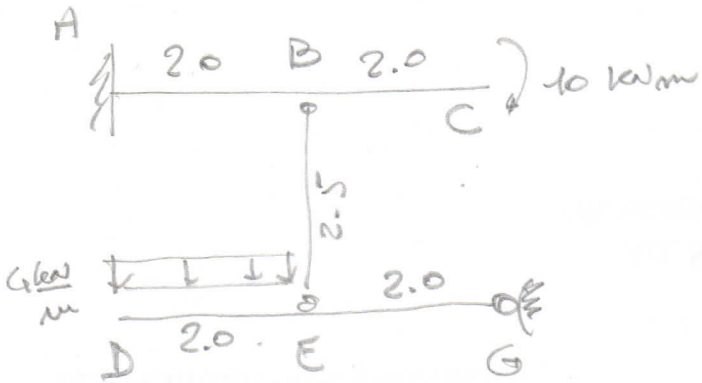
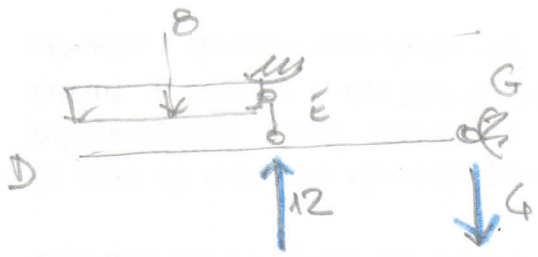
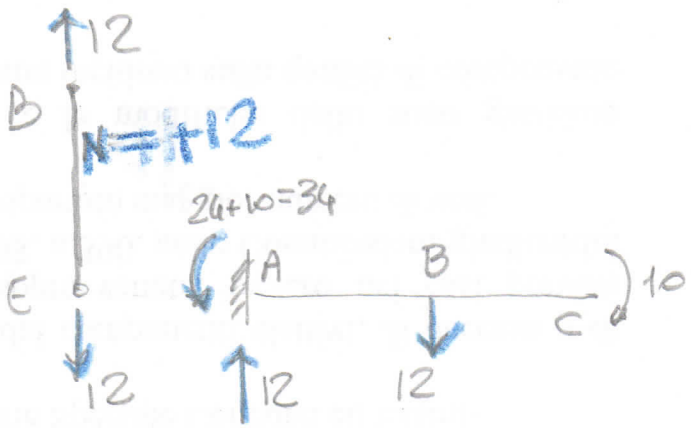
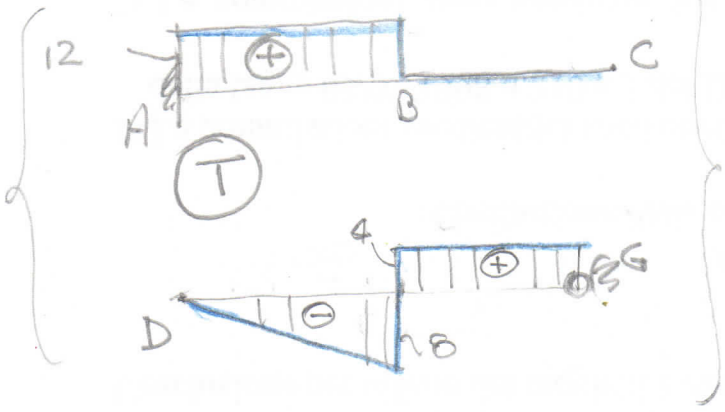
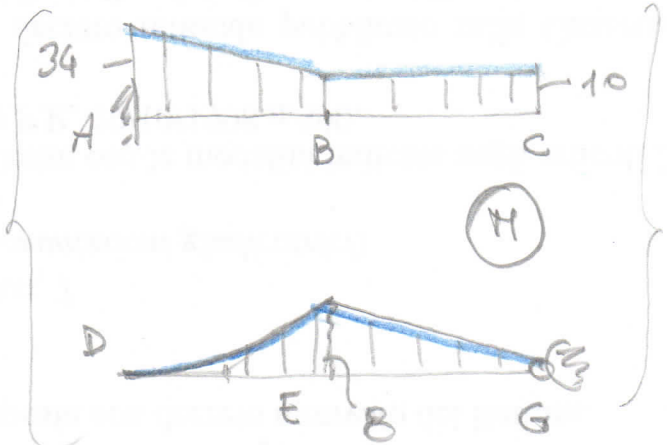
ES.1







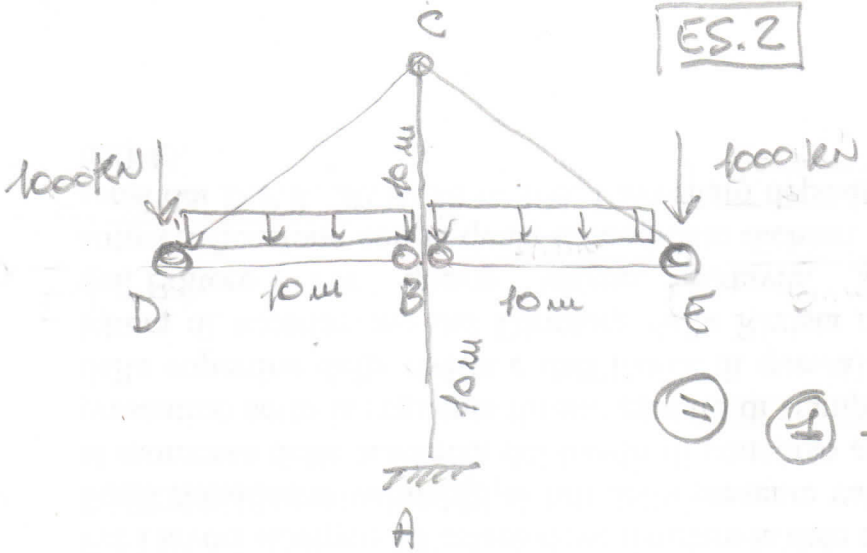




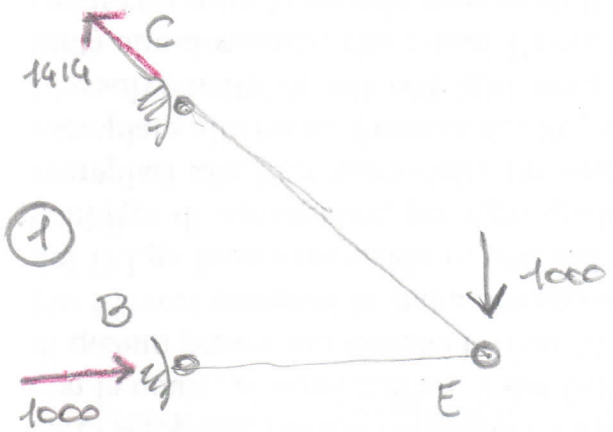
$$\Delta\varphi_{BE} = \frac{12000 * 2500}{30000 \times 500} = 2 \text{ mm}$$

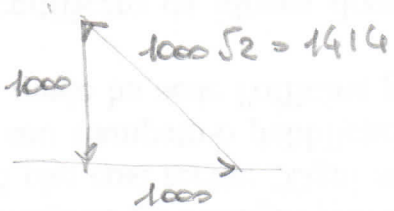
$$\Delta\varphi_{BC} = \frac{10\,000\,000 * 2000}{30000 \times 4000000} = 0.1\bar{6} \text{ rad} \simeq 10^{\circ}$$

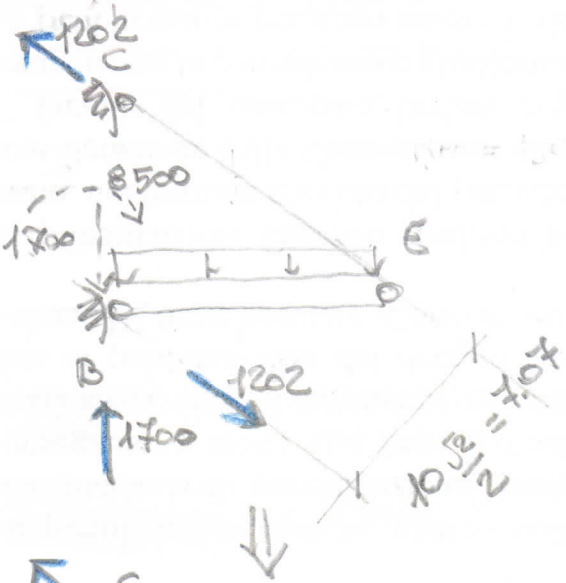
ES.2



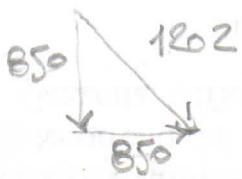
$= (1) + (2) + (3)$



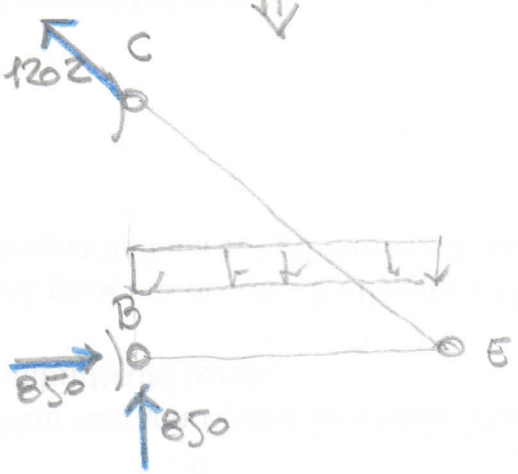




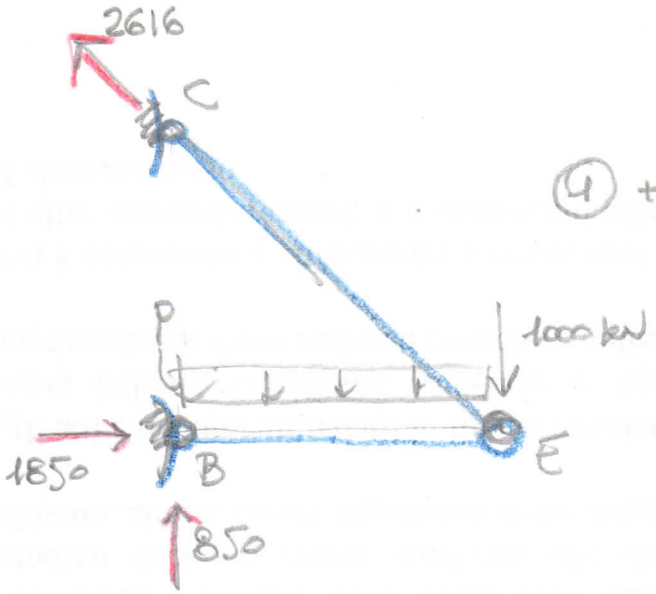
$\frac{8500}{7.07} = 1202$



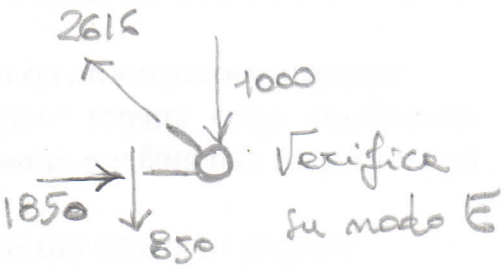
2

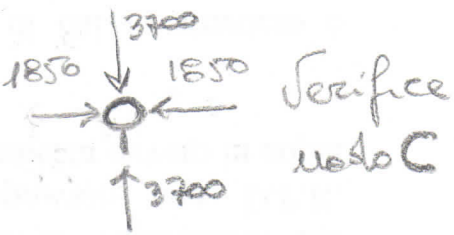


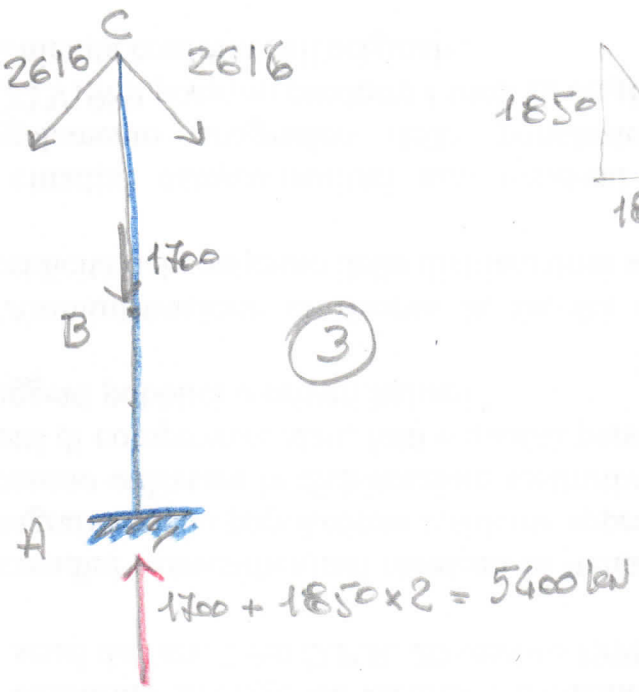
$1700 \uparrow \oplus 850 \downarrow = 850 \uparrow$


2616
C
P
1000 kN
1850
B
E
850

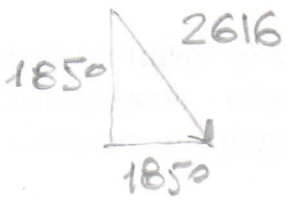
(1) + (2)

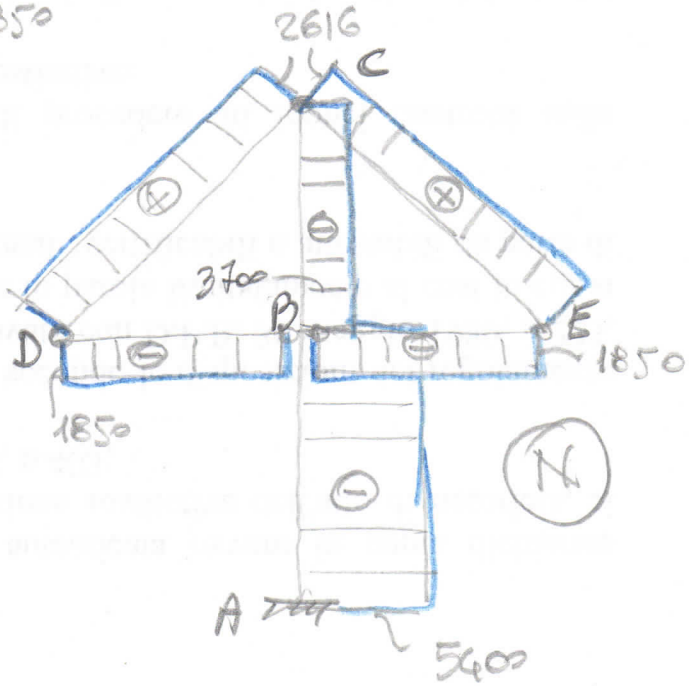

2616
1000
1850
850
Verifica su nodo E


3700
1850
1850
3700
Verifica nodo C

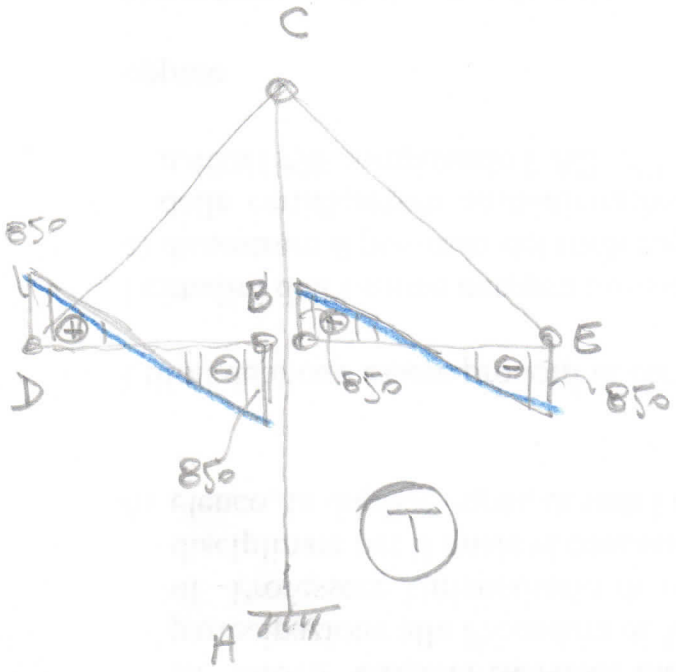

C
2616
2616
1700
B
A
1700 + 1850 × 2 = 5400 kN

(3)

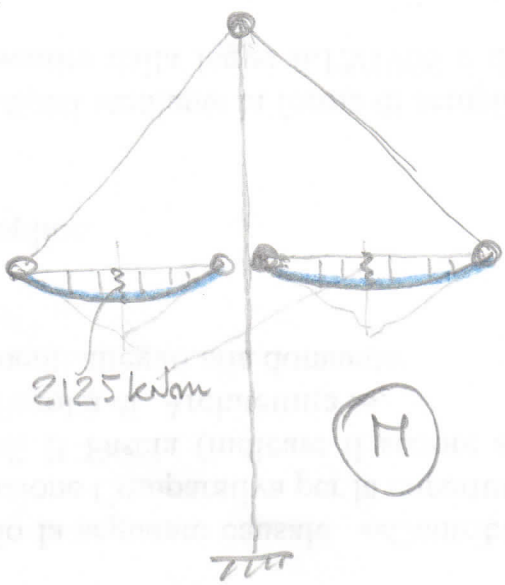

2616
1850
1850


2616
C
3700
B
D
E
1850
1850
A
5400

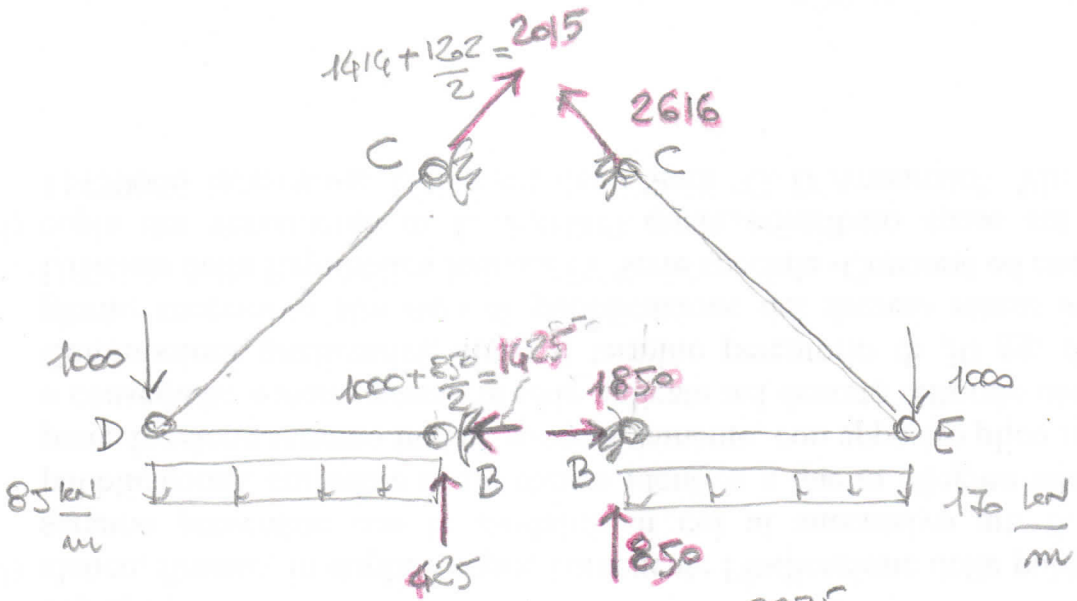
(N)

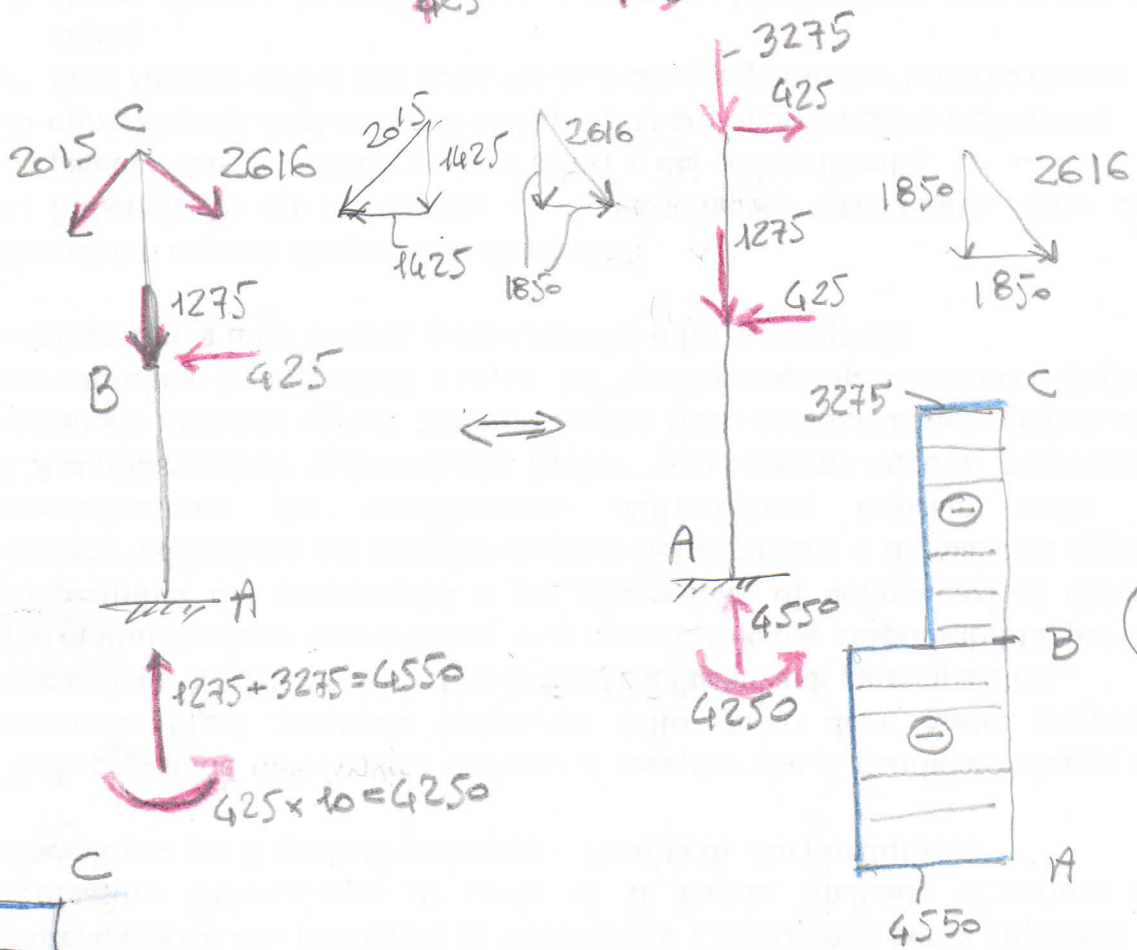

C
850
B
D
E
850
850
850
A

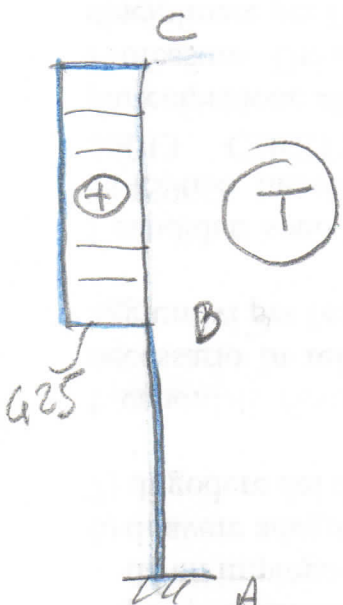
(T)

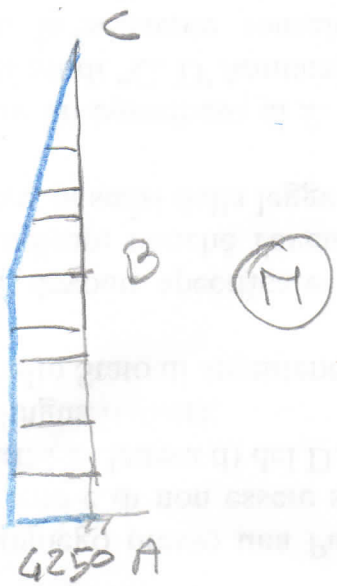

2125 kNm

(M)

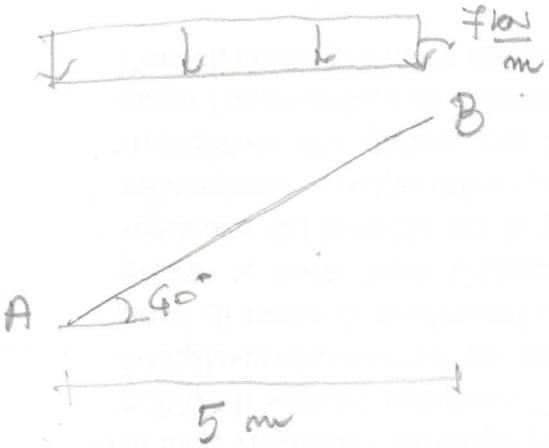

1414+1262/2 = 2015
2616
C
C
1000
1000+850/2 = 1425
1850
1000
D
B
B
E
85 kN/m
425
850
170 kN/m


2015
C
2616
1275
B
425
A
1275+3275=4550
425×10=4250
2015
1425
1425
2616
1850
3275
425
1275
425
A
4550
4250
1850
2616
1850
3275
C
B
A
4550
N

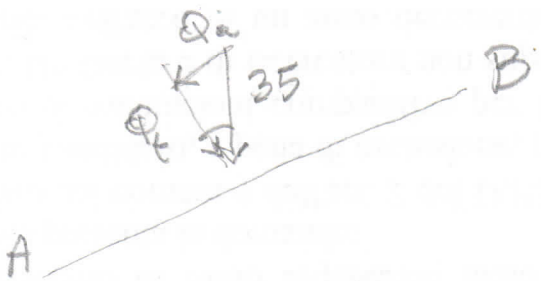

C
T
B
425
A


C
B
M
4250
A

ES.3

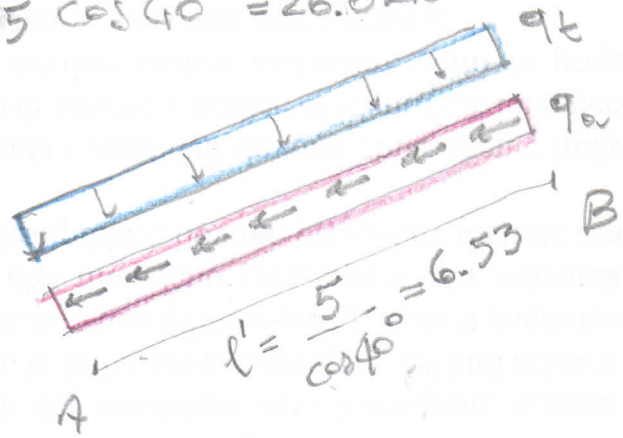


$R = 7 \times 5 = 35\ kN$



$Q_a = 35 \sin 40° = 22.5\ kN$

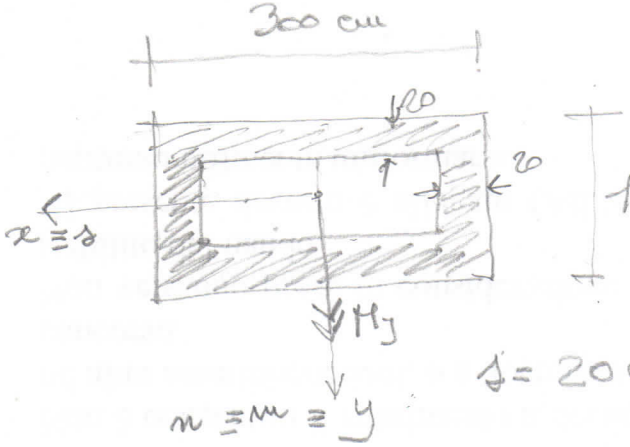
$Q_t = 35 \cos 40° = 26.8\ kN$



$q_a = \frac{22.5}{6.53} = 3.45\ \frac{kN}{m}$

$q_t = \frac{26.8}{6.53} = 4.10\ \frac{kN}{m}$

ES.4

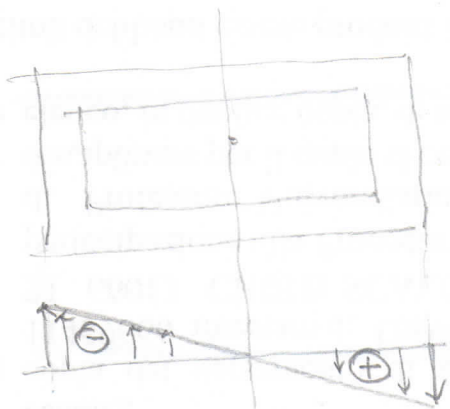


$M_y = 9000$ kNm

$s = 20$ cm

$$I_y = 100 \times \frac{300^3}{12} - 60 \times \frac{260^3}{12} = 137120000 \text{ cm}^4$$

$$\sigma_z = -\frac{9000 \cdot 10^6}{137120000 \times 10^4} x = 0.006564\,x \quad \left[\frac{N}{mm^2}\right]$$

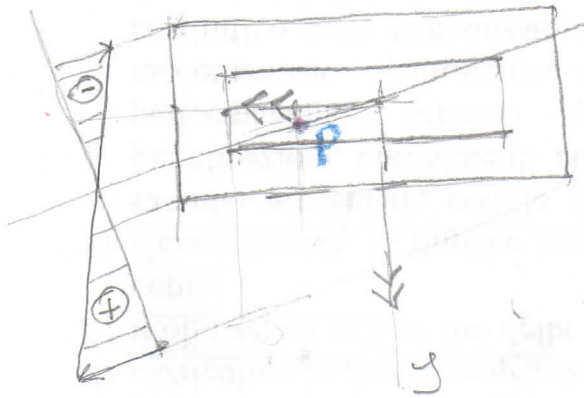


$$\sigma_z^{max} = 0.006564 \times 1500 = 9.9 \frac{N}{mm^2}$$

$$\sigma_z^{min} = -\sigma_z^{max}$$

$M_z = 12000$ kNm

$M_y = 9000$ kNm



$$I_z = 300 \times \frac{100^3}{12} - 260 \times \frac{60^3}{12} = 20320000$$

$$\sigma_z = \frac{12000 \times 10^6}{20320000 \times 10^4} y - 0.006564\,x = 0.05906\,y - 0.006564\,x$$

N-N $\Rightarrow \sigma_z = 0$ $\quad x_p = 750 \Rightarrow y_p = 83$ mm