Benchmarking of a Plasticity Material Model for Numerical Simulation of Concrete Filled Steel Tubes

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1 Abstract

The popularity of composite sections increased notably in recent years due to the possibility to combine materials with individual mechanical properties beneficial for structural applications. Focusing on concrete-filled steel tubes, such members exhibit primarily an increased ultimate strength as well as a higher ductility in comparison to similar members with a homogeneous cross section made from either steel or concrete. Research issues on the structural behavior of such composite members include the interaction of the materials as well as the mechanical behavior and stochastic characteristics of the individual materials. As the materials are subjected typically to a multiaxial stress state, modelling of the material behavior is still a challenging issue in those applications. In particular for concrete, different material models were proposed in previous research for simulation of the actual behavior. This paper reports on characteristics of the structural behavior of concrete-filled steel tubes as well as on a plasticity material model for numerical simulations of this behavior. Some common approaches in application of this material model are collected and discussed, followed by an exemplary numerical application on concrete-filled steel tube specimens for the purpose of benchmarking.

Keywords: Concrete-Filled Steel Tubes, Finite Element Analysis, Concrete Damaged Plasticity, Material Modeling.

2 Introduction

Concrete-filled steel tubes (CFST) are becoming increasingly popular throughout the world due to an advantageous composite action of steel and concrete in such members [1]. The structural behaviour of these members is fundamentally different from the one of members made exclusively of steel hollow sections. More precisely, the concrete filling prevents the steel section from buckling inward and thus affects the buckling mode. In the post-buckling domain, the behaviour of CFST members is more ductile than that of equivalent members with a hollow section [2]. In particular for composite members with a circular tube shape, a substantial post-yield strength and stiffness was observed in tests, which was not that striking for members with a square or rectangular hollow section [3].

Extensive research on the behaviour of CFST columns has been carried out since the 1950s, when

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