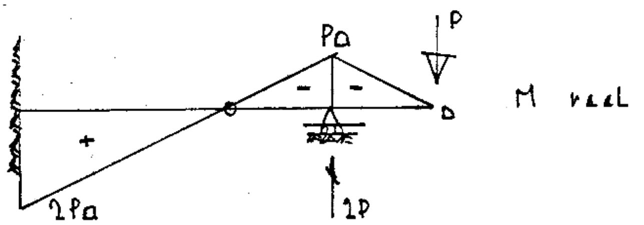
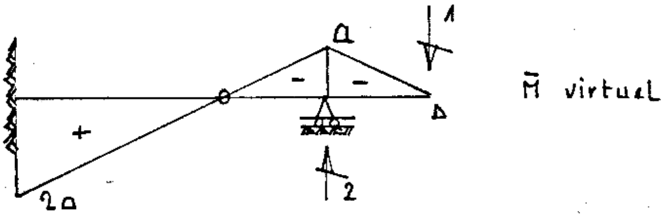
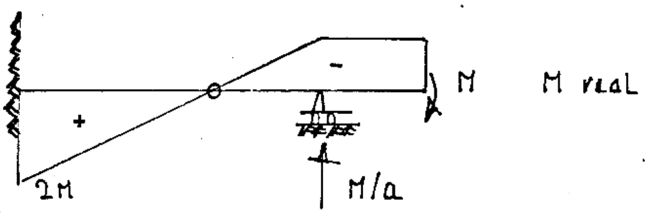
a)





$$1t\ \Delta_D = \int_0^l \frac{M\bar{M}}{EJ}dx = \frac{1}{EJ}\left[\frac{P.a^3}{3} + \frac{P.a^3}{3} + \frac{4.P.a^2.2}{3}\right] = \frac{10Pa^3}{3EJ}$$

b)



$\bar{M}$ virtuel : idem que a)

$$1t\ \Delta_D = \frac{1}{EJ}\left[\frac{Ma^2}{2} + \frac{Ma^2}{3} + \frac{2M2a\ 2a}{3}\right] = \frac{7\ Ma^2}{2EJ}$$

c) Système virtuel : idem que a)

$$d\phi = -\alpha\frac{\Delta t}{h}dx$$

$$\Delta_D = -\alpha\frac{\Delta t}{h}\int \bar{M}\,dx = -\left[\frac{-a^2-a^2+4a^2}{2}\right]\alpha\frac{\Delta t}{h} = -\frac{\alpha a^2\Delta t}{h}$$

avec $\Delta t = t_s - t_i$

Le système est semblable que A.
Il suffit de rajouter les contributions de l'appui souple [ressort].

a] $\Delta_D = \int \frac{M \bar{M}}{EJ} dx + \underbrace{R_D \Delta'_D}_{\text{travail du ressort}}$ $\quad R_D$: virtual $= 2$; Δ'_D : real $= \frac{2P}{K}$

$$\Delta_D = \frac{10 P a^3}{3EJ} + 2 \cdot \frac{2P}{K}$$

b] $$\Delta_D = \frac{7 M a^2}{2EJ} + 2 \cdot \frac{M}{aK}$$

c] $$\Delta_D = -\frac{\alpha a^2 \Delta t}{h}$$

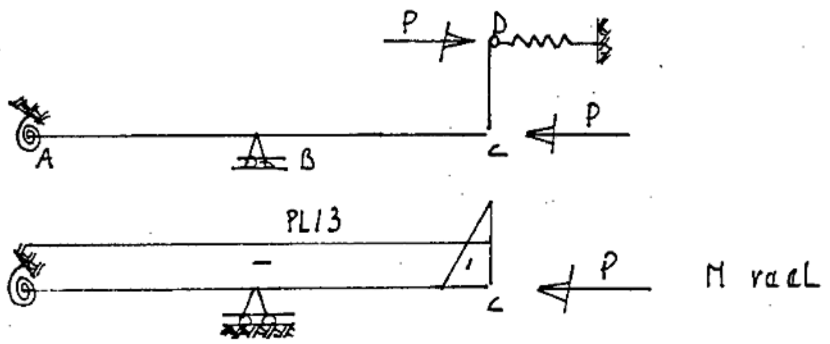
Le système est semblable que A.
Il suffit de rajouter les contributions du ressort

a] $$\Delta_D = \frac{10 P a^3}{3EJ} + 2a \cdot \frac{2Pa}{C} = \frac{10 P a^3}{3EJ} + \frac{4Pa^2}{C}$$

b] $$\Delta_D = \frac{7 M a^2}{2EJ} + 2a \frac{2M}{C} = \frac{7Ma^2}{2EJ} + \frac{4Ma}{C}$$

c] $$\Delta_D = -\frac{\alpha a^2 \Delta t}{h}$$

a)



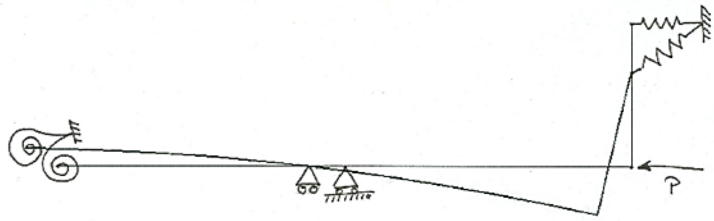
$$\Delta_C \text{ horizontal} = \int \frac{M\bar{M}}{EJ}\,dx + M_A\,\theta_A + R_D\,\Delta_D$$

$\bar{M}$ est déduit de M réel en remplaçant P par 1

$$\Delta_C = \frac{19PL^3}{81EJ} + (-L/3)(-PL/3K') + (-1)(-P/K)$$

$$\Delta_C = \frac{19PL^3}{81EJ} + PL^2/9K' + P/K$$

Exercice 1-2 : Déformée



b) Cas virtuel : idem que – D – a)

Cas réel : $d\phi = -\alpha \dfrac{\Delta t}{h}\,dx$

$$\Delta_C = \frac{13}{18}\,\alpha\,\Delta t\,\frac{L^2}{h}$$