

REVIEW ON CONSTRUCTION SAFETY MANAGEMENT IN BUILDING CONSTRUCTION PROJECTS

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Abstract-

In India after agriculture sector, construction sector is considered to be the second largest sector. Construction work is considered to be one of the most dangerous industrial activities. As compared to any other industry rate of accidents are more in construction industry. Every year, many people fall victim to injuries, harm and even deaths due to accidents at construction sites. Therefore, it is crucial for the construction industry to control site accidents. Despite having advanced technologies and several laws, safety in construction projects is not fully ensured which leads to occurrence of very large number of accidents. All this points out need for construction safety management. Safety Policy & Safety Plan, Roles/Responsibility and Authority, Safety Organization, Safety Communication, Safety Culture, Safety Monitoring Programme, Training/Orientation etc. are various measures to be followed while implementing safety management. The aim of this report is to determine types and causes of construction accidents, their effects, factors affecting construction safety performance with their ranking and at the end certain recommendations to promote safety are discussed. For this, a questionnaire survey method is used. After extensive literature review questionnaire survey form was designed and distributed among construction personnel. From responses obtained thereafter was used to arrive at final conclusion.

Keywords: Construction accidents, Construction safety management, Construction safety performance, Safety measures

I. INTRODUCTION

In India after agriculture sector, construction sector is considered to be the second largest sector. The construction sector is labour intensive, provides employment to around 33 million people. According to industry estimates, it is expected that the Indian construction industry will generate additional employment of 47 million. Due to which the total number of persons employed in the sector will reach to 83 million persons by 2022. Construction work is considered to be one of the most dangerous industrial activities. As compared to any other industry rate of accidents are more in construction industry. Every year, many people fall victim to injuries, harm and even deaths due to accidents at construction sites. Therefore, it is crucial for the construction industry to control site accidents. Accident statistics for Indian construction are not readily available. Although the exact data of fatality for the construction industry is not separately available in the case of India, frequent news reports of accidents at construction sites suggest very acute construction safety problems in country. Out of total world labour force, the Indian construction labour force is about 7.5% and it contributes to 16.4% of fatal global occupational accidents.

Despite having advanced technologies and several laws, safety in construction projects is not fully ensured which leads to occurrence of very large number of accidents. Properly investigating the root causes of such accidents and the actions required to address these accidents is a difficult task to accomplish. Speaking of India, safety management in construction is still in very primitive stages. Safety management is still superficial in Indian construction and the modern safety management concepts are yet to be employed. Fault-finding and not addressing systemic issues still plagues this industry, and there is an urgent need to change this old approach. All above discussion addresses the need for construction safety management.

Objectives of this research work are:

- i. To study hazards and safety measures of various construction activities,
- ii. To determine the effects due to poor construction safety management,
- iii. To identify factors affecting safety performance in construction projects,
- iv. To establish relative importance among factors affecting safety performance in construction

The aim of this report is to determine types and causes of construction accidents, their effects, factors affecting construction safety performance with their ranking and at the end certain recommendations to promote safety are discussed. For this, a questionnaire survey method is used. After extensive literature review questionnaire survey form was designed and distributed among construction personnel. From responses obtained thereafter was used to arrive at final conclusion.

II. OVERVIEW ON CONSTRUCTION SAFETYMANAGEMENT

It is well recognized that the construction is dynamic in nature and highly accident prone. So for safety management of the project below listed measures should be applied:

1 Safety Policy & Safety Plan:

Safety starts with the mindset that accidents may be avoided and that safe working procedures must be followed. Individuals controlling the work should integrate safety into regular work practices and regularly emphasize the importance of safety over that of expediency. In this regard, project management should develop a health and safety policy to convey the management commitment and intent of the organization towards health and safety. In order to meet the requirement of health and safety policy, a health and safety plan should be developed. Health and safety plan should identify and enumerate the control measures to mitigate the risks to the workers arising out of health and safety issues. After approval of the safety plan by the Project Director, the plan should be considered as a reference document for implementation, control and monitoring of health and safety aspects of the project.

2 Roles, Responsibility and Authority:

Project management should define, document and communicate the roles, responsibilities and authorities of all personnel who manage, perform and verify activities having an effect on health and safety risks including principal contractors and their sub-contractors. It is up to the top management to take absolute responsibility for health and safety. They should exhibit a visible management commitment and felt leadership towards health and safety. Top management should clearly transmit the message to the line management and people down the level in the organization that it considers safety as core value. Such messages when reaches to all the levels in the organization enable to create a positive health and safety culture.

Health and safety at work are directly under the control of the line management staff who are in responsible for executing the activities. Management should provide adequate resources (human resources, organizational infrastructure, technology and financial resources) necessary to effectively manage the health and safety requirements of the project.

3 Safety Organizations:

A robust safety organization assists in implementation of safety aspects in an effective manner. So, it is necessary to have such a setup at every construction site. In this context, following need to be ensured:

- A well-defined safety organization should be available at every site. Their responsibility is to guide the management on health and safety issues and facilitating the implementation of health and safety in the project site. A department should hold the position of the head of the safety organisation, and other functionaries can be combination of safety personnel of department and contractor in a approximate ratio of 1:3. There should be a well-defined interface between the safety setup of Department and Contractor.
- Safety organization should comply with all the requirements such as safety surveillance, safety training, safety enforcement measures, safety audit etc. related to all works.

4 Safety Communication:

Effective communication of workplace health and safety information is critical for preventing worker's injury and illness. In the following ways, health and safety hazards and risks may be communicated:

- Sharing of accident case studies
- Collecting feedback on health and safety from workers and appropriately addressing them for continual improvement.
- Health and safety posters and displays.
- Health and safety campaigns
- Sharing of results of the inspections, audits and other monitoring systems
- Safety signage etc.

Open communications with the workers motivate them to work safely and project management should always be ready to listen to their suggestions for improvement. The top management should clearly communicate that it considers safety as core value and it would not allow it to get compromised.

5 Safety Culture:

It is the product of individual and group values, competencies, attitudes, perceptions, and patterns of behaviour that determine the style, commitment, and proficiency of an organization. Project management should develop a safety culture that will give appropriate priority to safety realizing that safety has to be managed like other areas of the business. The presence of a positive safety culture is the most important factor in preventing injuries and in ensuring safe working conditions / practices. Management should always recognize importance of best established practices for development of sustained positive safety culture.

6 Safety Monitoring Programme:

The objective of the safety monitoring programme should address assurance of effective implementation of safety

measures in execution of works. There is proactive and reactive safety monitoring measures. Following are some of the safety monitoring measures that should be in place at sites:

Safety Inspections/audits should be carried out to observe the physical conditions of work and the work practices and procedures followed by workers and suggest measures to be adopted for removing the unsafe physical conditions and preventing unsafe actions by workers.

Specific surveillance should be ensured with respect to testing of equipment, electrical equipment and tools, transport equipment, earth moving equipment, portable power tools, hand tools, surveillance of material handling equipment, gas cylinders etc. to comply with various statutory requirements.

As a part of reactive monitoring measure, all incidents including near miss cases should be thoroughly investigated, direct and root causes determined and corrective action planned. The safety organization should monitor, maintain records and follow-up corrective actions to ensure effective implementation of the safety monitoring programme.

7 Training/Orientation:

Safe workplaces and safe work systems are key requirements to reduce accidents on construction sites. Safe workplaces can be created, but safe work systems can only be ensured through proper training of workers. Project management should ensure that all workers are competent to perform the assigned work safely on the basis of appropriate education, training and experience. Safety training should be a part of all construction work. It should include

- Hazards associated with work
- First aid
- Fire prevention & protection measures
- Accident Prevention
- Use & maintenance of safety equipment etc.

The training/orientation programme like induction training, refresher training, job specific pre-job briefing, on the job training should be carried out as mandatory requirements in line with the procedure made for training. Induction cum orientation training should cover the general instruction of the various hazards of the unit and the particular work, overall safety aspects of the unit and general do's and don'ts. Workers should be given demonstrations on use of personal protective equipment (PPE), use of tools etc. Records of training/re-training should be maintained. Refresher training should be carried out periodically. Pre-job briefing on day-to-day basis prior to start of specific hazardous jobs should be conducted in order to make the workers aware of the hazards and the precautions to be taken.

8 Certification of Construction Workers:

With increased experience and greater safety awareness, accident frequency decreases. In order to ensure that every worker on the job site has undergone safety awareness and job related hazards training before permitting them to begin the work, an accepted method of certification of construction workers need to be followed for the construction works.

Regular in depth training is required for these line managers, since they provide an interface between workers and health and safety practices at work. In the field of safety orientation, certification should also apply to all these line managers. After training and assessment of performance, this certification may be granted.

9 Engineering Solutions:

Engineering solutions that are appropriate for the situation should be used to prevent inherent unsafe conditions like faulty access ladders, unguarded working platforms, unguarded floor openings etc. It is one of the most effective hazard control techniques wherein the workers are isolated from the hazard rather than removing the hazard altogether. Common examples include interlocking systems, mechanical guards and safeguarding devices such as fences, safety mats etc. An established system to ensure the safety of work places should be available such as approved procedures, use of best practices; periodic checks etc. to maintain the place of work in a safe manner.

10 Safety Work Permit:

In order to ensure safety in all hazardous jobs such as work at height, using chemicals, excavation, performing electrical works, working in confined spaces, welding and gas cutting etc., safety permit should be taken. The procedure for work permit should be well established and practiced. The importance of permit system should be impressed upon by the line management. The record of the permit system should be kept in a systematic way and periodically checked by safety officials.

III. RESEARCH METHODOLOGY

Under research methodology in the preliminary stage, literatures from all available sources were reviewed. On the basis of literature review questionnaire form is designed. Designed Questionnaire survey form consists of following sections:

- Section 1: General information
- Section 2: Types and causes of construction accidents.
- Section 3: Effects of construction accidents.

• Section4: Factors affecting improper safetymanagement.

Nextly, the questionnaire had been distributed to various construction professionals associated with high rise building construction. Total 40 number of filled questionnaire forms was retrieved which are sufficient for qualitative analysis.

IV.RESULTS AND DISCUSSION

1 General:

As stated in methodology in the preliminary stage,literatures from all available sources were reviewed. On thebasis of literature review questionnaire form was designed. Designed Questionnaire survey form consist of followingsection:

- Section 1: General information
- Section2: Types and causes of constructionaccidents.
- Section3: Effects of construction accidents.
- Section4: Factors affecting improper safetymanagement.

Nextly, the questionnaire had been distributed to various construction professionals associated with high rise building construction. Total 25 number of filled questionnaire forms was retrieved which are sufficient for qualitative analysis.

2 General Information about Respondents:

It is obvious that the quality of the data collected by a questionnaire survey is highly dependent on the experience and knowledge of the respondents. Section 1 of questionnaire form deals with general information of respondents which consist of Name of respondent, Name of respondent’s organisation/company, Respondents primary role/responsibility in their organisation (designation), Years of experience. These questions were therefore involved to ensure that the respondents were suitable qualified to take part in the survey.

In questionnaire survey when respondents were asked about their roles/ responsibility within the organizations; then out of 25 respondent, 36% respondents stated that they were site engineer, 28% respondents were project manager, 24% were contractor and 12% respondentswere safety personnel. See Table 4.1 and Figure 4.1 below:

Table 4.1: Role/Responsibility (Designation) of Respondent

Role/Responsibility(Designation) of Respondent	Frequency	Percentage(%)
Project Manager	7	28.00
Safety personnel	3	12.00
Site Engineer	9	36.00
Contractor	6	24.00

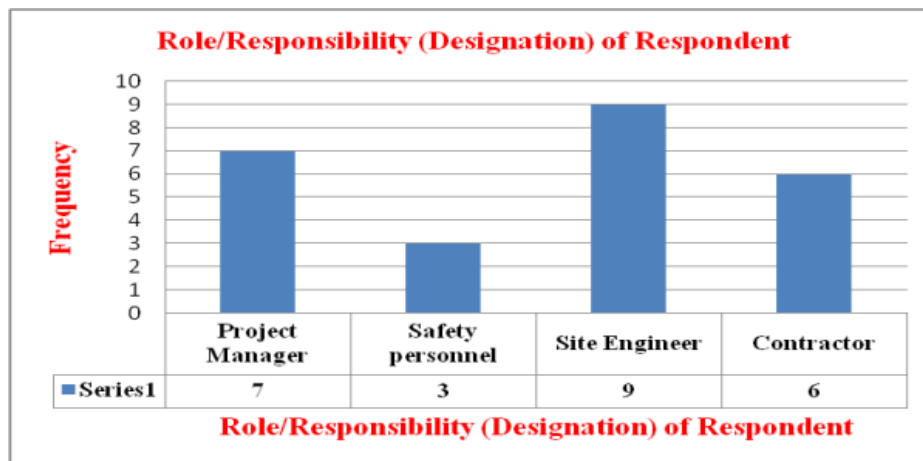


Figure 4.1: Role/ Responsibility (Designation) of Respondents

Table 4.2 and Figure 4.2 below shows the Respondent’s years of experience. The largest group (32%) had 5-10 years of experience, followed by 28% with 0-3 years, 24% with more than 10 years, and 16% with 3-5 years of experience. This result about respondents year of experience approve that the respondents have widespread ranges of experience and it can be determined that they all have adequate knowledge to take part in this research.

Table 4.2: Percentage (%) of Respondents Year of Experience

Respondent’s Year of experience	Frequency	Percentage(%)
From 0 to 3 Years	7	28.00
From 3 to 5 Years	4	16.00
From 5 to 10 Years	8	32.00
More than 10 Years	6	24.00

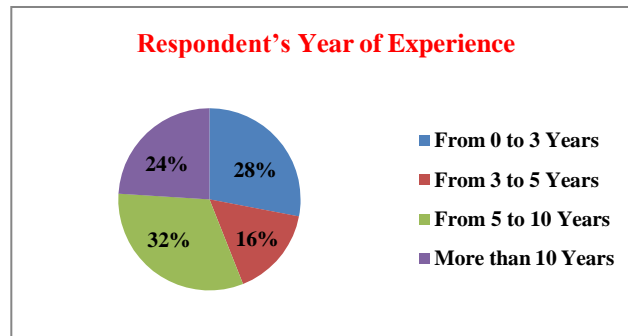


Figure 4.2 Respondent's Year of Experience

Further it was found that, against question *Are you aware with Safety Management in Construction Project? And Is your organisation applying safety management in construction projects?*, all i.e. 100 % respondents respond **YES**. This means that all respondents were familiar with construction safety management and their further answers will be their true opinions.

3 Types and Causes of Construction Accidents:

In section 2 of questionnaire form types of construction accidents and their causes from respondent's point of view were collected. Following Table 4.3 shows details of responses received regarding types of construction accidents.

Table 4.3: Types of Construction Accidents Causing Fatal Injury

Type of Construction Accident	Frequency	Percentage(%)
Scaffolding Accident	9	36.00
Slip, Trip and Falls	7	28.00
Crane Accident	1	4.00
Electrical Accident	1	4.00
Getting Caught inbetween Objects	0	0.00
Fire and Explosions	2	8.00
Falling debris, materials or objects	5	20.00

From above Table 4.3 it is clear that according to most of the respondent (36%) *Scaffolding Accident* is the type of construction accident causing fatal injury followed by *Slip, Trip and Falls* (28%) and *Falling debris, materials or objects* (20%). So Scaffolding Accident, Slip, Trip and Falls and Falling debris, materials or objects these types of construction accidents needs to be focused from safety management point of view.

Further respondents were asked about causes of construction accidents. Following figure 4.3 illustrate in detail the respondents answer to one of the survey question asked to show how strongly they agree or disagree with some factors which cause accidents and injuries on sites.

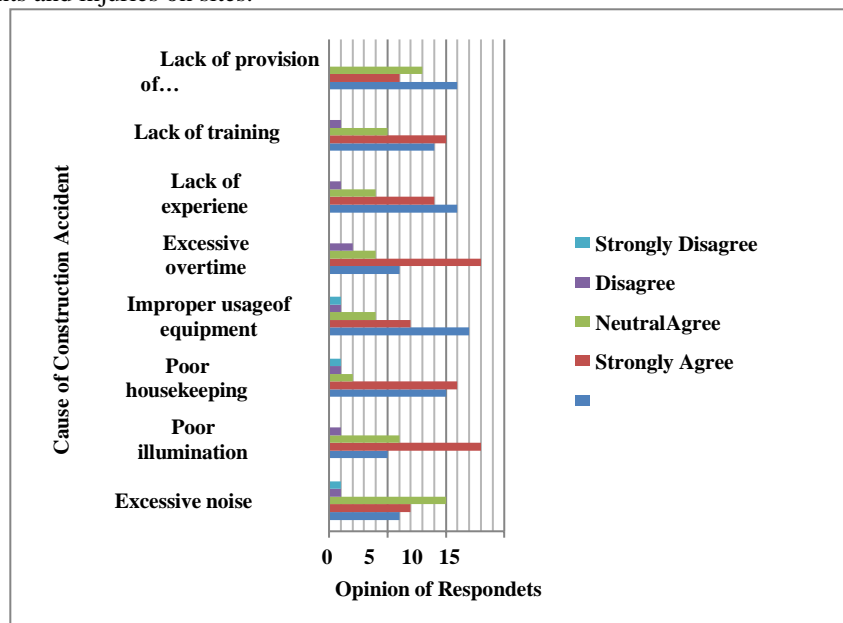


Figure 4.3: Causes of Construction Accidents

From Figure 4.3 it is clear that all above causes are less or more responsible for construction accidents or injury. Using the RELATIVE IMPORTANCE INDEX the causes resulting to accidents on construction sites can be achieved according to importance. Relative Importance Index can be calculated using formula-

$$RII = \Sigma W / A * N$$

Where;

RII: Relative Importance Indices;

W: Weights given to each construction safety management problems by the respondents (Ranging from 1 to 5),

A: Highest weight (i.e. 5 in this case), and

N: Total number of respondents. (25 in this case)

Relative Importance Index and ranking of factors causing construction accidents are enlisted in Table 4.4. From Table 4.4 it is clear that, according to respondent's opinion Lack of experience is 1st ranked cause of accident with RII of 0.840, Improper usage of equipment is 2nd ranked cause of accident with RII of 0.824 and Lack of provision of Personal Protective Equipments is 3rd ranked cause of accident with RII of 0.824. So from this data with respect to safety management point of view we can conclude that always employ skilled labours having sufficient experience of work, those are well trained, always wearing Personal Protective Equipments.

Table 4.4: Cause of Construction Accidents with RII & Ranking

Cause of Construction Accident	RII	Rank
Excessive noise	0.728	8
Poor illumination	0.776	7
Poor housekeeping	0.824	4
Improper usage of equipment	0.824	2
Excessive overtime	0.784	6
Lack of experience	0.840	1
Lack of training	0.816	5
Lack of provision of Personal Protective Equipments	0.824	3

4 Effects of Construction Accidents:

In section 3 of questionnaire form effects of construction accidents from respondent's point of view were collected. Following Table 4.5 shows details of effects of construction accidents with Relative Importance Index and ranking

Table 4.5: Effects of Construction Accidents with RII & Ranking

Effects of Construction Accident	RII	Rank
Negative impact on reputation of firm	0.824	2
Cost of medical bills/ expenses	0.824	1
Cost of workman compensation	0.800	5
Loss of productivity	0.800	4
Negative impact on psychology of worker	0.816	3

From above table it is clear that, according to respondent's opinion Cost of medical bills/ expenses is 1st ranked effect of construction accident with RII of 0.824, Negative impact on reputation of firm is 2nd ranked effect of construction accident with RII of 0.824 and Negative impact on psychology of worker is 3rd ranked effect of construction accident with RII of 0.816. So the most responded effect of construction accident *Cost of medical bills/ expenses* must be kept in mind.

5 Factors affecting Safety Performance:

In section 4 of questionnaire form respondent's opinion about factors affecting safety performance were collected. Following Table 4.6 shows details of factors affecting safety performance with Relative Importance Index and ranking.

From Table 4.6 it is clear that, top five factors affecting safety performance according to respondent's opinions are;

- Poor accident record keeping and reporting system,
- Poor equipment,
- Lack of safety training,
- Lack of protection in material carrying,
- Lack of safety inspection

So these factors must be taken into account while implementing construction safety management.

Table 4.6: Factors Affecting Improper Safety Management with Relative Importance Index and ranking

Factors affecting Improper Safety Management/ Safety Performance	RII	Rank
Poor accident record keeping and reporting system	0.864	1
Lack of safety inspection	0.856	5
Lack of staff for safety department	0.848	6
Lack of emergency plans and procedures	0.84	7
Lack of safety training	0.856	3
Lack of protection in material carrying	0.856	4
Poor selection and control of subcontractor	0.832	11
Lack of promotion on safety matters	0.832	12
Lack of management commitment towards safety	0.84	9
Lack of experienced project manager	0.76	18
Reckless actions	0.792	17
Lack of skilled labours	0.824	13
Excessive overtime work	0.792	15
Poor equipment	0.856	2
Lack of Personal Protective Equipments (PPE)	0.84	8
Lack of budget allocation for safety management	0.824	14
Poor legislation, codes and standards	0.792	16
Ineffectiveness of current safety policies	0.832	10

Lastly in the questionnaire survey respondents were asked about Strategies to reduce problems in implementing Construction Safety Management. Following Table 4.7 shows details about strategies suggested by respondent for safety management implementation with their Relative Importance Index and ranking. From this Table 4.7 it is clear that Provide effective safety training is 1st ranked strategy by respondent with RII of 0.896, Give rewards to the workers who exhibit excellent safety performances is 2nd ranked strategy with RII of 0.864 and Impose penalty to the workers who have offended the safety rules and regulations is 3rd ranked strategy with RII of 0.864. So effective safety training to workers is one of the effective strategies to implement safety management in building construction projects.

Table 4.7: Strategies to Reduce Problems in Implementing Construction Safety Management with Their Relative Importance

Index and Ranking.

Strategies to reduce problems in implementing Construction Safety Management	RII	Rank
Provide effective safety training (e.g. using photographs and videos)	0.896	1
Allocation of budget for safety management	0.832	7
Impose penalty to the workers who have offended the safety rules and regulations	0.864	3
Give rewards to the workers who exhibit excellent safety performances	0.864	2
Full commitment from the top management	0.824	8
Recruit more staff for the safety department	0.832	6
Provide safety booklets in various languages	0.848	4
Include cost for safety management in the Bills of Quantity (BQ)	0.84	5

V. CONCLUSION

For research work about 5 numbers of responses received against questionnaire survey were analyzed and concluded that from respondents point of view Lack of Experience is the top most cause of construction with RII of 0.840 followed by Improper Usage of Equipment and Lack of PPE are 2nd and 3rd ranked cause of construction accidents with RII of 0.824. This means that in order to ensure safety by minimizing construction accidents one can employ skilled and experienced worker having safety training with sufficient PPE.

According to respondent Cost of Medical Bill/Expenses is 1st ranked effect of construction accident which can be saved through effective construction safety management.

Poor accident record keeping and reporting system, Poor equipment, Lack of safety training, Lack of protection in material carrying, Lack of safety inspection are the top 5 factors affecting safety performance.

According to respondent Providing Effective Safety Training to workers is 1st ranked strategy to implement construction safety management. Further respondents also suggested that Give rewards to the workers who exhibit excellent safety

performances and impose penalty to the workers who have offended the safety rules and regulations could be one more strategy to implement construction safety management effectively.

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