Effect of environmental exposure on tensile characteristics of wood-plastic composites filled with low-grade woody biomass

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Wood-Plastic Composites (WPCs)

WPCs industry competes for quality commercial wood flour with CoGen plants.

Can low-grade woody biomass be a viable substitute?

http://www.allproducts.com/machine/intype/Product-200662142947.jpg

http://www.awf.com/industrial_faq.htm

Motivation

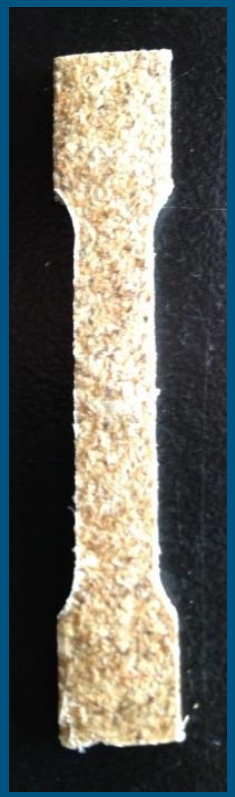
The state of Oregon was interested in replacing some road signs and road markers renewable sourced materials, but were concerned about durability.

Motivation

Estimated **867 Mg/yr** plastic used for in-road pavement markers and tubular markers purchased by private contractors in 8 western states (OR, CA, WA, ID, MT… [name them all]

Can WPC's filled with low-grade woody biomass do the job (getting hit and enduring the weather exposure)?

Encouraging response from a limited screening study (Karas 2011 - a masters thesis)



Objective

Determine the effect of low-grade woody biomass content on key mechanical properties and the resistance to artificial ageing.

Approach

Modified protocol from limited screening study (Karas 2011);

Extended material matrix

Material matrix:

3 types of polymer matrices
- HDPE, PLA, PVC

3 types of wood flour sources
- Commercial (reference), “urban biomass”, logging slash

4 loading levels (% wood flour by weight
- 0 (reference), 20%, 40%, 60%

1 Coupling agent (MAPE)

- 0 (reference), 4% in Neat configurations

Materials

- 60-mesh commercial wood flour was purchased
- Urban wood waste and logging slash were:
  - chipped,
  - hammer milled
  - ground in a Willey disc mill and
  - screened to 60-mesh

Materials

- Wood flours were mixed into plastic matrices and extruded with a Brabender extruder.
- The specimens were cut to size and shaped to “dog bones” with a router and jig.

Methods

- Specimens were subject to two types of aging exposures

  - QUV accelerated aging based on ASTM G154 Cycle 1 (without condensation, 1000 hours)
  - Soak-Freeze-Thaw (SFT) developed by Wang (2007)

Following the exposures microscopic surface effects of the treatments and impact on mechanical properties were examined


Instron ElectroPuls E1000

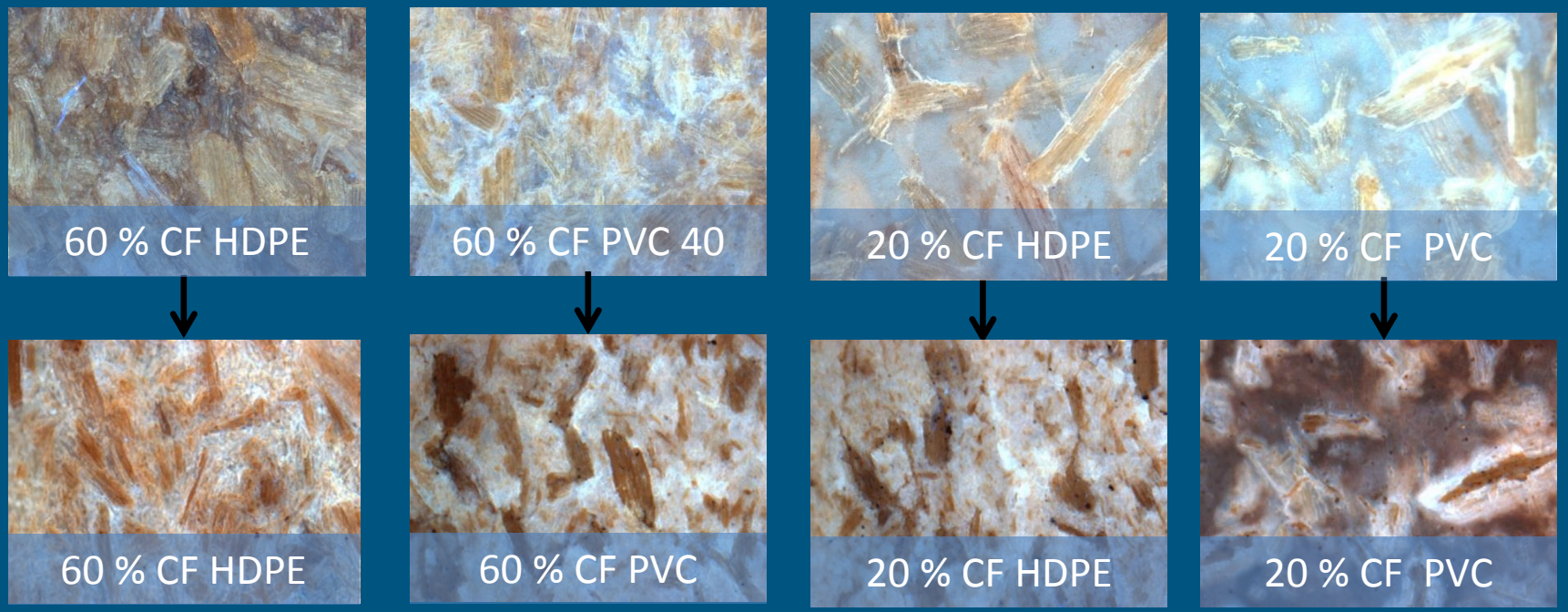
Methods

- Mechanical testing was conducted on an Instron ElectroPuls E1000.
- Tensile strength (UTS), elastic modulus (E) and work to failure (WTF)* were determined frfom the strain-stress curves.

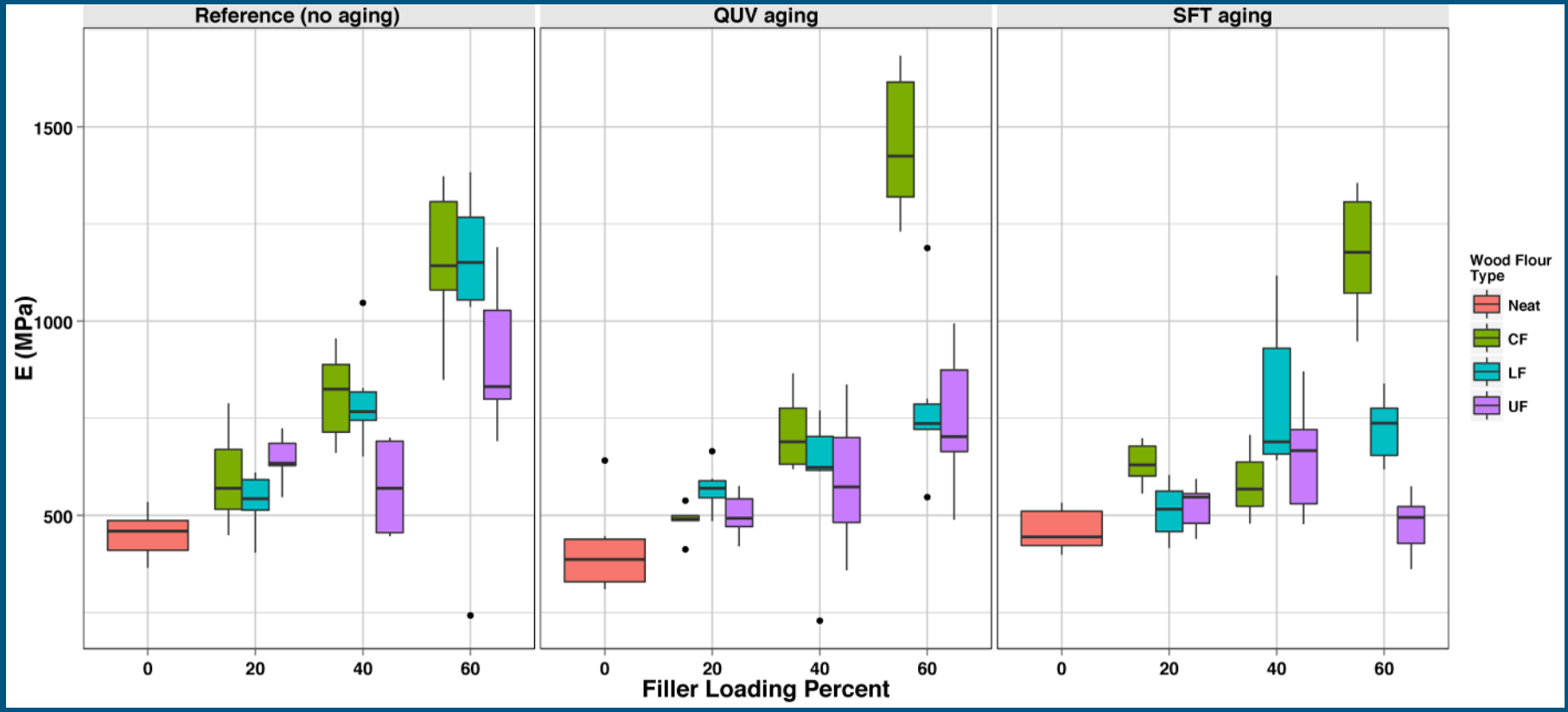
* Karas (2011) concluded that in WPCs work to failure is relatively well correlated with impact properties

PRELIMINARY RESULTS

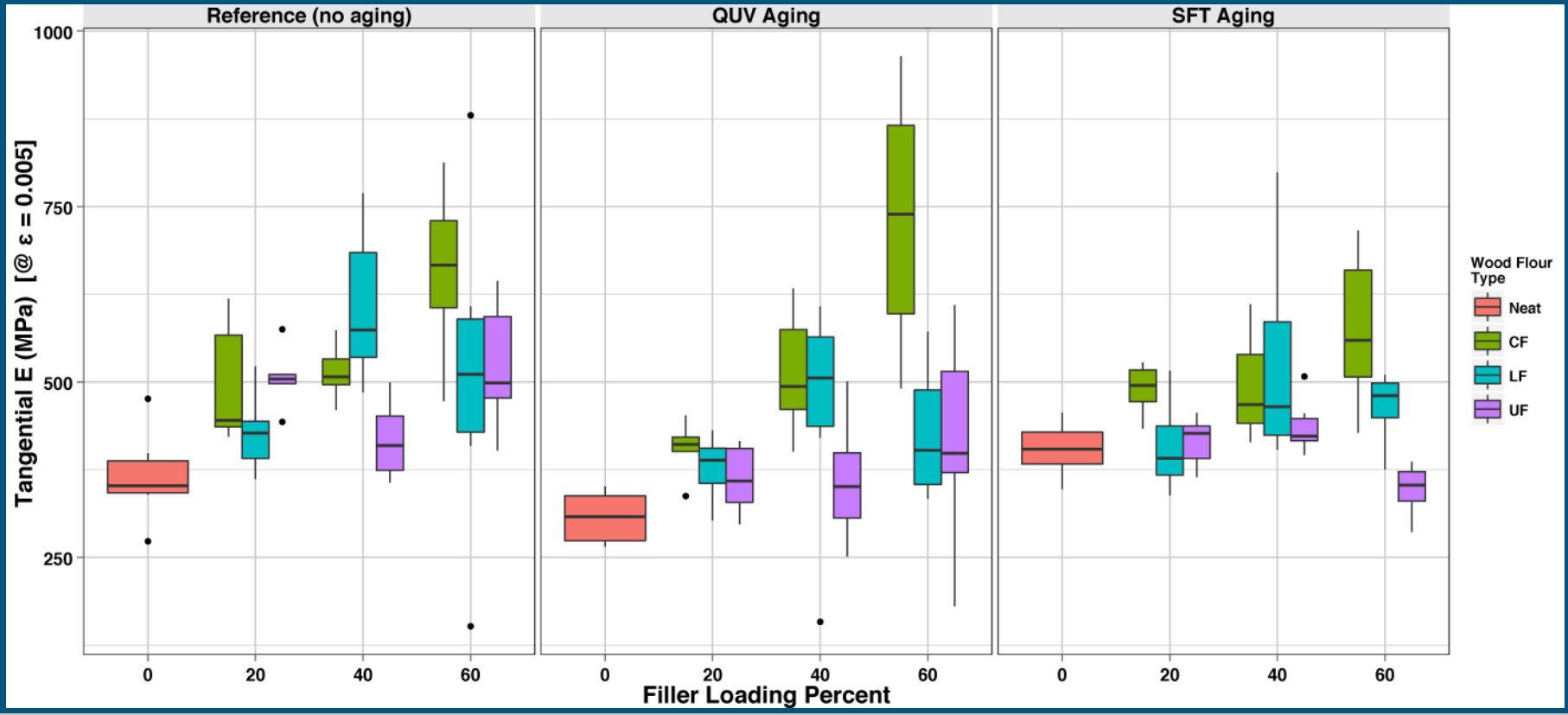
Aging: Before (top) and after (4x mag)



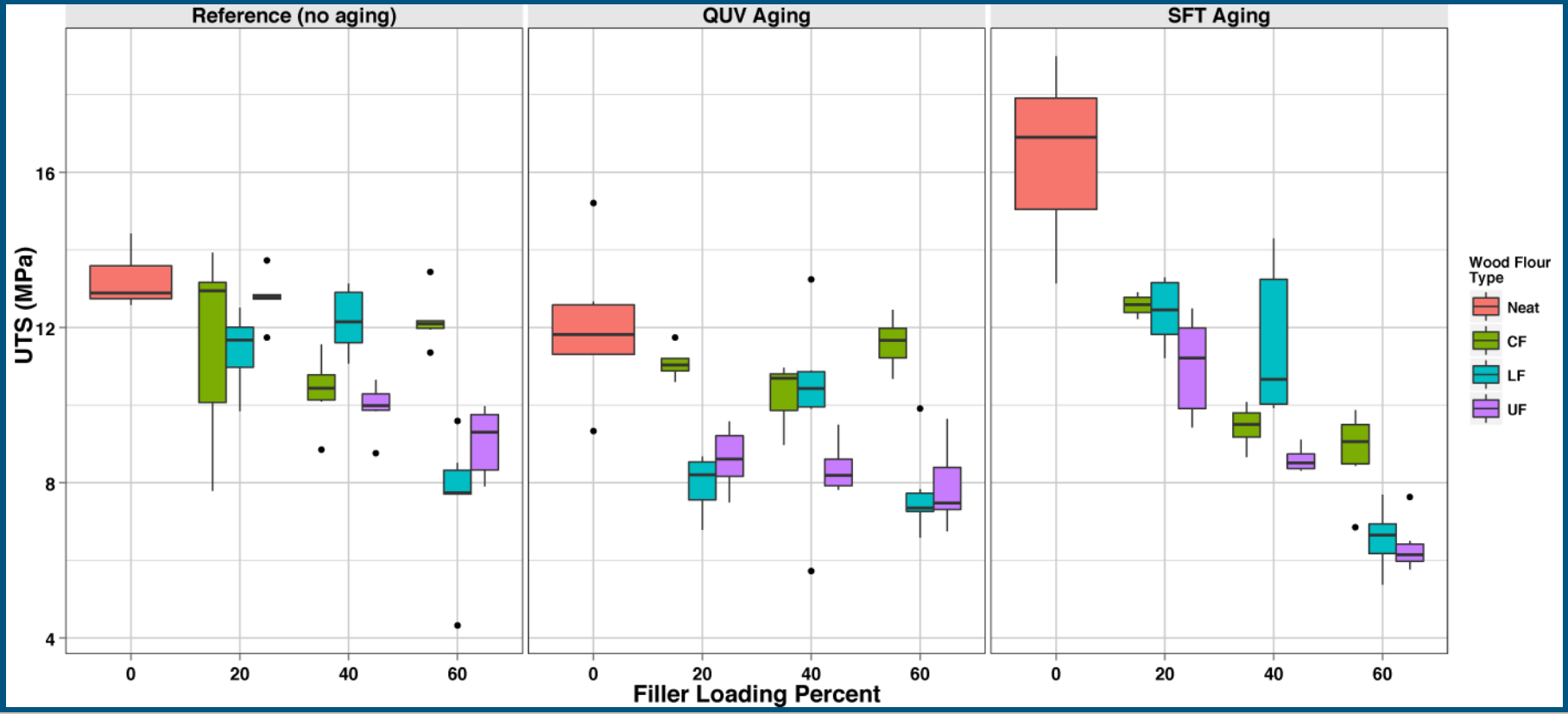
HDPE: Tangential Elastic Modulus (@ σ→0 MPa)



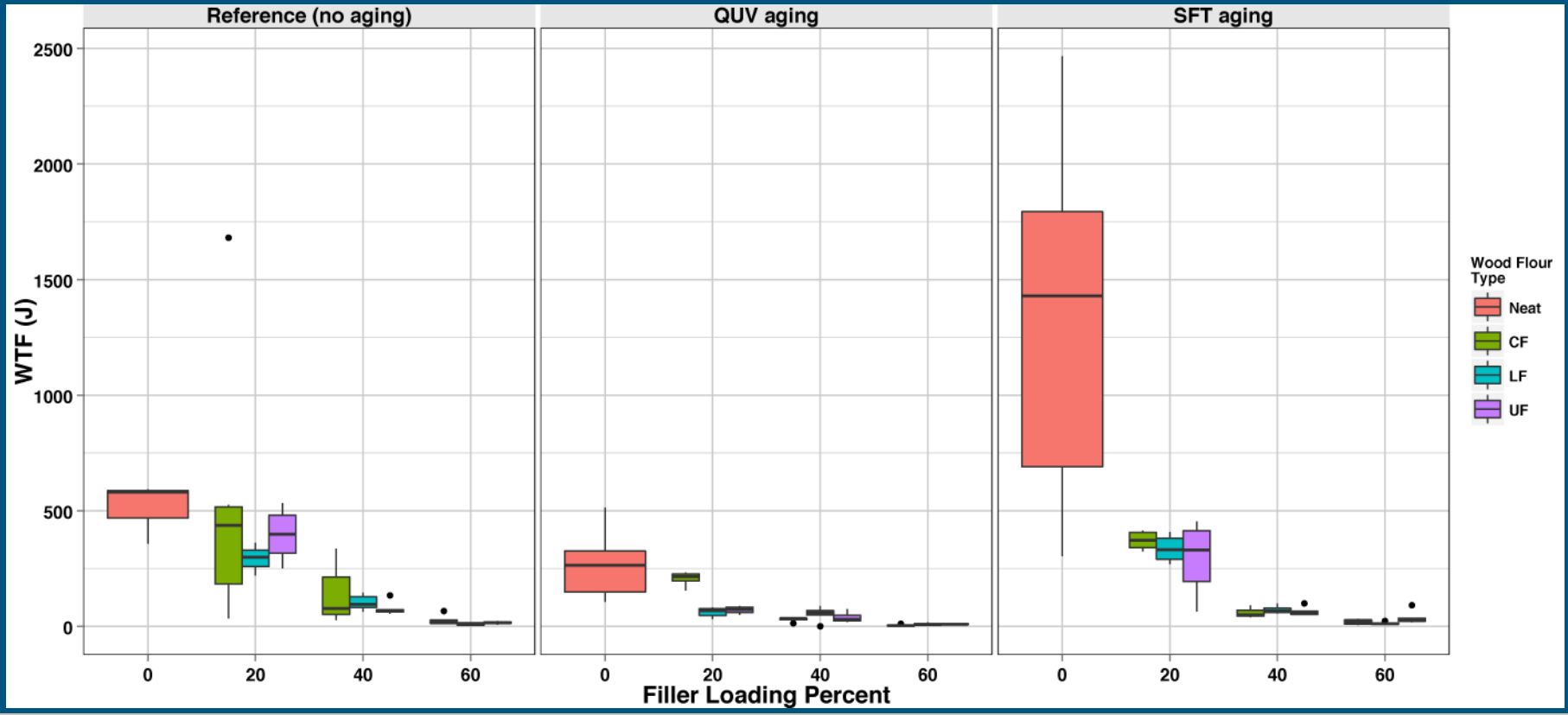
HDPE: Tangential Elastic Modulus (@ ε=0.005)



HDPE: Tensile Strength (UTS)



HDPE: Work to Failure (WTF)



THIS IS…

Preliminary Conclusions

- E increased with wood flour content (agreement with Karas 2011)
- UTS and WFT decreased with wood flour content.
- SFT aging had a greater effect than QUV

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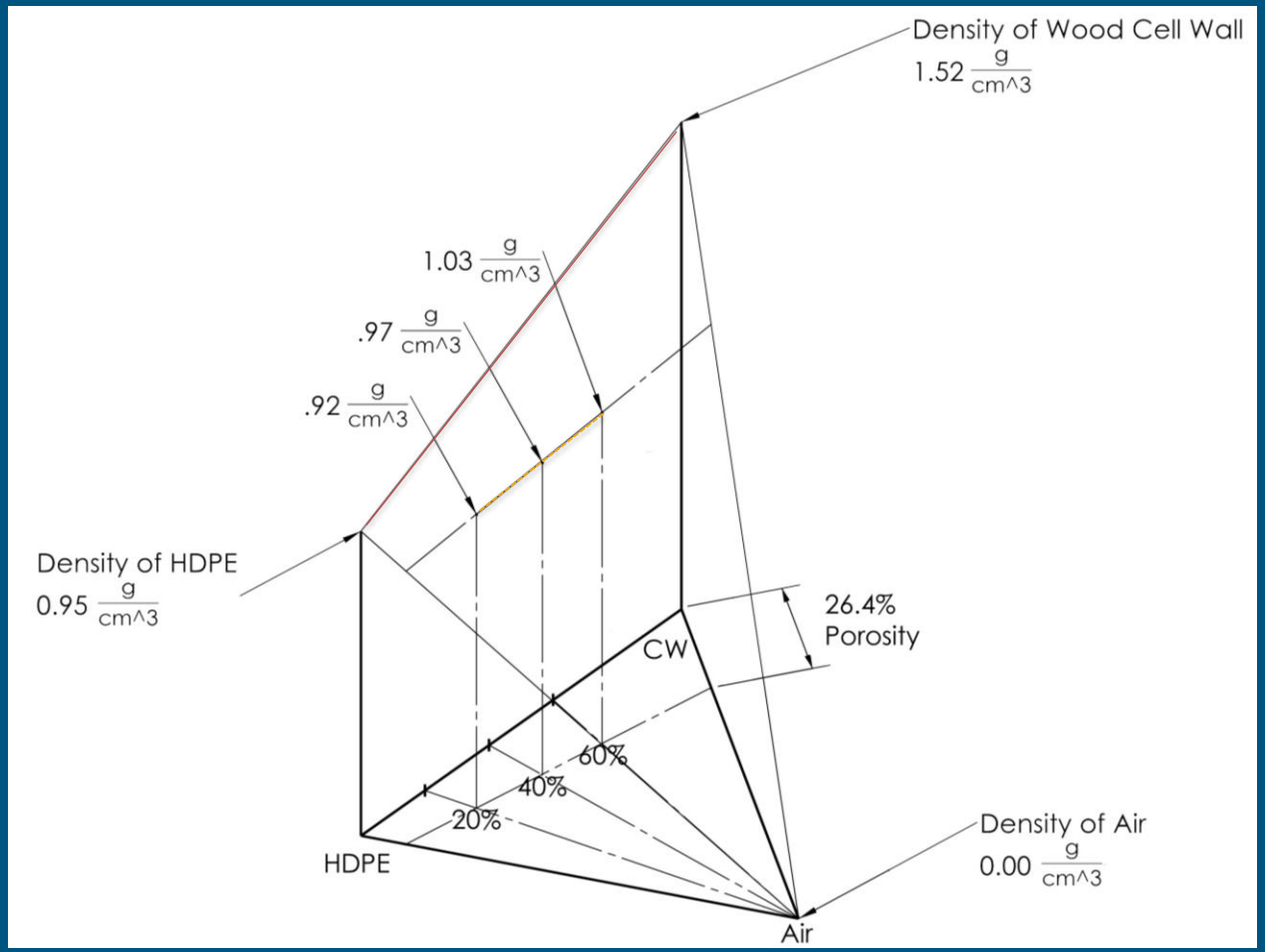
Density profiles



Karas & al. 2010