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Design, Analysis and Weight Reduction of Belt Conveyor System in Foundry

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ABSTRACT: Belt conveyor systems are indispensable material handling equipment in foundry industries due to their ability to transport raw materials, moulding sand, castings, and finished products efficiently and continuously. However, conventional conveyor systems often possess excessive structural weight, resulting in increased material costs, higher power consumption, and reduced operational efficiency. Consequently, significant research has focused on the design optimization and weight reduction of belt conveyor systems while ensuring structural strength, reliability, and safety. This review paper presents a comprehensive analysis of the existing literature on the design, structural analysis, and weight reduction of belt conveyor systems used in foundry applications. The review examines various design methodologies, analytical approaches, and optimization techniques adopted by researchers to improve conveyor performance. Particular emphasis is given to computer-aided design (CAD), finite element analysis (FEA), topology optimization, material selection, and lightweight structural modifications. Previous studies comparing different frame configurations, roller arrangements, support structures, and advanced materials are critically analyzed to evaluate their influence on stress distribution, deformation, factor of safety, manufacturing cost, and energy consumption. This review identifies current research trends, highlights limitations in existing studies, and suggests future directions for developing cost-effective, lightweight, and high-performance belt conveyor systems specifically suited for foundry industries.

KEYWORDS: Conveyor System, Foundry Industry, Weight Reduction, FEA, CAD, Design Optimization, Material Handling, Lightweight Design.

I. INTRODUCTION

Material handling is an important part of the industry and consuming a considerable proportion of the total power supply. Material handling system contains various types like Lifts, AGV's, Conveyors, etc. from that conveyors are used mostly in industries for continuous handling. Conveyors are further classified in various types like, belt conveyor, roller conveyor, chain conveyor, screw conveyor, pneumatic conveyor, roller belt conveyor, etc. Belt conveyor is used to transport material from one location to another. Belt conveyor is a commonly used equipment of continuous transport it has a high efficiency, large conveying capacity and it can be achieved at different distances, different materials transportation. Now a day's Belt conveyor system not only used in mining industries but also applied in cement industries, power plant, food industries, production industries etc. So it is essential equipment for in house material transportation today. It 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 various industries such as the material transport in foundry shop like supply and distribution of moulding sand, moulds and removal of waste, coal and mining industry, sugar industry, agricultural industry, bagasse industry, fuel industry etc.

The task of transportation within the conveyor belt systems can be defined as a process aimed at the transportation of the determined quantity of handled material within a defined period of time between the specified loading and unloading locations. To ensure operational reliability of the conveyor system consisting of rollers, roller brackets, bearings, belt lines, in terms of kinematic, dynamic, and energetic conditions is a very challenging task.

The coal loading conveyors can produce noise levels that become an annoyance, especially at night time when the ambient noise levels are low. For these reasons decreasing the noise produced by conveyors is an important topic, and producing an idler roller that lowers the noise emission from the conveyor belt assemblies which have significant benefits to both the workers in the factories and the community as a whole

It is significant to reduce the energy consumption or energy cost of material handling sector. This task accordingly depends on the improvement of the energy efficiency of belt conveyors, as these are the main energy consuming components of material handling systems. Operation is another aspect for energy efficiency of belt conveyors. The operation efficiency in terms of operational cost of belt conveyors is improved by introducing load shifting. Speed control is recommended for energy efficiency of belt conveyor systems, even though it is occasionally challenged. The core of speed control is to keep a constantly high amount of material along the whole belt, which is believed to have high operation efficiency.

The weight of traditional steel idler rollers can also be a problem, particularly for wide belts which can have an individual roller weigh in excess of 20kg. This presents an Occupational Health and Safety risk, as the rollers often need to be maneuvered into hard to reach positions, or places with limited access. The maintenance or replacement of these idler rollers has the potential to injure the worker conducting such maintenance through back and muscle strains. Hence in this project we are going to design the critical parts of roller belt conveyor used in Foundry, i.e., roller, bracket, bearing, belt and frame of conveyor.

II. LITERATURE SURVEY

Tabello Mathaba and Xiaohua Xia [1] The aim of this paper was to propose a generic energy model based on belt resistance for long belt conveyor. Here they have used two parameter power equation and also partial differential equation through the belt for calculating the variability of the material mass per unit length on the belt in order to give a more accurate representation of the transported bulk material throughout the belt. Here they have achieved with the error of less than 4 % the power consumption calculation of newly proposed simpler model are consistent with those of known non-linear model.

Shirong Zhang, Xiaohua Xia [2] The aim of this paper focuses on the saving energy of the belt conveyor system through improvement of the operation efficiency, thus optimization is employed here. We begin with the energy model of belt conveyors which is the base of optimization. The existing energy models are reviewed and then an analytic model, lumping all the parameters into four coefficients, was proposed. The four coefficients of the new model can be derived from the design parameters or be estimated through field experiments. The latter guarantees an improved accuracy of the model, consequently, the practicability of the energy optimization of belt conveyors. Off-line parameter estimation, based on least square (LSQ), and on-line parameter estimation, based on recursive least square (RLSQ), proposed to the identification of this energy model respectively. Off-line parameter estimation is applicable for the belt conveyors without permanent instruments for electrical power of motor, for belt speed and for feed rate. On the other hand, if a belt conveyor is equipped with permanent instruments, on-line parameter estimate is adopted to update the coefficients of the energy model automatically. Simulation results are presented to show the applicability of the proposed off-line and on-line parameter estimation of the energy model.

Mr. Amol Kharage et. al [3] The main objective of this paper was to analysis the gravity Roller Conveyor, the detail study of existing gravity roller and optimizing its parts by using composite material, so weight reduction of system is achieved. A finite element model was generated of existing system by using Pro-E software. In this paper only roller is optimized by using composite material.

Miroslav Bajda and Robert Krol [4] The aim of this paper was to reduce the energy consumption of belt conveyor by reducing the resistance of conveyor. The various resistances are belt rolling conveyor, sliding resistance of conveyor, bending resistance, idlers turning resistance, flexure resistance of bulk materials. The biggest savings of energy is expected in belts and idlers selection, and in some cases in unconventional solutions of the route. The test rig was used to test various resistances of the idlers and belt. By decreasing this resistance 34 % energy conservation was achieved. The belt conveyor used in mining was took in study.

Yogesh Padwal and Satish Rajmane [5] The aim of this paper was to convert the material handling from fork lift to belt conveyor of 30 m distance. The optimization in some parts like roller and frame was done in this paper. To develop the FEA model for engineering problem, solving requirements like static, dynamic, and nonlinear behavior; MSC/PATRAN software is used. The analysis was carried out by using MSC/NASTRAN software.

Pranav Deshmukh et. al [6] The aim of this paper focuses on choosing the right belt conveyor and suitable components in the system. It was a sponsored project carried out in Yash Enterprises, Khamgaon, Buldhana. The

problems of various components in the system was carried out and the proper solution was given to make larger life of components. The final aim was to create a modified design to achieve larger scale production of idler which enhance the efficiency and productivity. The remedies on various problems was given in this paper.

Rohini Sangolkar et. al., [7] In this paper the study of structural analysis was done. The modelling is done by using Creo Software and the FEA is performed to obtain variation of stress at critical location of system using the ANSYS software and applying the boundary conditions to evaluate the total deformation, equivalent stress and shear stress. ASTM A-36 hot rolled steel bar and nylon 66 materials was studied for rollers in system and belt respectively.

Vishal Balkrushna Tayade, [8], The aim of the paper is knowledge of damage process which is required for the correct regulation of operation conditions for conveyor belt. The aim is to determine conditions caused this type of damage (height of impact and weight of material impact). 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 Belt speed, Width, Wrapping angle, troughing angle, Pulley diameter and addition of Snub pulley .

Imran S.Khan *, Prof. Ravindra Gandhe [9] In this paper the study and analysis of roller is carried out. In industries, it is essential to move the workpiece from one workstation to the other for decreasing the workers involvement. In this paper design of conveyor which can be used in industries is done. The main objective of this study is to explore the analysis of a roller. This has entailed performing a detailed static analysis. The study deals with static analysis. A proper Finite Element Model is developed using Cad software Pro/E Wildfire 4.0.

III. PROBLEM DEFINATION

The current design for belt conveyor is heavy weight that includes the critical parts like roller, belt, roller shaft, supporting brackets, L channel base frame which directly affects on excess use of material with increase in costs, so that power consumption and also the maintenance is more due to heavy weight system. To overcome these problem redesign of existing system and analysis with optimization will be done.

IV. METHODOLOGY

following are important steps for completion of objectives -

1. Check design of existing conveyor system.
2. Creating geometric model and finite element model of existing conveyor system using suitable SIEMENS NX software.
3. Analysis of critical components of system like roller, bracket and frame of belt conveyor by using ANSYS software.
4. Simulations for Modal Analysis.
5. Optimization of conveyor assembly for weight reduction.
6. Comparison between existing and optimized design.

Following Are Some Components of Existing System in the Foundry



(a) (b) (c)

Fig. 1. (a) Belt Roller (b) Supporting Bricket (c) Hopper

V. CONCLUSION

The review of existing research on the design, analysis, and weight reduction of belt conveyor systems used in foundries highlights the growing importance of optimizing conveyor structures for improved performance, reliability, and cost-effectiveness. Various studies demonstrate that the application of advanced design methodologies, finite element analysis (FEA), and computer-aided engineering (CAE) tools enables accurate evaluation of stresses, deflection, vibration, and structural stability under different loading conditions.

Weight reduction has emerged as a key objective, as it lowers material consumption, manufacturing costs, power requirements, and maintenance while maintaining the required strength and safety. Researchers have successfully employed design optimization techniques, material substitution, and structural modifications to achieve significant reductions in conveyor component weight without compromising performance. The use of high-strength materials, optimized cross-sections, and simulation-based validation has further enhanced the efficiency and durability of conveyor systems. Overall, the reviewed literature indicates that integrating modern analytical techniques with optimization approaches can substantially improve the operational efficiency and service life of belt conveyor systems in foundry applications. Future research should focus on lightweight composite materials, intelligent condition monitoring, predictive maintenance, and energy-efficient conveyor designs to meet the increasing demands of Industry 4.0 and sustainable manufacturing. These developments will contribute to safer, more economical, and environmentally friendly material handling systems in the foundry industry.

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