SOME PROBLEMS IN STRUCTURAL INSTABILITY WITH SPECIAL REFERNCE TO BEAM OF I-SECTION

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Abstract

This thesis consists of two Parts: Part I is concerned with the basic types of elastic buckling and post-buckling; Part II with the theory of instability in the inelastic range and the actual behaviour and practical design of I-section metal beam-columns.

Semi-rigid models with one or two degrees of freedom are used in Part I to present and illustrate the different cases: namely, the models are constituted by a rigid compressed strut loaded at the top and either pinned or ball-ended at the bottom (one or two degrees of freedom respectively); a similar model illustrated the lateral-torsional buckling of deep beams, but in this case the load is applied at one end at 90^0 to the limb, which is restrained at the other end by two cylindrical hinges. Different behaviours are obtained by changing the elastic restraints; for each case the complete equations of equilibrium, valid for any value of the rotations, are written.

For the “strut” models, the load-deformation curves are plotted in both cases of perfectly vertical or slightly inclined (“imperfect”) strut, the loading force being vertical. It is noted in particular that in the second case separate paths of equilibrium exist, which tend to touch each other in the “bifurcation points” as the imperfections tend to vanish; in the “perfect” case, the buckled branches of the equilibrium path can be either rising or falling, depending on the restraints.

Only perfect “deep beam” models are studied, and it is noted that the torsional and lateral bending stiffnesses have different importance in determining the post-buckling strength.

General conclusion from the different examples are derived at the end of Part I, and these are put in relation with the results of more general researches.

The first Chapter of Part II deals with the general principles and fundamental cases of inelastic buckling, presenting firstly a critical synthesis of the present knowledge and then examples again obtained by means of a semi-rigid strut model, with a variety of inelastic stress-strain relationships.

The rest of Part II (Chapter 5 to 8) deals with an investigation on I-section “beam-columns”, and comprise

(i) a search of literature, wit particular emphasis on practical design procedure;

(ii) description and results of two groups of experiments, respectively on aluminium-alloy and mild-steel miniature stanchions, subjected to a compressive axial load and one end moment acting in the plane of the web;

(iii) comparison of the experimental results with theoretical and empirical predictions, and proposal of a simple empirical “interaction curve”, which fits the experimental results to the “rotation capacity” of beam-columns, that is, the ability to withstand end rotations with out excessive decrease of strength.