COMPRESSION IN WELDED WEB PLATES

K.E. Moxham

Abstract

This dissertation is concerned with the behaviour of realistic steel web plates loaded in in-plane compression. Even though this is a fundamental investigation, the practical steel plate has been foremost in the author's mind when deciding which plate parameter to consider.

The problem has been studied by experimental and analytical means. Both methods assumed similar importance.

Previous relevant work has been discussed in general in Chapter 1, and in addition, reference has been made to previous work throughout the text where relevant.

Because of the importance of welding as a fabrication method, and because of the known effect of the resultant residual stresses on this type of problem, the welding process, ad the effects of the residual stresses, have been studied in detail.

By consideration of the thermal-stress-strain behaviour of a plate undergoing welding, a theoretical method has been developed, which is able to show a simple relationship between the designer's specification of a weld, and the resultant residual stresses. Predictions can be made of the residual stresses by a simple slide rule calculation.

A theoretical method has been developed of the Raleigh-Ritz type, involving elasto-plastic behaviour, including unloading from the yield surface, which has been able to follow the complete loading path of a plate. This work has resulted in a computer program which is able to produce numerical answers based on the method. A large amount of computer time has been used in producing load-end-shortening curves, and other details for a wide range of plate parameters. Residual stresses and a range of initial out-of-flatness shapes, and amplitudes, have been studied, in addition to various material properties and plate geometries.

The method has been able to study without difficulty the important range of geometries in which the critical elastic buckling load, is similar to the squash load.

A large programme, of 150 tests, on model steel plates, with varying amounts of residual stresses, geometry and boundary conditions, has been carried out. These tests have been conducted in an elaborate test rig, designed by the author and which is able to provide either simply supported or clamped edge conditions. Because of its stiffness, it is able to follow the complete loading path of the plate without instability.

A series of 6 tests on large scale box columns, with failure loads in the vicinity of 800 tons, and weighing 0.6 tons each, have been conducted to check on the effects of size.

A large amount of data has been generated, which has resulted in some suggested design rules. However, this data would prove useful, for further research on this problem with regard to design rules and principles without the need for further theoretical and experimental work.