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Research Article

Safe Rail Lifting in Construction Industries

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ABSTRACT

Lifting activities currently challenges in compliance with construction requirements, particularly regarding handling, storage, and safety. This project aims to identify the risks and hazards associated with lifting in construction areas. The majority of incidents arise from unsafe conditions and behaviors, emphasizing the need for comprehensive risk assessment. Additionally, the project proposes improved methods for reporting hazards. Unsafe acts and conditions are highlighted, along with suggested solutions, while various safe lifting methods are recommended for unloading activities, depending on the type of crane used.

Key Words: Risk, Hazard, Lifting, Crane activity, Unsafe condition, Unsafe act, Unsafe behavior

Introduction

Past 10 years, lifting accidents in India take resulted in a total of 667 deaths and 358 injuries, averaging 1.73 deaths and 0.92 injuries per accident. The number of deaths exceeds the number of injuries by 1.86 times, indicating the high severity of lifting-related injuries. Safety performance in Indian construction's lifting activities has been a concern. Lifting activities are common across all industrial sectors, involving the lifting of heavy loads by teams or mechanized equipment. Lifting teams or supervisors face numerous challenges, particularly when working near live roads or sensitive areas such as schools, public spaces, and traffic zones. Several studies have addressed lifting incidents: Kaushal Kishore et al. (2020) discussed the failure analysis of a 24 T crane hook using a multidisciplinary approach.Vahid Kargar et al. (2022) identified the risk assessment of mobile crane overturning in Asymmetric Tandem Lifting (ATL) operations based on fuzzy fault tree analysis (FFTA).Vivian W.Y. and Ivan W. (2011) conducted a Hong Kong study on tower crane safety in the construction industry Helen Lingard et al. (2021) conducted a qualitative analysis of crane safety incident causation in the Australian construction field..SujungIm and Dugkeun Park (2020) discussed crane safety standards, problem analysis, and safety assurance planning. Marquez& P. Venturino and J.L. Otegui (2014) identified common root causes in recent crane failures. Jozef Kulka et al. (2016) analyzed crane track degradation due to operation.
The purpose of this project is to provide a step-by-step procedure for the safe unloading, handling, and stacking of rails, along with recommended handling procedures for personnel involved. It suggests using three CAM LOCKs instead of four during rail unloading, based on the final conclusions drawn after implementing control measures. Mobile cranes are extensively used for material handling, offering advantages such as reduced risks, increased vertical lift, and higher capacities compared to traditional cranes. They play a crucial role in construction projects. However, lifting activities in construction industries often result in fatal or severe injuries, leading to penalties imposed by enforcement agencies and customers.

Preventing and controlling incidents relies on implementing correct control measures. With advancements in technology and new ideas, it is possible to implement safer working procedures effectively.

Methodologies

It is proposed to use either a "Spreader Beam with CAMLOCK arrangement system" in all locations for handling individual rail pieces or groups, or a "Spreader Beam with slings system" for handling rail bundles. For rail bundles, four slings will be required for each rail, along with CAMLOCK provisions. The approved space connecting the external clamps in either the Spreader beam with Sling system or the Spreader Beam with CAMLOCK system should not exceed 12 meters when using three clamps. Two-point slinging of rails should be ensured for individual rails of 18 meters in length, while a four sling is recommended for the CAMLOCK system. Additionally, it is advised to ensure that lifting hooks and tools are free from damage and cracks, as emphasized by Mr. Kaushal Kishore. The overhanging portion of the rails on either side of the rail clamps should be limited to 3 meters and shall not exceed 3.25 meters under any circumstances. Rails should be kept horizontal and straight as much as possible during lifting, carrying, and stacking. Mr. Helen Lingard also said the use of spacers to protect the rails from point contact. Rails of the same dimension should be stored on even surface. Furthermore, the rail ends should be protected by avoiding stacking other materials too close to rail stockpiles and by providing proper barricades. No general welding operations should be carried out adjacent to stacked rails. Lifting girders attached with Cam locks, hooks, D- Shackles, Wire ropes found same will be provide for to make sure that rails further suitable position as per work condition and overlapping Rail is not allowed due to may be rail twisting.

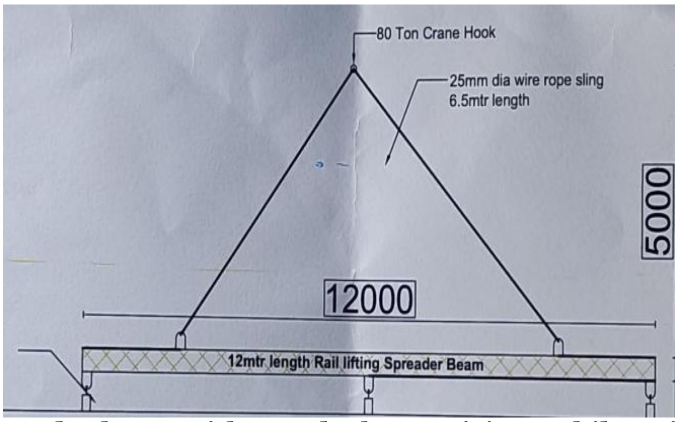

Figure 1- Spreader beam with Cam locks provisions while Rail unloading

In the event of handling individual rail, Rail grip devices (CAMLOCK) shall be used for the best rail loading and unloading activity. Constructions rails are lifted in bundles and suitably tightened with steel wire mesh or steel latchet for proper secured and avoid loose or rolled out. Additional camlocks is needed as adopt, for a shared distance of the lifting girder. High monitoring to be carried to ensure uniform assignation and detachment of the load to avoid sudden relief and effect disrupted on the rails. The locks, which are generally provided in sets, are provided with automated twice protection locks to defend alongside the rail found distributed by distress loads resulting from collisions with fixed superstructures. Not allow any dent marks or cracks will hit to the rail both sides while lifting activity in the around the rails. Rail lowering using a Spreader beam and 4 CAMLOCK system is shown below for reference and is indicative only

Figure 2 – Four Cam locks used while rail unloading

Problem Identification

In the construction industry, safe rail lifting refers to utilizing rail networks to transfer heavy equipment and supplies. Determining possible issues in this procedure is essential to guaranteeing worker safety and operational effectiveness. The following are some typical issues with safe rail lifting in the construction industry:

Equipment Failure: Cranes, winches, and hoists are just a few of the tools that rail raising systems depend on. Accidents and injuries may result from equipment failure brought on by wear and tear, poor maintenance, or an insufficient load capacity.
Unsafe Loading Practices: When items are improperly loaded into rail lifting machinery, instability and imbalance can result, raising the possibility of accidents during transit.
Inadequate Training: Employees engaged in rail lifting activities might not have received the necessary instruction in emergency protocols, equipment functioning, and safe lifting practices. This may lead to mistakes and mishaps.

Inadequate Communication: To coordinate movements and guarantee safety, effective communication between workers engaged in rail lifting operations is crucial. Errors and mishaps might result from unclear communication procedures.

Overloading: When rail lifting machinery is overloaded, it loses stability and structural integrity, which increases the risk of mishaps like equipment collapse or derailment.

Environmental Hazards: Weather-related factors like strong winds, rain, or snow can make it dangerous to operate rail lifting equipment. In addition, hazards to safe lifting can arise from uneven ground or obstructions along the rail track.

Lack of Safety Protocols: The risk of accidents and injuries might be increased by the lack or insufficiency of safety protocols and procedures unique to rail lifting operations.
Human mistake and fatigue: Extended work hours and monotonous jobs can make employees tired, which raises the possibility of mishaps and human error when lifting rails.

Inadequate Inspection: Unexpected failures and accidents can result from failing to routinely check rail lifting equipment, rails, and related infrastructure for indications of wear, corrosion, or faults.

Inadequate Personal Protective Equipment (PPE): Employees who are not outfitted with hard helmets, gloves, and safety harnesses, or who do not wear them properly, run a higher risk of suffering injuries in the event of an accident.

To ensure safe rail lifting in the construction industry, addressing these possible problem areas calls for a complete strategy that includes appropriate training, maintenance procedures, adherence to safety rules, effective communication, and ongoing operation monitoring.

Results and Discussions

Safety performance metrics: Quantitative proof of the efficacy of safety precautions can be obtained by comparing accident and injury rates before and after safe rail lifting procedures are put in place. Decreases in rail lifting-related occurrences, such as property damage, worker injuries, and equipment malfunctions, can be signs of better safety performance.

Regulation Compliance: One way to show a commitment to safety guidelines and compliance is to assess how well safe rail lifting techniques match industry regulations and standards. The effectiveness of the adopted measures in meeting particular regulatory requirements and industry best practices may be the subject of discussions.

Impact of Training and Education: Evaluating how training programs affect employees' attitudes, knowledge, and abilities regarding safe rail lifting procedures can shed light on how successful educational campaigns are. The relationship between worker safety practices and decision-making and training initiatives may be discussed.

Equipment Reliability and Maintenance: Proactive maintenance is crucial for averting equipment failures and reducing downtime. This may be demonstrated by evaluating the effectiveness of maintenance methods and the dependability of rail lifting equipment. Strategies for maximizing equipment performance and prolonging its lifespan through routine maintenance and repairs may be included in discussions.

Cost-Benefit Analysis: By weighing the possible expenses of accidents and injuries against the adoption of safe rail lifting procedures, decision-makers can gain important information. The cost of safety measures up front vs the savings over time from lower liabilities, insurance costs, and operational disruptions may be discussed.

Operational Efficiency: Finding possibilities for process improvements can be aided by evaluating how safe rail lifting methods affect operational efficiency metrics including productivity, turnaround times, and resource usage. Talks may center on how safety precautions make operations run more smoothly and save downtime from mishaps or malfunctioning equipment.

Strategies for Continuous Improvement: Having a conversation about methods for enhancing safe rail lifting procedures on a regular basis will help the company develop a culture of innovation and safety. This could entail asking employees for input, carrying out routine safety audits, and putting remedial measures in place to address any gaps or potential improvement areas.

Benchmarking and Industry Trends: Analyzing safety performance in comparison to industry peers and keeping an eye on new developments in safe rail lifting techniques can offer important insights into the competitive environment and help keep ahead of regulatory changes. Using cutting-edge technology and implementing industry-leading procedures to improve efficiency and safety may be the main topics of discussion.

Overall, the findings and discussions around safe rail lifting in the construction sector should highlight how crucial it is to put safety first while pursuing operational excellence and ongoing development. By incorporating safety measures into all facets of rail lifting operations, construction firms can reduce hazards, safeguard employees, and improve project results in general.

Analysis of Results

The analysis of the results involved examining accident details before any action was taken and comparing them with details observed after implementing adequate proactive measures. This included implementing safety assessments, risk assessments, and risk control techniques.

Table 1 Lifting accident statistical data

Year 2019 – 2020 While lifting

Quarterly	Q1	Q2	Q3	Q4	Q1	Q2	Overall Cases
First Aid cases	12	37	45	49	25	15	183

Solution,

We determine the critical value from a table of probabilities for the chi-square distribution with degrees of freedom (df) = k-1. In the test statistic,

The expected number of first aid cases per month is calculated as 183/6 = 31.

Table 2 – Chi Square distribution values before action taken.

Observed Frequency	Expected Frequency	(O-E)	(O-E)2	(O-E)2/E
12	31	-19	361	11.65
37	31	6	36	1.16
45	31	14	196	6.3
49	31	18	324	10.5
25	31	-6	36	1.2
15	31	-16	256	8.2
			∑	39

Now X square = $\sum(O - E)^2 / E =$ 39

Number of degrees of freedom V = 6

I have considered the period from 2019 to 2020, encompassing six quarters. For the particular year, I have a significance level of 5% and a confidence level of 95%.

Table 3- Chi Square Distribution Chart

Degree of freedom	0.99	0.975	0.95	0.90	0.10	0.05
1	----	0.001	0.004	0.016	2.706	3.841
2	0.20	0.051	0.103	0.211	4.605	5.991
3	0.115	0.352	0.352	0.584	6.251	7.815
4	0.297	0.711	0.711	1.064	7.779	9.488
5	0.554	1.145	1.145	1.610	9.236	11.071
6	0.872	1.635	1.635	2.204	10.645	12.592

Critical value for a 5% significance level, with degrees of freedom = 6-1 = 5, results in X2 = 11.071. Therefore, we conclude that X2 = 39 > 11.071. This indicates that control measures are ineffective and proactive measures are required to further control and reduce the number of accident cases.

Discussions

A significant number of first aid cases were observed and recorded due to poor lifting supervision, lack of knowledge, and the lifting team not wearing relevant PPE. Additionally, there was a failure to control traffic by trained personnel, leading to unauthorized entry at the site. Adequate control measures are necessary.

Control Techniques of Lifting Activities

- Ensure the provision of 4 Cam locks during rail unloading.
- Ensure the good quality of all lifting tools and tackles with valid third-party inspection and color coding.
- Fix hard barriers around the lifting area. Have trained traffic marshals monitor unauthorized entry.
- Secure tag lines/rope lines during loading and unloading of rails.
- Provide the correct type of crane and lifting accessories that are free from damage and collisions.
- Use multiple and equal sling load points to provide a rigid and safe structure.
- For loads exceeding 1 ton, prepare a lifting plan and lift method statement as per site availability and obtain approval.
- Utilize new equipment for lifting work, ensuring mobile cranes manufactured within the last 10 years and only using second hydra cranes. Provide all necessary PPEs to the site team.

Implementation and Prevention Action Taken

The need for Safety Assessment includes Hazard Identification and Risk Assessment (HIRA). Initiating the HIRA and selecting the approach involves the following steps:

- Identifying Hazards, Assessing the Risk, Controlling the Risk
- Hazards to be find out steps is,
- Capture hazards, Classification of hazards, resolve of the consequence, Restrict of important hazards through risk reduction method ERICPD method. Adequate Briefing, Instruction and guiding all work faces at site work location.
- We have re-considered the period from 2022 to 2024, encompassing six quarters. For the particular year,
- We have a significant level of 5% and a confidence level of 95%.

Table 5 – Chi Square distribution Values – After action

In year captured 3rd Quarterly 2022 to 1st Quarterly 2024

Quarterly	Q3 ‘22	Q4 ‘22	Q1 ‘23	Q2 ‘23	Q3 ‘23	Q4 ‘23	Q1 ‘24	Total
First Aid case	18		15	14	14	12	11	84

Table 6 – Observed Frequency and expected Frequency.

Observed Frequency	Expected frequency	(O-E)	(O-E)2	(O-E)2/E
18	14	4	16	1.143
15	14	1	1	0.071
14	14	0	0	0
14	14	0	0	0
12	14	-2	4	0.286
11	14	-3	9	.0643
			∑	2.143

Solution:
The expected number of accidents on any month = 84 / 6 = 14
Now X Square = $\sum(O - E)^2 / E$ = 2.143
Number of degrees of freedom V = 6
Critical value 5% Significance, degree of freedom= 6-1=5
X squared value has been taken from table 3.
Therefore
X^2 = 11.071

Conclusion

To sum up, safe rail lifting in the construction sector is essential to guaranteeing both the health and safety of employees and the accomplishment of building projects. By putting in place thorough safety procedures, efficient training programs, and conscientious maintenance procedures, construction organizations can reduce the hazards involved in rail lifting operations and establish a more secure working environment. Adopting safe rail lifting procedures has numerous benefits. They consist of lower accident rates, adherence to rules and regulations, better equipment dependability, increased operational effectiveness, and a favorable effect on the bottom line due to cost savings and better project results. Furthermore, spending money on safety not only keeps employees safe from injury but also improves the company's reputation, boosts morale among staff members, and fortifies ties with stakeholders and clients. Sustaining safe rail lifting procedures requires constant monitoring and development. Construction companies can ensure optimal safety and performance while adapting to changing circumstances and emerging industry trends by conducting thorough risk assessments, reviewing and updating safety procedures on a regular basis, and cultivating a safety culture within the organization. Safe rail lifting is essentially an investment in the long-term viability and sustainability of building projects, in addition to being required by law and morality. Construction businesses may effectively and quickly accomplish their project objectives while safeguarding their most valuable asset, which is their workforce, by placing a high priority on safety throughout the whole rail lifting operation.

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