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Curved concrete filled steel tubular (CCFST) built-up members under axial compression: Experiments

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ABSTRACT

A series of tests on curved concrete filled steel tubular (CCFST) built-up members subjected to axial compression is described in this paper. Twenty specimens, including 18 CCFST built-up members and 2 curved hollow tubular built-up columns, were tested to investigate the influence of variations in the tube shape (circular and square), initial curvature ratio (β_r, from 0 to 7.4%), nominal slenderness ratio (λ_n, from 9.9 to 18.9), section pattern (two main components, three main components and four main components), as well as brace pattern (battened and laced) on the performance of such composite built-up members. The experimental results showed that the ultimate strength and stiffness of CCFST built-up specimens decreased with increasing β_r or λ_n. Different load-bearing capacities and failure modes were obtained for the battened and laced built-up members. A simplified method using an equivalent slenderness ratio was suggested to calculate the strength of CCFST built-up members under axial compression.

1. Introduction

Compared with curved single members, both the in-plane and out-of-plane stability of curved built-up steel tubular members can be improved noticeably. Thus the latter have been increasingly used in large-span spatial structures and long-span bridge structures, such as roof structures, sports stadiums and arch bridges, not only for economical reasons but also for aesthetic appeals. It is believed that there is great potential to apply curved concrete filled steel tubular (CCFST) built-up members formed by two or more CCFST components with tubular braces or section steels in long span and space structures. Many such kinds of structures, such as arch bridges with CCFST built-up members, have been built in China [1]. In most cases, concrete can be pumped into the curved steel tubes and non-destructive technology, such as ultrasonic technology can be used to ensure the compaction of the concrete infilled.

In the past, a large number of studies on traditional straight concrete filled steel tubular (CFST) columns [1] and built-up members [2–5] have been carried out for many years. However, seldom research has been conducted on CCFST members, especially on built-up CCFST members. Ghasemian and Schmidt [6] and Han et al. [7] conducted tests on circular or square CCFST members. A relatively simple method was proposed to calculate the strength of the CCFST members by Han et al. [7]. These tests were conducted only on curved single members, and the main parameters were the initial curvature ratio and the nominal slenderness ratio.

The current study is a further investigation to report a series of tests on CCFST built-up members. The main parameters varied in the tests are: tube shape (circular and square); initial curvature ratio (from 0 to 7.4%); nominal slenderness ratio (from 9.9 to 18.9); section pattern (two, three and four main components); and brace pattern (battened and laced members). An equivalent slenderness ratio was proposed, and a simplified method was suggested to calculate the ultimate strength of CCFST built-up members under axial compression.

2. Experimental program

2.1. Specimen preparation

A total of 20 composite built-up members, including 10 with circular tubes and 10 with square tubes, were tested. For clarity, these members are referred to as circular built-up members and square built-up members in the following. The initial curve shape was circular arc for all of the specimens. All the members were concentrically loaded. The initial curvature values for the specimens and the range of parameters for the experimental investigations were determined based on engineering practice in China. A summary of the specimens

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