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Effect of the PVA gluing on bending strength properties of finger jointed turkey oakwood (*Quercus cerris L.*)

1 Subject

The objective of this study was to examine the influence of finger length, type of glue and finger orientation on bending strength (modulus of rupture and elasticity) of finger jointed turkey oakwood (*Quercus cerris L.*). Limited information is available on end gluing hardwoods in contrast to softwoods, which have been extensively investigated and industrially utilized (Pena 1999). Non-structural products include furniture, cladding, fencing, internal and external joinery. In structural uses finger jointing is finally the major method to end joint timber for the production of glue-laminated wood (Koch 1972, Jokerst 1981, Nestic and Milner 1993). The other methods to end joint timber (butt and scarf joint) did not find industrial acceptance (River 1994). There are no experimental results for finger-jointed oakwood in Greece. Oak is the most abundant tree species in Greece (746 400 ha) and covers 49% of the broadleaved Greek forests (about 2.5 million ha). Oakwood is produced from coppice forests in small dimensions and utilized almost exclusively as fuelwood and for charcoal production (Stamou 2001). Pena (1999) studied the suitability of producing non-structural finger joints made from European Oak (*Quercus petraea L.*). He examined the effect of the geometry of finger joint in bending strength, using two different finger lengths (9 and 12 mm). He concluded that modulus of elasticity of the jointed specimens did not differ significantly from the unjointed ones. On the contrary, the jointed specimens presented lower values of modulus of rupture than the unjointed ones (43%).

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2 Materials and methods

Dry oakwood with dimensions $50 \times 30 \times 400\ mm^3$ was used. Physical defects were removed according to EN 385/2001. The material was conditioned at 20 °C temperature and 65% relative humidity until the weight of the wood was stabilized. Finger profiling was performed by profiling cutterheads with the following characteristics: 4, 10 and 15 mm finger length and 1.6, 3.8 and 3.8 mm pitch, respectively. Two types of polyvinyl acetate (PVA) based glues (D1 and D2 type) for interior use were studied. The above types were applied by brush on one side of the joints. The applied end pressure was accomplished with manually operated press and lasted 60 s. The finger-jointed specimens were conditioned and cut to final dimensions 20 mm × 20 mm × 360 mm. Bending strength (modulus of rupture (MOR) and modulus of elasticity (MOE)) of the finger jointed specimens were examined according to ISO 10983/1999 and DIN 52186/1978. For every finger length the influence of the finger orientation (horizontal and vertical) with regard to the direction of the load, was also examined. For every parameter 15 specimens were tested according to EN 385/2001. Density and moisture content of the specimens were also determined.

3 Results and discussion

The average density of the specimens was $0.66\ g/cm^3$ (std 0.02) and the average moisture content 10.9% (std 0.201).

Bending strength (MOR) of the tested specimens fluctuated from 44.1 up to $97.8\ N/mm^2$ and was affected by the finger length (4, 10 and 15 mm), the type of glue (D1 and D2) and the finger orientation (horizontal and vertical) (Table 1). The higher percentage values compared with the solid wood, appeared in the specimens with 15 mm length of horizontal fingers, glued with D2 glue (73%) and the lower values in the specimens with 4 mm length of horizontal fingers, glued with D1 glue (32.9%). In all cases the increase in finger length

Table 1 Bending strength (MOR) of the materials tested
Tabelle 1 Biegefestigkeit (MOR) der Versuchsmaterialien

Name code	Solid wood	Finger length (mm) 4 PVA category D1	4 PVA category D2	10 PVA category D1	10 PVA category D2	15 PVA category D1	15 PVA category D2
		Bending Strength – MOR (N/mm^2)					
Horizontal		44.1* (5.9)	68.4 (5.0)	61.1 (9.5)	83.6 (6.3)	76.5 (6.8)	97.8 (6.9)
Vertical		49.5 (5.0)	67.7 (7.9)	68.6 (9.2)	85.6 (6.1)	76.2 (9.1)	97.2 (7.7)
Control	134.00 (16.1)						

* Mean values of 15 samples and standard deviation in parenthesis.

Table 2 Bending strength (MOE) of the materials tested
Tabelle 2 Biegefestigkeit (Elastizitätsmodul (MOE)) der Versuchsmaterialien

Name code	Solid wood	Finger length (mm) 4 PVA category D1	4 PVA category D2	10 PVA category D1	10 PVA category D2	15 PVA category D1	15 PVA category D2
		Bending Strength – MOE (N/mm^2)					
Horizontal		8,230* (1,171)	9,829 (1,024)	9,534 (839)	10,513 (1,013)	11,464 (1,040)	10,559 (1,085)
Vertical		10,521 (1,036)	10,626 (942)	10,239 (858)	10,749 (978)	10,709 (1,655)	11,078 (1,291)
Control	12,268 (2,427)						

* Mean values of 15 samples and standard deviation in parenthesis.

from 4 to 15 mm caused an increase in MOR values. Specimens glued with D2 glue appeared to have higher MOR values (from 67.7 up to 97.8 N/mm^2), than the specimens glued with D1 glue (from 44.1 up to 76.5 N/mm^2). Bending strength (MOR) was partly affected by the finger orientation (vertical and horizontal).

Bending strength (MOE) of the tested specimens fluctuated from 8230 up to 11 464 N/mm^2 and was partly affected by the finger length (4, 10 and 15 mm), the type of glue (D1 and D2) and the finger orientation (horizontal and vertical) (Table 2). In all cases specimens with 15 mm finger length showed higher MOE values than the specimens with 10 and 4 mm finger length.

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