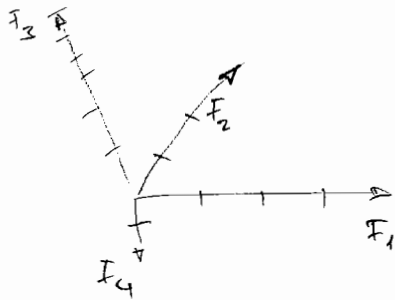
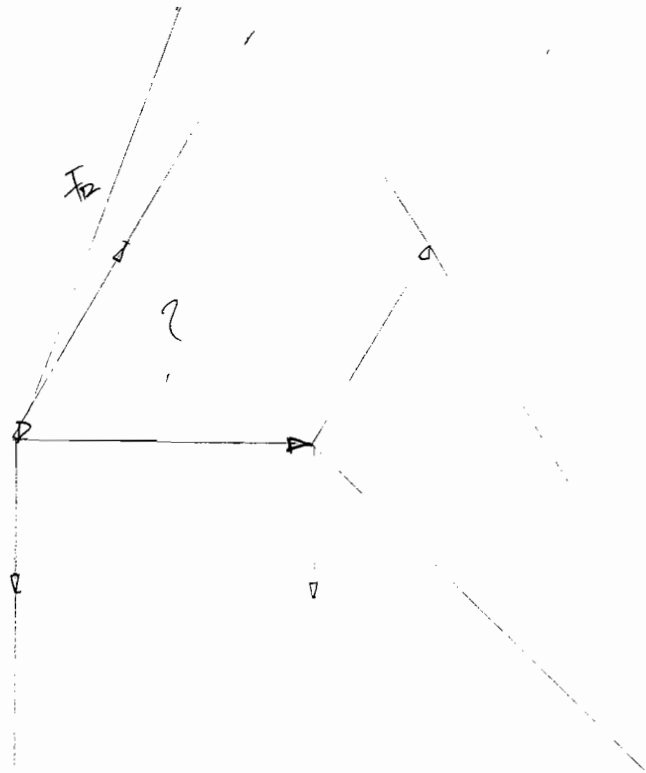


① 4 side



$$\begin{aligned}
 F_1 &= 4 \text{ kN} & \alpha_1 &= 0^\circ \\
 F_2 &= 3 \text{ kN} & \alpha_2 &= 60^\circ \\
 F_3 &= 6 \text{ kN} & \alpha_3 &= 120^\circ \\
 F_4 &= 2 \text{ kN} & \alpha_4 &= 270^\circ
 \end{aligned}$$



$$\begin{aligned}
 F_{1x} &= F_1 \cdot \cos \alpha_1 = 4 & F_{1y} &= 0 \\
 F_{2x} &= F_2 \cdot \cos \alpha_2 = 1,5 & F_{2y} &= \frac{\sqrt{3}}{2} \cdot 3 \\
 F_{3x} &= F_3 \cdot \cos \alpha_3 = -3 & F_{3y} &= \frac{\sqrt{3}}{2} \cdot 6 = 3\sqrt{3} \\
 F_{4x} &= 0 & F_{4y} &= -3
 \end{aligned}$$

$$F_{Rx} = F_{1x} + F_{2x} + F_{3x} + F_{4x} = 2,5$$

$$F_{Ry} = \frac{3\sqrt{3}}{2} + 3\sqrt{3} + (-3) = \frac{3\sqrt{3} + 6\sqrt{3} - 6}{2} = \frac{9\sqrt{3} - 6}{2} = 4,794$$

$$F_{R\text{mag}} = \sqrt{F_{Rx}^2 + F_{Ry}^2} = \sqrt{6,25 + 22,98} = 5,4$$

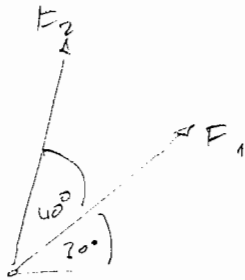
$$\cos \alpha = \frac{F_{Rx}}{F_{R\text{mag}}} = \frac{2,5}{5,4} = 0,462 \quad \alpha = 62,52$$

VEZBAŇE 1

$F_1 = 30\text{ N}$

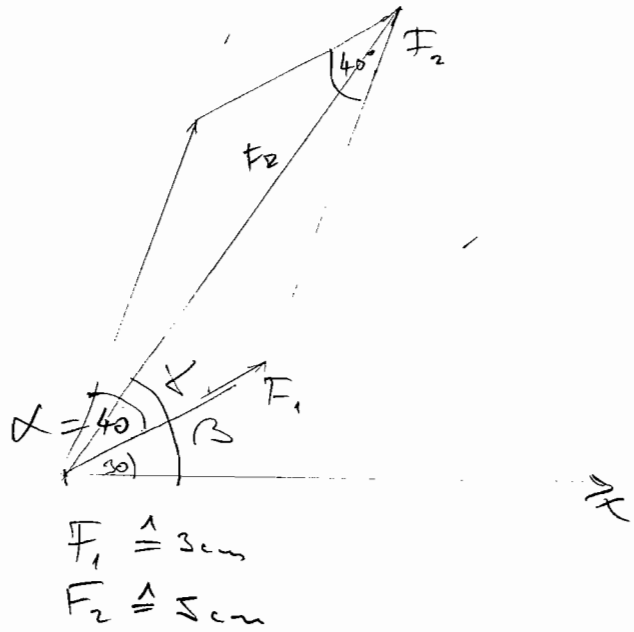
$F_2 = 50\text{ N}$

GRAFICKI
ANALITIČKI



$M_F = 10\text{ [N]} \hat{=} 1\text{ [cm]}$

očitanje
 $F_R \hat{=} 7,56\text{ kN}$



$F_1 \hat{=} 3\text{ cm}$
 $F_2 \hat{=} 5\text{ cm}$

~~FR~~ $F_R = 7,56 \cdot M_F = 75,6\text{ [N]}$

$\beta = 55^\circ$

analitički:

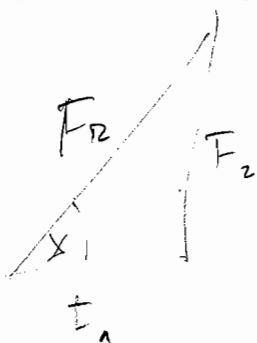
$F_R = \sqrt{F_1^2 + F_2^2 + 2F_1 \cdot F_2 \cdot \cos \alpha} = \sqrt{30^2 + 50^2 + 2 \cdot 30 \cdot 50 \cdot \cos 10^\circ} =$

$F_{R1} = F_1 \cdot \cos 30^\circ = 25,98\text{ N}$

F_2

$= \sqrt{900 + 2500 + 2298} =$
 $= 75,486\text{ [N]}$

~~$\beta = 30 + \gamma$~~



$F_2^2 = F_R^2 + F_1^2 - 2 \cdot F_R \cdot F_1 \cdot \cos \gamma \Rightarrow$

$2500 = 6598,74 - 2 \cdot F_R \cdot F_1 \cdot \cos \gamma$

$-\cos \gamma = \frac{2500 - 6598,74}{2 F_R F_1} =$

$\cos \gamma = 0,904$

$\gamma = 25,18$

$\beta = 30 + 25,18 = 55,18^\circ$

$$F_1 = 4 \text{ kN} \quad \alpha_1 = 60^\circ$$

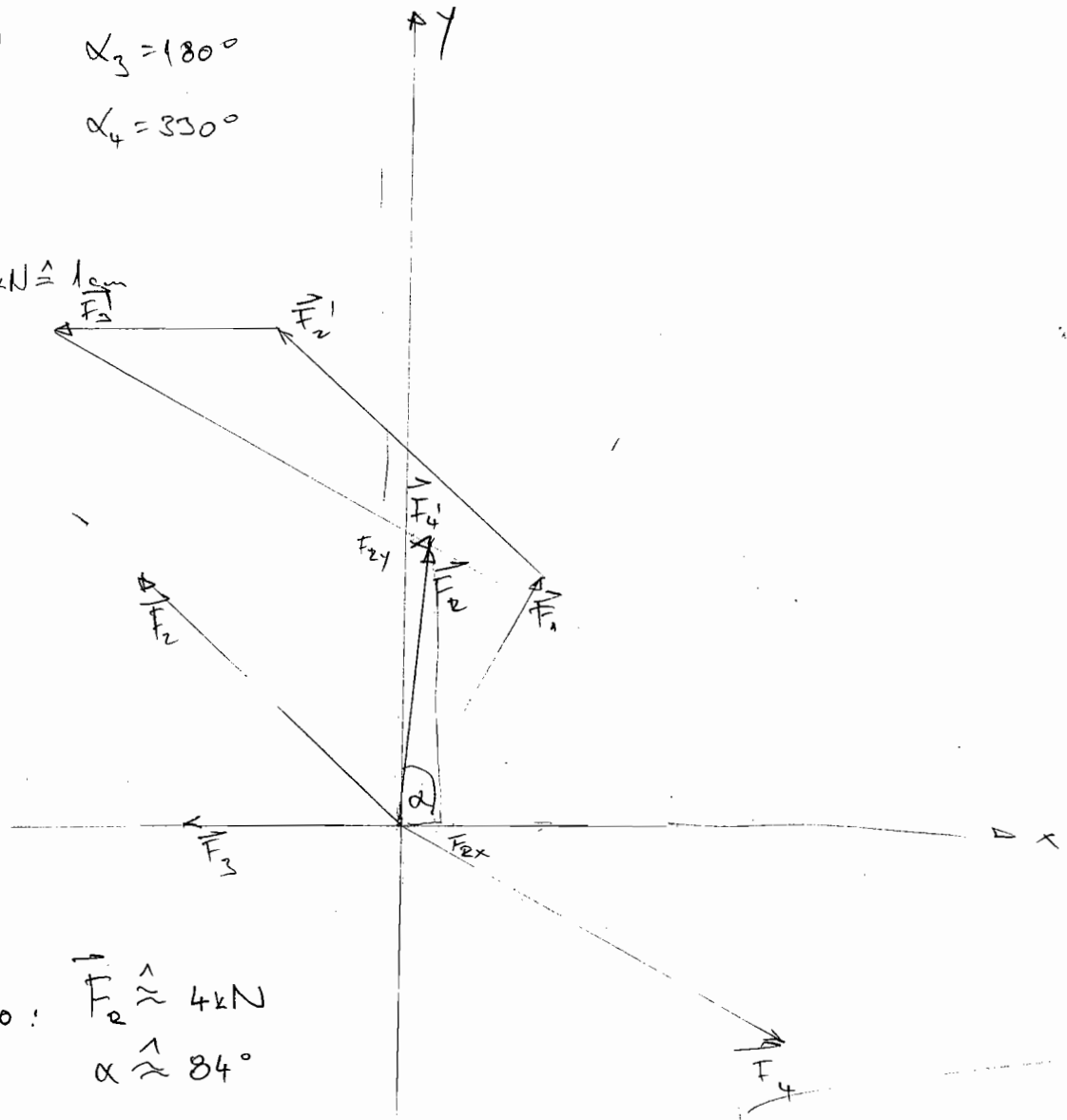
$$F_2 = 5 \text{ kN} \quad \alpha_2 = 135^\circ$$

$$F_3 = 3 \text{ kN} \quad \alpha_3 = 180^\circ$$

$$F_4 = 6 \text{ kN} \quad \alpha_4 = 330^\circ$$

graficki:

$$M_F = 1 \text{ kN} \hat{=} \frac{1 \text{ cm}}{F_2}$$



očitanje: $F_R \hat{=} 4 \text{ kN}$
 $\alpha \hat{=} 84^\circ$

analitički:

$$\alpha_1 = 60^\circ, \alpha_2 = 135^\circ, \alpha_3 = 180^\circ, \alpha_4 = 330^\circ$$

$$F_R = \sqrt{F_{Rx}^2 + F_{Ry}^2}$$

$$F_{Rx} = F_1 \cdot \cos 60^\circ + F_2 \cdot \cos 135^\circ + F_3 \cdot \cos 180^\circ + F_4 \cdot \cos 330^\circ =$$

$$= 2 + (-3,535) + (-3) + 5,196 = \underline{0,661}$$

$$F_{Ry} = F_1 \cdot \sin 60^\circ + F_2 \cdot \sin 135^\circ + F_3 \cdot \sin 180^\circ + F_4 \cdot \sin 330^\circ =$$

$$= 3,464 + 3,535 + 0 + (-3) = \underline{3,999}$$

$$F_R = \sqrt{3,999^2 + 0,661^2} = \boxed{4,053 \text{ kN}}$$

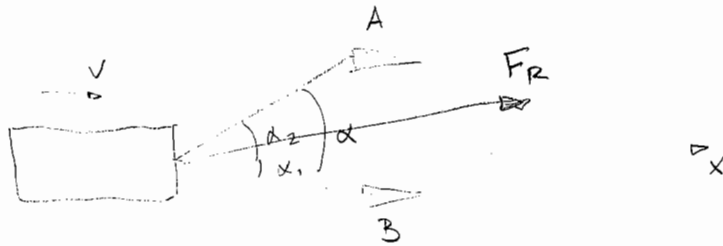
$$\operatorname{tg} \alpha = \frac{F_{Ry}}{F_{Rx}} =$$

$$= \underline{6,0499} \Rightarrow$$

$$\alpha = \underline{80,61^\circ}$$

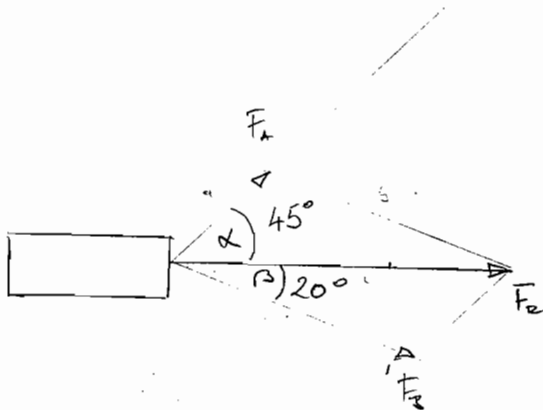
$$F_A, F_B = ?$$

$$F_R = 450 \text{ kN}$$



graficki

$$M_T: 100 \text{ kN} \cdot 1 \text{ cm}$$



očitanje

$$F_A \hat{=} 1,75 \text{ cm} = \underline{175 \text{ kN}}$$

$$F_B \hat{=} 3,5 \text{ cm} = \underline{350 \text{ kN}}$$

analitički

$$\frac{F_A}{F_B} = \frac{\sin \alpha}{\sin \beta} \Rightarrow F_A = 2,067 F_B$$

$$\cos \alpha = \frac{F_A^2 + F_R^2 - F_B^2}{2 F_A \cdot F_R} = F_A = 715 \text{ kN}$$

$$\frac{F_R}{2} = \frac{4,3 F_B^2 + 202500 - F_B^2}{1860,3 F_B} \quad \cdot 3720,6 F_B$$

$$2630,9 F_B = 6,6 F_B^2 + 405000$$

$$6,6 F_B^2 - 2630,9 F_B + 405000 = 0 \quad / : 6,6$$

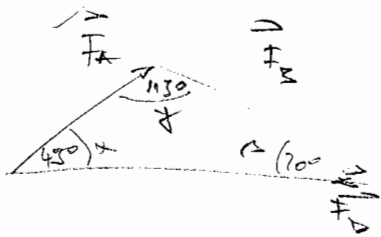
$$F_B^2 - 400 F_B + 61363,6 = 0$$

$$F_{B,1,2} = \frac{400 \pm \sqrt{160000 - 24545}}{2} = \frac{400 \pm 292,33}{2}$$

$$F_{B,1} = -53,9$$

$$F_{B,2} = 346 \text{ kN}$$

$$\frac{0,707}{0,342}$$

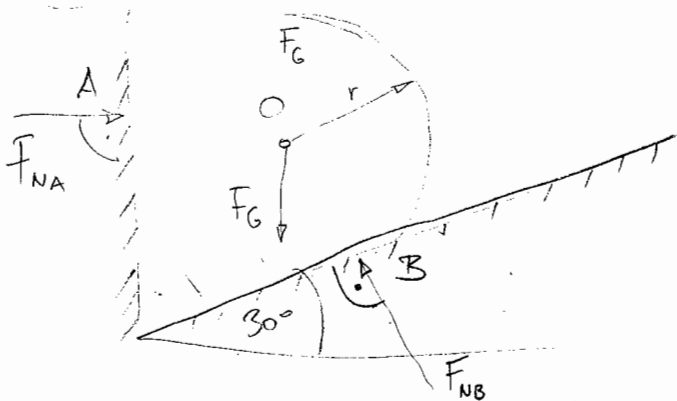


$$\alpha = 180 - \alpha - \beta = 115^\circ$$

$$\frac{F_B}{F_D} = \frac{\sin \alpha}{\sin \beta} \Rightarrow F_B = F_D \cdot \frac{\sin \alpha}{\sin \beta} = \underline{\underline{351,09 \text{ kN}}}$$

$$\frac{F_A}{F_D} = \frac{\sin \beta}{\sin \alpha} \Rightarrow F_A = F_D \cdot \frac{\sin \beta}{\sin \alpha} = \underline{\underline{169,82 \text{ kN}}}$$

$$F_G = 40 \text{ N}$$

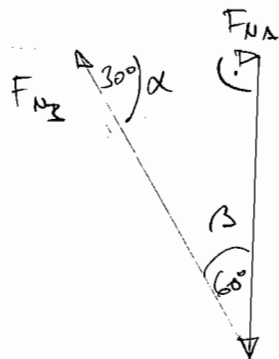


(konkurentne sile -

- zato plan sile: graf. uješt

- $\sum F_x = 0$, $\sum F_y = 0$ analitički uješt

grafički $M_F: AON \hat{=} 1 \text{ cm}$



očitanje

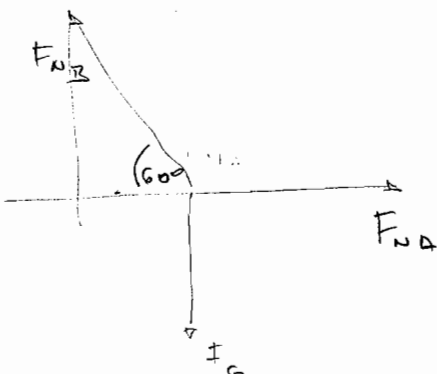
$$F_{NB} \hat{=} 4,2 = \underline{\underline{47 \text{ N}}}$$

$$F_{NA} \hat{=} 2,4 = \underline{\underline{24 \text{ N}}}$$

$$\alpha = 30^\circ$$

$$\beta = 60^\circ$$

analitički



$$\sum F_x = 0$$

$$-F_{NB} \cdot \cos 60 + F_{NA} = 0$$

$$\sum F_y = F_{NB} \cdot \sin 60 - F_G = 0$$

$$F_{NB} = \frac{F_G}{\sin 60} = \underline{\underline{46,2 \text{ N}}}$$

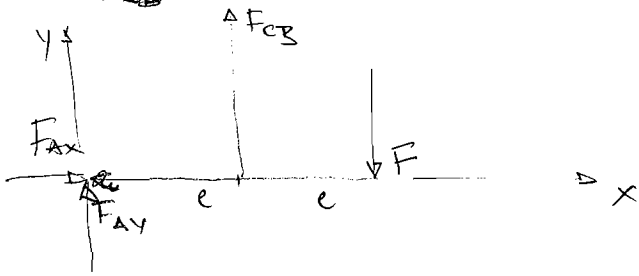
$$-\frac{F_{NB}}{2} + F_{NA} = 0$$

$$F_{NA} = \frac{F_{NB}}{2} = \underline{\underline{23,1 \text{ N}}}$$

ZAD 6

$$\frac{F}{CB} = 350 \text{ N}$$

$$F_{CB} = ?$$



$$\sum F_x = 0$$

$$\underline{\underline{F_{Ax} = 0}}$$

$$\sum F_y = F_{Ay} + F_{CB} - F = 0$$

$$F_{Ay} + F_{CB} - 350 = 0$$

$$\boxed{F_{Ay} + F_{CB} = 350} \quad (1)$$

$$\sum M_A = 0$$

$$F_{CB} \cdot L - F \cdot 2l = 0$$

$$F_{CB} = \frac{F \cdot 2l}{L} = \underline{\underline{700 \text{ N}}}$$

(1)

$$F_{Ay} + 700 = 350$$

$$F_{Ay} = 350 - 700 = \underline{\underline{-350 \text{ N}}}$$

$$F_A = \sqrt{F_{Ax}^2 + F_{Ay}^2} = \sqrt{0 + 350^2} = \underline{\underline{350}}$$

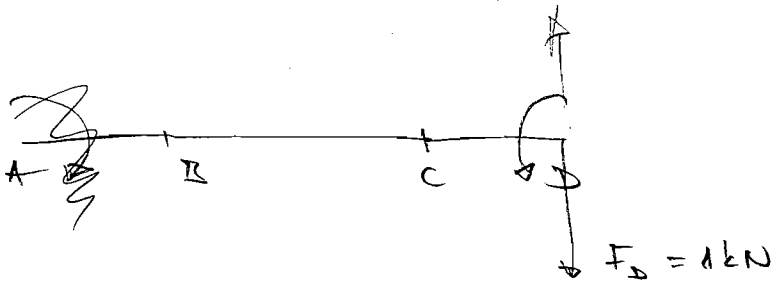
$$\textcircled{7} \quad F_1 = 2 \text{ kN}$$

$$F_2 = 3 \text{ kN}$$

$$F_3 = 4 \text{ kN}$$

$$M_D = -3F_3 + 7F_2 + 10F_1 = -12 + 21 + 20 = \boxed{29 \text{ kNm}}$$

$$F_{yD} = -F_1 - F_2 + F_3 = -2 - 3 + 4 = \boxed{-1 \text{ kN}}$$

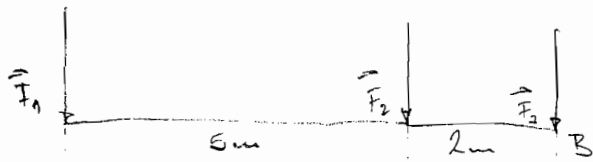


$$F_y = F_1 + F_2 - F_3 = 2 + 3 - 4 = \boxed{1 \text{ kN}}$$

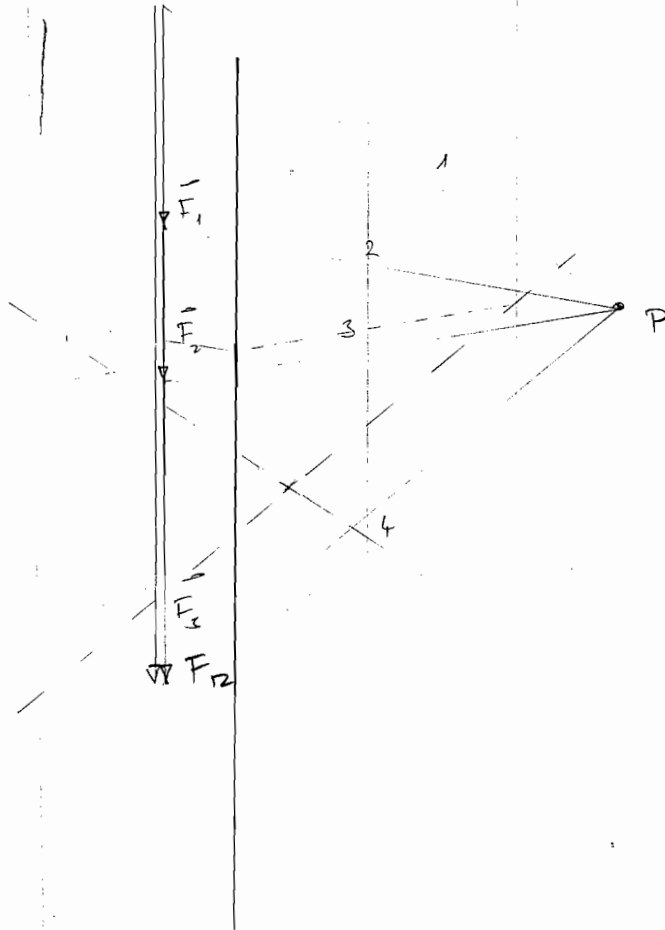
$$M_D = 10 \cdot F_1 + 7 \cdot F_2 - 3 \cdot F_3 =$$

$$= 20 + 7 \cdot 3 - 3 \cdot 4 = \boxed{29 \text{ kNm}}$$

10) $F_1 = 3\text{kN}$, $F_2 = 2\text{kN}$, $F_3 = 4\text{kN}$

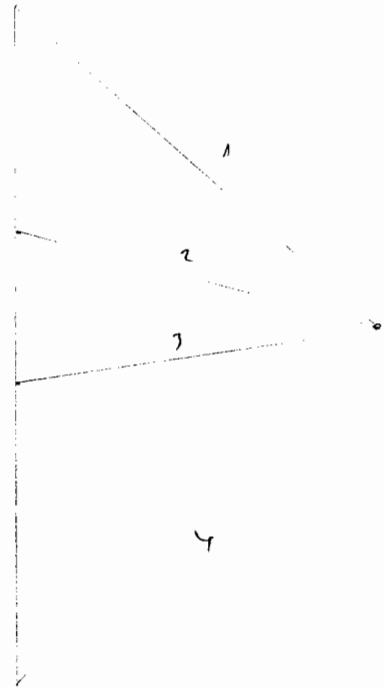
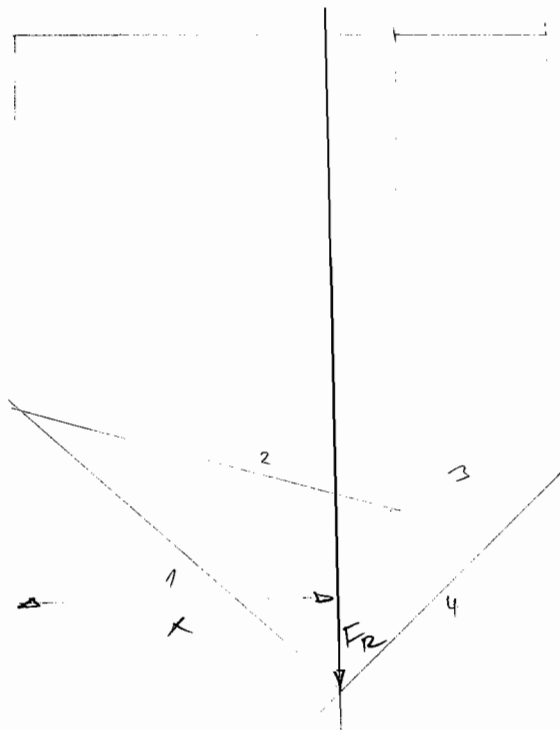


a) grafici: $M \triangleq 1\text{kN} \triangleq 1\text{cm}$



ocitans: $F_2 \triangleq 9\text{kN}$

a) grafisch



ocitano $\vec{F}_2 = 9 \text{ kN}$
 $x = 4,2 \text{ m}$

b) analitisch:

$$\vec{F}_R = \vec{F}_1 + \vec{F}_2 + \vec{F}_3 = \underline{\underline{9 \text{ kN}}}$$

~~$$\vec{M}_R = \vec{r} \times \vec{F}_2 = \vec{r} \times (\vec{F}_1 + \vec{F}_2 + \vec{F}_3)$$~~

~~$$\vec{r} = \vec{r}$$~~

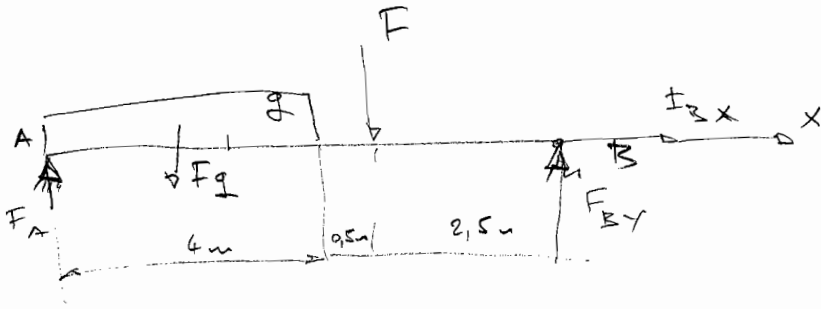
$$M_R = \sum F \cdot l$$

$$F_R \cdot x = F_2 \cdot 5 + F_3 \cdot 7$$

$$9 \cdot x = 10 + 28$$

$$x = 4,22 \text{ m} = 4 \text{ m}$$

11

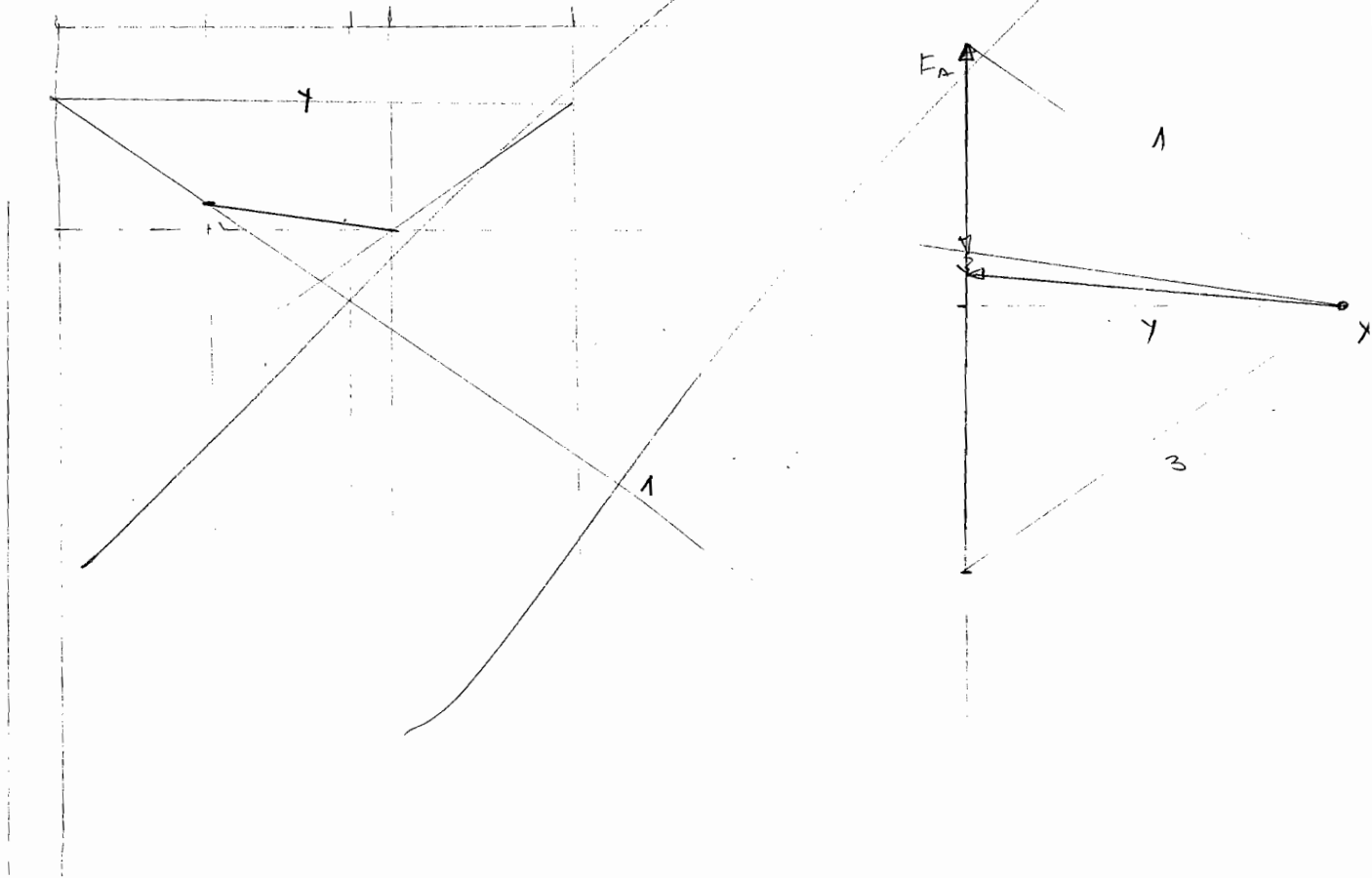


$$F = 4 \text{ kN}$$

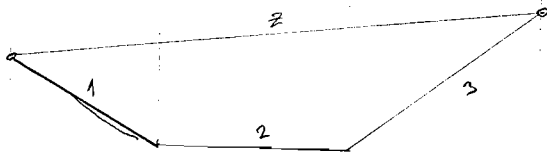
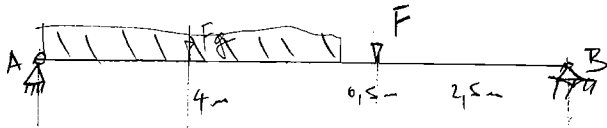
$$q = 0,8 \frac{\text{kN}}{\text{m}}$$

grafikli:

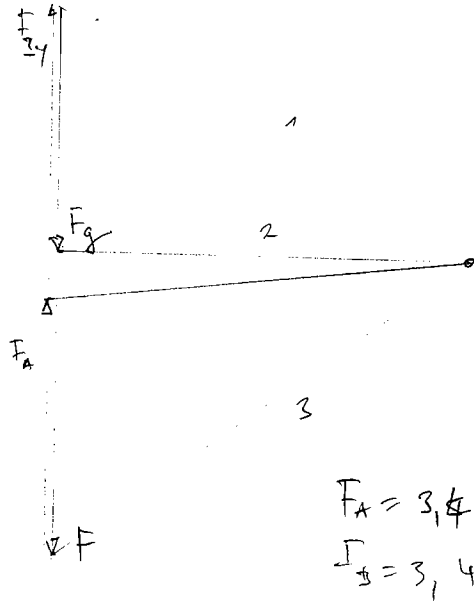
$$F_q = q \cdot 4 = 3,2 \text{ kN}$$



grafisch:



$$F = 4 \text{ kN}$$
$$F_q = 3,2 \text{ kN}$$



$$F_A = 3,4$$
$$F_B = 3,4$$

analytisch:

$$\sum F_x = 0$$

$$\sum F_y = 0$$

$$F_{Bx} = 0$$

$$F_A + F_{By} - q \cdot 4 - F = 0$$

$$F_A + F_{By} = 7,2$$

$$\sum M_A = 0$$

$$-q \cdot 4 \cdot 2 - F \cdot 4,5 + 7 \cdot F_{By} = 0$$

$$-6,4 - 18 + 7F_{By} = 0$$

$$F_{By} = 3,49 \text{ kN}$$

$$F_A = 3,71 \text{ kN}$$

12

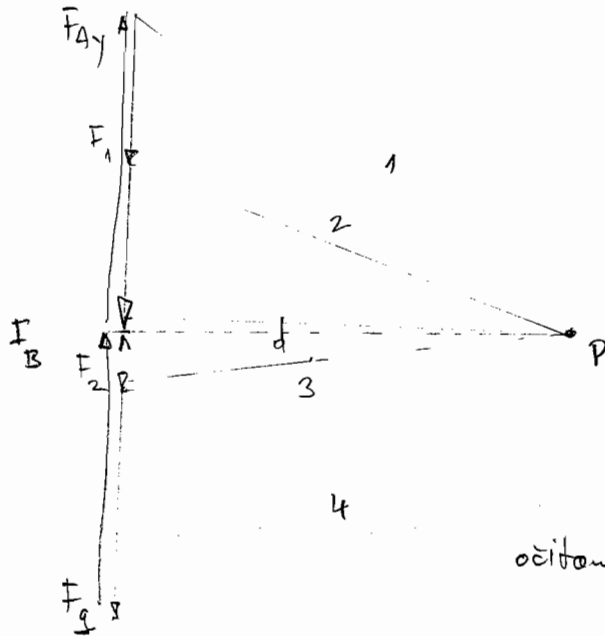
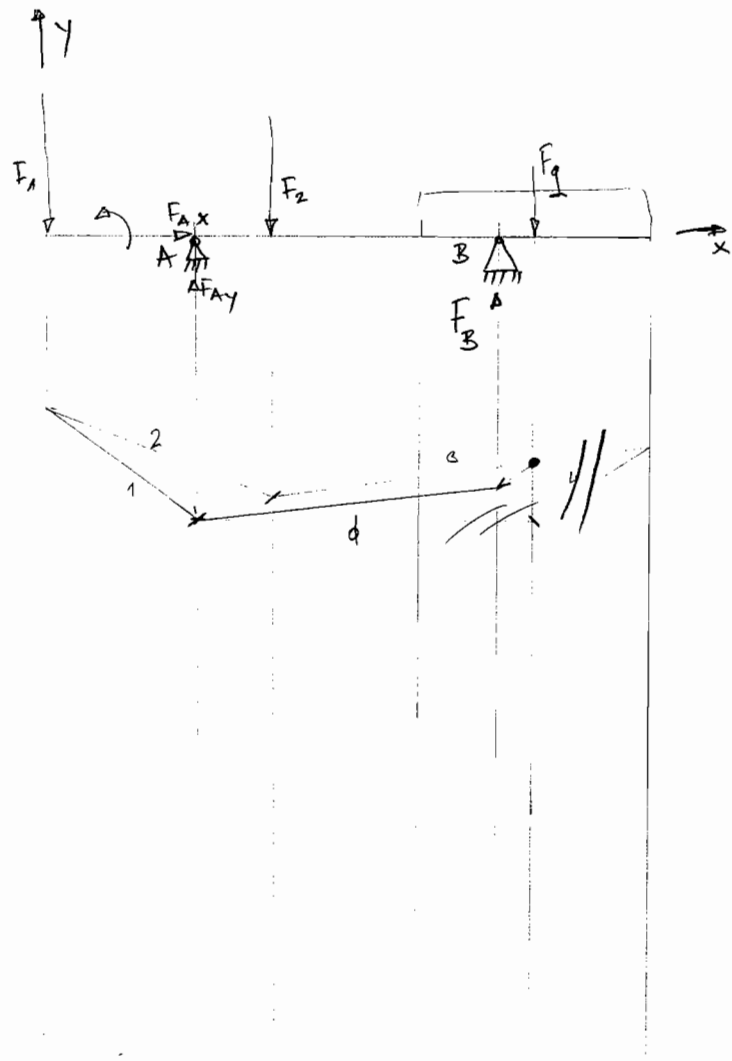
$$F_1 = 2 \text{ kN}$$

$$F_2 = 3 \text{ kN}$$

$$g = 1 \frac{\text{kN}}{\text{m}}$$

$$F_g = 1,8 = 3 \text{ kN}$$

$$M_F = 1 \text{ kN} \hat{=} 1 \text{ cm}$$



ocitano : $d = 4,5 \text{ cm} \quad 4 \text{ cm}$

$$F_{Ay} = 4,8 \text{ kN} \quad 4,9 \text{ kN}$$

$$F_B = 3,1 \text{ kN} \quad 3,1 \text{ kN}$$

$$\sum F_x = 0$$

$$F_{Ax} = 0$$

$$\sum F_y = 0$$

$$-F_1 + F_{Ay} - F_2 + F_B - F_g = 0$$

$$-2 + F_{Ay} - 3 - F_B - 3 = 0$$

$$F_{Ay} + F_B = 8$$

$$\sum M_A = 0$$

$$2F_1 - F_2 + 4F_B - 4,5F_g = 0$$

$$1 + 4F_B - 13,5 = 0$$

$$F_B = 3,125 \text{ kN}$$

$$F_A = 4,875 \text{ kN}$$

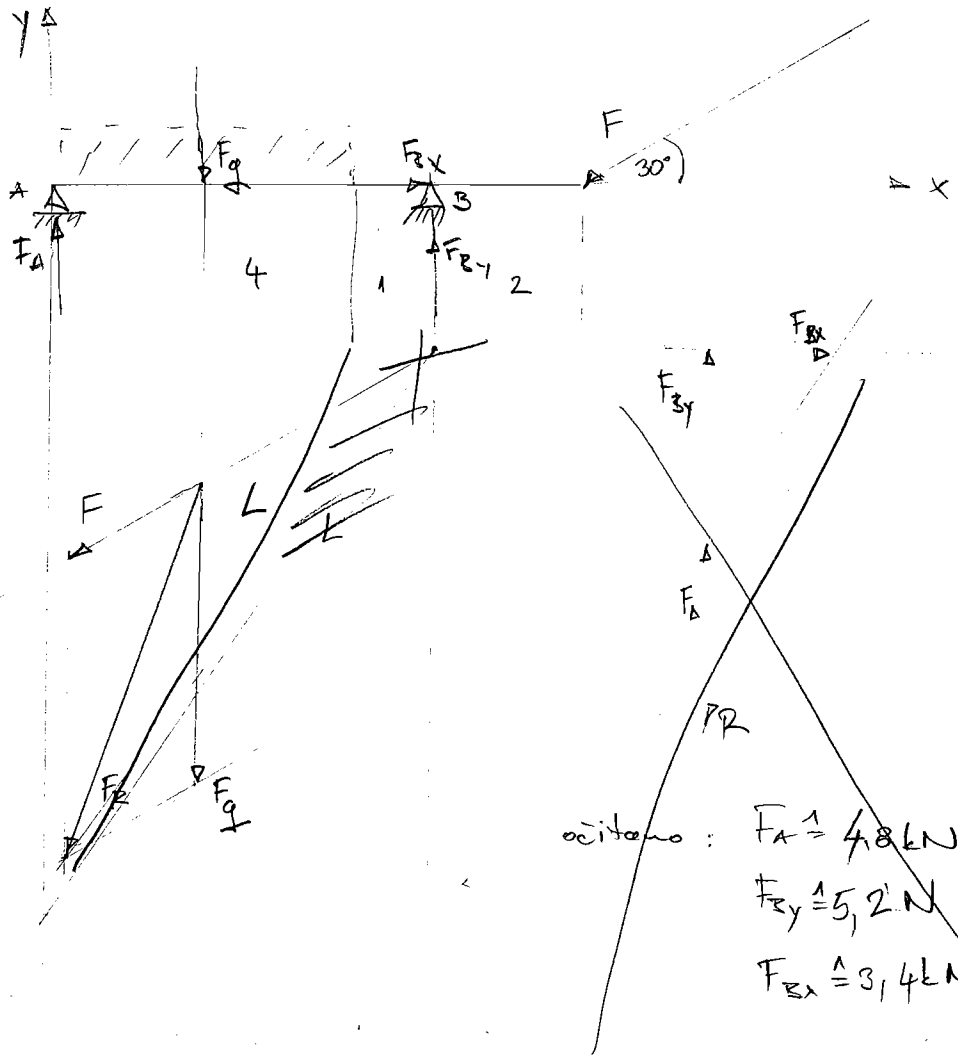
13

$$l = 2 \frac{\text{kN}}{\text{m}}$$

$$F = 4 \text{ kN}$$

$$F_g = 8 \text{ kN}$$

$$M_A = 2 \text{ kN} \cdot \text{m}$$



ocitano :

$$F_A = 4,8 \text{ kN}$$

$$F_{By} = 5,2 \text{ kN}$$

$$F_{Bx} = 3,4 \text{ kN}$$

$$\sum F_x = 0$$

$$F_{Bx} - F \cdot \cos 30^\circ = 0$$

$$F_{Bx} = 3,464 \text{ kN}$$

$$\sum F_y = 0$$

$$F_A - F_g + F_{By} - F \sin 30^\circ = 0$$

$$F_A - 8 + F_{By} - 2 = 0$$

$$-F_g \cdot 2 + F_{By} \cdot 5 - F \sin 30^\circ \cdot 7 = 0$$

$$F_A + F_{By} = 10$$

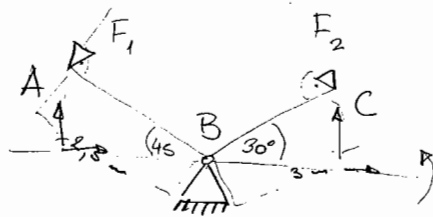
$$5F_{By} - 16 - 14 = 0$$

$$F_{By} = 6$$

$$F_A = 4 \text{ kN}$$

$$F_1 = 100 \text{ N}$$

$$F_2 = ?$$



$$\sum F_x = 0$$

$$\sum M_B = 0$$

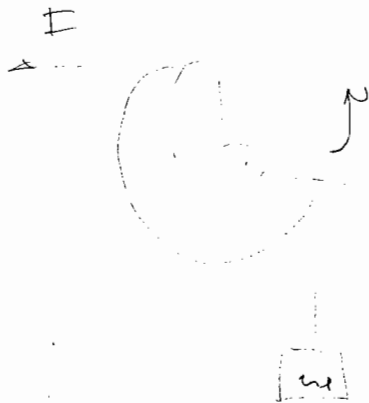
$$F_1 \cos 45 - F_2 \cos 30 = 0$$

$$F_1 \cos 45 \cdot 2,5 + F_1 \sin 45 \cdot 2,5 + F_2 \sin 30 \cdot 3 + F_2 \cos 30 \cdot 0 = 0$$

$$F_2 = -81,65 \text{ N}$$

$$176,776 + 176,776 + 1,5F_2 + 2,6F_2 = 0$$

$$F_2 = -86,227 \text{ N}$$



$$F = 50 \text{ N}$$

$$N = ?$$

$$m = 10 \text{ kg}$$

$$\alpha = 90^\circ$$



$$F_w = 10 \cdot 9,81 = 98,1 \text{ N}$$

$$F = F_w \cdot e^{N \cdot \alpha}$$

$$C_u \frac{F}{F_w} = \mu \cdot \alpha$$

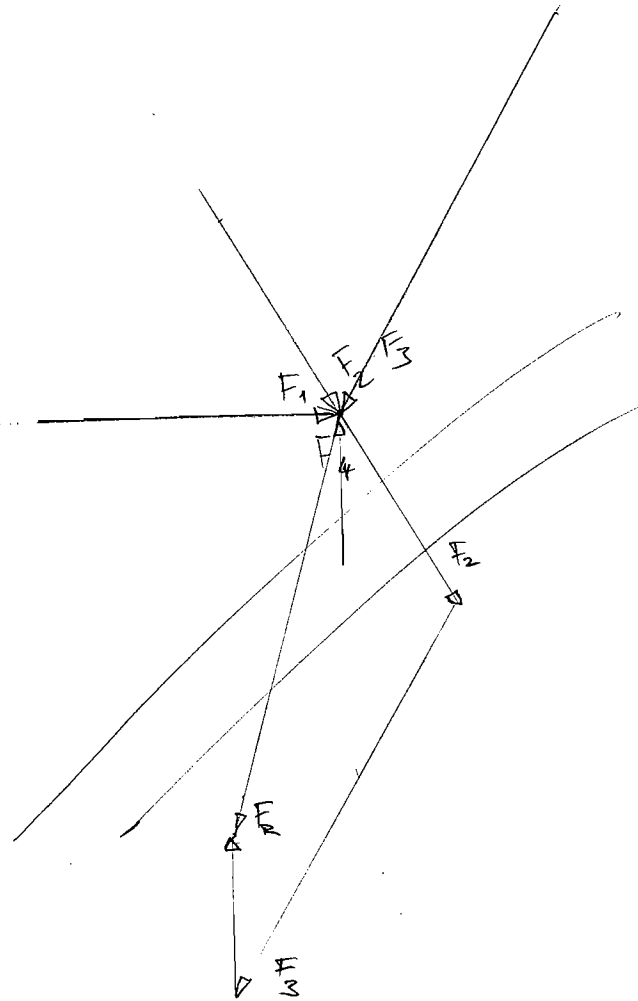
$$50 = 98,1 \cdot 2,71^{N \cdot 30}$$

$$N = -7,488 \cdot 10^{-3}$$

$$0,007488 \text{ ?}$$

D) $M_F: 1 \text{ kN} \hat{=} 1 \text{ cm}$

150
106
189



öcütano:

$F_R \hat{=} 5,8 \text{ kN}$

$\alpha_R \hat{=} 186^\circ$

analitik:

~~F_{Rx}~~ $F_1 \cdot \cos 50 + F_2 \cdot \cos 60 + F_3 \cdot \cos 120 + F_4 \cdot \cos 270 =$
 $= 4 + 1,5 - 3 + 0 = 2,5$

~~F_{Ry}~~

~~$F_1 \cdot \cos 50$~~ $F_1 \cdot \sin 0 + F_2 \cdot \sin 60 + F_3 \cdot \sin 120 + F_4 \cdot \sin 270 =$
 $= 0 + 2,598 + 5,196 - 2 =$
 $= 5,794$

$F_R = \sqrt{F_x^2 + F_y^2} = \underline{6,31 \text{ kN}}$



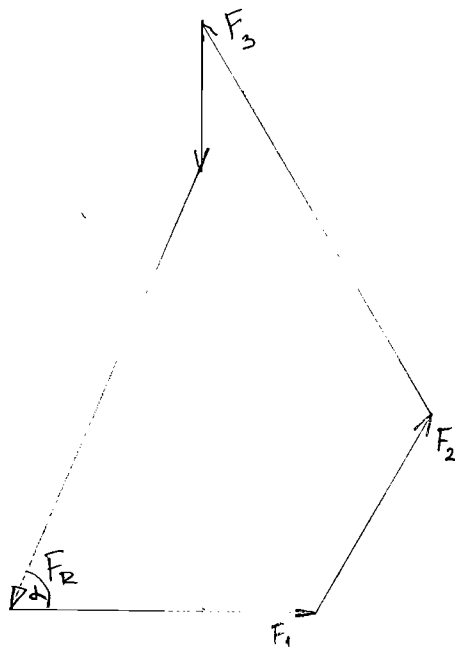
$\cos \alpha = \frac{F_x}{F_R} = \frac{2,5}{6,31} \Rightarrow \alpha = \underline{66,66^\circ}$

$$F_1 = 4 \text{ kN} \quad \alpha_1 = 0^\circ$$

$$F_2 = 3 \text{ kN} \quad \alpha_2 = 60^\circ$$

$$F_3 = 6 \text{ kN} \quad \alpha_3 = 120^\circ$$

$$F_4 = 2 \text{ kN} \quad \alpha_4 = 270^\circ$$



graficki $M_F = 1 \text{ kN} \cdot 1 \text{ cm}$
 očitavamo $F_R = 6,3 \text{ kN}$
 $\alpha_R = 67^\circ$

② $Q_x = ?$
 $M_x = ?$

$$\sum X = 0$$

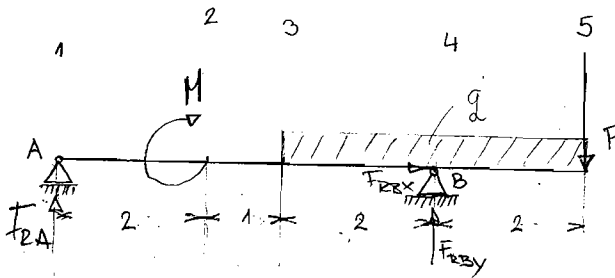
$$F_{R2X} = 0!$$

$$\sum Y = 0$$

$$F_{RA} + F_{R2Y} - F = 0$$

$$F_{RA} + F_{R2Y} = 2gl$$

$$\sum M_A = 0$$



$$l$$

$$q$$

$$F = 2gl$$

$$M = ql^2$$

$$M_1 = 0$$

$$M_2^L = F_{RA} \cdot 2 - M = F_{RA} \cdot 2 - ql^2$$

$$-M + F_{R2Y} \cdot 5 - q \cdot 4 \cdot 5$$

$$-7F = 0$$

$$ql^2 + (2gl - F_{RA}) \cdot 5 -$$

$$-q \cdot 20 - 7 \cdot 2gl = 0$$

$$ql^2 + 10gl - 5F_{RA} - 20q$$

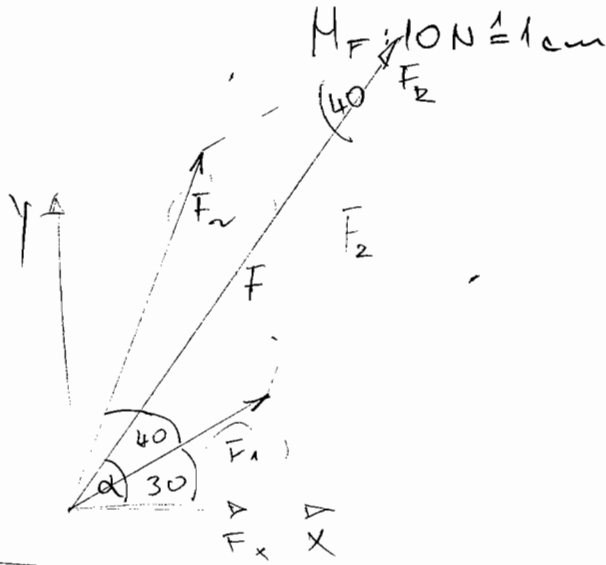
$$-14gl = 0$$

$$-5F_{RA} = 4gl + 20q - ql^2$$

$$F_{RA} = \frac{ql^2}{5} - \frac{4}{5}gl - 4q$$

$$F_{RA,12} = \frac{4}{5} \pm \sqrt{\frac{16q^2}{25} + \frac{16q^2l^2}{5}} = \frac{4}{5} \pm \sqrt{\frac{96q^2l^2}{25}}$$

① $F_1 = 30 \text{ N}$
 $F_2 = 50 \text{ N}$



grafički očitano:
 $F_2 \hat{=} 70 \text{ kN}$
 $\alpha \hat{=} 55^\circ$

$$F_y = F_1 \cdot \sin 30 + F_2 \cdot \sin 70 = 64,98$$

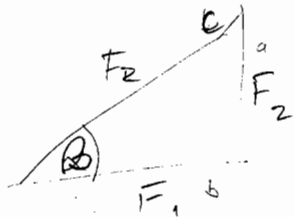
$$F_x = F_1 \cdot \cos 30 + F_2 \cdot \cos 70 = 43,08$$

$$F_2 = \sqrt{F_x^2 + F_y^2} = 75,48$$

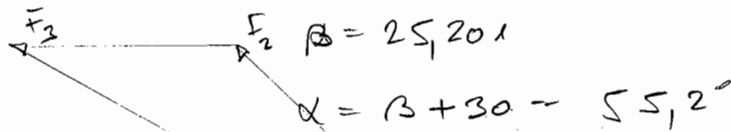
$$\text{tg } \alpha = \frac{F_y}{F_x} \Rightarrow \alpha = 55,19^\circ$$

analitički

$$F_2 = \sqrt{F_1^2 + F_2^2 + 2 F_1 F_2 \cdot \cos 40} = \sqrt{900 + 2500 + 2298} = 75,485 \text{ kN}$$



$$\cos \alpha = \frac{F_1^2 + F_2^2 - F^2}{2 \cdot F_2 \cdot F_1} = \frac{4097,98}{60 \cdot 50} = 0,9048$$



② $M_F = 1 \text{ kN} \hat{=} 1 \text{ cm}$
 očitano
 $F_2 \hat{=} 4,2 \text{ kN}$
 $\alpha \hat{=} 81^\circ$

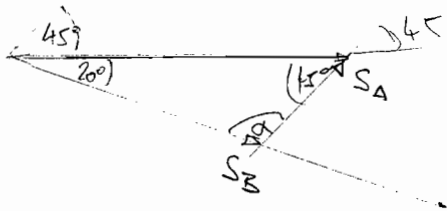


$$F_x = F_1 \cdot \cos 60 + F_2 \cdot \cos 135 + F_3 \cdot \cos 180 + F_4 \cdot \cos 330 = 2 + (-3,535) + (-3) + 5,196 = 0,661 \text{ kN}$$

$$F_y = F_1 \cdot \sin 60 + F_2 \cdot \sin 135 + F_3 \cdot \sin 180 + F_4 \cdot \sin 330 = 3,464 + 3,535 + 0 - 3 = 4 \text{ kN}$$

$$F_2 = \sqrt{F_x^2 + F_y^2} = 4,055 \text{ kN}$$

$$\text{tg } \alpha = \frac{F_y}{F_x} \Rightarrow \alpha = 80,616^\circ$$



$$M_F: 100 \text{ kN} \hat{=} 1 \text{ cm}$$

graf. očitano:

$$S_B \hat{=} 350 \text{ kN}$$

$$S_A \hat{=} 170 \text{ kN}$$

$$\alpha = 115^\circ$$

analitički:

$$F_x = S_A \cos 45 + S_B \cos 20$$

$$F_y = S_A \sin 45 + S_B \sin 20$$

$$F_R^2 = (S_A \cos 45 + S_B \cos 20)^2 + (S_A \sin 45 + S_B \sin 20)^2 = ? \text{ 1200}$$

$$= (S_A \cos 45)^2 + 2S_A \cos 45 S_B \cos 20 + (S_B \cos 20)^2 + (S_A \sin 45)^2 + 2S_A \sin 45 S_B \sin 20 + (S_B \sin 20)^2$$

=

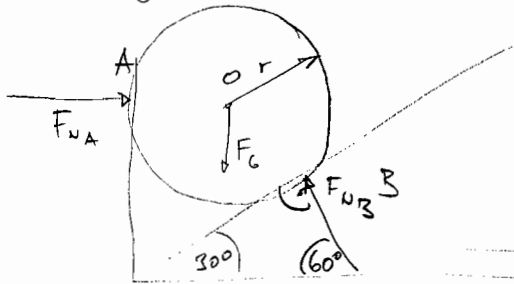
$$\frac{S_A}{S_B} = \frac{\sin 20^\circ}{\sin 45^\circ}$$

$$\frac{S_B}{F_R} = \frac{\sin 45^\circ}{\sin \alpha}$$

$$S_A = \underline{\underline{169,818 \text{ kN}}}$$

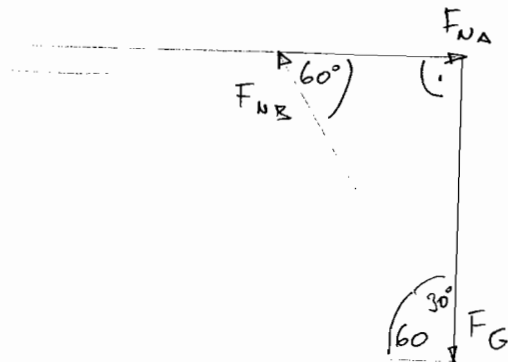
$$S_B = \underline{\underline{351,09 \text{ kN}}}$$

$$\textcircled{E} F_G = 40 \text{ N}$$



$$M_F: 10 \text{ N} \hat{=} 1 \text{ cm}$$

$$F_G = 40 \text{ N}$$



očitano:

$$F_{NB} \hat{=} 47 \text{ kN}$$

$$F_{NA} \hat{=} \underline{\underline{24 \text{ kN}}}$$

$$\sum F_x = 0$$

$$F_{NA} + F_{NB} \cos 60^\circ = 0$$

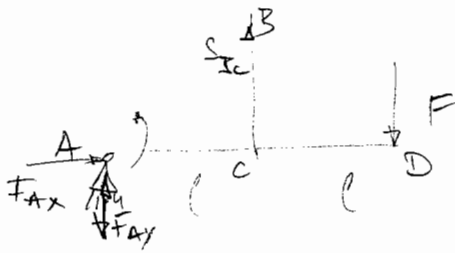
$$\sum F_y = 0$$

$$-F_G + F_{NB} \sin 60^\circ = 0$$

$$F_{NB} = \frac{F_G}{\sin 60^\circ} = \frac{40}{0,866} = \underline{\underline{46,188 \text{ kN}}}$$

$$F_{NA} = \underline{\underline{23,09 \text{ kN}}}$$

③



$$F = 350 \text{ N}$$

$$M_F: 100 \text{ N} \hat{=} 1 \text{ cm}$$

$$F_A = ?$$

$$S_{BC} = ?$$

$$\sum F_x = 0$$

$$F_{Ax} = 0$$

$$\sum F_y = 0$$

$$F_{Ay} + S_{BC} - F = 0$$

$$\boxed{F_{Ay} + S_{BC} = 350}$$

$$\sum M_A = 0$$

$$S_{BC} \cdot l - 2l \cdot F = 0$$

$$S_{BC} = 2F = \underline{\underline{700 \text{ N}}}$$

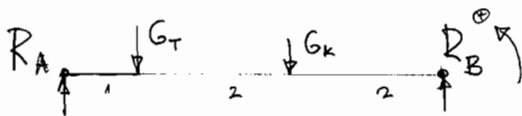
$$F_{Ay} = 350 - 700 = \underline{\underline{-350 \text{ N}}} \quad F_{Ay} \text{ deluje prema dolje}$$

$$F_A = \sqrt{F_{Ax}^2 + F_{Ay}^2} = \underline{\underline{350 \text{ N}}}$$

$$m_k = 2400 \text{ kg} \quad m_t = 1200 \text{ kg}$$

$$G_k = 23544 \text{ N}$$

$$G_t = 11772 \text{ N}$$



$$\sum F_y = 0$$

$$R_A - G_T - G_k + R_B = 0$$

$$R_A + R_B = 35316$$

$$\boxed{R_A = 18835,2 \text{ N}}$$

$$\sum M_A = 0$$

$$-G_T \cdot 1 - 3G_k + 5R_B = 0$$

$$R_B = \frac{11772 + 3 \cdot 23544}{5} = \underline{\underline{16480,8 \text{ N}}}$$

$$M_F = 20 \text{ N} \hat{=} 1 \text{ cm}$$

$$d = 3 \text{ m}$$

$$F_G = 80 \text{ N}$$

$$F_A, F_C = ?$$

oština (Culmanova metoda)

$$F_{Ax} = 24 \text{ N}$$

$$F_{Ay} = 42 \text{ N}$$

$$F_C = 44 \text{ N}$$

$$F_A = 46 \text{ N}$$

$$\sum F_x = 0$$

$$F_{Ax} + F_C \cdot \cos 120 = 0$$

$$F_{Ax} = \frac{F_C}{2}$$

$$\sum F_y = 0$$

$$F_{Ay} - F_G + F_C \cdot \sin 120 = 0$$

$$F_{Ay} - 80 + F_C \cdot 0,866 = 0$$

$$F_{Ay} = 80 - F_C \cdot 0,866$$

$$\sum M_A = 0$$

$$-1,3 F_G + 2 \cdot F_C = 0$$

$$F_C = 55 \text{ N}$$

$$\cos 30 = \frac{s}{1,5}$$

$$\cos 30 = \frac{2}{k}$$

$$s = 1,3 \text{ m}$$

$$k = \frac{2}{\cos 30} =$$

$$F_{Ay} = 34,97 \text{ N}$$

$$k = 2,309 \text{ km}$$

$$F_{Ax} = 27,5 \text{ N}$$

$$F_A = \sqrt{F_{Ax}^2 + F_{Ay}^2} =$$

$$= 44,48 \text{ N}$$

NIJE DOBRO!

$$\sum M_A = 0$$

$$F_C \cdot k - s \cdot F_G = 0$$

$$F_C = \frac{s \cdot F_G}{k} = 45,041 \text{ N}$$

$$F_{Ay} = 40,994$$

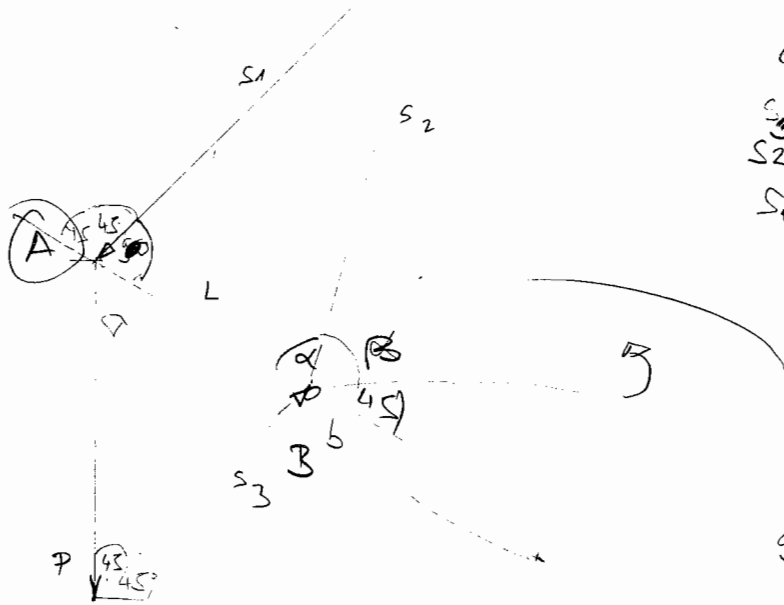
$$F_{Ax} = 22,520 \text{ N}$$

$$F_A = 46,77 \text{ N}$$

① $P = 9 \text{ kN}$

$M_P = 2 \text{ kN} \hat{=} 1 \text{ cm}$

$P \hat{=} \hat{A}, 5 \text{ cm}$



o e d a n o

$S_3 = 8 \text{ kN}$
 $S_2 = 6,3 \cdot 2 = 12,6 \text{ kN}$
 $S_1 = 6,3 \cdot 2 = 12,6 \text{ kN}$

$S_3 =$

$\sum F_x = 0$

$\cos 45 \cdot S_3 + S_1 \cdot \cos 45 + S_2 \cdot \cos \beta = 0$

$S_3 \cdot \frac{\sqrt{2}}{2} + S_1 \cdot \frac{\sqrt{2}}{2} + S_2 \cdot 0,253 = 0$

$a = \sqrt{1,6^2 + 1,6^2} = \underline{\underline{2,2627 \text{ m}}}$

$b = 5,463 \text{ m}$

$d = b = \underline{\underline{5,463 \text{ m}}}$

$\sum F_y = 0$

$-P - S_1 \cdot \sin 45^\circ + S_3 \sin 45 + S_2 \sin \beta = 0$

$-9 - \frac{\sqrt{2}}{2} S_1 + S_3 \frac{\sqrt{2}}{2} + S_2 \cdot 0,967 = 0$

$\text{tg } \alpha = \frac{d}{3,2} \rightarrow \alpha = \underline{\underline{59,54^\circ}}$

$\beta = 180^\circ - \alpha - 45^\circ = 75,36^\circ$

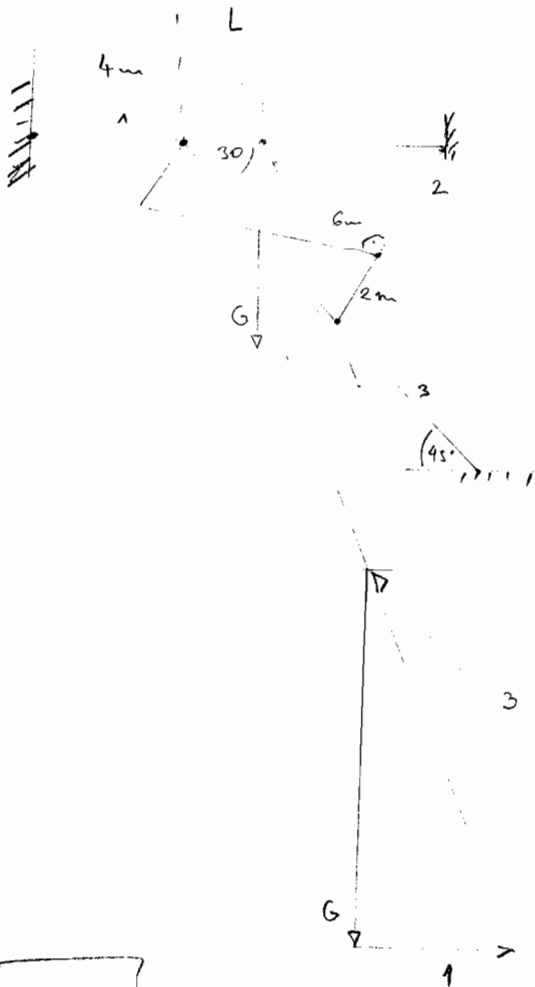
$\sum M_B = 0$

$P \cdot \cos 45^\circ \cdot 4 + S_1 \cdot 3,2 = 0$

$S_1 = -7,954 \text{ kN}$

$$M_F: 1 \text{ cm} \stackrel{1}{=} 2 \text{ kN}$$

$$G = 10 \text{ kN}$$



$$S_3 = 9 \text{ kN}$$

$$S_2 = 4 \text{ kN}$$

$$S_1 = 4 \text{ kN}$$

22 b

$$F_2 = ? \quad R_{Bx}, R_{By} = ? \quad F_1 = 4 \text{ kN}$$

$$\sum F_x = 0$$

$$R_{Bx} - F_2 \cdot \cos 60^\circ = 0$$

$$R_{Bx} = F_2 \cdot \cos 60^\circ$$

RAVNOTEĚA

$$\sum M_B = 0$$

$$\sum F_y = 0$$

$$-F_1 + R_{By} - F_2 \cdot \sin 60^\circ = 0$$

$$-4 + R_{By} - F_2 \cdot \sin 60^\circ = 0$$

$$R_{By} = F_2 \cdot \sin 60^\circ + 4$$

$$+3F_1 - 4 \cdot F_2 \sin 60^\circ - F_2 \cdot \cos 60^\circ \cdot k = 0$$

$$12 - 3,464 F_2 - 0,5775 F_2 = 0$$

$$F_2 = 2,969 \text{ kN}$$

$$F = 5 \text{ kN} \quad q = 0,6 \frac{\text{kN}}{\text{m}}$$

$$F_q = q \cdot 4 = \underline{2,4 \text{ kN}}$$

$$\sum F_x = 0$$

$$\sum F_y = F_{Ay} - F_q + F_D = 0$$

$$F - F_{Ax} = 0$$

$$\underline{F_{Ay} + F_D = 2,4}$$

$$\underline{F_{Ax} = 5 \text{ kN}}$$

$$\sum M_A = 0$$

$$\boxed{F_{Ay} = -1,7 \text{ kN}}$$

$$F_D \cdot 6 - \underbrace{q \cdot 4 \cdot 4}_{9,6} - \underbrace{F \cdot 3}_{15} = 0$$

$$\boxed{F_D = 4,1 \text{ kN}}$$

$$\sum M_B = 0$$

$$\sum F_{x_B} = 0$$

$$\sum F_{y_B} = 0$$

$$M_B + \overset{15}{F \cdot 3} - \overset{30}{F_{Ax} \cdot 6} = 0$$

$$F + F_{Bx} - F_{Ax} = 0$$

$$F_{By} + F_{Ay} = 0$$

$$\boxed{M_B = 15 \text{ kN}}$$

$$\underline{F_{Bx} = 0}$$

$$\underline{F_{By} = 1,7 \text{ kN}}$$

$$\sum M_C = 0$$

$$\sum F_{x_C} = 0$$

$$\sum F_{y_C} = 0$$

$$M_C = 0$$

$$-F_{Cx} = 0$$

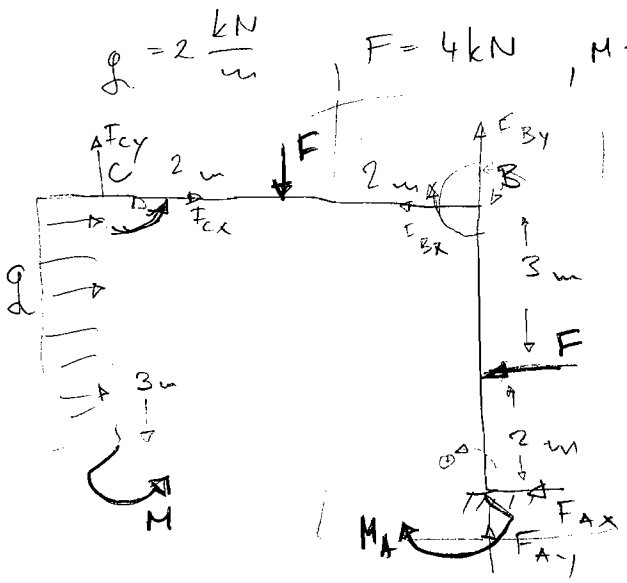
$$F_{Cy} + F_D = 0$$

$$I_{Cv} = 0$$

nemo nisi jedne druge site!

$$\boxed{F_{Cy} = -4,1}$$

20



$F_{Ax}, F_{Ay}, M_B, M_C = ?$

$\sum F_x = 0$

$q \cdot 3 - F - F_{Ax} = 0$

$F_{Ax} = 2 \text{ kN}$

$\sum F_y = 0$

$-F + F_{Ay} = 0$

$F_{Ay} = 4 \text{ kN}$

$\sum M_A = 0$

$-M_A + M - q \cdot 3 \cdot 3,5 + 2F + 2F = 0$

$-M_A + 10 - 21 + 8 + 8 = 0$

$M_A = 5 \text{ kNm}$

$\sum M_B = 0$

~~$-M_B - F \cdot 3 + M_A + 5F_{Ax} = 0$~~

$-M_B - F \cdot 3 - 5F_{Ax} - M_A = 0$

~~$-M_B = -2$~~

$M_B = -27 \text{ kNm}$

~~$M_B = 2 \text{ kNm}$~~

$\sum F_{xB} = 0$

$\sum F_{yB} = 0$

$-F_{Bx} - F - F_{Ax} = 0$

$F_{By} + F_{Ay} = 0$

$-F_{Bx} = 6$

$F_{By} = -4 \text{ kN}$

$F_{Bx} = -6 \text{ kN}$

$M_B - 3F - 5F_{Ax} - M_A = 0$

$M_B =$

1570!

$$F_g = g \cdot 3 = \underline{6kN}$$

$$\underline{\sum M_c = 0}$$

$$M_c + M + g \cdot 3 \cdot 1,5 = 0$$

$$\underline{M_c = -19,5 \text{ kNm}}$$

$$\underline{\sum F_{cx} = 0}$$

$$F_{cx} + F_g = 0$$

$$\underline{F_{cx} = -6kN}$$

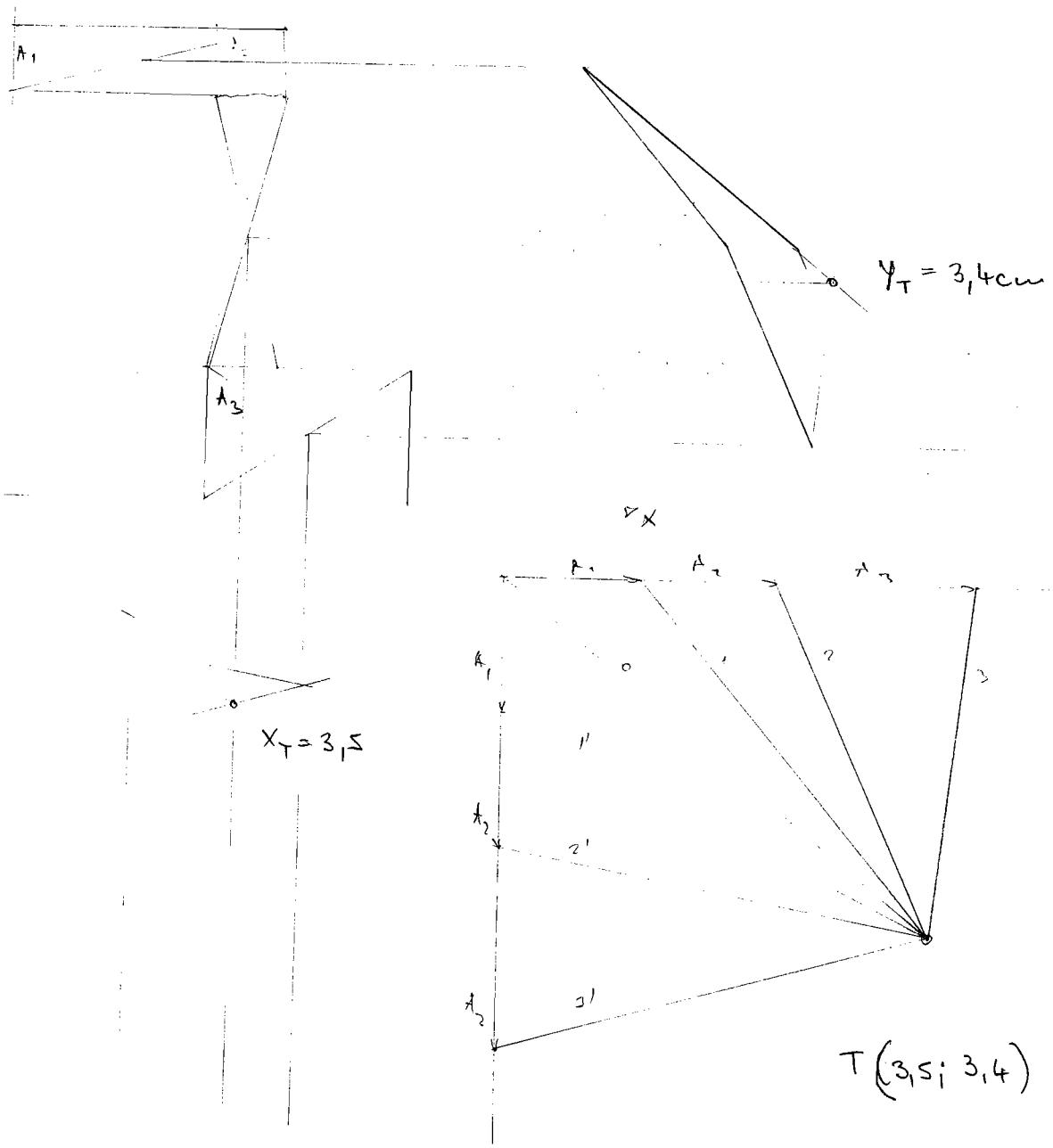
$$\underline{\sum F_{yc} = 0}$$

$$\underline{F_{cy} = 0}$$

(21)

y_x

$$A_1 = 4 \text{ cm}^2, A_2 = 4 \text{ cm}^2$$



$$x_T = \frac{2 \cdot 4 + 3,5 \cdot 4 + 4,5 \cdot 6}{4 + 4 + 6} = \frac{8 + 14 + 27}{14} = \underline{\underline{3,5 \text{ cm}}}$$

$$y_T = \frac{0,5 \cdot 4 + 4 \cdot 4 + 6}{4 + 4 + 6} = \underline{\underline{3,42857 \text{ cm}}}$$

$$T(3,5; 3,43)$$

24a) $F_A = ?$ $F_{Bx}, F_{By} = ?$ $F_g = 6 \cdot g = \underline{6 \text{ kN}}$

$$\sum F_x = F_A + F \cdot \cos 30 + F_{Bx} = 0$$

$$\sum F_y = 0$$

$$F_A + 10 \cdot \cos 30 + F_{Bx} = 0$$

$$-F \cdot \sin 30 - F_g + F_{By} = 0$$

$$-5 - 6 + F_{By} = 0$$

$$\textcircled{1} \quad \boxed{F_A + F_{Bx} = -8,66}$$

$$\boxed{F_{By} = 11 \text{ kN}}$$

$$\sum M_z = 0$$

~~$$F_A \cdot 6 + F \cdot \cos 30 \cdot 6 - g \cdot 6 \cdot 3 + M = 0$$~~

~~$$F_A \cdot 6 + 8,66 \cdot 6 - 18 + 20 = 0$$~~

~~$$F_A = -8,93 \text{ kN}$$~~

$$F_A \cdot 2 + F \cdot \cos 30 \cdot 8 - F \cdot \sin 30 \cdot 6 - g \cdot 6 \cdot 3 + M = 0$$

$$\underline{\underline{F_A = -20,64 \text{ kN}}}$$

$$\underline{\underline{F_{Bx} = 11,98 \text{ kN}}}$$

(22)

$$A_1 = \frac{6 \cdot 3}{2} = 9 \text{ m}^2$$

$$x_1 = 6 - \frac{6}{3} = 4 \text{ m}$$

$$y_1 = 4 + \frac{1}{3} \cdot 3 = 5 \text{ m}$$

$$A_2 = \frac{3 \cdot 6}{2} = 9 \text{ m}^2$$

$$x_2 = 1,5 + \frac{6}{3} = 3,5 \text{ m}$$

$$y_2 = 0,5 + \frac{3}{2} = 2 \text{ m}$$

$$A_3 = 4 \cdot 8 = 32 \text{ m}^2$$

$$x_3 = 4 \text{ m}$$

$$y_3 = 2 \text{ m}$$

$$x_T = \frac{x_1 A_1 + x_2 A_2 - x_3 A_3}{A_1 + A_2 - A_3} = \frac{4 \cdot 9 + 3,5 \cdot 32 - 4 \cdot 32}{9 + 9 - 32} = \underline{\underline{4,14 \text{ m}}}$$

$$y_T = \frac{y_1 A_1 + y_2 A_2 - y_3 A_3}{A_1 + A_2 - A_3} = \underline{\underline{2,844 \text{ m}}}$$

$$A_1 = 2 \cdot 2 = \underline{\underline{4 \text{ cm}^2}}$$

$$A_2 = 10 \cdot 5 = 50 \text{ cm}^2$$

$$A_3 = \frac{16\pi}{2} = \underline{\underline{8\pi \text{ cm}^2}}$$

$$x_1 = 9 \text{ cm}$$

$$y_1 = 6 \text{ cm}$$

$$x_2 = 5 \text{ cm}$$

$$y_2 = 2,5 \text{ cm}$$

$$x_3 = 4$$

$$y_3 = 5 - \frac{16}{3\pi} = \frac{15\pi - 16}{3\pi}$$

$$r = 4$$

$$P = \frac{1}{2} r^2 \pi$$

$$x_T = \dots$$

$$y_T = \dots$$

23

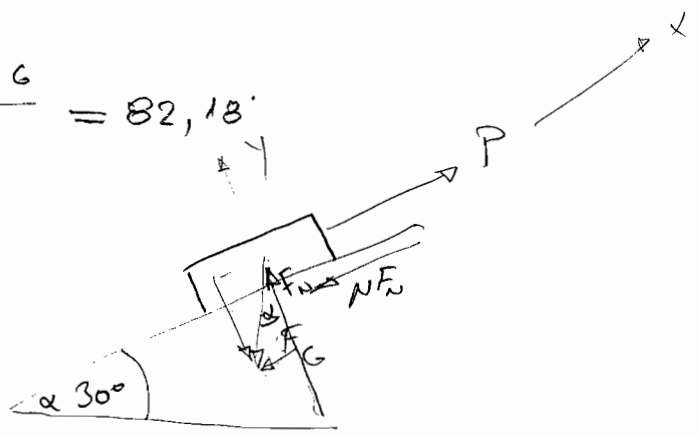
$P = ?$
 $G = 120 \text{ N}$
 $R = 40 \text{ cm} = 0,4 \text{ m}$
 $h = 7 \text{ cm} = 0,07 \text{ m}$

$x = R^2 - (R-h)^2 =$
 $= 511$
 $x = 22,6 \text{ cm} = 0,226 \text{ m}$

$\sum M_A = 0$

$P \cdot (R-h) - G \cdot x = 0$

$P_{\text{min}} = \frac{120 \cdot 0,226}{0,33} = 82,18$



24

$G = 500 \text{ N}$
 $\alpha = 30^\circ$
 $\mu = 0,4$
 $P = ?$

$\sum F_x = 0$

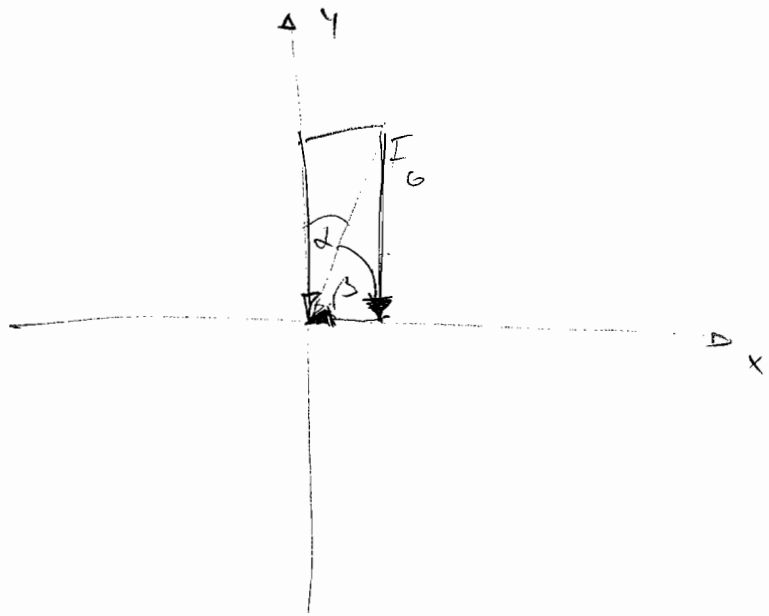
$\sum F_y = 0$

$P - F_G \sin \alpha - \mu \cdot F_N = 0$

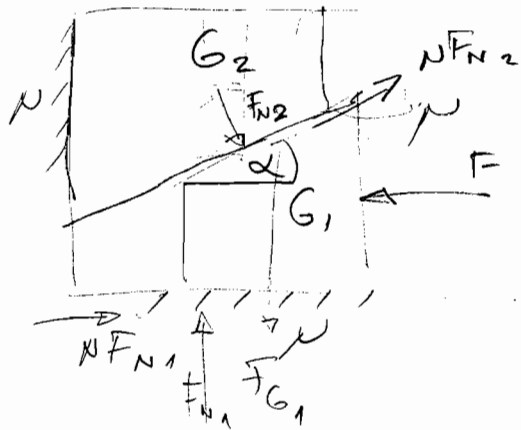
$F_N - F_G \cdot \cos 30^\circ = 0$

$P = 423,2$

$F_N = 433 \text{ N}$



25



$$\mu = 0,2$$

$$\alpha = 20^\circ$$

$$G_2 = 40\text{ N}$$

$$G_1 = 20\text{ N}$$

$$F_{\text{win}} = ?$$

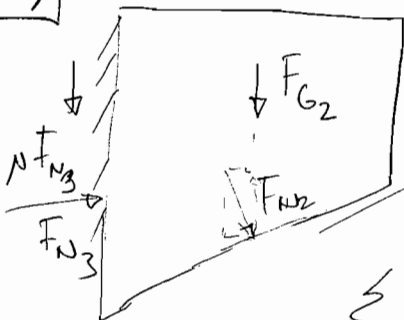


$$\sum F_x = 0$$

$$-F + \mu \cdot F_{N1} + \mu F_{N2} \cos 20^\circ + F_{N2} \cdot \cos 70^\circ = 0 \quad \checkmark$$

$$\sum F_y = 0$$

$$-F_{G1} - F_{N2} \cdot \cos 20^\circ + \mu \cdot F_{N2} \cdot \sin 70^\circ + F_{N1} = 0$$



$$\sum F_x = 0$$

$$\mu F_{N2} \quad F_{N3} \quad F_{N2} \cdot \cos 20^\circ \quad F_{N2} \cdot \sin 20^\circ = 0$$

$$\sum F_y = \mu F_{N2} - F_{G2} - \mu F_{N2} \cdot \sin 70^\circ + F_{N2} \cdot \cos 70^\circ = 0$$

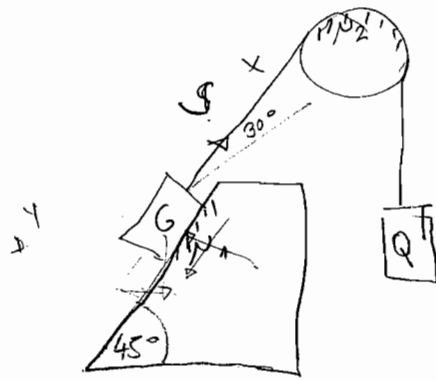
PAZITI NA SMJEROVE SILA!!!

$Q_{maks}, Q_{min} = ?$

$G = 2000 \text{ N}$

$\mu = 0,1$

$\mu = 0,2$



Q_{min}

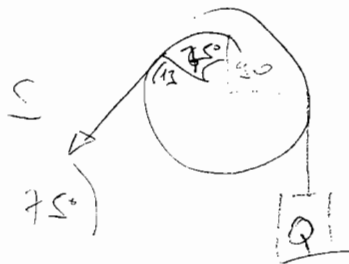
$\sum F_x = 0$

$\sum F_y = 0$

$S \cdot \cos 30^\circ + \mu F_N - G \cdot \sin 45^\circ = 0$

$G \cdot \cos 45^\circ + F_N + S \sin 30^\circ = 0$

KOTBC



$S = Q \cdot e^{\mu \alpha}$

$\alpha = 165^\circ$

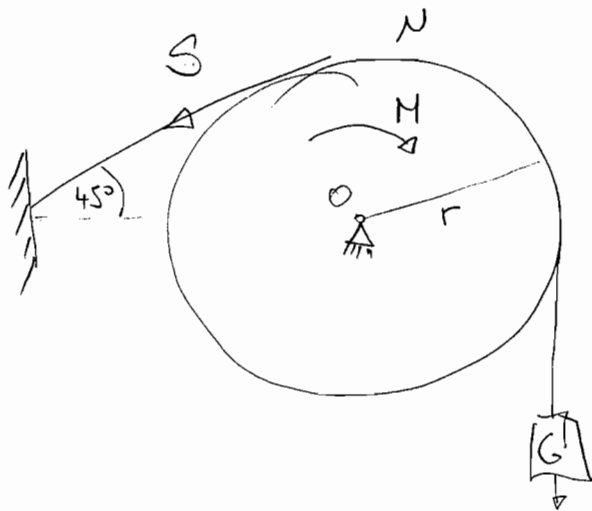
28a

$M_{min} = ?$

$\mu = 0,2$

$G = 40 \text{ N}$

$r = 0,2 \text{ m}$



$S = G \cdot e^{\mu \alpha}$

$\alpha = 135^\circ = \pi - \frac{\pi}{4} = \frac{3\pi}{4}$

$= 40 \cdot e^{0,2 \cdot \frac{3\pi}{4}} =$

64,01 N

$\sum M_o = 0$

$-S \cdot r + M + G \cdot r = 0$

$-12,81 + M + 8 = 0$

M = 4,8 Nm

209

$$F_G = 80 \text{ N}$$

$$F = 40 \text{ N}$$

$$R = 30 \text{ cm} = 0,3 \text{ m}$$

$$\alpha = 25^\circ$$

$$\sum F_x = 0$$

$$-F \cdot \cos \alpha + F_T = 0$$

$$F_T = \underline{36,25 \text{ N}}$$

$$\sum M_o = 0$$

$$F_T \cdot R - F_N \cdot x = 0$$

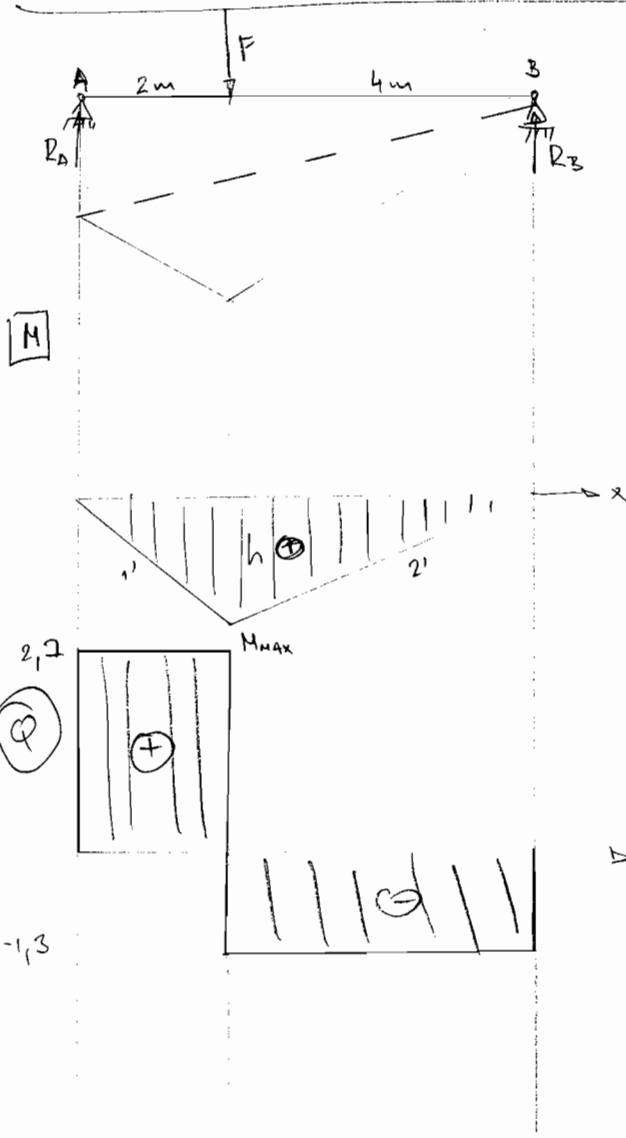
$$x = \frac{F_T \cdot R}{F_N} = \underline{0,0133 \text{ m}}$$

$$\sum F_y = 0$$

$$-F_G - F \cdot \sin \alpha + F_N = 0$$

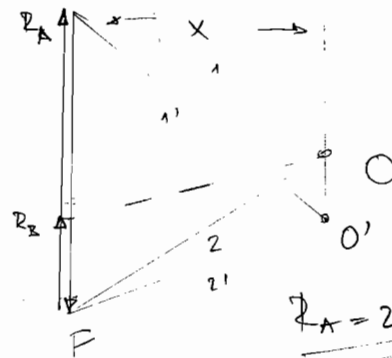
$$-800 - 40 \cdot \sin 25^\circ = -F_N$$

$$F_N = \underline{816,9 \text{ N}}$$



$$F = 4 \text{ kN}$$

$$M_F: 1 \text{ kN} \hat{=} 1 \text{ cm}$$



$$R_A = \underline{2,7 \text{ kN}}$$

$$R_B = \underline{1,3 \text{ kN}}$$

$$x = 3,35 \text{ cm}$$

$$h = 1,7 \text{ cm}$$

$$y_{max} = \underline{1,7 \text{ kN}}$$

$$M_{max} = y_{max} \cdot x = 5,695 \text{ kNm}$$

analitički

$$\sum F_y = 0$$

$$R_A - F + R_B = 0$$

$$\boxed{R_A + R_B = 4}$$

Moment savijanja

Na početku i na kraju Moment = 0!

$$M_A = 0 \quad M_B = 0$$

$$M_A^L = R_A \cdot 2 =$$

$$M_A^D = 4R_B - F \cdot 6 =$$

$$\sum M_A = 0$$

$$-2F + 6R_B = 0$$

$$R_B = 1,333 \text{ kN}$$

$$\rightarrow \underline{\underline{R_A = 2,667 \text{ kN}}}$$

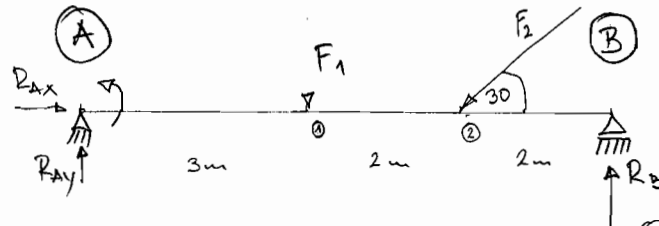
31) $F_1 = 6 \text{ kN}$, $F_2 = 8 \text{ kN}$

$M_F = 2 \text{ kN} \hat{=} 1 \text{ cm}$

$\sum F_x = 0$

$R_{Ax} - F_2 \cdot \cos 30^\circ = 0$

$R_{Ax} = 6,928 \text{ kN}$



$\sum F_y = 0$

$R_{Ay} - F_1 - F_2 \cdot \sin 30^\circ + R_B = 0$

$R_{Ay} + R_B = 10$

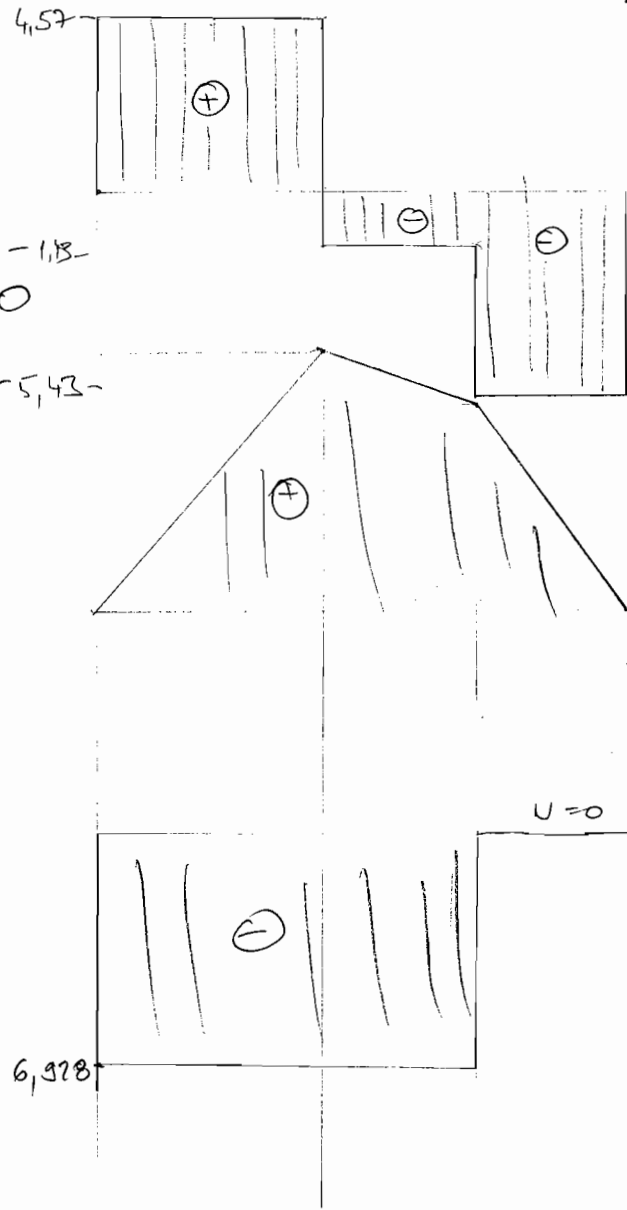
$\sum M_A = 0$

$-3F_1 - F_2 \cdot \sin 30^\circ \cdot 5 + R_B \cdot 7 = 0$

$R_B = \frac{3F_1 + F_2 \sin 30^\circ \cdot 5}{7} = -5,43$

$R_B = 5,429 \text{ kN}$

$R_{Ay} = 4,57 \text{ kN}$



$Q_A = R_{Ay}$

$Q_{A^D} = R_{Ay}$

$Q_1 = 4,57 - F_1 = -1,43 \text{ kN}$

$Q_{1^D} = R_A - F_1 = -1,43 \text{ kN}$

$Q_2 = -1,43 - F_2 \cdot \sin 30^\circ = \dots$

$Q_{2^D} = R_{Ay} - F_1 - F_2 \sin 30^\circ = \dots$

$R_B = -5,43 + R_B$

$M_A = 0 = M_B$

$M_1 = 4,57 \cdot 3 = 13,71$

$M_2 = 13,71 - 2 \cdot 1,43 = 10,85$

$U = 0$

$N_A^D = -R_{Ax} = 6,928$

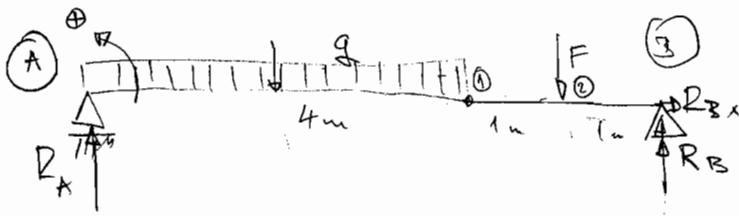
$N_x = -R_{Ax}$

$N_2^L = -R_{Ax}$

$N_2^D =$

$-6,928$

$$q = \frac{3 \text{ kN}}{\text{m}} \quad F = 3 \text{ kN}$$



$$\sum F_y = 0$$

$$R_A - F + R_B - q \cdot 4 = 0$$

$$R_A - 3 + R_B - 12 = 0$$

$$R_A + R_B = 15$$

$$\sum F_x = 0$$

$$R_{Bx} = 0$$

$$\sum M_A = 0$$

$$-q \cdot 4 \cdot 2 - F \cdot 5 + R_B \cdot 6 = 0$$

$$-24 - 15 + R_B \cdot 6 = 0$$

$$R_B = 6,5 \text{ kN}$$

$$R_A = 8,5 \text{ kN}$$

$$Q_A = R_A = 8,5$$

$$Q_1 = 8,5 - q \cdot 4 = -3,5$$

$$Q_2 = -3,5 - F = -6,5$$

$$Q_B = -6,5 - R_B = 0$$

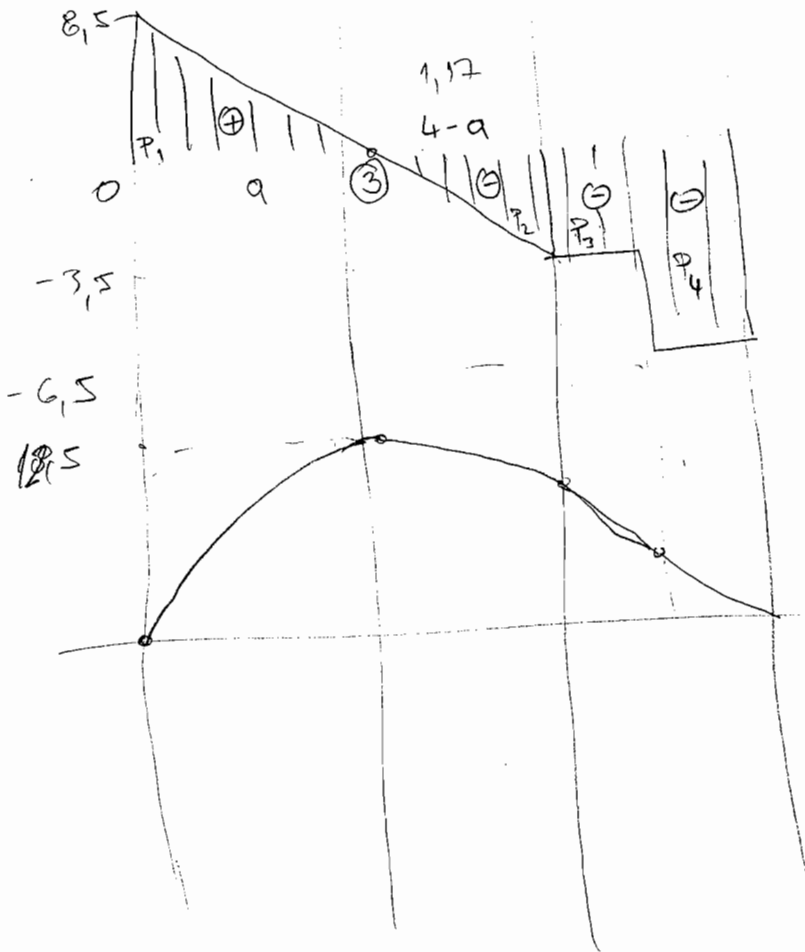
$$M_A = 0 = M_B$$

$$M_3 = P_1 = 8,5$$

$$M_4 = 8,5 - P_2 = 8,5 - 2,125 = 6,375$$

$$M_2 = 10 - 3,5 = 6,5$$

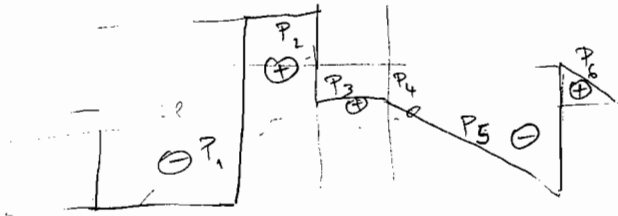
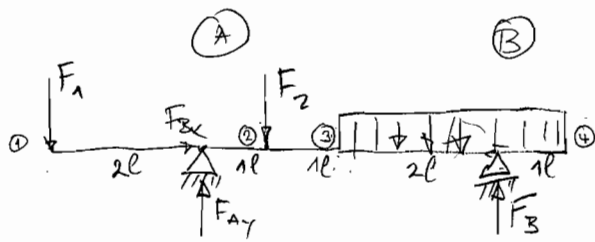
P_x



$$\frac{a}{8,5} = \frac{4-a}{3,5}$$

$$3,5a = 34 - 8,5a$$

$$12a = 34$$



$$F_1 = 2gl$$

$$F_2 = 3gl$$

$$\sum F_x = 0 \quad F_{Ay} = 5,675$$

$$F_{Bx} = 0 \quad F_B = 2,375$$

$$\sum F_y = 0$$

$$F_{Ay} + F_B - F_1 - F_2 - g \cdot 3l = 0$$

$$\sum M_A = 0$$

$$+F_1 \cdot 2l - F_2 l - g \cdot 3l \cdot 3,5l + F_B \cdot 4l = 0$$

$$Q_1 = -F_1$$

$$Q_2 = -F_1 + F_{Ay} = -2 + 5,675 = 3,6$$

$$Q_3 = 3,6 - F_2 = 0,6$$

$$Q_4^L = 0,6 - g \cdot 2l = -\frac{11}{8} = -1,375$$

$$Q_4^D = -1,375 + F_B = 0$$

$$Q_5 = gl - g \cdot l = 0$$

$$M_1 = 0 = M_4$$

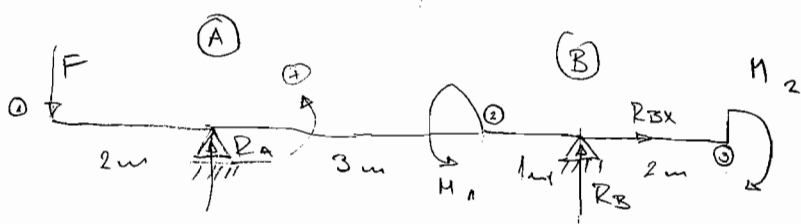
$$M_2 = 0 - F_1 \cdot l = -4gl^2$$

$$M_3 = -F_1 \cdot 2l + F_2 \cdot l = -\frac{2}{3}gl^2$$

$$M_5 =$$

34) $M_1 = 2 \text{ kNm}$, $M_2 = 3 \text{ kNm}$, $F = 1 \text{ kN}$

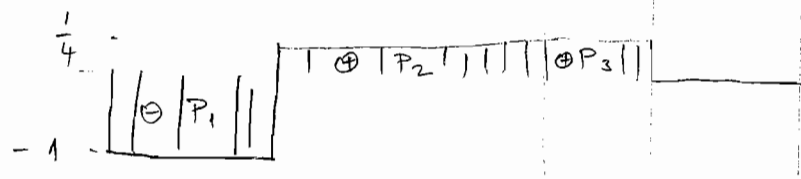
$$\begin{aligned} \sum F_x = 0 & \quad \sum F_y = 0 \\ R_{Ax} = 0 & \quad -F + R_A + R_B = 0 \\ & \quad \underline{R_A + R_B = 1} \end{aligned}$$



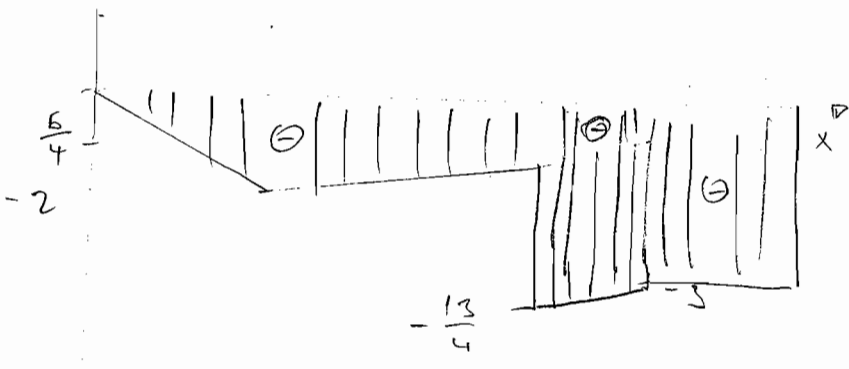
$$\begin{aligned} \sum M_A = 0 \\ +F \cdot 2 + M_1 + R_B \cdot 3 - M_2 = 0 \\ 2 + 2 + 3R_B - 3 = 0 \end{aligned}$$

$$R_B = -\frac{1}{4} \text{ kN} \quad R_A = \frac{5}{4} \text{ kN}$$

$Q_x [\text{kN}]$



$M_x [\text{kNm}]$

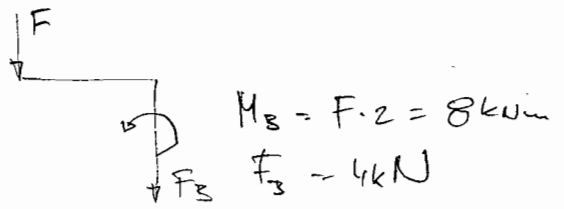
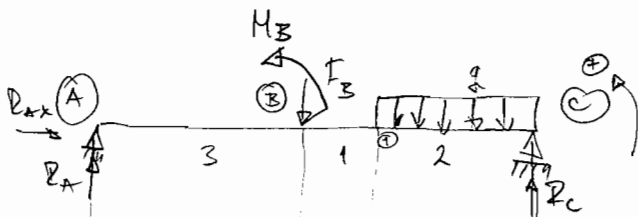


$$\begin{aligned} Q_1 &= -1 \text{ kN} \\ Q_A &= -1 \text{ kN} + R_A = \frac{1}{4} \text{ kN} \\ Q_B &= -F + R_A + R_B = 0 \\ Q_3 &= -F + R_A + R_B = 0 \end{aligned}$$

$$\begin{aligned} M_1 &= 0 \\ M_A &= 0 + P_1 = 0 - 2 = -2 \text{ kNm} \\ M_2^L &= -2 + P_2 = -\frac{5}{4} \text{ kNm} \\ M_2^D &= -\frac{5}{4} - M_1 = -\frac{13}{4} \\ M_B &= -\frac{13}{4} + P_3 = -3 \\ M_3^L &= -3 + P_4 = -3 \\ M_3^D &= -3 + M_2 = 0 \end{aligned}$$

36

$F = 4 \text{ kN}$
 $g = 2 \frac{\text{kN}}{\text{m}}$

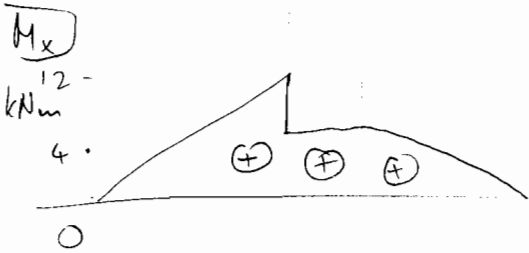
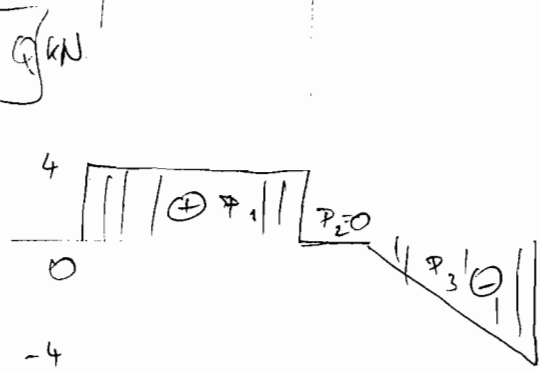


$$\sum F_x = 0 \quad \sum F_y = 0$$
$$R_{Ax} = 0 \quad R_A - F_B - g \cdot 2 + R_C = 0$$
$$\sum M_A = 0 \quad \underline{R_A + R_C = 8}$$

$$M_B - 3F_B - g \cdot 2 \cdot 5 + R_C \cdot 6 = 0$$
$$8 - 12 - 20 + 6R_C = 0$$

$R_C = 4 \text{ kN}$

$R_A = 4 \text{ kN}$



$$Q_A = R_A = 4 \text{ kN} \quad Q_B = 0$$

$$Q_B = 4 \text{ kN} - F_B = 0 \quad Q_C^L = 0 - g \cdot 2 = -4 \text{ kNm}$$

$$Q_C^D = -4 \text{ kN} + R_C = 0$$

$$M_A = 0 = M_C \quad M_B^D = 12 - M_B = 4 \text{ kNm}$$

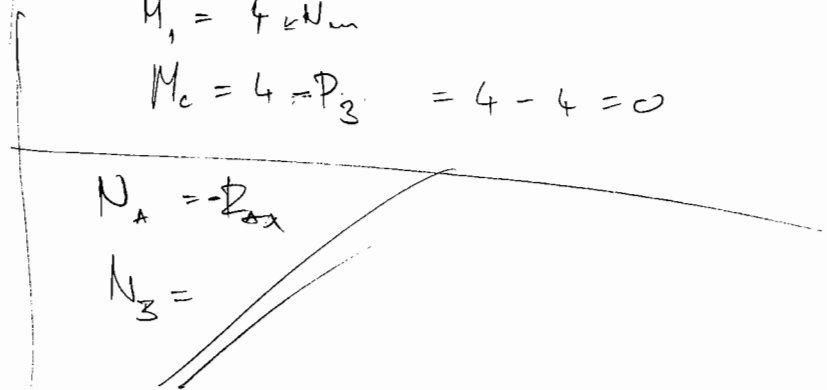
$$M_B^L = 0 + P_1 = 12 \text{ kNm}$$

$$M_1 = 4 \text{ kNm}$$

$$M_C = 4 - P_3 = 4 - 4 = 0$$

$$N_A = -R_{Ax}$$

$$N_B =$$



56)

$q = 2 \frac{kN}{m}$

$M = 16 kNm$

$F_g = 8 kN$

$\sum F_x = 0$

$R_{Ay} = 8 kN$

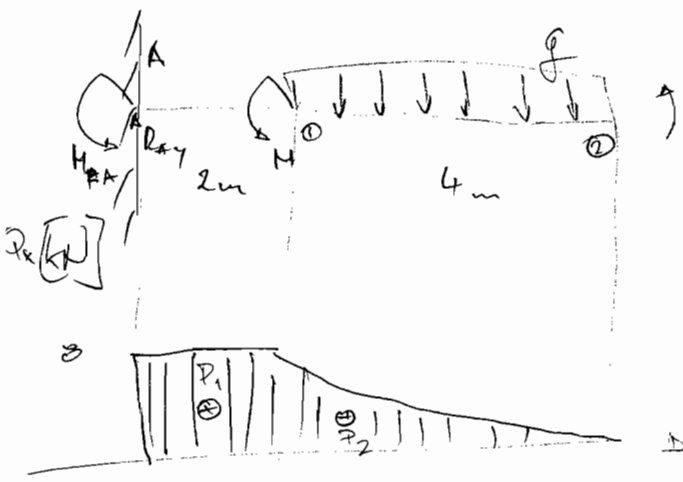
$\sum F_y = 0$

$R_{Ay} - F_g = 0$

$\sum M_A = 0$

$M_{BA} + M - q \cdot 4 \cdot 4 = 0$

$M_{BA} = 16 kNm$



Q

$Q_A = R_{Ay} = 8 kN$

$Q_1 = 8 kN$

$Q_2 = 8 - q \cdot 4 = 0$

M_x

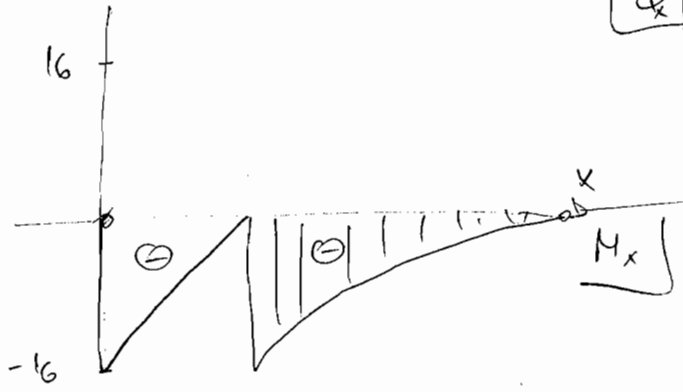
$M_A = 0 = M_2$

$M_A^D = 0 - M_{BA} = -16 kNm$

$M_1^L = -16 + P_1 = -16 + 16 = 0$

$M_A^D = 0 - M = -16 kNm$

$M_2 = -16 kNm + P_2 = -16 + \frac{4 \cdot 8}{2} = 0$



$M_1^L = F_{Ay} \cdot 2l = -2gl^2$

$M_A^D = -2gl^2 + gl^2 = -gl^2$

$M_2^D = -3gl^2 + gl^2 = -2gl^2$

$M_3^D = -5gl^2 + gl^2 - g \cdot 2l^2 = -6gl^2$

$M_3^L = -6gl^2 + F_{By} = +gl^2$

$M_3^L = -7gl^2 + (1^2)gl^2 + (4gl) \cdot 2gl^2 - F = -2gl^2$

$M_2 = 7 \cdot F_{Ay} + M - 2gl \cdot 3 + 2F_{By} - 2gl - F =$

$= -7 + 1 - 6 + 14 - 2 - 2$

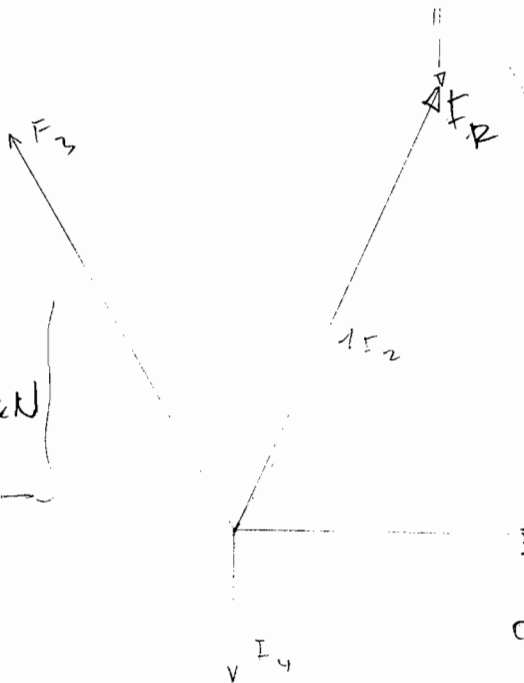
$M_1^D = 0 - P_1 = -2gl^2$

$M_1^L = -2gl^2 + gl^2 = -gl^2$

$M_2 = -gl^2 - P_2 = -2gl^2$

①

o c i t e n o
 $F_R = 6,4 \text{ kN}$
 $\alpha_R = 66^\circ$



$$F_{Rx} = F_1 \cdot \cos 0^\circ + F_2 \cdot \cos 60^\circ + F_3 \cdot \cos 120^\circ + F_4 \cdot \cos 270^\circ = 4 + 1,8 + (-3) + 0 = 2,5 \text{ kN}$$

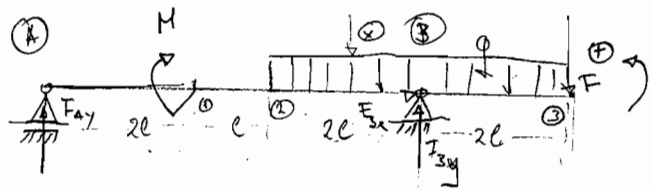
$$F_{Ry} = F_1 \cdot \sin 0^\circ + F_2 \cdot \sin 60^\circ + F_3 \cdot \sin 120^\circ + F_4 \cdot \sin 270^\circ = 0 + 2,6 + 5,2 + 2 = 9,8$$

$$F_R = \sqrt{F_{Rx}^2 + F_{Ry}^2} = \sqrt{2,5^2 + 9,8^2} = 10,16 \text{ kN}$$

$$\cos \alpha_R = \frac{F_x}{F_R} = \frac{2,5}{10,16} \Rightarrow \alpha_R = 66,68^\circ$$

②

$F = 2gl$ $M = gl^2$



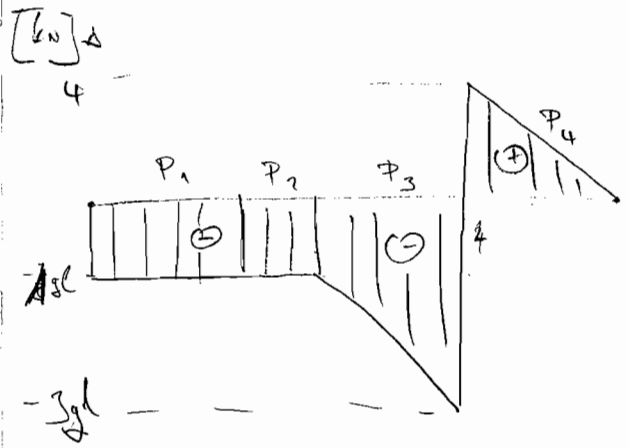
$\sum F_x = 0$ $\sum F_y = 0$ $F_g = q \cdot 4l$

$F_{Ax} = 0$
 $F_{Ay} + F_{By} - F_g - F = 0$
 $F_{Ay} + F_{By} = 4gl + 2gl = 6gl$

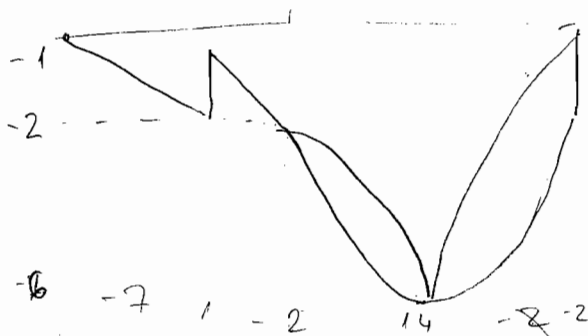
$\sum M_A = 0$
 $-M + F_{By} \cdot 5l - F \cdot 7l - F_g \cdot 5l = 0$
 $-gl^2 + F_{By} \cdot 5l - 2gl \cdot 7l - 4gl \cdot 5l = 0 \quad / : l$
 $-gl + F_{By} \cdot 5 - 14gl - 20gl = 0$

$F_{By} = 7gl$ $F_{Ay} = 6gl - 7gl = -gl$

$F_{Ax} = -gl$



$Q_A = F_{Ay} = -gl$
 $Q_1 = 4gl$ $M_A = 0 = M_0$
 $Q_2 = -gl$ $M_1 = 0 - P_1 = 2gl^2$
 $Q_3 = -3gl$ $M_2 = 2 - P_2 = -2gl^2$
 $Q_4 = -3gl + F_{By} = 4gl$ $M_3 = -2gl^2 + P_4 = -2gl^2$
 $Q_5 = 4gl - 2gl - F = 0$ $M_4 = -2gl^2 + P_4 = -2gl^2$



$M_3 = -7gl^2 + M_2 = -2gl^2 + 7.2gl^2 - 2gl^2 = 10gl^2$
 $M_4 = -2gl^2 + M = -gl^2$
 $M_5 = -6gl^2 + P_4 = -7gl^2$