

Tubo

■ Base

```
In[1]:= Funzioni = {Exp[Alpha x] Sin[Alpha x], Exp[Alpha x] Cos[Alpha x],
                  Exp[-Alpha x] Sin[Alpha x], Exp[-Alpha x] Cos[Alpha x]}

Out[1]= {eAlpha x Sin[Alpha x], eAlpha x Cos[Alpha x], e-Alpha x Sin[Alpha x], e-Alpha x Cos[Alpha x]}

In[2]:= Costanti01 = {A1, A2, A3, A4}

Out[2]= {A1, A2, A3, A4}

In[3]:= Costanti02 = {B1, B2, B3, B4}

Out[3]= {B1, B2, B3, B4}

In[4]:= w01 = 0;
          w02 = gamma (h2 - x) / CoeffBeta;

General::spell1 : Possible spelling error: new symbol name "gamma" is similar to existing symbol "Gamma".
```

■ Espressione generale delle equazioni dei due tratti

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In[6]:= w1 = (Funzioni /. x → x1).Costanti01 + w01
          w2 = (Funzioni /. x → x2).Costanti02 + w02 /. x → x2

Out[6]= A4 e-Alpha x1 Cos[Alpha x1] + A2 eAlpha x1 Cos[Alpha x1] +
          A3 e-Alpha x1 Sin[Alpha x1] + A1 eAlpha x1 Sin[Alpha x1]

Out[7]= 
$$\frac{\text{gamma} (\text{h2}-\text{x2})}{\text{CoeffBeta}} + \text{B4} e^{-\text{Alpha x2}} \text{Cos}[\text{Alpha x2}] +$$

          B2 eAlpha x2 Cos[Alpha x2] + B3 e-Alpha x2 Sin[Alpha x2] + B1 eAlpha x2 Sin[Alpha x2]
```

■ Condizioni al contorno

```
In[8]:= eq1 = w2 /. x2 → 0;
          eq2 = D[w2, {x2, 2}] /. x2 → 0;;
          eq3 = (w2 /. x2 → h2) - (w1 /. x1 → 0);
          eq4 = (D[w2, x2] /. x2 → h2) - (D[w1, x1] /. x1 → 0);
          eq5 = (D[w2, {x2, 2}] /. x2 → h2) - (D[w1, {x1, 2}] /. x1 → 0);
          eq6 = (D[w2, {x2, 3}] /. x2 → h2) - (D[w1, {x1, 3}] /. x1 → 0);
          eq7 = D[w1, {x1, 2}] /. x1 → h1;
          eq8 = D[w1, {x1, 3}] /. x1 → h1;
```

```
In[16]:= Equations = {eq1, eq2, eq3, eq4, eq5, eq6, eq7, eq8};
```

```
In[17]:= Incognite = Join[Costanti01, Costanti02]
```

```
Out[17]= {A1, A2, A3, A4, B1, B2, B3, B4}
```

■ Valori Numerici

```
In[18]:= R = 1000;
s = 50;
h2 = 6000;
h1 = 4000;
ModE = 210000;
CoeffNi = 0.3;
gamma = N[10000 / 1000000000];

General::spell :
Possible spelling error: new symbol name "ModE" is similar to existing symbols {Mod, Mode}.

In[25]:= CoeffBeta = ModE s / R^2;
ModD = ModE / (1 - CoeffNi^2) s^3 / 12;
Alpha = Sqrt[Sqrt[CoeffBeta / (4 ModD)]];

General::spell :
Possible spelling error: new symbol name "ModD" is similar to existing symbols {Mod, ModE}.

In[28]:= Equations
```

Out[28]= {0.00571429 + B2 + B4, 0.0000660908 B1 - 0.0000660908 B3, -A2 - A4 + 6.32899 × 10¹³ B1 - 9.51329 × 10¹⁴ B2 + 6.96233 × 10⁻¹⁷ B3 - 1.04653 × 10⁻¹⁵ B4, -9.52381 × 10⁻⁷ - 0.00574851 A1 - 0.00574851 A2 - 0.00574851 A3 + 0.00574851 A4 - 5.10491 × 10¹² B1 - 5.83255 × 10¹² B2 - 6.41622 × 10⁻¹⁸ B3 + 5.61576 × 10⁻¹⁸ B4, -0.0000660908 A1 + 0.0000660908 A3 - 6.28741 × 10¹⁰ B1 - 4.18288 × 10⁹ B2 + 6.9166 × 10⁻²⁰ B3 + 4.60146 × 10⁻²¹ B4, -3.79924 × 10⁻⁷ A1 + 3.79924 × 10⁻⁷ A2 - 3.79924 × 10⁻⁷ A3 - 3.79924 × 10⁻⁷ A4 - 3.85478 × 10⁸ B1 + 3.37388 × 10⁸ B2 - 3.7115 × 10⁻²² B3 - 4.24053 × 10⁻²² B4, -344347. A1 + 539738. A2 + 3.66952 × 10⁻¹⁵ A3 - 5.7517 × 10⁻¹⁵ A4, 1123.21 A1 + 5082.17 A2 - 5.41581 × 10⁻¹⁷ A3 + 1.19694 × 10⁻¹⁷ A4}

```
In[29]:= Sol = Solve[Equations == 0, Incognite] // Flatten

RowReduce::luc :
Result for RowReduce of badly conditioned matrix <> may contain significant numerical errors.

Out[29]= {A1 → -1.46903 × 10-24, A2 → -2.14255 × 10-25, A3 → -0.0000414186, A4 → 0.0000414186, B1 → -4.0462 × 10-20, B2 → -4.62294 × 10-20, B3 → -4.0462 × 10-20, B4 → -0.00571429}
```

```
In[30]:= w1Sol = Simplify[w1 /. Sol]
w2Sol = Simplify[w2 /. Sol]

Out[30]= e-0.00574851 x1 ((0.0000414186 - 2.14255 × 10-25 e0.011497 x1) Cos[0.00574851 x1] - 1.46903 × 10-24 (2.81945 × 1019 + 1. e0.011497 x1) Sin[0.00574851 x1])

Out[31]= e-0.00574851 x2 (-9.52381 × 10-7 e0.00574851 x2 (-6000. + 1. x2) + (-0.00571429 - 4.62294 × 10-20 e0.011497 x2) Cos[0.00574851 x2] + (-4.0462 × 10-20 - 4.0462 × 10-20 e0.011497 x2) Sin[0.00574851 x2])
```

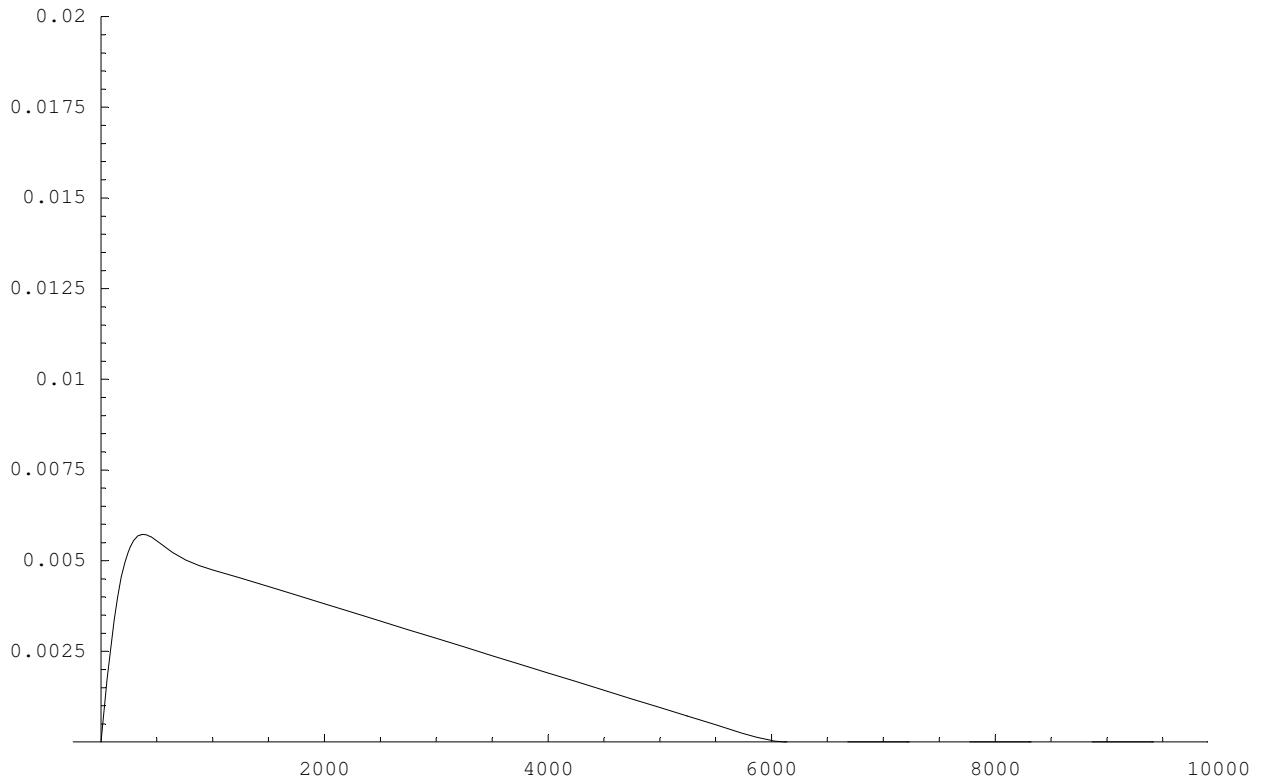
```
In[32]:= w1SolGlob = w1Sol /. x1 → x - h2
w2SolGlob = w2Sol /. x2 → x

Out[32]= e-0.00574851 (-6000+x)
((0.0000414186 - 2.14255×10-25 e0.011497 (-6000+x)) Cos[0.00574851 (-6000 + x)] -
1.46903×10-24 (2.81945×1019 + 1. e0.011497 (-6000+x)) Sin[0.00574851 (-6000 + x)])

Out[33]= e-0.00574851 x
(-9.52381×10-7 e0.00574851 x (-6000. + 1. x) + (-0.00571429 - 4.62294×10-20 e0.011497 x)
Cos[0.00574851 x] + (-4.0462×10-20 - 4.0462×10-20 e0.011497 x) Sin[0.00574851 x])
```

■ Andamento degli spostamenti

```
In[34]:= Show[Plot[w2SolGlob, {x, 0, h2}, PlotRange -> {0, 0.02}],
Plot[w1SolGlob, {x, h2, h1 + h2}, PlotRange -> {0, 0.02}]]
```

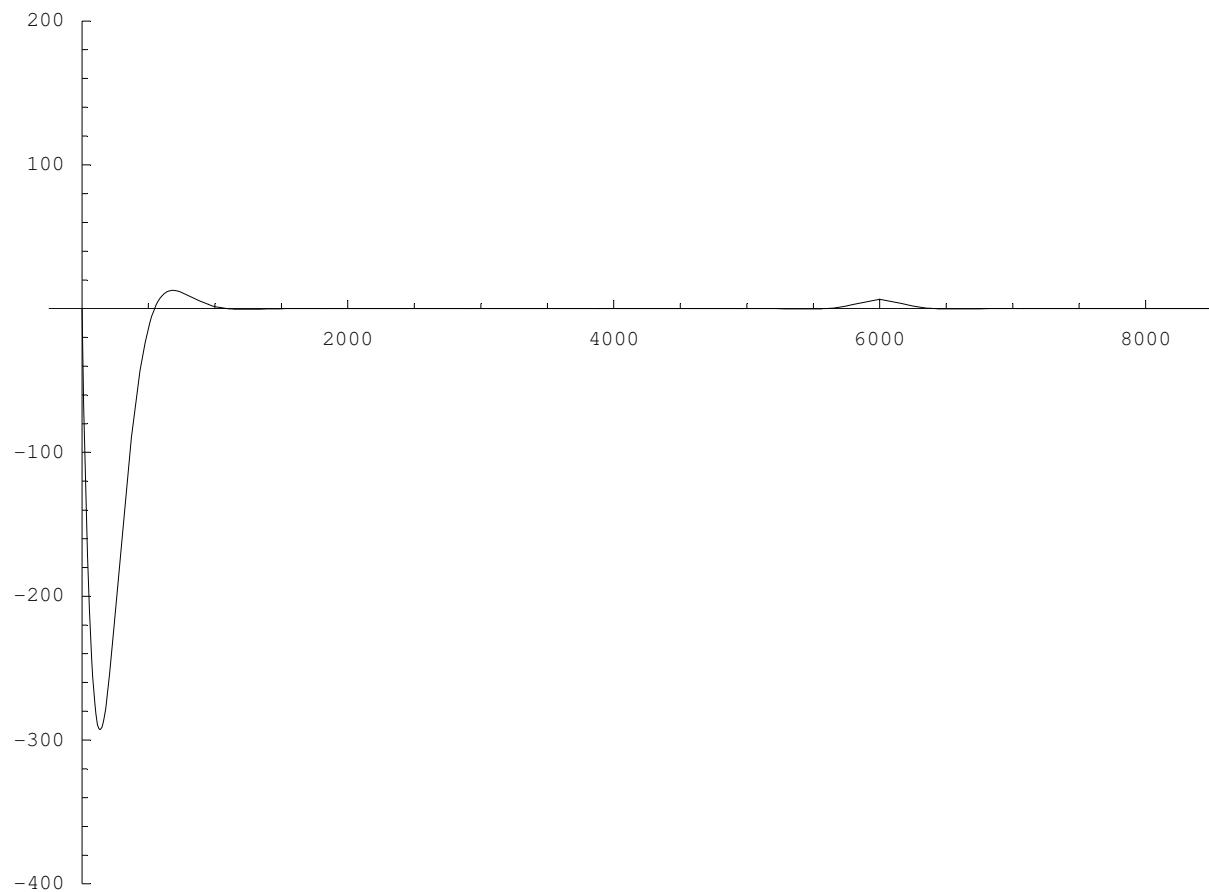


```
Out[34]= - Graphics -
```

■ Andamento dei momenti flettenti

```
In[35]:= M2SolGlob = ModD D[w2SolGlob, {x, 2}];
M1SolGlob = ModD D[w1SolGlob, {x, 2}];
```

```
In[38]:= Show[Plot[M2SolGlob, {x, 0, h2}, PlotRange -> {-400, 200}],
  Plot[M1SolGlob, {x, h2, h1 + h2}, PlotRange -> {-200, 200}]]
```



```
Out[38]= - Graphics -
```