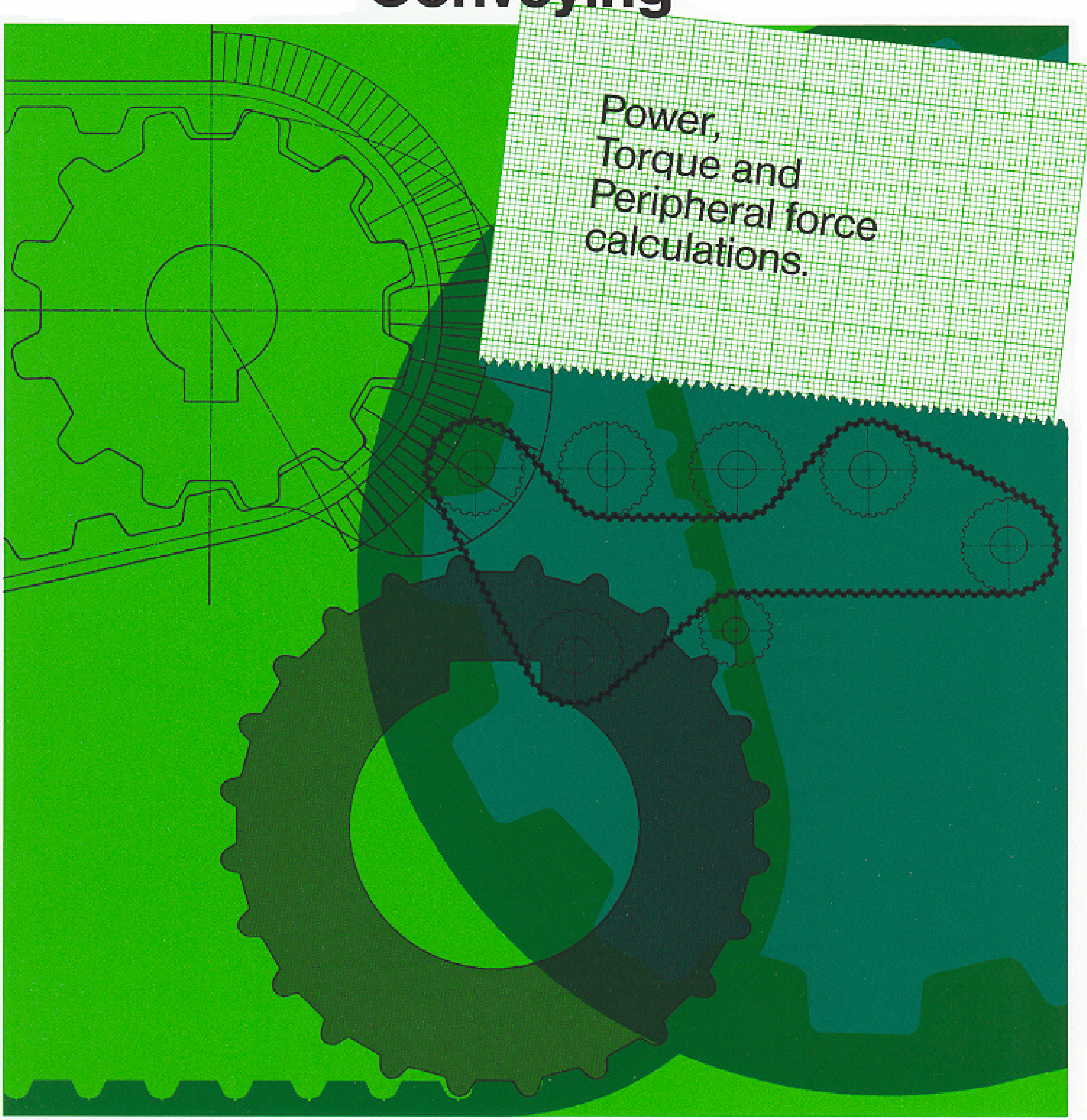
BRECOflex CO., L.L.C.

High Precision Drive Components

Driving
Positioning
Conveying



B 204 B

Correct selection and sizing of the timing belt are the critical factors for good drive design. The following design guidelines should help the designer make full use of the advantages of BRECO and BRECOFLEX timing belts. Our objective has been to provide easily understood tables, charts, formulae and calculation examples.

Available BRECOflex catalogs

B 212	Polyurethane timing belts covering available belt types with sizes for belts and pulleys
B 203	Profiled timing belts design considerations with drawings of stock profiles
B 204	Sizing of BRECO and BRECOFLEX belts Power-Torque-Peripheral force
B 205	Accessory Items for Polyurethane Timing Belts
B 206	Polyurethane timing belts ARC-POWER BAT10
B 207	SM3 Tension meter
B 208	Timing belt backings
B 209	ATN-Convertible timing belt system

General Information

Design Data

Calculation Guidelines

Application Examples

STANDARD RANGE

Construction

BRECO- and BRECOFLEX timing belts are constructed from an extremely wear resistant polyurethane and a high tensile braided steel tension member. The combination of both high grade materials forms the basis for the extremely accurate and reliable BRECO and BRECOFLEX timing belts. An additional nylon tooth facing produces an extremely quiet timing belt with a high efficiency.

Properties

All our timing belts have a temperature range of -30°C to +80°C, are oil and petrol resistant, and are up to 98% efficient. Even in continuous operation no permanent post-elongation of the tension members will occur. Polyurethane is hydrolysis, ozone and sunlight resistant and does not harden with age.

The superior performance characteristics are especially evident in drives with frequent directional changes and where varying acceleration and breaking conditions prevail. All of our timing belts have a low mass to power ratio. The combination of polyurethane timing belts and metal pulleys virtually eliminate any chance of tooth jumping due to positive engagement of the teeth. The proof of a BRECO or BRECOFLEX timing belt can be found in its exceptional performance in the harshest of environments.

Tooth Profiles

Three tooth profiles are available in our Standard Range (please refer to catalog).

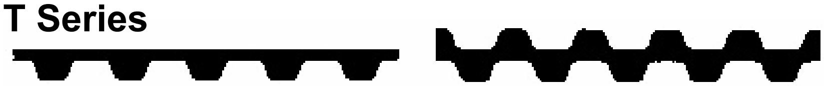
AT Series

Available in AT5, AT10 and AT20 metric pitches.

High performance timing belts with optimized tooth form, stronger tension member and large tooth cross section. For further information see page 6.

These timing belts should be employed in new drives whenever possible. They are especially recommended for drives with high performance, high torque and low noise requirements.

T Series



Available in both single and double-sided form in T5, T10 and T20 metric pitches to DIN 7721.

Standard timing belts with a trapezoidal tooth form. These belts are designed for use in standard applications and for multi-shaft drives where a double-sided belt needs to be employed.

Imperial Pitch Series

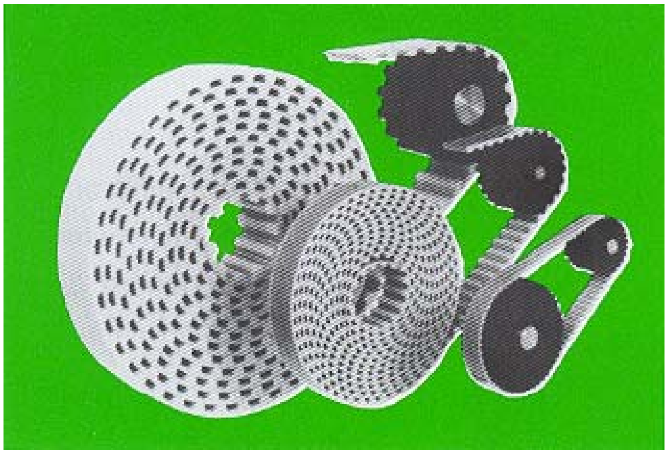
Available in XL (5.08 mm), L (9.525 mm), H (12.7 mm) and XH (22.225 mm) Imperial pitches to DIN/ISO 5296.

Standard timing belts with a trapezoidal tooth form. These belts are recommended for use as replacements on original drives with imperial pitches.

AT, T and Imperial pitch timing belts are all produced as continuous belts or as open lengths.

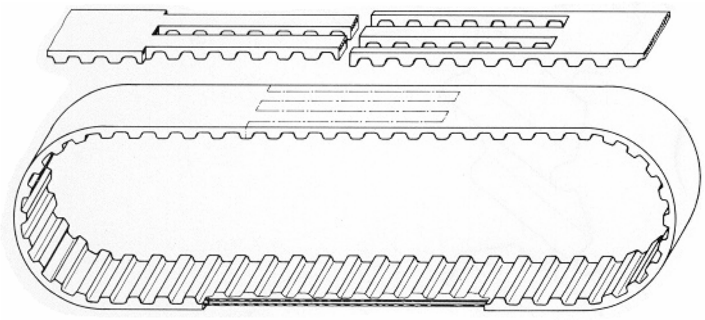
BRECO®-Timing Belts

BRECO M: Open length belting
BRECO V: Joined belting



BRECO M: The BRECO timing belt is produced in open lengths with the tension members lying parallel to the belt edge. A common application of open length belting is in linear drives. All loads are shared equally across the tension members.

BRECO V: By joining open lengths of belting, it is possible to obtain any length of BRECO timing belt. The belt strength at the join is derived from only half the number of tension members. Joined BRECO-timing belts are recommended for use in conveying applications over large center distances.



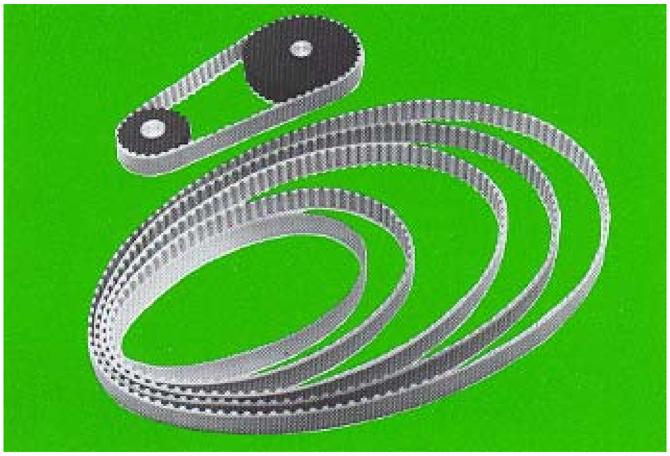
Where Used

Open Lengths in Linear Drives
In linear drives rotational motion is converted into linear movement. We recommend that the BRECO open length belt be clamped to the component of the machine to be moved. For application examples see page 37.

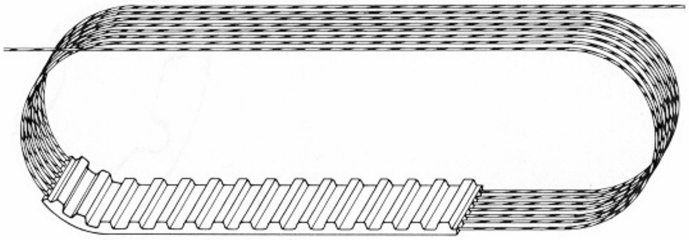
Joined Belts For Conveying Applications
There is no maximum length restriction for joined timing belts. For special conveying applications the timing belt can have a back covering or profiles welded to it. Refer to page 32 for application examples.

BRECOFLEX®-Timing Belts

Endless timing belts with continuous helically wound tension members.



BRECOFLEX: The BRECOFLEX timing belt is produced in endless lengths with a continuous tension member. The tension member is helically wound. BRECOFLEX timing belts are suitable for all drive applications up to 10,000 rpm.



Where Used

Endless timing belts for high power applications
BRECOFLEX timing belts with endlessly wound tension members are recommended for all high power drive applications. They are equally suited to drives with high duty cycles or stop/start applications up to a maximum 10,000 rpm.

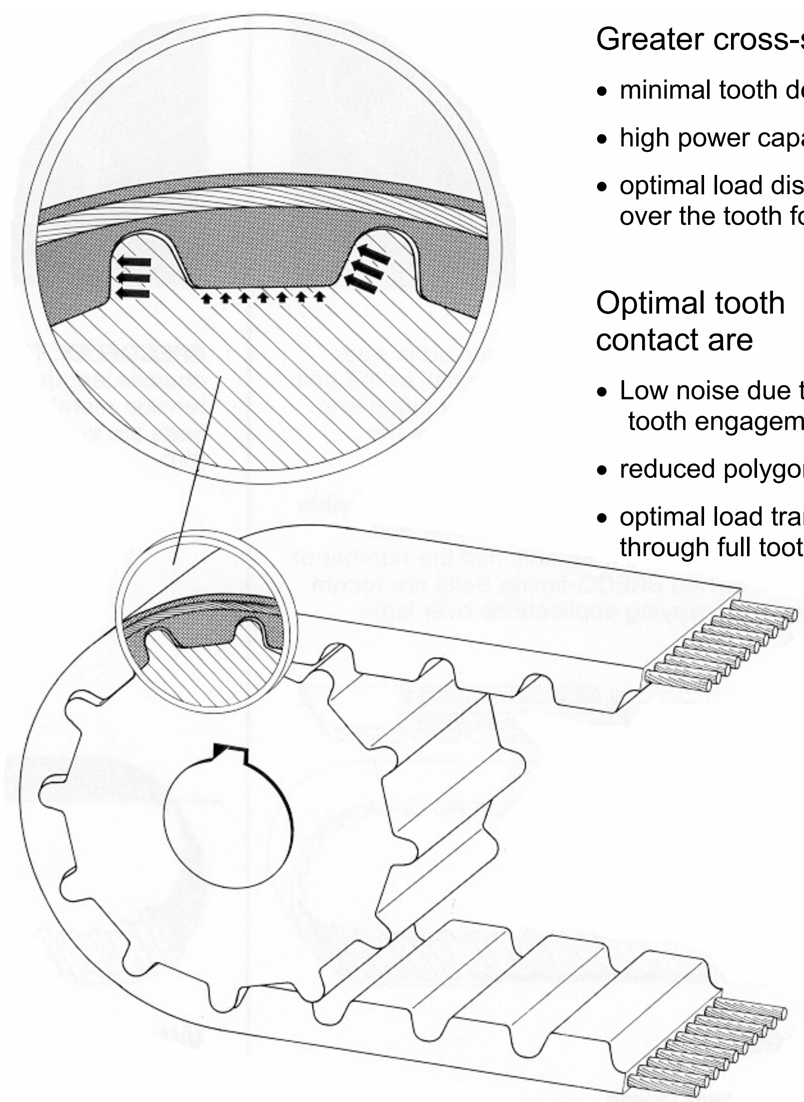
Endless timing belts are supplied in standard lengths (see Standard Range Catalog). Additionally, we can supply intermediate and longer pitch lengths up to a maximum of 22 meters.

AT-Timing Belts

AT5, AT10 and AT20 metric pitches.

BRECO AT timing belts for high power drives. Continuous development has produced a belt capable of transmitting 30% more power than standard types. The AT tooth form gives optimum load, torque and power transmission capabilities whilst at the same time minimizing tooth deformation and belt elongation.

This results in reliable and maintenance-free drives where abgular and postional accuracy is maintained even over very long duty cycles, thus offering the designer the highest quality drive belt possible.



Greater cross-section

- minimal tooth deformation
- high power capabilities
- optimal load distribution over the tooth form.

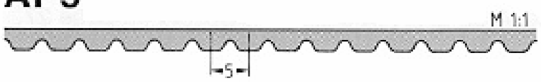
Optimal tooth contact are

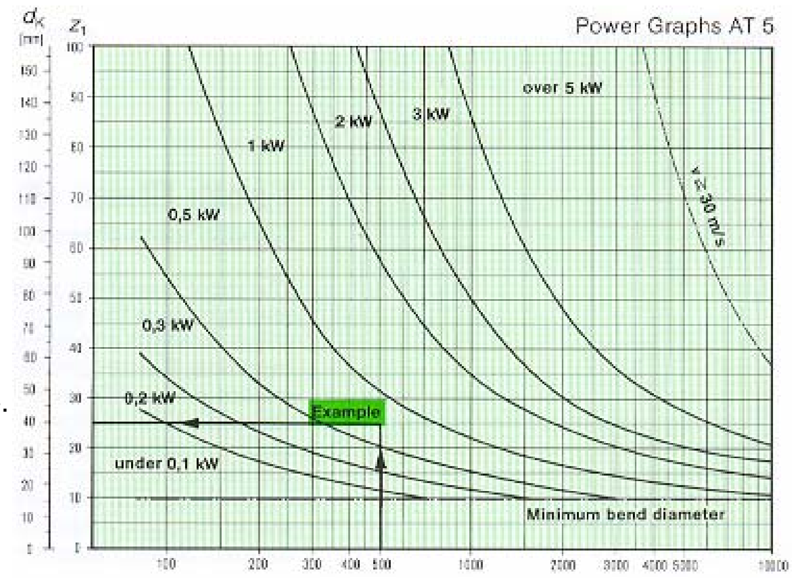
- Low noise due to optimal tooth engagement
- reduced polygonal effect
- optimal load transfer through full tooth contact

Stronger tension member

- high periferal force
- low elongation
- equal load distribution on each tooth in mesh

AT 5





Grinding machines

Small woodworking machinery

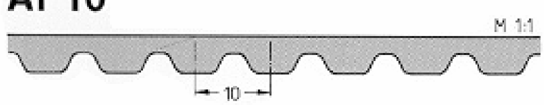
Control, regulating and positioning drives

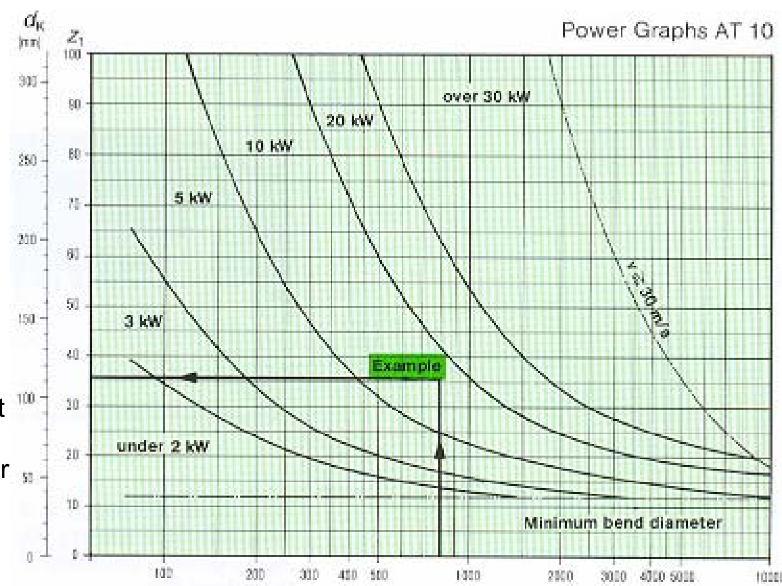
Linear drives for plotters

Light conveying applications

Example: To design a linear drive for a drafting machine. Power P=0.5 kW at a speed of N=500 rpm. Recommended drive = BRECO AT5 timing belt and timing pulley z_1=25. For precise data see pages 10 – 11.

AT 10





Construction machinery (main and auxiliary drives)

Printing and textile machinery

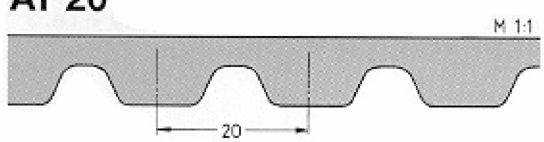
Woodworking machinery

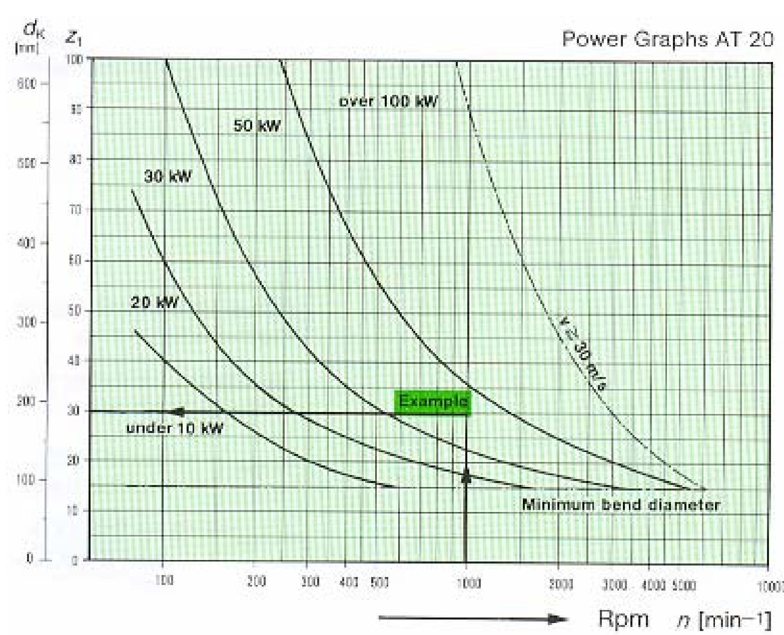
Traversing and linear drives in industrial robotics

Indexing and synchronous conveyors

Example: To design a roll table drive. Power P=10 kW at a speed of n=800 rpm. Recommended drive = BRECOFLEX AT10 timing belt and timing pulley z_1=36 teeth. For precise data see pages 12 – 13.

AT 20





High power drives

Paper making machinery

Pumps and compressors

Roll table drives

Linear and synchronous conveyors

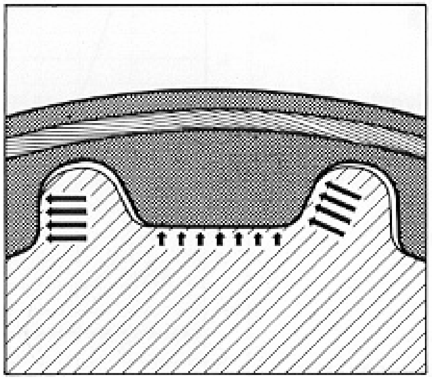
Example: To design a compressor drive. Power P=50 kW at a speed of n=1000 rpm. Recommended drive= BRECOFLEX AT20 timing belt and timing pulley z_1=30. For precise data see pages 14 – 15.

Providing that the following conditions of tooth shear strength (1), tension member tensile strength (2) and flexibility (3) conditions are met, then a maintenance-free timing belt drive can be expected. A calculation example appears on page 27.

Tooth Shear Strength

Specific tooth shear strength

The most important parameter to consider when sizing BRECO and BRECOFLEX timing belts is the tooth shear strength. The calculation is based on the specific shear strength of each tooth in mesh per cm belt width. By using the relevant formulae, the peripheral force, torque and power can all be determined. The maximum specific tooth shear strength must not be exceeded. This figure is defined as the marginal load which the belt can withstand without damage under all operating conditions. These values, which are related to the drive rpm, can be found in the following tables, charts and diagrams. A belt drive is correctly designed, that when under load, that load does not exceed the specific shear strength. A special safety factor is normally not required – see section headed Safety Factors on page 26.



The high specific tooth strength is achieved through a large cross-section and full tooth engagement.

The more belt teeth in mesh attainable, the better the load is spread. For simplicity it is always assumed that each tooth in mesh (z_e) will transmit the same power, in reality the force varies – see accompanying diagram – and therefore the value of z_e has a top limit as below.

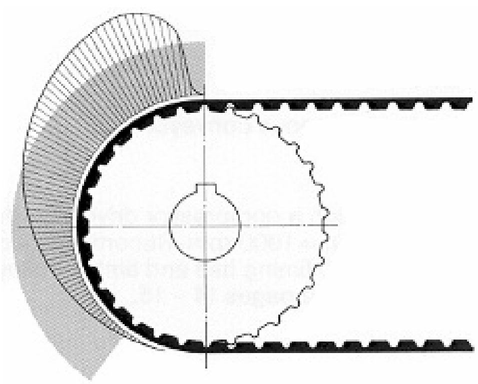
As a rule the tooth shear strength calculation is based on the small pulley – i.e. the pulley with the least teeth in mesh and worst load factors.

Actual load distribution over the tooth-in-mesh-area.

Calculated load over the tooth-in-mesh-area

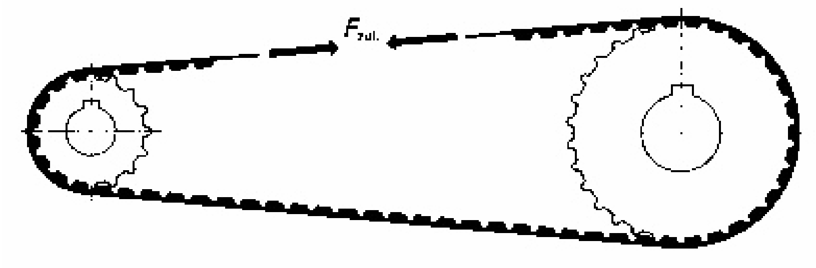
$z_{e\,max}$ = 6 for BRECO Joined belts

$z_{e\,max}$ = 12 for BRECOFLEX belts and BRECO open length belting



Tension Member Tensile Strength

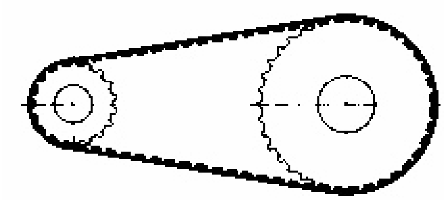
Allowable tensile load on belt cross section



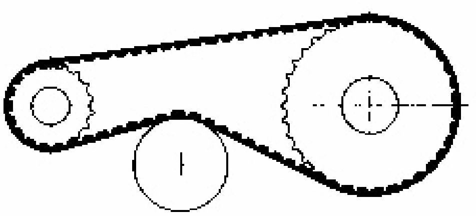
A drive is correctly designed when under all working conditions the maximum allowable tensile load on the tension members is not exceeded. The table values for F_{zul} refer to the working tensile strength.

Flexibility

Minimum no. of teeth on the pulley, minimum diameter



Drive layout without contraflexure



Drive layout with contraflexure

The minimum no. of teeth of the pulley/minimum diam. recommended for trouble-free operation is based upon the belt type being used. When conside-ring drives with contraflexure it is especially important to remember that the minimum no. of teeth on the pulley/minimum diam. must be increased.

1. Tooth Shear Strength

Specific tooth shear strength tables

Rpm. n [min^{-1}]	AT 5 $F_{U\ spez}$ [N/cm]	AT 5 M_{spez} [Ncm/cm]	AT 5 P_{spez} [W/cm]	T 5 $F_{U\ spez}$ [N/cm]	T 5 M_{spez} [Ncm/cm]	T 5 P_{spez} [W/cm]	Rpm. n [min^{-1}]	AT 5 $F_{U\ spez}$ [N/cm]	AT 5 M_{spez} [Ncm/cm]	AT 5 P_{spez} [W/cm]	T 5 $F_{U\ spez}$ [N/cm]	T 5 M_{spez} [Ncm/cm]	T 5 P_{spez} [W/cm]
0	35.3	2.81	0	24.0	1.910	0	2200	21.3	1.695	3.91	13.38	1.065	2.45
20	34.9	2.78	0.058	23.4	1.861	0.039	2400	20.8	1.654	4.16	13.10	1.042	2.62
40	34.5	2.75	0.115	22.9	1.819	0.076	2600	20.3	1.615	4.40	12.84	1.021	2.78
60	34.1	2.72	0.171	22.4	1.783	0.112	2800	19.84	1.579	4.63	12.59	1.002	2.94
80	33.8	2.69	0.225	22.0	1.751	0.147	3000	19.42	1.545	4.85	12.37	0.984	3.09
100	33.5	2.66	0.279	21.7	1.723	0.180	3200	19.01	1.513	5.07	12.16	0.967	3.24
200	32.0	2.55	0.534	20.3	1.614	0.338	3400	18.64	1.483	5.28	11.96	0.951	3.39
300	30.9	2.46	0.771	19.30	1.536	0.483	3600	18.28	1.454	5.48	11.77	0.936	3.53
400	29.8	2.37	0.995	18.55	1.476	0.618	3800	17.93	1.427	5.68	11.59	0.922	3.67
500	29.0	2.30	1.207	17.93	1.427	0.747	4000	17.61	1.401	5.87	11.42	0.909	3.81
600	28.2	2.24	1.409	17.41	1.385	0.870	4500	16.86	1.342	6.32	11.03	0.878	4.14
700	27.5	2.19	1.603	16.96	1.349	0.989	5000	16.18	1.288	6.74	10.68	0.850	4.45
800	26.8	2.14	1.789	16.56	1.318	1.104	5500	15.56	1.239	7.13	10.36	0.825	4.75
900	26.3	2.09	1.969	16.20	1.289	1.215	6000	15.00	1.194	7.50	10.07	0.802	5.04
1000	25.7	2.05	2.14	15.88	1.263	1.323	6500	14.48	1.152	7.84	9.81	0.780	5.31
1100	25.2	2.01	2.31	15.58	1.240	1.428	7000	13.99	1.113	8.16	9.56	0.761	5.58
1200	24.8	1.970	2.48	15.31	1.218	1.531	7500	13.54	1.077	8.46	9.33	0.742	5.83
1300	24.3	1.936	2.64	15.06	1.198	1.632	8000	13.11	1.043	8.74	9.11	0.725	6.08
1400	23.9	1.903	2.79	14.83	1.180	1.730	8500	12.71	1.011	9.00	8.91	0.709	6.31
1500	23.5	1.872	2.94	14.61	1.162	1.826	9000	12.33	0.981	9.24	8.72	0.694	6.54
1600	23.2	1.843	3.09	14.40	1.146	1.920	9500	11.97	0.953	9.47	8.54	0.679	6.76
1700	22.8	1.816	3.23	14.21	1.131	2.01	10000	11.63	0.925	9.69	8.37	0.666	6.97
1800	22.5	1.789	3.37	14.03	1.116	2.10							
1900	22.2	1.764	3.51	13.85	1.102	2.19							
2000	21.9	1.740	3.65	13.69	1.089	2.28							

2. Tensile Strength of Tension Member

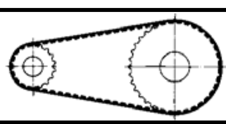
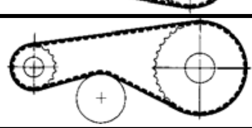
Allowable tensile load on belt cross section, F_{zul} in N

Belt width in mm		6	10	16	25	32	50	75	100
AT 5	BRECO M		560	1260	1680	2240	3500		
	BRECO V		280	630	840	1120	1750		
	BRECOFLEX		490	840	1400	1890	3010	4620	6160
T 5	BRECO M	180	300	540	840	960	1260		
	BRECO V	90	150	240	420	480	630		
	BRECOFLEX	180	330	570	930	1200	1920	2940	3930

BRECO M = Open length belting BRECO V = Joined belts BRECOFLEX = Truly endless belts

3. Flexibility

Minimum no. of teeth on the pulley, minimum diameter

Type of drive			AT 5	T 5
without contraflexure		Minimum no. of teeth on pulley	12	10
		Minimum diam. of flat tension pulley running on belt teeth	25 mm	30 mm
with contraflexure		Minimum no. of teeth on pulleys for belt type AT5 / T5 - DL	25	15
		Minimum diam. of flat tension pulley running on belt back	60 mm	30 mm

Calculation

Peripheral Force

$$F_U = F_{Uspez} \cdot z_e \cdot b$$

Torque

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

Power

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

$F_{U\,spez}$	Specific peripheral force in $\frac{N}{cm}$
M_{spez}	Specific torque in $\frac{Ncm}{cm}$
P_{spez}	Specific power in $\frac{W}{cm}$
z_1	No. of teeth on the small pulley
Z_e	No. of teeth in mesh $z_{e\,max}$ = 12 for BRECOFLEX and BRECO open length belting $z_{e\,max}$ = 6 for BRECO Joined belts
b	Belt width in cm

To calculate belt load ratings, enter the values from the tables and graphs into the above equations.

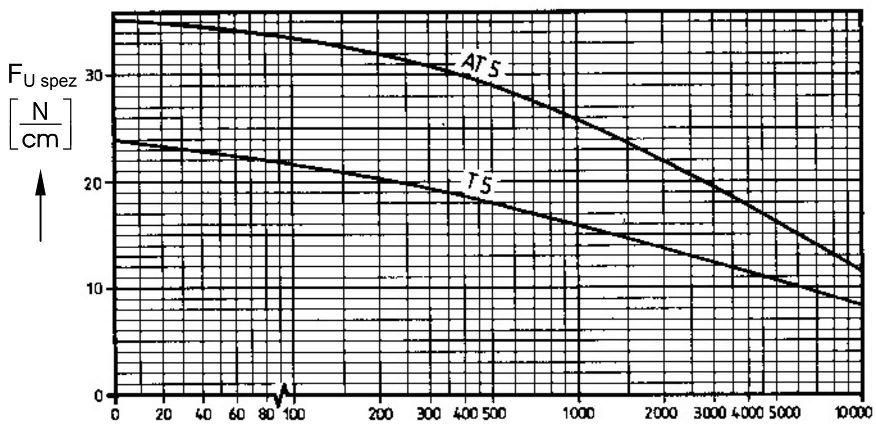
To calculate no. of teeth in mesh

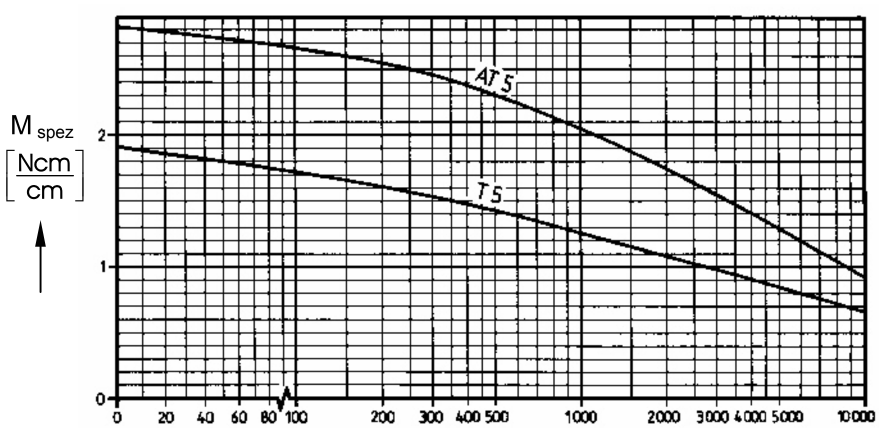
$$z_e = \frac{z_1}{180} \cdot \arccos \frac{(z_2 - z_1) \cdot t}{2\pi a}$$

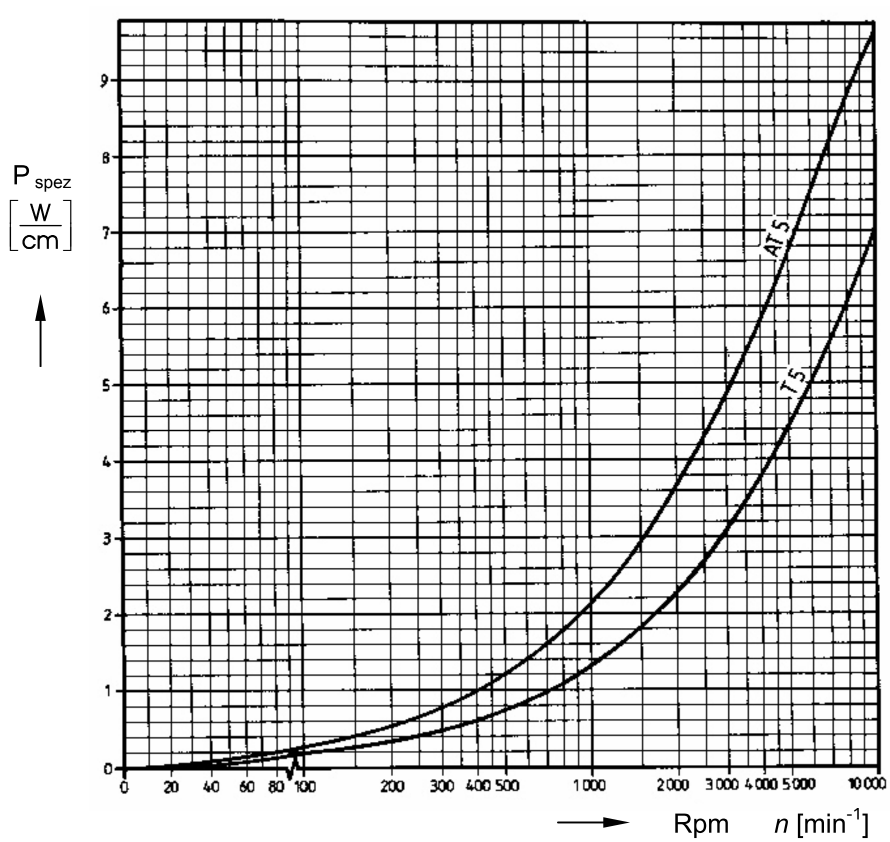
z_1	No. of teeth on the small pulley
z_e	No. of teeth on the large pulley
t	pitch in mm
a	center distance in mm

Refer also to calculation example on page 25.

Specific tooth shear strength graphs







1. Tooth Shear Strength

Specific tooth shear strength tables

Rpm.	AT 10			T 10			Rpm.	AT 10			T 10		
n	$F_{U\,spez}$	M_{spez}	P_{spez}	$F_{U\,spez}$	M_{spez}	P_{spez}	n	$F_{U\,spez}$	M_{spez}	P_{spez}	$F_{U\,spez}$	M_{spez}	P_{spez}
$\left[\frac{}{min^{-1}}\right]$	$\left[\frac{N}{cm}\right]$	$\left[\frac{Ncm}{cm}\right]$	$\left[\frac{W}{cm}\right]$	$\left[\frac{N}{cm}\right]$	$\left[\frac{Ncm}{cm}\right]$	$\left[\frac{W}{cm}\right]$	$\left[\frac{}{min^{-1}}\right]$	$\left[\frac{N}{cm}\right]$	$\left[\frac{Ncm}{cm}\right]$	$\left[\frac{W}{cm}\right]$	$\left[\frac{N}{cm}\right]$	$\left[\frac{Ncm}{cm}\right]$	$\left[\frac{W}{cm}\right]$
0	73.5	11.70	0	50.5	8.04	0	2200	39.0	6.20	14.30	24.6	3.92	9.03
20	72.4	11.53	0.241	49.0	7.80	0.163	2400	37.8	6.01	15.10	23.9	3.81	9.58
40	71.4	11.37	0.476	47.7	7.60	0.318	2600	36.6	5.83	15.86	23.3	3.71	10.10
60	70.5	11.21	0.705	46.6	7.42	0.466	2800	35.5	5.66	16.58	22.7	3.62	10.60
80	69.6	11.07	0.928	45.7	7.27	0.609	3000	34.5	5.50	17.27	22.2	3.53	11.08
100	68.7	10.94	1.145	44.8	7.13	0.746	3200	33.6	5.35	17.92	21.7	3.45	11.55
200	65.0	10.35	2.17	41.4	6.60	1.381	3400	32.7	5.20	18.53	21.2	3.36	11.99
300	62.1	9.88	3.10	39.1	6.22	1.953	3600	31.9	5.07	19.11	20.7	3.30	12.42
400	59.5	9.48	3.97	37.2	5.92	2.48	3800	31.1	4.94	19.67	20.3	3.23	12.84
500	57.4	9.13	4.78	35.7	5.68	2.98	4000	30.3	4.82	20.2	19.86	3.16	13.24
600	55.5	8.83	5.55	34.4	5.48	3.44	4500	28.5	4.54	21.4	18.91	3.01	14.18
700	53.7	8.55	6.27	33.3	5.31	3.89	5000	26.9	4.29	22.5	18.06	2.87	15.05
800	52.2	8.31	6.96	32.4	5.15	4.32	5500	25.5	4.06	23.4	17.28	2.75	15.84
900	50.8	8.08	7.62	31.5	5.01	4.73	6000	24.2	3.85	24.2	16.58	2.64	16.58
1000	49.5	7.88	8.25	30.7	4.89	5.12	6500	23.0	3.65	24.9	15.93	2.54	17.26
1100	48.3	7.69	8.86	30.0	4.77	5.50	7000	21.8	3.47	25.5	15.33	2.44	17.88
1200	47.2	7.51	9.44	29.3	4.67	5.87	7500	20.8	3.30	26.0	14.76	2.35	18.46
1300	46.2	7.35	10.00	28.7	4.57	6.22	8000	19.77	3.15	26.4	14.24	2.27	18.99
1400	45.2	7.19	10.54	28.2	4.48	6.57	8500	18.84	3.00	26.7	13.74	2.18	19.47
1500	44.3	7.04	11.07	27.6	4.40	6.91	9000	17.95	2.86	26.9	13.28	2.11	19.92
1600	43.4	6.91	11.57	27.1	4.32	7.23	9500	17.12	2.72	27.1	12.84	2.04	20.30
1700	42.6	6.78	12.06	26.7	4.24	7.55	10000	16.32	2.60	27.2	12.42	1.98	20.70
1800	41.8	6.65	12.54	26.2	4.17	7.86							
1900	41.0	6.53	13.00	25.8	4.10	8.16							
2000	40.3	6.42	13.44	25.4	4.04	8.46							

2. Tensile Strength of Tension Member

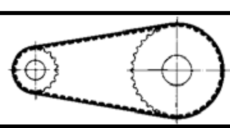
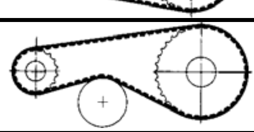
Allowable tensile load on belt cross section, F_{zul} in N

Belt width in mm		16	25	32	50	75	100	150
AT 10	BRECO M		3750	5000	7500	12000	16000	22000
	BRECO V		1875	2500	3750	6000	8000	11000
	BRECOFLEX		3500	4750	7750	12000	16000	24500
T 10	BRECO M	1300	2400	2600	4200	4900	6800	
	BRECO V	650	1200	1300	2100	2450	3400	
	BRECOFLEX	1100	1800	2300	3800	5800	7800	

BRECO M = Open length belting BRECO V = Joined belts BRECOFLEX = Truly endless belts

3. Flexibility

Minimum no. of teeth on the pulley, minimum diameter

Type of drive			**AT 10**	**T 10**
without contraflexure		Minimum no. of teeth on pulley	15	12
		Minimum diam. of flat tension pulley running on belt teeth	50 mm	60 mm
with contraflexure		Minimum no. of teeth on pulleys for belt type AT10 / T10 - DL	40	20
		Minimum diam. of flat tension pulley running on belt back	120 mm	60 mm

Calculation

Peripheral Force

$$F_U = F_{Uspez} \cdot z_e \cdot b$$

Torque

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

Power

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

$F_{U\,spez}$ Specific peripheral force in $\frac{N}{cm}$

M_{spez} Specific torque in $\frac{Ncm}{cm}$

P_{spez} Specific power in $\frac{W}{cm}$

z_1 No. of teeth on the small pulley

Z_e No. of teeth in mesh
$z_{e\,max}$ = 12 for BRECOFLEX and BRECO open length belting

$z_{e\,max}$ = 6 for BRECO Joined belts

b Belt width in cm

To calculate belt load ratings, enter the values from the tables and graphs into the above equations.

To calculate no. of teeth in mesh

$$z_e = \frac{z_1}{180} \cdot \arccos \frac{(z_2 - z_1) \cdot t}{2\pi a}$$

z_1 No. of teeth on the small pulley

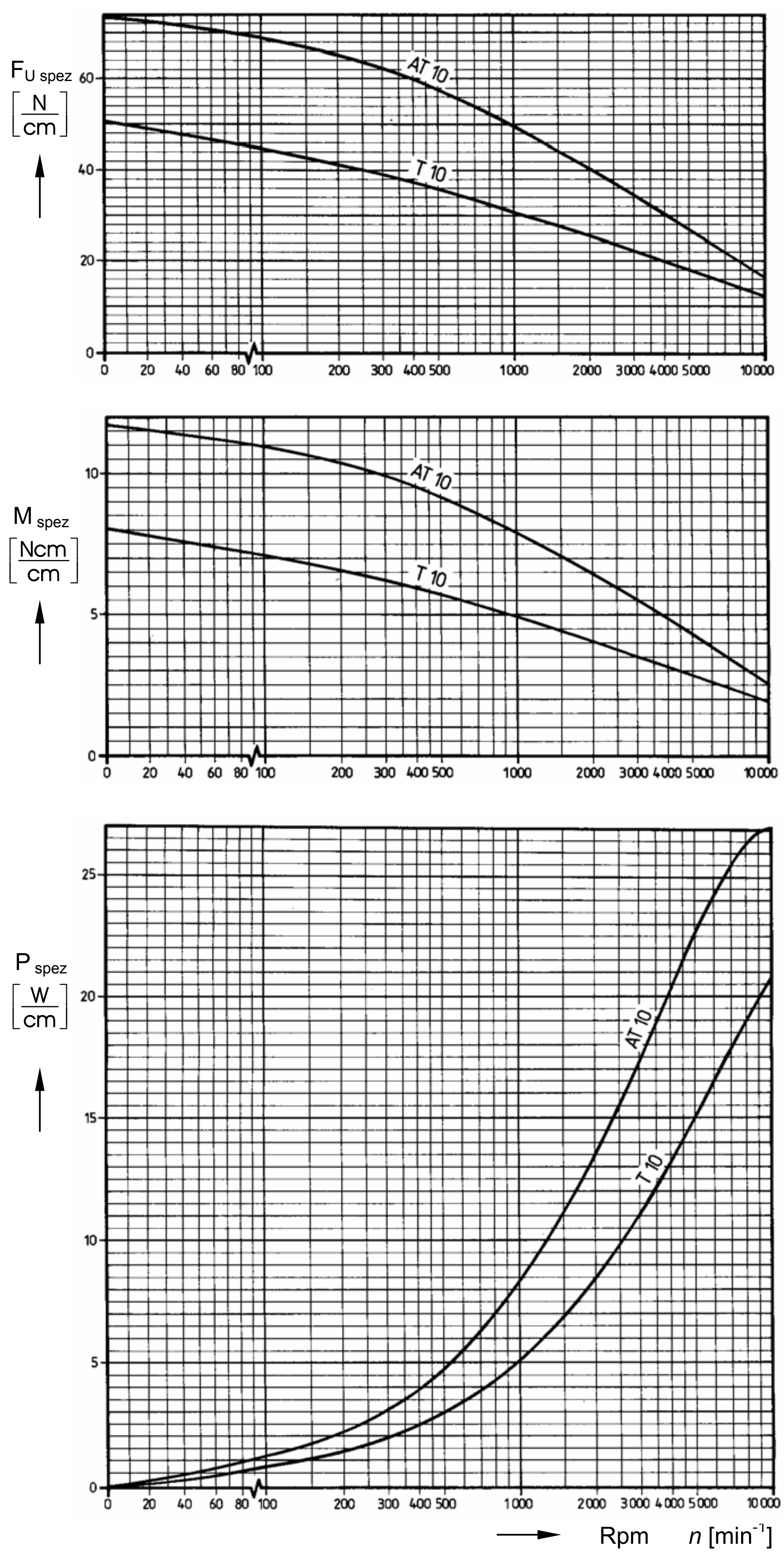
z_e No. of teeth on the large pulley

t pitch in mm

a center distance in mm

Refer also to calculation example on page 25.

Specific tooth shear strength graphs



1. Tooth Shear Strength

Specific tooth shear strength tables

Rpm. n $[\frac{}{min^{-1}}]$	AT 20 $F_{U\,spez}$ $[\frac{N}{cm}]$	AT 20 M_{spez} $[\frac{Ncm}{cm}]$	AT 20 P_{spez} $[\frac{W}{cm}]$	T 20 $F_{U\,spez}$ $[\frac{N}{cm}]$	T 20 M_{spez} $[\frac{Ncm}{cm}]$	T 20 P_{spez} $[\frac{W}{cm}]$
0	147.0	46.8	0	101.5	32.3	0
20	144.2	45.9	0.962	98.1	31.2	0.654
40	141.7	45.1	1.889	95.3	30.3	1.271
60	139.3	44.3	2.79	92.8	29.5	1.856
80	137.0	43.6	3.65	90.7	28.9	2.42
100	134.9	42.9	4.50	88.7	28.2	2.96
200	125.8	40.0	8.39	81.2	25.9	5.42
300	118.5	37.7	11.85	75.9	24.2	7.59
400	112.4	35.8	14.99	71.8	22.9	9.57
500	107.2	34.1	17.86	68.4	21.8	11.41
600	102.6	32.7	20.5	65.6	20.9	13.11
700	98.5	31.4	23.0	63.1	20.1	14.73
800	94.8	30.2	25.3	60.9	19.40	16.25
900	91.5	29.1	27.4	59.0	18.78	17.70
1000	88.4	28.1	29.5	57.2	18.22	19.08
1100	85.6	27.2	31.4	55.6	17.71	20.4
1200	82.9	26.4	33.2	54.2	17.24	21.7
1300	80.5	25.6	34.9	52.8	16.80	22.9
1400	78.2	24.9	36.5	51.5	16.40	24.0
1500	76.0	24.2	38.0	50.3	16.02	25.2
1600	73.9	23.5	39.4	49.2	15.66	26.2
1700	72.0	22.9	40.8	48.2	15.33	27.3
1800	70.1	22.3	42.1	47.2	15.01	28.3
1900	68.4	21.8	43.3	46.2	14.71	29.3
2000	66.7	21.2	44.5	45.3	14.42	30.2

Rpm. n $[\frac{}{min^{-1}}]$	AT 20 $F_{U\,spez}$ $[\frac{N}{cm}]$	AT 20 M_{spez} $[\frac{Ncm}{cm}]$	AT 20 P_{spez} $[\frac{W}{cm}]$	T 20 $F_{U\,spez}$ $[\frac{N}{cm}]$	T 20 M_{spez} $[\frac{Ncm}{cm}]$	T 20 P_{spez} $[\frac{W}{cm}]$
2200	63.6	20.20	46.6	43.6	13.89	32.0
2400	60.7	19.31	48.5	42.1	13.40	33.7
2600	58.0	18.45	50.2	40.7	12.95	35.2
2800	55.5	17.65	51.8	39.4	12.53	36.7
3000	53.1	16.90	53.1	38.1	12.13	38.1
3200	50.9	16.20	54.3	37.0	11.77	39.4
3400	48.8	15.53	55.3	35.9	11.42	40.7
3600	46.8	14.91	56.2	34.9	11.09	41.8
3800	45.0	14.31	56.9	33.9	10.78	42.9
4000	43.2	13.74	57.6	33.0	10.49	43.9
4500	39.0	12.43	58.6	30.8	9.81	46.2
5000	35.3	11.25	58.9	28.9	9.21	48.2
5500	32.0	10.17	58.6	27.2	8.66	49.9
6000	28.9	9.19	57.7	25.6	8.16	51.2
6500	26.0	8.28	56.4	24.2	7.69	52.4

2. Tensile Strength of Tension Member

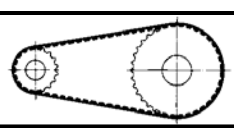
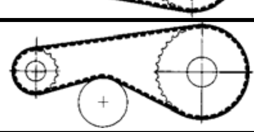
Allowable tensile load on belt cross section, F_{zul} in N

Belt width in mm		32	50	75	100	150		
AT 20	BRECO M	7200	11700	18000	25000	36000		
	BRECO V	3600	5850	9000	12600	18000		
	BRECOFLEX	6750	11250	17550	23850	36450		
T 20	BRECO M	4500	6500	10000	14000	20000		
	BRECO V	2250	3250	5000	7000	10000		
	BRECOFLEX	4750	7750	12000	16000	24500		

BRECO M = Open length belting BRECO V = Joined belts BRECOFLEX = Truly endless belts

3. Flexibility

Minimum no. of teeth on the pulley, minimum diameter

Type of drive			AT 20	T 20
without contraflexure		Minimum no. of teeth on pulley	18	15
		Minimum diam. of flat tension pulley running on belt teeth	120 mm	120 mm
with contraflexure		Minimum no. of teeth on pulleys for belt type T20 - DL		25
		Minimum diam. of flat tension pulley running on belt back	180 mm	120 mm

Calculation

Peripheral Force

$$F_U = F_{Uspez} \cdot z_e \cdot b$$

Torque

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

Power

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

$F_{U\,spez}$ Specific peripheral force in $\frac{N}{cm}$

M_{spez} Specific torque in $\frac{Ncm}{cm}$

P_{spez} Specific power in $\frac{W}{cm}$

z_1 No. of teeth on the small pulley

Z_e No. of teeth in mesh
$z_{e\,max}$ = 12 for BRECOFLEX and BRECO open length belting

$z_{e\,max}$ = 6 for BRECO Joined belts

b Belt width in cm

To calculate belt load ratings, enter the values from the tables and graphs into the above equations.

To calculate no. of teeth in mesh

$$z_e = \frac{z_1}{180} \cdot \arccos \frac{(z_2 - z_1) \cdot t}{2\pi a}$$

z_1 No. of teeth on the small pulley

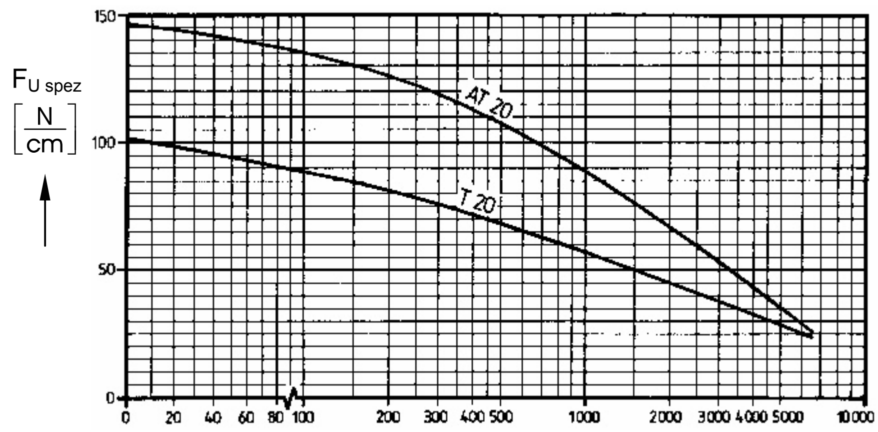
z_e No. of teeth on the large pulley

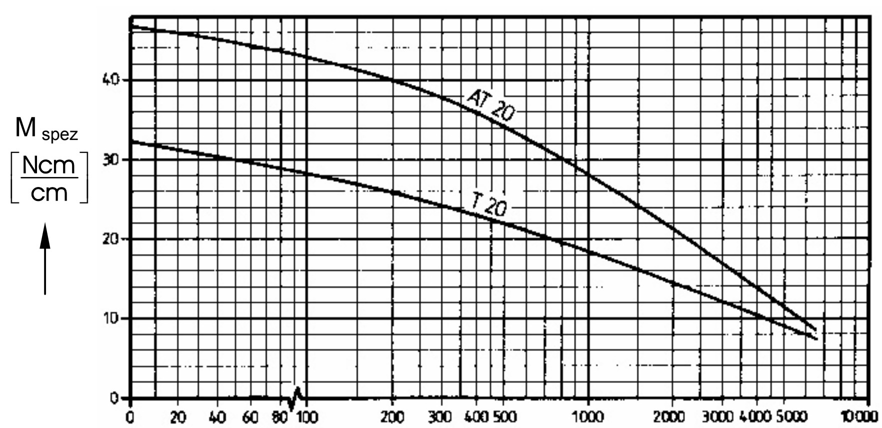
t pitch in mm

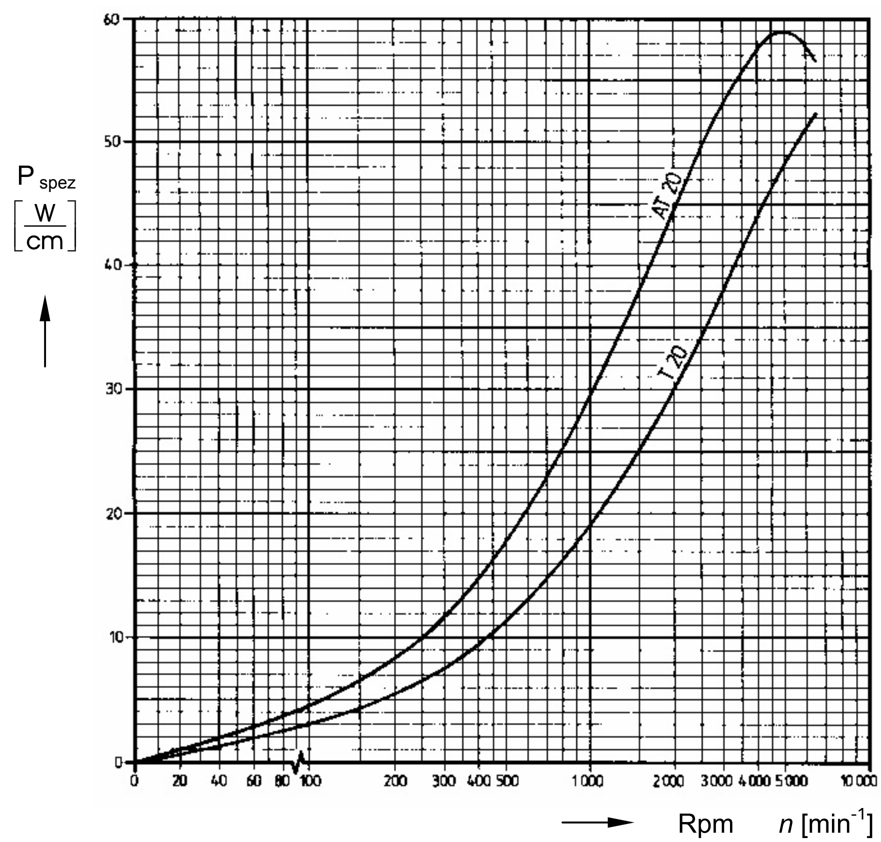
a center distance in mm

Refer also to calculation example on page 25.

Specific tooth shear strength graphs







1. Tooth Shear Strength

Specific tooth shear strength tables

Rpm. n [$\frac{}{min^{-1}}$]	XL $F_{U\,spez}$ [$\frac{N}{cm}$]	M_{spez} [$\frac{Ncm}{cm}$]	P_{spez} [$\frac{W}{cm}$]	Rpm. n [$\frac{}{min^{-1}}$]	XL $F_{U\,spez}$ [$\frac{N}{cm}$]	M_{spez} [$\frac{Ncm}{cm}$]	P_{spez} [$\frac{W}{cm}$]
0	24.4	1.973	0	2200	13.60	1.100	2.53
20	23.8	1.922	0.040	2400	13.31	1.076	2.71
40	23.2	1.879	0.079	2600	13.05	1.055	2.87
60	22.8	1.842	0.116	2800	12.80	1.035	3.06
80	22.4	1.809	0.152	3000	12.57	1.017	3.19
100	22.0	1.780	0.186	3200	12.36	0.999	3.35
200	20.6	1.667	0.349	3400	12.16	0.983	3.50
300	19.63	1.587	0.498	3600	11.96	0.967	3.65
400	18.86	1.525	0.639	3800	11.78	0.953	3.79
500	18.23	1.474	0.772	4000	11.61	0.939	3.93
600	17.70	1.431	0.889	4500	11.21	0.907	4.27
700	17.24	1.394	1.022	5000	10.86	0.878	4.60
800	16.83	1.361	1.140	5500	10.54	0.852	4.91
900	16.47	1.332	1.255	6000	10.24	0.828	5.20
1000	16.14	1.305	1.367	6500	9.97	0.806	5.49
1100	15.84	1.281	1.475	7000	9.72	0.786	5.76
1200	15.57	1.259	1.582	7500	9.49	0.767	6.02
1300	15.31	1.238	1.685	8000	9.27	0.749	6.28
1400	15.07	1.219	1.787	8500	9.06	0.732	6.52
1500	14.85	1.201	1.886	9000	8.86	0.717	6.76
1600	14.64	1.184	1.984	9500	8.68	0.702	6.98
1700	14.45	1.168	2.08	10000	8.51	0.688	7.20
1800	14.26	1.153	2.18				
1900	14.08	1.139	2.27				
2000	13.91	1.125	2.36				

2. Tensile Strength of Tension Member

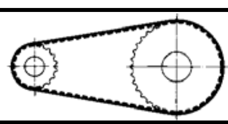
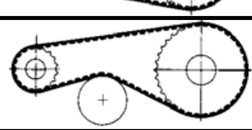
Allowable tensile load on belt cross section, F_{zul} in N

Belt width in mm	Code mm	025 6.35	032 7.94	037 9.53	050 12.7	075 19.1	100 25.4	
XL	BRECO M BRECO V BRECOFLEX	210 105 180	270 135 240	330 165 300	420 210 420	630 315 690	840 420 930	

BRECO M = Open length belting BRECO V = Joined belts BRECOFLEX = Truly endless belts

3. Flexibility

Minimum no. of teeth on the pulley, minimum diameter

Type of drive			**XL**
without contraflexure		Minimum no. of teeth on pulley	10
		Minimum diam. of flat tension pulley running on belt teeth	30 mm
with contraflexure			
		Minimum diam. of flat tension pulley running on belt back	30 mm

Calculation

Peripheral Force

$$F_U = F_{Uspez} \cdot z_e \cdot b$$

Torque

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

Power

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

$F_{U\,spez}$ Specific peripheral force in $\frac{N}{cm}$

M_{spez} Specific torque in $\frac{Ncm}{cm}$

P_{spez} Specific power in $\frac{W}{cm}$

z_1 No. of teeth on the small pulley

Z_e No. of teeth in mesh
$z_{e\,max}$ = 12 for BRECOFLEX and BRECO open length belting
$z_{e\,max}$ = 6 for BRECO Joined belts

b Belt width in cm

To calculate belt load ratings, enter the values from the tables and graphs into the above equations.

To calculate no. of teeth in mesh

$$z_e = \frac{z_1}{180} \cdot \arccos \frac{(z_2 - z_1) \cdot t}{2\pi a}$$

z_1 No. of teeth on the small pulley

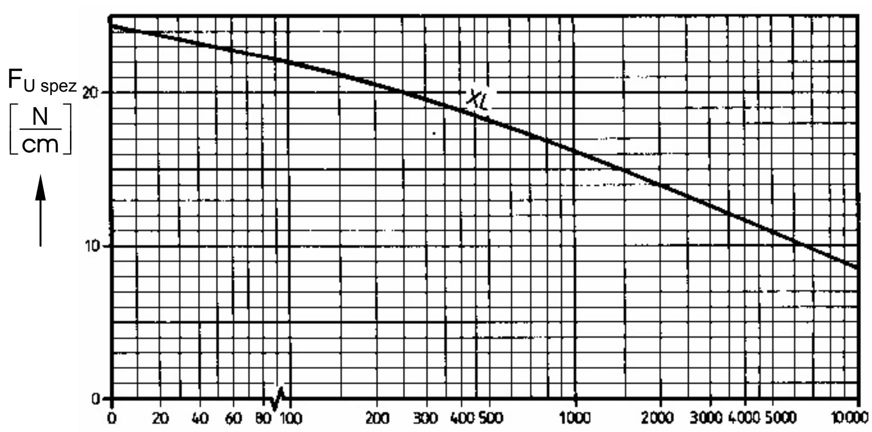
z_e No. of teeth on the large pulley

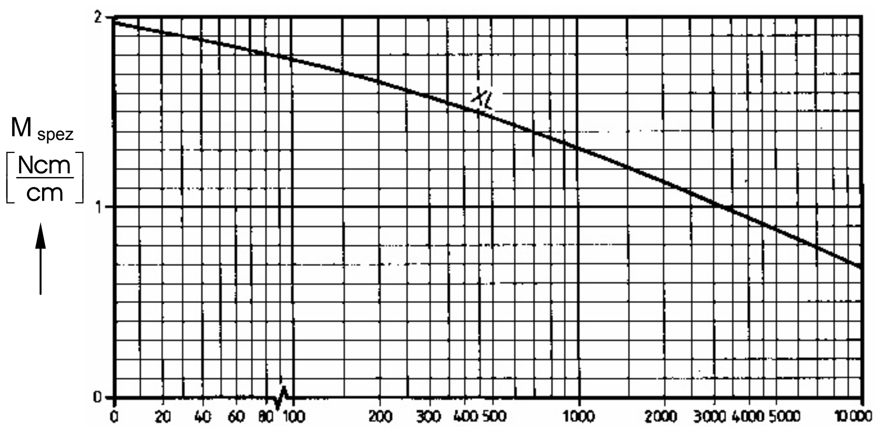
t pitch in mm

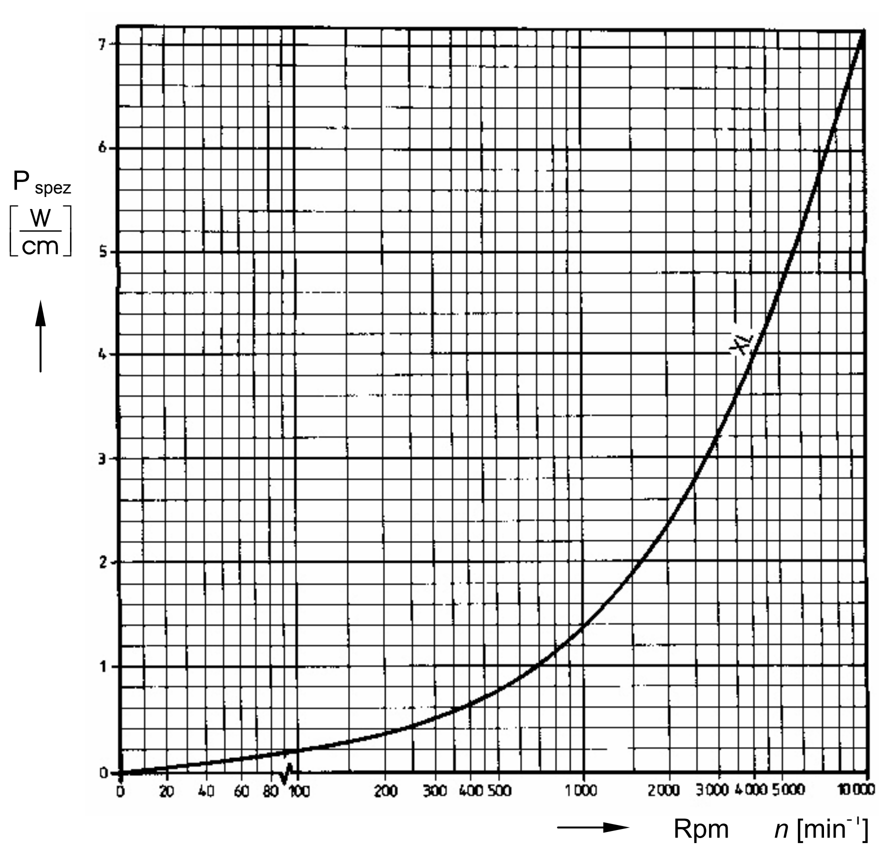
a center distance in mm

Refer also to calculation example on page 25.

Specific tooth shear strength graphs







1. Tooth Shear Strength

Specific tooth shear strength tables

Rpm. n $[\frac{}{min^{-1}}]$	L $F_{U\,spez}$ $[\frac{N}{cm}]$	M_{spez} $[\frac{Ncm}{cm}]$	P_{spez} $[\frac{W}{cm}]$	Rpm. n $[\frac{}{min^{-1}}]$	L $F_{U\,spez}$ $[\frac{N}{cm}]$	M_{spez} $[\frac{Ncm}{cm}]$	P_{spez} $[\frac{W}{cm}]$
0	37.4	5.67	0	2200	18.22	2.76	6.37
20	36.3	5.50	0.115	2400	17.71	2.69	6.75
40	35.3	5.35	0.224	2600	17.25	2.61	7.12
60	34.5	5.23	0.329	2800	16.81	2.55	7.47
80	33.8	5.12	0.429	3000	16.40	2.49	7.81
100	33.1	5.02	0.526	3200	16.02	2.43	8.14
200	30.7	4.65	0.974	3400	15.66	2.37	8.45
300	28.9	4.38	1.377	3600	15.32	2.32	8.76
400	27.5	4.18	1.749	3800	15.00	2.27	9.05
500	26.4	4.01	2.10	4000	14.69	2.23	9.33
600	25.5	3.86	2.43	4500	13.99	2.12	9.99
700	24.7	3.74	2.74	5000	13.36	2.03	10.61
800	24.0	3.63	3.04	5500	12.79	1.939	11.17
900	23.3	3.53	3.33	6000	12.27	1.860	11.69
1000	22.7	3.45	3.61	6500	11.79	1.787	12.16
1100	22.2	3.37	3.88	7000	11.34	1.719	12.60
1200	21.7	3.29	4.14	7500	10.93	1.656	13.01
1300	21.3	3.22	4.39	8000	10.54	1.597	13.38
1400	20.8	3.16	4.63	8500	10.17	1.542	13.72
1500	20.4	3.10	4.87	9000	9.83	1.490	14.04
1600	20.1	3.04	5.10	9500	9.50	1.440	14.33
1700	19.72	2.99	5.32	10000	9.19	1.393	14.59
1800	19.39	2.94	5.54				
1900	19.08	2.89	5.75				
2000	18.78	2.85	5.96				

2. Tensile Strength of Tension Member

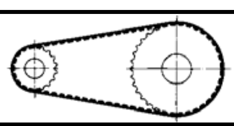
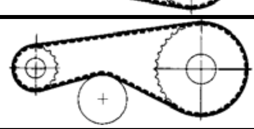
Allowable tensile load on belt cross section, F_{zul} in N

Belt width in mm	Code / mm	37 9.53	50 12.7	75 19.1	100 25.4	150 38.1	200 50.8	300 76.2	400 101.6
L	BRECO M	630	840	1260	1680	2520	3000		
	BRECO V	315	420	630	840	1260	1500		
	BRECOFLEX	420	630	1050	1470	2240	3080	4690	6300

BRECO M = Open length belting BRECO V = Joined belts BRECOFLEX = Truly endless belts

3. Flexibility

Minimum no. of teeth on the pulley, minimum diameter

Type of drive			**L**
without contraflexure		Minimum no. of teeth on pulley	10
		Minimum diam. of flat tension pulley running on belt teeth	50 mm
with contraflexure		Minimum no. of teeth on pulleys for belt type L-DL	15
		Minimum diam. of flat tension pulley running on belt back	60 mm

Calculation

Peripheral Force

$$F_U = F_{Uspez} \cdot z_e \cdot b$$

Torque

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

Power

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

$F_{U\ spez}$ Specific peripheral force in $\frac{N}{cm}$

M_{spez} Specific torque in $\frac{Ncm}{cm}$

P_{spez} Specific power in $\frac{W}{cm}$

z_1 No. of teeth on the small pulley

Z_e No. of teeth in mesh
$z_{e\ max}$ = 12 for BRECOFLEX and BRECO open length belting

$z_{e\ max}$ = 6 for BRECO Joined belts

b Belt width in cm

To calculate belt load ratings, enter the values from the tables and graphs into the above equations.

To calculate no. of teeth in mesh

$$z_e = \frac{z_1}{180} \cdot \arccos \frac{(z_2 - z_1) \cdot t}{2\pi a}$$

z_1 No. of teeth on the small pulley

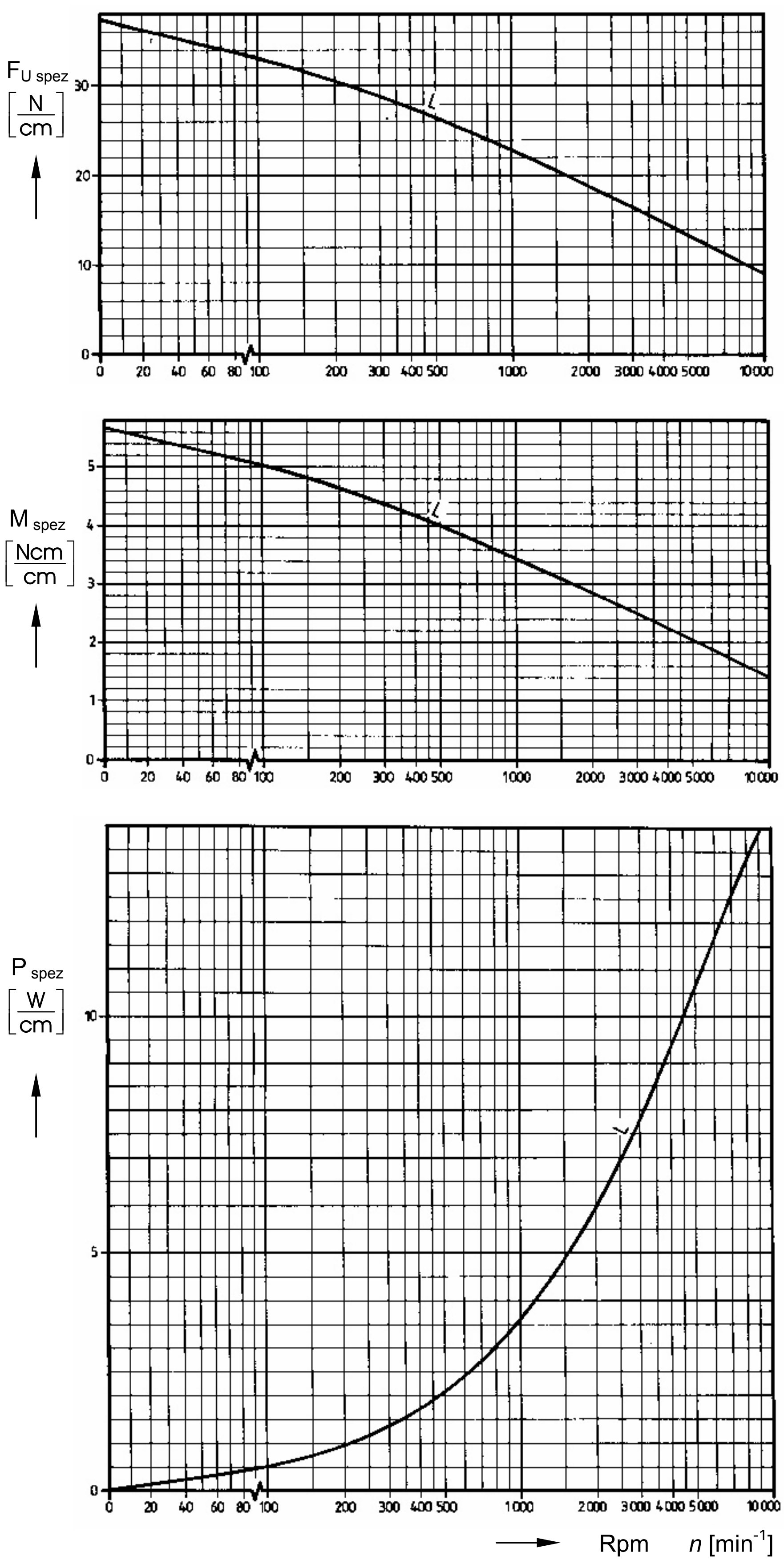
z_e No. of teeth on the large pulley

t pitch in mm

a center distance in mm

Refer also to calculation example on page 25.

Specific tooth shear strength graphs



1. Tooth Shear Strength

Specific tooth shear strength tables

Rpm. n [min^{-1}]	H $F_{U\,spez}$ [N/cm]	M_{spez} [Ncm/cm]	P_{spez} [W/cm]	Rpm. n [min^{-1}]	H $F_{U\,spez}$ [N/cm]	M_{spez} [Ncm/cm]	P_{spez} [W/cm]
0	44.0	8.90	0	2200	21.5	4.34	10.00
20	42.7	8.64	0.181	2400	20.9	4.22	10.60
40	41.6	8.41	0.352	2600	20.3	4.11	11.18
60	40.7	8.22	0.516	2800	19.81	4.00	11.74
80	39.8	8.05	0.674	3000	19.33	3.91	12.27
100	39.1	7.89	0.827	3200	18.88	3.82	12.79
200	36.1	7.30	1.530	3400	18.45	3.73	13.28
300	34.1	6.89	2.16	3600	18.05	3.65	13.76
400	32.5	6.56	2.75	3800	17.68	3.57	14.22
500	31.1	6.30	3.30	4000	17.32	3.50	14.66
600	30.0	6.07	3.81	4500	16.49	3.33	15.70
700	29.1	5.88	4.31	5000	15.74	3.18	16.66
800	28.2	5.71	4.78	5500	15.07	3.05	17.55
900	27.5	5.55	5.23	6000	14.46	2.92	18.36
1000	26.8	5.41	5.67	6500	13.89	2.81	19.11
1100	26.2	5.29	6.09	7000	13.36	2.70	19.80
1200	25.6	5.17	6.50	7500	12.87	2.60	20.4
1300	25.1	5.06	6.89	8000	12.42	2.51	21.0
1400	24.6	4.96	7.28	8500	11.99	2.42	21.6
1500	24.1	4.87	7.65	9000	11.58	2.34	22.1
1600	23.7	4.78	8.01	9500	11.19	2.26	22.5
1700	23.2	4.70	8.36	10000	10.83	2.19	22.9
1800	22.9	4.62	8.71				
1900	22.5	4.54	9.04				
2000	22.1	4.47	9.37				

2. Tensile Strength of Tension Member

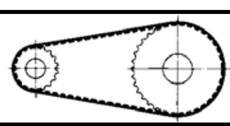
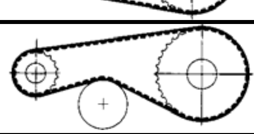
Allowable tensile load on belt cross section, F_{zul} in N

Belt width in mm	Code mm	050 12.7	075 19.1	100 25.4	150 38.1	200 50.8	300 76.2	400 101.6
H	BRECO M	1000	1600	2000	3200	4200	5200	6600
	BRECO V	500	800	1000	1600	2100	2600	3300
	BRECOFLEX	800	1300	1800	2800	3800	5800	7900

BRECO M = Open length belting BRECO V = Joined belts BRECOFLEX = Truly endless belts

3. Flexibility

Minimum no. of teeth on the pulley, minimum diameter

Type of drive		**H**
without contraflexure 	Minimum no. of teeth on pulley	14
	Minimum diam. of flat tension pulley running on belt teeth	80 mm
with contraflexure 	Minimum no. of teeth on pulleys for belt type H-DL	20
	Minimum diam. of flat tension pulley running on belt back	80 mm

Calculation

Peripheral Force

$$F_U = F_{Uspez} \cdot z_e \cdot b$$

Torque

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

Power

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

$F_{U\,spez}$ Specific peripheral force in $\frac{N}{cm}$

M_{spez} Specific torque in $\frac{Ncm}{cm}$

P_{spez} Specific power in $\frac{W}{cm}$

z_1 No. of teeth on the small pulley

Z_e No. of teeth in mesh
$z_{e\,max}$ = 12 for BRECOFLEX and BRECO open length belting

$z_{e\,max}$ = 6 for BRECO Joined belts

b Belt width in cm

To calculate belt load ratings, enter the values from the tables and graphs into the above equations.

To calculate no. of teeth in mesh

$$z_e = \frac{z_1}{180} \cdot \arccos \frac{(z_2 - z_1) \cdot t}{2\pi a}$$

z_1 No. of teeth on the small pulley

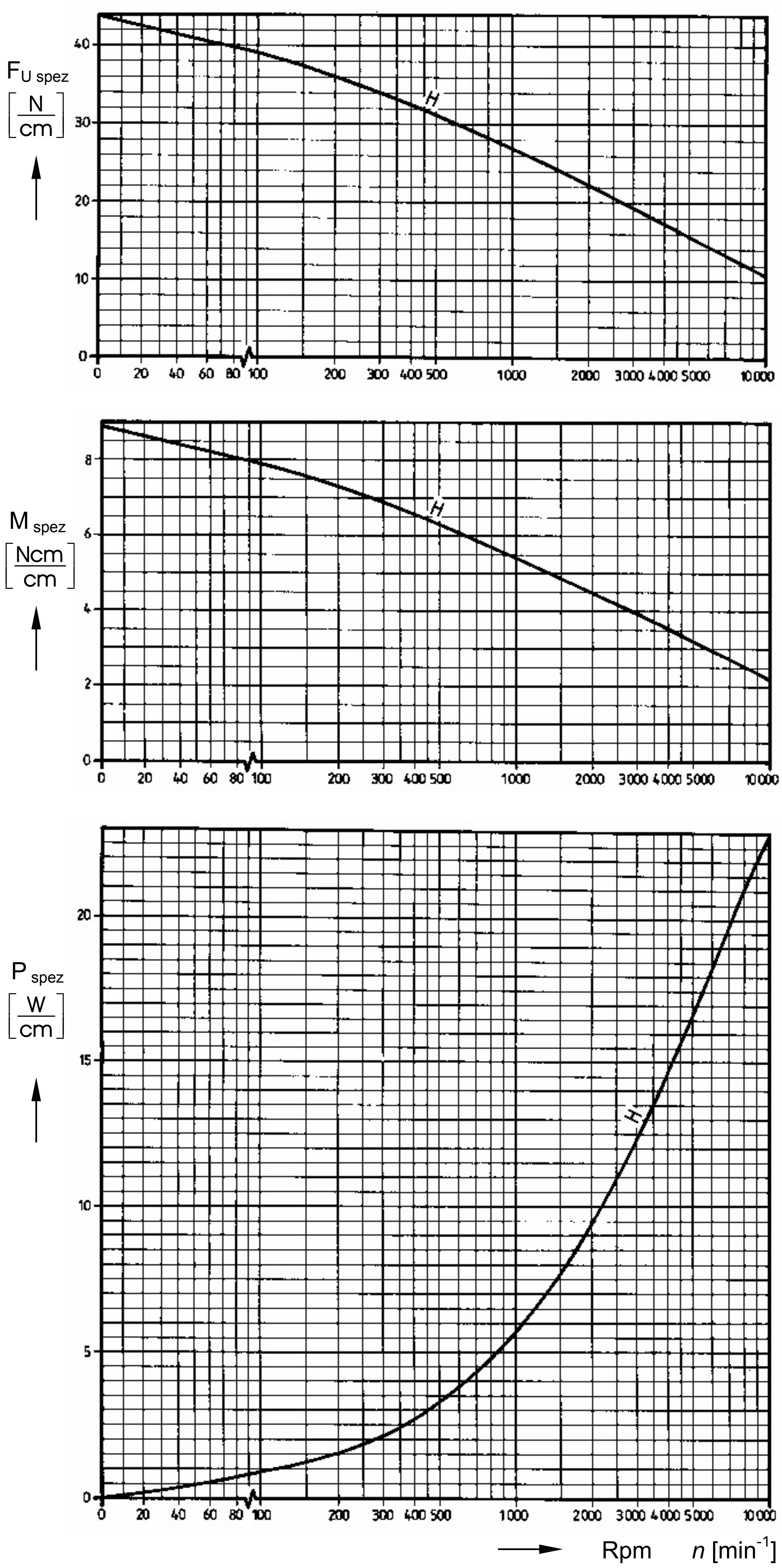
z_e No. of teeth on the large pulley

t pitch in mm

a center distance in mm

Refer also to calculation example on page 25.

Specific tooth shear strength graphs



1. Tooth Shear Strength

Specific tooth shear strength tables

Rpm. n $\left[\frac{}{\text{min}^{-1}}\right]$	XH $F_{U\,spez}$ $\left[\frac{N}{cm}\right]$	XH M_{spez} $\left[\frac{Ncm}{cm}\right]$	XH P_{spez} $\left[\frac{W}{cm}\right]$	Rpm. n $\left[\frac{}{\text{min}^{-1}}\right]$	XH $F_{U\,spez}$ $\left[\frac{N}{cm}\right]$	XH M_{spez} $\left[\frac{Ncm}{cm}\right]$	XH P_{spez} $\left[\frac{W}{cm}\right]$
0	126.3	44.7	0	2200	54.3	19.20	44.2
20	122.1	43.2	0.904	2400	52.4	18.52	46.5
40	118.5	41.9	1.756	2600	50.6	17.90	48.7
60	115.5	40.8	2.57	2800	49.0	17.31	50.8
80	112.8	39.9	3.34	3000	47.4	16.77	52.7
100	110.4	39.0	4.09	3200	46.0	16.27	54.5
200	101.0	35.7	7.49	3400	44.6	15.79	56.2
300	94.4	33.4	10.49	3600	43.4	15.34	57.8
400	89.3	31.6	13.23	3800	42.2	14.91	59.3
500	85.1	30.1	15.77	4000	41.0	14.50	60.7
600	81.6	28.9	18.13	4500	38.4	13.57	63.9
700	78.5	27.8	20.4				
800	75.8	26.8	22.5				
900	73.4	26.0	24.5				
1000	71.2	25.2	26.4				
1100	69.2	24.5	28.2				
1200	67.4	23.8	29.9				
1300	65.7	23.2	31.6				
1400	64.1	22.7	33.2				
1500	62.6	22.1	34.8				
1600	61.2	21.7	36.3				
1700	59.9	21.2	37.7				
1800	58.7	20.7	39.1				
1900	57.5	20.3	40.5				
2000	56.4	19.94	41.8				

2. Tensile Strength of Tension Member

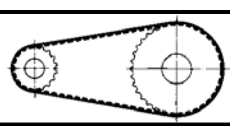
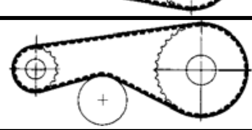
Allowable tensile load on belt cross section, F_{zul} in N

Belt width in mm	Code mm	200 50.8	300 76.2	400 101.6				
XH	BRECO M BRECO V BRECOFLEX	6500 3250 7750	10000 5000 12000	14000 7000 16250				

BRECO M = Open length belting BRECO V = Joined belts BRECOFLEX = Truly endless belts

3. Flexibility

Minimum no. of teeth on the pulley, minimum diameter

Type of drive			**XH**
without contraflexure		Minimum no. of teeth on pulley	18
		Minimum diam. of flat tension pulley running on belt teeth	150 mm
with contraflexure			
		Minimum diam. of flat tension pulley running on belt back	150 mm

Calculation

Peripheral Force

$$F_U = F_{Uspez} \cdot z_e \cdot b$$

Torque

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

Power

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

$F_{U\,spez}$ Specific peripheral force in $\frac{N}{cm}$

M_{spez} Specific torque in $\frac{Ncm}{cm}$

P_{spez} Specific power in $\frac{W}{cm}$

z_1 No. of teeth on the small pulley

Z_e No. of teeth in mesh
$z_{e\,max}$ = 12 for BRECOFLEX and BRECO open length belting

$z_{e\,max}$ = 6 for BRECO Joined belts

b Belt width in cm

To calculate belt load ratings, enter the values from the tables and graphs into the above equations.

To calculate no. of teeth in mesh

$$z_e = \frac{z_1}{180} \cdot \arccos \frac{(z_2 - z_1) \cdot t}{2\pi a}$$

z_1 No. of teeth on the small pulley

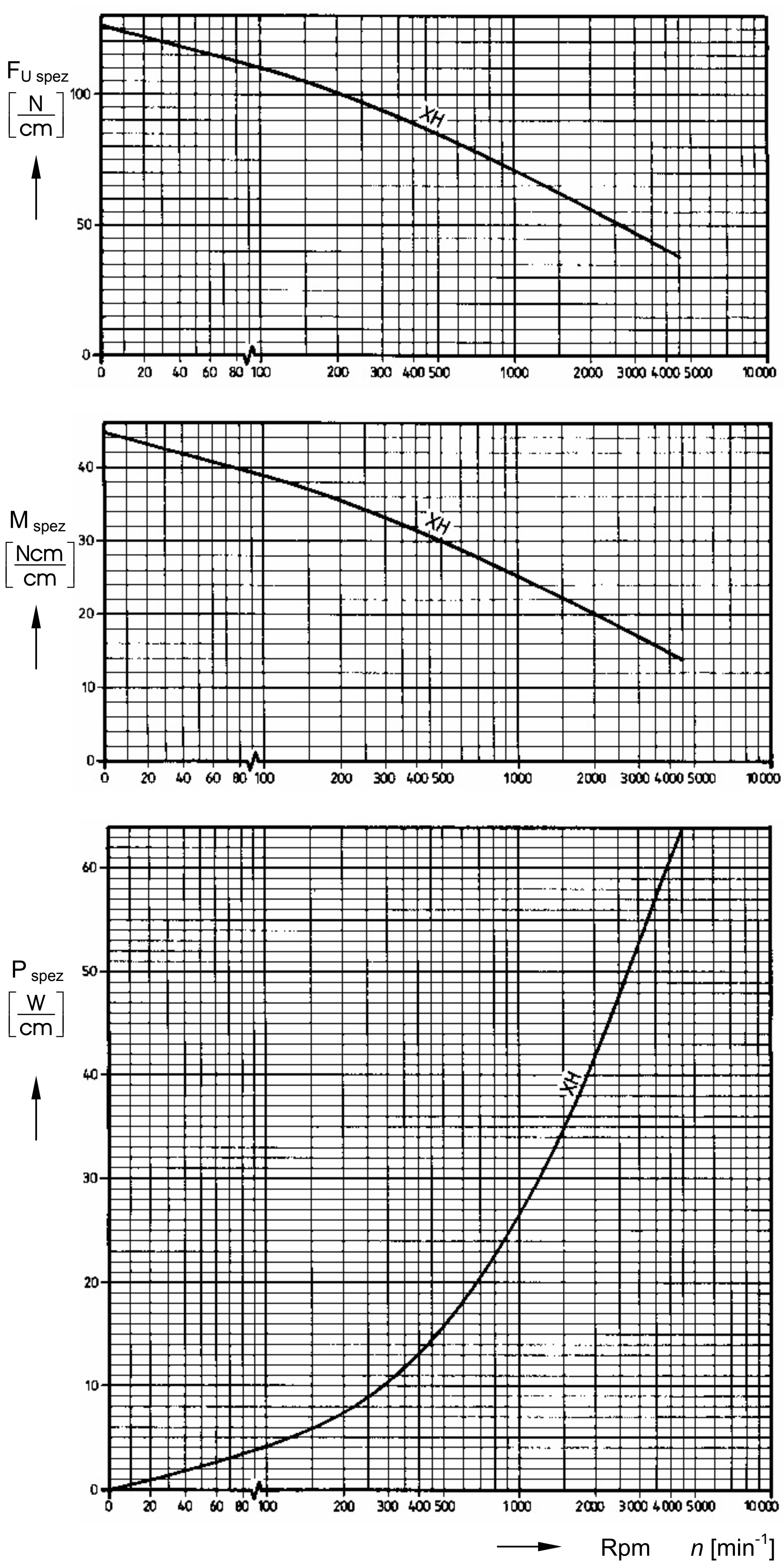
z_e No. of teeth on the large pulley

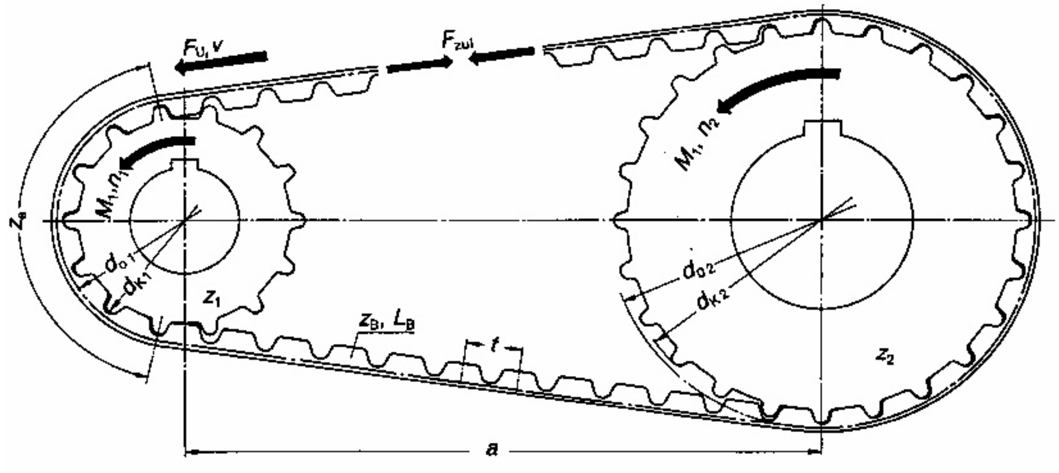
t pitch in mm

a center distance in mm

Refer also to calculation example on page 25.

Specific tooth shear strength graphs





Center distance	a	(mm)
Acceleration torque	M_B	(Nm)
Acceleration time	t_B	(s)
Bore	d	(mm)
Density	ρ	(kg/dm^3)
Torque	M	(Nm)
RPM	n	(min^{-1})
Outside diameter	d_K	(mm)
Power	P	(kW)
Moment of inertia	J	(kgm^2)
Belt length	L_B	(mm)
Ratio	i	
Allowable tensile strength of tension member	F_{zul}	(N)
Pulley width	B	(mm)
Pitch	t	(mm)
Velocity	v	(m/s)
Peripheral force	F_U	(N)
Angular velocity	ω	(s^{-1})
Pitch circle diameter	d_0	(mm)
No. of teeth when i = 1	z	
No. of teeth of small pulley	z_1	
No. of teeth of large pulley	z_2	
No. of teeth on the belt	z_B	
No. of teeth in mesh	z_e	

Belt length when i ≠ 1

$$L_B \approx \frac{t}{2}(z_2 + z_1) + 2a + \frac{1}{4a}\left[\frac{(z_2 - z_1)t}{\pi}\right]^2$$

Belt length when i = 1

$$L_B = 2a + \pi \cdot d_0 = 2a + z \cdot t$$

Peripheral Force

$$F_U = \frac{2 \cdot 10^3 \cdot M}{d_0} = \frac{19.1 \cdot 10^6 \cdot P}{n \cdot d_0} = \frac{10^3 \cdot P}{v}$$

Torque

$$M = \frac{d_0 \cdot F_U}{2 \cdot 10^3} = \frac{9.55 \cdot 10^3 \cdot P}{n} = \frac{d_0 \cdot P}{2 \cdot v}$$

Power

$$P = \frac{M \cdot n}{9.55 \cdot 10^3} = \frac{F_U \cdot d_0 \cdot n}{19.1 \cdot 10^6} = \frac{F_U \cdot v}{1000}$$

Angular velocity

$$\omega = \frac{\pi \cdot n}{30}$$

RPM

$$n = \frac{19.1 \cdot 10^3 \cdot v}{d_0}$$

Velocity

$$v = \frac{d_0 \cdot n}{19.1 \cdot 10^3}$$

Mass moment of inertia

$$J = 98.2 \cdot 10^{-15} \cdot B \cdot \rho \cdot (d_K^4 - d^4)$$

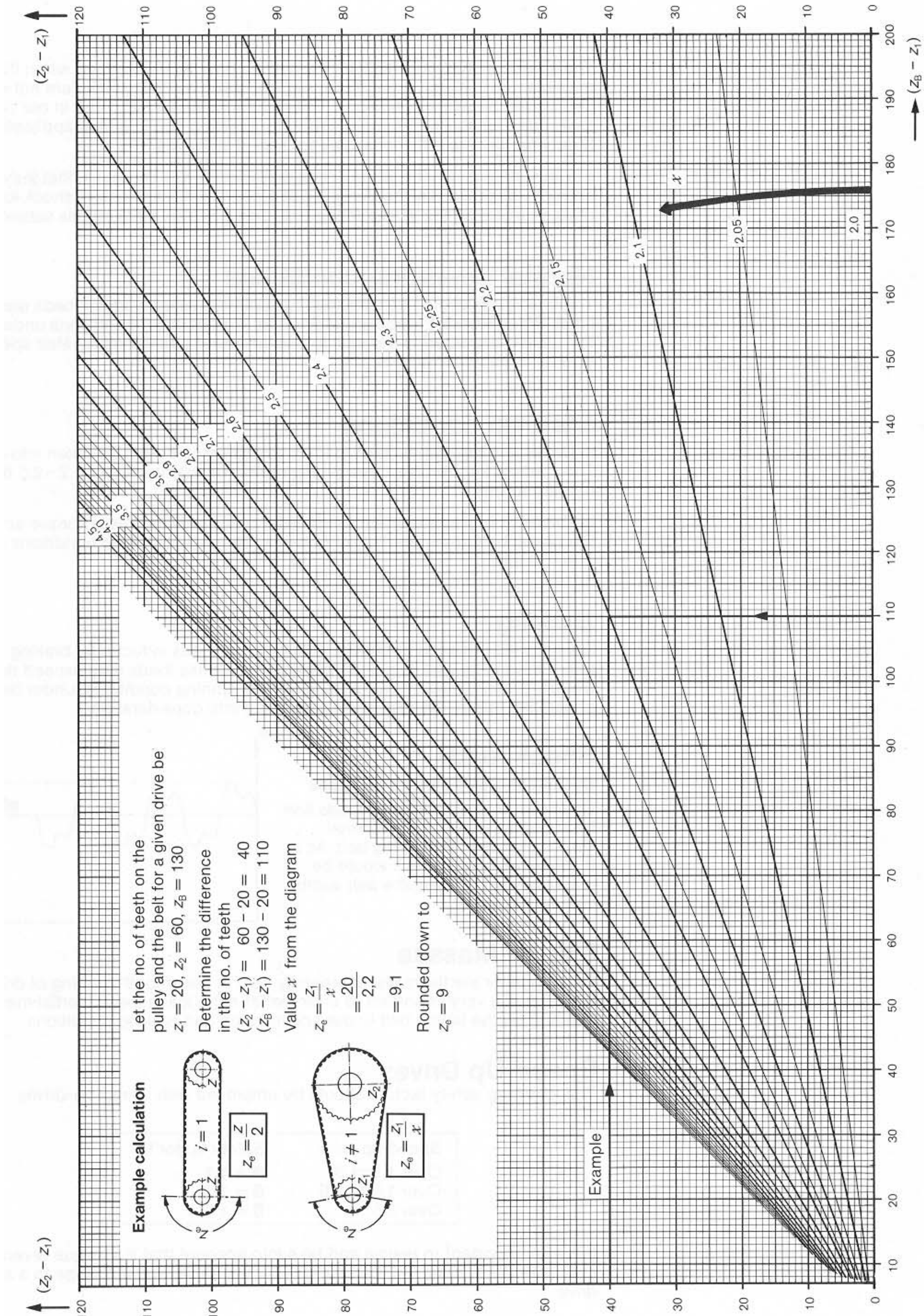
Acceleration torque

$$M_B = \frac{J \cdot \Delta n}{9.55 \cdot t_B}$$

Only the units listed above should be used in the formulae as they are the approved SI units. The unit of force, the Newton, is very important: 1N is the force required to accelerate a body with a mass of 1kg to $1 m/s^2$. ⇨ $1\ kg \cdot m/s^2$

Conversion of non-standard units:

Force	1 kp = 1 kg · $9.81 m/s^2$ = 9.81 N ≈ 1 daN
Torque	1 kpm = 9.81 kgm^2/s^2 = 9.81 Nm ≈ 1 daNm
Power	1 PS = 75 kpm/s = 0.736 kW
Centrifugal force	1 [GD^2] = 4 [J] when GD^2 in kpm^2 and J in kgm^2


Example calculation
i = 1
ze = z/2
i ≠ 1
ze = z1/x
Let the no. of teeth on the pulley and the belt for a given drive be z1 = 20, z2 = 60, zB = 130
Determine the difference in the no. of teeth
(z2 − z1) = 60 − 20 = 40
(zB − z1) = 130 − 20 = 110
Value x from the diagram
ze = z1/x = 20/2,2 = 9,1
Rounded down to ze = 9
Example
x
(z2 − z1)
(zB − z1)
2,0
2,05
2,1
2,15
2,2
2,25
2,3
2,4
2,5
2,6
2,7
2,8
2,9
3,0
3,5
4,0
4,5

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

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

Normal operating conditions

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

Start-up conditions

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

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

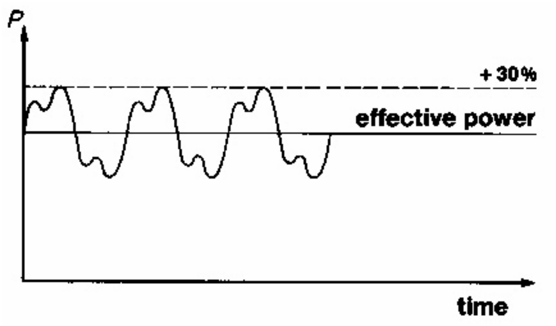
Breaking

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

Shock loads

Oscillational and vibrational loads

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



Inertial Masses

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

Speed-Up Drives

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

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

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

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

Drive data:

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

To determine the timing belt pitch and width.

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

Calculation of belt length from the formula on page 24.

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

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

Tooth Shear Strength

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

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

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

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

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

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

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

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

Tensile strength of tension members

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

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

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

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

Flexibility

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

The drive is correctly designed using a 75 mm wide belt. A maintenance-free drive can be expected.
Order reference: BRECOFLEX timing belt 75 AT10 / 1600.

Determining the Pre-tension

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

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

For two pulley drives:

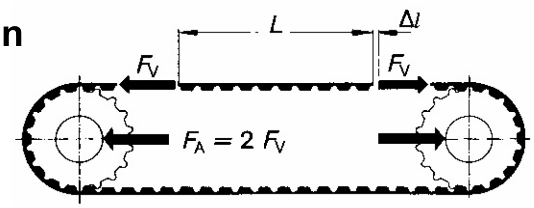
Pre-tension ≥ 0.5 · Peripheral force
$F_V \geq 0.5 \cdot F_U$

For multiple pulley and linear drives:

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

Checking the Pre-tension

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



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

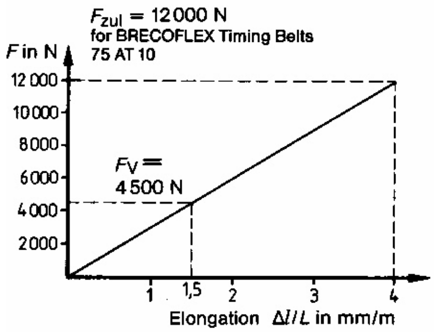
As, in accordance with Hookes' Law, the values for force versus elongation are linear over the entire load range, intermediate values can be determined in the manner illustrated below. The elongation of long belts can be measured with a rule or gauge.

Example

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

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

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



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

Notes for the designer

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

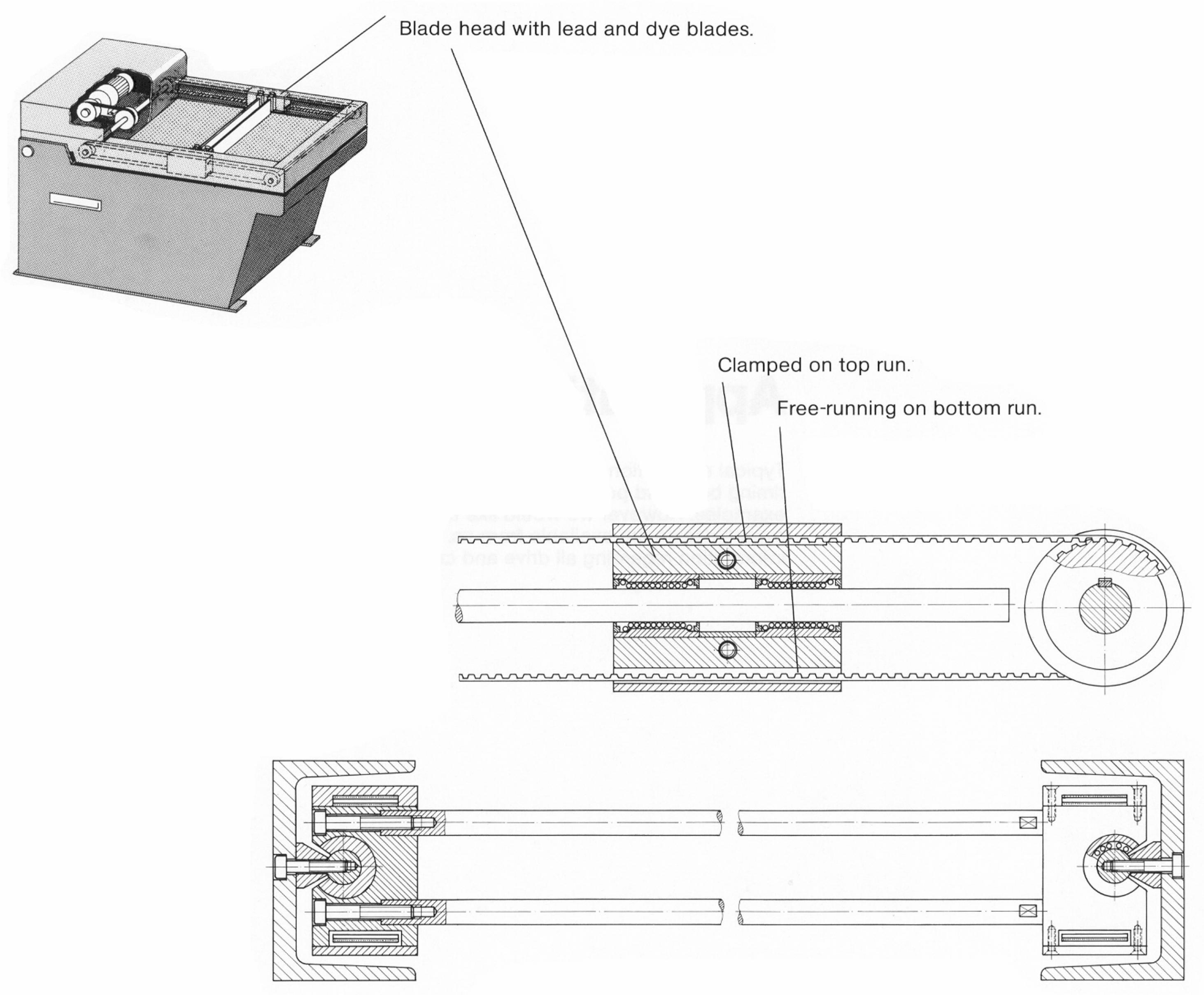
Notes for the fitter

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

Application Examples

Typical application examples are illustrated here for BRECO and BRECOFLEX timing belts and possibly you might find a solution to your drive problem in our examples. However we would like to point out that not all the details on the overall design are available from us. Please ask our technical department for information regarding all drive and conveying applications.

SCREENPRINTING MACHINE



The motion of a screen printing machine is characterized by fast forward and return strokes. Dye is spread over the screen printing surface by the leading blade and on the return stroke the dye is pressed through the screen by the dye blade. A considerable proportion of the drive power is used in accelerating and breaking the system.

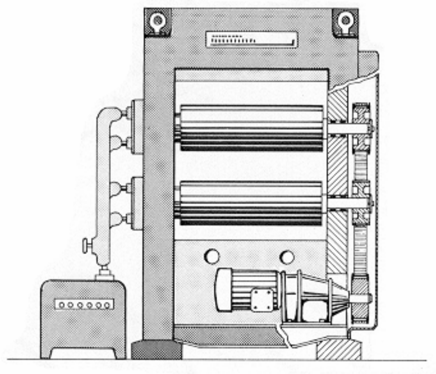
Design Characteristics:
The timing belt has a low mass. In order to move the system backwards and forwards two BRECO timing belts are used in parallel. Open length belting is employed, each belt being clamped to one side of the blade head on the top run. The bottom run of each belt freely passes through a slot on the underneath of the blade head.

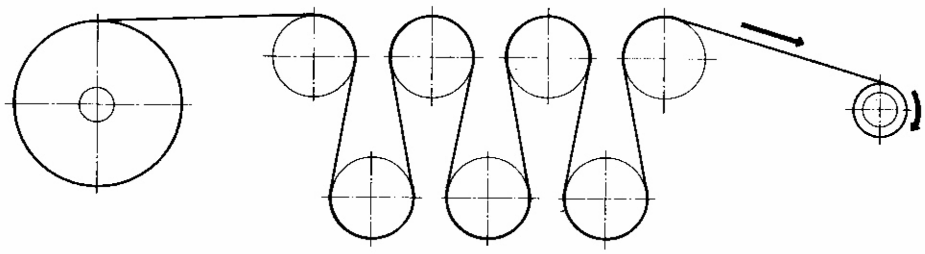
Drive data:

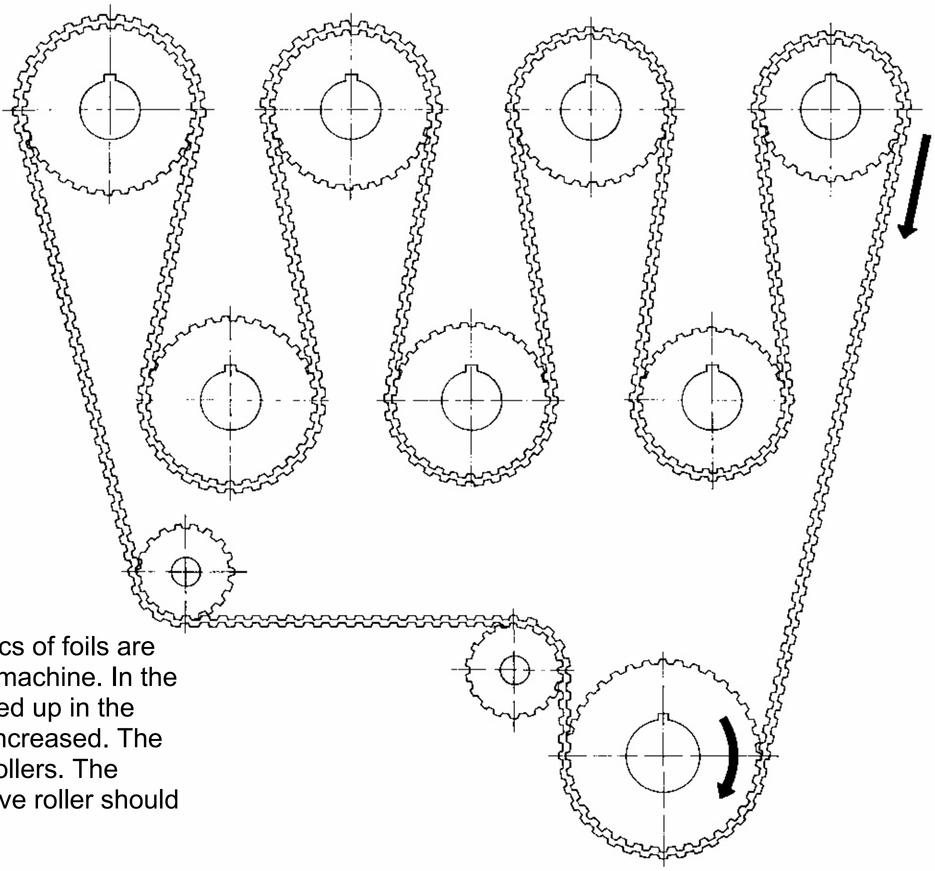
Power	P = 1.2 kW
Drive speed	n = 1000 rpm
Belt velocity	v = 3 m/s
Timing pulleys	z = 36

Choice of belting:
BRECO 25 T5 / open length timing belt. The timing belt has a mass of 0.055 kg/m. Due to the steel cord tension members there is no post elongation, therefore re-tensioning of the belting is not necessary and maintenance-free running without the need for lubrication can be expected.

Notes:
There is no length restriction on BRECO open length belting. The standard roll length is 50 meters.







The physical properties and characteristics of foils are deliberately changed in a foil converting machine. In the converting process the molecules are lined up in the direction of pull and the tear strength is increased. The converting process occurs over heated rollers. The change in speed between each successive roller should be in the region of 3 – 3.5%

Design Characteristics:
Bearing mounted pulleys should be fitted to the drive side of the rollers. Successive pulleys should differ from each other by one tooth i.e. z = 33 / 32 / 31 etc. The path of the timing belt should follow that of the foil.

Drive data:
Drive speed n = 400 rpm
Drive power P = 12 kW
Main drive pulley z = 36

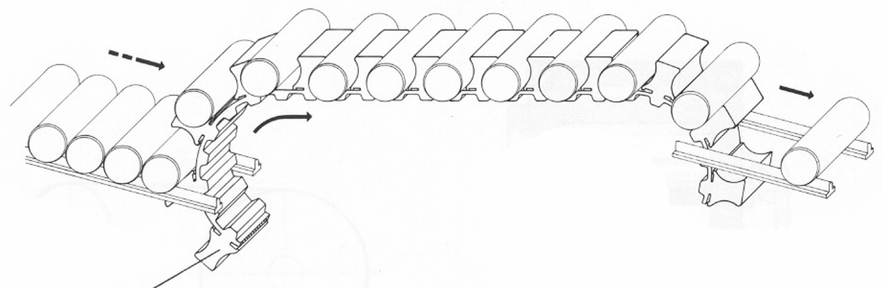
The surrounding components on the drive side are covered in an oil film due to neighboring machine components.

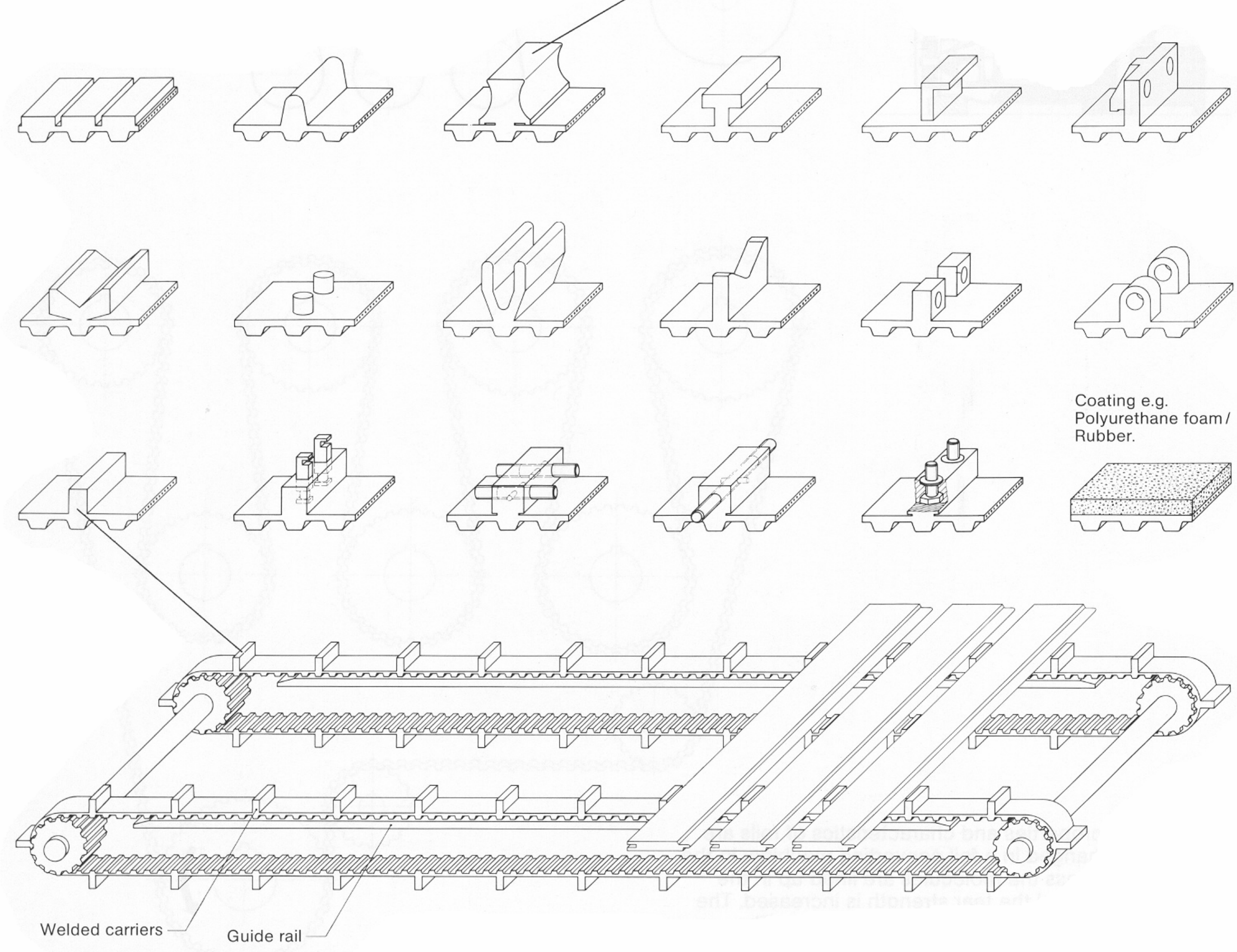
Choice of belting:
BRECOFLEX 50 T20 / 7500-DL timing belt. Both sides of the belt can carry the same loading. The belt is completely oil resistant due to the polyurethane used in its construction. The steel cord tension members ensure no post elongation, thus resulting in a maintenance-free drive.

Notes:
BRECOFLEX single and double sided timing belts are available in endless lengths up to 22 meters (longer lengths available on request).

PROFILED BELTS

The polyurethane timing belt material can be welded to and the belt back can have any design of profile at any pitch attached. The profile welding process is carried out in-house to your requirements.



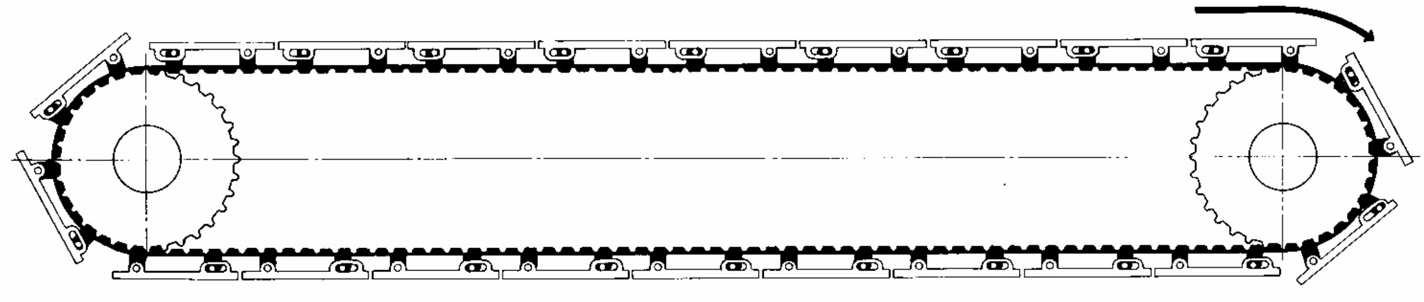


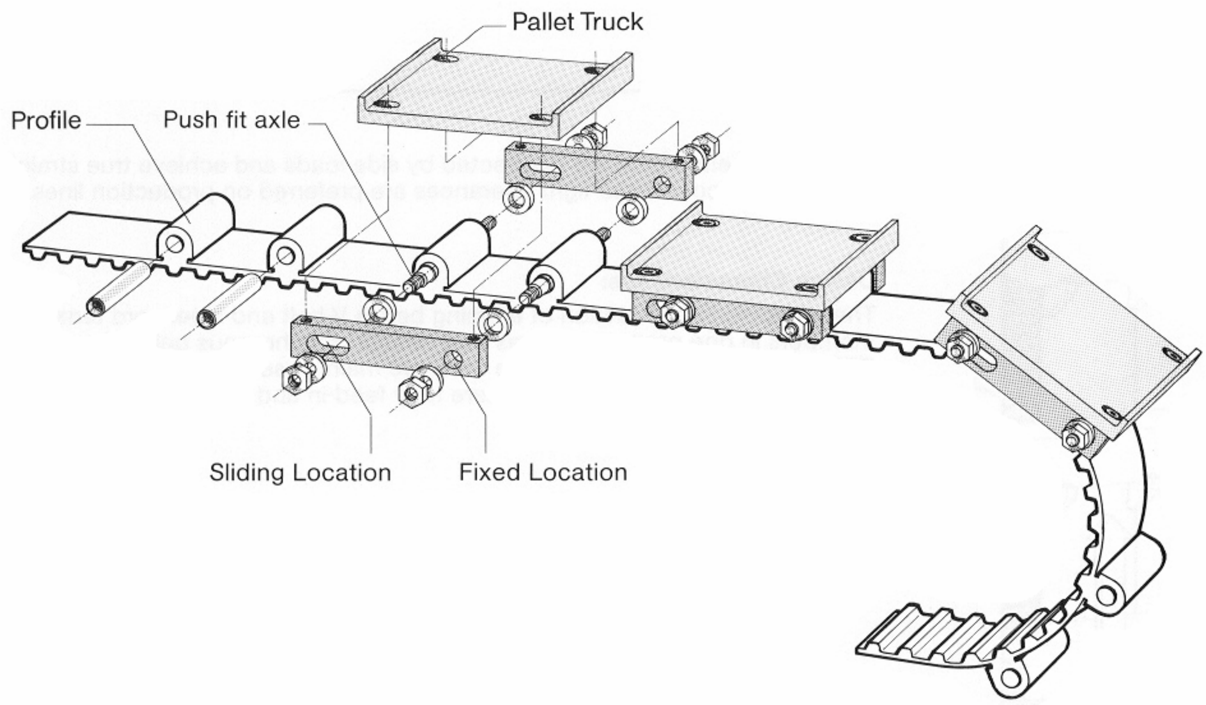
The profiled timing belt (Synchronous conveyor) can boast smooth running and positional accuracy. Long duty cycles with high repeatable accuracy are also attainable.

Design Characteristics:
The low mass of the BRECO and BRECOFLEX timing belts makes them well suited for indexing applications. The teeth can be protected by a smooth, wear resistant covering. The steel cord tension members ensure a constant pitch and positional accuracy. The positional accuracy of each profile to the required weld point is +/- 0.5 mm and it is possible to reduce this tolerance still further. It should be noted that the positioning of the profiles can affect the flexibility of the timing belt.

Choice of belting:
All timing belts in our range are suitable for indexing applications. For drives using guide rails the PAZ coating (PAZ = nylon coating on the tooth form) is recommended.

Notes:
Profiled Belt catalog available on request.





Indexing systems with pallet trucks are popular in transfer lines with circulatory conveyor systems. High positional accuracy can be achieved at all loading, working and transfer stations.

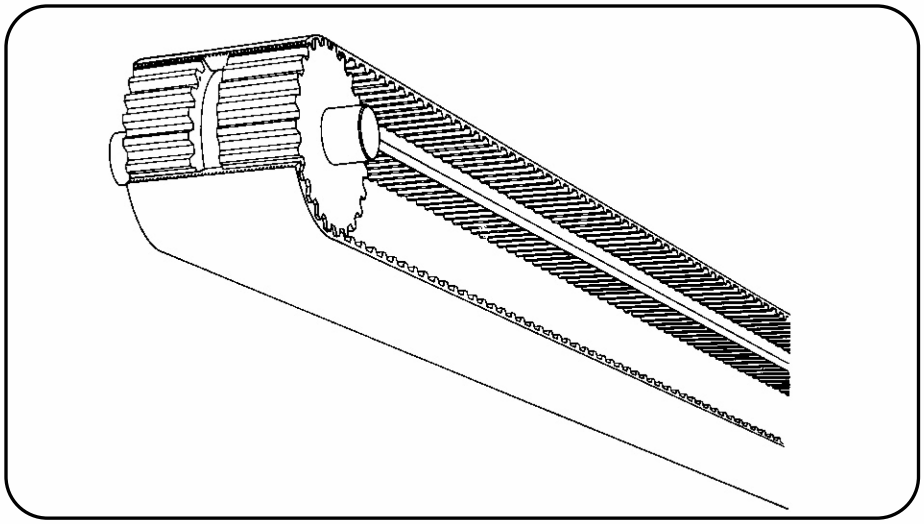
Design Characteristics:
Profiles with through holes are welded to the timing belt. The pallet trucks are mounted on axles which are a push fit into the profiles. One axle serves as the leading axle (in the fixed location), whilst the other is allowed movement within the sliding location. The conveying accuracy is set during initial operation using the elongated slots on the truck. Indexing drives using pallet trucks can be used in conjunction with either rollers or rails.

Drive data:
The system is driven by a stepper motor with the required acceleration and breaking capabilities. A repeatable accuracy of +/- 0.1 mm is possible after initial setting of the pallet trucks.

Choice of belting:
All of our range of belting can be employed. For the best results where positional accuracy is concerned, design the system around the AT5 / AT10 / AT20 BRECO/BRECOFLEX timing belts. Timing pulleys with a zero tooth form can also be used if necessary. No belt elongation is expected, even on drives with long duty cycles.

Notes:
Profile catalog available on request.

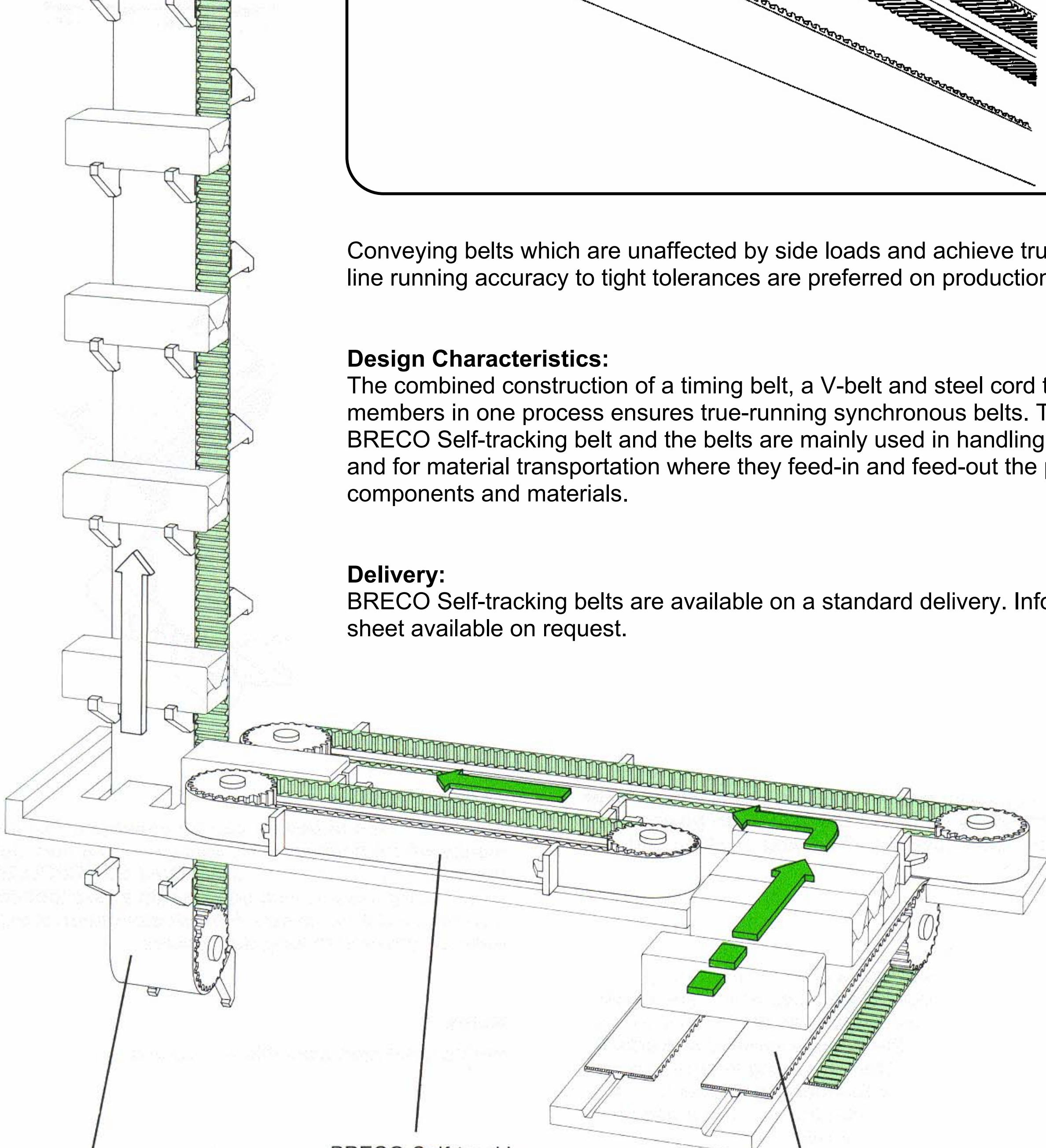
BRECO SELF TRACKING BELTS



Conveying belts which are unaffected by side loads and achieve true straight-line running accuracy to tight tolerances are preferred on production lines.

Design Characteristics:
The combined construction of a timing belt, a V-belt and steel cord tension members in one process ensures true-running synchronous belts. These are BRECO Self-tracking belt and the belts are mainly used in handling applications and for material transportation where they feed-in and feed-out the production components and materials.

Delivery:
BRECO Self-tracking belts are available on a standard delivery. Information sheet available on request.

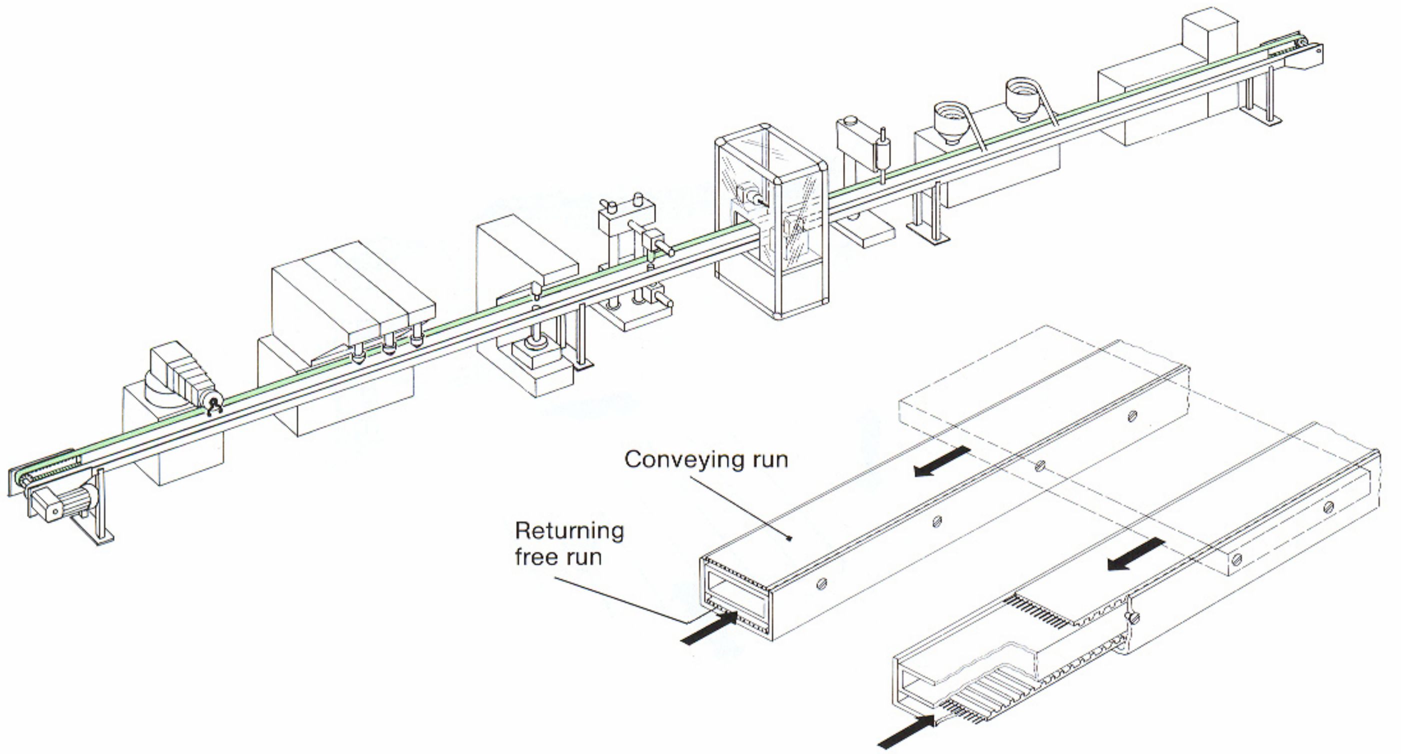


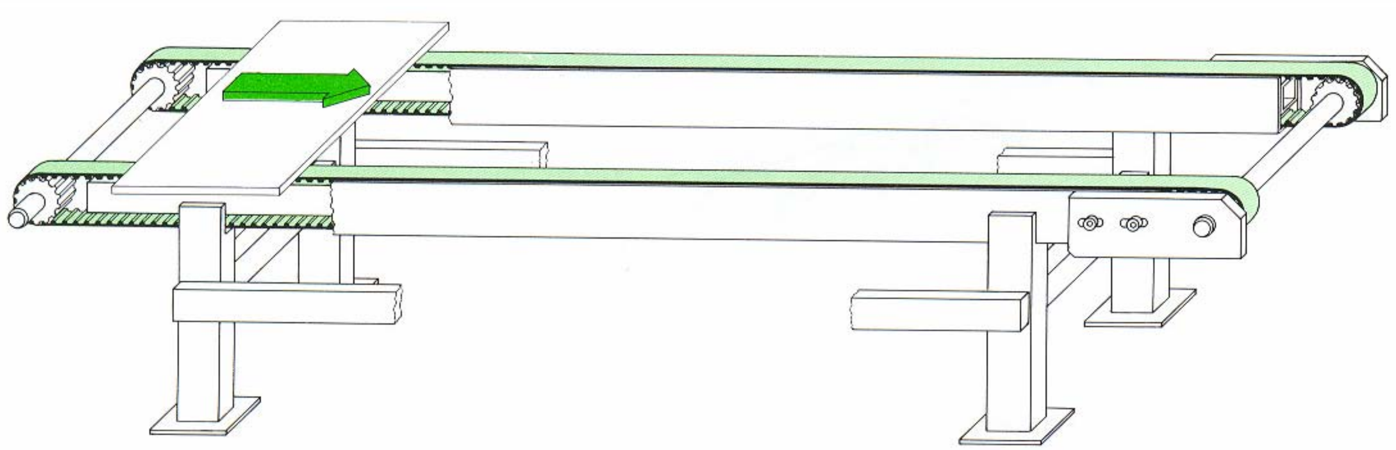
BRECO Self-tracking belt with welded profiles being used as an elevator. Its operation is synchronised with the separa-ting section.

BRECO Self-tracking belt with welded profiles being used as a transfer station. The vertical shaft axes makes secure belt tracking ne-cessary.

BRECO Self-tacking belts running in parallel as an accumulator conveyor. The conveyor belts are protected from side loads, due to product take-off at the transfer station, by the V-guides.

PALLET CONVEYOR
using parallel belts





Pallets and plates can be transported using parallel belts. It is particularly important when transporting loads over long distances to ensure that both belts are operating at the same speed. Failure to do so will result in the product slewing.

Design Characteristics:
The use of timing belts as parallel conveyors means a positive drive at the driving pulleys. Thus a constant speed relationship will occur between the two belts.

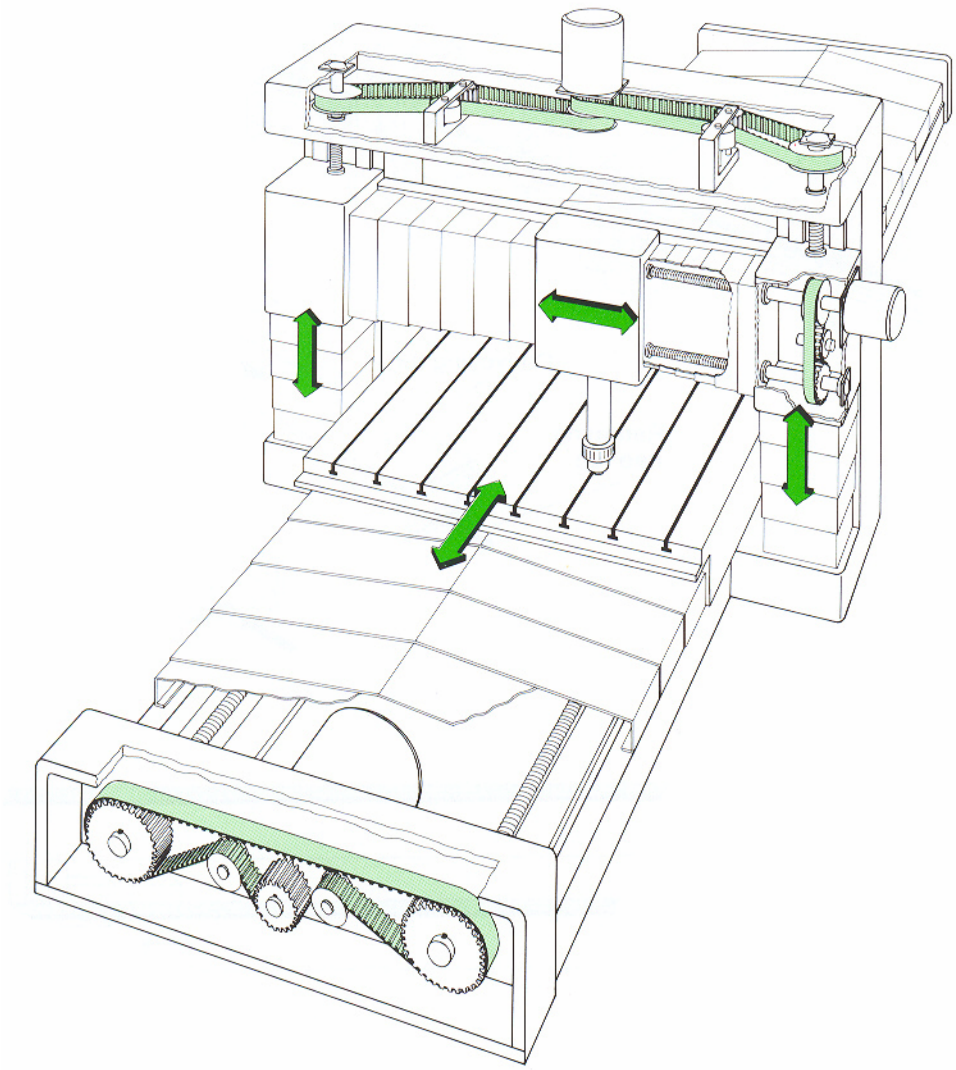
On the assembly line (top illustration) the space between the belts is used to position the various work stations.

The detailed illustration shows the possible belt path for conveying and return runs. The U and rectagonal sections (e.g. cold drawn steel) serve as both belt guides and channels to accommodate the belting on its return run.

Choice of belting:
The choice of belting depends on the material being transported, the size of the idler pulleys and the load exerted on the belts. All BRECO and BRECOFLEX timing belts are suitable for transport applications. For drives incorporating guide channels it is advisable to use belts with a PAZ coating. If a higher friction value is required for the back of the belt, then the T-coating is recommended. If accumulation occurs on the conveying system (low friction necessary on the belt back) then belts with a PAZ-PAR coating should be employed.

Notes:
There is no restriction on the length of a Joined BRECO timing belt. Standard range catalog available on request.

VERTICAL MACHINING CENTER, AXIS DRIVES



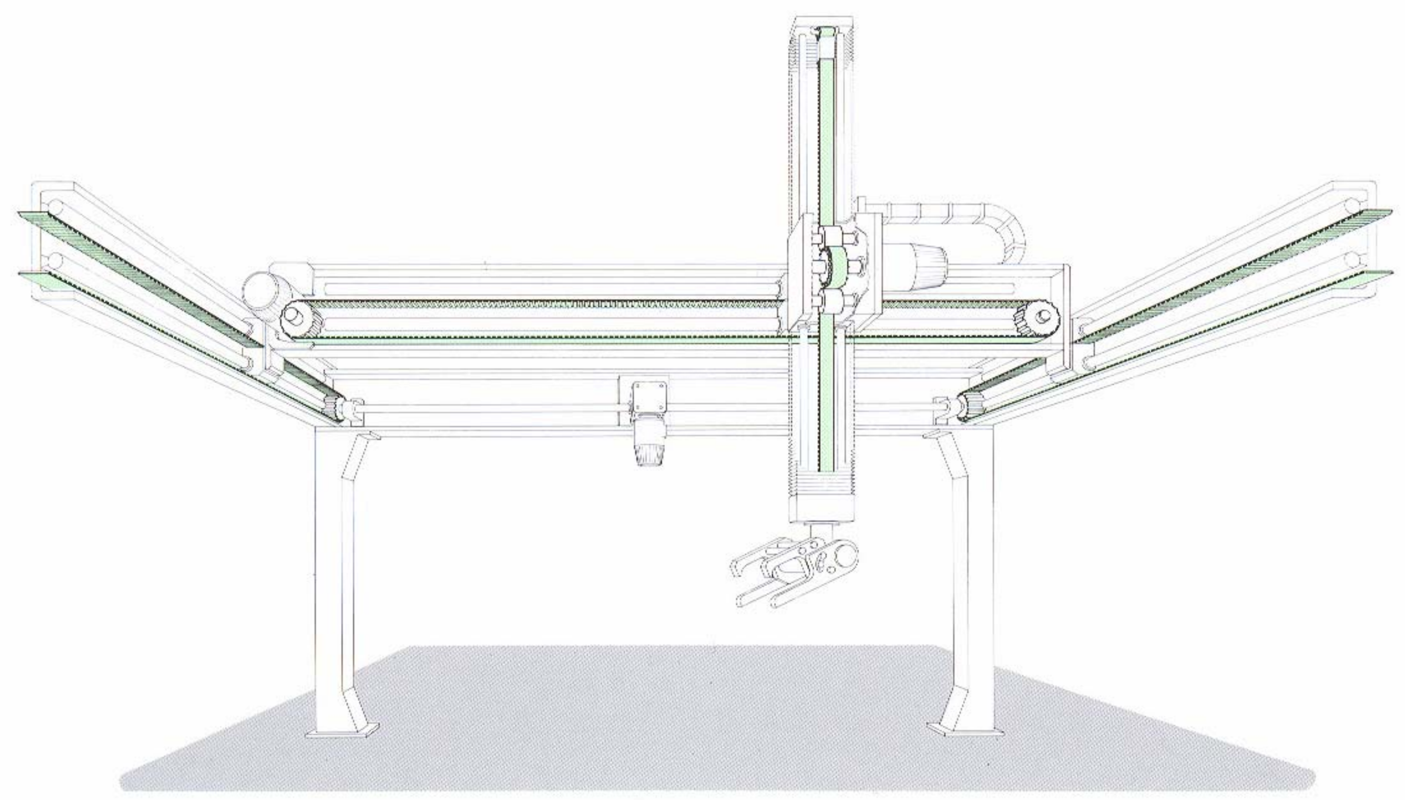
As a rule axis drives suffer frequent direction changes and the greatest loads are exerted under acceleration and breaking conditions, therefore a synchronous drive of high angular accuracy is required.

Design Characteristics:
A dimensionally stable and rigid frame contributes to a drive of high angular accuracy. Bearings and tensioning pulleys are positioned to give minimum free play. The tensioning pulleys are rigidly locked after tensioning of the belt has occurred.

If the BRECOFLEX timing belt is installed in this manner its tension will remain constant. No post elongation occurs within the steel cord tension members.

The materials in tooth engagement (steel synchronous pulleys and polyurethane timing belt teeth) give good performance in drives with frequent directional changes. By utilizing zero tooth form timing pulleys, backlash due to directional changes can be minimized.

Choice of belting:
BRECOFLEX timing belts with AT tooth form should be used in conjunction with zero tooth form timing pulleys. The choice of AT5, AT10 or AT20 belts depends on the type of machine and the maximum expected load. The elasticity of the belt can be minimized by increasing the belt width.



Linear drives are commonly used in handling systems, industrial robots, plotters and drawing machines. The timing belt translates rotational motion into linear movement. In the case of stepper motors, the angular movement of the stepper motor is translated into linear steps.

In linear applications e.g. lifting or traversing drives, moving masses must be continually accelerated and breaked. The designer should ensure that all moving components have a low mass and high rigidity. Positional accuracy and repeatability over long duty cycles should also be taken into consideration.

Design Characteristics:
The lifting and sliding movements are controlled by bushed housings which traverse guide rails. The timing belt is supplied joined or as an open length and is clamped to the moving machine component. It is important to ensure that a means of belt tensioning is incorporated in the system.

In the illustrated design of an X-Y-Z linear drive on an automatic handling machine, a repeatable accuracy in the region of +/- 0.1 mm per meter of linear travel is attainable.

Choice of belting:
All BRECO timing belts are suitable for this kind of drive: The size of belt depends on the mass being accelerated and the maximum expected forces. Maximum rigidity can be achieved by employing the BRECO AT series timing belts. Backlash due to directional changes can be minimized by utilizing zero tooth form timing pulleys.

Notes:
There is no length restriction on BRECO open length belting. The standard roll length is 50 meters. For further information consult our technical department.

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