Given:

$\delta_{1d} := 0.000731747482870981 \cdot in$

$\delta_{2d} := 0.0013112914893048 \cdot in$

$\delta_{1r} := 0.000292698993148392 \cdot in$

$\delta_{2r} := 0.00043319450985962 \cdot in$

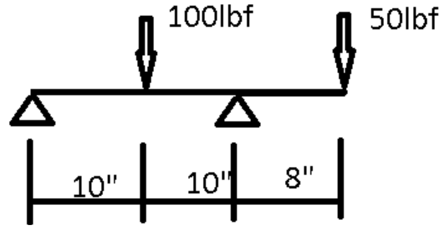
$w_1 := 100 \cdot lbf$

$w_2 := 50 \cdot lbf$

$E := 29 \cdot 10^3 \cdot ksi$

Deflections are determined from Excel Shaft Code, ME425 (d=Dunkerly, r=Rayleigh)
Dunkerly: Deflections for each mass calculated one by one on shaft (local)
Rayleigh: Deflections calculated at mass location with all masses attached at once (total)
See attached for deflection tables for each

Problem #6



Analysis:

"C:\Users\Chris\Desktop\Untitled.bmp"

b) Rayleigh Method

$$\omega_{nr} := \sqrt{\frac{g \cdot \left(w_1 \cdot \delta_{1r} + w_2 \cdot \delta_{2r}\right)}{\left(w_1 \cdot \delta_{1r}^{\,2} + w_2 \cdot \delta_{2r}^{\,2}\right)}} = 1046.634 Hz$$

$$\boxed{\omega_{nr} = 1046.634 Hz}$$

c) Dunkerly Method

$$\omega_{1d} := \sqrt{\frac{g}{\delta_{1d}}} = 726.378 Hz \qquad \omega_{2d} := \sqrt{\frac{g}{\delta_{2d}}} = 542.618 Hz$$

$$\omega_{nd} := \sqrt{\left(\omega_{1d}^{\,-2} + \omega_{2d}^{\,-2}\right)^{-1}} = 434.716 Hz$$

$$\boxed{\omega_{nd} = 434.716 Hz}$$

d) Suitable Operating Envelope

To avoid failure from occasional overloads, operate the shaft at a maximum of 80% of the first critical speed. Since Dunkerly's formula underestimates this speed already, choose this to be the proper value of the first critical speed and:

$$\omega_n := 0.8 \cdot \omega_{nd} = 3.321 \times 10^3 \cdot rpm \qquad \omega_{op} := \mathrm{Round}\left(\omega_n, 1000 rpm\right) = 3 \times 10^3 \cdot rpm$$

$$\boxed{\omega_{op} = 3000 \cdot rpm}$$