MATERIAL HANDLING:-

Material handling (MH) defined as "short-movement of material that usually takes place within the confines of a building such as a plant or a warehouse and between a building and a transportation agency." It can be used to create "time and place utility" through the handling, storage, and control of material, as distinct from manufacturing (i.e., fabrication and assembly operations), which creates "form utility" by changing the shape, form, and makeup of material.

Principles of Material Handling

Although there are no definite "rules" that can be followed when designing an effective MHS, the following "Ten Principles of Material Handling," as compiled by the College-Industry Council on Material Handling Education (CIC-MHE) in cooperation with the Material Handling Institute (MHI), represent the distillation of many years of accumulated experience and knowledge of many practitioners and students of material handling engineering.

1. Planning Principle. All MH should be the result of a deliberate plan where the needs, performance objectives, and functional specification of the proposed methods are completely defined at the outset.

2. Standardization Principle. MH methods, equipment, controls and software should be standardized within the limits of achieving overall performance objectives and without sacrificing needed flexibility, modularity, and throughput.

3. Work Principle. MH work (defined as material flow multiplied by the distance moved) should be minimized without sacrificing productivity or the level of service required of the operation.

4. Ergonomic Principle. Human capabilities and limitations must be recognized and respected in the design of MH tasks and equipment to ensure safe and effective operations.

5. Unit Load Principle. Unit loads shall be appropriately sized and configured in a way that achieves the material flow and inventory objectives at each stage in the supply chain.

6. Space Utilization Principle. Effective and efficient use must be made of all available (cubic) space.

7. System Principle. Material movement and storage activities should be fully integrated to form a coordinated, operational system which spans receiving, inspection, storage, production, assembly, packaging, unitizing, order selection, shipping, and transportation, and the handling of returns.

8. Automation Principle. MH operations should be mechanized and/or automated where feasible to improve operational efficiency, increase responsiveness, improve consistency and predictability, decrease operating costs, and to eliminate repetitive or potentially unsafe manual labour.

9. Environmental Principle. Environmental impact and energy consumption should be considered as criteria when designing or selecting alternative equipment and MHS.

10. Life Cycle Cost Principle. A thorough economic analysis should account for the entire life cycle of all MHE and resulting systems.

VARIOUS TYPES OF MATERIAL HANDLING EQUIPMENT:-

Hoist:-

Used for vertical translation (i.e., lifting and lowering) of loads, frequently attached to cranes and monorails to provide vertical translation capability. Can be operated manually, electrically, or pneumatically. Use chain or wire rope as its lifting medium.

Fig- Double Girder Crane Hoist

Manipulator:-

Used for vertical and horizontal translation and rotation of loads, Acting as "muscle multipliers," manipulators counterbalance the weight of a load so that an operator lifts a small portion (1%) of the load's weight. Can be powered manually, electrically, or pneumatically. Manipulator's end-effector can be equipped with mechanical grippers, vacuum grippers, electromechanical grippers, or other tooling. Manipulators fill the gap between hoists and industrial robots.

Industrial robot:-

Used in positioning to provide variable programmed motions of loads. "Intelligent" industrial robots utilize sensory information for complex control actions, as opposed to simple repetitive "pick-and-place" motions.

Industrial robots also used for parts fabrication, to simple repetitive "pick-and-place" motions, inspection, and assembly tasks, Consists of a chain of several rigid links connected in series by revolute or prismatic joints with one end of the chain attached to a supporting base and the other end free and equipped with an end effector.

Robot's end-effector can be equipped with mechanical grippers, vacuum grippers, electro-mechanical grippers, welding heads, paint spray heads, or any other tooling.

Although similar in construction, an industrial robot is distinguished from a manipulator by the use of programmed control logic.

Conveyors:-

Conveyors are used : -

- When material is to be moved frequently between specific points.
- To move materials over a fixed path.
- When there is a sufficient flow volume to justify the fixed conveyor investment.

Conveyors can be classified in different ways:

- Type of product being handled: unit load or bulk load

- Location of the conveyor: in-floor, on-floor, or overhead

- Whether loads can accumulate on the conveyor or no accumulation is possible

Various type of Conveyors :-

1. Chute conveyor 2. Wheel conveyor 3. Roller conveyor 4. Chain conveyor 5. Slat conveyor 6. Flat belt conveyor 8. Troughed belt conveyor 9. Bucket conveyor 11. Screw conveyor 12. Pneumatic conveyor 13. Vertical conveyor 14. Cart-on-track conveyor 15. Tow conveyor 16. Trolley conveyor 17. Power-and-free conveyor 18. Monorail 19. Sortation conveyor

CRANES

GENERAL CHARACTERISTICS OF CRANES:-

- Used to move loads over variable (horizontal and vertical) paths within a restricted area.
- Used when there is insufficient (or intermittent) flow volume such that the use of a conveyor cannot be justified.
- Provide more flexibility in movement than conveyors.
- Provide less flexibility in movement than industrial trucks.
- Loads handled are more varied with respect to their shape and weight than those handled by a conveyor.
- Most cranes utilize hoists for vertical movement, although manipulators can be used if precise positioning of the load is required.

BASIC TYPES OF CRANE:-

1. Jib crane 2. Bridge crane 3. Gantry crane 4. Stacker crane

1. Jib crane

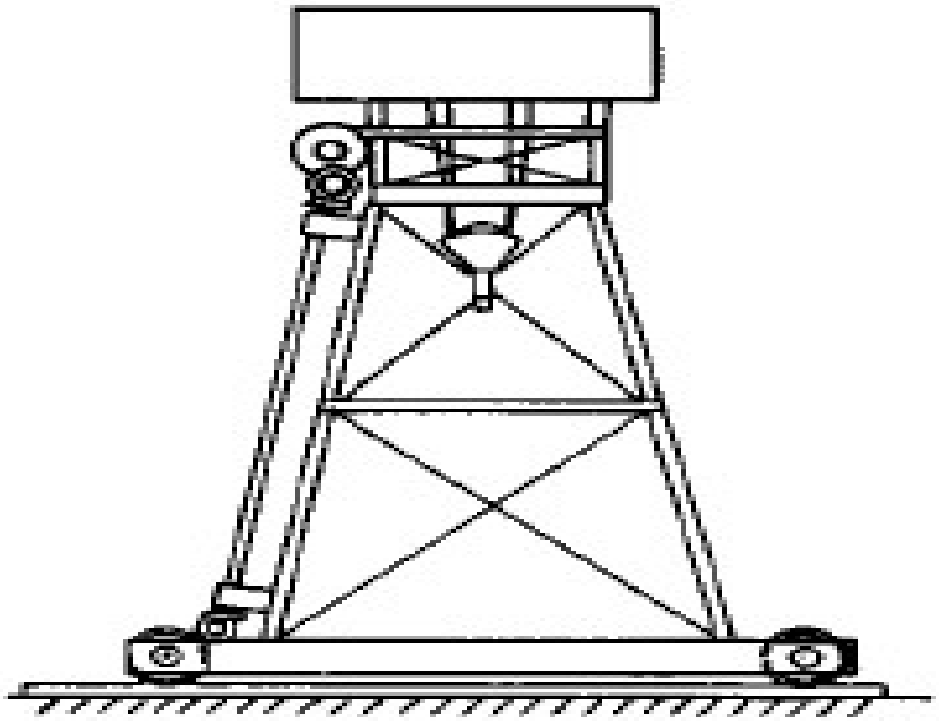
--Horizontal boom (jib) supported from a stationary vertical support
--Hoist can move along the jib and can be used for lifting materials.
--Operates like an arm in a work area, where it can function as a manipulator for positioning tasks
--Jib can also be mounted on the wall.
--Arm can rotate up to 360°.

2. Bridge crane

--Bridge mounted on tracks that are located on opposite walls of the facility.
--Enables three-dimensional handling.
--Top riding (heavier loads) or under hung (more versatile) versions of the crane.
--Under hung crane can transfer loads and interface with other MHS (e.g., monorail systems.

3. Gantry crane

--Single leg, double leg, and mobile types of gantry cranes
--Similar to a bridge crane except that it is floor supported at one or both ends instead of overhead (wall) supported .
--Used to span a smaller portion of the work area as compared to a bridge crane
--The supports can be fixed in position



Gantry crane.

or they can travel on runways
--Can be used outdoors when "floor" supported at both ends

4. Stacker crane

--Similar to a bridge crane except that, instead of a hoist, it uses a mast with forks or a platform to handle unit loads.
--Considered "fork trucks on a rail"
--Used for storing and retrieving unit loads in storage racks, especially in high-rise applications in which the racks are more than 50 feet high
--Can be controlled remotely or by an operator in a cab.

TYPES OF ELECTRIC OVERHEAD CRANES

There are various types of overhead cranes with many being highly specialized, but the great majority of installations fall into one of three categories: a) Top running single girder bridge cranes, b) Top running double girder bridge cranes and c) Under-running single girder bridge cranes. Electric Overhead Travelling (EOT) Cranes come in various types: -

1) Single girder cranes - The crane consists of a single bridge girder supported on two end trucks. It has a trolley hoist mechanism that runs on the bottom flange of the bridge girder.

2)Double Girder Bridge Cranes - The crane consists of two bridge girders supported on two end trucks. The trolley runs on rails on the top of the bridge girders.

3)Gantry Cranes - These cranes are essentially the same as the regular overhead cranes except that the bridge for carrying the trolley or trolleys is rigidly supported on two or more legs running on fixed rails or other runway. These "legs" eliminate the supporting runway and column system and connect to end trucks which run on a rail either embedded in, or laid on top of, the floor.

4)Monorail - For some applications such as production assembly line or service line, only a trolley hoist is required. The hoisting mechanism is similar to a single girder crane with a difference that the crane doesn't have a movable bridge and the hoisting trolley runs on a fixed girder. Monorail beams are usually I-beams(taperedbeamflanges).

EOT CRANE CONFIGURATION

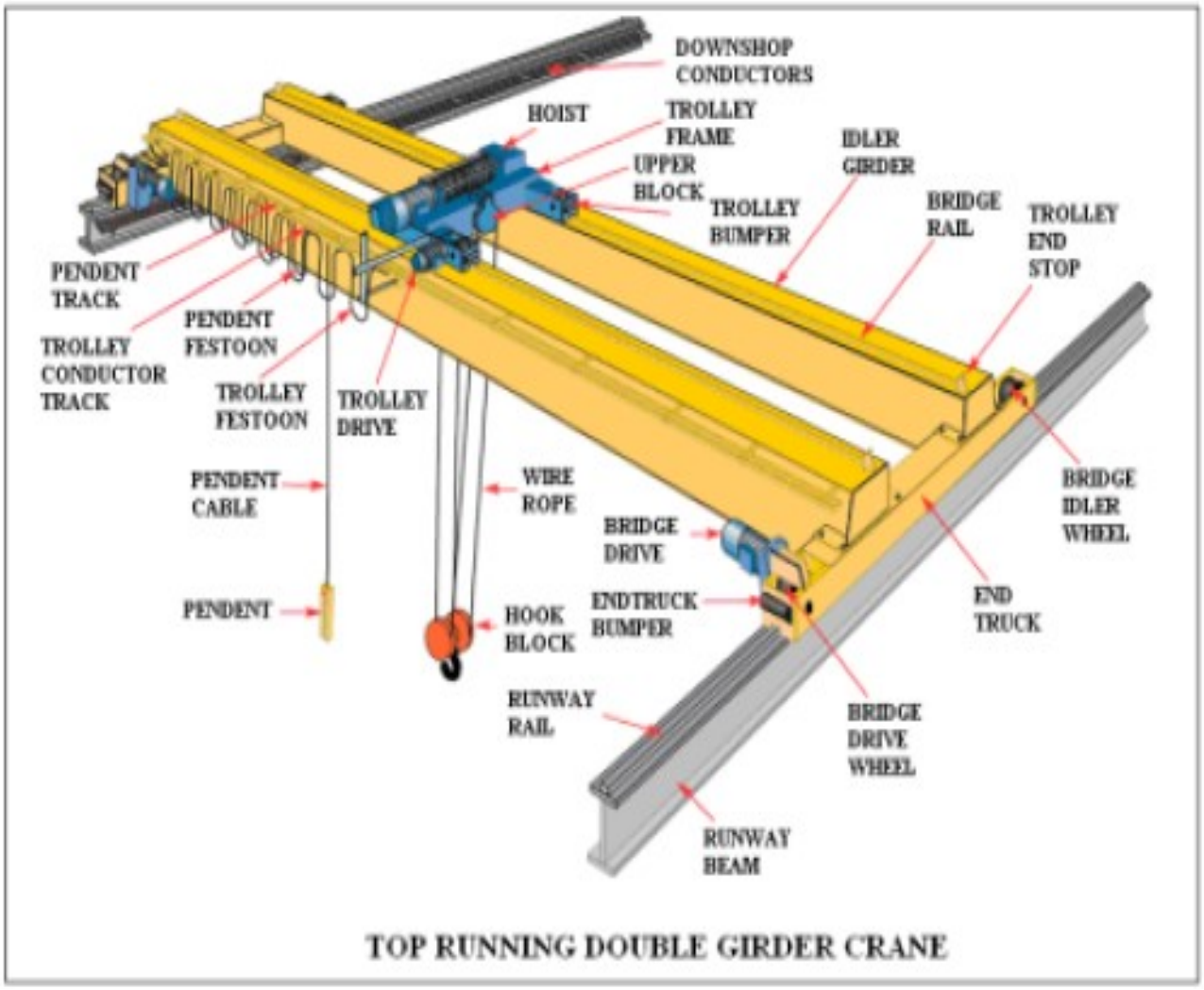
1) Under Running (U/R)
2) Top Running (T/R)

Under running cranes

Under Running or under slung cranes are distinguished by the fact that they are supported from the roof structure and run on the bottom flange of runway girders. Under running cranes are typically available in standard capacities up to 10 tons (special configurations up to 25 tons and over 90 ft spans). Under hung cranes offer excellent side approaches, close headroom and can be supported on runways hung from existing building members if adequate.

Top Running Cranes

The crane bridge travels on top of rails mounted on a runway beam supported by either the building columns or columns specifically engineered for the crane. Top Running Cranes are the most common form of crane design where the crane loads are transmitted to the building columns or free standing structure. These cranes have an advantage of minimum headroom / maximum height of lift.



BASIC CRANE COMPONENTS

To help the reader better understand names and expressions used throughout this course, find below is a diagram of basic crane components.

1) Bridge - The main travelling structure of the crane which spans the width of the bay and travels in a direction parallel to the runway. The bridge consists of two end trucks and one or two bridge girders depending on the equipment type. The bridge also supports the trolley and hoisting mechanism for up and down lifting of load.

2) End trucks - Located on either side of the bridge, the end trucks house the wheels on which the entire crane travels. It is an assembly consisting of structural members, wheels, bearings, axles,)etc., which supports the bridge girder(s) or the trolley cross member(s).

3)Bridge Girder(s) - The principal horizontal beam of the crane bridge which supports the trolley and is supported by the end trucks.

4)Runway - The rails, beams, brackets and framework on which the crane operates.

5)Runway Rail - The rail supported by the runway beams on which the crane travels.

6) Hoist - The hoist mechanism is a unit consisting of a motor drive, coupling, brakes, gearing, drum, ropes, and load block designed to raise, hold and lower the maximum rated load. Hoist mechanism is mounted to the trolley.

7) Trolley - The unit carrying the hoisting mechanism which travels on the bridge rails in a direction at right angles to the crane runway. Trolley frame is the basic structure of the trolley on which are mounted the hoisting and traversing mechanisms.

8) Bumper (Buffer) -An energy absorbing device for reducing impact when a moving crane or trolley reaches the end of its permitted travel, or when two moving cranes or trolleys come into contact. This device may be attached to the bridge, trolley or runway stop.

ESSENTIAL PARAMETERS FOR SPECIFING EOT CRANES

To select correct crane envelope that will fit in the building foot print, the user must identify and pass on the following key information to the supplier:

1) Crane Capacity - The rated load, the crane will be required to lift. Rated load shall mean the maximum load for which a crane or individual hoist is designed and built by the manufacturer and shown on the equipment identification plate.

2) Lift Height - The rated lift means the distance between the upper and lower elevations of travel of the load block and arithmetically it is usually the distance between the beam and the floor, minus the height of the hoist. This dimension is critical in most applications as it determines the height of the runway from the floor and is dependent on the clear inside.

3)Runway Height – The distance between the grade level and the top of the rail.

4)Clearance-The vertical distance between the grade level and the bottom of the crane girder.

5) Clear Span- Distance between columns across the width of the building. Building width is defined as the distance from outside of eave strut of one sidewall to outside of eave strut of the opposite Side wall. Crane Span is the horizontal center distance between the rails of the runway on which the crane is to travel. Typically distance is approximate to 500mm less than the width of the building.
How much span a crane requires depends on the crane coverage width dictated by the application. (According to the span and the maximum load handling capacity, the crane steel structure is selected to be either a single or double girder crane construction).

6) Building Height-Building height is the eave height which usually is the distance from the bottom of the main frame column base plate to the top outer point of the eave strut. Eave height is the distance from the finished floor to the top outer point of the eave strut. There must be a safety distance between the top edge of the crane runway rail and the first obstacle edge in the building (for example roof beams, lights and pipes).

7)Runway Length- The longitudinal run of the runway rail parallel to the length of the building.

8) Hook approaches -Maximum hook approach is the distance from the wall to the nearest possible position of the hook. The smaller the distance is, the better can the floor area be utilized. Always check which crane gives optimum hook approaches and when combined with the true lift of the hoist you can utilize most of the available floor space. This is also termed as side hook approach.
End Approach – This term describes the minimum horizontal distance, parallel to the runway, between the outermost extremities of the crane and the center line of the hook.

9)Bridge, Trolley and Lift Speeds - The rate at which the bridge or trolley travels or at which the hoist lifts is usually specified in feet per minute or FPM. The crane operating speeds are selected to allow safe operation whilst using the pendant. Dual operating speeds, normally a fast and slow speed with a ratio of 4:1 are commonly used but for optimum control a variable speed control system is strongly recommended.

10) Electrical Requirements - Specify the circuit voltage shall not exceed 600 volts for AC or DC current. Ideally 480 volt, 3 phase, 60 hertz for US requirements. The runway power is usually by conductor bar and hoisting trolley by festoon cable.

11) Control Requirements -The control circuit voltage at pendant pushbuttons shall not exceed 150 volts for AC and 300 volts for DC. Other control options including radio control, free-floating pendant (festooned) or hoist-mounted pendant requirements must be stated.

Which Crane should you choose – Single Girder or Double Girder?

A common misconception is that double girder cranes are more durable! Per the industry standards (CMMA/DIN/FEM), both single and double girder cranes are equally rigid, strong and durable. This is because single girder cranes use much stronger girders than double girder cranes. The difference between single and double girder cranes is the effective lifting height. Generally, double girder cranes provide better lifting height. Single girder cranes cost less in many ways, only one cross girder is required, trolley is simpler, installation is quicker and runway beams cost less due to the lighter crane dead weight. The building costs are also lower. However, not every crane can be a single girder crane. Generally, if the crane is more than 15 ton or the span is more than 30m, a double girder crane is a better solution.