CE 415
DESIGN OF STEEL STRUCTURES

LECTURE 19
REVIEW

SEMESTER: SUMMER 2020

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OUTLINE

- Welding Design
- Weld capacity calculation
- Column capacity

CLASS TEST ON WELDING

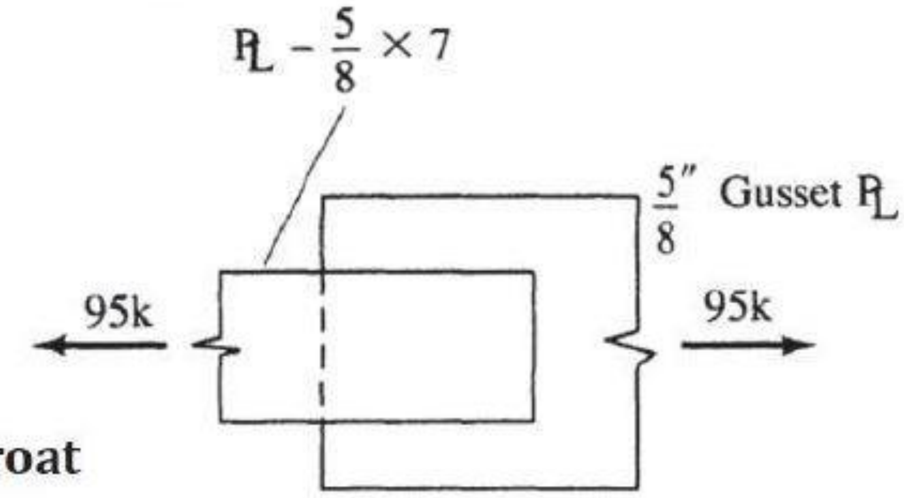
Examples

Determine the size and length of the fillet weld for the lap joint shown in Fig. Follow ASD. All plates are A36 steel (F_y = 36 ksi, F_u = 58 ksi)

Referring to Sec. 5.11, AISC-J2.2b gives the following limits of weld size,

$$\text{Maximum size} = \frac{5}{8} - \frac{1}{16} = \frac{9}{16}\ \text{in.}$$

$$\text{Minimum size} = \frac{1}{4}\ \text{in.}$$



(a) Problem

Use ½-in. fillet weld, the effective throat dimension, t_e, is taken as

$$t_e = 0.707a = 0.707(0.50) = 0.354\ \text{in.}$$

Choose E60XX weld, F_{EXX} = 60 ksi. The nominal strength of ½-in. fillet weld per inch of length, according to Eq. 5.13.1,

$R_{nw} = 0.6 t_e F_{EXX}$ = 0.6(0.354)(60)= 12.74 kip/in

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Example contd....

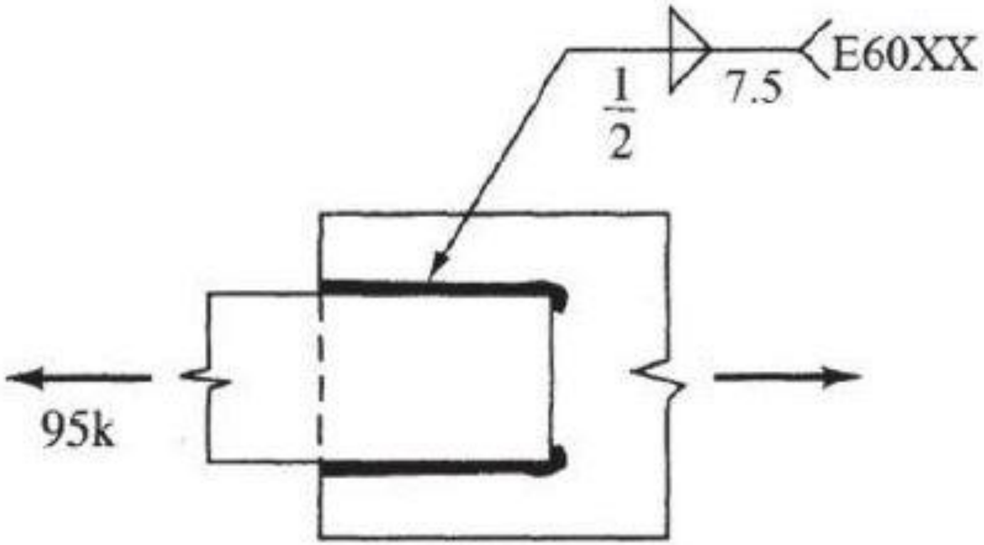
Allowable strength of weld , R_{nw}/Ω = 12.74/2.0 = 6.37 kip/in

Check 7" wide plate shear $\dfrac{R_n}{\Omega} = \dfrac{0.6tF_y}{1.50}$ **= [0.6(5/8)36]/1.5=9.0 k/in**

plate rupture $\dfrac{R_n}{\Omega} = \dfrac{0.6tF_u}{2.00}$ **= [0.6(5/8)58]/2=10.88 k/in**

$\therefore$ Weld strength controls,

Weld length = 95/6.37=14.9 in. Use 7½-in on each side.



SB- Quiz 3, 9.8.20

Restricted Not available unless any of:

You belong to **172DE1**

You belong to **172DE2**

SB- Quiz 3, 9.8.20

Upload your answer here. [Marks 15]

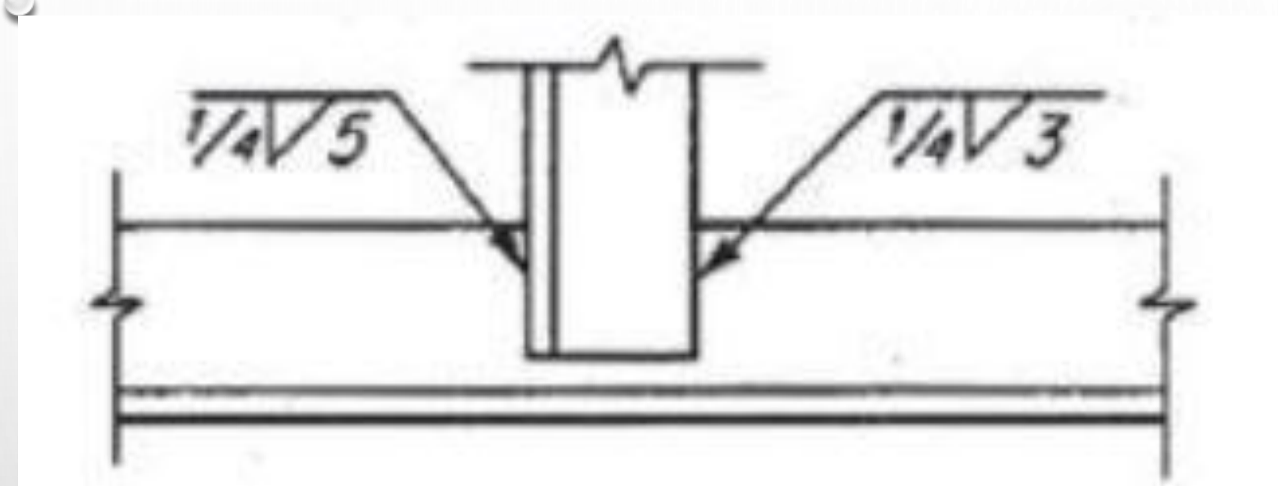
Attempts allowed: 2

The quiz will not be available until Saturday, 8 August 2020, 4:53 PM

This quiz will close on Thursday, 13 August 2020, 11:59 PM.

Time limit: 1 hour

Grading method: Average grade



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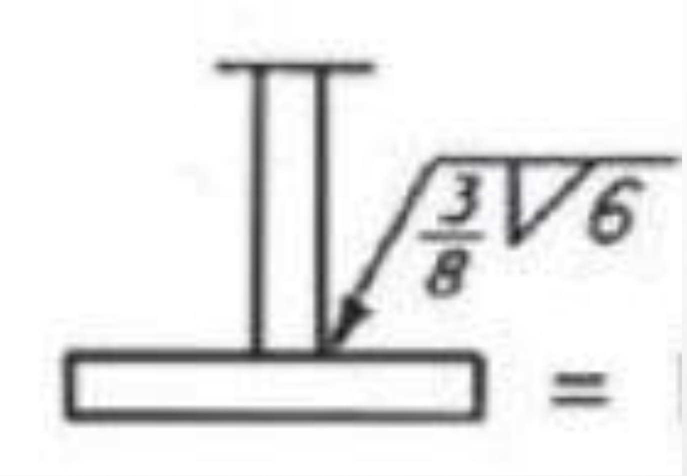

3/8 6
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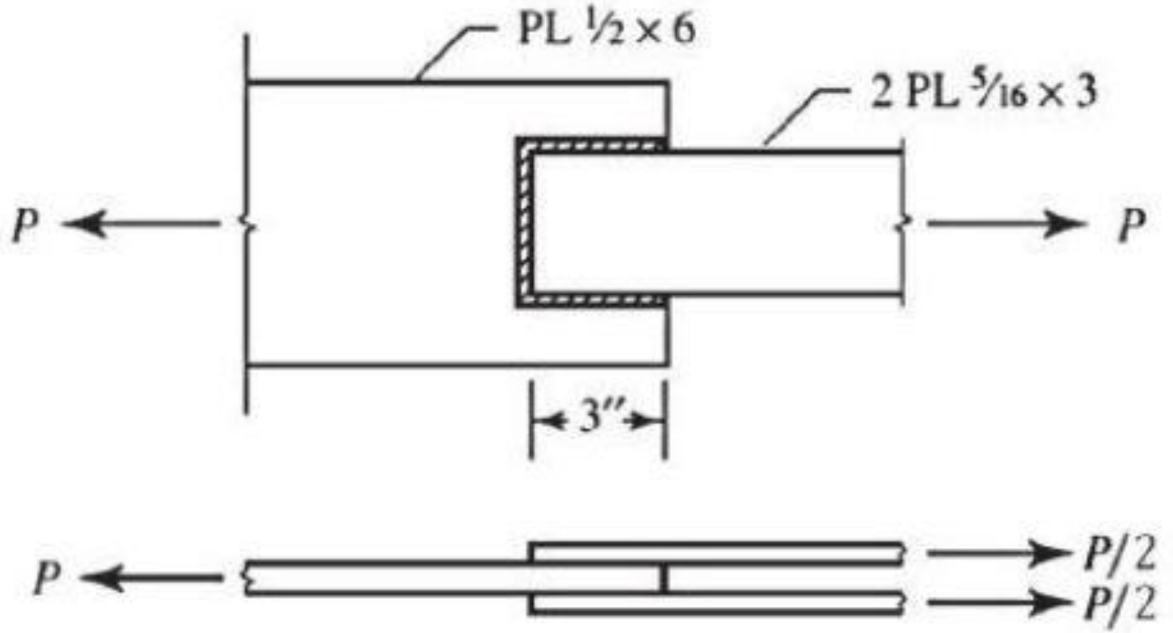
Example

A tension member splice is made with $\frac{1}{4}$-inch E70 fillet welds as shown in Figure. Each side of the splice is welded as shown. The inner member is a PL $\frac{1}{2} \times 6$ and each outer member is a PL $\frac{5}{16} \times 3$. All steel is A36. Determine the maximum design capacity, ϕP_n, based on weld limit states.



All plates A36:
$F_y = 36$ ksi, $F_u = 58$ ksi.

Weld strength: $F_{EXX} = 70$ ksi.
Weld length on each side = 3+3+3
= 9 inch.

Weld size, $s = \frac{1}{4}$ inch
$\therefore$ Throat $t_e = s/\sqrt{2} = 0.25/1.414$
$\therefore$ =0.177 inch

Fillet weld capacity: $\phi P_n = \phi R_{nw} L = 0.75[t_e(0.6F_{EXX})]L$

$$= 0.75 \times 0.177 \times 0.6 \times 70 \times (9+9) = 100.4 \text{ kip}$$

Base metal - Inner Plate:

Yielding: $\phi P_n = \phi R_n L = 1.0(0.6tF_y)L = 0.6 \times {}^{1}/_{2} \times 36 \times 9 = 97.2$ kip.

Rupture: $\phi P_n = \phi R_n L = 0.75(0.6tF_u)L = 0.75 \times {}^{1}/_{2} \times 58 \times 9 = 117.45$ kip.

Base metal - Outer Plate:

Yielding: $\phi P_n = \phi R_n L = 1.0(0.6tF_y)L = 0.6 \times {}^{5}/_{16} \times 36 \times 9 \times 2 = 121.5$ kip.

Rupture: $\phi P_n = \phi R_n L = 0.75(0.6tF_u)L = 0.75 \times {}^{5}/_{16} \times 58 \times 9 \times 2 = 117.45$ kip.

$\therefore$ Base metal (Inner plate) yielding governs.

$\therefore \phi P_n = 97.2$ kip. Ans.

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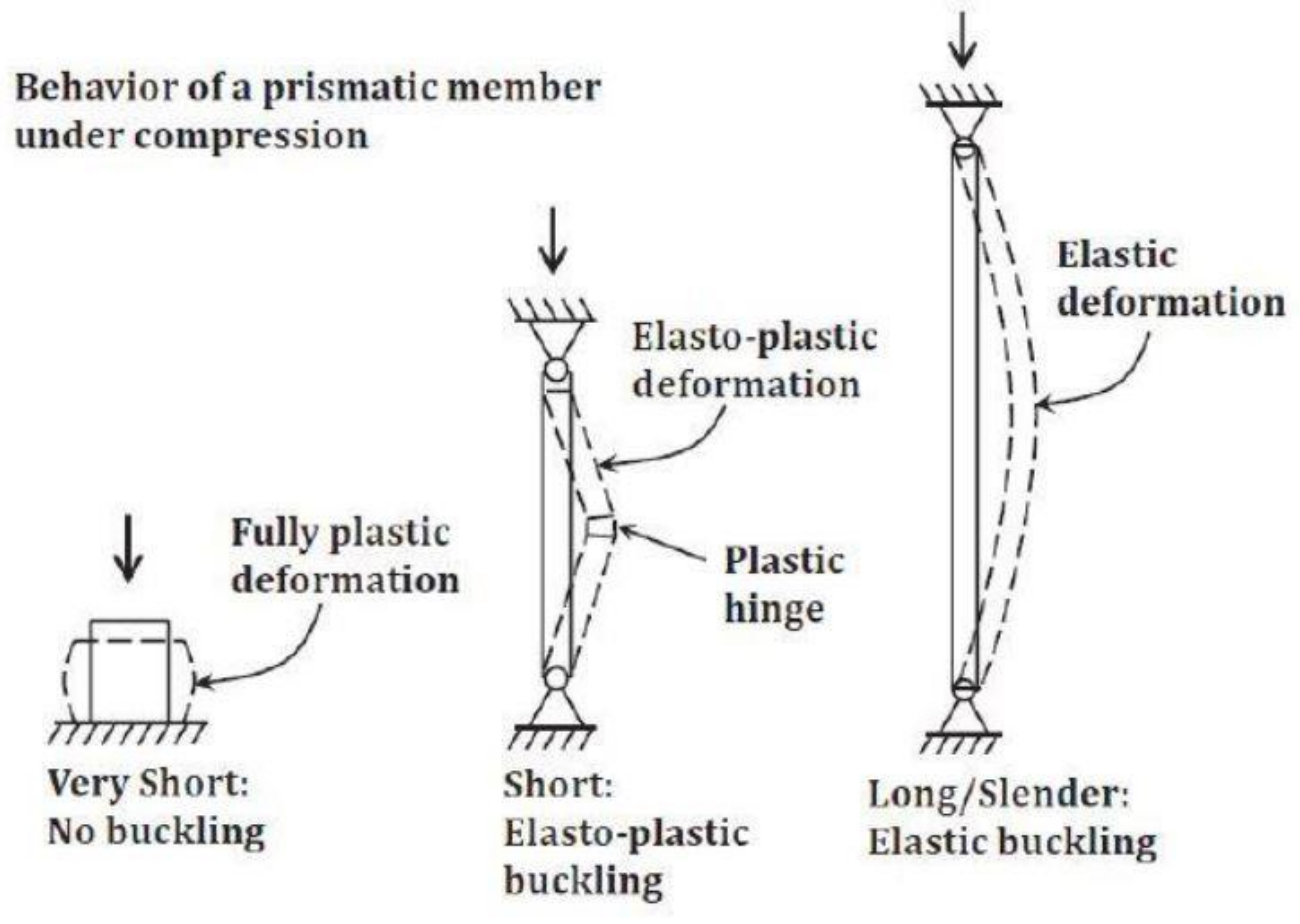

Behavior of a prismatic member
under compression
Fully plastic
deformation
Very Short:
No buckling
Elasto-plastic
deformation
Plastic
hinge
Short:
Elasto-plastic
buckling
Elastic
deformation
Long/Slender:
Elastic buckling

Determine Column Capacity Using AISC LRFD

Ques. A steel column of 25 ft length is made of W 14 × 61 shape which is supported by a fixed-hinge joint. Determine the axial capacity of the section. Steel is A992.

Soltuion.

$$K = 0.80 \quad \text{(for fixed-hinge joint)}$$

$$L = 25 \text{ ft}$$

$$F_y = 50 \text{ ksi}$$

From Table 1-7 of AISC Manual, $A_g = 17.90 \text{ in}^2$ and $r_y = 2.45$ in.

Check Failure Mode

$$KL = 0.8 \times 25 = 20 \text{ ft}$$

$$\frac{KL}{r} = \frac{20 \times 12}{2.45} = 97.9$$

$$C_c = 4.71\sqrt{\frac{E}{F_y}} = 4.71\sqrt{\frac{29000}{50}} = 113.4$$

Since, $KL/r < C_c$, failure is by crushing.

Determine Capacity

$$F_e = \frac{\pi^2 E}{(KL/r)^2} = \frac{\pi^2 \times 29000}{97.9^2} = 29.83 \text{ ksi}$$

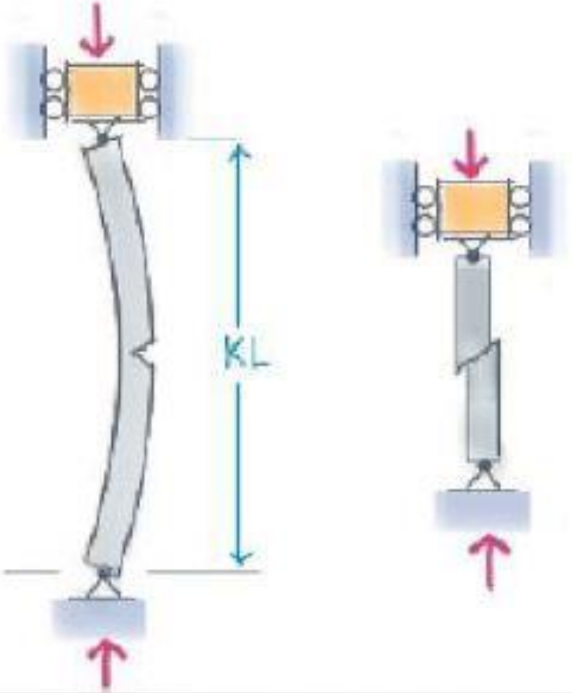
$$F_{cr} = 0.658^{F_y/F_e} F_y = 0.658^{50/29.83} \times 50 = 24.79 \text{ ksi}$$

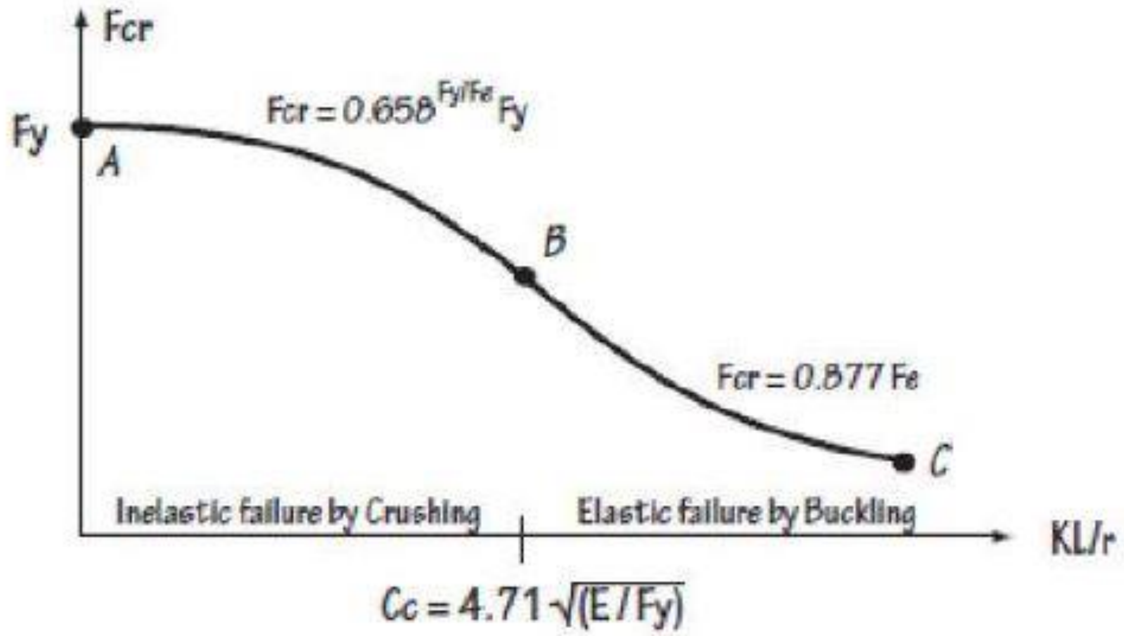
$$\Phi_c P_n = \Phi_c F_{cr} A_g = 0.9 \times 24.79 \times 17.9 = 399.3 \text{ kip}$$

Ans. 399.3 kip

Main formula: AISC 2005

L	Physical length of column
K	Effective length factor
KL	Effective length
r	Radius of gyration
KL/r	Slenderness ratio
F_{cr}	Critical stress
F_y	Yield stress
E	Modulus of elasticiy
C_c	Critical coefficents





$$F_{cr} = \begin{cases} 0.658^{F_y/F_e} F_y & \text{if } KL/r < C_c \\ 0.877 F_e & \text{if } KL/r > C_c \end{cases}$$

Ques. If the same column is changed to a length of 35 ft, then determine its capacity.

Soltuion.

$$K = 0.80 \quad \text{(for fixed-hinge joint)}$$

$$L = 35 \text{ ft}$$

$$F_y = 50 \text{ ksi}$$

Check Failure Mode

$$KL = 0.8 \times 35 = 28 \text{ ft}$$

$$\frac{KL}{r} = \frac{28 \times 12}{2.45} = 137.1$$

$$C_c = 113.4$$

Since, $KL/r > C_c$, failure is by buckling.

Determine Capacity

$$F_e = \frac{\pi^2 E}{(KL/r)^2} = \frac{\pi^2 \times 29000}{137.1^2} = 15.22 \text{ ksi}$$

$$F_{cr} = 0.877 F_e = 0.877 \times 15.22 = 13.35 \text{ ksi}$$

$$\Phi_c P_n = \Phi_c F_{cr} A_g = 0.9 \times 13.35 \times 17.9 = 215.1 \text{ kip}$$

Ans. 215.1 kip