

1) WARUNEK KONIECZNY

$$p = 2n - n$$

p - liczba prętów

n - liczba węzłów

n - liczba węzłów podporowych

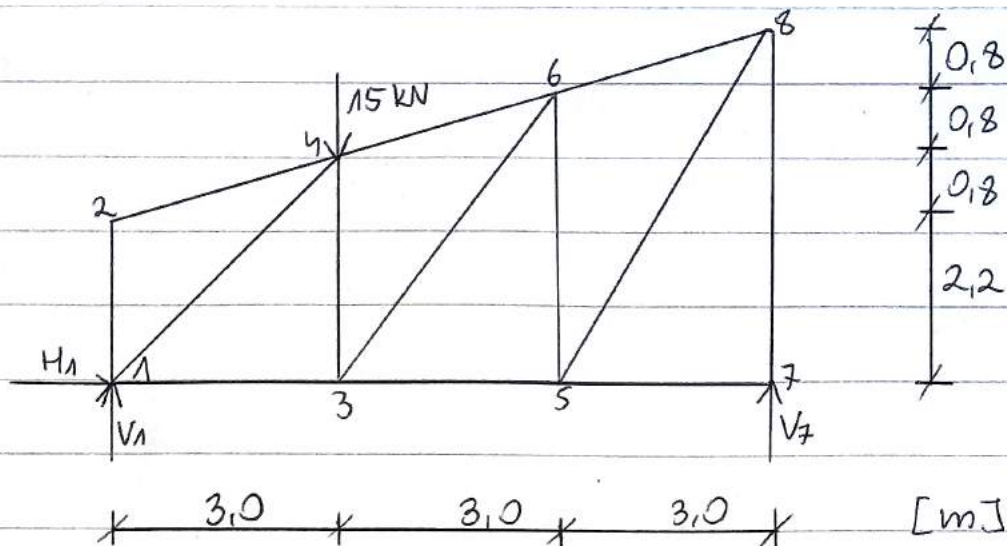
$$13 = 2 \cdot 8 - 3$$

$$13 = 13$$

2) WARUNEK DOSTATECZNY

Konstrukcja składa się z trójkątów przylegających do siebie co najmniej jednym bokiem, zatem wszystkie pręty można zastąpić jedną, twardą, zastępczą. Twarda zastępcza podparta jest w punkcie 1 podpora, przegubowo - nieprzesuwna oraz w punkcie 7 podpora, przegubowo - przesuwna. Przegub nie leży na kierunku pręta. Twarda zastępcza ma odebrane trzy stopnie swobody, więc układ ten jest geometrycznie niezmienny.

WYZNACZENIE REAKCJI I PODPORACH



$$1) \sum P_{ix} = 0$$

$$\underline{H_1 = 0 \text{ kN}}$$

$$2) \sum M_1 = 0$$

$$15 \cdot 3 - V_7 \cdot 9 = 0$$

$$45 = 9V_7$$

$$\underline{V_7 = 5 \text{ kN}}$$

$$3) \sum P_{iy} = 0$$

$$V_1 + V_7 - 15 = 0$$

$$V_1 + 5 - 15 = 0$$

$$\underline{V_1 = 10 \text{ kN}}$$

SPRAWDZENIE

$$\sum M_1 = 0$$

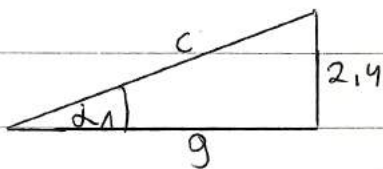
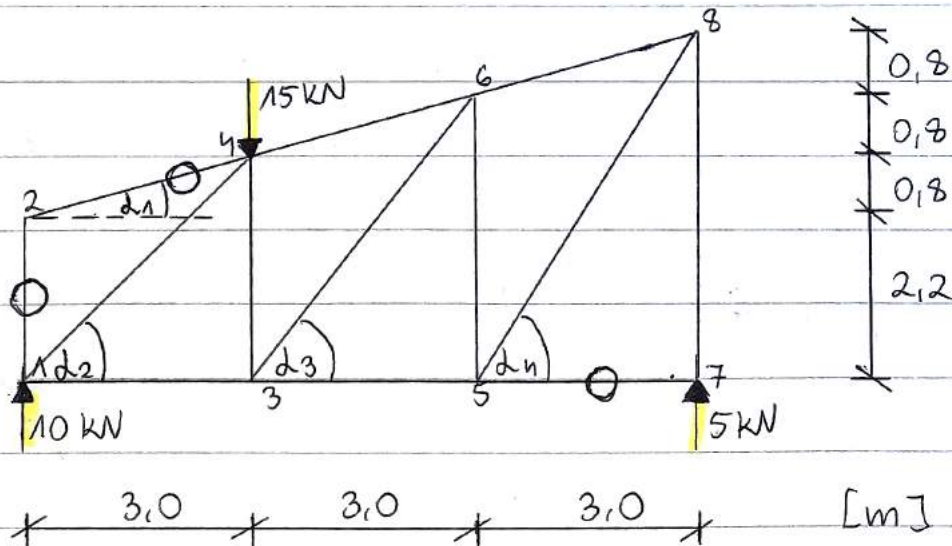
$$-H_1 \cdot 3 + V_1 \cdot 3 - V_7 \cdot 6 = 0$$

$$10 \cdot 3 - 5 \cdot 6 = 0$$

$$30 - 30 = 0$$

$$\underline{0 = 0}$$

WYZNACZENIE SIŁ METODĄ RÓWNOWAŻENIA WĘZŁÓW



$$\operatorname{tg} \alpha_1 = \frac{2,4}{9} = 0,2667$$

$$\operatorname{arctg} 0,2667 = 14,93$$

$$\alpha_1 = 14,93^\circ$$

$$\underline{\sin \alpha_1 = 0,2576}$$

$$\underline{\cos \alpha_1 = 0,9662}$$

$$\operatorname{tg} \alpha_2 = \frac{3}{3} = 1$$

$$\operatorname{arctg} 1 = 45$$

$$\alpha_2 = 45^\circ$$

$$\underline{\sin \alpha_2 = 0,707107}$$

$$\underline{\cos \alpha_2 = 0,707107}$$

$$\operatorname{tg} \alpha_3 = \frac{3,8}{3,0} = 1,267$$

$$\operatorname{arctg} 1,267 = 51,72 \quad \alpha_3 = 51,72^\circ$$

$$\underline{\sin \alpha_3 = 0,7850}$$

$$\underline{\cos \alpha_3 = 0,6195}$$

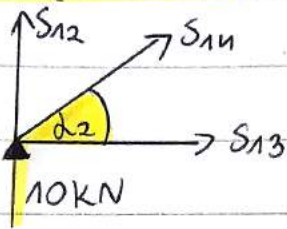
$$\operatorname{tg} \alpha_4 = \frac{4,6}{3} = 1,533$$

$$\operatorname{arctg} 1,533 = 56,88 \quad \alpha_4 = 56,88^\circ$$

$$\underline{\sin \alpha_4 = 0,8375}$$

$$\underline{\cos \alpha_4 = 0,5464}$$

NEZET 1



$$1) \sum P_{iy} = 0$$

$$10 + S_{14} \cdot \sin \alpha_2 = 0$$

$$S_{14} \cdot 0,707107 = -10$$

$$S_{14} = -14,14 \text{ kN}$$

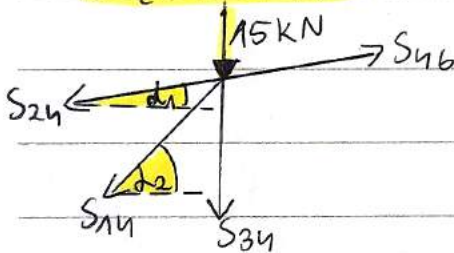
$$2) \sum P_{ix} = 0$$

$$S_{13} + S_{14} \cdot \cos \alpha_2 = 0$$

$$S_{13} = -S_{14} \cdot \cos \alpha_2$$

$$S_{13} = 9,998 \text{ kN}$$

NEZET 4



$$1) \sum P_{ix} = 0$$

$$S_{46} \cdot \cos \alpha_1 - S_{14} \cdot \cos \alpha_2 = 0$$

$$S_{46} \cdot 0,9662 + 14,14 \cdot 0,707107 = 0$$

$$S_{46} \cdot 0,9662 = -9,998$$

$$S_{46} = -10,35 \text{ kN}$$

$$2) \sum P_{iy} = 0$$

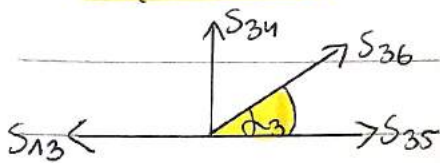
$$-15 - S_{43} + S_{46} \cdot \sin \alpha_1 - S_{14} \cdot \sin \alpha_2 = 0$$

$$S_{43} = -15 - 10,35 \cdot 0,2576 + 14,14 \cdot 0,707107$$

$$S_{43} = -15 - 2,667 + 9,998$$

$$S_{43} = -7,669$$

WEZET 3



$$1) \sum P_{iy} = 0$$

$$S_{34} + S_{36} \cdot \sin \alpha_3 = 0$$

$$S_{36} \cdot 0,7850 = 7,669$$

$$S_{36} = 9,769 \text{ kN}$$

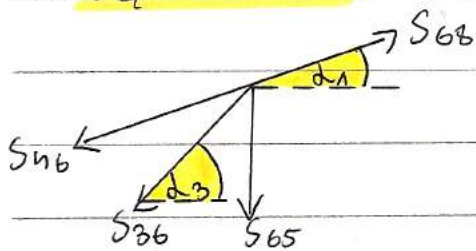
$$2) \sum P_{ix} = 0$$

$$-S_{13} + S_{35} + S_{36} \cdot \cos \alpha_3 = 0$$

$$-9,998 + S_{35} + 9,769 \cdot 0,6195 = 0$$

$$S_{35} = 3,946 \text{ kN}$$

WEZET 6



$$1) \sum P_{ix} = 0$$

$$-S_{46} \cdot \cos \alpha_1 - S_{63} \cdot \cos \alpha_3 + S_{68} \cdot \cos \alpha_1 = 0$$

$$10,35 \cdot 0,9662 - 9,769 \cdot 0,6195 + S_{68} \cdot 0,9662 = 0$$

$$3,94827 = -S_{68} \cdot 0,9662$$

$$S_{68} = -4,0864 \text{ kN}$$

$$2) \sum P_{iy} = 0$$

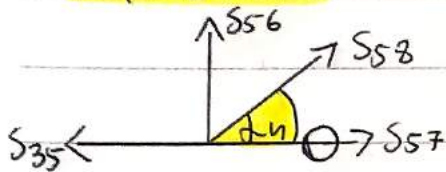
$$-S_{46} \cdot \sin \alpha_1 - S_{63} \cdot \sin \alpha_3 - S_{65} + S_{68} \cdot \sin \alpha_1 = 0$$

$$S_{65} = 10,35 \cdot 0,2576 - 9,769 \cdot 0,7850 - 4,0864 \cdot 0,2576$$

$$S_{65} = 2,666 - 7,669 - 1,0527$$

$$S_{65} = -6,0557 \text{ kN}$$

WEZET 5



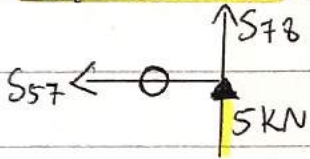
$$1) \sum P_{iy} = 0$$

$$S56 + S58 \cdot \sin \alpha = 0$$

$$-6,0557 + S58 \cdot 0,8375 = 0$$

$$S58 = 7,2307 \text{ kN}$$

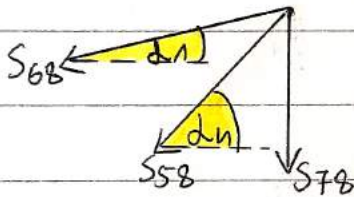
WEZET 7



$$1) \sum P_{iy} = 0$$

$$S78 = -5 \text{ kN}$$

SPRAWDZENIE - WEZET 8



$$* \sum P_{ix} = 0$$

$$-S68 \cdot \cos \alpha - S58 \cdot \cos \alpha = 0$$

$$4,0864 \cdot 0,9662 - 7,2307 \cdot 0,5464 = 0$$

$$3,948 - 3,9505 = 0$$

$$-0,0025 \approx 0$$

$$* \sum P_{iy} = 0$$

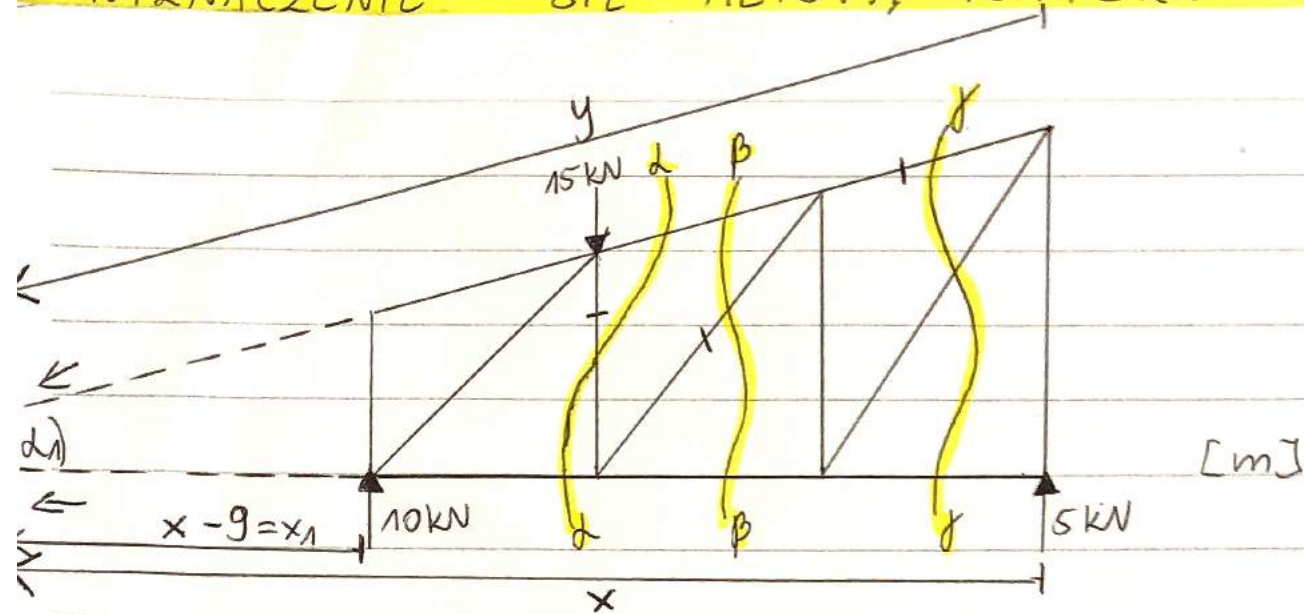
$$-S68 \cdot \sin \alpha - S58 \cdot \sin \alpha - S78 = 0$$

$$4,0864 \cdot 0,2576 - 7,2307 \cdot 0,8375 + 5 = 0$$

$$1,0527 - 6,0557 + 5 = 0$$

$$-0,003 \approx 0$$

WYZNACZENIE SIŁ METODĄ RITTERA



SILY DO WYZNACZENIA: S_{34}, S_{36}, S_{68}

$$\sin \alpha = \frac{h}{y} = \frac{2,2}{y}$$

$$0,2576 = \frac{2,2}{y} \cdot y$$

$$0,2576y = 2,2$$

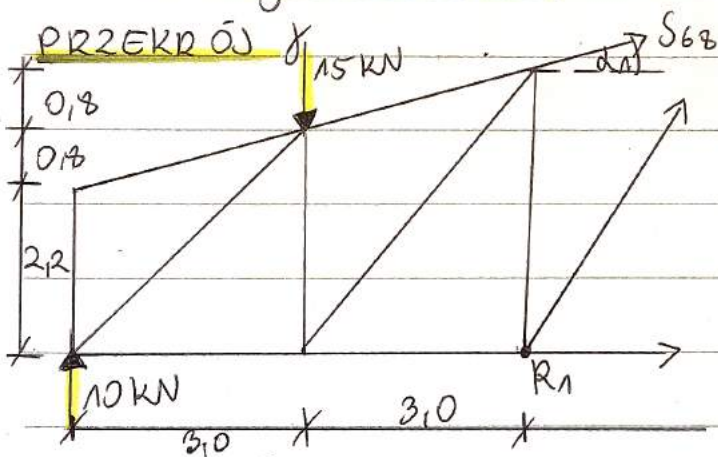
$$y = 8,54 \text{ m}$$

$$\cos \alpha = \frac{x}{y} = \frac{x}{8,54}$$

$$0,9662 = \frac{x}{8,54}$$

$$x = 8,26 \text{ m}$$

$$x_1 = x - 9 = -0,74 \text{ m}$$



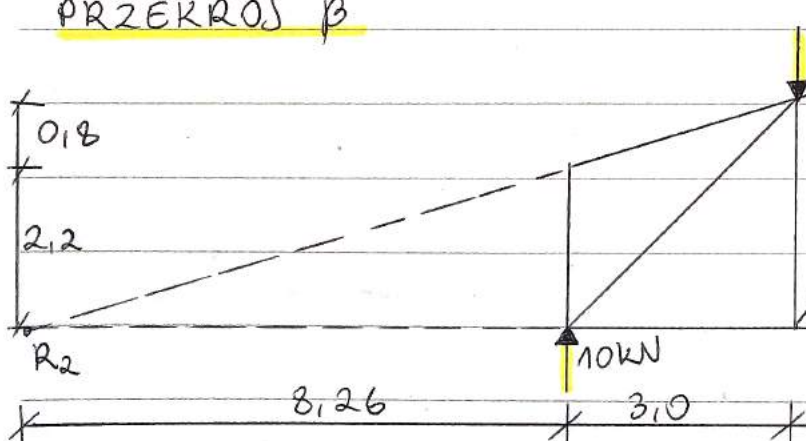
$$\sum M_{R1} = 0$$

$$10 \cdot 6 - 15 \cdot 3 + S_{68} \cdot \cos \alpha \cdot 3,8 = 0$$

$$60 - 45 + S_{68} \cdot 0,9662 \cdot 3,8 = 0$$

$$S_{68} = -4,0855 \text{ kN}$$

PRZEKRÓJ β



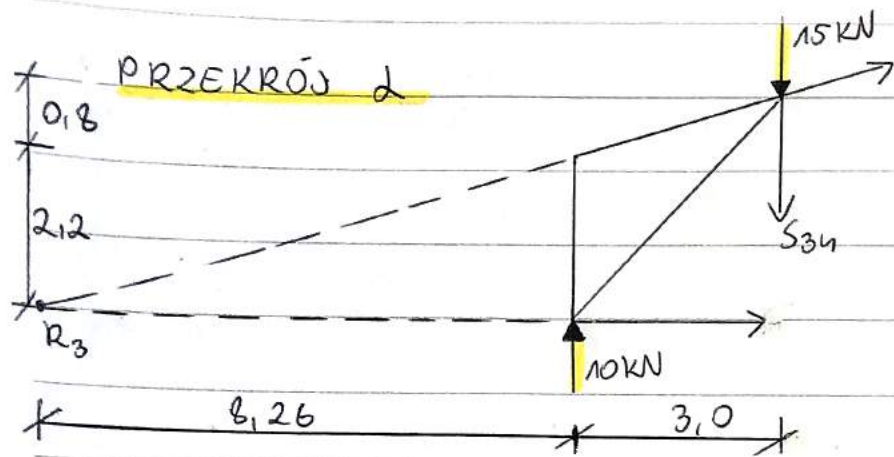
$$\sum M_{R2} = 0$$

$$0 = -10 \cdot 8,26 + 15 \cdot 11,26 - S_{36} \cdot \sin \alpha \cdot 11,26$$

$$-82,6 + 168,9 = 11,26 \cdot S_{36} \cdot 0,7850$$

$$86,3 = 8,816 S_{36}$$

$$S_{36} = 9,789 \text{ kN}$$



$$-10 \cdot 8,26 + 15 \cdot 11,26 + S_{34} \cdot 11,26 = 0$$

$$-82,6 + 168,9 = -S_{34} \cdot 11,26$$

$$-86,3 = S_{34} \cdot 11,26$$

$$S_{34} = -7,664 \text{ kN}$$

RYСУNEK ZESTAWIENIOWY

