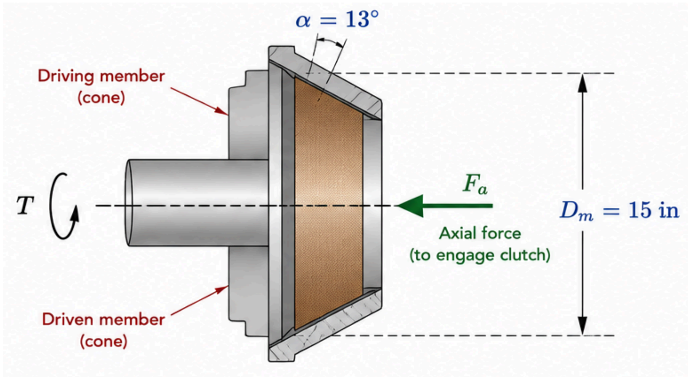

<u>Step 1:</u> Calculate the Transmitted Torque (T)

The power delivered by the engine and its rotational speed dictate the torsional moment traveling through the clutch. In US Customary Units, the relationship between horsepower, torque (in lb-ft), and rotational speed is expressed as:

$$P = \frac{2\pi TN}{33{,}000}$$

$$20hp = \frac{2\pi T(1000\ rpm)}{33{,}000}$$

$$T = 105.0423\ lb - ft = 1{,}260.5076\ lb - in$$

<u>Step 2:</u> Determine the Normal Force (F_n) acting on the Cone Surface

The torque is transmitted across the conical interface via the normal clamping force and the resulting friction force acting at the mean radius:

$$T = fF_n r_m$$

$$1{,}260.5076\ lb - in = (0.20)F_n\left(\frac{15}{2}\ in\right)$$

$$F_n = 840.3384\ lbs$$

<u>Step 3:</u> Calculate the Axial Force (F_a)

Applying the exact algebraic structure provided in your reviewer reference:

$$F_a = F_n\left(\sin\alpha + \frac{f\cos\alpha}{4}\right) = 840.3384\ lbs\left(\sin 13^o + \frac{0.20\cos 13^o}{4}\right) = 229.975\ lbs$$

The core reason engineers select a cone clutch over a standard flat disc clutch is the mechanical leverage offered by the cone angle (α). By wrapping the friction surface into a wedge, the normal force (F_n) becomes significantly larger than the input axial force (F_a). This allows the system to transmit massive amounts of torque without requiring heavy actuating springs.

While a smaller cone angle reduces the required axial force even further, making α too small risks a hazardous condition called **self-locking**. If $tan\,\alpha \le f$, the clutch will jam together and refuse to disengage when the pedal or actuator is released. For this reason, practical mechanical designs rarely go below α = 8^{o} to 12^{o}