IJARSCT

ISSN (Online) 2581-9429

International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)

Volume 2, Issue 8, June 2022

Impact Factor: 6.252

Design of Conveyor System and Fixture Assembly of Kit-Bin Handling System in Engine Assembly Area

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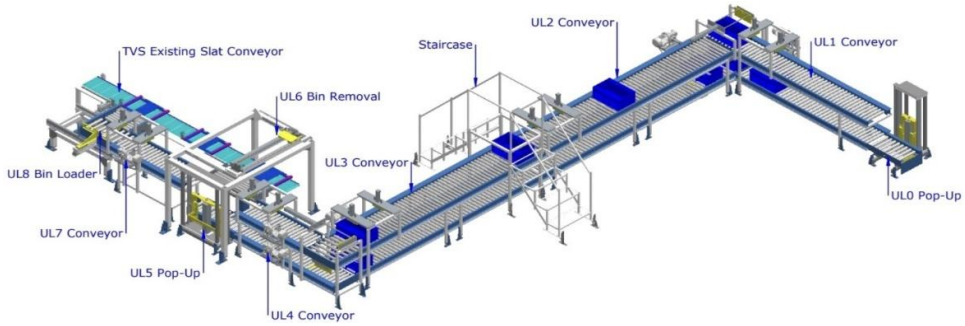
Abstract: *This work presents an application of the concept of concurrent engineering and the principles of design for manufacturing and design for assembly; several critical conveyor parts were investigated for their functionality cost and ease of assembly in the overall conveyor system. The critical 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 material, parts using the rules of design for manufacture and design for assembly. The semi-finished material has to be transported from one station in the assembly to another at a distance of up to 20 meters or more. The method of manual transport by fork-lift is time consuming. A mechanism for continuous and uninterrupted transport is desired. This is carried out with reference to the roller conveyor system (Existing system). The existing system will be redesigned and optimized for weight, resulting in material saving by modifying and analysing critical conveyor parts.*

Keywords: Belt Conveyor, Fixture Assembly, Roller and Kit-bin, etc.

I. INTRODUCTION

A transport framework is bit of mechanical hardware used to transfer the material from one place to another. These are used in transport the material which are having heavy weight and bulky material. Conveyor system allows the quick and efficient transport for a variety of material and having a very popular material in handling and packing industries. There are many types of conveyor system are used in present and used according to needs used in various industries. Conveyors are safely to transport the material from one level to another level and they can reduce the human labour and it is expensive.



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II. LITERATURE REVIEW

Alspaugh M. A. [1] 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 possibility. For Examples of complex conveying applications along with the numerical tools required to ensure 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 16.2611 km. But a 19.123 km conveyor is under construction in the USA now, and a 23.52 km flight is being designed in Australia. Other conveyors 30-50 km are being discussed in other parts of the world.

S.H. Masoodet. [2] Presents an application of concept of concurrent engineering and the principles of design for manufacturing and design for assembly, several critical conveyor parts were investigated for their functionality, material suitability, cost or 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 material, part and cost are using the rules of design for manufactured and designs are assembly. Results obtained on a test conveyor system verify the benefits of using the improves tacts. The overall material cost was reduced by 19% and the overall assembly cost was reduced by 20% compared to conventional methods.

Dima Nazzalet. [3] Discusses literature related to models of conveyor systems in semiconductors. Comprehensive overviews of simulation-oriented models are provided. We also identify and discuss specific research problems and needs in the design with control of closed-loop conveyor. It is concluded that new analytical and simulation models of conveyor systems need to be developed to understand the behaviour of such systems and bridge the gap between theoretical research and industry problems.

To minimize the product development time and improve the product quality, 3 dimensions at CAD/CAE system is essential. It is necessary to develop a system which utilizes the concept design data at the early stage for the whole process of the product development. The purpose of this paper is to improve the product quality by the sufficient design study iteration at the early stage of design. A CAD system which can be used for the concept of design and an appropriate CAD environment should be developed and another purpose is to shorten the product development time at the late stage of design, this is proposed by C. Sekimoto [4] in his paper. Discusses multi conveyor systems in supporting machine loading and unloading.
The study in this paper not only meditates the concept of balancing the number of parallel machines, the conveyor speed for adjacent pallets, the overall relevant costs and the determination of the number of conveyors into the objective, but also develops a two- staged method to optimize the combined problem to reach a maximum profit. Moreover, the computerized sensitivity analyses are discussed in this study. This paper contributes an applicable scheme for production design in manufacturing and provides a valuable tool to conclusively obtain the optimal profit of a given production quantity for operations research engineers in today's manufacturing with profound insight. It is concluded that this study definitely provides an adaptable and efficient tool for production design to optimize the profit of a given order quantity.

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[5] A Review of Preview of Programmable Logic Contr ammable Logic Controllers in Controllers in Control Systems of Systems Education, Foster, Michael R.; Hammerquist, Chad; and Melendy, Robert, "A Review of Programmable Logic Controllers in Control Systems Education" (2010). Faculty Publications - Biomedical, Mechanical, and Civil Engineering. 22. This paper reviews the literature devoted to control systems education. It shows how academia is using PLCs in education and how it can complement the traditional focus on continuous-based control. A key objective of this paper is to review the PLC use in mechanical engineering education, which traditionally takes place in a control system engineering course. This paper will also address a proposal by the authors that implementing PLCs into a control systems course for mechanical engineering students can enable a natural integration of continuous and non-continuous control theory.

Shirong Zhang, Xiaohua Xia [7] 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 off-line and online parameter estimation schemes are applied.

Pravin A. Mane, [9] published paper on Design, Manufacture and Analysis of Belt Conveyor System used for Cooling of Mould. This Paper worked on design and analysis of belt conveyor system. Their actual work shows that the major components and its parameters like belt capacity, belt width, and effective belt tension, power, and motor speed, diameter of shaft, idler spacing and diameter of pulley were designed successfully by using standard practice such as CEMA standard, Fenner Dunlop handbooks, available theories and software. The belt comp software was used to get the appropriate profile of pulley arrangement. Different alternatives of pulley arrangements are tried by altering the horizontal and vertical l distance between two consecutive pulleys. For each alternative the designed parameters like belt width, belt tension etc. are calculated by using CEMA standard and Dunlop handbook and those results are verified by using belt comp software. From the belt comp software, the effective belt tension and power observed was 50.0551 KN and 5.8 KW etc. and from theoretical results the effective belt width and power was found to be 47.908 KN and 7.5 KW. So, the results got from belt comp software found to be good agreement with the theoretical results.
The components like different types of pulleys namely drive pulley, tail pulley, pressure pulley, snub pulley and hold down pulley etc., carrying and return idlers, frame structures, and columns were e manufactured successfully with the required dimensions and also from motor speed, power required, diameter of pulley, diameter of shaft the horizontal foot mounted PBL type geared motor and foot mounted Elecon type gear box was procured from manufacturer's organization.

S.S. Gaikwad, [10] 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 degrees with the ground and the weight to be carried by the conveyor - 280Kg

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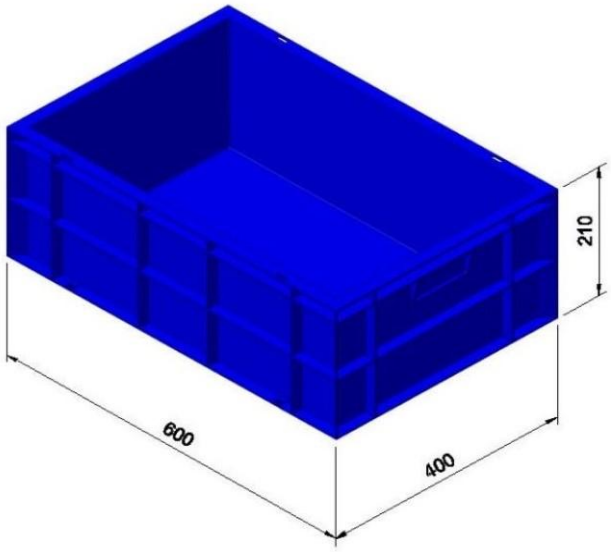
(350 kg with added factor of safety). This is the weight of the largest component to be transported over the conveyor. The conveyor would normally encounter gradually applied loads while the components are lowered by hoist. For reasons of safety, a `sudden load 'is already considered during its design 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 is 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.

III. DESIGN OF FIXTURE

Kit-Bin

A plastic Kit bin of dimensions 600x400x210 is to be used to carry the required material from one conveyor to another conveyor. It can transport a load of 30 kg, as our required load is 25 kg.



A fixture is a mechanism used in manufacturing to hold a work piece, position it correctly with respect to a machine tool, and support it during machining. Fixture is a device for locating, holding and supporting a work piece during a manufacturing operation. Fixtures are essential elements of production processes as they are required in most of the automated manufacturing, inspection, and assembly operations.

Fixture Design Procedure

In the design of a fixture, a definite sequence of design stages is involved. They can be grouped into three broad stages of design development.

- Stage one deals with information gathering and analysis, which includes study of the component which includes the shape of the component, size of the component, geometrical shape required, locating faces and clamping faces. Determination of setup work piece orientation and position.
- Stage two involves product analysis such as the study of design specifications, process planning, examining the processing equipment's and considering operators safety and ease of use. Determination of clamping and locating position. In this stage all critical dimensions and feasible datum areas are examined in detail and layout of fixture is done.

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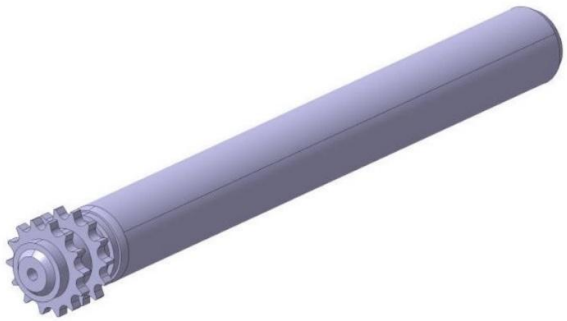
- Stage three involves design of fixture elements such as structure of the fixture body frame, locators, baseplate, clamping and tool guiding arrangement.
- Stage four deals with final design and verification, assembly of the fixture elements, evaluation of the design, incorporating the design changes if any required and completion of design. Work piece CAD model Machining Information Design requirement.

IV. CLASSIFICATION OF ROLLER SYSTEM:

Gravity feed Conveyor roller Electrical Belt Conveyor roller
Vibrating roller
Flexible roller system
Live Roller Conveyor system

SERIES 3500 HEAVY Fixed drive conveyor roller



Calculations

The design of a roller conveyor begins with calculation of conveyor elements for given initial data: total length, L=20 m, inclination angle, β=3°, unit capacity, Z=180 unit/h, dimensions of unit load a x b x h=1500 x 500 x 500 mm, load weight, G=25 kN, distance between unit loads, t=8.1 m.

The major design calculations should determine the force required to overcome the resistance to motion of the loads and the angle of inclination. Total resistance to motion consists of:

- Resistance to rolling of the load on rollers due to friction, - Frictional resistance in the roller bearings and
- Resistance due to sliding of the load on the rollers.

The resistance to motion of all pieces of load on the conveyor is:

$$W = m \cdot g \cdot z_o \left[\left(2 \cdot \frac{f}{D} + \mu \cdot \frac{d}{D} \right) \cos\beta \pm \sin\beta \right] + m_v \cdot g \cdot z \cdot \frac{\mu \cdot d}{D}$$

Where:

m –load unit mass,

zo – number of loads moving simultaneously on the conveyor, f – Rolling friction factor, D – Roller diameter,

d – Roller journal diameter, mv – roller mass,

μ – roller journal coefficient of friction z – number of rollers,

β – Inclination angle,

g –acceleration of gravity.

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The electric motor power for conveyor drive is:

$$P = \frac{W \cdot v}{\eta}$$

Where:
v – Velocity of the load,
η – Total efficiency of the drive mechanism.

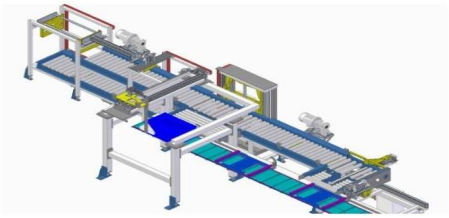
Empty Bin removal system with Pop down arrangement.

Empty bin removal is a Pneumatic pusher arrangement to remove the empty bins from the EA conveyor. There will be a suitable mechanical and roller arrangement for transferring the bin to the main double stack conveyor. The pusher arrangement will be guided on IGUS rail.

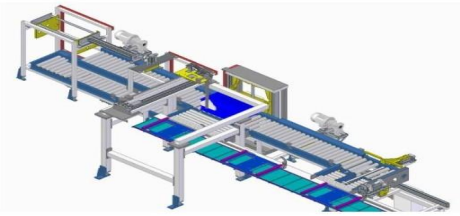
The Pneumatic Pop down unit is provided at this section for lowering and directing the empty bins to the lower deck conveyor.

The Empty Bin removal system will be mounted overhead of the E/A conveyor and fastened properly with Chemical Fasteners.

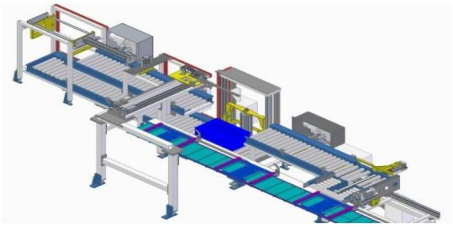
Suitable sensors will be provided across the station for bin sensing.



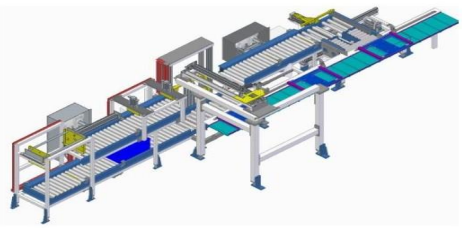
`Bin at EA conveyor



Bin removed from EA conveyor



Pop down to lower conveyor



Directed to the lower deck

V. CONCLUSION

From this paper by understanding the design of conveyor specially belt conveyor driven by pneumatic cylinder and factor which are considered for design of mechanism for belt conveyor which is driven by pneumatic cylinder. From design of rack and pinion mechanism and chain drive, the factors which are to be considered are totally depending upon force to be transmitted and gear ratio. The scope of this paper will be producing the conveyor system that will be infilling the required demands for the packing purpose.

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