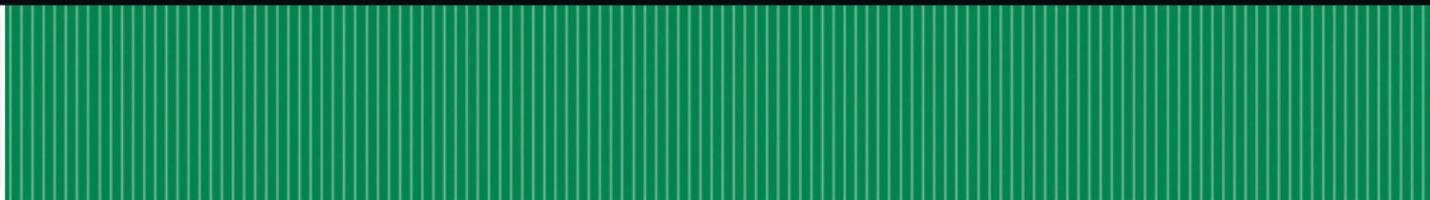


# **Mid-Rise Wood Frame Challenges & Solutions**

***Mid-Rise Wood Frame Building Seminar***

***April, 2016***

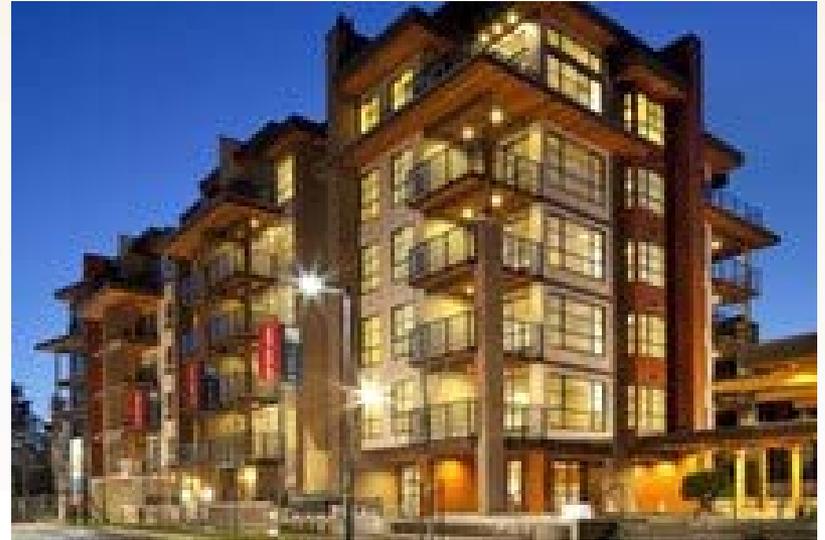
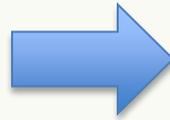


# What does it take to go from

Here

to

Here?



# Topics of Conversation

## Essential Keys to a Successful Mid-rise Project

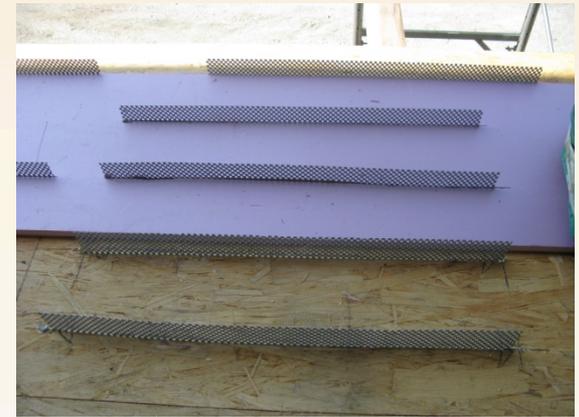
- Learned from experience, and other experts

## Solutions for:

- Dimensional Stability (Shrinkage)
- Higher Loads (Vertical & Lateral)
- Tighter Nail-spacing
- Safe and Effective Delivery and Construction

# CLT / LNT / LSL Panels

## Hybrid Panel alternatives



# CLT / NLT / LSL – Roofs and Walls



# Nail-Laminated Lumber Core

Elevator Core – Mid rise

5.25" x 10' x 17'

solid wood panels



Lumber and I-joist  
framing

# Engineered Lumber Products

Open Web

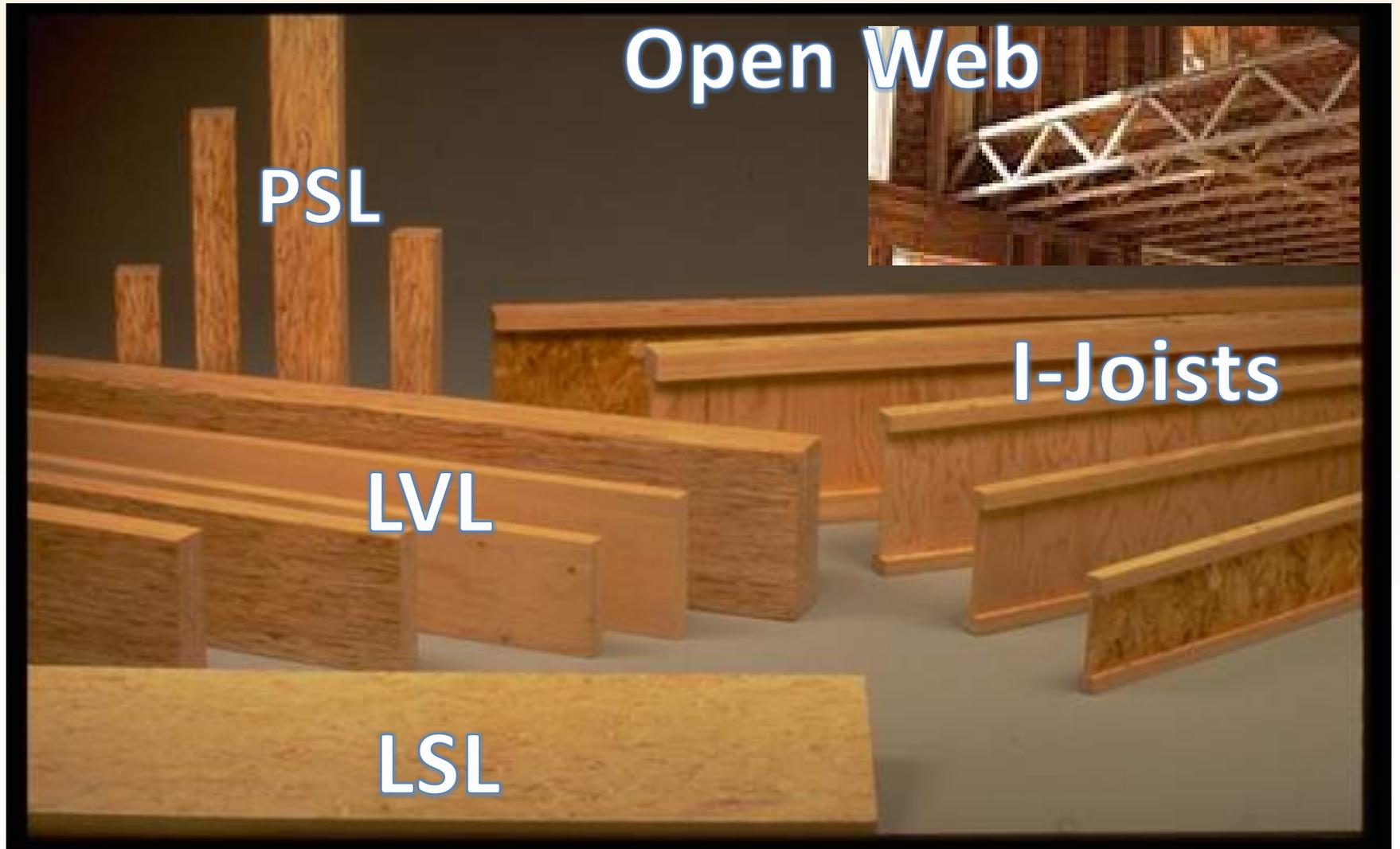
PSL



I-Joists

LVL

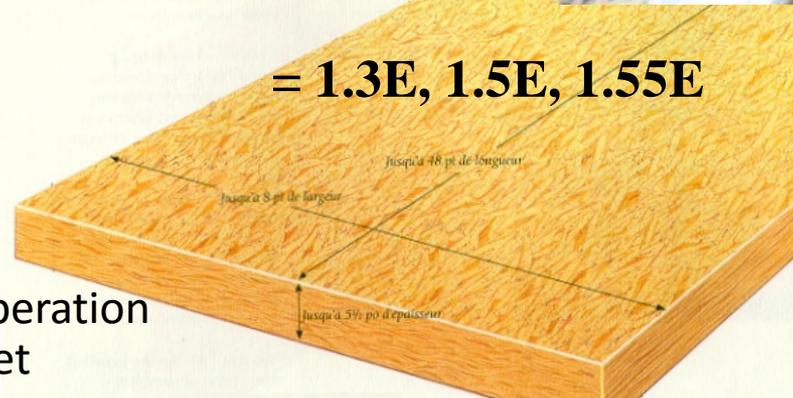
LSL



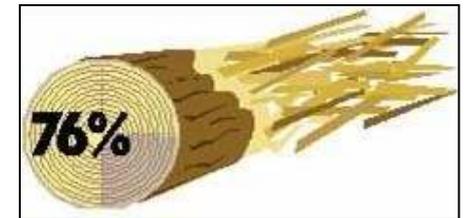
# Laminated Strand Lumber (LSL)



= 0.8E



Batch Manufacturing Operation  
3-1/2" x 8' x 60'/64' Billet



# Key No. 1

Treat this like a “commercial job”

- Mid-rise procedures require more time
- Details are MUCH different

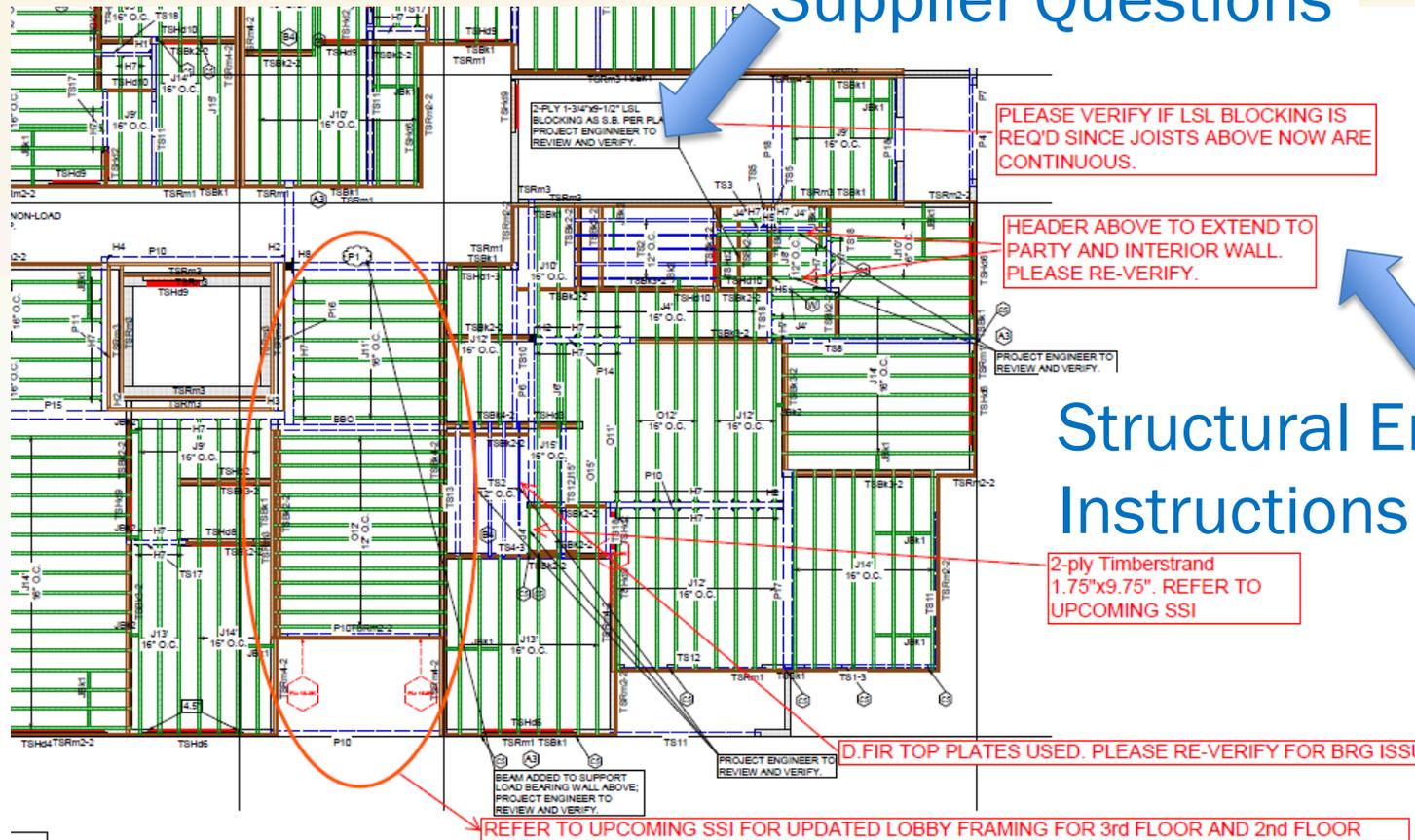


- ✓ Shop Drawings
- ✓ Review & Coordination

(Quotes / ordering your material require more time)

# Shop Drawings – Review process

## Supplier Questions



## Structural Engineer Instructions

at City

Wall Framing				
PlotID	Length	Product	Piles	Net Qty
PHd1	9' 0"	9' 1/4" x 9' 1/2" 2.2S Parallel® PSL	1	1
TS Hd1-3	4' 0"	1 3/4" x 9' 1/2" 1.55E Timberstrand® LSL	3	3

Framing Connector Summary									
PlotID	Qty	Manuf	Product	Face Nails	Top Nails	Member Nails	Backer Bolts	Filler	Web Stiff
H1	6	Simpson	HGU5410	46- 16d common	-	16- 16d double shear	No	No	No
H2	4	Simpson	HGU5510	46- 16d common	-	16- 16d double shear	No	No	No

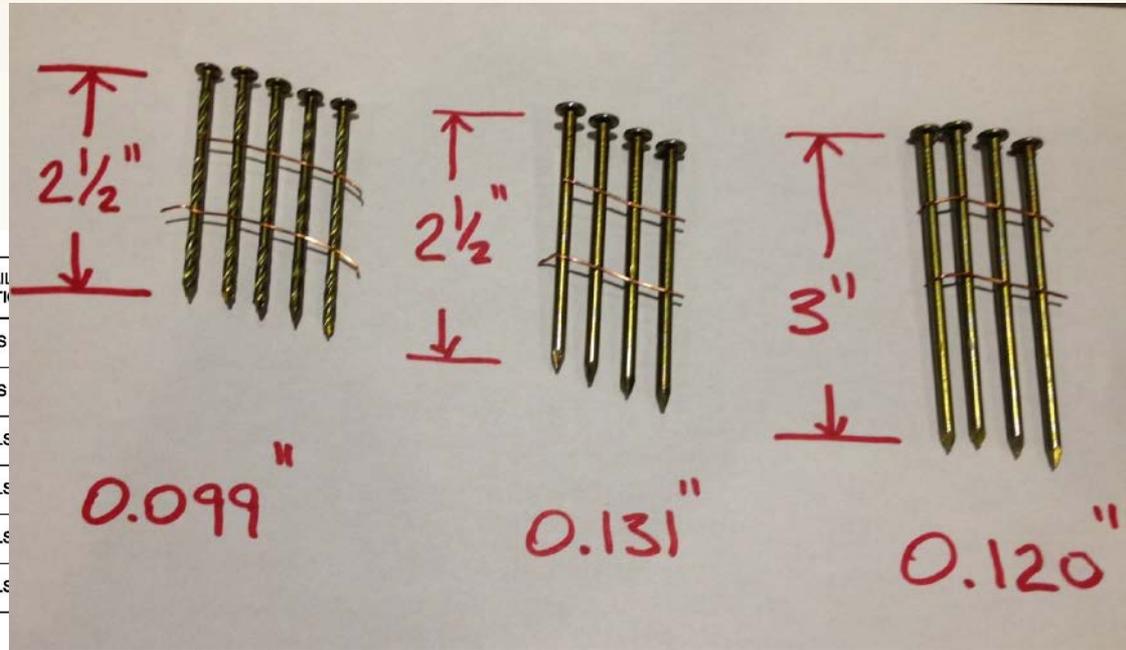
# Specific Details

The importance of following the plans

**2.5" x 0.131" Ø NAILS @ 2" O/C**



FLOOR LEVEL	SHEATHING SPECIFICATIONS	NAILING AT PANEL EDGES AND SHEAR WALL BOUNDARY	IN FIELD NAIL SPECIFICATION
MAIN	5/8" OSB SHEATHING	3" x 0.148" Ø NAILS @ 2" O/C	3" x 0.148" Ø NAILS
SECOND	5/8" OSB SHEATHING	3" x 0.148" Ø NAILS @ 2" O/C	3" x 0.148" Ø NAILS
THIRD	7/16" OSB SHEATHING	<b>2.5" x 0.131" Ø NAILS @ 2" O/C</b>	2.5" x 0.131" Ø NAILS
FOURTH	7/16" OSB SHEATHING	2.5" x 0.131" Ø NAILS @ 3" O/C	2.5" x 0.131" Ø NAILS
FIFTH	7/16" OSB SHEATHING	2.5" x 0.131" Ø NAILS @ 6" O/C	2.5" x 0.131" Ø NAILS
ROOF	7/16" OSB SHEATHING	2.5" x 0.131" Ø NAILS @ 6" O/C	2.5" x 0.131" Ø NAILS



# Specific Details



# Key No. 2

## Involve / Communicate with Trades on site

On site  
instruction and  
inspection

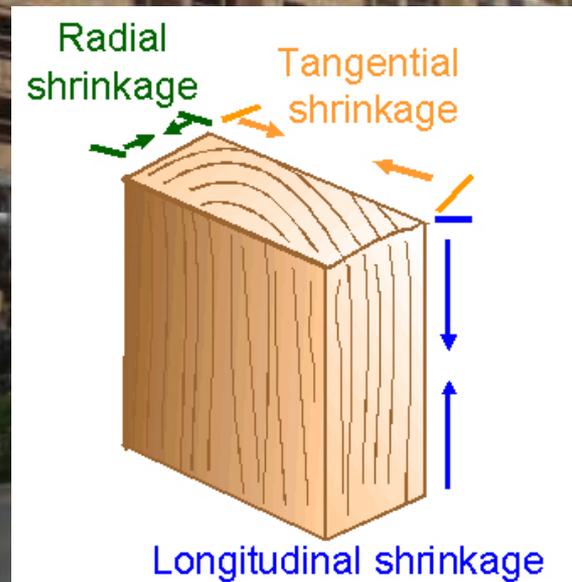
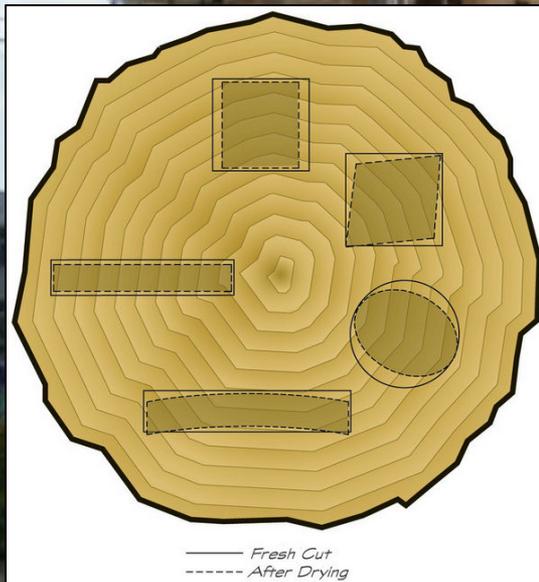


# Dimensional Stability – “Shrinkage”

Cumulative Effects

Cross-grain shrinkage of particular concern

- Radial and tangential directions

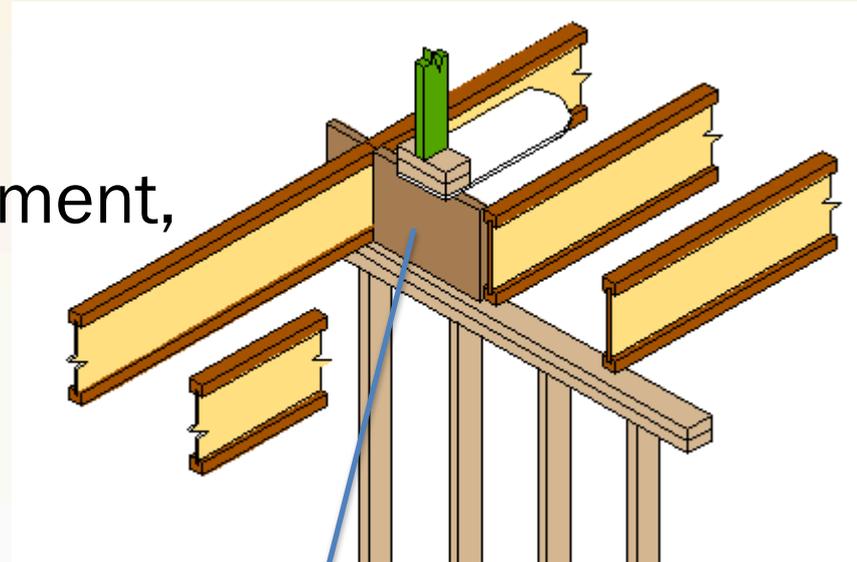


# Dimensional Stability – “Shrinkage”

## Vertical Movement:

- Combination of settlement, load deformation
- Moisture changes  
→ shrinkage

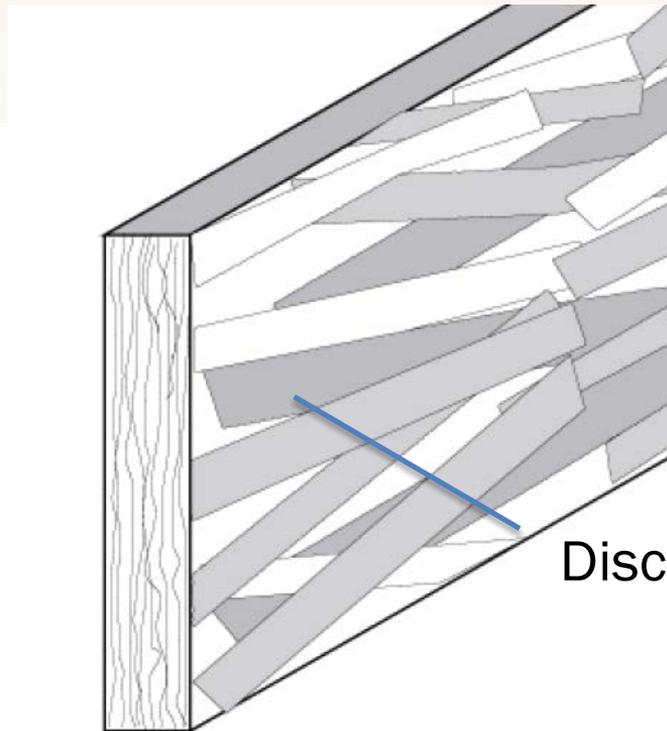
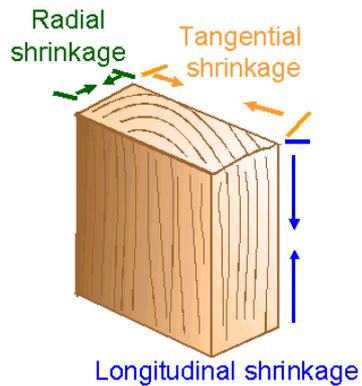
✓ Choose materials carefully



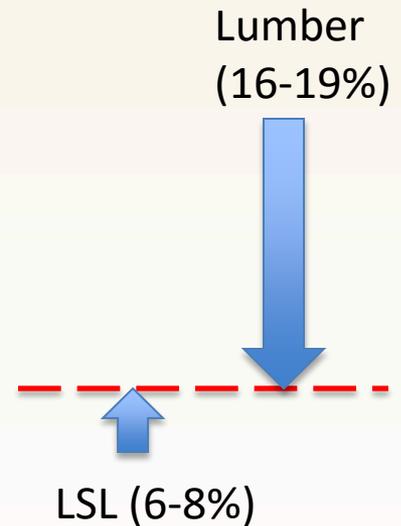
“Rim Board” or  
“Blocking panel”

# Dimensional Stability – LSL Rim Board

EMC for lumber ~12%;  
for ELP ~10%



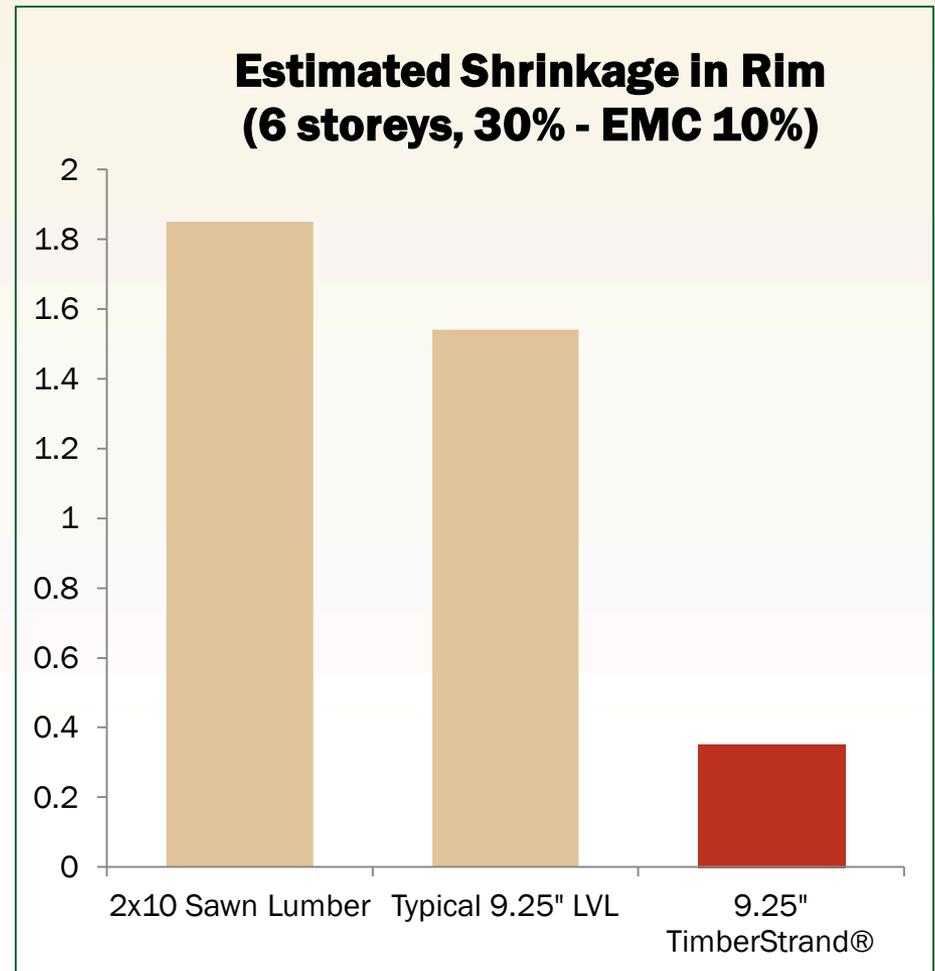
EMC  
(10-12%)



# Dimensional Stability – LSL Rim Board

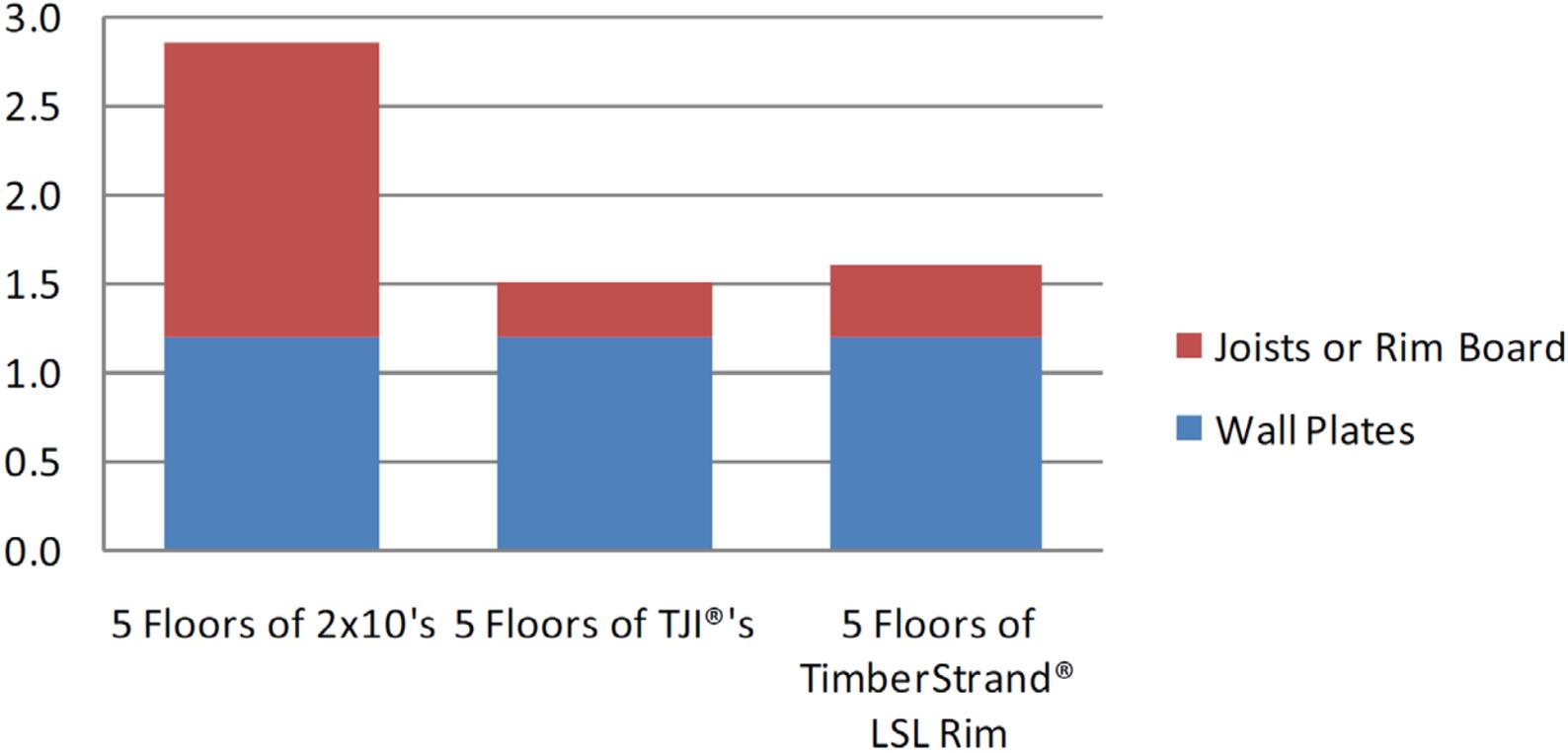
Relative study –  
worst-case  
conditions:

- Measured depth:
  - in yard (~10%)
  - saturated (>30% MC),
  - redried to original MC (~10%)



# Dimensional Stability – Rim Board

## 6-Storey Shrinkage\* (inches)



# Dimensional Stability – Engineered Wood

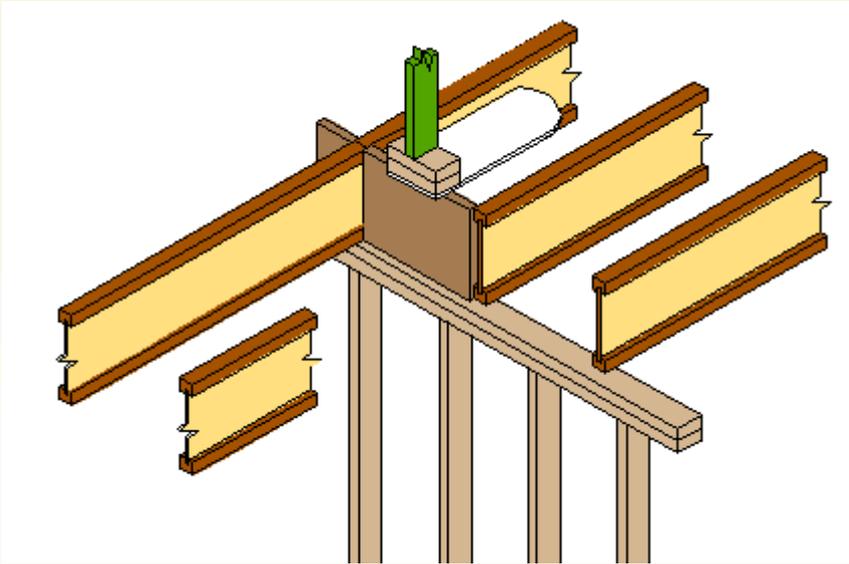
## FP Innovations Research & Guides:

- Mid-rise Wood-Frame Construction Handbook:

### Table of contents

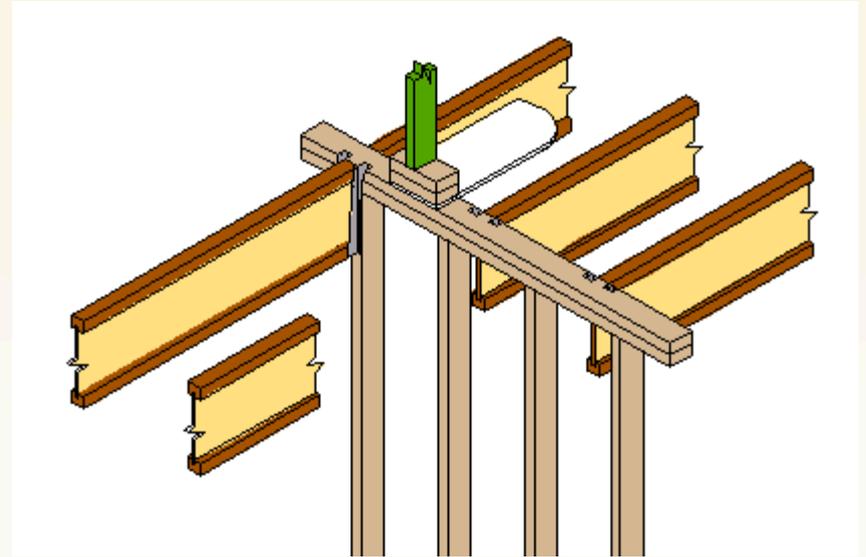
- Chapter 1: Introduction
- Chapter 2: Structural Products
- Chapter 3: Structural Design
- Chapter 4: Floor Vibration Control
- Chapter 5: Vertical Differential Movement
- Chapter 6: Fire Safety Design
- Chapter 7: Noise Control
- Chapter 8: Durable & Efficient Building Enclosure
- Chapter 9: Elevator Shafts and Stairwells
- Chapter 10: Prefabricated Systems

# Platform or Flush Wall Framing?



## Platform framing:

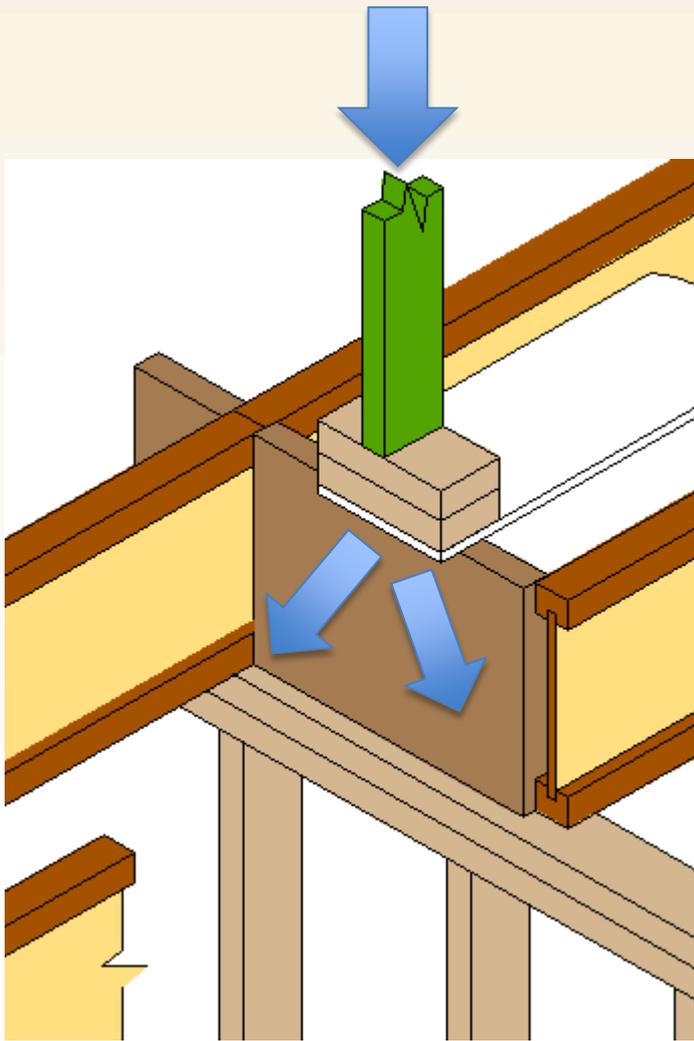
- Wall plates
- Rimboard
- Joists



## Flush wall framing:

- Full height walls
- Joists on Hangers

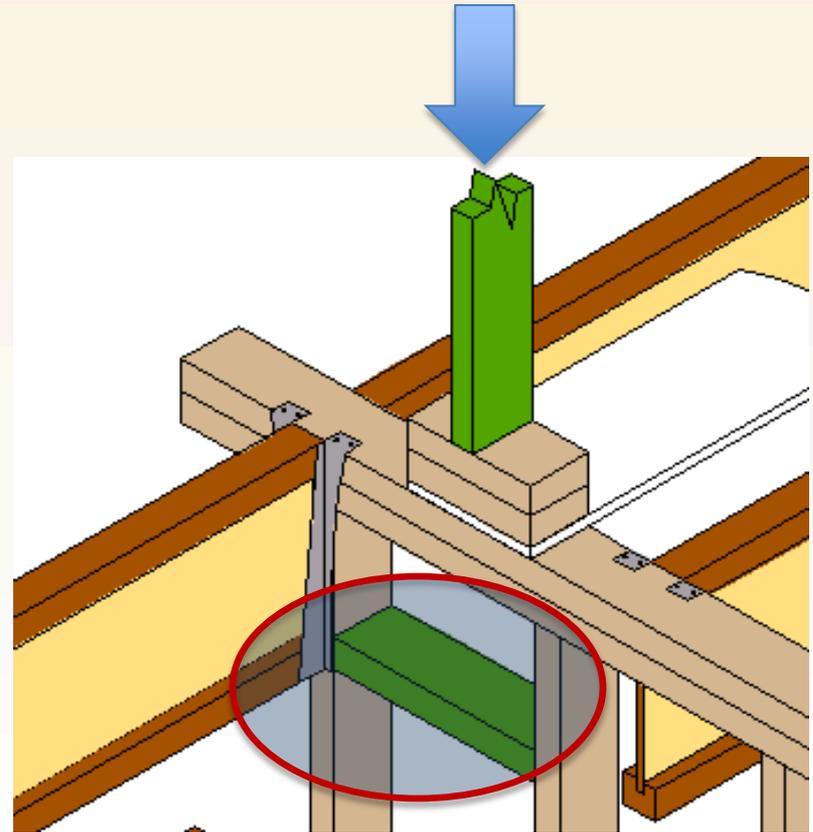
# Platform Framing



- Rimboard (or blocking): permits distribution of loads to studs
- Top and bottom nailing critical to shear transfer

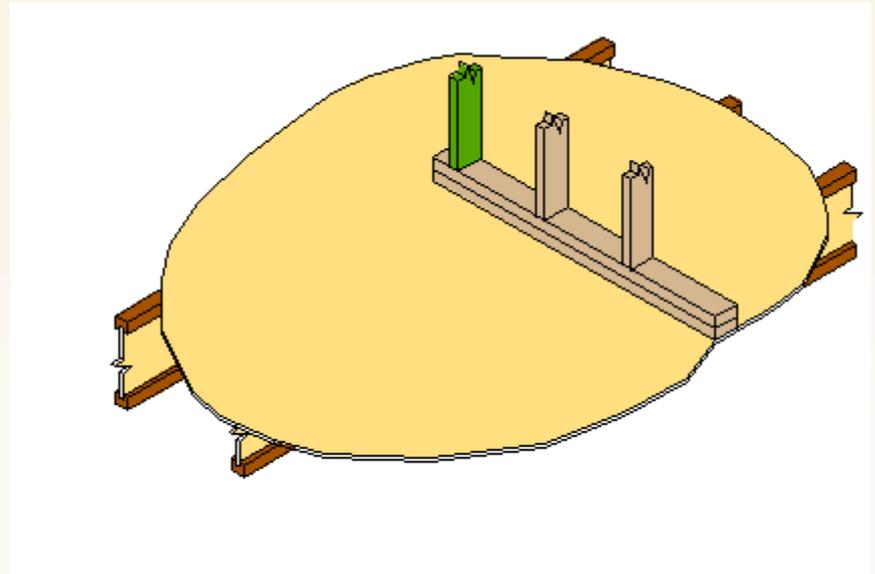
# Flush Wall Framing

- Direct Shear path – nailing still critical
- Vertical load path relies on “in-line” studs or “span capability” of top plate
- Gypsum placement can be challenging
- Additional fire blocking between studs

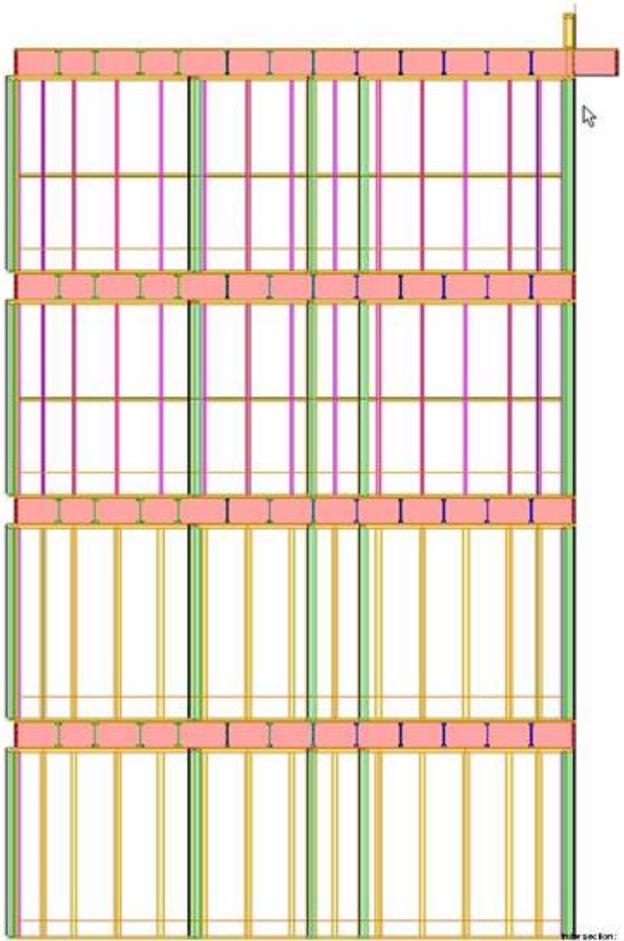


# Platform or Flush Wall Framing?

- “In-line” framing difficult to confirm on site.
- Very little gain in dimensional stability compared to I-joist and LSL platform framing



# LSL Rim



Enhanced vertical load capacities and bending values

Stiffer element to assist in transferring load evenly to studs below

Avoid the need for in-line framing when designed adequately

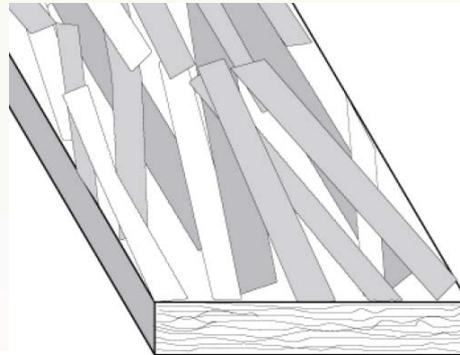
Proven dimensional stability  
→FP Innovations study

# Dimensional Stability – LSL Wall Plates

## Wall Plates

- 6 floors = 18 plates
- $\sim 1/16''$  each  $\rightarrow > 1''$

Alternative:  
LSL wall plates



Keep LSL dry to avoid swelling



*Photo Courtesy APEGBC*

# Dimensional Stability

Minimize moisture exposure through reduced open time.

- Wall Panels
- Floor Panels



# Tips for Midrise

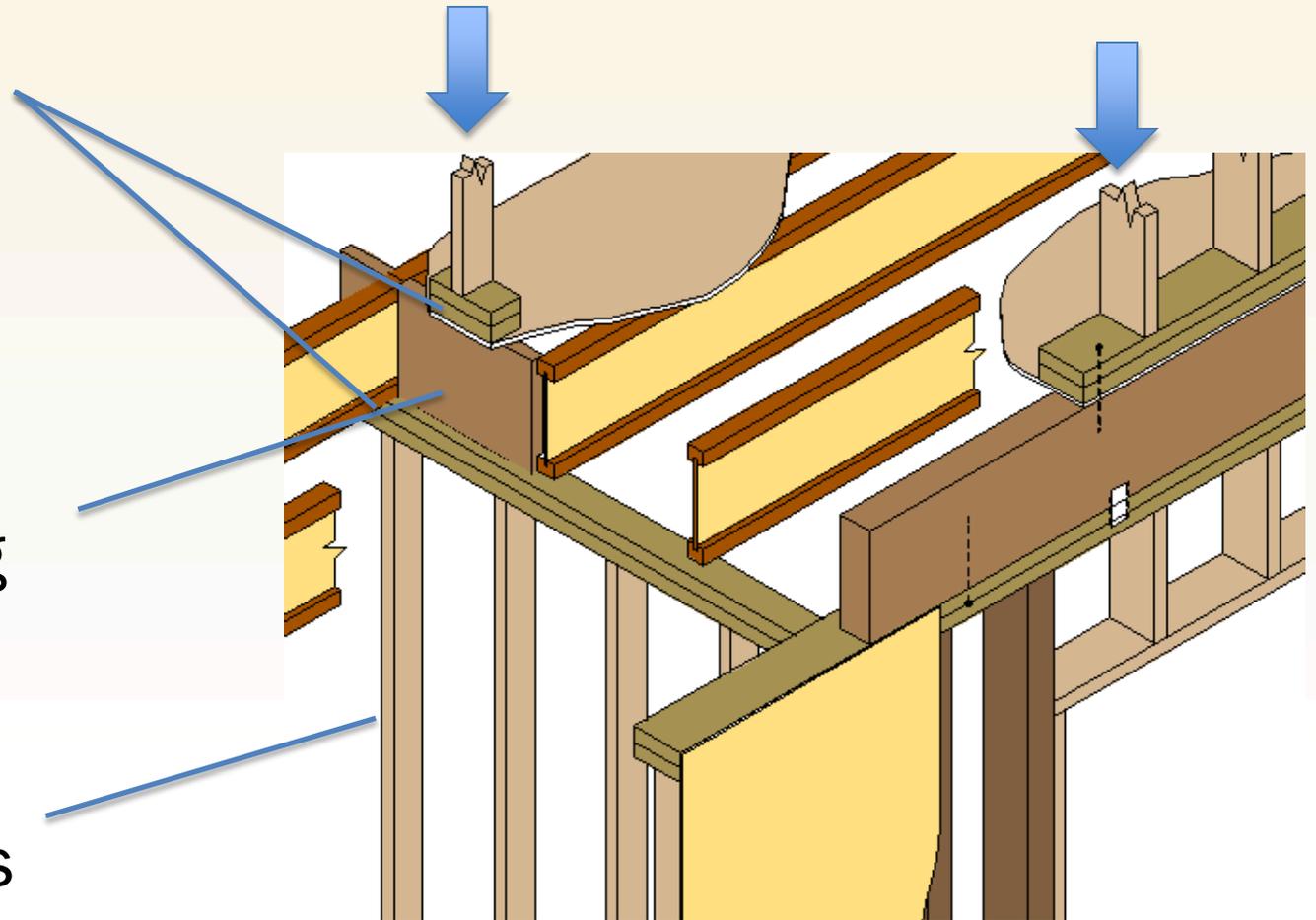
1. Approach like a commercial project, not a residential
2. Consultants: Involve the trades on site (and monitor).
3. Shrinkage demands point to LSL Rimboard
4. Better shrinkage performance is achieved with engineered lumber.

# Vertical Loads and Product Capacity

Wall Plates

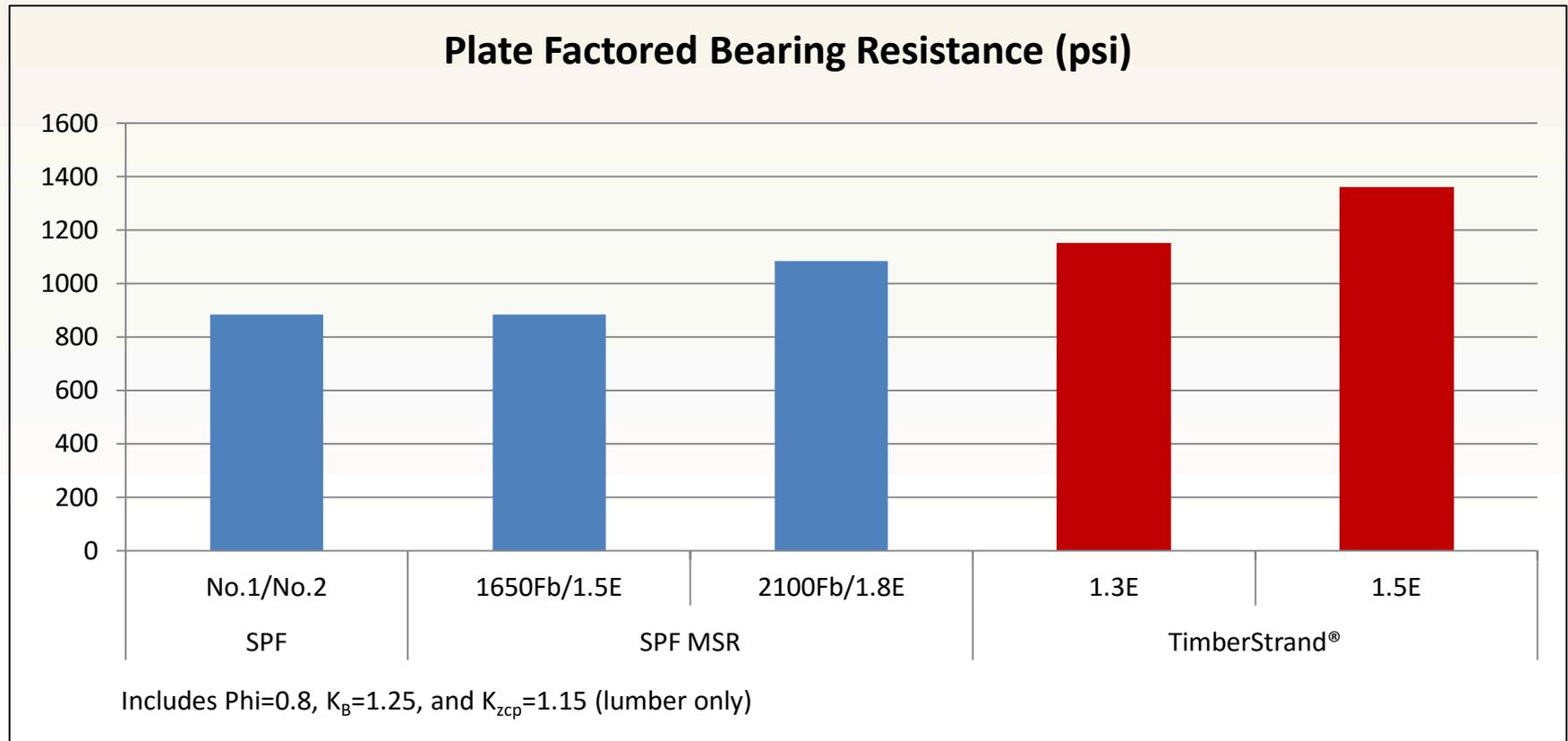
Rim Board  
and Blocking

Wall Studs  
and Columns



# Product Capacity - LSL Wall Plates

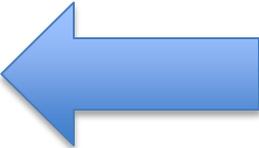
ASTM D5456 now allows  $F_{cp}$  determination for SCL based on proportional limit



# Product Capacity - LSL Wall Plates

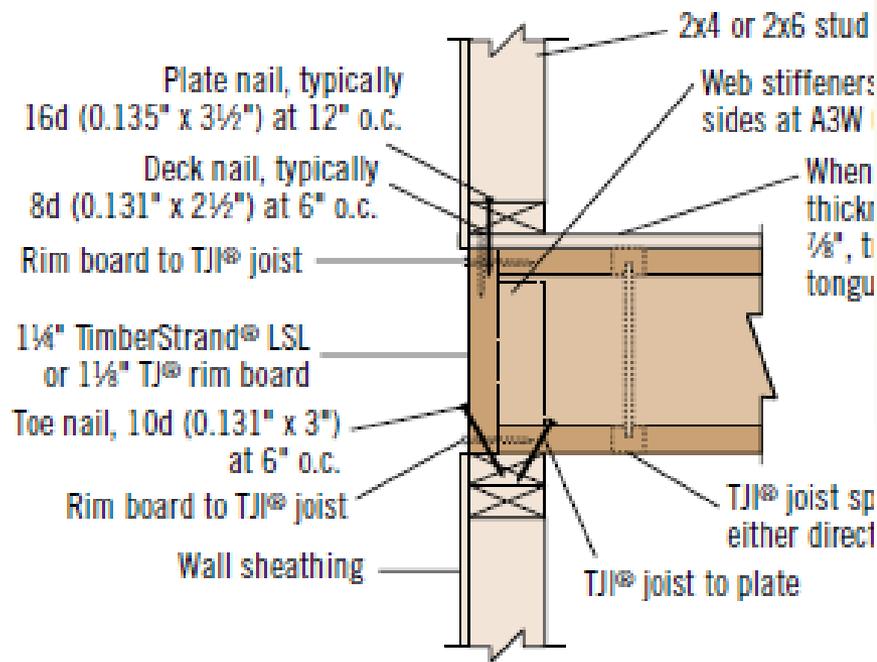
Effect of LSL plates (1.5E) on wall capacity:

		Estimated Capacity Increase Using TimberStrand Framing		
		1.5E TimberStrand Plate Only		
	Width	8' Wall	9' Wall	10' Wall
No.1/No.2 SPF	2x4	0%	0%	0%
	2x6	28%	17%	4%
	2x8	41%	34%	26%



# Support of Vertical Loads – Rim Board

This Way!

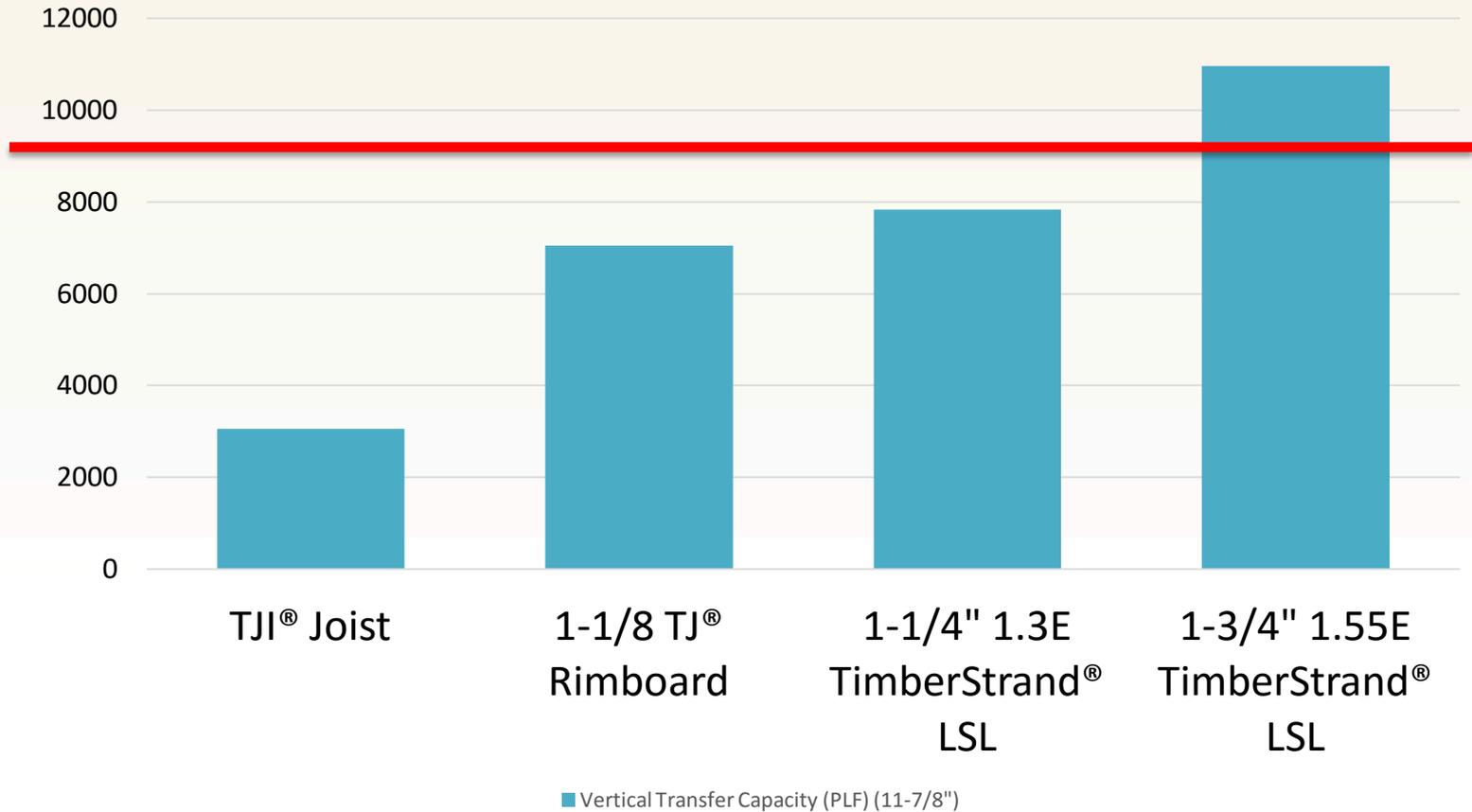


Not This Way!



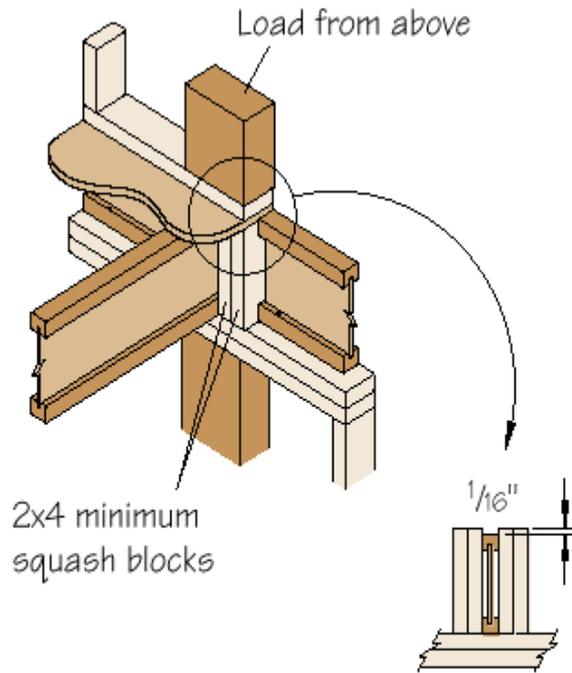
# Rim Board Vertical Capacity

## Vertical Load Capacity (PLF) (11-7/8")



# Support of Concentrated Loads

This Way!



*Use 2x4 minimum squash blocks to transfer load from above to bearing plate below*

Not This Way!



# Vertical Capacity – LSL Studs



TABLE 1B: WALL FACTORED AXIAL RESISTANCE (PLF) – **1.5E** **TIMBERSTRAND®** LSL

TimberStrand® LSL Grade	Stud	Exterior Stud Wall Spacing (in)					
		6	8	12	16	24	
<b>8 ft Wall Height</b>							
<b>1.5E</b>	<b>2x4</b>	11340	8415	5490	4030	2570	1
	<b>2x6</b>	20400	15300	10200	7650	5100	2
	<b>2x8</b>	26890	20165	13445	10080	6720	2
	<b>3" x 3½"</b>	23055	17200	11345	8420	5495	2
	<b>3" x 5½"</b>	36885	27660	18440	13830	9220	3
<b>9 ft Wall Height</b>							
<b>1.5E</b>	<b>2x4</b>	9500	7025	4550	3315	340	1
	<b>2x6</b>	20400	15300	10200	7650	5100	2
	<b>2x8</b>	26890	20165	13445	10080	6720	2
	<b>3" x 3½"</b>	19425	14465	9505	7030	4555	1
	<b>3" x 5½"</b>	36885	27660	18440	13830	9220	3
<b>10ft Wall Height</b>							
<b>1.5E</b>	<b>2x4</b>	7930	5840	3755	2010	*	1
	<b>2x6</b>	20400	15300	10200	7650	5100	2
	<b>2x8</b>	26890	20165	13445	10080	6720	2
	<b>3" x 3½"</b>	16315	12125	7935	5845	3755	1
	<b>3" x 5½"</b>	36885	27660	18440	13830	9220	3

General Notes:

# Vertical Capacity – LSL Studs

Possible solution:  
3" solid LSL stud

Wider spacing – easier on  
trades

Eliminate mid-height  
blocking

Shear nailing advantages  
(1.5E Grade only)

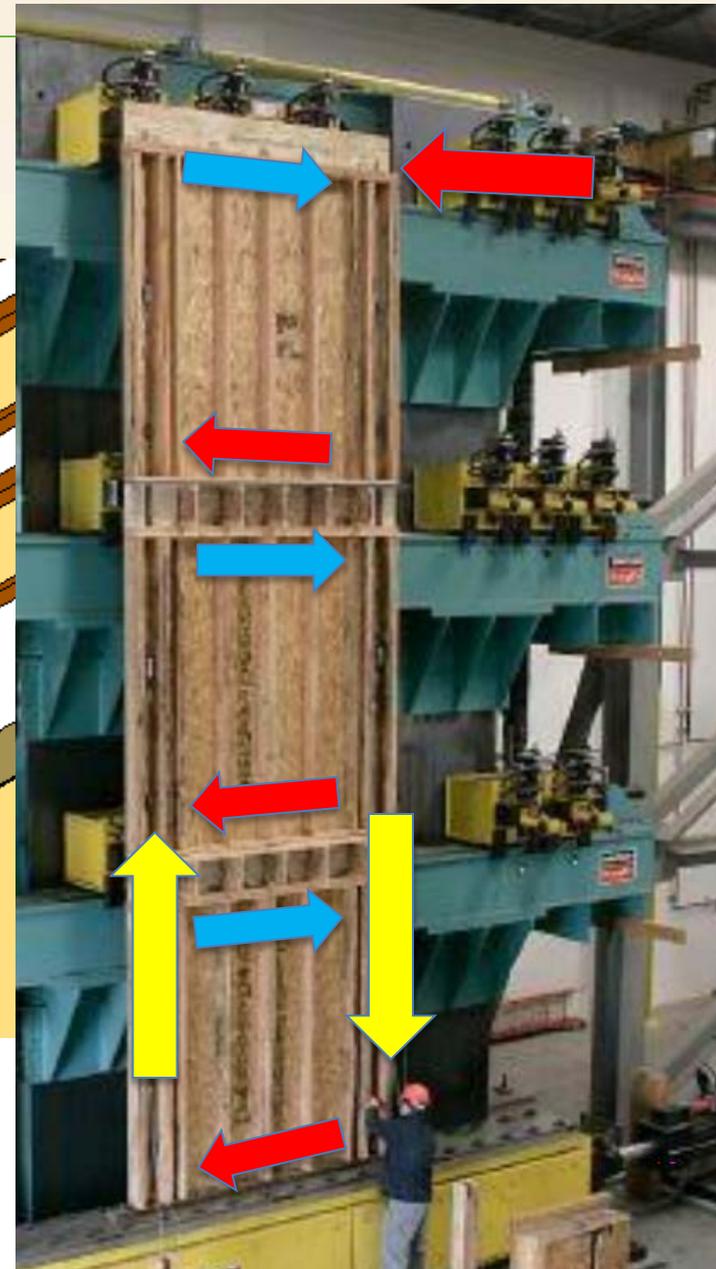
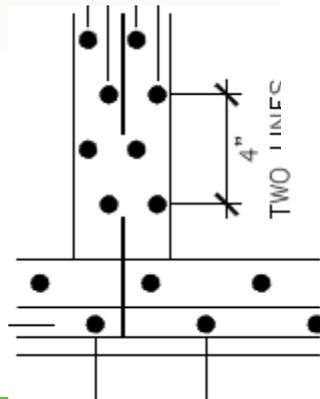
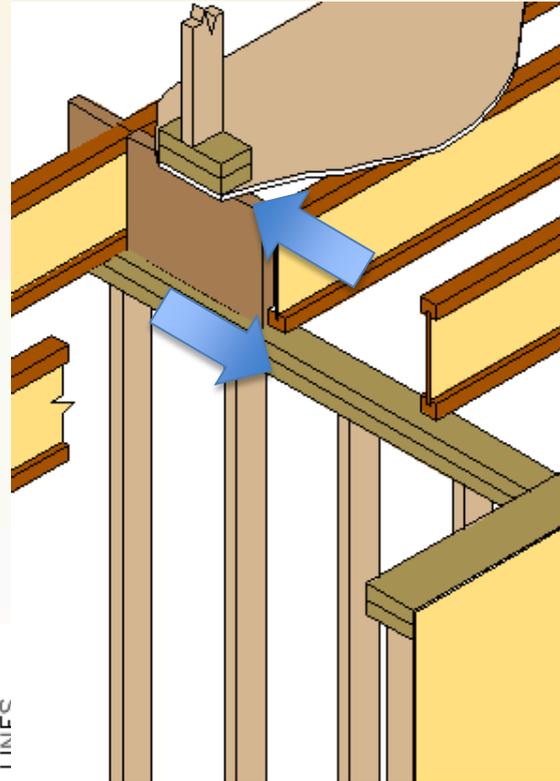


# Tips for Midrise

1. Approach like a commercial project, not a residential
2. Consultants: Involve the trades on site (and monitor).
3. Very tight nailing + shrinkage demands point to LSL Rimboard (not generic 1-1/8 residential rim)
4. Better shrinkage performance is achieved with engineered lumber.
5. Proper load-transfer blocking is essential
6. 1.5E LSL studs & plates can give you more space to run services at lower levels. Beware of lower-grade substitutes

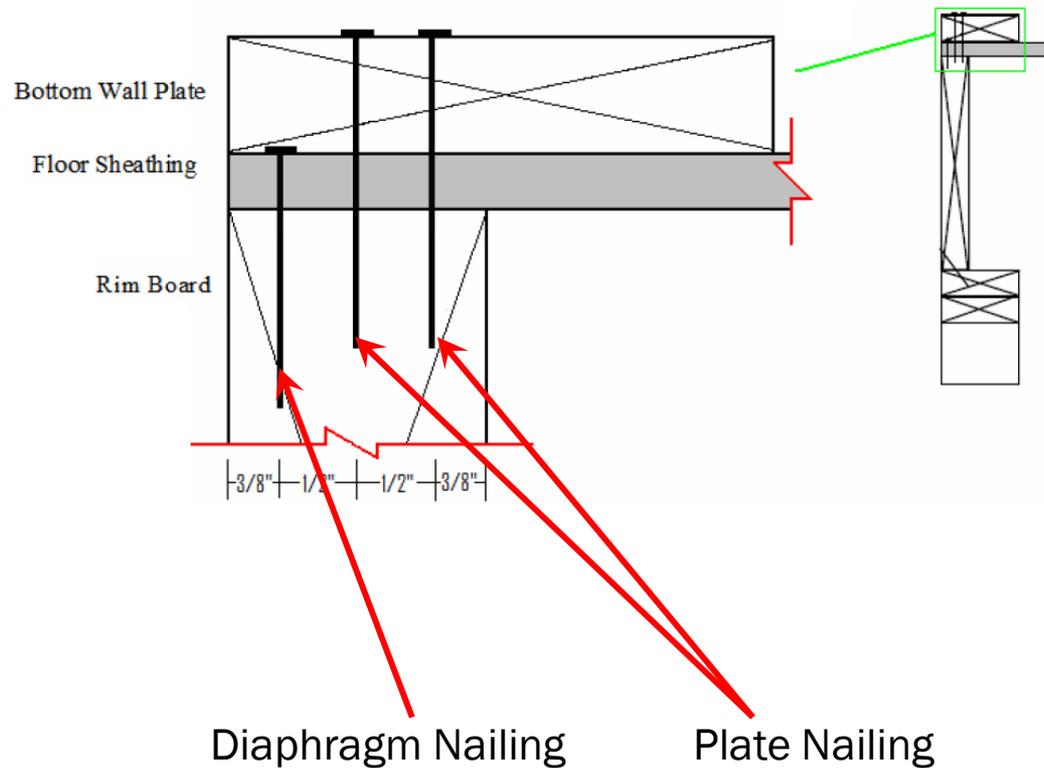
# Lateral Loading

- Transfer of wall shear loads through the floor depth
- Shear wall nailing



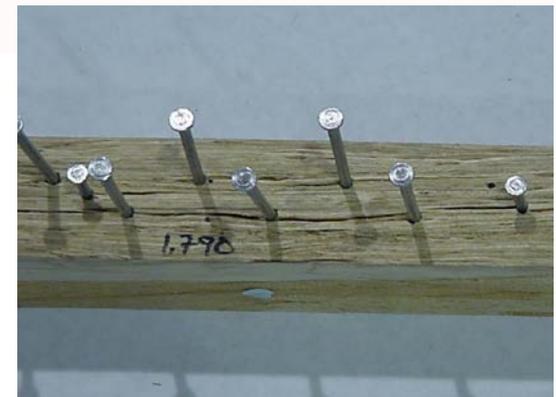
# Product Capacity – LSL Rim

1-1/8" rimboard may not be adequate for mid-rise applications



Lower strength and density:

- Limited nail spacing (6" o.c. typical)
- Higher likelihood of splitting when toe or edge nailed



# Product Capacity – LSL Rim



- 1-1/4" or thicker allows for 2 rows at tighter spacing
- LSL thicknesses up to 3-1/2"
- See code reports or published guides for allowable spacing
- [Beware of substitution](#)

# LSL Shear Walls

SHEAR WALL SCHEDULE - SWI										
LEVEL	SHEATHING	SIDES	NAIL SPACING ( in )	# COMP. STUDS ( 2x6 )	BOTTOM OF WALL TO RIM CONNECTION	TOP OF WALL TO RIM CONNECTION	ROD DIAMETER ( x 1/8" )	MIN. BEARING PLATE AREA ( in <sup>2</sup> )	FACTORED TENSION ( kips )	FACTORED COMPRESSION ( kips )
ROOF	 1/2" OSB	1	6	4	SEE DET. (6H02) TYPE A	SEE DET. (6H02) TYPE A	2-MSTC40 STRAPS	-	-	4.0
5		1	6	4			5	4.0	1.0	10.0
4		1	4	4			5	4.0	3.0	18.0
3		1	3	4			5	6.0	6.0	26.0
2		1	3	4			5	6.0	10.0	36.0
FOUNDATION 5/8" BOLTS @ 16" O/C										

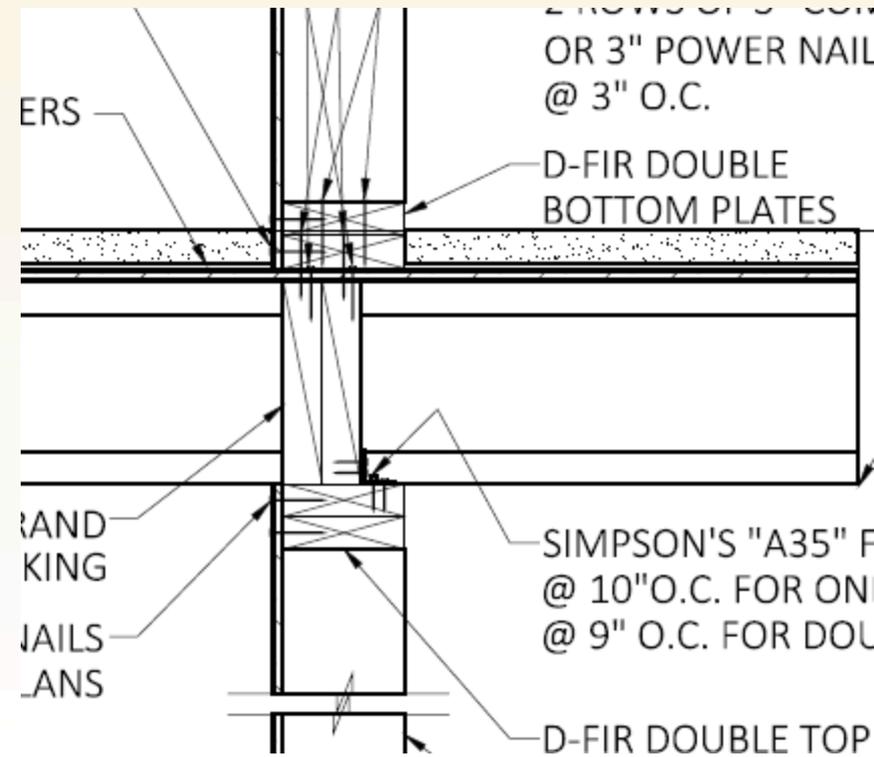
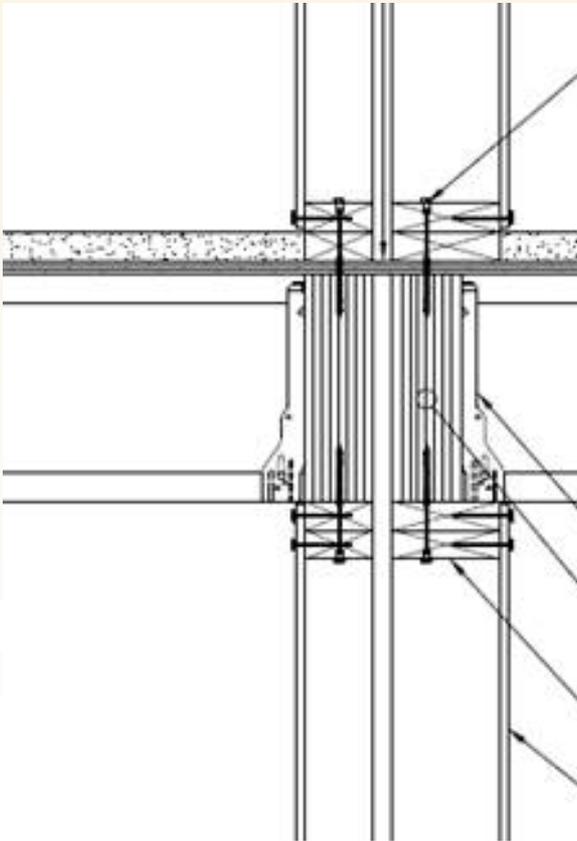
Tight Fastener spacing – even in wind-governed designs

3-4" commonly specified; 2" in SPF occasionally

1.5E LSL or greater needed for these nail patterns

Beware of substitution

# 3-1/2" LSL Rim



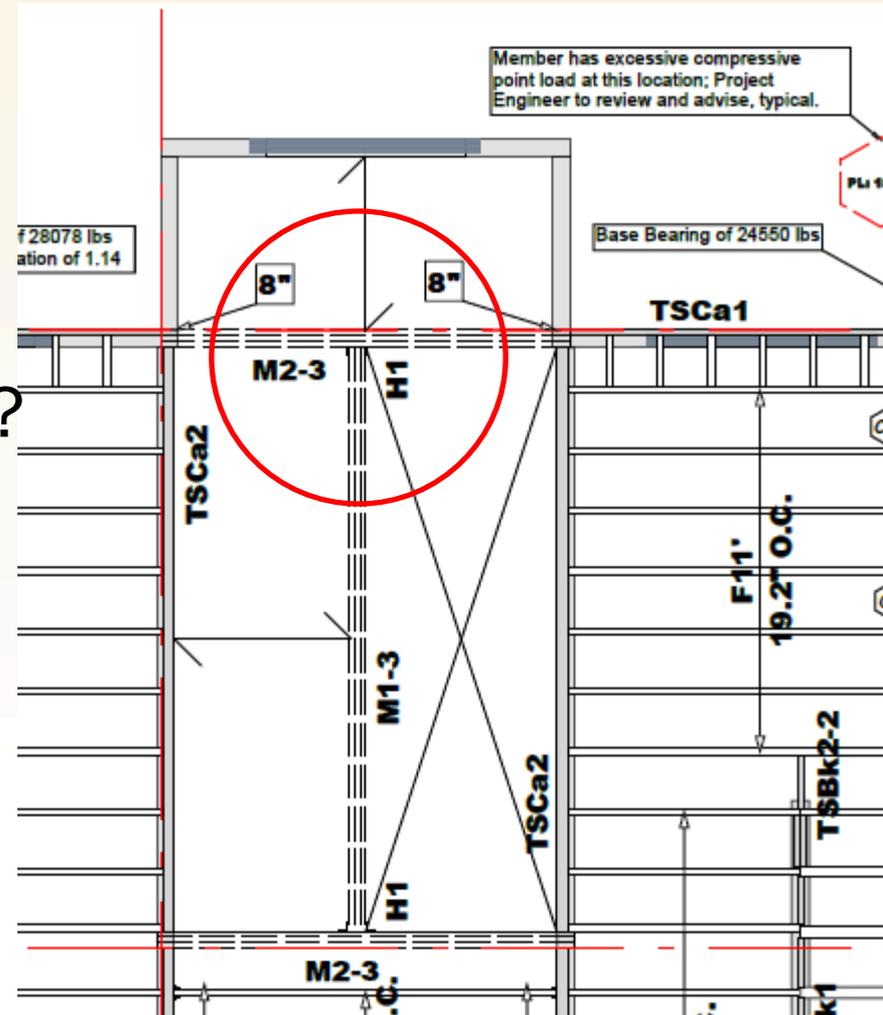
# Andy's Tips

1. Insist on LSL Rimboard  
(not regular LVL, **not generic 1-1/8 residential rim**)
2. **1.5E LSL wall plates** for high loads and better shrinkage performance
3. Don't crush your I-joists. Proper rim / blocking req'd
4. **1.5E LSL studs** can give you more space to run services at lower levels

# 1-piece beams vs multi-ply

Large “side loads” invite potential issues

- Correct connection pattern?
- Installed beam correctly?



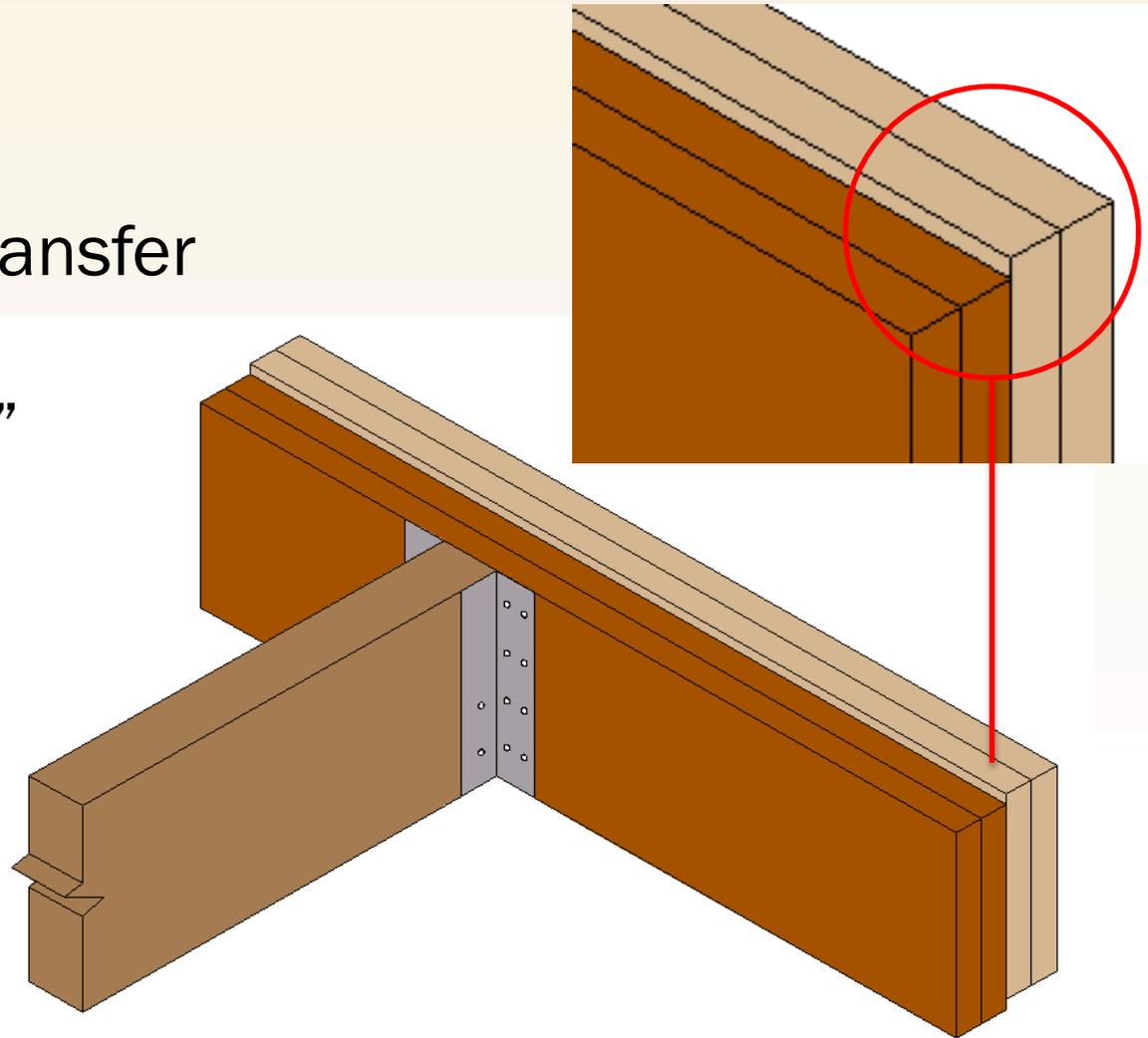
# 1-piece beams vs multi-ply



# 1-piece beams vs multi-ply

## Connections

Goal: Effective load transfer  
to all plies  
Avoid “slippage”



# Engineered Lumber Tools & Services

To achieve this



## Range of Products and Services



Manufacture-only

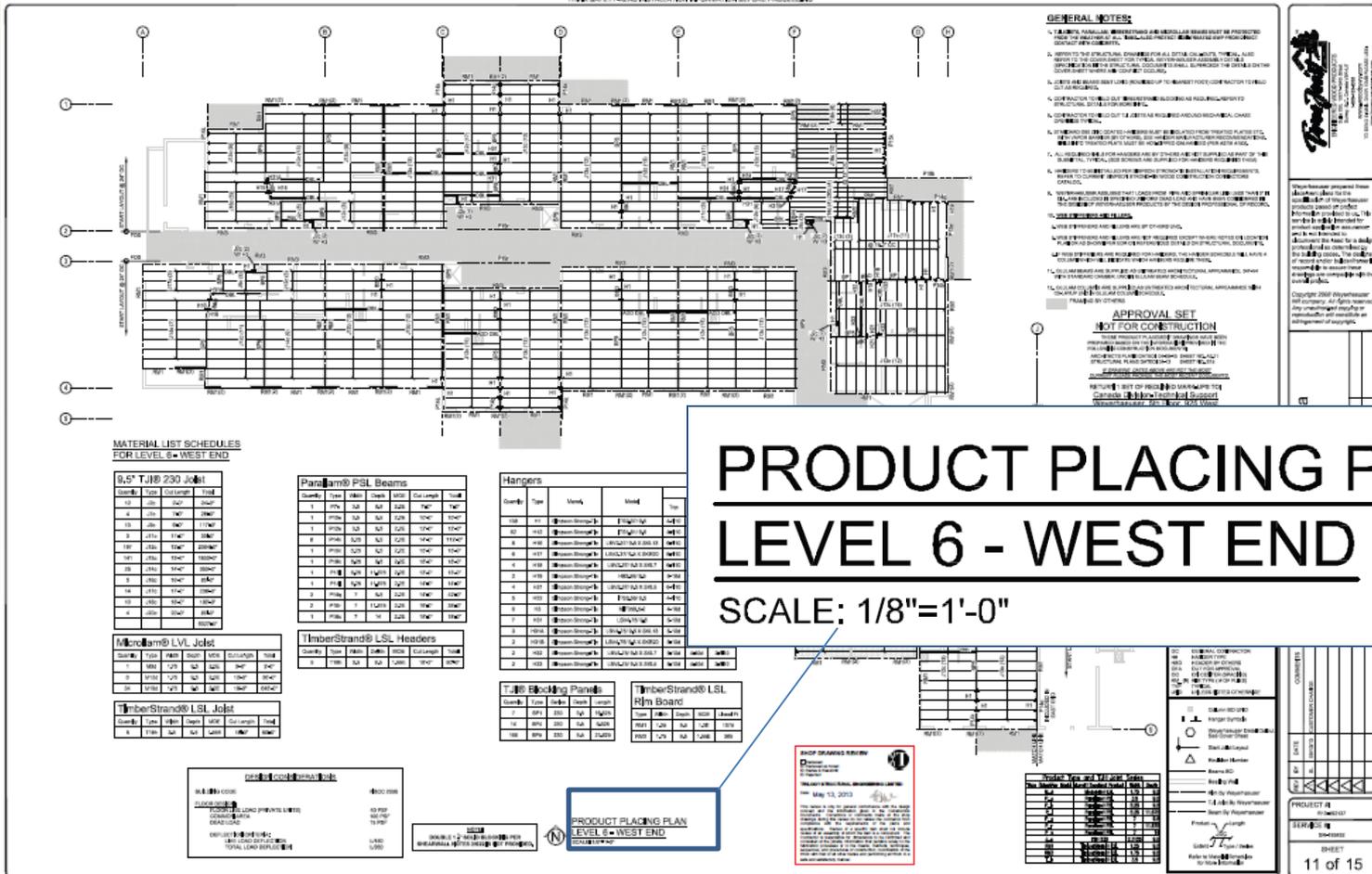
- Attractive price
- limited support

SF tools

**MF expertise**

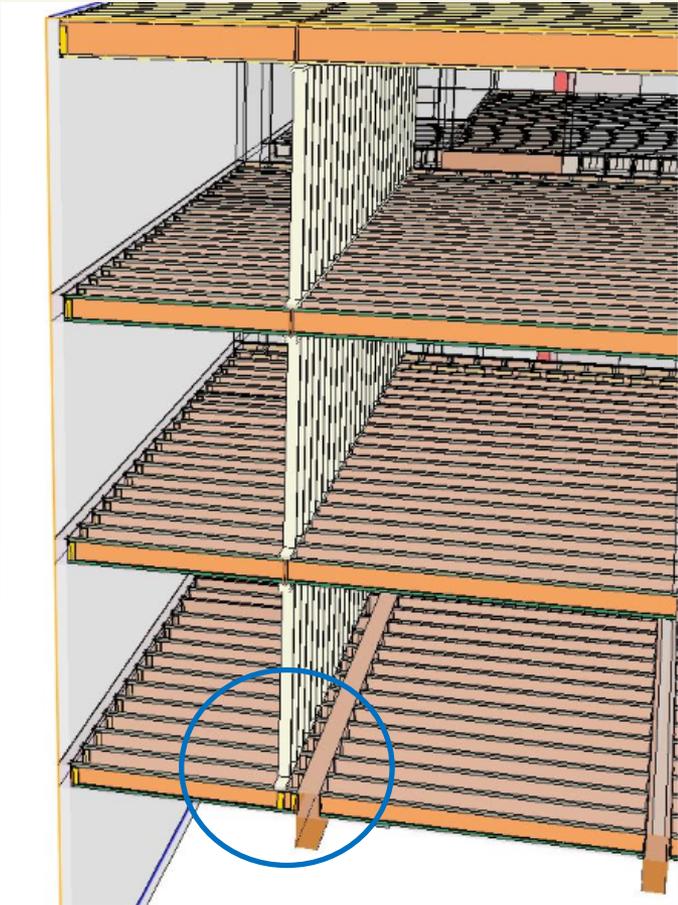
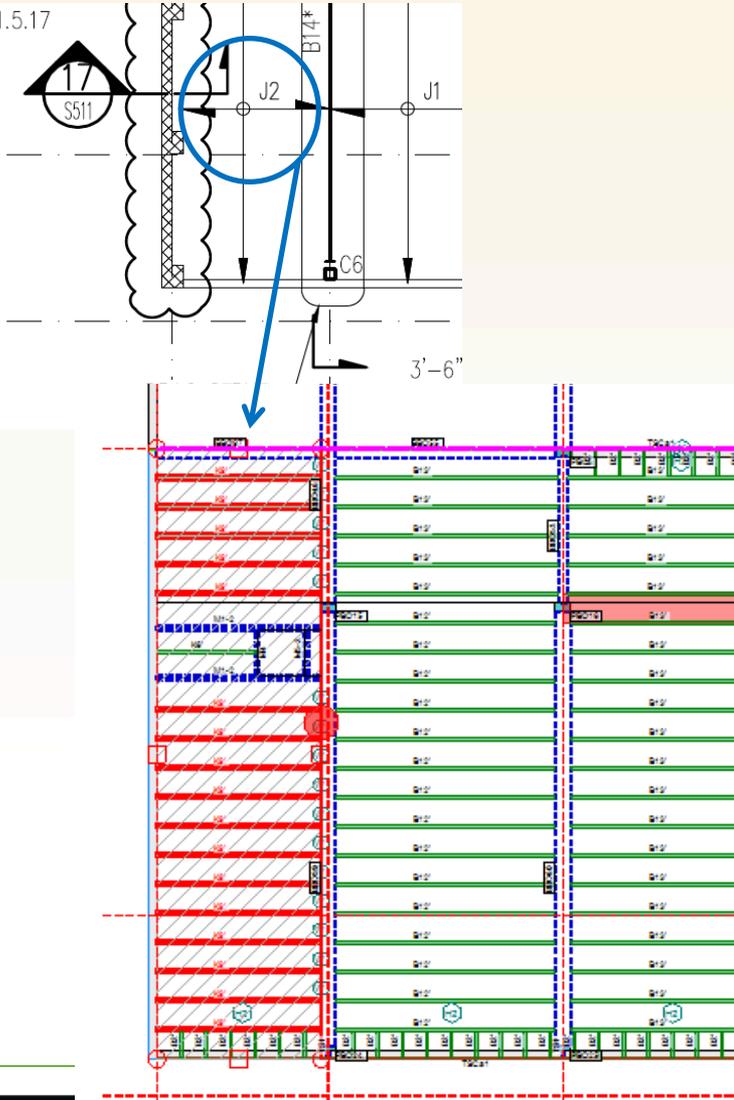
- Higher material cost
- Reliability & Savings in overall project

# Shop Drawings



# Software for Design and Fabrication

1.5.17



# People behind the Products

Key questions to ask about your ELP supplier:

- Can they **demonstrate** the expertise to offer design service appropriate for large multi-family structures?
- Supply only? Or committed to resolve project issues up front at quote /design stage?
- Responsiveness to changes as the project progresses?
- Will they switch products, or honour your specification?

# Adding Value at the Bid Stage

Successful builders have told us:

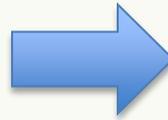
- Include performance criteria and product specifications your bid requirements. Why?
  - Delivery of material and construction meets the intent of the design team and owner
  - Avoids the race to the bottom in accepting attractive bids that can cost more in the long run
- Items considered key for quality:
  - List years experience, qualifications, work examples.

# What does it take to go from

Here

to

Here?



# Andy's Tips

1. Insist on 1-1/4" (min) LSL Rimboard  
(not regular LVL, not generic 1-1/8 residential rim)
2. LSL wall plates for high loads and better shrinkage performance
3. Don't crush your I-joists. Proper rim / blocking req'd
4. LSL studs can give you more space to run services at lower levels
5. Save bolts, time and get better results: use "thick section" PSL beams
6. Pick your ELP supplier carefully on mid-rise projects.