

THE STRUCTURAL BEHAVIOUR OF CROSS-LAMINATED TIMBER RIB PANELS IN FIRE

Miriam Kleinhenz¹, Alar Just², Andrea Frangi³

ABSTRACT

In the frame of a research project, the structural behaviour in fire and the fire resistance of cross-laminated timber rib panels were studied based on experimental and numerical investigations. The floor system consists of cross-laminated timber plates rigidly bonded to glued-laminated timber ribs. The full composite action between the composite components is provided by means of screw-press gluing. The results of the reference tests showed good agreement with results based on the method of rigidly bonded components and the effective width according to the final European draft of cross-laminated timber design [1]. The fire resistance tests resulted in fire resistances up to 120 min and confirmed the assumption that the effect of the composite action was maintained in fire. In this paper, the numerical investigations cover thermal, and uncoupled thermo-mechanical simulations using a 2D FE model of a linear beam system for discussion of the mechanical behaviour under fire exposure. The numerical results of the tested cross-sections are compared with the experimental results of the fire resistance tests. Depending on the modelled cross-section, the influence of the effective width on the numerical results is investigated.

Keywords: Massive timber rib panel; fire resistance; fire tests; finite element; effective width

1 INTRODUCTION

Long-span floor systems are required for building types such as commercial office buildings, residential buildings, schools, and industrial buildings. As a long-span floor system with spans up to 16 m, cross-laminated timber rib panels consist of cross-laminated timber (CLT) plates connected to glued-laminated timber (glulam) ribs (Figure 1). Full composite action is provided by a rigid connection between the composite components by means of screw-press gluing [2]. For ribbed cross-sections, the assumption that the cross-section remains plane is incorrect. The simple beam theory according to Euler-Bernoulli is not applicable because the strains in the flange vary with the distance from the rib due to the in-plane shear flexibility of the flange. This leads to a non-uniform distribution of the longitudinal strains along the flange width. For simplified structural analysis, the effective width defines an equivalent cross-section that provides the same maximum bending stress and effective bending stiffness as the actual cross-section [3]. The final European draft of CLT design [1] for a revised version of EN 1995-1-1 [4] proposes simplified formulae to estimate the effective width for ribbed plates build up from cross-laminated timber plates. In the case of uniformly distributed loads, equation (1) determines the effective width at normal temperature b_{ef} according to prEN 1995-1-1:20xx [1], as explained in Figure 1

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