ForestValue

innocrosslam

INNOVATIVE MULTIFUNCTIONAL CLT

The objective of the research presented is to further develop a CLT element, multifunctional in terms of thermal activation by circulating air in channels in one of its layers.
By determining e.g. **the mechanical properties**, the **deformation behavior under moisture change** such as the **safety in case of fire**, the main questions summarized in the Construction Product Regulation (CPR) are answered.

For testing purposes, **five different configurations** of multifunctional CLT were developed and produced with our partner Lignotrend GmbH (Series M1 to M5). To enable a quantitative evaluation, the results of all experiments are compared to a reference series on conventional CLT without channels.

The findings of the mechanical experiments have already proven that neither the asymmetric layup nor the channels significantly reduce the load-bearing capacity of the multifunctional layups.

Fig. 1: CLT Specimens in the climate chamber during the long-term investigation

In addition, the deformation behavior of multi-functional CLT under moisture changes as well as possible cracking in the front layers were analyzed.

Four specimens of each series were put into a climate chamber and experienced different heating and cooling phases as to be expected after assemby (Fig. 1). In four different depth, ram-in elcectrodes were brought into the elements, in order to measure the moisture profile over the cross-section. The upper charts at Fig. 2 represent the heating and cooling modes. The middle charts give the moisture content in different depths as a function of the time and operating modes of M1 series. The lower chart in Fig. 2 gives the curvature of M1 series before and after the starting of the heating mode. The switch of the moisture profile during heating mode leads to a switch of the overall curvature of the elements and therefore to cracking of the front layers.

The long-term climatic testing demonstrates that the quality of the front layer of multifunctional CLT is of decisive importance for the deformation behavior and crack pattern under thermal stress. It is therefore advisable to use high-quality (SWP/3) 1-layered better 3-layered solid wood panels for the front layers.

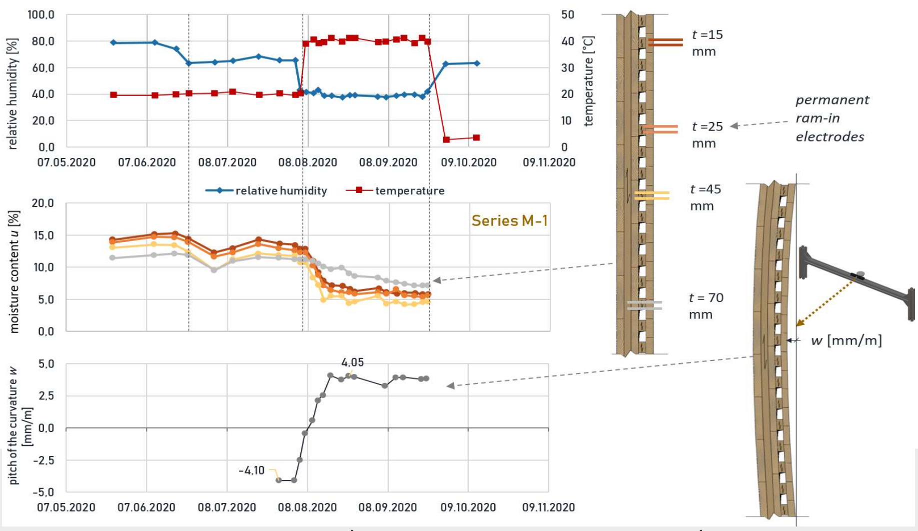

Fig. 2: Heating and cooling modes (relative humidity and temperature), wood moisture contents in different depths, and resulting pitch of the curvature of the M1 CLT series

Fire resistance

Compared to a standard CLT (five-layered, t_i = 20 mm), it can be seen that the discrepancy of the curves measured at 40 mm depth with and without channels differ significantly. The flash point of 300 degrees is reached about 15 minutes earlier for M1 series than for 01 series within the centre layer. Smoke passage for M1 is reached after 60 minutes. A burn-through after 90 minutes.

For the investigations of cavity fire, specimens were offset inwards into the oven, in order to simulate a circulating fire due to chimney effects. The specimens had a length of 1.3 m, and the time - temperature curves were measured at the bottom, in the middle and at the top of the specimens.

By comparing M1 series without additional cavity fire to M1 series with additional cavity fire it gets obvious, that the additional cavity fire leads to a shortage of the fire resistance by additional 10 minutes.

For detailed results, the authors may refer to the joint TUM final report of work packages 5 and 6 of the project InnoCrossLam.

Fig. 3:

Fire testing on the multifunctional CLT (90 min, ISO 834). Left side: Without cladding; Right side: With cladding; Middle: Simulation of circulating cavity fires.

Safety in case of fire is a key issue. We have therefore tried to answer as many questions as possible about the behavior in the case of fire. For example, the determination of mass burning rates and the fire protection closure. In large-scale fire tests, the time-temperature curves, the mass burning rate, and fire protection closure was investigated with and without cladding (Fig. 3). In additional investigations, the effects of circulating fire within the channels and the behavior of wall-ceiling joints were analysed.

The charts in Fig. 4 give the time-temperature curves behind each layer of the test specimens (i.e. at a depth of 20, 40, 60, and 80 mm) for a fire event following the ISO 834 curve. The question of how to limit or extinguish cavity fires is a question about the causality of a fire event that can only be answered analytically: Either a burning-in must be prevented by means of fire bulkheads or intumescent stripes have to be inserted into the cavities during production.

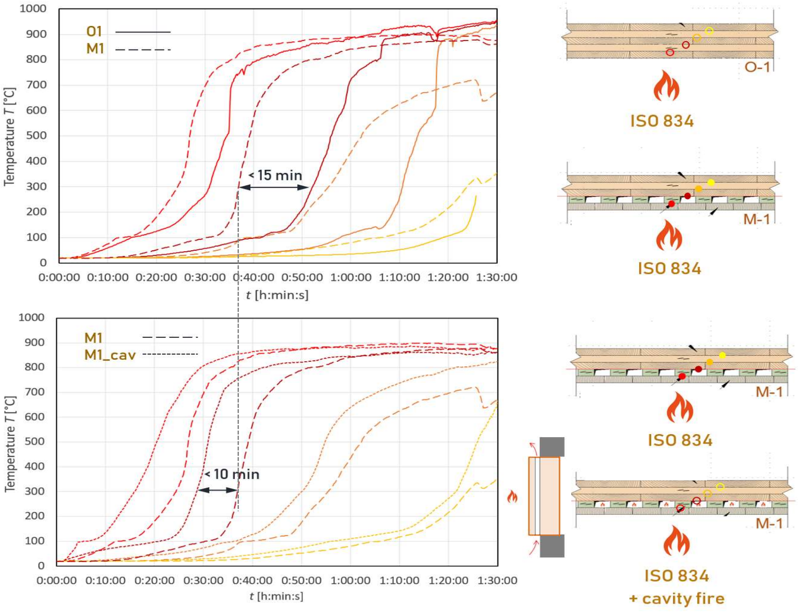

Fig. 4:

Time-temperature curves of the fire testing. Upper charts: Comparison of reference 01 to multifunctional M1 series; Lower charts: Comparison of multifunctional M1 series with and without additional cavity fire.

AUTHORS:

M. Arnold, P. Dietsch and S. Winter.