Redesign of Gravity Roller Conveyor System for Weight Reduction through Optimisation

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ABSTRACT

Over the years a lot of work has been done and is still continuing with great effort to save weight and cost of applications. The current trend is to provide weight per cost effective and reliable products which meet the stringent requirements. Conveyors are used in many industries to transport goods and materials between stages of a manufacturing and material handling process. By reducing repetitive lifting and carrying of objects, conveyor reduces risk of injuries in tasks or process that involves in manual handling. Gravity roller conveyor uses principle of gravity to convey weight. The aim of this project is to study existing conveyor system and optimize the critical parts like roller, C-channels for chassis and support, to reduce the overall weight of assembly and material saving.

Keywords — Factor of safety, Material handling system, Optimized design, Weight of assembly.

ARTICLE INFO

Article History
Received : 18th November 2015
Received in revised form : 19th November 2015
Accepted : 21st November, 2015
Published online : 22nd November 2015

I. 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 minimize the need for repetitive lifting and carrying. Conveyors are a powerful material handling tool. They offer the opportunity to boost productivity, minimize product handling and damage and minimize labor content in a manufacturing or distribution facility. Conveyors are classified as either Unit Load Conveyors that are designed to handle specific uniform units such as pallets, and Process Conveyors that are designed to handle loose product such as sand, coffee, cookies, etc. which are fed to machinery for further operations or mixing. It is common for manufacturing plants to combine both Process and Unit Load conveyors in its operations. Roller conveyor is not subjected to complex state of loading still we found that it is designed with higher factor of safety .If we redesigned critical parts example. Roller, Shaft, Bearing & Frame etc. then it is possible to minimize the overall weight of the assembly.

II. PROBLEM DEFINITION

The aim of the project is to Redesign existing gravity roller conveyor system by designing the critical parts (Roller, Shaft, Bearing), to minimize the overall weight of the assembly and to save considerable amount of material. Gravity roller Conveyor has to convey 200 kg load, 30 inch above ground. Fig. 1 shows roller conveyor assembly. Components of conveyor are as follows,

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Component</th>
<th>Material</th>
<th>Qty.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>C-Channels for Chassis</td>
<td>ISMC 100</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>Rollers</td>
<td>Mild Steel</td>
<td>20</td>
</tr>
<tr>
<td>3</td>
<td>Bearing</td>
<td>Std.</td>
<td>40</td>
</tr>
<tr>
<td>4</td>
<td>C-Channels for Stand</td>
<td>ISMC 100</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>Shaft</td>
<td>Mild Steel</td>
<td>20</td>
</tr>
</tbody>
</table>
III. OBJECTIVES OF PRESENT STUDY
The following objectives of the study:
1. Study existing roller conveyor system and its design.
2. Geometric modeling of existing roller conveyor.
3. To carry out modal, linear static, Transient and optimization analysis of existing roller conveyor.
5. To carry out Analysis of Modified design for same loading condition.

IV. SCOPE OF PRESENT STUDY
1. Check design of existing conveyor system.
2. Simulation method applied to optimize parameters web thickness, flange thickness, web height, roller thickness and shaft diameter.
3. Simulations for linear static Analysis.
4. Simulations for Modal Analysis.
5. Optimization of conveyor assembly for weight reduction.
6. Comparison between existing and optimized design.

V. STUDY OF EXISTING SYSTEM FOR CONVEYOR ASSEMBLY

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Name of Component</th>
<th>Weight (Kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>C-Channel for Chassis</td>
<td>52.20</td>
</tr>
<tr>
<td>2</td>
<td>Rollers</td>
<td>231.496</td>
</tr>
<tr>
<td>3</td>
<td>Shafts</td>
<td>32.594</td>
</tr>
<tr>
<td>4</td>
<td>Bearing</td>
<td>3.992</td>
</tr>
<tr>
<td>5</td>
<td>C-Channel for Supports</td>
<td>22.1765</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>342.4585</td>
</tr>
</tbody>
</table>
loads. A static analysis can include steady inertia load (such as gravity and rotational).

Design and analysis of roller conveyor for weight optimization & material saving, and time changing load that can be approximated as static equivalent loads (such as static equivalent wind and seismic loads commonly defined in many building codes). Select element and apply material properties shown in fig.5. Static analysis determines the displacements, stresses and forces in components caused by loads that do not induce significant inertia and damping effects. Response conditions and steady loading are assumed; that is, the loads and the structure’s response are assumed to vary slowly with respect to time.

- Critical load condition
  Load act on any 4 rollers hence by considering 200 kg load act on four rollers maximum deflection, maximum stress values are checked for existing design.

E) Procedure of Static analysis consists of these tasks:
- Build the Model
- Set Solution Controls
- Set Additional Solutions Options
- Apply the loads
- Solve the Analysis
- Review the result.

Results for static analysis,
1. Weight = the weight of the model is 342.46 kg.
2. Maximum deflection plot shown in fig 5
3. Maximum stress plot shown in fig 6

F) MODAL ANALYSIS
Modal analysis is used to determine the vibration characteristics (natural frequencies and mode shape) of a structure or a machine component while it is being designed. It also serves as a starting point for another, more detailed analysis, such as a transient dynamic analysis or a spectrum analysis. Modal analysis also used to determine the natural frequencies and mode shapes of a structure. The natural frequencies and mode shapes are important parameter in the design of a structure for dynamic loading condition. As the loading will be in upward direction (gravity) the mode shape which will show movement in vertical direction is important.

VI NEED OF OPTIMIZATION
PARAMETERS TO BE OPTIMIZED IN GIVEN ASSEMBLY
1) Effect of Flange Thickness
2) Effect of Web Thickness
3) Effect of Flange Width
4) Effect of Web Height
5) Effect of Roller Thickness
6) Effect of Roller Diameter

VII OPTIMISED STUDY
8) RESULT

TABLE 3
Effect of optimized design

<table>
<thead>
<tr>
<th>Sr.no</th>
<th>Name of Component</th>
<th>Weight (Kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>C-Channels for Chassis</td>
<td>33.650</td>
</tr>
<tr>
<td>2</td>
<td>Rollers</td>
<td>208.3464</td>
</tr>
<tr>
<td>3</td>
<td>Shafts</td>
<td>10.340</td>
</tr>
<tr>
<td>4</td>
<td>Bearings</td>
<td>3.5928</td>
</tr>
<tr>
<td>5</td>
<td>C-channels for Supports</td>
<td>22.17</td>
</tr>
<tr>
<td></td>
<td>Total Weight of Conveyor</td>
<td>278.1057</td>
</tr>
</tbody>
</table>

TABLE 4
Comparison between Existing And Optimized Assembly

<table>
<thead>
<tr>
<th>Design</th>
<th>Max def, mm</th>
<th>Nat freq,Hz</th>
<th>Max stress,N/mm²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing</td>
<td>0.41029</td>
<td>30.094</td>
<td>20.898</td>
</tr>
<tr>
<td>optimized</td>
<td>0.62271</td>
<td>32.64</td>
<td>23.965</td>
</tr>
</tbody>
</table>

9) CONCLUSION

Detail comparison of Optimized design Analytical and Working physical model:
- The overall change in analytical values and physical values are 18.79%.
- The difference in the weight is due to the case of manufacturing the components at lower limit values compare to the software where real values are used.
- The values of deflection and stress of the optimized design is more than existing design, but it is allowable.

ACKNOWLEDGMENT

I wish to thank my institution, ‘SRES’S COE, Kopargaon’ for giving me the opportunity to write a this paper. A special thanks to my Project guide Dr. A. G. Thakur for encouraging us and his support and guidance throughout and without whom, this work would have not been possible. Last but not the least, I would like to thank the authors of the various research papers that I have referred to, for the completion of this work.

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