

## الإجابة النموذجية

07

عدد الصفحات

الموضوع الأول

عناصر الإجابة

العلامة

مجزأة

مجموع

03

4 X 0.75

المسألة الأولى دراسة تكنولوجية (03 نقاط):

العناصر الحاملة المكونة للمنشأ العلوي لبناية هي :  
الأعمدة- الروافد - الأرضيات(البلاطات) - الجدران الحاملة.

المسألة الثانية دراسة طبوغرافية (4.5 نقاط):

مساحة القطعة ABCD:

|   | X      | Y      | $\Delta x$ | $\Delta y$ | $Y \Delta X$ | $X \Delta Y$ |
|---|--------|--------|------------|------------|--------------|--------------|
| D | 90.60  | 8.30   | /          | /          | /            | /            |
| A | 105.30 | 87.40  | -121.86    | -94.06     | -10650.56    | -9904.52     |
| B | 212.46 | 102.36 | -111.08    | 74.62      | -11370.15    | 15853.77     |
| C | 216.38 | 12.78  | 121.86     | 94.06      | 1557.37      | 20352.70     |
| D | 90.60  | 8.30   | 111.08     | -74.62     | 921.96       | -6760.57     |
| A | 105.30 | 87.40  | /          | /          | /            | /            |

01  
01  
01  
01

$$S = -\frac{1}{2} \sum y_n (x_{n-1} - x_{n+1}) \quad \text{أو} \quad S = \frac{1}{2} \sum x_n (y_{n-1} - y_{n+1})$$

0,5

$$S = \frac{1}{2} 1954,38 = 9770,69 \text{ m}^2$$

04.5



**المسألة الثالثة دراسة جملة مثلثية (6 نقاط):**

1- الجملة محددة سكونيا.  $b=2n-3=20-3=17$   
 2- حساب ردود الأفعال:

1-  $\sum F/x=0 \quad H_A=0$

2-  $\sum F/y=0 \rightarrow V_A=V_B= \sum \frac{F}{2} = \frac{120}{2} = 60\text{KN}$

3- حساب الجهود المؤثرة على القضبان 1; 2; 3; 4; 5; 6; 7; 8 و:

**العقدة F:**

$\sum F/x=0 \rightarrow N_2=0\text{KN}$

$\sum F/y=0 \rightarrow N_1-10=0 \rightarrow N_1=10\text{KN}$

**العقدة A:**

$\sum F/y=0, 60 - 10 - N_3 \sin \alpha = 0, N_3 = \frac{50}{0.32} = 156,25\text{KN}$

$\sum F/x=0, N_4 - N_3 \cos \alpha = 0, N_4 = (156,25) \cdot 0,95 = 148,44\text{KN}$

**العقدة H:**

$\sum F/x=0, N_6 + 156,25 \times 0,95 = 0 \quad N_6 = 148,44 \text{ KN}$

$\sum F/y=0, -N_5 - 20 + 158,23 \times 0,32 = 0, N_5 = 30\text{KN}$

**العقدة C:**

$N_7 = 93,75$

$N_7 = \frac{30}{\sin \alpha} = \frac{30}{0,32} = 93,75$

$N_8 = 148,44 + N_7 \cdot 0,95 = 237,50$

0.50

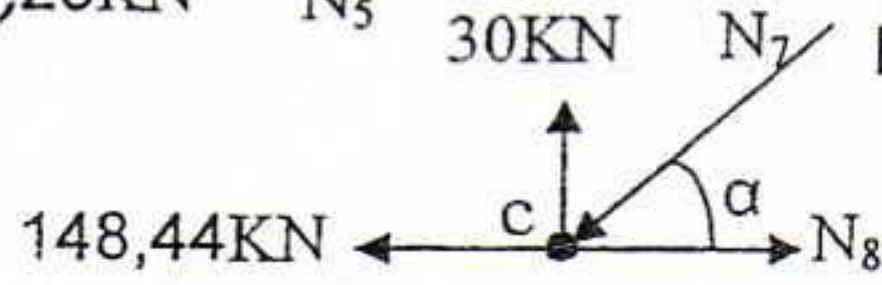
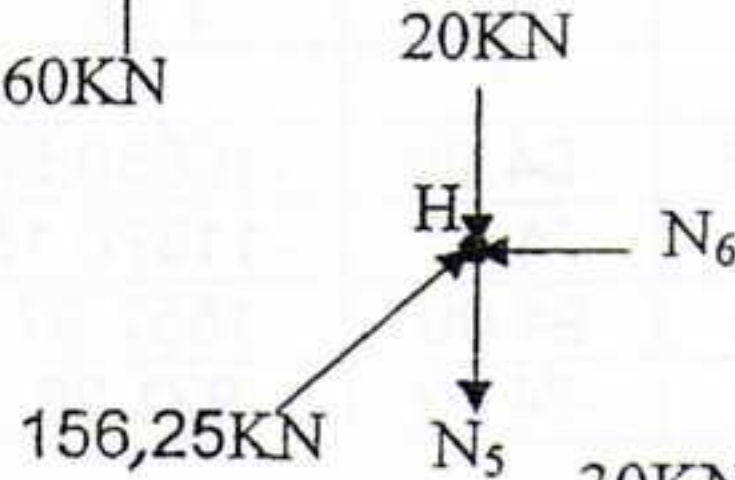
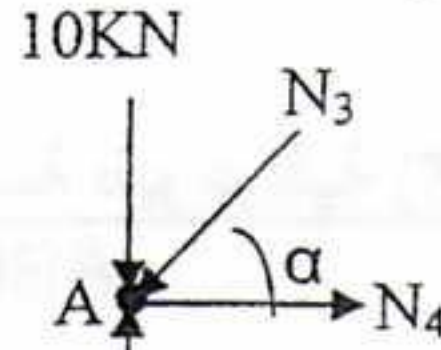
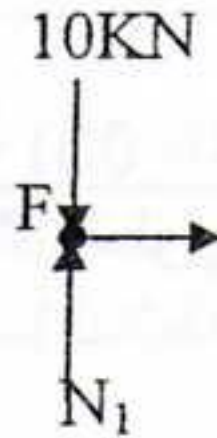
0.50x2

0.5 x2

0.5 x2

0.5 x2

0.5 x2



| القضبان       | AF  | FH | AH     | AC     | CH | HI     | CI    | CD     | ID |
|---------------|-----|----|--------|--------|----|--------|-------|--------|----|
| الجهد الداخلي | N1  | N2 | N3     | N4     | N5 | N6     | N7    | N8     | N9 |
| الشدة (KN)    | 10  | 0  | 156,25 | 148,44 | 30 | 148,44 | 93,75 | 237,50 | 40 |
| الطبيعة       | ضغط | /  | ضغط    | شد     | شد | ضغط    | ضغط   | شد     | شد |

4- المقاومة محققة في العنصر ID:

$\sigma < \bar{\sigma} \Leftrightarrow \frac{N_9}{2S} \leq \bar{\sigma}$

$\frac{40 \times 10^2}{2 \times 12,27} = 163 \leq 1600$

0.50



**المسألة الرابعة (6.50 نقطة):**

**1. حساب ردود الأفعال:**

$$\begin{cases} \Sigma H=0 \\ \Sigma V=0 \\ \Sigma M /_A=0 \end{cases} \Leftrightarrow \begin{cases} H_A = 0 \text{ KN} \\ V_A + V_B = (8 \times 5,50) + 14 \\ \frac{8 \times 5,50^2}{2} + 14 \times 5,50 = V_B \times 4,00 \end{cases}$$

$$\begin{cases} H_A = 0 \\ V_A + V_B = 58 \\ V_B = \frac{8 \times 5,50^2 + 14 \times 5,50}{4} = 49,50 \end{cases} \Leftrightarrow \begin{cases} H_A = 0 \text{ KN} \\ V_B = 49,50 \text{ KN} \\ V_A = 8,50 \text{ KN} \end{cases}$$

**2. كتابة معادلات  $M_f$  و  $T$ :**

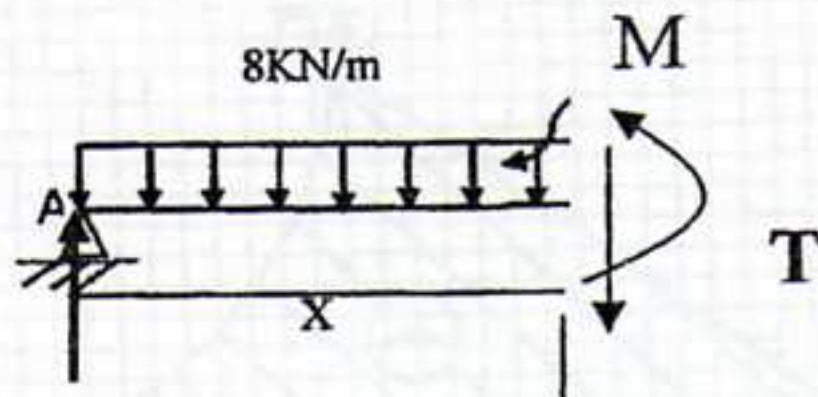
المجال الأول  $0 \leq x < 4,00$

0.50

0,25

0,5

0,25



$$M_f(x) = 8,50x - \frac{8x^2}{2}$$

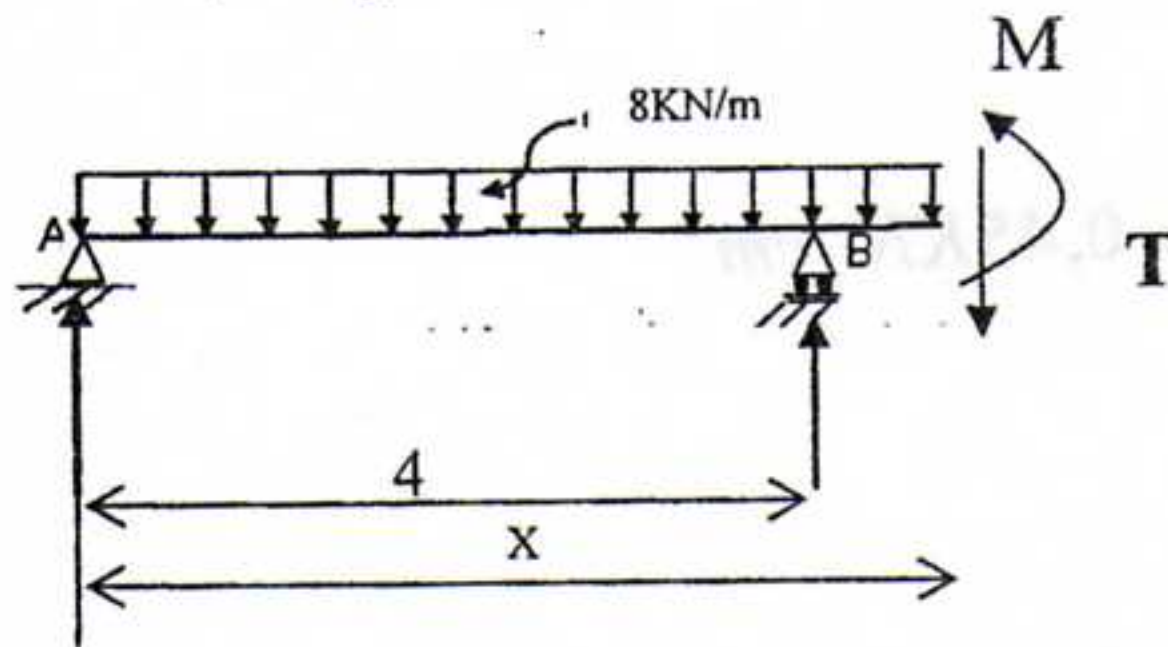
$$= -4x^2 + 8,50x \quad \begin{cases} M_f(0) = 0 \text{ (KN.m)} \\ M_f(4) = -30 \text{ (KN.m)} \end{cases}$$

$$T(x) = -8x + 8,50$$

$$\begin{cases} T(0) = 8,50 \text{ KN} \\ T(4) = -23,50 \text{ KN} \end{cases}$$

$$\begin{cases} T(4) = -23,50 \text{ KN} \end{cases}$$

المجال الثاني  $4,00 \leq x < 5,50$



0,5

0.25

0,5

0.25

$$M_f(x) = 8,50x - 8 \cdot \frac{x^2}{2} + 49,50(x - 4)$$

$$= -4x^2 + 58x - 198$$

$$\begin{cases} M_f(4) = -30 \\ M_f(5,5) = 0 \end{cases}$$

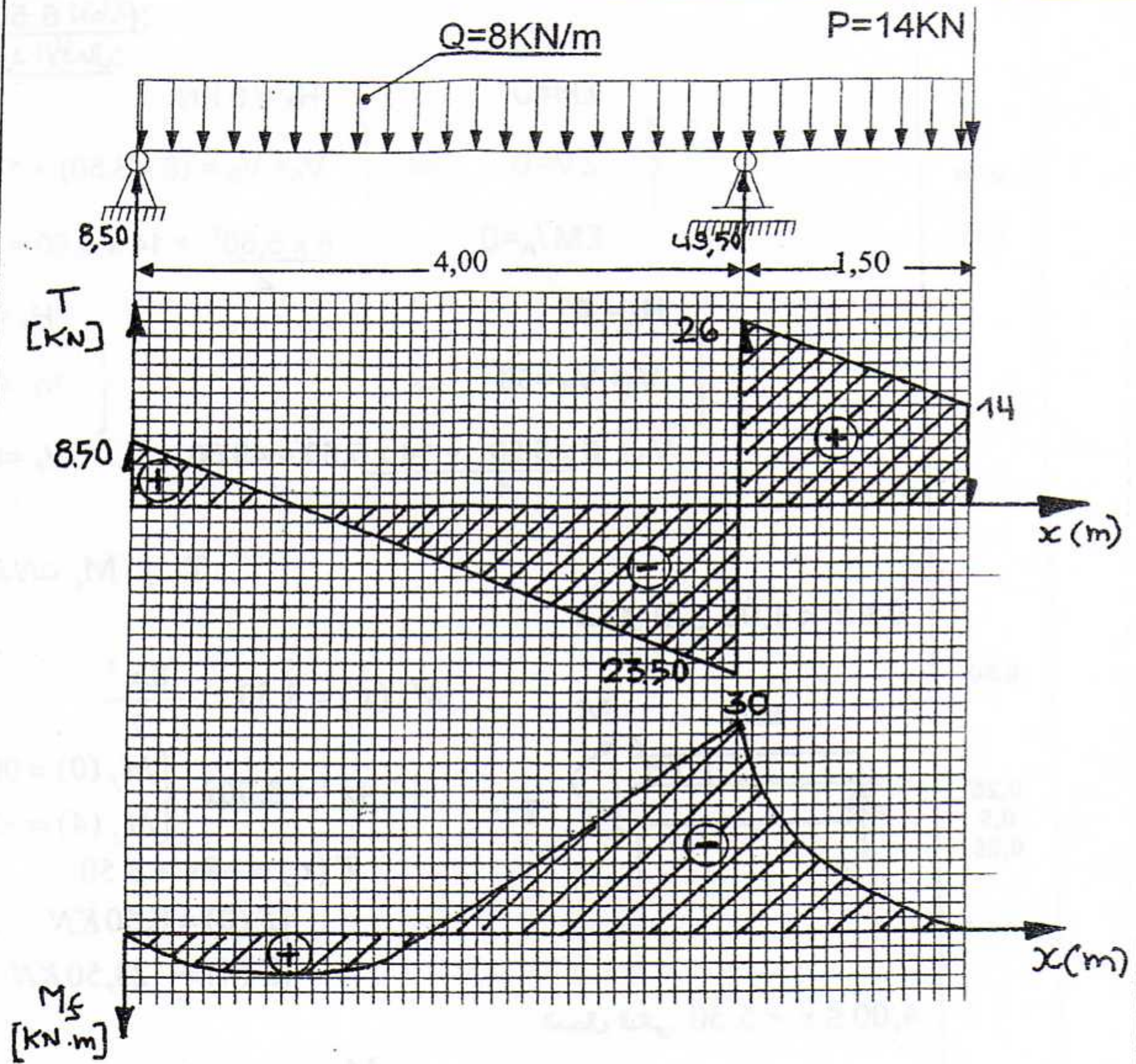
$$\begin{cases} M_f(5,5) = 0 \end{cases}$$

$$T(x) = M'_f(x) = -8x + 58$$

$$\begin{cases} T(4) = 26 \text{ KN} \\ T(5,5) = 14 \text{ KN} \end{cases}$$

$$\begin{cases} T(5,5) = 14 \text{ KN} \end{cases}$$





$$\sigma_{1\max} = \frac{M_{f\max} \times \frac{40}{2}}{25 \times 40^3} = 0,45 \text{ KN/cm}^2 \quad (1)$$

$$\sigma_{2\max} = \frac{M_{f\max} \times \frac{25}{2}}{40 \times 25^3} = 0,72 \text{ KN/cm}^2 \quad (2)$$

5- الوضعية المحققة للمقاومة هي : الوضعية A

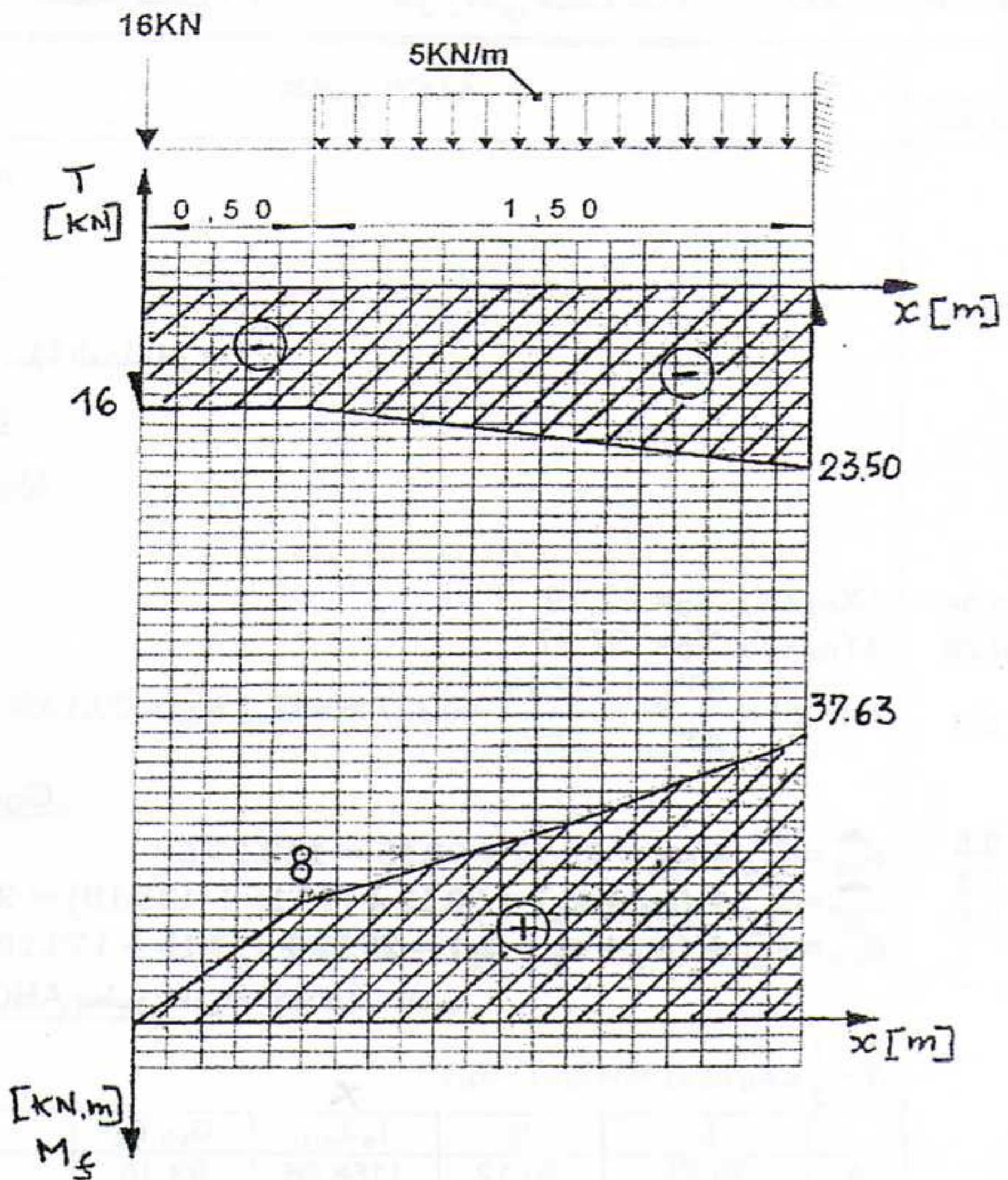
لأن :  $\sigma_{1\max} < \sigma_{2\max}$



| العلامة  |  | عناصر الإجابة  | الموضوع الثاني  |                 |                 |                  |  |   |                              |   |   |       |         |       |      |         |   |       |        |         |        |      |        |   |       |        |        |       |      |        |   |       |        |        |         |   |        |  |
|--|--|--|---|-----------------|-----------------|------------------|--|---|------------------------------|---|---|-------|---------|-------|------|---------|---|-------|--------|---------|--------|------|--------|---|-------|--------|--------|-------|------|--------|---|-------|--------|--------|---------|---|--------|--|
| مجموع  | مجزأة  |  |   |                 |                 |                  |  |   |                              |   |   |       |         |       |      |         |   |       |        |         |        |      |        |   |       |        |        |       |      |        |   |       |        |        |         |   |        |  |
| 03   | 01x3   | <b>المسألة الأولى (03 نقاط):</b>   |   |                 |                 |                  |  |   |                              |   |   |       |         |       |      |         |   |       |        |         |        |      |        |   |       |        |        |       |      |        |   |       |        |        |         |   |        |  |
|  |  | 1 طبقة الإنضغاط .....  |   |                 |                 |                  |  |   |                              |   |   |       |         |       |      |         |   |       |        |         |        |      |        |   |       |        |        |       |      |        |   |       |        |        |         |   |        |  |
|  |  | 2 شبكة ملحمة .....   |   |                 |                 |                  |  |   |                              |   |   |       |         |       |      |         |   |       |        |         |        |      |        |   |       |        |        |       |      |        |   |       |        |        |         |   |        |  |
|  |  | 3 عروق من الخرسانة المسلحة (رفيدات) .....  |   |                 |                 |                  |  |   |                              |   |   |       |         |       |      |         |   |       |        |         |        |      |        |   |       |        |        |       |      |        |   |       |        |        |         |   |        |  |
|  |  | <b>المسألة الثانية (05 نقاط):</b>  |   |                 |                 |                  |  |   |                              |   |   |       |         |       |      |         |   |       |        |         |        |      |        |   |       |        |        |       |      |        |   |       |        |        |         |   |        |  |
|  |  | 1. حساب السميت الاحداثي $G_{OA}$   |   |                 |                 |                  |  |   |                              |   |   |       |         |       |      |         |   |       |        |         |        |      |        |   |       |        |        |       |      |        |   |       |        |        |         |   |        |  |
|  |  | 0.25   | $\Delta X_{OA} = X_A - X_O = 12,19$   |                 |                 |                  |  |   |                              |   |   |       |         |       |      |         |   |       |        |         |        |      |        |   |       |        |        |       |      |        |   |       |        |        |         |   |        |  |
|  |  | 0.25   | $\Delta Y_{OA} = Y_A - Y_O = 37,27$   |                 |                 |                  |  |   |                              |   |   |       |         |       |      |         |   |       |        |         |        |      |        |   |       |        |        |       |      |        |   |       |        |        |         |   |        |  |
|  |  | 0.5  | $Tan(g) = \frac{\Delta X_{OA}}{\Delta Y_{OA}} = \frac{12,19}{37,27} = 0.327 \gg \gg G_{OA} = g = 20.12Gr$ |                 |                 |                  |  |   |                              |   |   |       |         |       |      |         |   |       |        |         |        |      |        |   |       |        |        |       |      |        |   |       |        |        |         |   |        |  |
|  |  | 2. حساب $G_{OB}$ ، $G_{OC}$ ، $G_{OD}$   |   |                 |                 |                  |  |   |                              |   |   |       |         |       |      |         |   |       |        |         |        |      |        |   |       |        |        |       |      |        |   |       |        |        |         |   |        |  |
| 0.5  | $G_{OB} = G_{OA} + \alpha_1 = 20.12 + 93.15 = 113.27Gr$  |  |   |                 |                 |                  |  |   |                              |   |   |       |         |       |      |         |   |       |        |         |        |      |        |   |       |        |        |       |      |        |   |       |        |        |         |   |        |  |
| 0.5  | $G_{OC} = G_{OA} + (\alpha_1 + \alpha_2) = 20.12 + (93.15 + 123.10) = 236.37Gr$  |  |   |                 |                 |                  |  |   |                              |   |   |       |         |       |      |         |   |       |        |         |        |      |        |   |       |        |        |       |      |        |   |       |        |        |         |   |        |  |
| 0.5  | $G_{OD} = G_{OA} + (\alpha_1 + \alpha_2 + \alpha_3) = 20.12 + (93.15 + 123.10 + 86.4) = 322.77Gr$  |  |   |                 |                 |                  |  |   |                              |   |   |       |         |       |      |         |   |       |        |         |        |      |        |   |       |        |        |       |      |        |   |       |        |        |         |   |        |  |
| 3. حساب مساحة القطعة ABCD بتطبيق طريقة الإحداثيات القطبية.   |  |  |   |                 |                 |                  |  |   |                              |   |   |       |         |       |      |         |   |       |        |         |        |      |        |   |       |        |        |       |      |        |   |       |        |        |         |   |        |  |
| $S = \frac{1}{2} \sum L_n L_{n+1} \cdot \sin(G_{n+1} - G_n)$   |  |  |   |                 |                 |                  |  |   |                              |   |   |       |         |       |      |         |   |       |        |         |        |      |        |   |       |        |        |       |      |        |   |       |        |        |         |   |        |  |
| 4x0.5  |  | <table border="1"> <thead> <tr> <th></th> <th>L</th> <th>G</th> <th><math>L_n - L_{n+1}</math></th> <th><math>G_{n+1} - G_n</math></th> <th>Sin <math>\Delta G</math></th> <th><math>L_n L_{n+1} \sin(\Delta G)</math></th> </tr> </thead> <tbody> <tr> <td>A</td> <td>39.21</td> <td>20.12</td> <td>1158.66</td> <td>93.15</td> <td>0.99</td> <td>1147.07</td> </tr> <tr> <td>B</td> <td>29.55</td> <td>113.27</td> <td>1002.04</td> <td>123.10</td> <td>0.93</td> <td>931.90</td> </tr> <tr> <td>C</td> <td>33.91</td> <td>236.37</td> <td>860.97</td> <td>86.40</td> <td>0.98</td> <td>843.75</td> </tr> <tr> <td>D</td> <td>25.39</td> <td>322.77</td> <td>995.54</td> <td>-302.65</td> <td>1</td> <td>995.54</td> </tr> </tbody> </table> |   | L               | G               | $L_n - L_{n+1}$  | $G_{n+1} - G_n$                          | Sin $\Delta G$                            | $L_n L_{n+1} \sin(\Delta G)$ | A   | 39.21   | 20.12 | 1158.66 | 93.15 | 0.99 | 1147.07 | B | 29.55 | 113.27 | 1002.04 | 123.10 | 0.93 | 931.90 | C | 33.91 | 236.37 | 860.97 | 86.40 | 0.98 | 843.75 | D | 25.39 | 322.77 | 995.54 | -302.65 | 1 | 995.54 |  |
|  |  | L  | G   | $L_n - L_{n+1}$ | $G_{n+1} - G_n$ | Sin $\Delta G$   | $L_n L_{n+1} \sin(\Delta G)$             |   |                              |   |   |       |         |       |      |         |   |       |        |         |        |      |        |   |       |        |        |       |      |        |   |       |        |        |         |   |        |  |
|  | A  | 39.21  | 20.12   | 1158.66         | 93.15           | 0.99             | 1147.07                                  |   |                              |   |   |       |         |       |      |         |   |       |        |         |        |      |        |   |       |        |        |       |      |        |   |       |        |        |         |   |        |  |
|  | B  | 29.55  | 113.27  | 1002.04         | 123.10          | 0.93             | 931.90                                   |   |                              |   |   |       |         |       |      |         |   |       |        |         |        |      |        |   |       |        |        |       |      |        |   |       |        |        |         |   |        |  |
|  | C  | 33.91  | 236.37  | 860.97          | 86.40           | 0.98             | 843.75                                   |   |                              |   |   |       |         |       |      |         |   |       |        |         |        |      |        |   |       |        |        |       |      |        |   |       |        |        |         |   |        |  |
| D  | 25.39  | 322.77   | 995.54  | -302.65         | 1               | 995.54           |  |   |                              |   |   |       |         |       |      |         |   |       |        |         |        |      |        |   |       |        |        |       |      |        |   |       |        |        |         |   |        |  |
| $S = \frac{1}{2} [1158,66 \cdot \sin(93,15) + 1002,04 \cdot \sin(123,10) + 860,97 \cdot \sin(86,40) + 995,54 \cdot \sin(-302,65)]$ |  |  |   |                 |                 |                  |  |   |                              |   |   |       |         |       |      |         |   |       |        |         |        |      |        |   |       |        |        |       |      |        |   |       |        |        |         |   |        |  |
| 0.50   | $= \begin{cases} \frac{1}{2} [3918,26] = 1959,13m^2 & \text{إذا أخذنا رقمين بعد الفاصلة} \\ \frac{1}{2} [3924,327] = 1962,164m^2 & \text{إذا أخذنا ثلاثة أرقام بعد الفاصلة} \end{cases}$ |  |   |                 |                 |                  |  |   |                              |   |   |       |         |       |      |         |   |       |        |         |        |      |        |   |       |        |        |       |      |        |   |       |        |        |         |   |        |  |
| <b>المسألة الثالثة (06 نقاط):</b>  |  |  |   |                 |                 |                  |  |   |                              |   |   |       |         |       |      |         |   |       |        |         |        |      |        |   |       |        |        |       |      |        |   |       |        |        |         |   |        |  |
| 1- حساب ردود الأفعال :   |  |  |   |                 |                 |                  |  |   |                              |   |   |       |         |       |      |         |   |       |        |         |        |      |        |   |       |        |        |       |      |        |   |       |        |        |         |   |        |  |
| 0,50   | $\Sigma F_x = 0 \Rightarrow H_A = 0 \text{ KN}$  |  |   |                 |                 |                  |  |   |                              |   |   |       |         |       |      |         |   |       |        |         |        |      |        |   |       |        |        |       |      |        |   |       |        |        |         |   |        |  |
| 0,50   | $\Sigma F_y = 0 \Rightarrow V_A = 23,50 \text{ KN}$  |  |   |                 |                 |                  |  |   |                              |   |   |       |         |       |      |         |   |       |        |         |        |      |        |   |       |        |        |       |      |        |   |       |        |        |         |   |        |  |
| 0,50   | $\Sigma M/A = 0 \Rightarrow M = 37,625 \text{ KN.m}$   |  |   |                 |                 |                  |  |   |                              |   |   |       |         |       |      |         |   |       |        |         |        |      |        |   |       |        |        |       |      |        |   |       |        |        |         |   |        |  |
| 2x0.75   |  | <table border="1"> <thead> <tr> <th>X(m)</th> <th>M(KN.m)</th> <th>T(KN)</th> </tr> </thead> <tbody> <tr> <td><math>0 \leq x &lt; 0,5</math></td> <td><math>M(x) = -16x</math><br/><math>M(0) = 0; M(0,5) = -8</math></td> <td><math>T(x) = -16</math><br/><math>T(0) = -16; T(0,5) = 16</math></td> </tr> <tr> <td><math>0,5 \leq x \leq 2,00</math></td> <td><math>M(x) = -5/2x^2 - 13,5x - 0,625</math><br/><math>M(x) = -8; M(2) = -37,625</math></td> <td><math>T(x) = -5x - 13,5</math><br/><math>T(0,5) = -16; T(2) = -23,5</math></td> </tr> </tbody> </table>   | X(m)  | M(KN.m)         | T(KN)           | $0 \leq x < 0,5$ | $M(x) = -16x$<br>$M(0) = 0; M(0,5) = -8$ | $T(x) = -16$<br>$T(0) = -16; T(0,5) = 16$ | $0,5 \leq x \leq 2,00$       | $M(x) = -5/2x^2 - 13,5x - 0,625$<br>$M(x) = -8; M(2) = -37,625$ | $T(x) = -5x - 13,5$<br>$T(0,5) = -16; T(2) = -23,5$ |       |         |       |      |         |   |       |        |         |        |      |        |   |       |        |        |       |      |        |   |       |        |        |         |   |        |  |
|  | X(m)   | M(KN.m)  | T(KN)   |                 |                 |                  |  |   |                              |   |   |       |         |       |      |         |   |       |        |         |        |      |        |   |       |        |        |       |      |        |   |       |        |        |         |   |        |  |
| $0 \leq x < 0,5$   | $M(x) = -16x$<br>$M(0) = 0; M(0,5) = -8$   | $T(x) = -16$<br>$T(0) = -16; T(0,5) = 16$  |   |                 |                 |                  |  |   |                              |   |   |       |         |       |      |         |   |       |        |         |        |      |        |   |       |        |        |       |      |        |   |       |        |        |         |   |        |  |
| $0,5 \leq x \leq 2,00$   | $M(x) = -5/2x^2 - 13,5x - 0,625$<br>$M(x) = -8; M(2) = -37,625$  | $T(x) = -5x - 13,5$<br>$T(0,5) = -16; T(2) = -23,5$  |   |                 |                 |                  |  |   |                              |   |   |       |         |       |      |         |   |       |        |         |        |      |        |   |       |        |        |       |      |        |   |       |        |        |         |   |        |  |



3- رسم منحنيات الجهد القاطعة T و عزم M



$$M_{f \max} = 37,63 \text{ kN.m} \quad -4$$

$$T_{\max} = 23,50 \text{ kN}$$

$$\sigma \leq \bar{\sigma} \Leftrightarrow \frac{M_{f \max}}{W_{/xx}} \leq \bar{\sigma} \quad -5 \quad \text{تحديد المجنب المناسب}$$

$$W_{/xx} \geq \frac{37,63}{1600} \times 10^4 \geq 235,19 \text{ cm}^3$$

نختار IPN 220



المسألة الرابعة دراسة مقاومة المواد (06 نقاط)  
الحالة الأولى :

a. نوع التحريض شد بسيط

$$\begin{cases} N > 0 \\ T = M = 0 \end{cases} \quad \text{لأنه}$$

$$\sigma = \frac{N}{S} = \frac{350 \times 10^2}{35^2} = 28,57 \text{ daN/cm}^2 \quad \text{ب)}$$

$$\sigma < \bar{\sigma} \Leftrightarrow 28,57 < 42 \quad \text{ج) المقاومة محققة}$$

الحالة الثانية :

أ) نوع التحريض قص بسيط

$$\begin{cases} T \neq 0 \\ N = M = 0 \end{cases} \quad \text{لأنه}$$

$$\tau = \frac{T}{S} = \frac{200 \times 10^2}{35^2} = 16,33 \text{ daN/cm}^2 \quad \text{ب)}$$

$$\tau < \bar{\tau} \Leftrightarrow 16,33 < 25 \quad \text{ج) المقاومة المحققة}$$

الحالة الثالثة :

$$\begin{cases} N = 0 \\ T \neq 0 \\ M \neq 0 \end{cases} \quad \text{لأنه}$$

أ) نوع التحريض انحناء مستوى بسيط

$$\sigma = \frac{M \cdot y}{I_x} = 120,35 \text{ daN/cm}^2 \quad \text{ب)}$$

$$\tau = \frac{3T}{2S} = 27,80 \text{ daN/cm}^2$$

$$\tau > \bar{\tau} \quad 27,80 > 20 \quad \text{أو} \quad \sigma > \bar{\sigma} \quad 120,35 > 84 \quad \text{ج) المقاومة غير محققة}$$

| المعطيات<br>الحالات | N<br>KN | T<br>KN | M<br>KN·m | نوع<br>التحريض       | $\sigma$<br>da N/cm <sup>2</sup> | $\tau$<br>da N/cm <sup>2</sup> | المقاومة<br>محققة |
|---------------------|---------|---------|-----------|----------------------|----------------------------------|--------------------------------|-------------------|
| الحالة الأولى       | 350     | 0       | 0         | شد بسيط              | 28.57                            | /                              | نعم               |
| الحالة الثانية      | 0       | 200     | 0         | قص بسيط              | /                                | 16.33                          | نعم               |
| الحالة الثالثة      | 0       | 227     | 86        | إنحناء مستوي<br>بسيط | 120.35                           | 27.80                          | لا                |

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