Moment-curvature-thrust relationships for beam-columns

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Abstract

Moment–curvature–thrust relationships (M–κ–N) are a useful resource for the solution of a variety of inelastic and geometrically non-linear structural problems involving elements under combined axial load and bending. A numerical discretised cross-section method is used in this research to generate such relationships for I-sections, rectangular box-sections and circular or elliptical hollow sections. The method is strain driven, with the maximum strain limited by an a priori defined local buckling strain, which can occur above or below the yield strain depending on the local slenderness of the cross-section. The relationship between the limiting strain and the local slenderness has been given for aluminium, mild steel and stainless steel cross-sections through the base curve of the Continuous Strength Method. Moment-curvature-thrust curves are derived from axial force and bending moment interaction curves by pairing the curvatures and moments for a given axial load level. These moment–curvature–thrust curves can be transformed into various formats to solve a variety of structural problems. The gradient of the curves is used to find the materially and geometrically non-linear solution of an example beam-column, by solving numerically the moment–curvature ordinary differential equations. The results capture the importance of the second order effects, particularly with regards to the plastic hinge formation at mid-height and the post-peak unloading response.