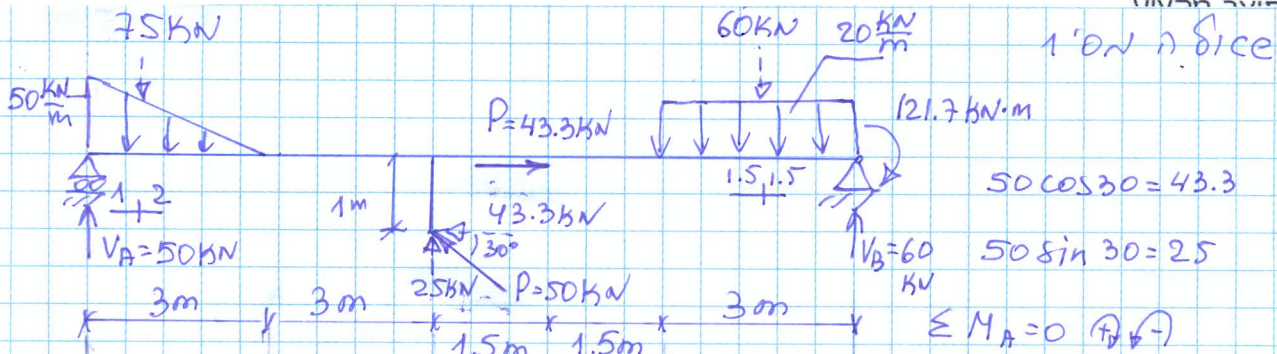


**פתרון מוצע לבחינת מה"ט בחישוב סטטי וחוזק חומרים.  
שאלון 90322**

מועד אביב תש"פ , 18/02/2020

מחברת: אינג' נדיה חיימוב מכללת אורט ירושלים



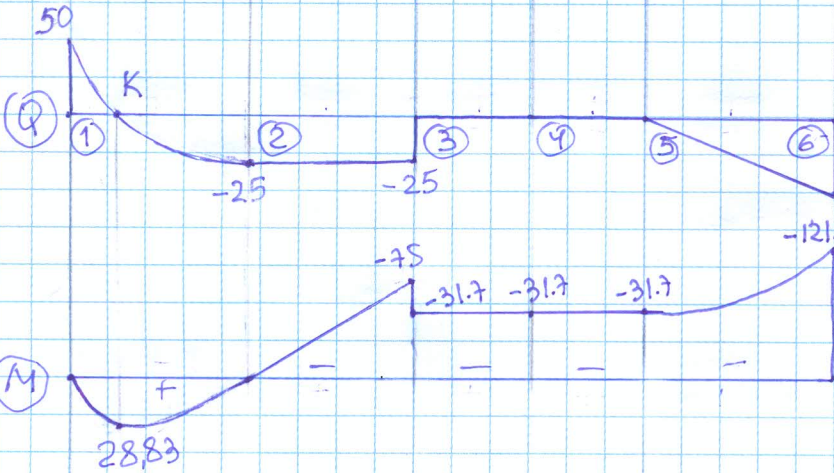
1' סדרה

$50 \cos 30 = 43.3$   
 $50 \sin 30 = 25$

$\sum M_A = 0$   
 $75 \times 1 - 25 \times 6 + 43.3 \times 1 + 60 \times 10.5 - V_B \times 12 + 121.7 = 0$

$V_B = 60 \text{ kN}$   
 $\sum P_y = 0$   
 $V_A + V_B + 25 - 75 - 60 = 0$

$V_A = 50 \text{ kN}$   
 $\sum P_x = 0$   
 $H_B - 43.3 + 43.3 = 0$   
 $H_B = 0$

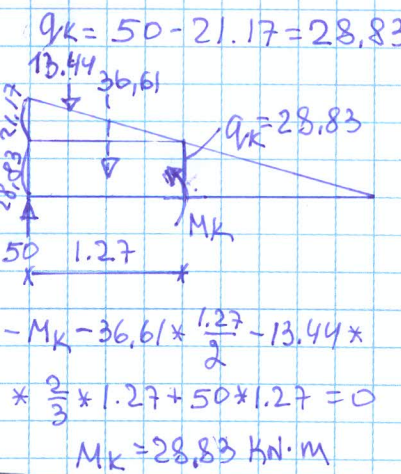


ח' סדרה מהע"פ נ/מ<sup>2</sup> ק

$M_1 = 0$   
 $M_2 = 50 \times 3 - 75 \times 2 = 0$   
 $M_3^L = 0 - 25 \times 3 = -75$   
 $M_3^R = -75 + 43.3 = -31.7$   
 $M_4 = -31.7$   
 $M_5 = -31.7$   
 $M_6^L = -31.7 - 60 \times 3 \times 0.5 = -121.7$   
 $M_6^R = -121.7 + 121.7 = 0$

ח' סדרה מהע"פ נ/מ<sup>2</sup> ק

$x = 3 \pm \sqrt{\frac{3 \times (3 \times 50 - 2 \times 50^2)}{50}}$   
 $x = 3 \pm 1.73$   
 $\bar{Q}_k = \frac{1.27 \times 50}{3} = 21.17$



ח' סדרה מהע"פ נ/מ<sup>2</sup> ק

$Q_1 = 0 + 50 = 50$   
 $Q_2 = 50 - 75 = -25$   
 $Q_3 = -25 + 25 = 0$   
 $Q_4 = 0$   
 $Q_5 = 0$   
 $Q_6^L = 0 - 60 = -60$   
 $Q_6^R = -60 + 60 = 0$

המשק כפול 1

סעיף ה. ח' של מאנין בנקודה G

$M_G = 31.7 \text{ Kcal}\cdot\text{m}$      $N_G = 0$

RHS 200/100/12.5    הקורה עולה הפלופים

$I_x = 3218 \text{ cm}^4$

ניתן גם הפלופים:

$W_x = 322 \text{ cm}^3$

הפלופים בצורה הפוכה.

$A = 68 \text{ cm}^2$

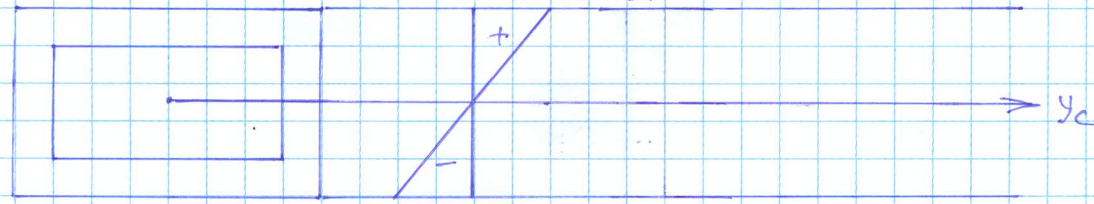
כפול  $\sigma_G = \frac{M_G \times 10^4}{W_y} = \frac{31.7 \times 10^4}{204}$

$I_y = 1022 \text{ cm}^4$

כפול  $\sigma_G = 1553,92 \frac{\text{kg}}{\text{cm}^2} < 1600 \frac{\text{kg}}{\text{cm}^2}$   
O.K!

$W_y = 204 \text{ cm}^3$

סעיף 1 ח' של מאנין בנק' E



כפול  $\sigma_E = \frac{M_E \times 10^4}{W_y} + \frac{N \times 10^2}{A} = \frac{31.7 \times 10^4}{204} + \frac{43.3 \times 10^2}{68}$

כפול  $\sigma_E = 1617,6 \frac{\text{kg}}{\text{cm}^2} > \sigma = 1600 \frac{\text{kg}}{\text{cm}^2}$  N.G!

סעיף 5 ח' של מאנין מותר בנק' B-F מותר

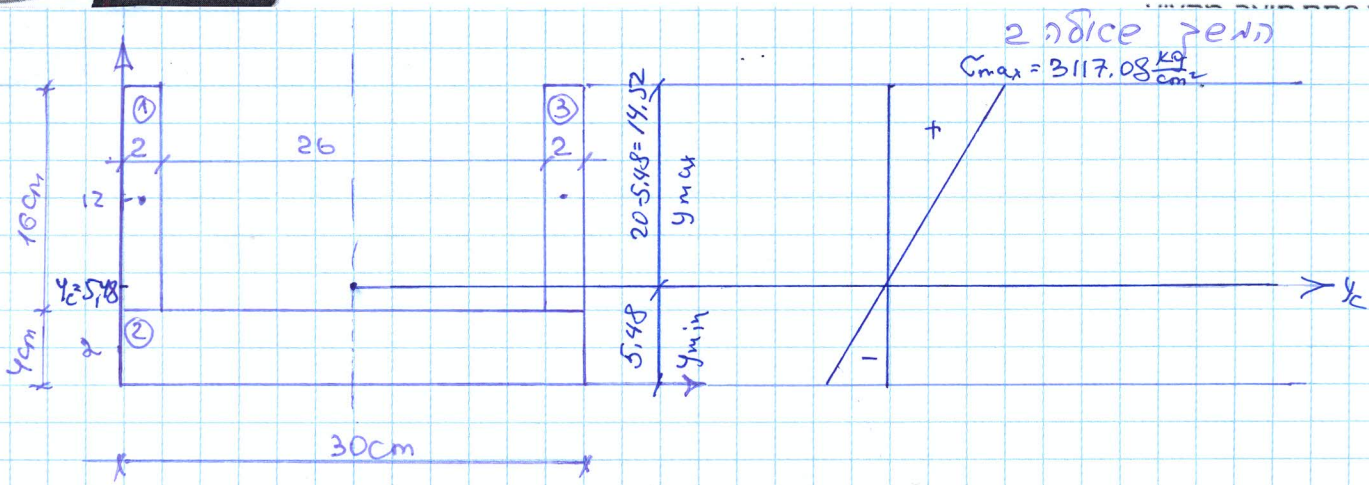
מותר בפלופים, אופרט הפלופים

$M_E = 31.7 \text{ Kcal}\cdot\text{m}$      $N = 43.3 \text{ KN}$     כפ'קה:

כפול הפלופים  $\sigma_E = \frac{M_E \times 10^4}{W_x} + \frac{N \times 10^2}{A} = \frac{31.7 \times 10^4}{322} + \frac{43.3 \times 10^2}{68}$

כפול הפלופים  $\sigma_E = 1048,15 \frac{\text{kg}}{\text{cm}^2} < \sigma = 1600 \frac{\text{kg}}{\text{cm}^2}$  O.K!





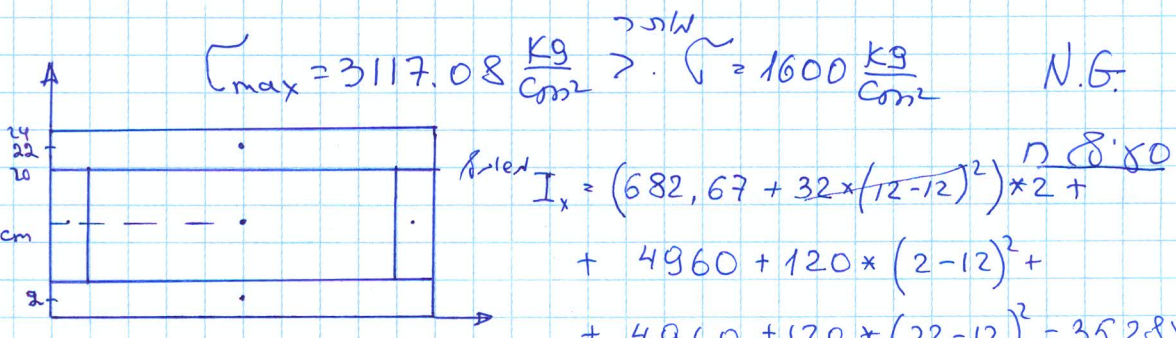
| סדר גודל | $x_i$<br>cm | $y_i$<br>cm | $A_i$<br>$cm^2$ | $I_{xi}$<br>$cm^4$ | $I_{yi}$<br>$cm^4$ |
|----------|-------------|-------------|-----------------|--------------------|--------------------|
| 1        | 1           | 12          | 32              | 682,67             | 10,67              |
| 2        | 15          | 2           | 120             | 4960               | 8000               |
| 3        | 29          | 12          | 32              | 682,67             | 10,67              |

$$y_c = \frac{12 \times 32 + 2 \times 120 + 12 \times 32}{32 \times 2 + 120} = 5.48 \text{ cm} \quad \text{נ' 8'80}$$

$$I_x = (682.67 + 32 \times (12 - 5.48)^2) \times 2 + 4960 + 120 \times (2 - 5.48)^2 = 10499.25 \text{ cm}^4 \quad \text{נ' 8'80}$$

$$M_{max} = 225 \text{ kN} \cdot \text{m} \quad N = 100 \text{ kN} \quad \text{נ' 8'80}$$

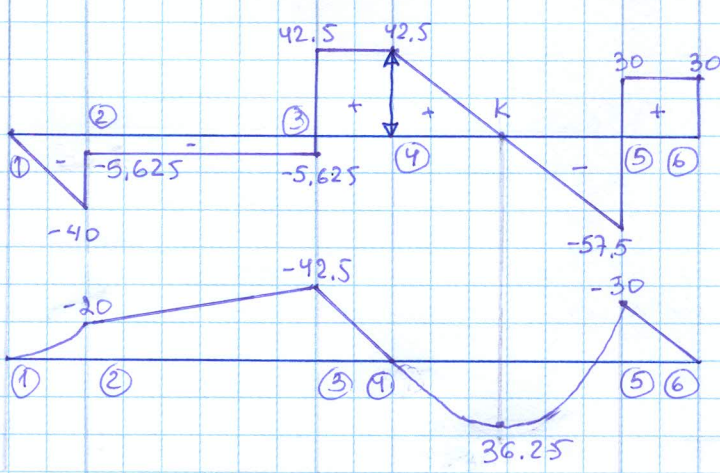
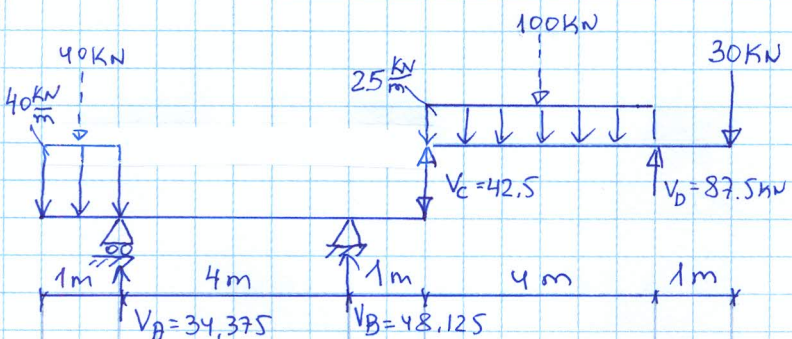
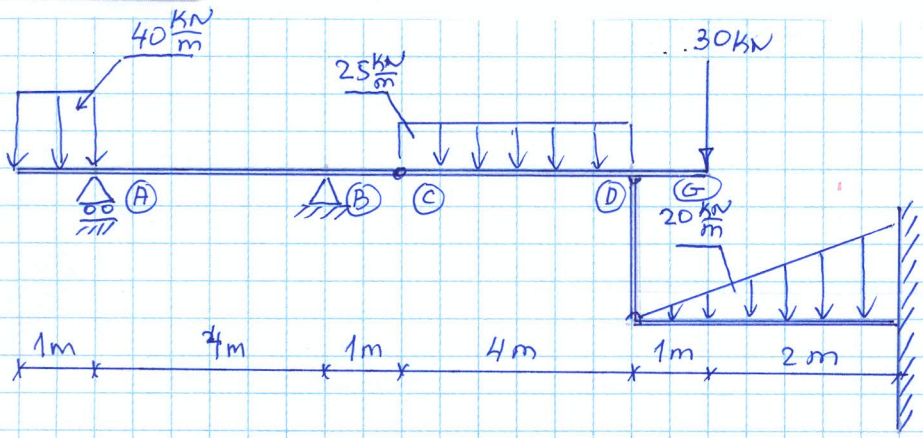
$$\sigma_{max} = \frac{225 \times 10^4}{10499.25} \times 14.52 + \frac{100 \times 10^2}{184} = 3117.08 \frac{\text{kg}}{\text{cm}^2} > 1600 \frac{\text{kg}}{\text{cm}^2}$$



$$\sigma = \frac{225 \times 10^4}{35285.34} \times 14.52 + \frac{100 \times 10^2}{184} = 980.23 \frac{\text{kg}}{\text{cm}^2} < \sigma = 1600 \frac{\text{kg}}{\text{cm}^2} \quad \text{נ' 8'80}$$

V O.K!

עמוד 3



פתיחון: קורה ABCDG  
קורה משני'ת: CDG

$$\sum M_c = 0 \quad (+\downarrow)$$

$$100 \times 2 - V_D \times 4 + 30 \times 5 = 0$$

$$V_D = 87.5 \text{ kN}$$

$$\sum P_y = 0 \quad \uparrow \downarrow$$

$$V_c + V_D - 100 - 30 = 0$$

$$V_c = 42.5 \text{ kN}$$

קורה ראש'ת: ABC

$$\sum M_A = 0 \quad (+\downarrow)$$

$$-40 \times 0.5 - V_B \times 4 + 42.5 \times 5 = 0$$

$$V_B = 48.125 \text{ kN}$$

$$\sum P_y = 0 \quad \uparrow \downarrow$$

$$V_A + V_B - 40 - 42.5 = 0$$

$$V_A = 34.375 \text{ kN}$$

| חישוב מומנטים [kN.m]          | חישוב כוחות [kN]                |
|-------------------------------|---------------------------------|
| $M_1 = 0$                     | $Q_1 = 0$                       |
| $M_2 = 0 - 20 = -20$          | $Q_2 = 0 - 40 = -40$            |
| $M_3 = -20 - 22.5 = -42.5$    | $Q_2^R = -40 + 34.375 = -5.625$ |
| $M_4 = -42.5 + 42.5 = 0$ במק  | $Q_3 = -5.625 + 48.125 = 42.5$  |
| $M_K = 0 + 36.125 = +36.125$  | $Q_4 = 42.5$                    |
| $M_5 = 36.125 - 66.125 = -30$ | $Q_5^L = 42.5 - 100 = -57.5$    |
| $M_6 = -30 + 30 = 0$          | $Q_5^R = -57.5 + 87.5 = +30$    |
|                               | $Q_6 = +30 - 30 = 0$            |

חישוב אזורי

$$x_1 = \frac{42.5}{25} = 1.7 \quad x_2 = 2.3$$

$$-A_1 = 40 \times 1 \times 0.5 = 20$$

$$-A_2 = 5.625 \times 4 = 22.5$$

$$+A_3 = 42.5 \times 1 = 42.5$$

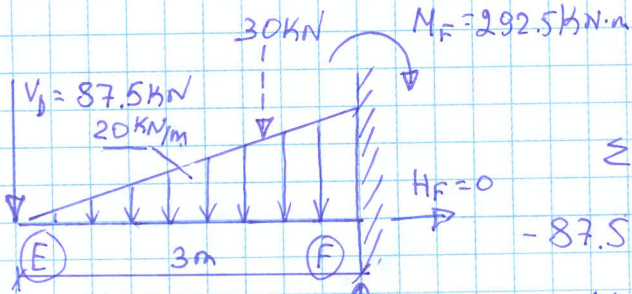
$$+A_4 = 42.5 \times 1.7 \times 0.5 = 36.125$$

$$-A_5 = 57.5 \times 2.3 \times 0.5 = 66.125$$

$$+A_6 = 30 \times 1 = 30$$

המשק שארזה 3.

ח'שוב קורה E-F



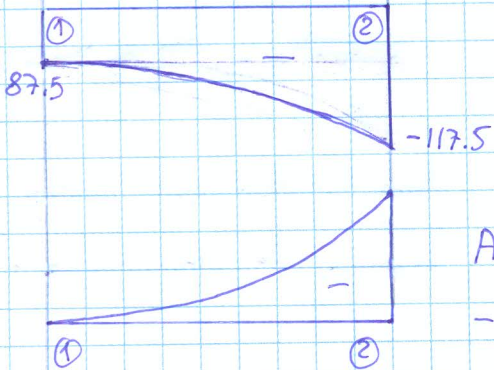
$$\sum M_F = 0 \quad (+ \downarrow -)$$

$$-87.5 \times 3 - 30 \times 1 + M_F = 0$$

$$\sum P_y = 0 \quad \uparrow \downarrow$$

$$V_F - 87.5 - 30 = 0 \quad V_F = 117.5 \text{ kN.}$$

$$\sum P_x = 0 \quad H_F = 0$$



ח'שוב מהע'ב' ע'כ'רה.

$$A = 87.5 \times 3 + \frac{1}{3} \times 30 \times 3$$

$$Q_1 = 0 - 87.5 = -87.5 \text{ kN}$$

$$-A = 292.5$$

$$Q_2^L = -87.5 - 30 = -117.5 \text{ kN}$$

ח'שוב נ'נ'ק'.

$$Q_2^R = -117.5 + 117.5 = 0.$$

$$M_1 = 0 \quad [\text{kN} \cdot \text{m}]$$

$$M_2^L = 0 - 292.5 = -292.5$$

$$M_2^R = -292.5 + 292.5 = 0.$$

$$\text{ע'כ'רה} \quad W_x = \frac{M_F \times 10^4}{\sigma_{\text{ת'כ'ר}}}$$

ע'כ'רה 3. ה'כ'רת פ'רוס'ם.

$$\text{ע'כ'רה} \quad W_x = \frac{292.5 \times 10^4}{1600} = 1828.125 \text{ cm}^3$$

$$W_x [\text{IPN 450}] = 2040 \text{ cm}^3$$

$$\text{ס'ת'ק'ר} \quad \sigma = \frac{292.5 \times 10^4}{2040} = 1433.82 \frac{\text{kg}}{\text{cm}^2} < \sigma_{\text{ת'כ'ר}} = 1600 \frac{\text{kg}}{\text{cm}^2} \quad \text{V.O.K.}$$

$$N_{ED} = V_D = 87.5 \text{ kN.}$$

ה'כ'רת ע'כ'רה.

$$\text{ח'שוב} \quad \sigma = \frac{w \times N \times 10^2}{A}$$

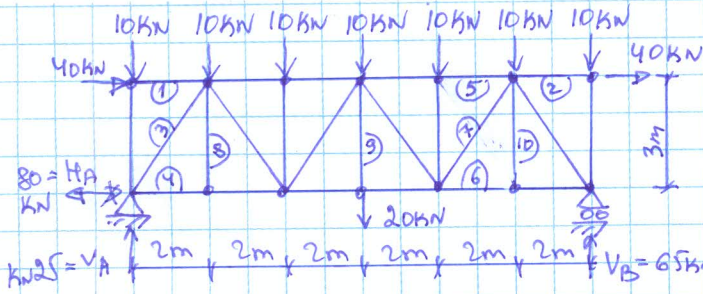
$$A [\text{RHS } 70/70/3.6] = 9.5 \text{ cm}^2$$

$$L = 2.7 \text{ cm.}$$

$$\lambda = \frac{L}{i} = \frac{200 \text{ cm}}{2.7 \text{ cm}} = 74.07$$

$$w(\lambda = 74.07) = 1.46$$

$$\text{ס'ת'ק'ר} \quad \sigma = \frac{1.46 \times 87.5 \times 10^2}{9.5} = 1344.74 \frac{\text{kg}}{\text{cm}^2} < \sigma_{\text{ת'כ'ר}} = 1600 \frac{\text{kg}}{\text{cm}^2}$$



אורך 4' מ' מ' - 13 ק"מ - 10' מ' מ' סכום

$\Sigma M_A = 0$  (+/-)

$40 \times 3 + 10 \times 2 + 10 \times 4 + 10 \times 6 + 20 \times 6 + 10 \times 8 + 10 \times 10 + 10 \times 12 + 40 \times 3 - V_B \times 12 = 0$

$V_B = 65 \text{ kN}$

$\Sigma P_y = 0$  (+/-)

$V_A + V_B - 10 \times 7 - 20 = 0$

$V_A = 25 \text{ kN}$

$\Sigma P_x = 0$  (+/-)

$H_A + 40 + 40 = 0$

$H_A = -80 \text{ kN}$

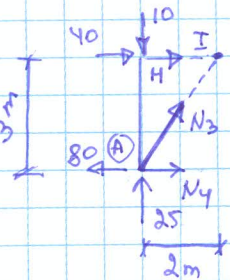
| ציר    | 1   | 2  | 3      | 4  | 5      | 6     | 7     |
|--------|-----|----|--------|----|--------|-------|-------|
| N [kN] | -40 | 40 | -18.03 | 90 | -26.67 | 36.56 | 54.09 |

$\tan \alpha = \frac{h}{b} = \frac{3}{2}$

$\alpha = 56.3$

$\sin 56.3 = 0.832$

$\cos 56.3 = 0.555$



$\Sigma M_I = 0$  (+/-)

$-N_4 \times 3 + 25 \times 2 - 10 \times 2 + 80 \times 3 = 0$

$-N_4 \times 3 + 270 = 0$

$N_4 = 90 \text{ kN}$

$\Sigma F_y = 0$  (+/-)

$N_3 \sin 56.3 + 25 - 10 = 0$

$0.832 N_3 + 15 = 0$

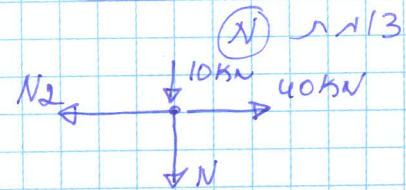
$N_3 = -18.03 \text{ kN}$

$\Sigma P_x = 0$  (+/-)

$N_4 + N_3 \cos 56.3 + N_1 + 40 - 80 = 0$

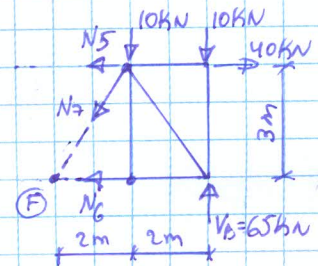
$90 + (-18.03) \times 0.555 + N_1 - 40 = 0$

$N_1 + 40 = 0$   $N_1 = -40 \text{ kN}$



$\Sigma P_x = 0$  (+/-)

$-N_2 + 40 = 0$   $N_2 = 40 \text{ kN}$



$\Sigma M_F = 0$  (+/-)

$-N_5 \times 3 + 40 \times 3 + 10 \times 2 + 10 \times 4 - 65 \times 4 = 0$

$N_5 = -26.67 \text{ kN}$

$\Sigma P_y = 0$  (+/-)

$-10 - 10 - N_7 \sin 56.3 + 65 = 0$   $N_7 = 54.09 \text{ kN}$

$\Sigma P_x = 0$  (+/-)

$-N_5 + 40 - N_6 - N_7 \cos 56.3 = 0$   $-(-26.67) + 40 - N_6 - 54.09 \times \cos 56.3 = 0$

$N_6 = 36.56 \text{ kN}$



המשק אולם 4

סליל

$$N_1 = -40 \text{ kN}$$

תכנון מ"ס 10

ס' 8 3

מ"ס ע"י מ' צ' נ"ר ב"ר

$$\phi 1.25'' (t=2)$$

$$i = 1.43 \text{ cm} \quad A = 2.54 \text{ cm}^2$$

$$\lambda = \frac{L}{i} = \frac{200}{1.43} = 139.86 \approx 140$$

$$w(\lambda=140) = 3.31$$

$$\sigma = \frac{3.31 \times 40 \times 10^3}{2.54} = 5212.6 \frac{\text{kg}}{\text{cm}^2} > 1600 \frac{\text{kg}}{\text{cm}^2}$$

N. G. 8

N<sub>2</sub>

מ"ס מ"ר

$$\sigma = \frac{N \times 10^3}{A} = \frac{40 \times 10^3}{2.54} = 1574.8 \frac{\text{kg}}{\text{cm}^2} < 1600 \frac{\text{kg}}{\text{cm}^2}$$

הסבר: מ"ס מ"ר הוא מ"ס מ' צ' נ"ר, ו'ר' מ' ק

התחב"ב המק"ם ק"ס"ה, ו'ר' מ' צ' נ"ר מ"ס מ"ר

ה'ר' מ' צ' נ"ר מ"ס מ"ר

ו'ר' מ' צ' נ"ר מ"ס מ"ר