Part 2: Sizing the Belt Width (b)

Step 1: Evaluating the Tension Wrap Ratio

According to the Euler-Belting log-friction equation, the ratio of the active tight-side tension to the slack-side tension is exponentially bound by the coefficient of friction (f) and the angle of wrap (θ) expressed in radians.

First, convert the angle of wrap from degrees to radians:

$$\theta = \left(140^{o}\right)\left(\frac{\pi}{180^{o}}\right) = 2.4435\, rad$$

Now, compute the exponential friction wrap factor:

$$\frac{F_1}{F_2} = e^{f\theta} = e^{(0.30)(2.4435\, rad)} = 2.0814$$

$$F_2 = \frac{F_1}{2.0814}$$

Step 2: Isolating Tight-Side Tension (F_1)

We can now combine our tension ratio with our net effective force equation ($F_e = F_1 - F_2$) to isolate the absolute maximum tension load (F_1):

$$F_e = \left(F_1 - F_2\right)$$

$$1.972\, kN = \left(F_1 - \frac{F_1}{2.0814}\right)$$

$$F_1 = 3,795.15\, N$$

Step 3: Calculating Required Cross-Sectional Geometry

The highest normal tensile stress (S_t) occurs along the tight-side line (F_1). To ensure operational safety, this stress must not exceed the safe working limit of 2.0 MPa (2.0 N/mm^2). The required cross-sectional area (A) is:

$$A = \frac{F_1}{S_t} = \frac{3{,}795.15\, N}{2.0\, \frac{N}{mm^2}} = 1,897.58\, mm^2$$

Since a flat belt has a rectangular profile, its area equals its thickness (t = 7mm) multiplied by its width (b):

$$A = bt$$

$$1,897.58\ mm^2 = b\ (7mm)$$

$$b = 271\ mm$$

The wrap angle is a major factor in determining total power capacity. If this drive system were modified so that the belt only wrapped around 120° of the pulley instead of 140°, the friction factor would drop significantly. To safely carry the same 40 kW load under those conditions, the belt width would have to be increased to over **315 mm** to handle the extra tension required to prevent slipping

In actual industrial settings, engineers do not custom-order a belt machined to exactly 271 mm. Instead, they consult standard manufacturer catalogs and select the next highest nominal standard commercial width—which in this case would be **280 mm** or **300 mm**. This practical adjustment provides a built-in safety margin to protect against unexpected torque spikes during machine startup.