increased by lean-on framing, in which a number of girders are stabilized by other girder systems by tying the members together by top- and bottom-flange struts. Stability evaluation of lean-on bracing systems is discussed by Zhou (2006).

5.3 FUNDAMENTAL COMPARISON OF DESIGN STANDARDS, PRISMATIC I-SECTION MEMBERS

To provide an indication of the variation in nominal beam strengths used or recommended for design practice, Fig. 5.17 shows a comparison of representative LTB nominal resistance predictions pertaining to four current standards. The applicable formulas are listed below. The curves and equations correspond to the uniform bending case ($C_b = 1$). The different standards are calibrated in conjunction with their corresponding building codes and the load factors within these codes. In addition, various considerations enter into the development of each standard's strength curves, such as the targeted level of reliability and whether the level of reliability is varied according to the beam slenderness. In short, while the nominal strengths presented here illustrate the approaches for calculating the LTB resistance, they do not convey the entire picture. The ordinate of the curves in Fig. 5.17 is the normalized nominal moment capacity M_n/M_p. The cross-section elements of the selected W27 × 84 section are sufficiently stocky such that the maximum flexural resistance is equal to the plastic moment capacity in all of these standards. The abscissa of the curves in Fig. 5.17 is the normalized unbraced length L/L_p, where L_p is taken as $1.1r_t\sqrt{E/F_y}$. This is the unbraced length at which the mean nominal resistance of general I-section members reachers M_p in uniform major axis bending, based on a comprehensive assessment of experimental data (White and Jung 2008).

In general, Fig. 5.17 shows a considerable variation in the nominal LTB resistances used by the different standards. All of the curves are based upon the same elastic critical moment M_{ocr}. One difference is in the type of mapping from the elastic buckling resistance to the nominal strength. In addition, the two North

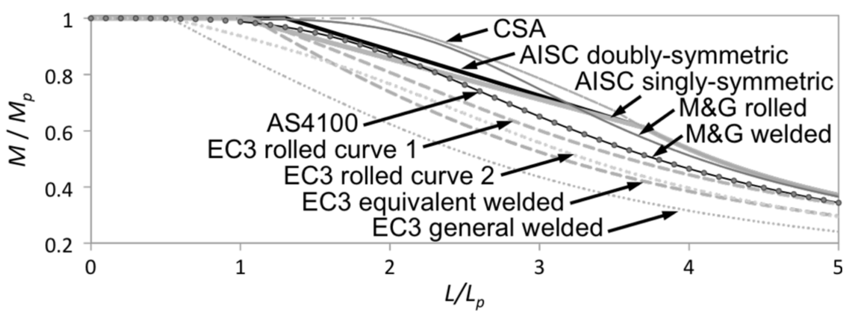

FIGURE 5.17 Comparison of nominal LTB resistances for different length W27x84 [F_y = 345 Mpa (50 ksi)] beams and equivalent section welded beams subjected to uniform bending moment.

American standards AISC and CSA implicitly assume that the beam has no initial out-of-straightness for long members that fail by elastic LTB. Conversely, the Australian and the European standards, AS4100 and EC3, provide a substantial penalty for geometric imperfections.

The Eurocode 3 (EC3) resistance equations corresponding to Fig. 5.17 are listed in Table 5.1. Similar to its handling of column buckling, EC3 (CEN, 2005) uses the Perry–Robertson formula (Robertson, 1925) for its characterization of beam LTB. Eurocode 3 provides two sets of coefficients for use with the equations shown in the table, one for general members and another for rolled I-section beams and equivalent welded beams. The coefficients $\overline{\lambda}_{LT,0}$, below which the resistance is constant at a maximum plateau level, and β, which affects the shape of the strength curve, are 0.2 and 1.0 for the general equation. For the special case of rolled I-section beams and equivalent welded beams, $\overline{\lambda}_{LT,0}$ may be increased to 0.4 and β can be reduced to 0.75. Eurocode 3 gives separate curves for relatively wide and narrow sections as well as for welded and rolled sections. These differences are expressed by different α_{LT} values as summarized in Table 5.2. Figure 5.17 shows the two sets of Eurocode 3 strength curves for a W27x84 rolled section as well as for a welded section with the same cross-sectional profile. The development of the Eurocode 3 equations is documented thoroughly in ECCS (2006) and is discussed further in Rebelo et al. (2009) and in Simoes da Silva et al. (2009). A key distinction between the Eurocode 3 and the AASHTO and AISC developments is in Eurocode 3 efforts to make extensive use of refined distributed plasticity

TABLE 5.1 Eurocode 3 Base Equations for Rolled or Welded Class 1 or Class 2 I-Section

$$M_n = \frac{M_p}{\Phi_{LT} + \sqrt{\Phi_{LT}^2 - \beta\overline{\lambda}_{LT}^2}} \le M_p$$

where: $\Phi_{LT} = 0.5\left[1 + \alpha_{LT}\left(\overline{\lambda}_{LT} - \overline{\lambda}_{LT,0}\right) + \beta\overline{\lambda}_{LT}^2\right]$

$$\overline{\lambda}_{LT} = \sqrt{\frac{M_p}{M_{ecr}}}$$

TABLE 5.2 Eurocode 3 LTB Curve Selection

		General Case		Rolled or Equivalent Welded Case	
Cross Section	Limits	Buckling Curve	α_{LT}	Buckling Curve	α_{LT}
Rolled I-sections	$d/b \le 2$	*a*	0.21	*b*	0.34
	$d/b > 2$	*b*	0.34	*c*	0.49
Welded I-sections	$d/b \le 2$	*c*	0.49	*c*	0.49
	$d/b > 2$	*d*	0.76	*d*	0.76
Other Cross-sections		*d*	0.76	*d*	0.76