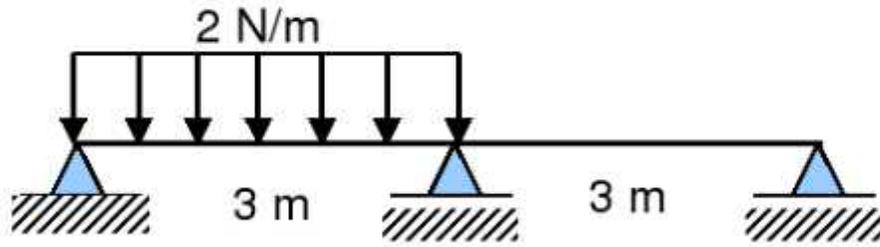


YAPI STATİĞİ II

KUVVET METODU_ UYGULAMA

Hazırlayan: Yard.Doç.Dr.Kıvanç TAŞKIN

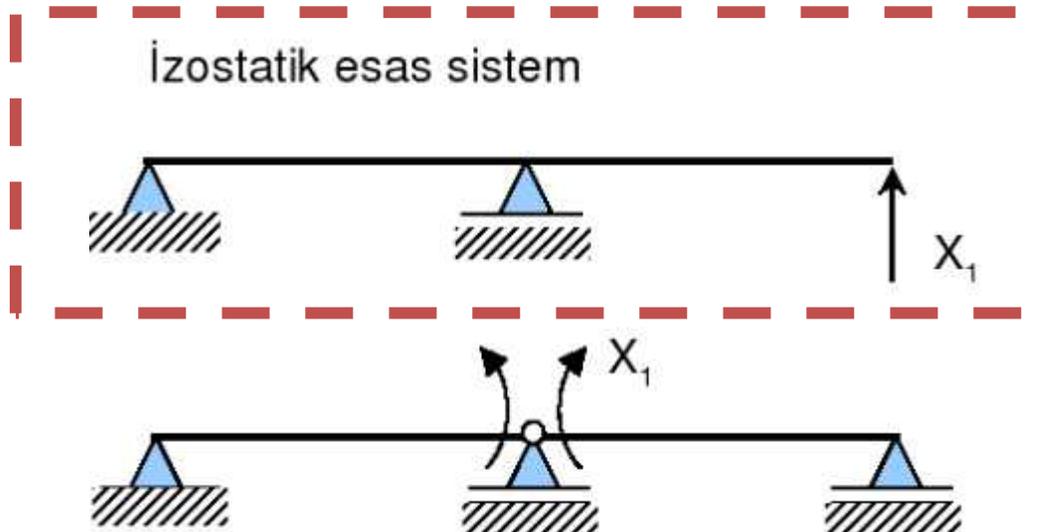
ÖRNEK 3



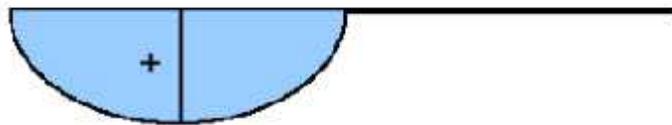
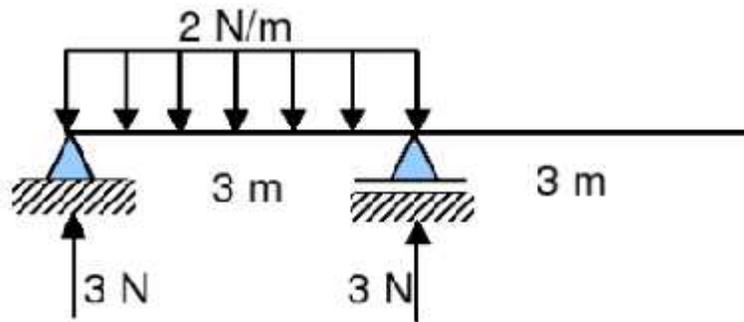
Yandaki hiperstatik sistemin moment ve kesme kuvveti değişim grafiklerini çiziniz.

1. Dereceden hiperstatik

$$\delta_1 = \delta_{10} + \delta_{11} X_1$$



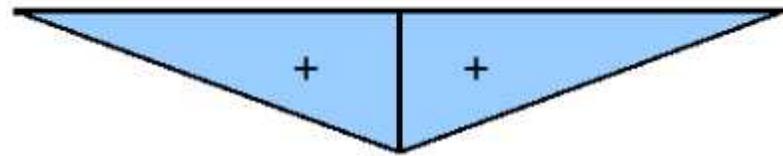
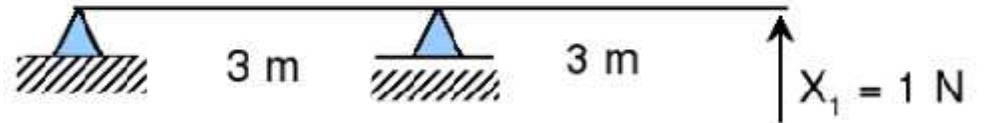
X_0 Yüklemesi



$M_0 = 2.25$

M_0 Moment diyagramı

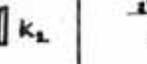
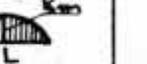
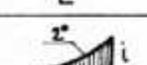
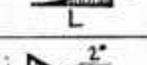
X_1 Yüklemesi



3 N.m

M_1 Moment diyagramı

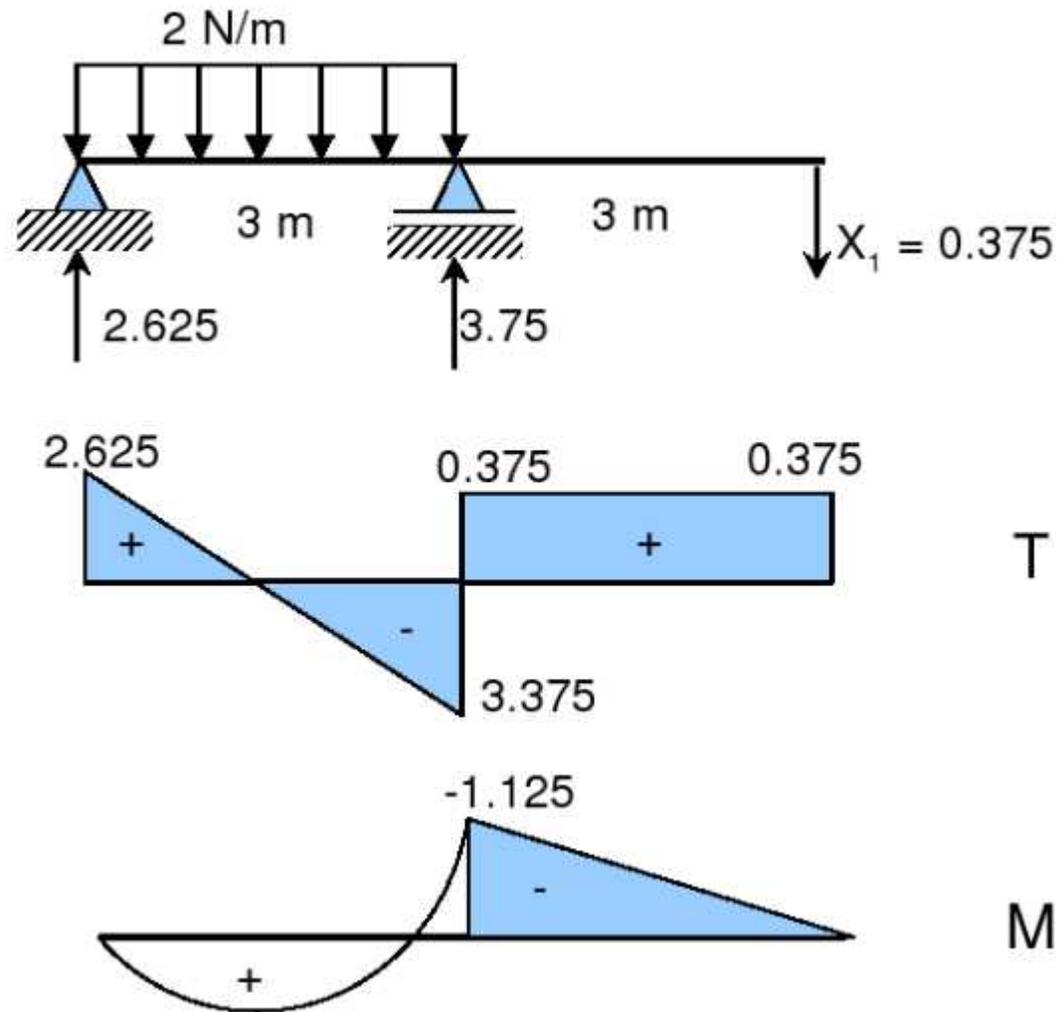
ÇARPIM TABLOSU $\int M_i M_k ds$

							
	Lik	$\frac{1}{2} Lik$	$\frac{1}{2} Li (k_1 + k_2)$	$\frac{2}{3} Li k_m$	$\frac{2}{3} Lik$	$\frac{1}{3} Lik$	$\frac{1}{2} Lik$
	$\frac{1}{2} Lik$	$\frac{1}{3} Lik$	$\frac{1}{6} Li (k_1 + 2k_2)$	$\frac{1}{3} Li k_m$	$\frac{5}{12} Lik$	$\frac{1}{4} Lik$	$\frac{1}{6} L(1+\alpha) ik$
	$\frac{1}{2} Lik$	$\frac{1}{6} Lik$	$\frac{1}{6} Li (2k_1 + k_2)$	$\frac{1}{3} Li k_m$	$\frac{1}{4} Lik$	$\frac{1}{12} Lik$	$\frac{1}{6} L(1+\beta) ik$
	$\frac{1}{2} L(i_1 + i_2) k$	$\frac{1}{6} L(i_1 + 2i_2) k$	$\frac{1}{6} L(2i_1 k_1 + i_1 k_2 + i_2 k_1 + 2i_2 k_2)$	$\frac{1}{3} L(i_1 + i_2) k_m$	$\frac{1}{12} L(3i_1 + 5i_2) k$	$\frac{1}{12} L(i_1 + 3i_2) k$	$\frac{1}{6} L k [(1+\beta)i_1 + (1+\alpha)i_2]$
	$\frac{2}{3} Lik$	$\frac{1}{3} Li k_m$	$\frac{1}{3} Li k_m (k_1 + k_2)$	$\frac{8}{15} Li k_m$	$\frac{7}{15} Lik$	$\frac{1}{5} Li k_m$	$\frac{1}{3} L(1+\beta) i k_m$
	$\frac{2}{3} Lik$	$\frac{5}{12} Lik$	$\frac{1}{12} Li (3k_1 + 5k_2)$	$\frac{7}{15} Li k_m$	$\frac{8}{15} Lik$	$\frac{3}{10} Lik$	$\frac{1}{12} L(5-\beta-\beta^2) ik$
	$\delta_{10} = \int M_1 M_0 \frac{ds}{EI} \quad EI \delta_{10} = \left(\frac{1}{3} Lik\right) = \frac{1}{3} * 3 * 3 * 2.25 = 6.75$						$(5-\alpha-\alpha^2) ik$
							$(1+\alpha+\alpha^2) ik$
	$\delta_{11} = \int M_1 M_1 \frac{ds}{EI}$ $EI \delta_{11} = \left(\frac{1}{3} Lik\right) + \left(\frac{1}{3} Lik\right) = \frac{1}{3} * 3 * 3 * 3 + \frac{1}{3} * 3 * 3 * 3 = 18$						$\frac{1}{12} L(1+\beta+\beta^2) ik$
							$\alpha^2) ik$

$$\delta_1 = \delta_{10} + \delta_{11} X_1 = 0$$

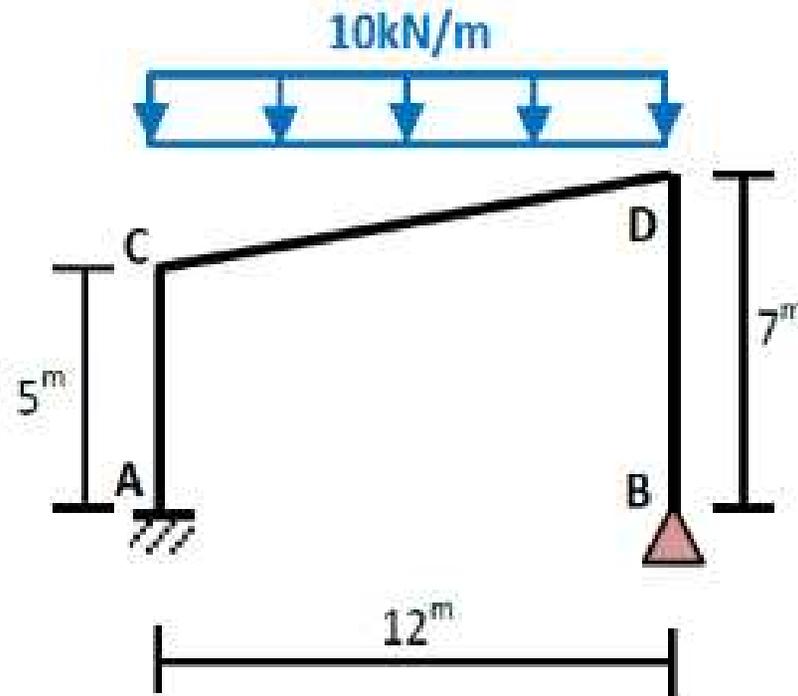
$$6.75 + 18 X_1 = 0$$

$$X_1 = -0.375$$



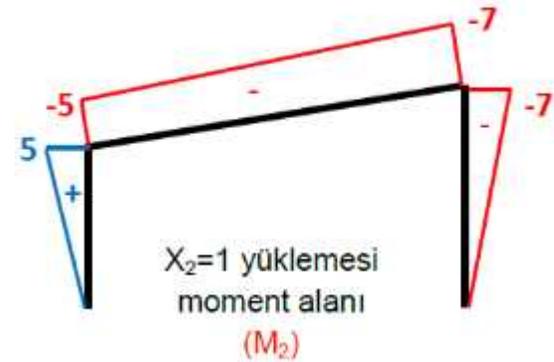
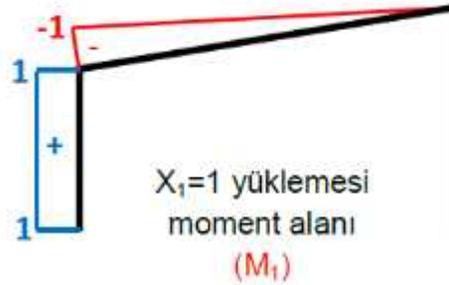
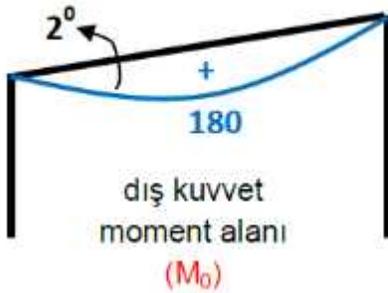
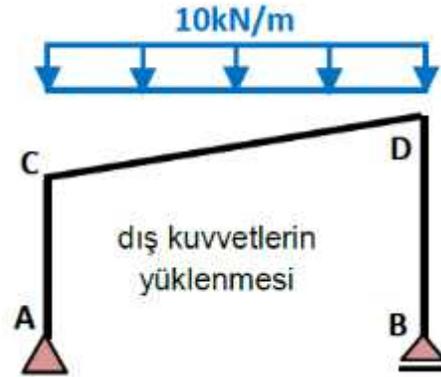
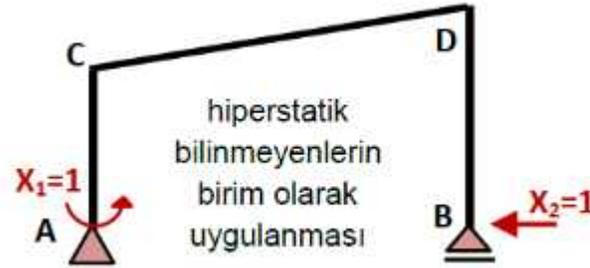
ÖRNEK 4

Şekilde verilen sistemin “Eğilme Momenti” (M) grafiğini kuvvet metodunu kullanarak çiziniz.



Çözüm: Sistem 2° hiperstatiktir. İzostatik esas sistem birden fazla şekilde seçilebilir. Her durumda aynı sonuca ulaşılabacaktır.

A mesnedinin moment bileşeni ve B mesnedinin yatay bileşeni hiperstatik bilinmeyen seçilerek sistemden kaldırılır, izostatik esas sistem elde edilir. Daha sonra A ve B mesnetlerine birim yükleme yapılarak sistem çözülür. Dış yüklerden oluşan moment alanında bulunarak süreklilik denklemleri elde edilir. Buradan süperpozisyon denklemleri yardımıyla uç momentleri hesap edilebilir.

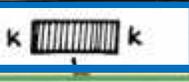
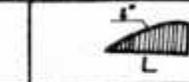
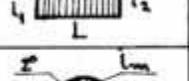
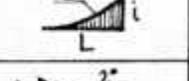


Sürekli denklemleri:

$$\delta_{11} \cdot X_1 + \delta_{12} \cdot X_2 + \delta_{10} = 0$$

$$\delta_{21} \cdot X_1 + \delta_{22} \cdot X_2 + \delta_{20} = 0$$

ÇARPIM TABLOSU $\int M_i M_k ds$

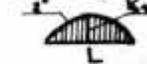
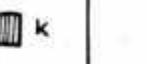
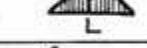
							
	Lik	$\frac{1}{2} Lik$	$\frac{1}{2} Li (k_1 + k_2)$	$\frac{2}{3} Li km$	$\frac{2}{3} Lik$	$\frac{1}{3} Lik$	$\frac{1}{2} Lik$
	$\frac{1}{2} Lik$	$\frac{1}{3} Lik$	$\frac{1}{6} Li (k_1 + 2k_2)$	$\frac{1}{3} Li km$	$\frac{5}{12} Lik$	$\frac{1}{4} Lik$	$\frac{1}{6} L(1+\alpha) ik$
	$\frac{1}{2} Lik$	$\frac{1}{6} Lik$	$\frac{1}{6} Li (2k_1 + k_2)$	$\frac{1}{3} Li km$	$\frac{1}{4} Lik$	$\frac{1}{12} Lik$	$\frac{1}{6} L(1+\beta) ik$
	$\frac{1}{2} L(i_1 + i_2) k$	$\frac{1}{6} L(i_1 + 2i_2) k$	$\frac{1}{6} L(2i_1 k_1 + i_1 k_2 + i_2 k_1 + 2i_2 k_2)$	$\frac{1}{3} L(i_1 + i_2) km$	$\frac{1}{12} L(3i_1 + 5i_2) k$	$\frac{1}{12} L(i_1 + 3i_2) k$	$\frac{1}{6} L k [(1+\beta)i_1 + (1+\alpha)i_2]$
	$\frac{2}{3} Lik$	$\delta_{11} = \int \frac{\bar{M}_1 \bar{M}_1}{EI} dl = 5 \cdot 1 \cdot 1 + \frac{1}{3} \cdot 12 \cdot 166 \cdot 1 \cdot 1 = 9,055$					
	$\frac{2}{3} Lik$						
	$\frac{2}{3} Lik$	$\frac{1}{4} Lik$	$\frac{1}{12} Li(5k_1 + 3k_2)$	$\frac{7}{15} Likm$	$\frac{11}{30} Lik$	$\frac{2}{15} Lik$	$\frac{1}{12} L(5-\alpha-\alpha^2) ik$
	$\frac{1}{3} Lik$	$\frac{1}{4} Lik$	$\frac{1}{12} Li(k_1 + 3k_2)$	$\frac{1}{5} Likm$	$\frac{3}{10} Lik$	$\frac{1}{5} Lik$	$\frac{1}{12} L(1+\alpha+\alpha^2) ik$
	$\frac{1}{3} Lik$	$\frac{1}{12} Lik$	$\frac{1}{12} Li(3k_1 + k_2)$	$\frac{1}{5} Lik$	$\frac{2}{15} Lik$	$\frac{1}{30} Lik$	$\frac{1}{12} L(1+\beta+\beta^2) ik$
	$\frac{1}{2} Lik$	$\frac{1}{6} L(1+\alpha) ik$	$\frac{1}{6} Li [(1+\beta)k_1 + (1+\alpha)k_2]$	$\frac{1}{3} L(1+\alpha\beta) ikm$	$\frac{1}{12} L(5-\beta-\beta^2) ik$	$\frac{1}{12} L(1+\alpha+\alpha^2) ik$	$\frac{1}{3} Lik$

Sürekli denklemleri:

$$\delta_{11} \cdot X_1 + \delta_{12} \cdot X_2 + \delta_{10} = 0$$

$$\delta_{21} \cdot X_1 + \delta_{22} \cdot X_2 + \delta_{20} = 0$$

ÇARPIM TABLOSU $\int M_i M_k ds$

							
	Lik	$\frac{1}{2} Lik$	$\frac{1}{2} Li (k_1 + k_2)$	$\frac{2}{3} Li k_m$	$\frac{2}{3} Lik$	$\frac{1}{3} Lik$	$\frac{1}{2} Lik$
	$\frac{1}{2} Lik$	$\frac{1}{3} Lik$	$\frac{1}{6} Li (k_1 + 2k_2)$	$\frac{1}{3} Li k_m$	$\frac{5}{12} Lik$	$\frac{1}{4} Lik$	$\frac{1}{6} L(1+\alpha) ik$
	$\frac{1}{2} Lik$	$\frac{1}{6} Lik$	$\frac{1}{6} Li (2k_1 + k_2)$	$\frac{1}{3} Li k_m$	$\frac{1}{4} Lik$	$\frac{1}{12} Lik$	$\frac{1}{6} L(1+\beta) ik$
	$\frac{1}{2} L (i_1 + i_2) k$	$\frac{1}{6} L (i_1 + 2i_2) k$	$\frac{1}{6} L (2i_1 k_1 + i_1 k_2 + i_2 k_1 + 2i_2 k_2)$	$\frac{1}{3} L (i_1 + i_2) k_m$	$\frac{1}{12} L (3i_1 + 5i_2) k$	$\frac{1}{12} L (i_1 + 3i_2) k$	$\frac{1}{6} L k [(1+\beta)i_1 + (1+\alpha)i_2]$
	$\frac{2}{3} Lik$	$\frac{1}{3} Li k$	$\frac{1}{3} Li m (k_1 + k_2)$	$\frac{8}{15} Li k_m$	$\frac{7}{15} Lik$	$\frac{1}{5} Li k$	$\frac{1}{3} L(1+\beta) i_m k$
	$\frac{2}{3} Lik$	$\frac{5}{12} Lik$	$\frac{1}{12} Li (3k_1 + 5k_2)$	$\frac{7}{15} Li k_m$	$\frac{8}{15} Lik$	$\frac{3}{10} Lik$	$\frac{1}{12} L(5-\beta-\beta^2) ik$
	$\frac{2}{3} Lik$	$\frac{1}{4} Lik$	$\frac{1}{12} Li (5k_1 + 3k_2)$	$\frac{7}{15} Li k_m$	$\frac{11}{30} Lik$	$\frac{2}{15} Lik$	$\frac{1}{12} L(5-\alpha-\alpha^2) ik$
	$\frac{1}{3} Lik$	$\frac{1}{4} Lik$	$\frac{1}{12} Li (k_1 + 3k_2)$	$\frac{1}{5} Li k_m$	$\frac{3}{10} Lik$	$\frac{1}{5} Lik$	$\frac{1}{12} L(1+\alpha+\alpha^2) ik$

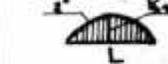
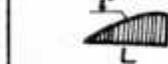
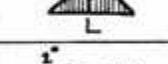
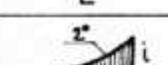
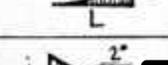
$$\delta_{22} = \int \frac{\bar{M}_2 \bar{M}_2}{EI} dl = \frac{1}{3} \cdot 5 \cdot 5 \cdot 5 + \frac{1}{6} \cdot 12,166 \cdot (2 \cdot 5 \cdot 5 + 5 \cdot 7 \cdot 2 + 2 \cdot 7 \cdot 7) + \frac{1}{3} \cdot 7 \cdot 7 \cdot 7 = 598,03$$

Sürekli denklemleri:

$$\delta_{11} \cdot X_1 + \delta_{12} \cdot X_2 + \delta_{10} = 0$$

$$\delta_{21} \cdot X_1 + \delta_{22} \cdot X_2 + \delta_{20} = 0$$

ÇARPIM TABLOSU $\int M_i M_k ds$

							
	Lik	$\frac{1}{2} Lik$	$\frac{1}{3} Li (k_1 + k_2)$	$\frac{2}{3} Li k_m$	$\frac{2}{3} Lik$	$\frac{1}{3} Lik$	$\frac{1}{2} Lik$
	$\frac{1}{2} Lik$	$\frac{1}{3} Lik$	$\frac{1}{6} Li (k_1 + 2k_2)$	$\frac{1}{3} Li k_m$	$\frac{5}{12} Lik$	$\frac{1}{4} Lik$	$\frac{1}{6} L (1 + \alpha) ik$
	$\frac{1}{2} Lik$	$\frac{1}{6} Lik$	$\frac{1}{6} Li (2k_1 + k_2)$	$\frac{1}{3} Li k_m$	$\frac{1}{4} Lik$	$\frac{1}{12} Lik$	$\frac{1}{6} L (1 + \beta) ik$
	$\frac{1}{2} L (i_1 + i_2) k$	$\frac{1}{6} L (i_1 + 2i_2) k$	$\frac{1}{6} L (2i_1 k_1 + i_1 k_2 + i_2 k_1 + 2i_2 k_2)$	$\frac{1}{3} L (i_1 + i_2) k_m$	$\frac{1}{12} L (3i_1 + 5i_2) k$	$\frac{1}{12} L (i_1 + 3i_2) k$	$\frac{1}{6} L k [(1 + \beta) i_1 + (1 + \alpha) i_2]$
	$\frac{2}{3} Lik$	$\frac{1}{3} Li k_m$	$\frac{1}{3} Li k_m (k_1 + k_2)$	$\frac{8}{15} Li k_m$	$\frac{7}{15} Lik$	$\frac{1}{5} Li k_m$	$\frac{1}{3} L (1 + \beta) i k_m$
	$\frac{2}{3} Lik$	$\frac{5}{12} Lik$	$\frac{1}{12} Li (3k_1 + 5k_2)$	$\frac{7}{15} Li k_m$	$\frac{8}{15} Lik$	$\frac{3}{10} Lik$	$\frac{1}{12} L (5 - \beta - \beta^2) ik$
	$\frac{2}{3} Lik$	$\frac{1}{4} Lik$	$\frac{1}{12} Li (5k_1 + 3k_2)$	$\frac{7}{15} Li k_m$	$\frac{11}{30} Lik$	$\frac{2}{15} Lik$	$\frac{1}{12} L (5 - \alpha - \alpha^2) ik$
	$\frac{1}{3} Lik$	$\frac{1}{4} Lik$	$\frac{1}{12} Li (k_1 + 3k_2)$	$\frac{1}{5} Li k_m$	$\frac{3}{10} Lik$	$\frac{1}{5} Lik$	$\frac{1}{12} L (1 + \alpha + \alpha^2) ik$
							$\frac{1}{12} L (1 + \beta + \beta^2) ik$
							$\frac{1}{3} Lik$

$$\delta_{12} = \delta_{21} = \int \frac{\bar{M}_1 \bar{M}_2}{EI} \cdot dl = \frac{1}{2} \cdot 5 \cdot 1.5 + \frac{1}{6} \cdot 12,166 \cdot 1 \cdot (7 + 2.5) = 46,97 \text{ (}^2\text{)ik}$$

Sürekli denklemleri:

$$\delta_{11} \cdot X_1 + \delta_{12} \cdot X_2 + \delta_{10} = 0$$

$$\delta_{21} \cdot X_1 + \delta_{22} \cdot X_2 + \delta_{20} = 0$$

ÇARPIM TABLOSU $\int M_i M_k ds$

	Lik	$\frac{1}{2} Lik$	$\frac{1}{2} Li (k_1 + k_2)$	$\frac{2}{3} Li k_m$	$\frac{2}{3} Lik$	$\frac{1}{3} Lik$	$\frac{1}{2} Lik$
	$\frac{1}{2} Lik$	$\frac{1}{3} Lik$	$\frac{1}{6} Li (k_1 + 2k_2)$	$\frac{1}{3} Li k_m$	$\frac{5}{12} Lik$	$\frac{1}{4} Lik$	$\frac{1}{6} L (1 + \alpha) ik$
	$\frac{1}{2} Lik$	$\frac{1}{6} Lik$	$\frac{1}{6} Li (2k_1 + k_2)$	$\frac{1}{3} Li k_m$	$\frac{1}{4} Lik$	$\frac{1}{12} Lik$	$\frac{1}{6} L (1 + \beta) ik$
	$\frac{1}{2} L (i_1 + i_2) k$	$\frac{1}{6} L (i_1 + 2i_2) k$	$\frac{1}{6} L (2i_1 k_1 + i_1 k_2 + i_2 k_1 + 2i_2 k_2)$	$\frac{1}{3} L (i_1 + i_2) k_m$	$\frac{1}{12} L (3i_1 + 5i_2) k$	$\frac{1}{12} L (i_1 + 3i_2) k$	$\frac{1}{6} L k [(1 + \beta) i_1 + (1 + \alpha) i_2]$
	$\frac{2}{3} Lik$	$\frac{1}{3} Li k$	$\frac{1}{3} Li k (k_1 + k_2)$	$\frac{8}{15} Li k_m$	$\frac{7}{15} Lik$	$\frac{1}{5} Li k$	$\frac{1}{3} L (1 + \beta) i k$
	$\frac{2}{3} Lik$	$\delta_{10} = \int \frac{\bar{M}_1 \bar{M}_0}{EI} dl = \frac{1}{3} \cdot 12,166 \cdot (-1) \cdot 180 = -729,96$					$\frac{1}{12} L (5 - \beta - \beta^2) ik$
	$\frac{2}{3} Lik$						$\frac{1}{12} L (5 - \alpha - \alpha^2) ik$
	$\frac{1}{3} Lik$	$\frac{1}{4} Lik$	$\frac{1}{12} L (k_1 + 3k_2)$	$\frac{1}{5} Li k_m$	$\frac{1}{10} Lik$	$\frac{1}{5} Lik$	$\frac{1}{12} L (1 + \alpha + \alpha^2) ik$
	$\frac{1}{3} Lik$	$\delta_{20} = \int \frac{\bar{M}_2 \bar{M}_0}{EI} dl = \frac{1}{3} \cdot 12,166 \cdot 180 \cdot (-5 - 7) = -8759,52$					$\frac{1}{12} L (1 + \beta + \beta^2) ik$
	$\frac{1}{2} Lik$						$\frac{1}{3} Lik$

$$\left. \begin{array}{l} 9,06 \cdot x_1 + 46,97 \cdot x_2 = 729,96 \\ 46,97 \cdot x_1 + 598,03 \cdot x_2 = 8759,52 \end{array} \right\} \begin{array}{l} x_1 = 7,82 \\ x_2 = 14,03 \end{array}$$

Süperpozisyon denklemleri:

$$M = x_1 \cdot M_1 + x_2 \cdot M_2 + M_0$$

$$M_{AC} = 7,82 \cdot 1 = 7,82 \text{ kNm}$$

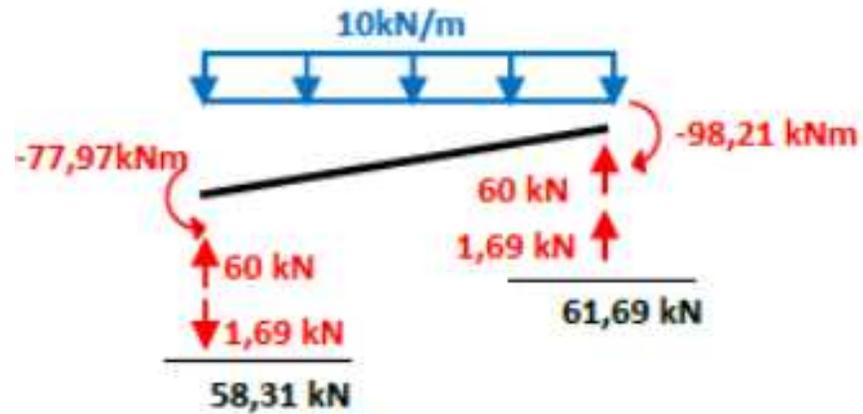
$$M_{CA} = 7,82 \cdot 1 + 14,03 \cdot 5 = 77,97 \text{ kNm}$$

$$M_{CD} = 7,82 \cdot (-1) + 14,03 \cdot (-5) = -77,97 \text{ kNm}$$

$$M_{DC} = 14,03 \cdot (-7) = -98,21 \text{ kNm}$$

$$M_{DB} = 14,03 \cdot (-7) = -98,21 \text{ kNm}$$

$$M_{BD} = 0$$

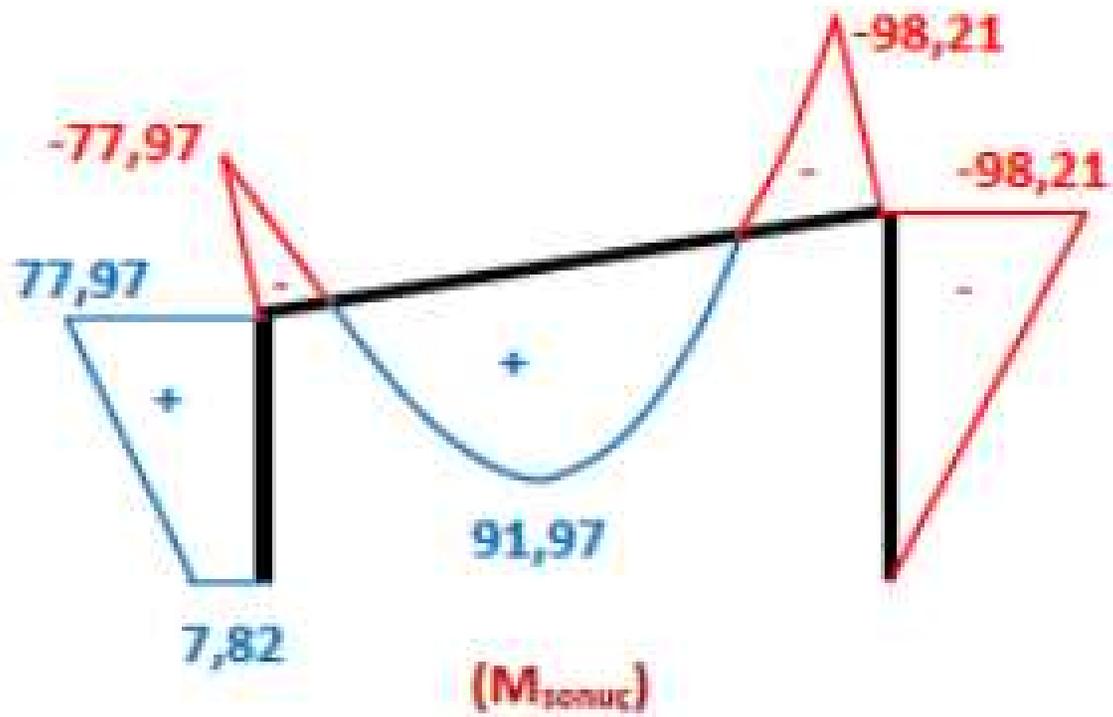


$$\frac{58,31}{61,69} = \frac{x}{12-x}$$

$$58,31 \cdot 12 - 58,31x = 61,69x$$

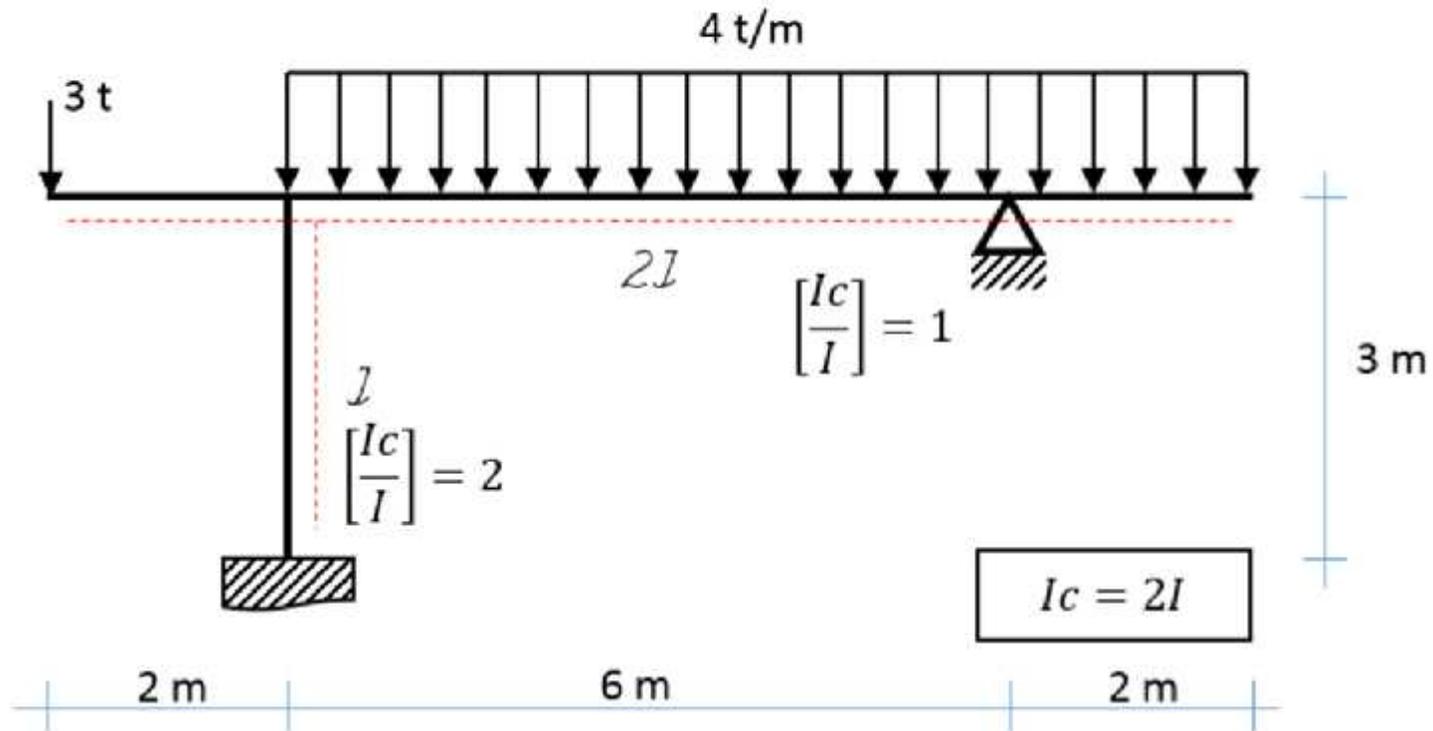
$$x = 5,83 \text{ m}$$

$$M_{maks} = -77,97 + \frac{10 \cdot 5,83^2}{2} = 91,97 \text{ kNm}$$

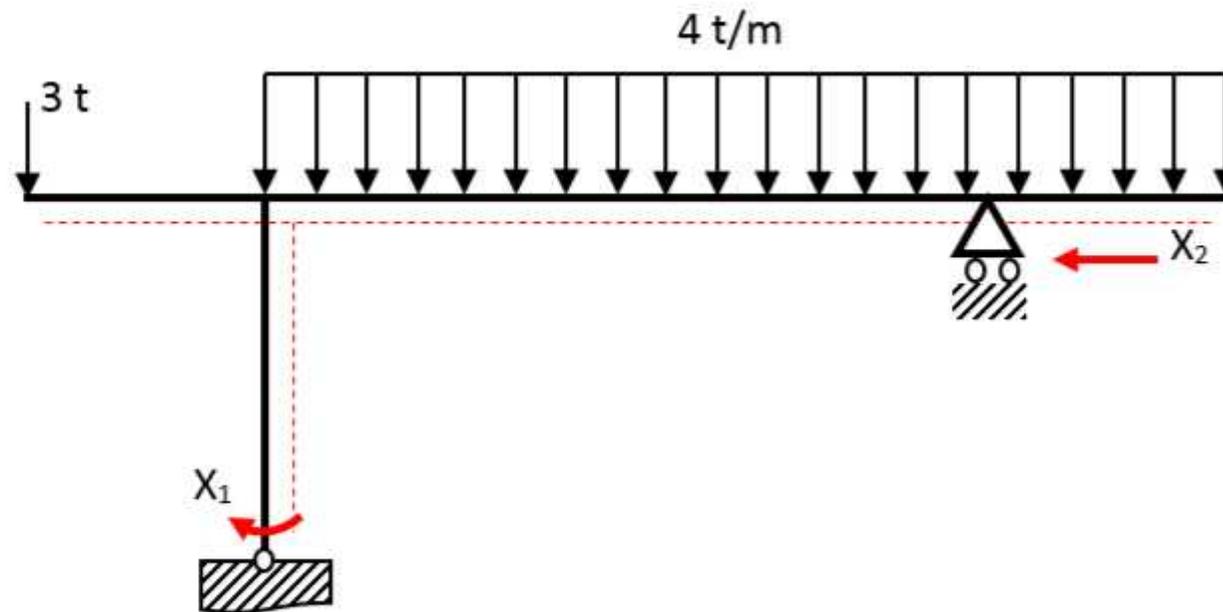


ÖRNEK 5

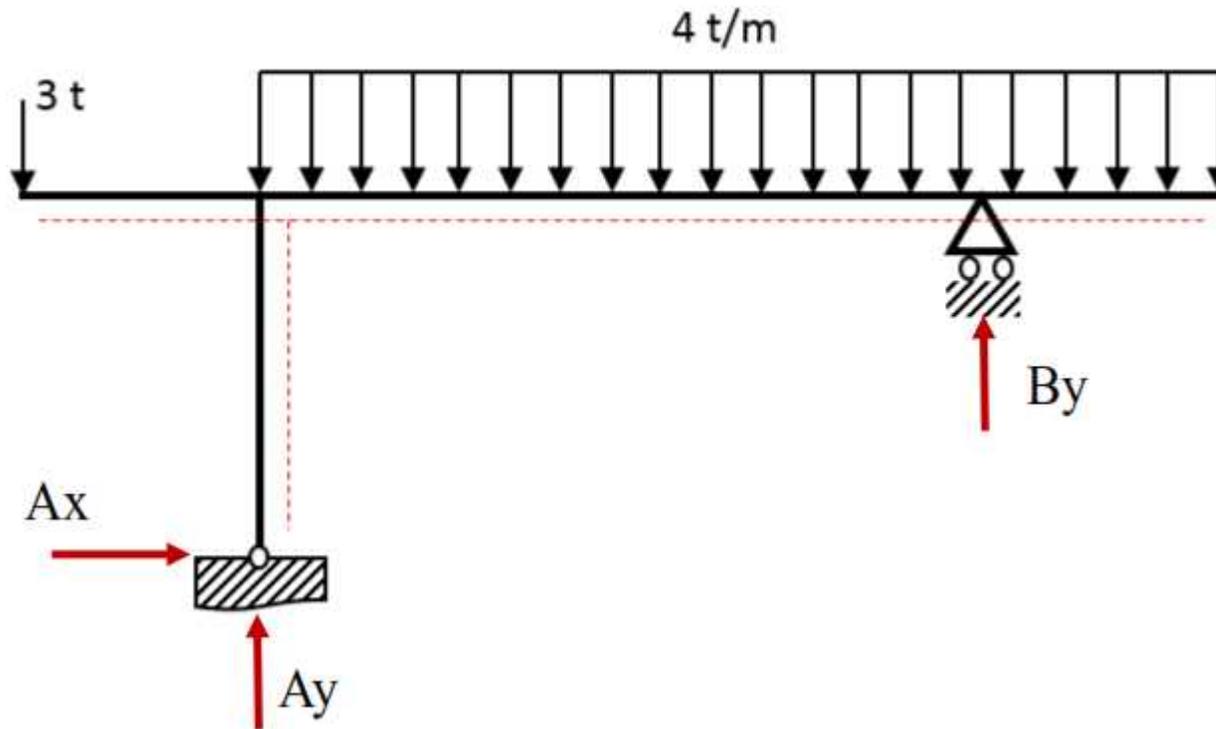
Şekilde verilen hiperstatik sistemin M, N, T diyagramlarını kuvvet yöntemi ile çiziniz.

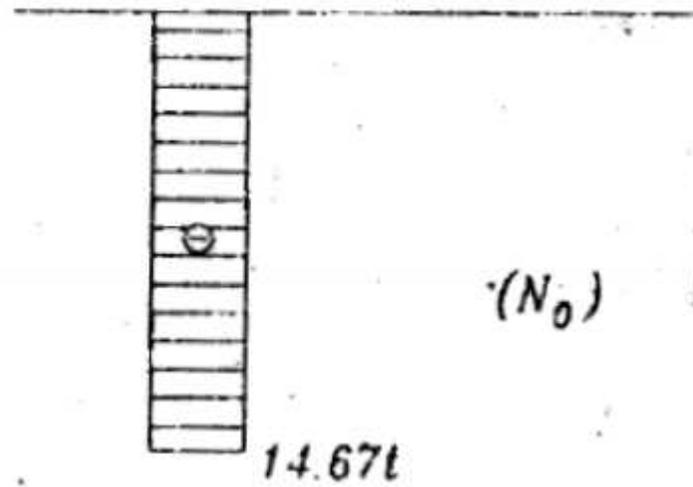
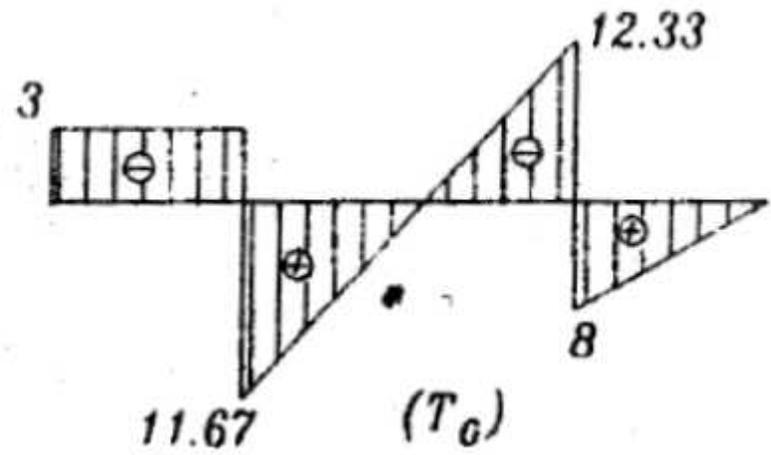
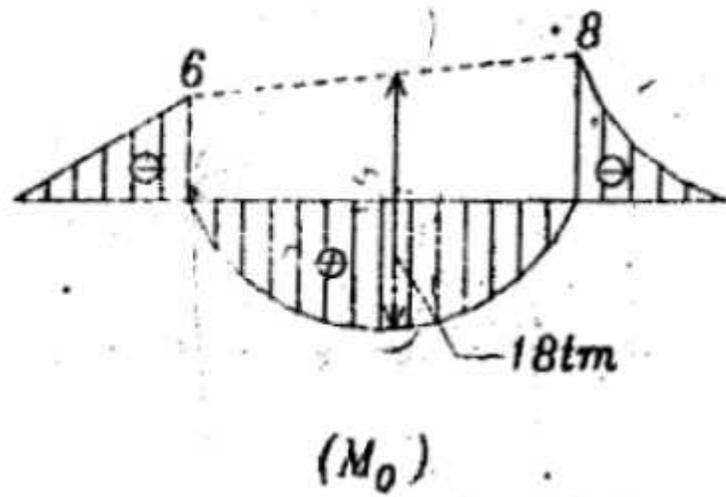


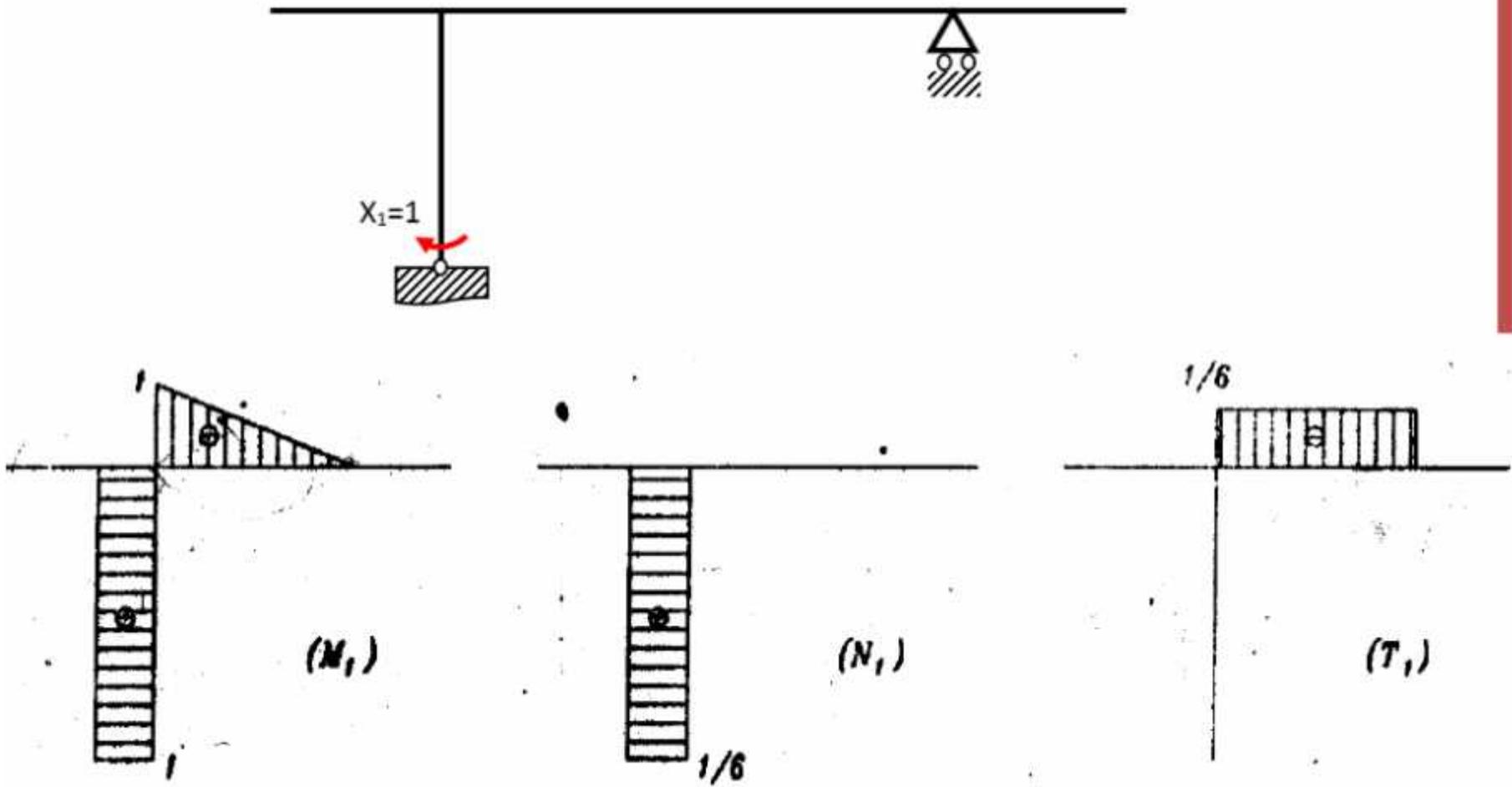
İzostatik eşlenik sistem seçimi

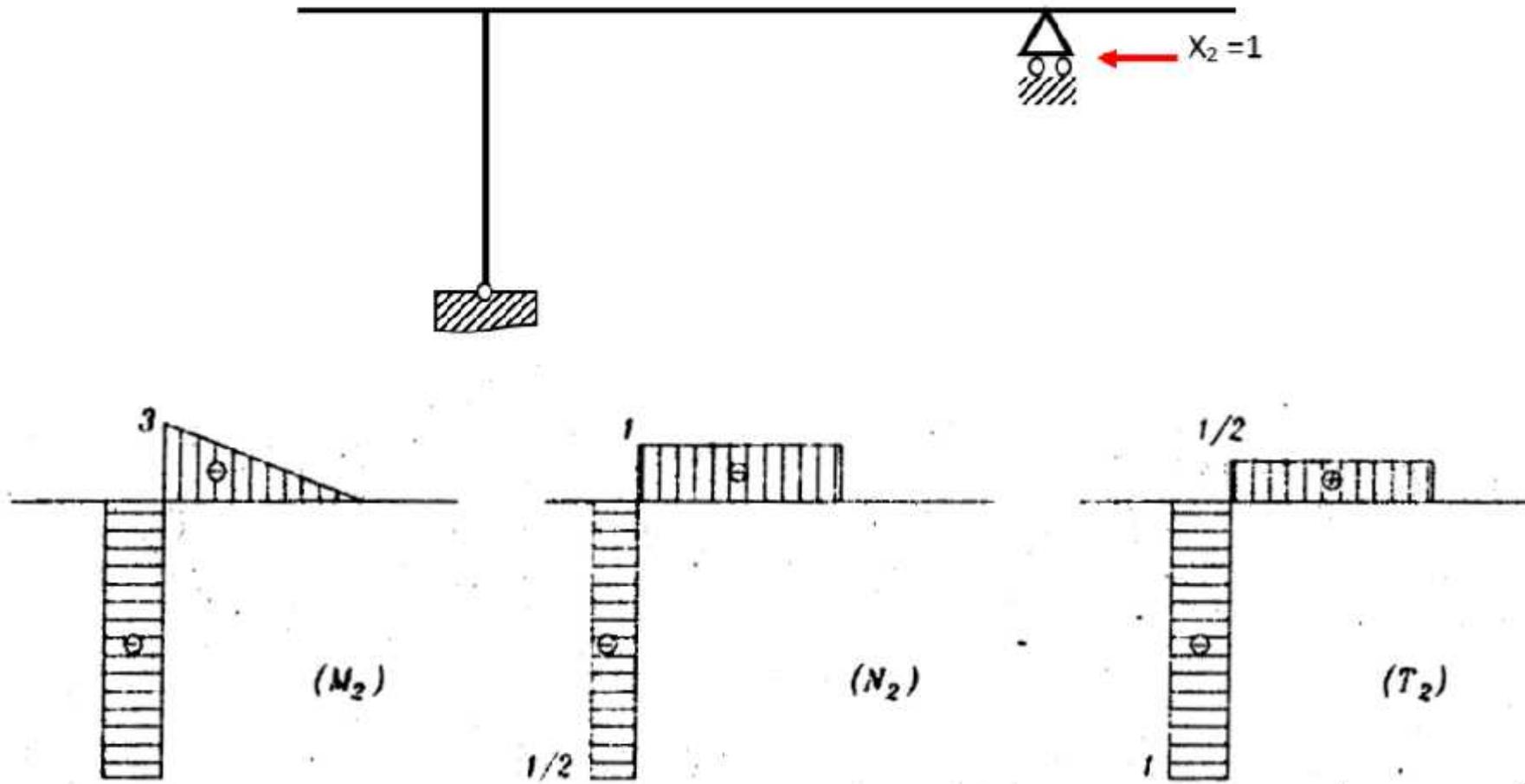


Mo, No, To Diyagramlarının Çizimi



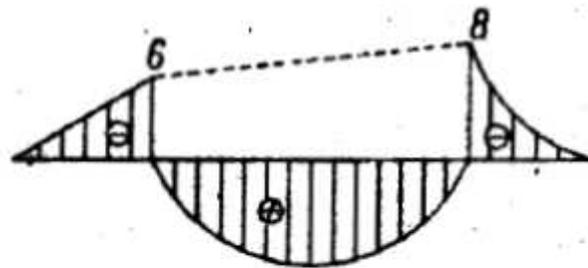




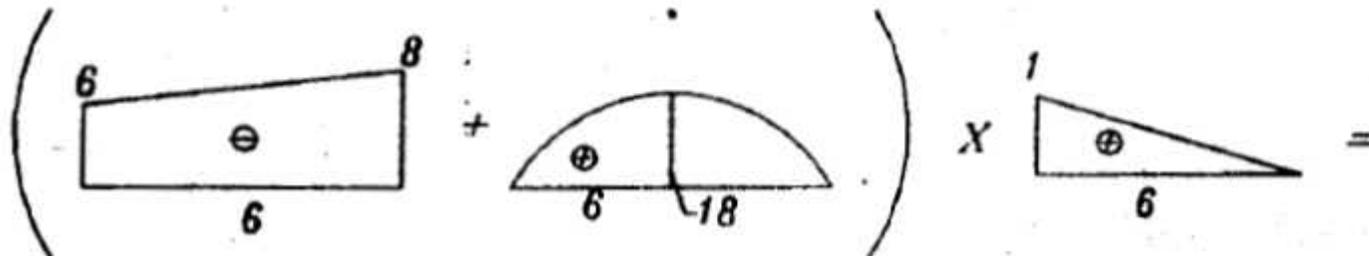
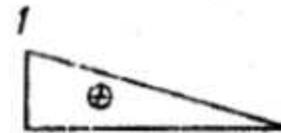


$$\delta_{10} = \int M_1 M_0 \frac{ds}{EI}$$

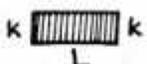
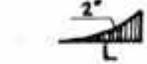
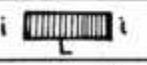
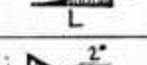
$$EI_C \delta_{10} = \int M_1 M_0 \left[\frac{I_C}{I} \right] ds$$



X

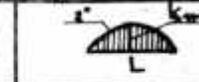
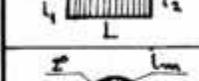
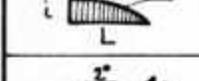


ÇARPIM TABLOSU $\int M_i M_k ds$

							
	Lik	$\frac{1}{2} Lik$	$\frac{1}{2} Li (k_1 + k_2)$	$\frac{2}{3} Li k_m$	$\frac{2}{3} Lik$	$\frac{1}{3} Lik$	$\frac{1}{2} Lik$
	$\frac{1}{2} Lik$	$\frac{1}{3} Lik$	$\frac{1}{6} Li (k_1 + 2k_2)$	$\frac{1}{3} Li k_m$	$\frac{5}{12} Lik$	$\frac{1}{4} Lik$	$\frac{1}{6} L(1+\alpha)ik$
	$\frac{1}{2} Lik$	$\frac{1}{6} Lik$	$\frac{1}{6} Li (2k_1 + k_2)$	$\frac{1}{3} Li k_m$	$\frac{1}{4} Lik$	$\frac{1}{12} Lik$	$\frac{1}{6} L(1+\beta)ik$
	$\frac{1}{2} L(i_1 + i_2)k$	$\frac{1}{6} L(i_1 + 2i_2)k$	$\frac{1}{6} L(2i_1 k_1 + i_1 k_2 + i_2 k_1 + 2i_2 k_2)$	$\frac{1}{3} L(i_1 + i_2)k_m$	$\frac{1}{12} L(3i_1 + 5i_2)k$	$\frac{1}{12} L(i_1 + 3i_2)k$	$\frac{1}{6} Lk[(1+\beta)i_1 + (1+\alpha)i_2]$
	$\frac{2}{3} Lik$	$\frac{1}{3} Lik$	$\frac{1}{3} Li m (k_1 + k_2)$	$\frac{8}{15} Li k_m$	$\frac{7}{15} Lik$	$\frac{1}{5} Lik$	$\frac{1}{3} L(1+\beta)ik$
	$\frac{2}{3} Lik$	$\frac{5}{12} Lik$	$\frac{1}{12} Li (3k_1 + 5k_2)$	$\frac{7}{15} Li k_m$	$\frac{8}{15} Lik$	$\frac{3}{10} Lik$	$\frac{1}{12} L(5-\beta-\beta^2)ik$
	$\frac{2}{3} Lik$	$\frac{1}{4} Lik$	$\frac{1}{12} Li (5k_1 + 3k_2)$	$\frac{7}{15} Li k_m$	$\frac{11}{30} Lik$	$\frac{2}{15} Lik$	$\frac{1}{12} L(5-\alpha-\alpha^2)ik$
	$\frac{1}{3} Lik$	$\frac{1}{4} Lik$	$\frac{1}{12} Li (k_1 + 3k_2)$	$\frac{1}{5} Li k_m$	$\frac{3}{10} Lik$	$\frac{1}{5} Lik$	$\frac{1}{12} L(1+\alpha+\alpha^2)ik$
	$\frac{1}{3} Lik$	$\frac{1}{12} Lik$					$\frac{1}{12} L(1+\beta+\beta^2)ik$
	$\frac{1}{2} Lik$	$\frac{1}{6} L(1+\beta)ik$					$\frac{1}{3} Lik$

$$-\frac{1}{6} 6(1)(2(6)+8) + \frac{1}{3} 6(18)1 = 16, \quad Elc \delta_{10} = 16$$

ÇARPIM TABLOSU $\int M_i M_k ds$

							
	Lik	$\frac{1}{2} Lik$	$\frac{1}{2} Li (k_1 + k_2)$	$\frac{2}{3} Likm$	$\frac{2}{3} Lik$	$\frac{1}{3} Lik$	$\frac{1}{2} Lik$
	$\frac{1}{2} Lik$	$\frac{1}{3} Lik$	$\frac{1}{6} Li (k_1 + 2k_2)$	$\frac{1}{3} Likm$	$\frac{5}{12} Lik$	$\frac{1}{4} Lik$	$\frac{1}{6} L(1+\alpha)ik$
	$\frac{1}{2} Lik$	$\frac{1}{6} Lik$	$\frac{1}{6} Li (2k_1 + k_2)$	$\frac{1}{3} Likm$	$\frac{1}{4} Lik$	$\frac{1}{12} Lik$	$\frac{1}{6} L(1+\beta)ik$
	$\frac{1}{2} L(i_1 + i_2)k$	$\frac{1}{6} L(i_1 + 2i_2)k$	$\frac{1}{6} L(2i_1k_1 + i_1k_2 + i_2k_1 + 2i_2k_2)$	$\frac{1}{3} L(i_1 + i_2)km$	$\frac{1}{12} L(3i_1 + 5i_2)k$	$\frac{1}{12} L(i_1 + 3i_2)k$	$\frac{1}{6} Lk[(1+\beta)i_1 + (1+\alpha)i_2]$
	$\frac{2}{3} Lik$	$\frac{1}{3} Lik$	$\frac{1}{3} Lim(k_1 + k_2)$	$\frac{8}{15} Likm$	$\frac{7}{15} Lik$	$\frac{1}{5} Lim$	$\frac{1}{3} L(1+\beta)imk$
	$\frac{2}{3} Lik$	$\frac{5}{12} Lik$	$\frac{1}{12} Li(3k_1 + 5k_2)$	$\frac{7}{15} Likm$	$\frac{8}{15} Lik$	$\frac{3}{10} Lik$	$\frac{1}{12} L(5-\beta-\beta^2)ik$
	$\frac{2}{3} Lik$	$\frac{1}{4} Lik$	$\frac{1}{12} Li(5k_1 + 3k_2)$	$\frac{7}{15} Likm$	$\frac{11}{30} Lik$	$\frac{2}{15} Lik$	$\frac{1}{12} L(5-\alpha-\alpha^2)ik$
	$\frac{1}{3} Lik$	$\frac{1}{4} Lik$	$\frac{1}{12} Li(k_1 + 3k_2)$	$\frac{1}{5} Likm$	$\frac{3}{10} Lik$	$\frac{1}{5} Lik$	$\frac{1}{12} L(1+\alpha+\alpha^2)ik$
	$\frac{1}{3} Lik$	$\frac{1}{12} Lik$	$\frac{1}{12} Li(3k_1 + k_2)$	$\frac{1}{5} Lik$	$\frac{2}{15} Lik$	$\frac{1}{30} Lik$	$\frac{1}{12} L(1+\beta+\beta^2)ik$
	$\frac{1}{2} Lik$	$\frac{1}{6} L(1+\alpha)ik$	$\frac{1}{6} Li[(1+\beta)k_1 + (1+\alpha)k_2]$	$\frac{1}{3} L(1+\beta)ikm$	$\frac{1}{12} L(5-\beta-\beta^2)ik$	$\frac{1}{12} L(1+\alpha+\alpha^2)ik$	$\frac{1}{3} Lik$

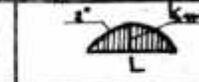
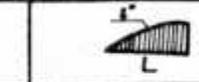
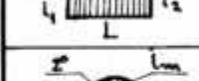
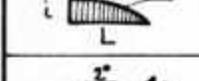
$$EI_C \delta_{11} = \int M_1 M_1 \left[\frac{I_C}{I} \right] ds$$

$$\left(\begin{array}{c} 1 \\ \text{+} \\ 3 \end{array} \right) \times \left(\begin{array}{c} 1 \\ \text{+} \\ 3 \end{array} \right) = 3(1)(1) = 3$$

$$\left(\begin{array}{c} 1 \\ \text{+} \\ 6 \end{array} \right) \times \left(\begin{array}{c} 1 \\ \text{+} \\ 6 \end{array} \right) = \frac{1}{3} 6(1)(1) = 2$$

$$EI_C \delta_{11} = 3(2) + 2(1) = 8$$

ÇARPIM TABLOSU $\int M_i M_k ds$

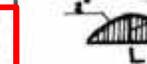
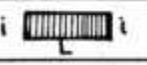
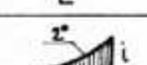
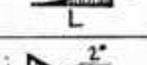
							
	Lik	$\frac{1}{2} Lik$	$\frac{1}{2} Li (k_1 + k_2)$	$\frac{2}{3} Likm$	$\frac{2}{3} Lik$	$\frac{1}{3} Lik$	$\frac{1}{2} Lik$
	$\frac{1}{2} Lik$	$\frac{1}{3} Lik$	$\frac{1}{6} Li (k_1 + 2k_2)$	$\frac{1}{3} Likm$	$\frac{5}{12} Lik$	$\frac{1}{4} Lik$	$\frac{1}{6} L(1+\alpha)ik$
	$\frac{1}{2} Lik$	$\frac{1}{6} Lik$	$\frac{1}{6} Li (2k_1 + k_2)$	$\frac{1}{3} Likm$	$\frac{1}{4} Lik$	$\frac{1}{12} Lik$	$\frac{1}{6} L(1+\beta)ik$
	$\frac{1}{2} L(i_1 + i_2)k$	$\frac{1}{6} L(i_1 + 2i_2)k$	$\frac{1}{6} L(2i_1k_1 + i_1k_2 + i_2k_1 + 2i_2k_2)$	$\frac{1}{3} L(i_1 + i_2)km$	$\frac{1}{12} L(3i_1 + 5i_2)k$	$\frac{1}{12} L(i_1 + 3i_2)k$	$\frac{1}{6} Lk[(1+\beta)i_1 + (1+\alpha)i_2]$
	$\frac{2}{3} Lik$	$\frac{1}{3} Likm$	$\frac{1}{3} Lim(k_1 + k_2)$	$\frac{8}{15} Likm$	$\frac{7}{15} Lik$	$\frac{1}{5} Limk$	$\frac{1}{3} L(1+\beta)imk$
	$\frac{2}{3} Lik$	$\frac{5}{12} Lik$	$\frac{1}{12} Li(3k_1 + 5k_2)$	$\frac{7}{15} Likm$	$\frac{8}{15} Lik$	$\frac{3}{10} Lik$	$\frac{1}{12} L(5-\beta-\beta^2)ik$
	$\frac{2}{3} Lik$	$\frac{1}{4} Lik$	$\frac{1}{12} Li(5k_1 + 3k_2)$	$\frac{7}{15} Likm$	$\frac{11}{30} Lik$	$\frac{2}{15} Lik$	$\frac{1}{12} L(5-\alpha-\alpha^2)ik$
	$\frac{1}{3} Lik$	$\frac{1}{4} Lik$	$\frac{1}{12} Li(k_1 + 3k_2)$	$\frac{1}{5} Likm$	$\frac{3}{10} Lik$	$\frac{1}{5} Lik$	$\frac{1}{12} L(1+\alpha+\alpha^2)ik$
	$\frac{1}{3} Lik$	$\frac{1}{12} Lik$	$\frac{1}{12} Li(3k_1 + k_2)$	$\frac{1}{5} Lik$	$\frac{2}{15} Lik$	$\frac{1}{30} Lik$	$\frac{1}{12} L(1+\beta+\beta^2)ik$
	$\frac{1}{2} Lik$	$\frac{1}{6} L(1+\alpha)ik$	$\frac{1}{6} Li[(1+\beta)k_1 + (1+\alpha)k_2]$	$\frac{1}{3} L(1+\alpha\beta)ikm$	$\frac{1}{12} L(5-\beta-\beta^2)ik$	$\frac{1}{12} L(1+\alpha+\alpha^2)ik$	$\frac{1}{3} Lik$

$$\left(\begin{array}{c} 1 \\ \text{---} \\ 3 \end{array} \right) \times \left(\begin{array}{c} 1 \\ \text{---} \\ 3 \end{array} \right) = -\frac{1}{2} 3(1)(3) = -4.5$$

$$\left(\begin{array}{c} 1 \\ \text{---} \\ 6 \end{array} \right) \times \left(\begin{array}{c} 1 \\ \text{---} \\ 6 \end{array} \right) = -\frac{1}{3} 6(1)(3) = -6$$

$$EI_C \delta_{12} = -4.5(2) - 6(1) = -15$$

ÇARPIM TABLOSU $\int M_i M_k ds$

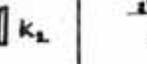
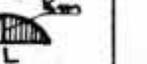
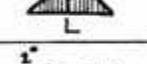
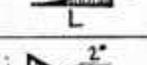
							
	Lik	$\frac{1}{2} Lik$	$\frac{1}{2} Li (k_1 + k_2)$	$\frac{2}{3} Li k_m$	$\frac{2}{3} Lik$	$\frac{1}{3} Lik$	$\frac{1}{2} Lik$
	$\frac{1}{2} Lik$	$\frac{1}{3} Lik$	$\frac{1}{6} Li (k_1 + 2k_2)$	$\frac{1}{3} Li k_m$	$\frac{5}{12} Lik$	$\frac{1}{4} Lik$	$\frac{1}{6} L(1+\alpha)ik$
	$\frac{1}{2} Lik$	$\frac{1}{6} Lik$	$\frac{1}{6} Li (2k_1 + k_2)$	$\frac{1}{3} Li k_m$	$\frac{1}{4} Lik$	$\frac{1}{12} Lik$	$\frac{1}{6} L(1+\beta)ik$
	$\frac{1}{2} L(i_1 + i_2)k$	$\frac{1}{6} L(i_1 + 2i_2)k$	$\frac{1}{6} L(2i_1 k_1 + i_1 k_2 + i_2 k_1 + 2i_2 k_2)$	$\frac{1}{3} L(i_1 + i_2)k_m$	$\frac{1}{12} L(3i_1 + 5i_2)k$	$\frac{1}{12} L(i_1 + 3i_2)k$	$\frac{1}{6} Lk[(1+\beta)i_1 + (1+\alpha)i_2]$
	$\frac{2}{3} Lik$	$\frac{1}{3} Lik$	$\frac{1}{3} Li m (k_1 + k_2)$	$\frac{8}{15} Li k_m$	$\frac{7}{15} Lik$	$\frac{1}{5} Li m k$	$\frac{1}{3} L(1+\beta)ik$
	$\frac{2}{3} Lik$	$\frac{5}{12} Lik$	$\frac{1}{12} Li (3k_1 + 5k_2)$	$\frac{7}{15} Li k_m$	$\frac{8}{15} Lik$	$\frac{3}{10} Lik$	$\frac{1}{12} L(5-\beta-\beta^2)ik$
	$\frac{2}{3} Lik$	$\frac{1}{4} Lik$	$\frac{1}{12} Li (5k_1 + 3k_2)$	$\frac{7}{15} Li k_m$	$\frac{11}{30} Lik$	$\frac{2}{15} Lik$	$\frac{1}{12} L(5-\alpha-\alpha^2)ik$
	$\frac{1}{3} Lik$	$\frac{1}{4} Lik$	$\frac{1}{12} Li (k_1 + 3k_2)$	$\frac{1}{5} Li k_m$	$\frac{3}{10} Lik$	$\frac{1}{5} Lik$	$\frac{1}{12} L(1+\alpha+\alpha^2)ik$
	$\frac{1}{3} Lik$	$\frac{1}{12} Lik$	$\frac{1}{12} Li (3k_1 + k_2)$	$\frac{1}{5} Li k_m$	$\frac{2}{15} Lik$	$\frac{1}{30} Lik$	$\frac{1}{12} L(1+\beta+\beta^2)ik$
	$\frac{1}{2} Lik$	$\frac{1}{6} L(1+\alpha)ik$	$\frac{1}{6} Li[(1+\beta)k_1 + (1+\alpha)k_2]$	$\frac{1}{3} L(1+\alpha\beta)ik_m$	$\frac{1}{12} L(5-\beta-\beta^2)ik$	$\frac{1}{12} L(1+\alpha+\alpha^2)ik$	$\frac{1}{3} Lik$

$\left(\begin{array}{c} \text{6} \\ \text{6} \end{array} \right) \times \left(\begin{array}{c} \text{18} \\ \text{6} \end{array} \right) = \frac{1}{6} 6 (3) ((2)(6) + 8) - \frac{1}{3} (18)(3)$

$$EI_C \delta_{20} = -48$$

$$EI_C \delta_{21} = EI_C \delta_{12} = -15$$

ÇARPIM TABLOSU $\int M_i M_k ds$

							
	Lik	$\frac{1}{2} Lik$	$\frac{1}{2} Li (k_1 + k_2)$	$\frac{2}{3} Lik_m$	$\frac{2}{3} Lik$	$\frac{1}{3} Lik$	$\frac{1}{2} Lik$
	$\frac{1}{2} Lik$	$\frac{1}{3} Lik$	$\frac{1}{6} Li (k_1 + 2k_2)$	$\frac{1}{3} Lik_m$	$\frac{5}{12} Lik$	$\frac{1}{4} Lik$	$\frac{1}{6} L(1+\alpha)ik$
	$\frac{1}{2} Lik$	$\frac{1}{6} Lik$	$\frac{1}{6} Li (2k_1 + k_2)$	$\frac{1}{3} Lik_m$	$\frac{1}{4} Lik$	$\frac{1}{12} Lik$	$\frac{1}{6} L(1+\beta)ik$
	$\frac{1}{2} L(i_1 + i_2)k$	$\frac{1}{6} L(i_1 + 2i_2)k$	$\frac{1}{6} L(2i_1 k_1 + i_1 k_2 + i_2 k_1 + 2i_2 k_2)$	$\frac{1}{3} L(i_1 + i_2)k_m$	$\frac{1}{12} L(3i_1 + 5i_2)k$	$\frac{1}{12} L(i_1 + 3i_2)k$	$\frac{1}{6} Lk[(1+\beta)i_1 + (1+\alpha)i_2]$
	$\frac{2}{3} Lik$	$\frac{1}{3} Lik$	$\frac{1}{3} Li_m(k_1 + k_2)$	$\frac{8}{15} Lik_m$	$\frac{7}{15} Lik$	$\frac{1}{5} Lik$	$\frac{1}{3} L(1+\beta)ik$
	$\frac{2}{3} Lik$	$\frac{5}{12} Lik$	$\frac{1}{12} Li(3k_1 + 5k_2)$	$\frac{7}{15} Lik_m$	$\frac{8}{15} Lik$	$\frac{3}{10} Lik$	$\frac{1}{12} L(5-\beta-\beta^2)ik$
	$\frac{2}{3} Lik$	$\frac{1}{4} Lik$	$\frac{1}{12} Li(5k_1 + 3k_2)$	$\frac{7}{15} Lik_m$	$\frac{11}{30} Lik$	$\frac{2}{15} Lik$	$\frac{1}{12} L(5-\alpha-\alpha^2)ik$
	$\frac{1}{3} Lik$	$\frac{1}{4} Lik$	$\frac{1}{12} Li(k_1 + 3k_2)$	$\frac{1}{5} Lik_m$	$\frac{3}{10} Lik$	$\frac{1}{5} Lik$	$\frac{1}{12} L(1+\alpha+\alpha^2)ik$
	$\frac{1}{3} Lik$	$\frac{1}{12} Lik$	$\frac{1}{12} Li(3k_1 + k_2)$	$\frac{1}{5} Lik$	$\frac{2}{15} Lik$	$\frac{1}{30} Lik$	$\frac{1}{12} L(1+\beta+\beta^2)ik$
	$\frac{1}{2} Lik$	$\frac{1}{6} L(1+\alpha)ik$	$\frac{1}{6} Li[(1+\beta)k_1 + (1+\alpha)k_2]$	$\frac{1}{3} L(1+\alpha\beta)ik_m$	$\frac{1}{12} L(5-\beta-\beta^2)ik$	$\frac{1}{12} L(1+\alpha+\alpha^2)ik$	$\frac{1}{3} Lik$

$$\left(\begin{array}{c} 3 \\ \text{---} \\ 3 \end{array} \right) \times \left(\begin{array}{c} 3 \\ \text{---} \\ 3 \end{array} \right) = \frac{1}{3} \cdot 3(3)(3) = 9$$

$$\left(\begin{array}{c} 3 \\ \text{---} \\ 6 \end{array} \right) \times \left(\begin{array}{c} 3 \\ \text{---} \\ 6 \end{array} \right) = \frac{1}{3} \cdot 6(3)(3) = 18$$

$$EI_c \delta_{22} = \int M_2 M_2 \left[\frac{I_c}{I} \right] ds$$

$$EI_c \delta_{22} = 9(2) + 18(1) = 36$$

Süreklilik denklemi ;

$$EI_C \delta_{10} = EI_C \delta_{11} X_1 + EI_C \delta_{12} X_2 = 0$$

$$EI_C \delta_{20} = EI_C \delta_{21} X_1 + EI_C \delta_{22} X_2 = 0$$

$$16 + 8 (X_1) - 15 (X_2) = 0$$

$$-48 - 15 (X_1) + 36 (X_2) = 0$$

Bu denklemler çözülürse, $X_1 = 2.3 \text{tm}$, $X_2 = 2.3 \text{t}$, bulunur.

$$M = M_0 + M_1 X_1 + M_2 X_2$$

$$M_a = 0 + 1(2.3) + 0 = 2.3 \text{tm}$$

$$M_b = 0 + 1(2.3) - 3(2.3) = -4.6 \text{tm}$$

$$M_c = -6 + 0 + 0 = -6 \text{tm}$$

$$M_d = -6 + 1(2.3) - 3(2.3) = -10.6 \text{tm}$$

$$M_e = -8 + 0 + 0 = -8 \text{tm}$$

$$M_f = -8 + 0 + 0 = -8 \text{tm}$$

$$T = T_0 + T_1 X_1 + T_2 X_2$$

$$T_a = 0 + 0 - 1(2.3) + 0 = -2.3 \text{t}$$

$$T_b = 0 + 0 - 1(2.3) = -2.3 \text{t}$$

$$T_c = -3 + 0 + 0 = -3 \text{t}$$

$$T_d = 11.67 - 1/6(2.3) + 1/2(2.3) = 12.44 \text{t}$$

$$T_e = -12.33 - 1/6(2.3) + 1/2(2.3) = -11.56 \text{t}$$

$$T_f = 8 + 0 + 0 = 8 \text{tm}$$

$$N = N_0 + N_1 X_1 + N_2 X_2$$

$$N_a = -14.67 + 1/6(2.3) - 1/2(2.3) = -15.44t$$

$$N_b = -15.44t$$

$$N_c = 0$$

$$N_e = -2.3t$$

$$N_d = -2.3t$$

$$N_f = 0$$

