Influence of different debonding gap types on mechanical performance of axially loaded CFST stub columns

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Abstract

The mechanical performance of concrete-filled steel tubular (CFST) members could be affected by the debonding gaps between steel tubes and core concrete. In this paper, the finite element models (FEMs) of axially loaded CFST stub columns with different debonding gap types, i.e., circumferential debonding gap (CDG) or spherical-cap debonding gap (SDG), were implemented by ABAQUS. The accuracy of FEMs was verified by test results. The influence of different debonding gap types on the mechanical performance of axially loaded CFST stub columns with the same debonding cross-sectional area was compared by using FEMs. The results showed that compared with SDG, the influence of CDG on the ultimate load-bearing capacity (N_u) was larger and on the failure mode was smaller. With an increase in CDG arc-length ratio (R_{CDG}), the reduction coefficient of N_u (K_D) firstly increased and then decreased. With an increase in SDG ratio (χ_{SDG}), the K_D decreased. With an increase in R_{CDG} or χ_{SDG}, the N_u decreased. All the debonding specimens showed inward buckling in steel tubes within the debonding range, while the outward lateral deflection towards the no-debonding range was also observed. With an increase in R_{CDG}, the inward buckling of steel tubes was more severely to contact with the core concrete at the middle-height of columns, then an outward buckling was found. With an increase in χ_{SDG}, the inward buckling of steel tubes become more significant, but the failure modes remained unchanged.

Keywords: Axially loaded CFST stub column; Circumferential debonding gap; Spherical-cap debonding gap; debonding area; Ultimate load-bearing capacity; failure mode.

1 Introduction

Concrete-filled steel tubular (CFST) structures have the advantages of high ultimate load-bearing capacity, good plasticity, and ductility [1-4]. In fact, the compressive strength and ductility of core concrete can be increased by the lateral confinement provided by the steel tube, and the local buckling of steel tube delayed and restrained by the filled concrete [5,6]. In engineering applications, debonding gaps can be found between steel tubes and core concrete, which can be divided into the circumferential debonding gap (CDG) and spherical-cap debonding gap (SDG), as shown in Figures 1(a) and (b), respectively. The CDG is mainly caused by several unavoidable reasons, such as concrete shrinkage [2,7,8], temperature difference [9], and confining force

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