

CROSS Safety Report

Tower crane base designs

This month's CROSS report again highlights the importance of a competent person fulfilling the role of Temporary Works Coordinator on a project and the need for suitable checking of designs.

Overview

A reporter's firm has been involved in the design and checking of numerous tower crane bases and has come across many examples where the supplier of the tower crane has supplied incorrect loadings. These incorrect loadings could have led to crane failures had the errors not been spotted.

Report

A reporter's firm has been involved in the design and checking of numerous tower crane bases and has come across many examples where the supplier of the tower crane has supplied incorrect loadings. It is only through their experience that the firm is picking up these errors and can challenge the suppliers. The reporter provides three examples found in a 12-month period to illustrate the problems.

Example 1: A tower crane supplier stated that the in-service moment was 500kNm, while the out-of-service was approaching 20 000kNm. These two numbers are a world apart and were challenged. The in-service moment was corrected to 5000kNm (a zero had been missed out). Admittedly, the in-service does not generally drive the design; however, suppose the mistake had been in the out-of-service moment, and we had designed for 5000kNm in service and 2000kNm (i.e., the same error of a missing zero) out-of-service. The base would have had less than a third of the capacity required.

Example 2: The loads to one of the legs of a self-erector tower crane were given as 0 under all three load cases. This could clearly not be the case. We challenged the supplier and a revised loading detail was provided showing the actual load.

Example 3: A tower crane was originally proposed to be used with minimal ballast, effectively just the self-weight of the kentledge base. The crane was quite short and not particularly large. The initial loadings supplied indicated a very minimal tension load of less than 100kN. The reporter's firm was undertaking the Category 3 checks on the base, and it became apparent that the designer had used an incorrect factor in the design.

As the piles had already been installed and did not have sufficient tensile capacity, the crane supplier was asked for loadings allowing for an additional 60t of kentledge on the base. The revised loadings supplied indicated a tensile load of over 200kN, over two times greater than the previous loadings supplied. Logically, the load should have reduced not increased. After discussion, the crane supplier admitted that the original set of loadings was completely wrong. A design based on this incorrect information could well have led to the tower crane falling over.

Data for tower crane loadings

The reporter believes the data for tower crane loadings are generally obtained from a large document that shows all variations. The crane supplier

possibly then copies the loads into another document. It appears that these transcribed numbers are in some cases not checked before they are supplied to the base designer.

The reporter would like this information shared to ensure that designers 'sense check', as far as they can, the loads they are supplied with. They would also like crane suppliers to use more care when providing loads, perhaps implementing a checking regime for all loads provided.

This firm carries out a significant number of tower crane base designs in an average year. If they are finding this many errors, they believe there must be others. They believe the problem of

Key learning outcomes

For crane and lifting equipment suppliers:

→| Base loadings should be validated before being provided to others

For civil and structural design engineers:

→| It is good practice to carry out an independent check to verify loads received from a third party
→| Check detailing of crane bases carefully, particularly tension resistance

For contractors:

→| Appoint a competent Temporary Works Coordinator who can coordinate the design and sequencing of temporary works
→| Good planning can ensure independent design checks are carried out in time and approved prior to the works commencing on site
→| Be mindful of the required tension capacity of crane bases

“ CONTRACTORS SHOULD BE MINDFUL OF THE REQUIRED TENSION CAPACITY OF CRANE BASES

incorrect loads being supplied may be happening quite regularly across the industry.

Expert Panel comments

This is clearly a worrying account, and the reporter does well to raise it. Good practice in crane foundation design will involve sense-checking input data. This can be relatively easily done by (a) reference to crane manufacturers' data, and (b) by basic mechanics to within an order of magnitude. Experience also plays its part; experienced and competent designers know what order of magnitude and scale of members they should be seeing, as appears to be displayed by this reporter. This applies as much to crane bases as to any other structural element.

Crane bases and their foundations are 'temporary works', which in accordance with good practice (and industry consensus) should be designed to *BS 5975 Code of practice for temporary works procedures and the permissible stress design of falsework*. One of the key features of BS 5975 is that it requires checks to be made on temporary works designs. The value of such checks has been demonstrated by this report.

CIRIA Report C761: *Guide to tower crane foundation and tie design* further states that the design of all tower crane bases should be subject to an independent design check to at least Category 2 as per BS 5975. Clearly, for this to be effective, it must surely be the case that the design loadings passed by the tower crane supplier to the foundation designer must also be checked to this standard.

The Temporary Works Coordinator (TWC), as appointed under BS 5975, may consider it appropriate to assure themselves that appropriate

checking processes are in place for all parts of the temporary works design, including for any tower crane and its foundations. The proper coordination and control of temporary works, as would be undertaken by an experienced TWC, is fundamental in avoiding confusion and, with it, reducing the risk of something going wrong.

The Construction Plant-hire Association confirms in its Technical Information Note 031, *Managing the design, construction and inspection of tower crane bases, grillages, and ties*, that 'for a tower crane installation to be safe, it must be properly managed at all stages of its procurement and use, from initial planning during the pre-construction phase to removal from site'. Clearly, this requires the correct design loadings to be provided to the foundation designer and tower crane providers may benefit from checking as to how they ensure the correct loadings are communicated to foundation designers.

The design and detailing of crane bases is an area where designers should be vigilant. Poorly detailed bases may see conflicts between holding-down assemblies, base reinforcement and/or piles that require amendment on site. In such cases, it has been known for the site amendments to remove tension resistance. Tension loads and tension resistance are a fundamental part of the whole crane installation. In many cases, it will be good practice to integrate the crane base into the permanent foundations. Contractors should be mindful of the required tension capacity of crane bases.

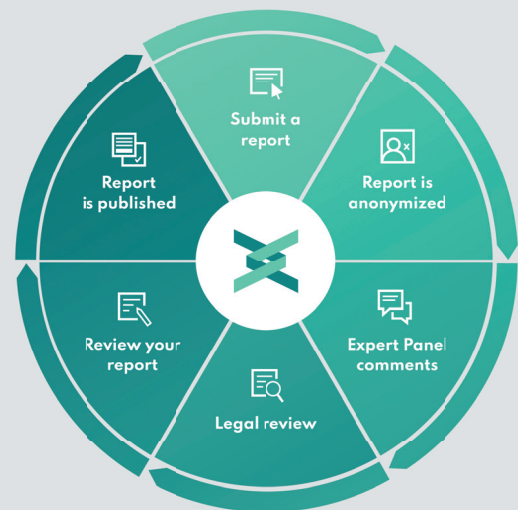
A previous CROSS report, *Tower crane foundation design error* (report ID: 662), described a case where incorrect foundation pile loadings were provided, albeit the error was made by the structural engineer and not the tower crane provider; nevertheless, this error again illustrates the need for all involved to validate tower crane foundation loads.

The full report, including links to guidance mentioned, is available on the CROSS website (report ID: 1093) at www.cross-safety.org/uk/safety-information/cross-safety-report/tower-crane-base-designs-1093.

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