

Case Study 6 – Tower Crane Collapse

Background

A 79m high tower crane was being used as part of a project to build a new eight-storey hotel and seven apartment blocks in Liverpool, UK.

During the construction of the crane foundation, Bingham Davis (Structural Engineering firm) advised Bowmer & Kirkland (site Principal Contractor) to cut-away steel reinforcement bars (rebar) from four concrete foundation piles to enable the crane feet to rest on the piles. The rebar was replaced with four steel rods in each pile.

The Incident

On 6 July 2009, the tower crane toppled while making a lift. The operator, a 53-year-old father of four, fell from his cab onto the roof of the apartments and through the hole created by the counterweights. He suffered multiple injuries including a brain haemorrhage and spinal injuries which resulted in his legs being paralysed.

There were no injuries to residents who were evacuated from the apartments. Some residents were rescued from their balconies and damage to the building was extensive.

Figure 1 The toppled tower crane lays across residential apartments



Findings

Serious failings were uncovered during an investigation into the crane collapse.

- Bingham Davis employees had no previous experience of designing the type of crane foundation and Bowmer & Kirkland's employees at Kings Dock Mill had no experience of building one.
- Bingham Davis failed to spot a mistake in its calculations for the loadings imposed by the crane. This created a material risk which had the potential to have led to a crane foundation being constructed that was not strong enough to hold the crane up.
- Bingham Davis advised Bowmer and Kirkland to cut away essential steel reinforcing bars in the foundation piles and replace such with steel rods. Removal of the reinforcing steel resulted in the foundation being too weak to support the crane.
- Bowmer and Kirkland failed to ensure the adequate insertion of the replacement steel rods which further weakened the foundation.
- Both Principal Contractors and Designers should have ensured at all times that effective systems for design checking were in-place and actioned.

Outcomes

- The crane operator is now unable to walk, for the rest of his life. It was only by pure chance that this event did not result in multiple fatalities.
- The damage to the building was extensive and residents were unable to return to their homes for nearly two years while major reconstruction work took place.
- The UK Health & Safety Executive (HSE) prosecuted the site's principal contractor, Bowmer & Kirkland, and Bingham Davis.
- Bingham Davis Ltd ceased trading since the crane collapse after going into voluntary liquidation.
- Bowmer and Kirkland Ltd was fined £280,000.

Engineering Management Systems: Learning from experience

Incident Review

Table 1 Incident contributing factors and related activities (process/es) within an engineering management system

Fault (Contributing Factors)	What engineering management activities should have prevented this incident?	Discussion
Lack of experience designing this type of equipment or system.	Competency requirements stated in the requirement specification and evaluated during the tendering stage	<p>This is unfortunately common and appears motivated by economic drivers and optimism. Checking that an organisation or person is competent should be viewed as necessary, acceptable and routine. Then, measures can be enacted to control the associated RISK.</p> <p>For example, the contract might be let with the proviso that the successful contractor trains some of its staff in some aspects of design and engineering work.</p> <p>This simple step results in win-win outcomes.</p>
Calculation error.	Peer review Verification Independent (second) calculation	Rookie/inexcusable error. Any engineering company must have calculation checks embedded in its culture.
Replace rebar with steel rods.	Design review Calculation Independent review	In the context of design, this error is basic, dangerous and indefensible.
Inadequate insertion of the replacement steel rods.	Validation	Demonstrates the importance of design validation. In a perfect world, it would be unnecessary, but that is not the case.
Lack of effective design checking	Design checking	<p>Fundamental design requirement.</p> <p><i>Why do you think in this case that such a fundamental activity was missed from the planning, scheduling, resourcing and project execution?</i></p>

Note that the measures to prevent this failure are relatively inexpensive and easy compared with dealing with the results of the failure.

Additional Resources

Crane collapse driver awarded £2.7m compensation. (2013). Retrieved from <https://www.constructionnews.co.uk/best-practice/health-and-safety/crane-collapse-driver-awarded-27m-compensation/8655216.article>

Contractor fined £280k for Liverpool tower crane collapse. (2012). Retrieved from <https://www.theconstructionindex.co.uk/news/view/contractor-fined-280k-for-liverpool-crane-collapse>