The ultimate strength of concrete-filled steel composite columns

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Summary

The concrete-filled composite member has been used as a building column and bridge pier owing to the enhancement of strength, stiffness and ductility due to mutual confinement between the steel skin and the filled-in concrete. A series of compression tests of circular hollow steel sections and concrete-filled circular steel composite sections were conducted. The diameter-thickness ratio of the test specimens ranged from 45-140 to study the effect of local buckling of the circular steel skin, while the test results for the rectangular composite section were referenced for comparison. An ultimate strength formula for the steel skin was developed to account for the post-local-buckling strength reserve. The strength of the filled-in concrete strength was proposed to account for the strength ratio of steel skin to filled-in concrete instead of 0.85 F_c or 1.0 F_c for the filled-in concrete, and cross section shape, which consequently can consider the increase of filled-in concrete due to the confining effect of steel skin against the outward deformation of the concrete. The ultimate strength of the composite columns was predicted by a kind of direct strength method which was first adopted by the NAS (AISI, 2004) to be applied for the cold-formed steel sections. The proposed direct strength method does not need computing the effective area of the steel skin and uses the gross area of the steel skin and the design strength formula based on the various test results. The direct strength method proposed was compared with the test results for verification.

Keywords: Concrete-filled Circular Composite Columns, Ultimate Strength, CHS Sections, Compression Tests, Diameter-Thickness Ratio, Direct Strength Method

1. Introduction

The concrete-filled steel columns have some advantages such as high ultimate strength, excellent ductility and large energy dissipation capacity. The application of the concrete-filled composite columns to columns of high-rise buildings, bridge piers and towers has recently been increased. Since the steel skin confined the in-filled concrete tri-axially and the concrete resist against the inward deformation of steel skin, both steel and concrete contribute the strength enhancement. However, the concrete-filled tubes are susceptible to local buckling of the steel skin, which is in many cases very thin. The accurate estimation of post-local-buckling strength of the steel skin and the concrete compressive strength due to tri-axial confinement by the steel skin, which contribute the ultimate strength of concrete-filled steel composite columns, should be needed to predict the ultimate composite column strength accurately.

The confining effect of a steel skin can enhance the concrete compressive strength a lot more than $0.85F_c$. However, since the micro-cracking can reduce the tri-axial effect, many researchers [1], [2] have conservatively suggest that the effective strength of concrete in a steel casing should not exceed $0.85F_c$. The Eurocode 4 [3] has the provision where $1.0F_c$ can replace $0.85F_c$ for the concrete-filled hollow sections and some amount of additional strengths can be considered for the circular composite tubes, while the AISC [4] uses $0.85F_c$ regardless of the shape of steel section.

In this research, a series of compression tests of circular hollow steel sections and concrete-filled steel

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