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CORRIGE

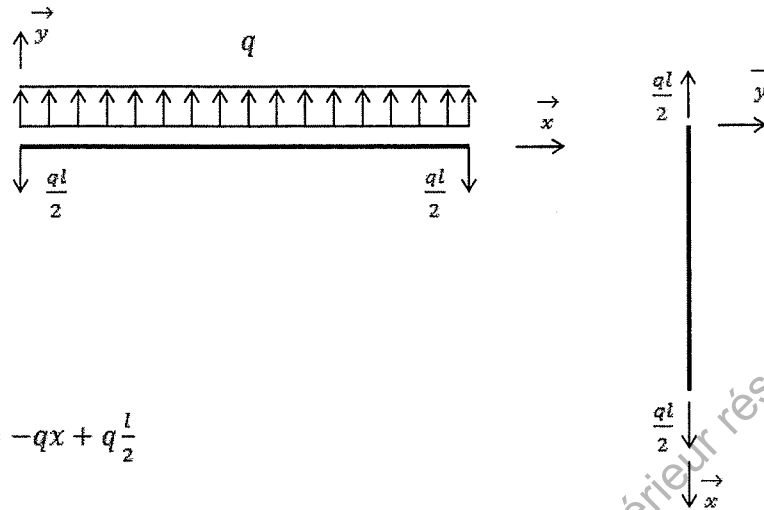
Ces éléments de correction n'ont qu'une valeur indicative. Ils ne peuvent en aucun cas engager la responsabilité des autorités académiques, chaque jury est souverain.

Mécanique

Éléments de correction

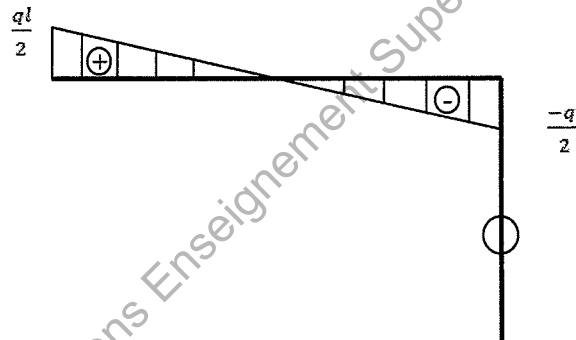
PARTIE 1 :

1.1



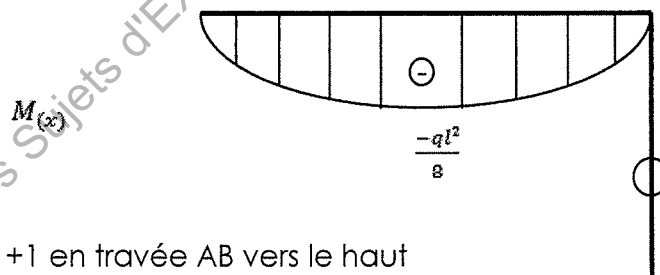
1.2 AB : $V_{(x)} = -qx + q\frac{l}{2}$

BC : $V_{(x)} = 0$

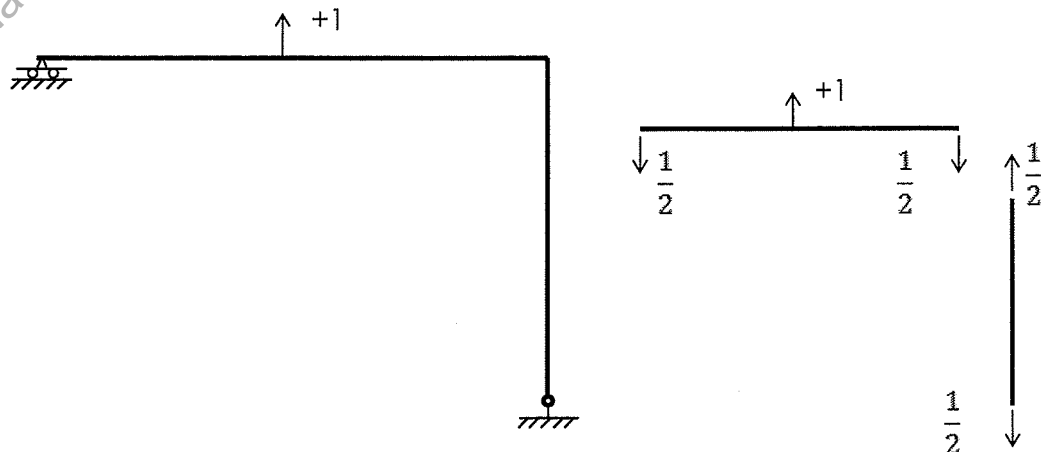


1.3 AB : $M_{(x)} = q\frac{x^2}{2} - q\frac{l}{2}x$

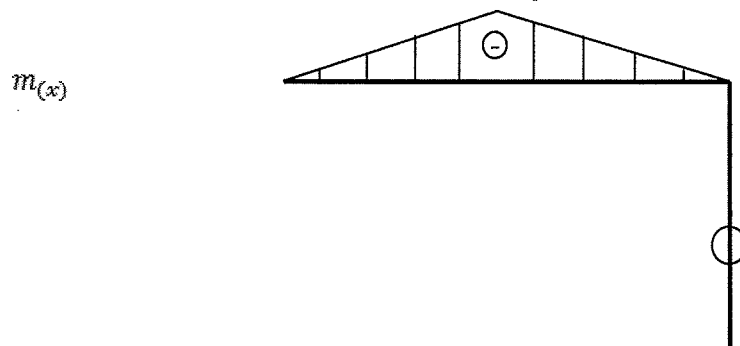
BC : $M_{(x)} = 0$



1.4 MDF charge +1 en travée AB vers le haut



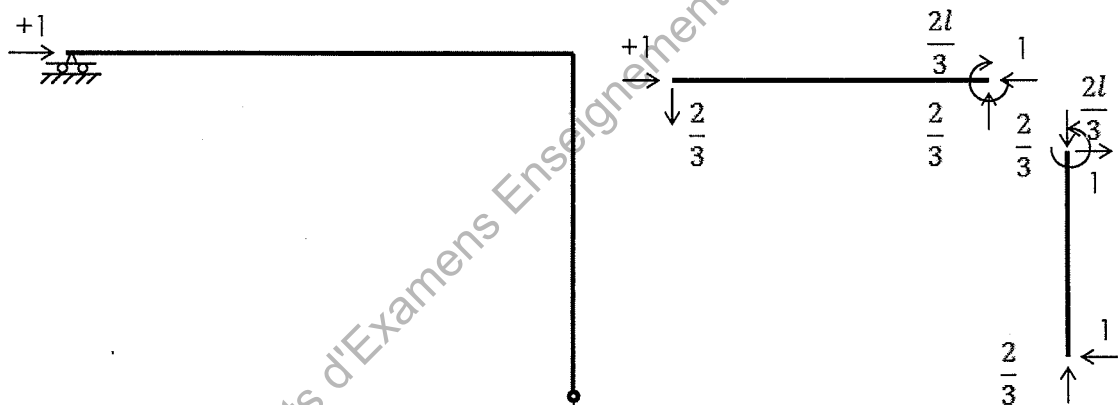
Structure essentiellement fléchie : $M(x)$



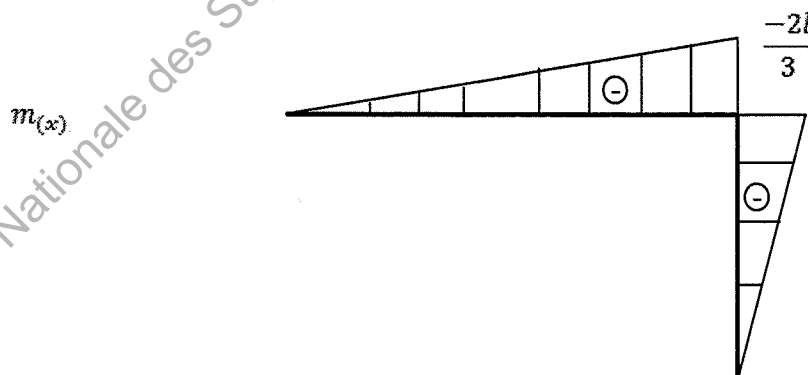
$$\Delta_{TAB} = \frac{l}{EI} \frac{1}{l} \int_{AB} M m ds + \frac{2l}{3EI} \frac{1}{\frac{2l}{3}} \int_{BC} M m ds = \frac{l}{EI} \left[\frac{5}{12} \left(\frac{-ql^2}{8} \right) \left(\frac{-l}{4} \right) \right] = \frac{5ql^4}{384EI} \text{ vers le haut } (\uparrow)$$

$$AN : \Delta_{TAB} = 62,8 \text{ mm}$$

1.5 MDF charge +1 en A ou B si on néglige la compression dans (AB)



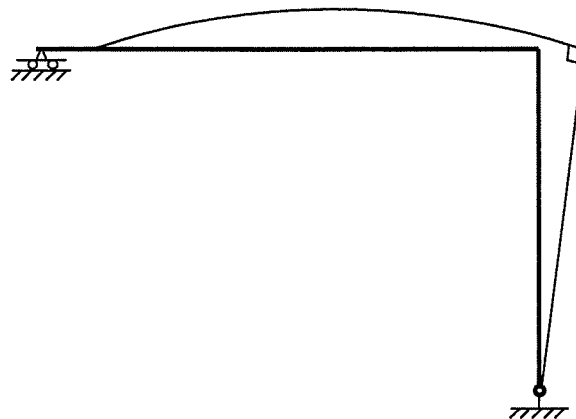
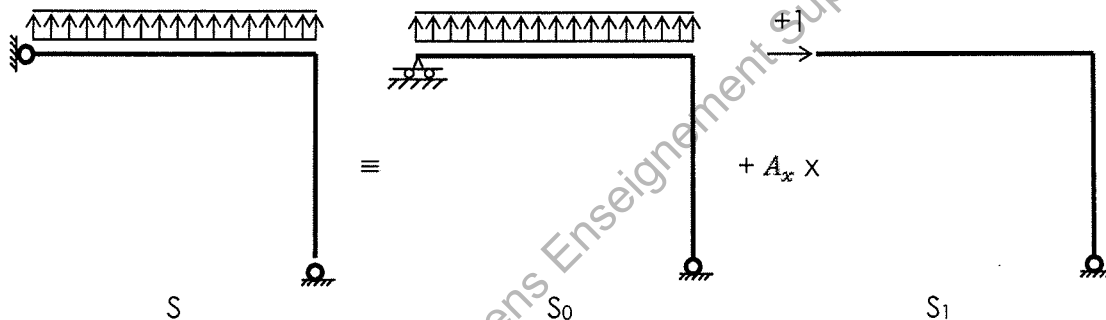
Structure essentiellement fléchie : $M(x)$



$$\Delta_{h(AB)} = \frac{l}{EI} \frac{1}{l} \int_{AB} M m ds + \frac{2l}{3EI} \frac{1}{\frac{2l}{3}} \int_{BC} M m ds = \frac{l}{EI} \left[\frac{1}{3} \left(\frac{-ql^2}{8} \right) \left(\frac{-2l}{3} \right) \right] = \frac{ql^4}{36EI} \text{ vers la droite } (\rightarrow)$$

$$AN : \Delta_{h(AB)} = 134 \text{ mm}$$

1.6

**PARTIE 2 :**2.1 $1l_3 + 2l_2 + 0l_1 - 3b = 3 + 4 - 6 = 1$ hyper degré 12.2 choix A_x car structure ISO associée de la partie 1

$$\Delta_{10} + A_x \delta_{11} = 0$$

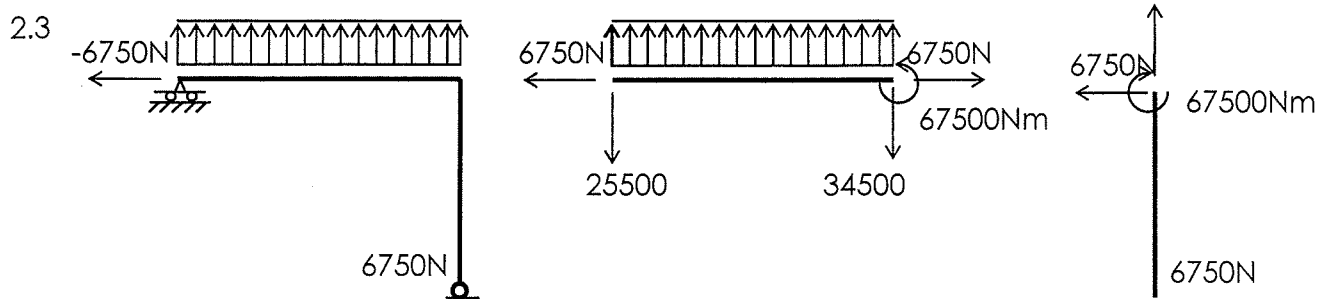
 S_0 étudié partie 1 S_1 étudié partie 1

$$\Delta_{10} = \frac{ql^4}{36EI}$$

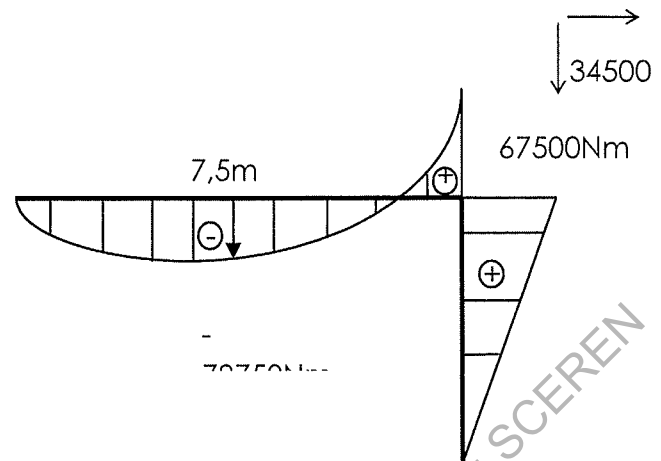
$$\delta_{11} = \frac{l}{EI} \left[\frac{1}{3} \left(\frac{-2l}{3} \right) \left(\frac{-2l}{3} \right) \right] + \frac{2l}{3EI} \left[\frac{1}{3} \left(\frac{-2l}{3} \right) \left(\frac{-2l}{3} \right) \right] = \frac{4l^3}{27EI} + \frac{8l^3}{81EI} = \frac{20l^3}{81EI}$$

$$A_x = \frac{-\Delta_{10}}{\delta_{11}} = \frac{-9ql}{80}$$

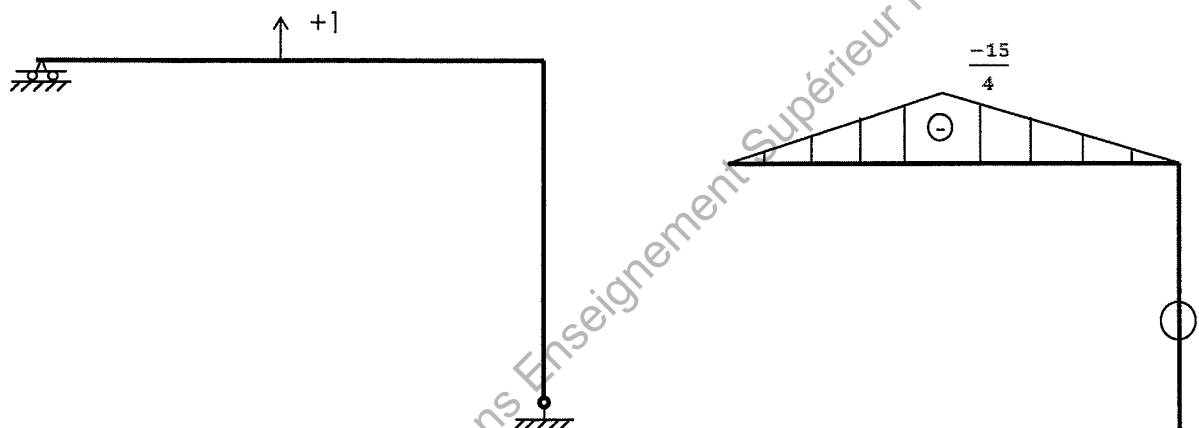
$$AN : A_x = -6750N$$



2.4 $M(x) = 4000 \frac{x^2}{2} - 25500x$



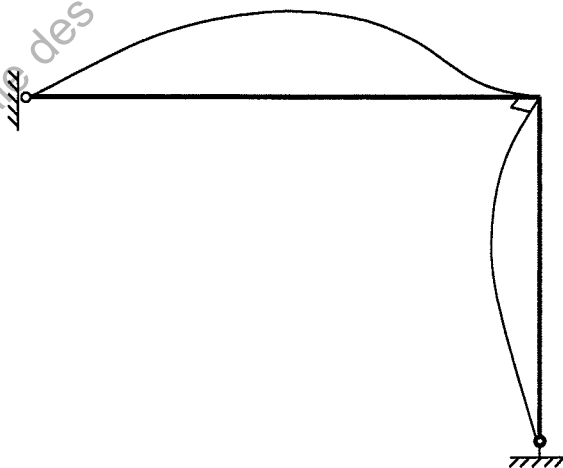
2.5 MDF charge +1 milieu AB sur n'importe quelle structure ISO associée



$$\Delta = \frac{l}{EI} \left[\frac{1}{24} m (M_1 + 10M_0 + M_2) \right] = \frac{15}{EI} \left[\frac{1}{24} \left(\frac{-15}{4} \right) (0 - 787500 + 67500) \right] = 0,04m$$

Soit 4cm vers le haut (↑)

2.6



PARTIE 3 :

3.1 $2l_3 + 1l_2 + 0l_1 - 3b = 6 + 2 - 6 = 2$ Hyper degré 2

3.2 MDR

- 1 inc cinématique ω_B
- Equations intrinsèques

$$AB \begin{cases} M_{AB} = 0 \\ M_{BA} = \frac{3EI}{l}(\omega_B) + \overline{M_{BA}} \end{cases} \quad \overline{M_{BA}} = \frac{ql^2}{8}$$

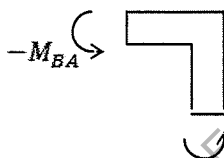
$$BC \begin{cases} M_{BC} = \frac{2EI}{\left(\frac{2l}{3}\right)}(2\omega_B + \omega_C) + M_{BC}^e \text{ avec } M_{BC}^e = 0 \\ M_{CB} = \frac{2EI}{\left(\frac{2l}{3}\right)}(\omega_B + 2\omega_C) + M_{CB}^e \text{ avec } M_{CB}^e = 0 \end{cases} \quad \text{et } \omega_C = 0$$

Soit :

$$AB \begin{cases} M_{AB} = 0 \\ M_{BA} = \frac{3EI}{l}(\omega_B) + \frac{ql^2}{8} \end{cases}$$

$$BC \begin{cases} M_{BC} = \frac{6EI}{l}\omega_B \\ M_{CB} = \frac{3EI}{l}\omega_B \end{cases}$$

- Equations d'équilibre

Noeud B  $M_{BA} + M_{BC} = 0$

- Résolution

$$\frac{3EI}{l}\omega_B + \frac{ql^2}{8} + \frac{6EI}{l}\omega_B = 0$$

$$\text{Soit } \omega_B = \frac{-ql^2}{72EI}$$

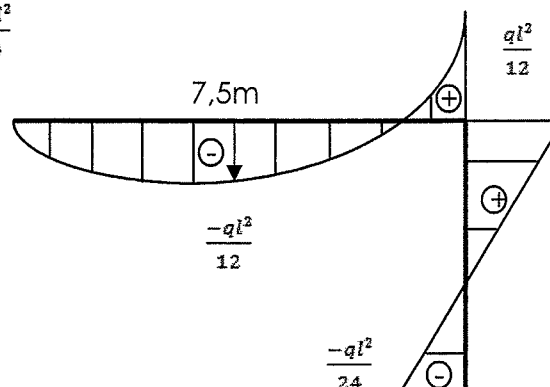
3.3 Calcul des M_{ij}

$$M_A = -M_{AB} = 0$$

$$M_{B/AB} = M_{BA} = \frac{ql^2}{12}$$

$$M_{B/BC} = -M_{BC} = \frac{ql^2}{12}$$

$$M_C = M_{CB} = \frac{-ql^2}{24}$$



$$M_{TAB} = M_{T_{0AB}} + \left(\frac{M_g + M_d}{2} \right) = \frac{-ql^2}{8} + \left(\frac{0 + \frac{ql^2}{12}}{2} \right) = \frac{-ql^2}{12}$$

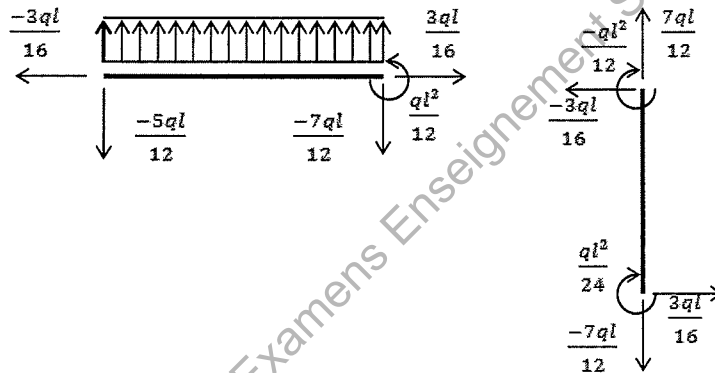
3.4 Actions aux appuis V_{ij}

$$V_{AB} = v_{AB} + \frac{M_{AB} + M_{BA}}{l} = \frac{-ql}{2} + \frac{ql}{12} = \frac{-5ql}{12}$$

$$V_{BA} = v_{BA} - \frac{M_{AB} + M_{BA}}{l} = \frac{-ql}{2} - \frac{ql}{12} = \frac{-7ql}{12}$$

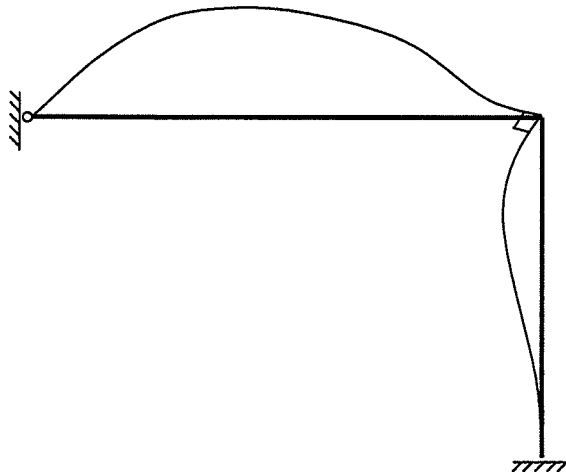
$$V_{BC} = v_{BC} + \frac{M_{BC} + M_{CB}}{\frac{2l}{3}} = 0 + \left(\frac{\frac{-ql^2}{12} + \frac{-ql^2}{24}}{\frac{2l}{3}} \right) = \frac{-3ql}{16}$$

$$V_{CB} = v_{CB} - \frac{M_{BC} + M_{CB}}{\frac{2l}{3}} = 0 - \left(\frac{\frac{-ql^2}{12} + \frac{-ql^2}{24}}{\frac{2l}{3}} \right) = \frac{3ql}{16}$$



$$3.5 \quad \Delta_{TAB} = \frac{3ql^4}{384EI} = 0,037m \text{ soit } 37mm$$

3.6



PARTIE 4 :

4.1 $X_G = 0$ pour des raisons de symétrie.

$$Y_G = \frac{95 \times 5380 + 300 \times 6430}{(5380 + 6430)} = \frac{2440100}{11810} = 206,61 \text{ mm}$$

4.2 $I_{GY} = 5409,7 + 1335,6 = 6745,3 \text{ cm}^4$

$$W_{el.Y} = \frac{I_{GY}}{v_Y} = \frac{6745,3}{10,5} = 642,4 \text{ cm}^3$$

$$i_Y = \sqrt{\frac{I_{GY}}{A}} = \sqrt{\frac{6745,3}{118,1}} = 7,56 \text{ cm}$$

4.3

$$I_{GX} = (1954,5 + 64,3 \times 9,34^2)_{HEA220} + (3692,2 + 53,8 \times 11,16^2)_{HEA200} = 7563,75 + 10393,$$

05

$$I_{GX} = 17956,8 \text{ cm}^4$$

$$W_{el.X} = \frac{I_{GX}}{v_X} = \frac{17956,8}{20,66} = 869,16 \text{ cm}^3$$

$$i_X = \sqrt{\frac{I_{GX}}{A}} = \sqrt{\frac{17956,8}{118,1}} = 12,33 \text{ cm}$$

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Document réponse DR1

