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Study on safety performance factors and sustainability in pipeline sleeper construction.

Estudio sobre factores de desempeño de seguridad y sostenibilidad en la construcción de traviesas de tuberías

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ABSTRACT

Construction industry is an important growth indicator because it generates investment opportunities across multiple related sectors. The construction task or work environment is very risky and hazardous and its susceptibility to accident. The major cause of the accident is the employees' poor safety performance in construction sites. These root causes of accidents and factors influencing them need to be studied in order to improve safety results. In pipeline sleeper construction, safety is a dynamic decision issue close to normal construction cases. The study identifies the critical risk factors affecting the safety performance and ways to achieve sustainability in pipeline sleeper construction to counteract the risk of accident occurrence. Based on the evaluation of the questionnaire survey, the study explains twelve most important factors and sub factors, which were rated to have more than a moderate effect on safety performance. The six keys to sustainable success for integrating worker protection in the assessment of sustainable construction is also discussed.

Keywords-Hazards, pipeline sleeper, safety performance, risk.

RESUMEN

La industria de la construcción es un indicador de crecimiento importante porque genera oportunidades de inversión en múltiples sectores relacionados. La tarea de construcción o el entorno de trabajo son muy riesgosos y peligrosos y su susceptibilidad a accidentes. La principal causa del accidente es el mal desempeño de los empleados en materia de seguridad en las obras de construcción. Es necesario estudiar estas causas fundamentales de los accidentes y los factores que influyen en ellos para mejorar los resultados de seguridad. En la construcción de traviesas de tuberías, la seguridad es una

cuestión de decisión dinámica cercana a los casos de construcción normales. El estudio identifica los factores de riesgo críticos que afectan el desempeño de la seguridad y las formas de lograr la sostenibilidad en la construcción de durmientes de tuberías para contrarrestar el riesgo de que ocurran accidentes. Sobre la base de la evaluación de la encuesta por cuestionario, el estudio explica los doce factores y subfactores más importantes, que se calificaron para tener un efecto más que moderado en el desempeño en seguridad. También se discuten las seis claves del éxito sostenible para integrar la protección de los trabajadores en la evaluación de la construcción sostenible.

Palabras clave: peligros, traviesa de tubería, desempeño de seguridad, riesgo

INTRODUCTION

Safety has consistently been of the utmost importance in the construction sector. Security issues can naturally arise during construction because of a failure to manage these site risks, including the collapse of structures during the construction process (Ahmed S M., Brahmachary T.K., & Mia M S.,2018). The oil and gas industry are regarded as a significant contributor to the nation's economy and infrastructure growth (May D R., & Schwoerer C., 2006). A pipeline sleeper is an element designed to move the load from a pipe which carries oil and gas to the supporting structures, weight and the materiel of the pipe, all the pipe fittings that are connected, and also the pipe that is insulated. Anchoring, directing, absorbing shock, and supporting a quantified load obtain is the primary objective of sleepers. The pipeline sleeper project is being carried out at two locations. In the precast yard, the casting process is carried out and the second one is the installation site. The pipeline continues for a vast distance and can cross rivers, bridges, highways, underground, etc. At a distance of 10m each, the sleepers are located. The safety performance of sleepers on the construction site is influenced by many risk factors. The critical move to safety and sustainable success of workers in pipeline sleeper construction from casting to the installation stage obtains the identification of the critical risk factors and the keys to achieve the sustainable environment. The sustainability and green building movement could set itself apart by taking a proactive stance on construction worker safety and health (Godfray R., Hinze J., & Sulivan J., 2013).

CONSTRUCTION SAFETY

Safety can be broadly defined as freedom from whatever exposes one to danger or from liability to cause danger or harm (Webster Dictionary). Occupational safety and health is the discipline concerned with preserving and protecting human and facility resources in the workplace (Wikipedia). It is common that construction industry is known for being a hazardous amongst other industries. Construction industry is one of those industries with

the highest rate of injury and fatality (Hinze J et al., 2006). Benefits of safety and health may include: less injuries, less property damage, less down time, improvement in morale, enhanced industrial relations, increased productivity, reduced cost, and enhanced quality (Enshassi A et al, 2009). The safety performance of the construction industry has consistently below that of most other industries (Hinze J et al., 2006). It is well known that, compared to other industries and the public sector, workers in the construction industry are at higher risk of work-related illnesses and accidents (Kartam N A et al., 1997). The need to continually enhance safety measures before the Zero Accident Approach is achieved is enhanced by thinking about safety as a human and financial problem (Allen A., & LaFollette S.,1977). Improving safety remains a priority but despite innovations that reconceive the relationship between planning and safety, no systematic theory or practice has yet been developed (Howell A S et al., 2012). Areas of safety that directly impact the improvement of safety performance as Demonstrated management commitment, Safety staffing, Safety planning, Orientation and training, Worker involvement, Rewards and incentives, Subcontract management, Drug testing, Accident investigations (Hinze J et al., 2006). The companies with several years of industry experience and large companies had the best safety records and almost all of them had safety protocols in place (Hoonakker et al., 2002).

A good safety management system should be fully integrated with the organization and with binding power; continuity and harmonization is provided by a consistent system of policies, strategies and procedures (Fernández-Muniz et al., 2009). Risk management is a strategy that has been increasingly used to improve safety and reliability and reduce risks in companies and in the public sector. This involves identifying, measuring and managing the risks (Cox et al., 1998). The reason is that perceptions of the work environment impact worker attitudes and so a well-designed job can impact positive psychological conditions (Banai M, et al., 2007). Management is responsible for monitoring employees' unsafe actions, largely because the unsafe acts occur in the course of employment that is created and directed by management. Through selection, recruitment, training and monitoring, management may monitor its personnel (Magid et al., 1982). A site safety executive exploratory analysis of construction site environments results provide practical knowledge for construction project managers and practitioners in the field of construction safety (Ahmed S M et al., 2008). Worker actions as the root cause of building accidents and one useful approach for supervising employee safety problems is the theory called behavior-based safety (BBS). Good safety awareness methods can be instilled in employees by the introduction of PBBS management, who can then extend their characteristic thinking of secure ways to accomplish all construction activities (Gray M, et al., 2015).

The realm of sustainability seems to concentrate on limiting impacts to the environment, reducing energy, and incorporating less harmful materials. This general theme is echoed in several definitions of sustainability like "A sustainable society is one that can persist over generations, one that is far-seeing enough, flexible enough, and wise enough not to compromise either its physical or its social mechanisms of support" (Meadows et al. 1992). Specifically, as the built environment is being constructed, appropriate consideration must be given not only to the previously noted factors, but also the well-being of the construction workers. In other words, the well-being of construction workers must be sustained (Godfray R., Hinze J., & Sulivan J., 2013). The construction workers are a very valuable part of the construction process and they should be regarded as the most valuable resource (Allen et al., 1977). Any sustainability system should facilitate the successful integration of issues about the long-term stability of the environment, the health and safety of employees, the community and the economic life of a specific business. (Quinn et al. 1998). The sustainability and green building movement could be instrumental in helping to transfer information about construction safety and health to a broader population. As a composite entity, the construction industry has a dismal reputation in safety and health. The consideration of the worker in the built environment would improve overall safety performance in the construction industry. This would appear to be the prudent direction to be pursued in sustainability and green building (Godfray R., Hinze J., & Sulivan J., 2013)..

FACTORS AFFECTING THE SAFETY PERFORMANCE

Construction industries are the most dangerous due to its working nature which has higher rate of injury than most other industries. The workplace has an important impact on health owing to the various hazards that occur in working environments (Balubaid S., etal., 2015). Based on literature reviews and questionnaire surveys performed at different sites, key factors affecting the safety performance of pipeline sleeper construction are defined as follows:

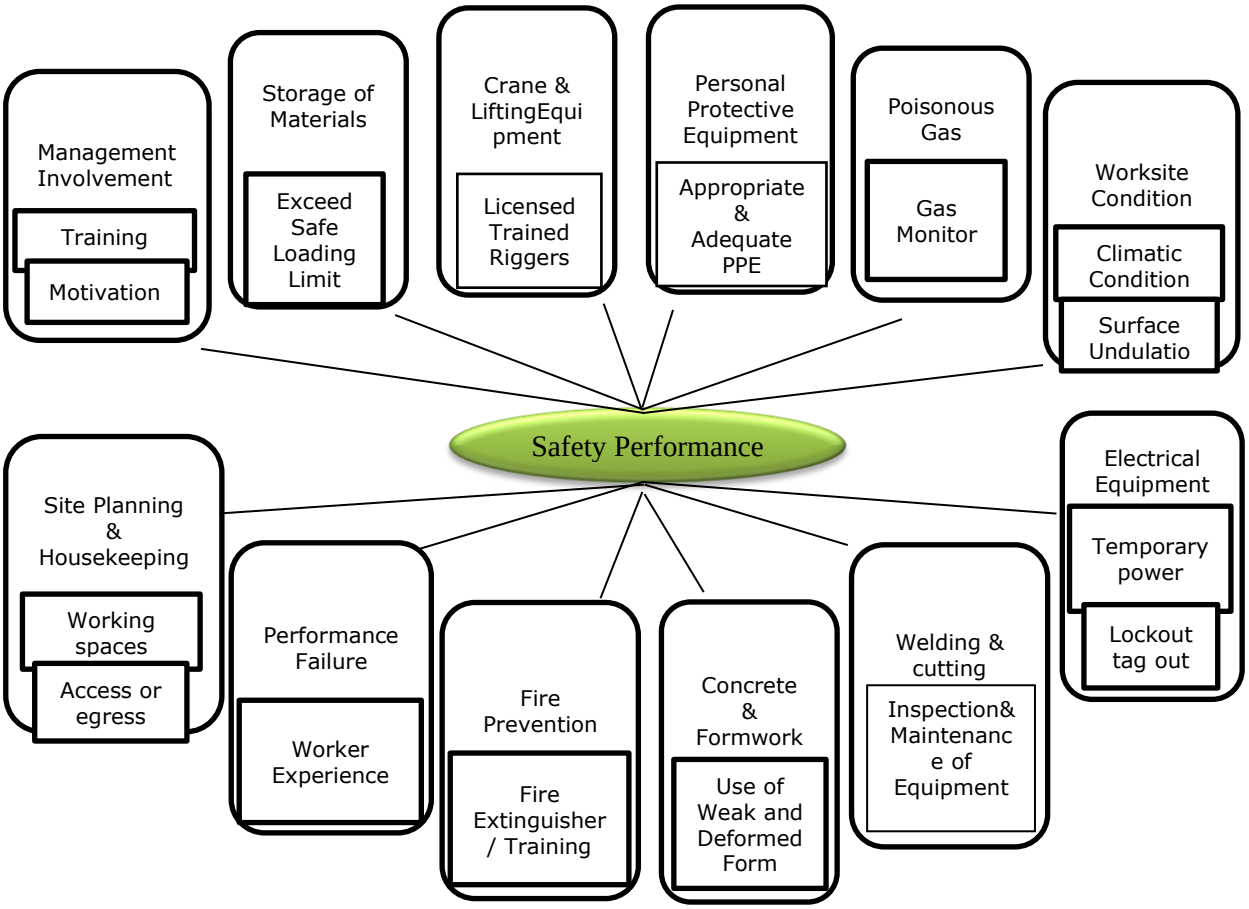

Fig.1. Flowchart of safety performance model

MANAGEMENT INVOLVEMENT

Safe work place is one of the most critical tasks of construction projects. If a team installs a sleeper from zero kilometers, it may take longer to complete the project. Therefore, management should add more teams to carry out the work efficiently and safely. Without proper management, project work cannot be done safely and efficiently. The policies and procedures adopted by management should be effective in maintaining the highest level of safety at work sites and with adequate training provided at the most appropriate time, that workers know how to conduct tasks safely and how they should act when on-site.

STORAGE OF MATERIALS

All materials should be delivered, stored and handled during a way that protects them from damage, moisture, dirt and intrusion of foreign materials. Ordering and delivery of materials should be planned according to the work progress to minimize storage on site, where there are higher possibilities of damages and deterioration of materials. The casting materials for the sleeper are to be of immense volume. If proper storage is absent then there are higher possibilities of damages and deterioration of materials.

CRANE AND LIFTING

Crane is a type of machine, usually fixed with wire ropes or chains, a hoist that can be used to raise, lower and fix the sleeper and carry it in parallel. The selection of a suitable crane for service, ensuring that sufficient clearances are established between the loads and the structure of the crane so cranes operators should undergo rigorous training and certified. Crane operators should also verify that there are no overhead power lines that would impede the operation. A minimum distance of three meters from lines of 750 volts should be maintained, while crane loads should be at least 4.5 meters from lines of 150 volts.

PERSONAL PROTECTIVE EQUIPMENT

Personal Protective Equipment (PPE) is one of the key safety lines for workers to mitigate certain risks of injury or sickness, often due to damage caused by hazardous environments. The PPE includes safety helmets, safety shoes, reflective jackets, eye and face protection, gloves, safety belts, etc. The employer must determine the hazards at the workplace in order to recognize the correct form of PPE to be given to ensure that the personal protective equipment is adequate to the risk. When the PPE is issued to workers, they must also be aware of the risks of which they are secured by the PPE.

POISONOUS GAS

Oil and gas pipes are positioned above the sleepers, so there is a risk of pipe leakage and thus various poisonous gas get spread over the region. This is a possible threat to the health of the workers and the situation is very pathetic. So a gas detector is a used to detect the presence of gasses in a region, often as part of a safety plan. This equipment is used to detect gas leakage or other contaminants and can interact with the control system in such a way that the process is often shut down automatically. A gas detector can sound an alarm to operators within the location where the leak occurs, giving them the chance to go away.

WORKSITE CONDITION

When the sleeper installation takes place in dry weather, there is a quantity of dust on the work site that can jam and clog the unit. Strong winds can strain machinery and cause breakage and hot weather can reduce the performance of materials such as sealants and mortar. Similarly, the pipeline stretches over long kilometers and positions the sleeper at a distance of 10 meters. Each location has a different site condition since the geography of the site can vary from site to site. The difficulties for installing the sleeper are significantly higher because the earth does have an uneven level difference.

ELECTRICAL EQUIPMENT

Sleeper construction project involves electrical power to operate a range of equipment and machinery used at sites where construction is taking place. Electrical risks, such as shocks and arc flashes or explosions, caused workers' deaths and multiple injuries are caused by the lack of safety measures. Some common violations found by temporary power at construction sites includes, using not rated by wiring, openings not protected by panels and enclosures, not using accurate cable terminations, and not using the correct covers at the junction boxes at the work site. Similarly, lockout- tag out might also be a safety practice in the industry.

WELDING AND CUTTING

If safety precautions are ignored, welders face various hazards that are potentially dangerous, including electrical shocks, fumes and gases, fire and explosions, and more. So inspect equipment for loose connections or bare or damaged wires and do not use defective equipment. When welding activities are carried out for sleeper, i.e., welding the hook inside the insert plate given at the top of the sleeper to keep the pipe not to move apart can result from extreme heat & sparks close to the welding. Danger also involves sensitivity to intense and continuous noise. Regular or immediate exposure to noise may cause permanent noise-induced hearing loss.

CONCRETE AND FORMWORK

Formwork may be a complete temporary framework system designed to contain fresh sleeper concrete to form and stabilize it in the specified shape and dimensions until it hardens enough to become self-supporting. The formwork method is vital to the final appearance of the hardened concrete sleeper. Localized weakness and overstress would occur which would destabilize the formwork framework.

FIRE PREVENTION

Construction sites should have appropriate fire extinguishers and the hazards associated with construction fires should be identified to all employees. In the case of a fireplace, routine fire training will help to keep workers informed and ready. A fire drill is a procedure in which in the building the occurrence of a fire or other issues is carried out the occupants can easily be transported inside the building as equivalent to evacuating the building.

PERFORMANCE FAILURE

Experienced employees have high levels of organizational skills, comprehensive assignments, coordination, listening, and have learned how to get along with others, solve problems without drama, and when necessary, call for help. An inexperienced employee does

not know where to concentrate on their efforts to deal with unforeseen issues and cannot stop costly errors and injuries. Unqualified workers, inadequate equipment and materials, and lack of project management are only a few factors that cause poor workmanship.

SITE PLANNING AND HOUSEKEEPING

Inappropriate workplace layout on a construction site creates problems in the workplace, resulting in loss of efficiency, safety risks, and low-quality problems. Good site layout preparation helps to reduce travel time and cost of driving, labor and materials, intrusion of operation during sleeper construction work, and site injuries. Housekeeping can prevent accidents and enhance the health, efficiency, and morale of the employees. Hazards such as slips and trips, collision with moving vehicles, unauthorized entry into dangerous work areas, falls into floor openings and falls into water can lead to severe harm when access and exit plans are not adequately retained in site planning.

ACHIEVING SUSTAINABILITY IN CONSTRUCTION SAFETY PROGRAMS

Sustainability has been focused on the use of resources as the materials being incorporated in the built environment and the energy consumed in the process of manufacturing the materials or their installation (Godfray R., Hinze J., & Sulivan J., 2013). Construction workers are also resources involved in the built environment, and it can easily be argued that they are the most valuable resource involved in the process of constructing facilities (Gray M., Hsu S C., Li H., & Lu M., 2015). The sustainability system should facilitate the successful integration of issues about the long-term stability of the environment, the health and safety of workers, the community and the economic life of a specific business (Godfray R., Hinze J., & Sulivan J. 2013). It would seem that a holistic view of sustainability demands that worker protection also be tackled. The six keys to sustainable success are:

KEY 1: VSP (VISION, STRATEGY, PLAN)

Develop some sort of vision, strategy, and plan to focus on sustainability. The Vision clarifies the direction you want your program to go in a desired end state. An example of a vision statement is by recognizing risks, enhancing EH&S processes and fostering a team-oriented approach to quality improvement and security of the lives of our workers and the environment. The strategy involves the individual components of the program to help the vision. Training, establishing a core safety steering committee, performing project safety audits and promising to maintain coordination within the program may be examples of these. The Plan component supports the strategies you developed and should be detailed so that it's very clear what will be incorporated into the safety program, to ensure that each of the strategies is met. Examples of the plan for the strategies given include deciding who will be trained and when, who will be involved in the executive board, when the group will meet and

what its mission will be, what the duration of the audits will be and the related methodology of inspection, and how to maintain contact.

KEY 2: EFFECTIVE GOAL PLANNING

Setting achievable goals for your safety management system is imperative. Options for goal choices differ greatly and to use this to our sustainable benefit upon completion of a specified number of inspections per week, prompt resolution of items requiring corrective action, percentage of risks with sufficient reporting and observation power.

KEY 3: TRAININGPROGRAMS

When thinking about sustainability as it refers to training, if possible, check that the right people are present and that it is appropriate to them. Avoid scheduling preparation after a person's move, as this significantly affects productivity, magnifies stress, and may cause moral problems.

KEY 4: COMMUNICATION

Communication is of primary importance in the sense of effective and sustainable protection processes. If you are obtaining safety information and not disseminating it to the right people at the right intervals, it is difficult to support a quality improvement loop.

KEY 5: UNDERSTANDING RISK

Understanding the threats on the basis of the activities being undertaken and the hazards defined in the project is the first move towards resolving them as safety practitioners and prioritizing corrective action and potential emphasis.

KEY 6: ACTIVE ENGAGEMENT

Active engagement is the requirement that should be given to leadership. Leaders really have to prove that they care for their workers by putting people ahead of money. Leaders are expected not only to actively promote safety programs, but also to obey the rules. The program's integrity would be lost if workers notice the company officials breaching basic safety standards.

CONCLUSION

The construction industry is concurrently recognized as a serious economic force and one among the foremost hazardous industries. In composite construction projects, risky situations and hazards are inevitable and they can have much negative influences on workers. It is not easy, but feasible to improve safety performance on the construction site. Two-thirds of the battle is to build the safety program, incorporate the components of reform

and turn the corner for progress. Sustainability might only be the final third, but it is responsible for enhancing the project's continuous safety and getting straight back to where you began, or worse. From the identified factors, the most prioritized one which influences the safety performance is Crane and Lifting equipment. Specific attention should be provided to the Communication key in the assessment of sustainable construction. The relationships and transparency driving this are vital to a program's continued success. Ignoring this step fosters working in a vacuum and creates a gap between management and safety representatives. Employees are the most important part of any safety program and when they are empowered and have positivity toward success and improvement, the process of maintaining program sustainability is much more manageable.

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