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Survey on Occupational Health Risk Assessment in Construction

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***Abstract*— Many building construction activities are congenitally risky to the health and safety of workers. It affects to productivity and overall performance of the construction project and diminishing the workforce and labor force etc. The purpose of study is to identify the factors affecting occupational health risk during construction and different diseases associated with the construction occupations. Construction of any facility or a building involves a number of vast activities such as Excavation, Foundation, RCC work, Masonry work, Plastering, Plumbing, Installation of door windows, Painting, Electrification. Many other miscellaneous work activities having different in nature. Workers can be exposed to different risks at the workplace, like chronic exposure to harmful substances, accidents, physical stress, natural disasters or may be any malicious act. In the entire world, almost adults and many children spend much of their waking hours at work. Work provides a number of economic and other benefits. But, during such a prominent activities of construction worker have to face such a challenging situations like work at height, to handle heavy materials tools equipment's, work with around heavy machinery, to handle hazardous chemicals/materials, work in environment vitiated with dust other harmful substances varied psychosocial factors etc. Fall from height is the most common cause of injury among all accident types, along with slip/trip on same level, Collapse of objects, electric shock, contact with falling objects, contact with moving machinery/vehicle, rotating/moving parts of tools, etc. this paper focus on studying the various occupations and associated risk with it by through study of paper published by research scholars'. This study helps us to identify common risky activities and associated occupation and also disease caused due to work place environment.**

Keywords*— *Occupational health, Risk Assessment, Occupational Disease, Injuries.

I INTRODUCTION

Occupational disease and injury vigilance/care which entails the systematic monitoring of health events in working populations is essential to assess the nature, and pattern of occupational diseases and injuries. The observed data will be useful in determining control strategies, and for evaluating the effectiveness of any interventions undertaken. They will also lead to the discovery of new associations between occupational agents and accompanying diseases, since the potential toxicity of most chemicals used in the workplace is not known. However, a comprehensive national surveillance system for occupational injuries and illnesses is lacking even in the developed countries. The Bureau of Labor Statistics' annual survey of occupational injuries and illnesses, compensation to workers, and physician reporting systems are some of the sources of data in the developed countries Because data produced by these systems have been described as scattered/unreliable.

As per the Report on Occupational Safety and Health for the Tenth Five Year Plan (2002-2007), 'Construction sector is one of the most vulnerable segments of the unorganized labor in our country. A large number of workers in this sector are vulnerable to the varieties of workplace accidents and occupational health problems. They are exposed to a wide variety of serious OSH hazards and the rate of fatal accidents in this industry is 4 to 5 times that of manufacturing sector. The workers are also subjected to a event of hazardous substances, which have a potential to cause serious occupational diseases etc. There is also a serious potential for fires due to storage and use of flammable substances and a potential for disasters due to collapse of the facility (structure) and subsidence of the soil on which the construction activity is being carried'.

According to ILO 2003, 'work-related fatalities in India estimates for 3, 10,067, the accidents in construction industry are mainly due to the factors such as:

1. Thousands of small firms and self-employed workers
2. Shorter run of construction activities at sites
3. High-turnover of workers
4. Large number of seasonal and migrant workers which are not familiar with construction activities.
5. Many different trades and occupations involved in construction activity.

A. Risk Events during Construction

1. Falling from heights –

Involves workers falling from higher floors to lower floors/ground and falling from ground level to excavation level. Those accidents may results in death and serious injuries of workers.

2. Struck by falling/moving objects/vehicles

Primarily involves workers being struck by equipment, private vehicles, falling objects, vertically hoisted members and horizontally transported materials.

3. Excavation related accidents

Encompasses accidents due to cave-in, contact with underground utilities, subsiding of nearby structures, falling of materials/vehicles/ objects onto people working in the excavation as well as fumes, gases and inrushes of water at the bottom of excavations.

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4. Accident due to exposure to machinery/tools
Caused by toppling of machinery, collapsing of the parts of machinery and unsuitable or inappropriate hand-held tools.
5. Electrocution
Caused by direct contact with electric current from machinery, tools, appliances or light fixtures, faulty electrical equipment's and tools, and contact with overhead/underground power lines.
6. Fire/explosion
Accidents resulting from the explosion of pressure vessels or gasoline pipes and fire due to welding/hot works.
7. Failure of temporary structures
Accidents owing to the failure of formworks and scaffoldings.
8. Others –
E.g. slipping on the same height, lack of oxygen in confined spaces, lightning strike, etc.
9. Contact with hazardous chemicals & solvents.
10. Workers surrounding vitiated with dust, etc.
Above mentioned risky events cause number of injuries & disease to the workers such as
a) Injuries:
Abrasion, Laceration/Fractures/Dislocations, Accidental wound, Incised, Stab, Firearm, Contusion, Burns, Chemical/Radiation/Electric/Lightening/Explosive burn, etc.
b) Disease: -
Asthma, Bronchitis, Dermatitis, Histoplasmoisis, Silicosis, Asbestosis, Chalicosis, Skin cancer, vascular disease & Neurological disease, etc.
c) Fatality/Death
So as mentioned above outcomes of risky construction activities, to avoid it some solution should be there. There are four substitute strategies – risk avoidance, risk transfer, risk mitigation, and risk acceptance, for treating risks in a construction project. But, risk cannot be ignored. Risk mitigation and risk response development is often the weakest part of the risk management process.

II. LITERATURE REVIEW

[1]As per Abel Pinto, Isabel L. Nunes, Rita A. Ribeiro, in paper 'Occupational risk assessment in construction industry – Overview and reflection' The construction industry is forced by occupational risky exposure and poor working conditions. On construction industry, ORA are rampant with insufficient data and or inaccurate and incomplete information, particularly in the design stage, for which traditional quantitative approaches do not give adequate answers. Abel Pinto & his team concluded that Occupational risk assessment on workplace and major sites is the first and key step to achieve adequate safety levels, particularly to support decision-making in safety programs. Most construction safety efforts are applied informally under the premise that simply allocating more resources to safety management will improve safety on site.
Moreover, there are many traditional methods to address ORA, but few have been adapted and validated for use in the construction industry, particularly in the design stage, for which traditional approaches do not give adequate answers. Here, they pointed that a state of the art on ORA traditional methods, for the construction industry, discussing their limitations and pointing advantages of using fuzzy sets approaches to deal with ill-defined situations. Finally they believe fuzzy approaches demonstrate the ability to manage uncertainty associated with modeling human characteristics.
[2]Authors Mesafint Molla Adane, Kassahun Alemu Gelaye, Getahun Kebede Beyera, Hardeep Rai Sharma and Walelegn Worku Yalew, in paper *'Occupational Injuries among Building Construction Workers in Gondar City, Ethiopia'* concludes that, occupational injuries were common among building construction workers. Therefore, counter measures such as creating awareness of risk factors, avoiding overtime work, providing training and personal protective devices could be effective to decrease prevalence of occupational injuries. Institution-based cross-sectional study was conducted from May 1 – 20, 2009 at six licensed construction sites in Gondar city. A total of 401 building construction workers were included in the study by using simple random sampling technique. Data were collected through interviews using structured and pre-tested questionnaire and the collected data were entered and analyzed using Statistical Package for the Social Sciences. The results show that prevalence rate of work-related injuries in the preceding one year was 38.7%. Of the total injuries, more than half (68.39%) were reported by males while the rest reported by females workers. The leading causes of injuries were fall from ground level (21.3%) followed by overexertion during lifting (20.6%), and fall from elevation (16.1%).Old age, being male, job dissatisfaction, lack of vocational training and working overtime were found to elevate the odds of having occupational injuries among construction workers.

[3]As per Adel Badri, André Gbodossou, Sylvie Nadeau, in paper '*Occupational health and safety risks: Towards the integration into project management*' Project management in industrial settings in many cases is deficient with respect to integrating OHS risks. This deficiency manifests itself as problems affecting the safety of industrial practices and is explained generally by poor knowledge of OHS within organizations and project teams. Adel Badri& his team conclude that publications identified are mainly derived from the construction industry and stress that the objectives, methodologies and results are largely heterogeneous. The integration of OHS risk is not systematic in all industrial fields despite the changing and improving laws and management systems. In order to complete the overview of their OHS integration, they suggest that future reviews and research that specifically investigates other innovative OHS applications and many analyses of recent industrial accidents. Also their complete synopsis will give opportunities for researchers to use or improve methods and approaches to promote OHS risk management in the manufacturing sector that suffer from lack of knowledge in this area. Adel Badri & his team introduced some of the tools, methods and approaches being developed or adapted to integrate OHS and a general description of the current status of this integration in various fields. Their focus includes, laws, management systems; OHS risk management throughout project lifecycle and efforts to integrate OHS risk management to industrial safety practices including approaches using historical data and industrial interventions.

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[4]Authors Ching-Wu Cheng, Sou-SenLeu, Ying-Mei Cheng, Tsung-Chih Wu, Chen-Chung Lin, in '*Applying data mining techniques to explore factors contributing to occupational injuries in Taiwan's construction industry'* states that The causes and distribution of occupational accidents in the Taiwan construction industry by analyzing such a database using the data mining method known as classification and regression tree (CART). Utilizing a database of 1542 accident cases during the period 2000–2009, the study seeks to establish potential cause-and-effect relationships regarding serious occupational accidents in the industry. The results of this study show that the occurrence rules for falls and collapses in both public and private project construction industries serve as key factors to predict the occurrence of occupational injuries. The results of the study provide a framework for improving the safety practices and training programs that are essential to protecting construction workers from occasional or unexpected accidents. Based on the analytical results of OLAP and Cramer's statistics, CART was used to investigate the occurrence rules of accident type in public and private projects using different independent variables, namely project type, company size, project contract amount, work being performed at the time of the accident, accident location, source of injury, worker type, unsafe conditions, and unsafe acts.

[5]As per Sinan Unsar and Necdet Sut in paper *'General assessment of the occupational accidents that occurred in Turkey between the years 2000 and 2005'*calculated index values based on the year 2000, and based on some sectors e.g. transportation, basic metal industry, foodstuff industry, manufacture of gravel, sand and clay, construction, coal mining etc. In this study, the statistical year books regularly published by Social Security Institution (SSI) have been used as a data source. A result of their study shows that, a fluctuation in Turkey in the number of occupational accidents between 2000 and 2005 and downward fluctuation in the number of deaths resulting from occupational accidents. Permanent disabilities have also shown a falling trend since 2002. Occupational accidents are mostly seen in the sectors of manufacture of metal goods (except for machines), construction, the textile industry, coal mining and manufacture of transportation vehicles, while the deaths of workers and Permanently disabled persons due to occupational accidents are mostly seen in the construction sector.

[6] Maria del Mar Casanovas & his team in '*Occupational Risk Index for Assessment of Risk in Construction Work by Activity'* states that the concern for occupational health and safety in construction work is reflected in the many preventive measures taken. However, examples of the systematic assessment of project alternatives aimed at minimizing occupational hazards are rare. Maria del Mar Casanovas & his team proposes a measure of occupational safety [occupational risk index (ORI)] that is based solely on the project design and resulting construction process, and is a function of the activities carried out and their specific occupational risk (probability and consequences of occurrence). The ORI can thus be used as an indicator to feed multi criteria decision-analysis tools. The proposal is illustrated with a simple example in which two alternatives (one precast and the other constructed in situ) are prioritized in terms of occupational safety, and certain aspects related to redesign are briefly addressed. To this end, first, the main risks associated with different construction activities are analyzed. Next, an occupational risk index (ORI) for construction work is defined, calculated as the sum total of the workload for the risk activity weighted by its relative risk. The workload for each risk activity is calculated as the total number of working hours spent on it. The relative risk of each activity is calculated based on the probability of occurrence of the risk and the likely severity of its consequences. This is followed by a brief discussion of different methodologies for supporting decision making in the context of project management. With the ORI, occupational safety goes from having a passive influence (application to projects that have already been designed) to an active one (influence on the design concept itself) in the design stage of construction projects. The research is based on an analysis of the applicable legislation and interviews with experts.

[7] As per Marta Gangolells, Miquel Casals, Núria Forcada, Xavier Roca, Alba Fuertes in'*Mitigating construction safety risks using prevention through design*' have demonstrated that decisions made prior to work at construction sites can influence construction worker safety. However, it has also been argued that most architects and design engineers possess neither the knowledge of construction safety nor the knowledge of construction processes necessary to effectively perform Construction Hazards Prevention through Design. Marta Gangolells & his team introduce a quantitative methodology that supports designers by providing a way to evaluate the safety-related performance of residential construction designs using a risk analysis–based approach. The methodology compares the overall safety risk level of various construction designs and ranks the significance of the various safety risks of each of these designs. The methodology also compares the absolute importance of a particular safety risk in various construction designs. Because the methodology identifies the relevance of each safety risk at a particular site prior to the construction stage, significant risks are highlighted in advance. Thus, a range of measures for mitigating safety risks can then be implemented during on-site construction. The methodology specified in this paper is especially worthwhile for designers, who can compare construction techniques and systems during the design phase and determine the corresponding level of safety risk without their creative talents being restricted. By using this methodology, construction companies can improve their on-site safety performance. The methodology is also worthwhile for those less-experienced designers who lack the skills and knowledge required to recognize hazards and develop optimal designs. Proactive hazard identification and elimination is always safer and more cost effective than reactive hazard management.

[8] As per O.N. Aneziris, E. Topali, I.A. Papazoglou, in paper 'Occupational *risk of building construction*' presents the quantification of occupational risk of a building construction project. O.N. Aneziris& his team have developed the Occupational Risk Model (ORCA) under the Workgroup

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Occupational Risk Model project (WORM), in the Netherlands, for quantifying occupational risk. This model assesses occupational risk of a worker, by taking into account his various tasks, activities and their hazards. Risk is evaluated for three types of consequences: recoverable injury, permanent injury and death. The occupational risk model is based on a set of 63 bowties, which assess risk owing to different hazards such as fall from ladder, scaffold, roofs, falling object, struck by moving vehicle, contact by moving parts, etc. ORCA calculates the risk profile of a building construction site, consisting of thirty-eight workers in different job positions, such as operators of excavators, loaders, compaction equipment, workers in excavation and framing phases, etc. All risk profiles of workers have been quantified and jobs have been ranked according to their risk. Workers installing timber form works have the highest fatality risk (1.57x10-3/yr), followed by the workers installing reinforcement (1.52x10-3/yr).The Occupational Risk Model contains a database with 347 risk reduction measures, applicable to all 63 hazards. The collection of measures consists of generic and circumstance specific measures aimed at strengthening organizational, human and technical aspects of barriers. Generic measures include safety training, inspection and maintenance of physical barriers, toolbox meetings, monitoring of safe work practices, daily work meetings for maintenance coordination and positioning of signs and warnings for the dangerous.

[9] Author R.A. Haslama, S.A. Hidea, A.G.F. Gibb, D.E. Gyia, T.Pavitt, Atkinson, A.R. Duff in paper '*Contributing factors in construction accidents'* have studied 100 individual construction accidents. They pursued issues raised by the focus groups, the accident studies collected qualitative information on the circumstances of each incident and the causal influences involved. Site based data collection entailed interviews with accident involved personnel and their supervisor or manager, inspection of the accident location, and review of appropriate documentation.

Relevant issues from the site investigations were then followed up with off-site stakeholders, including designers, manufacturers and suppliers. Levels of involvement of key factors in the accidents were: problems arising from workers or the work team (70% of accidents), workplace issues (49%), shortcomings with equipment (including PPE) (56%), problems with suitability and condition of materials (27%), and deficiencies with risk management (84%). Employing an ergonomics systems approach, a model is proposed, indicating the manner in which originating managerial, design and cultural factors shape the circumstances found in the work place, giving rise to the acts and conditions which, in turn, lead to accidents. It is argued that attention to the originating influences will be necessary for sustained improvement in construction safety to be achieved. The research did not encompass the small builders, working in isolation, generally regarded as having an especially poor health and safety record. The challenge of improving safety within these small enterprises is considerable.

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III. IDENTIFICATION OF RISKY EVENTS DURING CONSTRUCTION

Different hazards were identified based upon the literatures studied. The common hazards such as fall from height struck by machinery/moving vehicle, contact with hand held tools/machinery, exposure to dust/ UV radiation, environmental changes, etc. All this hazards then further grouped in 6 main risky events i.e.

1. Accidents
2. Hazardous exposure
3. Breakdown of tools & equipments
4. Mischievous acts
5. Natural calamities
6. Unscheduled activities

IV.FACTORS AFFECTING OCCUPATIONAL HEALTH RISK

Factors affecting occupational health risk during construction are identified from literatures & also with the help of experts in the field of construction. Total 12 factors was identified, e.g. Workers instincts, workers capabilities, communication between the workers and between workers and supervisors, condition of tools & equipments, safety culture, etc. The factors are then listed & grouped in 12 factors. Then finally regrouped into 5 main groups as shown in fig 1.

A. Workers & Work Team Oriented

Problems arising from workers or the work team, especially worker actions or behavior and worker capabilities, unsafe acts, safety being overlooked in the context of heavy workloads and other priorities, workers taking shortcuts to save effort and time, etc.

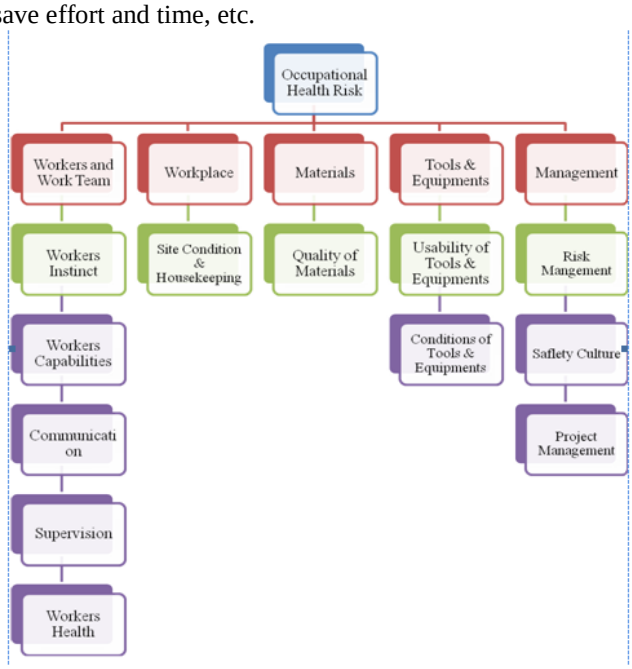

Fig 1:- Factors affecting Occupational Health Risk

B.Workplace Oriented

Workplace oriented factors includes poor housekeeping and problems with the site layout and space availability, lack of clearly defined walkways, constantly changing workplace and work activities, poor site conditions such as

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uneven ground or debris &muddy conditions, inadequate space or difficult access to perform a task & weather conditions during construction activities, etc. typically causes slip and trip hazards, etc.

C. Materials Oriented

Deficiencies with the suitability and condition of materials, including packaging, hazards were either inherent to the materials, as with the extremely heavy. Materials packaging can also cause problems with disposal, leading to other hazards introduced onto site (e.g. fall or fire hazards). Suppliers have to paid attention to the manual handling requirements of some materials, through the introduction of smaller cement bags, etc.

D.Tools & Equipments Oriented

A number of the hazards in past occurred due to tools & equipment's on construction site. Some of the incidents involved struck by machinery/vehicle, contact with hand held tools, vibration, etc. Injuries in several accidents arose from individuals striking their head or other body part against machinery. These hazards either due to poor configuration, site constraints or equipment limitations, etc.

E. Management Oriented

The management oriented causes of construction hazards are the high level source of the nature, extent and existence of immediate causes of accidents. Some researchers referred it as 'root causes'. It seems very clear that these causes do affect safety on construction sites. Many construction firms ignored risk assessment for the accident activities, despite this being a legal requirement, even for activities 'off-task'. Also, need of education & training exists across the industry, encompassing designers and suppliers, as well as site-based personnel, to raise awareness and understanding of the occupational health risks that are commonplace in construction.

V. IDENTIFICATION OF OCCUPATION IN CONSTRUCTION

Following are the Occupations in construction are identifies from previous research and risk in each occupation with associated injuries identified from survey. Occupation in construction includes

1. Painter, plaster
2. Electrician
3. Blasting for excavation
4. Work under hyperbaric condition
5. Mechanical load handling
6. Manual load handling
7. Work with heavy equipment or heavy good vehicle
8. Work with light equipment
9. Welding
10. Store houses.
11. Tile Flooring Work.

Table 1 shows the occupations in construction and risk injuries and diseases associated with each occupation.

Table 1:-Occupation and related risk, injuries and diseases in construction

Occupation	Risk	Injuries	occupational disease
Painter, plaster	Falls to lower level	breakdown of bones	disorders of muscles, tendons
Electrician	Direct/indirect electric contact	Electrical shock	brachial plexus injury (avulsion)
Blasting for Excavation	particle projection, accidental explosion	Physical injury	blunt, Epilepsy (Seizure Disorder)
work under hyperbaric condition	Decompression sickness	Sickness	Oxigen toxicity, Bends and Caisson
Mechanical load handling	collision with or entrapment by moving load due to its movement	minor/major physical	back injury, Radial styloid tenosynovitis
Manual load handling	blows to upper and lower limbs	Blows to upper and lower limbs	back injury, joint and bone disease
work with heavy equipment / vehicle	colllision with or running over heavy equipment	minor/major physical	Whole-body vibration,
work with light equipments	Cut,Blunt,truma	Minor injury	Cut,Blunt,truma ,lacerations from exposed nails,tools, mach inery, etc
Welding	arc radiation	eye irritation	tempary or permenent blindness
store houses	produces high concentration of silica dust	asthama ,conglomarate	Silicosis
Tile flooring work	exposure to high noise	Deafness	Deafness

VI. CONCLUSIONS

This paper focuses on related work done on occupational health risk assessment as well as identifies factors affecting occupational health. It also identifies risky events during construction and risk, injuries and associated diseases in each occupation.

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