FE Results of Conveyor Belt System for Rice Mill

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Abstract

Lifting operation are inherent to many occupations in the food processing industry. They can be performed manually or using lifting equipment. Manual lifting and mechanical operations can put workers at great risk of injury or health symptom causing sick leave or disability. The costs of accidents and ill health related to lifting operations are immense. To reduce the hazards of manual lifting in the food industry alternate solution of conveyor belt is recommended which is safe and efficient. A belt conveyor is an endless belt operating between two pulleys with its load supported on idlers. It may be flat for moving bags of rice, or V-shaped for moving bulk paddy. The belt conveyor consists of belt, drive and end pulleys, idlers and tension mechanism, loading and discharge devices. Its carrying capacity depends on the width of belt, angle of trough, and belt speed. Belt conveyors have a high mechanical efficiency because the load is carried on anti-friction bearings. Damage to paddy is virtually nil because there is no relative motion between the paddy grains and the belt. The carrying capacity is high because relatively high speeds are possible. Paddy can be conveyed over a long distance. In this project a belt conveyor system is designed for “Nerian Rice mill” with a daily capacity of 80 tonnes.

Keywords: Belt Conveyors, Rice Mill, Labours

I. INTRODUCTION

Material-handling equipment is equipment that relate to the movement, storage, control and protection of materials, goods and products throughout the process of manufacturing, distribution, consumption and disposal. Material handling equipment is the mechanical equipment involved in the complete system. Material handling equipment is generally separated into four main categories: storage and handling equipment, engineered systems, industrial trucks, and bulk material handling.

Belt Conveyor is the material handling equipment to convey the material from one point to another using the belt drive. The material is fed on the belt at one end and it is discharged at other end. The conveyor belt changed the face of the industrial economy around the world. Today, it has applicable uses in countless industries, such as transportation and food services. A bucket elevator or conveyer is a mechanism for hauling flow able bulk materials by following an assembly line in horizontal, vertical or inclined direction. According to the survey performed 85% industrial units face difficulties in handling bulk material packaging. The difficulties mainly arise when it is necessary to convey a bulk material through a linear distance as well as a certain height. Conventional ways are responsible for material wasting, time wasting & above all a poor management. In order to overcome those draw backs Belt conveyers are used.

II. LITERATURE REVIEW

Seema S. Vanamane [1] Belt conveyor system is the transportation of material from one location to another location. Belt conveyor has high load carrying capacity (upto 30000 t/h), large length of conveying path (upto 3-4 km), simple design, easy maintenance and high reliability of operation. Belt conveyor system is also used various industries such as the material transport in foundry shop like supply and distribution of molding sand, moulds and removal of waste, coal and mining industry, sugar industry, agricultural industry, biogas industry, fuel industry etc. In this paper the study is carried out on DISA pattern molding machine to meet the requirement of higher weight castings. From the DISA specification the belt conveyor system is designed by using different standards like CEMA (Conveyor Equipment Manufacture’s Association) standards, some handbooks of belt conveyor system etc. then this parameter are verified by using Belt Comp software. The result got from the Belt Comp software is in close agreement of theoretical results. After the design the manufacturing is done and the installation is done on the manufacturer’s site. The trials are carried out on the belt conveyor system successfully and the problems occurs during the trials are overcome in the analysis by taking proper steps.

Ghazi Abu Taher [2] Belt conveyor & Bucket elevator are the media of transportation of material from one location to another in a commercial space. Belt conveyor has huge load carrying capacity, large covering area simplified design, easy maintenance and high reliability of operation. Belt Conveyor system is also used in material transport in foundry shop like supply and distribution of molding sand, molds and removal of waste. On the other hand Bucket elevator can be of great use during bulk material handling. This paper is mainly based on the combination of Belt & Bucket Conveyors to perform complex task within a short time and successfully in a cost effective way. On account of this, a machine and its physical description is covered here with some basic calculation.
Konakalla Naga Sri Ananth, Vaitla Rakesh, Pothamsetty Kasi Visweswarao [3] Belt conveyor is the transportation of material from one location to another. Belt conveyor has high load carrying capacity, large length of conveying path, simple design, easy maintenance and high reliability of operation. Belt Conveyor system is also used in material transport in foundry shop like supply and distribution of molding sand, molds and removal of waste. This paper provides to design the conveyor system used for which includes belt speed, belt width, motor selection, belt specification, shaft diameter, pulley, gear box selection, with the help of standard model calculation

III. IDENTIFIED GAPS IN LITERATURE

Lifting operations are inherent to many occupations in the food processing industry. They can be performed manually or using lifting equipment. Manual lifting and mechanical operations can put workers at great risk of injury or health symptoms causing sick leave or disability. The costs of accidents and ill health related to lifting operations are immense. To reduce the hazards of manual lifting in the food industry alternate solution of conveyor belt is recommended which is safe and efficient.

IV. PROBLEM FORMULATION

Though decreasing lately, the rate of workers that report carrying or moving heavy loads, is still high, i.e. approximately 35 %. The physical load from manual lifting in the industry has been reported extensively. Examples of jobs in the industry with manual lifting tasks are handling of rice bags. Manual lifting tasks with high loads or frequencies may induce musculoskeletal disorders (MSD), e.g. low back pain. According to the European Working Conditions Survey 36.5% of the workers reported work related back aches. In addition, acute trauma such as cuts or fractures due to accidents may occur from manual lifting task. To reduce the hazards of manual lifting in the food industry alternate solution of conveyor belt is recommended which is safe and efficient.

V. OBJECTIVE

The main objectives of the work are

- To design a belt conveyor system that can supply rice continuously.
- The length of conveyor belt is to be 100 ft.
- The capacity of this conveyor system should be 80 tonnes/day.
- To reduce knee pain and back pain of workers due to rice bags lifting.

The result of the model analysis is displayed below,

![Fig. 1: Mode frequency and mode shapes](image)

In Mode shape 1, the natural frequency is 7.343e-002 Hz.

![Fig. 2: mode frequency and mode shapes](image)
In Mode shape 2, the natural frequency is 4.906e-001 Hz.

In Mode shape 3, the natural frequency is 1.096e+000 Hz.

In Mode shape 4, the natural frequency is 1.100e+000 Hz.

In mode shape 5, the natural frequency is 1.724e+000 Hz.
In mode shape 6, the natural frequency is 1.744e+000Hz

A. Displacement Contour Plot

The result of contour plot for the displacements shown in fig below. This states that the maximum displacement is found to be 0.55 mm.

![Displacement Contour Plot](image)

Fig. 7: Displacement contour plot

B. Von-Mises Stress Contour Plot

Von-mises stresses is used to check whether the design will withstand the given load condition or not. Using this information it is checked whether the maximum Von-mises stress induced in the material is more than strength of the material. It works mostly well for most of the cases especially for ductile material. (It is used for the distortion energy theory which is most preferred failure theory in industry)

The result of contour plot for the Von-mises stress is shown in fig below. This states that the maximum Von-mises stress is found to be 39 MPa

![Von-mises Stress Contour Plot](image)

Fig. 8: Von-mises stress contour plot

C. Von-Mises Strain Contour Plot

The result of contour plot for the Von-mises strain is shown in fig below. This states that the maximum Von-mises strain is found to be 4.30e-05.

![Von-mises Strain Contour Plot](image)

Fig. 9: Von-mises strain contour plot
Now as it can be seen the Von-mises stress is very less 39 MPa in the assembly one can optimize the assembly by reducing its weight and keeping the stress still in the safe limits. Thus for optimizing the model it decided to vary the “I” section.

1) Optimization

![Fig. 10: cross-section of I section beam](image1)

The actual I section is as shown in the above fig, as decided to alter dimensions of I section in order to reduce the weight. The mass of the current assembly is 4.146 tons.

2) 1st Iteration

![Fig. 11: modified cross-section of I section beam](image2)

D. Displacement Contour Plot

The result of contour plot for the displacement is shown in fig below. This states that the maximum displacement is found to be 3.83 mm.

![Fig. 12: Displacement contour plot for modified assembly](image3)
E. Von-Mises Stress Contour Plot

The result of contour plot for the Von-mises stress is shown in fig below. This states that the maximum Von-mises stress is found to be 51 MPa.

![Von-Mises Stress Contour Plot](image1)

Fig. 13: Von-mises stress contour plot for modified assembly

F. Von-Mises Strain Contour Plot

The result of contour plot for the Von-mises strain is shown in fig below. This states that the maximum Von-mises strain is found to be 6.020e-05.

![Von-Mises Strain Contour Plot](image2)

Fig. 14: Von-mises strain contour plot for modified assembly

As it can be seen the Von-mises stress is still less 51 MPa in the assembly and weight is 2.149 tons which reduced almost half the actual weight. Further optimization of the assembly is done by reducing its weight and keeping the stress still in the safe limits.

1) 2nd iteration

![Modified Cross-Section of I Section Beam](image3)

Fig. 15: modified cross-section of I section beam
G. Displacement Contour Plot
The result of contour plot for the displacement is shown in fig below. This states that the maximum displacement is found to be 7.38 mm.

Fig. 16: Displacement contour plot for modified assembly

II. Von-Mises Stress Contour Plot
The result of contour plot for the Von-mises stress is shown in fig below. This states that the maximum Von-mises stress is found to be 62.9 MPa.

Fig. 17: Von-mises stress contour plot for modified assembly

I. Von-Mises Strain Contour Plot
The result of contour plot for the Von-mises strain is shown in fig below. This states that the maximum Von-mises strain is found to be 7.45e-05.

Fig. 18: Von-mises strain contour plot for modified assembly
As it can be seen the Von-mises stress is still less 62.9 MPa in the assembly and weight is 1.840 tons which reduced almost half the actual weight. Further optimization of the assembly is done by reducing its weight and keeping the stress still in the safe limits.

1) 3rd Iteration (Uniform Thickness)

**J. Displacement Contour Plot**

The result of contour plot for the displacement is shown in fig below. This states that the maximum displacement is found to be 7.06 mm.

**K. Von-Mises Stress Contour Plot**

The result of contour plot for the Von-mises stress is shown in fig below. This states that the maximum Von-mises stress is found to be 62.1 MPa.
L. Von-Mises Strain Contour Plot

The result of contour plot for the Von-mises strain is shown in fig below. This states that the maximum Von-mises strain is found to be 7.35e-05.

![Von-Mises Strain Contour Plot](image)

Fig. 22: Von-mises strain contour plot for modified assembly

VI. RESEARCH METHODOLOGY

- Data collection from the rice mill.
- Conceptualization and calculations of belt conveyor system.
- CAD modeling of the concept.
- Analysis of design in FEA.
- Optimization of the design.
- Result discussion.
- Design finalization.

VII. CONCLUSION

Considering the problems in this project was successfully executed in stipulated time. Design and Analysis of belt conveyor system for rice mill performed. Belt conveyor system need to be designed that can supply rice continuously and reduces knee pain and back pain of workers. The structural integrity of the assembly should be permit the structure to sustain stresses and fulfill the need. Using three different optimizations we designed and analysed three modified belt conveyor system in FEA, it is observed in the results displayed above, the displacement and the stresses in the assembly and its various parts are within the allowable limit. Hence as per results we have selected modification 3 which can serve our need safely.

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REFERENCES

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