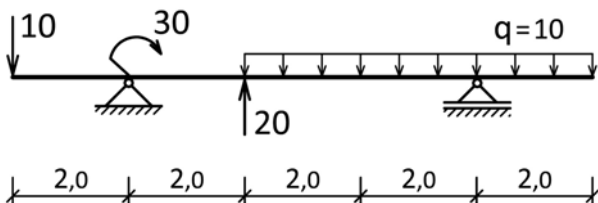


ГРАЂЕВИНСКИ ФАКУЛТЕТ УНИВЕРЗИТЕТА У БЕОГРАДУ
 Усмени (теоријски) део испита из **ТЕХНИЧКЕ МЕХАНИКЕ 1**
 (писмени део одржан 27.06.2019.)

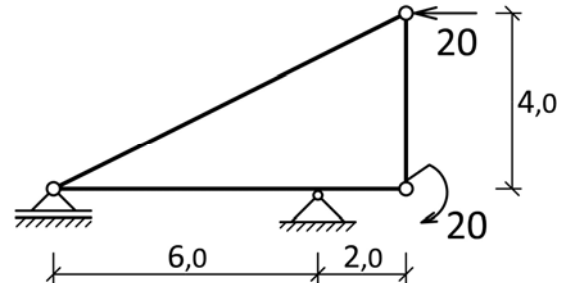
1. ЗАДАТАК (условни 50 %)

Нацртати дијаграме сила у пресеку за приказане носаче.

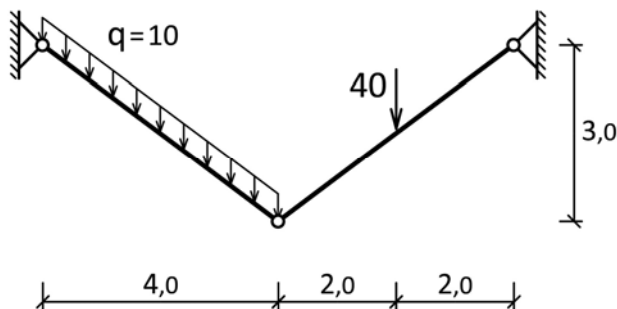
а)



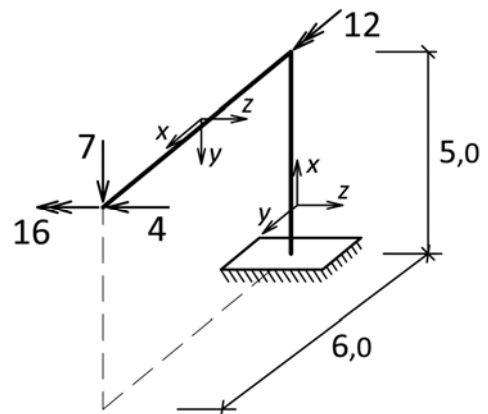
б)



в)



г)



2. ЗАДАТАК (30 %)

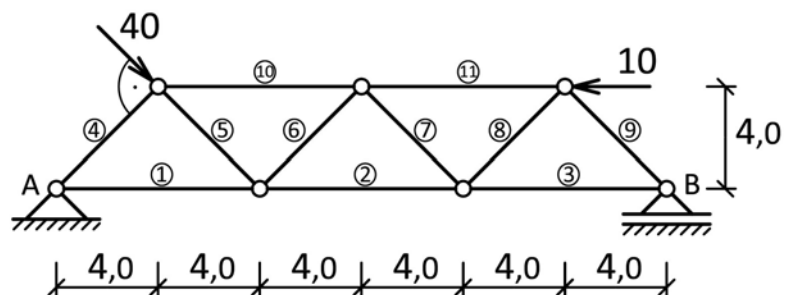
а) Приказати формулу за одређивање броја степени слободе кретања решеткастих носача у равни

б) За приказани решеткасти носач одредити:

* силе у штаповима 5, 6 и 10 применом методе равнотеже чворова.

* силе у штаповима 3, 8 и 11 применом Ритеровог поступка.

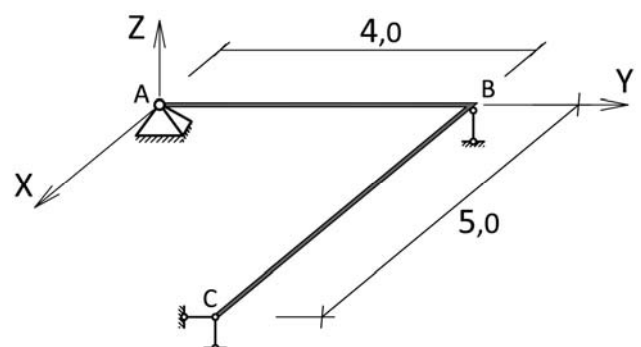
* силу у штапу 2 применом опште једначине статике.



3. ЗАДАТАК (20 %)

а) Објаснити појам доброг и лошег распореда веза код линијских система са $n=0$.

б) За приказани просторни носач испитати да ли су везе добро или лоше распоређене.



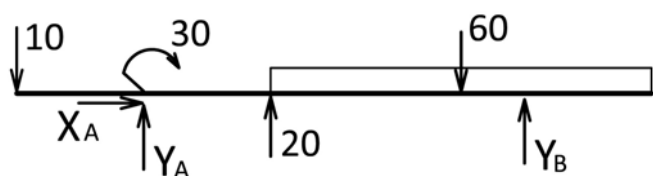
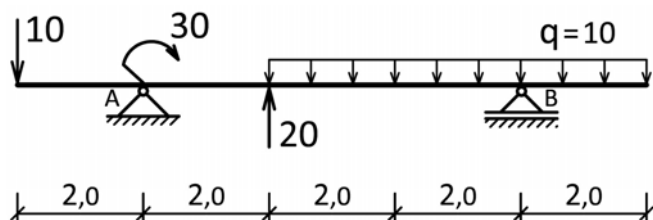
Напомена: У свим задацима димензије за дужине и силе су: m, N

ГРАЂЕВИНСКИ ФАКУЛТЕТ УНИВЕРЗИТЕТА У БЕОГРАДУ
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 (писмени део одржан 27.06.2019.)

- Р Е Ш Е Њ А -

1. ЗАДАТАК (условни 50 %)

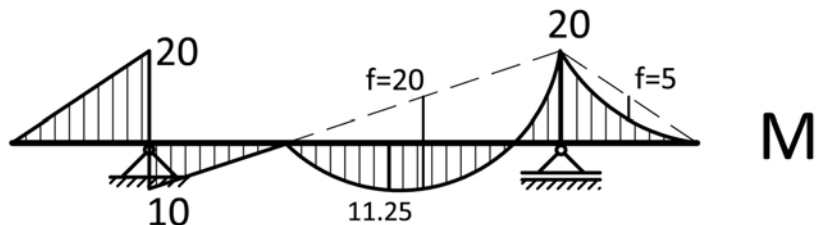
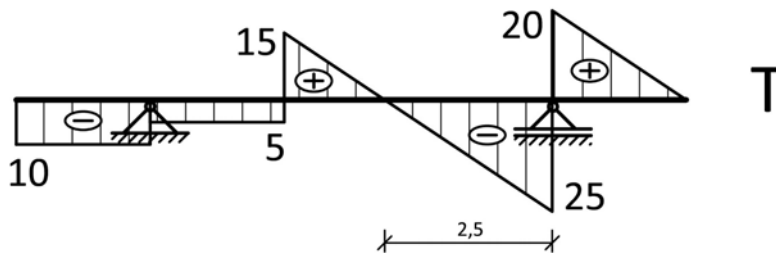
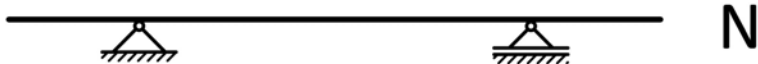
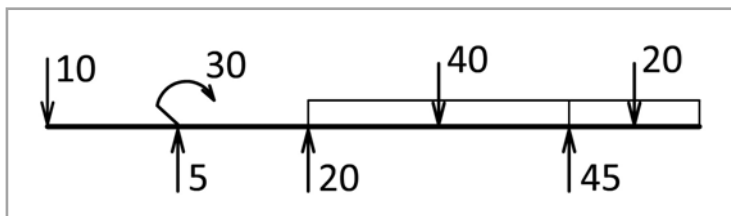
a)



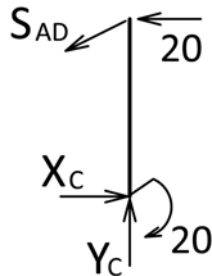
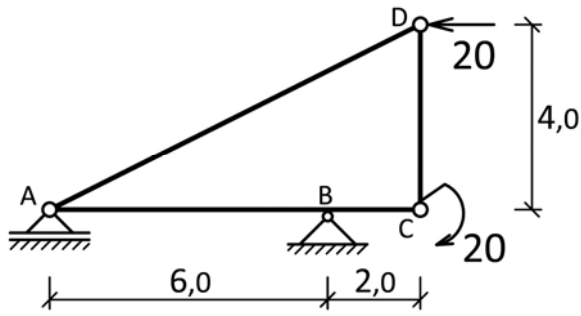
$$\sum F_x = 0 : X_A = 0$$

$$\sum M_A = 0 : Y_B \cdot 6 - 60 \cdot 5 + 20 \cdot 2 - 30 + 10 \cdot 2 = 0 \rightarrow Y_B = 45$$

$$\sum F_y = 0 : Y_A + Y_B - 60 + 20 - 10 = 0 \rightarrow Y_A = 5$$



6)

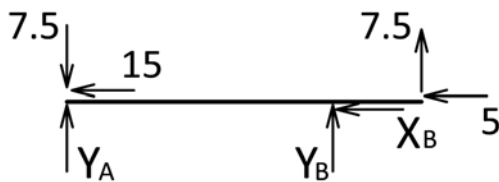


$$\sum M_C = 0 : 0.894 \cdot S_{AD} \cdot 4 + 20 \cdot 4 - 20 = 0 \rightarrow \underline{S_{AD} = -16.770}$$

(0.447S_{AB}=7.5; 0.894S_{AB}=15)

$$\sum F_Y = 0 : Y_C - 0.447 \cdot S_{AD} = 0 \rightarrow \underline{Y_C = -7.5}$$

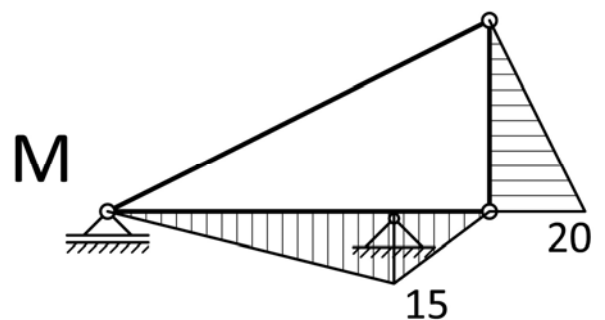
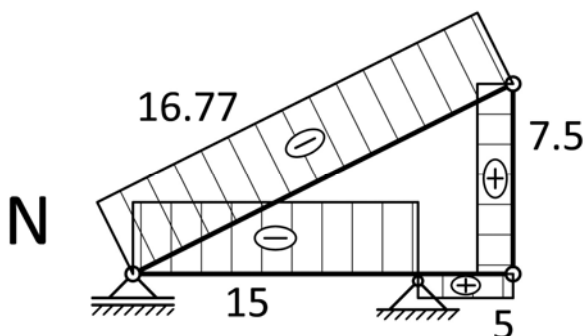
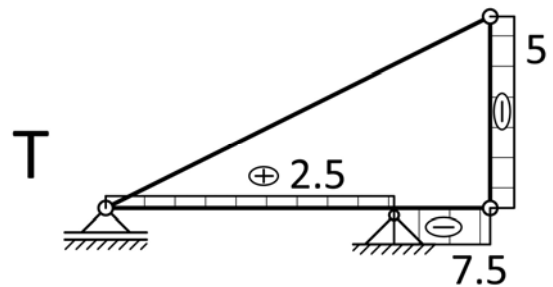
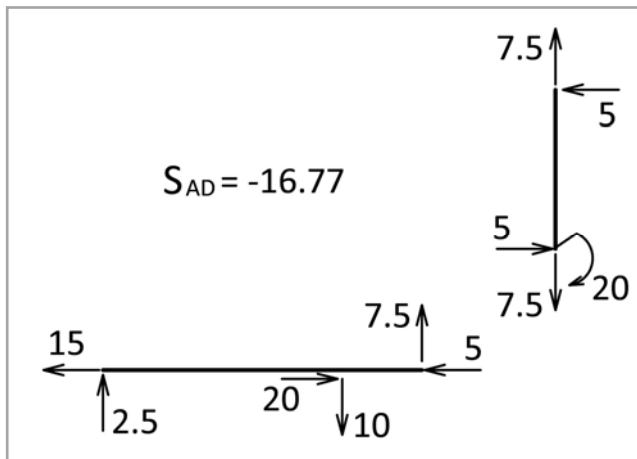
$$\sum F_X = 0 : X_C - 0.894 \cdot S_{AD} - 20 = 0 \rightarrow \underline{X_C = 5}$$

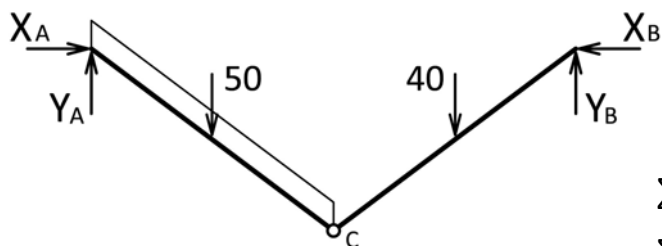
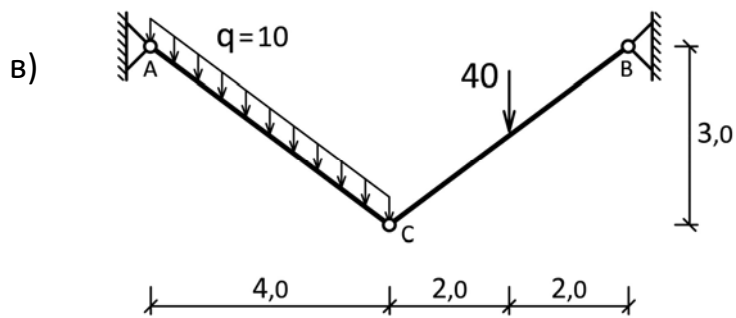


$$\sum F_X = 0 : -X_B - 15 - 5 = 0 \rightarrow \underline{X_B = -20}$$

$$\sum M_A = 0 : Y_B \cdot 6 + 7.5 \cdot 8 = 0 \rightarrow \underline{Y_B = -10}$$

$$\sum F_Y = 0 : Y_A + Y_B - 7.5 + 7.5 = 0 \rightarrow \underline{Y_A = 10}$$



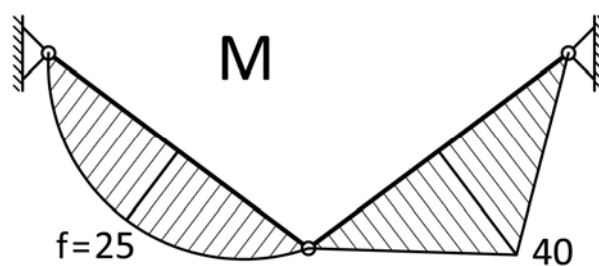
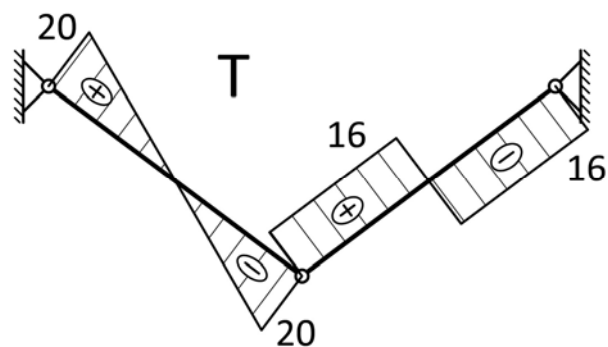
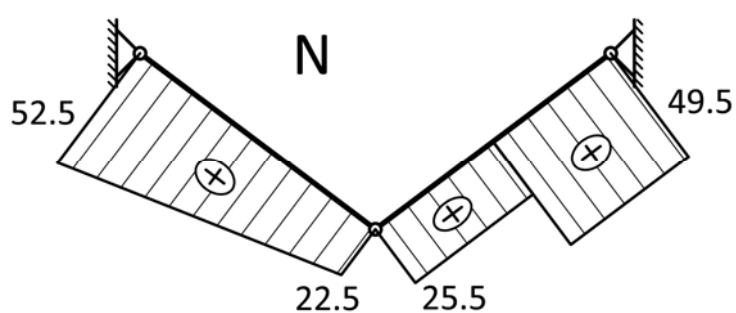
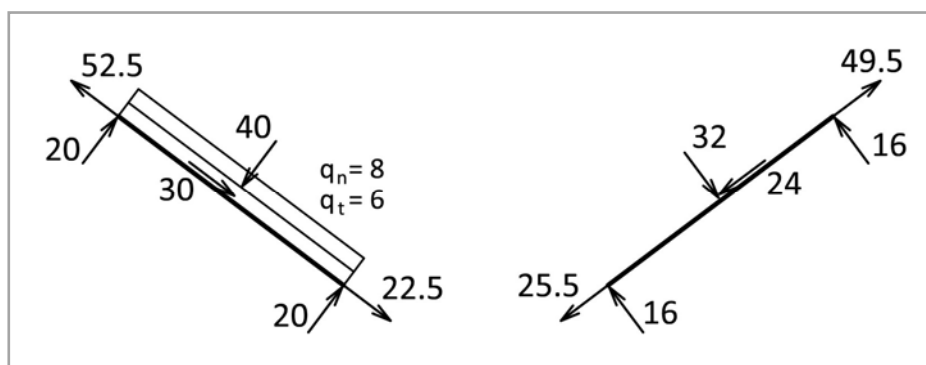


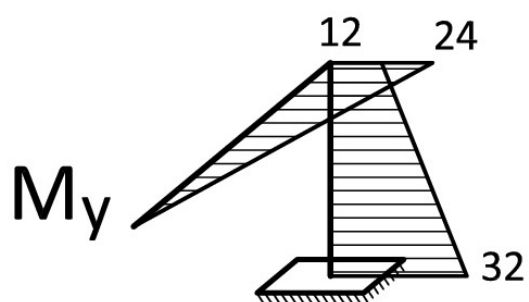
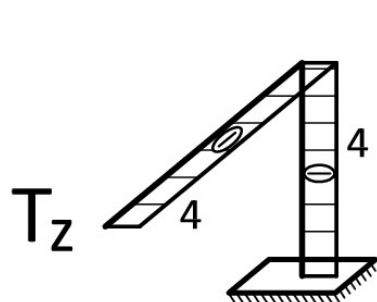
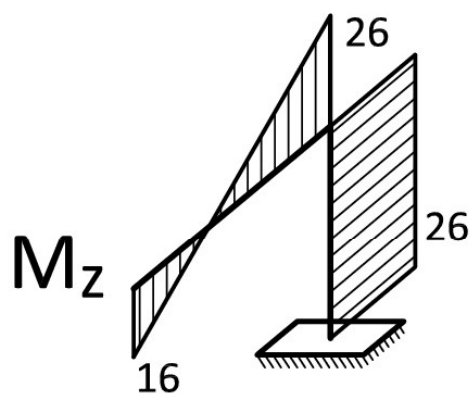
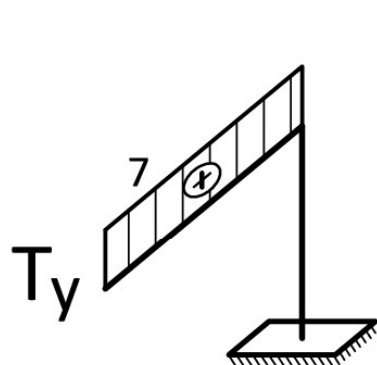
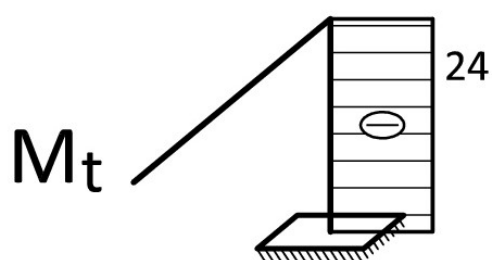
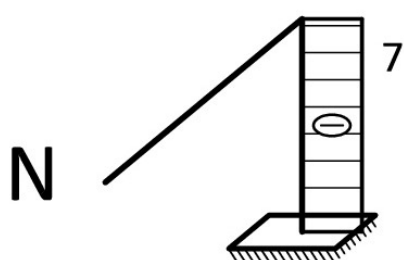
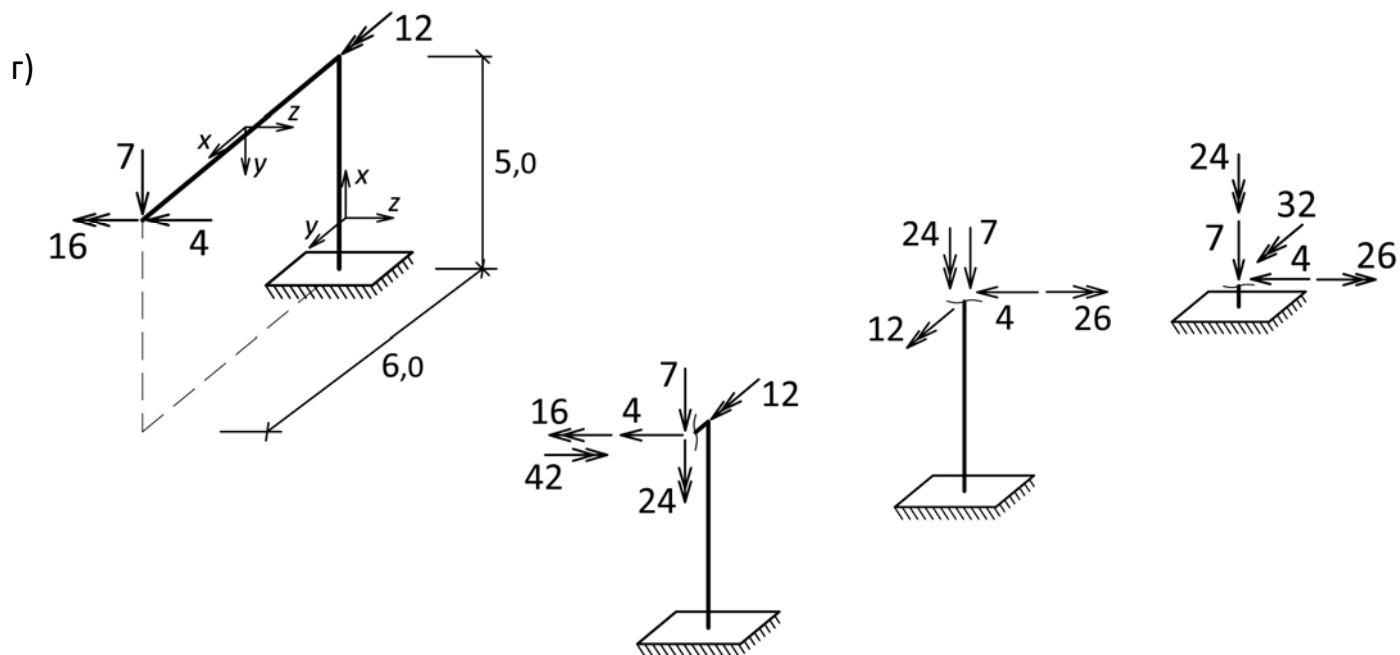
$$\sum M_A = 0 : Y_B \cdot 8 - 40 \cdot 6 - 50 \cdot 2 = 0 \rightarrow \underline{Y_B = 42.5}$$

$$\sum F_Y = 0 : Y_A + Y_B - 50 - 40 = 0 \rightarrow \underline{Y_A = 47.5}$$

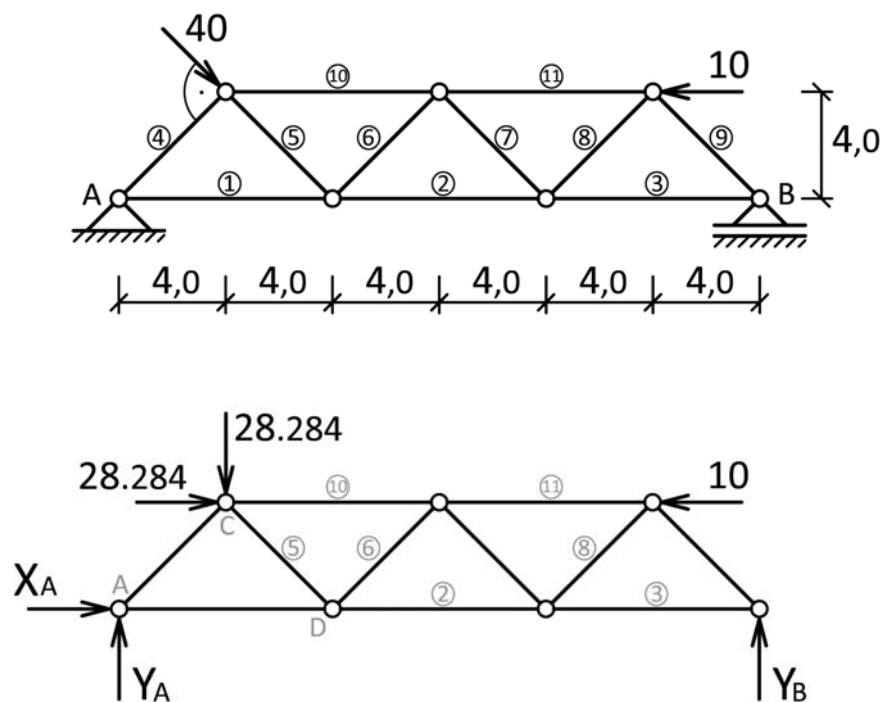
$$\sum M_{C, \text{dec}} = 0 : X_B \cdot 3 + Y_B \cdot 4 - 40 \cdot 2 = 0 \rightarrow \underline{X_B = -30}$$

$$\sum F_X = 0 : X_A - X_B = 0 \rightarrow \underline{X_A = -30}$$





2. ЗАДАТАК (30 %)



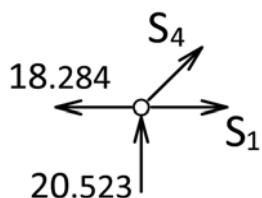
$$\sum F_x = 0 : X_A + 28.284 - 10 = 0 \rightarrow \underline{X_A = -18.284}$$

$$\sum M_A = 0 : Y_B \cdot 24 + 10 \cdot 4 - 28.284 \cdot 4 - 28.284 \cdot 4 = 0 \rightarrow \underline{Y_B = 7.761}$$

$$\sum F_y = 0 : Y_A + Y_B - 28.284 = 0 \rightarrow \underline{Y_A = 20.523}$$

б) Метода равнотеже чворова:

Чвор А:

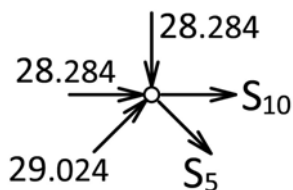


$$\sum F_y = 0 : 0.707 \cdot S_4 + 20.523 = 0 \rightarrow S_4 = -29.024$$

$$\sum F_x = 0 : S_1 + 0.707 \cdot (-29.024) - 18.284 = 0$$

$$\rightarrow S_1 = 38.807$$

Чвор С:

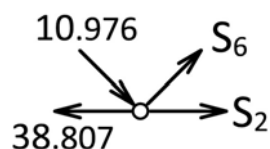


$$\sum F_y = 0 : -0.707 \cdot S_5 + 0.707 \cdot 29.024 - 28.284 = 0$$

$$\rightarrow \underline{S_5 = -10.976}$$

$$\sum F_x = 0 : S_{10} + 0.707 \cdot (-10.976) + 0.707 \cdot (29.024) + 28.284 = 0 \rightarrow \underline{S_{10} = -41.046}$$

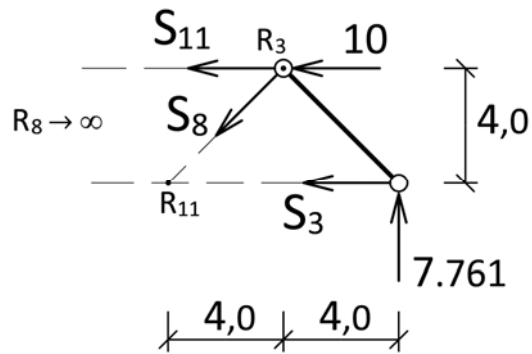
Чвор D:



$$\sum F_y = 0 : 0.707 \cdot S_6 - 0.707 \cdot 10.976 = 0 \rightarrow \underline{S_6 = 10.976}$$

$$\sum F_x = 0 : S_2 + 0.707 \cdot (10.976) + 0.707 \cdot (10.976) - 38.807 = 0 \rightarrow S_2 = 23.284$$

Ритеров поступак:



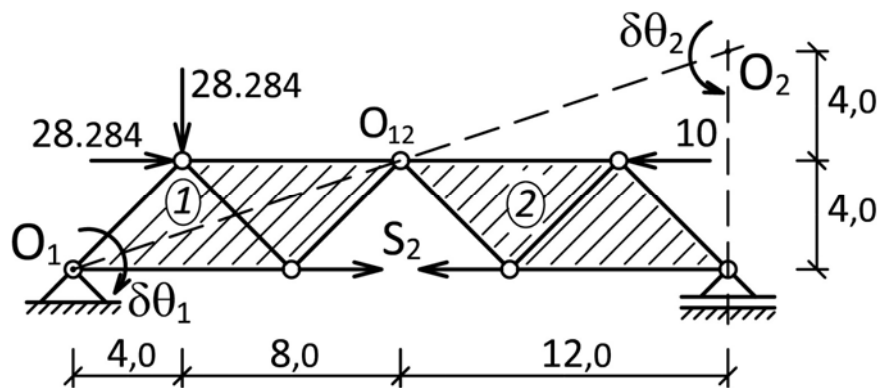
$$\sum M_{R3} = 0 : S_3 \cdot 4 - 7.761 \cdot 4 = 0 \rightarrow \underline{S_3 = 7.761} \text{ (затегнут штап)}$$

$$\sum F_Y = 0 : -0.707 \cdot S_8 + 7.761 = 0 \rightarrow \underline{S_8 = 10.976} \text{ (затегнут штап)}$$

$$\sum M_{R11} = 0 : S_{11} \cdot 4 + 10 \cdot 4 + 7.761 \cdot 8 = 0 \rightarrow \underline{S_{11} = -25.522} \text{ (притиснут штап)}$$

Примена опште једначине статике:

$S_2 = ?$



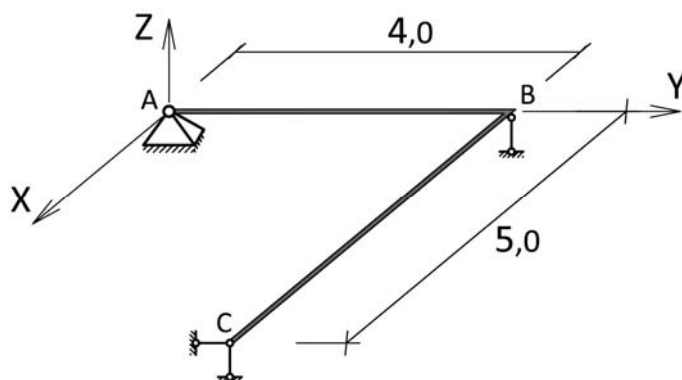
$$\delta r_{O12,Y} = \delta \theta_1 \cdot 12 = \delta \theta_2 \cdot 12 \rightarrow \delta \theta_1 = \delta \theta_2$$

$$\delta A = 28.284 \cdot (4 \cdot \delta \theta_1) + 28.284 \cdot (4 \cdot \delta \theta_1) - 10 \cdot (4 \cdot \delta \theta_2) - S_2 \cdot (8 \cdot \delta \theta_2) = 0$$

$$-8 \cdot S_2 \cdot \delta \theta_1 + 186.27 \cdot \delta \theta_1 = 0 \rightarrow \underline{S_2 = 23.284} \text{ (затегнут штап)}$$

3. ЗАДАТАК (20 %)

б)



$$\vec{\rho}_B = \overrightarrow{AB} = \{0, 4, 0\}$$

$$\vec{\rho}_C = \overrightarrow{AC} = \{5, 4, 0\}$$

Једначине везе:

$$\delta \vec{\rho}_A = 0, \quad \delta \vec{\rho}_B \cdot \vec{k} = 0, \quad \delta \vec{\rho}_C \cdot \vec{j} = 0, \quad \delta \vec{\rho}_C \cdot \vec{k} = 0$$

$$\delta \vec{\rho}_B = \delta \vec{\rho}_A + \delta \vec{\theta} \times \vec{\rho}_B = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ \delta \theta_x & \delta \theta_y & \delta \theta_z \\ 0 & 4 & 0 \end{vmatrix} = \{-4\delta \theta_z, 0, 4\delta \theta_x\}$$

$$\delta \vec{\rho}_C = \delta \vec{\rho}_A + \delta \vec{\theta} \times \vec{\rho}_C = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ \delta \theta_x & \delta \theta_y & \delta \theta_z \\ 5 & 4 & 0 \end{vmatrix} = \{-4\delta \theta_z, 5\delta \theta_z, 4\delta \theta_x - 5\delta \theta_y\}$$

$$\delta \rho_{B,z} = \delta \vec{\rho}_B \cdot \vec{k} = 4\delta \theta_x = 0$$

$$\delta \rho_{C,y} = \delta \vec{\rho}_C \cdot \vec{j} = 5\delta \theta_z = 0$$

$$\delta \rho_{C,z} = \delta \vec{\rho}_C \cdot \vec{k} = 4\delta \theta_x - 5\delta \theta_y = 0$$

$$\Rightarrow \begin{bmatrix} 4 & 0 & 0 \\ 0 & 0 & 5 \\ 4 & -5 & 0 \end{bmatrix} \begin{Bmatrix} \delta \theta_x \\ \delta \theta_y \\ \delta \theta_z \end{Bmatrix} = \begin{Bmatrix} 0 \\ 0 \\ 0 \end{Bmatrix} \Rightarrow \det A = 100 \neq 0$$

\Rightarrow Постоји само тривијално решење $\delta \theta_x = \delta \theta_y = \delta \theta_z = 0$,
што значи да су везе ДОБРО РАСПОРЕЂЕНЕ,
а приказани систем може да функционише као носач.