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DESIGN AND ANALYSIS OF ROLLER CONVEYOR FOR WEIGHT OPTIMIZATION BY USING COMPOSITE MATERIAL

P.S. Solankar*

Under the guidance of Prof. S. R.GAWDE

PG student, Mechanical Engineering Department, Dattakala Group of Institutions Faculty of engineering A/P: Swami Chincholi, Tal: Daund, Dist: Pune-413 130.

ABSTRACT

In the present work, an attempt is made to reduction in weight of existing roller conveyor by optimizing the critical parts of (e.g. Roller,) conveyor without hampering its structural strength. The existing Roller conveyor designed is considered for this project work. The dimensions being 6000 mm length, 34 inch above ground and inclined at 6 degree with the ground and the weight to be carried by the conveyor - 360Kg (360 kg with added factor of safety). This is the weight of the largest component to be transported over the conveyor. The conveyor would normally encounter gradually applied loads while the components are lowered by hoist. For reasons of safety, a `sudden load' is already considered during its design phase. Static analysis of roller of existing conveyor is carried out find out maximum deflection & stress. Then Optimization is carried out by modifying the dimensions of roller .Then analysis of optimized roller are carried out to find out maximum deflection & stress. As such, the existing roller conveyor structure is tested for mechanical strength over the shop-floor while a trial is taken using optimized designed rollers of assembly and with the real-time components of the excavator. Upon completion of the experimentation, the assembly is observed for any visible damage to the conveyor units. The units are measured for their height, especially at the central region along the length of the unit with a general purpose retractable measuring tape. The recorded measurement does not highlighting any sag induced in the unit during the experimentation phase. As the rollers in which changes are made in existing design are standard (the weight of the physical model is slightly more than the optimized model values). So made easily available in market..

KEYWORDS: Optimized design, Weight reduction and material handling systems.

INTRODUCTION

A conveyor system is a common piece of mechanical handling equipment that moves materials from one location to another. Conveyors are especially useful in applications involving the transportation of heavy or bulky materials. Conveyor systems allow quick and efficient transportation for a wide variety of materials, which make them very popular in the material handling and packaging industries. Many kinds of conveying systems are available, and are used according to the various needs of different industries. There are chain conveyors (floor and overhead) a swell. Chain conveyors consist of enclosed tracks, I-Beam, towline, power & free, and hand pushed trolleys. Conveyors systems are used wide spread across arrange of industries due to the numerous benefits they provide.

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, including the hydraulic, mechanical and fully automated systems, which are equipped of it 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 it ensue has beans and nuts, bottles and cans, automotive components, scrap metal, pills and powders, wood and furniture and grain and animal feed. Many factors are important in the accurate selection of a conveyor system. It is important to know how the conveyor system will be used beforehand. Some individual areas that are helpful to consider are the required conveyor operations, such as transportation, accumulation and sorting, the material sizes, weights and shapes and where the loading and pickup points need to be used.

Types of Conveyor Systems

- Gravity Conveyor systems
- Powered Belt Conveyor systems
- Pneumatic conveyor systems
- Vibrating conveyor systems
- Flexible conveyor systems
- Vertical conveyor systems and spiral conveyors
- Live Roller Conveyor systems

PROBLEM DEFINATION

- The aim of this project is to redesign existing gravity roller conveyor system by designing the critical parts (Roller, Shaft, Bearing and Frame), to minimize the overall weight of the assembly and to save considerable amount of material. Gravity roller Conveyor has to convey 360 kg load, 34 inch above ground and inclined at 6 degree.

OBJECTIVES OF THE STUDY

- The following are the objectives of the study:
- 1. Study existing roller conveyor system and its design.
- 2. Geometric modeling of existing roller conveyor.
- 3. To generate parametric model using ANSYS Parametric Design Language (APDL) program.
- 4. To carry out linear static, modal, transient and optimization analysis of existing roller conveyor.
- 5. Modification of critical conveyor parts for weight optimization.
- 6. To carry out Analysis of Modified design for same loading condition.
- 7. Recommendation of new solution for weight optimization.

SCOPE OF WORK

The geometry of the roller conveyor is amenable to the usage of 3D modeling. The design of the roller conveyor would necessitate knowledge of the fundamentals for Product Design coupled with intuition gained by experience of the Design Engineer. The information like `weight' of the roller conveyor and `location of the Centre of Gravity' can be readily offered by the three dimensional CAD interface.

Although it is iterative process the physical design can of each iteration for testing is not possible for conformance to the conditions specified (test conditions) could be done through the utilization of a suitable tool – Software for Analysis in the domain of Mechanism Design. With the past experience of the service provider in this field, `ANSYS' (from MSC Software) appears as a competent tool to pursue Analysis for this Project Work.

DESIGN OF ORIGINAL ROLLER

Material Mild steel
$E = 2.10x10^5$MPa, p=7860 Kg/m^3
Considering uniformly distributed load and FOS = 2
Maximum Stress Calculation for given condition
W= 36kg
D_1= Outer diameter of roller = 40 mm
D_1=Inner diameter of roller = 32 mm
w = Width of roller = 300 mm
y = Distance from neutral axis = 0.04/2 = 0.02

Considering uniformly distributed load,
Maximum Moment (Mmax) = W $xL^2/8$

= (36 x 9.81 0:3^2/8

Mmax = 3.973 Nm

Moment of Inertia (I) = 3.1416*(D_1^4 - D_2^4)/64

= 3.1416*(0.048^4-0.032^4)/64

I=7.4192 x 10 $^{-8}$m^4

Maximum bending stress (σb) =Mmax x y/I

= 3.973 x 0.024/ 7.4192 x 10 $^{-8}$

(σb)=1.0710Mpa

5.1 Design of epoxy glass fiber roller:

Material Glass Fiber

E = 34000 MPa, p=2600Kg/m^3

Considering uniformly distributed load and FOS = 2

Maximum Stress Calculation for given condition

W= 36kg

D_1= Outer diameter of roller = 54 mm

D_1=Inner diameter of roller = 32 mm

w = Width of roller = 300 mm

y = Distance from neutral axis = 0.054/2 = 0.027

Considering uniformly distributed load,

Maximum Moment (Mmax) = W xL^2/8

= (36 x 9.81 0:3^2/8)

Mmax = 3.973 Nm

Moment of Inertia (I) = 3.1416*(D_1^4 - D_2^4)/64

= 3.1416*(0.054^4-0.032^4)/64

I =3.65921 x 10 $^{-7}$m^4

Maximum bending stress (σb) = M_{max} x y/I

= 3.973 x 0.024/ 3.65921 x 10 $^{-7}$ **(σb)**

=0.29315Mpa

STATIC ANALYSIS

A static analysis calculates the effects of steady loading conditions on a structure, while ignoring inertia and damping effects, such as those caused by time-varying loads. A static analysis can, however, include steady inertia loads (such as gravity and rotational velocity), and time-varying loads that can be approximated as static equivalent loads.

Static analysis is used to determine the displacements, stresses, strains, and forces in structures or components caused by loads that do not induce significant inertia and damping etc. Steady loading and response conditions are assumed; that is, the loads and the structure's response are assumed to vary slowly with respect to time.

The kinds of loading that can be applied in a static analysis include:

Externally applied forces and pressures

Steady-state inertial forces (such as gravity or rotational velocity) Imposed displacements

Temperatures (for thermal strain) Fluencies (for nuclear swelling)

6.1.1 Material

6.1.2 Mild steel

Mild steel is the most commonly used steel. It is used in the industries as well in the different everyday objects we use. Even the pans and spoons of the kitchen are sometimes made of mild steel. The mild steel is very important in the manufacturing of metal items. Almost 90% steel products of the world is made up of mild steel because it is the cheapest form of steel.

Mild steel is the most widely used steel which is ductile and cheap in price. Mild steel is not readily tempered or hardened but possesses enough strength.
Mild steel Composition:
Mild steel contains -

Carbon 0.16 to 0.18 per (maximum 0.25% is allowable) Manganese 0.70 to 0.90%

Silicon maximum 0.400% Sulfur maximum 0.04%
Phosphorous maximum 0.04%
Mildest grade of carbon steel or mild steel contains a very low amount of carbon - 0.05 to 0.26%

Tables 1.5.1 Mild steel Properties

Young's modulus	10 10^5
Poisons ratio	0.3
density	7860kg/m^3
Tensile yield strength	240MPa
Compressive yield strength	240MPa

4.5 MATERIAL: Mild steel
6.2 Model
Roller Specification:
D2 = Inner diameter of roller = 32 mm
D1 = Outer diameter of roller = 40 mm
w = Width of roller = 300 mm
W= 36kg
Considering uniformly distributed load
Model

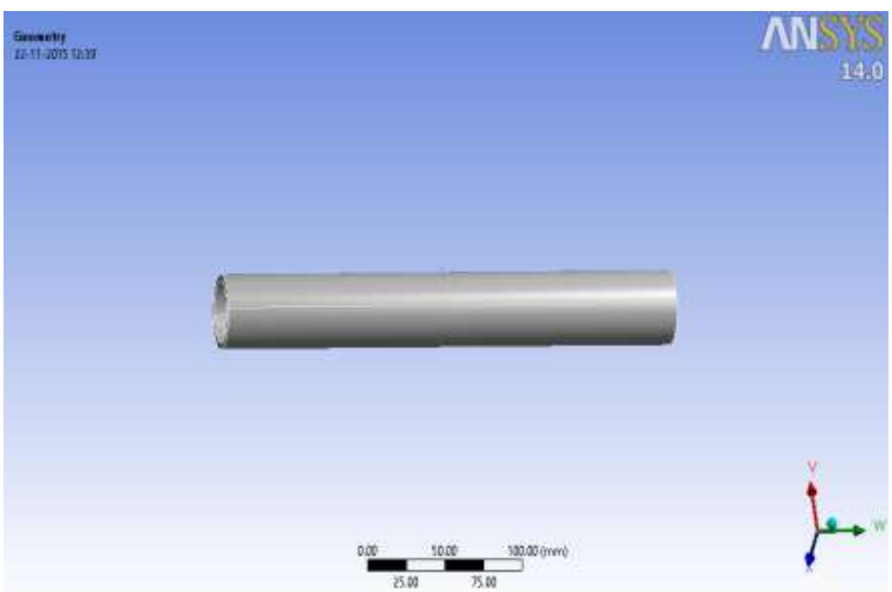
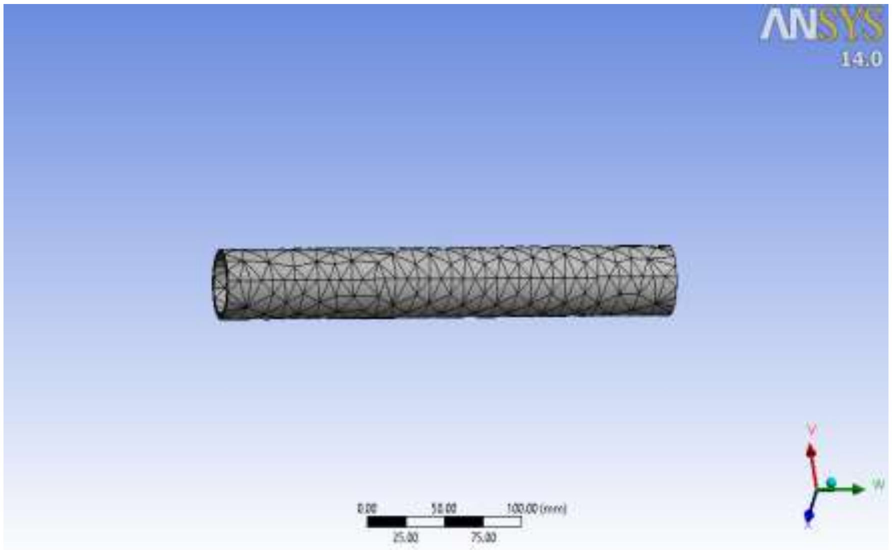


Figure 4.5.1 Mild steel roller in part drawing of catia

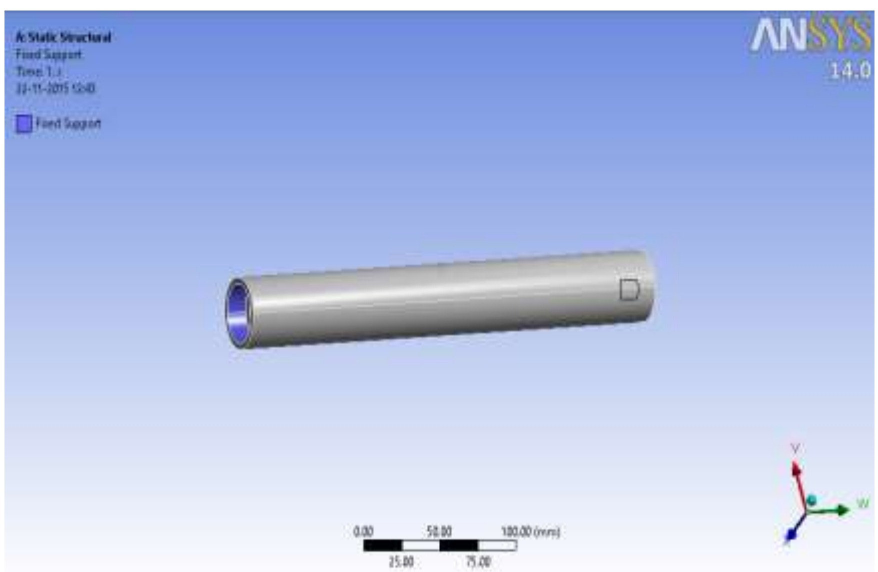
6.2.1 Meshing:



Statistics	
Nodes	3587
Elements	1785
Mesh Metric	None

Figure 4.5.3 Meshing of mild steel roller

6.2.2 Constraints and application of load:



4.5.4 Fixed support of mild steel bar

6.2.3 Force

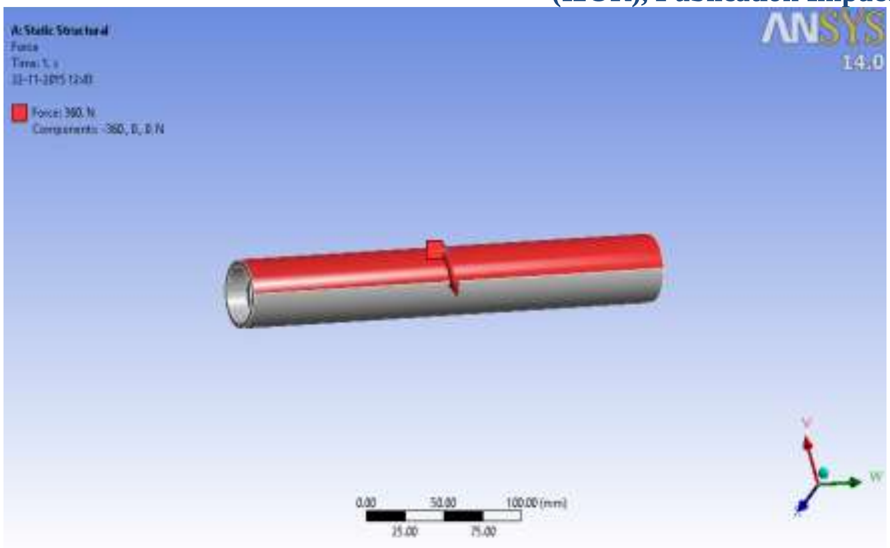


Figure 4.5.5 Application of load

6.2.4 Stress

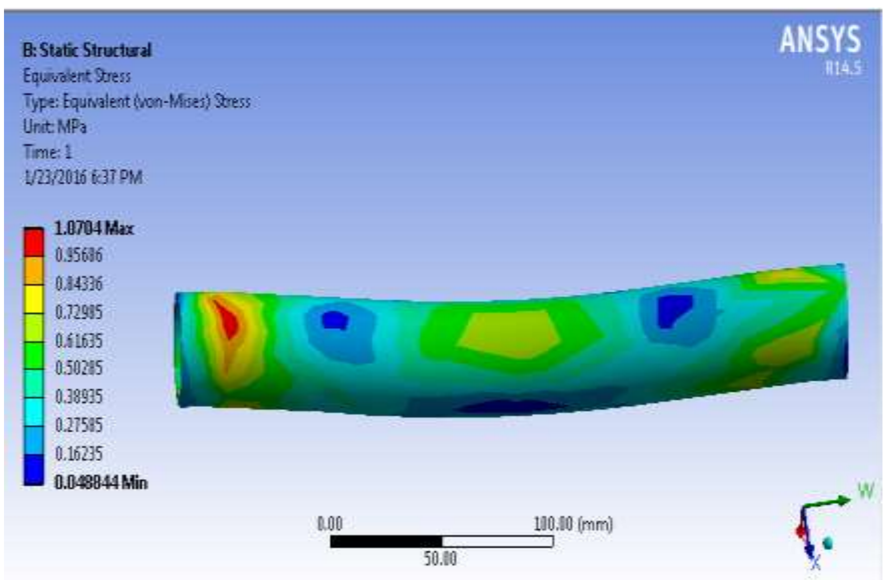


Figure 4.5.6 Stress in mild steel roller

Analysis type static analysis
Maximum stress for mild steel roller by ansys is 1.0704MPa.

6.3 MATERIAL: Epoxy glass fiber
6.3.1 Model
Roller Specification:
Inner diameter of roller = 32 mm
Outer diameter of roller = 40 mm
Width of roller = 300 mm

W= 36kg
Considering uniformly distributed load
Glass Fiber

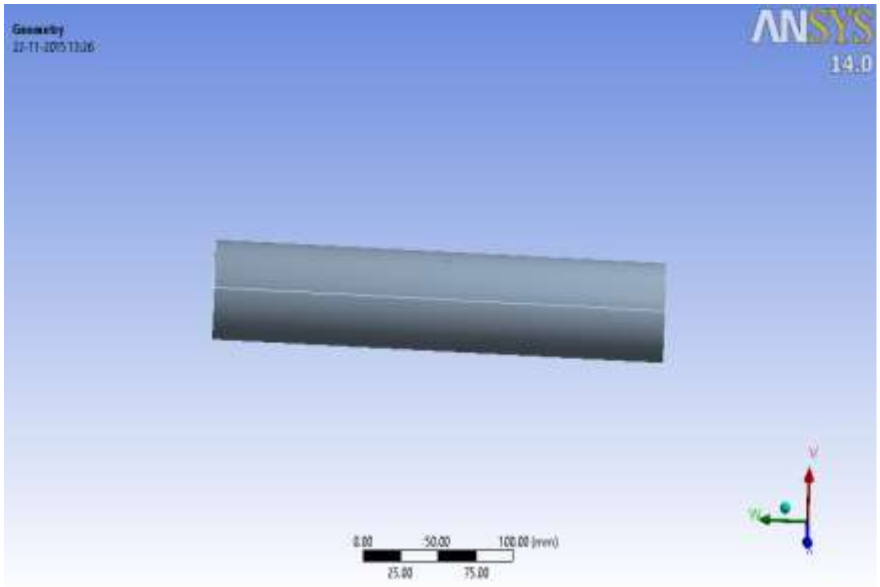
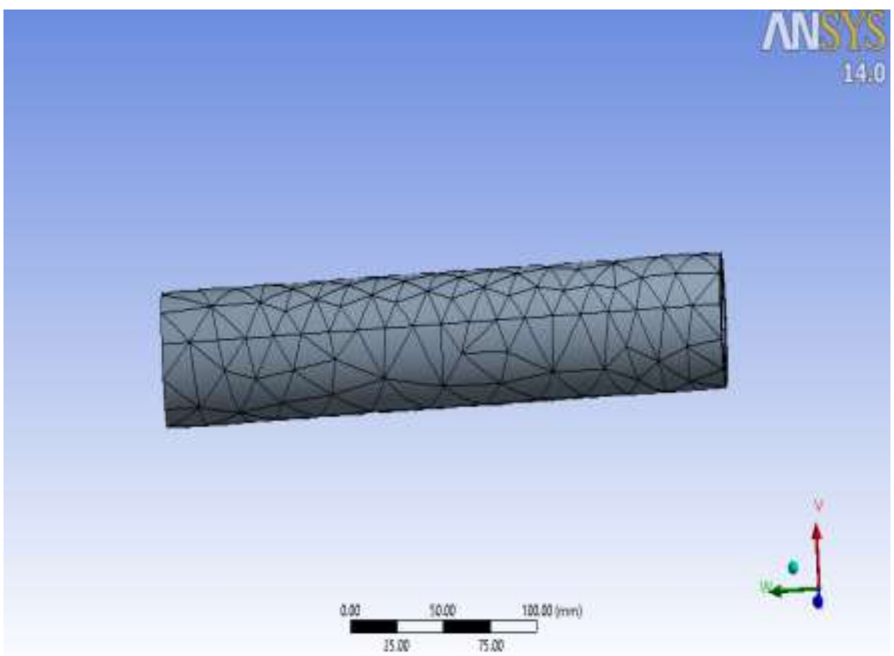


Figure 4.6.1 Glass Fiber roller in part drawing

6.3.2 Meshing



Statistics	
Nodes	2107
Elements	1041
Mesh Metric	None

Figure 4.6.3 Meshing of glass fiber roller

6.3.3 Fixed support

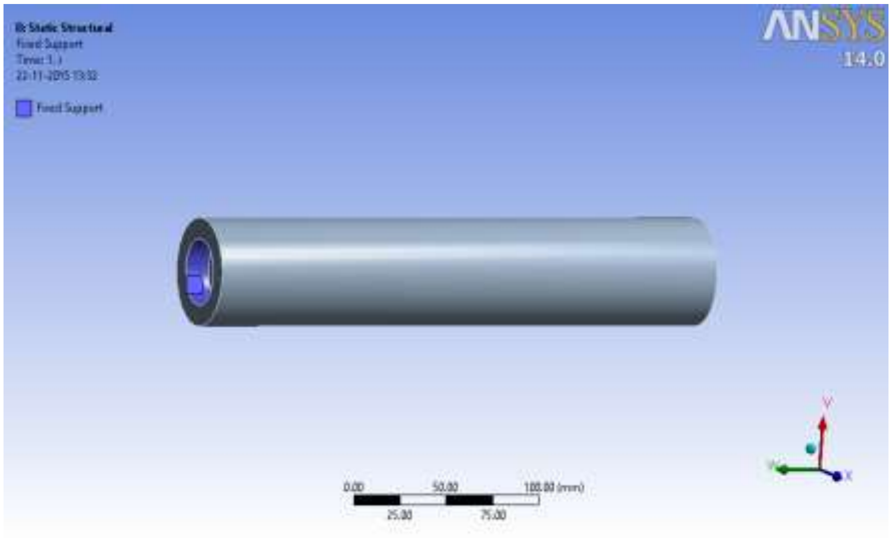


Figure 4.6.4 Selection of support

6.3.4 Force

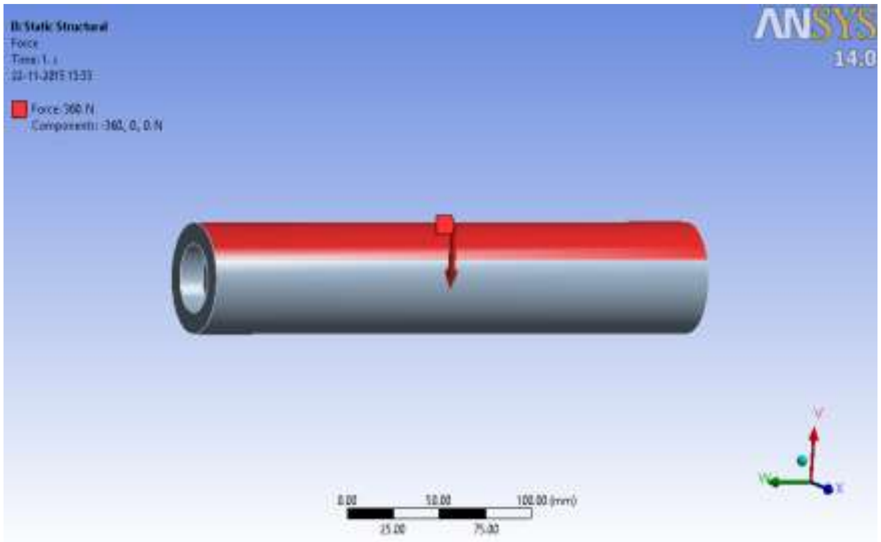


Figure 4.6.5 Force

6.3.5 Stress

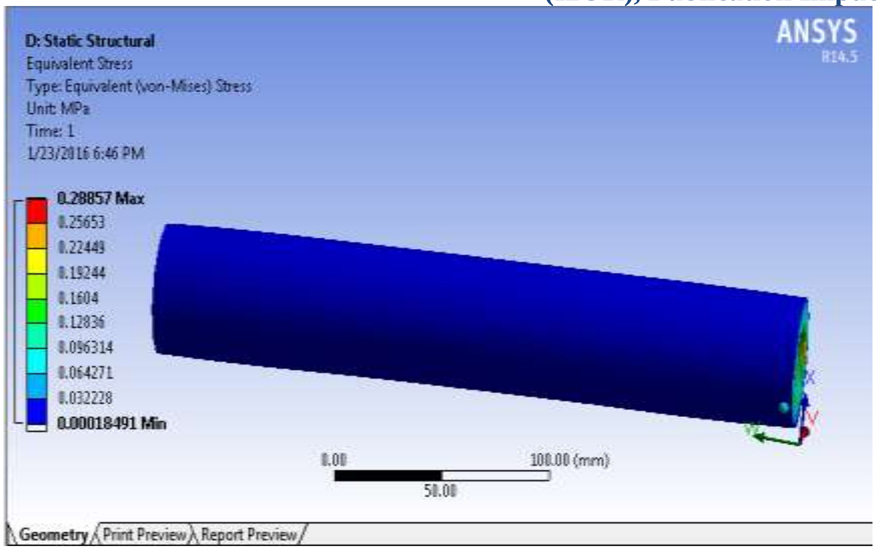


Figure 4.6.6 Stress in glass fiber roller

Analysis type static analysis
Maximum stress for mild steel roller by ansys is 0.28857MPa

RESULT TABLE

Stress analysis

Table 7.1: Stress Analysis

Sr.No	Material	Analytical (MPa)	ANSYS (MPa)	REDUCTION%
1	Mild steel	1.0710	1.0704	27.10%
2	Epoxy glass Fiber	0.29315	0.28857	

Percentage reduction in mass 27.10%

CONCLUSION

The following conclusions can be made from the obtained data:

1. When mild steel material is used the stresses are more as compare to composite material.
2. When composite material used weight is reduced and considerable for the same capacity of roller conveyor system.
3. While one more benefit of using glass fiber roller is it produces less noise than mild steel roller.

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