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# RAMALARNI KO'CHISHLAR USULIDA MATRITSA AMALLARI YORDAMIDA HISOBLASH

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**Annotatsiya:** Maqolada statik noaniq rama matrisa usulida bajarilgan. Statik noaniq ramalar hisobini zamonaviy kompyuter texnologiyalaridan foydalanib bajarish matrisalar usulida qulay ekanligi ko'rsatilgan.

**Kalit so`zlar:** deformatsiya, matritsa, rama, asosiy tizim, kanonik tenglamalar, sistema, eguvchi moment.

Qurilish mexanikasining murakkab tizimlarini hisoblashda zamonaviy kompyuterlardan foydalanish uchun ularda hosil bo'ladigan zo'riqish kuchlari va deformatsiyalarini aniqlash usullarini matritsa usulida ifodalash bir qancha qulayliklar yaratadi.

Statik aniqmas tizimlarni hisoblash uchun ko'chishlar usulining kanonik tenglamalar sistemasini yozamiz:

$$\begin{cases} r_{11}Z_1 + r_{12}Z_2 + \cdots + r_{1n}Z_n + R_{1P} = 0 \\ r_{21}Z_1 + r_{22}Z_2 + \cdots + r_{2n}Z_n + R_{2P} = 0 \\ \cdots\ \cdots\ \cdots\ \cdots\ \cdots\ \cdots\ \cdots\ \cdots \\ r_{31}Z_1 + 1r_{32}Z_2 + \cdots + r_{nn}Z_n + R_{nP} = 0 \end{cases}$$

bu yerda: r-reaktiv momentlar, R-ozod hadlar

## Birlik reaksiyalar va ozod hadlar matritsasini tuzish

Kanonik tenglamalar sistemasi matritsalar ko'rinishida quyidagicha ifodalanadi:

$$Rz + R_p = 0 \qquad \textbf{(1)}$$

R-birlik reaksiyalar matritsasi

$$R=\begin{Vmatrix} r_{11} & r_{12} \ldots . & r_{1n} \\ r_{21} & r_{22} \ldots . & r_{2n} \\ r_{31} & r_{32} \ldots . & r_{3n} \end{Vmatrix} \quad (2)$$

Birlik reaksiyalar matritsasini matritsalarning ko'paytmasi ko'rinishida quyidagicha yozish mumkin:

$$R=L_\varphi^T \times K \times L_\varphi \qquad \textbf{(3)}$$

$L_\varphi^T$-transponirlangan birlik ko'chishlar matritsasi,

$L_\varphi$-birlik ko'chishlar matritsasi

K-bikrlik matritsasi

$$K=\begin{Vmatrix} k_1 & & \\ \ddots & \ddots & \\ & & k_t \end{Vmatrix}$$, t-asosiy tizimda olingan elementlar soni.

Ikki uchi qistirib mahkamlangan t element uchun: $k_t = \frac{2EI}{l_t}\begin{Vmatrix} 2 & 1 \\ 1 & 2 \end{Vmatrix} = 2i_t \begin{Vmatrix} 2 & 1 \\ 1 & 2 \end{Vmatrix}$

Bir uchi qistirib, ikkinchiuchi sharnirli mahkamlangan t element uchun:

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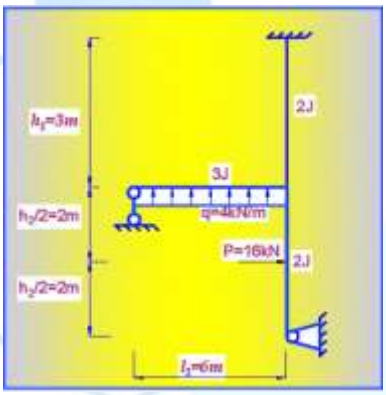
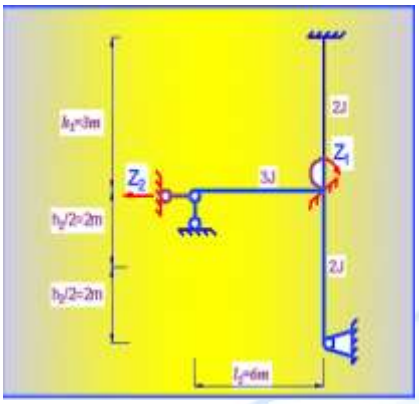
$$k_t = 3i_t\|1\|$$

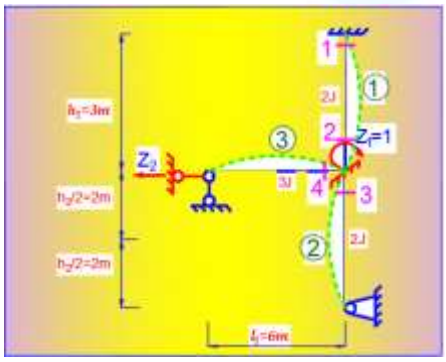
Berilgan rama



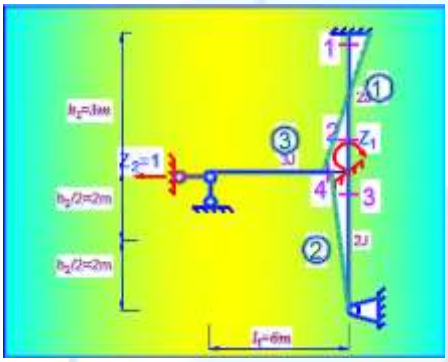

Asosiy tizim



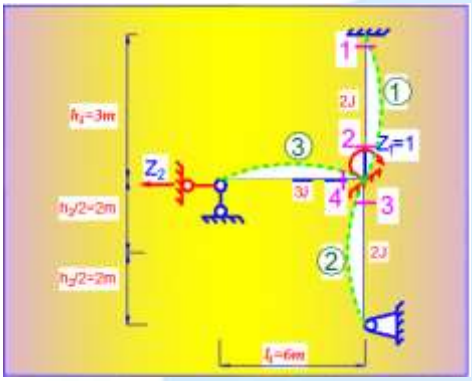

M1

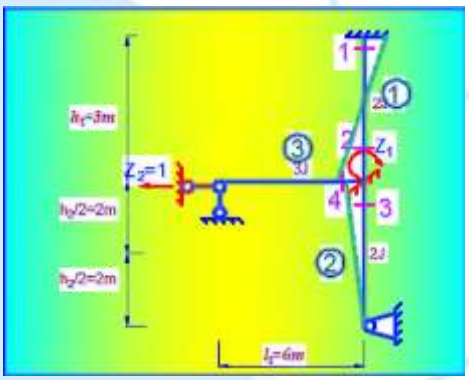



M2




$$L_\varphi = \begin{Vmatrix} 0 & -1/3 \\ 1 & -1/3 \\ 1 & 1/4 \\ 1 & 0 \end{Vmatrix};\quad L_\varphi^T = \begin{Vmatrix} 0 & 1 & 1 & 1 \\ -1/3 & -1/3 & 1/4 & 0 \end{Vmatrix}$$



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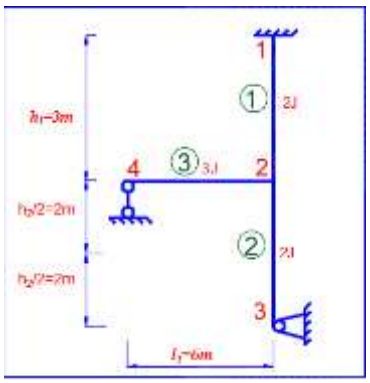
$EI=6kNm$

$i_{12}=4kNm,\ i_{23}=3kNm,\ i_{24}=3kNm$



$$K_1=2i_{12}\begin{Vmatrix}2 & 1\\ 1 & 2\end{Vmatrix}=\begin{Vmatrix}16 & 8\\ 8 & 16\end{Vmatrix}$$

$$K_2=3i_{23}\|1\|=\|9\|$$

$$K_3=3i_{24}\|1\|=\|9\|$$

$$R=L_\varphi{}^T\times K\times L_\varphi$$

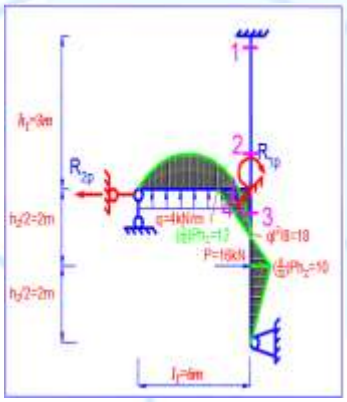
$$R=\begin{Vmatrix}0 & 1 & 1 & 1\\ -1/3 & -1/3 & 1/4 & 0\end{Vmatrix}\times\begin{Vmatrix}16 & 8 & & \\ 8 & 16 & & \\ & & 9 & \\ & & & 9\end{Vmatrix}\times L_\varphi$$

$$R=\begin{Vmatrix}8 & 16 & 9 & 9\\ -8 & -8 & 9/4 & 0\end{Vmatrix}\times\begin{Vmatrix}0 & -1/3\\ 1 & -1/3\\ 1 & 1/4\\ 1 & 0\end{Vmatrix}$$

$$R=\begin{Vmatrix}34 & -5,75\\ -5,75 & 5,8958\end{Vmatrix}$$

$$Z=-R^{-1}\times Rp$$

$$Rp=\begin{Vmatrix}-6\\ 11\end{Vmatrix}$$



$$Z=-\quad=\begin{Vmatrix}34 & -5,75\\ -5,75 & 5,8958\end{Vmatrix}^{-1}\times\begin{Vmatrix}-6\\ 11\end{Vmatrix}$$

$$Z=\begin{Vmatrix}0,1661\\ 2,0283\end{Vmatrix}$$

$$M_{um}=L_MZ+Mp$$

$$L_M=\mathrm{K}\times L_\varphi=\begin{Vmatrix}16 & 8 & & \\ 8 & 16 & & \\ & & 9 & \\ & & & 9\end{Vmatrix}\times\begin{Vmatrix}0 & -1/3\\ 1 & -1/3\\ 1 & 1/4\\ 1 & 0\end{Vmatrix}$$

$$L_M=\begin{Vmatrix}8 & -8\\ 16 & -8\\ 9 & 9/4\\ 9 & 0\end{Vmatrix}$$

$$M_{um}=\begin{Vmatrix}8 & -8\\ 16 & -8\\ 9 & 9/4\\ 9 & 0\end{Vmatrix}\times\begin{Vmatrix}0,1661\\ 2,0283\end{Vmatrix}+\begin{Vmatrix}0\\ 0\\ 12\\ -18\end{Vmatrix}$$

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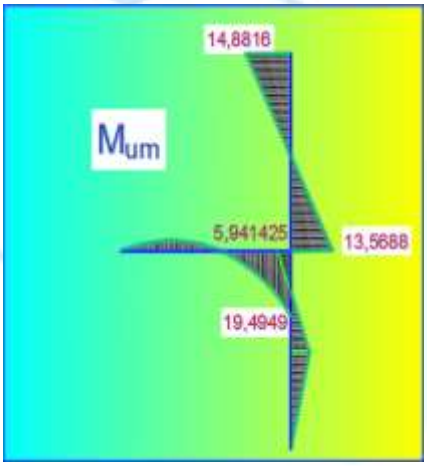
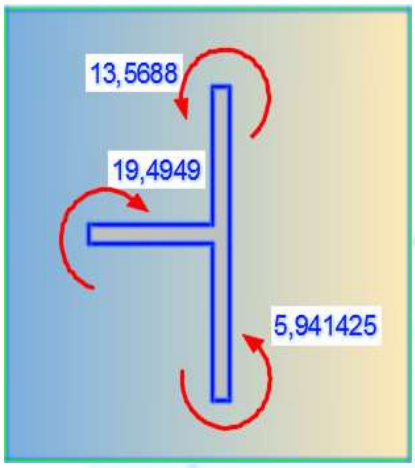
$$M_{um} = \begin{Vmatrix} 14{,}8816 \\ 13{,}5688 \\ 5{,}941425 \\ -19{,}4949 \end{Vmatrix}$$

Ramaning ko’chgan har qaysi tugunlaridagi eguvchi momentlar yig’indisi nolga teng bo’lishi kerak.




**Xulosa.** Statik aniqmaslik darajasi 2 va undan ortiq bo’lgan tizimlarda matritsa usulida hisoblash bir qancha qulayliklar yaratadi. Kam vaqt sarflab bir qancha tizimlarni hisoblash mumkin. Matritsa usulida hisoblash aniqlik ham oshib boradi sababi hisoblash algoritmi aniq.

**Adabiyotlar:**

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