Stress Analysis And Weight Reduction of Roller Of Roller Conveyor

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Abstract - *Conveyor is used in many industries to transport goods and materials between stages of a process. Using conveyor systems is a good way to reduce the risks of musculoskeletal injury in asks or processes that involve manual handling, as they reduce the need for repetitive lifting and carrying.*

Yet most people had worked on save material of roller and ease of design of roller for manufacturing and assemble it. The aim of this paper is to study existing conveyor system and new weight optimize roller conveyor system (like wt. of roller, shaft etc.) The current trend is to provide weight/cost effective products which can give less effort to user. In general, for convey parts from one place to another we can use different types of devices and among them one is roller conveyor. It is designed for ease for assembly, manufacturing safely convey part and reduce cost. The assembly of roller has different stresses issue in contact region between any matching parts. Roller conveyor is subjected to easy state of loading therefore we designed it with higher factor of safety.

Key Words: Roller conveyor, Automation Component Design, Analysis of Roller Assembly.

1. INTRODUCTION

Conveyor is used in many industries to transport goods and materials between stages of a process. Using conveyor systems is a good way to reduce the risks of musculoskeletal injury in tasks or processes that involve manual handling, as they reduce the need for repetitive lifting and carrying. Conveyors are a powerful material handling tool. They offer the opportunity to boost productivity, reduce product handling and damage, and minimize labour content in a manufacturing or distribution facility. Conveyors are generally classified as either Unit Load Conveyors that are designed to handle specific uniform units such as cartons or pallets, and Process. Chain Drive Roller Conveyor, Conveyors that are designed to handle loose product such as sand, gravel, coffee, cookies, etc as shown below figure 1.1 which are fed to machinery for further operations or mixing. It is quite common for manufacturing plants to combine both Process and Unit Load conveyors in its operations. Conveyors are generally classified as either Unit Load Conveyors that are designed to handle specific uniform units such as cartons or pallets, Process and Unit Load conveyors in its operations. It is not subjected to a complex state of loading still we found that it is designed with a higher factor of safety. If it is redesigned critical parts, e.g. Roller, Shaft, and Bearing & Frame.

1.1 Objectives

1. To reduce roller manufacturing cost & time consuming for assembly.
2. Study roller conveyor system and its design.
3. To generate model using CATIA/ ANSYS program.
4. To study conveyor parts for weight optimization.
5. To study a fixture system and its design.
6. To study the selection of sensors.
7. To study the laser machine and selection of camera.

2. DESIGN OF ROLLER

2.1 Component Details

As per the fig. 3D design of roller conveyor, the existing roller was designed. And for optimization we modify the design of shaft in roller assembly. The modelling like following –

The modeling of roller assembly consist of Roller 1 no, Shaft 1 no., and Bearing (6301) 2 nos. in existing conveyor and same in optimized roller consist roller no., Bearing (6301), & optimized shaft 2 nos. as redesign. The above fig. shows both existing and optimized roller design.

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Table 1- List of part's in Roller assembly

SR. NO.	COMPONENT	MATERIAL	QTY. (NOS.)
01	Roller	Schedule 40	01
02	Shaft	EN 8	01
03	Bearing	Standard (6201)	02

2.2 Computer Aided Fixture Designs

Roller Conveyor systems are a good way to reduce the risks of musculoskeletal injury in tasks or process that involve manual handling, as they reduce the need for repetitive lifting and carrying. Conveyors are a powerful material handling tool. Chain Drive Roller Conveyor that is designed to handle loose product such as sand, gravel, coffee, cookies, etc., which are fed to machinery for further operations or mixing. The roller conveyor includes dual chain socket for carrying heavy loads and smooth working. The detail design of roller conveyor is shown below in fig. It also minimizes the jerks while stopping and starting gravity force for palate travelling.

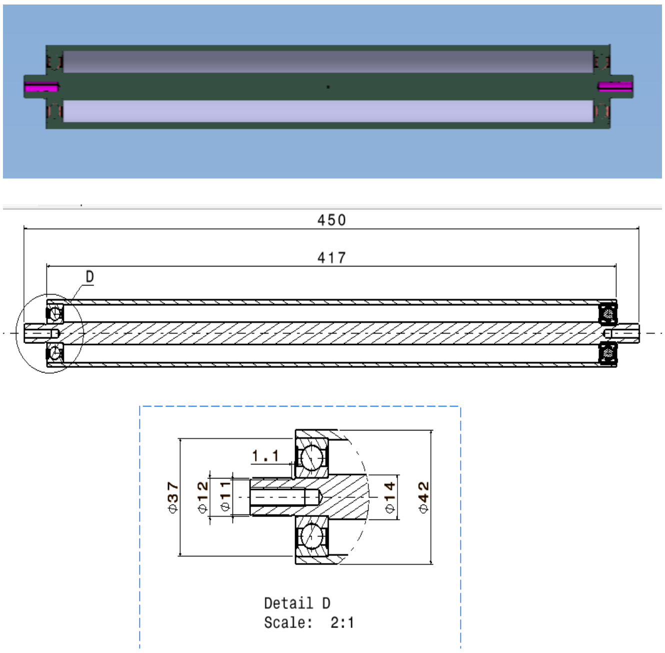

Fig-1: Existing roller modelling & drafting

In this technique before implement we analyze the testing instrument availability. Then the initial layout is generated so that we will select the proper location. The main parts of the project are roller. We proper study of roller materials and design with proper selection of inner diameter, outer diameter and check the stress, stain and bending capacity of rollers.

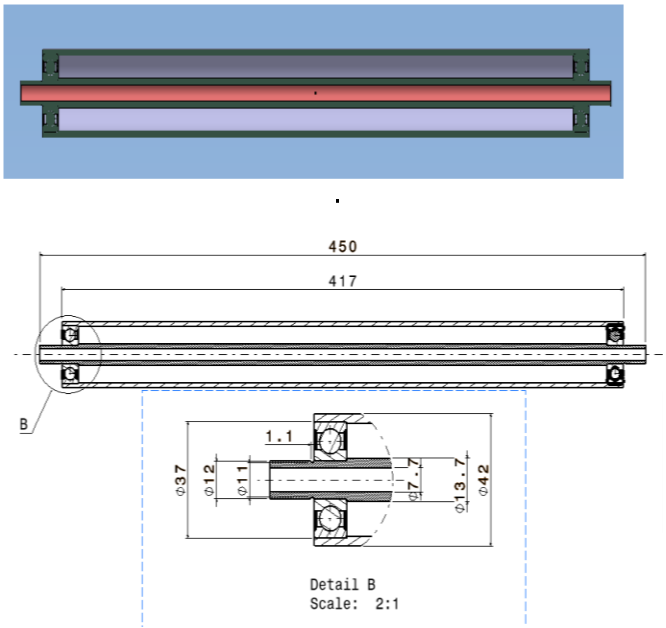

Fig-2: Optimized roller modeling & drafting

Its collective information, we implement the design of roller and its material. The problem formulated as a constrained design by considering of roller conveyor, roller, bearings, sprocket and chain and alignment of pins were serially programmed and used to solve the design of machine problem and established the total layout of the diesel engine assembly line.

2.3 Weight calculation of Roller -

For complete analysis of roller weight optimization is too necessary to show mathematical approach. The calculation of roller deformation is find by bending moment diagram which is we are going to see,

2.3.1 Weight of Roller –

= cross-section area x width x mass density

= π (0.062 – 0.052) *0.5*7850/4

=1.536 Kg

And Total Weight of rollers is

= 14 * 1.536 = 21.504 Kg.

As per Result Comparatively existing rollers weight is

= 14 * 1.903 = 26.652 Kg.

2.3.2 SFD & BMD calculation –

Free body diagram -

The diagram consist simply which type of load going to apply like we applied 0.83 N/mm UDL (Uniform Distributed Load) in length of 317 mm of centre side roller. And the reaction will be act on both end of shaft, which will be same for both roller.

And the reaction will be like,
RA and RB
So, let's find both reactions,

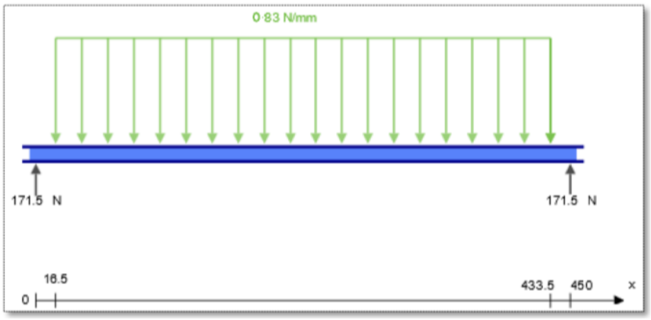

Fig-3: Free body diagram (FBD)

Here, find RA = RB
Therefore, the values are,
RA = 171.5 N and
RB = 171.5 N

Shear Force Diagram –
The shear force diagram is nothing but show over all shear forces acting on whole system on which we are testing. Therefore same we will find out shear forces as follow, As per the above both equation results we can draw easily shear force diagram and it's like,

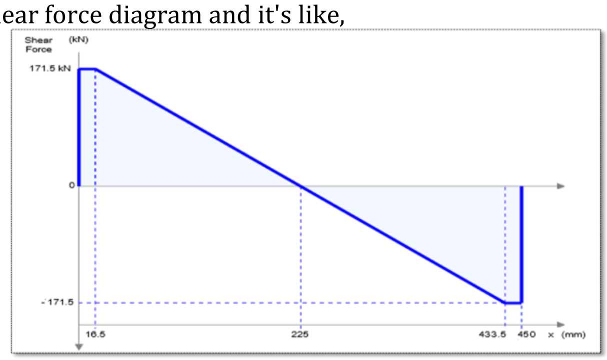

Fig-4: Shear force diagrame (SFD)

Bending Moment Diagram -

The given data for find out Bending moment is, Maximum Stress Calculation for given condition :

W= 140/4= 35kg (Load act on 4 rollers at a time)
D1 = Diameter of roller = 42 mm
D2 = Diameter of Shaft = 16 mm
w = Width of roller = 450 mm
y = Distance from neutral axis = 0.06/2 = 0.03m
Uniformly distributed load is considered,
Therefore the formula of B.M. is

Maximum Bending Moment at the centre of roller,

(Mb max) = W*L/8
(Mb max) = (35*9.81*0.5)/8

Mb max = 0.021 Nm

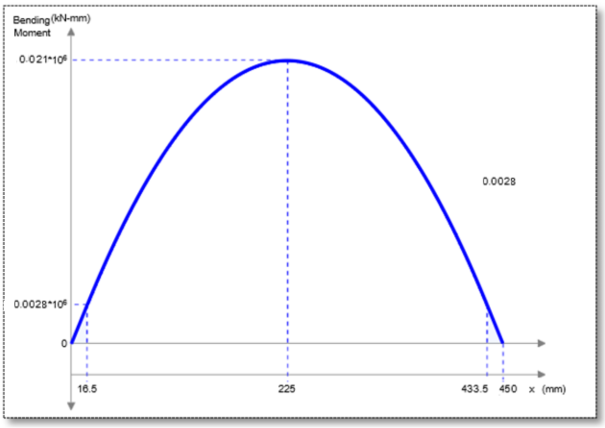

Fig-5: Bending moment diagram (BMD)

2.3.3 Deformation calculation -

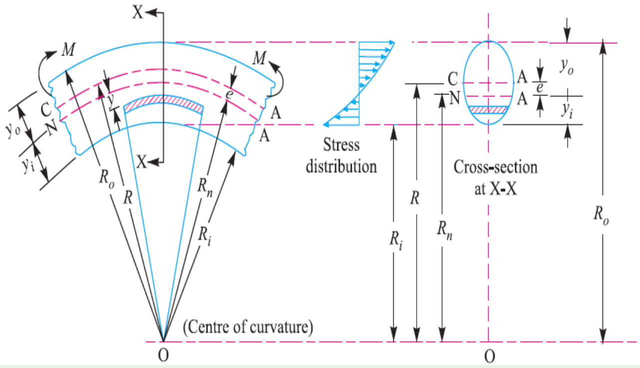

Fig-6: Bending stress in curved beam

The given axis is,

$$\sigma_b = \frac{M}{A \cdot e}\left(\frac{y}{R_n - y}\right)$$

Where, M = Bending moment

A = Area of cross section

e = Distance from centroid axis

R = Radius of curvature from centroid axis

Rn = Radius of axis from neutral axis

And , y = Distance from neutral axis = Deformation.

Therefore, y = 0.041 mm for existing roller

and same as for optimized roller is, y = 0.023 mm

3. ANALYSIS OF FIXTURE

3.1 Meshing & Boundary Conditions -

Here ANSYS 16 Static Workbench Software is used for FEA of CAFD's, here we have done FEA of both type of fixture work piece assembly designs.

As per below fig. I applied 35 kg UDL on top of roller. Generally the roller stress analysis should be dynamic, but due to experimental setup failure & results comparison I decide to go through static analysis.

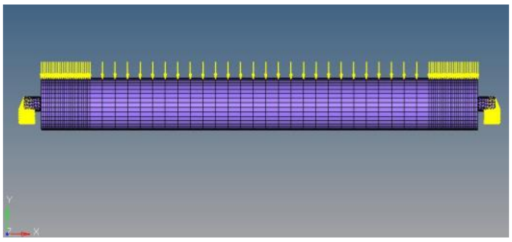

Fig-7: Loading & boundary condition's

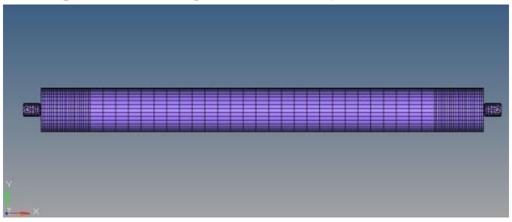

Fig-8: Meshing of existing & optimized roller

3.2 Software Results -

As we provide boundary condition, load and get meshing via. node the way to get different result is open for us. Like different stress we will get from ANSYS software. The best we can say suitable software for get FEM result is ANSYS. The compressive stresses of existing as well as optimized roller are shown in below fig. Those are also clear the different of both result's.

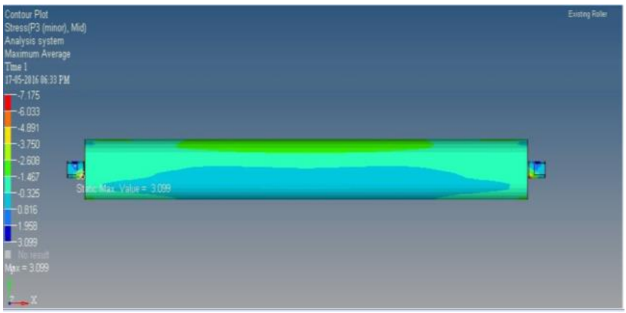

Fig- 9 : Existing roller compressive stress

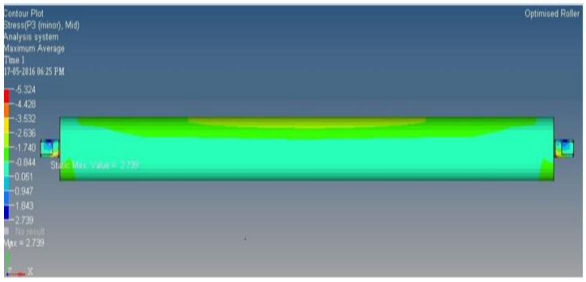

Fig-10 : Optimized roller compressive stress

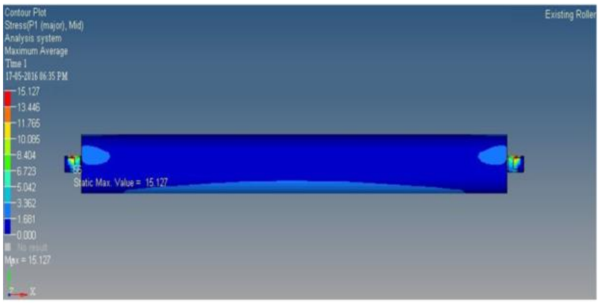

Fig-11 : Existing roller tensile stress

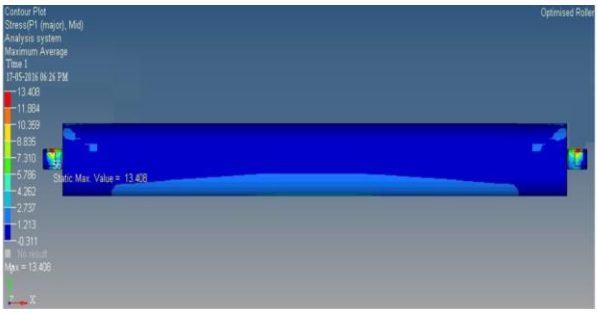

Fig - 12 : Optimized roller tensile stress

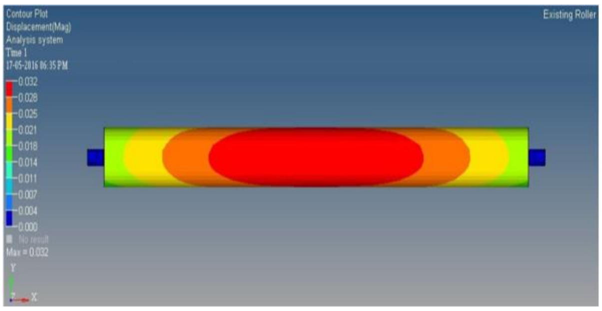

Fig -13 : Existing roller finds deformation

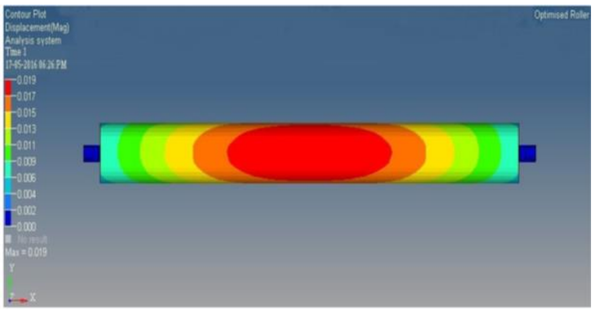

Fig - 14 : Optimized roller finds deformation

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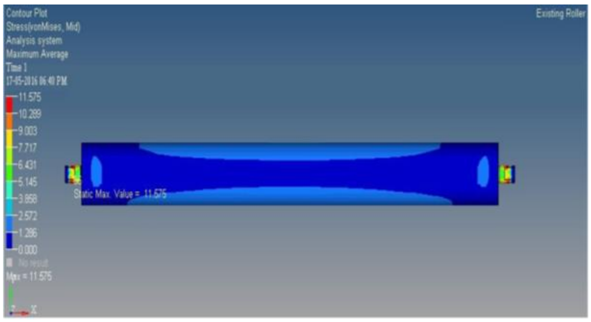


Fig - 15 : Existing roller von mises stress

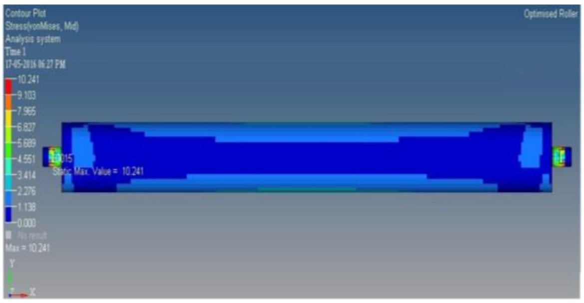


Fig -16 : Optimized roller von mises stress

The von mises stress results of existing and optimized roller is like, 11.575 N/mm2 & 10.241 N/mm2 respectively.
The detail result of existing and optimized roller which got in ANSYS software are as following. It has two different tables such as,

3.3 Results and Discussions

As per applied load the different stresses which I found via, software these are,

Table 2- Stress Analysis Result's & Applied forces

DESIGN	Applied Forces (Max) (N)	Compressive Stress (N/mm2)	Tensile Stress (N/mm2)
EXISTING ROLLER	350	3.099	15.127
OPTIMIZE D ROLLER	350	2.739	13.408

Table-3: Stress Analysis Result's

DESIGN	Von Mises Stresses (N/mm2)	Deformation (mm)
EXISTING ROLLER	11.575	0.032
OPTIMIZE D ROLLER	10.241	0.019

4. DEVELOPMENT AND EXPERIMENTATION OF FIXTURE

4.1 Conveyor Manufacturing -

Before start testing the whole manufacturing process for roller conveyor which completed in PROMECH AUTOMATION for MAHINDRA AND MAHINDRA, CHAKAN which is good running now date. The manufacturing process is as follow in detail from start to end-

Fig-17 : Manufactured Roller Child Part

Fig-18 : Conveyor Assembly And Fabrication

The part which is travelling from roller conveyor whose width 400 mm and length is 315 mm. The engine block covered width / length of roller and three nos. of roller. The block and manufactured roller as follow -

Fig-19 : Engine Block which travel on conveyor

4..2 Experimental Setup for UTM -

The experimental for testing deformation on UTM (Universal Testing Machine) is as below –
1. The set-up and usage are detailed in a test method, often published by a standards organization. This specifies the sample preparation, fixturing, gauge length (the length which is under study or observation), analysis, etc.

2. The specimen is placed in the machine between the grips and an extensometer if required can automatically record the change in gauge length during the test. If an extensometer is not fitted, the machine itself can record the displacement between its cross heads on which the specimen is held.
3. Once the machine is started it begins to apply an increasing load on specimen. Throughout the tests the control system and its associated software record the load and extension or compression of the specimen.
4. Machines range from very small table top systems to ones with over 1,000 KN capacity.

4.3 Operation Procedure -

The operation Procedure for experimental testing on UTM (Universal Testing Machine) is as below -

1. Ensure that all the switches and main switches are put on.

2. Ensure that release valve and the control valve mounted on control unit are closed

3. Move the middle crosshead of loading unit up and down with the help of mechanical motors; there by the space from upper crosshead and middle crosshead decreases or increase, this helps us to adjust the gap between crossheads as per length of the specimen.

4. Now put the machine on and open the control valve slowly. Observe the upward movement of upper and lower crosshead. The middle crosshead will remain stationary. One can control the movement speed of crosshead using control valve.

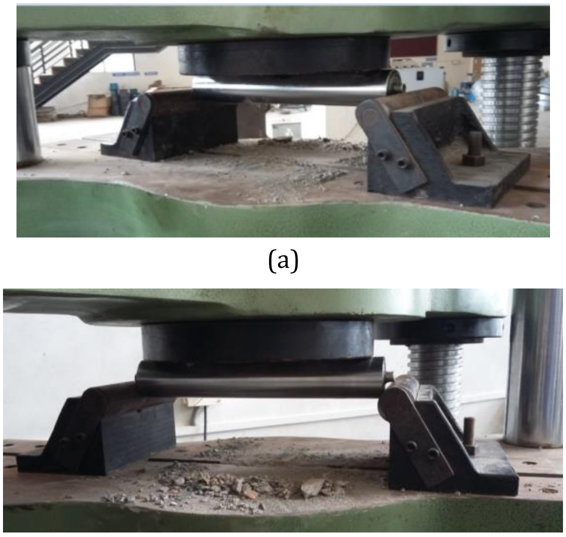
5. As soon as the control valve is opened observe the changes on load dial/display along with displacement dial/display. The value for load will increase for some time and the remain stationary but the value for displacement will go on increasing. This load value is nothing but the dead weight of lower crosshead.

6. Now make the load reading zero with the help of tare switch. Shut down the machine. Close the control valve and open the release valve.

7. Note the backflow of hydraulic oil and observe slow lowering of the crosshead. The valve for load will decrease for some time and then become negative and the values for displacement will go on decreasing. This is termed as adjustment is not done properly.

8. Put the timber specimen between middle and lower crosshead. Ensure that there is a small gap within crosshead and the specimen. After selecting suitable range on load dial gauge close the release valve and slowly open the control valve.

Fig-20 : UTM (Universal Testing Machine) with specimen



(a)

(b)

Fig- 21 : UTM (Universal Testing Machine) with specimen (a) Existing Roller & (b) Optimized Roller

4.4 Experimental Results -

The results taken by UTM (Universal Testing Machine) are –

4.4.1 Load Vs Displacement

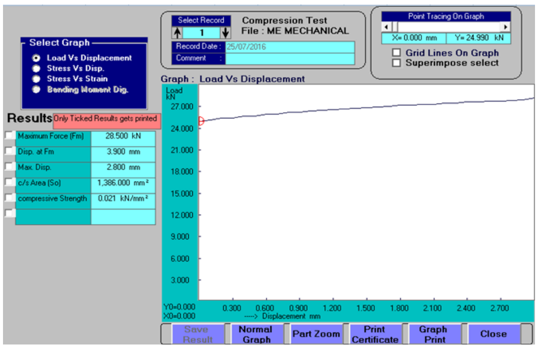


Fig-22: Load Vs Displ. result on UTM for Exiting roller

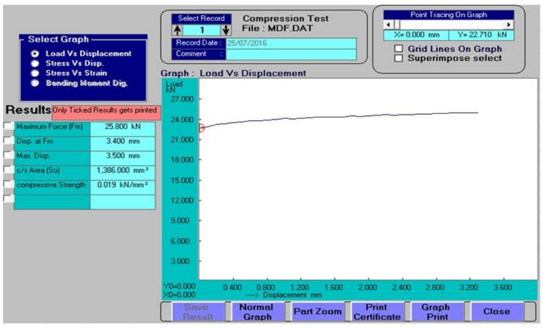


Fig-23 : Load Vs Displ. result on UTM for Optimized roller

4.4.1 Stress Vs Displacement

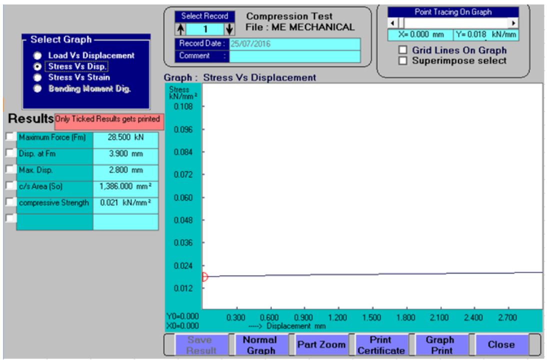


Fig-24 : Stress Vs Displ. result on UTM for Existing roller

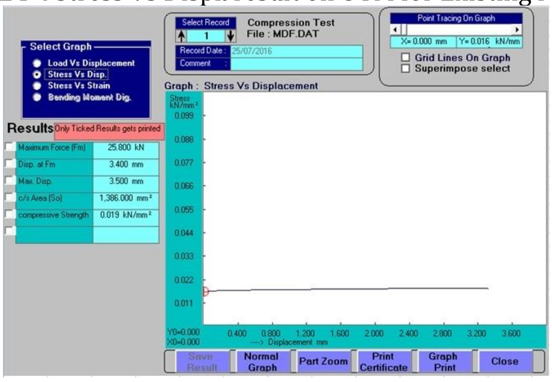


Fig-25 : Stress Vs Displ. result on UTM for Optimized roller

6. CONCLUSIONS

The conclusion of both roller (existing & optimized) analysis after software result and experimental result

1. The deformation of existing roller as compare to optimized roller is high therefore optimized roller design is suitable for weight optimization.
2. Due to optimization the reduced weight of roller is 19.46 %.
3. 0.367 Kg. Wt. Optimize per roller like those whole conveyors optimize weight is 5.138 Kg. Therefore the power required to move engine block from one place to another via conveyor is also reduce.
4. Also the model manufactured as a physically and it work safely as observed.

ACKNOWLEDGEMENT

It is indeed a great pleasure to present this project on "STRESS ANALYSIS AND WEIGHT REDUCTION OF ROLLER OF ROLLER CONVEYOR". This provides me with the first and the best opportunity to put my engineering knowledge to practical use.
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