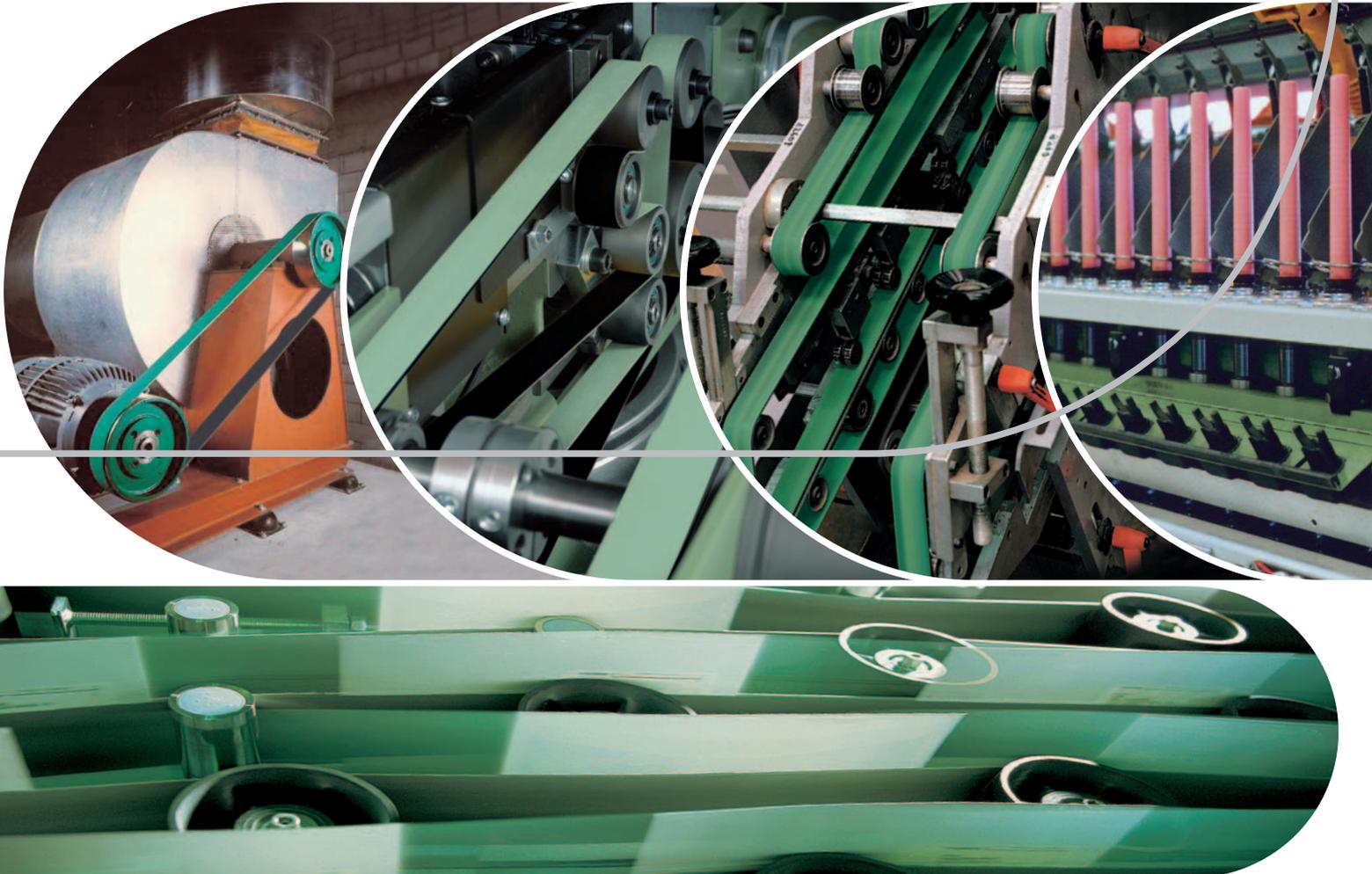


# HabaDRIVE® Engineering Guidelines

Habasit – Solutions in motion



### **Product liability, application considerations**

If the proper selection and application of Habasit products are NOT recommended by an authorized Habasit sales specialist, the selection and application of Habasit products, including the related area of product safety, are the responsibility of the customer.

All indications / information are recommendations and believed to be reliable, but no representations, guarantees, or warranties of any kind are made as to their accuracy or suitability for particular applications. The data provided herein are based on laboratory work with small-scale test equipment, running at standard conditions, and do not necessarily match product performance in industrial use. New knowledge and experiences can lead to modifications and changes within a short time without prior notice.

BECAUSE CONDITIONS OF USE ARE OUTSIDE OF HABASIT'S AND ITS AFFILIATED COMPANIES CONTROL, WE CANNOT ASSUME ANY LIABILITY CONCERNING THE SUITABILITY AND PROCESS ABILITY OF THE PRODUCTS MENTIONED HEREIN. THIS ALSO APPLIES TO PROCESS RESULTS / OUTPUT / MANUFACTURING GOODS AS WELL AS TO POSSIBLE DEFECTS, DAMAGES, CONSEQUENTIAL DAMAGES, AND FURTHER-REACHING CONSEQUENCES.

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## **What are the HabaDRIVE® Engineering Guidelines?**

### **The HabaDRIVE® Engineering Guidelines are ...**

- a comprehensive manual of technical know-how about power transmission flat belts
- designed to meet the needs of machine designers, project leaders, engineers, technicians, fitters (installers), maintenance staff and other interested parties

### **The HabaDRIVE® Engineering Guidelines contain:**

- information about the design, features and benefits of modern power transmission flat belts
- aids for the selection of the optimal HabaDRIVE® belt type
- explanations of common technical expressions
- basic knowledge about the calculation of power transmission flat belts
- guidelines for the design of flat belt drives
- details of joining methods and required tools
- hints about correct belt installation, maintenance and storage
- a trouble-shooting list

### **The HabaDRIVE® Engineering Guidelines facilitate:**

- innovative power transmission solutions
- professional design of flat belt power transmission drives
- professional belt installation
- long and trouble-free belt service life

**Habasit is the worldwide market leader in the belting industry, providing the entire range of belts and delivering the highest levels of service. Our key objective is to offer superior solutions in motion for our customers. Anywhere. Anytime.**

## **HabaDRIVE®**

Due to their high flexibility Habasit's power transmission belts save energy and help reducing costs. The superior belt design allows also for small pulley diameters and versatile machine designs, which is especially important in the textile and printing & paper industry.

## **Your solutions partner**

Habasit is committed to understanding your design parameters and application needs. After reviewing your requirements, our specialists will suggest the best solution for each application and cooperate closely with you for a perfect implementation.



## **The complete range of products**

To meet all your needs, we supply plastic modular as well as fabric belting, accessories and gears. Based on over 60 years of experience and continuous innovation, you receive the best solution for your application. Exactly the right products, right on time.

## **Major investments in R&D**

Because your belting challenges never let up, we have dedicated more than 3% of our employees to the research and development of new products and to improving our existing range. We own the best laboratory facilities in the industry, and the annual R&D budget for belts is over 8% of the company's turnover.

## **Unparalleled global service coverage**

Habasit serves you through its more than 30 fully owned Affiliated Companies around the world. Every company has its own inventory, fabrication, assembly and service facilities. Each one is committed to customers with a single aim: to react on time, expertly and reliably.

## **Full commitment of the leading global belting supplier**

Our entire organization of more than 3,300 employees is dedicated to meeting your needs for solutions in motion. No matter how fast they develop. At all times, Habasit is driven by the absolute commitment to adding true value to your business.

**For additional information please visit: [www.habasit.com](http://www.habasit.com)**

## Worldwide leading product range

Habasit offers the largest selection of belting, conveying, processing and complementary products in the industry. Our response to any request is exactly your best solution.

## Certified for quality

We deliver the highest quality standards not only in our products and solutions, but also in our employees' daily work processes. Habasit AG is certified according to ISO 9001:2000.



## Our key product ranges



**HabaFLOW®**  
Fabric-based conveyor and processing belts



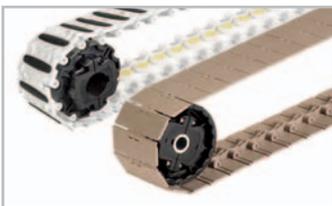
**HabasitLINK®**  
Plastic modular belts



**HabaDRIVE®**  
Power transmission belts



**HabaSYNC®**  
Timing belts



**HabaCHAIN®**  
Slat and conveyor chains



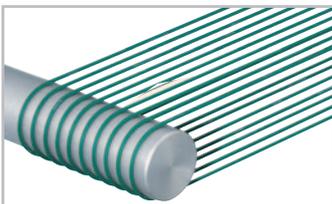
**HabiPLAST®**  
Profiles, Guides, Wearstrips



**Machine tapes**



**Seamless belts**



**Round belts**



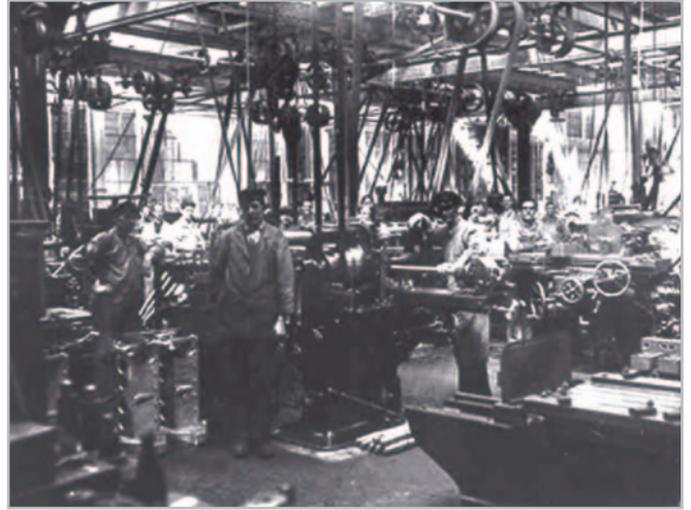
**Fabrication tools (joining tools)**



**Gear reducers, Gear motors, Motion control**



**Electric motors**



Belts, ropes and chains have been used as traction devices for centuries. Babylonians and Assyrians used chains for the first time for water drawing machines. By 1430, endless rope haulage was used to drive grinding devices, and in the drawings of Leonardo da Vinci (1452 to 1519) link chains are shown.

During the course of industrialization, which started with the invention of the steam engine in the 18th century, the power transmission drive with flat belts made of chrome leather became the indispensable basis for industrial production. The power generated centrally by the steam engine was transmitted to individual production machines via long transmission shafts.

Leonhard Euler (mathematician, 1707–1783) authored the first theoretical essays on the traction mechanism. Based on these essays, the engineer Johann Albert Eytelwein (1764–1848) established his rope friction equation in 1808, an equation that is still indispensable for calculating frictionally engaged drives. At the same time, traction mechanisms continued to develop at a rapid pace.

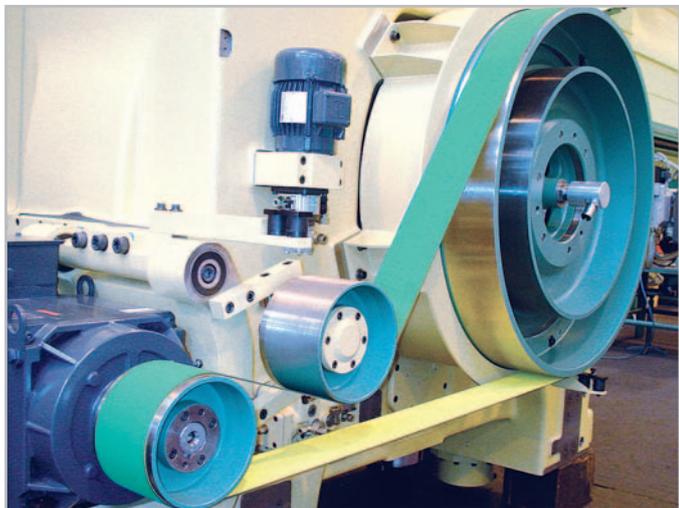
Due to the introduction of the electric motor, its application as an individual drive, and the drawbacks of the leather belt (friction degradation; waning tension; vibration-stimulation, noise, and accident-prone mechanical joints), the power transmission belt was temporarily displaced.

The invention of polyamide in the Second World War presented an opportunity to Fernand Habegger (engineer and founder of Habasit AG Switzerland, 1921–1992) to create a flat belt with stable and predictable elastic characteristics which could be made endless by a glued joint. At that time, chrome leather was adhered to the polyamide traction layer as a friction cover.

Today's modern, fully synthetic, high-duty power transmission flat belts are equipped with a strong and resilient traction layer made of polyamide, polyester or aramide, and with wear-resistant, oil and grease resistant friction covers made of NBR-rubber (elastomer) that provide a high degree of consistent friction between belt and pulleys.

High efficiency synthetic flat belts are currently being used in all areas of power transmission technology due to their versatility, excellent properties, and outstanding reliability.

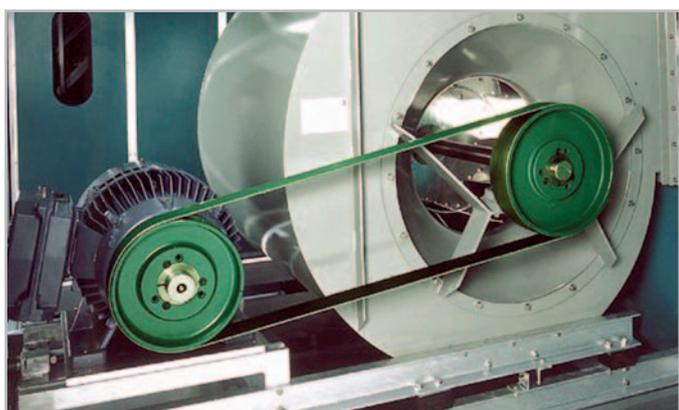
Examples of modern power transmission flat belt applications:



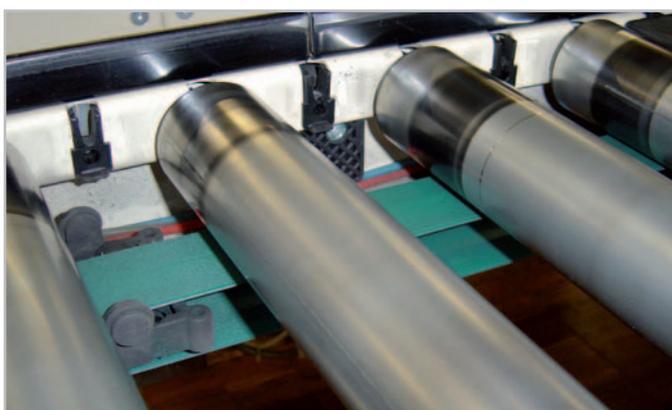
Flat belt driven 160 ton press



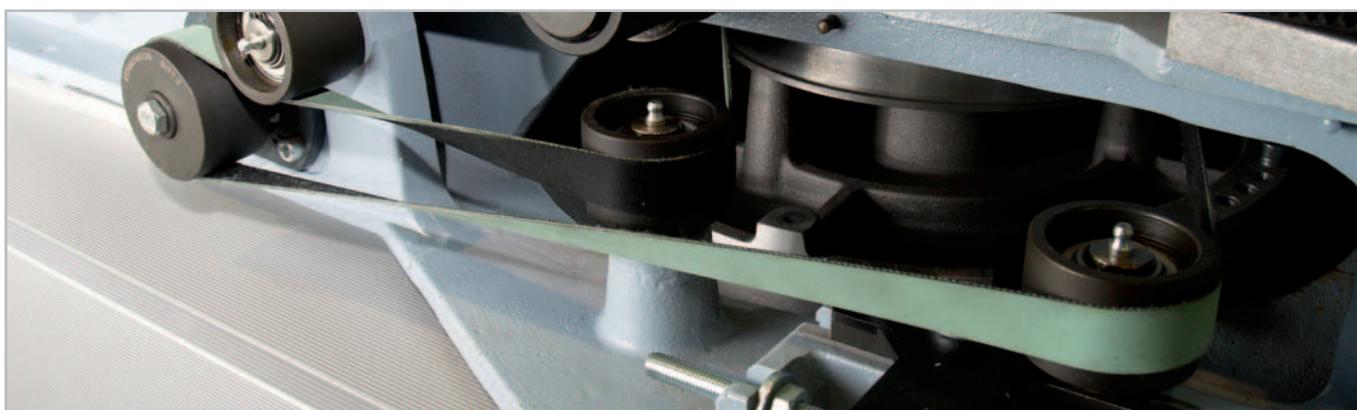
Tangential belt on a spinning machine



Flat belt driven industry fan



Flat belt driven live roller conveyor

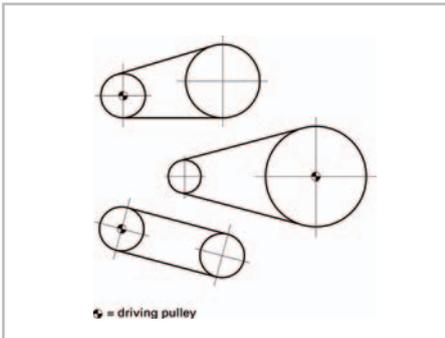


Twisted flat belt drive on a textile machine

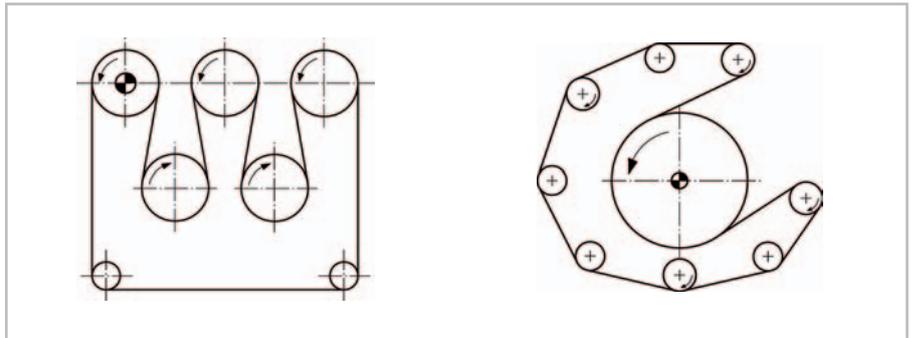
## The Flat Belt as a Versatile Machine Element

The modern power transmission flat belt can be used in many forms of power transmission. Basically it is known as a two pulley drive (open drive), consisting of a driving pulley, a driven pulley and the belt.

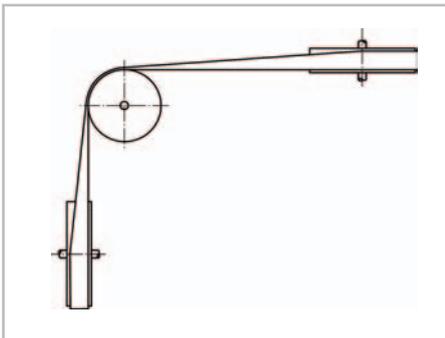
However, the flat belt can be used in a great number of design variations. Here some typical examples:



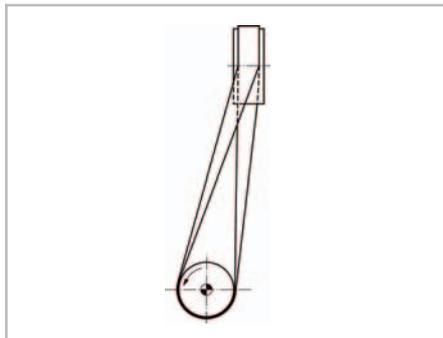
Two pulley drive (open drive)



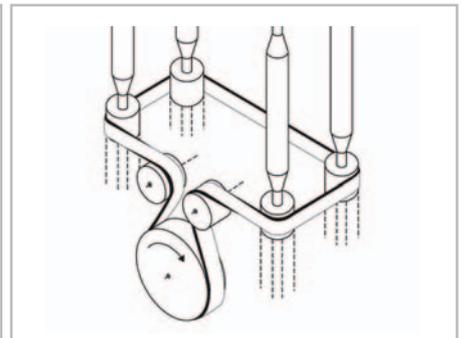
Multi pulley drive (power branching)



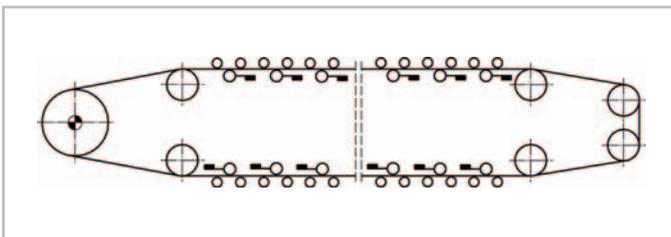
Mule drive



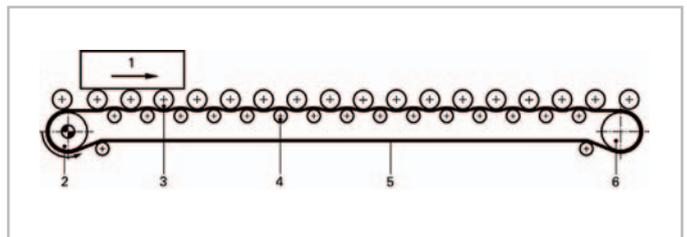
Half-cross drive



Spindle tape drive



Tangential belt drive



Live roller conveyor drive

Details are available in the chapter on "Special flat belt drives"



## The Belt Concept

Habasit has developed the HabaDRIVE® range of power transmission belts to allow you to choose the most suitable belt for your specific application.

The concept is based on the three traction layer materials used:

	<b>Polyester</b> power transmission belts		<b>Polyamide</b> power transmission belts		<b>Aramide</b> power transmission belts
	<b>The versatile belt</b>		<b>The hard-working belt</b>		<b>The sophisticated belt</b>
	Outstanding price-to-value ratio  First choice of machine manufacturers and end users worldwide		Well known for its reliability and long service life  Robust and highly resilient, copes with intermittent overload and high temperatures (up to 100 °C)		Best choice for long belts.  Short take-up and highest accuracy for numbers of revolutions (rpm) and belt speed
	<b>TC-</b>	<b>TCF-xxEL</b>	<b>S-</b>	<b>A-</b>	<b>TF-</b>
	<ul style="list-style-type: none"> <li>• Low energy consumption</li> <li>• Highly flexible</li> <li>• Simple to join</li> <li>• Reliable performance</li> </ul>	<ul style="list-style-type: none"> <li>• Low energy consumption</li> <li>• Grooves enable high grip</li> <li>• Highly flexible</li> <li>• Simple to join</li> </ul>	<ul style="list-style-type: none"> <li>• Resilient</li> <li>• Shock resistant</li> </ul>	<ul style="list-style-type: none"> <li>• Resilient</li> <li>• Shock resistant</li> <li>• Grooves enable high grip</li> </ul>	<ul style="list-style-type: none"> <li>• Low energy consumption</li> <li>• Highly flexible</li> <li>• Simple to join</li> <li>• High E-modulus</li> </ul>
<b>Application as/for</b>					
Tangential drive	●	—	●	—	●
Multiple pulley drive	●	●	●	●	●
Live roller drive	●	—	●	—	●
Double-sided power transmission	●	—	●	—	●
<b>Design and materials</b>	e.g.: TC-55ER 	e.g.: TCF-20EL 	e.g.: S-250H 	e.g.: A-2 	e.g.: TF-50 
Friction cover (Material)	NBR-Rubber	NBR-Rubber	NBR-Rubber	NBR-Rubber	NBR-Rubber <sup>1)</sup>
Traction layer (Material)	Polyester		Polyamide		Aramide
Reverse cover (Material)	NBR-Rubber	Hamid	NBR-Rubber	NBR-Rubber (protection cover)	NBR-Rubber <sup>1)</sup>
Operating temperature admissible (continuous)	-20 °C / 70 °C -4 °F / 158 °F		-20 °C / 100 °C -4 °F / 212 °F		-20 °C / 65 °C -4 °F / 149 °F
Fabrication/ joining system	Flexproof (adhesive-free)		Thermofix		Flexproof (adhesive-free)

<sup>1)</sup> except TF-15H (Hamid)

## Product Key Data

The table below lists the key data of the most commonly used HabaDRIVE® belts.

**For detailed and up-to-date product data, contact [www.habasit.com](http://www.habasit.com)**

	Belt group	Belt code	Double-sided power transmission, tangential drives	Thickness [mm]	Pulley diameter minimum with counter flexion [mm]	Tensile force for 1% elongation per unit of width [N/mm] (k <sub>1</sub> % after running in)	Nominal peripheral force per unit of width [N/mm]	
<b>Polyester</b> power transmission belts	<b>TC-</b>	TC-10EF	●	1.8	25	5	10	
		TC-20EF	●	2.0	25	10	21	
		TC-20/25EF	●	2.5	50	11	23	
		TC-35ER	●	2.5	50	18	38	
		TC-35/30ER	●	3.0	50	18	38	
		TC-35/35ER	●	3.5	70	18	38	
		TC-55ER	●	3.0	70	25	53	
	<b>TCF-</b>	TCF-20EL	○	2.6	80	10	21	
		TCF-35EL	○	3.0	100	18	38	
		TCF-55EL	○	3.5	150	25	53	
		TCF-20H	●	1.5	25	10	20	
		TCF-50H	●	2.0	60	24	48	
<b>Polyamide</b> power transmission belts	<b>S-</b>	S-10/15	●	1.5	40	4.4	12	
		S-18/20	●	2.0	60	8	22	
		S-18/30	●	3.0	60	8	22	
		S-33/40	●	4.0	125	13	37	
		S-33/50	●	5.0	125	13	37	
		S-140H	●	1.7	40	4.8	13	
		S-141H	●	2.3	40	4.8	13	
		S-250H	●	2.3	100	11	29	
		S-250HR	●	2.6	100	11	29	
		S-251H	●	3.0	100	11	29	
		S-321H	●	3.2	125	13	35	
		S-390H	●	3.2	160	14	38	
		S-391H	●	4.0	160	14	38	
		<b>A-</b>	A-2	○	2.7	60	7.5	22
	A-3		○	3.4	125	12	36	
	A-4		○	5.0	300	21	63	
	A-5		○	6.8	450	30	92	
	<b>Aramide</b> power transmission belts	<b>TF-</b>	TF-10	●	1.7	25	10	10
TF-15			●	2.0	30	15	15	
TF-15H			●	1.5	30	15	15	
TF-22			●	2.4	60	22	22	
TF-33			●	3.0	100	33	33	
TF-50			●	3.9	125	50	50	
TF-75TE			○	4.4	200	70	70	

● Applicable ○ Not applicable

All data are approximate values under standard climatic conditions: 23 °C/73 °F, 50% relative humidity (DIN 50005/ISO 554), and are based on the Habasit master joining method.

## Gathering the Drive Data

In order to guarantee problem-free running and to benefit from the features of a HabaDRIVE® power transmission belt, the following three factors must be defined:

- Belt type
- Belt width
- Initial elongation

If one of the three factors changes, the belt must be re-calculated.

The professional specification of power transmission belts comprises the following steps:

1. Gathering the drive data
2. Selection of the optimal belt type
3. Calculation of the required belt dimensions

### Gathering the drive data

In order to select the optimal belt type and to calculate the required belt dimensions it is crucial to have exact information on the application, the drive data and the operating conditions.

For the calculation of a common two-pulley power transmission belt the following data are required:

- $P_M$  = motor power or power to be transmitted [kW]  
 $n_1$  = number of revolutions of driving pulley [1/min]  
 $n_2$  = number of revolutions of driven pulley [1/min]  
 $d_1$  = diameter of driving pulley [mm]  
 $d_2$  = diameter of driven pulley [mm]  
 $c$  = center distance [mm]

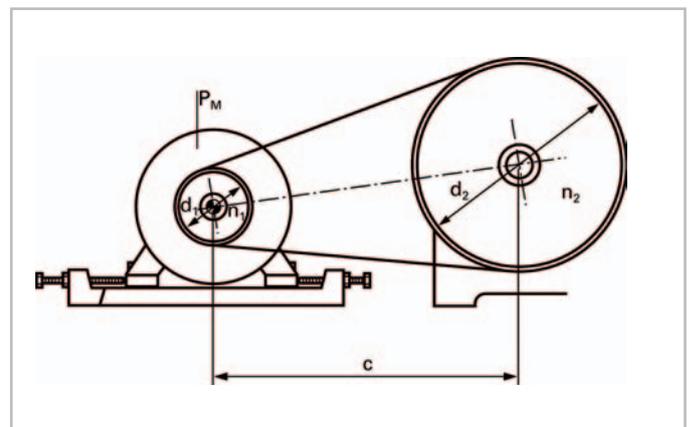
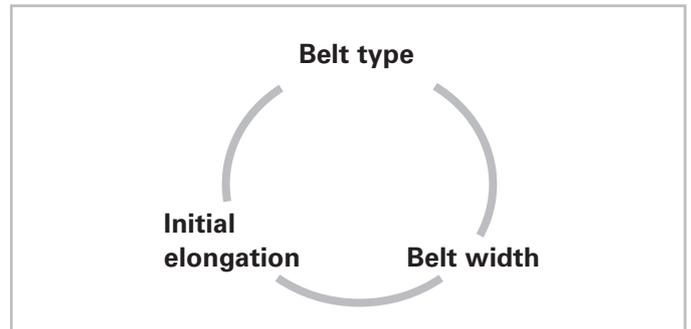
Please use the **Questionnaires** (see Appendix). These should be copied, completed and forwarded to the person responsible for belt selection and calculation.

### Selection of the optimal belt type

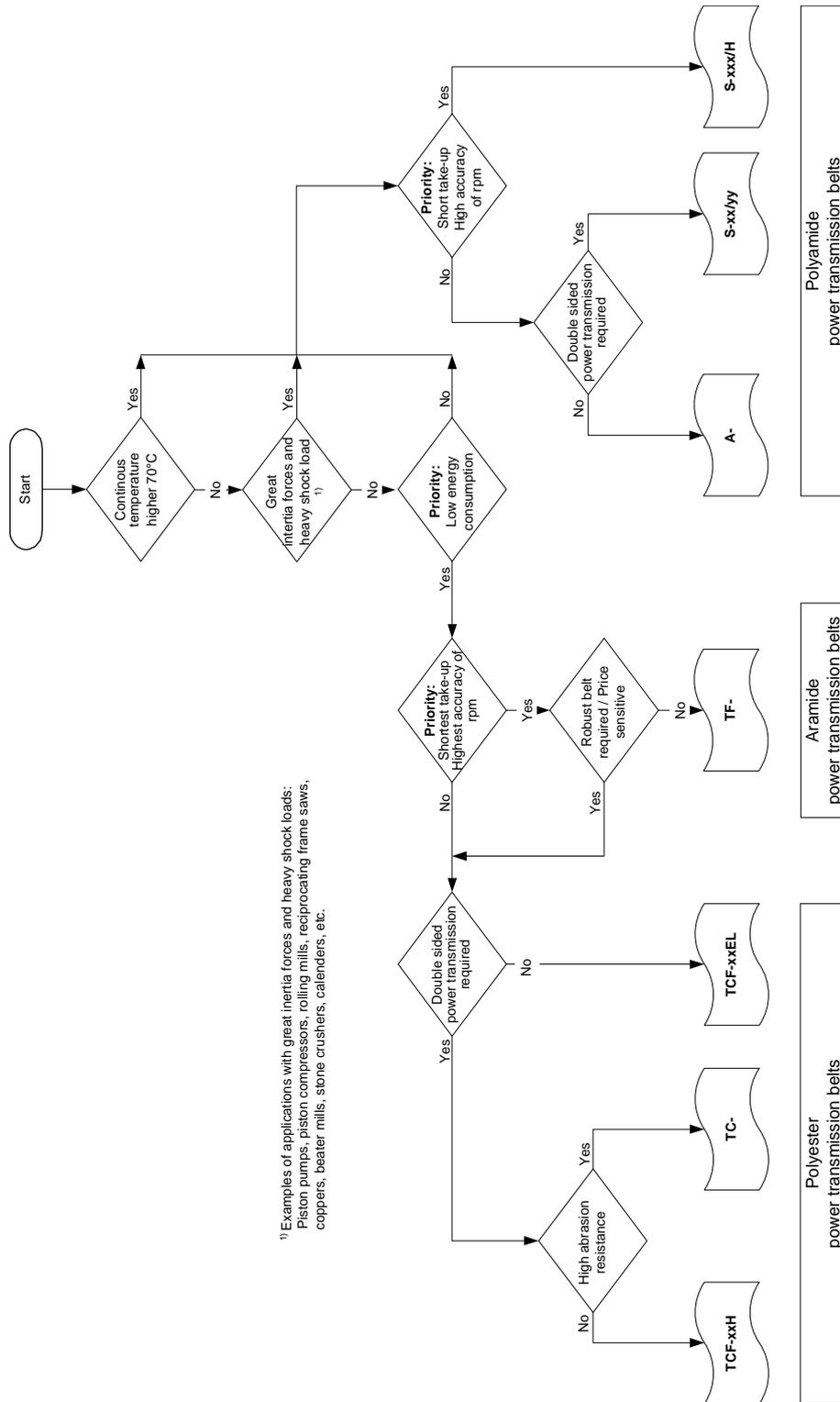
The optimal belt type can be determined by reference to the **Belt selection chart** on the following page.

If the Habasit POWER-SeleCalc program is available, use the easy to handle Belt Selector in order to select the optimal belt type.

For further support please contact your Habasit partner.



## Selection of the Optimal Belt Type



Calculation by POWER-SeleCalc

The Habasit POWER-SeleCalc program enables the user to perform a belt selection in terms of machine and environmental influences, and to calculate the technical drive data such as belt width, initial elongation, static and dynamic shaft load, effective belt length, etc. of two pulley drives, drives with tension pulley, and tangential belt drives, in a quick and easy way.

**Single stage drive / open drive** (two pulley drive)

Selection /input mask



Further input mask



Belt selector mask



Result screen



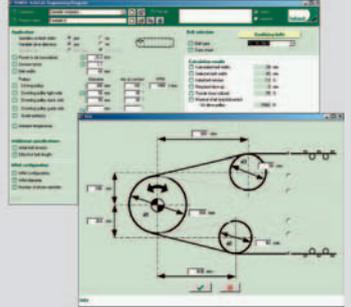
Result printout



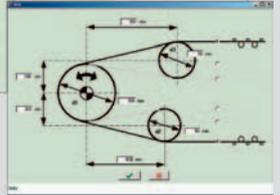
Option: Printout of Product Data Sheets

**Tangential belt drive**

Selection /input mask



Drive configuration input /selection mask



The Habasit POWER-SeleCalc program can be ordered free of charge via our website [www.habasit.com](http://www.habasit.com), by e-mail [info@habasit.com](mailto:info@habasit.com), or by contacting your Habasit partner.



## Belt Length

In belting technology, there are a few special expressions and technical data which need a brief explanation.

### Belt length

The length of power transmission flat belts can be expressed in three ways:

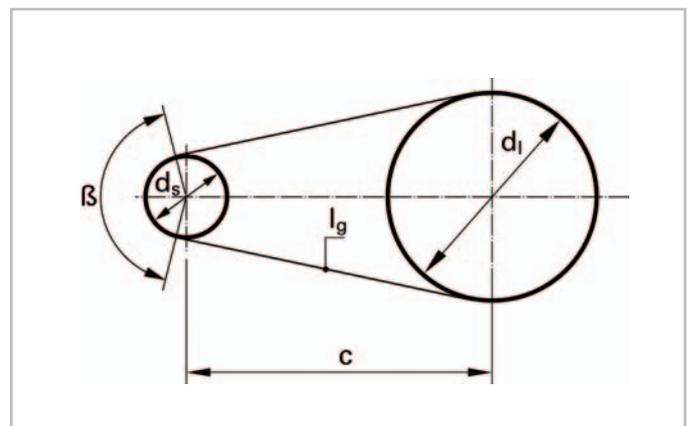
- Geometric belt length ( $l_g$ )
- Effective belt length ( $l_{eff}$ )
- Shortened belt length ( $l_s$ )

For common two pulley drives, the difference between geometric and effective belt length is negligible. However, in specific applications, e.g. short centre distance and/or relatively thick belts, limited take-up etc., greater calculation accuracy is necessary.

Please note that the theoretical considerations below are automatically taken into consideration when using the POWER-SeleCalc calculation program.

### Geometric belt length ( $l_g$ )

The geometric belt length means the inner circumference of an un-tensioned belt drive on the assumption that the belt is infinitely thin. The belt thickness and the position of the neutral layer are not considered.



Exact formula for the calculation of the geometric belt length of a two pulley drive:

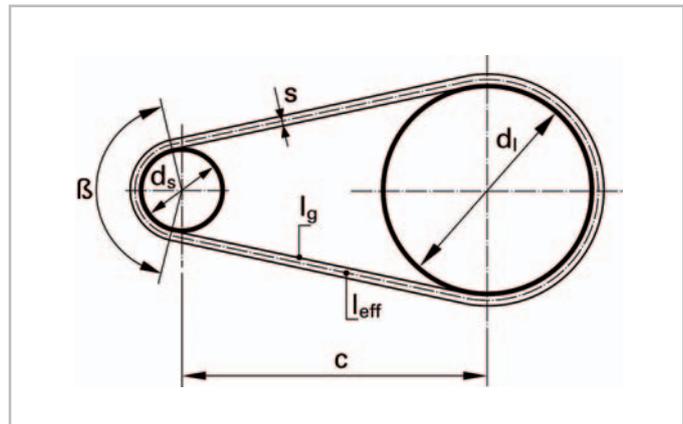
$$l_g = 2c \cdot \sin\left(\frac{\beta}{2}\right) + \frac{\pi}{2} \left[ d_s + d_l + \frac{(d_l - d_s)(180 - \beta)}{180} \right] \text{ [mm]}$$

- $c$  = center distance [mm]  
 $d_s$  = diameter of small pulley [mm]  
 $d_l$  = diameter of large pulley [mm]  
 $\beta$  = arc of contact on small pulley [°]

## Belt Length

### Effective belt length ( $l_{\text{eff}}$ )

The effective belt length is the length of the neutral layer of an un-tensioned belt. It is identical with the fabrication length.

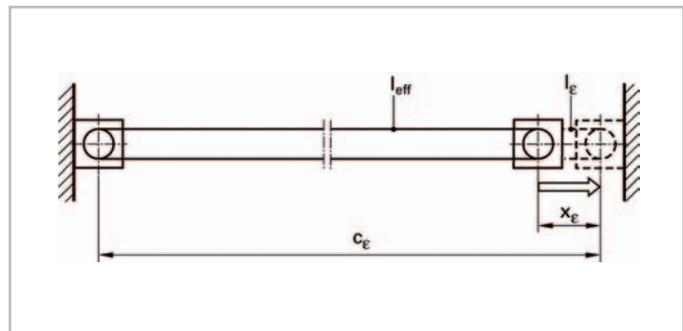


Exact formula for calculation of the effective belt length of a two pulley drive:

$$l_{\text{eff}} = 2c \cdot \sin\left(\frac{\beta}{2}\right) + \frac{\pi}{2} \left[ d_s + d_l + 4s + \frac{(d_l - d_s)(180 - \beta)}{180} \right] \quad [\text{mm}]$$

- $c$  = center distance [mm]
- $d_s$  = diameter of small pulley [mm]
- $d_l$  = diameter of large pulley [mm]
- $s$  = position of the neutral layer measured from running side [mm]
- $\beta$  = arc of contact on small pulley [°]

In machines with **defined take-up displacement**, where the belt is elongated to a fixed end position, usually the center distance for the tensioned belt ( $c_e$ ) is known.



The effective length (fabrication length) of the un-tensioned belt has to be calculated accordingly:

$$l_{\text{eff}} = 2(c_e - x_e) \cdot \sin\left(\frac{\beta}{2}\right) + \frac{\pi}{2} \left[ d_s + d_l + 4s + \frac{(d_l - d_s)(180 - \beta)}{180} \right] \quad [\text{mm}]$$

- $c_e$  = center distance of tensioned belt [mm]
- $x_e$  = take-up displacement [mm]

Formula for the calculation of the take-up displacement ( $x_e$ ):

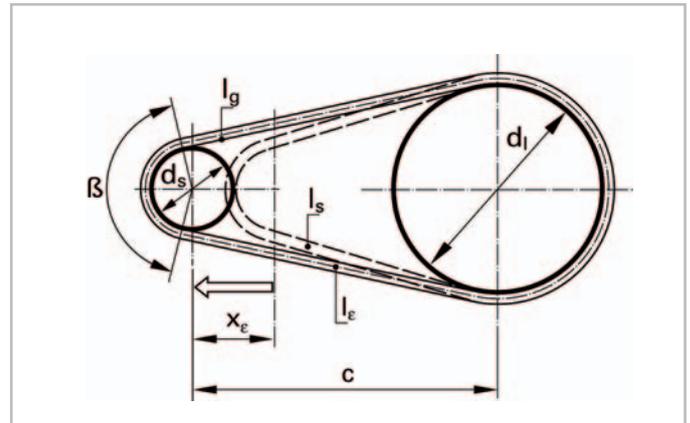
$$x_e = \frac{l_{\text{eff}} \cdot \epsilon_0}{2 \cdot 100}$$

- $l_{\text{eff}}$  = effective length of the un-tensioned belt [mm]
- $\epsilon_0$  = initial elongation [%]

## Belt Length

### Shortened belt length ( $l_s$ )

In applications without any tensioning device at all, the belt must be fabricated shorter by the amount equal to the required initial elongation.



The basic formula for the calculation of the shortened belt length ( $l_s$ ), that is the fabrication length, is:

$$l_s = \frac{l_e}{1 + \frac{\epsilon_o}{100}} = \frac{100 \cdot l_e}{100 + \epsilon_o} \quad [\text{mm}]$$

$l_e$  = length of the tensioned belt [mm]

$\epsilon_o$  = initial elongation [%]

Usually the geometric belt length ( $l_g$ ), this means the inner circumference of the tensioned belt, is known. The position of the neutral layer ( $s$ ) has therefore to be considered in the formula for the calculation of the shortened belt length:

$$l_s = \frac{100 \cdot [l_g + (2s \cdot \pi)]}{100 \cdot \epsilon_o} \quad [\text{mm}]$$

**Note:** If the drive is equipped with a tensioning device, but the available take-up displacement is not sufficient to obtain the effectively calculated take-up displacement ( $x_e$ ), the belt may be partially shortened.

## Tensile Force for 1% Elongation ( $k_{1\%}$ Value)

### Tensile force for 1% elongation ( $k_{1\%}$ value)

The  $k_{1\%}$  value indicates the tensile force per unit of belt width that is required to elongate it by 1% [N/mm].

### Tensile force for 1% elongation after running-in ( $k_{1\%a.r.i.}$ )

The correlation of force and elongation of synthetic material is influenced by the elapsed time after stretching, temperature and humidity. While the influence of temperature and humidity is quite complex (and will not be further discussed here), the influence of time on force/elongation behavior after stretching synthetic material cannot be neglected.

In the following it is described what happens when a synthetic material, like a power transmission belt, is elongated:

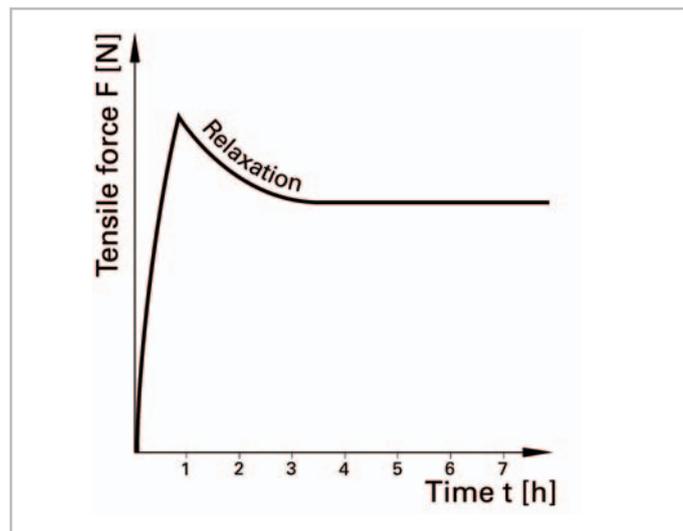
To achieve elongation a certain tensile force ( $F$ ) is required. At the end of the elongation the tensile force immediately starts to decrease, first considerably, later moderately, until the force remains constant. The explanation for this is a microscopic displacement of molecular chains against each other. This viscoelastic phenomenon is called "relaxation."

Habasit considers the relaxation of power transmission belts by measuring the  $k_{1\%}$  value after the relaxation phase or running-in time period.

This is why the value is called  **$k_{1\%}$  after running-in**:

$k_{1\%a.r.i.}$  = tensile force for 1% elongation per unit of width after running-in [N/mm]

The  $k_{1\%a.r.i.}$  is the decisive value for calculating the required belt width and the resulting shaft load after belt relaxation.



## Shaft Load

The described relaxation phenomena directly influence the shaft load.

If a power transmission belt is tensioned to the required initial elongation, the resulting shaft load will be at maximum ( $F_{Wpeak}$ ) immediately after elongation.

Where the belt is tensioned to a constant elongation, the shaft load decreases over the course of time. While the shaft load reduction is relatively large at first (the main part of the belt relaxation takes place within the first 2-3 hours after tensioning), it gradually tapers off until the shaft load remains constant ( $F_{Wa.r.i.}$ ).

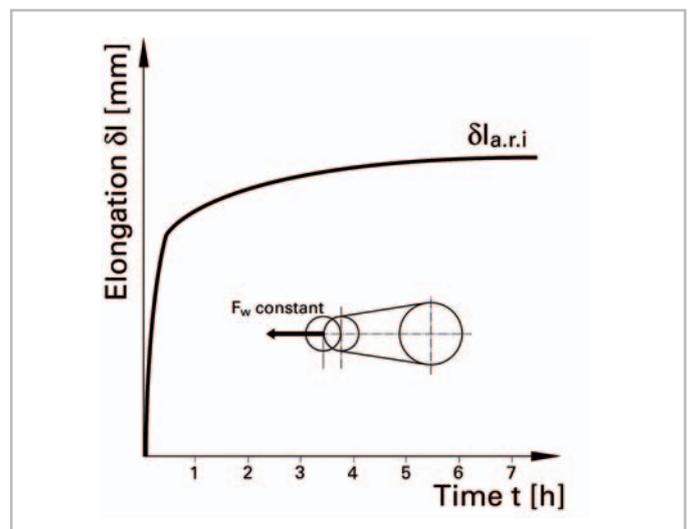
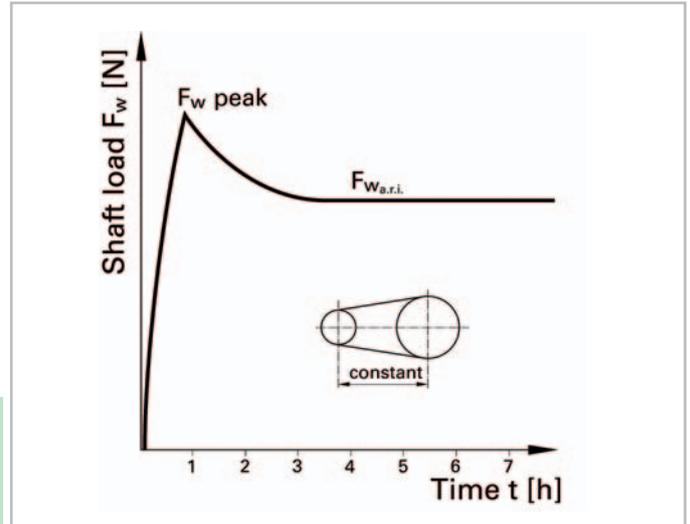
The highest shaft load ( $F_{Wpeak}$ ), appearing immediately after elongation, is about 40% to 50% higher than the shaft load after relaxation or after running-in ( $F_{Wa.r.i.}$ ), depending on belt type and elongation conditions.

This fact must be considered when specifying shafts and bearings (see the chapter on “Design guidelines, Bearings”), in the engineering of the drive frame, as well as during belt installation (see the chapter on “Belt installation”).

Habasit’s shaft load indications refer to the situation after relaxation, after running-in respectively.

We distinguish between the static shaft load (at standstill,  $F_{Ws}$ ) and the dynamic shaft load (in operation  $F_{Wd}$ ), where centrifugal forces are considered.

**Note:** Where the belt is tensioned by a constant force, mechanical force (hydraulic or pneumatic cylinder or spring) or by force of gravity, the shaft load remains constant, but the belt changes its length. This means it elongates after tensioning due to relaxation, until the length remains constant.



## Nominal Peripheral Force

---

The nominal peripheral force ( $F'_{UN}$ ) indicates the force which can be transferred from the circumference of the drive pulley to the belt in Newton per unit of belt width [N/mm].

The  $F'_{UN}$  is the product of the  $k_{1\%}$  after running-in ( $k_{1\%a.r.i.}$ ) and the admissible elongation ( $\epsilon_{adm}$ ) of the belt, considering the coefficient of friction ( $\mu$ ) between belt and steel pulley.

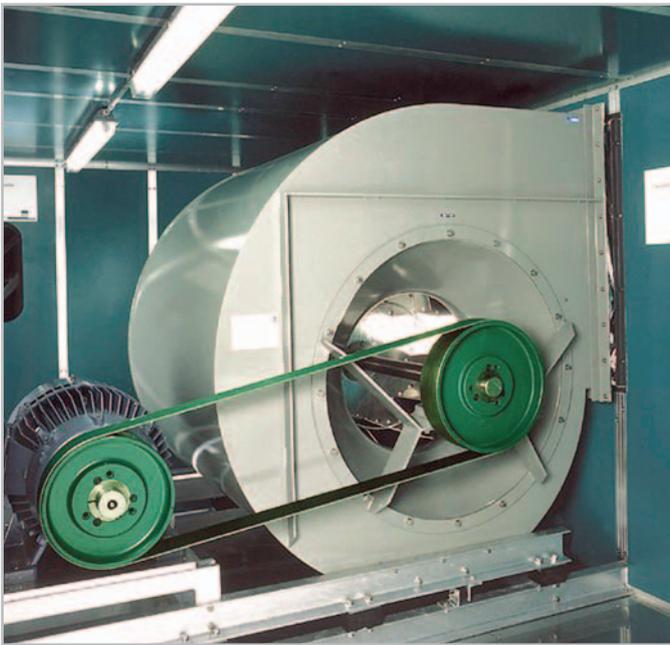
The admissible elongation is determined by extensive tests for each belt type.

Note: The nominal peripheral force indicates the effective strength of a power transmission flat belt.

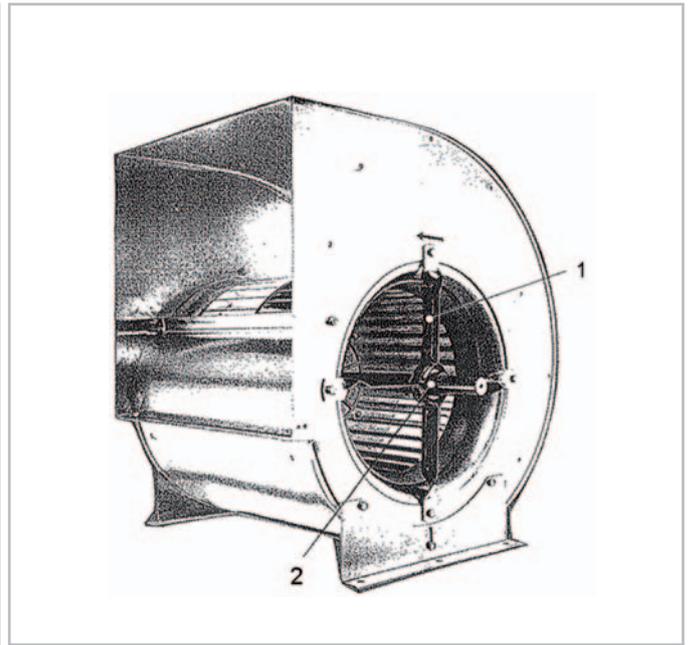
## General Drive Design

Flat belt drives transmit power by friction. This fact means that the belt needs to be pressed onto the periphery of the pulley with a certain force. This force creates a shaft load which has to be borne by the shafts and bearings. Finally, the installation has to take up all forces without appreciable distortion. This leads to the following conclusions:

- The drive structure must be rigid and distortion-resistant, i.e. machine frame, shaft bearings and motor mounting must be sized in accordance with the maximum developed tension forces and related shaft loads.
- All shaft and roller axes coming into contact with the belt must be perpendicular to the belt running axis.
- The installation must be grounded (electrically connected with the earth potential) in order to prevent an electrostatic charge. Exercise caution with synthetic-supported bearings or mobile installations on rubber wheels!



a) Example of an appropriate, distortion-resistant bearing support



b) Example of an inappropriate design

- 1 Weak and non-distortion-resistant design of the bearing support
- 2 Bearings supported by rubber rings (mechanically weak and cause electrostatic charge)

## Flat Belt Pulleys

### Pulley material

For peripheral speeds of  $v \leq 35$  m/s, it is preferable to choose **cast iron** pulleys. For  $v > 35$  m/s, use steel pulleys or cast iron pulleys of higher strength. The above data refer to solid pulleys and center disc pulleys.

Injection-molded pulleys of **duroplastic** material are becoming common for weight and cost reasons. In general it is not recommended to use duroplastic pulleys for driving or driven pulleys due to the low heat conductivity of synthetic material which can result in inadmissible temperatures of the pulleys and belt.

**Aluminum** pulleys and rollers have to be **anodized**. However, premature wear and “blackening” of the pulleys has been observed.

### Pulley dimensions

Pulley diameter and width depends on the requirements and geometric data of the application.

### Pulley width

The width of the pulleys should be at least 1.05 to 1.1 times belt width  $b_o$ .

### Pulley diameter

The required transmission ratio for the application must be observed.

The minimum pulley diameter according to the flat belt product data sheet must be respected.

The maximum diameter is usually limited by the size of the installation, often by the belt safety guard.

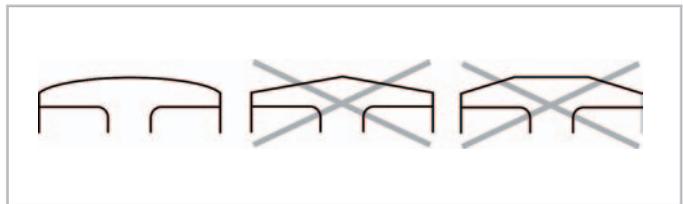
General rule: The larger the pulley diameters, the higher the belt speed and, consequentially, the lower the shaft load.

Basically, pulleys may have any dimensions. Whenever possible, however, pulleys with a standard diameter according to ISO 22 should be used.

### Pulley crown

To prevent the flat belts from running off, **at least one of the pulleys has to be crowned**, preferably the larger pulley, or the pulley with the largest arc of contact.

It is recommended that the shape of the profile should be a regular, symmetrical curve. Do not use conical or cylindrical-conical shaped pulleys, and avoid sharp edges under all circumstances.



Commercial pulleys are usually crowned according to ISO 22. **If Habasit flat belts are used, the height of the crown can be reduced** because of their superior lateral rigidity and subsequent excellent tracking properties.

## Flat Belt Pulleys

Whenever new pulleys are made, Habasit recommends crown heights as indicated in the table below:

Pulley diameter acc. to ISO 22	Recommended crown height (h) [mm]					Crown height acc. to ISO 22 <b>Not recommended</b> [mm]				
							Pulley width [mm]			
[mm]	Pulley width b acc. to ISO 22 [mm]					Pulley width [mm]				
	20, 25, 32, 40, 50	63, 71, 80, 90, 100	112, 125, 140, 160	180, 200, 244, 250	280, 315, 355, 400	b ≤ 250	b ≥ 280			
40	<b>0.3</b>	<b>0.3</b>				<b>0.3</b>	<b>0.3</b>			
50										
63										
71										
80										
90										
100										
112										
125			<b>0.3</b>							
140	<b>0.4</b>	<b>0.4</b>	<b>0.4</b>			<b>0.4</b>	<b>0.4</b>			
160										
180						<b>0.4</b>				
200						<b>0.5</b>				
224							<b>0.5</b>	<b>0.5</b>		
250					<b>0.4</b>		<b>0.6</b>	<b>0.6</b>		
280					<b>0.5</b>		<b>0.7</b>	<b>0.8</b>		
315	<b>0.5</b>	<b>0.5</b>								
355										
400					<b>0.6</b>		<b>0.8</b>	<b>1.0</b>		
450						<b>0.7</b>	<b>0.8</b>	<b>1.0</b>		
500										
560					<b>0.6</b>		<b>0.9</b>	<b>1.2</b>		
630			<b>0.6</b>	<b>0.6</b>	<b>0.7</b>		<b>0.8</b>	<b>1.2</b>	<b>1.2</b>	
710										
800					<b>0.7</b>		<b>1.0</b>	<b>1.2</b>		
900					<b>0.8</b>		<b>0.9</b>	<b>1.5</b>		
1000	<b>0.7</b>	<b>0.7</b>								
1120									<b>1.1</b>	<b>1.5</b>
1250							<b>0.8</b>		<b>1.0</b>	<b>2.0</b>
1400					<b>0.9</b>		<b>1.2</b>	<b>2.0</b>		
1600										
1800			<b>0.8</b>	<b>0.8</b>						
2000					<b>0.8</b>	<b>1.0</b>	<b>1.1</b>	<b>1.3</b>	<b>1.8</b>	<b>2.5</b>

For recommendations regarding pulley diameters > 2000 mm, please contact your Habasit partner.

## Flat Belt Pulleys

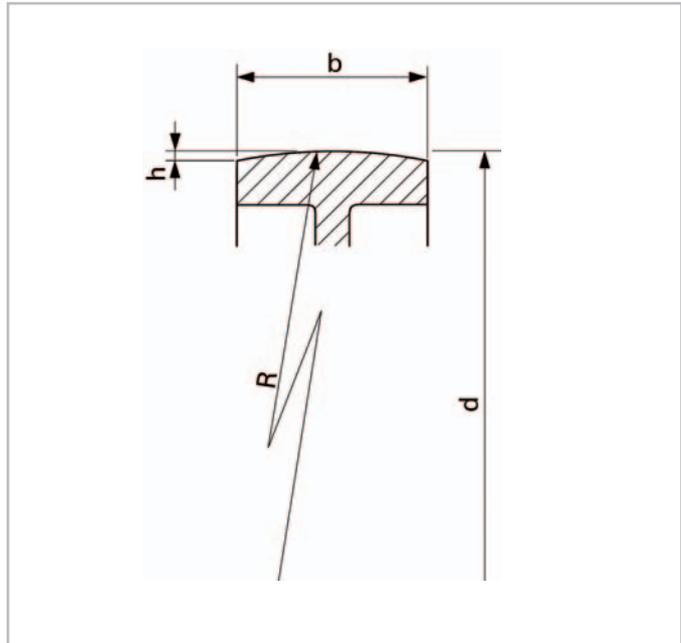
Crown heights greater than indicated in the table above may result in a loss of guiding effect, especially with laterally stiff belts.

Correlation of crown (h) and manufacturing radius (R):

$$R = \frac{h}{2} + \frac{b^2}{8h} \quad [\text{mm}]$$

$$h = \frac{b}{2} \operatorname{tg} \left( \frac{\arcsin \left( \frac{b}{2R} \right)}{2} \right) \quad [\text{mm}]$$

The higher the arc of contact, the better the tracking effect of crowned pulleys.

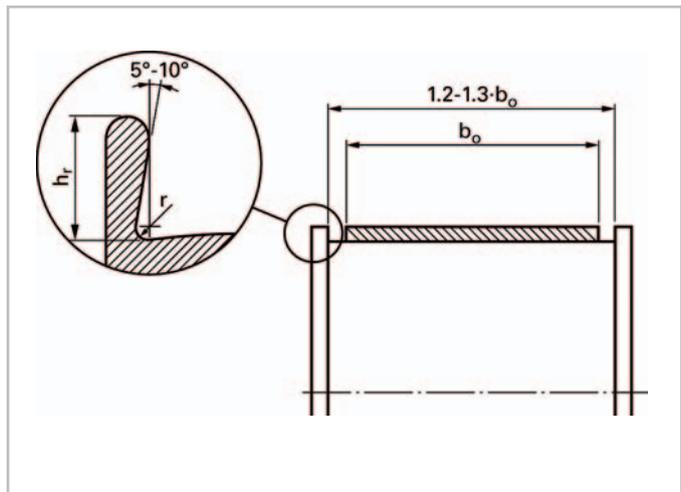


### Flanged pulleys

Avoid flanged pulleys and flanged rollers because there is a risk of belt damage if the belt runs onto the flanges.

In exceptional cases, e.g. where long tangential belts have to be kept in the right position during installation, flanged pressure rollers may be acceptable. However, the belt should not touch the flanges during normal operation.

The width of the running surface should be 20% to 30% wider than the belt width ( $b_0$ ). The flange height ( $h_r$ ) should be about the same as the belt thickness and should be undercut to minimize the contact area with the belt.



## Flat Belt Pulleys

### **Pulley running surface**

Clean and smooth running surfaces increase the efficiency and service life of power transmission belts.

The running surface of driving pulleys must not be too smooth, due to the risk of stick-slip and noise creation, and not too rough (no knurled surfaces!) as this can cause excessive belt wear and premature belt failure.

Habasit's recommendation for the roughness of the running surface:

$R_a = 6.3$  to  $3.2 \mu\text{m}$  (attainable by normal tooling on a lathe)

$R_a$  = arithmetical mean deviation of the profile according to ISO 4287

For small pulley and roller diameters (approx. 200 mm) a smoother surface is possible, but not necessary, e.g.  $R_a = 1.6 \mu\text{m}$  (only attainable on a precision lathe with high accuracy).

Avoid smoother surface roughness than  $R_a = 3.2 \mu\text{m}$  on large and wide driving and driven pulleys due to the risk of stick-slip.

The indication "R<sub>z</sub>" (ten point height) is deleted as an ISO parameter, as well as the indication "N", the roughness grade according to ISO 1302.

### **Pulley balance quality**

For peripheral speeds up to  $v = 30$  m/s and diameter  $d = 355$  mm, pulleys are usually balanced in one plane, quality grade G 1.6, according to ISO 1940 (VDI 2060).

For higher peripheral speeds of  $v > 30$  m/s and diameter  $d > 355$  mm, pulleys are best dynamically balanced in two planes.

## Bearings

### Bearing selection and specification

Selection and specification of bearings according to the manufacturers' guidelines.

### Bearing load

It is a prerequisite for the determination of the bearing load to know the shaft load created by the tensioned belt (see the chapter on "Technical belt data, Shaft load").

When using the POWER-SeleCalc calculation program, both the static shaft load ( $F_{Ws}$ ) and the dynamic shaft load ( $F_{Wd}$ ), are determined while calculating the belt.

Please consider when specifying the bearings that the highest shaft load ( $F_{Wpeak}$ ), appearing for a short time immediately after elongation, is about 40 % to 50 % higher than the indicated shaft load  $F_{Ws}$  or  $F_{Wd}$ .

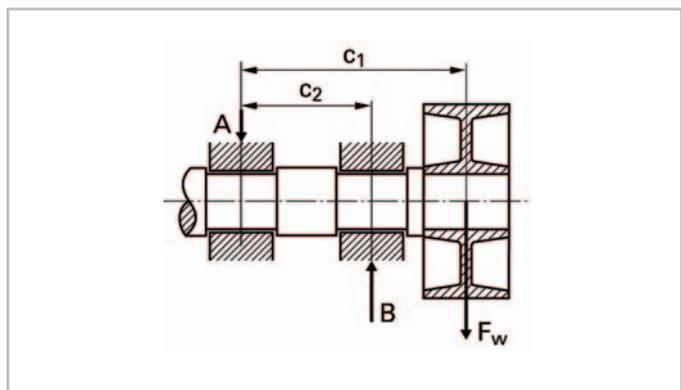
**Note:** In rare cases, e.g. if a very strong belt is unusually fast elongated, the shaft load appearing for a short time immediately after the first elongation can be up to 100% higher than the indicated shaft load in the POWER-SeleCalc calculation program.

If the basis for the calculation of the bearing load, the shaft load ( $F_W$ ), is known, the actual bearing load can be calculated as follows:

- **One-side bearing arrangement**

Load on bearing A =  $F_W \cdot \frac{c_1 - c_2}{c_2}$  [N]

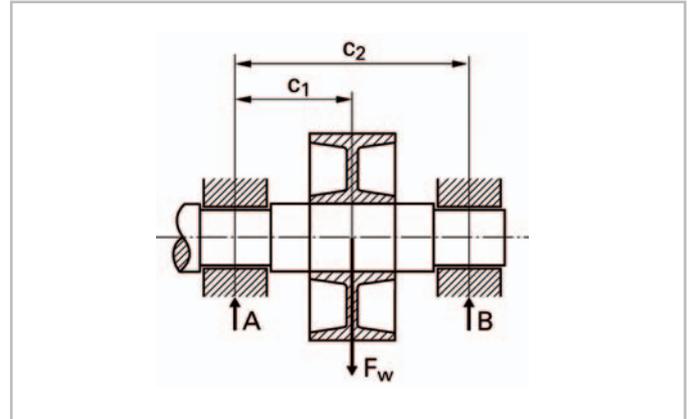
Load on bearing B =  $F_W \cdot \frac{c_1}{c_2}$  [N]



### • Two-side bearing arrangement

$$\text{Load on bearing A} = F_w \cdot \frac{c_2 - c_1}{c_2} \quad [\text{N}]$$

$$\text{Load on bearing B} = F_w \cdot \frac{c_1}{c_2} \quad [\text{N}]$$



It goes without saying that the resulting bearing load must not exceed the admissible bearing load indicated in the bearing data sheet.

If the calculated maximal bearing load that appears is close to the limit or exceeds the admissible load of the bearings used, the following measures can be taken:

- If possible increase pulley diameters in order to reduce the shaft load
- Choose a belt tension system using mechanical force (hydraulic or pneumatic cylinder or spring) or force of gravity (constant shaft load).
- Tension the belt in two steps when installing (see the chapter on "Belt installation, Two step tensioning").

**Note:** Contrary to the wide-spread opinion, the shaft load and the resulting bearing load of power transmission flat belts are not higher, but about the same as in other non-positive driving elements such as V-belts and poly-V-belts, provided that they are installed properly.

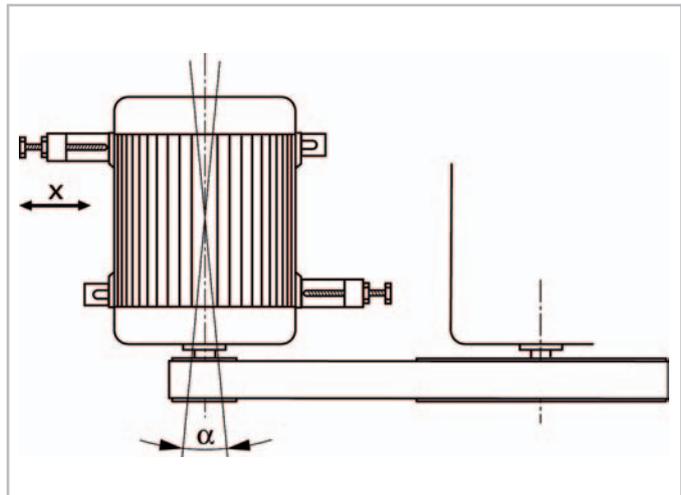
## Tensioning Device

Correct and sufficient initial elongation is a prerequisite for trouble-free operation of power transmission flat belts. The calculated initial elongation ( $\epsilon_0$ ) must be observed!

One has to distinguish between drive systems with variable centre distance, systems with defined take-up, systems with tensioning pulley, and systems with no tensioning device.

### Systems with variable centre distance

The most common system for two pulley drives. Usually the motor is mounted on an adjustable base. The belt is tensioned by moving the base. After tensioning, the base is fixed with screws.



Sufficient tensioning length in the direction of  $x$  must be provided corresponding to installation and belt length tolerance due to the influences of temperature and humidity on the belt length (namely the polyamide traction layer) etc. Furthermore, the shaft has to be adjusted square to the belt running axis by adjusting the  $\alpha$  angle.

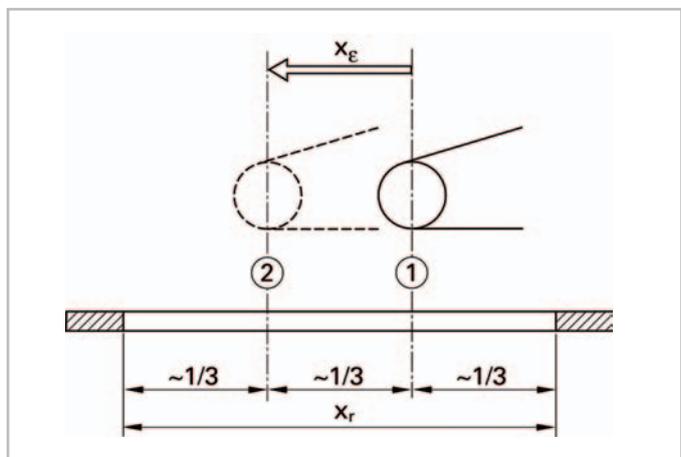
Recommended take-up of the tensioning device:

$$x_r \cong 3 \cdot x_\epsilon$$

- ① Position of the pulley with un-tensioned belt
- ② Position of the pulley after tensioning to initial elongation  $\epsilon_0$

$x_\epsilon$  Effective required take-up displacement [mm]

$x_r$  Recommended take-up of the tensioning device [mm]



## Tensioning Device

### Systems with defined take-up

Due to the well-defined take-up displacement (the belt is elongated to a fixed end position), improper adjustment of the required initial elongation during installation can be avoided.

- $l_{eff}$  = effective length (fabrication length) of the un-tensioned belt [mm]
- $l_e$  = length of tensioned belt [mm]
- $c_e$  = center distance of tensioned belt [mm]
- $x_e$  = take-up displacement [mm]

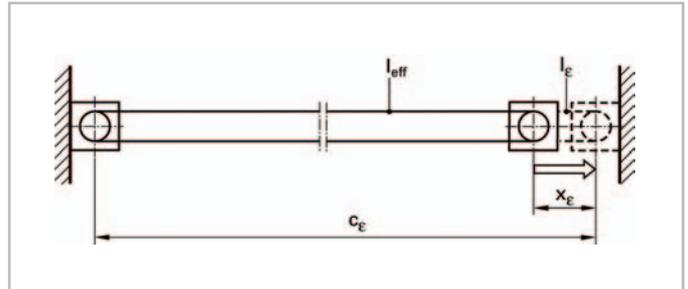
Machines with defined take-up displacement appear to be an intelligent and user-friendly solution. However, the system has some drawbacks:

1. The effective belt length (fabrication length,  $l_{eff}$ ) must be produced with a high level of accuracy. Small differences in length may cause considerable deviations in belt tension. This is especially true with a short belt length and/or belts with a high modulus of elasticity (high  $k_{1\%}$  value).

Observing the exact belt fabrication length is highly important with this system! Recommended fabrication length tolerance: **0/-** yy mm.

Deviations in belt length cannot be compensated for on such a machine design. Re-tensioning is impossible. Problems including slip and premature belt wear result if the belt is too long.

2. Influences on the belt dimension due to temperature or humidity changes (polyamide belts) cannot be compensated for and may lead to an increase or decrease in the shaft load.
3. Tensioning can be done by a hand-driven spindle, which is quite a slow process that allows the belt to relax. Other methods, such as a knee-lever or pneumatic or hydraulic cylinder, tension the belt very fast, causing high belt stress and high shaft load before the belt relaxes, leading to excessive bearing and shaft load.



Abrupt tensioning, e.g. provided by hydraulic or pneumatic cylinders, may damage aramide belts (TF-range).

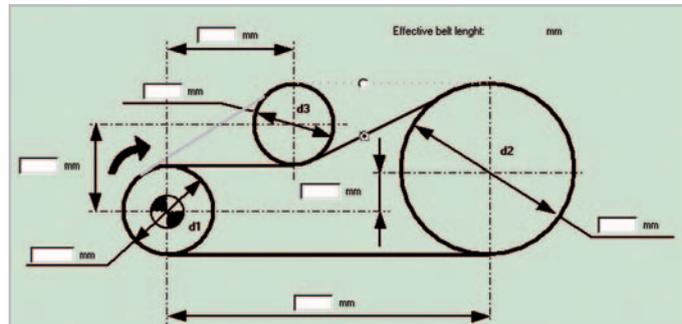
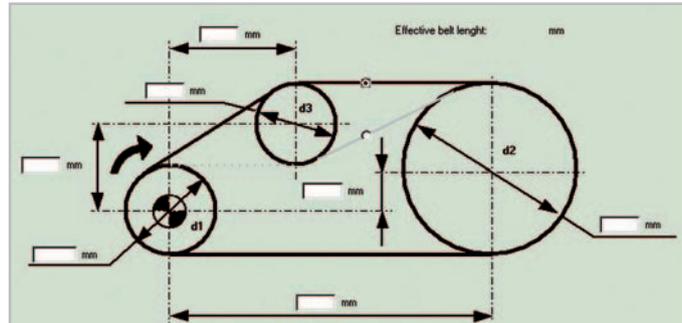
4. This kind of tensioning device is often designed for one particular belt type. Changing later to another belt type can lead to problems.

## Tensioning Device

### Systems with tensioning pulley

In this system, the center distance between the driving and the driven pulley is fixed. A tensioning pulley, preferably placed on the slack side (less tensioning forces required), pushes the belt and thus provides the required initial elongation. The required pushing force can be provided by a hydraulic or pneumatic cylinder, spring load, or by a gravity system.

The Habasit POWER-SeleCalc calculation program automatically determines the shaft load of all three pulleys and the required take-up.



### Systems without tensioning device

Old drive designs sometimes have no tensioning device at all. In this case the belt has to be forced onto the pulleys by hand.

In systems without tensioning device the required initial elongation ( $\epsilon_0$ ) is determined by reducing the length to the shortened belt length ( $l_s$ ), which is the fabrication length.

It is important to pay attention when installing the belt. Twisting and excessive lateral forces to the belt, etc. must be avoided.

Aramide belts (TF-range) are not recommended for use in such applications due to the risk of damaging the traction layer during installation.

## Tangential Belt Drive

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### Overview

In addition to the classical two pulley drive, there are many different drive applications where the flat power transmission belt is the ideal solution.

The following drive systems are presented in this chapter:

- Tangential belt drive
- Spindle tape drive
- Live roller drive
- Multi pulley drive (power branching)
- Mule drive
- Half-cross drive

### Introduction to the tangential belt drive

The tangential belt drive is mainly used in the textile industry for driving spindles on ring spinning, open-end spinning, twisting and texturizing machines.

In principle, this is a tangential drive where the power is not transmitted to a single driven pulley but to an array of spindles or rotors. The spindles (rotors) are arranged in a linear manner with the belt pressed against them by pressure rollers to drive them tangentially.

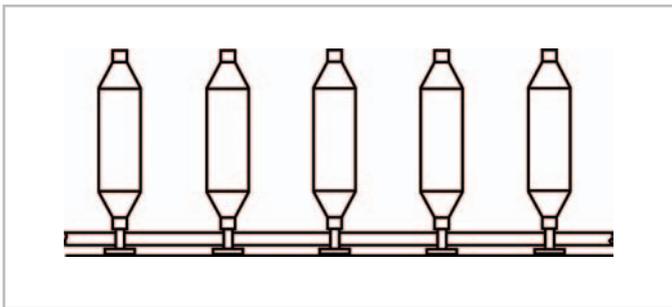
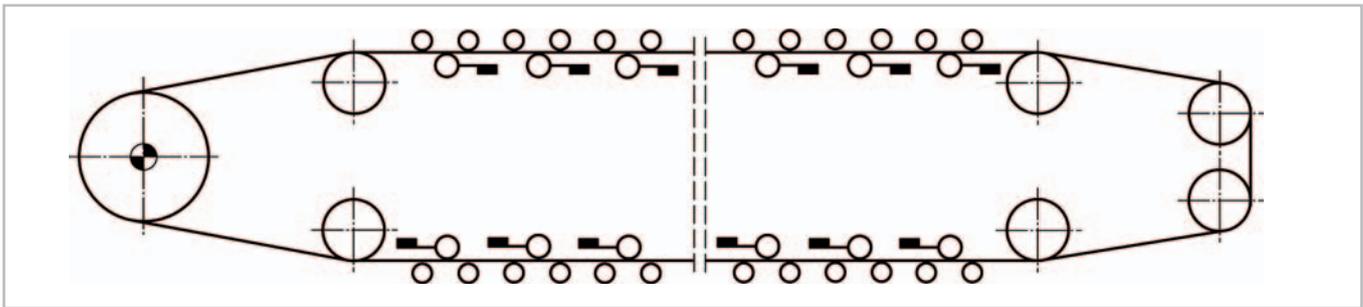
This is why it is referred to as a “tangential belt drive”.

Tangential belt drives may have various arrangements, depending on the machine manufacturer, type and size of machines, etc. The most important systems are described in the following, without claim to completeness. The advantages and weaknesses described are general statements, which can be compensated for by special machine designs or special belt types, depending on the situation.

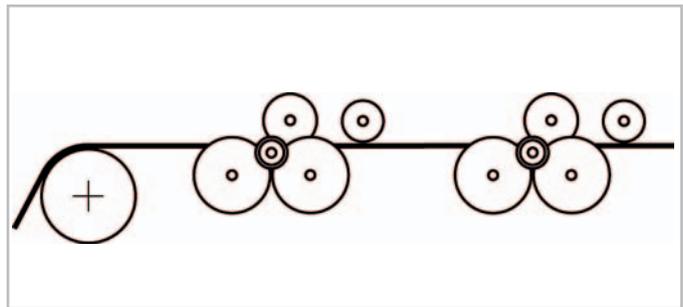
## Tangential Belt Drive

### Single belt/single drive system

The tangential belt is driven on one end of the machine by a drive pulley and on the other end diverted by one or two rollers to return to the drive. The belt is normally driven on its inner side; on the outer side it drives hundreds of spindles or rotors.



Ring spinning



Open-end spinning

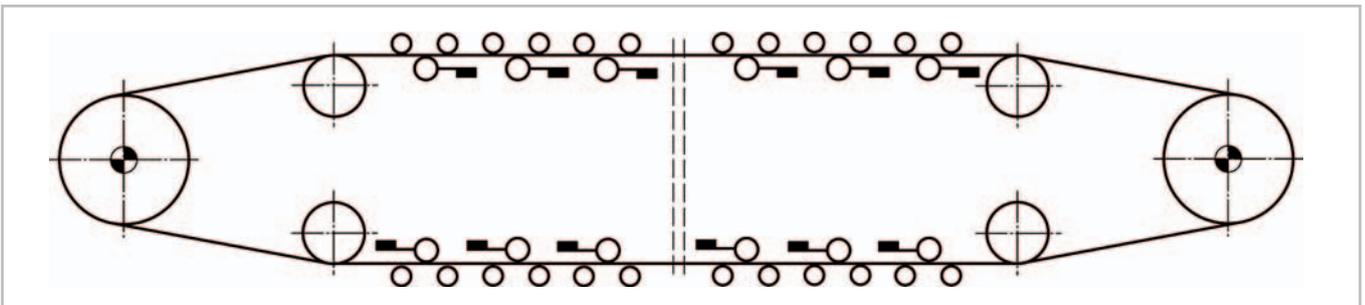
Advantages of the system	Weaknesses of the system
<ul style="list-style-type: none"> <li>• Simple drive principle</li> <li>• Large pulleys, few flections, no counter flection → long belt service life</li> <li>• Easy belt installation</li> </ul>	<ul style="list-style-type: none"> <li>• Strong belts required, thus                             <ul style="list-style-type: none"> <li>• high shaft and bearing load</li> <li>• heavy machine design</li> <li>• long take-up displacement <sup>1)</sup></li> </ul> </li> <li>• Significant deviation of spindle rpm from first to last spindle <sup>1)</sup></li> <li>• Demanding belt tracking</li> <li>• Efficiency not optimal</li> <li>• If belt fails all spindles (rotors) are out of production</li> </ul>

<sup>1)</sup> Can be compensated for by using TF-belts with aramide tensile members

## Tangential Belt Drive

### Single belt/dual drive system

The tangential belt is driven by two motors placed at both ends of the machine. This reduces the power to be transmitted per motor and belt to 50 % compared with the “one-belt-one-drive” system.



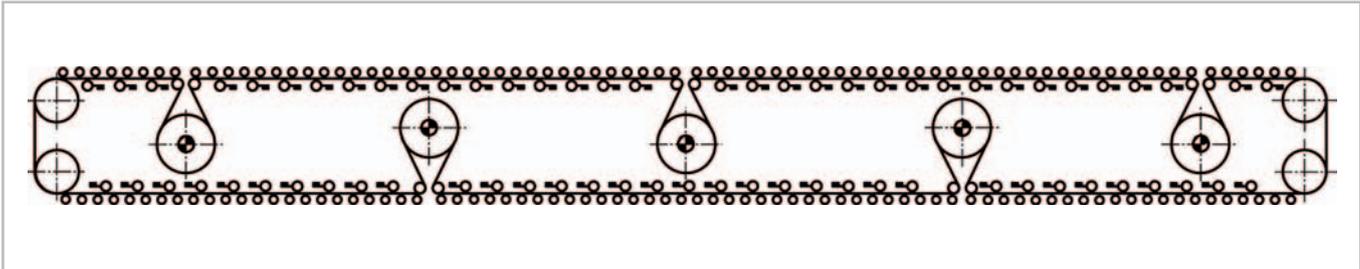
Advantages of the system	Weaknesses of the system
<ul style="list-style-type: none"> <li>• Lower strength belts required compared with the single belt/single drive system, thus                             <ul style="list-style-type: none"> <li>• smaller shaft and bearing load</li> <li>• lighter machine design</li> </ul> </li> <li>• Automatic speed control and adjustment of variable speed motors is less demanding compared with “multi drive” systems</li> <li>• Large pulleys, few flections, no counter flexion → long belt service life</li> <li>• Easy belt installation</li> </ul>	<ul style="list-style-type: none"> <li>• Deviation of spindle rpm from first to last spindle considerable <sup>1)</sup></li> <li>• Demanding belt tracking</li> <li>• Greater efficiency compared with the “single belt / single drive;” but still not optimal</li> <li>• If belt fails, all spindles (rotors) are out of production</li> </ul>

<sup>1)</sup> Can be compensated by using TF- belts with aramide traction layers

## Tangential Belt Drive

### Single belt / multi drive system

With the multi motor drive, the tangential belt is driven by several motors arranged in regular intervals around the machine. As a consequence, lower strength tangential belts can be used. Machines with such a group drive have been produced to 60 meters in length, containing as many as 1500 spindles.



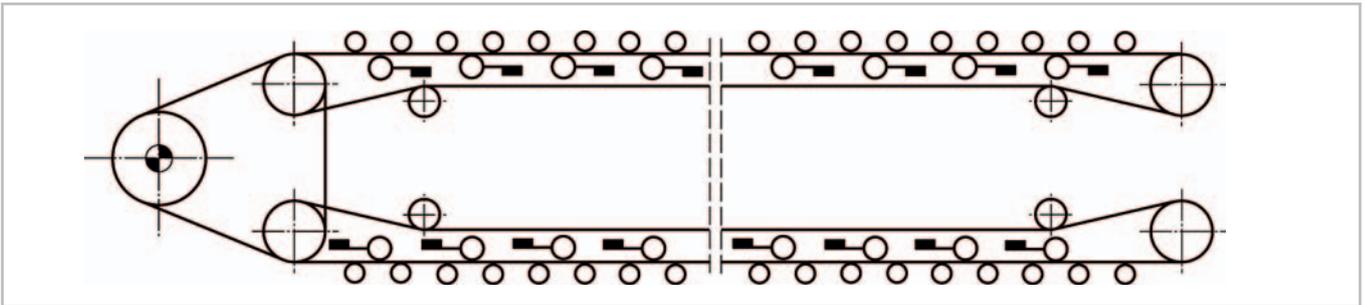
The number of revolutions of the individual motors must be perfectly synchronized and the diameter of the driving pulleys have to be in a narrow tolerance, otherwise the belt assumes the stresses of equalizing the speed, resulting in premature belt wear and reduced belt service life.

Advantages of the system	Weaknesses of the system
<ul style="list-style-type: none"> <li>• Lower strength belts required compared with the single belt/single drive system, thus                             <ul style="list-style-type: none"> <li>• smaller shaft and bearing load</li> <li>• lighter machine design</li> </ul> </li> <li>• High efficiency, low energy consumption</li> <li>• Minimal difference in spindle rpm</li> </ul>	<ul style="list-style-type: none"> <li>• Automatic speed control and adjustment of variable speed motors is                             <ul style="list-style-type: none"> <li>• technically demanding</li> <li>• expensive</li> <li>• sensitive</li> </ul> </li> <li>• Premature belt wear, reduced service life and irregular yarn quality result if motors are not perfectly synchronized</li> <li>• If belt fails, all spindles (rotors) are out of production</li> <li>• Reduced service life due too small pulleys, a high number of reverse bending cycles and because only one side of the belt is used</li> </ul>

## Tangential Belt Drive

### Dual belt drive system

Two separately-driven tangential belts, one located on each side of the machine, each drives half of all the spindles, thus reducing the power to be transmitted per belt to 50%. This permits the use of lower strength belts and lower belt tension.



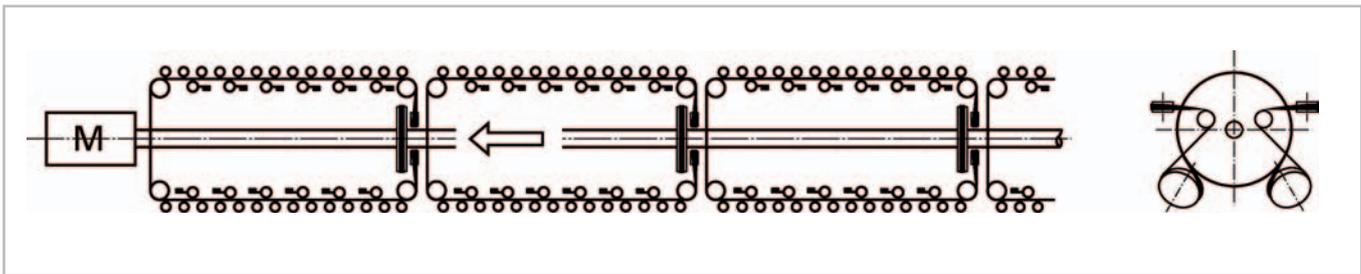
Advantages of the system	Weaknesses of the system
<ul style="list-style-type: none"> <li>• Lower strength belts required compared with the single belt/single drive system, thus                             <ul style="list-style-type: none"> <li>• smaller shaft and bearing load</li> <li>• lighter machine design</li> </ul> </li> <li>• Relatively large pulleys, few flexions and counter flexions → long belt service life</li> <li>• If one belt fails, production can still run at 50% until repair is made</li> </ul>	<ul style="list-style-type: none"> <li>• Different initial elongation and running conditions for the two belts</li> <li>• Difference in spindle rpm between left and right side (due to creep of the main drive) <sup>1)</sup></li> <li>• Demanding belt tracking</li> <li>• Demanding belt specification</li> <li>• Additional time required to replace all belts</li> </ul>

<sup>1)</sup> Can be reduced by using TF- belts with aramide traction layers

## Tangential Belt Drive

### Section (segmented) drive system

With the section drive (also called segmented or group drive) a single motor drives a central shaft, which is oriented along the length of the machine. Driving pulleys are fixed on the shaft and drive multiple tangential belts. Each tangential belt drives a small group of spindles, e.g. 24 spindles on each side.



Advantages of the system	Weaknesses of the system
<ul style="list-style-type: none"> <li>• Lower strength belts required</li> <li>• Small difference in spindle rpm between left and right side of the machine</li> <li>• High efficiency, low energy consumption</li> <li>• If one belt fails, only limited loss to production until repair is made</li> </ul>	<ul style="list-style-type: none"> <li>• Extensive drive system</li> <li>• Small pulley diameters, high numbers of reverse bending cycles and belt twists → reducing belt service life</li> <li>• Limited number of suitable products (mainly TC-range)</li> <li>• Accurate belt length required due to defined take-up</li> </ul>

## Tangential Belt Drive

### Technical requirements on tangential belts

The demands on tangential belts are many and may have different priority, depending on the type of application, machine type, belt speed, operating conditions, maintenance capabilities, etc.

- **Energy saving**

Modern, flexible belts with a high modulus of elasticity, such as polyester fabric (TC-range) and aramide fabric (TF-range), can produce a high degree of efficiency and as a consequence, realize considerable savings in energy costs.

- **Long service life, low down-time**

This highly stressed machine element can still deliver a long service life provided that the belt is selected, installed and maintained according to these guidelines.

- **Easy, fast and reliable joining method**

If belts have to be joined on the machine, an easy joining method – producing a uniform, reliable splice – is important in order to optimize up-time. The joint (splice) must not lead to belt vibrations.

- **Suitable and constant force/elongation-ratio**

An optimal force/elongation-ratio (E-modulus,  $k_{1\%}$ -value), which remains constant throughout the belt's service life ensures highly consistent and superior yarn quality, low belt maintenance, and long belt life.

- **High and constant coefficient of friction**

Tangential belts must transmit the necessary peripheral force without slipping under all operating conditions. This requires a high coefficient of friction of the cover that will remain constant during the entire service life. The normal influence of humidity, batching oil, fibers and other debris must not lead to slipping problems.

- **Vibration-free running**

For reasons of noise control and yarn quality, as well as with regard to achieving a high service life of the tangential belt, spindle bearings and other machine parts, the belt should provide quiet, vibration-free operation, particularly at the highest running speed. Uniform belt thickness and a homogeneous joining area are, therefore, important belt features.

- **Minimum run-up time**

After splicing of the thread, the spindle (rotor) brake is released and the spindle (rotor) is again accelerated to its normal operating speed. The run-up time has to be within a time frame of few seconds. This is attainable with a high E-modulus ( $k_{1\%}$ -value) and a high and consistent friction tangential belt.

- **Perfect tracking, no maintenance**

To ensure optimum, maintenance-free belt performance and service life, tangential belts must not run off the pulleys and/or whirls during operation. Therefore, proper component alignment and belt tension must be ensured.

- **Short take-up**

The considerable length of today's textile machines should not be additionally increased by the need for a long take-up mechanism. A high E-modulus ( $k_{1\%}$ -value) of the tangential belt is, therefore, desirable.

- **High accuracy of spindle revolutions**

Consistent yarn quality is a function of spindle speed accuracy. A high E-modulus ( $k_{1\%}$ -value) produces less creep in the belt drive, which means a smaller speed difference between the first and the last spindle, thereby improving yarn quality.

- **Resistant to chemicals**

Belts must be resistant to typical lubricating chemicals (oil, fat, batching oil, avivage) to ensure consistent performance and optimum service.

## Tangential Belt Drive

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### **Recommended product range**

For new machines with a high focus on low energy consumption:

- **TC-range**

For highly demanding applications regarding shortest take-up, lowest energy consumption and highest accuracy of rpm:

- **TF-range**

For older machines, flanged pulleys and very warm environments:

- **S-range**

### **Belt calculation**

If the machine data are known (complete the questionnaire in the appendix), the required belt data can be calculated exactly by means of the POWER-SeleCalc program.

**Note:** The calculation of tangential belts is quite demanding, even with the POWER-SeleCalc program, and specific know-how is required. In case of doubt we recommend to contact your Habasit partner to perform or check your calculation.

### **Design recommendations**

The general statements in the chapter "Design guidelines" should be observed. Use crowned pulleys and rollers, and avoid flanged pulleys!

It is always good to contact your Habasit partner for detailed support.

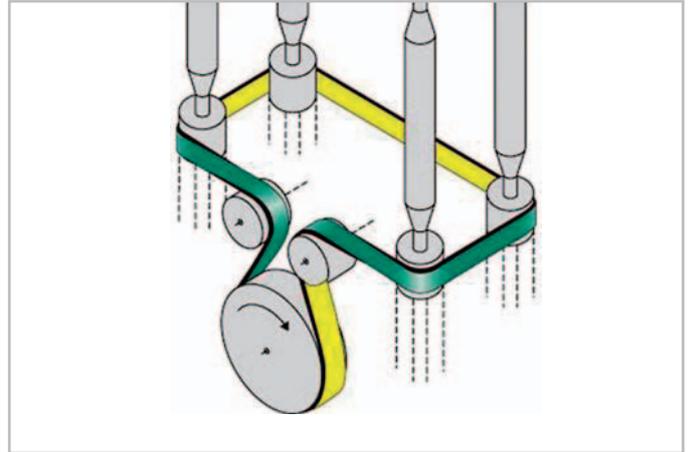
### **Installation and maintenance**

The general statements in these chapters should be observed.

## Spindle Belt Drive

### Introduction

The spindle drive is an alternative to the tangential belt. It is used in the textile industry for driving spindles on ring spinning and twisting machines. The spindle tape touches the whirls with an arc of contact of at least 90°.



### Technical requirements on spindle tapes

High quality spindle tapes must have specific properties such as:

- **Energy saving**

Modern, flexible spindle tapes have a high degree of efficiency. As a consequence, considerable energy cost savings can be realized.

- **Easy, fast and reliable joining method**

Considering that hundreds of spindle tapes per machine have to be made endless, an easy (preferably adhesive-free) and reliable joining method is required.

- **Highest spindle revolution (rpm)**

Spindle tapes for modern spinning machines must be designed for spindle speeds up to 20,000 rpm and higher.

- **High accuracy of spindle revolution**

A high modulus of elasticity produces less creep, which means that a smaller speed difference results between the first and the last spindle, which in turn improves yarn quality.

- **No fiber/fluff accumulation**

Spindle tapes must have sharp, clean, smooth edges, and must not accumulate static charges, so that no fibers or debris is attracted and sticks to the tape surface, thus reducing friction.

- **Long service life, low down-time**

A long service life of this highly stressed machine element can be expected.

- **Low speed loss of running spindles when neighbor spindles are stopped**

When a spindle is braked, it is expected that the adjacent spindles continue to run with negligible loss of speed (objective: uniform yarn quality).

- **High temperature resistance**

At thread breakage, the spindle will be stopped by a mechanical break. The spindle tape, however, continues to run on the stopped whirl. The resulting temperatures of up to 60 °C must be overcome by the spindle tape without any damage.

- **Minimum run-up time**

After automatic or manual splicing of the thread, the spindle brake is released and the spindle is again accelerated to its nominal number of revolutions. The run-up time must be within a time frame of a few seconds.

## Spindle Belt Drive

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### Available spindle tape products

- W-8** The best energy-saving spindle tape in the world (adhesive-free joint)
- W-16** Stronger alternative to W-8 (adhesive-free joint)
- TS-5** The most popular spindle tape in the world (polyamide type); excellent heat resistance, very robust, long lasting
- TS-55** Stronger alternative to TS-5
- TS-10** Suitable when lubricants are present; not applicable for applications requiring the braking (stopping) of spindles.
- HS-5,** Economical alternatives to TS-5 and TS-55  
**HS-55** (polyamide type)

### Belt selection and calculation aids

Belt selection is according to the requirements of the machine and customer preferences. Contact your Habasit partner to provide calculations for special requests.

### Design recommendations

The general statements in the chapter "Design guidelines" should be observed.

### Installation and maintenance

The general statements in these chapters and the following additional statement must be observed.

All spindle tapes have two different friction covers. In order to ensure trouble-free, efficient performance of the tapes, it is essential to follow the following rules during installation:

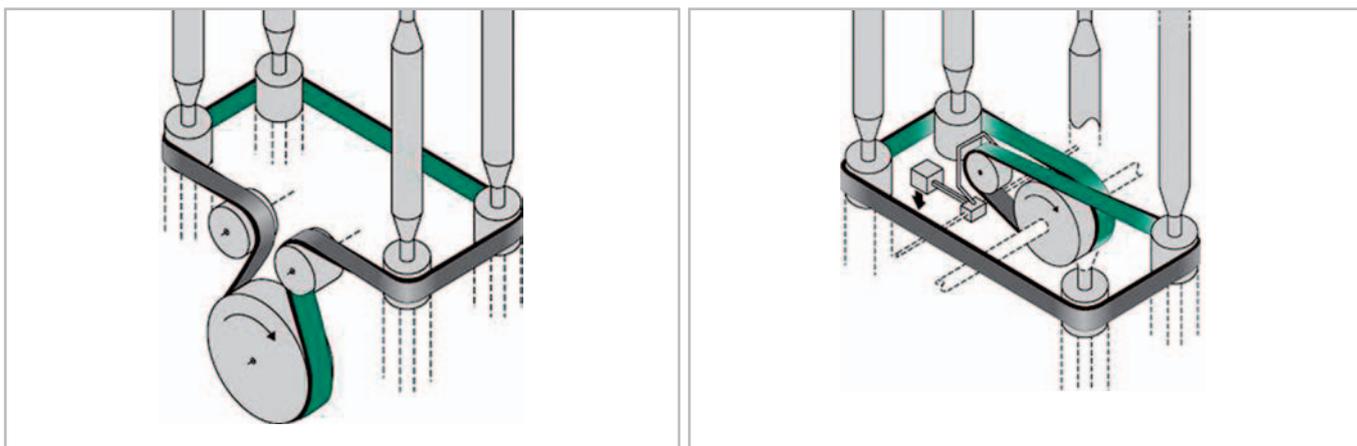
- High coefficient of friction on driving pulley
- Low coefficient of friction on spindle whirl

## Spindle Belt Drive

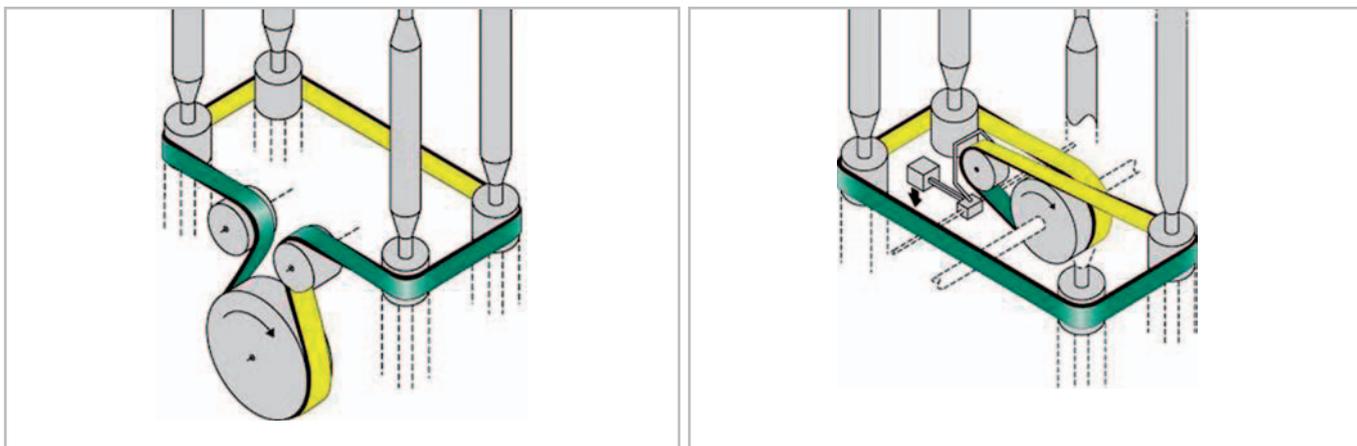
### Correlation of color and coefficient of friction:

Spindle tape type	High coefficient of friction on driving pulley side	Low coefficient of friction on whirl side
W-8, W-16	Black	Green
TS-5, TS-55, TS-10	Green	Yellow
HS-5, HS-55	Green	Beige

Correct installation of W-8 and W-16:



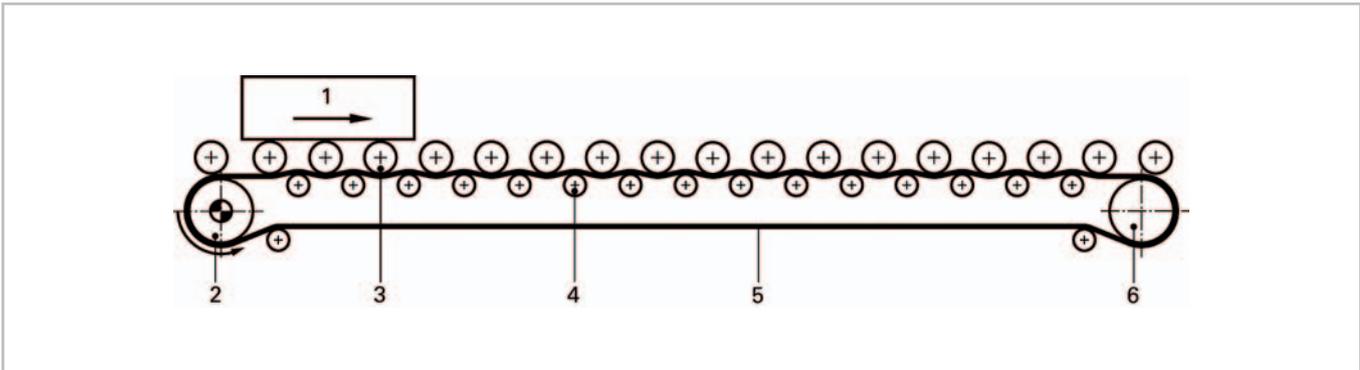
Correct installation of TS-5 (HS-5), TS-55 (HS-55) and TS-10:



## Live Roller Conveyor Drive

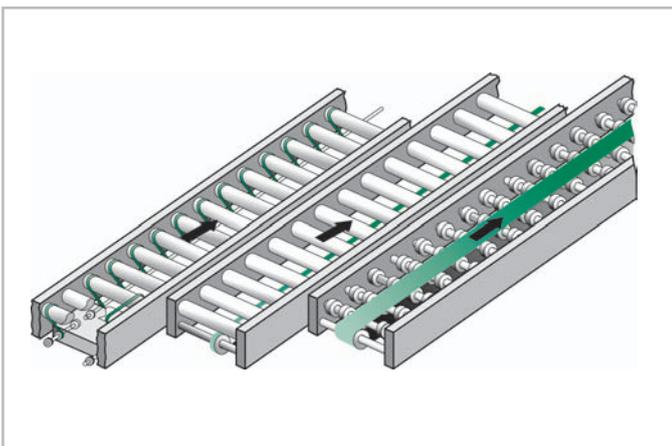
### Introduction

Live roller conveyors (LRC) play an important role in modern materials handling engineering. Piece goods in a broad range of sizes can be carried over shorter or longer distances, in a straight line as well as through curves, with relatively low energy consumption. Transport usually takes place horizontally, although slight inclines are also possible.



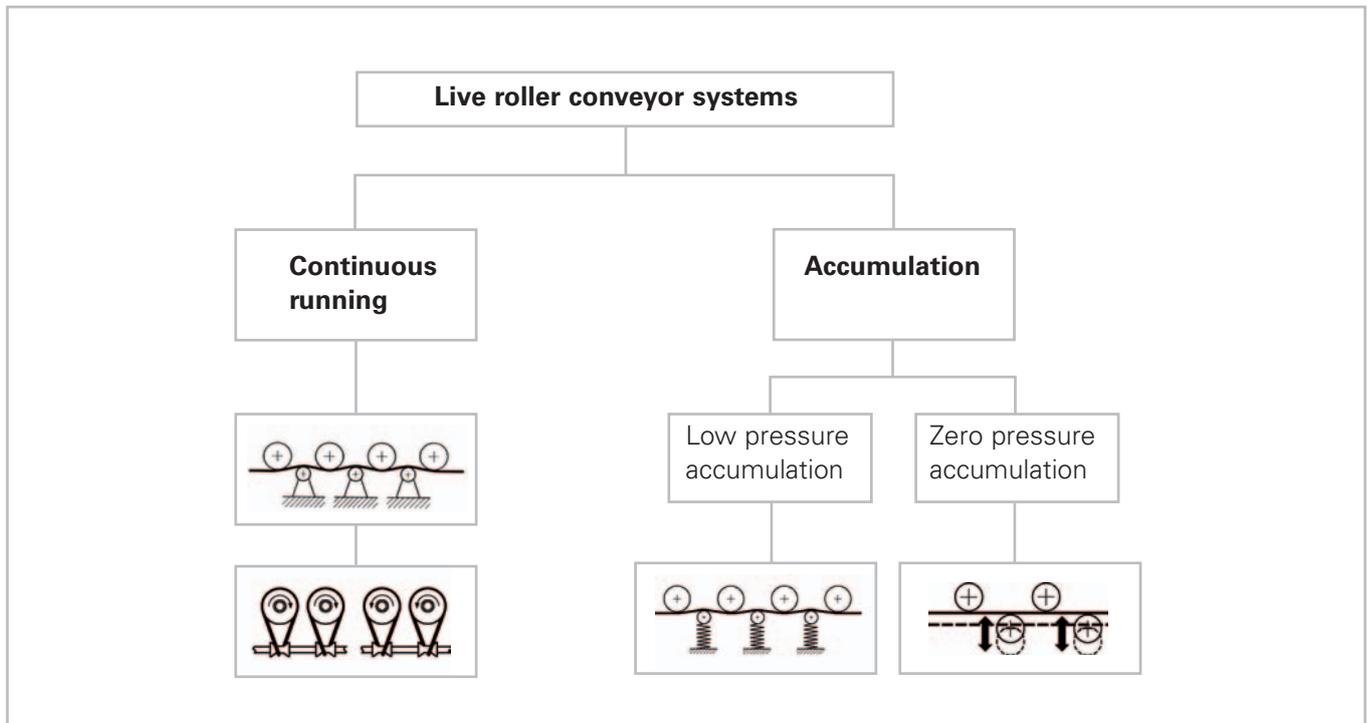
The goods are transported by a roller conveyor. The rollers are driven by a strong and therefore relatively narrow flat belt. The power transmission between belt and rollers is accomplished by the use of pressure rollers. The transported goods move in the opposite direction to that of the drive belt.

- 1 Transported piece good
- 2 Driving pulley
- 3 Carrying rollers
- 4 Pressure rollers
- 5 Driving belt
- 6 Return pulley



## Live Roller Conveyor Drive

Flat belt driven LRC are particularly well suited for goods accumulation and subsequent singulation processes. For the selection of the flat belt it is important to know exactly which LRC system will be used.



### Continuous running system

In a continuous running system, the carrying rollers are driven continually. There is no accumulation of goods and thus no stopping of the rollers. Pressure rollers can be fitted therefore in a fixed position. Flat belts with friction covers (NBR) on both sides are used as driving element. Rollers in continuous running systems may also be driven by Polycord round belts – a solution that is particularly suited for curves.

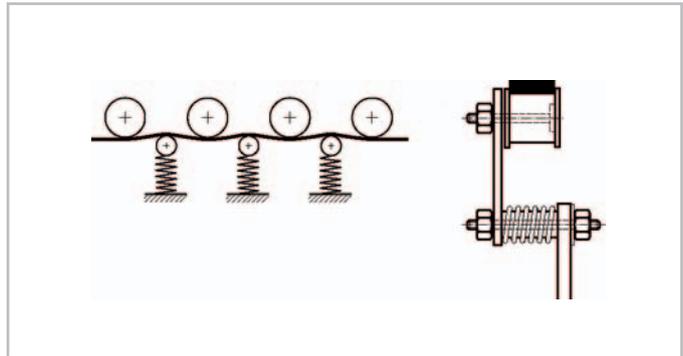
### Accumulation system

Where products need to be accumulated on the LRC for subsequent controlled retrieval, a distinction is made between systems where the continuous running belt remains in contact with the rollers while they are blocked by the accumulated goods (low pressure accumulation), and systems where the belt is separated from the rollers (zero pressure accumulation).

## Live Roller Conveyor Drive

### • Low pressure accumulation

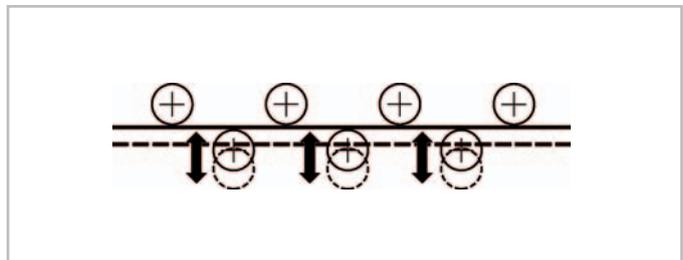
On the relatively simple low pressure accumulation system, the belt is pressed against the rollers by a spring-loaded mechanism. If the carried goods are accumulated, e.g. by means of a mechanical stop or gate, the rollers in question stop while the belt continues to run. The surface touching the carrying rollers must be formed so that it can slip with minimum resistance on the stationary rollers, but at the same time have sufficient friction to continue driving the other carrying rollers reliably. On the driving pulley side, the belt must have a high coefficient of friction (preferably NBR rubber cover).



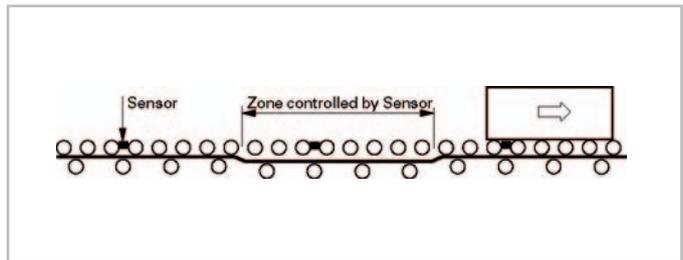
### • Zero pressure accumulation

On the more sophisticated zero pressure accumulation system, the pressure rollers are separated from the carrying rollers by mechanical devices during the accumulation process.

The goods being carried will stop moving once the rollers are disconnected from the drive. However, if they are to be conveyed further, the pressure rollers are simply returned to their operating position, pressing the drive belt back onto the rollers.



In this fashion, different sections of the roller conveyor can be engaged and disengaged from the drive completely independently of each other. The pressure roller lifting device itself can be mechanically, pneumatically or electromechanically operated, while the control sensors are mechanical, electrical, pneumatic or optical.



Since in the zero pressure accumulation system there is absolutely no contact between the driving belt and the carrying rollers during accumulation, drive belts with friction covers on both sides (NBR rubber) can be used. This results in increased transport reliability and belt service, and reduced power consumption compared with the low pressure system.

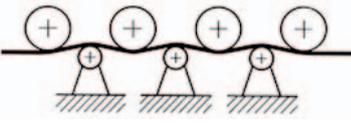
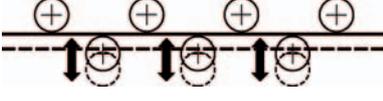
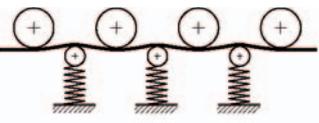
## Live Roller Conveyor Drive

### Technical requirements on live roller driving belts

Due to their relatively low belt speeds, the demands regarding running properties are relatively low. However, the belts still have to be robust, because they are often exposed to strong mechanical loads, e.g. due to start-stop operation, relative movement on stationary rollers, lateral contact on flanged pulleys, etc.

### Belt selection

Habasit can provide the optimal belt type for every LRC system:

LRC system	Required belt design	Belt recommendations
<p><b>Continuous running system</b></p>  <p><b>Zero pressure accumulation</b></p> 	<p>Carrying roller side: Adhesive surface *</p>  <p>Driving pulley side: Adhesive surface *</p>	<p><b>HabaDRIVE® power transmission belts:</b> TC-range TCF-20H, TCF-50H TF-range S-range</p> <p><b>Other possibilities (examples):</b> MAM-5E CM-18/30F</p>
<p><b>Low pressure accumulation</b></p> 	<p>Carrying roller side: Non-adhesive surface</p>  <p>Driving pulley side: Adhesive surface *</p>	<p><b>HabaDRIVE® power transmission belts:</b> TF-75TE</p> <p><b>Other possibilities (examples):</b> MAM-5P FAB-xxE EMB-12EMCH ENU-20EXBD EMB-27EHBT</p>

\* NBR rubber by preference.

## Live Roller Conveyor Drive

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Further belt types are available for special requirements, such as use in cold environments, etc. As an alternative to flat belts, LRC are often equipped with round belts (Polycord®, Habicord). For further information please contact your Habasit partner.

### **Calculation aids**

For driving belt calculations for special requests please contact your Habasit partner.

### **Design recommendations**

The general statements in the chapter on “Design guidelines” should be observed.

### **Belt installation and maintenance**

The general statements in these chapters should be observed.

### **Alternative: HabasitLINK® modular belt conveyor**

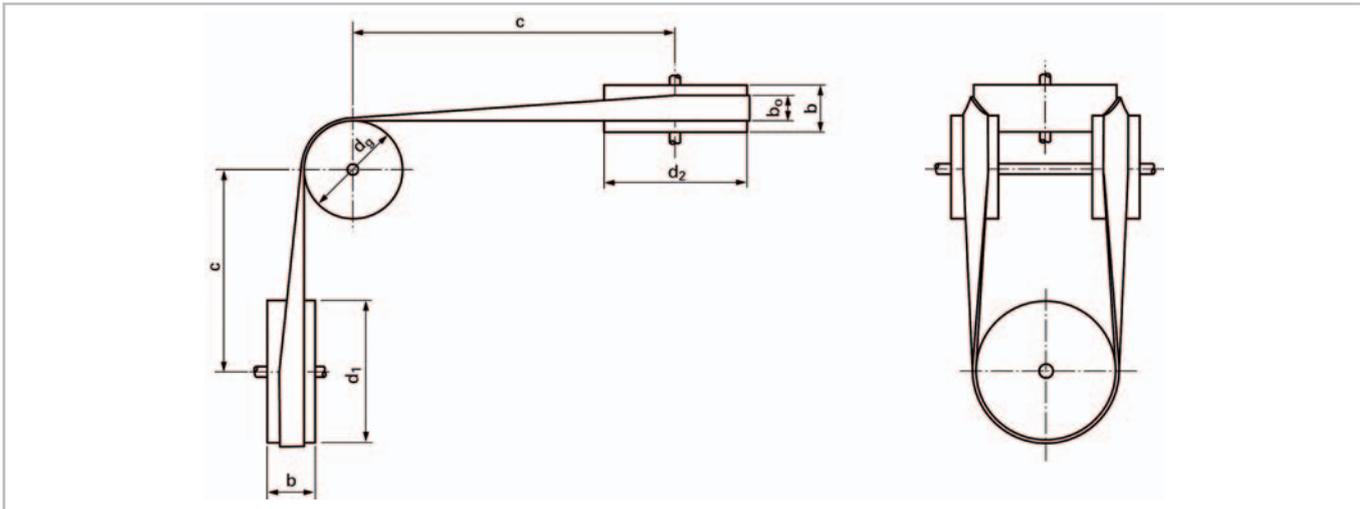
As an alternative to the belt driven live roller conveyor system, the HabasitLINK® modular belt conveyor can be considered for new installations. For further information see [www.habasitlink.com](http://www.habasitlink.com) or contact your Habasit partner.



## Mule Drive

### Introduction

In a mule drive the driving and the driven pulley can be arranged in various positions thanks to the guiding rollers, which can be made adjustable in any direction.



### Recommended product range

#### • TC- or TCF-xxEL range

Also possible A- and S-range

### Non-recommended product range

Do not use TF-belts

(aramide is sensitive regarding twisting and buckling).

$d_1$  = diameter of driving pulley

$d_2$  = diameter of driven pulley

$d_g$  = diameter of guiding rollers

$b$  = pulley width

$b_0$  = belt width

$c_1$  = center distance

$c_2$  = center distance

### Belt calculation

If the machine data are known, the required belt data can be calculated by the POWER-SeleCalc program.

### Design recommendations

The general statements in the chapter "Design guidelines" should be observed. The following additional recommendations for mule drives are based on experience:

- The greater the center distance ( $c_1$ ,  $c_2$ ), the better. It should be at least 10 times the belt width
- The width of the driving and driven pulley must be 1.5 to 2 times the belt width
- Crown both the driving and the driven pulley
- The guiding roller width must be at least 2 times the belt width
- The guiding rollers must be cylindrically

### Belt installation and maintenance

The general statements in these chapters should be observed.

## Half-Cross Drive

### Introduction

The half-cross drive serves to transmit power between two shafts, the axes of which cross at an angle of  $1^\circ$  to  $90^\circ$ .

### Preconditions

The belt must run parallel onto the pulleys (perpendicular to the axis). Running in reverse direction is not possible.

### Recommended product range

#### • TC-range

Also possible S-range

### Not recommended product range

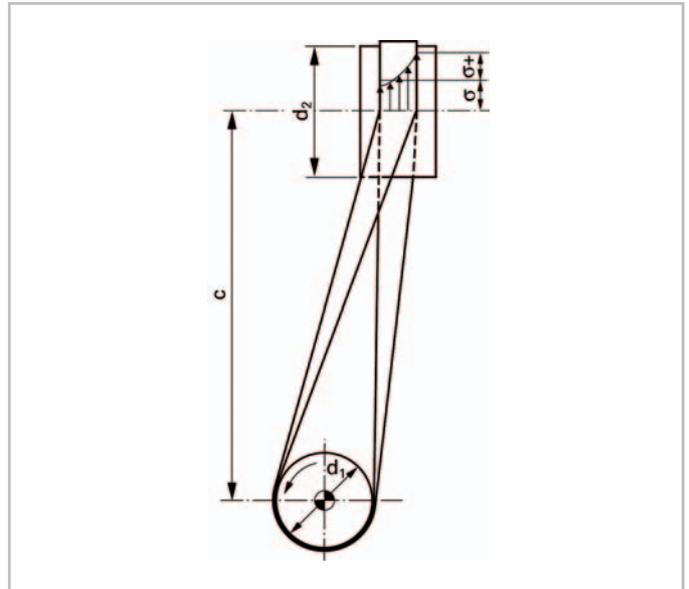
Do not use TF-belts

(aramide is sensitive regarding twisting and buckling).

### Belt calculation

If the machine data are known, the required belt data can be calculated by the POWER-SeleCalc program.

Note: One belt edge experiences additional tensile stress ( $\sigma_+$ , see figure) through distortion. Belts in half-cross drives must therefore be stressed only up to 80% of their performance. This can be taken into consideration by increasing the indicated belt width by approx. 20%.



$d_1$  = diameter of driving pulley

$d_2$  = diameter of driven pulley

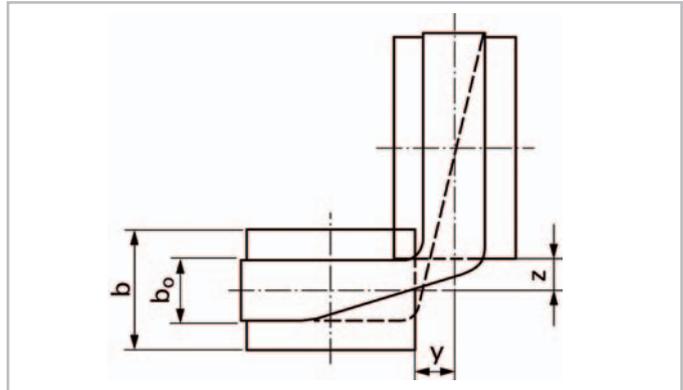
$c$  = center distance

## Half-Cross Drive

### Design recommendations

The general statements in the chapter “Design guidelines” should be observed. The following additional recommendations for half-cross drives are based on experience:

- The ratio of the small to the large pulley must not exceed 0.4
- It is an advantage to make the distance between the axes as big as possible and to choose a narrow belt
- The greater the center distance (c) the better. It should be at least 10 times the belt width
- The pulley width must be at least twice the belt width
- Both pulleys must be designed cylindrically
- At least one pulley has to be designed in a way that it can be pivoted in plane parallel to its own axis and perpendicular to the other pulley axis.
- The pulleys must be displaced by the amounts:  
 $y \cong 0.5 \cdot b_0$   
 $z \cong (0.1-0.2) \cdot b_0$
- The displacements must be made in such a way that the belt at the driving end is less laterally buckled than at the slack end.



### Belt installation and maintenance

The general statements in these chapters should be observed.

## Introduction

Belt fabrication means to manufacture the belts to the required size in width and length and to join the belt ends with the appropriate joining methods and tools.

Habasit's standard joining systems for power transmission belts are **Flexproof** and **Thermofix**.

### Flexproof joining system ("Finger joint")

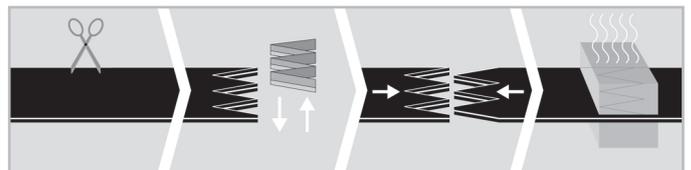
Flexproof is a fusion joint used without the addition of adhesive. It ensures simple joining and quick installation.

#### Advantages

- Longitudinal flexibility, no stiffening of the joint.
- Adhesive free, no thickness difference over the joint – low vibration running!
- Good appearance; quality is easily assessed by visual inspection.

#### Limitations

- Temperature resistance, not for high operating temperatures (limit 60° to 80 °C)



### Thermofix joining system

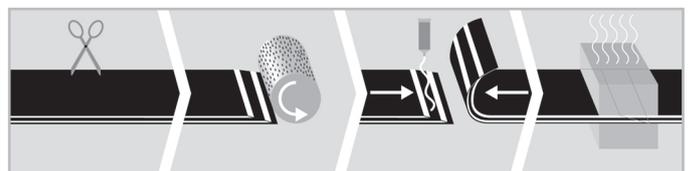
Thermofix is an adhesive bonded joint. A variety of procedures and adhesives are employed, which are dependent upon belt type.

#### Advantages

- Admissible operating temperature up to 100 °C.

#### Limitations

- Belt is slightly stiffer at the joint
- Quality of joint is highly dependent on fabricator

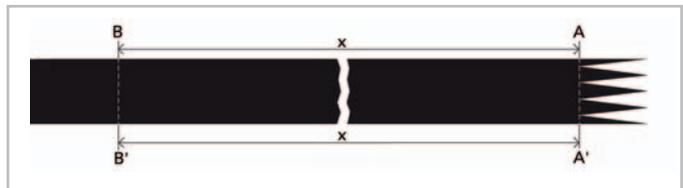
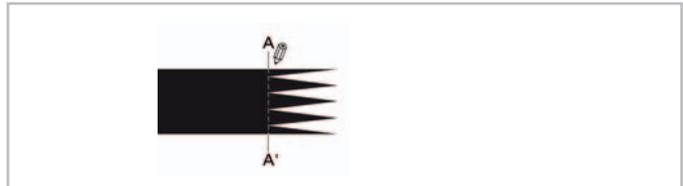


## Flexproof Joining System ("Finger Joint")

### Quick process reference

Start with a coil of belt of sufficient length, already cut to width (for a single belt or multiple belts, if production is done in sleeves).

- Select the optimal available finger cutting device for the job.
- Measure belt length and mark belt. (Additional belt material is required for the finger joint.)
- Finger cut first belt end.
- Finger cut second belt end, making sure:
  - to get the correct belt length
  - that the second finger pattern matches the first belt end (gap meets finger, no additional off set caused by small lateral misalignments).
- Select the optimal available hot-pressing device for the job (see recommended preparing and pressing devices).
- Obtain joining data (from [www.habasit.com](http://www.habasit.com)).
- Lay up the press according to the "Inserts" diagram in the joining instructions.
- Close the press.
- Following the operating instructions for the press and/or the data in the joining instructions:
  - pressurize the press
  - set top and bottom press temperatures
  - set pressing (holding) time
  - start welding cycle
  - cool down (accelerated with water or forced air, if the press design allows this)
  - thoroughly expel cooling water from the press (remaining water affects the next welding cycle)
  - release pressure from the press.
- Open press and remove top inserts.

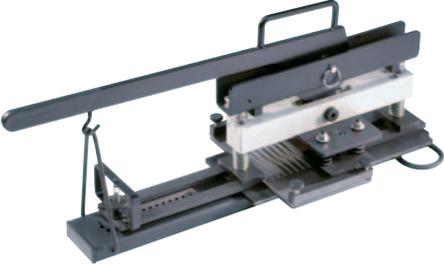
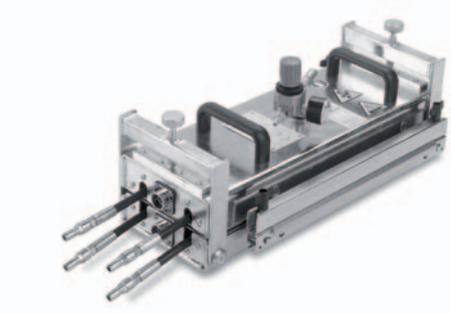


## Flexproof Joining System ("Finger Joint")

- Check welding quality of the top belt surface. On the rubber covered surface of power transmission belts, the finger tips should be sealed – exhibiting thermoplastic core material which has flowed to the surface. Similarly, a fine line or dots of core material should outline the fingers.
- Slide a cutting pad under the belt edge and trim belt edges.
- Remove belt from the press and check quality of bottom welding. Criteria are the same as for the top side.
- If flow is not sufficient, the belt can be re-pressed with slightly adapted temperatures (5° to 10 °C higher); if there is too much flow, the temperature for the next pressing of this material should be reduced by 5° to 10 °C.



### Recommended preparing devices and pressing devices

Preparing devices	Pressing devices
 <p data-bbox="165 1375 293 1406">AF-100/US</p>	 <p data-bbox="849 1375 919 1406">PF-61</p>
 <p data-bbox="165 1814 341 1845">AF-1201 family</p>	 <p data-bbox="849 1814 1088 1845">PM-02/04/06 family</p>

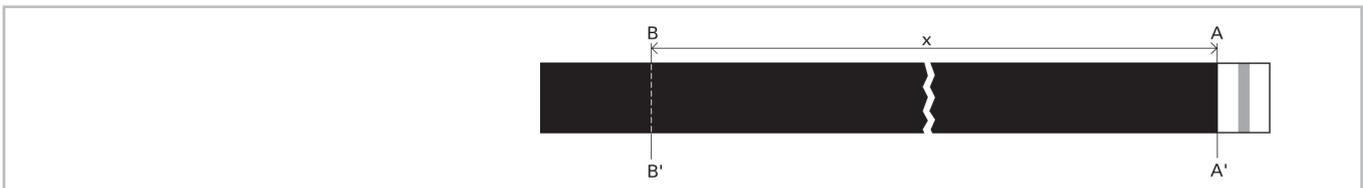
### Quick process reference

Start with a coil of belt of sufficient length, already cut to width (for a single belt or multiple belts, if production is done in sleeves).

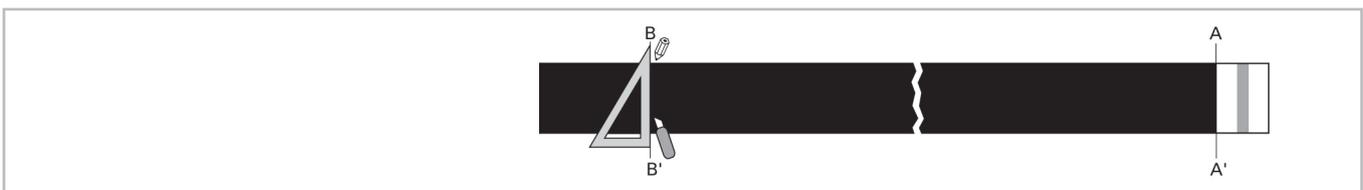
- Select the optimal available skiving device for the job (see recommended preparing device).
- Obtain joining data (from [www.habasit.com](http://www.habasit.com)).
- Cut first end at desired angle (75° and 90° are the most common) and skive this end, using the settings indicated in the tool's operating instructions.
- After skiving of the first belt end, mark measuring points A and A' along the trailing end of the skive as illustrated below.
- Check whether the angle between A – A' and the lateral edges corresponds to the angle at which the belt end was cut. If the angle differs, repeat skiving.



- From points A – A' mark off belt length X and mark measuring points B – B'



- At points B – B', draw a parallel line to A – A' and cut along this



- Skive the second belt on the opposite side of the belt.



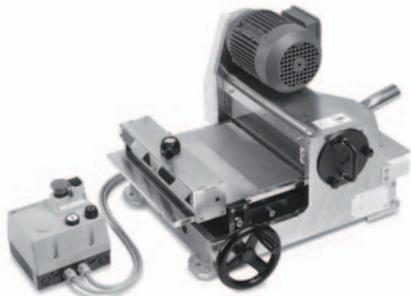
- Select the optimal available hot-pressing device for the job (see recommended pressing devices).

## Thermofix Joining System

- Lay up the press according to the “Inserts” diagram in the joining instructions.
- Close the press.
- Following the operating instructions for the press and/or the data in the joining instructions:
  - pressurize the press
  - set top and bottom press temperatures
  - set pressing (holding) time
  - start welding cycle
  - cool down (accelerated with water or forced air, if the press design allows this; however, for Thermofix active cooling is not required)
  - thoroughly expel cooling water from the press (remaining water affects the next welding cycle)
  - release pressure from the press.
- Open press and remove belt from the press and check quality.

### Recommended preparing devices and pressing devices

#### Preparing devices

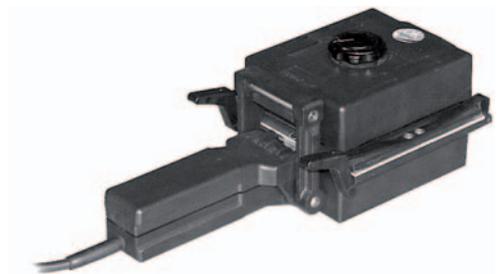


AT-305



AT-1201 family

#### Pressing devices



PT-100



PT-300



## Safety Regulations

### Belt installation

In order to guarantee problem-free running and to benefit from the features of the flat belt drive, the power transmission belts must be selected and installed correctly. Safety regulations and installation hints must be followed thoroughly.

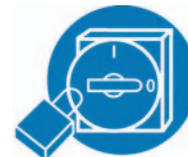
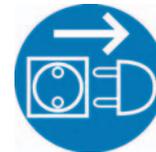
### Safety regulations

If touched, running belts can catch parts of the body and objects e.g. clothing, tools, etc. and cause serious bodily injury and machine damage.

Switch off the machine using the main switch and ensure that it cannot be switched on again before installation, adjustment or maintenance work is carried out.

Power transmission belts should only be installed on the equipment for which they have been selected and calculated according to Habasit documentation.

Only qualified personnel who are authorized to perform the required installation and equipment maintenance may perform this work. They must possess the requisite knowledge and skills to effectively perform such work in accordance with the necessary provisions and accident-prevention regulations.

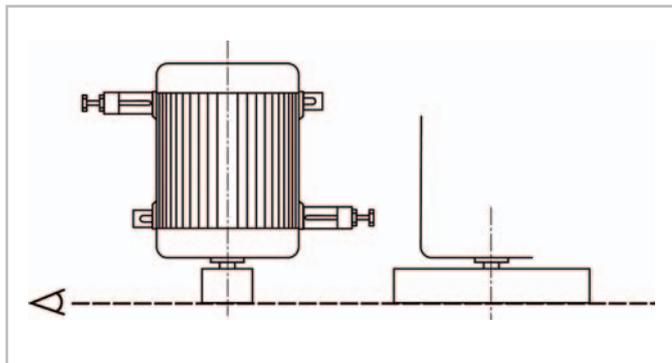


## First-Time Installation

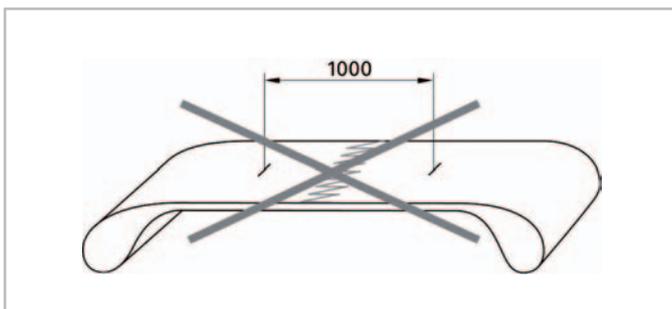
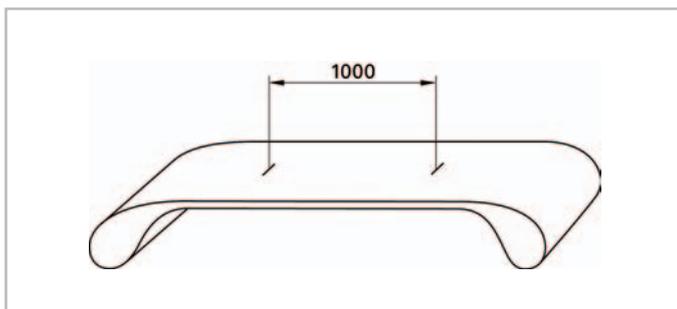
The following recommendations apply to the first installation of endless belts.

Proceed as follows:

1. Make sure that the tensioning device is in the innermost position.
2. Check that the shafts are parallel and the pulleys aligned perpendicular to the belt running axis.



3. The running surfaces of the pulleys must be clean and free from grease, soil and dust.
4. Before installing, trace small measuring marks at a distance of e.g. 1000 mm (recommendation) on the un-tensioned belt. Use a ball-point pen and mark as accurately as possible! Do not place the measuring distance over the joining area.



For short belts or if the control distance on the machine is shorter, choose a shorter measuring mark distance, e.g. 500 mm.

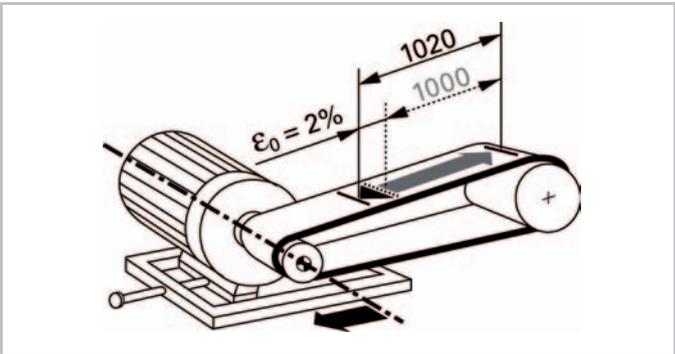
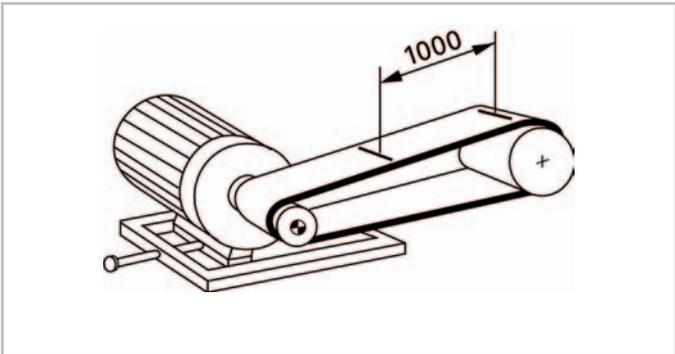
The longer the distance between the measuring marks, the higher the tensioning accuracy.

## First-Time Installation

- Install the belt carefully. Lay it first on the small pulley, then on the large pulley. Do not force the belt over the pulley edges. Do not use unsuitable tools such as screwdrivers, hammers, etc.

Special care has to be taken when installing belts with an aramide traction layer (TF-belts). These belts are sensitive to twisting and buckling.

- Tension flat belt by enlarging the center distance until the distance between the measuring marks has increased by the value of the required (calculated) **initial elongation ( $\epsilon_0$ )**.



**Example:**

Required initial elongation  $\epsilon_0 = 2.0\%$   
 Measuring mark distance of un-tensioned belt:  
 1000 mm  
 Measuring mark distance of tensioned belt:  
 1020 mm

If the initial measuring mark distance of an un-tensioned belt is not 1000 mm as recommended, adapt the tensioning accordingly. For examples see the table below:

Initial measuring mark distance (un-tensioned belt) [mm]	Measuring mark distance of tensioned belt [mm]				
	Calculated initial elongation $\epsilon_0$ [%]				
	0.5	1.0	1.5	2.0	2.5
200	201	202	203	204	205
500	502.5	505	507.5	510	512.5
750	753.8	757.5	761.3	765	768.8
<b>1000 (recommended)</b>	<b>1005</b>	<b>1010</b>	<b>1015</b>	<b>1020</b>	<b>1025</b>
1500	1507.5	1515	1522.5	1530	1537.5
2000	2010	2020	2030	2040	2050

## First-Time Installation

Never tension a power transmission belt by guesswork; always observe the calculated initial elongation  $\epsilon_0$ !

If the correct initial elongation is not known, calculate it with the POWER-SeleCalc program or call Habasit application support.

7. Rotate the belt once or twice by hand. The flat belt must not drift or run off even when the direction of rotation is changed.
8. Check the distance of the measuring marks again. If necessary, tension the belt to the required initial elongation.
9. Fix the screws of the tensioning device.
10. Secure the original protective casing before starting the motor.
11. Make sure that the belt data (type, dimensions, quoted initial elongation, date of installation and maintenance instructions are stored near the machine, e.g. in a self-adhesive envelope stuck on the machine).

### Installation of aramide belts

Power transmission belts with an aramide traction layer (TF-range) must be installed with special care.

Do not twist belts with an aramide traction layer and do not tension the belts with sudden or excessive force!

The high modulus of elasticity of aramide fibres in the TF-belts leads to two special features:

- The required take-up displacement is extremely short
- Even a small increase in the initial elongation may lead to a considerable increase in the tensile force and shaft load. Extensive shaft deflection or early breakdown of bearings may be the result.

## Installation of Strong Belts; Re-Installation

### Installation of strong belts (two-step tensioning)

In applications where a relatively strong belt is being installed on an inappropriately **weak drive design** we recommend tensioning in two steps:

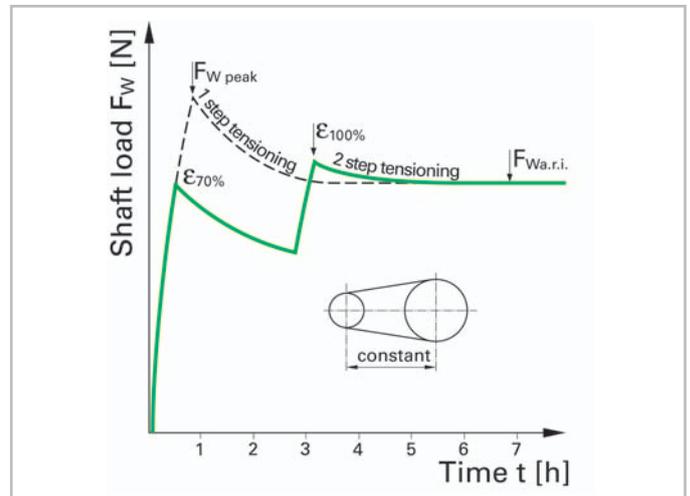
- 1st step: Tension the belt to 60% to 70% of the required initial elongation ( $\epsilon_{1st\ step}$ ) only. Let it relax for 3 to 6 hours
- 2nd step: Re-tension the belt to the required initial elongation ( $\epsilon_{2nd\ step} = \epsilon_0$ )

### Conclusion:

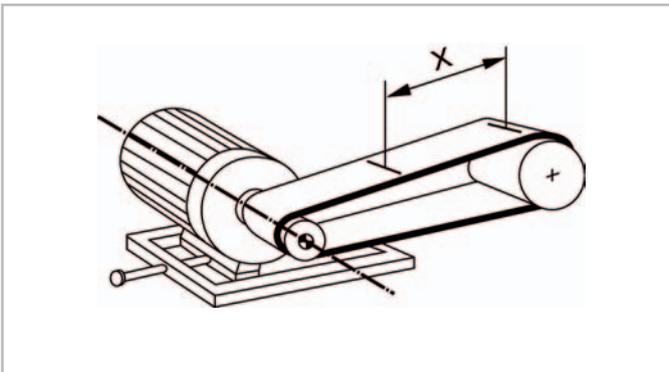
Using the two-step tensioning method avoids the maximum peak value of the shaft load ( $F_{W\ peak}$ ) appearing when the belt is tensioned in one step to the required initial elongation ( $\epsilon_0$ ).

The shaft load immediately after the first step and after the second step elongation remains below the admissible load ( $F_{Wadm}$ ).

The shaft load after relaxation ( $F_{Wa.r.i.}$ ) is not influenced in a negative way by the two-step tensioning method.

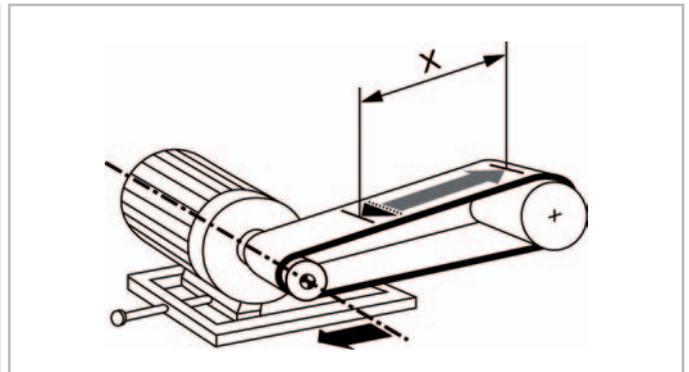


### Re-installation of used belts



**Before (!)** releasing the belt, measure and note the distance between two existing or newly-applied measuring marks.

Otherwise, follow the directions for first-time installation.



When re-installing the same used belt, tension it until the initial distance between the measuring marks comes up.



## Belt Maintenance

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Provided there has been correct dimensioning and professional installation, Habasit's power transmission belts do not usually need to be maintained or re-tensioned.

However, regular checks are recommended in order to guarantee problem-free performance of the drive.

### **Cleaning**

The running surfaces of pulleys must be clean and free from grease and accumulated dust. Dirty belts can be cleaned easily with lukewarm water and soap.

### **Check**

Look out for changes in the friction cover and joint. Replace the belt if changes are considerable or in the event of damage. Check pulleys for excessive wear.

### **Re-tensioning**

If the power transmission flat belt no longer transmits the capacity it was calculated for, clean the pulleys and belt and if necessary re-tension it carefully.

### **Prerequisites for trouble free operation**

Power transmission flat belts are very reliable and long lasting if the following prerequisites are met:

- The belt should be specified and calculated according to its application
- The belt type, belt dimensions (width and length) and calculated initial elongation are known
- The belt joint is made carefully in line with Habasit's guidelines
- The belt is carefully installed in accordance with Habasit guidelines, and initial elongation is exactly applied
- The actual operating conditions correspond to the initial specifications
- There is no mechanical damage to the belts

## Trouble-Shooting

### Trouble-shooting list

The most common problems with power transmission flat belts, their possible causes and recommended action to solve the problems are listed below.

If the problem still remains, please contact your Habasit representative.

Problem	Possible causes	Remedies
Poor tracking I Belt runs to one side	<ul style="list-style-type: none"> <li>• Pulleys or rollers out of alignment</li> <li>• Pulleys or rollers covered with dirt</li> </ul>	<ul style="list-style-type: none"> <li>• Check that all shafts are parallel and that the pulleys are exactly aligned perpendicular to the belt running axis</li> <li>• Clean pulley surfaces</li> </ul>
Poor tracking II Belt runs from one to the other pulley side and backwards	<ul style="list-style-type: none"> <li>• Improper pulley or roller crown (usually crowned too high) or no crown at all</li> <li>• Pulleys or rollers covered with dirt</li> </ul>	<ul style="list-style-type: none"> <li>• Retooling of the pulley shape according to Habasit recommendations</li> <li>• Clean pulley surfaces</li> </ul>
Belt edges wear out	<ul style="list-style-type: none"> <li>• Belt is running over pulley edges, caused by poor tracking</li> <li>• Belt is touching flanges or machine parts, even if it runs straight on</li> </ul>	<ul style="list-style-type: none"> <li>• See "Poor tracking"</li> <li>• Avoid allowing belt edges to come into contact with flanges or other machine parts</li> <li>• Avoid flanged pulleys</li> <li>• Increase pulley width or chose a stronger but smaller belt (new belt calculation necessary)</li> </ul>
Belt running surface wears out	<ul style="list-style-type: none"> <li>• Slip between driving or driven pulley(s) and belt</li> <li>• Knurled or too rough pulley surface</li> </ul>	<ul style="list-style-type: none"> <li>• See "Belt slip"</li> <li>• Reduce roughness according to Habasit recommendations (<math>R_a = 6.3</math> to <math>3.2 \mu\text{m}</math>)</li> </ul>
Belt failure immediately after motor start up	<ul style="list-style-type: none"> <li>• Bad joint quality</li> <li>• Heavy, unconsidered shock load or overload</li> </ul>	<ul style="list-style-type: none"> <li>• Use a new belt with appropriate joint quality</li> <li>• Check drive data, as well as belt design and calculation</li> </ul>

Problem	Possible causes	Remedies
Belt service life does not fulfill customer expectations	<ul style="list-style-type: none"> <li>• High bending frequency over small pulley diameter</li> <li>• Power to be transmitted [kW] higher or operating conditions more demanding than indicated</li> <li>• Extraordinary influence of temperature and humidity</li> <li>• Belt tension too high or too low</li> <li>• Unrealistic customer expectations</li> </ul>	<ul style="list-style-type: none"> <li>• Increase pulley diameter or choose a more flexible belt</li> <li>• Check drive data, as well as belt specification and calculation</li> <li>• Check drive data, as well as belt specification and calculation</li> <li>• Observe calculated initial elongation (<math>\epsilon_0</math>)</li> <li>• Inform customer about realistic belt service life</li> </ul>
Layer separation on polyamide belts or cracks in the PA-layer	<ul style="list-style-type: none"> <li>• Compression of the PA-layer due to a combination of small pulley diameter, thick traction layer and too low initial elongation</li> </ul>	<ul style="list-style-type: none"> <li>• Observe the calculated initial elongation! Re-tension the belt if necessary</li> <li>• Use a belt type with fabric traction layer, e.g. TC- or TF-type</li> </ul>
Belt slip	<ul style="list-style-type: none"> <li>• Initial elongation too low</li> <li>• Power to be transmitted [kW] higher or operating conditions more demanding than indicated</li> <li>• Dirty, greasy, oily or wet pulley or belt surfaces</li> </ul> <p>Important: Slip on power transmission belt drives <u>must not</u> be eliminated by increasing the friction or the surface roughness of the driving pulley: Premature belt wear would be the consequence!</p>	<ul style="list-style-type: none"> <li>• Observe the calculated initial elongation! Re-tension the belt carefully if necessary</li> <li>• Check drive data, re-calculate the belt</li> <li>• Clean pulley and belt surfaces</li> <li>• Never use lagged driving pulleys</li> <li>• Avoid knurled surfaces</li> </ul>

## Trouble-Shooting

Problem	Possible causes	Remedies
Excessive noise – loud whistling	<ul style="list-style-type: none"> <li>• Stick-slip effect, mainly appearing with wide belts on big (&gt; 2000 mm), very smooth, polished pulleys with a large arc of contact</li> </ul>	<ul style="list-style-type: none"> <li>• Use a belt with a higher modulus of elasticity (<math>k_{1\%}</math>-value)</li> <li>• Use a belt with a lower coefficient of friction, e.g. leather coated belts</li> <li>• Reduce coefficient of friction with talcum powder or with a water-spirit mixture (2 dl spirit to 10 l water)</li> <li>• Reduce friction by roughening the pulley surface to <math>R_a = 6.3</math> to <math>3.2 \mu\text{m}</math></li> </ul>
Joining area “kicks out” periodically on running belt	<ul style="list-style-type: none"> <li>• Joint partially damaged</li> <li>• Joint slightly aslant, not absolutely parallel</li> </ul>	<ul style="list-style-type: none"> <li>• Change belt</li> <li>• No danger for belt or drive, as long the belt does not run over pulley edges.</li> <li>• No action necessary</li> </ul>
Belt shows a wiggly line	<ul style="list-style-type: none"> <li>• Belt not cut absolutely straight (“banana”)</li> </ul>	<ul style="list-style-type: none"> <li>• No danger for belt or drive, as long the belt does not run over pulley edges.</li> <li>• No action necessary</li> </ul>

## Storage Conditions

Unfavorable storage conditions or improper handling result in changes in the physical characteristics of synthetic power transmission belts. The main effects of improper storage conditions are on the coefficient of friction and the service life of the products.

Proper storage conditions in brief:

- Protect belts from sunlight/UV-radiation/dust and dirt
- Store spare belts in a cool (recommended 15 °C to 25 °C) and dry place
- Store the belts if possible in their original packaging

### Storage location

The storeroom should be cool, dry, dust-free and moderately ventilated. Belts and tapes may be stored outside only if they are covered to provide protection from the weather.

### Temperature

Belts should not be stored at temperatures below -10 °C (14 °F) or above +25 °C (77 °F), except for very short periods of time.

When exposed to lower temperatures during storage or transport, products may stiffen. Before putting them into operation or further processing, these products should be conditioned at room temperature over a period of at least 48 hours. This is best carried out while the items are still in their packaging, to prevent the formation of condensation on the product itself.

### Heating

In heated storerooms, belts must be shielded from the heat source. There must be a distance of more than 1 meter between a radiant heat source and an unshielded product. A greater distance from the heat source is necessary in rooms with forced-air heating systems.

### Humidity

Storage in damp conditions should be avoided. Relative humidity of between 40% and 65% is recommended.

### Lighting

Products should be protected from light, in particular from the direct rays of the sun and from strong artificial light with a high ultraviolet component. Light from incandescent lighting sources is preferable.

### Ozone

Belts should not be stored close to ozone-producing equipment such as UV lamps, AC arc welding machines, laser printers, etc.

### Chemicals

Solvents, fuels, lubricants, chemicals, acids, alkalis, and disinfectants should not be kept together with belts in the same storeroom.

### Handling

Care is to be taken that products, when stored, are not subject to stress, i.e. with no excess tension, pressure or other deformation, since stress can promote permanent distortion and crack formation.

Contact between belts of different compositions or colors should be avoided.

With long-term storage, ensure that recently received products are stored separately from products already in stock (first in, first out!).

### Packaging

Belts must be protected by suitable packaging against soiling. Products containing polyamide should always be wrapped airtight, to avoid undesirable absorption of humidity or drying out.

Covering materials should contain no additives that are harmful to the products, e.g. plasticizers, benzene, oil or similar agents. Suitable packaging, for example, is anti-static black film or polyethylene or polyamide bags. Habasit belts should be stored preferably in their original packaging.

Should moisture, nevertheless, accumulate inside due to damage to the packaging materials, the packaging must be removed to prevent mold formation.



Symbol	Unit	Unit	Explanation
a	mm	in.	Belt thickness
b	mm	in.	Pulley width
b <sub>o</sub>	mm	in.	Belt width
c	mm	in.	Center distance of un-tensioned belt (corresponds to l <sub>eff</sub> )
c <sub>ε</sub>	mm	in.	Center distance of tensioned belt (corresponds to l <sub>ε</sub> )
d <sub>l</sub>	mm	in.	Diameter of large pulley
d <sub>s</sub>	mm	in.	Diameter of small pulley
d <sub>1</sub>	mm	in.	Diameter of driving pulley
d <sub>2</sub>	mm	in.	Diameter of driven pulley
E	N/mm <sup>2</sup>	ksi	Modulus of elasticity
F' <sub>UN</sub>	N/mm	lbs./in.	Nominal peripheral force per unit of width
F <sub>Wadm</sub>	N	lbs.	Admissible shaft load
F <sub>W<sub>s</sub></sub>	N	lbs.	Static shaft load (after relaxation)
F <sub>W<sub>d</sub></sub>	N	lbs.	Dynamic shaft load (after relaxation)
h	mm	in.	Pulley crown height
h <sub>r</sub>	mm	in.	Pulley flange height
k <sub>1%</sub>	N/mm	lbs./in.	Tensile force for 1% elongation per unit of width
k <sub>1%a.r.i.</sub>	N/mm	lbs./in.	Tensile force for 1% elongation per unit of width after running-in
l <sub>g</sub>	mm	in.	Geometric belt length (belt thickness not considered)
l <sub>eff</sub>	mm	in.	Effective length of un-tensioned belt (length of the neutral layer, fabrication length)
l <sub>s</sub>	mm	in.	Shortened belt length for fixed center distance or no take-up (length of the neutral layer, fabrication length)
l <sub>ε</sub>	mm	in.	Length of tensioned belt (elongated to ε <sub>o</sub> )
n <sub>1</sub>	1/min	rpm	Number of revolutions of driving pulley
n <sub>2</sub>	1/min	rpm	Number of revolutions of driven pulley
P	kW	HP	Power to be transmitted
P <sub>M</sub>	kW	HP	Motor power
R	mm	in.	Pulley crown manufacturing radius
s	mm	in.	Position of the neutral layer measured from the running side
v	m/s	fpm	Belt speed
x	mm	in.	Available take-up displacement of tensioning device
x <sub>r</sub>	mm	in.	Recommended take-up of tensioning device
x <sub>ε</sub>	mm	in.	Effective take-up displacement, required to elongate the belt to ε <sub>o</sub> )
β	°	°	Arc of contact
ε <sub>o</sub>	%	%	Initial elongation (initial tension)
ε <sub>adm</sub>	%	%	Admissible elongation
μ	–	–	Coefficient of friction



## Questionnaire: Power Transmission Belts

### Selection parameters

#### General requirements

- Common application, no specific requirements
- Both sides power transmission
  - Utilisation as tangential belt
    - Low creep, high accuracy and uniform number of revolution
    - High efficiency, low energy consumption
    - Short take-up (in combination with long belts)
      - Wide and large pulleys
      - Crossed drive
      - Permanently antistatic

#### Mechanical influences

- Heavy shock loads
  - Small pulleys, high bending cycle frequency
  - High belt speed, low vibration required
  - Transverse bending and / or twist
  - Rough belt handling (during installation etc.)

#### Environmental influences

- Very wet, dirty and / or dusty conditions
  - Considerable oil and / or grease influence
  - Changing climat (humidity, temperature)
    - Operating temperature > 60 °C/140 °F (continuous)

#### Joining system

- Skived and glued joint (Thermofix)
  - Adhesive free joint (Flexproof)
    - Seamless

### Calculation parameters

Power to be transmitted

kW or  PS

Service factor

1)

Center distance

mm or effective belt length  mm

#### Pulleys

Driving pulley

Diameter  mm

Width

mm

Arc of contact

°

Number of revolution

rpm

Driven pulley

mm

mm

°

rpm

Tension pulley

2)  mm

mm

°

#### Ambient temperature

Minimum

°C

Maximum

°C

### Alternative parameters

1) Start up:

Operating conditions:

Environmental influences:

- Smooth starting
- Uniform operation
- Very wet
- Medium starting
- Medium inertia forces
- Oil or grease
- Abrupt starting
- Heavy shock loads
- Dusty conditions

2) Drive with tension pulley

- Tension pulley on slack side
- Tension pulley on tight side

Measurements

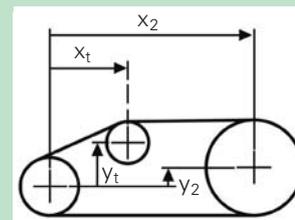
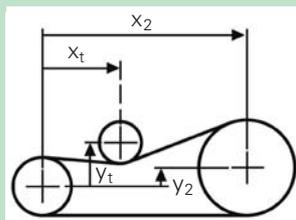
- Tension pulley outside
- Tension pulley inside

$x_2$   mm

$y_2$   mm

$x_t$   mm

$y_t$   mm



## Questionnaire: Tangential Belt

### Selection parameters

#### General requirements

- Common application, no specific requirements
- Low creep, high accuracy and uniform number of revolution
  - High efficiency, low energy consumption
  - Short take-up (in combination with long belts)
    - Wide and large pulleys
    - Crossed drive
    - Permanently antistatic

#### Mechanical influences

- Heavy shock loads
  - Small pulleys, high bending cycle frequency
  - High belt speed, low vibration required
  - Transverse bending and / or twist
  - Rough belt handling (during installation etc.)

#### Environmental influences

- Very wet, dirty and / or dusty conditions
  - Considerable oil and / or grease influence
  - Changing climat (humidity, temperature)
    - Operating temperature > 60 °C/140 °F (continuous)

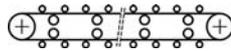
#### Joining system

- Skived and glued joint (Thermofix)
  - Adhesive free joint (Flexproof)
  - Seamless

### Calculation parameters

#### Configuration

- Spindles on both sides
- Spindles on one side



Variable drive direction

- Yes
- No

Spindles on tight side

Spindles on slack side

Power to be transmitted

kW or  PS

Service factor

1)

Belt width

mm

Effective belt length

mm

#### Pulleys

Driving pulley  $d_1$

2)  mm

Arc of contact  °

Number of revolution  rpm

Diverting pulley tight side  $d_t$

2)  mm

°

Diverting pulley slack side  $d_s$

2)  mm

°

Diverting pulley guide side  $d_m$

2)  mm

°

Guide pulley(s)  $d_u$

2)  mm

°

#### Ambient temperature

Minimum

°C

Maximum

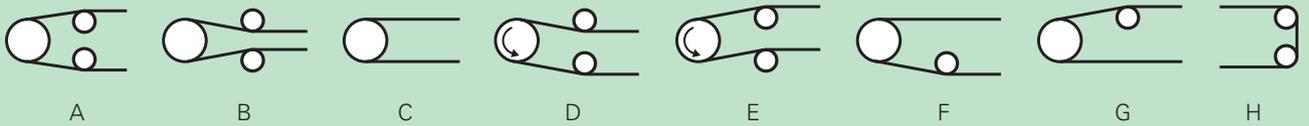
°C

## Questionnaire: Tangential Belt

### Alternative parameters

- 1) Start up:  Smooth starting     Medium starting     Abrupt starting  
 Operating conditions:  Uniform operation     Medium inertia forces     Heavy shock loads  
 Environmental influences:  Very wet     Oil or grease     Dusty conditions

2) Configuration

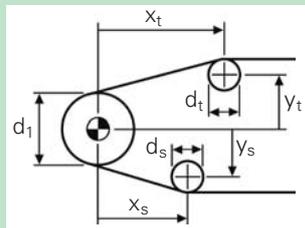


Driving side configuration (A,B,C,D,E,F,G)

Guiding side configuration (A,B,C,D,E,F,G,H)

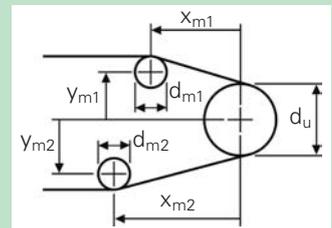
Measurements

$x_t$   mm  
 $y_t$   mm  
 $x_s$   mm  
 $y_s$   mm



Measurements

$x_{m1}$   mm  
 $y_{m1}$   mm  
 $x_{m2}$   mm  
 $y_{m2}$   mm



### Whirl calculation parameters

- Whirl configuration  One pressure roller per 2 spindles     One pressure roller per spindle     No pressure rollers
- 

Spindle pitch  mm  
 Whirl diameter  mm or number of revolutions  rpm  
 Number of spindles





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