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Structural Fire Assessment of Concrete Filled Steel Hollow Sections

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Abstract

Concrete filled hollow steel (CHS) members offer a number of benefits and are often used in tall buildings and other industrial structures. In this case the behaviour of the concrete filled hollow section is investigated as a component of a restrained diagrid truss system at the fire limit state.

Firstly, a FE solid model was developed and used to investigate the thermo-mechanical interaction of the composite member under fire loads. The results were used to develop a simplified representation of the member which could be included within a global model of a diagrid truss system and analysed under many different scenarios.

The purpose of this paper is to discuss the innovative methodology used, and the results obtained within the detailed analyses to study the inherent capacity of the diagrid structure with no additional passive fire protection.

Keywords: Infill-concrete hollow steel, Abaqus, non-linearity, thermo-mechanical sequential analysis.

1 Introduction

A key component in any fire strategy is to ensure that the structural system has sufficient capacity at the fire limit state to prevent collapse enabling occupants to safely escape and firefighters enough time to fight the fire. The usual way of ensuring this is to prescriptively provide a certain fire resistance specified in the regulations to each individual element of structure normally considered acting as isolated and unrestrained. However, alternative performance based approaches are also allowed and for some large and complex structures are the only way to ensure conformance with the functional requirements of the code.

Many European fire research programmes have shown that fire protection cost can be reduced and encouraged the development of new methods for performance-based fire engineering of structures. Many researchers have studied the field of concrete filled hollow sections through experimental fire tests [1][2] and numerical models [3][4][5] to represent and understand the excellent synergic effect of steel and concrete to carry applied forces at high temperature. All of these recent studies have resulted in practical guidance that can be used in industry.

The key concept of a diagrid system is that the main members are arranged over a number of floors to form a major role in both the lateral and vertical load carrying system. The main diagrid members are generally sized to control the overall stiffness of the building and therefore are often significantly under-utilised at the fire limit state. Filling with concrete further enhances load carrying capacity and stiffness.

Due to the diagrid composite section, a detailed Finite Element (FE) analysis was conducted to capture the interaction between steel and infill concrete contributing to the member capacity

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