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DEVELOPMENT OF A NEW METHOD OF CONNECTING CONVEYOR BELTS IN MINING ENTERPRISES

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Abstract
This article presents the methods of connecting conveyor belts used in mining enterprises, developed new methods for connecting conveyor belts. In addition, the disadvantages of the current connection method are also mentioned. The methodology for conducting experimental studies using newly developed methods and the preliminary results obtained are also presented.

Keywords: conveyor belt, connection methods, rollers, rubber-fabric belt, rubber-cable belts, cold method.

Introduction

The extraction of minerals and their delivery to the address of the consumer or processing enterprise is the basis of any industry that ensures the growth of the sectors of the economy of any state. In mines with a depth of 400-700 meters, one of the most effective ways is to transport the rock mass by conveyors. It will also reduce the cost of other modes of transport.

The vehicles used in the mining industry must have high performance, large payload and durability, ensure the uninterrupted delivery of minerals over long distances.

One of the most efficient types of continuous transport machines are belt conveyors because they can transport minerals over long distances with minimal labor and energy. Cross-linked conveyors can be effectively used for the delivery of minerals over long distances, as well as in batch-continuous technological complexes.

Today's experience shows that one of the biggest problems with belt conveyors is that the belts often break and need to be repaired. As you know, the process of servicing the conveyor belt takes a certain time, resulting in uninterrupted stops of transport and a decrease in its productivity. To prevent such cases, it will be necessary to improve the methods of connecting the conveyor belt.

Delivery of raw materials and semi-finished products from mining enterprises to processing enterprises, maintaining product quality, increasing the durability of the

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conveyor belt, reducing the time spent on repairing the belt and increasing productivity is one of the urgent tasks of our time.

The belt is the most expensive element of the conveyor. The cost of repairing and replacing a belt is a major part of the cost of using a belt conveyor.

The most common type of conveyor belt is the rubberized fabric belt (Figure 1). The basis of such tapes is usually made up of several layers of cotton fabric (belting) or synthetic (anid, nylon, nylon, etc.) fibrous fabrics, called gaskets, in the production of a tape between the gaskets and the top, bottom, and the sides of natural or synthetic mass are pushed from rubber, and they are glued together by vulcanization and pressing. The layers of fabric are then joined together to form a protective layer (rubber pad) on the top, bottom and sides.

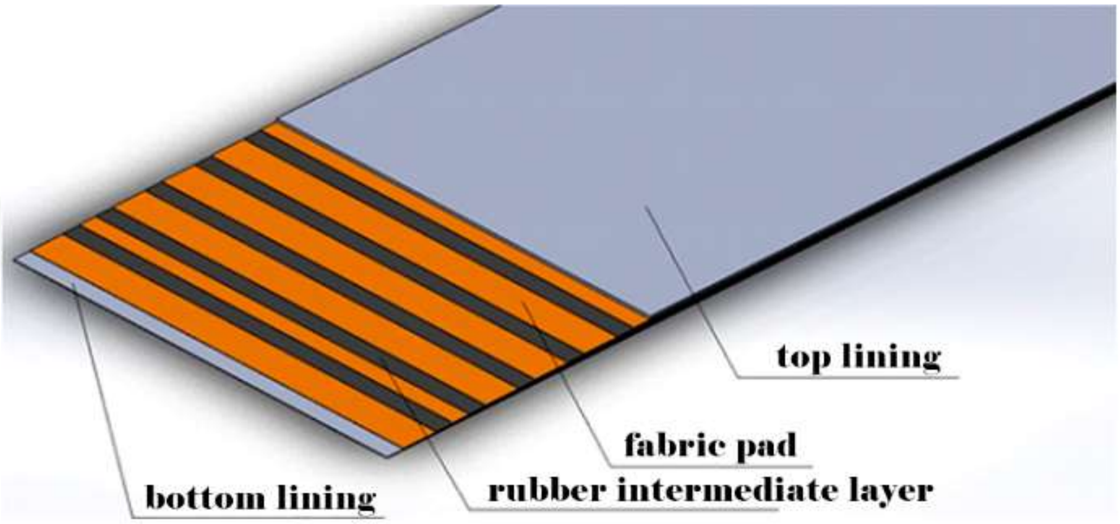

Figure 1. Rubber fabric tapes

To date, the most advanced and efficient is the mechanical cutting of conveyor belts and cutting the tape in the form of a ladder (Fig. 2).

In this method, the conveyor belt is cut into a 16-degree step and a special adhesive is applied. It is then flattened with a heavy load or hot vulcanized. As a result, the connections of the conveyor belts are ready for operation and the belts are mounted on the conveyor device.

However, the fact that the lining of the tapes adheres poorly and firmly to each other leads to frequent breaks of the tape from its connection [2].

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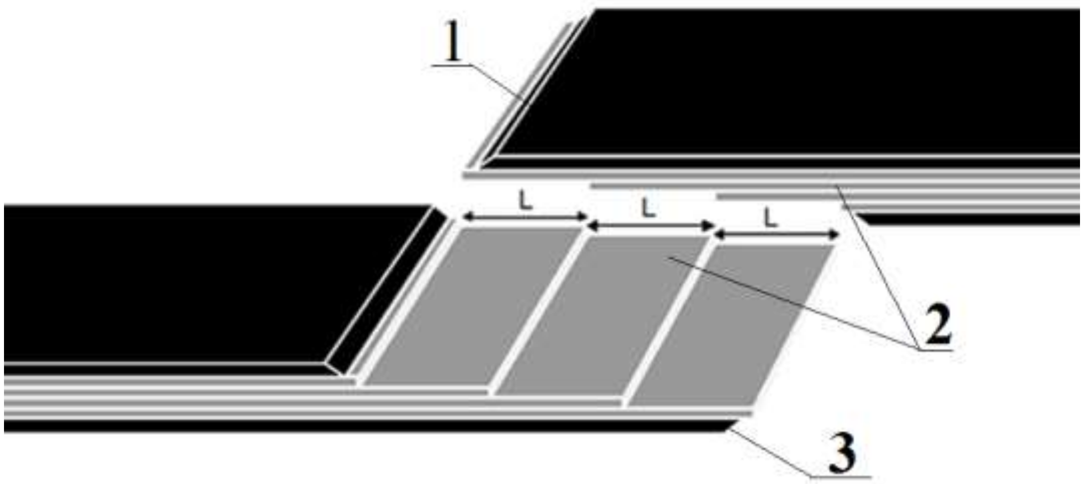

Figure 2 Way of cutting and connecting the conveyor belt in the form of a ladder
1 - top lining, 2 - fabric lining, 3 - bottom lining.

This method of connecting conveyor belts has a number of disadvantages, which include:
- lack of adhesion forces on the inner surface of the cut strips;
- high slip force on the lining and lining parts of the belts in relation to the friction force
- belt joints can separate from each other when a load is applied (fig. 3) and so on.
- frequent detachment of conveyor belts not only negatively affects its performance, but also increases the cost of repairs.

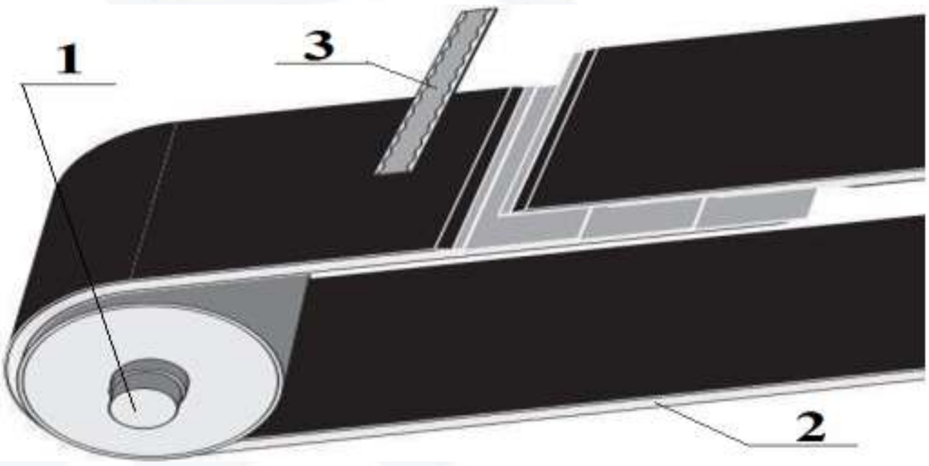

Figure 3 Method of connecting a three-layer rubberized conveyor belt in the form of a ladder
1 - drum, 2 - rubber band, 3 - fabric filler impregnated with liquid rubber

Materials and Methods

Increasing the durability of conveyor belts requires the introduction of new innovative and highly efficient technical solutions.

Therefore, it will be necessary to develop a new way of connecting conveyor belts. In this case, it may be more efficient and economical to cut the strip strip across the surface of the log and reduce the gaps between them, rather than cut the strip part of the planks in the current stepped way. Features of the cross-section of the tape coating on the surface of the log, its small size, i.e., the proximity of the gap and the presence of interconnected rows, improves the efficiency of continuous conveying by preventing momentary detachment of the conveyor belt joint and prolonging the service life. On fig. 2 (a, b, c) shows the cross connection of the conveyor belt.

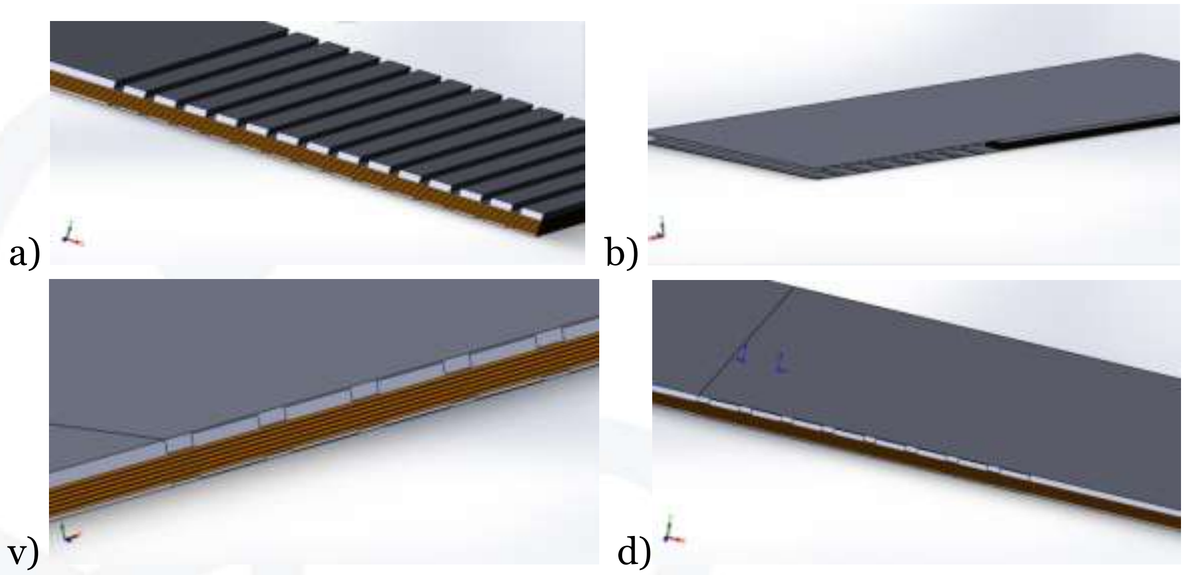

Figure 4 The conveyor belt is connected across the entire cross-sectional area.
a) view of the left side of the tape; b) view on the right side of the tape; v) is a side view of the tape in the connected position; d) view of the tape from above when connected

Experimental tests were carried out to determine the resistance of a conveyor belt cut along the cross-sectional surface to the forces of gravity acting on it.

The maximum allowable force was determined depending on the state of the strength of the belt.

$$S_{max} = \frac{S_u}{m}, \qquad \text{kg· strength} \qquad (1)$$

where Su - tensile strength of the belt, kg·force; m - safety factor, 9-12 for rubber-fabric straps and 7-9 for rubber-fabric straps.
The breaking strength Su is defined as follows:
- for fabric tape:

$$S_u = B \cdot i \cdot p \quad , \qquad (2)$$

where i is the number of fabric layers; p - breaking force of a layer 1 cm wide, kg · force / cm, (1 - taken from the table); B - tape width, cm;
Conversely, it is also possible to determine the required number of layers according to the condition of strength at maximum tension of the tape. On horizontal and inclined conveyors, the maximum belt tension when the load moves down the slope is at the entry point on the drive drum (Smax = Skir). The required number of layers is determined as follows:

$$i = \frac{S_{\max} \cdot m}{B \cdot p} \quad , \qquad (3)$$

If the number of folds, determined by formula (3), is less than or equal to the value specified in the tape passport, this tape satisfies the condition and is accepted for use.

Table 1 Specifications of rubber bands

Indicators	Tape types					
	2TA-100	2LX-120	2TA-150	2K-300	1TK-300 1TA-300	1TK-400 1TA-400
Basis of production	TU38-1058-70	TU38-105544-73	TU-38-1058-70	TU38-105544-73	TU38-10561-70	TU38-10567-70
Type of multilayer fabrics	TA-100 (fabric-anid)	LX-120 (Lavsan and cotton)	TA-150 (anid)	К-10-2-3T va A-10-2-3T	TK-300, TA-300	TK-400, TA-400
				(kapron and anid)		
Layer tensile strength, kg/cm: - based - on fiber	100 60	120 36	150 70	300 -	300 60	400 80
Relative elongation of the belt base under working load (10% relative to elongation), %	3,5	2	3,5	3	3,5-4	5
Rubber coating thickness, mm Worker Not used	4,5 2,0	4,5-6,0 2,0	4,5 2,0	4,5-6,0 2,0	4,5-6,0 2,0	4,5-6,0 2,0

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The vector representation of the resulting forces on conveyor belts was determined as follows:

$$\overrightarrow{F_N} = \overrightarrow{F_T} + \vec{N} + \vec{G} + \overrightarrow{F_{el}} + \overrightarrow{F_w} \quad (1)$$

where; F_T - gravity force [H]

$\vec{N}$ - Normally directed reaction force [H]

$\vec{G}$ - conveyor belt weight[H]

$\overrightarrow{F_{el}}$ - resulting elastic force [H]

$\overrightarrow{F_w}$ - frictional force at rest or in motion[H]

The elastic force formed in the straps was determined on the basis of the following relationship:

$$F_{el} = k \times \Delta x = \frac{E \times S}{l_o} \times (x_2 - x_1) \ (2)$$

where; Δx-relative extension[м]

k- elastic modulus $\left[\frac{H}{м}\right]$

In experimental and verification work, the resultant (1) and elastic forces (2) of the tape were obtained from the above expressions.

The results of experimental work made it possible to determine the dependence of a conveyor belt connected along the cross-sectional surface on the increase in friction forces and the reaction of interacting surfaces as a result of the action of traction, gravitational forces.

A schematic diagram of experimental equipment for experimental testing of conveyor belts cut along the cross-sectional surface is shown in fig. 3.

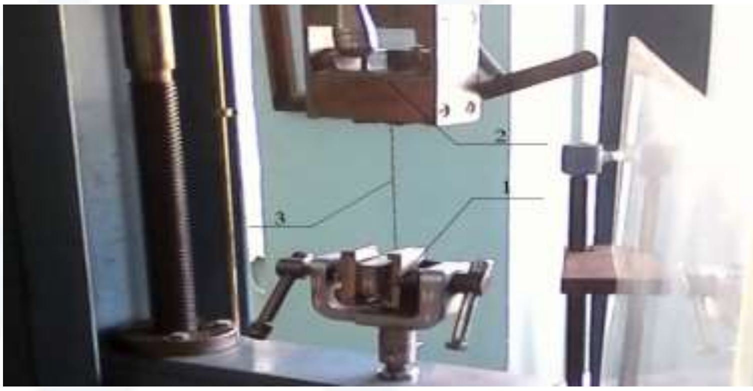

Figure 5 Equipment for determining the resistance of conveyor belts to acting and elastic forces

1 - holding bracket; 2 - control clamp; 3 - tape; 4 - scale.

An experimental device that determines the resistance of conveyor belts to emerging and elastic forces works as follows. The first end of the belt is attached to the clip (1), the second end of the belt is connected to the clip (2) controlled by the lever, and the belt is slowly pulled out. As a result, the binding and synthetic fabric that make up the tape begin to tear, and when a certain gravity is reached, the tape breaks completely. The result is a result on a scale (4) set to determine the degree of tightening and rupture. The obtained values are compared with the dimensions in the passport of the conveyor belt and the result is checked.

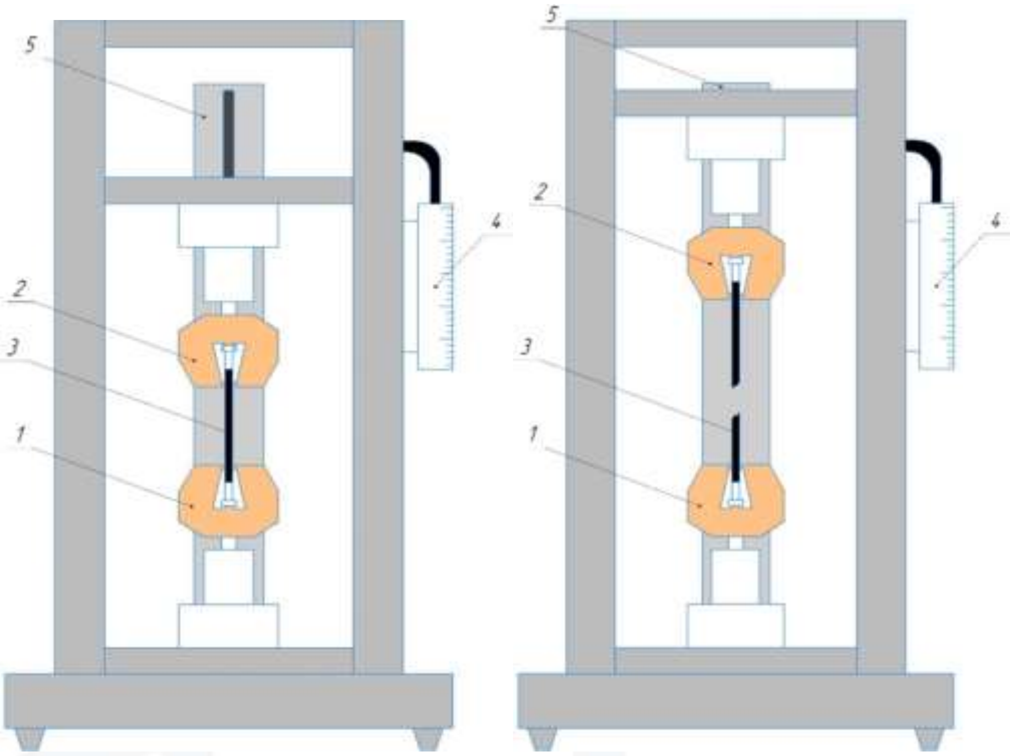

Figure 6 Equipment for determining the resistance of conveyor belts to acting and elastic forces

1 - holding bracket; 2 - control clamp; 3 - tape; 4 - scale; 5 - traction mechanism

When we stretch the conveyor belts in this device, we have the opportunity to compare the strength of the belt, the degree of elasticity before and after the repair.

During the experimental work, the following positive results were obtained.

- Reduce the number of breaks during the movement of the belt as a result of increased adhesive strength
- Reduction of resistance forces
- Correct direction of the resulting force to prevent breakage of traction conveyor belts
- Preliminary analysis of the resulting elastic force

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The connection of conveyor belts along the cross-sectional surface increases the strength of the belts, creates a favorable environment for the smooth operation of continuous transport, and eliminates one of the factors that negatively affect the annual productivity of the enterprise [6].

On fig. 4 shows a diagram of an experimental setup for testing the resistance of conveyor belts cut along the cross-sectional surface to the resulting or mechanical forces.

The experimental work was carried out as follows. The tape was attached to the equipment to determine the mechanical strength of the conveyor belts and the readiness of the experimental equipment for testing was checked. On the side of the tested traction conveyor belts, scales were installed to determine the degree of resistance of the belt to the emerging forces. The belt test device was connected to the inverter in the direction F_T - gravity, then, when the test device was started, the equipment was given the rotation frequency n and the reaction force $\vec{N}$ directed along the normal.

After establishing the operating mode, the resulting elastic force $\overrightarrow{F_{el}}$ of the conveyor belt, the tensile strength F_T of the resistance of the belt to mechanical stress were measured. The duration of the experimental work T, 10 min, to obtain the determined values for each, then the breaking force F was measured. n.

The results of experiments on checking the connection of conveyor belts on the cross-sectional surface made it possible to establish the relationship between the belt F_T - traction force and $\vec{N}$ - reaction force directed along the normal.

When connecting conveyor belts along the cross-sectional surface, a longer service life is achieved than when connecting belts in the usual (ladder) way.

Conclusion

The connection of conveyor belts along the cross-sectional surface first of all increased their mechanical strength, extended their service life, strengthened the tension reactions of the inner surfaces of the belts and increased reliability, which is based on the results of experimental studies, presented graphically in fig. 7.

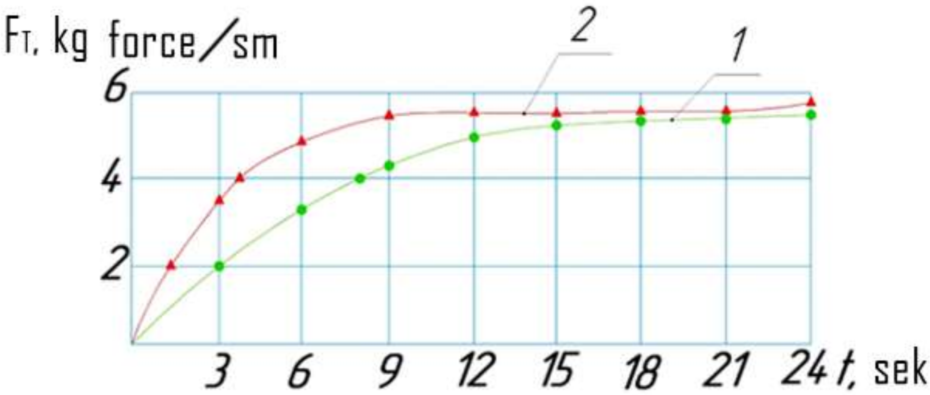

Figure 7 Graph showing belt resistance to gravity

Conveyor belts are made in such a way as to resist the forces of gravity and gravity by tightly connecting the joints or cuts to each other.

The results of the study and generalization of the experience of connecting conveyor belts used to date show that the method of connecting modern belts used in continuous-periodic transport by cutting along the cross-sectional surface with the formation of ditches has found its application.

By cutting the conveyor belt along the cross-sectional surface, the cost of repairing conveyor belts is reduced while increasing the resistance of the belts to mechanical stress, which leads to a reduction in downtime required for belt repair by 7%.

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