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Thesis

Structural Fire Performance of Beam-to-Column Moment Connections Joining Tubular Steel Members

Abstract

Connections in steel building structures play a vital role in joining different elements together and in ensuring the integrity of the whole structure. One of the most popular steel connection types in steel-framed structures is the beam-to-column moment connection. Unfortunately, limited experimental work has been done to investigate the behaviour of this type of connection in fire conditions due to the complexity of the subject and the need for adequate fire testing facility. Also, most current design codes assume that steel connections would be heated more slowly than beams or columns in fire situations, and are therefore less likely to be the critical component in fire design. However, evidence from the collapse of the World Trade Centre buildings indicates that steel connections may often be the weakest links in steel-framed structures in fire conditions. The research presented in this thesis deals with one of the commonly-used moment connection in steel-framed structures, which is the extended end-plate moment connection. In this research, this type of connection is used to connect beams to columns that are made of Hollow Structural Sections (HSS).

HSS are increasingly being used in recent years for structural and architectural reasons. Besides the attractive appearance of HSS steel elements in modern steel construction, their sections possess high strength to weight ratios, which makes them cost-effective. Another aspect of HSS steel elements is their internal voids that can be utilized in different ways, such as to increase the fire and bearing resistance of HSS columns by filling their voids with concrete. Although the closed shape of HSS steel elements has several structural advantages, connecting these elements together is challenging. Besides studying the regular extended end-plate moment connection configuration joining HSS beams and columns, a new connection configuration has been introduced and examined in this research at elevated temperatures. The research includes full-scale fire experiments, finite-element modeling, and an analytical study. Different parameters have been experimentally and numerically studied in order to investigate their effects on the structural performance of restrained steel beams and their end connections in fire. The study parameters include the connection end plate thickness, the degree of beam axial restraint, the level of fire protection, the beam load ratio, and the beam span length.

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