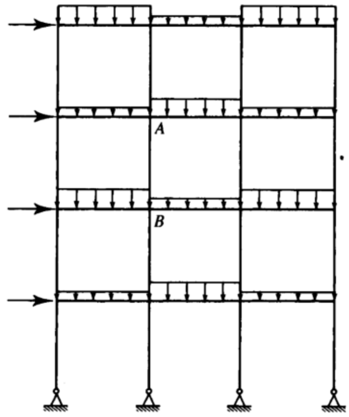
3.6 Column Within a Rigid Frames

The factor K will depend on the ratio of the column to girder stiffness at each end.

$$G = \frac{\left(\sum \frac{EI}{L}\right)_{Columns}}{\left(\sum \frac{EI}{L}\right)_{Girders}} = \frac{\left(\sum \frac{I}{L}\right)_{Columns}}{\left(\sum \frac{I}{L}\right)_{Girders}}$$



Notes:

1. For pinned column base, use $G = 10$.
2. For fixed column base, use $G = 1$.

Also it is depending on the relative movements between the columns ends. i.e. frame without side sway (inhibited side sway) and with side sway or (uninhibited side sway). See Fig. C-C2.3 and Fig. C-C2.4.

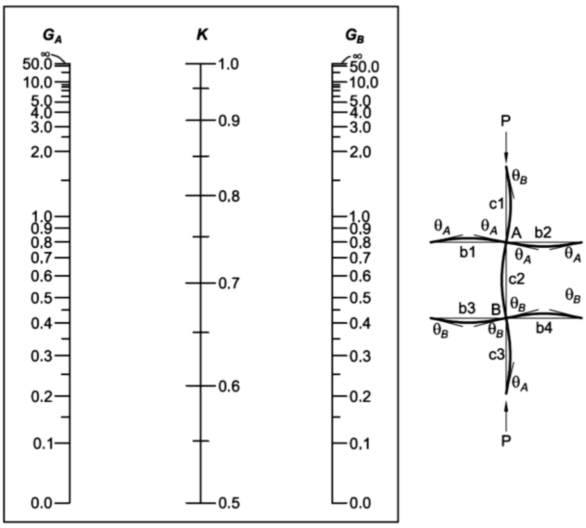


Fig. C-C2.3. Alignment chart—sidesway inhibited (braced frame).

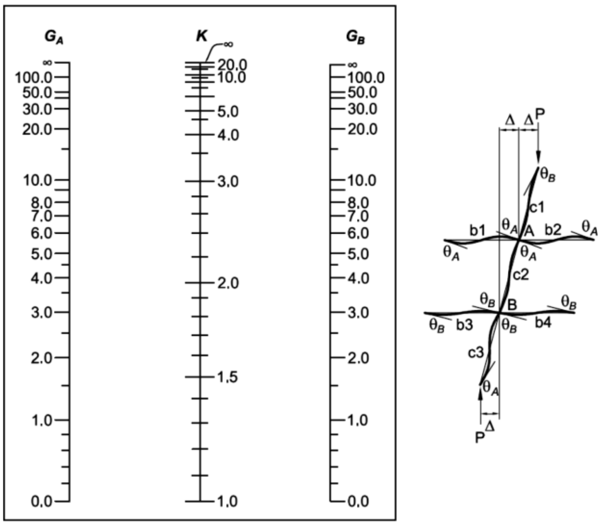
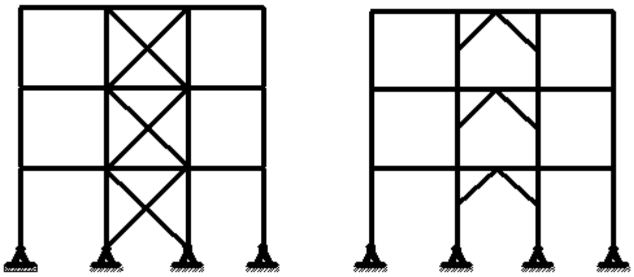
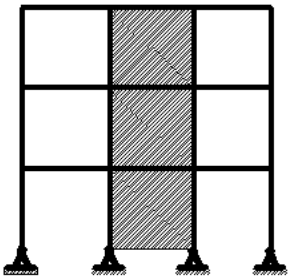


Fig. C-C2.4. Alignment chart—sidesway uninhibited (moment frame).

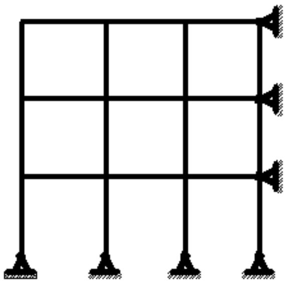
The frame is called braced frame (sides way inhibited), if it has one of the following:



Diagonal Bracing



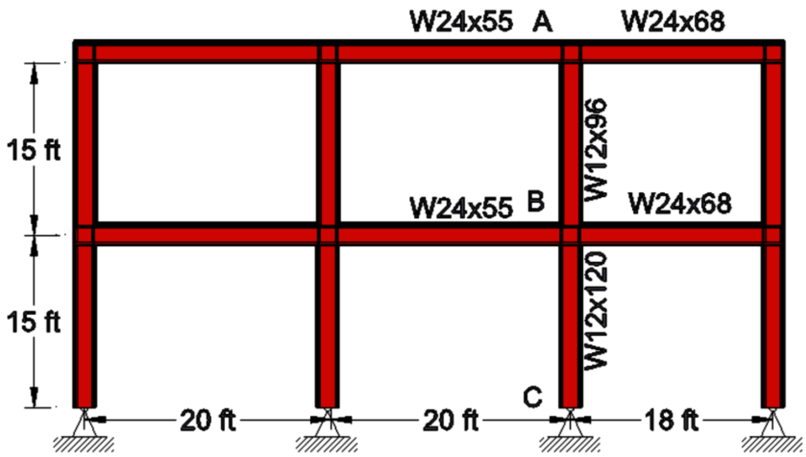
Shear Walls



Lateral Bracing

Other else the frame is called unbraced frame (sides way uninhibited).

Example No. 1: The rigid frame shown in Figure is unbraced. Each member is oriented so that its web is in the plane of frame (bending about x-axis). Determine the effective length factor for columns AB and BC.



Maryam Hameed Nasir

Solve:

1) Section Properties:

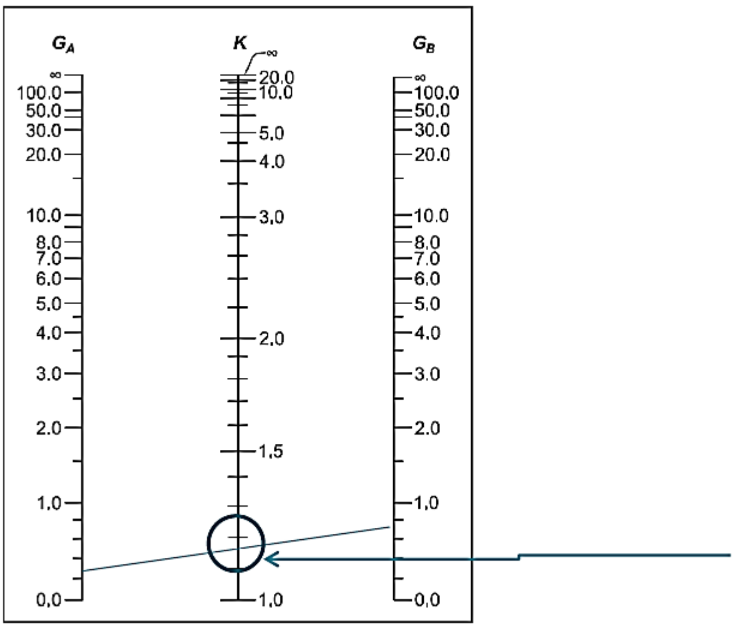
Section	$I_x\ (in^4)$	$Length\ (ft)$
$W12 \times 96$	833	15
$W12 \times 120$	1070	15
$W24 \times 55$	1350	20
$W24 \times 68$	1830	18

2) Column AB

$$\boldsymbol{For\ joint\ A}: G_A = \frac{\left(\sum \frac{I}{L}\right)_{Columns}}{\left(\sum \frac{I}{L}\right)_{Girders}} = \frac{833/15}{1350/20 + 1830/18} = \frac{55.53}{169.17} = 0.328$$

$$\boldsymbol{For\ joint\ B}: G_B = \frac{\left(\sum \frac{I}{L}\right)_{Columns}}{\left(\sum \frac{I}{L}\right)_{Girders}} = \frac{833/15 + 1070/15}{1350/20 + 1830/18} = \frac{126.87}{169.17} = 0.75$$

From the alignment chart for sides way uninhibited (AISC Figure C-C2.4). $use\ G_A = 0.328\ and\ G_B = 0.75.$

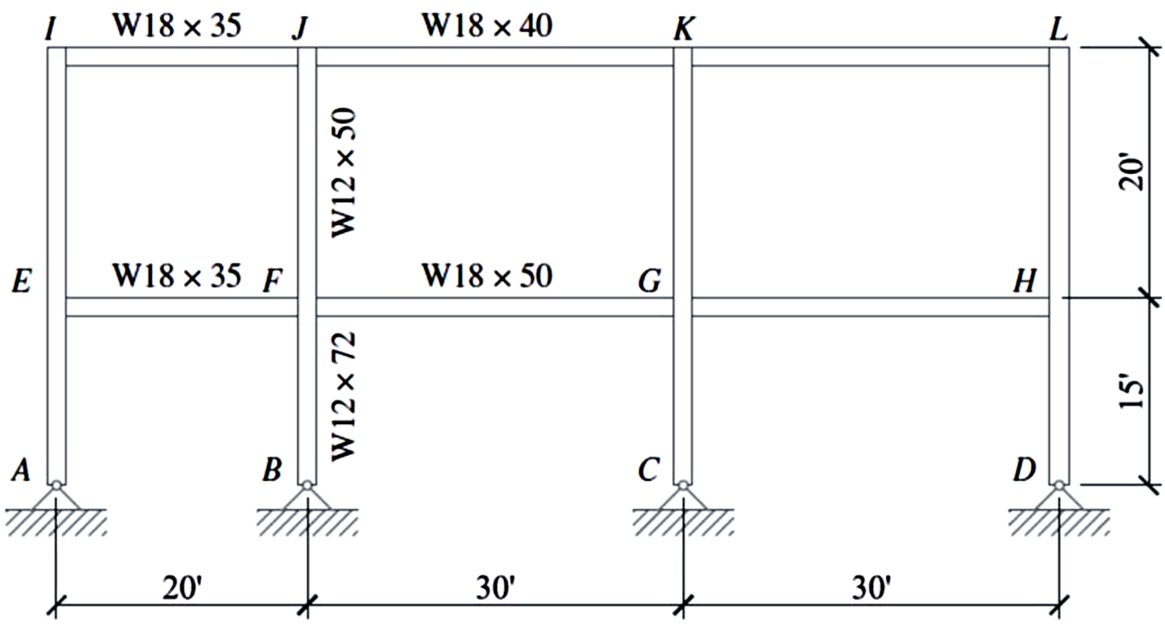


$K_x = 1.16$

Fig. C-C2.4. Alignment chart—sidesway uninhibited

H.W: Determine the effective length factor for columns BC. (Ans: $K_x = 1.8$)

Example No. 2: For the two-story moment frame shown down, the column and girder sizes have been determined as shown. Assume in-plane bending about the strong axes for the columns and girders. Determine the effective length factor, ***K***, for columns ***BF*** and ***FJ*** using the alignment charts.



Solve:

1) Section Properties:

Member	Section	$I_x\ (in^4)$	$Length\ (ft)$
FJ	$W12 \times 50$	391	20
BF	$W12 \times 72$	597	15
EF, IJ	$W18 \times 35$	510	20
JK	$W18 \times 40$	612	30
FG	$W18 \times 50$	800	30

2) Column BF

$$\boldsymbol{For\ joint\ B}: G_A = 10 \quad \text{(pinned Support)}$$

$$\boldsymbol{For\ joint\ F}: G_B = \frac{\left(\Sigma \frac{I}{L}\right)_{Columns}}{\left(\Sigma \frac{I}{L}\right)_{Girders}} = \frac{391/20 + 597/15}{510/20 + 800/30} = \frac{59.35}{52.167} = 1.14$$

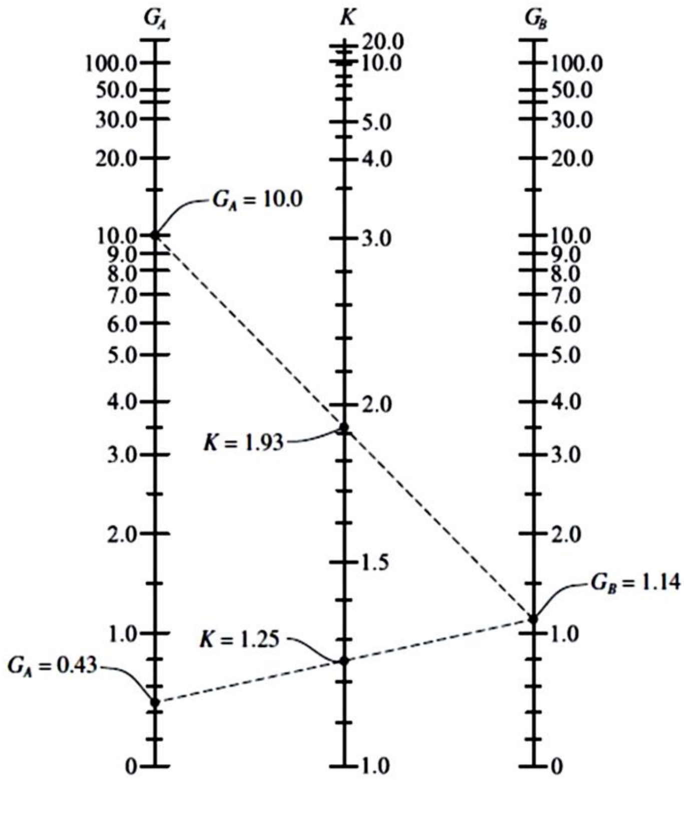
From the alignment chart for sides way uninhibited (AISC Figure C-C2.4), $use\ G_A = 10\ and\ G_B = 1.14$. Get: $K_x = 1.93$.

3) Column FJ

$\boldsymbol{For\ joint\ F}$: $G_A = 1.14$

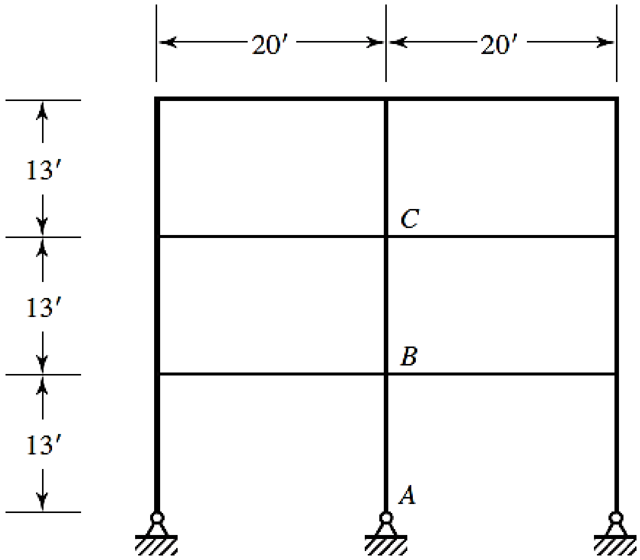
$$\boldsymbol{For\ joint\ J}: G_B = \frac{\left(\sum \frac{I}{L}\right)_{Columns}}{\left(\sum \frac{I}{L}\right)_{Girders}} = \frac{391/20}{510/20 + 612/30} = \frac{19.55}{45.9} = 0.43$$

From the alignment chart for sides way uninhibited (AISC Figure C-C2.4), $use\ G_A = 1.14\ and\ G_B = 0.43$. Get: $K_x = 1.25$.



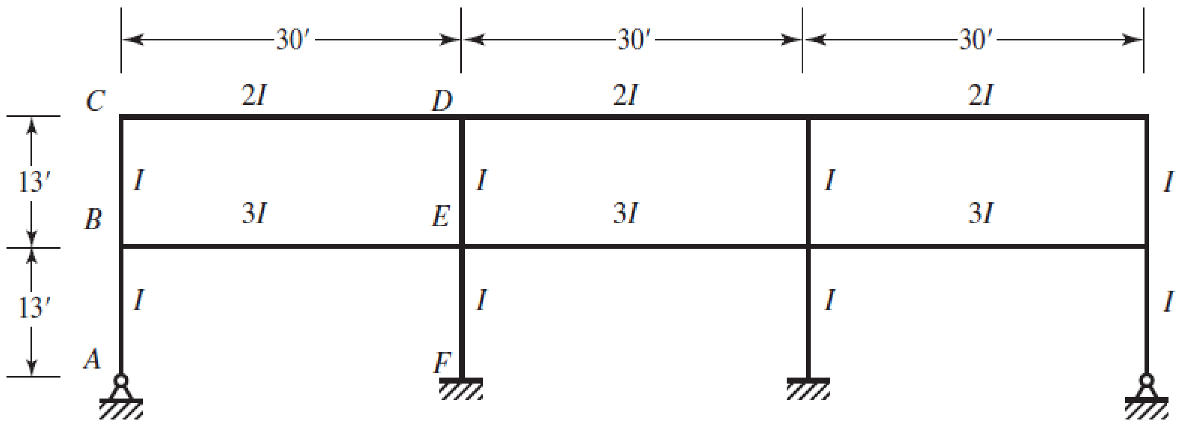
Problem:

1. The frame shown in Figure is unbraced, and bending is about the x-axis of the members. All beams are W16 × 40, and all columns are W12 × 58. Determine the effective length factor K_x for column AB and BC.



Ans: $a.\ Kx = 1.98, \quad b. Kx = 1.42$

2. The frame shown in Figure is unbraced against sides way. Relative moments of inertia of the members have been assumed for preliminary design purposes. Use the alignment chart and determine K_x for members AB, BC, DE, and EF.



Ans: $Member\ AB: Kx = 2.00, \quad BC: Kx = 1.40, \quad DE: Kx = 1.20, \quad EF: Kx = 1.28.$