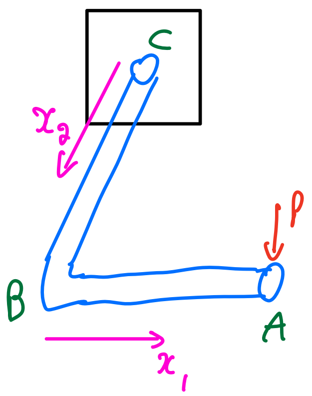
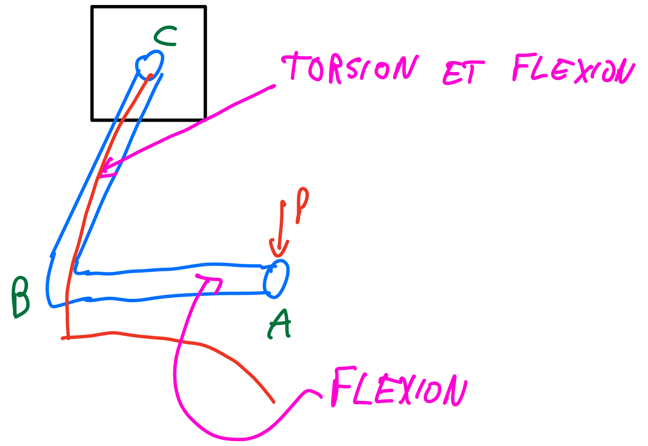
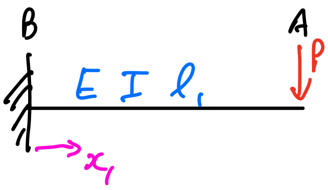
10.1



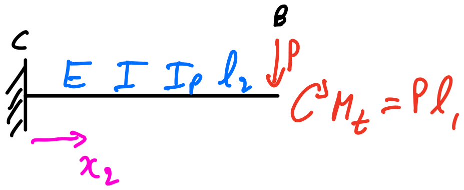


① BA



FLEXION $M_f(P,x)$

② CB



FLEXION $M_f(P,x)$

TORSION $M_T(P,x)$

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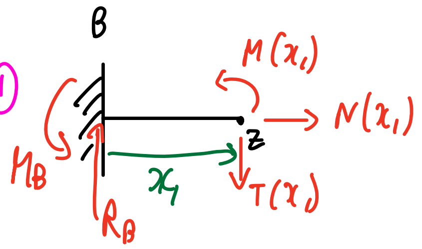
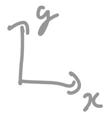
①



$R_B = P$

$M_B = P\ell_1$



$\Sigma F_x = 0$ $\quad N(x_1) = 0$ $\qquad \Sigma F_y = 0$ $\quad T(x_1) = P$

$\Sigma \vec{M}_{pt\,z} = 0$ $\qquad M_B + M_1(x) - R_B x_1 = 0$ $\qquad M_1(x) = -M_B + R_B x_1$

$= P x_1 - P\ell_1$

$= P(x_1 - \ell_1)$

check $M_f(x_1 = 0) = -M_B$

$M_f(x_1 = \ell_1) = 0$

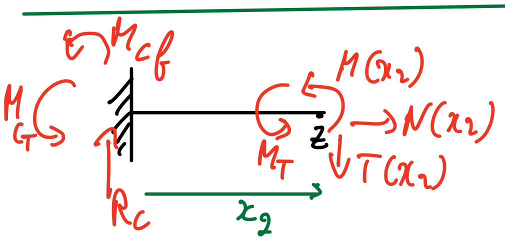
δ_A^{BA}

!! pas δ_B^{BA} !!

$$\delta_A^{BA} = \frac{\partial U}{\partial P} = \int_{x_1=0}^{x_1} \frac{M_f(x)}{EI}\,\frac{\partial M_f}{\partial P}\,dx_1$$

$$= \frac{1}{EI}\int_0^{l_1} P(x_1-l_1)\cdot(x_1-l_1)\,dx_1$$

$$= \frac{P}{EI}\,\frac{1}{3}\,(x_1-l_1)^3\Big|_0^{l_1} = \frac{Pl_1^3}{3EI} = \delta_A^{BA}$$



$R_C = P$

$M_{cf} = Pl_2$

$M_{ct} = Pl_1$

$\Sigma F_x = 0 \quad N(x_2) = 0$

$\Sigma M_{y_z} = 0 \quad M_{cf} + M(x_2) - R_c x_2 = 0$

$$\boxed{M_{cf}(x_2) = P(x_2 - l_2) \qquad \frac{\partial M_{cf}}{\partial P} = x_2 - l_2}$$

$\Sigma M_{x_z} = 0 \quad M_{CT}(x_2) + M_T = 0$

$$\boxed{M_{CT}(x_2) = -Pl_1 \qquad \frac{\partial M_{CT}}{\partial P} = -l_1}$$

$$\delta_A^{BC} = \int_0^{l_2} \frac{M_f}{EI}\,\frac{\partial M_f}{\partial P}\,dx_2 + \int_0^{l_2} \frac{M_T}{GI_p}\,\frac{\partial M_T}{\partial P}\,dx_2$$

$$= \frac{1}{EI}\int_0^{l_2} (x_2-l_2)^2 \cdot P\,dx_2 + \frac{1}{GI_p}\int_0^{l_2} Pl_1^2\,dx_2$$

$I_p = 2I$

$$\delta_A^{BC} = \frac{P}{3EI} l_2^3 + \frac{P l_1^2 l_2}{2GI}$$

$$\delta_A = \delta_A^{BC} + \delta_A^{AB}$$

⚠ pas d'angle à calculer

$$\boxed{\delta_A = \underbrace{\frac{P}{3EI}\left(l_1^3 + l_2^3\right)}_{\text{2 poutres en flexion}} + \underbrace{\frac{P l_1^2 l_2}{2GI}}_{P l_1 \text{ due à torsion}}}$$

Pl_1 due à torsion : $\delta = \phi \cdot l_1$

$$= \frac{M_t \, l_2}{G I_p} = \frac{P l_1 \cdot l_2}{2GI}$$