Energy Stored in a Flywheel

Inner and outer radius

$r_i := 12\ \mathbf{mm} \qquad r_o := 200\ \mathbf{mm}$

Thickness of flywheel

$t := 50\ \mathbf{mm}$

Material density and Poisson's ratio

$\rho := 7.8\ \mathbf{Mg \cdot m^{-3}} \qquad v := 0.78$

Angular velocity of flywheel

$\omega := 5000\ \mathbf{rpm}$

Mass of flywheel

$m := \pi \cdot \rho \cdot \left(r_o^{\,2} - r_i^{\,2} \right) \cdot t = 48.832\ \mathbf{kg}$

Mass moment of inertia of flywheel

$I_m := \frac{m}{2} \cdot \left(r_o^{\,2} + r_i^{\,2} \right) = 0.980\ \mathbf{kg \cdot m^2}$

Energy stored in a ring-shaped flywheel

$E := \frac{1}{2} \cdot I_m \cdot \omega^2 = 134.359\ \mathbf{kJ}$

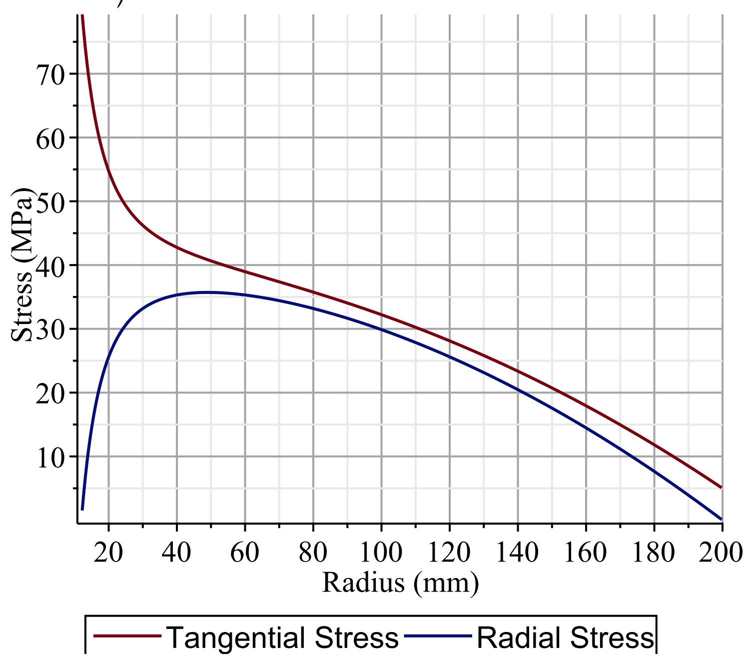
$E = 37.322\ \mathbf{W\ h}$

Tangential and radial components of stress

$$\sigma_t := r \to \rho \cdot \omega^2 \cdot \frac{3+v}{8} \cdot \left(r_i^{\,2} + r_o^{\,2} + \frac{r_i^{\,2} \cdot r_o^{\,2}}{r^2} - \frac{1+3\cdot v}{3+v} \cdot r^2 \right)$$

$$\sigma_r := r \to \rho \cdot \omega^2 \cdot \frac{3+v}{8} \cdot \left(r_i^{\,2} + r_o^{\,2} - \frac{r_i^{\,2} \cdot r_o^{\,2}}{r^2} - r^2 \right)$$

plot$\left(\left[\sigma_t(r), \sigma_r(r) \right], r = r_i .. r_o, \right.$ useunits = [mm, MPa],
labels = ["Radius (mm)", "Stress (MPa)"],
labeldirections = ["horizontal", "vertical"],
legend = ["Tangential Stress", "Radial Stress"],
gridlines) =



Peak stress

$$\sigma_t(r_i) = 80.849 \text{ MPa}$$