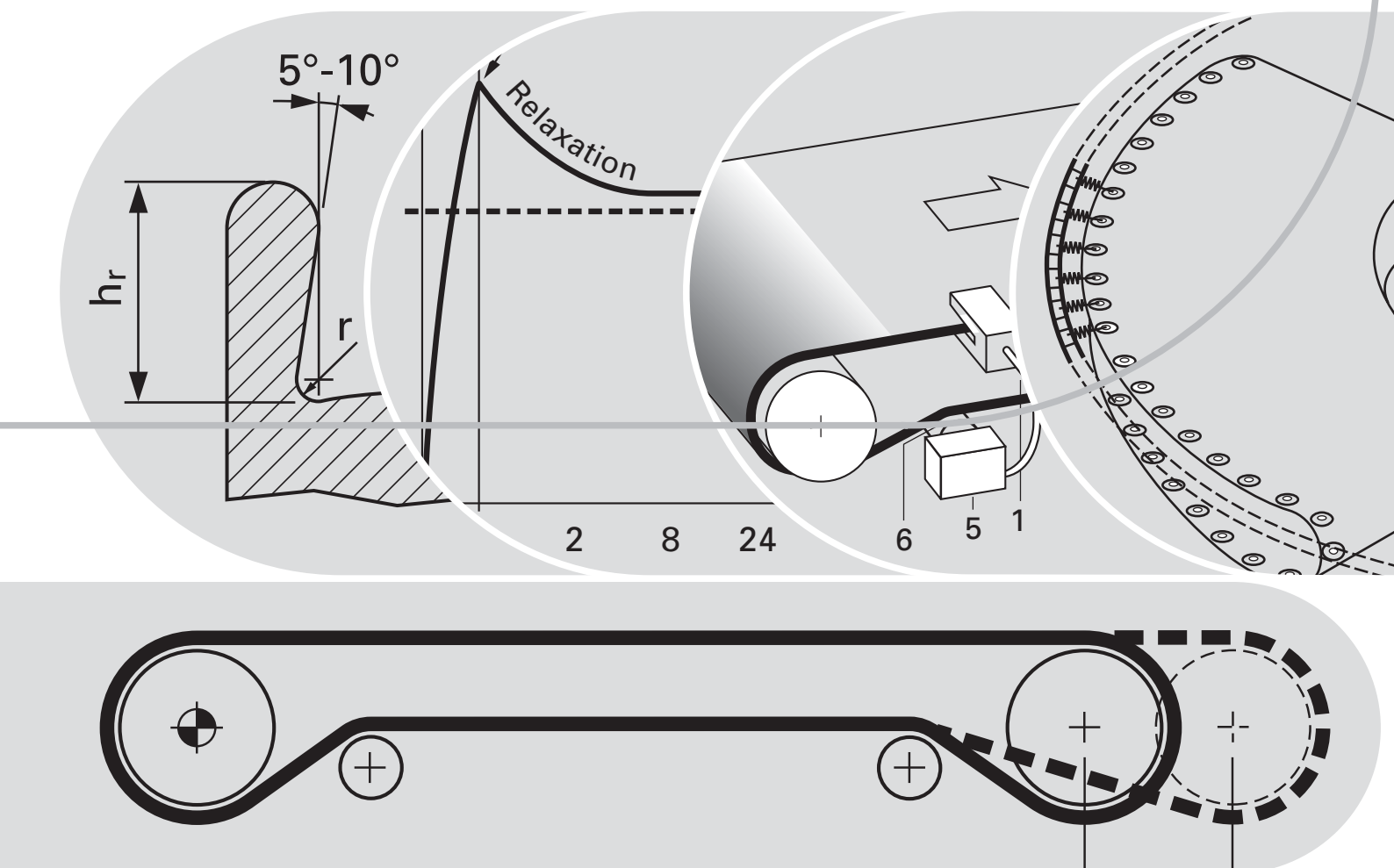


Fabric Conveyor Belts Engineering Guide

Habasit—Solutions in motion



Introduction	4
Belt conveyor components	6
System components	6
Support structure, pulley and roller fixing	7 – 8
Support structure	7
Mounting of pulleys and rollers	8
Belt Support	9 – 10
Slider bed	9
Support by carrying rollers	10
Belt support on the return side	10
Drive concept	11 – 14
Head drive	11
Tail drive	12
Center drive	12
Tandem drive	12
Drive units	13
Power transmission	14
Tensioning devices	15 – 16
Fixed tensioning devices	15
Constant-force tensioning devices	16
Take-up x_E	16
Pulley design	17 – 23
Minimum pulley diameter regarding the bending flexibility (d_{min})	17
Minimum pulley diameter with respect to the pulley deflection (d_y)	18
Effective pulley diameter d_{eff}	18
Pulley width	18
Pulley surface	19
Crowned pulleys	19
Radially crowned pulley form	21
Cylindrical pulleys	22
Driving pulleys	22
Lagged driving pulleys	22
Snub pulleys	23
Belt tracking	24 – 37
Tracking effect of cylindrical-conical or radially crowned pulleys	25
Guiding pulley	26
Inclined rollers on the return side	27
Pivotable carrying rollers	28
Guiding profiles	29
Automatic belt control	31
Additional belt wrap	32
Carrying rollers with friction cover	32
Pivoted rollers on the carrying side	32
Belt sensing combined with pivotable carrying roller	33
Lateral guide strips and guide rollers	33
Guiding of short, wide belts	34
Overview about tracking measures and recommendations	36
Checklist regarding design issues in order to avoid tracking problems	37

Loading, accumulation, diverting of goods	38 – 39
Loading of conveyor with goods to be carried.....	38
Accumulation of carried goods	38
Diverting of conveyed goods.....	39
Belt cleaning systems	40
Inclined/declined conveying	41 – 43
Steep-angle conveyor installation.....	41
Z-conveyor installations.....	42
Nosebar (knife-edge) and noseroller	44 - 47
Fixed nosebar (knife-edge)	44
Noseroller	47
Powerturn installations (curved conveyors)	48 – 50
Guidance by pairs of rollers.....	48
Guidance by means of profiles at the belt edge.....	48
Guidance by means of drive chain	49
Execution of the end pulleys	49
Belt drive by frictional wheel	49
Conveyor belt selection	50
Belt fabrication	50
45°/30° belt merge conveyors (transfer conveyors)	51 – 52
Belt tracking measures.....	51
Belt selection	52
Alternative to powerturn installation	52
Narrow belts in parallel (e.g. machine tapes)	53 - 55
Roller design.....	53
Arrangement of the rollers, belt guidance.....	55
Belt drive and tensioning device	55
Troughed conveyors	56
Live roller conveyors	57 – 58
Continuous conveying operations.....	57
Accumulation operations	58
Conveyor belt selection and calculation	59
The Habasit solution	63
Contacts	64

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.

Objective of the Engineering Guide

The objective of this Engineering Guide is to provide a comprehensive, albeit summarized overview of the most important aspects of the design of conveyor systems as it pertains to light fabric conveyor belts. Special emphasis has been placed on belt tracking measures.

Light fabric conveyor belts

Light fabric conveyor belts are, according to the International Standard ISO 21183-1 "Light conveyor belts - Principal characteristics and applications", predominantly used for the indoor transport of unit loads, like industrial goods of all kinds and foodstuffs, parcels, boxes, crates, cans, containers, luggage, etc.

Fabric conveyor belts are made of various layers, where the tensile strength is provided by synthetic fabric plies. In light fabric conveyor belts, the fabric is usually made of polyester, in some cases of polyamide or aramide. The fabrics are connected by bonding agents or by means of intermediate layers of thermoplastic materials. The conveying side is function-related in material, thickness and texture. Coatings are mainly made of thermoplastic materials like TPU, TPO, PVC, etc. and elastomers like rubbers, PUR, etc. The running side is usually a fabric, often impregnated with a thermoplastic material or with special wear-resistant PUR. Fabric conveyor belts are manufactured in large widths, transported in coils and then fabricated to any required dimensions.

According to the belt construction and target application, fabric belts are distinguished in common "conveyor belts" and highly specialized "processing belts":

Conveyor belts

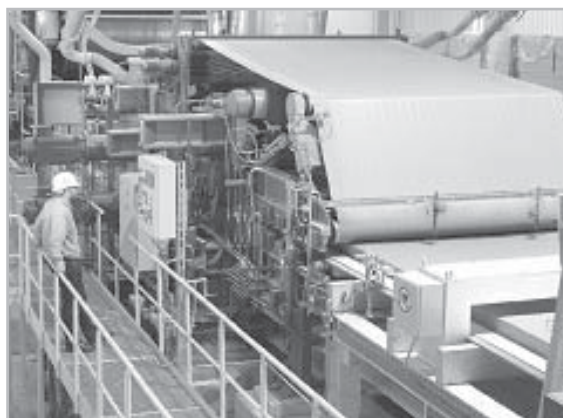
The term "conveyor belt" describes belts used to convey all kinds of semi-finished and finished industrial products from one point to another. They are mainly used in the handling of unit goods both in the food and non-food production and packaging sectors and in general materials handling for storage and distribution.



Processing belts

The term "processing belts" is used for belts that not only perform purely conveying functions, but also have to fulfill important functions in the actual work process. Typical examples of processing belts are:

- Belts in the processing of unpacked and packed food
- Printing blankets on textile printing machines
- Crosslapper belts in nonwoven production
- Prepress belts in particle board production
- Treadmill belts, etc.



Unit and bulk goods

Although fabric belt conveyors are used primarily to convey small to medium sized unit goods, they can also be used for conveying bulk materials. As far as fabric belt conveyor engineering is concerned, bulk materials are generally categorized as granular, such as corn, rice, sugar or even powder.

Structure of the Engineering Guide

This Engineering Guide is divided into a number of distinct chapters - each providing easily found and readily understandable information on a particular subject. More detailed performance information and common themes are clearly marked with relevant cross references to other sections and pages. Simple drawings have been included to provide the reader with a clearer understanding of what is being described. Details about supporting frame, slider bed, carrying roller, shaft bearing and belt running direction, etc. have only been included in these drawings where necessary or where they are the actual issue being dealt with. Mathematic formulae are excluded except in cases where the author believe that inclusion is essential to the readers understanding. For greater clarity, certain details have been deliberately exaggerated: an example here is the geometry of crowned pulleys.

The design recommendations in this Engineering Guide have been found to be successful as a general rule in practice. It should be noted, however, that specific applications, specialized processes, and goods that need to be transported in a particular manner present unique issues that will impact the overall system, its design, installation and operation. It is our belief that the principles detail herein will enable the designer or user of a conveyor to address such issues with a positive impact on its operation and function within the production process.

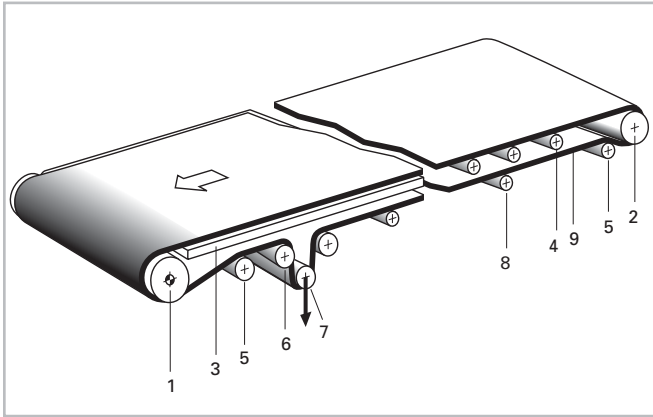
Belt selection and belt data

The choice of the optimal conveyor belt is a precondition for effective system operation and is often determined by the mechanical, thermal and chemical requirements of both the actual processes involved and the materials being transported. Detailed information on belt characteristics and application suitability can be found in the relevant Habasit literature and on www.habasit.com.

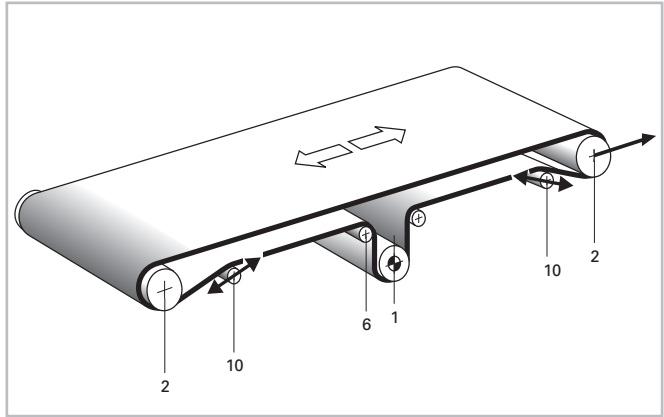
Habasit is able to provide a broad range of application experience and technical expertise and general product support worldwide. Please do not hesitate to contact your Habasit partner whenever you need support.

System components

In its simplest form, a belt conveyor consists of a driving pulley (often the head pulley), a tail pulley, the tensioning device, a conveyor belt, and the supporting structure with the belt support (slider bed or carrying rollers).



Example: Head-driven conveyor



Example: Center-driven conveyor

- | | |
|--|--|
| 1 Driving pulley | 6 Deflection roller (idler) |
| 2 Head or tail pulley (dep. on belt running direction) | 7 Tension pulley (take-up pulley) |
| 3 Slider bed | 8 Carrying roller (on the return side) |
| 4 Carrying roller | 9 Conveyor belt |
| 5 Snub pulley | 10 Guiding pulley |



Sign for driving pulley



Sign for tension pulley with tensioning direction



Belt running direction

If no additional information available the conveying system is assumed as horizontal.

Many conveyor systems have additional components such as nosebars, diverters, accumulators, belt tracking elements, cleaning systems, etc.

Support structure

The supporting structure must be rigid. It must not distort or flex from the forces it is subjected to, i.e. belt tension, weight of the conveyed goods, uneven floors, etc. Without a rigid structure, it would be almost impossible to track the conveyor belt by conventional means and keep it from running off under varying operating conditions (no load/partial load/full load).

Furthermore, the supporting structure must be accurately aligned in all planes. Checking for squareness should preferably be done by measuring across the diagonals (see "Installation and Maintenance Guide").

The conveyor belt must be able to move slightly from side to side without interfering with any fixed components. For this to be possible, it is essential that the pulleys/rollers are of sufficient length, and the supporting structure has ample clearance from the belt edges.

Additionally, it is advantageous to configure the conveyor so the belt is visible along its path, and so there is sufficient accessibility for effective cleaning.

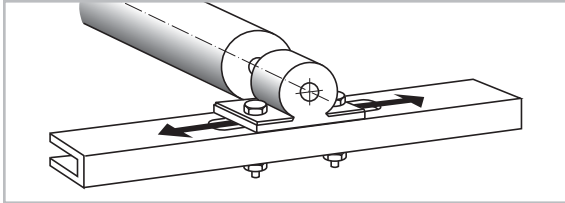
It is essential for the supporting structure to have an earth ground through which the antistatic belts can discharge electrostatic potential through the pulleys and rollers.

Note: Standard plastic pulleys and rollers, synthetic bearings and lubricants, and plastic slider beds are all insulators and will magnify the electrostatic charge of the belt.

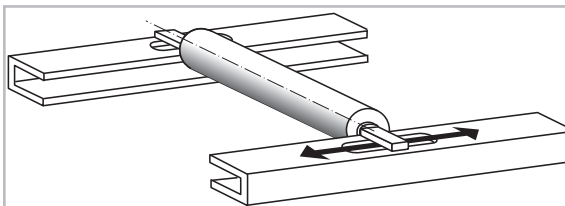
In case low noise is of importance for conveying equipment, its superstructure requires special attention. The slider bed needs to be designed to dampen sound generating vibration. The diffusion of sound conducted through solid components and rigid mounting points must be avoided. Noise-absorbent conveyor belts can merely support noise reduction, but cannot replace special design measures.

Mounting of pulleys and rollers

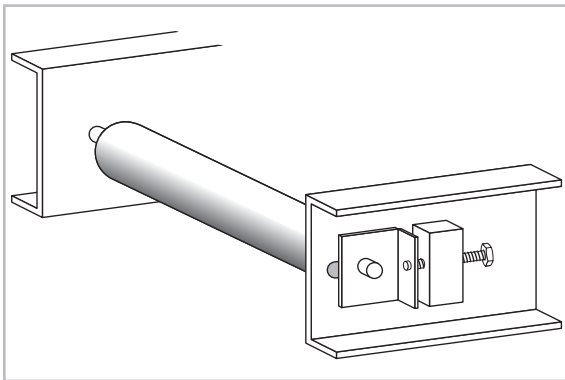
Normally, the driving pulley is not adjustable and as with all other pulleys and rollers, it must be aligned at right angles to the belt running axis.



Adjustable bearings are recommended for head, tail, deflection and tension pulleys which are heavily loaded by the belt tensile force.



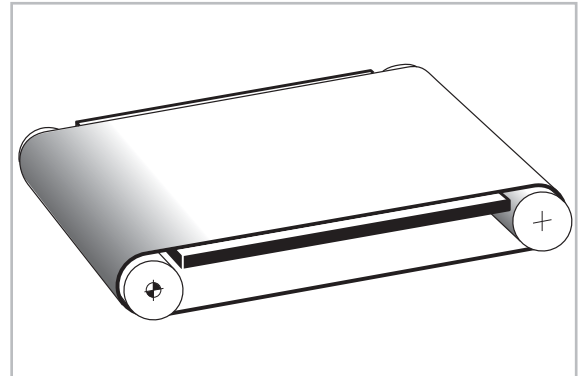
Slotted mounts are suitable for less heavily loaded rollers, e.g. for pivotable carrying rollers.



As a general rule, only as many pulleys and rollers should be installed as are necessary to carry and guide the belt. Each pulley and roller can be the cause for belt running problems as well as for accumulation of debris.

Slider bed

The advantages of a belt supported by means of a slider bed are primarily that the transported goods lay with greater stability on the belt, and it presents virtually no influence on belt tracking – a distinct benefit versus a similar design which employs carrying rollers. With the correctly selected belt (with appropriate running side fabric) and slider bed material it is possible to favorably influence the coefficient of friction, running noise and the belt service life.



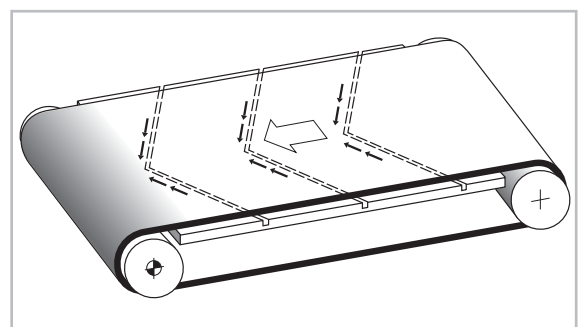
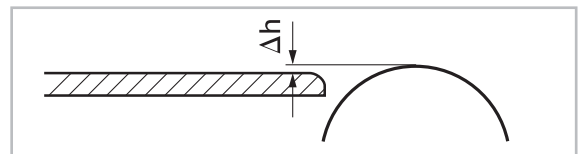
Preferred slider bed materials are:

- Pickled steel sheet (chemically descaled steel sheet)
- Stainless steel sheet (used especially in the food sector)
- Hard plastics (duroplastics such as phenolic resin, etc.), mostly as a cover on chipboard or plywood
- Laminated hardwood sheets (beech, oak)

The friction between slider bed and belt is considerably influenced by material type and surface finish of the slider bed as well as by humidity, dust, dirt, etc.

Attention is to be paid to the following points:

- The edge of the support must be rounded and lower than the pulley surface ($\Delta h = \text{approx. } 2 \text{ mm} / 0.08 \text{ in}$)
- The heads of mechanical fasteners must be recessed below the sliding surface
- The slider bed must be precisely aligned relative to the running direction of the belt and it must be leveled so that there is no tilt (this is particularly important with slider beds of steel sheet panels), otherwise the belt will tend to run off
- Thoroughly clean the slider bed before being put into service. If necessary, the slider bed, pulleys and conveyor belt are to be periodically cleaned as dirt deposits can be a significant cause of performance problems, i.e. belt running problems, increased coefficient of friction, belt damage, etc.
- Excessive moisture between slider bed and belt increases adhesion (suction effect), resulting in a higher energy requirement, potentially leading to the overloading of the drive. Recommended measures to prevent the suction effect is to perforate the slider bed, to use a belt with a structured running side (i.e. quadrille structure) or to use carrying rollers instead of a slider bed.
- Also grooves in the slider bed can provide effective drainage and remedy suction problems. Where these grooves are oriented in a "V" or chevron pattern, a belt tracking effect can be obtained simultaneously.
- Shallow strips e.g. of UHMW-PE, attached in a steep angle "V" or chevron pattern, have a similar effect and further minimizes the running noise

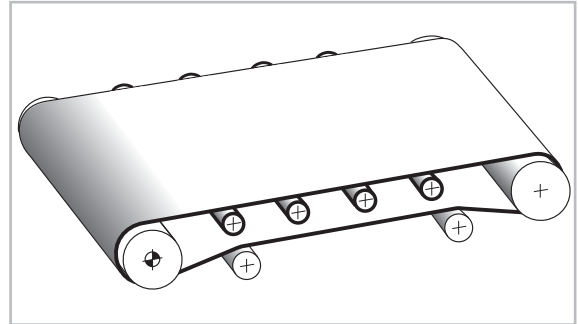


Support by carrying rollers

With long conveying distances and high overall product loads, carrying rollers can be used instead of a slider bed. In many cases, the roller bed reduces friction losses. Peripheral force and drive power requirements are proportionally reduced.

Most commonly used are rollers made from precision steel tubes and roller bearings.

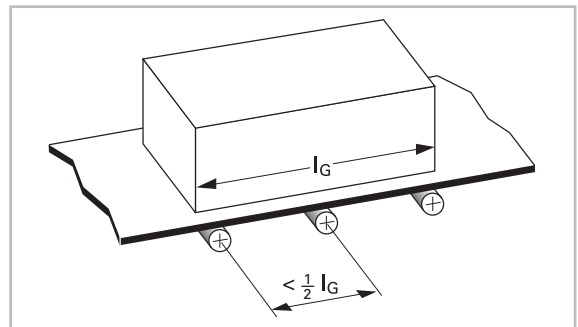
Rollers with a plastic sheathing can also be used as they are resistant to corrosion and certain chemicals. A non-conductive synthetic cover can produce higher static charges during operation, particularly when used in conjunction with plastic bearings!



Carrying rollers, in virtually all cases, have a cylindrical profile. As the conveyor belt only travels tangentially along the surface of these rollers and does not wrap around them, these rollers may have a smaller diameter than that specified for the belt's $d_{\min}$ (see page 17). The specified diameter must resist excessive deflection when the conveyor belt is under operational load.

Attention must be paid to the following points:

- The distance between the carrying rollers should be less than half the length of the transported unit loads l_G , in order that the goods carried are always on at least two rollers
- Carrying rollers must be accurately fitted at right angles to the belt running axis as skewed carrying rollers are frequently the cause of belt tracking problems. It is sufficient if the rollers can only be adjusted from one side, i.e. by means of slots in the supporting structure (see page 8).
- Pivotal carrying rollers can be installed for the purpose of guiding belt running; in these cases the pivot angle γ must be at least $\pm 5^\circ$ (see page 28). It is recommended, especially with long conveyors, that some of the carrying rollers are adjustable.



Belt support on the return side

Return rollers are recommended to have a center distance of under 2 meters / *approx. 6 ft*, this will prevent excessive belt sag due to the belt's own weight.

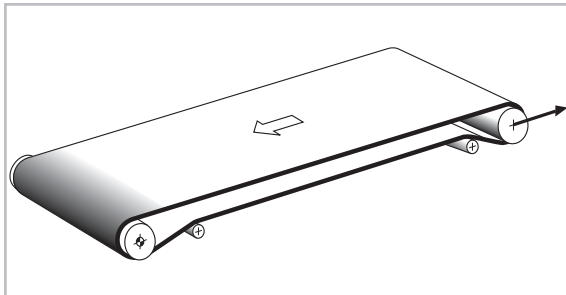
These carrying rollers on the return side must also be installed accurately at right angles to the belt running axis as again inaccurately aligned rollers will often cause belt tracking problems, particularly in cases where high friction or structured belt covers are used.

The following standard system illustrations depict those most commonly found in use for fabric belt conveyors.

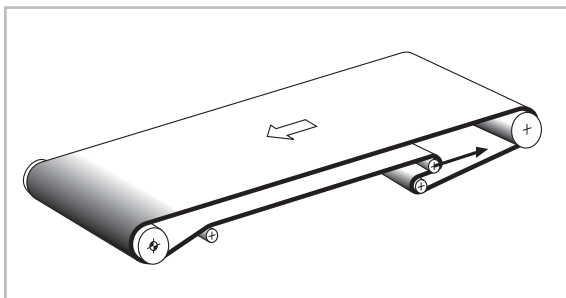
Head drive

In the case of a head-driven conveyor, the conveyor belt is said to be pulled on the carrying side. The head drive is preferred to the tail drive because of lower belt stress and smaller forces imparted to the conveyor components, i.e., pulleys and bearings.¹⁾

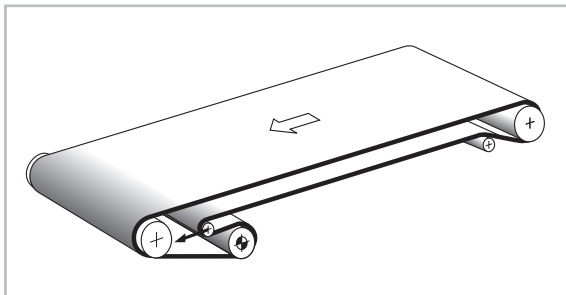
Examples of design variations with regard to the position of the tensioning device:



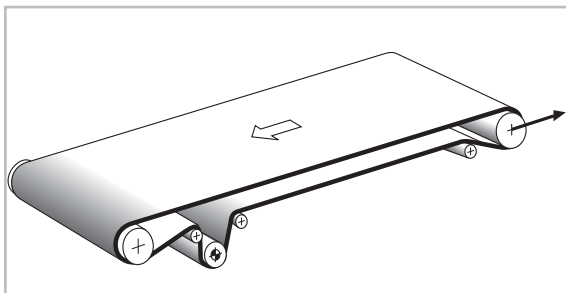
Head drive, tail pulley as tension pulley.



Head drive, tensioning device on the return side.



Driving pulley and tensioning device on the return side near the head pulley (equates to a head drive).

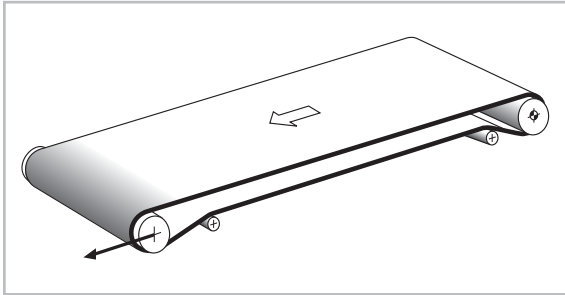


Driving pulley on the return side near the head pulley (equates to a head drive), tail pulley as tension pulley.

¹⁾ Two exceptions have to be mentioned:

- The declined conveyor where the magnitude of carried load, angle of decline, and friction make it possible for the conveyed product to drive, or push, the belt and create a “negative” peripheral force. In this case the tail drive is recommended for optimum performance.
- In case of reversing operations the center drive is recommended

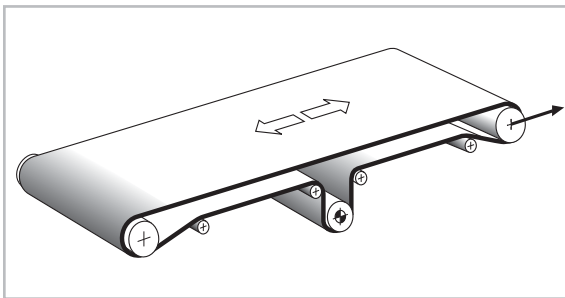
Tail drive



Greater belt tensile forces and higher shaft loads that occur in tail-driven installations may demand stronger and more robust system construction. This issue becomes far more significant in long installations and where the mass of goods transported is great.

As mentioned above, the tail drive is preferable on declined conveyors as the drive acts as a braking mechanism for the belt.

Center drive

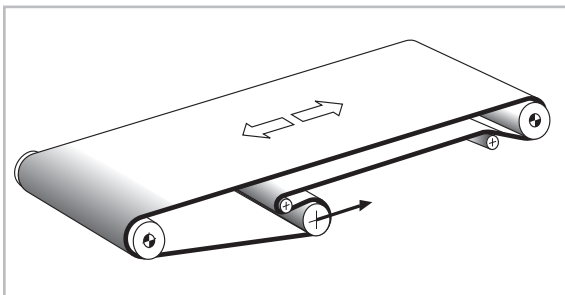


Center drives are commonly specified for reversing operations. In this case, the rollers at each end of the conveyor may have cylindrical-conical shape (see page 19).

The center drive is also used for conveyors equipped on both the infeed and discharge ends with a nosebar (see page 44).

In such conveyor design, peripheral force is significantly increased as a result of these fixed components. Consequently, the increased power consumption and shaft load must be considered. Belt guidance in conveyors with one or two nosebars and center drive is quite demanding. It is best to minimize the arc of contact on nosebars and the total number of pulleys and rollers in the belt path.

Tandem drive



In processes where a high degree of positioning accuracy is required, often in combination with reverse operation, or in situations demanding large drive power ratings, then both end rollers are typically driven.

This is seldom the case with fabric belt conveyors as in most cases it is sufficient to increase the arc of contact on the driving pulley by means of a snub pulley or to fit the driving pulley with a friction cover (see page 22).

Where each of the tandem driving pulleys is driven by a dedicated motor, the drive system should incorporate a speed control system. The drive of one motor by another is to be avoided, as this can lead to the overloading of the belt.

Drive units

Generally the drive comprises an electric motor, a power transmission element (gearbox or belt) and the driving pulley.

Standardized three-phase squirrel-cage motors with star-delta start are preferable. The starting is usually smooth. The belt speed is often controlled through an electronic frequency inverter.

The drive power ratings of fabric conveyor belts usually are relatively small (typically between 0.5 – 5 kW). The effective required motor power, required to move the fully loaded belt along the support structure, can easily be calculated by the CONVEY-SeleCalc program. The calculation does not include bearing drag or belt flexion forces (particularly important in low temperature environment).

Converting motor speed to the required conveyor speed commonly takes place via a gearbox or a transmission belt and pulley combination. Often motor and gearbox are directly combined in a compact design (garmotor). Possible options are spur gear, bevel, or worm gears. If a power transmission belt is used, flat belt drives are recommended; these are space-saving, cost-effective, maintenance-free and highly efficient.

Drum motors are also often used with relatively low power ratings. It is important to note that drum motors are surface-cooled, thereby partially dissipating its heat through the belt. It is particularly noteworthy in short conveyors with a highly loaded drum motor, motorheat can result in severe, sometimes unacceptable overheating of the belt. Excessive and nonuniform heating of the belt is a common cause of belt running problems such as mistracking and belt shrinkage.

In special cases the drive station can also act as a brake. With steep gradient conveying (incline or decline) the drive unit is used to prevent the belt from moving when at rest.

Power transmission

The power has to be transferred from the drive to the belt. This is the function of the driving pulley (see page 22).

It transfers the drive force (peripheral force) from the pulley surface to the belt. In driving the flat conveyor belt, where there is no positive engagement with the driving pulley, the power transmission capacity is dependent upon the following factors:

- Arc of contact of the belt at the driving pulley
- Coefficient of friction between belt and driving pulley
- Contact pressure between belt and driving pulley

Commonly used measures for increasing this power transmission capacity:

- Use of a snub pulley to increase the arc of contact
- Use of a lagged driving pulley to increase the coefficient of friction
- Increasing the initial elongation (tension) of the belt.
This option, however, results in additional shaft and bearing load. Additionally, the allowable elongation of the belt must not be exceeded; therefore, a stronger belt may be required.

Effective power transmission is largely dependent on the friction between belt and pulley surfaces. Oil, grease, moisture, rust, dirt, conveyed product build-up, etc., all reduce friction and increase the potential for slip. Consequently, the belt and the system as a whole can no longer function properly. Cleanliness is equally important for issues such as belt tracking and service life. Care must be taken to ensure that the belt and installation are kept as clean as possible. The following measures should be considered:

- Soil- and dirt-repellent conveyor design
- Appropriate belt cleaning system (see page 40)
- Effective cleaning procedure (see "Installation and Maintenance Guide")

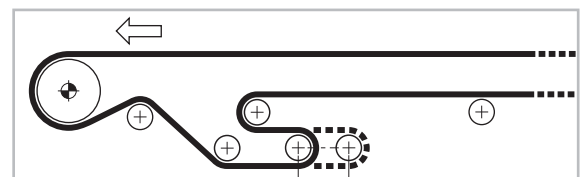
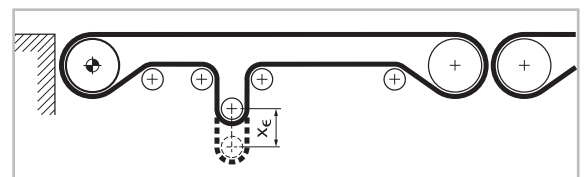
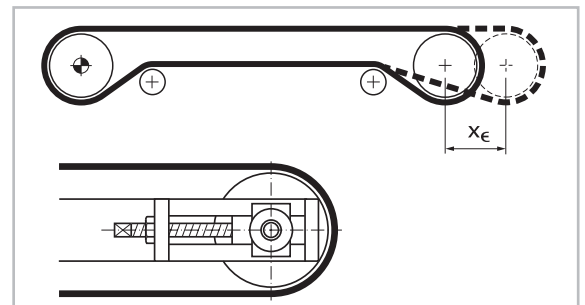
The required contact pressure of the conveyor belt on the driving pulley is achieved by means of a belt tensioning device. Tensioning force and resulting shaft load are lower if the tensioning device is placed on the low tension (slack) side of the driving unit.

A distinction must be made between fixed tensioning devices and constant-force tensioning devices:

Fixed tensioning devices

Fixed tensioning devices are to be used in installations where there is no need to compensate for variations in belt length or belt tension during operation, further for reversing operation under full load. Usually, fixed tensioning devices are sufficient for fabric belt conveying installations, because Habasit conveyor belts are dimensionally stable, with negligible elongation changes during start-up and load changes.

- A simple solution for tensioning is to use the tail pulley with a tensioning device that runs parallel to the belt's axis or the belt's running direction
- When the center distance between head and tail pulleys may not be changed, e.g. with intermediate, or transition conveyors, the tensioning device is incorporated in the return side
- With long, heavyload installations, the tensioning device should be positioned directly after the driving pulley
- Tensioning pulleys can be adjusted manually, but may also be fitted with pneumatic or hydraulic cylinders or even electric positioning motors to provide a fixed take-up position

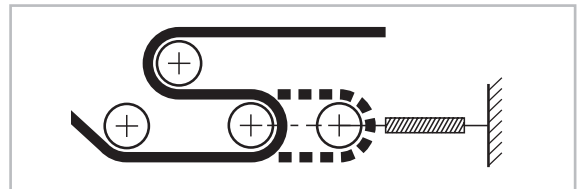


Constant-force tensioning device

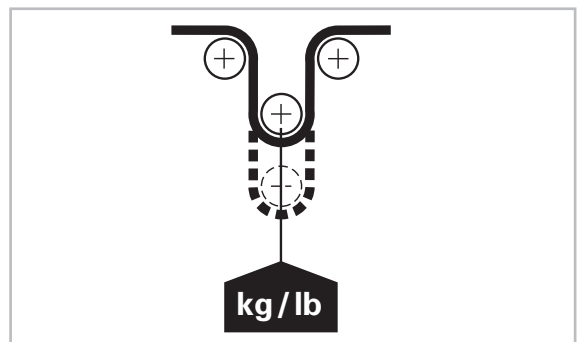
It is advisable to use constant-force tensioning devices where the conveyor installation is lengthy and if the weight of the transported good is great relative to the force/elongation ratio (elastic modulus) of the belt, or the load is rapidly fluctuating. The constant-force tensioning is also advisable for belts with polyamide tensile member and if there is considerable variation in humidity, but it is **not** recommended for reversing operation under full load (unless the conveyor is equipped with two tensioning devices, one on either side of the driving pulley).

With active, constant-force tensioning systems, belt length changes occurring during operation are compensated automatically. It is obvious, therefore, that these devices must be designed and built with the capability to compensate for these operational length changes as well as to take up the belt length for the required initial tension.

Constant-force belt tension is typically achieved either by spring-loaded tensioning or by pneumatic or hydraulic tensioners.



For heavy belts or long conveyors, also gravity tensioners provide constant-force belt tension.



Take-up x_e

For belts with polyester tensile member (traction fabric), the take-up should be at least 1.5% of the belt length. For belts with polyamide traction element, at least 2.5% take-up length should be included.

Adequate consideration when determining the configuration and effective length of take-up must be given due to various factors: Required take-up for belt tensioning, influences due to fluctuations in temperature and moisture, potential for the build-up of debris on the conveyor components (increasing the length of the belt path), manufacturing tolerances of belt and installation, requirements to provide ease of installation (joining) and maintenance, etc.

Effective measures for keeping the take-up as short as possible are: Head drive (instead of tail drive), driving pulley with friction cover, large arc of contact at the driving pulley, conveyor belt with a high modulus of elasticity ($k_{1\%}$ value).

Although small pulley diameters in general are welcome because they reduce the overall conveyor height, decrease the installation weight and cut cost, it has to be considered: the larger the pulley diameter, the greater will be the durability of the conveyor belt.

The following factors are used to determine the smallest possible diameter:

- Flexibility of the conveyor belt and that of any applied profiles (V-guides, cleats, etc.)
See "Minimum pulley diameter regarding the bending flexibility $d_{\min}$ "
- Admissible pulley deflection
See "Minimum pulley diameter with respect to the pulley deflection d_y " (see page 18)

Minimum pulley diameter regarding the bending flexibility ($d_{\min}$)

Habasit defines a minimum pulley diameter $d_{\min}$ for each type of belt, applicable for an arc of contact greater than 30°. The minimum pulley diameter $d_{\min}^{1)}$ is stated in the product data sheet and is a key component toward designing for optimum performance; therefore, every effort should be made to be in compliance. The use of diameters smaller than those recommended can shorten belt life considerably.

In cases where the belt's arc of contact with pulleys and rollers is minimal, the specified diameter can be smaller. For arc of contact less than 30°, the admissible minimal diameter can be about 50% of $d_{\min}$. For arc of contact less than 5°, as in the case of carrying rollers, the minimum pulley diameter $d_{\min}$ does not need to be considered.

For **backward bending** the minimum pulley diameter with counter flexion has to be considered (see conveyor belt product data sheet).

For belts with bonded **profiles**, the minimum pulley diameter is a function of the belt flexibility as well as the size, shape, material and hardness of the profile and type of bond. Therefore, minimum pulley diameter for belts with profiles is determined by comparing the $d_{\min}$ of the belt to that listed for the desired profile, and then abiding by the larger.

¹⁾ The stated value is valid for 23 °C / 73 °F. For lower temperatures the pulley diameter has to be increased accordingly.

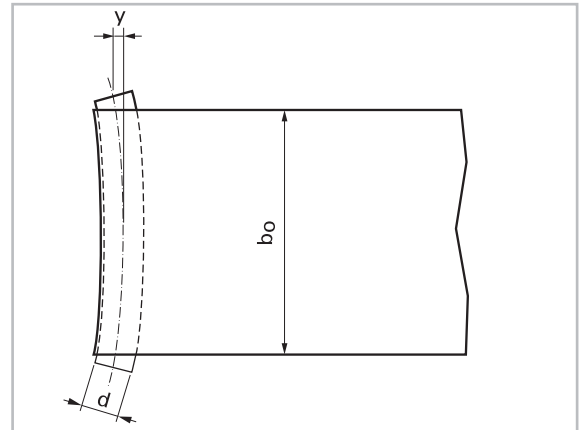
Minimum pulley diameter with respect to the pulley deflection (d_y)

To support stable tracking of the conveyor belt, the pulley deflection y , caused by the belt tension must be minimized.

As a rule of thumb, Habasit recommends the following values for the admissible deflection y :

Cylindrical pulleys: $y \leq 0.001 \cdot b_o$ [mm]
 Cylindrical-conical pulleys: $y \leq (0.001 \cdot d) + 0.07$ [mm]

In order to check the pulley deflection, it is recommended to use the CONVEY-SeleCalc calculation program.



Effective pulley diameter d_{eff}

The effective pulley diameter d_{eff} must be at least as large as or larger than the minimum pulley diameter d_{min} stated in the product data sheet **and** the smallest diameter with respect to the pulley deflection d_y :

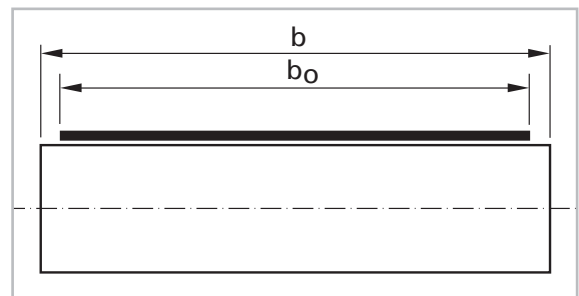
$$d_{eff} \geq d_{min}$$

and

$$d_{eff} \geq d_y$$

Pulley width

Pulleys and rollers should be wide enough so that the belt makes full contact with them over its entire width, even when it is not positioned on the exact center of the pulley.



Pulley width recommendations:

Belt width b_o	Pulley width b
$b_o \leq 100 \text{ mm} / 4 \text{ in}$	$b = b_o + 20 \text{ mm} / 0.8 \text{ in}$
$b_o > 100 \text{ mm} / 4 \text{ in}$	$b = (1.08 \cdot b_o) + 12 \text{ mm} / 0.5 \text{ in}$

Pulley surface

Clean, oil- and grease-free steel pulleys with a smooth, almost polished surface, corresponding to a roughness $R_a = 1.6 \mu\text{m}$ are in most cases sufficient to ensure slip-free power transmission on **driving pulleys**. Pulleys with grooves or knurling are to be avoided as they may induce belt tracking problems and may also lead to excessive wear of the driven surface of the belt.

Fewer demands are made on the surface finish of pulleys and rollers without power transmission, **like tail, snub, tensioning, and deflection pulleys**. Since the tensile forces before and after these pulleys are identical, there is no elongation difference and no movement at the pulley surface.

Recommended roughness $R_a = 3.2 \mu\text{m}$.

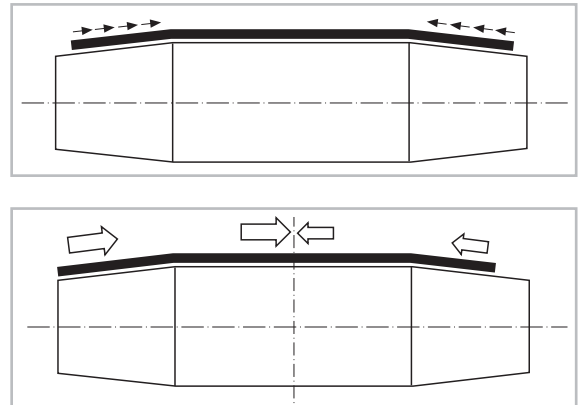
Cylindrical-conical (trapezoidal crowned) pulleys

For the tracking of conveyor belts cylindrical-conically formed (trapezoidal crowned) or simple crowned pulleys are effective for use. As the belt tries to run to the highest point of a pulley diameter, it is constantly directed towards the center of the pulley by the conical ends.

If the belt has the tendency to run to one side, e.g. to the left, the belt centering forces on the left increase as the contact area increases and, conversely, the tracking forces on right end of pulley decrease. The resultant force consequently directs the belt back toward its centered (neutral) location on the pulley where the centering forces become balanced on each side.

Pulleys with this shape exert a **self-tracking** effect to the belt, so that, even with changing run-off tendencies during operation or with reversal running direction, the belt will be tracked optimally without the need to adjust the axis.

The cylindrical-conical (crowned) form is commonly used for the driving pulley, but may also be incorporated on idling pulleys like tensioning and deflection pulleys.



In order to achieve an effective belt tracking and this without experiencing any negative impact on belt operating behavior or belt service life, the crown shape, that is the ratio of the conical parts to the cylindrical part and the height of crown (conicity), should be done according to the following guidelines.

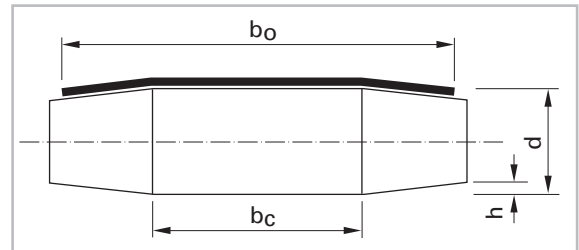
Length of the cylindrical part b_c

$b_o \leq 2,000 \text{ mm} / 80 \text{ in}$:

$$b_c = \frac{b_o}{2}$$

$b_o > 2,000 \text{ mm} / 80 \text{ in}$:

$$b_c = b_o - 1,000 \text{ mm} / 40 \text{ in}$$



Height of crown h

The required height of crown to track a conveyor belt depends on the lateral flexibility of the belt and/or the friction between belt and pulley.

Habasit recommends for **2-ply**, fabric conveyor belts (against steel pulley) an average crown height of **2 to 3 (0.001 · d + 0.075) mm**. The resulting values are listed in the following table:

Pulley diameter d	mm	≤ 50	100	150	200	250	300	350	400	450	500
Height of crown h for conveyor belts against steel pulleys	mm	0.25 to 0.4	0.35 to 0.5	0.45 to 0.7	0.55 to 0.8	0.65 to 1.0	0.75 to 1.1	0.85 to 1.3	0.95 to 1.4	1.05 to 1.6	1.15 to 1.7

Pulley diameter d	in	≤ 2	4	6	8	10	12	14	16	18	20
Height of crown h for conveyor belts against steel pulleys	in	0.01 to 0.016	0.014 to 0.021	0.018 to 0.027	0.022 to 0.033	0.026 to 0.039	0.03 to 0.045	0.034 to 0.051	0.038 to 0.057	0.042 to 0.063	0.046 to 0.069

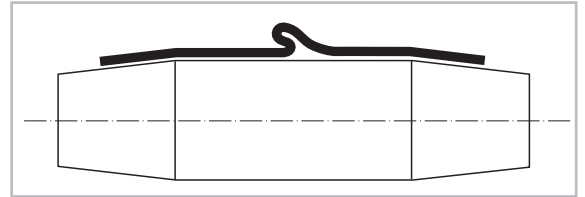
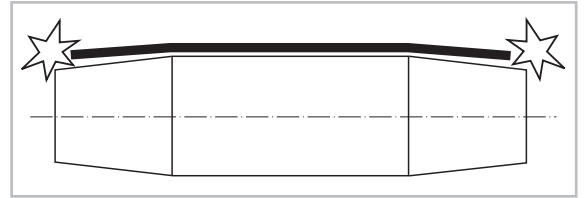
The above indications must be employed with regard to pulley width recommendations. These guidelines are suggestions only and may be adapted as necessary.

Note: Pulley crown dimensions according to C.E.M.A. standard 402 are focused on relatively thick and heavy belts and therefore, can be considerably more aggressive compared to the recommended values in the table above, which are deemed to be sufficient for light fabric conveyor belts.

- Excessive height of crown may either result ...
... in a loss of the tracking effect because the belt does not conform sufficiently to the conical ends (this is especially the case for belts with high transverse rigidity)

or

in longitudinal creasing and, in extreme cases, to belt overlapping in case of thin and laterally very flexible belts



- For **thin, laterally very flexible belts** (1-ply belts), for belts with running side cover, or in applications with lagged pulleys, it is advisable to reduce the height of crown, h , to approximately 50% of the afore-listed values

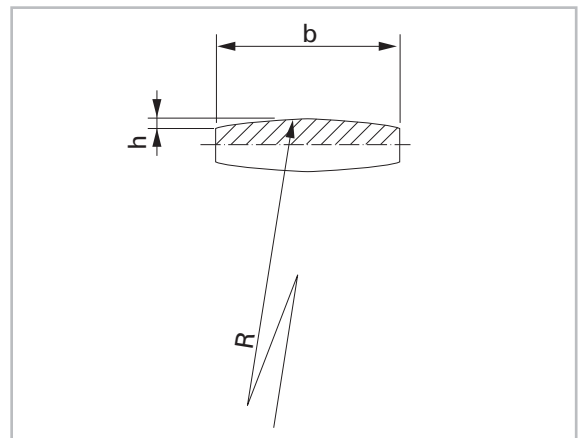
Radially crowned pulley form

The afore-listed height of crown is also valid for radially crowned pulley form. Referring to the tracking effect it makes no difference whether a pulley is crowned or has cylindrical-conical (trapezoidal) profile.

Conversion of the crown radius R and crown height h :

$$R = \frac{h}{2} + \frac{b^2}{8h}$$

$$h = \frac{b}{2} \tan \left[\frac{\arcsin \left[\frac{b}{2R} \right]}{2} \right]$$



Cylindrical pulleys

Pulleys with cylindrical shape exert **no centering effect** to the belt. It is, therefore, of high importance that the conveyor system features at least one measure to keep the belt on center, e.g. cylindrical-conical pulley(s), guiding pulley(s) or other tracking measures.

Tail, deflection, snub, guide and tension pulleys are usually made with cylindrical shape.

Rollers and pulleys that run against the coated conveying side of the belt should normally be cylindrical.

Driving pulleys

The principal function of the driving pulley is to transfer the peripheral force from the driving system to the conveyor belt.

If the driving pulley is cylindrical-conical in shape, it will also produce a self-centering effect on the running behavior of the belt. For detailed information about cylindrical-conical pulleys refer to page 19.

Clean, oil- and grease-free steel pulleys with a smooth, almost polished surface (corresponding to a roughness $R_a = 1.6 \mu\text{m}$) are in most cases sufficient to ensure slip-free power transmission.

Driving pulleys with grooves or knurling are to be avoided as they may induce belt tracking problems and also will lead to excessive wear of the driven surface of the belt.

To improve traction between belt and driving pulley, increase the arc of contact or the coefficient of friction by providing the pulley surface with a friction cover (pulley lagging).

Lagged driving pulleys

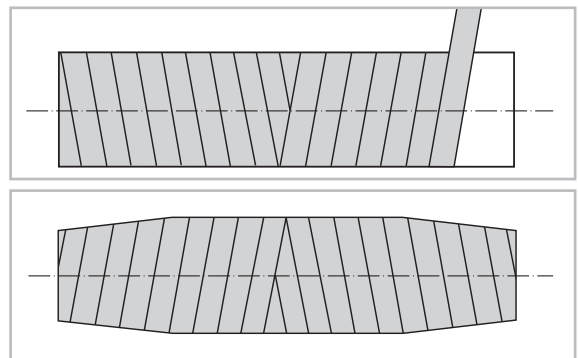
Driving pulleys covered with an abrasion-resistant elastomer, e.g. nitrile rubber (recommended hardness 60 – 80 Shore A) or urethane (recommended hardness 80 – 90 Shore A), increase the coefficient of friction and thus the transferable peripheral force. Such friction covers may be applied in the form of a tube, a sheet, dip coated or sprayed on. It is important to note that the surface finish of lagging should be a dull or matt finish or finely textured, as glossy finish may create excessive friction and accumulate debris.

Most commonly strips glued on in a spiral manner have proven to be a successful alternative to commercially available rubber-covered pulleys.

Habasit offers special lagging materials. Also conveyor belts and flat belts have successfully been used as friction cover material.

Recommended glues: TRS Plasto or Balco ME.

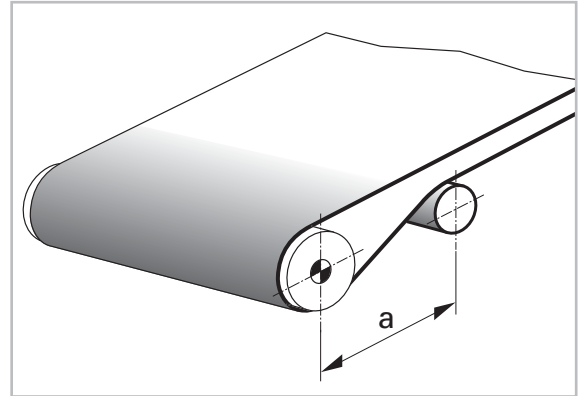
If possible, fix the ends of the strips with screws or with wear-resistant tape.



Snub pulleys

Snub pulleys are primarily used for the following reasons:

- To increase the arc of contact at the driving pulley (→ improvement in power transmission, lower initial tension, lower shaft load)
- To reduce the distance between carrying side and return side (→ reduced overall height of the conveyor installation)
- To provide tracking adjustment. **Adjustable** snub pulleys are particularly effective in improving the belt tracking. This is why adjustable snub pulleys are known as **guiding pulleys** (see page 26).



The center distance “a” between end pulley and snub or guiding pulley should be at least twice the diameter of the end pulley.

Observe the minimum diameter for counterflexions according to the indication in the product data sheet.

Special attention is demanded when belts with structured surface are running over snub pulleys. The belt might be difficult to track, create noise or the belt lifetime could decrease due to added abrasion.

Conveyor belts are frequently blamed for belt tracking problems and in most cases this is unjustified. The failure cause is usually to be found in the installation itself and may be the result of poorly adjusted pulleys and rollers, incorrect application of belt tracking measures or faulty design. It is therefore essential to be fully aware of the basic characteristics of the different belt tracking measures and for these to be employed correctly.

A distinction needs to be made between basic and additional measures for belt tracking. The former are appropriate for maintaining a correctly aligned belt in its central position as long as no great external influences are exerted on the belt, such as transverse forces. The latter are necessary when the basic measures alone are either insufficient or inappropriate to control belt tracking sufficiently.

Regardless which measures are taken, the following conditions are essential for problem-free belt tracking:

- The supporting structure must be rigid and stable. It must be able to withstand all the forces acting upon it (belt tension, weight of the conveyed goods, uneven floors, etc.).
- All pulleys and rollers must be fitted at right angles to the belt running axis. Adjustable pulleys and rollers are only to be adjusted after the belt has been properly run in.
- All parts of the installation that come into contact with the belt are to be protected from dirt and soiling and to be cleaned if necessary

What happens if a conveyor has no tracking measure at all?

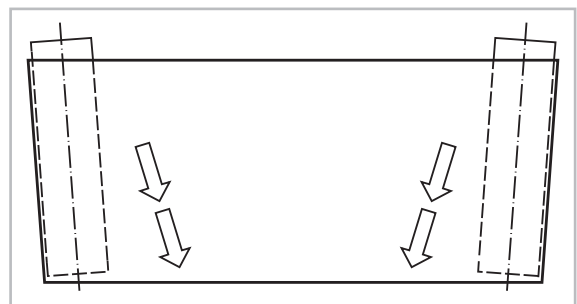
Where a belt runs over **cylindrical** pulleys that are at right angles to its directional path, then the forces acting upon it will be parallel to the running direction of the belt. No tracking forces are exerted on the belt.

In fact, the belt is running in a state of unstable equilibrium and would run off immediately if subjected to the slightest external factors such as off-center loading of product, dirt between belt and pulley, belt distortion or lateral feeding or diverting of goods.

The same scenario applies if one or both of the two pulleys are not positioned accurately at right angles to the belt running axis. The belt will inevitably run off towards the less- tensioned side.

Tracking rule 1

The belt tracks to the side with the least tension.

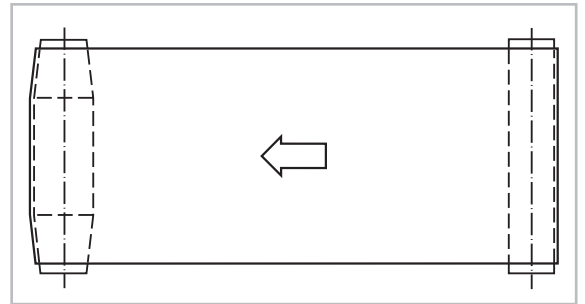


Tracking effect of cylindrical-conical or radially crowned pulleys

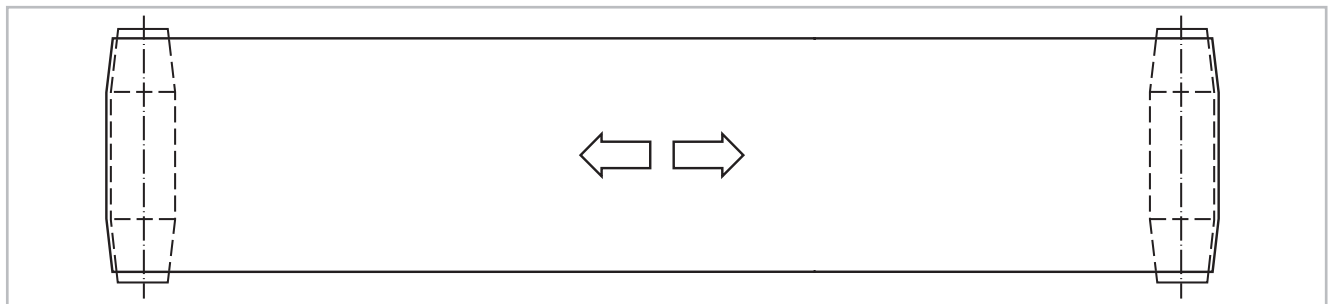
Fabric belt conveyors are normally equipped with at least one, sometimes with several pulleys with cylindrical-conical or radially crowned form. This basic measure is usually sufficient to achieve straight and stable running.

Pulleys with this shape exert a **self-tracking** effect. If there is a variable run-off tendency, or a reversal in running direction, the belt is centered without the need to adjust the axis. Detailed information on cylindrical-conical pulleys (see page 19).

In simple two-pulley conveyors with defined running direction it is usually the head pulley that is the driving pulley. It is designed in cylindrical-conical shape.



With conveyor aspect ratio (conveyor length to belt width) in excess of about 5 to 1 and in installations with reversing operations, it is advisable to crown both, head pulley and tail pulley.



Following this method, a correctly aligned belt can be maintained in its central position as long as there is no excessive deflection of the pulleys.

Additional belt tracking measures:

On installations with a pronounced run-off tendency and considerable transverse forces (side feed, diverter bar, a lot of redirection in the belt path, etc.), the basic use of cylindrical-conical pulleys, will not be sufficient. Additional belt tracking measures will be required, but these will be determined by application and operating conditions.

Please refer to the following pages for further detail:

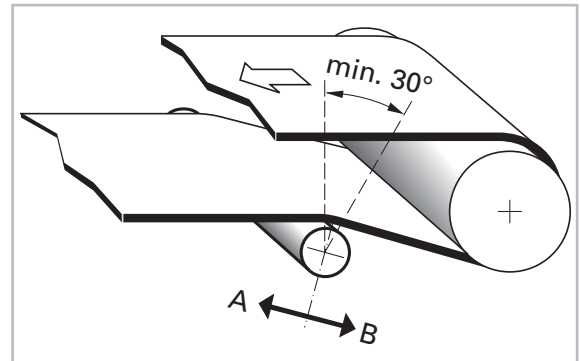
- Guiding pulley (page 26)
- Inclined rollers on the return side (page 27)
- Pivotal carrying rollers (page 28)
- Guiding profiles (page 29)
- Automatic belt control (page 31)
- Further belt tracking measures (pages 32 and 33)

Guiding pulley

Guiding pulleys, also called control pulleys, are adjustable snub pulleys.

Guiding pulleys are usually cylindrical. Observe the minimum diameter for counterflections according to the indication in the product data sheets.

To achieve good tracking, the arc of contact at the guiding pulley should be minimum 30°. For belts with non-adhesive surface, the tracking effect can be improved with a friction cover of abrasion-resistant rubber or synthetic material (recommended hardness 80 – 90 Shore A).



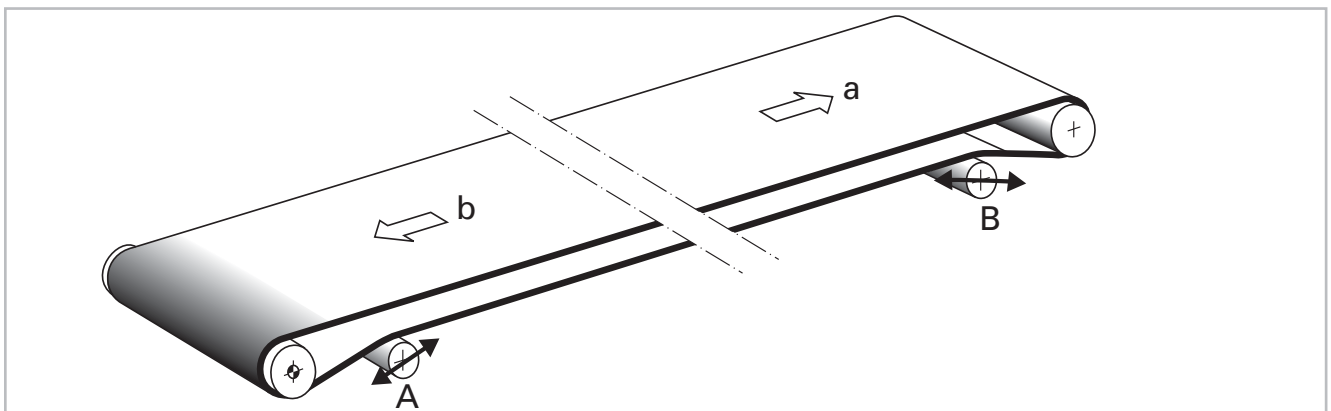
Tracking rule 2

The larger the arc of contact and the higher the friction, the greater the tracking effect.

To keep the belt tension as low as possible, the pivoting movement should, wherever possible, be perpendicular to the median line of the arc of contact (plane A ↔ B). The center distance between the end pulley and guiding pulley should be at least twice the diameter of the larger pulley.

Unlike cylindrical-conical pulleys, adjustable cylindrical rollers are not self-tracking. This means when belt running direction changes, the pivoted position of cylindrical pulleys must be reset. As this is not practicable, the use of adjustable cylindrical rollers for belt tracking **is not recommended for reversing operation**.

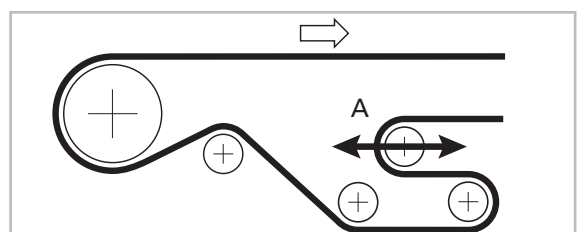
However, exception to this rule can be made for long conveyors. Provided there is sufficient distance between the guiding pulleys, they can be used even for reversing operations as well.



Guiding pulley A tracks the belt correctly in running direction a, guiding pulley B tracks the belt correctly in running direction b.

Tracking rule 3

In group of pulleys and rollers the one that the belt first makes contact with has the larger tracking effect (in the adjacent example roller A).

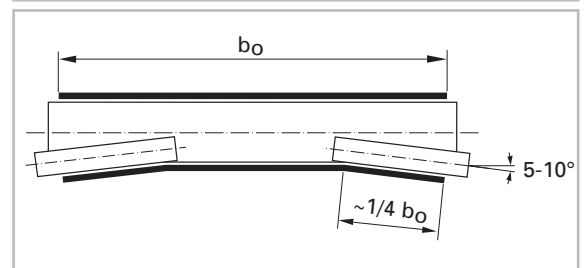
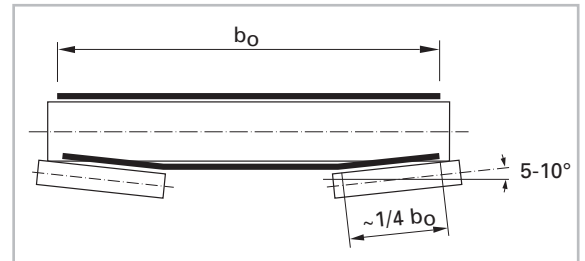


Inclined rollers on the return side

The tracking effect of inclined rollers on the return side is maximized if they are fitted to the running-on side in front of the tail pulley for head drive and in front of the driving pulley for tail drive.

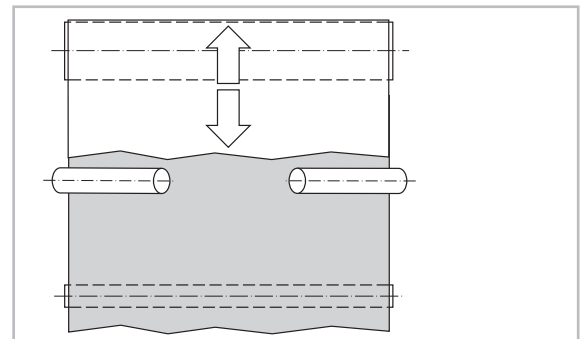
The positioning of rollers under the belt, i.e. on the conveying side of the belt, produces a good tracking effect due to the higher coefficient of friction, however, possible tracking marks on the belt cover must also be taken into consideration.

The rollers can also be positioned above the belt on its running side. This is desirable in cases where the belt has a delicate or highly structured conveying side, or has transversely mounted profiles.

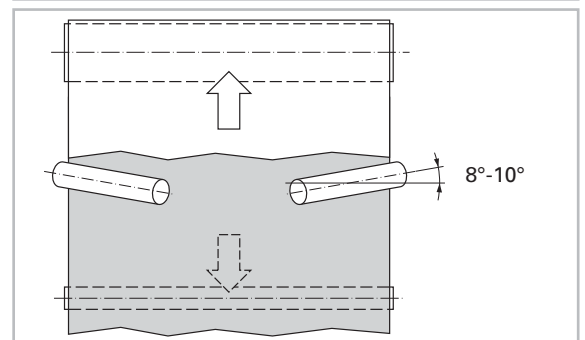


To achieve a satisfactory tracking effect, the belt contact of a roller should be around $\frac{1}{4}$ of the belt width and the rollers angle of incline should be 5° to 10° .

If the inclined rollers are fitted exactly at right angles to the belt running direction, the belt will automatically correct its own position should a change in run-off tendency occur.



This measure works also in reversing operation. Belt tracking is further improved when the inclined rollers are **angled forward** by 8° to 10° at the belt edges in the running direction of the belt. Their effect can be enhanced by adding a friction cover.



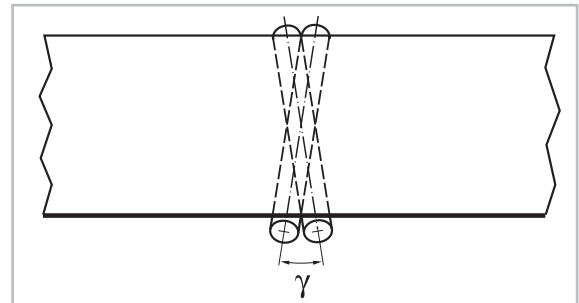
However, rollers angled forward shall not be used for reversing operation as the belt centering forces are thereby reversed as well.

Inclined rollers on the return side have also proven successful for tracking wide, short belts (see page 34) and with thin belts at high speeds. In this case driving pulleys and tail pulleys are to be fitted with cylindrical profiles in order to avoid folding or creasing.

Pivotal carrying rollers

Carrying rollers, on the conveying and return side, can also be installed for pivoted action, but as belt contact is minimal, the tracking effect of these adjustable rollers is limited.

Pivoted cylindrical rollers are **not self-tracking** as is the case with cylindrical-conical pulleys. This means that when the run-off tendency or running direction changes, the pivoted position must be reset. As this is not practicable, the use of pivoted cylindrical rollers for belt tracking is, in general, not suitable for reversing operation.



For long installations, it is recommended to install some pivotal carrying rollers. The adjustable pivoting angle γ should be at least $\pm 5^\circ$.

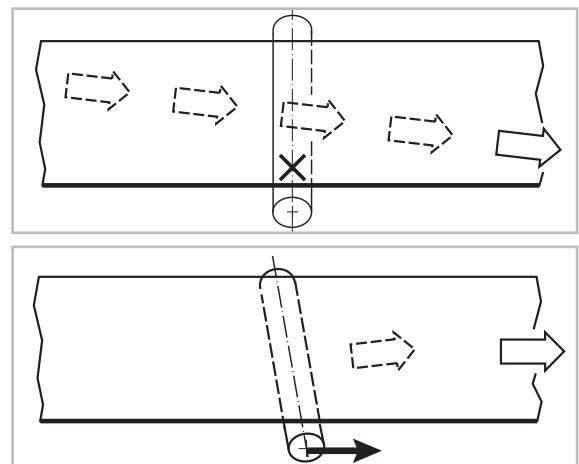
Prior to belt installation, care must be taken to ensure that all rollers are perpendicular to the direction of belt travel. After running-in, any run-off tendency can be corrected by adjustments to one or more rollers.

Tracking rule 4

The belt tracks to the side to which it first makes contact with the roller.

Example:

To track a belt that is moving off to the *right*, the carrying roller must be adjusted so that the belt runs off towards the *left*.



Friction is the force that prevents the belt from running off and it results from the movement of the belt over the roller. The degree of friction force is determined by the amount of pressure exerted by the belt on the roller and on the coefficient of friction between the belt and roller. The consequences of this are as follows:

- The tracking effect of skewed carrying rollers is dependent upon the belt load. The belt position will, therefore, shift differently under different loading conditions.
- Belt slip on skewed carrying rollers causes friction related drag and abrasion
- The tracking effect can be improved by fitting a friction cover to the skewed roller. This will, in turn, increase abrasion and belt wear however.

Guiding profiles

Guiding profiles are usually V-shaped, welded or glued onto the running side of the conveyor belt. Rectangular and semicircular profiles are also used at times.

Because of the relatively high production costs and their limited effectiveness, guiding profiles are not recommended as a general belt tracking measure. Particularly not suitable are guiding profiles in applications with high speed, as they have a tendency to be forced out of the groove allowing the belt to continue to run off.

Guiding profiles are well suited for offsetting localized transverse forces. In this context the term “transverse forces” refers to those forces exerted briefly on the side of the conveyor belt, for instance during side loading or diverting.

General rule:

In principle, the belt must be tracked by common measures, usually by cylindrical-conical pulleys. Only in the zone where the transverse forces occur, the guiding profile has to prevent the belt from running off.

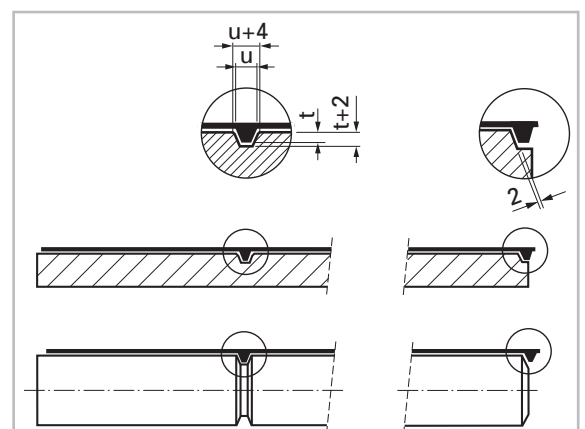
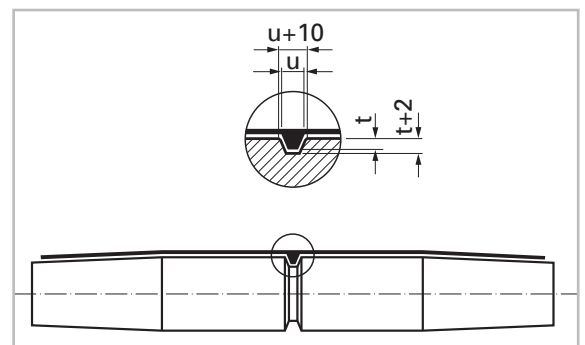
This means, the groove dimensions should have different sizes:

- a) In locations where no lateral forces occur, the **grooves should be wide**, that is around 8 to 10 mm / *0.31 to 0.39 in* wider than the guiding profile. The greater clearance permits the adjustment of the belt without the guiding profiles permanently running against the sides of the grooves.

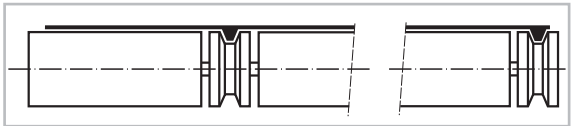
This is particularly true for the drive, head and tail pulleys.

An exception of this general rule has to be considered for guiding profiles in short, but wide conveyors (see page 35). In this case it is advisable to make the grooves in the pulleys narrower than those in the slider bed.

- b) In the zone where the transverse force occurs, that is to say on the slider bed or on the carrying rollers, the **grooves should be narrow**, i.e. only around 4 mm / *0.16 in* wider than the guiding profile.



To consider:

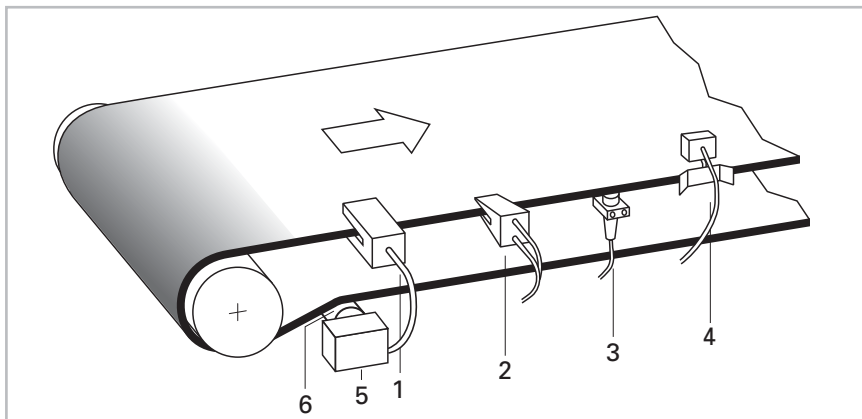
- The belt must have sufficient transverse rigidity to prevent it from being thrown out of the grooves by transverse forces
 - The minimum pulley diameter of the profile has to be observed
 - Generally, a single V-profile in the center of the belt is sufficient
 - For thin belts with low transverse rigidity and also for wide belts, two guiding profiles should be used and positioned as near to the belt edges as possible. Both V-profiles and flat profiles can be used in these cases.
 - With wide and fast running belts, the use of idler rollers is recommended to prevent the profile from climbing out of the grooves
- 
- The edges of the grooves must have a 2 to 4 mm / *0.08 to 0.16 in* chamfer to prevent damage to the guiding profiles
 - Before installing the belt, all grooves must be accurately aligned
 - Great care is necessary during running-in. Belt should be tracked by use of appropriate measures, e.g. cylindrical-conical pulleys. The guiding profile should run without touching the flanks of the groove, as soon as no transverse forces exist.
 - Grooves may be wider than specified if there is sufficient clearance between the belt edges and end of pulleys and/or adjacent frame work to prevent the belt from running off the end of pulleys or colliding with framework. Additionally, consideration must be given to any required tolerance for product placement with respect to the center line or edge of the belt.

Automatic belt control

Automatic belt control can solve even the most serious belt tracking problems. However, it is a comparatively expensive option and, therefore, used where belt tracking behavior is either highly critical and/or where other belt tracking methods have proven ineffective i.e., chronic build up contaminating rollers/pulleys.

Automatic belt control works by sensing the edges of the belt, either by means of noncontact sensors or by mechanical means. The signal is sent to a control mechanism, which actuates a guiding pulley (see page 26), which accurately centers the belt.

It is advisable to make the tail pulley cylindrical. With a cylindrical-conical tail pulley a conflict between the two regulation systems would possibly result in a quite disturbed belt run.

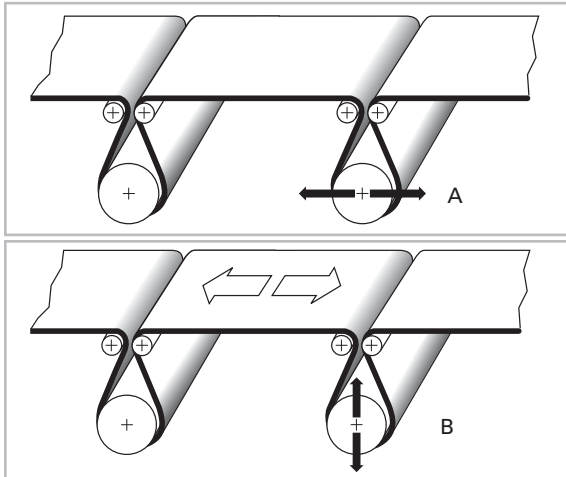


- 1 Optical scanner (photocell, light barrier)
- 2 Pneumatic sensor (air jet)
- 3 Electrical sensor (capacitive sensor)
- 4 Mechanical sensor (microswitch, stylus)
- 5 Control mechanism: electrical (servodrive), pneumatic or hydraulic (pressure cylinder)
- 6 Guiding pulley

It is recommended that one side of the guide/control roller is equipped with a standard adjustment device so that the tracker assembly can be initially aligned manually. While this is being done, the automatic control should be in the neutral position.

A number of companies supply automatic belt tracker products and we recommend that where an installation demands these devices that specialist advice is taken.

In addition to the belt tracking measures previously described, there are other options that can be used depending on certain preconditions and on type of application. The advantages and disadvantages of a number of these alternatives are detailed below.

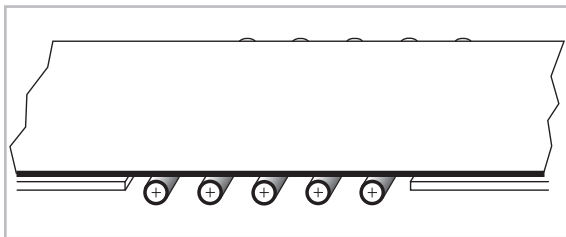


Additional belt wrap

In areas where local transverse forces occur, tracked belts will be kept in place by additional belt wraps. The effect can be enhanced by covering the additional pulleys.

Running-off belts can be tracked by adjustable rollers. Horizontal adjustment (A) is suitable for one running direction only.

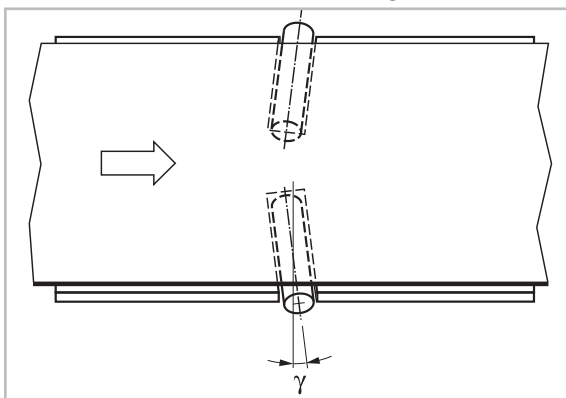
Vertical adjustment (B) will also track the belt for reversing operation.



Carrying rollers with adhesive cover

Local transverse forces can also be dealt with by installing multiple carrying rollers with friction cover. This method is suitable both for installations with slider bed and carrying rollers. With rollers adjusted exactly perpendicular to the belt running direction, the tracking will also work for reversing operation.

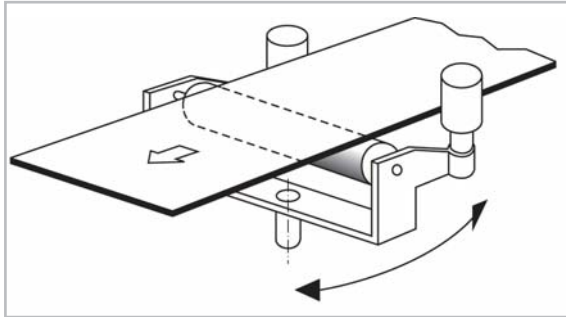
Pivoted rollers on the carrying side



Cylindrical rollers are installed at the belt edges and angled forward in the belt running direction. The skew angle, γ , should be 3° to 12° depending upon belt load, the friction between roller and belt, and on the belt speed.

This method is not recommended to be used with thin belts of low transverse rigidity. Since the belt does not only run on the rollers but also slides, friction exists and thus increases belt wear. This tracking method centers the belt only in the running direction. This method is only effective for centrally located and uniformly distributed conveying goods.

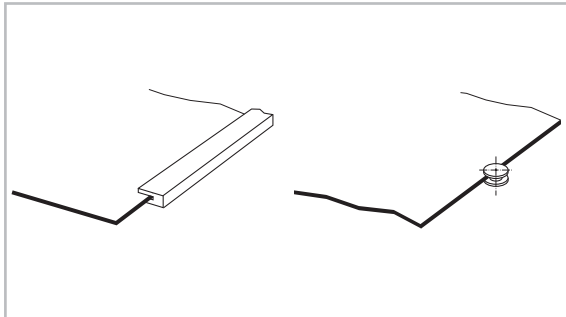
Belt sensing combined with pivotable carrying roller



This tracking device is used for heavy belts and for belts with high lateral stability. Specialty manufacturers supply these units, which can also be equipped with adjustable sensors that substantially reduce belt edge wear.

This tracking method works only in one running direction.

Lateral guide strips and guide rollers



This tracking measure is only possible for belts with sufficient lateral rigidity and edge integrity, however, belt edge wear will increase. Guide rollers are preferable to lateral wear strips in this respect.

The tracking measure will also work for reversing operation.

Edge guide strips are best suited for relatively clean conveying operations as debris may become lodged between the belt and guide strip causing significant belt damage and other performance problems.

The entrance of edge guide strips must be radiused in order to minimize potential edge damage.

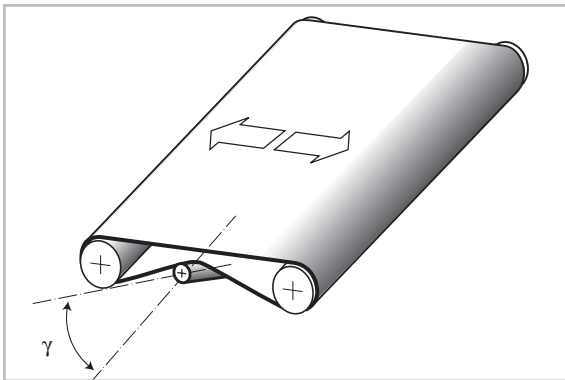
The belt edges can be abrasive themselves. It is advisable, therefore, to consider using durable low friction materials for edge guide strips i.e., stainless steel, phenolic (such as Delrin) etc.

Guiding of short, wide belts

Conveyor belts on installations, where the belt width is equal or larger than the conveying length, are increasingly difficult to guide. Namely thin belts with little lateral stiffness, particularly at high speed, have a tendency to buckle and potentially fold over when fitted on short conveying distances with cylindrical-conical pulleys. Habasit recommends that the head and tail pulleys should be cylindrical and must be installed absolutely parallel and square to the belt running direction.

Further measures, as recommended in the following, should be considered to ensure effective belt guidance in these cases.

Inclined rollers on the return side

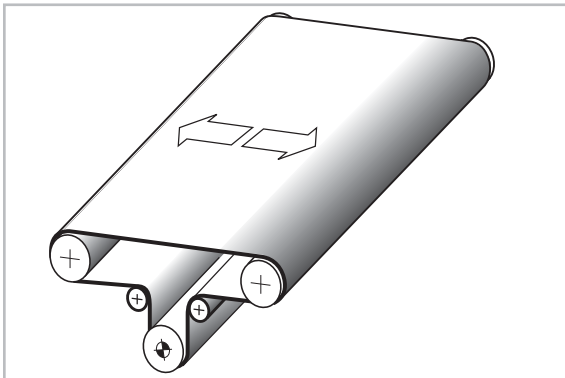


Advisable for guiding wide belts with short conveying distances are inclined rollers on the return side (see page 27).

To achieve a satisfactory tracking effect the roller inclination γ , should be at minimum 5° to 10° in some cases up to 45° . This configuration provides for a self centering effect of the belt

Provided the rollers are fitted at right angles to the belt running direction, the measure is also effective with reversing operations.

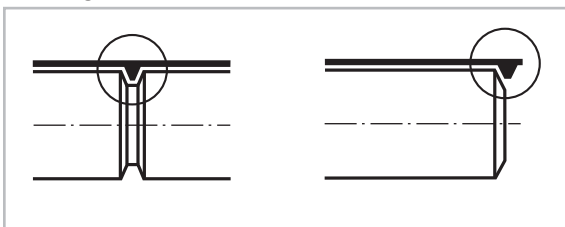
Center drive



Center drive is recommended for reversing operation. The driving pulley should be cylindrical-conical and, if required, lagged. Head and tail pulley as well as deflection rollers are of cylindrical shape.

For slow belt speed the head and/or tail pulleys can be cylindrical-conical shaped.

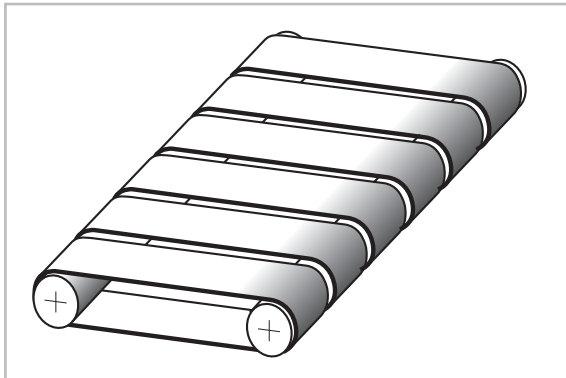
Guiding profiles



Short, wide belts can be guided effectively by using guiding profiles, provided there is sufficient belt transverse rigidity and fairly low speed. It is advisable to guide the belt in the pulleys rather than in the slider bed. This means, the grooves in the pulleys should be narrower than those in the slider bed. This is an exception to the general rule described on page 29.

Grooved rollers must be large enough to offset the added deflection created by the small diameter of the roller at the base of the groove. By moving the groove to the edge of the roller, deflection is significantly reduced. As a result, it may be possible to use a smaller diameter roller without creating excessive deflection (minimum pulley diameter of guide must be considered).

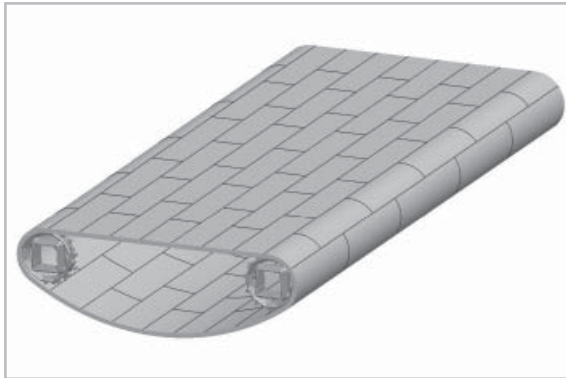
Alternative A: Narrow belts running in parallel



In cases where the application does not require a wide belt, the use of several narrow belts is recommended. The tracking can be controlled much easier.

Note: Each belt has to be guided and tensioned separately, unless elastic belts are used. Further references see page 53.

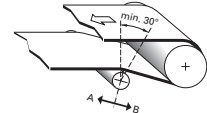
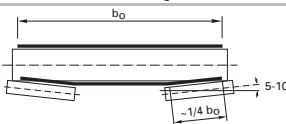
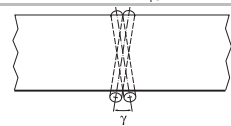
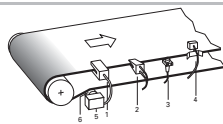
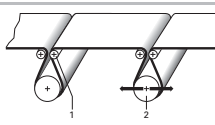
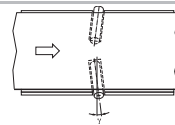
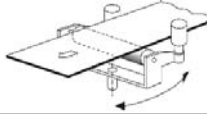
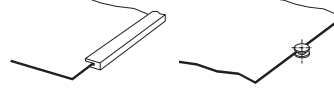
Alternative B: Plastic modular belt



For short and wide conveyors, plastic modular belts are common alternative to traditional fabric belts. Plastic modular belts are sprocket driven, and thereby positively located by the fixed position of a drive sprocket. For the design of modular belts, the conveyor's special requirements must be taken into account. Please contact HabasitLINK® plastic modular belt specialists for further design assistance.

Overview about tracking measures and recommendations

As a basic measure it is recommended to equip at least one, sometimes several pulleys with **cylindrical-conical** or crowned shape. If this basic measure is not sufficient to achieve straight and stable running, additional tracking measures need to be considered.

X Well applicable, 1st priority (X) Applicable depending on the application or under observation of specific limitations – Not recommended		Basic tracking measures	Additional tracking measures	For reversing operation	For absorbing of local transverse forces	For short and wide belts	For heavy belts, high lateral stability	For light belts, low lateral stability
Cylindrical-conical or crowned pulley		X	X	X	–	(X)	X	X
Guiding pulley		–	X	(X)	–	X	X	X
Inclined rollers on the return side		–	X	(X)	–	X	X	(X)
Pivotal carrying rollers		–	X	–	–	–	X	–
Guiding profiles		–	X	X	X	X	X	(X)
Automatic belt control		(X)	X	(X)	–	–	X	X
Additional belt wrap		–	X	(X)	X	–	X	X
Carrying rollers with adhesive cover		–	X	X	X	–	X	(X)
Pivoted rollers on the carrying side		–	X	–	–	–	X	X
Belt scanning combined with pivotal carrying roller		–	X	–	–	–	X	–
Lateral guide strips and guiding rollers		–	X	X	(X)	–	X	–

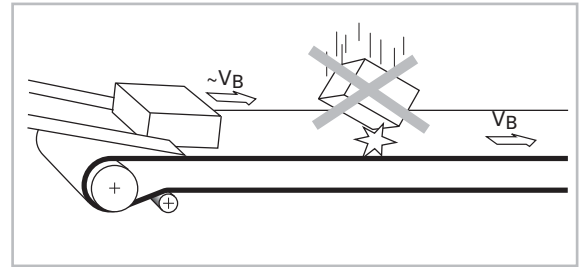
Checklist regarding design issues in order to avoid tracking problems

- Is the conveyor construction rigid enough? Is no inadmissible distortion of the supporting structure, pulleys or rollers under full load and maximal belt tension possible?
- Are the bearings for highly stressed pulleys like head, tail, tension and deflection pulleys made adjustable?
- Is there at least one cylindrical-conical or radial crowned pulley?
- Are the necessary belt tracking measures taken, e.g. cylindrical-conical or radially crowned shaped pulleys or other appropriate tracking measures mentioned in this guide?
- Is the crown height of the cylindrical-conical or radially crowned pulleys correct and made according to our recommendations?
- Is it considered, that the first pulley in belt running direction has the largest tracking effect in a group of pulleys and rollers and it is therefore made adjustable?
- Are snub rollers made adjustable in order to make them usable for belt tracking?
- Have all common tracking methods been considered before using guiding profiles?
- If guiding profiles are used, e.g. to absorb temporary lateral forces, are the grooves narrow in the zone where the transverse forces occur and wider in the rest of the belt path?
- Are all possible measures done to keep belt, pulleys, rollers and slider bed clean?

Checklist for trouble-shooting of tracking problems see "Installation and Maintenance Guide".

Loading of conveyor with goods to be carried

Conveyor belts are mechanically stressed during the loading of goods, both from the impact of actual loading as well as from the additional movement between the goods themselves and the belt. Effective loading of goods onto conveyors can require a number of fixtures, such as side plates, chutes and funnels to be fitted to the overall installation.



Loading should preferably take place:

- With low energy impact
- In the same direction as the belt is running
- At belt speed
- With goods positioned centrally on the belt

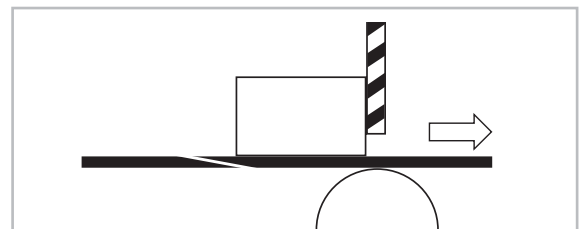
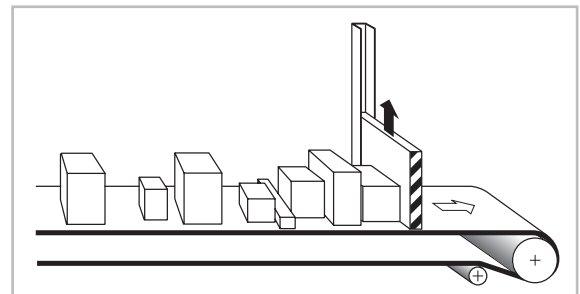
These ideal conditions are not always possible and in the case of lateral loading the belt is subject to unavoidable high stress. Accordingly, belts with high abrasion resistance and transverse rigidity must be employed. It is essential that the belt remains centrally positioned on the conveying installation at the point of loading. The following measures deliver good solutions:

- Additional belt wrap (see page 32)
- Carrying rollers with adhesive cover (see page 32)
- Guiding profiles (see page 29)

Accumulation of carried goods

The term accumulation describes the situation that arises when either the whole or part of the belt becomes congested with goods while the belt continues to run. Special attention should be given to the following points when specifying belts in these cases:

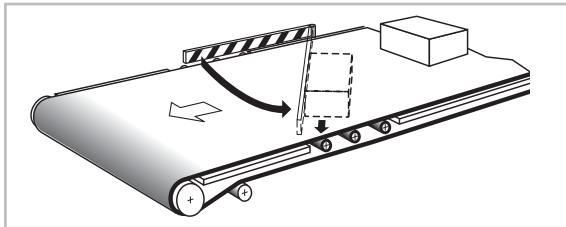
- Install a conveyor belt with a low-friction, wear-resistant surface
- Take into account the increase in the peripheral force resulting from the dynamic friction generated by the accumulated goods on the continuously running belt
- In the case of skived, glued joints, care needs to be taken to ensure that goods will not damage or tear the joint. Note the orientation of the joint laps in the illustration
- Where large amounts of goods have to be accumulated, a live roller conveyor (see page 58) or a plastic modular belt conveyor is probably more effective than a fabric belt conveyor



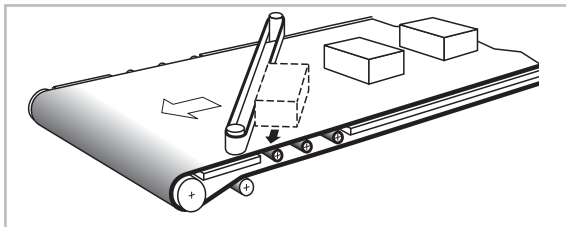
Diverting of conveyed goods

Where piece goods are diverted or retrieved from the side, care is to be taken to keep transverse forces on the belt as low as possible. Diverters must not touch the belt.

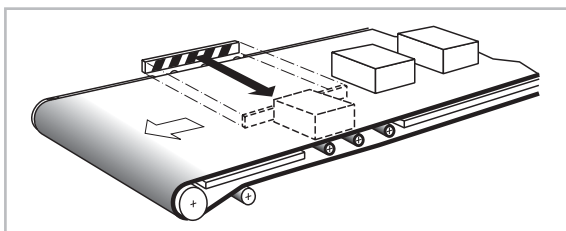
Common types of diverters are:



Laterally pivoting, rigid diverters



Laterally pivoting diverters with driven discharge belts



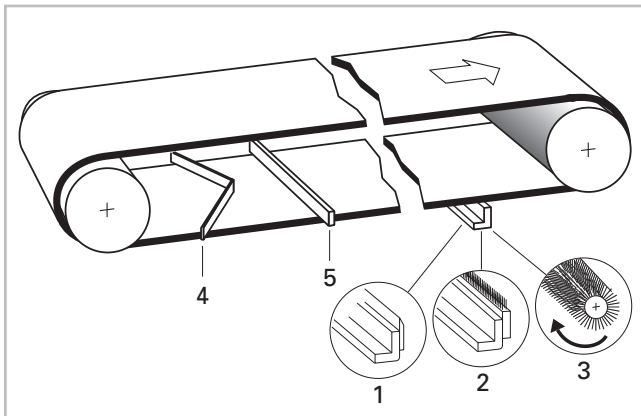
Right-angled lateral diverters

As the belt is mechanically heavily stressed in the diverting zone, a belt with relatively low coefficient of friction, high abrasion resistance and transverse rigidity should be installed. Measures must be taken to ensure that the belt remains centered on the conveying system at the point of diversion. The following measures can be recommended:

- Additional belt wrap (see page 32)
- Carrying rollers with adhesive covers (see page 32)
- Guiding profiles (see page 29)
- Increase belt's initial tension (elongation)

Soiled belts and system components cause belt tracking and drive problems and shorten belt life. Dirty belt surfaces can impair the belt's carrying ability and release properties that lead to conveying and processing problems. From a hygiene point of view dirty belts are unacceptable for food industry processes, but they are also undesirable, for environmental and aesthetic reasons.

To maintain continuous cleanliness, various measures are available such as mounted scrapers and brushes.



Scrapers are bars of synthetic material or rubber fitted across the belt's running direction. The scraper material should be less durable than that of the belt and should be adjustable, being as it is, subject to wear.

Scrapers (1) should be mounted very close to the belt, in fact may lightly touch it. Fixed brushes (2) will help to protect the coating on the conveying side. Brushes that rotate against the belt running direction (3) are well suited to cleaning applications where the waste material is sticky or dusty, especially for textured surfaces. It is also possible to attach water spray devices if this is deemed necessary. Scrapers and brushes must of course be thoroughly cleaned on a regular basis.

It may also be necessary to prevent build up debris on rollers as well. In such cases, a scraper may be installed against the pulley face.

To prevent the accumulation of dirt and other material between pulleys and belt, scrapers should be fitted on the running side and as close as possible to the tail pulley. Plow type scrapers (4) do not affect belt running behavior as is the case with adjustable/slanted scrapers (5).

Attention must be paid to ensure that cleaning systems are properly and correctly installed as, otherwise, belt tracking problems may occur. Another point that must be considered is the increase in peripheral force due to friction.

Steep-angle conveyor installation

Head drive is recommended for upward conveyance, while tail drive is preferable for downward installations as it acts as a brake when required. This finally means, in both cases it is best to install the drive station at the top of the conveyor.

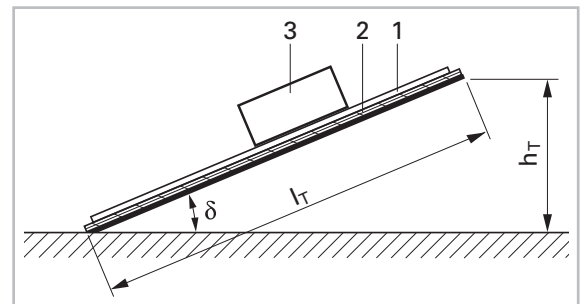
The maximum gradient on which goods can be conveyed without slipping or toppling depends on the following factors:

- Weight, surface finish (material, structure) and position of the center of gravity of the conveyed goods
- Surface finish (material, structure) of the conveyor belt
- Operating conditions (belt speed, stop-and-go, vibration)
- External influences (humidity, temperature, soiling)

The choice of the correct conveyor belt is very important. As a general rule, belts with a smooth but adhesive surface can be used for installations with gradients of about $\delta \leq 20^\circ$.

Belts with a structured conveying side can be used for gradients of up to $\delta \cong 40^\circ$. From about $\delta > 40^\circ$ transverse profiles are typically required. Extreme gradients are often managed by spiral conveyors.

The maximum possible angle of inclination δ for the conveyance of product X with belt Y can be determined by a simple method. Fix a sample belt (1) on a fixed support, such as a wooden board (2), and place on it one or more of the goods to be conveyed (3). Now incline the support until the goods start to slide. Measure the gradient height h_T , just before sliding starts and divide this height by the length of support l_T ; in this way you obtain the

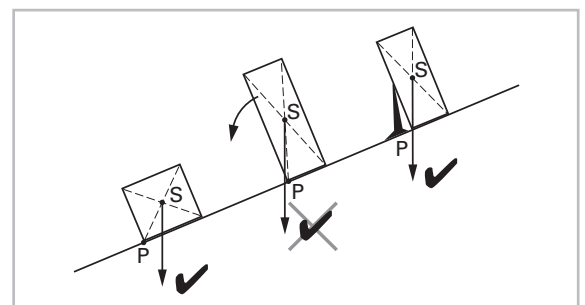


$$\text{maximal possible angle of inclination } \delta_{\max} \leq \arcsin \frac{h_T}{l_T}$$

Of course, the maximum angle of inclination will, in practice be greatly affected by external influences such as temperature, humidity and soiling as well as by general operating conditions and belt age. These factors must be fully taken into account when determining the effective angle of incline δ_{eff} for a particular installation: Set always $\delta_{\text{eff}} < \delta_{\max}$!

Care must be taken that the goods do not fall over. In other words, it is essential that the center of gravity S of each conveyed piece is in front of point P.

This applies to belts both with and without short profiles.

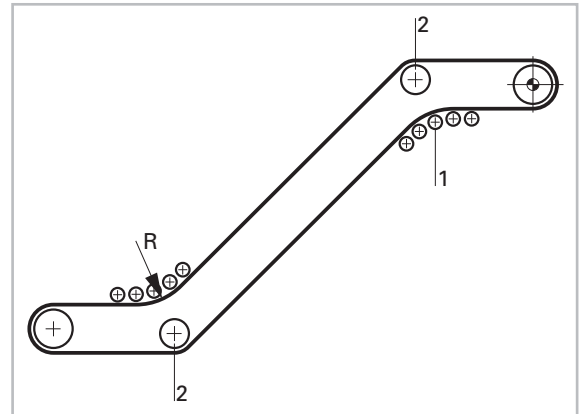


Z-conveyor installations

Due to its special appearance, the Z-conveyor is also known as the swan-neck conveyor.

In general the same points apply for the Z-conveyor as for a simple steep-angle conveyor. However, with the Z-conveyor one must also pay particular attention to the transition point due to the increased transverse belt stress in this area.

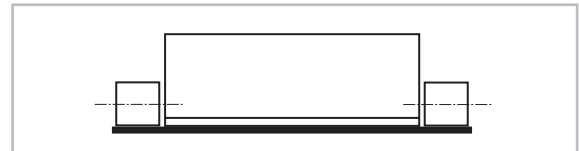
- Select the smallest practical transition radius R
The smaller the radius, the greater the lateral stiffness of belt.
- On the conveying side, install preferably 3 to 5 smaller supporting rollers (1), alternatively fit a deflection roller (2) with a diameter of at least $d = 200 \text{ mm} / 8 \text{ in}$



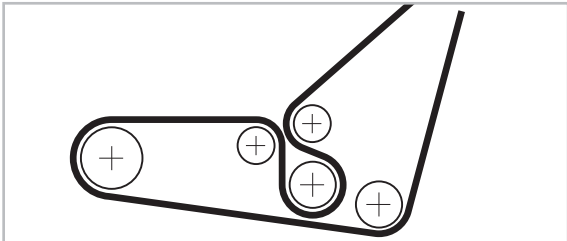
- Select the widest possible supporting rollers
Recommendation: $B \geq 50 \text{ mm} / 2 \text{ in}$

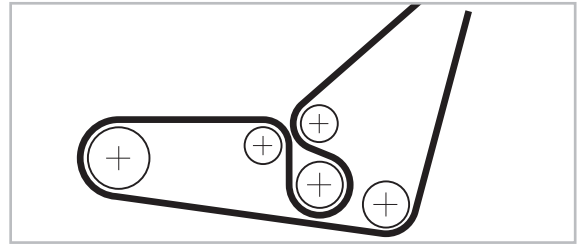


- Fit the supporting rollers as close as possible to the transverse profiles and corrugated side walls



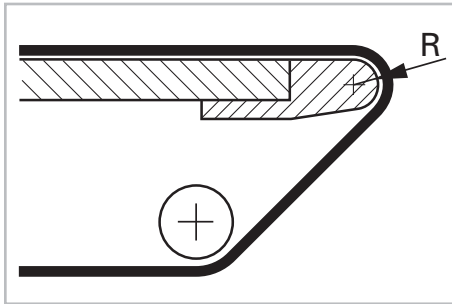
- As the supporting rollers have bearings on only one side, care must be taken to ensure that they are rigidly supported and stable. The rollers must be installed at right angles to the belt running direction and must not be affected by the tensile forces acting upon the belt.
- Specify a conveyor belt with the highest possible transversal rigidity
- To keep the belt tension as low as possible, it is advisable to provide the driving pulley with a friction cover and large arc of contact
- For belts fitted with transverse profiles, at least one profile should be mounted across the splice to add to its transverse rigidity

- As an alternative to pulley driving, a frictional wheel can be installed on the running side of the belt (lowest belt tension)
 - Belt tracking is to be effected by means of cylindrical-conical tail pulley, or with cylindrical-conical driving pulley, which can be assisted additionally by pivoting deflection rollers (2)
 - With a special design, a solution with the smallest transition radius can be achieved. Negative effects associated with this method are chiefly an increased risk of belt soiling (debris becoming trapped and likely damaging the belt) and increased belt load due to counterflexion. Attention must be paid to pulley diameter sizes!
- 
- The diagram illustrates a belt drive system. A belt is shown entering from the left, passing over a large cylindrical pulley, and then turning upwards and to the right. The belt is supported by a series of rollers. The first roller is a large cylindrical pulley. The second roller is a cylindrical-conical pulley, which is designed to guide the belt. The third roller is a pivoting deflection roller, which is shown in two positions: one where it is in contact with the belt and another where it is not, indicating its ability to pivot. The belt is shown in a loop, with the rollers positioned at various points along its path.
- Alternatively, the use of the plastic modular belt technology might be considered

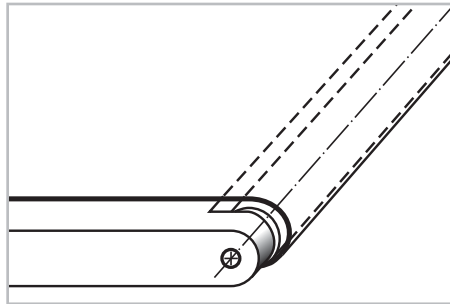


With small goods, in particular, the transfer between installations must be as short as possible. To assist in these cases, the use of a nosebar (also called knife-edge) or of a noseroller, placed at the infeed and/or discharge end of the conveyor, is common.

The nosebar is commonly a steel plate with one end that has a radius, whereas the noseroller, as the name suggests, is a small diameter roller mounted on a shaft. One further distinction: a nosebar with a radius of approximately 3 mm / 0.12 in or less is typically referred to as a knife-edge.



Nosebar (knife-edge)

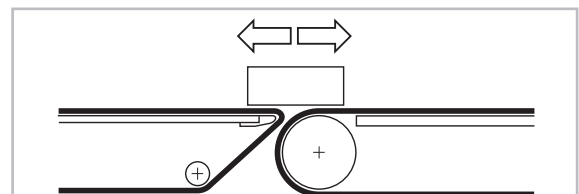


Noseroller

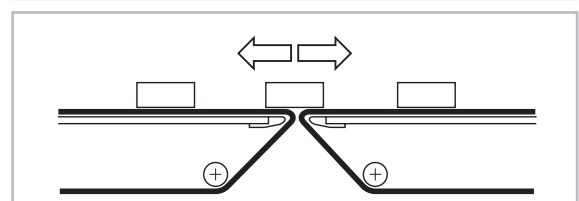
In both cases, fabric belts with a high degree of longitudinal flexibility should be installed. Nosebar-suitable belts can be selected with help of the Habasit Belt Selector. Two-ply belt design is commonly employed for its lateral stability on wide belt applications; however, single-ply belt design is most desirable for reducing flexion related drag at the nosebar. In any case, special care has to be taken regarding the admissible nosebar radius. The Flexproof joint is mandatory and, preferably, a bias Flexproof joint to insure optimal performance and service life.

Fixed nosebar (knife-edge)

Transfer of goods can take place by means of one nosebar combined with a roller ...



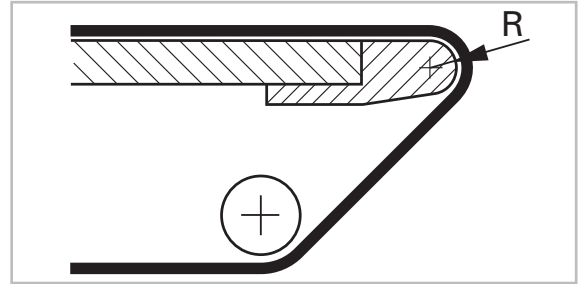
... or by two nosebars.



Frictional heating of the belt and nosebar occurs at the fixed nosebars. The combination of increased frictional losses and belt flexion results in markedly greater drag and, consequently, power consumption. Such drag can lead to belt slip on the driving pulley. Increasing belt tension will not solve this problem. In fact, it will most likely make it worse by increasing the contact pressure and, thereby, drag between the belt and nosebar surfaces.

Friction and its production of heat at the nosebar can be minimized by the following measures:

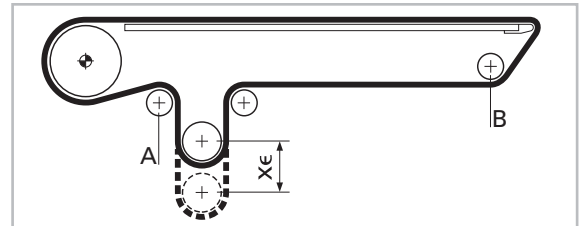
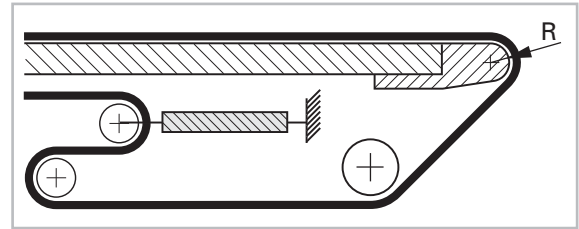
- Nosebars made of stainless steel with polished surface or bright chrome-plated steel (other more exotic options are also possible)
- When possible, the nosebar radius should be limited to a minimum of 3 mm / 0.12 in, maximum 6 mm / 0.24 in
- Arc of contact on the nosebar to be as small as possible
- Driving pulley / belt friction to be optimized by lagging the driving pulley (which in turn allows a lower belt tension to reduce drag)
- Belt speed as low as possible
- Conveyor belt with low drag, abrasion-resistant running side
- Air- or water-cooled nosebars



With regard to the nosebar and noseroller it is critical that the construction is rigid and supported where necessary in order to avoid deformation and/or bending.

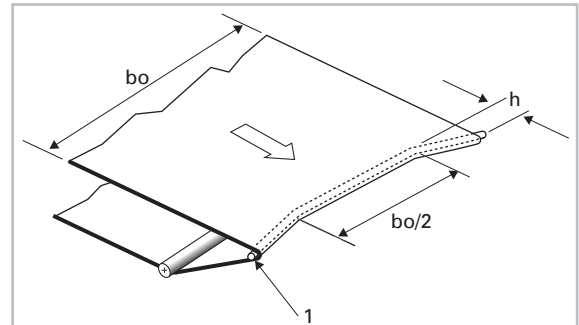
Belt elongation can occur due to nosebar/belt heating, especially on belts with polyamide traction layer. This elongation is best dealt with by use of a tensioning device that supplies a constant tension, e.g. a spring-loaded or pneumatic device. It should be placed in the belt path on the low-tension side of the driving pulley; a reduction of frictional losses and belt wear will be the result.

On short installations with one single knife-edge it is recommended to crown the driving pulley and support positioning of the belt with an adjustable guide roller B.

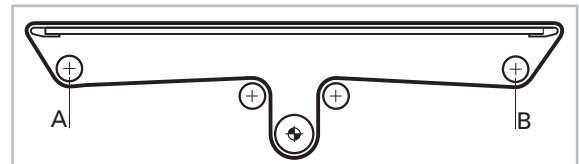


A concave nosebar is another option for belt tracking on nosebar conveyors. The nosebar may be formed with multiple linear segments (1), or preferably as a uniform arc. In either case, the minimum recommended depth of the form, h , should be approx. 0.25 mm / 0.010 in and not exceed a value equal 1/1000 of the belt width b_0 :

$$h \leq \frac{b_0}{1000}$$



Belt guidance in conveyors equipped with two nosebars (on each end) is most demanding. It is best to crown the driving pulley of the center drive.



For additional belt control it is advisable to install an adjustable guide roller A (for clockwise belt running direction) or roller B (counterclockwise belt running direction) that pivots at one end. For reversing operation, pivoting guide rollers may not be suitable for belt guidance unless the position is controlled automatically. Automatic belt tracking devices (see page 31) are frequently fitted to such conveyors. In general, it is best to minimize the total number of rollers in the belt path.

Noseroller

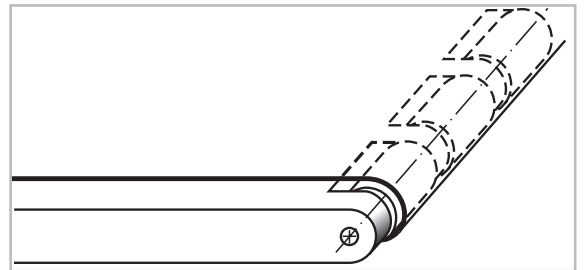
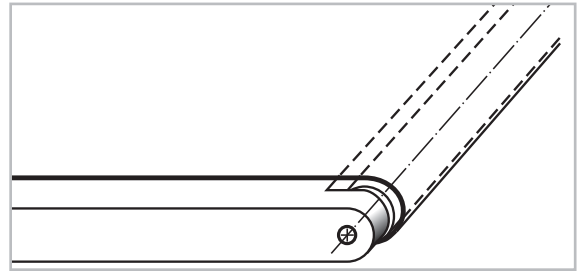
The main problem with fixed nosebars is the high belt drag, but this can be considerably reduced by using a noseroller. The advantages of the noseroller are reduced heat production, lower belt tension and less belt wear.

As with all pulleys and rollers, rotating roller edges exert an influence on belt running behavior. It is, therefore, crucial that the noseroller is aligned perpendicular to the belt's running axis. Where space and installation permit it, the noseroller can be slightly radially crowned or cylindrical-conical shaped to further improve belt tracking.

On wide installations, several narrow rollers can be fitted instead of one continuous roller. The advantage here is that the shaft is supported by several bearings, thereby reducing shaft deflection.

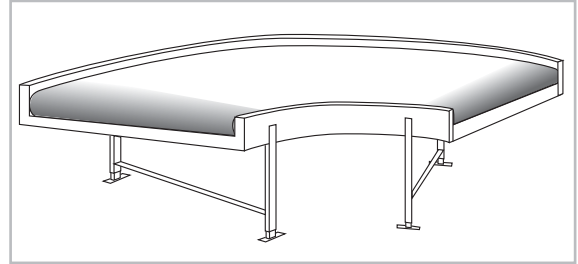
The principle disadvantages of the noseroller are bearing capacity and maintenance. As belt speed increases, small bearings with high load and speed ratings become increasingly difficult to obtain; commonly leading to the use of bushings that are more subject to failure (stop rotating) due to contamination.

The matter of contamination becomes of greater concern in the conveyance of unpackaged food items. Foodstuff commonly migrates throughout the conveyor, building up on and contaminating rollers and their related components.



Conveying goods around bends and corners is frequently necessary both for space-saving and process control reasons.

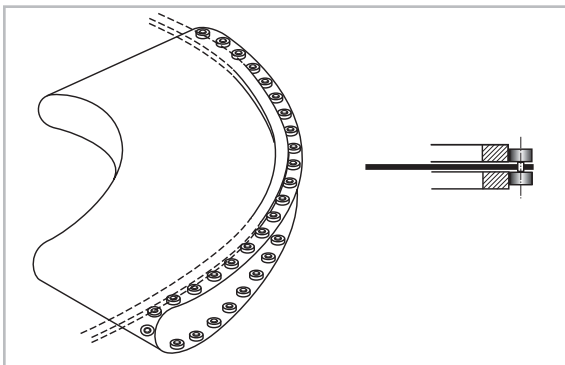
Curved belt installations are primarily used to change the transportation direction by around 30° to 180°, any angle between these parameters being possible. The spiral curve conveyor is a special type of curved belt conveyor and is used for coping with height differences in a constricted or limited space.



The chief benefit of curved belt conveyor installations is that the goods conveyed maintain their position in the curve, meaning that these conveying systems are well suited for shingle stream goods, such as newspapers. Their disadvantage is the high cost of belt fabrication and the often complex installations of which they form an important part. Due to the nature of the curved belt, strong transverse forces occur that pull the curved belts inwards towards the center point of the curve. These forces must be offset by the installation.

The best available options for offsetting these transverse forces are detailed below.

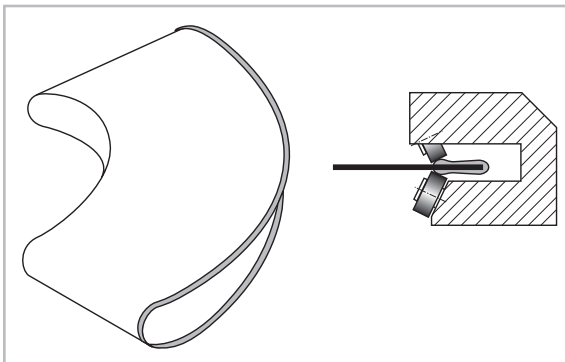
Guidance by pairs of rollers



Transverse forces are offset by pairs of rollers mounted on the outer belt edge and running on curved rails.

This method demands high precision belt and frame fabrication with very accurate mounting hole placement along the outer part of the belt.

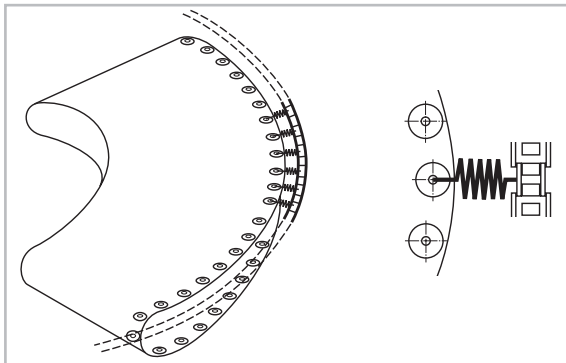
Guidance by means of profiles at the belt edge



Guidance here is provided by sewing or welding a profile (plastic bead) to the outer edge of the belt. As the profile runs over angled rollers, the belt is maintained in position.

Extremely accurate positioning of the guiding profile is demanded for this measure to be effective. It is worth mentioning that apart from the high cost of belt fabrication, there are also relatively high energy losses caused by the flexing of the plastic bead through the guiding pulleys. On the plus side, however, are smooth running and relatively simple belt replacement.

Guidance by means of drive chain

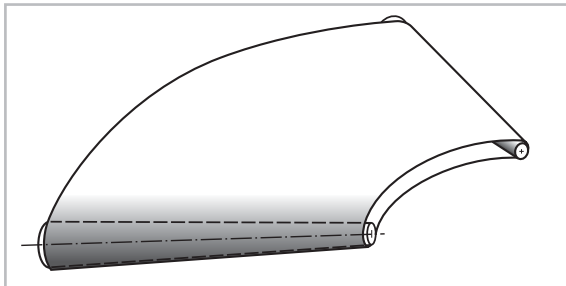


A simple solution where a chain runs at the outer edge of the installation. The belt is connected to the chain via round belts, springs or metal brackets and, therefore, both driven and held in the correct position.

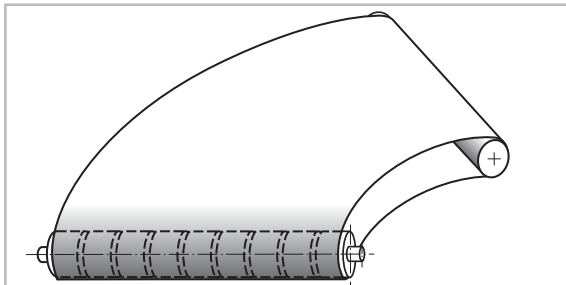
Due to the position of the eyelets at the outer edges of the belt, minor inaccuracies are unlikely to cause problems. As the drive takes place via the chain, there is no frictionally engaged power transmission on the driving pulley, so belt tension can be very low.

Execution of the tail pulleys

The varying take-off length over the width of the curve results in differing peripheral speeds at each point of the tail pulley.



This situation is best dealt with by fitting conical tail pulleys, the conicity of which is directly in proportion to the ratio "external radius : internal radius." The belt drive then normally passes through one of the two conical rollers, preferably the head drive, while the driving pulley is equipped with a friction cover.



Another option is to fit either one or two cylindrical tail pulleys whereby these have to consist of single, narrow rollers, freely rotating on a shaft as each roller has a different peripheral speed. A number of narrow rollers are more effective than fewer wide rollers. Cylindrical rollers generate a narrow, parallel transition gap to the following installation which allows the transportation of small and delicate goods. If both tail pulleys are cylindrical, the drive must take place on the return side (because of the loosely running rollers), preferably via a conical driving pulley.

Belt drive by frictional wheel

Fitting a frictional wheel on the running side of the belt can provide a good alternative solution to a pulley drive. It requires lower belt tension, but will usually demand more attention being spent on belt tracking measures.

Conveyor belt selection

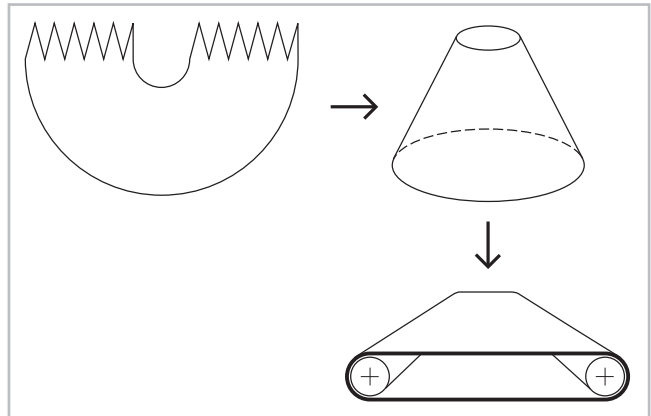
As a general rule most fabric conveyor belts are suitable for curved installations. However, it must be remembered that belts on curved installations are subject to bending stresses in all directions. The typical conveyor belt, although longitudinally very flexible, tends to be rigid transversely. For this reason, the minimum required pulley diameter $d_{\min}$ (see page 17), given in the product data sheets, must be substantially increased for curved belt installations. However, this rule does not apply to special “curve belts” that have approximately equal elasticity and bending properties both longitudinally and transversely.

Alternatively the use of the plastic modular belt technology might be considered.

Belt fabrication

Belt fabrication for curved belt conveyors demands great precision during cutting to size and joining. Experience shows that it is generally not the inaccurate fabrication process, but inaccurate installation data that causes performance problems. Therefore, precise belt dimensions must always be available. In cases where only the installation data are available, Habasit will be happy to assist in determining the correct belt geometry.

In simple terms, a curved belt consists of a number of sections joined to form a cone-shaped belt, this construction is then leveled out and tensioned around the tail pulleys.

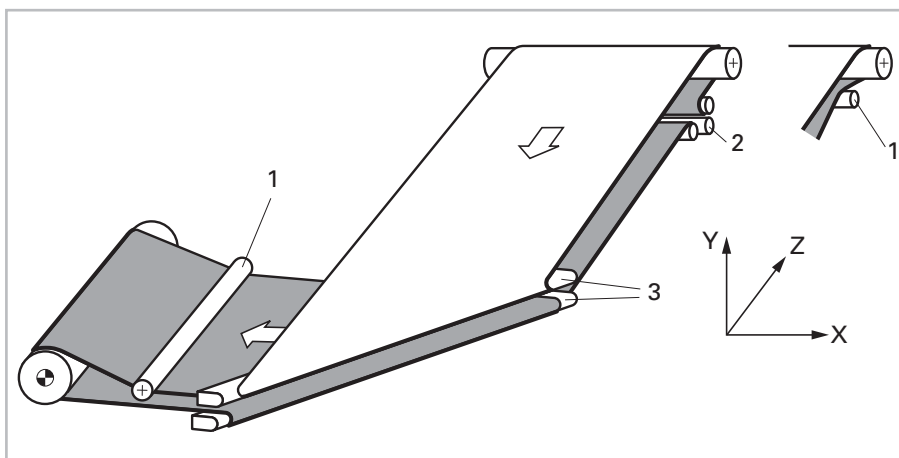


Angled belt merge conveyors (typically 30°/45°) are core elements in automated material flow systems for infeed and distribution functions.

In order to attain closest possible transfer points between belt conveyors and effective belt tracking, the conveyors are designed so that the belts are running over fixed nosebars (knife-edges) at the angled transfer point. Rollers must not be used as they have a negative impact on tracking!

Belt tracking measures

Generally, tracking of angled belt merge conveyors is a special challenge. The following measures to enhance belt tracking are empirically based and presented with the understanding that the unique design and operating parameters of individual conveyors present similarly unique challenges in belt tracking.



- 1 Guiding pulley, arc of contact min. 30°
- 2 Additional belt wrap with skewing middle roller
- 3 Fix positioned nosebars

Recommendations:

- Head drive, usually with snub pulley to increase the arc of contact and support belt tracking without skewing driving pulley
- Lagging may also be employed to enhance belt traction with reduced tension, and reduce contact pressure of belt with the nosebar in an effort to minimize heat generation
- Both drive and tail pulleys should be crowned with a cylindrical-conical shape
- Usually cylindrical-conical pulleys alone are not sufficient to track the belt in angular transfer applications. Therefore it is advisable to use snub pulleys (1) that may be pivotable on the approach side of both end rollers.
- Alternatively, on the approach side of the tail pulley, an additional belt wrap with a middle roller may be used (2). The middle should be pivotable in the Y axis. The deflection rollers must be aligned with the tail pulley. Such an assembly is well suited for belt take-up tensioning.
- Sufficient room on conveyor components should be kept available to facilitate lateral belt travel to prevent belt damage when tracking the belt
- For larger nosebar diameters and/or high belt speeds, tubular steel can effectively serve to minimize heat development in both the belt and related conveyor components
- Adjustment built in for nosebars should be minimal to reduce the points of adjustment that can be accessed to influence belt tracking
- Also, please refer to recommendations for nosebar conveyors on page 44

Belt selection

As the belt traverses the diagonal nosebars it is flexed not only longitudinally, but laterally as well. Therefore, for this type of equipment, specially designed belt types with appropriate lateral flexibility and elastic properties must be used. One should further consider the nosebar diameter. Low friction on the running side is highly recommended.

Use the online Habasit Belt Selector on www.habasit.com and search for a “powerturn suitable” belt. For small nosebar radius ($\leq 4 \text{ mm} / 0.16 \text{ in}$) select “nosebar suitable” too.

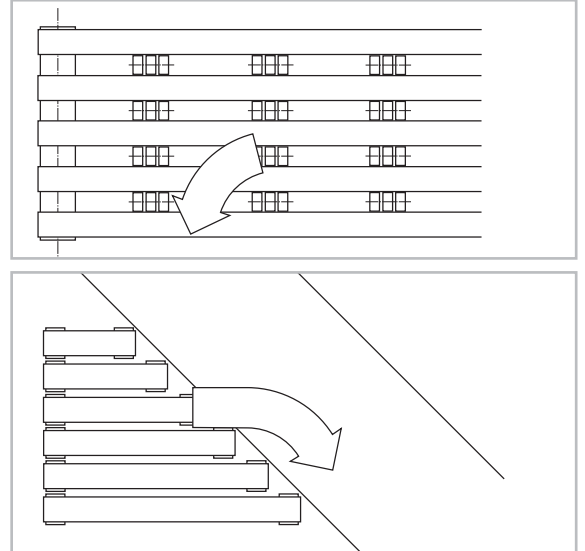
Alternative to powerturn installation

Two identical 45° belt merge conveyors can be combined to form a single 90° transfer as an alternative to powerturn installations (see page 48).

- The belt fabrication for angled belt merge conveyors is simpler than for curved belt conveyors, because no circular belt layout is required. It should be noted, however, that transferred goods will be rotated and may be repositioned relative to each other.
- The transfer nosebars should be properly leveled and aligned to ensure optimal conditions for stable product transfer
- Because of the abrupt redirection of product with such a configuration, consideration should be given to belt speed and the use of structural sidewall (that can be adapted to the conveyor framework) to support effective and safe transfer of product at high speed

With certain applications, several narrow belts running in parallel may be preferred to provide a better solution than a single conveyor belt. There are a number of reasons for this:

- Coarse debris, dirt, etc. can drop down between the belts and are so separated from the carried goods
- Under very wet conditions, excess water will drain away more easily
- Accumulation and diverter devices (pop-up rollers) that intervene from below can be fitted in the spaces between these belts
- Positioned at an angle to a conveyor belt, they can serve both as infeed and discharge transfer belts, as an alternative to wide angled belt merge conveyors



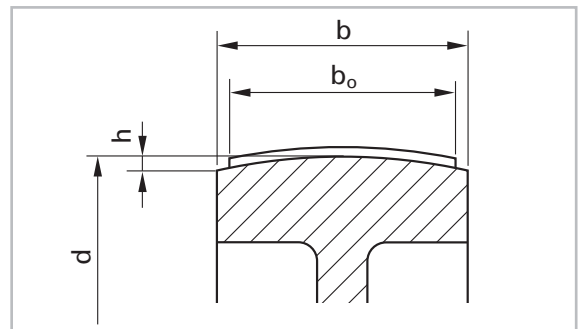
- With short, wide installations, several narrow belts in parallel are more easily tracked than a single wide belt. This is especially true for conveyor installations where the width of the belt is greater than its conveying length.
- Narrow belts, often running in parallel, are particularly well suited to paper printing, finishing and converting processing machines. With these applications they are known as “machine tapes.”

Roller design

With narrow belts it is customary to speak of rollers rather than pulleys.

- Roller width, b
The roller width is to be dimensioned so that the belt maintains contact across the entire width of the roller, even in cases where belt running is not exactly centered on the roller

$$\begin{aligned} \text{Recommended roller width: } b &= (1.2 - 1.3) b_o \\ b_{\min} &= b_o + 5 \text{ mm} / 0.2 \text{ in} \end{aligned}$$



- Roller crown
The use of crowned rollers provides an adequate degree of belt guidance as long as the belt maintains contact with the rollers across its full width and the wrap angle is sufficient (minimum 30°)

Recommended height of crown, h (valid up to 100 mm width):

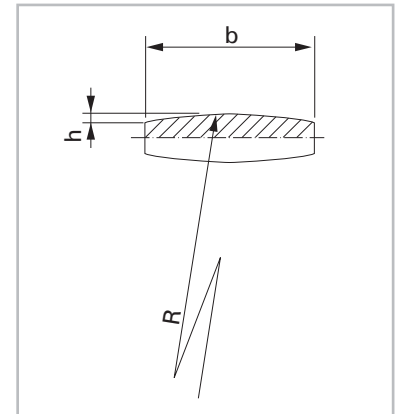
Roller diameter d [mm] [in]	Height of crown h [mm] [in]
≤ 40 / 1.6	0.2 – 0.3 / 0.008 – 0.012
$\leq 40 - 112$ / 1.6 – 4.4	0.3 / 0.012
$> 112 - 200$ / 4.4 – 7.9	0.4 / 0.016
$> 200 - 355$ / 7.9 – 14	0.5 / 0.020

Note: Excessive crown height reduces tracking effect!

Conversion of the crown radius R and crown height, h:

$$R = \frac{b^2}{8h} + \frac{h}{2}$$

$$h = \frac{b}{2} \tan \left[\frac{\arcsin \left(\frac{b}{2R} \right)}{2} \right]$$

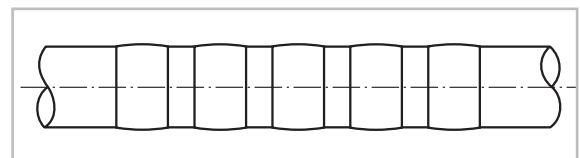


The surface of the roller has to be smooth, max. roughness $R_a = 1.6 \mu\text{m}$ / 63 μin .

Friction increase by roughening or knurling the surface leads to premature wear and is, therefore, not advisable.

- Cylindrical shafts

Cylindrical shafts are often used instead of multiple rollers. Where no crowned rollers or other measures are taken to ensure belt guidance, the shaft itself must be formed with the appropriate crowns. Crown height to be according to the above-listed values.

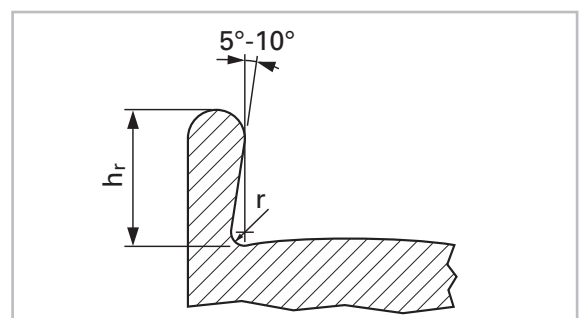


- Flanged rollers

Flanged rollers are in general not recommended due to increased wear on the belt edges. They can only track the machine tape satisfactorily if the run-off risk is small or if there are short-time transverse forces only.

The width of the running surface must be 20% to 30% wider than the belt width.

Recommendation for the flange height $h_f = 15 - 30 \text{ mm}$ / 0.6 – 1.2 in. Minor value for small diameters, major value for large diameters. The tapered face of the flange minimizes risk of belt damage.

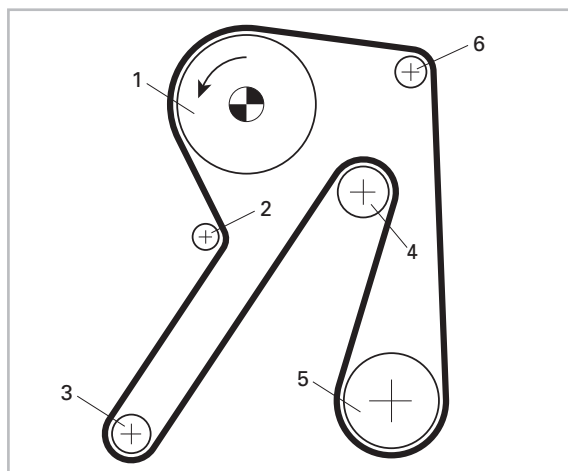


Arrangement of the rollers, belt guidance

The positioning and arrangement of the rollers has a significant impact on belt guidance and belt service life. Rollers with crowned as well as with cylindrical shape can be used.

- Fit at least one crowned roller for short conveying distance and several crowned rollers where the conveying belt installation is long. The more crowned rollers, the better the tracking for long/narrow installations.
- Large arcs of contact enhance the tracking effect of crowned rollers. Less than 90° wrap angle provides low belt guidance only.
- The tracking effect of crowned rollers is only effective as long as the belt maintains contact with the rollers across its total width
- The center line of the rollers (related to the width) must be set in line. Where this cannot be guaranteed, and distance between rollers is relatively short, use cylindrically shaped rollers adjacent to a crowned roller.
- All rollers must be positioned exactly at right angles to the direction in which the belt is running; this applies particularly in the case of cylindrical rollers
- The slanting or angling of rollers to correct belt running problems is not recommended and must be avoided completely with reversing operations
- If a couple of rollers are placed in short distance one after another, it is recommended to position the crowned rollers on the same side of the belt such that the belt is always flexed in the same direction (minimizing flex fatigue)

Example: Roller arrangement in a multiroller application



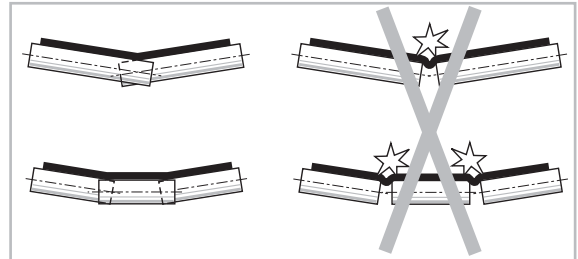
- 1 Driving pulley **crowned**
(large diameter, large arc of contact)
- 2 Deflection roller **cylindrical**
(small arc of contact)
- 3 Deflection roller **crowned**
(large arc of contact, large distance to roller 4)
- 4 Deflection roller **crowned**
(large arc of contact, large distance to roller 3 and 5)
- 5 Deflection roller **crowned**
(large arc of contact, large distance to roller 4)
- 6 Deflection roller **cylindrical**
(small arc of contact)

Belt drive and tensioning device

Parallel running belts can be driven either by individual drive rollers or by means of a continuous shaft. In all cases belts must have the capability to be individually tensioned. The fitting of adjustable rollers, spring-loaded or weighed tensioning devices is one way of achieving this result while the use of elastic belts (e.g. elastic Hamid machine tapes) or Polycord round belts negates the need to use any tensioning device

Troughed conveyor belts are used by conveying systems that transport bulk materials. In principle each conveyor belt can be used for drafted conveyors, provided it is laterally not too stiff. Essential is the angle of the inclined rollers.

With most troughed installations, belt support is provided on the carrying side by either two or three of carrying rollers. On occasion, however support is provided by means of a trough-form slider bed and longitudinally oriented rails.



If the arrangement of carrying rollers is staggered with sufficient overlap, this will prevent belt buckling. It is advisable that the inclined angle, α , for the lateral carrying rollers should not exceed 25° in installations with two rollers and 40° where there are three rollers. On the carrying side, the degree of belt sag under load must be no more than 1% of the pitch of the carrying rollers. The pitch of the carrying rollers can be calculated as follows:

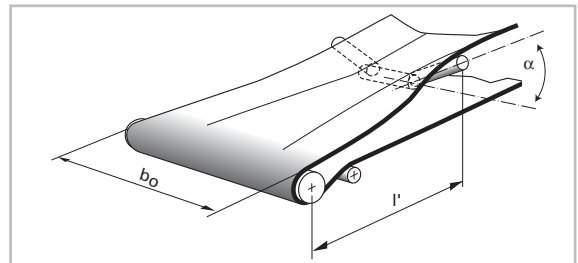
Pitch of carrying rollers
$$l_R \cong \frac{8 \cdot F}{m' + m'_B}$$

F = Belt tensile force at the relevant point [N]
 $m' + m'_B$ = Weight of carried goods and belt per meter [kg/m]

The belt edges will be subject to increased elongation and forces as the belt moves from the drive roller to the first set of troughed rollers. It is important to ensure that the selected transition length l' is not too small.

Recommended transition length $l' = c \cdot b_0$

Trough angle α	10°	20°	30°	40°
Factor c	0.5	1.0	1.5	2.0

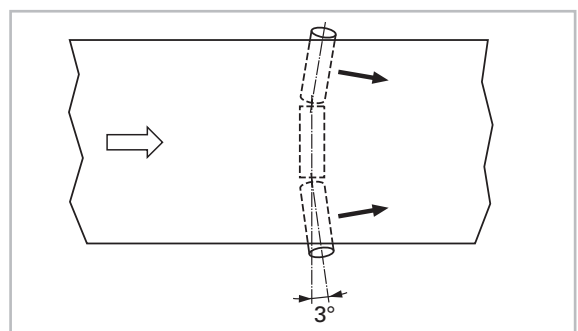


The upper edge of the end pulley should be the same height as the middle carrying roller.

The belt guidance measures are in general the same as for flat fabric conveyor belts. It is recommended to install cylindrical-conical pulleys for belt tracking (see page 19).

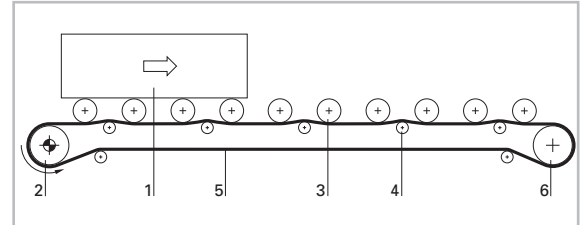
With troughed belts additional tracking effect can be obtained by angling some of the sets of carrying rollers forward a few degrees (max. 3°) in the running direction of the belt. However, angled rollers are not self-tracking and have to be reset when used with reversing operations.

With systems with three sets of carrying rollers the belt should always be completely in contact with the center roller while in a tensioned but unloaded state.



Live roller conveyors are used exclusively for piece goods and are, quite apart from continuous conveying, particularly well suited to accumulation and subsequent singulation processes.

Goods transported (1) by a roller conveyor, in contrast to those moved by a normal belt conveyor, sit on the carrying rollers (3) and not on the belt. The rollers are belt driven (5), and the belt is fitted under the rollers. The power transmission is created by pressure rollers (4). The transported goods will move in the opposite direction to that of the drive belt.

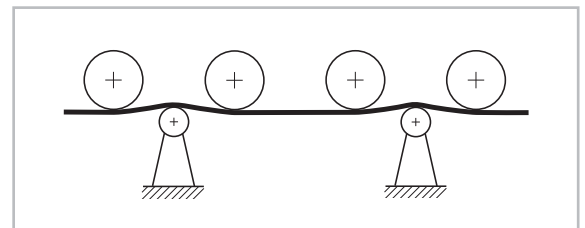


The type and width of belt used depend upon the weight of the goods to be transported and the operating conditions. In general, narrow, high efficiency flat power transmission belts are being used to drive the live rollers transporting heavy loads. It is recommended that standard, crowned flat belt driving pulleys be installed.

Continuous conveying operations

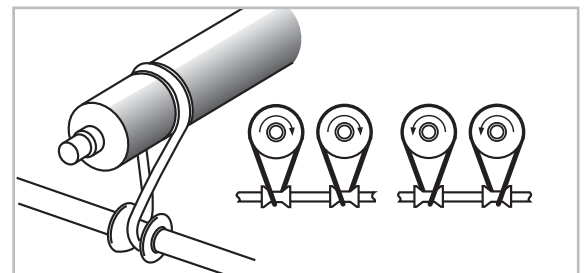
For continuous straightforward conveying operations that involve no accumulation processes, pressure rollers can be fitted in a fixed position.

Both sides of the drive belt should have an abrasion-resistant friction cover, preferably made of rubber.



Rollers in continuous conveying operations may also be driven by Polycord round belts on a line shaft as an alternative to the flat belt solution.

Drive provided by round belts is particularly suited to curved live roller conveyor installations.

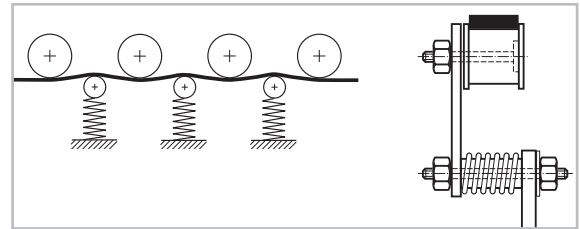


Accumulation operations

Where it is a question of accumulating products on the live roller conveyor for their subsequently controlled retrieval, a distinction is made between systems in which the drive belt continues to run while the rollers are stopped by the accumulated goods (low pressure accumulation) and those in which the belt is lifted from the rollers (zero pressure accumulation).

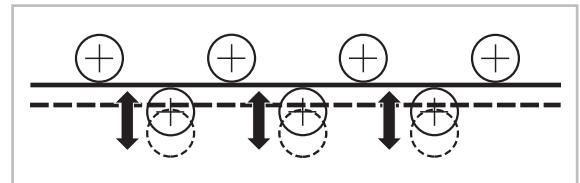
Low pressure accumulation:

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

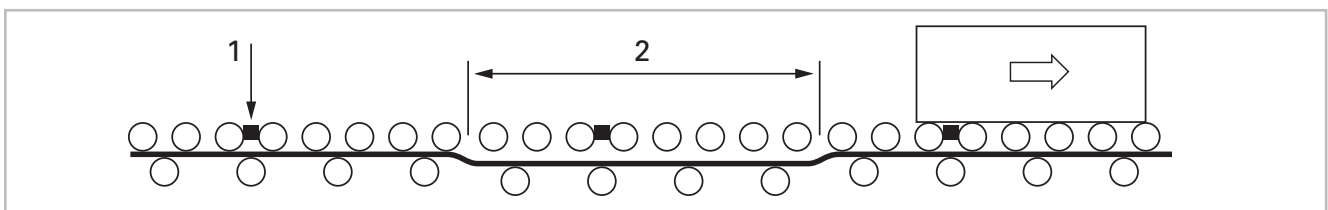


Zero pressure accumulation:

On this more costly system, the pressure rollers are moved away from the carrying rollers during the accumulation process. The goods being carried will therefore stop moving once the rollers are disengaged from the driving belt. However, if they are to be conveyed further, the pressure rollers are simply returned to their operational position pressing the drive belt back on to the rollers.



In this fashion different sections of the roller conveyor can be disengaged and reengaged to the drive completely independent 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.



- 1 Sensor
- 2 Zone controlled sensor

In order to select and/or calculate the optimal conveyor belt type, it is of paramount importance to know exactly the application and operating conditions.

Conveyor belt selection

If the required product features are known, the selection can be done with help of the **Habasisit Conveyor Belt Selector**.

The Belt Selector is available on the Habasit website **www.habasit.com**.

The Habasit Belt Selector displays all belt types which fulfill the selected properties. The final selection has to be done according to further criteria like chemical resistance, availability, price, etc.

Belt type	Master Type of joint	Belt width	Forward speed	Reverse speed	Additional property
E-SECT-GS	Flapproof 10 x 60	4000	15	15	4
E-SECT-GS	Flapproof 10 x 60	4000	15	15	4.5
E-SECT-GS	Flapproof 10 x 60	4000	15	15	8
E-SECT-GS	Flapproof 15 x 60	4000	15	15	3

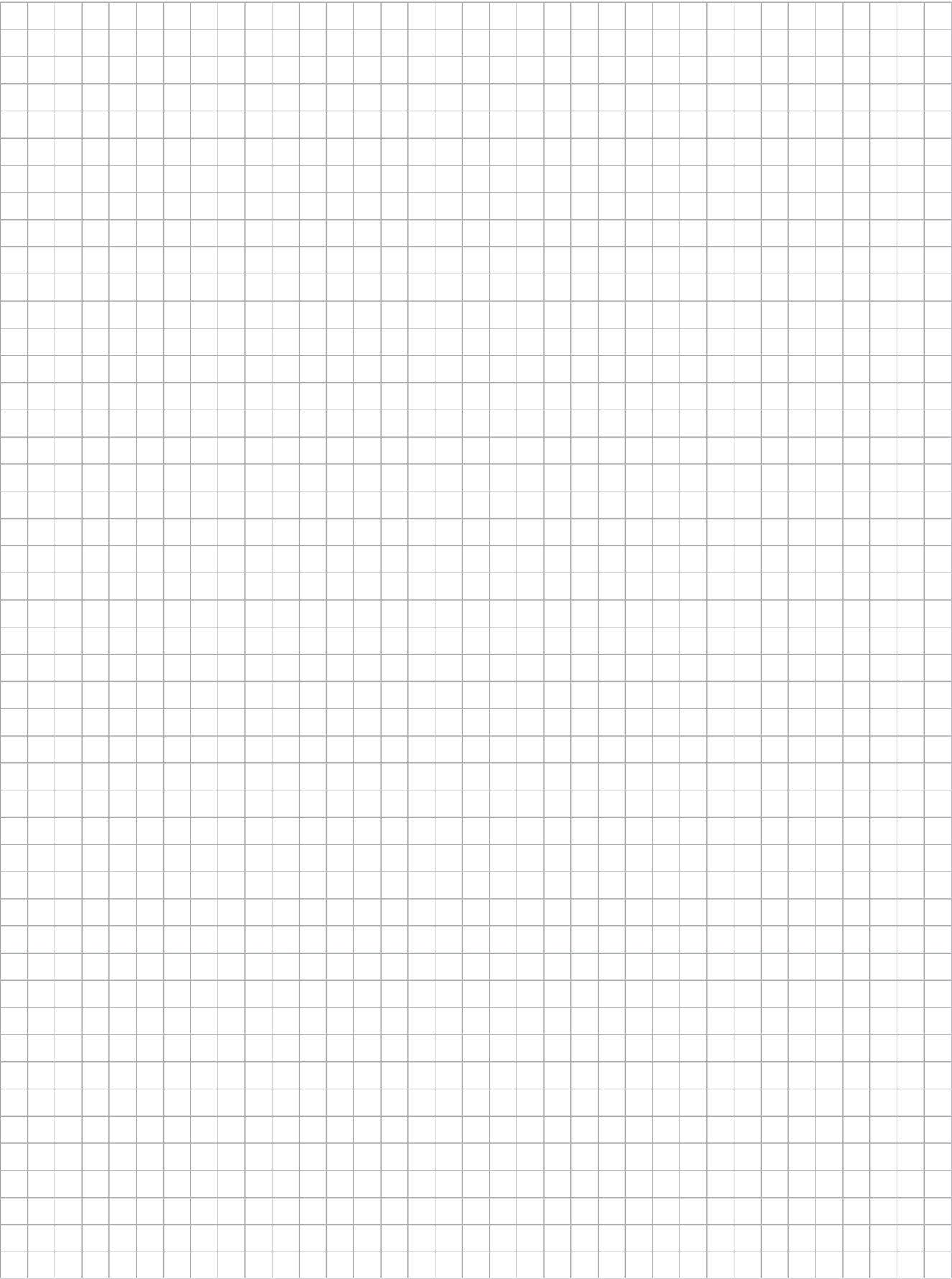
Conveyor belt calculation

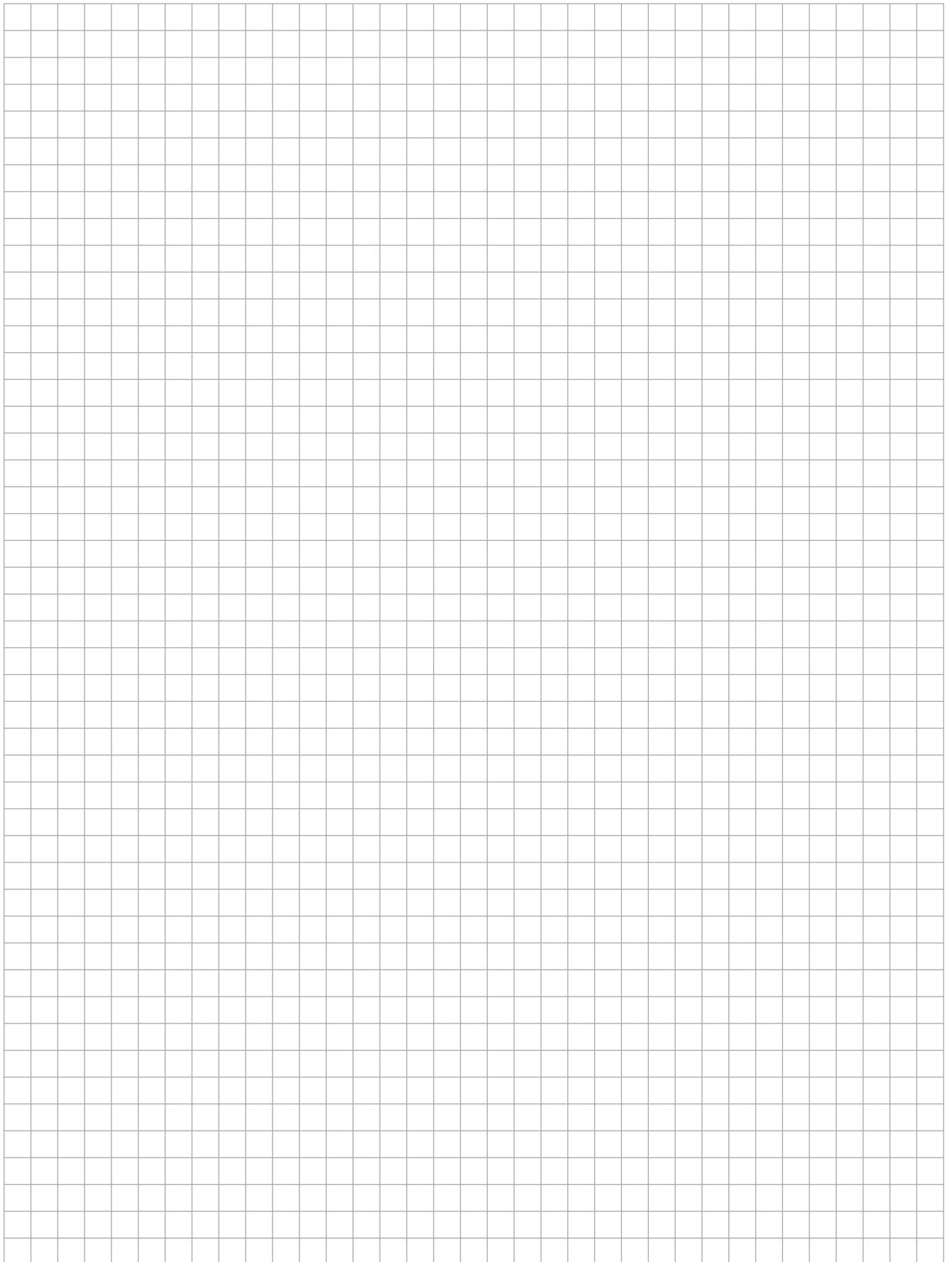
If the conveyor data and operating conditions are known, the following data can be calculated with help of the **Habasisit CONVEY-SeleCalc program**:

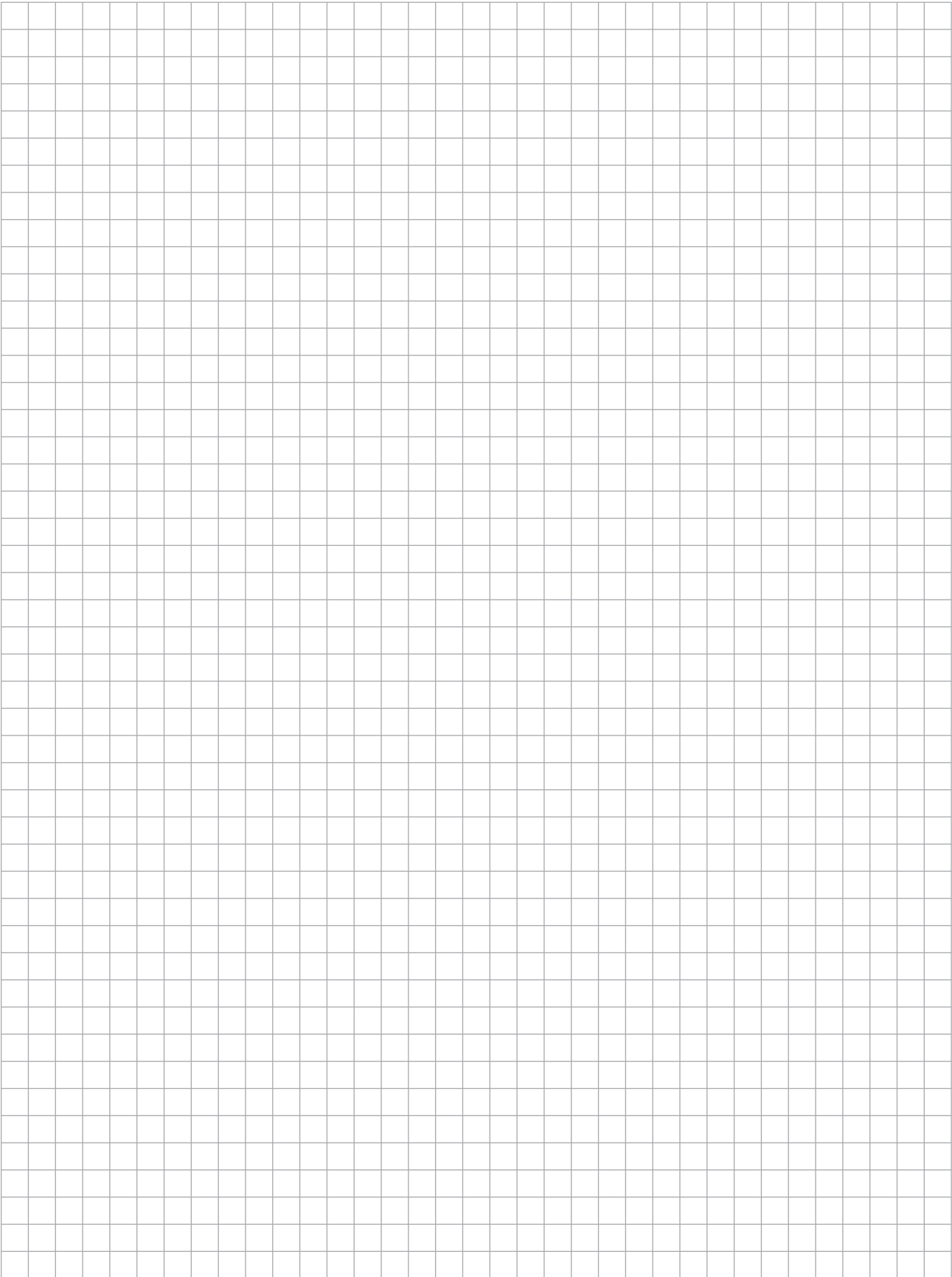
- Initial elongation
- Required take-up
- Maximal tensile force
- Tensile force utilized
- Maximal shaft load
- Required motor power

The CONVEY-SeleCalc program also includes the belt selector and can be downloaded from the Habasit website **www.habasit.com**

Calculation results	Value
Initial elongation	0.34 %
Required take-up	8 mm
Maximal tensile force	14.5 kN
Tensile force utilized	1 kN
Maximal shaft load	14 kN
Required motor power	1.5 kW









Customers first

At Habasit we understand that our success depends on your success. This is why we offer solutions, not just products; partnership, not just sales. Since our foundation in 1946, Habasit has brought this understanding of customer needs to life every day and for every application. That's why we're the No. 1 in belting today. Worldwide. Learn more on www.habasit.com

Committed to innovation

Because our customers' belting challenges and needs never cease, we consistently dedicate a substantial percentage of our employees and resources to the research and development of new products and solutions.

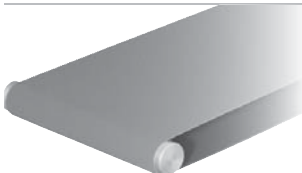
Certified for quality

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 9001:2008.

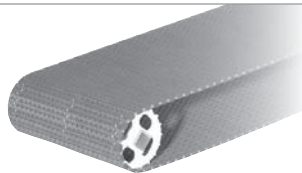


Worldwide leading product range

Habasit offers the largest selection of belting, conveying, processing and complementary products in the industry. Our response to any request is nothing less than a specific, tailor-made solution.



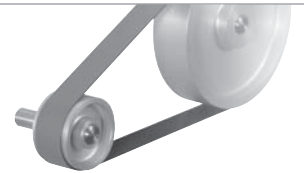
Fabric based conveyor and processing belts
HabaFLOW®



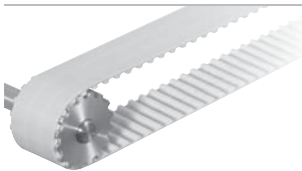
Plastic modular belts
HabasitLINK®



Positive drive conveyor and processing belts
Habasit Cleandrive™



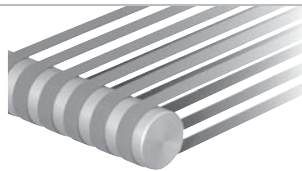
Power transmission belts
HabaDRIVE®



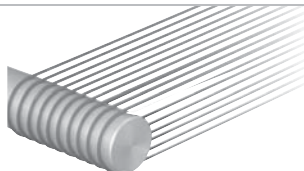
Timing belts
HabaSYNC®



Chains (slat and conveyor chains)
HabaCHAIN®



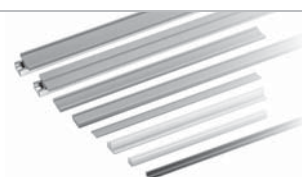
Machine tapes



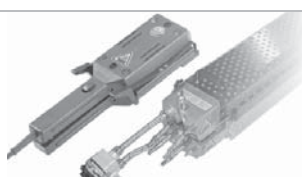
Round belts



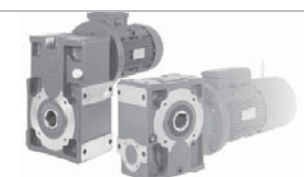
Seamless belts



Profiles, Guides, Wear strips
HabiPLAST®



Fabrication tools (joining tools)



Gearmotors
Electric motors
Motion control

Austria

Habasit GmbH
Wien
Phone: +43 1 690 66
www.habasit.at

Belgium

Habasit Belgium N.V.
Zaventem
Phone: +32 27 250 430
www.habasit.be

Canada

Habasit Canada Ltd.
Oakville
Phone: +1 905 827 41 31
www.habasit.ca

China

Habasit East Asia Ltd.
Hong Kong
Phone: +85 221 450 150
www.habasit.com.hk

Habasit (Shanghai) Co. Ltd.
Shanghai
Phone: +8621 5488 1228
Phone: +8621 5488 1218
www.habasit.com.hk

France

Habasit France S.A.S.
Mulhouse
Phone: +33 389 338 903
www.habasit.fr

Germany

Habasit GmbH
Eppertshausen
Phone: +49 6071 969 0
www.habasit.de

India

Habasit-lakoka Pvt. Ltd.
Coimbatore
Phone: +91 422 262 78 79
www.habasitlakoka.com

Italy

Habasit Italiana SpA
Customer Care:
Phone: 199 199 333
For int. calls: +39 0438 911 444
www.habasit.it

Japan

Habasit Nippon Co. Ltd.
Yokohama
Phone: +81 45 476 0371
www.habasit.co.jp

Netherlands

Habasit Netherlands BV
Nijkerk
Phone: +31 332 472 030
www.habasit.nl

New Zealand

Habasit Australasia Ltd.
Hornby
Phone: +64 3348 5600
www.habasit.co.nz

Norway

Habasit Norge A/S, Oslo
Phone: +47 815 58 458
www.habasit.no

Poland

Habasit Polska Sp. zo.o.
Dąbrowa Górnicza
Phone: +48 32639 02 40

www.habasit.pl

Russia

OOO Habasit Ltd.
St. Petersburg
Phone: +7 812 600 40 80
www.habasit.ru

Singapore

Habasit Far East Pte. Ltd.
Singapore
Phone: +65 686 255 66
www.habasit.com.sg

Spain

Habasit Hispanica S.A.
Barberà del Vallès
Phone: +34 937 191 912
www.habasit.es

Sweden

Habasit AB
Hindas
Phone: +46 30 122 600
www.habasit.se

Switzerland

Habasit GmbH
Reinach
Phone: +41 61 577 51 00
www.habasit.ch

Taiwan

Habasit Rossi (Taiwan) Ltd.
Taipei Hsien
Phone: +886 2 2267 0538
www.habasit.com.tw

Turkey

Habasit Kayis San. Ve Tic. Ltd. Sti.
Yenibosna-Bahcelievler-Istanbul

Phone: +90 212 654 94 04
www.habasit.com.tr

Ukraine

Habasit Ukraina
Vinnica
Phone: +38 0432 58 47 35
www.habasit.ua

United Kingdom and Ireland

Habasit (UK) Ltd.
Silsden
Phone: +44 844 835 9555
www.habasit.co.uk

USA

Habasit America
Conveyor belts, power
transmission belts, gearmotors
Suwanee, Georgia
Phone: +1 800 458 6431
www.habasitamerica.com

Habasit America
Seamless belts, timing belts
Middletown, Connecticut
Phone: +1 860 632 2211
www.habasitamerica.com

Rossi is one of Europe's largest manufacturers of gear reducers, gearmotors, inverters, standard and brakemotors, and is a member of the Habasit Group.

Rossi S.p.A.
Via Emilia Ovest 915/A
41100 Modena – Italy
Phone: +39 059 33 02 88
www.rossi-group.com
info@rossi-group.com

Headquarters

Habasit AG
CH-4153 Reinach-Basel
Phone +41 61 715 15 15
Fax +41 61 715 15 55
E-mail info@habasit.com
www.habasit.com

Copyright Habasit AG
Subject to alterations
Printed in Switzerland
Publication data:
6039BRO.CVB-en01212HQR