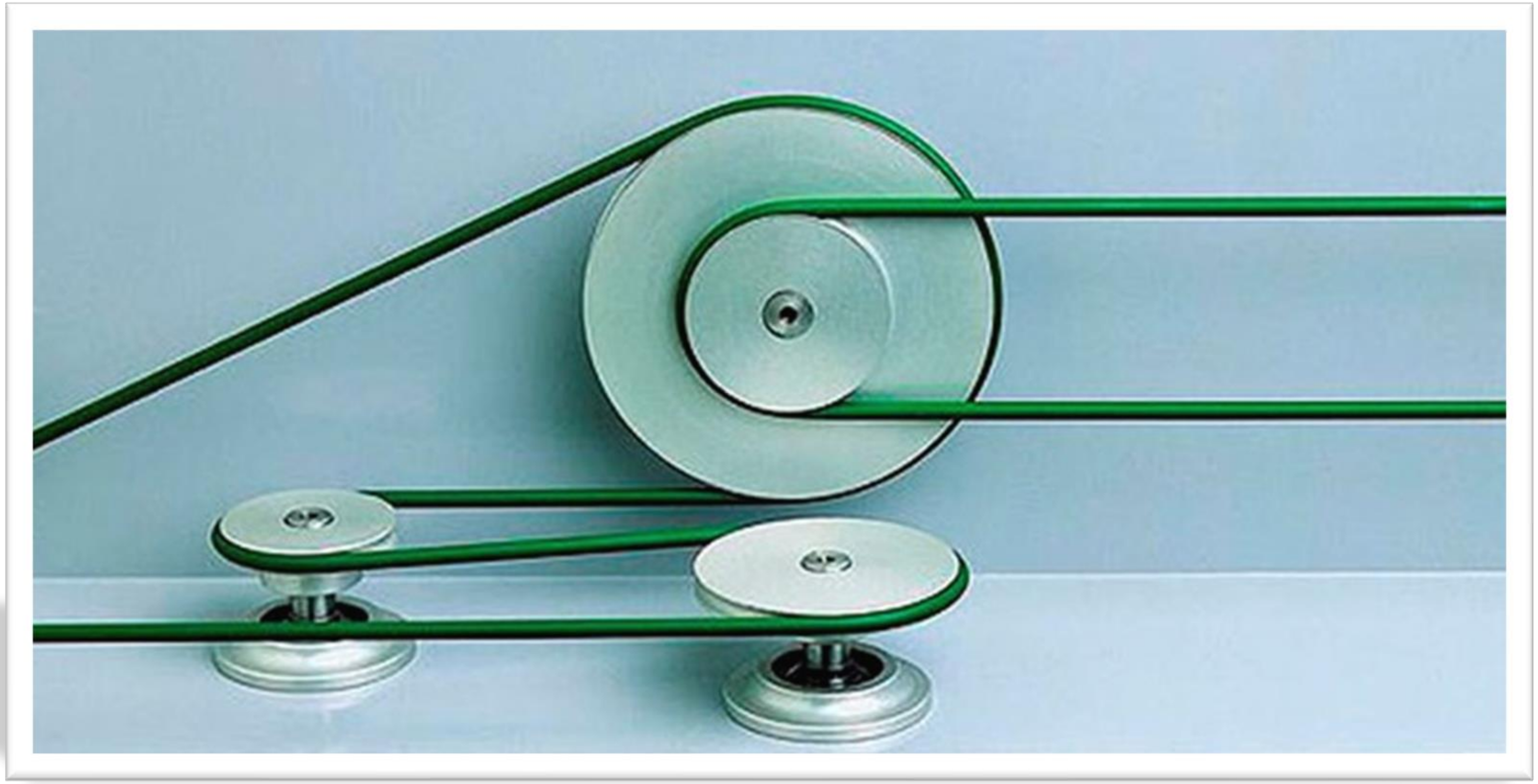
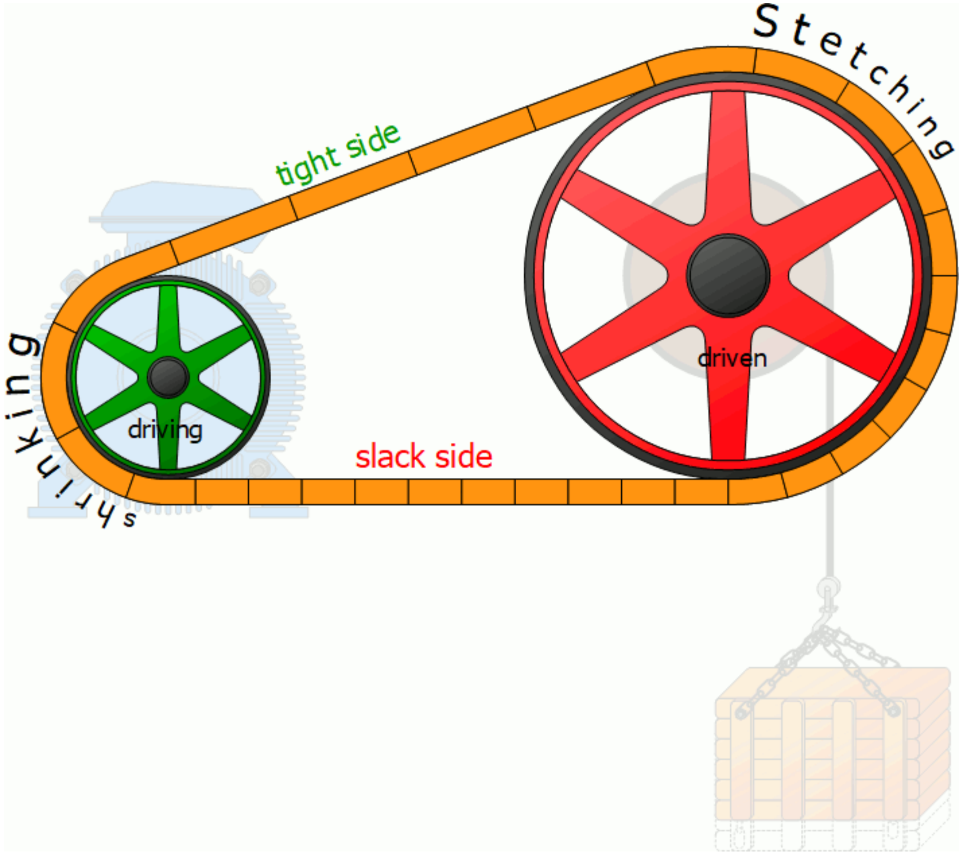
The belt drive
part 2



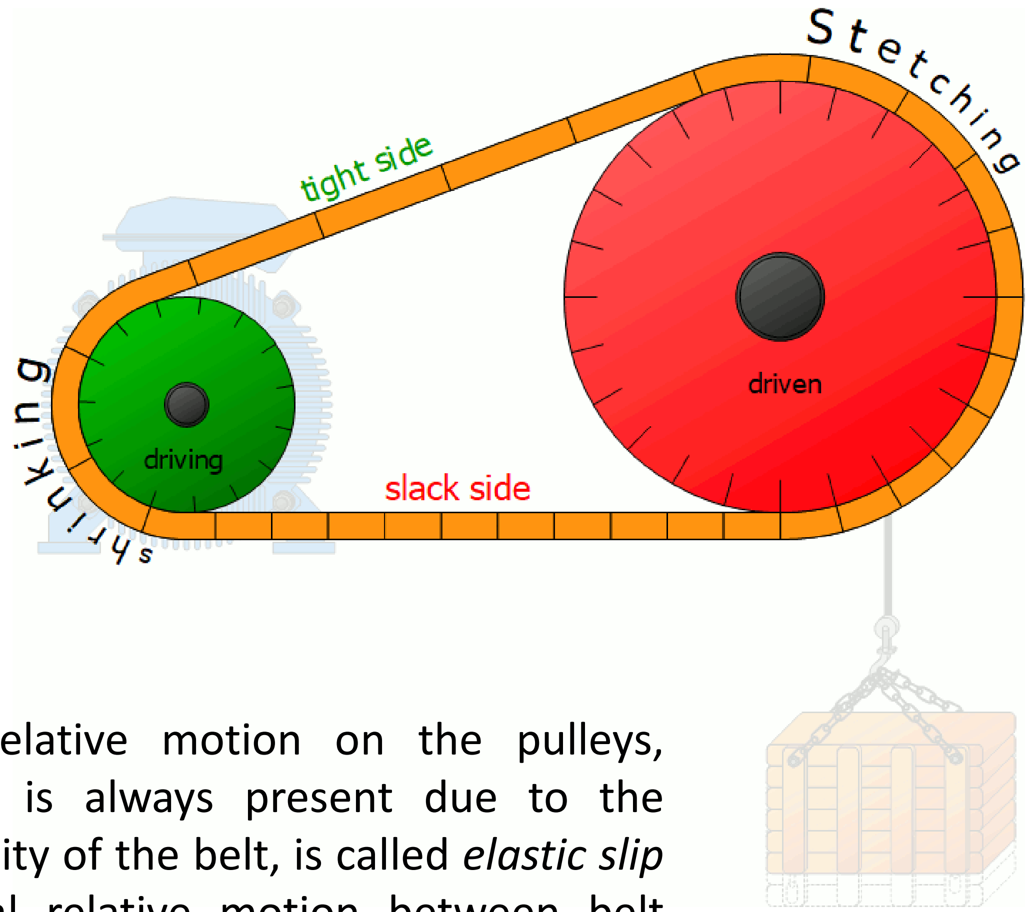
Elastic strains in the belt



When the belt rotates around the pulleys, it is exposed to different forces. Due to the elasticity of the belt, the different forces also cause different elastic strains.

If marking lines are applied to the belt at equal distances in the load-free state, the line distances on the tight side of the belt increase due to the increased belt force during operation and decrease accordingly on the slack side due to the reduced force. The line spacings gradually adapt to the new conditions as the belt moves around the pulleys.

Elastic slip

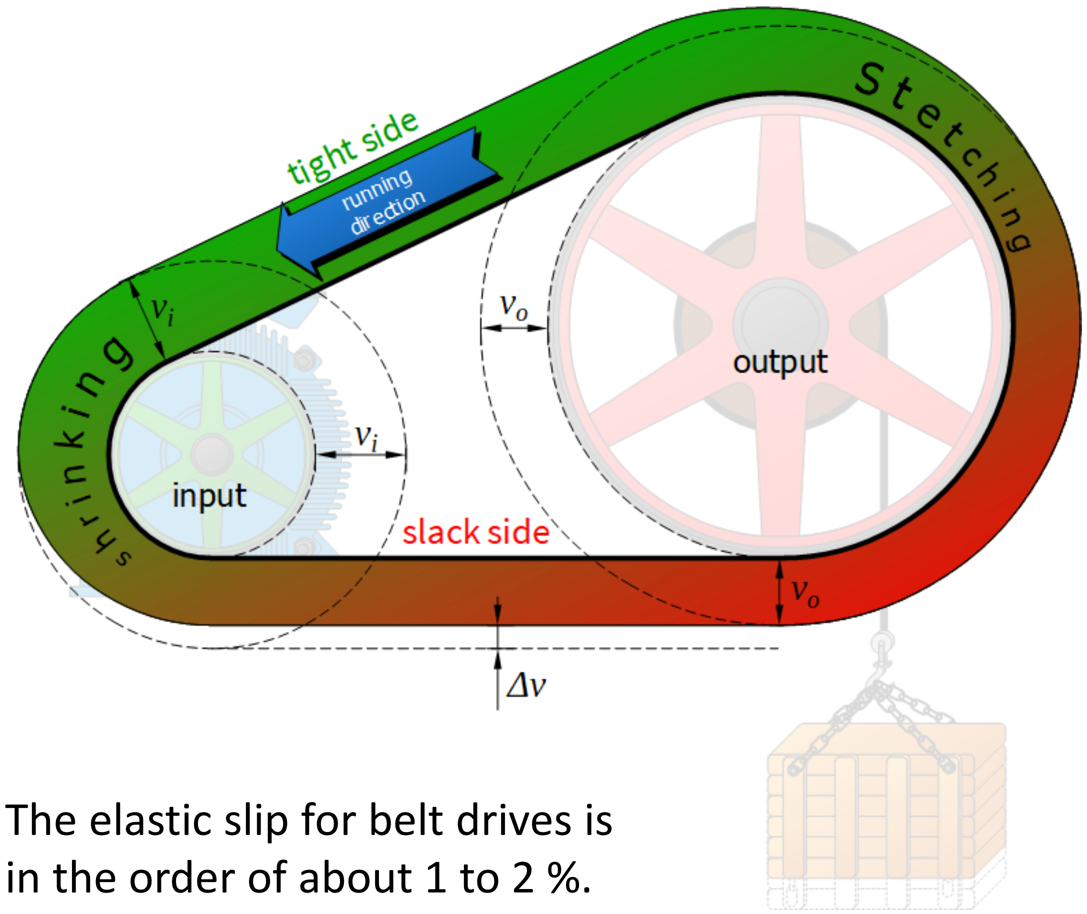


Marking lines are attached to the pulleys for better orientation. If one compares these pulley markings with the belt markings, the relative motion between belt and pulley can be seen very clearly.

A belt section between two marking lines is obviously stretched on the driven pulley during rotation. The stretching belt section is pulled over the pulley, so there is relative motion between belt and pulley and thus sliding!

The relative motion on the pulleys, which is always present due to the elasticity of the belt, is called *elastic slip* (partial relative motion between belt and pulley)

Belt velocities



The elastic slip for belt drives is in the order of about 1 to 2 %.

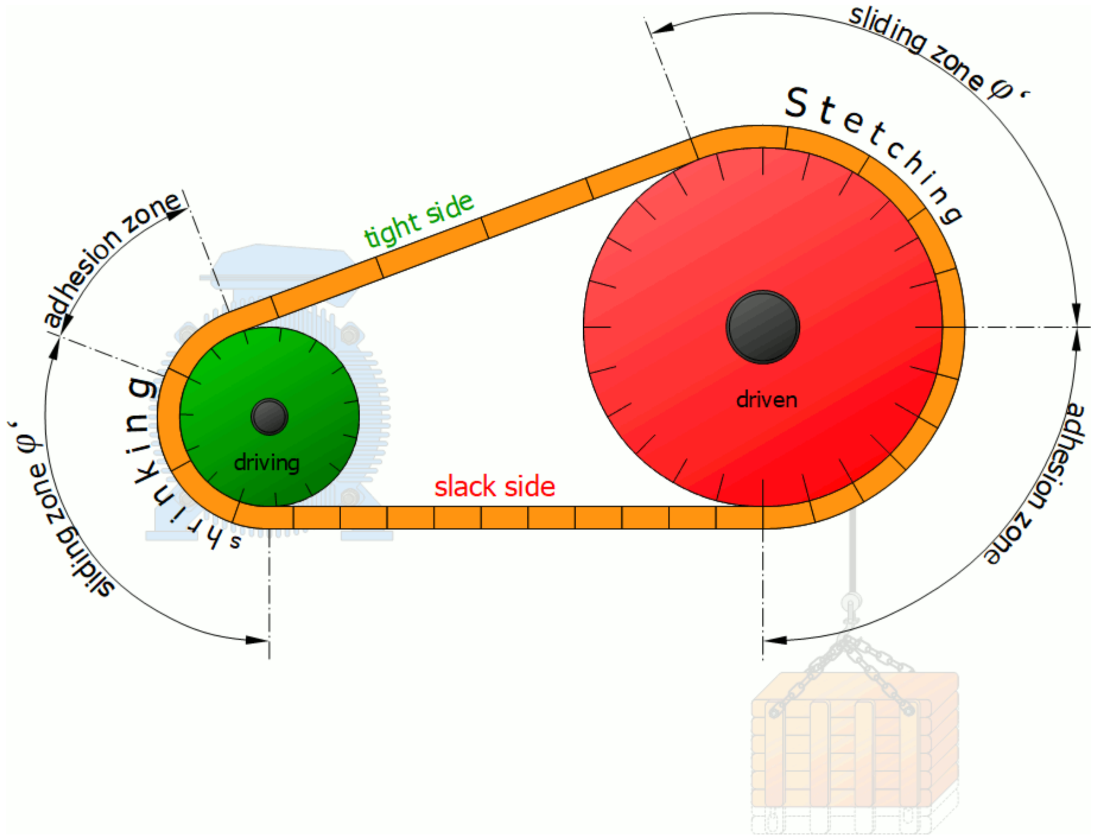
The belt strain and the belt velocity are directly related. The belt velocity increases and decreases to the same extent as the belt elongation increases and decreases.

The more the belt stretches, i.e. the greater the elastic slip, the greater the difference in belt velocities and thus also in the circumferential speeds of the pulleys. Therefore, the elastic slip ξ can be defined like the relative loss of velocity.

$$\xi = \frac{\Delta V}{Vi} = \frac{Vi - Vo}{Vi} = 1 - \frac{Vo}{Vi}$$

$$\xi = 1 - \frac{n_2 \cdot d_2}{n_1 \cdot d_1} = 1 - \frac{d_2}{i \cdot d_1}$$

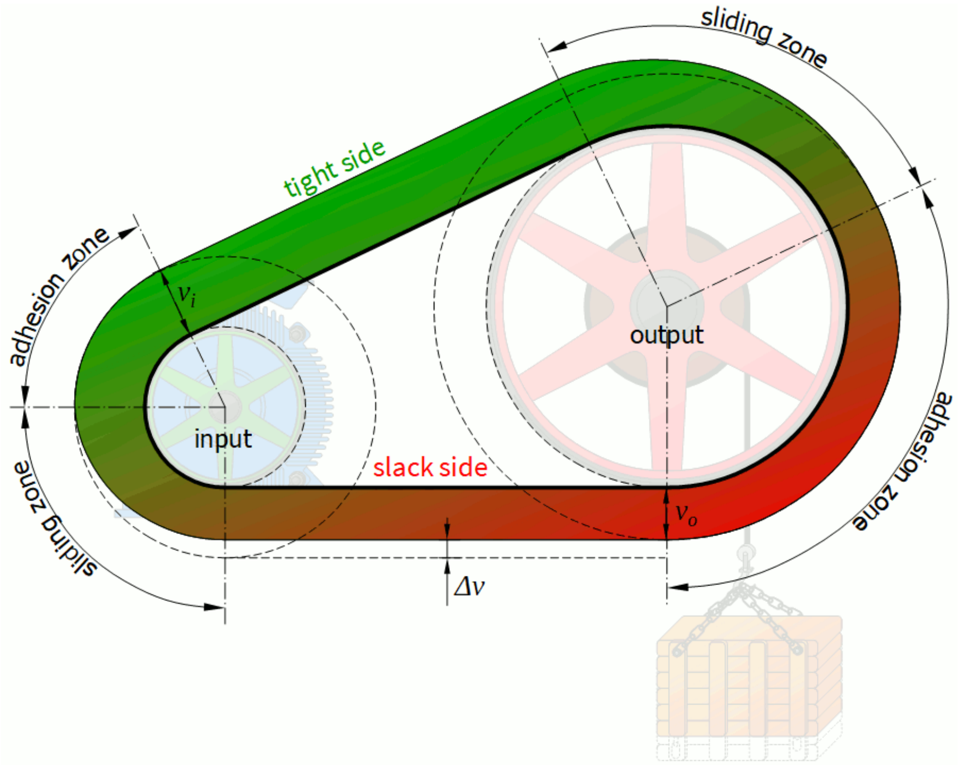
Sliding and adhesive zones



The entire wrap area can therefore be divided into two zones. In the co-called sliding zone a relative motion takes place between belt and pulley. With the acting sliding friction, this zone ensures the transmission of the circumferential force. In the remaining adhesion zone, the belt adheres to the pulley without a relative motion and without force transmission.

The adhesion zone serves as a safety measure against slippage and will usually be used up first on the smaller of the two pulleys.

Calculation of the elastic slip



$$\xi = \frac{Vi - Vo}{Vi} = \frac{\varepsilon 1 - \varepsilon 2}{1 + \varepsilon 1}$$

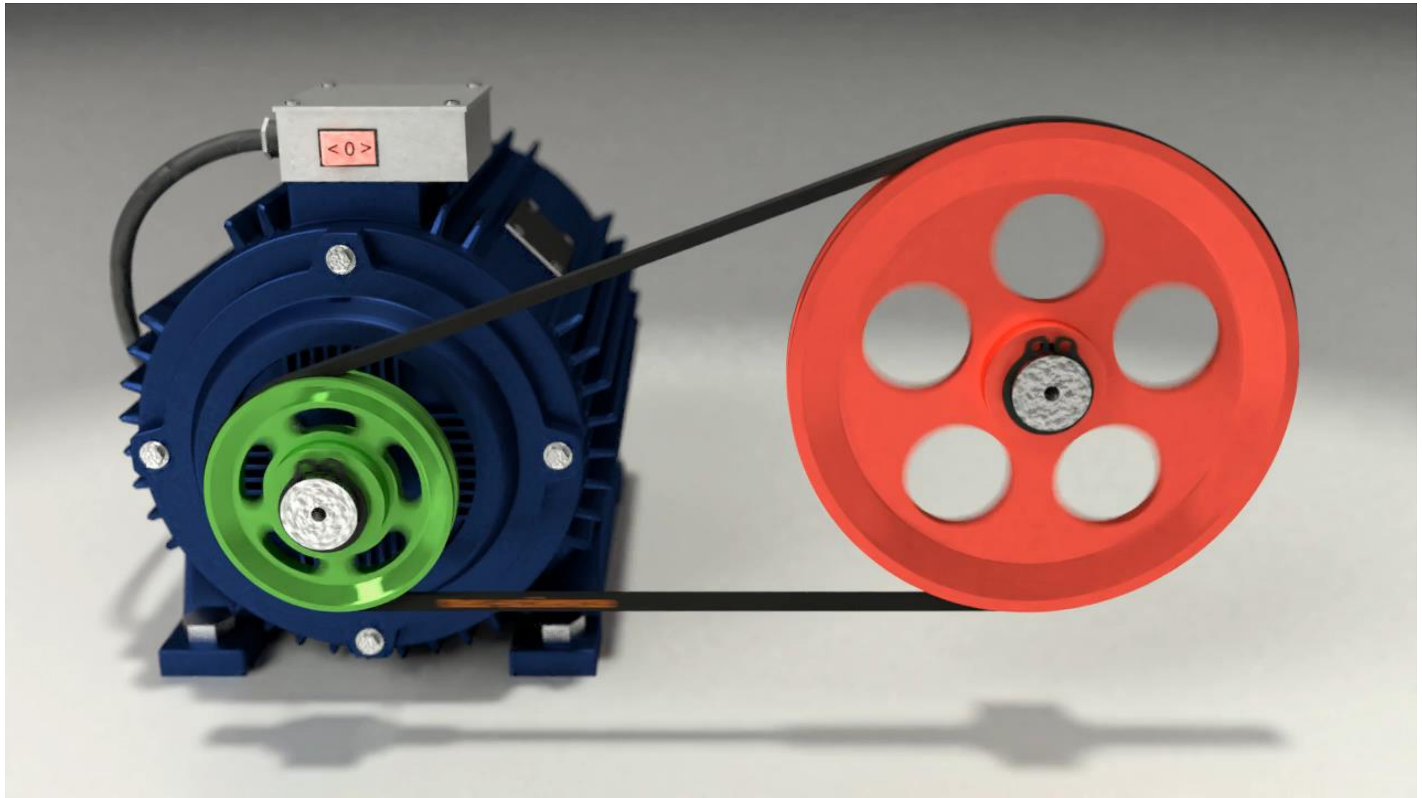
$$\varepsilon = \frac{F}{E \cdot A}$$

$$\xi \approx \frac{Fc}{E \cdot A}$$

The higher the circumferential forces to be transmitted and the more elastic the belt is (e.g. low Young's modulus!), the greater the elastic slip. With the increased elastic slip, the sliding zone also includes a larger portion of the wrap angle.

Belt drive calculations

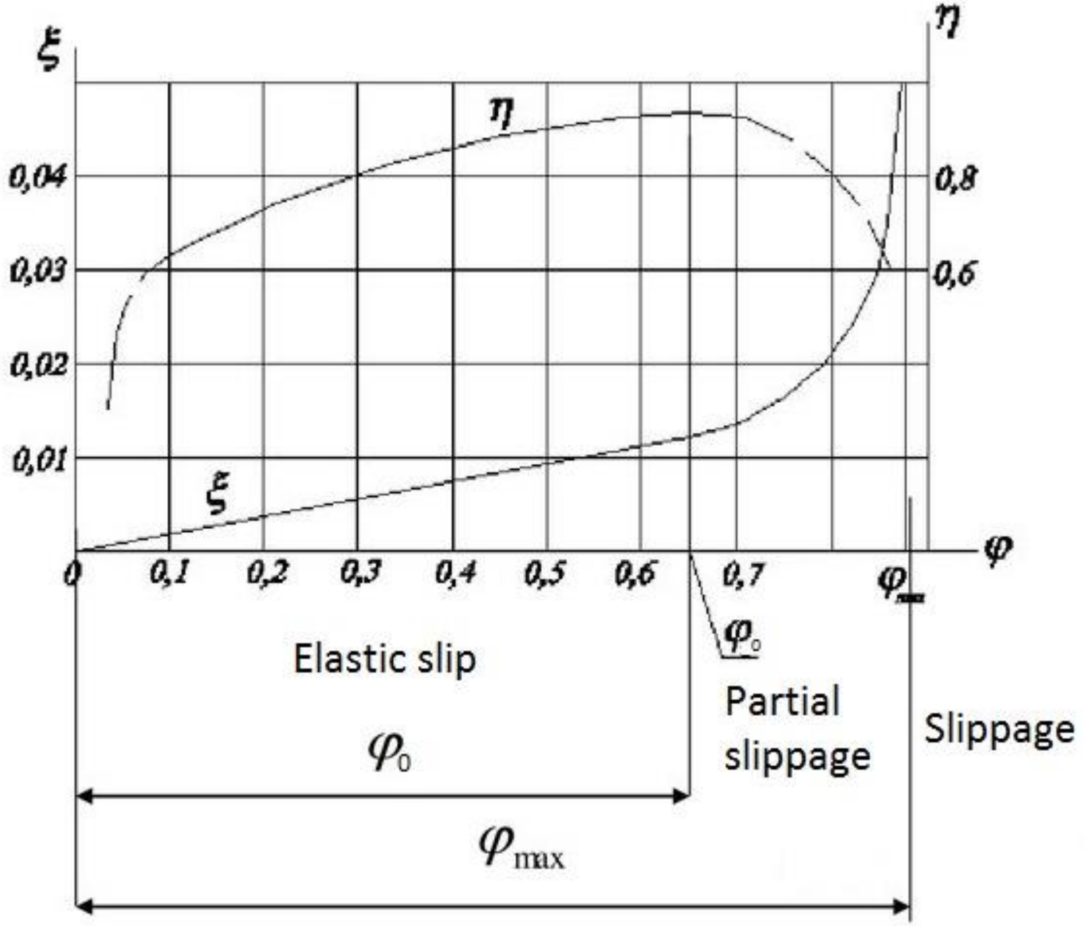
Sliding slippage



Overload (sliding slippage)

This protects the transmission from major damage. In the worst case, only the belt needs to be replaced and not the entire gears and shafts as in the case of a damaged gear drive.

Traction coefficient



$$\varphi = \frac{S1 - S2}{S1 + S2} = \frac{Fc}{2 \cdot S0} = \frac{\sigma c}{2 \cdot \sigma 0}$$

$$\varphi 0 = 0.6 \ldots 0.75$$

$$[\sigma c] = \sigma 0 \cdot \varphi 0 \cdot Cv \cdot Cw \cdot C\alpha \cdot C\theta$$