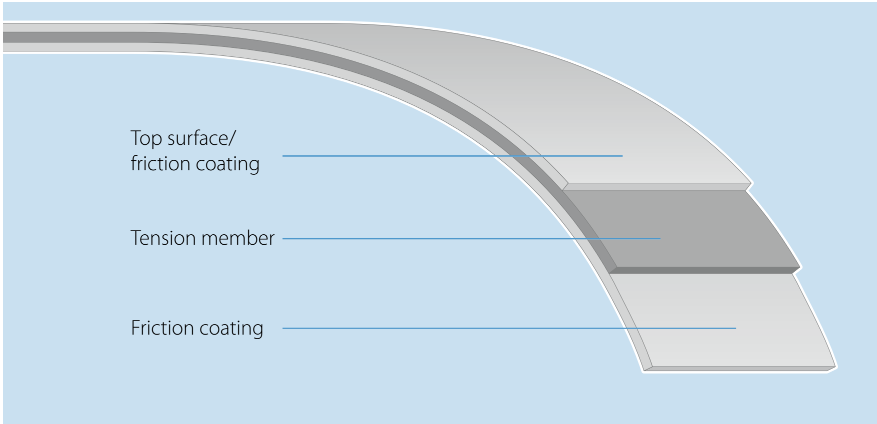
siegling extremultus
flat belts

Technical Information/ Calculation methods



This brochure includes important basic information about Siegling Extremultus and equally power transmission, tangential, folder and carrier, live roller belts, spindle and machine tapes.

With excellent damping properties, Siegling Extremultus flat belts are resilient, very efficient, exceptionally robust and durable.

This makes them the ideal power transmission element for dry and also dusty operating conditions in all sectors of industry.

Energy consumption is low, they treat machinery gently and cut costs.

Lines

There are 5 Siegling Extremultus lines with different tension members.

P line

– with a tension member of highly-orientated polyamide sheet or a tension member of polyamide fabric.

E line

– with a thermoplastic polyester fabric tension member with a high modulus of elasticity.

A line

– with a thermoplastic aramide fabric tension member with a high modulus of elasticity.

Elastic line

– with elastic tension member

Endless line

– with a tension member of truly endless polyester cord

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Types

In each line, distinctions are made between various types according to their coating materials.

Materials

G	=	G elastomer
L	=	Chrome leather
N	=	Novo (polyester web)
T	=	Polyamide fabric
U	=	Urethane
P	=	Polyamide

Examples of sub-types

GT	=	G elastomer friction coating/fabric top surface
GG	=	G elastomer friction coating on both faces
LT	=	Chrome leather friction covering/fabric top surface
LL	=	Chrome leather friction covering on both faces
TU	=	Urethane friction coating/ fabric top surface
UU	=	Urethane friction coating on both faces
UN	=	NOVO (polyester nonwoven) top face/ urethane friction coating

Properties

Siegling Extremultus is antistatic, meeting standard international and many national regulations on the prevention of electrostatic build-up in explosion-proof areas.

European and any relevant national regulations on explosion protection must be observed: RL 94/4 EC (ATEX), BGR 132 by the Accident Prevention and Insurance Association for the German Chemicals Industry "Directives for avoiding ignition risks due to electrostatic build-up".

Siegling Extremultus sub-types GT, GG, TG, TU, TT, UU, UN, NN, UG, PU, PP are impervious to oils and greases as well as most commercially available solvents. To ensure however that Siegling Extremultus functions perfectly, it must be kept free of oil and grease.

Siegling Extremultus sub-types LL, LT, TT are impervious to machine oil, diesel fuel, petrol, benzene, commercially available solvents such as ethyl acetate, acetone, etc., chlorinated hydrocarbons such as perchloro-ethylene, etc.

Sub-types with leather coverings on one or both sides can be used where oil and grease are a factor.

Siegling Extremultus is not impervious to organic or inorganic acids.

Detailed information about the chemical resistance is available on request.

Permissible operating temperatures:

P line	(all types)	–20/+80 °C
E line	(power transmission and machine tapes)	–20/+70 °C
A line	(all types)	–20/+70 °C
Elastic line	(elastic machine tapes)	–20/+50 °C
Endless line	(truly endless types)	–40/+60 °C

Effect of moisture on PA sheet tension members
The E modulus in polyamide can change in moist conditions or on contact with water. If you are using this tension member in extreme ambient conditions, we recommend you contact Forbo Siegling application engineers.

Storage

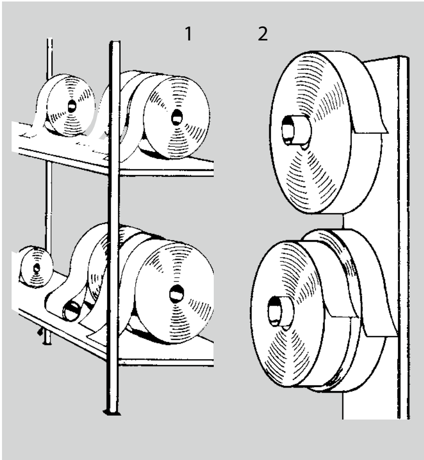
Store Siegling Extremultus in a cool but not too dry ambience, ideally at a standard environment of 20 °C/50 % humidity.

When rolled up, do not place material upright on its edge, but hang it with a cardboard core over a pipe or something similar (fig. 1 and 2).

The material – especially the P line – can deform slightly if exposed to humidity or heat from one side. But this deformation will disappear once elongated by 0.2 to 0.4 % so that perfect running is guaranteed.

Tangential belts of the P line are dispatched from our works packaged in special air-tight bags. Do not open these bags until the belts are to be fitted.

Do not subject Siegling Extremultus with G elastomer coating to direct sunlight if at all possible (might discolour).



Tolerances

Production tolerances (lengths)

E/A and elastic line

300	–	5000 mm	± 0.30 %
5000	–	15000 mm	± 0.20 %
over		15000 mm	± 0.15 %

P line

300	–	5000 mm	± 0.50 %
5000	–	15000 mm	± 0.30 %
over		15000 mm	± 0.20 %

Endless line (truly endless types)

500	–	1000 mm	± 0.50 %
1000	–	5000 mm	± 0.40 %
over		5000 mm	± 0.30 %

Production tolerances (widths)

E/A and elastic line

10	–	120 mm	+ 0.2/– 0.3 mm
120	–	500 mm	± 1.5 mm
500	–	1000 mm	± 5.0 mm

P line

10	–	50 mm	– 1.0 mm
50	–	120 mm	± 2.0 mm
120	–	500 mm	± 3.0 mm
500	–	1000 mm	± 10.0 mm

Endless line (truly endless types)

20	–	50 mm	± 1.0 mm
50	–	100 mm	± 1.5 mm
100	–	250 mm	± 2.0 mm
over		250 mm	± 3.0 mm

Production tolerances (punching)

P/E/A and elastic lines

Diameter of hole	± 0.5 mm
Spacing between holes	± 1.0 mm

The manufacturing tolerances listed depend on manufacturing processes. They do not include any changes in width or length that could occur after manufacture due to fluctuations in ambient conditions or other external influences.

Our Forbo Siegling service team will come and fit belts on request.

Standard sizes

Lengths and widths available for belts finished endless
(special sizes available on request)

Length min. (max.) [mm]	Width max. [mm]	Splice angle[°]	Types	Thickness max. [mm]
E line (machine tapes) and elastic line (Z-splice 35 x 5.75 and butt splice)				
320	300		all	
1090	500		all	
E line (power transmission and tangential belts, folder and carrier belts) and A line (Z-splice 70 x 11.5 und Z-splice 110 x 11.5)				
1090	500		all	
P line (wedge splice)				
750	135	60/90	to type 40	4.5
1280	220	60/90	to type 40	4.5
1380	300	60/90	to type 40	5.0
1450	500	60	all	7.5
2000	750	60	on request	7.5
3000	1000	60	on request	7.5
Endless line				
500 (13800)	450		all with GT and GG coating	
700 (10600)	250		all with UU coating	

Availibility

Endless
All lines can be supplied as finished endless belts ready to be fitted.

Open
The P, E and A lines as well as the elastic types are available open as roll material:

	width	max. length
up to	750 mm	150 m
up to	1000 mm	75 m

Prepared
For on-site fittings, the P, E and A lines as well as the elastic types are available prepared:

- cut at 90° or 60° angle
- one end prepared for splicing
- both ends prepared for splicing

On request, our local Forbo Siegling service team will do the fitting.

Technical information

Splicing/equipment selection

Except for the endless line (truly endless types) all construction types can be shortened, lengthened and repaired.

P line with wedge splice E line with Z-splice
- power transmission, folder and carrier belts with 70 x 11.5 mm pitch and 110 x 11.5 mm pitch
- machine tapes with 35 x 5.75 mm pitch

A line with Z-splice
- power transmission and tangential belts with 110 x 11.5 mm pitch

Elastic line
- machine tapes with Z-splice 35 x 5.75 mm pitch or butt splice.

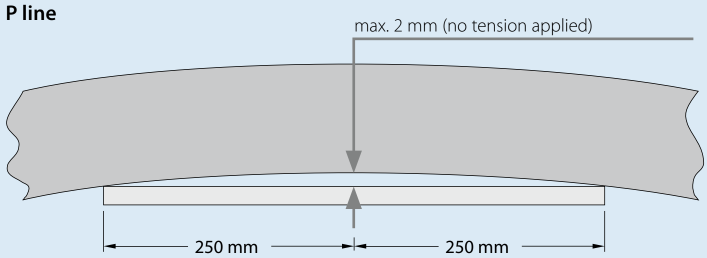
Soiled belt ends must be cleaned with naphta or white spirits before being spliced.

Bulk users may wish to purchase roll material to be spliced on-site.

Detailed information about the finishing equipment and accessories and splicing instructions are available on request.

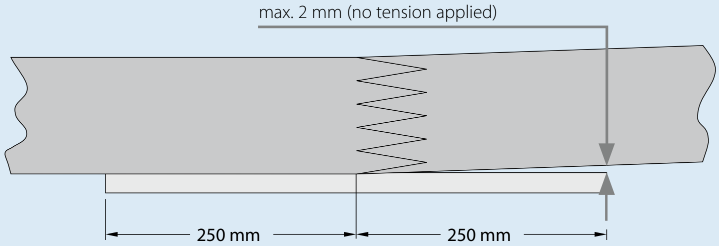
Manufacturing tolerances · Curvature

P line



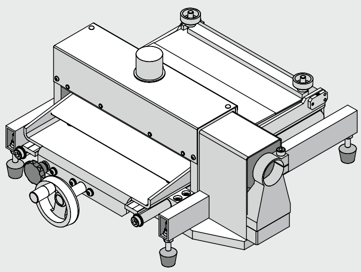
Manufacturing tolerances · Splice

P, E and A lines

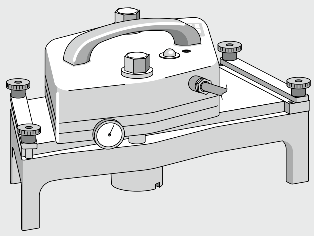


Splicing equipment

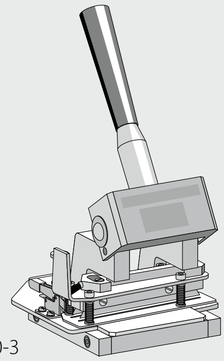
Belt width up to	20 mm	40 mm	60 mm	80 mm	150 mm
Z-punch cutter (Z-splice)					
	–	PP-ZP-V/40-3	PP-ZP-V/80-3	PP-ZP-V/80-3	PP-ZP-V/150-6
Grinder (wedge splice)					
	PG-GM-V/130	PG-GM-V/130	PG-GM-V/230-T	PG-GM-V/230-T	PG-GM-V/230-T
Splice heating device for A line					
– power transmission and tangential belts, belts for live roller conveyors	SMX-HC-140/40	SM-HP-140/40	SM-HP-120/130	SM-HP-150/100	SM-HP-120/150
Splice heating device for E line					
– spindle tapes	SM-HC-50/40	SM-HC-50/60	–	–	–
– layboy tapes	SM-HC-50/60	SM-HC-50/60	SM-HC-50/80	SM-HC-50/80	–
– power transmission belts	SMX-HC-140/40	SMX-HC-140/40	SM-HP-120/130	SM-HP-150/100	SM-HP-120/150
– tangential belts	SMX-HC-140/40	SMX-HC-140/40	SM-HP-120/130	–	–
– belts for live roller conveyors	SMX-HC-140/40	SMX-HC-140/40	SM-HP-120/130	–	–
– folder and carrier belts	SMX-HC-140/40	SMX-HC-140/40	SM-HP-120/130	SM-HP-150/100	SM-HP-120/150
Splice heating device for P line					
– spindle tapes	SM-HC-50/40	SM-HC-50/60	–	–	–
– layboy tapes	SM-HC-50/60	SM-HC-50/60	SM-HC-50/80 (SB-HP-160/100)	SM-HC-50/80 (SB-HP-160/150)	SM-HP-120/150
– power transmission and tangential belts, belts for live roller conveyors, folder and carrier belts	SB-HP-120/50	SB-HP-120/50	SB-HP-160/100	SB-HP-160/100	SB-HP-160/150



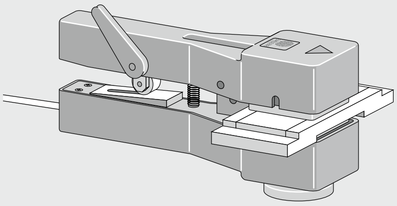
PG-GM-V/230-T



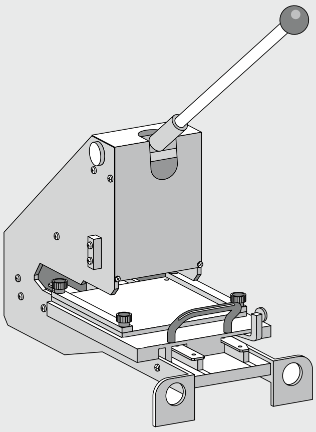
SB-HP-160/150



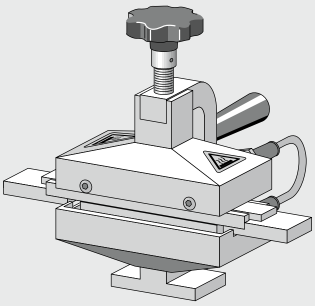
PP-ZP-V/40-3



SM-HC-50/40



PP-ZP-V/150-6

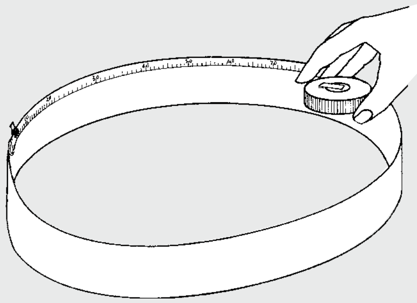


SM-HPS-140/40

Measurement

When ordering belts spliced endless, the length is measured inside, i.e. on the friction coating.

Place the belt on its edge, affix a steel tape firmly on its inside (1) or measure directly over the pulleys (2).



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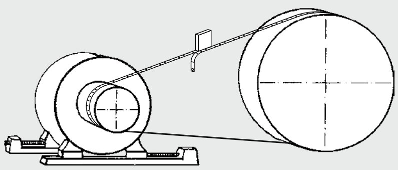
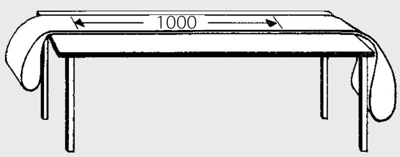


2

MOVEMENT SYSTEMS

Technical information

Elongating (tensioning) the belt



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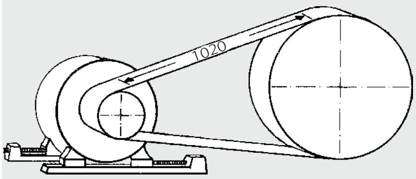

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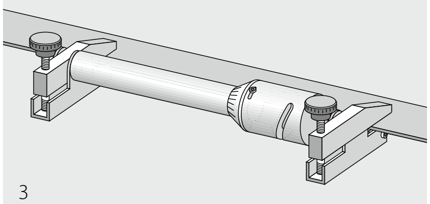


3

4 Elongation gauge

To be able to transmit a given torque without slip, belts must be elongated (tensioned) sufficiently. The required elongation value is calculated according to the type selected and the belt width and is specified in percent.

Elongating new belts
With the belt placed flat, draw two thin lines (1) on the top side.

After the belt has been mounted on the drive, elongate it by increasing the pulley centre distance (2) until the space between the measuring marks reaches the calculated value. Check the elongation by turning the drive several times and then checking the distance between the measuring marks.

Example: Distance between measuring marks for a required 2 % belt elongation.

not elongated	elongated
1000 mm	1020 mm
500 mm	510 mm
250 mm	255 mm

To measure the elongation at fitting simply, use an elongation measuring device from Forbo Siegling (3).

The calculation produces the elongation figures. Guideline figures can only be taken from the table below for applications not used for power transmission.

If requested, the elongation figure can be stated if A and E line power transmission and tangential belts are supplied. To make using them easier, reference measurement marks can already be applied to these types. After tensioning, elongation can be checked, after several turns with the elongation gauge (4) supplied.

Elongating used belts
When a used Siegling Extremultus flat belt is removed, the same elongation as before must be selected if the belt is re-applied.

We recommend marking the position of the motor on the plinth, or applying measurement markings to the belt before slackening it and taking it off.

When you put the belt back on again, you must restore the original settings to the motor and original measurement markings.

Recommended values for elongation (%)

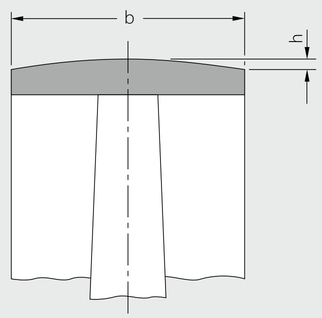
Line	Function	Uniform loads	Intermittent loads	Severe intermittent loads
Elastic Line	Machine tape	3.0 – 8.0		
P, E, and A Line	Folder and carrier belt Machine tape Belt for live roller conveyor	Tension just enough to ensure they function properly		

Flat belt pulleys (design)

Using flat belt pulleys in line with DIN 111 or ISO/R 100 ensures belt durability, enhanced efficiency and belt tracking, as well as low shaft loads.

The crown height values recommended by ISO and DIN are not absolutely identical.
According to these standards, the crown should have a finish $R_z \leq 25 \triangleq R_a$ 6.3 (as per DIN EN ISO 4288).

Solid and plate pulleys can be used for speeds up to V_{max} = 40 m/s. Special pulleys must be used for higher speeds (e.g. steel, counter-balanced).



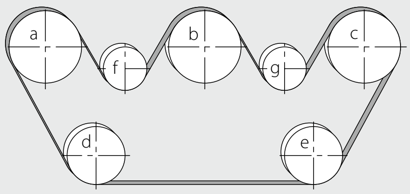
For pulley diameters > 2000 mm, we recommend contacting Forbo Siegling applications engineers about the crown height.

Crown height h [mm] as per DIN 111

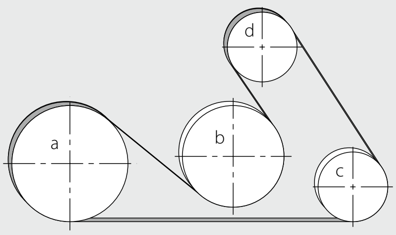
Belt pulley diameter [mm]			Belt pulley width b [mm] < 250 h	> 250 h
40	to	112	0.3	0.3
125	and	140	0.4	0.4
160	and	180	0.5	0.5
200	and	224	0.6	0.6
250	and	355	0.8	0.8
400	to	500	1.0	1.0
560	to	710	1.2	1.2
800	to	1000	1.2	1.5
1120	to	1400	1.5	2.0
1600	to	2000	1.8	2.5

For drives with horizontal shafts with ratios of more than 1:3, the smaller pulley can be cylindrical.

For drives with vertical shafts both pulleys should be crowned in accordance with DIN or ISO regardless of the transmission ratio.



1



2

In multi-pulley drives, only the pulleys that bend the belts in the same direction should be crowned (these are usually the pulleys located inside). It is usually sufficient just to crown the largest pulley to ensure reliable belt tracking.

In example 1, we recommend to crown pulleys a, b, c, d and e. With shorter belts, however, it is sufficient to crown only pulleys a and c.

In example 2, we recommend to crown pulleys a, c and d. With shorter belts, however, only pulley a would normally be crowned.

MOVEMENT SYSTEMS

Technical information

Maintenance

GT, GG, TT, TG, TU, UU, NN, UG, PU and PP belts are maintenance-free.

G elastomer, urethane and fabric surfaces must be kept free of grease and oil to ensure they function properly.

Please note: Belt cleaning agents must not be used.

The chrome leather friction layer on the LT and LL types will lose its special properties if not cared for regularly (or if care is overdone). Therefore, it should be checked every 2 to 3 weeks.

The leather surface should be soft, greasy and matt. If the film of grease has noticeably worn down since last checked, apply Siegling Extremultus spray paste. Please note: never use other spray pastes.

Should the leather already have a hard, shiny and dry surface or be very soiled, roughen it up beforehand with a soft wire brush.

While carrying out this maintenance, clean the pulleys too.

Should there be a noticeable change in the appearance of the belt, or unusual noises develop, we recommend you contact Forbo Siegling immediately.

Aligning and fitting

Aligning of pulleys and shafts
Make certain that pulley faces are clean of anti-corrosion agents, dirt and oil.

Before fitting Siegling Extremultus check parallelism of shafts and align pulleys, adjusting in accordance with manufacturer's instructions as needed.

Fitting
Note: Never wind Siegling Extremultus belts over pulley edges or use accessories which cause edge damage and result in creasing or tearing of the belt.

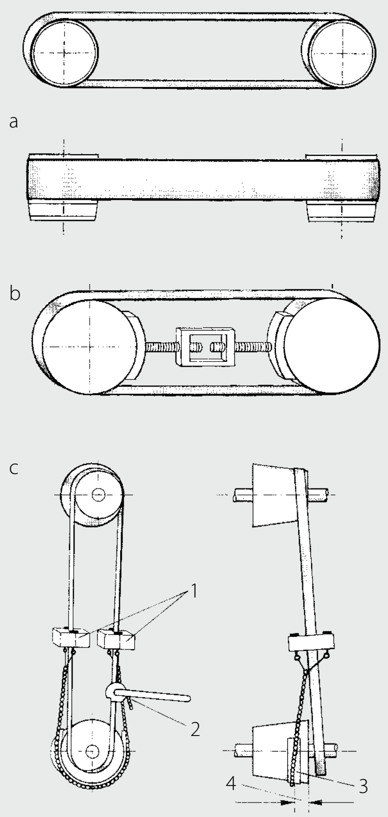
Types from the A line are particularly susceptible to this kind of damage (due to their aramide tension members).

– variable centre distances
When fitting the belt, follow the instructions specified by the machine manufacturer.

In most cases the centre distance can be decreased sufficiently to fit the belt by adjusting one pulley.

– fixed centre distances
For drives with fixed centre distances, the belt length must be selected such that the necessary elongation has been achieved after fitting.

In such cases, use either mounting cones (a), screw jack (b) or chain hoist (c – only for the P line).



c:
1 Clamps
2 Chain hoist
3 Protective layer (piece of belt)
4 Belt width (approx.)

Calculation methods

This brochure contains up to date formulae, figures and recommendations, based on our longstanding experience. They concern power transmission between friction layers elastomer G, or chrome leather and steel/cast iron pulleys. The results of the calculations can however vary from those offered by our calculation program B_Rex (download free at www.forbo-siegling.com).

These variations are due to the very different approaches: While B_Rex is based on empirical measurements and requires a detailed description of the machinery, the calculation methods shown here are based on general, simple physical formulae and derivations, supplemented by certain safety factors (C_2).

In the majority of cases, the safety factor in calculations in this brochure will be greater than in the corresponding B_Rex calculation.

Power transmission belts from the elastic line are not primarily intended for transmitting power and the relevant data cannot be calculated using these formulae.

Power transmission on flat belts

For force-fit transmission of a given torque, the high-efficiency flat belt must apply appropriate contact pressure to the belt pulleys which is generated by pre-tension force F_W.

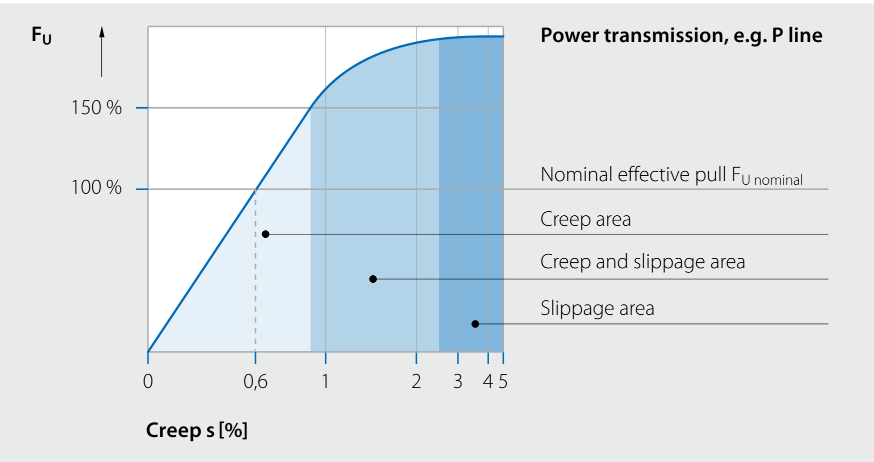
The difference in tension between the F_1 and F_2 strand forces is compensated for on the pulleys by creep. The creep and effective pull diagram below shows this clearly.

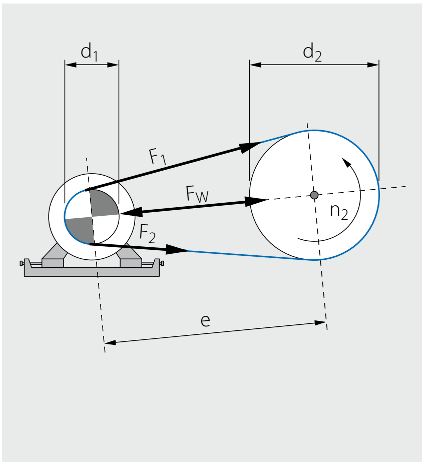
The nominal effective pull F_u for a shaft load of $F_W = 2 \cdot F_u$ can be transmitted without slippage.

The portion of the creep curve for (100 %) nominal effective pull F_u is linear and creep is free of any slip. If > 150 % of the nominal effective pull is applied to this belt, the slip threshold is exceeded, the belt will slip and possibly slide off the pulleys.

When transmitting the nominal effective pull, the Siegling Extremultus creep values are between 0.3 % (A line) and 0.6 % (P line).

More detailed background material on the theory of flat belt gear dimensioning is available on request.





Calculation methods

Terminology

Designation	Abbreviation	Unit
Width of pulley ring	b	mm
Belt width	b_0	mm
Spring constant of the belt	c_R	N/m
Running-in ratio = $\frac{F_{w\,initial}}{F_{ws}}$	$c_{initial}$	
Operating factor	C_2	
Basic elongation at fitting	C_4	
Elongation supplement for centrifugal force	C_5	
Diameter of the driving pulley	d_1	mm
Diameter of the driven pulley	d_2	mm
Diameter of the smallest pulley	d_{small}	mm
Shaft distance, distance between shaft centres	e	mm
Force	F	N
Effective pull to be transmitted	F_U	N
Nominal effective pull = type	$F_U'{}_{nominal}$	N
Transmittable specific effective pull per mm belt width	F_U'	N/mm
Reference force for sizing the belt	F_B	N
Instantaneous value of the shaft load when tensioning the belt	$F_{W\,initial}$	N
Static shaft load in a relaxed state	F_{Ws}	N
Dynamic shaft load in a relaxed state	F_{Wd}	N
Bending frequency	f_B	1/s
Crown height	h	mm
Transmission ratio $(i = \frac{n_1}{n_2}$ or $\frac{d_2}{d_1})$	i	
Mass moment of inertia	J	Nms^2 or kgm^2
Geometrical belt length – calculated or measured –	l	mm
Freely vibrating belt length (for vibration calculation)	l_s	mm
Torque	M	Nm
Weight per metre of the belt	m'_R	kg/m
Tensile force tight side of the belt	F_1	N
Tensile force slack side of the belt	F_2	N
Belt pulley revolutions d_1	n_1	1/min
Belt pulley revolutions d_2	n_2	1/min
Power to be transmitted	P	kW
Belt speed	v	m/s
Number of pulleys belt winds around	z	
Arc of contact of small pulley	β	°
Elongation at fitting required for power transmission	ε	%

Operating factor (Overloads/punctual loads)

Type of drive	Examples of drives	Operation factor C_2
Consistent operation Small masses to be accelerated Load-free acceleration	Generators with low capacity Centrifugal pumps Automatic lathes Lightweight textile machinery	1.0
Almost consistent operation Medium-sized masses to be accelerated Usually load-free acceleration	Small fans up to 8 kW Tool machines Rotary piston compressor Wood processing machinery Light and medium-weight Generators Grain mills Multi-stage gearbox Carding machines Extruders Stone frame saws Screw-type compressors	1.2
Irregular operation Medium-sized masses to be accelerated Sudden force	Piston pumps, compressors Degree of uniformity > 1:80 Centrifuges Large pressure pumps Fans Kneading machines Beaters Crushing mills Pebble mills Tube mills Looms Wood frame saws Agitators Cutting machines wood industry Vehicle body presses Conical belts paper industry	1.35
Irregular operation Large-sized masses to be accelerated Substantial sudden force Acceleration under load	Piston pumps, compressors Degree of uniformity > 1:80 Jolters Excavator drives Edge runners Rolling machines Brick presses Forging presses Sheers Punch presses Roller mills Stone crushers Flakers	1.7

Depending on drive's torque, the following minimum parameters during operation must be kept to:

Drive	Minimum value C_2
Speed-controlled electric motors (e.g. frequency converters)	1.0
Electrical motors with Y-delta connection Electrical motors with mechanical, or hydrodynamic clutch Pole-changing electrical motors Combustion engines Water turbines	1.3
Electrical motors, directly switched on without centrifugal clutch	1.7

MOVEMENT SYSTEMS

Calculation methods

Calculation method

Known are: P [kW], d_1 [mm], n_1 [1/min], d_2 [mm] and e [mm]

1 Arc of contact β on the small pulley

$\beta \approx 180 - \frac{60\,(d_2 - d_1)}{e}$ [°] or from $\cos \frac{\beta}{2} = \frac{d_2 - d_1}{2e}$

If $d_1 > d_2$ insert $(d_1 - d_2)$

2 Effective pull to be transmitted F_U

$F_U = \frac{P \cdot 1000}{v}$ [N] $v = \frac{d_1 \cdot n_1}{19100}$ [m/s]

3 Reference force F_B operating factor C_2

$F_B = F_U \cdot C_2$ [N] C_2 from operating factor table (page 11)

4 Specific effective pull F_U' type, basic elongation at fitting C_4

in diagram of d_{min} (small pulley diameter), going vertically to the top till the intersection with β line, read off F_U', to the left and C_4 and type to the right.

5 Flat belt width b_0

$b_0 = \frac{F_B}{F_U'}$ [mm]

Normal widths b_0 and smallest recommended pulley width b

b_0	b	b_0	b	b_0	b	b_0	b [mm]
20	25	70	80	180	200	450	500
25	32	75	90	200	225	500	560
30	40	80	90	220	250	550	630
35	40	85	100	250	280	600	630
40	50	90	100	280	315	650	710
45	50	95	112	300	315	700	800
50	63	100	112	320	355	750	800
55	63	120	140	350	400	800	900
60	71	140	160	380	400	900	1000
65	71	160	180	400	450	1000	1120

6 Geometrical belt length l

$l \approx 2e + 1.57\,(d_1 + d_2) + \frac{(d_2 - d_1)^2}{4e}$ [mm]

Please note: the length of the belt ordered depends on the tensioning method (see page 8).

If $d_1 > d_2$ then instead of $(d_2 - d_1)$ apply $(d_1 - d_2)$

7 Elongation at fitting ε

$\varepsilon = C_4 + C_5$

Read of C_5 from the table (centrifugal force) for the belt type selected (page 18/19).

8 Shaft load F_W

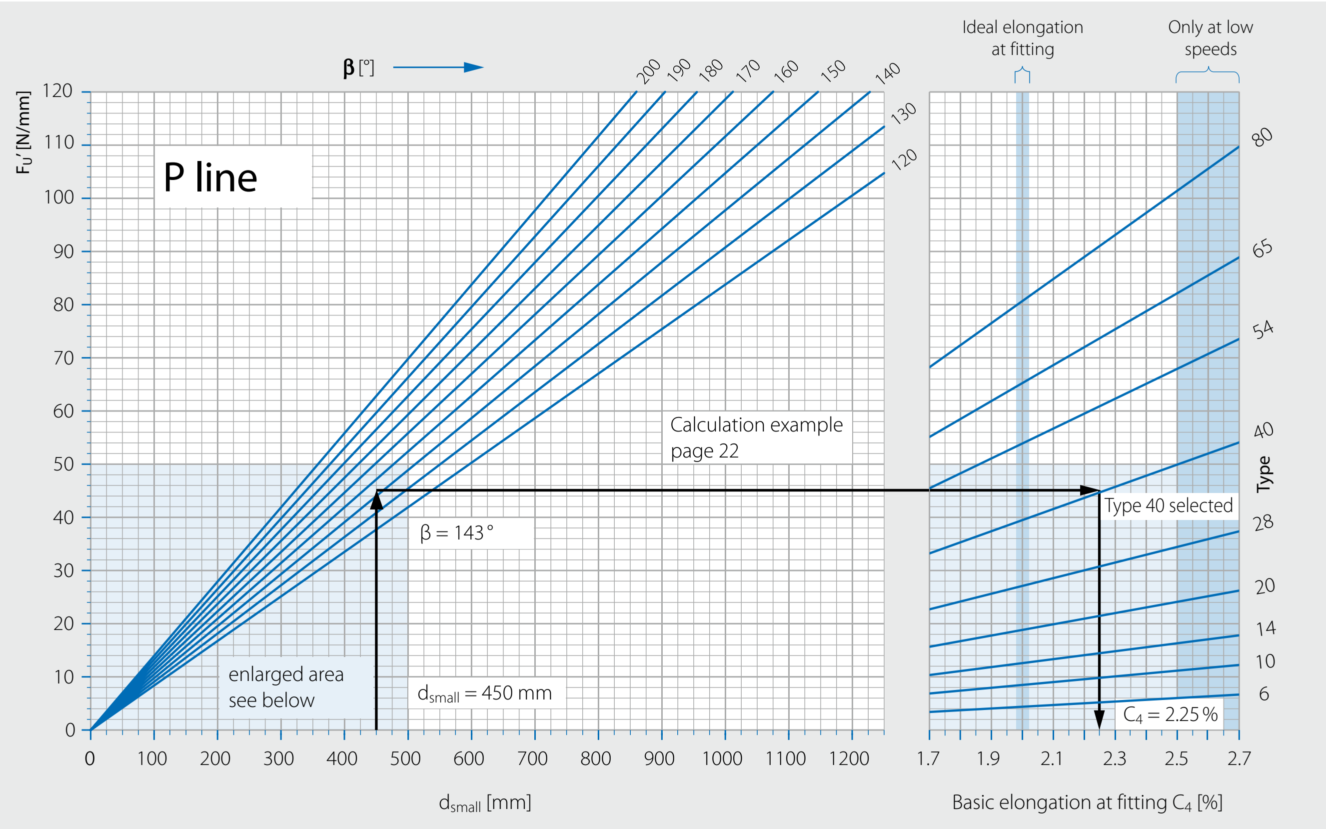
At a standstill F_{Ws}: $F_{Ws} = \varepsilon \cdot \text{Type} \cdot b_0$

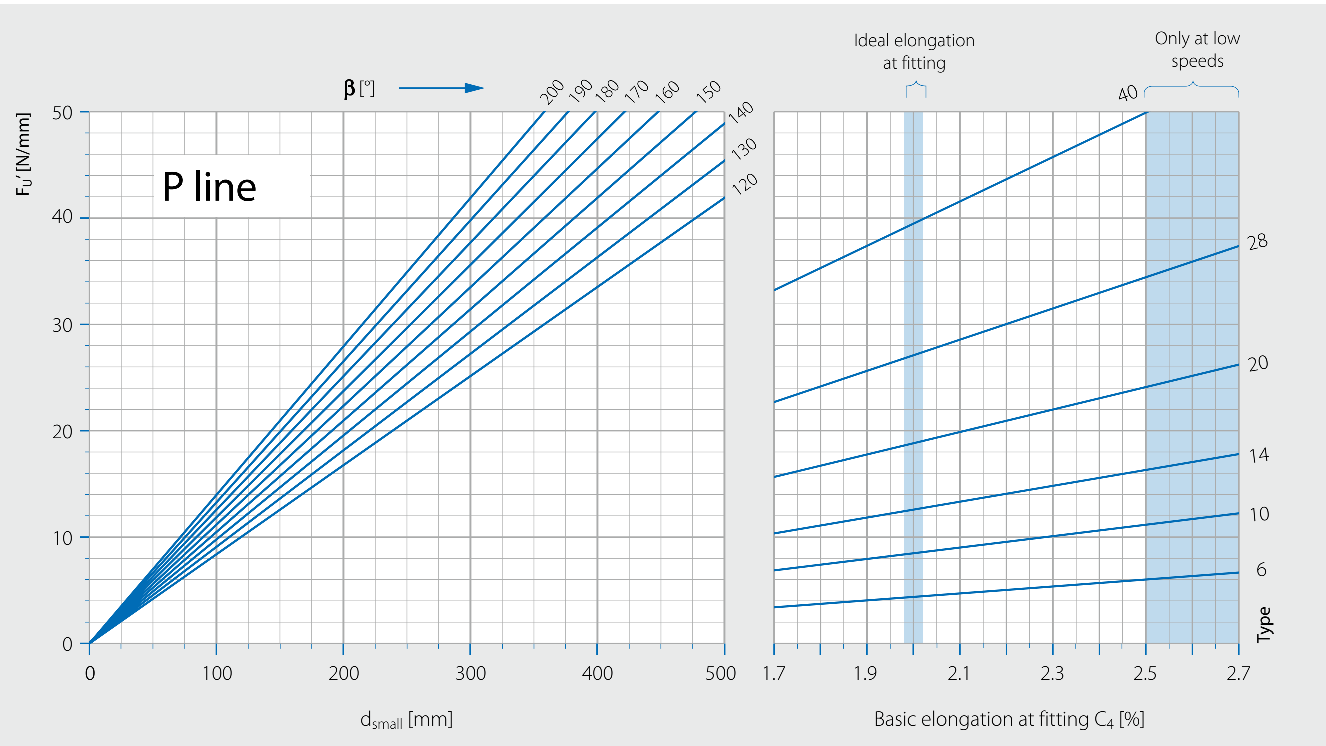
While operating F_{Wd}: $F_{Wd} = C_4 \cdot \text{Type} \cdot b_0$

Initial value when tensioning $F_{W\,initial}$: $F_{W\,initial} = C_{initial} \cdot \varepsilon \cdot \text{Type} \cdot b_0$

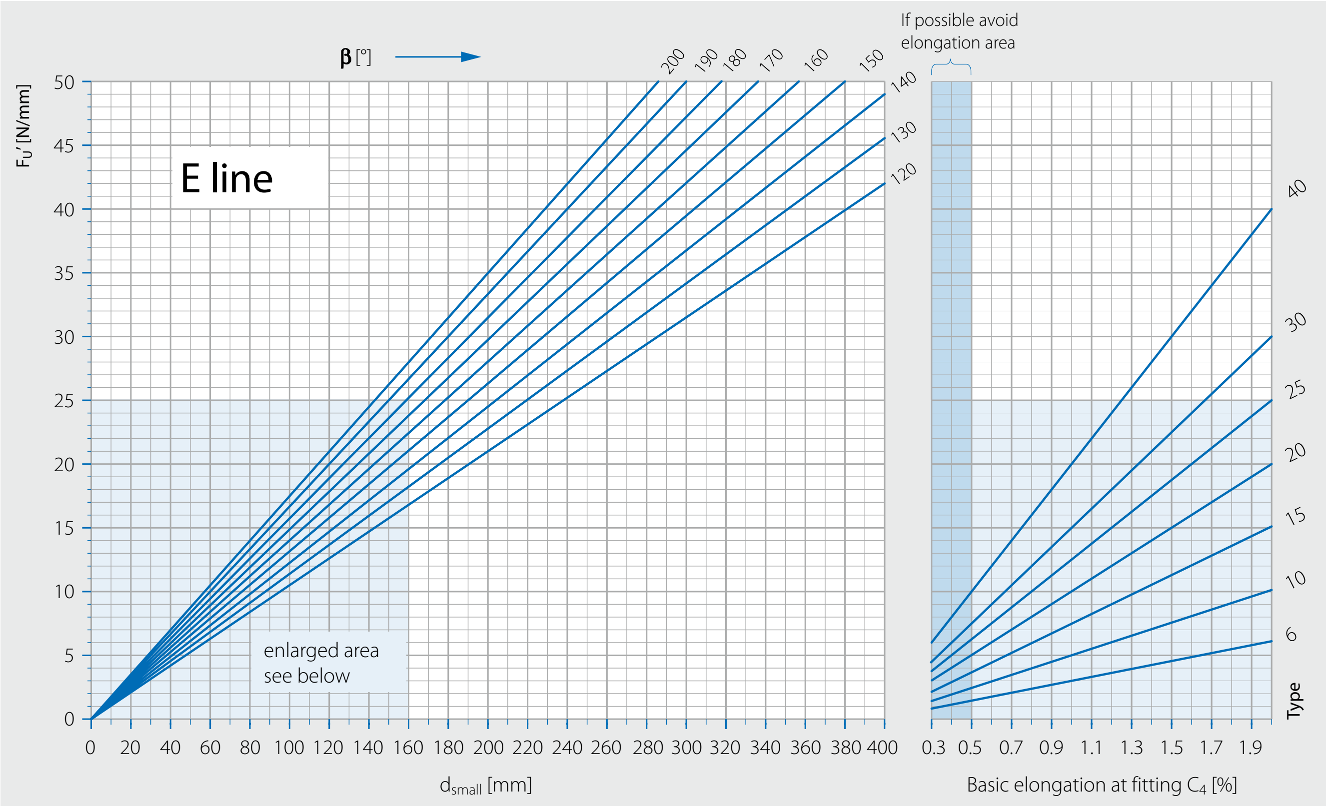
$C_{initial}$ see table on page 20

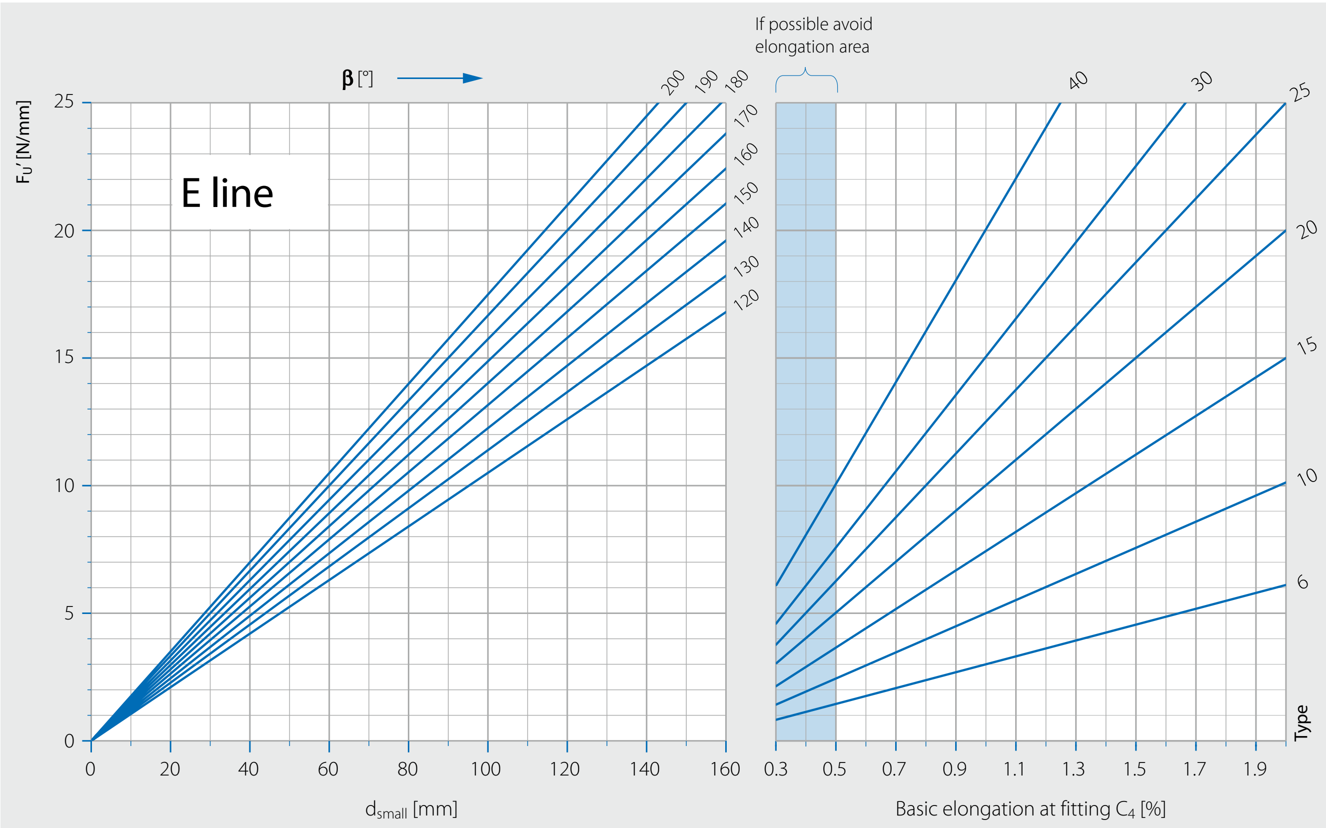
Allocation F_U' to belt type and basic elongation at fitting C_4



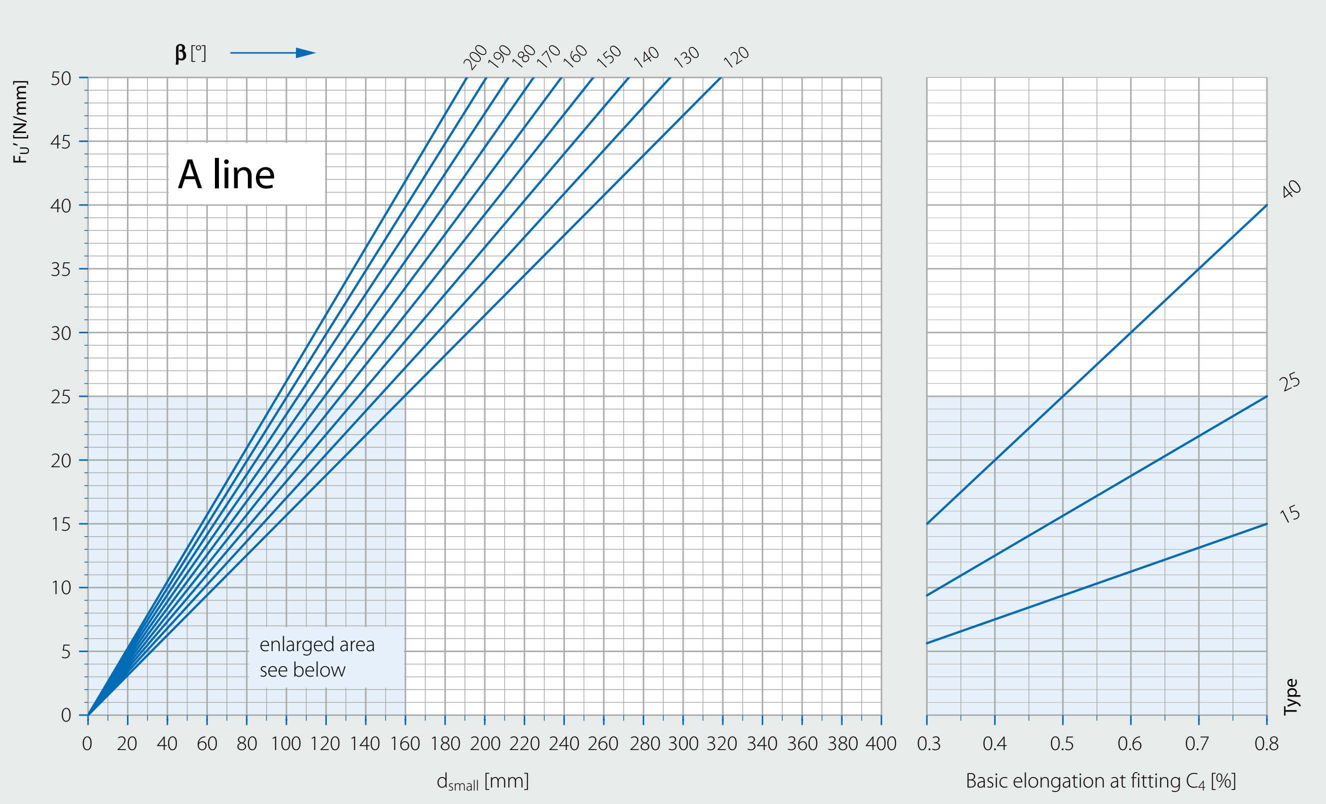


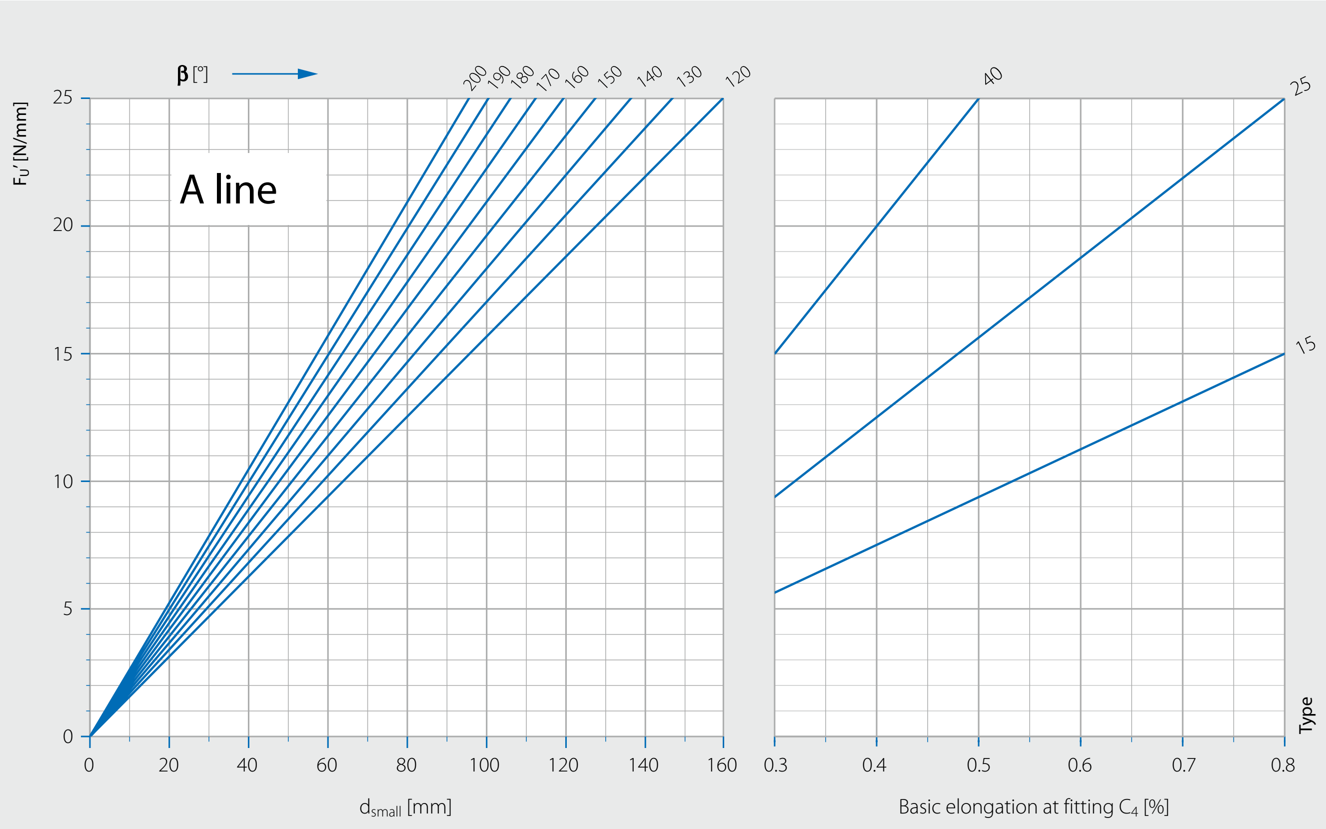
Calculation methods





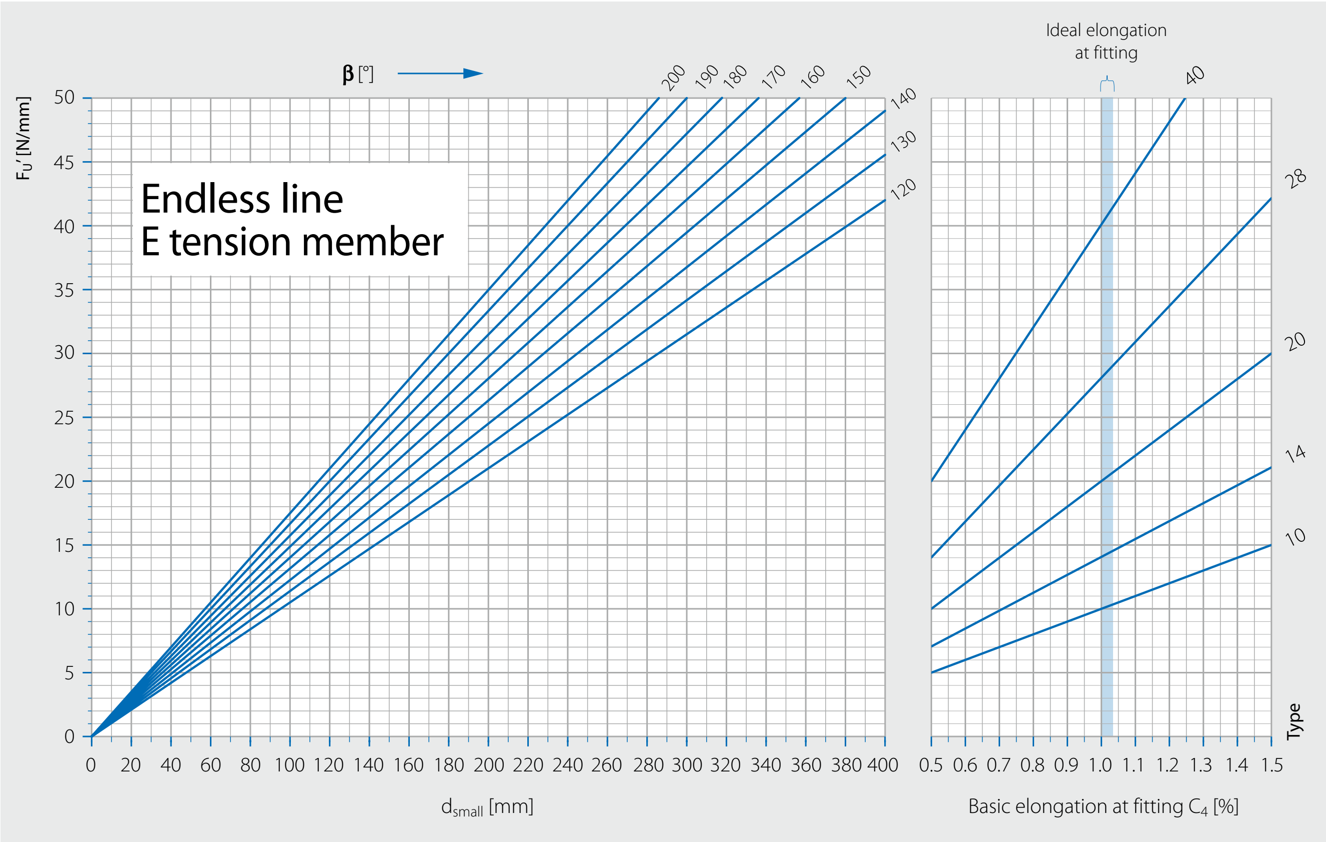
Info about the E line: where belts have U coating, due to the low structural strength of the urethane, the transferrable effective pull must be reduced by 1/3. Depending on the type, basic elongation at fitting of > 2.0 % is possible, but Forbo Siegling should be consulted.



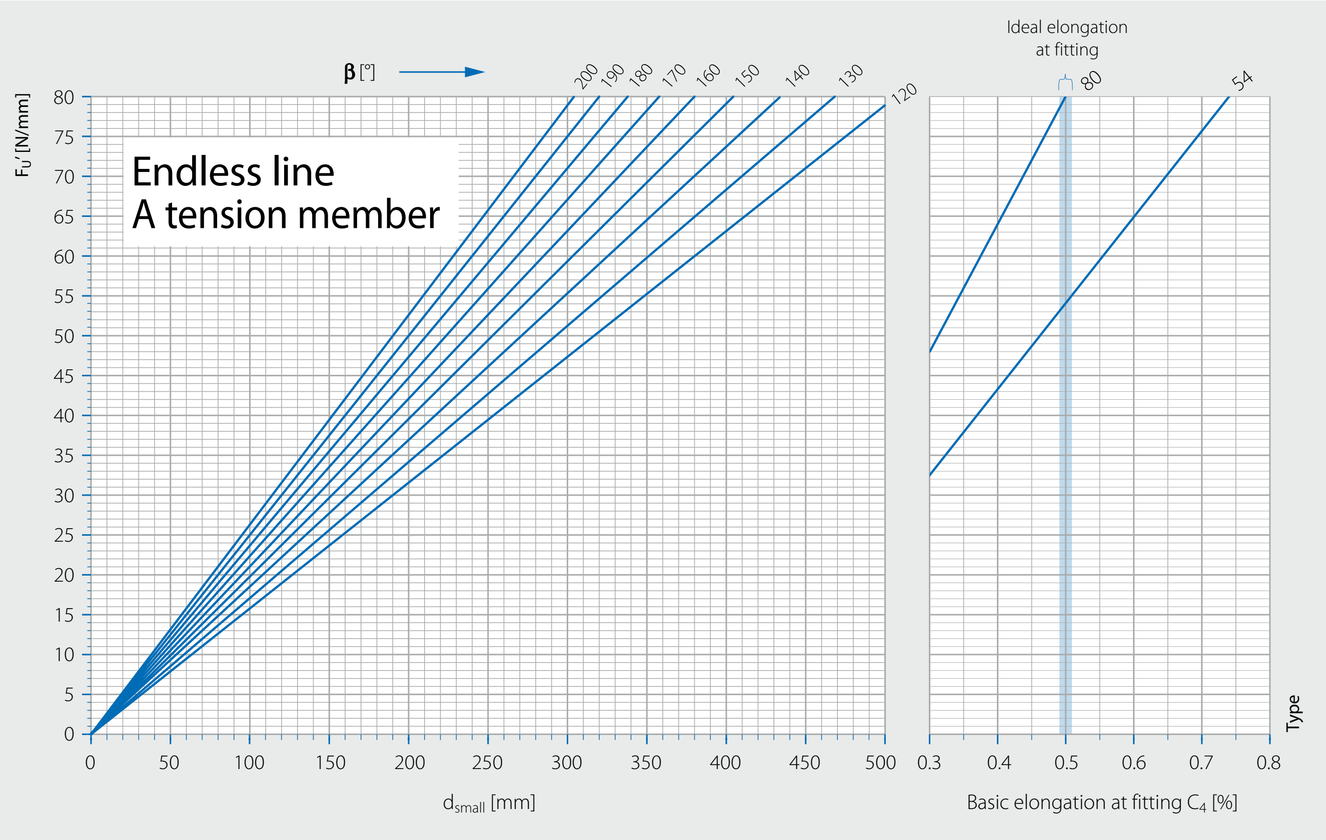


Info about the A line: where belts have U coating, due to the low structural strength of the urethane, the transferrable effective pull must be reduced by 1/3. Depending on the type, basic elongation at fitting of > 0.8 % is possible, but application engineers at Forbo Siegling should be consulted.

Calculation methods



Info about the E line: where belts have U coating, due to the low structural strength of the urethane, the transferrable effective pull must be reduced by 1/3. The belts can be subjected to extreme stress and when they have a rubber friction layer, they may fall below the diameter thresholds shown in the diagram. Where heavy-duty drives are concerned, we recommend you talk to Forbo Siegling application engineers.



Info about the A line: The belts can be subjected to extreme stress and when they have a rubber friction layer, they may fall below the diameter thresholds shown in the diagram. Under certain conditions, the transferable effective pull can also be increased far above the nominal effective pull. Where heavy-duty drives are concerned, we recommend you talk to Forbo Siegling application engineers.

MOVEMENT SYSTEMS

Calculation methods

Allowances for centrifugal force for basic elongation in fitting in %

For belt speeds of 70 m/s and higher, we recommend you always ask Forbo Siegling to support you in selecting the right belt type.
To calculate centrifugal force: $\varepsilon = C_4 + C_5$ [%]

Allowance C_5 (centrifugal force)

v [m/s]	20	30	40	50	60	70	
Type 6	0.2	0.3	0.7	1.0	inquire	inquire	[%]
Type 10	0.2	0.3	0.6	0.9	inquire	inquire	[%]
Type 14	0.1	0.3	0.5	0.8	1.0	inquire	[%]
Type 20	0.1	0.3	0.4	0.7	1.0	inquire	[%]
Type 28	0.1	0.2	0.4	0.6	0.8	inquire	[%]
Type 40	0.1	0.2	0.3	0.5	0.7	1.0	[%]
Type 54	0.1	0.2	0.3	0.5	0.7	0.9	[%]
Type 80	0.1	0.2	0.3	0.4	0.6	0.8	[%]

P line GT
In P line belts, the total elongation at fitting ε must not exceed 3 %.

v [m/s]	20	30	40	50	60	70	
Type 6	0.3	0.6	1.0	inquire	inquire	inquire	[%]
Type 10	0.2	0.5	0.8	inquire	inquire	inquire	[%]
Type 14	0.2	0.4	0.6	1.0	inquire	inquire	[%]
Type 20	0.1	0.3	0.5	0.9	1.0	inquire	[%]
Type 28	0.1	0.2	0.4	0.7	0.9	inquire	[%]
Type 40	0.1	0.2	0.3	0.6	0.8	1.0	[%]
Type 54	0.1	0.2	0.3	0.5	0.8	1.0	[%]
Type 65	0.1	0.2	0.3	0.5	0.7	0.9	[%]
Type 80	0.1	0.2	0.3	0.5	0.7	0.9	[%]

P line LT
In P line belts, the total elongation at fitting ε must not exceed 3 %.

v [m/s]	30	40	50	
Type 6	0.1	0.15	0.2	[%]
Type 10	0.1	0.15	0.2	[%]
Type 15	0.1	0.15	0.2	[%]
Type 20	0.1	0.15	0.2	[%]
Type 25	0.1	0.15	0.2	[%]
Type 30	0.1	0.15	0.2	[%]
Type 40	0.1	0.15	0.2	[%]

E line
In E line belts, the total elongation at fitting ε must not exceed 2.1 %.

v [m/s]	40	50	
Type 15	0.05	0.05	[%]
Type 25	0.05	0.05	[%]
Type 40	0.05	0.05	[%]

A line
In A line belts, the total elongation at fitting ε must not exceed 1 %.

v [m/s]	40	50	60	
Type 10	0.1	0.2	0.3	[%]
Type 14	0.1	0.2	0.3	[%]
Type 20	0.1	0.2	0.3	[%]
Type 28	0.1	0.2	0.3	[%]
Type 40	0.1	0.2	0.3	[%]

Endless line with polyester tension members GT, GG, UU

In endless line belts with E tension members, the total elongation at fitting ε may not exceed 1.5 %. In the case of belt speeds over 60 m/s please contact Forbo Siegling application engineers.

v [m/s]	30	40	50	60	
Type 10	0.1	0.15	0.2	0.25	[%]
Type 14	0.1	0.15	0.2	0.25	[%]
Type 20	0.1	0.15	0.2	0.25	[%]
Type 28	0.1	0.15	0.2	0.25	[%]
Type 40	0.1	0.15	0.2	0.25	[%]

Endless line with polyester tension members LT, LL

In endless line belts with E tension members, the total elongation at fitting ε may not exceed 1.5 %. In the case of belt speeds over 60 m/s please contact Forbo Siegling application engineers.

v [m/s]	40	50	60	
Type 54	0.05	0.05	0.1	[%]
Type 80	0.05	0.05	0.1	[%]

Endless line with aramide tension members GT, GG, LT

In endless line belts with A tension members, the total elongation at fitting ε may not exceed 1 %. In the case of belt speeds over 60 m/s please contact Forbo Siegling application engineers.

Calculation methods

Shaft load

Running-in behaviour of plastic tension members when constantly elongated

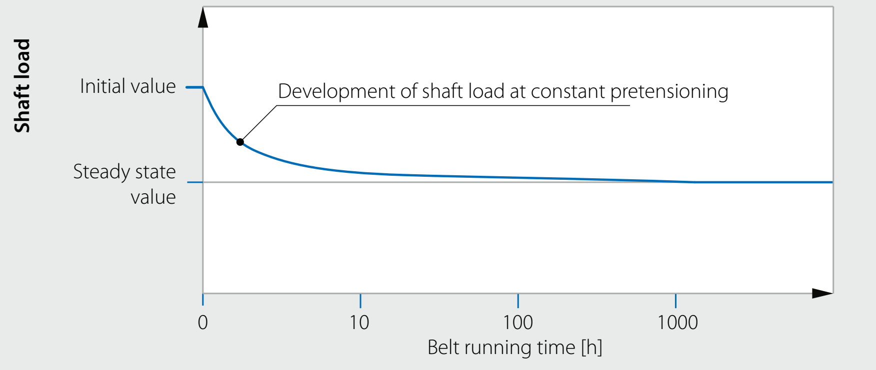
When fitting at a particular elongation, a higher shaft load occurs to start with in all plastic tension members. This initial value decreases during the first revolutions of the belt to a steady value that can be considered constant.

The duration of the running-in process cannot be predicted because so many factors are involved. Testing rigs with 2-pulley drives showed that the steady state was achieved after about 250,000 counter bending processes.

The steady state value of the shaft load is the basis for calculating the power transmission of a belt.

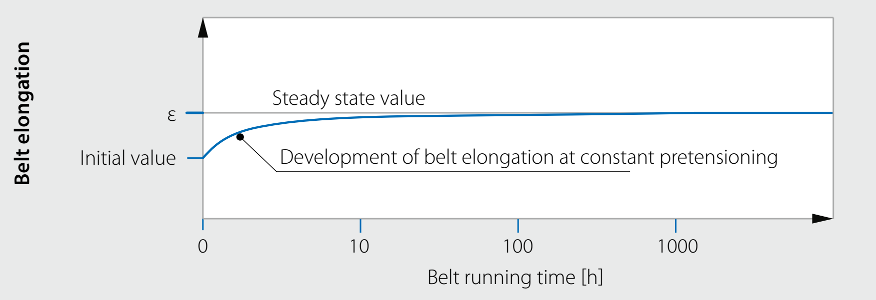
The higher initial shaft load value should be taken into account by the designer, at least when dimensioning the shaft bearings based on static loads.
Particularly in the case of strong belts with polyamide tension members, it is easier to tension the belts to the calculated elongation at fitting in two stages in order to reduce the maximum levels of immediate force.

Forbo Siegling advises you strongly not to tension the belts in more than two stages, otherwise the shaft load-elongation behaviour in the tension members can change.



Running-in behaviour of plastic tension members when constantly pretensioned

Pneumatic, sprung, or weight-loaded take-up units must tension the belts at least with the constant force F_{wd} produced in the calculation. Due to the running-in behaviour of the tension members, the appropriate elongation at fitting ε is only reached after a certain running-in period. In other words, the centre distance will increase slightly during the running-in period.



Ratio of shaft load initial/steady state (reference values)

Line	Tension member initial/steady state reference value	Ratio of cinitial $c_{initial}$
P line	Polyamide sheet	2.2
E line	Polyester fabric	1.8
A line	Aramide fabric	1.4
Endless line	Polyester filaments	1.5

Shaft load F_W

$F_{Ws} = \varepsilon \cdot \text{Type} \cdot b_0$	[N] (static)
$F_{Wd} = C_4 \cdot \text{Type} \cdot b_0$	[N] (dynamic)
$F_{W\,initial} = c_{initial} \cdot \varepsilon \cdot \text{Type} \cdot b_0$	[N] (static)

Belt vibrations

The belt drive is a system that can vibrate.

Due to the way the driving and/or driven machine operates, the belt can be excited periodically. Transversal or longitudinal vibrations can occur in the belt.

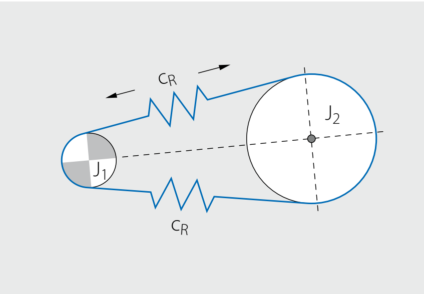
In order to avoid resonance, the machine's exciter frequency must not be close to the belt's eigenfrequency.

The eigenfrequencies in Siegling Extremultus flat belts is relatively low because they have good damping properties. As a result, resonance rarely occurs.

However, we recommend that vibration calculations are carried out by Forbo Siegling, in particular for piston compressors, water turbines (Kaplans, Francis), multiple blade frame saws or similar components.

Bending frequency

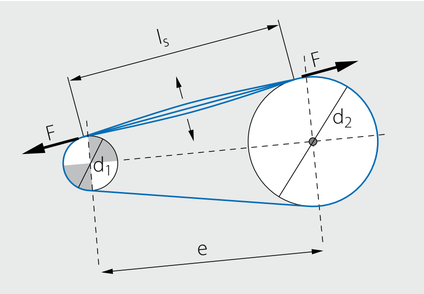
The maximum bending frequency allowed depends on the belt type. Too high bending frequency will shorten the service life of the belt. If there is a bending frequency greater than 30 1/s, please consult Forbo Siegling.



Longitudinal eigenfrequency
The longitudinal eigenfrequency of a belt depends on the spring rate of the belt c_R and on the mass moments of inertia J of the driving and driven machine.

In terms of measurement, it is very difficult to show longitudinal vibrations.

Resonance is avoided, if there is a difference between the exciter frequency and eigenfrequency of the system of at least 30 %.



Transversal eigenfrequency
The transversal eigenfrequency of a belt depends on the freely-vibrating belt length, the force in the belt strand and the belt's weight. As a result, both the eigenfrequency of the tight side of belt and the frequency of the slack side of the belt are to be assessed.

Transversal vibrations are obvious – the belt flaps excessively. This can be avoided by integrating a fixed tangential roller, or by changing the shaft distance or belt tension.

Resonance is avoided if there is a difference of at least 20 % between the exciter frequency and the belt's eigenfrequency.

The transversal eigenfrequency f of a belt strand is calculated at

$$f = \frac{1000}{l_s} \sqrt{\frac{F}{4 \cdot m'_R}} \quad [\text{Hz}]$$

With the freely-vibrating length

$$l_s = \sqrt{e^2 - \frac{(d_2 - d_1)^2}{4}} \quad \text{with } d_2 \geq d_1$$

MOVEMENT SYSTEMS

Calculation methods

Calculation example

Motor capacity	$P = 280$ kW
Diameter of drive pulleys	$d_1 = 450$ mm
Motor speed	$n_1 = 1490$ 1/min
Centre distance	$e = 2500$ mm
Diameter of driven pulley	$d_2 = 2000$ mm
Speed of drive pulley	$n_2 = 335$ 1/min

Ambient conditions are dusty, without presence of oil, normal temperature

Required: Power transmission belt for electrical drive in a gang saw

1 Arc of contact ß to the small pulley

$$\beta = 180 - \frac{60 \cdot (2000 - 450)}{2500} = 142.8^\circ$$

2 Effective pull to be transmitted F_U

$$v = \frac{450 \cdot 1490}{19100} = 35.1 \text{ m/s}$$

$$F_U = \frac{280 \cdot 1000}{35.1} = 7976 \text{ N}$$

3 Reference force of the drive F_B

As operating factor C_2 1.35 is selected from the table on page 11.

$$F_B = 7976 \text{ N} \cdot 1.7 = 10768 \text{ N}$$

4 Specific effective pull, belt type and basic elongation at fitting

Due to the ambient conditions, a P line belt with rubber friction coating is selected, as a result the P line diagram on page 13 is analysed:

F_U'		β		C_4	Type
45 N/mm	←	142.8 °	→	2.25 %	40
		↑			
		$d_{small} = 450 \text{ mm} = d_1$			

5 Belt width b_0

$$b_0 = \frac{10768 \text{ N}}{45 \text{ N/mm}} = 239 \text{ mm}$$

$b_0 = 250$ mm is selected from the "Flat belt width" table on page 12.

6 Geometrical belt length

$$l = 2 \cdot 2500 + 1.57 \cdot (450 + 2000) + \frac{(2000 - 450)^2}{4 \cdot 2500} = 9087 \text{ mm}$$

7 Elongation at fitting taking into account elongation due to centrifugal force

For belt GT 40 P at the speed stated. the allowance for centrifugal force is stated in the "P line GT" table on page 18. The elongation at fitting required is therefore:

$C_5 = 0.25\,\%$

The elongation at fitting required is therefore:

$\varepsilon = C_4 + C_5 = 2.50\,\%$

Run-in belt during operation: $F_{Wd} = 2.25 \cdot 40 \cdot 250 = 22500$ N

Run-in belt at a standstill: $F_{Ws} = 2.5 \cdot 40 \cdot 250 = 25000$ N

Brand new belt when tensioned for the first time: $F_{W\,initial} = 2.2 \cdot 2.5 \cdot 40 \cdot 250 = 55000$ N

See comments on the instantaneous value under "shaft load" in the technical information on page 20.

Shaft loads in different operational states **8**

Vibration calculation **9**

Like all crank drives, a gang saw displays irregular power transmission behaviour. It carries out 2 strokes each time the drive pulley turns.

$$f_{err} = \frac{335}{60} \cdot 2 = 11.2 \text{ Hz}$$

$$l_s = \sqrt{25002 - \frac{(2000 - 450)^2}{4}} = 2377 \text{ mm}$$

Belt GT 40P weights 4 kg/m²; which produces the following figures if the belt is 250 mm wide:

$m'_R = 4 \text{ kg/m}^2 \cdot 0.25 \text{ m} = 1 \text{ kg/m}$

Belt force in tight side of belt:

$$F_1 = \frac{F_{Ws}}{2} + \frac{F_U}{2} = \frac{2.5 \cdot 40 \cdot 250}{2} + \frac{7976}{2} = 16488 \text{ N}$$

Belt force in the slack side of the belt:

$$F_2 = \frac{F_{Ws}}{2} - \frac{F_U}{2} = \frac{2.5 \cdot 40 \cdot 250}{2} - \frac{7976}{2} = 8512 \text{ N}$$

Transversal eigenfrequency tight side of belt:

$$f_1 = \frac{1000}{2377} \cdot \sqrt{\frac{16488}{4 \cdot 1}} = 27.0 \text{ Hz}$$

Transversal eigenfrequency slack side of the belt:

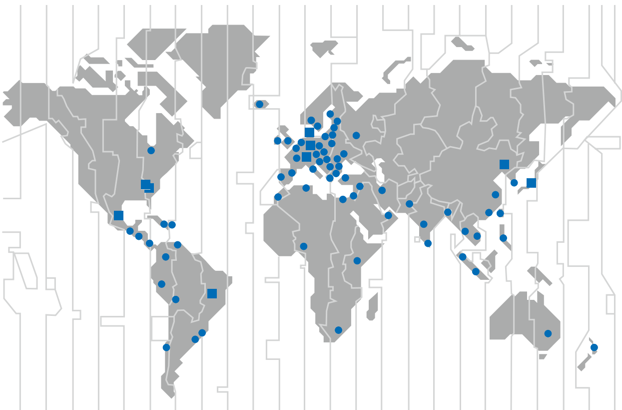
$$f_2 = \frac{1000}{2377} \cdot \sqrt{\frac{8512}{4 \cdot 1}} = 19.4 \text{ Hz}$$

The eigenfrequencies of both sides of the belt are much more than 20% away from the exciter frequency. There is no risk of transversal vibrations (flapping) in the belt.

MOVEMENT SYSTEMS

Siegling – total belting solutions

Because our products are used in so many applications and because of the individual factors involved, our operating instructions, details and information on the suitability and use of the products are only general guidelines and do not absolve the ordering party from carrying out checks and tests themselves. When we provide technical support on the application, the ordering party bears the risk of the machinery functioning properly.



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The Forbo Siegling Group employs more than 2,000 people. Our products are manufactured in nine production facilities across the world. You can find companies and agencies with warehouses and workshops in over 80 countries. Forbo Siegling service points are located in more than 300 places worldwide.

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MOVEMENT SYSTEMS

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