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ELABORATION OF THE MATHEMATICAL MODEL OF THE INTERMEDIATE LINEAR DRIVE BELT WITH PRESSURE ROLLERS

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ABSTRACT

This article describes the options for increasing traction effort. Mathematical model of intermediate linear drive with different types of pressure rollers has been given. The tractive effort transmission through the rollers with an angle of wrap in comparison with the classical theory of tractive effort transmission by the drive pulleys shows increasing in traction with equal constructive parameters.

Keywords: belt, tension, conveyor, intermediate drive, linear drive, mathematical model.

INTRODUCTION

Conveyor belt with intermediate drive is closed loop load-bearing belt in which there is one or more intermediate tape drives in the form of short belt conveyors, and the upper branch of their belt is in force frictional contact with the load-carrying conveyor belt.

Each intermediate drive overcomes the resistance of only its own interval section and provides a constant traction ability at the maximum level, which makes it independent of the angle of inclination of the conveyor and causes the reduction of the conveyor's length, technical and economic indicators are significantly improved, and the scope of use of the multidrive belt conveyors expands.

MAIN PART

To determine the effectiveness of the tractive effort transmission with an intermediate conveyor belt linear drive with clamping elements mathematical model was developed based on our suggested designs of the intermediate linear drives [1, 2, 3]. Design scheme of the model is shown in Figure-1.

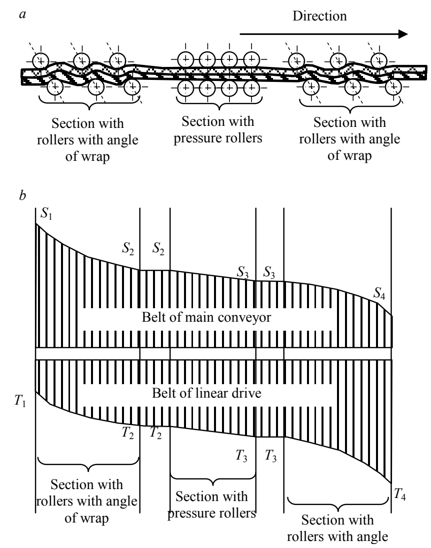

Figure-1. Design scheme developed mathematical model: *a* - drive scheme; *b* - belt tension diagrams.

It is known that the section with the angle of wrap operates effectively only with the great tension, while the section with the pressing with any. So we put a section with the angle of wrap in the area with the greatest tension where the belt of the main conveyor rides on the section of the linear drive, and put in the section with the pressing in the middle. It is also considered that the drive belt tension grows while belts go through the zones of frictional contact, and the drive belt tension becomes greater than the tension of the conveyor belt, which enhances transmission efficiency of traction, and thus decided to put another section at the end of our drive.

Thus, the first and third section will operate particularly effective with great tension, while the second and the third will be effective at low tightening applications.

The use of the third type of linear drive with partitions generally is not justified since the range of the working tension is not known in advance.

Input Data:

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Initial tension S_1, T_1,
Options q, α, f

$$\begin{cases} S_2 = S_1 - \sum_{i=1}^{i=n_1} \Delta S_i & \Delta S_i = T_i(e^{f\alpha_1} - 1) + (S_i - T_i(e^{f\alpha_1} - 1))(e^{f\alpha_2} - 1) \\ T_2 = T_1 + \sum_{i=1}^{i=n_1} \Delta S_i & \\ S_3 = S_2 - q f n_2 & \\ T_3 = T_2 + q f n_2 & \\ S_4 = S_3 - \sum_{i=1}^{i=n_3} \Delta S_i & \Delta S_j = T_j(e^{f\alpha_1} - 1) + (S_j - T_j(e^{f\alpha_1} - 1))(e^{f\alpha_2} - 1) \\ T_4 = T_3 + \sum_{i=1}^{i=n_3} \Delta T_i & \end{cases} \quad (1)$$

Output
Tractive force $F = S_1 - S_4$
Optimization criteria:

$$\begin{cases} n_1 + n_2 + n_3 \longrightarrow \min \\ F = (0{,}3 \div 1{,}0) F_{\text{need}} \end{cases}$$

Where Si - belt tension at characteristic contour points of the conveyor, N, T_i - belt tension at characteristic contour points of the linear drive, N, n_i - number of rollers on each section, α – angle of wrap, f - friction coefficient, q – weight of one roller, N.

Figure-2 shows the results of the mathematical model. The Figure-2 shows that the maximum number of rollers in all cases less than 10 rows. This means that 10 pairs of rolls with a wrap angle of 5 degrees each can pass any tension, and the length of the actuator does not exceed three meters. And it is clear that with the pressing of the belt rollers are only applicable at low tension, and then gain of traction by rollers with an angle of wrap exceeds the traction force of the rollers with simple pressing.

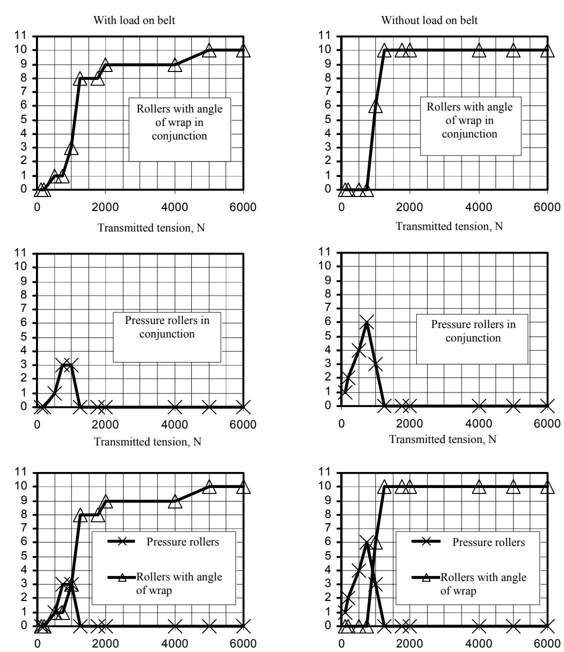

Figure-2. The required amount and distribution of the types of rollers depending on the transmission tension.

Figure-3 shows a comparison of the transmitted traction of the drive with pressure rollers, traction of the drive with rollers with an angle of wrap and their total use.

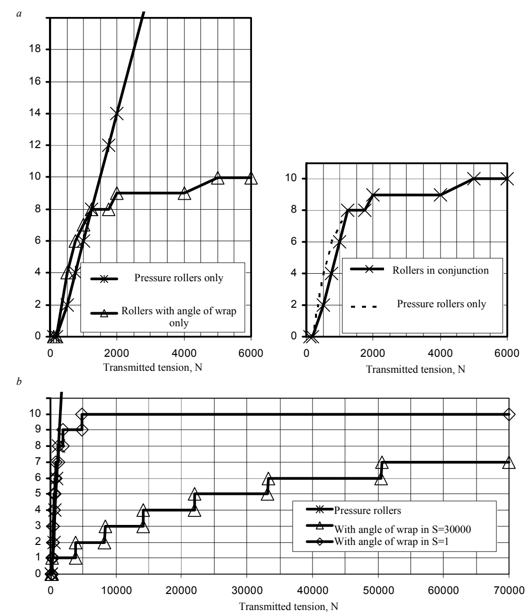

Figure-3. The required amount and distribution of the types of rollers depending on the transmitted tension: *a* - by belt tension S4 = 0; *b* - by belt tension S4 = 30000 N.

As seen in Figure-3, the total use of rollers the first and the second type gives minimal total number of rollers than the use of a one single drive type. This effect is achieved through the features of traction transmission drive with rollers with an angle of wrap which is an operation of the multiplication from a mathematical point of view. Thus, the use of the combined drive design provides benefit over the use of a one single type of drive.

CONCLUSIONS

The tractive effort transmission through the rollers with an angle of wrap in comparison with the classical theory of tractive effort transmission by the drive pulleys shows increasing in traction with equal constructive parameters: for the angle of wrap 10˚ increasing is less than 1%; 40˚ - 210%; 70˚ - 312%; 80˚ - 490%, while the belts of the drive and the main conveyor experience the equal maximum tension that allows to use the same belt.

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