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Computer Aided Analysis and Design Of Hoisting Mechanism Of An EOT Crane

Shyam Lal Sharma
Department of Mechanical Engineering,
Al Falah School of Engineering and Technology, India
Dr.Tasmeem Ahmad Khan
Professor, Department of Mechanical Engineering,
Al Falah School of Engineering and Technology, India
Md. Parvez
HOD & Professor, Department of Mechanical Engineering,
Al Falah School of Engineering and Technology, India
Kamlesh Kumari
Mechanical Design Engineer,
DESEIN & INDURE PVT. LIMITED, New Delhi, India

Abstract:

In this project an overall design the hoists generally confirm to IS: 3177 of the hoisting mechanism of an EOT crane has been carried out. The dimensions of the main components have been determined for a load capacity of 50 ton crane having 8 rope falls. Various dimensions for cross sections of various shapes for crane have been found. After the system was designed, the stress and deflection are calculated at critical points using ANSYS and optimized. Which cross section would be better keeping some parameters constant for all the case .Various dimensions and load per wire for wire ropes has been found.

Using various formulae found the dimensions for pulley, Rope-drum.

Also calculated the Power and ratings for the motor brakes used in the hoist mechanism.

Key words: *Single Girder Electrical Overhead Traveling Crane in Cross Travel and Long Travel, Hoisting Mechanism, No. of Falls, Computer Aided Design, ANSYS and Optimization, Pulley, Rope-drum, Hook Block, Motor Brakes.*

1.History Of Cranes

The cranes have found many uses since the beginning of the history, and the history of cranes has come across since then. The Greek were the first people to use cranes for doing the lifting jobs. After this many other peoples like the Roman, the Chinese etc used the cranes and made many changes to the existing design of that time.

2.Methodology

Hoisting is the process of lifting something or some load from lower position to higher position with the help of some device or mechanism.

The Electric Overhead Traveling Crane consists essentially of a girder, or girders, supported at each end on tracks capable of traveling on elevated fixed tracks,

And a trolley, equipped with hoisting and other mechanism, capable of traversing from end to end of such girder or girders. Such cranes vary in lifting capacity from about 2 tons to 400 tons, and in span from 20 ft. to 150 ft, or more. For capacities of 10 tons and upwards an independent auxiliary hoist rated at 1/5 to 1/3 that of the main hoist is frequently provided. The computer Aided Design facilitates gives alternative parameters and thus calculates the unknown parameter which speeds up the design process. In the computerization the scope for providing cabins fixed to bridge is eliminated thus reducing the cost and and space.

Computer Aided Design of Electric Overhead Traveling Crane employs Visual Basic as the front end. In the design using Visual Basic, the user will have to input, the Load to be lifted, the operating conditions as in nature of duty, service factors, hoisting speed and then the design of rope is done. The Design of rope is on the basis of life criteria and can be checked for strength criteria and vice versa based upon the data available. The diameter of rope is calculated and the thus the diameter of sheave is calculated. During calculation of rope diameter the tackle efficiency, fall system depending on load, lay of rope and thus various parameters are analyzed for selecting the diameter of rope. In the tackle assembly the moving sheave assembly and hook Assembly are calculated. In case of Moving sheave assembly the diameter of moving sheaves and corresponding dimensions of sheave is calculated. Similarly the selection of bearings, dimensions of shackle plate and check plate are calculated. In case of hook assembly the bed diameter is decided based on load and then the corresponding dimensions are generated by empirical relations and thus all the dimensions are obtained. Then failure analysis is carried at every part. For example when the tensile failure at the threaded part is carried out in case of failure the dimensions are rectified thus modifying the load and the overall dimensions. Thrust bearing design is followed and the bearing selection is completed. Finally the cross-piece design is carried out taking into account the various design considerations. The hoisting mechanism is designed by selection of appropriate drive unit and rope drum.

3.Mechanics And Operation

In contrast to modern cranes, medieval cranes and hoists – much like their counterparts in Greece and Rome- were primarily capable of a vertical lift, and not used to move loads for a considerable distance horizontally as well.

Accordingly, lifting work was organized at the workplace in a different way than today. In building construction, for example, it is assumed that the crane lifted the stonne blocks either from the bottom directly into place,[or from a place opposite the centre of the wall from where it could deliver the blocks for two teams working at each end of the wall.

Additionally, the crane master who usually gave orders at the tread wheel workers from outside the crane was able to manipulate the movement laterally by a small rope attached to the load. Slewing cranes which allowed a rotation of the load and were thus particularly suited for dockside work appeared as early as 1340.

While ashlar blocks were directly lifted by sling, Lewis or devil's clamp (German Teufelskralle), other objects were placed before in containers like pallets, baskets,wooden boxes or barrels.

It is noteworthy that medieval cranes rarely featured ratchets or brakes to forestall the load from running backward. This curious absence is explained by the high friction force exercised by medieval tread wheels which normally prevented the wheel from accelerating beyond control.

4.Literature Survey

Rajendra Parmanik in a post “Design Of Hoisting Arrangement Of Electric Overhead Traveling Crane(2008).has discussed about history of crane, various types of crane ,application and a model design of the various parts of the EOT crane

R. Uddanwadiker, in the paper "Stress Analysis of Crane Hook and Validation by Photo-Elasticity” states that “Crane Hooks are highly liable components and are always subjected to failure due to accumulation of large amount of stresses which can eventually lead to its failure by predicting the stress concentration area, the shape of the crane is modified to increase its working life and reduce the failure rates."

Figure 1: Diagram of Single Girder EOT Crane (Hoist Mechanism)

Single Girder EOT Crane diagram includes Single Girder, Bus Bar, Hoist for lifting something or some load from lower position to higher position with the help of some device or mechanism.

5.Plan Of Action

In the designed hoist model trapezoidal section show less stress

The modified section should show less stress but due to reduction in area it shows more stress. Using more no. of rope falls divide the load and make the tension less. Also it makes the work faster .E.g if we use 4 rope falls then using the same force 4 times work is done. But increase in rope fall increase the rope length by that times, which is expensive also the rope lengths determine the drum length. Increase in drum length increase the volume of setup to reduce the volume we can double winding of rope on the drum can be adopted

Motor power required depends on lifting speed and load applied

The angular speed of drum and the motor are different so a gear box is used for power transmission. Performing number of experiment on principle of bending of a beam with large initial curvature

- Algebraic calculations

- Empirical calculations
- 3D modeling Software
- ANSYS for stress calculation and deformation analysis

6.Crane And Hoist Safety Design Requirements

The following are the design requirements for cranes and hoists and their components:

The design of all commercial cranes and hoists shall comply with the requirements of ASME/ANSI B30 standards and Crane Manufacturer's Association of America standards (CMAA-70 and CMAA-74).

All crane and hoist hooks shall have safety latches.

Hooks shall not be painted (or re-painted) if the paint previously applied by the manufacturer is worn.

Crane pendants shall have an electrical disconnect switch or button to open the main-line control circuit.

Cranes and hoists shall have a main electrical disconnect switch. This switch shall be in a separate box that is labelled with lockout capability.

Crane bridges and hoist monorails shall be labelled on both sides with the maximum capacity.

Each hoist-hook block shall be labelled with the maximum hook capacity.

Directional signs indicating N-W-S-E shall be displayed on the bridge underside, and a corresponding directional label shall be placed on the pendant.

A device such as an upper-limit switch or slip clutch shall be installed on all building cranes and hoists. A lower-limit switch may be required when there is insufficient hoist rope on the drum to reach the lowest point.

All newly installed cranes and hoists, or those that have been extensively repaired or rebuilt structurally, shall be load tested at 125% capacity prior to being placed into service.

If an overload device is installed, a load test to the adjusted setting is required.

Personnel baskets and platforms suspended from any crane shall be designed in accordance with the specifications in 29 CFR 1926.550(g) and COMAR 09.12.38.

All cranes used for personnel lifting, shall have anti-two blocking devices installed and operational.

Cranes taken out of service, for extended periods, shall be clearly tagged/labeled “Out of Service;” OOS labels shall be signed and dated. Cranes that are out of service shall have the power physically disconnected or locked out.

7.Crane & Hoist Operation Rules

7.1.Pre-operational Test

At the start of each work shift (on a day when the crane and/or hoist will be used), operators shall do the following steps before making lifts with any crane or hoist:

- Test the upper-limit switch. Slowly raise the unloaded hook block until the limit switch trips.
- Visually inspect the hook, load lines, trolley, and bridge as much as possible from the operator's station; in most instances, this will be the floor of the building.
- If provided, test the lower-limit switch.
- Test all direction and speed controls for both bridge and trolley travel.
- Test all bridge and trolley limit switches, where provided, if operation will bring the equipment in close proximity to the limit switches.
- Test the pendant emergency stop.
- Test the hoist brake to verify there is no drift without a load.
- If provided, test the bridge movement alarm.
- Lock out and tag for repair any crane or hoist that fails any of the above tests. Do not return to service until necessary maintenance is completed.

7.2.Moving A Load

- Center the hook over the load to keep the cables from slipping out of the drum grooves and overlapping, and to prevent the load from swinging when it is lifted. Inspect the drum to verify that the cable is in the grooves.
- Use a tag line when loads must traverse long distances or must otherwise be controlled. Manila rope may be used for tag lines.
- Plan and check the travel path to avoid personnel and obstructions.
- Lift the load only high enough to clear the tallest obstruction in the travel path.
- Start and stop slowly.
- Land the load when the move is finished. Choose a safe landing.

- Never leave suspended loads unattended. In an emergency where the crane or hoist has become inoperative, if a load must be left suspended, barricade and post signs in the surrounding area, under the load, and on all four sides. Lock open and tag the crane or hoist's main electrical disconnect switch.

7.3.Parking A Crane Or Hoist

- Remove all slings and accessories from the hook. Return the rigging device to the designated storage racks.
- Raise the hook at least 2.1 m (7 ft) above the floor.
- Store the pendant away from aisles and work areas, or raise it at least 2.1 m (7 ft) above the floor.
- Place the emergency stop switch (or push button) in the OFF position.

8.General Rigging Safety Requirements

Use only select rigging equipment that is in good condition. All rigging equipment shall be inspected at least annually. Defective equipment shall be removed from service and destroyed to prevent inadvertent reuse. The load capacity limits shall be stamped or affixed to all rigging components. Prudent practice requires a minimum safety factor of 5 to be maintained for wire rope slings.

8.1.The Following Types Of Slings Shall Be Rejected Or Destroyed

8.1.1.Nylon Slings With

- Abnormal wear.
- Torn stitching.
- Broken or cut fibers.
- Discoloration or deterioration.

8.1.2.Wire-Rope Slings With

- Kinking, crushing, bird-caging, or other distortions.
- Evidence of heat damage.
- Cracks, deformation, or worn end attachments.
- Six randomly broken wires in a single rope lay.
- Three broken wires in one strand of rope.
- Hooks opened more than 15% at the throat.
- Hooks twisted sideways more than 10 degrees from the plane of the unbent hook.

8.1.3.Alloy Steel Chain Slings With

- Cracked, bent, or elongated links or components.
- Cracked hooks.

Shackles, eye bolts, turnbuckles, or other components that are damaged or deformed.

8.2.Rigging A Load

Operators shall do the following when rigging a load:

- Determine the weight of the load. Do not guess.

- Determine the proper size for slings and components.
- Do not use manila rope for rigging.
- Make sure that shackle pins and shouldered eye bolts are installed in accordance with the manufacturer's recommendations.
- Make sure that ordinary (shoulder less) eye bolts are threaded in at least 1.5 times the bolt diameter. (Grade 8 preferred.)
- Use safety hoist rings (swivel eyes) as a preferred substitute for eye bolts wherever possible.
- Pad sharp edges to protect slings. Remember that machinery foundations or angle-iron edges may not feel sharp to the touch but will cut into rigging when under several tons of load. Wood, tire rubber, or other pliable materials may be suitable for padding.
- Do not use slings, eye bolts, shackles, or hooks that have been cut, welded, brazed, or otherwise altered.
- Install wire-rope clips with the base only on the live end and the U-bolt only on the dead end.

Follow the manufacturer's recommendations for the spacing for each specific wire size.

- Determine the center of gravity and balance the load before moving it.
- Initially lift the load only a few inches to test the rigging and balance.

8.2.1.Applications

The most common Electric Overhead Traveling Crane use is in the steel industry. At every step of the manufacturing process, until it leaves a factory as a finished product, steel is handled by an overhead crane. Raw materials are poured into a furnace by crane, hot steel is stored for cooling by an overhead crane, the finished coils are lifted and loaded onto trucks and trains by overhead crane, and the fabricator or stamper uses an Electric Overhead Traveling Crane to handle the steel in his factory. The automobile industry uses overhead cranes for handling of raw materials. Smaller workstation cranes handle lighter loads in a work-area, such as CNC mill or saw. Almost all paper mills use bridge cranes for regular maintenance requiring removal of heavy press rolls and other equipment. The bridge cranes are used in the initial construction of paper machines because they facilitate installation of the heavy cast iron paper drying drums and other massive equipment, some weighing as much as 70 tons.

In many instances the cost of a bridge crane can be largely offset with savings from not renting mobile cranes in the construction of a facility that uses a lot of heavy process equipment.

9.Conclusion

In the designed hoist model trapezoidal section show less stress

The modified section should show less stress but due to reduction in area it shows more Stress.

Using more no. of rope falls divide the load and make the tension less. Also it makes the work faster .E.g if we use 4 rope falls then using the same force 4 times work is done.

But increase in rope fall increase the rope length by that times, which is expensive

Also the rope lengths determine the drum length.

Increase in drum length increase the volume of setup to reduce the volume we can double winding of rope on the drum can be adopted Motor power required depends on lifting speed and load applied.

The angular speed of drum and the motor are different so a gear box is used for power transmission.

10.Reference

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