APPENDIX A

CALCULATION OF MEMBER STRENGTH DEMANDS IN AISC-LRFD

This appendix provides formulas that are used in AISC-LRFD (1994) for calculating member strength demands for steel SMRF structures.

A.1 Second order effects

For structures designed on the basis of an elastic analysis, the required flexural strength M_u can be determined from the following approximate second-order analysis procedure:

$$M_u = B_1 M_{nt} + B_2 M_{lt} \tag{A.1}$$

where M_{nt} = required member flexural strength assuming no lateral translation of the frame; M_{lt} = required member flexural strength as a result of lateral translation of the frame only; B_1 an amplification factor for side-way inhibited bending moments

$$B_1 = \frac{C_m}{1 - P_u / P_{e1}} \geq 1 \tag{A.2}$$

with $P_{e1} = A_g F_y / \lambda_c^2$ where A_g = gross member area; F_y = specified yield stress; λ_c = the slenderness parameter, which is computed by:

$$\lambda_c = \frac{Kl}{r\pi}\sqrt{\frac{F_y}{E}} \tag{A.3}$$

with K = effective length factor in the plane of bending shall be determined the same as for the *braced* frame; E = modulus of elasticity; l = laterally unbraced member length; r = governing radius of gyration about the axis of buckling. As another variable in Equation (A.2), P_u = the required axial compressive strength for the member under consideration; C_m = a coefficient based on elastic first-order analysis assuming no lateral translation of the frame and its value for compression members not subject to transverse loading between their support in the plane of bending can be calculated as:

$$C_m = 0.6 - 0.4\left(M_1/M_2\right) \tag{A.4}$$

where M_1/M_2 is the ratio of the smaller to larger moments at the ends of that portion of the member unbraced in the plane of bending under consideration. B_2 is the other amplification factor for side-sway bending moments:

$$B_2 = \frac{1}{1 - \dfrac{\sum P_u}{\sum P_{e2}}} \tag{A.5}$$

where $\sum P_u$ = required axial strength of all columns in a story; $P_{e2} = A_g F_y / \lambda_c^2$ where λ_c is the slenderness parameter, in which the effective length factor K in the plane of bending shall be determined the same as for the *unbraced* frame.

A.2 Effective length factor

For braced frames, the K factor can be calculated from the transcendental alignment chart equation:

$$\begin{cases} \dfrac{G_A G_B}{4}\left(\pi/K\right)^2 + \dfrac{G_A + G_B}{2}\left(1 - \dfrac{\pi/K}{\tan\left(\pi/K\right)}\right) + 2\left(\dfrac{\tan\left(\pi/2K\right)}{\pi/K}\right) = 1 \\ 0.5 \le K \le 1.0 \end{cases} \tag{A.6}$$

and for unbraced frames, the K factor can be calculated from the other transcendental alignment chart equation:

$$\begin{cases} \left(G_A G_B (\pi/K)^2 - 36\right)\sin(\pi/K) - (6\pi/K)(G_A + G_B)\cos(\pi/K) = 0 \\ 1.0 \le K \le 20 \end{cases} \tag{A.7}$$

where

$$G = \frac{\sum(I_c/L_c)}{\sum(I_g/L_g)} \tag{A.8}$$

in which $\sum$ indicates a summation of all members rigidly connected to that joint and lying on the plane in which buckling of the column is considered; I_c is the moment of inertia and L_c the unsupported length of a column section; I_g is the moment of inertia and L_g the unsupported length of a girder or other restraining member. The extreme value of *G* can be taken from 10 for a pinned column end or 1.0 for a fixed column end.

A.3 Design compressive strength for flexural buckling

The design strength for flexural buckling of non-slender compression members is $\phi_c P_n$ with $\phi_c = 0.85$ and $P_n = A_g F_{cr}$. For $\lambda_c \le 1.5$ (inelastic buckling),

$$F_{cr} = \left(0.658^{\lambda_c^2}\right) F_y \tag{A.9}$$

and for $\lambda_c > 1.5$ (elastic buckling),

$$F_{cr} = \left(\frac{0.877}{\lambda_c^2}\right) F_y \tag{A.10}$$