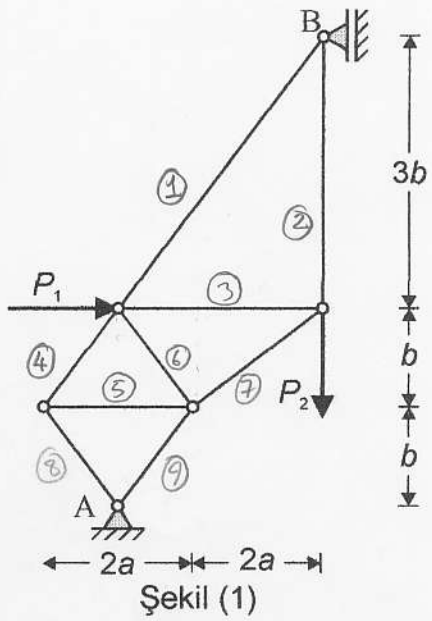
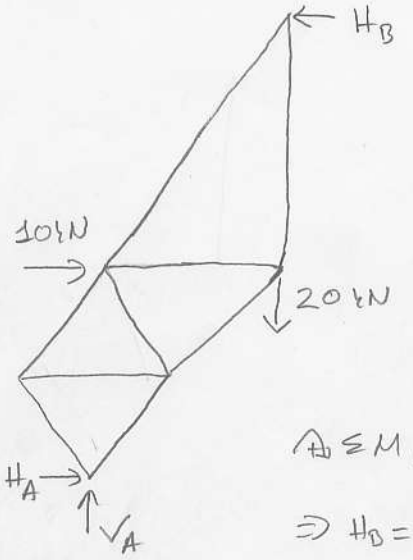
Statik Vize 2 (19.04.'06)
Prof. Dr. Reha ARTAN
Dersin yardımcısı: Akif KUTLU

Soru(1): Şekil (1)' de verilen kafes sisteminde bütün çubuk kuvvetlerini hesaplayınız.
(a=3m, b=4m, P_1=10kN, P_2=20kN)



Şekil (1)

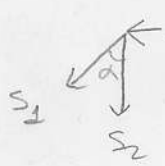


$\curvearrowleft_B \Sigma M_A = 0 \Rightarrow 20.9 - H_B.20 + 10.8 = 0$

$\Rightarrow H_B = 13\,kN$ $\quad \pm \Sigma F_x = 0 \Rightarrow H_A + 10 - 13 = 0$

$\Rightarrow H_A = 3\,kN$ $\quad +\uparrow \Sigma F_y = 0 \Rightarrow V_A - 20 = 0 \Rightarrow V_A = 20\,kN$

B noktasında denge yazılırsa



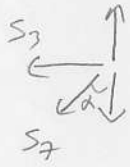
$\pm \Sigma F_x = 0$

$S_1 . \sin\alpha + 13 = 0 \quad S_1 . \frac{3}{5} + 13 = 0 \Rightarrow S_1 = -21,66\,kN$ //

$+\downarrow \Sigma F_y = 0 \Rightarrow S_2 + S_1 . \frac{4}{5} = 0 \quad S_2 - 21,66 . \frac{4}{5} = 0$

$\Rightarrow S_2 = 17,328\,kN$ //

P_2'nin etkidiği noktada

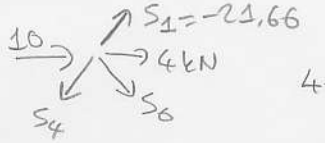


$+\uparrow \Sigma F_y = 0 \Rightarrow 17,328 - 20 - S_7 . 0,5547 = 0$ ($\rightarrow \cos\alpha$)

$\Rightarrow S_7 = -4,817\,kN$ // $\quad \pm \Sigma F_x = 0 \Rightarrow$

$-S_3 - S_7 . 0,832 = 0 \quad -S_3 + 4,817 . 0,832 = 0 \quad S_3 = 4\,kN$ //

P_1'in etkidiği noktada



$\pm \Sigma F_x = 0 \Rightarrow$

$4 + S_6 . \frac{3}{5} - S_4 . \frac{3}{5} + 10 - 21,66 . \frac{3}{5} = 0$

$S_6 - S_4 = -1,673 \quad +\uparrow \Sigma F_y = 0 \Rightarrow -21,66 . \frac{4}{5} - S_4 . \frac{4}{5} - S_6 . \frac{4}{5} = 0 \Rightarrow$

$S_4 = -10\,kN$ // $\quad S_6 = -11,66\,kN$ //

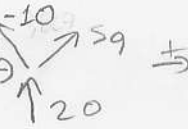
④,⑤,⑧ kesişiminde $\rightarrow -10\,(S_4)$ $\quad +\uparrow \Sigma F_y = 0 \Rightarrow -10 . \frac{4}{5} - S_8 . \frac{4}{5} = 0 \Rightarrow S_8 = -10\,kN$ //

$\rightarrow S_5$

$\searrow S_8$

$\rightarrow \Sigma F_x = 0 \Rightarrow -10 . \frac{3}{5} + S_5 - 10 . \frac{3}{5} = 0 \Rightarrow S_5 = 12\,kN$ //

A noktasında



$\pm \Sigma F_x = 0 \Rightarrow S_9 . \frac{3}{5} + 3 + 10 . \frac{3}{5} = 0 \Rightarrow S_9 = -15\,kN$ //

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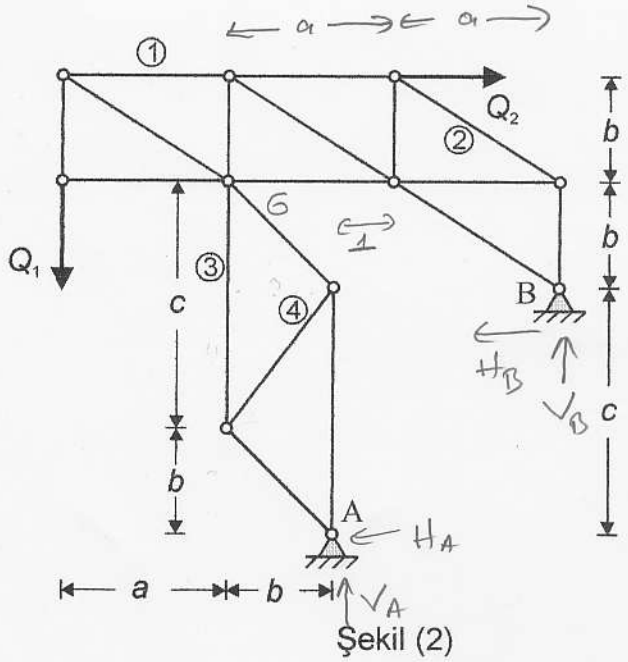
Soru(2): Şekil(2)' de verilen kafes taşıyıcı sistemde numaralandırılmış çubuk kuvvetlerini hesaplayınız.
(a=4m, b=3m, c=7m, Q_1=8kN, Q_2=10kN)

Q_1=10kN Q_2=8kN



Şekil (2)

$\curvearrowleft \Sigma M_B = 0 \Rightarrow$

$H_A \cdot 10 - V_A \cdot 3 = 0$

$\curvearrowright \Sigma M_B = 0 \Rightarrow$

$V_A \cdot 5 + H_A \cdot 7 + Q_2 \cdot 6 - Q_1 \cdot 12 = 0$

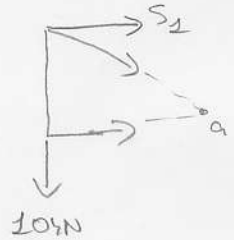
$5V_A + 7H_A + 48 - 120 = 0$

$\Rightarrow H_A = 3{,}042$ kN

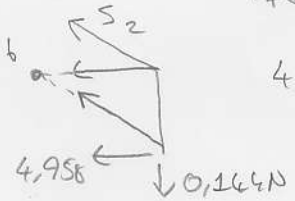
$V_A = 10{,}14$ kN

$\rightarrow \Sigma F_x = 0 \Rightarrow \quad Q_2 - H_B - H_A = 0 \quad 8 - H_B - 3{,}042 = 0 \Rightarrow H_B = 4{,}958$ kN

$+\uparrow \Sigma F_y = 0 \Rightarrow \quad V_A + V_B - Q_1 = 0 \Rightarrow \quad 10{,}14 + V_B - 10 = 0 \Rightarrow V_B = -0{,}14$ kN



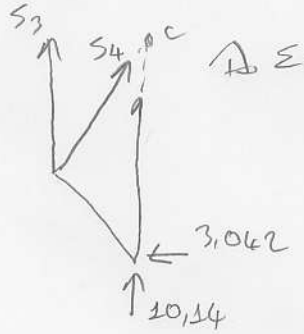
$\curvearrowleft \Sigma M_a = 0 \Rightarrow \quad S_1 \cdot 3 - 10 \cdot 4 = 0 \Rightarrow S_1 = 13{,}33$ kN //



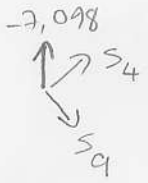
$\curvearrowleft \Sigma M_b = 0$

$4{,}958 \cdot 3 + 0{,}14 \cdot 4 - S_2 \cdot \frac{3}{5} \cdot 8 = 0$

$\Rightarrow S_2 = 5{,}144$ kN //



$\curvearrowleft \Sigma M_c = 0 \Rightarrow \quad S_3 \cdot 3 + 3{,}042 \cdot 7 = 0 \Rightarrow S_3 = -7{,}098$ kN //



$\rightarrow \Sigma F_x = 0 \Rightarrow \quad S_4 \cdot \frac{4}{5} + S_9 \frac{\sqrt{2}}{2} = 0$

$+\uparrow \Sigma F_y = 0 \Rightarrow \quad S_4 \cdot \frac{4}{5} - 7{,}098 - S_9 \cdot \frac{\sqrt{2}}{2} = 0$

$\Rightarrow S_4 = 4{,}436$ kN //

$S_9 = -5{,}019$

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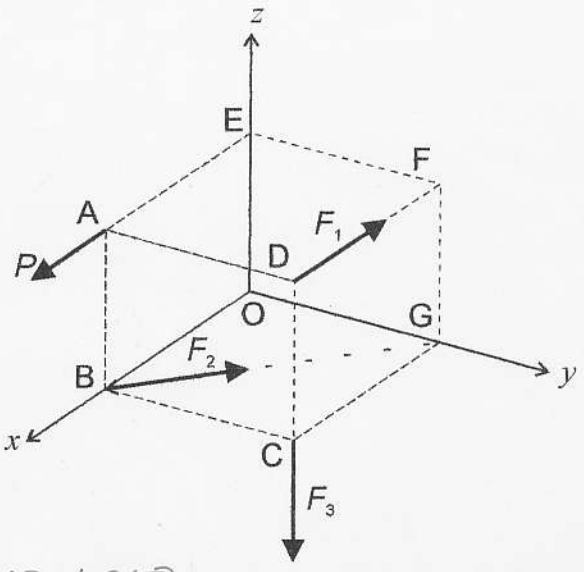
SORU(3): Şekil(3)' de görülen, köşesi kartezyen koordinat takımının merkezine yerleştirilmiş küpün kenar uzunluğu 4m'dir. F_3 kuvveti CD doğrultusunda P kuvveti AD doğrultusunda bulunmaktadır. P kuvveti şiddeti bilinmeyen bir kuvvettir.

a) Sistemdeki bütün kuvvetleri O noktasına taşıyınız. (P kuvveti bilinmeyen olarak taşınacaktır.)

b) Kuvvetler sisteminin tek bir kuvvete indirgenebilir olması için P' nin alması gereken değeri bulunuz.

(F_1=6kN, F_2=9kN, F_3= 4kN)



Şekil (3)

a) $\vec{F_1} = -6\vec{i}$ $\quad \vec{F_2} = -9\cdot\frac{\sqrt{2}}{2}\vec{i} + 9\cdot\frac{\sqrt{2}}{2}\vec{j} = -6{,}36\vec{i} + 6{,}36\vec{j}$

$\vec{F_3} = -4\vec{k}$ $\quad \vec{P} = P\vec{i}$

$\vec{r}_{F_1} = 4\vec{i} + 4\vec{j} + 4\vec{k}$ $\quad \vec{r}_{F_2} = 4\vec{i}$ $\quad \vec{r}_{F_3} = 4\vec{i} + 4\vec{j}$ $\quad \vec{r}_{P} = 4\vec{i} + 4\vec{k}$

$$M_{OF_1} = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 4 & 4 & 4 \\ -6 & 0 & 0 \end{vmatrix} = -24\vec{j} + 24\vec{k}$$

$$M_{OF_2} = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 4 & 0 & 0 \\ -6{,}36 & 6{,}36 & 0 \end{vmatrix} = 25{,}44\vec{k}$$

$$M_{OF_3} = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 4 & 4 & 0 \\ 0 & 0 & -4 \end{vmatrix} = -16\vec{i} + 16\vec{j}$$

$$M_{OP} = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 4 & 0 & 4 \\ P & 0 & 0 \end{vmatrix} = 4P\vec{j}$$

$R = (-6 - 6{,}36 + P)\vec{i} + (6{,}36)\vec{j} - 4\vec{k} = (-12{,}36 + P)\vec{i} + 6{,}36\vec{j} - 4\vec{k}$

$M_O = -16\vec{i} + (-24 + 16 + 4P)\vec{j} + (24 + 25{,}44)\vec{k} = -16\vec{i} + (-8 + 4P)\vec{j} + 49{,}44\vec{k}$

b) Sistemin tek bir kuvvete indirgenmesi için $M_O \perp R$ olmalıdır.

$-16\cdot(-12{,}36 + P) + 6{,}36(-8 + 4P) - 4\cdot 49{,}44 = 0 \Rightarrow$

$197{,}76 - 16P - 50{,}88 + 25{,}44P - 197{,}76 = 0 \Rightarrow 9{,}44P = 50{,}88$

$\Rightarrow P = 5{,}38$ kN olmalı.