Design and Analysis of Material Handling System- Review Paper

Kulkarni Prabhanjan P[1] Gudhate Saurabh S[2] Tolmare Ashish M[3] Waghmare Santosh R[4] Praveen K Mali[5]

[1,2,3,4]Student [5]Assistant Professor

[1,2,3,4,5]Department of Mechanical Engineering

[1,2,3,4,5]G. H. Raisoni College of Engineering, Ahmednagar, India

Abstract— Material handling systems is used for continuous movement of material from one point to another. They are uncommon in service systems. Material is conveyed everywhere in a factory or warehouse—before, during, and after processing. Material handling work should be minimized without compromising production or the level of quality required of the operation. Material handling operations should be mechanized and/or automated where feasible to improve operational efficiency, increase reaction, improve uniformity and unavoidability, decrease operating costs, and eliminate recurring or potentially unsafe manual labor. The intelligent system approach to selection of conveyor provides advantages of unbiased decision making, greater availability, faster response, and reduced cost as compared to human experts. This paper discuss the design and analysis of material handling system- Conveyor system

Key words: Low Cost Automation, Material Handling System, Conveyors, Conveyor selection, Decision making, rolling contact, rolling friction material handling equipment, materials handling system

I. INTRODUCTION

Expressed in simple language, material handling is loading, moving and unloading of materials. To do it carefully and cheaply, different types of tackles, gadgets and equipment are used, when the materials handling is referred to as mechanical handling of materials. Any human activity involving materials need materials handling. However, in the field of engineering and technology, the term materials handling is used with reference to industrial activity. In any industry, be it big or small, manufacturing or construction work, material have to be handled as raw material, intermediate goods or finished product from the point of receipt and storage of raw materials, through production processes and up to finished goods storage and dispatch points. Material handling is not a production process and does not add to the value of the product. It also cost money; therefore it must be eliminated or at least reduce as much as possible. Depending on the weight, volume and throughput of materials, mechanical handling of materials may become unavoidable. In many cases, mechanical handling reduces the cost of manual handling of materials, where such material handling is highly desirable. All these facts indicate that types and extent of use of material handling should be carefully designed to suit the application and which become cost effective.

The essential requirements of a good materials handling system may be summarized as:

1) Efficient and safe movement of materials to the desired place.
2) Timely movement of material when needed.
3) Supply of material at desired rate.
4) Storing of materials utilizing minimum space.

Fig. 1: Chain Conveyor

A. *Problem statement*

The concept behind design of the system should be as per customer requirements. The customer requirements are as follows.

Sr. No.	Description	Specifications/Requirements
	Critical inputs for design	
1	Basic Component details	Hex rod A/F=22/25mm & length from 0.9 to 9m. Min wt=3kg to Max 30 kg.
2	Min Component in buffer for machining	40 nos.
3	Load & Unload of the two component	Individually powered
4	Cycle time	5 min per cycle for loading & unloading parallel operation per side.
5	Component to be loaded at a time	02 nos.
6	Conveyor pitch	Equal or in Multiple to fixture pitch -16 inches

Table .1. Customer requirements

B. *Possible solutions*

The problem outlined in customer requirements is thus related to material handling. Any material handling process consists of three activities:

1) Picking up the load
2) Transporting the load
3) Setting the load down

– Classification of material handling equipment

The material handling equipments are classified into three groups:

1) Hoisting equipment
2) Conveying equipment
3) Surface and overhead equipment

In our case, the loading and unloading is a manual operation and it should carry a batch of minimum 45 rods. As such, this loading is not possible by hoisting machine. Also, the raw material to be handled varies in a large range from 0.9m to 9m in length and from 2.7kg to 27 kg in weight. This limits the use of manual or automatic trolley. Therefore, we select an automatic conveyor system.

Conveyor system has many advantages like

- Large conveying capacities at desired speeds.
- Ability to transport unit loads as well as bulky and heavy loads over large distances.
- Fairly high structural rigidity.
- Cost effective
- Labor saving
- Environmentally acceptable
- Versatile
- Compact size

There are different conveyor types as already stated above. But belt and chain conveyors are most commonly used.

Out of the two we selected chain conveyor considering its advantages over belt conveyors as follows-

- Do not slip or creep (no power loss from slippage)
- More compact for given capacity
- Lower loads on shafts
- Easy to install
- Not affected by sun, heat, or flu
- Do not deteriorate with age
- More effective at lower speeds
- Require little adjustment

In addition, the large variations in weight of rods will cause of over-sizing of belt in belt conveyors. This will add considerably to the cost.

Chain conveyor can carry large loads with minimum friction. It gives accurate positioning even at slow speeds. It also provides surface for attaching pallets which can be designed to hold the jobs in proper orientation. This proper orientation is a necessity in our case for ease of operation of gripping system.

So, out of all possible solutions chain conveyor is the most suitable solution.

II. LITERATURE REVIEW

A. Optimization Model

The optimization modeling approaches reported in previous research are focused on the improvement of the utilization of MHE. A minimum cost MHE is selected first and then some moves are assigned to the MHE until its utilization meets an acceptable level. Moshe et al. (1985) formulated the selection problem as an integer program with the objective of minimizing the total operating and purchasing costs of the selected MHE. Two sets of constraints are specified. The first set of constraints ensures that every move is assigned to only one MHE type. The second set ensures that the time required by all moves does not exceed the available operating time of the selected number of units of the equipment. The problem is solved using a heuristic algorithm. The interesting aspect in the heuristic is that when the MHE types are considered one at a time it reveals some similarities between the MHE selection problem and both the loading and knapsack problem.

B. Knowledge-based Rules

The MHE selection problem is difficult and knowledge-intensive because there are several feasible solutions of varying efficiency, and numerous and conflicting objective functions. Thus, the use of a knowledge-based rule approach has been proposed in solving the problems of MHE selection. This approach emulates the decision-making process of a Human expert in a given area. Even though the decision procedure is complicated and not well understood, knowledge-based rules have been used to a limited extent in some problem areas Combined Knowledge-based Rules and

C. Optimization Approach

Because of the complexities involved in the problem of selection of MHE, knowledge-based rules seem to have great potential for this problem. However, a general limitation of knowledge-base approaches is that they commonly suggest feasible alternatives based on certain requirement and no attempts are performed to optimize the overall material-handling system. Even though hybrid knowledge-based rules and optimization approaches have been rarely applied in MHE selection problems until now, they have great potential consists of rules and facts to determine the possibility of using a MHE type for a material flow link specified by users. The optimization part suggests the layout of machines to minimize the material-handling costs and the dead space in the given layout using a multi-criteria optimization model. The optimization procedure consists of two stages in which concepts in Abdou (1989) and Hassan (1985) are incorporated into a modified algorithm. During the first stage, the procedure finds the minimum cost MHE for each move without trying to maximize the utilization of the MHE. During the second stage, the algorithm attempts to maximize the utilization of MHE. The objective function of the optimization model minimizes material handling cost, aisle space usage, and dead space in the layout. They use penalty cost values per unit area of aisle space to measure the cost of aisle space. These papers proposed models for the calculation of material handling cost that include both the investment cost and operating cost of MHE. The domain of the knowledge-based rules was limited to heavy industrial equipment situations.

III. WORK METHODOLOGY

Stepwise planning for execution of project can be summarized as in figure 1:

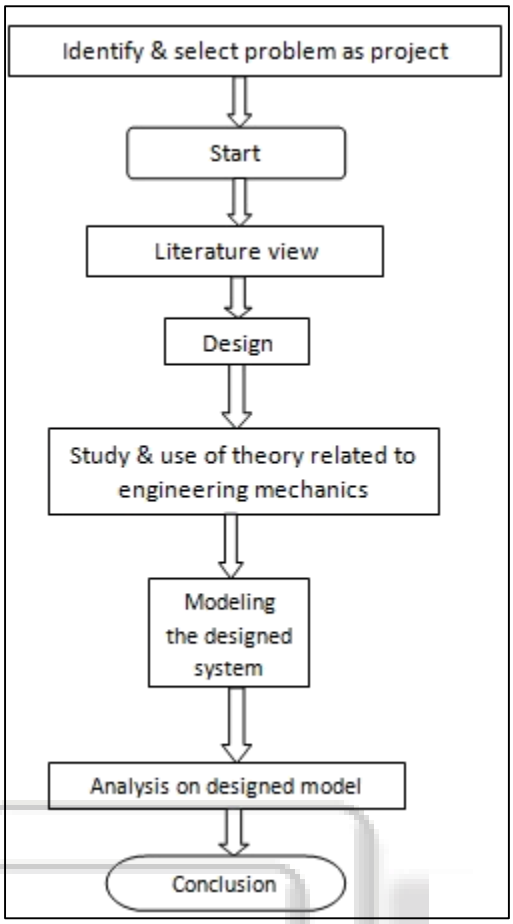

Fig. 2: Flowchart for design

A. Detailed design procedure

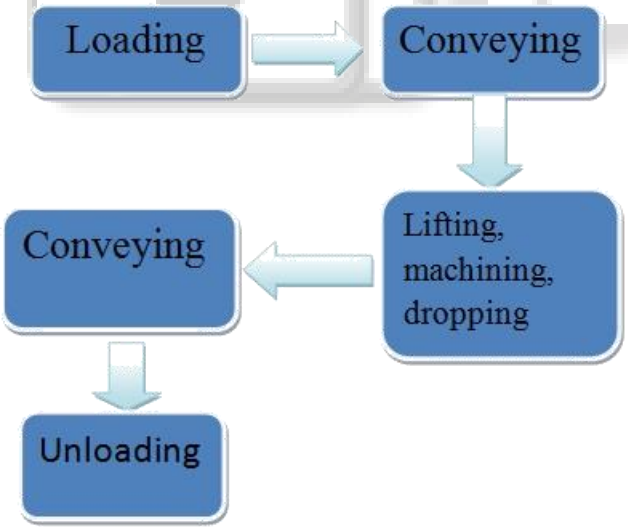

Fig. 3: Sequence of operation

Our aim is to convey high alloy steel rods of hexagonal cross section (Across/Flat 22-25mm) and lengths varying from 0.9 to 9m. Minimum no of rods to be conveyed at a time is 40.

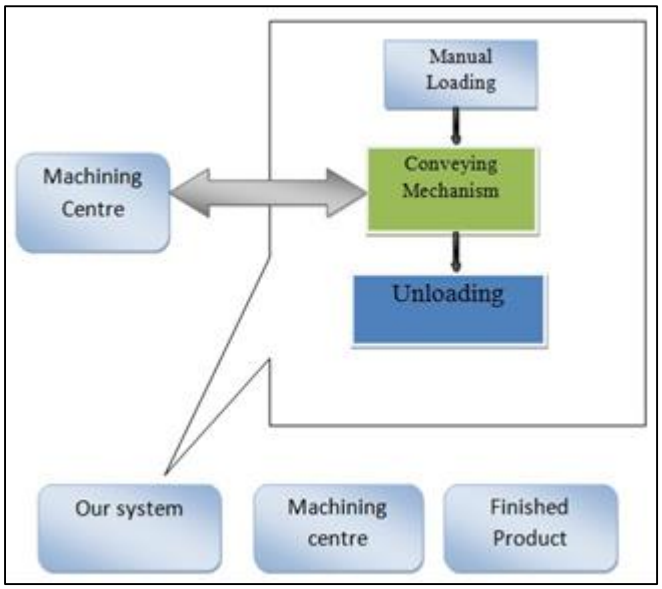

Fig. 4: schematic Diagram of the System Operation

B. Chain selection Steps

In order the Ensure a correct approach to the selection of conveyor chain the following point should be considered .

1) Type of conveyor
2) Total load be carried
3) Chain speed
4) Type of attachment
5) Operating condition
6) Lubrication
7) Chain braking load

IV. CHAIN DESIGN

We have selected the simplex roller chain to convey rods. We have used 2 simplex chains instead of duplex chain for cost reduction and stability of attachments.

Advantages of roller chain over sliding chain as follow

- Smooth operation, less pulsation
- Lower friction which permits longer distance, smaller motors and lower operating cost.
- Less HP required.

A. Advantage of using 2 chains:

1) Uniform speed
2) Less lateral improvement
3) Much more rigidity.

B. Calculating chain pull

Chain is that force required removing the chain, the connected mechanical parts and load to be conveyed. The chain pull required for a particulars application is dependent on following factor:

1) Weight of material carried.
2) Weight of chains and support element(slats, swing trays, cross bar etc.)
3) Coefficient of friction.
4) Service factor
5) Gearing factor

The calculating for chain pull is carried out in phases:

- The preliminary phase, a calculating which determinates type of chain required by the chain weights and coefficient of friction.

- The second phase, a control calculation, confirms preliminary chain weight and coefficient of friction by substituting actual value of identify chain.
- Weights of material carried=P1[Kg]
- Total weight of all rods that being carried (considering max) plus chain and attachments weights.
- Weights of chain=P[Kg]
- For the preliminary calculation this the approximate weight of entire chain circuit including any attachment. For the control calculation it is the actual weights of the entire chain circuit.

V. CONCLUSION

This research established the fact that a MHS consists of three main pillars; design principles and physical elements, information and software, human and management, which are equally important in order to achieve a well functioning MHS on a manufacturing shop floor. Moreover, based on the comprehensive literature review and case company investigation the existing issues with the traditional MHS (manual transportation & forklift transportation) were identified and categorized as; delivery performance, buffer levels, operation costs, delivery quality, information flow, and safety. To cope with the mentioned problems above various methods and techniques such as JIT concept, standardized work methods, hybrid pull/push system, AGV system, and etc. were suggested. However, the core element in an effective and efficient MHS was pointed out as real-time information sharing. The latter fact enables companies to rapidly react to different requests and changes on the shop floor area; and thereby, to obtain increased delivery performance and decreased buffer levels. It was also clearly argued that by integrating information technology with production processes many undesirable material handling activities could be easily avoided, in addition, the companies would be able to attain increased space efficiency on the production/assembly area and decreased work in process (WIP).

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