

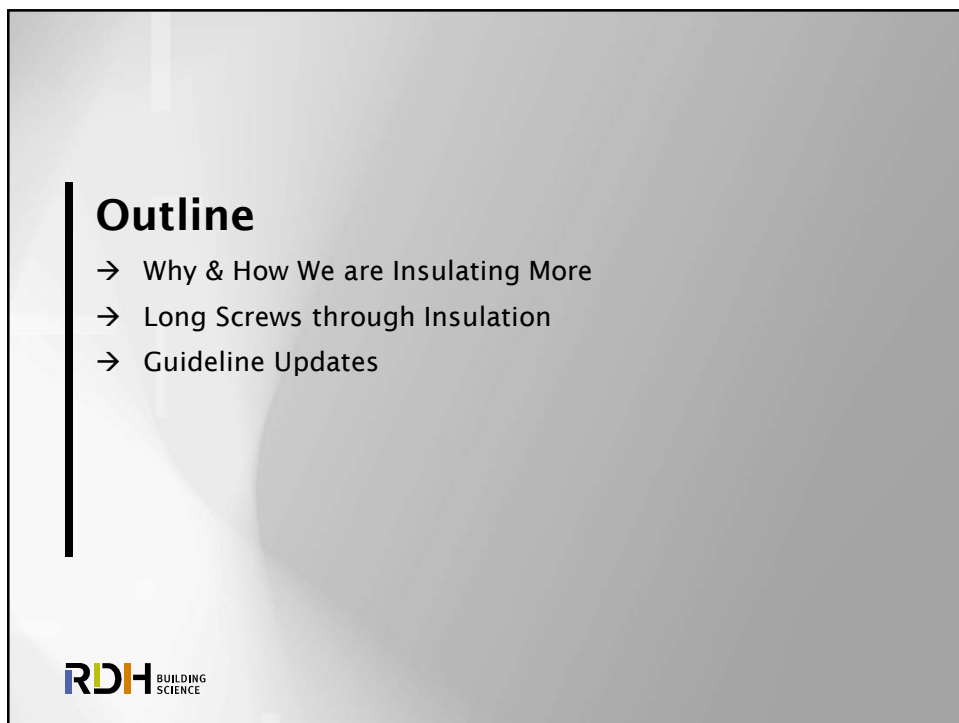


**Attaching Cladding with Long Screws**

PHIUS 12<sup>th</sup> Annual North American Passive House Conference  
September 29, 2017

Presented by: Michael Aoki-Kramer | LEED AP™

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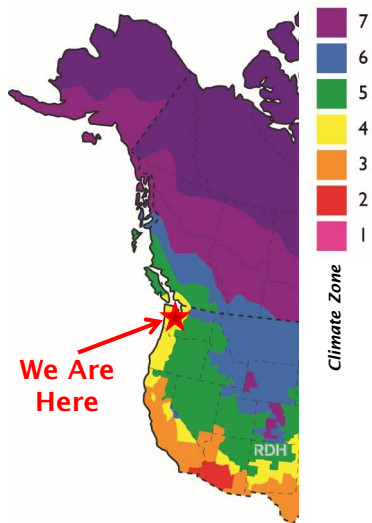
**Outline**

- Why & How We are Insulating More
- Long Screws through Insulation
- Guideline Updates

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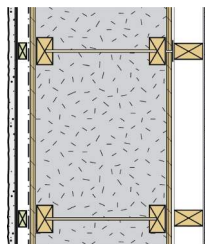
## Why We are Insulating More

- Increasing energy efficiency expectations are **changing insulation requirements in codes**
  - **Passive House** thermal bridge free construction, super insulated
  - **Effective R-18 to R-19 walls and CI requirements** have lead to widespread change in approach
  
- **Better accounting for thermal bridging** means not overlooking bridging by cladding attachments

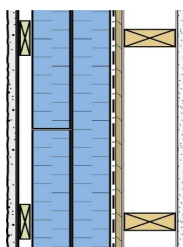


## How to Insulate More

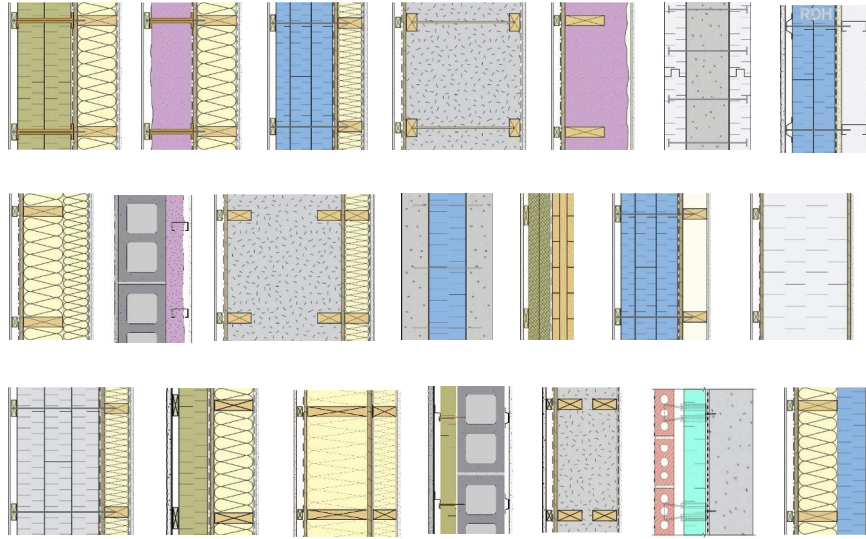
Stuff It?



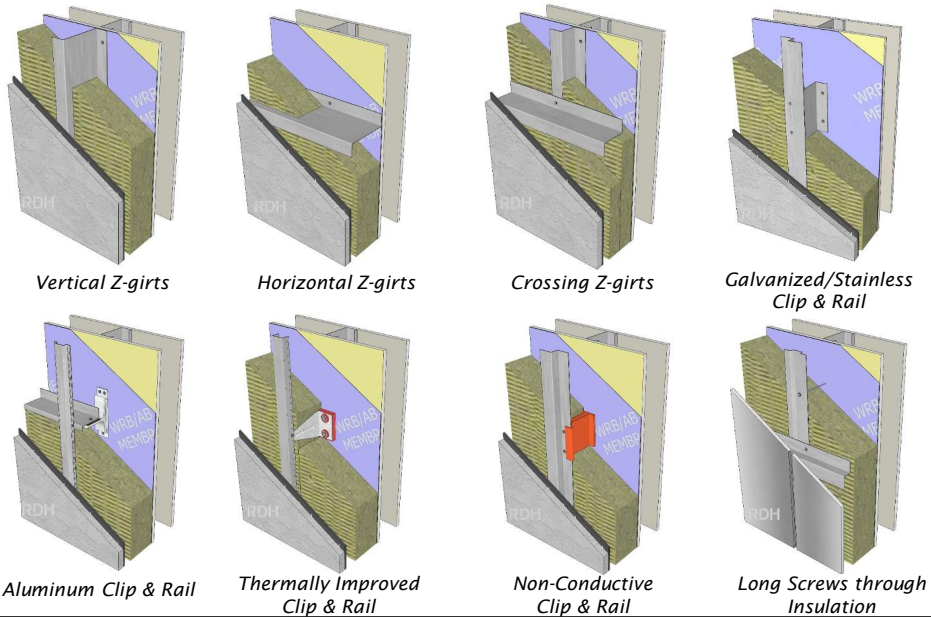
Wrap It?



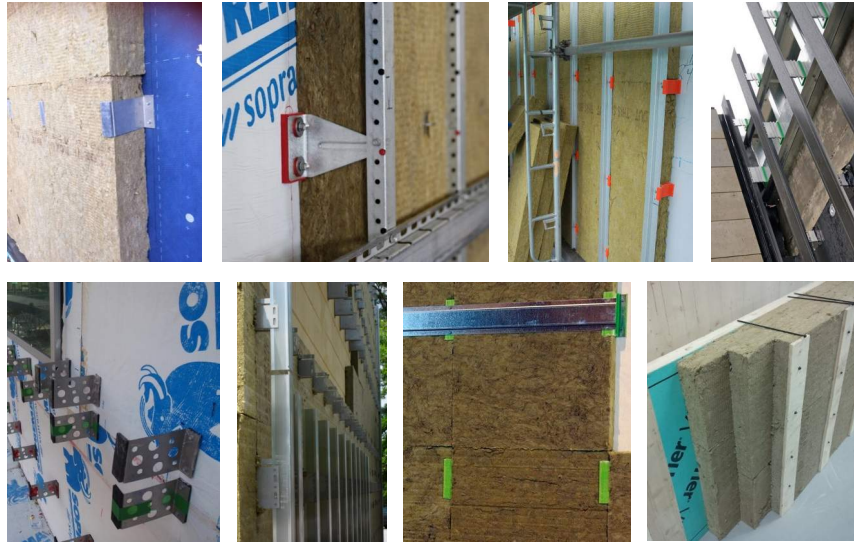
### More than one way to get there...



### Exterior Insulation Approaches Gaining Popularity

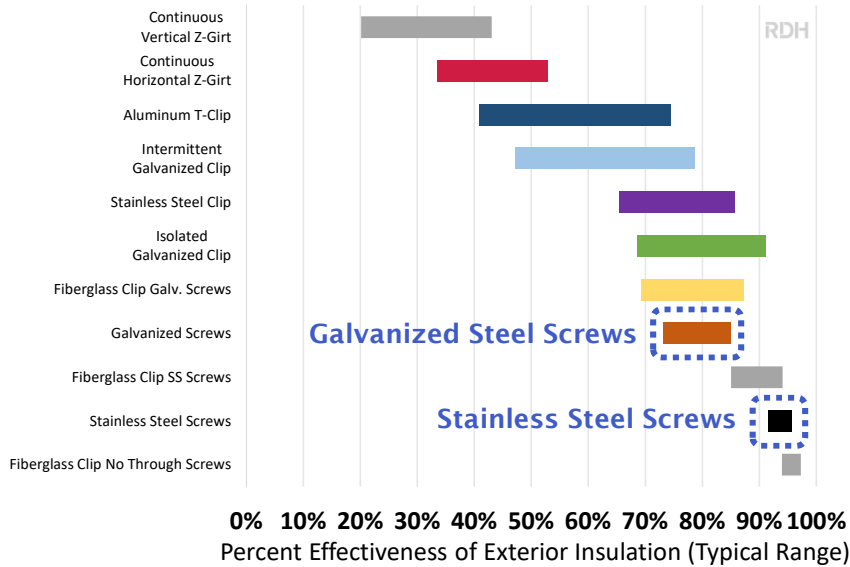


### Exterior Insulation Approaches

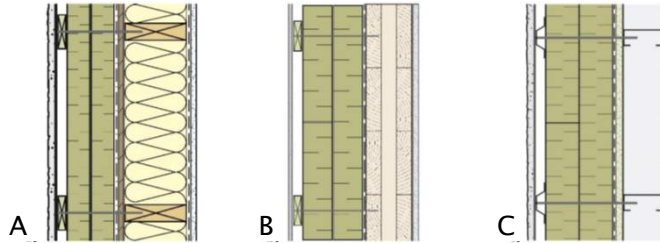


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### Screws Through Insulation Highly Effective



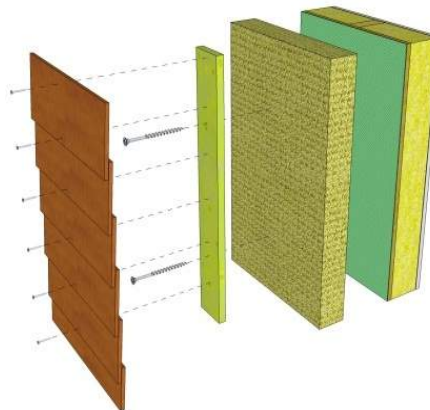
### Screws through Insulation - Chi-Values



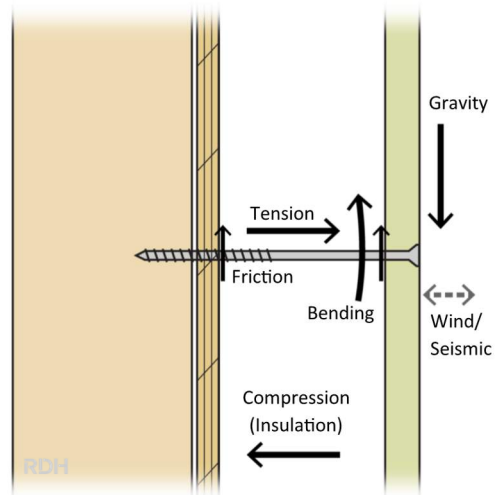
R <sub>e</sub> Value Ext. Insulation (m <sup>2</sup> K/W)	Nominal R <sub>e</sub> Value Wall (m <sup>2</sup> K/W)	Chi (W/10)	Chi/Area (W/m <sup>2</sup> )			Effectiveness of Exterior Insulation (%)			
			12"x16"	16"x16"	24"x16"	12"x16"	16"x16"	24"x16"	
<b>a) 2x6 Exterior Insulated Wood Framed Wall with R<sub>e</sub> 3.87 Cavity Fill, #10 screws</b>									
4"	2.82	6.71	0.0010	0.0082	0.0062	0.0041	98%	98%	99%
8"	5.64	9.51	0.0012	0.0098	0.0074	0.0049	94%	96%	97%
12"	8.45	12.33	0.0013	0.0103	0.0078	0.0052	91%	93%	95%
<b>b) 7" Cross Laminated Timber (CLT) Exterior Insulated, #12 screws</b>									
10"	7.04	8.84	0.0018	0.0145	0.0109	0.0072	90%	92%	95%
<b>c) 3 5/8" Steel Stud Wall no Cavity Fill, #10 screws</b>									
4"	2.82	3.44	0.0076*	0.0613	0.0460	0.0306	82%	86%	91%

### Screws Through Insulation

- Rapidly gaining popularity to meet increasing R-value requirements
- Uncertainty about:
  - How to do it
  - Allowable loads
  - Fastener types
  - Fastener spacing
  - Angle of installation
  - Deflection



## Design and Forces



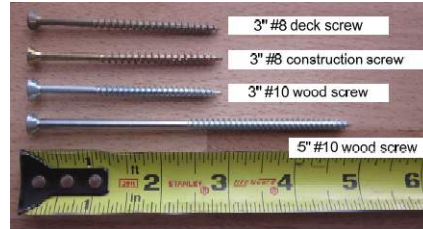
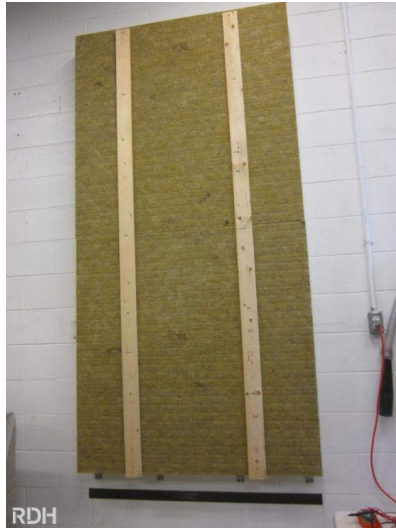
Service Load State  
(Section View)



## Testing



### Testing - Initial Testing



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### Testing

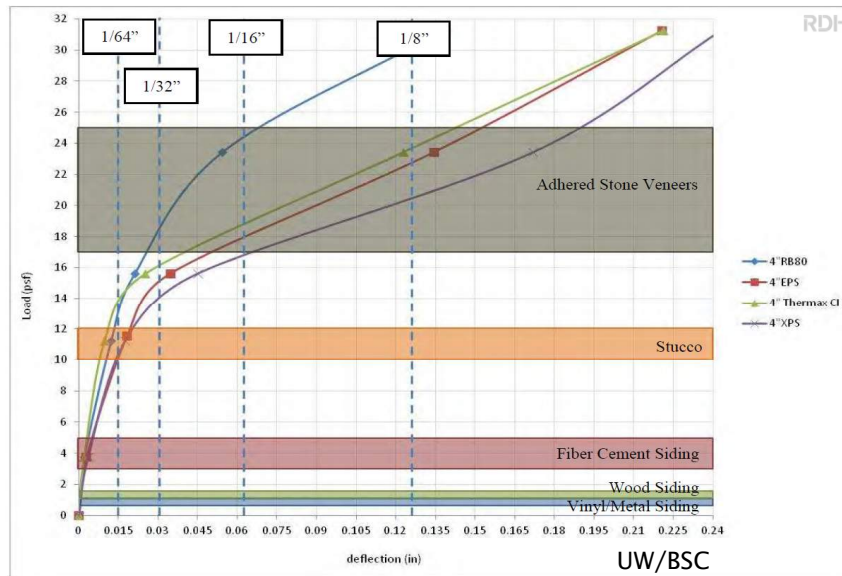


Figure 9: Short term deflection testing results (4" thick insulation)

## Testing



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## Testing

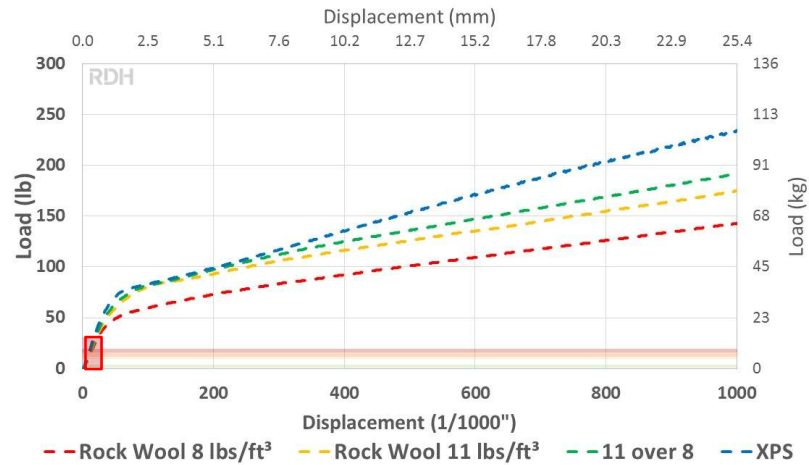
- 3", 6", 9" and 12" thicknesses of insulation
- Different insulation types (mineral wool and XPS) and different compressive strengths
- Different screw head types (pan and countersunk)





## Testing – Insulation Type

Load Displacement for Different Insulation Types (6" Thick)

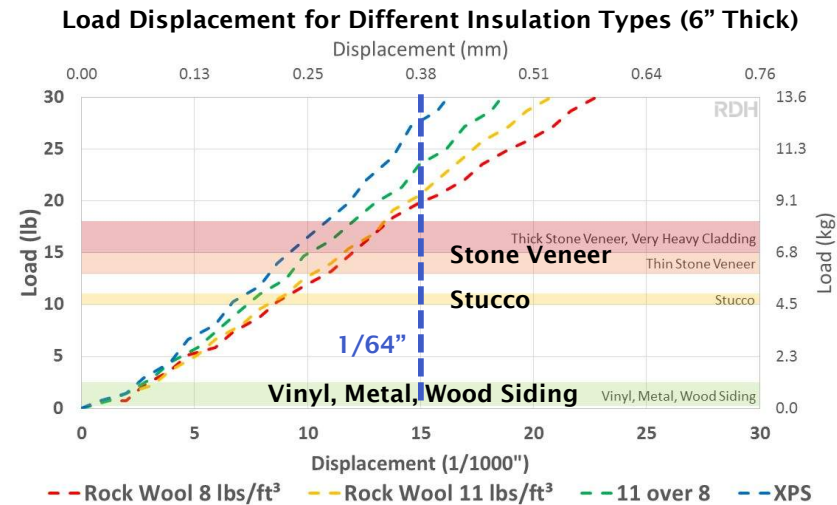


## Cladding Weights

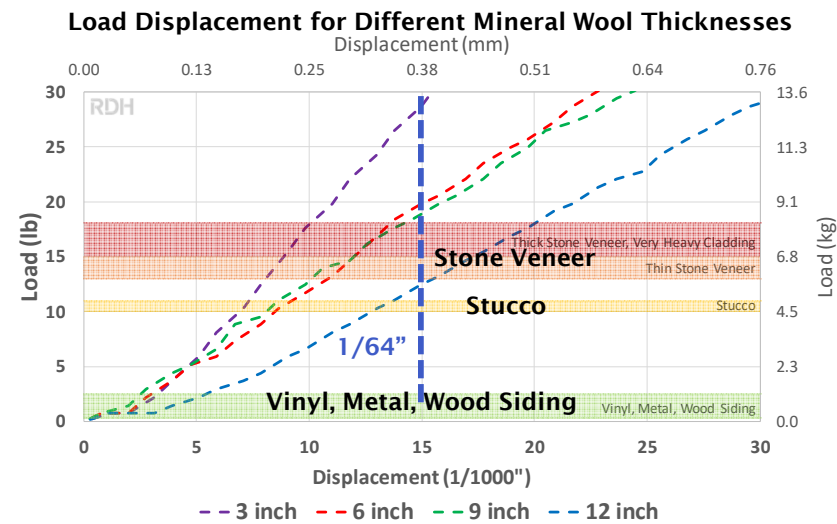
→ Most claddings are “light weight” with only a few select products being heavier



### Testing - Insulation Type



### Testing - Insulation Thickness

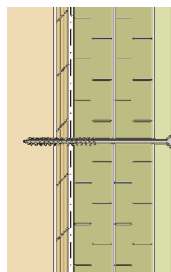


## Testing - Insulation Thickness

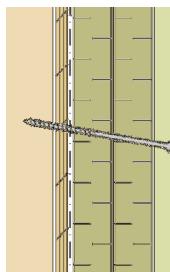
→ For the record, this is what 12" of insulation looks like...



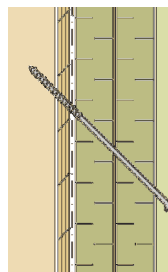
## Testing - Different Fastener Arrangements



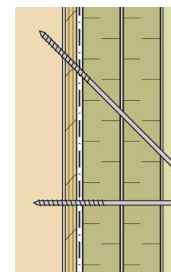
Horizontal  
(90°)



1:6  
(80.5°)



45°

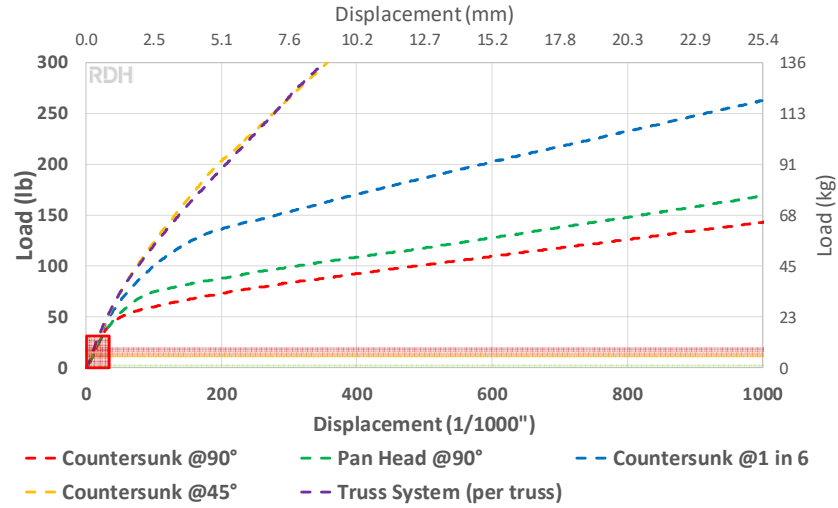


Truss  
(90° + 45°)



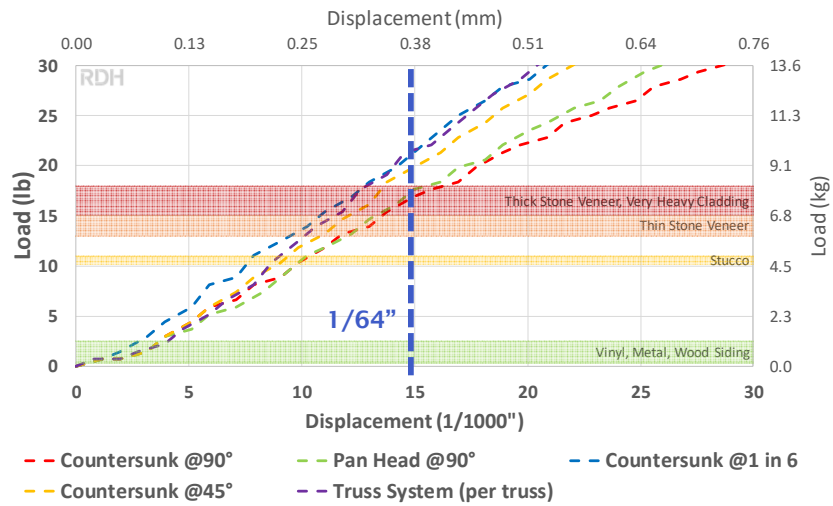
## Testing - Fastener Arrangements

Load Displacement for Different Fastener Arrangements

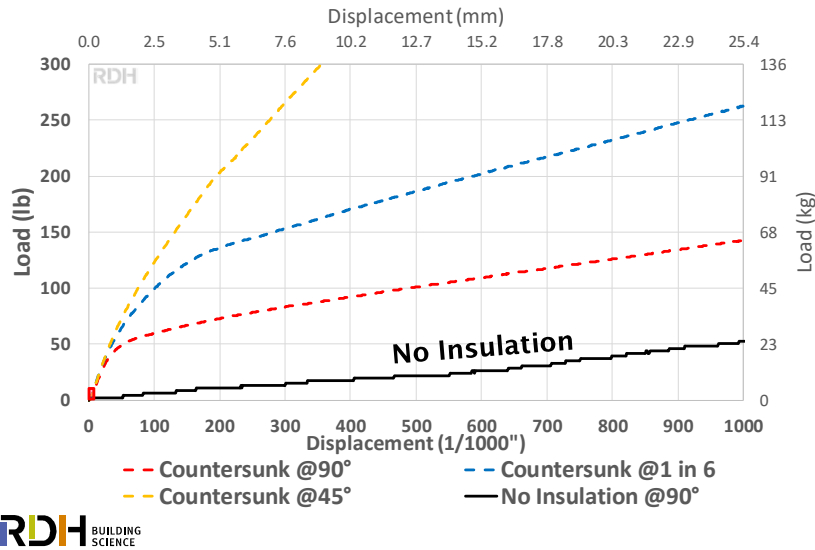


## Testing - Fastener Arrangements

Load Displacement for Different Fastener Arrangements

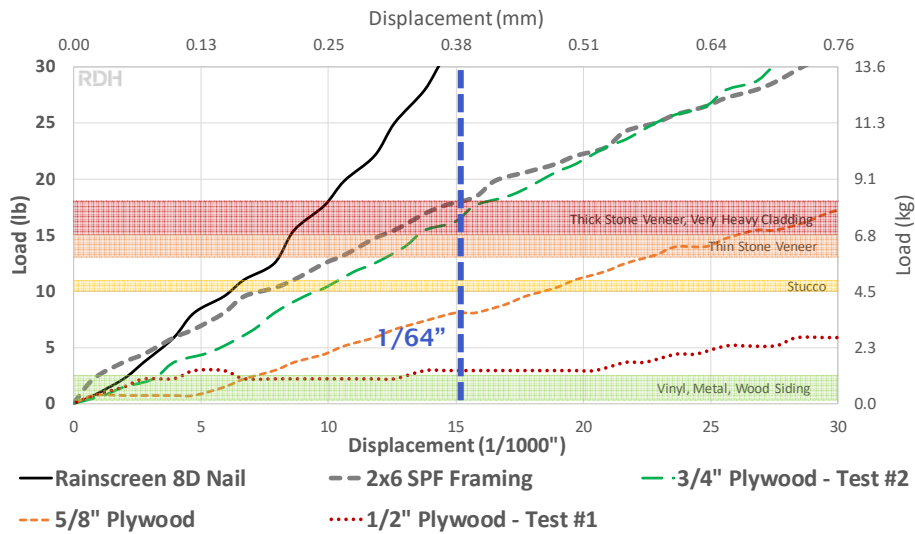


### Testing - Is this just the fastener?



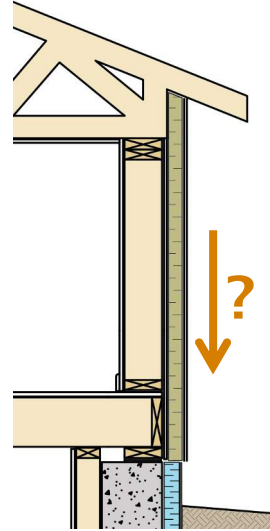
### Testing - What if we miss the stud?

Load Displacement for Screw Penetration into Framing vs. Non-Framing (9" Insulation) and 8D Nail Rainscreen (No Insulation)



### Deflection - How much is too much?

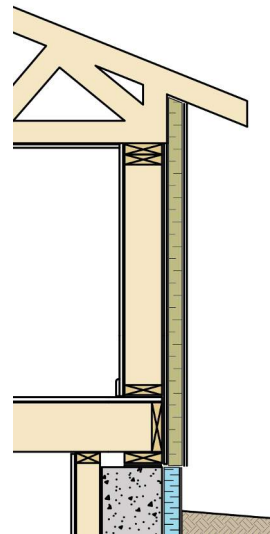
- Difficult to define precise deflection limit but many claddings can easily accommodate 1/8" (125 mil, 3mm) deflection
- Staged loading of the support system helps to "pre-deflect" the strapping prior to cladding completion
- Can see it is different than rainscreen furring direct to sheathing, but not much



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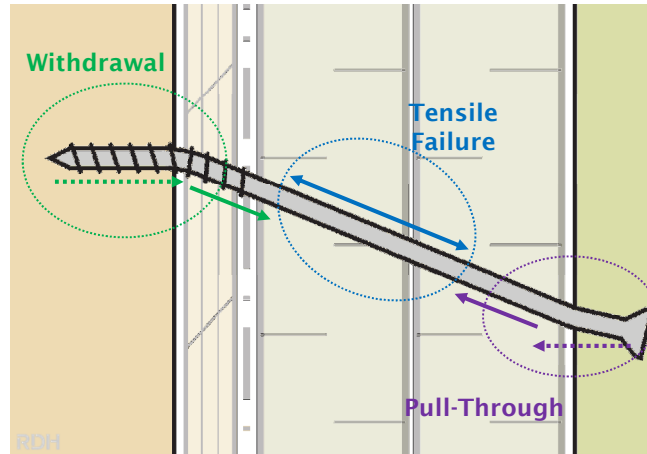
### Deflection - How much is too much?

- Comparison: Wood Shrinkage
  - One wood-frame story: Double top plate, single bottom plate, 8' ceilings, rim joist
  - Assume 19% initial MC and 10% final MC at equilibrium with interior
  - Wood shrinkage due to drying
    - › 0.25%/MC across grain
    - › 0.0053%/MC with grain
  - Approximately **3/8" (375mil, 10mm)** shrinkage in one story height
    - › **Roughly 10x** more than measured deflection in test for any arrangement

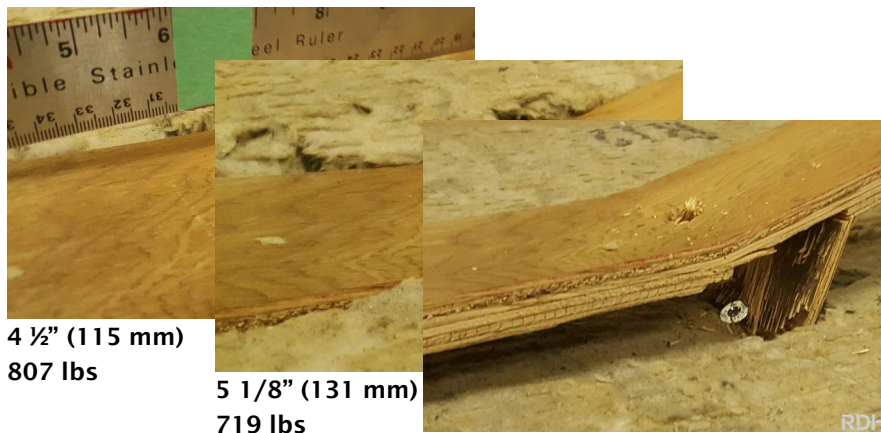


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### Testing - Ultimate Failure Modes



### Testing - Ultimate Failure Mode



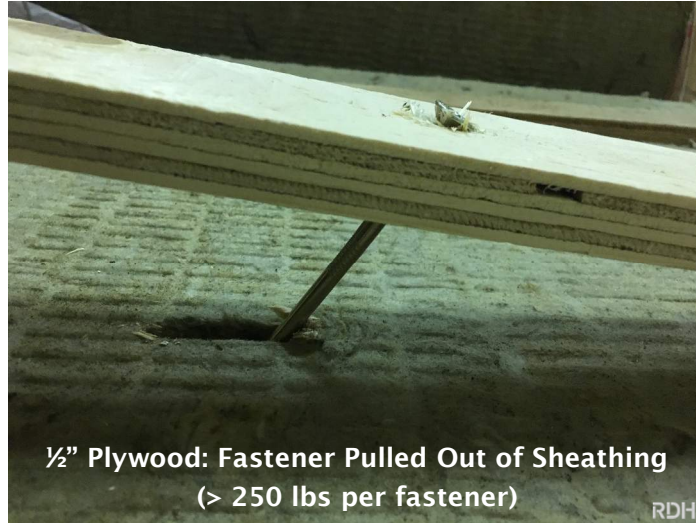
4 1/2" (115 mm)  
807 lbs

5 1/8" (131 mm)  
719 lbs

5 1/4" (133 mm)  
0 lbs (failure)



### Testing - Ultimate Failure Mode



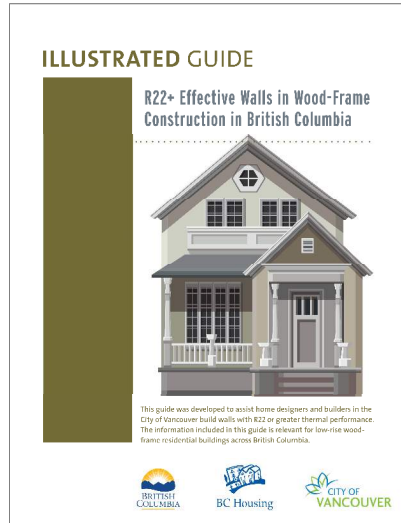
RDH

### Case Study - Bella Bella Passive House

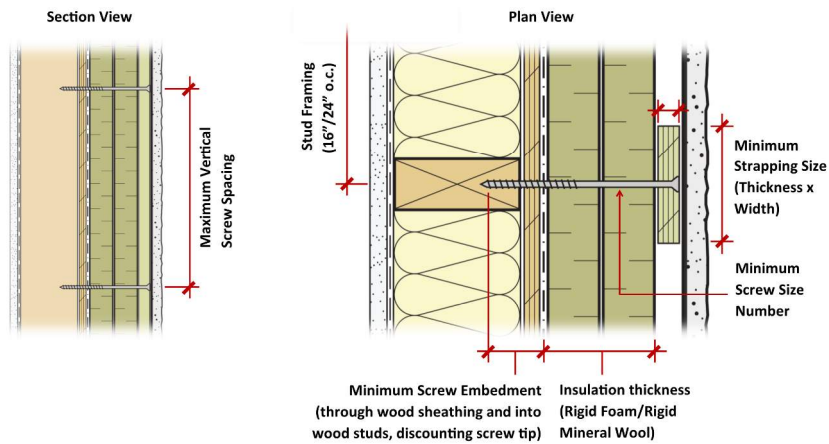




## R22+ Wall Guide Update



## Design Tables



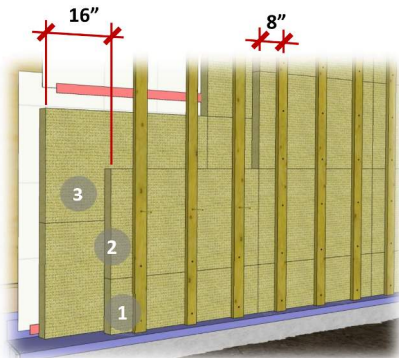
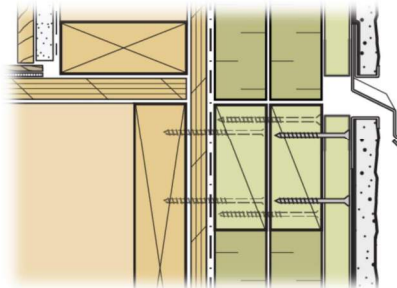
## Design Tables

Fastener/Strapping Installation Requirements—Light Weight Cladding					
Thickness of Exterior Insulation	Maximum Vertical Screw Spacing	Minimum Screw Size	Minimum Screw Embedment	Minimum Strapping Size	
				Rigid Foam	Rigid Mineral Wool
Light Weight Cladding Below 5 lbs/ft <sup>2</sup> - 16" o.c. Stud Framing					
1" to 2" "	24"	#10	1"	3/8" x 1-1/2"	3/8" x 2-1/2"
>2" to 8"	16"				
Light Weight Cladding Below 5 lbs/ft <sup>2</sup> - 24" o.c. Stud Framing					
1" to 2" "	16"	#10	1"	3/8" x 2-1/2"	3/8" x 2-1/2"
>2" to 8"	12"				



## Additional Guidance

Deflection Block →



← Installation Methods

## Discussion + Questions

FOR FURTHER INFORMATION PLEASE VISIT

→ [www.rdh.com](http://www.rdh.com)

→ [www.buildingsciencelabs.com](http://www.buildingsciencelabs.com)

→ Michael Aoki-Kramer - [maokikramer@rdh.com](mailto:maokikramer@rdh.com)

