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TAKE UP PULLEY SELECTION OF BELT CONVEYOR FOR THE ORE IN TERMS OF AXLE SIZING

Abstract

This work gives the methodology of take up pulley axle calculation on the example of belt conveyor for ore T 3505 designed for the needs of Majdanpek open pit with capacity of 800 t/h.

The analysis was made by calculation and represents a universal method for belt conveyor take up pulley axle calculation whose results are indispensable for reliability the check of this important part of belt conveyors.

Also, technical characteristics of all elements of the take up assembly are given, as well as their graphical representation.

Keywords*: belt conveyor for ore, take up pulley axle calculation, take up assembly*

1 INTRODUCTION

It is necessary that the conveyor belt is tense for correct operation of belt conveyors by corresponding force during the operation. Belt tensioning is made by take up pulley, while tensioning force itself is mostly obtained via screw take up device for the belt conveyors of shorter length or via counter weight for the belt conveyors of longer length.

Belt conveyor for the ore T 3505 was designed for transportation the small fraction screening product at the Majdanpek open pit from the screening facility to the belt conveyor T 3504[1].

Accordingly, it is a horizontal belt conveyor with a drive pulley on the discharge side of the conveyor and a take up pulley on the loading side of the conveyor. Considering that it is a belt conveyor of shorter length than 50 m, a screw take up device was predicted for obtaining the tensioning force by axial moving of the take up pulley what consequently tightens the belt.

Tensioning force on the take up pulley is a result of the preliminary calculation of the belt conveyor and it is an input value for the sizing of its elements.

2 TECHNICAL DESCRIPTION OF TAKE UP ASSEMBLY

The take up assembly of the belt conveyor consists of take up pulley assembly with axle and bearings, screw take up device, snub pulley assembly with axle and bearings, carrying troughing set with rollers, plow cleaner and bearing construction.

Technical characteristics of the belt conveyor itself are as follows:

- capacity: –
- material type: copper ore
- maximum lump size:
- bulk density: —

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- transport length:
- lifting of the material on belt:

- side carrying rollers inclination angle:

- belt speed: –
- belt type: 800/4 EP250 7/2
- electric motor power for belt drive:

The take up pulley (mark USF,620,950, 65,YA,RR,15; made by Rulmeca) is placed at the opposite side of the belt conveyor in relation to the drive pulley and it is equipped with the screw take up device with travel of 457,2 mm (mark TUHD-300-18; manufactured by Superior). Bearings of the take up pulley are self-adjusting (mark 22215 EK; manufactured by SKF). The snub pulley is placed in front of the take up pulley (mark USF,320,950,40,YA; manufactured by Rulmeca) with self-adjusting bearings (mark 22209 EK; manufactured by SKF). To prevent material from getting between the belt and the take up pulley the plow cleaner is predicted (mark E 4000 „V" plough; manufactured by BMS). Within the take up assembly there is also a carrying troughing set (mark A3P/50,800,F22,H160,YA, manufactured by Rulmeca) with three carrying rollers (mark PSV4,30F,133N,323, manufactured by Rulmeca). All the elements of the take up assembly are placed on the bearing steel construction made by welding from hot rolled steel profiles.

The take up pulley dimensions with rubber lagging are as follows according to Fig. 1:

D=650 mm
B=950 mm
d=65 mm
d_1=70 mm
G=1140 mm
F=35 mm
C=1210 mm

According to the catalog data of the Rulmeca manufacturer [2] series USF pulleys with clamping units connection between the axle and hub enables the compression axle locking using a system of screws and tapered sleeves eliminating the play and eccentricity. This locking system is used mostly today having in mind the strength, simplicity of construction, easy assembly and disassembly as well as the maintenance. The advantage compared to the traditional connection between the axle and the hub by key is in the fact that there is module of resistance reduction at traditional connection due to the key groove as well as difficult alignment on the assembly and difficult disassembly of pulleys being long time in exploitation.

The take up assembly of the belt conveyor T 3505 is given in Fig. 2.

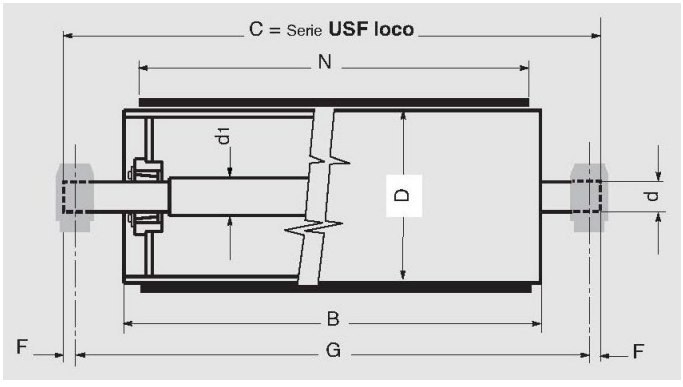

Fig. 1 *Take up pulley of belt conveyor T 3505*

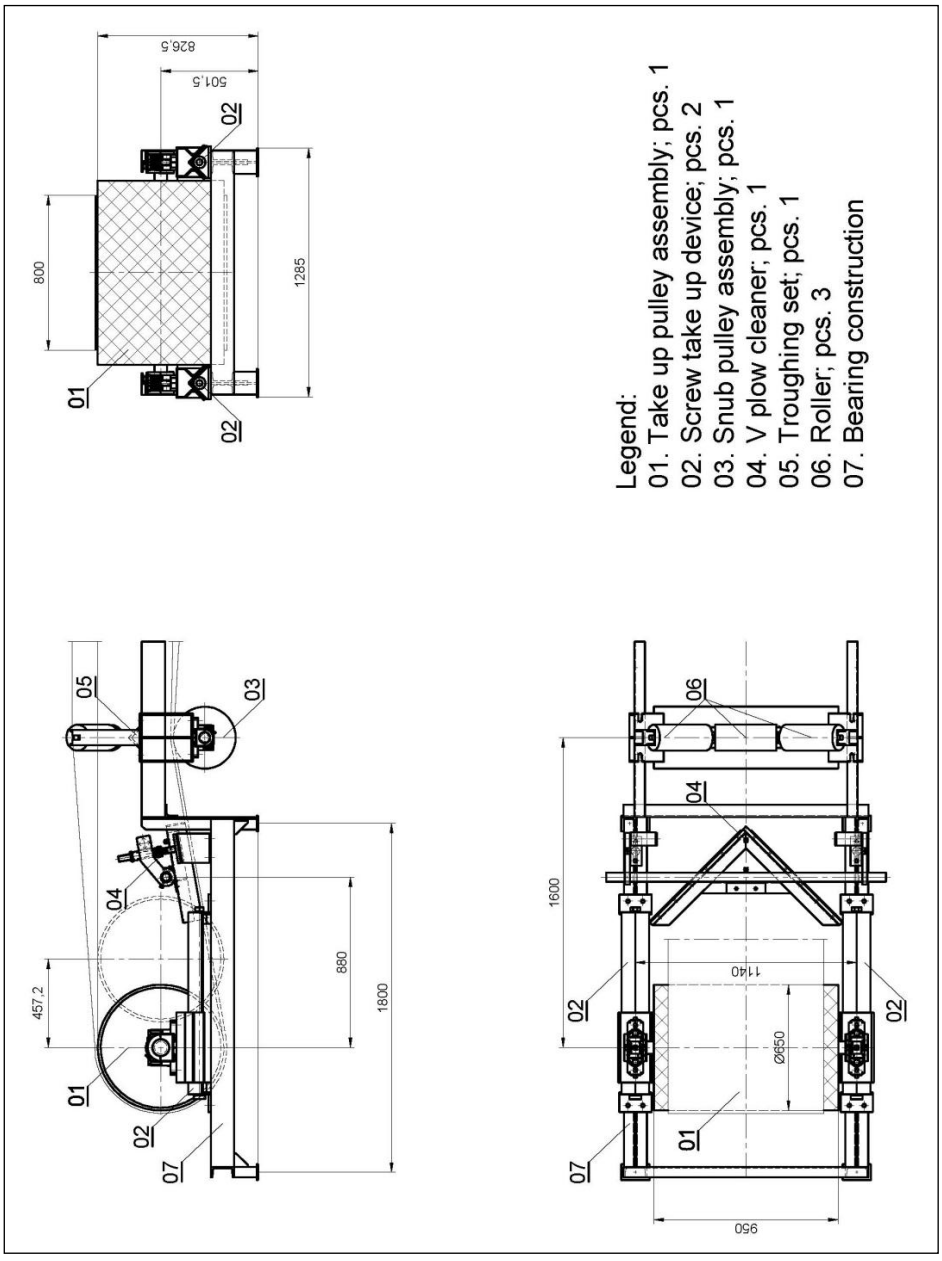

Fig. 2 *Take up assembly of belt conveyor T 3505*

3 CALCULATION OF TAKE UP PULLEY AXLE

3.1 Calculation of take up pulley axle diameter according to the stress limit

1. Calculation of take up pulley axle diameter according to the stress limit has for a purpose of determination the minimum axle diameter considering the load and admissible stress and it is given according to [2].

2. Bending moment

–

3. Module of resistance

4. Axle diameter

Where is:

–tension force at the pulley

–geometrical parameter

– admissible stress for material of the axle steel C40

3.2 Calculation of take up pulley axle according to the axle deflection at hub

1. Calculation of take up pulley axle according to axle deflection at hub has for a purpose the determination of deflection angle made as a result of axle elastic deformation under load considering allowable deflection and it is given according to [3] and figure 3.

2. Tangent of angle made by the deflected axle and its natural axis before bending, at the take up pulley hub

Where are:

– tension force at the pulley

– geometrical parameter

– geometrical parameter

– geometrical parameter

– modules of elasticity of steel

– area moment of inertia for diameter D

– axle diameter at hub

– area moment of inertia for diameter D2

–axle diameter inside the pulley

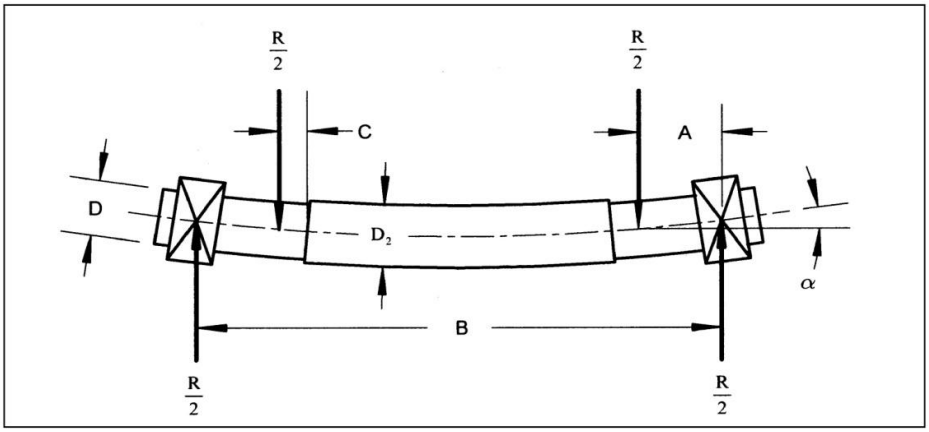

Figure 3 *Take up pulley axle deflection – geometrical parameters*

4 DISCUSSION OF CALCULATION

The take up pulley axle is symmetrically loaded in bending. Steel C40 (heat treated) was selected as the axle material from the manufacturer's catalog. The axle is calculated according to the stress limit and allowable deflection angle. Calculation of take up pulley axle diameter according to the stress limit indicates that selected axle diameter is larger than required what means that the axle is satisfactory regarding the stress limit. The axle was designed with two different diameters so that its diameter inside the pulley is larger reducing the elastic deformations of axle under load compared to the case in which the axle is designed with constant diameter. Calculation of take up pulley axle according to the axle deflection at hub indicates that the deflection angle of axle is within acceptable limits. Namely, according to data from literature [3], maximum value of this angle amounts 8' while calculated value in this particular case amounts 3.9'. Applying the above formula, it is easily shown that the axle designed with constant diameter of 65 mm would have a deflection angle of 4.7'.

CONCLUSION

The results obtained by calculation show that the take up pulley axle is sized correctly by both criteria, i.e. according to the stress limit and according to the allowable deflection.

Take up pulley selection is usually done from the catalog data of the manufacturers. On this occasion, it is often necessary to check how the take up pulley axle is resistant in given operating conditions, so this work may be useful in this sense.

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IZBOR ZATEZNOG BUBNJA TRAKASTOG TRANSPORTERA ZA RUDU SA ASPEKTA DIMENZIONISANJA OSOVINE

Izvod

U ovom radu je, na primeru trakastog transportera za rudu T 3505 projektovanog za potrebe površinskog kopa u Majdanpeku sa kapacitetom 800 t/h, data metodologija proračuna osovine zateznog bubnja.

Analiza je urađena računskim putem i predstavlja univerzalni metod za proračun osovine zateznih bubnjeva trakastih transportera čiji su rezultati neophodni za proveru pouzdanosti ovog važnog dela trakastih transportera.

Takođe su date tehničke karakteristike svih elemenata zatezne grupe i njihov grafički prikaz.

Ključne reči*: trakasti transporter za rudu, proračun osovine zateznog bubnja, zatezna grupa*

1. UVOD

Za ispravan rad trakastih transportera neophodno je da transportna traka u toku rada bude zategnuta odgovarajućom silom. Zatezanje trake ostvaruje se preko zateznog bubnja, a sama sila zatezanja najčešće se ostvaruje, za transportere manje dužine preko navojnog vretena, a za transportere veće dužine preko zateznog tega.

Trakasti transporter za rudu T 3505 projektovan je za transport podrešetnog proizvoda rude na površinskom kopu u Majdanpeku od sitare do trakastog transportera T 3504 [1].

Dakle, radi se o horizontalnom trakastom transporteru sa pogonskim bubnjem na istovarnoj strani transportera i sa zateznim bubnjem na utovarnoj strani transportera. S obzirom da se radi o transporteru manje dužine od 50 m za ostvarivanje sile zatezanja predviđeno je navojno vreteno kojim se aksijalno pomera zatezni bubanj i na taj način zateže traka.

Zatezna sila na zateznom bubnju je rezultat prethodnog proračuna transportera i predstavlja ulazni podatak za dimenzionisanje njenih elemenata.

2. TEHNIČKI OPIS ZATEZNE GRUPE

Zatezna grupa trakastog transportera sastoji se od sklopa zateznog bubnja sa osovinom i ležajima, uređaja za zatezanje trake sa navojnim vretenom, sklopa otklonskog bubnja sa osovinom i ležajima, nosećeg sloga sa valjcima, plužnog brisača i noseće konstrukcije.

Tehničke karakteristike samog transportera su sledeće:

- kapacitet: –
- vrsta materijala: ruda bakra
- krupnoća:
- nasipna gustina: —

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- dužina transporta:
- visina dizanja materijala na traci:
- ugao nagiba bočnih nosećih rolni:
- brzina trake: –
- tip trake: 800/4 EP250 7/2
- snaga elektromotora za pogon trake:

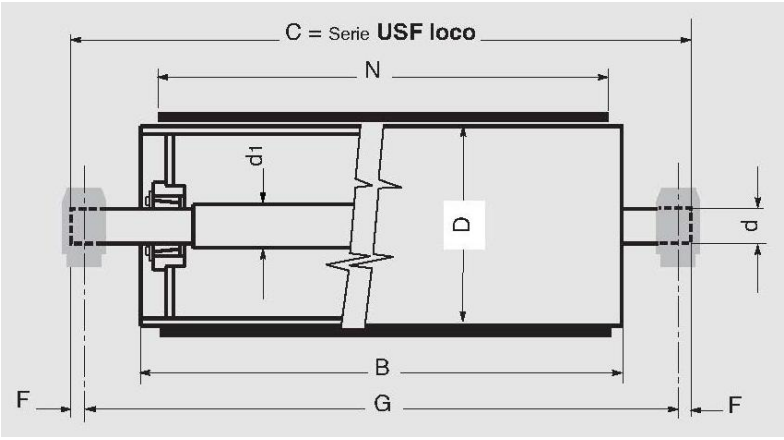
Zatezni bubanj (oznake USF,620,950,65, YA,RR,15; proizvođača Rulmeca) nalazi se na suprotnom kraju transportera u odnosu na pogonski bubanj i snabdeven je uređajem za zatezanje trake sa navojnim vretenom čiji je hod 457,2 mm (oznake TUHD-300-18; proizvođača Superior). Ležaji zateznog bubnja su samopodesivi (oznake 22215 EK; proizvođača SKF). Ispred zateznog bubnja se nalazi otklonski bubanj (oznake USF,320,950,40,YA; proizvođača Rulmeca) sa samopodesivim ležajima (oznake 22209 EK; proizvođača SKF). Za zaštitu od upadanja materijala između trake i zateznog bubnja predviđen je plužni brisač (oznake E 4000 „V“ plough; proizvođača BMS). U sastav zatezne grupe ulazi i noseći slog (oznake A3P/50,800,F22,H160,YA, proizvođača Rulmeca) sa tri noseća valjka (oznake PSV4,30F,133N,323, proizvođača Rulmeca). Svi elementi zatezne grupe smešteni su na noseću čeličnu konstrukciju izrađenu zavarivanjem od toplo valjanih čeličnih profila.

Dimenzije zateznog bubnja sa gumenom oblogom su sledeće prema slici 1.:

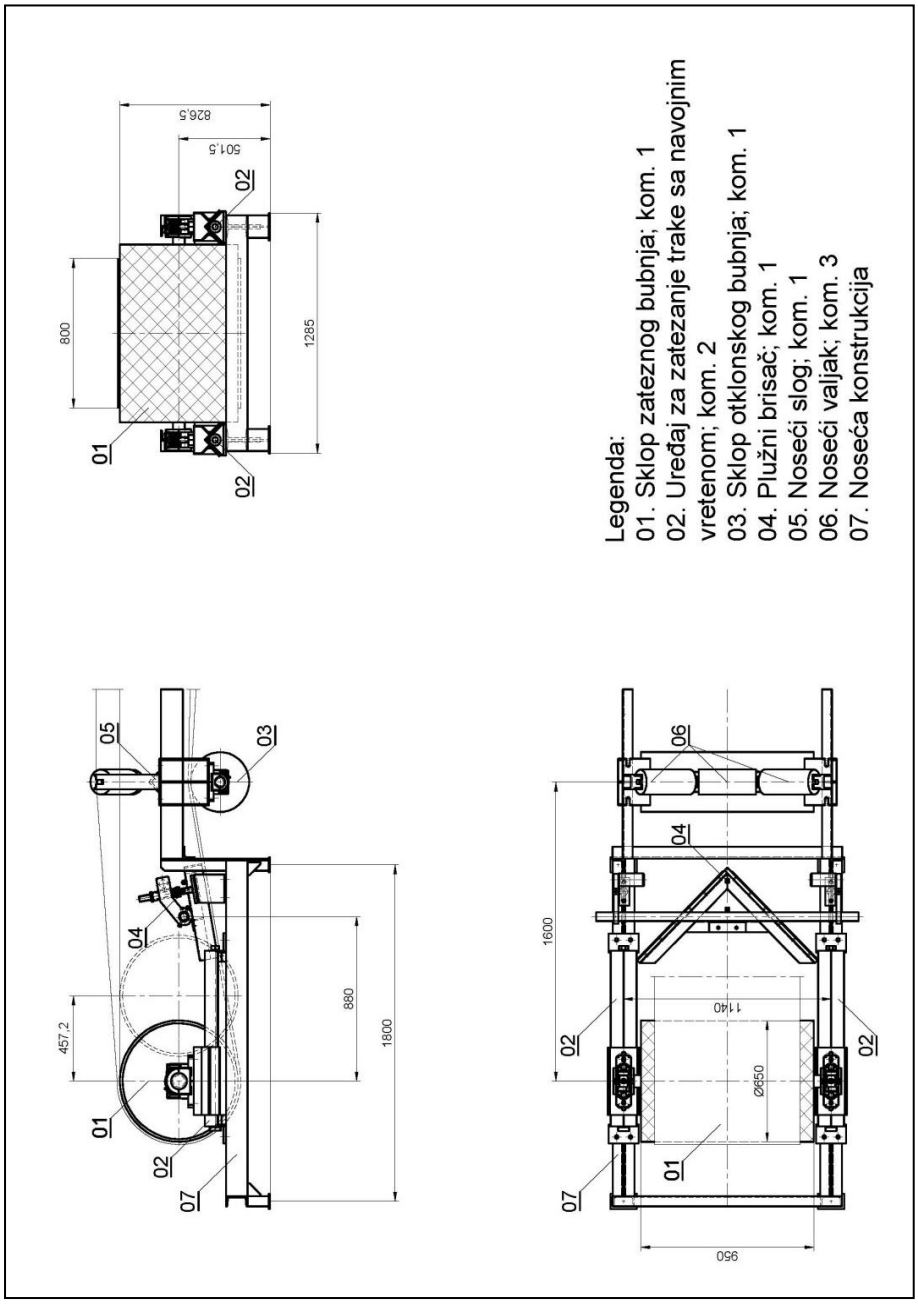
D=650 mm
B=950 mm
d=65 mm
d_1=70 mm
G=1140 mm
F=35 mm
C=1210 mm

Prema kataloškim podacima proizvođača Rulmeca [2] serija USF bubnjeva sa vezom između osovine i glavčine bubnja steznim jedinicama omogućava zabravljivanje osovine kompresijom koristeći sistem zavrtnjeva i konusnih rukavaca eliminišući mrtvi hod i ekscentricitet. Ovaj sistem zabravljivanja se danas najčešće koristi imajući u vidu jačinu, jednostavnost konstrukcije, laku montažu i demontažu, kao i održavanje. Prednost u odnosu na tradicionalnu vezu između osovine i glavčine bubnja klinom je što kod tradicionalne veze postoji smanjenja otpornog momenta osovine usled žleba za klin, kao i otežano centriranje pri montaži odnosno otežana demontaža kod bubnjeva koji su duže vreme u eksploataciji.

Prikaz zatezne grupe trakastog transportera T 3505 dat je na slici 2.



Sl. 1. *Zatezni bubanj trakastog transportera T 3505*



Sl. 2. *Zatezna grupa trakastog transportera T 3505*

3. PRORAČUN OSOVINE ZATEZNOG BUBNJA

3.1. Proračun prečnika osovine zateznog bubnja prema dozvoljenom naponu

1. Proračun prečnika osovine zateznog bubnja prema dozvoljenom naponu ima za cilj određivanje minimalnog prečnika osovine s obzirom na opterećenje i dozvoljeni napon i dat je prema [2].

2. Moment savijanja

–

3. Otporni moment

4. Prečnik osovine

gde su:

–zatezna sila na bubnju

–geometrijski parametar

– dozvoljeni napon za materijal osovine čelik C40

3.2. Proračun osovine zateznog bubnja prema nagibu osovine na glavčini

1. Proračun osovine zateznog bubnja prema nagibu osovine na glavčini ima za cilj određivanje ugla nagiba koji nastaje kao posledica elastične deformacije osovine pod opterećenjem s obzirom na dozvoljenu deformaciju i dat je prema [3] i slici 3.

2. Tangens ugla između deformisane osovine i njene prirodne ose pre savijanja na mestu glavčine zateznog bubnja

–

gde su:

– zatezna sila na bubnju

– geometrijski parametar

– geometrijski parametar

– geometrijski parametar

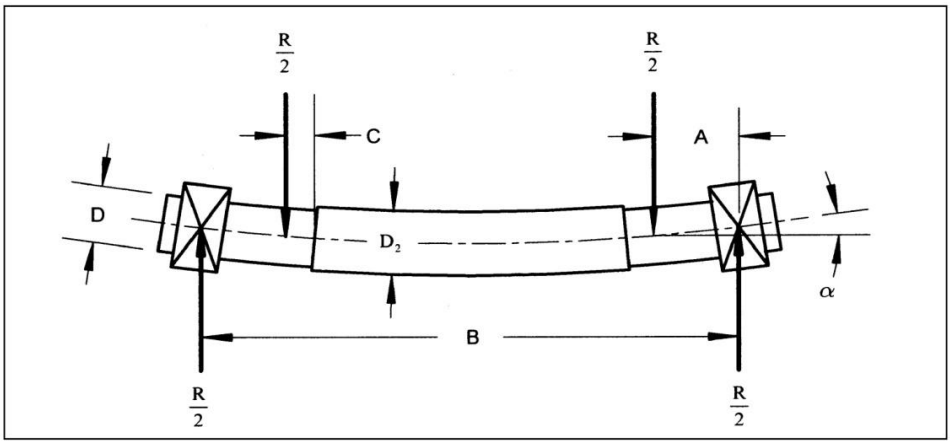
– modul elastičnosti za čelik

– moment inercije za prečnik D

–prečnik osovine na glavčini

– moment inercije za prečnik D_2

– prečnik osovine unutar bubnja



Sl 3. *Deformacija osovine zateznog bubnja-geometrijski parametri*

4. DISKUSIJA PRORAČUNA

Osovina zateznog bubnja simetrično je opterećena na savijanje. Iz kataloga proizvođača usvojen je kao materijal osovine čelik C40 (poboljšan). Osovina se proračunava prema dozvoljenom naponu i prema dozvoljenom nagibu. Proračun prečnika osovine prema dozvoljenom naponu pokazuje da je usvojeni prečnik osovine veći od potrebnog što znači da u pogledu dozvoljenog napona osovina zadovoljava. Osovina je izvedena sa dva različita prečnika tako da je njen prečnik unutar bubnja veći čime se smanjuju elastične deformacije osovine pod opterećenjem u odnosu na slučaj kada se osovina izvodi sa konstantnim prečnikom. Proračun osovine prema nagibu osovine na glavčini pokazuje da je nagib osovine u dozvoljenim granicama. Naime, prema podacima iz literature [3] maksimalna vrednost ovog nagiba iznosi 8' dok proračunska vrednost u konkretnom slučaju iznosi 3,9'. Primenom gornje formule lako se pokazuje da bi osovina izvedena sa konstantnim prečnikom od 65 mm imala nagib od 4,7'.

ZAKLJUČAK

Proračunom dobijeni rezultati pokazuju da je osovina zateznog bubnja ispravno dimenzionisana po oba kriterijuma tj. i prema dozvoljenom naponu i prema dozvoljenoj deformaciji.

Izbor zateznih bubnjeva obično se vrši iz kataloških podataka proizvođača. Tom prilikom često je potrebno proveriti kako se ponaša osovina zateznog bubnja u datim radnim uslovima, te ovaj rad može biti koristan doprinos u tom smislu.

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