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PARAMETERS OF TRANSITIONAL SECTION OF HIGH ANGLE SANDWICH BELT CONVEYORS

PARAMETRI VERTIKALNIH KRIVINA TRANSPORTERA SA PRITISNOM TRAKOM ZA VELIKIE NAGIBE

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Abstract: *Methods of definition of radius of transitional curves at high angle sandwich belt conveyors are examined in this article. The dependences of radius of transitional part are given for conveyors with different productivity and different mechanical characteristics conveyor belts.*

Key words: *sandwich belt conveyors, high angle*

Apstrakt: *U ovom radu razmatraju se metode za određivanje radijusa vertikalniih krivina koje se javljaju kod transportera sa pritisnom trakom za velike nagibe. Prikazan je uticaj radijusa vertikalne krivine za trakaste transportere različitih proizvodnih i mehaničkih karakteristika.*

Ključne reči: *transporteri sa pritisnom trakom, veliki nagib*

1 INTRODUCTION

High angle sandwich belt conveyors, where the rise of an angle of lifting, is achieved by creation of normal pressure on a material through additional covered belt have received the large distribution in world practice. Despite of some constructive complexity such conveyors have conclusive advantages in conditions of open cast mines especially at large productivity and large conveying angle.

These conveyors are unified with standard type belt conveyors in the large degree. Two type contours with two traditional drives enable creations of installations with high capacities, and opportunity of realization of significant speeds of movement - with high efficiencies.

1 UVOD

Za transport materijala pod velikim nagibom u svetu se sve više koriste trakasti transporteri sa pritisnom trakom gde se upravni pritisak stvara postavljanjem dodatne trake preko materijala koji se transportuje. I pored složene konstrukcije, pomenuti transporteri imaju velike prednosti naročito u uslovima površinske eksploatacije, kod masovne proizvodnje i prilikom transporta pod velikim nagibom.

Ovi transporteri kombinuju se sa standardnim trakastim transporterima. Koriste se dva tipa pogona tradicionalnog tipa, što omogućava postizanje velikih kapaciteta i ostvarivanje značajne brzine kretanja, čime se bitno povećava produktivnost proizvodnje.

2 THE MEANING OF VERTICAL TRANSITIONAL CURVE OF HIGH ANGLE SANDWICH BELT CONVEYOR.

The significant meaning have the radius of vertical transitional curve from horizontal (loading) section to high angle section of this conveyor so it determines compactness units (especially of an overloading from one conveyor to another).

It is known, that there are some methods of definition of minimally allowable radius of a transitive curve on conveyors. The general requirements to radius of transitive curves - absence of rise of a belt above roller, preservation fluted form and some others for high angle conveyor with pressing belt are not determining, as the presence of pressing belt interferes with their occurrence. At the same time there is a new requirement - absence over-exertion in both belts on curvilinear part.

Some researchers by consideration of this unit use methods used for elastic beams with fillers. Having set a tension on first roller of curvilinear section, they receive minimal radius of a transitive curve on the first roller, and then and on all others, taking into account rigidity of a belt, resistance to movement, corner curvilinear section, number of rollers and others. At such account it is necessary previously to choose number rollers, step between them, i.e. beforehand to assume rough size of radius of a transitive site [1].

In other source of information is examined as an elastic beam and it is considered that the vertical curve should be projected so that does not cause a deflection or excessive pressure in any part of cross section of belt. The elastic body is exposed simultaneously to tension on curvilinear section, and bend by the moment M, appearing on transitive section of radius R and tests a total pressure from these two values. [2]

The model is assumed, that the curve is correct. Thus if depth and width of a chute is much less than length of a curve, and the supporting rollers are located closely to each other

$$M = EI/R, \quad (1)$$

2 ZNAČAJ VERTIKALNE KRIVINE KOD TRANSPORTERA ZA VELIKE NAGIBE SA PRITISNOM TRAKOM

Radijus vertikalne krivine pri prelasku materijala sa horizontalne sekcije na sekciju koja se nalazi pod velikim nagibom je veoma značajan parametar, jer se njegovim pravilnim dimenzionisanjem obezbeđuje ujednačenost transporta i sprečava nagomilavanje materijala pri prelasku sa jednog transportera na drugi.

Poznato je da postoji nekoliko metoda za utvrđivanje minimalno dozvoljenog radijusa vertikane krivine kod transportera. Neki od opštih zahteva, koji su bitni za transport u krivinama, kao što je prijanjanje trake (ne odizanje sa valjaka), održavanje koritastog oblika i drugi, nisu od presudnog značaja kod transportera sa pritisnom trakom s obzirom na to da pritisna traka eliminiše pomenute pojave. Istovremeno javljaju se neki novi zahtevi, kao što je na primer sprečavanje prenaprezanja obe trake u krivolinijskoj sekciji.

Uzimajući u obzir ovu činjenicu, neki autori primenjuju metode koje se koriste kod elastičnih nosača sa ispunom. Pošto se odredi sila zatezanja na prvom valjku krivolinijske sekcije, moguće je ustanoviti i minimalni radijus krive na prvom valjku i tako i na svim ostalim valjcima. Pri tom treba uzeti u obzir i sve relevantne karakteristike kao što je otpor trake pri kretanju, ugao krivolinijske sekcije, broj valjaka itd. Neophodno je prethodno odrediti broj valjaka, razmak između valjaka, tj. unapred odrediti približnu vrednost poluprečnika na mestu zakrivljenja [1].

Ako se ova veza posmatra kao elastičan nosač, vertikalna krivina će se projektovati tako da ni u jednom delu poprečnog preseka trake ne dolazi do defleksije ili do prenaprezanja. Elastično telo je izloženo istovremenom zatezanju u krivolinijskoj sekciji i momentu savijanja M, koji se javlja u krivini radijusa R, čime se dobija ukupan pritisak koji nastaje iz ove dve vrednosti. [2].

Model podrazumeva da je krivina pravilna. Prema tome, dubina i širina korita su mnogo manje od dužine krivine, a potporni valjci su postavljeni blizu jedan drugom.

$$M = EI/R, \quad (1)$$

where: E- the module of elasticity (N/mm^2),
I - moment of inertia of system, (m^4),
R - radius of a curve, (m).

The radius of a curve is determined from (1) after some transformer.

3 THE DETERMINATION OF VERTICAL TRANSITIONAL CURVE OF HIGH ANGLE SANDWICH BELT CONVEYOR.

Agreed foregoing opinion, we want to amplify that we have not homogeneous structure, we have the system "belt – material – belt". As this system sags between rollers, the relative displacement of sections of system "belt - material-belt" at distribution of an elastic wave develops of elastic longitudinal deformations of elements of system and moving at the expense of sample of dip. This moving Δl depends on a tension of system S_c and distance between rollers l_r:

$$\Delta l = q^2 l_r^3/(12S_c^2). \qquad (2)$$

The meaning can be presented as deformation following the law of Hook:

$$\Delta l = S_c l_r/E'.$$

Then the conditional rigidity E' of examined system freely laying on support, will be

$$E' = 12S_c^3/(q^2 l_r^2).$$

So if the system " belt – material – belt" is examined as a core, it will have identical displacement with a real system when we enter concept of "modular" rigidity of system E_a, equal [3]

$$E_a = E/\{1+q^2 l_r^2 E/(12S_c^3)\}. \qquad (3)$$

Here: E – total rigidity of belts, N;
$q = q_c + q_p + q_m$, - linear weight carrying belt, pressing belt and portion of load between both belts.

Rigidity E for each of plying belts in this case

$$E_{1,2} = E_0 B i,$$

Here: E_0 - the module of elasticity of 1mm of one belt ply,

gde je: E- modul elastičnosti (N/mm^2),
I - moment intecije sistema, (m^4),
R - radijus krivine, (m).

Radius krivine određuje se na osnovu (1) nakon nekih izmena.

3 ODREĐIVANJE VERTIKALNE KRIVINE TRANSPORTERA SA PRITISNOM TRAKOM ZA VELIKE NAGIBE

Osim prethodno navedenih činjenica treba imati u vidu da se ovde ne radi o homogenoj strukturi, jer se sistem sastoji od trake - materijala - trake. Kako se sistem ugiba između valjaka dolazi do relativnog pomeranja sekcija sistema "traka-materijal-traka" i pri distribuciji elastičnog talasa nastaju uzdužne elastične deformacije elemenata sistema. Pomeranje Δl zavisi od naprezanja sistema S_c i od razmaka između valjaka l_r:

$$\Delta l = q^2 l_r^3/(12S_c^2). \qquad (2)$$

Predstavljeno kao deformacija po Hukovom zakonu:

$$\Delta l = S_c l_r/E'.$$

Tada će uslovna krutost E' posmatranog sistema koji slopodno leži na nosećoj konstrukciji iznositi:

$$E' = 12S_c^3/(q^2 l_r^2).$$

Prema tome, ukoliko se sistem "traka-materijal-traka" posmatra kao središte, pomeranje će biti identično, kao i u slučaju realnog sistema kada se pređe na koncept "modularne krutosti" sistema E_a, koji je jednak [3]

$$E_a = E/\{1+q^2 l_r^2 E/(12S_c^3)\}. \qquad (3)$$

gde je: E – ukupna krutost trake, N;
$q = q_c + q_p + q_m$, - linearna težina koju nosi traka, pritisna traka i deo tereta između obe trake.

Krutost E za svaki uložak, u ovom slučaju

$$E_{1,2} = E_0 B i,$$

gde je: E_0 - modul elastičnosti za 1mm uloška trake,

B- belt width, *mm*,
i – number of plies of one of belt.

At such approach to the matter we allow to make any conclusions.

Radius of a transitive curve can be limited as excessive pressure carrying belt and pressing. One plies of both belts work on a stretching others on compression. When belt work on a stretching efforts it should not exceed the maximal working tension, and on compression - total pressure does not exceed 0.05 from maximal. [4]

Accounts have shown, that radius of a curve is limited by pressure arising on an internal surface of carrying belt. In a fig. 1 the settlement data of radius (*m*) of a transitive curve (axis ordinate) are shown for the conveyor by productivity Q = *2000 t/h* for belts with the module elasticity (E_0) accordingly *3000, 2000* and *1000 N /mm* of a ply. The tension of belts on transitive site changed from *25 kN* (minimum settlement meaning) up to *150 kN* took on the axis abscissa (seven situations of an abscissa axis). First three situations for of pressure of compression and 4, 5 and 6 lines for a stretching carrying belt.

B- širina trake, *mm*,
i – broj uložaka u jednoj traci.

Na osnovu ovoga mogu se doneti sledeći zaključci.

Radijus vertikalne krivine ograničen je pritiskom noseće i pritisne trake. Ulošci jedne trake su pod dejstvom istezanja, dok su ulošci druge trake pod dejsvom nabijanja. Kod istezanja trake sila ne sme biti veća od maksimalnog radnog napona, a kod nabijanja ukupan pritisak ne prelazi vrednost od 0.05 od maksimalnog [4].

Proračuni pokazuju da radijus krive ograničava pritisak koji nastaje na unutrašnjoj površini noseće trake. Na slici 1 prikazan je radius (*m*) vertikalne krivine (ordinata) za transporter kapaciteta Q = *2000 t/h* čije trake imaju modul elastičnosti (E_0) odnosno *3000, 2000* i *1000 N /mm* uloška. Napon trake na mestu zakrivljenja menja se od *25 kN* (minimalna srednja vrednost) do *150 kN* na apcisi (sedam situacija na apscisi). Prve tri linije označavaju nabijanje, a 4, 5 i šesta linija istezanje noseće trake.

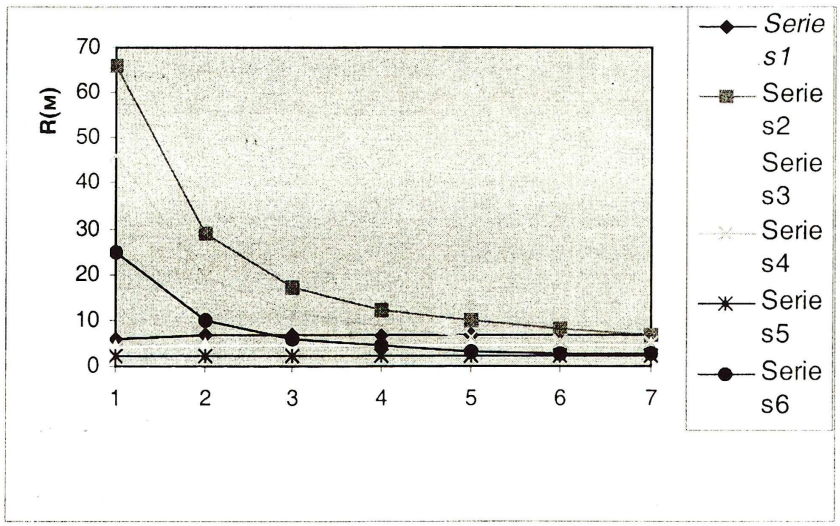

Figure 1 The meanings of radius of vertical transitive curve depending on tension for productivity of the conveyor Q =2000 t/h
slika 1 Radjius vertikalne krive u zavisnosti od napona za transporter kapaciteta Q =2000 t/h

In a figure 2 are given meanings for the conveyor with productivity *5000 t/h* and tension of transitive site from *50 kN* (minimum settlement meaning) up to *300 kN* (seven situations of an abscissa axis).

Na slici 2 date su vrednosti za transporter kapaciteta *5000 t/h* i silu zatezanja na mestu zakrivljenja od *50 kN* (minimalna srednja vrednost) do *300 kN* (sedam situacija prikazanih na apscisi).

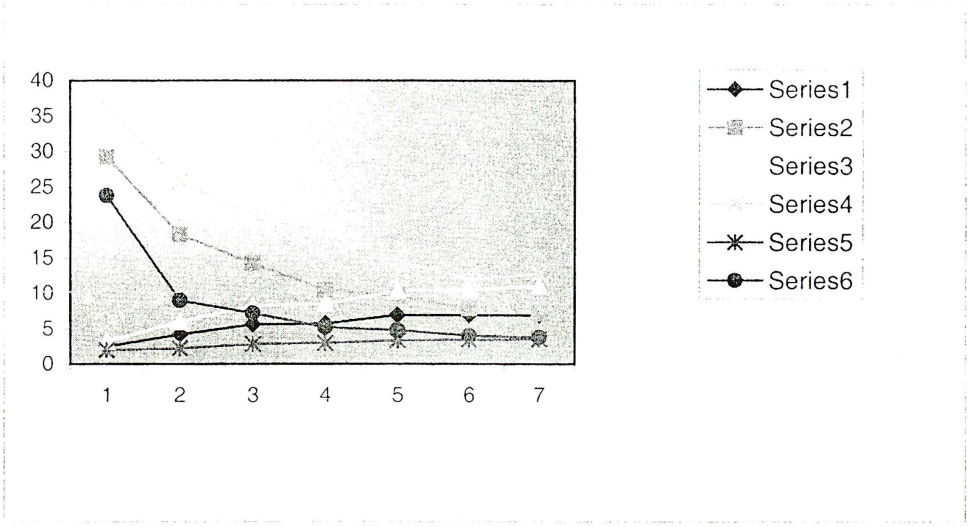

Figure 2 The meanings of radius of vertical curve depending on tension for productivity of the conveyor Q = 5000 t/h
slika 2 Radijus vertikalne krive u zavisnosti od napona za transporter kapaciteta Q = 5000 t/h

3 CONCLUSION

It is necessary to use the notion of "modular" rigidity of system E_a, takes into account a tension of a belt, rigidity of a belt, distance between rollers, linear weight of carrying belt, pressing belt and bulk material, when substantiating the radius of transitive site. Thus settlement radius of a transitive curve is decreased with reduction of the module of elasticity of a ply of a belt and increase of a tension on site. As increase of a tension over settlement results to negative consequences for the conveyor as a whole, the speech can go only about the two - three first positions, - there are real minimal meanings

3 ZAKLJUČAK

Za određivanje radijusa vertikalne krivine transportera sa pritisnom trakom neophodno je uvesti pojam "modularne krutosti" sistema E_a, koji uzima u obzir zatezanje trake, krutost trake, razmak između valjaka, linearnu težinu noseće trake, pritisne trake i rastresitog materijala koji se transportuje. Tako određen radius umanjuje se sa opadanjem modula elastičnosti uloška trake i sa povećanjem zatezanja. Povećanje zatezanja preko srednjih vrednosti ima negativne posledice po rad transportera u celini i ovde možemo govoriti samo o prve dve-tri pozicije kao o realnim minimalnim vrednostima.

REFERENCES / LITERATURA

[1] *Kartaviy A.N « Determination of parameters of ecologically safe inclined conveyor with press - down belt» International Conference "Mining 2000",Gliwice, 23-24 of November 1999, Poland.*
[2] *J.A. Dos Santos "Sandwich belt high angle conveyors according to the expanded conveyor technology" Bulk solid handling, N1,2000.*
[3] *A.A. Andreev, V.A. Dyakov, E.E. Sheshko " Transport machines and automated complexes of open - cast mining Moscow "Nedra" 1975.*
[4] *Conveyor Equipment Manufacturers Association [CEMA] 1998: Belt Conveyors for Bulk Materials – 4tn Edn.*

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