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An Overview on Electric Overhead Crane

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***Abstract*: Electric overhead crane is a type of material handling device used for positioned of materials to the required location with minimum human interference and with high positioning accuracy. It generally has hoist, trolley and gantry used for raising and lowering of materials, positioned material above required location and long travel of materials respectively. This paper is going to focus on design and layout of crane bridges, selection of crane as per the capacity, selection of proper material for rail supports, design and manufacturing of customized plate for holding irregular surfaces with the help of magnetism, selection of end carriages and installation of the active unit for any practical applications.**

***Keywords*: Customized plates, Gantry.**

1. Introduction

A crane is a machine that is capable of raising and lowering heavy objects and moving the objects from one place to other. An overhead crane usually consists of three separate motions firstly the hoist which is used to raise and lowers the material then is the trolley allows the hoist to be positioned directly above the material for placement and lastly gantry which assists the entire crane to be moved along the working area. Due to high flexibility, variable load carrying capacity and efficient transportation overhead crane can be find in almost every type of the industry such as automobile industry, pharma industries, construction sites, ports, manufacturing and transportation industry etc. More or less each and every type of crane have similar basic structure irrespective with its type (Fig. 1.0 shows General layout of overhead crane). They are having trolley-pendent structure, supporting robust frames, rail supports etc.

The cranes are slightly different from hoist in respect that they only lift object but cannot move object sideways.

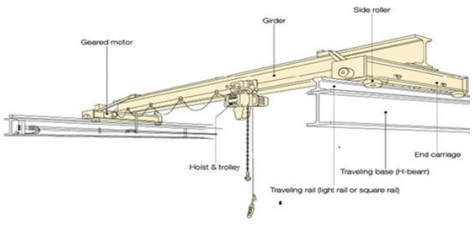


Fig. 1. General layout of overhead crane

2. Types of overhead electric cranes

There are numerous types of overhead cranes but the very common types of installations are;

1) Single Girder Cranes - The crane has a single bridge girder mounted on two end supports. It has a trolley and the hoist which runs at the bottom of the bridge girder.
2) Double Girder Bridge Cranes - The crane has two bridge girders mounted on two end supports. The trolley supported on rails which is at the top of the bridge girders.
3) Gantry Cranes - These cranes are similar to simple cranes with only difference that the bridge which carries the trolley is firmly supported on two or more legs which runs on fixed rails or other runways .
4) Monorail - This type of crane is designed using I-beams which are found in ceiling structures of many industries. The trolleys run along with the flat surface which is on the bottom longitudinal bars of the beam.

3. Methodology of crane selection

Selection of overhead cranes depends on the various factors hence it becomes important factor as well as tedious to select proper crane as per application. It depends widely on their major operational specifications such as: type of motion of the crane structure, weight and type of the load, location of the crane, geometric features, operating and environmental conditions. It also depends on capacity, how often the crane is used, span, runway travel, how high the load is to be lift, location of crane i.e. indoor or outdoor, motorization, automation and type of control required. The selection crane differs by location and designers but some things are same which follows the CMAA (Crane Manufacturers Association of America) codes.

Major classification is given as:

Hook Height: Double girder cranes typically allow 18-36 inches higher lift, because the hoist is placed between the cross girders rather than under them.

Lifting Capacity: Single girder- Less than 15 Tons Double girder-More than 15 Tons.

Span: Single girder-Less than 80 feet Double girder- More than 80 feet.

Cost: Off course single girder is cheaper than double girder.

4. Terminology of cranes

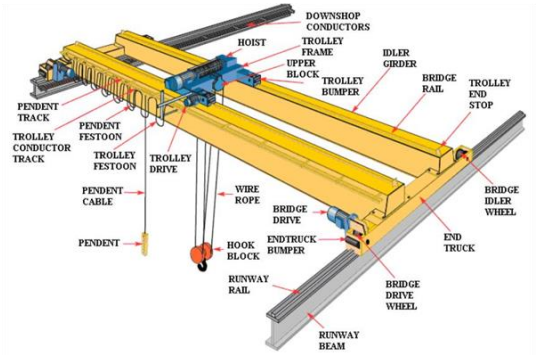


Fig. 2. Terminology of Cranes

1) Bridge: The Bridge is the most supreme structural component of the overhead crane. It covers horizontal distance of the building and comprises one or more load girders.
2) Runway: The track and the support system about which the crane operates. It is generally considered a part of the fundamental structure.
3) Runway Rail: The rail is supported by the runway beams on which the crane is travels.
4) End trucks: These are Located on both sides of the bridge; the end trucks have pair of wheels on which the whole crane travels. It is unit comprising of structural members, wheels, bearings, axles.
5) Trolley or Crab: It is 'cross travel unit' about which the hook is lowered or raised. The trolley has the electric wire rope hoist that supports a load block and hook through an arrangement of pulleys. It is fitted with a variable-speed AC motor which drives the load up or down. Limit switches avoids the load block from get collided with the trolley.
6) Bumper (Buffer): It is simple energy absorbing device used to neutralize the vibrations formed during the impact of the cranes to its end points.

5. Structural design considerations of cranes

1) Sections of beams: The beams should be selected properly available sections such as 'I- section' or 'C- section' depending on application. Generally, for intermediate beam I- section should be selected to while for side sections C- sections should be preferred. Those structural members selected should must be confirms to the specifications of the American Institute of Construction (AISC) current edition and any welded construction shall be in accordance with the standard of the American Welding Society (AWS)
2) Loads: Various loads are acted upon the cranes,
   Vertical loads:
   a) Weight of trolley and lifted load
   b) Weight of crane bridge
   c) Self-weight of crane girders and rails

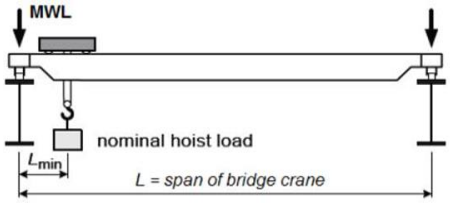


Fig. 3. Vertical loading on crane bridges

Lateral Loads (side thrust): Lateral crane loads are oriented perpendicular to the crane runway and are applied at the top of the rails.

Lateral loads are caused by:

a) Acceleration and deceleration of trolleys
b) Non vertical lifting
c) Unbalanced drive mechanism
d) Oblique travel of bridge

Longitudinal Forces (bumper impact loads) -Longitudinal crane forces are due to either acceleration or deceleration of the crane impacting the bumper. These are tractive force and impact force.

6. Calculation

Let us take sample example of set of calculations for single girder overhead crane, this step by step approach can be applied to any of the single girder overhead crane.

Lets consider total load to be lifted by crane for which we are designing = 60kg

Total span of intermediate I section= 600cm

Total span of side I section= 800cm (This span can be find out by considering dimensions of shop floor for which we are designing)

By considering FOS of 1.5 for gradual loading by V.B. Bhandari and considering static load factor for accounting of acceleration (Due to motion of the hoist) is 1.3,

Total load =60x1.5x1.3
=117kg (1)

Firstly, by trial and error method consider the beam with designation of (150x150x7/10x600) of material MSIS2062 grade.

Now let's consider loads on side I sections = total load of intermediate member +total weight of intermediate I sections itself.

Lets, The total weight of intermediate I section= 31.1kg/m
…. by Yomato steel Co. catalogue
We are having total 6m of section
As total span is 600cm,
Total weight=31.1x6=186.6kg (2)
Total load=117+186.6=303.6kg
adding (1) & (2)
By considering FOS for static loading,
Total load =303.6x 1.31
= 400kg

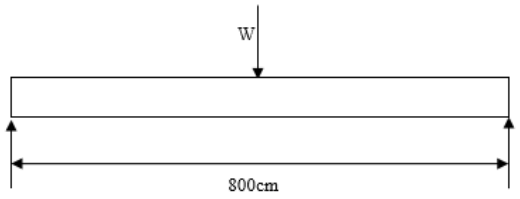
As there are two supports at the both end load will be distributed equally,
Load on each support = 400/2

=200kg
=1962N

To calculate weather this section is safe in loading analyze It by Flexural formula for that consider side section with of (100x100x6/8x800)

Ultimate tensile strength of the material is 410 mpa
Permissible strength= 410/1.3
=315.38N/mm^2

It is simply supported beam with centered active load,



Bending moment = (M) = WL/4
= 1962x8000/4 = 3.92x10^6

Distance from neutral axis= (Y) =100/2 =50 mm
Moment of Inertia=(I)= BD^3-bd^3/12 = (100x100)^3-(94x84)^3/12
= 3.690x10^6 mm^4

By flexural formula,
M/I=6b/Y

Calculated bending stress= (6b) = 53.10N/mm^2

Hence this design is safe as calculated bending stress is lower than permissible stress.
i.e. (53.10<315.38)

This is the generalizes procedure for the section design for any of the crane.

We can validate our calculations by using software's like ANSYS also,

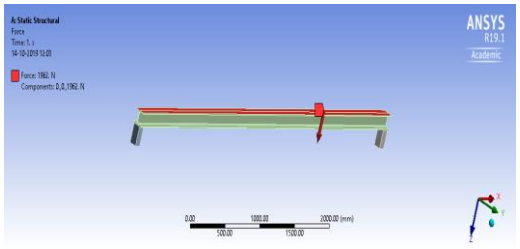


Fig. 4. Loading of side, I-section

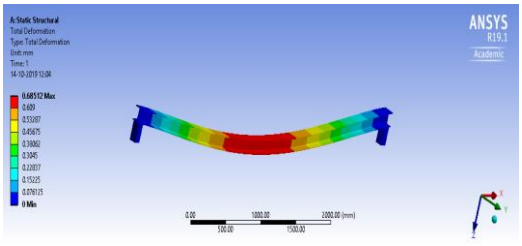


Fig. 5. Total deformation after load application

Fig. 4, shows loading of side I-section while Fig. 5, shows deformation of section under given load. We can see the maximum deformation is at the centre while minimum deformation is the supports. As maximum deformation is very negligible it will not have any adverse effect on the section. By such analytical as well as software mean we can design sections for cranes which are very vital parts of crane.

7. Conclusion

This paper presented an overview on electric overhead crane.

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