# Water Absorption and Durability of Wood Plastic Composites

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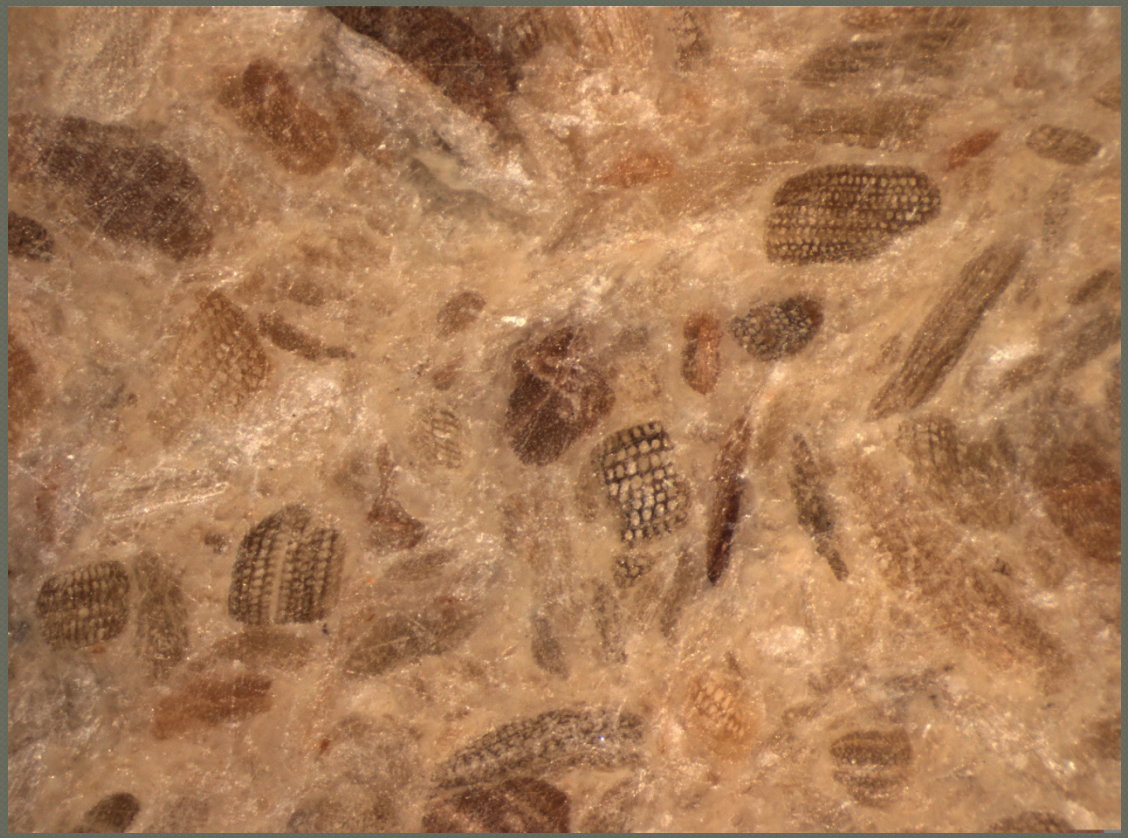
10th International Conference on Wood & Biofiber Plastic Composites
Madison, WN
May 11-13, 2009

# Water in the Environment

# Water in Exterior Exposure

# Wood Plastic Composites Exposed to Water



Wood particles are encapsulated in plastic

Polyethylene water saturation ~0.01%

Wood fiber water saturation ~25%

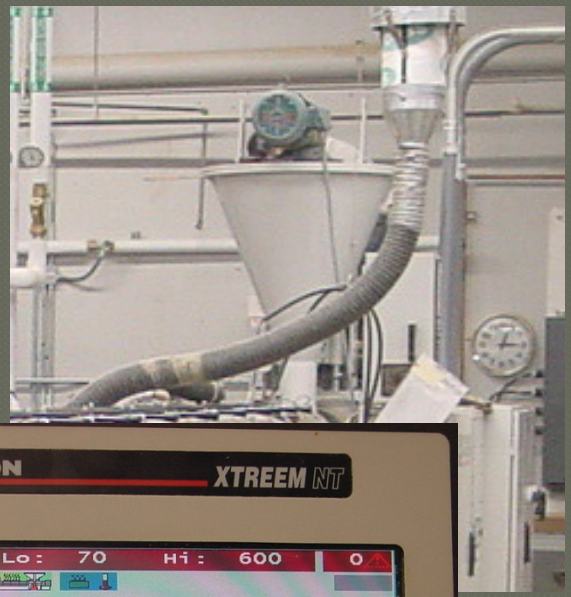
# Wood Plastic Composites Exposed to Water

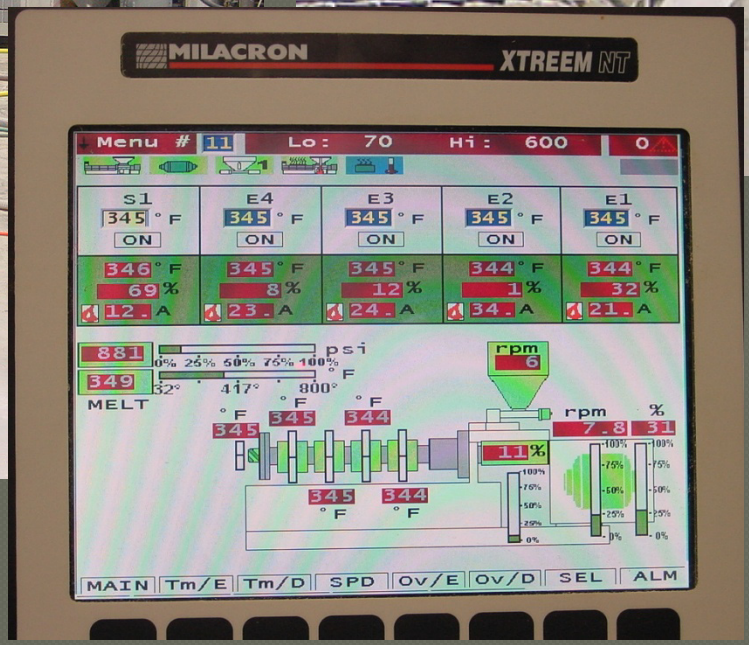
# Experimental WPC

| Ingredients | Formulation ID # | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 3 | 4 | 5 | 6 | 8 | 10 | 11 | 12 | 13 | 27 | 28 | 31 | 33 |
| **Wood - Pine** | 50 | 50 | 50 | 50 | 50 | 65 | 65 | 65 | 65 | 65 | | | | |
| Wood - Oak | | | | | | | | | | | 50 | 50 | 65 | 65 |
| **HDPE** | 45 | 45 | 45 | 45 | 45 | 30 | 30 | 30 | 30 | 30 | 45 | 45 | 30 | 30 |
| **Talc %** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| **Lubricants %** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **UV Stabilizer** | Yes | Yes | Yes | No | No | Yes | Yes | Yes | No | No | Yes | Yes | Yes | Yes |
| **Zinc Borate %** | 0 | 2 | 3 | 0 | 3 | 0 | 2 | 3 | 0 | 3 | 3 | 0 | 0 | 0 |
| **Board Cross-section (inches)** | 6 x ½ | 6 x ½ | 6 x ½ | 6 x ½ | 6 x ½ | 6 x 1 | 6 x 1 | 6 x 1 | 6 x 1 | 6 x 1 | 6 x ½ | 6 x ½ | 6 x 1 | 6 x 1 |

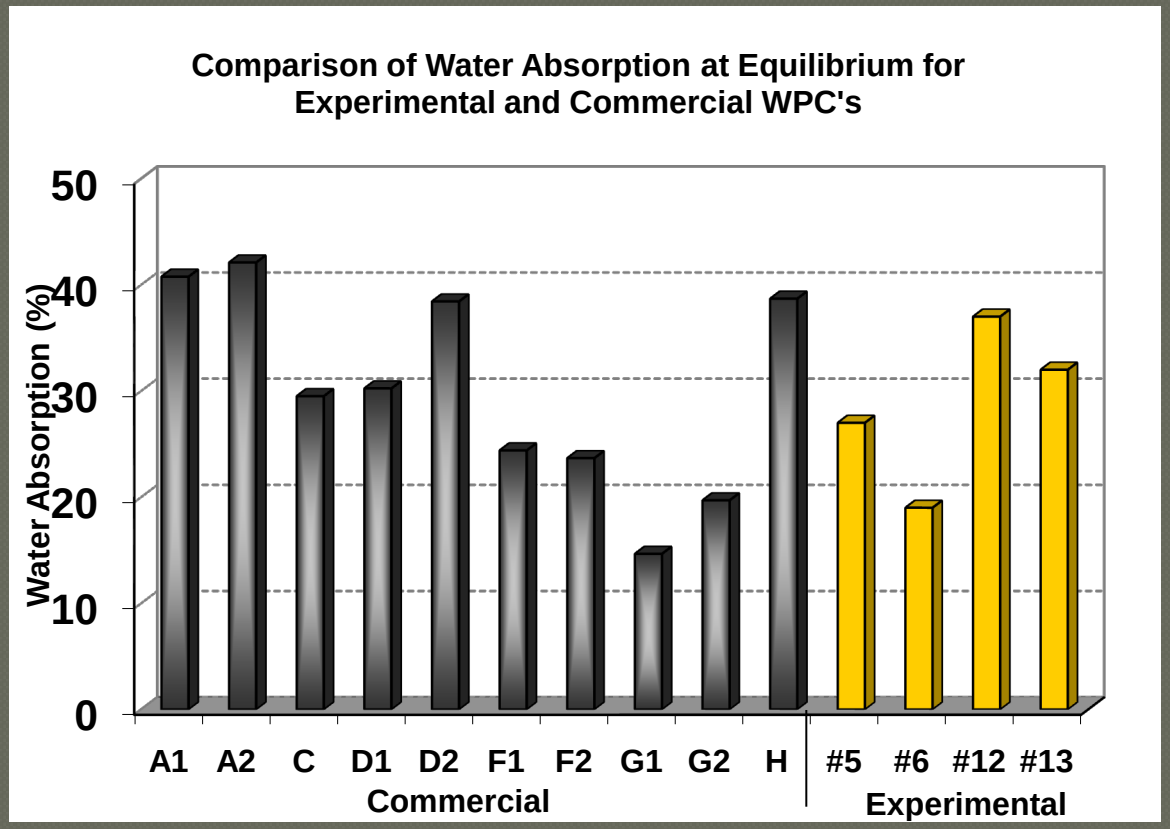
Quantities are approximate

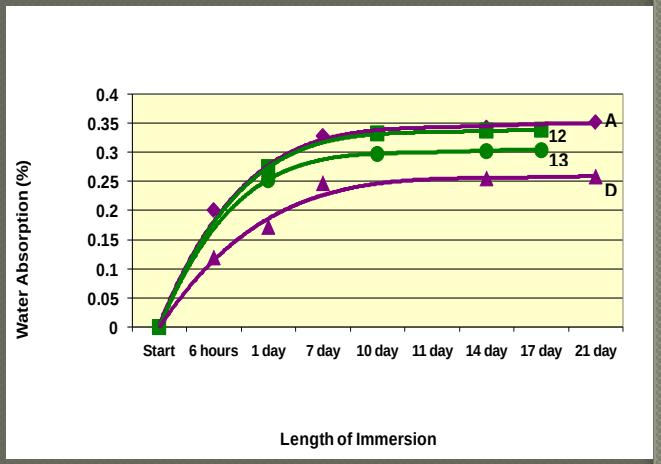
# Experimental WPC

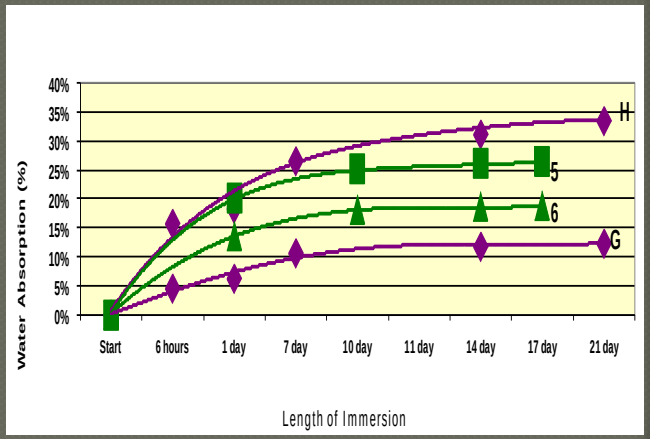





# Experimental WPC



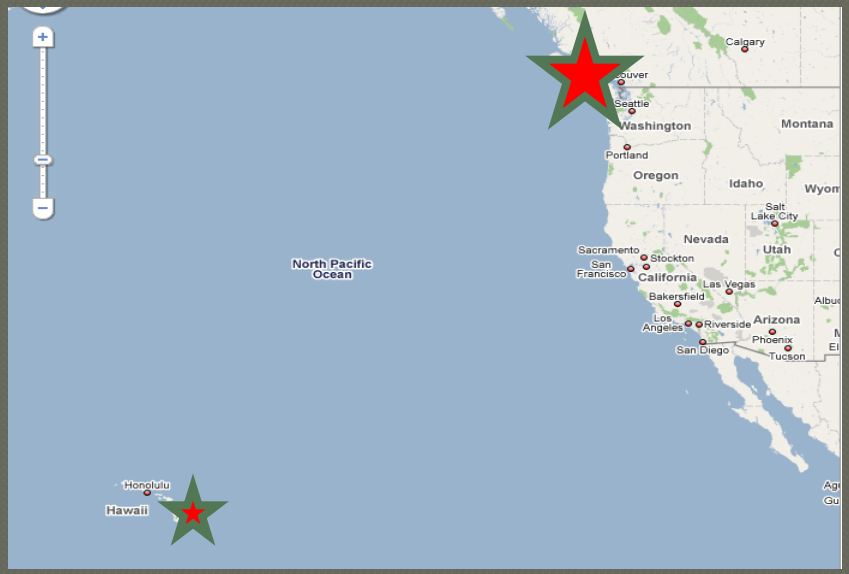
# Exposure Location

## Vancouver, BC

Annual precipitation: 44 inches
Annual minimum temperature: 8°F
Annual maximum temperature: 72°F
Annual hours of sunshine: 1950
Pan evaporation: 22 (Bellingham, WA)
Scheffer index: ~50

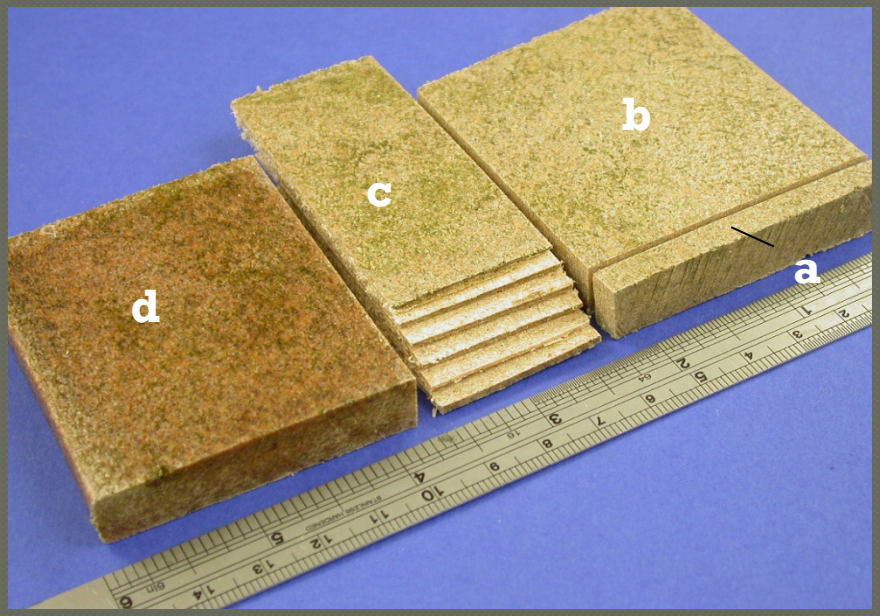
## Hilo, Hawaii

Annual precipitation: 129 inches
Annual minimum temperature: 53°F
Annual maximum temperature: 93°F
Annual hours of sunshine: 2100
Pan evaporation: 91 (Honolulu)
Scheffer index: ~330

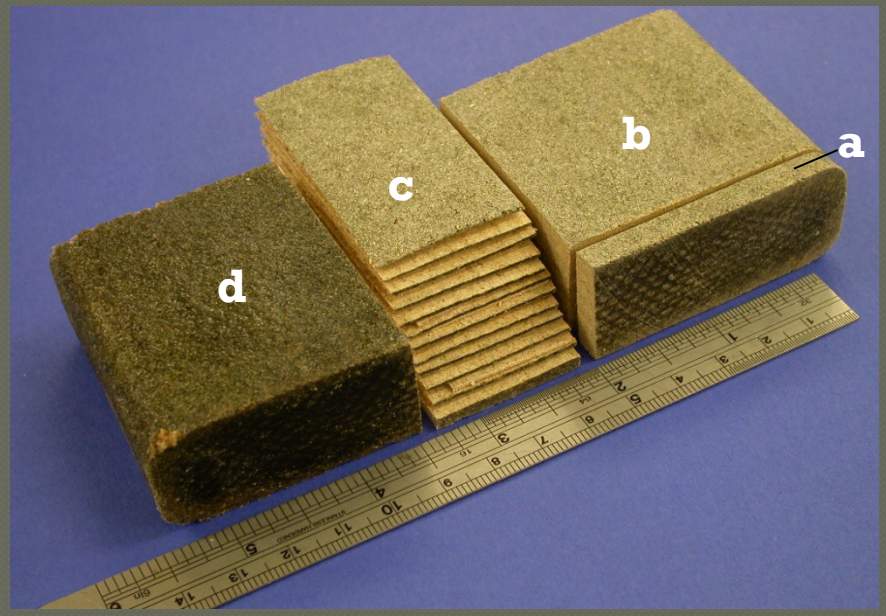


# Sample Evaluation

**Specimen preparation #5 and #6**



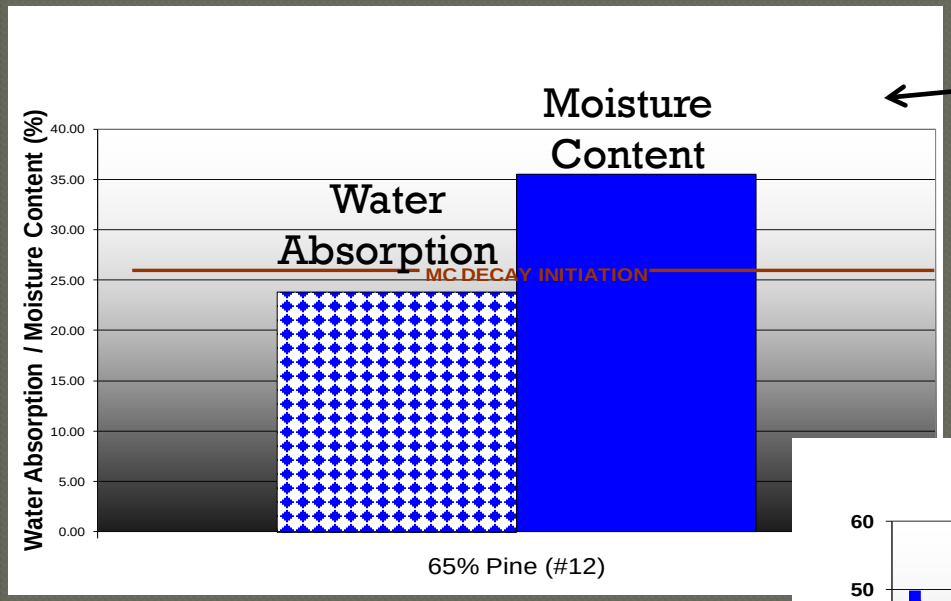

**Specimen preparation #12 and #13**

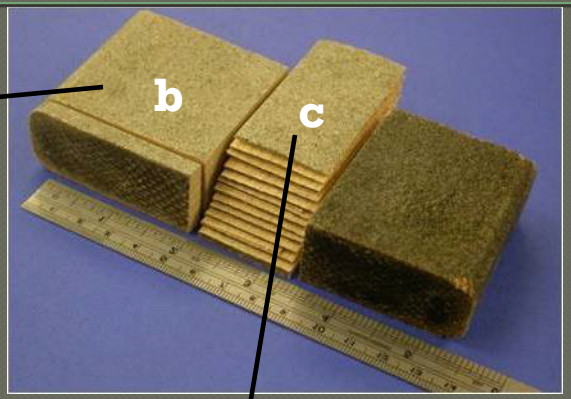


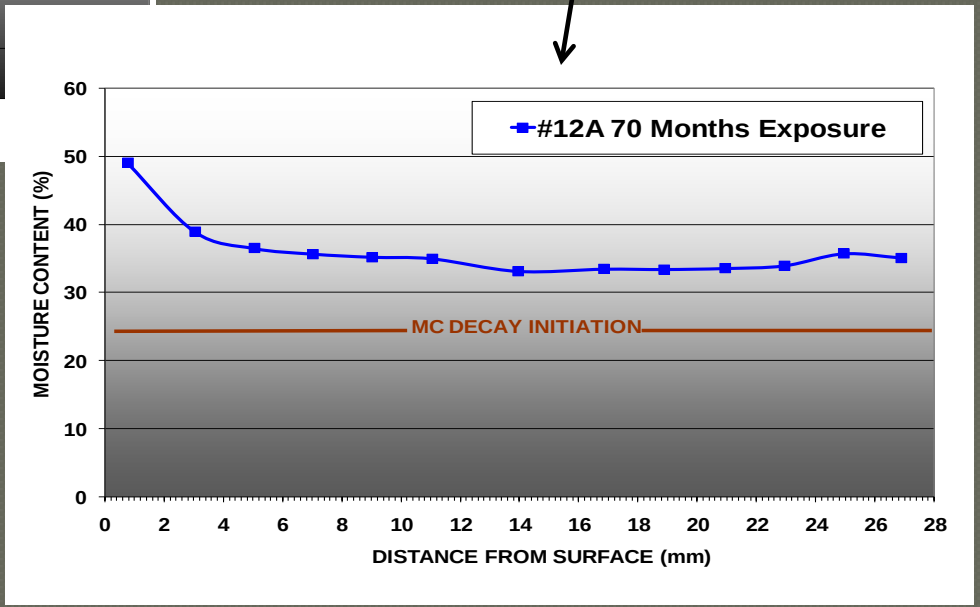

- 8th International Conference on Woodfiber-Plastic Composites, Madison, WI, May 23-25, 2005
- www.polymerengineering.ca

Author: M. Gnatowski "Water Absorption by Wood-Plastic Composites in Exterior Exposure"

# Sample Evaluation



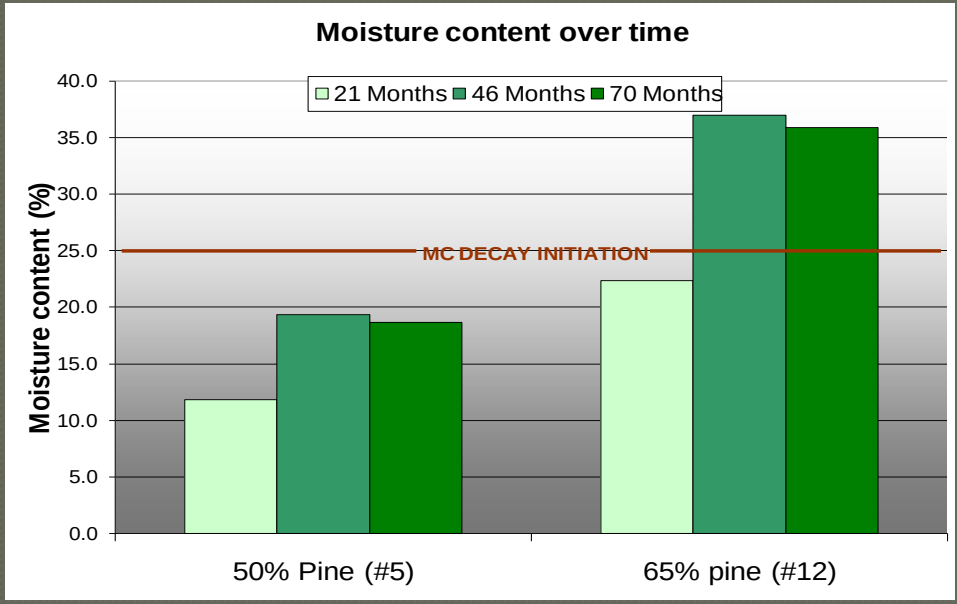



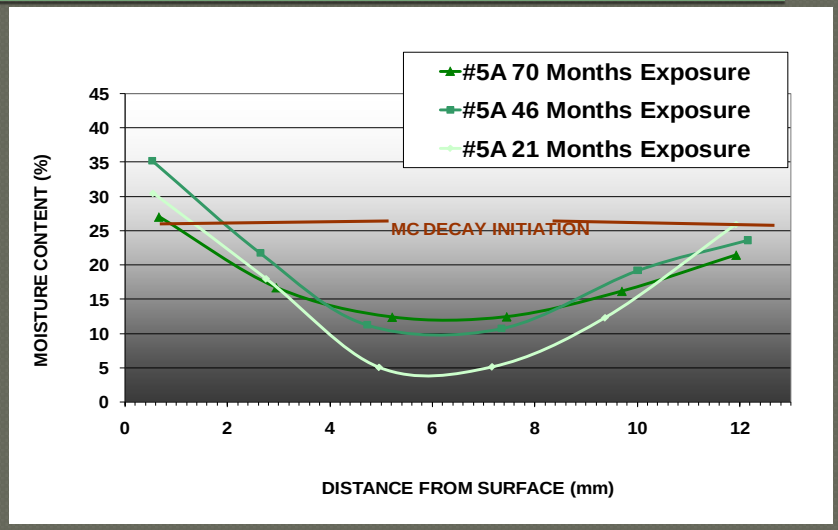
# Factors Affecting Water Absorption

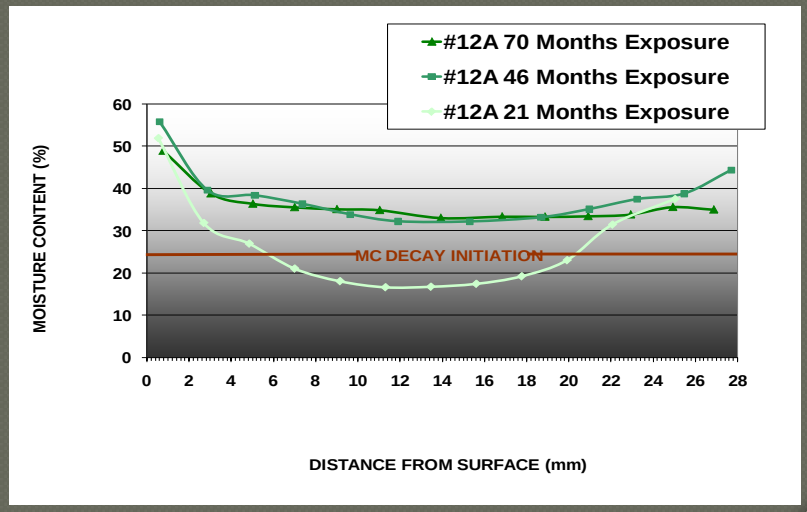
- Period of exposure
- Wood content in WPC
- Exposure location (sun and shadow)
- Exposure geographical location
- Wood species
- Presence of additives
  - UV Stabilizers
  - Biocides (Zinc Borate)

# Period of Exposure

## Sunny Exposure in Vancouver, BC

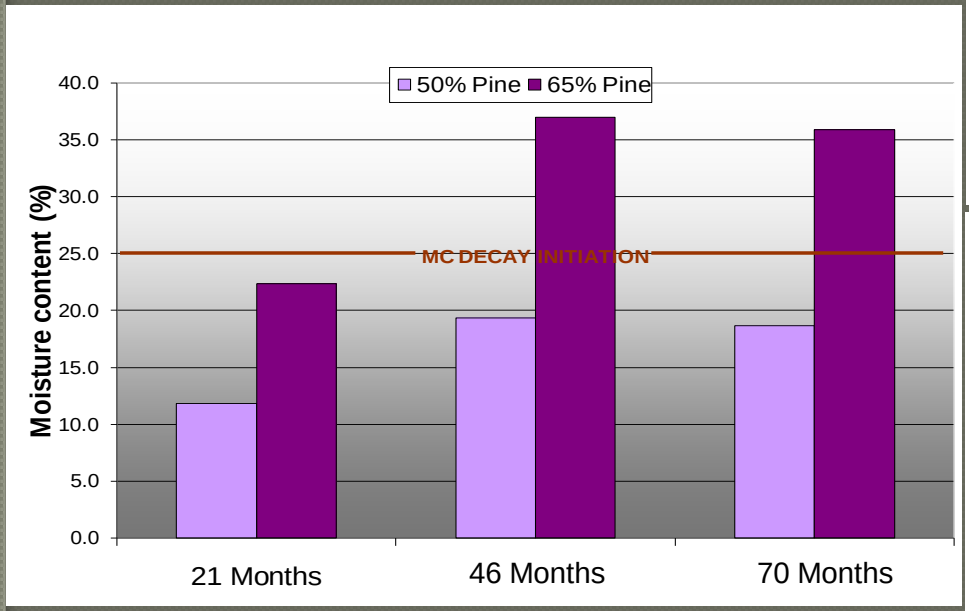


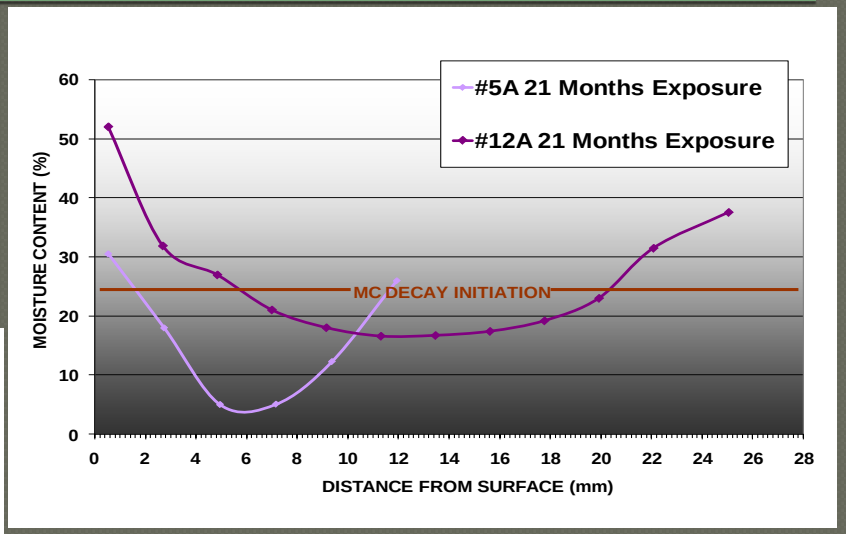



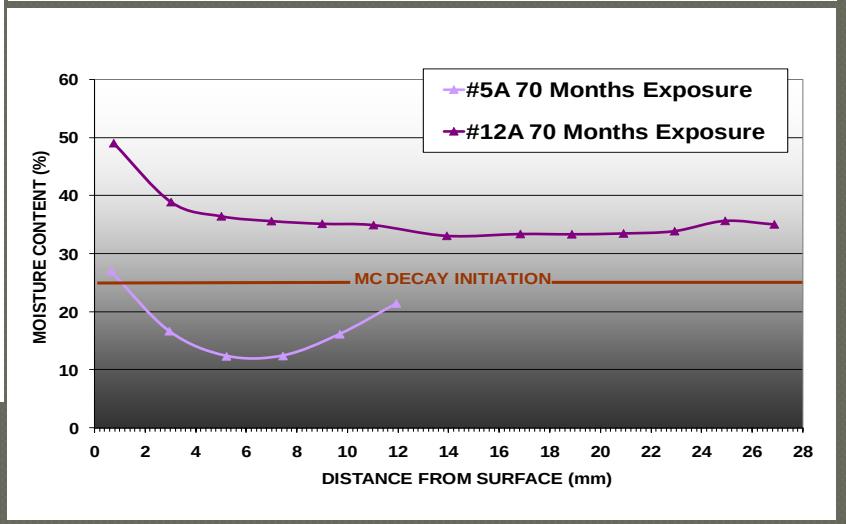



# Wood Content in WPC

## Sunny Exposure in Vancouver, BC

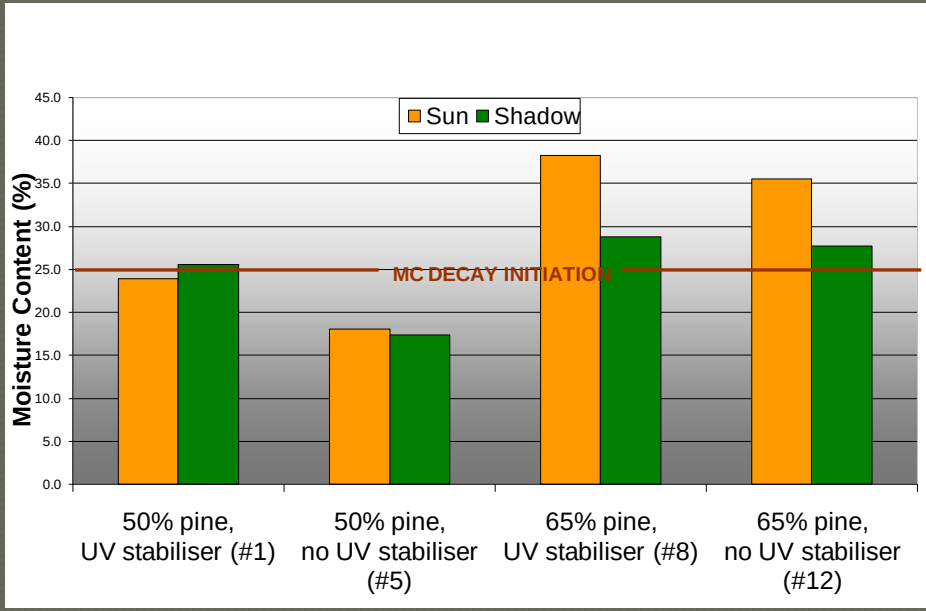


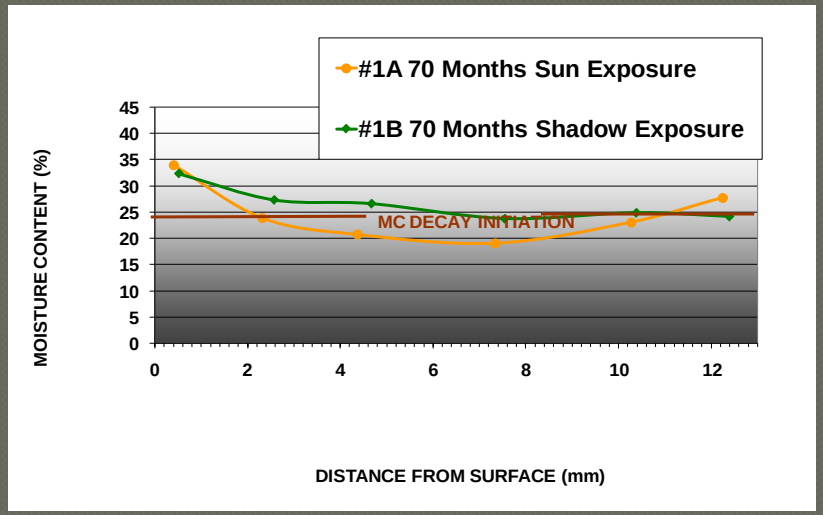



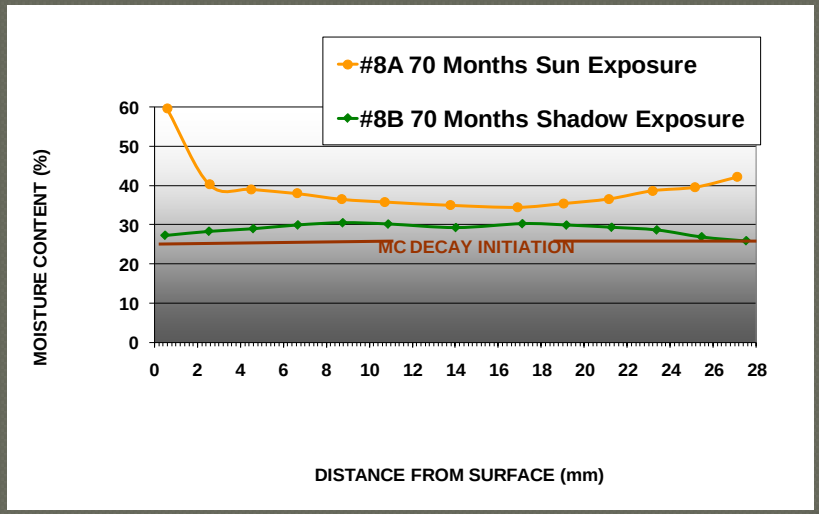



# Exposure Location Sun and Shadow

## Exposure in Vancouver, BC 70 months

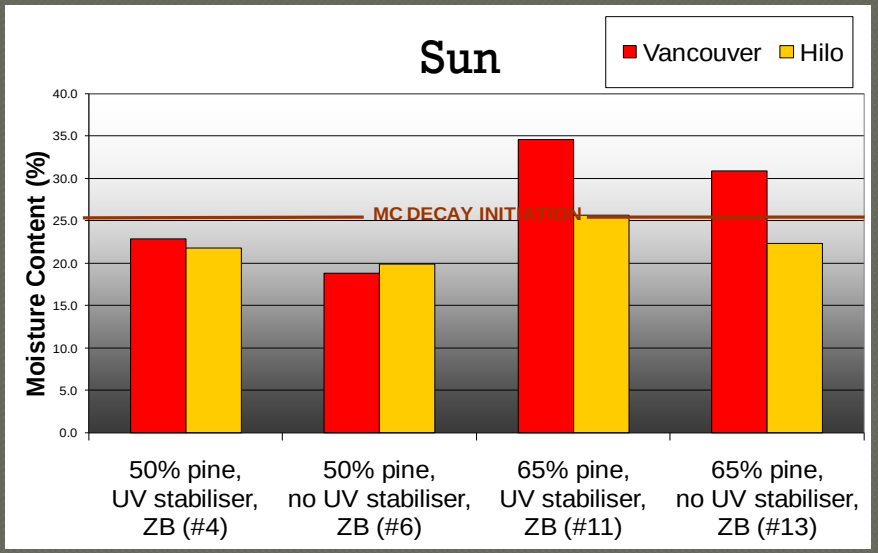


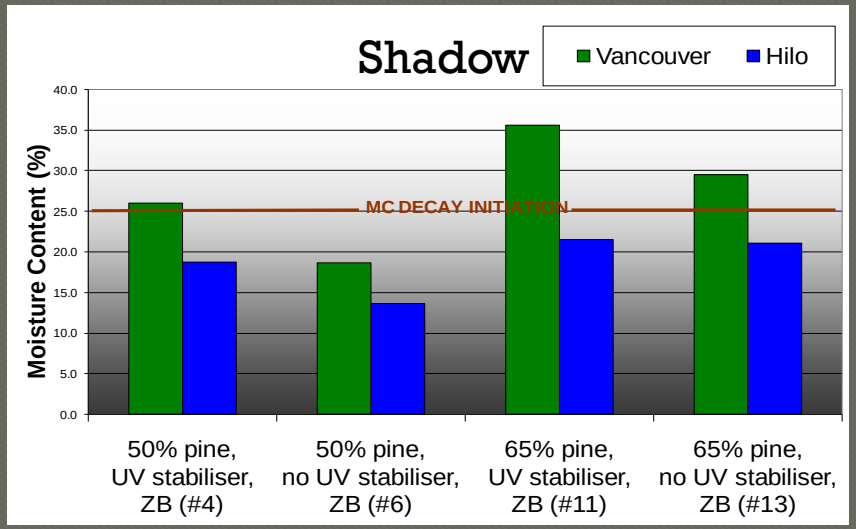



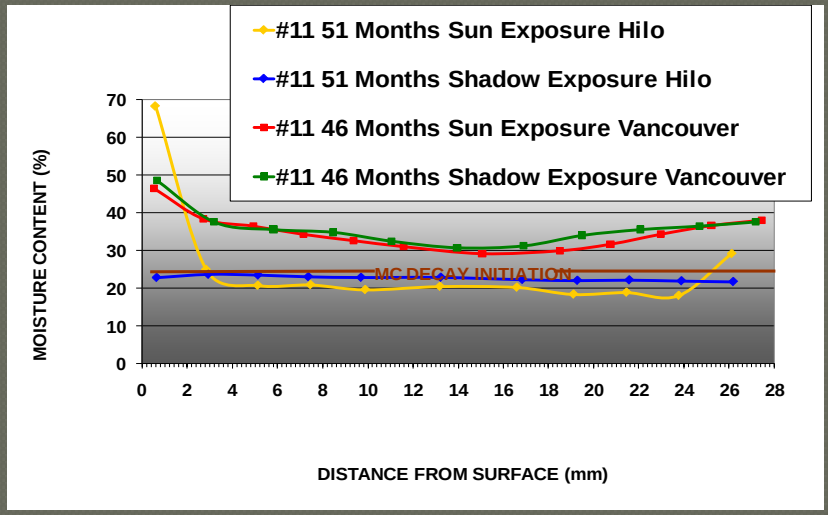



# Exposure Geographical Location

Exposure in Vancouver, BC (46 months)
and Hilo, Hawaii (51 months)

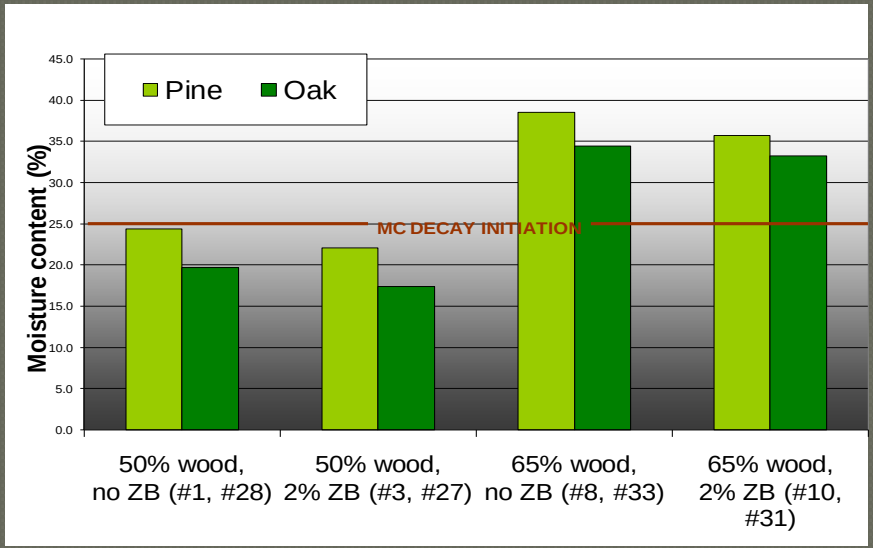


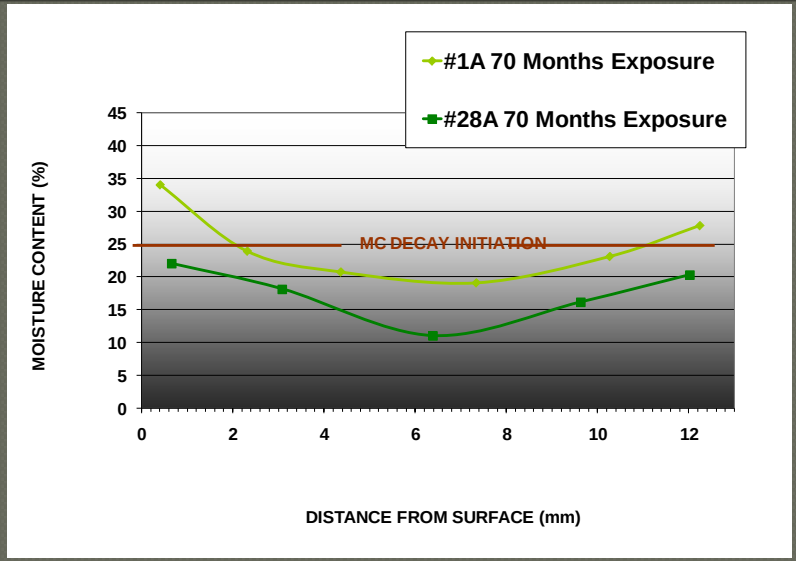



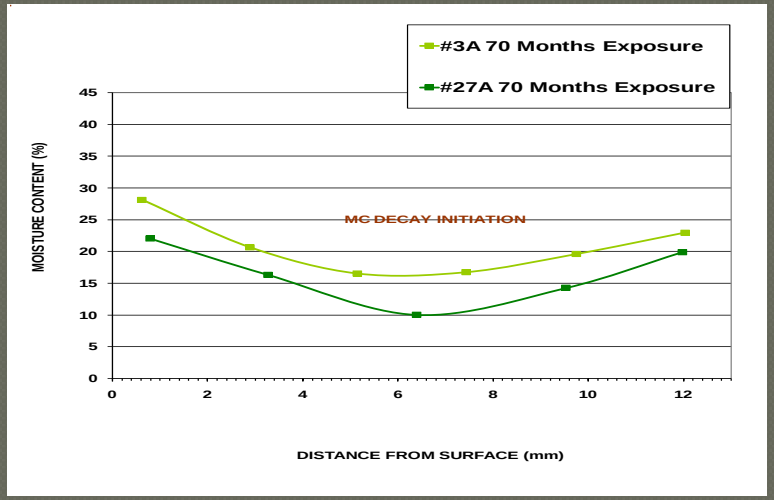



# Wood Species

## Sunny Exposure in Vancouver, BC (70 months)

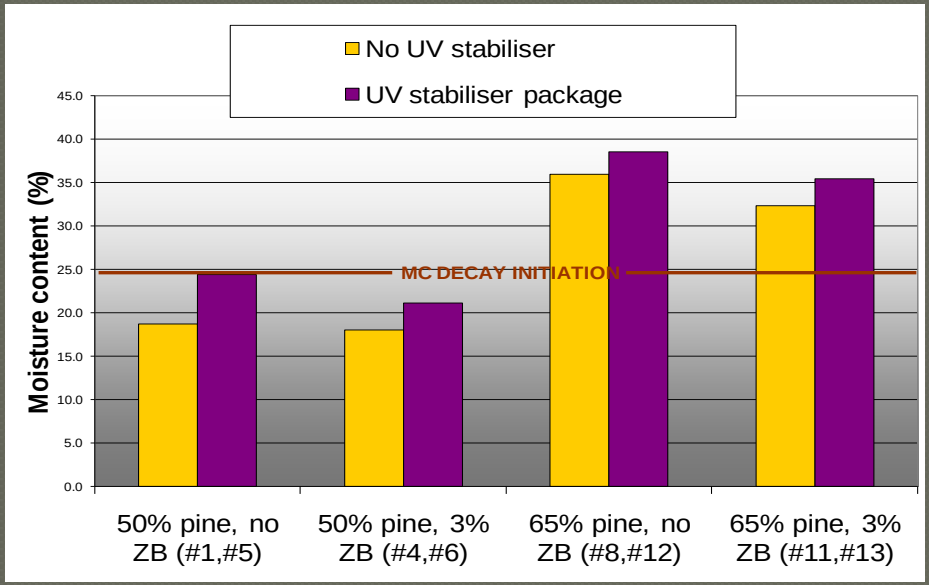


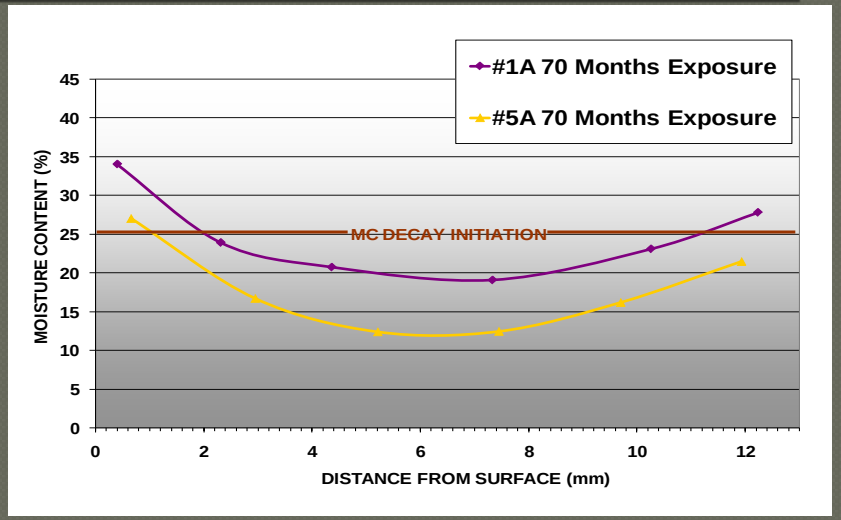



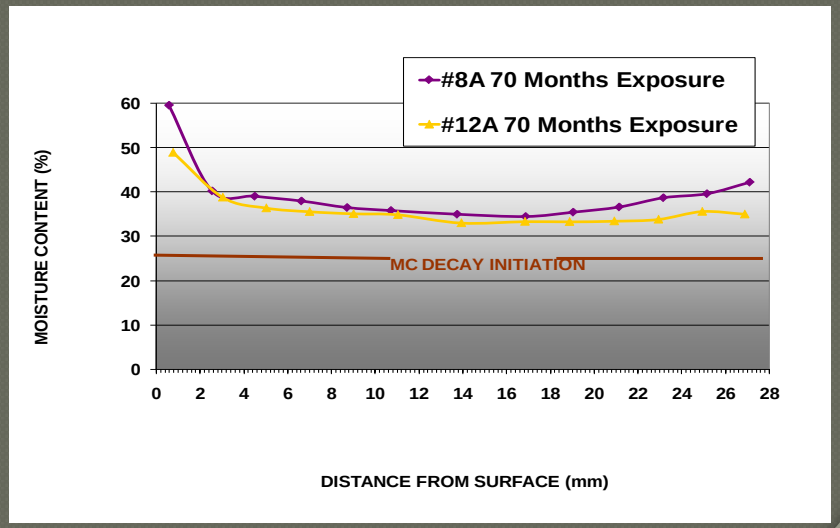



# Presence of Additives UV Stabilizers

Sunny Exposure in Vancouver, BC (70 months)

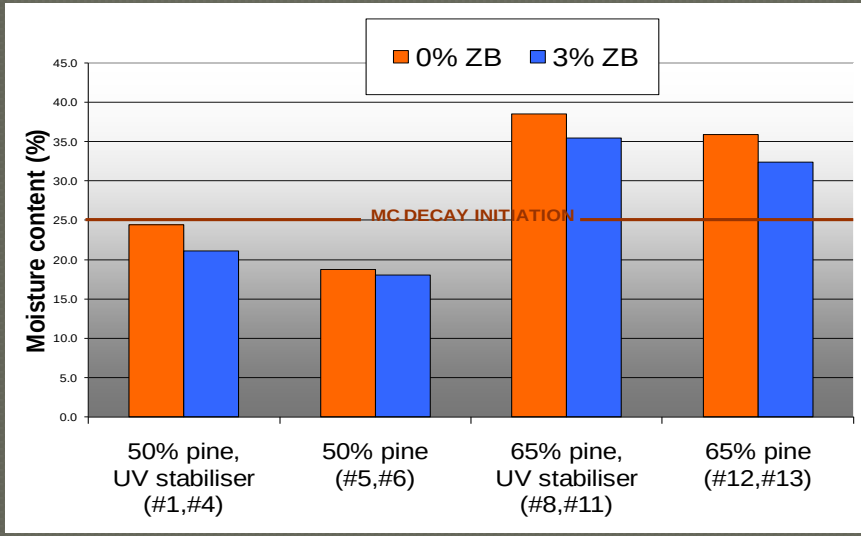


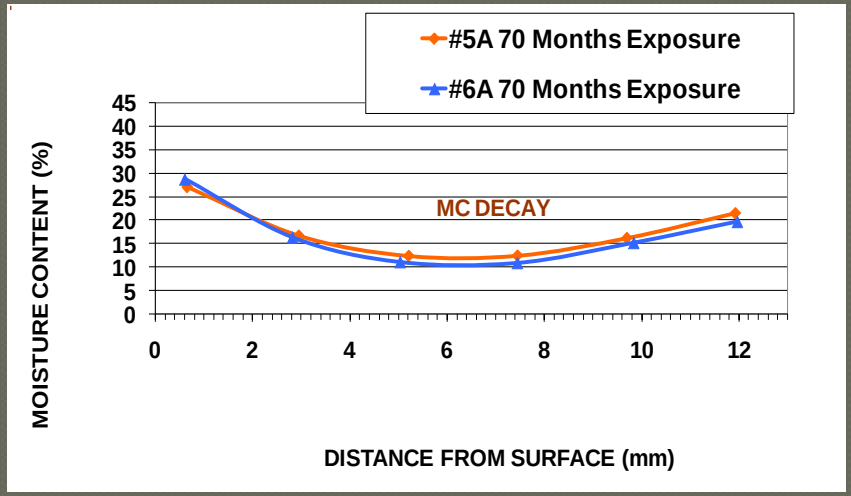



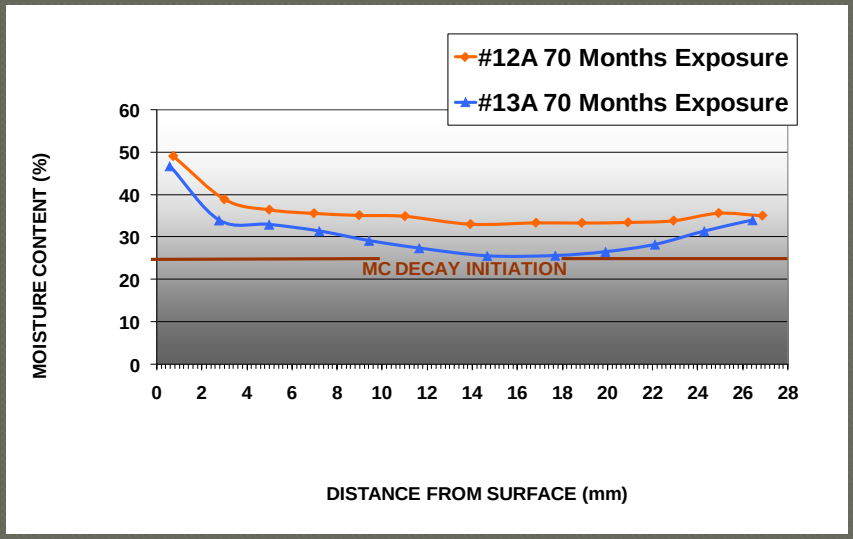



# Presence of Additives Zinc Borate

Sunny Exposure in Vancouver, BC (70 months)

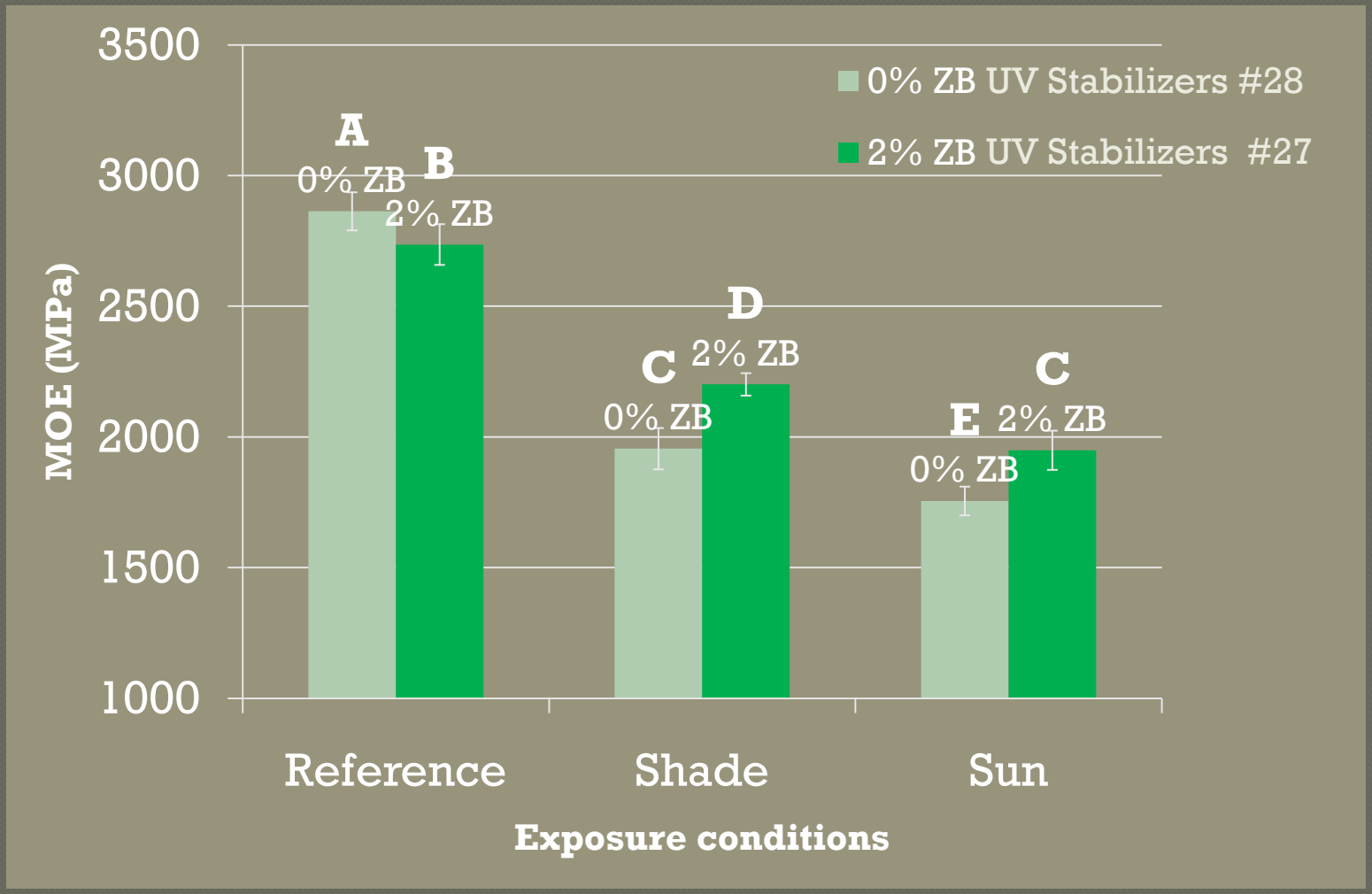


# Water Absorption Mechanical Properties

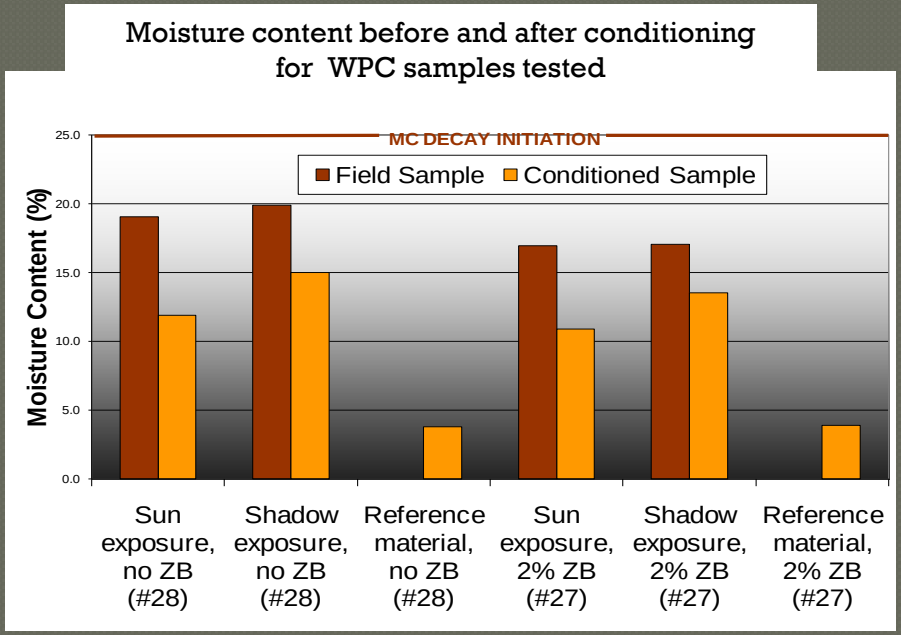
Vancouver exposure 70 months

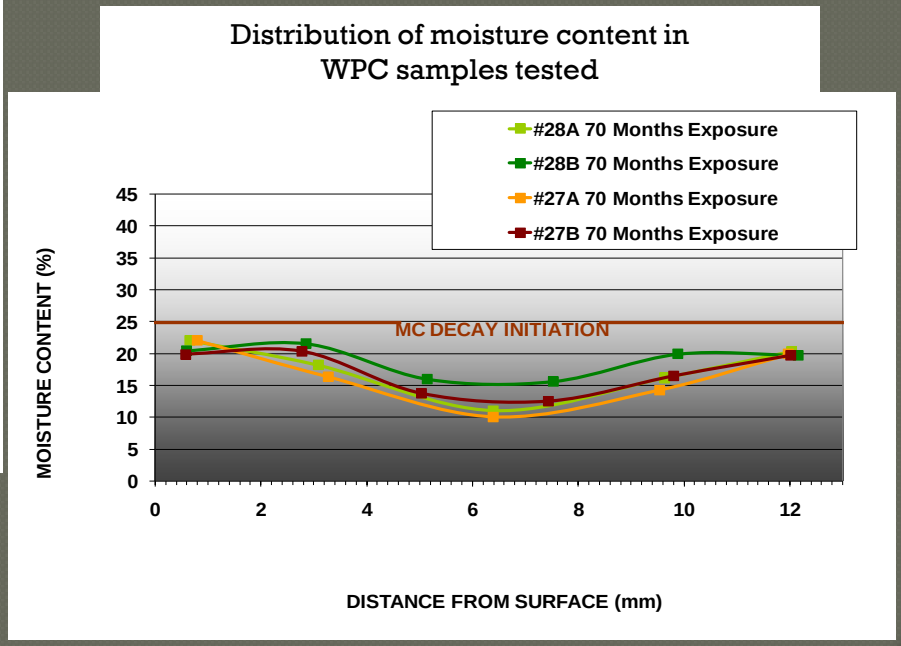


# Water Absorption Mechanical Properties

Sun and Shadow Exposure in Vancouver, BC (70 months)

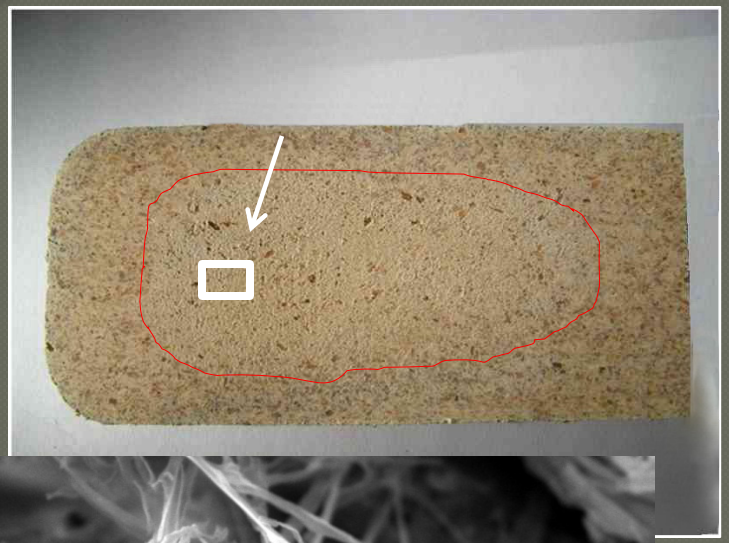
Conditioning:
6 days at 23°C and 50% RH
Final MC change: >0.1% per 24 hrs

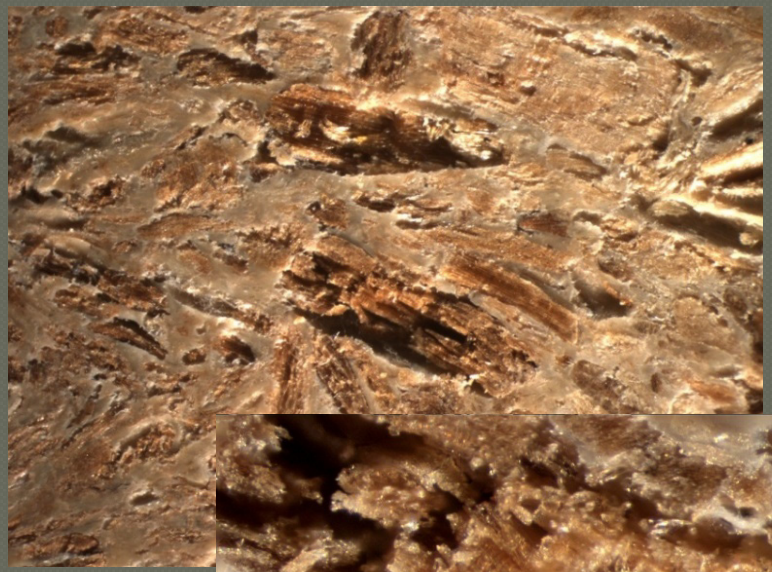


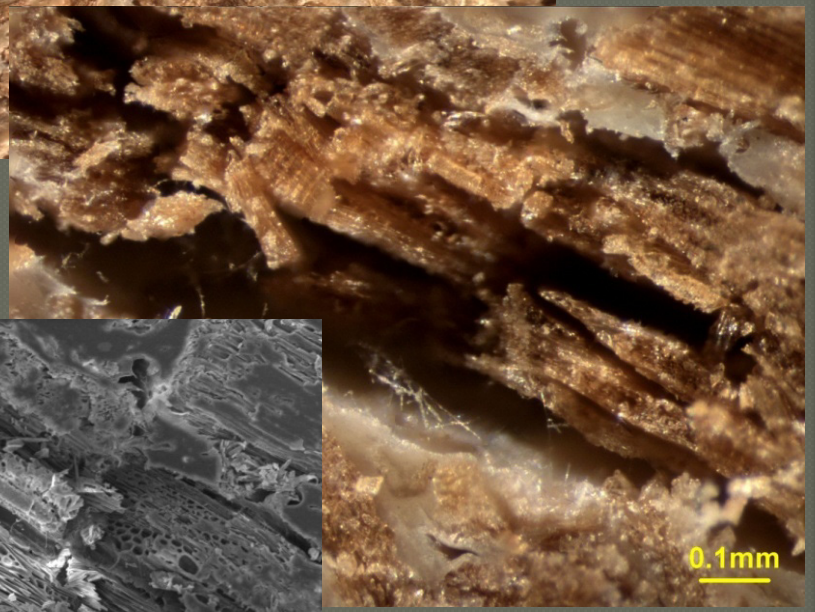



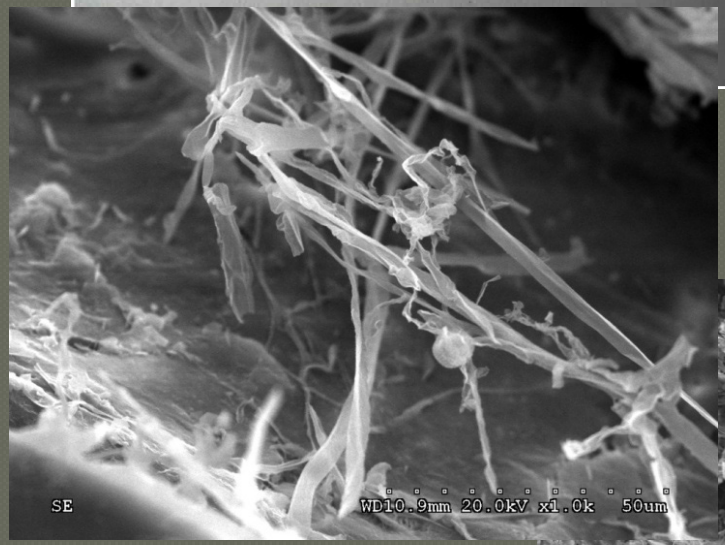
# Water Absorption Biological Activity

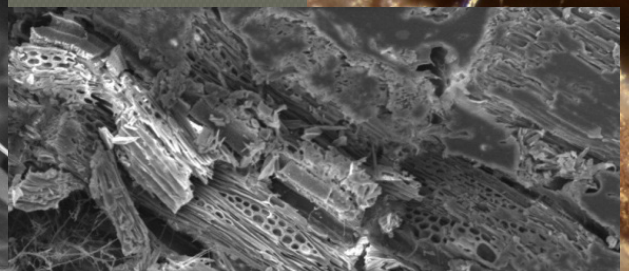
Decay – Hilo, Hawaii 28 months exposure
Sample #8

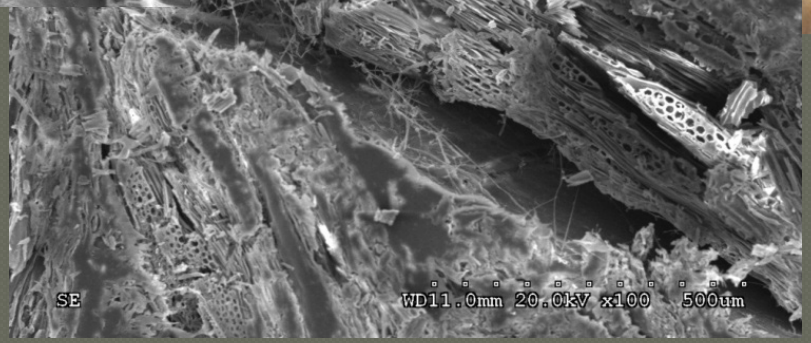





0.1mm


SE
WD10.9mm 20.0kV x1.0k 50um




SE
WD11.0mm 20.0kV x100 500um

# Conclusions

- Wood Plastic Composites (WPC) boards absorb a significant quantity of water during exterior exposure. Moisture content distribution in the board cross-sections have a characteristic U-shape, frequently exceeding the concentration required for decay initiation.

- A major factor in water absorption by WPC was the ratio of wood to plastic binder

- Another factor in water absorption is the material composition of WPC. Certain additives may significantly increase or decrease water absorption (for example zinc borate decreased water absorption in the tested formulations)

- Water absorption is a long process, and even after 6 years exposure in a moderate climate, equilibrium has likely not been reached

- Climate and sample location (sun or shadow) may not be a major factor in water absorption

- It was shown that water absorption in exterior exposure most likely influenced MOE of selected samples (decrease ~30%). It was observed that some experimental samples with a significant amount of water absorption underwent decay in exterior exposure.

# Acknowledgements

Polymer Engineering staff involved in this research:
- Cecilia Stevens, Ph.D.
- Mathew Leung, B.Sc.
- Kate Mao, B.Eng.
- David Lesewick
- Christine Mah, B.Sc.
- Beverly Start

Washington State University
(Wood Materials and Engineering Lab)