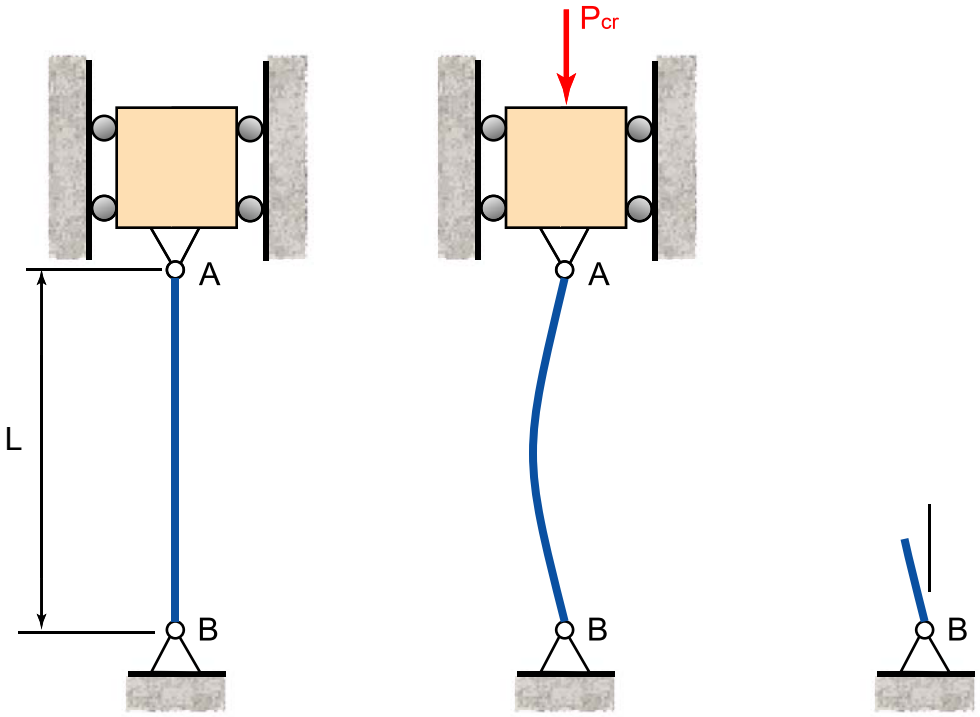
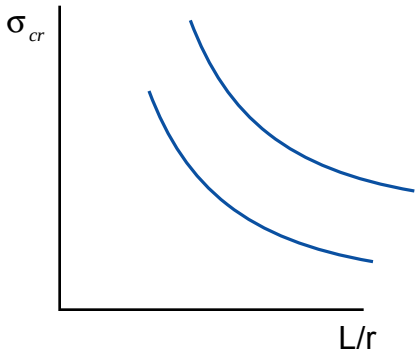
Chapter 10
Columns

COLUMNS WITH PINNED-ENDS



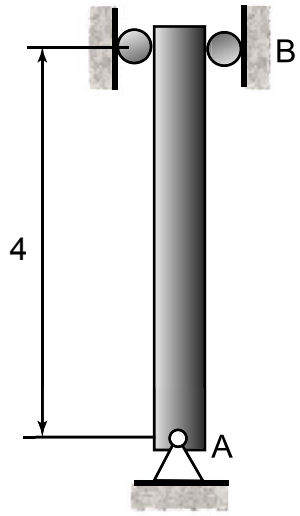
$$P_{cr} = \frac{\pi^2 EI}{L^2}$$

$$\sigma_{cr} = \frac{\pi^2 E}{(L/r)^2}$$



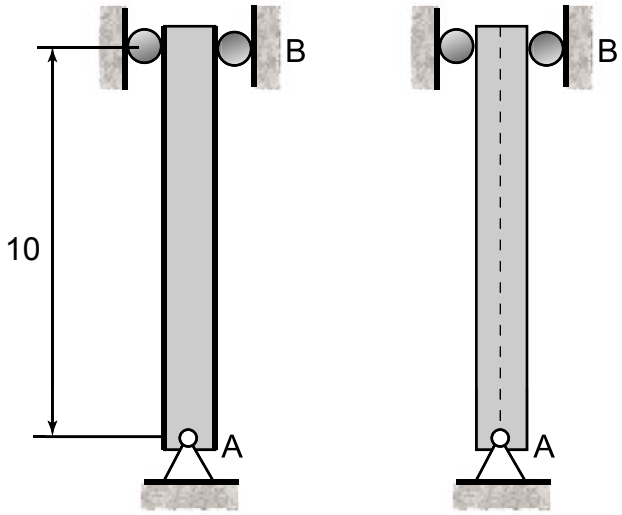
Example

a) Using a factor of safety of 2.5 against buckling, determine the largest load the column can support before it begins to buckle. Consider only in-plane buckling. b) Find the maximum load if the allowable axial stress is 80 MPa. The pipe has an outside diameter of 100 mm and a wall thickness of 6 mm. E=200 GPa. Units: m.



Example

Using a factor of safety of 1.85, determine the largest load the W6x20 column can support before it begins to buckle. Consider both in-plane and out of plane buckling. E= 29E6 psi. Units: ft.



W6x20

Area, $A = 5.87^{in^2}$

Depth, $d = 6.20^{in}$

Flange Width, $b_f = 6.02^{in}$

Flange Thickness, $t_f = 0.365^{in}$

Web Thickness, $t_w = 0.260^{in}$

$I_x = 41.4^{in^4}$

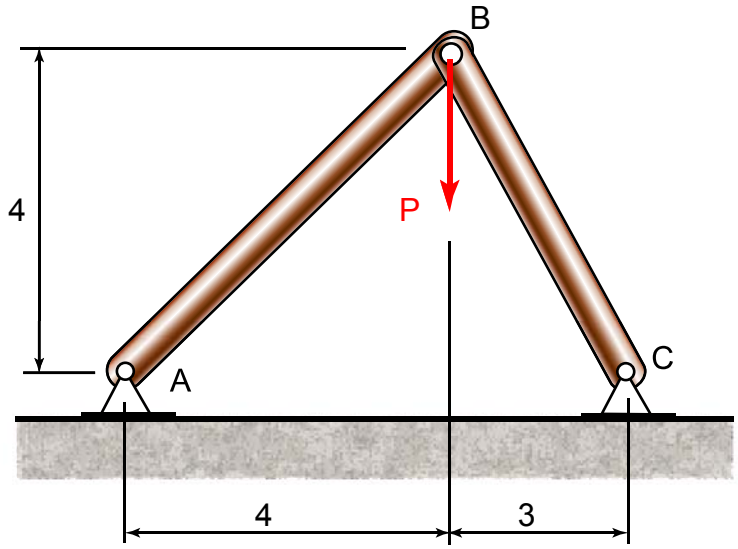
$I_y = 13.3^{in^4}$

$S_x = 13.4^{in^3}$

$S_y = 4.41^{in^3}$

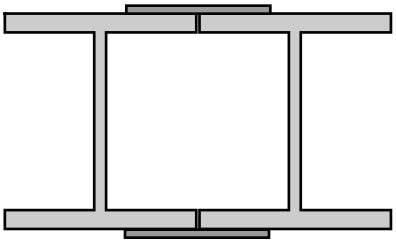
Example

Both members are identical pipe sections with an outside diameter of 100 mm and a wall thickness of 6 mm. Determine the largest load P based on in-plane buckling. E= 200 GPa. Units: m.



Example

Find the critical buckling load for a 28 ft pin-pin columm. The two W6x20 columns are spliced together to insure they work as one. Ignore the properties of the plates used to make the splice.
E= 30E6 psi. Units: ft.

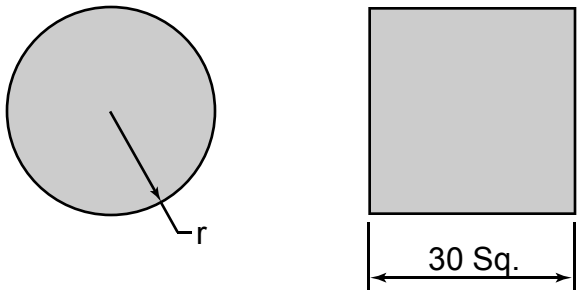


W6x20

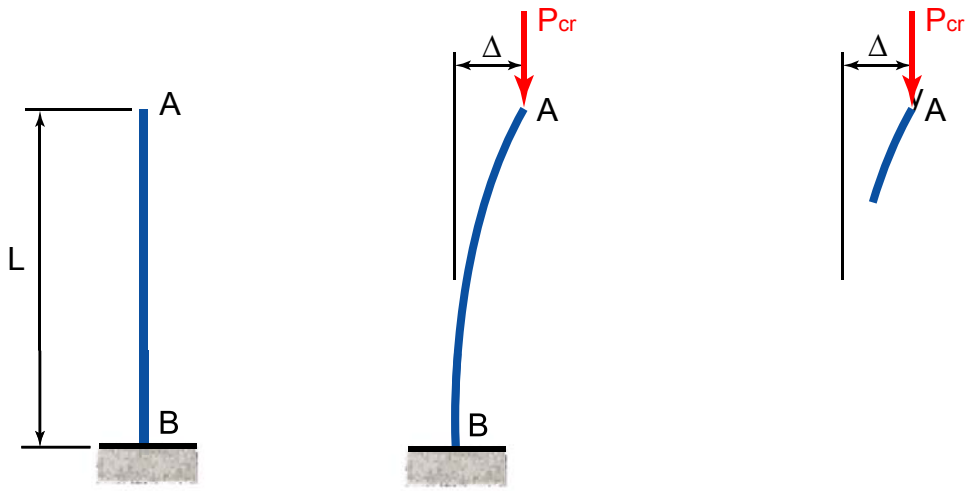
Area, $A = 5.87^{in^2}$
Depth, $d = 6.20^{in}$
Flange Width, $b_f = 6.02^{in}$
Flange Thickness, $t_f = 0.365^{in}$
Web Thickness, $t_w = 0.260^{in}$
$I_x = 41.4^{in^4}$
$I_y = 13.3^{in^4}$
$S_x = 13.4^{in^3}$
$S_y = 4.41^{in^3}$

Example

Determine the radius of a round column so that it has the same buckling capacity as that of a square 30 mm column. Both columns are identical other than their cross section. Units: mm.



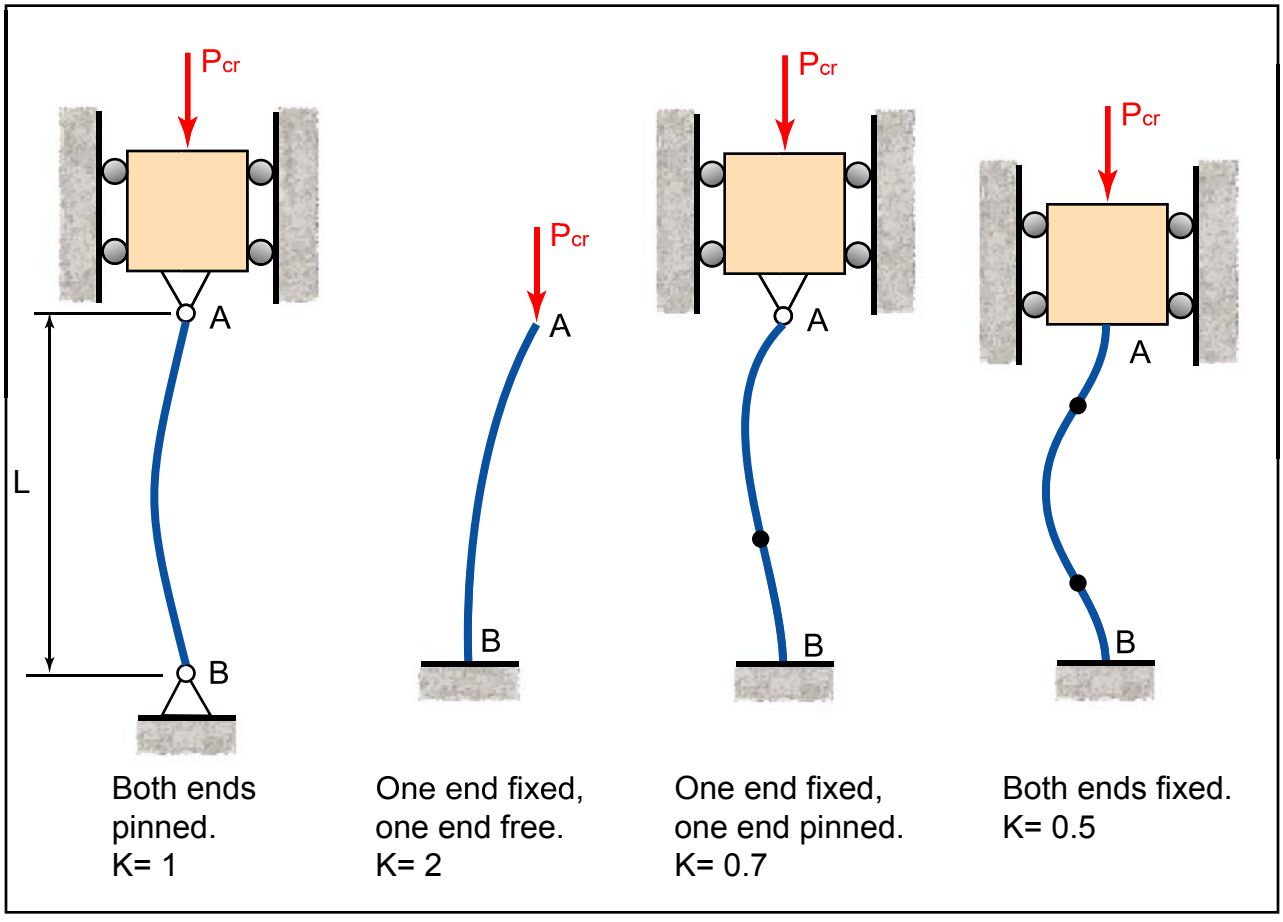
COLUMNS WITH OTHER END CONDITIONS



$$P_{cr} = \frac{\pi^2 EI}{4L^2}$$

Effective Length

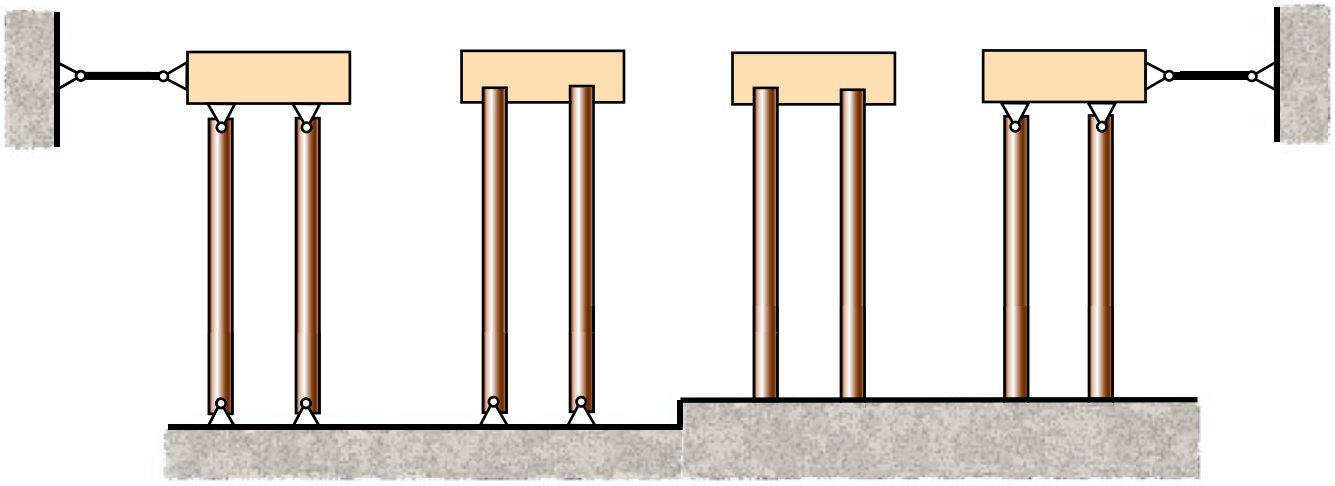
$$P_{cr} = \frac{\pi^2 EI}{(kL)^2} = \frac{\pi^2 EI}{(L_e)^2}$$



Column K values

Example

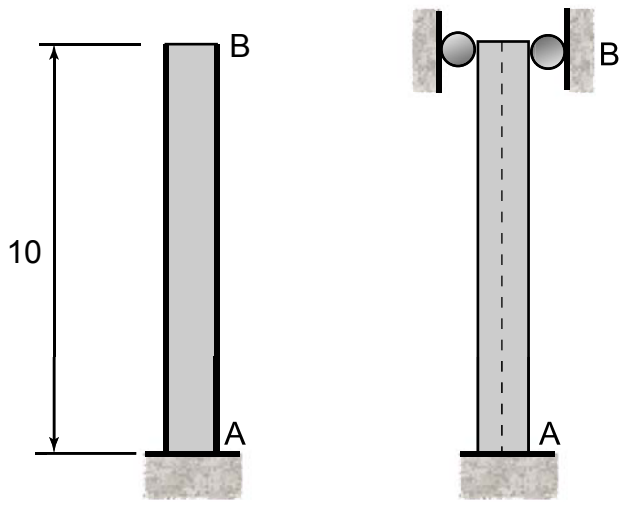
Determine the K value for each of the following conditions:



(a) (b) (c) (d)

Example

Determine the largest load the W6x20 column can support before it begins to buckle. Consider both in-plane and out of plane buckling. E= 29E6 psi. Units: ft.



Front View Side View

W6x20

Area, $A = 5.87^{in^2}$

Depth, $d = 6.20^{in}$

Flange Width, $b_f = 6.02^{in}$

Flange Thickness, $t_f = 0.365^{in}$

Web Thickness, $t_w = 0.260^{in}$

$I_x = 41.4^{in^4}$

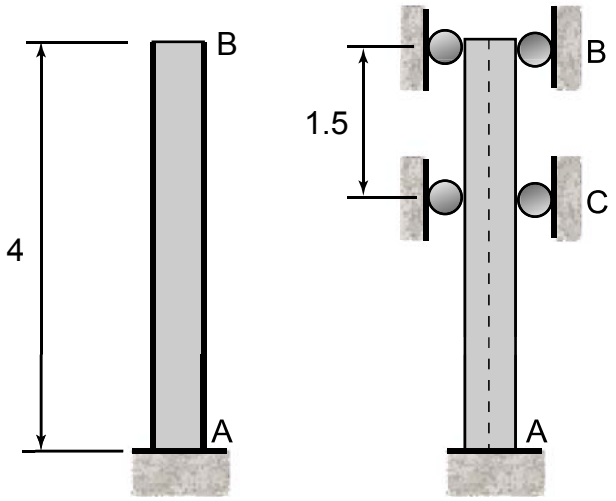
$I_y = 13.3^{in^4}$

$S_x = 13.4^{in^3}$

$S_y = 4.41^{in^3}$

Example

Determine the largest load the W150x29.8 column can support before it begins to buckle. Consider both in-plane and out of plane buckling. E= 200 GPa. Units: m.



Front View Side View

W150x29.8

Area, $A = 3790^{mm^2}$

Depth, $d = 157^{mm}$

Flange Width, $b_f = 153^{mm}$

Flange Thickness, $t_f = 9.3^{mm}$

Web Thickness, $t_w = 6.6^{mm}$

$I_x = 17.2x10^{6mm^4}$

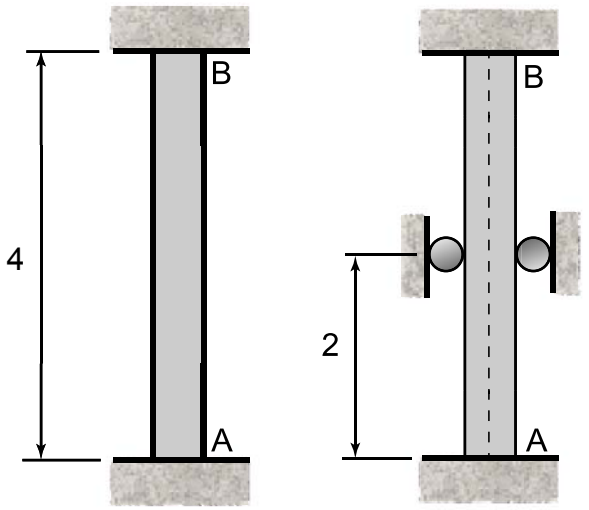
$I_y = 5.56x10^{6mm^4}$

$S_x = 219x10^{3mm^3}$

$S_y = 72.7x10^{3mm^3}$

Example

Determine the largest load the W150x29.8 column can support before it begins to buckle. Consider both in-plane and out of plane buckling. E= 200 GPa. Units: m.



Front View Side View

W150x29.8

Area, $A = 3790^{mm^2}$

Depth, $d = 157^{mm}$

Flange Width, $b_f = 153^{mm}$

Flange Thickness, $t_f = 9.3^{mm}$

Web Thickness, $t_w = 6.6^{mm}$

$I_x = 17.2x10^{6mm^4}$

$I_y = 5.56x10^{6mm^4}$

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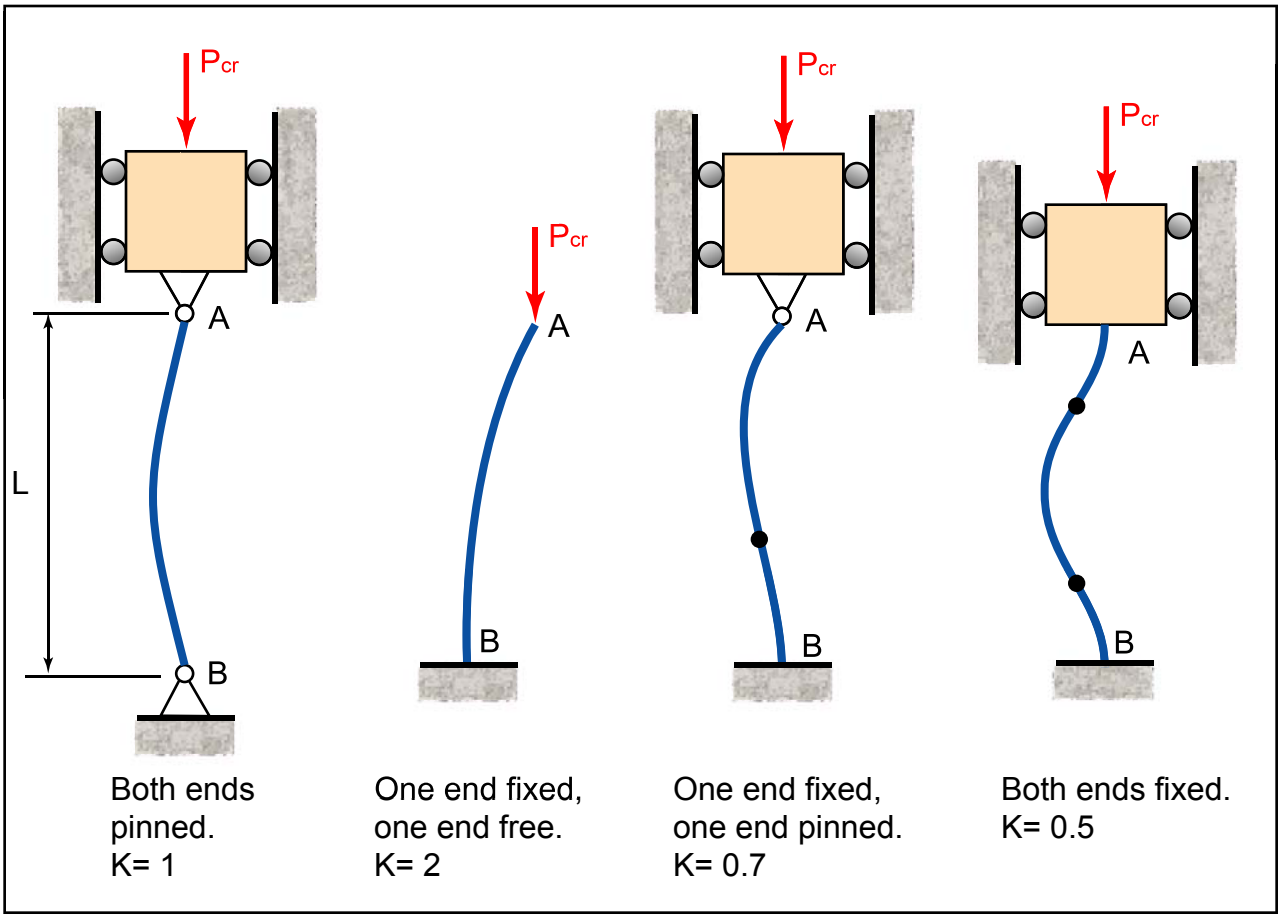
SUMMARY



Column K values

$$P_{cr} = \frac{\pi^2 EI}{(kL)^2} = \frac{\pi^2 EI}{(L_e)^2}$$