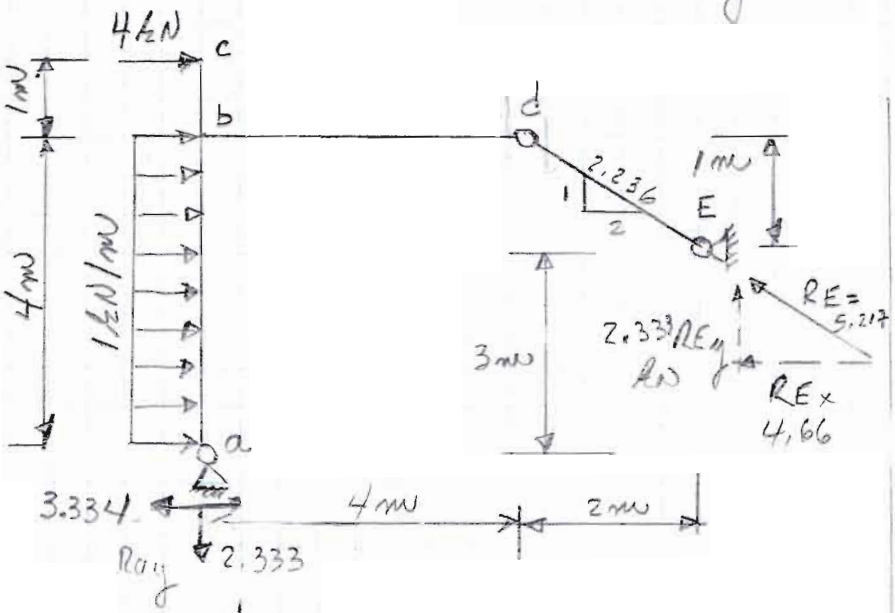
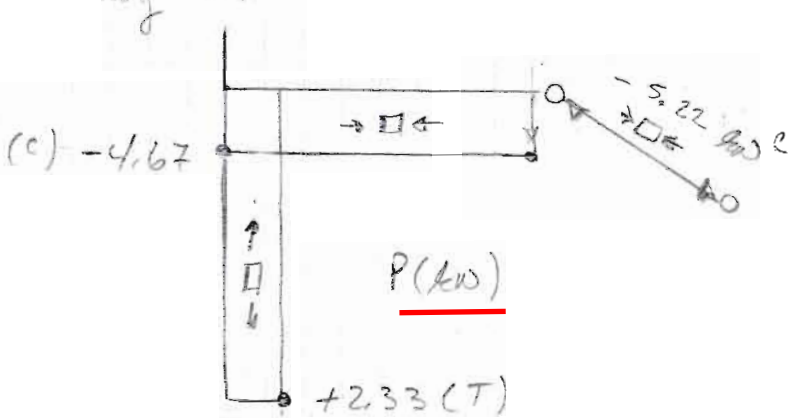
CIV3502

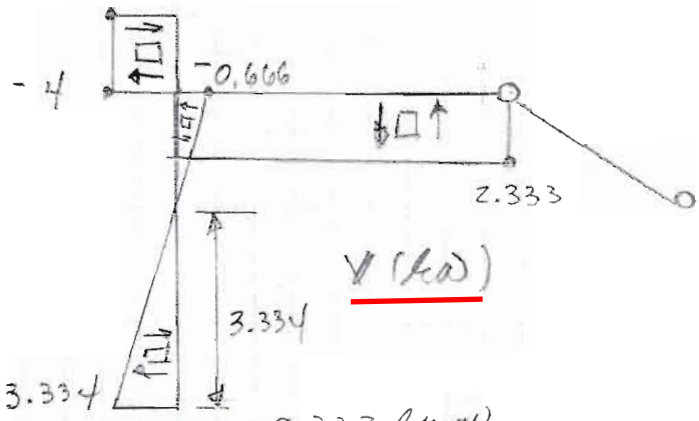
CP- A11

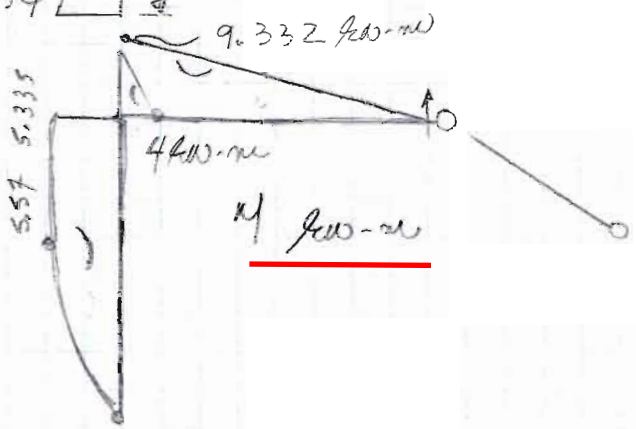
#1

- Calcul des réactions
- Calcul des diag. P, V, M









1. Calcul des réactions

$\circlearrowleft + \Sigma M_A = 0$

$-4(5) - (4)(1)(2) + RE_y(6) + RE_x(3) = 0$

$-20 - 8 + (6)RE\left(\frac{1}{2.236}\right) + (3)RE\left(\frac{2}{2.236}\right) = 0$

$RE = \frac{(20)+(8)}{\frac{1}{2.236}(6+(2)(3))} = 5.217$ ✓

$RE_y = 5.217\left(\frac{1}{2.236}\right) = 2.333$ kN ↑

$RE_x = 5.217\left(\frac{2}{2.236}\right) = 4.666$ kN ←

$\rightarrow + \Sigma F_x = 0 \quad 4 + (4)(1) - 4.666 + Rax = 0$

$Rax = 4.666 - 8 = -3.334$ ←

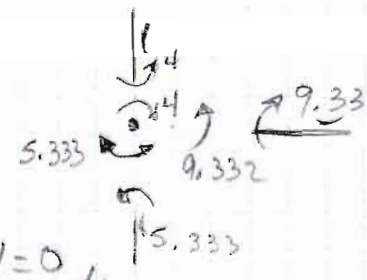
$\uparrow + \Sigma F_y = 0 \quad Ray =$

- Diag P
- Diag V $-3,334 + 4(1) = 0.666$
- Diag M $(4 \times 1) = 4$

$(2.333 \times 4) = 9.332$

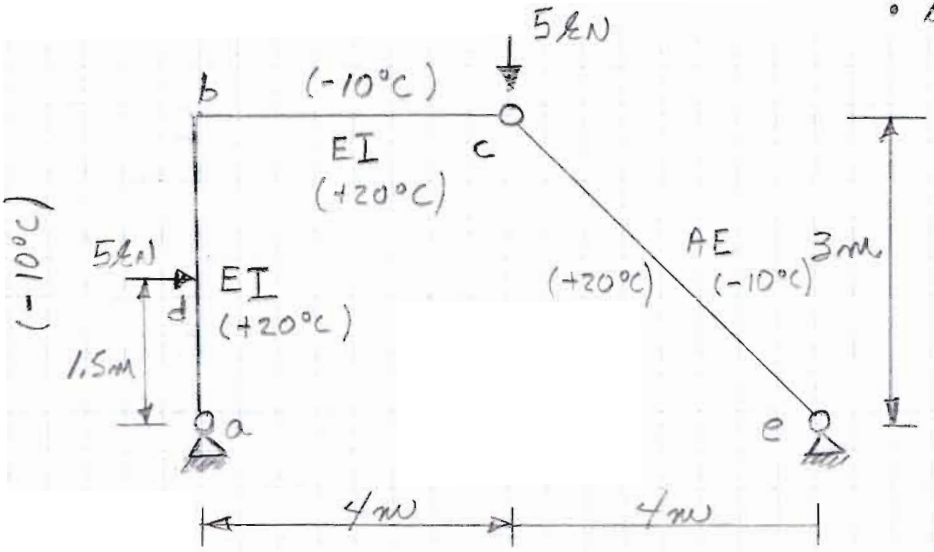
- $\frac{(3.334 \times 3.334)}{2} - \frac{0.666(4-3.334)}{2}$

$= +5.557 - 0.2217 = +5.335$



$\circlearrowleft + \Sigma M = 0$ ✓

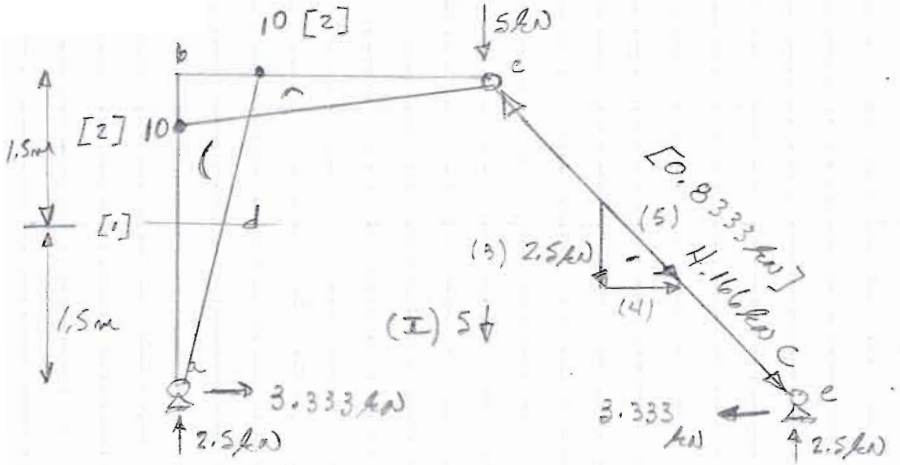
#2



- $EA = 3738 \times 10^2$ kN
- $EI = 3184$ kN-m^2
- $T°_{REF} = 10°C$
- $\alpha = 12 \times 10^{-6}$ m/m/°C
- $b = 0.5$ m

- **Calcul de la déflexion verticale au point C**

- Calcul pour 5 kN ↓
- Réactions verticales 2.5 kN ↑
- $R_{ex} = 2.5\left(\frac{4}{3}\right) = 3.333$ kN ←
- $\Sigma \vec{F}_x = 0$ $R_{ax} = 3.333$ kN
- $\Sigma M_e = 0$ $+ 3.333(3) - 2.5(4) = 0$
- $R_c = 2.5\left(\frac{5}{3}\right) = 4.166$



Calcul pour 5 kN →

$\Sigma M_a = 0$ $R_{ey}(8) - (5)(1.5) = 0$

$R_{ey} = \frac{5(1.5)}{8} = 0.9375$

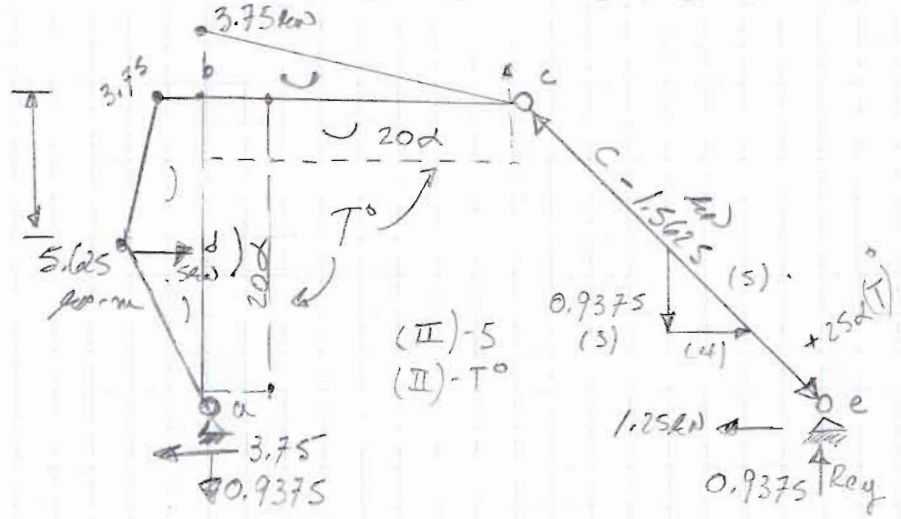
- $F_{ce} = \frac{0.9375}{3}(5) = 1.5625$
- $R_{ex} = \frac{0.9375}{3}(4) = 1.25$
- $\Sigma F_y = 0$ $\Sigma F_x = 0$

$\vec{R}_{ax} + 5 - 1.25 = 0$

$R_{ax} = -5 + 1.25 = -3.75$

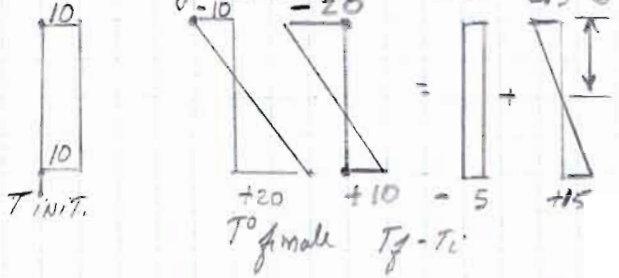
check: $\Sigma M_c = 0$ $+ 0.9375(4) - 3.75(3) + 5(1.5) = 0$ ✓

Pour 1 kN on divise les efforts par 5 □



- **Treillis** : $\alpha \Delta T° L = (12 \times 10^{-6})(5)(5) = 25\alpha$ m
- **Courbure** : **POUTRES** $\frac{\alpha \Delta T}{0.25 m} = \frac{(12 \times 10^{-6})(5)}{0.25} = 20\alpha$ rad/m

- **Calcul pour l'effet de la température :**



• Calcul de la flèche Vert. calc à C : $D_c^V = \int \left(\frac{PL}{AE}\right) + \sum_i \int m \left(\frac{M}{EI}\right) dx$ ($\delta^{T°}$, $\beta^{T°}$)

(A) Contribution 5 kN ↓ (RI - VI (avec 1 kN ↓))

• $\frac{1}{3484}\left[\underbrace{\frac{(10)(3)}{2}\left(\frac{2}{3}\cdot 2\right)}_{20}{}^{ab} + \underbrace{\frac{(10)(4)}{2}\left(\frac{2}{3}\cdot 2\right)}_{26.67}{}^{bc}\right] + \frac{1}{3738\times 10^2}\left[\underbrace{0.8333\,(4.1666)\,(5)}_{17.36}{}^{cc}\right]$

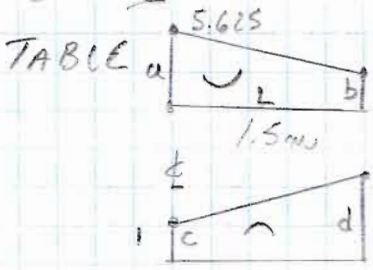
$= 0.0133\,m + 4.64\times 10^{-5} = 0.01335\,m = 13.35\,mm$ ↓

(B) Contribution 5 kN → (RII - VI avec 1 kN ↓)

• $\frac{1}{3738\times 10^2}\left[(1.5625)(0.833)(5)\right] = 1.7416\times 10^{-5}$ ↓

• $\frac{1}{3484}\left[-\frac{(5.625)(1.5)}{2}\left(\frac{2}{3}\cdot\frac{2}{3}(1.5)\right)^{ad} + -\frac{(3.75)(4)}{2}\left(\frac{2}{3}\cdot 2\right)^{bc} + \right.$

TABLE



$\left. - \frac{1.5}{6}\left[2(5.625)(1) + (5.625)(2) + 2(3.75)(2) + (3.75)(1)\right]\right]$

• $\frac{1}{3484}\left[-1.4062 - 10 - 10.3125\right]$ ↑ $+ 1.7416\times 10^{-5}$ ↓ $= -6.62\,mm$ ↑

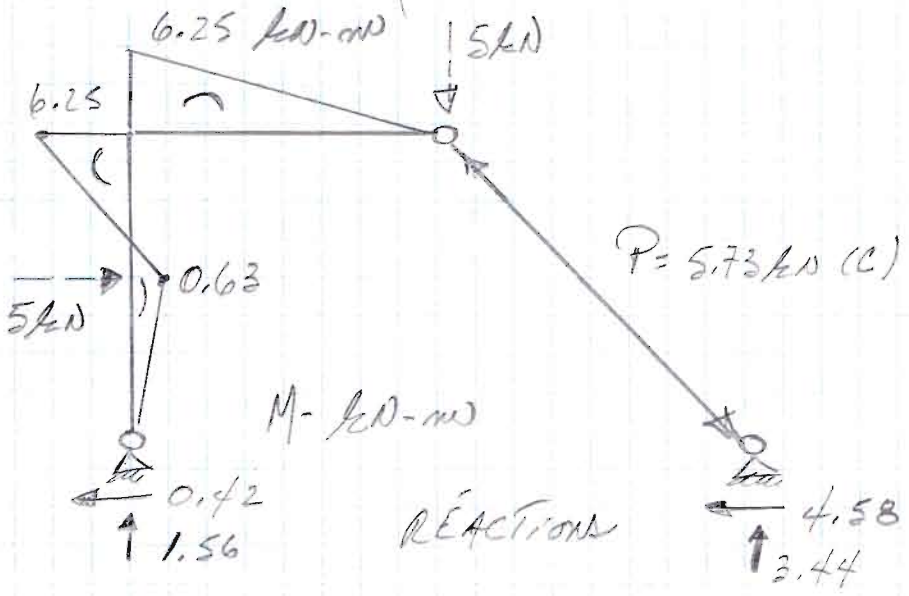
(C) Température (RII ($T^{°}$) - VI (1 kN ↓)) $\sum_i \int m(\beta)\,dx + \delta(\delta^{T°})$ (allongement ↓)

• $-\left(\frac{(2)(3)}{2}\cdot 60\alpha\right)^{ab} - \left(\frac{(2)(4)}{2}\cdot 60\alpha\right)^{bc} + (-0.833)(25\alpha)$

• $-\alpha\,(-180 - 240 + 20.825) = (-12\times 10^{-6})(399.175) = -4.79\times 10^{-3}$ ↑

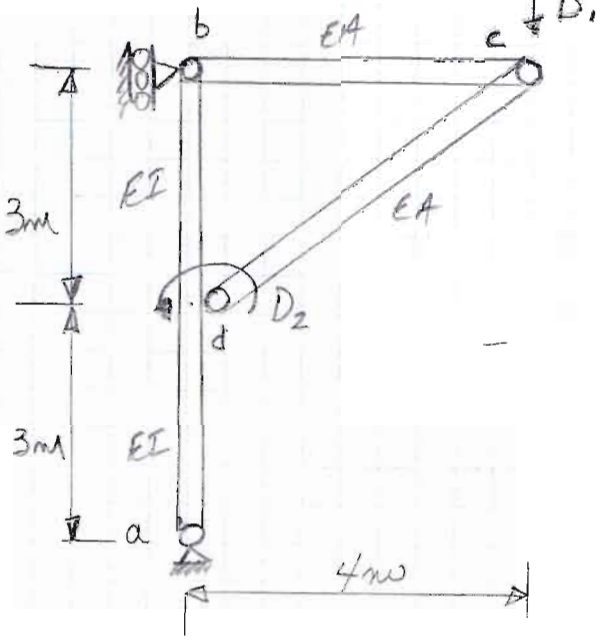
TOTAL : $13.35\,mm$ ↓ $-6.62\,mm$ ↑ $-4.79\,mm$ ↑ $= 1.94\,mm$ ↓

• → ALTERNATIVE



- CALCUL ALTERNATIF.

#3



• Calcul de la matrice de flexibilité

$EA = 3738 \times 10^2$ kN

$EI = 3484$ kN-m^2

• 1kN à D_1. Analyse sur la structure

$\sum M_a = 0 \quad -(1)(4) + R_b(6) = 0 \quad R_b = 4/6$

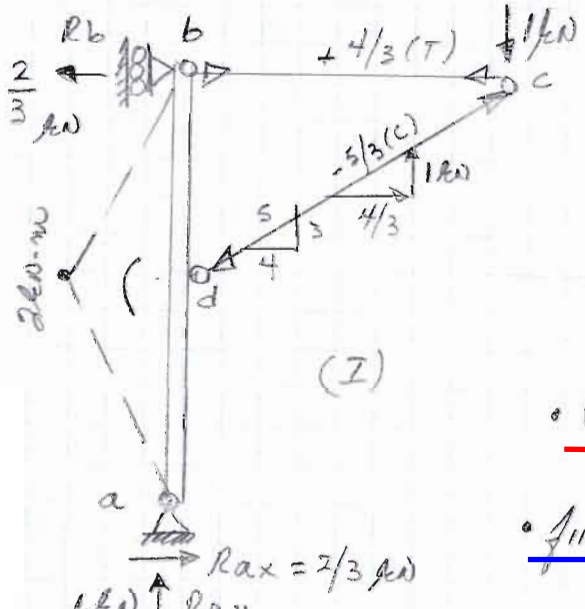
$\sum F_x = 0 \quad R_{ax} = 2/3 \rightarrow$

$\sum F_y = 0 \quad R_{ay} = 1 \uparrow$

• $F_{dcx} = 1\left(\frac{4}{3}\right) = 4/3$ kN

• $F_{dc} = 1(5/3) = 5/3$ kN

• $M_1 = 2/3 \cdot 3 = 2$ kN-m (pour fibre Tendue pour + de classe)



• 1kN-m à D_2 Analyse la structure

$\sum M_b = 0 \quad +1 - R_{ax}(6) = 0$

$R_{ax} = 1/6 \leftarrow$

$\sum F_y = 0 \quad R_b = 1/6 \rightarrow$

• Calcul $f_{ij} = \sum \int \left(\frac{PL}{AE}\right) + \sum \int m\left(\frac{M}{EI}\right) dx$

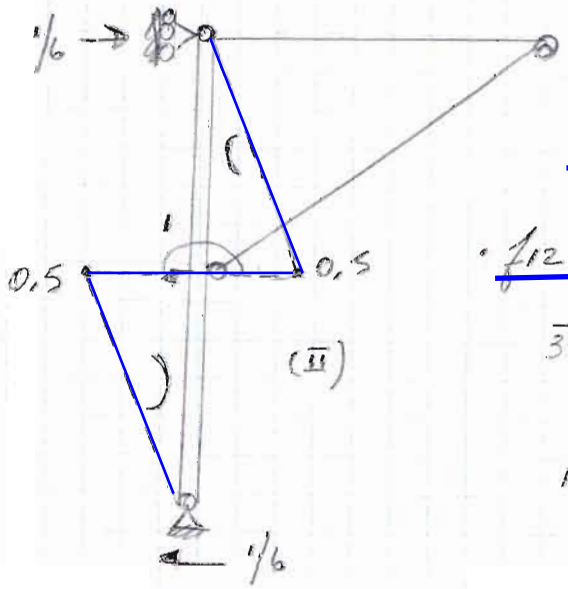
• $f_{11}(R_I - V_I)$: $\frac{1}{3738\times10^2}\left(\left[\left(-\frac{4}{3}\right)^2(4)\right]_{bc} + \left[(5/3)^2(5)\right]_{dc}\right) +$

$\frac{1}{3484}\left(12\right)\left(\frac{(2)(3)}{2}\left(\frac{2}{3}\cdot 2\right)\right)_{ab} = \frac{5.6179\times10^{-5}}{2.2962\times10^{-3}} = 2.352\times10^{-3}$

• $f_{22}(R_{II} - V_{II}) = \frac{1}{3484}\left(12\right)\left(\frac{(0.5)(3)}{2}\left(\frac{2}{3}\,0.5\right)\right) = 1.435\times10^{-4}$

• $f_{12}(R_{II} - V_I) = 0$

$\frac{1}{3484}\left[-\frac{(0.5)(3)}{2}\left(\frac{2}{3}\cdot 2\right) + \frac{0.5(3)}{2}\left(\frac{2}{3}\cdot 2\right)\right] = 0$



$$F = \begin{bmatrix} 2.352 & 0 \\ 0 & 0.143 \end{bmatrix} 10^{-3} \text{ m/kN}$$