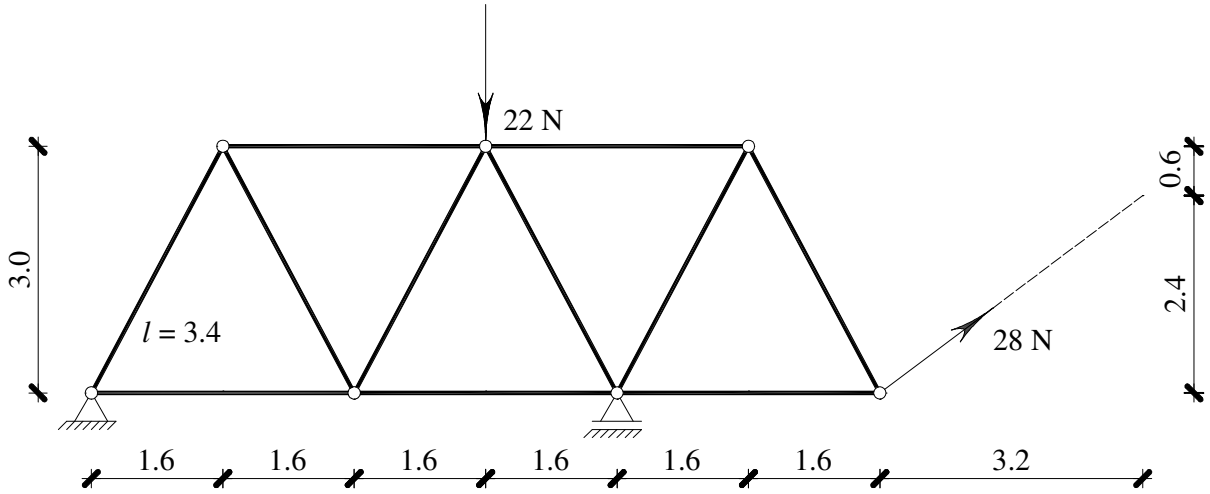
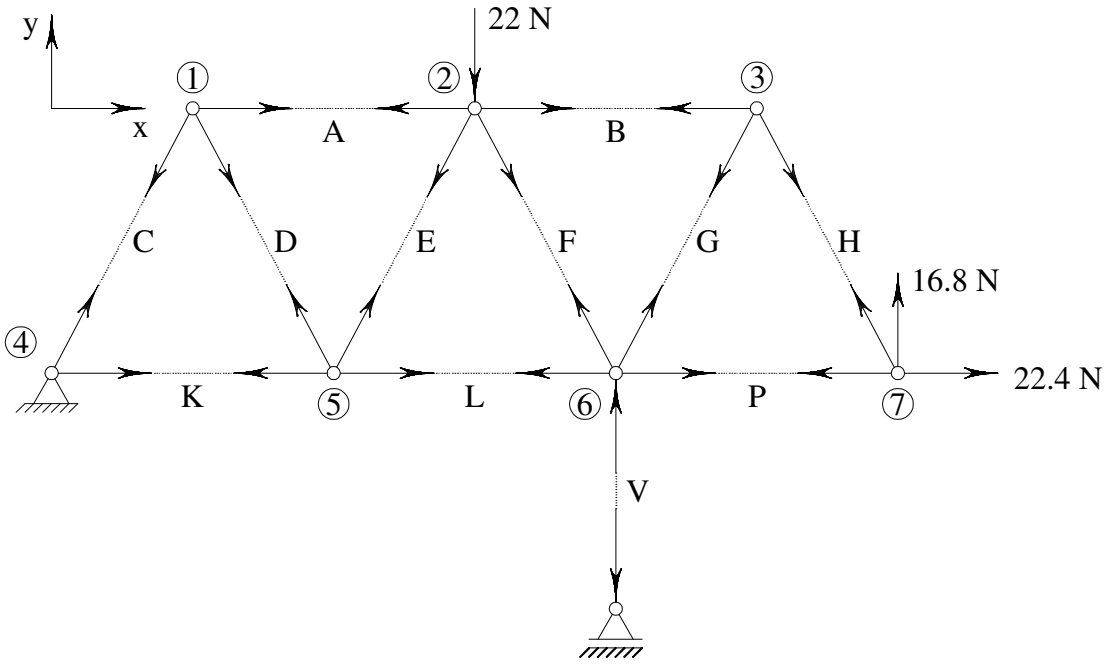
1. Treba računski(analitički) i grafički riješiti ravninsku rešetku



Statička shema



Sile P i H mogu se direktno odrediti iz ravnoteže čvora 7, a sile G i B iz ravnoteže čvora 3. Sila V se direktno određuje iz ravnoteže rešetke 1-2-3-5-6-7 i to iz uvjeta:

$$\Sigma M_4 = -4.8 \cdot 22 + 9.6 \cdot 16.8 + 6.4 \cdot V = 0 \quad \Rightarrow \quad V = \frac{4.8 \cdot 22 - 9.6 \cdot 16.8}{6.4} = -\ 8.7\ \ N$$

Iz ravnoteže iste rešetke odredit će se C i K:

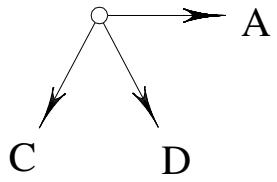
$$\Sigma F_y = -22 - 8.7 + 16.8 - \frac{3.0}{3.4} \cdot C = 0 \quad \Rightarrow \quad C = \frac{3.4}{3.0}(-22 - 8.7 + 16.8) = -15.753 \ N$$

$$\Sigma F_x = -K - \frac{1.6}{3.4} \cdot C + 22.4 = 0 \qquad \Rightarrow \qquad K = -\frac{1.6}{3.4} \cdot (-15.753) + 22.4 = 29.813 \ N$$

Analitičko rješavanje po čvorovima

Direktno se mogu riješiti čvorovi 1 i 5. Nakon rješavanja čvorova 7 i 3 u čvoru 2 ostaje samo jedna nepoznata sila F pa jedan uvjet ravnoteže služi za kontrolu. Time su određene sve sile pa uvjeti ravnoteže čvora 6 služe samo za kontrolu.

Čvor 1



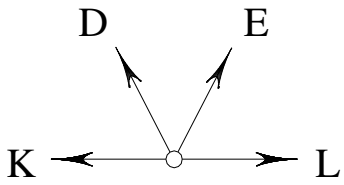
$$\sum F_y = -\frac{3.0}{3.4} \cdot C - \frac{3.0}{3.4} \cdot D = 0$$

$$D = -C = 15.753 \ N$$

$$\sum F_x = -\frac{1.6}{3.4} \cdot C + \frac{1.6}{3.4} \cdot D + A = 0$$

$$A = \frac{1.6}{3.4} \cdot C - \frac{1.6}{3.4} \cdot D = -14.826 \ N$$

Čvor 5



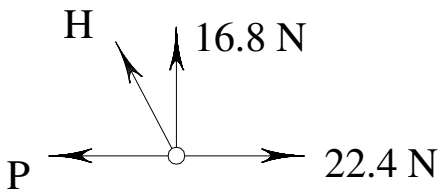
$$\sum F_y = \frac{3.0}{3.4} \cdot E + \frac{3.0}{3.4} \cdot D = 0$$

$$E = -D = -15.753 \ N$$

$$\sum F_x = -\frac{1.6}{3.4} \cdot D + \frac{1.6}{3.4} \cdot E - K + L = 0$$

$$L = \frac{1.6}{3.4} \cdot D - \frac{1.6}{3.4} \cdot E + K = 44.639 \ N$$

Čvor 7



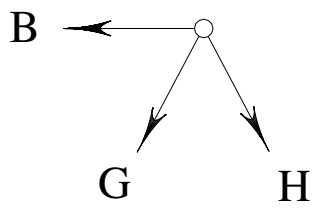
$$\sum F_y = \frac{3.0}{3.4}\cdot H + 16.8 = 0$$

$$H = -\frac{3.4}{3.0}\cdot 16.8 = -19.04 \ \ N$$

$$\sum F_x = -\frac{1.6}{3.4}\cdot H - P + 22.4 = 0$$

$$P = 22.4 - \frac{1.6}{3.4}\cdot H = 31.36 \ \ N$$

Čvor 3



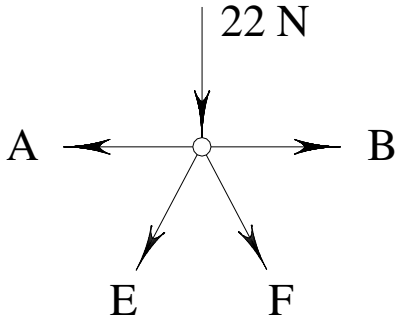
$$\sum F_y = -\frac{3.0}{3.4}\cdot G - \frac{3.0}{3.4}\cdot H = 0$$

$$G = -H = 19.04 \ \ N$$

$$\sum F_x = -\frac{1.6}{3.4}\cdot G + \frac{1.6}{3.4}\cdot H - B = 0$$

$$B = \frac{1.6}{3.4}\cdot H - \frac{1.6}{3.4}\cdot G = -17.92 \ \ N$$

Čvor 2



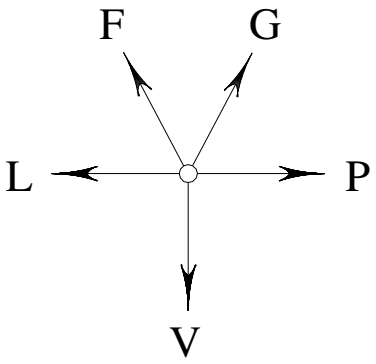
$$\sum F_y = -22 - \frac{3.0}{3.4}\cdot E - \frac{3.0}{3.4}\cdot F = 0$$

$$F = -E - \frac{3.4}{3.0}\cdot 22 = -9.180 \ \ N$$

Kontrola:

$$\sum F_x = -\frac{1.6}{3.4}\cdot E + \frac{1.6}{3.4}\cdot F - A + B = 0$$

Čvor 6



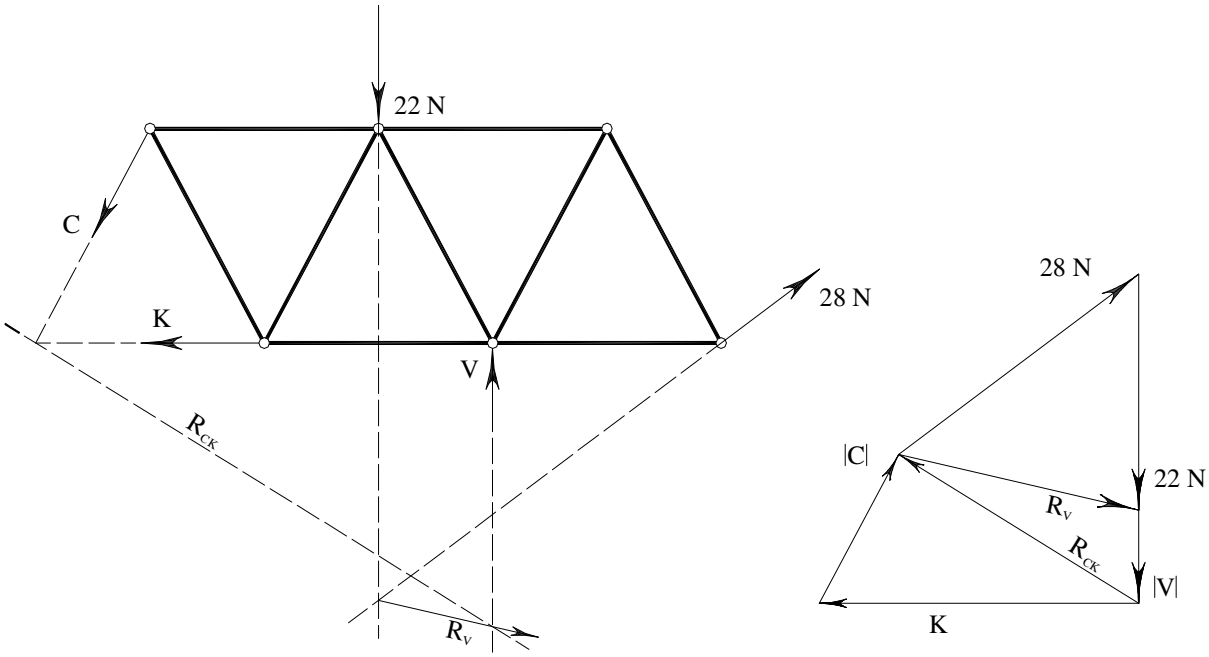
Kontrola:

$$\sum F_y = \frac{3.0}{3.4}\cdot F + \frac{3.0}{3.4}\cdot G - V = 0$$

$$\sum F_x = -\frac{1.6}{3.4}\cdot F + \frac{1.6}{3.4}\cdot G - L + P = 0$$

Samostalno skicirati stvarna djelovanja!

Grafički postupak

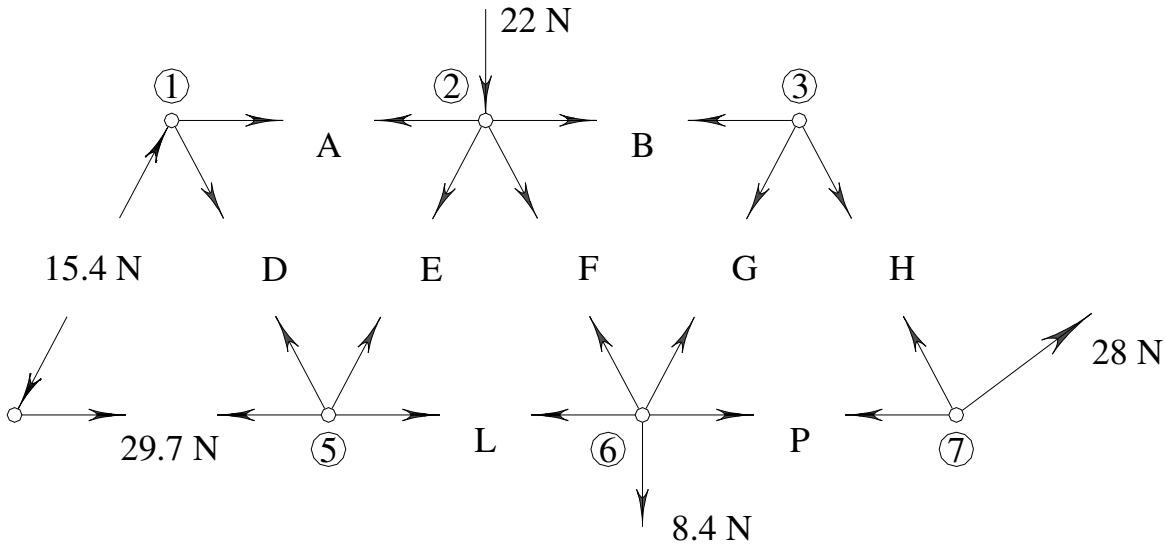


Očitano: $V = -8.4\ N$

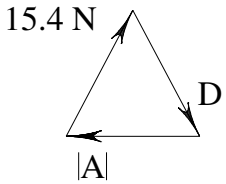
$K = 29.7\ N$

$C = -15.4\ N$

mjerilo sila 1 cm :: 7 N

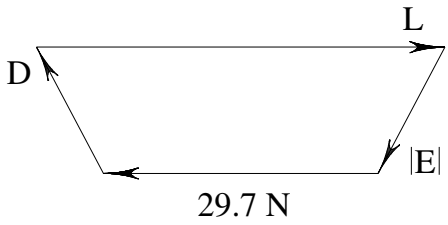


Čvor 1



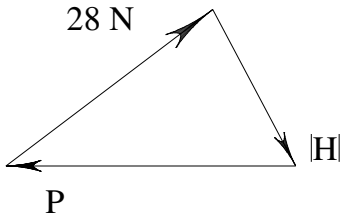
A = - 14.5 N
D = 15.4 N

Čvor 5



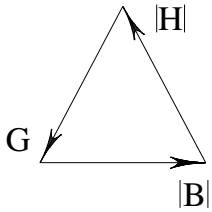
E = - 15.4 N
L = 44.2 N

Čvor 7



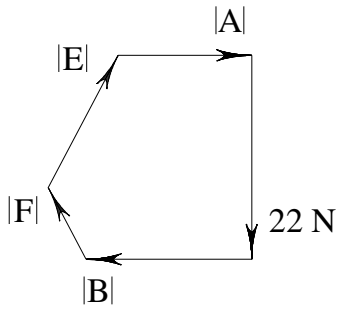
H = - 19.1 N
P = 31.3 N

Čvor 3



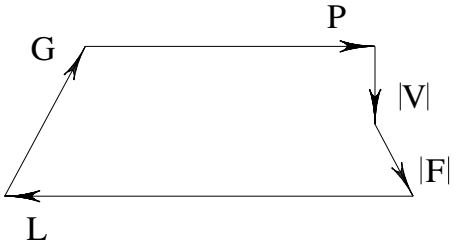
G = 19.1 N
B = - 17.9 N

Čvor 2

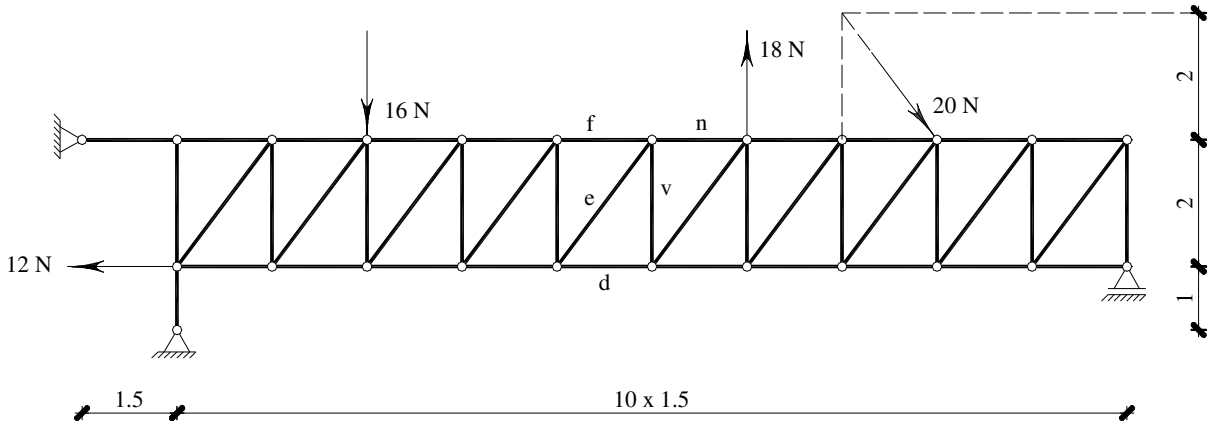


F = - 8.8 N

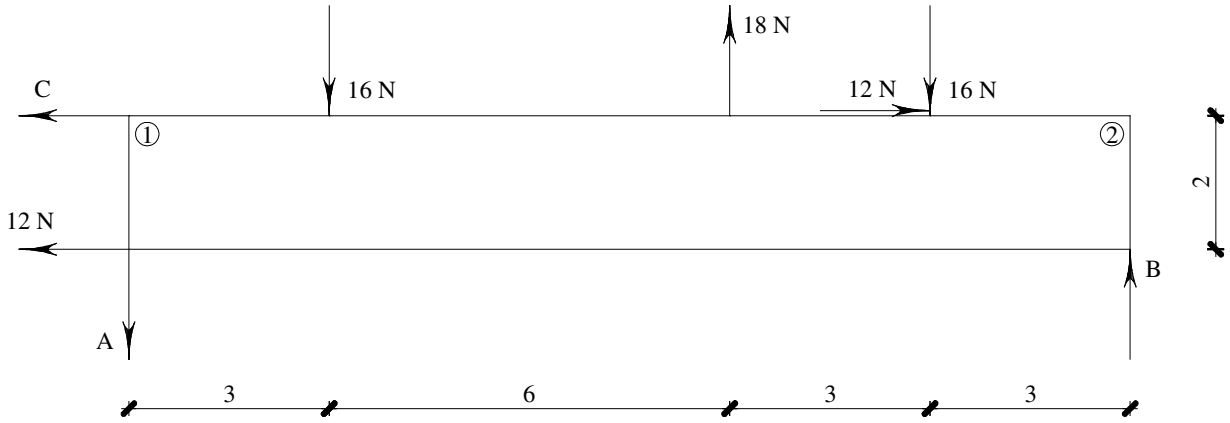
Čvor 6 (kontrola)



2. Treba odrediti sile u spojevima s podlogom i, metodom presjeka, sile u označenim štapovima rešetke



Statička shema za određivanje sila s podlogom



$$\sum M_1 = -16\cdot 3 + 18\cdot 9 - 16\cdot 12 + 15\cdot B - 12\cdot 2 = 0$$

$$\boldsymbol{B} = \frac{16\cdot 3 - 18\cdot 9 + 16\cdot 12 + 12\cdot 2}{15} = \mathbf{6.8\ N}$$

$$\sum M_2 = 16\cdot 3 - 18\cdot 6 + 16\cdot 12 + 15\cdot A - 12\cdot 2 = 0$$

$$\boldsymbol{A} = \frac{-16\cdot 3 + 18\cdot 6 - 16\cdot 12 + 12\cdot 2}{15} = \mathbf{-7.2\ N}$$

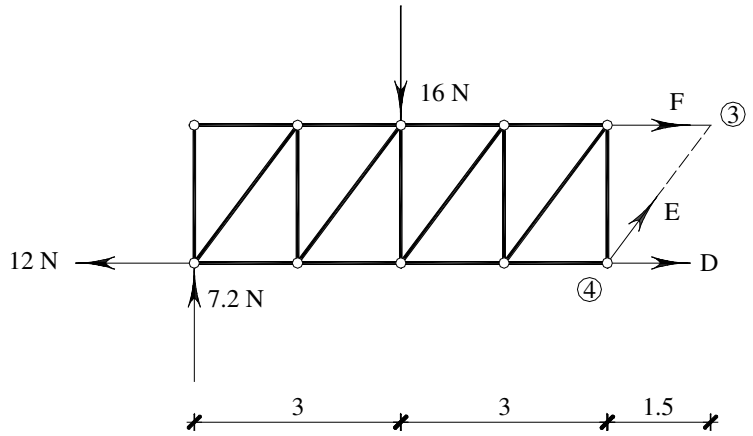
Konrola: $\sum F_y = -A - 16 + 18 - 16 + B = 0 \quad \Rightarrow \quad 0 = 0$

$$\sum F_x = -12 - C + 12 = 0$$

$$\boldsymbol{C = 0.0\ \mathrm{N}}$$

Sile se mogu odrediti i na poznate grafičke načine!

Sile u štapovima *d*, *e* i *f* mogu se odrediti iz ravnoteže svakog od dijelova rešetke koje ti štapovi spajaju. Radi kontrole provest će se oba proračuna.



$$\sum M_3 = 16 \cdot 4.5 - 7.2 \cdot 7.5 - 12 \cdot 2 + 2 \cdot D = 0$$

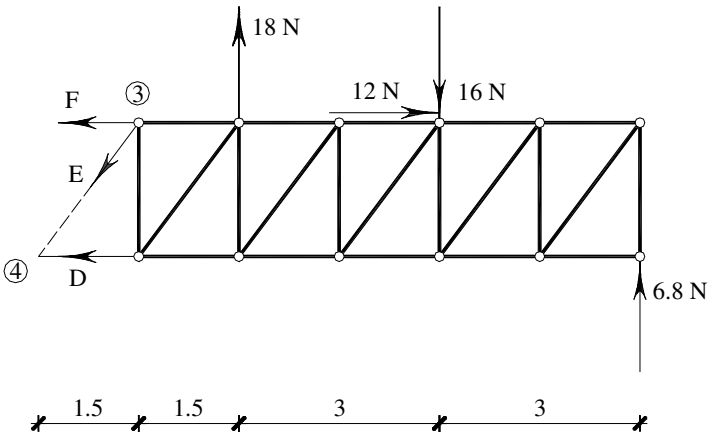
$$\boldsymbol{D} = \frac{-16 \cdot 4.5 + 7.2 \cdot 7.5 + 12 \cdot 2}{2} = \mathbf{3\ N}$$

$$\sum F_y = 7.2 - 16 + \frac{2.0}{2.5} \cdot E = 0$$

$$\boldsymbol{E} = \frac{2.5}{2.0} \cdot (16 - 7.2) = \mathbf{11\ N}$$

$$\sum M_4 = 16 \cdot 3 - 7.2 \cdot 6 - 2 \cdot F = 0$$

$$\boldsymbol{F} = \frac{16 \cdot 3 - 7.2 \cdot 6}{2} = \mathbf{2.4\ N}$$



$$\sum M_3 = 18\cdot 1.5 - 16\cdot 4.5 + 6.8\cdot 7.5 - 2\cdot D = 0$$

$$\boldsymbol{D} = \frac{18\cdot 1.5 - 16\cdot 4.5 + 6.8\cdot 7.5}{2} = \mathbf{3\ N}$$

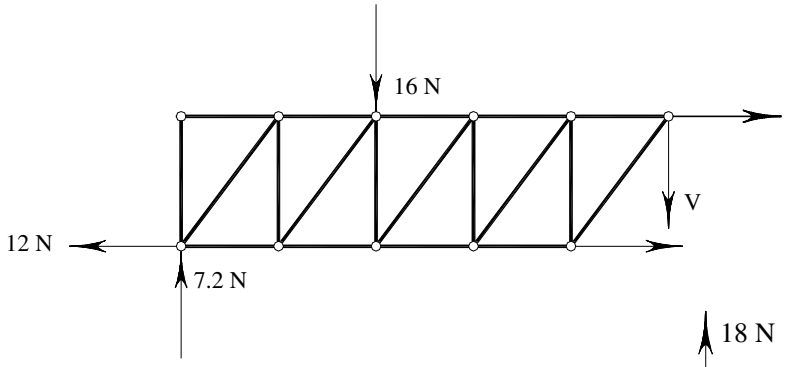
$$\sum F_y = 18 - 16 + 6.8 - \frac{2.0}{2.5}\cdot E = 0$$

$$\boldsymbol{E} = \frac{2.5}{2.0}\cdot(18 - 16 + 6.8) = \mathbf{11\ N}$$

$$\sum M_4 = 18\cdot 3 - 16\cdot 6 + 6.8\cdot 9 - 12\cdot 2 + 2\cdot F = 0$$

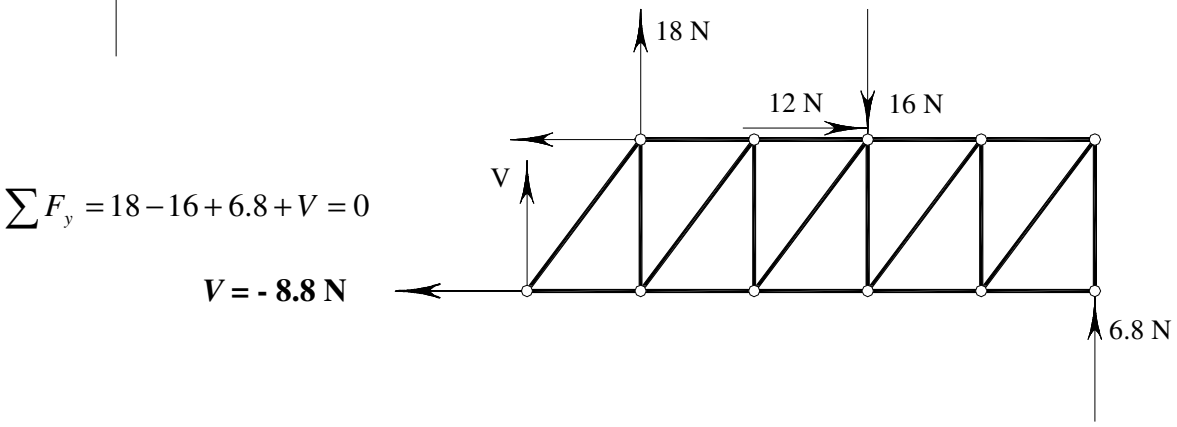
$$\boldsymbol{F} = \frac{-18\cdot 3 + 16\cdot 6 - 6.8\cdot 9 + 12\cdot 2}{2} = \mathbf{2.4\ N}$$

Za neposredno određivanje sile u štapu v treba promatrati dijelove rešetke koje spajaju štapovi *d*, *v* i *n*.



$$\sum F_y = 7.2 - 16 - V = 0$$

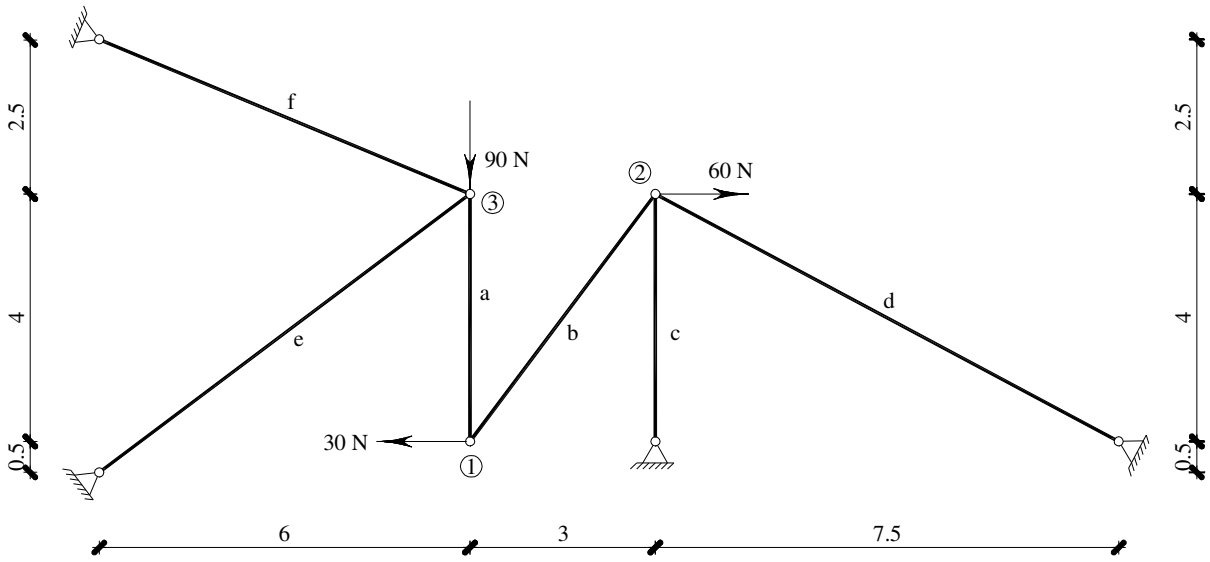
$$\boldsymbol{V} = \mathbf{-\ 8.8\ N}$$



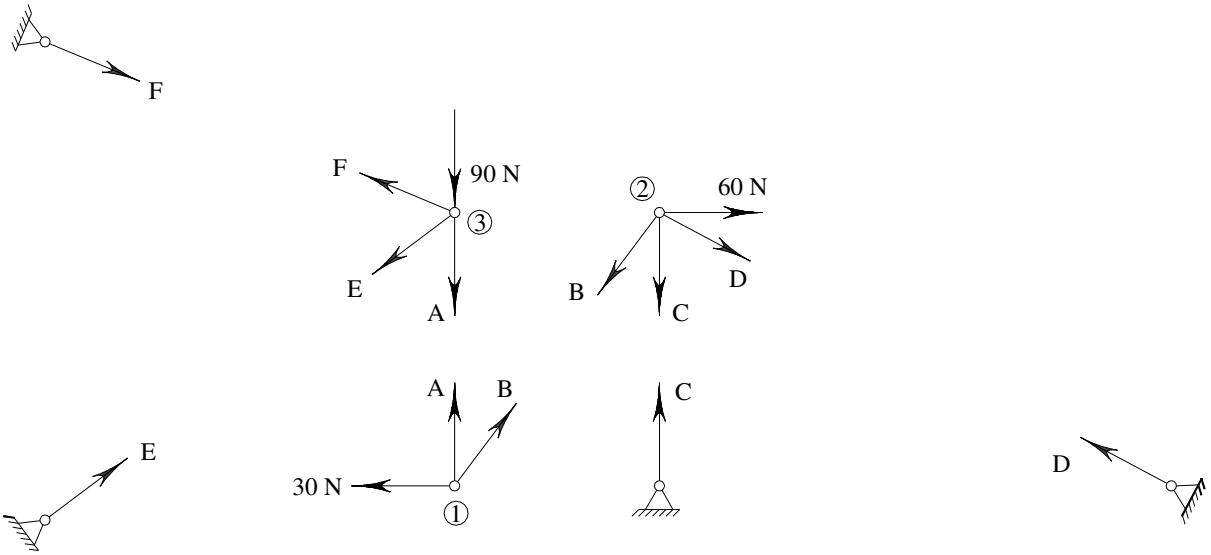
$$\sum F_y = 18 - 16 + 6.8 + V = 0$$

$$\boldsymbol{V} = \mathbf{-\ 8.8\ N}$$

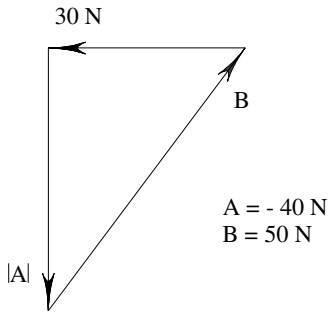
3. Treba grafički riješiti rešetkasti sustav



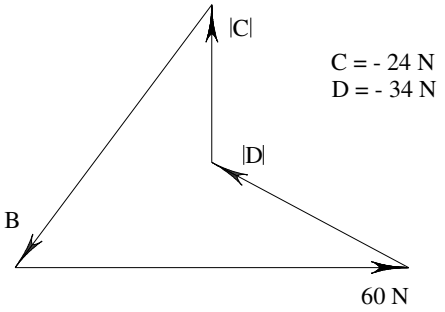
Statička shema



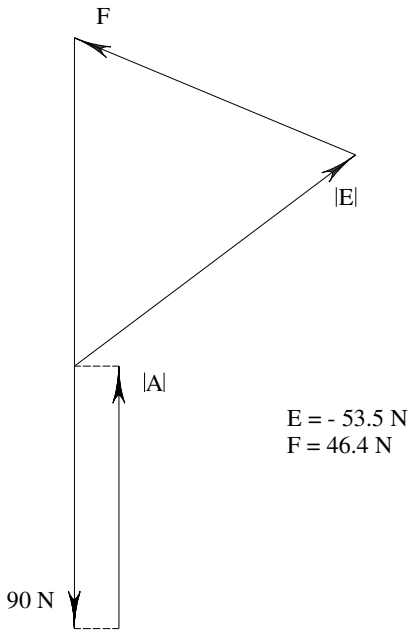
Čvor 1



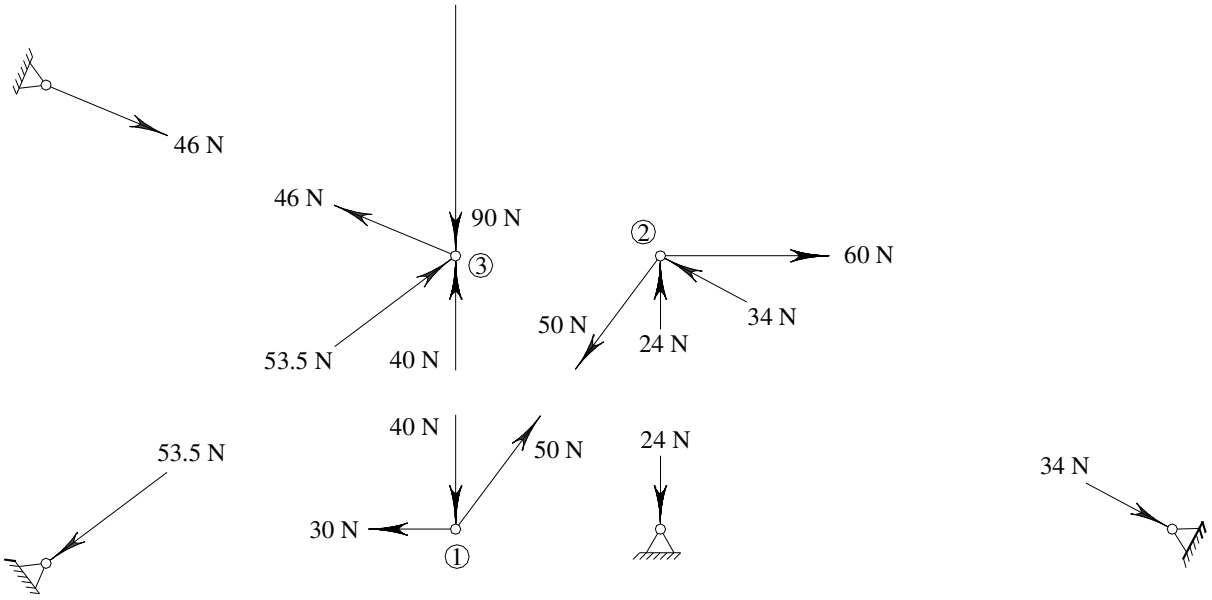
Čvor 2



Čvor 3



Skica stvarnih djelovanja



Samostalno riješiti analitički!