GLOBAL EKSEN TAKIMINDA ELEMAN STİFNES (RİJİTLİK) MATRİS TABLOSU

(x-y Düzlemindeki doğru eksenli prizmatik j çubuk elemanı için)

$$\left(s_j\right)=\left[\begin{array}{ccc|ccc} s(1,1) & s(1,2) & s(1,3) & (-) & (-) & (+) \\ s(2,1) & s(2,2) & s(2,3) & (-) & (-) & (+) \\ s(3,1) & s(3,2) & s(3,3) & (-) & (-) & \frac{1}{2}(+) \\ \hline (-) & (-) & (-) & (+) & (+) & (-) \\ (-) & (-) & (-) & (+) & (+) & (-) \\ (+) & (+) & \frac{1}{2}(+) & (-) & (-) & (+) \end{array}\right]$$

Sol üst köşedeki tablo elemanları aşağıda tarif edilmektedir. Tabloda verilen katsayı ve işaretlerle aşağıda tarif edilen tablo elemanları çarpılarak tablonun diğer elemanları elde edilir.

$$s(1,1)=\left(E_jA_j/L_j\right)\left(\cos\alpha_j\right)^2+\left(12E_jI_j/L_j^3\right)\left(\sin\alpha_j\right)^2$$

$$s(1,2)=\left[(E_jA_j/L_j)-\left(12E_jI_j/L_j^3\right)\right]\left(\cos\alpha_j.\sin\alpha_j\right)$$

$$s(1,3)=-\left(6E_jI_j/L_j^2\right)\left(\sin\alpha_j\right)$$

$$s(2,1)=s(1,2)$$

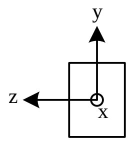
$$s(2,2)=\left(E_jA_j/L_j\right)\left(\sin\alpha_j\right)^2+\left(12E_jI_j/L_j^3\right)\left(\cos\alpha_j\right)^2$$

$$s(2,3)=\left(6E_jI_j/L_j^2\right)\left(\cos\alpha_j\right)$$

$$s(3,1)=s(1,3)$$

$$s(3,2)=s(2,3)$$

$$s(3,3)=\left(4E_jI_j/L_j\right)$$



α_j = Elemanın Referan Açısı

A_j = Elemanın Dik Kesit Alanı

I_j = Elemanın Asal Atalet Momenti (z eksenine göre)

L_j = Elemanın Boyu

E_j = Elemanın Malzeme Elastisite Modülü

ÖZEL HALLER

Kiriş Elemanı ($\alpha_j = 0$)

(Referans noktası sol uçta)

$$s(1,1)=\left(E_jA_j/L_j\right)$$
$$s(1,2)=0$$
$$s(1,3)=0$$
$$s(2,1)=0$$
$$s(2,2)=\left(12E_jI_j/L_j^3\right)$$
$$s(2,3)=\left(6E_jI_j/L_j^2\right)$$
$$s(3,1)=0$$
$$s(3,2)=\left(6E_jI_j/L_j^2\right)$$
$$s(3,3)=\left(4E_jI_j/L_j\right)$$

Kolon Elemanı ($\alpha_j = 90$)

(Referans noktası alt uçta)

$$s(1,1)=\left(12E_jI_j/L_j^3\right)$$
$$s(1,2)=0$$
$$s(1,3)=-\left(6E_jI_j/L_j^2\right)$$
$$s(2,1)=0$$
$$s(2,2)=\left(E_jA_j/L_j\right)$$
$$s(2,3)=0$$
$$s(3,1)=-\left(6E_jI_j/L_j^2\right)$$
$$s(3,2)=0$$
$$s(3,3)=\left(4E_jI_j/L_j\right)$$

Kafes Elemanı ($I_j = 0$)

(S matrisindeki tüm I_j=0)

$$s(1,1)=\left(E_jA_j/L_j\right)\left(\cos\alpha_j\right)^2$$
$$s(1,2)=(E_jA_j/L_j)\left(\cos\alpha_j.\sin\alpha_j\right)$$
$$s(1,3)=0$$
$$s(2,1)=(E_jA_j/L_j)\left(\cos\alpha_j.\sin\alpha_j\right)$$
$$s(2,2)=\left(E_jA_j/L_j\right)\left(\sin\alpha_j\right)^2$$
$$s(2,3)=0$$
$$s(3,1)=0$$
$$s(3,2)=0$$
$$s(3,3)=0$$

Eleman eksen takımındaki çubuk ucu kuvvetleri $\left[q'_j\right]$'lerin, global eksen takımındaki düğüm noktası deplasmanları $\left[d_j\right]$'ler cinsinden tarifleri

$$q'_{j1}=-\left(E_jA_j/L_j\right)\left[\left(d_{j4}-d_{j1}\right)\left(\cos\alpha_j\right)+\left(d_{j5}-d_{j2}\right)\left(\sin\alpha_j\right)\right]$$

$$q'_{j2}=\left(E_jI_j/L_j^2\right)\left[6d_{j3}+6d_{j6}-\frac{12}{L_j}\left[\left(d_{j5}-d_{j2}\right)\left(\cos\alpha_j\right)-\left(d_{j4}-d_{j1}\right)\left(\sin\alpha_j\right)\right]\right]$$

$$q'_{j3}=\left(E_jI_j/L_j\right)\left[4d_{j3}+2d_{j6}-\frac{6}{L_j}\left[\left(d_{j5}-d_{j2}\right)\left(\cos\alpha_j\right)-\left(d_{j4}-d_{j1}\right)\left(\sin\alpha_j\right)\right]\right]$$

$$q'_{j4}=\left(E_jA_j/L_j\right)\left[\left(d_{j4}-d_{j1}\right)\left(\cos\alpha_j\right)+\left(d_{j5}-d_{j2}\right)\left(\sin\alpha_j\right)\right]$$

$$q'_{j5}=-\left(E_jI_j/L_j^2\right)\left[6d_{j3}+6d_{j6}-\frac{12}{L_j}\left[\left(d_{j5}-d_{j2}\right)\left(\cos\alpha_j\right)-\left(d_{j4}-d_{j1}\right)\left(\sin\alpha_j\right)\right]\right]$$

$$q'_{j6}=\left(E_jI_j/L_j\right)\left[2d_{j3}+4d_{j6}-\frac{6}{L_j}\left[\left(d_{j5}-d_{j2}\right)\left(\cos\alpha_j\right)-\left(d_{j4}-d_{j1}\right)\left(\sin\alpha_j\right)\right]\right]$$

ÖZEL HALLER

<u>Kiriş Elemanı</u> $(\alpha_j = 0)$

$$q'_{j1} = -\left(E_jA_j/L_j\right)\left(d_{j4}-d_{j1}\right)$$

$$q'_{j2} = \left(E_jI_j/L_j^2\right)\left[6d_{j3}+6d_{j6}-\frac{12}{L_j}\left(d_{j5}-d_{j2}\right)\right]$$

$$q'_{j3} = \left(E_jI_j/L_j\right)\left[4d_{j3}+2d_{j6}-\frac{6}{L_j}\left(d_{j5}-d_{j2}\right)\right]$$

$$q'_{j4} = \left(E_jA_j/L_j\right)\left(d_{j4}-d_{j1}\right)$$

$$q'_{j5} = -\left(E_jI_j/L_j^2\right)\left[6d_{j3}+6d_{j6}-\frac{12}{L_j}\left(d_{j5}-d_{j2}\right)\right]$$

$$q'_{j6} = \left(E_jI_j/L_j\right)\left[2d_{j3}+4d_{j6}-\frac{6}{L_j}\left(d_{j5}-d_{j2}\right)\right]$$

<u>Kolon Elemanı</u> $(\alpha_j = 90)$

$$q'_{j1} = -\left(E_jA_j/L_j\right)\left(d_{j5}-d_{j2}\right)$$

$$q'_{j2} = \left(E_jI_j/L_j^2\right)\left[6d_{j3}+6d_{j6}+\frac{12}{L_j}\left(d_{j4}-d_{j1}\right)\right]$$

$$q'_{j3} = \left(E_jI_j/L_j\right)\left[4d_{j3}+2d_{j6}+\frac{6}{L_j}\left(d_{j4}-d_{j1}\right)\right]$$

$$q'_{j4} = \left(E_jA_j/L_j\right)\left(d_{j5}-d_{j2}\right)$$

$$q'_{j5} = -\left(E_jI_j/L_j^2\right)\left[6d_{j3}+6d_{j6}+\frac{12}{L_j}\left(d_{j4}-d_{j1}\right)\right]$$

$$q'_{j6} = \left(E_jI_j/L_j\right)\left[2d_{j3}+4d_{j6}+\frac{6}{L_j}\left(d_{j4}-d_{j1}\right)\right]$$

<u>Kafes Elemanı</u> $(I_j = 0)$

$$q'_{j1} = -\left(E_jA_j/L_j\right)\left[\left(d_{j4}-d_{j1}\right)\left(\cos\alpha_j\right)+\left(d_{j5}-d_{j2}\right)\left(\sin\alpha_j\right)\right]$$

$$q'_{j2} = 0$$

$$q'_{j3} = 0$$

$$q'_{j4} = \left(E_jA_j/L_j\right)\left[\left(d_{j4}-d_{j1}\right)\left(\cos\alpha_j\right)+\left(d_{j5}-d_{j2}\right)\left(\sin\alpha_j\right)\right]$$

$$q'_{j5} = 0$$

$$q'_{j6} = 0$$

---

j çubuk elemanı üzerine etki eden (w_j, P_j, N_j, M_j) yüklerine bağlı eleman eksen takımındaki çubuk ucu kuvvetleri $\left[\overline{q^1_j}\right]$'lerin tarifi

$$\overline{q'_{j1}} = \frac{b_jN_j}{L_j}$$

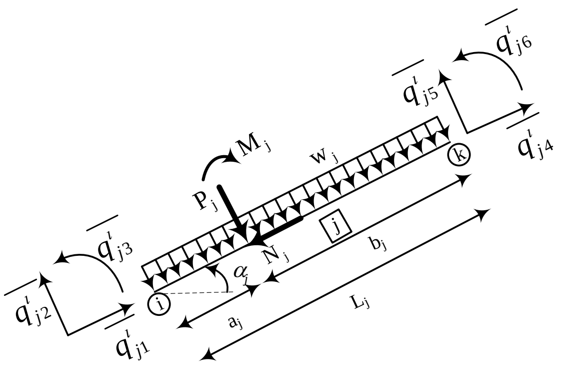
$$\overline{q'_{j2}} = \frac{w_jL_j}{2}+\frac{P_jb_j^2\left(3a_j+b_j\right)}{L_j^3}-\frac{6M_ja_jb_j}{L_j^3}$$

$$\overline{q'_{j3}} = \frac{w_jL_j^2}{12}+\frac{P_jb_j^2a_j}{L_j^2}+\frac{M_jb_j\left(b_j-2a_j\right)}{L_j^2}$$

$$\overline{q'_{j4}} = \frac{a_jN_j}{L_j}$$

$$\overline{q'_{j5}} = \frac{w_jL_j}{2}+\frac{P_ja_j^2\left(3b_j+a_j\right)}{L_j^3}+\frac{6M_ja_jb_j}{L_j^3}$$

$$\overline{q'_{j6}} = -\frac{w_jL_j^2}{12}-\frac{P_ja_j^2b_j}{L_j^2}+\frac{M_ja_j\left(a_j-2b_j\right)}{L_j^2}$$



Global eksen takımındaki çubuk ucu kuvvetleri $\left[\overline{q_j}\right]$'lerin yukarıda tarif edilen $\left[\overline{q'_j}\right]$'ler cinsinden ifadeleri

<u>Genel Elemanı</u>

$$\overline{q_{j1}} = \overline{q'_{j1}}\left(\cos\alpha_j\right)-\overline{q'_{j2}}\left(\sin\alpha_j\right)$$

$$\overline{q_{j2}} = \overline{q'_{j1}}\left(\sin\alpha_j\right)+\overline{q'_{j2}}\left(\cos\alpha_j\right)$$

$$\overline{q_{j3}} = \overline{q'_{j3}}$$

$$\overline{q_{j4}} = \overline{q'_{j4}}\left(\cos\alpha_j\right)-\overline{q'_{j5}}\left(\sin\alpha_j\right)$$

$$\overline{q_{j5}} = \overline{q'_{j4}}\left(\sin\alpha_j\right)+\overline{q'_{j5}}\left(\cos\alpha_j\right)$$

$$\overline{q_{j6}} = \overline{q'_{j6}}$$

<u>Kiriş Elemanı</u> $(\alpha_j = 0)$

$$\overline{q_{j1}} = \overline{q'_{j1}}$$

$$\overline{q_{j2}} = \overline{q'_{j2}}$$

$$\overline{q_{j3}} = \overline{q'_{j3}}$$

$$\overline{q_{j4}} = \overline{q'_{j4}}$$

$$\overline{q_{j5}} = \overline{q'_{j5}}$$

$$\overline{q_{j6}} = \overline{q'_{j6}}$$

<u>Kolon Elemanı</u> $(\alpha_j = 90)$

$$\overline{q_{j1}} = -\overline{q'_{j2}}$$

$$\overline{q_{j2}} = \overline{q'_{j1}}$$

$$\overline{q_{j3}} = \overline{q'_{j3}}$$

$$\overline{q_{j4}} = -\overline{q'_{j5}}$$

$$\overline{q_{j5}} = \overline{q'_{j4}}$$

$$\overline{q_{j6}} = \overline{q'_{j6}}$$