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LIFETIME PROLONGATION OF BELT CONVEYOR'S DRUMS BY DESIGN CHANGES

PRODUŽAVANJE VEKA TRAJANJA BUBNJEVA TRANSPORTERA SA TRAKAMA PUTEM MENJANJA DIZAJNA

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Abstract: *Belt conveyor's drums are the most important parts of all belt conveyors. We sorted drums to two main sorts: drive drums or driven one. It is evident, that most loaded drums are drive drums, which transfer not only forces on drum faces area (belt forces), but mainly provide transfer of torque moment to belt or take up element and load of power units too. Well, commonly happen destruction of relatively low loaded driven drum of the belt conveyors mainly thanks to no very good their design.*

Key words: *Drum, Conveyor, Lifetime, Prolongation.*

Apstrakt: *Bubnjevi trakastih transportera predstavljaju najvažniji deo transportera sa trakama. Bubnjeve delimo u dve glavne vrste: pogonski i povratni bubanj. Očigledno je da su najopterećeniji bubnjevi pogonski bubnjevi, koji prenose ne samo zateznu silu na površinu bubnja (sila trake), već i uglavnom omogućavaju prenos obrtnog momenta na traku ili zatezni element, a takođe prihvataju i težinu pogonskih jedinica. Dakle, obično se dešava propadanje relativno slabo opterećenog pogonskog bubnja trakastih transportera uglavnom zbog njihovog ne tako dobrog dizajna.*

Ključne reči: *Bubanj, transporter, vek trajanja, produžavanje.*

1 INTRODUCTION

One reason from others of belt conveyor drums deformations and their successive destructions is solid duress between drum's faces and drum's shaft (Figure 1). Thanks to the duress happen to considerable cyclical stress mainly in welds areas – connecting of faces with shaft or hub fixed on shaft respectively and between faces and drum's shell of course. There are places with start reactions of chaps which lead to mentioned destruction of conveyor drums.

1. UVOD

Jedan od razloga, između ostalih, za deformacije bubnjeva trakastih transportera i njihovog kasnijeg propadanja je konstantna zatezna sila u delu između površine bubnja i vratila bubnja (slika 1). Zahvaljujući upotrebi sile dolazi do značajnog cikličnog naprezanja, uglavnom u područjima vara – koje povezuju površina sa vratilom ili glavčinom pričvršćenom na vratilo i naravno između površine i omotača bubnja. Postoje mesta u početnoj fazi pucanja koje može dovesti do pomenutog propadanja bubnjeva transportera.

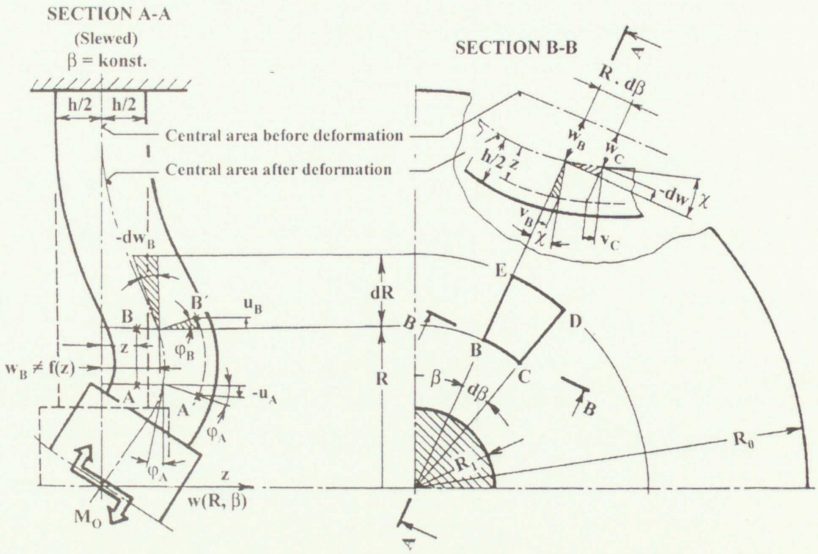


Figure 1 Duress between face and hub of drum
slika 1 Upotreba sile u predelu između površine i glavčine bubnja

2 SOLVING THE PROBLEM

It is very simple solving the problem about driven drums of belt conveyors and eliminating the undesirable duress by bearing using. Bearings, which are located on shaft ends together with bearing housings and are parts of the whole return station's frame we replace between face (hub) and shaft of the drum (Figure 2). Thereby we disturb duress and will not happen to face bending caused by shaft deflexion and welds not will be over loaded.

It is logical, that the solving is not applicable on drive drums, because the drums have to provide transfer of torsion moment to drum's shell and in form of tensile force to conveyor belts.

2 REŠAVANJE PROBLEMA

Korišćenjem ležajeva veoma se jednostavno rešava ovaj problem kod pogonskih bubnjeva trakastih transportera i eliminiše neželjena upotreba sile. Ležajeve, koji su smešteni na krajevima vratila zajedno sa kućištem ležaja i deo su okvira cele povratne stanice, stavljamo između površine (glavčine) i vratila bubnja (slika 2). Time raspodeljujemo upotrebu sile i neće se desiti da se površina savija zbog otklona, a varovi neće biti preopterećeni.

Logično je da se rešenje ne može primeniti na pogonske bubnjeve, jer bubnjevi moraju da omoguće prenos momenta uvrtanja na omotač bubnja a u obliku vučne sile na transportne trake.

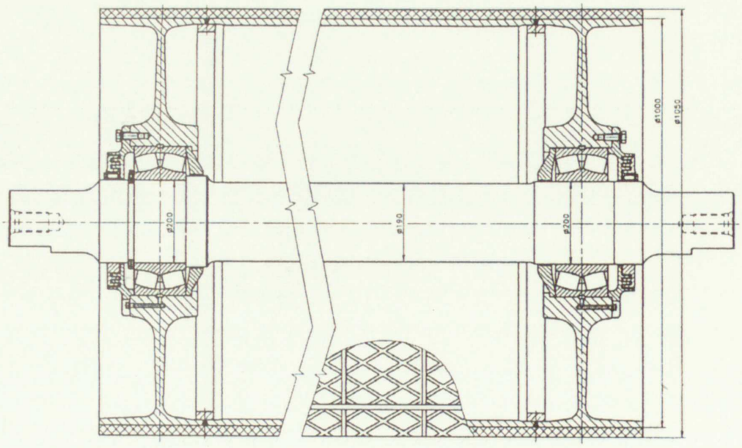


Figure 2 Driven drum with bearing under faces
slika 2 Pogonski bubanj sa ležajevima ispod površine

For conveyors with relatively small load, and all other equivalent parameters, up to 10 kW, problem can be solved by electro drums, which are drums with built-in electromotor (Figure 3). It can't be used for more powerful conveyors and in the case not solve the problem.

Za transportere sa relativno malim opterećenjem i drugim odgovarajućim parametrima, do 10kW, problem se može rešiti putem električnih bubnjeva, koji predstavljaju bubnjeve sa ugrađenim elektromotorom (slika 3). Ne može se koristiti za snažnije transportere i u ovom slučaju ne rešava problem.

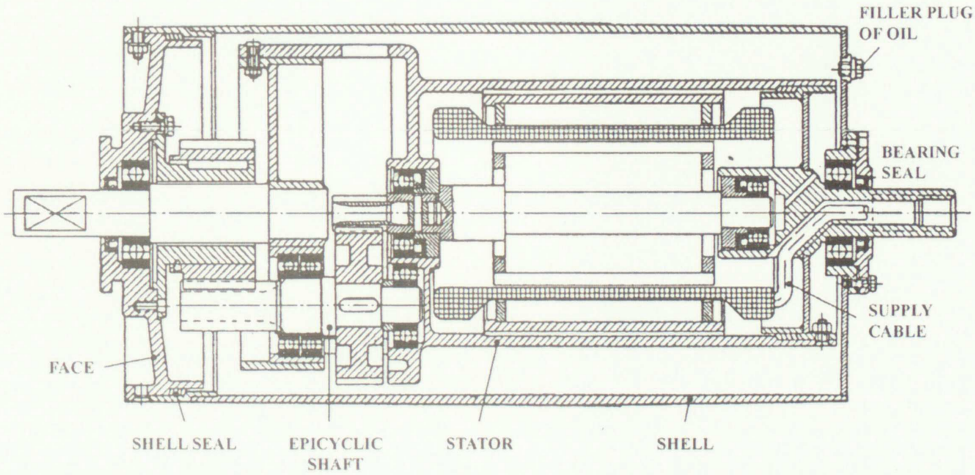


Figure 3 Electro drum for small load conveyors
slika 3 Električni bubanj za transportere sa malim opterećenjem

Partial solving of the problem could be viewed in better constructional bearing placing, more close to face of drum. Thereby the bending moment caused by tensile forces in belt of conveyor will be smaller then upon big distance of bearing housing from face. From whence it follows that faces will be loaded by smaller bending moment too (Figure 4).

Delimično rešavanje problema se može postići boljim konstrukcionim postavljanjem ležaja, bliže površini bubnja. Time će moment savijanja, koji nastaje usled vučnih sila u traci transportera, biti manji nego kod većeg rastojanja kućišta ležišta od površine. Iz toga sledi da će i površine biti opterećene manjim momentom savijanja (slika 4).

To radical solving of the problem we have to find better drum design, which solves - removes the duress between face and shaft together with providing of torque moment transmission. Thereby we prolong drum lifetime and lifetime of whole machine of course.

Za radikalno rešenje problema moramo pronaći bolji dizajn bubnja, koji rešava – uklanja upotrebu sile između površine i vratila a u isto vreme omogućava prenos obrtnog momenta. Time se produžava vek trajanja bubnja i naravno vek trajanja cele mašine.

The mentioned solving is insertion of swivel bearing or of ball joint between face (hub) and shaft of driving drum together with toothed clutch or similar device (Figure 5).

Pomenuto rešenje sastoji se u umetanju obrtnog ležaja ili kugličnog zgloba između površine (glavčine) i vratila pogonskog bubnja zajedno sa ozubljenim kvačilom ili sličnim uređajem (slika 5).

The bearing transmits radial forces (forces in belt of conveyor and mass of driving units) and toothed clutch mainly torque moment. Thank to possibility of the clutch to slew its both together catching part up to 2,5° without influence to torque moment transmit, we relieve drum's face, which not will be loaded by additional bending moment from shaft deflection.

Ležaj prenosi radijalne sile (sile u remenu transportera i masu pogonskih jedinica) a ozubljeno kvačilo uglavnom obrtni moment. Zahvaljujući mogućnosti kvačila da zaokrene oba svoja noseća dela do 2,5° bez uticaja prenosa obrtnog momenta, oslobađamo površinu bubnja, koja neće biti opterećena dodatnim momentom savijanja sa otklona vratila.

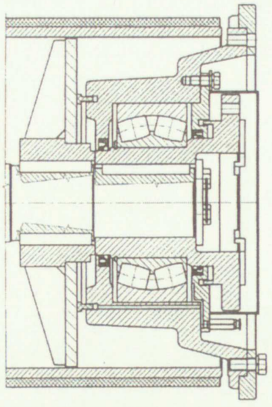


Figure 4 Drum with better bearing placing
slika 4 Bubanj sa boljim smeštanjem ležaja

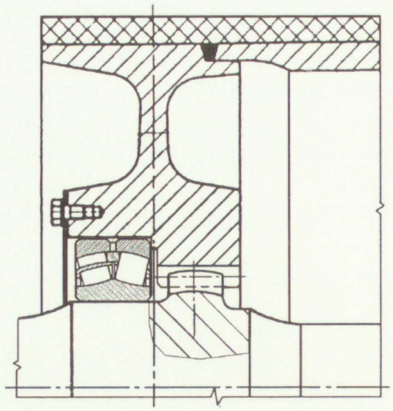


Figure 5 Possibility to solve the duress
sika 5 Mogućnost za rešavanje upotrebe sile

Another advantage is possibility to weight decrease of drum's shaft, because its part between faces could be with lower diameter. Just now, if we used bracing rings, we have to guarantee maximum wind up of shaft cross-section under the rings up to 3´ and thank to it, the shaft between the faces must be with slightly big diameter. I aware of bigger manufacturing costs of new type driving drum, but middle and more powerful drums with larger diameter (over 1200 mm) is the solving more profitable and the drums have longer lifetime and are lighter. We save about 3500 kg on central shaft part (only between faces) upon used the solving on middle powerful drums. Savings are bigger in reality.

Još jednu prednost predstavlja i mogućnost da se izmeri smanjenje vratila bubnja, jer njegov deo između površina može biti manjeg prečnika. Sada, ako bismo koristili sigurnosne prstenove, moramo da garantujemo maksimalno uvijanje poprečnog preseka vratila ispod prstenova do 3´, a zahvaljujući tome, vratilo između površina mora biti neznatno većeg prečnika. Svesni smo većih proizvodnih troškova novog tipa pogonskog bubnja, ali srednji i snažniji bubnjevi većeg prečnika (preko 1200 mm) predstavljaju profitabilnije rešenje a bubnjevi imaju veći vek trajanja i lakši su. Uštedećemo oko 3500 kg na centralnom delu vratila (samo između površina) kada upotrebimo ovo rešenje na srednje jakim bubnjevima. U stvarnosti ušteda je veća.

3 TENSION IN DRUM'S PARTS

Below are mentioned graphs showed stress sizes in the selected parts of concrete driving drum with dependence on some parameters of the each parts. Some graphs showed comparison of common used driving drums (in graphs marked like "original") versus proposed design of driven drum (in graphs marked like "new type").

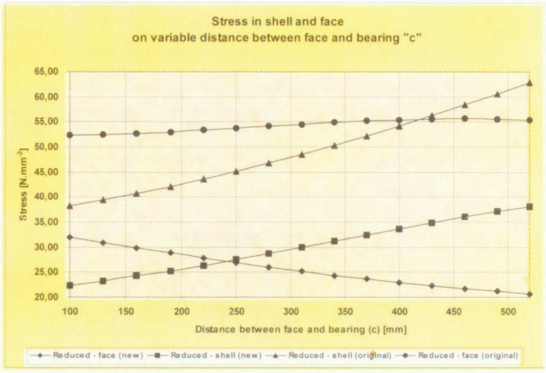
In graph no. 1 is showed stress form of confronted drums in face and shell on variable distance between face and bearing position „c". There is evident stress decreasing on new type drum and mainly sequential decreasing of reduced stress in face of the drum upon increasing distance between face and bearing - parameter "c".

3 ZATEZANJE U DELOVIMA BUBNJA

U daljem tekstu su navedeni grafikoni koji pokazuju veličinu naprezanja u određenim delovima konkretnog pogonskog bubnja, pri čemu to zavisi od nekih parametara svakog od delova. Neki grafikoni prikazuju poređenje pogonskih bubnjeva koji se obično koriste (u grafikonima su obeleženi kao „originalni") naspram predloženog nacrta povratnog bubnja (u grafikonu obeleženog kao „novi tip").

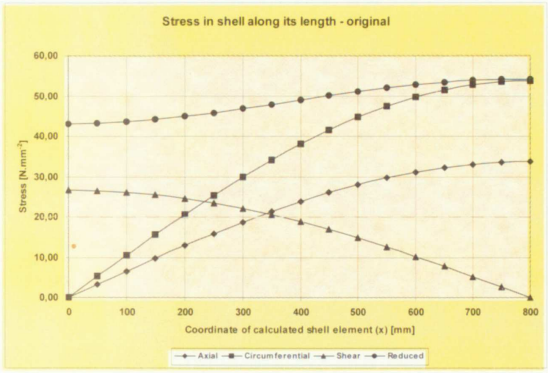
Na grafikonu 1 prikazan je oblik naprezanja naspramnih bubnjeva na površini i omotaču, na promenljivoj razdaljini između površina i položaja ležaja „c". Očigledno naprezanje se smanjuje kod novog tipa bubnja a uglavnom dolazi do kasnijeg smanjivanja naprezanja na površini bubnja nakon povećavanja razdaljine između površina i ležaja – parametar „c".

In graph no. 2 are stresses in shell depended on position of calculated shell element – distance from face "x" (original).



Graph 1 Stress in shell and face on variable distance between face and bearing
Grafikon 1 Naprezanje u omotaču i na površini pri promenljivoj razdaljini između površine i ležaja

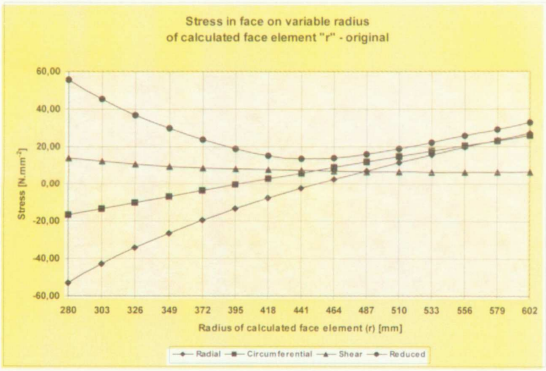
Na grafikonu 2, naprezanja u omotaču zavise od položaja proračunatog elementa omotača – udaljenosti od površine „x" (originalni).



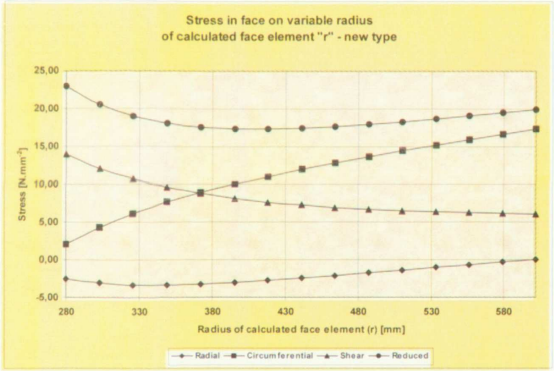
Graph 2 Stress in shell along its length – original
Grafikon 2 Naprezanje u omotaču i celom njegovom dužinom – originalni tip

In graph no. 3 (original) and graph no. 4 showed stresses in face of the drums depending on variable radius of calculated face element "r".

Na grafikonu 3 (originalni) i grafikonu 4 prikazana su naprezanja na površini bubnjeva koja zavise od promenljivog poluprečnika proračunatog elementa omotača „r".



Graph 3 Stress in face on variable radius of calculated face element "r" - original
Grafikon 3 Naprezanje u omotaču pri promenljivom poluprečniku proračunatog elementa površine „r" – originalni tip



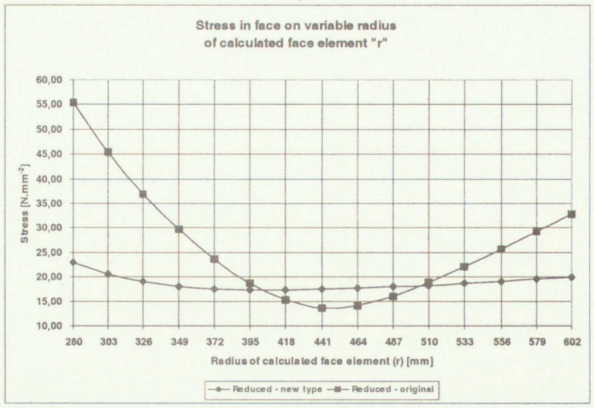
Graph 4 Stress in face on variable radius of calculated face element "r" – new type
Grafikon 4 Naprezanje u omotaču pri promenljivom poluprečniku proračunatog elementa površine „r" – novi tip

For better comparison of the drums, reduced stresses are showed separately by graph no. 5. There are evident advantages of the new tape drum – we can use more thin face instead of original one.

If we will compare up reduced stress in drum's face depended on face thickness „t", it is transparent, that reduced stress of new type drum with thickness increasing decreases, because the face don't transfer bending moment from shaft deflection (graph no. 6). Again about original drum, stress increase with face thickness increasing.

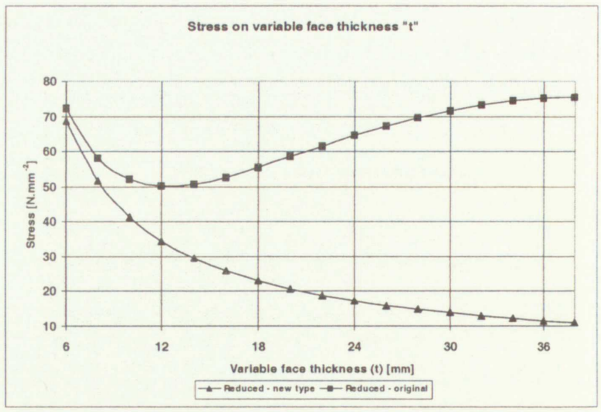
Radi boljeg poređenja bubnjeva, smanjena naprezanja su prikazana odvojeno na grafikonu 5. Tu vidimo očigledne prednosti novog tipa bubnja – možemo da upotrebimo tanju površinu umesto prvobitne.

Ako uporedimo smanjeno naprezanje na površini bubnja koje zavisi od debljine površine „t", jasno je da se smanjuje naprezanje novog tipa bubnja kako se povećava debljina, zbog toga što prednji deo ne prenosi moment savijanja sa otklona vratila (grafikon 6). Da podsetimo, kod originalnog bubnja, naprezanje se povećava kako se povećava debljina površine.



Graph 5 Stress in face on variable radius of calculated face element "r"

Grafikon 5 Naprezanje na površini pri promenljivom poluprečniku proračunatog elementa površine „r"



Graph 6 Stress on variable face thickness "t"

Grafikon 6 Naprezanje pri promenljivoj debljini površine „t"

4 CONCLUSION

From the mentioned and lower showed graph is evident prolongation lifetime of new type – designed driving drum of belt conveyors.

4 ZAKLJUČAK

Iz pomenutog a zatim prikazanog grafikona, očigledno je da se produžava vek trajanja kod novog tipa – dizajna pogonskog bubnja trakastih transportera.

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