Development and Characterization of Biobased Construction Adhesives

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Abstract

This project investigated the development and characterization of biobased construction adhesives produced from the glycerin, a byproduct of the biodiesel production process. These sustainable and biobased adhesives have zero volatile organic compounds (VOCs) and the results of this investigation have indicated that this adhesive has the potential to perform better than or as well as commercially available petroleum adhesives. Lap shear strength, water stability, creep resistance, and three-point bend strength were all the parameters in which the adhesive was compared. In addition, construction materials, such as orientated strand board (OSB), were manufactured with the biobased adhesive and compared to commercially available OSB products. Tests suggest that the bio-based OSB products performed as well as the OSB produced from petroleum derivatives. Future research includes determining additional adhesive applications and optimizing the adhesive's flexibility for water-borne and pressure sensitive applications.

Objectives

- Develop biobased adhesive from glycerin acrylates for construction applications
- Investigate processing conditions and mechanical behavior of OSB
- Characterize thermal behavior of the biobased adhesive

Materials

Biobased Adhesive (1 MDa)

Biobased Oriented Strand Board OSB

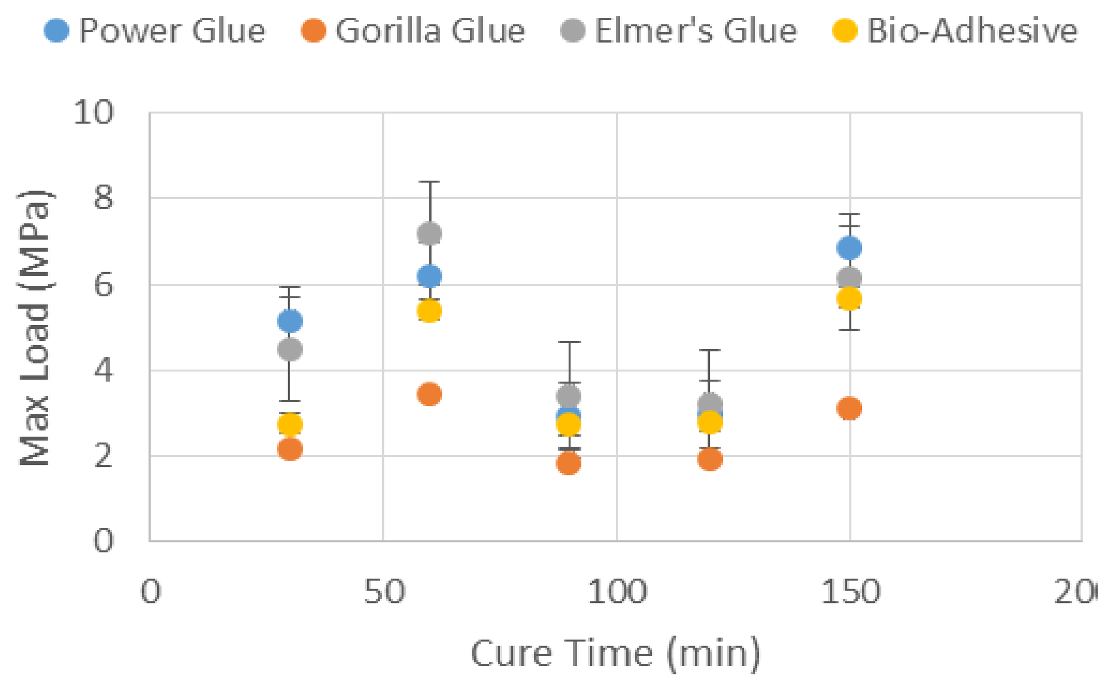
Methods

Lap Shear Strength

Lap shear samples of maple wood with a gauge length of 25.4 mm and overlap length of 50 mm were prepared and tested using a tensile testing machine in a lap shear configuration with a cross head speed of 1.3 mm/min, following a modified ASTM D1002 standard. All samples were cured at 120 °C for various times.

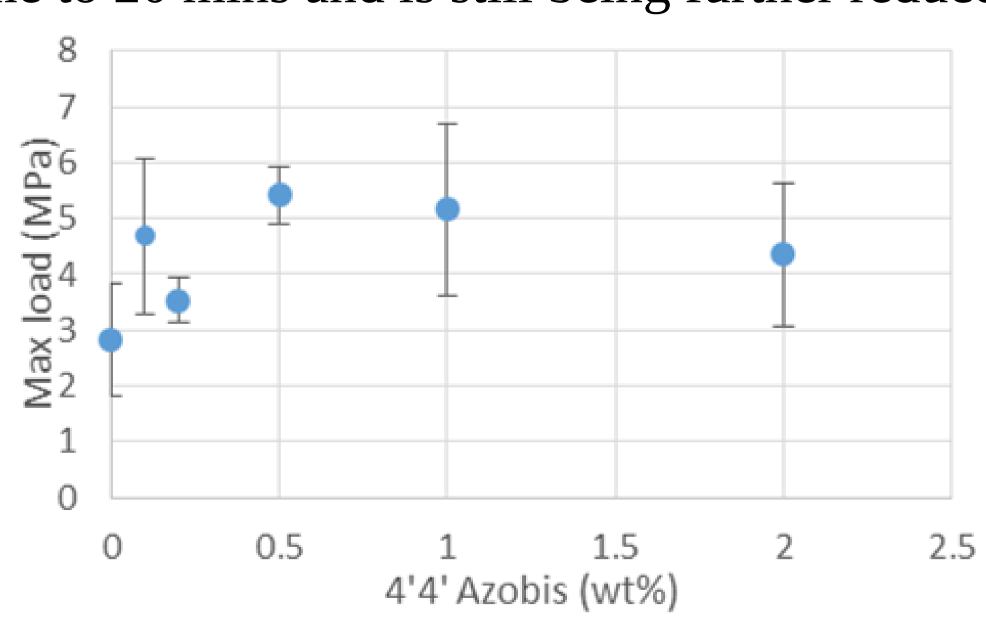
Results

The results showed that the biobased adhesive and petroleum adhesives demonstrate similar strength after 120 min.



OSB Production

OSB, 12.7 cm x 12.7 cm x 0.635 cm, samples were prepared with a compression molding system. Maple wood strands were randomly oriented in angles of 0,90,180, 270, and 360 degrees. Originally the compression time was completed in 3 hours, at a pressure of 4.137 x 106 (N/m2) on to the board and a temperature of 120 ºC. The use of cross linking agent 4'4'-Azobis (4-cyanovaleric acid) reduced the curing time to 20 mins and is still being further reduced.



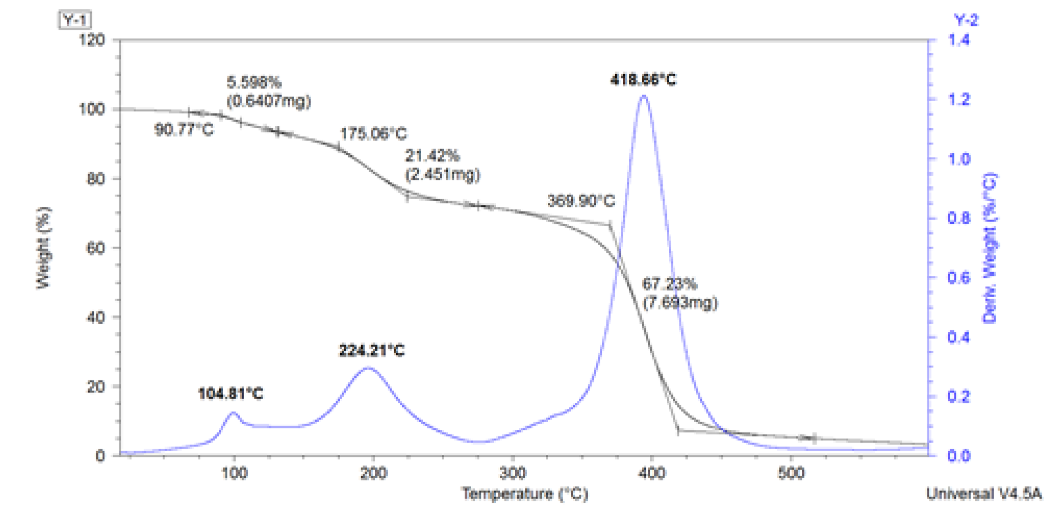
3-Point Bend

Samples were cut at a size of 2.54 cm x 10.16 cm x 0.635 cm from the OSB boards, for 3-point bend. Commercial grade OSB boards were also purchased from a local supplier for comparative testing. Five samples of each OSB sampler were tested. The two performed similarly.

OSB Type	Strength (MPa)
Commercial grade OSB	0.668
Bio Adhesive OSB	0.638

Thermal Analysis

Degradation profiles of the biobased adhesive were measured with a TA instruments Q50 thermal gravimetric analyzer (TGA) at a rate of 50mL/min under nitrogen atmosphere. The samples were placed in a ceramic pan and heated from 25°C to 600°C at a heating rate of 5°C/min



Three decomposition events are seen in the TGA and DTG curves. Residual water is the initial inflection point of 90°C , boiling of un-reacted, residual glycerol at 175 °C, and thermal degradation at 418°C of the polymer.

Conclusions

Based on preliminary results, biobased adhesive may prove as a viable option with a goal to match and replace the petrochemical based adhesives.

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