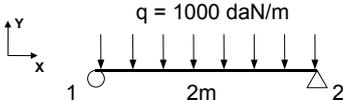
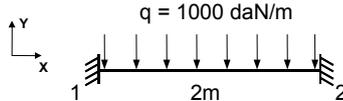
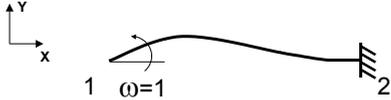


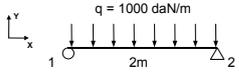
# - Méthode des déplacements -

- TP Rdm Le Mans

1/ Problème et résultats	2/ Système à degrés de liberté bloqués												
 <p style="text-align: center;"><i>Notations : indice 12 = action du nœud 1 sur la barre 12 indice 21 = action du nœud 2 sur la barre 12</i></p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; border-right: 1px solid black; padding: 5px;"><math>N_{12} = 0 \text{ daN}</math></td> <td style="padding: 5px;"><math>N_{21} = 0 \text{ daN}</math></td> </tr> <tr> <td style="border-right: 1px solid black; padding: 5px;"><math>V_{12} = 1000 \text{ daN}</math></td> <td style="padding: 5px;"><math>V_{21} = 1000 \text{ daN}</math></td> </tr> <tr> <td style="border-right: 1px solid black; padding: 5px;"><math>M_{12} = 0 \text{ daNm}</math></td> <td style="padding: 5px;"><math>M_{21} = 0 \text{ daNm}</math></td> </tr> </table> <p>Déplacements</p> <p><math>\omega_1 = -9.28 \cdot 10^{-3} \text{ rad}</math>      <math>\omega_2 = 9.28 \cdot 10^{-3} \text{ rad}</math></p>	$N_{12} = 0 \text{ daN}$	$N_{21} = 0 \text{ daN}$	$V_{12} = 1000 \text{ daN}$	$V_{21} = 1000 \text{ daN}$	$M_{12} = 0 \text{ daNm}$	$M_{21} = 0 \text{ daNm}$	 <p style="text-align: center;"><i>Section de la poutre IPE 100</i></p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; border-right: 1px solid black; padding: 5px;"><math>N^{\circ}_{12} = 0 \text{ daN}</math></td> <td style="padding: 5px;"><math>N^{\circ}_{21} = 0 \text{ daN}</math></td> </tr> <tr> <td style="border-right: 1px solid black; padding: 5px;"><math>V^{\circ}_{12} = 1000 \text{ daN}</math></td> <td style="padding: 5px;"><math>V^{\circ}_{21} = 1000 \text{ daN}</math></td> </tr> <tr> <td style="border-right: 1px solid black; padding: 5px;"><math>M^{\circ}_{12} = 333.33 \text{ daNm}</math></td> <td style="padding: 5px;"><math>M^{\circ}_{21} = -333.33 \text{ daNm}</math></td> </tr> </table>	$N^{\circ}_{12} = 0 \text{ daN}$	$N^{\circ}_{21} = 0 \text{ daN}$	$V^{\circ}_{12} = 1000 \text{ daN}$	$V^{\circ}_{21} = 1000 \text{ daN}$	$M^{\circ}_{12} = 333.33 \text{ daNm}$	$M^{\circ}_{21} = -333.33 \text{ daNm}$
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3/ Système à déplacement unitaire imposé en 1	4/ Système à déplacement unitaire imposé en 2												
 <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; border-right: 1px solid black; padding: 5px;"><math>N_{12} = 0</math></td> <td style="padding: 5px;"><math>N_{21} = 0</math></td> </tr> <tr> <td style="border-right: 1px solid black; padding: 5px;"><math>V_{12} = 53868.8 \text{ daN}</math></td> <td style="padding: 5px;"><math>V_{21} = -53868.8 \text{ daN}</math></td> </tr> <tr> <td style="border-right: 1px solid black; padding: 5px;"><math>M_{12} = 71825.09 \text{ daNm}</math></td> <td style="padding: 5px;"><math>M_{21} = 35912.6 \text{ daNm}</math></td> </tr> </table>	$N_{12} = 0$	$N_{21} = 0$	$V_{12} = 53868.8 \text{ daN}$	$V_{21} = -53868.8 \text{ daN}$	$M_{12} = 71825.09 \text{ daNm}$	$M_{21} = 35912.6 \text{ daNm}$	 <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; border-right: 1px solid black; padding: 5px;"><math>N_{12} = 0 \text{ daN}</math></td> <td style="padding: 5px;"><math>N_{21} = 0 \text{ daN}</math></td> </tr> <tr> <td style="border-right: 1px solid black; padding: 5px;"><math>V_{12} = 53868.8 \text{ daN}</math></td> <td style="padding: 5px;"><math>V_{21} = -53868.8 \text{ daN}</math></td> </tr> <tr> <td style="border-right: 1px solid black; padding: 5px;"><math>M_{12} = 35912.6 \text{ daNm}</math></td> <td style="padding: 5px;"><math>M_{21} = 71825.09 \text{ daNm}</math></td> </tr> </table>	$N_{12} = 0 \text{ daN}$	$N_{21} = 0 \text{ daN}$	$V_{12} = 53868.8 \text{ daN}$	$V_{21} = -53868.8 \text{ daN}$	$M_{12} = 35912.6 \text{ daNm}$	$M_{21} = 71825.09 \text{ daNm}$
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5/ Proportionnalités dans un système élastique linéaire													
 <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; border-right: 1px solid black; padding: 5px;"><math>N_{12}</math></td> <td style="padding: 5px;"><math>N_{21}</math></td> </tr> <tr> <td style="border-right: 1px solid black; padding: 5px;"><math>V_{12}</math></td> <td style="padding: 5px;"><math>V_{21}</math></td> </tr> <tr> <td style="border-right: 1px solid black; padding: 5px;"><math>M_{12}</math></td> <td style="padding: 5px;"><math>M_{21}</math></td> </tr> </table>	$N_{12}$	$N_{21}$	$V_{12}$	$V_{21}$	$M_{12}$	$M_{21}$	 <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; border-right: 1px solid black; padding: 5px;"><math>K N_{12}</math></td> <td style="padding: 5px;"><math>K N_{21}</math></td> </tr> <tr> <td style="border-right: 1px solid black; padding: 5px;"><math>K V_{12}</math></td> <td style="padding: 5px;"><math>K V_{21}</math></td> </tr> <tr> <td style="border-right: 1px solid black; padding: 5px;"><math>K M_{12}</math></td> <td style="padding: 5px;"><math>K M_{21}</math></td> </tr> </table>	$K N_{12}$	$K N_{21}$	$K V_{12}$	$K V_{21}$	$K M_{12}$	$K M_{21}$
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6/ Superposition des systèmes	
	$= \omega_1 \left( \text{Diagram 3} \right) + \omega_2 \left( \text{Diagram 4} \right) + \text{Diagram 2}$
$N_{12} = 0 \text{ daN}$ $V_{12} = 1000 \text{ daN}$ $M_{12} = 0 \text{ daNm}$	$= \omega_1 \begin{bmatrix} N_{12} = 0 \\ V_{12} = 53868.8 \text{ daN} \\ M_{12} = 71825.09 \text{ daNm} \end{bmatrix} + \omega_2 \begin{bmatrix} N_{12} = 0 \text{ daN} \\ V_{12} = 53868.8 \text{ daN} \\ M_{12} = 35912.6 \text{ daNm} \end{bmatrix} + \begin{bmatrix} N^{\circ}_{12} = 0 \text{ daN} \\ V^{\circ}_{12} = 1000 \text{ daN} \\ M^{\circ}_{12} = 333.33 \text{ daNm} \end{bmatrix}$
$N_{21} = 0 \text{ daN}$ $V_{21} = 2000 \text{ daN}$ $M_{21} = 0 \text{ daNm}$	$= \omega_1 \begin{bmatrix} N_{21} = 0 \\ V_{21} = -51868.8 \text{ daN} \\ M_{21} = 35912.6 \text{ daNm} \end{bmatrix} + \omega_2 \begin{bmatrix} N_{21} = 0 \text{ daN} \\ V_{21} = -51868.8 \text{ daN} \\ M_{21} = 71825.0 \text{ daNm} \end{bmatrix} + \begin{bmatrix} N^{\circ}_{21} = 0 \text{ daN} \\ V^{\circ}_{21} = 2000 \text{ daN} \\ M^{\circ}_{21} = 333.33 \text{ daNm} \end{bmatrix}$

7/ On vérifie les équations intrinsèques du système ( à quelques % près )					
Au nœud 1	Avec déplacements imposés		Au nœud 2	Avec déplacements imposés	
	en 1↓	en 2↓		en 1↓	en 2↓
$N_{12} = \omega_1 N_{12} + \omega_2 N_{12} + N^{\circ}_{12}$			$N_{21} = \omega_1 N_{21} + \omega_2 N_{21} + N^{\circ}_{21}$		
$V_{12} = \omega_1 V_{12} + \omega_2 V_{12} + V^{\circ}_{12}$			$V_{21} = \omega_1 V_{21} + \omega_2 V_{21} + V^{\circ}_{21}$		
$M_{12} = \omega_1 M_{12} + \omega_2 M_{12} + M^{\circ}_{12}$			$M_{21} = \omega_1 M_{21} + \omega_2 M_{21} + M^{\circ}_{21}$		