

CURRENT STATUS FOR SAFETY KNOWLEDGE AND TRAINING FOR WORKERS INVOLVED IN TUNNEL CONSTRUCTION: A CASE STUDY

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Abstract— Being one of the important factor for construction safety, safety training is considered with high priority in tunnel construction projects to achieve a good working environment in tunnel. In this research paper an effort is made to figure out the current status of safety knowledge for workers involved in tunnel construction within the study areas. The knowledge of workers on safety in relation to safety training, safety orientation and personal experience of worker is analyzed, discussed and concluded based on perception of the workers and the perception of technical personnel.

Keywords—safety training, safety orientation, construction, tunnel, safety knowledge, workers, technical personnel

I. INTRODUCTION

Tunneling work, a job of specialized and hazardous nature, is widely carried out in the construction of railway, road, hydro, water supply and sanitation projects. Cramped working space in the heading, wet and slippery flooring, artificial lighting all too often inadequate, difficult ventilation, obnoxious gases, unseen weaknesses in the rock, handling of explosives, leading and hauling muck, etc. might contribute to accidents. In order to avoid hazards, it is necessary to lay down the safety precautions for the use of machinery, electrical installations and labor in tunnels, during the construction period, and arrange for their compliance.[1]

The construction of underground tunnels, shafts, chambers, and passageways are essential yet dangerous activities, where underground workers face dangers while working under reduced light conditions, difficult or limited access and egress, with the potential for exposure to air contaminants and the hazards of fire and explosion.[2]

More often than not, the construction site is dirty, disorganized, and cluttered with different kinds of resources. Moreover, it can be identified by a continually changing environment with the movement and interactions between workers and equipment. In such a chaotic and dynamic place, an incredibly high number of construction activities take place, which easily lead to construction accidents and work-related injuries and deaths. Therefore, the construction sector is recognized as one of the most dangerous job sectors in the world for the large number of injuries and deaths occurring in the workplace.[3]

The foremost technique to improve safety at construction projects is to adopt a proactive approach in safety programmes. A successful safety programme incorporates

employing safe construction procedures and preparing a safe working environment for the employees, thereby considerably decreasing the accident rate. Likewise, an effective safety programme aids in achieving a good safety culture that can be obtained through the application of an effective programme after all it demands a co-operation between management and employees in the implementation of the programmes. There are various factors and elements influencing safety programmes in construction projects. These should be thoroughly identified to improve the operational effectiveness of the programmes. Since most of the construction companies designate limited resources to safety management, contractors are compelled to select a limited subset of the available elements. This situation raised a concern of, "What are the most appropriate programme factors to improve and control health and safety in construction projects?"[4]

The root causes of accidents are lack of proper training deficient enforcement of safety, not providing safe equipment, unsafe methods or sequencing for task, unsafe site conditions, not using provided safety equipment, poor attitude towards safety and isolated sudden deviation from prescribed behavior of the worker.[5]

The conceptualization of proactive role orientation toward safety management has emerged as a broad set of psychological and motivational orientations by individuals and teams in preventing accidents, managing safety-related issues in the day-by-day individual and teamwork activities and improving workplace safety conditions.[6]

A. General Training on Safety

Training is perhaps the most important things to do, to avoid a disaster or the consequences of a serious situation. Studies after serious accidents shows that people who practice an emergency is more likely to survive. Testing of equipment and how it works is also critical. Fire in the tunnel is one of the worst scenarios. The employees should train how to use their PPE (Personal Protective Equipment), how to use the rescue containers and how to execute first aid. [7] To achieve a good working environment below ground, it is especially important to develop general knowledge and skill by giving every owner, consultant, contractor, manager and worker training on the working environment and health hazards associated with the work site, equipment and tasks.[7] The needs of each target group are different and the content and methods of presenting training material should be tailored to meet the specific needs of each group.[8]

A vital factor of a successful safety programme is to periodically train and educate all employees to enhance their knowledge and skill about safety at work. For new employees, safety orientation is necessary to inform them about safety goals.[7] Information provided to the worker through training increases safety awareness and alerts workers to potential hazards on construction jobsites.[8]

Computer supported training systems are very useful for training rescue personnel and disaster management organizations, with the objective of increasing the effectiveness of rescue operations. Nevertheless, it has to be mentioned that each software is dedicated to one purpose and therefore its use has to be indicated for the correct one and focused to the appropriate personnel.[9]

B. PPE training

Employers should make sure that each employee demonstrates an understanding of the PPE training as well as the ability to properly wear and use PPE before they are allowed to perform work requiring the use of the PPE. If an employer believes that a previously trained employee is not demonstrating the proper understanding and skill level in the use of PPE, that employee should receive retraining. Other situations that require additional or retraining of employees include circumstances changes in the workplace or in the type of required PPE that make prior training obsolete. The employer must document the training of each employee required to wear or use PPE by preparing a certification containing the name of each employee trained, the date of training and a clear identification of the subject of the certification.[10] It is also important that employees be given the necessary training on measures to avoid exposure to air pollution.[7]

C. Toolbox-training

The Toolbox-training programme aims to improve construction workers' knowledge and skills in planning and safety communication, not only with their crew members, but also with their colleagues, leaders, other professions and customers. The goal of the training programme would be to reduce physical attrition of workers' health and improve injury and accident prevention, health and safety culture. More specifically, it is assumed that the programme will promote safety communication on a daily basis between workers and the various parties on site, which will improve cooperation between site members and increase their individual participation in OSH (Operational Safety and Health) dialogue. Participation is proposed to then increase the workers' and site member's influence on planning and safety procedures, which improves the promotion of OSH and safety culture on construction sites and subsequently results in improved business.[11]

ACCORDING TO JESCHKE THE OUTCOMES OF TOOLBOX TRAINING HELP TO IMPROVE THE FOLLOWING:

- Increases in safety communication and leadership skills.
- Increase in cooperation and teamwork skills.
- Improve knowledge about working environment and OSH risks.
- Improve planning skill for safe work task.

- Improve the OSH risk awareness on site.[11]

II. RESEARCH METHODOLOGY

A. Study Approach

The overall research design is descriptive as well as explorative in nature. This study intended to look the present status of safety knowledge of workers in relation to safety training and safety orientation of workers in tunnel construction within study area. The study also intended to determine the other possible factors influencing the safety knowledge of workers and check the technical personnel's and workers' perception on importance of safety training. The study involved combination of research methods used simultaneously in line of the objectives of the study. These included: i) review of relevant literatures, ii) analysis of relevant data obtained from primary sources, and iii) analysis of relevant data obtained from secondary sources. Prior to defining the study objectives to understand the present situation, direct observation of the tunnel construction site has also been carried out. The rationale for using descriptive design is to describe empirical facts in the research site and it is also explorative, in order to unbox how technical personnel and the workers themselves perceive importance of safety knowledge, safety training and orientation.

B. Delineation of the Study Area

This study, in order to meet the objective of the study, was carried in the four out of ten different under-constructing tunnels of Nepal namely Madhya Bhotekoshi HEP (Hydro Electric Project) Tunnel, Upper Trishuli HEP Tunnel, Melamchi Water Supply Project Tunnel and Upper Tamakoshi HEP Tunnel. Total of 37 tunnel construction

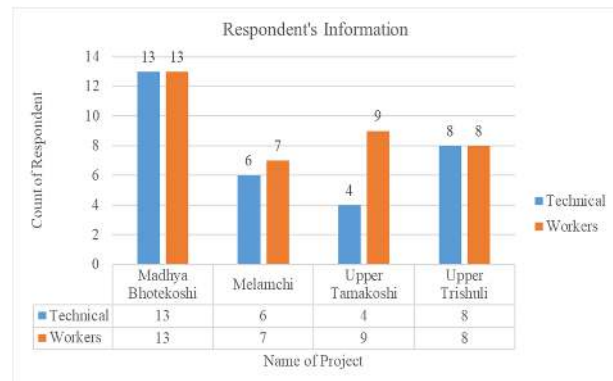


Fig. 1. General information of Respondents

workers and 31 technical personnel who are working in the tunnel construction site were selected to participate in the survey for the research purpose. The respondents were selected through random/purposive sampling method. The bar chart in Fig. 1. shows the general information of all the respondents.

C. Literature Review

Extensive review of relevant literatures on the different aspects of safety training was important part of methodology. This involved review of past studies and graduate thesis, commissioned studies and published and unpublished reports produced by different organizations. Alongside the different code of practice from different countries on tunnel

construction safety and its reviews by different researcher has been the prime source of data for the study. This helped developing the interpretation of safety in construction of tunnel.

D. Collection and Analysis of Secondary Data

Secondary data were collected in order to conceptualize the understanding of current practices of safety training in different countries. This includes the definition of safety training according to different codes of tunnel safety, impact of safety training, importance of safety training and workers' and technical personnel's perception on construction safety training in tunnel. This also includes case studies related to the safety training practices in general construction projects other than tunnel construction projects.

E. Collection and Analysis of Primary Data

The primary data used in the analysis were obtained using two simultaneous tools: 1) Questionnaire Survey 2) Direct Observations.

1) Survey Questionnaire

Questionnaire consisting a number of questions was designed for the statistical analysis of the responses so as to help to get the standardized response from the respondents. Questionnaire survey was conducted in research areas in order to study the current status and perception of workers and technical personnel on importance of safety training and orientation in tunnel construction. The respondents were classified in two groups: technical personnel and workers. Two different but related sets of questionnaire were designed to get the views of each classified groups. Each set of questionnaire for this research consisted of 5 sets of objective questions which were supportive for finding research objectives.

2) Direct Observation

Direct observation is method of collecting information through observational study by the researcher. It was conducted in order to collect some additional information regarding the situation, behavior and research needs. The condition of construction safety practices has been observed in study areas.

F. Analytical Techniques and Presentation of Results

The study essentially involved qualitative analyses that are supported by the facts and figures to the extent of needs. The information on workers' and technical personnel's perception relating to the practice and trends of safety training and orientation are organized and tabulated to compare. The results are presented with the help of appropriate charts and diagrams and the inferences relating to the safety knowledge has been drawn.

III. RESULT ANALYSIS AND DISCUSSION

A. Analysis of Literature

The major factors that need to be considered with high priority in tunnel construction are construction safety training and orientation. Construction safety orientation is a subset of construction training. Construction safety orientation could be given in all the subjects in which construction safety training could be provided. The orientation may be formal or

informal, of short duration, and generally provided at the time of hiring the workers. [6], [7]

Safety knowledge and skill can be achieved through good working condition which can be enhanced by construction safety training and orientation.[7]

B. Status of Safety Training

As per the bar chart shown in Fig. 2., 67% of workers from Upper Tamakoshi and 23% from Madhya Bhotekoshi have received orientation at the time of hiring. No workers in the projects under study have ever received any safety training. In case of Upper Trishuli and Melamchi, even orientation about safety is not provided to workers. On the whole, 76% of workers are not getting safety orientation and training, thus we can conclude that safety training and orientation programmes on tunnel construction are seriously lacking in the projects under study.

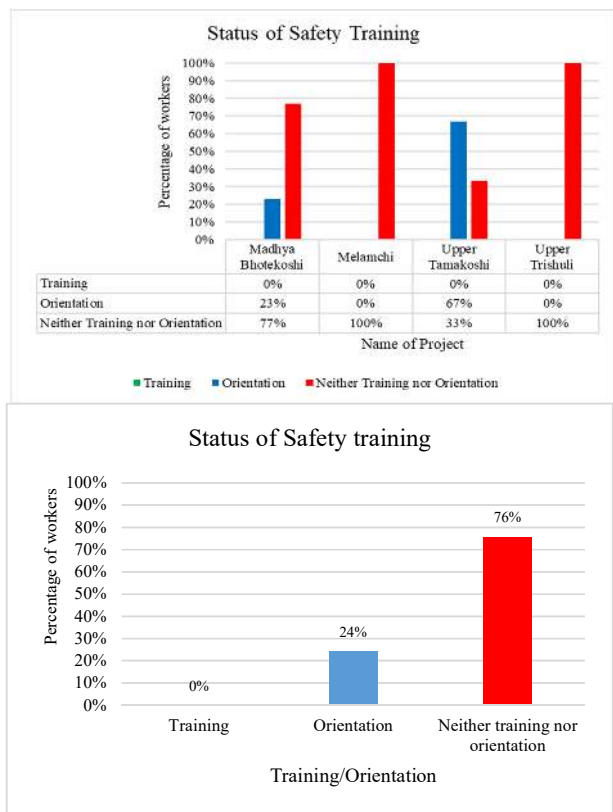


Fig. 2. Status of safety training

C. Worker's Knowledge on Safety

As per bar-graph given in Fig. 3., the correlation between safety orientation and workers' knowledge on safety is strong for Madhya Bhotekoshi. However, for the remaining projects orientation shows no distinct effect on safety knowledge. In case of Upper Tamakoshi HEP, in which 67% of the workers have got orientation, 67% of the total have heard about safety but none of them claim to have knowledge on safety. This indicates that the orientation can introduce the concept of safety but not necessarily impart the knowledge on them. Furthermore, 43% of workers of Melamchi Water Supply Project are aware about the construction safety though they have never received any training or orientation. Similar case is observed in case of Upper Trishuli HEP. This shows that

there are other factors which play a role to make workers aware about the safety practice during tunnel construction.

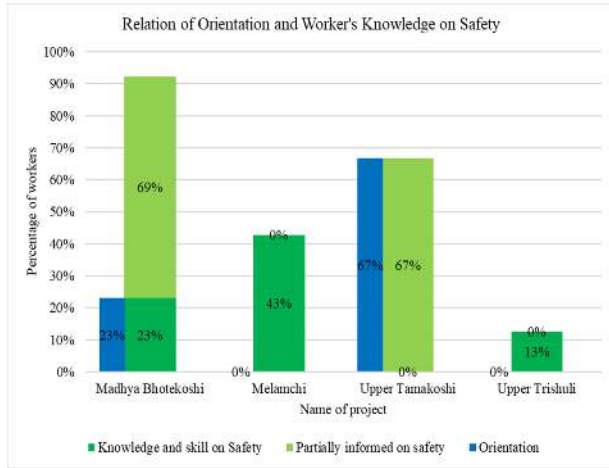


Fig. 3. Relation of worker's knowledge on safety and safety orientation programme

From the open ended questionnaire survey, experience and orientation are found to be the factors that affect the status of safety awareness in workers. The graph in Fig. 4., summarizes the impact of these factors. 71%, who claimed to have knowledge on construction safety and all the workers who have only heard about construction safety in tunneling have given the credit to their past experience. Hence, knowledge and skill on construction safety is based primarily on the experience of workers than any other factors.

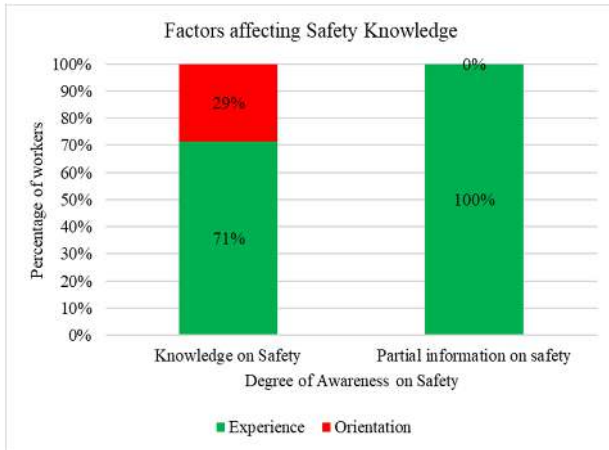


Fig. 4. Factors affecting safety knowledge

D. Perception on requirement of safety training

According to the results obtained above, current practice of safety in tunnel construction is only based on experience of workers. In order to improve the situation, providing periodical safety training can be the best option. In reference to Fig. 5., and Fig. 6., 71% of technical personnel believe that workers have knowledge and skill on safe construction practice in tunnel, however 90% of them yet emphasize on the requirement of safety training. 95% of the workers have agreed to the requirement of safety training too.

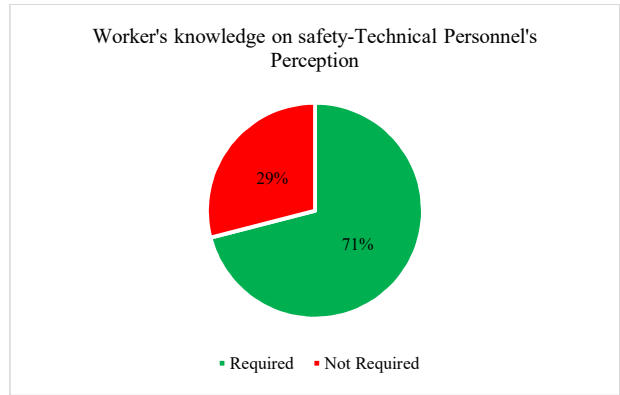


Fig. 5. Technical Personnel's Perception on worker's knowledge on safety



Fig. 6. Technical personnel and workers' perception on requirement of training

IV. CONCLUSION

Construction safety training is one of the important factor that should be considered with high priority in tunnel construction projects. To achieve a good working environment in tunnel, it is especially important to develop general knowledge and skill by giving every worker training and orientation on the safe working environment and health hazards associated with the work site, equipment and tasks. The objective of this research is to figure out the current status of safety knowledge and training for workers involved in tunnel construction within the projects under study. For all the projects under study it is found that no workers have attended safety training on tunnel construction, while, some have received safety orientation at the time of hiring. The results of questionnaire survey have indicated that the knowledge on construction safety depends more on the experience rather than the orientation received. The literatures have suggested that the current situations can be improved by providing training and orientation programmes on safety which is also emphasized by technical personnel and workers involved in the construction.

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