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ROBUSTNESS OF STRUCTURES IN NATURAL FIRE

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1 Introduction

In this contribution, the thermo-mechanical analysis of civil engineering structure is considered. The focus of research is concentrated on finding the most influencing fire scenario for evaluation of fire resistance time, as well as the relationship between mechanical loading cases and corresponding the most severe fire scenarios in order to provide effective and robust design. In this paper, natural fire formulation is assumed. Advantages in relation to Eurocode regulations [2] for steel structures with ISO fire curve model are performed. Nevertheless, estimating structural resistance using natural fire model needs significantly more effort and computational resources.

2 Theoretical background

Analyses of structures in natural fire need to adopt comprehensive approaches for coupling Computational Fluid Dynamics for fire simulation [4], and Finite Element Method for analysis of structural response. Therefore, an interface have to be provided between those two. In this contribution, sets of special scripts are used to solve multiphysical problem of heat transfer from ambient environment into the solid phase of structural members [3]. Nonetheless, the amount of simulations that have to be done in order to compute all of the fire scenarios that can occur in complex structures, is still an obstacle regarding the computational time. Thus, the new method, proposed by De Biagi and Chiaia [1], is adopted in order to select the most critical elements for certain load case. That method base on the graph theory and the principle of the minimum of complementary potential, and allows to find fundamental structure which act as a preferential path through which the loads are carried.

3 Numerical example

Two-storey frame structure with dimensions of 6,0x6,0m and 4m storey height is analysed (Fig.3). Structure is subjected to various mechanical load cases and for each one, the fundamental structure is derived [1], and then a specific fire scenario is chosen.

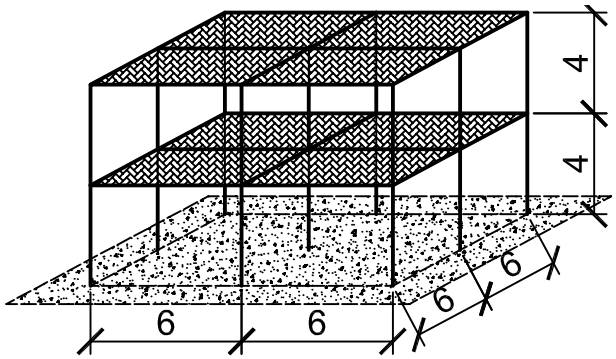

Figure 1: Structural model taken into consideration.

4 Final remarks

The main outcomes from the analyses are the fire resistances of entire structure subjected to natural fire conditions. Those values are set together with the corresponding fundamental structures and load conditions. The influence of fire scenario and external loads scheme onto the structural safety during the fire course is examined. Structural complexity index and beam importance factor are calculated in order to find critical elements regarding robustness of structure. Without numerical simulation within CDF/FEM, influence of natural fire influence onto complex construction is practically indeterminable. Therefore, results of described analysis significantly contribute to evaluation of design and operational security of structure.

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