Soluzione del telaio secondo il Metodo degli Spostamenti (MdS)

à Dati Numerici

```
Clear@EqD;
```

ü Dati Generali

```
L1 = 400;
L2 = 600;
H = 300;
q = 50;
```

```
F = q H
EIt = 288480 30 50^3 ê 12
EIp = 288480 30 30^3 ê 12
KP = N@2050000 Pi 3^2 ê 4 ê Sqrt@L1^2 + H^2DD
Omega = N@ArcTan@H ê L1DD
```

```
15000
```

```
90150000000
```

```
19472400000
```

```
28981.2
```

```
0.643501
```

ü Asta AD

```
WAD = 4 EIp ê H
WDA = 4 EIp ê H
VAD = 2 EIp ê H
VDA = VAD
UAD = 6 EIp ê H^2
UDA = 6 EIp ê H^2
MuAD = 0
MuDA = 0
```

```
259632000
```

```
259632000
```

```
129816000
```

```
129816000
```

```
1298160
```

```
1298160
```

```
0
```

```
0
```

ü Asta BE

```
WBE = 0
WEB = 3 EIp ê H
VBE = 0
VEB = VBE
UBE = 3 EIp ê H^2
UEB = 3 EIp ê H^2
MuBE = 0
MuEB = 0
```

```
0
```

```
194724000
```

```
0
```

```
0
```

```
649080
```

```
649080
```

```
0
```

```
0
```

ü Asta CG

```
WCG = 4 EIp ê H
WGC = 4 EIp ê H
VCG = 2 EIp ê H
VGC = VCG
UCG = 6 EIp ê H^2
UGC = 6 EIp ê H^2
MuCG = 0
MuGC = 0
```

259632000

259632000

129816000

129816000

1298160

1298160

0

0

ü Asta DE

```
WDE = 4 EIt ê L1
WED = 4 EIt ê L1
VDE = 2 EIt ê L1
VED = VDE
UDE = 6 EIt ê L1^2
UED = 6 EIt ê L1^2
MuDE = -q L1^2 ê 12
MuED = q L1^2 ê 12
```

901500000

901500000

450750000

450750000

3380625

3380625

$-\frac{2000000}{3}$

$\frac{2000000}{3}$

ü Asta EG

```
WEG = 4 EIt ê L2
WGE = 4 EIt ê L2
VEG = 2 EIt ê L2
VGE = VEG
UEG = 6 EIt ê L2^2
UGE = 6 EIt ê L2^2
MuEG = -q L2^2 ê 12
MuGE = q L2^2 ê 12
```

```
601000000
```

```
601000000
```

```
300500000
```

```
300500000
```

```
1502500
```

```
1502500
```

```
-1500000
```

```
1500000
```

à Incognite

```
Incognite = 8FiD, FiE, FiG, Delta<;
```

à Equazioni

```
Eq = Table@0, 8i, 1, 4<D;
```

ü Equazioni di Equilibrio alla rotazione dei nodi

```
Eq@@1DD = MDA + MDE;
Eq@@2DD = MEB + MED + MEG;
Eq@@3DD = MGE + MGC;
```

ü Equazioni di Equilibrio Globale alla traslazione

```
Eq@@4DD = -HHMDA + MADL ê H + MEB ê H + HMCG + MGCL ê H + F - XE Cos@OmegaDL;
```

ü Definizione delle rotazioni in funzione dei momenti

```
MAD = VAD FiD − UAD Delta;
MDA = WDA FiD − UDA Delta;
MBE = 0;
MEB = WEB FiE − UEB Delta;
MCG = VCG FiG − UCG Delta;
MGC = WGC FiG − UGC Delta;
MDE = WDE FiD + VDE FiE + MuDE;
MED = WED FiE + VED FiD + MuED;
MEG = WEG FiE + VEG FiG + MuEG;
MGE = WGE FiG + VGE FiE + MuGE;
```

ü Relazione tra Spostemeto e Forza del Pendolo

```
XE = KP Delta Cos@OmegaD;
```

à Soluzione del sistema

```
Eq
```

$$\left\{-\frac{2000000}{3} - 1298160\,\text{Delta} + 1161132000\,\text{FiD} + 450750000\,\text{FiE},\right.$$
$$-\frac{2500000}{3} - 649080\,\text{Delta} + 450750000\,\text{FiD} + 1697224000\,\text{FiE} + 300500000\,\text{FiG},$$
$$1500000 - 1298160\,\text{Delta} + 300500000\,\text{FiE} + 860632000\,\text{FiG},$$
$$-15000 + 18548.\,\text{Delta} + \frac{1}{300}\left(2596320\,\text{Delta} - 389448000\,\text{FiD}\right) +$$
$$\left.\frac{1}{300}\left(649080\,\text{Delta} - 194724000\,\text{FiE}\right) + \frac{1}{300}\left(2596320\,\text{Delta} - 389448000\,\text{FiG}\right) = 0\right\}$$

```
K = Table@Table@Coefficient@Eq@@iDD, Incognite@@jDDD, 8j, 1, 4<D, 8i, 1, 4<D;
MatrixForm@KD
```

$$\begin{pmatrix} 1161132000 & 450750000 & 0 & -1298160 \\ 450750000 & 1697224000 & 300500000 & -649080 \\ 0 & 300500000 & 860632000 & -1298160 \\ -1298160 & -649080 & -1298160 & 38020.4 \end{pmatrix}$$

```
Q = Simplify@−MatrixForm@Eq ê. 8FiD → 0, FiE → 0, FiG → 0, Delta → 0<DD
```

$$\begin{pmatrix} -\frac{2000000}{3} \\ -\frac{2500000}{3} \\ 1500000 \\ -15000 \end{pmatrix}$$

```
Sol = Solve@Eq « 0, IncogniteD êê Flatten
```

```
8FiD → 0.000734337, FiE → 0.000691545, FiG → −0.00140606, Delta → 0.383396<
```

ü Calcolo dei momenti nodali

```
MADSol = MAD ê. Sol
MDASol = MDA ê. Sol
MEBSol = MEB ê. Sol
MCGSol = MCG ê. Sol
MGCSol = MGC ê. Sol
MDESol = MDE ê. Sol
MRDSol = MED ê. Sol
MEGSol = MEG ê. Sol
MGESol = MGE ê. Sol
```

```
-402381.
```

```
-307052.
```

```
-114194.
```

```
-680239.
```

```
-862768.
```

```
307052.
```

$$1.6211 \times 10^{6}$$

$$-1.5069 \times 10^{6}$$

```
862768.
```