Wood Drying

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A STUDY OF DISTORTION OF INDIVIDUAL BOARDS AND LAMINATED TIMBER PRODUCTS

Sigurdur Ormarsson (Presently with Forest Research on sabbatical from Chalmers University of Technology, Göteborg, Sweden)

The warping of sawn timber can be a serious problem, both for the sawmill industry during drying and for users of wood products. Getting straight boards from sawmills is not enough if these warp later when exposed to variations in moisture.

The results of trials with Norway spruce show that the parameters influencing twist deformation most strongly are spiral grain angle and the annual ring curvature. Fig. 1 shows experimentally obtained variations in spiral grain over the cross section of a typical spruce log. The spiral grain is clearly largest near the pith and decreases with distance from it. Boards, from the central part of the cross section of a log, with a normal variation in spiral grain, always have a strong tendency to twist in response to variations in moisture. It would be very difficult, therefore, to construct drying schedules for such boards that would permanently result in good shape stability.

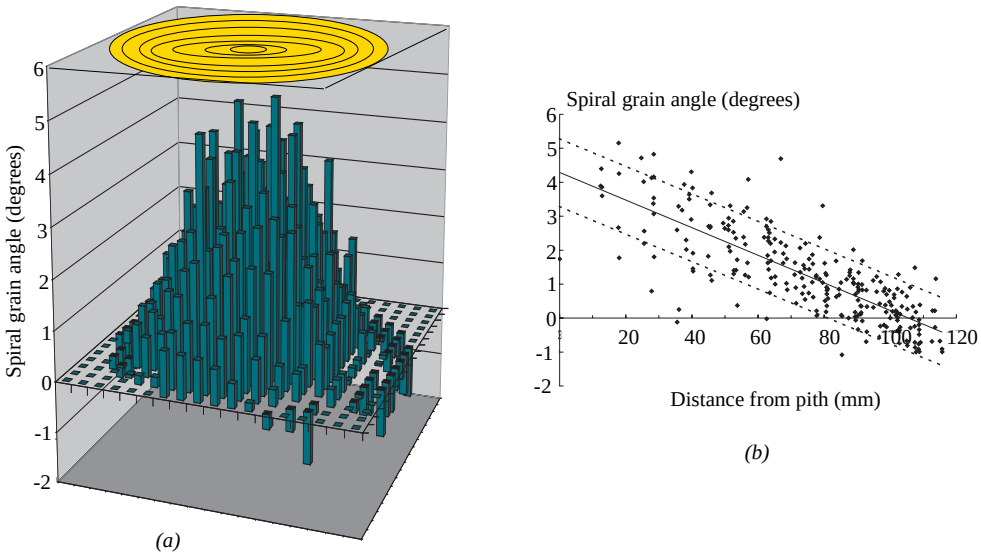
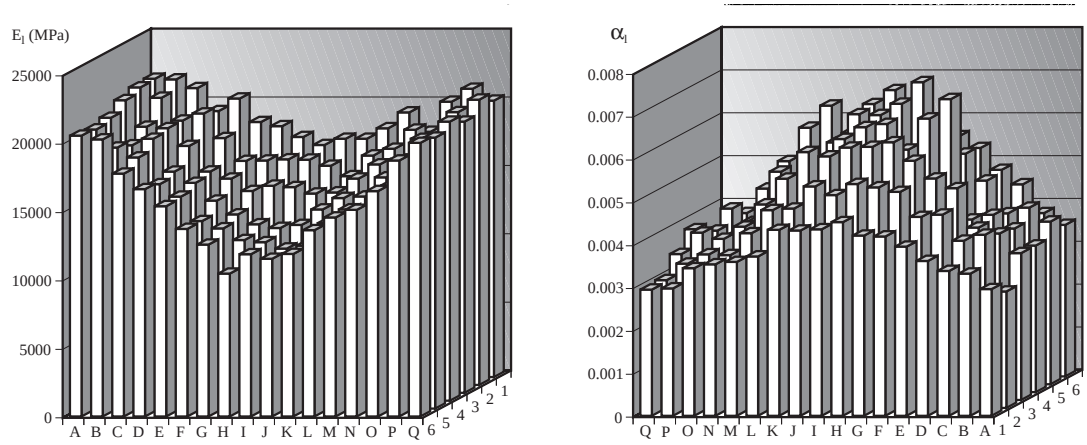


Figure 1. **Spiral grain in Norway spruce**
(a) **Variations over a cross section of a log**
(b) **Variations from pith to bark.**

Simulation results have also shown that radial variations in shrinkage and the elastic modulus have a considerable effect on bow and crook deformations in sawn boards. Fig. 2 shows variations in the longitudinal elastic modulus and the longitudinal shrinkage coefficients for Norway spruce. The results show clearly that the elastic modulus has a low value near the pith and increases with the distance from it, whereas shrinkage has the opposite tendency, being high in value close to the pith and decreasing with distance from the pith.

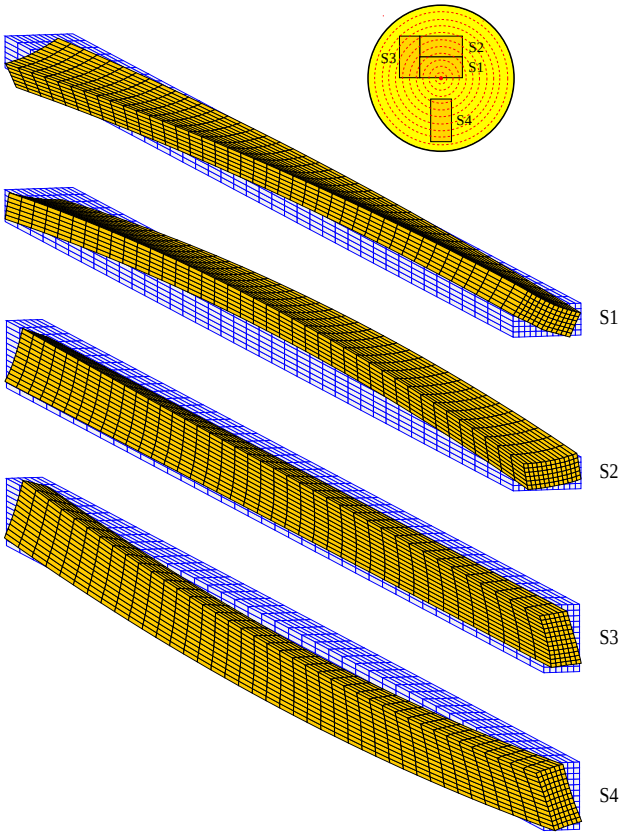
Computer simulation has been shown to be a realistic method of predicting deformation after drying (Fig. 3).

The results presented above show clearly that the deformations of a drying board are highly dependent upon its original location in the timber log. For boards near the pith, the most significant deformations are the twist and cup deformations, whereas for boards lying far from the pith it is the bow and crook deformations that are most significant. Knowledge gained by



(a) *(b)*

Figure 2. **Experimentally obtained variations in the material parameters of Norway spruce**
(a) **Longitudinal elastic modulus E_l**
(b) **Longitudinal shrinkage coefficient a_l.**



computer simulation makes it possible to improve conventional technical solutions and to develop new approaches aimed at overcoming the problems of limited shape stability of wood. The simulations performed have shown it to be possible to markedly improve the shape stability of boards by lamination in an optimal way.

Lamination

The individual board with highest twist tendency is a board where the pith is located in the centre of the board. Numerical simulations have shown for Norway spruce that the shape stability of timber products can be much improved by laminating in an optimal way (Fig.4). The results shown in the figure show clearly that the glued boards have very good shape stability despite consisting of the same material as the badly twisted individual boards.

Figure 3. **Distortion of boards S1-S4 after drying down to 11 % moisture content (all deformations are magnified by factor of five).**

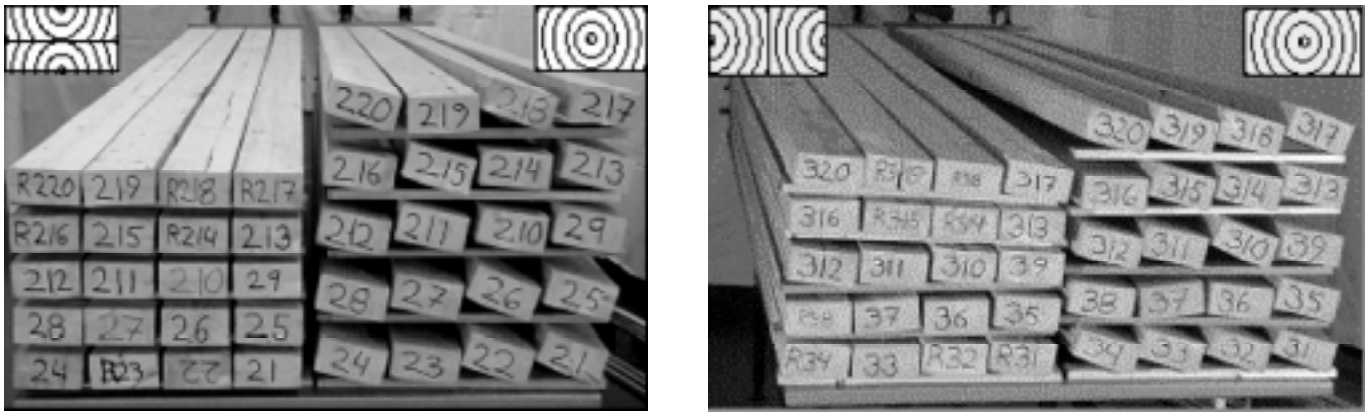


Figure 4. **(a) Twist distortions in face to face glued boards (left) and in the control boards (right) at 8% mean moisture content (b) Twist distortions in edge to edge glued boards (left) and in the control boards (right) at 8% mean moisture content**

Summary

The results obtained show clearly that if pieces of Norway spruce are oriented in an optimal way, glued products of very good shape stability can be obtained. The twist stability of the laminated board is extremely good. Thus this product can be produced industrially without demanding requirements being placed on the position of the pith. Laminating boards in an optimal way may solve most of the problems that sawmills are faced with today regarding the warping of sawn timber during drying and in use.

(During his stay in New Zealand, Ormarsson will use radiata pine data and perform similar simulations to compare with the Norway spruce results.)