The influence of annual ring orientation on strength and dimensional changes during moisture variation in finger joints.

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Subject

This investigation elucidates the significance of uniform annual ring orientation on the dimensional changes and strength of finger jointed boards.

Materials and methods

30 radially sawn Scots pine (*Pinus silvestris* L.) boards free from knots and visible defects with a cross section of 45 by 45 mm and 900 mm length, were cut into two equal lengths. Each pair was finger-joined in two ways.

Half the boards, i.e. 15 pairs, were joined using the same annual ring orientation in both pieces. In the remaining 15 pairs, one of the boards was turned 90 degrees. This means a board with vertical annual rings was joined to a board with horizontal annual rings (figure 1).

The joints were glued using a PVAc-glue (Bostic 742, harder 743) and the end grain was sealed with silicon. The boards were conditioned to a moisture content of 8 %. The length:width ratio of the finger joint was 10:3.5. The cross-sectional dimensions were measured on both sides of the finger joints at intervals of 5 mm over a distance of 50 mm and then at a distance of 75 mm and 100 mm.

The boards were then soaked in water for 7 days, which resulted in a moisture content above fibre saturation at a depth of at least 10 mm from the surfaces of the boards. After wetting, the cross sectional dimensions were measured again as described above. The boards were then dried using a conventional drying schedule (drying temperature 50 °C) for 10 days followed by a conditioning period of 3 weeks to a moisture content of 8 %. Thereafter the boards were loaded to failure in a 4-point bending test.

Results

Figure 2 shows the mean swelling values of the surface of the boards as a function of the distance from the finger joint. Since the tangential shrinkage and swelling due to moisture movement was about twice as large as the radial shrinkage, non-uniform swelling occurs in the finger joint with crossed annual rings, i.e. in the finger jointed boards with both vertical and horizontal annual rings, (figure 2a). In finger joints with a uniform annual ring orientation the swelling was uniform as shown in figure 2b.

As a result of non-uniform swelling and shrinkage in the joint when boards with different annual ring orientations are joined, stresses will develop in the joint. These stress variations may, ultimately, lead to a weakened joint. As for the appearance, a uniform annual ring orientation is preferable. If the joined boards are orientated in a such way that the radial surfaces are exposed and colourless glue is used, the joint has a very homogeneous pattern which is practically invisible. This implies that the width of the annual rings in the joined boards and the shade of colour of the wood are practically the same.

The result of the strength test did not show any significant differences in failure strength between the two groups, i.e. finger jointed boards with the same annual ring orientation contra finger jointed boards with both vertical and horizontal annual rings.

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Figure 1. Finger joined boards from the investigation. The upper board has the same annual ring orientation in the whole length. The lower board was joined by boards with vertical and horizontal annual rings.

Figure 2. Mean values for the swelling in finger joined boards with the same annual ring orientation (a) and with a difference of 90 degrees in annual ring orientation between the joined boards (b).