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# SAFETY ANALYSIS IN MATERIAL HANDLING OF CONSTRUCTION INDUSTRY

**Muralitharan T[1] and Elangovan T[2]**

[1]Department of Mechanical Engineering, Sathyabama University, Chennai, 600117, Tamilnadu, India.
[2]Department of HSE, Saipem Eni, Abudhabi, UAE

## ABSTRACT

Construction industry is statistically one of the most hazardous industries in the world. Approximately 30% of fatal accidents occur in the construction industries. Besides causing human tragedy, construction accidents also delay project progress, increases costs and the reputation of the construction industry. The accident factors may occur due to employees, equipments, materials, techniques and circumstances are underlying causes of poor safety management. Material handling has been one of the important activities in the infrastructure industries. Heavy materials are moved from one place to other with the help of cranes, hoists, etc., Unsafe operating procedures, negligence of maintenance, human errors contribute for many accidents while handling the materials.

A detailed study is made in a construction company by applying the methodology such as inspection, interview with workers and safety managers, investigation of accidents, job safety analysis focusing on the failures in material handling. This study concludes that by implementing few new techniques and suggestions for safe working procedures can very much minimize the accidents in material handling.

## 1. Introduction

India is the second most popular country in the world, yet having approximately 40% of the population living below the poverty line has look at the imperatives of construction in a different perspectives with the vast natural resources remaining unexploited, projecting construction as the most important element of our developmental efforts is must. Even though the construction industry has accounts for nearly 45% of the total investment on development, scope and necessity for enhancing the investment obvious. 21 million construction workers (or about 18% of the working population of India as per construction industry development council's estimate) and one could perhaps have a glimpse of the problem at the hand. 85% of this work force is drawn from the rural background. They lack technical perspective and industrially relevant common sense. The other 15% semiskilled and skilled workers also have had their training through the trail-and-error route, making their required skills short of the desirable. Besides, the visible back of the safety rationale in our social system cultural beliefs further make safety management a difficult proposition.[1]

### 1.1 Accident – causatives

The majority of accidents which occur in the construction industry are:

- Through the collapse of walls, building parts, stacks, masses of earth
- Through the collapse and overturning of ladders, scaffolds, stairs, beams,
- By fall of objects, tools, pieces of work
- By falls of person from ladders, stairs, roofs, scaffolds, buildings; through hatches and windows; in to openings; on the level
- During loading, unloading, lifting, carrying and transporting loads
- On or in connection with vehicles of all kinds
- In the operation of railways
- On working machines
- On lifting and transport appliances
- On welding and gas- cutting equipment
- On compressed- air equipment
- In connection with combustible, inflammable, hot or corrosive materials
- In connection with dangerous gases
- During blasting with explosives
- When using or handling hand tools
- In connection with traffic on the building site
- On way to and from work

Fall of person, fall of object, falls from collapsing structures and material handling account for nearly 85% of the accidents and are responsible for the majority of fatality. Electric shock is also a major factor but its frequency is found to be comparatively low. If suitable steps are taken, these accidents potentials can be eliminated[6]

*Corresponding Author - E- mail: murali114@gmail.com

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### 1.2 Material handling

Lots of material is to handled and re-handled for project activities. Due to improper signalling, a person working at lower level could get injured. Correct signalling while hoisting/ lowering materials is of prime importance.

Material handling equipments like crane, forklift, chain hoists, slings etc should be of proper capacity and well maintained, inspected and recorded. The correct signalling practices and rigging methods can avoid many accidents, which are otherwise caused due to bad slinging practices and rigging methods.[10]

### 1.3 Steps in project methodology

The following steps are involved for safety in material handling in construction. The steps shown in the fig.1

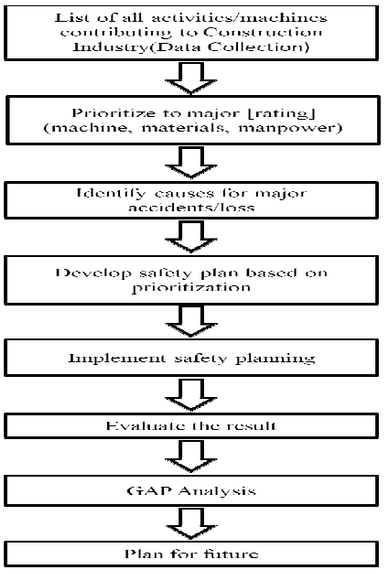


**Fig.1 Steps for Safety Methodology**

## 2. Questionnairs Survey Report

### 2.1 General information

From the above survey shown in Fig.2, we have clearly understood that 91% of employees have accepted that the safety is required while material handling. We need clear supervision and must identify abnormal sound in material handling working area. We must do preventive maintenance and also to check base level of tyre mounted any cranes, tower cranes and builder hoist. We must regularly care out third part inspection and must use signals while material handling.

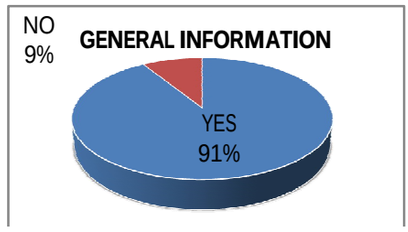


**Fig. 2 General Information**

### 2.2 Accidents

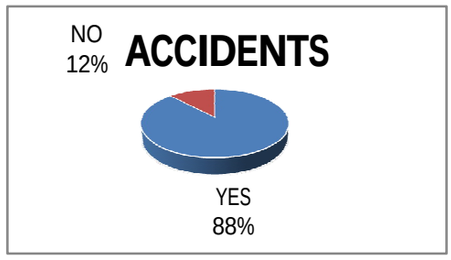


**Fig. 3 Accidents**

From the survey as shown in Fig. 3, we found that 88% of employees accepted that proper transportation, proper load and unloading. Most of the employees are aware of material handling accidents and avid them and make accident free zone. They need to have working area secure and wants no risk in material handling. They want to lift any object by proper machinery like Tower cranes, builder hoist etc. Avoiding the mobile phone usage at working area and avoid consuming alcohol while doing work. Only 12% of employees are not interested in material handling working area. It is our responsibility to give 100% of secure safety in construction work.

### 2.3 Safety Issues

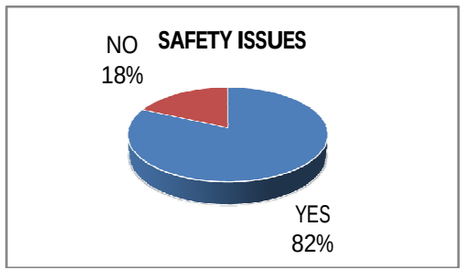


**Fig. 4 Safety Issues**

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From the survey as shown in Fig. 4, we can get the result of 82 % of workmen follow safety issues. Only remaining of 18% of workmen are not giving importance to safety issues. So it is our responsibility to make 100% of safety issues in construction working area. All must follow safety rules and regulation in working area and must be example to others. We must eradicate any problems or any excuses and must make our working area safe working environment.

### 2.4 Training

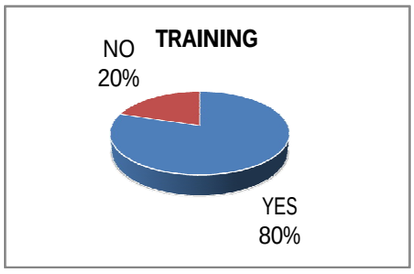


**Fig. 5 Training**

From the survey shown in Fig. 5, 80% of employees are satisfied with the training given by the company. Regular tool box talk, Safety induction training, work experience speech makes them to aware of training in work area. Principle of operation and maintenance of tower cranes, builders hoist and technical data gives them motivation. Material handling during raining or heavy wind force and training to operator, riggers and supervisor must be given them to understand working area. Only 20% of employees are not satisfied in safety training. So it is our responsibility to encourage them to understand the safety in working area.

### 2.5 Consolidated Survey Chart

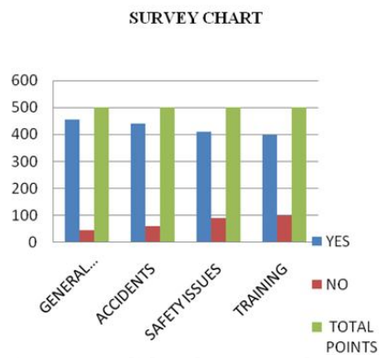


**Fig. 6 Consolidated Survey Chart**

From the Consolidated survey illustrated in Fig. 6, we would like to present varies activities carried out in construction sites and more safety is given while working. We have given importance to employees and also site activities. There is very less negative impact among the worker due to unaware of many things. It is our responsibility to make everybody to understand and minimize negative impact.

## 3. Suggested Instruction to Improve Safety in Tower Cranes

To prevent overturning, a tower crane must either be anchored to the ground or securely counterweighted or ballasted. If the crane is rail mounted, the rail tracks cannot be used as an anchor.

Make sure that equipment such as slings and chains used with the crane does not clutter access ways or ladders and is well clear of any machinery in which it may become entangled.

Loads must be lifted vertically, as any out-of-vertical lifting may result in crane collapse. Never lift loads having a large surface area in windy conditions.

The crane must be positioned to ensure that the crane jib or boom is free to wind vane or turn through 360° around the tower. Crane manufacturers specify the maximum wind speed at which tower cranes may be safely used.

Before a crane is used on site, management should consider all the factors that could affect its safe use, such as:

the weight, size and type of load it will have to lift

the maximum reach or radius required of it; restrictions on use such as overhead power lines, the state of the site and the type of ground

The need for trained operators and signalers.

Whatever the load, the operator should ensure that the machine can safely lift and place it exactly where needed.

Only slings and ropes which have a marked safe working load should be used. Pad sharp corners of the load to prevent damage to the sling and make sure you have screwed home the shackle pins.

Both the erection and dismantling of cranes should be done by skilled workers under the immediate direction of a competent and experienced supervisor. The manufacturers' instructions should be closely followed.

Crane operators and signalers must be over the age of 18, and trained and sufficiently experienced. There should always be a signaler, or a signaling system such as walkie-talkies, if the crane operator cannot see the load throughout the lift. Hand signals should be

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clear and distinct, and should follow a recognized code or system.

Overloading, causing vital parts to be stressed beyond rated capacities, can easily occur when neither the operator nor the supervisor is able to estimate the weight of material to be lifted, which is likely in the case of odd-shaped items.

An operator who is not properly trained may then lower a load at too high a speed so that when the brake is abruptly applied the jib snaps. All cranes should be marked with their safe working load which must not be exceeded during the use of the crane.

All cranes should have an automatic safe load indicator which alerts the operator, usually by a light, just before the safe load is reached, and warns both the operator and others nearby, usually by a siren or horn, if the safe load is exceeded. The safe load indicator is an aid to safe crane operation, but does not guarantee it.

If a load is allowed to swing or is lowered rapidly, the radius of the jib may be increased unintentionally by flexing of the jib. Some indicators operate also as an overload cut-out. Never bypass the indicator in order to lift an overload.

Cranes are subject to wear and tear which may not be easily detected.

Cranes should be tested and examined by a competent person before they are used on a construction site, and subsequently inspected at regular intervals in accordance with government requirements.

The manufacturer's recommended programs of operator checks and maintenance should be followed and any damage or defect should be reported to the supervisor. Never use a crane if you think it unsafe.

Particularly susceptible components are wire ropes, brakes and safety devices. The constant contact of wire ropes with the sheaves on the jib accelerates wear. Brakes are in constant use and need to be checked, adjusted or renewed regularly.

Safe load indicators and other safety devices such as overload cut-outs and limit switches are often susceptible to breakdown under site conditions and are sometimes deliberately disconnected.

### 3.1 Suggested instruction to improve safety in mobile cranes

A mobile crane is inherently unstable and is liable to overturn if used on uncompacted ground or on a slope. Rain can soften the ground and sites which are not level impose strains on the crane which may lead to unintentional overloading.

Crane operator should understand the advantages and limitations of outrigger settings and be aware of the dangers of failing to use them.

Lifting outdoors may be made more difficult or hazardous by the wind. Make sure that there is adequate clearance for the crane's jib or boom and counterweight from traffic and fixed structures such as buildings, and that no part of the crane or the crane load will be closer to live overhead power lines.

Safe lifting depends on three key elements, which require that the operation must be:

properly planned by a competent person

appropriately supervised by a crane supervisor and carried out in a safe manner

No lift is small enough to be left to chance. Every lift should be planned and carried out by trained, competent people. If no one has the expertise, contract out the work to someone who does. If a lift is going to be carried out, accidents can be avoided by appointing someone (not the crane operator) with the expertise to take charge and control the lifting operation.

The crane is positioned to ensure adequate clearance between the wall and the counterweight. The slings are protected by packing around the load.

The supervisor should be someone other than the crane operator.

Supervisors should have sufficient training and be competent to supervise the operation.

A supervisor should:

direct and supervise the work.

be fully briefed on the safe system of work described in the lift plan.

be able to identify any problems either arising from changed site conditions or occurring while the lifting operation is in progress and have the authority to stop the operation until guidance can be provided by the person who planned the lift.

be capable of giving clear, unambiguous instructions to all the members of the team.

### 3.2 Suggested safety measures in cranes

Employers must permit only thoroughly trained and competent workers to operate cranes. Operators should know what they are lifting and what it weighs. When a crane has a telescoping boom, a load may be safe to lift at a short boom length or a short boom radius, but may overload the crane when the boom is extended and the radius increases. To reduce the severity of an injury, employers must take the following precautions:

Equip all cranes that have adjustable booms with boom angle indicators.

Provide cranes with telescoping booms with some means to determine boom lengths unless the load rating is independent of the boom length.

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Require workers to always check the crane's load chart to ensure that the crane will not be overloaded by operating conditions.

Instruct workers to plan lifts before starting them to ensure that they are safe.

Tell workers to take additional precautions and exercise extra care when operating around power lines.

Teach workers that outriggers on mobile cranes must rest on firm ground, on timbers, or be sufficiently cribbed to spread the weight of the crane and the load over a large enough area.

Direct workers to always keep hoisting chains and ropes free of kinks or twists and never wrapped around a load.

Train workers to attach loads to the load hook by slings, fixtures, and other devices that have the capacity to support the load on the hook.

Instruct workers to pad sharp edges of loads to prevent cutting slings.

Teach workers to maintain proper sling angles so that slings are not loaded in excess of their capacity.

Ensure that all cranes are inspected frequently by persons thoroughly familiar with the crane, the methods of inspecting the crane, and what can make the crane unserviceable. Crane activity, the severity of use, and environmental conditions should determine inspection schedules.

Ensure that the critical parts of a crane such as crane operating mechanisms, hooks, air, or hydraulic system components and other load-carrying components are inspected daily for any maladjustment, deterioration, leakage, deformation, or other damage.

### 3.3 Suggested instruction to improve safety in hoists

Only authorized employees may use hoists to move heavy objects and equipment. When using hoists.

Never walk, stand, or work beneath a hoist.

Isolate hoisting area with barriers, guards, and signs, as appropriate.

Never exceed the capacity limits of your hoist.

Wear gloves and other personal protective equipment, as appropriate, when working with hoists and cables.

Ensure that hoists are inspected regularly.

Always hold tension on the cable when reeling it in or out.

When the work is complete, always rig the hoist down and secure it.

When the load block or hook is at floor level or its lowest point of travel, ensure that at least two turns of rope remain on the drum.

Be prepared to stop operations immediately if signaled by the safety watch or another person.

Ensure that the hoist is directly above a load before picking it up. This keeps the hoist from becoming stressed. Picking up loads at odd angles may result in injury to people or damage to the hoist.

Do not pick up loads by running the cable through, over, or around obstructions. These obstructions can foul the cable or catch on the load and cause an accident.

Do not hoist loads when any portion of the hoisting equipment or suspended load can come within 6 feet of high-voltage electrical lines or equipment.

If you need to hoist near high-voltage electrical lines or equipment, obtain clearance from your supervisor first.

The hooks on all blocks, including snatch blocks, must have properly working safety latches.

All hooks on hoisting equipment should be free of cracks and damage.

The maximum load capacity for the hoist must be noted on the equipment.

Cables and wiring should be intact and free of damage.

Properly constructed of sound materials and capable of lifting the required loads.

Properly marked as to use either for equipment and materials only, or for passengers in addition to goods, and the number that can be carried, together with a safe working load notice. Never allow passengers to ride on a goods-only hoist.

Erected only by trained and experienced people following the manufacturer's instructions and properly secured to the supporting structure.

Operated only by trained and competent people.

Thoroughly examined and tested after erection, substantial alteration or repair and at relevant intervals. Regular checks should be carried out and the results recorded. As a general guide, weekly checks should sufficient.

The hoist can be operated from one position only, eg ground level.

The operator can see all the landing levels from the operating position.

Enclose the hoistway at places where people might be struck, eg working platforms or window openings.

Provide gates at all landings and at ground level.

The hoistway is fenced where people could fall down it.

The gates at landings are kept closed except during loading and unloading. Gates should be secure and not free to swing into the hoistway.

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The edge of the hoist platform is close to the edge of the landing so that there is no gap to fall through.

Stopping loads falling from the platform eg make sure wheelbarrows are securely chocked and are not overfilled and that loads are evenly distributed on the hoist platform.

Not carrying loose loads such as bricks. Put loose loads in proper containers or use a hoist with an enclosed platform.

Not overloading the platform. It should be clearly marked with its working load limit.

The operator of this hoist has a clear view of each landing. The base of the hoist is protected by a cage and each landing is protected by a sliding gate.

The controls need to be set up so that the hoist can be operated from one position only. Make sure that from this position the operator can see all landing levels clearly. If this is not possible, a signaling system must be used during loading and unloading. There should be overhead protection for the operator if, as is usually the case, he or she is at ground level.

Loose bricks or other materials should never be carried on an open hoist platform. No one should be allowed to ride on the platform and there should be a notice on the platform forbidding riding.

Every hoist should be tested and examined after installation, and checks made on the arrester and overrun devices. Weekly recorded checks should then be made by a competent person.

## 4. Conclusion

In construction industry many accidents occurred owing to the various activities associated with it. Complete study was made on construction industry accidents in material handling and construction through literature survey. There was no much difference between real and survey accidents. In the construction industry through the literature survey and real time experience, we Collected data and risk analysis of all activities was prepared with severity and occurrence rate in construction work. From the risk analysis material handling was one of the major risk activities in construction work. Even though it is impossible to minimize the accidents to zero but regular attempt was made to reduce the accident as much as possible. In future implementing the instructions and suggestions of safe working procedures for the material handling activities will minimize the accidents in constructions industry.

It is concluded that the construction industry has given more importance for safety than the extraction of work. This survey has been appreciated by the workers and the management.

## References


1. *Aneziris O N et al (2008), "Towards risk assessment for crane activities", journal of Safety Science, Vol. 46, 872–884.*
2. *Paivi Hamalainen et al (2006), "Global estimates of occupational accidents" ", journal of Safety Science, Vol. 44,137–156.*
3. *Shepherd G W et al (2000), "Crane fatalities a taxonomic analysis" journal of Safety Science, vol. 36, 83-93.*
4. *Hartmut Pasternak (1996), 'Crane load modelling' Journal of Structural Safety, Vol.17, 205-224.*
5. *Al-Humaidi H M and Hadipriono Tan F (2009), "Mobile crane safe operation approach to prevent electrocution using fuzzy-set logic models", Advances in Engineering Software, Vol.40, 686–696.*
6. *Michael McCann (2003), "Deaths in construction related to personnel lifts 1992–1999" Journal of Safety Research, Vol.34 507–514.*
7. *Abel Pinto et al (2011) "Occupational risk assessment in construction industry" journal of Safety Science, Vol. 49, 616–624.*
8. *Frank E Mc Elroy P E, CSP (1984), "Accident Prevention Manual for Industrial Operations", National Safety Council,8th Edition.*
9. *Jain R K and Sunil S Rao (2006), Industrial Safety, "Health and Environment Management Systems", Khanna publishers, New Delhi.*
10. *Davies V J and Tomasin K, "Construction Safety handbook", Thomas Telford, Second edition.*


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