THE COMPRESSIVE BEHAVIOUR OF THIN-WALLED COLD-FORMED STEEL COLUMNS

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Abstract

Thin-walled cold-formed steel columns of complex open cross-section, such as lipped channels and warehouse racking column sections, exhibit complicated behaviour modes which affect their strength. Warehouse racking columns are commonly perforated, and this also affects their strength.

Consideration has been given to perforated plate behaviour, and to local and interactive buckling collapse of complex thin-walled structures as independent problems.

The results of an experimental parametric study of perforated plate behaviour are reported. The experiments involved uniformly compressing mild steel plates of varying slenderness and with a variety of perforated geometries and patterns. Behaviour was observed to be dependent upon the slenderness of the entire plate *and* the slenderness of the region of plate adjacent to the perforation.

Based on these observations a new simple model for predicting the strength of a perforated plate or cross-section with holes of general form is presented. The overall strength of the plate or cross-section with holes of general form is presented. The overall strength of the plate or cross-section (ignoring the presence of perforations) and the strength of individual regions of plate adjoining the perforation are both evaluated. The lesser of these two values determines the predicted strength. The model was found to compare satisfactorily with the results of the experiments performed by the author and with those of other researchers, although interaction between the modes associated with the two slenderness parameters (identified above) limits the application of the new model. A prospective refinement to the model is proposed.

The results of an experimental study of the behaviour of thin-walled lipped channel and warehouse racking section columns are reported, in which fixed-end column tests were

performed. Complex modes of local buckling (distortional and pure local buckling) and overall buckling (minor axis flexural and flexural-torsional buckling) as well as interaction between these modes were observed. Slenderness parameters governing behaviour were identified, and the results were compares with existing design rules.

An existing computer program was developed to analyse the collapse behaviour of cross-sections susceptible to local and interactive buckling modes. The method involved minimising the strain energy of the compressed element to satisfy equilibrium, and made use of the powerful finite strip technique for describing the displacement field. The method takes proper account of large deflection theory, elastic-plastic behaviour and initial imperfections. Solutions were found for both distortional and pure local buckling collapse modes, but the program failed to predict interactive buckling collapse accurately.

The new computer model was verified against the results of the column tests and other collapse analyses for local buckling failures. A parametric study of the maximum strength of thin-walled lipped channels was performed and existing design rules were compared with the rigorous solutions obtained using the new computer model.