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ANALYSIS AND OPTIMIZATION OF GRAVITY ROLLER CONVEYOR USING ANSYS

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ABSTRACT

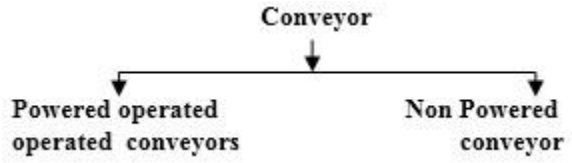
The main objective of this study is to explore the analysis of Gravity roller conveyor. This has entailed performing a detailed Study of existing Gravity Roller Conveyor system and optimize the critical part like roller, C-channel etc. by using composite material, so to minimize the overall weight of the assembly without hampering its structural strength. A proper Finite Element Model is developed using Cad software Pro/E Wildfire 5. Results of Static, Modal and Transient analysis of existing design and optimized design are compared. The material used for roller and C-channel frame is a composite material i.e. carbon fiber.

KEYWORDS: structural strength, material handling systems, optimized design, weight reduction, composite material, FEA.

INTRODUCTION

A conveyor system is a common piece of mechanical handling equipment that moves materials from one location to another. Conveyor systems are commonly used in many industries, including the 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 and sorting, the material sizes, weights and shapes and where the loading and pickup points need to be[3].

Types of conveyor



-Powered Belt Conveyor systems - Gravity
-Pneumatic conveyor systems
Conveyor systems
- Vibrating conveyor systems
- Live Roller Conveyor systems

Gravity roller conveyor system

Gravity conveyor provides one of the most versatile & economical means of moving product gravity conveyor can quickly move large quantities of items in virtually any direction with a minimum of effort & expense. Fig. 1 shows the application of gravity roller conveyor.

Gravity conveyor move the product in two ways :

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1) On a pitch, utilizing the natural flow of gravity or
2) On a level line where conveyance of the item is accomplished by pushing.

Gravity, or non-powered, roller conveyors are ideal for moving most unit loads which have a firm, flat bottom surface. They can use in both permanent & portable applications[15].

Fig 1 : gravity roller conveyor

Details of existing gravity roller Conveyor as follows:

Length of conveyor = 3000 mm
Width of roller = 450 mm
Overall width of conveyor = 600 mm
Load capacity = 100 kg/m
Roller diameter = 60 mm
Roller pitch = 100 mm
No. of roller / meter = 10 Nos
Height of roller from ground = 600 mm

Table no.1- Components of conveyor

Name of Component	Material	Qty.
C-Channel for Chassis	ISMC 100	2
Rollers	Mild Steel	30
Shafts	Mild Steel	30
Bearing	Std.	60
C-Channel for Supports	ISMC 100	4

Table No.-2-Total Weight of Existing Conveyor Assembly

Name of Component	**Weight (Kg)**
C-Channel (Frame)	54.97
Rollers	166.46
Shafts	40.58
Bearing	14.96
C-Channel for Supports	20.81
Total weight of assembly	**297.78**

In existing design, the weight of roller & C-channel (Frame) is more, so there is scope of weight reduction of this component.

PROBLEM DEFINATION

The Gravity roller conveyor assembly normally involves the use of channels, rollers and shaft that are heavy by virtue of their structure and the material used as steel.

OBJECTIVES OF THE WORK

The main objective is to suggest the alternative material for roller used in Gravity roller conveyor for weight optimization. The following are important points regarding this objective of study -

1. Study existing roller conveyor system and its design.
2. Geometric modeling of existing roller conveyor.
3. To carry out linear static, modal, transient and optimization analysis of existing roller conveyor by using ANSYS 14.0 Workbench software.
4. Using composite material for conveyor parts i.e. roller.
5. To carry out Analysis of Modified design for same loading condition.
6. Recommendation of new solution for weight optimization.

LITERATURE SURVEY

S.S. Gaikwad et. al, in this paper, an attempt is made to reduction in weight of existing roller conveyor by optimizing the critical parts of (e.g. Roller,) conveyor without hampering its structural strength. The existing Roller conveyor designed is considered for this project work. The dimensions being 2200 mm length, 30 inch above ground and inclined at 2 to 4 degree with the ground and the weight to be carried by the conveyor - 280Kg (350 kg with added factor of safety). This is the weight of the largest component to be transported over the conveyor. The conveyor would normally encounter gradually applied loads while the components are lowered by hoist. For reasons of safety, a `sudden load' is already considered during its design phase. Static analysis of roller of existing conveyor is carried out find out maximum deflection & stress. Then Optimization is carried out by modifying the dimensions of roller .Then analysis of optimized roller are carried out to find out maximum deflection & stress. 29.54 % of weight reduction is achieved due to Optimized design. About 56.18 Kg. weight reduction achieved by optimized design than existing design. Actual physical model is done for validation using optimized design parameters and it is found that the design is working safely.

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D.K. Nannaware et. al, in this paper we studied existing conveyor system and optimized critical parts of roller conveyor system like Roller, C-channels for chassis and support, to minimize the overall weight of assembly and material & cost saving. Paper contains geometrical modeling and finite element modeling of existing design and optimized design. Geometrical modeling is done using CATIA V5 and finite modeling was done with the help of ANSYS software .Results shows safe design of optimized design. Optimization gives optimum design for same loading condition with huge amount of weight reduction. Using optimized procedure and using practical available structure 39.26% weight reduction is achieved.

Suhas M. Shinde et. al, the current trend is to provide weight/cost effective products which meet the stringent requirements. The aim of this paper is to study existing conveyor system and optimize the critical parts like roller, shafts, C-channels for chassis and support, to minimize the overall weight of assembly and material saving. Critical parameter which reduces the weight is C channels, roller outer diameter and roller thickness. Though value of deflection, stress is more in case of Optimized design, but it is allowable. 30.931 % of weight reduction due to Optimized design.

Rajratna A. Bhalerao et. al, one of the major equipment in material handling is roller conveyor. As the roller conveyors are not generally subjected to complex state of stress they can be designed by providing higher factor of safety it leads to unnecessarily increase in material cost. This can be reduced effectively by separately designing conveyor part and testing whole assembly for transient and mode shape analysis for critical parts.

Yogesh T. Padwal et. al, a lot of work has been done from years to save weight and cost of applications, it still continuing with great effort. The recent trend is to provide weight or cost effective products which meet severe requirement. The purpose of this paper is to study current conveyor system and optimize the critical parts like roller, shafts, C-channels for chassis and support, to reduce the overall weight of assembly and save the material. Critical parameter which reduces the weight is C-channels, roller outer diameter and roller thickness. 34.931 % of weight reduction due to Optimized design.

S.H. Masood et. al, this paper presents a application of concept of concurrent engineering and the principles of design for manufacturing and design for assembly [4, 5], several critical conveyor parts were investigated for their functionality, material suitability, strength criterion, cost and ease of assembly in the overall conveyor system. 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, parts and costs, using the rules of design for manufacture and design for assembly. Results obtained on a test conveyor system verify the benefits of using the improved techniques. The overall material cost was reduced by 19% and the overall assembly cost was reduced by 20% compared to conventional methods.

M. A. Alspaugh et. al, this paper presents latest development in belt conveyor technology & the application of traditional components in non-traditional applications requiring horizontal curves and intermediate drives have changed and expanded belt conveyor possibilities. Examples of complex conveying applications along with the numerical tools required to insure reliability and availability will be reviewed. This paper referenced Henderson PC2 which is one of the longest single flight conventional conveyors in the world at 16.26 km. But a 19.1 km conveyor is under construction in the USA now, and a 23.5 km flight is being designed in Australia. Other conveyors 30-40 km long are being discussed in other parts of the world.

Shirong Zhang et. al, in this paper the improvement of the energy efficiency of belt conveyor systems can be achieved at equipment and operation levels. Specifically, variable speed control, an equipment level intervention, is recommended to improve operation efficiency of belt conveyors. However, the current implementations mostly focus on lower level control loops without operational considerations at the system level. This paper intends to take a model based optimization approach to improve the efficiency of belt conveyors at the operational level. An analytical energy model, originating from ISO 5048, is firstly proposed, which lumps all the parameters into four coefficients. Subsequently, both an off-line and an on-line parameter estimation schemes are applied to

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identify the new energy model, respectively. Simulation results are presented for the estimates of the four coefficients. Finally, optimization is done to achieve the best operation efficiency of belt conveyors under various constraints. Six optimization problems of a typical belt conveyor system are formulated, respectively, with solutions in simulation for a case study.

Daniel J. Fonseca et.al, this paper Conveyor equipment selection is a complex, and sometimes, tedious task since there are literally hundreds of equipment types and manufacturers to choose from. The expert system approach to conveyor selection provides advantages of unbiased decision making, greater availability, faster response, and reduced cost as compared to human experts. This paper discusses the development of a prototype expert system for industrial conveyor selection. The system, which was developed on Level V Object, provides the user with a list of conveyor solutions for their material handling needs along with a list of suppliers for the suggested conveyor devices. Conveyor types are selected on the basis of a suitability score, which is a measure of the fulfillment of the material handling requirements by the characteristics of the conveyor. The computation of the score is performed through the Weighted Evaluation Method, and the Expected Value Criterion for decision making under risk. The prototype system was successfully validated through two industrial case studies.

Pawar Jyotsna et. al, The aim of this paper is to study existing Belt conveyor system and optimize the critical parts like Roller, Lchannelsand support, to minimize the overall weight of assembly. Paper also involves geometrical and finite element modeling of existing design and optimized design. Geometrical modeling was done using Catia V5R20 and finite modeling done in ANSYS14.0. Results of Linear static, Modal and Transient analysis of existing design and optimized design are compared to prove design is safe. In this paper we work on the roller design and optimization.

Chetan Kothalkar et. al, in this paper an oscillatory type short distance gravity actuated trolley conveyer is conceptualized to be used for conveying light material to and fro to shorter distances. This is a unique conveyer which uses the gravity principle of the gravity conveyor but differs from it . It has two hinged platforms at its ends on which the wheeled trolley rests. To move the trolley, platform is to be raised by an angle more than the limiting angle of friction between the platform and the trolley wheels. Overcoming the static friction, the trolley moves in the direction of the slant and gains momentum. It covers a distance before coming to to halt, which depends on coefficient of friction trolley mass, energizing length of the platform, angle of inclination etc. Analysis of GAOTC has been done using the computer program. This paper is discussing the studies on length of travel of the trolley using various combinations of the length and friction of the platform with the applications.

Lihua ZHAO et. al, The paper analyzes two typical failure forms of roller and conveyor at the belt conveyor, and describes the maintenance methods of prevention and elimination failures to ensure the normal operation of belt conveyor.

Yibowei Moses et. al, in this paper the Mechanical properties of composites based on epoxy resin (ER) filled with metal powders and carbon fibers have been studied. Metal particles (MP) having different particle shapes were used as fillers. The composite preparation conditions allow the formation of a random distribution of metallic particles in the polymer matrix. Carbon fiber (CF) is one of the most useful filler materials in composites, its major use being the manufacture of components in the aerospace, automotive, and leisure industries. Carbon fiber reinforced epoxy (C-E) composites filled with different weight proportions of steel were fabricated. Materials added to the matrix help improve operating properties of a composite. The penetration and hardness behavior of the composites have been studied and were carried out using an Indentation rig and Shore D hardness tester respectively. The epoxy was filled with CF: MP in the ratio 10%:40%, 20%:30%, 30%:20%, and 40%:10%. It was observed that with increasing CF content the surface hardness increases but better resistance to penetration was got with increasing MP.

B.E. Gite et. al, Many new raw materials have been discovered and many ground-breaking composite have been developed, of which not all but some have proved to be a phenomenal success. Carbon fiber is one of these materials, which is usually used in combination with other materials to form a composite. The properties of carbon fiber, such as high stiffness, high tensile strength, low weight, high chemical resistance, high temperature tolerance and low thermal expansion makes them one of the most popular material in civil engineering possessing strength up to five times that of steel and being one-third its weight, we might as well call it ‘the superhero’ of the material world.

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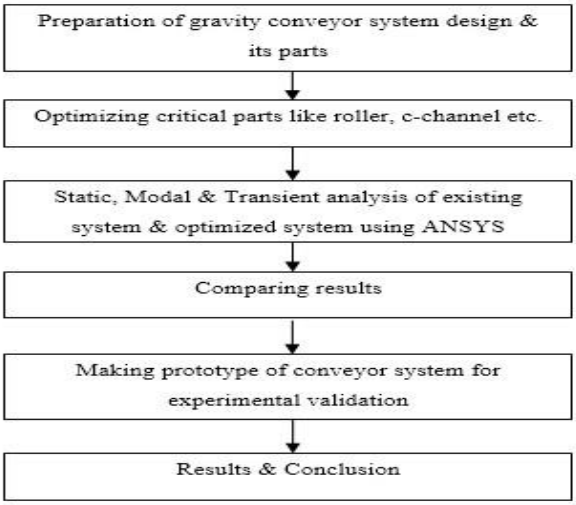
PROPOSED FLOW OF WORK AND METHODOLOGY



CONCLUSION

In most of the research papers the authors were tried to optimizing weight of conveyor assembly by reducing diameter of the roller because roller is the crucial part of the conveyor assembly and its weight is more as compared to other components. Here an attempt is made to optimize weight of conveyor assembly by using composite material i.e. carbon fiber for roller and C- channel frame which is not done earlier.

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