“SLENDER” BEAM THEORY

- $L/D > 10$
- $y/L < 100$
- Ideal loading
WHAT MATTERS?

1. 
2. 
3. 
4.
WHAT MATTERS?

1. Load
2. Elasticity
3. Geometry
4. Boundary conditions
load

geometry

boundary conditions

elasticity

\[ y = \frac{PL^3}{3EI} \]
Geometry

\[ I = \int y^2 \, dA \]

\[ I = \frac{bh^3}{12} \]

\[ I = \frac{\pi D^4}{64} \]
## Elasticity (material)

<table>
<thead>
<tr>
<th>Material</th>
<th>E ($10^6$ psi)</th>
<th>Density (lb/in$^3$)</th>
<th>Yield strength (kpsi)</th>
<th>Cost ($/lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum</td>
<td>10.4</td>
<td>0.10</td>
<td>11</td>
<td>0.60</td>
</tr>
<tr>
<td>Steel, low-strength</td>
<td>30.0</td>
<td>0.28</td>
<td>26</td>
<td>0.40</td>
</tr>
<tr>
<td>Steel, high-strength</td>
<td>30.0</td>
<td>0.28</td>
<td>75</td>
<td>1.00</td>
</tr>
<tr>
<td>Plastic, ABS</td>
<td>0.3</td>
<td>0.04</td>
<td>6</td>
<td>0.10</td>
</tr>
</tbody>
</table>
Boundary conditions

- Free
- Simple
- Pin
- Clamp
Yardstick expt

\[ y = \frac{PL^3}{48EI} \]

\[ E = \frac{L^3}{48I} \left( \frac{P}{y} \right) \]

<table>
<thead>
<tr>
<th>P</th>
<th>y1</th>
<th>y2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

slope = \frac{y}{P}