
RELATIONSHIP OF DEMOGRAPHIC VARIABLES WITH RESPECT TO INCIDENT STATISTICS FOR CRANE OPERATORS IN VIEW FOR BETTER SAFETY MANAGEMENT SYSTEM OF A STEEL PLANT IN INDIA

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Abstract

Operation of lifting machineries used in steel plant for material handling is associated with a large number of hazards that can be reduced by safety inspection checklist, questionnaire study and other low-cost solutions. The relationship amongst work injuries and demographic variables like age, experience of crane operators in a steel plant is a critical parameter to assess the risk associated with this operation.

This work focuses on measurement of relationship of work injuries with demographic variables, using self-reported injury experiences through Safety inspection checklist where ergonomically and psychological aspects of worker and operator conditions has been considered and job related risk using 'job safety' questionnaire as well as actual safety performance has been touched upon.

Keywords:

Overhead Gantry Cranes;
Safe operation of Overhead cranes;
Safe Load Indicators;
Electric Overhead Travelling Cranes and Pendant;

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1. Introduction

In a steel plant cranes play a major role, in various sub sections of steel plant like Steel Melting Shop (SMS) , Blast Furnace and Strip Mills , these cranes helps in shifting and lifting of hot slabs as well as hot rolled coils and other intermediate products. The lifting machineries are most widely used for lifting, shifting, and placement of large, heavy & uneven loads in manufacturing industries. As crane manufacturing and installation is done from different manufacturers. The risk associated with it increases depending upon the design and technology, which as a result will make changes in safety devices, motion & braking systems, remote controls in lifting machineries. This paper reviews the hazards associated with lifting machinery in their operations in a steel plant. It also focuses on demographic interpretation with lifting operation, where lifting machineries are used having capacities ranging from 1 ton to 450 ton. By questionnaire study (Annexure 2), the positive response of all levels are taken and is interpreted into graphical study showing the

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effectiveness of present safety and health program and based on that recommendations are given for further improvement.

Operators perform shifting and placement by means of raising, lowering and movement of heavy loads from one place to another. To perform such types of operations in shop floor Electric Overhead Travelling (EOT) cranes, Semi gantry cranes, forklifts and Pick and carry cranes are used depending upon the nature of operations to be performed. EOT [1] and semi gantry cranes generally includes mainly three-motion travel that are longitudinal travel (LT), cross-travel (CT) and UP-DOWN hoist motion [2].



Fig 1: Overhead travelling crane

These cranes can transfer heavy loads on the existing rail track which is mounted at a certain height, and which is supported on the shop floor. Forklifts, pick and carry cranes are used to shift loads from one shop floor to another as they can travel remotely and locally [3]. Every now and then some common hazards prevail while performing lifting and shifting activities, like Hit by moving object, fall of material etc. These type of hazards generally occur while lifting and shifting operations through moving the controls of the cranes, which results in incident or near misses. This happens due to lack of training, experience and education crane operators possess and by the usage of multiple types of cranes at different locations. Some of the lifting cranes operate with the help of remote control or Pendant, these lifting cranes have different types of Pendant at different locations. When shift changing takes place, the operator's face difficulties in operating the cranes. It becomes a troublesome situation. The risk is not only to the persons who are involved in lifting operations, but according to accident statistics, it shows that the floor employees are also prone to these risks. Lifting cranes operation have some common hazards in their day to day routine, but the management does not take the action required to minimize these hazards seriously, as to achieved production deadline[2][4]. All lifting cranes have their advantages and hazards associated with it. In order to minimize these hazards associated with it hazard identification and risk assessment is to be carried out in an engineering industry, but there are many techniques, which are available to identify these hazards in lifting operations. This can be achieved by the use of safety inspection checklist and questionnaire study.

2. Research Method

By usage of inspection checklist (Annexure 1) of lifting machinery and questionnaire study (Annexure 2) the hazards associated with lifting crane operations is assessed. Lack of knowledge and training of operators is regarding particular machinery, which they operate. Different types of cranes from different manufactures are installed in steel plants, which differ in their design from each other. It creates a difficulty for the operator to operate the cranes.

Pendant operated cranes have different types of pendants as these are manufactured from different agencies. In these pendant operated lifting cranes pendants controls are in such a way, that the longitudinal travel (LT) button is placed at the top and Cross travel (CT) button is placed at the middle and UP & DOWN motion at bottom. In some, it is vice versa are pendant operated and some is remote operated [5]. This complicated and differed design of pendant/ remote creates disturbance to operators. Lack of direction marking on cranes and their pendant operators does not know how to operate in single direction LT, CT or UP and Down. For movement the operator have to push buttons one by one as to check the right button, by which he wants to direct the crane. There is a hazard armed while operating cranes when crane carries load, which can result in major accident. Apart from that, Forklifts and Mobiles cranes are used to lift the load under load chart specification, which shows the actual SWL at different configuration and forklift SLI is not provided by some manufactures. In each motion of crane having safety limit switches as to stop the motion under the limit, Anti two blocking, CT, LT, Anti-collision, Hooters, Warning Lights etc. electrical devices are provided. As per ANSI recommendation, it is said that the use of this device should consider a damage prevention measure only.

The National Safety Council has referred 90% of mobile crane accidents are due to “operator error” [6]. There must be a daily checklist for inspection of lifting cranes throughout the steel plant.

Another problem which comes in to picture in steel plant is that different types of lifting machinery available. In comparison to that only few operators are available to operate the crane, the workload is given to the operator's for achieve production targets for doing so achieving so they face difficulties to operate different types of cranes, as the number of crane operators is a serious concern. Among these, the use of reversing motion to stop the cranes, applying brakes may become one of the hazardous condition when two or three cranes operate in same track. Rigorous and harsh operating conditions and due to overloading and swinging of the load might affect the wire rope conditions which will give bending, crushing, cutting or un-stranding to the wire rope.



Fig2: Broken strands

Overhead cranes also have a durability period and after certain time the alignment, gets disturbed which may result in accidents, failure of crane/derailment. As a result it will result in costly repairs and replacement of parts

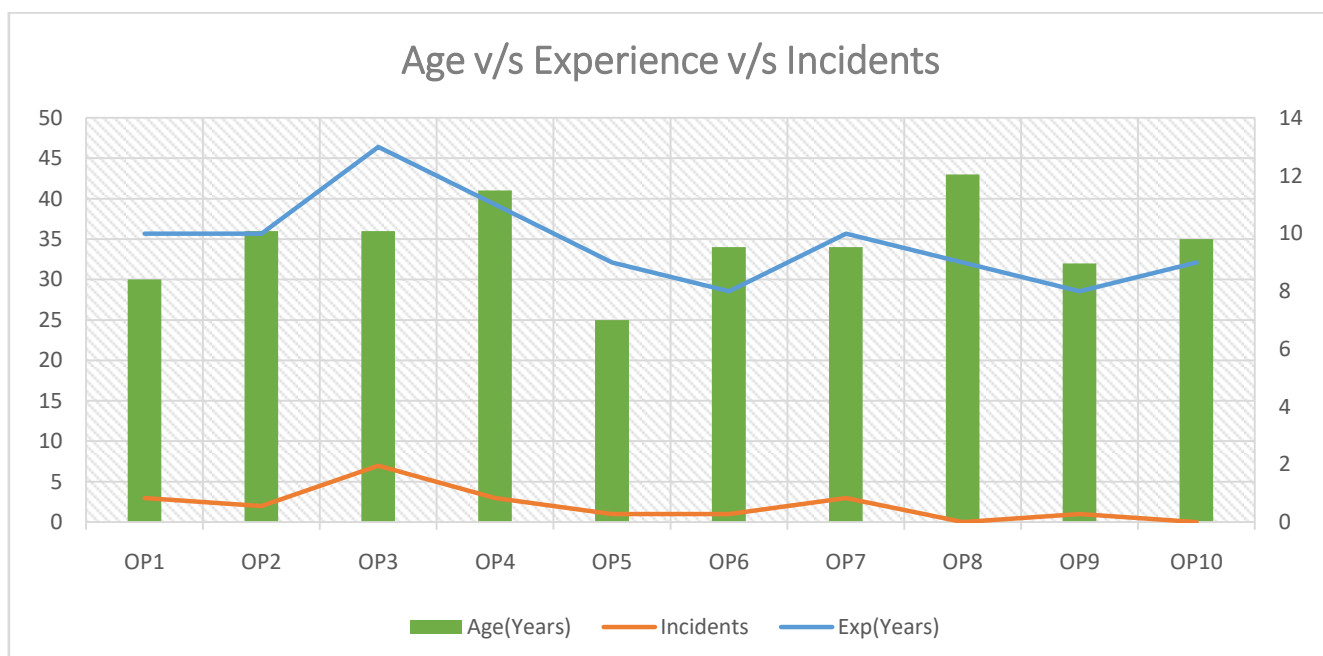
The excessive wear and tear to the rails wheels of which will create unwanted noise, derailment and a bumpy motion based on the wear [7]. This wear to the wheel will also result in high power loss and there will be no smooth operation. Absence of guide rope /tagline to sling the load according to the path of travel, and to avoid the unwanted swing of the hooked load. The limit switches [8] also plays a main role in functioning of the crane, and the operators do not take it seriously. To continue motion in such condition the crane operator's by pass the limit switch to perform the task easily. Another major problem is the use of bent or damaged hooks for lifting which might cause major mishaps like toppling of load, slipping of load and imbalance, which will result in major accident.



Fig3:Cranehook

3. Results and Analysis

After doing a survey in the steel plant by the help of Safety inspection checklist & Job Questionnaire Study, the result is formulated as shown in figure below.



Based on these results it is clear that the incidents relate with experience. It means that more experienced operators are resulting in more incidents. When one to one interactive session was done with operators it was found that the operators having more number of experience are showing casual approach towards their job. Thus they are not at all listening to what others are directing and explaining. This is a clear indication of Behavioural issues and it can be overcome by conducting interactive sessions, training and giving more focus to Behaviour based safety[9].

Apart from that another concern came up were the Crane operators were unable to sustain development with respect to new crane amendments and technical features, during time to time new type of cranes are used in lifting operations. In some cases it is operated by pendants of different type. This creates a problematic situation to the operators, thus it leads to an incident.

The methodology is to initially identify the Hazards then, assess the risk and consequences associated with the hazard, and finally recommend control measures to prevent accidents.

4. Conclusion

Based on the problem identified some recommendations for the control of risk is as follows.

- ❖ Universal stereotype of remote controls for all the cranes
- ❖ We must ensure that the operator training for the safe operation of the cranes is done periodically. There is no universally accepted certification or licensing of crane operators [10]. A proper card system to validate operators so that only authorized operator's crane operates the crane. Proper directions marked by permanent marking or painting on pendant or remote once in a week.
- ❖ Daily checklist filled by operator helps other shift operator to assist the crane problem if any. Preventive maintenance is to be carried out once in 15 days interval in which limit switches and brakes must be operationally checked[11] In future, while constructing new cranes standardized ergonomic control arrangements.

As, per survey conducted in Steel Industry the proper arrangement of push buttons in pendant/remote is set depending upon the nature of use in a day. Nine out Twelve operators says they mostly use 65% of UP DOWN, 20 % CT and 15 % LT motion per day. It is easily possible for electrical maintenance to change the position of push buttons and arranged it depending upon the nature of use in pendant, which reduce the hazards involved in wrong motion. In mobile cranes and Hydra SLI must be installed to know about the capacity at different radius[12]. The position of the wire of pendant also adjusts it usually front at the chest of the operator's. Other means of safety devices, which are not electrical, like buffer and stoppers at the end of the Cross travel and Long travel motion and wheel guards for anti-two blocking marking to be done by which the last position of hoist is marked so that the operator's knows about the limitations. Load testing once in a year for lifting machinery, fork of the forklift checked by NDT methods [13]. Changing the position of operator's from one crane to another. Simplify control buttons of remotes related to another by which the machinery can easily operate. To overcome this, the crane operators must operate into three different groups (A, B, C) where shifts denoted the time in a particular day, one shift be of 8 hours. In addition, the associated group of operators should always operate these cranes and they must not be interchanged. The signals used for communicating should be clear and universal, and easily understood by the signaler and the operator. The ideal way to prevent damage or failure of a wire rope is to inspect it before each shift.

After every six months, checking of cranes for the alignment and certificate for safe operation, from a licensed third party authority. The inspection and maintenance of the end wheels of the cranes at regular intervals will ensure the continuous working of the crane. If the wear is beyond the tolerable limit then the wheels are disposed and new wheels installed. Depending on the dynamics of the load, usage of tag line used to avoid swinging of the load. In addition, a crane helper always hold Tagline in hand all the time. The limit switches and the control sensors should be tested and maintained periodically. To reduce the wearing wear of the bearings and other moving parts, periodic lubrication is a necessity.

If the crane hook is deformed and is more than the tolerance limit then it should be disposed and replaced.

The travel path of the crane must be permanently marked to avoid collision with other objects or structures.

ANNEXURE 1**SAMPLE CHECKLIST FOR OVERHEAD CRANES**

COMPONENTS	INSPECTION CRITERION	Yes	No	Remarks
Tagged Crane or Hoist	Check for the locked out/ Tagged out			
Control devices	Check all the markings agree with control device markings			
Braking	Verify proper brake operations at all motions			
Hook	Visually inspect for deformation, wear, safety latch operation and corrosion if any			
Hook latch	Visually verify proper operation of hook latch ,should operate smoothly without any hindrance			
Wire rope	Visually inspect for damage ,tear & wear on wire ropes and slings			
Load chain	Visually inspect for corrosion and damage or wear on chains			
Reeving	Visually inspect for proper reeving of ropes			
Limit switches	Verify and inspect for proper operation of limit devices in all three motions			
Oil leakage	Visually inspect for signs of oil leakage especially in hydraulic arms and systems			
Functional	All operating mechanisms for proper operation.			
Below hook devices	Visually inspect for wear, damage or diminished capacity			
Miscellaneous	Pendant strain relief, labels, warning devices, capacity signs			

ANNEXURE 2**Sample Questionnaires for Overhead cranes Operators**

Following table shows the questionnaire study for the workers

Q.1	Have you undergone an induction Training? a) We all get induction training when we start b) Not everyone gets induction training when they start c) We don't get induction training when we start
Q.2	Have you undergone Safe work procedure training? a) Training is given before starting the job b) Only experienced persons are given training c) Training is not given before starting the job
Q.3	Does your managers/supervisors check for safe work? a) Our managers/supervisors make sure that we can do the work safely b) Our managers/supervisors check sometimes that we can do the work safely c) No one checks if you can do the job safely
Q.4	Are you aware about the Safety issues and safety objectives? a) We are made aware about the incidents and safety related issues happened in our plant b) Only experienced persons are made aware about the incidents and safety related issues c) No awareness is given on safety related issues.
Q.5	Does the company perform Risk assessment? a) For all jobs/task Risk assessment is done prior to the startup of the job b) Only hazardous jobs/task risk assessment is done. c) No risk assessment is done for any jobs/task
Q.6	Any other problem / improvement suggestions

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