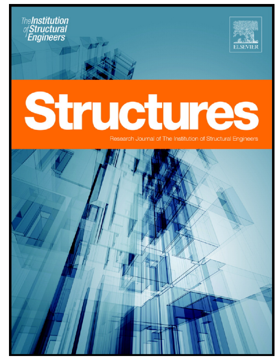

Advanced Finite Element Simulation of Ductile Structural Steel Incorporating a Crack Growth Model

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Advanced finite element simulation of ductile structural steel incorporating a crack growth model

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Abstract

A design methodology that addresses the modelling of ductile steel behaviour in a unified format is presented. In this methodology, three empirical laws defined as Hook's Law, Hollomon Law, Modified Weighted Average Law and a crack driven law based on the extended finite element method (XFEM) linked empirically and systematically to format an advanced design approach. A set of test data representing forty-five coupon tests of 40x40x2.5, 20x20x2.0, and 50x25x2.5 (mm) square and rectangular steel hollow sections is used to demonstrate its applicability and effectiveness in driving material-model. The material model developed is employed in developing a robust numerical model of the steel hollow sections. Another set of data representing twenty-three monotonic static tests of steel hollow sections is employed to validate XFEM model's performance. The XFEM results are found to match the physical tests values relatively well. In other words, when comparing the ratio of yield force, ultimate displacement, and energy dissipation capacity estimated from the FE model to the measured values in the physical test, the mean values are found to be 1.03, 1.08, and 1.05 with a coefficient of variation of 0.05, 0.19, and 0.19 respectively. Hence, the design methodology presented and the XFEM model developed can be used with confidence as they have been calibrated and validated using the test data.

Keywords: Empirical models; extended finite element method; tension; steel hollow sections; ductile behaviour; steel; braced frames

1. Introduction

The accuracy and performance of a numerical model depend principally on the correct representation of the material characteristics by constitutive relationships. It is unlikely that a structural designer will have a comprehensive set of data on material properties for modelling structural elements in practice, unless extensive physical testing and data analysis has been carried out in advance. In such cases, models based on the empirical formulation play a crucial role and fill the design