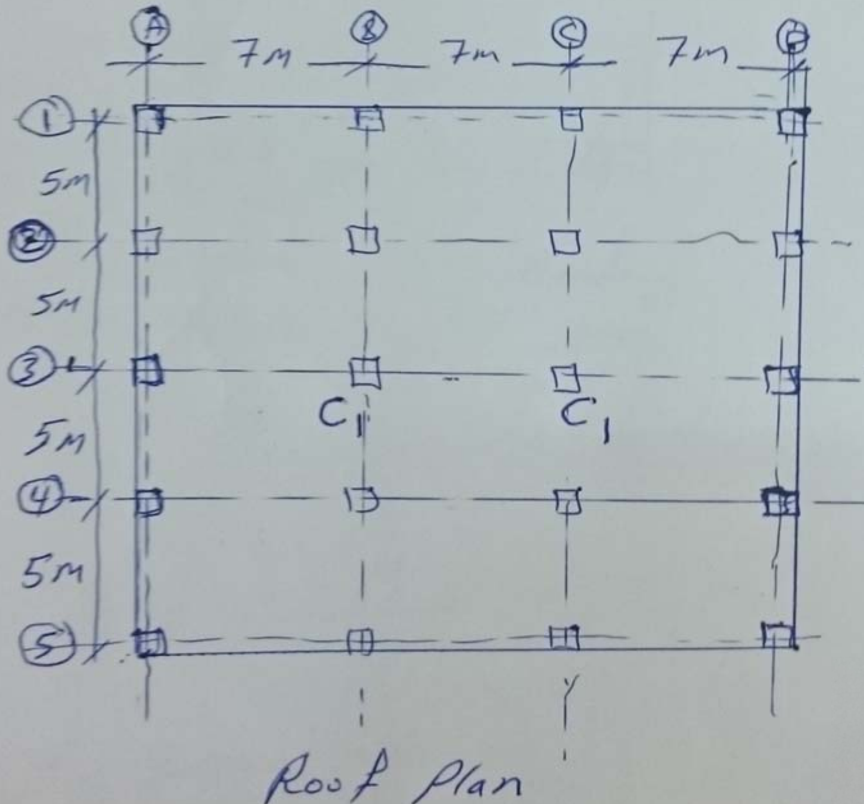
H.W.1 : Design a tied-Column to Support,

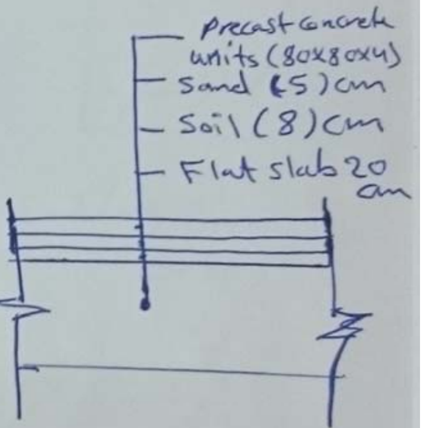
$P_u = 950$ kN , $M_u = 120$ kN.m , $f'_c = 30$ MPa

$f_y = 420$ MPa.

H.W.2 : Design a Short tied-Column (C_1) Shown in the following drawing? $\gamma_c = 24$ kN/m^3, $\gamma_{soil} = 16$ kN/m^3



Roof Plan

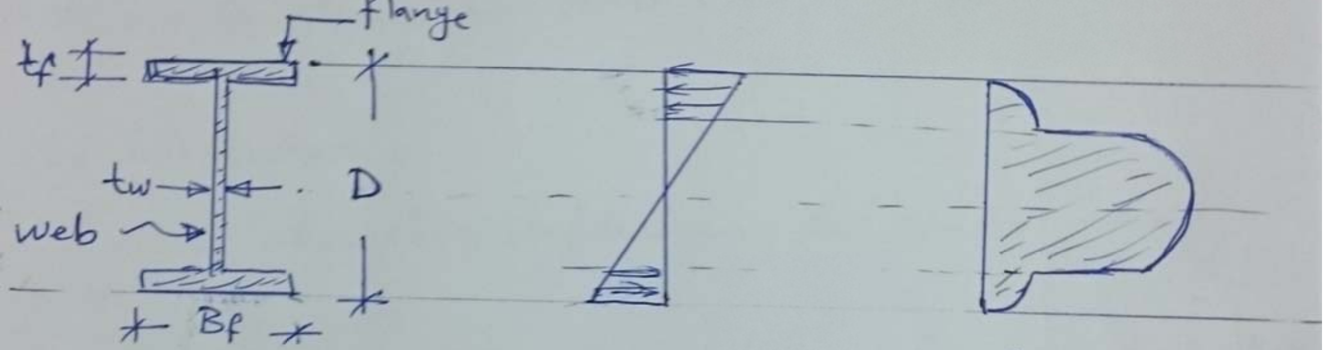


section in slab

Steel Design

* Design ; for design of steel members, three requirements shall be satisfied ;

1- Bending :



I_Section
Steel member

Bending Stress

$$f_b = \frac{M.y}{I}$$

Shear Stress

$$\nu = \frac{V.A}{I_b}$$

$$Z_{req.} = \frac{M}{P_b} \quad ;$$

Z = Section Modulus
M = Bending Moment
P_b = Steel section bending stress . (allowable)

* The steel section selected must be most suitable & economical.

2- Shear

$$v = \frac{V}{t_w(D-2t_f)} \leq P_q$$

v = Shear resistance MPa.

V = Shear force.

P_q = allowable shear stress MPa.

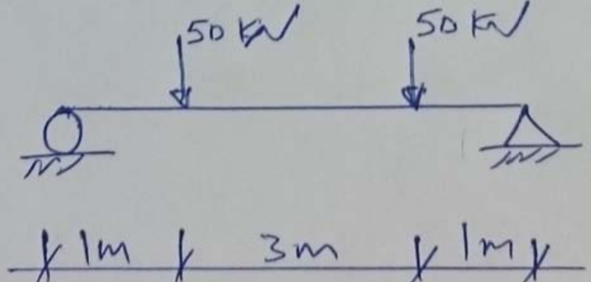
3- Deflection;

max. allowable deflection for simple span

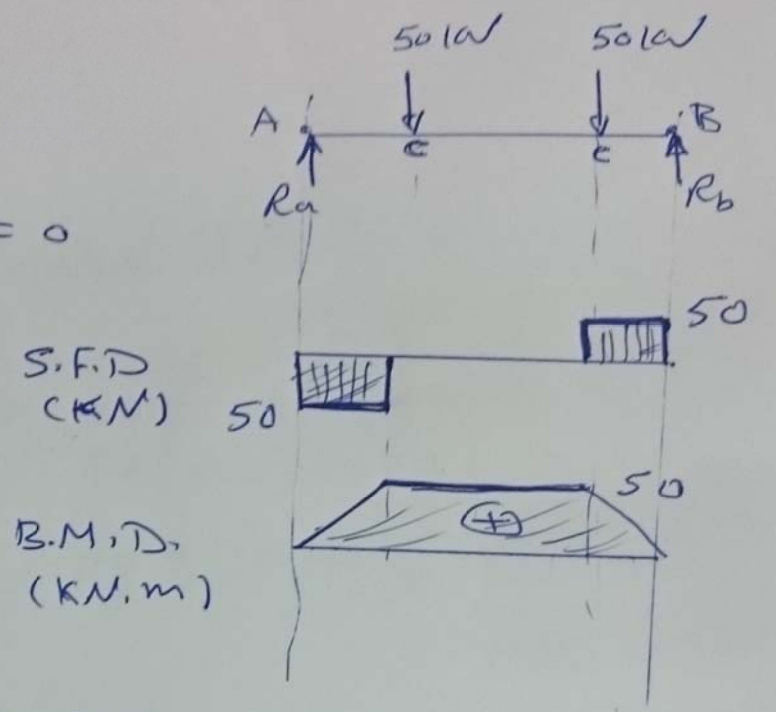
$$\delta_{all} \leq L/360$$

Example:

A steel beam 5 m long subjected to two point load as shown. If the beam subjected to 50 KN load. Find the dimensions of I beam? given that $\delta_{all} \leq L/360$.



Solution



$\Sigma M_B = 0$

$\therefore R_a * 5 - 50*4 - 50*1 = 0$

$R_a = 50$ kN

$\Sigma F_y = 0$

$R_b = 50$ kN

$M_c = R_a * 1$

$= 50 * 1 = 50$ kN.m

If we use Standard Steel section according to europe standards

$P_b = 275$ MPa ; If S275 steel used

$\because Z = \frac{M}{P_b} \Rightarrow Z = \frac{50*10^6}{275} = 181818.2 \ mm^3$

$= 181.82 \ cm^3$

If we use IPE 200 $\Rightarrow$

$D = 200$ mm , $B_f = 100$ mm , $T_f = 8.5$ mm , $T_w = 5.6$ mm

$Z_x = 221.0 \ cm^3$, $Z_y = 45 \ cm^3$, $I = 1943 \ cm^4$

$Z_{provided} = 221.0 > 181.82 \ cm^3$ ($Z_{required}$)

OK for bending

* Check for Shear ;

$P_{bs} = 400$ MPa ;

check the used section IPE 200

$$P = \frac{V_{max}}{t_w(D-2t_f)} = \frac{50 \times 10^3}{5.6(200-2 \times 8.5)}$$

$$= 48.8 \text{ MPa} < 400 \text{ MPa}$$

o.K.

* Check for deflection ;

$$\delta_{all} = \frac{P.a(3L^2-4a^2)}{24\,EI}$$

$$= \frac{50 \times 1(3 \times 5^2 - 4 \times 1^2) \times 10^{3+3+6}}{24 \times 2 \times 10^5 \times 1943 \times 10^4}$$

$$= \frac{3350 \times 10^3}{93264} = 35.9 \text{ mm}$$

not o.K

so that deflection is governed the design

$$\delta_{all} = \frac{L}{360} \Rightarrow \delta_{all} = \frac{5 \times 10^3}{360} = 13.9 \text{ mm}$$

allowed

$$\Rightarrow I_{Min} = \frac{P.a(3L^2-4a^2)}{24 \times E \times \delta_{all}}$$

$$I_{min} = \frac{50*1*(3*5^2-4*1^2)*10^{3+3+6}}{24*2*10^5*13.9}$$

$$= 53207434 \ mm^4 = 5321 \ cm^4$$

If we use IPE 300 steel section

D = 300 mm, Bf = 150 mm, Tf = 10.7 mm, Tw = 7.1 mm, Z = 628 cm^3

$I_{provided} = 8356 \ cm^4 > I_{req.} = 5321 \ cm^4$

O.K.

$$\delta_{actual} = \frac{50*1*(3*5^2-4*1^2)*10^{3+3+6}}{24*2*10^5*8356*10^4}$$

$$= \frac{3350*10^3}{401088} = 8.35 \ mm < \delta_{all} = 13.9 \ mm$$

OK

<u>H.W</u> For the same steel beam 5 m long subjected to two point load as shown below, If steel section is IPE 300, find the maximum value of P that the beam can be resist. $\delta_{all} = \frac{L}{360}$?