# Cladding Support System: Direct Attachment Through Insulation

August 8, 2019

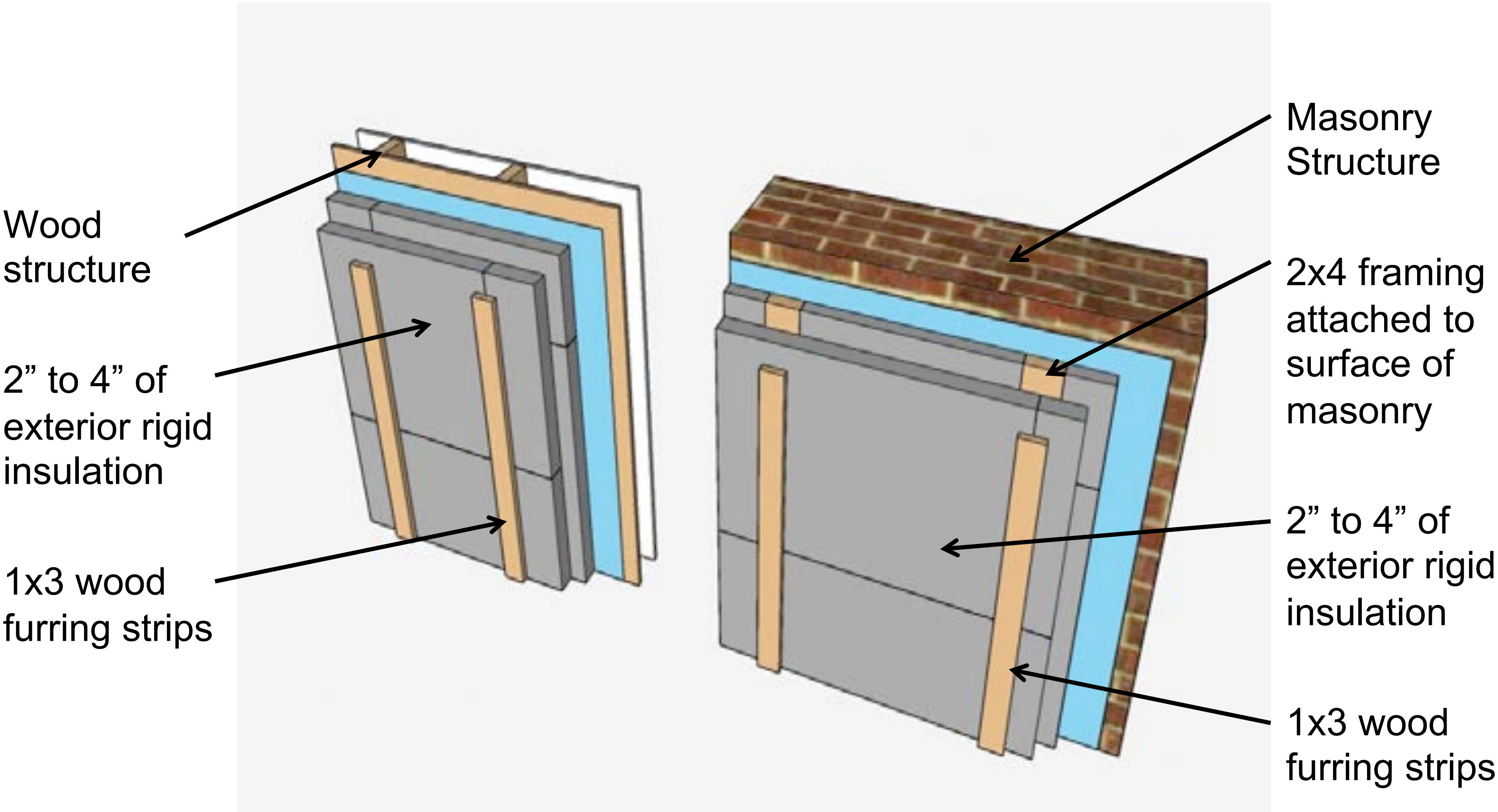
# Background

- Industry trend to using exterior rigid insulation
  - Increased thermal value
  - Condensation resistance
  - Increased air tightness (possibly)
  - Increased rainwater management (possibly)
- Need to develop a means to attach cladding over thick layers of exterior insulation that can meet the following requirements:
  - Provides good thermal performance
  - Low cost
  - Easy to construct/install (low cost)

# Background

- Current pneumatic nailers have maximum fastener lengths of 3” to 3.5” which limits insulation thicknesses to 1.5” max
  - 3.5” fastener, ¼” to ½” siding, 1 ½” embedment (3.5-0.5-1.5 = 1.5” max insulation)
- Therefore, for insulation greater than 1.5” direct attachment of cladding though the insulation back to the structure is often not practical

# Direct Attachment Through Insulation



# Direct Attachment Through Insulation

# Direct Attachment Through Insulation

- Lots of practical experience with this approach for lightweight cladding systems over thick layers of insulation (several decades).
- Approach has demonstrated very good long term performance
- High resistance from industry
  - Compression resistance of insulation
  - Long term creep

# “Myths”

- “Does the insulation crush under load?”
- YES!
- Loading a system until failure (500lbs to 1000lbs or more per screw fastener) will crush most rigid insulations

…..Unfortunately that is the wrong question

# "Myths"

- "Does the insulation crush under a load similar to what will be imposed on it in a cladding support application?"
- The answer is no!...

Context is important

# Typical Loads

- Typical cladding weights (psf)

| | low | high |
|---|---|---|
| Vinyl | 0.6 | 1.0 |
| wood | 1.0 | 1.5 |
| fiber cement | 3.0 | 5.0 |
| stucco | 10.0 | 12.0 |
| adhered stone veneers | 17.0 | 25.0 |

# Typical Loads

- Typical weights per fastener (lbs)

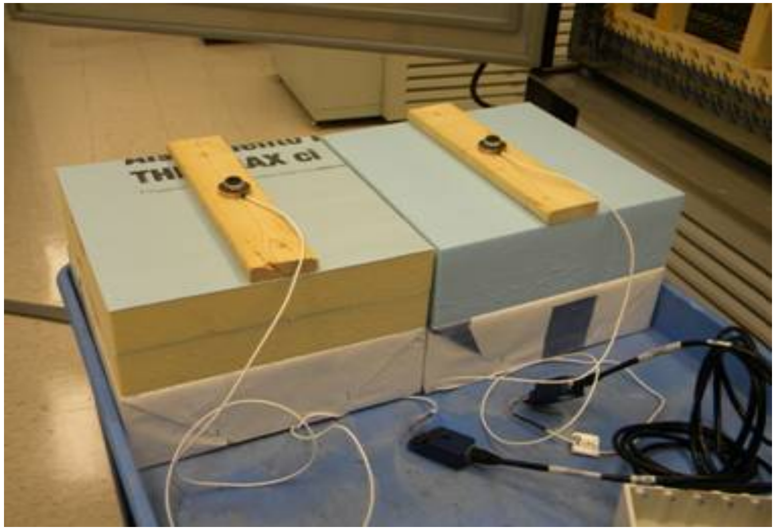
| **fastener spacing (in)** | **16" x 16"** | **16" x 24"** | **24" x 24"** |
|---|---|---|---|
| **area/fastener (ft2)** | **1.78** | **2.67** | **4** |
| vinyl | 1.8 | 2.7 | 4.0 |
| wood | 2.7 | 4.0 | 6.0 |
| fibercement | 8.9 | 13.3 | 20.0 |
| stucco | 21.3 | 32.0 | 48.0 |
| adhered stone veneers | 44.4 | 66.7 | 100.0 |

# Design Criteria

- Acceptable deflection not ultimate capacity governs
- What is acceptable deflection?
  - Movement a cladding system can accommodate without physical damage or exceeding aesthetic tolerances
- Proposed limit of 1/16” vertical deflection

# BSC Cladding Attachment Research

- Began in 2011
- Looking to expand on previous research
- Broken into two sections:
  - mechanics of the cladding attachment system
  - long term environmental exposure



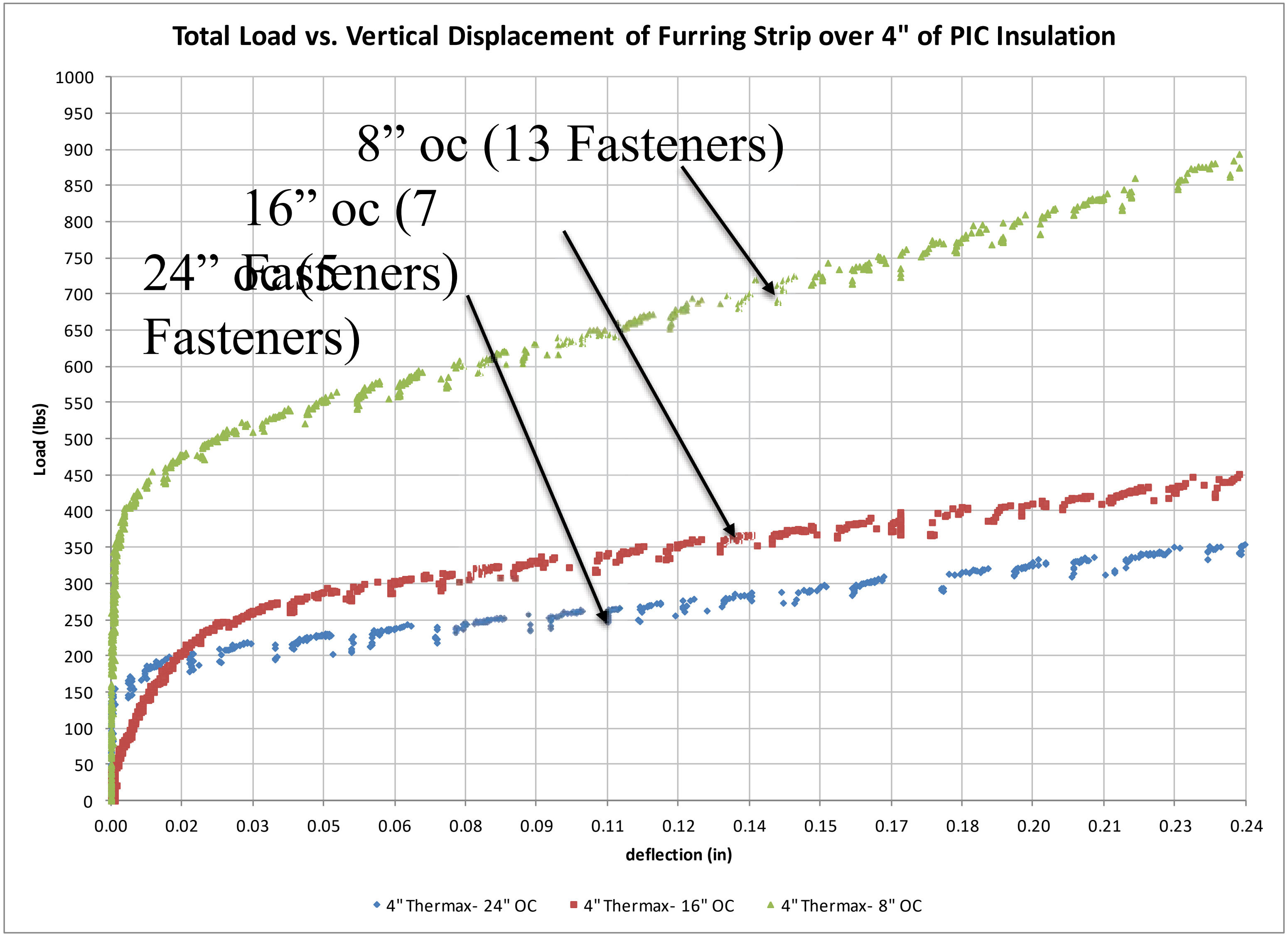
# Full System Laboratory Tests

- Looked at initial response full system capacity as well as long term sustained loading
- Used full scale samples to limit variations in fastener installation

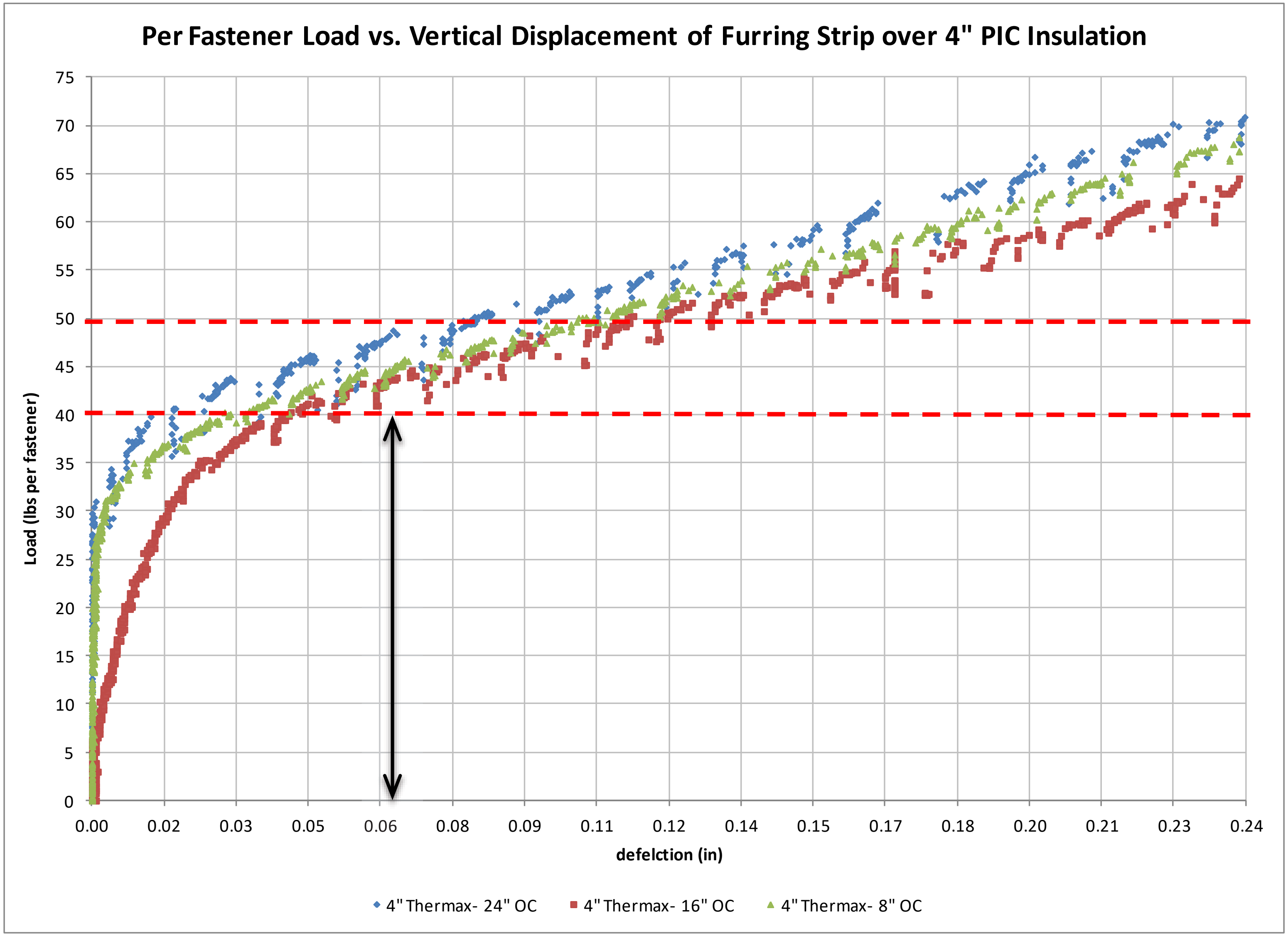
# Full System Laboratory Tests

- Results
  - Insulation type not a significant influence on system capacity
  - System capacity is a function of the number of fasteners used
  - High measured capacities and stable performance under controlled environmental conditions

# Full System Laboratory Tests

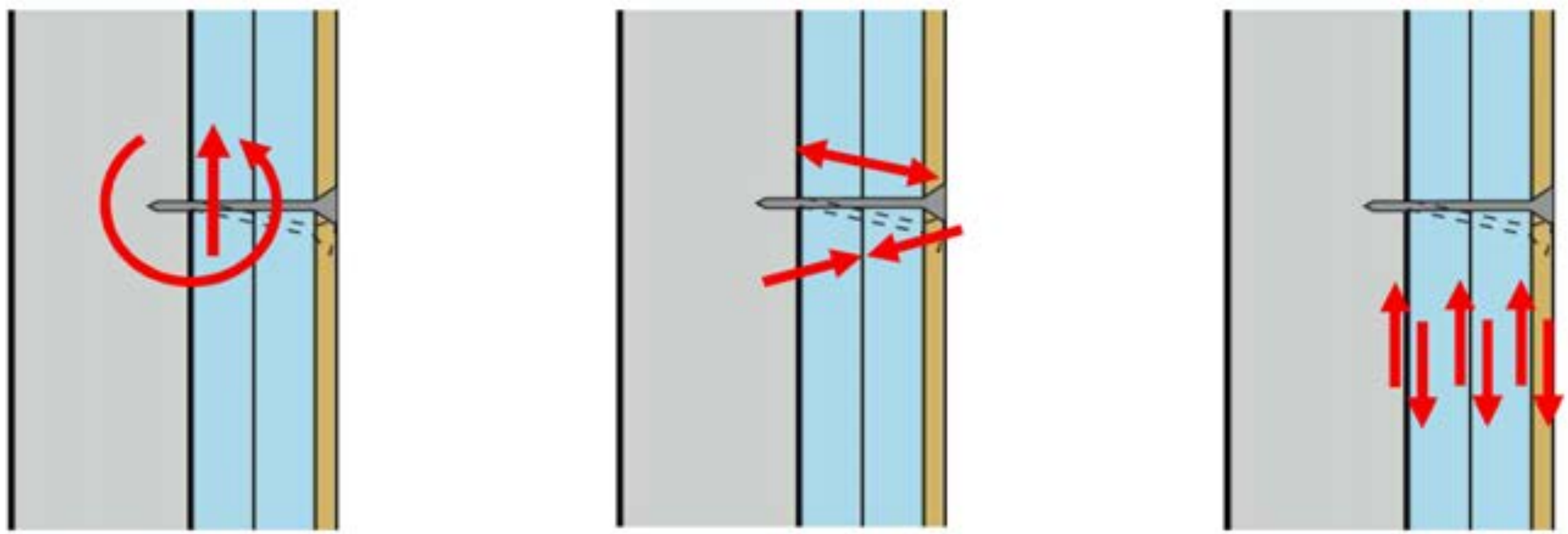


# Full System Laboratory Tests



# BSC Cladding Attachment Research

- System Mechanics



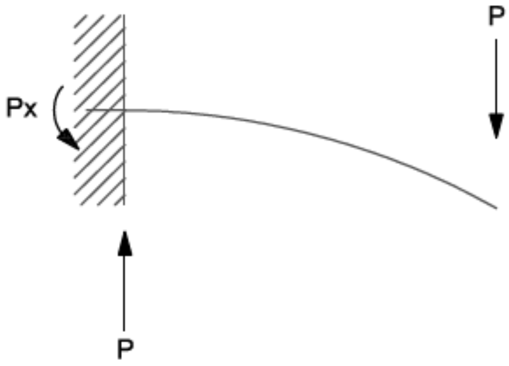
Shear and rotational resistance provided by fastener to wood connections

Rotational resistance provided by tension in fastener and compression of the insulation

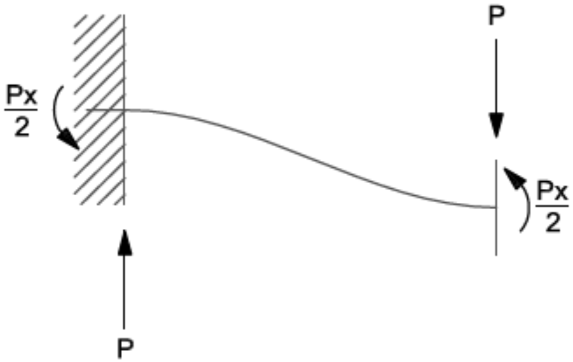
Vertical movement resistance provided by friction between layers

# Screw Bending

- Cantilever
- Double Bending
- Screw Shaft Bearing



CANTILEVERED BEAM MODEL

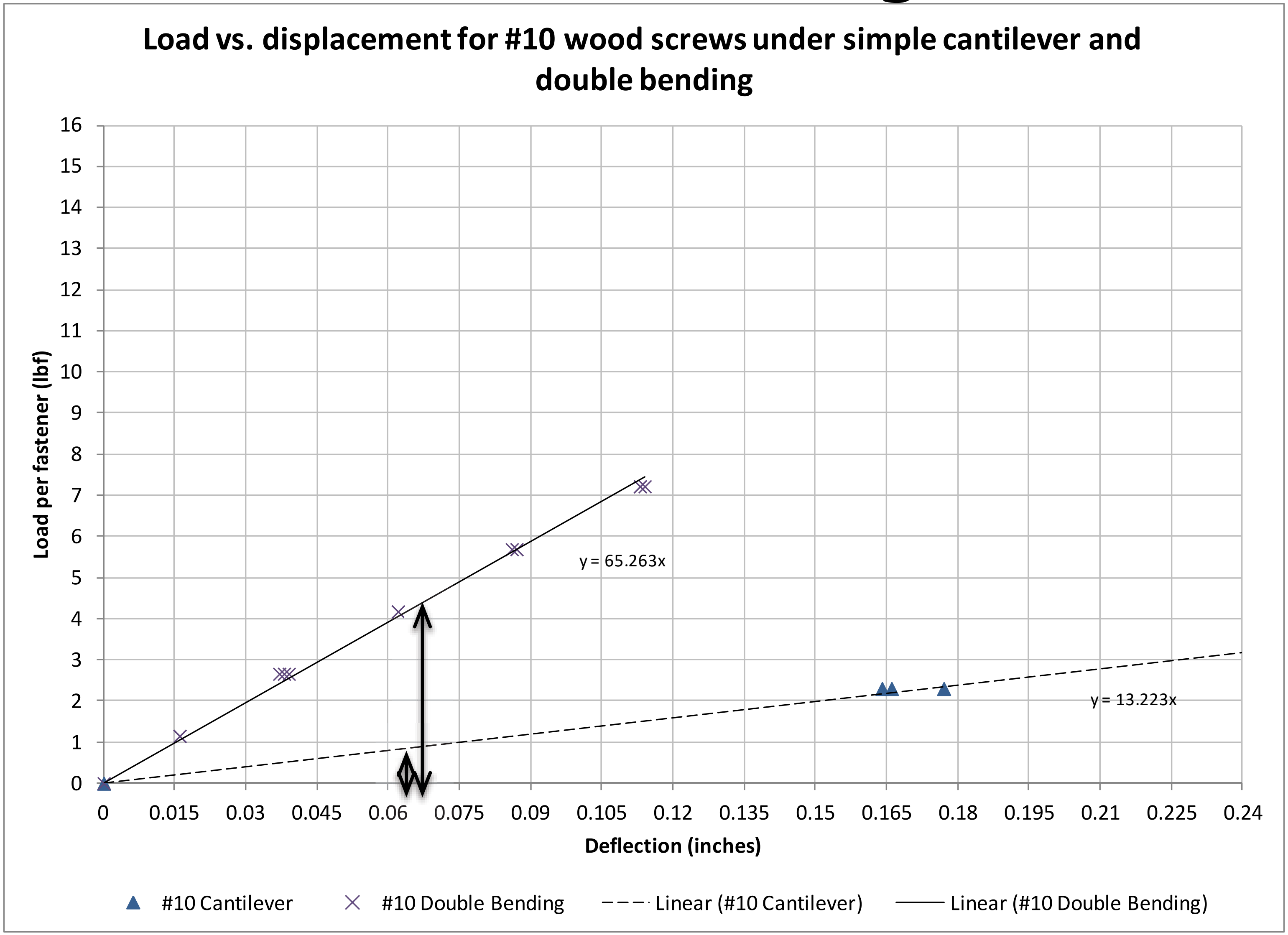


BEAM MODEL WITH FIXED END AND GUIDED END

# Screw Bending

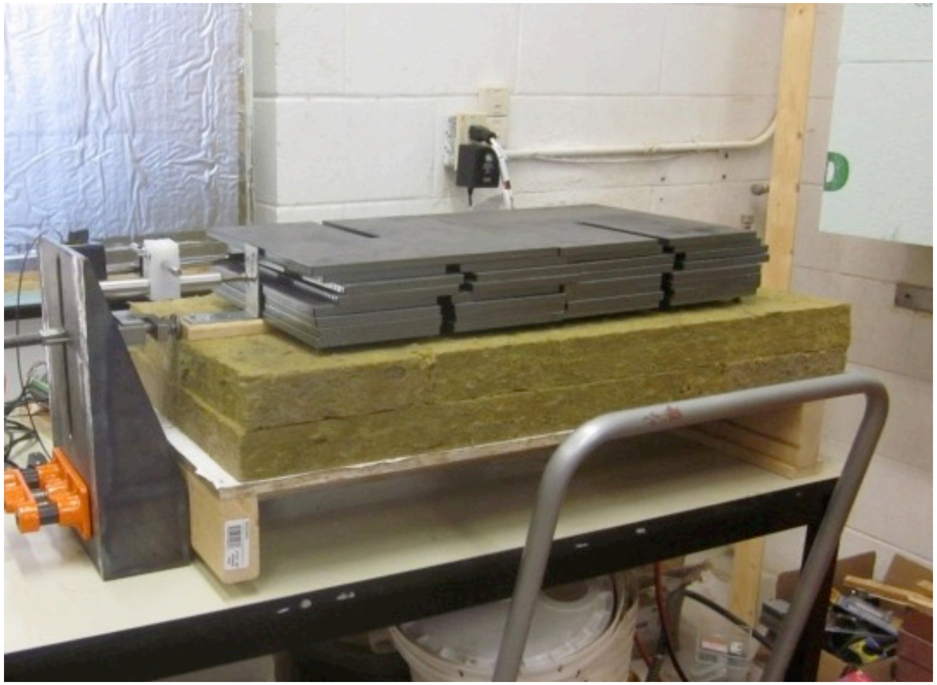
- Double bending resistance was significantly higher (~4 times) than simple cantilever.
- Double bending is more in line with the expected performance of the assemblies but still only accounted for a fraction of the total measured system capacity
- Screw shaft bearing on the insulation was hard to quantify, but appeared to be significant in short term (initial response) tests

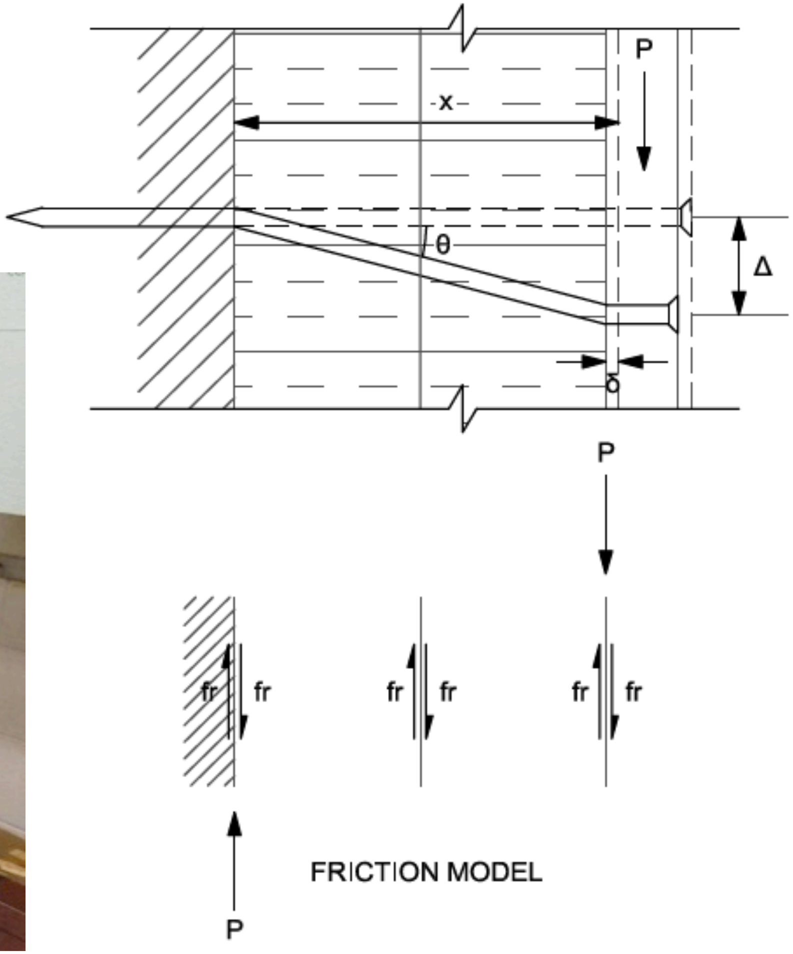
# Screw Bending



# System Friction

- Compression Forces
- Coefficients of Friction



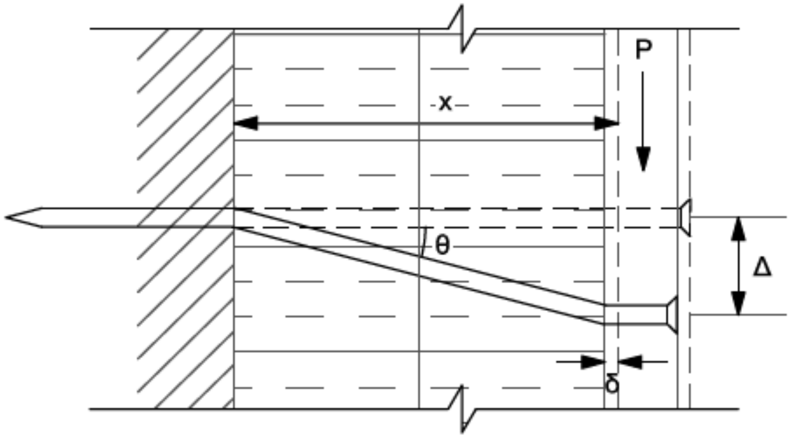


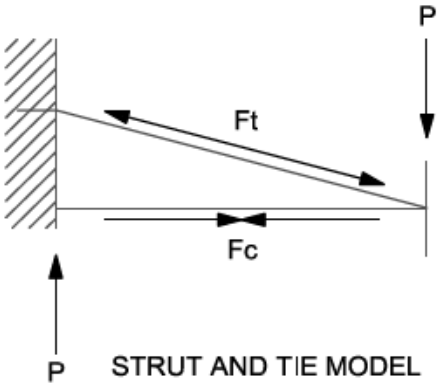
# System Friction

- Compression Forces were measured at around 150lbf/fastener to drive a #10 wood screw flush with face of furring
- Coefficients of frictions were typically around 0.25
- Compression forces were also measured to drop off over time (around 20% to 30%) after initial loading and be highly sensitive to environmental conditions

# Compression Strut

- Function of fastener tension and insulation compression
- Measured insulation compression properties
- Difficult to measure directly
  - Fastener bending present
  - Hard to create a “frictionless” system
- May have a more significant contribution in the form of additional friction than compression resistance



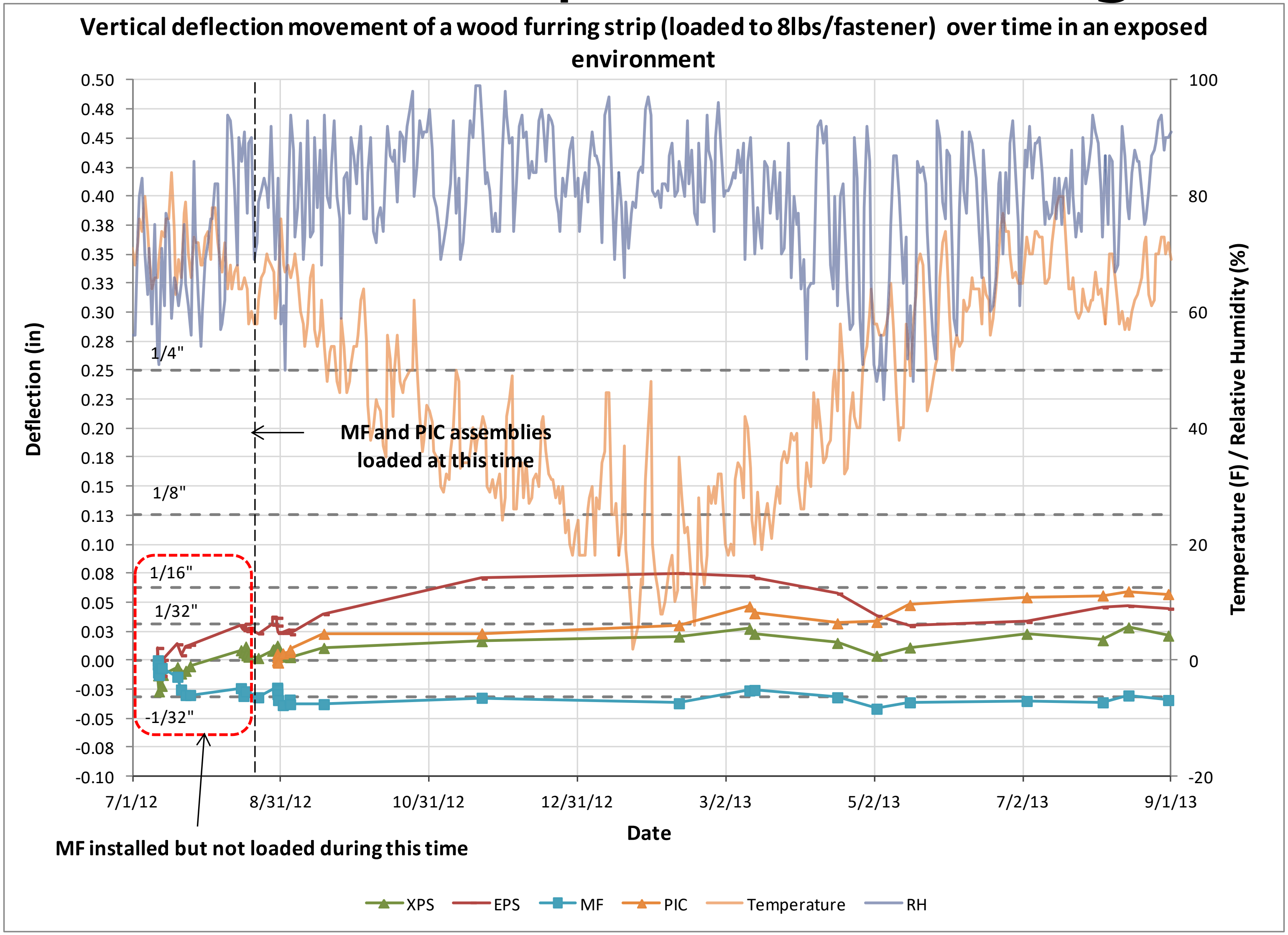



STRUT AND TIE MODEL

# Exterior Exposure Testing

- Looked at long term movement of systems under sustained loads in an exposed environment

# Exterior Exposure Testing



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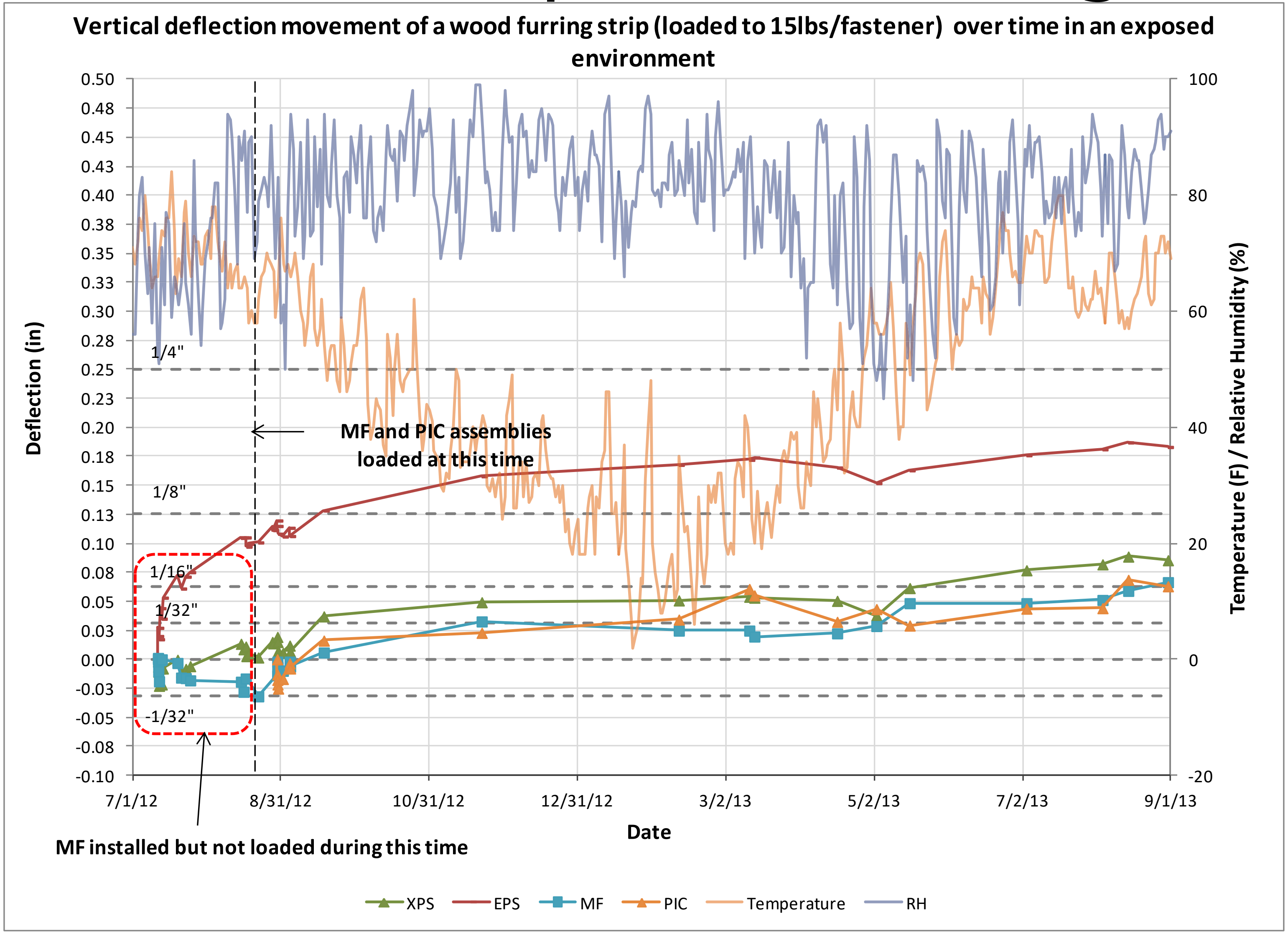

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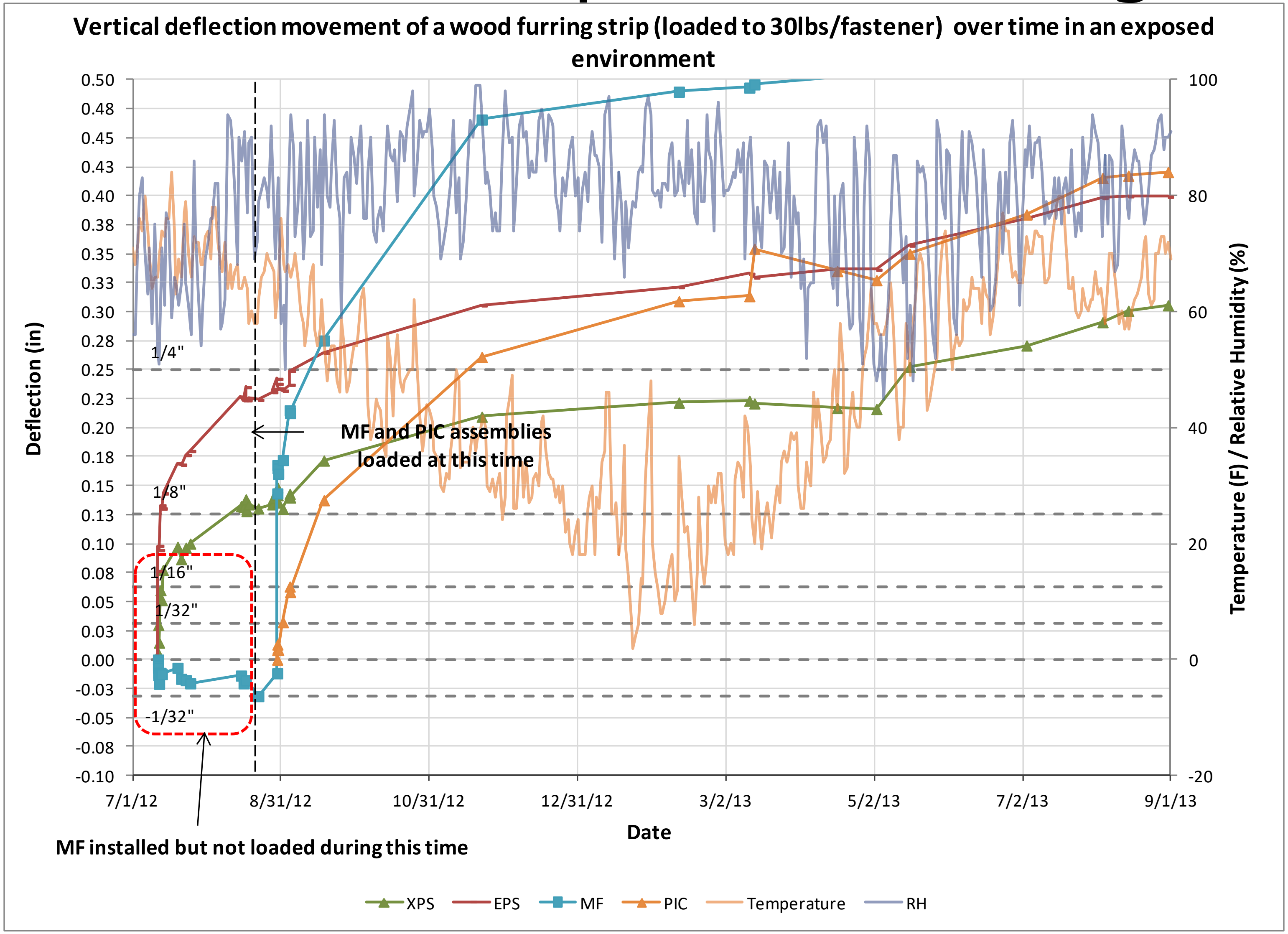

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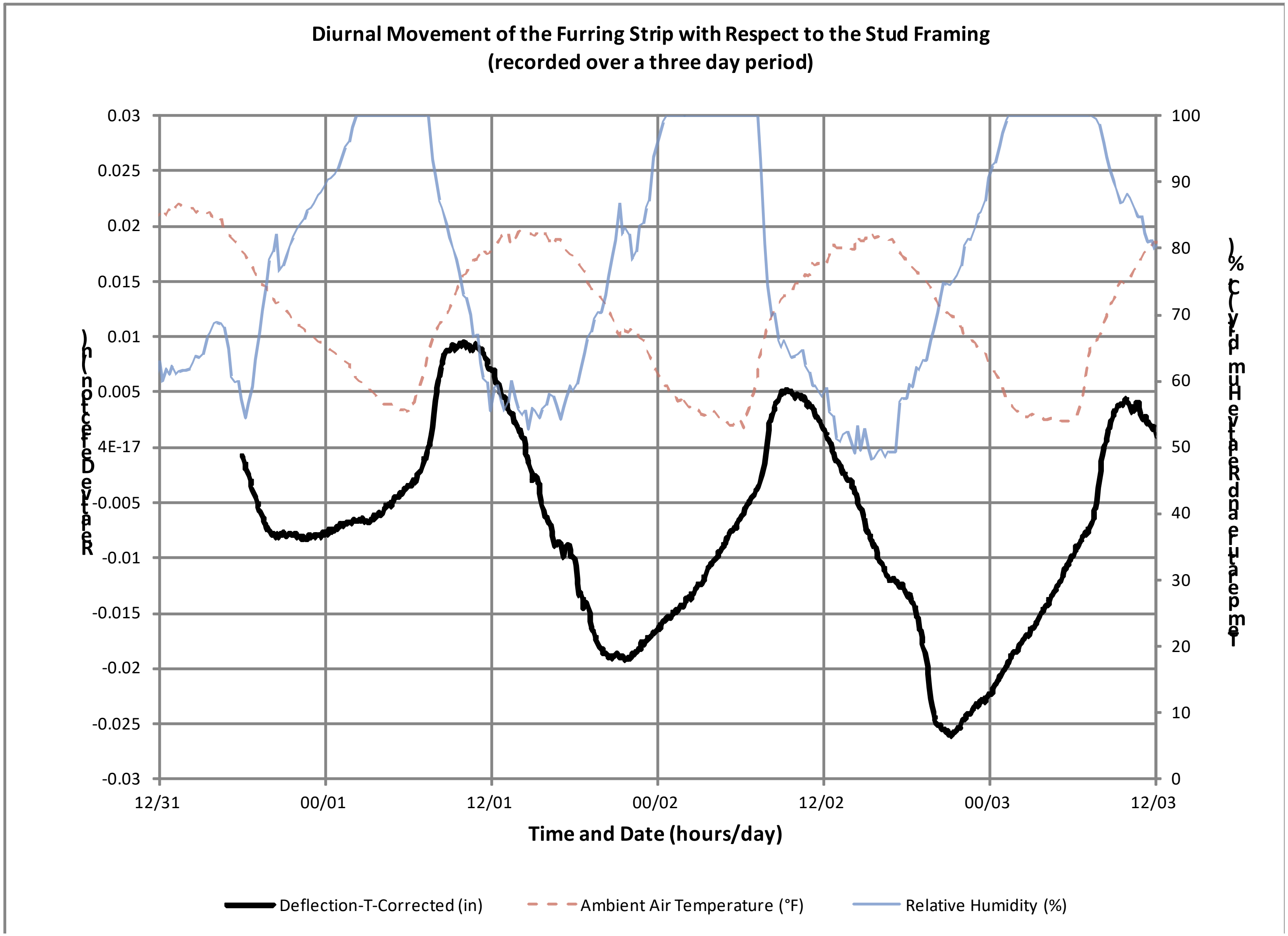

# Conclusions (System Mechanics)

- Initial load response measurements are on the order of 40 to 50lbf/fastener at 1/16” deflection and 4” of insulation
- Insulation type does not appear to be overly significant
- Capacity is a function of the number of fasteners used.
- Capacity would be expected to increase for less insulation due to higher fastener component at a smaller cantilever
- Friction component is significant, but highly variable due to initial clamping magnitudes and thermal expansion and contraction of materials
- Compression strut component is present, however the magnitude of the impact is difficult to quantify.

# Conclusions (Long Term Exposure)

- System creep was apparent at high per fastener sustained loading (30lbs/fastener)
- At low per fastener loads (8lbs/fastener) the system demonstrated stable performance
- At moderate per fastener load (15lbs/fastener) the system demonstrated relatively stable performance, though there is some possible slight indication of system creep

# Recommendations

- Based on the results of the testing it is currently recommended to use a maximum load per fastener of no more than 10lbs for up to 4" of insulation

Vertical fastener spacing (in) per cladding weight

| Cladding weight (psf) | 16" oc Furring | 24" oc Furring |
|---|---|---|
| **5** | 18 | 12 |
| **10** | 9 | 6 |
| **15** | 6 | 4 |
| **20** | 4 | 3 |
| **25** | 3 | 2 |