

# International Journal of Innovative Research in Science, Engineering and Technology

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## Safety Aspects in the Construction Industry

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**ABSTRACT:** The construction industry is the second largest industry after agriculture. Financial development of any nation and at the same time globally it is known fact that it is the most hazardous industry, due to its nature and various types of activities of work carried out during the course of construction. It is labour intensive and requires vigorous movement of resources like men, material and machinery within a confined space, leading to high level of accidental risks for the workforce at the site. The present poor scenario and past records of safety measures within the construction industry are leading to a high rate of accident. The primary source of these accidents prevails in the private sector in the construction industry. This paper aims to illustrate the safety performance of low and medium size projects in private sectors in general through observation. Our study focuses on general safety aspects related to construction sites like worker personal protective equipment (PPE's), machinery, excavation, height and fall protection. The findings globally suggest that there is a serious need for improvement of safety of labours in the construction industry.

**KEYWORDS:** Construction, safety, Hazardous.

### I. INTRODUCTION

Construction industry being an unorganized sector imparts high risk to the workers associated with construction activities. Construction workers are exposed to a variety of hazards exists due to ever-changing locations and work environment. In spite of a lot of technological development and substantial improvement in construction safety throughout the years, the rate of accidents is still highest in the construction industry. Globally, past studies confirm that injury rates (Fatal, major and minor) are recorded highest in the construction industry compared to other industries. The most common factor that leads to death or injuries in the construction sector are: electric shock, height fall, trench collapse, equipment breakdowns (crane, shovel).

As a construction worker comes from rural areas they do not have proper training and educational background in construction safety. These workers during the course of construction are exposed to different risks involves with construction works and other occupational diseases, resulting in the delay of construction projects completion time due to legal hassles and loss in working hours. Therefore, in order to minimise the losses in terms of time and cost it should be made essential for any construction projects to have certain minimum guidelines and procedures, safety things to be followed for site activities and create awareness among workforce right from engineers, supervisors, foremen, skilled labours and unskilled labours.

### II. LITERATURE REVIEW

It is obvious that accident may occur in the construction site due to the presence of hazards in the workplace. As we know the construction site is hazardous and this must be managed through the implementation of safety guidelines in order to avoid accidents. There exist a relationship between hazard, risk and harm. A hazard is defined as

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anything that has the capacity to harm people, whereas the risk is defined as the possibility of a hazard which will harm people and family, harm is a result of hazard or risk thereby causing illness or diseases, injury and death. A number of event will occur before an individual is injured during their work period in the construction site. These events become an important factor in the research area and also provide prime information to decrease the risk of hazard.

Potential hazards for workers in construction include:

- Falls (from height)
- Trench collapse/excavation
- Scaffolding collapse
- Electric shock
- Neglecting to use proper personnel protective equipment's
- Being hit by falling objects
- Hand tool injury

These potential hazards must be considered by safety engineers/personnel on the construction site for the safety of workers and other people in the work area. The concept of construction safety is to mitigate possible hazards by taking necessary measures from reliable source information on safety hazards by experts and experienced worker on site, this will promote safety performance and awareness on construction site by enabling construction managers to be aware of potential hazards and risks. Actually, construction safety lies in the scope of the main contractor in addition occupational safety and health management should be conducted at all levels of the construction management team from top management down to the worker of a site. Therefore, all stakeholder should take part in construction site safety in order to cover different aspects.

A number of reasons that influence safety performance in the construction industry are listed by many researchers on an occupational risk assessment which includes:

- Project size
- Cost and time-related to project
- Inefficient coordination
- Workers poor involvement in safety matters inadequate training and work fatigue you
- Poor safety awareness
- Holding workers responsible for their own protection at the workplace

In 2014, there were 4679 of employee insured in the United States while working in their respective sector, an event rate of 3.3 per 100,000 for the employee working full time. In the same year, the fatal injuries rate is increased by 5% in the construction sector. 20% of the death of workers reported in 2014 were related to construction. In spite of having only 6% of workers in the construction sector in the United States, but the largest fatalities reported were 17% of the construction industry as compared to any other sector.

In the UK, about 31% of fatalities have been reported related to construction and also 10% of major workplace injuries. Every year about 150 fatalities and approximately 400 injurious has been recorded in South Africa. In Brazil, the incident rate of 3.6 per 100,000 for all working sector.

### III. PROPOSED METHODOLOGY

Construction sites are prone to accidents which leads to injuries and fatalities. This is just because of the risk and hazard associated with construction activities in a confined area. This methodology is designed to help and understand safety aspects in the construction industry in an explanatory manner. Here we focus on the private sector where low to medium class construction projects which are prone to a high level of risk and hazards because they neglect safety aspects and follows the lowest measures of safety guidelines.

Our objective of the study is to examine the general status of safety aspects in the construction industry and to propose suggestion and recommendation to improve safety awareness at the construction site. In order to fulfil these objectives, the study is carried in the following stages:

- Literature review

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- Data collection and analysis
- Result and discussion

Literature review stage requires a wide range of data collection related to this topic. This can be achieved by browsing many online databases and technical papers to various search engines. The data used in this research are collected by observation.

Major data collection method is through observation when it comes to realistic and natural fieldwork locations. These involve watching people act in a sequential manner then record, analyse and explain their behaviour. Most of the studies in the field of construction safety used observation as a mean to collect data from construction sites through the checklist. For example, observation used for data collection in a study that aimed to determine the risk factor that affects carpenter working in a construction site. After collecting data from the field this data were analysed by the use of predictive analytics software (PASW). Quantitative analysis was conducted through descriptive statistics. Finally, the objective is achieved by the Conclusion and Recommendation part of this paper.

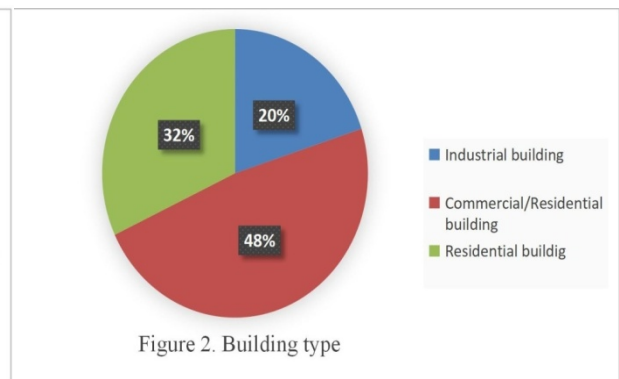
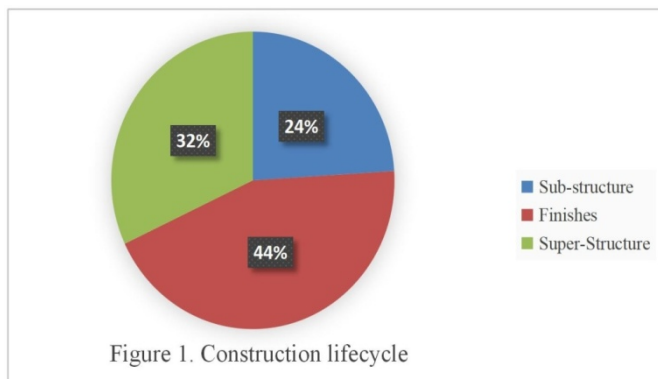
## IV.RESULT AND DISCUSSION

### Classification of Construction Sites:

In order to ascertain accurate result pertaining to safety aspects of the construction site, it is necessary to collect authentic data from the site through observation then analyse these data by suitable tools. In this study, a random sample of 50 construction sites was selected as the main source of data. The construction sites were classified into two types:

1. Construction life-cycle
2. Building type

In the construction life cycle stage, there are three basic phases: substructure, superstructure and finishes. In terms of this classification 12 construction sites were at substructure stage, 16 sites were at superstructure stage and 22 construction sites at finishes stage. The majority of construction site studied were at finishes stage where all the agency works simultaneously finish the project in space constraints. In the building type classification 24 construction sites were commercial/residential building, 16 construction sites were residential building, and 10 construction sites were industrial building. Commercial/residential building represented the largest portion of the study sample.



### Present scenario of safety aspects and risk on construction site:

The general status of safety on construction sites in the construction industry is accessed by using a checklist which was filled during the observation period. The checklist provides information on actual safety condition of the construction site and also assist to identify accident-prone areas on site. The analysis results of the checklist are

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summarised in Table 1. The Table 1 contains safety aspects applicable for each safety issue out of a total of 50 sites, frequency count and total percentage. There are 34 safety aspects which are categorized under five groups:

- 1) General construction site
- 2) Workers' PPE
- 3) Heights and fall protection
- 4) Machinery/equipment
- 5) Excavation

Out of 50 construction sites, only a few of them shares all five safety. Hence, all the safety aspects are not applicable to all different sites. The safety aspect which comes under general construction site and workers' PPE are only applicable to all 50 sites. The remaining 3 depends on the life cycle and building type. For example, during the visit of sites, the machinery was not in use or the excavation/basement work was not going on in all the sites. Hence, this group assessment is not applicable. The group with the least number of the applicable site was machinery with only 7 applicable safety site. As far as the number of safety aspects concerned it was found that general construction site includes 12, workers' PPE includes 6, Height and fall protection includes 7 and both machinery and excavation includes

4. In general, all groups showed a very poor safety record in the construction site. For example, there are five safety aspects which were not followed by even a single construction site includes: display of emergency exists, workers wearing safety glasses, workers wearing hearing protection, safety belts for workers fall protection and availability of flag person for machinery. The main four safety aspects with the highest positive effect were no slippery or muddy surfaces at 80%, no smoking workers at 88%, concrete formwork properly installed and braced at 100% and machinery equipped with handles and latches at 85.7%.

Table 1: Safety Aspects

Safety aspect	Sites	Frequency	%
<b>A) General – construction site</b>			
Site perimeter fenced and secured	50	18	36%
Availability of safety signs boards	50	3	6%
Display of emergency contacts/Telephone	50	1	2%
Availability of fire extinguisher	50	1	2%
Clear approach roads to site and internal access	50	20	40%
Display of emergency exit	50	0	0
Good housekeeping	50	6	12%
Sufficient working area	50	24	48%
No slippery or muddy surfaces	50	40	80%
No loose electric cables on ground	50	36	72%
Materials are safely stored and secured	50	5	10%
Non-smoking workers	50	44	88%
<b>B) Workers' PPE</b>			
Workers wearing safety helmets	50	2	4%
Workers wearing safety glasses	50	0	0
Workers wearing hearing protection	50	0	0
Workers wearing hand gloves	50	2	4%
Workers wearing safety boots	50	8	16%
Workers wearing gum boots	50	2	4%
Workers wearing appropriate clothing	50	25	50%

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<b>C) Heights and fall protection</b>			
Safety belts for workers fall protection	30	0	0
Openings on floors and roofs covered and protected	25	2	8%
Availability of protection against falling objects	32	2	6.24%
Stable and safely secured scaffoldings	16	8	50%
Crane loads do not pass over the public	5	1	20%
Concrete formwork properly installed and braced	24	24	100%
Stairways with stair rails	20	2	10%
<b>D) Machinery</b>			
Workers on machines wearing seatbelts	7	1	14.3%
Machine secured when not in use	7	3	42.8%
Availability of flag persons for machinery	7	0	0
Machinery equipped with handles and latches	7	6	85.7%
<b>E) Excavation</b>			
Safe access / exists in excavations	8	2	25%
Covered and fenced holes and piles in excavations	8	1	12.5%
Availability of supports to prevent soil movement	8	4	50%
Safe distance of materials and equipment from excavation edge	8	2	25%

### General - construction site:

In general, it is presumed that the main contractor should provide the safety Gardens and procedure. "The worker's safety is the contractor's responsibility". So he should communicate and facilitate to all the workers involved. But in order to make more money contracted neglect safety guidelines thereby increasing the rate of incidents on site.

The positive results which were constrained from the investigation under the general construction site group are illustrated in Table 1. Firstly, 80% of the construction site did not have slippery and muddy surfaces due to the climatic condition of the area wherein the study was conducted. Secondly, 88% of the construction site does not have worker smoking on them during the site visit. On the other hand Table 1 also depicts low scoring safety aspects under this group. Only a few numbers of sites had displayed safety sign boards and emergency contact numbers which are very important because they keep us reminding about the safety measures that are to be followed on the sites and also none of the construction site display emergency exit plan. This is an indication that safety standards are not followed in the majority of the construction site and also reflect top management careless towards safety measures. Only 12% of construction site had good housekeeping which reflects low percentage and affects other safety aspects such as the presence of naked electric cable on the ground about 72%, only 40% of construction site have clear approach roads to site and internal access, only 48% of the site had sufficient working area and 90% of the construction site did not safely store materials (store their materials on adjacent streets or sidewalk) and this is the sign of very unsafe construction sites for workers and inexperienced person entering the site. These type of storing materials is the prime cause of accidents for workers and other individuals. Only 36% of the construction site perimeters were fenced and secured, increasing the chances of accidents, especially bad housekeeping of the majority of these construction sites. We all know fire is a dangerous hazard in a construction site, unfortunately, only 2% of construction site visited had the fire extinguisher on it. These raises concern regarding the safety measures implemented in the construction industry as a whole.

### Worker's PPE:

Minimum safety measures followed globally on the construction site are Personal Protective Equipment's (PPE'S). It is mandatory for all the workers, this includes helmets (hard hats), safety shoe (steel toed shoe), safety glasses (for eye protection), safety hand gloves and appropriate clothing. All this will protect workers from the hazard surrounding them and neglecting the use of these basic safety measures will cause accidents and injuries.

Table 1 shows infrequent use of PPE'S by workers, safety glasses and hearing protection were not used by any

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workers at any construction site, hand gloves and safety helmets were used by a limited number of workers at few construction sites, safety boots which are essential at the construction site were only worn by the majority of workers in 16% of construction site. It is observed that most of the workers wear regular footwear which provides minimum protection at the construction site and are considered unsafe wear in the construction environment. Only 50% off construction site

had workers wearing appropriate clothing and the majority of workers on site found to be in inappropriate clothing. Due to this, an increase in the number of accidents on the construction site becomes rational, specifically minor accident to hand and foot.

### **Heights and Fall Protection:**

In order to construct a permanent structure, various temporary structures such as scaffolds, formworks, shoring, ramps, platform are needed to be created. These temporary structures contribute to a number of accidents in the construction industry by collapsing, workers falling from them. The main contractor, subcontractor and top management must consider height and fall risks as an absolute priority for injury prevention as it may lead to major accidents causing disablement and fatalities. All Construction sites with concrete formwork activities should make sure proper installation and brace of concrete formwork this helps to abide formwork collapse on workers and create a safe environment on construction site. On the other hand, it is observed that none of the 30 applicable construction sites on which workers working on height had a safety harness belt. Only 8% of the construction site with openings on floors and roofs had covered and protected. It is also observed that protection against falling objects due to workers working on structure edges was found only 2 construction site out of 32 applicable sites. Out of 5 construction sites with cranes, only two didn't pass over the public space, only 10% of applicable construction site had stair rails for staircase which increases the chances of falling due to tripping thereby causing accidents. Almost all sites to be observed that concrete formworks were properly installed and braced.

### **Machinery and Equipment:**

Movement of construction material internally on the site from the stores to various location is carried out by machinery like a shovel, JCB, dumpers, forklift and cranes. Even machinery is required for unloading material on site. This operation had to be carried out by skilled workers and operators abiding by safety aspects related to various machines and equipment. On the other hand, if it is not carried out in a safe environment it leads to accidents on the construction site. All these machinery provide a hazardous work environment for all worker involved in their operations. It also imparts efficiency and speed in construction projects. The vehicle operators and co-operators to help in the construction site by using gesture, signs or flags. The presence of a flag person in a construction site is important to help the vehicle operator work more efficiently to finish the job faster and implement safety rules. In this study 7 construction site out of 50 had machinery operating in them. In this above 85% of the site, machinery was equipped with handle and latches which provide easy access to operators. In 42% of the sites, machinery was secured when not in use, care should be taken in parking the machinery when not in used in safe areas rather than near the steep excavation or hazard-prone areas. Out of the 7 sites only at one site operators used seat belts while operating the machine. This is the case of pure negligence of safety aspects not enforced by the authorities (Safety officers and construction manager) on construction site and also none of the sites are having flag person to help main operators. This is most likely because flag person generally is seen as an extra cost to the contractor.

### **Excavation:**

Excavation being very important and foremost activity on site for making foundation, temporary water storage, substructure. Safety measures in excavation depend on the area of the site, depth of excavation and type of soil. In this study lack of safety precautions in the most construction site with excavation were observed. Excavation should be supported from outside to prevent soil movement but only 50% of the applicable construction site noticed in this study whereas other sites were lacking in this safety aspects thereby increasing the probability of soil movement and



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collapse hazards. Safe access and safe distance of materials and equipment were found in only 2 sites out of 7 applicable sites. This makes the process of evacuation during emergency more complicated and hazardous and also becomes very likely for materials and equipment to fall into the excavation not properly handled. It is also observed that only one out of 7 applicable sites had excavation holes and piles covered with the fence. Here the likely hood of the injuring inexperienced workers is increased. These results reveal the existence of many hazards in the excavation construction site and this to be managed in order to create a safe zone for the workers to perform their work.

## IV. CONCLUSIONS AND RECOMMENDATIONS

In our study we considered five groups of basic safety aspects prevailing in the construction industry neglecting of these aspects leads to minor and major injuries at the site. In our study, we noticed a few safety aspects were found and implemented on sites whereas the majority of others are not given importance and neglected by the authorities. All different safety aspect rule which was given little importance in safety performance needs significant improvement in safety practices. Out of the 34, safety aspects explode in our study, few are not observed in any of the 50 focused construction sites like display of emergency exists, workers wearing safety glasses, workers wearing hearing protection, safety belts for workers fall protection and availability of flag person for machinery. These show the general negligence of construction manager and project owners in terms of safety consideration. In order to improve the safety performance of the construction industry in general, different participants (main contractor, subcontractors, owners, engineers, workers) must give high priority to safety aspects on construction sites. Based on the study conducted and information gathered from 50 construction sites following recommendations for the improvement of safety aspects in the construction industry are:

1. Prepare safety procedures, manuals, guidelines, and checklist for the construction industry related to type and size of construction enforceable by law.
2. Government and private bodies exclusively deploy safety team on construction sites for inspecting, monitoring and enforcing safety aspects in the construction site.
3. Construction team (owner, engineer/architect, contractor).
4. Neglecting safety aspects in construction site are held accountable for not maintaining the safe environment in the construction site.
5. Advice to conduct safety awareness, workshops and meetings with all the participants of a construction site at fixed duration (weekly or monthly).
6. Promote the implementation of safety practices throughout the life cycle of building and structures.
7. Arrange safety training courses to workers by a recognised institution to develop professional skills.
8. Depute qualified safety person on site as per the nature of the job.
9. As the construction industry is growing, invent and publish other safety aspects and create awareness among the public.

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