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Simulation of the temperature distribution in glued butt-joint timber connections

Dio Lins[1*] and Prof. Dr. Steffen Franke[2]

[1] Bern University of Applied Sciences, Solothurnstrasse 102, 2500 Biel, Switzerland, dio.lins@bfh.ch

[2] Bern University of Applied Sciences, Solothurnstrasse 102, 2500 Biel, Switzerland, steffen.franke@bfh.ch

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With the Timber Structures 3.0 technology, timber components are bonded together in a statically load-bearing manner by a 4 mm thick butt joint on the face side of cross-laminated timber (CLT) plates filled with a casting resin. In particular, this offers the possibility of creating biaxial load-bearing ceiling panels made of CLT in any geometry.

However, the processing temperature of at least 17 °C [1] specified by the casting resin manufacturer still poses a challenge for the construction site application. Therefore, the possibility of locally tempering the 4 mm thick casting resin joint during the curing process is being investigated. For this purpose, a groove is milled into the surface to be cast, into which a heating wire is inserted. This heating wire is intended to heat the casting resin joint to above 17 °C during curing by low ambient temperatures.

In order to investigate whether this measure causes a sufficient temperature in the joint, a numerical simulation is carried out in Ansys. For the timber, the material parameters (thermal conductivity and heat storage capacity) are known as a function of the respective fibre direction, but for the casting resin, the values known for the cured state are used first. Although these differ from those in the fluid respectively curing state, they represent a good first approximation. Likewise, a justified assumption is made for the exotherm. With these input values and clearly defined boundary conditions of geometry, ambient temperature and heat transport, the temperature distribution in the joint is calculated over time and over the cross-section. Subsequently, an experiment with the same boundary conditions is carried out and the results are compared. In the following, the material parameters of the casting resin in the simulation are adjusted so that the simulation and experiment match. With the values determined, the application is planned and carried out on the construction site.

To verify the input values, the site application is monitored with temperature sensors and compared with the previous simulation. This comparison shows that the simulation represents reality sufficiently accurately. Therefore, the simulation can be extended to different boundary conditions, such as panel thicknesses and ambient temperatures, and used in the future to determine the number and amperage of heating wires for construction projects at below 17 °C.

REFERENCES

[1] Henkel & Cie. AG: *Loctite CR 821 Purbond.* 2019-05