COLLAPSE OF RIGIDLY JOINTED TRUSSES

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Abstract

This dissertation describes a theoretical and experimental study of strut failure jointed steel trusses.

It is found that the behaviour of the critical strut in a statically determinate truss is accurately matched by that of the same strut in a properly chosen goalpost structure (the strut with a restraining member attached to each end). Rules are given which enable a goalpost analogy to be set up for the critical strut in any given truss, no matter what is configuration and loading.

Two computer programs for studying goalposts are described. The first, a simple program for finding the elastic behaviour and the first yield strength of goalpost struts, has been used extensively in a preliminary study. The second, a Finite Element program, called FESTRAN, for finding the complete behaviour and the ultimate strength of goalpost struts, has been used in a more elective study. FESTRAN takes full account of geometric and material non-linearities, and simulates inelastic behaviour using a sophisticated yielding model which incorporates upper yield and strain-hardening. It also takes account of initial imperfections.

The theoretical results emphasise that the magnitude and pattern of secondary moments generated by truss deformations have an important influence on critical strut strength.

A description is also given of an experimental programme in which a full scale 8-bay Warren truss was tested to collapse fourteen times, each time replacing the failed strut with a new one. The critical struts, of low and medium slenderness, were subjected to a variety of influences from the rest of the truss by changing the truss support locations. The agreement between test results and theoretical predictions was encouraging.

Current design rules for struts in trusses, based on effective length method, are reviews and shown to be unsatisfactory in comparison with the new theoretical and

experimental results. It is suggested that designers could check the ultimate strength of their truss designs either by using FESTRAN directly, or by using charts which are presented in this dissertation.