Experimental characterization of material properties for numerical modelling of timber engineering applications

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The focus of this contribution is to give examples of new experimental setups developed at the Chair of Timber Structures and Building Construction (TUM) in order to characterize and quantify material properties which are subsequently included in numerical models of timber engineering applications. These examples mirror the scientific approach taken at the research group which is (1) to provide experimental evidence and (2) to interpolate and (very cautiously extrapolate) from these experimental results using numerical models, in order to receive a wider picture on the investigated topic.

The first example concerns the determination of the axial embedding stiffness k_{ax} of fully threaded self-tapping screws (STS) in order to predict their share in the transfer of relevant stresses when used as reinforcement. A STS is drilled through a timber specimen at desired angle between STS and grain. The STS traverses the timber specimen, projecting on both sides. A compression strain (deformation) is applied to the timber specimen while measuring the relative deformation of the STS which extends through two small holes in the steel plates used for load application. The embedding stiffness between the STS and the wood material is regressively determined with a numerical model [1]-[3].

The second example covers the determination of the axial strain of STS when used as reinforcement of e.g. holes in timber members. This is realized by drilling a hole from the screw head through the core of the screw and applying a glued-in strain gauge in the hole at the location where the highest strains in the screw are expected for the specific reinforcement application. Subsequently the screw is applied as reinforcement in a timber specimen. During the testing of the timber specimen, the strains in the STS are measured. Following this, these are compared to the strains determined by numerical modelling. The results are used to e.g. verify the applied embedding stiffness of the screw [3], [4].

The third example is related to the determination of the angle of stress distribution (stress dispersion) into cross laminated timber (CLT) elements under concentrated loads in plane. The upper flange and web of a specifically designed steel beam (I-section) are slotted into single elements, each featuring 50 mm horizontal length. Strain gauges are applied to both sides of the web-sections of each single element. The CLT element is placed vertically on the steel beam. A concentrated load is applied to the CLT-element in plane direction. During the test, the strains are measured in each steel element. The measured strains are converted into compression stress in the steel, correspondingly the force per unit length in the contact line between steel and CLT, and thus the distribution of stresses in the CLT-element can be estimated [5]. The results are used to e.g. verify numerical results of stress distribution angles for different CLT layups.

The fourth example concerns the continuous monitoring of timber moisture content (MC) and surrounding climate. At each location of measurement, four pairs of teflon-insulated electrodes with varying length are installed to enable the measurement of MC at clearly defined depths of the cross-section. The ram-in electrodes with partly teflon-insulated heads are connected to the moisture meter by custom built, shielded coaxial cables. The moisture meter records the resistance at up to eight channels. Each channel is actuated separately once per hour. Relative humidity and air temperature are recorded via a second data logger installed at the location of MC measurement. In addition to surface temperature, material temperature is recorded at two depths to allow for temperature compensation of the MC [6], [7]. The data (records of up to 3 consecutive years available) can be used to e.g. verify hygro-mechanical numerical models.

References

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