Beam-column behaviour of stainless steel I-section members

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Abstract

Stainless steel beam-columns were experimentally and numerically investigated in this study. All members were subjected to compression and major axis bending induced by an eccentricity of the compressive load. The loading eccentricities for the tests varied to provide a wide range of bending moment-to-axial load ratios. The experimental program covers ordinary-welded and laser-welded I-section specimens made of stainless steel. Material tensile coupon tests and initial geometric imperfection measurements are also described in detail. Measurements of initial imperfections were performed using two different methods, using a mechanical dial and laser scanning. The test results were subsequently used for a validation of a finite element (FE) model, developed in ABAQUS software to replicate the beam-column behaviour. The accuracy of the models with the two combinations of local and global imperfections were evaluated by comparison with the test results.

Keywords: Beam-column, Stainless steel, Welded profiles, Experiments, Numerical modelling

1 Introduction

Stainless steel is now widely used as a structural material because of its good corrosion resistance, aesthetic appearance, durability, and low maintenance cost. This material also exhibits very favourable mechanical properties, such as high strength and ductility, good weldability and strain hardening. The material characteristics of stainless steel are distinctly different from more common carbon steel with a non-linear stress-strain response and absence of a clearly defines yield point. Therefore, the procedures for stainless steel structural design differ from those for common carbon steels. The main purpose of this study is to investigate the structural response of welded austenitic stainless steel I-section beam-columns.

In recent years, a number of studies were reported to provide a better understanding of the structural response of stainless steel material [1], [2], cross-section behaviour [3], [4], [5], flexural buckling behaviour [6] [7] or lateral-torsional buckling behaviour [8], [9]. For cold-formed stainless steel sections, residual stresses were investigated by Jandera et al. [10]. Yuan et al. [11] proposed a new residual stress pattern for stainless steel conventionally arc-welded box-sections and I-sections. Extensive research has been conducted on laser-welded stainless steel elements, including proposed representative residual stress pattern for this section type [12], column buckling [13] and beam-column behaviour [14] [15]. An experimental study on conventionally arc-welded I-section beam-columns were presented in [16], [17]