DISTORTIONAL BUCKLING IN MONOSYMMETRIC I-BEAMS

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While a large number of investigations are available in respect of lateral-torsion buckling of beams, the available literature on distortional buckling of short span beams with mono-symmetric I-sections is limited. Hence the present investigation is aimed at studying distortional buckling in three types of mono-symmetric I-beams: (i) simply supported, (ii) propped cantilever, and (iii) braced cantilever, under three types of load: a point load, a uniformly distributed load and a uniform moment. Both the top and bottom flange loadings are considered for the first two types of load. In order to take into account distortional buckling in the finite element analysis using ABAQUS, quadratic shell elements are used to model the beam-sections which consider small strains but large rotations. Eigenvalue analyses are performed to determine the buckling loads. For simply supported and propped cantilever beams, moment modification factors are calculated and compared with the provisions given in SSRC Guidelines (see[1]). For braced cantilever beams, the effect of different types of brace and their positions along the beam span are investigated to find out the most effective bracing type and its location.

A general observation based on the present investigation is that the distortional buckling has a significant effect on short length beams, at least for the types of beam considered. For simply supported beams it is seen that for a uniform moment case, the difference between the flexural-torsion buckling moment and the distortional buckling moment is very less, even in short span beams. However, for a uniformly distributed load and a point load case the difference between the two buckling loads is considerable. Since all available design specifications provide solutions for lateral-torsion buckling only, these solutions are to be used with caution for short beams as they may yield overestimated values of the buckling load for these two load cases. It is noted that for relatively long beams, SSRC Guidelines give reasonably good estimation of moment modification factors but for short beams these may lead to overestimated calculation of the buckling capacity of the beam. Moment modification factors are dependent on the degree of beam mono-symmetry as well as on the span-to-depth ratio. For propped-cantilever beams, SSRC Guidelines [1] and Helwig et al. [2] always provide overestimated values of moment modification factors and the difference is too large for short beams.

For long cantilever beams present results closely match with the experimental results of Kitipornchai et al. [3]. The effect of different types of brace (i.e. lateral translational bracing at top flange only, or at bottom flange only, or at both top and bottom flanges) is examined on the buckling behaviour of short and long monosymmetric I-beams. It is seen that top lateral bracings are very effective for beam-sections having larger bottom flanges when a point load or a uniformly distributed load acts at the top flange and for the uniform moment case, except for the T-section or the inverted T-section cantilever beams. On the other hand, bottom lateral bracings are effective for beam-sections having larger top flanges. Simultaneously bracing both top and bottom flanges is definitely more effective. The bracing serves no purpose when the load acts at the bottom flange, except for inverted T-beams.

References

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Keywords: buckling, beams