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Design and Analysis of Gravity Roller Conveyor System for Moped Engine Assembly Line

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Abstract

In the manufacturing industry, raw materials need to be transported from one manufacturing stage to another. Material coping with system's are designed such that they facilitate clean, speedy and secure loading and unloading. For instance roller conveyor machine can be hired for clean and secure coping with of materials. The goal of the venture is to design a gravity roller conveyor device in moped engine meeting line of vehicles Production Company. The existing conveyor system was studied thoroughly and its drawbacks were analyzed. Gravity roller conveyor system is designed to minimize the overall cycle time of the process and make the process to complete in one single stroke. Each and every components of the conveyor system is designed considering their functionality. Detailed drawing is also prepared using solid works. Geometrical model of each components including assembly of the same were generated in solid works. Linear static analysis, contact stress analysis, model analysis and life estimation and life estimation were carried out in ANSYS with proper loading and boundary condition.

Keywords: *Gravity Roller, engine assembly Line, analysis of conveyor, ANSYS.*

INTRODUCTION

A gravity conveyor moves the weight without utilizing motor power resources, usually down an incline or through a person pushing the burden alongside a flat conveyor. Gravity conveyors delivery products or work in process from one work area to some other. Those conveyors, as their name implies, use gravity to transport substances and merchandise from place to place. Gravity conveyors are broadly utilized in industry because they do no longer require power for operations, they require very little maintenance, and they're smooth to repair while breakdowns occur. B. Abbas, E. Shayan [1] have investigated in design and manufacturing of mechanical Conveyors Systems. The critical parts were modified and redesigned with new shape and geometry, and some with new materials. The improved design methods and the functionality of new conveyor parts were verified and tested on a new test conveyor system designed, manufactured and assembled using the new improved parts. The improved methodology for design and production of conveyor components is based on the minimization of materials, elements and fees, the usage of the rules of design for manufacture and layout for assembly. S.H. Masood, B. Abbas, E. Shayan, A. Kara [2] provides an utility of idea of concurrent engineering and the principles of design for manufacturing and design for meeting. the overall fabric cost changed into reduced by 19% and the overall assembly cost was reduced by using 20% in comparison to traditional strategies. Suhas M, et.al [3] designed the prevailing device for decreasing weight. In those studies they layout some critical elements like roller, shaft and body. They advocate to lessen the burden of C-phase, roller thickness and curler Outer Diameter. by means of redesigning the gadget, overall weight was

decreased as much as 30%. Mr. Amol, et.al [4] the principle objective of this study is to discover the analysis of Gravity curler conveyor using composite cloth like carbon fiber to lowering average weight of the meeting without hampering its structural power. Rajratna A. Bhalerao [5] one of the major equipment in material handling is curler conveyor. Because the roller conveyors aren't usually subjected to complicated nation of stress they can be designed via supplying better factor of protection it ends in unnecessarily growth in cloth value. This can be decreased effectively through one by one designing conveyor part and testing complete meeting for brief and mode form evaluation for essential element. Daniel J Fonseca, et.al [6] this paper discusses the development of a prototype expert device for commercial conveyor selection. Conveyor types are selected on the idea of a suitability rating, that's a measure of the success of the material coping with necessities by the characteristics of the conveyor. The computation of the score is accomplished through the weighted evaluation approach, and the expected value Criterion for decision making beneath risk. The prototype gadget became correctly confirmed thru two commercial case studies. A.J.G. Nuttall, et.al [7] the main aim of this approach is to determine the rolling friction due to hysteresis and the relationship between traction and slip in wheel driven belt conveyors. Prayag. R, et.al [8] in this study, roller conveyor conveying massive load over varying lengths is taken into consideration. The pallet along with the load rolls over the rollers making a line contact in between. High stresses are generated in this case as the overall load acts thru this line of touch. Effects such as most contact strain, most shear strain, and maximum foremost stress are decided. a true evaluation of the touch region is made if you want to expect the conduct at excessive conditions.

In general, roller conveyor is designed with a set of element to reduce cost, easy of assembly and manufacture ability. It is also important to address the stress induced at the contact region between any two elements. Roller conveyor conveying loads over varying lengths is considered. The finite element analysis software ANSYS workbench was used for analysis purpose. Results such as maximum pressure, maximum shear stress, maximum principal stress and maximum deformation are determined. The successful completion of research work has generated design for industry users in the development of gravity roller conveyor system.

DESIGN OF MODIFIED CONVEYOR SYSTEM

To modifying the each component of gravity roller parts like C-channel, rollers, pallets, transfer units and supports to reducing weight and material handling cycle time. The Figure1 shows the model of the gravity roller.

Fig. 1: *Model of a Frame*

NUMERICAL ANALYSIS USING ANSYS

The finite element analysis of assembled conveyor is carried out in ANSYS. The Figure 2 shows the meshing and boundary condition of assembled conveyor. Meshing is the method of dividing a larger structure into smaller and finer parts and subjecting it to analysis, tetrahedral fine mesh is created. Total number of nodes and elements generated are shown in

Figure2.

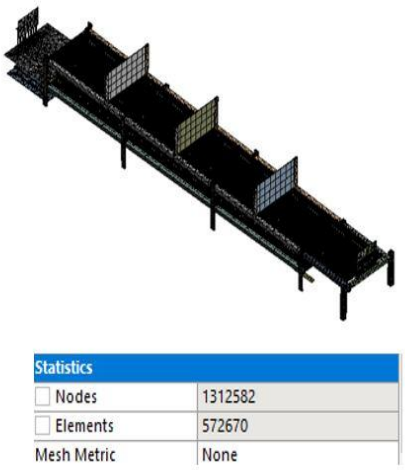

Fig. 2: *Meshing of a Geometrical Model*

RESULTS AND DISSCUSSION

Static Stress Analysis of Frame

Static stress analysis of frame was carried out in ANYSIS. Figures 3-6 show equivalent stress, maximum principal stress, maximum shear stress and total deformation plots.

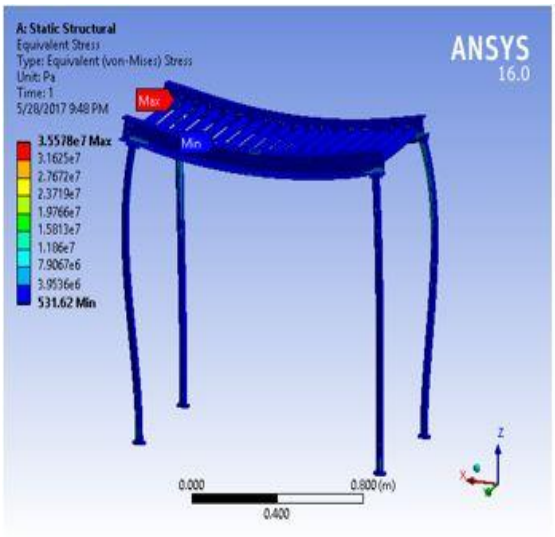

Fig. 3: *Equivalent Stress Plot of Frame*

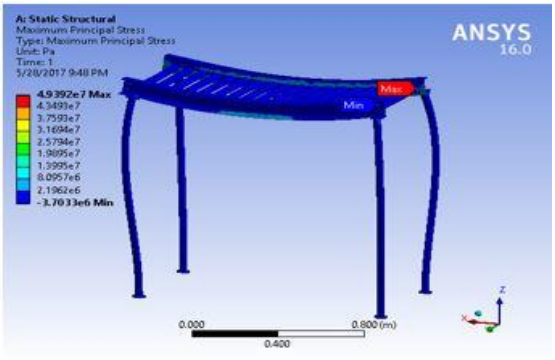

Fig. 4: *Maximum Principal Stress Plot of Frame*

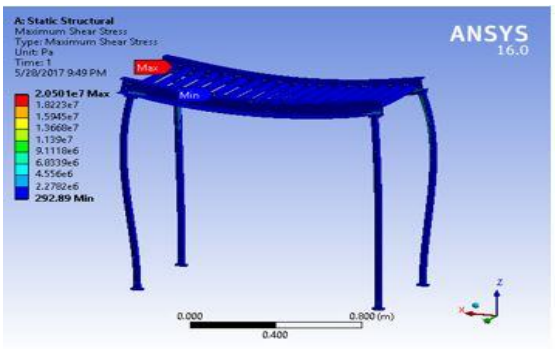

Fig. 5: *Maximum shear stress Plot of Frame*

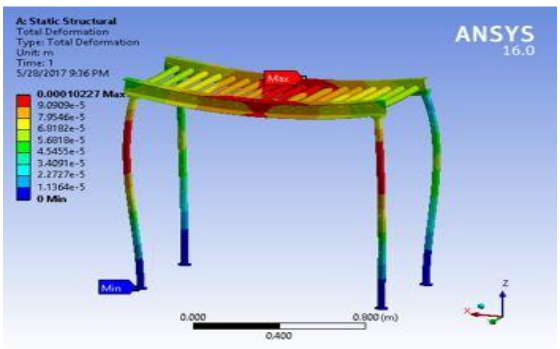

Fig. 6: *Total Deformation Plot of Frame*

The location of maximum principal stress and maximum shear stress are just near the supports and at the joining portion of connecting plates and side rail as shown in figure 4 and figure 5 Figure 3 shows Equivalent stress of 35.57 MPa, figure 4 shows Maximum principal stress of 49.39 MPa and figure 5 shows Maximum shear stress of 20.50 MPa. The material used is mild steel. As the yield strength of mild steel is 247 MPa the value obtained is below yield limit the material plastic deformation will not be occur. Minimum

resultant displacement is 0 mm and maximum resultant displacement is 0.00010227 mm as shown in figure 6.

Static Stress Analysis of Assembled Conveyor System

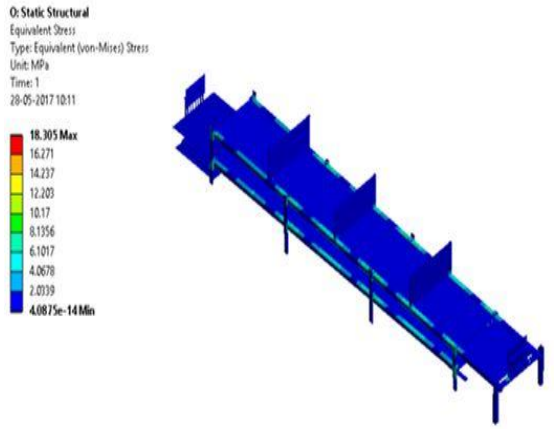

Fig. 7: *Equivalent Stress Plot of Modified Conveyor*

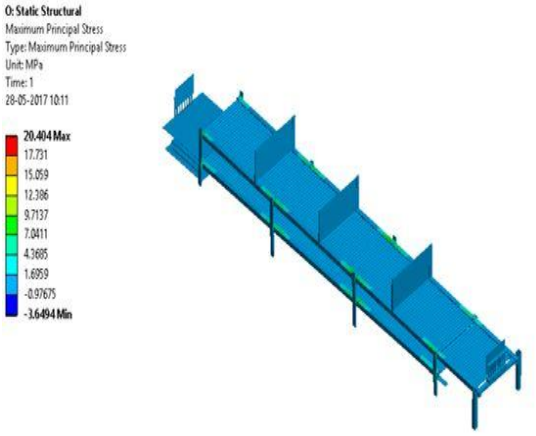

Fig. 8: *Maximum Principal Stress Plot of Modified Conveyor*

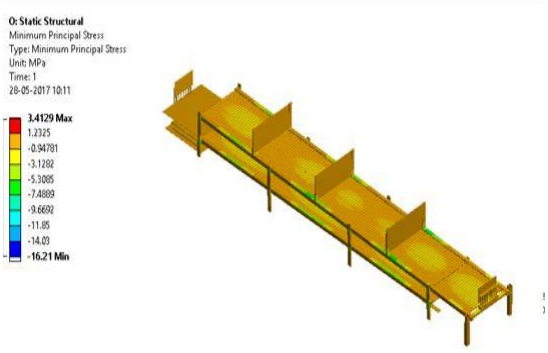

Fig. 9: *Minimum Principal Stress Plot of Modified Conveyor*

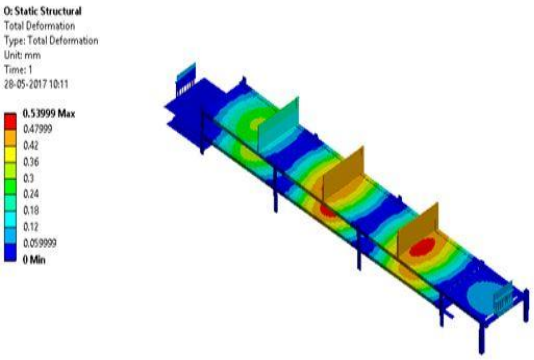

Fig. 10: *Total Deformation Plot of Modified Conveyor*

The various stresses and pressures developed are as shown in the figures above. Figure 7 shows Equivalent stress of 18.3 MPa, Figure 8 shows maximum principal stress of 20.43 MPa, Figure 9 shows minimum principal stress of 3.4 MPa, the material used is stainless steel as the yield strength of material is 1300 MPa the value obtained is below yield limit the material plastic deformation will not be occur. Figure 10 shows total deformation of 0.53 mm for the given boundary condition.

The result shows that the assembly is stable as there is very less deformation generated which is 0.531 mm and also stress developed are very negligible that is up to 20.43 MPa. Thus the material selected for conveyor structure with proper dimensions is safe.

Results of Modal Analysis of the Assembled Conveyor System

The modal analysis is the most basic and important part of analysis of dynamic character. Modal analysis is carried out to find natural frequency and mode shapes. As the loading will be in vertical direction (gravity) the mode shape which will show movement in vertical direction is important. The rigidity could be analyzed and the resonance vibration could be avoided. The main characteristics of each

mode of the structure can be figured out through the modal analysis, and the actual vibration response under this frequency range can be predicted. There are different types of critical mode shapes occur in the conveyor system. We selected the transverse mode shape which require for the analysis purpose. The modal analysis of assembled conveyor system was carried out in ANYSIS. First six natural frequencies were extracted. The TWO mode shapes are shown in the Figure 11 and 12 and frequencies are tabulated in table 1.

Table 1: *First 6 Natural Frequencies of Assembled Conveyor System*

Mode Number	Frequency in Hz
1	21.883
2	21.954
3	23.341
4	23.801
5	24.732
6	24.928

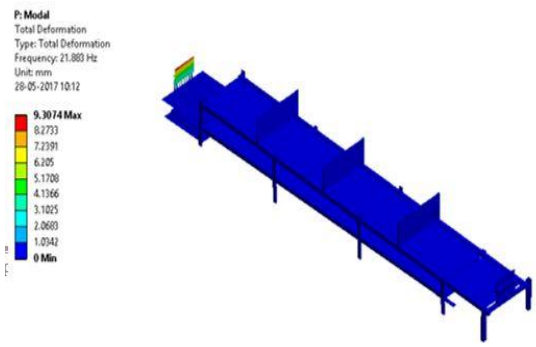

Fig. 11: *First Mode of Natural Frequency*

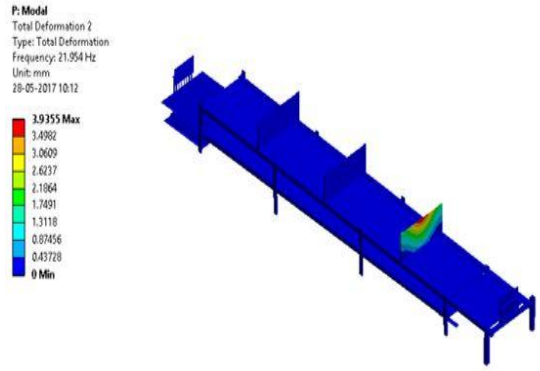

Fig. 12: *Second Mode of Natural Frequency*

There are two types of vibration, which are global and local vibrations. The global vibration means that the whole conveyor structure is vibrating while local vibration means the vibration is localized and only part of the conveyor structure is vibrating. Figure 11 shows first mode shape of the conveyor system at 21.883 Hz. The conveyor experienced first twisting mode about x-axis (longitudinal) and fall under local vibration. The maximum translation was at the front end of the conveyor system.

LIFE ESTIMATION

The useful of a conveyor is an estimate of the number of years a conveyor is likely to remain in service. In this case it is estimated that the system tends to fail after minimum of 10, 00,000 cycle carried out. Shown in Figure 13.

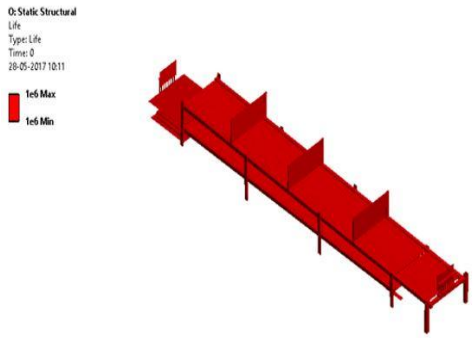

Fig. 13: *Life Estimation Plot of Geometrical Mode*

CONCLUSIONS

This work provides a comprehensive knowledge of basic production process theory of designing a roller gravity conveyor. The project focuses on choosing the suitable components to ensure manufacturing of high first-class curler gravity conveyor. The purpose turned into to adjust the existing conveyor machine design to gain the huge scale manufacturing. That is done through decreasing the cycle time, pallet exchange in time and making the process to complete in single stroke. Modified

gravity roller conveyor is designed with separate set of path is provided to carry the empty pallet. Four intermediate stoppers are provided and different operations are carried out. Thus the modified gravity conveyor overcomes the drawbacks and the process is made continuous so as to complete in in stroke. By providing separate path for the transfer of empty pallet cycle time for complete of one set of operation reduces to great extent. Linear static structural analysis has been carried out to estimate the maximum stress, strain and deformation at conveyor system. It is found that peak stress of 20.43 MPa, total deformation of 2.423 mm is obtained along the hook which is well below the yield stress of the material is 1300 MPa, which satisfies the design. Initial modes and corresponding natural frequency of conveyor system were extracted. First six frequency modes of the modified conveyor that determine its dynamic behavior and vary from 21.883 to 24.928 Hz. For the first four modes, the conveyor chassis experienced local vibration. The local bending vibration occurs at the top member and at the end of the stopper mounted on conveyor system. The global vibrations of the conveyor include torsion and vertical bending. Mode five and six experience global vibration. The natural frequency of the system was found to be 56.5 Hz. we have to prevent coinciding the simulation force frequencies and natural frequencies. Otherwise resonance phenomenon occurs and if these two frequencies coincide, this phenomenon destroys the conveyor system. Fatigue analysis of conveyor system was carried out for 1000000 cycles of startup and shutdown, the fatigue life results obtained is more than 100000 cycles, hence the design is safe.

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