3

MATERIAL HANDLING

CHAPTER OUTLINE

3.1 INTRODUCTION AND MEANING

Haynes defines "*Material handling embraces the basic operations in connection with the movement of bulk, packaged and individual products in a semi-solid or solid state by means of gravity manually or power-actuated equipment and within the limits of individual producing, fabricating, processing or service establishment*". Material handling does not add any value to the product but adds to the cost of the product and hence it will cost the customer more. So the handling should be kept at minimum. Material handling in Indian industries accounts for nearly 40% of the cost of production. Out of the total time spent for manufacturing a product, 20% of the time is utilised for actual processing on them while the remaining 80% of the time is spent in moving from one place to another, waiting for the processing. Poor material handling may result in delays leading to idling of equipment.

Materials handling can be also defined as '*the function dealing with the preparation, placing and positioning of materials to facilitate their movement or storage*'. Material handling is the art and science involving the movement, handling and storage of materials during different stages of manufacturing. Thus the function includes every consideration of the product except the actual processing operation. In many cases, the handling is also included as an integral part of the process. Through scientific material handling considerable reduction in the cost as well as in the production cycle time can be achieved.

3.2 OBJECTIVES OF MATERIAL HANDLING

Following are the objectives of material handling:

1. Minimise cost of material handling.
2. Minimise delays and interruptions by making available the materials at the point of use at right quantity and at right time.
3. Increase the productive capacity of the production facilities by effective utilisation of capacity and enhancing productivity.
4. Safety in material handling through improvement in working condition.
5. Maximum utilisation of material handling equipment.
6. Prevention of damages to materials.
7. Lower investment in process inventory.

3.3 PRINCIPLES OF MATERIAL HANDLING

Following are the principles of material handling:

1. **Planning principle:** All handling activities should be planned.
2. **Systems principle:** Plan a system integrating as many handling activities as possible and co-ordinating the full scope of operations (receiving, storage, production, inspection, packing, warehousing, supply and transportation).
3. **Space utilisation principle:** Make optimum use of cubic space.
4. **Unit load principle:** Increase quantity, size, weight of load handled.
5. **Gravity principle:** Utilise gravity to move a material wherever practicable.
6. **Material flow principle:** Plan an operation sequence and equipment arrangement to optimise material flow.
7. **Simplification principle:** Reduce combine or eliminate unnecessary movement and/or equipment.
8. **Safety principle:** Provide for safe handling methods and equipment.
9. **Mechanisation principle:** Use mechanical or automated material handling equipment.
10. **Standardisation principle:** Standardise method, types, size of material handling equipment.
11. **Flexibility principle:** Use methods and equipment that can perform a variety of task and applications.
12. **Equipment selection principle:** Consider all aspect of material, move and method to be utilised.
13. **Dead weight principle:** Reduce the ratio of dead weight to pay load in mobile equipment.
14. **Motion principle:** Equipment designed to transport material should be kept in motion.
15. **Idle time principle:** Reduce idle time/unproductive time of both MH equipment and man power.
16. **Maintenance principle:** Plan for preventive maintenance or scheduled repair of all handling equipment.

17. **Obsolescence principle:** Replace obsolete handling methods/equipment when more efficient method/equipment will improve operation.
18. **Capacity principle:** Use handling equipment to help achieve its full capacity.
19. **Control principle:** Use material handling equipment to improve production control, inventory control and other handling.
20. **Performance principle:** Determine efficiency of handling performance in terms of cost per unit handled which is the primary criterion.

3.4 SELECTION OF MATERIAL HANDLING EQUIPMENTS

Selection of Material Handling equipment is an important decision as it affects both cost and efficiency of handling system. The following factors are to be taken into account while selecting material handling equipment.

1. Properties of the Material

Whether it is solid, liquid or gas, and in what size, shape and weight it is to be moved, are important considerations and can already lead to a preliminary elimination from the range of available equipment under review. Similarly, if a material is fragile, corrosive or toxic this will imply that certain handling methods and containers will be preferable to others.

2. Layout and Characteristics of the Building

Another restricting factor is the availability of space for handling. Low-level ceiling may preclude the use of hoists or cranes, and the presence of supporting columns in awkward places can limit the size of the material-handling equipment. If the building is multi-storeyed, chutes or ramps for industrial trucks may be used. Layout itself will indicate the type of production operation (continuous, intermittent, fixed position or group) and can indicate some items of equipment that will be more suitable than others. Floor capacity also helps in selecting the best material handling equipment.

3. Production Flow

If the flow is fairly constant between two fixed positions that are not likely to change, fixed equipment such as conveyors or chutes can be successfully used. If, on the other hand, the flow is not constant and the direction changes occasionally from one point to another because several products are being produced simultaneously, moving equipment such as trucks would be preferable.

4. Cost Considerations

This is one of the most important considerations. The above factors can help to narrow the range of suitable equipment, while costing can help in taking a final decision. Several cost elements need to be taken into consideration when comparisons are made between various items of equipment that are all capable of handling the same load. Initial investment and operating and maintenance costs are the major cost to be considered. By calculating and comparing the total cost for each of the items of equipment under consideration, a more rational decision can be reached on the most appropriate choice.

5. NATURE OF OPERATIONS

Selection of equipment also depends on nature of operations like whether handling is temporary or permanent, whether the flow is continuous or intermittent and material flow pattern-vertical or horizontal.

6. ENGINEERING FACTORS

Selection of equipment also depends on engineering factors like door and ceiling dimensions, floor space, floor conditions and structural strength.

7. EQUIPMENT RELIABILITY

Reliability of the equipment and supplier reputation and the after sale service also plays an important role in selecting material handling equipments.

3.5 EVALUATION OF MATERIAL HANDLING SYSTEM

The cost factors include investment cost, labour cost, and anticipated service hours per year, utilization, and unit load carrying ability, loading and unloading characteristics, operating costs and the size requirements are the factors for evolution of material handling equipment. Other factors to be considered are source of power, conditions where the equipment has to operate and such other technical aspects. Therefore, choices of equipments in organisation will improve the material handling system through work study techniques. They usually result in improving the ratio of operating time to loading time through palletizing, avoiding duplicative movements, etc. Obsolete handling systems can be replaced with more efficient equipments.

The effectiveness of the material handling system can be measured in terms of the ratio of the time spent in the handling to the total time spent in production. This will cover the time element. The cost effectiveness can be measured by the expenses incurred per unit weight handled. It can be safely said that very few organisations try to collate the expenses and time in this manner so as to objectively view the performance and to take remedial measures. Some of the other indices which can be used for evaluating the performance of handling systems are listed below:

EQUIPMENT UTILISATION RATIO

Equipment utilisation ratio is an important indicator for judging the materials handling system. This ratio can be computed and compared with similar firms or in the same over a period of time.

In order to know the total effort needed for moving materials, it may be necessary to compute **Materials Handling Labour (MHL) ratio**. This ratio is calculated as under:

$$\text{MHL} = \frac{\text{Personnel assigned to materials handling}}{\text{Total operating work force}}$$

In order to ascertain whether is the handling system delivers materials work centres with maximum efficiency, it is desirable to compute direct labour handling loss ratio. The ratio is:

$$\text{DLHL} = \frac{\text{Materials handling time lost of labour}}{\text{Total direct labour time}}$$

The movement's operations ratio which is calculated after dividing total number of moves by total number of productive operations indicates whether the workers are going through too many motions because of poor routing.

It should, however, be emphasized that the efficiency of materials handling mainly depends on the following factors: (*i*) efficiency of handling methods employed for handling a unit weight through a unit distance, (*ii*) efficiency of the layout which determines the distance through which the materials have to be handled, (*iii*) utilisation of the handling facilities, and (*iv*) efficiency of the speed of handling.

In conclusion, it can be said that an effective material handling system depends upon tailoring the layout and equipments to suit specific requirements. When a large volume has to be moved from a limited number of sources to a limited number of destinations the fixed path equipments like rollers, belt conveyors, overhead conveyors and gauntry cranes are preferred. For increased flexibility varied path equipments are preferred.

3.6 MATERIAL HANDING EQUIPMENTS

Broadly material handling equipment's can be classified into two categories, namely: (*a*) Fixed path equipments, and (*b*) Variable path equipments.

(*a*) *Fixed path equipments* which move in a fixed path. Conveyors, monorail devices, chutes and pulley drive equipments belong to this category. A slight variation in this category is provided by the overhead crane, which though restricted, can move materials in any manner within a restricted area by virtue of its design. Overhead cranes have a very good range in terms of hauling tonnage and are used for handling bulky raw materials, stacking and at times palletizing.

(*b*) *Variable path equipments* have no restrictions in the direction of movement although their size is a factor to be given due consideration trucks, forklifts mobile cranes and industrial tractors belong to this category. Forklifts are available in many ranges, they are manoeuvrable and various attachments are provided to increase their versatility.

Material Handing Equipments may be classified in five major categories.

1. CONVEYORS

Conveyors are useful for moving material between two fixed workstations, either continuously or intermittently. They are mainly used for continuous or mass production operations—indeed, they are suitable for most operations where the flow is more or less steady. Conveyors may be of various types, with rollers, wheels or belts to help move the material along: these may be power-driven or may roll freely. The decision to provide conveyors must be taken with care, since they are usually costly to install; moreover, they are less flexible and, where two or more converge, it is necessary to coordinate the speeds at which the two conveyors move.

2. INDUSTRIAL TRUCKS

Industrial trucks are more flexible in use than conveyors since they can move between various points and are not permanently fixed in one place. They are, therefore, most suitable for intermittent

production and for handling various sizes and shapes of material. There are many types of truck-petrol-driven, electric, hand-powered, and so on. Their greatest advantage lies in the wide range of attachments available; these increase the trucks ability to handle various types and shapes of material.

3. Cranes and Hoists

The major advantage of cranes and hoists is that they can move heavy materials through overhead space. However, they can usually serve only a limited area. Here again, there are several types of crane and hoist, and within each type there are various loading capacities. Cranes and hoists may be used both for intermittent and for continuous production.

4. Containers

These are either 'dead' containers (*e.g*. Cartons, barrels, skids, pallets) which hold the material to be transported but do not move themselves, or 'live' containers (*e.g*. wagons, wheelbarrows or computer self-driven containers). Handling equipments of this kind can both contain and move the material, and is usually operated manually.

5. Robots

Many types of robot exist. They vary in size, and in function and manoeuvrability. While many robots are used for handling and transporting material, others are used to perform operations such as welding or spray painting. An advantage of robots is that they can perform in a hostile environment such as unhealthy conditions or carry on arduous tasks such as the repetitive movement of heavy materials.

The choice of material-handling equipment among the various possibilities that exist is not easy. In several cases the same material may be handled by various types of equipments, and the great diversity of equipment and attachments available does not make the problem any easier. In several cases, however, the nature of the material to be handled narrows the choice. Some of the material handling equipment are shown in Figs. 3.1 to 3.11.

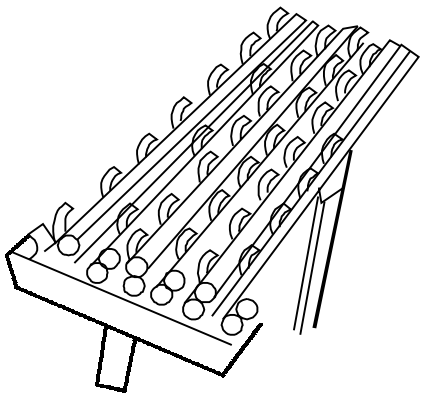

Fig. 3.1 *Wheel conveyor*

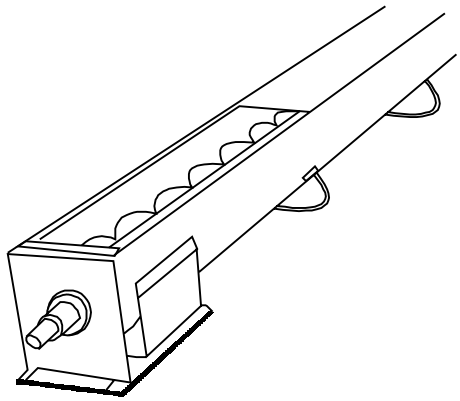

Fig. 3.2 *Secrew conveyor*

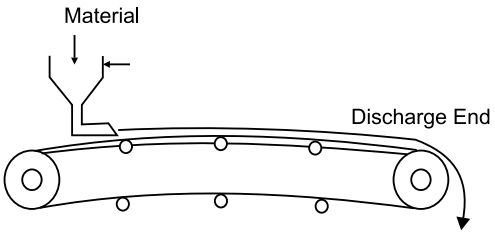

Fig. 3.3 *Belt conveyor*

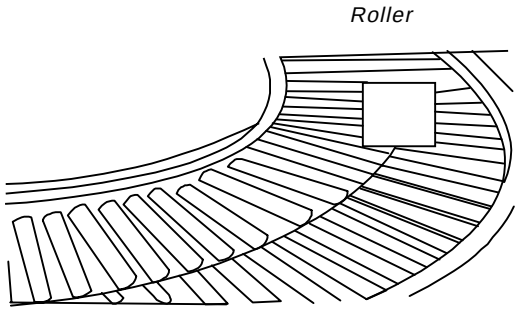

Fig. 3.4 *Roller conveyor*

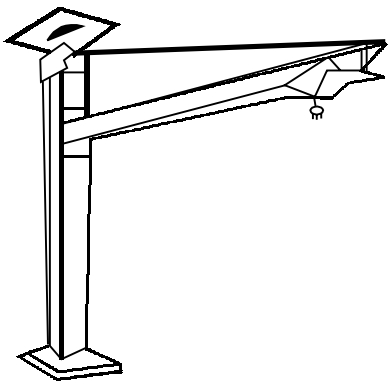

Fig. 3.5 *Jib crane*

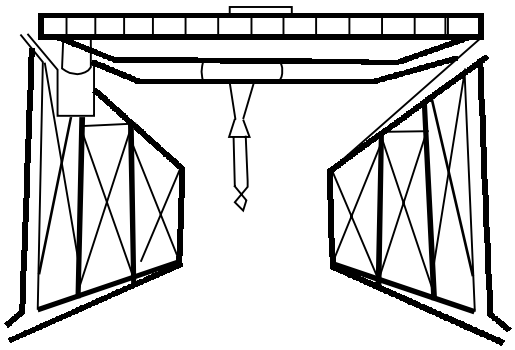

Fig. 3.6 *Bridge crane*

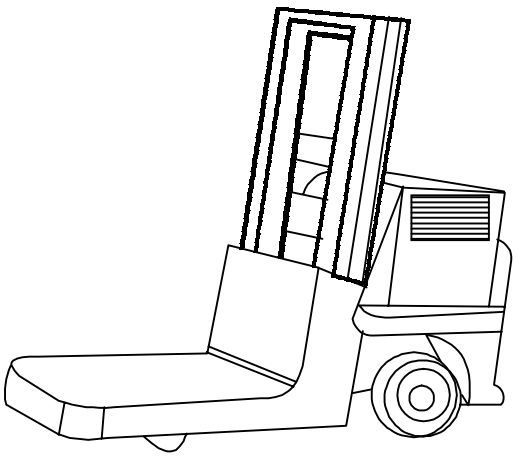

Fig. 3.7 *Platform truck*

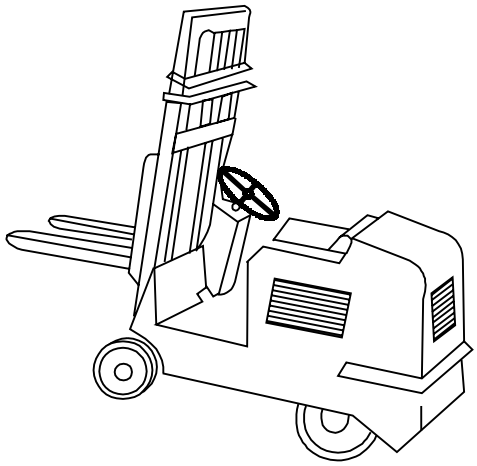

Fig. 3.8 *Fork truck*

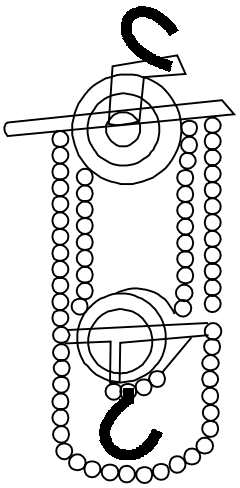

Fig. 3.9 *Chain hoist*

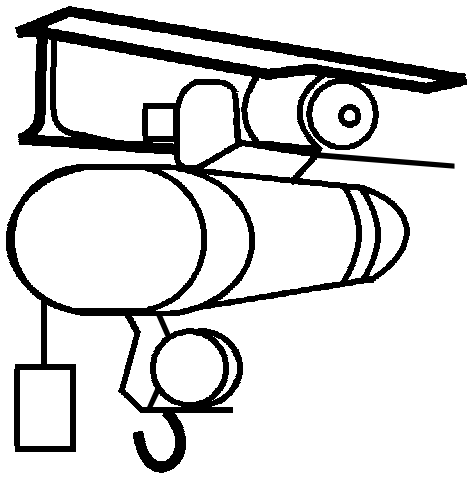

Fig. 3.10 *Electric hoist*

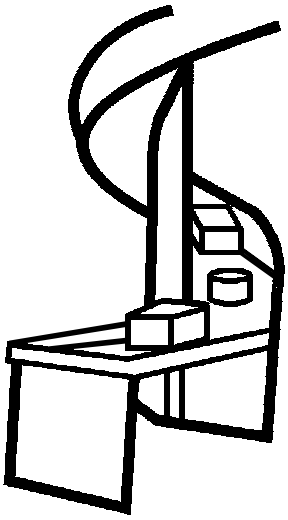

Fig. 3.11 *Spiral chute*

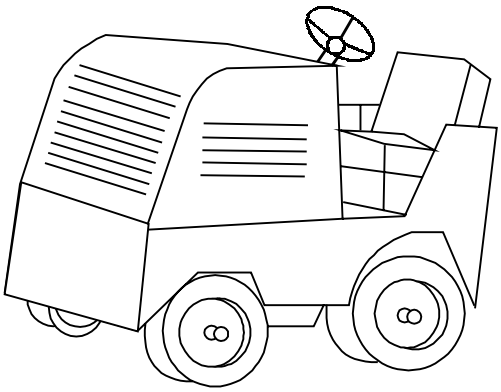

Fig. 3.12 *Industrial tractor*

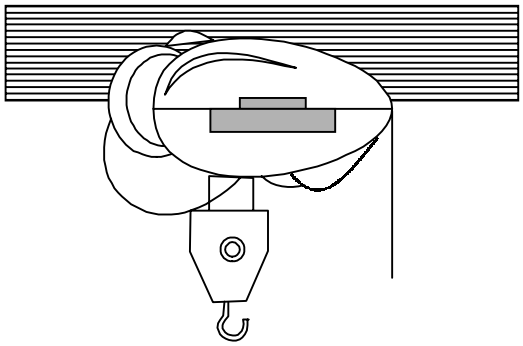

Fig. 3.13 *Electrical hoist*

3.7 GUIDELINES FOR EFFECTIVE UTILISATION OF MATERIAL HANDLING EQUIPMENTS

The following guidelines are invaluable in the design and cost reduction of the materials handling system:

1. As material handling adds no value but increases the production cycle time, eliminate handling wherever possible. Ideally there should not be any handling at all!
2. Sequence the operations in logical manner so that handling is unidirectional and smooth.
3. Use gravity wherever possible as it results in conservation of power and fuel.
4. Standardise the handling equipments to the extent possible as it means interchangeable usage, better utilisation of handling equipments, and lesser spares holding.
5. Install a regular preventive maintenance programme for material handling equipments so that downtime is minimum.
6. In selection of handling equipments, criteria of versatility and adaptability must be the governing factor. This will ensure that investments in special purpose handling equipments are kept at a minimum.
7. Weight of unit load must be maximum so that each 'handling trip' is productive.
8. Work study aspects, such a elimination of unnecessary movements and combination of processes should be considered while installing a material handling system.
9. Non-productive operations in handling, such as slinging, loading, etc., should be kept at a minimum through appropriate design of handling equipment. Magnetic cranes for scrap movement and loading in furnaces combination of excavators and tippers for ores loading and unloading in mines are examples in this respect.
10. Location of stores should be as close as possible to the plant which uses the materials. This avoids handling and minimizing investment in material handling system.
11. Application of OR techniques such as queueing can be very effective in optimal utilisation of materials handling equipments.
12. A very important aspect in the design of a material handling system is the safety aspect. The system designed should be simple and safe to operate.
13. Avoid any wasteful movements-method study can be conducted for this purpose.
14. Ensure proper coordination through judicious selection of equipments and training of workmen.

3.8 RELATIONSHIP BETWEEN PLANT LAYOUT AND MATERIAL HANDLING

There is a close relationship between plant layout and material handling. A good layout ensures minimum material handling and eliminates rehandling in the following ways:

1. Material movement does not add any value to the product so, the material handling should be kept at minimum though not avoid it. This is possible only through the systematic plant layout. Thus a good layout minimises handling.
2. The productive time of workers will go without production if they are required to travel long distance to get the material tools, etc. Thus a good layout ensures minimum travel

for workman thus enhancing the production time and eliminating the hunting time and travelling time.

3. Space is an important criterion. Plant layout integrates all the movements of men, material through a well designed layout with material handling system.
4. Good plant layout helps in building efficient material handling system. It helps to keep material handling shorter, faster and economical. A good layout reduces the material backtracking, unnecessary workmen movement ensuring effectiveness in manufacturing.

Thus a good layout always ensures minimum material handling.

EXERCISES

Section A

1. Define material handling
2. Mention any four objectives of material handling.
3. Mention any four principles of material handling.
4. What do you mean by "Equipment Utilisation Ratio"?
5. Mention some of the fixed path equipments.
6. Mention some of the valuable path equipments.

Section B

1. Explain the objectives of material handling.
2. Explain the principles of material handling.
3. How do you evaluate the material handling system?
4. What are the relationship between plant layout and material handling?

Section C

1. Discuss the factors to be considered while selecting material handling equipment.
2. Discuss the different material handling equipments.
3. Discuss the guidelines for effective utilisation of material handling equipments.

Skill Development

FAST FOOD RESTAURANT VISIT: Get the information for the following questions:

1. Material handling in the restaurant for production and services.
2. Type of material handling equipment used for production and services.
3. Utilisation of material handling equipment.