Investigations of crack formation and delamination in bonded wooden elements in variable climatic conditions in the interior

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In wood construction, but also in interior construction, increasingly glued wood is used. Glued laminated timber (GLT) or cross laminated timber (CLT) are often used in timber constructions, while solid wood panels or multi-layer parquet are typical products for the interior.

Especially in the winter season, when buildings are heated, low indoor air humidity levels of 35% or significantly lower occur. This drives to the formation of moisture profiles in the timber components and subsequently cause tensions. In particular shrinkage stresses lead by the low maximum breaking strain of wood to a failure. As a result, cracks in wood but also in the bonding line occur. The tension influencing factor are

a) the structure of the material. Layer thickness, properties of the layers (type of wood, coating), moisture difference of the layers during bonding, arrangement of annual rings, adhesive type, adhesion quality, surface treatment
b) the ambient climate (relative humidity, temperature, air circulation).

The tensions resulting from changing climate conditions can be measured (free cutting, analogous to wood drying) and also calculated. Comprehensive material characteristics are required for computation (e.g., wood, adhesive, coating material). Relatively few research approache exist about the aging of the bonded components and there is considerable more research needed. Aging effect can occur quite soon after the wood-adhesive-composite is built in. In case of parquet, delamination can take place only after years. In case of cross laminated timber, cracking and delamination are often recognizable after just a few months. The damage rarely leads to a reduction in the load-bearing capacity of glued laminated timber and cross-laminated timber. In cross-laminated lumber or multi-ply solid wood panels (see Figure 1), the risk of cracking is higher than in glulam. This is due to the considerable orthotropy in the swelling and shrinkage behavior of the wood. Technological (moisture content during production, pressure during pressing, wood elaboration) and structural influencing factors (lamella properties, lamella thickness ratio) are presented as well as selected cases of damages and positive examples.

a) shrinking cracks in solid wood panel (middle layer) b) delamination in glulam

Fig 1: Moisture induced cracks and delamination in glued wooden elements under dry conditions

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