Comparison of steel strength retention models for fire exposed concrete slabs

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Abstract

In structural fire engineering, there is a growing trend towards the use of performance based approaches to evaluate structural behaviour during or after a fire. Consequently, there is a need for an increased level of confidence in properties of construction materials used in these performance based approaches. Both steel and concrete have been experimentally observed to show a dispersal in the value of their respective structural strengths, at room temperature, but more significantly at high temperatures. In this paper the influence of three temperature dependent strength retention models for reinforcement steel on the bending moment capacity of simply supported reinforced concrete slabs exposed to a standardized fire is analysed. The results show that the structural response of reinforced concrete slabs strongly depends on the chosen probabilistic model, thus highlighting the importance of appropriate model selection.

Keywords: Concrete slab; Structural fire safety; Strength retention; Performance based design.

1 Introduction

Traditionally, the fire resistance rating of concrete structural elements is determined through standardized tests or tabulated data, in accordance with national design codes. These design codes (e.g. Eurocode 2, ASCE 7) are typically highly prescriptive and use semi-probabilistic approaches to design structures for exposure to fire. While these design approaches are easy to apply, the risk of damage or collapse of the designed structures remains unknown. Therefore, in structural fire engineering, there is a growing trend towards the use of performance based approaches to evaluate structural behaviour during or after a fire. Performance based methods have the advantage that they can be used to optimize a design, and ensure a certain level of safety. With the rise of performance based design methods, there is also a need for an increased level of confidence in properties of construction materials. Both steel and concrete have been experimentally observed to show a dispersal in the value of their respective structural strengths, at room temperature, but more significantly at the high temperatures typically associated with a building fire [1]. This scatter in temperature dependent strength values also leads to a scatter in values of the critical temperature, time to failure, or maximum resistance capacities, thus strongly affecting structural reliability under fire hazards. Therefore, in this paper, the influence on the distribution of the structural response of reinforced concrete (RC) slabs is compared for three probabilistic models for the reinforcement tensile strength retention at elevated temperatures found in literature. Through the use of Monte Carlo simulations and a subsequent full probabilistic analysis, the influence of these models on the bending moment capacity of simply supported RC slabs exposed to a

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