THE POST-BUCKLING BEHAVIOUR OF FRAMES

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Abstract

This thesis describes an investigation into the post-buckling behaviour of pin and rigidly-jointed triangulated frames. The main questions examined are the condition of equilibrium at incipient flexural buckling of a frame, and the subsequent post-buckling behaviour of the frame.

The work is divided into two parts. In Part I pin-jointed frames are considered; both plane and space frames are discussed. A generalised theory is given in the case of plane and space iso-static pin-jointed frames and also of hyper-static plane pin-jointed frames. Space hyper-static frames are considered only briefly.

Some consideration is given also to the inelastic post-buckling of pin-jointed frames consisting of idealised members, with special reference to members made of mild steel.

Further, a special loading device is described which makes it possible to study experimentally the stability of a given structure in positions of statical equilibrium.

In Part II the post-buckling behaviour of rigidly-jointed plane triangulated frames is considered. Frames are analysed mostly by approximate equilibrium methods, and an approximate energy method is demonstrated on two simple examples only. Also a generalised equilibrium analysis is given for proportionate changed in the applied loads.

It is shown that in post-buckling frames may be held in positions of statical equilibrium by the applied loads, provided these are suitably adjusted. The frames were studied theoretically by two methods that one using the equilibrium approach and the energy approach. In the case of rigidly-jointed plane frames, the two approaches are developed in an approximate fashion only because of the complexity of an exact analysis. The two methods of theoretical analysis give results which agree to a certain degree of accuracy and are reasonably in agreement with the experiments.

It is further shown that statical equilibrium in post-buckling may be stable or unstable. Stability of a given system is analysed for conditions either of statical equilibrium or motion, and criteria of stability for such a system are deduced.

Two theorems are established concerning the stability of a given system in positions of statical equilibrium; these theorems are useful in determining the condition of stability for any position of statical equilibrium of a frame.