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DETERMINING OF BREAKING AND RELAXING FORCE FOR TRAPEZOID BELT

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Abstract: Like other mechanical parts, the main part of the belts transmitter is belt as very sensitive element. For this reason, it is important to know values of forces which caused its breaking. To determine these forces, the belt investigation with destructive way it is necessary. In this paper will be presented the results of the tests carried out in the laboratory with test machine, which loads belts in pull until its breaking. The testing machine has provided measuring results of these tests in tabular and graphical form. Also transition of power by belt transmitter its important force which act on the belt branches when the transmitter is out of work. This force is necessary to create the friction force between the belt and the pulleys for power transfer. With practical importance it is to know that the force with which we fasten the belt stays at that value at all times or changes its value. This phenomenon that in the theory of belt transmitters is called belt relaxation which has been investigated with laboratory equipment and the performed results are presented in this paper.
Keywords: V-belts, breaking force, relaxing force, pull test for trapezoid belt

1. INTRODUCTION

Trapezoid belt transmitters have extensive use in the machines of various industrial branches as well as in automotive vehicles, agricultural and mining machinery. The most important and at the same time the most sensitive part of these transmitters is the belt. These transmitters may be with one or more belts, depending on the power they carry from the driving pulley to the driven pulley.

Therefore, it is of practical importance to know that under the action of which force, belt will breaking. This is determined by the tensile test, respectively with destructive test. In the practice of the destruction test of the belts, two methods are in use:

- Method A, during which a certain length a part of belt will cut and placed on the tensile machine. The tension continues until the sample of the belt is breaking.
- Method B, during which the entire belt is placed on the tensile machine and withdrawn until it is breaking. The tensile machine gives the test results in graphic and tabular form.

The obtained research results should be more reliable when the investigation is carried out according to method B, because the tensile force act in the entire belt, while according to method A, the tensile force act only in the taken part of the belt as a test sample.

The damaged belts in the transmitter changed and replaced with new belts. Immediately after the belt has been placed, it must be tightened with the help of appropriate mechanism for tightening.

In the particular importance is to know how much should be tightness force and also to know that this force changes over time and as long as the changes occur. If the initial tightening force decreases to a constant value of the belt force, then this force is called a relaxing force.

2. DETERMINING OF THE BREAKING FORCE

The breaking force F_k and relative deformation ε_k are determined in the tensile machine ZWICK 1465. In this case, tensile tests have been carried out until the breaking belt for the trapezoid belt with narrow profile such as SPZ, SPA and SPB belts. For all three profiles are investigated by three samples were test results are presented in Table 1 and 2. Diagrams force - relative deformities are shown in Figure 2, Figure 3 and Figure 4. Investigations are conducted according to method B.

- **Investigation of belt with destructive method**

The destructive method is more accurate because the belt is placed in the tensile machine exactly as it is placed in the belt transmitter during its work. The tensile machine schematically is presented in Figure 1.

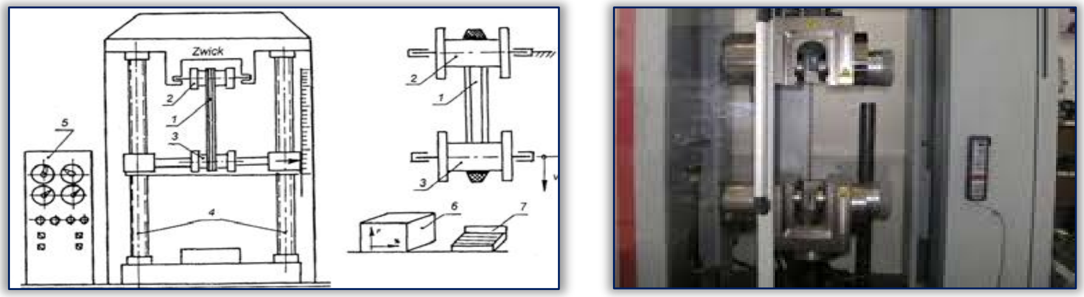


Figure 1. Tensile machine for investigation of belt characteristics: 1. Belt, 2. & 3. Pulleys, 4. Shaft with trapezoidal threads, 5. Remote control, 6. Computer, and 7. Keyboard

The speed of motion of the lower wheel can be varied, but according to the standard for investigation of the belts it is recommended that the speed be v_t = 50 mm/min.

The values for:

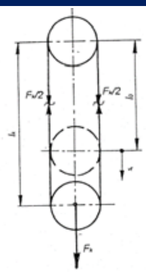
- » belt's active and breaking load,
- » relative extension for the respective tensile force,
- » relative deformation (stretching) at the moment of breaking,
- » load needed for research start,
- » preloading speed,
- » speed during testing,
- » ambient temperature, and
- » relative humidity.

can be shown and printed from computer connected to the tensile machine.

Table 1. Labor result obtained from destructive tests

Belt Profile		Test Sample	Force F (N)					Breaking Force	Elongation at the breaking point	The number of tensile cord
			500	1000	1500	2000	5000	F_{ki} (N)	ε_k (%)	z
SPZx 737L_p	Relative deformation ε_k (%)	1	4.41	5.73	7.46	9.44	18.12	6190	20.73	5
		2	4.16	5.48	7.15	9.12	17.88	6310	20.78	5
		3	4.09	5.47	7.15	9.14	17.89	6090	20.24	5
SPAx 982L_p	Relative deformation ε_k (%)	1	4.27	5.64	6.50	7.49	13.91	9080	20.02	7
		2	4.39	5.81	6.65	7.62	14.03	8830	19.73	7
		3	6.57	8.80	10.10	11.60	21.08	9180	30.08	7
SPBx 2000L_p	Relative deformation ε_k (%)	1	1.12	1.63	2.09	2.65	7.91	12490	14.70	8
		2	0.96	1.39	1.82	2.37	7.84	12380	14.54	8
		3	1.53	2.24	2.72	3.32	9.72	12860	17.10	8

Table 2. Labor result obtained from destructive tests

	Test Sample	Breaking Force F_{ki} (N)	Average Breaking Force F_k (N)	Relative deformation ε_{ki} (%)	Average relative deformation ε_k (%)	Experiment conditions	Experiment scheme
SPZx 737L_p	1	6310	6197	20.583	20.583	- velocity v_t = 50 mm/min - temperature t_a = 23°C - humidity φ_r = 52%	
	2	6190		20.73			
	3	6090		20.24			
SPAx 982L_p	1	9080	9030	20.02	23.277		
	2	8830		19.73			
	3	9180		30.08			
SPBx 2000	1	12490	12577	14.70	15.447		
	2	12380		14.54			
	3	12860		17.10			

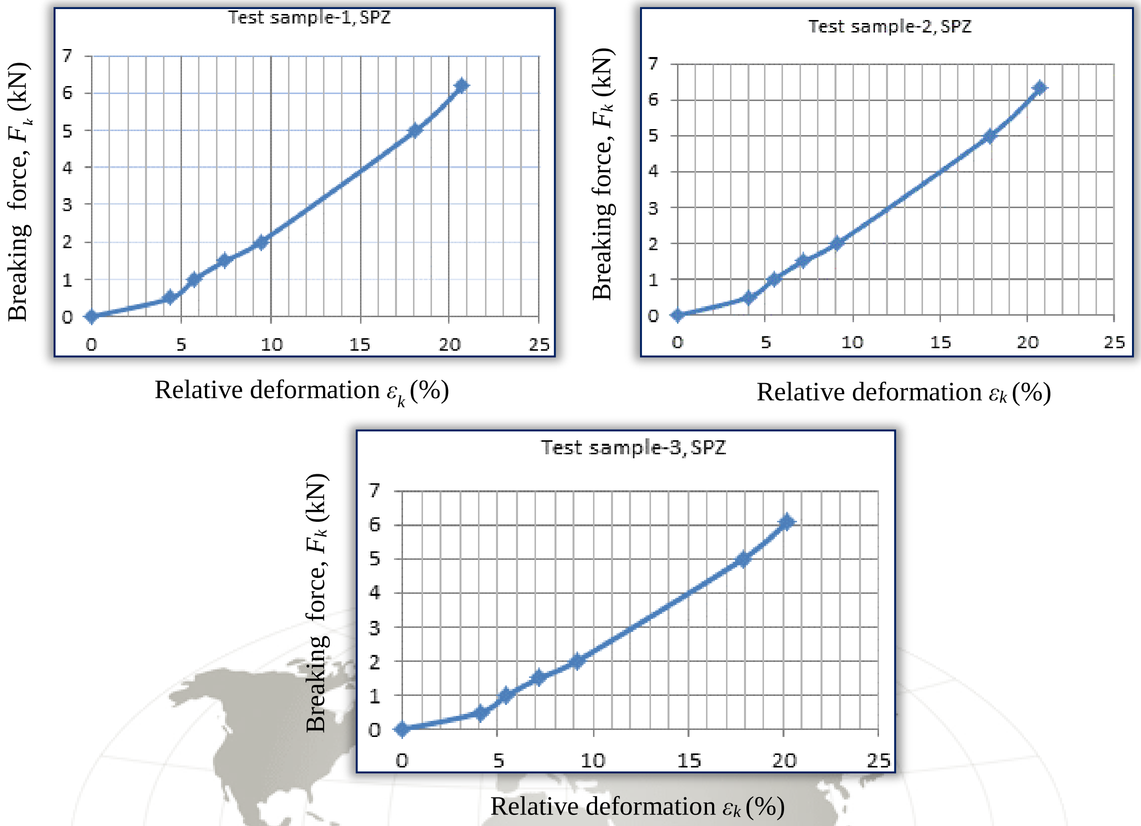


Figure 2. Force – relative deformation diagrams for SPZx737L_p

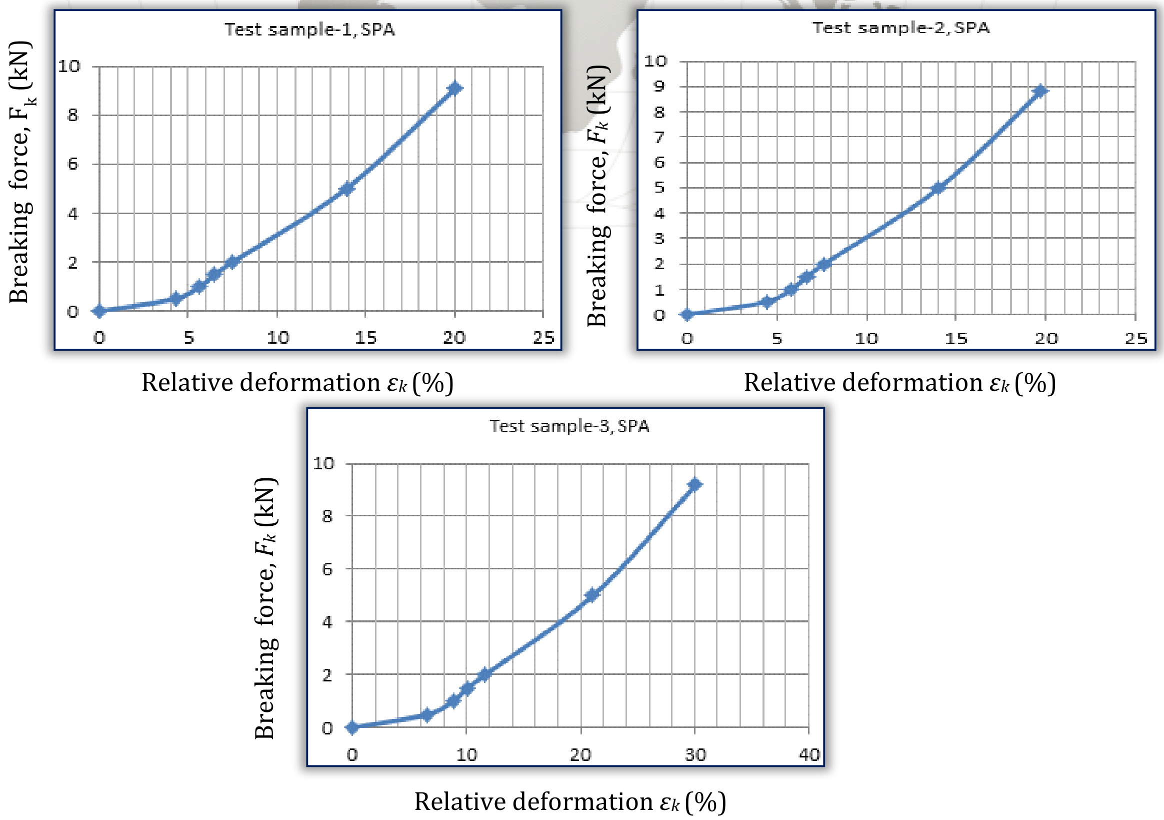


Figure 3. Force – relative deformation diagrams for SPAx982L_p

In Figure 2, Figure 3 and Figure 4 are presented force – relative deformation diagrams obtained from equipment for investigation of belts. Three different profiles (SPZ, SPA and SPB) are researched in three test scenarios until the breaking of the belt, but diagrams are shown only for three test samples respectively. Tabular results on ε_{ki} longitudinal relative deformation (%) depending on the tensile force

F_k (N) are given for all researched test samples. The results for the breaking force F_{ki} (N) and relative stretching at the moment of breaking ε_k (%) are obtained as well through these tests.

From Figure 2, Figure 3 and Figure 4, it can be seen that the breaking force has different values for different profiles, ranging from the SPZ profile to SPB profiles. The breaking point for each belt profile is defined by coordinates: breaking force F_k (N) and relative deformation at this point ε_k(%).

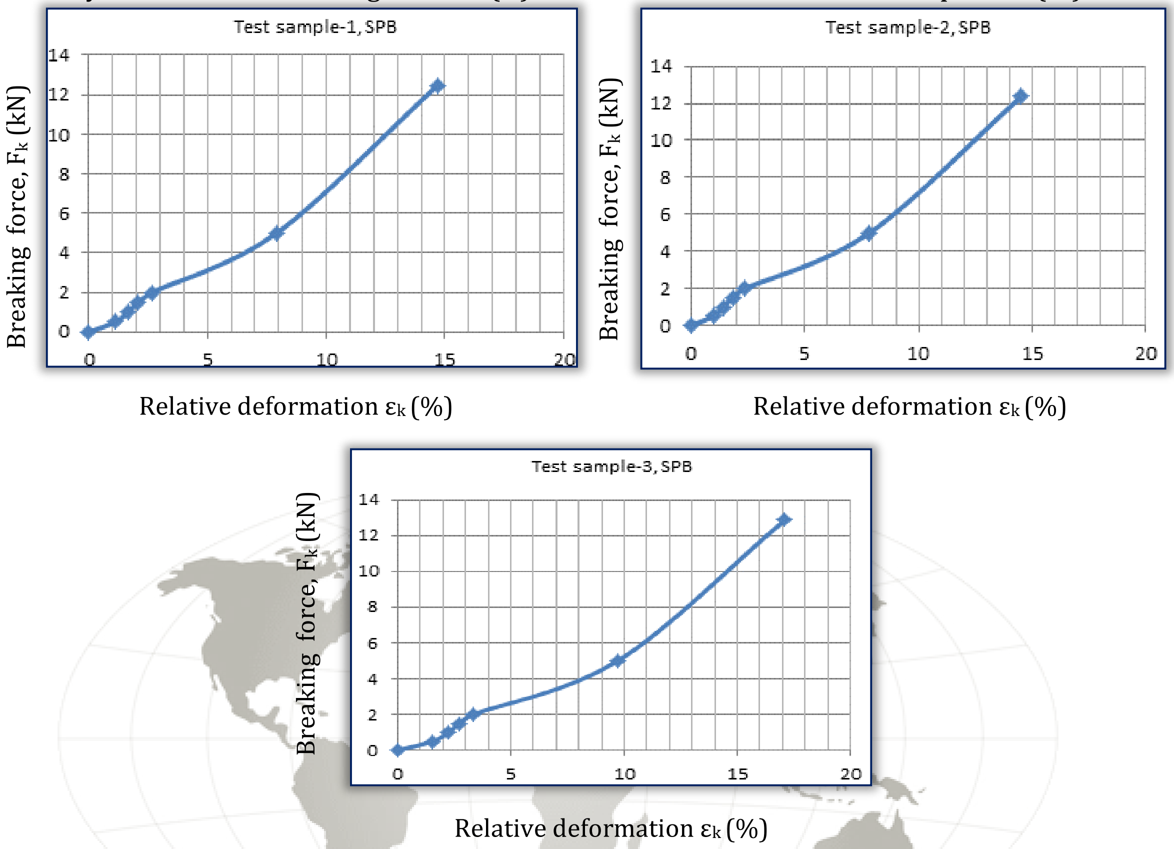


Figure 4. Force – relative deformation diagrams for SPBx2000L_p

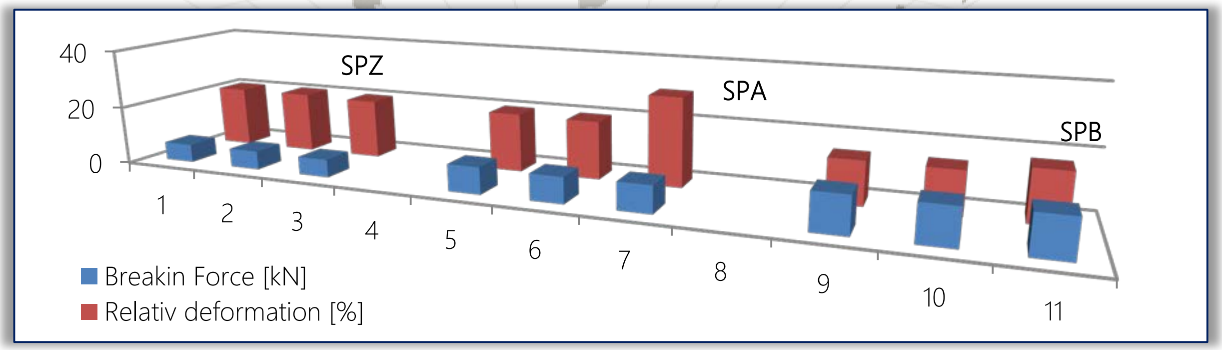


Figure 5. Graphical representation of the breaking force F_k [kN] and relative deformation ε_k [%] for investigated samples

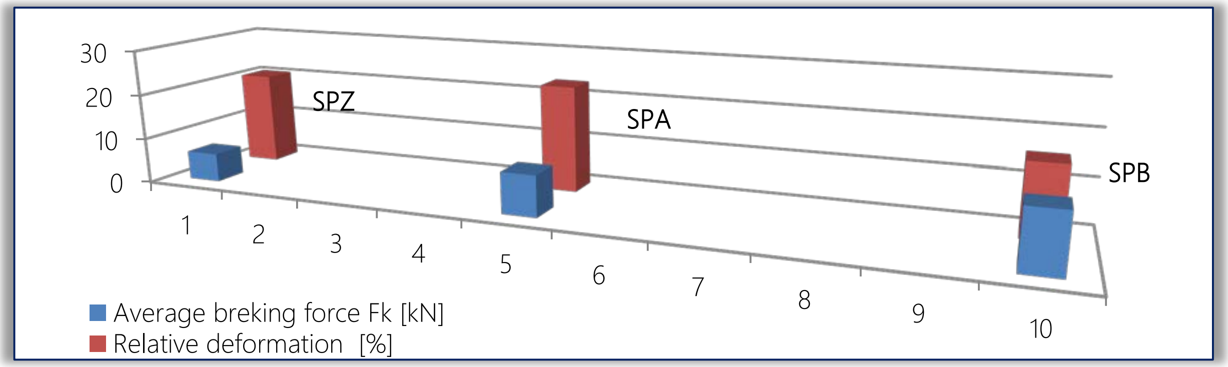


Figure 6. Graphical representation of the breaking force F_k [kN] and average relative deformation ε_k [%] for investigated samples

3. DETERMINING OF THE RELAXING FORCE

To ensure the transfer of power from the driving pulley to the driven pulley, the friction force between the pulleys and the belt must be created. This friction force is created by tightening the belt with a certain force. In practice it is important to know that the force value with which we tight the belt will remain in that value or not over the time. The answer to this question is achieved by experimenting the belt, respectively by following the change of this force over the time. The force value at which it stabilizes after a certain time is called a relaxing force, and the phenomenon is called the relaxation of the belt.
This test is performed on the belt profile AV10x725La. The test was performed on 4 samples (tubes) by loading them with different forces. In one sample (sample-1), the test was repeated in order to see how the force would be changed in this case. The tensile machine has provided the results of self-changing belt force over a 5 minute time interval. In Figure 7, the diagrams of the investigations results are presented.

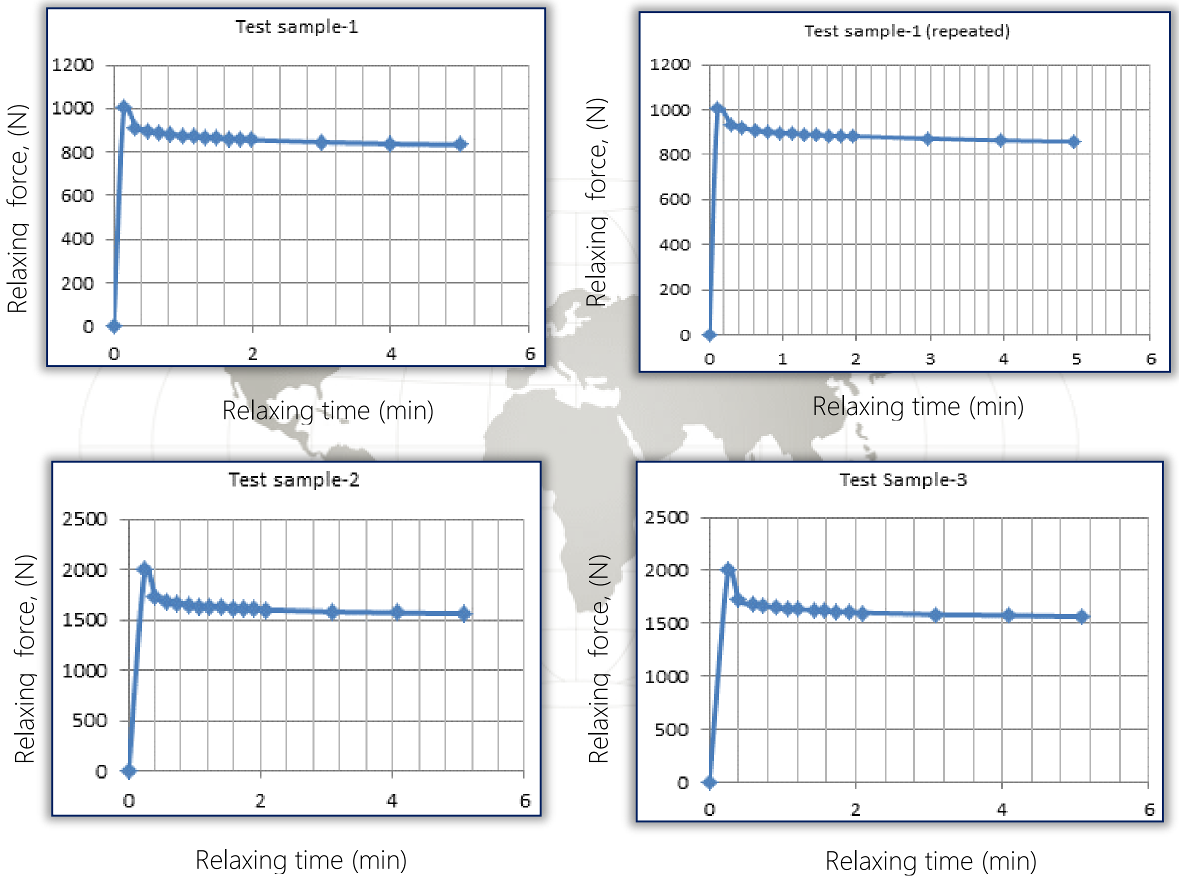


Figure 7. Relaxing force for the profile AV10x725La

From the all diagrams presented in Figure 7, it can be seen that the phenomenon of relaxation of the belt is defined by: relaxing force and relaxation time. From the presented diagrams can be read the relaxation forces, as follows:

- Sample 1, the relaxing force is equals 83% of the active force,
- Sample 1 (repeated test), the relaxation force is equals 85% of the active force,
- Sample 2, the relaxation force is equals 78% of the active force,
- Sample 3, the relaxation force is equals 76% of the active force,

4. CONCLUSION

The obtained results with laboratory tests are with practical importance, because they enable other belt calculation such as strain and carrying capacity. From the performed study in this paper it can be concluded that:

- Function of force - deformation, is different for different profiles of trapezoidal belts,
- Multiple strands of the strings on the tensile layer have greater breaking force,
- The presented diagrams enable for any values of acting forces in the belt can be determined its relative duration,
- At the beginning of force action deformations grow faster than force due to elasticity of wrapping and rubber textile,

- Stabilization of tightening forces on the belt occurs after the time of 3 minutes
- The initial tightening force of the belt is reduced by approximately 20% due to the phenomenon of relaxation of the belt.

Therefore, in order to measure correctly the tightening force for case of changing the trapezoidal belt to the transmitter, the measurement of the tightening force should be made after of the 4-5 min of tightening belt.

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