Current Trends in Technology and Science
ISSN: 2279- 0535. Volume: 3, Issue: 4(June-July 2014)

Safety and Emergency Management on Construction Sites

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Abstract - The construction industry has one of the largest employers in India after agriculture and there is rapid development in construction industry. Safety of human life is most important than any other thing. Most People come from rural parts, so lack of knowledge about their safety and also lack of training are some of the major causes of accidents. As construction industry is growing, proper safety and emergency management is needed. This study uses safety and Emergency management (SEM) guideline Model for effective safety management. Data collected through questionnaire survey was analyzed with four residential sites and SEM guideline model developed which can be of great help for safety of engineer and trainer.

Keywords – Safety management, Emergency management, Accidents.

1. INTRODUCTION

India is a developing country and most developments are going on in construction industry. India has maximum manpower to utilize as optional to the machine work to promote employment. Over 3 crore people are working in construction industry of India. Across the world, it is felt that safety in construction industry is matter of concern. In India this is among one of the most important issues. Last year 1000 workers got injured and 341 workers died at construction site as per international labor organization (ILO). Human life and safety is most important than anything, so systematic safety and emergency management is required at construction site.

Not only construction industry but also government should take active participation in this process. As per National safety council (NSC), till day many construction companies do not have safety and emergency department. The responsibility is just given to individuals who do not posses proper knowledge and experience in this field. The safety record of construction industry is always poor. Sometimes though there are safety and emergency provision made but implementation of these provisions are not found which can prevent accidents. Government must give not only proper guidelines and effective implementation of laws but also should actively participate in it by the medium of surprise safety and emergency audit by government itself.

1.1 Safety Management Problem

Safety means no loss of people, process, and property. The step we take and the program we put in place to avoid loss is called as safety management or Safety management is the implementation of a safety management system into a organization and safety is nothing but the condition of being protected from the risk and injury. Emergency management is the discipline dealing with and avoiding both natural and manmade disasters. Emergency is a serious, unexpected and often dangerous situation requiring immediate action.

Following are the main safety management problems in construction companies in Pune.

[1] Motivation problem,[2] No use of PPE'S ,[3] Communication problem,[4]Lack of knowledge about safety in workers.

1.2 Objective of study

- Study the current status of safety and emergency management on construction sites.
- To study and determine data required for SEM in residential project with respect to following
  a) Safety activity b) Emergency activity c) Activity characteristics d) Risk assessment
- To study following parameters for SEM
  a) Height of building b) Hazards area identification c) Processing and monitoring d) Warning and report
- Develop a SEM guideline model.

1.3 Safety management

For avoiding these accidents, SEM guideline model can be developed with the survey of various sites with their data and parameters regarding safety management. It is developed based on questionnaire survey, data collection, interviewing safety engineers from all the four sites selected for study. It contains the organization chart, general safety rules and gives activity wise precaution on the site.

The main purpose of SEM is to reduce the accidents on site and enhance safety management on sites.

2. ANALYSIS

2.1 Case Study

In Pune, 4 construction companies were surveyed regarding their current safety management process. This Survey was questionnaire type survey. The survey was taken regarding safety and emergency (SEM) as well as accidents on sites. Following tables contains the detail analysis of four surveyed companies with questionnaire .It was found that the safety management on site is poor and problem of implementation of safety are various.

Table.2.1 Table For Analysis Of Surveyd Construction Companies For Safety Management

Name of Company	Adwitiya (P) Ltd. Company no.1	Paranjape Infrastructure (P) Ltd. Company no.2	Creative Reva Associates company no.3	Suvijay buildcon (P).Ltd Company no.4
Type of project	Residential	Residential, SEZ, School, Malls	Residential, Commercial	Residential, Commercial
Cost of project (Cores)	100	5000	50	10
Is SM carried out?	Yes	Yes	No	Yes
Method adopted for SM process	No	HIRA	No	HIRA
Using PPE'S	Yes-	Yes	No	Yes
Satisfaction of Current SM process?	Yes	Yes	No	No
Benefit of current SM	Accidents are reduces.	Minimum accidents on sites. Profit to organization.	No	Minimum accidents on sites. Management is controllable.
Problem facing in current SM	Motivation problem Financial problem	Motivation problem, not use PPE	No	Workers not use PPE'S ,Motivation problem
Why do you feel need of SM?	SM is important for legal and finical aspects. So it is duty to safe people on the sites.	For accidents reduces, provide safe and secure environment for work.,	Yes, but they want free of cost for SM and they did not need the safety on the sites.	for accidents reduces, provide safe and secure environment for work.
SEM guideline model used?	No	No	No	No
How record and maintain the accidents on sites	Accidents investigation format and first aid register at every sites.	Accident reports First aid box content Incident near miss report	No anyone record on the sites.	Fire fitting register. Emergency prepaidness and response plan. Accident report

2.2 Results

2.2.1 Types of the accidents and its causes

After completion of questionnaire survey, following outcomes were found regarding safety management from the various four construction companies. As per the study, we have analyzed the total number of accidents and their causes. These accidents are classified into 2 types-major and minor, in major cases death, permanent body part injury, fatal etc. and in minor cases first aid cases, temporary body part injury etc. are recorded. It is found that Total major accidents are 9 in number and minor are 18 numbers. Based on the no of accidents causes are classified into three categories with percentage as follows.

Unsafe act (67%)–following activities are considered as an unsafe act

1. Operating without permission
2. Using unsafe tools/equipment
3. Avoiding instruction procedure
4. No use of PPE's

Unsafe condition (26%)-following activities are considered as an unsafe condition.

1. Improper barricading
2. Poor housekeeping
3. Improper electric connection.

Beyond human control (7%)

Current Trends in Technology and Science
ISSN: 2279- 0535. Volume: 3, Issue: 4(June-July 2014)

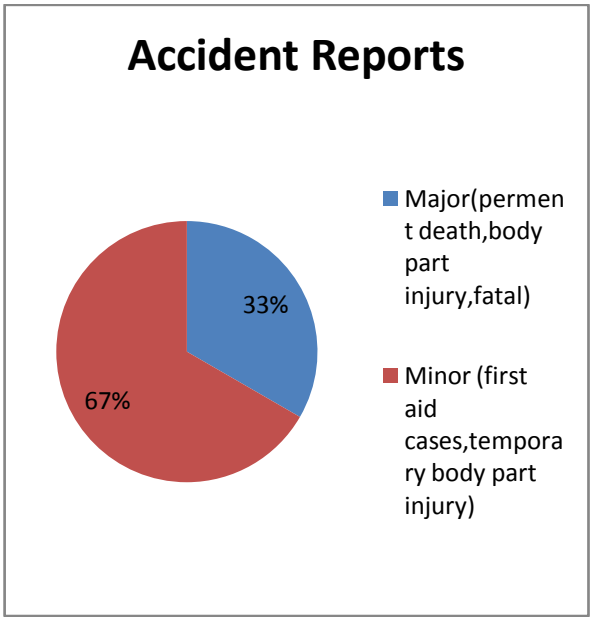

Fig.no.2.1 Accident reports

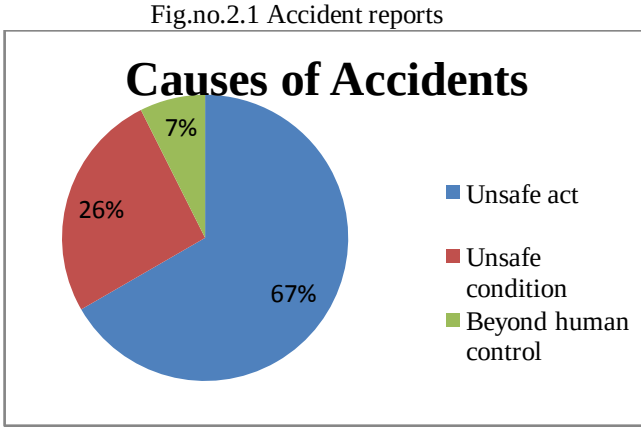

Fig.2.2 Causes of accidents

3. Safety and Emergency Management (SEM)

As discussed regarding causes of accident and type of accident, model has been suggested which describes the organizational chart along with duties and responsibilities of various safety personal and also matrix has been designed a consider activities which need special attention with respect to duties and responsibilities of safety on site.

Fig.no.3.1 Organizational structure

3.1 Safety on Construction Sites-Model

The matrix is prepared of safety activity and safety official responsible for the construction sites that is safety manager, safety officer, safety supervisor and for each activity duties and responsibility of safety official is defined. Based on questionnaire survey of four construction sites, on construction sites, various activities are available but for this model I have chosen some most dangerous activities namely
1.Excavation 2.Scaffolding 3. Plastering 4.Welding and gas cutting 5. Fire

Table.3.1 Safety activity and personal Responsible

	Safety officials		
Safety Activities	**Safety manager**	**Safety officer**	**Safety supervisor**
Excavation	• Design checklist. • Establish direct communication with safety officer and other key person.	• Monitor hazards like serious body injury, falling of person. • Monitor work site. • Site induction to new workers.	• Inspection of check list. • Various sign boards. • Inspection of PPE'S like safety belt, shoes.
Scaffolding	• Design checklist • Assembly of scaffolding. • Erected on solid footing	• Monitor hazards like fall of person, materials. • Develop and procedure of safe system work.	• Inspection of check list. • PPE'S like safety belt, safety helmet. • barricade the area
Plastering	• Design a proper platform. • Safety net provided.	• Monitor hazards like fall of person, skin causes.	• Check standing platform. • Proper housekeeping.

	• Tool box meeting conducted • Work permit procedure.	• Monitor the availability of PPE'S	• Barricade the area.
Gas cutting and welding	• Proper connection of electricity. • Earthing provided. • Work permit procedure.	• persons working should be trained. • Monitor hazards like dangerous gases, electric shocks.	• Check PPE'S like safety goggles, shoes. • Proper ventilation. • Proper eye protection.
Fire	• Establish a team. • A system of permit to work. • Supply of water. • Fire measures,	• Check persons must be trained and he knows about fire. • Maintain fire extinguishing equipment.	• Check PPE'S. • Schedules of daily, weekly inspections. • All combustible materials are kept away from fire.

3.2. Decision Making Model-Safety activity

In this model a matrix has been designed to consider a hazardous activity which needs special attention with respect to the safety personal on sites. Hazardous activity contains the probability of occurrence in terms of safety activities. Assumed that the actions of safety activities are well maintained. An attempt is made to suggest a model which will help the safety personal to take decision under various probability of occurrence of event and will thus improve and enhance the safety activity on construction site.

Table no.3.2 shows the details of general matrix of decision making model.

Table.3.2.General matrix

Actions to control safety activity	Probability occurrence of Hazardous activity in terms of intensity(P)		
	SmSall (P1)	Medium (P2)	High(P3)
A1	a_{11}	a_{12}	a_{13}
A2	a_{21}	a_{22}	a_{23}
A3	a_{31}	a_{32}	a_{33}

Following are the assumptions

1. All actions required for safety e.g. Fire measures like extinguishers; hydrants etc. are well maintained as per norms in case a fire breaks out. In the model suggested the actions are assumed as A1, A2 and A3 and all are well maintained.
2. a_{11} is the outcome of Safety activity A1 and Probability of occurrence of Hazardous activity with it's 'small' intensity, Similarly a_{12} is the outcome of safety activity A1 and Probability of occurrence of Hazardous activity with 'medium' intensity. a_{13} is the outcome of safety activity A1 and probability of occurrence of Hazardous activity with ' high' intensity, Similarly outcome and probability of occurrence of hazardous activity with various intensity for A2 and A3 actions are mentioned.
3. Losses in case of occurrence will be calculated based on of Hazardous activities are calculated as shown in table 5.13. L is losses due to occurrence of event. Where L_1=loss of life, L_2= delay in work, L_3= other miscellaneous losses A1, A2, A3, are actions to control safety activity. Table.3.2 loss of occurrence

Losses(L)	Actions		
	A1	A2	A3
L1=loss of life	C11	C12	C13
L2=delay in work	C21	C22	C23
L3=other miscellaneous losses	C31	C32	C33

All losses are in rupees

C11, C12, C13= Loss of life with respect to A1, A2, A3 actions

C21, C22, C23 = Delay in work with respect to A1, A2, A3 actions.

C31, C32, C33= Other miscellaneous losses with respect to A1, A2, A3 actions

4. P = Probability of occurrence of accidents.
   P1, P2, P3 are probability occurrences of safety activity in terms of small, medium and high intensity respectively. These intensities are assumed from references.
5. EMV= Expected monetary value.
   Calculate the EMV= Probability occurrence intensity x outcome ($a_{n\,m}$)

Sample calculations are as follows-

3.2.1 Decision making model in case occurrence of fire

Following are the assumptions

1. All actions required for safety are well maintained as per norms in case a fire breaks out. In the model suggested the actions are assumed as A1, A2 and A3 and the all well maintained.
2. a_{11} is the outcome of Safety activity A1 and Probability of occurrence of Hazardous activity with 'small' intensity, Similarly a_{12} is the outcome of safety activity A1 and Probability of occurrence of Hazardous activity with 'medium' intensity, similarly a_{13} is the outcome of safety activity A1 and probability of occurrence of Hazardous activity with 'high' intensity, Similarly outcome and probability of occurrence of hazardous activity with various intensity for A2 and A3 actions are mentioned.
3. Losses in case of occurrence will be calculated based on of Hazardous activities are calculated as shown in table 3.2, L is losses due to occurrence of event.
   Where L_1=loss of life, L_2= delay in work, L_3= other miscellaneous losses
   A1, A2, A3, are actions to control safety activity.
4. P = Probability of occurrence of accidents; P1, P2, P3 are probability occurrences of safety activity in terms of small, medium and high intensity respectively. These intensities are assumed from references.
5. EMV= Expected monetary value.

Calculate the EMV= Probability occurrence intensity x outcome ($a_{n\,m}$)

Table.3.2 In case of occurrence of fire

Action to control fire		Probability occurrence of fire in terms of intensity(P)		
		Small(0.5)	Medium (0.3)	High (0.2)
A1	Fire control measures	95000	140000	600000
A2	PPE'S	85000	100000	480000
A3	Supply of water	95000	130000	600000

For small intensity

$a_{11} = L_1+L_2+L_3$=50,000+20000+25000=95000
$_{a21} = L_{1+}L_2+L_3$=40000+15000+20000=85000
$a_{23} = L_1+L_2+L_3$=50000+20000+25000=95000

Where L_1=loss of life, L_2= delay in work, L_3= other miscellaneous losses

Similarly For medium intensity

$a_{12} = L_1+L_2+L_3$=70,000+35000+35000=140000
$a_{22} = L_{1+}L_2+L_3$=50000+25000+25000=100000
$a_{32} = L_1+L_2+L_3$=70000+30000+30000=130000

For high intensity

$a_{13}=L_1+L_2+L_3$=500000+50000+50000=600000
$a_{23}=L_{1+}L_2+L_3$=400000+40000+40000=480000
$a_{33}=L_1+L_2+L_3$=500000+50000+50000=600000

By using Laplace method

$EMVA_1$=0.5*95,000+0.3*140000+0.2*60000
= Rs.209500
$EMVA_2$=0.5*85,000+0.3*100000+0.2*48000
= Rs.168500
$EMVA_3$=0.5*95,000+0.3*130000+0.2*60000
= Rs.206500

Decision

From the above expected monetary value of action A1 having more loss than other two actions after that action A3 having more loss so we can suggest the safety officer to give first preference to fire measures, then second to action A2 i.e. supply of water and last to A3 i.e. PPE'S.

4. DISCUSSION

Every construction company carries safety management process. Each company does not use advanced technique but at least they carry safety management. According to survey only company no. 2 has good safety management and company no. 3 are not use any safety management and remaining all carry safety management but they are not satisfied with their management because motivation of worker towards safety is most important problem. According to safety engineer of company 2, there should be advanced guideline and need of management from top to bottom level, and then it becomes economical and effective. Therefore there should be a good or new guideline model use rather than current safety management. Some companies' uses HIRA or Job safety analysis for safety management, but it is not effective. The SEM model is having lots of advantages as compared to current safety management.

5. CONCLUSION

Based on questionnaire survey of four companies following are the conclusions.

- From questionnaire survey it is found out that Reva associate company are not carrying out safety management process. Other three companies carry safety management but only

55% implementation of safety process is done on sites.

- From the surveys of all sites, we analyzed the total number of accidents. These accidents are classified into 2 types -major and minor. In major cases Permanent death, body part injury, fatal etc. and in minor cases first aid cases, temporary body part injury.
- Total major accidents are 9 no. and minor 18 no. based on questionnaire survey and interviewing safety engineers. Major accidents occurs 33.33% and Minor accidents occurs 66.67% from all sites.
- Based on no. of accidents and data collection, mostly accidents are occurred due to unsafe conditions. They are classified as Causes of accidents -unsafe condition 67%, unsafe act 26 %, beyond human control only 7%.
- Safety and Emergency management (SEM) is developed with responsibilities of various safety personals.
- Decision making model under risk, for occurrence of hazardous event is suggested, where the losses in case of accidents are studied with respect to action and probability of occurrence of event.
- By using SEM model these accidents may be reduce up to large extent from the four construction sites. The level of awareness of SEM will be enhanced if proper awareness is carried out than the current safety management.

SEM model is helpful for motivates towards the safety and it increases the company profit due to less accidents. It can be implement from ground to top level of management.

REFERENCES

[1] Ganapathi Bhat, Y.S.Sidde Gowda (2013) 'Safety Management System of Construction Activities in UAE Infrastructure Project' ISSN: 2249 – 8958 international journal of Engineering. Vol-2 Issue-6

[2] Gregory Carter and Simon D. Smith, "Safety Hazard Identification on Construction." journal of construction Engineering and Management," vol 132 , pp.197-205

[3] Jimmie Hinze, xCaroline Pedersen and John Fredley, "Identifying root causes of construction injuries", journal of construction Engineering and Management 1998 vol.124 , pp.67-71

[4] R. Navon, M.ASCE and O. Kolton, "Model for Automated Monitoring of Fall Hazards in Building Construction", journal of construction Engineering and Management Vol. 2, 2006 pp.733-740

[5] S. Chockalingam and T. Sornakumar, "A Study on identifying hazard,aspect and risk in the activities involved at construction site", journal of construction Engineering and Management. Vol.3.no.1.pp.11-31.

Questionnaire

Following are the questionnaire was prepared to carry out survey for safety management.

SR. No.	Details						
1	Name of organization						
2	Name of owner						
3	Address of organization						
4	Address of site						
5	Year of establishment of organization						
6	Turnover of organization						
7	Which types of projects are going on?	1.	2.	3.	4.	5.	
8	Cost of the project						
9	Telephone No.						
10	Email address						
1	Do you carry out safety management on your site?					Yes	No
2	Are you satisfied with current safety management process?						
3	Are there any benefits of current safety management process?						
4	Are you using personal precaution equipments?						
5	Are you using any guild line model for safety management?						
6	Are safety management details have been discussed within the organization?						
7	Is there any type of model is used for safety management?						
8	Are you organizing any safety training process?						

9	Are you maintaining daily diary of principle activity?		
10	Are you carrying out inspection of work sites?		
11	Any special department available for safety?		
12	Any vocational training provided or not?		

Sr. No.	Questions	Comment
13	From when you are using safety management process in your industry?	○ None ○ 6 Months ○ 1 Year ○ 1.5 Years ○ 2 Years ○ 2.5 Years ○ 3 Years ○ 5 years ○ More than 5 years
14	In which activity safety management process is carried out?	○ Exaction ○ Slab formwork ○ Concreting of slab ○ Electric wires/cables ○ Plaster work ○ Painting work ○ Collapse of temporary structure. ○ Collapse of slab, columns.
15	Are you meeting any safety meetings during the project duration?	○ Weekly client ,contractor inspection meeting ○ Monthly safety committee meeting ○ Job specific toolbox meeting.
16	Are you organizing health and safety induction training?	○ Location of first aid/emergency medical treatment. ○ Information regarding any hazards in their areas of work.
17	Have you given copy of hazard data sheet to the safety engineer?	Yes/ No

18. Why do you feel the need to use safety management in your construction industry?
19. What is the process of safety and emergency management?
20. If not, why you don't carry out safety management in your construction industry?
21. What are the benefits of current safety management process?
22. What are the problems you are facing in current management process?
23. How do you record and maintain the accidents on your site?
24. According to your management policy for safety are the numbers of accidents reduced or not?