Review Article

DESIGN AND ANALYSIS OF A ROLLER CONVEYOR FOR WEIGHT OPTIMIZATION & MATERIAL SAVING

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1. PROBLEM DEFINITION

The semi finished material has to be transported from one station in the assembly to another at a distance of up to 30 meters or more. The method of manual transport by fork-lift is time consuming. A mechanism for continuous and uninterrupted transport is desired.

2. 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 reduce the need for repetitive lifting and carrying.

Conveyors are a powerful material handling tool. They offer the opportunity to boost productivity, reduce product handling and damage, and minimize labor content in a manufacturing or distribution facility. Conveyors are generally classified as either Unit Load Conveyors that are designed to handle specific uniform units such as cartons or pallets, and Process Conveyors that are designed to handle loose product such as sand, gravel, coffee, cookies, etc. which are fed to machinery for further operations or mixing. It is quite 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 eg. Roller, Shaft, Bearing& Frame etc then it is possible to minimize the overall weight of the assembly. Powered belt conveyors are considerable long (9000 meter to 10000 meter) as compared to roller conveyor. So we can achieve considerable amount of material saving if we apply above study related to roller conveyor to this belt conveyor 'Finite Element Method' is a mathematical technique used to carry out the stress analysis. In this method the solid model of the component is subdivided into smaller elements. Constraints and loads are applied to the model at specified locations. Various properties are assigned to the model like material, thickness, etc. The model is then analyzed in FE solver. The results are plotted in the post processor. The scalar plot shows us the stresses and deformations over entire span.

3. NEED FOR ANALYSIS

The geometry of the roller conveyor is amenable to the usage of 3D modeling. The design of the roller conveyor would necessitate knowledge of the fundamentals for Product Design coupled with intuition gained by experience of the Design Engineer. The information like `weight' of the roller conveyor and `location of the Centre of Gravity' can be readily offered by the three dimensional CAD interface.

Although it is iterative process the physical design can of each iteration for testing is not possible for conformance to the conditions specified (test conditions) could be done through the utilization of a suitable tool – Software for Analysis in the domain of Mechanism Design. With the past experience of the Service provider in this field, `NASTRAN' (from MSC Software) appears as a competent tool to pursue Analysis for this Project Work.

4. OBJECTIVES OF THE WORK

The following are the objectives of the study:

- Study existing roller conveyor system.
- Geometry modeling existing roller conveyor.
- Analysis of existing roller conveyor.
- Modification of critical conveyor parts for weight optimization.
- Analysis of Modified design for same loading condition.
- Recommendation of new solution for weight optimization.

5. LITERATURE REVIEW

We could not find much of the literature directly related to the weight optimization of roller conveyor. Few of the literatures are cited below.

1. An investigation into design and manufacturing of mechanical Conveyors Systems for food processing.

S.H. Masood, B. Abbas, E. Shayan, A. Kara

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.

2. Latest Developments in Belt Conveyor Technology

M. A. Alspaugh, Overland Conveyor Co., Inc.

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.

3. Availability modeling of powered roller conveyers

John R. English, University of Arkansas, John Usher, University of Louisville

This paper provides an analysis of the reliability and availability of two common designs of the line-shaft roller conveyor. The first is a standard design in which each roller is belted directly to a spinning line shaft under the conveyor. The second is a new design in which only one top roller is belted to the line shaft, and all other rollers are belted to the one powered roller in a series arrangement. The main reason for this design is that the upper belts are faster to replace than belts connected to the line shaft, thus increasing system availability. However, the latter design is less reliable in that the failure of a single belt may lead to multiple roller failures.

4. Modeling power & free roller conveyor system

Dev P. Sathyadev, Sanjay Upendram, Eric Grajo, Ali Gunal, Onur Ulgen Production Modeling Corporation.

This paper establishes the groundwork to model power and free conveyor systems using AutoMOD II simulation software. A methodology to identify and model system parameters, control and routing logic, and sequencing product mixes is developed. A description of pitfalls, work-arounds, and other issues of concern in using AutoMOD to model power and free systems is presented. Recommendations for future enhancements and a comparison of power and free systems with state-of-the-art movement systems conclude the paper.

5. Development of concept design CAD system

C. Sekimoto Energy and Mechanical Research Laboratories, Research and Development Center Toshiba Corporation.

In order to shorten 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 project 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 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.

6. Survey of research in modeling conveyor-based automated material handling systems in wafer fabs

Dima Nazzal, Ahmed El-Nashar Department of Industrial Engineering and management Systems, University of Central Florida.

This paper discusses literature related to models of conveyor systems in semiconductor fabs. A comprehensive overview of simulation-based models is provided. We also identify and discuss specific research problems and needs in the design and control of closed-loop conveyors. It is concluded that new analytical and simulation models of conveyor systems need to be developed to understand the behavior of such systems and bridge the gap between theoretical research and industry problems.

6. SCOPE OF THE STUDY

The mechanical elements of the Roller Conveyed need to be designed individually and tested in the assembly environment. The structure need to be tested for external forces acting on the entire assembly.

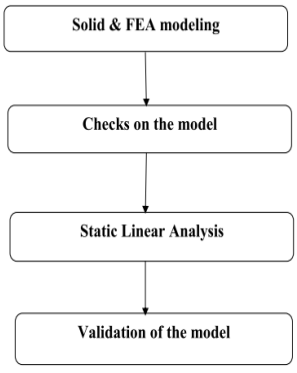
7. SOFTWARE FOR DESIGN AND ANALYSES CATIA V5 R18

CATIA V5 provides three basic platforms: P1, P2, and P3. P1 is for small and medium sized process oriented companies that wish to grow toward the large scale digitized product definition. P2 is for the advanced design engineering companies that require product, process, and resource modeling. P3 is for the high-end design applications and is basically for Automotive and Aerospace Industry, where high quality surfacing or Class-A surfacing is used for designing. A good feature is that any change made to the external data is notified to user and the model can be updated quickly.

8. MSC/PATRAN AND MSC/NASTRAN

The general purpose FEA software MSC/PATRAN is used to develop the model for a wide range of engineering problem-solving requirements (e.g., static, dynamic, nonlinear behavior, thermal analysis, or optimization). PATRAN is a CAE pre-processing software package. For the purpose of analysis MSC/NASTRAN, post-processor is used. It is a compressive general purpose finite element analysis program for structures.

9. PROPOSED FLOW OF WORK AND METHODOLOGY



- To generate a surface model suitable for linear static analysis.
- To generate a finite element model of the same.
- To carry out all the necessary checks on the model.
- To carry out the linear analysis to study the behavior.
- To validate the model for the limiting load (permissible load)

REFERENCES

1. "Survey of research in modeling conveyor based automated material handling system in wafer Fabs". - Dima Nazzal ,Ahmed El-Nashar, Department of Industrial Proceedings of the 2007 Winter Simulation Conference S. G. Henderson, B. Biller, M.-H. Hsieh, J. Shortle, J. D. Tew, and R. R. Barton, eds.
2. "An investigation into design and manufacturing of mechanical conveyors systems for food processing" S.H. Masood · B. Abbas · E. Shayan · A. Kara Int J Adv Manuf Technol (2005).

3. "Latest Developments in Belt Conveyor Technology", M. A. Alspaugh ,Overland Conveyor Co., Inc. Presented at MINExpo 2004 Las Vegas, NV, USA.
4. Kung, Walter, "The Henderson Coarse Ore Conveying System- A Review of Commissioning, Start-up, and Operation", Bulk Material Handling by Belt Conveyor 5, Society for Mining, Metallurgy and Exploration, Inc., 2004.
5. Goodnough, Ryne, "In-Pit Conveying at the Wyodak Mine- Gillette, Wyoming", Bulk Material Handling by Belt Conveyor 5, Society for Mining, Metallurgy and Exploration, Inc., 2004
6. Modeling power & free conveyor systems" Dev P. Sathyadev, Sanjay Upendram Eric Grajo, Ali Gunal, Onur Ulgen Production Modeling Corporation Dearborn, Michigan 48126.
7. "Availability modeling of powered roller conveyor John" R. English University of Arkansas, John Usher University of Louisville G., Don Taylor Virginia Polytechnic Institute and State University Ed Pohl University of Arkansas.
8. "Development of Concept Design CAD System" C. Sekimoto Energy and Mechanical Research Laboratories Research and Development Center Toshiba Corporation.