

Paper Composites Reinforced with GFPP or NFPP Lattices

Christopher Webb, UTK

Christopher Oberste, Ph.D., WEAV3D



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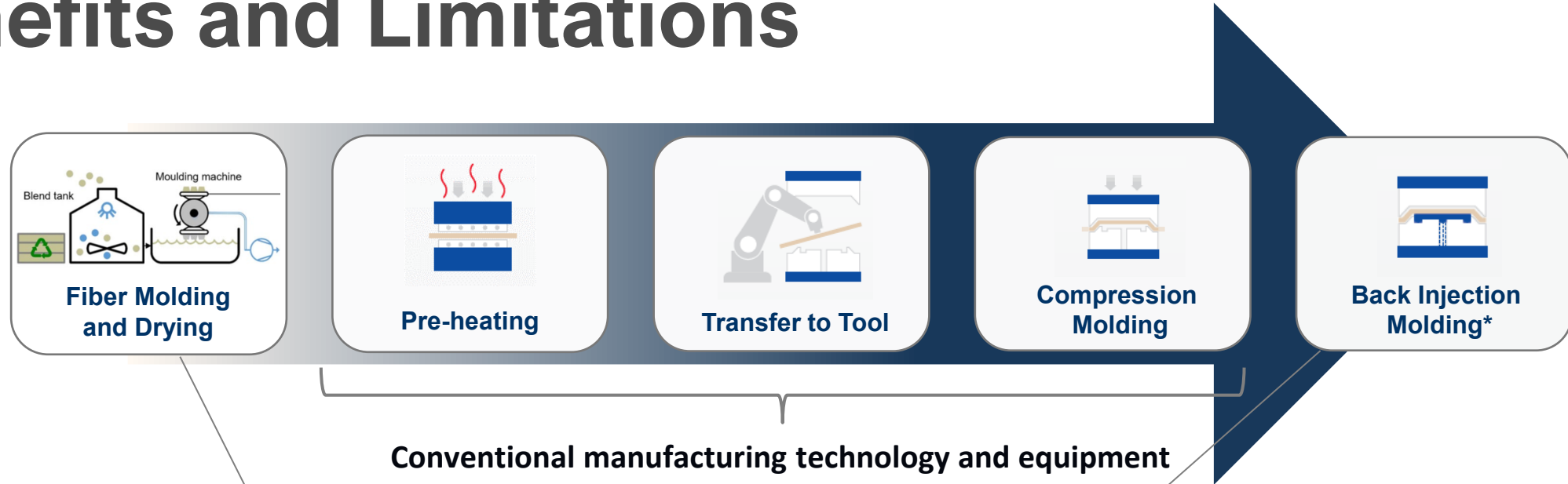
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Outline

- About UTK
- Background on Paper Composites
- Overview of Project Objectives
- Experimental Plan and Results
- Conclusions and Future Work

About UTK/Harper Lab

Paper Composites – Benefits and Limitations

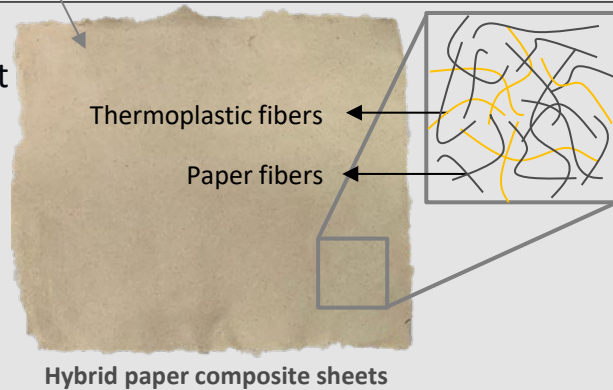


Benefits

- Established molding equipment
- Robust supply chains

Limitations

- Short fiber lengths
- Low melt shear strength
- Low gsm / sheet



Opportunities

- Parts can be back injection molded
- Natural fiber composites are fully recyclable
- Can combine recycled pulp and recycled plastic
- Lattices can improve molding of complex geometries from flat sheets



Paper composites are a cost-efficient alternative to nonwoven NFPP

Why WEA3D Composite Lattice?

TUNEABLE

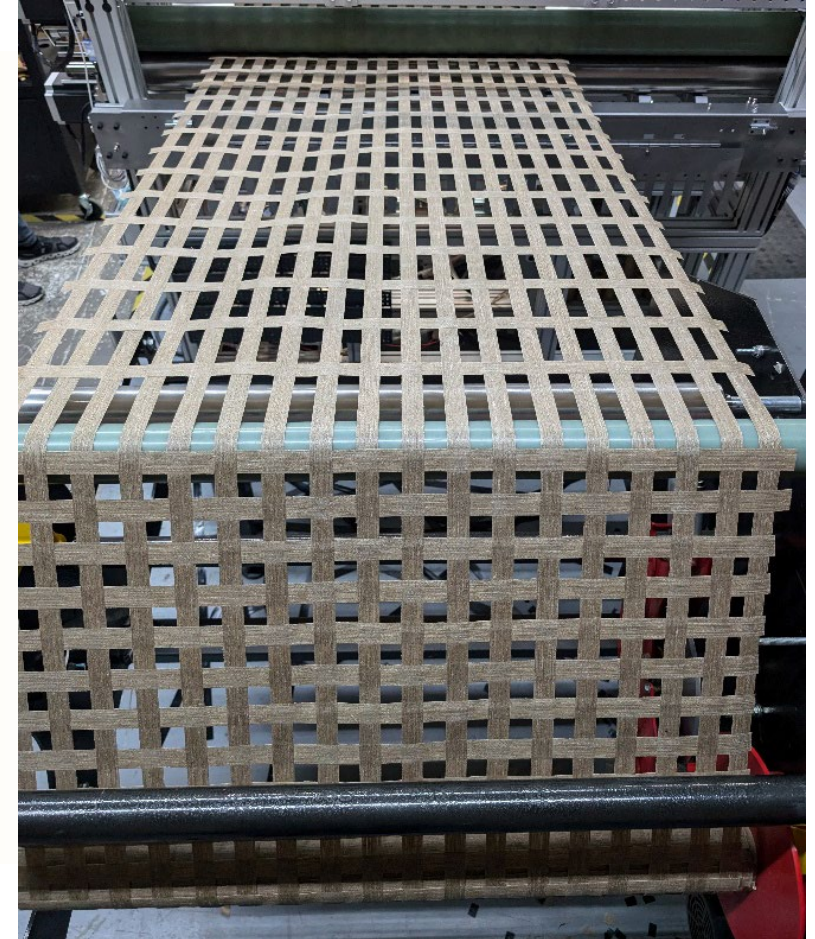
- Locally optimized lattice density
- UD tapes control strain during forming and increase melt strength

COST-EFFECTIVE

- Automated continuous process
- Co-formable with paper composite in single step

COMPATIBLE

- Sheet or roll format
- NFPP tape option available for monomaterial solution



Strategic use of UD tapes in lattice provides a cost-effective solution

Project Objectives

Experimental Goals

1. Characterize effect of lattice on flexural properties vs. baseline
2. Characterize water uptake of lattice reinforced panels vs. baseline

Full Scale Part Forming Goals

1. Eliminate thru-thickness tearing of paper composite in deep draw/complex parts
2. Identify tool and process changes needed to convert from nonwoven NFPP to paper composite

Upcoming
Presentation:



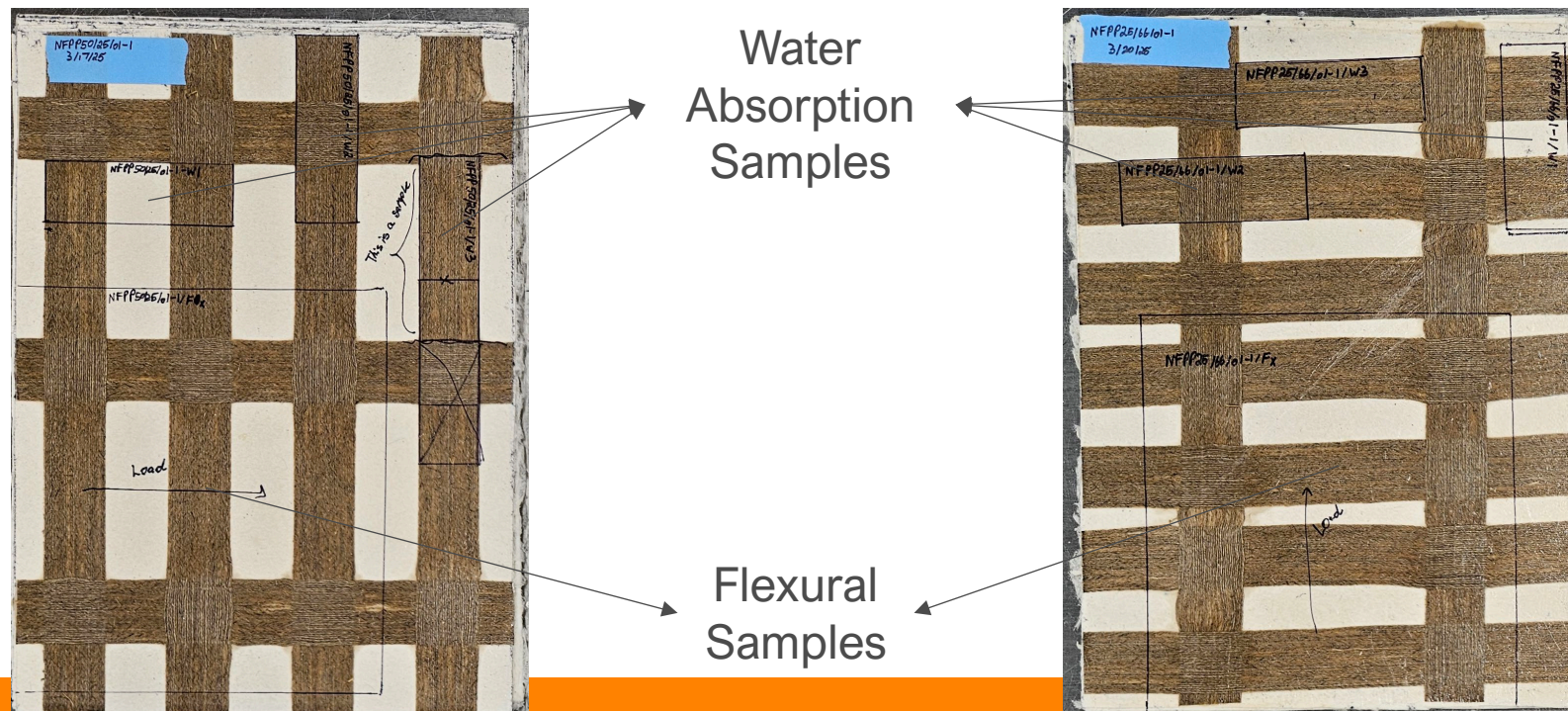
Experimental Approach



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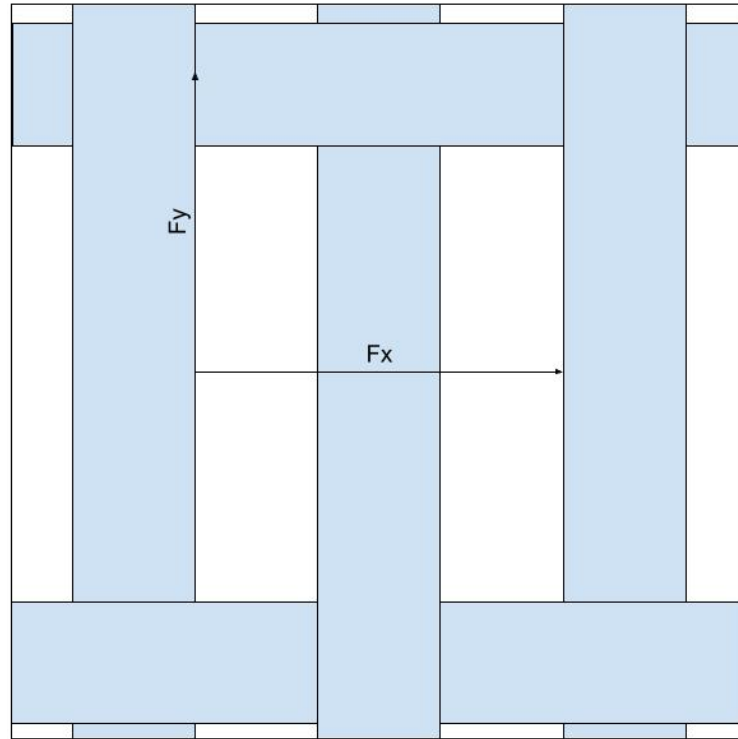
Methods

- Ten 203.2 x 279.4 mm sheets of 60:40 (cellulose:PP) and 1 lattice were compression molded at 190 °C for 5 minutes under 1.38 MPa then cooled under pressure
- 1 flexural sample was cut from each panel with dimensions 152.4 x 165.1 mm
- 3 water absorption samples were cut from each panel with dimensions 25.4 x 76.2 mm



Nomenclature

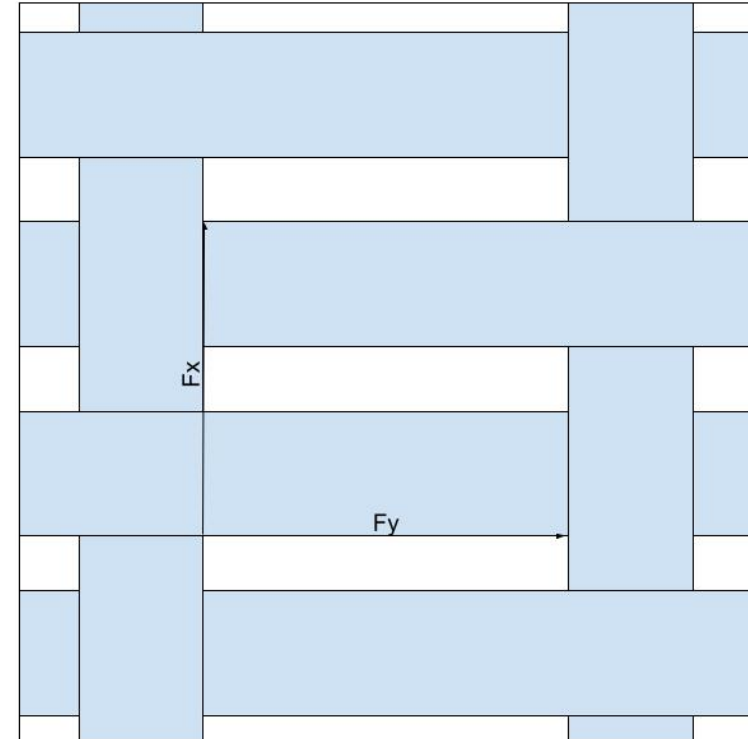
50/25 (Warp/Weft)



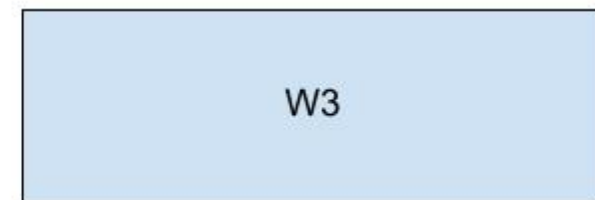
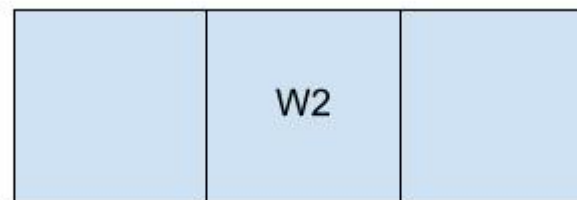
Flexural Samples

- Fx and Fy refers to the direction that the load is applied.
- W1: white area refers to no tape
- W2: center represents area where tapes overlap
- W3: only tape

25/66 (Warp/Weft)



Water Absorption Samples



3-point Flexure



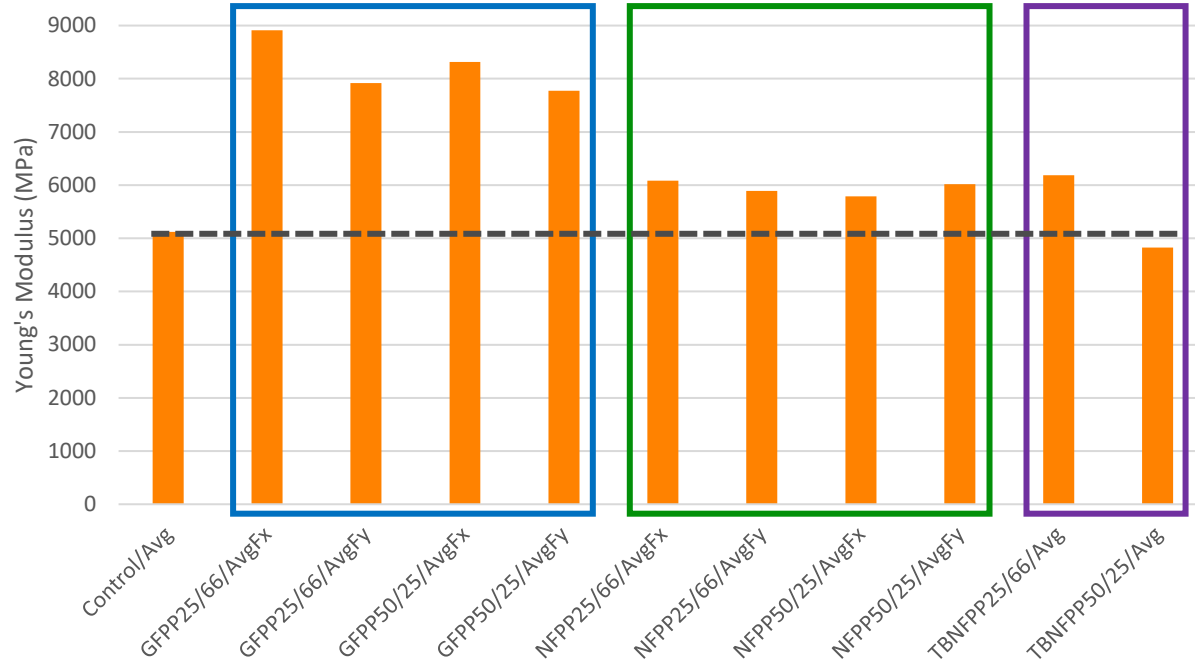
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Flex Modulus

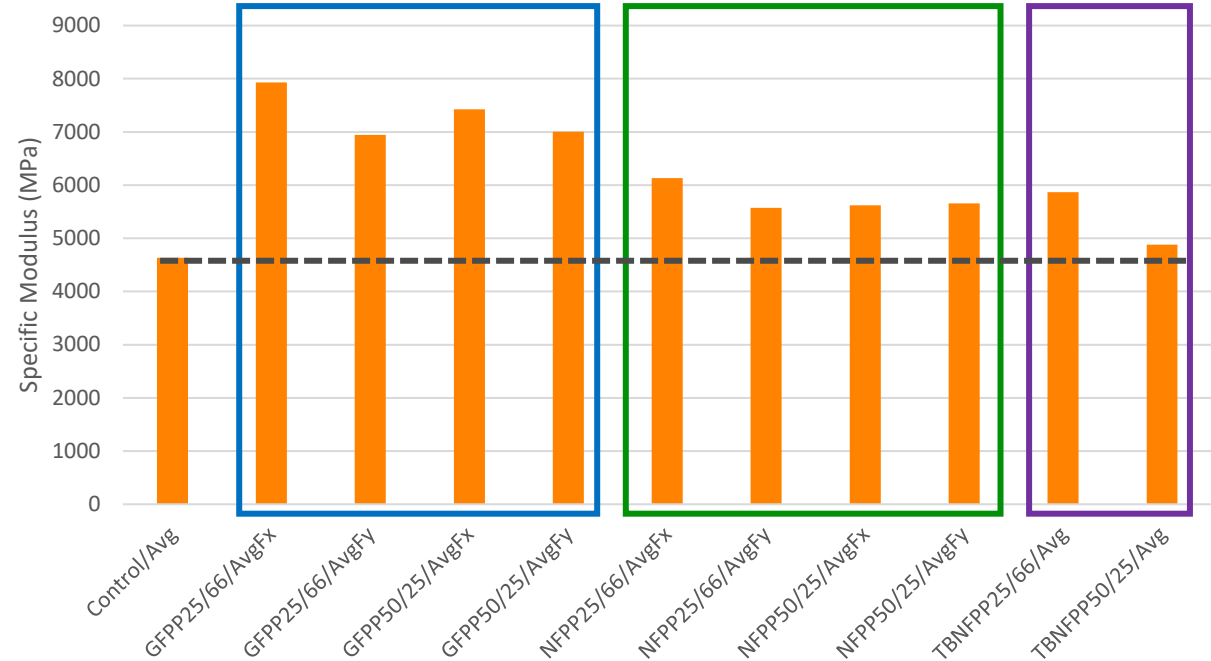
Key

- GF – Glass Fiber (Blue)
- NF – Natural Fiber (Green)
- TB – Top & Bottom Reinforced (Purple)
- 50/25 & 25/66 – Warp/Weft
- Fx & Fy – load direction

Young's Modulus



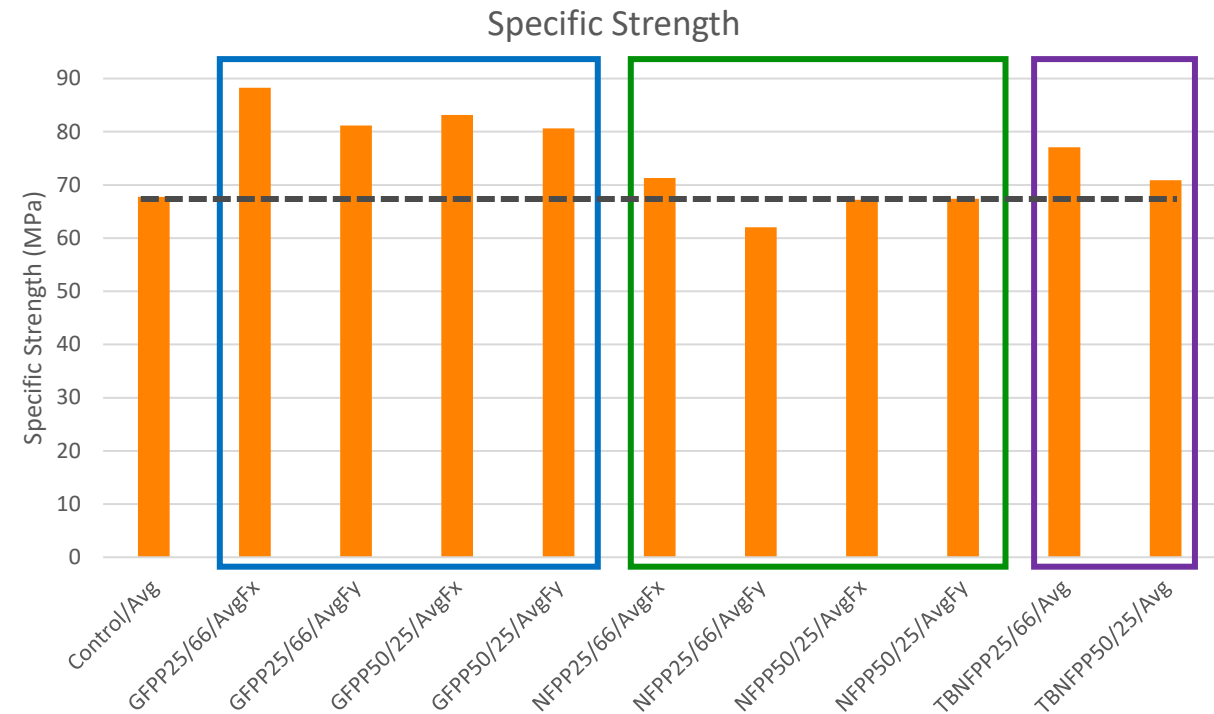
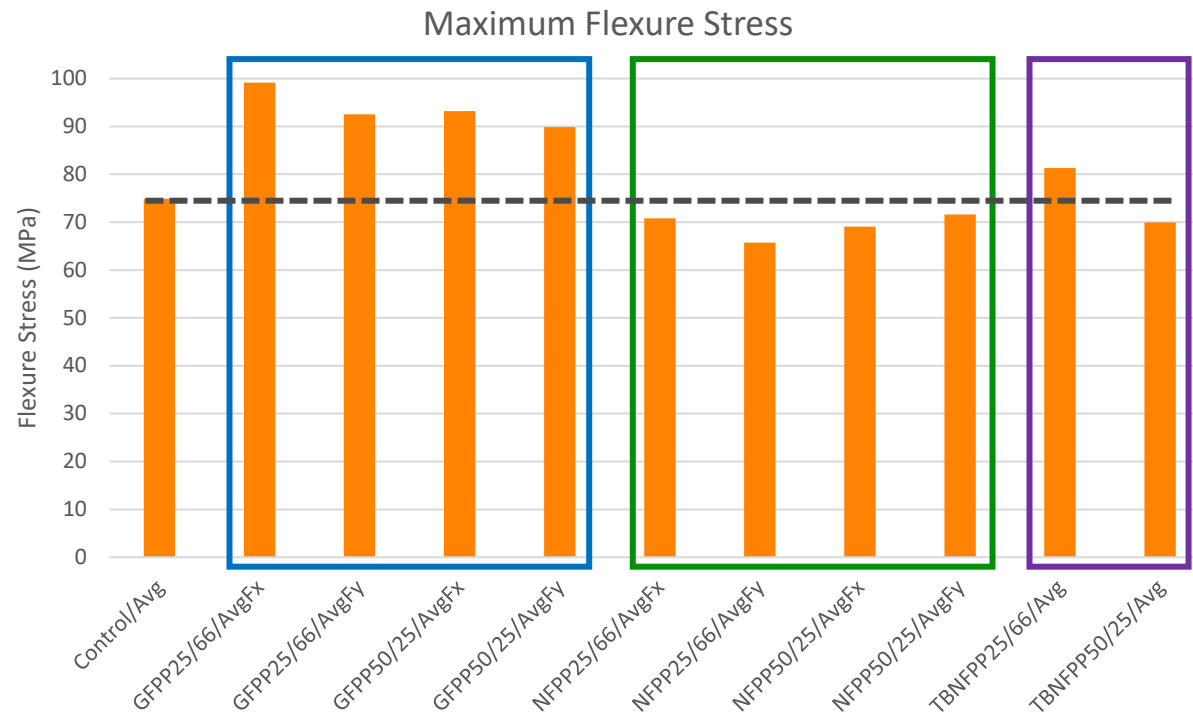
Specific Modulus



Flex Strength

Key

- GF – Glass Fiber (Blue)
- NF – Natural Fiber (Green)
- TB – Top & Bottom Reinforced (Purple)
- 50/25 & 25/66 – Warp/Weft
- Fx & Fy – load direction



Specimens Post-Test

Bottom Side

Top Side

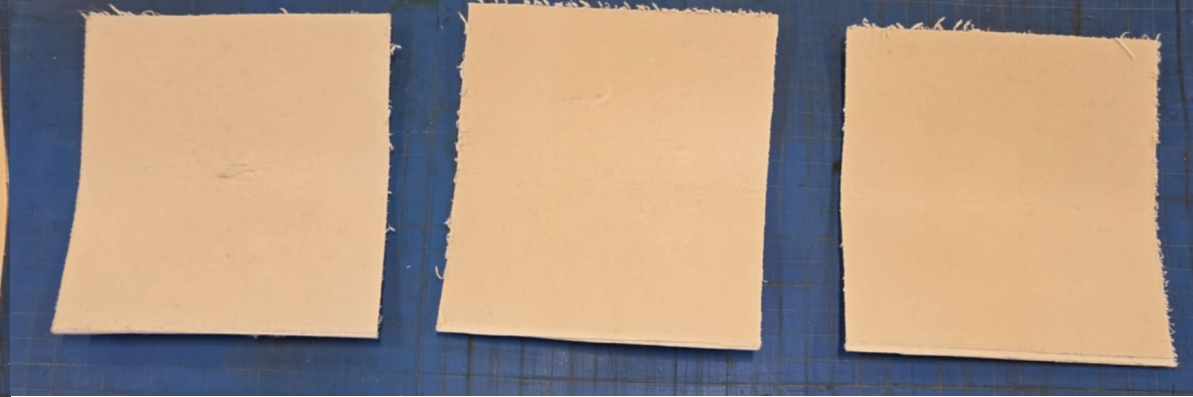
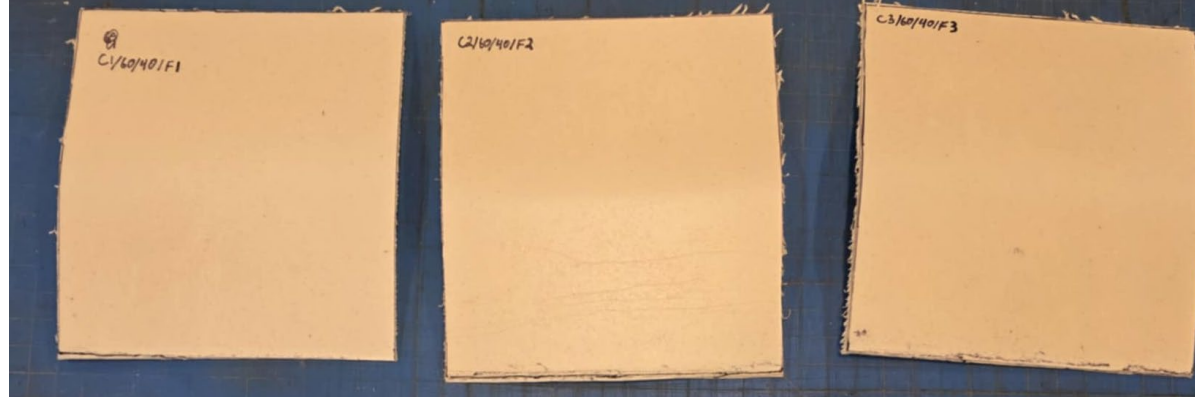
NFPP



GFPP



Control



NFPP Fiber Breakage and Buckling



NFPP5025/01-VFS

Load

Buckling Region

The load arrow does not appear to match the damage pattern

GFPP Fiber Breakage and Buckling



Buckling Region

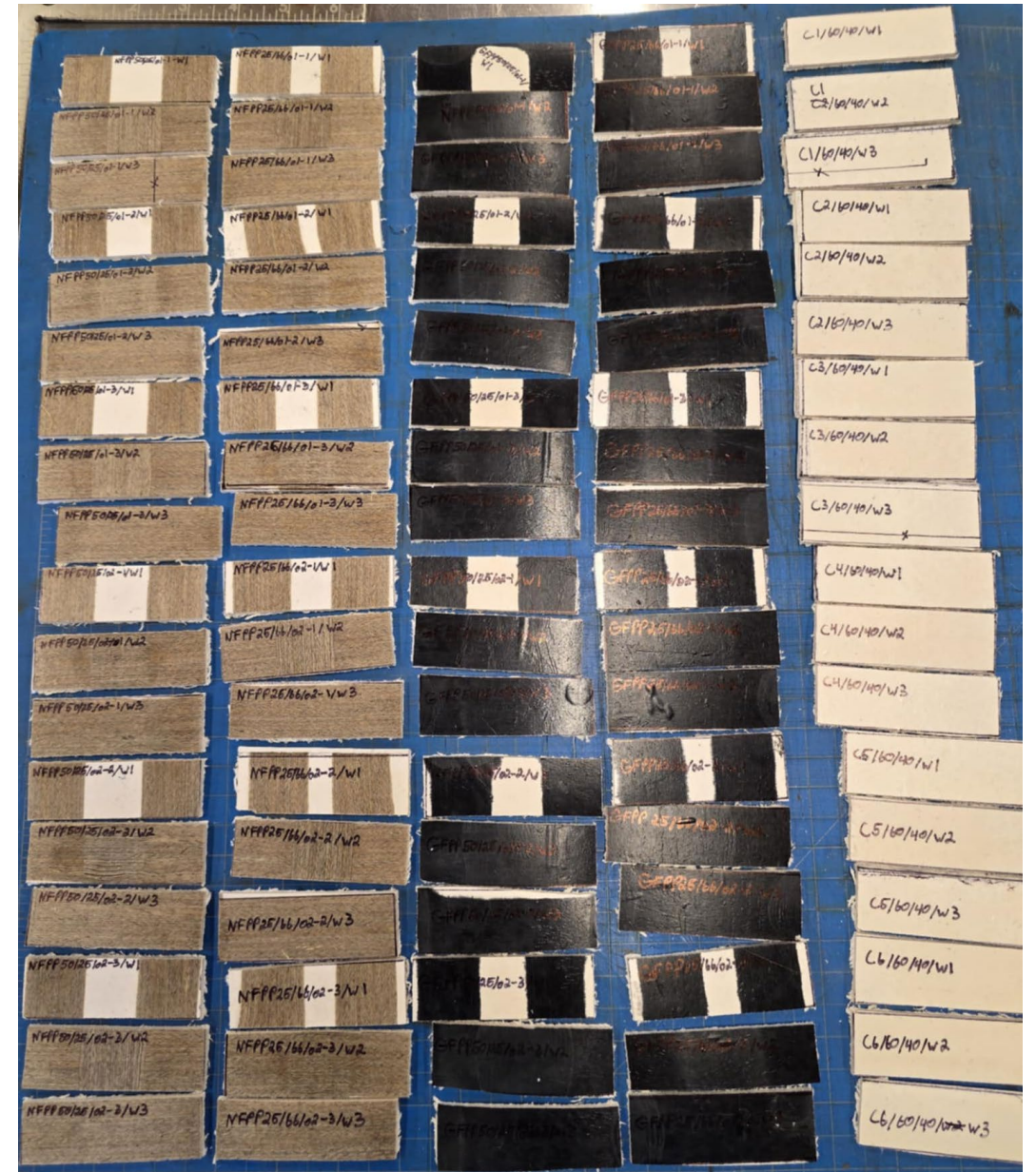
The load arrow does not appear to match the damage pattern

Water Uptake



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Water Absorption Specimens

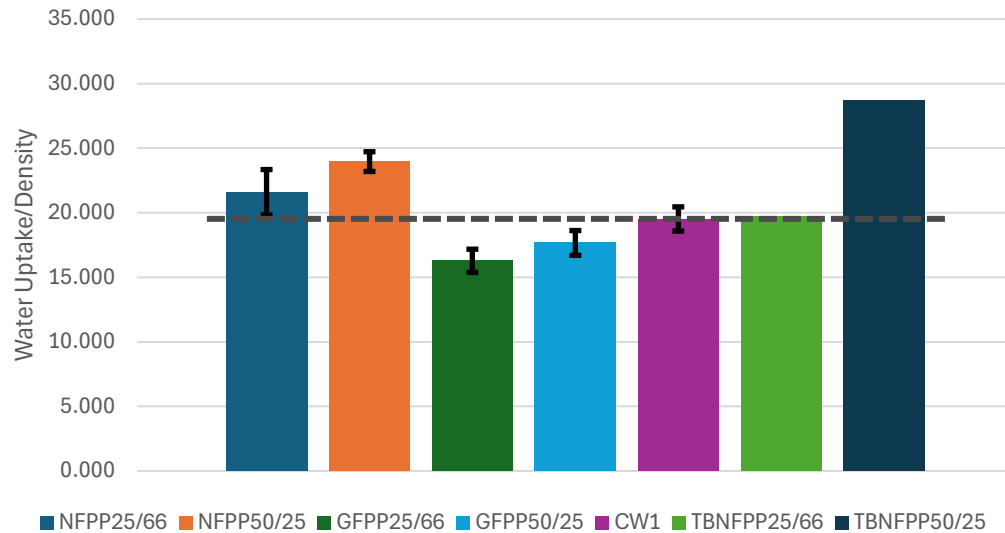


Water Absorption Data

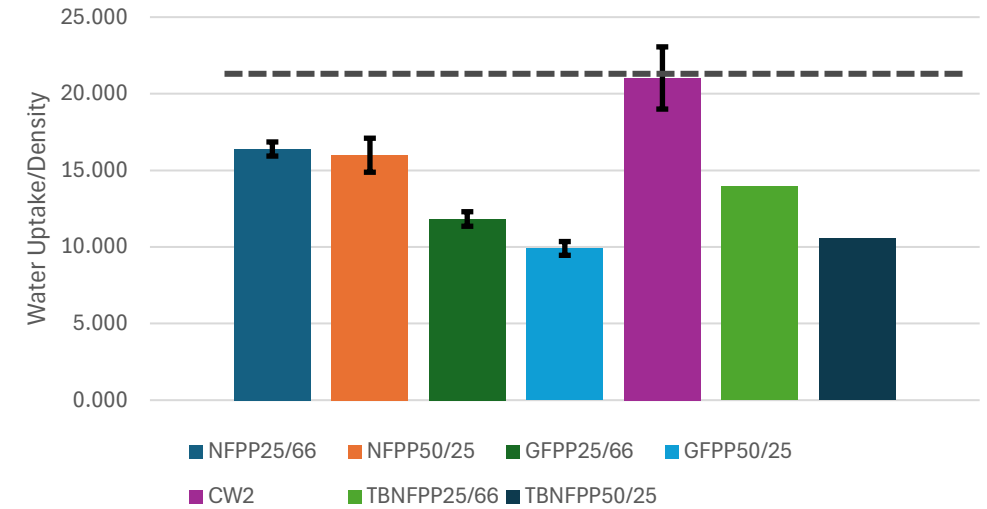
Key

- GF – Glass Fiber
- NF – Natural Fiber
- TB – Top & Bottom Reinforced
- 50/25 & 25/66 – Warp/Weft
- C – Control
- W# - Water absorption sample #

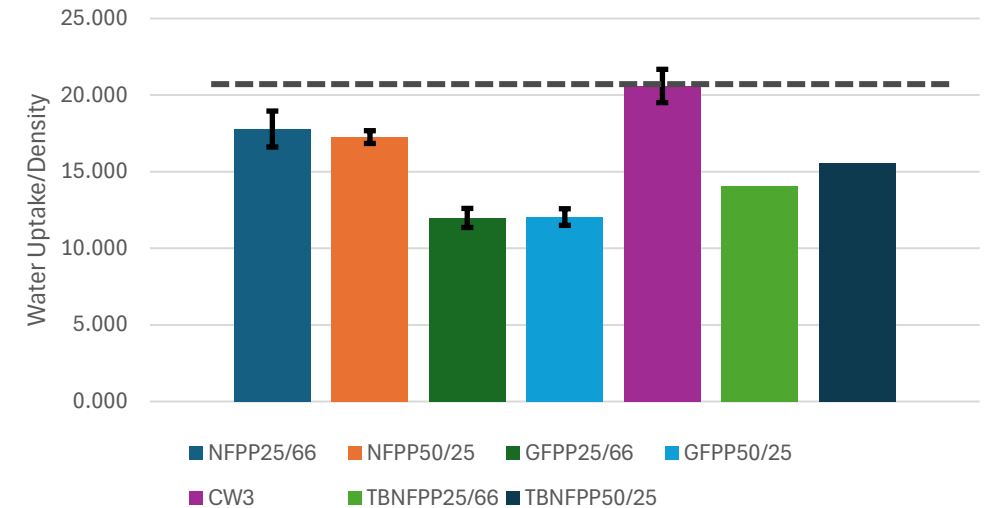
Normalized Water Uptake of W1 Samples



Normalized Water Uptake of W2 Samples



Normalized Water Uptake of W3 Samples



Conclusions

1. NFPP lattices provide a 0-9% increase to specific strength and 8-30% increase to specific modulus
2. GFPP lattices provide a 10-32% increase to specific strength and 34-44% increase to specific modulus
3. Water uptake of lattice-reinforced panels is equivalent or better than control



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Learn more at SPE TPO: “NFPP Lattices to Enhance Formability of Cellulose Nonwovens”

