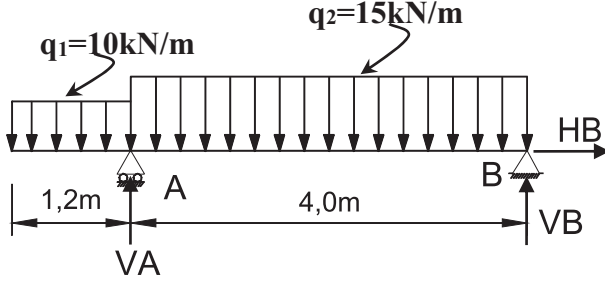
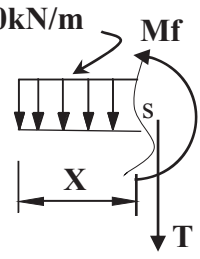
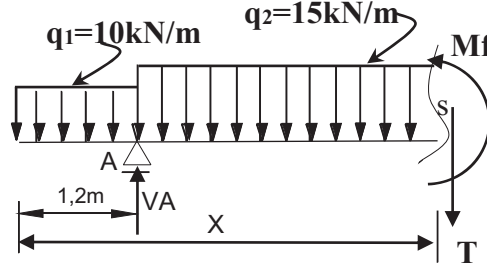


العلامة		عناصر الإجابة: الموضوع الأول
مجموع	مجزأة	
		الميكانيك المطبقة: النشاط الأول: (1) حساب ردود الأفعال:  0.25 $\sum F_x = 0 \Rightarrow H_B = 0$ $\sum F_y = 0 \Rightarrow V_A + V_B - (10 \times 1.2) - (15 \times 4) = 0$ $V_A + V_B = 72 \text{ kN}$ $\sum M_B = 0 \Rightarrow V_A \times 4 - (10 \times 1.2 \times 4.6) - (15 \times 4 \times 2) = 0$ $V_A = \frac{55.2 + 120}{4} = 43.8 \text{ kN}$ 0.5 $\boxed{V_A = 43.8 \text{ kN}}$ $\sum M_A = 0 \Rightarrow -V_B \times 4 + (15 \times 4 \times 2) - (10 \times 1.2 \times 0.6) = 0$ $V_B = \frac{120 - 7.2}{4} = 28.2 \text{ kN}$ 0.5 $\boxed{V_B = 28.2 \text{ kN}}$ $\boxed{V_A + V_B = 43.8 + 28.2 = 72 \text{ kN}}$ محقق (2) كتابة معادلات الجهد القاطع وعزم الانحناء المجال: $0 \leq x \leq 1.2$  0.75 $\sum F_y = 0 \Rightarrow -T(x) - 10x = 0 \Rightarrow T(x) = -10x$ $x = 0 \Rightarrow \boxed{T = 0 \text{ kN}} ; \quad x = 1.2 \Rightarrow \boxed{T = -12 \text{ kN}}$ 0.75 $\sum M_{/s} = 0 \Rightarrow -Mf(x) - 10x \cdot \frac{x}{2} = 0 \Rightarrow Mf(x) = -5x^2$ $x = 0 \Rightarrow \boxed{Mf = 0 \text{ kN.m}} ; \quad x = 1.2 \text{ m} \Rightarrow Mf = \boxed{-7.2 \text{ kN.m}}$

المجال: $1.2 \leq x \leq 5.2$



0.75

$$\sum F_Y = 0 \Rightarrow -T(x) + 43.8 - (10 \times 1.2) - 15 \cdot (x - 1.2) = 0$$

$$T(x) = -15x + 49.8$$

$$x = 1.2 \Rightarrow T = 31.8 \text{ kN}; \quad x = 5.2 \Rightarrow T = -28.2 \text{ kN}$$

$$T = 0 \Rightarrow x = \frac{49.8}{15} = 3.32 \text{ m} \quad \text{فاصلة الذروة:}$$

0.75

$$\sum M_{/s} = 0 \Rightarrow -Mf(x) - [10 \times (1.2) \times (x - 0.6)] + [43.8 \times (x - 1.2)] - \left[\frac{15}{2} (x - 1.2) \times (x - 1.2) \right] = 0$$

$$\Rightarrow Mf(x) = -7.5x^2 + 49.8x - 56.16$$

$$x = 1.2 \text{ m} \Rightarrow Mf = -7.2 \text{ kN.m}; \quad x = 5.2 \Rightarrow Mf = 0 \text{ kN.m}$$

$$x = 3.32 \text{ m} \Rightarrow Mf = 26.51 \text{ kN.m} \quad \text{قيمة الذروة:}$$

(3) تحديد المجنب المناسب الذي يحقق شرط المقاومة:

$$\sigma_{\max} \leq \bar{\sigma}$$

$$\frac{M_{f \max}}{W_{/xx'}} \leq \bar{\sigma}$$

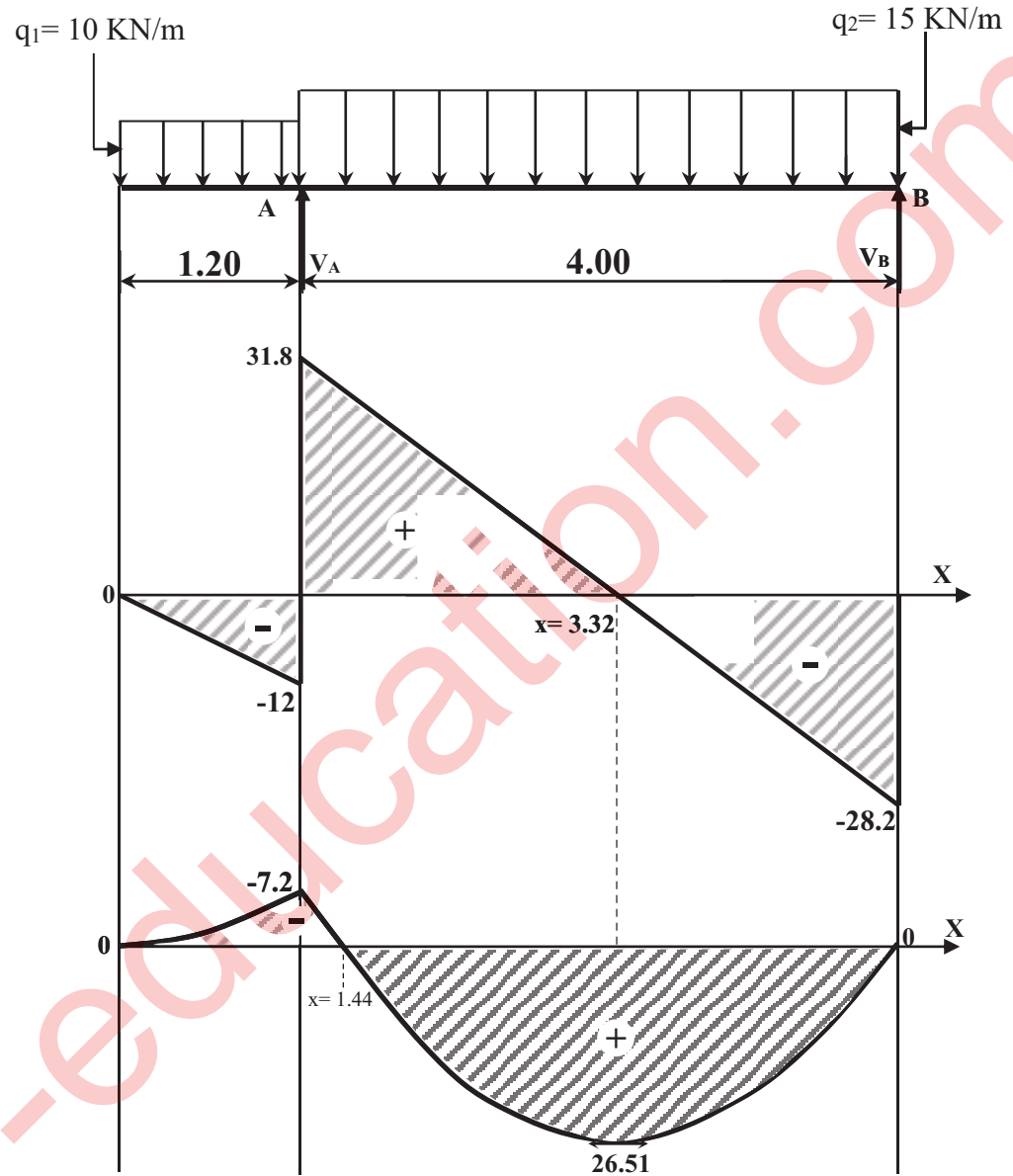
$$W_{/xx'} \geq \frac{M_{f \max}}{\bar{\sigma}}$$

$$W_{/xx'} \geq \frac{Mf_{\max}}{\bar{\sigma}} \Rightarrow W_{/xx'} \geq \frac{26.51 \times 10^4}{1400} \Rightarrow W_{/xx'} \geq 165.69 \text{ cm}^3$$

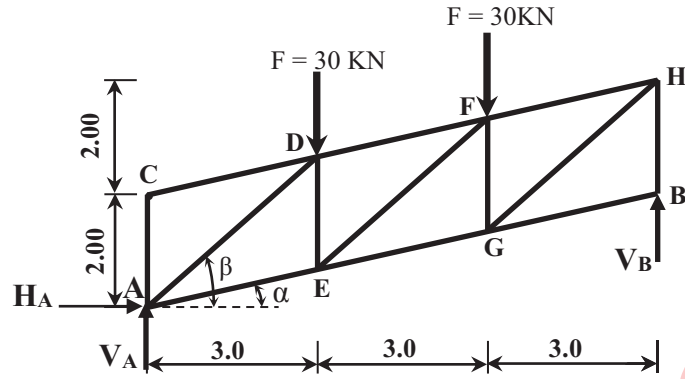
0.75

نختار من الجدول $W(x) = 214 \text{ cm}^3$ أي المجنب IPN200

- رسم منحنيات الجهد القاطع وعزم الانحناء:



النشاط الثاني:



(1) حساب ردود الأفعال:

0.25

$$\sum F_{/XX'} = 0 \Rightarrow H_A = 0$$

$$\sum F_{/YY'} = 0 \Rightarrow V_A + V_B = 60 \text{ kN}$$

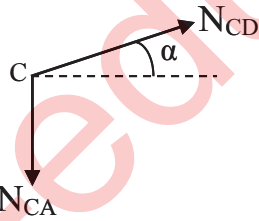
$$\sum M_{/A} = (30 \times 3) + (30 \times 6) - (V_B \times 9) = 0$$

0.25×2

$$V_B = \frac{270}{9} \Rightarrow \boxed{V_B = 30 \text{ kN} \Rightarrow V_A = 30 \text{ kN}}$$

(2) تحديد قيمة وطبيعة الجهود الداخلية في القضبان

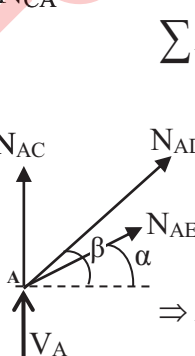
● العقدة (C)



$$\sum F_{/XX'} = 0 \Rightarrow N_{CD} \cos \alpha = 0 \Rightarrow \boxed{N_{CD} = 0}$$

$$\sum F_{/YY'} = 0 \Rightarrow N_{CD} \sin \alpha - N_{CA} = 0 \Rightarrow \boxed{N_{CA} = 0}$$

● العقدة (A)



$$\sum F_{/XX'} = 0 \Rightarrow N_{AE} \cos \alpha + N_{AD} \cos \beta = 0 \Rightarrow N_{AD} = \frac{-N_{AE} \cos \alpha}{\cos \beta} \dots (1)$$

$$\sum F_{/YY'} = 0 \Rightarrow 30 + N_{AE} \sin \alpha + N_{AC} + N_{AD} \sin \beta = 0 \dots (2)$$

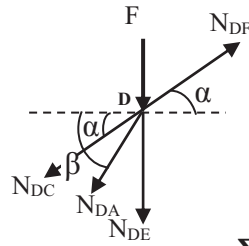
$$(2) \Rightarrow N_{AE} \sin \alpha + \left(\frac{-N_{AE} \cos \alpha}{\cos \beta} \right) \times \sin \beta = -30$$

$$\Rightarrow N_{AE} \times \left(\sin \alpha - \frac{\cos \alpha}{\cos \beta} \times \sin \beta \right) = -30 \Rightarrow N_{AE} = \frac{-30}{0.217 - \left(\frac{0.976}{0.747} \times 0.664 \right)}$$

$$\Rightarrow \boxed{N_{AE} = 46.11 \text{ kN}}$$

$$(1) \Rightarrow N_{AD} = \frac{-46.11 \times 0.976}{0.747} \Rightarrow \boxed{N_{AD} = -60.25 \text{ kN}}$$

● العقدة (D)



$$\sum F_{/xx'} = 0 \Rightarrow N_{DF} \cos \alpha - N_{DA} \cos \beta - N_{DC} \cos \alpha = 0$$

$$N_{DF} = \frac{N_{DA} \cos \beta - N_{DC} \cos \alpha}{\cos \alpha} = \frac{(-60.25 \times 0.747) - 0}{0.976}$$

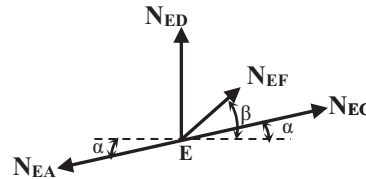
$$\Rightarrow \boxed{N_{DF} = -46.11 \text{KN}}$$

$$\sum F_{/yy'} = 0 \Rightarrow -F + N_{DF} \sin \alpha - N_{DE} - N_{DA} \sin \beta - N_{DC} \sin \alpha = 0$$

$$\Rightarrow N_{DE} = -30 + (-46.11 \times 0.217) - (-60.25 \times 0.664) - 0$$

$$\Rightarrow \boxed{N_{DE} = 0}$$

● العقدة (E)



$$\sum F_{/xx'} = 0 \Rightarrow N_{EG} \cos \alpha + N_{EF} \cos \beta - N_{EA} \cos \alpha = 0$$

$$N_{EG} = \frac{N_{EA} \cos \alpha - N_{EF} \cos \beta}{\cos \alpha} = \frac{(46.11 \times 0.976) - (N_{EF} \times 0.747)}{0.976}$$

$$\Rightarrow \boxed{N_{EG} = 46.11 - 0.765 \times N_{EF}} \dots\dots\dots (1)$$

$$\sum F_{/yy'} = 0 \Rightarrow N_{ED} + N_{EF} \sin \beta + N_{EG} \sin \alpha - N_{EA} \sin \alpha = 0$$

$$\Rightarrow N_{EF} \times 0.664 + N_{EG} \times 0.217 = 10$$

$$\Rightarrow N_{EF} \times 0.664 + (46.11 - 0.765 \times N_{EF}) \times 0.217 = 10$$

$$\Rightarrow \boxed{N_{EF} = 0}$$

$$(1) \Rightarrow \boxed{N_{EG} = 46.11 \text{KN}}$$

جدول النتائج

N _{EG}	N _{EF}	N _{DF}	N _{DE}	N _{AE}	N _{AD}	N _{CD}	N _{CA}	الجهد الناظمي
46.11	0	46.11	0	46.11	60.25	0	0	الشدة (KN)
شد	تركيبى	ضغط	تركيبى	شد	ضغط	تركيبى	تركيبى	الطبيعة

(3) تحديد نوع المجنب:

$$\sigma_{\max} \leq \bar{\sigma} \Rightarrow \frac{N_{\max}}{2S} \leq \bar{\sigma}$$

$$\Rightarrow 2S \geq \frac{N_{\max}}{\bar{\sigma}} \Rightarrow S \geq \frac{N_{\max}}{2\bar{\sigma}}$$

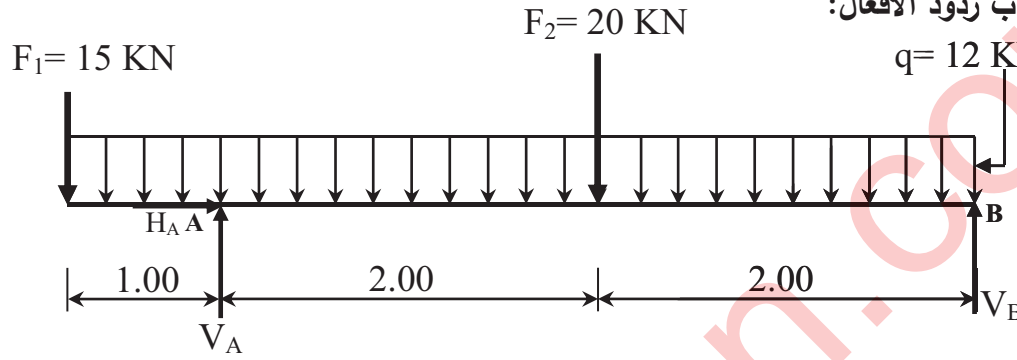
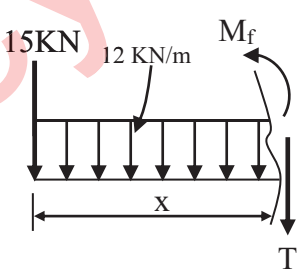
$$\Rightarrow S \geq \frac{60.30 \times (10)^2}{2(1600)} \Rightarrow S \geq 1.88 \text{cm}^2$$

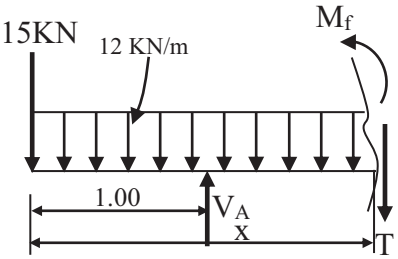
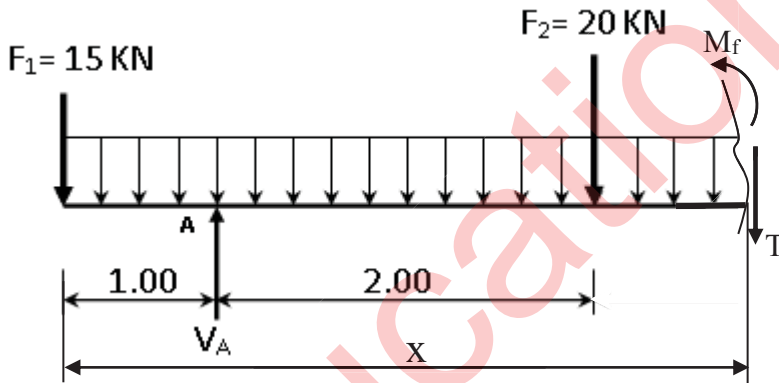
من الجدول نختار S=2.39cm² أي المجنب المناسب L(35×35×3.5)

0.50

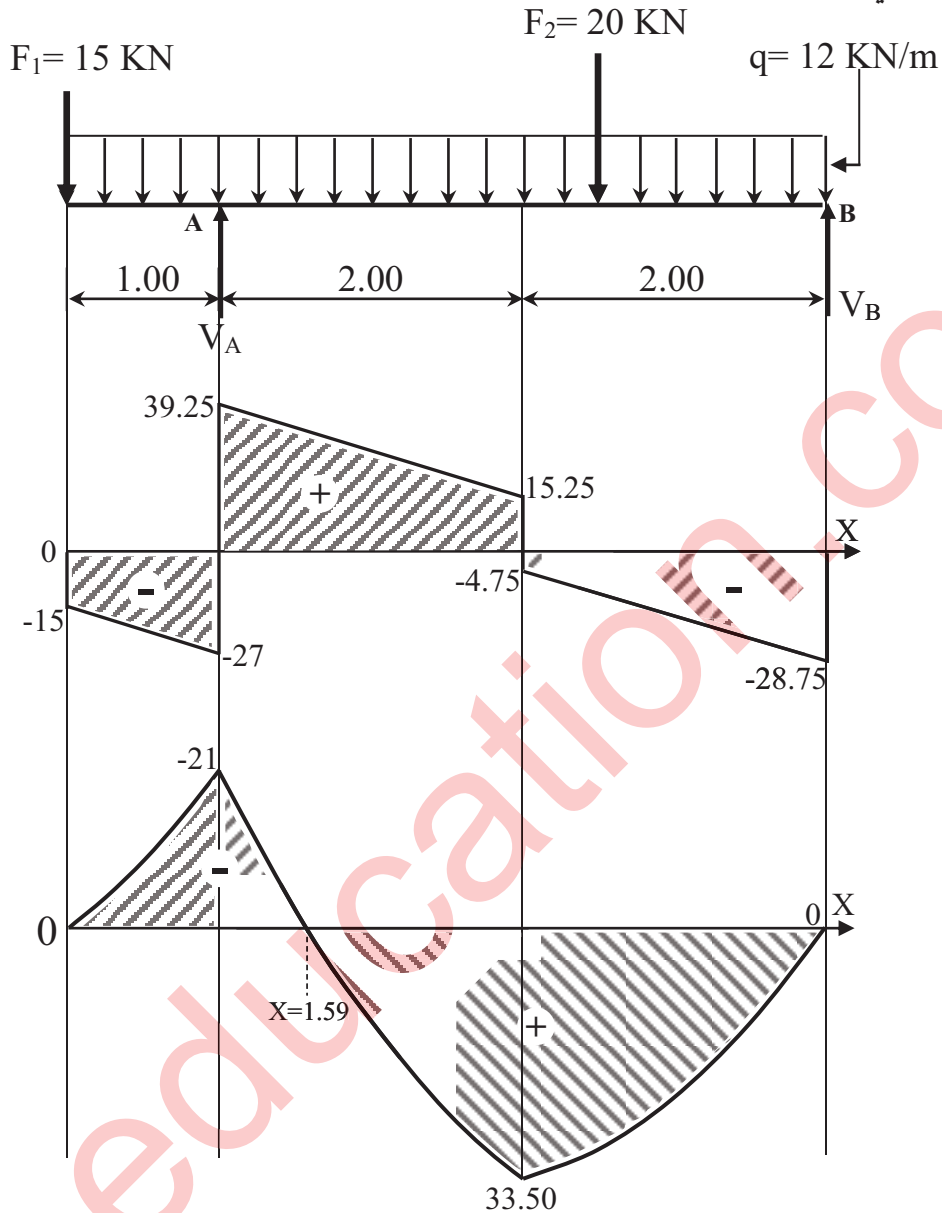
0.75

		البناء: النشاط الأول: 1. حساب مساحة القطعة ABCD باستعمال طريقة الاحداثيات القائمة: $S_{ABCD} = \frac{1}{2} [X_A(Y_D - Y_B) + X_B(Y_A - Y_C) + X_C(Y_B - Y_D) + X_D(Y_C - Y_A)]$ $S_{ABCD} = \frac{1}{2} [80 \times (70 - 40) + 40 \times (0 - 110) + 50 \times (40 - 70) + 120 \times (110 - 0)]$ $S_{ABCD} = 4850m^2$
01		
0.5		
0.5		
		2. التحقق من مساحة القطعة ABCD باستعمال الاحداثيات القطبية: $S_{ABCD} = \frac{1}{2} [L_{AB} \times L_{AC} \times \sin \alpha + L_{AC} \times L_{AD} \times \sin \beta]$ - حساب المسافات: $L_{AB} = \sqrt{(\Delta X_{AB})^2 + (\Delta Y_{AB})^2}$ $L_{AB} = \sqrt{(-40)^2 + (40)^2} = 56.57m$ $L_{AC} = \sqrt{(\Delta X_{AC})^2 + (\Delta Y_{AC})^2}$ $L_{AC} = \sqrt{(-30)^2 + (110)^2} = 114.02m$ $L_{AD} = \sqrt{(\Delta X_{AD})^2 + (\Delta Y_{AD})^2}$ $L_{AD} = \sqrt{(40)^2 + (70)^2} = 80.62m$ - حساب المساحة: $S_{ABCD} = \frac{1}{2} [56.57 \times 114.02 \sin 33.05 + 114.02 \times 80.62 \sin 50]$ $S_{ABCD} = 4850m^2$
05		
		النشاط الثاني: • العناصر المكونة للجسر هي: - الأساسات - المتكأ - الركائز الوسطية - سطح الجسر.
03	4x0.75	
20	20	

العلامة		عناصر الإجابة (الموضوع الثاني)
مجموع	مجزأة	
		الميكانيك التطبيقية: النشاط الأول: (1) حساب ردود الأفعال:  0.25 $\sum F_{xx'} = 0 \Rightarrow H_A = 0$ $\sum F_{yy'} = 0 \Rightarrow V_A + V_B - q(5) - F_1 - F_2 = 0$ $\Rightarrow V_A + V_B = 95$ $\sum M_{/A} = 0 \Rightarrow -F_1(1) - V_B(4) + F_2(2) + (q \times 5)1.5 = 0$ $\Rightarrow V_B = \frac{90 - 15 + 40}{4}$ 0.50 $\Rightarrow \boxed{V_B = 28.75 \text{ KN}}$ $\sum M_{/B} = 0 \Rightarrow -F_1(5) - F_2(2) - q(5)(2.5) + V_A(4) = 0$ $V_A = \frac{75 + 150 + 40}{5}$ 0.50 $\Rightarrow \boxed{V_A = 66.25 \text{ KN}}$ (2) كتابة معادلات الجهد القاطع وعزم الانحناء المجال: $0 \leq x \leq 1$  0.50 $\sum F_{yy'} = 0 \Rightarrow -15 - (12x) - T(x) = 0$ $\Rightarrow T(x) = -12x - 15$ $\left(\begin{array}{l} x = 0 \Rightarrow T = -15 \text{ KN} \\ x = 1 \Rightarrow T = -27 \text{ KN} \end{array} \right)$ $\sum M = 0 \Rightarrow -15x - 12x \frac{x}{2} - M_f(x) = 0$ $\Rightarrow M_f(x) = -6x^2 - 15x$ 0.50 $\left(\begin{array}{l} x = 0 \Rightarrow M_f(0) = 0 \\ x = 1 \Rightarrow M_f(1) = -21 \text{ KN.m} \end{array} \right)$

		- المجال: $1 \leq x \leq 3$  $\sum F_{/YY'} = 0 \Rightarrow 66.25 - 15 - (12x) - T(x) = 0$ $\Rightarrow T(x) = -12x + 51.25$ $\left(\begin{array}{l} x = 1 \Rightarrow T = 39.25 \text{ KN} \\ x = 3 \Rightarrow T = 15.25 \text{ KN} \end{array} \right)$ $\sum M = 0 \Rightarrow [66.25(x-1)] - 15x - 12x \frac{x}{2} - M_f(x) = 0$ $\Rightarrow M_f(x) = -6x^2 + 51.25x - 66.25$ $\left(\begin{array}{l} x = 1 \Rightarrow M_f(1) = -21 \text{ KN.m} \\ x = 3 \Rightarrow M_f(3) = 33.25 \text{ KN.m} \end{array} \right)$ - المجال: $3 \leq x \leq 5$  $\sum F_{/YY'} = 0 \Rightarrow -15 - (12x) - T(x) - 20 + 66.25 = 0$ $\Rightarrow T(x) = -12x + 31.25$ $\left(\begin{array}{l} x = 3 \Rightarrow T = -4.75 \text{ KN} \\ x = 5 \Rightarrow T = -28.75 \text{ KN} \end{array} \right)$ $\sum M = 0 \Rightarrow -15x - 12x \frac{x}{2} - M_f(x) - 20(x-3) + 66.25(x-1) = 0$ $\Rightarrow M_f(x) = -6x^2 + 31.25x - 6.25$ $\left(\begin{array}{l} x = 3 \Rightarrow M_f(3) = 33.25 \text{ KN.m} \\ x = 5 \Rightarrow M_f(5) = 0 \end{array} \right)$
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• رسم المنحنيات



(3) تحديد ارتفاع مقطع الرافدة:

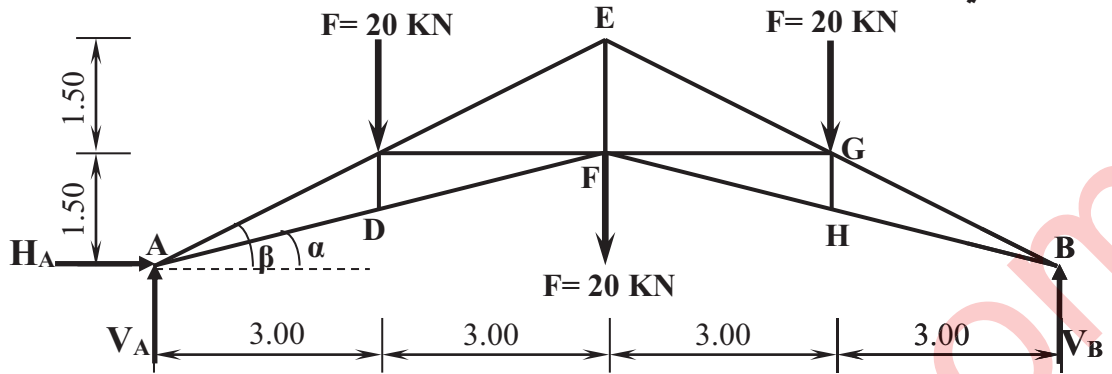
$$\sigma_{\max} \leq \bar{\sigma} \Rightarrow \frac{6M_{\max}}{b(h^2)} \leq \bar{\sigma}$$

$$\Rightarrow h^2 \geq \frac{6M_{\max}}{b \times \bar{\sigma}} \Rightarrow h \geq \sqrt{\frac{6M_{\max}}{b \times \bar{\sigma}}} \Rightarrow h \geq \sqrt{\frac{6(33.50)(10^4)}{15 \times 216}}$$

$$\Rightarrow h \geq 24.91 \text{ cm}$$

$$\boxed{h=25 \text{ cm}} \quad \text{نقترح}$$

النشاط الثاني:



(1) حساب ردود الأفعال:

0.25

2x0.25

$$\sum F_{/XX'} = 0 \Rightarrow H_A = 0$$

بما أن النظام متناظر فإن:

$$V_A = V_B = \frac{3 \times F}{2} = \frac{60}{2} = 30 \text{ KN}$$

(2) تحديد قيمة وطبيعة الجهود الداخلية في القضبان:

• العقدة (A)

$$\sum F_{/XX'} = 0 \Rightarrow N_{AD} \cos \alpha + N_{AC} \cos \beta = 0 \Rightarrow N_{AC} = \frac{-N_{AD} \cos \alpha}{\cos \beta} \dots (1)$$

$$\sum F_{/YY'} = 0 \Rightarrow V_A + N_{AD} \sin \alpha + N_{AC} \sin \beta = 0 \dots (2)$$

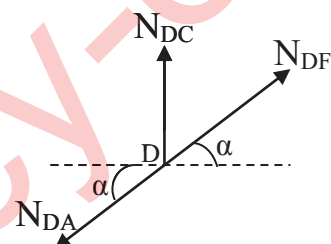
$$(2) \Rightarrow N_{AD} \sin \alpha + \frac{-N_{AD} \cos \alpha}{\cos \beta} \times \sin \beta = -30$$

$$\Rightarrow N_{AD} \times \left(\sin \alpha - \frac{\cos \alpha}{\cos \beta} \times \sin \beta \right) = -30$$

$$\Rightarrow N_{AD} \times (-0.242) = -30 \Rightarrow \boxed{N_{AD} = 123.97 \text{ KN}}$$

$$(1) \Rightarrow N_{AC} = \frac{-123.97 \times 0.97}{0.894} \Rightarrow \boxed{N_{AC} = 134.51 \text{ KN}}$$

• العقدة (D)

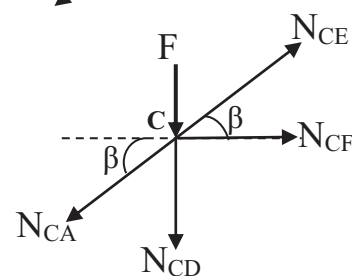


$$\sum F_{/XX'} = 0 \Rightarrow \boxed{N_{DF} = N_{DA} = 123.97 \text{ KN}}$$

$$\sum F_{/YY'} = 0 \Rightarrow N_{DC} + N_{DF} \sin \alpha - N_{DA} \sin \alpha = 0$$

$$\Rightarrow \boxed{N_{DC} = 0}$$

• العقدة (C)



$$\sum F_{/XX'} = 0 \Rightarrow N_{CE} \cos \beta - N_{CA} \cos \beta + N_{CF} = 0$$

$$\Rightarrow N_{CF} = (N_{CA} - N_{CE}) \times \cos \beta \dots (1)$$

$$\sum F_{/YY'} = 0 \Rightarrow -F - N_{CD} + N_{CE} \sin \beta - N_{CA} \sin \beta = 0 \dots \dots \dots (2)$$

$$(2) \Rightarrow N_{CE} = \frac{F + N_{CD} + N_{CA} \sin \beta}{\sin \beta}$$

$$\Rightarrow N_{CE} = \frac{20 + 0 + (-134.51) \times 0.447}{0.447}$$

$$\Rightarrow \boxed{N_{CE} = -89.77 \text{ KN}}$$

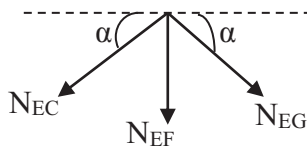
$$(1) \Rightarrow N_{CF} = [-134.51 - (-89.77)] \times 0.894$$

$$\Rightarrow \boxed{N_{CF} = -40 \text{ KN}}$$

• العقدة (E)

$$\sum F_{/XX'} = 0 \Rightarrow N_{EG} \cos \beta - N_{EC} \cos \beta = 0$$

$$\Rightarrow N_{EG} = N_{EC} \Rightarrow \boxed{N_{EG} = N_{EC} = -89.77 \text{ KN}}$$



$$\sum F_{/YY'} = 0 \Rightarrow -N_{EF} - N_{EG} \sin \beta - N_{EC} \sin \beta = 0$$

$$\Rightarrow N_{EF} = -N_{EG} \sin \beta - N_{EC} \sin \beta = -2 \times N_{EC} \sin \beta$$

$$\Rightarrow N_{EF} = -(2 \times -89.77 \times 0.447)$$

$$\Rightarrow \boxed{N_{EF} = 80.25 \text{ KN}}$$

يتم استنتاج باقي الجهود الداخلية بالتناظر.

- جدول النتائج:

EF	DF=HF	CF=GF	CE=GE	CD=GH	AD=BH	AC=BG	القضبان
80.25	123.97	40	89.77	0	123.97	134.51	الشدة (KN)
شد	شد	ضغط	ضغط	تركبي	شد	ضغط	الطبيعة

01

(3) تحديد نوع المجنب:

$$\sigma_{\max} \leq \bar{\sigma} \Rightarrow \frac{N_{\max}}{2S} \leq \bar{\sigma}$$

$$\Rightarrow S \geq \frac{N}{2 \times \bar{\sigma}} \Rightarrow S \geq \frac{N}{2\bar{\sigma}}$$

$$\Rightarrow S \geq \frac{134.51 \times (10)^2}{2(1600)} \Rightarrow S \geq 4.20 \text{ cm}^2$$

0.75

من الجدول نختار $S = 4.5 \text{ cm}^2$ أي المجنب المناسب: $L(50 \times 50 \times 5)$

06

البناء:

النشاط الأول:

(1.1) حساب إحداثيات النقطة B

$$\Delta X_{AB} = L_{AB} \times \sin G_{AB} = 74.69 \times \sin 125 \Rightarrow \Delta X_{AB} = 69 \text{ m}$$

$$X_B = X_A + \Delta X_{AB} \Rightarrow X_B = 65 + 69 \Rightarrow \boxed{X_B = 134 \text{ m}}$$

$$\Delta Y_{AB} = L_{AB} \times \cos G_{AB} = 74.69 \times \cos 125 \Rightarrow \Delta Y_{AB} = -28.58 \text{ m}$$

$$Y_B = Y_A + \Delta Y_{AB} = 135 + (-28.58) \Rightarrow \boxed{Y_B = 106.42 \text{ m}}$$

إحداثيات النقطة B: B (134 , 106.42)

0.50

0.50

0.25

