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Applying Inherently Safer Design Principles to Hazard Identification and Risk Assessment in Metro Infrastructure Projects: A Design-Centric Approach

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Abstract: *Developing an efficient rail or road transport system involves building viaducts to ensure safe and smooth traffic flow without congestion. Viaducts also help link existing networks across challenging terrains and allow for better utilization of limited land. Constructing rail and road infrastructure often involves working in dangerous conditions, and while ground-level work poses risks, these risks are significantly higher when construction takes place above ground level According to estimates from the Occupational Safety Administration (OSHA) in the UK, over 10% of workers engaged in viaduct construction experience accidents, which can range from minor injuries to fatalities. Hence, it is crucial to reassess current safety protocols and explore ways to enhance the existing safety standards. Reducing injuries begins with identifying hazards and evaluating associated risks. Hazard Identification and Risk Assessment (HIRA) methods are used to detect potential dangers at construction sites and to determine their level of risk. While HIRA is widely adopted across the construction industry and forms part of the overall management system, certain critical elements that could improve its effectiveness are often overlooked. As a result, some inherent hazards go unnoticed, leading to accidents during project execution. These gaps impact the project both directly and indirectly, contributing to substandard safety performance on-site and fostering a weak safety culture*

This thesis examines the current safety practices and standards implemented in the viaduct construction industry. It identifies the factors contributing to the high accident rate and offers recommendations to enhance worker safety, ultimately aiming to significantly reduce the number of injuries. Several aspects often missed—whether deliberately or unintentionally—during hazard identification and risk assessment using HIRA have been recognized and incorporated to enhance the existing methodology. A comprehensive framework has been developed, based on twelve key considerations identified through an in-depth review of various method statements. Each of these considerations includes six subcategories or focus areas. The quantification of each area is carried out through data analysis, studies, and surveys conducted at the construction site. These considerations have been quantified and risk multiplication factor (RMF) is generated. Finally, a modified risk level (MRL) is obtained by multiplying initial risk level with RMF. The control action plan can be updated based on the revised Maximum Risk Level (MRL). By applying this risk assessment framework, several areas or concerns—often missed by traditional HIRA methods—can be effectively identified. The framework also incorporates a color-coded risk rating system: red indicates a critical level where all work must halt until corrective actions are taken; yellow signifies the need for immediate attention; and green represents an acceptable risk level. This framework is applicable throughout the entire construction process, from site selection to project execution. Its implementation can either prevent accidents entirely or significantly reduce their occurrence during construction activities

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Keywords: Construction activities, Hazards, Risk, OSHA), HIRA, RMF, MRL, Accidents, Health, Safety, and Related Safety Measures etc.

I. INTRODUCTION

Construction ranks as the third most accident-prone industry and is often poorly organized, largely due to the involvement of untrained and illiterate workers. The industry relies on various interdependent roles and responsibilities assigned by management, while supervision is typically handled by engineers or supervisors within the constraints of limited time and resources.

Viaduct work consists of most vulnerable work activity where availability of inherent risk remains consistent. Although in recent years accidents frequency rate in construction industry has decreases involving the technological approach. In recent few years it has been found that the majority of accidents coming from construction work activity is “work at height” which consist up to 56% of total accidents coming out from construction work and it is majorly involved in viaduct construction work where it has been noticed approx. 60%. Rather from work at height, material handling, excavation, hot work etc. are main concern where incident rate are majorly recognized.

Based on initial design, planning of executing the work comes first where safety issued and its regulatory requirements discussed. Management concern towards hazard and risk involved in the planning stage remain theoretical and they remain eager to accept the challenges. Although while during its execution, time frame restriction, resources limitations and cost effectiveness bring the instability to the real approach towards implementation of safety at work place which lack the concentration of assessing the inherent risk which indirectly involved in the process. Therefore, to minimizing the accident frequency it will be favorable to assess all vital part of a project by applying the concept of implementation of inherent safer way to identification of hazard and risk assessment involve since design stage to execution of work till its completion

Problem Statement

The construction industry serves as the backbone of the Indian economy. Among its various components, viaduct construction plays a crucial role, contributing not only to economic growth but also to shaping infrastructure at a global standard. However, the enforcement and adherence to safety standards remain a major concern within India's construction sector. Since the start of many projects, numerous accidents have been reported, posing serious consequences for both individuals and the nation. The complexities of infrastructure development—combined with strict timelines and budget constraints—make project execution particularly challenging. Furthermore, a shortage of qualified supervision and improper deployment of skilled personnel contribute significantly to the high rate of accidents in the industry. In the construction industry, visible progress is often prioritized, while safety considerations tend to take a back seat—even though legislation acknowledges the significance of safety. Many accidents originate as early as the design phase, and risk assessments are either outdated or inadequately quantified, making it difficult to effectively address potential hazards and risks. Hence, adopting a safety-oriented approach that includes the quantification of risks and the continuous reassessment of activities—from the design phase through to execution—can play a crucial role in mitigating the inherent hazards and risks associated with viaduct construction.

Role of viaduct in sustainable development

As reasonable improvement turns into a more imperative target in common base arranging and approach making, Quality of Life is an inexorably vital measure to comprehend, describe and apply viably in the inquiry and advancement of suitable framework answers for practical improvement.

The illustrations exhibit how foundation can be deliberately created or re-created to enhance local personal satisfaction and financial intensity while saving or upgrading the common habitat.

The most well-known and generally utilized meaning of manageable advancement originates from the United Nations' Brundtland Commission's report: "addressing the necessities (and desires) of the present era without trading off the capacity of future eras to address their own issues and yearnings" (WCED 1987).

As a rule, it is additionally comprehended that reasonable improvement has three angles: natural, monetary, and social. While meanings of and ways to deal with supportable advancement and assessment change, the applied premise of practical improvement is in a general sense the same: to give a worthy or enhancing personal satisfaction for groups while safeguarding that normal resources that empower such arrangement to proceed. Viaducts are scaffolds made out of a few little traverses for intersection a valley or a crevasse.

Alongside improvement and enhancing network, viaducts ought to be practical. This could be accomplished through powerful arranging and planning. Viaduct is an impeccable case of a maintainable development artful culmination

Motivation/ Need of research

In India, construction has contributed to approximately 40% of developmental investments over the last five decades. About 16% of the country's workforce relies on this sector for employment. Major accidents of construction particularly bridges or viaduct structures which has been happened recently in India who motivates to look some alternative or research which could able to minimize the impact or accidents ratios. Investigation and analyzing the past accidents, it reveals the root causes of accidents which has been happened in viaduct work (Metro rail work or other bridges work) and various aspects has come to work in. Commonly human error and technical assessment of work by team leader or concern engineer has played important role in leading to the accidents. Site Engineer/ team leaders' job is to identification of hazard and risk assessment carrying during and at the time of construction activities plays an important role. The risk quantification barrier which indicates to change its methodology or planning is the vital part or concern which an engineer or team leader or designer may take in priority before executing the work.

During my research, it will be focused to use all inherent safer approach to identify hazard and its risk quantification including re assessment in all levels of activities by which we will be able to justify the risk rating by which there will be a way to change the methodology or design and probably frequency of accidents can be reduced.

Scope

In recent scenario various technique and methods are available worldwide for hazard identification and risk assessment although every technique has its own limitation and scope. Taking it further, we have been thought to reconstruct the technique and conceptualize in a way we can take it forward to assessing risk in construction more significantly. In this way, we have been taken consideration of safety in design, analysis of inherent risk available since inception, coordination between designer and engineers.

Objective

Study of method statements, design proposals and all safety management system, Study of various techniques used for identification of hazard and risk assessment for construction projects (mainly in design and execution of bridges/ metro rail viaduct works),To introduce the framework for risk assessment in construction of viaduct work and to provide a palette of techniques facilitating the various steps of risk assessments including utilization of inherent safer concept from design stage to completion stage of a project and To assess the effectiveness in eliminating and minimizing accidents rates by validating the model.

II. LITERATURE REVIEW

S.No	Project involved	Study objective and aspect covered	Gist of Work	Key findings	Reference
1.	Construction safety	Study aims to reduce construction industry hazards through design in planning stage.	Identifying risks during construction process. Assessment of construction safety risk	During study following observations were noted- The risk levels during construction work due to concrete structure were observed to be high but level of safety risk for precast designing	(Gangolells et al, 2024)

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				structure was less. During the designing of precast structure below are the risk which gets minimize : Injuries due to reinforcement. Injuries due to falling object or collapse. Cut and blow injuries from objects and tools during foundation and structure work	
2	Construction safety	Early warning system	Implementation of RBFNN (Radial Basis Function Neural Network) models. Calculation of Probability Assignment (BPA)	During study following observations were noted- Construction Safety management requires diverse, systematic information for decision making. By web based system it makes easy to collect information related to project, data measurement and visual inspection data	(Ding & Zhou,2024)
3	Climate heat stress risk management in construction	Climatic heat stress can lead to accidents and develop methodology for effective decision making process	Find out indicators of heat strain Find out environmental heat stress indices and environmental threshold Assessing metabolic heat and work place Assessing clothing effects Assess individual factors	Following points were observed during study- Lack of research into real industrial situations has been observed. So there is an inability to formulate effective guidelines for managing problem.	(Rowlinson et al, 2023)
4	Hazard Recognition	Aim is to explore the Awareness of superintendents towards hazards and how well they associate them with risk.	Population consisting of students, superintendents, safety directors was chosen. Scope of hazard was determined by accident types reported in UK, US and Israel. In test, each subject was asked to examine set of photographs from construction site with respect to hazards. In this step virtual test was carried out by simulation model of the same construction site.	Following observation were noted during study- Superintendents who had work experience and had formal safety training were able to assess risk level more than students. They also assessed probability of each hazard to occur more than students. It has clearly concluded that ability to identify hazard has positive correlation with work experience.	(Perlman et al, 2023)

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III. HAZARD IDENTIFICATION AND RISK ASSESSMENT

Overview

A proactive Occupational Health and Safety (OH&S) management system involves identifying hazards, assessing associated risks, and determining appropriate control measures. Although there are no universally accepted guidelines for the terminology used in practices such as Hazard Identification and Risk Assessment (HIRA) and selecting control measures within OH&S systems, for the sake of consistency, this discussion adopts the terminology defined by OHSAS 18001:2007 (Sousa, Almeida et al., 2012). Different standards use varying terms: BS 8800:2004 refers to "hazard prevention," while both OHSAS 18001:2007 and ILO-OHS: 2001 distinguish among "risk assessment" and "hazard assessment," treating these as separate processes in a manner similar to OHSAS 18001:2007. Likewise, HSG 65:1997 outlines the entire risk and health control process in three stages: “risk assessment,” “risk control,” and “hazard identification,” aligning with the approach taken by OHSAS 18001:2007 (OHSAS 2007). Conversely, BS 8800:2004 consolidates all these processes under a single term—“risk assessment”.

ILO-OHS: 2001, OHSAS 18001:2007 and BS8800: 2004, defines hazard as impairment to human with respect to ill health or injury or amalgamation of those two. However under HSG 65:1997 the possibility to cause harm to plant, environment, property or the product (Health Safety Executive 2013) is termed as hazard. There is a difference in the definition of terminologies like “incident” and “accident”. There is some variation in the guidelines and standards.

As per OHSAS 18001:2007; HSG 65:1997, ILO-OHS: 2001 and BS 8800:2004, defines “incident” discriminately as events causing no harm, and “ accident” as which causes ill health, injury or fatality. OHSAS 18001:2007 has replaced the term “acceptable risk” with “tolerable risk”.

The items of instituting, executing and adopting effective process of HIRA process (Hester and Harrison 1998) are achieved mainly by:

• Adopting processes measures to identity hazard and risk assessment,

• Hazards are classified as per the activity or place,

• Evaluate the threats related to common hazards by assessing and defining the levels of risk as per their acceptability,

• Evaluating the tolerable risk control mechanisms, which are important and conforms legitimately to other necessities and the requirements, which are necessary as per OH&S objectives and policy

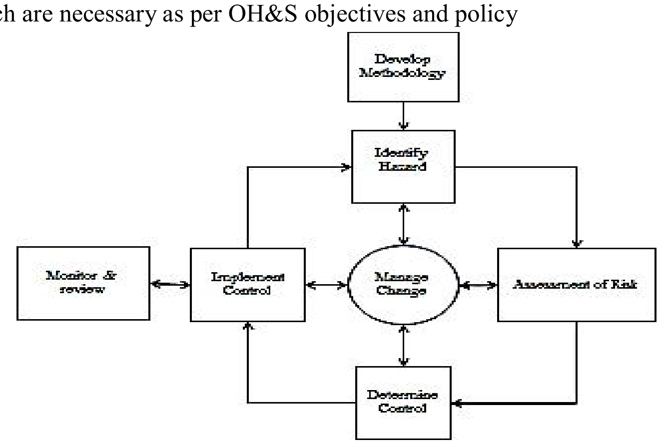

Figure 1: Outline of the identification of hazard and assessment of risk process

This addresses the execution of controls, observing and review. So, the “implementation of controls” and “review monitoring” procedures displayed in Figure 1 are those key processes of the organization’s OH&S management system and are hence performed accordingly.

Whenever we talk about hazard, we assume a source or situation which could able to harm and may turn into Ill health, loss of property, loss of environment and injury etc. or amalgamation of these. Although, hazard identification is a process of recognizing the hazards that exists in any activity and defining its characteristics (Lees 2012). While risk is a result of any miss happening in which it signifies the likelihood of consequences of any hazard and severity of an injuries.

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But when we take the considerations of risk assessment then we call it as process in which risk will be evaluated from the available hazard for the purpose of further control measure. There are numbers of standard which gives guidelines in which it is assume that work place hazard can be identified in any activities or sub activities and their associated risk can be determined (Kennedy and Kirwan 1998). The determined risk will be evaluated based on the risk matrix available for the further control.

OHSAS tells about the identification of risk in significant categories where it is required to classify the risk in a range where further control will be taken by special attentions or based on the control operating procedures (Labodová 2004) . The identification of risk is the judgment made by the competent person and person involve in project management and those knows the trend of occurrences of any hazard or risk in past.

The OH&S hazard are the behavior of any process unit, activity, product and procedures which adverse as an impacts inline to the concern activity or process or procedures. Therefore, if impact noticed before and a suitable control applies at right time, the risk coming out from these activities or process will be under control or not able to touch its significant range.

Therefore, it is important for an organization to identify hazard in each and every process or activity and assessing its risk for suitable control measures. The control measure suggested should be impartial and should be applied without any interference.

Whenever risk assessment is done, it is always the combination or multiplication of likelihood of any hazard and its severity. In mathematical way, the risk can be calculated by

Risk (R) = Likelihood (L) of an event x Severity (S) of any outcome

Where, Likelihood (L) is an occurrence of any event in a specified time or in specified circumstances while severity is a result or outcome from that event in terms of injury/ health of people, properties damage, damage or adverse on environment or may be combination of these.

Purpose of HIRA

- Identification of the purposes which cause harm to employee
- Possibility of that cause of harm to the employee and its severity.
- An organization should able to plan, introduce necessary preventive measures controlling risk.

Planning for HIRA

a. It can be planned for a situation

- Where there is a significant hazard available
- Where control measures not adequate
- In which corrective and preventive measures are need to be implemented

b. An organization which is intended to improve safety management system

Process of HIRA

HIRA has certain steps to do at work site and they are as follows

- Identification of activity or sub activity hazards
- Assessing the risk related to each hazard (tolerable or non- tolerable)
- Control measure for risk categorized under non tolerable and its monitoring
- Verify adequate health and safety objective and action plan to reduce risk identified and follow up monitoring reduction of risk.
- Training needs identification for the adequate risk control measures and adequate control measures should be a part of operational control

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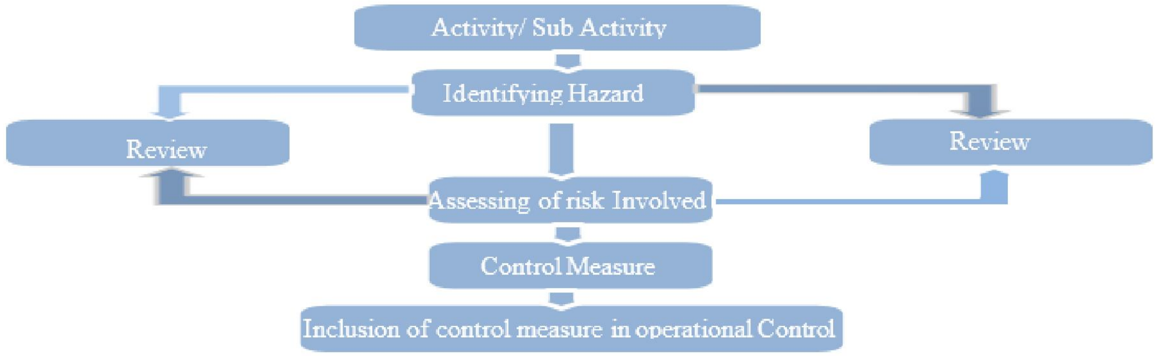

Figure 2: Steps involve in HIRA

Assessment of probability and severity

Table 4: Probability Rating (PR)

High (H)	When it occurs frequently or Chances approx. more than 50%
Medium (M)	When it occurs occasionally or Chances between 10% to 50%
Low (L)	When it has never occurred before or chances less than approximately 10%

Table 5: Severity Rating (SR)

High = H	When it can lead to fatality or permanent disability Or when Property Loss is more than Rs 100,000
Medium = M	When it can lead to temporary disability or doctor visit is required Or when Property Loss is more than Rs 10,000 but less than Rs 100,000
Low = L	When it can lead to First aid Injury Or when Property Loss is less than Rs 10,000

Risk Matrix

Table 6: Risk analysis matrix

Probability	H	3	4	5
	M	2	3	4
	L	1	2	3
		L	M	H
Severity				

Table 7: Risk level

Risk Level (RL)	Trivial	Tolerable	Moderate	Substantial	Intolerable
Number	1	2	3	4	5

IV. METHODOLOGY

Research framework-Theoretical Framework

Viaduct metro rail construction sites have being selected for research study. The main focus of the research is the techniques – job safety analysis (JSA), group risk assessment, What-if analysis and inherent safety approaches – used for hazard identification and risk assessment. Job safety analysis is the technique which is specifically chosen for construction work. Due to the nature of construction work activities, which keep changing on day to day basis, it is difficult to fix the risk level of any particular activity. JSA is helpful in identifying the hazards associated with activities which keep changing on day to day basis. During execution of work, certain changes in activities or any unplanned activities can be assessed using JSA. JSA is relevant in most of the cases if the recommendations given during assessment are considered. The most exhaustive concept or technique which we use at construction site hazard identification and risk assessment is the group risk assessment. Hazard identification and risk assessment (HIRA) is broadly used in construction industry to identify the hazard, risk and based on it control measures can be taken place. Team from execution, safety, planning etc. carry HIRA and assess relevant hazard and risk for particular activities since design to execution stage of work. What-if analysis is also helpful while planning and designing or work activities. We take consideration of experience people at work place and they really help out in deciding the hierarchy of control for hazard and risk inherently available in some of activities. The expertise required for doing safety analysis is gained through years of experience at construction sites. The expert studies the nature of the work and behavior and skill of the person involved in execution of concerned activities. The expert takes into consideration many factors or challenges faced during execution. Years long involvement in construction work execution, system implementation and worked as core team member of risk assessment, many favorable and unfavorable considerations were identified which gives a scope of working in these areas and to bring improvement in it.

For this research total 58 method statements, and 20 health safety and environment manuals were studied and critically analyzed for different types of activity at viaduct construction sites. Similarly state-of-the-art review of hazard and risk present at construction work activities has been done

Data Collection-Source of data-primary data

To complete research work, data collection has been done. Approach of using data collection is via both the mode. i.e. Primary and secondary data source.

i. Site observations
ii. Audit reports
iii. Accident analysis
iv. Method statements
v. HSE plan/ Manual
vi. Questionnaire

V. RESULT AND DISCUSSION

Inspection and observations.

Inspections reports from three different construction sites, over the period Feb 2024 - July 2025 was taken into considerations for data analysis purposes. Following are activities have been considered for trend analysis and gaps identified:

- Housekeeping
- Barricading
- Electrical work
- Work at height
- Hot work
- Mechanical work
- Excavation work
- Hand rails/ Edge protection
- Material handling/ Lifting
- Hand tool & power tool
- PPE’s
- Fire
- Others

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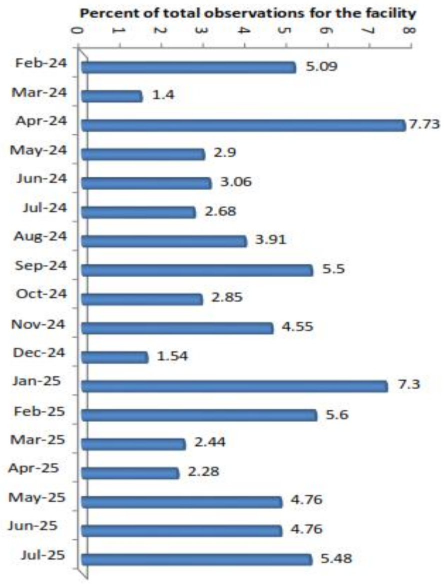

Figure 3: HSE inspection for Housekeeping

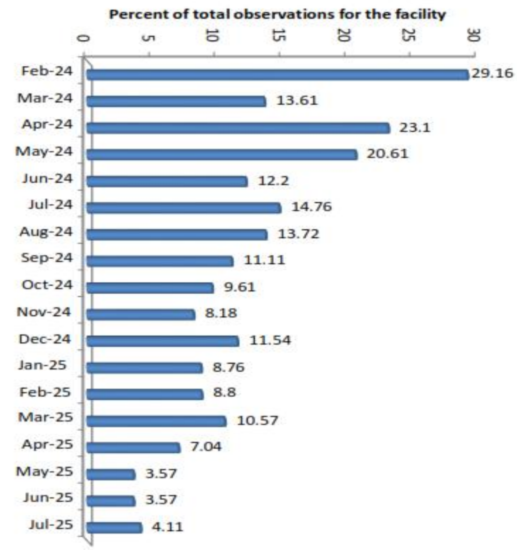

Figure 13: HSE inspection for Work at height

Figure 5: HSE inspection for Electrical Work

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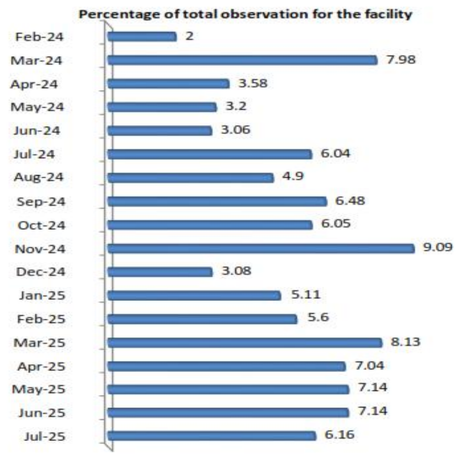

Figure 7: HSE inspection for Mechanical Work

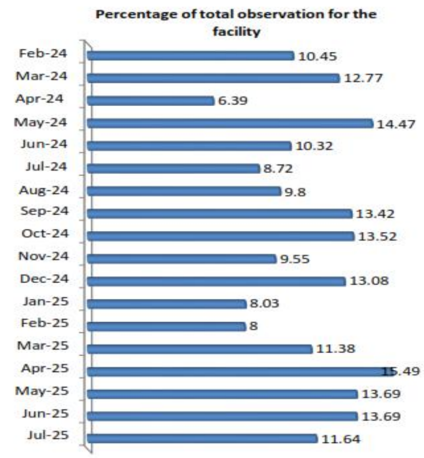

Figure 6: HSE inspection for Hot Work

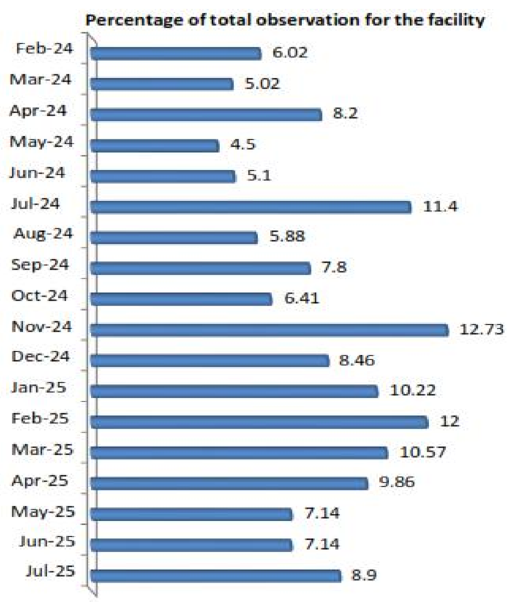

Figure 9: HSE inspection for Hand rails / Edge protection

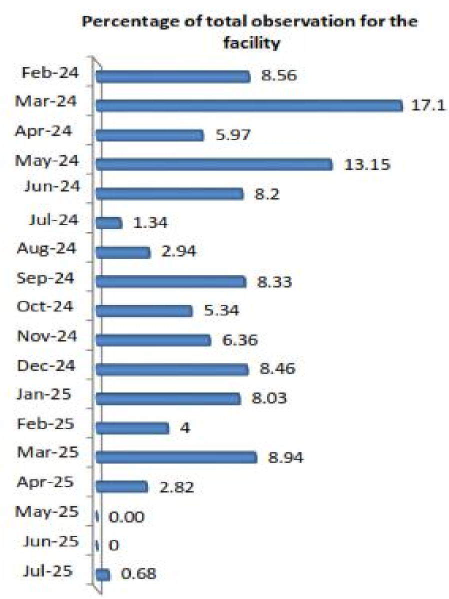

Figure 8: HSE inspection for Excavation Work

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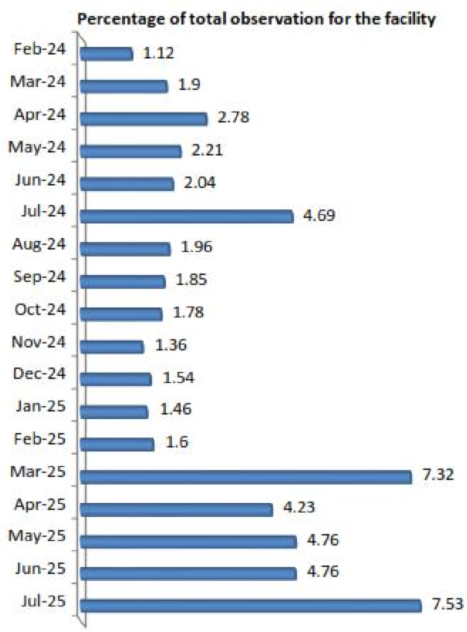

Figure 11: HSE inspection for Hand tool & Power tools

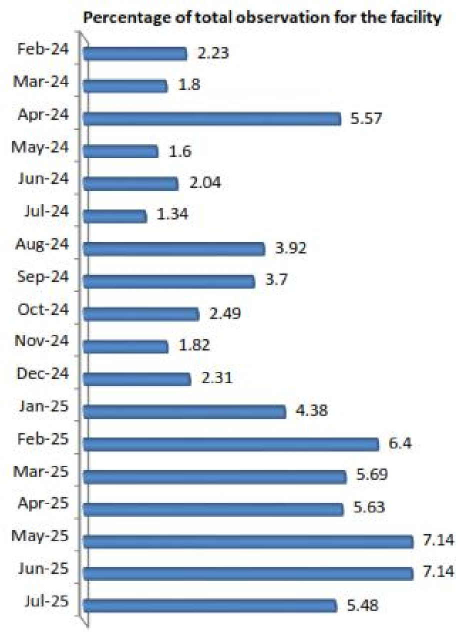

Figure 10: HSE inspection for Material Handling / Lifting

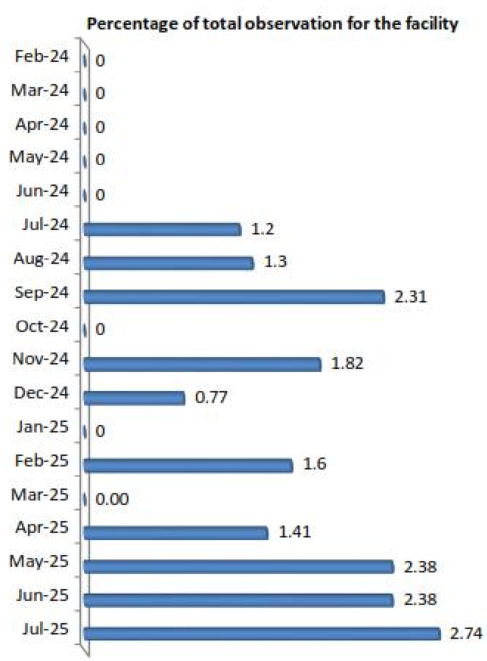

Figure 13: HSE inspection for Fire

Figure 12: HSE inspection for PPE's

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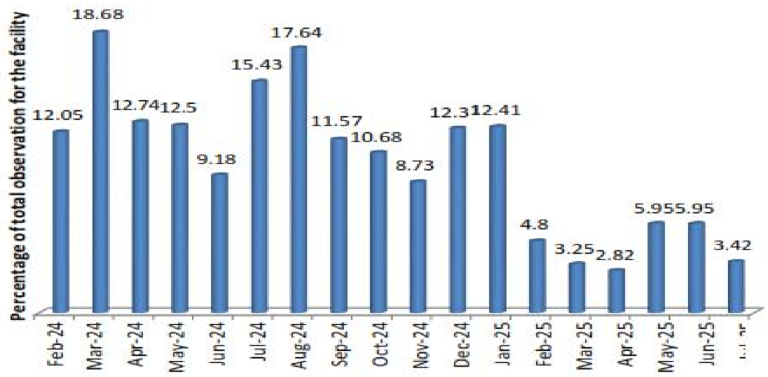

Figure 14: HSE inspection for others

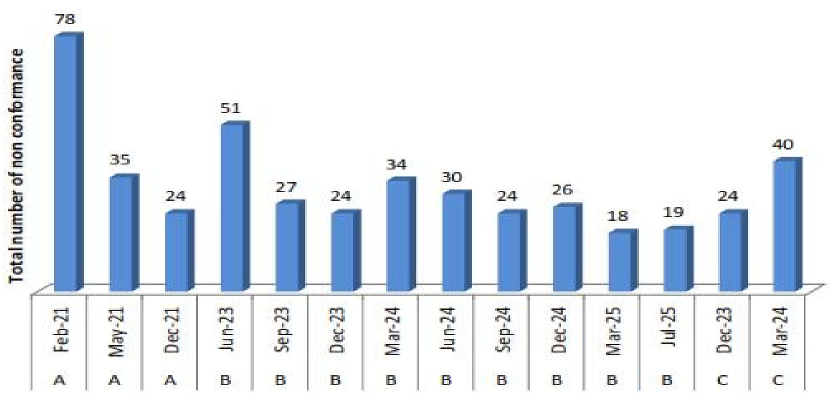

Figure 15:Non-compliance from external audit for three companies (A, B and C) (2021-2025)

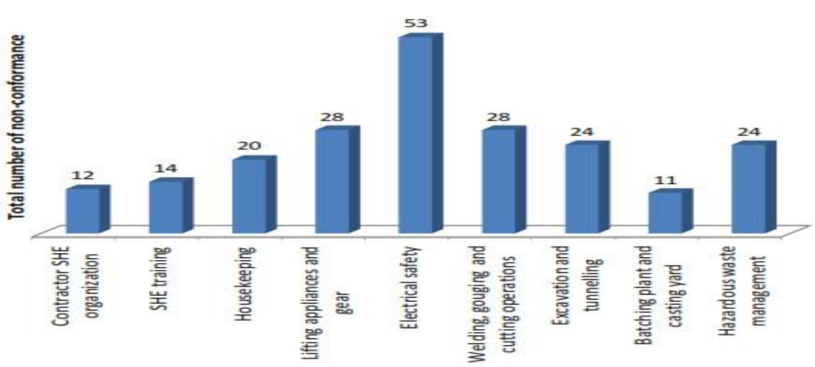

Figure 16: Critical areas at company A B & C (2021-2025)

5.4 Major/ fatal accident analysis:

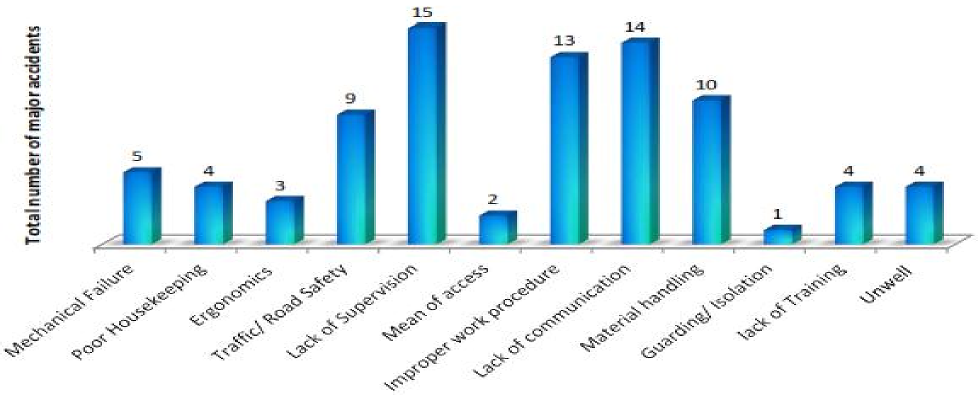

Figure 17: Total number of major accident (2018 – 2025) at three construction site

Table 11: No. of minor injured cases

S. No	Month	No. Of injured cases
1	Aug-23	10
2	Sep-23	9
3	Oct-23	8
4	Nov-23	10
5	Dec-23	8
6	Jane-24	6
7	Feb-24	8
8	Mar-24	5
9	Apr-24	5
10	May-24	6
11	Jun-24	6
12	Jul-24	5
13	Aug-24	6
14	Sep-24	5
15	Oct-24	5
16	Nov-24	5
17	Dec-24	7
18	Jan-25	7
19	Feb-25	6
20	Mar-25	5
21	Apr-25	6
22	May-25	3
23	Jun-25	4
24	Jul-25	4
Total		149

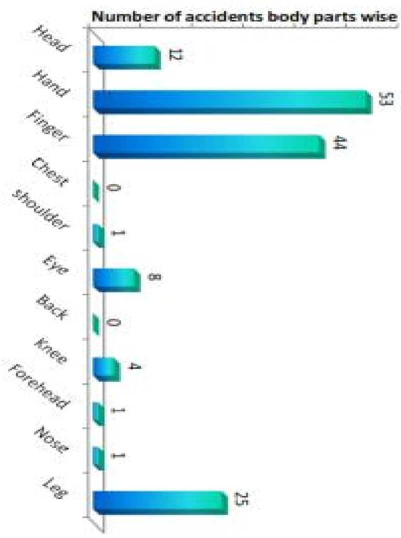

Figure 19: Injured case (Body part wise)

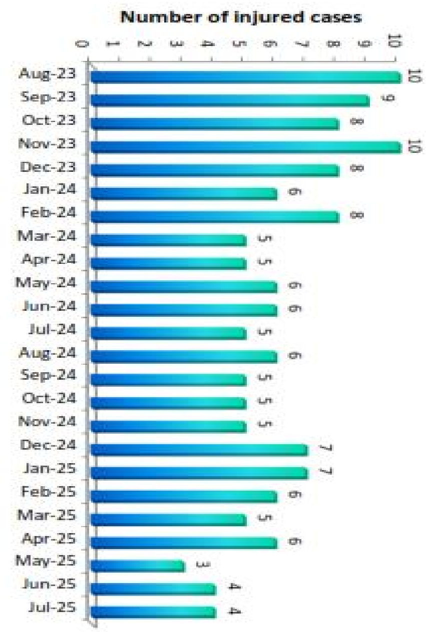

Figure 18: Injured case (month wise)

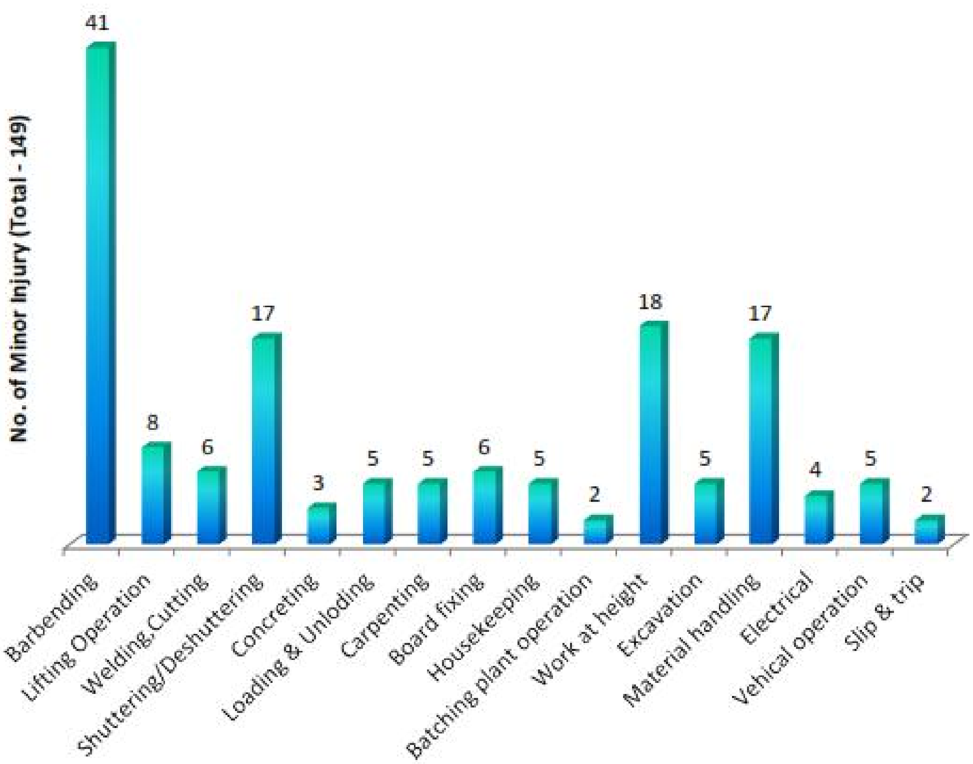

Figure 20: Activity wise injury analysis

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RL Category	Initial RL	Risk Multiplication Factor (RMF)	MRL	MRL range
Intolerable	5	0.2	1	MRL > 0.8
Substantial	4	0.2	0.8	0.6 < MRL ≤ 0.8
Moderate	3	0.2	0.6	0.4 < MRL ≤ 0.6
Tolerable	2	0.2	0.4	0.2 < MRL ≤ 0.4
Trivial	1	0.2	0.2	MRL ≤ 0.2

Figure 22: Modified risk level (MRL)

The infrastructure involved in viaduct construction plays a vital role in easing the burden on the existing, overstrained transportation systems. While construction at ground level already carries significant risks, these hazards are greatly amplified when the work is carried out at elevated heights.

Various principle/theories exist for analyzing hazard and risk − Job Safety Analysis, What-If analysis, preliminary hazard analysis (PHA), checklist analysis, past accidents analysis, HAZOP, FMECA, FTA, ETA, cause consequence analysis, Human Error Analysis etc. – use of which can help identify and minimize the risk involved. But most of these hazard and risk analysis technique have not be designed for evaluation of risk in construction activities which make calls for great caution while applying these techniques.

Risk assessment methodologies used in method of statement lack thoroughness, as it is highly subjective, and no specific framework exists for the steps to be followed while doing risk assessment. Safety design considerations are an effective way to reduce construction accidents but lack of expertise and confidence on part of designer has resulted in many accidents in the past The situation becomes grave because of the lack of knowledge of safety consideration by the personnel involved in the design stage. This lack of awareness of safety considerations is present even at the highest level of management. In maximum cases, which were analyzed, assigned activity was done by foreman and supervisor who are not competent. In most of the cases discrepancy is found in implementation of recommendations of the method statement. In order to address this problem and we have developed a comprehensive framework to assist in risk assessment for viaduct construction activities. Subjectivity of the user has been eliminated or minimized by assigning specific hazard values that have been arrived at after thorough analysis of the collected data. Further effect of subjectivity has been minimized with the inclusion of all the relevant sub-activities and assignment of a weightage factor for each activity.

Validation of the developed framework was performed by asking various construction companies to use and implement the recommendations and provide feedback. It has been found that the implementation of the developed framework resulted in reducing the accident. Case studies: Implementation of developed framework at two construction sites. Two construction sites were considered for the implementation of developed framework. The two sites selected for the case study, were both engaged in viaduct construction activities and both have very good safety tact record. The construction companies engaged for the construction activity have QMS, EMS and OHSAS certification, and also have very good track record in India and overseas. The sites chosen for the implementation of developed framework were functioning for more than a year before implementation of the modified risk levels. Chief safety reviewed the effect of implantation of the findings of developed framework over a period of four months. The effectiveness of this framework was evaluated by analyzing previous four months incident record. Significant improvement, as reported in Table 15 & 16 and Figure 24 & 25, was observed at the two sites.

Table 15: Analysis of previous months incident record Site –A

ACTIVITY	Incident Percent reduction	No of accidents (Jan 25-Apr 25)	No of Incidences (May 25-June 25)
Bar bending	28	21	15
Lifting Operation	12	5	4

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Welding, Cutting	14	5	4
Shuttering/DE shuttering	21	13	10
Concreting	10	8	7
Loading & Unloading	30	16	11
Carpeting	8	6	6
Board fixing	5	6	6
Housekeeping	15	9	8
Batching plant operation	5	3	3
Work at height	21	16	13
Excavation	16	7	6
Material handling	26	6	4
Electrical	5	6	6
Vehicle operation	12	7	6

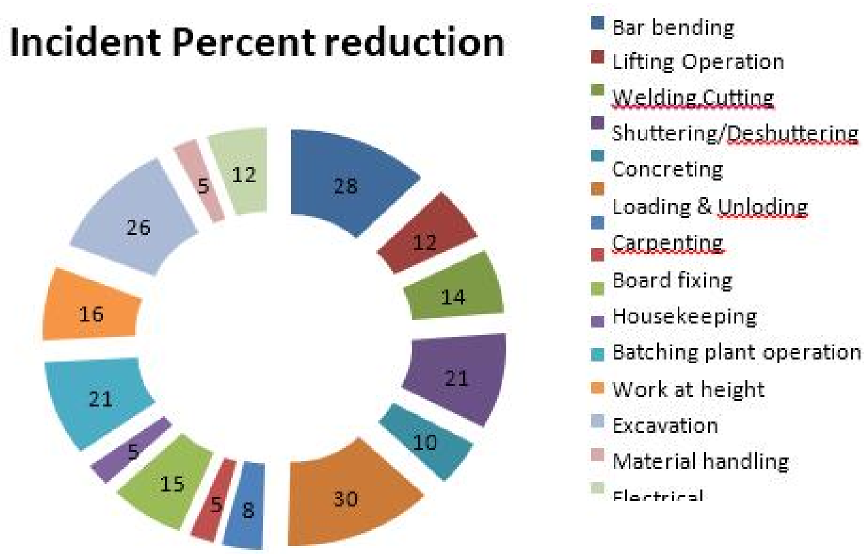

Figure 24: Analysis of previous four months incident record Site A

Table 16: Analysis of previous four months incident record Site B

ACTIVITY	**Incident Percent reduction**	**No of accidents (Jan 25-Apr 25)**	**No of Incidences (May 25-June 25)**
Bar bending	20	15	12
Lifting Operation	8	7	6
Welding, Cutting	10	4	4
Shuttering/De shuttering	19	16	13
Concreting	6	11	10
Loading & Unloading	14	13	11
Carpenting	18	3	2
Board fixing	20	4	3
Housekeeping	10	11	10
Batching plant operation	6	5	5
Work at height	17	14	12

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Excavation	8	9	8
Material handling	21	8	6
Electrical	20	4	3
Vehicle operation	15	4	3

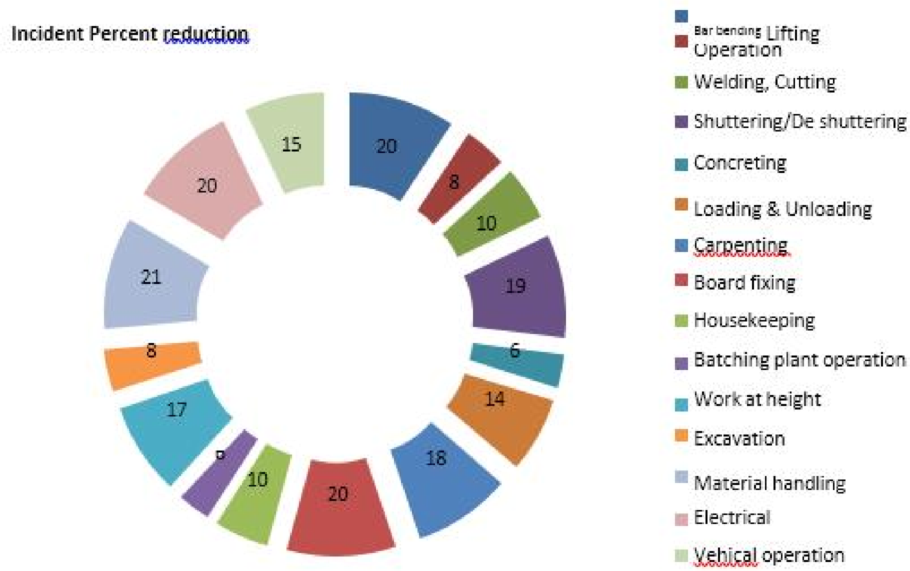

Figure 25: Analysis of previous four months incident record Site B

SCOPE OF FUTURE WORK

Generation of list of corrective measures, as indicated in Chapter 6, can be incorporated in the developed framework. Additionally, the developed framework can also be extended to incorporate considerations for other industry type as well.

The framework can also be modified to incorporate case studies that can be used to train safety officers and other concerned authorities about the effect of neglecting various safety parameters/considerations.

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