

COSTRUZIONI - 4^a B

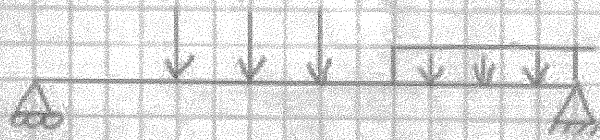
A.S. 2014/2015

LE STRUTTURE IPERSTATICHE

- LA DEFORMABILITA' DEI CORPI
- LE DEFORMAZIONI PER FLESSIONE
- TEOREMI DI MOHR
- STRUTTURE IPERSTATICHE AD UNA CAMPATA
- LE TRAVI CONTINUE
- EQUAZIONE DEI 3 MOMENTI DI CLAPEYRON

PROGETTAZIONE e COSTRUZIONE IMPIANTI

Riparo diagrammi di sollecitazione

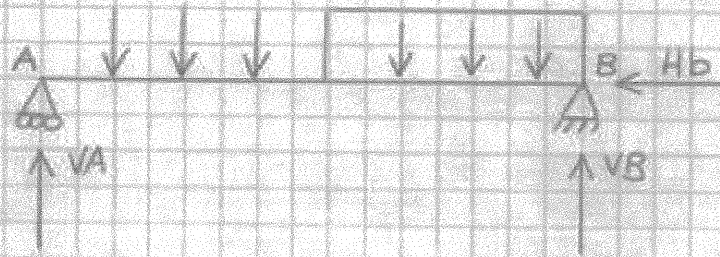


Definizione Vincolo: Il vincolo è un dispositivo che toglie un grado di libertà

Carrello: Impedisce il movimento verticale

Cerniera: Impedisce il movimento verticale e il movimento orizzontale

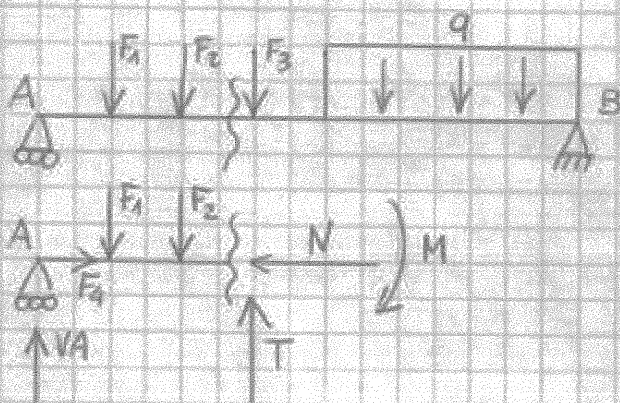
Incastrio: Impedisce qualsiasi tipo di movimento (verticale, orizzontale e momento).



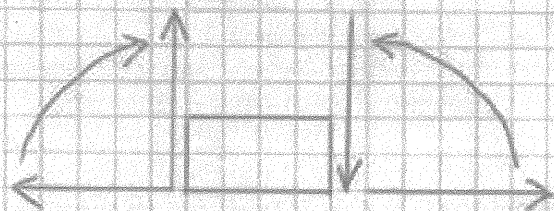
Condizioni di equilibrio

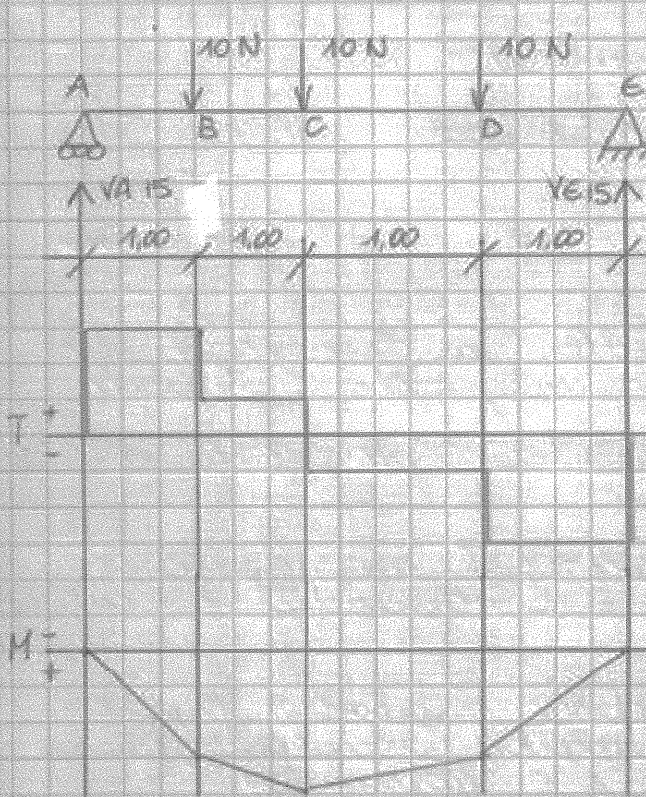
$$\begin{aligned} \sum M &= 0 \\ \sum H &= 0 \\ \sum V &= 0 \end{aligned}$$

$$F = m \cdot a$$



Condizioni di segno





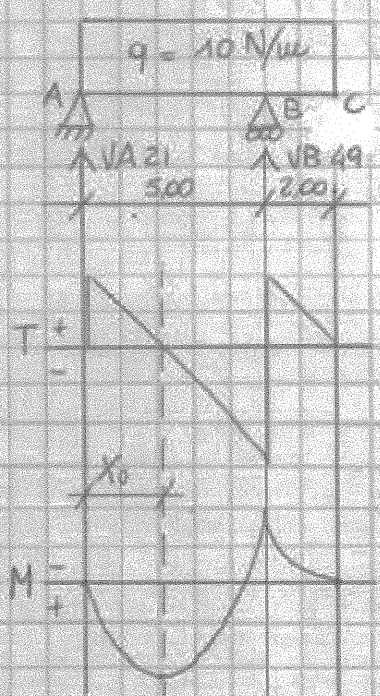
$\sum V = 0$
 $\sum M_A = 0$

$$\begin{cases} V_A + V_E - 10 - 10 - 10 = 0 \\ 10 \cdot 1 + 10 \cdot 2 + 10 \cdot 3 - V_E \cdot 4 = 0 \end{cases}$$

$$\begin{cases} V_A + V_E - 30 = 0 \\ 4V_E = 60 \Rightarrow V_E = 15 \end{cases}$$

$$\begin{cases} V_A = 15 \\ V_E = 15 \end{cases}$$

$T_A < \begin{matrix} 0 \\ 0 + 15 = 15 \end{matrix}$ $M_A = 0$
 $T_B < \begin{matrix} 5 \\ 15 - 10 = 5 \end{matrix}$ $M_B = 15 \cdot 1 = 15$
 $T_C < \begin{matrix} 5 \\ 5 - 10 = -5 \end{matrix}$ $M_C = 15 \cdot 2 - 10 \cdot 1 = 20$
 $T_D < \begin{matrix} -5 \\ -5 - 10 = -15 \end{matrix}$ $M_D = 15 \cdot 3 - 10 \cdot 2 - 10 \cdot 1 = 15$
 $T_E < \begin{matrix} -15 \\ -15 + 15 = 0 \end{matrix}$ $M_E = 15 \cdot 4 - 10 \cdot 3 - 10 \cdot 2 - 10 \cdot 1 = 0$



$\sum V = 0$
 $\sum H = 0$
 $\sum M_A = 0$

$$\begin{cases} V_A + V_B - 10 \cdot 7 = 0 \\ 10 \cdot 7 \cdot 3,5 - V_B \cdot 5 = 0 \end{cases}$$

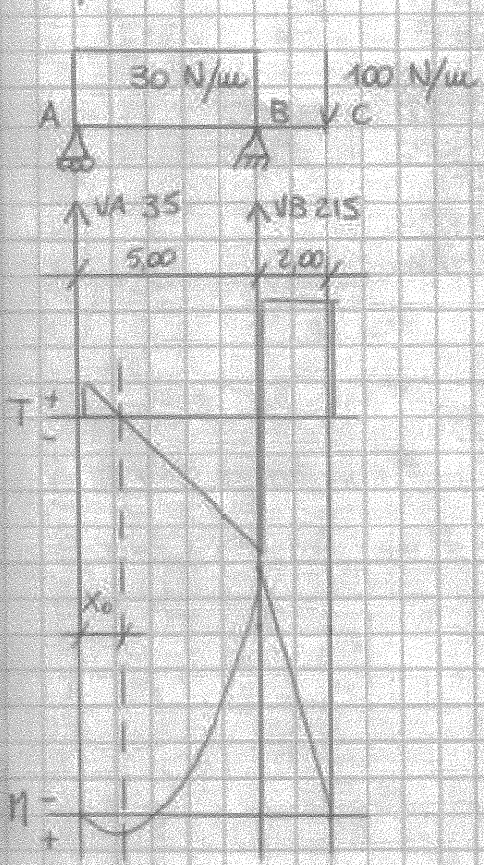
$$\begin{cases} V_A + V_B - 70 = 0 \\ + 5V_B = + \frac{245}{5} = 49 \end{cases}$$

$$\begin{cases} V_A = 21 \text{ N} \\ V_B = 49 \text{ N} \end{cases}$$

$T_A < \begin{matrix} 0 \\ 0 + 21 = 21 \end{matrix}$ $M_A = 0$
 $T_B < \begin{matrix} 21 - 10 \cdot 5 = -29 \\ -29 + 49 = 20 \end{matrix}$ $M_B = 21 \cdot 5 - 10 \cdot 5 \cdot 2,5 = -20$
 $T_C = 20 - 10 \cdot 2 = 0$ $M_C = 21 \cdot 7 - 10 \cdot 7 \cdot 3,5 + 49 \cdot 2 = 0$

$x_0 = 21 \cdot 2,5 - 10 \cdot 2,5 \cdot 1,25 = 21,25$
 $x_0 = \frac{T_A}{q} \Rightarrow T_A = x_0 \cdot q$
 $x_0 = \frac{21}{10} = 2,1$
 $M_{x_0} = 21 \cdot 2,1 - 10 \cdot 2,1 \cdot 1,05 = 22,05$

$T = 21 - q \cdot x = 0$
 $x = \frac{T_A}{q}$



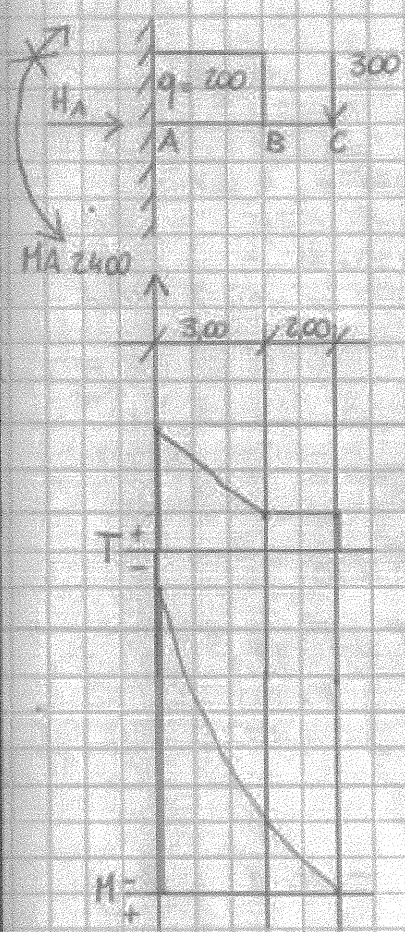
$$\begin{aligned} \sum F_y = 0 & \quad \left\{ \begin{aligned} V_A + V_B - 30 \cdot 5 - 100 &= 0 \\ H &= 0 \\ 30 \cdot 5 \cdot 2,5 - V_B \cdot 5 + 100 \cdot 7 &= 0 \end{aligned} \right. \\ \sum M_H = 0 & \\ \sum M_A = 0 & \end{aligned}$$

$$\begin{aligned} & \left\{ \begin{aligned} V_A + V_B - 250 &= 0 \\ +V_B &= +215 \end{aligned} \right. \end{aligned}$$

$$\begin{aligned} T_A & \left\{ \begin{aligned} 0 + 35 &= 35 \\ M_A &= 0 \end{aligned} \right. \\ T_B & \left\{ \begin{aligned} 35 - 30 \cdot 5 &= -115 \\ -115 + 215 &= 100 \end{aligned} \right. & M_B &= 35 \cdot 5 - 30 \cdot 5 \cdot 2,5 = -200 \\ T_C & \left\{ \begin{aligned} 100 \\ 100 - 100 &= 0 \end{aligned} \right. & M_C &= 35 \cdot 7 - 30 \cdot 5 \cdot 4,5 + 215 \cdot 7 = 0 \end{aligned}$$

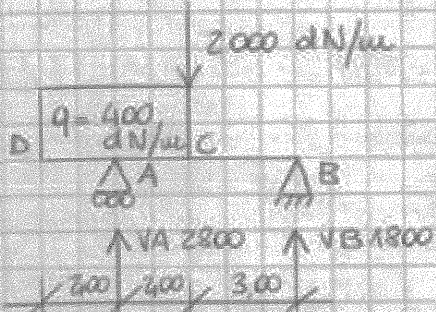
$$x = \frac{V_A}{q} = \frac{35}{30} = 1,1\bar{6}$$

$$M_{x_0} = 35 \cdot 1,1\bar{6} - 30 \cdot 1,1\bar{6} \cdot 0,58 = 20,416$$

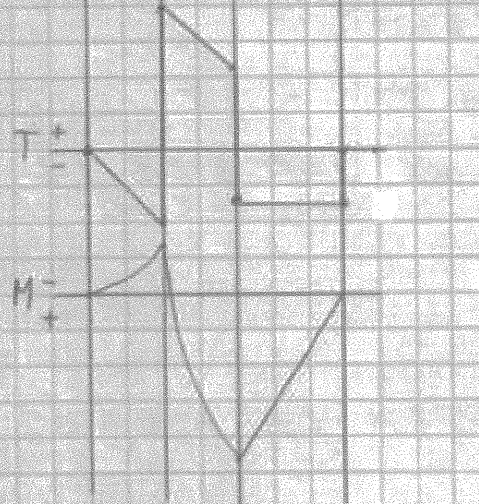


$$\begin{aligned} \sum F_y = 0 & \quad \left\{ \begin{aligned} V_A - 200 \cdot 3 - 300 &= 0 \\ \sum M_A = 0 & \quad \left\{ \begin{aligned} M_A + 200 \cdot 3 \cdot 1,5 + 300 \cdot 5 &= 0 \\ V_A &= 900 \\ M_A &= -2400 \end{aligned} \right. \end{aligned} \right. \end{aligned}$$

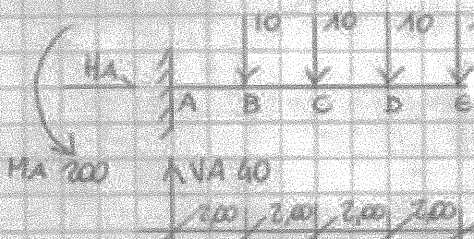
$$\begin{aligned} T_A & \left\{ \begin{aligned} 0 + 900 \\ T_B &= 900 - 200 \cdot 3 = 300 \\ T_C & \left\{ \begin{aligned} 300 \\ 300 - 300 &= 0 \end{aligned} \right. \\ M_A & \left\{ \begin{aligned} 0 \\ -2400 \end{aligned} \right. \\ M_B &= -2400 + 900 \cdot 3 - 200 \cdot 3 \cdot 1,5 = -600 \\ M_C &= -2400 + 900 \cdot 5 - 200 \cdot 3 \cdot 3,5 = 0 \end{aligned} \right. \end{aligned}$$



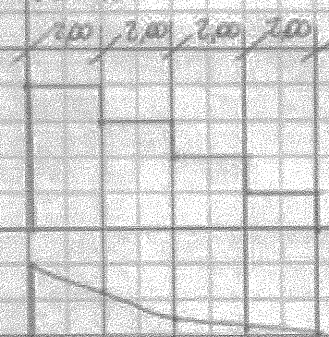
$$\begin{aligned} \sum V = 0 & \left\{ \begin{aligned} -400 \cdot 4 - 2000 + V_A + V_B \\ -400 \cdot 4 \cdot 5 - 2000 \cdot 3 + V_A \cdot 5 = 0 \end{aligned} \right. \\ \sum H = 0 & \left\{ \begin{aligned} -1600 - 2000 + 2800 + V_B = 0 \\ 5V_A = \frac{3000 + 6000}{5} = 2800 \end{aligned} \right. \\ & \left\{ \begin{aligned} V_B = 1800 \text{ dN/m} \\ V_A = 2800 \text{ dN/m} \end{aligned} \right. \end{aligned}$$



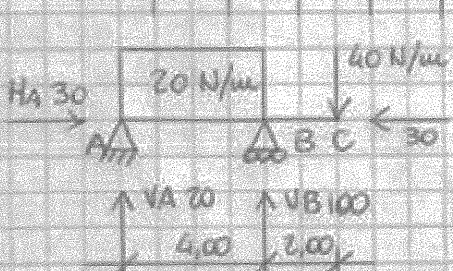
$$\begin{aligned} T_D &= 0 & M_D &= 0 \\ T_A &\left\{ \begin{aligned} -400 \cdot 2 \cdot 1 &= -800 \\ -800 + 2800 &= 2000 \end{aligned} \right. & M_A &= -400 \cdot 2 \cdot 1 = -200 \\ T_C &\left\{ \begin{aligned} 2000 - 400 \cdot 2 &= 1200 \\ 1200 - 2000 &= -800 \end{aligned} \right. & M_C &= -400 \cdot 4 \cdot 2 + 2800 \cdot 2 = 2400 \\ T_B &= -800 + 800 = 0 & M_B &= -400 \cdot 4 \cdot 5 + 2800 \cdot 5 - 2000 \cdot 3 = 0 \end{aligned}$$



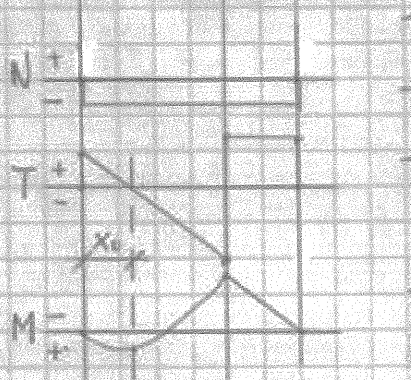
$$\begin{aligned} \sum V = 0 & \left\{ \begin{aligned} V_A - 10 - 10 - 10 - 10 = 0 \\ \sum H = 0 \\ \sum M_A = 0 \end{aligned} \right. \\ & \left\{ \begin{aligned} -M_A + 10 \cdot 2 + 10 \cdot 4 + 10 \cdot 6 + 10 \cdot 8 = 0 \\ V_A = 40 \\ M_A = 200 \end{aligned} \right. \end{aligned}$$



$$\begin{aligned} T_A &\left\{ \begin{aligned} 0 \\ 40 \end{aligned} \right. & M_A &\left\{ \begin{aligned} 0 \\ -200 \end{aligned} \right. \\ T_B &= 40 - 10 = 30 & M_B &= 200 + 40 \cdot 2 = -120 \\ T_C &= 30 - 10 = 20 & M_C &= 200 + 40 \cdot 4 - 10 \cdot 2 = -60 \\ T_D &= 20 - 10 = 10 & M_D &= 200 + 40 \cdot 6 - 10 \cdot 4 - 10 \cdot 2 = -20 \\ T_E &= 10 - 10 = 0 & M_E &= 200 + 40 \cdot 8 - 10 \cdot 6 - 10 \cdot 4 - 10 \cdot 2 = 0 \end{aligned}$$

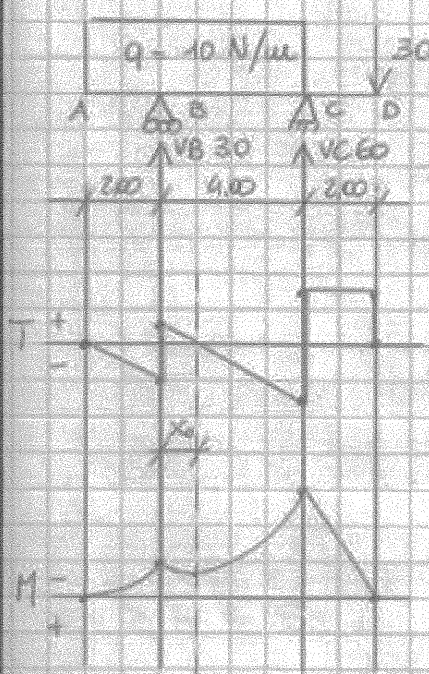


$$\begin{aligned} \sum V = 0 & \left\{ \begin{aligned} V_A + V_B - 20 \cdot 4 - 40 = 0 \\ \sum H = 0 \\ \sum M = 0 \end{aligned} \right. \\ & \left\{ \begin{aligned} -M_A + 30 = 0 \\ 20 \cdot 4 \cdot 2 - V_B \cdot 4 + 40 \cdot 6 = 0 \\ V_A + V_B - 120 = 0 \\ HA = 30 \\ V_B = 100 \end{aligned} \right. \end{aligned}$$



$$\begin{aligned} T_A &\left\{ \begin{aligned} 0 \\ 20 \end{aligned} \right. & M_A &= 0 \\ T_B &\left\{ \begin{aligned} 20 - 20 \cdot 4 &= -60 \\ 20 - 20 \cdot 4 + 100 &= 40 \end{aligned} \right. & M_B &= 20 \cdot 4 - 20 \cdot 4 \cdot 2 = -80 \\ T_C &\left\{ \begin{aligned} 40 \\ 40 - 40 &= 0 \end{aligned} \right. & M_C &= 20 \cdot 6 - 20 \cdot 4 \cdot 4 + 100 \cdot 2 = 0 \\ X_0 &= \frac{T}{q} = \frac{20}{20} = 1 \\ M_{X_0} &= 20 \cdot 1 - 20 \cdot 0,5 = 10 \end{aligned}$$

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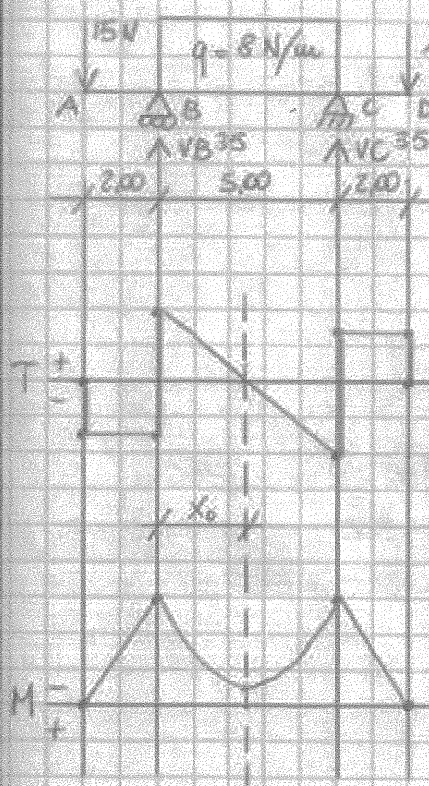


$$\begin{aligned} \sum Y = 0 & \quad \begin{cases} V_B + V_C - 10 \cdot 6 - 30 = 0 \\ -10 \cdot 2 - 1 + 10 \cdot 4 - 2 - V_C + 30 = 0 \end{cases} \\ \sum H = 0 & \\ \sum M_B = 0 & \quad \begin{cases} V_B + V_C - 90 = 0 \\ -V_C = -\frac{240}{4} = 60 \end{cases} \\ & \quad \begin{cases} V_B = 30 \\ V_C = 60 \end{cases} \end{aligned}$$

$$\begin{aligned} T_A &= 0 & M_A &= 0 \\ T_B &\begin{cases} -10 \cdot 2 = -20 \\ -20 + 30 = 10 \end{cases} & M_B &= -10 \cdot 2 \cdot 1 = -20 \\ T_C &\begin{cases} 10 - 10 \cdot 4 = -30 \\ -30 + 60 = 30 \end{cases} & M_C &= -10 \cdot 6 \cdot 3 + 30 \cdot 4 = -60 \\ T_D &= 30 - 30 = 0 & M_D &= -10 \cdot 6 \cdot 5 + 30 \cdot 6 + 60 \cdot 2 = 0 \end{aligned}$$

$$x_0 = \frac{T_{VB}}{q} = \frac{10}{10} = 1$$

$$M_{x_0} = T_{VB} \cdot x_0 - 10 \cdot 3 \cdot 1,5 = 30 \cdot 1 - 10 \cdot 3 \cdot 1,5 = -15$$



$$\begin{aligned} \sum Y = 0 & \quad \begin{cases} V_B + V_C - 15 - 8 \cdot 5 - 15 = 0 \\ -15 \cdot 7 + 5V_B - 8 \cdot 5 \cdot 2,5 + 15 \cdot 2 = 0 \end{cases} \\ \sum H = 0 & \\ \sum M_C = 0 & \quad \begin{cases} V_B + V_C - 70 = 0 \\ 5V_B = \frac{175}{5} = 35 \end{cases} \\ & \quad \begin{cases} V_C = 35 \\ V_B = 35 \end{cases} \end{aligned}$$

$$\begin{aligned} T_A &\begin{cases} 0 \\ 0 - 15 = -15 \end{cases} & M_A &= 0 \\ T_B &\begin{cases} -15 \\ -15 + 35 = 20 \end{cases} & M_B &= -15 \cdot 2 = -30 \\ T_C &\begin{cases} 20 - 8 \cdot 5 = -20 \\ -20 + 35 = 15 \end{cases} & M_C &= -15 \cdot 7 + 35 \cdot 5 - 8 \cdot 5 \cdot 2,5 = -5 \\ T_D &= 15 - 15 = 0 & M_D &= -15 \cdot 9 + 35 \cdot 7 - 8 \cdot 5 \cdot 4,5 + 35 \cdot 2 = 0 \end{aligned}$$

$$x_0 = \frac{T_{VB}}{q} = \frac{20}{8} = 2,5$$

$$M_{x_0} = -15 \cdot 4,5 + 35 \cdot 2,5 - 8 \cdot 2,5 \cdot 1,25 = -5$$