Abstract

The available standard and design fire curves used to analyse structural fire performance, do not reliably predict the exposure temperature for fires in large compartments. Also, these fire curves do not consider the effects of the extra fire load when combustible elements are a part of the structure.

A Performance-Based Designs (PBD) approach was required to analyse a large Industrial Hall, formed of a wooden structure, to understand the performance during a fire. This thesis presents a methodology that involves using advanced calculation techniques to generate real fire scenarios in timber buildings and to analyse structural performance due to those fires.

Fire Dynamic Simulator (FDS) was used to simulate a critical fire in the Industrial Hall accounting for the additional fire load from the combustion of timber elements. Key parameters and boundary conditions required to simulate the fire scenario and timber combustion have been discussed in detail. The FDS results were used to generate the parametric design fire curves, which were in turn used to study structural performance during the fire.

The thermo-mechanical analysis for timber columns was done using the commercial software package Abaqus. The temperature profiles inside the timber columns were predicted with temperature dependent material properties during an ISO standard fire exposure and parametric design fire exposure. Then the mechanical analysis was conducted using the predicted temperature values with the temperature dependent mechanical properties. The load bearing capacity and the buckling capacity of the timber element was checked during the 60 minutes of fire exposure for failure. The finite element model results were compared with the Eurocode 5 design calculations to see the difference between PBD method and the prescriptive code values. The results showed that the Eurocode 5 provides an over conservative solution to the structural performance of timber elements in the Industrial Hall compared to the PBD design