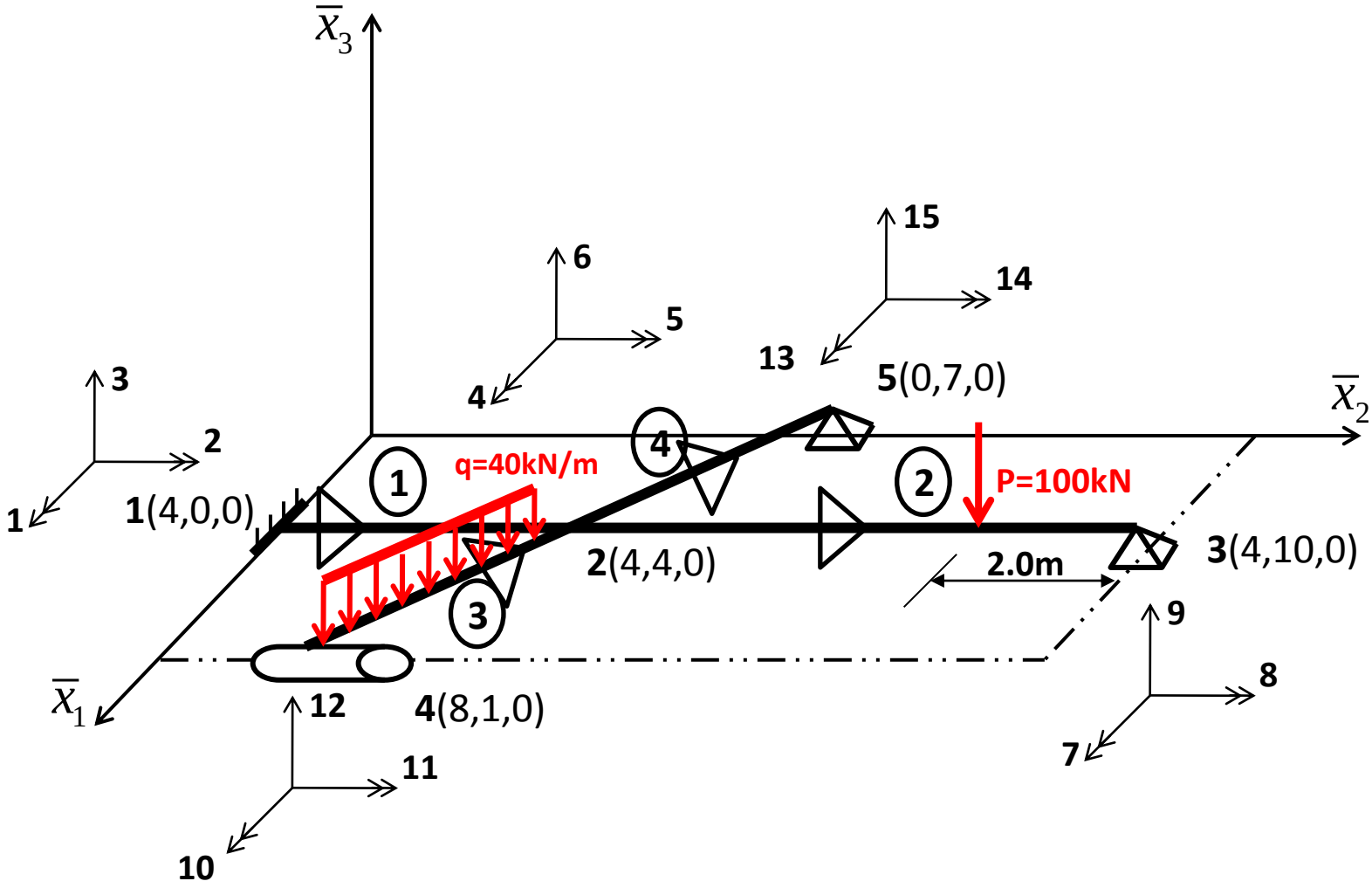
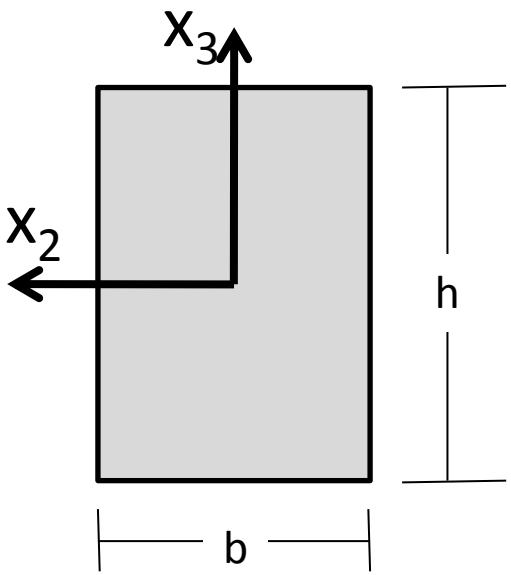
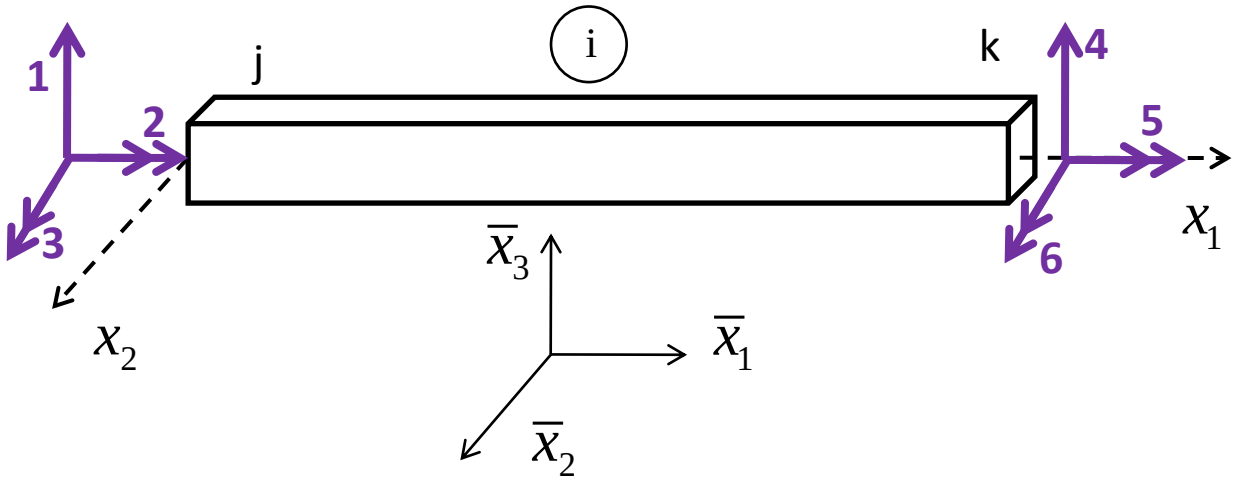
Ασκηση Εσχαρας



Μόρφωση τοπικών μητρώων δυσκαμψίας





$$\left[k^i\right]=\begin{bmatrix} 12E_iI^i/L_i^3 & 0 & -6E_iI^i/L_i^2 & -12E_iI^i/L_i^3 & 0 & -6E_iI^i/L_i^2 \\ 0 & G_iI_1^i/L_i & 0 & 0 & -G_iI_1^i/L_i & 0 \\ -6E_iI^i/L_i^2 & 0 & 4E_iI^i/L_i & 6E_iI^i/L_i^2 & 0 & 2E_iI^i/L_i \\ -12E_iI^i/L_i^3 & 0 & 6E_iI^i/L_i^2 & 12E_iI^i/L_i^3 & 0 & 6E_iI^i/L_i^2 \\ 0 & -G_iI_1^i/L_i & 0 & 0 & G_iI_1^i/L_i & 0 \\ -6E_iI^i/L_i^2 & 0 & 2E_iI^i/L_i & 6E_iI^i/L_i^2 & 0 & 4E_iI^i/L_i \end{bmatrix} \quad (i=1,2,3,4)$$

Μόρφωση τοπικών μητρώων δυσκαμψίας

$$[k^1] = EI_2 \begin{array}{c} \\ P3 \\ M1 \\ M2 \\ P6 \\ M4 \\ M5 \end{array} \begin{array}{c} \begin{array}{cccccc} \Delta 3 & \theta 1 & \theta 2 & \Delta 6 & \theta 4 & \theta 5 \end{array} \\ \begin{bmatrix} 0.1875 & & & & & \\ 0 & 0.074 & & & & \\ 0.375 & 0 & 1 & & & \\ -0.1875 & 0 & 0.375 & 0.1875 & & \\ 0 & -0.074 & 0 & 0 & 0.074 & \\ 0.375 & 0 & 0.5 & 0.375 & 0 & 1 \end{bmatrix} \end{array}$$

$$[k^2] = EI_2 \begin{array}{c} \\ P6 \\ M4 \\ M5 \\ P9 \\ M7 \\ M8 \end{array} \begin{array}{c} \begin{array}{cccccc} \Delta 6 & \theta 4 & \theta 5 & \Delta 9 & \theta 7 & \theta 8 \end{array} \\ \begin{bmatrix} 0.055 & & & & & \\ 0 & 0.049 & & & & \\ 0.166 & 0 & 0.666 & & & \\ -0.055 & 0 & 0.166 & 0.055 & & \\ 0 & -0.049 & 0 & 0 & 0.049 & \\ 0.166 & 0 & 0.333 & 0.166 & 0 & 0.666 \end{bmatrix} \end{array}$$

$$[k^3] = EI_2 \begin{array}{c} \\ P12 \\ M10 \\ M11 \\ P6 \\ M4 \\ M5 \end{array} \begin{array}{c} \begin{array}{cccccc} \Delta 12 & \theta 10 & \theta 11 & \Delta 6 & \theta 4 & \theta 5 \end{array} \\ \begin{bmatrix} 0.096 & & & & & \\ 0 & 0.059 & & & & \\ 0.240 & 0 & 0.8 & & & \\ -0.096 & 0 & 0.240 & 0.096 & & \\ 0 & -0.059 & 0 & 0 & 0.059 & \\ 0.240 & 0 & 0.4 & 0.240 & 0 & 0.8 \end{bmatrix} \end{array}$$

$$[k^4] = EI_2 \begin{array}{c} \\ P6 \\ M4 \\ M5 \\ P15 \\ M13 \\ M14 \end{array} \begin{array}{c} \begin{array}{cccccc} \Delta 6 & \theta 4 & \theta 5 & \Delta 15 & \theta 13 & \theta 14 \end{array} \\ \begin{bmatrix} 0.096 & & & & & \\ 0 & 0.059 & & & & \\ 0.240 & 0 & 0.8 & & & \\ -0.096 & 0 & 0.240 & 0.096 & & \\ 0 & -0.059 & 0 & 0 & 0.059 & \\ 0.240 & 0 & 0.4 & 0.240 & 0 & 0.8 \end{bmatrix} \end{array}$$

Μόρφωση μητρώων μετασχηματισμού (P2)

$$\left[\Lambda_{GG}^{i}\right]=\begin{bmatrix} 1 & 0 & 0 & & \\ 0 & \cos\varphi_i & \sin\varphi_i & [0] & \\ 0 & -\sin\varphi_i & \cos\varphi_i & & \\ & & & 1 & 0 & 0 \\ & [0] & & 0 & \cos\varphi_i & \sin\varphi_i \\ & & & 0 & -\sin\varphi_i & \cos\varphi_i \end{bmatrix} \quad (i=1,2,3,4)$$

$$\left[\Lambda_{GG}^{1}\right]=\left[\Lambda_{GG}^{2}\right]=\begin{bmatrix} 1 & 0 & 0 & & \\ 0 & 0 & 1 & [0] & \\ 0 & -1 & 0 & & \\ & & & 1 & 0 & 0 \\ & [0] & & 0 & 0 & 1 \\ & & & 0 & -1 & 0 \end{bmatrix} \Longleftarrow \varphi_1=\varphi_2=90^o$$

$$\varphi_3=\varphi_4=143.13^o \Longrightarrow \left[\Lambda_{GG}^{3}\right]=\left[\Lambda_{GG}^{4}\right]=\begin{bmatrix} 1 & 0 & 0 & & \\ 0 & -0.8 & 0.6 & [0] & \\ 0 & -0.6 & -0.8 & & \\ & & & 1 & 0 & 0 \\ & [0] & & 0 & -0.8 & 0.6 \\ & & & 0 & -0.6 & -0.8 \end{bmatrix}$$

Μόρφωση καθολικών μητρώων δυσκαμψίας: $\left[\bar{k}^{i}\right]=\left[\Lambda_{GG}^{i}\right]^{T}\left[k^{i}\right]\left[\Lambda_{GG}^{i}\right]$

$$\left[\bar{k}^{1}\right]=EI_2\left[\begin{array}{ccc|ccc} 0.1875 & & & & & \\ 0.375 & 1 & & & & \\ 0 & 0 & 0.074 & & & \\ \hline -0.1875 & -0.375 & 0 & 0.1875 & & \\ 0.375 & 0.5 & 0 & -0.375 & 1 & \\ 0 & 0 & -0.074 & 0 & 0 & 0.074 \end{array}\right]$$

$$\left[\bar{k}^{2}\right]=EI_2\left[\begin{array}{ccc|ccc} 0.055 & & & & & \\ 0.166 & 0.666 & & & & \\ 0 & 0 & 0.049 & & & \\ \hline -0.055 & -0.166 & 0 & 0.055 & & \\ 0.166 & 0.333 & 0 & -0.166 & 0.666 & \\ 0 & 0 & -0.049 & 0 & 0 & 0.049 \end{array}\right]$$

$$\left[\bar{k}^{3}\right]=\left[\bar{k}^{4}\right]=EI_2\left[\begin{array}{ccc|ccc} 0.096 & & & & & \\ 0.144 & 0.325 & & & & \\ 0.192 & 0.356 & 0.533 & & & \\ \hline -0.096 & -0.144 & -0.192 & 0.096 & & \\ 0.144 & 0.106 & 0.220 & -0.144 & 0.325 & \\ 0.192 & 0.220 & 0.235 & -0.192 & 0.356 & 0.533 \end{array}\right]$$

Μόρφωση ολικού μητρώου δυσκαμψίας του φορέα

$$
\left[\bar{k}\right] = \begin{array}{c} \\ \#1 \\ \#2 \\ \\ \#3 \\ \#4 \\ \#5 \end{array}
\begin{array}{c}
\begin{array}{ccccc} \#1 & \#2 & \#3 & \#4 & \#5 \end{array} \\
\begin{bmatrix}
\bar{k}^{1}_{jj} & \bar{k}^{1}_{jk} & [0] & [0] & [0] \\
\bar{k}^{1}_{kj} & \bar{k}^{1}_{kk} + \bar{k}^{2}_{jj} + \bar{k}^{3}_{kk} + \bar{k}^{4}_{jj} & \bar{k}^{2}_{jk} & \bar{k}^{3}_{kj} & \bar{k}^{4}_{jk} \\
[0] & \bar{k}^{2}_{kj} & \bar{k}^{2}_{kk} & [0] & [0] \\
[0] & \bar{k}^{3}_{jk} & [0] & \bar{k}^{3}_{jj} & [0] \\
[0] & \bar{k}^{4}_{kj} & [0] & [0] & \bar{k}^{4}_{kk}
\end{bmatrix}
\end{array}
$$

Μόρφωση ολικού μητρώου δυσκαμψίας του φορέα

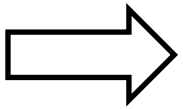
	#1			#2			#3			#4			#5		
	u_3^1	θ_1^1	θ_2^1	u_3^2	θ_1^2	θ_2^2	u_3^3	θ_1^3	θ_2^3	u_3^4	θ_1^4	θ_2^4	u_3^5	θ_1^5	θ_2^5
$\bar{P}_3^1$	0.187														
$\bar{M}_1^1$	0.375	1.0													
$\bar{M}_2^1$	0	0	0.074												
$\bar{P}_3^2$	−0.187	−0.375	0	0.434											
$\bar{M}_1^2$	0.375	0.5	0	−0.209	2.316										
$\bar{M}_2^2$	0	0	−0.074	0	0.710	1.189									
$\bar{P}_3^3$	0	0	0	−0.055	−0.166	0	0.055								
$\bar{M}_1^3$	0	0	0	0.166	0.333	0	−0.166	0.666							
$\bar{M}_2^3$	0	0	0	0	0	−0.049	0	0	0.049						
$\bar{P}_3^4$	0	0	0	−0.096	0.144	0.192	0	0	0	0.096					
$\bar{M}_1^4$	0	0	0	−0.144	0.106	0.220	0	0	0	0.144	0.325				
$\bar{M}_2^4$	0	0	0	−0.192	0.220	0.234	0	0	0	0.192	0.355	0.533			
$\bar{P}_3^5$	0	0	0	−0.096	−0.144	−0.192	0	0	0	0	0	0	0.096		
$\bar{M}_1^5$	0	0	0	0.144	0.106	0.220	0	0	0	0	0	0	−0.144	0.325	
$\bar{M}_2^5$	0	0	0	0.192	0.220	0.234	0	0	0	0	0	0	−0.192	0.355	0.533

$$\left[\bar{k}\right] = EI_2$$

Αναδιάταξη ολικού μητρώου δυσκαμψίας του φορέα
γνωστές-άγνωστες ποσότητες

$$[V] = \begin{array}{c} \\ \mathbf{u}_3^2 \\ \boldsymbol{\theta}_1^2 \\ \boldsymbol{\theta}_2^2 \\ \boldsymbol{\theta}_1^3 \\ \boldsymbol{\theta}_2^3 \\ \boldsymbol{\theta}_2^4 \\ \boldsymbol{\theta}_1^5 \\ \boldsymbol{\theta}_2^5 \\ \hline \mathbf{u}_3^1 \\ \boldsymbol{\theta}_1^1 \\ \boldsymbol{\theta}_2^1 \\ \mathbf{u}_3^3 \\ \mathbf{u}_3^4 \\ \boldsymbol{\theta}_1^4 \\ \mathbf{u}_3^5 \end{array} \begin{array}{c} \begin{array}{ccccccccccccccc} \mathbf{u}_3^1 & \boldsymbol{\theta}_1^1 & \boldsymbol{\theta}_2^1 & \mathbf{u}_3^2 & \boldsymbol{\theta}_1^2 & \boldsymbol{\theta}_2^2 & \mathbf{u}_3^3 & \boldsymbol{\theta}_1^3 & \boldsymbol{\theta}_2^3 & \mathbf{u}_3^4 & \boldsymbol{\theta}_1^4 & \boldsymbol{\theta}_2^4 & \mathbf{u}_3^5 & \boldsymbol{\theta}_1^5 & \boldsymbol{\theta}_2^5 \end{array} \\ \left[\begin{array}{ccccccccccccccc} 0 & 0 & 0 & \mathbf{1} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & \mathbf{1} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & \mathbf{1} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & \mathbf{1} & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \mathbf{1} & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \mathbf{1} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \mathbf{1} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \mathbf{1} \\ \hline \mathbf{1} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & \mathbf{1} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & \mathbf{1} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & \mathbf{1} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \mathbf{1} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \mathbf{1} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \mathbf{1} & 0 & 0 \end{array}\right] \end{array}$$

$$\left[\bar{k}_m\right] = [V]\left[\bar{k}\right][V]^T$$



Αναδιάταξη ολικού μητρώου δυσκαμψίας του φορέα γνωστές-άγνωστες ποσότητες

Μητρώο δυσκαμψίας φορέα

$$\left[\bar{k}_m\right] = EI_2 \begin{array}{c} \\ \mathbf{u}_3^2 \\ \boldsymbol{\theta}_1^2 \\ \boldsymbol{\theta}_2^2 \\ \boldsymbol{\theta}_1^3 \\ \boldsymbol{\theta}_2^3 \\ \boldsymbol{\theta}_2^4 \\ \boldsymbol{\theta}_1^5 \\ \boldsymbol{\theta}_2^5 \\ \mathbf{u}_3^1 \\ \boldsymbol{\theta}_1^1 \\ \boldsymbol{\theta}_2^1 \\ \mathbf{u}_3^3 \\ \mathbf{u}_3^4 \\ \boldsymbol{\theta}_1^4 \\ \mathbf{u}_3^5 \end{array} \begin{array}{c} \begin{array}{cccccccc} \mathbf{u}_3^2 & \boldsymbol{\theta}_1^2 & \boldsymbol{\theta}_2^2 & \boldsymbol{\theta}_1^3 & \boldsymbol{\theta}_2^3 & \boldsymbol{\theta}_2^4 & \boldsymbol{\theta}_1^5 & \boldsymbol{\theta}_2^5 \end{array} \\ \left[\begin{array}{cccccccc} 0.434 & & & & & & & \\ -0.209 & 2.316 & & & & & & \\ 0 & 0.710 & 1.189 & & & & & \\ -0.166 & 0.333 & 0 & 0.666 & & & & \\ 0 & 0 & -0.049 & 0 & 0.049 & & & \\ -0.192 & 0.220 & 0.234 & 0 & 0 & 0.533 & & \\ 0.144 & 0.106 & 0.220 & 0 & 0 & 0 & 0.325 & \\ 0.192 & 0.220 & 0.234 & 0 & 0 & 0 & 0.355 & 0.533 \\ -0.187 & 0.375 & 0 & 0 & 0 & 0 & 0 & 0 \\ -0.375 & 0.5 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & -0.074 & 0 & 0 & 0 & 0 & 0 \\ -0.055 & -0.166 & 0 & 0.166 & 0 & 0 & 0 & 0 \\ -0.096 & 0.144 & 0.192 & 0 & 0 & 0.192 & 0 & 0 \\ -0.144 & 0.106 & 0.220 & 0 & 0 & 0.355 & 0 & 0 \\ -0.096 & -0.144 & -0.192 & 0 & 0 & 0 & -0.144 & -0.192 \end{array}\right] \\ \left[\bar{k}_{sf}\right] \end{array} \begin{array}{c} \begin{array}{ccccccc} \mathbf{u}_3^1 & \boldsymbol{\theta}_1^1 & \boldsymbol{\theta}_2^1 & \mathbf{u}_3^3 & \mathbf{u}_3^4 & \boldsymbol{\theta}_1^4 & \mathbf{u}_3^5 \end{array} \\ \left[\begin{array}{ccccccc} 0.187 & & & & & & \\ 0.375 & 1.0 & & & & & \\ 0 & 0 & 0.074 & & & & \\ 0 & 0 & 0 & 0.055 & & & \\ 0 & 0 & 0 & 0 & 0.096 & & \\ 0 & 0 & 0 & 0 & 0.144 & 0.325 & \\ 0 & 0 & 0 & 0 & 0 & 0 & 0.096 \end{array}\right] \\ \left[\bar{k}_{ss}\right] \end{array}$$

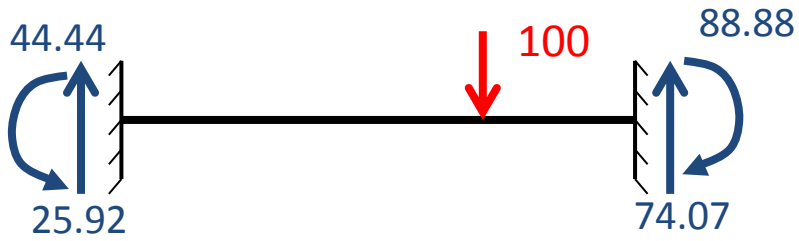
$$\left[\bar{k}\right] \qquad \left[\bar{k}_{fs}\right]$$

Υπολογισμός δράσεων παγιώσεως μελών:

$$\left\{\bar{A}_r^i\right\} = \left[\hat{\Lambda}_{GG}^i\right]^T \left\{A_r^i\right\} = \left\{\begin{matrix}\bar{A}_r^{ij} \\ \bar{A}_r^{ik}\end{matrix}\right\}$$

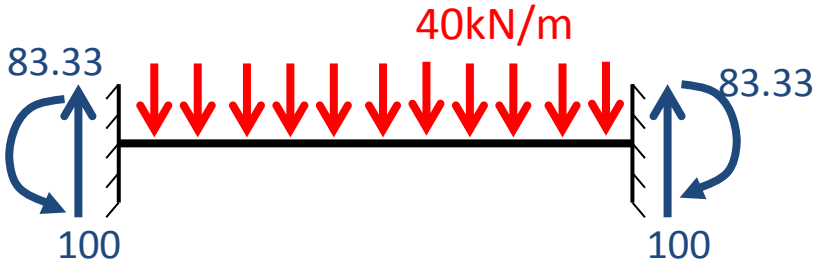
Μέλος 1: Αφόρτιστο $\left\{A_r^1\right\} = [0]$

Μέλος 2:



$$\left\{A_r^2\right\} = \left\{\begin{matrix}25.92 \\ 0 \\ -44.44 \\ 74.07 \\ 0 \\ 88.88\end{matrix}\right\}$$

Μέλος 3:



$$\left\{A_r^3\right\} = \left\{\begin{matrix}100 \\ 0 \\ -83.33 \\ 100 \\ 0 \\ 83.33\end{matrix}\right\}$$

Μέλος 4: Αφόρτιστο $\left\{A_r^4\right\} = [0]$

Υπολογισμός δράσεων παγιώσεως μελών:

$$\left\{\bar{A}_r^i\right\} = \left[\hat{\Lambda}_{GG}^{\,i}\right]^T \left\{A_r^i\right\} = \begin{Bmatrix} \bar{A}_r^{ij} \\ \bar{A}_r^{ik} \end{Bmatrix}$$

$$\left\{\bar{A}_r^1\right\} = \left\{\bar{A}_r^4\right\} = \begin{Bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{Bmatrix} \qquad \left\{\bar{A}_r^2\right\} = \left[\Lambda_{GG}^2\right]^T \left\{A_r^2\right\} = \begin{Bmatrix} 25.92 \\ 44.44 \\ 0 \\ 74.07 \\ -88.88 \\ 0 \end{Bmatrix} \qquad \left\{\bar{A}_r^3\right\} = \left[\Lambda_{GG}^3\right]^T \left\{A_r^3\right\} = \begin{Bmatrix} 100 \\ 50 \\ 66.66 \\ 100 \\ -50 \\ -66.66 \end{Bmatrix}$$

Υπολογισμός δράσεων παγιώσεως κόμβων:

$$\left\{\bar{S}^1\right\} = \left[\bar{A}_r^{1j}\right] = \begin{Bmatrix} 0 \\ 0 \\ 0 \end{Bmatrix} \qquad \left\{\bar{S}^2\right\} = \left[\bar{A}_r^{1k}\right] + \left[\bar{A}_r^{2j}\right] + \left[\bar{A}_r^{3k}\right] + \left[\bar{A}_r^{4j}\right] = \begin{Bmatrix} 125.92 \\ -5.56 \\ -66.66 \end{Bmatrix}$$

$$\left\{\bar{S}^3\right\} = \left[\bar{A}_r^{2k}\right] = \begin{Bmatrix} 74.07 \\ -88.88 \\ 0 \end{Bmatrix} \qquad \left\{\bar{S}^4\right\} = \left[\bar{A}_r^{3j}\right] = \begin{Bmatrix} 100 \\ 50 \\ 66.66 \end{Bmatrix} \qquad \left\{\bar{S}^5\right\} = \left[\bar{A}_r^{4k}\right] = \begin{Bmatrix} 0 \\ 0 \\ 0 \end{Bmatrix}$$

Μόρφωση αναδιατεταγμένων μητρώων εξωτερικών δράσεων και μετακινήσεων κόμβων

$$\left\{\bar{P}_m\right\}=\begin{Bmatrix}\bar{P}_f\\ \bar{P}_s\end{Bmatrix}=\begin{Bmatrix}-125.92\\ 5.56\\ 66.66\\ 88.88\\ 0\\ -66.66\\ 0\\ 0\\ \hline \bar{P}_3^1\\ \bar{M}_1^1\\ \bar{M}_2^1\\ \bar{P}_3^3-74.07\\ \bar{P}_3^4-100\\ \bar{M}_1^4-50\\ \bar{P}_3^5\end{Bmatrix}.\qquad \left\{\bar{\Delta}_m\right\}=\begin{Bmatrix}\bar{\Delta}_f\\ \bar{\Delta}_s\end{Bmatrix}=\begin{Bmatrix}\bar{u}_2^2=u_6\\ \bar{\theta}_2^1=\theta_4\\ \bar{\theta}_2^2=\theta_5\\ \bar{\theta}_1^3=\theta_7\\ \bar{\theta}_2^3=\theta_8\\ \bar{\theta}_2^4=\theta_{11}\\ \bar{\theta}_1^5=\theta_{13}\\ \bar{\theta}_2^5=\theta_{14}\\ \hline 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\end{Bmatrix}$$

Επίλυση συστήματος

$$\begin{Bmatrix}\bar{P}_f\\ \bar{P}_s\end{Bmatrix}=\begin{bmatrix}\bar{k}_{ff} & \bar{k}_{fs}\\ \bar{k}_{sf} & \bar{k}_{ss}\end{bmatrix}\begin{Bmatrix}\bar{\Delta}_f\\ \bar{\Delta}_s\end{Bmatrix}$$

Αποτελέσματα:

Υπολογισμός αγνώστων μετακινήσεων των κόμβων [Δ] και αγνώστων αντιδράσεων στις στηρίξεις [P_s]

$$\left\{\bar{\Delta}_f\right\} = \begin{Bmatrix} \bar{u}_2^2 \\ \bar{\theta}_2^1 \\ \bar{\theta}_2^2 \\ \bar{\theta}_1^3 \\ \bar{\theta}_2^3 \\ \bar{\theta}_2^4 \\ \bar{\theta}_1^5 \\ \bar{\theta}_2^5 \end{Bmatrix} = \frac{1}{EI_2} \begin{Bmatrix} -898.934 \\ -198.196 \\ 218.101 \\ 456.622 \\ 218.101 \\ -462.84 \\ -85.057 \\ 366.525 \end{Bmatrix}$$

$$\left\{\bar{P}_s\right\} = \begin{Bmatrix} \bar{P}_3^1 \\ \bar{M}_1^1 \\ \bar{M}_2^1 \\ \bar{P}_3^3 \\ \bar{P}_3^4 \\ \bar{M}_1^4 \\ \bar{P}_3^5 \end{Bmatrix} = \begin{Bmatrix} 93.777 \\ 238.002 \\ -16.139 \\ 6.542 \\ 10.767 \\ -7.888 \\ 14.837 \end{Bmatrix}$$

Υπολογισμός ακραίων δράσεων μελών

$$[A^i] = [A_r^i] + [k^i][\Lambda_{GG}^i][\bar{D}^i]$$

$$\begin{Bmatrix} F_3^{1j} \\ M_1^{1j} \\ M_2^{1j} \\ F_3^{1k} \\ M_1^{1k} \\ M_2^{1k} \end{Bmatrix} = \begin{Bmatrix} 93.777 \\ -16.139 \\ -238.002 \\ -93.777 \\ 16.139 \\ -138.99 \end{Bmatrix}$$

$$\begin{Bmatrix} F_3^{2j} \\ M_1^{2j} \\ M_2^{2j} \\ F_3^{2k} \\ M_1^{2k} \\ M_2^{2k} \end{Bmatrix} = \begin{Bmatrix} 19.383 \\ 0 \\ 84.722 \\ 80.617 \\ 0 \\ 0.001 \end{Bmatrix} (\approx 0)$$

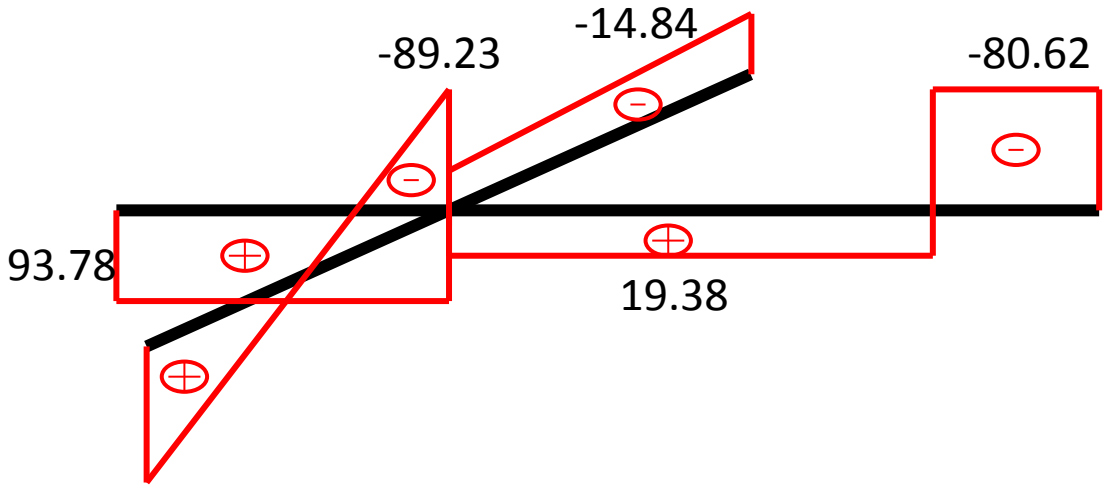
$$\begin{Bmatrix} F_3^{3j} \\ M_1^{3j} \\ M_2^{3j} \\ F_3^{3k} \\ M_1^{3k} \\ M_2^{3k} \end{Bmatrix} = \begin{Bmatrix} 110.767 \\ -33.148 \\ -25.085 \\ 89.233 \\ 33.148 \\ -28.752 \end{Bmatrix}$$

$$\begin{Bmatrix} F_3^{4j} \\ M_1^{4j} \\ M_2^{4j} \\ F_3^{4k} \\ M_1^{4k} \\ M_2^{4k} \end{Bmatrix} = \begin{Bmatrix} -14.837 \\ 0.122 \\ 74.419 \\ 14.837 \\ -0.122 \\ -0.229 \end{Bmatrix}$$

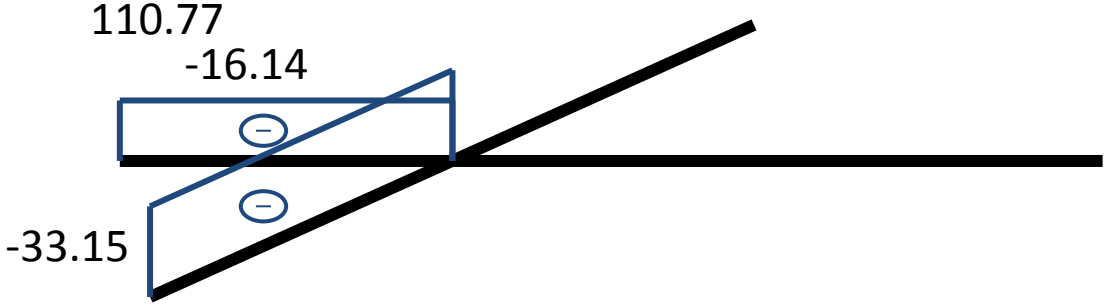
⇒ Διαγράμματα εντατικών μεγεθών $[M_1]$, $[M_2]$ και $[Q_3]$

⇓

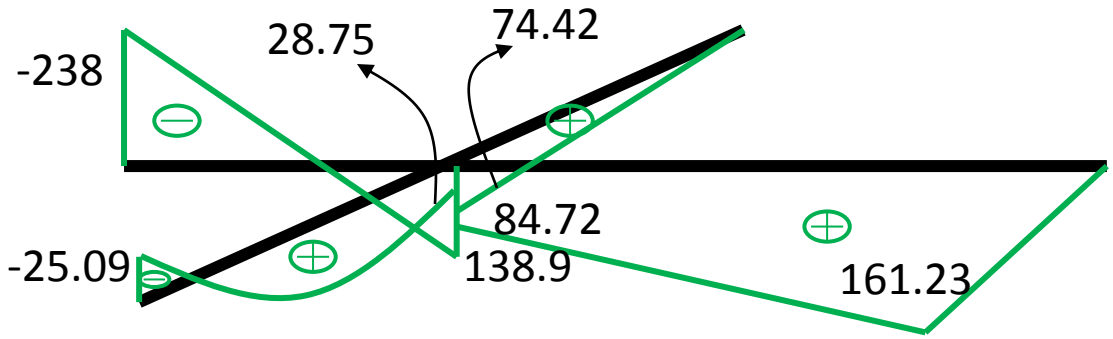
Διαγράμματα εντατικών μεγεθών [M_1], [M_2] και [Q_3]



[Q_3]

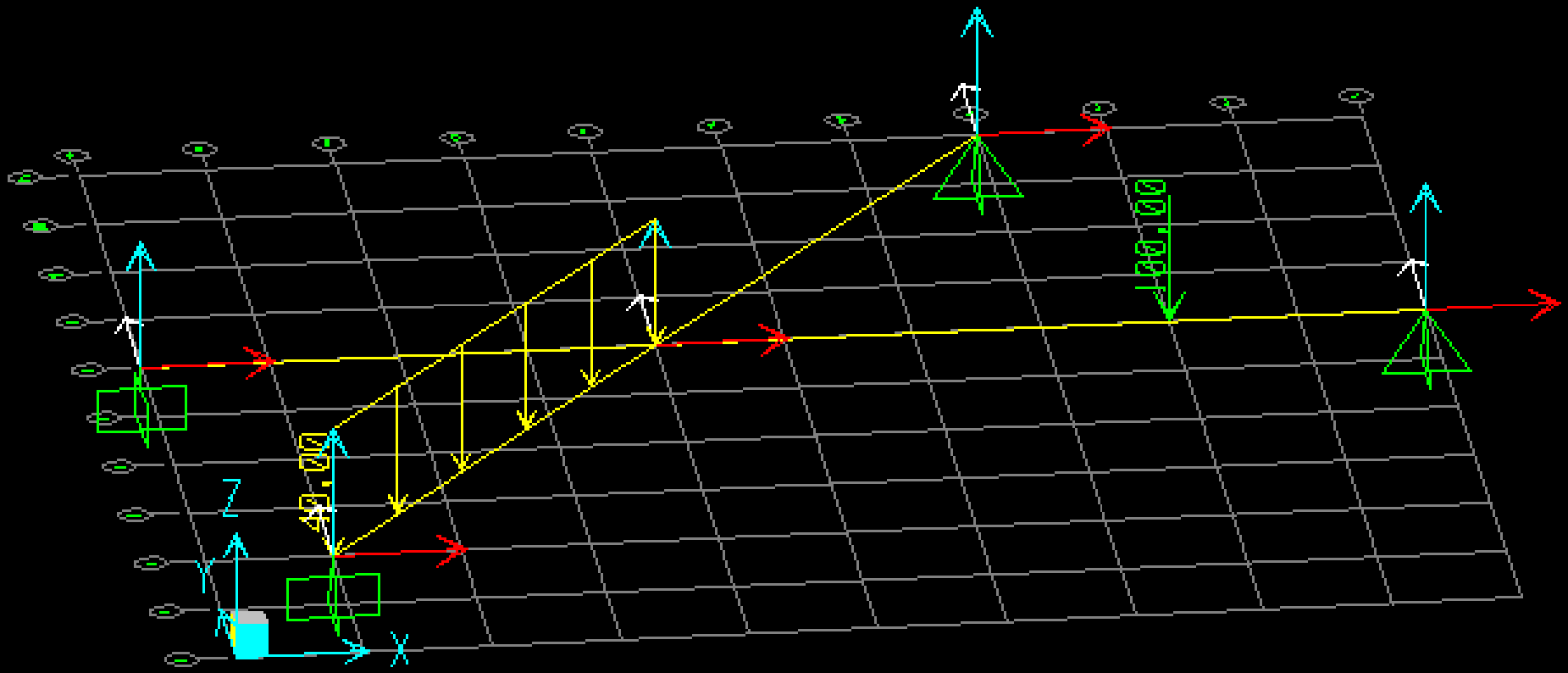


[M_1]

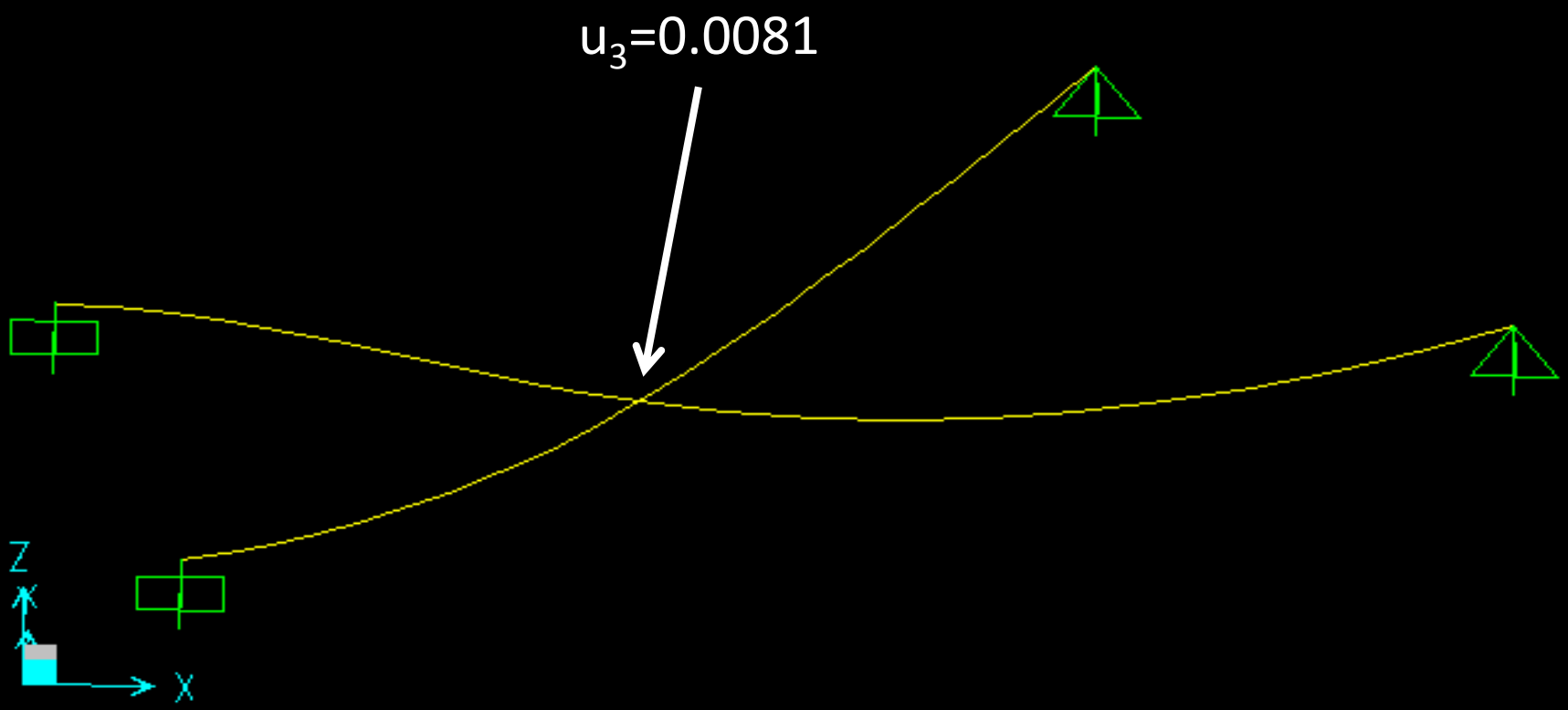


[M_2]

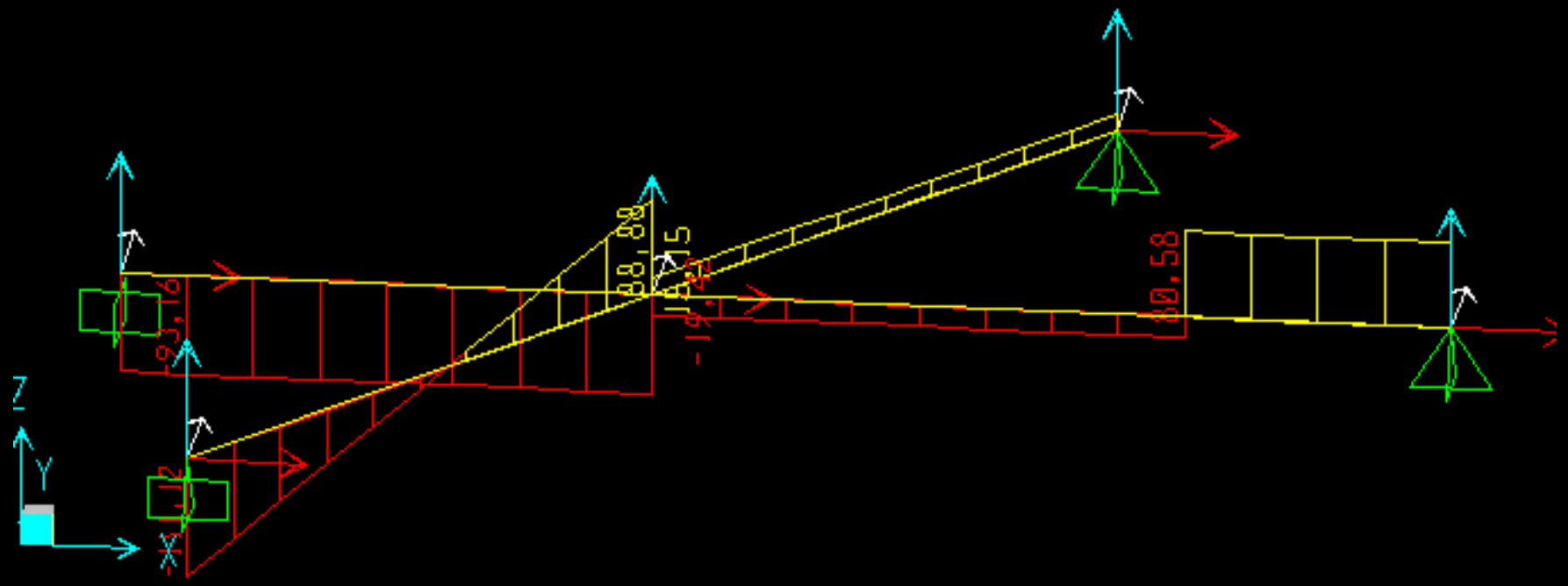
Ασκηση Εσχαρας σε Προγραμμα FEM



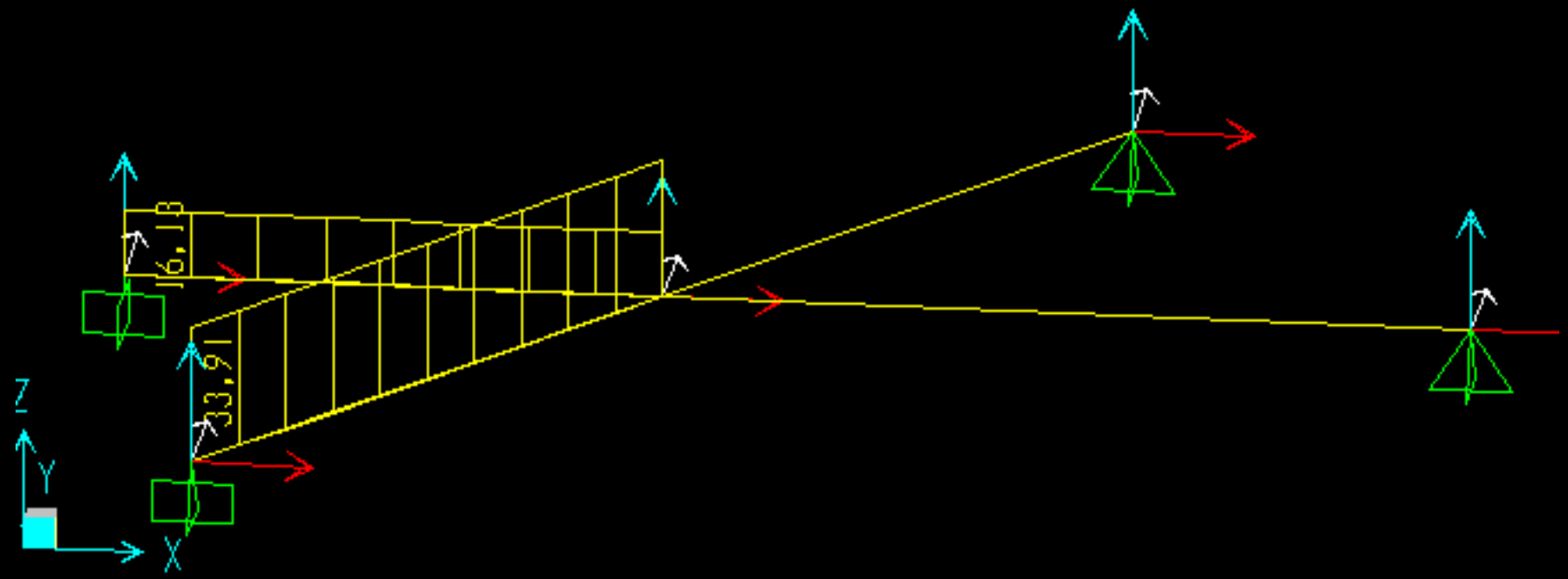
Παραμορφωμενος Φορεα



[Q3]



[M1]



[M2]