Experimental and numerical investigations for I-girders in bending and shear stiffened by closed trapezoidal stiffeners for use in steel bridges

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Summary

The paper summarizes the investigations on shear resistance of I-girders longitudinally stiffened by closed trapezoidal stiffeners, performed in the frame of a European RFCS project (RFS-CR-03018) designated as “ComBri” (Competitive Steel and Composite Bridges by improved Steel Plated Structures), with configurations typical of what may be expected in the design of modern steel bridges. It first reports on four full-scale tests performed at RWTH Aachen, on stiffened panels with strong closed stiffeners where the deformations have been measured with photogrammetric devices. As expected, failure in the subpanels has been governing. A devoted FEA shell model is then described and validated towards these results and other experimental sources. The numerical simulations demonstrate a very good agreement with the test-results. Parametric studies performed with a sophisticated numerical tool help pointing out several aspects where the recommendations of EN 1993-1-5 [1] on stiffened panels in bending and shear may be improved.

Keywords: plate girders, shear buckling behaviour, trapezoidal longitudinal stiffeners, experimental tests, photogrammetric measurement, EN 1993-1-5.

1. Introduction

The investigations for an optimised design for the webs and flanges of I- and box girders longitudinally stiffened by closed section stiffeners are summarized within this paper. The work was performed, aiming at optimised positions and number of stiffeners as well as optimised choice of steel grade for web plates and flanges. Typical configurations of what may be expected in the design of modern steel bridges have been taken into account during pre-design of the test specimens.

Indeed, web subpanels adjacent to a closed (trapezoidal) stiffener may be significantly strengthened by the high torsional stiffness of the longitudinal stiffener that improves the subpanels’ resistance to shear buckling. In addition, buckling of the whole stiffened panel may be significantly restrained by the use of a trapezoidal stiffener. The problem is here to determine to which extent this may positively affect the resistance of the whole girder. In this field, Eurocode 3 Part 1.5 appears to be one of the most advanced set of design rules. It proposes general recommendations, but the particular case of closed stiffeners is not especially addressed.

A test series of four steel girders (two with unstiffened web plates and two with longitudinally stiffened web plates – see Table 2) has been designed in order to investigate the shear buckling behaviour of longitudinally stiffened girders and the influence of different M-V-ratios. The tests have been performed successfully at RWTH Aachen.

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