



To VENTILATE or SEAL A SEATTLE FLAT ROOF ???

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Presentation Layout



- Developing Successful Building Retrofit Design for Low Slopped Roof in Seattle

Roof Investigation Approach



Research Activities

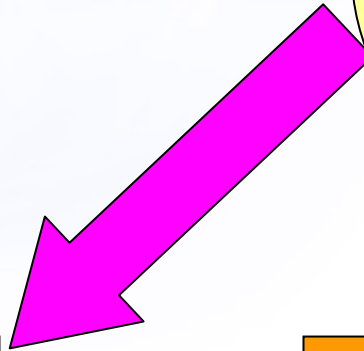
Balanced Solutions Inc.

**Monitor
Existing
Roof**

**Simulate existing
Roof System**

**Simulate
Retrofit
Strategies**

**Monitor
Retrofit for 1
year**



Field Testing

Commonly Found in Seattle and **Everywhere**



Field Testing Worst Across the Street (Greener Neighbor)

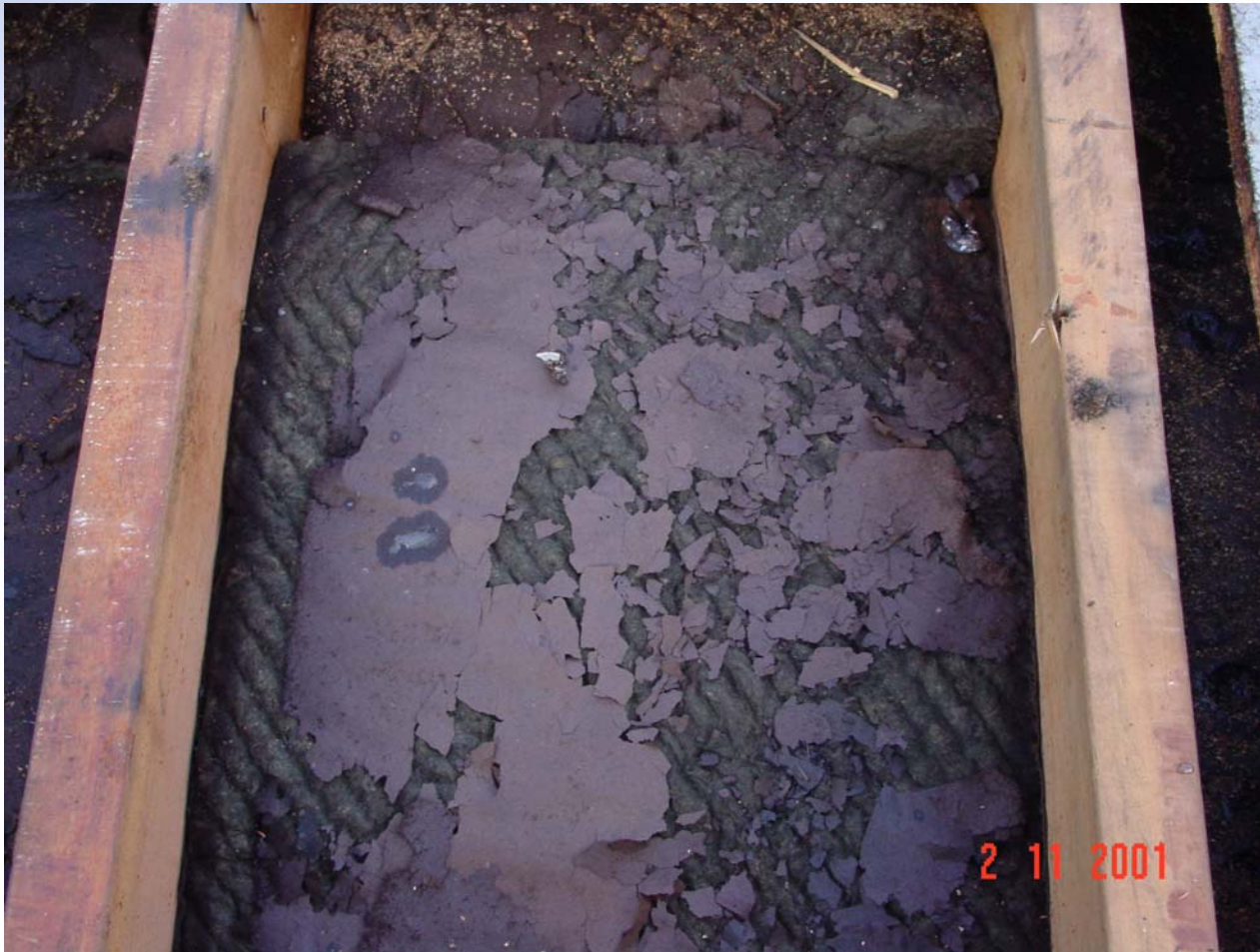


**Local Recommended Solution:
Ventilate MORE**

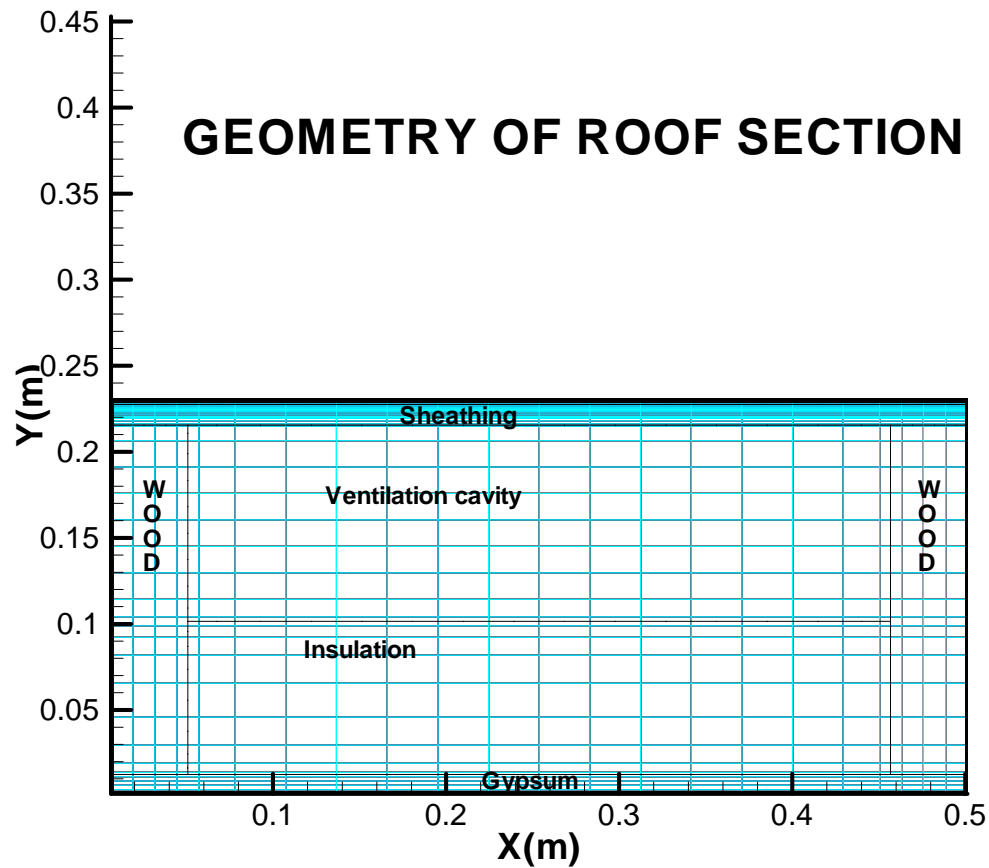
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Field Testing

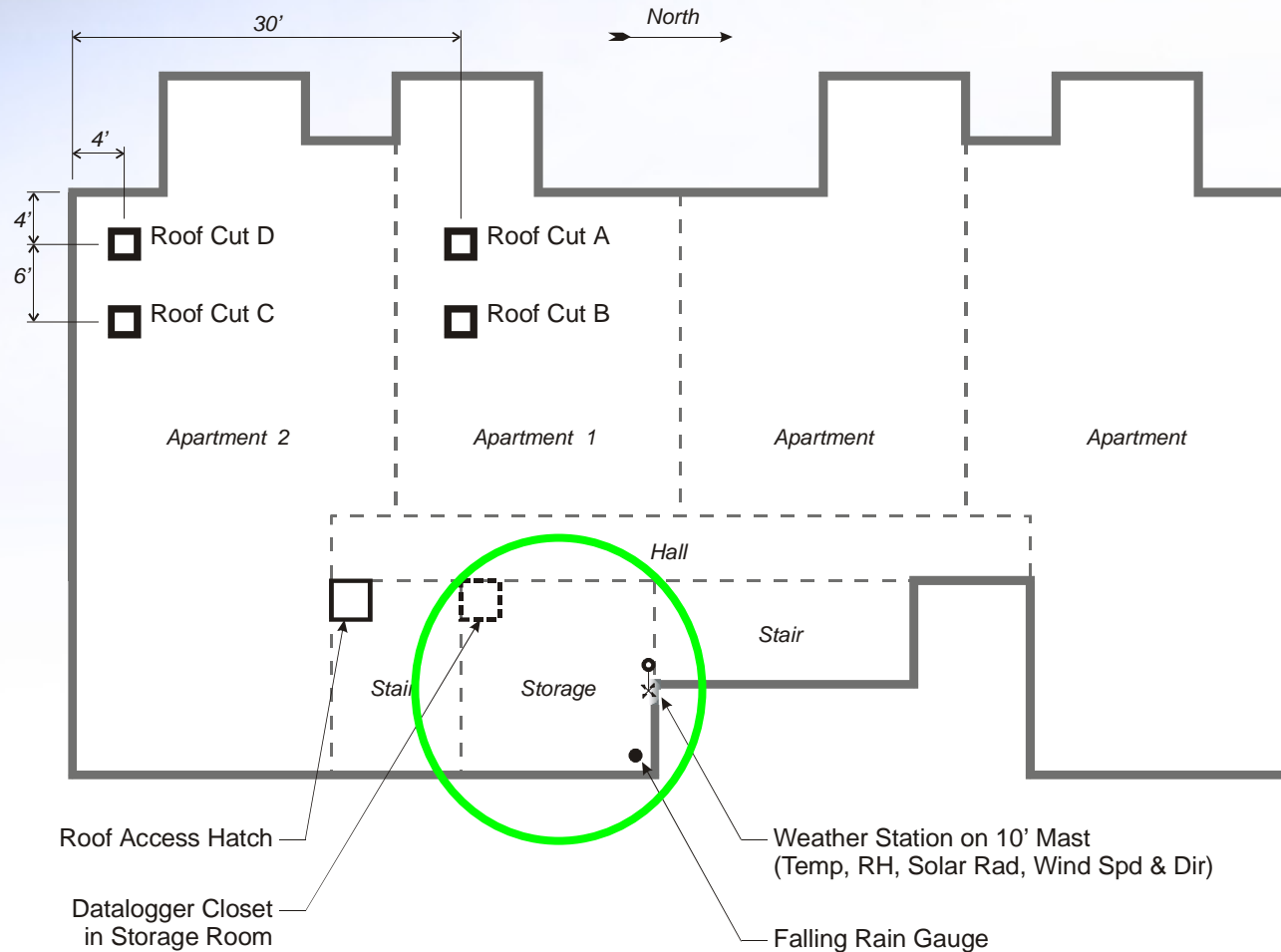
20 years in Service



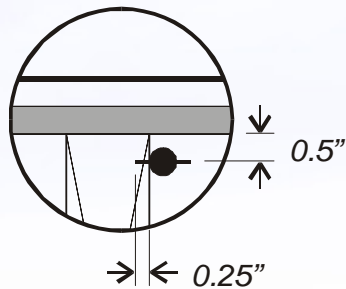
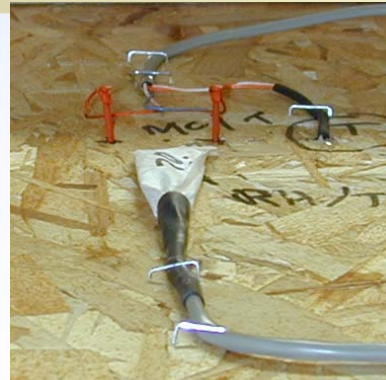
Existing Roof System



Existing Roof System



Existing Roof System



A-JT-T
A-JT-MC

A-JB-T
A-JB-MC

A-RS-T

A-SB-T
A-SB-MC

A-JB-T
A-JB-MC

A-JS-T
A-JS-H

A-GT-T

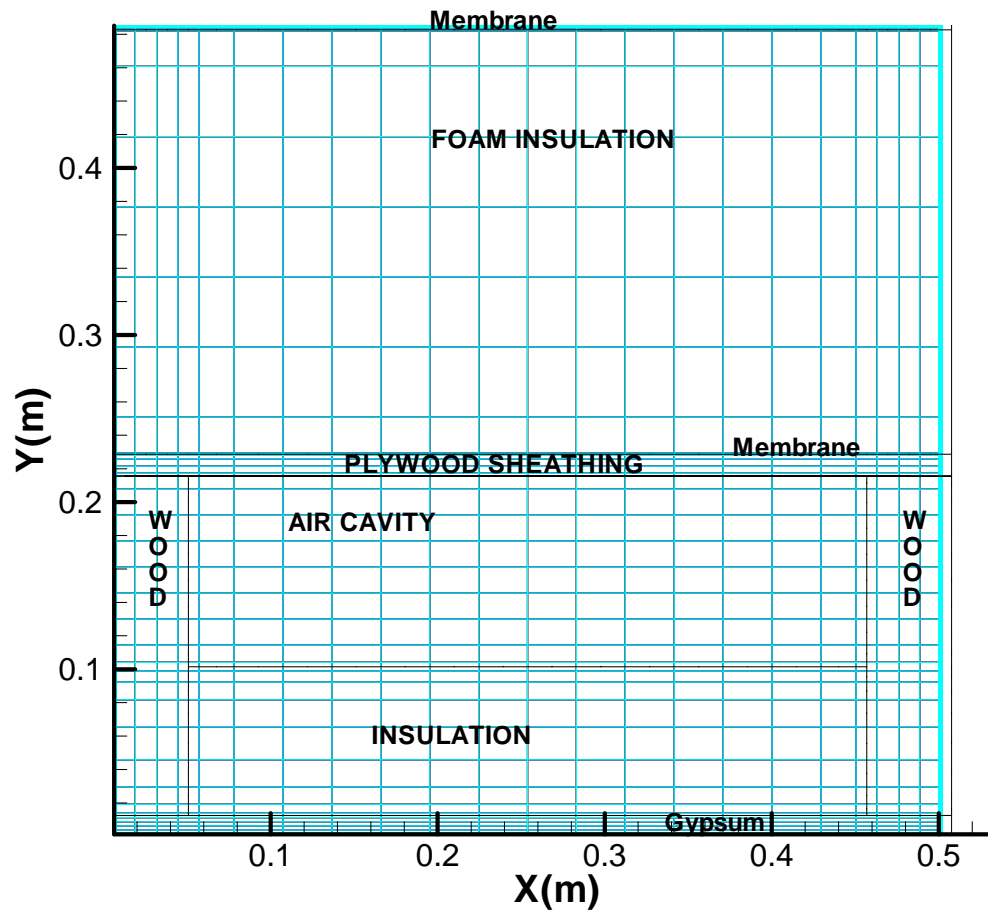
A-F

Existing Roof System



Where did we have NO INSULATION ????

Proposed Retrofit Roof System



Simulation Series



Table 1: Roof Simulations

Existing Roof I.C. at 90 % RH						Retrofit Roof I.C. at 90 % RH					
Case1	Case2	Case3	Case4	Case 5	Case 6	Case1	Case2	Case3	Case4	Case 5	Case6
0.001 ACH Exterior Ventilati on	0.001 Interior air leakage	0.01 ACH Exterior Ventilati on	0.01 Interior air leakage	1.0ACH Exterior Ventilation	1 Interior air leakage	0.001 ACH Exterior Ventilati on	0.001 Interior air leakage	0.01 ACH Exterior Ventilati on	0.01 Interior air leakage	1.0ACH Exterior Ventilation	1 Interior air leakage

Results



RH 90 %

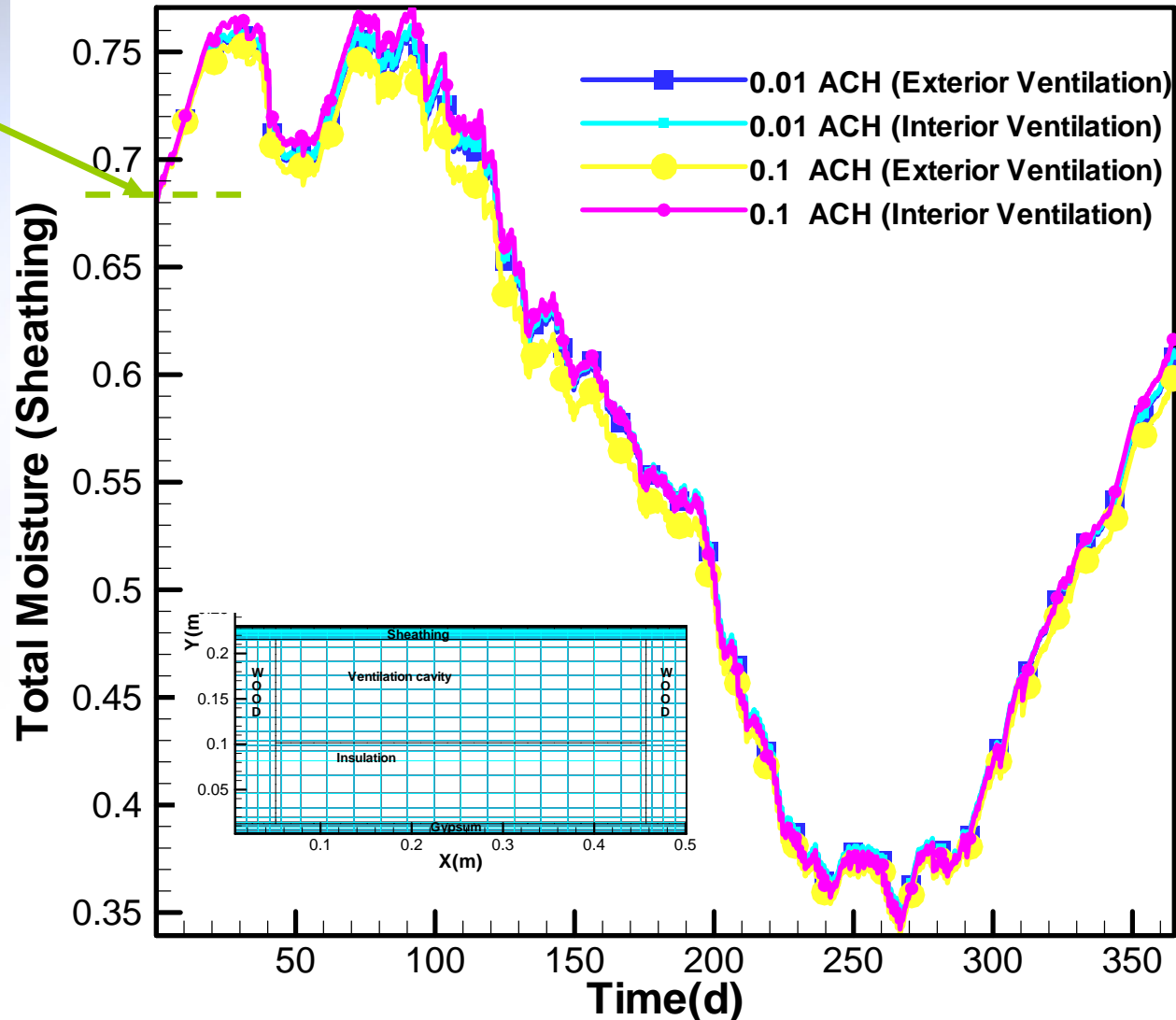
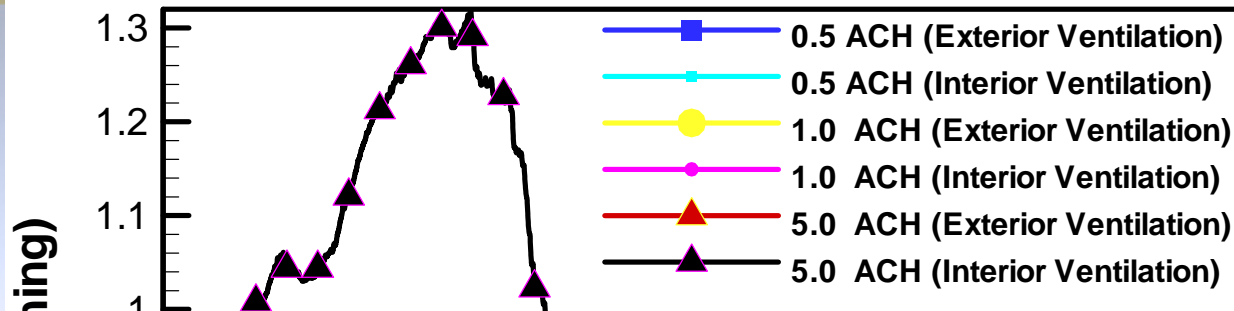


Figure 6: Performance of Existing Roof Sheathing as a function of low interior or exterior ventilation (0.001 and 0.1 ACH)

Results



Either Ventilate (Exterior) a LOT or PROBLEMS

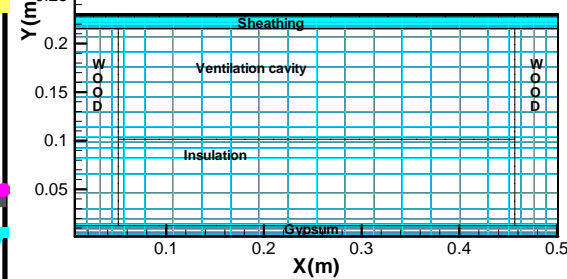
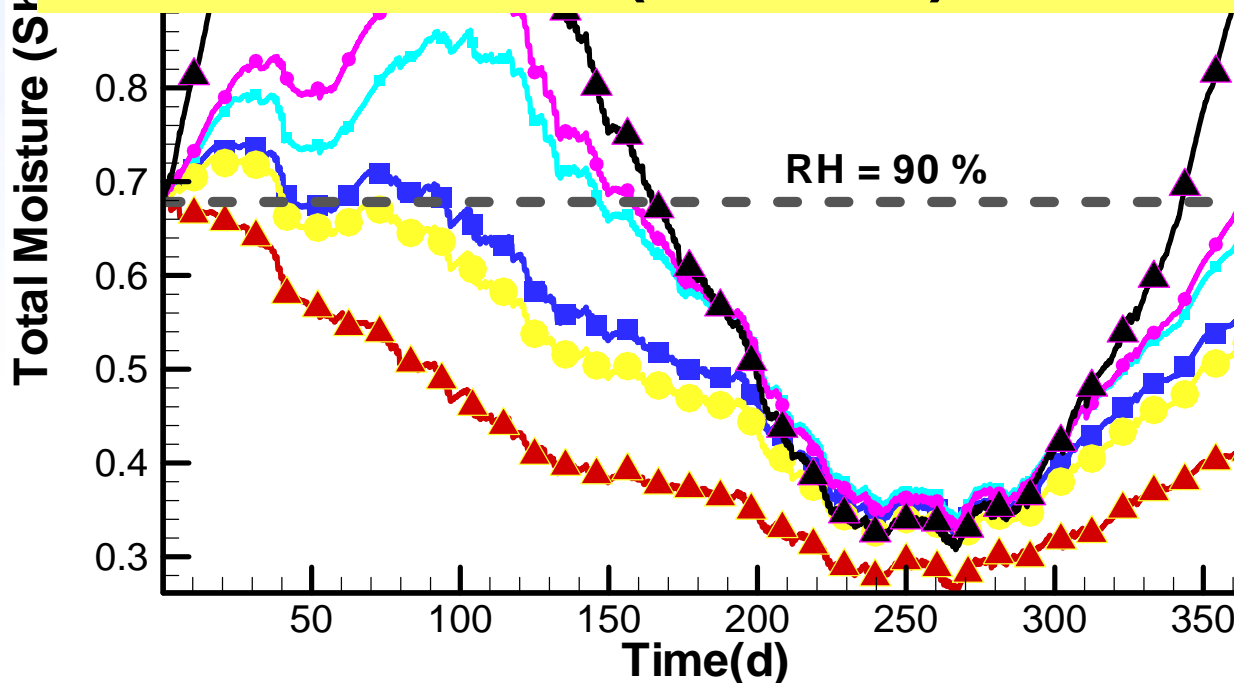
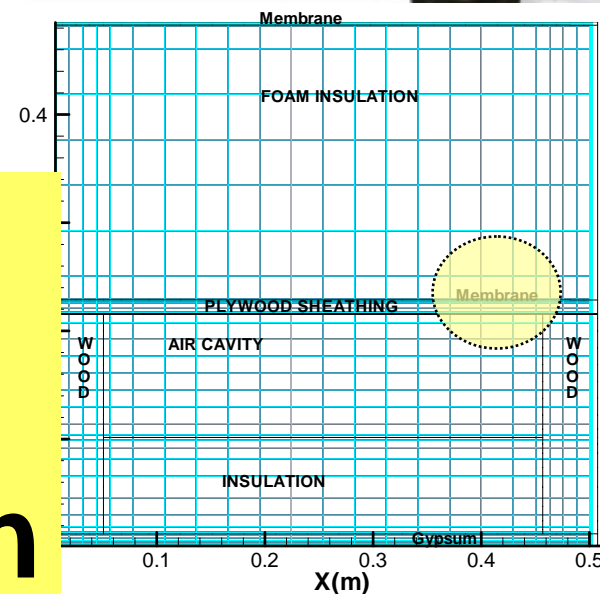
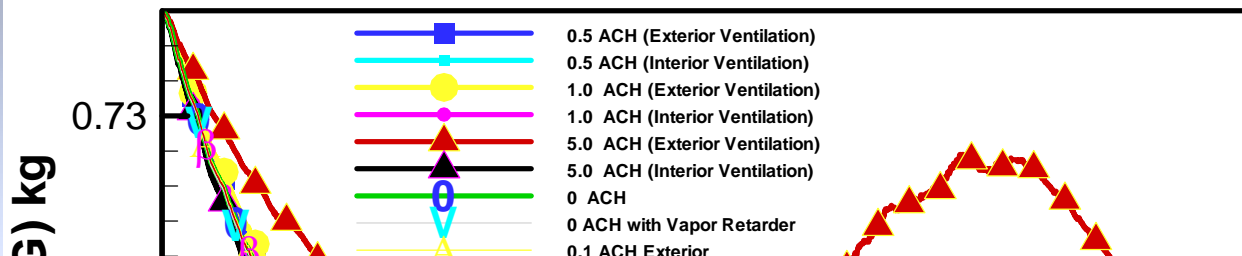


Figure 7: Performance of Existing Roof Sheathing as a function of interior or exterior ventilation (0.5, 1, 5.0)

Results



Robust Design
Forgiving Design
Energy Efficient Design
Durable Design

Retrofit Roof

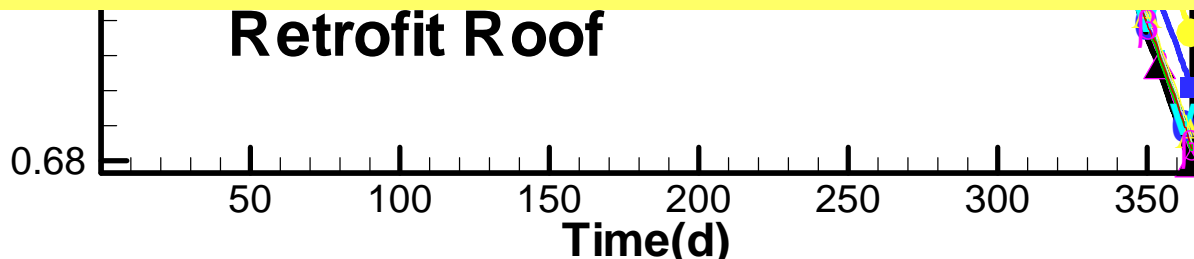
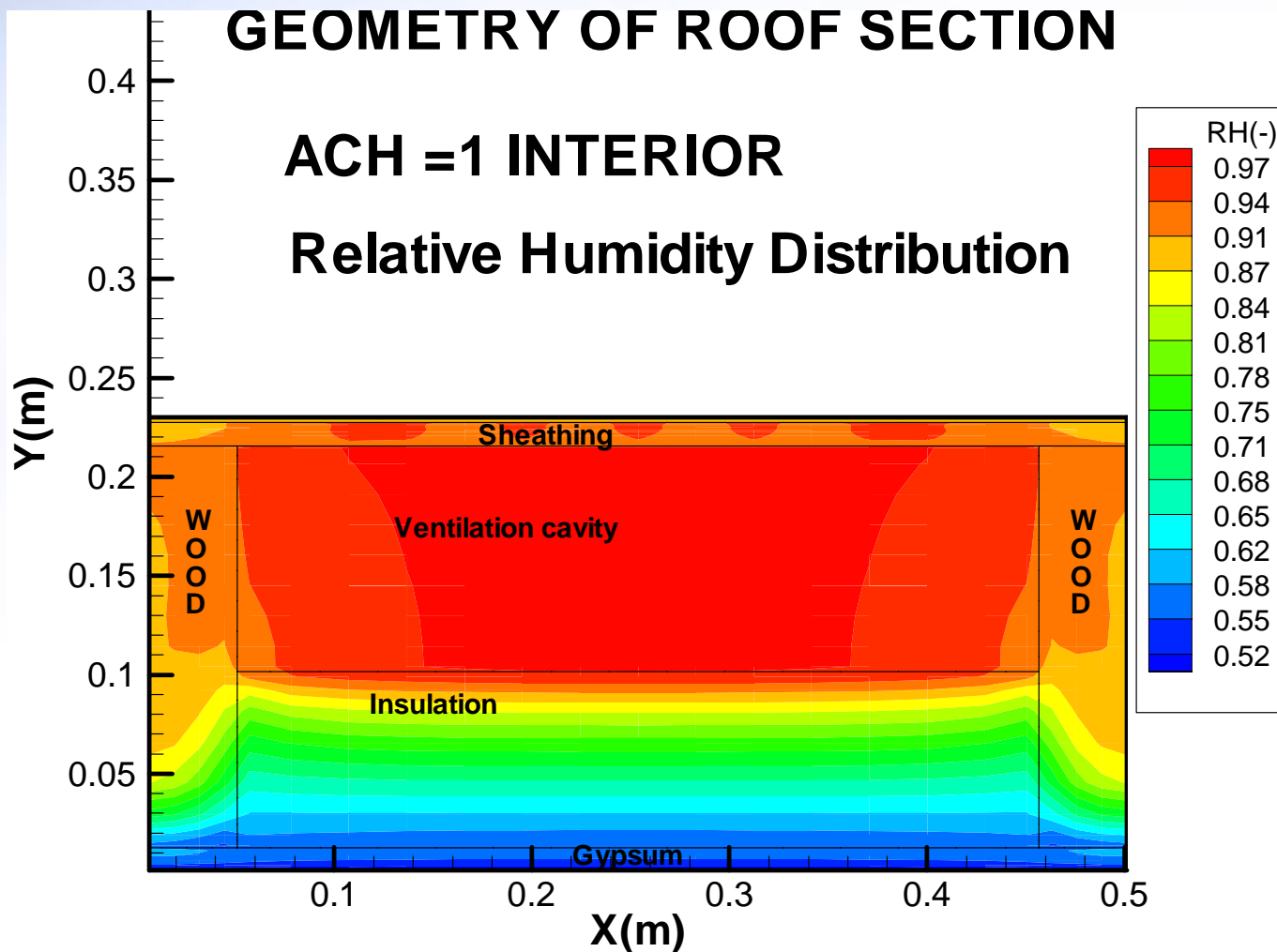
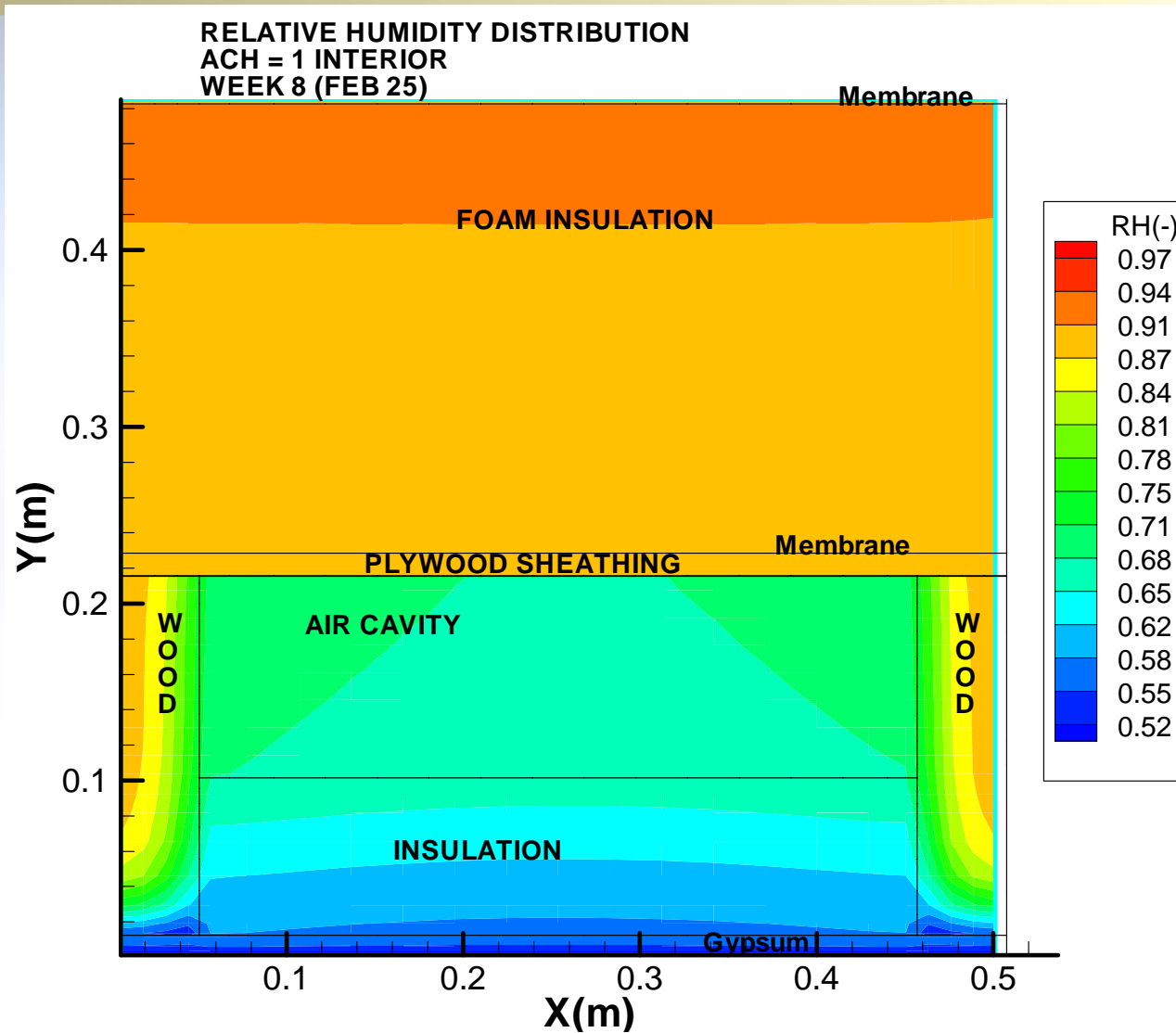


Figure 13: Performance of Retrofit Roof Sheathing as a function of interior or exterior ventilation 0.5, 1.0 and 5.0 ACH)

Results (Existing)



Results (Retrofit)



Results (Retrofit)

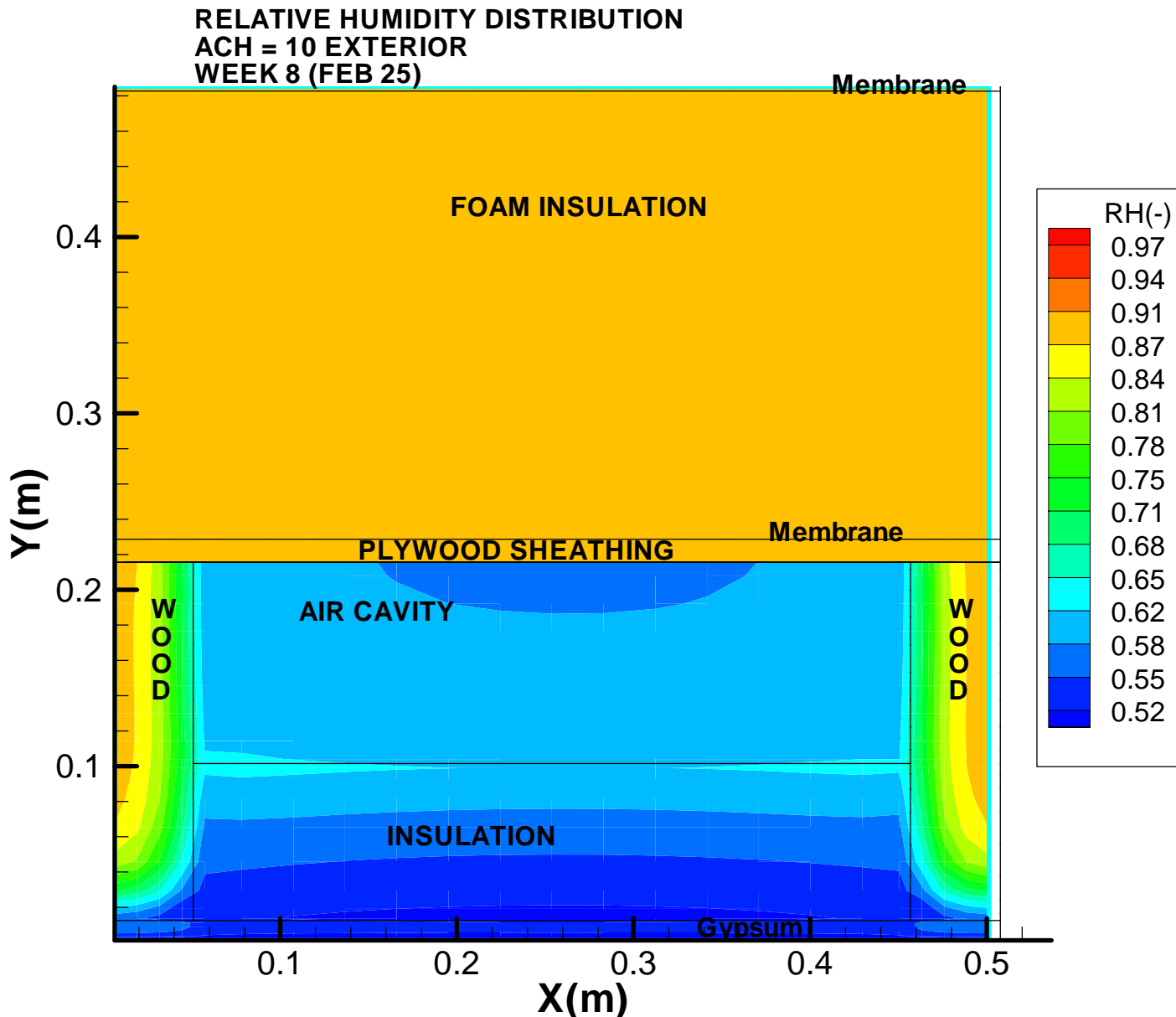


Figure 22: Retrofitted Roof Relative Humidity Distribution at week 8 with ACH =10 EXTERIOR

Temperature Distribution

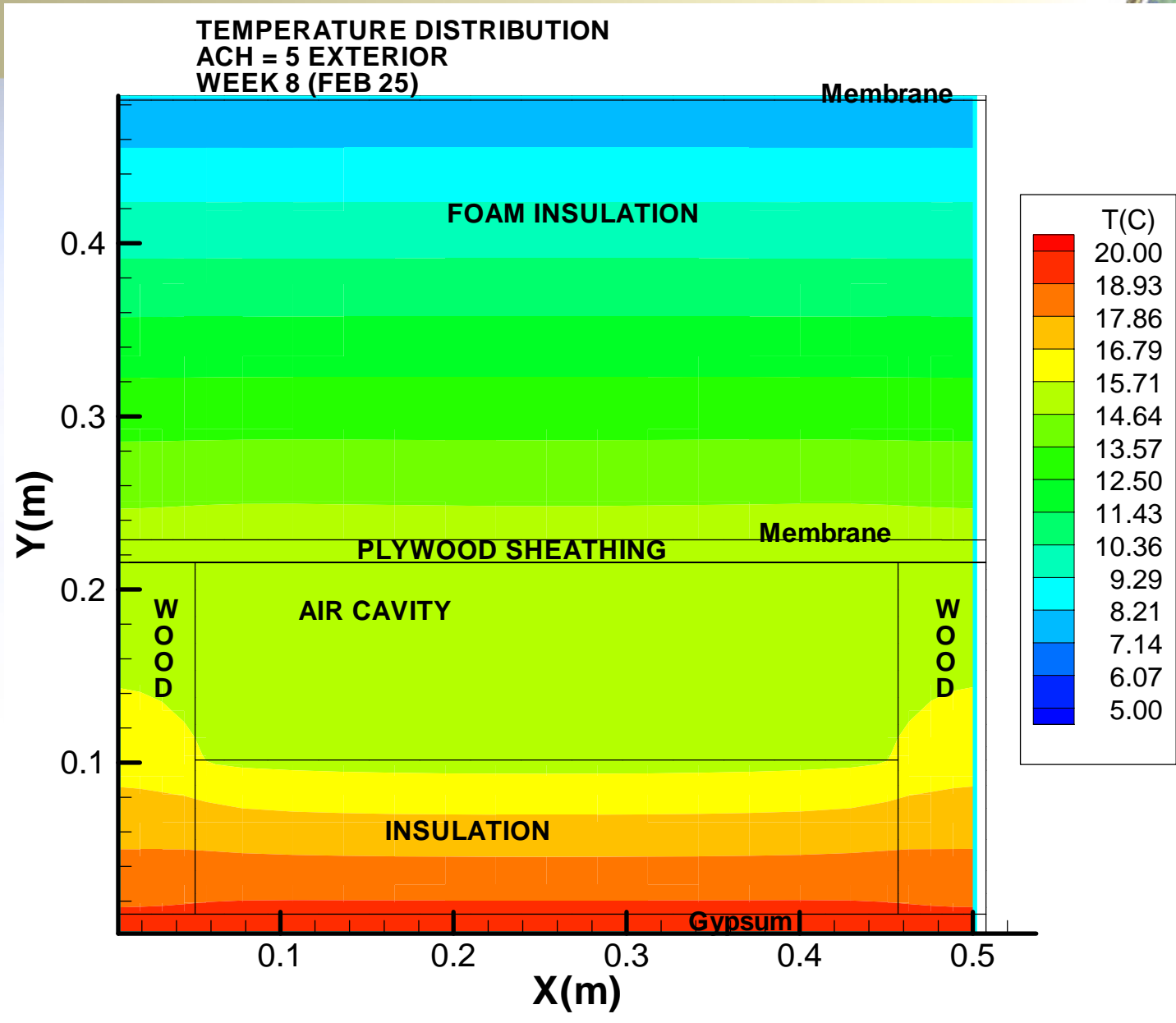
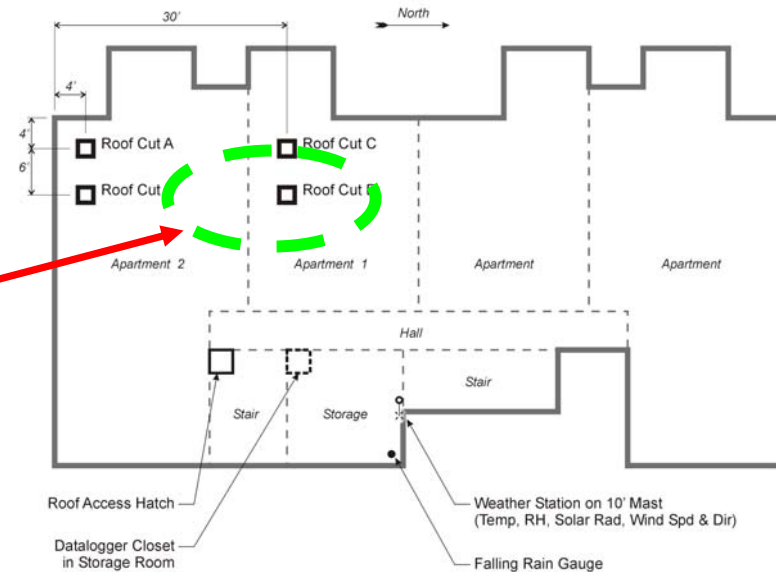


Figure 28 Retrofitted Roof Temperature Distribution week 8 at ACH=5 from the EXTERIOR

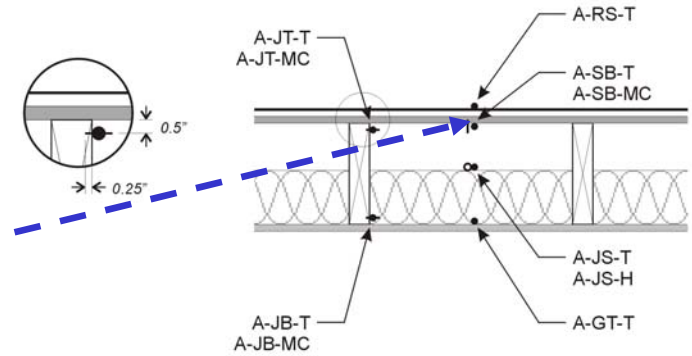
Retrofit Measured Results



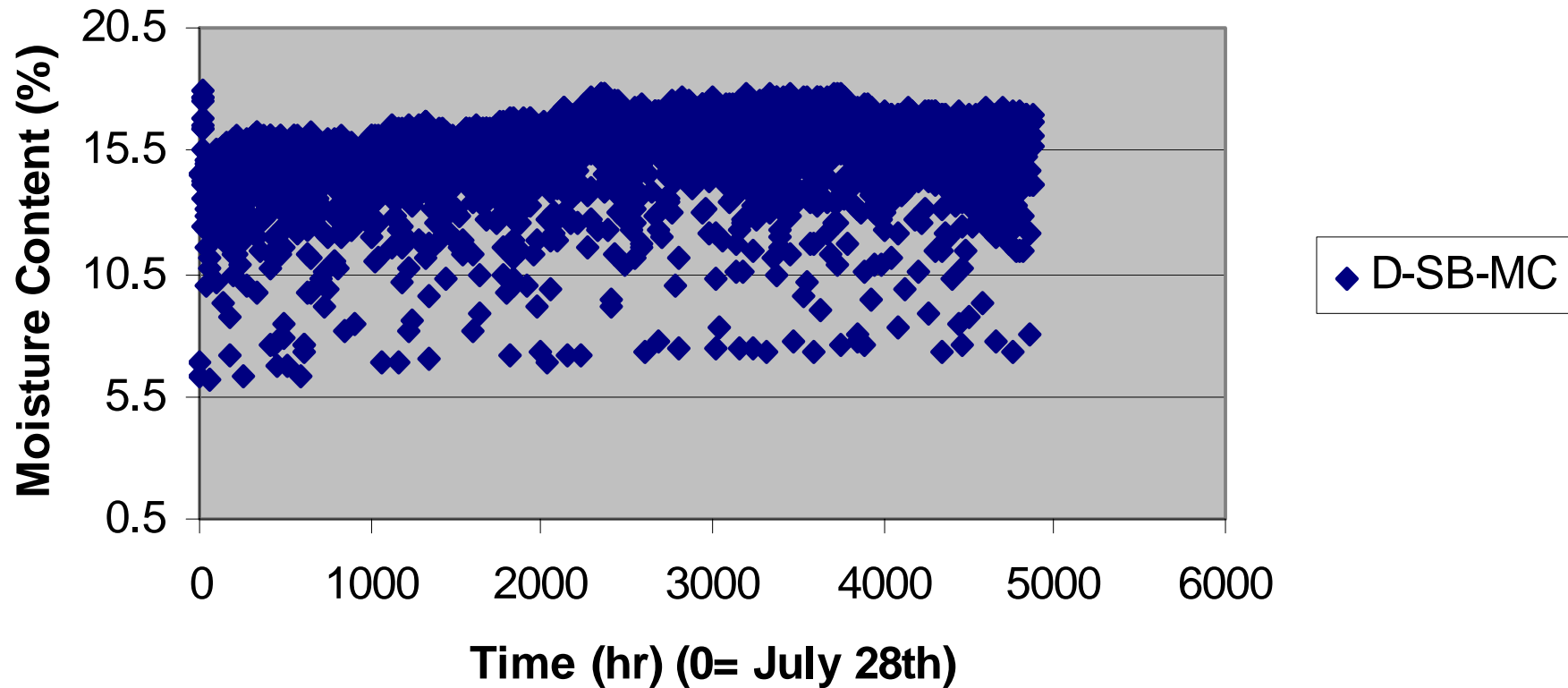
- Lets look to see what is happening to Roof after the actual retrofit took place.....?
- Was the model right ?
- Lets look at the opening at D



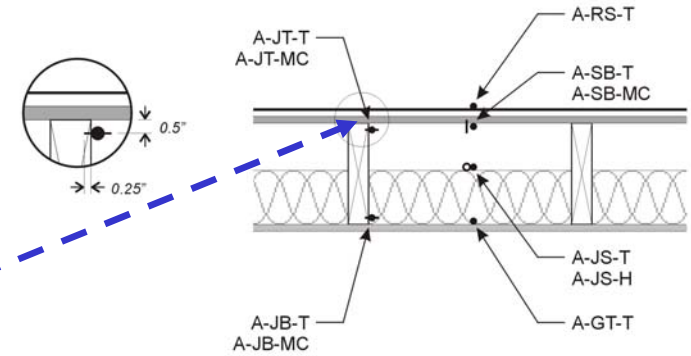
Measured Retrofit MC Distribution (Sheathing)



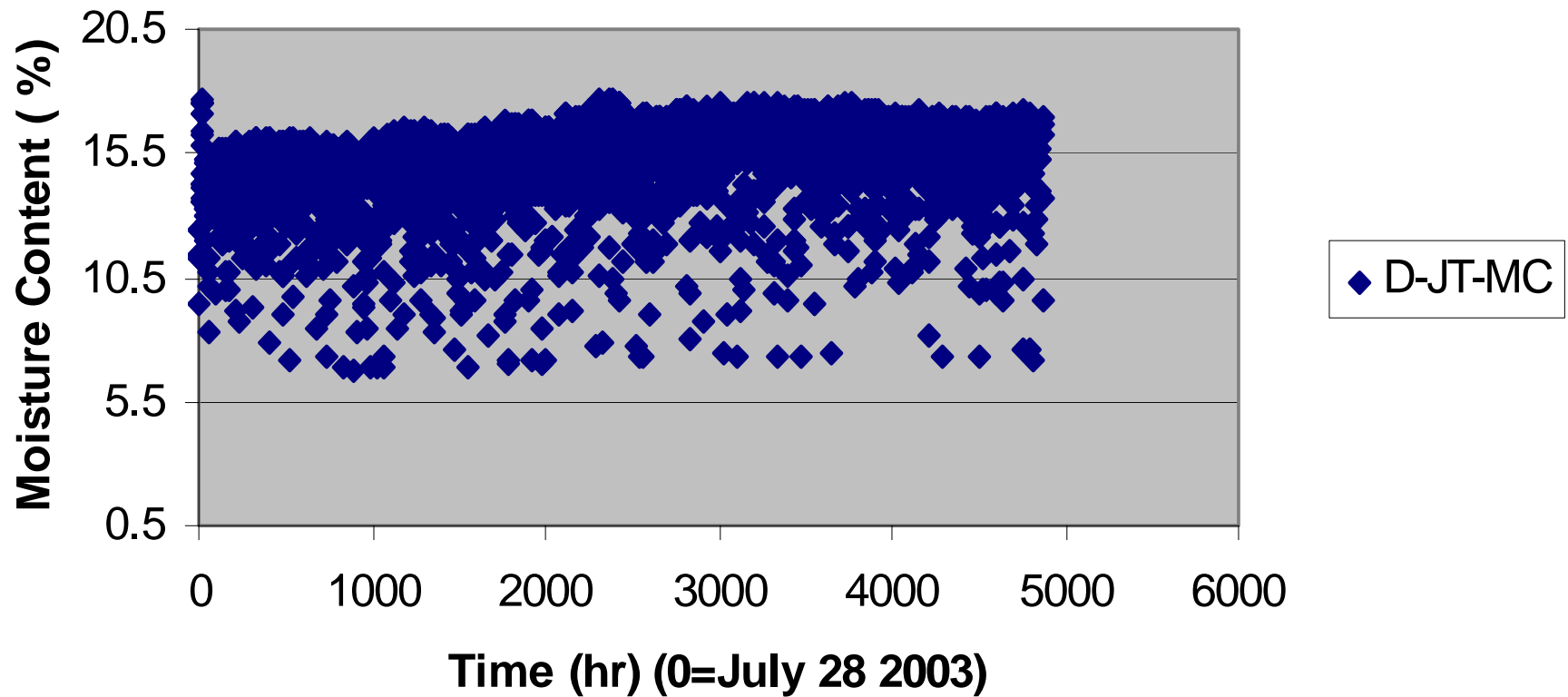
D-SB-MC



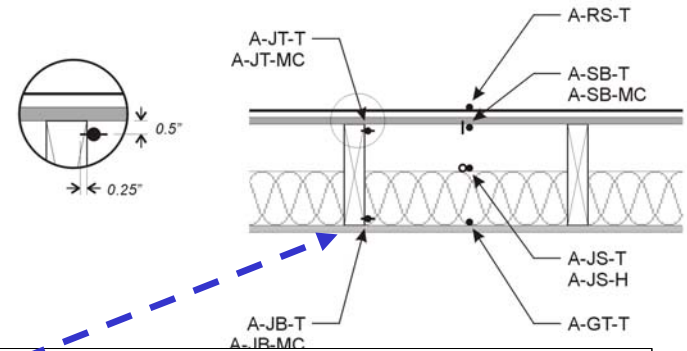
Measured Retrofit MC Distribution (Top Joist)



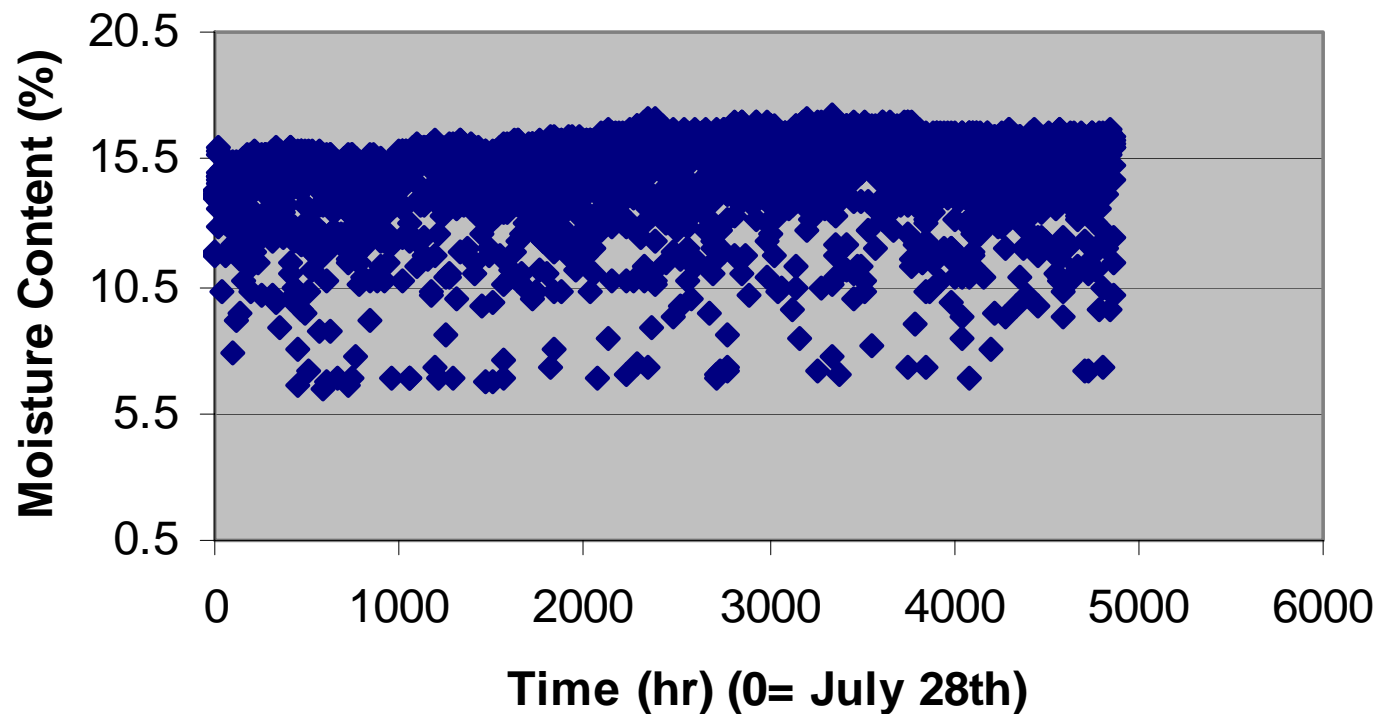
D-JT-MC



Measured Retrofit MC Distribution (Top Joist)



D-JB-MC





Summary

The retrofit ROOF resulted in DRY wood conditions

The model and measured retrofit data showed good predictive ability

.....Conclusions



- *The existing roof system was found to be very sensitive to interior moisture loads especially air leakage.*
- *Net yearly accumulation in the sheathing board was found for the existing roof suggesting that the performance of such a roof should not be employed in climatic conditions as found in the greater Seattle area.*
- *The proposed retrofit roof was found to be less sensitive to climatic loads and interior load and provided enhanced drying potential.*
- *The proposed roof was found to be both more energy efficient and had a lower risk for moisture problems.*
- *Interior and exterior air ventilation did not display a strong dominating roof as found in the existing roof*
- *However exterior ventilation for the retrofitted system did increase diurnal moisture accumulation and soffit ventilation should be blocked.*
- *Elimination of roof membrane during the retrofit action was found not to increase the drying performance of the roof.*