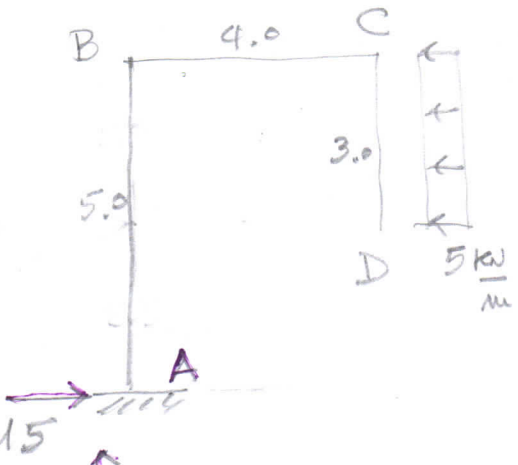
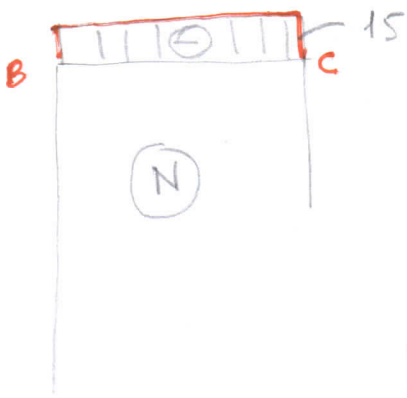
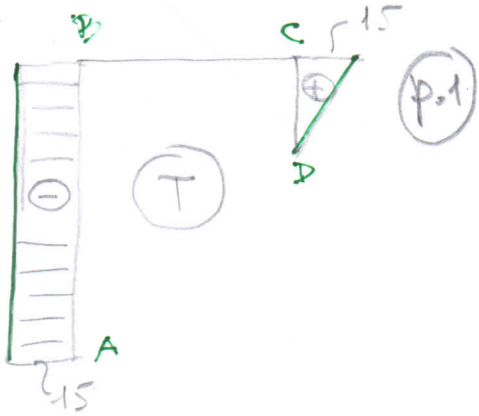
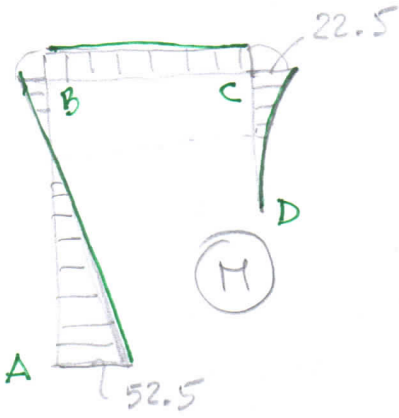




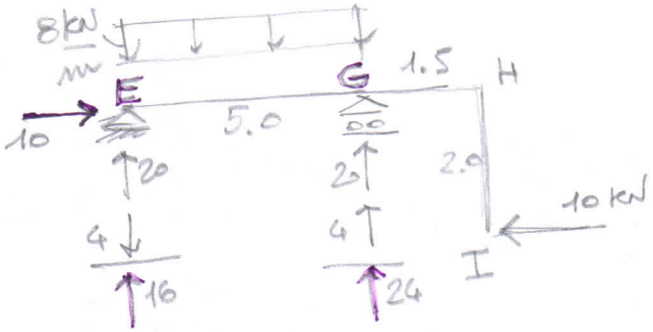


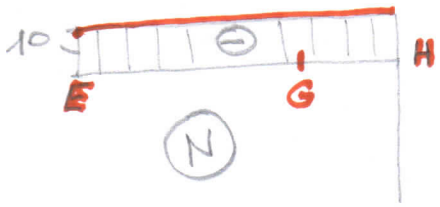
ES.1

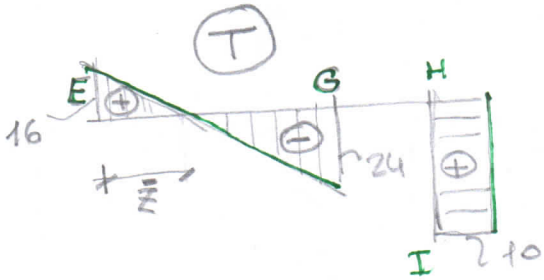


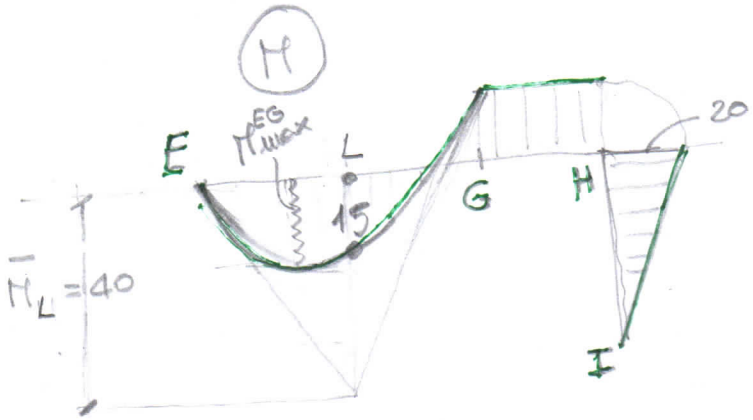
$$M(z)^{AB}_{O\equiv A} = 52.5 - 15 \cdot z$$

$$M(z)^{CD}_{O\equiv D} = -5\frac{z^2}{2}$$









$$T(z)^{EG}_{O\equiv E} = 16 - 8z$$

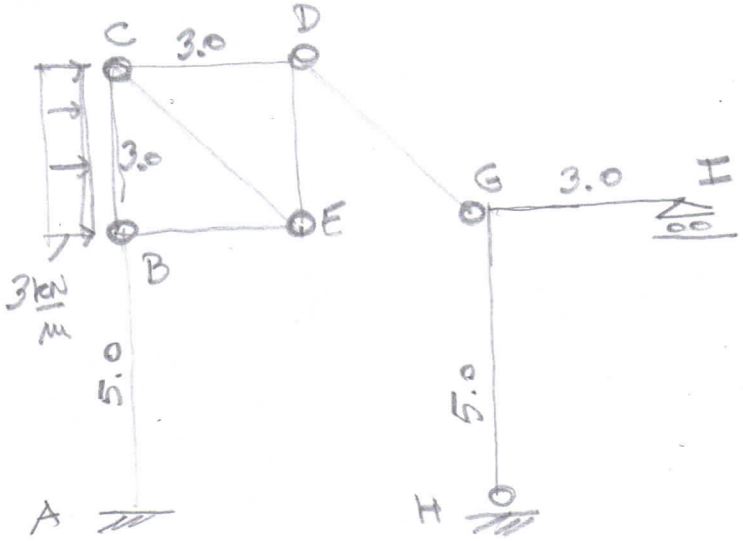
$$16 - 8\bar{z} = 0 \Rightarrow \bar{z} = \frac{16}{8} = 2\ m$$

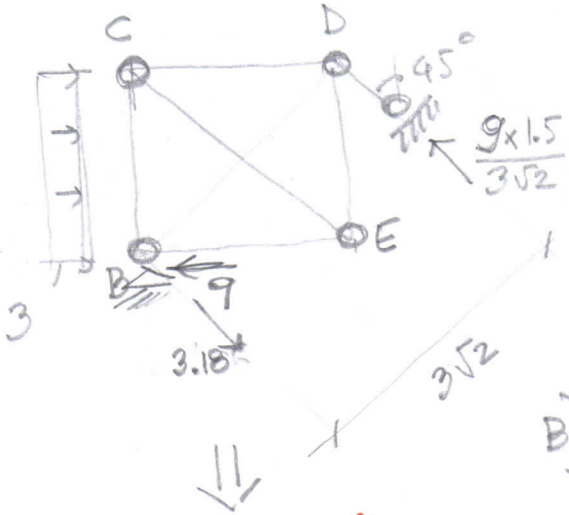
$$M^{EG}_{max} = M(\bar{z}) = 16 \times 2 - 8 \times \frac{2^2}{2} = 16$$

$$M_L = 16 \times 2.5 - 8 \times \frac{2.5^2}{2} = 15$$

$$\bar{M}_4 = 16 \times 2.5 = 40$$

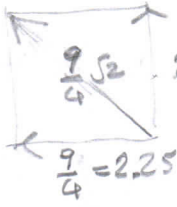
ES.2



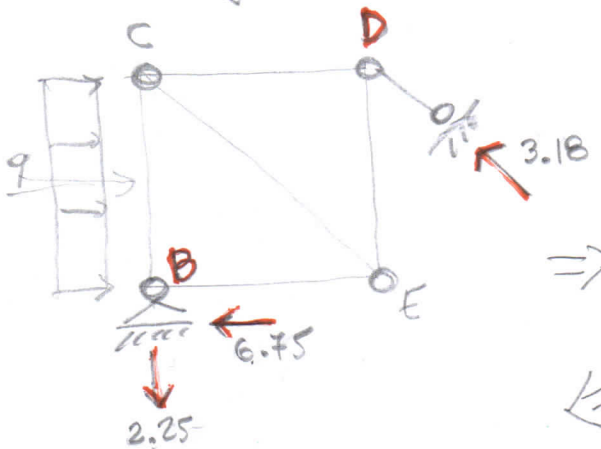


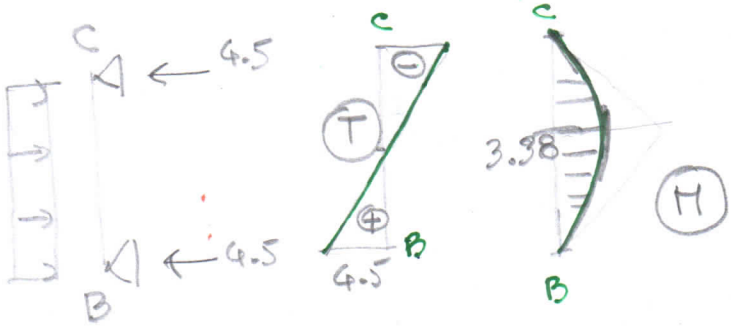
$\frac{9 \times 1.5}{3\sqrt{2}} = \frac{9}{2\sqrt{2}} = \frac{9}{4}\sqrt{2} = 2.25\sqrt{2} = 3.18$

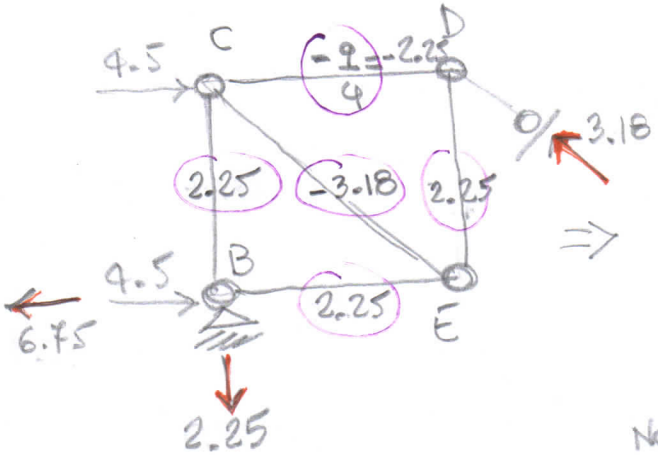
D)



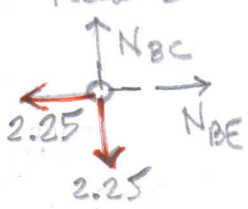
B) $\leftarrow 9 + \downarrow 2.25 + \rightarrow 2.25 = \leftarrow 6.75 + \downarrow 2.25$







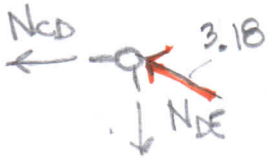
Nodo B



$N_{BC} = 2.25$

$N_{BE} = 2.25$

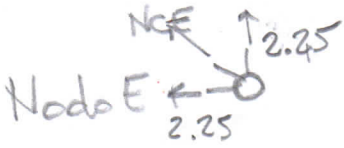
Nodo D



$-N_{CD} - \frac{9}{4} = 0 \Rightarrow N_{CD} = -\frac{9}{4}$

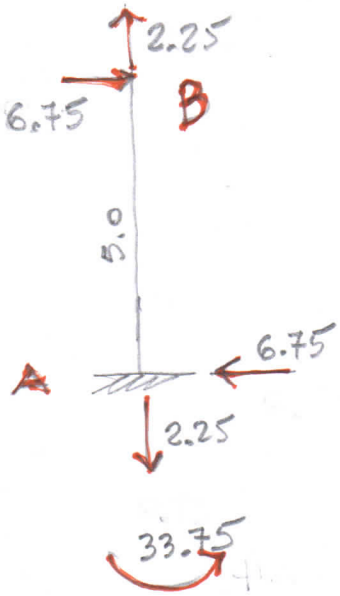
$-N_{DE} + \frac{9}{4} = 0 \Rightarrow N_{DE} = \frac{9}{4} = 2.25$

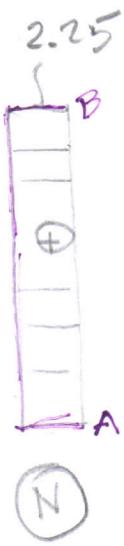
Nodo E



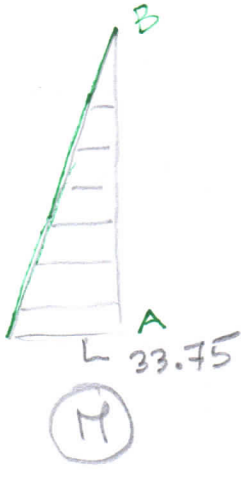
$N_{CE}\frac{\sqrt{2}}{2} + \frac{9}{4} = 0 \Rightarrow N_{CE} = -\frac{9}{4}\frac{2}{\sqrt{2}} =$

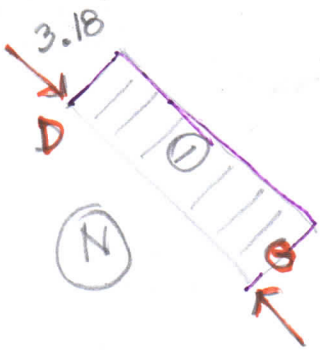
$= -\frac{9}{4}\sqrt{2} = -3.18$

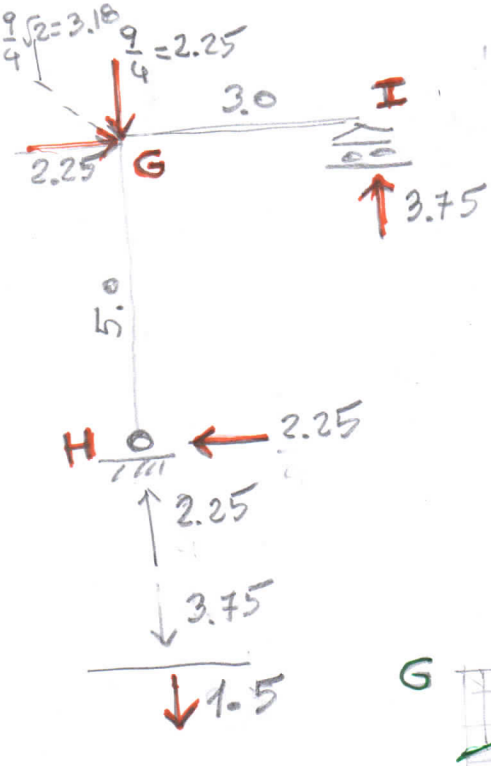

2.25
6.75
B
m
A
6.75
2.25
33.75

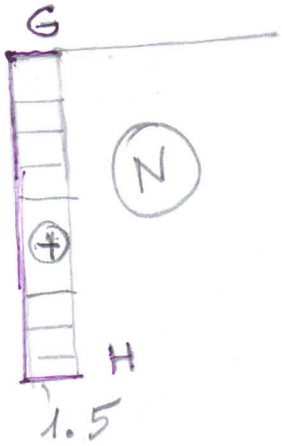

2.25
B
A
N

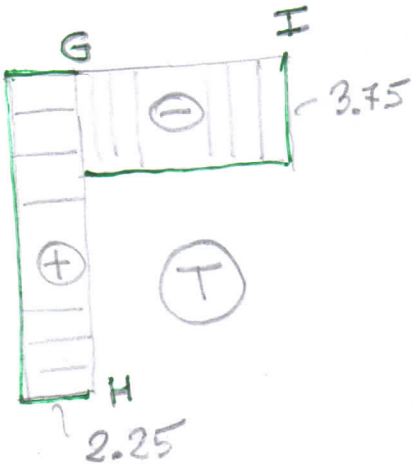

6.75
B
A
T

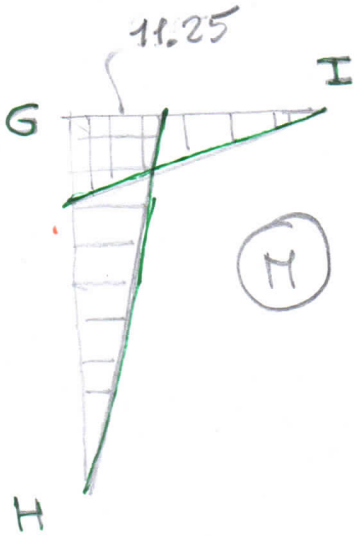

B
A
L
33.75
M


3.18
D
N
G

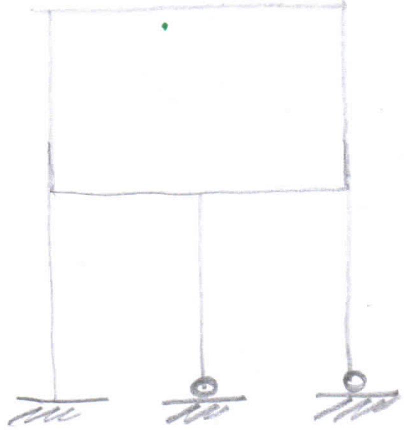

9/4 √2=3.18
9/4 =2.25
3.0
I
2.25
G
3.75
m
H
2.25
2.25
3.75
1.5


G
N
H
1.5

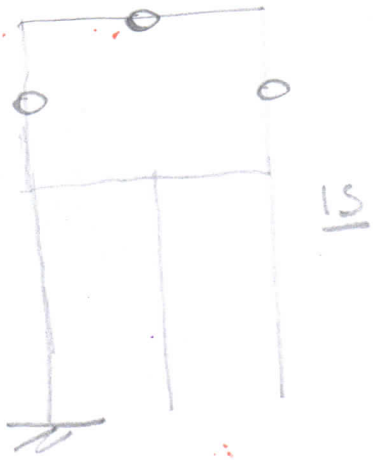

G
I
3.75
T
H
2.25

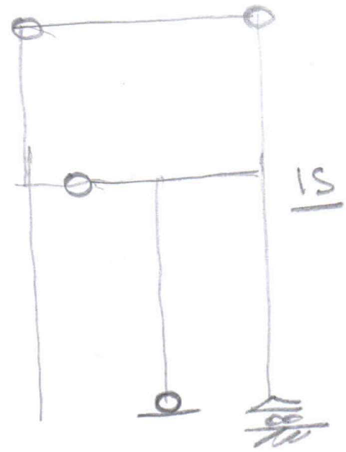

11.25
G
I
M
H

ES: 3

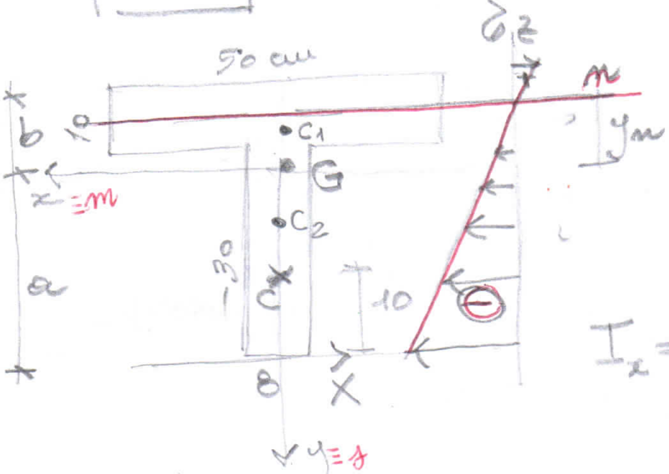


3 ip. int.
+
4 ip. ext.





ES. 4



$A_{tot} = 50 \times 10 + 30 \times 8 = 740\ cm^2$

$S_x = \overset{17500}{50 \times 10 \times 35} + \overset{3600}{30 \times 8 \times 15} = 21100$

$a = \frac{S_x}{A} = 28.5\ cm \qquad b = 40 - a = 11.5$

$I_x = \frac{50 \times 10^3}{12} + 50 \times 10 \times (35 - 28.5)^2 +$

$+ \frac{8 \times 30^3}{12} + 8 \times 30 \times (15 - 28.5)^2 = 87032\ cm^4$

$\sigma_z = \frac{N}{A} + \frac{M_x}{I_x} y = -2.027 - 0.0318 y$

$y_c = e_y = 28.5 - 10 = 18.5\ cm \ ; \ \rho_x^2 = \frac{I_x}{A} = 118\ cm^2 \Rightarrow$ Oppure $y_n = -6.4\ cm$

oppure : $N_G = -150\ kN \qquad M_x = N_c\ e_y = (-150) \times 0.185 = -27.7\ kNm$

$y_n = -\frac{N}{A} \frac{I_x}{M_x} = -\frac{(-150) \times 10^3}{740 \times 10^2} \times \frac{87032 \times 10^4}{(-27.7 \times 10^6)} = -64\ mm$

$\sigma_z^{max} = -\frac{150 \times 10^3}{740 \times 10^2} + \frac{-27.7 \times 10^6}{87032 \times 10^4} (-115) = +1.63 \frac{N}{mm^2} \qquad \sigma_z^{min} = -11.1 \frac{N}{mm^2}$

$y_{c_1} = -\frac{118}{28.5} = -4.1\ cm \qquad y_{c_2} = -\frac{118}{(-11.5)} = 10.3\ cm$