COMPRESSION MEMBERS IN TRUSSES

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Abstract

Attempts at predicting the collapse behaviour of rigidly jointed trusses have been limited by the lack of information available on the behaviour of compression members in such a structure. In this dissertation, the particular case of a symmetrically restrained, symmetrically loaded strut in a truss is examined both theoretically and experimentally – this being the worst case for given magnitude of end moments.

The problem is considered in two parts:-

(i) The estimation of the end conditions and disturbances forced on the strut by the rest of the truss while it is deforming.

(ii) From a knowledge of these end conditions, the prediction of the behaviour and, the ultimate load or plastic plateau length of the strut.

The discontinuous yield outlined by Farnell, and developed for structural application by Lay, is examined and extended to apply to tubular cross sections. By expressing the properties of sections at different axial strain values in a suitable form, a computer analysis is developed for a strut which within the framework of a matrix stiffness approach. A simple structure incorporating this strut is used as a basis for the investigation of the effect on the strut behaviour, provided that it is above a small threshold value. A part from slenderness, the important factor is found to be the initial magnitude of secondary moments generated by truss deformation.

The ability of the model to be incorporated into a conventional frame stiffness analysis is demonstrated by considering a three-bay Warren truss structure.

A description is given of an experimental programme in which 76 struts, of rectangular and tubular cross section, were tested in a rig specially designed to simulate the conditions existing in a truss. In addition, seven tests were performed on three-bay Warren trusses of commercial manufacture.

Significant residual moments, caused by the welding process, were measured in the trusses. The effect on the subsequent loading behaviour of the trusses is examined both experimentally and theoretically.

The agreement between theoretical predictions and the test results is in most cases satisfactory.

The irrational nature of current design methods as applied to truss compression members is illustrated. An alternative design procedure, based on the work of this dissertation, is suggested, and possible methods for dealing with imperfections compared.