Drawing reinforcement

Widen of envelope curve:

Section 1: $a_{l_1} = \frac{z}{2} \cot\theta = \frac{51,34}{2} \cdot 1,5 \simeq 38,5\ cm$

Section 2: $a_{l_2} = \frac{z}{2} \cot\theta = \frac{55,3}{2} \cdot 1,5 \simeq 41,5\ cm$

Section 3: $a_{l_3} = \frac{z}{2} \cot\theta = \frac{48,4}{2} \times 1,5 \simeq 36,3\ cm$

Anchorage length

$$l_{b,rqd} = \frac{\phi}{4} \cdot \frac{\sigma_{sd}}{f_{bd}}$$

$\sigma_{sd} = f_{yd} = 435\ MPa$

$f_{ctd} = \frac{f_{ct,k0,05}}{1,5}$

For C30/37 $f_{ct,k0,05} = 2\ MPa$

$f_{ctd} = \frac{2}{1,5} \simeq 1,33\ MPa$

$f_{bd} = 2,25 \cdot \eta_1 \cdot \eta_2 \cdot f_{ctd}$
$= 2,25 \cdot 1 \cdot 1 \cdot 1,33$
$\simeq 3,00\ MPa$

For ϕ 20 mm

$l_{b,rqd} = \frac{20}{4} \cdot \frac{435}{3} = 725\ mm$; $l_{bd} = \alpha_1 \alpha_2 \alpha_3 \alpha_4 \alpha_5 \cdot l_{b,rqd}$ ($\alpha_1 \alpha_2 \alpha_3 \alpha_4 \alpha_5 = 1$)
$= 725\ mm$

$l_{B,min} = \max(0,3 l_{b,rqd}\ ;\ 10\phi\ ;\ 100\ mm)$
$= \max(0,3 \times 725\ ;\ 10 \times 20\ ;\ 100\ mm) = 217,5\ mm$

For ϕ18 mm

$$l_{b,rqd} = \frac{\phi}{4} \cdot \frac{\sigma_{sd}}{f_{bd}} = \frac{18}{4} \cdot \frac{435}{3} = 652,5 \text{ mm}$$

$$l_{bd} = 625,5 \text{ mm}$$

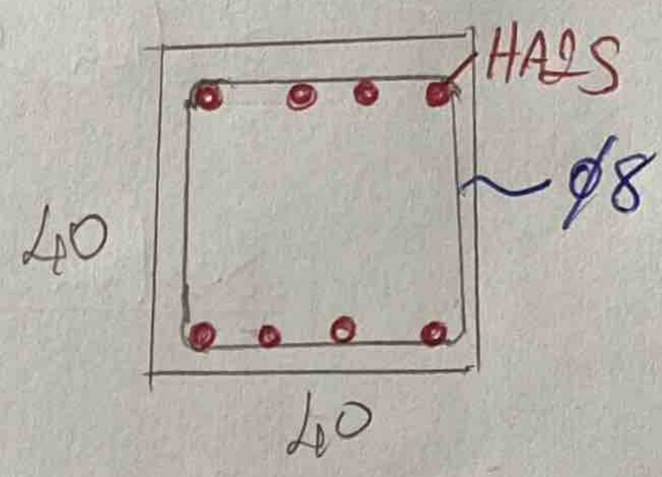
$$l_{b,min} = \max(0,3 \cdot l_{b,rqd} ; 10\phi ; 100\text{mm}) = 187,65 \text{ mm}$$

For ϕ16 mm

$$l_{brqd} = \frac{16}{4} \cdot \frac{435}{3} = 580 \text{ mm} ; \quad l_{bd} = 580 \text{ mm}$$

$$l_{b,min} = \max(174 ; 160 ; 100) = 174 \text{ mm}$$

Design of column ties



Diameter estimation

$$\phi_{tie} \geq \max\left(\frac{\phi_s}{4} ; 6\text{mm}\right)$$

$$\phi_{tie} \geq \max\left(\frac{25}{4} ; 6\text{mm}\right) = \max(6,25 ; 6\text{mm}) = 7 \text{ mm}$$

So, we can use ϕ8 mm for stirrups

Basic spacing

$$s_1 \leq \min(20\phi_s ; \min(b_{col} ; h_{col}) ; 400\text{mm})$$

$$\leq \min(20 \cdot 25 ; 400 ; 400\text{mm}) = 400 \text{ mm}$$

$$s_2 \leq 0,6 s_1$$

$$s_2 \leq 0,6 \times 400 = 240 \text{ mm}$$

Lapping Length

$$l_{0,d} = \overbrace{\alpha_1 \cdot \alpha_2 \cdot \alpha_3 \cdot \alpha_4 \cdot \alpha_5 \cdot \alpha_6}^{1} \cdot l_{b,rqd}$$

$$= 1,5 \cdot 906,25$$

$$\simeq \underline{1360 \text{ mm}}$$

$$l_{b,rqd} = \frac{\phi}{4} \cdot \frac{\sigma_{sd}}{f_{bd}}$$

$$= \frac{25}{4} \cdot \frac{435}{3}$$

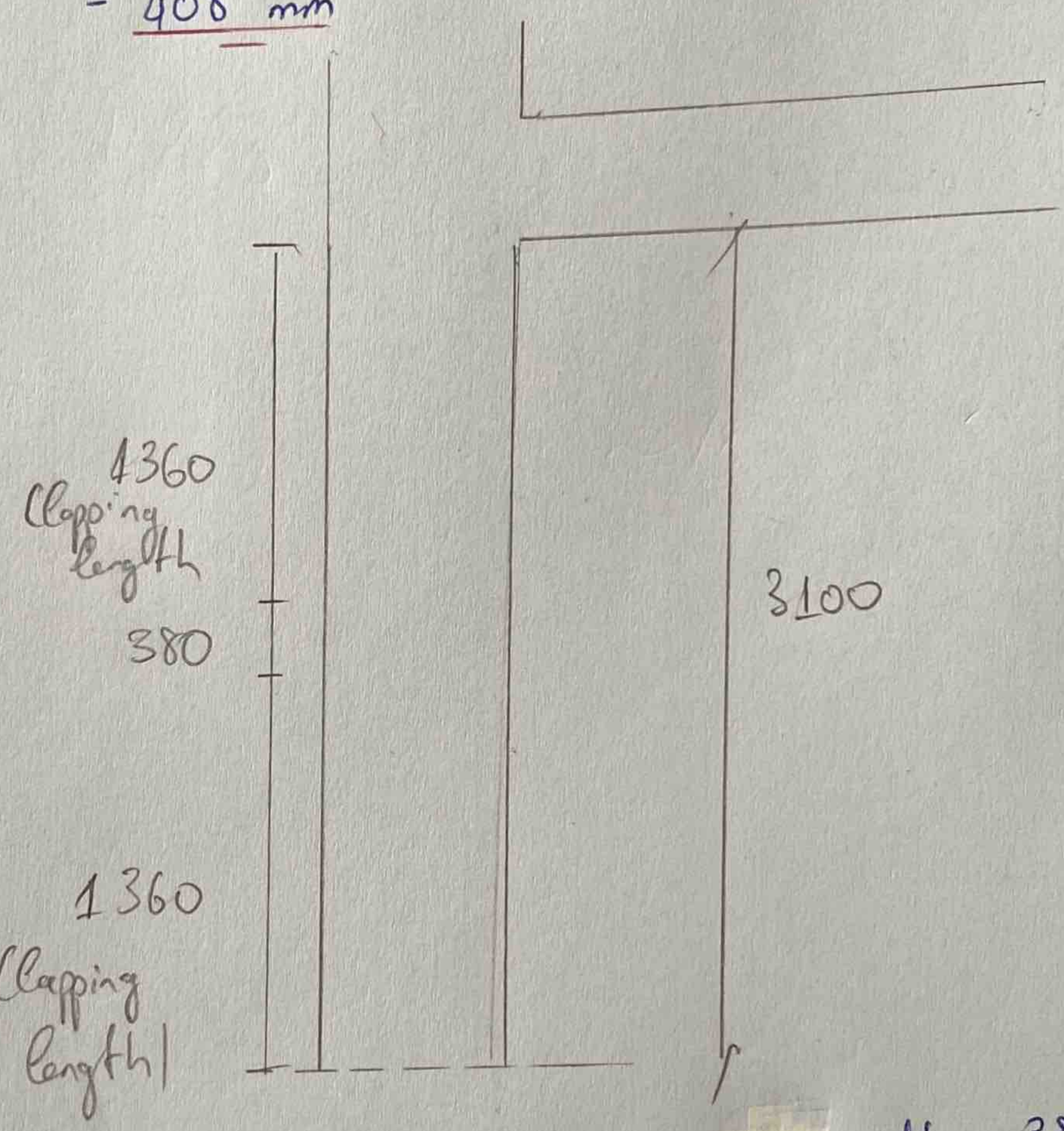
$$= 906,25 \text{ mm}$$

Minimum Lapping

$$l_{0,min} = \max(0,3 \alpha_6 \cdot l_{b,rqd};\ 1,5\phi;\ 200 \text{ mm})$$

$$= \max(0,3 \cdot 1,5 \cdot 906,25;\ 1,5 \cdot 25;\ 200 \text{ mm})$$

$$\simeq \underline{408 \text{ mm}}$$



The basic spacing s_1 (400) is more than 380 mm. Consequently, we don't have any other choice than using only one spacing s_2 (240 mm) for the column.