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Safety Practices during Lifting Operations in Metro Projects

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Abstract: Currently, metro rail transit projects are growing rapidly in India. Almost every state has a metro project or very soon to start. When we think about safety, its new field and have unique challenges where lots of safety research, analysis and risk management to be established. Throughout the metro construction process, the highest priority on the safety of workers and the community are the main challenges. One of the riskiest activities in metro constructions is lifting operations of civil heavy materials, electrical equipment & Cable drums into metro stations as well as to viaducts (metro tracks) in the busy roads. In case of any negligible mistake can also may lead to major accident and it will cause property loss, loss of life and damage the company reputation. To prevent such incidents in metro sites, implementation of robust safety procedures/process/practices are required during lifting operations.
Keywords: Lifting Operations, Lifting activities, health, safety, Training

I. INTRODUCTION

Lifting Operations is a regular common activity in the metro sites, and which also carries more risk all the times. For the lifting material completely depends on with cranes to minimize the manual efforts and material can be shifted immediately. The common issues in the metro lifting activities are mainly most of liftings are carried out in dark hours where there will be no natural light, lifting activities are carried out on the major roads where lots of public vehicle movements interfering with lifting equipment and also increase risk of people involved in the lifting activity. Also, notifiable risks are lack of competency of operator and lifting operation team and their human errors will lead to disasters during lifting activity in the metro industry. This type of activities are always having inherent safety risks to the people involved, nearby and property. Every year, incorrect lifting procedures cause injuries, loss of work time and property. People, machinery, loads, methods and the work environment, are all important factors for correct lifting. For successful safe lifting it is necessary to have lots of co-ordination, planning, competency of people and sound lifting equipment.

II. METHODOLOGY

A complete dedicated lifting plan needs to make and it should address all lifting risks and containment actions to control those risks. Lifting starts with Identification of lifting hazards, Risk Assessment & making containment actions before start of the activity, type of tools, tackles and lifting equipment which are going to use, type of sling configuration as per the manufacturer recommendations, calculations of slings capacity as per the angle factor and safe working load (SWL) of the sling. Crane capacity is also should assess before starting of lifting. SWL of the crane is depends upon the boom length, angle and radius of the crane. All load details are must be part of lifting plan where required details needs to capture such as weight of load, identification of lifting points and dimensions of the load. All lifting equipment, tools and tackles are required to qualify all required legal requirements and third-party certifications before deploying at site. Permit to Work document is also key procedure must need to implement for all lifting activities, it will help to control all foreseeable risks before starting of lifting job. Competency assessment of operational team and vehicle driver must be established and approved for whoever involved in the lifting activities. Unauthorised people should not engage to lifting Operations.

A. Systematic Approach to Control Foreseeable Hazards & Risks

1) *Safety aspects in Operation of Lifting Appliance and Gears:*Lifting equipment means a crane, hoist machinery, derrick, winch, gin pole, sheer legs, jack, hoist drum, slewing machinery, pulley blocks, hooks or other equipment used for lifting materials, objects or building workers and lifting accessories means ropes, chain slings, web slings, shackles, hooks, Spreader beam, lifting lugs, wire ropes, lifting eye-bolts and eye nuts and other accessories of a lifting appliance.

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As per the Indian Factory Act 1948; following provisions shall be complied within respect of every lifting machine (other than a hoist and lift) and every chain, rope and lifting tackle for the purpose of raising or lowering persons, goods or materials:

a) all parts, including the working gear, whether fixed or movable, of every lifting machine and every chain, rope orlifting tackle shall be

b) of good construction, sound material and adequate strength and free from defect

c) properly maintained; andthoroughly examined by a competent person at least once in every period of twelve months, or at such intervals as the Chief Inspector may specify in writing; and a register shall be kept containing the prescribed particulars of every such examination.

no lifting machine and no chain, rope or lifting tackle shall, except for the purpose of test, be loaded beyond the safe working load which shall be plainly marked thereon together with an identification mark and dulyentered in the prescribed register; and where this is not practicable, a table showing the safe working loads of every kind and size of lifting machine or chain, rope or lifting tackle in use shall be displayed in prominent positions on the premises.

while any person is employed or working on or near the wheel track of a travelling crane in any place where he would be liable to be struck by the crane, effective measures shall be taken to ensure that the crane does not approach within 1*[six months] of that place.

Item Description	Statutory inspection Periodicity
Lifting equipment (Ex; Crane)	Once in Year
Lifting accessories (Ex; Slings, wire ropes)	Once in 06month

B. Apart from Legal Requirements Also Required Focus During Operation of lifting Appliance

1) No lifting appliances shall be left by the operator while power is on or load is suspended

2) After completion of the lifting operation, all doors of the appliances shall be closed by the operator and ignition/operation key should be handed over to competent reliever operator or site In-charge

3) No person shall be allowed to ride or sit under suspended load.

4) Every receptacle/material bucket used for hoisting bricks, tiles, or other material shall be enclosed from all side including bottom completely to prevent fall of any material. No wheelbarrow shall be used to lift or lower the material. Such receptacle or bucket shall not be overloaded, or the material shall not cross the top level of the bucketPersonnel Protective Equipment.

5) No material shall be raised or lowered or slewed which can leads to sudden jerks to appliances.

6) No load shall be slewed over public areas without stopping the pedestrians and road traffic first. Measures shall be adopted to divert the traffic during lifting/lowering operation requiring long duration traffic stoppage

7) All loads are provided with minimum two tag lines to ensure that the load can always be controlled

8) No close working to any live overhead power line is permitted without system of a ‘Permit to Work’ and prior permission of the employer shall be obtained before performing such operation.

9) During shifting of material near open edges, signalman and other workers shall not be allowed to lean out for communicating with ground staff unless they are provided with full body safety harness duly anchored with sturdy points

10) Danger zone shall be identified and cordoned off for all lifting appliances during their operation

11) Appropriate measures shall be adopted to prevent foot of the derrick to lift out of its socket or support

12) All guy ropes of the derrick shall be adequately anchored to rigid points and should in tension with the use of turn buckle without any sagging.

13) All lifting appliances, gears, tools & tackles shall always be maintained in good condition to avoid any damage to them. Slings shall be discarded once they get any sign of deterioration beyond permissible limit defined by OEM and authenticated by Plant & Machinery In-charge.

14) All lifting gears & slings shall be stamped or appropriate tags for their identification no & SWL.

15) Practice of Knotting/wrapping of chains & slings shall not be allowed.

16) Lifting appliances shall not be used for any dragging or pulling purposes. Contract shall refer to 75% capacity load chart for ascertaining the suitability of crane for safe lifting of load.

17) During hoisting of long material, use of suitable lifting beam is recommended.

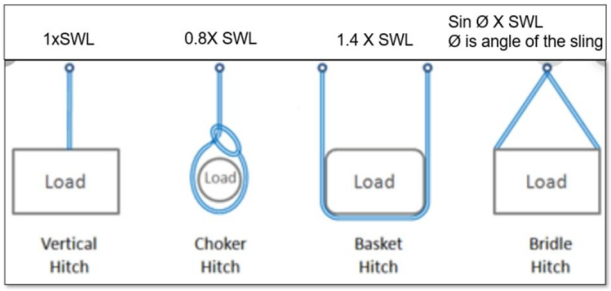
18) Lifting operation for handling load above one ton shall not be allowed without approval of lift plan/study and permit to work. The lift plan/study as well as checklist & work permit shall be signed by the nominated lifting engineer before performing any lifting operation.
19) No person shall be allowed to rig or de-rig at height unless safe means of access is provided.
20) Only original equipment manufacturer (OEM) supplied/provided load chart shall be used during lifting operation.
21) Before performing any lifting operation, all electronic devices, control levers, hydraulic oil, wind pressure etc.shall be checked and necessary spare parts to be kept in stock to handle any breakdown during time bound
22) lifting operation.
23) All underground utilities shall be identified, and necessary measures shall be adopted before setting up of cranes for lifting.
24) Loose as well as long material shall be adequately tied up with each other before lifting.
25) All equipment including Electrical panels, Hoist if gantries etc shall only be lifted with the help of all lifting point/eye bolts as provided & recommended by the original equipment manufacturer. Safe slinging shall be ensured.
26) Lifting point shall be considered on the I-Girders/U Girder/C Girder/Steel girder/parapet etc during the casting of the same. Design load calculation for the same should be conducted.
27) Lifting and lowering of the plant & machines like transit mixer, excavator, tractor etc shall be done as per recommendation from the Original Equipment Manufacturer.
28) Certification from designer for the stability and load bearing of "A" frame used for lifting of the escalators shall be obtained before its use.
29) All lifting activities shall be stopped in case of highspeed wind and similar adverse whether condition or as prescribed by the crane manufacturer.
30) All cranes shall be provided with fail safe devices to avoid any hoist free fall in case of brake failure.
31) Minimum lighting is to be ensured at all lifting operations.

To ensure carne physical condition, crane operator must conduct a visual inspection before use by using pre-defined checklist.

C. Calculation of Sling SWL

It is depends on type of sling using , common type slings are web sling, wire rope or chain. Before engaging any slings to work must calculate SWL based on type of lifting using it.

Let's check calculation of SWL for the web sling:



Note: SWL will be given by the manufacturer for all web slings.

When SWL not mentioned for the Wire ropes, by using below formula SWL can be derived .

SWL = ROPE DIAMETER X ROPE DIAMETER X 8

Examples:

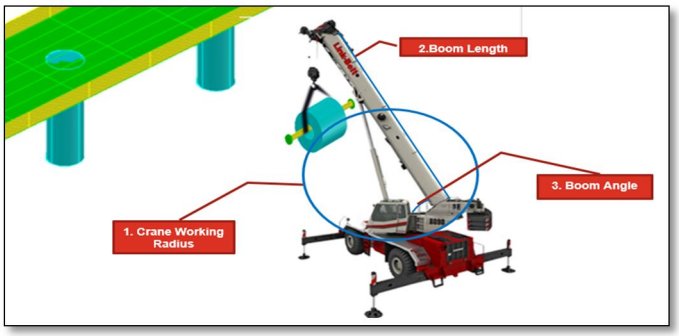
(a) $^1/_2$ inch diameter rope.
SWL = $^1/_2$ x $^1/_2$ x 8 = 2 Tons.

(b) $^5/_8$ inch diameter rope.
SWL = $^5/_8$ x $^5/_8$ x 8 = 3.125 Tons.

(c) 1 inch diameter rope.
SWL = 1 x 1 x 8 = 8 Tons.

D. Calculation of Crane SWL

Ideally SWL is based on three parameter 1. Crane radius in between load and centre point of crane 2. Boom length 3. Boom Angle.



Based on these parameters, operator needs to refer crane chart provided by manufacturer to get exact SWL of the Crane and SWL is accurately displayed on a real time basis on the Automatic safe load indicators (ASLI) unit infront of the operator. It is also mandate to all carne must equipped with (ASLI).

E. Permit To Work (PTW)

A PTW document is an administrative control before staring of lifting operation to assess the current hazards and risks in the activity based on pre-defined check list and re-ensure all requirements are compliant as per safety norms. This document must be filled by competent person and approved by authorised person.

	Risk Control measures check prior to issue of Permit to Work	Yes/ No/ NA	Comments
People	A valid HMV License of the CraneOperator		
	Medical fitness certificate is available for drivers/operators		
	Deployment of Competent person for crane signalling		
	All adequate PPE worn by all concerned person		
Plant Equipment (Lifting equipment & accessories)	Valid Registration Certificate, Insurance & PUC available for the Forklift/Crane.		
	Valid Fitness Certificate available for the Lifting equipment & accessories.		
	Hook and safety latch are in good working condition.		
	Reverse horn is available.		
	All equipment and accessories used for lifting operations must be uniquely identified, marked with the safe working load, listed in a register, and subject to formal regular inspections.		
	All limit switches are working.		
	Safe working load (SWL) of the tools & tackles and lifting equipment is enough to be handle the loads.		
	Hoisting Ropes is in good working condition.		
	Guide rope (Min length of 5mtr) is in use to prevent undesired movement of load		
	ASLI (Automatic Safe Load Indicator) in working condition		
	Out riggers are in good condition		
	Number of load lines/falls should not less than load lines/falls mentioned in fitness certificate		
	Guards available for all rotating parts.		
Premises	Clearance of at-least 3 Mtr is maintained from high voltage overhead line up to and including 11KV		
	Crane movement path is compacted and levelled, and operator visibility is unobstructed throughout the lifting		
	Adequate illumination provided during dark hour work		
	Wind and other climatic condition are favourable for lifting operation		
	When lifting in public area, ensure enough barricade & prior information to others contractor.		
Procedures	Lifting Plan is available and briefed to those involved in lifting operation		
	Load Chart is available, readable and understood by operator		
	Risk Assessment for lifting activity is available and briefed to involved team.		

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F. Lifting Plan

A lifting plan is developed every time when a load is being lifted. The basic idea behind a lifting plan is to have control and establish safety precautions. It is an important planning process that will identify all hazardous situations that might be encountered during lifting. Formal recorded process to control risks associated with lifting operations. It includes in a risk assessment approach:

1) The type, weight, size, shape and centre of gravity of the load
2) Consideration for weather conditions and work environments where appropriate
3) The proximity of hazards and obstructions to the load
4) Consideration for simultaneous operations and the measures taken to avoid conflicting tasks in the lifting area
5) Consideration for overturning, load integrity
6) The required qualifications for all operators involved in the lifting operation It must define
7) The lifting methodology, step by step
8) The identification of the designated lifting area, the fall zone and the control measures to prevent access such as barriers, signs, etc…
9) The method used for slinging, attaching and detaching the load with the availability of approved lifting points on the load when necessary
10) The list of equipment and lifting accessories to be used
11) The composition of the team required to perform the task (crane driver, rigger, etc.) with the description of their roles and responsibilities including the intended communication method if appropriate.

A lifting plan must be prepared, checked and issued by competent authorised persons prior to any lifting operation.

G. Competency of the Lifting Team

It is one of the important aspects need to be taken care liftings. Lifting operations are always a high-risk activity where it requires competency and authorization to each involved person. All persons involved in lifting operations and involved in lifting operations must be subject to recorded competence checks to ensure necessary training experience and qualification prior to commencing work:

Training	Engineering	Industrial Engineering Site Method	Supervisor	Crane Operator	Rigger	Worker
PTW training			✓	✓	✓	✓
Classical rigging				✓	✓	
Complex rigging & lifting SV		✓			✓	
Lifting access. / equip.checker			✓			
Crane Operator certification				✓		
Lifting plan design		✓				
Lifting plan execution		✓	✓	✓	✓	✓
Lifting equipment design	✓					
Lifting lug orientation to centre of gravity	✓					
Legal Requirements	✓	✓	✓	✓	✓	✓
Risk Assessment	✓	✓	✓	✓	✓	✓
Basic EHS fundamentals	✓	✓	✓	✓	✓	✓

III.PROBLEM IDENTIFICATION

Almost all metro projects in India had very bad tragedy incidents during lifting heavy material to higher heights. It may because of many failures taken place at single point of time. Metro sites always carries risky environmental conditions such as working on busy roads, working in night with poor lighting conditions. If small negligence can also impact on life public nearby.These failuresare not limited to:

A. Overloading of crane.
B. Overloading of Slings.
C. Using damaged slings.
D. Using of uncertified lifting equipment.
E. Uneven or unstable ground.
F. Failure outriggers & crane.
G. Lifting Activities near live electrical lines
H. Unfavored climatic conditions ex: Heavy wind.
I. Failure of Structural Parts.
J. Unsafe operation by in-competent operators.
K. Interface of public vehicle into lifting zone.
L. Poor communication to crane driver.
M. Lack of competency of lifting team.

IV.CONCLUSIONS

Any lifting activity requires systematic approach to handle all unexpected situationsand it will play major role in preventing loss oflife, company reputation and property damages. Particularly in metro construction industries it is necessity to give paramount importance to safety of lifting operations. In any industry for execution of safe lifting operations, Always need to keep in mind fitness of lifting equipment and lifting accessories, competency of the lifting team , each high-risk lifting activity must have dedicated lifting plan, never overload cranes and slings than its safe working load, a proper communication needs to setup with defined signals to avoid confusion, traffic diversion and traffic management plan is key requirement to metro sites as these activities having interface with public vehicle and to ensure road safety. In recent years accidents related to lifting are reduced in the metro industries as compared to previous times, it is because of companies are giving highest priority to safety of the people. Also, National Safety Council & Regional Labour Institutes are conducting regular technical trainings on lifting operations to develop competencies in different industries based on their needs.

V. ACKNOWLEDGMENT

It is a matter of great satisfaction and pleasure to present this report on “Safety Practices During Lifting Operations in Metro Projects and I express my sincere thanks andgratitude to my honourable Chairman, Prof. Dr A.K.NATESAN, M.Com. MBA., M.Phil., Ph.D., PHF for all the help he have provided in accomplishing this task.
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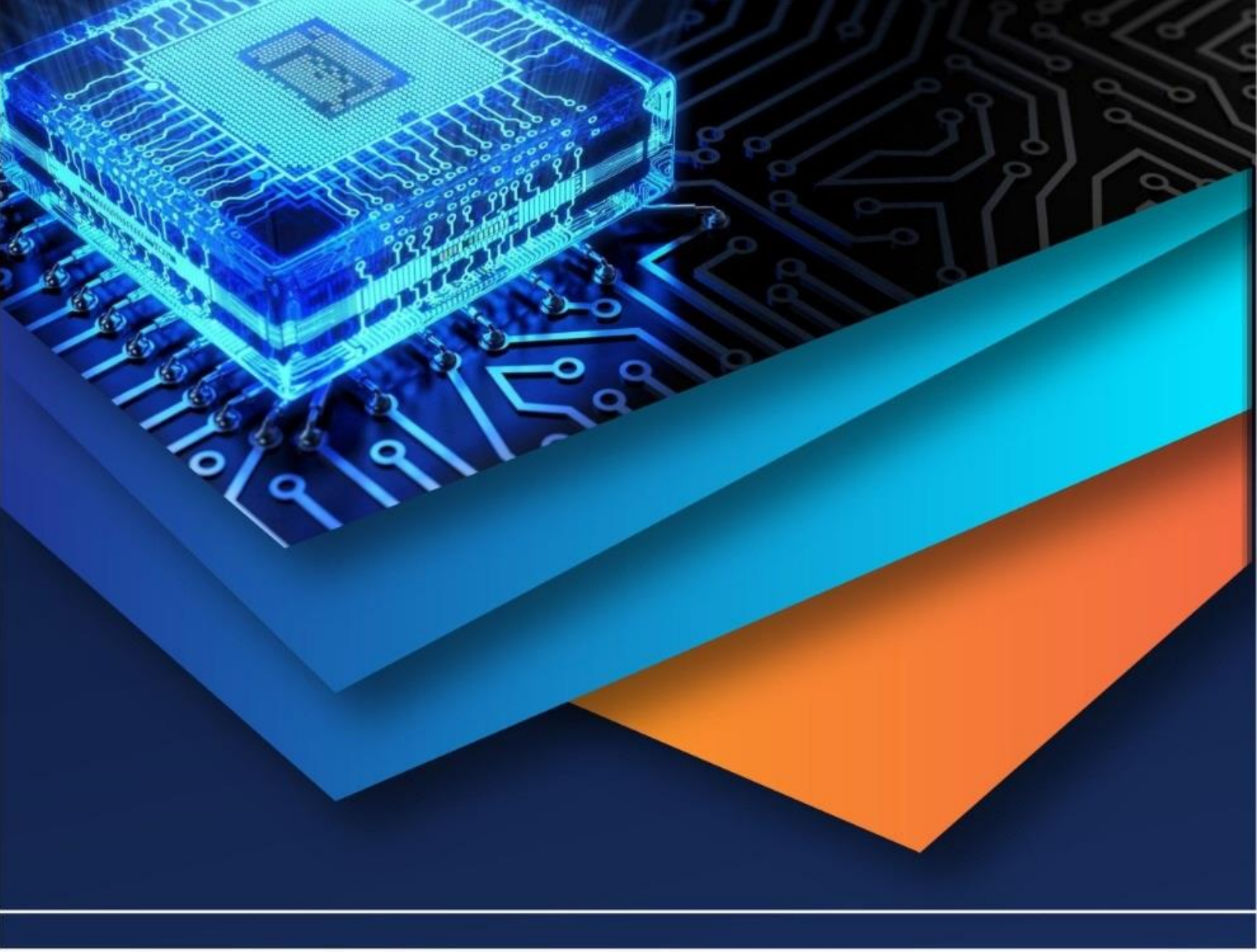

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