Design, Analysis and Weight Reduction of Roller of Conveyor System through Optimization

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Abstract - *Conveyors are the major parts of the industries that play an important role for transportation of materials. Heavy and Bulky load of any sizes and shape can be transferred from one location to other. Conveyors generally used for efficient transportation of material from one location to another. The existing roller of a conveyor system is made up of mild steel which is higher in weight. Because of this higher weight bending occur between two supports after some period of duration. So aim of this work is to study existing roller of conveyor system for weight reduction. In our work we are going to reduce the weight of roller by changing the material. As these material are light in weight than mild steel so expected outcome of project is reduction in weight of roller.*

Key Words: Optimization, Weight Reduction, Material Handling System.

1. INTRODUCTION

Conveyors play an important role in all the industries for efficient transportation of material from one location to other.

Conveyors are generally used for safely moving of materials from one level to another, which when done by human would be time consuming and expensive. Conveyors can be installed anywhere, and are much safer than using other machine to move materials. Conveyors generally move loads of all types of shapes, sizes, and weight. Because of higher self-weight of roller, after some period bending occurs between two supports.

The problem is taken for study and involving execution for alternative design while obtaining weight optimization for the Roller of the conveyor system. The FEA methodology would be applied to solve the for finding out the structural strength of the roller and getting the reduction in weight without affecting on the strength of material handling member parts in the assembly of conveyor system.

1.1 Objectives

Objectives of the Work as follows:

- Study the existing roller of conveyor system.
- Creating Geometric model of existing Roller of conveyor system.
- Numerical study and Analysis of roller of conveyor system is carried out.
- Optimization of Roller is carried out by changing material.
- Comparison is done between existing and optimized design.

1.2 Problem Statement

The aim of this work is to analyze existing roller of conveyor system by using suitable material, to minimize the overall weight of the roller. There are number of rollers in between two supports. Because of higher self-weight of roller, after some period bending occurs between two supports. It affects performance of gravity roller conveyor.

2. PROPOSED METHODOLOGY

1. Study the existing roller of conveyor system.
2. Analytical calculations, Geometrical modeling and analysis of existing roller are carried out.
3. Selection of material is carried out on the basis of CEMA.
4. Analytical calculations, Geometrical modeling and analysis of selected material roller are carried out.
5. Manufacturing of selected material roller are carried out.
6. Weight measurement is carried out by using weighting machine.
7. Experimentation is carried out for existing roller and selected material roller for calculating how much it can resist load by using UTM machine.
8. Determine percentage reduction in Weight.
9. Conclusion.

Nomenclature

Symbol	Description
σ_b	Maximum bending stress
M_{max}	Maximum Moment
L	Width of roller
I	Moment of Inertia
W	Maximum load on one roller
E	Modulus of Elasticity
ρ	Density

3. DESIGN FOR ROLLER

Details about Roller (By company)-
D_1= Outer diameter of roller = 48 mm
D_2 = Inner diameter of roller = 41 mm
L = Width of roller = 450 mm
W= Maximum load on one roller = 40Kg
N= Number of Rollers = 18
Existing Roller weight (M.S.) = 1.28Kg

3.1 Design of Existing Roller

Material – MS
Standard Properties of Material
$E = 2.10*10^5$ MPa, ρ= 7860 Kg/m^3
Maximum Stress Calculation

W= 40kg
D_1= Outer diameter of roller = 48 mm
D_2 = Inner diameter of roller = 41 mm
w = Width of roller = 450 mm
y = Neutral axis Distance = 0.048/2 = 0.024

Considering uniformly distributed load
Maximum Moment (M_{max}) = $W*L^2/8$
$M_{max} = (40*9.81*.45^2)/8$
M_{max} = 9.9326 Nm

Moment of Inertia (I) = $\Pi (D_1^4 - D_2^4) / 64$
$I = \Pi (0.048^4 - 0.041^4)/64$
$I = 1.2186*10^{-7} m^4$

Maximum bending stress $\sigma_b = M_{max} * y / I$
$\sigma_b = 9.9326 * 0.024 / 1.2186*10^{-7}$
σ_b = 1.95 MPa

3.1.1 ANSYS Result of Existing Roller

Geometrical modeling of Roller is carried out in CATIA V5 R20 .Analysis is carried out in ANSYS 13.0
Load Applied-400N
Boundary Condition- Roller is fixed at the place where bearing is placed.

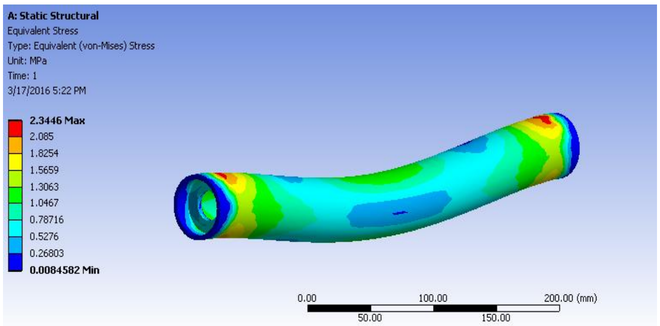

Fig No.-1 Equivalent (Von-Mises) stresses

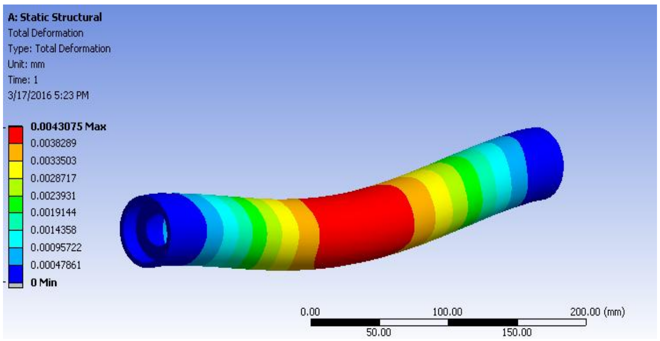

Fig No- 2 Total deformation

3.2 Design of Polyoxymethylene (POM) or Delrin Roller

Standard Properties of Material
E = 2760 MPa, ρ=1420Kg/m^3
Maximum Stress Calculation
W= 40kg
D_1= Outer diameter of roller = 58 mm
D_2 = Inner diameter of roller = 41 mm
w = Width of roller = 450 mm
y = Distance from neutral axis = 0.058/2 = 0.029

Considering uniformly distributed load,
Maximum Moment (M_{max}) = $W*L^2/8$
$M_{max} = (40*9.81*.450^2)/8$
M_{max} = 9.9326 Nm

Moment of Inertia (I) = $\Pi (D_1^4 - D_2^4) / 64$
$I = \Pi (0.058^4 - 0.041^4)/64$
$I = 4.16*10^{-7} m^4$

Maximum bending stress $\sigma_b = M_{max} * y / I$
$\sigma_{b=}$ $9.9326 * 0.024 / 4.16*10^{-7}$
σ_b = 0.573 Mpa

3.2.1 ANSYS Results of Polyoxymethylene Roller

Geometrical modeling of Roller is carried out in CATIA V5 R20. Analysis is carried out in ANSYS 13.0
Load Applied-400N
Boundary Condition- Roller is fixed at the place where bearing is placed.

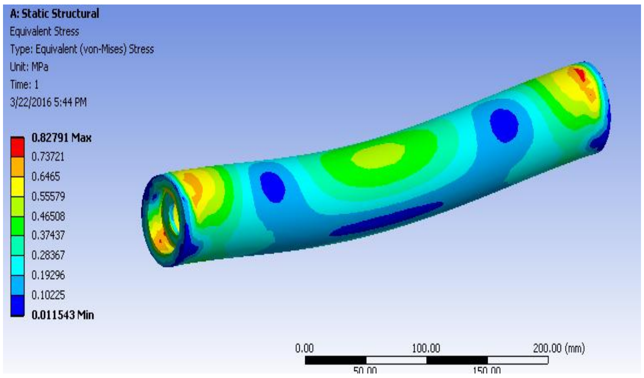

Fig No.-3 Equivalent (Von-Mises) stresses

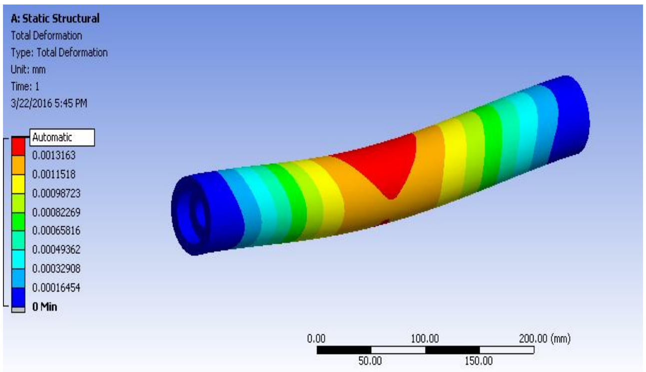

Fig No- 4 Total deformation

4. EXPERIMENTATION

Experimentation is carried for existing roller and selected material roller for calculating how much it can resist load by using UTM machine.

Fig No 5- Manufacturing of Roller using Lathe Machine.

4.1 Weight Measurement

Weight measurement is carried out by using weighting Machine

Fig No.6-Weight measurement of DELRIN Roller

Fig No.7-Weight measurement of Existing (M.S.) Roller

4.2 Testing of Roller

Fig No.-8 Testing of materials using UTM

5. RESULT AND DISCUSSION

Table No. 1 - Results for Stresses

Sr. No.	Material	Analytical	ANSYS	Weight
		(MPa)	(MPa)	(Kg.)
1	M.S.	1.95	2.34	1.28
2	POM	0.57	0.82	0.71

Chart-1 Graph for weights measurement

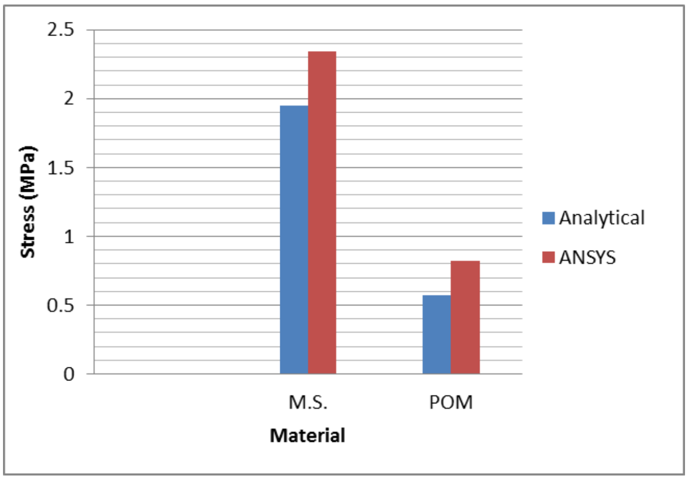

Chart-1: Graph for stresses

5.1 Result for Maximum load by UTM Machine

Table No. 3 – Maximum Load Measurement

Sr. No.	Material	Maximum load (Kg)
1	Delrin	5740

6. CONCLUSION

- Existing calculations shows that factor of safety of existing roller is more than requirement and hence there is scope for certain weight reduction.
- Though we get the value of deflection and stresses more than the existing, but it is in allowable limit.
- Actual optimized physical model is done for validation for selected material.
- Results obtained from the ANSYS and analytical calculations for existing roller are compared.
- Results obtained from the ANSYS and analytical calculations for POM roller are compared.
- 44.57% weight reduction is achieved when compared with Delrin (POM).
- Delrin Roller is then tested by using UTM Machine for calculating the maximum load.

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