Canadian Wood Council

G063

Common Mid-Rise Structural Design Challenges – and Solutions

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

Course Description

Examining recent 6-storey projects, this presentation will highlight specific challenges, important details and procedures, and to illustrate how various engineered wood products were applied strategically to ensure success.

Learning Objectives

At the end of the this course, participants will be able to:

Key learning points:

- Gain insight into some of the critical structural challenges for wood framed mid-rise buildings
- Understand how use of Engineered Lumber (particularly LSL) can assist in decreasing building shrinkage and resisting higher loads
- Know what a qualified ELP supplier can provide to assist in these projects
- Examine a few emerging technologies that may impact this type of construction in the future

Common Mid-Rise Structural Design Challenges – ELP Solutions

Ontario Wood Solutions Fair

November 24, 2015

Topics of Conversation

Mid-Rise Structural Challenges:

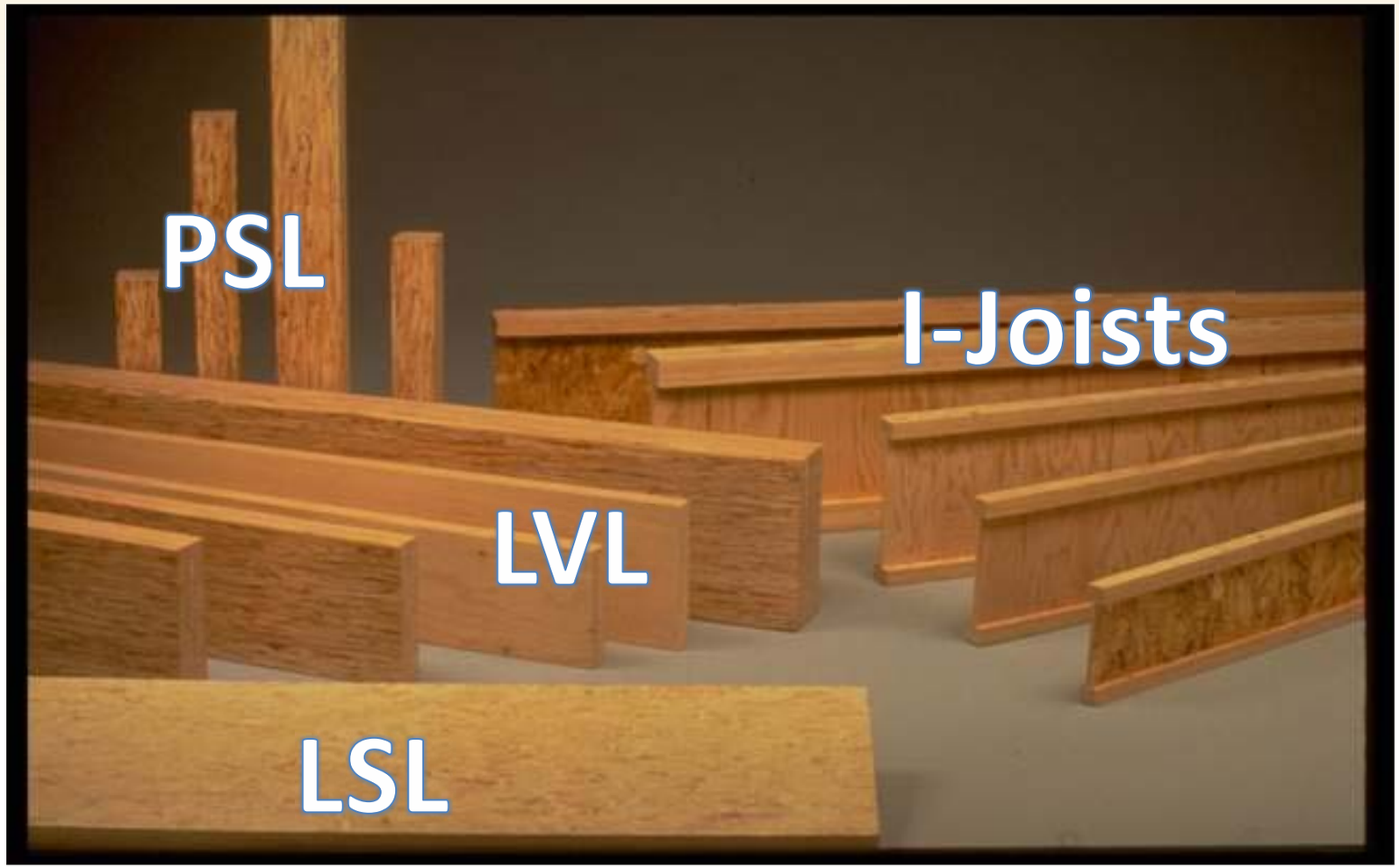
- Dimensional Stability (“Shrinkage”)
- Increased Vertical Loads
- Increased Lateral Loads

Solutions:

- ELP Product Performance
- Supplier Support

Questions?

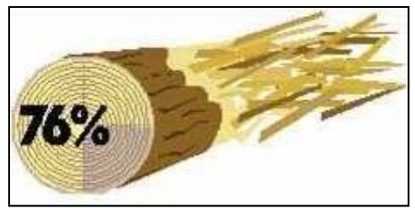
Engineered Lumber Products



Laminated Strand Lumber (LSL)

= 0.8E

= 1.3E, 1.5E, 1.55E



Batch Manufacturing Operation
3-1/2” x 8’ x 60’/64’ Billet

LSL - Manufacturing

Up to 64’ long, 1-3/4” and 3-1/2” thicknesses

Fully graded and sanded up to 4’ width

LSL – Typical Dimensions

Beams and Headers:

- Thickness: 1-¾”, 3-½”
- Depths: 9-½”, 11-⅞”, 14”, 16”

Rim board

- Thickness: 1-⅛”, 1-¼”, 1-½”
- Depths up to 24”

Studs

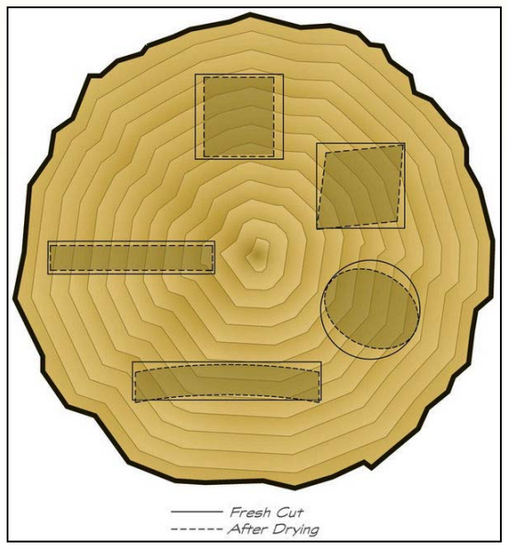
- 2x4, 2x6, 2x8, 3”x3-½” , 3”x5-½”

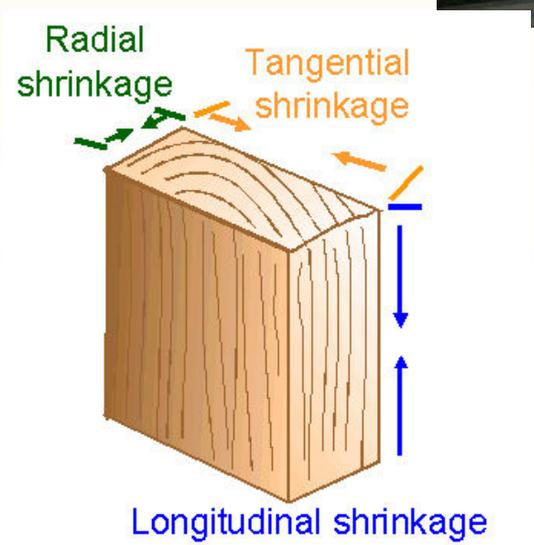
Dimensional Stability – “Shrinkage”

Cumulative Effects

Cross-grain shrinkage of particular concern

- Radial and tangential directions

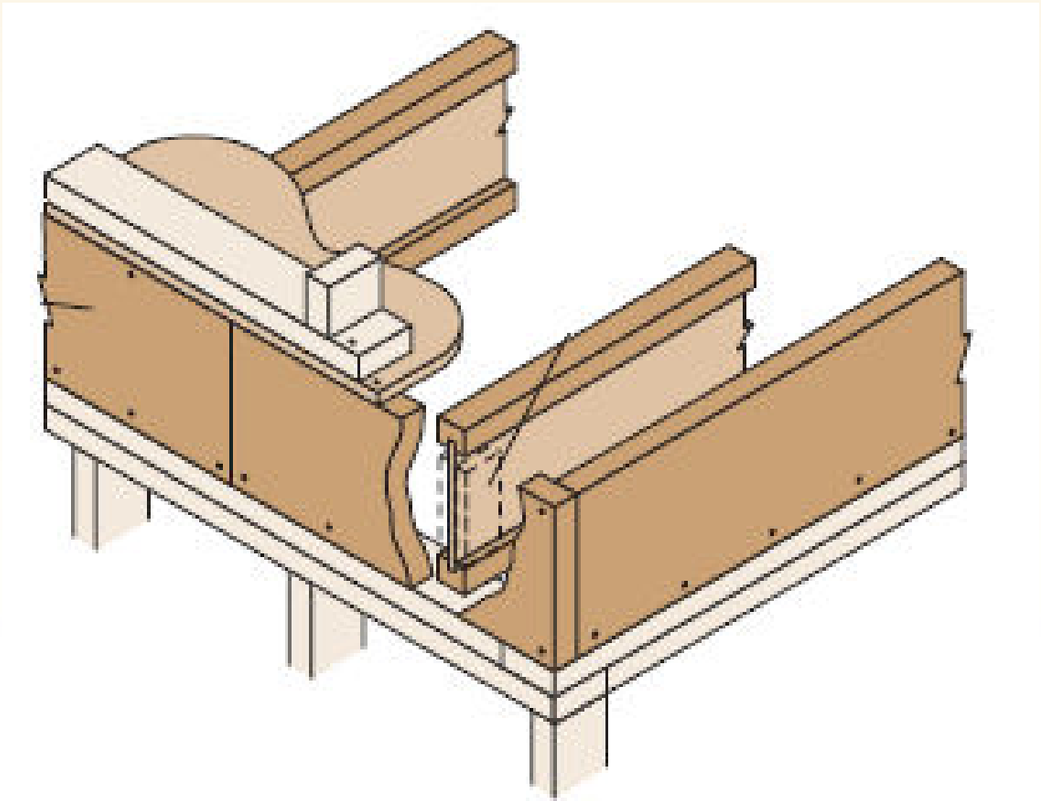




Dimensional Stability – “Shrinkage”

Platform construction:

- Wall plates
- Rimboard
- Joists



Dimensional Stability – LSL Rim Board

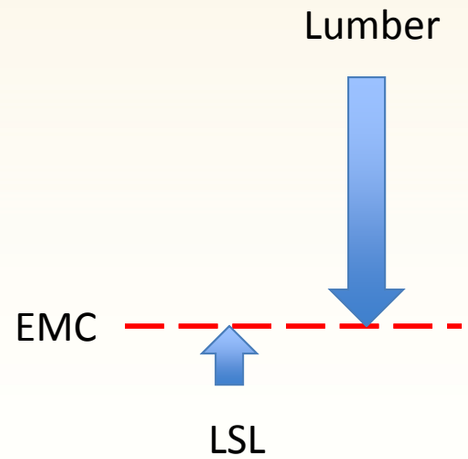
EMC for lumber ~12%; for ELP ~10%

KD dimension lumber dried to ~16%-19% moisture content

- shrinkage occurs as wood dries

LSL made ~6-8%

- manufactured to match nominal depth at anticipated MC ~9-10%
- No continuous grain - reduces dimensional change and thus less shrinkage at rim locations

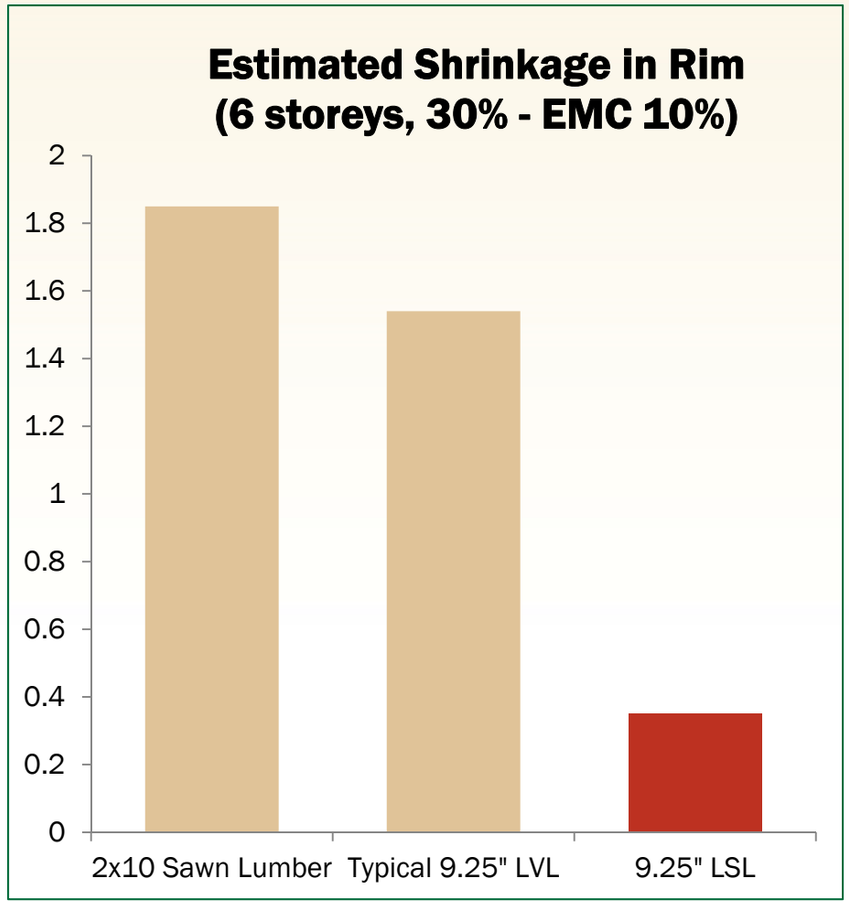


Dimensional Stability – LSL Rim Board

Relative study –

worst-case conditions:

- Measured depth: in yard, saturated (>30% MC), redried to original MC
- Fully saturated swell = 1.0%
- Retained depth swell = 0.3%



Dimensional Stability – LSL Wall plates

Wall Plates

- 3 per floor x 6 floors = 18 plates
- ~1/16” shrinkage x 18 plates → >1”

Keep LSL dry to avoid swelling

- Works well with panelized construction

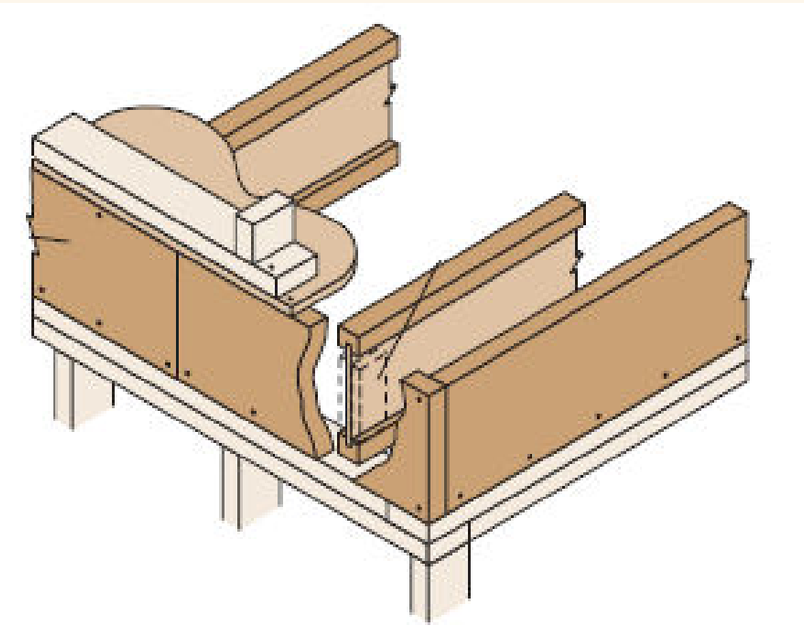
Photo Courtesy APEGBC

Dimensional Stability

Minimize moisture exposure through reduced open time.

- Wall Panels
- Floor Panels

Vertical Loads and Product Capacity



- Increased demand on structural elements, particularly at lower floor levels
- Stud walls, plates, rim – greater loads

Vertical Capacity – LSL Wall Studs

FACTORED AXIAL RESISTANCE (PLF) - WALLS WITH 1.5E LSL PLATES

8' Wall Height

		Exterior Walls					Interior Walls				
Grade	Stud	6" o.c.	8" o.c.	12" o.c.	16" o.c.	24" o.c.	6" o.c.	8" o.c.	12" o.c.	16" o.c.	24" o.c.
1.3E LSL	2x4	8890	6575	4265	3105	1955	9260	6945	4630	3470	2315
	2x6	19650	14735	9825	7365	4910	19650	14735	9825	7365	4910
1.5E LSL	2x4	11330	8400	5480	4020	2560	11710	8780	5855	4390	2925
	2x6	20400	15300	10200	7650	5100	20400	15300	10200	7650	5100
	2x8	26890	20165	13445	10080	6720	26890	20165	13445	10080	6720
1.3E/1.5E LSL	3" x 3-½"	18140	13515	8890	6575	4265	18520	13890	9260	6945	4630
	3" x 5-½"	36880	27660	18440	13830	9220	36880	27660	18440	13830	9220

9' Wall Height

		Exterior Walls					Interior Walls				
Grade	Stud	6" o.c.	8" o.c.	12" o.c.	16" o.c.	24" o.c.	6" o.c.	8" o.c.	12" o.c.	16" o.c.	24" o.c.
1.3E LSL	2x4	7520	5535	3555	2565	*	7950	5960	3975	2980	1985
	2x6	18700	14025	9350	7000	4550	18700	14025	9350	7010	4675
1.5E LSL	2x4	9490	7010	4540	3300	2075	9920	7440	4960	3720	2480
	2x6	20400	15300	10200	7650	5100	20400	15300	10200	7650	5100
	2x8	26890	20165	13445	10080	6720	26890	20165	13445	10080	6720
1.3E/1.5E LSL	3" x 3-½"	15470	11490	7525	5535	3555	15900	11925	7950	5960	3975
	3" x 5-½"	36880	27660	18440	13830	9220	36880	27660	18440	13830	9220

10' Wall Height

		Exterior Walls					Interior Walls				
Grade	Stud	6" o.c.	8" o.c.	12" o.c.	16" o.c.	24" o.c.	6" o.c.	8" o.c.	12" o.c.	16" o.c.	24" o.c.
1.3E LSL	2x4	6320	4625	2945	*	*	6790	5090	3395	2545	1695
	2x6	17640	13190	8655	6385	4120	17640	13230	8820	6615	4410
1.5E LSL	2x4	7910	5825	3740	2700	*	8380	6285	4190	3140	2095
	2x6	20400	15300	10200	7650	5100	20400	15300	10200	7650	5100
	2x8	26890	20165	13445	10080	6720	26890	20165	13445	10080	6720
1.3E/1.5E LSL	3" x 3-½"	13100	9710	6325	4630	2945	13580	10185	6790	5090	3395
	3" x 5-½"	35280	26460	17640	13190	8655	35280	26460	17640	13230	8820

* Deflection limit exceeded by wind load

Vertical Capacity – LSL Wall Studs

Another concern: gypsum for lateral bracing of studs?

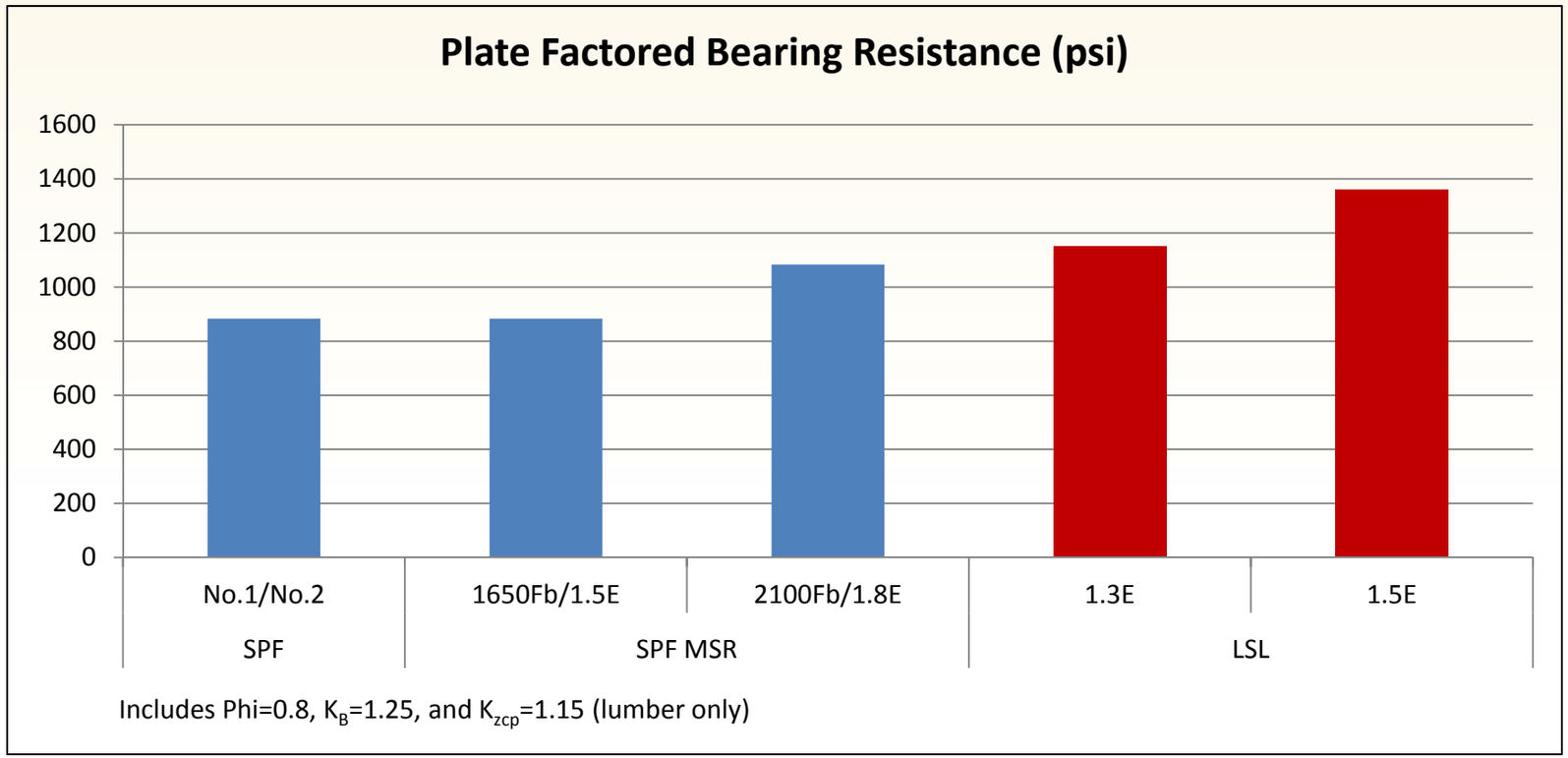
- Seismic drift must be less than hs/100

Possible solution: 3” solid LSL stud

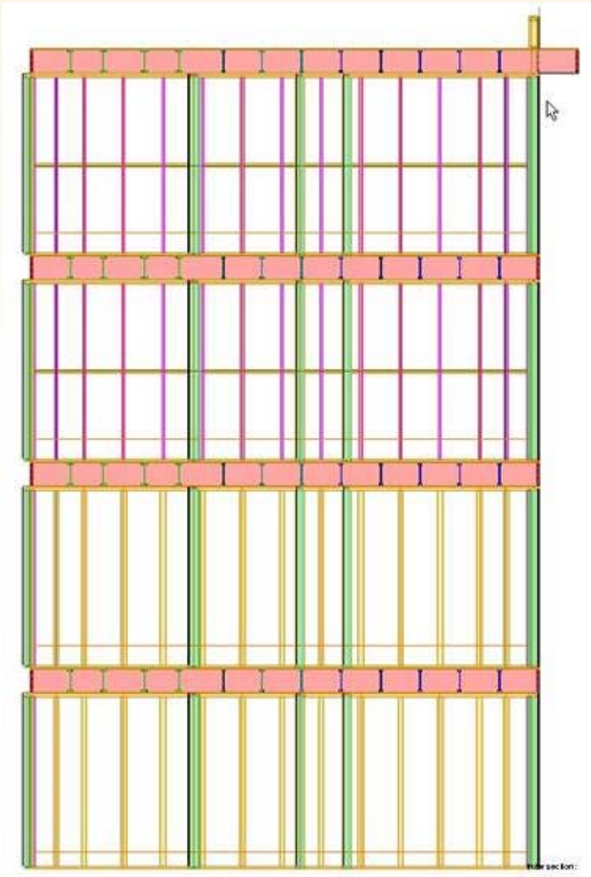
Wider spacing – easier on trades

Product Capacity - LSL Wall Plates

Recent standard changes allow F_{cp} determination for SCL based on proportional limit



Product Capacity – LSL Rim



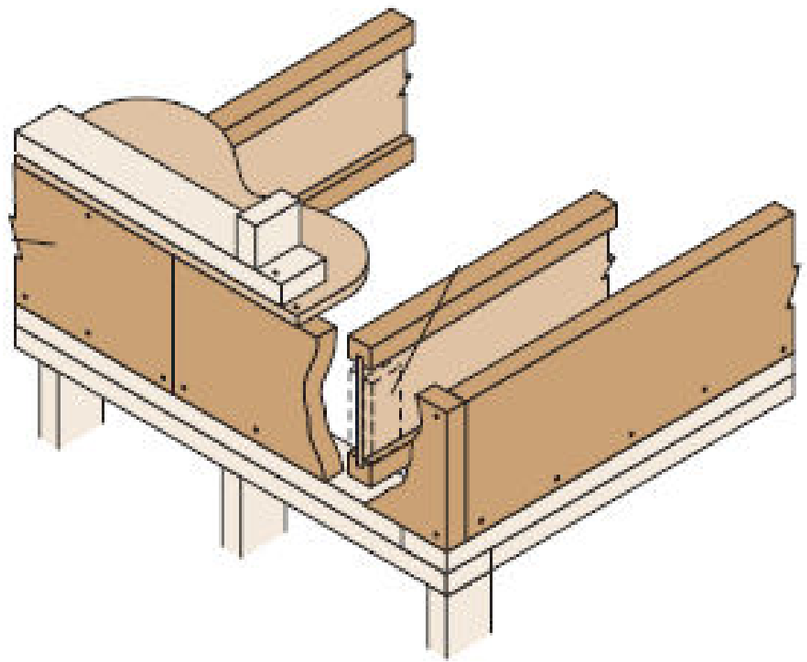
Enhanced vertical load capacities and bending values

Stiffer element to assist in transferring load evenly to studs below

Avoid the need for in-line framing when designed adequately

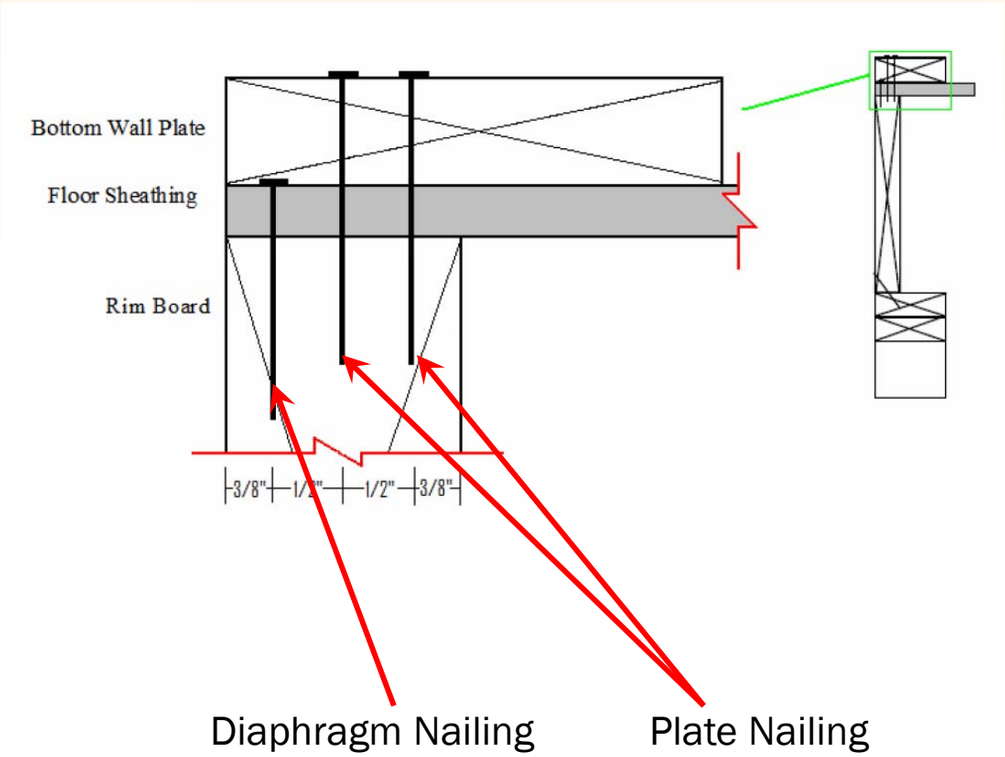
Lateral Loading

- Transfer of wall shear loads through the diaphragm
- Shear wall nailing



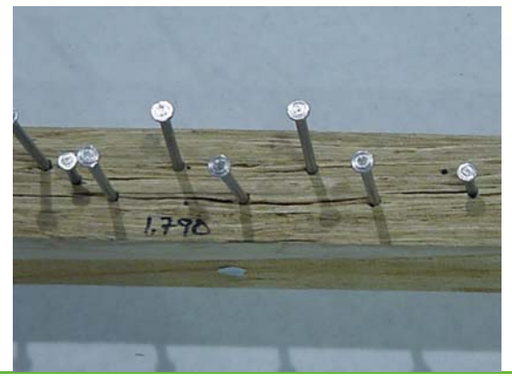
Product Capacity – LSL Rim

1-⅛” 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” used
- See manufacturer’s code reports or published guidelines for allowable spacing

Lateral Loads - 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 (in²)	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"ø BOLTS @ 16" O/C									

Tight Fastener spacing – even in wind-governed designs

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

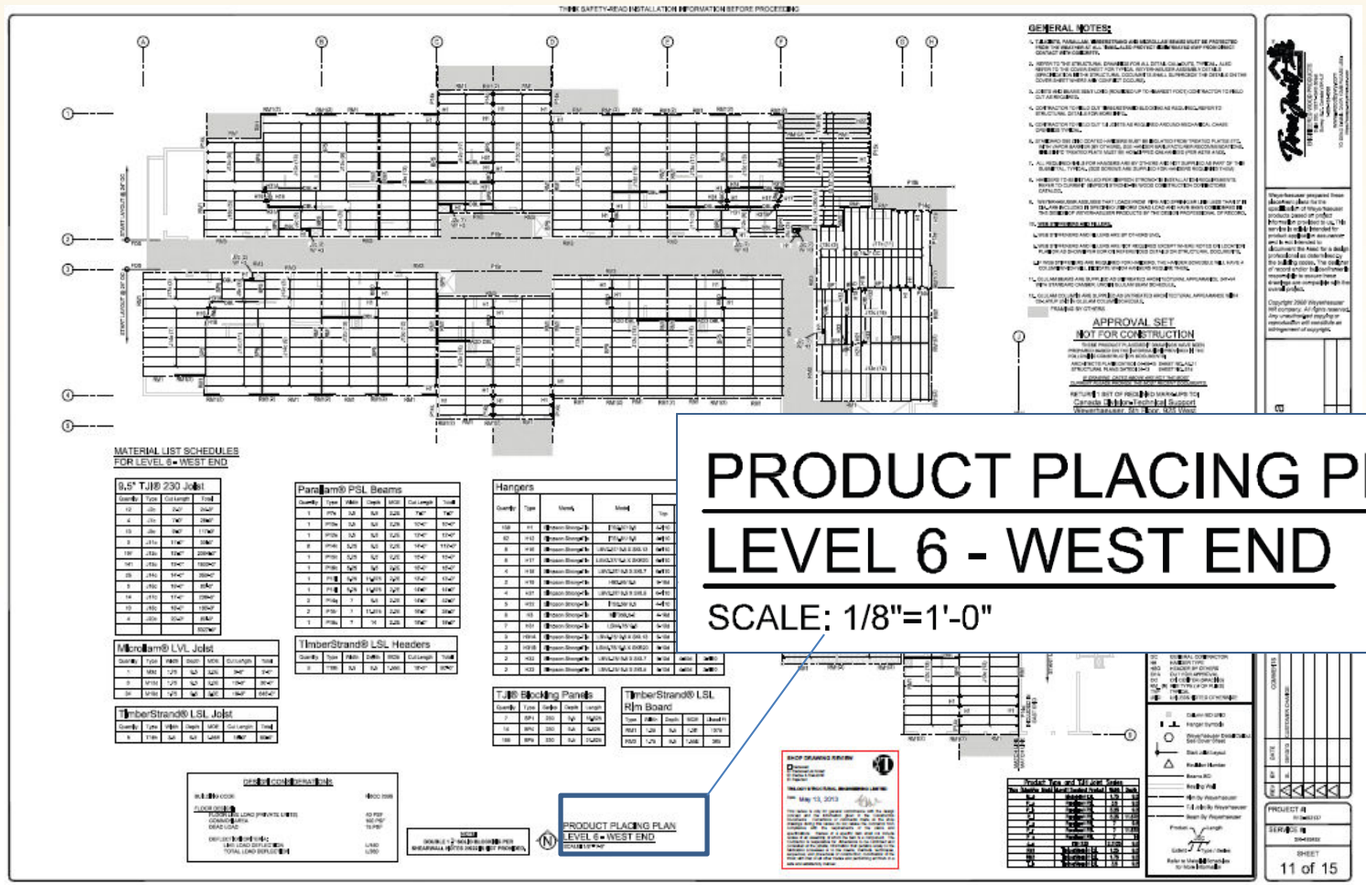
1.5E LSL or greater needed for these spacings

People behind the Products

Key questions to ask about your ELP supplier:

- Do they have the expertise to offer design service appropriate for large multi-family structures?
- Can they partner with you at the design stage to resolve project issues up front?
- Will they be there to assist as the project progresses?
- Will they help you hold your specification?

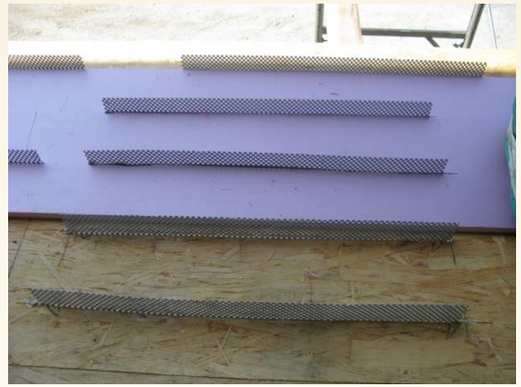
Software for Design and Fabrication



Opportunities – Roof/Wall Panels

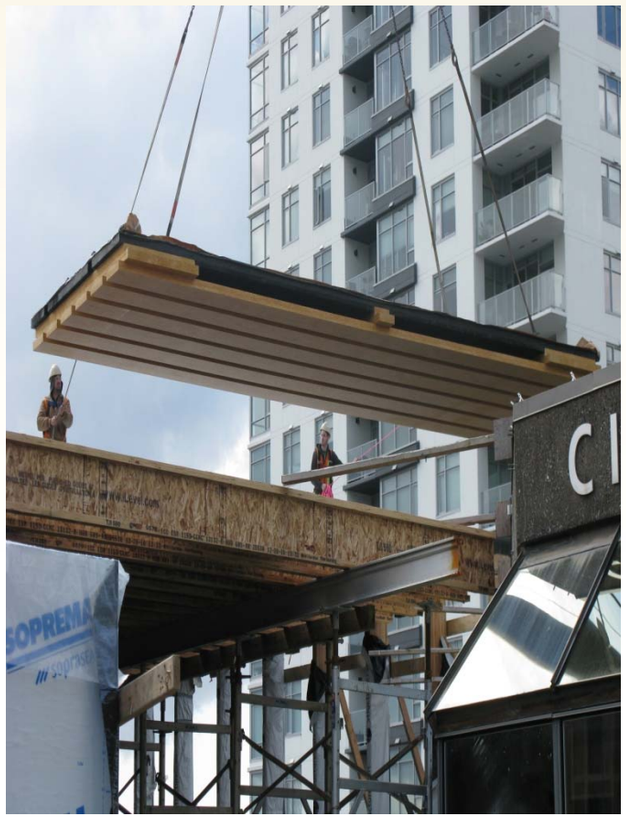
Opportunities – Hybrid Panels

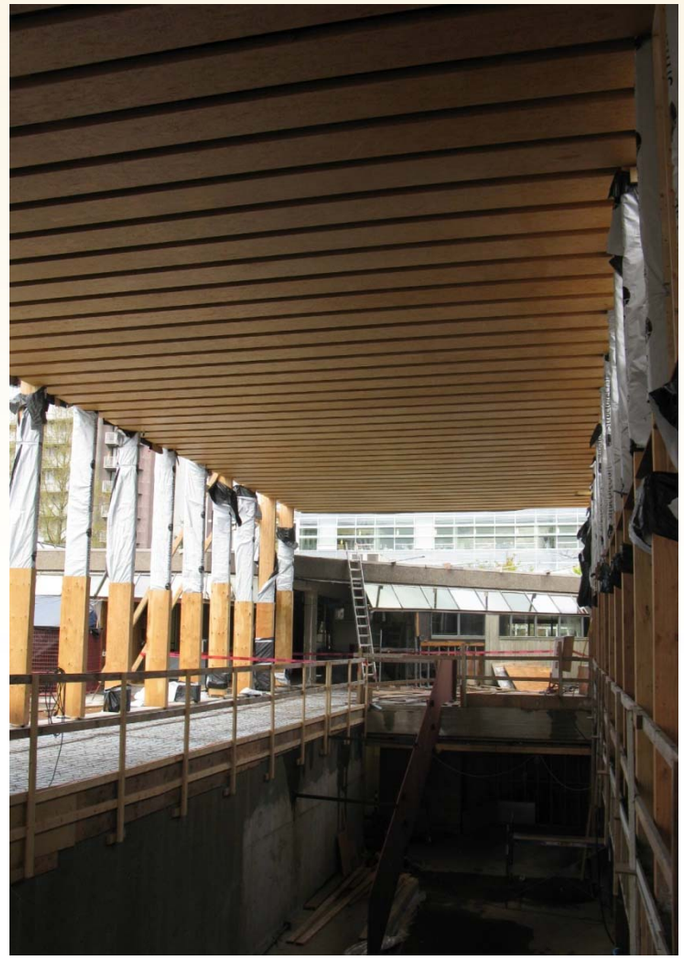
Hybrid Panel alternatives



Opportunities – Hybrid Panels

Hybrid Panel alternatives





In Conclusion….

- LSL provides significant benefit in addressing shrinkage and increased loading in mid-rise structures
- Partnering with an experienced supplier enhances the possibility of a successful project

This concludes The American Institute of Architects
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