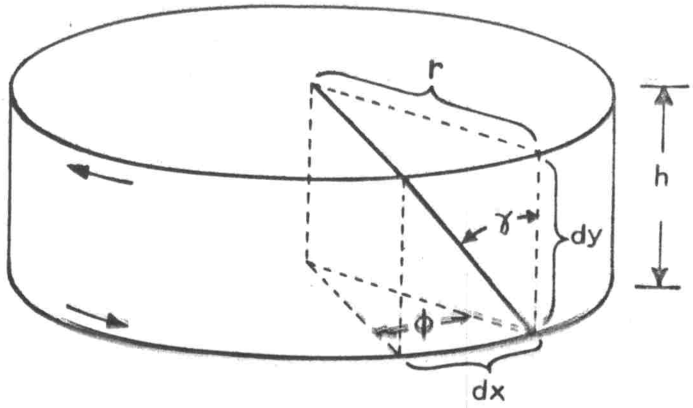

FOR TORSIONAL STRAIN γ,

$$\tan \gamma = \frac{dx}{dy} ,$$

OR, TO A FIRST APPROXIMATION,

$$\gamma = r_m \frac{\phi}{h} ,$$

WHERE r_m IS THE LIMITING RADIUS.

SUBSTITUTING ω FOR $\frac{\phi}{h}$, AND DEFINING TORSIONAL SHEAR STRENGTH AS,

$$\tau = G \gamma ,$$

WHERE G IS THE MODULUS OF RIGIDITY,

WE HAVE

$$\tau_{max.} = G \omega r_m .$$

THE MOMENT ABOUT THE DISK AXIS IS

$$M = \tau \, dA \, r ,$$

$$= G \omega r^2 dA .$$

TAKING THE MOMENT OVER THE CROSS SECTION OF THE DISK,

WE HAVE

$$M = 2\pi \int_0^{r_m} G \omega r^3 dr .$$

SUBSTITUTING $\tau = G \omega r$,

$$M = 2\pi \int_0^{r_m} \tau r^2 dr ,$$

$$M = \frac{2\pi r^3 \tau}{3} ,$$

AND $\tau_m = \frac{3M}{2\pi r^3}$.

$$M = \frac{\pi G \omega r_m^4}{2} .$$

SUBSTITUTING $\tau = G \omega r$.,

$$M = \frac{\pi \tau r^3}{2} ,$$

AND $\tau_m = \frac{2M}{\pi r^3}$.