Imperial College London

Structural behaviour of laser-welded stainless steel I-section subjected to combined axial compression and bending

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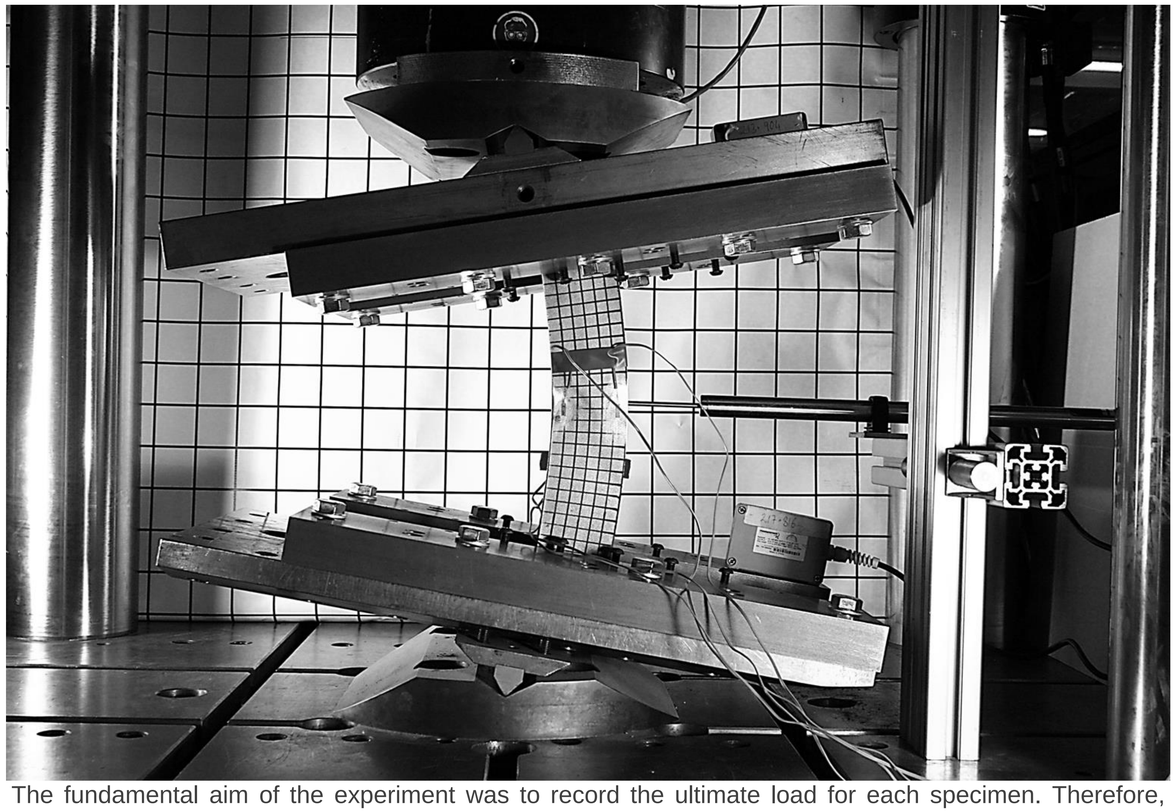
S3

Introduction

This project concerns the structural response of stainless steel I-section subjected to combined axial compression and bending. In total, 24 stub columns, which comprised of two different cross-sections, have been tested experimentally with various combinations of axial compression and bending. A parametric numerical study was also performed. Since the cost of stainless steel is typically higher than conventional carbon steel, efficiency of the structural designs is paramount in making stainless steel economically practical as structural. The main problem of Eurocode 3 Part 1-4 is that the design code itself is based on carbon steel and the enhanced plastic hardening of stainless steel over carbon steel is not considered.

Experiment



The fundamental aim of the experiment was to record the ultimate load for each specimen. Therefore, applied load was constantly monitored throughout the tests. In addition, rotation and deflection were recorded with the inclinometers and a linear variable differential transformer (LVDT) respectively. Specimens were placed in different positions for different combinations of axial compression and bending. The two cross-sections investigated were 50×50×4×4 and 102×68×5×5. They were of grade EN 1.4307 and EN 1.4571 respectively. All tests performed for the experiment programme was completed under the supervision of Mr. Gordon Herbert.

References

European Committee for Standardization. 2005. EN 1993-1-1:2005 Eurocode 3: Design of steel structures - part 1-1: General rules and rules for buildings.

Gardner, L., & Ashraf, M. 2006. Structural design for non-linear metallic materials. Engineering structures, 28(6), 926–934.

Result

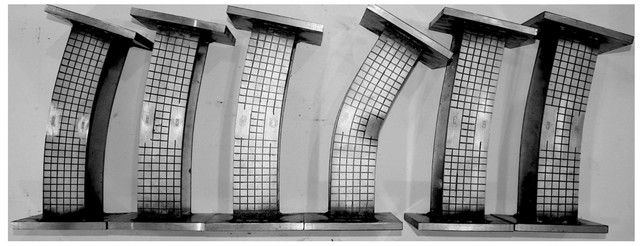
Deformed specimens - 50×50×4×4 section

Eccentric bending about the major axis

Eccentric bending about the minor axis

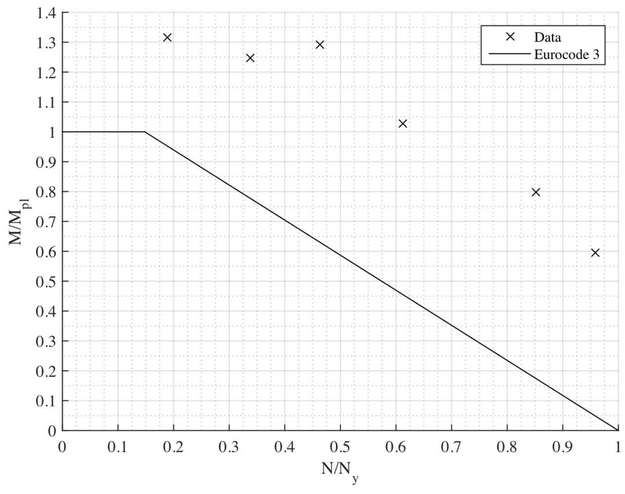
Deformed specimens - 102×68×5×5 section

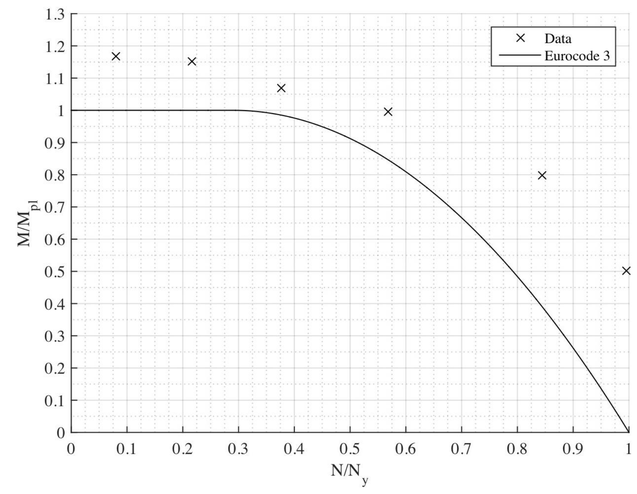
Eccentric bending about the major axis



Eccentric bending about the minor axis

Comparison with Eurocode 3 Part 1-1





Conclusion

The above figures show the result for the 50×50×4×4 section. The ultimate load and the ultimate moment were normalised by the yield load and plastic moment respectively. Data points were generated from the test results and compared against the design curves suggested in Eurocode 3 Part 1-1. The design curves over-predicted the moment capacity by at least 30% for combined axial compression and bending about the major axis and the over-prediction was at least 10% for the minor axis case. The continuous strength method was proposed as a new approach to structural stainless steel design. When adapted and applied to the test and parametric study results, this method gave an improved prediction of the member strength.