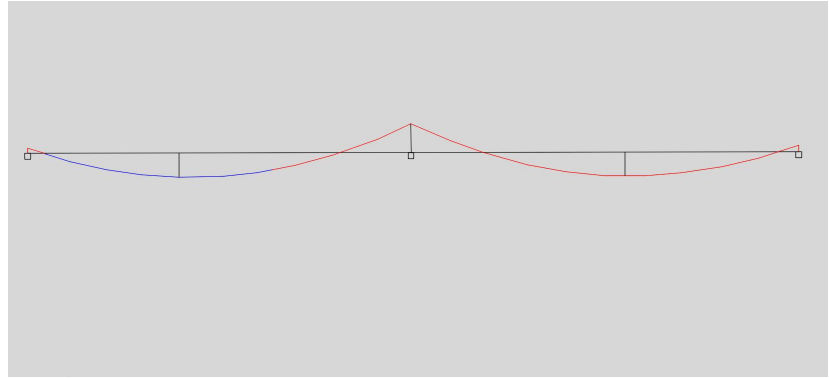


# 5<sup>th</sup> TASK: DRAWING OF REINFORCEMENT

## 1. ENVELOPE

Taking the bending moments of COMB 1 and COMB 2 I obtained the following envelope.

Where BLUE is COMB2 and RED is COMB1

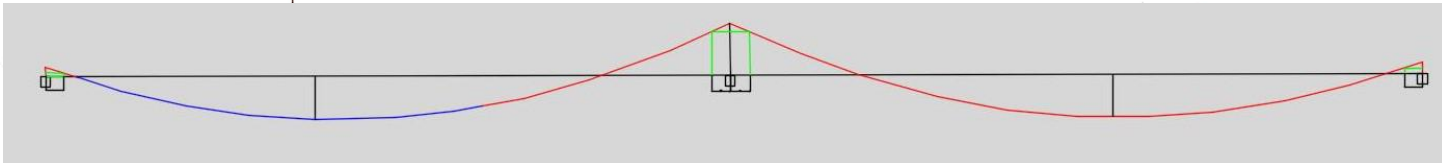


Now, I reduced support moments to value in the face of the column:  $0.5b_{sup} = 150 \text{ mm}$

$b_{sup}$  = width of the support / column

From TASK 4 :

$$b_{sup} = 300 \text{ mm}$$



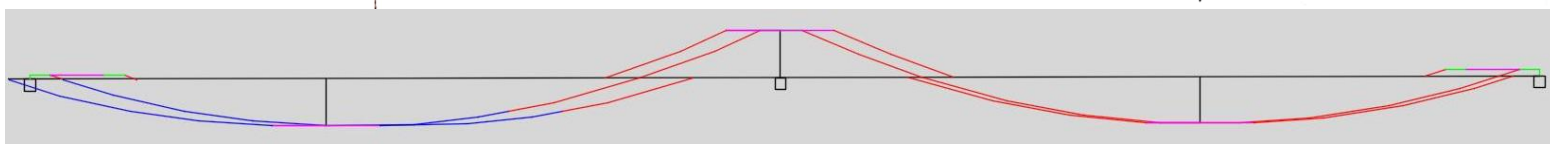
Finally, I will shift the envelope by  $a_1 = \frac{z}{2} \cdot \cot \theta$

$$z = 537.87 \text{ mm}$$

From TASK 3

$$\cot \theta = 1.5$$

$$a_1 = \frac{537.87}{2} \cdot 1.5 = 403.4 \text{ mm} = 403 \text{ mm}$$



## 2. LENGTHS OF BENDING REINFORCEMENT

I should divide the design bending moment by the number of rebars designed for the cross section.

From TASK 3

OUTER SUPPORT :  $2\phi 14$  and from the diagram

$$M_{redu} = 3'31 \text{ kN}\cdot\text{m} \rightarrow \frac{3'31}{2} = 1'65 \approx 2 \text{ divisions}$$

INNER SUPPORT :  $6\phi 12$  and  $M_{redu} = 78 \text{ kN}$

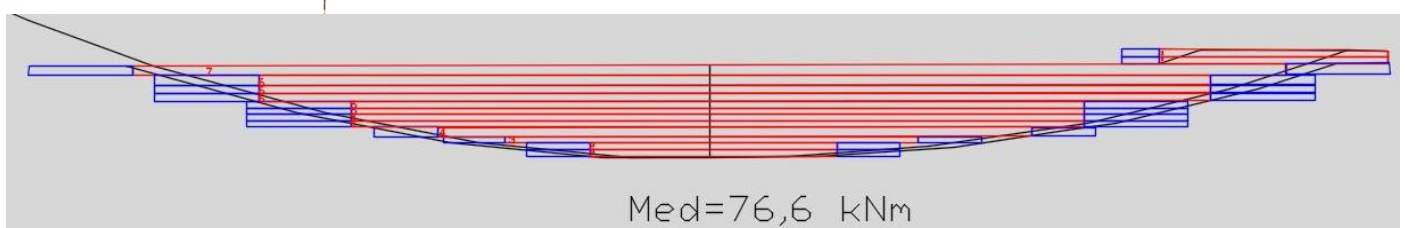
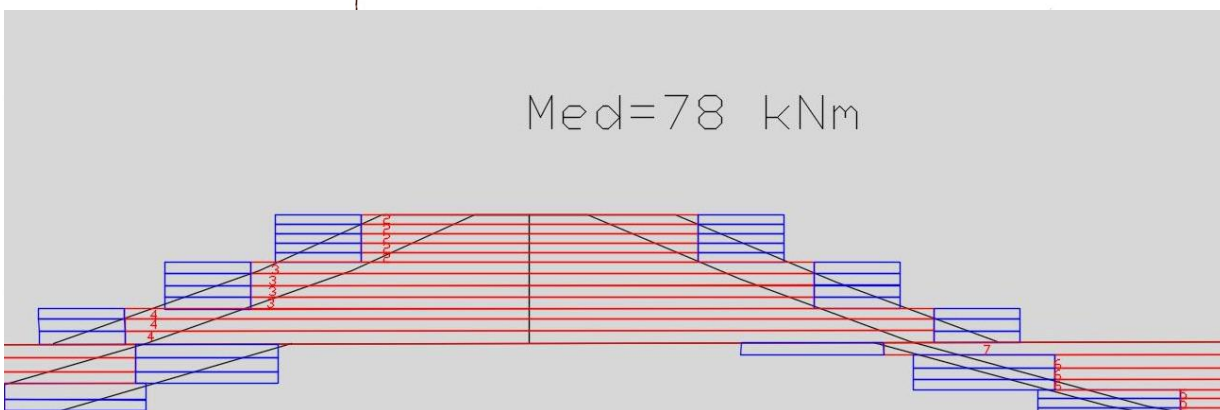
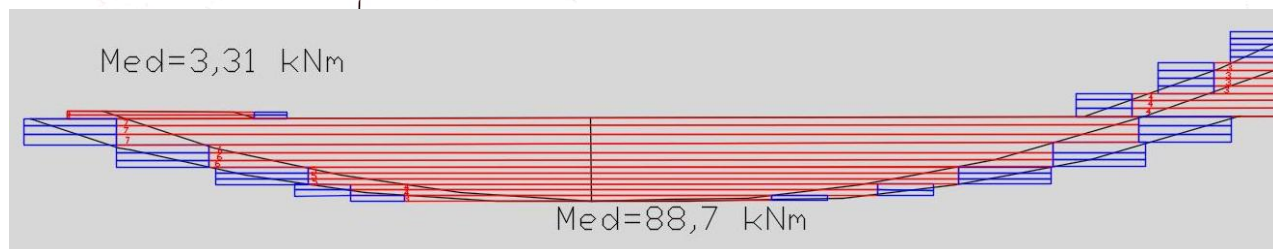
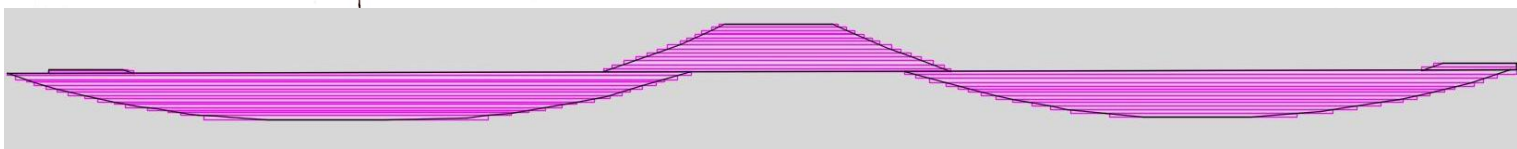
$$\frac{78}{6} = 13 \text{ divisions}$$

MIDSPAN :  $6\phi 12$  and  $88'7 \text{ kN} = M_1$

$$76'7 \text{ kN}\cdot\text{m} = M_2$$

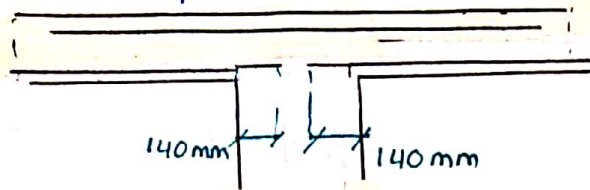
$$\frac{88'7}{6} \approx 15$$

$$\frac{76'7}{6} \approx 13$$

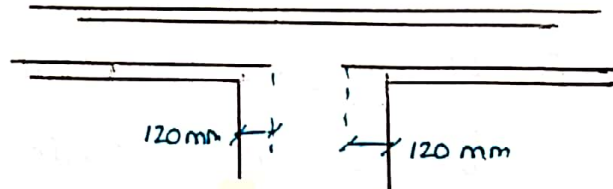


For lower reinforcement, at least two outer bars must be extended at least  $10\phi$  behind the face of the column.

For the outer support:  $10 \cdot 14 = 140 \text{ mm}$



For the inner support:  $10 \cdot 12 = 120 \text{ mm}$



### 3. COLUMN TIES

#### DIAMETER

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

$$\phi_{tie} \geq \max\left(\frac{20}{4}; 6\right) \text{ mm} = \max(5; 6) \text{ mm}$$

$$\phi_{tie} = 6 \text{ mm}$$

#### BASIC SPACING

$$S_1 \leq \min(20 \cdot \phi_s; \min(\text{bed}; \text{hcol}); 400 \text{ mm})$$

$$S_1 \leq \min(20 \cdot 20; 300; 400)$$

$$S_1 \leq \min(400; 300; 400)$$

$$S_1 = 300 \text{ mm}$$

$$S_2 \leq 0.6 \cdot S_1 = 0.6 \cdot 300 = 180 \text{ mm}$$

#### TIE/STIRRUP END

It can be estimated as  $10 \cdot \phi_{tie} = 10 \cdot 6 = 60 \text{ mm}$

$\phi_s$  from TASK 4  
I obtained  $6\phi 20$

$$\text{bed} = \text{hcol} = 300 \text{ mm}$$

Taking into consideration the height of the column:

3.9 m I will take

$$S_1 = 1800 \text{ mm}$$

$$S_2 = 1000 \text{ mm}$$

#### 4. LAPPING LENGTH

$$f_{yd} = 434.78 \text{ MPa}$$

$f_{ctk,0.05} \Rightarrow$  for a  
Concrete C 35/45

$$f_{ctk,0.05} = 2.2 \text{ MPa}$$

$$l_{o,d} = \alpha_1 \cdot \alpha_2 \cdot \alpha_3 \cdot \alpha_4 \cdot \alpha_5 \cdot \alpha_6 \cdot l_{b,reqd} \geq l_{o,min}$$

$$\alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = 1 ; \alpha_6 = 1.5$$

$$l_{b,reqd} = \frac{\sigma}{4} \cdot \frac{f_{sd}}{f_{bd}} ; f_{sd} = f_{yd}$$

$$f_{bd} = 2.25 \cdot \eta_1 \cdot \eta_2 \cdot f_{ctd} ; \eta_1 = 1 = \eta_2 ; f_{ctd} = \frac{f_{ctk,0.05}}{1.5}$$

$$l_{o,min} = \max(0.3 \cdot \alpha_6 \cdot l_{b,reqd} ; 15\phi , 200 \text{ mm})$$

$$- f_{ctd} = \frac{2.2 \text{ MPa}}{1.5} = 1.46 \text{ MPa}$$

$$- f_{bd} = 2.25 \cdot 1.46 = 3.3 \text{ MPa}$$

$$- l_{b,reqd} = \frac{20}{4} \cdot \frac{434.78}{3.3} \approx 659 \text{ mm}$$

$$- l_{o,d} = 1.5 \cdot 659 = 988.5 \text{ mm} \approx 989 \text{ mm}$$

$$- l_{o,min} = \max(0.3 \cdot 1.5 \cdot 659 ; 15 \cdot 20 ; 200)$$

$$l_{o,min} = \max(297 ; 300 ; 200)$$

$$l_{o,min} = 300 \text{ mm}$$

$$\rightarrow l_{o,d} = 989 \text{ mm} > l_{o,min} = 300 \text{ mm} \checkmark$$

#### 5. ANCHORAGE LENGTH

OUTER SUPPORT ( $2\phi 14$ )

$$l_{b,reqd} = \frac{14}{4} \cdot \frac{434.78}{3.3} = 461 \text{ mm}$$

$$l_{b,d} = l_{b,reqd} = 461 \text{ mm}$$

$$l_{b,min} = \max(0.3 l_{b,reqd} , 10\phi , 100) = (138 ; 140 ; 100)$$

$$l_{b,min} = 140 \text{ mm} < l_{b,d} = 461 \text{ mm} \checkmark$$

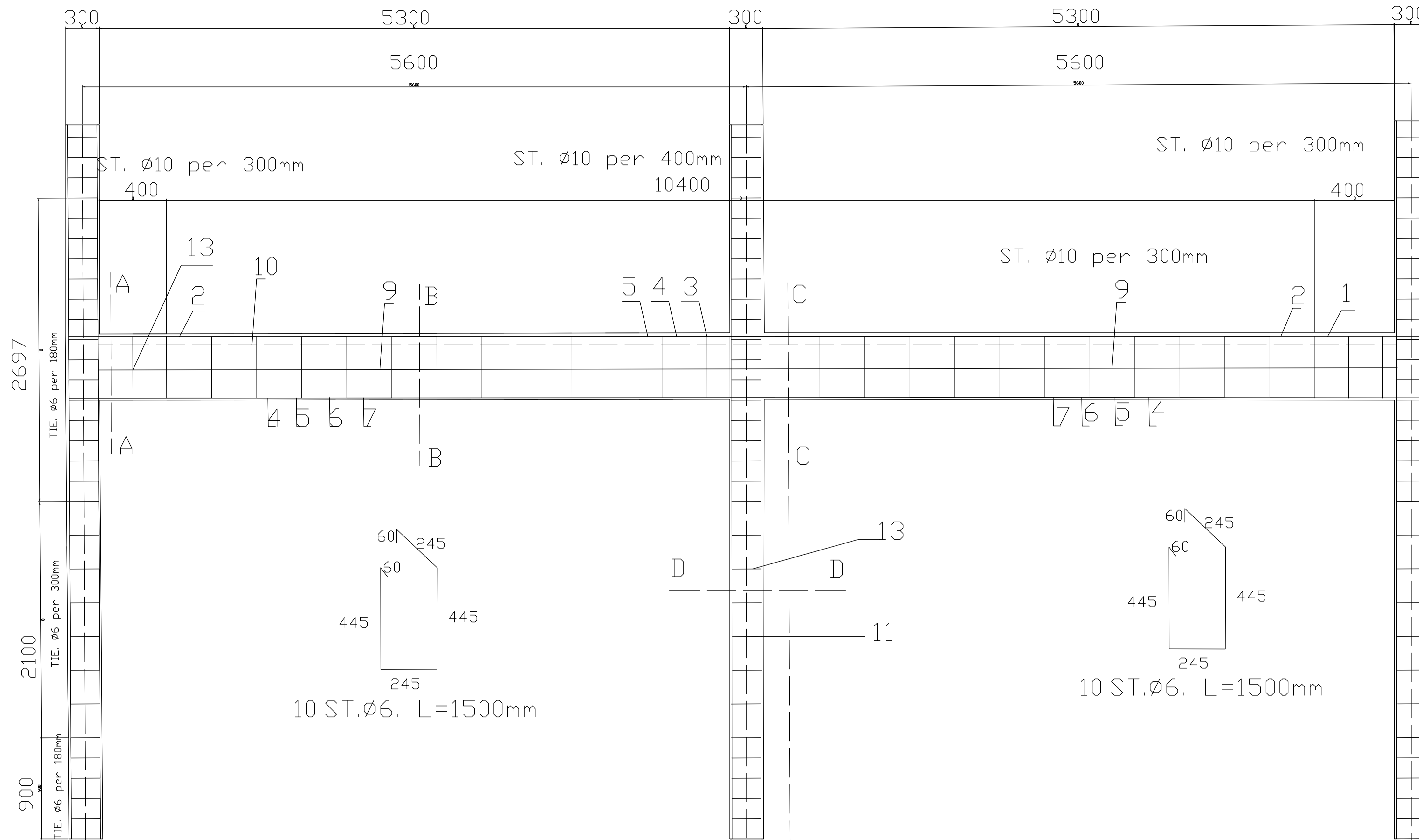
INNER and MIDSPAN ( $6\phi 12$ )

$$l_{b,reqd} = \frac{12}{4} \cdot \frac{434.78}{3.3} = 395 \text{ mm} = l_{b,d}$$

$$l_{b,min} = \max(118.5 ; 120 ; 100) = 120 \text{ mm}$$

$$l_{b,min} < l_{b,d} \checkmark$$





Lo,d=989mm  
 11: 6Ø20. L=5489mm

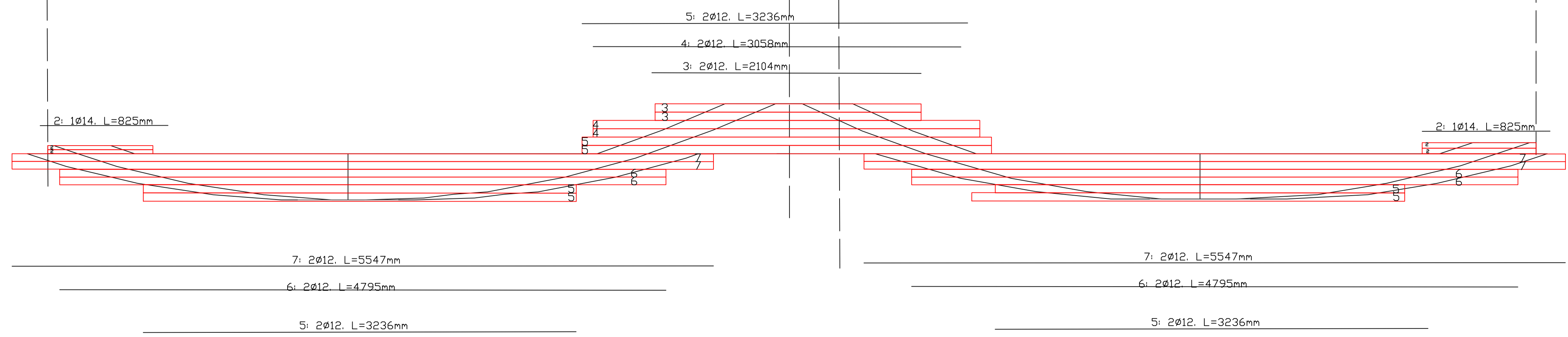
9:TR. 2Ø12. L=5700mm

9:TR. 2Ø12. L=5700mm

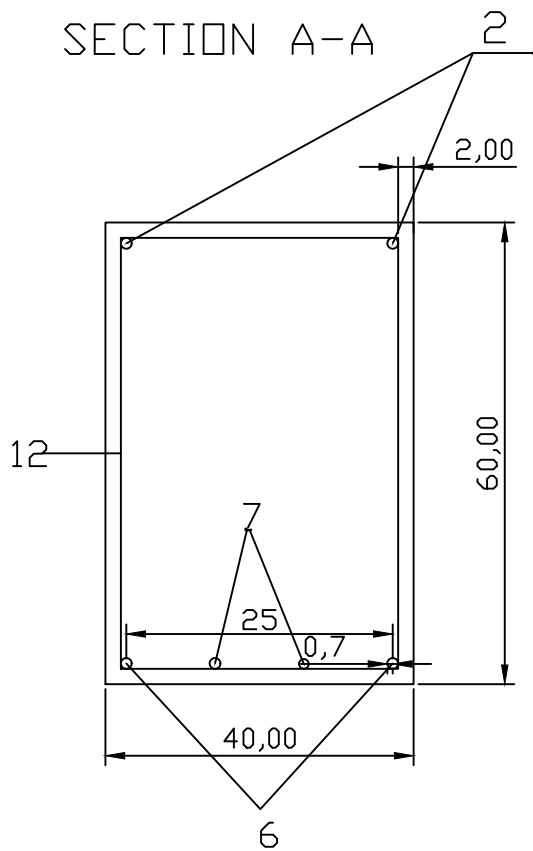
VERA LÓPEZ GARCÍA

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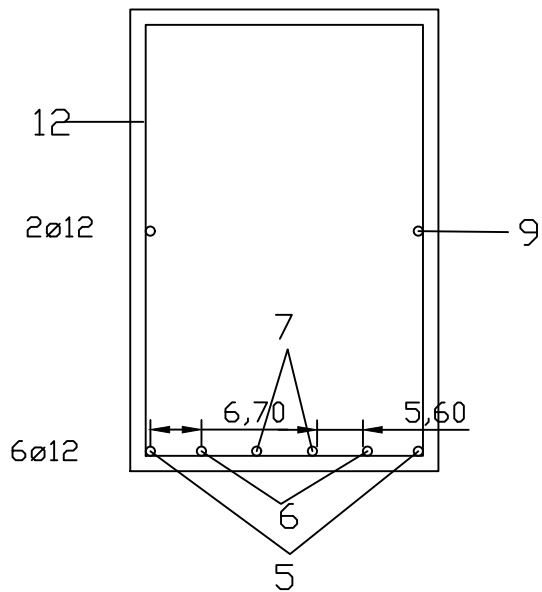
1:1  
(mm)



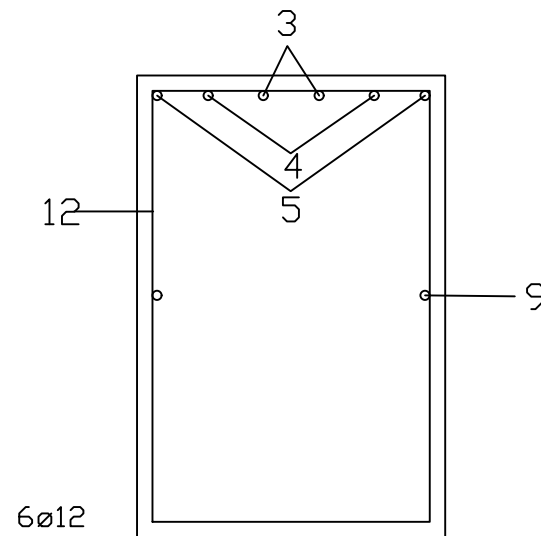
SECTION A-A



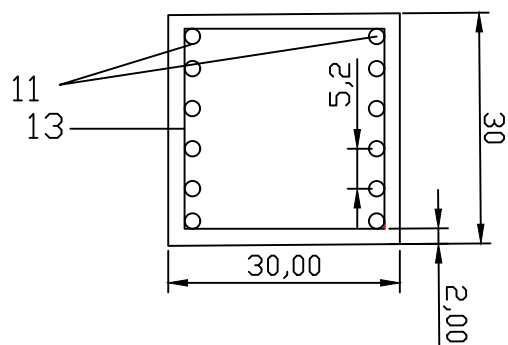
SECTION B-B



SECTION C-C



SECTION D-D



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1:10