belt conveyors, special cassettes, very long sections

Janusz ŁUSZCZKIEWICZ, Czesław PYPNO*
Silesian University of Technology, Faculty of Transport
Krasińskiego st. 8, 40-019 Katowice, Poland
Corresponding author. E-mail: czeslaw.pypno@polsl.pl

CASSETTE FOR COLLECTING LONG SECTIONS OF CONVEYOR BELTS AND ITS POSSIBILITIES OF TRANSPORT

Summary. In the nineties of 20th century there were plenty of applications of long distance belt conveyors. This tendency has been noticed in many designing centres all over the world [2]. The article presents the project of long distance conveyor in which the belt is vulcanized of few but very long (of kilometre length) sections instead of many (several dozen) short sections. A small amount of sections results in a small amount of connections and has influence on the price and resistance of motion of the belt.

KASETA DO GROMADZENIA DŁUGICH ODCINKÓW TAŚM PRZENOŚNIKOWYCH ORAZ MOŻLIWOŚCI JEJ TRANSPORTU

Streszczenie. Ostatnie lata XX w. zaowocowały aplikacjami przenośników taśmowych dalekiego zasięgu. Jest to zauważalna tendencja występująca w wielu ośrodkach projektowych na świecie [2]. W artykule przedstawiono projekt przenośnika długiego lub dalekiego zasięgu, w którym taśma jest zwulkanizowana z małej ilości (kilku), ale za to bardzo długich (kilometrowych lub dłuższych) odcinków, w zamian za bardzo wiele (kilkunastu, kilkudziesięciu) odcinków krótkich (kilkusetmetrowych). Mała ilość odcinków taśm to również mała ilość łączeń, co ma wpływ na cenę oraz opory ruchu taśmy.

1. EXTENDED BELT SECTIONS FOR LONG-DISTANCE CONVEYERS

Each plant producing belts for conveyors has possibility to manufacture multi-kilometers belt sections. The only problem is with its collecting and transporting. of the most famous 10 kilometer long conveyors called BHP Gregory/Crinum runs in Australian coal mine, it was vulcanized using 18 belts, each about 1120 meters long. Belt was delivered in a special cassettes (fig. 1) [3]. After analyzing those figures we can assume, that diameter of one pulley on which there were winded half of whole belt is about 4 meters. Two pulleys mounted together on one cage makes rectangle in a plane section with length of 9 m and height 4,5 m. The height of such cargo placed on weight wagon or even car will be much bigger than vehicle gauge or building limitations, resulting in deterioration of transport.
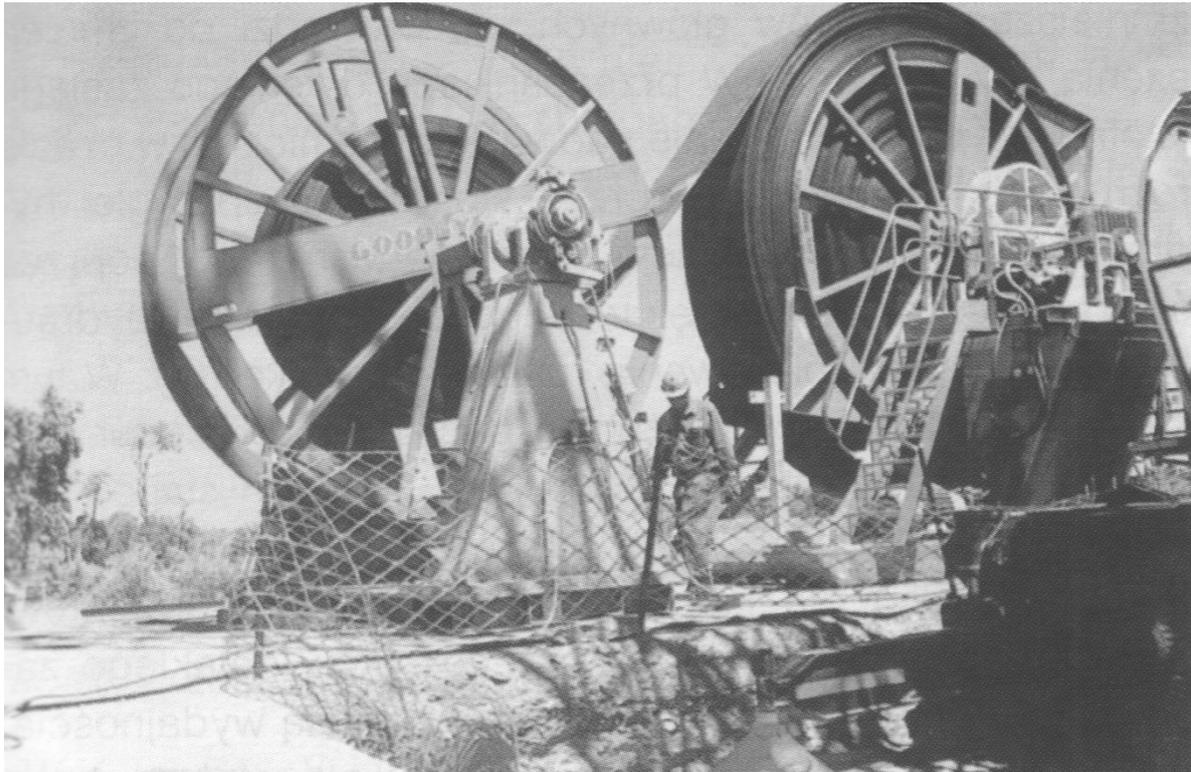
Fig. 1. 1120 meters belt section in as special cassette (Bulk Solids Handling)
Rys. 1. Odcinek taśmy 1120 m w specjalnej kasecie

2. OPERATION MODE OF CASSETTE ORIENTED TO COLLECT LONG DISTANCE BELT

The idea of operation of such cassette is described in fig. 2 and 3. Each cassette consists of 5 maxi or 3 mini pulleys designed for this special purpose, each one is individually driven. Larger cassette is placed on the axis next to the vulcanizing press, then first section of vulcanized belt (10-12 m long) is being manually hauled through stationary reels in following direction 5-4-3-2-1. For the smaller reel application, belt section (5-6 m long) is being manually hauled in direction 3-2-1. Finally end of the belt is attached to reel with number 1.

3. MINI CASSETTES WAY OF OPERATION

Mini cassettes (fig.2) enables to accumulate long belt sections, which can be used to assemble middle and long distance conveyors, especially for coal mine application. It's assumed that on the specified max. pulley diameter there can be reeled belt with a length of x, related to its thickness.

The operation mode can be specify in three phases:

Phase 1- newly vulcanized belt is reeled on pulley number 1 with length of $1,5x$, the two other pulleys are fixed.

Phase 2 – $2x$ long belt is reeled on pulley no 2, with assumption that half of its length is unreeled from pulley no 1 and other half is from newly vulcanized section. Pulley no 3 is fixed.

Phase 3 – $0,5x$ long belt is reeled on pulley no 1 from pulley no 2, the other section with similar length is reeled on pulley no 3. Simultaneously, newly vulcanized belt with a length $0,5x$ is being reeled on pulley no 3.

Above presented functionality effects that belt with length $L=3x$ has been reeled on pulleys.

Unreeling of belts should be made in inverse direction: starting on phase 3 and ending on phase 1, the pulleys should also work in opposite direction.
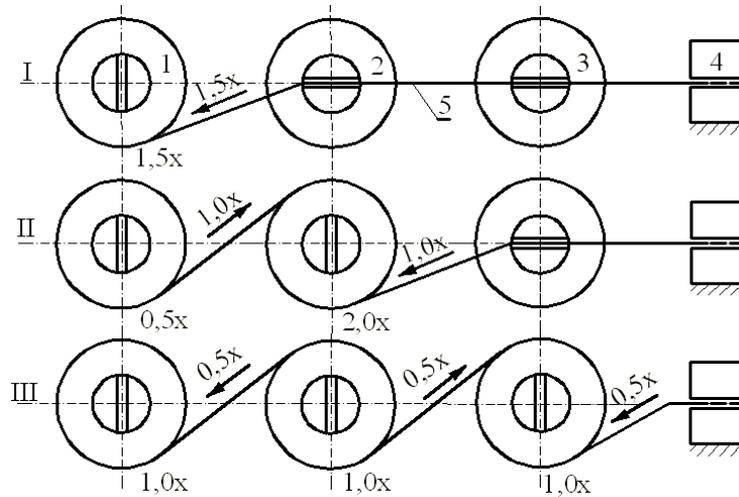
Fig. 2. The idea of operation of the 3-pulley cassette: 1-3 – pulleys for belt reeling, 4 - vulcanizing press, 5 – belt, I-III – consecutive cassette operation phases, x – length of the belt section reeled on the specified pulley diameter

Rys. 2. Zasada działania kasety w wersji trzybębnowej: 1 – 3 - bębny do nawijania taśmy, 4 – prasa wulkanizacyjna, 5 – taśma, I – III kolejne etapy działania kasety, x – długość odcinka taśmy nawiniętej na ustaloną średnicę szpuli

4. MAXI CASSETTES WAY OF OPERATION

Conveyors with a longest range should be made with long belt sections, this is the main reason why maxi cassettes (fig. 3) are applicable. It's assumed that on the specified max. pulley diameter there can be reeled belt with a length of x, related to its thickness.

Phase 1 – newly vulcanized belt with length 2x is reeled on pulley no 1, the other pulleys are fixed. This type of cassette requires pulley no 1 with a diameter greater than the rest of pulleys (comparison fig. 4b).

Phase 2 – 4x long belt is reeled on pulley no 2, with assumption that half of its length is unreeled from pulley no 1 and other half is from newly vulcanized section. Pulley no 3, 4 and 5 are fixed.

Phase 3 – 1x long belt is reeled on pulley no 1 from pulley no 2, the other section with similar length is reeled on pulley no 4. Simultaneously, newly vulcanized belt with a length 1x is being reeled on pulley no 4. Pulley no 3 and 5 are fixed.

Phase 4 – 0,5x long belt is unreeled from pulley no 2 and then reeled on pulley no 1, the other section with similar length is reeled on pulley no 3. Simultaneously, belt with length 0,5x is unreeled from pulley no 4 and reeled on pulley no 3 and the other section with similar length is reeled on pulley no 5. At the same time newly vulcanized belt with a length of 0,5x is reeled on pulley no 5.

Above presented functionality effects that belt with length L=5,5x has been reeled on pulleys.

Unreeling of belts should be made in inverse direction: starting on phase 4 and ending on phase 1, the pulleys should also work in opposite direction.
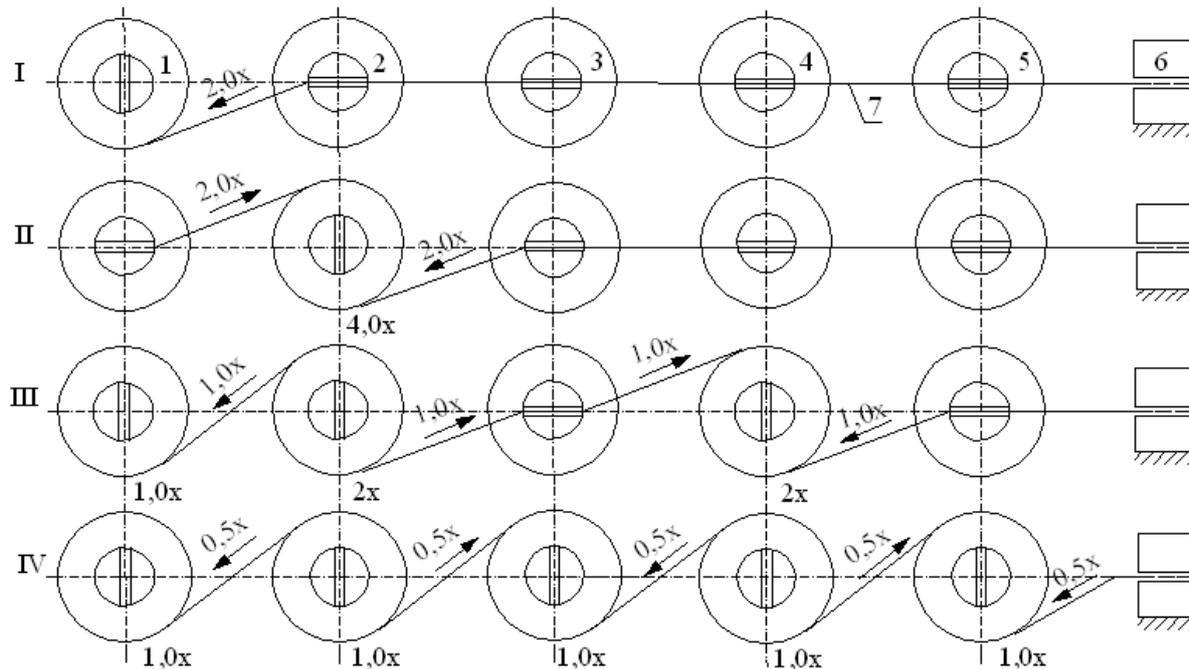
Fig. 3. The idea of operation of the 5-pulley cassette: 1-5 – pulleys for belt reeling, 4 - vulcanizing press, 5 – belt, I-IV – consecutive cassette operation phases, x – length of the belt section reeled on the specified pulley diameter

Rys. 3. Zasada dziania kasety w wersji pięciobębnowej: 1 – 5 - bębny do nawijania taśmy, 6 – prasa wulkaniza- cyjna, 7 – taśma, I – IV - kolejne etapy działania kasety, x – długość odcinka taśmy nawiniętej na ustalo- ną średnicę szpuli

5. GENERAL REMARKS CONCERNING CASSETTE DESIGNING AND TRANSPORTING

The operation of reeling and unreeling of belts results that following parameter of pulley varies: rotational speed and direction of rotation, exceptionally pulleys have speed of rotation equal to 0. Those functionality could be provided using microcontroller, which consists of sensor to measure changes in diameter of pulley belt layer and controllers to collect signals from sensors. The whole system should be driven by asynchronous motor controlled using frequency converter and specially designed controller program.

Supporting structure for the maxi cassette could be made of space truss with a dimension closed to train containers. Such solution will guarantee feasible reloading of cargo using container crane, truck-mounted crane of reachstacker type or TTREX Demag type. Depending on cassette size it can be transported by flat wagon, pocket wagon or articulated road train (fig. 4b).

For mini cassette, supporting structure should be adequately smaller spacer truss. However its reloading and transportation will be similar to maxi one. Important notice is that transport of cassette must be possible using mine's pit-shaft (fig. 4a). Such possibility will allow to assembly mine conveyor using one segment of belt.

Total load limit for above mentioned wagon is 900 kN, which is the same as maximum allowable load for railway line of class C4 with max. velocity of 100 km/h. Maximal load of large-size cassette is 180 kN.
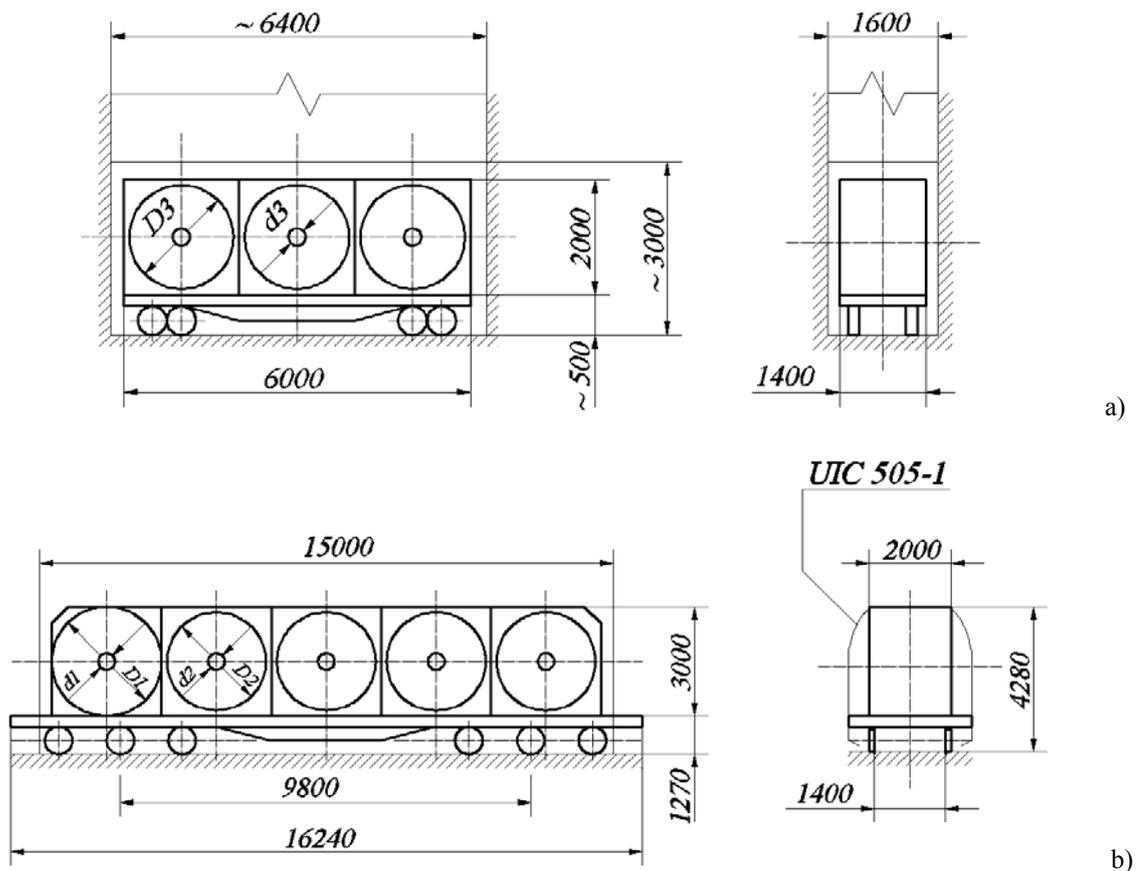
Fig. 4. Possibilities of cassettes transport: a) transporting of 3-pulleys large-size cassettes using mine pit-shaft, b) 5- pulleys cassette transport by Samos 622Za flat wagon

Rys. 4. Możliwości transportu kaset: a) transport kasety trójbębnowej klatką wielkogabarytową w szybie górniczym, b) transport kasety pięciobębnowej wagonem platformą serii Samos, typ 622Za

6. EXEMPLARY CALCULATION FOR THE LENGTH OF BELT SEGMENTS ACCUMULATED IN CASSETTES

By use of given formulas [5], there is possibility to calculate length and mass of belt reeled on a cassette. It was assumed that the diameter of pulley and reeled belt layer will be determined so there will be no possibility to exceed vehicle gauge for a case of maxi cassette or dimension of mine's pit for mini cassette [1].

Calculation for mini cassette case (as on fig. 4a)

$$x = \frac{D_3^2 - d_3^2}{k \cdot g} = \frac{2000^2 - 200^2}{1275 \cdot 14} = 222m \tag{1}$$

where: D_3=2000 mm, max. diameter of reel limited to dimension of mine's pit, d_3=200 mm, diameter of reel core, g=14mm, belt thickness, exact value for GTP (popular belt in mine industry), k=1275, constant coefficient.

Total length of reeled belt can be found from formula
$$L = 3 \cdot x = 3 \cdot 222m = 666m$$

Belt total mass with given width B_t=1 m and unit mass

$$m_j \approx 18 \frac{kg}{m^2} \quad \text{is equal to :}$$

$$M = L \cdot m_j \cdot B_t = 666m \cdot 18 \frac{kg}{m^2} \cdot 1m \approx 11988 kg$$

Calculation for maxi cassette case (as on fig. 4b)

$$1{,}5x = \frac{D_1^2 - d_1^2}{k \cdot g} = \frac{3000^2 - 400^2}{1275 \cdot 30} = 231m \tag{2}$$

where: D_1=3000 mm, max. diameter of reel limited to transport safety condition [5], d_1=d_2=400 mm, diameter of reel core, D_2=diameter of smaller reel, g=30mm, GTP belt thickness with steel strand, k=1275, constant coefficient, x=154 m.

$$D_2 = \sqrt{k \cdot x \cdot g + d_2^2}$$
$$D_2 = \sqrt{1275 \cdot 154 \cdot 30 + 400^2} = 2460mm \tag{3}$$

Total length of reeled belt can be found from formula
$$L = 5{,}5 \cdot x = 5{,}5 \cdot 154m = 847m$$

Belt total mass with given width B_t=1m and unit mass

$$m_j \approx 55 \frac{kg}{m^2} \quad \text{is equal to:}$$

$$M = L \cdot m_j \cdot B_t = 847m \cdot 55 \frac{kg}{m^2} \cdot 1m \approx 46585 kg$$

7. SUMMARY

The production of belts conveyor using long sections will allow to reduce amount of joints on the conveyor route. Consequently, it will bring economical and utilization benefits to both its users and to belt producers.

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