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Correlation between Radial Variation and Mechanical Properties of Laminated Veneer Lumber made from 14 Poplar Cultivars

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## Introduction











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## **LVL Production**

### **Veneer Selection**

Poplar cultivars : Brenta, Dvina, I-214, Koster, Lambro, Lena, Mella, Soligo, Taro, A4A, Alcinde, Polargo, Trichobel, Triplo

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From each log, we manufactured two types of panels:

- A panel made of "adult" veneer (type B and E);
- A panel made of juvenile veneer (from false heartwood type D and F).

We made LVL of 7 layer from 3 mm veneer and 4 layer from 5.25 mm veneer, so that the average thickness of our LVL was 21 mm.

All of veneers had already been dried until they reached 8 - 10% of moisture content.









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### **Gluing Process**

x 500 mm surface

We used PVAc (Poly Vinyl Acetat) as adhesive. The vinyl adhesive that we used was marketed under the name "Rakoll®" \_GXL 4. It is in the form of an emulsion and ready for application.

□ We produced 188 LVL panels of 21 mm thickness and 500 mm

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### **Preparation Samples for Mechanical Properties**

- Each board was cut into standardized test samples (EN 789), parallel to grain with 10 samples for each board specimens for testing non-destructive characterization and static bending.
- □ BING: 3720 (1860 x 2) samples

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□ static bending and MOR : 1860 samples

The parameter that we used for mechanical properties were Modulus of Elasticity (MOE) and Modulus of Rupture (MOR) computed according to the procedure detailed into the norme EN310.







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Non destructive (BING) and Destructive Test (Instron)

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- Providence of the second secon
- 4 point bending
- Load range of 5000 N at a constant speed 5mm/min until the samples broke
- Obtained MOE and MOR







□ These results were very satisfactory from the point of view of the homogeneity of the samples that we used in this research.





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Arts et Métiers ParisTech	MOE (2)	
Introduction Materials & methods Results and discussion Conclusion	<ul> <li>The MOE values that we used were the average values from LVL made from 3 mm and 5 mm veneers in flatwise and edgewise bending test. The results were very well correlated with MOE of solid wood (Figure Top), in line with Haouzali (2009)</li> <li>However, as Haouzali (2009) observe it, the MOE of LVL were generally lower than the MOE of solid wood.</li> <li>Thus, for the LVL, there were cultivars with high rigidity values (Lambro, Brenta, Taro, Alcinde, Soligo, Lena, Koster) and three cultivars (I214, A4A and Triplo) were unsuitable for structural applications (Figure Down).</li> </ul>	$MOE \text{ quasistatique}$ $y = 0.5319x + 3321.9$ $R^2 = 0.7455$ $g = 0.000$ $g = 0.000$ $R^2 = 0.7455$









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ParisTech Laboratore Bourguiston

Istie RAHAYU

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### **Effect of Radial Position**

The advantage of using veneers taken from sapwood, and therefore supposed to be less juvenil than heartwood, is obvious since the mechanical properties are much better (between 14 to 21%) for a comprarble density (Table down). This proved that there was an effect due to juvelinity in every poplar cultivar. It also showed that LVL from 5 mm veneers had the highest increase percentage from juvenile to mature in MOE dynamic, MOE quasistatique MOR and density, 16%, 18%, 21% and 2% subsequently.

Mean Value of 14 Poplar Cultivars		MOE dynamique (MPa)	MOE quasistatique (MPa)	MOR (Mpa)	Density (kg/m³)
LVL 5	Mature	9429	9129	54	400
mm	Juvenile	8126	7737	45	390
gain in %		+16	+18	+21	+2
LVL 3	Mature	9259	8769	56	417
mm	Juvenile	8193	7629	48	412
gain in %		+13	+15	+16	+1





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### Conclusion

 BING, was reliable instrument for estimating MOE from destructive test. Some cultivars have a real potential for structural applications (Lambro, Soligo, Alcinde, Brenta and Taro) while others could be excluded (A4A, I-214, Triplo).

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- All cultivars could be well peeled and presents an excellent peelability as [NURBAITY.2012]. General cutting conditions used for I214 were applied for the 14<sup>th</sup> cultivars.
- There was significant variation sapwood to heartwood (supposed mature to juvenile wood) for each cultivar. The difference of mean MOE and mean MOR between juvenile and mature LVL were 15% and 17% for an increase of density of 1%. Finally, the use of thicker veneers reduced the use of adhesive, simplified and accelerated the production of panels without altering their mechanical properties.





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# Thank You – Merci Beaucoup – Terima Kasih

# Any Questions ?

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