

Construction Crane Safety Management

Crane accidents have occurred with some frequency since the invention of lifting machinery. Recent accidents that have involved the loss of lives have focused industry attention on cranes. Contrary to popular belief, there is no central repository of crane loss data. Indian crane accidents that cause a loss of life to workers, or injuries to multiple workers must be reported to the Factory Inspector. Other than that, and a few local ordinances, most accidents are not reported. Many crane operators carry large insurance deductibles. Smaller losses may not be reported to insurance carriers. There has been some discussion about national loss reporting requirements, but workable solutions are not imminent.

The volume of crane accidents can only be estimated. The definition of "accident" is not universal. Some include only events that result in injury or death. Some do not include liability considerations. Others include only some industry segments, while others exclude some loss categories. Even the definition of a crane is not in agreement. Some exclude non-construction cranes such as industrial gantry, bridge and jib cranes. Some exclude port or mining operations.

The exact number of cranes in India is not known. The best estimates put the number of mobile and tower cranes used in construction at between 95,000 and 100,000. Accident may be defined as any event that caused physical damage to the crane or injury to a person.

There are three basic types of crane accidents:

- Structural failure
- Tip-over
- Collision

The basic causes of crane accidents are one or more of the following categories:

- Operations
- Assembly/disassembly
- Rigging
- Maintenance
- Weather

Other fringe causes exist, including design, vandalism, faulty repairs, or counterfeit parts. Most of these could be included in the operations or maintenance categories above. Firm data is not available to put numerical values on the accident cause categories. Nearly all agree that operations represent well over half of the losses.

Most crane accidents are the result of human action, or a lack thereof. The focus of many safety audits is unsafe conditions, rather than unsafe acts. Conditions are relatively static, and easier to observe than unsafe acts, which are often transient. For crane operations, unsafe conditions are often caused by unsafe acts.

Following is a guide for safety audits around construction crane operations. Equipment and conditions vary widely, and it is certain that this guide does not cover all potential issues.

Supplemental Guides and Reference Material Such materials include:

- Crane operator's manual (should be in the crane cab)
- Crane maintenance manual (often kept on file at the shop)
- OSHA Standards – Part 1926, Subpart CC (1926.1400-1442)
- ASME B30.5 (mobile cranes)
- ASME B30.3 (tower cranes)
 - IS 6521-1 (1972 Code of Practice for design of Tower cranes (Part 1)
 - IS 13834 (1995) Cranes –Classification Part 3 :Tower cranes
 - IS 13367(1992) Safe Use of Cranes Code of Practice Part 1 Gen reaffirmed in 2008
 - IS 13473 (1992) Cranes Vocabulary Part 2 Mobile Cranes
 - IS 13473 (1993) Cranes Vocabulary Part 3 Tower Cranes Reaffirmed in 2009
 - Construction Safety Manual for Works contract BARC

Documentation

Types of documentation to look for include:

- Annual crane inspection report: any deficiencies that affect safe operations should be noted as having been corrected
- Monthly crane inspections: documents for last three months should be available, with issue resolution as above
- Pre-shift safety inspections (documentation not required by authorities)
- Crane operator's certification for the class of equipment in use
- Critical lift plans (if appropriate)
- Load chart on durable material, legible, serial number on the chart matches the crane

Operator Knowledge

Crane operators should have the following knowledge:

- Ability to identify the load chart page(s) that match the crane configuration
 - Boom type and length
 - Boom extensions (if any)

- Base configuration
- Counterweight configuration
- Ability to produce and interpret inspection reports
- Ability to accurately identify weights of attachments
 - Ball
 - Block
 - Stowed or idle jibs
- Ability to calculate crane net hook capacity
- Ability to program and operate the crane's computer (if equipped)

Questions to Ask a Crane Operator

The following are questions that one could ask the crane operator:

- What is your radius? The answer should be the horizontal distance in feet from the center of rotation to the center of the hook.
- What is your boom length? The answer is a fixed number for lattice booms, measured from the boom heel pin to the center of the tip sheave. For a telescopic boom, length is given by an indicator.
- How much weight is on the hook? The answer should be the load plus all attached rigging
- May I see your load chart? The answer should be an offer of a durable chart, such as laminated paper, or a metal data plate riveted to the inside of the cab. A few of the newest cranes may have a digital chart on a screen similar to a computer screen.
- What is the weight of your block (or ball)? The answer should be on a data plate on the block or ball, but the operator must know this number.
- What is your rope type, size and weight? The answer should be type RB, or ZB or similar code plus rope structure (such as 6x19), plus a rope diameter plus a weight per foot of the rope. The answer should match one of the rope specifications on the load chart
- What is your net hook capacity? The answer should be the gross capacity from the load chart less deductions for all attachments including blocks, balls, unused jibs, excess rope.
- When was your last crane inspection? The answer should be today's date.
- When was your last annual inspection? The answer should be available on a sticker, certificate or document on the crane.
- When did you last check your level? The answer should be today, and should not have been made with the target level in the crane. A carpenter's level should have been used each shift, plus any time the crane is moved to a new location.

If an operator cannot immediately and accurately answer any of these questions, they should be removed from service until they complete a training program. If an operator says, "I don't need to know that; the computer does all that for me;" there should be concern. The only acceptable reliance on a crane computer should be if the operator enters all of the data (boom length, block weight, etc.), the computer may serve as a

backup to the operator, and to perform some load chart calculations to deduct the attachments from the internal load chart.

Crane Setup

The crane should be set up in the following manner:

- The crane should be level, within 1% (0.57 degrees), unless the manufacturer states otherwise
- Crawlers or outriggers are level and fully supported (no gaps)
- Outriggers are fully extended, or matching chart in use
- All boom pins are secured in place
- Extended outriggers will usually require blocking below the floats set on soil to spread the load over a larger area. Inadequate cribbing has contributed to many crane accidents.
- There should be swing radius protection

Obstructions:

Careful planning is needed when potential obstructions are within the crane's radius of operation. Any obstruction is a potential threat to crane safety. These include structures, bridges, other cranes, and the big one—power lines. No crane boom, load line or pendant should contact any obstruction, especially when under load. For power lines, a clearance of ten feet or more should always be maintained from any energized overhead power line. Being struck by a moving object is also an exposure to consider.

Equipment Condition

Equipment should be in the following condition:

- Cab glass clean and in good condition
- Running rope free of wear and broken wires
- Anti-two-block in place and in service
- Pendant lines in good condition
- Portable fire extinguisher available
- Steps and hand holds in good condition
- Drum brakes will hold loads
- Power line warning sticker visible to the operator

Signaling

The new crane standard contains specific requirements to be met by anyone who signals a crane operator. A common question arises regarding signal person certifications. Accredited certifications are available, but are not presently required by the authorities. They do require qualified signal persons, and specific requirements must be met to comply with that part of the standard:

Signal person qualification requires passing either a written or oral test on the method(s) to be used, and a practical test, providing signals to an examiner and receiving/interpreting same. Two options for qualification; one can use either a qualified third party (vendor, testing company, etc.) or a qualified person who works for the employer.

Signal persons should be visibly distinct. Common methods include unique gloves, vests, hard hat covers or hard hat stickers. There should be written evidence readily available that indicates that each signal person was trained, and has passed both written and practical examinations.

Rigging

Rigging is a task that may be performed by many, with some may be lacking proper training or equipment. If the rigging fails during a pick, or the load slips from the rigging, the load will fall, endangering life and property below. In addition, the load itself may be damaged, and the recoil from sudden load loss may either snap the boom or cause the crane to topple over backwards.

- **Trained riggers:**

There are no certifications or specific training requirements for riggers that are specified by the authorities. However, all riggers must be "qualified." Each rigger should be thoroughly trained on selection, inspection and application of the rigging equipment. They should be able to determine load weights, load attachment, types of hitches, sling angles and sling protection

- **Rigging equipment:**

Only approved rigging equipment, in good condition, should be used. Each piece of equipment should be inspected immediately prior to each use. All equipment should be marked with capacities. Rigging equipment should be stored out of the weather, and should be protected from damage.

Critical Picks

There is not a universally accepted critical pick criteria. There is limited guidance to help identify potential scenarios that warrant special considerations.

Theoretically, cranes can make picks up to 100% of their gross capacity. The gross capacity includes the weight of the load, plus the rigging, blocks and balls, excess rope below the boom (some manufacturer's say all rope), unused boom attachments (jibs), certain other attachments such as added sheaves, upper boom points, etc.

Crane load charts list gross capacity for the crane for static conditions. This means that there will be no movement of the crane or load. Picks are not made that way, as a crane

is used to move loads. This movement adds dynamic loading, which is not contemplated in the load charts.

Load charts assume perfect conditions. This includes correct assembly, brand new equipment, zero wear, perfect inspection results, new rope, perfectly level, and perhaps the toughest of all—zero wind conditions.

The effects of wind are never included in the chart capacities due to the infinite combinations of wind factors. Wind speed often varies with elevation changes. Ground level wind speed is often lower than wind at the boom tip. Wind direction is another factor. Wind behind the boom pushes the boom and the load, increasing the operating radius. Wind on the front decreases the load radius, but tries to push the boom over backwards and may push the load into the boom. Wind from the side could be a major issue. Side wind pushes the boom and load sideways, introducing side loading on the crane. Most cranes can tolerate only minimal side loading from suspended loads hung from level cranes. A few models have special attachments to increase the crane's tolerance of wind. These are often found in applications such as erecting towers and windmills.

Because of the many factors that are normally present that act to reduce a crane's operating capacity, prudent operation calls for backing off of the crane's theoretical capacity. An unofficial crane capacity limit commonly used for mobile cranes in construction is 75% of the crane's net hook capacity. Anything higher should trigger a critical pick plan. Even when conditions are nearly ideal, prudent operation suggests backing off a bit from the manufacturer's limits. Anything higher than 90% should be considered to be a very risky undertaking.

The construction industry has informally developed internal criteria to designate critical picks. Uniformity is lacking, but there are many areas of general agreement. Scenarios that warrant consideration to trigger critical pick planning:

- Load weight, including rigging, exceeds 75% of the crane's net hook capacity
- Very expensive loads
- Loads that would take significant time to replace
- Loads with unusual characteristics
 - Dangerous materials
 - Liquid filled containers
- Multi-crane picks
- Crane set on a structure such as a bridge deck, pier or platform
- Unusual hazards
 - over open highways or rail lines
 - Near high hazard environments
- Project owner's requirements

Picks of personnel are not necessarily considered to be critical. Requirements limit cranes to 50% of their capacity, and 50% of the rope working limits when picking

personnel. This is well below the commonly accepted threshold of 75% used to trigger critical pick plans. There are other requirements such as wind speed limits and daily test picks listed in the rules.

There are two common weaknesses in critical lift programs. One is that the forms are completed, calculations made, limits determined, then the plan is simply not followed. The other is that critical picks are made, but not recognized as such. Most accidents occur with light loads on the hook. With a light load, assumptions are made that surely the crane must have sufficient capacity. The longer the radius, and the longer the boom, the lower the net hook capacity will be.

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