Redesigning of Material Handling System and Layout Analysis

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Abstract- *Carriers are used for transportation of components. It is a vertically shaped profile which comprises of three rods which are connected to each other to support three rectangular profiles. Components are to be mounted on rectangular profiles. Out of these three rods two are vertical and one of them is aligned. Layout analysis is very useful in understanding the material flow of various industries. It helps to increase the overall productivity. The objectives of redesigning the carrier system are to increase the component carrying capacity, to improve ergonomics and material handling process.The objective of layout analysis is to increase the efficiency of production and minimize the production time. For layout analysis, load-distance technique is used and load-distance factor is measured for general and proposed systems.The conclusion of this study indicates that redesigned carrier system has more component carrying capacity than general systems. It helps to make material handling process much simpler. Layout analysis helps to improve the material flow and reduce overall production time.*

I. INTRODUCTION

This study mainly focuses on redesigning of carrier which is an integral part of whole overhead conveyor system. There is a need of redesigning of carrier system as there are various flaws in it. It affects the production capacity of whole unit. It also results into stoppage of production and wastage of production time. For layout analysis, several case studies were analysed. The flow of material from one place to another depends on layout of an industry. Layout plays a significant role in total productivity.

II. LITERATURE REVIEW

Principles used in layout analysis:

1. Principle of minimum distance:

This principle is concerned with the minimum travel of man and materials. The facilities are arranged in such a way that distance travelled by man and materials should be minimum. This will reduce the considerable amount of delay.

2. Principle of minimum handling:

This principle is based on minimum handling of material at the workstations. As the handling is minimum, there will be less chance of falling of material and damaging of materials. This will reduce the time and cost of rework required.

Considerations in Layout Design:

1) Man Factor:

It includes manpower requirement, safety and working conditions.

2) Material Factor:

It includes following:
a) The design and specifications of the product.
b) The quantity and variety of products
c) The components and their sequence of operations

3) Machine Factor:

It includes following:
a) Selection of proper machinery and other requirements
b) Machines should be used at optimum conditions.
c) Maintenance and replacement of machinery parts

4) Movement Factor:

It includes following:
a) Routing and flow pattern
b) Reduce the unwanted and uneconomical handling
c) Consider the space for movement
d) Analyse the handling methods and equipments.

5) Waiting Factor:

It includes following:
a) Location of storage and delay points
b) Designing of waiting material space
c) Methods of storage

III. PROBLEM DEFINITION

Flaws of general carrier systems are briefly discussed below

1. The spacing between two carriers is too less. It results into clogging of these carriers and ultimately falling of components. This can cause serious damage to components. Due to these reasons, cost and time for rework increases.
2. Generally most of the carrier systems are designed in such a way that it increases handling of components. It causes worker fatigue. Hence these systems lack ease of handling.

The problems of layout in different industries are as follows:

1. Generally most of the layout systems have major problem of storage of the components. The components are stored in very less available floor space. These stored components are then transferred to assembly line as per required.
2. The components are stored near the Gangway so it becomes difficult to load and unload these components on the transportation device. Loading and unloading takes too much considerable time.

IV. REDESIGNING OF CARRIER

In shell shop, components are mounted on these carriers and they are carried further with the help of overhead conveyor by using various chain attachments. These shells undergo into various operations like spraying of various chemicals, washing, etc. There are two types of carriers such as large and small carriers. Large carrier can carry 8 components. Small carrier can carry 4 components.

Material used: Stainless steel
Weight of small carrier- 5 kg
Weight of large carrier- 6.5 kg

Description of general system

1. For large carrier, four rectangular portions attached to the straight rod in a successive manner. Two of them are attached on one side and vice-versa. For small carrier, four square shaped carriers are attached to the straight rod.
2. These carriers are arranged in such a manner that every large carrier is followed by a small carrier.
3. According to our observations, the maximum carrier spacing is 50 cm and minimum carrier spacing is 12 cm.
4. The rectangular portions are designed in such a way that all the four types of components can get easily carried.

Calculation

System production rate:

- Carrier capacity: 8 parts
- Production requirements: 134/hr
- Required no. of carriers/hr: 17
- Required no. of carriers /min: 0.28

Carrier spacing:

Maximum carrier spacing is 50 cm and minimum carrier spacing is 12 cm.

Conveyor speed:

- Required no. of carriers /min: 0.28
- Carrier spacing: 50 cm or 1.67 feet
- Conveyor speed: 0.28*1.67 = 0.4676 F.P.M

Friction chain pull:

- Total moving load: 1210.5 kg/ hr
- Friction factor: 0.03
- Friction chain pull: 1210.5*0.03= 36.315

Proposed system

The main aim of redesigning the carrier is to increase its component carrying capacity and to avoid the flaws which are present in the general systems.

Brief description of proposed system

1. In this system, carriers are redesigned in such a way that their components carrying capacity is increased. In general system large carrier can carry 8 components. In proposed system carrier can carry 12 components. Both these carriers have same space requirements.
2. Instead of using a single rod, three rods are used for supporting whole assembly. Out of these three rods two are straight rods and one is aligned by 30°.
3. Three rectangular profiles are attached to the bottom rod. These profiles actually carry the components. Each profile can carry 4 components.
4. These profiles have webbed structure in order to carry various types of components.
5. For the sake of ergonomics and ease of material handling, these profiles are kept to the only one side of rod. Hence worker will not have to go to both sides of carrier for handling. It will reduce worker fatigue.
6. Proposed system is redesigned in such a way that while turning two carriers can avoid clogging. It will eliminate the chances of stoppage of production and enhance the whole production.
7. A proper gap is to be maintained between two carriers in order to avoid clogging.

Calculation

System production rate:

- Carrier capacity: 12 parts
- Production requirements: 134/hr
- Required no. of carriers/hr: 11
- Required no. of carriers /min: 0.186

Carrier spacing:

Carrier spacing should be between 15 – 40 cm.

Conveyor speed:

- Required no. of carriers /min: 0.186
- Carrier spacing: 40 cm or 1.33 feet
- Conveyor speed: 0.186*1.33 = 0.2474 F.P.M

Friction chain pull:

- Total moving load: 1309 kg/ hr
- Friction factor: 0.03
- Friction chain pull: 1309*0.03= 39.27

Diagrammatic representation of proposed system

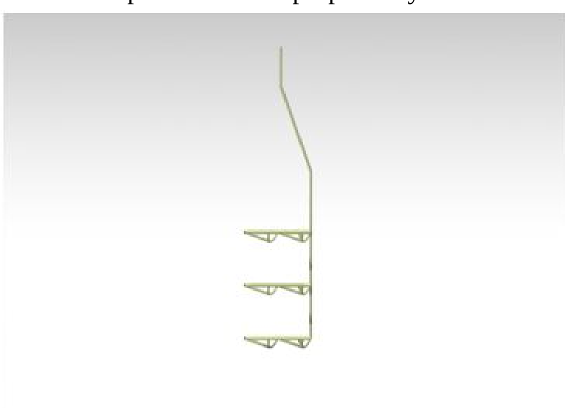

Fig. 4.1 Side view

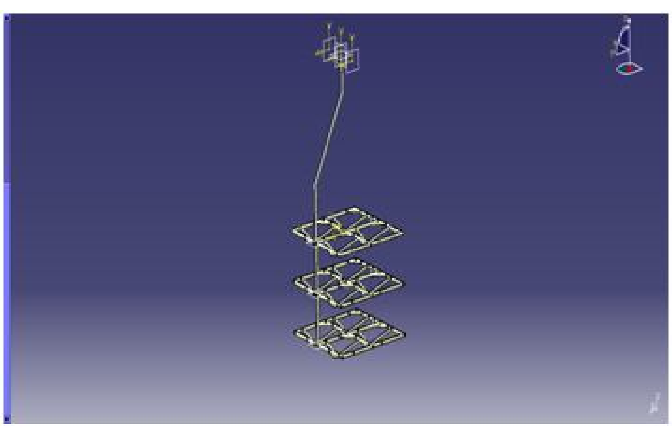

Fig. 4.2 Isometric view

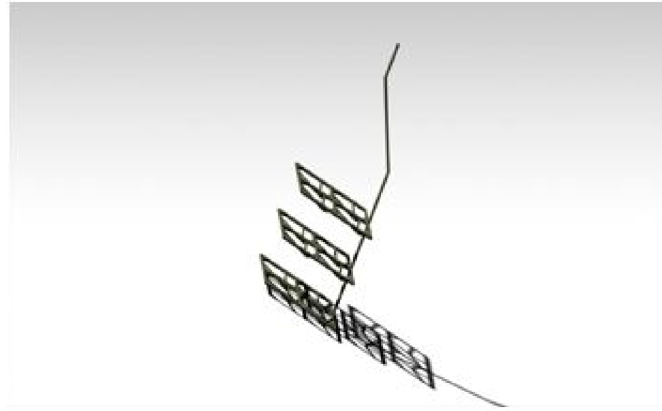

Fig. 4.3 Isometric view

V. LAYOUT ANALYSIS

For layout analysis, load-distance technique is used.

Load-Distance Technique-

This is the most commonly used quantitative process layout model that minimises flow. Load distance model – an algorithm for laying out work stations to minimise product flow, based on number of loads moved and the distance between each pair of work station. Various locations are evaluated using a load-distance value that is a measure of weight and distance. For a single potential location, a load-distance value is computed as follows:

$$LD = \sum lidi$$

Where

LD = the load-distance value

li = the load expressed as a weight, number of trips, or units being shipped from the proposed site to location i

di = the distance between the proposed site and location i

For general layout system-

For this case, assembly and storage are considered as two work-stations. There are four production lines for various models. Loads are the values of components which are transported from storage to assembly per day. Load-distance technique is applied to various models.

Table 5.1 Model A

Load	Dist.	LiDi
1019	4.7	4789.3
1043	4.7	4902.1
1027	4.7	4826.9
1005	4.7	4723.5
1012	4.7	4756.5
1005	4.7	4732.9

LD = ∑ lidi
= ∑ (1019*4.7)
= 4789.3

Table 5.2 Model B

Load	Dist.	LiDi
850	13.9	11815
835	13.9	11606.5
841	13.9	11689.9
867	13.9	12051.3
848	13.9	11787.2
863	13.9	11995.7

LD = ∑ lidi
= ∑ (850*13.9)
= 11815

Table 5.3 Model C

Load	Dist.	LiDi
991	22.1	21901.1
987	22.1	21812.7
973	22.1	21503.3
985	22.1	21768.5
1002	22.1	22144.2
995	22.1	21989.5

LD = ∑ lidi
= ∑ (991*22.1)
= 21901.1

Table 5.4 Model D

Load	Dist.	LiDi
1520	28.9	43928
1487	28.9	42974.3
1465	28.9	42338.5
1477	28.9	42685.3
1509	28.9	43610.1
1512	28.9	43696.8

LD = ∑ lidi
= ∑ (1520*28.9)
= 43928

Total load distance value is 82433.4

For this case, assembly and rework are considered as two work-stations. Loads are the values of defective components which are transported from assembly to rework per day.

Table 5.5 Defective components

Load	Dist.	LiDi
38	60.30	2291.4
41	60.30	2472.3
36	60.30	2170.8
35	60.30	2110.5
37	60.30	2231.1
39	60.30	2351.7

LD = ∑ lidi
= ∑ (38*60.3)
= 2291.4

Total load distance value is 2291.4

For proposed layout system-

For this case, assembly and storage are considered as two work-stations. There are four production lines for various models. Loads are the values of components which are transported from storage to assembly per day. Load-distance technique is applied to various models.

Table 5.6 Model A

Load	Dist.	LiDi
1019	9.36	9537.8
1043	9.36	9162.5
1027	9.36	9612.7
1005	9.36	9406.8
1012	9.36	9472.3
1005	9.36	9425.5

LD = ∑ lidi
= ∑ (1019*9.36)
= 9537.8

Table 5.7 Model B

Load	Dist.	LiDi
850	9.36	7956
835	9.36	7815.6
841	9.36	7871.7
867	9.36	8115.1
848	9.36	7937.3
863	9.36	8077.7

LD = ∑ $l_i d_i$
= ∑ (850*9.36)
= 7956

Table 5.8 Model C

Load	Dist.	LiDi
991	14.04	13913.6
987	14.04	13857.5
973	14.04	13607.9
985	14.04	13829.4
1002	14.04	14068.1
995	14.04	13969.8

LD = ∑ $l_i d_i$

= ∑ (991*14.04)
= 13913.6

Table 5.9 Model D

Load	Dist.	LiDi
1520	20.28	30825.6
1487	20.28	30156.4
1465	20.28	29710.2
1477	20.28	29953.6
1509	20.28	30602.5
1512	20.28	30663.4

$LD = \sum l_i d_i$
= ∑ (1520*20.28)
= 30825.6

Total load distance value is 62333

For this case, assembly and rework are considered as two work-stations. Loads are the values of defective components which are transported from assembly to rework per day.

Table 5.10 Defective components

Load	Dist.	LiDi
38	48.8	1854.4
41	48.8	2000.8
36	48.8	1756.8
35	48.8	1708
37	48.8	1805.6
39	48.8	1903.2

LD = ∑ lidi
= ∑ (38*48.8)
= 1854.4

Total load distance value is 1854.4

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