International Journal of Scientific Engineering and Applied Science (IJSEAS) - Volume-1, Issue-5, August 2015
ISSN: 2395-3470
www.ijseas.com

Design, Analysis and Weight Optimization of Belt Conveyor for Sugarcane Industries

[1]Miss Pawar Jyotsna, [2]Prof.D.D.Date, [3]Prof.A.B.Galke

PG student, Terna Public Charitable Trust College of Engineering Osmanabad, India.[1]

Associate Professor, Terna Public Charitable Trust College of Engineering Osmanabad, India.[2]

Head of Dept (Mech), Terna Public Charitable Trust College of Engineering Osmanabad, India.[3]

ABSTRACT:
The aim of this thesis is to study existing conveyor system and optimize the critical parts like Roller, Support Bracket, Roller Shaft, Base frame to minimize the overall weight of assembly and material saving. Thesis also involves geometrical and finite element modelling of existing design and optimized design. Geometrical modelling was done by using CATIA V5 R20 and finite modelling was done by using ANSYS14.5.Results of Linear static analysis of existing design and optimized design are compared to prove design is safe. Optimization gives optimum design for same loading condition with huge amount of weight reduction. Using this procedure and using practical available structure 39.25% weight reduction is achieved.

Key Words: Optimized design, Weight reduction, material handling systems.

1. Introduction:

Material handling is an important sector of industry, which is consuming a considerable proportion of the total power supply. For instance, material handling contributes about 10% of the total maximum demand in India. Belt conveyors are being employed to form the most important parts of material handling systems because of their high efficiency of transportation. Conveyors are able to safely transport materials from one level to another, which when done by human labor would be strenuous and expensive. They can be installed almost anywhere, and are much safer than using a forklift or other machine to move materials. They can move loads of all shapes, sizes and weights. Also, many have advanced safety features that help prevent accidents.

There are a variety of options available for running conveying systems, [3] including the hydraulic, mechanical and fully automated systems, which are equipped to fit individual needs. Conveyor systems are commonly used in many industries, including the automotive, agricultural, computer, electronic, food processing, aerospace, pharmaceutical, chemical, bottling and canning, print finishing and packaging. Although a wide variety of materials can be conveyed, some of the most common include food items such as beans and nuts, bottles and cans, automotive components, scrap metal, pills

Sr.	Component	Material	Qty.
1	Rollers	Mild Steel	**22**
2	Rollers Shafts	Mild Steel	**22**
3	Bearings	STD	**44**
4	Support Brackets	Mild Steel	**44**
5	Base frame	C-10	-

and powders, wood and furniture and grain and animal feed.

1.1Principle of working:

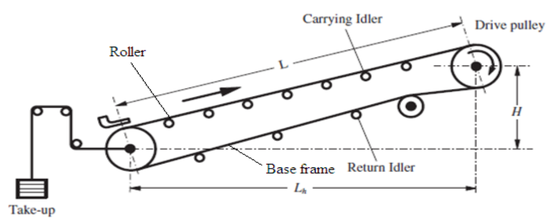

Fig. 3.1 Profile of Belt conveyors

Belt conveyor is commonly used equipment for continuous transport, as it has a high efficiency, large conveying capacity, simpler construction, small amount of maintenance. Such type of conveyors are used in sugarcane industries for transportation purpose in this project we did work on the various parts of conveyor for the **Shreenath Mhaskoba Sakhar Karkhana Ltd.,A/P Patethan,Tal-Daund.**

2. Problem statement

The aim of this project is to redesign existing belt roller conveyor system by designing the critical parts (Roller, Shaft, Bearing & Frame), to minimize the overall weight of the assembly and to save considerable amount of material.

Table No. 2.1 Critical components for design

3. Objective of the Study:

The following are the objectives of the study:

1. Check design of existing conveyor system.
2. ANSYS APDL codes applied for linear static, modal, transient and optimization analysis.
3. Simulations for linear static Analysis.
4. Simulations for Modal Analysis.
5. Optimization of conveyor assembly for weight reduction.
6. Comparison between existing and optimized design.

4. Design and Study of the Existing Assembly of Conveyor System

4.1 Design of Roller

4.1.1 Material – MS

E = 2.10*105 Mpa, ρ= 7860 Kg/m3, Syt = 590 Mpa

Considering uniformly distributed load & FOS = 3

Allowable Stress (σall) = Syt / Fs =590/2=196.67Mpa

4.1.2 Maximum Stress Calculation for given condition

W= 100 kg

D1= Outer diameter of roller = 61 mm

D2 = Inner diameter of roller = 51 mm

w = Width of roller = 730 mm

y = Distance from neutral axis = 0.061/2 = 0.0305

Considering uniformly distributed load,
Maximum Moment (Mmax) = $W*L^2/8$
= $(100*9.81*0.73^2)/8$
Mmax = 65.35 N-m
Moment of Inertia (I) =$\Pi\ (D_1^{\ 4} - D_2^{\ 4})/64$
= $\Pi\ (0.061^4 - 0.051^4)/64$
I = 3.476*10-7 m4
Maximum bending stress σb = Mmax * y/ I
= 65.35 * 0.0305/ 3.476*10-7
σb = 5.74 Mpa

4.1.3 Checking Factor of Safety for design-

Fs = σall / σb
= 196.67/5.74
Fs =34.26

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

4.1.4 Maximum Deflection (Y_{max}) = 5*W*L3/384EI

= $(5*100*9.81*.73^3) / (384*2.10*1011*8.7179*10\text{-}7)$
Y_{max} = 0.1142 mm

As compared to length 500 mm deflection of 0.1142 mm is very negligible. Hence selected channel can be considered as safe.

4.1.5 Weight of Rollers -

= cross-section area*width * mass density* number of rollers
= $\Pi\ (0.061^2 - 0.051^2)$ *0.73*7860*15/22
=111.039 Kg

Table 4.1 Total Weight of Existing Conveyor Assembly

Sr. No.	Name Of Component	Weight(Kg.) Existing Design
1	Rollers	111.039
2	Roller shaft	39.65
3	Support Bracket	13.10
4	Base frame	11.57
5	L-Support Channel	165.06
6	Bearing	4.28
	Total=	343.69

4.2 Geometric model of existing roller:

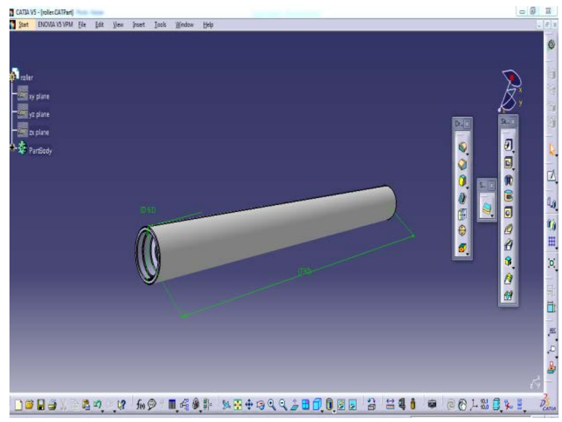

Fig. 4.1.Geometric model of existing roller

4.3 ANSYS Results for Existing roller:

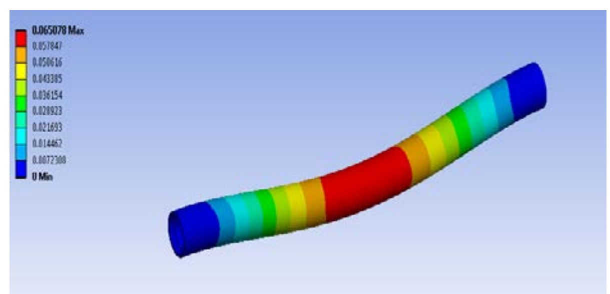

Fig.4.2.Deformation in existing roller

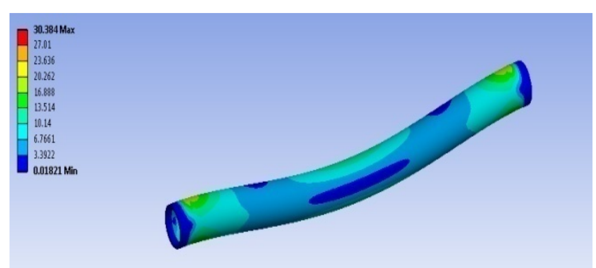

Fig.4.3.Stress on existing roller

5. Need of Optimization

As factor of safety of Rollers is very high there is scope of weight reduction in this component.

5.1 Selection of Critical Parameter

Roller Outer diameter

Roller Inner diameter

6. Design and Study of the Existing Assembly of Conveyor System

6.1 Design of Roller

6.1.1 Material – MS

E = 2.10*105 Mpa, ρ= 7860 Kg/m3, Syt = 590 Mpa

Considering uniformly distributed load & FOS = 3

Allowable Stress (σall) = Syt / Fs =590/2=196.67Mpa

6.1.2 Maximum Stress Calculation for given condition

W= 100 kg

D1= Outer diameter of roller = 57 mm

D2 = Inner diameter of roller = 47 mm

w = Width of roller = 730 mm

y = Distance from neutral axis = 0.057/2 = 0.0285

Considering uniformly distributed load,

Maximum Moment (Mmax) = $W*L^2/8$

= $(100*9.81*0.73^2)/8$

Mmax = 65.35 N-m

Moment of Inertia (I) =$\Pi (D_1^4 – D_2^4)/64$

= $\Pi (0.057^4 – 0.047^4)/64$

I = 2.35*10-5 m4

Maximum bending stress σb = Mmax * y/ I

= 65.35 * 0.0285/ 2.35*10-5

σb = 28.374 Mpa

6.1.3 Checking Factor of Safety for design-

Fs = σall / σb

= 196.67/28.374

Fs = 6.39

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

6.1.4 Maximum Deflection (Y_{max}) = 5*W*L3/384EI

= $(5*100*9.81*.73^3)$ / $(384*2.10*10^{11}*$ 2.35*10-5)

Y_{max} = 0.1975 mm

As compared to length 500 mm deflection of 0.1975 mm is very negligible. Hence selected channel can be considered as safe.

6.1.5 Weight of Rollers -

= cross-section area*width * mass density* number of rollers

= $\Pi (0.057^2 - 0.047^2)$ *0.73*7860*15/4

=64.3275 Kg

Table.6.1. Total Weight of Existing Conveyor Assembly

Sr. No.	Name Of Component	Weight(Kg.) Optimized Design
1	Rollers	64.32
2	Roller shaft	39.65
3	Support Bracket	8.066
4	Base frame	11.57
5	L-Support Channel	165.06
6	Bearing	4.28
	Total=	282.94

6.2 Geometric model of optimized roller:

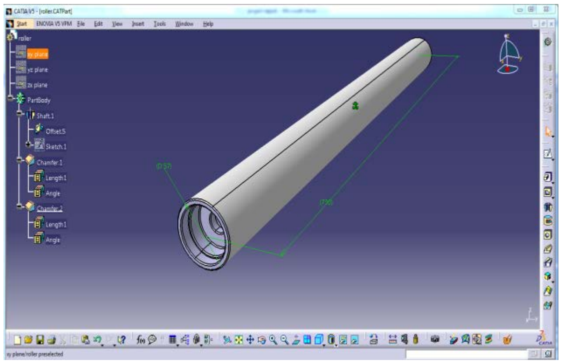

Fig. 6.1.Geometric model of existing roller

6.3 ANSYS Results for Existing roller:

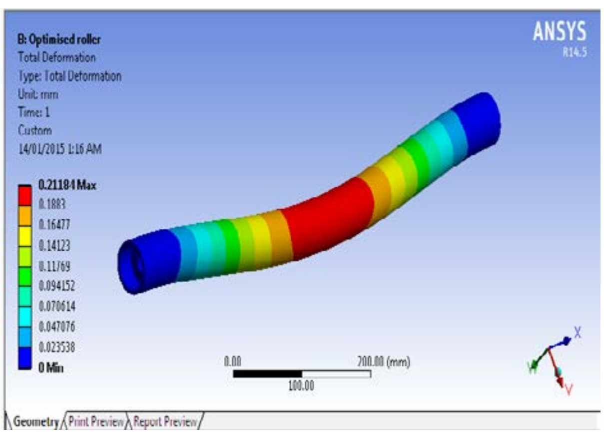

Fig.6.2.Deformation in optimized roller

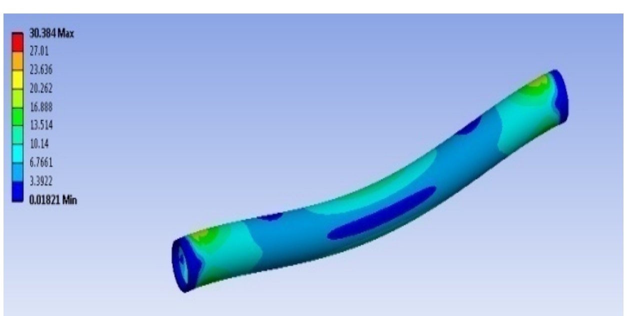

Fig.6.3.stresses of optimized roller

7. Results:

7.1Effect of optimized design compared with existing design

Sr. No.	Name Of Component	Weight(Kg.) Existing Design	Weight(Kg.) Optimized Design
1	Rollers	111.039	64.32
2	Roller shaft	39.65	39.65
3	Support Bracket	13.10	8.066
4	Base frame	11.57	11.57
5	L-Support Channel	165.06	165.06
6	Bearing	4.28	4.28
	Total=	343.69	282.94

Design	Weight (Kg)	%Material required compared to existing design	% Material save compared to Existing design
Existing	343.69	100	--
Optimized	282.94	60.75	39.25

7.2. Weight reduction due to Optimization

8. CONCLUSIONS:

- Existing design calculations shows the factor of safety is very greater than requirement and there is a scope for weight reduction.
- Critical parameters which reduce the weight are roller, support bracket.
- Though value of deflection, stress is more in case of optimized design, but its allowable.
- 39.25% of weight reduction achieved by optimized design than existing design.
- 60.75 kg. weight reduction achieved by optimize design than existing design.

9. REFERENCES

1. Shirong Zhang, Xiaohua Xia "*Modeling and energy efficiency optimization of belt conveyors*", Department of Automation, Wuhan University, Wuhan 430072, China Department of Electrical, Electronic and Computer Engineering, University of Pretoria, Pretoria 0002, South Africa 'Journal homepage: www.elsevier.com/locate/apenergy' 16 March 2011.

2. Mr.Raghvendra Singh Gurjar*, Mr.Arvind Yadav, Dr. Pratesh Jayaswal "*Failure Analysis Of Belt Conveyor System In A Thermal Power Plant*", Department of Mechanical Engineering of MITS College Gwalior (M.P.) India, 'International Journal of Advanced Technology & Engineering Research (IJATER)',Volume 2, Issue 3, May 2012.

3. Yogesh Tanajirao Padwal, Mr. Satish M. Rajmane, Swapnil S. Kulkarni "*Design And Analysis Of A Roller Conveyor For Weight Optimization & Material Saving*", ME-Design-pursuing, 2Asst. Prof., Bharatratna Indira Gandhi College of Engineering, Kegaon, Solapur Director-Able Technologies India Pvt. Ltd., Pune, 'Padwal, et al, International Journal of Advanced Engineering Research and Studies',E-ISSN2249–8974 July-Sept.,2013/138-140

4. D. Nazzal, J. A. Jimenez, H. J. Carlo, A. L. Johnson, and V. Lasrado "*An Analytical Model For Conveyor-*