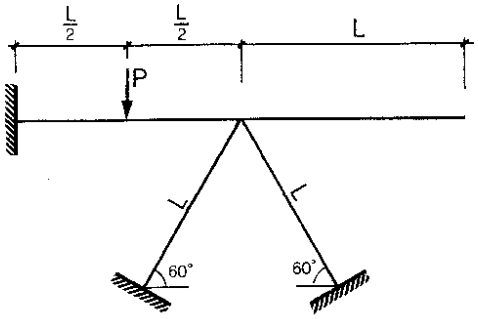
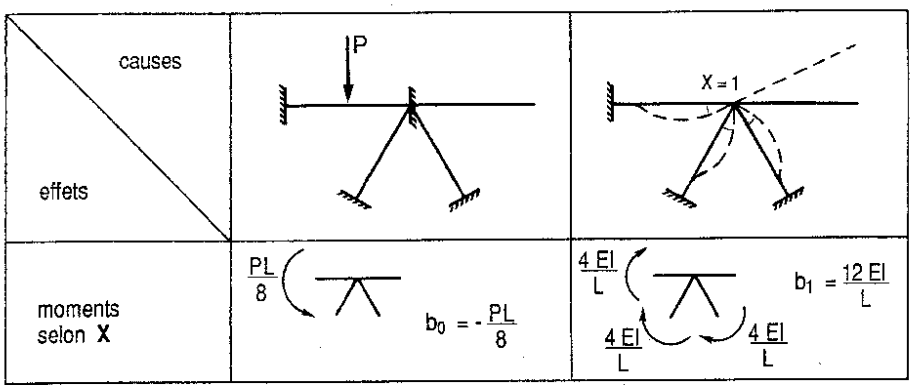
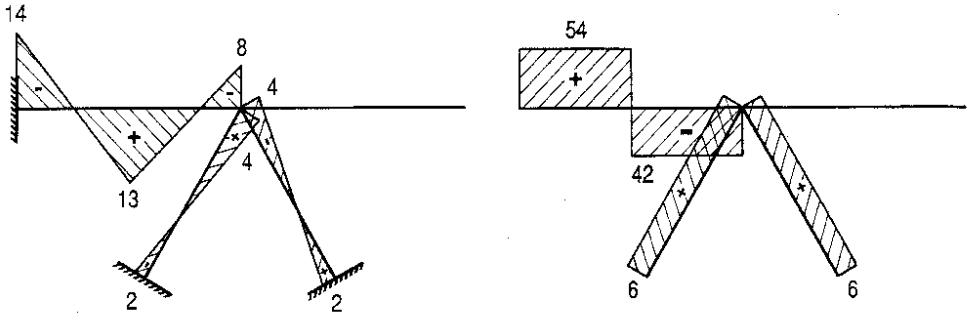
1.





Condition d'équilibre :

$$b_0 + b_1 x = 0 \longrightarrow x = -\frac{b_0}{b_1} = \frac{PL^2}{96\,EI}$$



M $\left[\frac{PL}{96}\right]$ V $\left[\frac{P}{96}\right]$

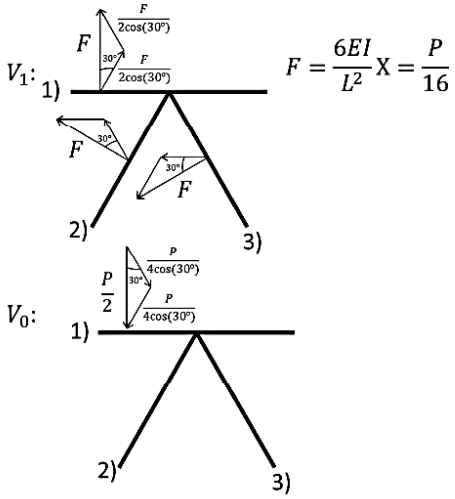
Calcul de l'effort normal

- Il faut décomposer les forces dues aux efforts tranchant en les projetant sur les axes des autres barres pour le déplacement unitaire et les charges externes
- On les additionne pour chaque barre

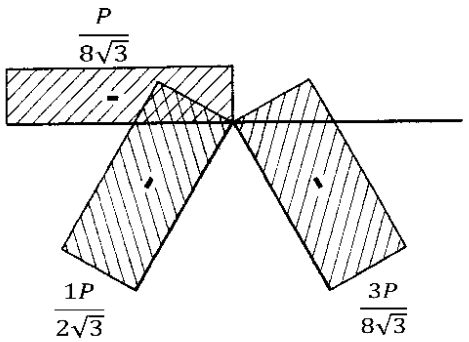
1) $N = -\frac{F}{2\cos(30°)} - \frac{F}{2\cos(30°)} = -\frac{P}{8\sqrt{3}}$

2) $N = 0 - \frac{P}{4\cos(30°)} = -\frac{P}{2\sqrt{3}}$

3) $N = \frac{P}{8\sqrt{3}} - \frac{P}{4\cos(30°)} = -\frac{3P}{8\sqrt{3}}$

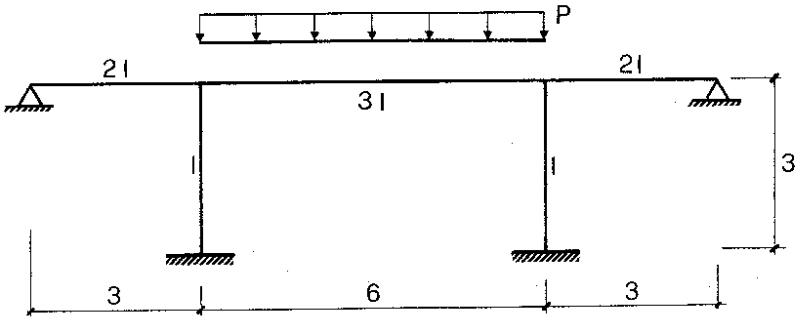


$F = \frac{6EI}{L^2}\mathrm{X} = \frac{P}{16}$



N

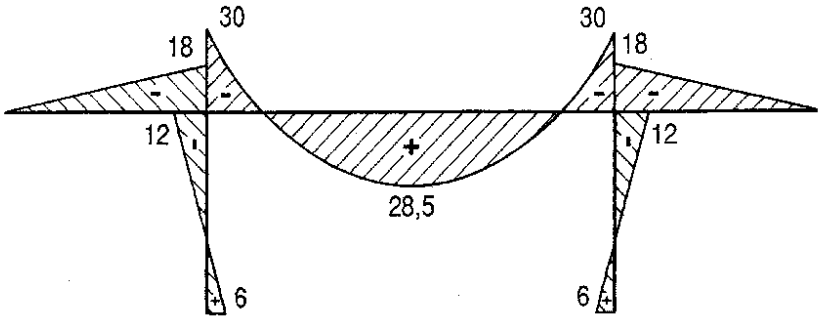
2.



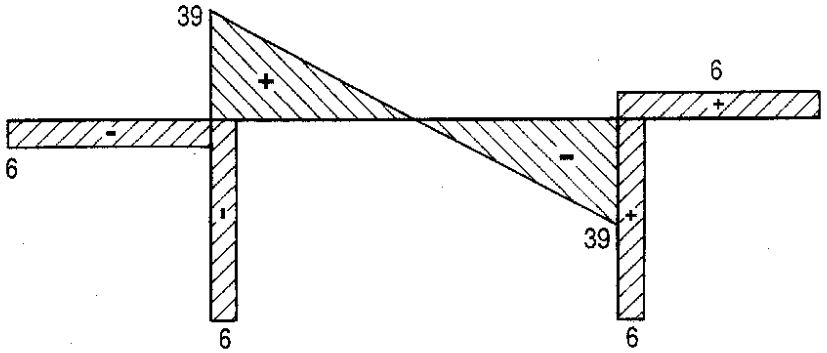
causes / effets	P	X = 1 X = 1
moments selon **X**	$\frac{PL^2}{12}$ $b_0 = -3p$	$\frac{3\,E2I}{3}$ $\frac{2\,E3I}{6}$ $\frac{4\,EI}{3}$ $b_1 = \frac{13\,EI}{3}$

Condition d'équilibre :

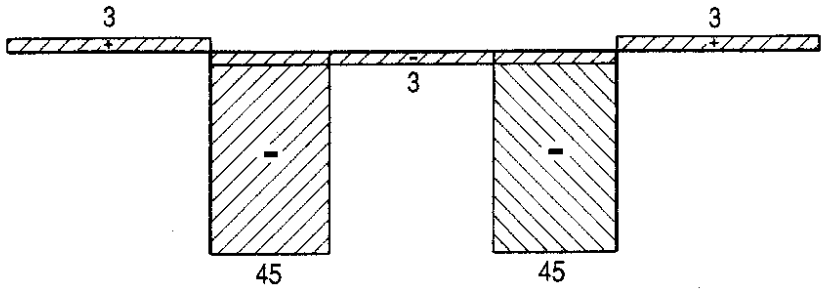
$$b_0 + b_1 x = 0 \longrightarrow x = -\frac{b_0}{b_1} = \frac{9p}{13\,EI}$$



M $\left[\frac{P}{13}\right]$

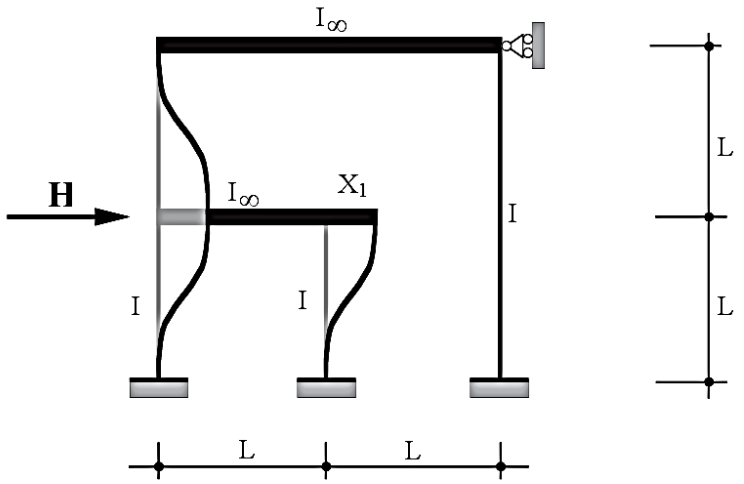


V $\left[\frac{P}{13}\right]$



N $\left[\frac{P}{13}\right]$

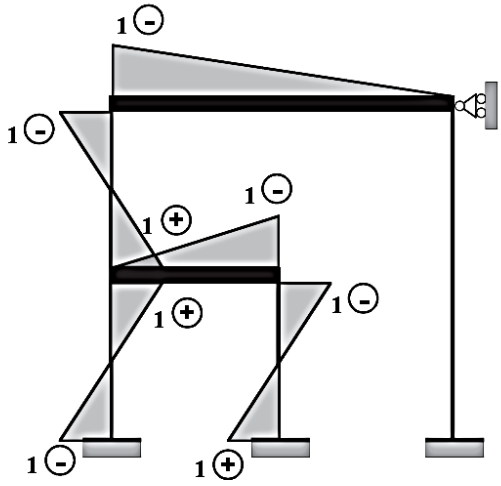
3.



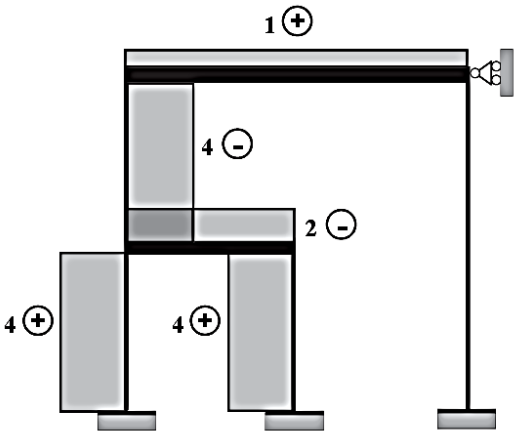
Causes / Effets	$X_1 = 1$	H
Forces selon X_1	$\frac{12\,EI}{L^3}$; $\frac{12\,EI}{L^3}$; $\frac{12\,EI}{L^3}$	H

Condition d' équilibre : $\frac{36\,EI}{L^3} X_1 - H = 0$

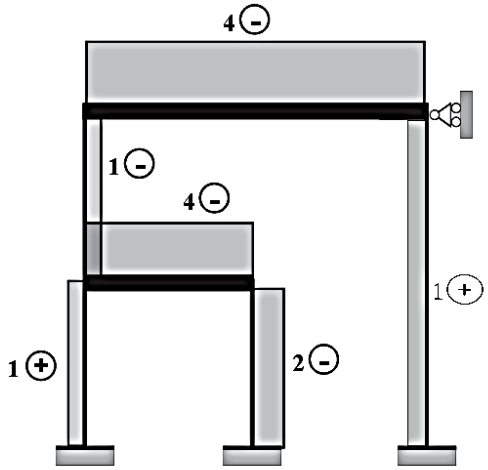
$$X_1 = \frac{H L^3}{36\,EI}$$



$\mathbf{M}\left[\frac{HL}{6}\right]$



$\mathbf{Q}\left[\frac{H}{12}\right]$



$\mathbf{N}\left[\frac{H}{12}\right]$

ANNEXE

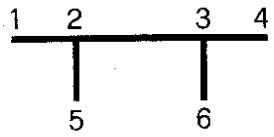
DETERMINATION DES DIAGRAMMES

Marche à suivre :

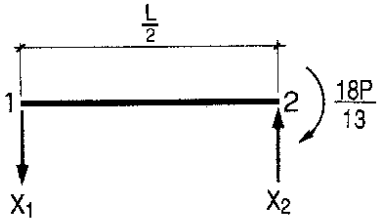
1 .- Calculer le diagramme des moments de flexion
2 .- Isoler chaque barre et exprimer les conditions d'équilibre (efforts tranchants)
3 .- Isoler chaque noeud et exprimer les conditions d'équilibre (efforts normaux)

Exemple : 2

Détermination des efforts tranchants à partir des moments de flexion

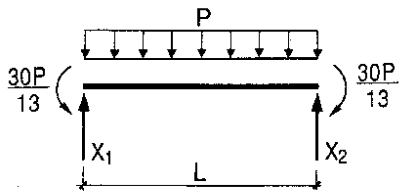


poutre 1-2



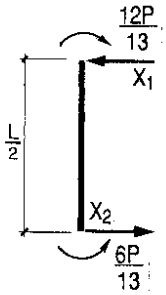
$\Sigma v = 0 \qquad X_1 = X_2$

$\Sigma M_{en\,1} = 0 \qquad X_2 = \frac{6P}{13}$



poutre 2-3

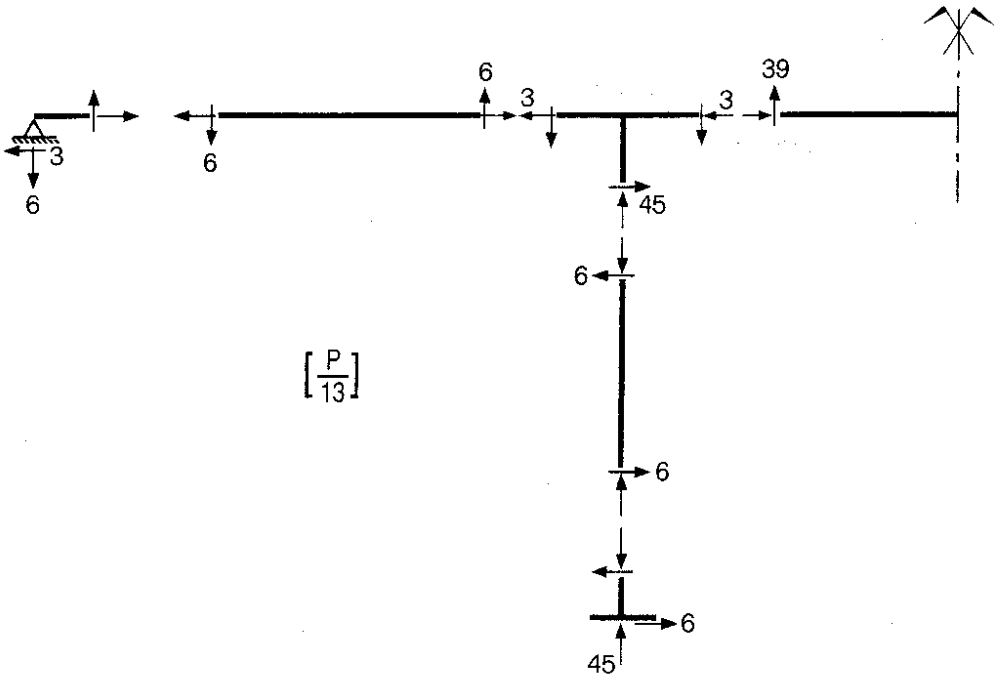
$$X_1 = X_2 = \frac{6P}{2}$$



poutre 2-5

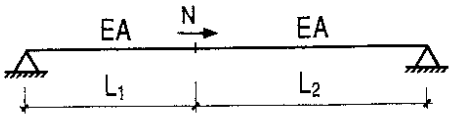
$$\Sigma v = 0 \qquad X_1 = X_2$$

$$\Sigma M_{en\,2} = 0 \qquad X_2 = \frac{6P}{13}$$

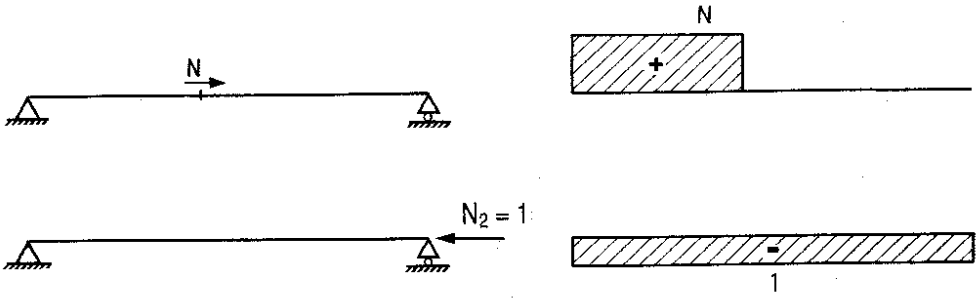


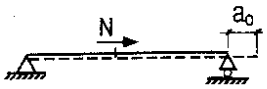
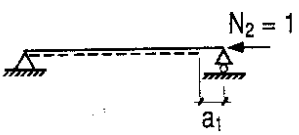
$\left[\frac{P}{13}\right]$

Répartition hyperstatique des efforts normaux :



Système fondamental :



causes / effets		
déplacements selon N_2	$a_0 = -\frac{N\,1}{EA} \cdot L_1$	$a_1 = \frac{1 \cdot 1}{EA}\,(L_1+L_2)$

Condition de compatibilité cinématique :

$$a_0 + a_1 N_2 = 0 \longrightarrow N_2 = -\frac{a_0}{a_1} = \frac{N L_1}{(L_1+L_2)}$$

Equilibre : $N_1 + N_2 = N \longrightarrow N_1 = \frac{N L_2}{(L_1+L_2)}$