

HAZARD ANALYSIS AND IMPELEMENTATION OF SAFETY FEATURES IN CONSTRUCTION OF OVER HEAD TANK

Thukkaram. M¹, Saravanakumar.S², P.Nithyanand³, M.Sanjay⁴

¹Student, M.E-Industrial Safety Engineering, Department of Mechanical Engineering, Excel College of Engineering and Technology, Tamil Nadu, India

²Assistant Professor, Department of Safety and Fire Engineering, Excel Engineering College, Tamil Nadu, India

³Assistant Professor, Department of Mechanical Engineering, Excel Engineering College, Tamil Nadu, India

³Assistant Professor, Department of Aeronautical Engineering, Excel Engineering College, Tamil Nadu, India

Abstract: Construction industry has accomplished extensive growth worldwide particularly in past few decades. For a construction project to be successful, safety of the structures as well as that of the personnel is of utmost importance. The safety issues are to be considered right from the design stage till the completion and handing over of the structure. Construction industry employs skilled and unskilled labourers subject to construction site accidents and health risks. A proper coordination between contractors, clients, and workforce is needed for safe work conditions which are very much lacking in Indian construction companies. Though labour safety laws are available, the numerous accidents taking place at construction sites are continuing. Management commitment towards health and safety of the workers is also lagging. A detailed literature study was carried out to understand the causes of accidents, preventive measures, and development of safe work environment. This paper presents the results of a questionnaire survey, which was distributed among various categories of construction workers in Chennai region. The paper examines and discusses in detail the total working hours, work shifts, nativity of the workers, number of accidents, and type of injuries taking place in small and large construction sites. Every construction company shall be responsible for maintaining “Safety, Health & Environment” in their works. Operation line management shall be responsible in enforcing safety norms and standards in their respective areas and activities. Each individual staff/supervisors has the responsibility & accountability in his work assignment and with in his level of experience. Every man in his own safety officer and has a duty to care for his coworkers’ health and safety. All section heads / managers and supervisors develop and implement necessary safety awareness programmes for safe guarding health and safety of their subordinate in accordance with the company policy and procedure.

Keywords: safety practice, improving the performance, management control.

1.INTRODUCTION

The Construction Industry is the second largest economic activity in the country and accounts for 40% of the national and state outlays. Apart from modernization, standardization, increased mechanization and training, quality demanded by the end user today, Safety in Construction should also become the keyword. The effort needs to percolate down to the basic activity in construction projects.

Safety is the number one priority in any construction site and is committed to ensure safe environment capable of protecting human resources and properties. Construction works are dangerous by nature. Many agencies are working together whose co-ordination is important to ensure safety during construction.

Safety in construction is a prime requisite but it often gets neglected on work site. With the advancement in construction technology, the need for proper attention to safety aspects has become essential for human, economic and other consideration. The wide range of construction and building activities involving complex technique have led to many new problems of safety. Proper steps should be taken to improve safety on construction sites so that loss of limb and life, suffering and damage resulting from avoidable accidents is prevented. Promotion of safety measures at site will result in a better work environment, higher productivity and greater contentment among workers. Current Scenario – High Rise Building have become the order of the day in today’s competitive world, where the availability of land is becoming increasingly difficult.

2. LITERATURE SURVEY

Based on the findings of both the literature and descriptive surveys, the following conclusions are drawn. The level of construction fatalities and injuries in South Africa in construction is unacceptable, and a partnering approach is likely to have a positive effect due to the holistic effort of all project stakeholders, project managers included. Health and safety complements cost, environment, productivity, quality, schedule and customer satisfaction.

Health and safety reduces variability and consequently project risk. Health and safety should be both an organizational and project value, as opposed to a priority, as priorities may change. Various processes, strategies, systems and practices, such as suitable procurement systems, constructability management, pre-qualification, partnering, and TQM complement health and safety. PMs are in a unique position as they influence health and safety both directly in their capacity as project leaders and coordinators, and also indirectly through design, detail and specifications. PMs currently contribute to health and safety, which contribution can be used as a foundation for increased consideration.

International research indicates that internal health and safety organizations (HSO) and health and safety committees (HSC) do not have the intended impact on companies' safety performance. The aim of this case study at an industrial plant was to test whether the HSO can improve company safety culture by creating more and better safety-related interactions both within the HSO and between HSO members and the shop-floor. Methods: A quasi-experimental single case study design based on action research with both quantitative and qualitative measures was used. Intervention: Based on baseline mapping of safety culture and the efficiency of the HSO three developmental processes were started aimed at the HSC, the whole HSO, and the safety representatives, respectively. Results: Results at follow-up indicated a marked improvement in HSO performance, interaction patterns concerning safety, safety culture indicators, and a changed trend in injury rates. These improvements are interpreted as cultural change because an organizational double-loop learning process leading to modification of the basic assumptions could be identified. Practical applications: The study provides evidence that the HSO can improve company safety culture by focusing on safety-related interactions.

The current project adds to the safety literature, not only in providing a rare case study on safety culture intervention, but also by showing some evidence for the link between leadership, safety climate, and culture. The study shows that the HSO can improve company safety culture by creating more and better safety-related interactions both within the HSO and between HSO members and the shop-floor. Results indicated a marked improvement in HSO performance interaction patterns concerning safety, safety culture indicators, and a changed trend in injury rates. 17 improvements are interpreted as cultural change because an organizational double-loop learning process leading to modification of the basic assumptions could be identified. However, due to the single case design of the study it is not possible to infer causality.

3. PROBLEM IDENTIFICATION

As per statutory requirement **IS 3786** the four years accident was analyzed and recommended an accident analyses report. We have categorized like Trade wise, Injury wise, Age wise, Type of accident, Unsafe act and Unsafe condition wise based on that recommendation given.

Falls are the most common construction site injury, making up about 35% of all construction accidents. These often occur when a worker falls from scaffolding, ladders, roofs, chimneys, etc. The severity of the fall depends on how far from the ground the worker was when they fell and the circumstances of the fall.

The major factors causing these accidents are technical causes, organizational causes, human causes, and environmental causes.

As per Factory Act sec. 88, Factory Rule no. 96 Accident was notified

$$\text{Freq. Rate} = \frac{\text{No of Reportable Accidents}}{\text{Total Man Hours Worked}} \times 100000$$

$$\text{Severity Rate} = \frac{\text{No of Man Days Lost Due to Reportable Accidents}}{\text{Total Man Days}} \times 10,00,000$$

Man hrs, worked data not available so frequency rate, severity rate was not projected any have accident rate in control.

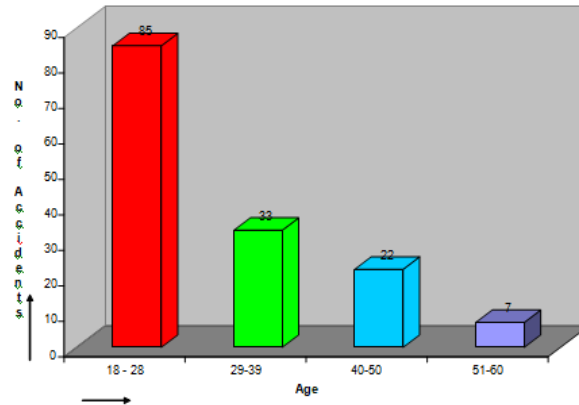


Figure.3.1 Age Wise Accident Analysis

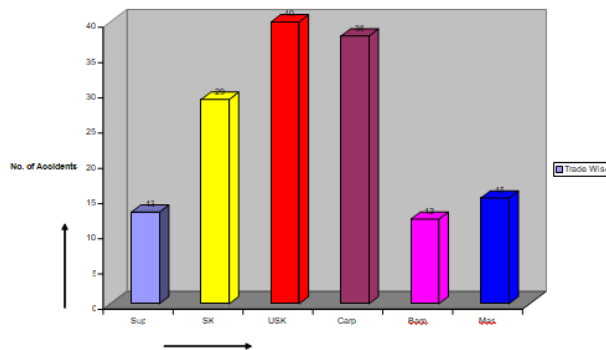


Figure.3.2 Injury Wise Accident Analysis

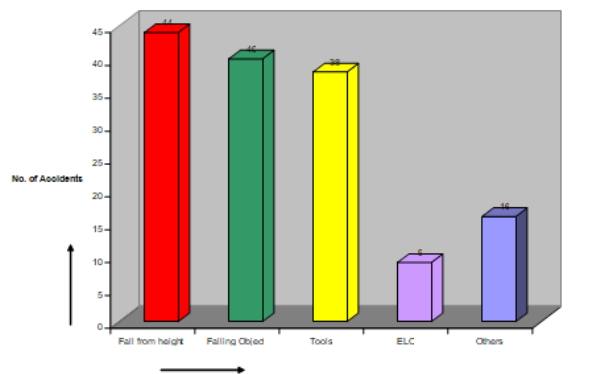


Figure.3.3 Type Of Accident

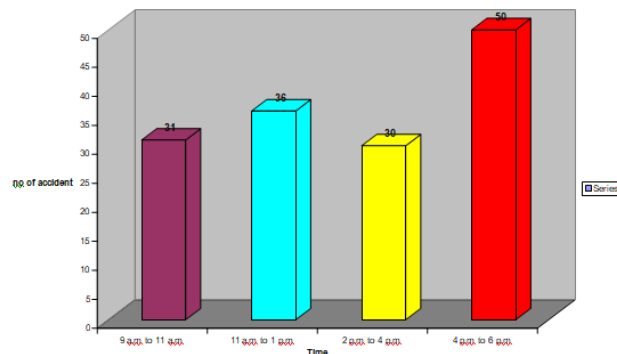


Figure.3.4 Time Wise 2003 - 2007

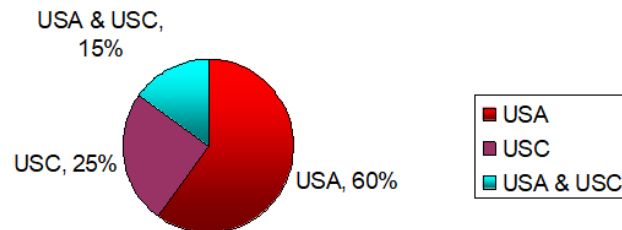


Figure.3.5 Analysis Of Usa / Usc: 2003 – 2007

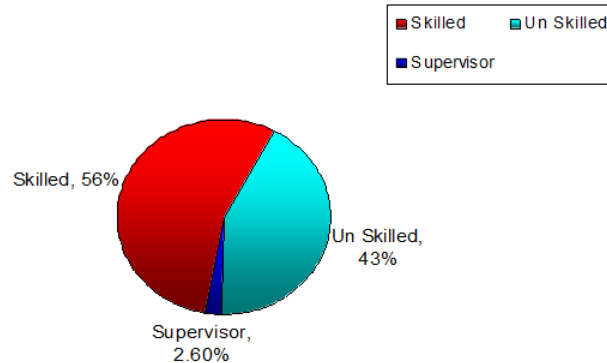


Figure.3.6 Category Wise: 2003 – 2007

4. Methodology

1. By observation in project site.
2. By collecting various data at site.
3. By having discussion with management.
4. By previous accident case studies.
5. By referring websites.
6. By having discussion and collecting data from safety, civil, electrical and mechanical department.

4.1 Legal Aspects

The construction safety is an upcoming field in safety and its legal provisions are ensured by the Building and other Construction Workers (Regulation of Employment and Conditions of Service) Act 1996 and the Building and other Construction Workers (Regulation of Employment and Condition of Service) Rule 1998. Even though the state rules are mandatory still many states have not come out with their rules to supplement the Act.

The Building And Other Construction Workers Act 1996

- ✓ Section 32, Drinking Water
- ✓ Section 33, Latrines & Urinals
- ✓ Section 36, First Aid
- ✓ Section 38, Safety committee & Safety Officer
- ✓ Section: 44. Responsibilities of employer

4.2 The Building and Other Construction Worker's Central Rule 1998

- ✓ Rule 6, Responsibilities of project manager
- ✓ Rules 8, Responsibilities of workers
- ✓ Rule 34, Excessive noise
- ✓ Rule 35, Fire Protection
- ✓ Rule 39, Safety Policy
- ✓ Rule 45, Eye Protection
- ✓ Rules 47, Safety in Electrical Works
- ✓ Section 41, Over Head Protection
- ✓ Rule 50, Illumination of passageway, etc.
- ✓ Rule 51, Stacking of Materials
- ✓ Rule 54, Use of Safety Helmets & Safety Shoe
- ✓ Rules 96, Concreting
- ✓ Rules 119, Excavation.
- ✓ Rules 169, Roofing
- ✓ Rules 171, Crawling Board
- ✓ Rules 172, Ladders

- ✓ Rule 178, Safety Belt
- ✓ Rules 179, Safety Net
- ✓ Rule 183, Erection of Steel & Prefabricated Structure
- ✓ Rules 184, Form Work
- ✓ Rule 186, Stacking of Materials
- ✓ Rule 187, Cement
- ✓ Rule 188, Scaffold
- ✓ Rule 192, Working Platform
- ✓ Rule 210, Reporting of Accident
- ✓ Rule 226, Ambulance Room
- ✓ Rule 231, First-Aid Boxes.

5. SAFETY AWARENESS AND TRAINING

Our organization shall identify training needs and provide appropriate training for all personnel whose work duties having significant effect on safety in accordance with the training procedure.

- Personnel performing specific assigned tasks shall be competent on the basis of appropriate education, training and / or experience, by legislation or regulation requirements and by the organization.
- The knowledge and skill necessary to achieve safety objectives shall be identified and considered in personnel selection and recruitment.
- The contractors have appropriate and requisite knowledge and skill to perform the work in a safe and environmentally responsible manner.
- The training needs shall be identified based on the consideration of the importance of conformance with EHS policy and objectives, significant EHS impacts, personnel work activities, performance, emergency preparedness / response requirements and potential consequences of deviation from specified operating procedures.
- The safety awareness, training and competence program include the following:
 1. Safety induction training for new employees
 2. Safety talks and presentation.
 3. Safety training for supervisor and engineers/
 4. Pep talks.
 5. Display of safety policy
 6. Display of accident statistics
 7. Display of safety signs and posters & Specialized safety training.

5.1 Safe Operational Methods

Site Planning & Layout

A well planned and tidy site is the safe site and prevent accidents resulting from fall of material persons and collisions between workers and plant or equipment space constraints, particularly in urban work sites, are nearly always the biggest limiting factor and a layout, which caters best for the safety and health of workers, may appear to be difficult to reconcile with productivity. Proper planning by management is an efficient running of a construction operation.

Main office industrial relation cum time office, stores, activities, steel storage, bulk materials storage, gases cylinder, Diesel and Greases and paints storage shelters, shall be located suitably. To ensure storage, none obstructing the access to the work location and not near the work areas. Drinking water facilities shall be located in such way ensuring that they are away from urinals and concrete production plant.

Before work even begins on site, thought need to be given to;

- The sequence or order in which work will be done and to any especially hazardous operations process.
- Access for workers on and around the site.
- Routes should be free from obstruction and from exposure to hazards such as falling materials, materials – handling equipment and vehicles.
- Suitable warning notices should be posted.
- Edge protection will be required at the edge of floor opening and stairs, and wherever there is a drop of 2 M or more.
- Routes for vehicular traffic. These should be ‘one way’ as far as practicable.
- Storage areas for materials and equipment. Materials need to be stored as close as possible to the appropriate workstation.

- Artificial lighting at places where work continues or workers pass after dark
- Arrangement to keep the site tidy and for the collection and removal of waste.
- The need for low voltage electric power supplies for temporary lighting, portable tools and equipment.
- Training needs of both workers and supervisors

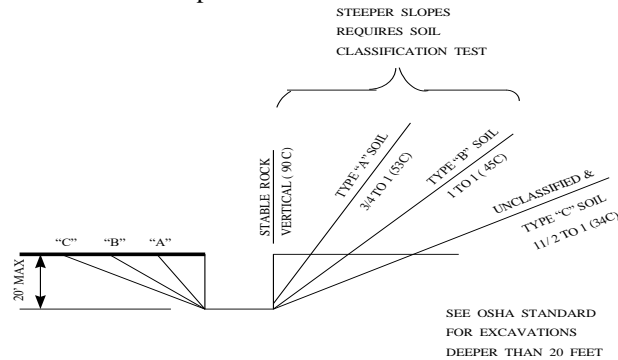


Figure 5.1 Sloping & Benching System

The following table describes the soil types and minimum acceptable slope requirements for excavations

Soil Type	Description	Maximum Slope (Horizontal to Vertical)
Solid rock	N/A	Vertical (90°)
A	Strong soils, compressive strength greater than 3000 lbs./ft ² , clay or clay soils, hardpan, caliches.	¾ to 1 (53°)
B	Medium soils, strength > 1000 lbs./ft ² angular gravels, silty soils, Type A soil which has been disturbed, subjected to vibration or is fissured.	1 to 1 (45°)
C	Weak soils, strength < or = 1000 lbs./ft ² gravel, sand, wet (seeping or submerged) soil.	1 ½ to 1 (34°)

Table 5.1 Excavation Slope Requirement

6.SCAFFOLDING

A temporary structure supporting one or more platforms and which is used either as a workplace or for the storage of materials in the course of any type of construction work

Falls of person from a height, and similarly of materials and objects, represent the most serious safety risk in the construction of high rise building industry. A high proportion of deaths are caused by falls. Many of the falls are from unsafe working places or from unsafe means of access to working places.

7.FIRE PREVENTATION & CONTROL

Fires on construction of high rise building sites arise from the misuse of compressed gas and highly flammable liquids, from the ignition of waste materials, wood shaving and cellular plastic materials, and from the failure to recognize that adhesives and some floor and wall coating are highly flammable.

Installation of Fire Extinguisher

- The extinguishers shall be placed in conspicuous positions and shall be readily accessible for intermediate use in all the parts of the occupancy.
- The extinguishers shall be available for intermediate use at all time. Extinguishers shall be sited in such a way that is not necessary to travel more than 15 meters from the site of the fire to reach the extinguishers.
- Extinguishers shall be hung at one meter height from ground with a background having red and white strips.
- Extinguishers provided to deal with special risk shall be sited near to risk area concerned but not so as to be inaccessible in case of fire. If the special risk is contained in a confined space, it is generally advisable to position the extinguishers outside that space.

Type of Work	Type of Extinguishers
Carpentry Works	Sand Buckets, Water in Drums
Diesel or petrol store	Foam
Gas Cutting and Welding	DCP or CO2
Office & General Store	CO2/DCP
P&M (Mech)	DCP / CO2
P&M (Elec)	DCP /CO2 Water or Foam should not be used for fires on Electrical Machines

Table 7.1 Location of Fire extinguishers

8.OCCUPATIONAL HEALTH & ENVIRONMENT

Health Hazard control

Appropriate measures shall be implemented to control the following categories of hazards prevailing in construction activities:

Hazard Category	Examples
Physical Hazards	Heat, ionizing Radiation, Noise, Vibration, etc.
Chemical Hazards	Exposure to toxic materials such as dusts, fumes and gases
Biological hazards	Infections like, tetanus, etc.

Table 8.1. Health Hazards

8.1 Physical Hazards

Ionizing Radiation

Engineering Control Measures shall be utilized to minimize radiation level. Examples are,

- Shielding the radioactive source
- Using collimators, etc.

Administrative Control Measures shall be implemented to minimize the duration of exposure to radiation. Examples are,

- Minimizing duration of radiography
- Carrying out radiography in the lean hours like lunch time, night etc.
- Note: Please refer to the Chapter, Radiography for further details.

Non-Ionizing Radiation

Eye & Face Protective Equipment shall be used to protect eyes from infrared and ultraviolet rays while performing welding and gas-cutting operations

Heat Radiation:

While working in hot conditions, preventive measures to avoid heat stress shall include

- Rest in cool areas and
- Adequate supply of Drinking Water

8.2 Chemical Hazards

Exposure of workmen through

- Inhalation,
- Ingestion,
- Skin absorption of
- Contact / Penetration

With any material or substance at a concentration above these specified in the table “Threshold Limit Values” shall not be exceeded. Administrative or engineering controls shall be implemented to achieve compliance with this requirement.

Chemical Entry routes	Suitable PPE
Inhalation	Respirators
Ingestion	Chemical Proof Face Shields, Gloves, Aprons, Hoods
Skin Absorption	
Contact / Penetration	

Table 8.2. Chemical Hazards

Atmospheric Content	TLV – TWA	
	ppm	mg/m ³
Carbon Monoxide (CO)	25	29
Hydrogen Sulphide (H ₂ S)	10	14
Carbon-dioxide (CO ₂)	5000	9000
Total inspirable Dust (Comprises particles small enough to enter the nose or mouth, upper respiratory tract)		10
Respirable Dust (Comprises particles fine enough to penetrate to the deep lung)		5
Oxygen	percentage	
	19.5 to 21%	

Table 8.3. TLV in Airborne

8.3 Biological Hazards

General Measures for protection against infection:

The following preventive measures shall be implemented against infection and ill health of workmen:

- Ensuring all the workmen welfare facilities are adequate and suitable for the site.
- Maintaining the cleanliness of washrooms, lavatories, etc.
- Provision for suitable and well maintained canteen facility
- Taking suitable measures against vectors: such as rats and insects.
- Providing Medical facility

Potable water:

- An adequate supply of potable water shall be provided in the construction site.
- Water container shall be clearly marked and kept closed.
- The container shall be provided with a tap to collect water for drinking.
- Any container used to distribute drinking water shall be clearly marked as to the nature of its contents and not used for any to her purpose.
- Random sampling of water shall be done to check the suitability to drinking
- The water container shall be under a shed.

Non-potable water

- Outlets for non potable water, such as water for industrial or fire fighting purposes only, shall be identified by signs to indicate clearly that the water is unsafe and is not to be used for drinking washing or cooking purposes.

- There shall be no cross-connection, open of potential, between a system furnishing potable water and a system furnishing non-potable water.

9.SAFETY MANAGEMENT

Safety takes the highest priority in the whole scheme of activities. A carefully-designed, extensive Safety Program has earned an excellent safety record for CCCL, which has been consistently better than the industry average. Every accident and every injury is preventable. It is from this perspective we approach safety, and take into consideration all parameters that have a bearing on safety. Besides adopting the right procedures, CCCL also has an ongoing training program that underlines fact that safety is of paramount importance.

CCCL has developed its own methodology for on-site safety that ensures safety at every level. Right at the entry level, our company gathers data about every employee and makes an objective assessment. This guarantees the right and fit between the employee and his job. Further, our safety induction program puts the employees through rigorous procedures and practices concerning safety, to ensure that they are aware of and fully prepared to eliminate all possible hazards and administers this methodology also in the case of subcontractors, through periodic meetings and discussions. The organization of safety in the construction site will be determined by the size of the work, the system of employment and the way in which the project is being organized. Safety and health records should be kept which facilitate the identification and resolution of safety and health problems on the site in construction projects where the sub contractors were deployed used. The contract should set out the responsibilities, duties and safety measures that are expected from the work force. These measures may include the provision and use of specific safety equipment, methods of carrying out specific tasks safely and the inspection of tools/equipment.

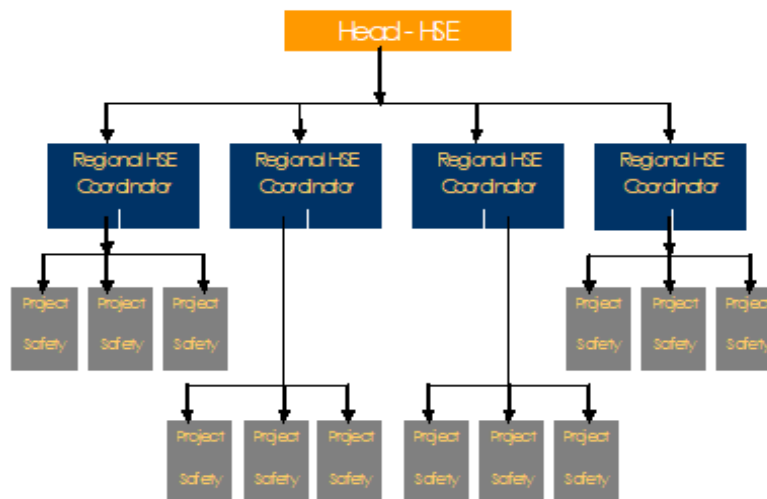


Figure9.1.Safety Organisation Chart

9.1 Safety Policy

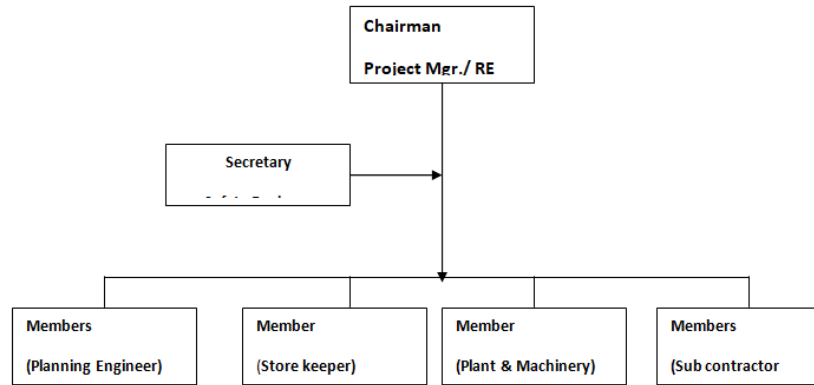
Consolidated Construction Consortium Ltd. recognizes Health, Safety and Environment as among the highest goals and objectives. The management is fully committed to address all the areas to provide and maintain healthy and safe working environment to all employees and to meet the requirement of the customers.

The responsibility for implementing this policy is assigned with all line mangers and other staffs; they are expected to be responsible for their actions, including those, which may impact others.

Employees are encouraged to discuss openly on their concerns and issues about hazards and impacts on their work, wastes or services. Employees are expected to work safely and maintain clean, healthy and safe working condition.

9.2 Safety Committee & Safe Work Permit

Employer shall established where five hundred or more workers are ordinarily employed equal numbers of representatives shall be appointed in the safety committee by employer.

**Figure.9.1 Safety Committee**

10. FINDING AND RECOMMENDATIONS

1. Warning sign in electrical room and distribution board is missing. It is suggested to display suitable warning sign at conspicuous places in Hindi and local language to understand by the majority of the construction workers as per BOCW Rule 47.
2. It is observed that during night working hours illumination is inadequate at working place. It is suggested to ensure adequate illumination for maintaining safe working conditions meeting natural standards and also BOCW Rule 50.
3. During the visit the some of the workmen's were not wearing Personal Protective Equipment. It is suggested that the group workman to be adequately trained for usage of Personal Protective Equipment as per BOCW Rule 46.
4. During the construction site visit tying of safety net is inadequate for height work. It is suggested to tie safety net at all area, where the height is more than 3 meter as per BOCW Rule 179.
5. Guard rails are not fitted in working platform. It is suggested to fit guard rails with adequate strength and 1 meter height as per BOCW Rule 190.
6. It is observed that during material lifting in builder hoist platform is not protected against fall of materials. It is suggested that the every hoisting like bricks, cement bags, sand bags and other materials is suitably protected to prevent the fall of material as per BOCW Rule 64.
7. Floor and wall opening in slab areas are not protected against fall of men. It is suggested for providing hard barricading to comply the BOCW Rule 115.
8. It is observed that the Ground Fault Circuit interruptor in some electrical boards are not tripping at 30 mA.. It is suggested adequate number of ground fault circuit interruptor regular inspection shall be carried to check the effective function of GFCI and shall be record to comply BOCW Rule 160.
9. Made shift ladders are put in to use at many places. A control system of using good construction ladders meeting requirements of BOCW Rule 172.
10. Cement bags were stacked more than 10 bags height. It is suggested that not to stack more than 10 bags in height unless such stack is stacked in a adequate support as per BOCW Rule 187.
11. Mobile scaffold were put on use with caster wheel, but safety locks are missing. It is suggested to provide caster wheel with safety locking devices to hold scaffold in position as per BOCW Rule 200.
12. During the construction site visit, it was observed that the house keeping is poor. It is suggested to improve house keeping by daily cleaned workplace.

CONCLUSION

Every construction company shall be responsible for maintaining "Safety, Health & Environment" in their works. Operation line management shall be responsible in enforcing safety norms and standards in their respective areas and activities. Each individual staff/supervisors has the responsibility & accountability in his work assignment and within his level of experience. Every man in his own safety officer and has a duty to care for his co-workmen's health and safety.

All section heads / managers and supervisors develop and implement necessary safety awareness programmes for safe guarding health and safety of their subordinate in accordance with the company policy and procedure.

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