THE INELASTIC LATERAL STABILITY OF MILD STEEL I BEAMS

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Abstract

A basic assumption in the proportioning of structures for ultimate strength by plastic design methods is that large inelastic rotations, and consequent redistribution of moments, are possible at certain regions. This assumption implies that premature failure by buckling does not occur. It is the purpose of this dissertation to examine the phenomenon of lateral buckling of beams, more particularly mild steel I beams, which have been strained beyond yield by bending in the plane of maximum rigidity. Existing theories are studied critically and modified where necessary, a programme of uniform bending tests on small scale model steel I beams is described and the result are correlated with theoretical predictions.

First, a new theory to describe the reduction in torsional rigidity with increase in primary bending moment beyond yield is formulated and supported experimentally. Then the lateral stability in the inelastic range generally is discussed, with a comparison of theoretical and experimental findings, a variation of the Southwell Plot is developed and used for inelastic stability predictions.

Rotation capacity is next examined and a relation between laterally unsupported length and amount of possible rotation before collapse is determined. It is also shown that sufficient rotation may be possible in cases where the full plastic moment of the beam cannot be developed before it becomes unstable.

The effect of residual stresses is studied theoretically and it is shown quantitatively how much stresses precipitate the onset of instability in the plastic range.

Beams with non uniform are then discusses and examined analytically by means of an approximate method of calculation, based on the moment are principles, which is developed for the purpose.

Finally, a theory is formulated to predict the required force applied horizontally at mid span to prevent lateral instability up to the full plastic moment. This theory is also supported experimentally.