



**LBTU**  
Faculty of Forest and  
Environmental Sciences



# GLUABILITY OF THERMALLY MODIFIED BIRCH (*BETULA PENDULA* ROTH.), ASPEN (*POPULUS TREMULA* L.), AND POPLAR (*POPULUS X CANADENSIS* MOENCH) VENEERS USING COMMERCIAL ADHESIVES

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- 53% of Latvia's area is covered by forests
- Birch (*Betula pendula* Roth.) is the most common species, accounting for 30% of the forested land.
- Aspen (*Populus tremula* L.) makes up to 7% of Latvia's forests. Fast growing species, particularly its hybrid varieties.
- Poplar (*Populus x canadensis* Moench) is a natural hybrid, originally selected in France, fast growing.
- Wood thermal modification – thermal treatment (150°-240°C) to enhance its properties, including durability and water resistance.



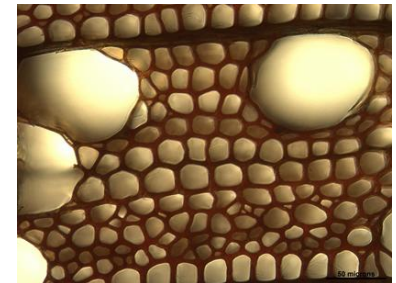
[https://en.wikipedia.org/wiki/Betula\\_pendula](https://en.wikipedia.org/wiki/Betula_pendula)



[https://lv.wikipedia.org/wiki/Parast%C4%81\\_apse](https://lv.wikipedia.org/wiki/Parast%C4%81_apse)



[https://en.wikipedia.org/wiki/Populus\\_%C3%97\\_canadensis](https://en.wikipedia.org/wiki/Populus_%C3%97_canadensis)





## RESEARCH OBJECTIVE

This study aims to evaluate the bonding performance of plywood made from thermally modified veneers, treated using two different methods — TV and WTT. The veneers were bonded with commercially available adhesives, including phenol-formaldehyde resin, melamine-urea-formaldehyde resin, hybrid polymer, and polyurethane glue.



WTT



TV



# MATERIALS

- Aspen, birch, and poplar veneers were rotary-cut for the study and thermally modified in water steam environment at 160°C for 50 minutes (WTT)
- Aspen, birch, and poplar veneers were rotary-cut for the study and thermally modified in reduced pressure (TV):
  - 160°C for 50 min
  - 204°C for 120 min
  - 214°C for 120 min
  - 217°C for 180 min
  - 218°C for 30 min
- Phenol formaldehyde resin (SFŽ-3014), melamine urea formaldehyde resin (Casco Adhesives MUF system 1257/7557), hybrid polymer glue (Soudal HB Construct), and polyurethane glue (PURBOND HB S159)



<https://intanwijaya.com/products/phenol-formaldehyde-resin/>

PF



<http://www.soudal.eu/soudalweb/productDetail.aspx?w=&p=282&ID=4403>

HB



## MANUFACTURING AND TESTING METHODS

- Three-layer plywood samples were obtained after pressing the veneers at a temperature of 145 °C and pressure of 1.8 MPa and maintaining the pressure for 7 minutes (PF); 20°C/1.8MPa/20min (HB); 20°C/1.8MPa/116min(MUF); 20°C/1.8MPa/90min (PUR)
- Plywood performance indicators were determined using three pre-treatment methods:
  - 24h: Immersion in water at 20±3 °C for 24 hours
  - 4h+16h+4h+1h: Immersion in boiling water for 4 hours, drying in a ventilated oven at 60±3 °C for 16 hours, repeated boiling water immersion for 4 hours, followed by cooling in water at 20±3 °C for 1 hour.
  - 72h+1h: Immersion in boiling water for 72±1 hours, followed by cooling in water at 20±3 °C for 1 hour.
- Tensile—shear strength in MPa and cohesive wood failure in percentage according to standard EN 314-1:2004 were determined, and conformity with bonding Class 3 according to EN 314-2:1993 was evaluated.





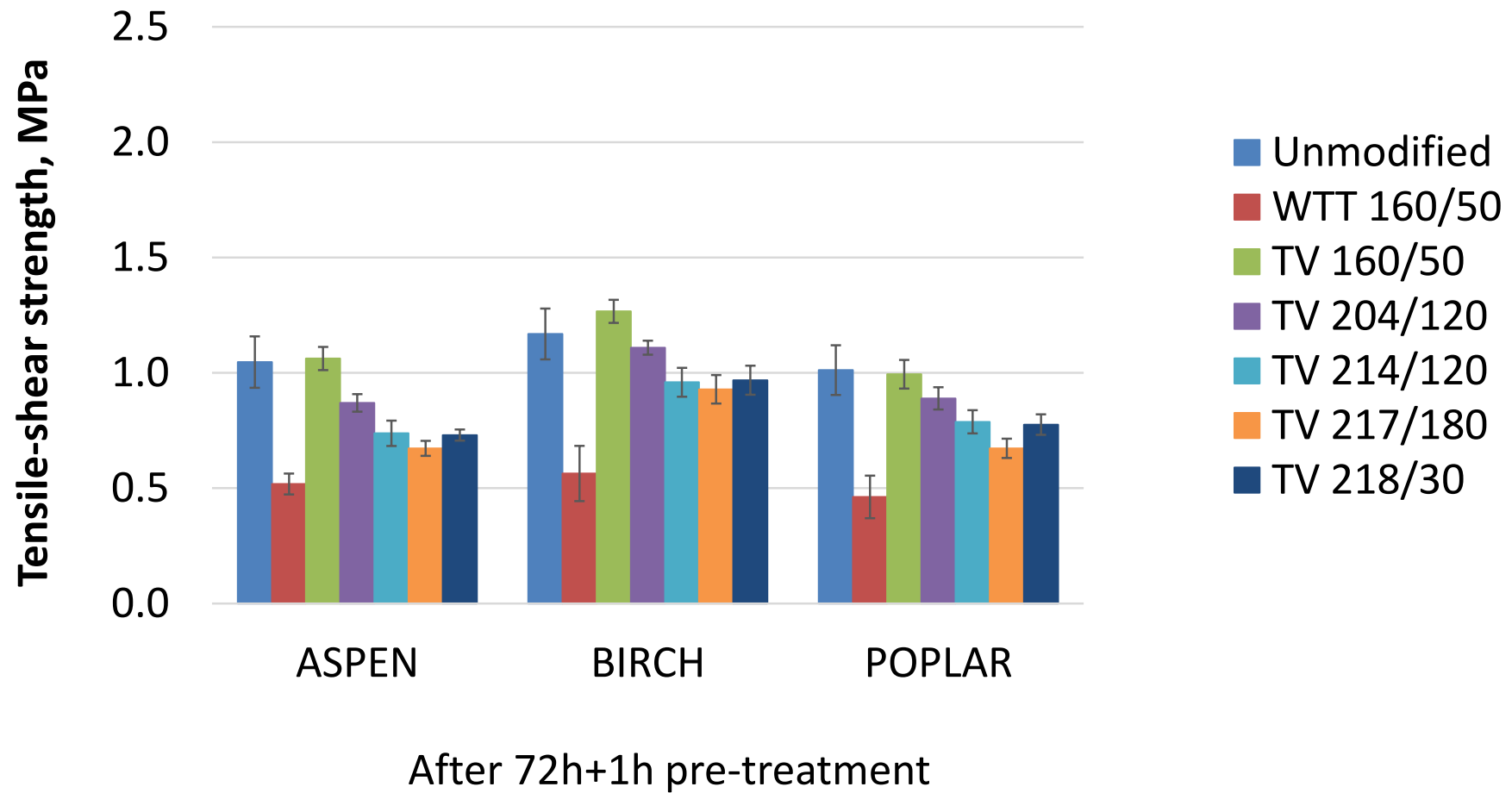
## GLUE CONSUMPTION RESULTS

| Glue | Consumption, g/m <sup>2</sup> |                                   | Deviation,<br>% |
|------|-------------------------------|-----------------------------------|-----------------|
|      | Nominal, g/m <sup>2</sup>     | Actual $\pm$ SD, g/m <sup>2</sup> |                 |
| PF   | 150                           | 156 $\pm$ 11                      | 4.0             |
| HB   | 300                           | 317 $\pm$ 13                      | 5.7             |
| MUF  | 340                           | 343 $\pm$ 16                      | 0.9             |
| PUR  | 150                           | 162 $\pm$ 15                      | 8.0             |



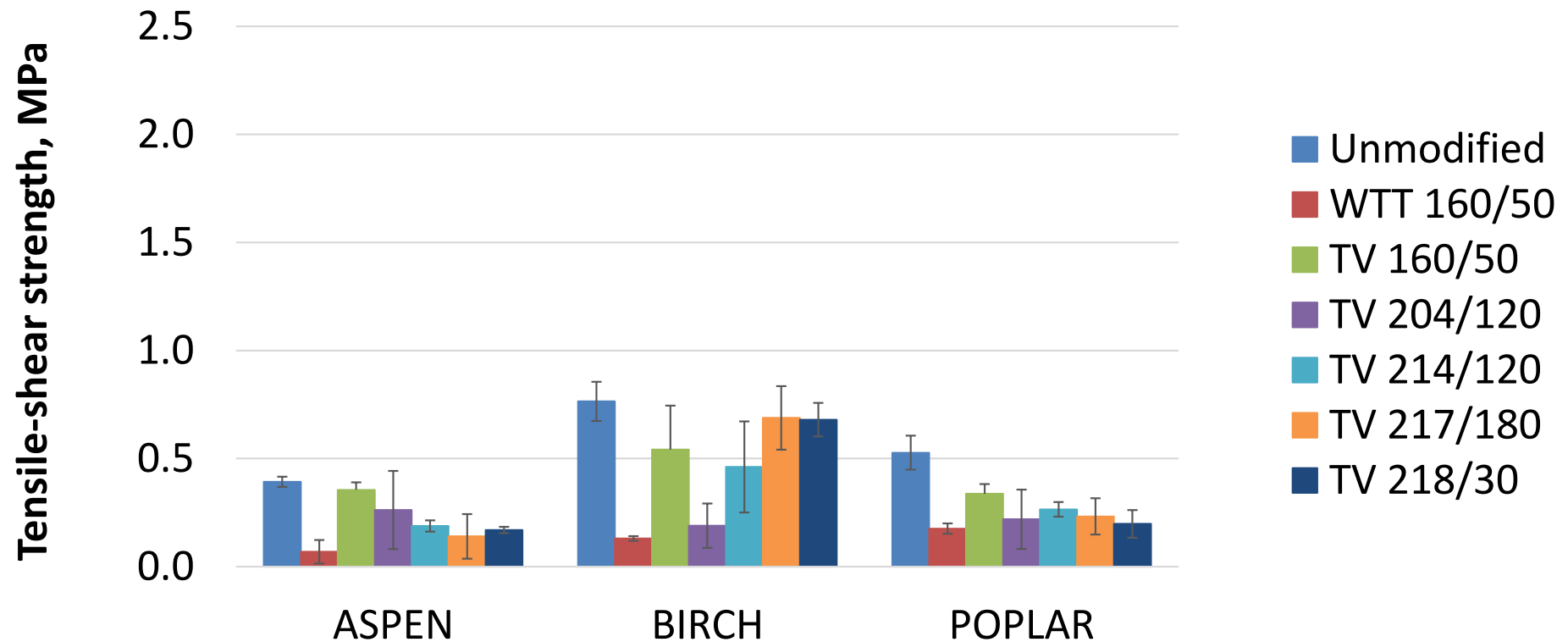


## PF ADHESIVE GLUABILITY





## HB ADHESIVE GLUABILITY

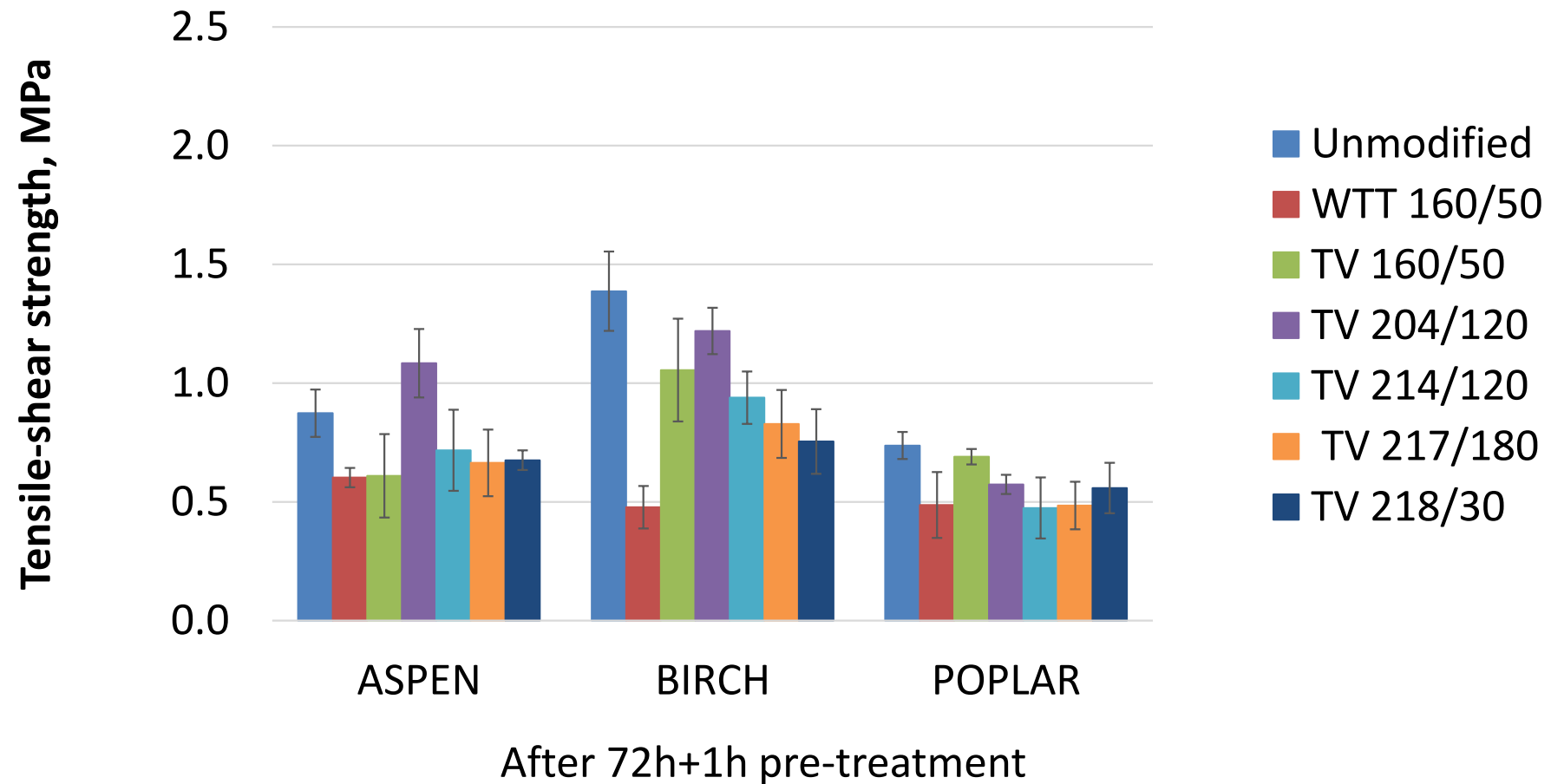


After 72h+1h pre-treatment



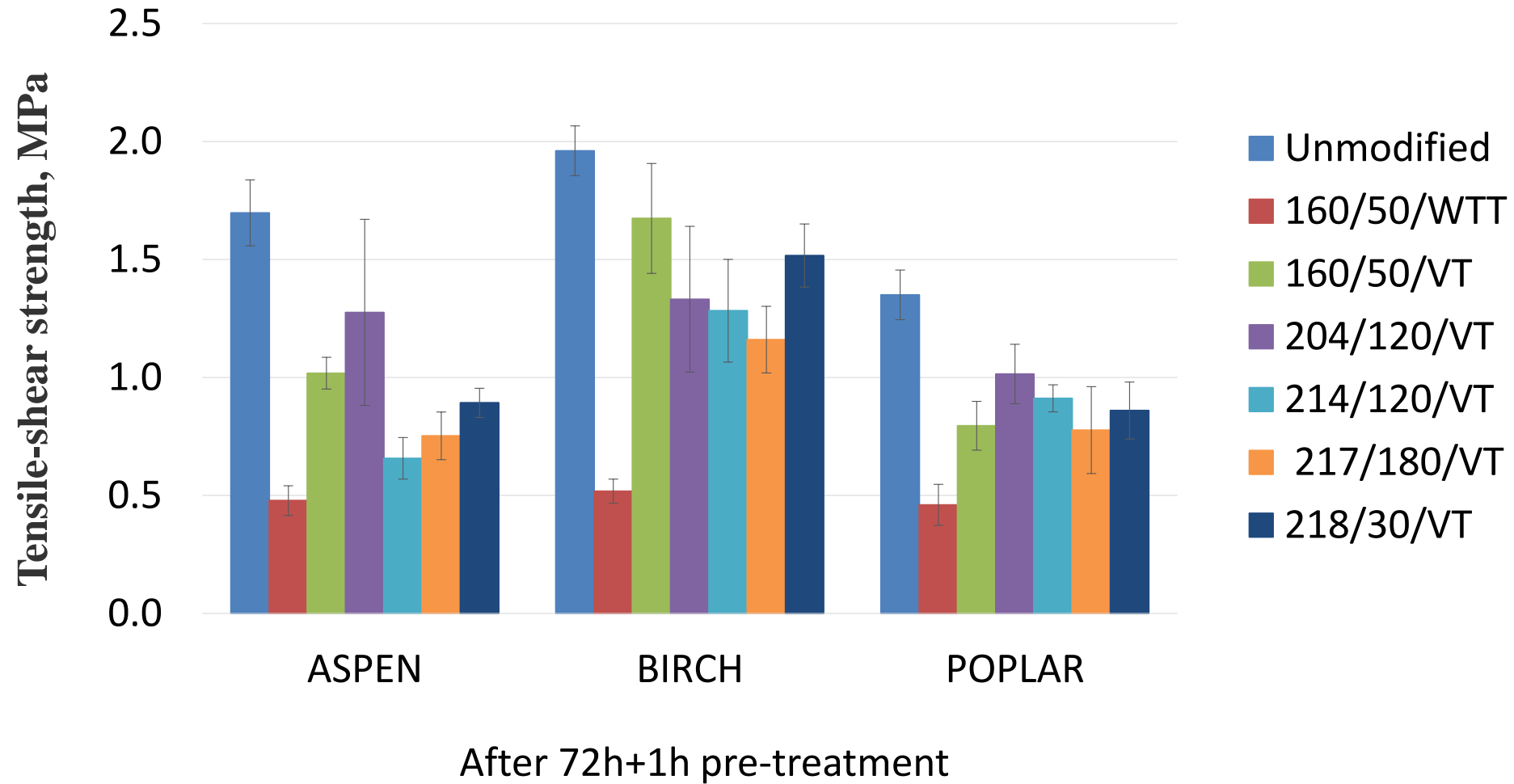


## MUF ADHESIVE GLUABILITY





## PUR ADHESIVE GLUABILITY





1. After 72h+1h PT, the highest shear strength ( $1.96 \pm 0.11$  MPa) was observed in plywood made from **unmodified birch veneers bonded with polyurethane adhesive**, with wood failure of 75%.
2. **Birch veneers** thermally modified in a vacuum environment under the modification regime **TV 218/30** and **aspen veneers** modified under the regime **TV 214/120** are the most suitable for plywood production when using polyurethane adhesive.



3. The most suitable adhesives for manufacturing plywood intended for bonding Class 3 (outdoor use) from thermally modified veneers are phenol formaldehyde resin adhesive and polyurethane adhesive.
4. Plywood glued from veneers thermally modified in a vacuum environment under identical modification conditions exhibit **50% higher shear strength** compared to plywood from veneers thermally modified in a water steam environment and therefore **TV veneers are more suitable for plywood production.**



## THANK YOU!

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