RÁCSOS SZERKEZETEK

- egyenes rudakból áll
- rudak csuklókkal kapcsolódnak egymáshoz
- terhelés/megfogás csak csuklón

$\Rightarrow$ rudakban csak rúdirányú erő keletkezhet (húzás vagy nyomás)

rúderő meghatározása

1. csomóponti módszer

-> kiragadott csukló egyensúlyát vizsgáljuk

-> felírható egyenletek száma 2:

$$\left.\begin{array}{l} F_x = 0 \\ F_y = 0 \end{array}\right\} \Rightarrow$$ ② rúderő határozható meg

2. átmetsző módszer

-> a szerkezetet 2 részre bontjuk

-> egyik részt megtartjuk

-> a megtartott rész egyensúlyából számítjuk a rúderőket

-> felírható egyenletek száma: 3

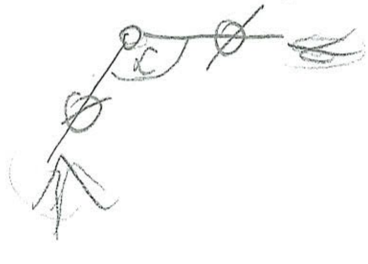
pl: $$\left.\begin{array}{l} F_x = 0 \\ F_y = 0 \\ M_a = 0 \end{array}\right\} \Rightarrow$$ ③ rúderő határozható meg

nyomatéki egyenletek $\Rightarrow$ Ritter számítás!

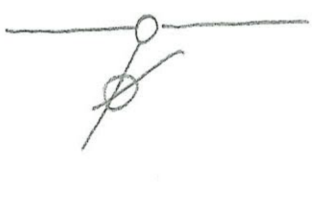
vakrudak : ha $N = 0$ (zérus a rúderő) $\Rightarrow$ a rúd vakrúd jele: $\varnothing$

vakrúdvadászat

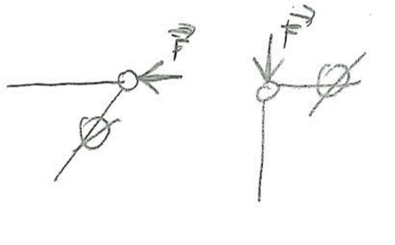
$\boxed{1}$ terheletlen csuklóhoz 2 rúd csatlakozik és $\measuredangle < 180°$



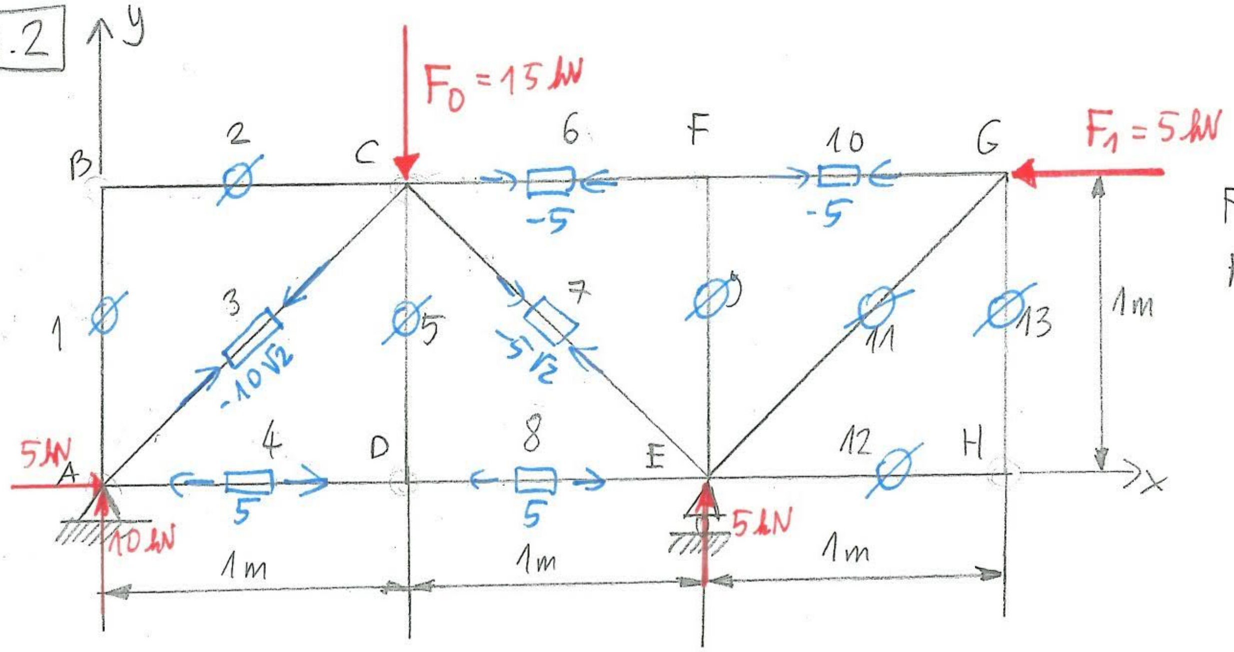
$\boxed{2}$ terheletlen csuklóhoz 3 rúd csatlakozik amiből 2 egy egyenesbe esik $\Rightarrow$ a 3. vakrúd



$\boxed{3}$ terhelt csuklóhoz 2 rúd csatlakozik de a terhelés az egyik rúd tengelyébe esik $\Rightarrow$ másik vakrúd



13.2



$F_0 = 15\,kN$

$F_1 = 5\,kN$

- támasztóerők

$$M_a = 0 = -1\cdot F_0 + 1\cdot F_1 + 2F_{Ey} \Rightarrow F_{Ey} = \frac{F_0 - F_1}{2} = \frac{15-5}{2} = 5\,kN\ (\uparrow)$$

$$F_x = 0 = F_{Ax} - F_1 \Rightarrow F_{Ax} = F_1 = 5\,kN\ (\rightarrow)$$

$$F_y = 0 = F_{Ay} - F_0 + F_{Ey} \Rightarrow F_{Ay} = F_0 - F_{Ey} = 15 - 5 = 10\,kN\ (\uparrow)$$

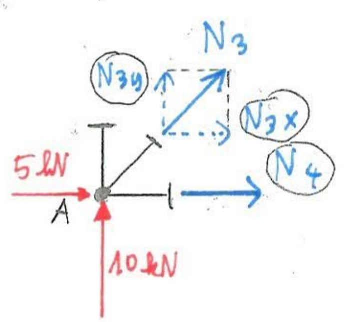
- vakrúdvadászat

$\boxed{1} \rightarrow B \rightarrow \boxed{N_1 = 0}$; $\boxed{N_2 = 0}$ $\quad \boxed{2} \rightarrow D \rightarrow \boxed{N_5 = 0}$ $\quad \boxed{3} \rightarrow G \rightarrow \boxed{N_{11} = 0}$

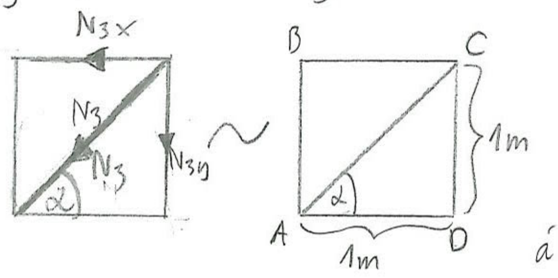
$\rightarrow H \rightarrow \boxed{N_{12} = 0}$; $\boxed{N_{13} = 0}$ $\quad \rightarrow F \rightarrow \boxed{N_9 = 0}$

- további rúderők:

A $\rightarrow N_3, N_4$



$$F_y = 0 = 10 + N_{3y} \Rightarrow N_{3y} = -10\,kN\ (\downarrow)$$



$$\text{tg}\,\alpha = \frac{1}{1} = \frac{|N_{3y}|}{|N_{3x}|}$$

$$|N_{3x}| = \frac{1}{1}\cdot|N_{3y}| = |N_{3y}| = 10\,kN$$

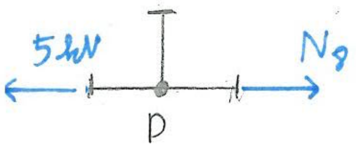
ábra alapján $N_{3x} = -10\,kN\ (\leftarrow)$

$$N_3 = -\sqrt{10^2 + 10^2} = -10\sqrt{2}\,kN = -14,14\,kN$$

$$F_x = 0 = 5 + N_4 + N_{3x} \Rightarrow N_4 = -5 - (-10) =$$

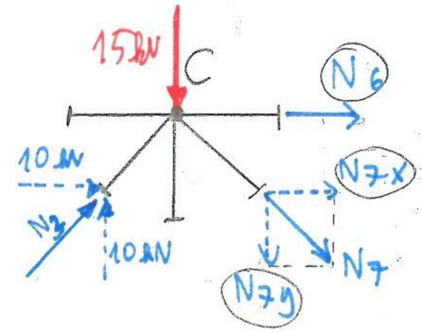
$$= 5\,kN\ (\rightarrow)$$

Ⓓ → N_8

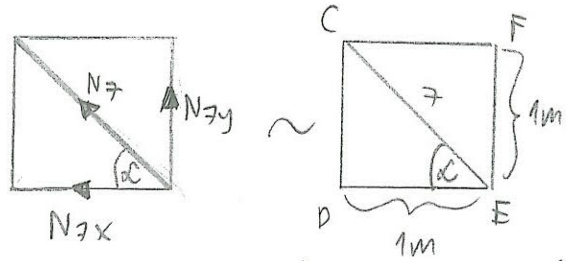


$F_x = 0 = -5 + N_8 \rightarrow N_8 = 5\ kN\ (\rightarrow)$

Ⓒ → N_7, N_6



$F_y = 0 = -15 + 10 - N_{7y} \Rightarrow N_{7y} = -15 + 10 = -5\ kN\ (\uparrow)$



$tg\,\alpha = \frac{1}{1} = \frac{|N_{7y}|}{|N_{7x}|}$

$\Downarrow$

$|N_{7x}| = \frac{1}{1}|N_{7y}| = 5\ kN$

ábra alapján: $N_{7x} = -5\ kN\ (\leftarrow)$

$N_7 = -\sqrt{5^2+5^2} = -5\sqrt{2} = -7{,}07\ kN$

$F_x = 0 = 10 + N_{7x} + N_6 \Rightarrow N_6 = -10 - N_{7x} =$

$= -10 - (-5) = -10 + 5 = -5\ kN$

Ⓕ → N_{10}

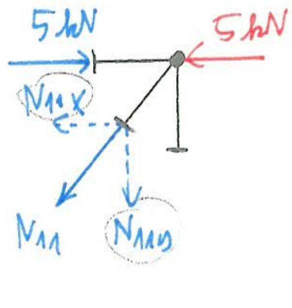
$F_x = 0 = 5 + N_{10} \Rightarrow N_{10} = -5\ kN\ (\leftarrow)$

Ⓖ → N_{11}

$F_x = 0 = 5 - 5 + N_{11x} \Rightarrow N_{11x} = 0$

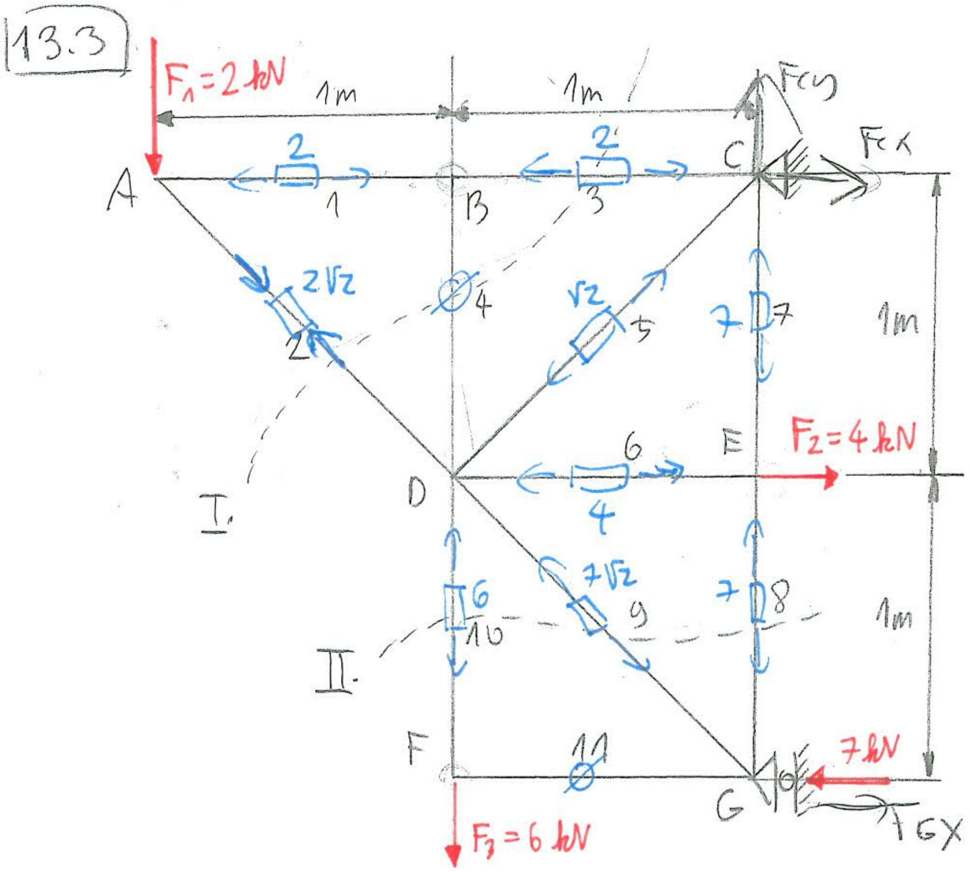
$\Downarrow$

$N_{11y} = 0$



$\boxed{N_{11} = 0}$ (vakrúd)

13.3



támasztóerők:

$$M_c = 0 = 2F_1 + 1F_2 + 1F_3 + 2F_{Gx} \Rightarrow F_{Gx} = \frac{-2F_1 - F_2 - F_3}{2} = \frac{-2\cdot 2 - 4 - 6}{2} = -7 \text{ kN} (\leftarrow)$$

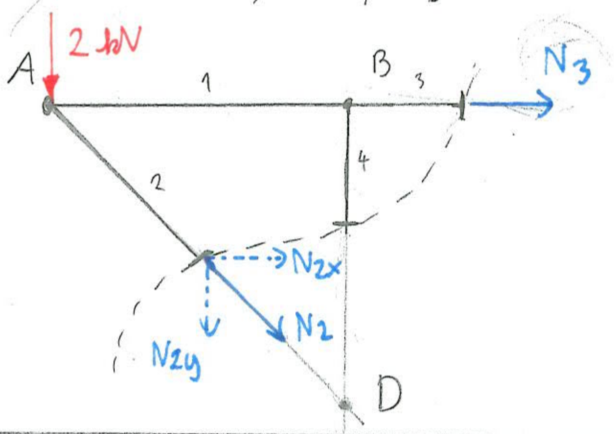
$$F_x = 0 = F_2 + F_{Gx} + F_{cx} \Rightarrow F_{cx} = -F_2 - F_{Gx} = -4 - (-7) = 3 \text{ kN} (\rightarrow)$$

$$F_y = 0 = -F_1 - F_3 + F_{cy} \Rightarrow F_{cy} = F_1 + F_3 = 2 + 6 = 8 \text{ kN} (\uparrow)$$

vakrúdvadászat

$\boxed{2} \rightarrow (B) \rightarrow \boxed{N_4 = 0}$ $\quad$ $(3) \rightarrow (F) \rightarrow \boxed{N_{11} = 0}$

I. átmetszés ⇒ N_2, N_3



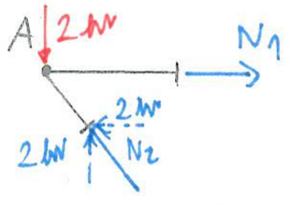
$$M_d = 0 = 1\cdot 2 - 1\cdot N_3 \Rightarrow N_3 = 2 \text{ kN} (\rightarrow)$$

$$F_x = 0 = N_{2x} + N_3 \Rightarrow N_{2x} = -N_3 = -2 \text{ kN} (\leftarrow)$$

$$F_y = 0 = -N_{2y} - 2 \Rightarrow N_{2y} = -2 \text{ kN} (\uparrow)$$

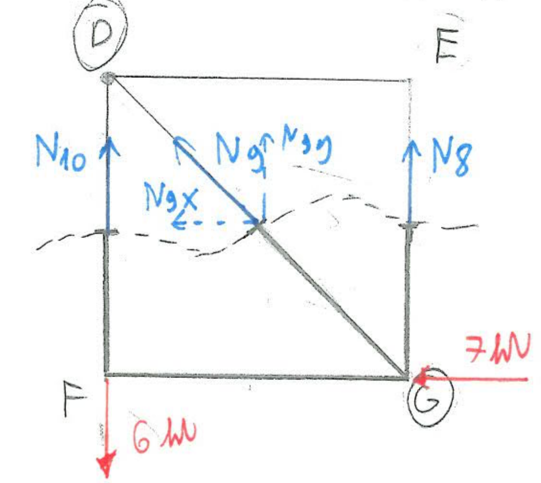
$$N_2 = -\sqrt{2^2 + 2^2} = -2\sqrt{2} = -2{,}828 \text{ kN}$$

(A) $\rightarrow N_1$



$$F_x = 0 = -2 + N_1 \Rightarrow N_1 = 2 \text{ kN} (\rightarrow)$$

II. átmetszés $\Rightarrow N_8, N_9, N_{10}$



$$M_d = 0 = -1\cdot 7 + 1\cdot N_8 \Rightarrow N_8 = 7\ kN\ (\uparrow)$$

$$M_g = 0 = 1\cdot 6 - 1\cdot N_{10} \Rightarrow N_{10} = 6\ kN\ (\uparrow)$$

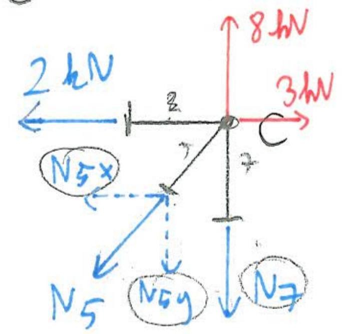
$$F_x = 0 = -7 - N_{9x} \Rightarrow N_{9x} = -7\ kN$$

$$F_y = 0 = N_{10} + N_8 - 6 + N_{9y} \Rightarrow N_{9y} =$$

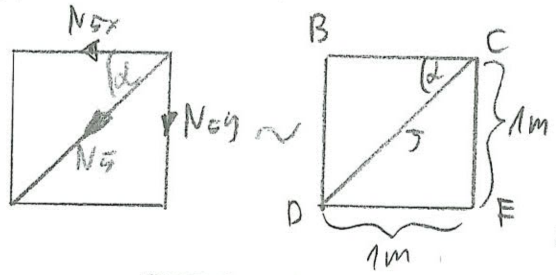
$$= 6 - N_{10} - N_8 = 6 - 6 - 7 = -7\ kN\ (\downarrow)$$

$$N_9 = -\sqrt{7^2+7^2} = -7\sqrt{2} = -9{,}9\ kN$$

Ⓒ $\Rightarrow N_5, N_7$



$$F_x = 0 = -2 - N_{5x} + 3 \Rightarrow N_{5x} = -2+3 = 1\ kN\ (\leftarrow)$$



$$tg\alpha = \frac{1}{1} = \frac{|N_{5y}|}{|N_{5x}|}$$

$$\Downarrow$$

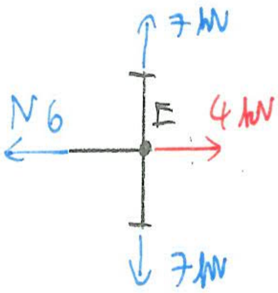
$$N_{5y} = \frac{1}{1}|N_{5x}| = 1\ kN$$

ábra $\rightarrow N_{5y} = 1\ kN\ (\downarrow)$

$$N_5 = \sqrt{1^2+1^2} = \sqrt{2} = 1{,}41\ kN$$

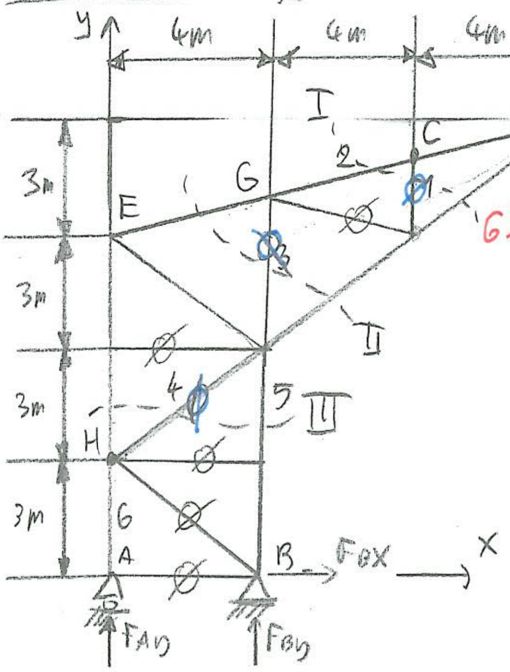
$$F_y = 0 = 8 - N_{5y} - N_7 \Rightarrow N_7 = 8 - N_{5y} = 8 - 1 = 7\ kN\ (\downarrow)$$

Ⓔ $\rightarrow N_6$



$$F_x = 0 = -N_6 + 4 \Rightarrow N_6 = 4\ kN\ (\leftarrow)$$

TK10.3.10



- támasztóerők

$$M_b = 0 = -4F_{Ay} - 8 \cdot 6$$

$$F_{Ay} = \frac{-8 \cdot 6}{4} = -12 \text{ kN } (\downarrow)$$

$$F_x = 0 = F_{Bx}$$

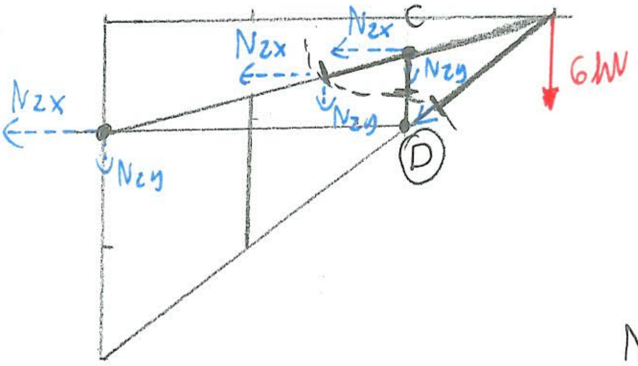
$$F_y = 0 = F_{Ay} + F_{By} - 6$$

$$F_{By} = -F_{Ay} + 6 = -(-12) + 6 = 18 \text{ kN } (\uparrow)$$

- vakrúd (a megjelöltek közül):

(2) → (C) → $\boxed{N_1 = 0}$ (3) → (G) → $\boxed{N_3 = 0}$
→ (H) → $\boxed{N_4 = 0}$

I. metszés → N_2



$$M_d = 0 = 2N_{2x} - 4 \cdot 6$$

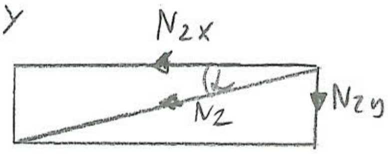
$$N_{2x} = \frac{4 \cdot 6}{2} = 12 \text{ kN } (\leftarrow)$$

$$M_d = 0 = 8N_{2y} - 4 \cdot 6$$

$$N_{2y} = \frac{4 \cdot 6}{8} = 3 \text{ kN } (\downarrow)$$

$$N_2 = +\sqrt{3^2 + 12^2} = 12{,}4 \text{ kN}$$

VAGY



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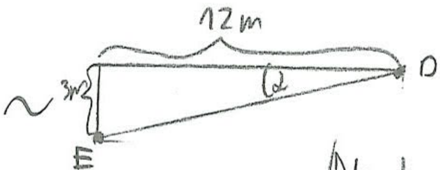
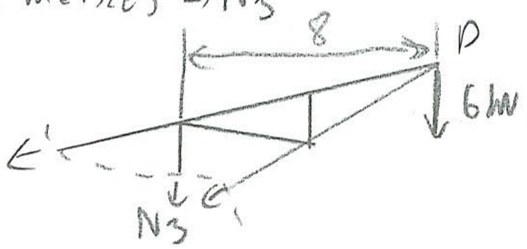


$$\operatorname{tg}\alpha = \frac{3}{12} = \frac{|N_{2y}|}{|N_{2x}|}$$

$$|N_{2y}| = \frac{3}{12}|N_{2x}| = 3 \text{ kN}$$

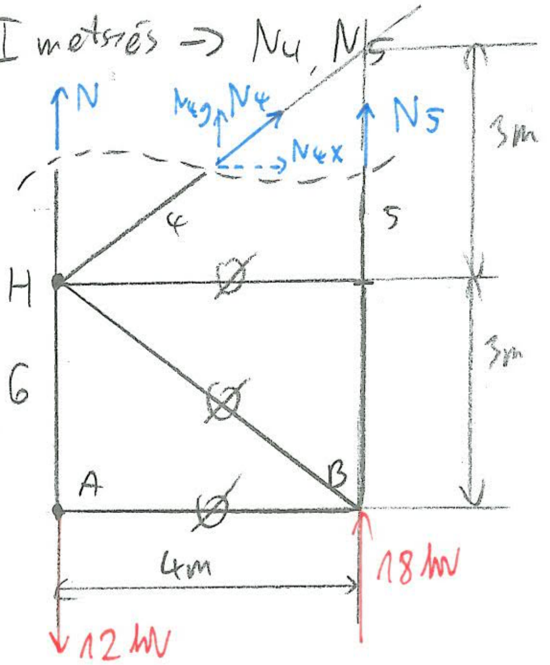
ábra: $N_{2x} = 3 \text{ kN } (\leftarrow)$

II metszés → N_3



$$M_d = 0 = 8N_3 \Rightarrow \boxed{N_3 = 0}$$

III metszés → N_4, N_5



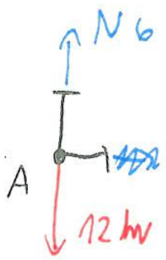
$M_h = 0 = +4 \cdot 18 + 4N_5$

$N_5 = \frac{-4 \cdot 18}{4} = -18\ kN\ (\downarrow)$ (D ⊖)

$F_x = 0 = N_{4x} \Rightarrow N_{4y} = 0$

$\boxed{N_4 = 0}$

(A) → N_6



$F_y = 0 = -12 + N_6 \Rightarrow N_6 = 12\ kN$ (D ⊕)