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ANALYSIS OF INCIDENTS AND IMPLEMENTATION OF SAFETY FEATURES IN EOT CRANE

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Abstract: The manufacturing industry today is greatly different from the one of the past. There have been many remarkable changes and advancement not only in terms of the structures that are today being build and the tools that are being used, but most importantly in the techniques and methods that are available now for the actual crane works. Electric Overhead Traveling (EOT) Cranes are considered as the centerpiece of Material transfer/Assembly lines in various industries. They play a key role in transporting a variety of materials vertically and horizontally. The efficiency of EOT cranes largely depends on their type, number, location, operator skill and many more. But considering the safety related crane, crane accidents are high in India. There are many improvements developed in crane designs but still the control measures implemented in the crane is not making the effectiveness in many Industries/construction sites. The aim of the present research work was to analysis the past incidents related to cranes and identify the root causes of each incidents. Based on the root cause analysis, inspection done on a manufacturing industry to check the implementation status of control measures in the EOT cranes. Based on the site inspection, we will identify the requirements of advanced control measures and implement those control measures to avoid further accidents related to cranes..

Keywords: Electric Overhead Traveling (EOT) Crane. Incidents Analysis, Material Transfer/Assembly Line, Safety Features.

1.INTRODUCTION

Electric overhead traveling cranes or EOT cranes are a common type of overhead crane, also called bridge cranes. They consist of parallel runways, much akin to rails of a railroad, with a traveling bridge spanning the gap. EOT cranes are specifically powered by electricity. The slip ring induction motor is connected to power resistance in 4 to 5 steps by power contactors. There are mainly two types of EOT cranes- single girder EOT and double girder EOT.
Cranes are indispensable for industries and working landscapes. They are most commonly used in the automotive, construction, and shipbuilding industries. They are used to lift and handle heavy objects and materials that are not possible manually. They make the work easier and enhances productivity. There are different types of cranes used for various purposes. The industries use them as per their requirements. Each type of crane is crafted with unique features to meet the requirements of the users. Here, we will discuss one of the most common and popular types of cranes, the EOT crane also known as Electric Overhead Traveling Cranes.
EOT crane stands for electric overhead traveling crane. This is the most commonly used crane for lifting and shifting heavy loads. These cranes are electrically powered and operated by a control pendant, radio/IR remote pendant, or an operator cabin attached with the crane itself. These cranes have the capacity to lift both heavy and light weights. It is also known as bridge cranes as it consists of a parallel runway connected with a traveling bridge. The hoist is mounted on the traveling bridge. It has three functional movements- Crane Hook Up and Down Lifting, Trolley Lateral Movement, and Crane Long Traveling Longitudinal Motion.

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2. LITERATURE SURVEY

Since cranes and tower cranes are complex installations they constitute critical aspects of safety at construction sites. The risks posed by cranes are specific and should be treated as such. Prior to assessing the impact of management and organizational factors, accident analysis should first start with an analysis of the actual accident process. The Dutch Safety Board conducted such an accident analysis involving a non- mobile, peak less, trolley tower crane. This tower crane collapsed at a Rotterdam building site on July 10th 2008. The results show that the flexibility of the configuration of the mast and the horizontal arm of the crane or the jib was greater than that calculated by the design engineer. While hoisting a heavy load, the crane collapsed. The defects in the design of the crane were not identified, so the accident was classified as a 'normal accident', one that was essentially integral to the design and could also thus occur in other tower cranes of the same make. Such tower crane design shortcomings emerge as process disturbance s once the crane is operational. Despite its short comings, the collapsed crane did have a CE mark. Other officially required safety audits and crane inspections did not add responsible defects in the design, production, or operation of the crane. Once on the market there app ears to be no further effective safety net for the detection of structural weaknesses. The article will also discuss the role of parties involved in construction and inspection of tower cranes.

This paper addresses quantitative measurement and risk scales of safety hazards on construction sites due to the work of tower cranes. Hazard measurement and risk scales are essential components of an integrated model aimed at quantitatively determining the safety level of individual construction sites, on a comparative basis. The paper focuses on two factors identified in earlier studies as considerably affecting safety on sites with tower cranes, "overlapping cranes" and "operator proficiency." These two factors are inherently different from each other in their characteristics and therefore also in the methods used to measure both the factors and the risk resulting from them. A probability-based method was prescribed for the measurement of overlapping cranes, while the analytical hierarchy process method and knowledge elicitation from experts were applied to develop metrics for operator proficiency. In both cases, an intimate understanding of the crane work environment is necessary. The uniform format and specific methodologies presented here can be used in the development of measurement techniques and risk scales for other safety factors concerning crane operation on construction sites.

3.PROBLEM IDENTIFICATION

3.1 Accidents Related to EOT Cranes

Cranes are extensively used for lifting materials in industries. Most of the Crane are very confined and close to public. EOT crane accidents not only hazard workers in industry, but also pedestrians.

One of these incidents took place in the industry. Investigations and any legal proceedings which might arise from the investigation. Consequently, this incident has not been included in any analysis of the causes of the incidents in this report.

- Erection/Dismantling/Extending of the crane – 29 Incidents (34%)
- Extreme Weather – 15 Incidents (18%)
- Foundation Issues – 2 Incidents (2%)
- Mechanical or Structural Issues – 4 Incidents (5%)
- Misuse – 6 Incidents (7%)
- Electrical/Control System Issues – 1 Incident (1%)
- Unknown Cause – 28 Incidents (33%)

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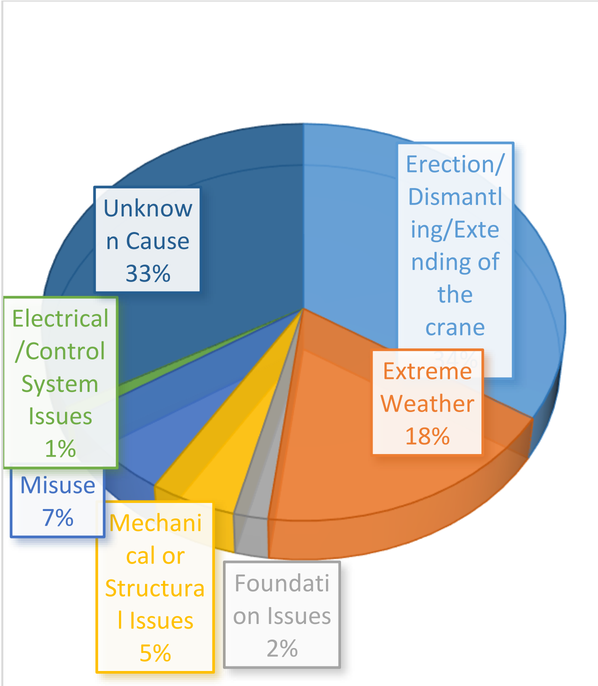

Figure.3.1 Hazard Analysis

Only major incidents resulting in the collapse of the crane or a substantial part of its structure (e.g. the jib) have been considered in the research. Other incidents e.g. dropped loads, falls from height, trapping and crushing, fires, slips and trips and electrocutions etc. have not been considered.

4.METHODOLOGY

We are already analyzed the past accidents related to EOT cranes and categorized the accidents based on the causes of the accident.
From the site inspection, I found that following hazards are present in the EOT cranes in erection stage, operation stage and dismantling stage.

- Soil condition
- Presence of OH electrical lines in operating radius.
- Failure to comply the legal requirements
- Unauthorized Operation
- Excessive working Hours
- Inadequate access to the crane cabin
- Unsecured materials at crane platform
- Inadequate illumination
- Nonfunctioning of safety Device
- Crane overloading
- Improper communication
- Wrong rigging practices
- High Wind Velocity / Thunder storm / Lightening

For each hazards present in the EOT crane, we worked out the control measures which is existing in the site.

- The Safe Bearing capacity of the soil is determined. The Base foundation is designed & laid considering all type of load transmission from the EOT crane.
- Control the boom swinging to the OH line area by installing limit switch
- System of obtaining Equipment fitness test by Competent Person for Mobile crane & All Lifting accessories like D shackle, Wire rope / Web / Chain Sling.
- Only authorized operator allowed to operate the crane.
- Provision of access to approach platform of crane from ground level.
- Access free from material stacking, protrusion.

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- System of providing Illumination of at least 150 Lux in practice.
- Practice of providing metal halide lamp (1000 Watts) in the main Jib
- Over load, over hoist limit switch& Trolley limit switch in the EOT crane is provided & checked for its function.
- Verifying the weight of an object to be lifted against the crane SWL (Safe Working Load) with respect to boom length and horizontal angle by referring manufacturer chart. Load chart of the Crane to be displayed at the operator Cabin.

It is found that all the control measures implemented in the site is not adequately ensure the safety of the EOT crane.

5.EXISTING SYSTEM

Reviewed the existing system for the EOT crane in Manufacturing Industry.
Following control measures they are following in the site,

- EOT Crane used must have valid test certificate.
- Crane operator must have competency certificate from third party agency.
- Before starting the work, operator must check the crane visually
- Ensure that electrical connections are routed through MCB and ELCB's.
- Power cables to the crane shall be protected from damages.
- Trained and skilled person to be involved in the lifting activity.
- Adequate supervision to be made all the time.
- Warning horn fitted to the crane to be in working condition.
- Check for overhead power lines (if any overhead power lines; maintain required distance from power lines.)
- Give hazard information and training to the operator and others about activity through Tool Box Talk.
- Before use, lifting tackles to be inspected by visually and valid test certificates to be made available at site.
- Use tag line to guide the load.
- Clear visibility to be maintained between signalman and lifted load. Walkie-talkie shall be used whenever the signaller/ operator cannot see each other clearly.
- Proper access ladder must be available to operator cabin.
- Avoid the use of crane in strong windy conditions. (more than 22 knots)
- Use proper PPE like safety helmets, safety shoes, and hand gloves.
- Adequate drinking water facility to be made available in operator cabin.
- Place packing material below the load to avoid finger and toe trap

From the past incident analysis, the major categories of incidents are, Erection/Dismantling/Extending of the crane, Extreme Weather, Foundation Issues, Mechanical or Structural Issues, Misuse etc. the existing system of control measures and not able to fulfil for avoiding further accidents.

6.GUIDELINES TO PREVENT CRANE ACCIDENTS

OSHA has examined a myriad of overhead crane accidents and identified the precautions to be taken to prevent them-

- Inspection of the machine by a qualified inspector before every operation to check for any mechanical faults
- Regular comprehensive inspection to pre-determine any faulty wiring, damaged parts, or frayed ropes or coils
- Repairs by a qualified and trained person
- Operation by a trained person who understands the rigging and the balance points for load.
- Chock the load whenever possible
- Avoid working under suspended loads
- Periodically review the load capacity and safety margin of the equipment
- Use the equipment at slightly below capacity
- Mark out a danger zone – suggested 90 feet radius – and do not work within this zone.
- Draw up a pre-work plan identifying hazards, event sequence, and danger zones
- Identify pinch points
- Identify and follow removal procedures

Apart from the physical precautions such as marking out the danger zone, these guidelines repeatedly, highlight three precautionary measures

- 1. Identify risk in advance of operation
- 2. This may be done by periodic scheduled inspections and inspection before every operation
- 3. Regular maintenance of the cranes

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In India the provisions of the Bureau of Indian Standards (BIS) Act (1986) has published a legal document that details the norms for manufacture, erection, operation and maintenance of cranes and crane parts.

7.CRANE INSPECTION AND MAINTENANCE PROTOCOL

OSHA as well as the BIS recommends that all active cranes should be inspected at least once a year in order to identify potential problems. A trained inspector having a minimum experience of 2000 field hours dealing with servicing and maintenance of cranes should conduct inspection of cranes says CMAA (Crane Manufacturers Association of America). ANSI recommends four categories of inspection –

- Initial – prior to first use (OSHA 1910.179). Overhead cranes must also undergo a rated load test – according to ANSI B30.11. The actual load should not be more than 80% of that tested.
- Functional – The functionality of the crane must be tested before every shift. Specifically, maladjustments, leak in tanks, valves, pumps and other parts, chains and ropes, hooks, and other components must be checked for wear.
- Frequent – Frequent inspections must be conducted based on the usage of the crane. Thus, a heavy service crane may be inspected weekly. During these inspections, particular attention must be paid to load chain, wire rope, and hoist brake. The inspector must listen for abnormal sounds.
- Periodic inspections may be conducted annually or with greater frequency depending on the usage. Attention must be paid to all operational parts of the crane for wear and potential malfunctioning.

A log or record of all inspections and observations must be maintained.

Extending the Crane Work Life

If the crane is new, it is perhaps built as per regulatory standards and requires little care. However, if you are using an older crane, or plan to use your new crane as heavy service equipment, it is important to understand the work life of a crane [13,14,15], and how you can get the maximum productivity from your crane at the lowest cost. A crane has many components that may deteriorate, malfunction, or simply break down – requiring costly maintenance and downtime. Understanding the causes of breakdown is important if you wish to get the maximum productivity out of your crane.

The two major factors that cause deterioration in cranes are corrosion and fatigue. Corrosion is the result of environmental factors while fatigue is caused by varying loads and extensive use over long periods. Both factors are controllable with proper care and maintenance. Corrosion is easily controlled through plating techniques that protect the surface layer of component parts. Managing fatigue however is a challenge.

Any steel structure has some built in cracks that react to stress. Depending on the force and frequency of stress, these cracks widen causing component parts to malfunction. In cranes, the force of stress varies with the load. The more the fluctuations in the weight of the load – and consequently the stress – the faster the cracks will widen. Cracks grow faster on thicker components as compared to thinner ones. Soldered connections tend to crack faster than bolted joints. In overhead cranes, the wire ropes or coils used may succumb sooner because of fluctuating tension. Tension may also be caused due to frequent braking and reversing.

Frequent and untimely breakdown may be avoided by mapping the usage and identifying faults early, thus facilitating planned downtime. This, coupled with periodic maintenance as well as timely replacement of cranes and crane parts can not only ensure safety in crane operations but also save your business extensive costs in terms of loss due to down time and healthcare compensation.

CONCLUSION

Inspected the EOT crane of the industry and checked the implementation status of the control measures in EOT crane. It is concluded that existing system for crane safety is not making any roles in minimizing the crane accidents. Still we need to improve the safety systems of the EOT cranes to avoid further accidents. From the root cause analysis, we made a decision that implementing of advanced safety equipment shall improve the safety systems of the EOT cranes.

EOT cranes are reliable, safe, and more productive in comparison to other types of overhead cranes. They have wide applications and are most commonly used by industries. Electric Overhead Traveling cranes are essential tools and equipment used in industrial production and transportation and production processes.

Material handling equipment like cranes experience tremendous wear and tear during its life cycle. It, therefore, becomes essential to get your cranes assessed regularly.

Creating health checkup reports, along with recommendations from technical experts, will empower you with the correct information about the condition of your crane. Experts help you reach an informed decision and select the most appropriate plan of action to enhance your cranes' safety and longevity. These checkups must cover every crane component for its integrity and compliance to the industry and safety standards.

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