Earlier in this section it was stated that "When comparing a solid shaft with a hollow shaft of equal section modulus, both will transmit the torque with equal stress levels, but the hollow shaft will be stiffer, or rather will deflect less under the same overhung moment". The following is an engineering analysis to support this statement:

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"

Moment of inertia for hollow shaft = $0.049087 \times \left(OD^4 - ID^4\right)$ = 40.4904

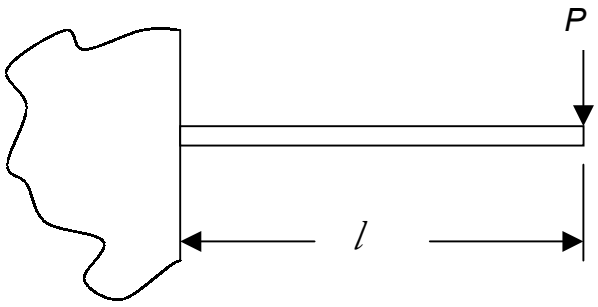
Section modulus for hollow shaft = $\frac{0.049087 \times \left(OD^4 - ID^4\right) \times 2}{OD}$ = **12.2**

4.99" dia. Solid Shaft:

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

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

Deflection on simple cantilevered beam:



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

Where P= 50 lbs

l= 100 inches

E= 30,000,000

I= Moment of Inertia

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

4.99" Solid Deflection = $\frac{50lbs \times 100^3 in}{3 \times 30{,}000{,}000 \times 30.4349}$ = ***0.01825"***

(33% more deflection)

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