

Parameters

```
In[1]:= width = 60; thickness = 0.15; density = 0.3; modulus = 30 000; load = 66;
```

Intermediates

```
In[2]:= leng =  $\sqrt{\left(\frac{\text{width}}{2}\right)^2 + \text{height}^2}$  ;
```

```
In[3]:= area =  $\pi * \text{diameter} * \text{thickness}$ ;
```

```
In[4]:= iovera =  $\frac{\text{diameter}^2 + \text{thickness}^2}{8}$  ;
```

```
In[5]:= stress =  $\frac{\text{load} * \text{leng}}{2 * \text{area} * \text{height}}$  ;
```

```
In[6]:= buckling =  $\frac{\pi^2 * \text{modulus} * \text{iovera}}{\text{leng}^2}$  ;
```

```
In[7]:= deflection =  $\frac{\text{load} * \text{leng}^3}{2 * \text{modulus} * \text{area} * \text{height}^2}$  ;
```

Equations

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In[8]:= weight = 2 * density * area * leng;
```

Optimization

```
In[9]:= Timing @
```

```
FindMinimum[{weight, weight ≤ 24, stress ≤ 100, stress ≤ buckling, deflection ≤ 0.25`,  
10 ≤ height ≤ 50, 1 ≤ diameter ≤ 4}, {{height, 10}, {diameter, 3}}]
```

```
Out[9]= {0.078001, {15.8683, {height → 14.2149, diameter → 1.69057}}}
```

Graphics

```
In[10]:= p1 = RegionPlot[stress ≤ 100 && deflection ≤ 0.25 && stress - buckling ≤ 0,  
{height, 10, 30}, {diameter, 1, 2.8}, Frame → True,  
FrameLabel → {"Height", "Diameter"}];
```

```
In[11]:= p2 = ContourPlot[weight, {height, 10, 30},  
{diameter, 1, 2.8}, ContourShading → None, ContourLabels → All];
```

In[12]:= Show[p1, p2]

