UNSTIFFENED STEEL COMPRESSION PANELS WITH AND WITHOUT COINCIDENT SHEAR

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Abstract

This dissertation is concerned with the ultimate strength of unstiffened panels loaded principally by in plane compression. Plate geometries are chosen so that the region studied is that in which local buckling and material yielding interact. The material considered is weldable structural steel which displays a yield point followed by a plastic plateau. Plates with practical levels of flatness and weld induced residual stresses are considered.

Experiments on the axial strength of rectangular section box columns are described. These allow the study of uniaxially loaded, unstiffened panels where the slender plates receive rotational restraint along the unloaded edges from their stocky neighbours. The tests show that the effects of restraint are noticed in the elastic range but produce no change in the strength of rectangular section box-columns. A more important feature is the average axial strain at which the various plates achieve their peak load. It is shown that in stress relieved plates this occurs at the same strain for an important range of plate geometries. However, this is not the case for as-welded plates and, in consequence the effective width concept can produce unsafe predictions of strength.

The design and construction of a rig to load square-section box columns in simultaneous compression and torsion is described. This is used to test both as-welded and stress-relieved specimens. Consecutive and proportional load path resulted in a slight lowering of expected axial strength. For as-welded specimens the weakening effect was greater. This is explained by means of a simple model that considers the stress histories of key parts of the plate. Experimental results are compared with available theoretical studies, previous experiments on uniaxially loaded steel plates and tests on compressed and twisted aluminium alloy tubes. The requirements of recently proposed codes for the design of plated structures are also considered. The experiments show that quite high coincident shear stresses may be present before they have a significant weakening effect on compressed panels.

A simple theory is developed on the basis of a number of postulates for the behaviour of a steel plate under uniaxial compression. Evidence is advanced to support these postulates. As a result, a simple method for calculating the load-shortening curves of plates is proposed and shown to compare favourably with the results of large-scale computer analyses. Results also compare well with the results of large-scale computer analyses. Results also compare well with recent tests. A development of the method allows the strength of welded and unwelded plates to be found with one calculation.