THE PLASTIC BEHAVIOUR OF FLEXURAL MEMBERS AND CONNEXIONS UNDER COMBINED LOADING

George Douglas Tyndall Wright

Trinity College, Cambridge and the University of Toronto

Abstract

The dissertation describes studies made in the plastic theory to determine methods of designing compressed beams and structural connexions.

Beams and flexural members subjected to axial compressions are often encountered in structural frames, and the design of such members is of considerable importance. It is shown that axial compressions have an appreciable effect in reducing the ability of beams to carry transverse load, and that instability occurs on the plastic range. Formal analyses are presented for various cases, and it is shown that the behaviour of beams under combined axial stress, slenderness ratio, and Young modulus. Alternative solutions based upon numerical methods of analysis are also presented; these may be used for problems of any degrees of complexity. The numerical analyses are employed to explore the significance of the approximations used in the formal analyses are reasonably accurate for axial stresses up to at least six-tenths of the lower yield point. Experimental evidence is presented, and this appears to confirm the theory satisfactorily. The first section of the dissertation closes with a study of the effects of axial compressions on the strength and stability of portal frames.

The second section of the dissertation deals with the two most common types of rigid connexion: the knee joint, used in portal frames, and the symmetrical beam-stanchion joint, used in multi-story, multi-bay frames. From an examination of previously published studies of the knee joints, a new and apparently better method of design for square knees is derived and confirmed. For beam-stanchion connexions it is shown that the strength of joints embodying profile fillet welds can be predicted on the basis of standard weld tests, and it is shown that this connexion type fails abruptly with no plastic deformation, indicating that, for frames designed by the plastic theory, such connexions must be adequate to develop to full plastic resistance of the beams. Methods of design for stanchion reinforcement, used to prevent crippling of the stanchion at the joint, are also presented.