DMA investigation of melamine formaldehyde and polyurethane curing within preservative treated veneer

Cody Wainscott and Gerald Presley

WBC Spring Meeting | Corvallis, OR | March 17,2024

Introduction

Mass timber building construction is increasing dramatically across North America which presents challenges to these structures not seen in Northern Europe. Large parts of the United States harbor termites and high moisture areas promote biological decay. Preservative treatments can prevent wood decay and insect attack, but chemical presence introduces difficulties with resin compatibility and may increase manufacturing assembly time.

This work examines the impact of preservative treatment on resin curing through treated veneers using Dynamic Mechanical Analysis (DMA).

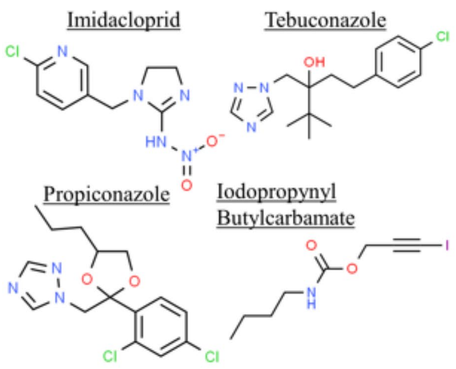
Project setup

Maple Veneer | **Preservative pressure vessel** | **DMA cantilever veneer placement**

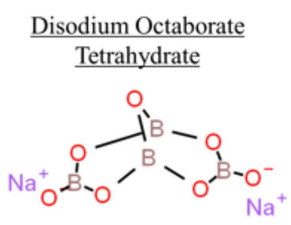
Zhang, C., et al. (2019)

- **Individual veneer treated with:**

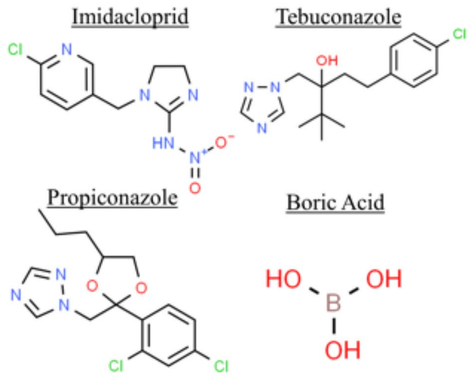
PTIP



Borate

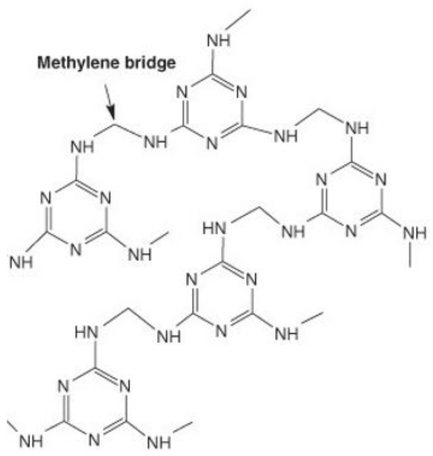


PTIB

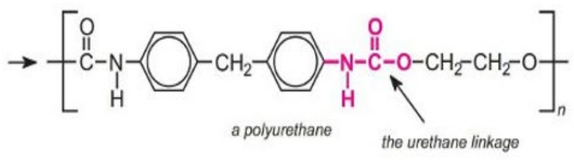


- **Veneer glued together with:**

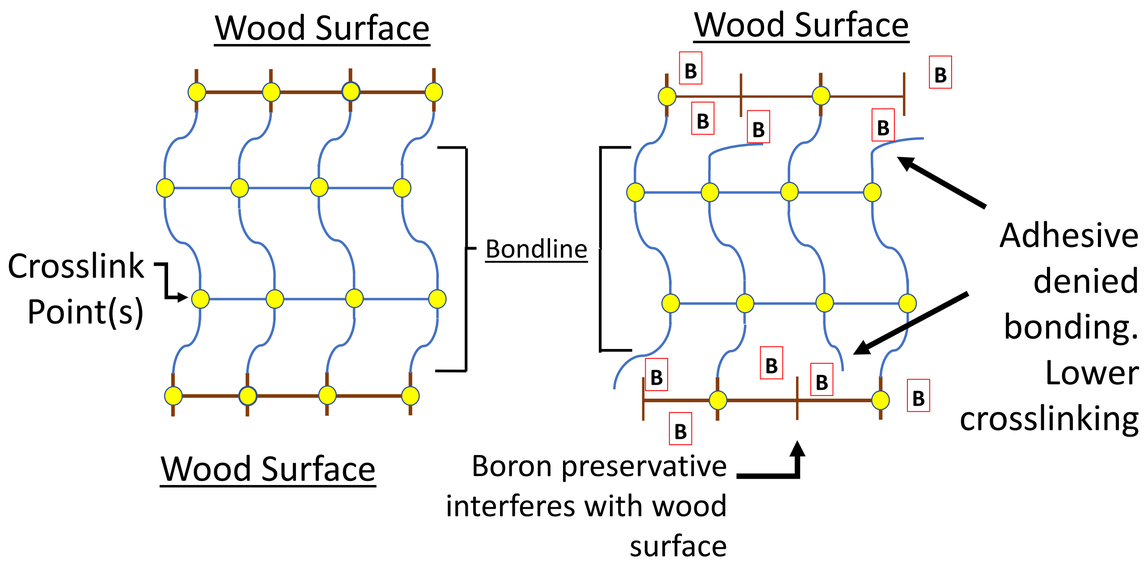
Melamine Formeldehyde Resin (MF)



Polyurethane Resin (PUR)



Preservative and Resin negative interaction



DMA Results

- **Phase 1: Isothermal 30C for 180 mins, curing process**

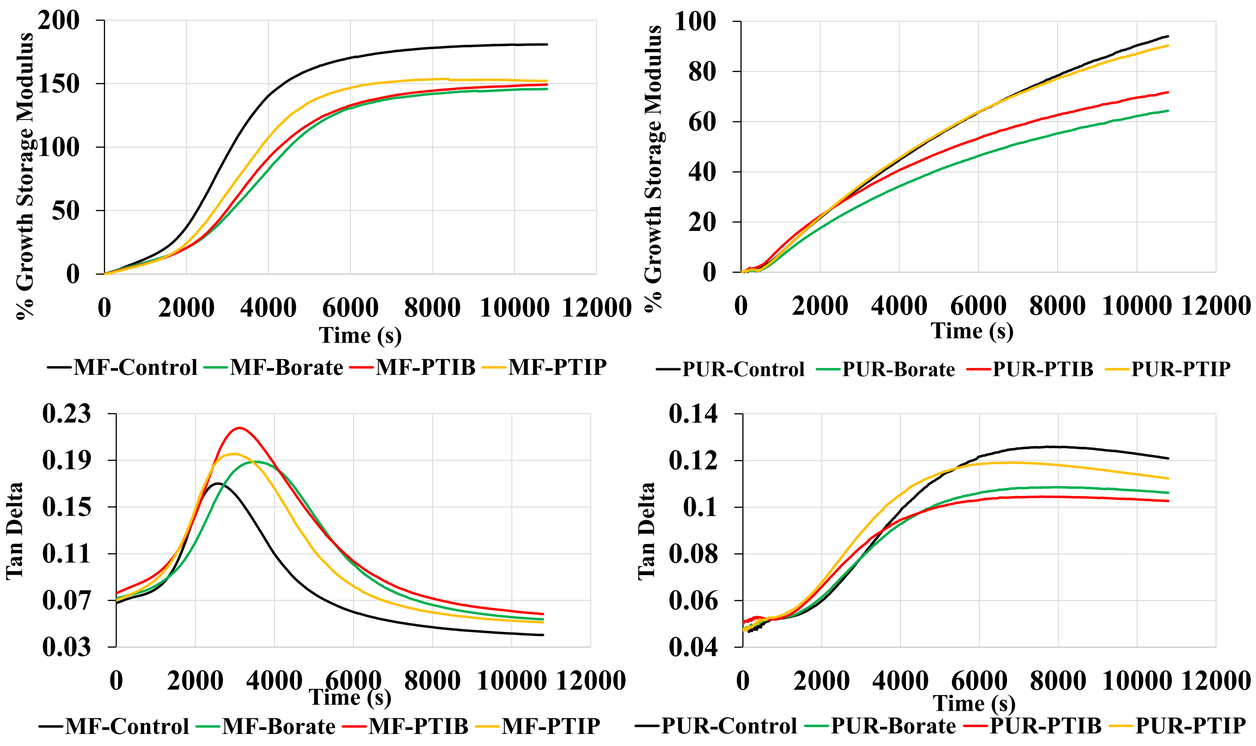
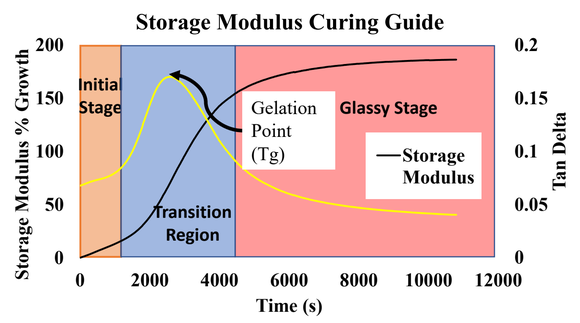
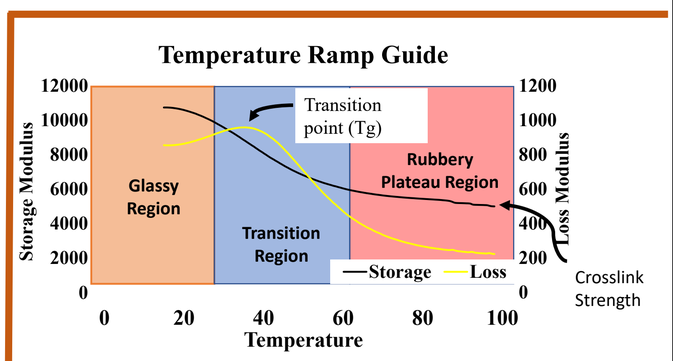


Figure 1: Percent growth in storage modulus (E) over a 3 hr curing period at 30ºC of maple veneers glued with melamine formaldehyde (A) and polyurethane (B) alone on maple veneers or in the presence of three different preservative systems. Control-adhesive only control, Borate-sodium octaborate tetrahydrate, PTI- borates and propiconazole, tebuconazole, and Imidacloprid, PTIP- organic preservative treatment propiconazole, tebuconazole, Imidacloprid, permethrin, and IPBC.





- **Phase 2: Temperature ramp, residual curing**

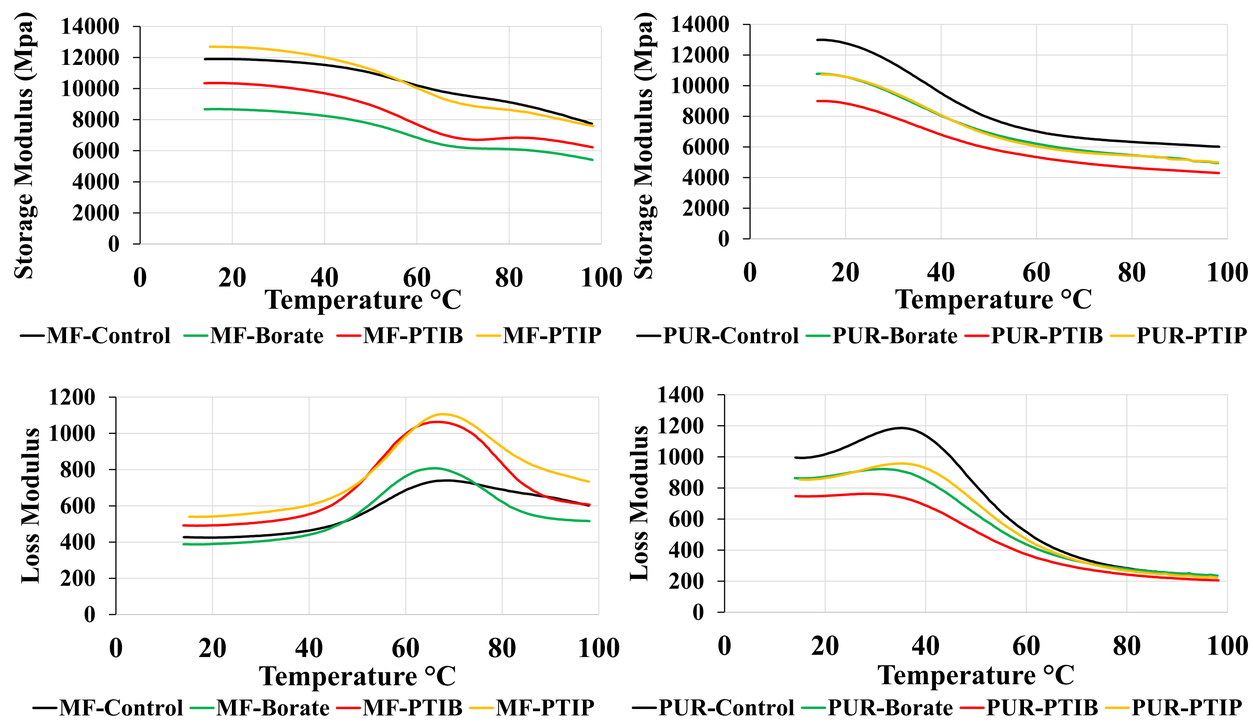


Figure 2:Storage modulus temperature ramp 10-100°C, melamine formaldehyde (A) and polyurethane (B). Loss modulus, melamine formaldehyde (C) and polyurethane (D). Control-adhesive only control, Borate-sodium octaborate tetrahydrate, PTI- borates and propiconazole, tebuconazole, and Imidacloprid, PTIP- organic preservative treatment propiconazole, tebuconazole, Imidacloprid, permethrin, and IPBC.

Crosslink Density

- Effectiveness of resin crosslinking strength

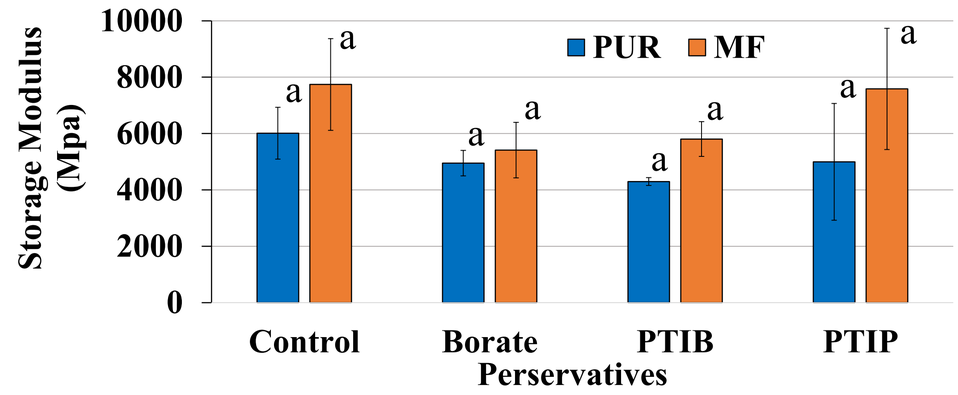
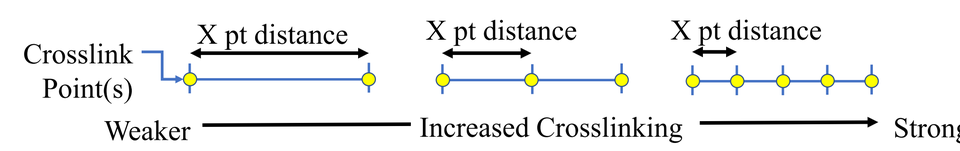


Figure 3: Crosslink density of MF and PUR resin and their preservative combinations. Stats compared to control and respective resin treatment combination within the same group.



Crosslinking strength diagram.

As more crosslinking points are created the stronger the polymer becomes.

Conclusion

This work highlights issues with borate-based treatments causing a negative interaction with common cold set resins used in CLT manufacturing. Though all treatments delayed gelation, borate and PTIB treatments caused the worst delays before crosslinking could take place. This may indicate that manufactures who use preservative in their mass timber production, might need extra time to ensure maximum crosslinking. PTIP showed less of an effect on gelation delay and better crosslinking over other treatments. However, there was no statistical difference between the crosslinking strength among treatments and control. More testing should be done before conclusive evidence that organic treatments perform better than inorganic.