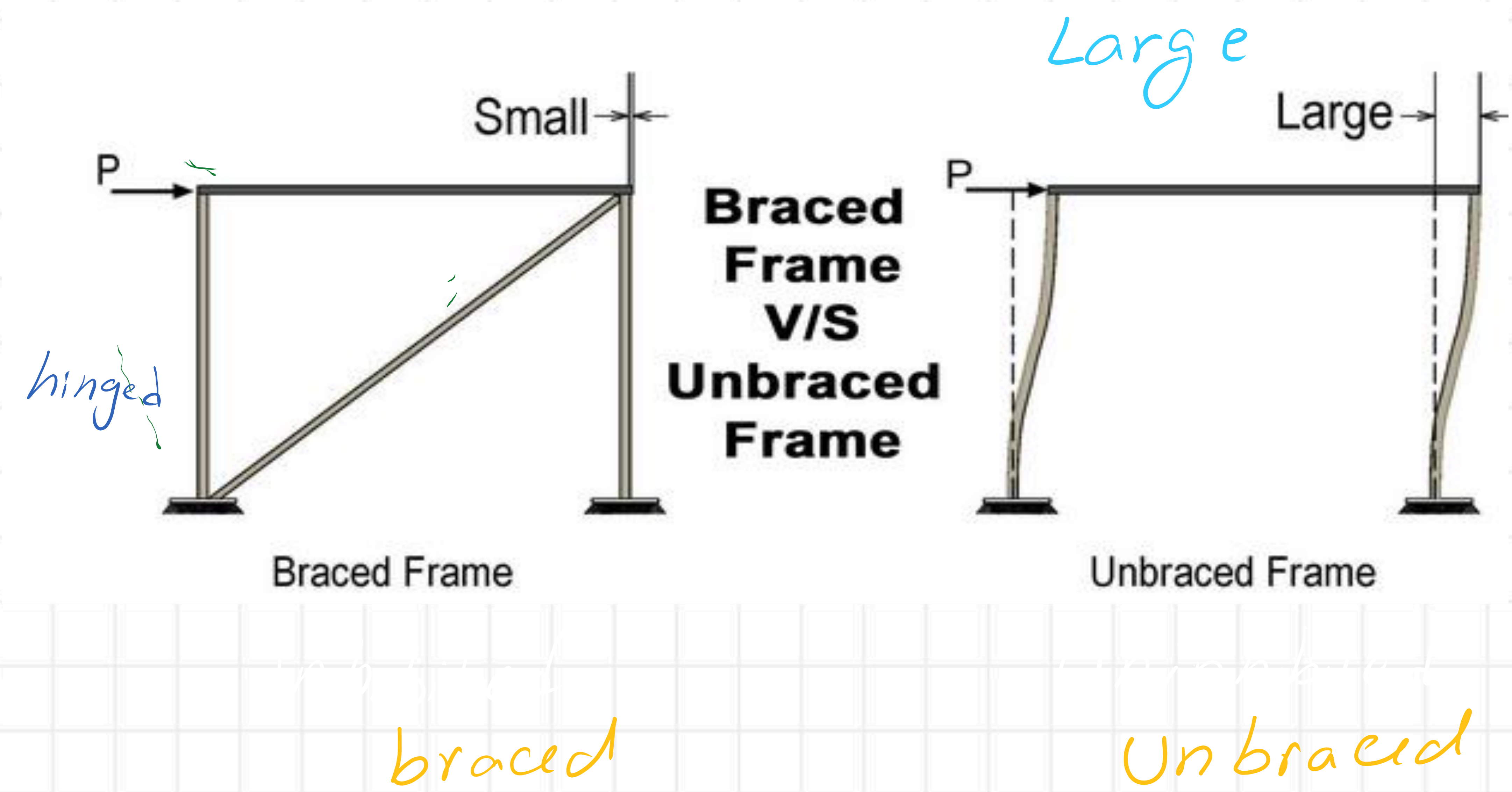

Large
Small
Large
P
P
hinged
Braced
Frame
V/S
Unbraced
Frame
Braced Frame
Unbraced Frame
braced
Unbraced

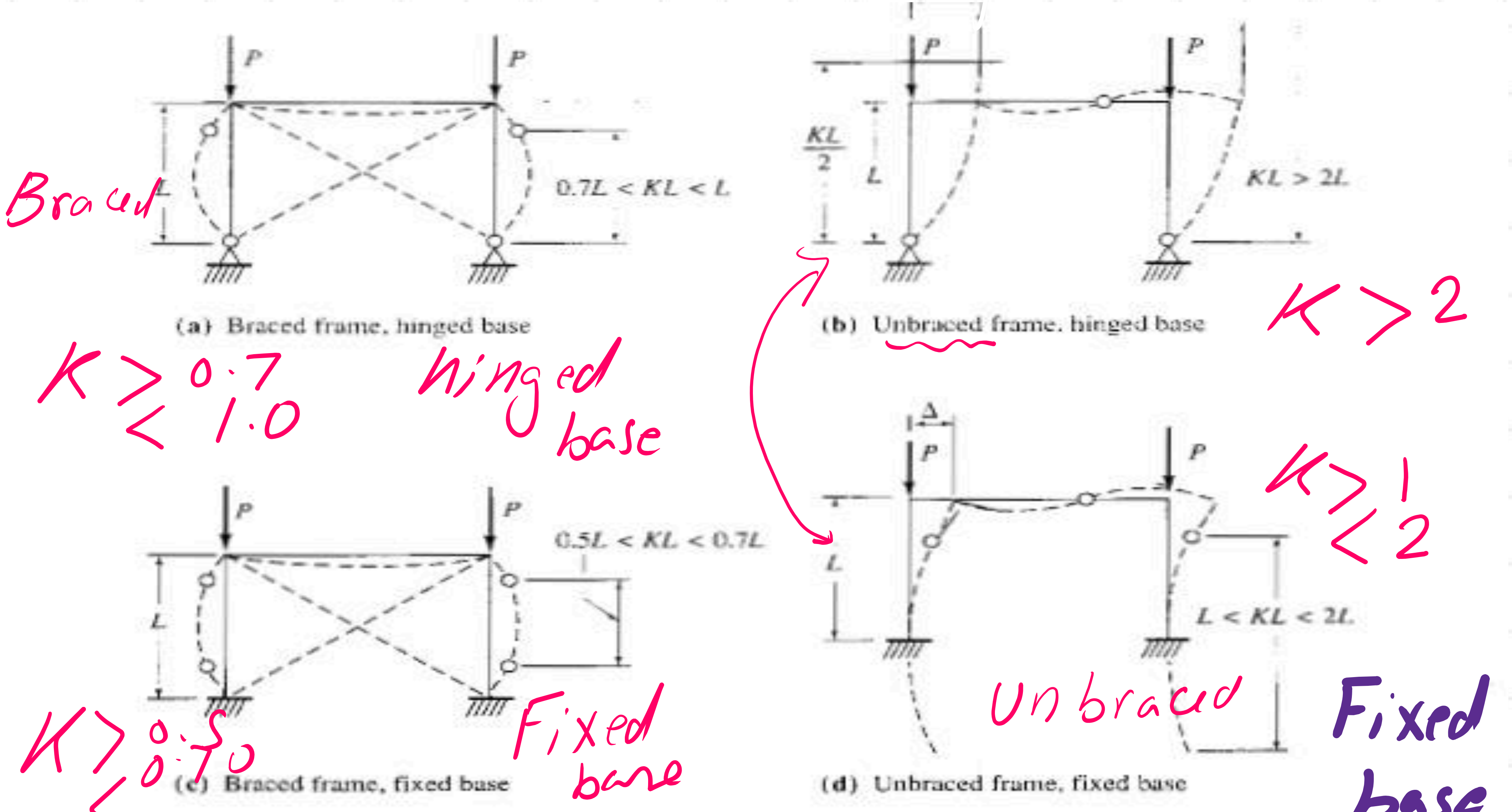
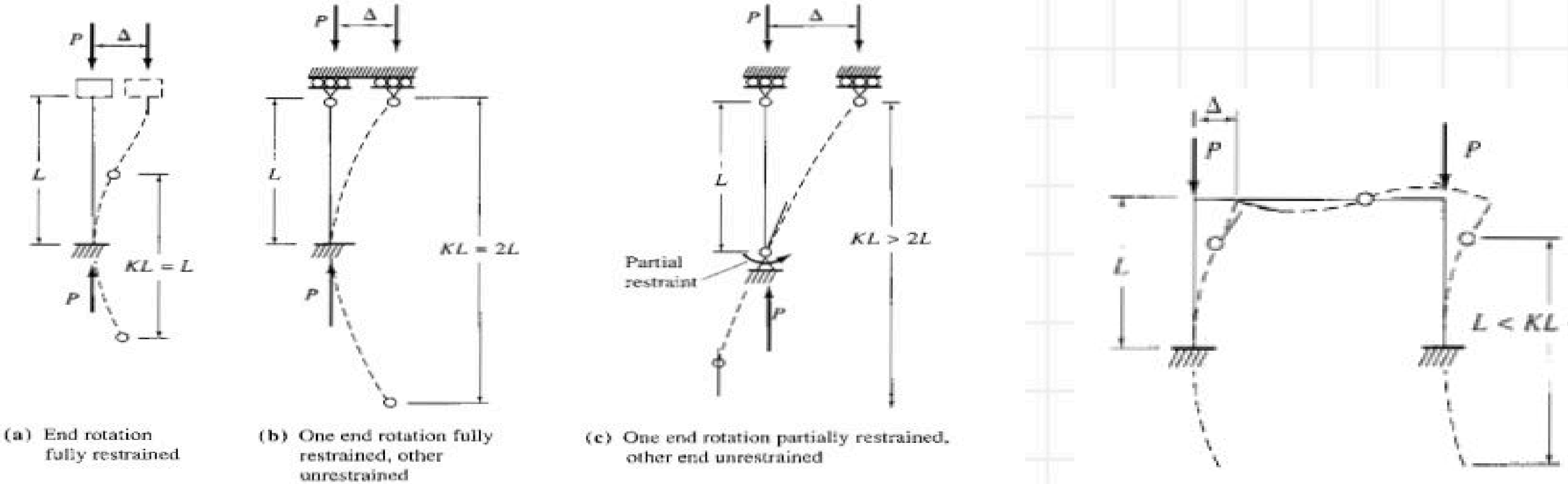


Figure 6.9.2 Effective length *KL* for frames.

To understand why the *minimum* value of K in an unbraced frame is theoretically 1.0, examine the rectangular frame of Fig. 6.9.2d. The stiffest situation would be when the beam is infinitely stiff, that is, it cannot bend. The inflection point would then be at mid-height and the buckled shape would be as in Fig.6.9.3a.

The practical situation in an unbraced frame is that K is always *greater than unity*. Furthermore, there is no simple way of obtaining a value other than evaluating the end restraint. LRFD-C2.2 requires that K "shall be determined by structural analysis."



(a) End rotation fully restrained

(b) One end rotation fully restrained, other unrestrained

(c) One end rotation partially restrained, other end unrestrained

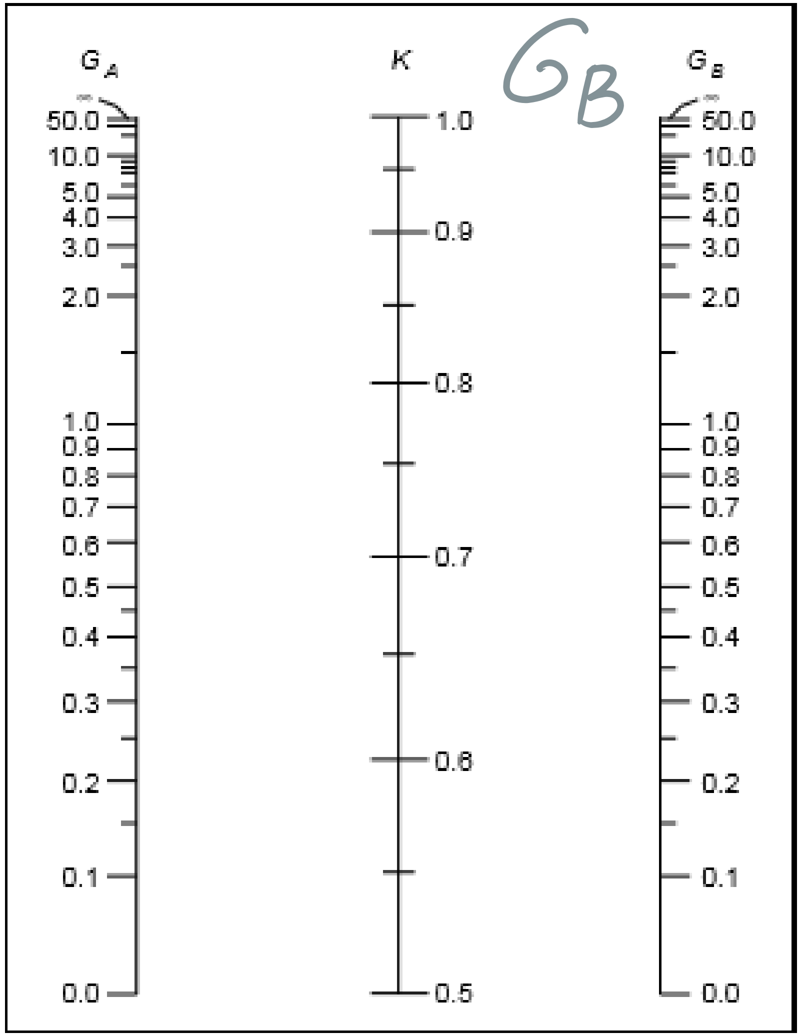
(d) Unbraced frame, fixed base

Figure 6.9.3 Effective length KL; joint translation possible.

GA

AISC Figure C-A-7.1

Alignment chart, sidesway inhibited (braced frame)



Steel Construction Manual, 14th ed., AISC, 2011.

The alignment chart for sidesway inhibited frames shown in Figure C-A-7.1 is based on the following equation:

$$\frac{G_A G_B}{4}(\pi/K)^2+\left(\frac{G_A+G_B}{2}\right)\left(1-\frac{\pi/K}{\tan(\pi/K)}\right)+\frac{2\tan(\pi/2K)}{(\pi/K)}-1=0 \qquad \text{(C-A-7-1)}$$

Determining K factors by Alignment Charts

Sidesway Inhibited:
Braced frame
1.0 > K > 0.5

Sidesway Uninhibited:
Un-braced frame
unstable > K > 1.0

More Pinned:
If Ic/Lc is large
and Ig/Lg is small
The connection is more pinned

More Fixed:
If Ic/Lc is small
and Ig/Lg is large
The connection is more fixed

Theoritically ∞

Sidesway inhibited

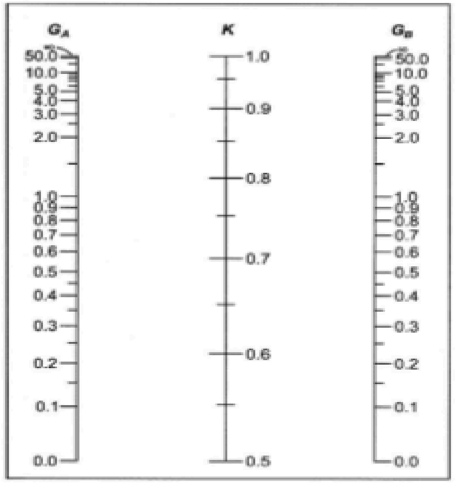
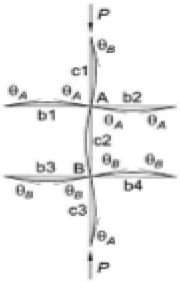
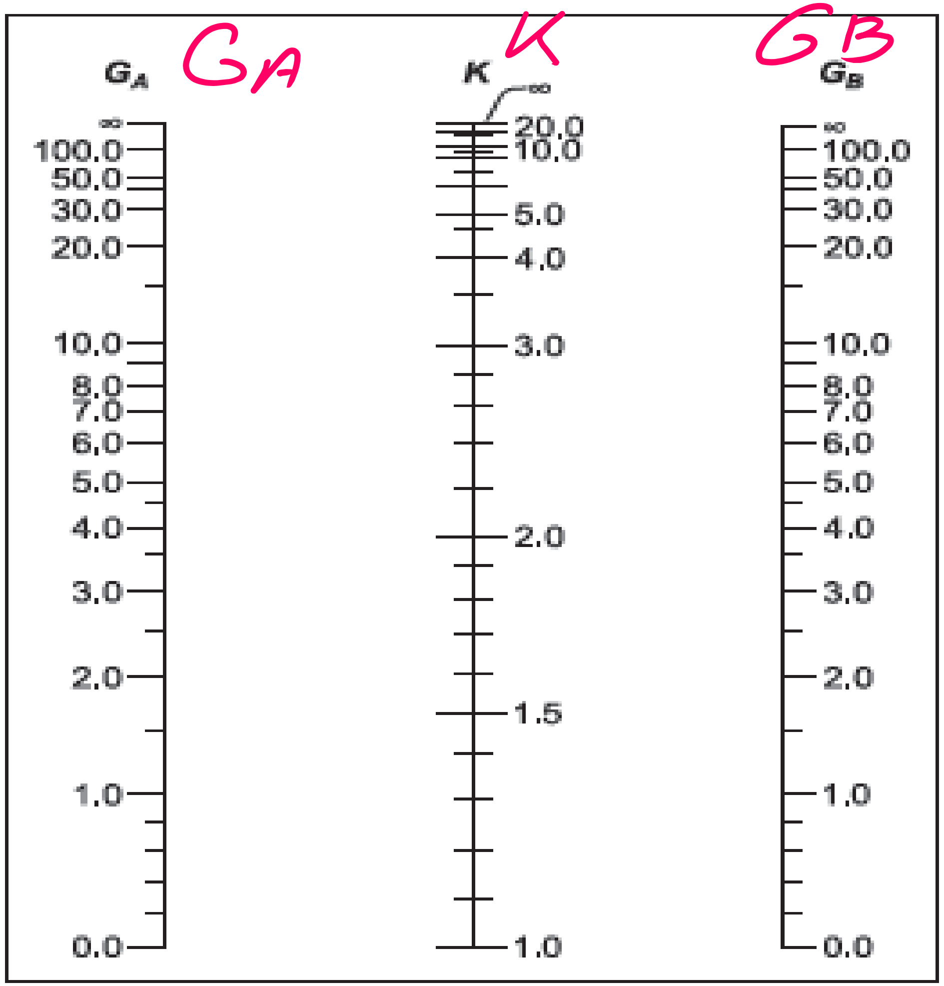


Fig. C-A-7.1. Alignment chart—sidesway inhibited (braced frame).



$$G=\frac{\Sigma\left(\frac{EI}{L}\right)_{column}}{\Sigma\left(\frac{EI}{L}\right)_{beam}}$$



Uninhibited

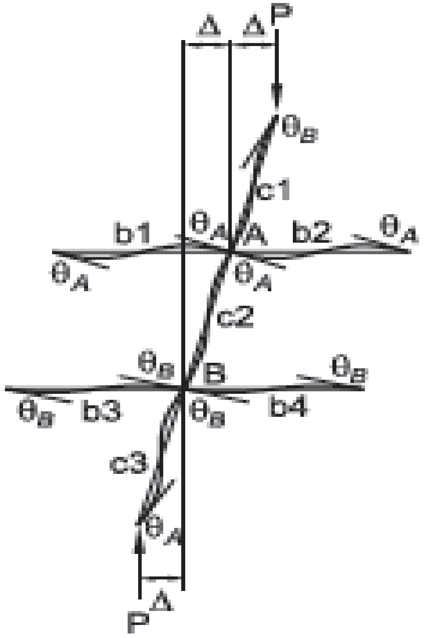


Fig. C-A-7.2. Alignment chart sidesway—uninhibited (moment frame).

$$\frac{G_A G_B (\pi / K)^2 - 36}{6(G_A + G_B)} - \frac{(\pi / K)}{\tan(\pi / K)} = 0$$

where

$$G = \frac{\Sigma(E_c I_c / L_c)}{\Sigma(E_g I_g / L_g)} = \frac{\Sigma(EI/L)_c}{\Sigma(EI/L)_g} \qquad \text{(C-A-7-3)}$$

The subscripts *A* and *B* refer to the joints at the ends of the column being considered. The symbol Σ indicates a summation of all members rigidly connected to that joint and located in the plane in which buckling of the column is being considered. E_c is the elastic modulus of the column, I_c is the moment of inertia of the column, and L_c is the unsupported length of the column. E_g is the elastic modulus of the girder, I_g is the moment of inertia of the girder, and L_g is the unsupported length of the girder or other restraining member. I_c and I_g are taken about axes perpendicular to the plane of buckling being considered. The alignment charts are valid for different materials if an appropriate effective rigidity, *EI*, is used in the calculation of *G*.

If the girders at a joint are very stiff (that is, they have very large *EI*/*L* values) the value of $G = \Sigma(E_c I_c/L_c)/\Sigma(E_g I_g/L_g)$ will approach zero and the *K* factors will be small. If *G* is very small, the column moments cannot rotate the joint very much; thus, the joint is close to a fixed-end situation. Usually, however, *G* is appreciably larger than zero, resulting in significantly larger values of *K*.

Effect of Stiff Girders on the value of G

7.3 FRAMES MEETING ALIGNMENT CHART ASSUMPTIONS

The Jackson and Moreland charts were developed on the basis of a certain set of assumptions, a complete list of which is given in Section 7.2 of the Commentary of Appendix 7 of the AISC Specification. Among these assumptions are the following:

1. The members are elastic, have constant cross sections, and are connected with rigid joints.
2. All columns buckle simultaneously.
3. For braced frames, the rotations at opposite ends of each beam are equal in magnitude, and each beam bends in single curvature.
4. For unbraced frames, the rotations at opposite ends of each beam are equal in magnitude, but each beam bends in double curvature.
5. Axial compression forces in the girders are neglibible.

Adjustments for Girders With Differing End Conditions. For sidesway inhibited frames, these adjustments for different girder end conditions may be made:

(a) If the far end of a girder is fixed, multiply the $(EI/L)_g$ of the member by 2.
(b) If the far end of the girder is pinned, multiply the $(EI/L)_g$ of the member by $1^1/_2$.

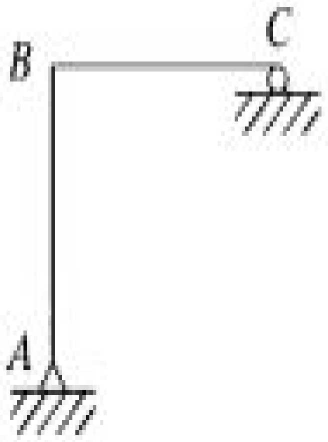


FIGURE 7.5

TABLE 7.1 Multipliers for Rigidly Attached Members

Condition at Far End of Girder	Sidesway Prevented, Multiply by:	Sidesway Uninhibited, Multiply by:
Pinned	1.5	0.5
Fixed against rotation	2.0	0.67