Orca Offshore bv
Office
Lepelaarpark 35
1444 HR Purmerend
The Netherlands
Telephone
+31 (0)6 23180849
E-mail
info@orca-offshore.com
Internet
www.orca-offshore.com

TECHNICAL NOTE

To	: All crane users, designers and owners
Date	: 6 July 2016
From	: Herm Bussemaker (Senior Naval Architect)
Reference	: 153026.TN.001.R1

Project **: Crane barge stability using land based crane**

Subject **: Notification to Crane barge operators, owners and designers.**

Summary,

A recent accident investigation has revealed a normally unaccounted stability feature related to the flexibility or compliance of the used crane on a floating barge or ship. This stability feature is not described in any known rule, guideline or course material. The feature can have a strong reducing effect on the calculated stability which could be a tread to any lift system based on a land based crane on a barge, pontoon or ship.

The Incident

In Alphen aan den Rijn in the Netherland on August 2015 an accident happened with two telescopic land based mobile cranes performing a twin crane lift from two flat pontoons.

During the lift the barges developed a large and uncontrolled list which led to a progressive collapse and a complete fall over of the two cranes. The involved cranes were:

- Liebherr LTM 1400-1
- Terex AC700

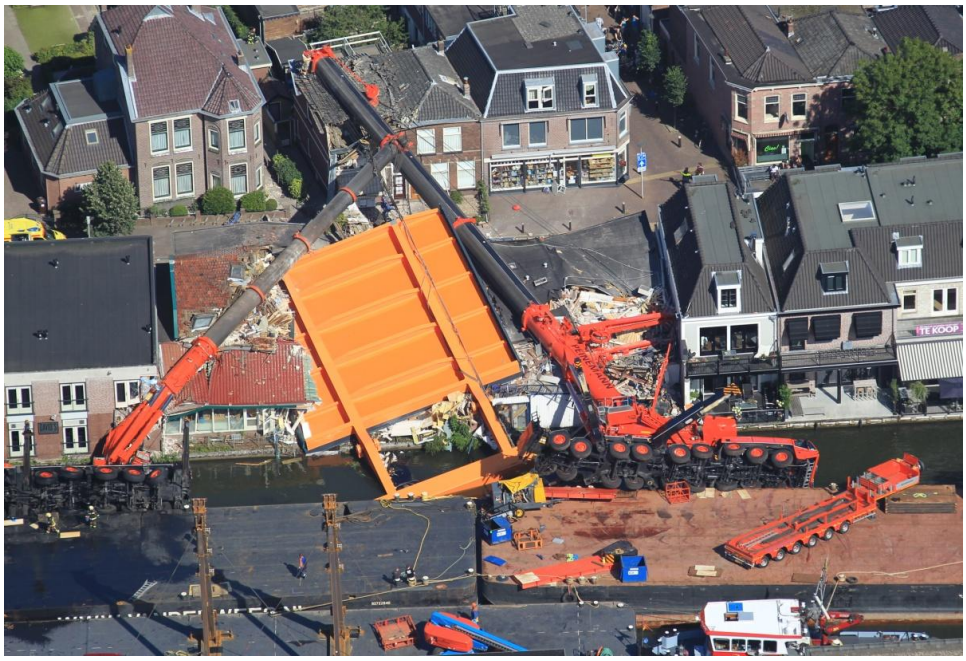

Figure 1 Situation after the accident (Source: Onderzoeksraad voor Veiligheid)

The accident investigation revealed that the cause of the accident was instability of one of the barges due to an unaccounted de-stabilising feature related to the used land based crane..

The Stability Issue

The general consensus to calculate stability of a crane barge combination is to assume that the lift load acts in the upper connection point of the lift arrangement generally referred to as the crane tip. This assumption is valid if the crane is infinitively stiff in all directions. Marine and offshore cranes are designed to accommodate a large side lead load which results in relative large stiffness in the side direction. Land based cranes are in general not designed for large side lead which results in a lot lower horizontal stiffness of the crane.

It has been found that the assumption that the lift load acts in the upper crane block is not valid if the crane is flexible in horizontal direction. The lift load actually acts in a virtual point above the upper block with a vertical offset distance related to the horizontal stiffness of the crane tip.

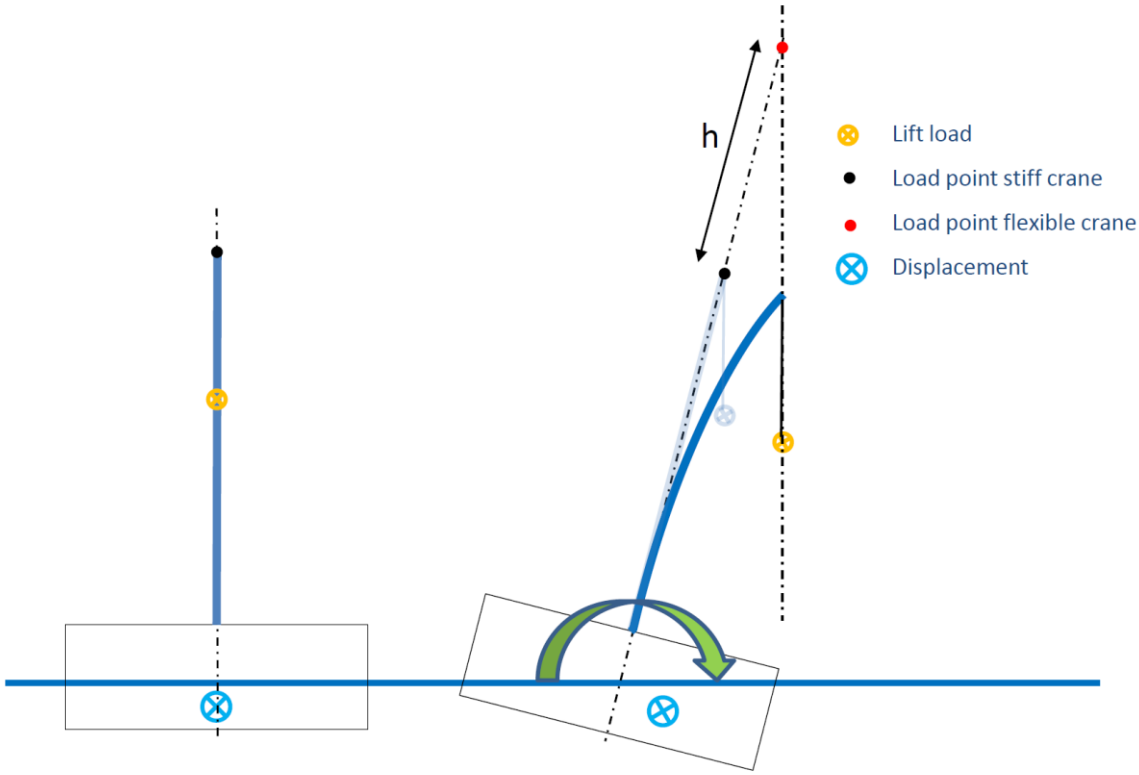

Figure 2 Diagram showing effect of flexible crane

Figure 2 shows a diagram explaining this effect. The diagram shows the deformation of the blue crane boom at a certain barge heel angle. As can be seen, the lift load attachment point has shifted due to the deflection of the boom. The lift load vector now crosses the crane centre line at the red dot which is at h meters above the black dot representing the lift load attachment point for an infinite stiff crane.

A simple formula has been derived which relates the vertical offset of the virtual lift attachment point from the crane tip to the crane tip stiffness as follows:

$$h = HL/k$$

with: h = vertical shift of centre of load (m)

HL = Hookload (kN)

k = Crane tip stiffness (kN/m)

The telescopic crane used for the subject lift showed a vertical shift of the lift attachment point of 12 meter while the height above the barge deck of the crane tip was around 36 m.

The barge stability with suspended load of a barge is normally addressed as the Metacentric height GM. This effect resulted in a GMt reduction of 0.8 m. The calculated GMt without the effect of the flexible crane was only 0.8 m so with the effect the actual GMt was zero.

Recommendation

- Without proper stiffness information of a land based crane it should be assumed that the lift load vertical centre of gravity as used for stability calculation is at least 30% of the crane boom height above the crane tip.
- For any critical lift using telescopic cranes on a pontoon or any other floating unit the stability reduction should be calculated using crane manufacturer supplied crane tip stiffness for the planned crane settings.
- In addition, it is recommended to study the white paper regarding this incident if a twin lift from one or more barges is being considered.

References

- "Hijsongeval Alphen aan de Rijn", Onderzoeksraad voor de veiligheid, juni 2016, available at www.onderzoeksraad.nl
- "Berekenen technische haalbaarheid en kwetsbaarheid", Orca Offshore, 15-06-2016, available at www.onderzoeksraad.nl
- "Technical investigation of an inshore accident with a twin crane lift arrangement from two barges", white paper by MSc H.B.Bussemaker, Orca Offshore bv, July 2016, available at www.orca-offshore.com, reference 153026.WP.001.