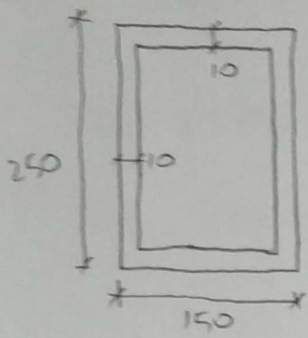


Calculate flexural design strength of the filled composite member



Concrete: C35 $f_{ck} = 35 \text{ N/mm}^2$

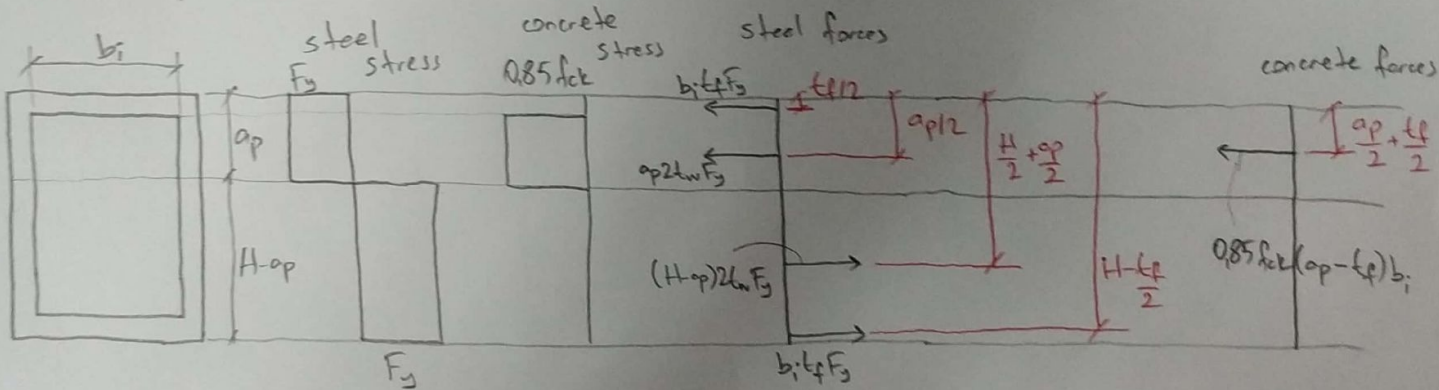
Steel: S355 $F_y = 35,5 \text{ N/mm}^2$

Local buckling control

→ flanges: $\lambda = \frac{150 - 2 \cdot 10}{10} = 13$ $\lambda_p = 2,26 \sqrt{\frac{E}{F_y}} = 53,64$ kompakt

→ webs: $\lambda = \frac{250 - 2 \cdot 10}{10} = 23$ $\lambda_p = 3 \cdot \sqrt{\frac{E}{F_y}} = 71,21$ kompakt

$M_n = M_p$



$$a_p = \frac{2 F_y H t_w + 0.85 f_{ck} b_i t_f}{4 t_w F_y + 0.85 f_{ck} b_i} = \frac{2 \cdot 35,5 \cdot 25 \cdot 1 + 0.85 \cdot 35 \cdot 13 \cdot 1}{4 \cdot 1 \cdot 35,5 + 0.85 \cdot 35 \cdot 13} = 10,04 \text{ cm}$$

$b_i = B - 2 t_w = 150 - 2 \cdot 10 = 130$

Üst baslıgın merkezi göre M denesi:

$$M_p = b_i t_f F_y (H - t_f) + (H - a_p) 2 t_w F_y \left(\frac{H}{2} + \frac{a_p}{2} - \frac{t_f}{2} \right) - 0.85 f_{ck} (a_p - t_f) b_i \cdot \left(\frac{a_p}{2} \right) - a_p 2 t_w F_y \left(\frac{a_p}{2} - \frac{t_f}{2} \right)$$

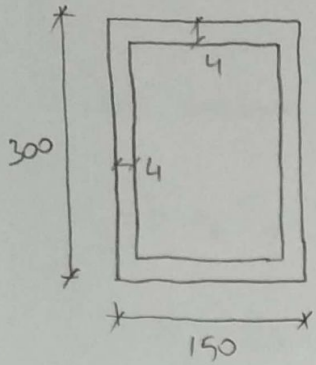
$$M_p = 13 \cdot 1.35,5 \cdot (25-1) + (25-10,04) \cdot 2 \cdot 1.35,5 \cdot \left(\frac{25}{2} + \frac{10,04}{2} - \frac{1}{2} \right)$$

$$- 0,85 \cdot 3,5 \cdot (10,04-1) \cdot 13 \cdot \left(\frac{10,04}{2} \right) - 10,04 \cdot 2 \cdot 1.35,5 \cdot \left(\frac{10,04}{2} - \frac{1}{2} \right)$$

$$M_p = 25756,82 \text{ kNcm} = M_n$$

$$\phi M_n = 0,90 \cdot 25756,82 = \underline{\underline{23181 \text{ kNcm}}}$$

Calculate flexural design strength of the filled composite member



Concrete: C35

Steel: S355

Local buckling control:

→ flanges: $\lambda = \frac{150 - 2 \cdot 4}{4} = 35,5$ $\lambda_p = 53,64$ compact

→ webs: $\lambda = \frac{300 - 2 \cdot 4}{4} = 73$ $\lambda_p = 71,21$ $\lambda_r = 5,70 \sqrt{\frac{E}{F_y}} = 135,29$ non-compact

$M_p = ?$

$b_i = 150 - 2 \cdot 4 = 142$

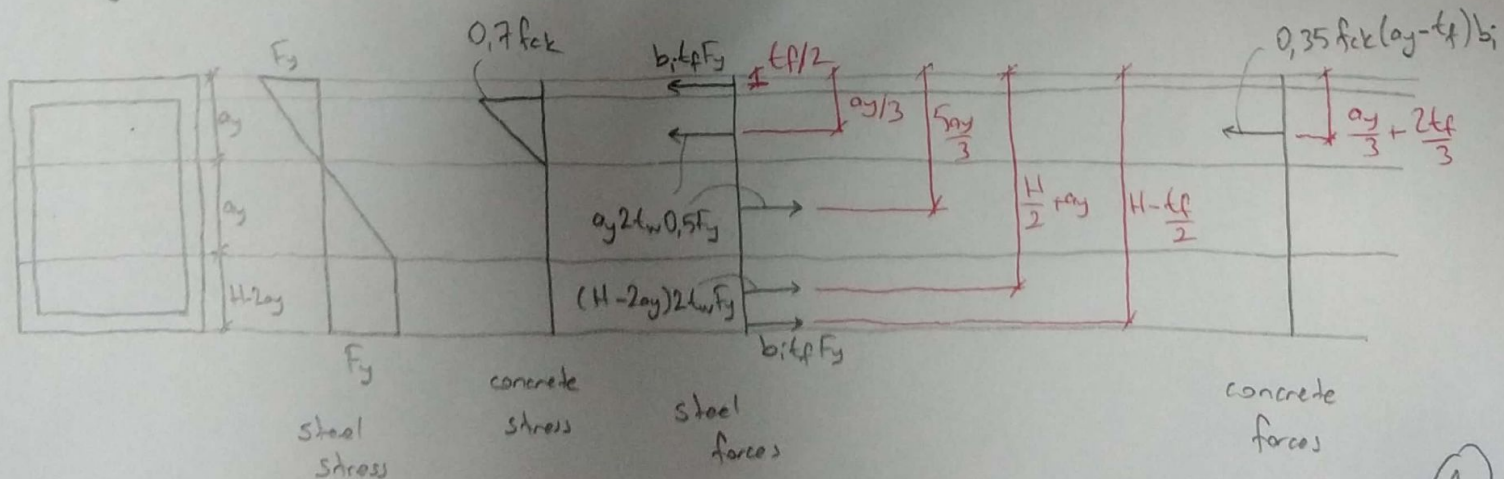
$a_p = \frac{2 \cdot 35,5 \cdot 30 \cdot 0,4 + 0,85 \cdot 35 \cdot 14,2 \cdot 0,4}{4 \cdot 0,4 \cdot 35,5 + 0,85 \cdot 35 \cdot 14,2} = 8,77 \text{ cm}$

Ubt baulign merkeerne göre M dengesiz:

$$M_p = 14,2 \cdot 0,4 \cdot 35,5 \cdot (30 - 0,4) + (30 - 8,77) \cdot 2 \cdot 0,4 \cdot 35,5 \cdot \left(\frac{30}{2} + \frac{8,77}{2} - \frac{0,4}{2} \right) - 0,85 \cdot 35 \cdot (8,77 - 0,4) \cdot 14,2 \cdot \left(\frac{8,77}{2} \right) - 8,77 \cdot 2 \cdot 0,4 \cdot 35,5 \cdot \left(\frac{8,77}{2} - \frac{0,4}{2} \right)$$

$M_p = 5968,54 + 11567,25 - 1550,5 - 1042,35 = 14942,94 \text{ kNm}$

$M_y = ?$



$$a_y = \frac{2F_y H t_w + 0,35 f_{ck} b_i t_f}{4 t_w F_y + 0,35 f_{ck} b_i} = \frac{2 \cdot 35,5 \cdot 30 \cdot 0,4 + 0,35 \cdot 3,5 \cdot 14,2 \cdot 0,4}{4 \cdot 0,4 \cdot 35,5 + 0,35 \cdot 3,5 \cdot 14,2} = 11,58 \text{ cm}$$

Üst bağların merkezine göre M dengesi;

$$M_y = b_i t_f F_y (H - t_f) + (H - 2a_y) 2 t_w F_y \left(\frac{H}{2} + a_y - \frac{t_f}{2} \right) + a_y 2 t_w 0,5 F_y \left(\frac{5a_y}{3} - \frac{t_f}{2} \right) - 0,35 f_{ck} (a_y - t_f) b_i \left(\frac{a_y}{3} + \frac{2t_f}{3} - \frac{t_f}{2} \right) - a_y 2 t_w 0,5 F_y \left(\frac{a_y}{3} - \frac{t_f}{2} \right)$$

$$M_y = 14,2 \cdot 0,4 \cdot 35,5 \cdot (30 - 0,4) + (30 - 2 \cdot 11,58) \cdot 2 \cdot 0,4 \cdot 35,5 \cdot \left(\frac{30}{2} + 11,58 - \frac{0,4}{2} \right) + 11,58 \cdot 2 \cdot 0,4 \cdot 0,5 \cdot 35,5 \cdot \left(\frac{5 \cdot 11,58}{3} - \frac{0,4}{2} \right) - 0,35 \cdot 3,5 \cdot (11,58 - 0,4) \cdot 14,2 \cdot \left(\frac{11,58}{3} + \frac{0,4}{6} \right) - 11,58 \cdot 2 \cdot 0,4 \cdot 0,5 \cdot 35,5 \cdot \left(\frac{11,58}{3} - \frac{0,4}{2} \right) = 5968,54 + 5124,47 + 3140,73 - 763,64 - 601,84$$

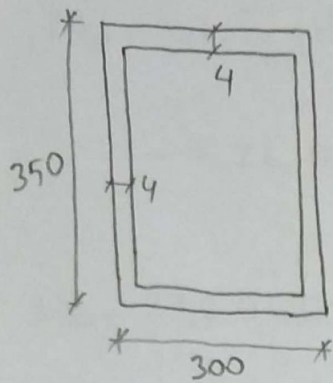
$$M_y = 12868,26 \text{ kNm}$$

$$M_n = M_p - (M_p - M_y) \left(\frac{\lambda - \lambda_p}{\lambda_r - \lambda_p} \right) = 14942,94 - (14942,94 - 12868,26) \left(\frac{73 - 71,21}{135,29 - 71,21} \right)$$

$$M_n = 14884,99 \text{ kNm}$$

$$\phi M_n = 0,90 \cdot 14884,99 = \underline{13396,49 \text{ kNm}}$$

Calculate flexural design strength of the filled composite member



Concrete: C35

Steel: S355

Local buckling control:

→ flanges: $\lambda = \frac{300 - 2 \cdot 4}{4} = 73$

$\lambda_p = 53,64$

(slender)

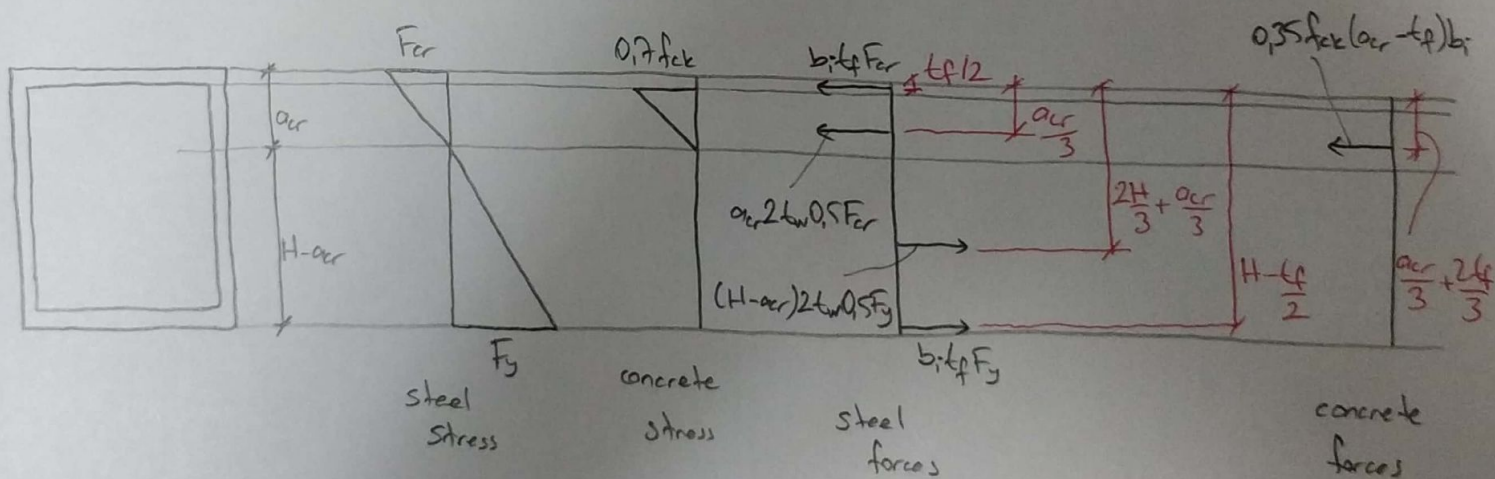
$\lambda_r = 3 \sqrt{\frac{E}{F_y}} = 71,21$

→ webs: $\lambda = \frac{350 - 2 \cdot 4}{4} = 85,5$

$\lambda_p = 71,21$

$\lambda_r = 135,29$ (non-compact)

$M_n = M_{cr}$



$$a_{cr} = \frac{F_y H t_w + (0,35 f_{ck} + F_y - F_{cr}) b_i t_f}{t_w (F_{cr} + F_y) + 0,35 f_{ck} b_i} = \frac{35,5 \cdot 35 \cdot 0,4 + (0,35 \cdot 3,5 + 35,5 - 23,51) \cdot 29,2 \cdot 0,4}{0,4 \cdot (23,51 + 35,5) + 0,35 \cdot 3,5 \cdot 29,2}$$

$$F_{cr} = \frac{9 E_s}{\left(\frac{b}{t}\right)^2} = \frac{9 \cdot 20000}{\left(\frac{35}{0,4}\right)^2} = 23,51 \text{ kN/cm}^2$$

$a_{cr} = 10,97 \text{ cm}$

$b_i = 30 - 2 \cdot 0,4 = 29,2 \text{ cm}$

Üst baskın momenti göre M dengesi;

$$M_{cr} = b_i t_f F_y \cdot (H - t_f) + (H - a_{cr}) 2 t_w 0,5 F_y \cdot \left(\frac{2H}{3} + \frac{a_{cr}}{3} - \frac{t_f}{2} \right) \\ - a_{cr} 2 t_w 0,5 F_{cr} \cdot \left(\frac{a_{cr}}{3} - \frac{t_f}{2} \right) - 0,35 f_{ck} (a_{cr} - t_f) b_i \left(\frac{a_{cr}}{3} + \frac{t_f}{6} \right)$$

$$M_{cr} = 29,2 \cdot 0,4 \cdot 35,5 \cdot (35 - 0,4) + (35 - 10,97) \cdot 2 \cdot 0,4 \cdot 0,5 \cdot 35,5 \cdot \left(\frac{2 \cdot 35}{3} + \frac{10,97}{3} - \frac{0,4}{2} \right) \\ - 10,97 \cdot 2 \cdot 0,4 \cdot 0,5 \cdot 23,51 \cdot \left(\frac{10,97}{3} - \frac{0,4}{2} \right) - 0,35 \cdot 3,5 \cdot (10,97 - 0,4) \cdot 29,2 \cdot \left(\frac{10,97}{3} + \frac{0,4}{6} \right)$$

$$M_{cr} = 14346,54 + 9141,44 - 356,6 - 1407,75 = 21723,63 \text{ kNm}$$

$$M_n = 21723,63 \text{ kNm}$$

$$\phi M_n = 0,90 \cdot 21723,63 = \underline{19551,27 \text{ kNm}}$$