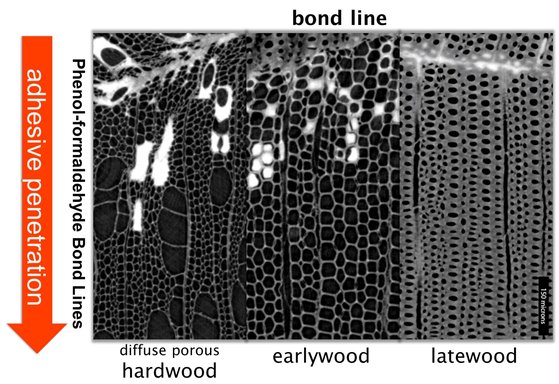
In situ deformation of wood adhesive bonds with stepwise shear loading and digital volume correlation.

Daniel J. Ching[a], Brian K. Bay[a], Fred A. Kamke[b], and Michaela Zauner[c]

[a] College of Engineering, Oregon State University, Corvallis, Oregon, USA [b] College of Forestry, Oregon State University, Corvallis, Oregon, USA [c] Institut f. Baustoffe (IfB), ETH Zurich, Zürich, Switzerland

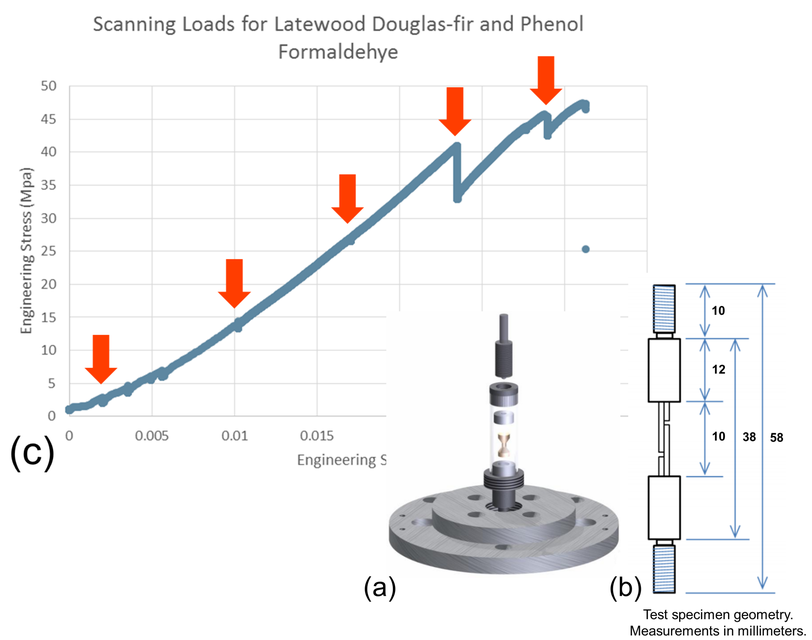
1 : Purpose

Adhesive morphology inside wood adhesive bonds is variable, but how that morphology affects bond strength and durability at the wood-adhesive interface is largely unknown. Until the recent advent of X-ray computed tomography and tagged adhesives, non-destructive investigation of adhesive morphology was not possible. The figure below shows 3 different adhesive morphologies.



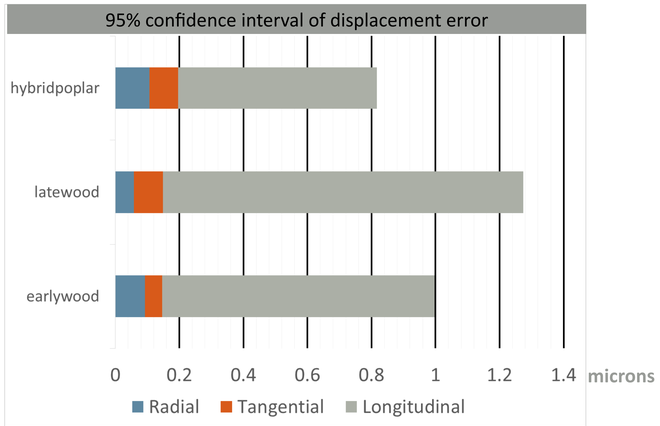
2 : Data Collection

Using a custom in situ mechanical testing device (a), we collected 3D images of bonded lap-shear specimens (b) undergoing deformation in the elastic, plastic, and failure regions. Arrows show at which loads an exemplar sample was scanned (c).



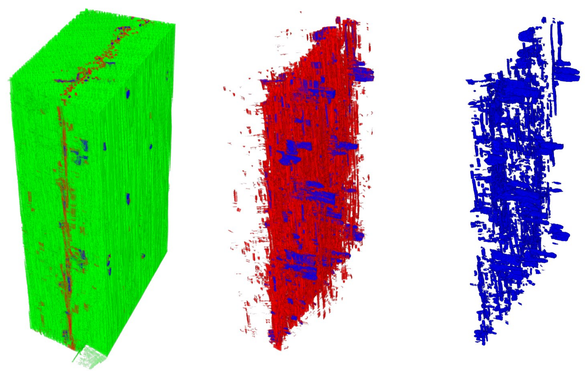
3a : Digital Volume Correlation

Digital volume correlation is a non-contact method that allows us to quantitatively measure the deformations in a sequence of 3D images. Using artificial deformations we quantified the expected precision for this method in wood structures, and found that using the correct parameters, we can expect a displacement precision of +/- 0.5



3b : Bond Line Characterizations

Segmented adhesive bonds can be quantitatively characterized using the weighted penetration and effective penetration. (left) segmented wood adhesive bond line. (center) adhesive and wood/adhesive mixture. (right) adhesive only.

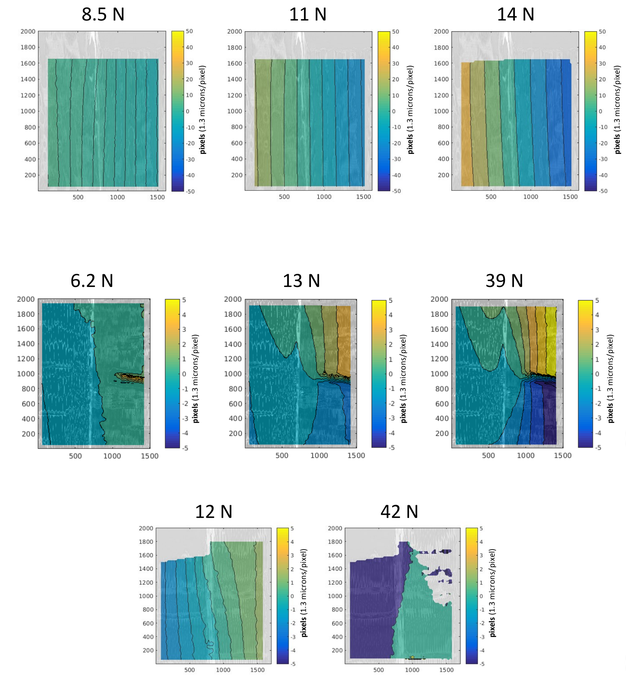


Contact Information

Daniel J. Ching
daniel.ching@oregonstate.edu
people.oregonstate.edu/ ~chingd

4 : Results

So far we have analyzed only a few of our datasets, but the calculated displacements appear to be the expected deformations for the lap shear geometry. Below are displacement maps for the radial cross-section for three different lap-shear samples. The plots show the average longitudinal displacement of the sample through the cross-section with the applied load above. (d) hybrid poplar (e) earlywood-latewood Douglas -fir (f) earlywood-earlywood Douglas-fir; in this sample, the left half has broken away and displaced uniformly down.



5 : Future Work

Analyzing all of our data sets and comparing the performance of different bond lines by quantifying the variability of load transfer from one side of the bond to the other. Sharing data with mechanical modeling group.

Acknowledgements

Dept. Wood Science & Engineering, Oregon State University
US Dept. of Agriculture, National Institute for Food and Agriculture Grant No. OREZ-WSE-589-U. Use of the Advanced Photon Source, an Office of Science User Facility operated for the U.S. Department of Energy (DOE) Office of Science by Argonne National Laboratory, was supported by the U.S. DOE under Contract No. DE-AC02- 06CH11357