Steel compression members

1- Short members → Material failure

2- Long members → Instability failure (Buckling)

* Load carrying capacity of the compression member depends on :-

1- Member properties, area, shape, length, --- etc.

2- End condition, fixed-fixed, fixed-pinned, --- etc.

* Member may be under :-

1- Axial Load only.

2- Axial load + bending.

* Design of compression members

1- Cross-section area is considered when calculating the stresses. ($\sigma_c = \frac{P}{A} \Rightarrow A_{required} \leq \frac{P}{\sigma_{ac}}$)

2- Stresses depend on $\frac{Kl}{r} = \lambda$, see table 4.1 Page 114

K = end condition factor ; see table 4.5 Page 116

L = actual length

r = least radius of gyration

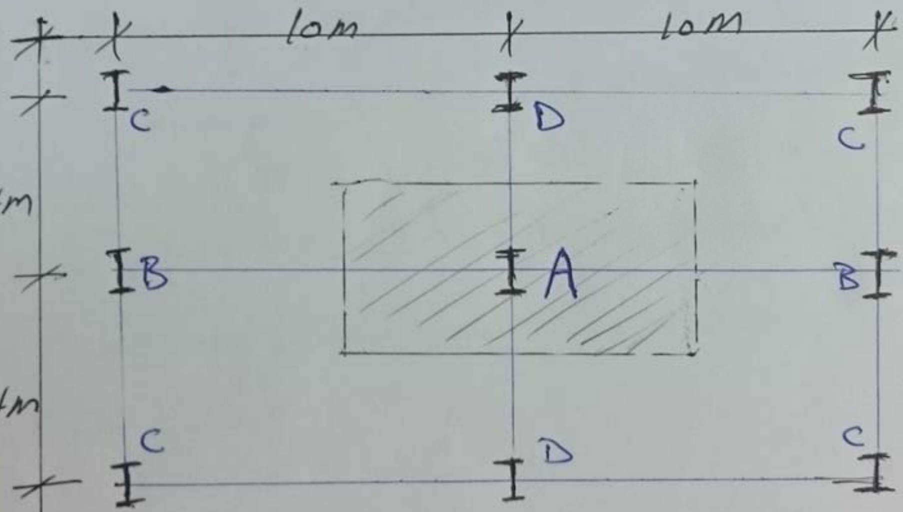
KL = effective length = L_e

$\frac{KL}{r}$ = Slenderness ratio ; $\frac{Kl}{r} \leq 180$ for members carrying dead or imposed loads

* Reduction factor for Live load of multi-story buildings :-

No. of floors including roof	% reduction of LL on all floors
1	0
2	10
3	20
4	30
5 to 10	40
over 10	50

Ex: Design column A in two story building as shown



Design Data ;

DL on roof = 7.6 kN/m²
LL on roof = 1.5 kN/m²

DL on 1st floor = 6.0 kN/m²
LL on 1st floor = 5.0 kN/m²

* Floor height = 4.0m (Fixed - Hinge) end condition

Solution :-

- From table 4.5 ⇒ $K = 0.8$
- Loading area $= 4 * 10 = 40\ m^2$
- Load (KN)

① Dead load on roof $= 7.6 * 40 = 304$ KN
② Dead load on floor $= 6 * 40 = 240$ KN
③ Live load on roof & 1st floor $= 0.9(1.5+5) * 40 = 234$ KN

Total load $= 778$ KN

- Effective length $(L_e) = Kl = 0.8 * 4 = 3.2\ m$

= Try HE 200 A steel section

$A_x = 53.80\ cm^2$, $I_z = 3692\ cm^4$, $I_y = 1336\ cm^4$

$$r_{least} = \sqrt{\frac{I_{min}}{A}} = \sqrt{\frac{1336}{53.8}} = 5.0\ cm = 50\ mm$$

$$\frac{KL}{r} = \frac{3.2 * 10^3}{50} = 64.0 < 180 \quad \underline{\text{o.k}}$$

- From table 4.1 find allowable stress

$\lambda = 64 \Rightarrow \sigma_{ac} = 118.8$ MPa

$$\therefore \sigma_c = \frac{P}{A} = \frac{778 * 10^3}{53.80 * 10^2} = 144.61\ \text{MPa} > \sigma_{ac}$$

not safe

- Try HE240 A Steel section

$A_x = 76.80\ cm^2$, $I_z = 7763\ cm^4$, $I_y = 2769\ cm^4$

$$r = \sqrt{\frac{I}{A}} = \sqrt{\frac{2769}{76.8}} = 6.0\ cm = 60\ mm$$

$$\lambda = \frac{Kl}{r} = \frac{3.2 \times 10^3}{60} = 53.3 < 180 \quad \underline{\underline{O.K}}$$

From table 4.1 $\Rightarrow$ $\sigma_{ac} = 130$ MPa

$$\sigma_c = \frac{P}{A} = \frac{778 \times 10^3}{76.80 \times 10^2} = 101.3 < 130\ MPa$$

<u>OK</u> safe

<u>H.W</u> / Design Column (B) in the ground floor of previous example ?