Different design approaches to structural fire safety

Fire has always been a major threat for buildings and other structures, leading to consequences that can affect both the safety of people and the usage or in some cases the very survival of constructions, due to collapse mechanisms induced by fire or fire effects. Aim of this paper is to highlight how both safety issues (avoid people injuries and preserve integrity of constructions) are addressed in the framework of current design practice for fire safety of steel constructions. In particular, three distinct approaches are distinguished and applied to the case study of a steel car park: i) design for resistance class; ii) design for fully developed fire; iii) advanced design. The first two refer to well established procedures proposed by prescriptive regulations, and even if it seems possible to identify different unexpressed safety goals among the two, still it is not easy to a-priori evaluate which design is the safest or the most economical one: a punctual analysis of the different aspects and a comparison of the resulting designs is therefore of interest and is presented in this paper with reference to the case study considered. The third approach refers instead to a performance-based fire design of the structure (PBFD), where safety goals are explicitly defined and a deeper knowledge of the structural response to fire effects can be achieved, for example with the avail of finite element analyses (FEA). On the other hand, designers can’t follow established procedures when undertaking such advanced investigations, which are generally quite complex ones, due to the presence of material degradation and large displacements induced by fire, as well as the possible triggering of local mechanism in the system. An example of advanced investigations for fire design is given in the paper with reference to one frame of the considered car park, outlining the most problematic aspects in the modelling and in the interpretation of the results and making a focus on the collapse mechanisms of steel frames such as catenary action and sway and non-sway collapse.