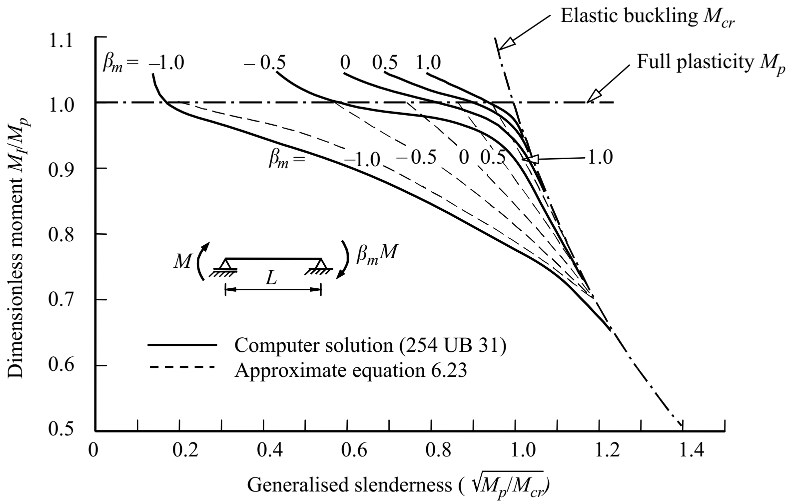

Figure 6.10 Inelastic buckling of beams with unequal end moments.

in double curvature ($\beta_m = 1$), for which the moment gradient is steepest and the regions of yielding are most limited.

The range of modified slenderness $\sqrt{(M_p/M_{cr})}$ for which a beam can reach the full plastic moment M_p depends very much on the loading arrangement. An approximate expression for the limit of this range for beams with end moments M and $\beta_m M$ can be obtained from equation 6.23 as

$$\sqrt{\left(\frac{M_p}{M_{cr}}\right)_p} = \sqrt{\left(\frac{0.39 + 0.30\beta_m - 0.07\beta_m^2}{0.70}\right)}. \tag{6.24}$$

In the case of a simply supported beam with an unbraced central concentrated load, yielding is confined to a small central portion of the beam, so that any reductions in the section properties are limited to this region. Inelastic buckling can be approximated by using equation 6.23 with $\beta_m = -0.7$ and $\alpha_m = 1.35$.

6.4 Real beams

Real beams differ from the ideal beams analysed in Section 6.2.1 in much the same way as do real compression members (see Section 3.4.1). Thus any small imperfections such as initial crookedness, twist, eccentricity of load, or horizontal load components cause the beam to behave as if it had an equivalent initial crookedness and twist (see Section 6.2.2), as shown by curve A in Figure 6.11. On the other hand, imperfections such as residual stresses or variations in material

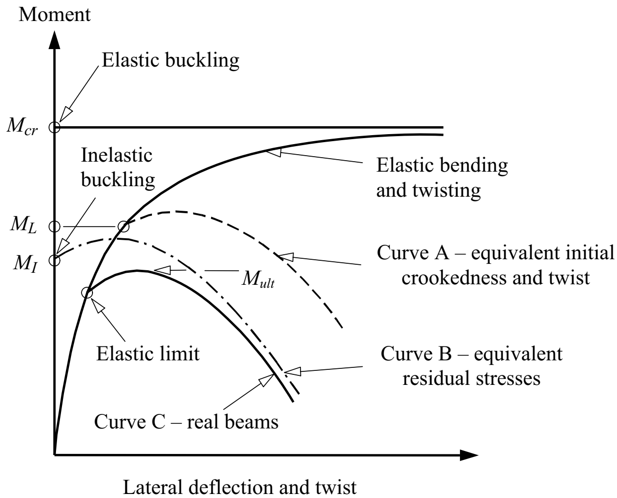

Figure 6.11 Behaviour of real beams.

properties cause the beam to behave as shown by curve B in Figure 6.11. The behaviour of real beams having both types of imperfection is indicated by curve C in Figure 6.11, which shows a transition from the elastic behaviour of a beam with curvature and twist to the inelastic post-buckling behaviour of a beam with residual stresses.

6.5 Design against lateral buckling

6.5.1 General

It is possible to develop a refined analysis of the behaviour of real beams which includes the effects of all types of imperfection. However, the use of such an analysis is not warranted because the magnitudes of the imperfections are uncertain. Instead, design rules are often based on a simple analysis for one type of equivalent imperfection which allows approximately for all imperfections, or on approximations of experimental results such as those shown in Figure 6.12.

For the EC3 method of designing against lateral buckling, the maximum moment in the beam at elastic lateral buckling M_{cr} and the beam section resistance $W_y f_y$ are used to define a generalised slenderness

$$\overline{\lambda}_{LT} = \sqrt{(W_y f_y / M_{cr})} \tag{6.25}$$