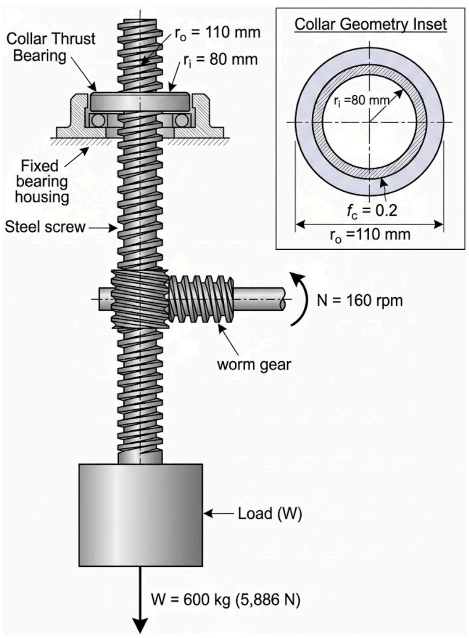


**Axial Load (W):** 600kg
**Outside Radius ($r_o$):** 110mm= 0.11 m
**Inside Radius ($r_i$):** 80mm = 0.08 m
**Coefficient of Collar Friction ($f_c$):** 0.20
**Rotational Speed (N):** 160 rpm

**Step 1: Convert Mass to Axial Force (Weight)**

In engineering mechanics, formulas for friction torque and power require load inputs in terms of force (Newtons) rather than mass (kilograms). Using the standard acceleration due to gravity, $g_o = 9.81\ \frac{m}{s^2}$, we compute the acting axial force:

$$W = m\frac{g_o}{g_c} = (600\ kg)\left(\frac{9.81\ \frac{m}{s^2}}{1\ \frac{kg-m}{N-s^2}}\right) = 5,886\ N = 5.886\ kN$$

**Step 2: Determine the Mean Collar Diameter ($D_C$)**

Collar thrust bearings generally operate under the assumption of **Uniform Wear** for broken-in surfaces (the standard design assumption unless "uniform pressure" is explicitly specified). Under the uniform wear theory, the effective friction radius is equal to the mean radius of the collar:

$$R_C = \frac{r_o + r_i}{2}$$

Correspondingly, the collar mean diameter (**$D_C$**) is simply the sum of the inner and outer radii:

$$D_C = r_o + r_i = (0.11 + 0.08)m = 0.19\ m$$

**<u>Step 3:</u> Calculate the Friction Torque ($T_C$)**

The torque required to overcome friction on a flat collar is given by:

$$T_C = W\frac{D_C}{2}f_C = (5.886\ kN)\left(\frac{0.19\ m}{2}\right)(0.20) = 0.11183\ kN - m$$

**<u>Step 4:</u> Compute Friction Power in Kilowatts**

Rotational power (P) is derived from torque and angular velocity:

$$P = \frac{2\pi\, T_C N}{60} = \frac{2\pi\,(0.11183\ kN-m)(160\ rpm)}{60} = 1.8737\ kW$$

**<u>Step 5</u>: Convert Power to Horsepower (hp)**

To match standard board exam conventions, we convert metric power (kW) to mechanical horsepower (hp) using the standard conversion factor (1 hp = 0.746 kW):

$$Friction\ Horsepower\ (FHP) = (1.8737\ kW)\left(\frac{1\ hp}{0.746\ kW}\right) = 2.5117\ hp$$

A loss of 2.5 hp purely to collar friction represents wasted energy that dissipates entirely as heat. In a closed machine system, this heat will raise the temperature of the lubricant, lowering its viscosity and risking accelerated wear.

To reduce this power loss in practical applications, designers can use three main approaches:

1. **Reduce collar contact area:** Decrease the mean diameter ($D_C$) where structurally permissible.
2. **Improve lubrication:** Use active oil circulation or extreme-pressure additives to lower $f_C$.
3. **Upgrade the bearing type:** Replace the sliding collar thrust bearing with a rolling-element thrust bearing (e.g., ball or roller thrust bearings), which reduces the coefficient of friction by up to an order of magnitude.