LEARNING FROM ACCIDENTS

Safety Alert from SEA (India)

SEA (INDIA)

HQ & Correspondence address: Safety Engineers Association
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Vol - 6 / No - 70	ALERT - 105	Dec’2021

Title: Failure of Tower Crane

What Happened

While lifting a bundle of scaffold material with the help of luffing jib tower crane, the jib of the tower crane suddenly buckled. This resulted in the load and the hook block of the tower crane plummeting down to the ground. The accident resulted in one fatality and an injury to another worker. Photographs and sketches related to the incident is given below.

Photographs of the Incident

Fig. 1

Fig. 2

Information on Luffing Jib Cranes

Operating Principle

⇒ Luffing Jib Tower Cranes are a type of tower crane that vary their working radius by raising or lowering their jib through a luffing jib system. The upper portion of a Luffing Jib Tower Crane is shown in *Fig. 3*

Installation of a Luffing Jib Tower Crane and Erection Ropes

⇒ Normally Luffing Jib Tower Cranes are installed on-site. The installation process begins with the casting of a strong concrete foundation for the tower crane to be sited on & followed by installation and assembly of various components, including the mast sections, slew ring, operator cabin, counter-jib, counterweights etc.,

Fig. 3

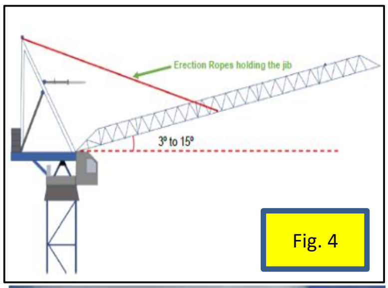

Fig. 4

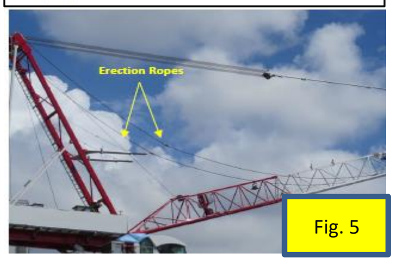

Fig. 5

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Erection Ropes

- ⇒ During the jib installation process, Erection Ropes are typically used to hold and balance the jib in position for the crane erectors to install and secure the jib onto the A-frame head (please see *Fig. 4 & Fig. 5*).
- ⇒ Erection Ropes usually come in a pair, with one end of each rope secured to the A-frame head and the other end secured to one of the jib sections (please see Fig. 4). Erection Ropes can come in a single length or as an assembly comprising of shorter lengths of ropes. The length of the jib determines the length of the Erection Ropes used and the location on the jib they are secured to. This ensures that the Erection Ropes used are of optimal length (not excessively long or short). The specific length & position of installation of the Erection Ropes will be prescribed in the tower crane manual.
- ⇒ After the luffing system of the jib has been installed, the Erection Ropes play no further role in the function and operation of the tower crane.

Management of Erection Ropes

- ⇒ Some tower crane manufacturers recommend for the Erection Ropes to be removed after the jib installation. In such cases, the Erection Ropes are required to be reinstalled back onto the cranes before any jib maintenance or dismantling of the cranes can occur.
- ⇒ There are other tower crane manufacturers who allow for the Erection Ropes to be left on the tower cranes after the jib installation (as in the case for this TC). This eases subsequent jib maintenance and dismantling of the cranes, as the Erection Ropes need not be reinstalled back onto the cranes. Some manufacturers also recommend leaving the Erection Ropes on the tower cranes to support the jib in the event of troubleshooting or repair of a defective jib mechanism. Leaving the Erection Ropes on the tower cranes also eliminate working at height risks during its re-installation.
- ⇒ For Erection Ropes that are left on the tower cranes after the jib installation, the amount of slack in the Erection Ropes will vary during operation - they will have more slack when the jib is raised and less slack when the jib is lowered. As such, support brackets are often provided on the tower crane to contain and guide the Erection Ropes into its proper resting position and prevent excessive dangling of the Erection Ropes when the jib is raised (please see *Fig. 6*).

Fig. 6

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Event Sequence:

- ⇒ Tower crane (TC) was operated to lift a load at the time of the accident.
- ⇒ Jib of TC was raised to reach the load which was positioned near to the TC's mast. During the process, the Erection Ropes slackened, and the right Erection Rope likely slipped out of its support bracket instead of resting within it, as shown in *Fig. 7*.
- ⇒ After the load was picked up, the TC's jib was lowered to reach the intended unloading position. During the process, as the Erection Ropes straightened, the right Erection Rope became entangled with the outer pivot joint on the right side of the A-frame, (please see *Fig. 8*).
- ⇒ The entanglement of the right Erection Rope caused a mechanical restriction to the luffing function of the jib of the TC i.e., the jib was prevented from being lowered further.
- ⇒ The attempt to continue luffing down the TC's jib resulted in the luffing winch continuing to unspool and thereby releasing the luffing wire rope from the drum. As the luffing wire rope became slackened, the entangled right Erection Rope began to take on the weight of the jib and the suspended load. Under continual stress, the right Erection Rope eventually failed at the entanglement point, and the jib jerked downwards in free-fall.
- ⇒ As the jib was held back by the luffing wire rope, it buckled at jib section #3 as it fell. The buckling of the jib occurred after the jib started to fall and was not the cause of the accident.
- ⇒ Consequently, the hook block and load also plummeted down to the ground, hitting the deceased and another worker who were working in the vicinity.
- ⇒ TC was not overloaded at the time of the accident & full sequence of events is illustrated in *Fig. 9*.

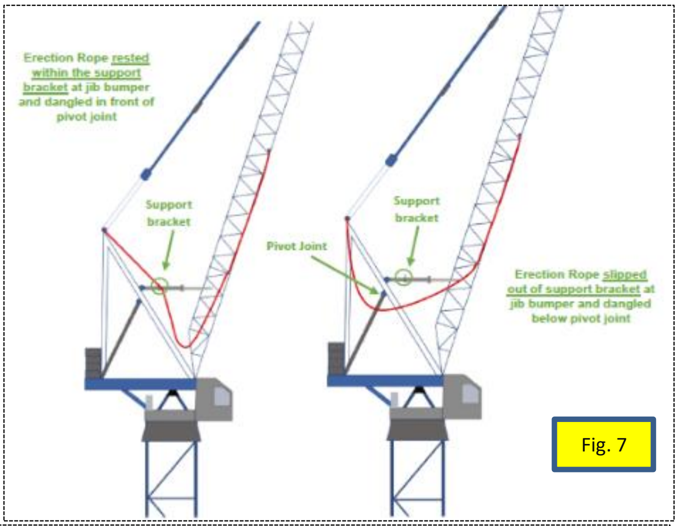

Fig. 7

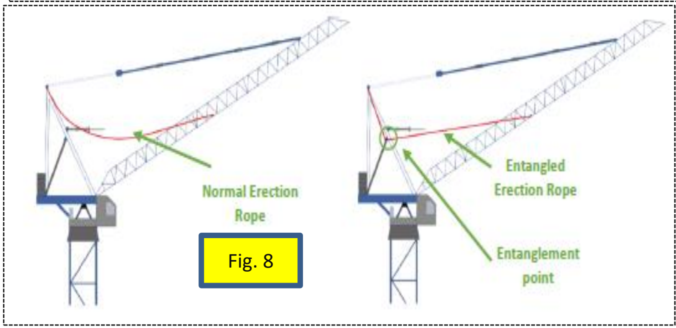

Fig. 8

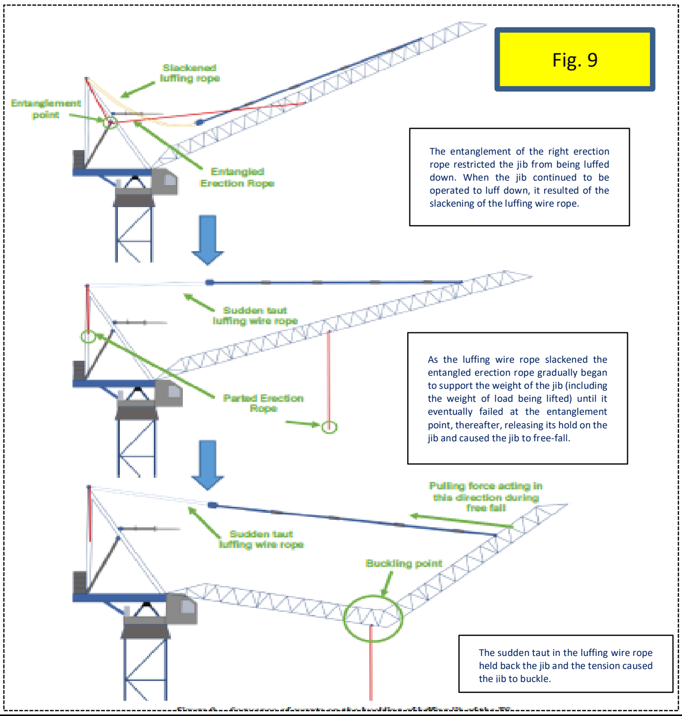

Fig. 9

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Contributing Factors

Design of Supporting Brackets

⇒ Design of the support brackets (to contain and guide the Erection Ropes) was open and shallow - in a widened “U” shape (please see *Fig. 6*). This was deliberate so that the Erection Ropes could move freely as it slackened or tightened depending on whether the jib was raised or lowered. The support brackets were not meant to be load bearing.

⇒ When the Erection Ropes were not positioned within the support brackets, they would dangle below the A-frame (please see *Fig. 7*), resulting in the possibility of them being entangled with other parts of the crane. As the jib was subsequently lowered, any entanglement would cause mechanical restriction to the luffing of the jib of the tower crane and could impact the operation of the crane.

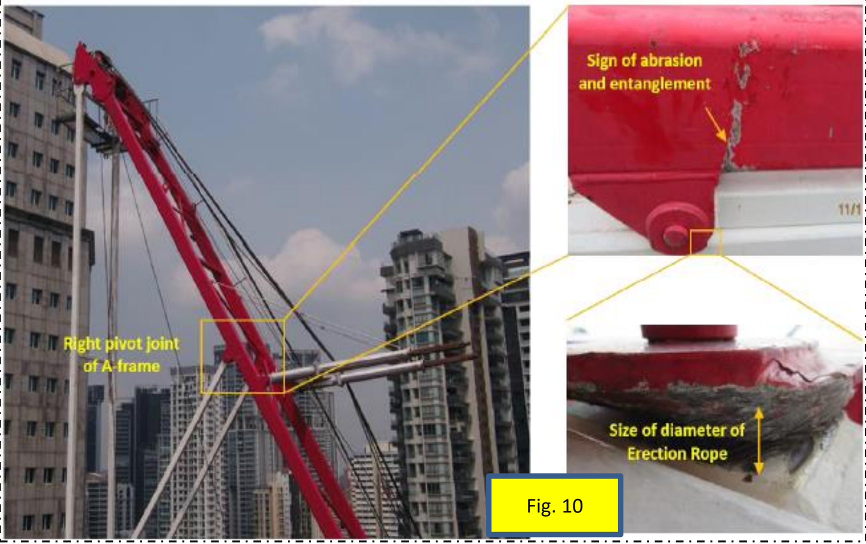

Fig. 10

Entanglement Risks

⇒ There was a groove/gap at the connection between the main and supporting frame of the A-frame at the pivot joint (please see *Fig. 10*). The size of the gap was about the size of the diameter of the Erection Rope. This created an entanglement risk when the Erection Rope glided past the pivot joint while the jib was being lowered.

Lessons Learnt

⇒ Eliminate Risk of Entanglement between Erection Ropes and other Structures

⇒ Ensure Erection Ropes return to their Resting Position

⇒ Conduct Regular Examination and Inspection of Tower Cranes

⇒ Ensure Installation, Dismantling and Repair of Tower Cranes are done in accordance to Manufacturer’s Recommendations

⇒ Implement proper Lifting Plans to ensure Safe Lifting Operations

Further Information on this Incident can be obtained from the below link:
https://www.mom.gov.sg/-/media/mom/documents/safety-health/learning-reports/learning-report-tower-crane-failure.pdf