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## Numerical model to evaluate the protected and unprotected wooden slabs under fire

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### Abstract

The main objective of this work is to present a numerical methodology, based on the finite element program, to predict the thermal assessment in wooden cellular slabs under fire. The designed wood models represent different building applications in construction engineering, as walls, ceilings and floors. The proposed models represent protected and unprotected wooden slabs to determine the fire resistance, and increase the use prevention of these materials.

**Keywords.** Fire behaviour, charring rate, temperature, wood.

### 1. Introduction

Wood has been broadly used as construction material due to their availability in nature, variety, lightness, having good physical characteristics, as chemical and mechanical properties. This material is used in many different civil construction applications, namely in floors, ceilings and walls. Furthermore, the mentioned advantages, wood has excellent architectural, thermal and acoustics characteristics, allowing easy assembly of sets (Pinto, et al., 2004).

Under adverse work conditions, the material properties might degrade, compromising its performance and safety. Over the last few years new numeric and experimental studies have been performed, which objective was to predict the material behaviour, under influence of external factors, as fire situations (Janssens, 2004), (Gay et al., 2011), (White et al., 1999), (David et al., 2016), (Fonseca et al., 2012). Wood is considered a combustible material, when it burns, flames are released. However, wood on fire, it presents a peculiar behaviour, since its core may remain unchanged. When being consumed by flames, a char layer formed will condition the heat inside wood, therefore protecting its core. The wood charring rate is one of the major parameters used to describe wood behaviour towards fire, as it allows determine the time fire resistance that the structures will performed in site and its structural safety (Frangi, A. 2009).

To improve wood fire resistance, some insulating materials are used in wood structures. In general, these materials have low thermal conductivity, therefore a reduced heat transfer rate is transferred through the wood member.

### 2. Work discussion

The main goal of this study is to evaluate the thermal behaviour of wooden cellular slabs exposed to fire conditions, according the standard ISO 843 curve. Different numerical simulations for nonlinear thermal and transient analysis will be obtained, using the finite element method. The wood thermal material properties are temperature dependent and vary according to the Eurocode 5. The wood specie considered in the present study is Douglas-Fir tree, with a density equal 341[kg/m<sup>3</sup>] and moisture of 11% (Frangi, et al., 2008).

To validate the proposed thermal numerical model, the wood charring rate was determined in different time instants. The mean value was determined to guarantee the results precision. A comparison between the obtained numerical value and the value prescribed by the Eurocode 5 were verified with a good agreement.

The importance of this study relies on its contribution to an alternative numerical methodology, which allows to determine the safety and fire resistance levels in wooden cellular slabs, with or without insulation materials.

### 3. Conclusions

Results identified in all models permit to determine the temperature evolution and the residual cross-section through the slab element at different time instants for fire situations. Different wooden cellular slabs configurations were developed to identify the best and worst design model. Discussion of the numerical results and the comparison between protected and unprotected slabs will be obtained.

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