Design of compression members—

STEP-1 Find the effective length l_{eff} by given end conditions.

STEP-2 Assume suitable value of slenderness ratio

(i) For single angle assume λ b/w 120 to 150
(ii) For double angle " 100 to 120
(iii) For channel secⁿ " 80 to 100
(iv) for I section " 60 to 90
(v) for builtup secⁿ " 30 to 50.

STEP-3 ~~Cal~~ select the value of σ_{ac} corresponding to assumed value of λ.

STEP-4 compute gross area $A = \frac{P}{\sigma_{ac}}$

STEP-5 Choose a suitable secⁿ from steel table having area computed in step-4.

STEP-6 find r_{min} for secⁿ.

STEP-7 Compute selenderness ratio

$$\lambda = \frac{l_{eff}}{r_{min}}$$

if this matches with assumed value of λ then design is o.k. otherwise repeat steps 3 to 7.

See prob. P. 195. B. C. Punmia.

Compression members

Permissible compressive stress —

$$\sigma_{ac} = 0.6 f_y \frac{f_{cc} \cdot f_y}{[(f_{cc})^n + (f_y)^n]^{1/n}}$$

f_y = yield stress of steel.

f_{cc} = Elastic critical stress in compression

$= \frac{\pi^2 E}{\lambda^2}$

E = modulus of elasticity of steel $= 2 \times 10^5$ MPa

λ = slenderness ratio $= \frac{l_{eff}}{r_{min}}$

n = a factor assumed as 1.4

Compressive strength $\boxed{P = A \times \sigma_{ac}}$

Min radius of gyration

$$r_{min} = \sqrt{\frac{I_{min}}{A}}$$

I_{min} = Min moment of Inertia.

(Pb) A single angle strut ISA 50×50×6 mm of a roof truss is 1.06 m long. It is connected by one rivet at each end. Determine the safe load this strut can carry. (f_y = 250 MPa)

Sol.

For ISA 50×50×6 mm (from steel table)

$A = 5.68$ cm²

$r_{min} = 0.96$ cm.

~~[illegible]~~ For one rivet at each end $l_{eff} = 1.06$ m

$$\lambda_{max} = \frac{l_{eff}}{r_{min}} = \frac{1.06 \times 100}{0.96} = 110.42$$

From steel table (f_y = 250 MPa, λ = 110.42)

$$\sigma_{ac} = 72 - \frac{(72-64)(110.42-110)}{(120-110)}$$

$$= 72 - \frac{8 \times 0.42}{10}$$

$= 71.664$ N/mm²

From steel table for single angle and each end connected by one rivet

Per. compressive stress $= 0.8 \times \sigma_{ac}$

$= 0.8 \times 71.664$

$= 57.33$ N/mm²

$\sqrt{\frac{5}{2}} = \sqrt{\frac{5}{2} \times \frac{5}{2}}$

2.5

So. ~~Ex~~ safe load.

$P = A \times \sigma_{ac}$

$= 5.68 \times 100 \times 57.33$

$= 32.56$ KN.

(P3) A ~~discontineous~~ discontinuous strut 2.5 m long consists of an angle ISA 100X75X8 mm longer leg connected with 10 mm thick gusset plate. find strength of this compression member ~~if~~ (i) each end connected by one rivets.
(ii) each end connected by two rivets
($f_y = 250 N/mm^2$)

Sol. for ISA 100X75X8 mm

$A = 1336 mm^2$

$r_{min} = 15.9 mm.$

For one rivet at each end

$l_{eff} = 2.5 m$

$$\lambda_{max} = \frac{l_{eff}}{r_{min}} = \frac{2.5 \times 1000}{15.9} = 157.23.$$

From steel table ($f_y = 250 N/mm^2$, $\lambda = 157.23$)

$$\sigma_{ac} = 45 - \frac{(45-41)(157.23-150)}{160-150}$$

$= 42.11 N/mm^2$

Per. compressive stress = $0.8 \times \sigma_{ac}$
$= 0.8 \times 42.11$
$= 33.69 N/mm^2$

strength of member
$P = A \times \sigma_{ac}$
$= 1336 \times 33.69$
$= 45 KN.$

For Two rivets at each end-

$l_{eff} = 0.85 L$
$= 0.85 \times 2.5$
$= 2.125 m.$

$$\lambda = \frac{l_{eff}}{r_{min}} = \frac{2.125 \times 1000}{15.9} = 133.65$$

from steel table ($f_y = 250 N/mm^2$, $\lambda = 133.65$)

$$\sigma_{ac} = 57 - \frac{(57-51)(133.65-130)}{140-130}$$

$= 57 - 2.19$
$= 54.81 N/mm^2$

Per. combross Stress = $54.81 N/mm^2$

∴ strength of member = $A \times \sigma_{ac}$
$= 1336 \times 54.81$
$= 73.23 KN.$