WOOD-OVER-PODIUM DESIGN TIPS

Lateral Design and Detailing for Wood-over-Podium Construction

H+O

STRUCTURAL ENGINEERING

BOSTON | DENVER

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WOOD OVER-PODIUM: WHAT IS A PODIUM?

WHAT IS A PODIUM?

IBC 510.2 – HORIZONTAL BUILDING SEPARATION ALLOWANCE

A BUILDING SHALL BE CONSIDERED AS SEPARATE AND DISTINCT BUILDINGS FOR THE PURPOSE OF DETERMINING AREA LIMITATION, CONTINUITY OF FIRE WALLS, LIMITATION OF NUMBER OF STORIES AND TYPE OF CONSTRUCTION WHERE ALL OF THE FOLLOWING CONDITIONS ARE MET:

1. THE BUILDINGS ARE SEPARATED WITH A HORIZONTAL ASSEMBLY HAVING A FIRE-RESISTANCE RATING OF NOT LESS THAN 3 HOURS
2. THE BUILDING BELOW THE HORIZONTAL ASSEMBLY IS OF TYPE IA CONSTRUCTION.
3. AND MORE….SEE IBC!

MAX PODIUM STORIES?

IBC 2012 (AND PREVIOUS VERSIONS) A PODIUM WAS LIMITED TO 1-STORY IN HEIGHT. 4-ON-1 AND 5-ON-1

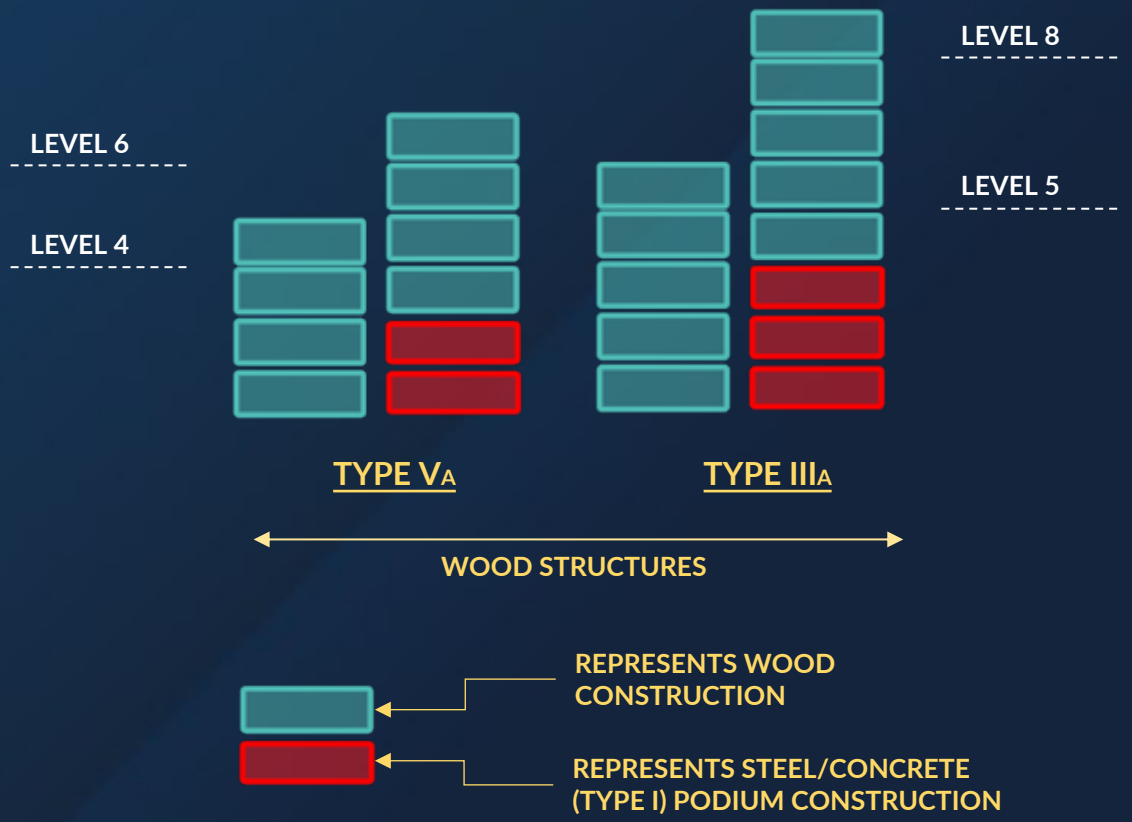
STARTING IN IBC 2015, THIS LIMIT WAS REMOVED ALLOWING FOR PODIUMS TALLER THAN ONE STORY. NOW THE MAX OVERALL BUILDING HEIGHT OF THE MORE RESTRICTIVE CONSTRUCTION TYPE WILL LIMIT THE PODIUM HEIGHT. 4-ON-2 AND 5-ON-2, 5-ON-3

WOOD OVER-PODIUM: HOW TALL?

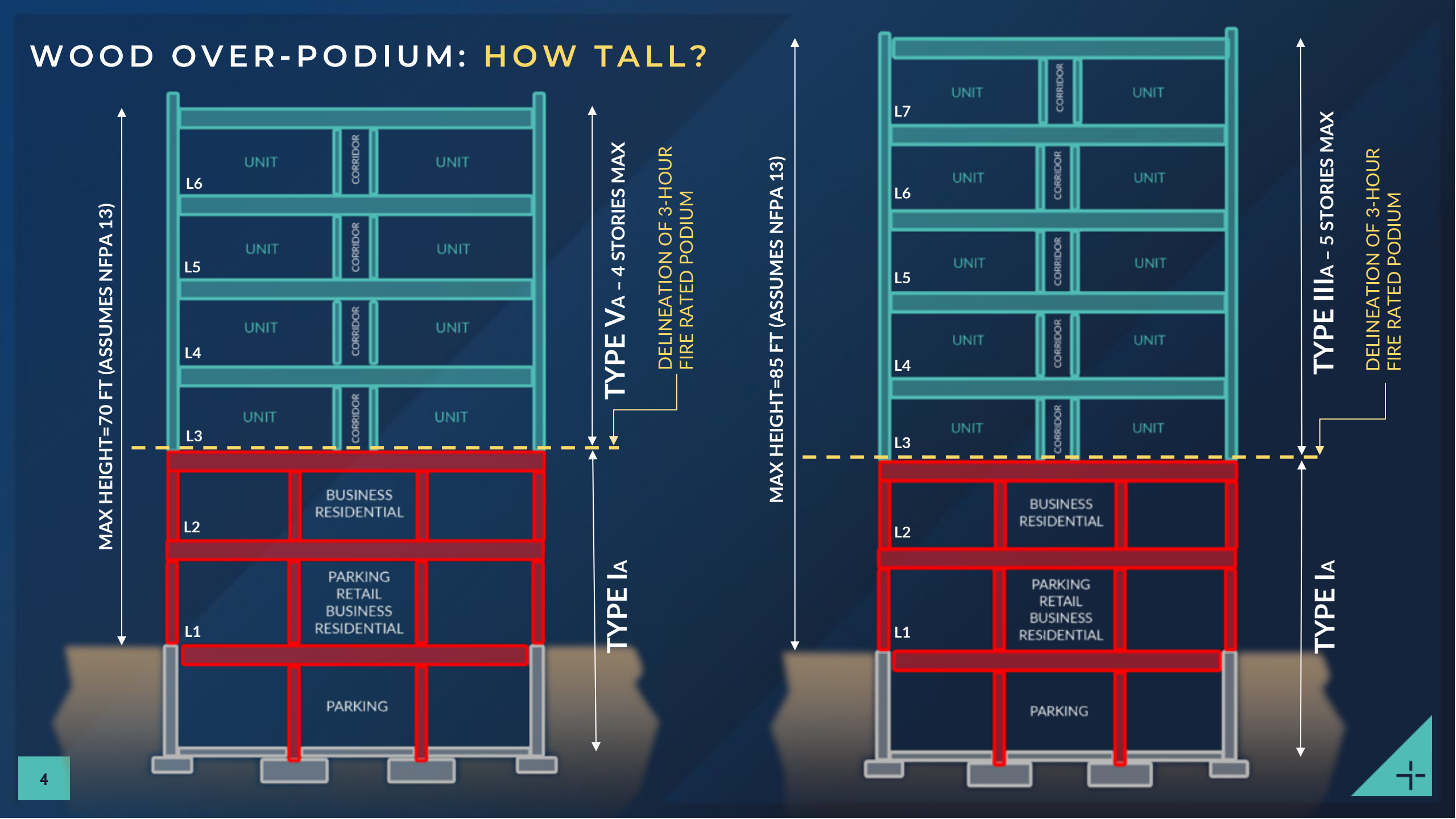
MAX BUILDING SIZES DEPENDING ON CONSTR. TYPE

	TYPE IIIA	TYPE IIIB	TYPE VA	TYPE VB
MAX STORIES	5	5	4	3
MAX BUILDING HEIGHT	85 FT	75 FT	70 FT	60 FT

-ASSUMES RESIDENTIAL USE TYPE R-2
-ASSUMES AUTOMATIC SPRINKLERS
-BASED ON IBC 2015



WOOD OVER-PODIUM: HOW TALL?

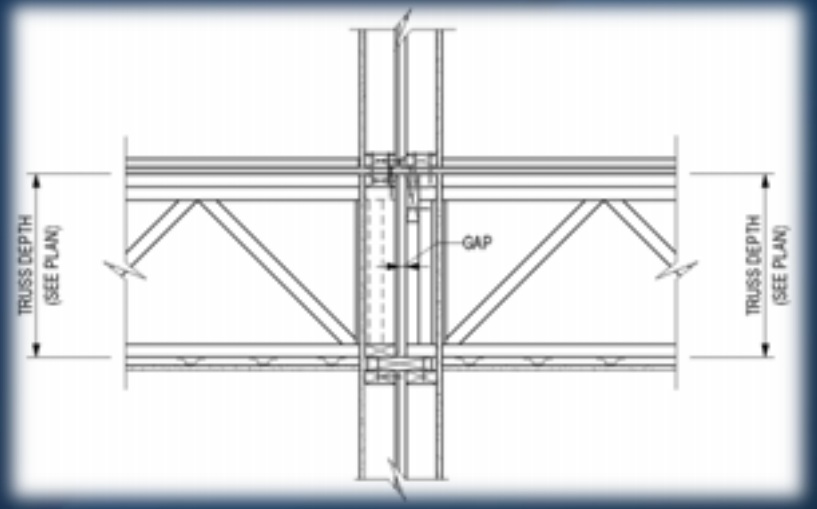


TYPICAL FRAMING

1. OPEN WEB FLOOR TRUSSES
2. CORRIDOR FRAMING 2X10@16” o.c.
3. ¾” SUBFLOOR + ACOUSTIC MAT + GYPCRETE
4. TRUSSES TYPICALLY RUN PARALLEL TO CORRIDOR
    1. MAXIMIZES DEAD LOAD ON SHEAR WALLS
    2. REDUCES LOAD LANDING ON SLAB EDGE
    3. EXTERIOR WALL HEADERS NON-BEARING
5. DOUBLE PARTITION WALL

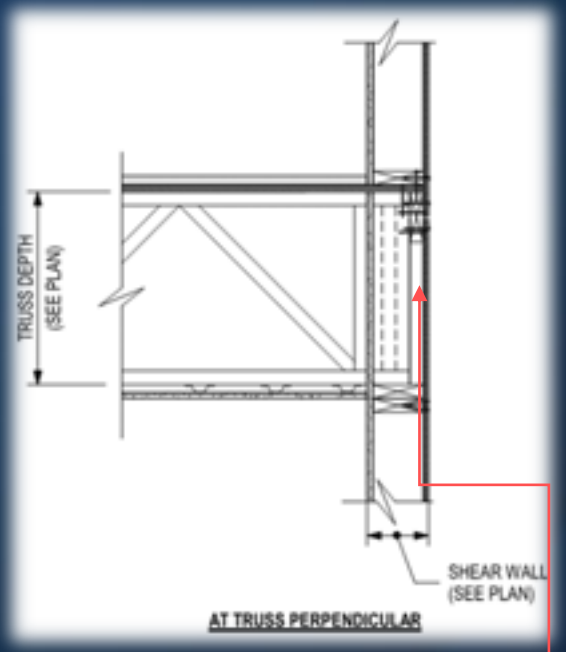
GRAVITY – HIGH AXIAL LOADS

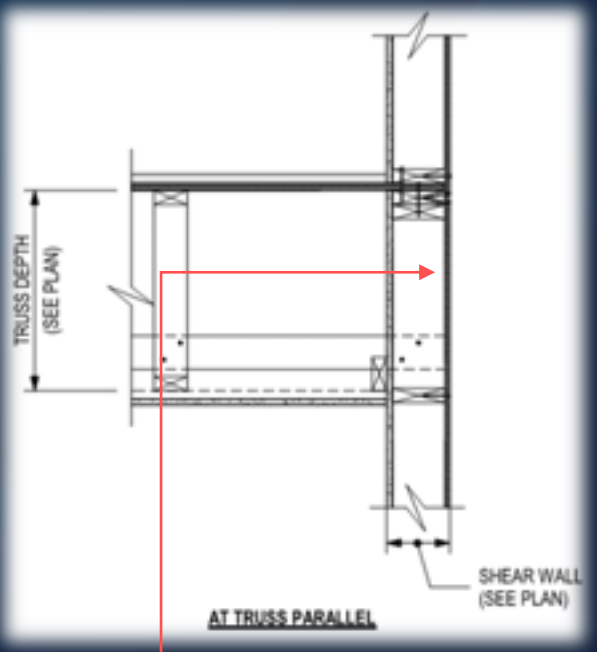
1. GRAVITY LOADS BECOME SUBSTANTIAL AT THE LOWER LEVELS
    1. EXPECT BEARING WALLS TO HAVE BUILT UP STUDS AT LOWER LEVELS, (3)-2X6 @ 24” O.C. FOR EXAMPLE
    2. DOUBLE PARTITION WALLS CAN BE DOUBLE 2X4 WALLS
    3. AT NON-DOUBLE PARTITION WALLS, IF POSSIBLE, USE 2X6 WALLS AT BEARING WALLS, NOT 2X4
2. STACKING WOOD POSTS BECOME LARGE. AVOID LARGE BEAM SPANS WHERE POSSIBLE.
3. THE CONTROLLING FACTOR FOR POST AND STUD SIZING IS OFTEN THE SILL/TOP PLATES LOADED PERPENDICULAR TO THE GRAIN



GRAVITY – SHRINKAGE CONSIDERATIONS

- BE AWARE OF SHRINKAGE
- LOOK FOR:
  - MASONRY SHAFTS
  - MASONRY VENEERS
  - PLUMBING RUNS
  - CHANGES IN VERTICAL MATERIAL CONSTRUCTION TYPES
- DETAIL TO MINIMIZE SHRINKAGE
- NOTIFY CONTRACTOR OF THIS





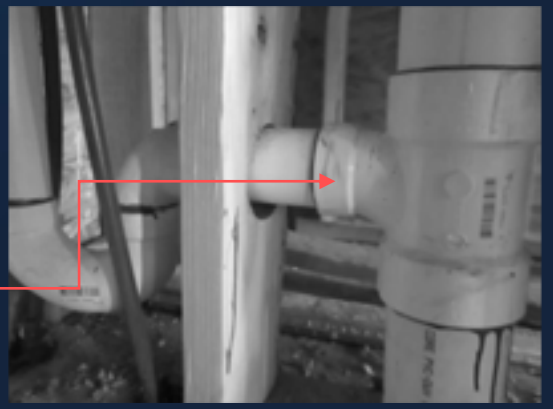
NO RIM BOARDS

<WOOD FRAMED STRUCTURE SHRINKAGE ESTIMATES>					
LEVEL	2	3	4	5	ROOF
TOTAL SHRINKAGE AT FLOOR	1/4"-3/8"	1/2"-3/4"	3/4"-1 1/8"	1"-1 1/2"	1 1/4"-1 7/8"

NOTES:

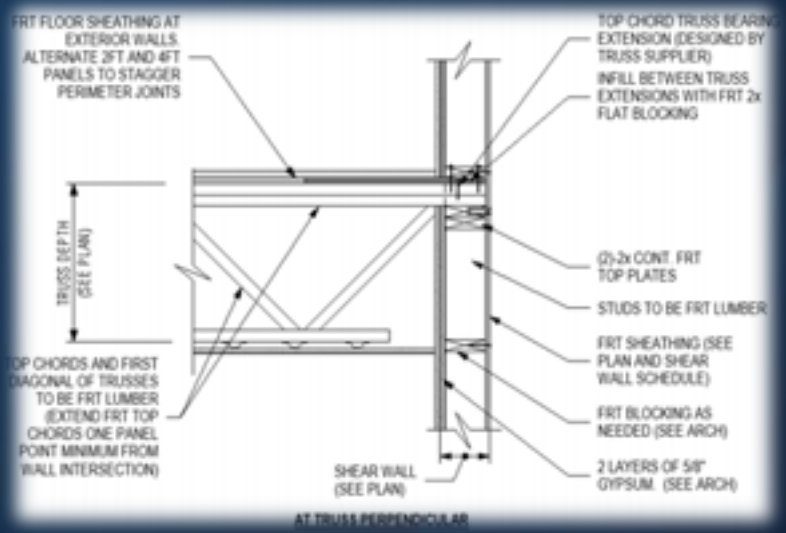
1. THE VALUES ABOVE ARE AN ESTIMATE OF THE TOTAL SHRINKAGE A GIVEN FLOOR WILL EXPERIENCE FROM THE INITIAL WOOD INSTALLATION TO THE POINT OF FINAL EQUILIBRIUM. THE ESTIMATED SHRINKAGE VALUES WITHIN THIS TABLE ARE BASED ON VARIOUS ASSUMPTIONS SUCH AS STARTING MOISTURE CONTENT OF LUMBER. ACTUAL LUMBER AND ENVIRONMENTAL CONDITIONS WILL IMPACT THE ACTURAL SHRINKAGE WHICH WE HAVE ATTEMPTED TO ENVELOPE BY PROVIDING A RANGE TO THE SHRINKAGE ESTIMATE
2. ALL PLUMBING SHOULD BE INSTALLED AND DETAILED TO BE ABLE TO ACCOMMODATE THIS MOVEMENT. EXAMPLES ARE USING FLEXIBLE COUPLINGS ON VERTICAL PLUMBING RISERS BETWEEN FLOORS AND WHERE T-JOINTS FROM A RISER PENETRATE A WOOD STUD. THESE JOINTS ARE INTENDED TO ALLOW THE MEP SYSTEMS TO COMPENSATE FOR THE ANTICIPATED SETTLEMENT. THE DESIGN AND SPECIFICATION FOR THESE SYSTEMS SHALL BE PROVIDED BY THE PLUMBING ENGINEER
3. AT FACADES WITH BRICK VENEER THE SETTLEMENTS ABOVE SHALL BE CONSIDERED IN WINDOW DETAILING. THE WINDOW ASSEMBLY WILL MOVE WITH THE WOOD WALL, MEANING IT WILL MOVE DOWN IN ELEVATION AS THE WOOD SHRINKS. CONVERSELY, THE BRICK VENEER WILL NOT SHRINK, IN FACT WILL EXPAND AS IT ABSORBS MOISTURE FROM THE ATMOSPHERE. THIS DEFERENTIAL MOVEMENT NEEDS TO BE ACCOMMODATED IN THE DETAILING OF THE WINDOW HEAD AND SILL. WE RECOMMEND THAT THE GC OR OWNER CARRY AN ALLOWANCE TO RECAULK ALL WINDOWS PENETRATING A BRICK VENEER APPROXIMATELY 1 YEAR AFTER THE INSTALLATION WHEN THE MAJORITY OF THE WOOD SHRINKAGE WILL HAVE OCCURRED.

USE FLEXIBLE COUPLING



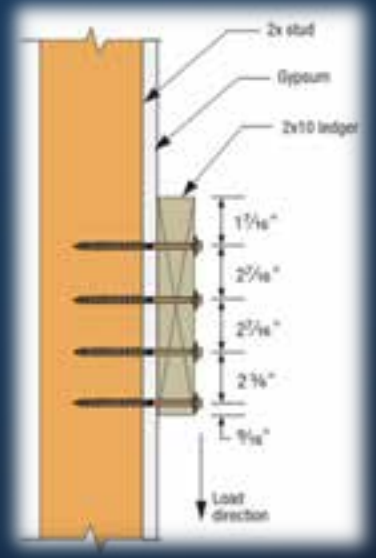
GRAVITY – TYPE IIIA DETAILING

- EXTERIOR **BEARING** WALLS NEED TO BE 2 HOUR RATED
- EXTERIOR WALLS NEED TO USE FIRE TREATED LUMBER
- TRANSFERS OF EXTERIOR BEARING WALLS (THINK BUILDING STEPS) NEED TO MAINTAIN THE 2-HR RATING TO THE PODIUM

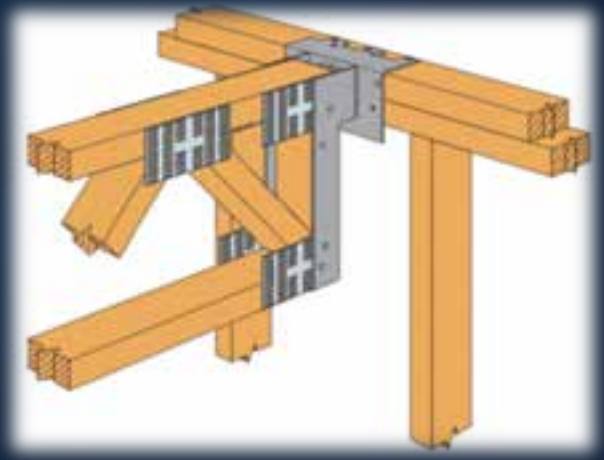


TOP CHORD BEARING TRUSS

FIRE RATED SHEATHING



LEDGER THRU DRYWALL



SIMPSON DGHF FIRE HANGER

LATERAL – ANALYSIS CONSIDERATIONS

1. WIND
2. SEISMIC
    1. 2-STAGE SEISMIC ANALYSIS (NEXT SLIDE)
3. STRENGTH DESIGN
    1. NAILING PATTERN
    2. HOLD-DOWN SIZING
4. DRIFT DESIGN
    1. LONGER WALLS
    2. INCREASED NAILING
    3. LARGER HOLD DOWN

$$\delta_{sw} = \frac{8vh^3}{EAb} + \frac{vh}{1000G_a} + \frac{h\Delta_a}{b}$$

FLEXURAL DEFORMATION

SHEAR DEFORMATION

HOLD DOWN ELONGATION

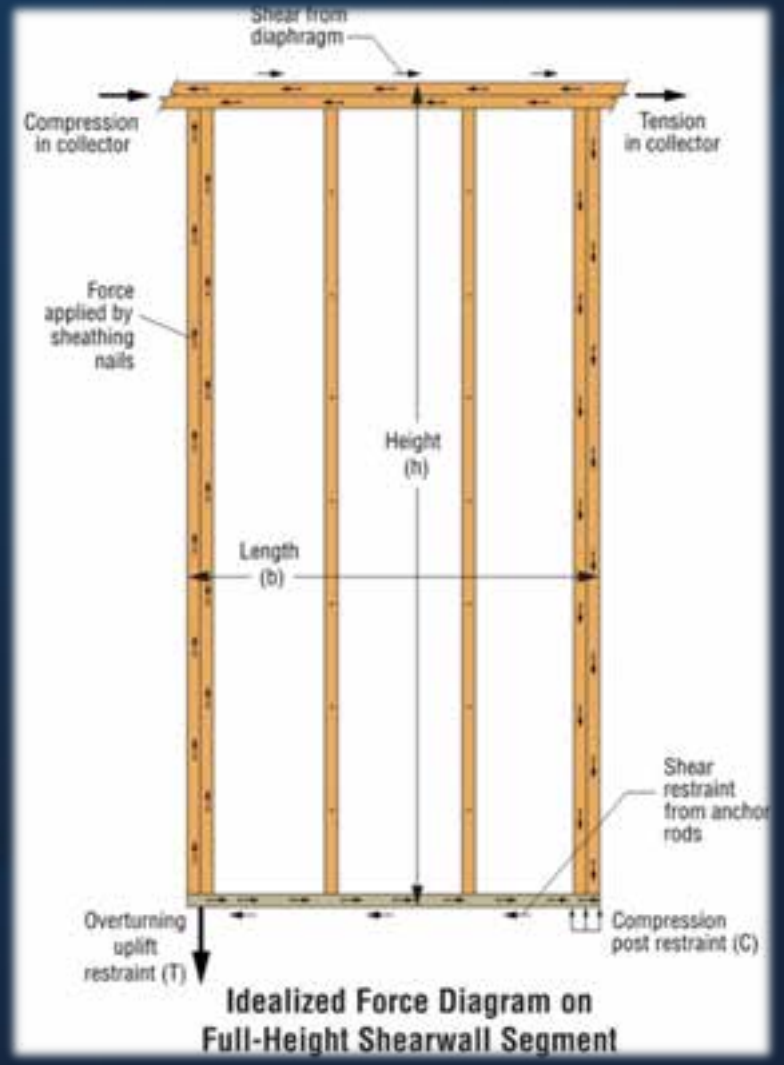


PHOTO BY SIMPSON

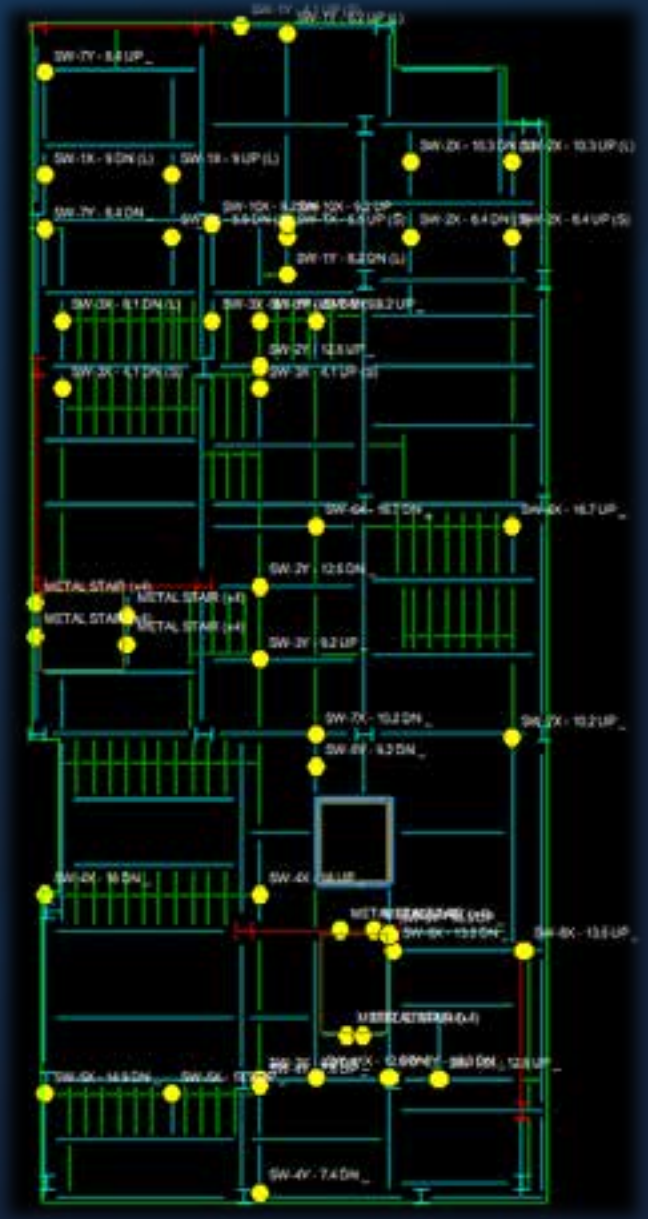
LATERAL – SEISMIC 2-STAGE ANALYSIS

1. TREAT WOOD LEVELS AS STAND-ALONE
2. AMPLIFY SEISMIC COMPONENT ONTO PODIUM
    1. R=6.5 @ WOOD SHEAR WALLS
    2. R~3 @ PODIUM

ASCE 7-10 SECTION 12.2.3.2 – TWO STAGE ANALYSIS PROCEDURE

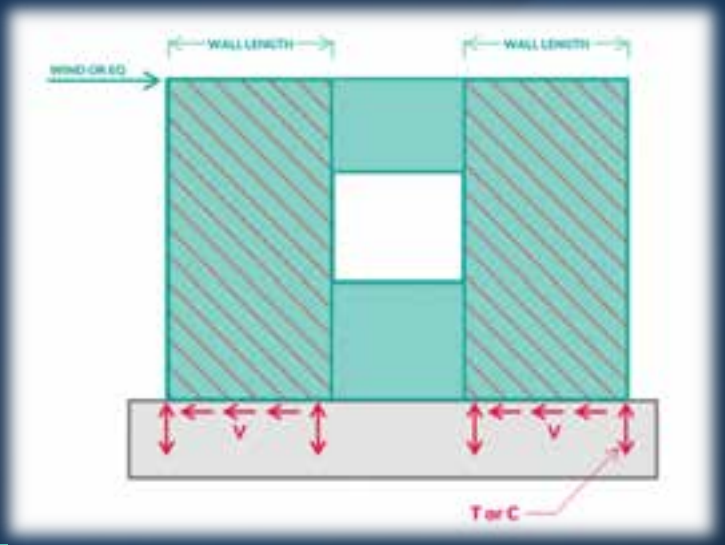
A two-stage equivalent lateral force procedure is permitted to be used for structures having a flexible upper portion above a rigid lower portion, provided the design of the structure complies with all of the following:

a. The stiffness of the lower portion shall be at least 10 times the stiffness of the upper portion.
b. The period of the entire structure shall not be greater than 1.1 times the period of the upper portion considered as a separate structure supported at the transition from the upper to the lower portion.
c. The upper portion shall be designed as a separate structure using the appropriate values of R and ρ.
d. The lower portion shall be designed as a separate structure using the appropriate values of R and ρ. The reactions from the upper portion shall be those determined from the analysis of the upper portion amplified by the ratio of the R/ρ of the upper portion over R/ρ of the lower portion. This ratio shall not be less than 1.0.
e. The upper portion is analyzed with the equivalent lateral force or modal response spectrum procedure, and the lower portion is analyzed with the equivalent lateral force procedure.

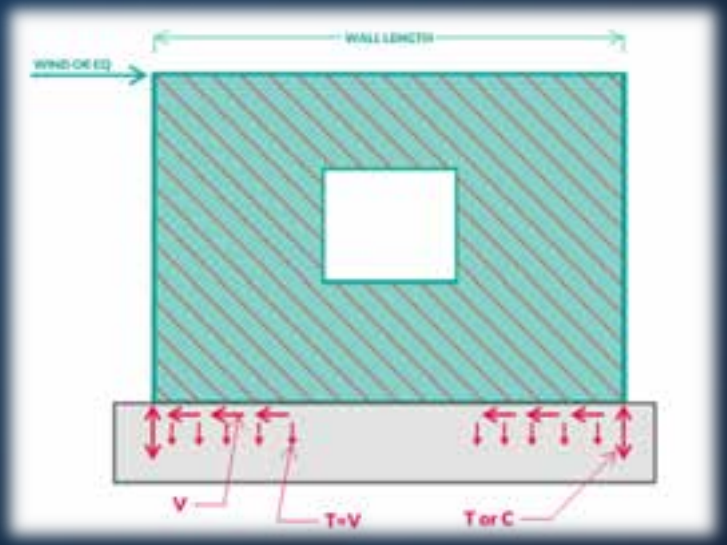


LATERAL – SHEAR WALL TYPES

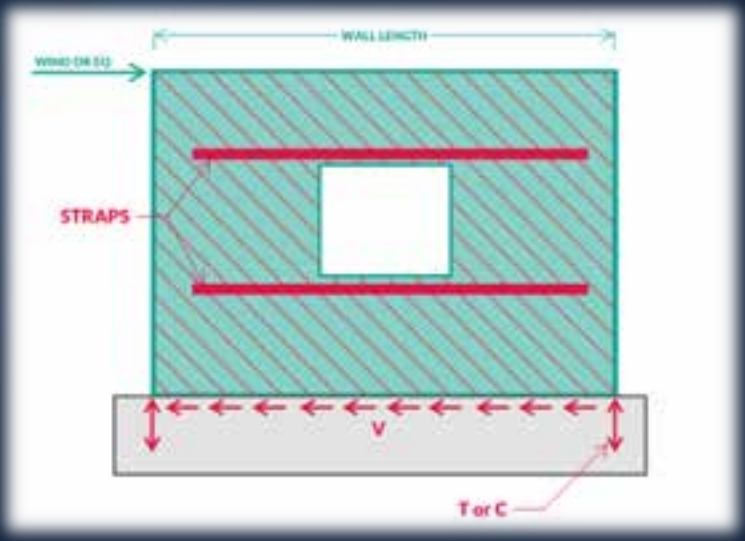
1. SEGMENTED
    1. IDEAL!
2. PERFORATED
    1. EMPIRICAL
    2. WATCH OUT FOR UNIFORM UPLIFT ALONG LENGTH OF WALL
    3. AMPLIFIES HOLD DOWN FORCES
3. FTAO – FORCE TRANSFER AROUND OPENING
    1. CONTRACTORS MAY NOT PREFER
    2. ADDITIONAL ANALYSIS



SEGMENTED



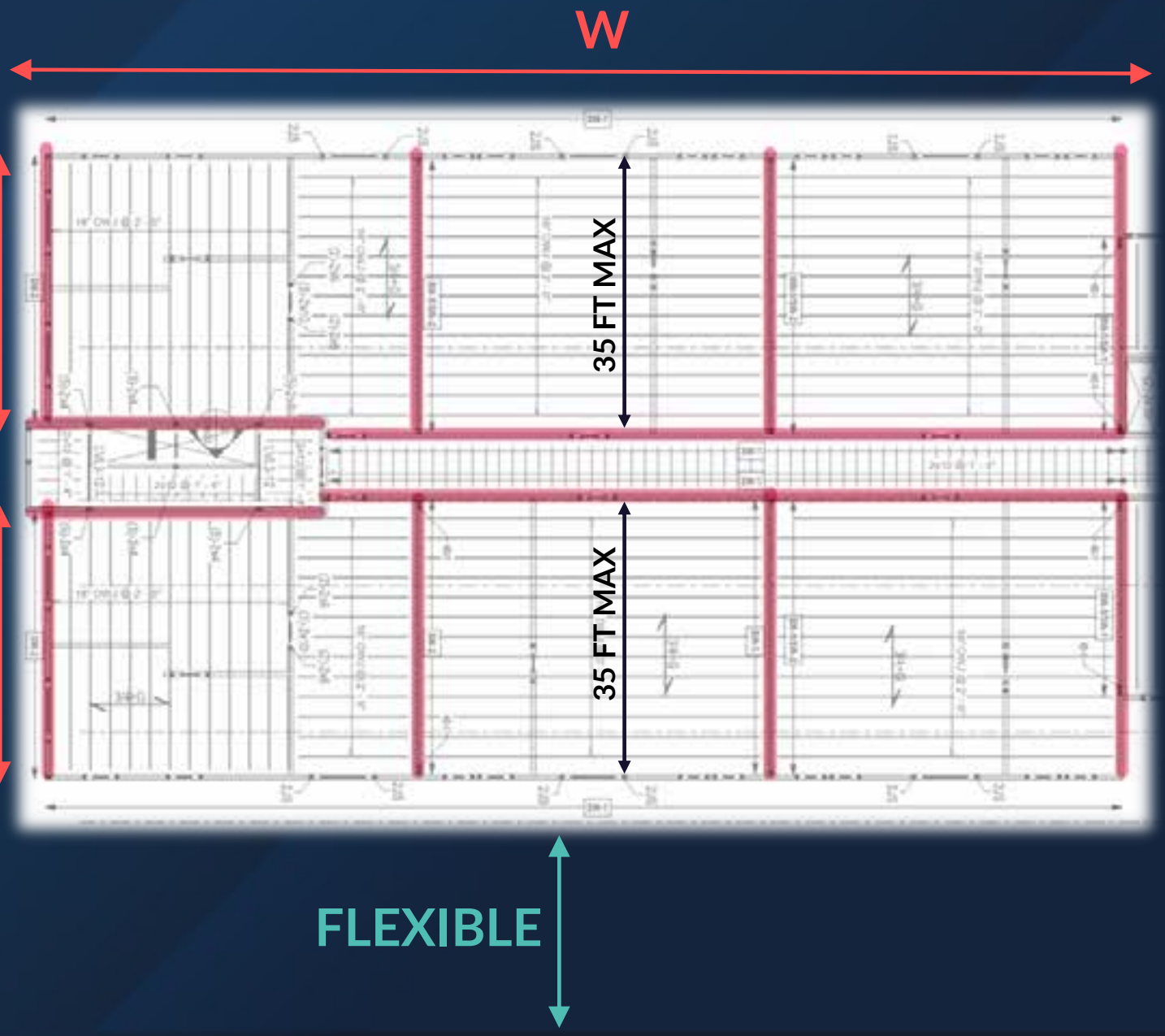
PERFORATED



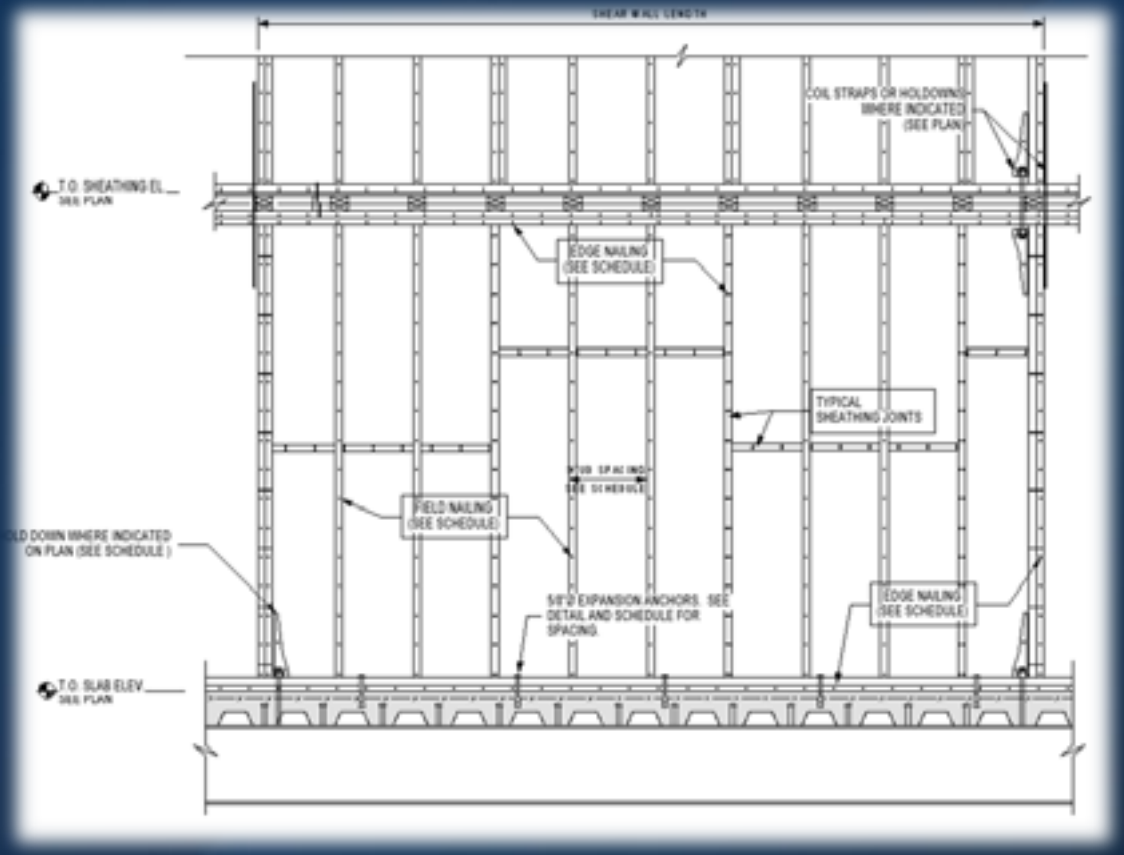
FTAO

LATERAL – SHEAR WALL LAYOUTS

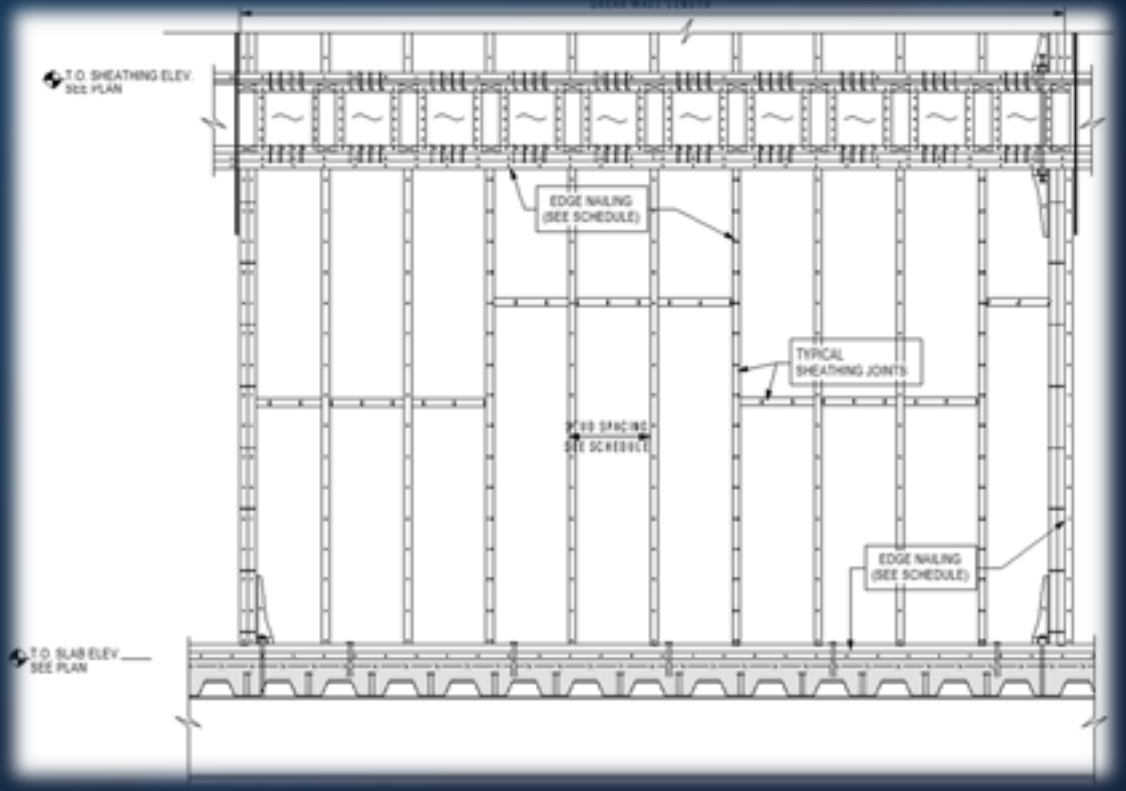
- FLEXIBLE VS RIGID DIAPHRAGM
- OPEN FRONT STRUCTURE
  - 35 FT MAX CANTILEVER
  - L/W < 1.5:1
- IDEALLY USE SOLID WALLS
- LONGER WALLS ARE BETTER!



LATERAL – SHEAR WALLS



TOP CHORD BEARING TRUSSES

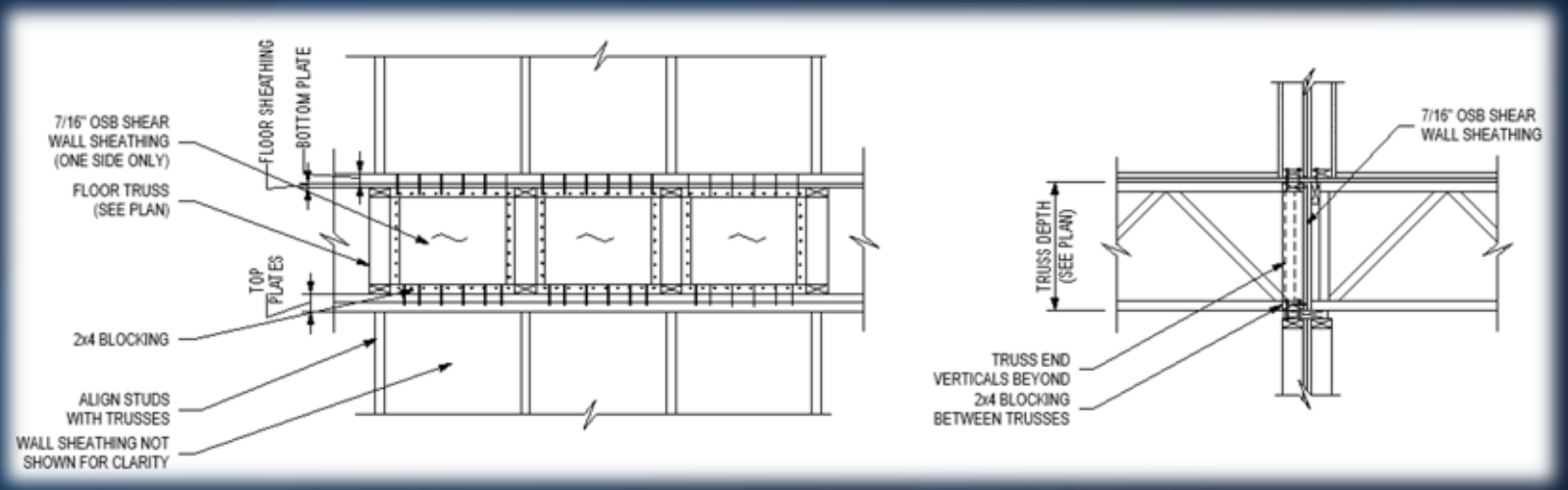


BOTTOM CHORD BEARING TRUSSES

LATERAL – SHEAR WALL DETAILING

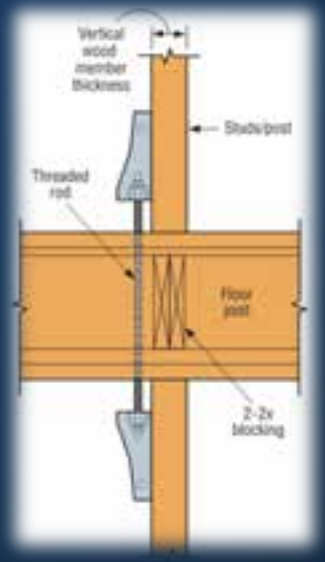
HOW TO PASS SHEAR THROUGH FLOORS?

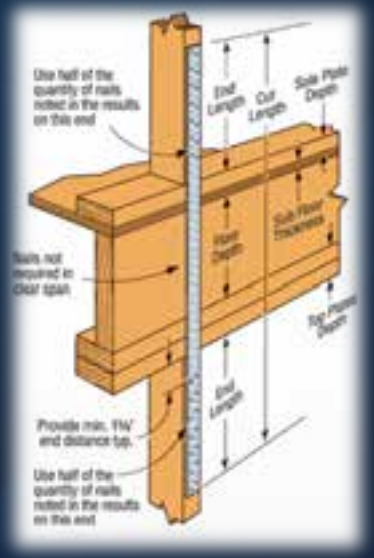
1. TOP CHORD BEARING – EASY
2. BOTTOM CHORD BEARING
    1. TRUSS BLOCKS
    2. SITE INSTALLED OSB BLOCKS

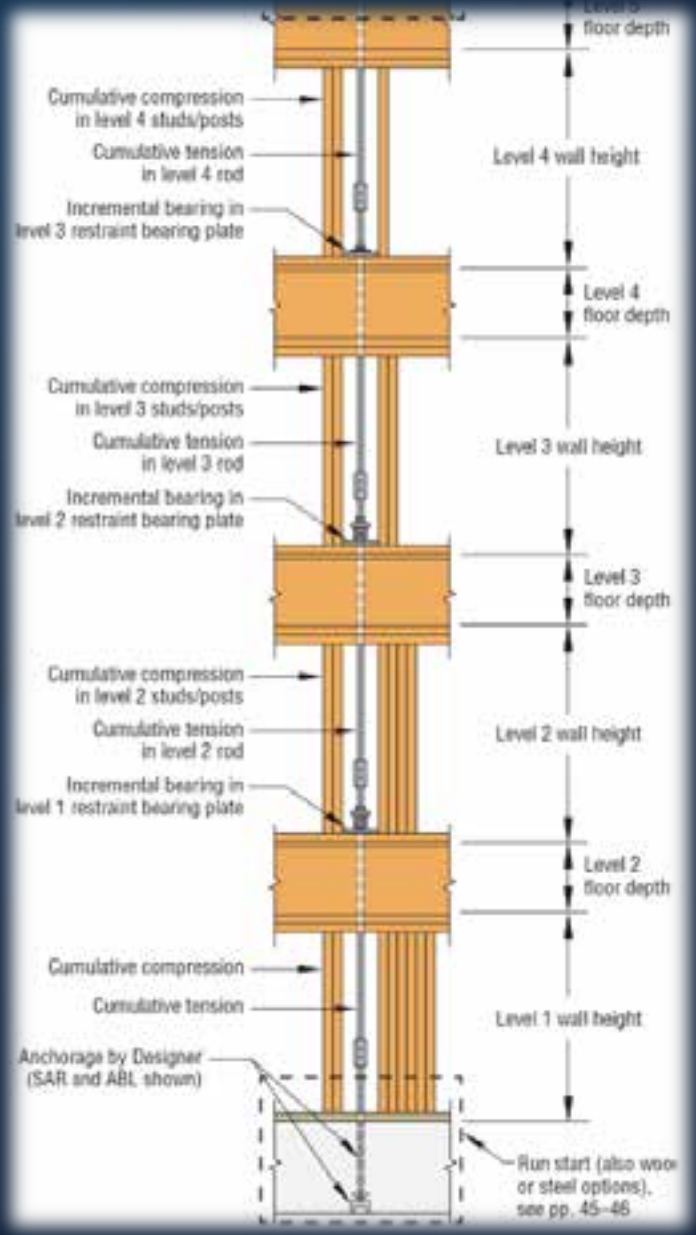


LATERAL – HOLD DOWN OPTIONS

1. COIL STRAPS
    1. CHEAPEST OPTION
    2. CANNOT ACCOMMODATE SHRINKAGE
    3. IF USED, NAIL TOP PORTION AS LATER AS POSSIBLE
    4. MORE COMMON IN SHORTER WOOD BUILDINGS
2. HOLD DOWNS
    1. MIDDLE GROUND
    2. CANNOT ACCOMMODATE SHRINKAGE AUTOMATICALLY
    3. CAN ALWAYS TIGHTEN THE NUT AFTER SHRINKAGE HAS OCCURRED
    4. DIRECT GC TO RETIGHTEN ALL HOLD DOWN NUTS PRIOR TO INSTALLING DRYWALL
3. CONTINUOUS ROD SYSTEMS
    1. AUTOMATICALLY COMPENSATES FOR SHRINKAGE
    2. CAN ACHIEVE HIGHER CAPACITIES
    3. SIMPSON ATS (ANCHOR TIE-DOWN SYSTEM)
    4. CLP (CONTINUOUS LOAD PATH)
    5. SUPPLIERS WILL DESIGN THE SYSTEM…EOR TO PROVIDE LOADS







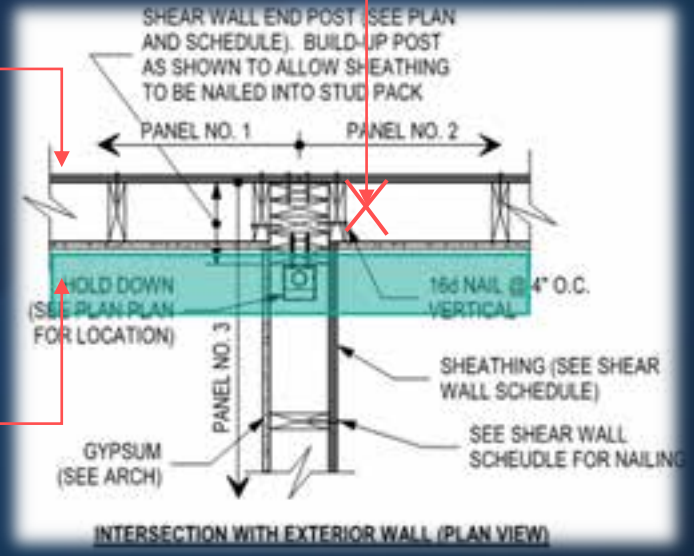
LATERAL – HOLD DOWN ATTACHMENT TO PODIUM

1. NEED TO TRANSFER LARGE UPLIFT LOADS TO THE PODIUM
2. TRY TO KEEP THE HOLD DOWNS AWAY FROM SLAB EDGES
3. PROVIDE CONSTRUCTION TOLERANCE IN THESE DETAILS
    1. THIS IS WHERE MANY TRADES MEET
4. DRILL AND EPOXY ANCHORS……MAYBE
    1. ONLY FOR LOW LOAD CONDITIONS
    2. AT POST-TENSIONED SLABS TRY TO AVOID DRILLING
5. ALWAYS HAVE RETROFIT SOLUTIONS IN MIND!

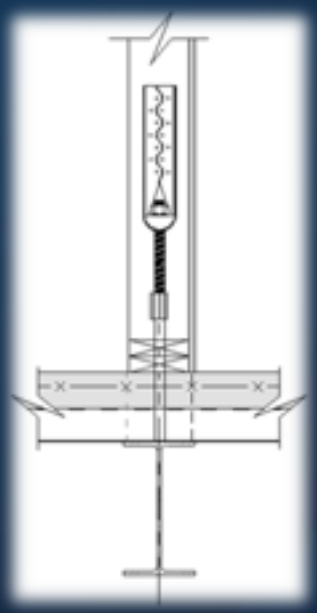
BAD LOCATION FOR HOLD DOWN

SLAB EDGE

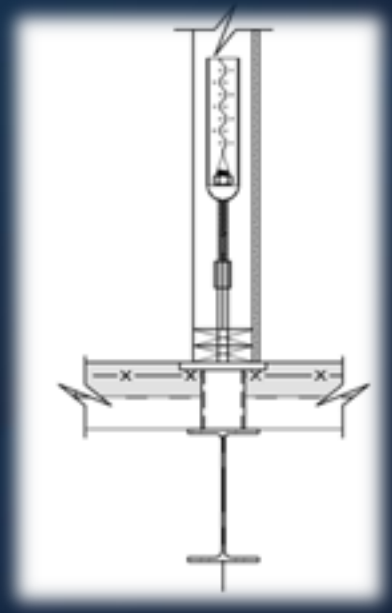
BEAM BELOW



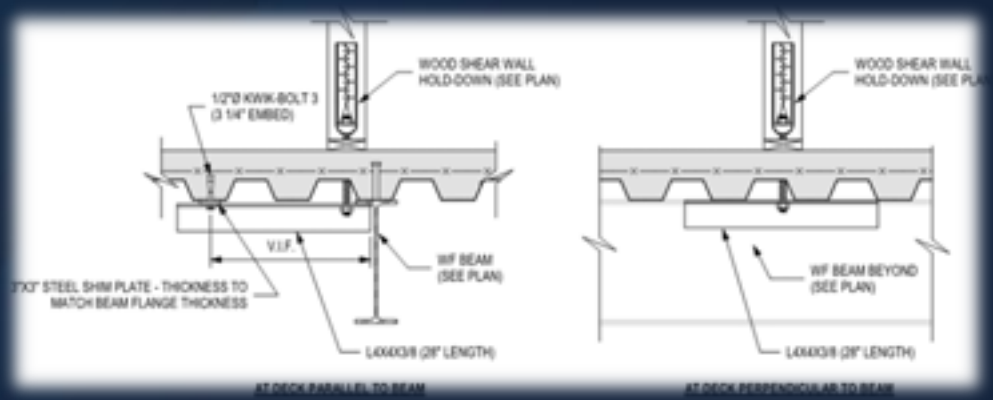
AVOID SLAB EDGES



LESS TOLERANCE



MORE TOLERANCE



RETROFIT SOLUTION

QUESTIONS?

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