① Alignment chart or Nomograph detailing (effective length Method) ELM

② Adjustement of Column due to different End Conditions

m-value For end Condition For girders of braced Frames

③ Solved problem - 7-2 Prof. Mccormac. ↓ Later

④ French equation For braced Frame.

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Assumption For Alignment Chart

As discussed previously in this chapter, the alignment charts, or nomographs, are an alternate method for determining the effective length factor, *K*. These nomographs take into account the restraints provided at the ends of the column by the beams or girders framing into the columns. They provide more accurate *K*-values, but require knowledge of the sizes of the beams, girders, and columns, and are more cumbersome to use. Two charts are presented in the *AISCM*: sidesway inhibited (i.e., buildings with braced frames or shearwalls), reproduced in Figure 5-9, and sidesway uninhibited (i.e., buildings with moment frames), reproduced in Figure 5-10. The following assumptions have been used in deriving these alignment charts, or nomographs [1]:

1. Behavior is purely elastic.
2. All members have a constant cross section.
3. All joints are rigid.

} Conditions For the Graph

4. For columns in sidesway-inhibited frames (i.e., braced frames), rotations at opposite ends of the restraint beams or girders are equal in magnitude and opposite in direction, producing single-curvature bending.

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5. For columns in sidesway-uninhibited frames, rotations at opposite ends of the restraining beams or girders are equal in magnitude and direction, producing double- or reverse-curvature bending.
6. The stiffness parameters, $L\sqrt{P/EI}$, of all columns are equal.
7. Joint restraint is distributed to the column above and below the joint in proportion to EI/L for the two columns.
8. All columns buckle simultaneously.
9. No significant axial compression force exists in the beams or girders.

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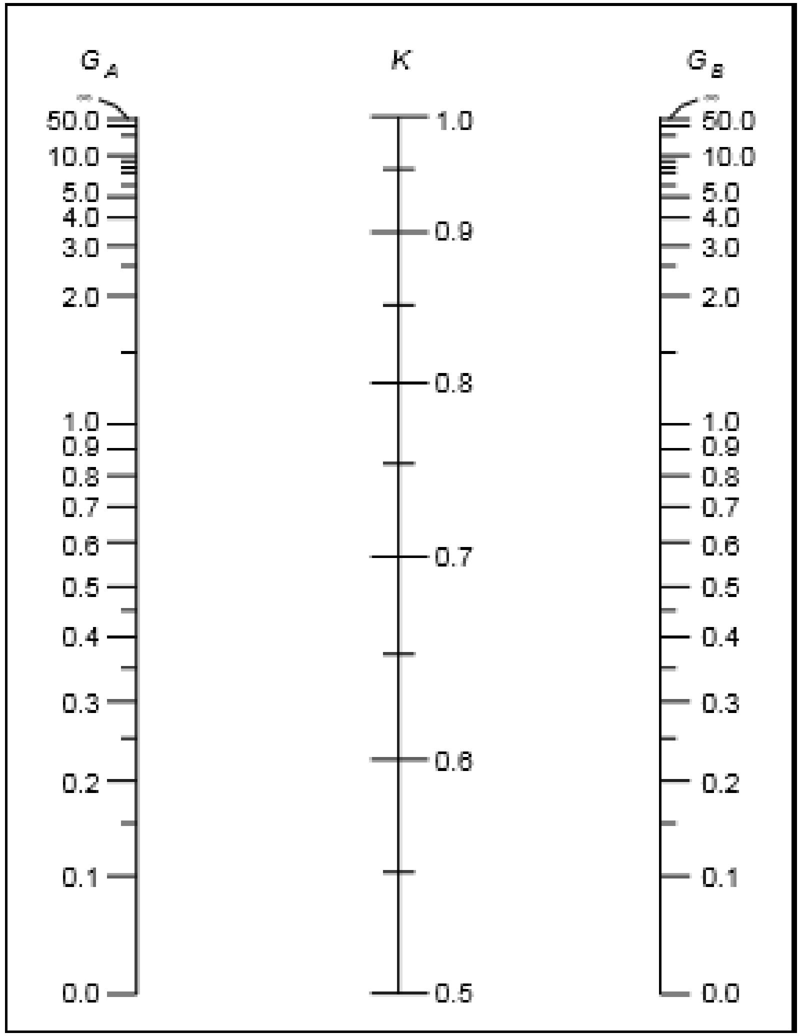
Side Sway - inhibited → Braced

AISC Figure C-A-7.1

Alignment chart, sidesway inhibited (braced frame)



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

∞

0

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

Sidesway inhibited

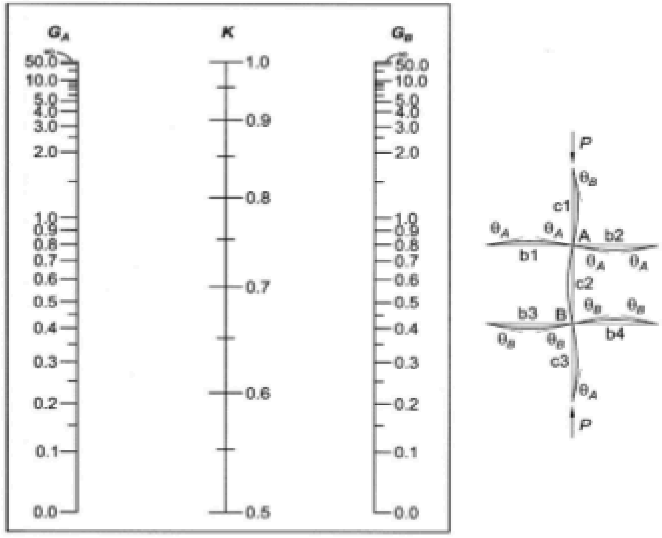


Fig. C-A-7.1. Alignment chart—sidesway inhibited (braced frame).

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

G=10 Pinned support. → theortically ∞

G=1 Fixed support → theoritcally 0

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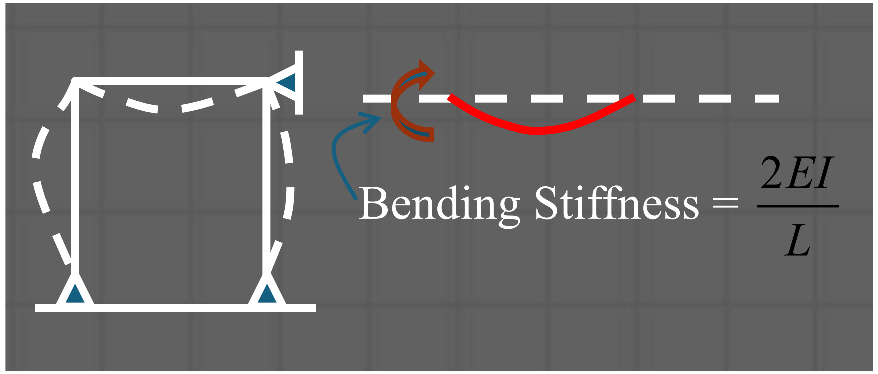
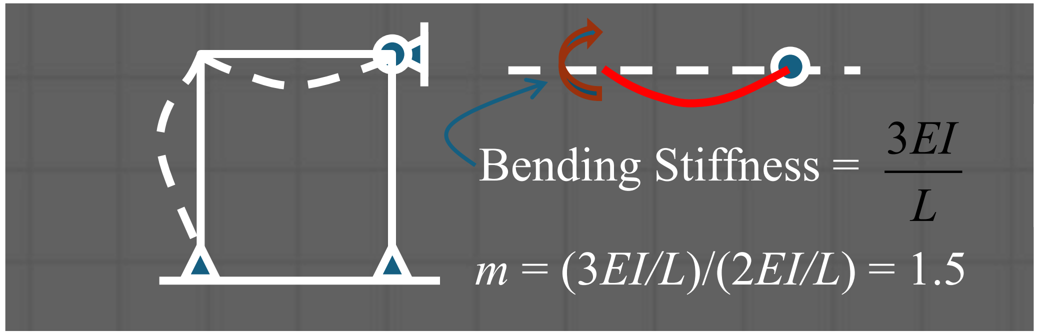
Alignment Charts

http://www.ecs.umass.edu/cee542/

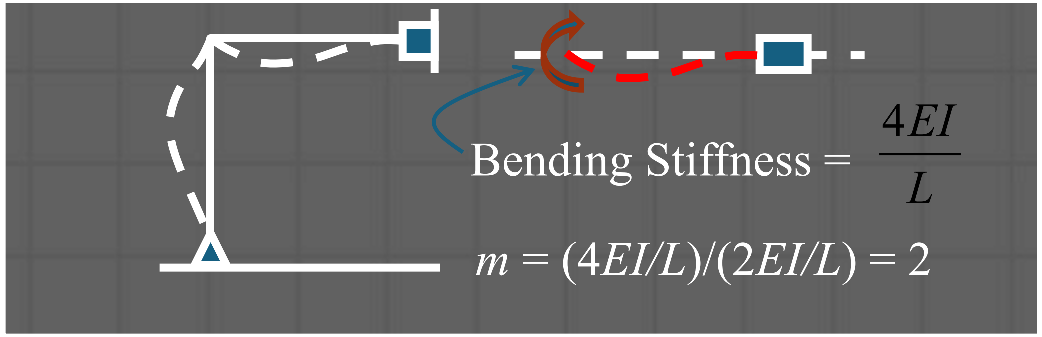


Side-sway Inhibited (Braced)
Assumption: single curvature bending of girder.

$$G = \frac{\sum\left(\frac{EI}{L}\right)_{columns}}{\sum\left(m\frac{EI}{L}\right)_{girders}}$$



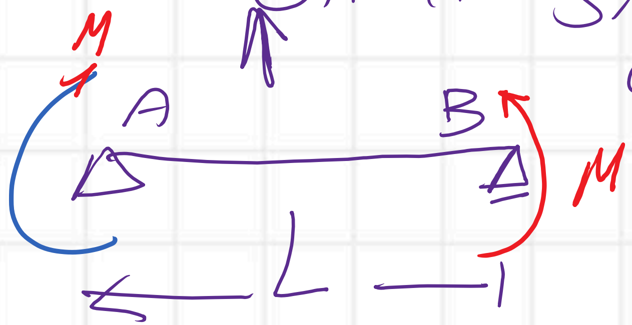
Far end pinned

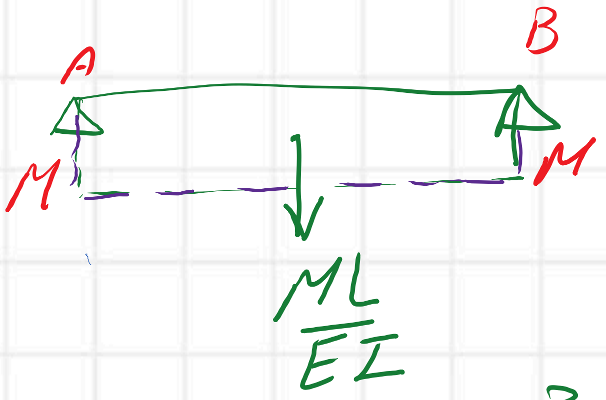


Far end fixed

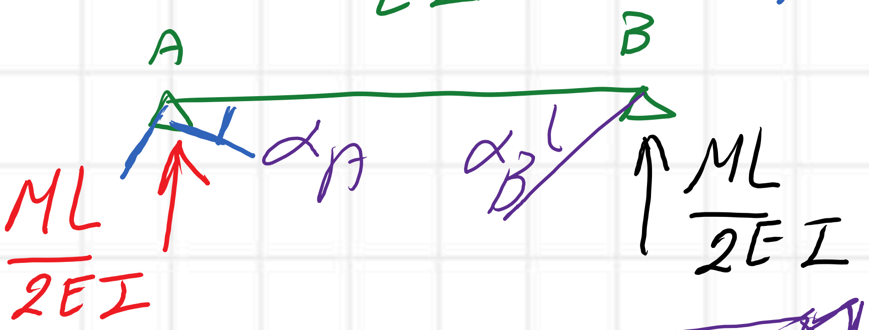
Girder Single Curvation Bending

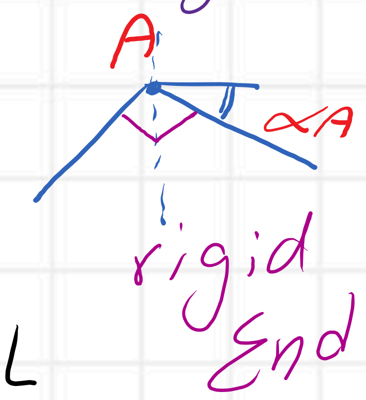
The Condition for which the Formula was derived





B.M Diagram



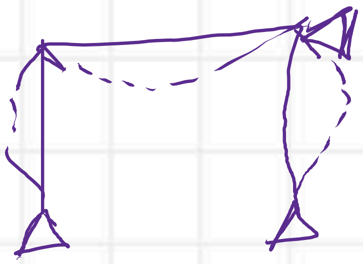


$\alpha_A = \frac{ML}{2EI}$ → slope at A Due to M

$K(\alpha) = M$

$K = \frac{M}{\alpha} = \frac{M}{\frac{ML}{2EI}} = \frac{2EI}{L}$

$m = \frac{New}{main} = \frac{2}{2} = 1$ ⇒ no Change



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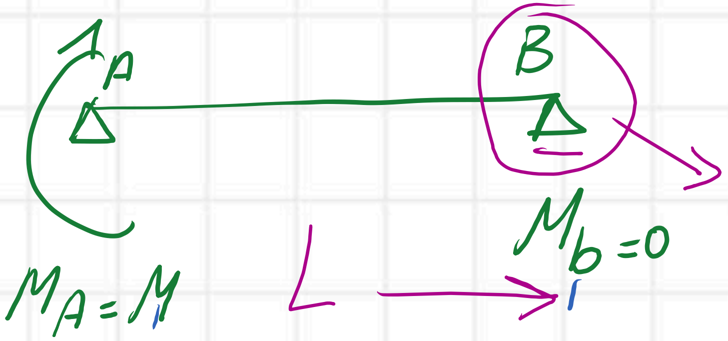
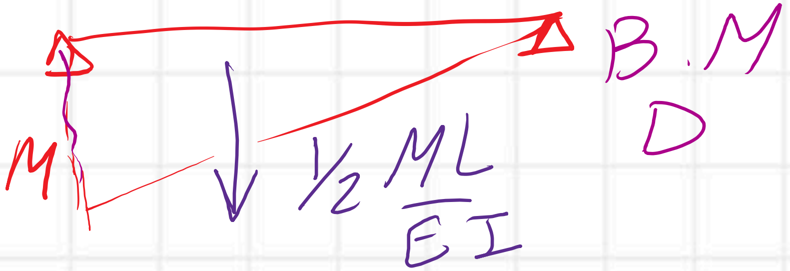
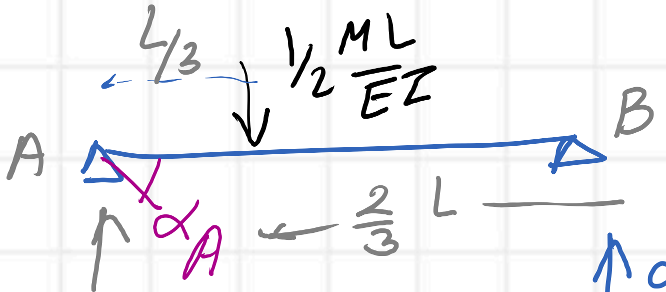
When Far end is pinned

K: bending stiffness







$$\alpha_A = \frac{ML}{3EI}$$

$$\alpha_b = \frac{ML}{6EI}$$

$$K_2 = \frac{M_2}{\alpha} = \frac{M}{\left(\frac{ML}{3EI}\right)} = \frac{3EI}{L}$$

new K value

$$m = \frac{\text{New}}{\text{main}} = \frac{3EI/L}{\frac{2EI}{L}} = 1.50$$

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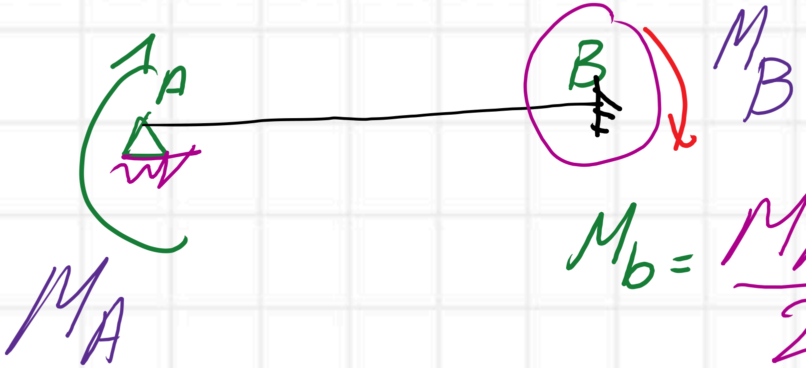
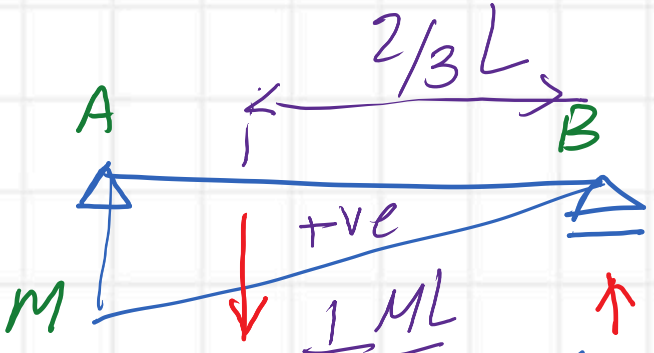
Far end is Fixed



$$M_b = \frac{M_A}{2}$$

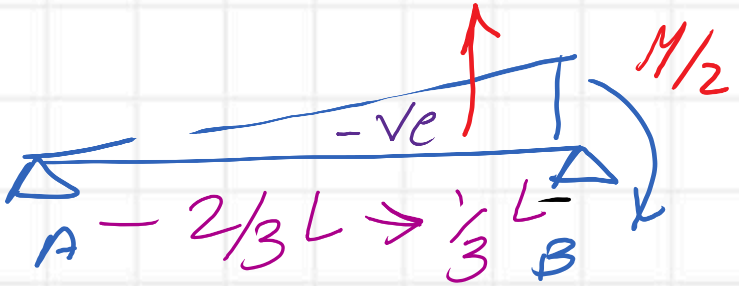


$$\frac{1}{2}\frac{ML}{EI}$$

$$\alpha_A = \frac{ML}{3EI} \qquad \alpha_B = \frac{ML}{6EI}$$

+

$$\frac{1}{2}\frac{M}{2}\frac{\ell}{EI}$$



$$\alpha_A = \frac{ML}{12EI}$$

$$\alpha_{A_F} = \frac{ML}{3EI} - \frac{ML}{12EI} = \frac{3ML}{12EI}$$

$$K = \frac{M_3}{\alpha} = \frac{4EI\cdot\alpha}{L\alpha} = \frac{4EI}{L}$$

$$m_3 = \frac{New}{main} = \frac{4EI/L}{2EI/L} = 2$$

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AISC Commentary - For m Factor

Adjustments for Columns With Differing End Conditions. For column ends supported by, but not rigidly connected to, a footing or foundation, G is theoretically infinity but unless designed as a true friction-free pin, may be taken as 10 for practical designs. If the column end is rigidly attached to a properly designed footing, G may be taken as 1.0. Smaller values may be used if justified by analysis.

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

(a) If rotation at the far end of a girder is prevented, multiply $(EI/L)_g$ of the member by 2.

pinned

(b) If the far end of the girder is pinned, multiply $(EI/L)_g$ of the member by 1.5.

braced Frame

For sidesway uninhibited frames and girders with different boundary conditions, the modified girder length, L_g', should be used in place of the actual girder length, where

$$L_g' = L_g\,(2 - M_F/M_N) \qquad \text{(C-A-7-4)}$$

M_F is the far end girder moment and M_N is the near end girder moment from a first-order lateral analysis of the frame. The ratio of the two moments is positive if the girder is in reverse curvature. If M_F/M_N is more than 2.0, then L_g' becomes negative, in which case G is negative and the alignment chart equation must be used. For sidesway uninhibited frames, the following adjustments for different girder end conditions may be made:

(a) If rotation at the far end of a girder is prevented, multiply $(EI/L)_g$ of the member by $^2/_3$.

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

Unbraced Frame

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