Impact of Insulation Dimensional Stability on Conventional Roofs

2017 CCBST Conference – Day 3

November 8th, 2017

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RDH BUILDING SCIENCE

Presentation Outline

- → Introduction & Background
- → Laboratory Testing
  - → Methodology
  - → Findings
- → Conclusion & Next Step

Introduction & Background

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→ Thermal expansion and contraction of insulation products within conventional roof assemblies has been identified as a potential performance concern in the roofing industry

Laboratory Testing Overview

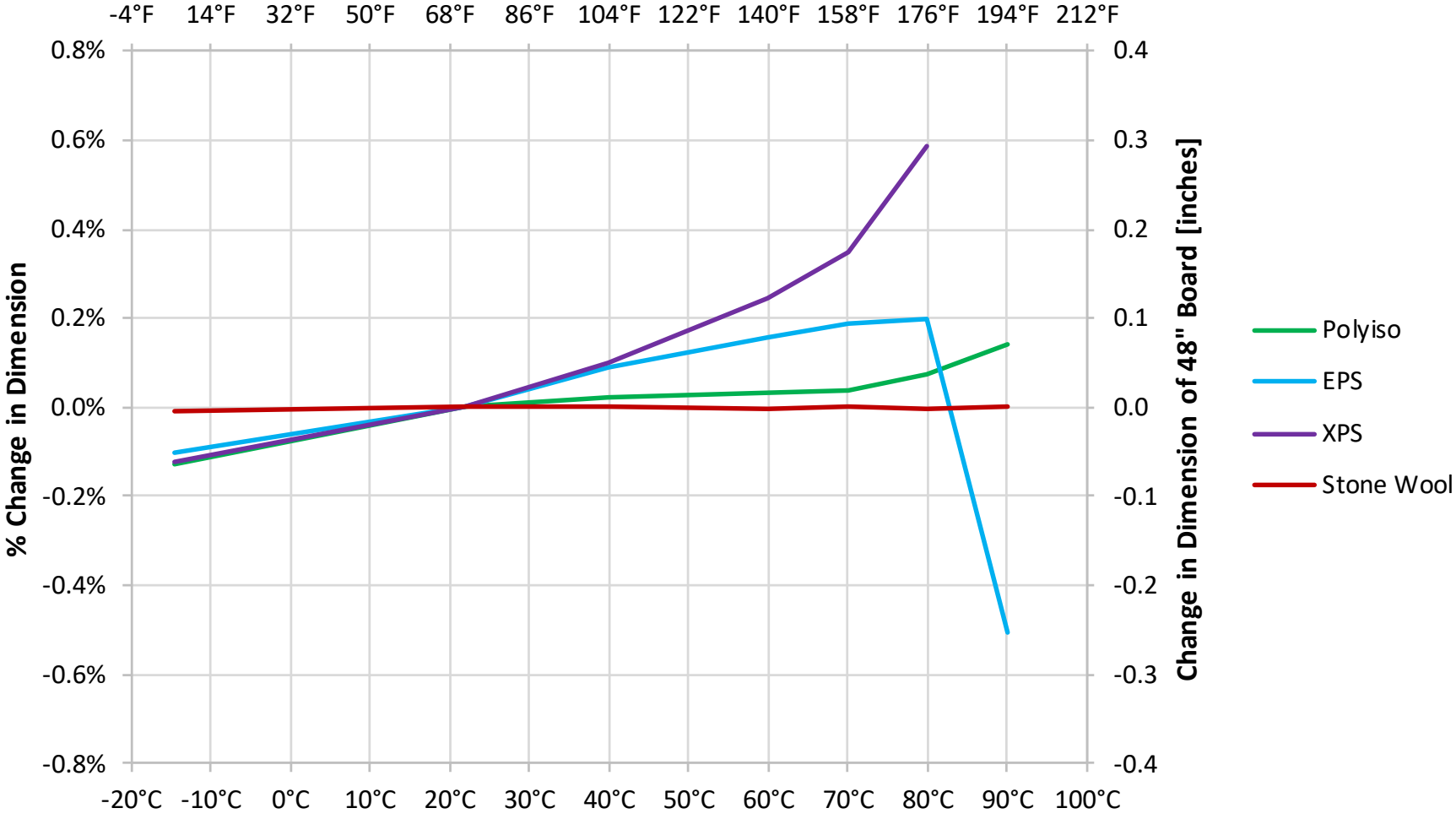
→ Insulation and SBS membrane material testing

→ Laboratory testing using purpose-built climate chamber

- → *Can we recreate the wrinkles?*
  - › Attempt to reproduce the creasing observed in the field
- → *What parameters impact the occurrence of wrinkles?*
  - › Dimensional movement of insulation within the assembly
  - › Asphaltic and Fibreboard Cover Boards

Insulation Material Testing

→ EPS insulation found to expand up to ~80˚C, then contraced rapidly between 80-90˚C



Methodology – Roof Specimen

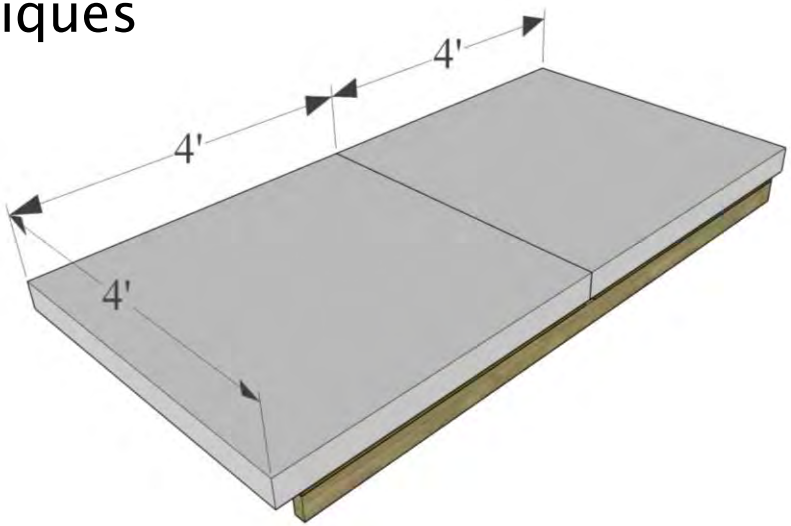
→ 2-ply conventional roof roughly 4' x 8' with 4" of insulation

→ Continuous joint in the middle of the insulation layer perpendicular to the length of the specimen

→ Cover board and roof membrane were installed continuously across the insulation joint

→ Constructed by a certified roofer familiar with roofing products and installation techniques

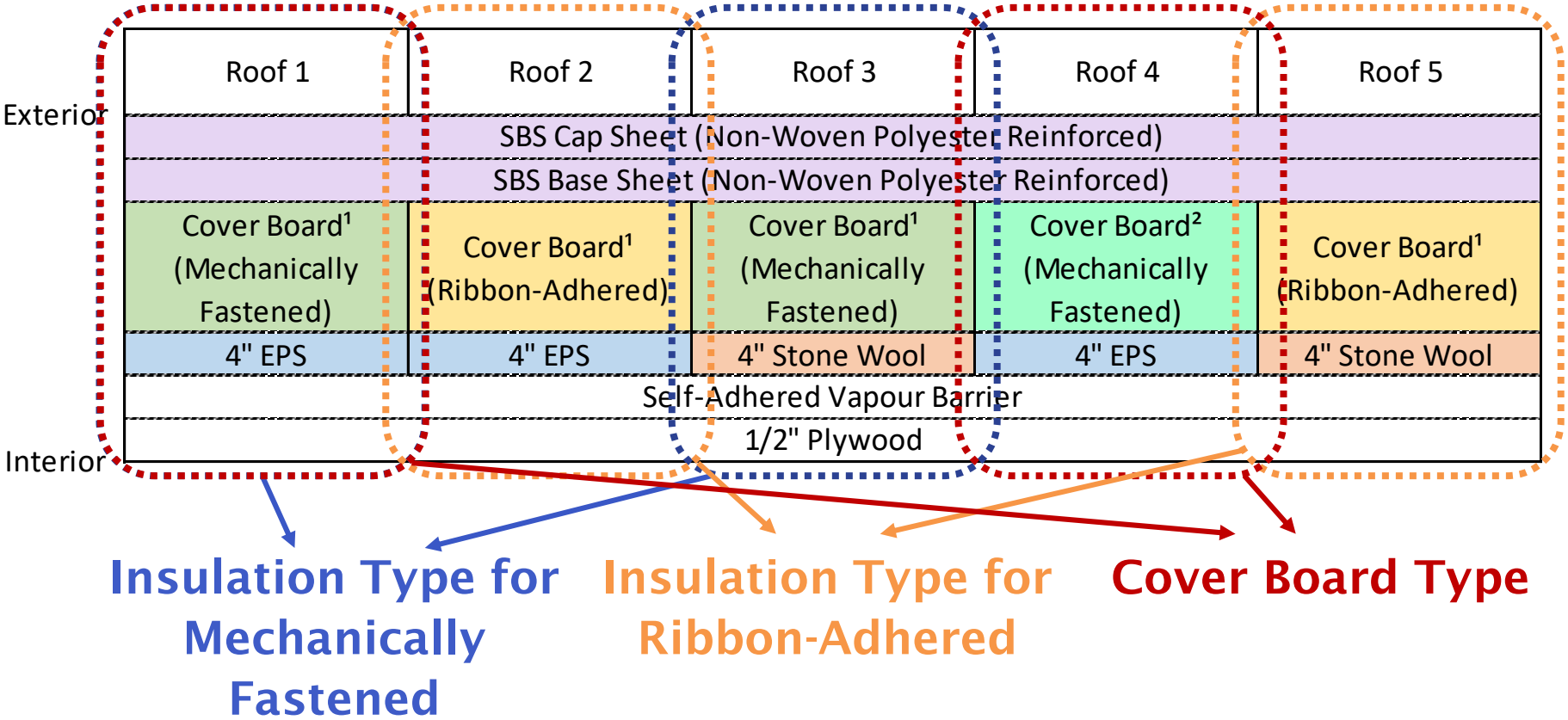
Ribbon-adhered specimen in the process of attaching cover board to SW insulation



Schematic drawing of roof specimen showing insulation layout with central joint between insulation boards (EPS roof specimen shown)

Methodology – Roof Specimen

→ Total of 5 roof specimens were tested



Insulation Type for Mechanically Fastened

Insulation Type for Ribbon-Adhered

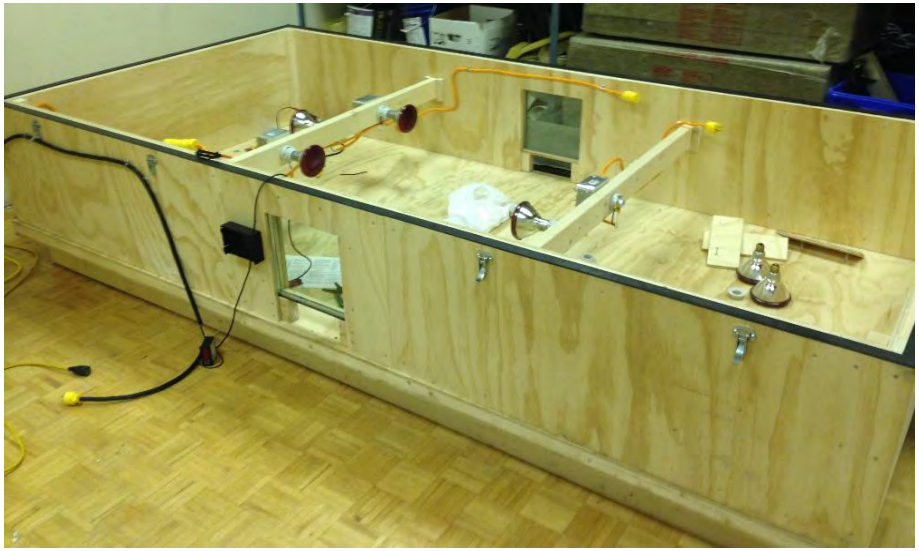
Cover Board Type

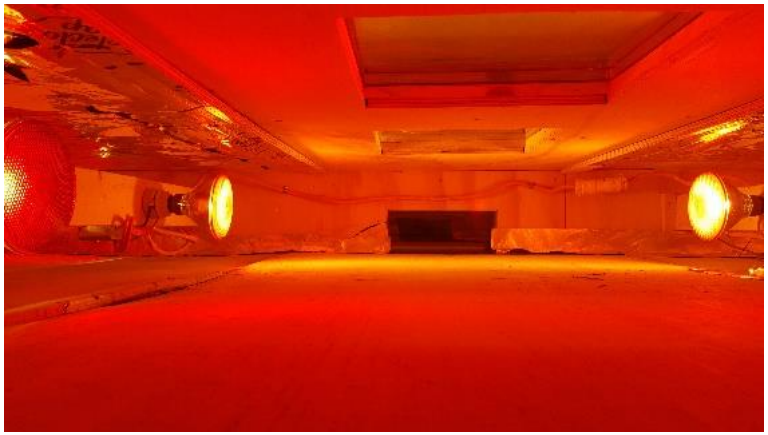
Cover board¹: 4.8 mm (3/16“), glass mat-reinforced asphaltic cover board
Cover board²: 12.7 mm (1/2") high density fire-resistant fiberboard

Methodology – Climate Chamber

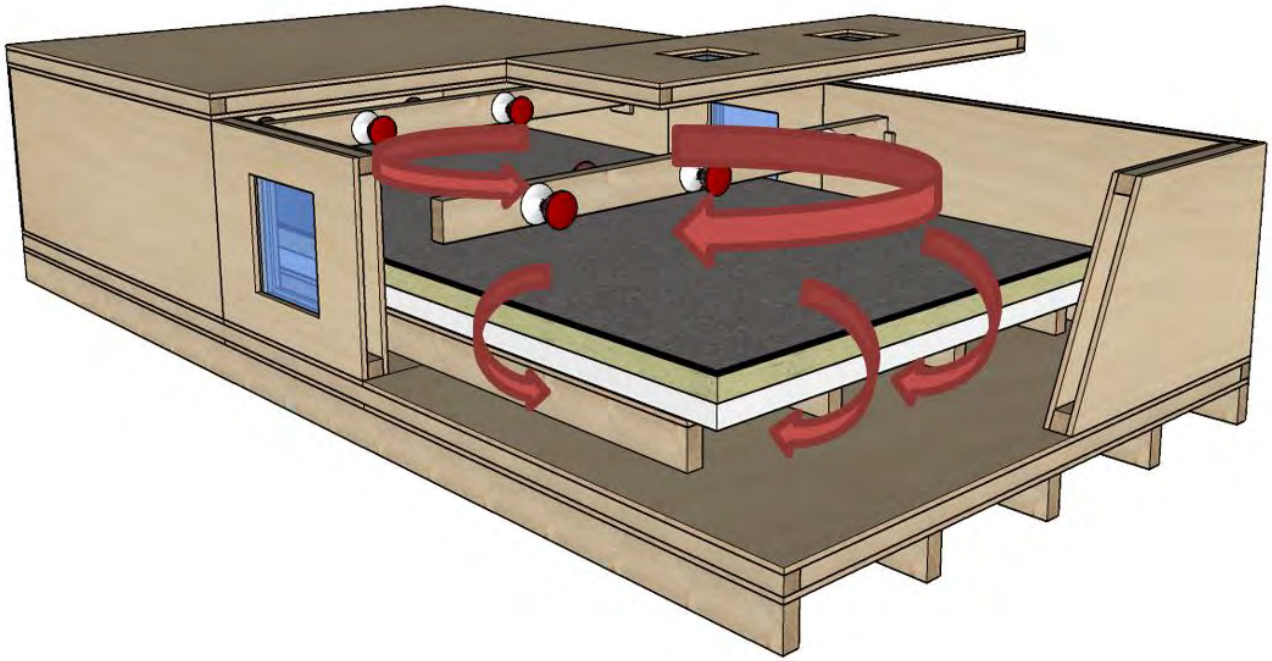
→ RDH's purpose-built climate chamber

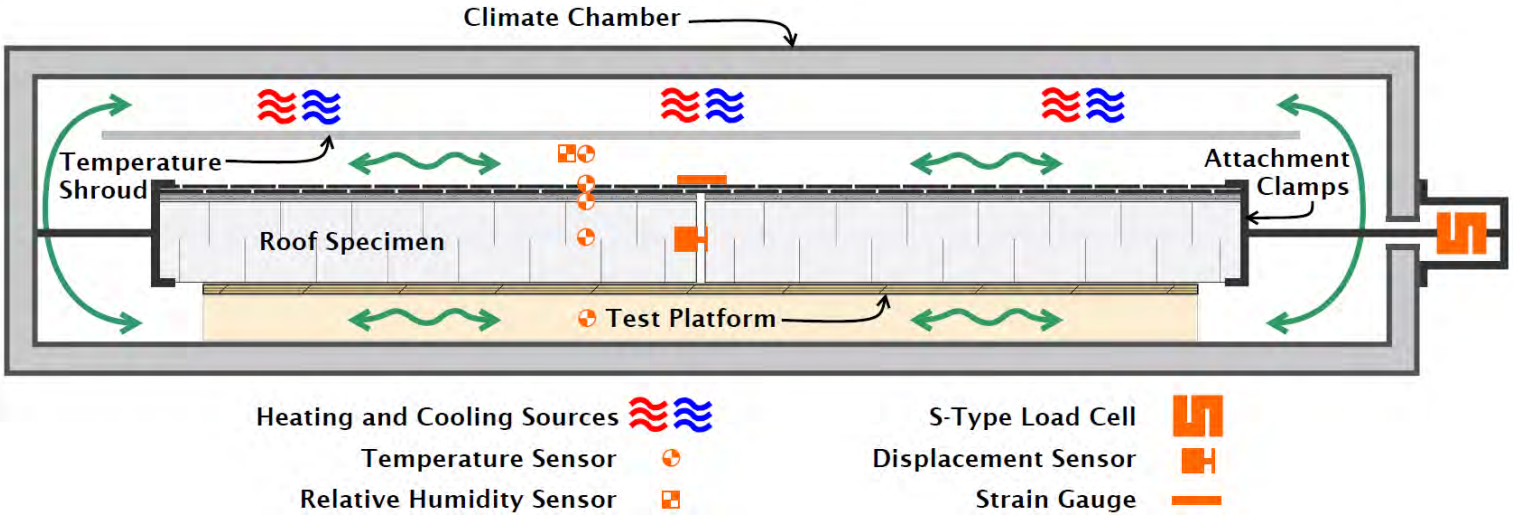
→ Roof specimens were exposed to both cold (-15˚C) and hot (90˚C) temperatures while monitoring performance characteristics such as dimensional movement and force exerted by roof specimen





Methodology – Climate Chamber



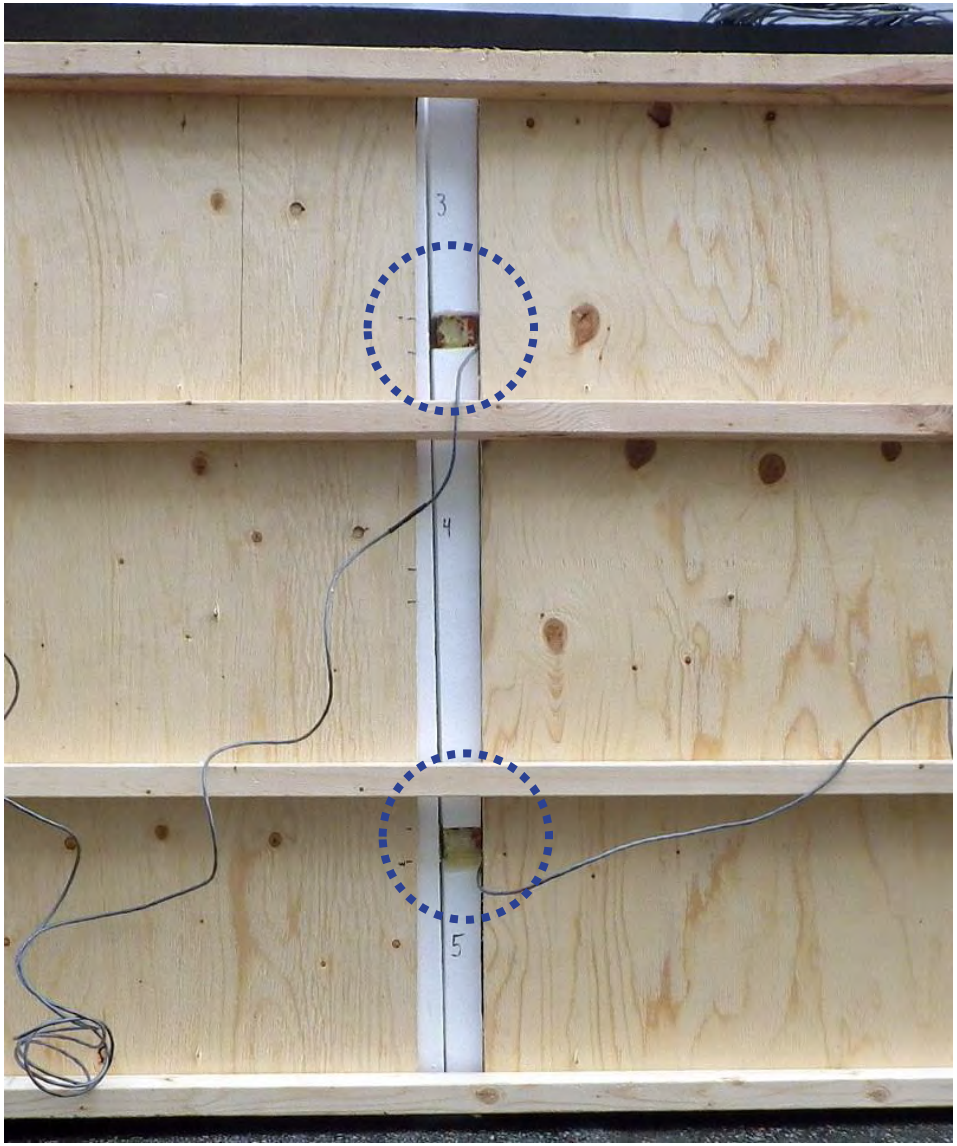


Methodology – Displacement Sensors

→ Insulation Movement

→ One of the key measurements was taken with displacement sensors installed between insulation boards

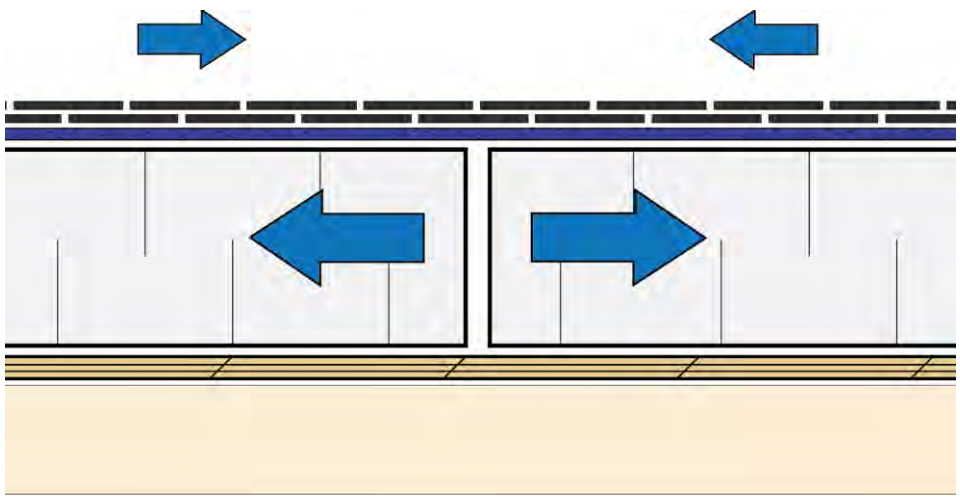
→ Displacement sensors were embedded in the insulation



Methodology

→ What makes a wrinkle?

- → Important to note that to make a wrinkle some kind of differential movement or fixation is typically required.
- → Unlikely that a membrane wrinkles in the field all on its own
- → This is a problem involving the interaction of multiple components and factors

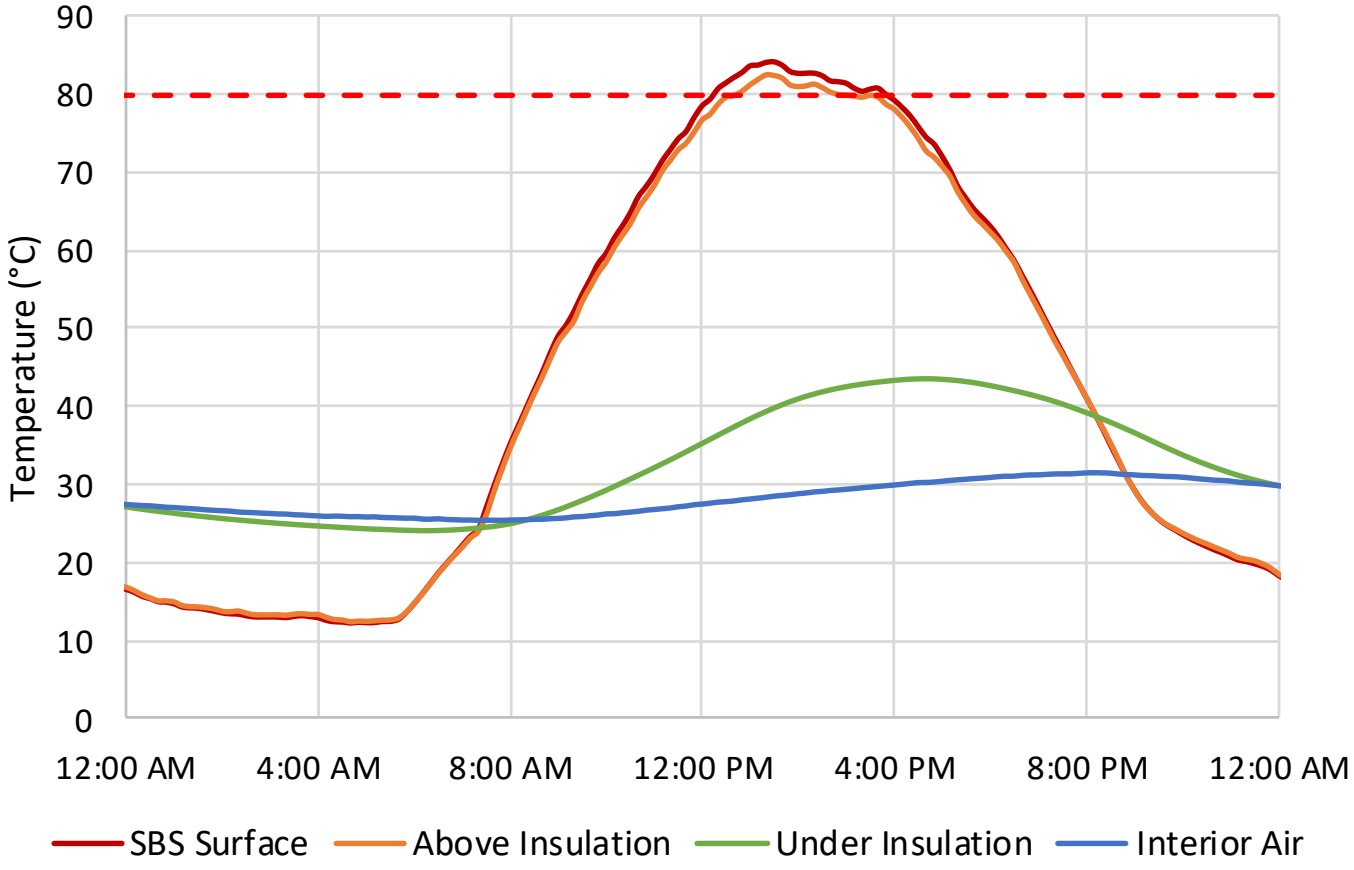


An example of insulation contraction/shrinkage widening the gap.

Methodology – Test Procedure

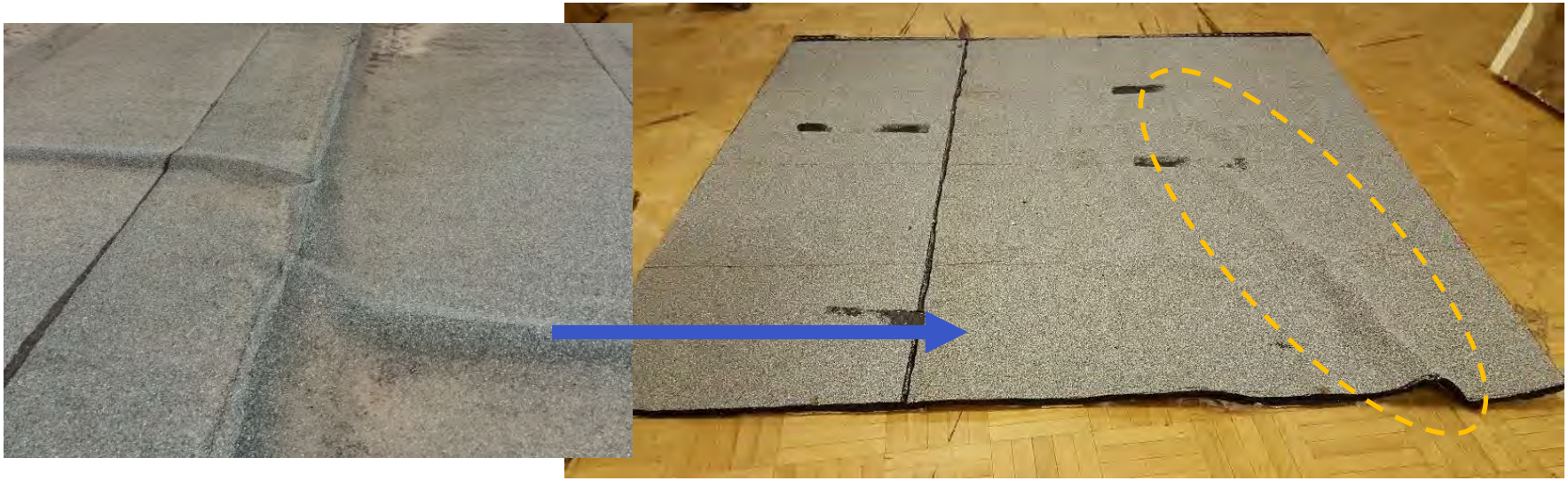
→ Uniform Cooling and Heating

→ Create a worst-case temperature conditions to highlight performance of each roof arrangement



Can we recreate the wrinkles?

→ Ribbon-adhered EPS insulated roof specimen

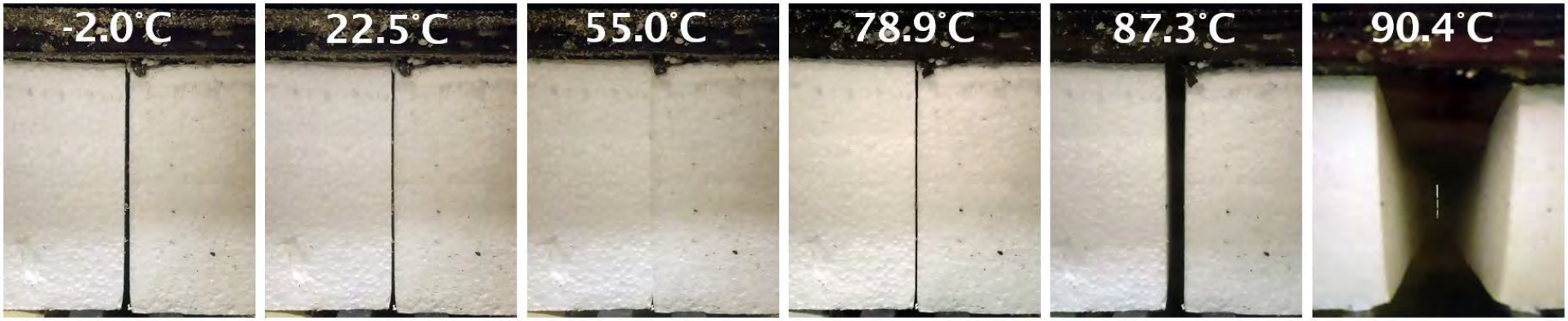


What parameters impact wrinkling?

Dimensional Movement of Insulation

→ Insulation gap measurements from the EPS roof specimens indicate that:

- Gap widened as insulation temperature lowered, insulation shrinking
- Gap narrowed as the insulation temperature increased—until around 80˚C, at which point the gap widened at a significant rate and this change was permanent

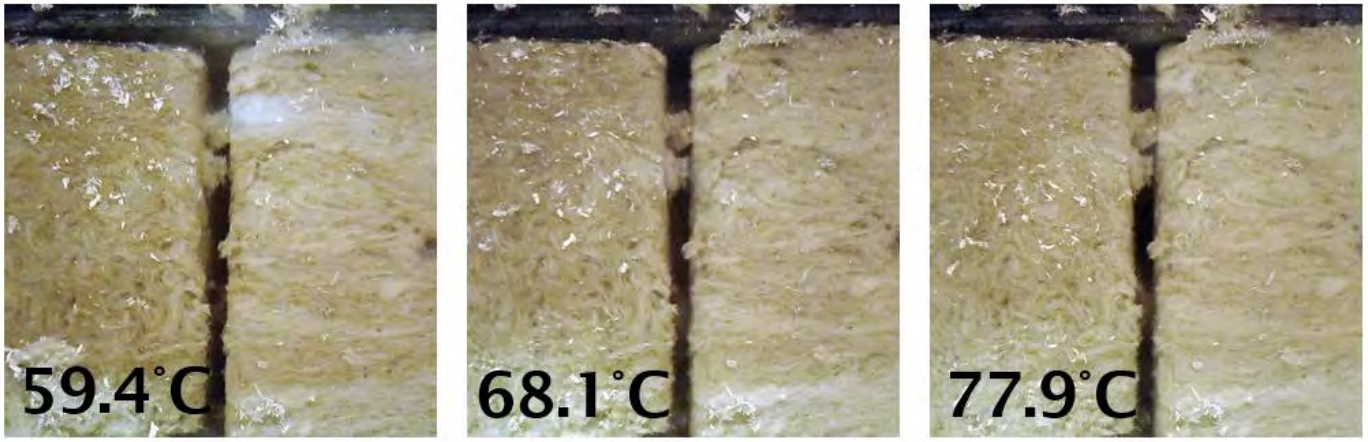


What parameters impact wrinkling?

Dimensional Movement of Insulation

→ Insulation gap measurements from the SW roof specimens indicate no noticeable change in gap width

› There was actually a very small amount of movement in the gap in the opposite direction one would expect, likely due to dimensional movement of other components of the system

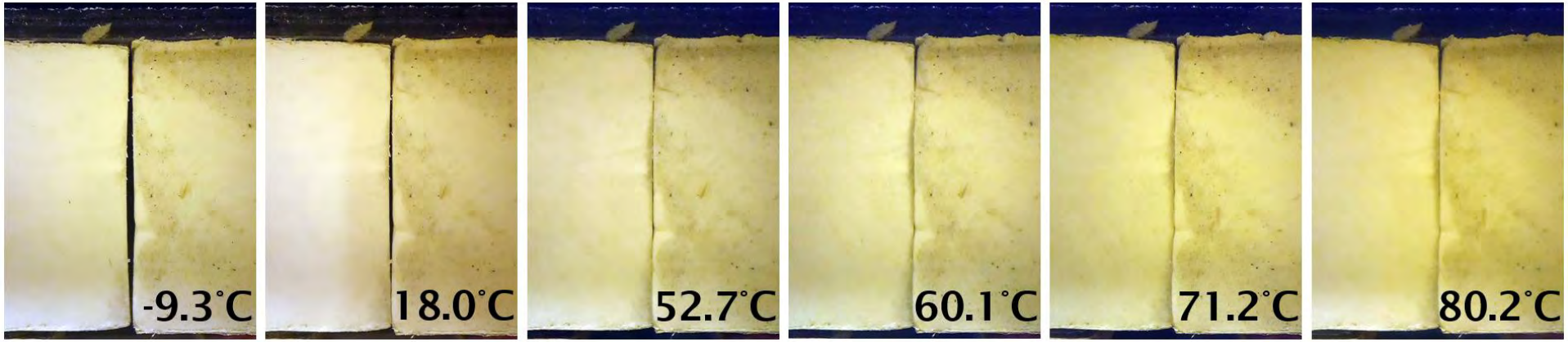


What parameters impact wrinkling?

Dimensional Movement of Insulation

→ Insulation gap measurements from the Polyiso roof specimens indicate that:

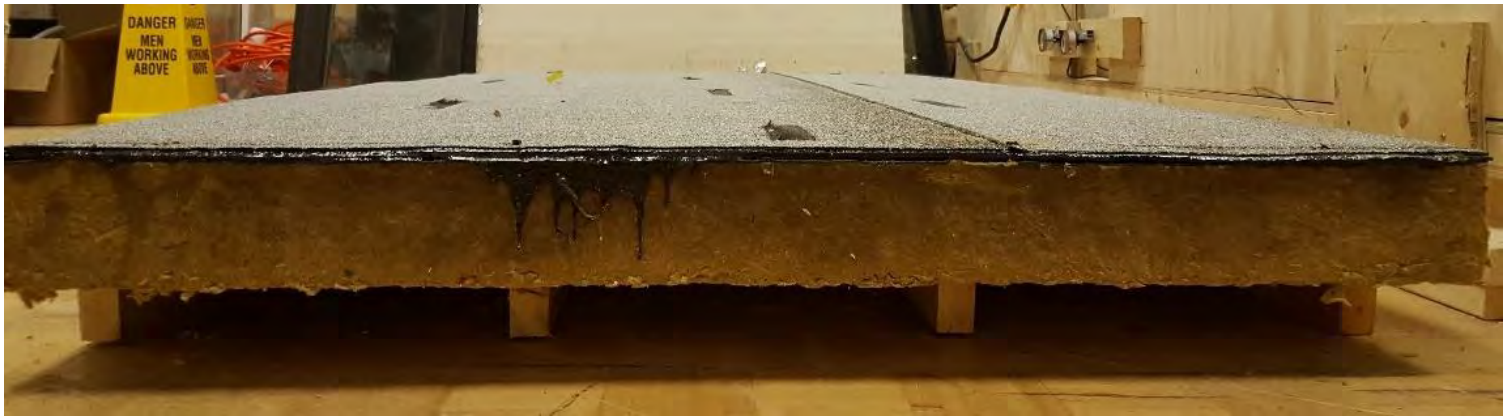
- Gap widened as insulation temperature lowered, insulation shrinking
- Gap narrowed as the insulation temperature increased until the boards came in to contact
- Boards remained in contact at high temperature



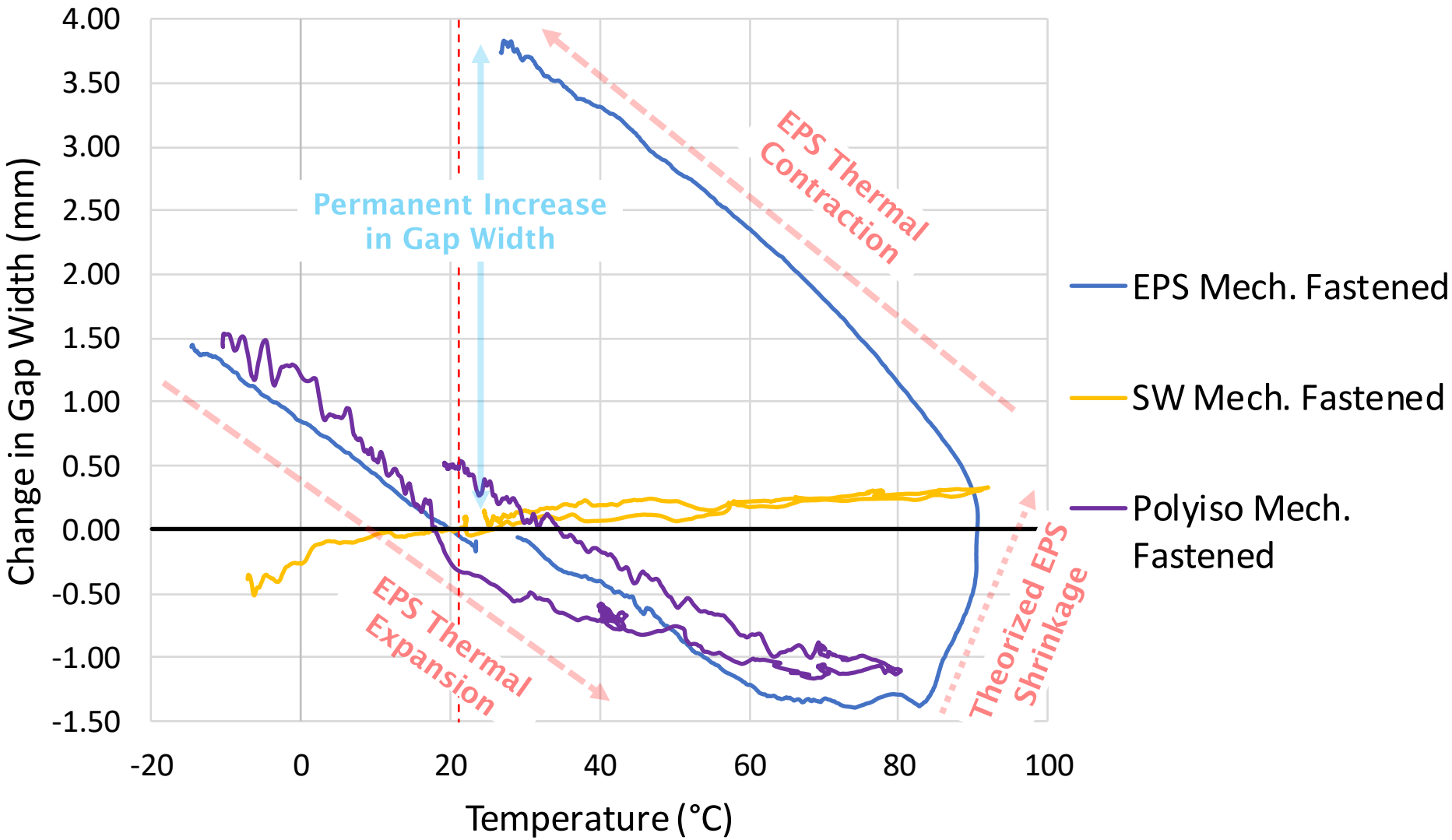
What parameters impact wrinkling?

Dimensional Movement of Insulation (ribbon-adhered)

→ Insulation is the only difference in the test specimens



What parameters impact wrinkling?



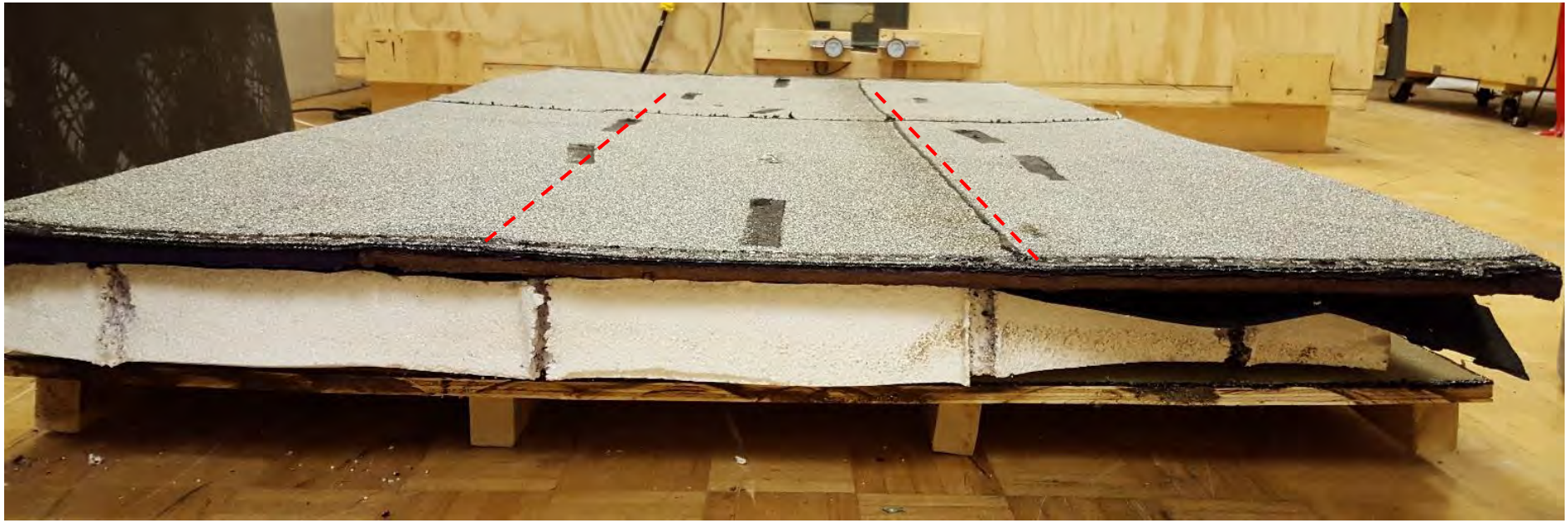
What parameters impact wrinkling?

Impact of Cover Board Material

→ Mechanically Fastened EPS roof specimen

- → Flexible, Loose-laid, Sanded Underlayment (Previously Tested) } Wrinkled
- → Rigid Asphalt Cover Board
- → Fibreboard Cover Board

} No Wrinkles, sagging/bulging

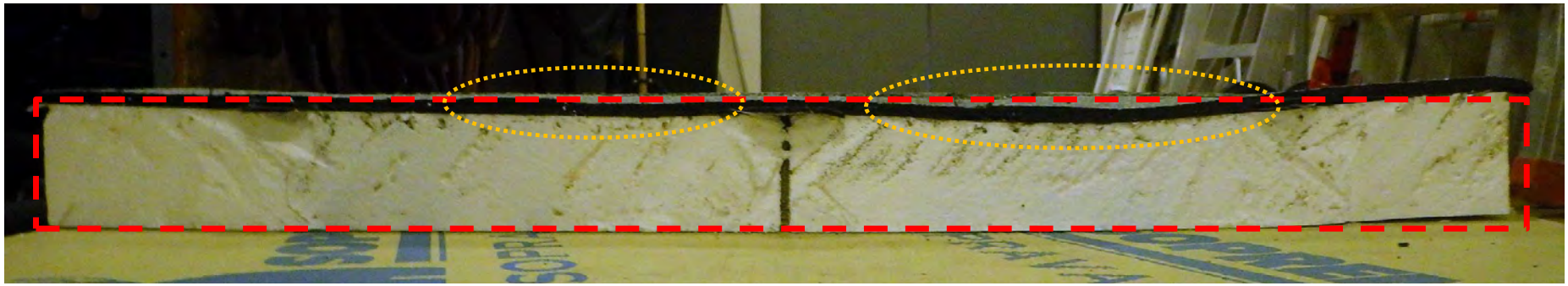


What parameters impact wrinkling?

Impact of Cover Board Material

→ Mechanically Fastened EPS roof specimens (fibreboard cover board)

- → SBS roof membrane remained relatively flat compared to identical roof specimen which was ribbon-adhered
- → Locally reduced thickness of EPS and consequential bulging of fastener heads visible through membrane

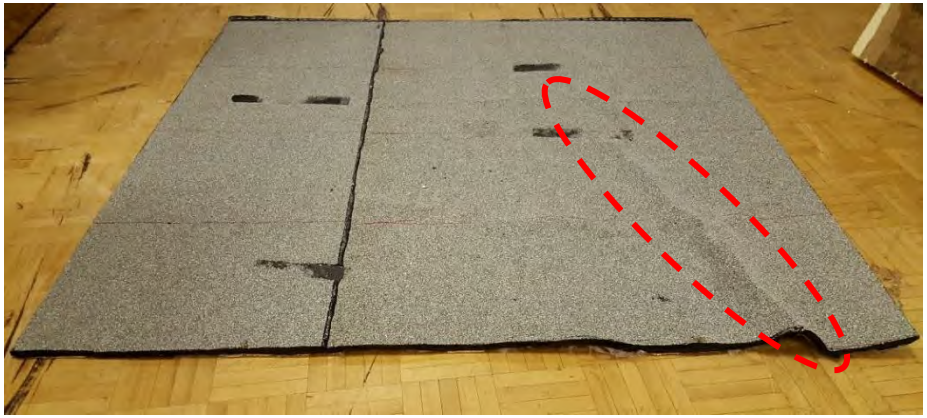


What parameters impact wrinkling?

Impact of Cover Board & Attachment Strategy

→ Ribbon-adhered EPS roof specimens (asphalt cover board)

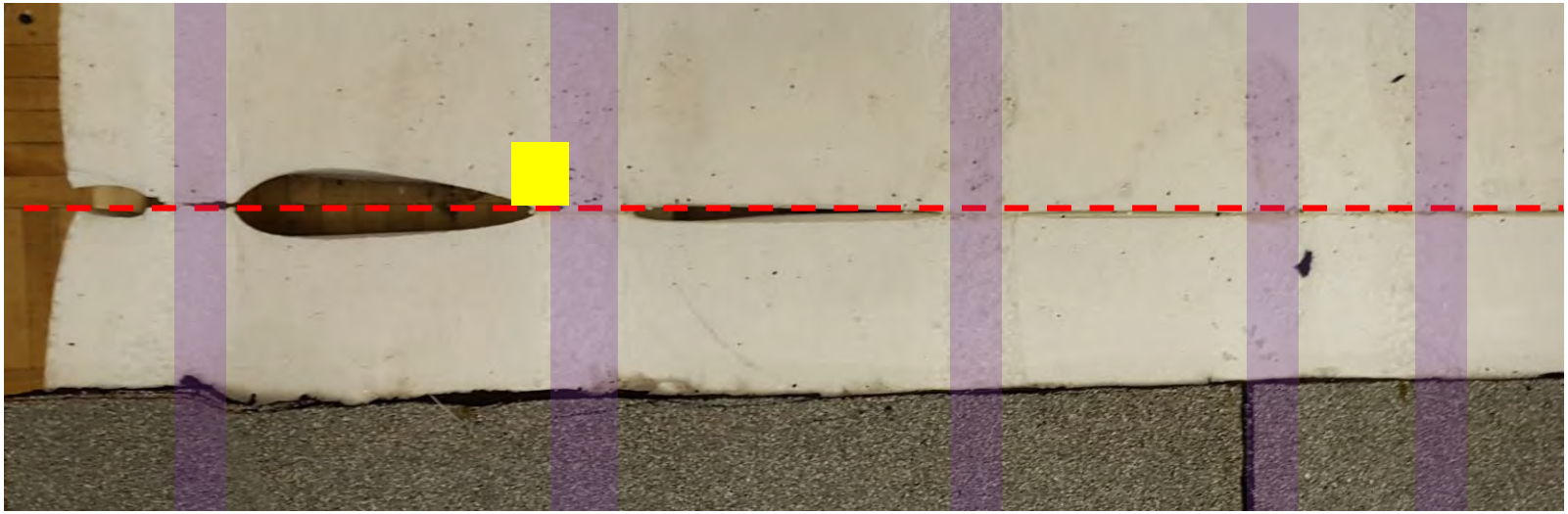
→ Experienced ridging along the length of the specimen typically between the ribbons of the adhesive

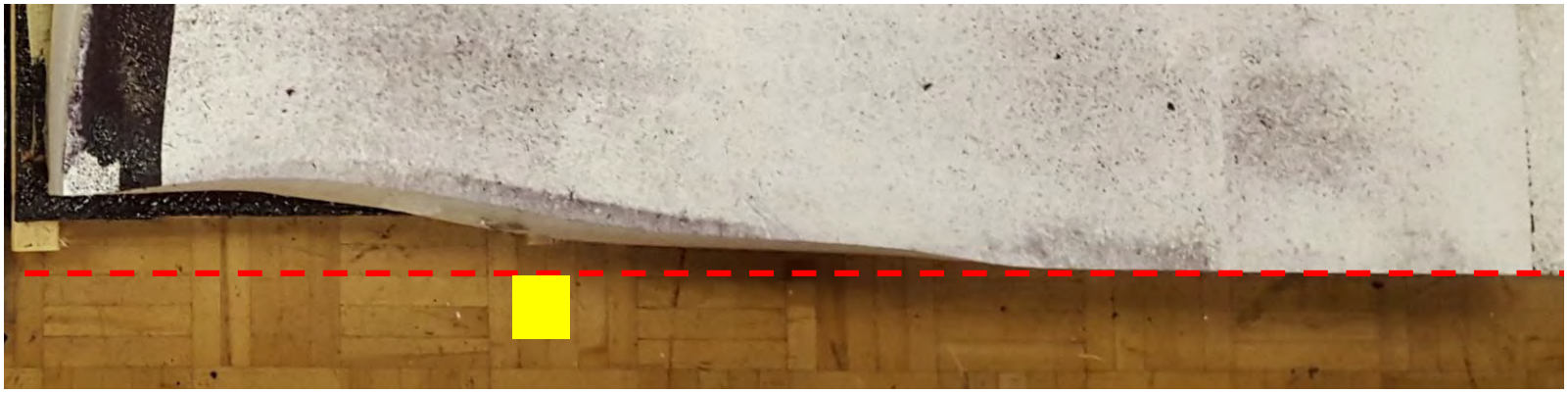


What parameters impact wrinkling?

Impact of Attachment Technique

→ Mechanically Fastened vs. Ribbon-Adhered with EPS Insulation





Summary

→ Able to reproduce wrinkles in the lab that appear similar to wrinkles observed in the field

→ EPS insulation was present in all of the laboratory roof specimens for which wrinkling occurred

→ Rigid cover boards can help reduce wrinkling, but underlying insulation is still damaged

→ Attachment technique does impact the amount of wrinkling when a cover board is used, with mechanically fastened systems with rigid cover boards showing the least wrinkling

Next Steps

→ Exposure of the roof specimens to more realistic conditions including arrangements with a **temperature gradient**

→ Examination of potential methods to **protect temperature sensitive insulation** layers from extreme temperatures

  → These are actually already done, but in a separate paper. See you at RCI!

→ Perform field investigations to assess patterns with regards to components of assembly, climate, etc

→ Perform field monitoring of insulation and membrane movement to assess in-situ performance

Next Steps

→ This research is live!

Next Steps

Next Steps

Next Steps

Discussion + Questions

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