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Modeling, Analysis and Manufacturing of Belt Conveyor Roller Shaft

[1] Ashvini Sukhdeo More, [2] P.V.Jawale
[1] PG Student, [2] Assistant professor
Department of Mechanical Engineering
Deogiri Institute of Engineering and Management Studies, Aurangabad..

Abstract: -- **In belt conveyor roller shaft system there is the problem i.e. shaft breakage and wear problem. Due to this problem shaft will breakage after every 2 months. To overcome this problem will be done by the Material selection study and process of modeling analysis and manufacture efficient shaft for the conveyor system. For the design purpose of the shaft CREO-2015 used and FEA analysis is done in ANSYS R-18.1 software. While doing analysis, comparison of the MS bright material shaft with EN 24 material shaft. EN24 having efficient mechanical properties than mild steel and other material properties like, hardness, tensile strength and availability. Analytical results and software (ANSYS) results show that the maximum deflection of the EN 24 is always lower than the bright M S. The experimental setup of the project and taking the trials for the EN24 material shaft is for the same load, EN24 shaft will be durable for long life as compared MS bright shaft. By taking the experimental trials on EN24 material shaft achieve more strength and more life i.e.50-55 days as compared to Ms Bright shaft of the same size. Cost of maintenance and replacing of the shaft is saved.**

Index Terms: **ANSYS R-18.1, CREO-2015, EN 24 material, Experimental results, FEA analysis.**

I. INTRODUCTION

Belt-conveyors are more suitable than other means of moving bulk materials; they neither pollute the air nor deafen the ears. Belt conveyor is one of the main transport equipment in coal mine, driving drum and belt is its key part. Proper attention should be paid while designing the roller conveyor system for particular application. Friction principle is used to initiate mechanical drive for belt conveyor. So friction is the driving force. In demand to increase transportation efficiency of belt conveyor, driving force of drum must be increased. Energy saving & efficiency, friction, fire & safety, maintenance and inspection are the other key factors of belt conveyor design. Most of the researchers focused on design modification to reduce the pulley (drum) and belt failures, maintenance cost, breakdowns, energy consumption and overall cost of the system for continuous transportation of material. The proposed system is the concept of automatic faulty job rejection system. The system used in steel company, and to eliminate the manual errors of quality issue the automatic rejection system utilized in a company. The system use conveyor system to transfer the job from one point to another and for the transfer of the material the conveyor system utilizes the drive side shaft drives by the gear box and the gear box rotated by the AC motor.

A. Problem Statement

Belt Conveyor system of Sunrise Automation was subjected to breakage and wear, resulting in reduces life of the conveyor system.

B. Objectives

1. To increase the life of the shaft used for conveyor belt system by suggesting suitable and economical shaft material.
2. To reduce the economic loss due to failure of conveyor shaft.

II. METHODOLOGY

A. Material Selection

The material selection of a shaft depends on following factors;

1. Load on a shaft
2. Machining process on a shaft
3. Operating time of a conveyor

Table: 2.1 Comparisons of Different Materials [26]

Material	Tensile strength in Mpa	Cost per Kg
MS Bright	370	62
Epoxy Glass Fiber	700	350
EN24	**850-1000**	**74**
EN8	500	55
EN9	800	55

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As compared to cost and Tensile Strength EN24 material is better than the other materials because of this I have selected EN24 Material for Conveyor belt Shaft.

B. Analytical Design Calculations of a Shaft

Given data

Motor speed: 1440, here we consider 1000rpm, Gear box: ration: 20:1

G=N1/N2 [23]; 20/1=1000/N2; N2=50rpm

Therefore, shaft speed = 50 rpm

1. Calculations of the stresses act on the Ms. Bright shaft

Maximum bending moment,

$M / I = \sigma_b / y$

Here W_R= 1041.67N; L=588 mm

Shaft is simply supported beam with UDL

Mmax = W x L^2 /8 = (1041.67 x 0.588^2)/8**; Mmax= 45.01 N-m**

Moment of inertia,

$I = \pi / 64 \times d^4 = \pi / 64 \times 0.055^{4;}$ **I = 4.42 x 10^{-7} m^4**

Maximum bending stress,

Y=d/2=55/2=27.5mm

$\sigma_b = M_{max} \times y / I = 45.01 \times 27.5 \times 10^{-3} / 4.42 \times 10^{-7} = 280.09 \times 10^4$ σ_b = 2.8009 Mpa

Maximum deflection,

$y_{max} = 5 \times W \times L^4 / 384EI$

W: weight of the conveyor: 1041 N ; E: young's modulus of the shaft (mild steel): 200GPa =200x $10^9 N/m^2$

$y_{max} = 5 \times 1041 \times 0.588^4 / 384 \times 200 \times 10^9 \times 4.42 \times 10^{-7}$,

y_{max} = 0.01832mm

Therefore, the maximum deflection of the shaft is **0.01832mm** and it is as length of conveyor of 588 mm is negligible.

1. Calculations of the stresses act on the EN24 shaft

Maximum bending moment,

E= 207 Gpa, Syt = 680 Mpa; Considering uniformly distributed load & FOS =2

Allowable Stress (σall) = Syt / Fs = 680/2= 340 Mpa

Here W=1041 N

Checking Factor of Safety for design- Fs = σall / σb = 340/2.90 Fs = 117.24

As Calculated Fs is greater than assumed Fs, Selected Material can be considered as safe.

Shaft is simply supported beam with UDL

Maximum deflection,

$y_{max} = 5 \times W \times L^3 / 384EI$

W: weight of the conveyor: 150N; E: young's modulus of the shaft (EN24): 207GPa =207 x $10^9 N/m^2$

$y_{max} = 5 \times 1041 \times 0.588^4 / 384 \times 207 \times 10^9 \times 4.42 \times 10^{-7}$

y_{max} = 0.01770mm

Therefore, the maximum deflection of the shaft is **0.01770 mm** and it is as length of conveyor of 588 mm is negligible.

III. MODELING AND COPUTATIONAL ANALYSIS

A. Modeling of Shaft

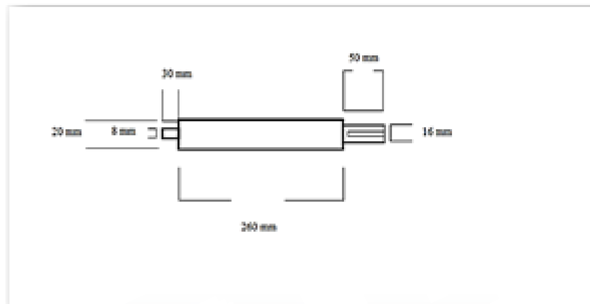


Fig: 3.1 2D Model of Shaft

B. Computational Analysis

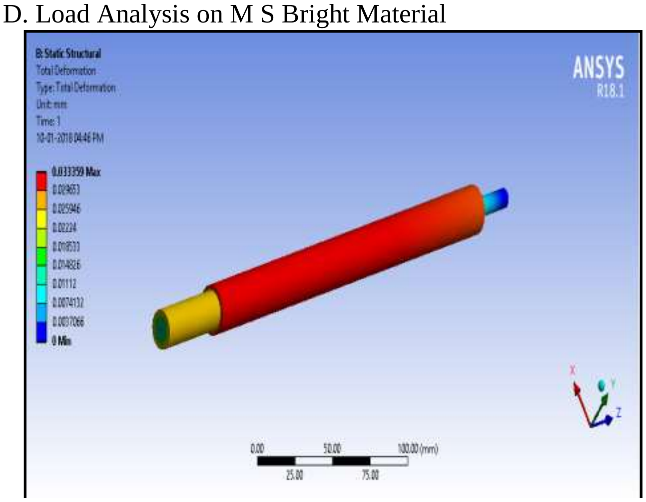
Table: 4.1 Input parameters for Load Analysis in ANSYS

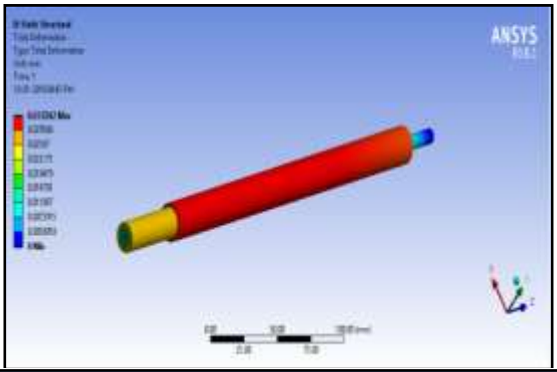
Sr. No.	Parameters	
1.	Speed	50 RPM
2.	Belt weight	4.5 N
3.	Job weight on belt	10 N
4.	Shaft weight	7.36 N + 9.12 N = 16.48 N
5.	Roller weight	25.31 N
6.	Total Weight	4.5 +10+ 25.31+16.48= 56.29N

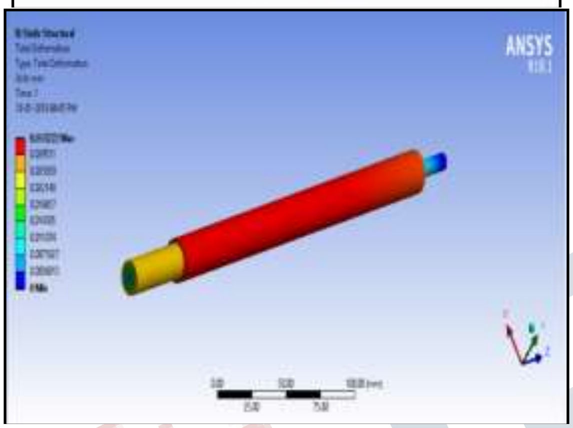
C. Boundary conditions (Adding Constraints):

In the process of work, on both sides of the shaft is supported by bearings, therefore, on the surface of the shaft nodes add full constraints.

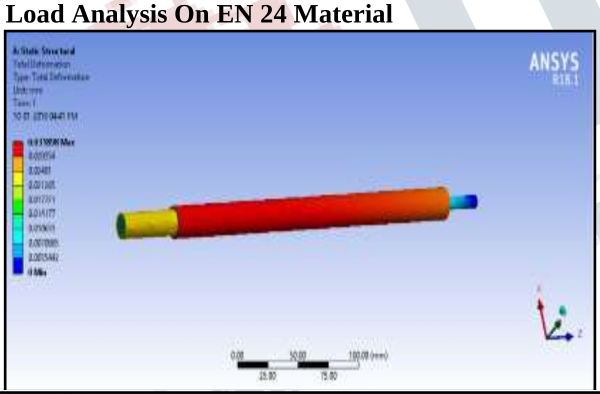
D. Load Analysis on M S Bright Material

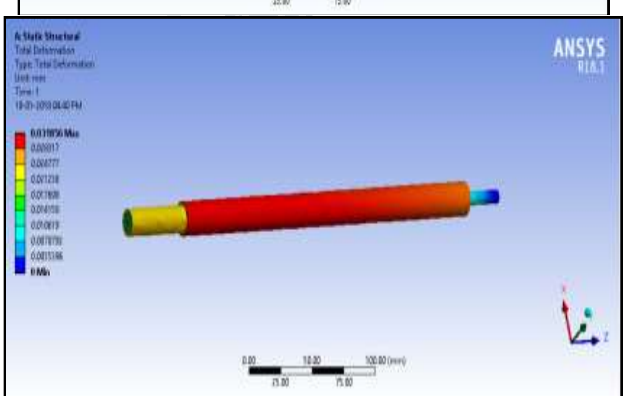


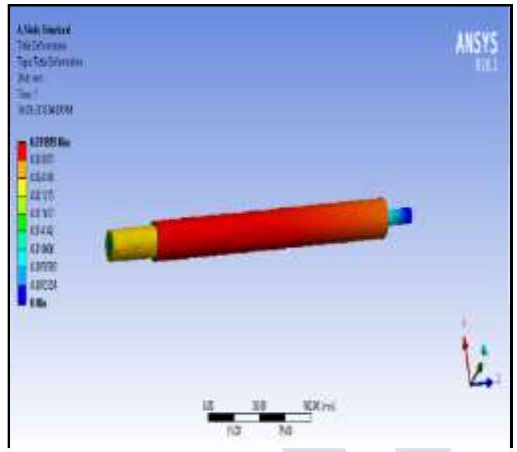




E. Load Analysis On EN 24 Material







IV. EXPERIMENTAL SETUP

A. Components of Belt Conveyor System

• We have design shaft on the basis of applications, our aim to carry objects over the conveyor so, the conveyor shaft must be design by taking consideration of following points,

1. Belt width
2. Load on shaft
3. Bearing arrangement
4. Gear box fitting arrangement
5. Encoder assembly arrangement

Fig: 4.1 Assembly of Belt Conveyor shaft

Fig: 5.4 Assembly of system of shaft when loaded

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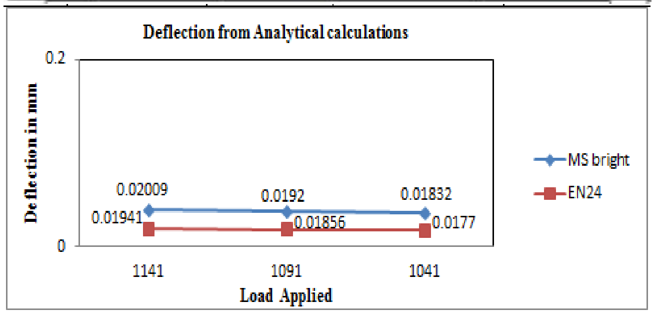
V. RESULTS AND DISCUSSION

A. Results from Analytical Analysis

Table: 5.1 Results Obtained from Analytical calculations

Sr. no.	Load of material on conveyor (N)	Resultant Load(N)	Maximum deflection M S bright (mm)	Maximum deflection EN 24 (mm)
1.	150 N	1141N	0.02009	0.01941
2.	200 N	1091N	0.01920	0.01856
3.	250 N	1041N	0.01832	0.01770



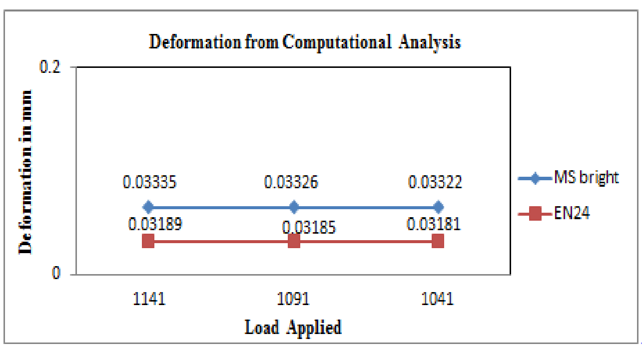
Plot: 5.1 Deflection from Analytical Analysis curve

B. Results from Computational Analysis

Table: 5.4 Results Obtained from Analysis in ANSYS Software

Sr. no.	Load of material on conveyor (N)	Resultant Load(N)	Maximum deformation M S bright (mm)	Maximum deformation EN 24 (mm)
1.	150 N	1141N	0.03335	0.03189
2.	200 N	1091N	0.03326	0.03185
3.	250 N	1041N	0.03322	0.03181

Plot 5.2 Deformation from Software (ANSYS) Results curve



VI. CONCLUSIONS

The following conclusions are being made from the Analytical (Theoretical), Computational (software) analysis and Experimental trials:

1. It was observed experimentally that the shaft of material EN24 had more life i.e. 50-55 days as compared to Ms. Bright shaft of same size
2. Break Downtime of machine is reduced by using EN24 material Shaft from 132 hrs to 44 hrs.
3. Economical loss of Company is Reduced by the 18252 Rs. Per Annum.

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