Job Safety Analysis (JSA) Applied In Construction Industry

Shekhar Choudhary
PG Scholar
Shiv Kumar Singh Institute of Technology and Science, Indore

Pulkit Solanki
Assistant Professor
Shiv Kumar Singh Institute of Technology and Science, Indore

Dr. GD Gidwani
Executive Director
Shiv Kumar Singh Institute of Technology and Science, Indore

Abstract

Indian construction industry is passing through very unique phase. Massive infrastructure like, National Highway, Dam construction for Irrigation, Airports up-gradation for Tourism of domestic & International tourists, Urban rapid transportation like Metros, Bus Rapid Transport system Flyover poised to grow exponentially within last 10 years. This situation leads to excellent opportunities for the construction industry in terms of business opportunity. This also leads to Indian economic growth even through FDI. Many national constructions housed such as Hindustan Construction Company, DLF, Tata projects and Larson & Turbo limited actively managing projects in India & Aboard. Job safety analysis (JSA) was one of the great methods used for the purpose of safety analysis. Here we approach the method on construction area and also elaborate our results. We are here provide a vast knowledge of various hazards developed in the construction department with their brief study and also give knowledge of solving and overcoming these hazards.

Keywords: Construction sites, JSA (Job Safety Analysis), Materials, Manufacturing etc.

I. INTRODUCTION

The main reason of boost of the construction industry is due to increase of Purchas power of middle class and improved living standard. Only Construction industry would provide the basic physical infrastructure for the nation as well as other industries.

Today, Housing & Real estate construction business is around 15.3% of total Construction, is the only one segment which flourished not only in Metro cities but also at Taluka level places construction. With reference to recent survey, Construction industries generate maximum jobs for skilled & unskilled labors in urban & ruler areas in India

Many Public Private Partnership projects construction activities undergoing in the following sectors:

1) Passenger Jetty, seaports, Roads and bridges, airports, inland waterways.
2) Thermal Hydro Power, Non-conventional power.
3) Bus Rapid Transport Systems in Metros, Elevated Urban transport, sewerage, water supply, solid waste management and other physical infrastructure in industrial estates & urban areas.
4) Special Economic Zones; Agriculture Economic Zones Infrastructure projects
5) Tourism infrastructure projects International convention centers

These Infrastructure project expenses covered under scheme as:

1) Contractor provide a service against payment of a predetermined tariff or user charge like Toll
2) Condition that that the tariff/user charges cannot be increased to eliminate or reduce the viability gap of the Public private Partnership.
3) Project Period/Term cannot be increased for reducing the viability gap by contractor.
4) Material standards and specifications applicable to such projects

A. Type of Construction

Residential Construction: It is apartment or a group of buildings whenever construction work is being performed for residential purpose [1].

Fig. 1.1: Residential Flats [1]

In urban Area in India Commercial cum Residential buildings also acceptable by society for daily requirements shops like Grocery, Hotel and General stores etc. In Metros, apartment complex would more likely be considered a commercial residential project instead of a residential project.

1) Commercial Construction:

Generally Commercial construction includes a large variety of projects including building, skyscrapers, restaurants, grocery stores, shopping centers, sports facilities, hospitals, private schools, etc [2].

The definition of Commercial construction is the construction of any buildings or similar structures for business purposes. Today, in any Indian Urban areas you may observe construction boom of IT Buildings, multiplex. Shopping Mall, Convention hall and Recreation complexes construction.

Fig. 1.2: Infosys Technologies Limited's building [2]

2) Industrial Construction:

Industrial projects include power plants, manufacturing plants, solar wind farms, refineries, etc this is a relatively small segment of the construction industry. While termed "industrial construction," it is also called with "commercial purpose construction." [3]

Fig. 1.3: POL Storage Tanks [3]

There are more several types of constructions like

- Infrastructure construction
- Tunnel
- Ports
- Modern Oil Terminal
- Break water wall
- Bridges

The main reason for working in this area is to study and overcome the accidents held in construction department. The deep knowledge of my study was explained in this section given below.

B. Construction related Accidents in India

National safety council of India published that about 7.5% Labors involved in construction Industry .In world, 16.4% of fatal accidents occurs during construction activities. ILO indicate that about 11% of occupational injuries and 20% of deaths resulting from accidents in the construction industry [4]. The possibility of a fatality is five times more likely than in a manufacturing industry, the risk of a major injury is two and a half times higher. Each year, up to hundreds of people is killed at work place in the developed countries like UK/USA too. Not only construction workers but Visitors, pubic and children also suffer from unsafe conditions of construction industry.

Fig. 1.4: Scaffolding collapse fetal accident [4]

Indian construction industry is more labor-intensive than that of the developed countries, involving 2.5-10 times more workers per activity.

II. LITERATURE REVIEW

As we know before doing any research or innovation we have to adopt knowledge of previous researchers who already do something on the same or related topic for the betterment. So here in this section we are going to acknowledge the work of some past researchers from whom we got help for our study.

Ophir Rozenfeld et al [5] 2010 Job Safety Analysis (JSA), which is also known as Job Hazard Analysis, is an efficient proactive measure for safety risk assessment used in industrial manufacturing settings. However, unlike the manufacturing set-tings for which JSA was developed, at construction sites the physical environment is constantly changing, workers move through the site in the course of their work, and they are often endangered by activities performed by other teams.

The method involves identification of potential loss-of-control events for detailed stages of the activities commonly performed in construction, and assessment of the probability of occurrence for each event identified. It was applied to explore 14 primary construction activities in an extensive trial implementation that included expert workshops and a series of 101 interviews with site engineers and superintendents. Detailed quantitative results were obtained for a total of 699 possible loss-of-control events; the most frequent events are those related to exterior work at height.

Henny Yustisia et al [6] 2014 this study focuses on constructability terms of construction safety. Safety here is not only an occupational safety but within the scope of the safety dimension that worker, property, environmental and public. The purpose of this study was to evaluate the project constructability issues associated with Kelok-9 bridge construction safety problems and evaluate the implementation of the project if the contractor can do the appropriate design and implement construction safety. From these results it can be concluded: Constructability evaluation of the safety construction on the Kelok-9 bridge project quite good but design projects not yet incorporate the experience and knowledge of the construction in terms of construction safety. Constructability evaluation of the safety of construction on Kelok 9 Bridge Project in terms of the analysis results obtained on blasting work is good and the work Pillar is enough. Design projects not yet on the bridge Kelok 9 experience and knowledge of the construction of safety in terms of construction, this can be proved with the requirements specified in the contract documents are not everything can be applied in the field.

One of the principles of constructability in the operational phase applied to this project is the use of innovative construction methods, for example using a launching girder Bridge installation.

Seok J. Yoon et al [7] 2013The study was conducted to investigate the current status of the occupational health and safety management system (OHSMS) in the construction industry and the effect of OHSMS on accident rates. Differences of awareness levels on safety issues among site general managers and occupational health and safety (OHS) managers are identified through surveys. Methods: The accident rates for the OHSMS-certified construction companies from 2006 to 2011, when the construction OHSMS became widely available, were analyzed to understand the effect of OHSMS on the work-related injury rates in the construction industry. The Korea Occupational Safety and Health Agency 18001 is the certification to these companies performing OHSMS in South Korea. The questionnaire was created to analyze the differences of OHSMS awareness between site general managers and OHS managers of construction companies.

Abdulkadir Ganah et al [8] 2015 Health and safety (H&S) on a construction site can either make or break a contractor, if not properly managed. The usage of Building Information Modeling (BIM) for H&S on construction execution has the potential to augment practitioner understanding of their sites, and by so doing reduce the probability of accidents.

Conclusion: From the survey, toolbox talk will have to be integrated with the BIM environment, because it is the predominantly used procedure for enhancing H&S issues within construction sites. The advantage is that personnel can visually understand H&S issues as work progresses during the toolbox talk onsite. The Plan for Growth by the Government in the UK, published alongside Budget 2011, emphasized the significance of an efficient construction industry in the country to the economy. Construction accounts for about 7% of the gross domestic product or £110 bn of expenditure per year with approximately 40% of this being in the public sector, with Central Government being the biggest customer of the construction industry In construction, it is apparent that most practitioners within the industry still believe that the H&S file is the single most important repository within the UK construction project, especially at the implementation phase for all H&S Further informal discussion with practitioners revealed that BIM will be a duplicate information resource and that it is not necessary.

III. SYSTEM DOMAIN

A. Introduction

Madhya Pradesh Power Generation Company limited (MPPGCL) is a wholly owned company of government of engaged in generation of electricity in state of Madhya Pradesh. The company while operating and maintain its existing units and also construction new power plant for increasing capacity in the state of Madhya Pradesh. The company has been incorporated as a part of the implementations of the power sector in government of Madhya Pradesh. The MPPGCL head Qatar in Jabalpur, India [9].

Fig. 3.1: M.P.P.G.C.L (S.S.T.P.P) plant image and abut plant info chart [9]

- The power generation capacity Madhya Pradesh Power Generation Company limited (GCL).
- The installed capacity of as on 01.01.2015 is 5235 MW out of which Madhya Pradesh share is about 5237.5 MW.
- The company has taken over the generation activities of MPSEB.
- The company is a public company fully owned by Govt. of M.P.
- The company obtained the certificate of commencement of business on 16-07-2002.
- The corporate identity number of MPPGCL IS U40109MP2001SGC014882.
- The opening balance sheet of Madhya Pradesh Power Generation Company limited (MPPGCL) as on 31-05-2005 has also been notified.

B. L&T Power (Larsen & Toubro)

In M.P.P.G.C.L. the construction work of plant to L&T POWER (LARSEN & TOUBRO) in this the L&T got the tender for " BOP-BALANCE OF PLANT AND BTG- BOILER TARBINE GENERATOR" this is the main construction process to be done by the L&T POWER [10].

1) BOP:

In this balance of plant company construct building and chimney, cooling tower, main building , canteen, parking, boiler turbine generator room, are buildup by company and transfer point of coal, coal storage, store room, reservoir, etc. in M.P.P.G.C.L. the construction company L&T made 273 meter high chimney, and 253 meter high cool

2) BTG:

In this company will installed boiler, turbine, generator & big machine's, for the plant and because of this heavy metal the production of electricity will generated and main and big work is the installation of btg.

3) L&T Main Office:

In the company main officer and meeting rooms and all facilities and official works done in this office and because of this the every official work done.

4) RAW Material Storage Area:

This is the raw material storage area this is the area closer from construction side and all types of construction material will stored like, send, cement, bricks, ballast, and iron rod. Etc.

5) Batching Plant:

The batching plant is that area at which we can produced concert from batching cell and in this a big tube well and well for water mixing in raw material and its very closer from raw material storage and this concrete is supply by the concrete mixer from batching plant to construction side.

6) Canteen:

This is canteen for workers and their officer in lunch time the canteen will provide lunch to workers, and company employee. It gives refreshment and mil to workers and employee

7) Worker Rest Room:

This is the rest room which is very closer from work place and this facilities will provide by L&T POWER in the summer session the hotness of that area is very high there is big open land at the under construction side and there is a glucoses and energy drink facilities for worker and special facilities in raining & winter session.

8) Hospital:
hospital facilities foe workers of M.P.P.G.C.L AND L&T POWER if there is an incident our injury or a big accident at plant they can refer in internal hospital of plant, if there is an serious injury the refer to khandwa hospital the distance is 40km.
9) Store & Machine Parking:
This certified area for the big machines parking-crane, JCB, dumper, miller, concrete mixer, miller, boom placer, and this machines are used which can work very quickly. This must the system

C. *Rules & Regulations related to Construction*

Now a Days need for safety awareness among construction companies has greatly increased because of high cost associated with work-related injuries, workers' compensation, insurance premium, indirect costs of injuries, and litigation. Basic safety rules and regulations are observed by corporate construction companies but even today many accidents are not reported due to lack of awareness .Hence government has enacted specific legislation like: -

1) The Minimum Wages Act
2) The Workmen's Compensation Act of 1923 (modified in 1962)
3) The Contract Labor (Regulation and abolition) Act of 1970
4) National Building Code of India 2005 provides guidelines for regulating construction activities across the country.
5) The Building & Other Construction Workers' (Regulation of Employment and Conditions of Service) Rules, 2007 protect workman from their right of safe work conditions.
6) The Child Labor (Prohibition & Regulation) Act, 1986 protect child labor

IV. PROBLEM FORMULATION

A. *Introduction*

Construction work site is a dangers' place with a large number of works taking place. It started with the basic of human need shelter, home or dwelling house and the growing of population and their growing needs of residential and commercial buildings, shops, offices, factories, roads, bridges, dams, railways, power transmission lines. The various types of accident occur in construction industry. The many people are injured on construction work site. Many people are not completely trained but works are occurring they are creating on dangerous situation on works site.

There is improving their working condition is the safety philosophy. It should be realized that construction is inherently hazardous industry, contract based industry, demands heavy work load, contributes high frequency and severity of accidents, less protected by law, movable and needs continuous efforts to maintain safety at all levels. It may not be possible to completely eliminate the hazards, but it is certainly possible to minimize them by enforcing certain safety precautions. The working and service conditions of the workers need to be improved. Peculiarity of accidents is well known. Falling from height, struck by falling body including landslide, material and equipment, striking against object, falling on the flat or into pit, sump, and gutter etc. These types of problem are generally occurred in construction site, for avoiding the chance of fatalities in construction site Job Hazard Analysis is compulsory. In construction site, there are several types of hazard occurred due to unawareness and unsafe act.

Hazard Identification & Prevention Matrix

Here we make Hazard identification & prevention Matrix for Crane use in two types.

Table - 4.1
Two blocking

	Eliminate the Hazard		*Guard the Hazard*		*Provide a Safety Factor*		*Provide Redundancy*		*Provide Reliability*
	Hazard	*Safety*	*Hazard*	*safety*	*hazard*	*safety*	*hazard*	*safety*	
Natural	*Gravity/ instability*								
Structural/ Mechanical	*Cable Tensions*	*Anti- Two Block Stops Sources Tensions*							*100%*
Electrical				*Anti- Two Block Alarm*					*100%*
Chemical									
Radiant Energy									
Biological									
Automated system									

V. ANALYSIS AND METHODOLOGY

Job Safety Analysis (JSA), which is also known as Job Hazard Analysis, is an efficient proactive measure of safety risk assessment used in industrial manufacturing settings. However, unlike the manufacturing settings for which JSA was developed, at

construction sites the physical environment is constantly changing, workers move through the site in the course of their work, and they are often endangered by activities performed by other teams.

To address this difficulty, a structured method for hazard analysis and assessment for construction activities, called ‘‘Construction Job Safety Analysis” (CJSA), was developed. The method was developed within the framework of research toward a lean approach to safety management in construction, which required the ability to predict fluctuating safety risk levels in order to support safety conscious planning and pulling of safety management efforts to the places and times where they are most effective. The method involves identification of potential loss-of-control events for detailed stages of the activities commonly performed in construction, and assessment of the probability of occurrence for each event identified.

A. Job Safety Analysis method

- Identification: - choosing a specific job or activity and breaking it down into a sequence of stages, and then, identifying all possible loss-of-control incident that may occur during the work.
- Assessment: - evaluating the relative level of risk for all the identified incidents.
- Action: - controlling the risk by taking sufficient measures to reduce or eliminate it.

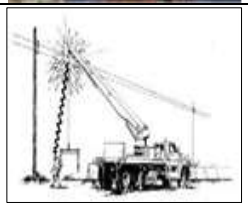
B. CJSA Process

The Construction Job Safety Analysis (CJSA) method generates a large knowledge-base describing all possible loss-of-control events in construction.

C. The CJSA Process Comprises Three Major Steps:

- Identify Hazards: - identify the set of direct and supporting construction activities needed for a domain, define their procedures, and analyze all possible loss-of-control events that may occur during their execution.
- Assess Probability: - evaluate the likelihood of occurrence of each loss-of-control event, the levels of possible intensifying factors, and the likelihood of use of personal safety gear.
- Assess Severity: - associate the possible loss-of-control events with possible accident scenarios, and assess the expected degree of severity for each type of accident scenario

Table - 5.1
Job Safety Analysis

Diagrams which co-relate with points	*POTENTIAL SAFETY & ENVIRONMENTAL*	*CONTROL MEASURES*	*PERSON RESPONSIBLE*
	*Dropped Loads (personnel / static object / equipment / machinery)*	*Working area to be delineated with clear signage clearly stating that access is restricted. All control is necessary on construction fields. Around the crane area. Authorizes person of company are observed in all process.*	*Operator*
	*Crush injuries (personnel / static object*	*Use Taglines Wear correct PPE. the glove are good quality of rubber materials .Observe the Load and the load placement area and keep well clear*	*Operator*
	*Oil leaks / fluid spills (environmental)*	*Spill Kits are kept on all cranes*	*Operator*
	*Electrical power line which place overhead*	*If required to work close to power line use a spotter or where possible have the power lines turned off*	*Operator*

	*Faults with Crane Plant, becoming bogged in sand & mud Onsite traffic / plan*	*Pre-start Checks Plant to stick to designated roadways and turning areas Personnel on hand to warn others of crane Alternate pathway defined by bollards and reflective tape*	*Operator*
	*Falling from sling and injuring Lifting gear failure Crush Injuries & Pinch Point*	*Tagline used to guide into position PPE – Riggers Gloves ,Watch for crush & pinch points between chain and where it is inserted into the Tank components lift points*	*Operator*
	*Load falling from lift*	*Slings to be appropriately positioned to prevent Slippage. All slings and lifting equipment to be free from damage*	*Operator*

The experts begin by dividing each activity into sub-activities. They determine the start and finish times of each sub-activity in relation to the overall activity duration as it would be defined in a construction hazards. The planned duration (activity start = 0%, activity end = 100%).

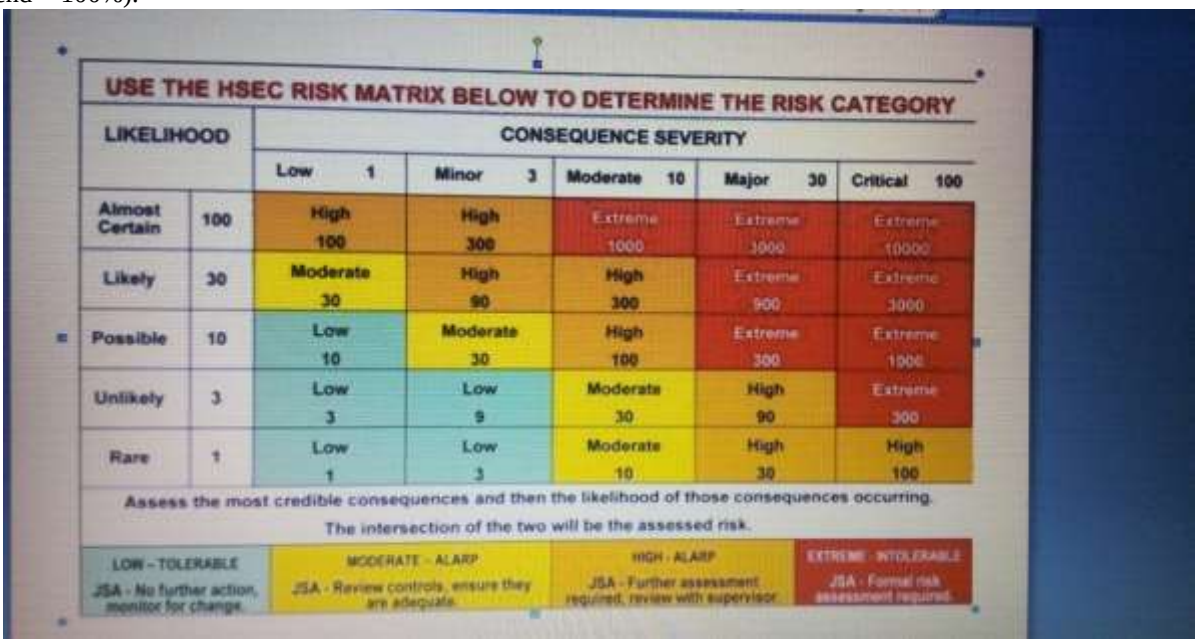


Fig. 5.1: work sheet of JSA

Table - 5.2
Job safety analysis

Sr. No.	*Work or Basic Job Steps*	*Potential Hazard*	*Control or Recommended Action*
1.	*Work at height*	*Fall, slip*	*Safety belt, harness provide*
2.	*Work at crane*	*Outriggers failure, crane touch to any electric wire, Struck by object falling from a crane*	*Maintain distance from electric sources*
3.	*Work on excavation*	*Earth slide*	*Helmet, PPE*
4.	*Foundation*	*Fall of material*	*Safety helmet, proper protection*
5.	*Trenching*	*Respiration problem*	*Respiratory system*
6.	*Steel erection*	*Fall of object & workers*	*Safety helmet, safety harness and belt provide*

7.	*Scaffold work*	*Fall, slip of workers, object fall*	*Safety harness at height,*
8.	*Work at column*	*Workers slip*	*Safety harness, hook*
9.	*Work at slabs*	*Fall from height or slip*	*Use net form, use proper safety belt and PPE*
10.	*Lifting crane*	*Fall any object,*	*Should be used safety helmet, give proper instructions to the crane operator*

Job Breakdown Sheet			
Operation Step	*Description*	*Hazards*	*Precautions / controls*
1.	*Start the job.*	*Breakage of wheel* *Contact with wheel* *Flying particles*	*Check and adjust the Guard* *Adjust tool rest* *Get wheel dressed if necessary* *Use goggles/ shield*
2.	*Pick up the job.*	*Sharp edges* *Unsafe gripping or lifting*	*Use hand gloves* *Use Safety shoes* *Proper method of storing* *Proper training in lifting.*
3.	*Grind*	*Flying particles* *Wheel breakage due to jamming etc.* *Dust-Silicosis, nuisance*	*Use goggles shield* *Do not jam* *Local exhaust for machine and respirator.* *Aprons Gloves*
4.	*Replace tjob.*	*Sharp edges* *Fall of casting* *Strain and sprain*	*Use hand gloves* *Use safety shoes* *Proper method of storing* *Proper training in lifting*

Table - 5.3
Severity rate

Severity Level	*Severity weight*	*Expected occurrence (%)*		*Weighted average*
		With safety gear (33%)	*Without safety gear (67%)*	
Minor injury	*1*	*79*	*1*	*0.3*
Medium injury	*5*	*17*	*5*	*0.5*
Severe injury	*25*	*4*	*23*	*4.2*
Death	*100*	*0*	*71*	*47.6*
Severity level				*52.6*

Table - 5.4
Activity analysis

Activity		*Interviewee specialization*	*Activity analysis summary*	
			Number of stages	*Number of loss-of-control events*
Foundations Structural activities	*Piling*	*Superintendent*	*2* *3* *2*	*57*
	Concrete slabs	*Superintendent*	*2*	*85*
	Cast-in-place concrete	*Superintendent*	*2*	
	columns and walls	*safety inspector*	*8* *2*	*74*
	Erecting precast slabs	*Superintendent*	*3* *2*	*59*
	Erecting precast walls	*Superintendent*	*3* *2*	*57*
	Forming walls with stone cladding	*Superintendent*	*4* *1*	*67*
Finishing activities	*Brick masonry*	*Superintendent* *Superintendent stone*	*2* *1*	*33*
	Stone cladding	*contractor*	*4* *2*	*32*
	Exterior plastering	*Superintendent*	*7*	*62*
	Gypsum boards	*Finishing foreman*	*1* *4* *1*	*25*
	Floor tiling	*Finishing foreman*	*2* *1*	*19*
	Roof insulation	*Insulation contractor*	*1*	*29*
	Roof sealing	*Sealing contractor*	*6* *1*	*18*

	Glazing	*Glazing contractor*	*1*	*46*
Other activities	*Electrical installation*	*Electrical engineer*	*2* *3* *2*	*75*
	Plumbing	*Plumbing engineer*	*9* *4*	*57*
	HVAC installation	*A.C. Engineer*	*6* *3*	*80*
			4	*87*
			8	*5*
TOTAL				

R = P×S Where:
P = Likelihood of occurrence
S = Potential severity of harm
Now for work at height R= P×S=3×4=12
Now for work at cranes R= P×S=3×3=9

Table - 5.5
Risk Categories

Category of Risk	*Evaluation of Tolerability*
Very low (Level 1, 2,3, 4)	*Acceptable (or Negligible)*
Low (Level 5, 6)	*Risks that should be reduced so that they are tolerable or acceptable(Unwanted)*
Medium (Level 8, 9)	*Risks that should be reduced so that they are tolerable or acceptable(Unwanted)*
High (Level 10, 12)	*Risks that should be reduced so that they are tolerable or acceptable(Unwanted)*
Very high (Level 15,16,)	*Unacceptable*

VI. APPLICATION OF OUR PROJECT

The factory should prepare Safety Manual containing information on policies (on safety, health and environment), safe methods, practices and procedures on various operations and processes, first-aid treatment, fire protection & control, handling and storage of materials, safe use of hand tools, testing and examination of equipment, electrical safety etc. Such manual will act as guided to help achieving better safety and accident free performance in the factory.

VII. EXCEPTED OUTCOME & CONCLUSION

A constant throughout this discussion is recognition that workers in the construction industry are involved in a dangerous trade. Construction work-related risks are well understood, but it remains a leader for raised injury, illness and fatality rates; and associated costs to business, society and families. It is unconscionable that construction remains hazardous, while resources over decades - statistics, causal factors, and control measures to reduce risk.

The CHASTE approach represents a progressive way to evaluate risks in construction. It confronts the difficulties and unique hazards of the construction industry by considering likelihood of loss-of-control events and exposure of potential victims to their consequences separately. The CJSA method provides a mechanism for collecting the extensive knowledge of the likelihood of loss-of-control events in construction that is needed for implementation of the CHASTE approach. The CJSA method is loosely based on the standard JSA approach to safety planning in manufacturing.

The CJSA method described was implemented for the construction activities and methods typical of the Israeli building construction industry, and a comprehensive analysis was con-ducted of its results.

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