CRCA - 2015

Research: Roof Insulation Facers and Water Based Adhesives

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Drury Lanes Conference Center

What is this all about?

1. Air quality requirements are curtailing the use of solvent based adhesives, referred to as high VOC materials
2. Water Based Adhesives (WBA) are very low VOC materials
3. The following program outlines the basic research by the MRCA/NRCA Technical committees on WBA
4. But paper/fiber reinforced facers on polyisocyanurate roof insulation are the weak link due to moisture
5. The Chicagoland Roofing Council sponsored an important study on polyisocyanurate facers to answer some key questions related to moisture gain.

Part 1 : Water Based Adhesives

Solvents (VOC’s) in Bonding Adhesives

- Neoprene general purpose Adhesive – high VOC at 600 gram/liter
- Low VOC bonding Adhesive's – 250 grams/liter
- Some Asphalt cold Adhesives - 250 grams/liter
- Air Quality Control Districts - up to 150 grams/liter
- Water Based Adhesives - below 100 grams/liter

Water Based Bonding Adhesives Properties

- Low VOC
- Low odor
- Easy to apply
- Get more coverage

But there are some drawbacks …..

- Application temperature has to be 40° F and rising
- Storage, shipping and handling must be done within specified temperature ranges, generally 50° F to 95° F range, although some manufactures have slight variations to this
- Longer drying time is needed than with solvent based bonding adhesives (such as neoprene based material)

Drawbacks continued…..

- The material cannot be allowed to freeze in the pail awaiting use or in shipping and storage
- Some water based bonding adhesives will revert in the presence of high heat and humidity
- The material has a shelf life

MRCA/NRCA Research on WBA


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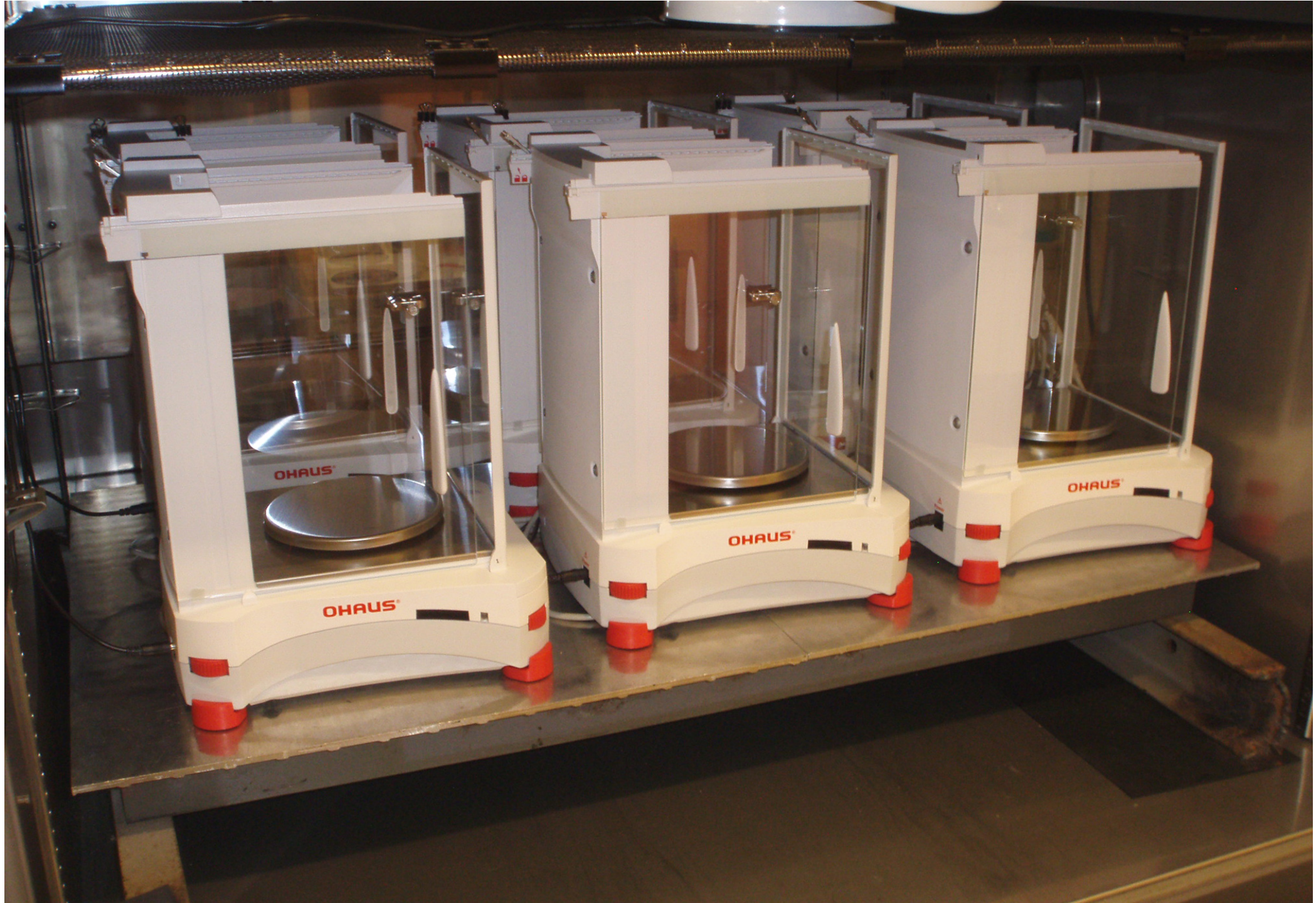
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Conclusions of moisture work:

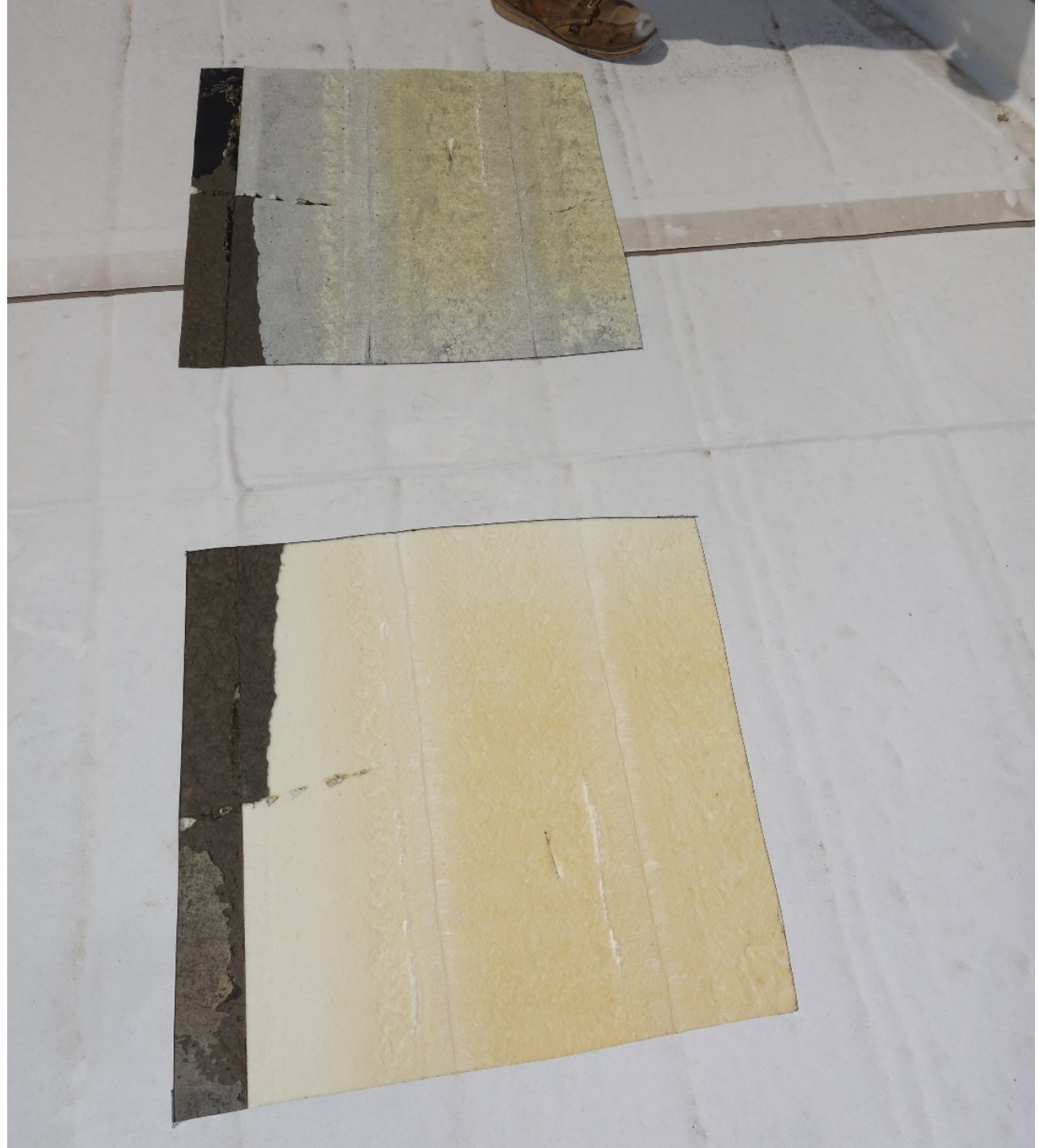
1. Looked at dry down behavior of assembly including insulation, water based adhesive and membrane together

2. Need to Research moisture behavior of facers on polyisocyanurate

Part 2: Roof Insulation Facers

Facer Experience from Field Investigations

- When moisture is present
  - Failure = cohesive failure in “paper” facer
- When evidence of moisture history in the roof system
  - Failure = cohesive failure in “paper” facer
- NRCA/MRCA WBA lab work
  - Failure = cohesive failure in “paper” facer
- When no moisture is present or no evidence of past moisture
  - Failure = cohesive in the polyisocyanurate foam



Facer Study

- The Chicagoland Roofing Council sponsored an important study on polyisocyanurate facers to answer key questions related to moisture gain.
  - In leak investigations, moisture accumulation issues and WBA research found the “paper” facer has been observed to have a reduced membrane peel strength when wet or having been previously exposed to elevated moisture.
  - The question is how much strength is lost and does it decrease with increased moisture content in the facer?

Facer Study

- **ASTM Designation: C1289 – 14 Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board**
  - 4.1.2 *Type II:*
  - 4.1.2.1 *Class 1*—Faced with glass fiber reinforced cellulosic felt facers on both major surfaces of the core foam.
    - *(1)* Grade 1—16 psi (110 kPa), min, compressive strength.
    - *(2)* Grade 2—20 psi (138 kPa), min, compressive strength.
    - *(3)* Grade 3—25 psi (172 kPa), min, compressive strength.
  - 4.1.2.2 *Class 2*—Faced with coated polymer-bonded glass fiber mat facers on both major surfaces of the core foam.

Facer Study

- Collected facer samples from point of manufacture for polyisocyanurate roof insulation boards
  - Samples were virgin facer of “Glass Reinforced Felt” (GRF) and “Coated Glass Facer” (CGF)
- 2 Manufacturers
  - Each with a GRF and CGF
- Therefore 4 total samples of facer to test

But there are some drawbacks …..

- Conditions to be tensile tested
  - Oven dry (60° C / 140° F)
  - 30% RH @73° F
  - 50% RH @73° F
  - 70% RH @73° F
  - 90% RH @73° F
  - Immersed in water 24hrs (Saturated)
  - Immersed 24hrs and oven dried 24hrs
  - Immersed 24hrs and oven dried 24hrs X 5 cycles
- Tensile test per ASTM D828 using MTS with jaws (1in / min).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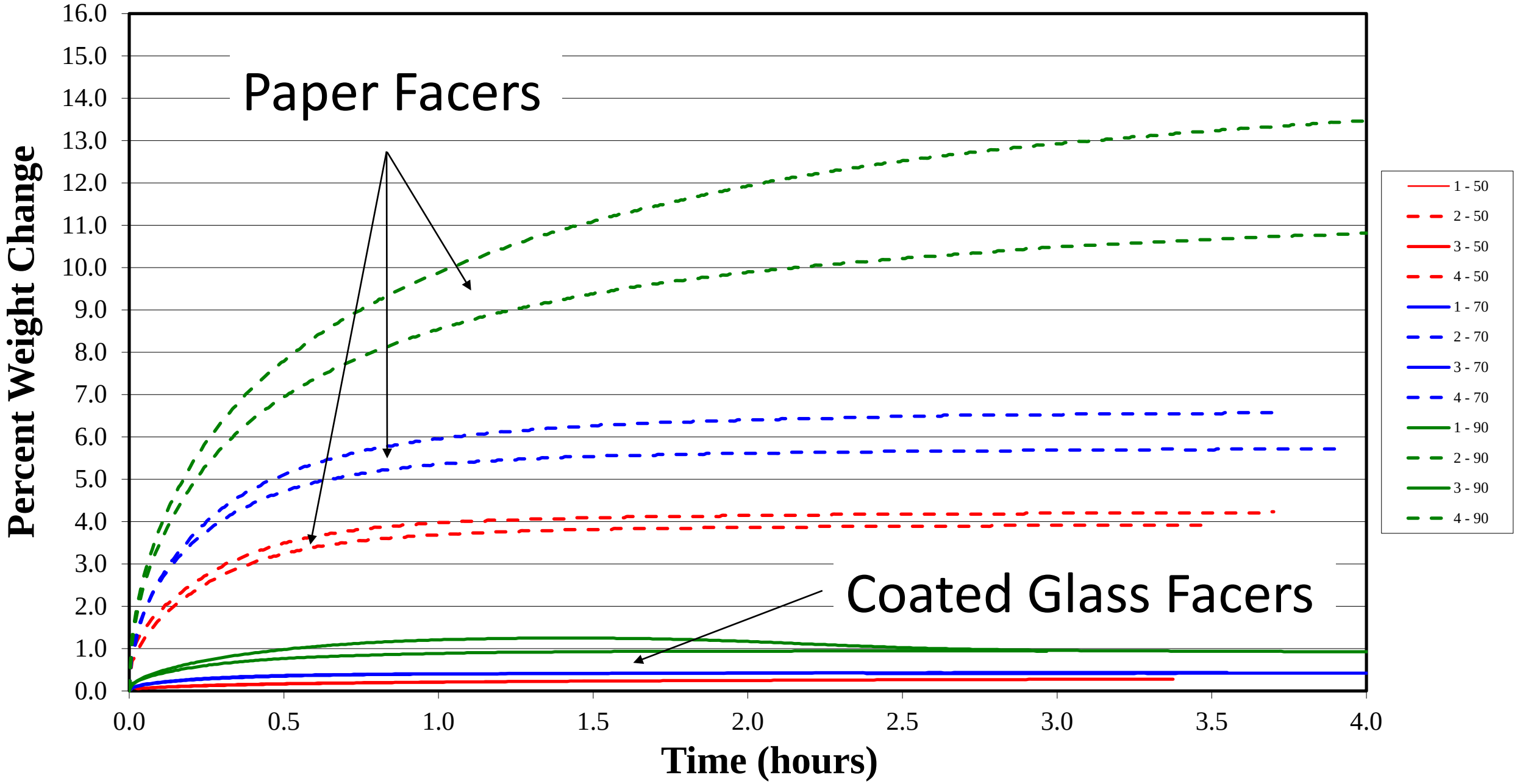
Weight Change Over Time in Environmental Chamber

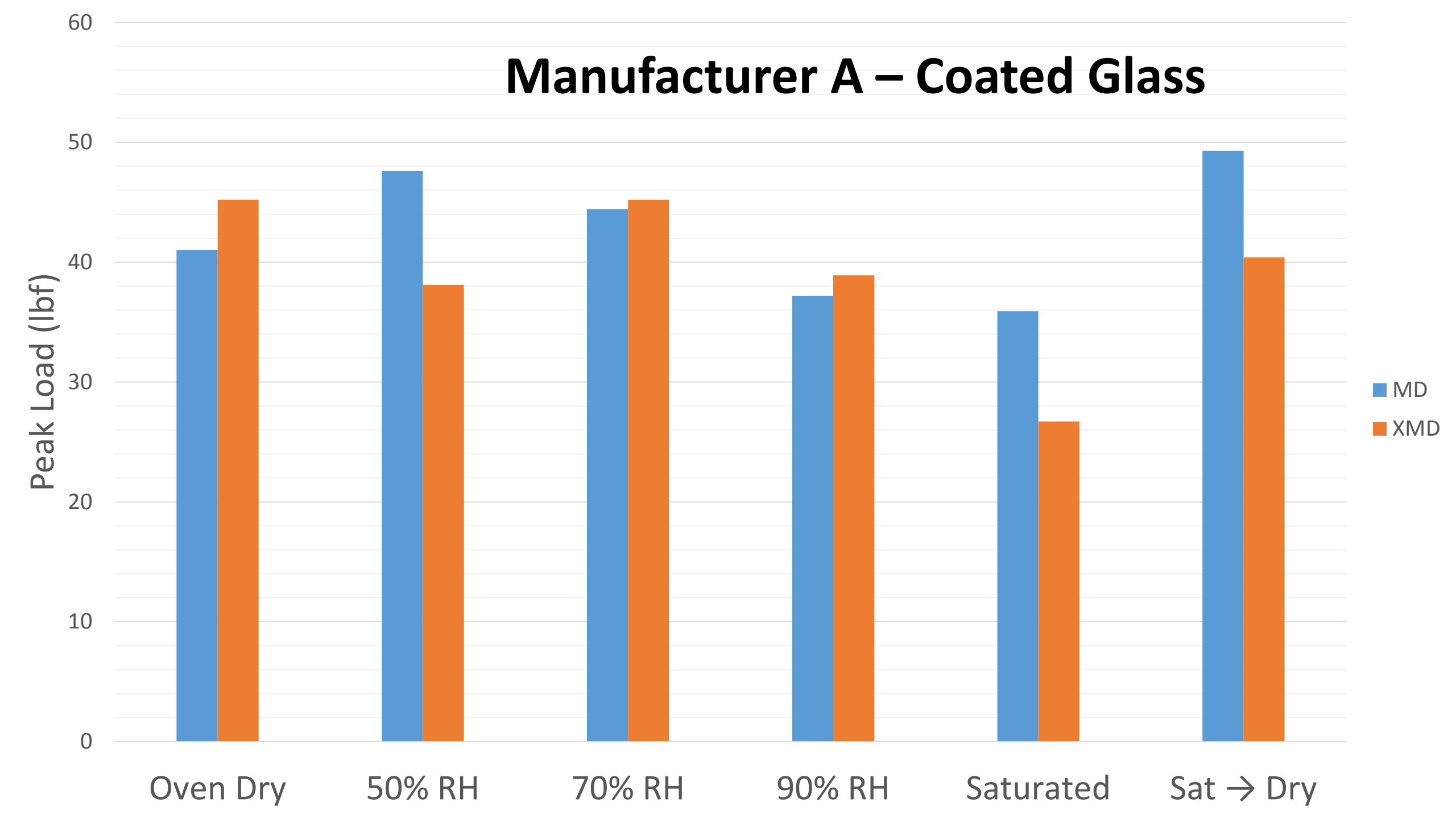


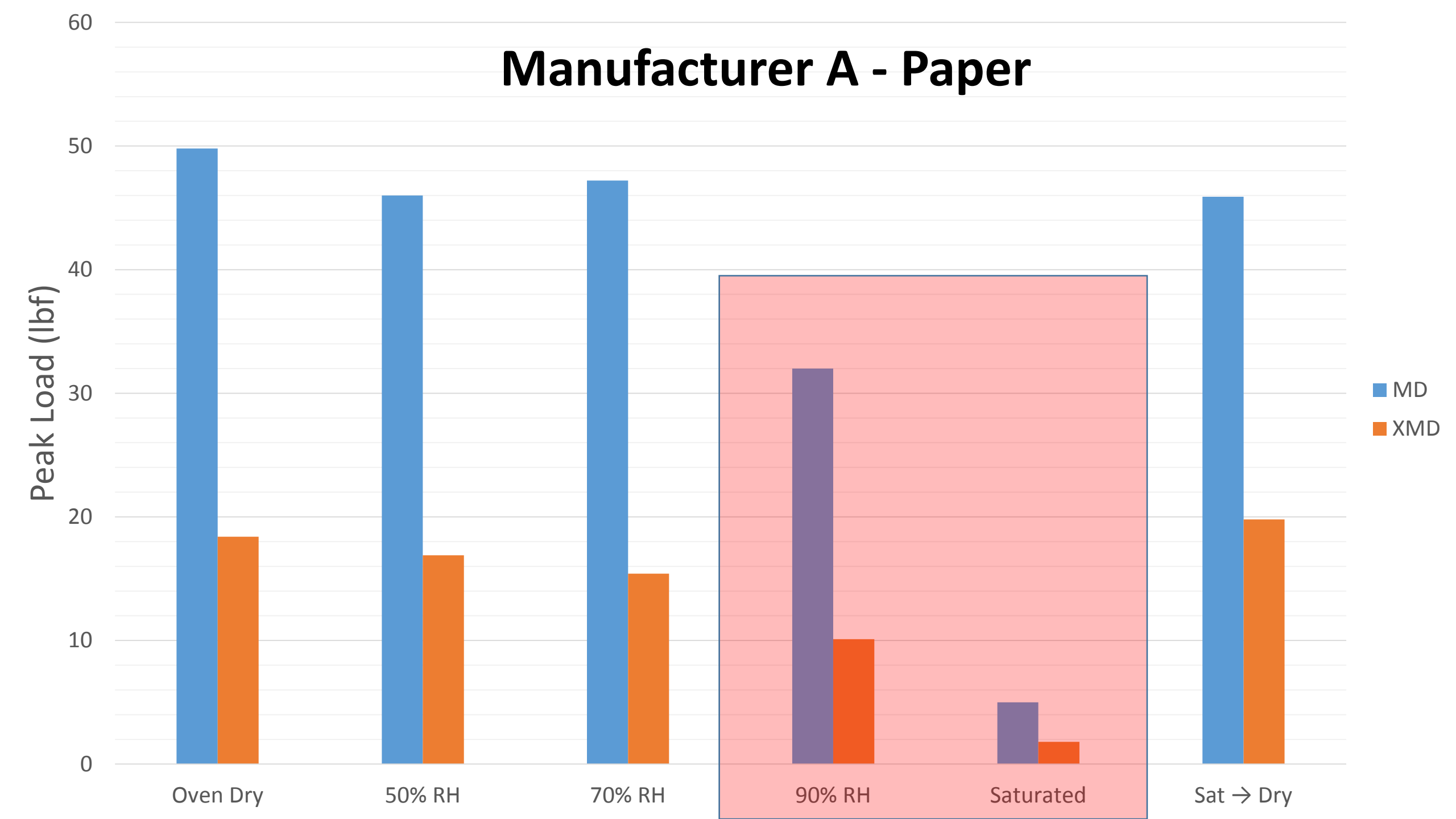
Hygric Behavior of Facers

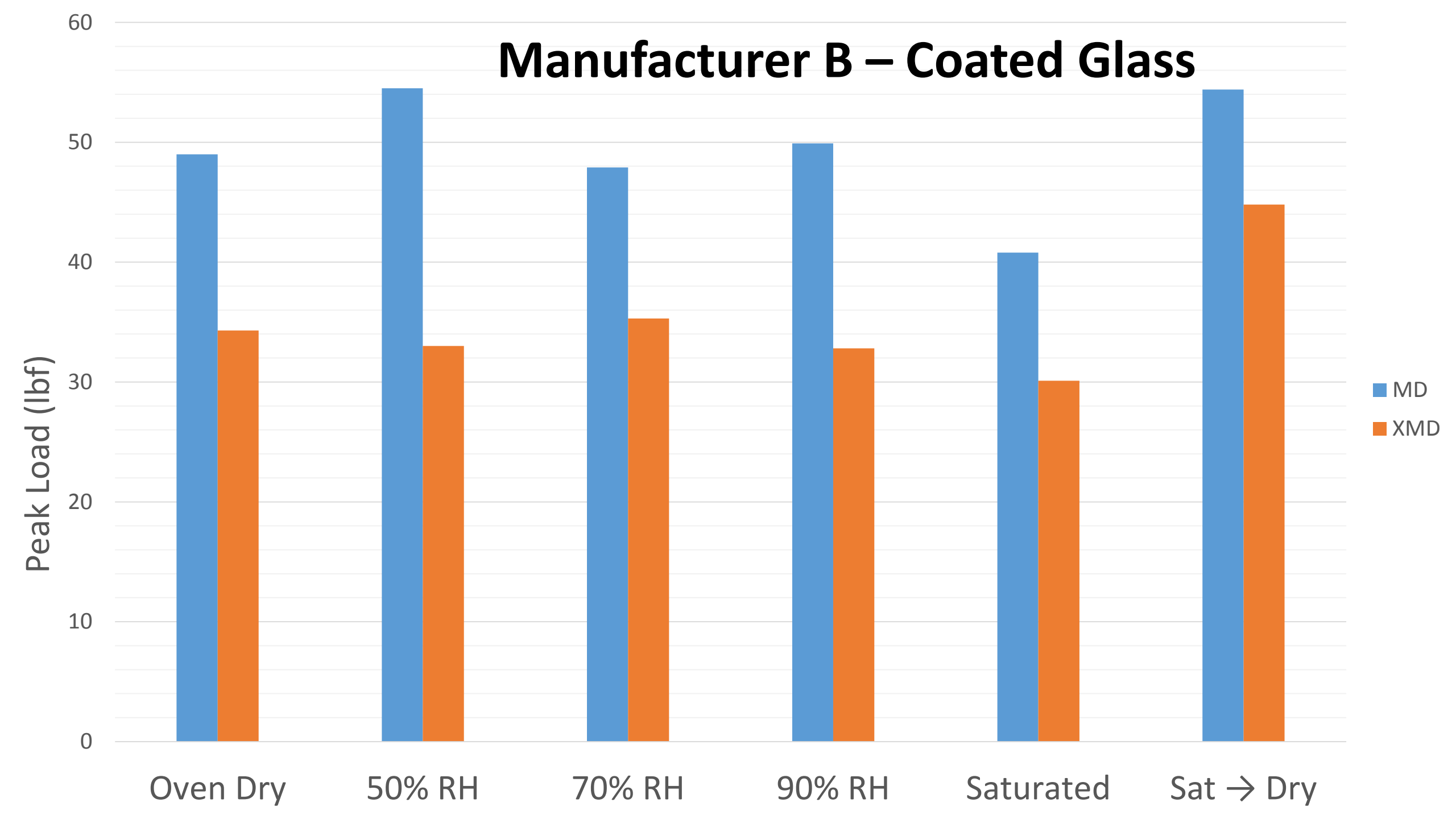
- Both Coated Glass and Paper take on moisture; within several hours at room temperature
  - Higher temperatures should exacerbate this behavior
  - Should behave similarly in dry down – needs to be confirmed
- Coated Glass takes on very little moisture compared to Paper

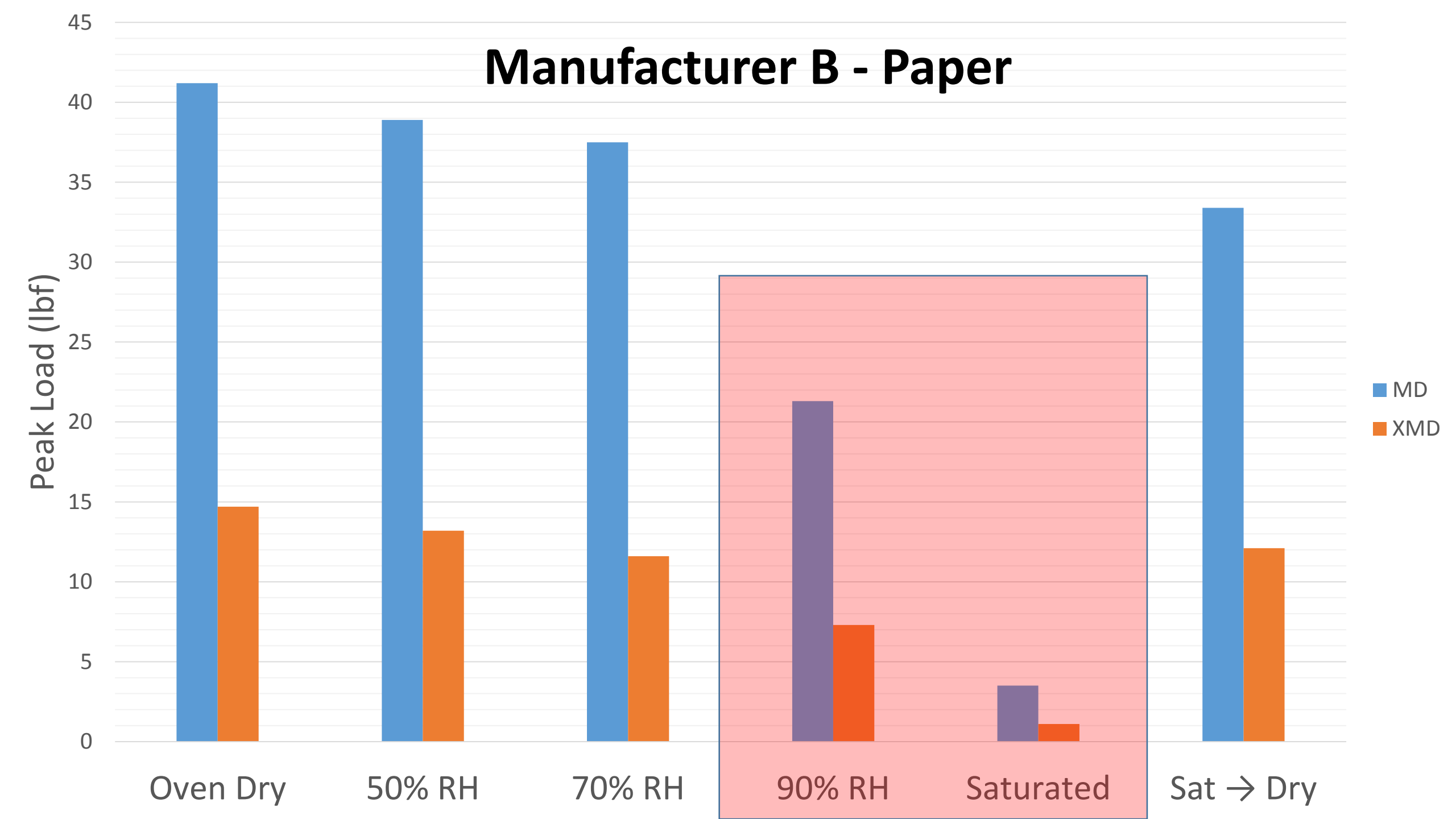
Tensile test results

- Manufacturer A (MD & XMD)
  - Coated Glass
  - Paper
- Manufacturer B (MD & XMD)
  - Coated Glass
  - Paper


Manufacturer A – Coated Glass
Peak Load (lbf)
60
50
40
30
20
10
0
Oven Dry
50% RH
70% RH
90% RH
Saturated
Sat → Dry
MD
XMD


Manufacturer A - Paper
Peak Load (lbf)
60
50
40
30
20
10
0
Oven Dry
50% RH
70% RH
90% RH
Saturated
Sat → Dry
MD
XMD


Manufacturer B – Coated Glass
Peak Load (lbf)
60
50
40
30
20
10
0
Oven Dry
50% RH
70% RH
90% RH
Saturated
Sat → Dry
MD
XMD

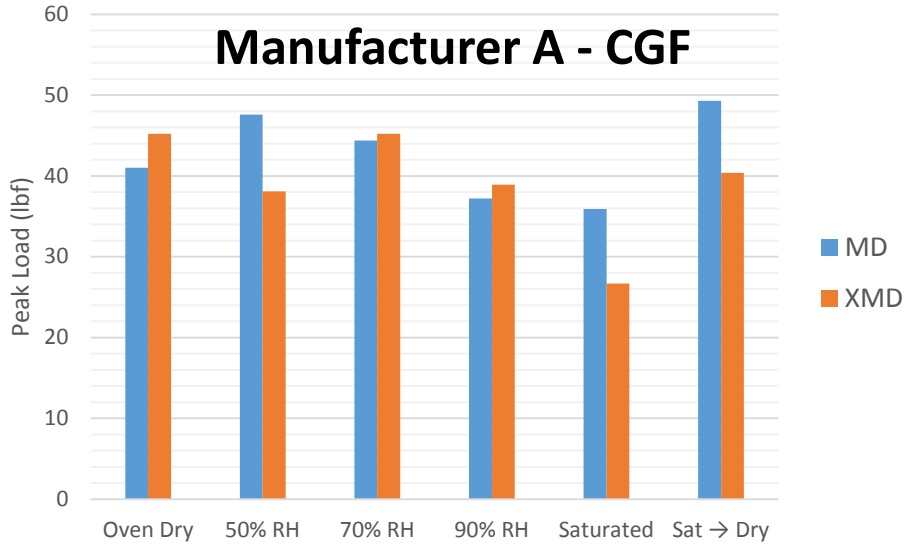

Manufacturer B - Paper
Peak Load (lbf)
45
40
35
30
25
20
15
10
5
0
Oven Dry
50% RH
70% RH
90% RH
Saturated
Sat → Dry
MD
XMD

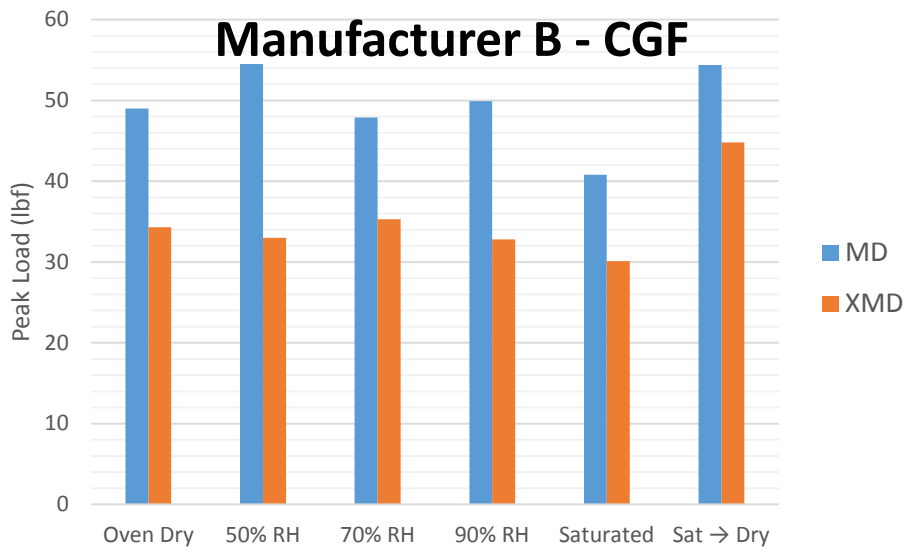
Tensile Behavior of Facers

- Clearly Coated Glass has superior strength
- Coated Glass has superior strength at all moisture levels
- Coated Glass is more isotropic
  - This means MD vs. XMD
  - Supports industry reports of better dimensional stability for ISO boards with Coated Glass
- Paper loses strength as moisture content increases from humid conditions or liquid moisture
  - Saturated strength for Paper is miserable at best

Tensile Behavior of Facers

- Surprisingly both Coated Glass and Paper regained all or more of oven dry strength
  - Paper returned to near lab condition strength after one cycle
  - Coated Glass even GAINED STRENGTH after saturation → oven dry!





Moisture Content of Facer by Meter Reading

- Using a Delmhorst BD-2000 on Scale 1
- Readings taken on facers after equilibrating in chamber
- Moisture content percentage determined

Condition	MC (%)			
	A - CGF	A - GRF	B - CGF	B - GRF
24 hr Oven Dry	0.1	0.2	0.0	0.4
73°/30%				
73°/50%	0.27	3.92	0.28	4.23
73°/70%	0.43	5.72	0.44	6.57
73°/90%	1.25	10.92	0.95	13.85
24 Hr Soak (Saturated)	26.3	107.8	27.8	111.1
24 Hr Soak/24 Hr Oven Dry	-0.6	-1.0	-0.5	-1.3
24 Hr Soak/24 Hr Oven Dry * 5				

Condition	MC (%)				Delmhorst (BD 2000 Scale 1)			
	A - CGF	A - GRF	B - CGF	B - GRF	A - CGF	A - GRF	B - CGF	B - GRF
24 hr Oven Dry	0.1	0.2	0.0	0.4	**0.0**	**0.0**	**0.0**	**0.0**
73°/30%								
73°/50%	0.27	3.92	0.28	4.23	**0.0**	**0.0**	**0.0**	**0.0**
73°/70%	0.43	5.72	0.44	6.57	**13.6**	**8.1**	**13.4**	**9.9**
73°/90%	1.25	10.92	0.95	13.85	**20.6**	**16.0**	**20.3**	**22.0**
24 Hr Soak (Saturated)	26.3	107.8	27.8	111.1	**19.0**	**23.9**	**18.7**	**24.2**
24 Hr Soak/24 Hr Oven Dry	-0.6	-1.0	-0.5	-1.3	**0.0**	**0.0**	**0.0**	**0.0**
24 Hr Soak/24 Hr Oven Dry * 5								

Conclusions

- MRCA / NRCA WBA research has shown variable behavior of Water Based Adhesives at the same conditions
  - All Water Based Adhesives are not created equal
- Field application of Water Based Adhesives has been plagued with reported installation issues
- Reintroduction of moisture from any source can compromise Water Based Adhesive, in adhered roof systems with wind uplift
  - Particularly when attached to paper faced ISO.
- Lab testing and field failure investigations show cohesive failure in facer as dominate failure mechanism in peels

Conclusions

- Facer research clearly shows
  - Paper facers suffer loss of strength as moisture content increases
  - Coated Glass generally indifferent to moisture content
  - Paper facer is non-isotropic (MD vs. XMD)
- Based on these two research programs it is clear
  - Paper facers are unsuitable for use with Water Based Adhesives
  - Paper facers are a poor choice for adhered systems if moisture is present
    - Ballasted and mechanically fastened systems still have biological growth concern with GRF (paper) facer
  - Coated Glass is recommended for adhered systems at this time

Conclusions

- Current thinking is to utilize a hygric buffer in adhered systems
  - Mineral wool as top layer to allow for rapid movement of water molecules away from bond site while not being damaged by presence of moisture
  - Other select cover boards may also have hygric benefit

Questions?