



The study of safety measures and usage of PPEs in construction projects.

¹Hemant kumar, ²Balwant Kumar Singh

¹Safety Supervisor, ² Student of PG diploma in Industrial safety Management

¹Tata projects, Kalinganagar, Odisha,

²Patna University

ABSTRACT

The aim of this project is to spot and evaluate the hazards in the construction projects and implement the safety measures and controls in order to reduce or completely eliminate them. Therefore lead health and safety of construction working person with maintaining good working environment (HSE). Survey is done to gather a good classify of opinions from competent experts working in a few construction sites for correlation between them. The study of the related literature review paper-works and my own on job experience are the elementary step in obtaining clues regarding safety of construction workers.

The my practical knowledge at work site and literature reviews impart me both theoretical as well as factual attainment in regard to safety management. Safety in construction encloses all the forms of safety and measures relevant to all structural actions such as :-

- on the groundworks
- above the groundworks and
- below the ground.

The construction works associated may be buildings, bridges, dams, towers, chimneys, and making of Boiler and so many civil and mechanical structures. Safety aspects require in following ways -

- a) Before construction
- b) During construction and
- c) Afterwards construction works.

The hazards involved in the construction processes and their fall- out could be summarized as follows-

- Those hazards or accidents that can cause instant death (fatal cases) .
- Those hazards or accidents which can cause injury or loss of limbs of the employees.
- Those hazards or accidents that can cause only harm of property like man-hours loss.

These three mentioned level of hazards will quick or immediate ill- effects. Another kind is the time dependent effects due to environmental and other pollution effects (like noise problem, defective light system etc.). An absence of appropriate safety measures to counter the hideous effects of this long drawn conditioned ailment can cause severe health problems to the employees and can hurdle the proficiency of the workers. Since, The productivity is directly proportional to the safety of the employees,hence safety is an essential condition in the present industrial scenario, which we have to strictly implement at work place in effective and efficient manners. Therefore this report is prepared, how to provide a good health to the employees at construction site along with best working premises with their safe behaviour conducts towards safety Management.

KEY WORDS: HSE, Hazards Identification and their causes, Risk Analysis, construction works, employees, Accidents and Injuries, Suitable PPEs,etc.

Introduction- Any practice or technique or process which can curtail undesirable occurrences (accidents) in an industrial establishment may be assigned to as a practice, technique or process of industrial safety. Industrial safety is usually exercised reducing hazards in the industries. Hazard is a potential condition awaiting to be transformed into an unwanted event.Hazard is omni- present and entire hazards are encompassed by steady conditions. Hence Industrial safety management is that branch of management which is interested with lessening, controlling and eliminating hazards from the work- place or manufacturing units. Industrial management is inherently an effort to make sure that the jobs get done adroitly. Risks emerges out of hazards. Safety is exemption from risk to the level wanted intensely. Safety is fulfilled by making an entity, a process etc. secure, or fully safe. Risk is defined as-

Risk = (probability of the event that might occur) X (Severity of the event).

In other words safety is defined as " It is a condition which gives you freedom from hazards,risk, accidents which may cause injury, damage, and loss to a material or property damage and even death.

Safety is derived from Latin word "salvus " means uninjured or in good health. Infact, If we carefully observe the word safety, the meaning of its is hidden in it only. That is each alphabet in this word is discribed as follows-

S - Search for hazards

A- Analysis of risk

F- Find the causes

E- Eliminate the causes

T- Tell the followers

Y- You are safe and sound.

The Industrial safety management involves several fields, being ,a skilled in this field has to put himself in alignment of the current findings, research and developments. To exemplify, one can recite the example of a pneumatic caisson,where safety norms respecting working pressure inside the caisson, working and rest hours,rates of compression and decompression etc. have to be presumed and followed. Alike, while handling with material lifting operation ,one has to have complete knowledge of type of crane to be used with capacity,sling capacity, weight of the load, details of D- shackles and lifting fixtures to be used, location of centre of gravity of the load,boom angle and boom length calculation, working radius, Hoisting capacity (SWL) , margin, Total

weight etc. As a result of this, it be understood, that industrial safety management has to deal with multitude of trouble both at theoretical and practical levels.

Accidents and Their causes :

Industrial Accidents :

An unwanted event which can't be predicted in advance may be called as an accident. It is consistently a unforeseen process and not a gradual one. An incident of an unwanted event which hamper the well- Ordered progress of work in an industrial venture may be termed as an industrial Accidents. According to Factory Act 1948, industrial accident had been defined as " an occurrence in an industrial organization causing bodily injury to a person which makes him incapable to resume his duties in the next 48 hours".

Types of Accidents :

Accidents may be of various nature rely upon the severity, persistence and extent of the injury. An accident causing end of life or continual or lengthened disability to the injured worker is called ' major accident. A cut that does not impart the worker disabled is termed as ' minor' accident. When an employee gets injury with external endorse of it, it is external injury.

Occupational Safety & Health Administration (OSHA) reports that there were 3,945 worker fatalities in private industry in 2012. Total of mentioned data 775 or 19.6% were in construction works only. There are many agents of an accident on a construction site. The major causes of construction employees loss of life on the job were falls, be subsequent to struck by object, electrocution, and caught-in/between. These " Fatal Four" were accountable for nearly three out of five of the creation worker fatality.

The myriad of incidents may be characteristic to some kind of negligence and may include unsafe work site surroundings, wrong use of tools and-or equipment, and lack inadequacy of protective safeguards.

The major construction accidents in brief discussed as following-

- i. **Falls:** Falls estimated for 279 out of 775 (36%) deaths in construction in 2012, confer to OSHA. An injury of this kind may arise when a worker near an open-sided floor steps backwards or sideways without looking. Falling hazards also usually occur on stairwells with no guardrails. Since high elevations many a time play a role in these falls, the outcome can be disastrous to workers who carry intent injuries. The main reason of end of life in formation works occurs where incompetent or no fall protection is arranged.
- ii. **Struck by object:** 78 construction laborer died due to struck by an object in 2012. These decease may have been obviated if the workers had undergone proper training and used equipment and machinery well. Employees must keep in mind to use parking brakes on stationary vehicles, reverse vehicle alarms, tool guards, personal protection equipment, debris nets, catch platforms and more.
- iii. **Electrocutions:** In 2012, 66 workers (9%) were vigorously injured or die due to electrocution. Electrocution is defined as " when a person, tool or piece of equipment comes into direct contact with power lines or bared to electrical sources. Sometimes, these types of accident occur because workers are

- simply unaware of all energized power sources, from overhead and underground power lines busted holder and connections. As an example, a construction worker carrying a metal ladder may strike an overhead power line.
- iv. **Caught-in/between:** Even though it appears obvious to never stand between a piece of heavy equipment and an immobile object, sometimes workers focusing on their jobs find themselves in unpredictable danger. Caught in/between accidents are when a worker's body part or limbs is caught, crushed, squeezed, compressed or pinched among two or more objects. For illustration, cave-ins or collapsing materials, body parts caught in the moving parts of an unguarded portion of machinery, equipment rollovers and grasping pinned between stationary objects, like a wall, and piece of heavy equipment.
 - v. **Slip and falls:** These are amid the greatest common accidents on a construction site. These accidents may be related to unsafe conditions along with naked holes or trenches and exposed stakes.
 - vi. **Poor housekeeping:** Falls and slips takes place on the construction site due to not maintaining good housekeeping. A site has bad off housekeeping if the work area is not clean and orderly and has fine particles, tools, construction waste etc. lying everywhere." **A stitch in time saves nine** " is a good maxim of housekeeping standards.
 - vii. **Excavation:** A worker may fall into the excavated crater or collapse of Earth may occur on the workers during excavation work. . The use of shoring is necessary when sites of the excavation works is enough deep or on weak soils. If required, proper slopes or steps are to be provided to excavated sites so that safety in working zone is ensured.
 - viii. **Working at Heights:** Major accidents occur due to perform operations at heights specially in case of construction, repair and maintenance works etc. The root causes of accidents are improper use of ladders, incorrect scaffolding and negligence on the safety norms. Use of safety belts tied to the platforms should be encouraged in order to prevent accidents, which may be serious injury or even fatality.
 - ix. **Ladder accidents:** This is one of the prominent causes of injury and long-standing disability. Most ladder accidents, including falls, take place because workers practice the wrong kind of ladder for their job or they set up the ladder inappropriately possibly on a slippery or uneven surface, and the ladder accidentally turn or slip- up. Workers foot slip occurs, or they may lose their equity or outreach. Ladders may also be carelessly or badly keep- up.
 - x. **Scaffolding-accidents:** Although stringent regulations, scaffolding accidents take place. In a Bureau of Labor and Statistics (BLS) study, 72% of workers injured in scaffold accidents reffed the mishap either to the found or carry giving way, or to the workers slipping or being struck by a falling object. In a general sense, most scaffolding accidents are take place due to wrong construction or inattentive perpetuation.
 - xi. **Power tool and machinery accidents:** The reason of such type of incident are mechanical imperfections, electrical breakdown, incompetent training and lack of proper safety equipment. A large number of injuries are occurs due to the application of power tools and large machines.
 - xii. **Vehicle Accidents:** Hazardous construction site vehicles contain forklifts, graders, backhoes and dump trucks. A frequent forklift accident happens when the vehicle is turned or move with the load lifted. Large trucks all too usually back up and hit a pedestrian. Other type of hazards at creation site is falling from a carrier.

Even though construction sites may seem to be hazardous, many of such type of accidents can be prevented by usage of common sense and safeguarding measures. Prevention starts with requisite awareness and a suitable keep up working environment that is safe and sound.

Causes of Accidents:

The causes of accidents are mainly categories into three types which are as following-

1. Unsafe Conditions

2. Unsafe Acts

3. Other Causes

These are discussed, in brief.

1. Unsafe Conditions (job-related causes):

It has been seen that majority of the accidents takes place due to unsafe conditions. These work-related causes are also known as Technical causes. These are related with faulty machines, tools and equipments, materials etc. They come out, when there are improperly guarded machines, defective equipments, improper construction, lack of supervision, faulty layout and location of plant, inadequate lighting arrangements and ventilation, unsafe storage, inadequate safety provisions, etc. Besides, the psychological reasons such as working over long time, distrust, hard labour, monotony, fatigue, tiredness, frustration and anxiety are also some other reasons that cause accidents. Safety officers recognize that there are some high risk zones at work-place. These are, for example, hand lift trucks, wheel-barrows, gears and pulleys, saws and hand rails, chisels and screw drivers, electric drop lights, etc.

2. Unsafe Acts (On the parts of workers):

Due to unsafe acts on the parts of workers accidents are takes place in the industries establishment. These acts may be the result of lack of knowledge or skill coupled with wrong notions on the part of the worker, certain kinds of bodily infirmity and misdeed attitude. The example of some such accidents are as follows:

- (a) Operating machines without approval of the concerning authority.
- (b) Failure to use safety devices and PPEs.
- (c) Careless throwing of material at the work place and rubbish on the working floor.
- (d) Practicing hazardous equipment in an irresponsible manner.

- (e) Working at unsafe speed, i.e., too fast or too low.
- (f) Applying wrong methods in such operations like loading, unloading, placing, removing etc.
- (g) Taking unsafe position under suspended loads.
- (h) Distracting, teasing, abusing, quarrelling, day-dreaming, horseplay
- (i) One' s own accident prone personality and behaviour, as for example, overconfidence, unusual attitudes,morale etc.
- (j) Lifting or hauling in an improper manner.
- (k) carelessness during the maintenance and repair work on machines.

3. Other Causes:

These causes occurs due to unsafe situational problems and inclement climatic conditions and variations. These may comprises excessively long duration of work, harsh and domineering behaviour of management towards workers,excessive noise, very high temperature, humid conditions, bad working conditions, unhealthy environment, slippery floors, excessive glare, dust and fume, smog in the atmosphere etc.The nature and type of motivation adopted by the management towards the workers, Reduced vision and hearing capacity of workers, Marital status of the workers, Lack of proper inspection and supervision by the superior staff, The type of leadership style adopted by management in the organization, Feeling of job uncertainty between workers etc.

A Case Study :

To determine the frequency of accidents occurring at a construction site, we have considered a construction project of Tata Steel, Kalinganagar location, in Odisha, which is under supervision work of Tata projects. The details of Man days lost, severity rate, no.of fatal accidents, near Miss etc.is given for a particular calendar year from April 2018 to July 2019. All details are shown in tabular form as below :-

Lead & Lag Indicator Report	From April18 to July19
Total Man- hours	4599215
Total safe Man - hours	1138270 (1.1 Million)
Frequency rate	0.21
Severity rate	3.26
Man days lost	15
No. of fatal incident	0
No. of LTI	1
No. of MTC	0
No.of high potential incident	0

No.of first Aids	1
Near Miss	9

Where LTI means lost time injury and,

MTC represents medical treatment cases.

Effect of Industrial Accident

- Industrial accident have immense ill- effects on the employees, employer, and the nation economy.

1. Effect of Industrial Accident on the Employees (victims):

- Physical pain experienced by the worker(s)
- Mental agony experienced by the worker(s)

Disability

- Extra expenditures for services the worker(s) cannot longer render for himself.
- Loss of limbs and life
- Loss of earning capacity
- Psychological trauma

2. Effects of Accident on the Employer:

The impact of accident on the employer are as follows:

- It defame the reputation of the company

Damage of properties and equipments

- It leads to increases in insurance levy of the company.
- Time loss
- Unnecessary financial cost of settling hospital bills and compensation of accident victim(s)

3. Effects of Industrial Accident on the Nation

It is a known fact that the major source of generating revenue in any nation is through tax collected from citizens and corporate bodies. However, industrial accident has great effect on the nation's revenue. This is so because, when there is accident in the company, it will affect the company finance which will make them not to be able to settle their tax. Also, when workers loss their job due to accident, it will also affect the nations revenue because they are not expected to pay tax when they have no job.

Accident Investigation

This is usually done when accident occurs in an industry, which is aimed at ascertaining the causes and impact of the accident in order to prevent its reoccurrence in future.

Steps in Accident Investigation

Below are the various steps in accident investigation;

- Take care of the accident victim(s)/worker(s).
- Interview the accident victim(s) worker(s).
- Interview those that witness the accident.
- Record in details the work area of the accident

Snap the scene of the accident with camera or sketch when camera cannot be reached.

- Find a valid conclusion

- Recommend best practice that will prevent the recurrence of a similar accident.
- Submit written report of the accident investigated.

Accident Prevention and Protection

In this paper, we shall only focus accidents at construction sites. According to random sources, is that 38 construction workers die every day working on sites. However, neither the Government of India, nor the International Labour Organization, has any authentic data which could suggest the plight of a sector which employs such a huge workforce.” Data suggest that the possibility of a fatality is five times more likely in the construction industry than in a manufacturing industry, and the risk of a major injury is 2.5 times higher, which can't be accepted in a good working culture and today's modern age. It has caused the loss of human life, money loss and numerous other damages to humans and it's dependent physically as well as mentally. Along with these impacts, It also causes bad publicity to the profession. Worldwide, authorities have tightened up safety standards, which have enhanced the performance in construction sites. However, accidents are still happening and there is a need for further investigation to prevent it and control it to minimum level as possible. From construction organization's point of view, following precautions may be adopted to advert the ill- effects of the accidents-

- Structural design must be entrusted to qualified and experienced structural engineers.
- By carrying out regular repairs and maintenance under the expert guidance of qualified and experienced engineers.
- Materials of construction must be tested for strength and durability by standards laboratories under expert guidance.
- The planning of the structures etc. Should be entrusted to architects or engineers having sound knowledge of safety principles and practices.
- All supervision work must be done under the expert and guidance of skilled engineers.
- Care must be taken that the norms of sound engineering practices are not violated.

- The work- force responsible for construction must be instructed to remain careful and responsible and follow safety rules and norms.

Personal Protective Equipments (PPEs) and Clothings :

Miscellaneous kinds of PPEs and Clothings are broadly used by the personnel working in industries as protective measures against injury that may be fatal and non- fatal. The ideal PPEs and Clothings are those which are safe, appropriate to users, economical, durable, free from discomfort when in usage and easy to clean. Commonly used PPEs and Clothings are as following-

1. Head protection :

i) **Helmet:** These must be sledgehammer and strong adequately to save workers from head injury specially due to falling objects, flying splinters, rotating machine parts etc. Steel (Metal) helmets are usually used in industries.



ii) **Hard hats:** These protecting headwears are quite effective and generally lighter as compared to steel helmets and offer reasonable protection against injury to head including face and neck.

iii) **Caps:** These are particularly used to prohibit worker's hair from being caught by rotating parts of the machines. It should be fire resistant and should be electrically insulated.

2. Ear protection:

i) **Ear- plug:** This is in the form of rubber or plastic plug which can be comfortably placed into the ear- passage.



ii) **Ear- muff :** It is very persuasive device which covers the entire ear when worn. This device is however annoying to workers.



iii) **Cotton :** A piece of cotton or wool can be snugly placed in ear- canal.

3. Finger, Hand and Arm protection:

i) **Gloves:** These are used for full protection of hands and commonly supported with wristbands to ensure a tight fit. These are generally made of rubber, leather, plastics, cotton



etc.

ii) **Mittens:** These are used to redeem individual fingers from injuries and usually made of leather, rubber etc.

iii) **Hand guards and Hand pads:** These are mainly adopted to save hands from possible injuries while working with hand - trucks, gritty shard as well as highly heated objects.

iv) **Sleeves and Cuffs:** Sleeves snugly fitting coverings are protend for protection to arms except hands against injuries which may be made of leather, asbestos or plastics etc.

The cuff guards protect the lower part of the forearms from injuries uniquely when working under contiguousness of heat sources along with Sparks. The materials used for making guard- cuffs are rubber, asbestos, leather, metal, Plastics, etc.



4. Eye- protection: These are generally goggles and eye- glasses. The protection for eyes needed may be from Sparks, glare, dust, noxious gases and vapours etc. The haphazard operations which warrant eye protection accessories may be cutting, grinding, galvanizing, welding etc.

5. Face and Eye protection:

The face shields and the hood are two kinds of face and eye protection equipments in used during dealing with various mechanical operations. Welding, Grindings and operations involving fairly big size of flying particles etc. are needed protection to the entire face including eyes. Thus face shields are used for such tasks at work- place. Hoods are used under particular prospects for face and eye protection to deal with intensely hazardous situation like working with highly corrosive substances.

6. Foot and Leg Protection:

Safety shoes: This may be different types depends upon the nature of job to be performed. For protection against toe injuries, crushing of feet etc. the shoe used in such works are reinforced by suitable steel. For safety from other tasks as electric shocks, harmful chemicals different safety shoes are recommended.

i) Boots : These are generally used working under wet conditions as for example Gum boots.

ii) Leg guards or leggings: Leggings are wrapped around the legs upto knee or even upto hip. Plastics, fabrics, leather etc. types are materials used for making it and used of these different leg- guards depends upon nature of the works.

7. Safety harnesses and life line:

i) A **safety harness** is a type of protective equipment that prevent the wearer from falling from a height. By wearing the belt or harness the risk of injury from a fall is highly abbreviated.

The harness allows the user to attach themselves to a stationary object, therefore ensuring they will not hit the ground in the event of a fall. Falling from a height is one of the most frequent causes of personal injury in the workplace, so it is very important to make sure you are properly equipped when working at height.

ii) The **safety device lifeline** is a fall protection system, in the shape of an open barbed wire and stanchions assured around the perimeter of an area to prevent incidental falls.



8. Lungs and Respiratory Tract protection:

Respirators help to protect the user from breathing in impurity in the air, hence maintaining the health of one's respiratory tract. There are two major categories of respirators. The variety of one respirator works by filtering out chemicals and gases, or airborne molecules, from the air breathed by the user. The process of filtration may be active or passive mode. Gas masks and particulate respirators (such as N95 masks) are examples of this type of respirator. A second kind of respirator protects users by supplying clean, respirable air from another source. This class includes airline respirators and self-contained breathing apparatus (SCBA). In working environments, respirators are depended upon when sufficient ventilation is not accessible or other engineering control setup are not attainable or deficient.



Air- purifying respirator and N- 95mask.

9. Body protection:

i) Aprons: Aprons are made of several types of materials are extensively used as a protective clothings in different industries. These aprons provide adequate protection to the body of the workers engaged in various hazardous jobs. As for example Lead- rubber aprons for protection against radiation (X- rays radiation)

ii) Suits: In extremely hazardous situation and emergency conditions workers use specially designed suits. The materials of suits are rubber, asbestos etc. Rubber suits are suitable for body protection in hazardous chemical plants whereas asbestos suits are suitable in case of fire hazards.

Methodology of establishing best safety measures at construction site:

For implementing best safety practices at construction sites various methods should be adopted which are as follows:

- Study cases of construction accidents of different industries which involves same kind of jobs.
- The study of details of process, Plant manuals and preventive measures was taken earlier.
- Review of technical literature with respect to construction jobs for identification of hazards was done.
- Study past accidents of concerned sites.
- Study the different safety measures had been taken by other industries which indulge in same type of works.
- Identifying the several hazards present at the work- place
- Find the causes of hazards and eliminate them.
- Discuss with workers at different levels and supervisors for Knowing their techniques and suggestions for the further improvement.
- Gather all safety related information before implementations.
- Organized the safety training and motivation program on the behalf of safety measures prepared by safety personnel.
- Time to time give rewards to workers for the following the rules and regulations of safety during jobs. It will increases his morale and his follow workers.
- Maintaining good housekeeping is also a necessary safety norms.
- Put on the practices and repeat the above all these steps and make the changes,if any recommendations.

Thus, by following the above said safety norms, construction accidents are reduced which fruitful for any organization along with their employees.

Findings and Conclusions:

The construction industries has a large numbers of fatalities and long period Injuries. Since the limbs and life of each and every persons are very important.Hence industrial accidents are not accepted in a well cultured and advanced society. Hence in this prospective industrial safety management is playing a vital role to eliminate risk prone areas or minimized them at lowest possible value and provided the workers a safe and sound working environment. If an organization is free from serious hazards and accidents and workers are ensured safety at all costs,then in such situations the morale of the workers will be high and he will possibly work with more zeal and thus productivity will increase considerably. Industrial Safety minimise risks to people, and processes. Process control and safety systems are generally come- together.Maintaining a safe and healthy working environment is not only a valuable human resources issue, it's the law. For best implementation of safety programs in construction projects we have to adopt software based safety norms or measures. As we all know that safety is no accident. Hence, it is superior for every industrial organization to have and maintain a great industrial safety management programs in order to prevent haphazard and accidents at sites.

REFERENCES

- (1) Jha K.N., Construction Project Management- Theory and practice 2nd Edition, Pearson India Education Services Pvt. Ltd., UP, India 2015M. Young, The Technical Writer' s Handbook. Mill Valley, CA: University Science, 1989.
- (2) Prof.N.K.Tarafdar, Industrial safety Management (Patna University) textbook,Dhanpat Rai & co.,Publication services.
- (3) <https://phys.org/news/2016-03-smart-vests-workers-safety-heart.html>.
- (4) Refer to journal, basic concepts in industrial safety Management by I.Serumu,2012.
- (5) Recommend practices for safety and health programs in construction, Occupational safety and Health Administration, October 2016.

(6) Journal,safety Management in construction projects by Y.S.Saeed,2017.

(7) Google.com./ en.m.Eikipedia.org.

(8) [https://blog.safety culture.com/industry-trends/wearable-technology-that-will-change-the construction-industry.](https://blog.safety culture.com/industry-trends/wearable-technology-that-will-change-the construction-industry)

(9)<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5615591/>

(10) [https://www.tobipro.com/situational-awareness-at-construction-work-sites.](https://www.tobipro.com/situational-awareness-at-construction-work-sites)

