SAFETY FACTORS

The size of a BRECO / BRECOFLEX belt is correctly determined when the permissible tooth shear strength, tensile loads and flexibility limits are not exceeded under the worst conditions. The maximum load limit given in our catalog have been established through laboratory testing and in actual applications. Safety factors are only necessary for speed-up drives.

It is important that peak loads acting on the drive are known i.e. that they are correctly assessed by the designer. In a positive drive transient shock loads will have an effect on the whole timing belt. Some helpful hints on this subject are:

Normal operating conditions

The timing belt should be designed to cope with rated working loads and conditions. Rated working loads are defined as the operating conditions under which the drive is expected to transmit torque or power based on the rated speed and normal running conditions.

Start-up conditions

a) Driver: the maximum start-up torque of the motor must be taken into account. The start-up torque on a three phase motor for example can be 2 – 2.5 times the running torque.

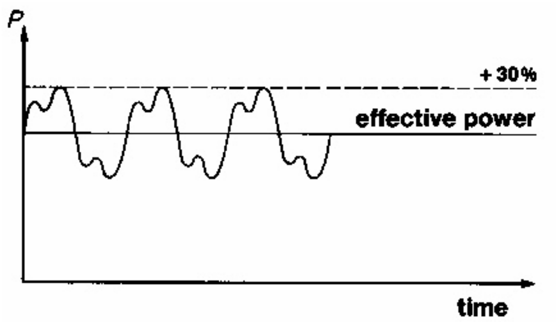
b) Driven: it is also important to consider possible break-away torque acting on the timing belt under start-up conditions. Check belt loading conditions a) or b) at n = 0 rpm.

Breaking

It is necessary also to determine whether any loads induced by breaking will affect the timing belt. It is quite possible that these loads may exceed those already present due to start-up and normal running conditions. Under breaking conditions torque reversal should be taken into consideration.

Shock loads

Oscillational and vibrational loads
Oscillational and vibrational loads can be super-imposed on the normal working loads of the timing belt. As in the illustrated example it would be necessary to increase the belt width by a factor of 1.3.



Inertial Masses

Centrifugal or inertial masses generally help in the smooth running of drives. However it is very important to check what extra loads these inertial masses are exerting on the timing belt under acceleration and breaking conditions.

Speed-Up Drives

The following safety factors should be employed with speed-up drives:

Speed-up ratio	Safety factor S
Over 1 to 1.5	**S = 1.1**
Over 1.5 to 2.5	**S = 1.2**
Over 2.5	**S = 1.3**

It is also important to realize and take into account that if a torque reversal occurs under breaking, then a speed reduction drive would change to a speed-up drive.

To design a roll table drive for heavy transport duty. Under start-up conditions 2.5 times the torque is exerted on the timing belt.

Drive data:

Power	P = 10 kW
Nominal speed	n = 800 rpm
Rated torque	M = 300 Nm
Ratio	i = 1
Center distance	a = 620 mm

To determine the timing belt pitch and width.

According to the power tables on page 7 a power rating of 10 kW is within the range of a BRECOFLEX AT10 timing belt in conjunction with 36 tooth pulleys.

Calculation of belt length from the formula on page 24.

$L_B = 2 \cdot a + z \cdot t$

$= 2 \cdot 620 + 36 \cdot 10 = 1600$ mm

Tooth Shear Strength

18 teeth are in mesh. As the load distribution on the last teeth in mesh can be ignored, $z_e = 12$ will be used in this calculation (see also Design Guidelines at the bottom of page 8).

Pages 12 – 13: Calculating the belt width using the power equations and the given running speed. The equation is transposed to give:

$$b = \frac{1000 \cdot P}{z_1 \cdot z_e \cdot P_{spez}}$$

$$= \frac{1000 \cdot 10}{36 \cdot 12 \cdot 6.96} = 3.33\text{cm}$$

Pages 12 – 13: Calculating the belt width under start up torque at n = 0 rpm. The torque equation is transposed to give:

$$b = \frac{100 \cdot M}{z_1 \cdot z_e \cdot M_{spez}}$$

$$= \frac{100 \cdot 300}{36 \cdot 12 \cdot 11.70} = 5.94\text{cm}$$

The belt width should be determined from the least favorable conditions. The next largest standard width is chosen, b = 75 mm.

Tensile strength of tension members

The corresponding peripheral force can be calculated from the data supplied (see formulae on page 23):

$$F_U = \frac{2 \cdot 10^3 \cdot M}{d_0}$$

$$= \frac{2 \cdot 10^3 \cdot 300}{114.59} = 5236 \text{ N}$$

Page 12: The table value F_{zul} for 75 mm BRECOFLEX AT10 timing belt is 12000 N. Thus there is a sufficient built-in safety factor within the tension members.

Flexibility

It is intended to design a drive without contraflexure. The minimum number of teeth in the pulley is given in the table on page 12.

The drive is correctly designed using a 75 mm wide belt. A maintenance-free drive can be expected.

Order reference: BRECOFLEX timing belt 75 AT10 / 1600.

TENSIONING

Determining the Pre-tension

The pre-tension F_V is determined by the maximum operating peripheral force F_U. The purpose of pre-tension is to allow both sides of the belt between the pulleys to run without sagging. It is important to recognize the difference between the loaded (tight) and unloaded (slack) side of a drive as when power is applied, the tension increases in the loaded (tight) side and decreases proportionately in the slack side.

The pre-tension is correctly set when the unloaded (slack) side of the belt always remains taut under the maximum operating loads. Any sag or flap indicates too low a pre-tension.

For two pulley drives:

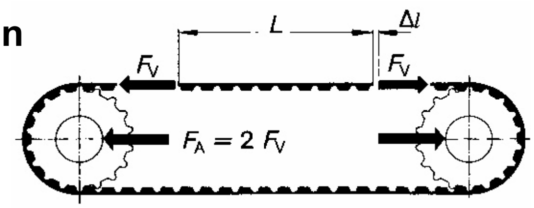
Pre-tension ≥ 0.5 · Peripheral force
$F_V \geq 0.5 \cdot F_U$

For multiple pulley and linear drives:

Pre-tension ≥ 1.0 · Peripheral force
$F_V \geq 1.0 \cdot F_U$

Checking the Pre-tension

The pre-tension can be checked by measuring the elongation of the belt. At the maximum allowable tensile load F_{zul} the belt elongation is:



BRECOFLEX Timing Belts	4 mm per meter
BRECO Timing Belts M	4 mm per meter
BRECO Timing Belts V	2 mm per meter

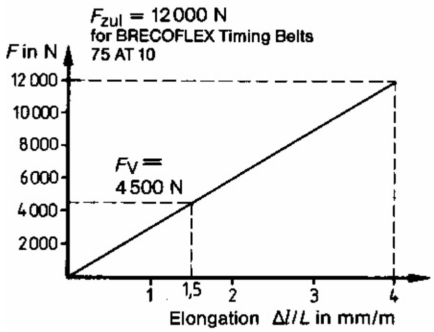
As, in accordance with Hookes' Law, the values for force versus elongation are linear over the entire load range, intermediate values can be determined in the manner illustrated below. The elongation of long belts can be measured with a rule or gauge.

Example

A drive is designed to use a BRECOFLEX 75 AT10 / 2500 timing belt. The drive will transmit a maximum operating peripheral force F_U = 9000 N.

Thus the belt should be pre-tensioned with $F_V = 0.5 \cdot 9000$ N = 4500 N.

The relevant pre-tension elongation can be calculated from the adjoining force/ elongation graph. In this example the value is 1.5 mm per meter.



Note: for values for F_{zul} see Technical data sections.

Notes for the designer

A timing belt drive needs a minimum of one adjustable axis. With fixed centers an adjustable idler (not spring loaded) is recommended.

Notes for the fitter

Do not fit belts loosely or force them over the pulley flanges. Use the recommended pre-tension. Beware of adjustable axes becoming loose.