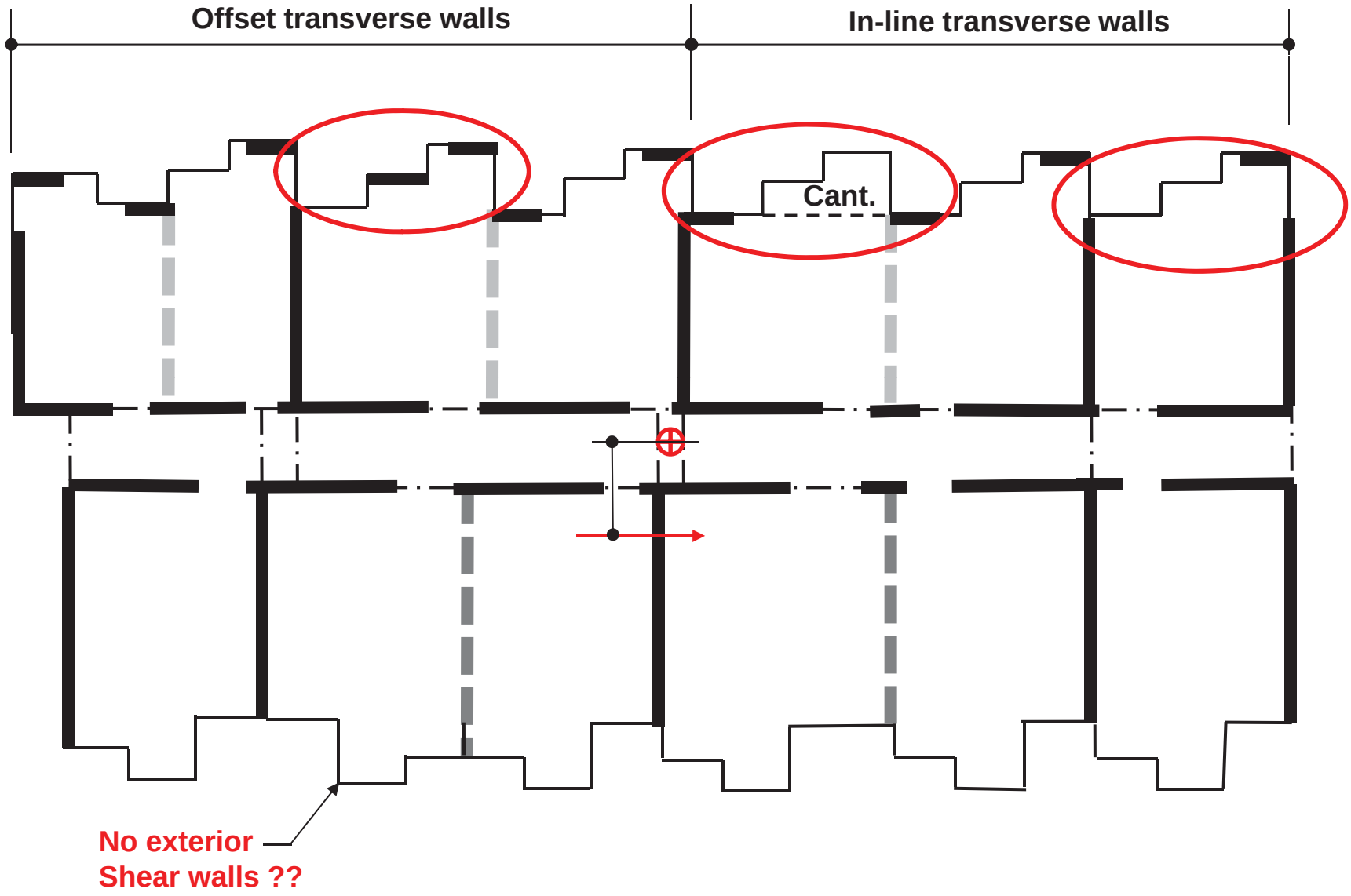


Typical mid-rise multi-family structure at exterior wall line

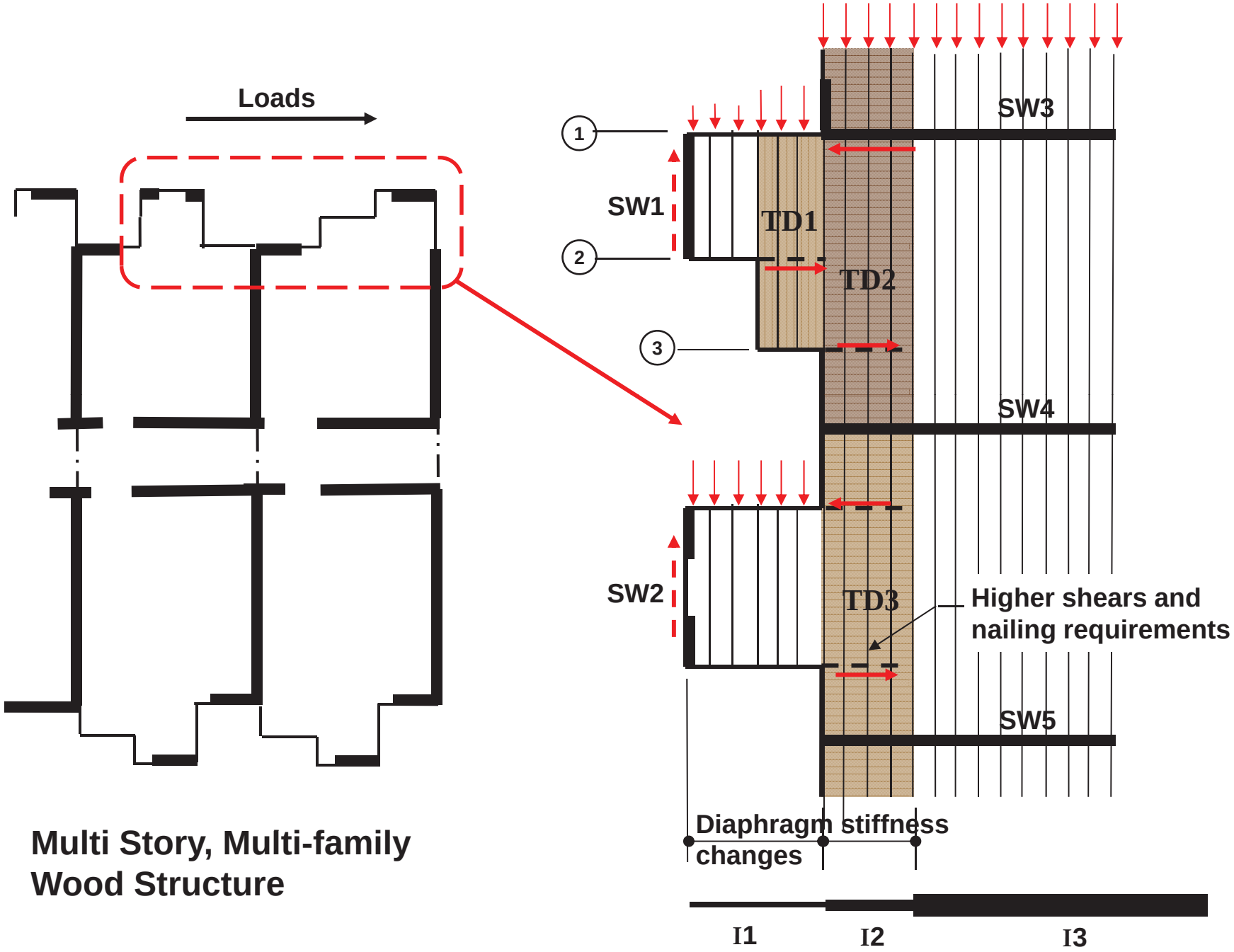
- Offset walls are typically assumed to act in the same line of lateral-force-resistance.
- Calculations are rarely provided showing how the walls are interconnected to act as a unit, or to verify that a complete lateral load path has been provided.
- Collectors are often not installed to transfer the disrupted forces across the offsets.

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.

Longitudinal Loading



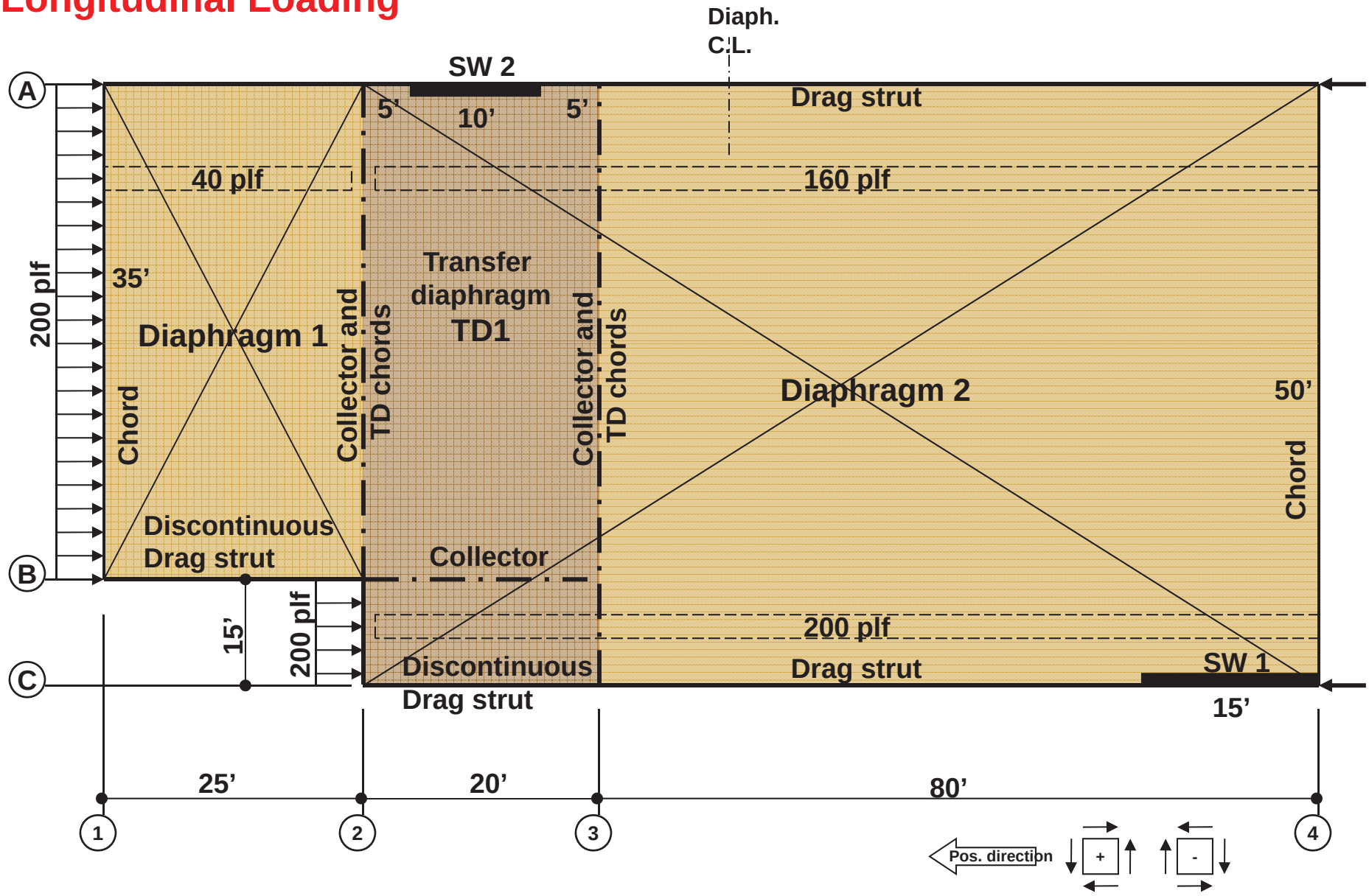
Flexible, semi-rigid, or rigid???

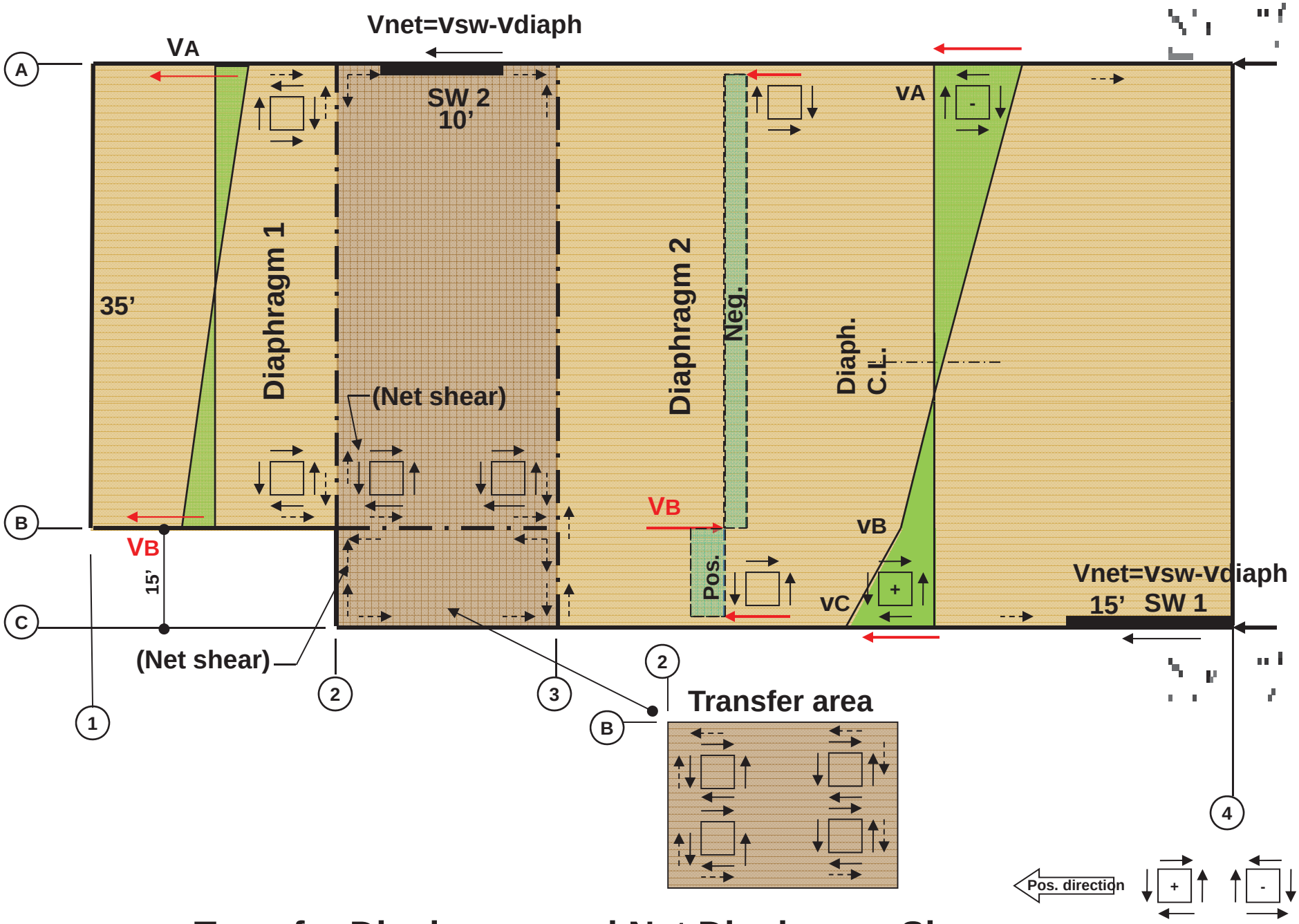


Multi Story, Multi-family Wood Structure

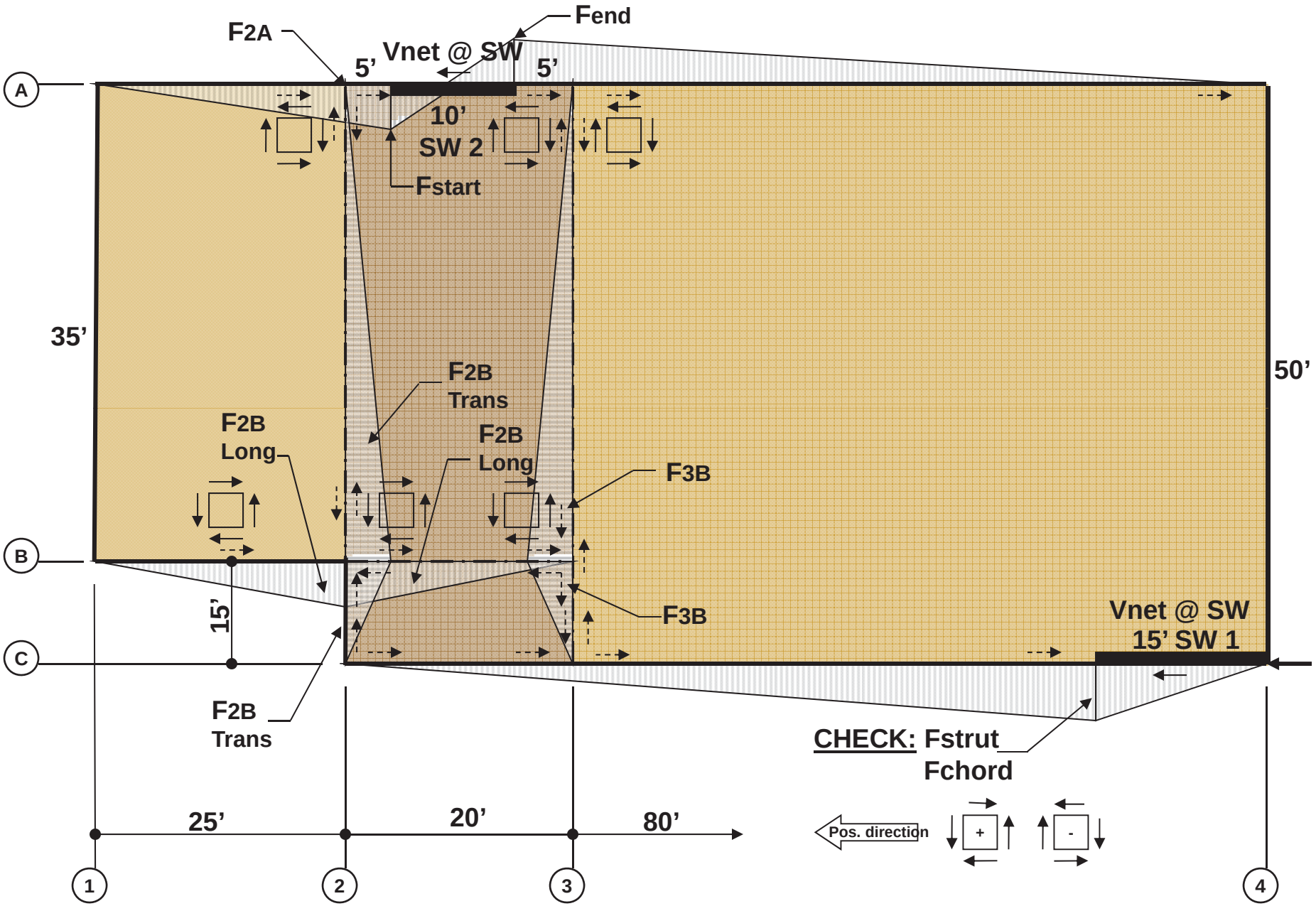
Example 2-Diaphragm with Horizontal End Offset

Longitudinal Loading





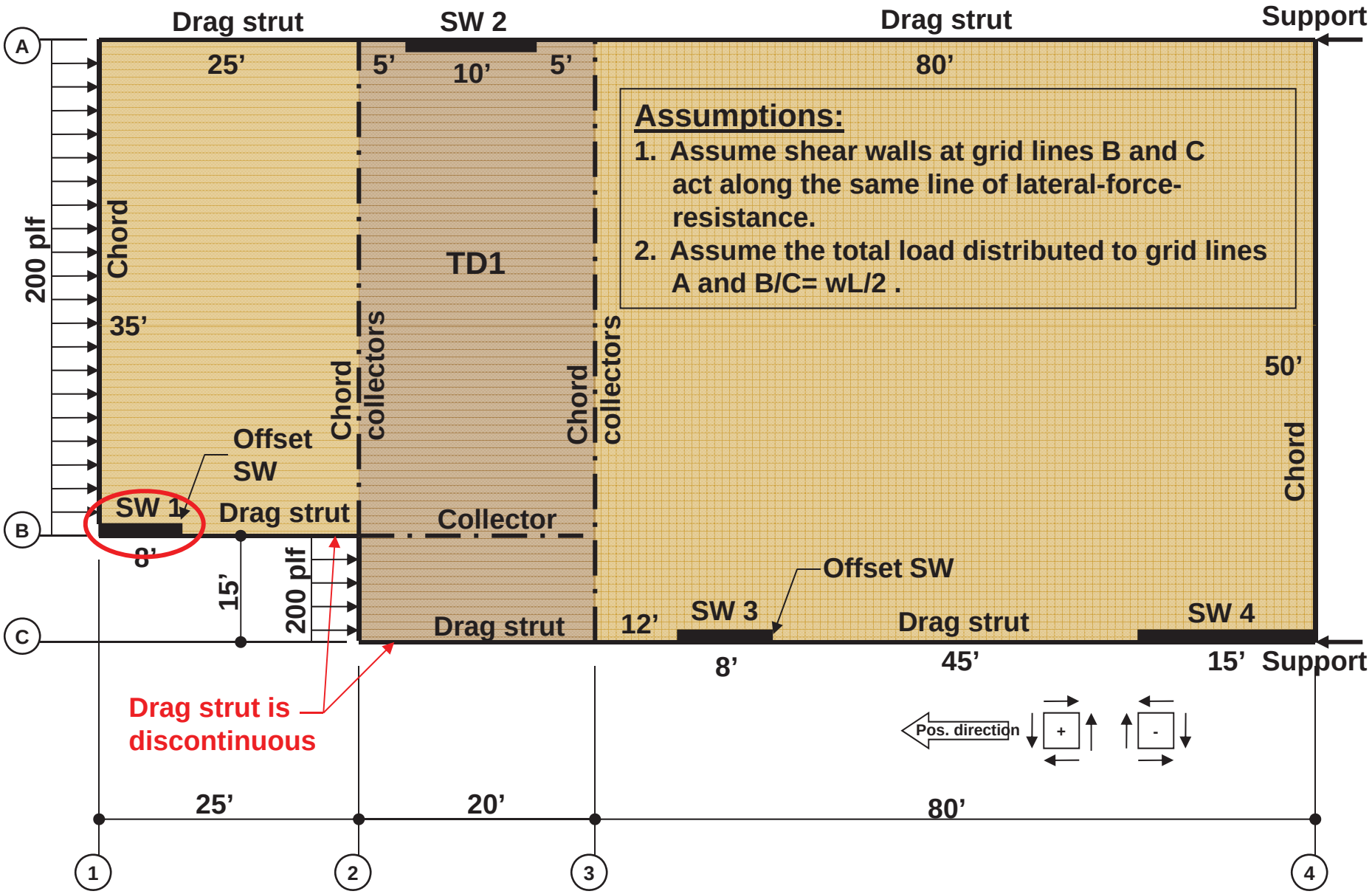
Transfer Diaphragm and Net Diaphragm Shear



Longitudinal and Transverse Collector/Strut Force Diagrams

Example 3-Diaphragm with Horizontal End Offset

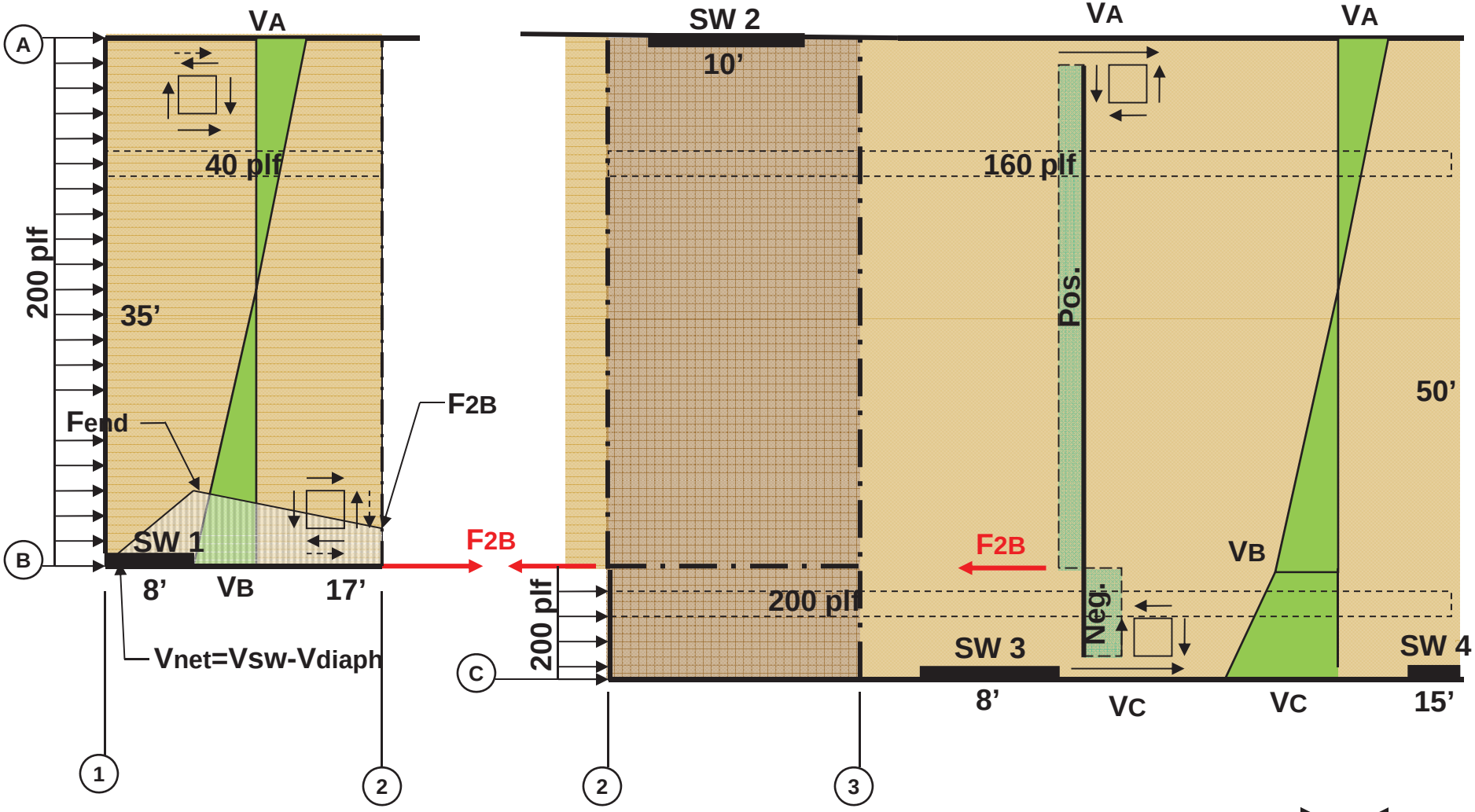
Longitudinal Loading-Offset Shear Walls



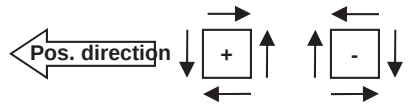
Total Shear to Shear Walls (Assumed)

Vsw2=wL/2 plf

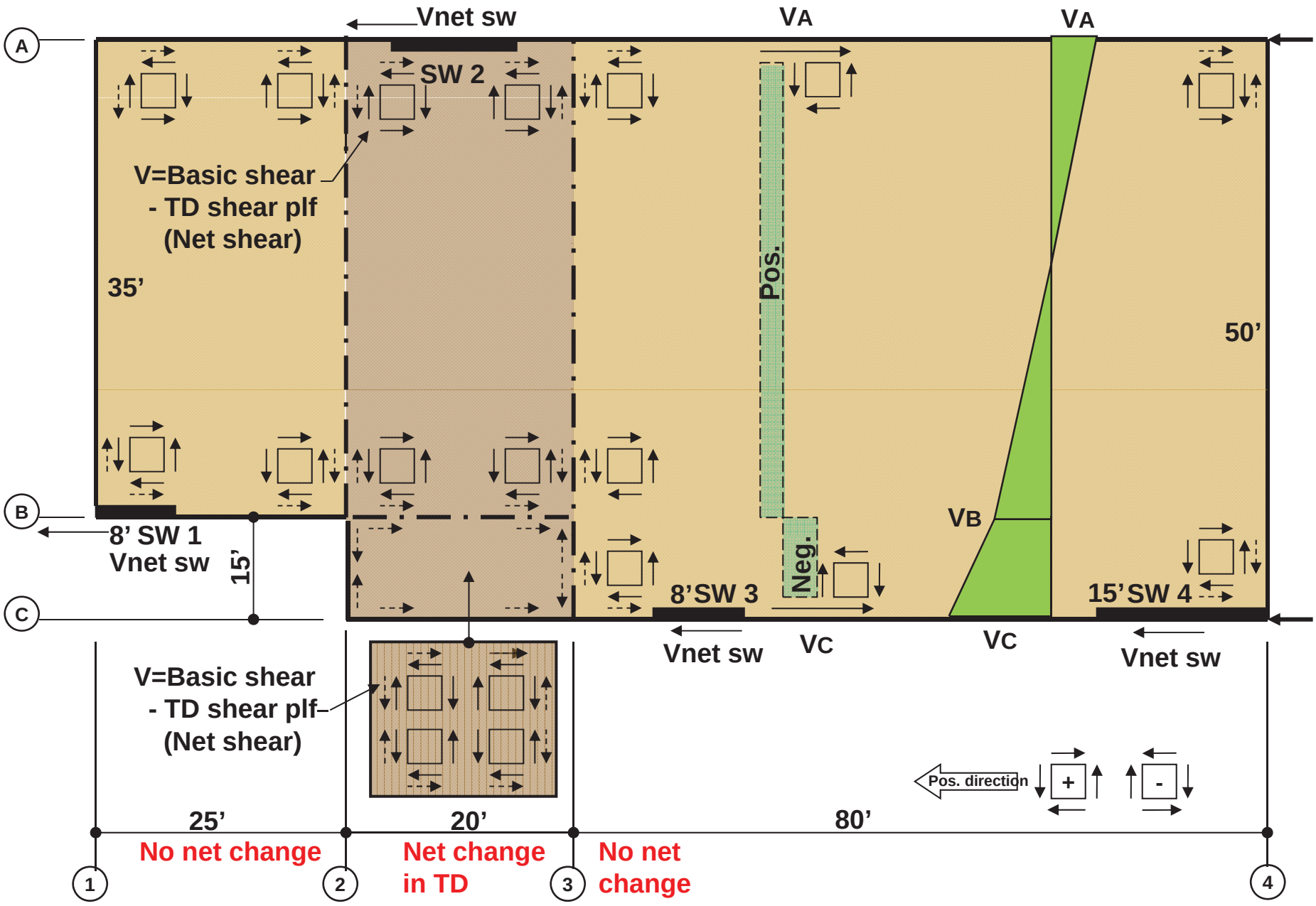
∑ Vsw1, sw3, sw4=wL/2, vsw=∑V1,3,4/(Lsw1+Lsw3+Lsw4) plf



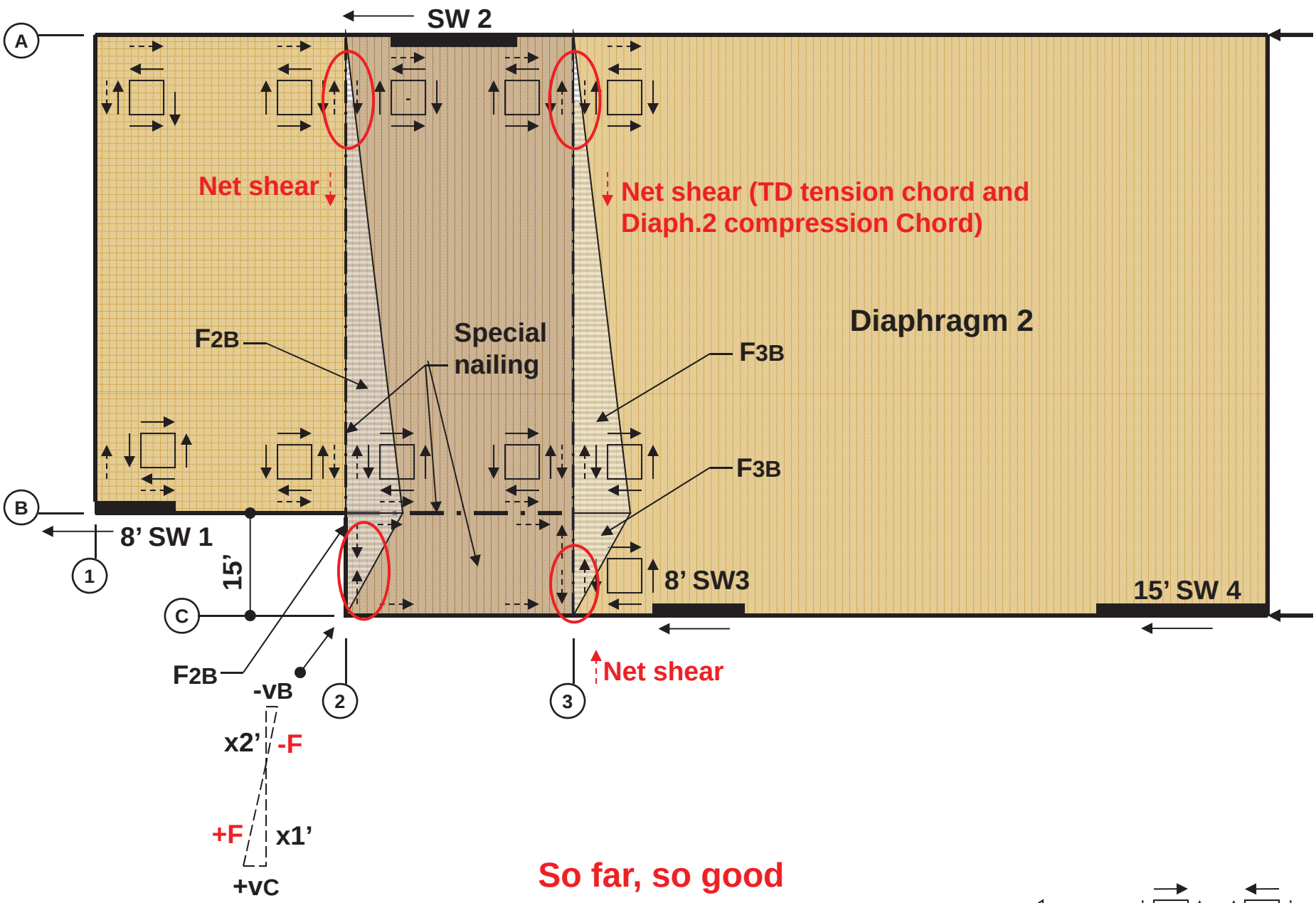
Determine Force transferred Into Transfer Diaphragm



Basic Diaphragm Shears and Transfer Diaphragm Shear

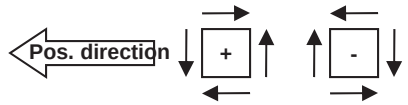


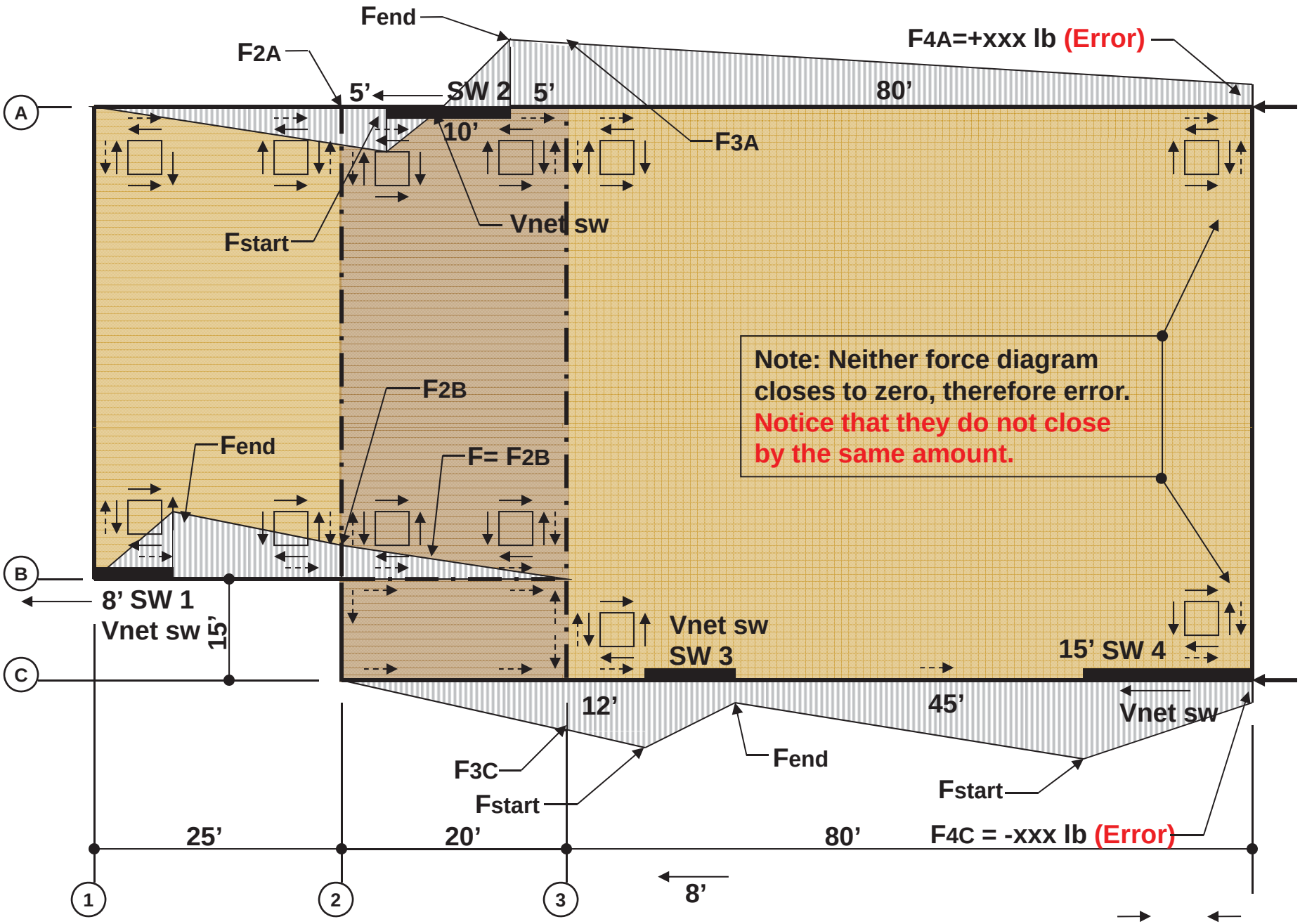
Net Diaphragm Shears



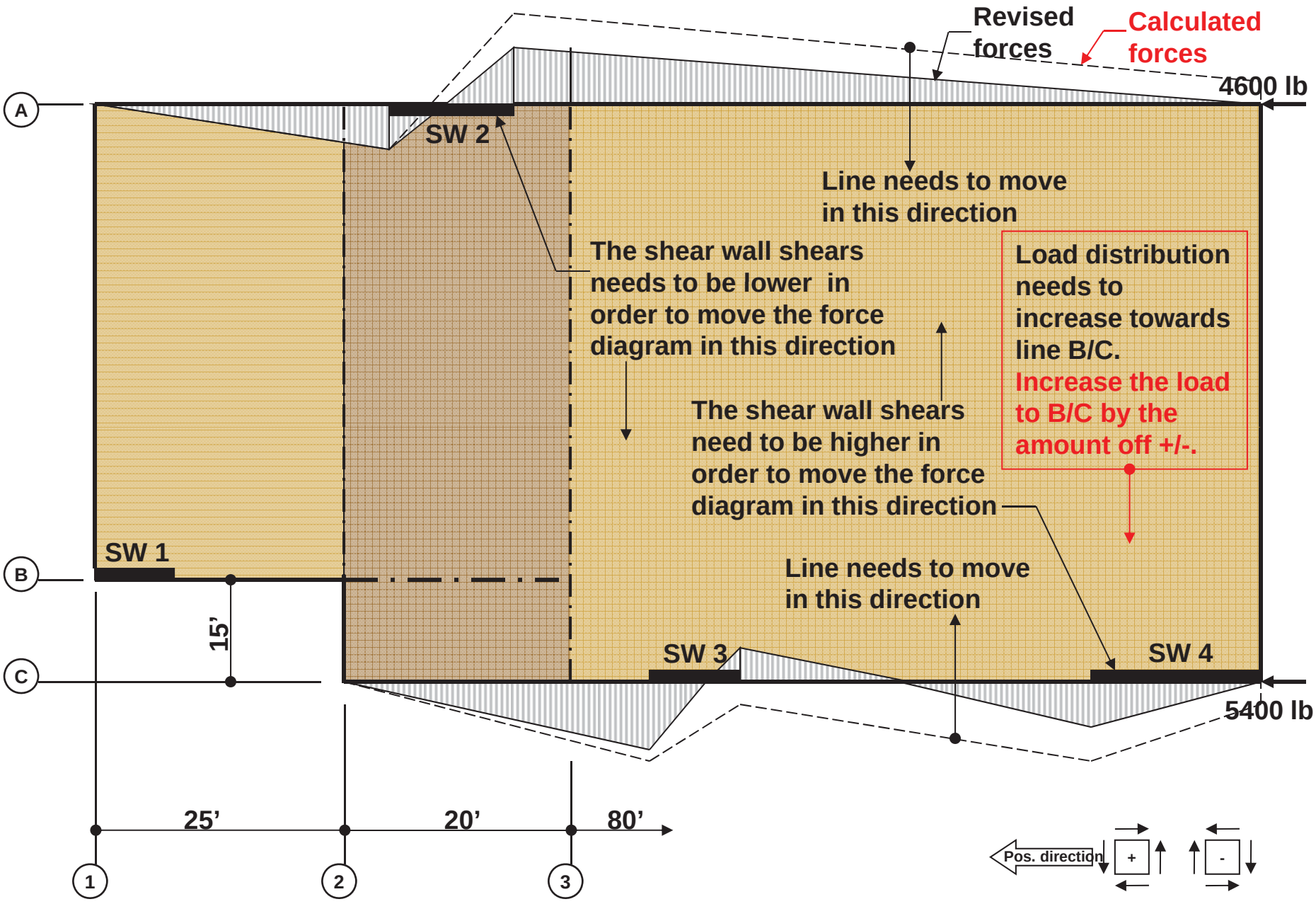
So far, so good

Transverse Collector Force Diagrams





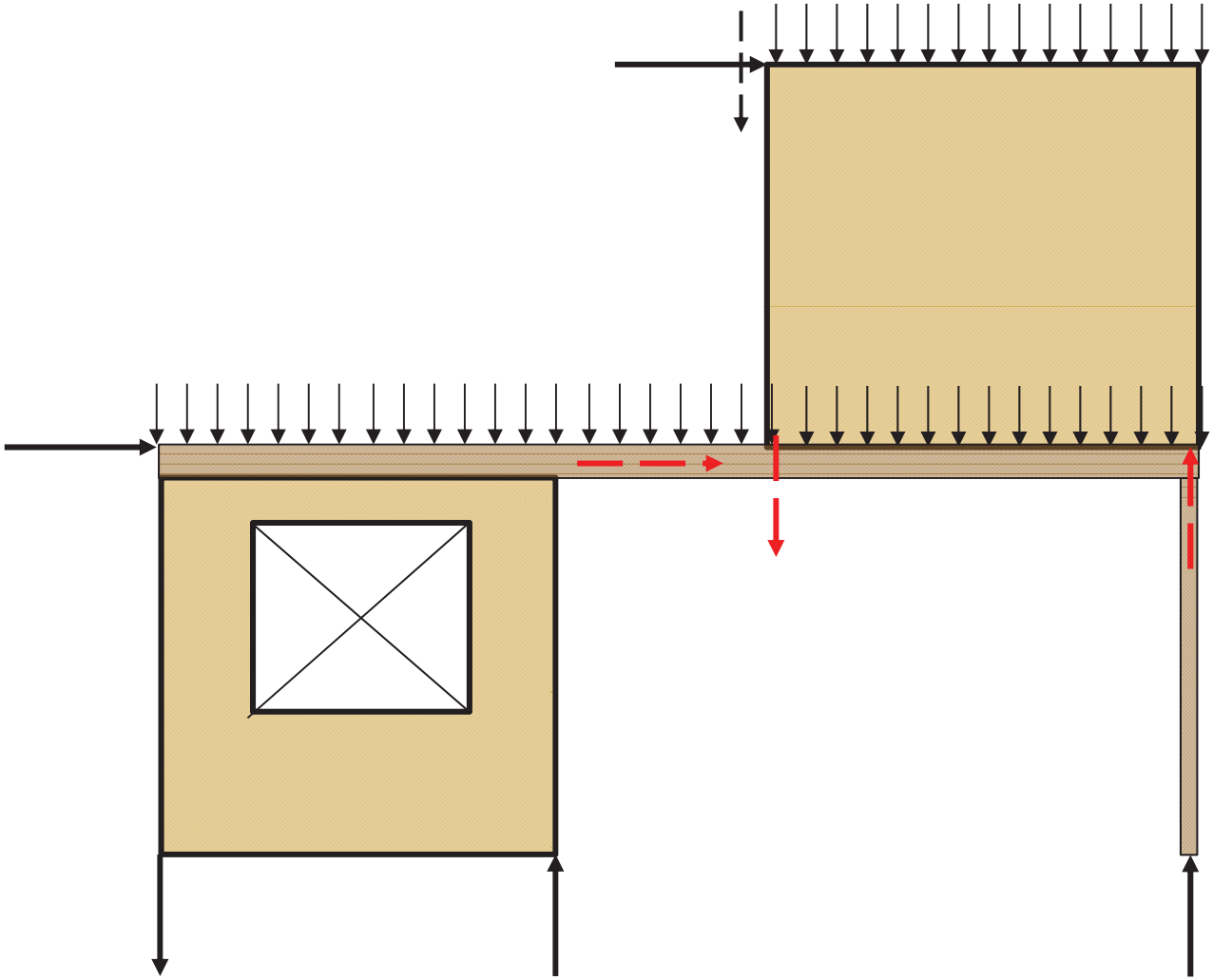
Longitudinal Strut Force Diagrams

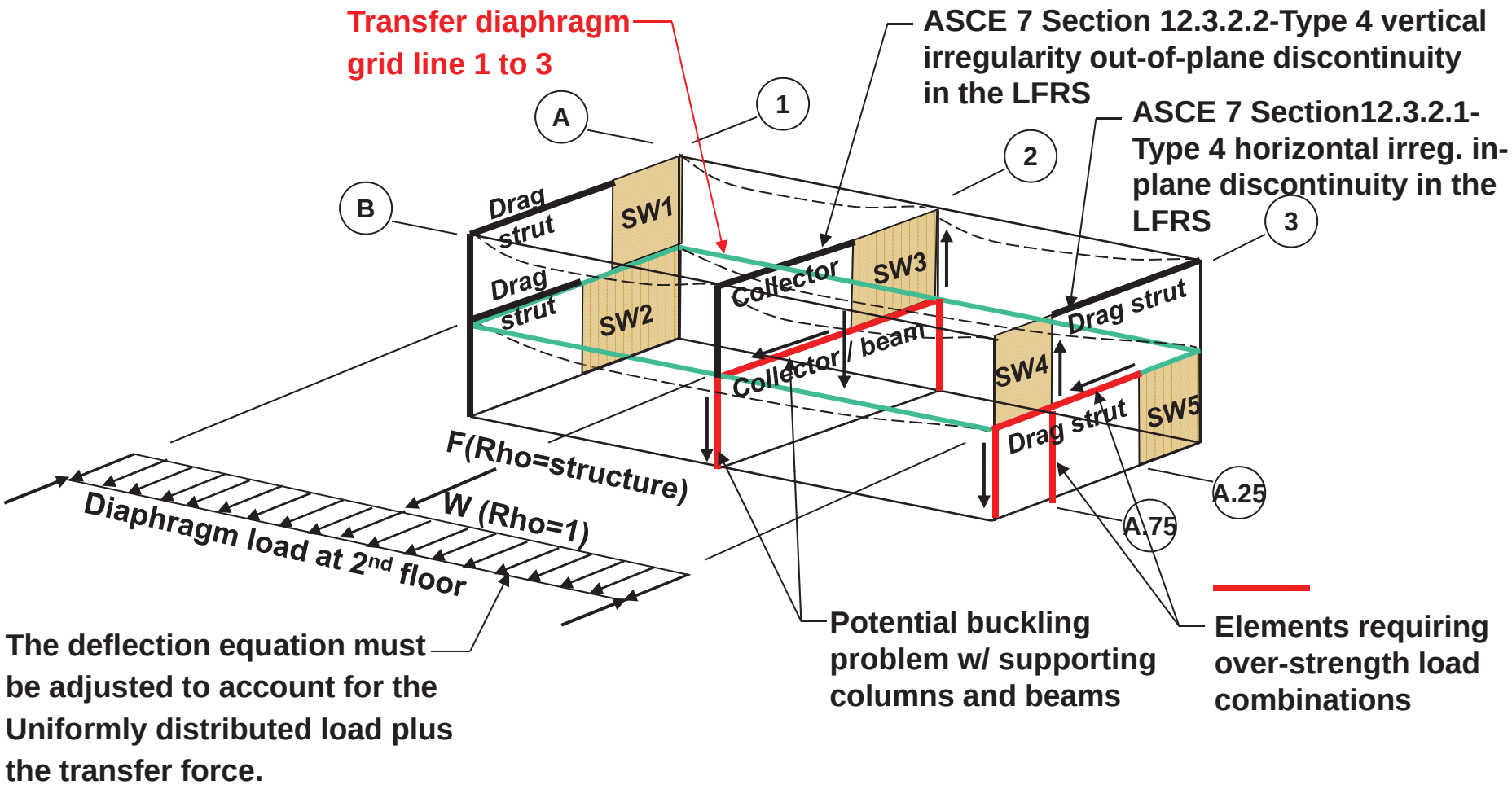


Adjusted Longitudinal Strut Force Diagrams (8% increase to B/C)

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

In-plane Offset Shear Walls



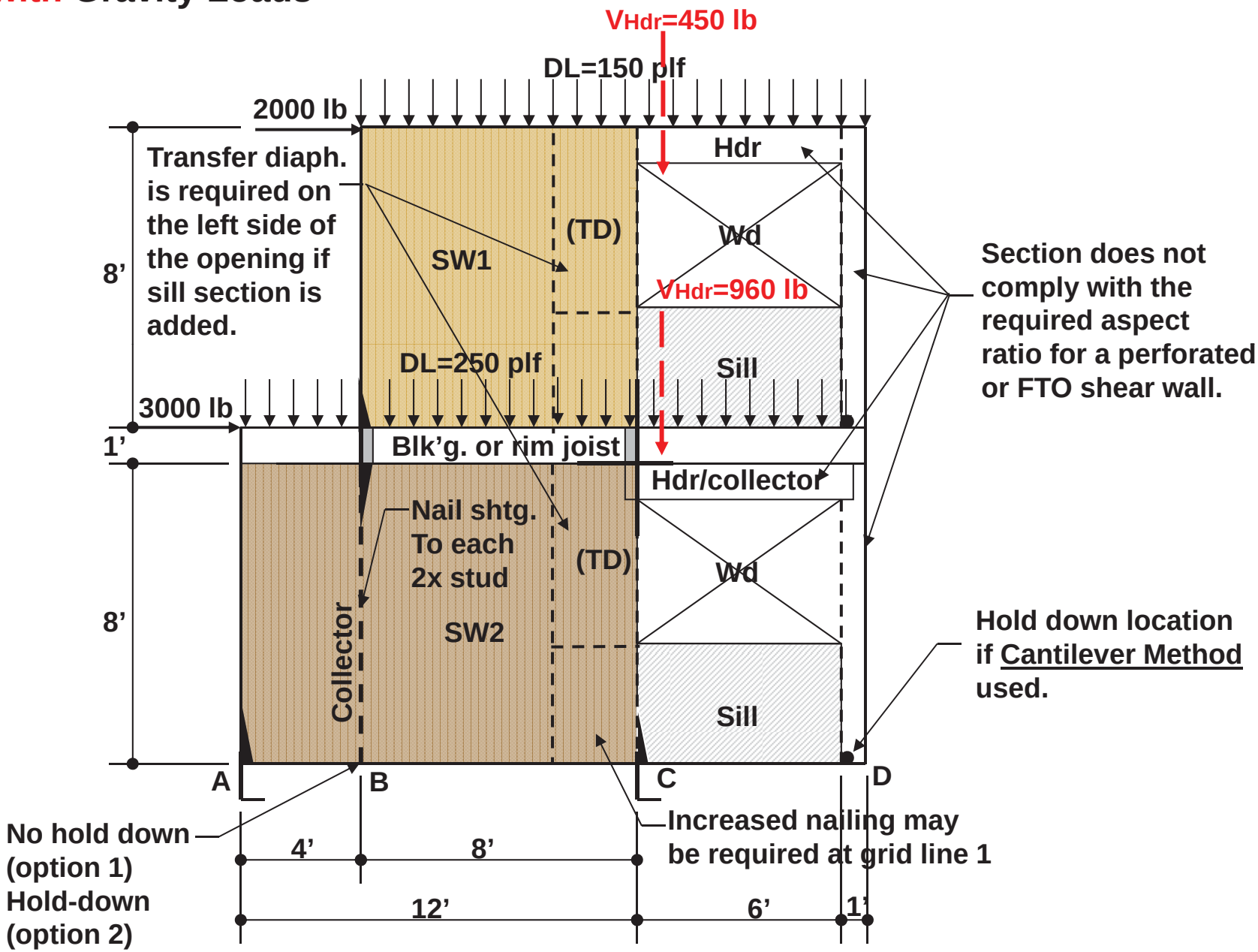


ASCE 7 Section 12.3.3.4-Type 4 vertical or horizontal irregularity in SDC D, E, F design forces determined from Section 12.10.1.1 (Fpx) shall be increased 25% (See section for details)

ASCE 7 section 12.3.3.3
Elements supporting discontinuous walls and frames (Rho required if SDC D thru F)

Example 4-In-plane Offset Segmented Shear Wall

-with Gravity Loads



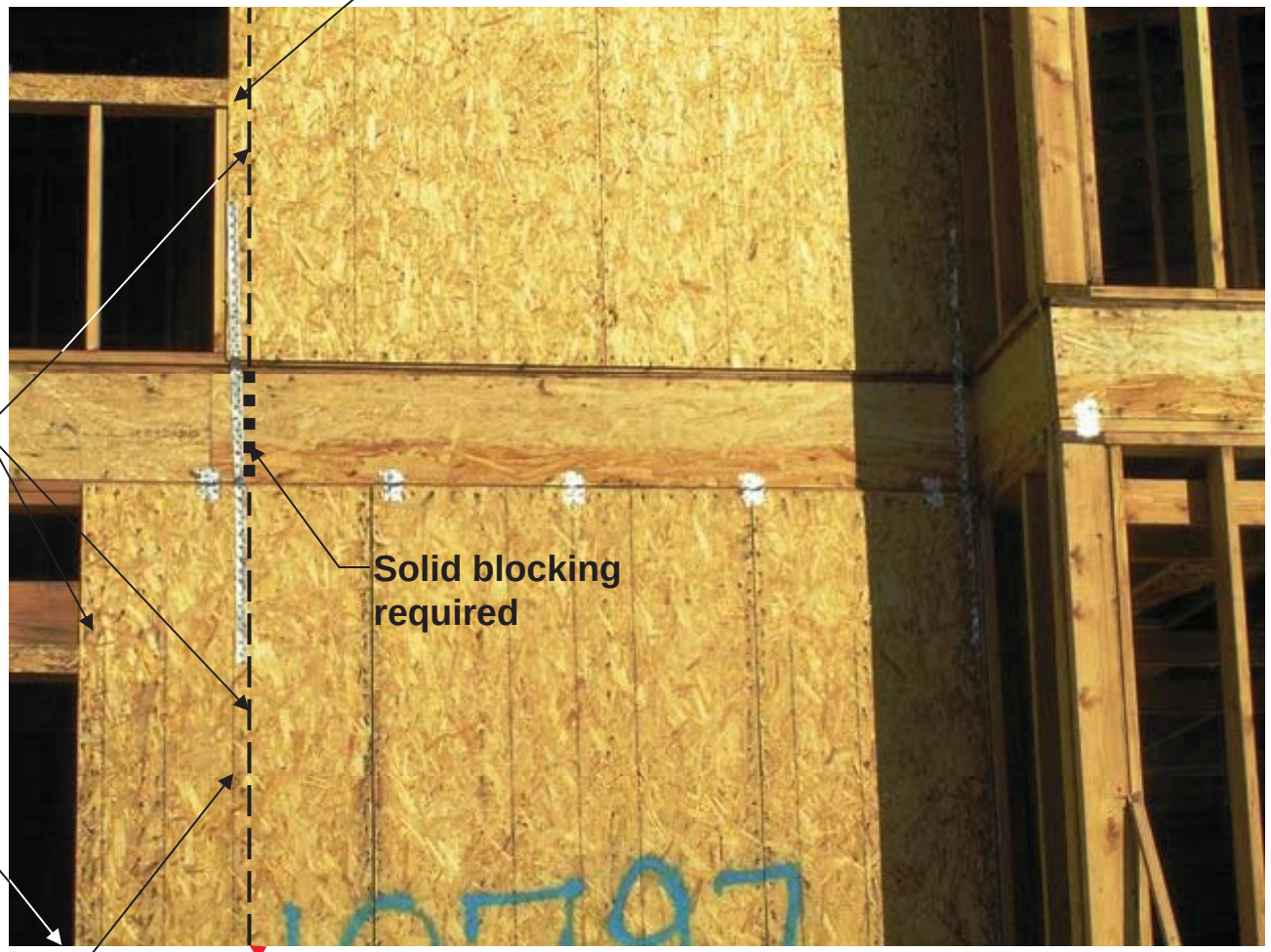
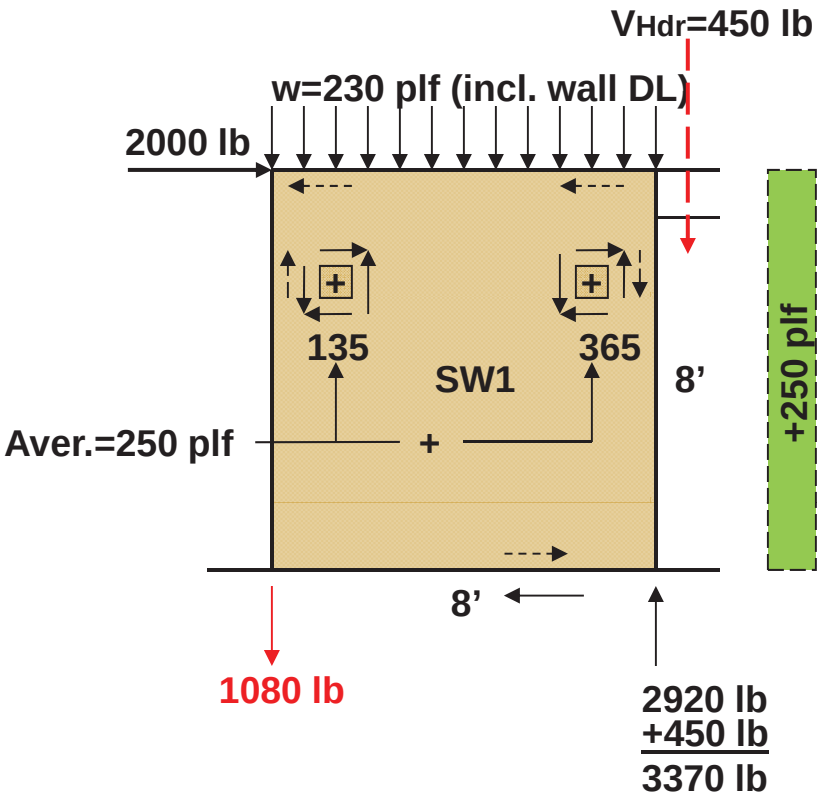
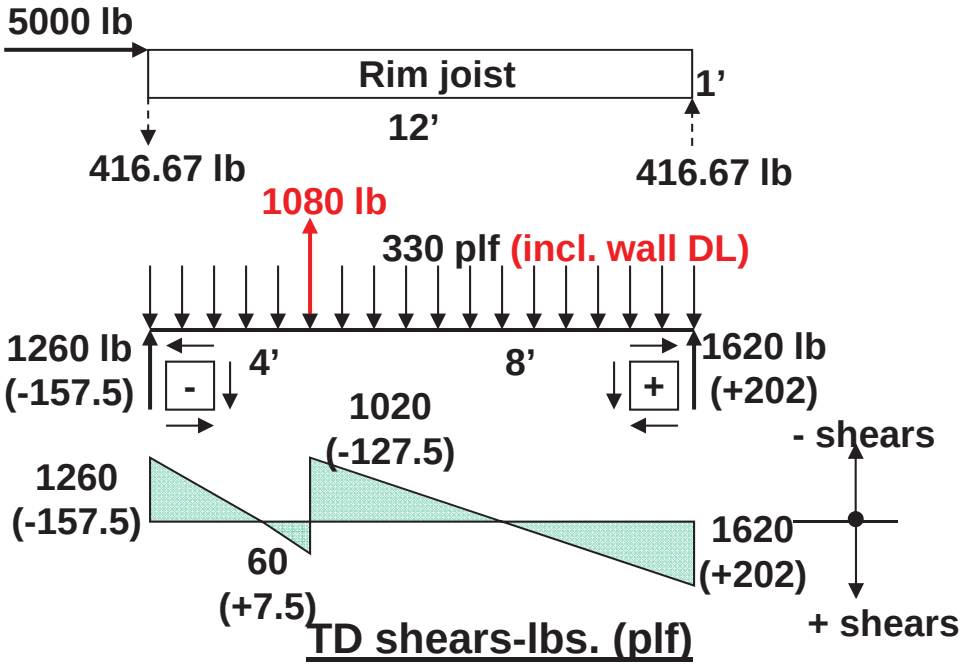


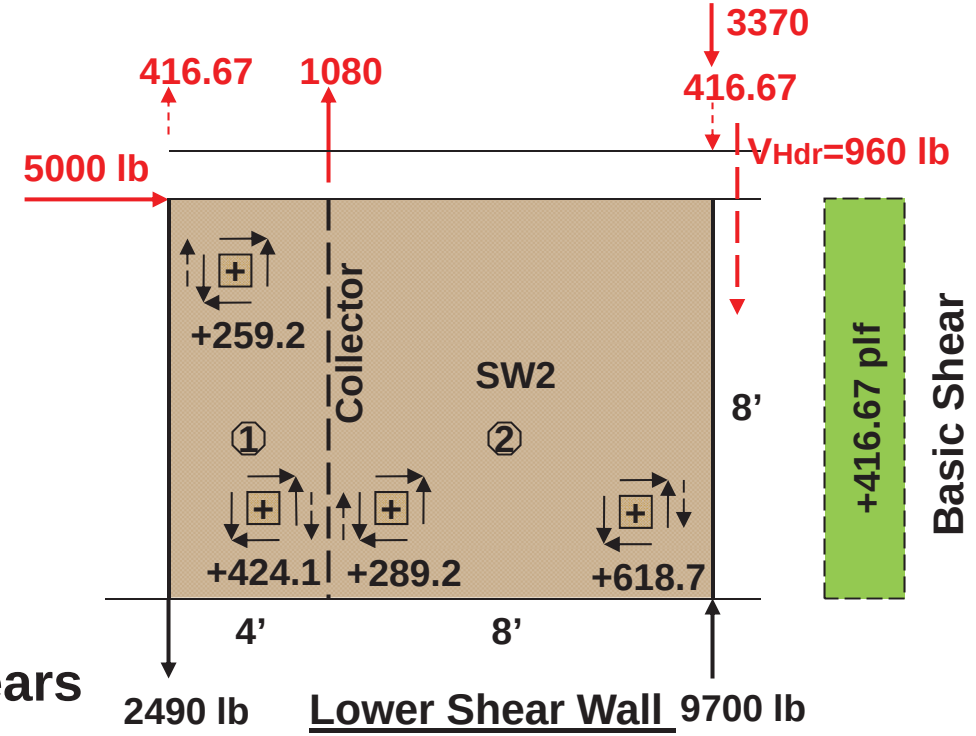
Photo-In-plane Offset Segmented Shear Walls



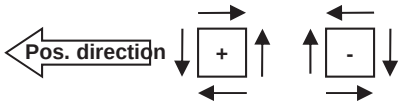
Upper Shear Wall



TD shears-lbs. (plf)

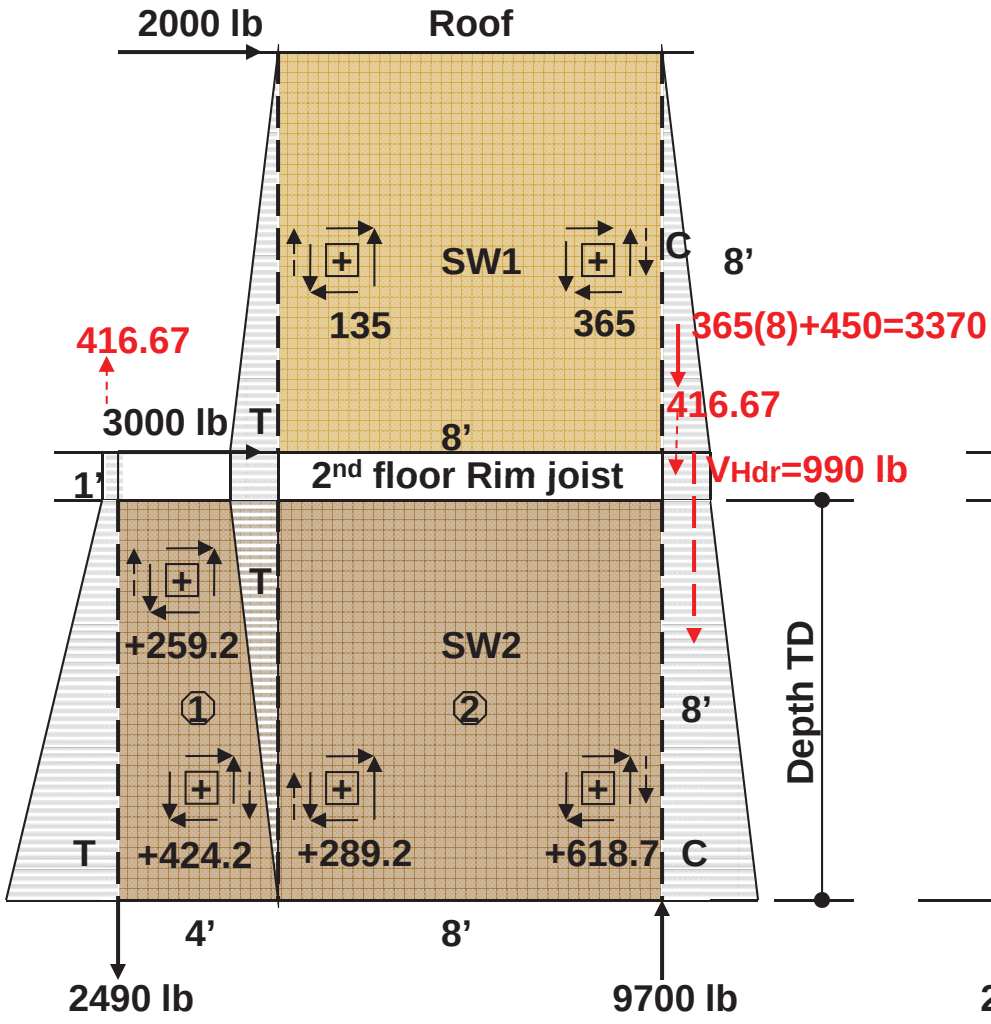


Lower Shear Wall



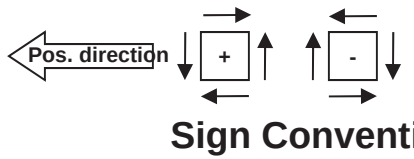
Sign Convention

Wall and Transfer Diaphragm Shears



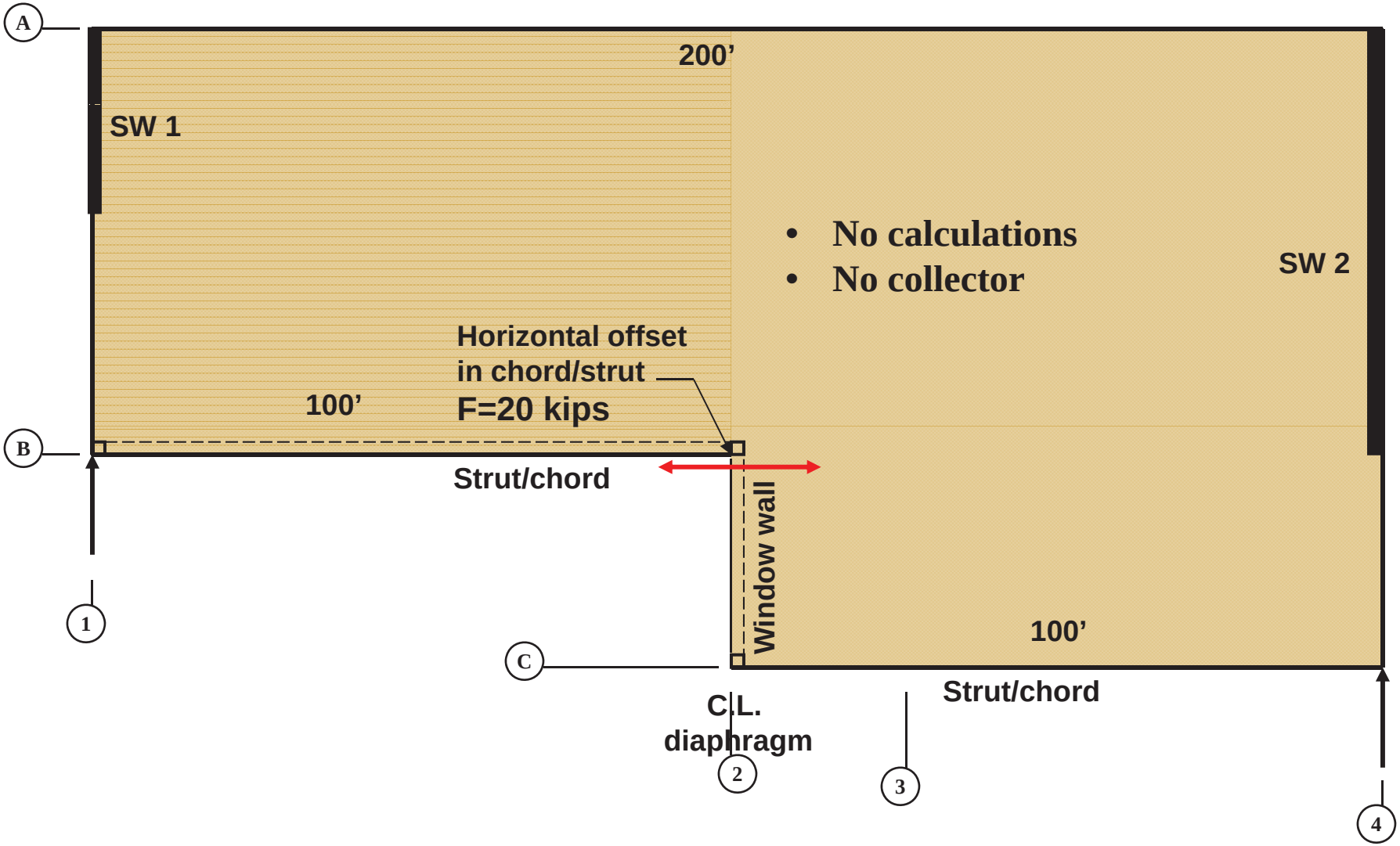
Vertical Collector Forces

Horizontal Collector Forces

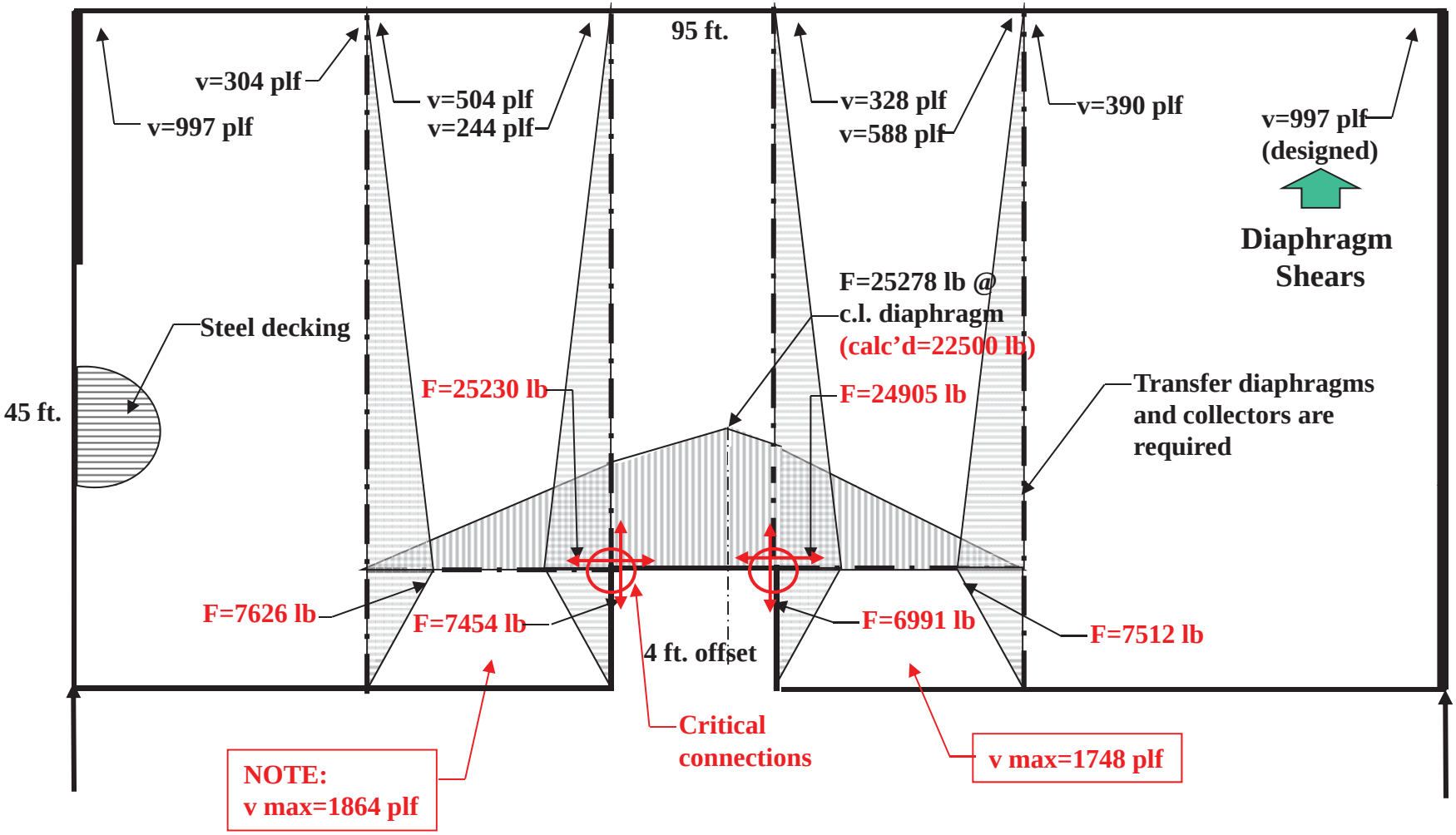


Sign Convention

Collector Force Diagrams



Actual Project



- Diaphragm designed as a simple rectangular diaphragm, no offset, using only a spreadsheet.
- Checked only diaphragm shear and chord force (maximum depth, not offset depth).
- No collectors, connection designs or details at re-entrant corners.
- Forces on trusses at collectors were not called out on drawing.

Actual Project

QUESTIONS?

This concludes The American Institute of Architects Continuing Education Systems Course

Part 2- Offset Shear Walls

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