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Real Time Safety Assessment Based on Hira for Portable and Overhanging Lifting Machine-Construction Site

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Abstract: *Cranes are an essential machine for many industries. Due to the fact that it is so large, and it moves such heavy gadget, it can also be very dangerous. Most cranes manage to move at the base in order to put the load where it needs to go. When this occurs, anyone who is in the area surrounding the crane could get trapped in a pinch point and get crushed. The crane driver typically does not have visibility to the area directly on every side the machine, which produces this safety hazard even more serious. Unfortunately, when large numbers of cranes have been dispatched to a Industrial site, the hazard exposure also increases for workers who work with, around or under these cranes. As per OSHA, 85% of all cranes unsettle and structural failures can be allocate to exceeding the crane's operational capacity. When a crane is overloaded, it is subject to structural stresses that may cause irreparable damage. Swinging or unexpected dropping of the load, using defective components, hoisting a load far away capacity, pull a load, and side-loading a boom can all cause overloading. The only way to eliminate the accidents is Identify the Hazards to assess the associated controls with the Material Lifting machinery with their operations to bring the hazard to tolerable level. As the part of this dissertation hazard recognition will carried out with the help of checklist and different mathematical methodology with respect to various lifting machines and their control measures will also be given in this work, improved safe work conditions in industry for using this engineering tool this is the objective of this project work and to reduce the number of accidents. The main objective of this study was to examine the various hazards associated with using cranes will help of checklist to identify the risks in the workplace.*

Keywords: Hazard Identification and Risk Assessment (HIRA), Lifting Machinery, Hazard and Risk calculation with Check list Methodology

I. INTRODUCTION

Every Manufacturing organization or Construction company believes that there is no task which is more important than workmen's health and safety. In case of any job that represents a potential safety or health threat, every effort should be made to plan a better way to complete the task in a safer manner. Every procedure must be a safe procedure. Shortcuts in safe procedures by management and all the other associates should not be tolerated. If a worker observes any unsafe or unprotected exposure, which may pose a potential threat to their safety and health, he or she must inform the management immediately.

At any workplace there are physical, chemical, biological, psychosocial, electrical, mechanical and traffic hazards. Then there are common hazards in terms of falls from heights, falls into a depth, slips, trips and falls; manual handling and exposure to hazardous substances [1]. In addition to these, there are identifiable hazards like a body part striking against, being struck by, making harmful contact with an object, caught in, on, by or between objects, slip, trip or fall, abrasion from any object, reaction to any chemicals, strains from pushing, pulling, lifting, bending or twisting etc.

1.1 Lifting Operations and Related Accidents

A lifting operation is an operation concerned with the lifting and lowering of a load. A load is the item or items being lifted which could include a person or people. A lifting operation may be performed manually or using lifting equipment. Manual lifting, holding, putting down, carrying or moving is often referred to as 'manual handling of loads [3].

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Accidents have occurred due to:

1. Failure of lifting equipment
2. Falling loads; and
3. Workers being crushed by a moving load or lifting equipment.

1.2 Lifting Equipment's in Industries

Lifting equipment includes any equipment and machinery used at work for lifting or loweringloads or people, including accessories and attachments used for anchoring, fixing or supporting the equipment [4]. There is a wide range of lifting equipment in the industry. Typical examples are:

1. A hoist: is a device used for lifting or lowering a load by means of a drum or lift- wheel around which rope or chain wraps. It may be manually operated, electrically or pneumatically driven and may use chain, fiber or wire rope as its lifting medium.
2. A crane: is a type of machine, generally equipped with a hoist, wire ropes or chains, and sheaves, that can be used to lift and lower heavy materials and to move them horizontally.

II. OBJECTIVE AND SCOPE

After identifying and defining the problem, the following were set as the objectives of the research work being reported here.

- **Objective 1:** To study the hazards identification techniques with respect to industries.
- **Objective 2:** To study the hazards of Lifting Machines in industry using the parameters of crane and different material handling and lifting steps.
- **Objective 3:** To apply questionnaire and checklist method for the identification of hazards using HAZARD IDENTIFICAATION AND RISK ASSESSMENTS by Check List methodology (HAZID)
- **Objective 4:** To suggest the control measures of hazards and safety for lifting operation.

III. COMPANY DOMAIN AND PROBLEM IDENTIFICATION

3.1 Company Domain

AFCONS Infrastructure Limited is a construction and engineering company based in Mumbai, Maharashtra, India. The company provides infrastructure services and is involved in the construction of infrastructure projects such as via ducts, flyovers, metros, bridges, pipelines, roads, ports, barrages, oil and gas projects etc.

3.1.1 Construction Site

Kanpur Metro is a rail-based mass transit system serving the city of Kanpur, Uttar Pradesh, India, and extendable to the Kanpur metropolitan area. The feasibility study for the project was done by RITES in June 2015.Construction of the orange line begun on 15 November 2019 with the 8.98 km (5.3 mi) stretch from IIT Kanpur to Motijheel.

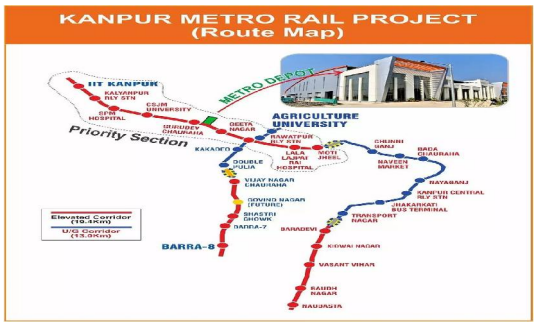

Figure1.1 Route map of Kanpur metro rail

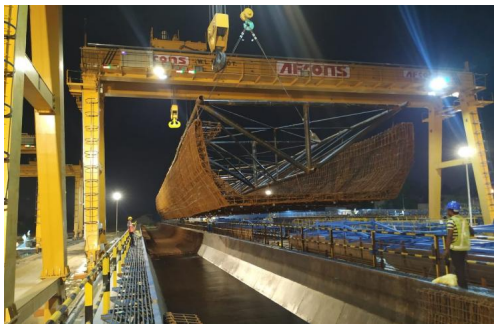

Figure1.2 Civil Construction work on Kanpur Metro

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3.2 Problem Identification

Several accidents are occurs inside the industries and the owner of the factory face many problem like loss of the trained worker, loss of production, loss of materials. There are various challenges in the heavy industry. In field of industry every day an accident is occurred due to unawareness, lack training, absence of personal protective equipment etc. The manufacturing industry involves complex and dynamic work environments that present new hazards to workers on a daily, or even hourly, basis. As a result of the complicated and constantly changing nature of lifting operations, the manufacturing industry has very high injury and fatality rates compared to other industries.

According to Bureau of Labor Statistics (BLS), February 6, 2020, the data are for 2021, in that year, there were 72 bridge crane-related fatal work-related injuries, down from an average of 78 fatalities per year from 2020 to 2010. These comprise all fatalities where the source of the injury was a crane, the secondary source of the injury was a crane, or where the worker activity was operating a crane.

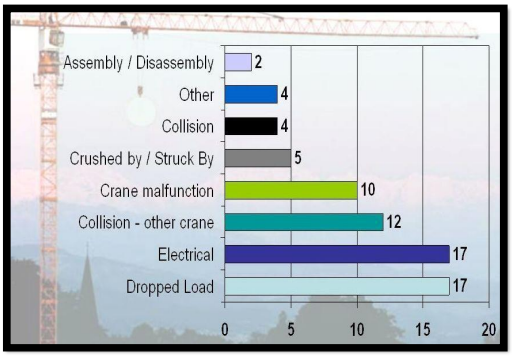

Figure 1.3 Crane Accidental Data

Figure 1.4 Death Statistics Data from crane accident

Typically, there are several categories of failure modes which easily caused crane accidents, such as struck objects, load fall, toppling (tip over), boom/jib fracture or buckling and wire rope breakage. Besides, malfunction of other devices (such as engine, electronic devices) of cranes may also affect the operations of cranes and result in accidents. The typical failure modes consequences, failure mechanisms, main root causes and contribution factors are summarized in Table 3.1

Table 3.1 Failure Modes and Crane Cause for Crane accidents

S. No	Failure modes	Consequences	Failure mechanisms	Main root causes and contributing factors
1	Struck objects	Damage to surroundings Personnel injuries Electrocution	Impact Contact electricity lines(Conduction)	Improper operation, miscommunication, improper planning, inadequate risk management, operator fatigue
2	Boom/jib fracture or buckling	Damages to surroundings and lifted goods Personnel injuries	Corrosion, fatigue, overstress, stress corrosion cracking	Poor design, manufacturing defects, material defects, improper maintenance, improper inspection, overload, heavy wind
3	Toppling or tipping over (instability)	Damages to surroundings and lifted goods Personnel injuries	Instability	Overload, unfavorable weather including heavy wind, poor ground conditions, insufficient rigger extension, insufficient counter weight, improper planning, malfunction of devices, failure of 4.outrigger
4	Load fall	Damages to surroundings and lifted goods Personnel injuries	Corrosion, fatigue, overstress, stress corrosion cracking,wear	Wire rope or hook fracture, unsecured load, improper operation, aged devices, malfunction of braking
5.	Wire rope breakage	Damages to surroundings and lifted goods Personnel injuries	Corrosion, fatigue, overstress, stress corrosion cracking,wear	Overload, material defects, manufacturing defects, poor maintenance, improperinspection, adverse environment, incorrect dimension of pulleys and sheaves
6	Component(s) fall or stuck	Damage to surroundings Personnel injuries	Impact	Improper assembling or dismantling operation, miscommunication, improper planning, inadequate risk management

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7	Breakdown of Electrical devices	Inoperable Damage to surroundings Personnel injuries	Short circuit, opencircuit, current leakage, arcing Corrosion	Electrical overstress, contamination, manufacturing defects,poor maintenance, degradation
8	Damages of other key mechanical parts	Inoperable Damage to surroundingsPersonnel injuries	Fatigue, overstress, corrosion, stress corrosion cracking,wear	Overload, poor weather,poor ground conditions, material defects, manufacturing defects, Improper maintenance

IV. METHODOLOGY

As in the plant we are mainly focus on Portable and Overhanging cranes and their systems so the main objective of this procedure is to provide minimum requirements for safe operation of Portable and Overhanging cranes and to establish mandatory requirements and practices to protect personnel & property from hazards associated with Portable and Overhanging crane related jobs. This procedure applies to all operating and project sites of our Group companies. The exact methodology shows some expected results as:

- Manage jobs related to Portable and Overhanging Crane safely.
- Control of incidents related to Portable and Overhanging Crane operation.
- Compliance to Regulatory requirements related to Portable and Overhanging Crane & Lifting tools.

4.1 Record of Monitoring with Check Lists

The facilities will maintain a register of all the lifting equipment on the facility. Hard copies of the lifting equipment certifications and a thorough examination certificate must be kept on- site. Each item must be given a site identification number and the description should include the following information:

1. Location
2. Area
3. Unique identification number
4. SWL or WLL
5. Test certificate details
6. Dates of last and next thorough examination
7. Quarantine / defect report number

Due to the design and layout of facilities, it may not be feasible to have only one loft due to available space, in cases such as this, multiple rigging lofts are acceptable as long as they are controlled and contain an inventory of all rigging in that particular loft.

Checklist method is used to take a detailed examination of Overhanging cranes related hazards, their operational condition; availability of component and safety equipments the main task for the assessment is to identify the potential hazards of lifting machinery. Once the hazard has been identified recommendations should be made of possible methods for to be minimized them. The various methods, and check list used in the company are presents below:

Table 4.1 Portable and Overhanging Crane Daily Check List (HAZID)

Operator:	Mr. XYZ		
Company:	AFCRONS Infrastructure Ltd		
Crane type:	Portable and Overhanging Crane		
Model:	141E58RHG:1689045:OC		
Location:	Kanpur Metro		
Unit no.:	Base Unit - II		
Date:	xx/xx/xxxx		
Shift:	Shift - II		
1 – PRE START-UP WALK-AROUND		**OK**	**NO**
1.	Cab–glass/doors/2ndexit	□	□
2.	Steps/ladder – secure/clean	□	□
3.	Wheels & tires – rims/lug nuts/tire condition/ inflation	□	□

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4.	Boom – angle indicator/jib/condition	□	□
5.	Main/auxiliary hoist(s) hook/attachment/block/sheaves/wire rope	□	□
6.	Hydraulics – cylinders/hosing/pins/fittings/fluid level	□	□
7.	Turntable – ring & pinion condition	□	□
8.	Engine – fluids/belts/hoses/leaks/debris	□	□
9.	Battery/batteries – secure/electrolyte level/ connections clean & tight	□	□
10.	Counterweight–secure/condition	□	□
11.	Drum(s) – condition/line spooled properly	□	□
12.	Air(brake)tanks –condition/water drained/ petcock closed	□	□
13.	Outriggers/stabilizers – condition/leaks	□	□
14.	Lights/strobes – condition	□	□
15.	Warning decals – in place/ condition/ legible	□	□
2 – INTERIOR CAB CHECKS		**OK**	**NO**
1.	Housekeeping	□	□
2.	Fire extinguisher	□	□
3.	Manufacturer's operating manual	□	□
4.	Log book	□	□
5.	Inspection Certificate	□	□
6.	External Certification	□	□
7.	Load charts/range diagrams	□	□
8.	Level indicator	□	□
9.	Seat belt	□	□

3 – START-UP		**OK**	**NO**
1.	Instrumentation – warning	□	□
2.	Oil Pressure	□	□
3.	Air (brake) pressure	□	□
4.	Coolant temperature	□	□
5.	Battery charge rate/level	□	□
6.	Fuel level	□	□
7.	Noises – engine sounds normal	□	□
8.	Lights	□	□
9.	Horn	□	□
10.	Accessories – wipers/heater/fan/radio	□	□
11.	LMI – functions/calibrated properly	□	□
12.	House lock-pin – disengaged (as applicable)	□	□
13.	Other:		
4 - FUNCTION CHECKS			
1.	Boom – lift/lower/extend/retract	□	□
2.	Hoist(s) – raise/lower	□	□
3.	Turntable swing	□	□
4.	Outriggers/stabilizers	□	□
5.	Steering	□	□
6.	Transmission – gear & direction	□	□
7.	Selector	□	□
8.	Other:		
9.	Comments		
10.	Operator Name & Sign:		

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Table 4.2 Risk Assessment/Management Form Lifting & Fixing

	Ref:																	
Section / Dept: / **Safety**				Activity: **Risk Assessment-Lifting &Fixing**														
S. No	**Basic Job Steps**	**Potential Hazard**	**Consequence**	**Current controlmeasure**	**Risk rating**				**Probability**	**Initial Risk**	**Additional control measure**	**Risk rating**				**Probability**	**Residual risk**
					P	**E**	**A**	**R**				**P**	**E**	**A**	**R**		
1	Shifting of the materials	Fall of materials	Get Injury/ Fatality	Use guide rope during shifting of materials and always keep away from swing area. Daily tool box talk before startingof job by crew supervisor.	0	1	0	2	1	2							
		Failure ofwire ropesling/ D-shackle	Get Injury	All the wire rope sling &D-shackle must be visually checked. Tested sling must be color coded by a specific color.													
		Hooking of material	Get injury	Skilled workmen shall be engaged for hooking of material. Hook mustbe provided with hook patchily tool box talk before starting of job by crew supervisor.													
		Shifting of material	Get injury	People should maintain safe distance from the load while lifting andshifting. Guide rope to be fixed on both ends of the material. Communication with thehydra operator will be one to one talk and signal will be issued by the signal man with blue helmet.													
		Unhookingof material	Injury to person	People should notunhook the sling during tension. Only skilled person will remove the sling from the hook.													
		Toppling of Hydra due to excess loading	Injury / Fatality	Marking of SWL at different lifting hooks of hydra. Only Trained & experienced operator will operate. Material above the safe working load mentioned at the lifting position shall not be lifted.													
		Traffic Control	Man/ Materials loss	Deploy one hydra helper with whistle wearing of florescent jacket walking minimum 3m.away fromhydra (left side) and 2persons are to be standing for the guidance of guide rope & Hydra speed can be restricted, Reverse horn sounds during reversal of hydra.													
		Traffic Control	Man/ Materials Loss	Deploy one hydra helper with whistle wearing of florescent jacket walking minimum 3m.away from hydra(left side) and 2 persons are to be standing for the guidance of guide rope Hydra speed can be restricted. Reverse horn sounds during reversal of hydra.													
2	Stacking of materials	Tripping	Get Injury	All the materials shall be stacked at designated place	1	1	0	0	2	1							
		Unloading& Stacking	Get Injury	Height of stacked materials shall be maintained as per safety norms & users convenience													
				Stacking shall be done asper the shape, size & weight of the materials													
3	Lifting of materials	Slip ofTools	Get Injury	Lifting of materials up to 15m.to be done by RopePulley	1	0	0	2	2	4							
				All the tools should betied up with rope while using													
		Fall of materials	Get Injury	All the loose materials should be lifted by gunny bag with rope pulley system													
				Area should bebarricaded and nobody allow under the suspended load													

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V. CONCLUSION

In industries where the Overhanging cranes are installed hazards related to them can only be eliminated or prevented by the proper safety management in which techniques are available to identify hazards related to lifting machinery and its operation which we used in this project work that is questionnaire study and checklist methodology by checklist method we go through inspection depending upon the checkpoints and questionnaire study by which we can evaluate the effectiveness of present safety and health related program.

Identification of hazardous condition (which results fatal injury or incidents results to death of workers) and their control measure is given by these methodology. There are lots of hazard are present in any organization in which workers are surroundings, safety and health programs are must be emphasis on the prevention and elimination of hazards. Hazards Prevention and evaluation work related accidents and diseases must be goal of management of organization, there are many types of hazard present in workplace or regarding the particular machinery such as physical, electrical, ergonomically, psychological, fire etc. due to lack of training, maintenance and ineffective safety management programmers and negligence of safety rules by workers work-related injury and fatal accidents continue to be serious problems in all over the world, HAZID, checklist method Table 4.1 and questionnaire study used in industry to overcome these problem.

By these techniques we can easily identify the hazards in any organization, there analysis and performed evaluation of safety and health program and their preventive measures also be taken. Checklist inspection is one of the most useful techniques in safety management to identify the hazards related to particular job or machinery in which we can thoroughly inspected the physical conditions regarding workplace or machinery with the help of data which we obtained by checklist method recommendations can be given to eliminate the hazard.

From checklist survey we find the observations and physical condition which may leads to hazardous condition of Overhanging crane because checklist had following advantages: -

a. It easy to apply the overall principle of this method is simple it's used to compare and identify list wise condition whether it's safe or unsafe.
b. It also can be performed by inexperienced person.
c. It is a point to point survey so that no data can be remaining to check.
d. This is the qualitative method, but observations are also used for quantitative assessment.
e. It is also be used for determine underlying causes of hazards. The outcome of effective training program and questionnaire study also will impact the workers nature by which we can improved the workers efficiency and mental thinking condition related to work place.

Hazards identification of lifting machinery have been done with the help of questionnaire study and checklist inspection and control measure on the basis of these two methodology have been given.

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