Ammeraal Beltech

EN

Technical Manual

Plied Synthetic Belting
- Belt Tension and Elongation

Innovation and Service in Belting

Table of contents

1. Scope of this document

This technical documentation is about several aspects related to force elongation of plied synthetic belting. It covers properties like static and dynamic force elongation and is meant to offer a better understanding of the different belt properties having to do with the force elongation behavior of plied synthetic belting. It does not cover other types of belts than plied synthetic belting, nor is it meant to be exhaustive. This document is for internal use within Ammeraal Beltech only. Its content is best understood if you have already read the Synthetic Belting Engineering Guide.

Each chapter gives information on a particular topic. Basic sketches are used for clarification. These sketches might be out of proportion to show some details more clearly.

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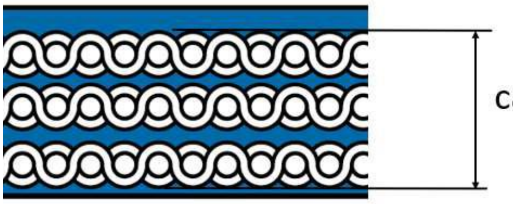
2. Force and elongation of a conveyor belt

A plied synthetic conveyor belt is pulled by the drive drum to make it move and transport the product, see images 7 and 8. The force driving the belt has to overcome all forces resisting the conveyor belt from moving. In friction driven belt conveyors the drive drum can only transmit adequate driving force to the belt if that belt is pretensioned so that there is enough friction between the belt and drive drum. The pretension force and the pulling force create stress in the conveyor belt. As a result, the belt will elongate. The amount of elongation of the belt depends mainly on the strength of the belt carcass.

2.1 The belt carcass

The carcass of a plied synthetic belt consists of one or more woven fabrics. Varied materials, like polyester, cotton, polyamide, and aramid can be used to construct the yarns for weaving the fabric. In light weight synthetic plied belting, polyester is by far the most used material. The choice of material and the thickness of the yarns in the longitudinal (warp) direction of the belt carcass as well as the weaving pattern and the number of fabric plies, determine the force-elongation behavior of the belt.

Image 1: belt carcass



3. Pretensioning a belt

A plied synthetic belt mounted on a conveyor is driven by friction between the belt and the drive drum. AmmDrive belts are positive driven plied synthetic belts. Sprockets that match the toothed lug-profile on the belt drive the belt. The positive AmmDrive belts require far less pretension than friction driven belts.

All friction driven belts must be tensioned to create enough surface pressure between the surface of belt and the surface of the drive drum. At Ammeraal Beltech, we say; A plied synthetic belt must be tensioned so that there is no slip between belt and drive drum, even in a full load start-up situation and after relaxation of the belt.

3.1 Too little pretension

If there is too little pretension, the belt either slips over the drive drum, especially at start up when fully loaded, or the tracking measures taken on the conveyor, like crowning, have little or no effect. For crowning to be effective, the belt needs a certain pre-tension to follow the crowning of the crowned pulley(s). A belt with too little pretension might show an unacceptable amount of belt sag between the support rollers in the return part (slack side) of the conveyor.

3.2 Too much pretension

Too much pretension, on the other hand, is also not desirable. It will unnecessarily strain the belt. Consequently, reducing the lifetime of the belt. Usually, it is the splice or belt fastener that fails first since this is always the weakest spot in the belt. Besides the belt, conveyor parts like pulleys, shafts and bearings will unnecessarily suffer from wear and tear if the belt tension is too high.

Note: A plied synthetic belt must be tensioned so that there is no slip between belt and drive drum, even in a full load start-up situation and after relaxation of the belt.

3.3 Relaxation

When a new plied synthetic belt is installed on a conveyor, the belt carcass will set during the running in period. On conveyors with a fixed tensioning system, a certain amount of the initial pretension is lost as a result of relaxation of the fabric, see image 3. The remaining pretension after the running in period must be at least as high as the minimum required pretension.

Image 2: fixed tensioning system, threaded end

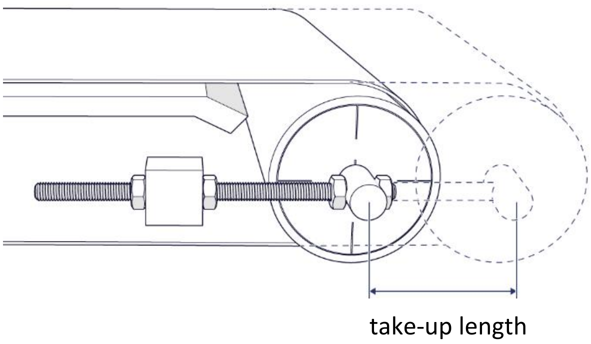
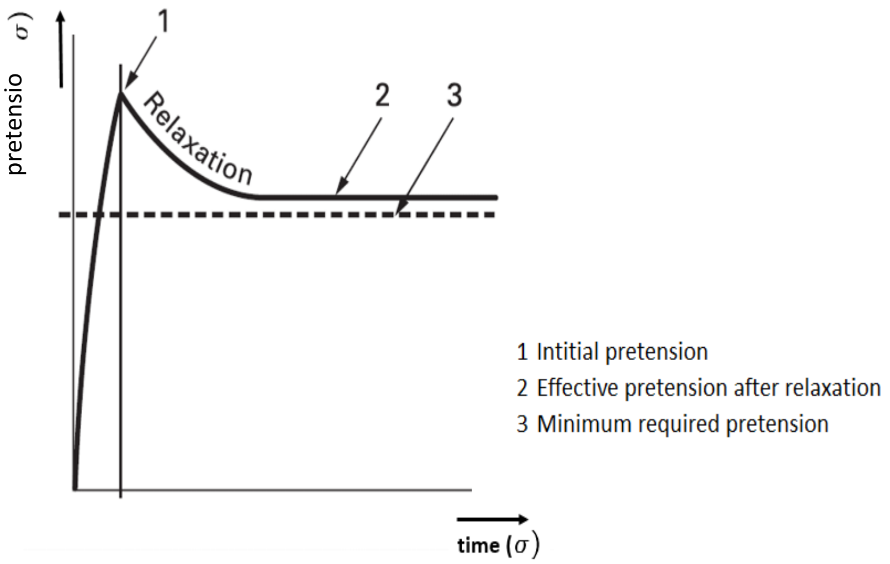


Image 3: pretension and relaxation, fixed tensioning system



Automatic tensioning systems, such as air cylinders, metal strings or gravity take-up systems, will compensate for the belt elongation and keep the pretension at the same level. Provided that the take-up length is adequately long. Therefore, belts on a conveyor with an automatic tensioning system require less pretension than belts on conveyors with a fixed tensioning system.

Image 4: automatic tensioning system, steel spring

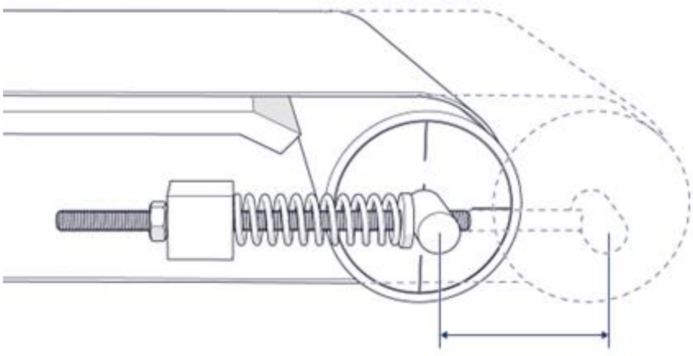
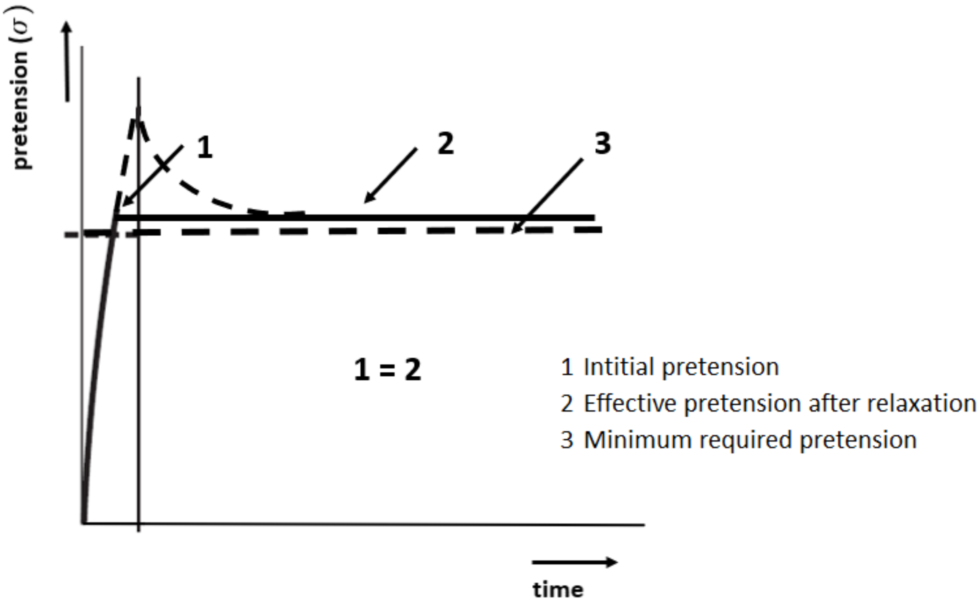


Image 5: pretension and relaxation, automatic tensioning system



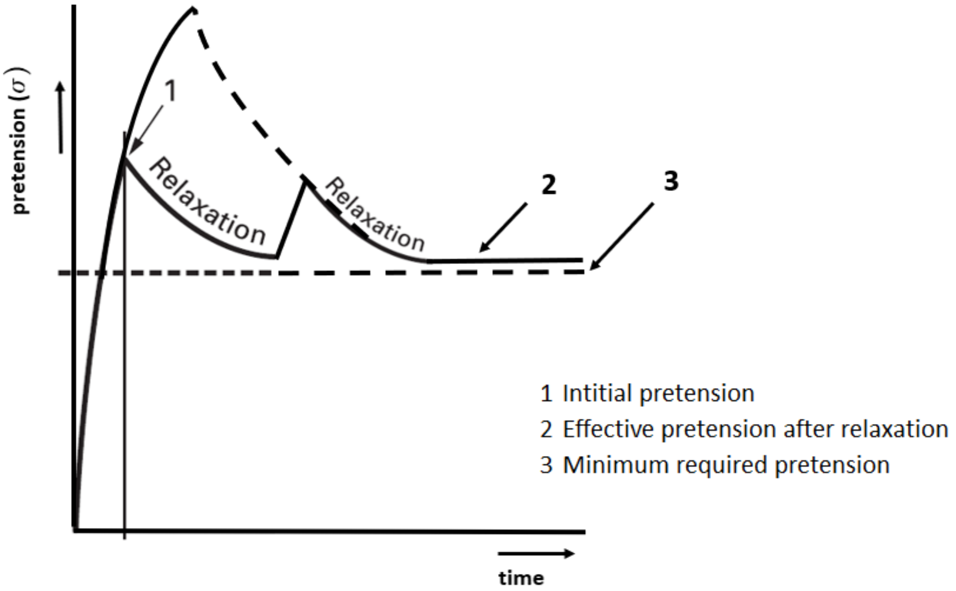
Relaxation of belts is a normal phenomenon in plied synthetic belting. The amount of relaxation depends mainly on the type of the belt carcass, it varies between the different belt types.

Relaxation of a belt on a fixed tensioning system, causes the belt to lose some of its pretension.

Relaxation of a belt on an automatic tensioning system, causes the belt to elongate, while keeping the pretension at the same level.

Some belts, like the Flexam SW solid woven belts, have a relatively high relaxation. Solid woven belts on a fixed tensioning system would therefore need a higher initial pretension. It could be that the conveyor is not built to resist a high initial pretension or has a relatively short tension way. In those cases, the pretention-relaxation process must be divided into smaller steps. It is widespread practice that solid woven belts must be re-tensioned or shortened, sometimes even several times.

Image 6: re-tensioning



The elongation of a belt due to relaxation is permanent, meaning that after releasing the belt tension it does not recover its original belt length. This permanent elongation is also referred to as structural elongation.

3.4 Rule of thumb for pretension

The advised pretension (ε_0) of diverse types of plied synthetic belts is given in a percentage of belt elongation. In fact, the pretension needed in a belt conveyor depends on more factors than just the type of belt used. Factors like the belt load, belt speed and conveyor design influence the amount of pretension that should be applied for trouble free conveying. This is why the pretensions given below should be considered as a rule of thumb.

Table 1: advised pretension (ε_0) in % of belt length

Belt type	European style plied synthetic belts	self tracking belts	solid woven belts/ American style belts
	ε_0 in %	ε_0 in %	ε_0 in %
light to medium belt load	0.2 - 0.5	3 - 5	0.5 - 1
heavy belt load	0.5 - 1.0	not suitable	1 - 2

4 Total belt tension and elongation

The total belt tension in a belt running on a conveyor does not consist of just the pretension that is applied when installing that belt. In addition to the pretension, the drive drum pulls the belt to overcome all forces resisting that belt to move. This pulling force divided by the belt width is the required driving tension.

Factors most responsible for resisting the belt to move are:

- Frictional force caused by the belt support in the upper part of the conveyor
- Frictional force caused by the belt support in the return part of the conveyor
- Forces needed for inclined conveying
- Frictional force from side walls
- Frictional force from belts scraper
- Frictional force from knife edges
- Total of resistance of bearings in snub pulleys

Other than the above-mentioned forces, factors related to the design of the conveyor, like the type of tensioning system and the position of the drive drum are taken into account as well, when making a belt calculation in the calculation tool from Ammeraal Beltech: AmCalc. The result of a calculation in AmCalc is the required power to drive the belt, the minimum pulley diameter of the drive drum to be able to transmit that power to the belt. Other than that, AmCalc gives the advised pretension and the total belt tension. The total belt tension is the highest level of belt tension, that the belt will suffer when running at full load. At a full load start-up both the total belt tension and thus the driving power needed are higher than the calculated total belt tension. An electromotor with the nominal power calculated in AmCalc is able to manage that kind of peak load at start-up and so should the conveyor belt of choice.

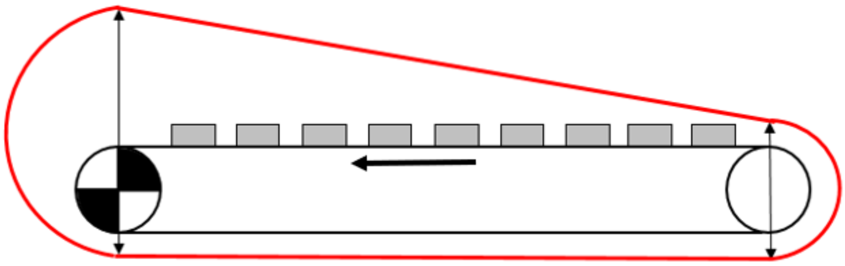
Ammeraal Beltech has a wide range of both American and European style synthetic polyester reinforced belts available. The strength of a belt carcass, resisting elongation, varies between the different belt types in the plied synthetic belt range. This means that the advised maximum elongation of 1.6% is reached at a low belt tension in, for example a 1 ply belt with a low strength fabric. While a much greater belt tension is needed to reach the same elongation in a belt with, for example, three strong fabrics.

4.1 Total belt elongation

A combination of the total belt elongation and the available tension way on a conveyor determine if a relaxed conveyor belt can still be driven free of slippage at start-up with a full belt load. Therefore, in some cases, it is necessary to predict the total belt elongation. Before we can say something about the total belt elongation, we first need to calculate the average belt tension over the whole of the belt length. In appendix 1 and 2 we give examples of calculations of average belt tension and total belt elongation of a conveyor belt.

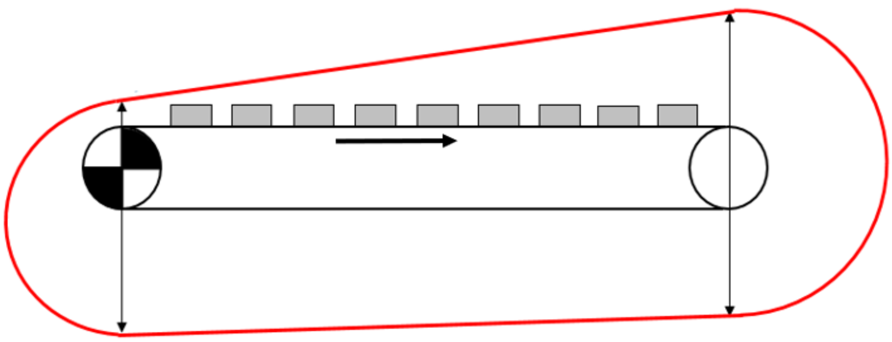
Image 7 shows a belt conveyor with pulling configuration, the red line indicating the level of belt tension. The belt tension peaks directly after the drive drum.

Image 7: pulling configuration



In a pushing configuration, as shown in image 8, a high force is present in the full length of the return part and over the tail pulley. This means that the elongation of a belt in a pushing configuration will be greater than the elongation of a belt in a pulling configuration.

Image 8: pushing configuration

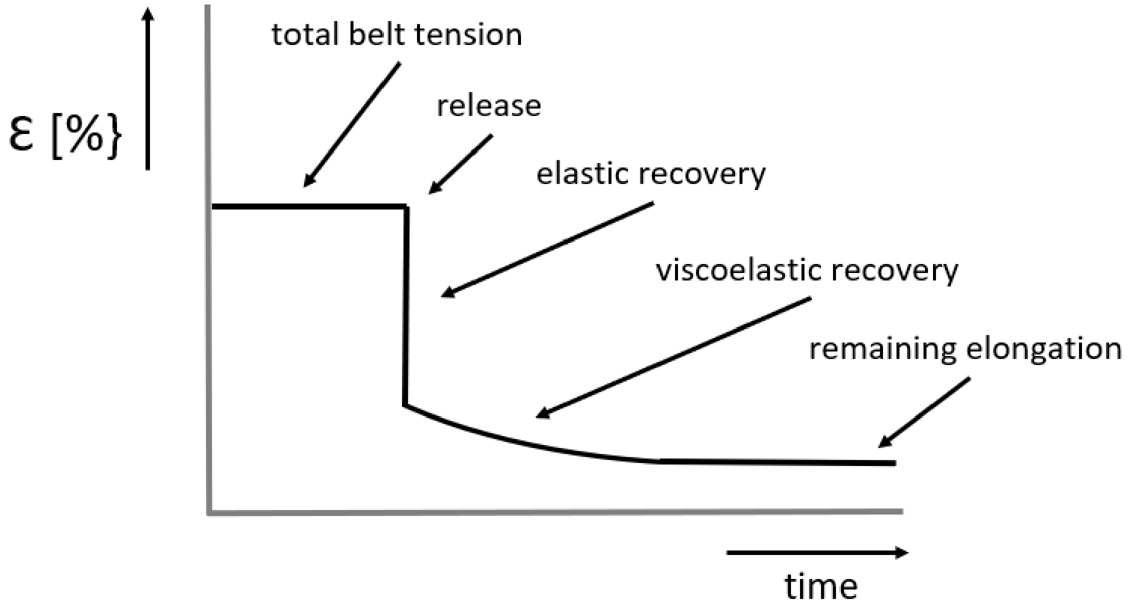


Images 7 and 8 make clear that when a belt on a conveyor is running, the belt tension is not constant over the length of the belt. The tension varies between the level of pretension and the total belt tension. As a consequence, the elongation of the belt also is not constant over the length of the belt.

4.2 Permanent elongation and elastic elongation

The elongation of a belt caused by relaxation is permanent. This means that after releasing the belt tension, the belt does not return to its original length completely, see image 9. Provided, the belt is not overloaded, all other elongation is considered elastic. Although, part of the elastic elongation might take some time to disappear when the belt tension is fully released, this is called viscoelastic recovery.

Image 9: elastic recovery, viscoelastic recovery, remaining elongation



5 Nomenclature and belt strength

One of the things given in the nomenclature of plied synthetic belting from Ammeraal Beltech is an indication of the belt strength. It needs to be said, that this is not a measured value, it is merely a value given to indicate the belt's resistance to stretch (elongate) when tensioned. In the belting industry belt tension is given in force per belt width. In the metric system, the unit of measure usually is N/mm, in the imperial system example PIW (pounds per inch belt width) is commonly used. The number 10 in image 10, indicates that a belt tension of 10 N/mm, needed to elongate this belt 1% in length.

Image 10: Nomenclature European style plied synthetic belting

		Nonex	EF	10	/	2	A18	+	07		white	FG
		Ropanyl	EM	8	/	2	00	+	02	(PVC)	dark green	AS FG
1	Type of top cover											
2	Type of fabric											
3	Tension at 1% elongation											
4	Number of plies											
5	Bottom (cover) thickness or Profile style											
6	Top (cover) thickness or Profile style											
7	Innerlayer (if different from top cover)											
8	Colour of the top cover											
9	Additional											

It is widespread practice that American belt manufacturers rate their belts according to the maximum allowable tension of a belt, this is called the working tension or rated tension, or safe working load of a belt. Usually, the working tension of a belt is considered to be 10% of the tensile strength. In other words, a safety factor of 10 is applied to the minimum tensile strength to calculate the safe working load of a belt. Ammeraal Beltech adopted the American way of naming for our solid woven, American style belts. For example, the SW100 in the name of the belt in image 11, means that for this belt Ammeraal Beltech advised a maximum working tension of 100 PIW (= 18 N/mm). Also, in this case the value is not a measured value. The conversion factor for belt tension between the units of measure PIW and N/mm is: 1 N/mm = 5.710 PIW (lbf/inch).

Image 11: Nomenclature American style plied synthetic belting

		Flexam	SW100	00	+	03	Black	M2
1	Type of top cover							
2	Type and strength of fabric							
3	Bottom (cover) thickness or Profile style							
4	Top (cover) thickness or Profile style							
5	Colour of the top cover							
6	Additional							

6 Measuring force-elongation

Measuring the belt tension of a plied synthetic belt on conveyors is not really possible, unless that conveyor is fitted with load cells measuring shaft loads like on specially designed test conveyors. In practice it is much more common to use the term elongation (ε) in percent (%) of the belt length, to indicate the level of belt tension.

With a tensiometer (image 12) a pulling force can be applied to a belt sample that is clamped between two clamps. The tension meter constantly measures the force needed to pull the two clams apart, thus elongating the belt sample. The pulling force divided by the width of the sample equals the belt tension. The clamps are moved further apart at a certain, constant speed. With the data retrieved, the equipment draws up a diagram of the relation between tension and elongation of the belt sample.

Image 12: Zwick tensiometer

7 Different force-elongation tests

In this chapter, we discuss several different force-elongation tests that are used to define force-elongation behavior of a belt material. Some aspects of the force elongation behavior of a plied synthetic belt can be measured according to international standards such as DIN, ISO, or ASTM. Internal standards that are used by Ammeraal Beltech to measure the different force-elongation properties of a belt type are based on international standards.

7.1 Ultimate tensile strength

In some cases, it is useful to know the ultimate tensile strength and elongation at break of a belt material. The ultimate tensile or breaking strength of a belt material is the tension at which a belt material breaks. At Ammeraal Beltech we measure the (ultimate) tensile strength and elongation at break according to an internal test method that is based on the international standard ISO 21180. The result of such a measurement is shown in image 13. In practice, it rarely happens that a conveyor breaks in any other place than the joint. The weakest point of a conveyor belt is always the joint area. Therefore, when developing a joint for a belt the tensile strength of the joint is compared with the tensile strength of the belt material. For certain belt types, the tensile strength of a belt material is also used to advise the customer about maximum allowable belt tension that the belt should be exposed to, See chapter 4.

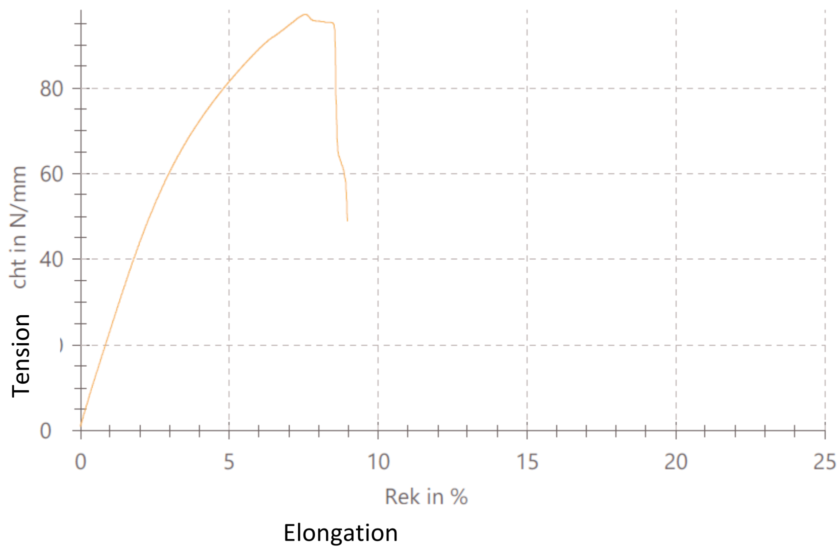
The ISO 21180 standard describes the determination of the maximum tensile strength of light conveyor belts.

Image 13: results and graph of a tensile strength measurement

Results:

Legend	No.	Tensile strength	Elongation at max. force	Elongation at break
	1	97	7,6	9,0

Series graphics:



7.2 Static force-elongation

The static force-elongation of a belt is tested in a similar way testing the tensile force. When testing the static force elongation, a belt sample is pulled to a certain pretension and from that point pulled to a certain elongation, for example from 0 to 5%. Ammeraal Beltech measures static force-elongation of belts according to an internal standard. The result of such a measurement is shown in image 14. The information of this test is not useful to learn about the dynamic behavior of a belt on a conveyor. In a static force-elongation test, relaxation of the belt carcass does not take place. The relation between force and elongation is that of a new belt, which has not been run-in on a conveyor.

When calculating a belt application in AmCalc one of the results is the advised minimum pretension in N/mm or PIW. However, it is much more practical to advise a customer the pretension of a belt as a percentage of belt elongation. The static force-elongation of a belt can be used to convert the advised minimum pretension to an advised percentage of elongation for installing that belt on the conveyor. If we have a belt with a static force elongation of 10 N/mm at 1% elongation and the advised pretension from AmCalc is 3 N/mm, we have to elongate that belt: (3 / 10) * 1% = 0.3% to get a belt tension of 3 N/mm, see image 15. In this calculation we assume the that part of the F/E-graph linear.

Image 14: static force-elongation graph

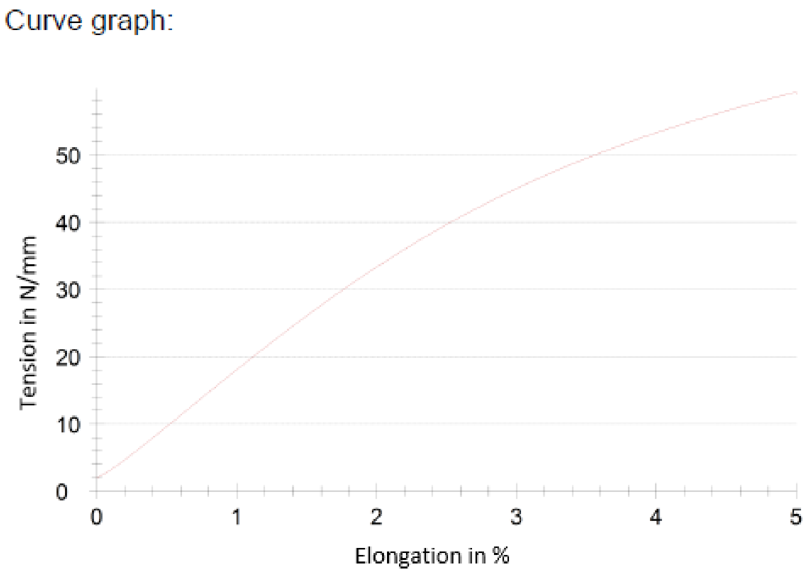
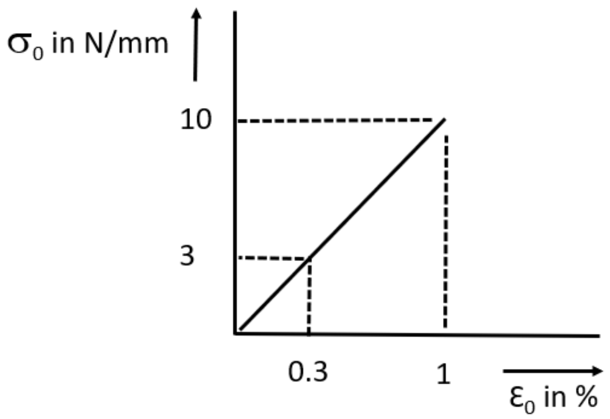


Image 15: linear part of the static force-elongation graph



7.3 Dynamic force-elongation

The static force-elongation properties of a belt are of limited practical use. More interesting is to be able to know the force-elongation behavior of a belt after relaxation has taken place during the running-in period. The relation between belt tension and elongation of a relaxed belt is called dynamic force-elongation or relaxed modulus of a belt. With the relaxed modules we are able to predict if the elongation of a conveyor belt installed is within limits to see if the take-up length of the tension system is sufficient.

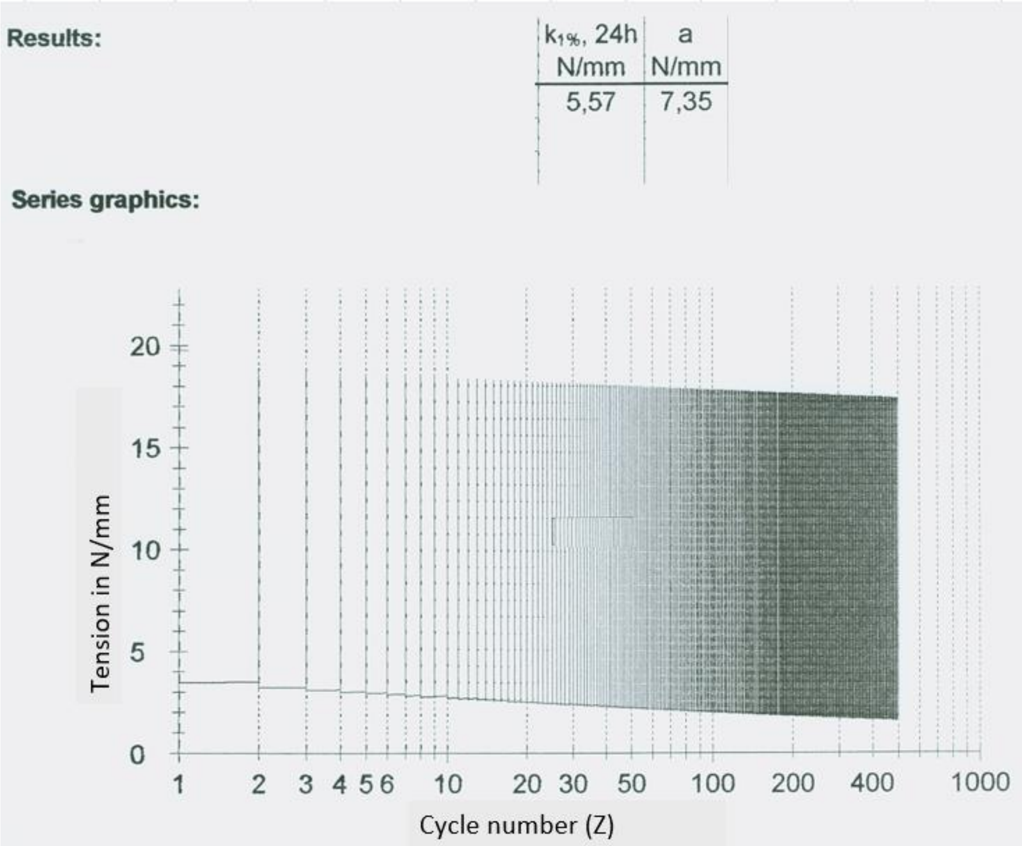
The international ISO 21181 standard describes the way to measure the relaxed modulus of a belt material. In this test a belt sample at a certain pretension is stretched and relaxed five hundred times between 1% and 2% elongation. The software of the tensiometer then calculates the required tension to elongate the belt to 1% elongation as if the stretch-relax cycles lasted for 24 hours. This value is called the relaxed elastic modulus or the $k_{1\%}$24h value. The $k_{1\%}$24h value is the belt tension needed to elongate the relaxed belt 1%.

The result of the ISO 21181 test for the relaxed elastic modulus also gives the a-value of a belt. The a-value is the belt tension k1% of the first pull-relax cycle (Z=1), see image 16.

The ISO 21181 standard describes the test method for determination of the relaxed elastic modulus ($k_{1\%}$24h) for light conveyor belts.

With the $k_{1\%}$24h value and the average belt tension from chapter 4.1 Total belt elongation, of the endless conveyor belt on a conveyor the total belt elongation can be calculated.

Image 16: result of a measurement according to ISO 21181



8 Appendices

Appendix 1 terminology

Terminology	Meaning	Symbol	Unit of measure (EU)
Friction driven belt conveyor	A belt conveyor where the friction between drive drum and belt surface transmits the force/power to drive the belt to make it move. As opposed to positive driven.		
Total belt pull, total belt force	The total of all pulling forces in a belt making it move forward, including the pretension tension force.	F	N
Total belt tension	Total belt pull divided by the belt width.	σ_{tot}	N/mm
Required pretension, initial tension	Belt tension needed to create enough friction between drive drum and belt to drive the belt without slippage. Also at full-load start-up and after belt relaxation.	σ_{pre}	N/mm
Relaxation	As a new belt is running in, the belt carcass sets, this process is called belt relaxation. The result is a certain elongation of the belt and a reduction of the modulus of that belt. After the running in period the belt carcass stabilizes.		
Full load at start-up	The conveyor is fully loaded and starts up from a stand still situation (belt speed = 0) to full belt speed at maximum acceleration.		
Re-tensioning	Re-tensioning of a belt is necessary if belt elongation, due to, for example, relaxation is such that the pretension remaining in the belt is no longer sufficient to drive the belt free of slippage.		
Carcass	The set of one or more fabric tension members of a belt.		
Modulus, Elastic modulus, Force elongation of a belt, E-modulus (E), Young's modulus, F/E properties	A measure of how much a belt elongates when under tension. $E = \sigma * 100 / \varepsilon$	E	N/mm

Static modulus, k1% or a-value	An indication of a new belt materials resistance to elongate when tensioned. a-value is the belt tension needed to elongate the belt 1% at the first pull in the test according to ISO21181.	E_{stat}	N/mm
Dynamic, relaxed modulus, k1%24h value	The relaxed modulus or k1%24h-value of a belt according ISO21181 is the calculated belt tension according needed to elongate the relaxed belt material 1%.	E_{dyn}	N/mm
ISO21181	The international standard ISO21181 describes the test to determine the relaxed elastic modulus of light conveyor belts.		
Friction force	The force that resists the sliding or rolling of one solid object over another.	F_{fr}	N
Coefficient of friction	The coefficient of friction is the ratio between friction force and normal force. With the nominal force being the force directed square to the surface creating the friction.	μ	[-]
Strain	The amound of deformation (elongation) of a belt in relation to its original length due to stress (tension).	ε	%
Stress	The pulling force divided by the belt width, in other words belt tension.	σ	N/mm
Maximum working tension, admissible tension, allowable tension, rated tension, maximum rated tension	The maximum belt tension that the belt manufacturer considers safe for that specific belt type.	σ	N/mm
Safety factor, service factor	Maximum working tension * safety factor = minimum tensile strength		[-]
Tensile strength, ultimate breaking strength, breaking strength	The tension at which a belt breaks.	σ	N/mm
Effective belt tension (TE)	The belt tension needed to move belt with load (tension from driving force). This does not include pretension.	σ	N/mm
Slack Side Tension (TS), pretension	Additional tension to prevent belt slippage.	σ	N/mm
Operating tension (TO), total belt tension	TO = TE + TS	σ	N/mm
Tight side – Slack side	Upper part – return part		
Slippage	The speed of the drive drum is higher than the speed of the belt.		

Appendix 2 calculating of belt elongation, pulling

@1

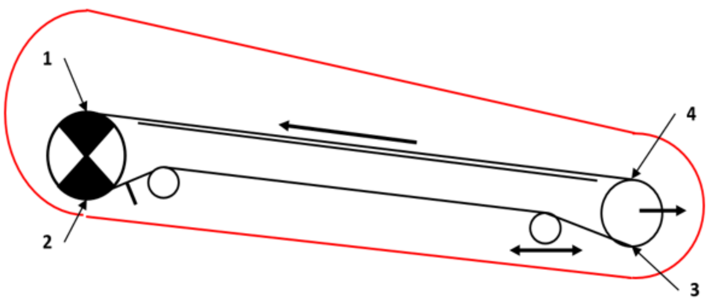
F pretension

F drive includes:

- F friction upper part
- F friction return part
- F inclined
- F side wall
- F scraper
- F knife edges
- F bearings

@4

F pretension
F friction return part
F scraper
F knife
F bearings



@2

F pretension

@3

F pretension
F friction return part
F scraper

Example of a pulling belt application, AmCalc calculation:

Input

Belt width	1,000	mm
Belt length	51,000	mm
Conveyor length	25,000	mm
Angle of inclination	5	°
Belt speed	1.00	m/s
Mass of the load	25.00	kg/m
Mass of the belt	4.00	kg/m²
Belt support	◉ Slider bed ○ Rollers	
COF slider support	0.30	
COF support rollers	0.03	
Mass of return rollers	0.72	kg/m
Efficiency drive drum	0.90	
Arc of contact drive drum	210	°
COF drive drum	0.30	

Tension device	◉ Fixed tension ○ Automatic tension	
Position of the drive drum	◉ Head (pulling) ○ Center ○ Tail (pushing)	
Number of drums > 90°	2	
Optional: Sidewalls	◉ With sidewalls ○ No sidewalls	
COF sidewalls	0.50	
Specific mass material	0.85	x10³ kg/m³
Length per sidewall	25,000	mm
Width between sidewalls	900	mm
Dynamic loading angle	5	°
Belt scraper	◉ With belt scraper ○ No belt scraper	
COF belt scraper	0.60	
Surface pressure belt scraper	0.10	N/mm²
Area of contact belt scraper	3,000.00	mm²
Knife edge	○ With knife edge ◉ No knife edge	

Results

Frictional force upper part	2,125.56	N	F1
Frictional force return part	34.62	N	F2
Force inclined conveying	534.37	N	F3
Frictional force sidewalls	93.47	N	F4
Frictional force belt scraper	180.00	N	F5
Frictional force knife edges	0.00	N	F7
Total resistance of bearings	64.73	N	F6
	+		
Required driving force	3,032.7	N	
Initial tensile force	2,223.9	N	Fp
Initial tension	2.22	N/mm	
Total belt force	5,256.6	N	
Total belt tension	5.26	N/mm	
Power of the drive motor	3.37	kW	
Minimum diameter drive drum	92	mm	

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		results from AmCalc			BB 1000 mm		
upper	F1	2125.56	N	σ1	2.126	N/mm	40%
return	F2	34.62	N	σ2	0.035	N/mm	1%
incline	F3	534.37	N	σ3	0.534	N/mm	10%
side walls	F4	93.47	N	σ4	0.093	N/mm	2%
scraper	F5	180.00	N	σ5	0.180	N/mm	3%
knife	F7	0.00	N	σ7	0.000	N/mm	0%
bearing, snub	F6	64.73	N	σ6	0.065	N/mm	1%
drive	FB	3032.75	N	σB	3.033	N/mm	58%
pretension	FP	2223.90	N	σP	2.224	N/mm	42%
	Ftot	5256.65	N	σtot	5.257	N/mm	100%

Tension in N/mm	upper	return	inclined	side walls	scraper	knife	bearing		pretension	
	1	2	3	4	5	7	6	B	P	
results AmCalc	2.126	0.035	0.534	0.093	0.180	0.000	0.065	3.033	2.224	
tension at 1	2.126	0.035	0.534	0.093	0.180	0.000	0.065		2.224	5.257
tension at 4		0.035			0.180	0.000	0.065		2.224	2.503
tension at 2									2.224	2.224
tension at 3		0.035			0.180				2.224	2.43852

Average tension upper part: = 0.5*(tension@1-tension@4)+tension@4 = 3.9 N/mm

Average tension return part: = 0.5*(tension@3-tension@2)+tension@2 = 2.3 N/mm

Average tension total belt length: = (tension average upper + tension average return)/2 = 3.1 N/mm

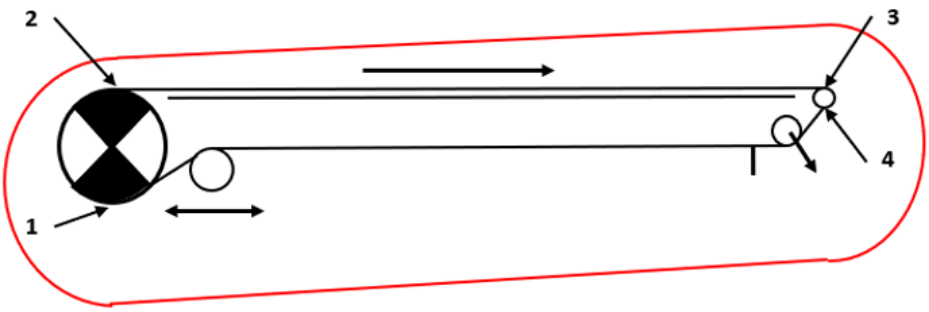
Total belt elongation = (average belt tension / k1%,24h) * total belt length
Assume a belt with a relaced force elongation (k1%24h) of: 5.0 N/mm

Total belt elongation = 1% * 3.1 / 5.0 = 0.62%
or in mm: 51,000 * 0.0062 mm
317 mm

Appendix 3 calculating of belt elongation, pushing

@2 F pretension

@3 F pretension
F friction upper part
F inclined
F side wall



@1 F pretension
F drive includes:
- F friction upper part
- F friction return part
- F inclined
- F side wall
- F scraper
- F knife edges
- F bearings

@4 F pretension
F friction upper part
F inclined
F side wall
F knife edges

Example of a pushing belt application, AmCalc calculation:

Input

Belt width	1,000	mm
Belt length	15,000	mm
Conveyor length	7,000	mm
Angle of inclination	0	°
Belt speed	0.50	m/s
Mass of the load	5.00	kg/m
Mass of the belt	3.00	kg/m²
Belt support	(●) Slider bed / ( ) Rollers	
COF slider support	0.30	
COF support rollers	0.03	
Mass of return rollers	7.20	kg/m
Efficiency drive drum	0.90	
Arc of contact drive drum	210	°
COF drive drum	0.30	

Tension device	(●) Fixed tension / ( ) Automatic tension	
Position of the drive drum	( ) Head (pulling) / ( ) Center / (●) Tail (pushing)	
Number of drums > 90°	2	
Optional:		
Sidewalls	( ) With sidewalls / (●) No sidewalls	
Belt scraper	(●) With belt scraper / ( ) No belt scraper	
COF belt scraper	0.60	
Surface pressure belt scraper	0.10	N/mm²
Area of contact belt scraper	3,000.00	mm²
Knife edge	(●) With knife edge / ( ) No knife edge	
Number of knife edges	1	
COF knife edge	0.40	
Surface pressure knife edge	0.10	N/mm²
Diameter knife edge	8	mm
Arc of contact knife edge	135	°

Results

Frictional force upper part	164.81	N	F1
Frictional force return part	21.01	N	F2
Force inclined conveying	0.00	N	F3
Frictional force sidewalls	0.00	N	F4
Frictional force belt scraper	180.00	N	F5
Frictional force knife edges	376.99	N	F7
Total resistance of bearings	33.04	N	F6
	+		
Required driving force	775.8	N	
Initial tensile force	928.0	N	Fp
Initial tension	0.93	N/mm	
Total belt force	1,703.8	N	
Total belt tension	1.70	N/mm	
Power of the drive motor	0.43	kW	
Minimum diameter drive drum	24	mm	

	results from AmCalc		BB 1000 mm			
upper F1	164.81	N	σ1	0.165	N/mm	10%
return F2	21.01	N	σ2	0.021	N/mm	1%
incline F3	0.00	N	σ3	0.000	N/mm	0%
side wall F4	0.00	N	σ4	0.000	N/mm	0%
scraper F5	180.00	N	σ5	0.180	N/mm	11%
knife F7	376.99	N	σ7	0.377	N/mm	22%
bearing, snub F6	33.04	N	σ6	0.033	N/mm	2%
FB	775.85	N	σB	0.776	N/mm	46%
pretension FP	928.00	N	σP	0.928	N/mm	54%
Ftot	1703.85	N	σtot	1.704	N/mm	100%

Tension in	upper	return	incline	side wall	scraper	knife	bearing, snub		pretension	
N/mm	1	2	3	4	5	7	6	B	P	
results AmCalc	0.165	0.021	0.000	0.000	0.180	0.377	0.033	0.776	0.928	
tension @ 2									0.928	0.928
tension @ 3	0.165		0.000	0.000			0.033		0.928	1.126
tension @ 1	0.165	0.021	0.000	0.000	0.180	0.377	0.033		0.928	1.704
tension @ 4	0.165		0.000	0.000		0.377			0.928	1.470

Average tension upper part: = 0.5*(tension@3-tension@2)+tension@2 = 1.0 N/mm

Average tension return part: = 0.5*(tension@1-tension@4)+tension@4 = 1.6 N/mm

Average tension total belt length: = (tension average upper + tension average return)/2 = 1.3 N/mm

Total belt elongation = (average belt tension / k1%,24h) * total belt length
Assume a belt with a relaced force elongation (k1%,24h) of: 3.0 N/mm

Total belt elongation = 1% * 1.3 / 3.0 = 0.44%
or in mm: 15,000 * 0.0044 mm
65 mm