ABOUT QUICK METHOD OF CALCULUS FOR MOVING PARTS OF A BELT CONVEYOR

Prof. Cătălin Iancu, *Constantin Brâncuşi University of Târgu-Jiu, ROMANIA*

ABSTRACT: In this paperwork are first presented general consideration about a belt conveyor, one of the most wide spread of continuous transportation equipment, designed both for moving loads granules as well as the movement of the individual loads. Further are made considerations about main moving parts, respectively the belt and the drums, being presented a method for calculating principal geometric parameters of these parts, useful in pre-sizing and pre-calculation

KEY WORDS: belt conveyor, rubber belt, drums, quick calculus.

1. INTRODUCTION

The belt conveyor is one of the most wide spread of continuous transportation equipment. It is designed both for moving loads granules as well as the movement of the individual loads.
For exemplification it is considered designing a belt conveyor for coal, with imposed capacity of 4500 m^3/h, with total length of approx. 360 m, having an angled portion in order to flush on other transmission line.
The length of transporting lines can reach up to 200 km, but a modern conveyor has a length of maximum 2 – 3 km; the belt speed is usually 1.5 – 5 m/s, and the width up to 2 m. The belt conveyors allow construction of various schemes of technological flows.
The main moving parts of a conveyor, which will be considered for following calculus, are the belt and the drums. In figure 1 is presented a generic belt conveyor, where can be seen the principal parts [1].

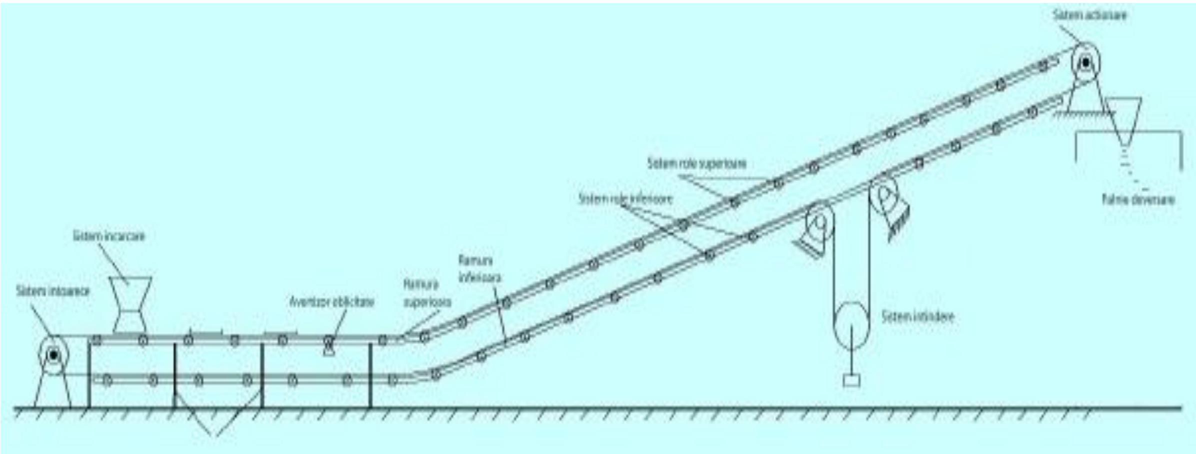

Figure 1. Generic belt conveyor

2. CONVEYOR BELT

Conveyor belt is the flexible traction organ and in the same time the carrier for transported material. It is made of rubber with textile insertions (polyester in warp and polyamide in weft), symbolized according to STAS 8983-75[2];PES/PA 125; PES/PA 160; PES/PA 400 where 125, 160, 250 and 400 represents breaking strength in N/mm for 1 insertion in finite belt, according to STAS 2077/1-85, figure 2.

Figure 2. Rubber belt with textile insertion

Textile insertions have a thickness of 1.2-3 mm, and the rubber between is about 0.2-0.3 mm. Greater thickness insertions have the warp made of textile cord with double twist. The rows of textile cord are tied together by transverse common wires.

Textile insertions can be formed by a single piece wrapped in spiral or gradually reduced in middle zone for increasing the belt elasticity. Number of insertions and the thickness of rubber coating are indicated in STAS 2077/1-85. Nominal width of textile insertion belt is: 400, 500, 650, 1000, 1200, 1400, 1600, 1800 and 2000 mm (according to STAS10674-86).

Belts with steel cables, figure 3, have usually on both sides 1-2 insertions which are designed to take kicks from transported material pieces, to assure the transverse strength of belt and to protect rubber against cuts from cables when passing over drums.

Figure 3. Rubber belt with steel cables

Belts without rubber coating can be used only in extremely favorable conditions. By the way of arrangement of cables it can be distinguished belts with separate cables and belts with wrapped cables.

Number of intermediate layers on which depends its strength is chosen according to belt width, increasing with it. The belt must have a certain degree of elasticity, but not to

be very wider, so that the edges not to bend down.
By this cause, in case of heavy individual loads or granular loads with thick pieces, regardless of number of layers requested of strength condition, must exists more intermediate layers then light loads case.
Usual types of belts can work well at medium temperatures, that is from -20 till +50/+60 C. When temperatures are lower or higher, one must use special types of belts.
Even on short conveyors the belt has al least one splice, because mounting an endless belt is quite complicated. The splice most logical for belt ends is done by gluing and then vulcanization or by sewing.
For this purpose the belt ends are cut oblique in steps, are overlapped so the number of layers from splice point and the belt thickness remain the same.

3. BELT CALCULUS

The calculus principles are based on DIN 22101, DIN 22102, DIN 22107, DIN 15207, norms [3], Belt Conveyor Design-Dunlop and other Romanian norms for conveyor calculus.
So, for the exemplified conveyor, the initial data are:

Transported material: wet or dry lignite
Medium density: 1.25 [t /m^3]
Angle by the material cone = 28-32° for crushed lignite and 25-26° for uncrushed lignite.
Transport capacity: Q = 4500 [m^3/h]
Temperature of environment: -10°C - +35°C.
Size of transported material approx. K= 0 - 60 [mm], figure 4.

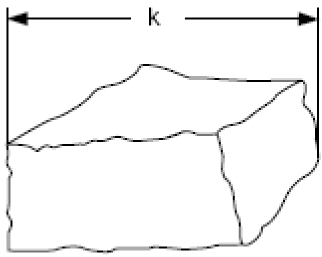

Figure 4. Dimension K for transported material

Transport speed is another characteristic parameter. The belt speed is chosen depending on transported products type, but also depending on productivity, to DIN 2201.

$$v = 5.24 \text{ [m/s]} \qquad (1)$$

3.1. Load section and belt width calculus

According to impose capacity

$$Q_V = 4500 \text{ [m}^3\text{/h]} \qquad (2)$$

For transverse section area, figure 5, the area of load section A [4], can be used geometric relations that can be composed of:

A = A1+A2 – section area
λ - roll angle (so called river bed angle of rollers)
b 1- useful width of belt
β - overload angle of belt
l - length of base roll

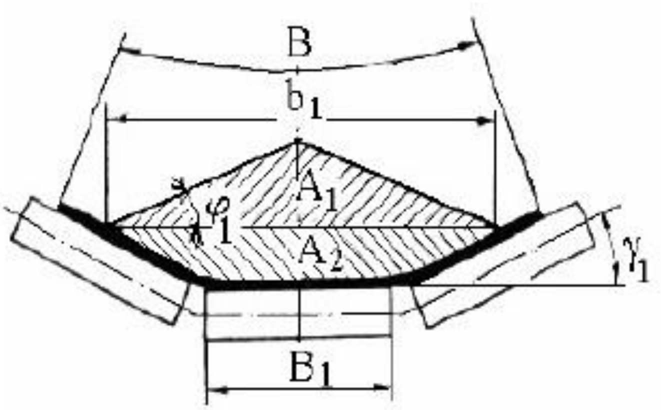

Figure 5. Section area trough material and belt

Due to the shock and vibration in the movement of the belt, the cross-section of the material layer changes. For establishing real

section must be considered the filling degree of belt, expressed by filling factor φ.

The filling factor takes into account the working conditions [φ1] and the reduction area during transportation of A1 area, by [φ2] factor, so:

$$\varphi = \varphi 1 + \varphi 2 \qquad (3)$$

Where:

-for normal working conditions [φ1] =1

-for other working conditions [φ1] =0.5-1, factor depending on degree of inclination of rollers.

For river bed like belt [φ2] = 0.4-0.6.

The real transport capacity (mass) Qm [t/h], is calculated with:

$$Q_m = Q_v \cdot \rho \quad [t/h] \qquad (4)$$

$$Q_m = 4500 \cdot 1.25 = 5625\ [t/h] \quad (5)$$

For determining of belt width B, [m] for river bed like belt is used the relation:

$$B = \sqrt{\frac{Q_m}{270 \cdot v \cdot \rho \cdot \varphi}}\ [m] \qquad (6)$$

$$B = \sqrt{\frac{5625}{270 \cdot 5,24 \cdot 1.25 \cdot 1}} = 1.78\,m \quad (7)$$

So regarding the established parameters is chosen the conveyor belt according to STAS 2077/1-85, belt width 1800 mm, PES/PA-400- (8+4).

3. DRUMS CHOICE

For movement of rubber belts, as well as steel reinforced belts are used driven drums, which forms and dimensions are standardized according to STAS 7541-86 and deviation drums which forms and dimensions are standardized according to STAS 7540-86.

Driven drums have the role to move the belt by friction and deviation drums have the role to increase the wrapping angle of belt on drum.

Driven drums are made either by cast iron, marks Fc250; Fc150, molded in one piece, figure 6a, either in welded construction from plates and laminated, figure 6b.

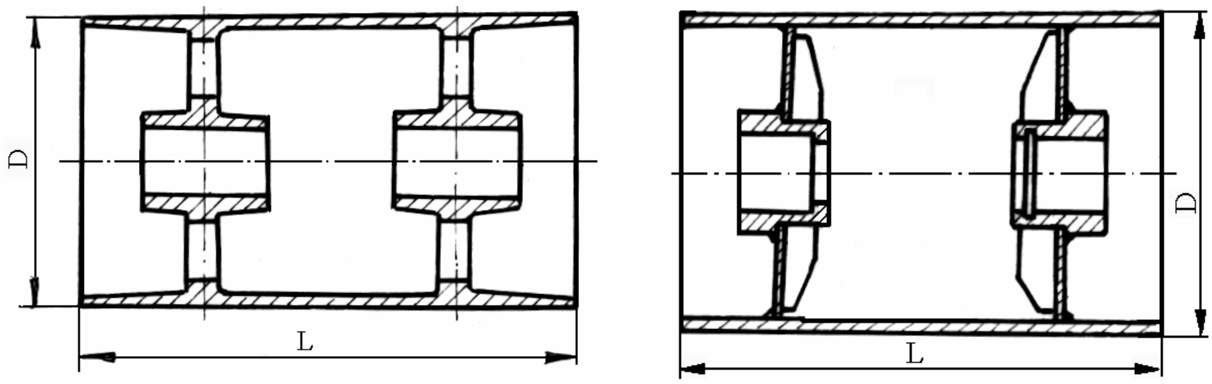

Figure 6. Variants of drums

In order to increase adherence to drum surface this is lining with rubber.
The walls of steel drum are 10 mm thick for diameters smaller than 750 mm; 12 mm thick for diameters between 750 and 900 mm; and 15 mm and thicker for diameters over 900 mm [5].

For avoiding lateral sliding of rubber belt the drum is more bulging in the middle.
In figure 7 is presented the ensemble of a driven drum, and in figure 8 is presented the ensemble of a free drum, which can be mounted as stretching drum or deviation drum.

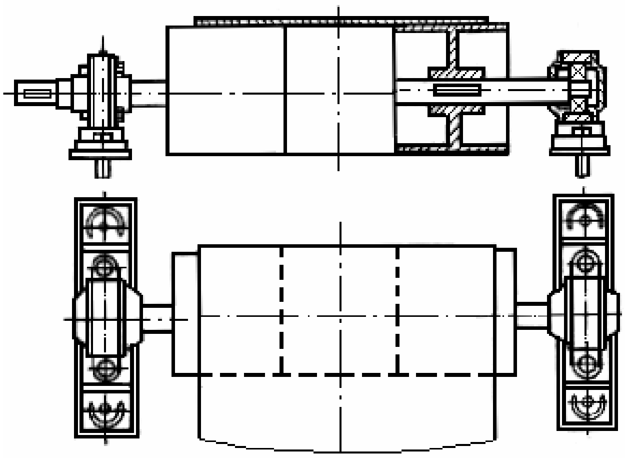

Figure 7. Mounting of a driven drum

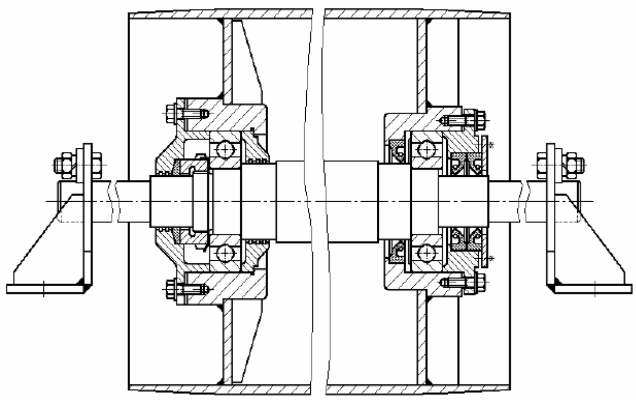

Figure 8. Mounting of a free drum

Drum diameter for rubber belt is established based on relations:
- for driven drums:

$$D_A \geq 130 \cdot i$$
$$D_A = 130 \cdot 6 = 780\,mm \quad (8)$$

It is chosen according to STAS 7540-86, the pre sizing diameter:

$$D_A = 800 \text{ mm} \quad (9)$$

- for deviation drums:

$$D_D \geq 100 \cdot i \quad (10)$$

According to STAS 7540-86:

$$D_D = 100 \cdot 6 = 600\,mm \quad (11)$$

Where:
i – number of layers of belt.

Normally are chosen upper value diameters for lowering belt ware.

4. CONCLUSIONS

The belt conveyor is one of the most wide spread of continuous transportation equipment. The main moving parts of a conveyor, which have been considered for presented calculus, are the belt and the drums.
Conveyor belt is the flexible traction organ and in the same time the carrier for transported material.
For movement of rubber belts, as well as steel reinforced belts are used driven drums, stretching drums and deviation drums.
Driven drums have the role to move the belt by friction and deviation drums have the role to increase the wrapping angle of belt on drum.
By following the presented quick method of calculus, one can determine easy principal parameters of main moving parts, that are the belt of conveyor and the driven and deviation drums.
That can be useful for SME when participating in various auctions for repairing or manufacturing mining equipment.

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