Bonding quality of laminated veneer lumber manufactured from densified poplar veneers – the effect of pressure level

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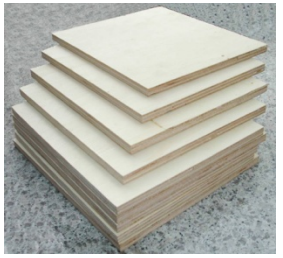
INTRODUCTION

Poplar Wood



Fast growing (10 to 15 years)

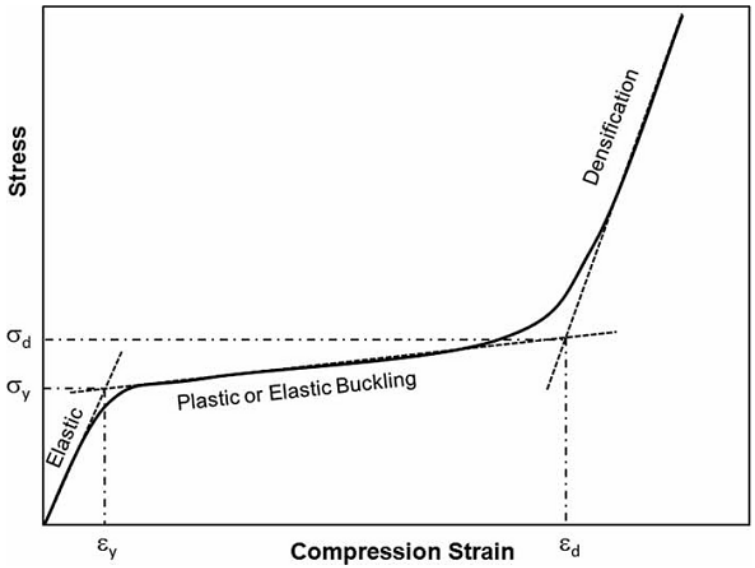
Low-density thereby low mechanical properties

Paper, furniture, plywood etc.

Wood Densification

Lumen filling with a substance (polymers, resins etc.)

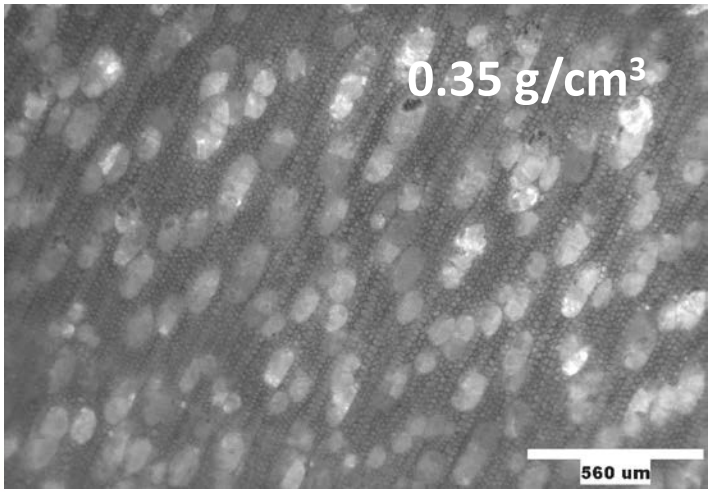
Compression in the transverse direction



- Thermo Mechanical (TM) Densification
- Thermo Hydro Mechanical (THM) Densification
- Viscoelastic Thermal Compression (VTC)

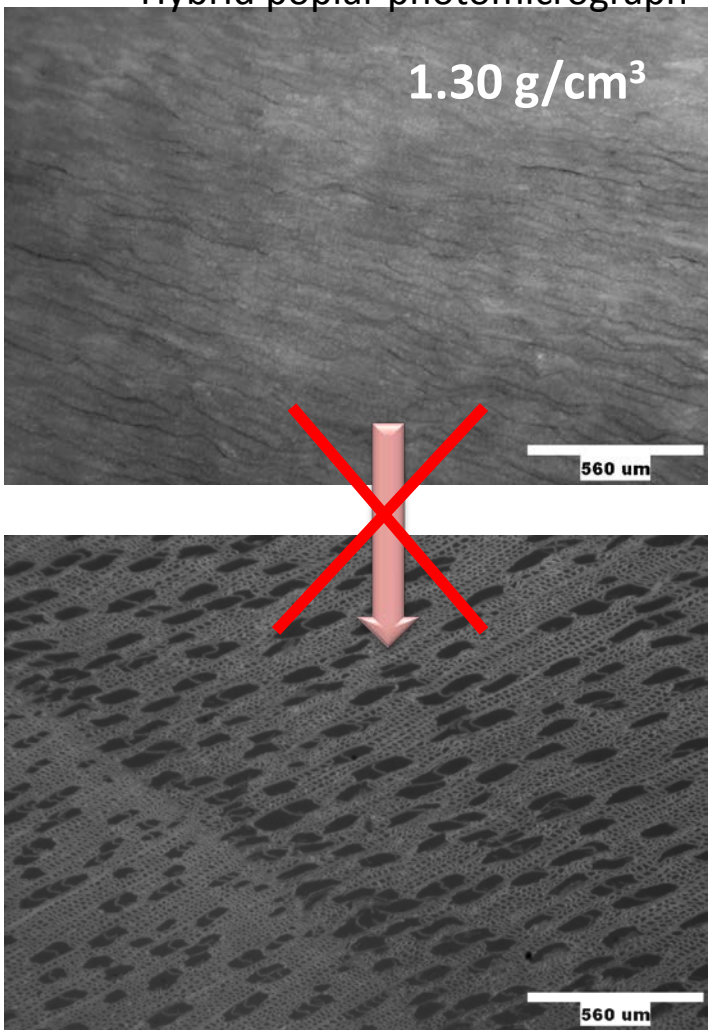
Spring Back

Spring Back



Densification

Hybrid poplar photomicrograph



Changing the higroscopicity of cell wall.

Forming covalent crosslinks between wood components in deformed state.

Releasing the elastic stresses and strains stored in the microfibrils and matrix during compression (Morsing 2000).

(Kutnar et al. 2009)

Why Wood Densification?

Increased mechanical properties

Utilization of a low-value wood species

100% natural

Cost

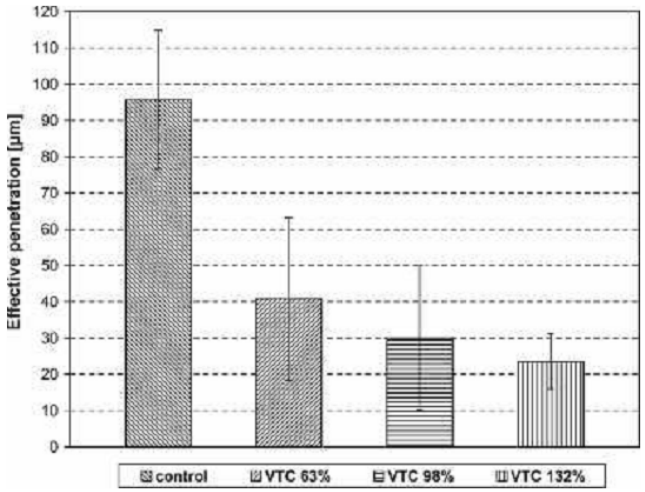
Resistance to change

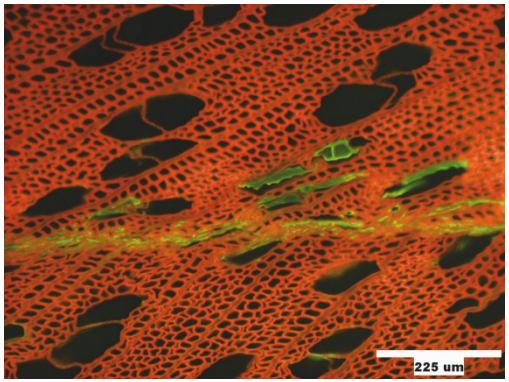
Use of densified low-density wood veneers in structural LVL production has great potential

Bonding of Densified Wood

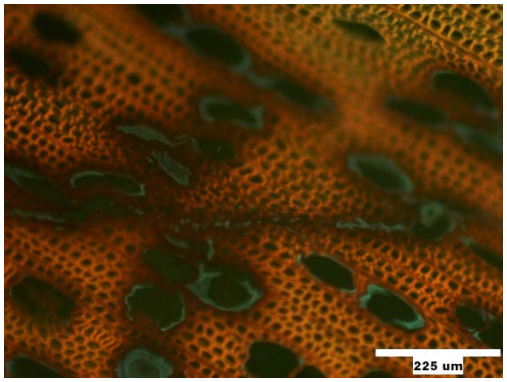
Densification influences the morphology and surface roughness of densified wood

Adhesive penetration depth
Adhesive distribution uniformity
Improves the bonding quality





VTC 98%



Control

(Kutnar et al. 2007)

The aim of this work is to evaluate the effect of pressing pressure on the bonding strength of LVL manufactured from densified poplar veneers.

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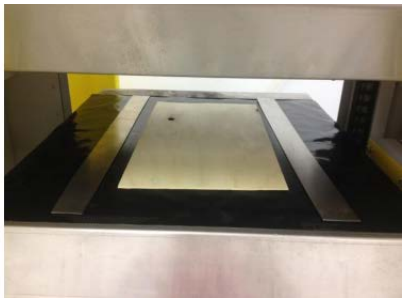
Densifications of poplar veneers, SLOVENIA



Production of LVL from densified poplar veneers, TURKEY

Determine the bonding strength, TURKEY

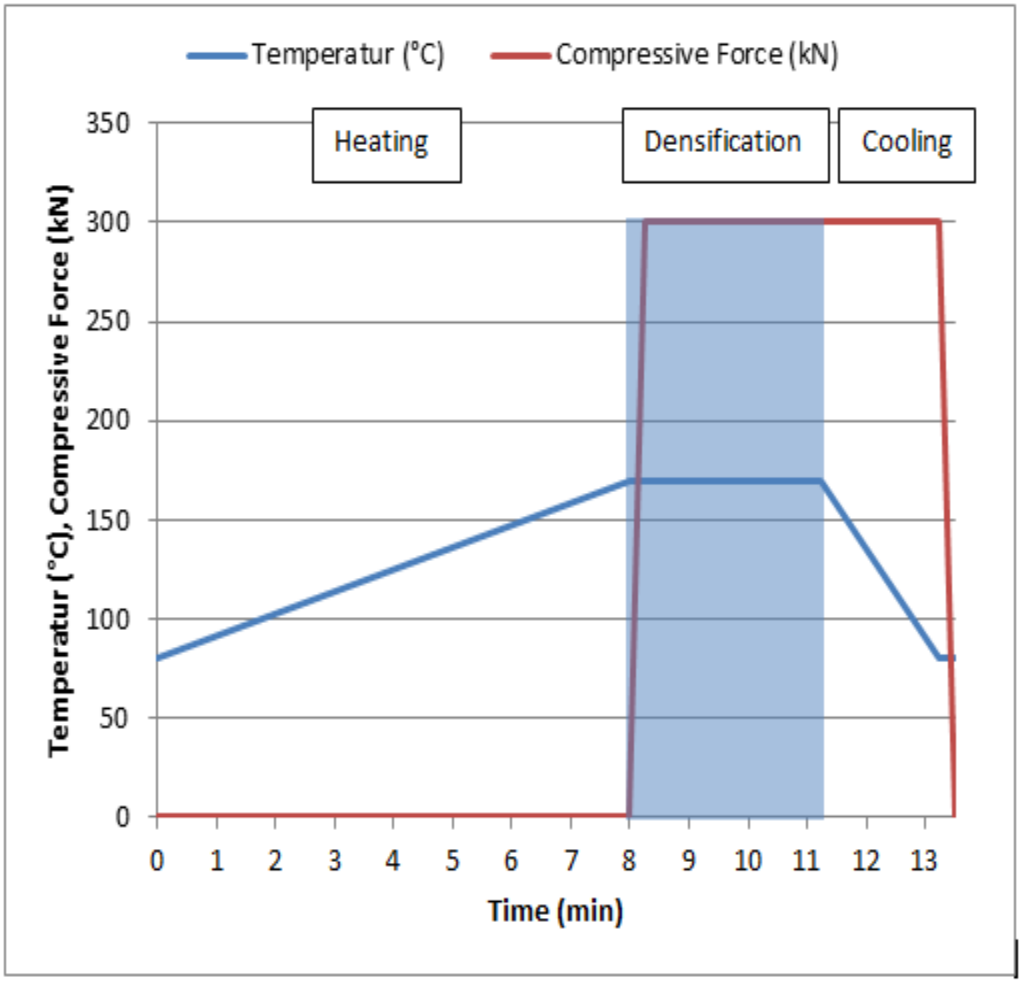
MATERIAL

Veneers	Initial thickness (mm)	Densification rate (%)
Poplar	2	0 (Control)
	3	50
	3,5	75
	4	100

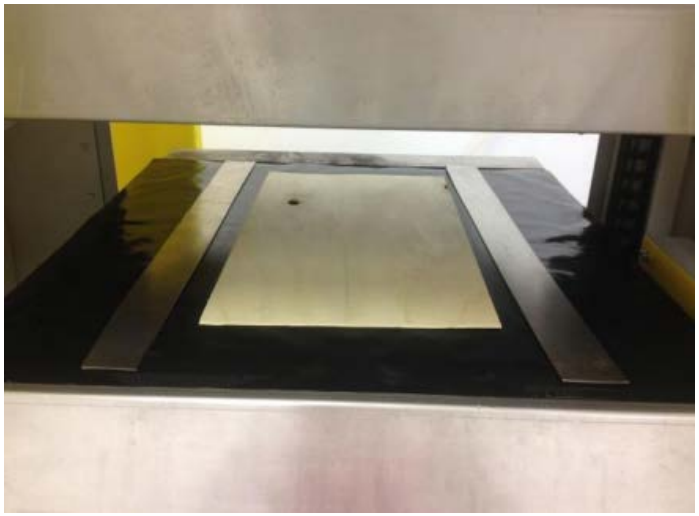
Adhesive
Urea Formaldehyde (UF)
Polyvinyl Acetate (PVAc)

Hybrid poplar (*populus euramericana I-214*)
Eskipazar, Karabük, TURKEY

METHOD



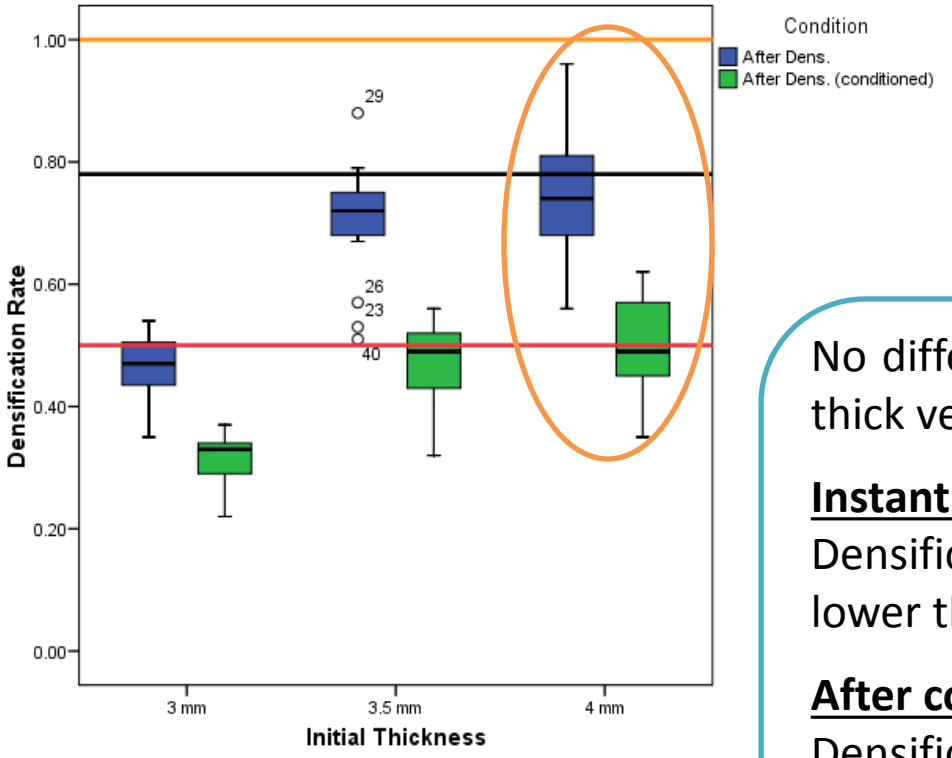
Press Temperature	170 ± 0.1	°C
Cooling Temperature	80 ± 2	°C
Press Speed	3	mm/min
Pressing Time	3	min
Mechanical Stop	2	mm



RESULTS

TM-Densification

Moisture content of veneers decreased from 14% to 3% due to the densification.



Red line: expected densification rate for 3 mm veneers,
Black line: expected densification rate for 3.5 mm veneers
Yellow line: expected densification rate for 4 mm veneers

$$DR = \left(\frac{T}{t}\right) - 1$$

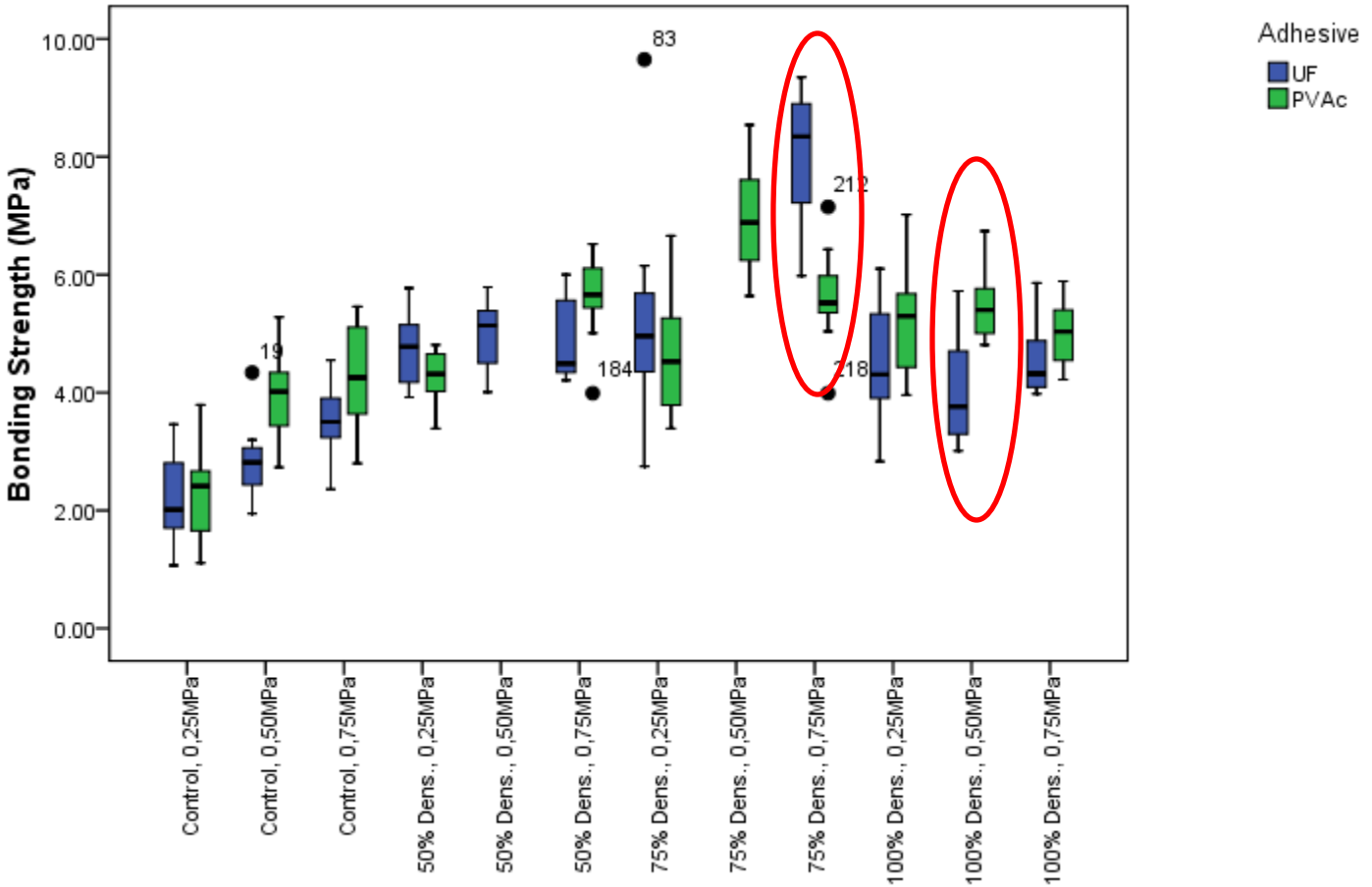
DR: Densification Rate,
T: Thickness after densification,
t: Thickness before densification

No difference between 3.5mm and 4mm thick veneers .

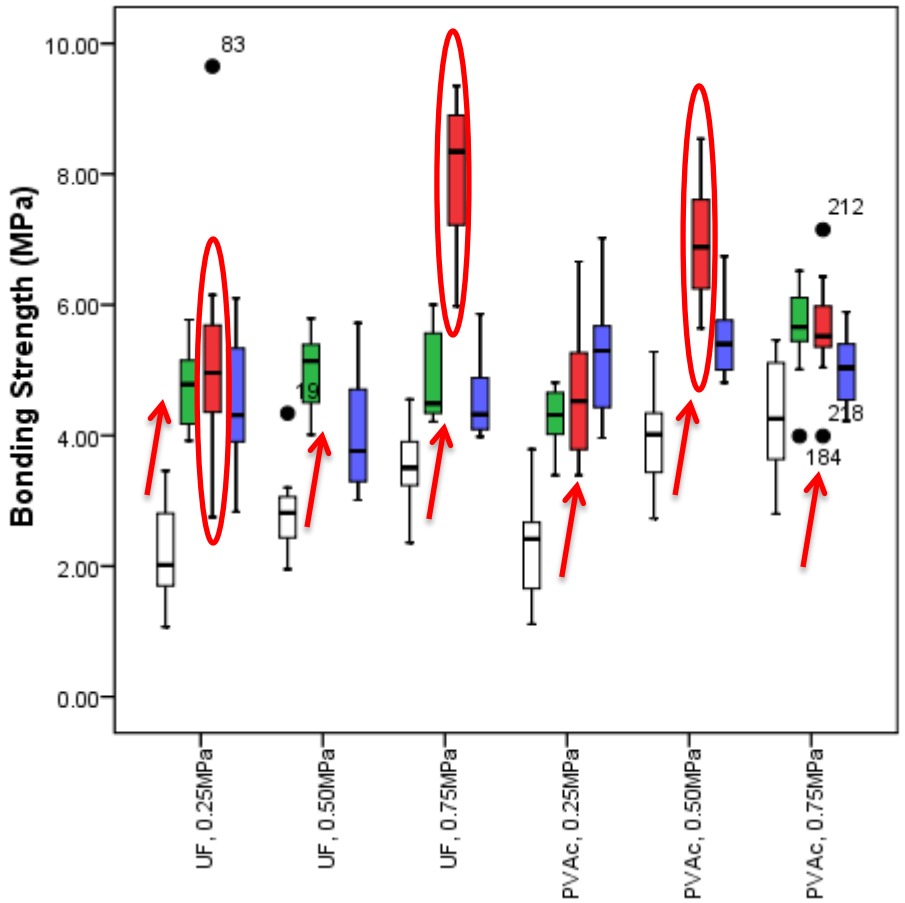
Instant spring-back:
Densification rates were 4%, 7% and 28% lower than expected, respectively.

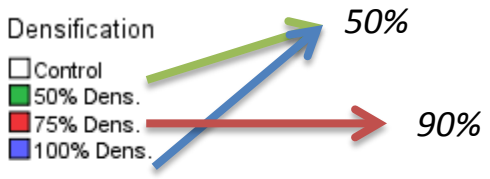
After conditioning spring-back:
Densification rates also decreased 15%, 23% and 25% more after conditioning, respectively.

The Effect of Adhesive Type on Bonding Strength of LVL



The Effect of Densification on Bonding Strength of LVL

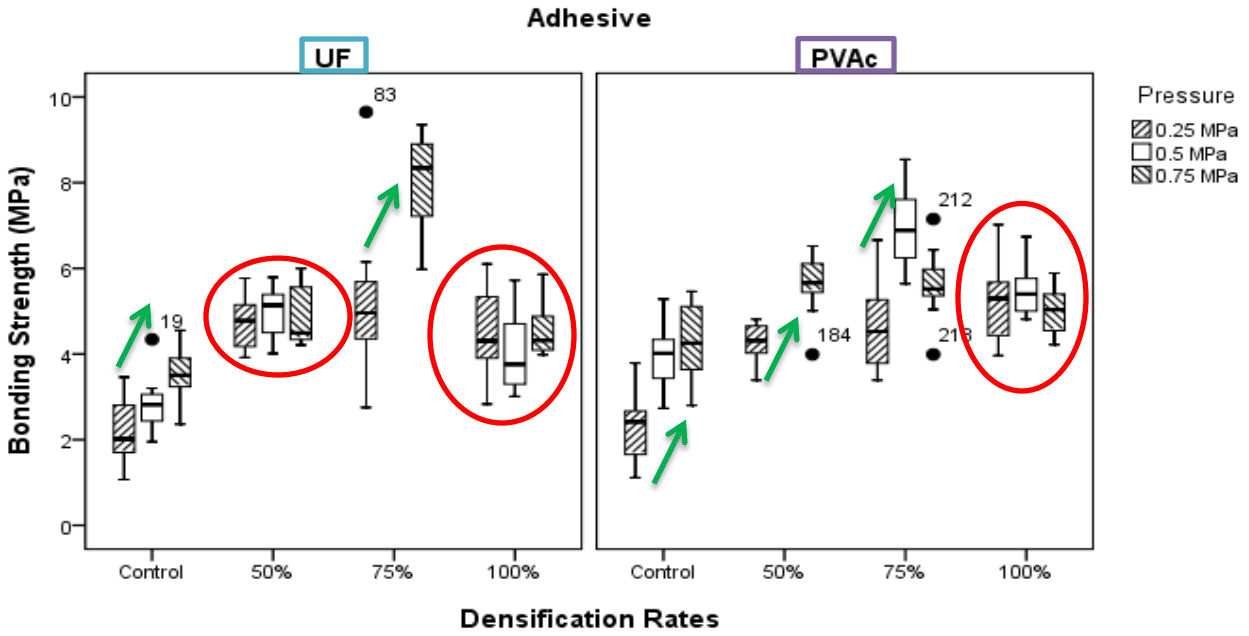




The bonding strengths of all LVLs manufactured from densified veneers were higher than control groups.

The highest bonding strength was observed in LVLs manufactured from 75% densified veneers.

The Effect of Pressure Level on Bonding Strength of LVL



Significantly increased bonding strength was observed when pressing pressure was increased from 0.25 MPa to 0.75 MPa for control samples and LVLs manufactured with 75% densified veneers.

There was no significant effect of pressing pressure on bonding strength of LVLs manufactured 50% and 100% densified veneers in the UF group.

Significantly increased bonding strength was observed when pressing pressures higher than 0.25 MPa were used for control samples and LVLs manufactured with 50% and 75% densified veneers.

Pressure had no significant effect on bonding strength of LVLs manufactured with 100% densified veneers.

CONCLUSION

- The results indicated that the selected densification parameters would need to be changed to obtain the **100% densification**. The **longer pressing time and/or higher temperature** could lead to lower internal stresses and/or higher stress relaxation prior the press opening.
- **UF and PVAc** adhesives showed **similar bonding strength** value.
- The LVLs manufactured from **densified veneers had higher bonding strength than** manufactured from **undensified** veneers.
- The **highest bonding strength** was observed in LVLs manufactured **75% densified veneers.**
- In conclusion, higher bonding strengths might be obtained when **75% densified veneers** and pressures **greater than 0.25 MPa** are used in LVL manufacturing.

THANK YOU FOR YOUR ATTENTION