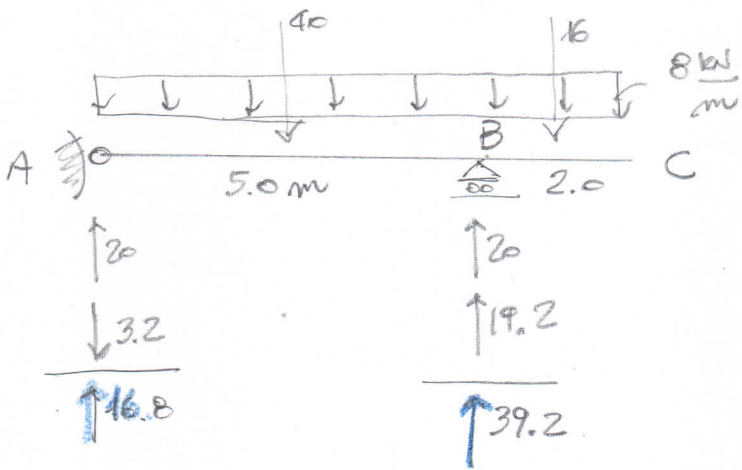


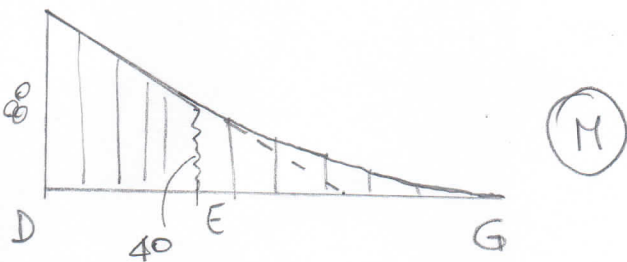
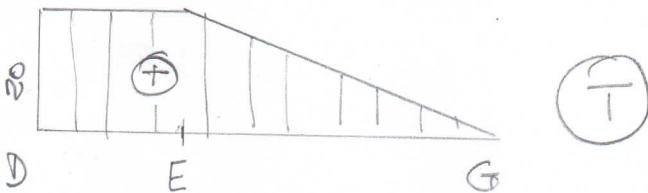
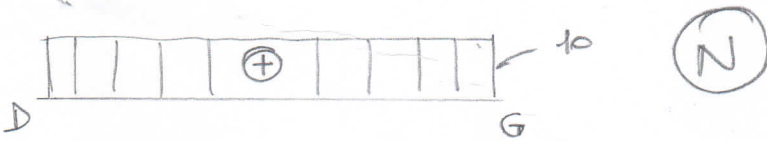
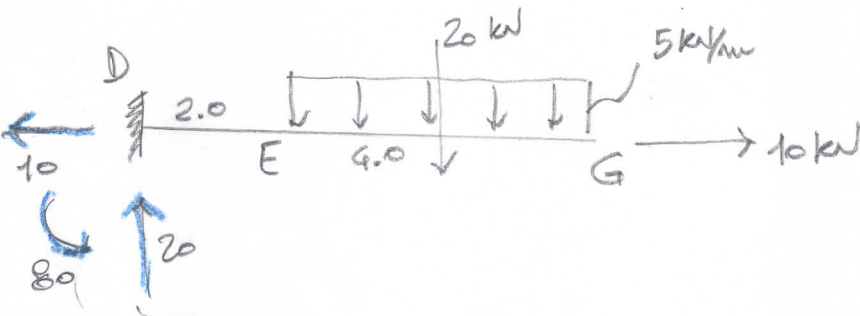
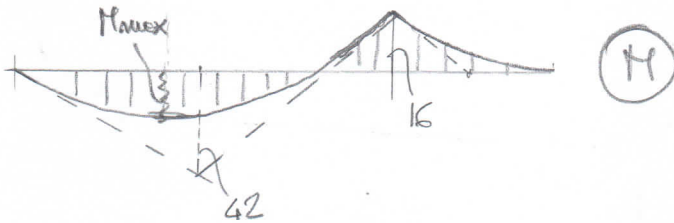
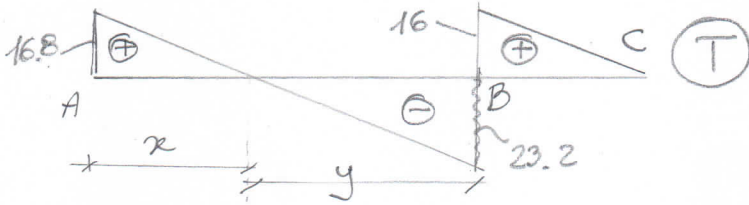
ES.1



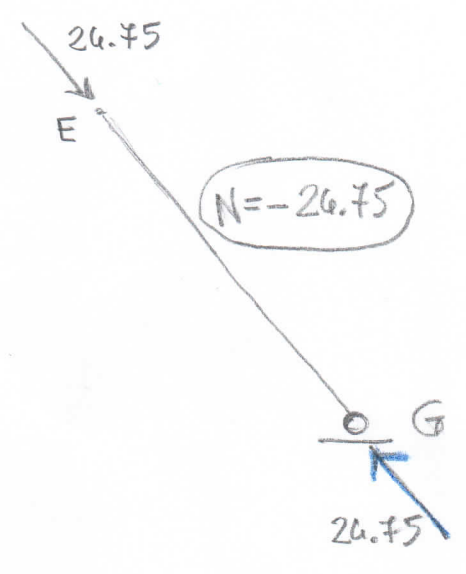
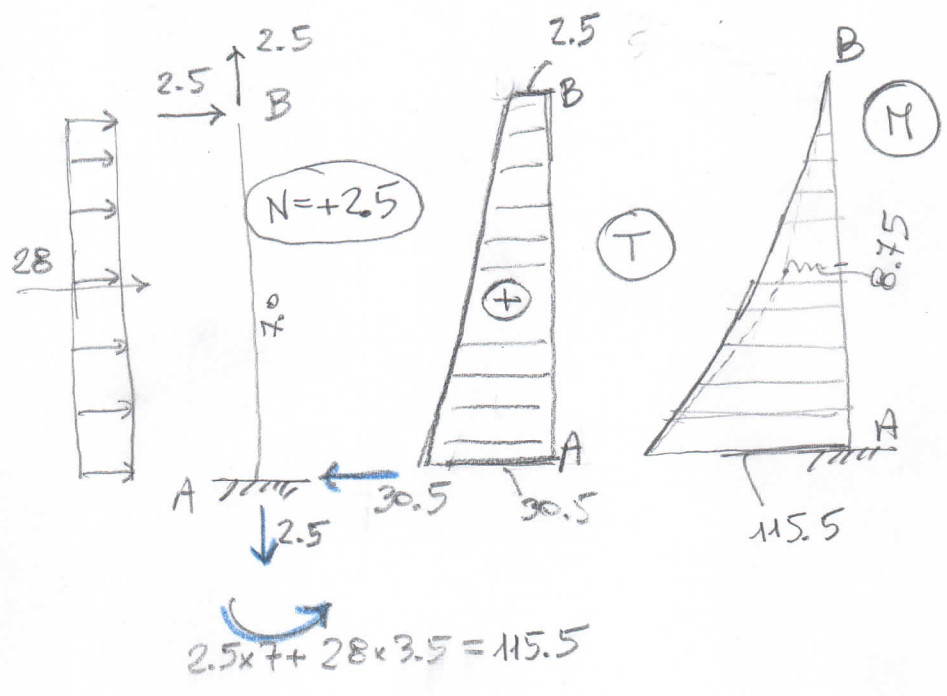
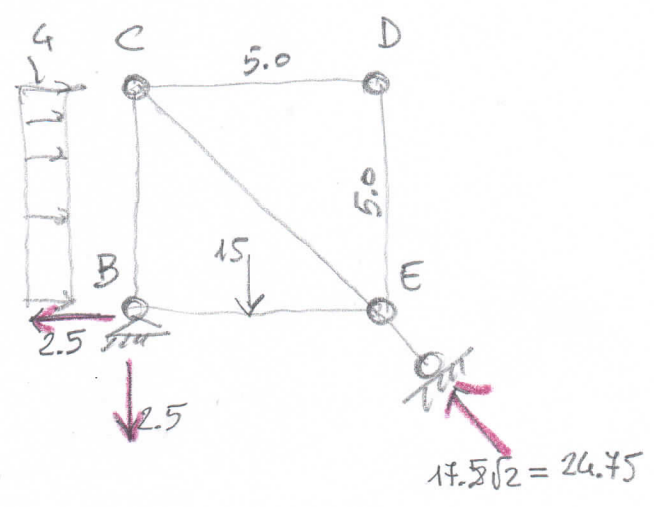
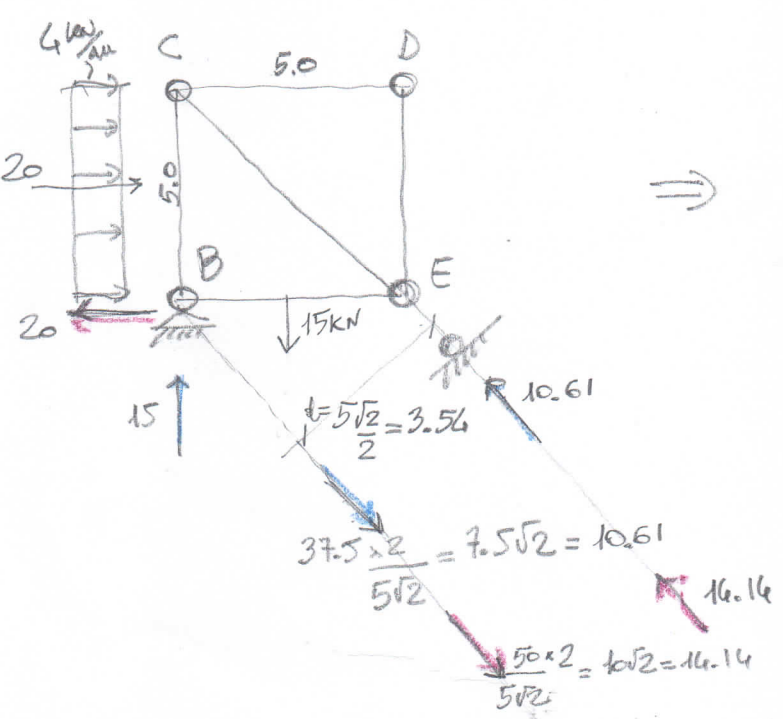
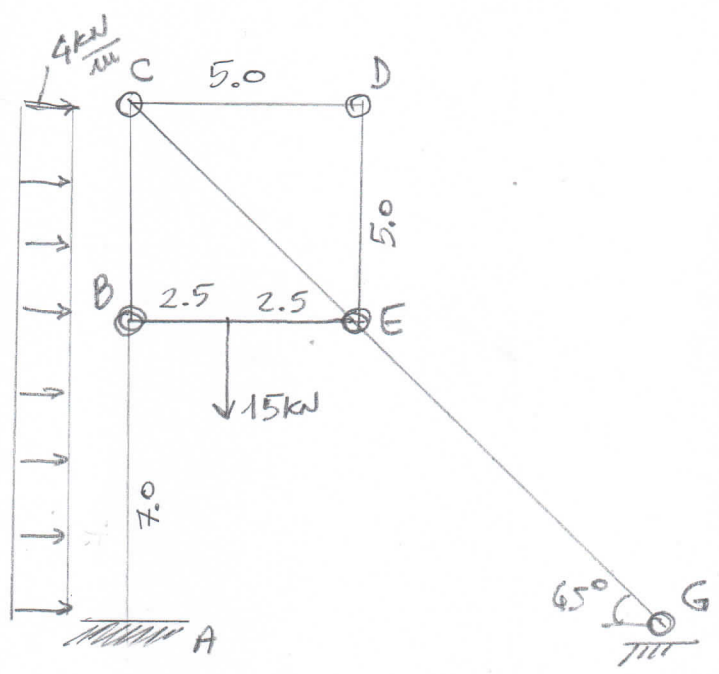
$$16.8 = 8x \Rightarrow x = \frac{16.8}{8} = 2.1 \text{ m}$$

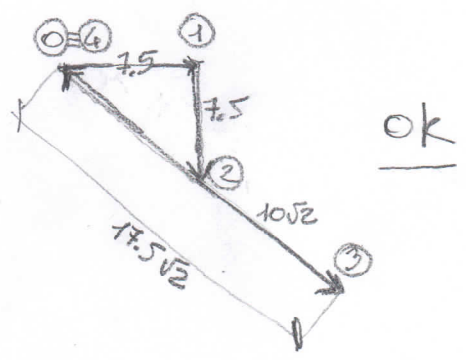
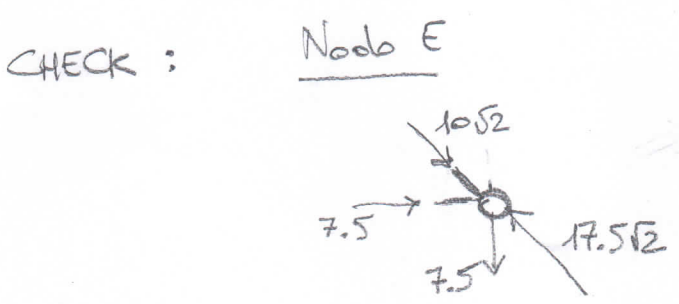
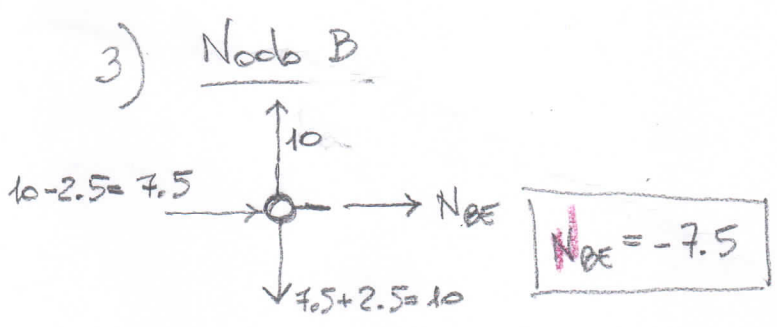
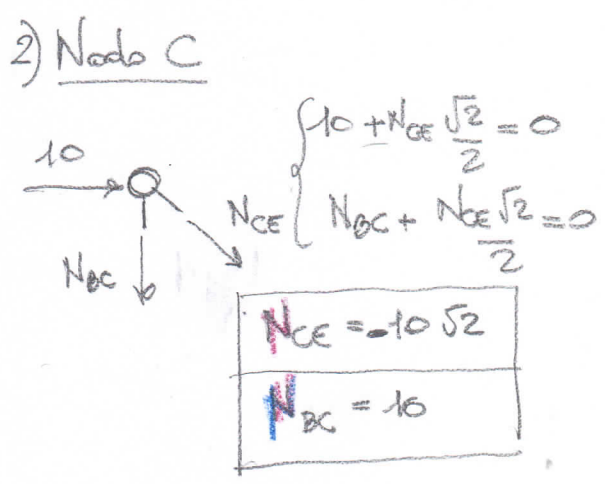
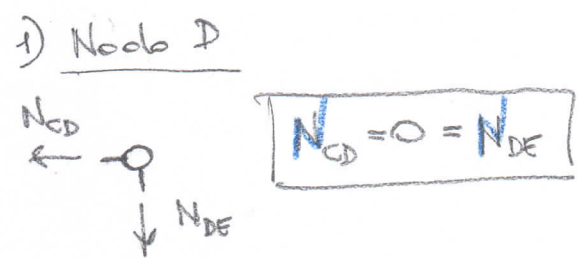
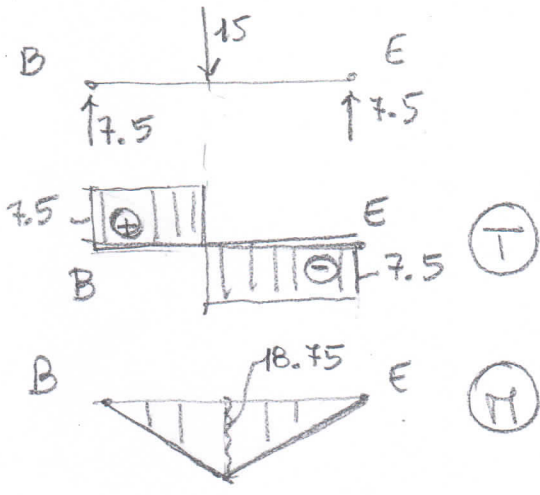
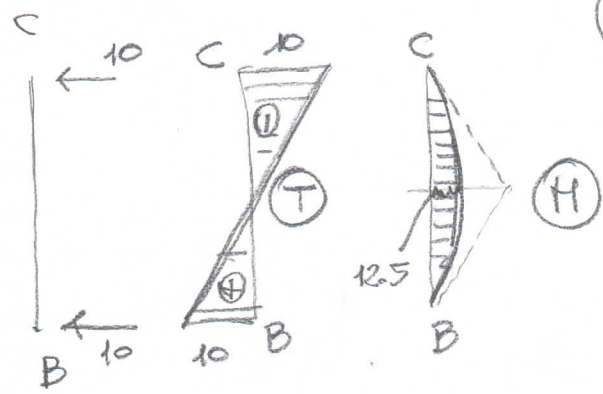
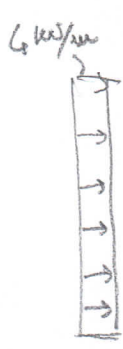
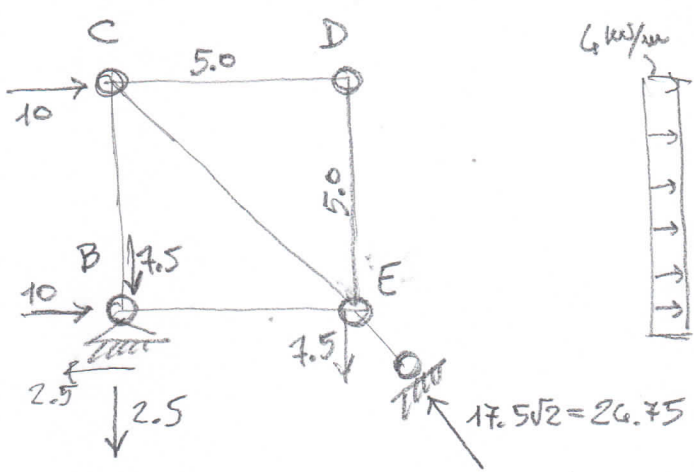
$$y = 5 - 2.1 = 2.9$$

$$M_{\text{max}} = 16.8 \times \frac{2.1}{2} = 17.64 \text{ kNm}$$

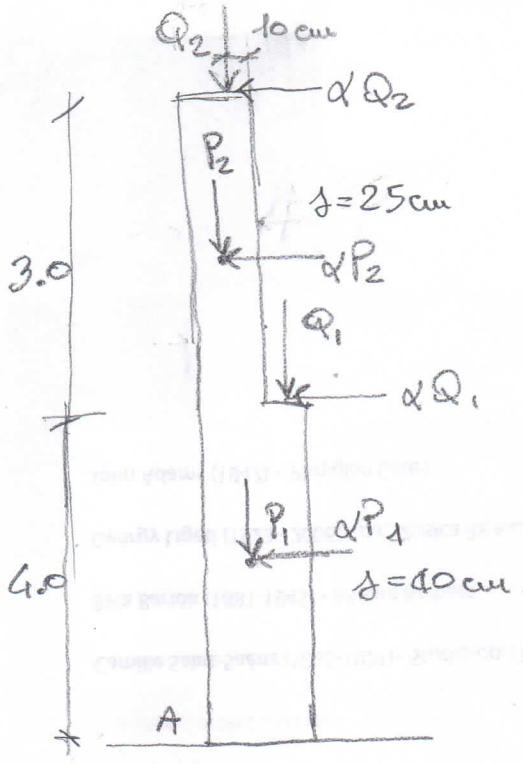


ES.2





$\gamma_{\text{max}} = 18 \text{ kN/m}^3$ ES.3



$l_{\text{sol}} = 5 \text{ m}$

① $q_{\text{sol}} = 6 \text{ kN/m}$

② $q_{\text{sol}} = 4 \text{ kN/m}$

$Q_1 = 6 \times \frac{5}{2} = 15 \text{ kN}$

$Q_2 = 4 \times \frac{5}{2} = 10 \text{ kN}$

$P_1 = 18 \times 0.4 \times 4 = 28.8$

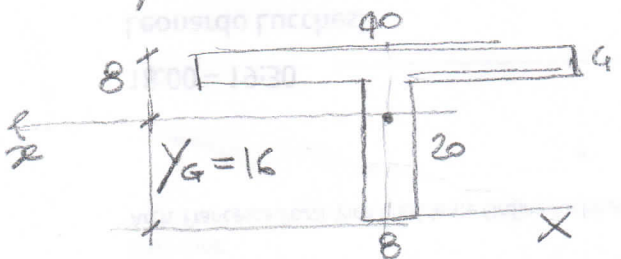
$P_2 = 18 \times 0.25 \times 3 = 13.5$

$M_{\text{st}} = 28.8 \times \frac{0.4}{2} + 15 \times \left(\frac{.25 + .15}{2} \right) + 13.5 \times \frac{.25}{2} + 10 \times .3 = 15.32 \text{ kNm}$

$M_{\text{inst}} = \alpha \left(28.8 \times \frac{4}{2} + 15 \times 4 + 13.5 \times 5.5 + 10 \times 7 \right) = 261.85 \alpha$

$\alpha = \frac{15.32}{261.85} = 0.059$

ES.4



$A = 40 \times 4 + 20 \times 8 = 320 \text{ cm}^2$

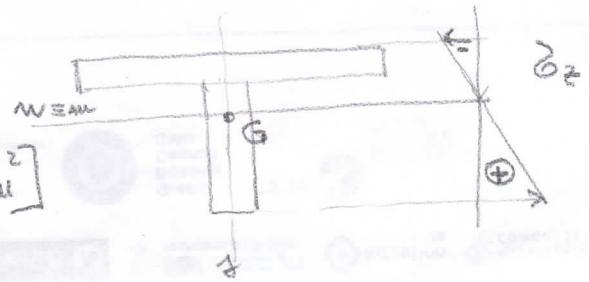
$S_x = 40 \times 4 \times 22 + 8 \times 20 \times 10 = 5120 \text{ cm}^3$

$Y_G = \frac{5120}{320} = 16 \text{ cm}$

$I_z = 8 \times \frac{20^3}{12} + 8 \times 20 \times (10 - 16)^2 + 40 \times \frac{4^3}{12} + 40 \times 4 \times (22 - 16)^2 = 17067 \text{ cm}^4$

$M_{\text{max}} = 7 \times \frac{5^2}{8} = 21.88 \text{ kNm}$

$\sigma_z = \frac{21.88 \times 10^6}{17067 \times 10^4} y = 0.1282 y \text{ [N/mm}^2\text{]}$



$\sigma_z^{\text{max}} = 0.1282 \times 160 = 21 \text{ N/mm}^2$

$\sigma_z^{\text{min}} = 0.1282 \times (-80) = -10 \frac{\text{N}}{\text{mm}^2}$