

Center-to-center calculation for power transmission belts

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Abstract

Belts are pretty easy to use and calculate the appropriate distances for. When this center distance is calculated and manufactured properly, they should not require adjustment.

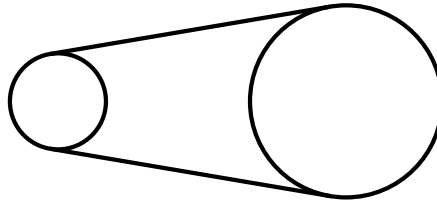


Figure 1: Belt and Sprockets

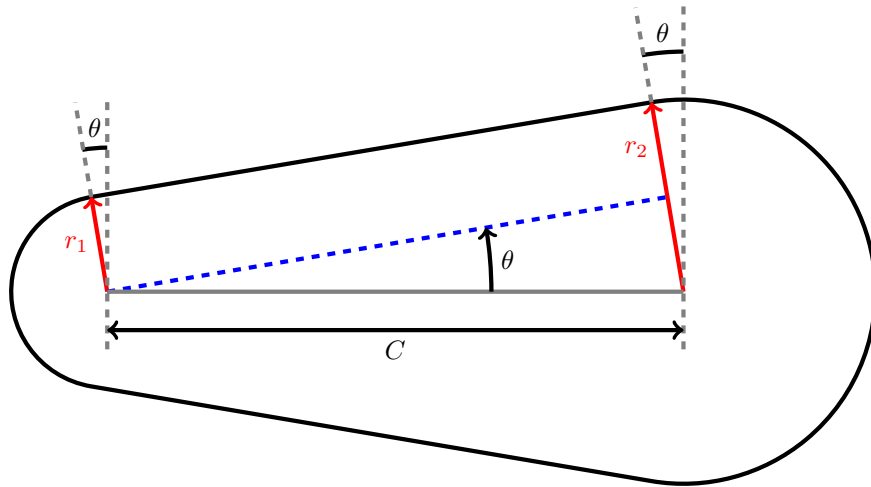


Figure 2: Belt Dimensions, Labeled

Quickly, the pitch radii and diameters of the pulleys are:

$$d_1 = 2r_1 \tag{1}$$

$$d_2 = 2r_2 \tag{2}$$

$$\sin(\theta) = \frac{r_2 - r_1}{C} \tag{3}$$

The total length of the pulley L can be expressed as:

$$L = 2 \langle \text{straight segment} \rangle + \langle \text{arc for pulley 1} \rangle + \langle \text{arc for pulley 2} \rangle$$

$$L = 2 \frac{C}{\cos(\theta)} + r_1(\pi - 2\theta) + r_2(\pi + 2\theta) \quad (4)$$

The trig identity for the cosine of an arcsine will be helpful:

$$\cos(\arcsin(x)) = \sqrt{1 - x^2} \quad (5)$$

Putting this all together lets us determine the total belt length in terms of pitch diameters d_1 , d_2 , and the center-center distance C :

$$L = \frac{2C}{\sqrt{1 - (\frac{d_2 - d_1}{2C})^2}} + \frac{d_1}{2}(\pi - 2\theta) + \frac{d_2}{2}(\pi + 2\theta) \quad (6)$$

This equation isn't easy to analytically solve for C in terms of d_1 , d_2 , and L . WolframAlpha yields a solution, though it is quite atrocious. I found that it's best to use a numeric algorithm (such as bisection, which my calculator uses).

The same approach can be taken with a crossed drive belt (which is used in order to reverse direction of rotation).

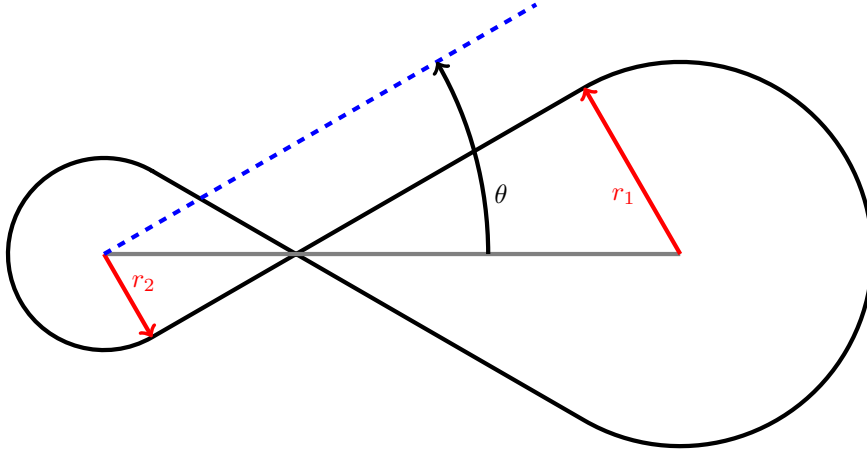


Figure 3: Belt Dimensions, Labeled

The belt angle now is

$$\sin(\theta) = \frac{r_2 + r_1}{C} \quad (7)$$

$$L = 2 \frac{C}{\cos(\theta)} + r_1(\pi + 2\theta) + r_2(\pi + 2\theta) \quad (8)$$

Resulting in:

$$L = \frac{2C}{\sqrt{1 - (\frac{d_2 + d_1}{2C})^2}} + \frac{d_1 + d_2}{2}(\pi + 2\theta) \quad (9)$$

Belt Strength Calculation

Belt strength is calculated from the tables in the Gates Light Power and Precision Manual.

These tables list allowable pulley torque $T(\omega, N)$ as a function of RPM ω and pulley teeth N . Note that 6 teeth should be in engagement. 2-D interpolation is used to determine values on the in-betweens. Tabulated values outside the bounds are extrapolated. Omitted values are presumed to be zero. The multiplier factors are used to determine strength of different width belts.