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Electrical Safety Awareness among Workers in Construction Industry

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ABSTRACT: The electrocution, arc flash, and arc blast are universal, therefore employers, along with their employees who operate and maintain or otherwise interact with, electrical power systems and equipment, must have a clear understanding of the hazards and what they need to do for their safety. Electricity is no respecter of persons; it will injure or kill a custodian, labourer, supervisor, or office worker just as fast as it will injure or kill an electrician. All electrical power systems and equipment must be assessed to determine which of the electrical hazards exist or may exist, in order to develop an effective electrical safety program, safe work procedures, training for qualified and unqualified personnel, and PPE requirements. The study examined the level of knowledge of construction industry workers of electrical safety at workplace. Random sampling technique was used to select total 136 workers from for construction sites in India and Nepal. The collated questionnaire was then analysed. The investigation revealed that the workers have a considerably fair knowledge of electrical safety at workplace. The electricians possess a greater knowledge of electrical safety than the general workers. Based on these findings few recommendations were suggested.

KEYWORDS: Electrical Hazard, Personal Protective Equipment (PPE), Electrical Safety.

I. INTRODUCTION

Electric energy is an essential part of our life because it is the main source of an economic and social development as well as poverty reduction in our country and every other sector around it for growth. However, it has the potential to cause great harm. It is a fact that electricity is dangerous and can cause accidents in our workplace, homes, etc. With the increase dependency on electricity in every fact of life, electrical safety became imperative. In construction site we use electricity to carry out a large range of everyday activities such as drilling, lighting, etc and as well as powering industrial plants for the manufacture of goods for local use and export. Electricity is a clean, quiet and invisible means. Every year in India 2.6% of deaths are due to electrocution in construction industry, which means electricity of kill's considerable number of people. Most of the injuries occur due to lack of knowledge on electricity and its danger. The utility of Construction Company continues to be concerned by labour and old ignorance of electrical safety and consequent risk of personal injury and death from electrocution by interfering with power lines and electrical equipment. The above percentage is an evidence that majority of labours working with electrical equipment have no idea of the danger they put themselves and others too when they carry out these activities. A large part of any system installation is concerned ensuring that accidents will not happen, or if they do, their effect will be minimal. The construction site electrical equipment most often involved in electric shock and electric fire. Some of the major shocks are caused by electrical system failure, defects, misuse, and lack of maintenance, incorrectly installed wiring, overloaded circuits, extension cords and bad earthing. The use of wrong equipment can also be a source of hazard. An exposed live conductor has no insulation that will confine the flow of current to its body; thus, any contact will lead to electric shock, electrocution and possible fire outbreak. When an electrical machine or equipment is installed without sufficient ventilation, it is likely to overheat and this can eventually result to electrical fire. Though electricity has contributed a lot towards our modern civilization and day-to-day living, a slight mishandling can cause fatal accident. The lowest voltage at which death occurs from electric shock is 110volt. Electricity can kill or severely injure people and cause damage property. Even non-fatal shocks can cause severe and permanent injury. Most of these accidents can be avoided by careful planning and straightforward precautions not only in the construction sites but also at schools in the science laboratories and workshops. Workshops by nature are potentially hazardous places. In this study the descriptive research and survey are used interchangeably. The descriptive study aims at providing accurate quantitative description of a phenomenon rather than discovering the cause of it.



II. LITERATURE REVIEW

The literature pertains to previous research conducted on electrical safety awareness was reviewed and furnished here under.

- The objective of this study was to quantify safety risks at activity level and evaluate injury prevention techniques used. For this contextual information regarding work practices and preventive measures used was obtained. This information was analyzed and rated by expert panel. The results allow electrical utilities to evaluate risk level and design effective safety programs (Alex and Matthew, 2013). A study was conducted where 250 electrical fatalities on construction industry were reanalyzed in seven patterns based on the source of electricity. From this analysis a series of flow diagrams were constructed which will illustrate flow of electric current from source to human body and will be effective in creating an overview of occurrence of accidents and to find its cause and design feasible preventive strategies (Chi, Yuanl-yuan & Ikhjwan, 2012). A study was conducted in Greece to ascertain the cause of accident where a concrete pump came into contact with power lines. The preliminary investigation shows that protection system was failed to operate and power supply was not stopped immediately. In order to prevent this of accident changes are required in practice at organizational level and to impart technical awareness to keep workplace safe (Koustellis et al, 2011).
- A study was conducted to asses electrical safety practices in Hail region, Saudi Arabia by considering electrical accidents. The study analyzed the electrical safety level which was found to be very poor (Shabi, Sauad & Haussem, 2017). A study was conducted to examine the level of knowledge of students on electrical safety at home and in school laboratories. Random sampling was done on 400 students from six schools in Benin City EDO state through questionnaires of yes or no type. The data and analyzed and the result shows that student have positive attitude towards electrical safety (Daniel, Patience & Samual, 2014). A study of design an earthing system with a new method called finite element method, this method is used for more safety from electrical accident. The design and implementation of grounding system was made using a FEM software package named as COSMOL Multi physics. The method presented is highly useful in determining precise formula applied to calculating ground resistance in different kinds of grounding grid (Sajad, Farhad & Mohammad, 2016).
- A study of an electrical safety assessment in industries to identify the potential electrical hazard. This study could be significantly useful for minimizing essential energy cost and other benefits like improved production, better quality. Electrical safety audit is an effective tool in identifying and pursuing a comprehensive safety management program. In order to prevent the electrical hazard the proper auditing should be done by auditee and to impart awareness to keep safe (Shahadat & Salam, 2015). A study of changes of behavior of earthing system under high impulse condition from its steady-state condition. There are four different earthing system is tested under power frequency and high impulse current. The value of degree of nonlinearity in earthing system is found which is dependent on resistance of earth. The results suggested more effective earthing system (Shahrriman et al, 2015). The study was conducted to analyze, the different techniques of grounding systems. The general approach to the problem of substation grounding analysis was presented which defined methodologies for computation of potentials for any type and size of grounding mats. The methodology also extended to the analysis of multi-grounding systems and computation of transfer voltage. The general analysis method has been presented for grounding system design. The analysis takes few importance points into consideration and helps for approaching this objective of safe grounding system (Meliopoulos, Webb & Joy, 1981).
- Study was conducted to determine one of the important factors in designing an efficient lightning protection (LPS) system. The methodology used is installation of proper earth termination and effective bounding system for reliable lightning protection. Finally the study states the importance of selection of material and test procedure used for manufacturing of suitable electrodes, conductors and clamps and also find out their high corrosion resistance value in different type of environment condition determine by soil parameters and climatic condition (Marek & Marciniak, 2010). Ground potential rise of grounding systems during transients was analyzed and adopted finite element analysis, to model the constituent parts of a grounding system. Leakage resistance to earth is accurately computed with the method of moments. This paper also includes the Maxwell equation for finding out inductance and capacitance. In the conclusion the parameters of the finite elements are rigorously computed from the solution of Laplace's equation (Meliopoulos & Moharam, 1983). The study conducted gives us the brief idea about the electrical safety. The method used to find out the earth resistivity Wenner 4 point test is studied. The result of the study suggests to follow rules and regulations to avoid accidents indoor and outdoor and recommended the need of trained people to work and qualified



electricians. Precautions must be taken when working near electricity or with electrical equipment (Ghosh et al, 2015).

- A study was conducted for finding the efficient method for electrical earth resistance to ensure safety of person and electrical equipment we have to install earthing system so here measurement of earth resistance without soil treatment as well as which soil treatment here use the electrode driving method is used for measuring the earth resistance measured earth resistance is very less when biochar is used with soil treatment the final investigation from this study was application of biogas and efficient method for earth resistance (Lukong Pius et al, 2015). The study was carried out at Central Power Research Institute (CPRI) Bangalore after extensive survey of land measurements of soil characteristics at the project site for designing grounding system for fairy hydro power project. Design has been carried out using the GMAT software developed at CPRI design of the grounding system are to be interconnected in order to achieve at overall reduction of grounding resistance in order to achieve these overall reduction of grounding resistance all design parameters have to be taken into consideration the overall grounding system resistance at theory is calculated as 0.2885 ohm, which is acceptable for Major power stations (Babu et al, 2002). A study was conducted to analyze the effect of electrical hazard at workplace. Prime reason of the study to aware the uses of electricity about electrical hazards. In this study three hazards of electricity are discussed and its effects that are three major hazards are electrical shock electric arc flash and electric arc blast. The effect of that hazards are taken from various published studies after finding the cause and factors of that electrical hazards finally they told about some protective measures for reducing the hazards and its effect and keep workplace safe (Madhav et al, 2013).
- A study was conducted in Australia to determine how the managers and workers interpret and use safe for method statements in controlling risk. National standard for construction work was released in 2005 with aim of protecting person from the hazards associated with construction works and the study was conducted about safety rules and highest construction activities. Therefore companies identify and resolve the gap between safe work method statement, practice and task demand to make safer workplace (Borys, 2011). A study was conducted to ascertain trend in electrical safety in industries and discussed about electrical hazard and its effect the types of electrical hazards effects of current on human body and causes for electrical hazards. The important safety audit was suggested (Shahnavaz et al, 2016).

III. METHODOLOGY



IV. EXPERIMENTAL RESULTS

This section contains the results and discussion of the study. It provides analysis of answers to the research questions. Additionally, the outcomes were deciphered to reveal insight into the discoveries. The responses to questionnaire were shown in Table 1 and Table 2 Table 3 represents responses from general workers regarding electrical safety and Table 2 represents responses from electricians, electrical supervisors and electrical engineers regarding electrical safety. Total number of construction industry employee who participated in the study is 136 from different companies like HCC (Nikachu Hydropower Project, Bhutan), HCC (Munirka Elevated Corridore Project, New Delhi), TCE (High Storey Building, Wipro, Kodathi, Bengaluru), ITDC (Nagpur Metro Project, Nagpur). The number and percentage (in parenthesis) of employee who answered “YES” to a particular question are presented on the right column immediately after the number of respondents and those that answered ‘NO’ are presented in the next column in the same manner.

Table 1 Questionnaire for general worker regarding electrical safety awareness with their response.

SR. NO.	QUESTIONS	YES	%	NO	%
1	Do you know about electrical shock?	115	100	0	0
2	Have you ever accidentally met with an electrical shock?	104	90.4	11	9.60
3	Do you think that electrical current pass through human body?	115	100	0	0
4	Do you know what kind of injuries results from electrical shock?	99	86	16	14
5	Do you think you possess knowledge on electrical safety?	95	82.6	20	17.4
6	Do you take care of electrical appliances/machines which are installed nearer to ground level before washing or mopping the floor?	115	100	0	0
7	Have you ever been given a training on electrical safety rules and safe operating procedures?	112	97.3	3	2.7
8	Do you leave power supply of electrical machines 'on' when you are not using them?	20	17.4	95	82.6
9	Is it safe to use extension cords for portable electrical instruments?	34	29.5	81	70.5
10	Is it safe to lift up or carry portable devices by their cords instead of using the handles?	0	0	115	100
11	Do you operate electrical equipment without authorization?	17	14.7	98	85.3
12	Do you ever use defective electrical equipments?	0	0	115	100
13	Do you know the importance of electrical insulation?	115	100	0	0
14	Do you check the insulation of electrical equipment before using them?	79	68.6	36	31.4
15	Do you unplug electrical instrument/equipment by pulling on the cord instead of the plug?	0	0	115	100
16	Do you engage in horse play in operating electrical equipment/machines?	0	0	115	100
17	Have you heard about electrical short circuit?	115	100	0	0
18	Do you touch electrical equipments with wet hands?	0	0	115	100
19	Do you know about earthing?	115	100	0	0

Table 2. Questionnaire for Electricians, Electrical Supervisors, Engineer regarding electrical safety awareness with their response.

SR. NO	QUESTIONS	YES	%	NO	%
1	Do you follow manufacturer's operating manual before installing the machine?	21	100	0	0
2	Do you follow manufacturer's operating guidelines while Operating any Electrical Machine?	19	90	2	10
3	Do you disconnect the main electrical supply when carrying out electrical Maintenance work?	21	100	0	0
4	Have you ever been given training on electrical safety rules and safe operating procedures?	21	100	0	0
5	Do you know about earthing?	21	100	0	0
6	Do you know how electrical earthing is to be done?	19	90	2	10
7	Do you check whether earthing of particular electrical machine is done properly before operating it?	21	100	0	0
8	Do you know effect of lightening on electrical equipment?	21	100	0	0
9	Do you know what effect of lightening?	18	85	3	15
10	Is it safe to lift up or carry portable devices by their cords instead of using the handles?	0	0	21	100
11	Do you know the importance of electrical insulation?	21	100	0	0
12	Do you check insulation of electrical equipment before using them?	14	66.6	7	33.4
13	Have you ever heard about short circuit?	21	100	0	0
14	Do you know the reasons behind electrical short circuit?	17	80	4	20
15	Do you know how to measure earth pit resistance?	13	61.9	8	38.1
16	Are you wearing hand gloves of electricians while working on live equipment?	21	100	0	0
17	Do you know how to conduct continuity test?	21	100	0	0
18	Do you know how to test circuit breakers?	20	95.2	1	4.80

The responses in Table 1 shows that the knowledge of electrical safety by construction workers on construction site is considerably low as compare to electricians. For instance, in the construction worker's response shown in Table 1, the first question, that is, "Do you know about electrical shock?", a great percentage of the employee responded 'YES'

(100%) compared to those that responded 'NO' (0%), means on site everyone knows about the electrical shock and ones in their lifetime then must face the electrical shock accidentally. Conversely, only a few employee responded "YES" (0%) to the question "Do you touch electrical equipment with wet hands?" compared to the large number of employee that responded "NO" (100%) to the same question. This suggests that the knowledge of electrical safety of the employees is generally high. There were 115 normal construction worker and 21 electricians, electrical supervisors and engineers at the 5 different construction sites from different places and the results is presented in Table 3. The result of the analysis was shown in Table 3 and it indicates that there exist some considerable differences between construction worker and electricians in their knowledge of electrical safety measures.

Table 3 Results of Chi Square test

ITEMS	Y/N	Observed(O)			Expected(E)		(O-E) ² /E		$\Sigma (O-E)^2/E$	Total X ²
		electricians	Worker	total	electricians	Worker	electricians	worker		
Have you ever been given training on electrical safety rules and safe operating procedures?	yes	21	112	133	20.53	112.46	0.0107	0.0018	0.0125	0.5595
	no	0	3	3	0.46	2.53	0.46	0.087	0.547	
Is it safe to lift up or carry portable devices by their cords instead of using the handles?	yes	0	0	0	0	0	0	0	0	0
	no	21	115	136	21	115	0	0	0	
Do you know the importance of electrical insulation?	yes	21	115	136	21	115	0	0	0	0
	no	0	0	0	0	0	0	0	0	
Do you check insulation of electrical equipment before using them?	yes	14	79	93	14.36	78.63	0.009	0.0017	0.0107	0.0342
	no	7	36	43	6.63	36.36	0.02	0.0035	0.0235	
Have you ever heard about short circuit?	yes	21	115	136	21	115	0	0	0	0
	no	0	0	0	0	0	0	0	0	
Do you know what is electrical earthing?	yes	21	115	136	21	115	0	0	0	0
	no	0	0	0	0	0	0	0	0	
									$\Sigma X^2 =$	0.5937



Research hypothesis:

The electrical safety awareness and hazards preventive program with improve the knowledge of general workers regarding the electrical hazards and help them to conduct electricity hazards preventive measure.

Testing of hypothesis:

Null hypothesis H0: Most employees of construction side do not have awareness about electrical safety. Alternative hypothesis H1: Most employees of construction site have awareness about electrical safety. Chi square test result, Calculated value of $\chi^2 = 0.5937$ (Shown in Table 5.3)

χ^2 table value at 11 degrees of freedom using 95% level of confidence is **19.675**.

The calculated value of χ^2 is **0.5937** is less than the table value, the null hypothesis is accepted and it can be concluded that most of the employees do not have awareness about electrical safety on construction site.

V. CONCLUSION

The results of the study indicate that electrical safety awareness between two groups that is general workers and employees of electrical department is found to be varying, though basic knowledge on electrical safety awareness between two groups appears to be same. To bring electrical safety awareness among various groups of worker in the industry it is suggested to follow the following practices,

- Electrical safety training and workshop should be organized periodically to train and aware the workers and electricians about the importance of electrical safety.
- All the workers should be made aware of proper handling, usage and storage of electrical equipment, which can be achieved by providing monthly training and making them used to safe work procedures.
- Inspect and examine the electrical equipment regularly, to prevent electrical hazards.
- It is advisable to report any defect in an electrical device in the site to the electrician to take appropriate action.

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