

# SHAFTING, HOLLOW vs. SOLID

$$\text{SECTION MODULUS} = \frac{I}{c}$$

Where  $I$  = Moment of Inertia

$c$  = Distance to extreme fiber

*Hollow Shaft* : O.D.= 6.625", I.D. = 5.761" (6" Sch40) 28.57 pounds/ft

$$\text{Moment of inertia for hollow shaft} = 0.049087 \times (OD^4 - ID^4) = 40.4904$$

$$\text{Section modulus for hollow shaft} = \frac{0.049087 \times (OD^4 - ID^4) \times 2}{OD} = 12.2$$

*4.99" dia. Solid Shaft: 66.65 pounds/ft*

$$\text{Moment of inertia for 4.99" solid shaft} = 0.785398 \times R^4 = 30.4349$$

$$\text{Section modulus for 4.99" solid shaft} = \frac{0.785398 \times R^4}{R} = 12.2$$

**(57% material savings for the same section modulus)**

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## DEFLECTION

Deflection on simple cantilevered beam:

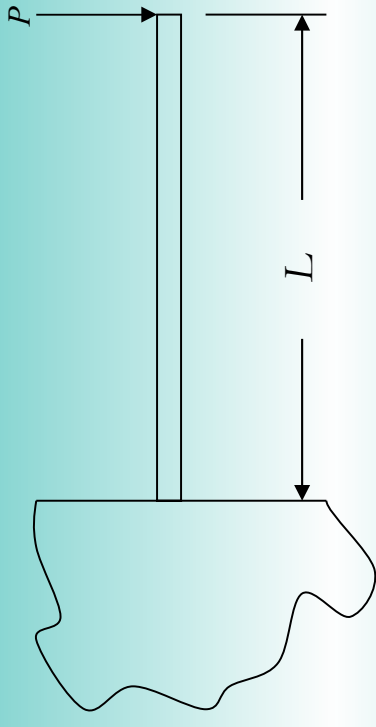
$$\text{Max Deflection} = \frac{Pl^3}{3EI}$$

Where  $P = 50$  lbs

$L = 100$  inches

$E = 30,000,000$  psi

$I =$  Moment of Inertia inches<sup>4</sup>



$$\text{Hollow Shaft Deflection} = \frac{50\text{lbs} \times 100^3 \text{ in}}{3 \times 30,000,000 \times 40.4904} = 0.01372''$$

$$4.99'' \text{ Solid Deflection} = \frac{50\text{lbs} \times 100^3 \text{ in}}{3 \times 30,000,000 \times 30.4349}$$

**= 0.01825''**  
**(33% more deflection)**