IJNRD.ORG ISSN : 2456-4184

INTERNATIONAL JOURNAL OF NOVEL RESEARCH AND DEVELOPMENT (IJNRD) | IJNRD.ORG

An International Open Access, Peer-reviewed, Refereed Journal

DESIGN, DEVELOPMENT AND OPTIMIZATION OF ROLLER CONVEYOR

Name-Mr. Nilesh Chandrakant Thonte

Guide name-Prof. S. M. Nagure

M.B.E.S college of Engineering Ambajogai, Maharashtra, India.

nileshthonte25@gmail.com

---***---

Abstract – *The paper highlights study existing roller conveyor system and optimize and analyses the critical parts like Roller, C-channels for chassis and support to minimizethe overall weight of the assembly and material saving. This work also involves geometrical and finite element modelling of existing design and optimized design. Geometrical modelling will be going to do by using CATIA V5R20 and the finite modelling tool. Results of linear static in this work testing on the sample will do using a universal testing machine (UTM). In this work, the composite material is considered for the sample testing for eg. glass fibre. The Paper also involves a discussion about comparative study of different composite materials and the behaviour of the composite material as per variable loading conditions for eg. 500N, 1000N, 1500N, 2000N, 2500Nof force. Manufacturing of the roller by applying 0.5 mm thick glass fibre material on roller and load vs. deformation graph is generated on UTM. Paper also involves hand calculations like stress, banding moment, bending moment, and deflection calculations.*

Keywords- *Composite material, CATIA V5R20, ANSYS software*

1. 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 are commonly used in many industries, including 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 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 sorting, and the material sizes, weights and shapes of objects. Conveyor systems allow quick and efficient transportation for a wide variety of materials, whichmakes 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) as well. Chain conveyors consist of enclosed tracks, I-Beam, towline, power & free and hand-pushed trolleys. Conveyor systems are used widespread across a range of industries due to the numerous benefits they provide a transport framework is a typical piece of mechanical taking care of gear that moves materials starting with one area and then onto the next. They can move loads of all shapes, sizes and weights also many have advanced safety features that help prevent accidents.

Summary of the paper: The article highlights the introduction regarding the conveyor system, especially the roller conveyor system. In this report's introduction parts give information about the benefits of roller conveyors and their application in the industrial platform, classification of the conveyor system is added in the report along with various types of steel rollers and their manufacturing methods. The selection criteria regarding the selection of roller for testing optimization and validation are added in the reports including roller size, overall size and elevation of gravity roller conveyor and ministry of the shaft. The whole work is to minimize theoverall weight of the conveyor system made up of MS roller. The objective of the work is to provide an optimized solution to minimize the weight of the system and save material. The workincludes the use of various software tools like CATIA and ANSYS workbench for creating and analyzing the model that will be used for further work. The validation of the optimized solution is done by actual manufacturing of the actual roller with a layer of the glass fibre and its testing under a UTM machine to create a load vs. deformation graph. The geometric model of the roller, bearing, shaft, C-channel, L-channel and the whole assembly is included in the report along with the comparative study of the MS roller and glass fibre roller is done. The Finite element analysis of the parts is done by ANSYS software. FEA of the parts is done under different loading conditions i.e. 500N, 1000N, 1500N, 2000N and 2500N to identify the stress and deformation on the models. The hand calculations like bending moment, stress calculation, and calculation of deformation are done by considering MS and glass fibre roller by considering the total of 84 rollers. The work also includes the deformation and FEA results for the MS roller and glass fibre roller.

2. LITERATURE REVIEW

2.1 Mr. Amol studies the methods for analysis and optimization of gravity roller conveyors using ANSYS software.

Mr. Amol has studied the gravity roller conveyor system for analysis and optimization of the roller conveyor because this type of roller conveyor is very easy to use and not so much bulky but it is the most efficient type of conveyor to carry out the object from one place to other places. The main objective of thisstudy was to explore the analysis of gravity roller conveyors. This has entailed performing a detailed studyof the existing gravity roller conveyor system and optimizing the critical part like roller, C-channel etc. by using composite material, so to minimize the overall weight of the assembly without hampering its structural strength. He considers carbon fibre material for this work. He used various tools like CATIA and ANSYS software for modelling and finite element model. According to the author, the gravity roller conveyor assembly normally involves the use of channels, rollers and shafts that are heavy in their structure and the material used as steel. The objective of this studyis to suggest an alternative material for roller used in gravity roller conveyors for weight optimization. Results of Static, Modal and transient analysis of existing design and optimized design were compared. The material used for roller and C-channel frame is a composite material i.e. carbon fibre. The results and conclusions of the work he concluded that most of the research papers tried to optimize the weight of conveyor assembly by reducing the diameter of the roller because the roller is the crucial part of the conveyor assembly and its weight was more as compared to other components. Here an attempt is made to optimize the weight of conveyor assembly by using composite material i.e. carbon fibre for roller and C-channel frame which was not done earlier. He successfully minimized the weight. In most of the research papers, the authors tried to optimise the weight of the conveyor assembly by reducing the diameter of the roller because the roller is the crucial part of the conveyor assembly and its weight is moreas compared to other components. Here an attempt is made to optimize the weight of conveyor assembly by using composite material i.e. carbon fibre for roller and C- channel frame which is not done earlier.

2.1. S. M. Shinde studied various optimization techniques to minimize the weight and material savings of the conveyor.

Mr. S. M. Shinde studied the gravity roller conveyor to reduce the weight of the system to transport it easily from one place to another place. This paper aimed to study the existing conveyor system and optimize the critical parts like rollers, and C-channels for chassis and support, to minimize the overall weight of the assembly and material saving. The scope of this work was to check the design of the existing conveyor system. ANSYS APDL codes are applied for linear static, modal, transient and optimization analysis. 150 simulations for linear static Analysis, 150 simulations for modal analysis, and Optimization of conveyor assembly for weight reduction. Comparison between existing and optimized design. Paper also involves geometrical and finite element modelling of existing design and optimized design. Geometrical modelling was done using CATIA V5R19 and finite modelling was done. The objective of the project was to redesign the existing gravity roller conveyor system by designing the critical parts (Roller, Shaft, Bearing & Frame), to minimize the overall weight of the assembly and save a considerable amount of material. Gravity roller Conveyor has to convey 350 kg load, 30 inches above the ground and inclined at 4-degree results of linear static, modal and transient analysis of existing design and optimized design were compared to prove design was safe. The actual physical model is done for validation using optimized design parameters and it is found that the design is working safely as the parts in which changes are made in the existing design are standard so made easily available in the market and are assembled for testing on which 350 kg load was applied and safety is checked. The results and conclusions of work: Optimization gives an optimum design for the same loading condition with a huge amount of weight reduction. They successfully minimized the weight of the structure and they achieved a 30.931% weight reduction. They concluded that the existing design calculation shows the factor of safety was very greater than the requirement and there will be scope for weight reduction. He concluded work as existing design calculation shows the factor of safety was very greater than the requirement and there is a scope for weight reduction. The critical parameter which reduces the weight was C-channels, roller outer diameter and roller thickness. Though the value of deflection and stress is more in the case of Optimized design, it is allowable. 30.931 % of weight reduction was achieved due to an optimized design of 59.5159 Kg. weight reduction achieved by optimized design than the existing design. An actual physical model was done for validation using optimized design parameters and it was found that the design is working safely.

3. DESIGN CALCULATIONS OF MS AND GF

Design calculation of mild steel

E = 2.10*105 Mpa, ρ= 7860 Kg/m^3

Considering uniformly distributed load & FOS = 2

Maximum Stress Calculation for given condition

W= 25 kg (Weight is distributed on two roller which is 12.50 kg)

D_1= Outer diameter of roller = 46 mm

D_2 = Inner diameter of roller = 40 mm

w = Width of roller = 370 mm

y = Distance from neutral axis = 0.046/2 = 0.023

Considering uniformly distributed load,

Maximum Moment (M_{max}**)** = W*L/8

= (12.5*9.81*0.37)/8

M_{max} = 5.67 Nm

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

I= Π ((0.046)^4 – (0.040)^4)/64

I= 9.410*10^{-8} m^4

Maximum bending stress

σb = Mmax * y/ I

= 5.67 * 0.023/9.410*10^{-8}

σb = 1.24 MPa

Deflection

Ymax = 5*w*l^3/384*E*I

= 5*12.5*9.81* 0.37^3 / 384*2.10*10^{11} * 9.4*10^{-8}

Ymax = 0.00409 mm

Design Calculation for GF roller

E = 43000 Mpa, ρ= 2600Kg/m^3,

Maximum Stress Calculation for given condition,

W= 12.5kg

(Following design values are taken by using Optimization tool- Genetic algorithm)

D_1= Outer diameter of roller = 50 mm

D_2 = Inner diameter of roller = 40 mm

w = Width of roller = 370 mm

y = Distance from neutral axis

= 0.050/2 = 0.025

Considering uniformly distributed load,

Maximum Moment (Mmax) = W*L/8

= (12.5*9.81*0.37)/8

Mmax = 5.67 Nm

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

= Π (0.0504– 0.0404)/64

$\mathbf{I = 1.81*10^{-7}\ m^4}$

Maximum bending stress σb

= M_{max} * y/ I

= $5.67 * 0.025/ 1.81*10^{-7}$

σb = 0.782 Mpa

Ymax = $5*W*L^3/384*E*I$

= 0.01038 mm

4. ANALYSIS

Meshing and boundary conditions

Meshing is the process of turning irregular shapes into more recognizable volumes called "elements." Meshing is an integral part of the computer-aided engineering simulation process. The mesh influences the accuracy, convergence and speed of the solution. Furthermore, the time it takes to create and mesh a model is often a significant portion of the time it takes to get results from a CAE solution. Therefore, the better and more automated the meshing tools, the better the solution. From easy, automatic meshing to a highly crafted mesh, ANSYS provides the ultimate solution. Meshing is one of the most important steps in performing an accurate simulation using FEA. Powerful automation capabilities ease the initial meshing of a new geometry by keying off physics preferences and using smart defaults so a mesh can be obtained upon first try. Additionally, a user can update immediately to a parameter change, making the handoff from CAD to CAE seamless and aiding in upfront design.

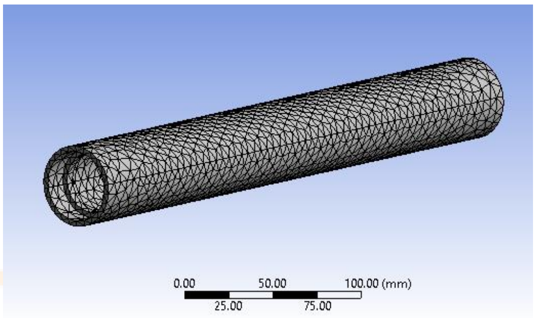

Fig.1: Meshing of original MS roller

To define a problem that results in a unique solution, you must specify information on the dependent (flow) variables at the domain boundaries Specify fluxes of mass, momentum, energy, etc. into the domain. Defining boundary conditions involves: Identifying the location of the boundaries (e.g., inlets, walls, symmetry) and supplying information at the boundaries. The data required at a boundary depends upon the boundary condition type and the physical models employed.

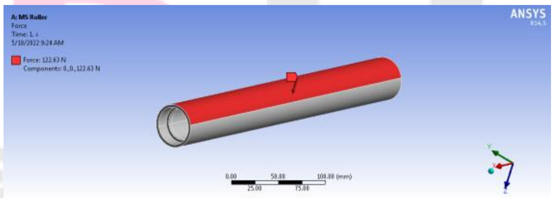

Fig. 2 Boundary condition of MS roller

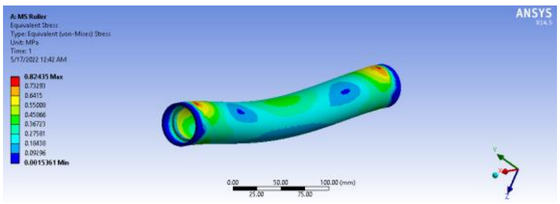

Fig. 3 Stress in MS roller

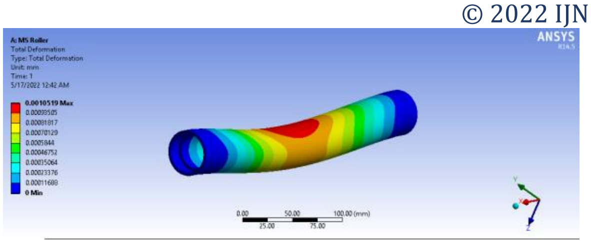

Fig. 4 Total deformation in MS roller

Result of Glass Fiber Roller

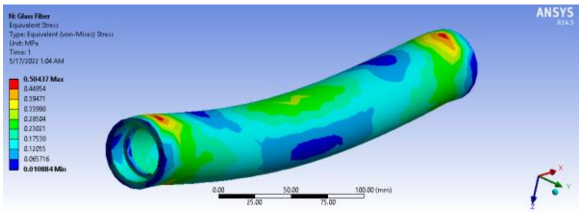

Fig. 5 Stress in glass fiber roller

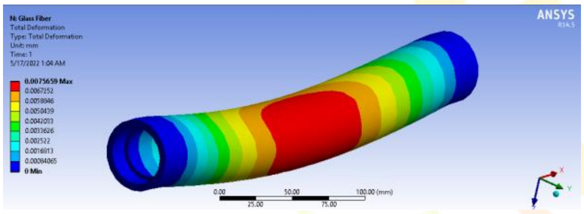

Fig. 6 Total deformation in Glass fiber roller

5. PRACTICAL SETUP

UTM TESTING

A universal testing machine, also known as a universal tester, materials testing machine is used to test the tensile strength and compressive strength of materials. The validation of the work is done using the testing of sample under the UTM machine. The results of the analysis and practical results are tested in the work. If the difference in deformation in analysis and UTM results are less than 10% than it is allowable.

Fig. 7 UTM testing of roller sample

RESULTS OF PRATICAL TESTING

Fig.8 shows the relation between load and displacement developed in both Rollers. It is observed that the steel roller has less deformation than the glass fibre roller.

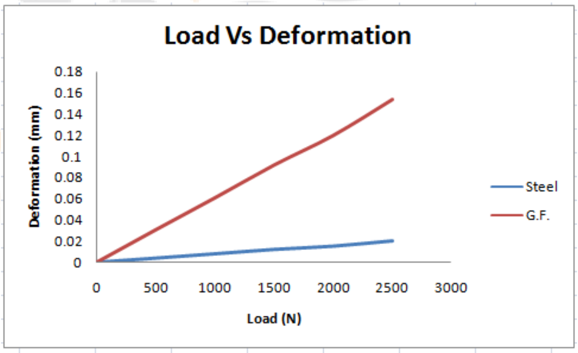

Fig.8 Load vs. Deformation of both rollers

UTM Result

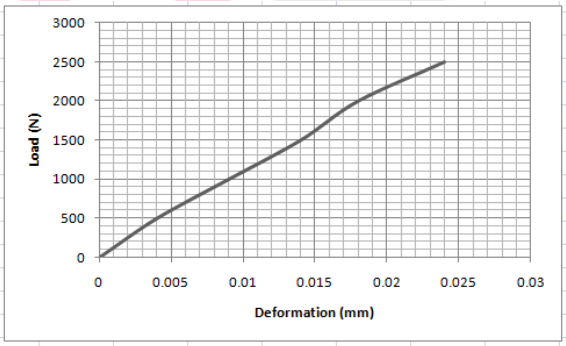

Fig.9 Load vs. Deformation of MS roller on UTM

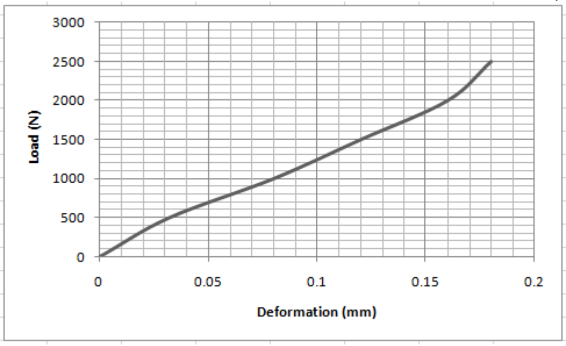

Fig.10 Load vs. Deformation of glass fiber roller on UTM

Following table1.Gives information about the deflections and deformation in the MS and glass fibre composite material with the theoretical, practical and hand calculation results of the material using different tools.

Sr. No.	Parameters	Material	FEA	Theoretical	Testing
1	Deflection (mm)	Steel	0.002	0.00409	0.005
2		E-Glass	0.012	0.01038	0.02
1	Bending stress (Mpa)	Steel	1.27	1.24	NA
2		E-Glass	0.71	0.782	NA

Table 1. Result obtains by different method

6. RESULTS AND DISCUSSION

After studying the existing conveyor system get the information about geometrical as well as structural analysis of roller conveyors and we will get the result of equivalent stress and deformation at the required force.

When MS material is used stress is more as compared to GF composite material. The respective graph is added in the paper load vs. deformation for both the material. The value of deformation and stress is more in the case of GF but it is allowable. GF composite material is used for weight reduction at the same capacity as a roller conveyor system. 42.42% of weight reduction done. Another benefit is that by using a glass fibre roller noise gets reduced than MS.

5. CONCLUSIONS

From the experiment it is seen that there we can reduce the weight of the whole system by replacing MS with GF material. Deflection in materials is 0.005 and 0.02 mm from MS and GF materials respectively.

1. It is observed that the overall weight of the roller conveyor system with a roller made of mild steel is so much high and bulky but it is possible to minimize the overall weight of the system by considering other materials like glass fibre and carbon fibre as roller material.
2. It is found that when MS material is used stress is more as compared to GF composite material.
3. Finite element analysis of the parts under various loading forces i.e. 500N,1000N, 2000N and 2500N is carryout out using ANSYS 14.0 Workbench software.
4. Value of deformation and stress is more in the case of GF but it is allowable.
5. The comparative study of the MS roller and GF roller is done in this projectand 42.42% of weight reduction is done using glass fibre material instead ofMS roller and there is a reduction of noise.

REFERENCES

[1] Mr Amol B. Kharage, Prof. Balaji Nelge, Prof. Dhumal Ketan, "Analysis and optimization ofgravity roller conveyor using ANSYS", ISSN: 2277-9655, Kharage, 4(4): April 2015.

[2] S. M. Shinde and R. B. Patil "Optimization technique used for the roller conveyor system for weight reduction". International journal of engineering research & technology 2012. ISSN: 2278-0181, Vol. 1 Issue 5, July 2012.

[3] Yogesh T. Padwal, "Weight reduction technique used for a roller conveyor",

International Journal of Latest Trends in Engineering and Technology (IJLTET) Vol. 3, Vol. 3 Issue 1 September 2013.

[4] S.S. Gaikwad et.al "Static analysis of a roller of gravity roller conveyor for structural strength& weight optimization", International Journal of Advanced Engineering Technology E-ISSN 0976-3945, Oct-Dec. 2013.

[5] Dipen Rajak, Durgesh Pagar, Pradeep Menezes and Emanoil Linul, "Fiber-Reinforced Polymer Composites: Manufacturing, Properties and Applications, 2019 Dec.

[6] Yunfu Ou, Deju Zhu et. al "Mechanical characterization of the tensile properties of glass fibre and its reinforced polymer (GFRP) composite under varying strain rates and temperatures", Polymers 8(5):196, May 2016.

[7] S. H. Masood, E. Shayan et. al., "An investigation into design and manufacturing of mechanical conveyors systems for food processing", Volume 1, 2017.

[8] N. Milorado, R. Vujanac Et. al., "Modeling and calculation of the powered roller conveyor", 2016.