

Corrigé Type



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Examen de **Elements Finis** : Session Normale (2019/2020)

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1^{ère} Master Construction1+ Fabrication et Productique

Correction

1 Matrices de rigidité des éléments:

elt ①; 1 → 2 $\theta = 0$

$$K_1 = \frac{ES}{L} \begin{bmatrix} 1 & 0 & -1 & 0 \\ 0 & 0 & 0 & 0 \\ -1 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix} ; \begin{cases} U_1 \\ V_1 \\ U_2 \\ V_2 \end{cases}$$

2

elt ②; 2 → 3 $\theta = 135$

$$[K_2] = \frac{ES}{L} \begin{bmatrix} 1/2 & -1/2 & -1/2 & 1/2 \\ -1/2 & 1/2 & 1/2 & -1/2 \\ -1/2 & 1/2 & 1/2 & -1/2 \\ 1/2 & -1/2 & -1/2 & 1/2 \end{bmatrix} ; \begin{cases} U_2 \\ V_2 \\ U_3 \\ V_3 \end{cases}$$

2

elt ③; 2 → 4 $\theta = 45$

$$[K_3] = \frac{ES}{L} \begin{bmatrix} 1/2 & 1/2 & -1/2 & -1/2 \\ 1/2 & 1/2 & -1/2 & -1/2 \\ -1/2 & -1/2 & 1/2 & 1/2 \\ -1/2 & -1/2 & 1/2 & 1/2 \end{bmatrix} ; \begin{cases} U_2 \\ V_2 \\ U_4 \\ V_4 \end{cases}$$

2

2- Matrice de rigidité du système

$$\textcircled{4} \quad [K_s] = \frac{ES}{L} \begin{bmatrix} 1 & 0 & -1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ -1 & 0 & 2 & 0 & -1/2 & 1/2 & -1/2 & -1/2 \\ 0 & 0 & 0 & 1 & 1/2 & -1/2 & -1/2 & -1/2 \\ 0 & 0 & -1/2 & 1/2 & 1/2 & -1/2 & 0 & 0 \\ 0 & 0 & 1/2 & -1/2 & -1/2 & 1/2 & 0 & 0 \\ 0 & 0 & -1/2 & -1/2 & 0 & 0 & 1/2 & 1/2 \\ 0 & 0 & -1/2 & -1/2 & 0 & 0 & 1/2 & 1/2 \end{bmatrix}; \quad \left\{ \begin{array}{l} U_1 \\ V_1 \\ U_2 \\ V_2 \\ U_3 \\ V_3 \\ U_4 \\ V_4 \end{array} \right.$$

3 Calcul des déplacements nodaux

$$U_1 = V_1 = U_3 = V_3 = U_4 = V_4 = 0 \quad \text{c.L.}$$

$$\frac{ES}{L} \begin{bmatrix} 2 & 0 \\ 0 & 1 \end{bmatrix} \begin{Bmatrix} U_2 \\ V_2 \end{Bmatrix} = \begin{Bmatrix} F \\ 0 \end{Bmatrix}$$

$$U_2 = \frac{FL}{2ES} = 0,3125 \text{ mm}$$

$$\frac{ES}{L} V_2 = 0; \quad V_2 = 0 \text{ mm}$$

4- Calcul des Reactions R_{1x} et R_{1y}

$$R_{1x} = \frac{ES}{L} (U_1 - U_2) = -800000 \text{ N}$$

$$R_{1y} = 0$$