Influence of bamboo fiber microstructure on Mechanical Response

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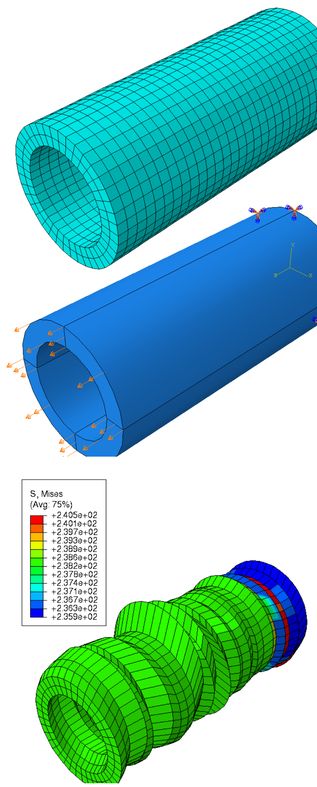
How do microstructures of bamboo fibers affect the deformation response under typical engineering loads like axial tension, lateral compression, torsion, etc.?

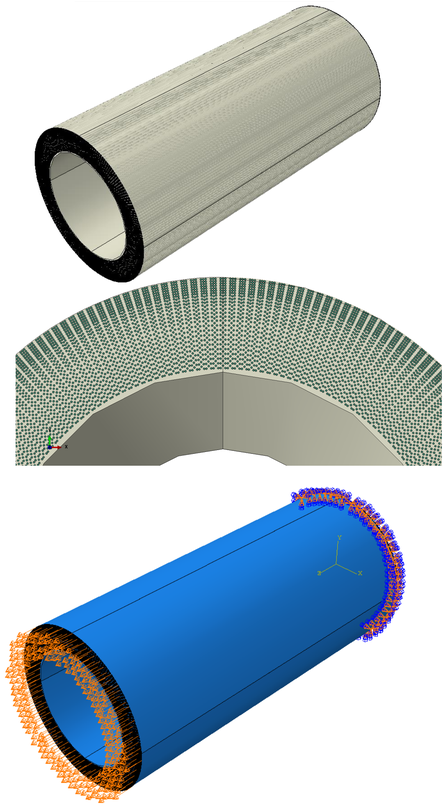
Introduction

- Traditional lumber is used in most construction applications due to its abundance and in-depth studies of its material structure.
- The abundance of quality lumber has dramatically decreased because wood takes too long to grow to maturity.
- Bamboo can offer an alternative with the same strength, with a much quicker time to harvest

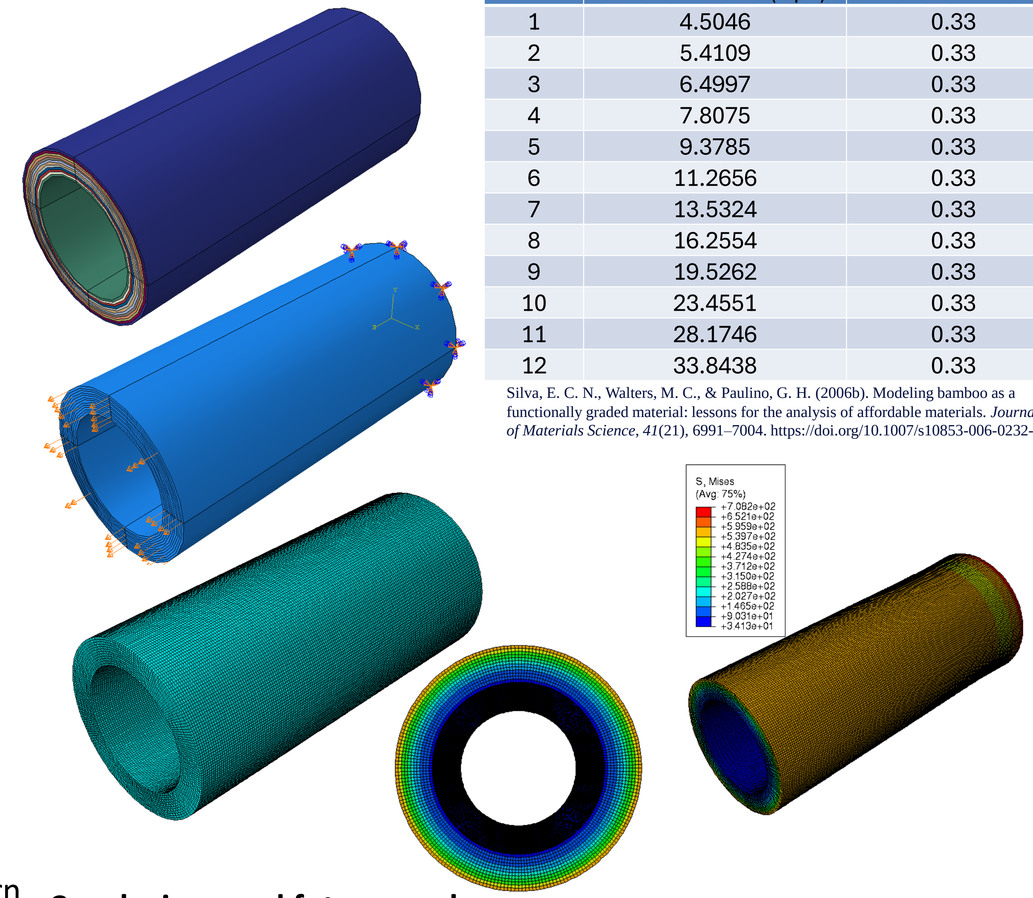
Orthotropic Model



Composite Model



Cylindrical Model



Shell #	Elastic Modulus (Gpa)	Poisson Ratio
1	4.5046	0.33
2	5.4109	0.33
3	6.4997	0.33
4	7.8075	0.33
5	9.3785	0.33
6	11.2656	0.33
7	13.5324	0.33
8	16.2554	0.33
9	19.5262	0.33
10	23.4551	0.33
11	28.1746	0.33
12	33.8438	0.33

Silva, E. C. N., Walters, M. C., & Paulino, G. H. (2006b). Modeling bamboo as a functionally graded material: lessons for the analysis of affordable materials. *Journal of Materials Science*, *41*(21), 6991–7004. https://doi.org/10.1007/s10853-006-0232-3

Methodology

Using finite element software, ABAQUS, multiple models were made to check the validity of model simplification. By applying the correct boundary and loading conditions, reasonable results were obtained that will be validated in a lab setting

Challenges

- Abaqus was a new software that I was able to learn and utilize throughout this research, which resulted in many roadblocks along the learning process.
- The loading conditions in the green figure above were incorrectly defined, and later adjusted appropriately

Conclusions and future work

- The cylindrical shell model is a valid simplification of the bamboo structure given enough layers
- Create a model to represent a densified bamboo from literature
- Validate with physical lab testing, stress, and strain gauges

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