THE ELASTIC STABILITY OF FRAMEWORKS

J.D. Renton

Abstract

(A summary of the thesis submitted for the degree of Doctor of Philosophy by J.D. Renton)

The writer has presented the general solution of the differential equations of the small deflection theory for the elastic equilibrium of a strut. Geometrical expressions are also derived for the loads acting at its ends. There are used to present more exact analyses of tests on aluminium struts by Baker and Roderick.

A summary of methods for analysing the warping behaviour of joints is given and includes the analysis of a particular case by the writer. It is shown that the warping of joints probably has little effect on the stability of a framework, unless the members are very stocky. A fixed base portal frame composed of bi-symmetrical members is analysed on this assumption and shown to have five basic modes of instability when unrestrained at the heads of the stanchions.

Manual methods of analysis by the direct solution of the critical equations, as used in the case of the above portal frame, become excessively arduous for more complex frameworks. It is shown the Howard diagrams may be used to solve certain classes of stability problems and to analyse some problems of flexure with torsion. The areas in these diagrams are related to parts of the total energy of the system. The relaxation methods of Masur and Cukurs for the lateral buckling of plane frames are extended to cope with joint displacement and used to analyse a simple frame. Finite difference methods, such as those used by Dean and Tauber, are applied to solving lateral buckling problems. The results obtained compare well with more rigorous solutions.

Three computer programmes based on those used by Livesley and described. The first analyses the lateral buckling of plane frames, the second the buckling of ’just stiff’ space frames (ignoring axial compression effects) and the third is a general programme for the analysis of space frames.

Experimental tests on ‘xylonite’ and steel frames are described and the critical loads found from Southwell plots of the experimental results compared with those predicted from the computer programmes.