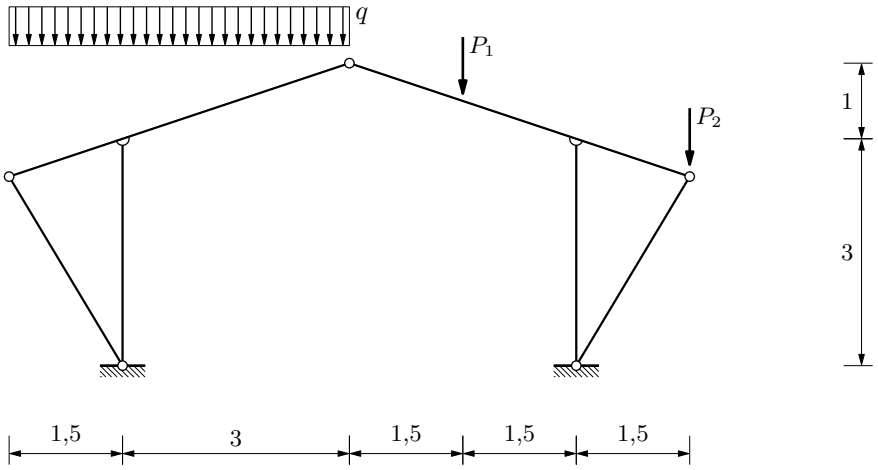
Trozglobni sistem (sa zategama) – superpozicijski postupak

Superpozicijskim postupkom nacrtajte momentni dijagram! Na temelju diferencijalnoga odnosa nacrtajte dijagram poprečnih sila, a potom primjenom uvjetā ravnoteže dijagram uzdužnih sila!

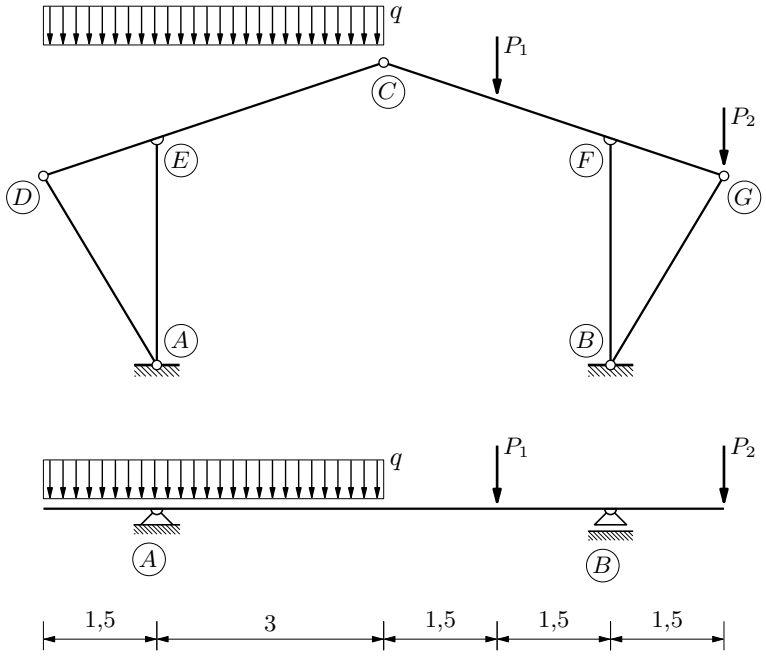
$P_1 = 125\,\text{kN}$

$P_2 = 62{,}5\,\text{kN}$

$q = 75\,\text{kN/m}$



zamjenjujuća jednostavno oslonjena greda s prepustima:



dijagram M^0:

(afina preslikavanja verižnoga poligona: $M^0(x) = H\,w(x),$ osi stranice 5, 0 i 4)

$Q_1 \;=\; 75 \cdot 1{,}5 \;=\; 112{,}5\,\mathrm{kN}$

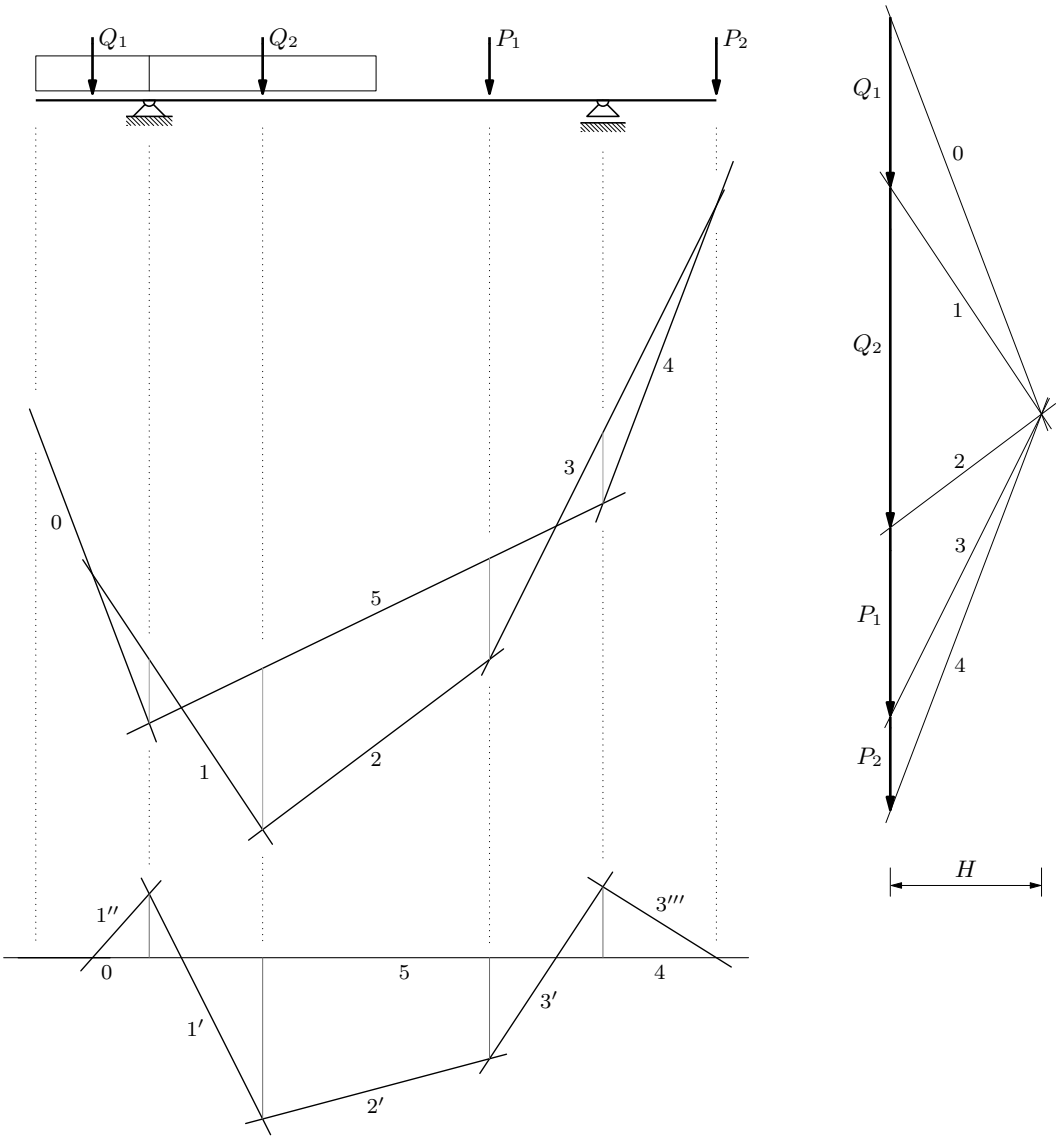
$Q_2 \;=\; 75 \cdot 3 \;=\; 225\,\mathrm{kN}$

$H \;=\; 100\,\mathrm{kN}$

mjerilo duljina: $1\,\mathrm{cm} \;::\; 1\,\mathrm{m}$

mjerilo sila: $1\,\mathrm{cm} \;::\; 50\,\mathrm{kN}$

mjerilo momenata: $1\,\mathrm{cm} \;::\; 100\,\mathrm{kNm} \quad \big(= H \cdot 1\,[\mathrm{m}] \;=\; 100\,[\mathrm{kN}] \cdot 1\,[\mathrm{m}]\big)$

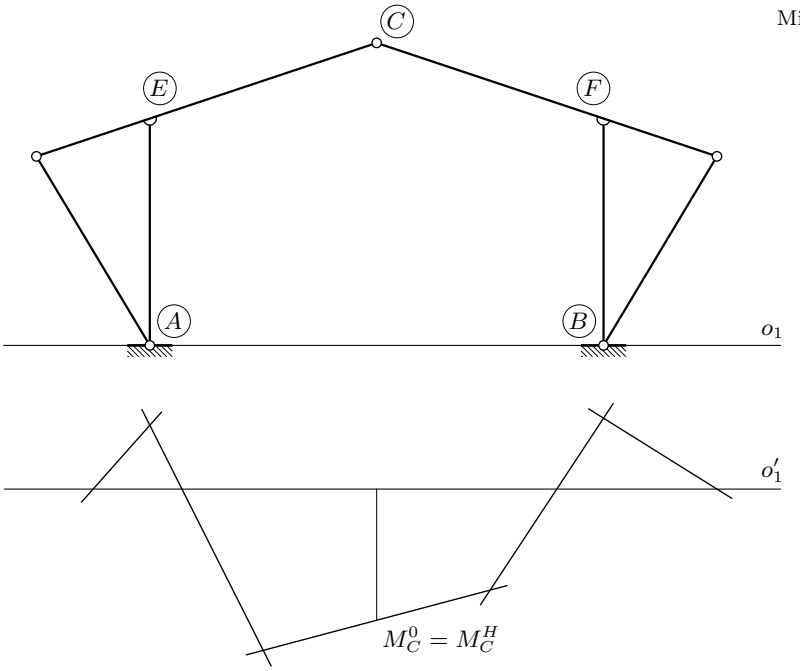


(dijagram M^0 nije dovršen (i ne treba biti dovršen) — na dijelu pod distribuiranim opterećenjem nacrtan je samo tangentni poligon)

dijagram M^H na dijelu nosača između točaka E i F:

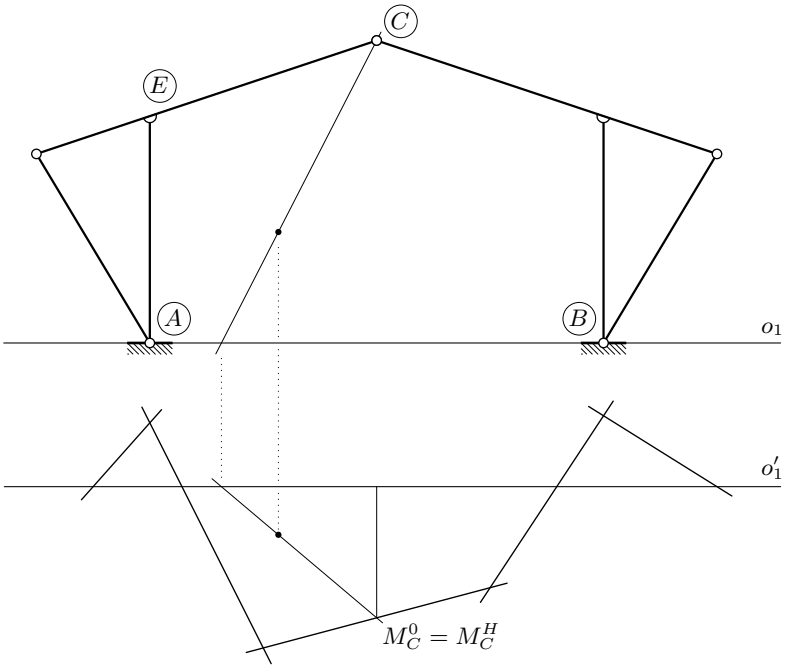
os (o_1) i par pridruženih točaka $(C \;\&\; M_C^0 = M_C^H)$ afinoga preslikavanja konture nosača:

> ... sobom vleče s kožum preslečene knjige.
> Čtavce, falot, vara, knigu za tri lige
> terži svoje laži, norije, cigumige,
> šegavi fkanljivec, kaj nam ni dost brige?
> Z te scoprane norije šantavi van luče ...
>
> Miroslav Krleža: *Komendrijaši*

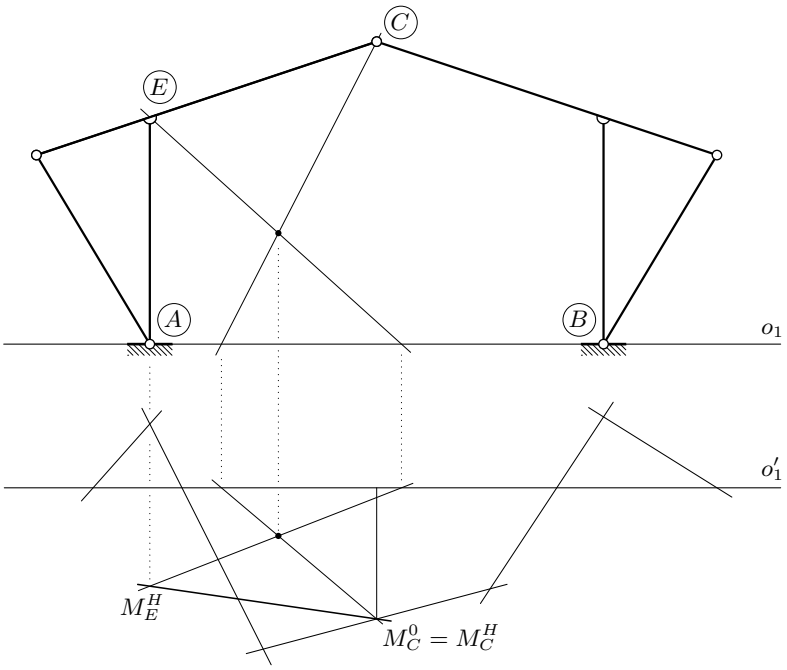


pomoćna točka za preslikavanje točke E:

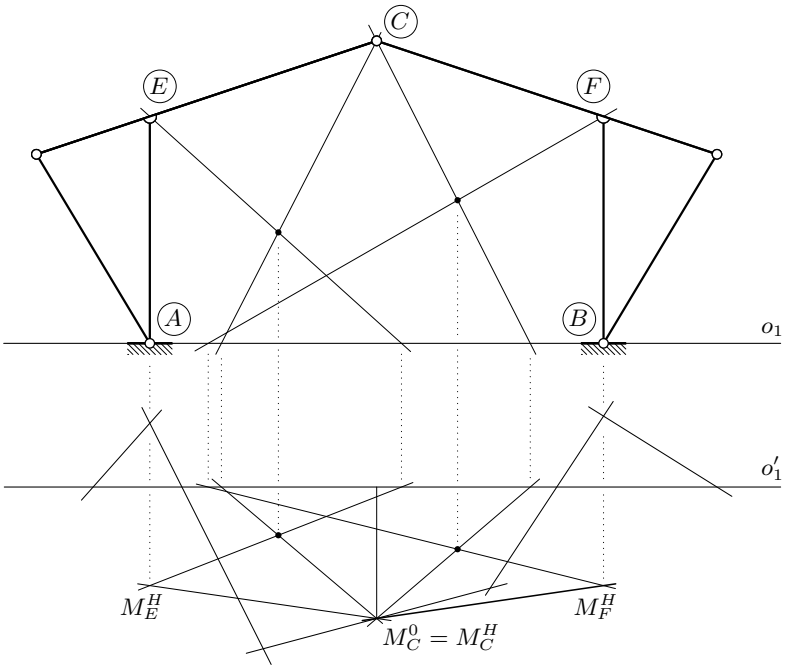
(jer se pravac kroz točke C i E i os o_1 sijeku izvan papira)



preslikavanje točke E i štapa E–C:



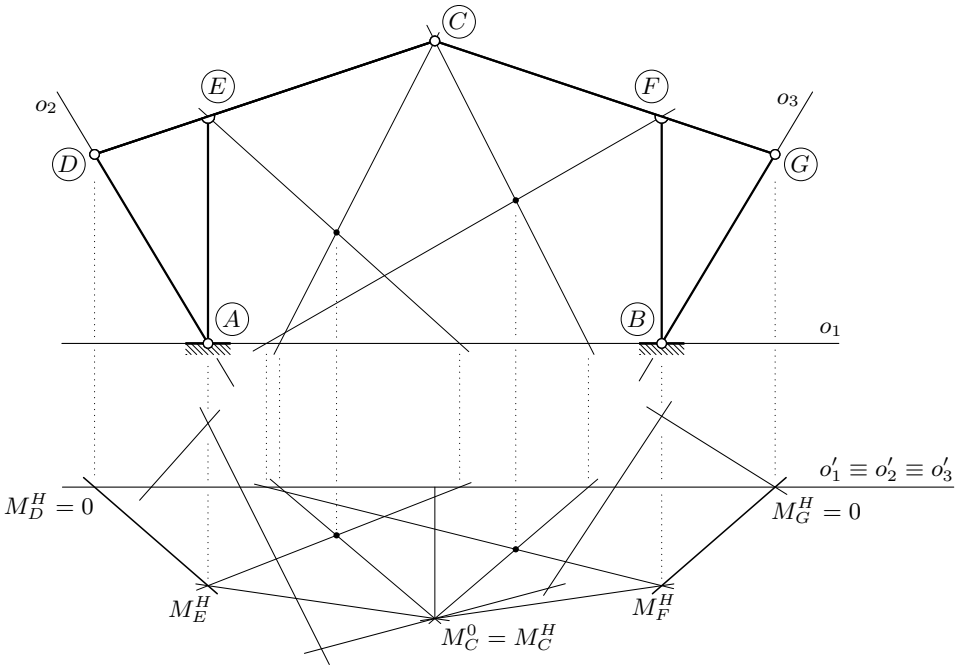
preslikavanje točke F i štapa C–F:



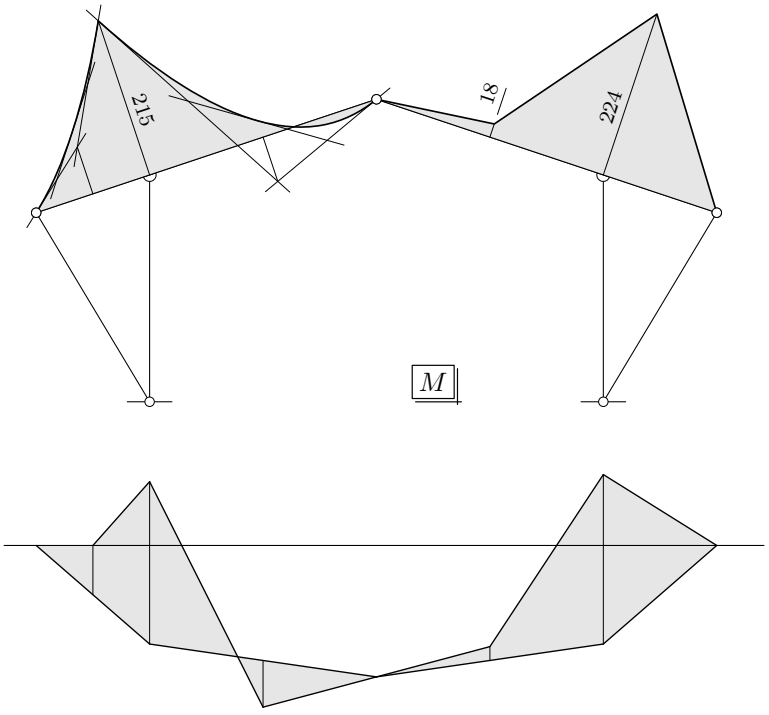
dijagram M^H na dijelovima nosača lijevo od točke E i desno od točke F:

lijevo: os afinoga preslikavanja o_2, pridružene točke E i M_E^H

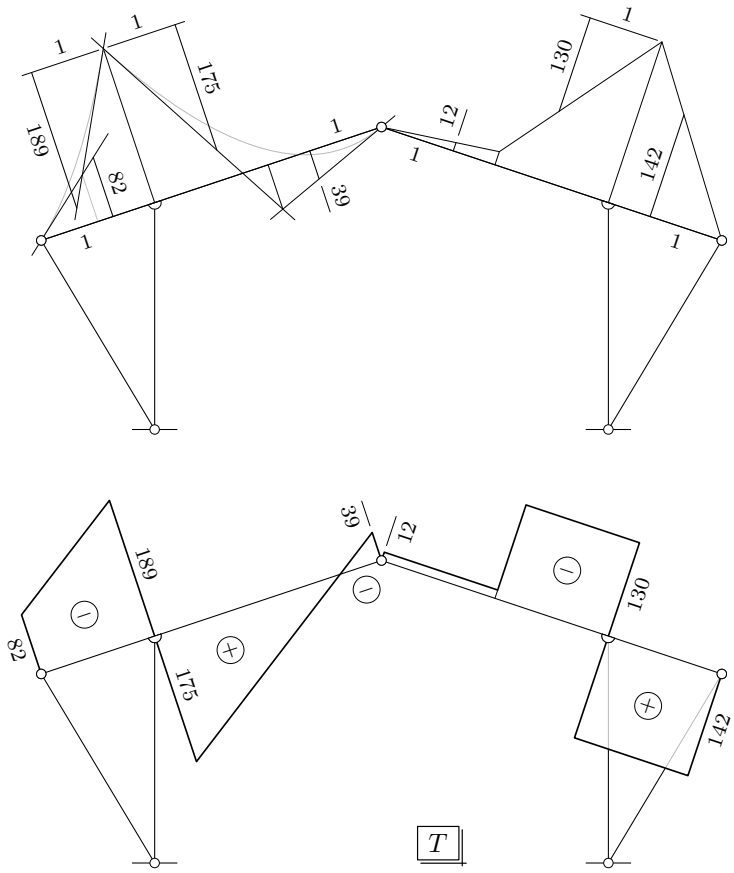
desno: os afinoga preslikavanja o_3, pridružene točke F i M_F^H



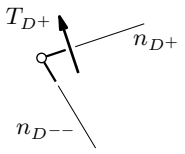
„razlika" dijagramā M^0 i M^H & dijagram M na osima štapova nosača:

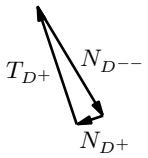


$T = M'$ & dijagram T:



vrijednosti uzdužnih sila (grafički):



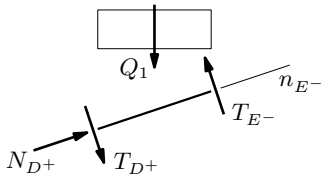


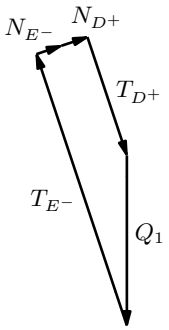
mjerilo sila: 1 cm :: 50 kN

očitano:

$N_{D^{--}} = 84\,\text{kN}$ (vlak)

$N_{D^+} = 18\,\text{kN}$ (tlak)



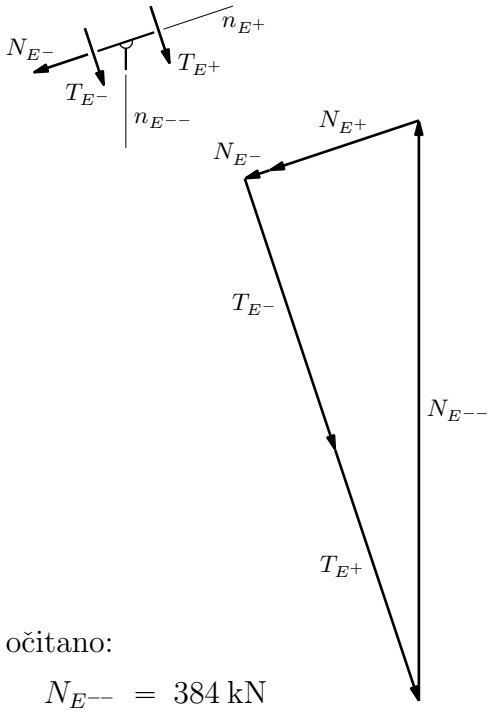


očitano:

$N_{E^-} = 17\,\text{kN}$ (vlak)

(kao kontrola:

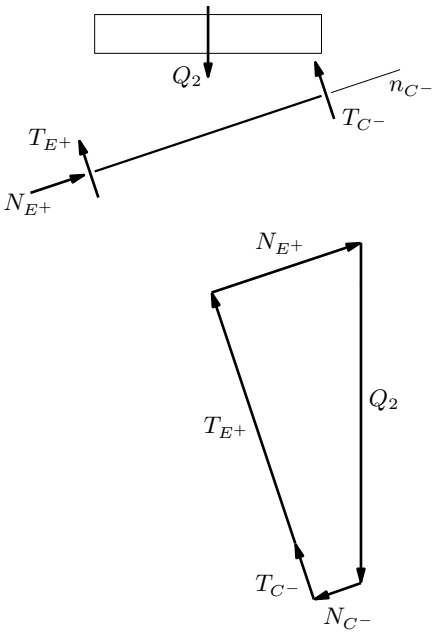
pravac djelovanja sile N_{E^-} mora se u poligonu sila poklopiti s pravcem djelovanja sile N_{D^+})



očitano:

$N_{E--} = 384\,\text{kN}$ (tlak)

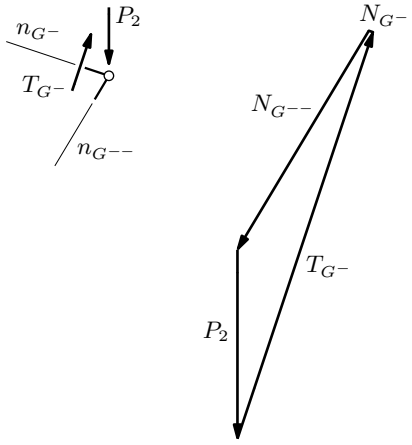
$N_{E+} = 104\,\text{kN}$ (tlak)



očitano:

$N_{C-} = 33\,\text{kN}$ (tlak)

(kao kontrola:
pravac djelovanja sile N_{C-} mora
u poligonu sila biti usporedan
s pravcem djelovanja sile N_{E+})

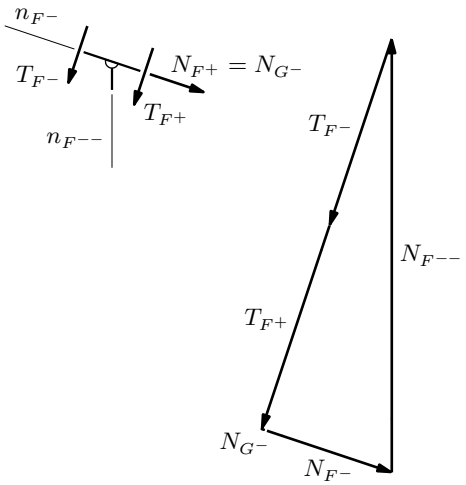


mjerilo sila: 1 cm :: 25 kN

očitano:

$N_{G--} = 84\,\text{kN}$ (vlak)

$N_{G-} = 1\,\text{kN}$ (vlak)

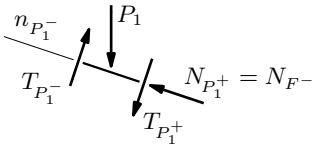


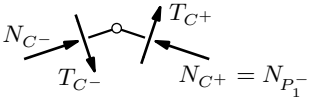
mjerilo sila: 1 cm :: 50 kN

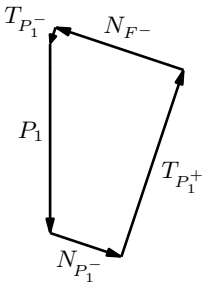
očitano:

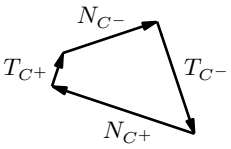
$N_{F--} = 287\,\text{kN}$ (tlak)

$N_{F-} = 89\,\text{kN}$ (tlak)









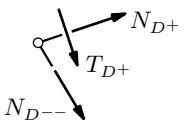
... i konačna kontrola:
poligon sila koje djeluju na zglob C mora biti zatvoren

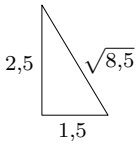
očitano:

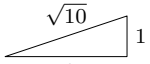
$N_{P_1^-} = 50\,\mathrm{kN}$ (tlak)

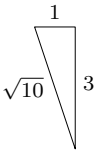
(kao kontrola:
u poligonu sila moraju pravci djelovanjā sila $N_{P_1^-}$ i $N_{P_1^+} = N_{F-}$ biti usporedni)

ili: vrijednosti uzdužnih sila (analitički):







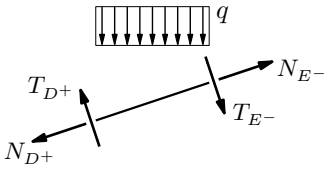


$$\left.\begin{aligned} N^{\mathrm{h}}_{D--} + N^{\mathrm{h}}_{D+} + T^{\mathrm{h}}_{D+} &= 0 \\ N^{\mathrm{v}}_{D--} - N^{\mathrm{v}}_{D+} + T^{\mathrm{v}}_{D+} &= 0 \end{aligned}\right\}$$

$$\left.\begin{aligned} \frac{1{,}5}{\sqrt{8{,}5}}\,N_{D--} + \frac{3}{\sqrt{10}}\,N_{D+} + \frac{1}{\sqrt{10}}\,T_{D+} &= 0 \\ \frac{2{,}5}{\sqrt{8{,}5}}\,N_{D--} - \frac{1}{\sqrt{10}}\,N_{D+} + \frac{3}{\sqrt{10}}\,T_{D+} &= 0 \end{aligned}\right\}$$

$$\left.\begin{aligned} \frac{1{,}5}{\sqrt{8{,}5}}\,N_{D--} + \frac{3}{\sqrt{10}}\,N_{D+} &= -\frac{1}{\sqrt{10}}\,(-82) \\ \frac{2{,}5}{\sqrt{8{,}5}}\,N_{D--} - \frac{1}{\sqrt{10}}\,N_{D+} &= -\frac{3}{\sqrt{10}}\,(-82) \end{aligned}\right\}$$

$N_{D--} = 84\,\mathrm{kN}$ & $N_{D+} = -18\,\mathrm{kN}$



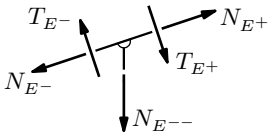
$$-N^{\mathrm{h}}_{D+} - T^{\mathrm{h}}_{D+} + N^{\mathrm{h}}_{E-} + T^{\mathrm{h}}_{E-} = 0$$

$$-3\,N_{D+} - T_{D+} + 3\,N_{E-} + T_{E-} = 0 \qquad \text{(pomnoženo s } \sqrt{10}\text{)}$$

$$3\,N_{E-} = 3\,N_{D+} + T_{D+} - T_{E-}$$

$$3\,N_{E-} = 3\,(-18) + (-82) - (-189)$$

$$N_{E-} = 18\,\mathrm{kN}$$



$$\left.\begin{aligned} -N^{\mathrm{h}}_{E-} - T^{\mathrm{h}}_{E-} + N^{\mathrm{h}}_{E+} + T^{\mathrm{h}}_{E+} &= 0 \\ N^{\mathrm{v}}_{E-} - T^{\mathrm{v}}_{E-} + N_{E--} - N^{\mathrm{v}}_{E+} + T^{\mathrm{v}}_{E+} &= 0 \end{aligned}\right\}$$

$$\left.\begin{aligned} -3\,N_{E-} - T_{E-} + 3\,N_{E+} + T_{E+} &= 0 \\ N_{E-} - 3\,T_{E-} + \sqrt{10}\,N_{E--} - N_{E+} + 3\,T_{E+} &= 0 \end{aligned}\right\}$$

$$\left.\begin{aligned} 3\,N_{E+} &= 3\,N_{E-} + T_{E-} - T_{E+} \\ \sqrt{10}\,N_{E--} &= -N_{E-} + 3\,T_{E-} + N_{E+} - 3\,T_{E+} \end{aligned}\right\}$$

$$3\,N_{E+} = 3 \cdot 18 + (-189) - 175$$

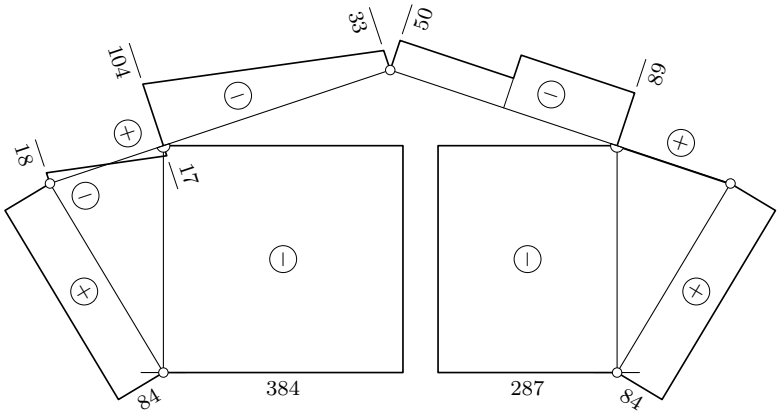
$$N_{E+} = -103\,\mathrm{kN}$$

$$\sqrt{10}\,N_{E--} = -18 + 3 \cdot (-189) + (-103) - 3 \cdot 175$$

$$N_{E--} = -384\,\mathrm{kN}$$

&td. — domaća zabava . . . & usporedite rezultate s rezultatima grafičkoga postupka

dijagram N:



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