JULY 2015
www.craneworld.com
A KHL Group publication

INTERNATIONAL cranes AND SPECIALIZED TRANSPORT

Energy sector

Hydraulic gantries

Latin America

Legislation update

All terrains

S&RA
OFFICIAL MAGAZINE

THE MAGAZINE FOR EQUIPMENT USERS AND BUYERS

Craning a crane

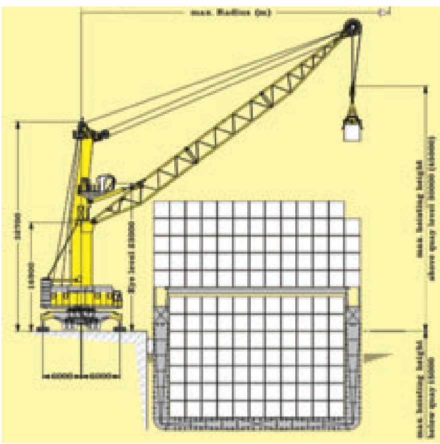
In a slight variation from the usual theme of our technical how-to series, this month MARCO VAN DAAL uses a case study to illustrate several of the principles and calculation methods explained in earlier articles

Aruba in the Dutch Caribbean is home to 100,000 inhabitants. It is a beautiful island, measuring only 20 x 6 miles (32 x 10 km), famous for its endless white beaches with many beach bars and restaurants. More than 200 cruise ships visit the island every year and bring thousands of passengers to visit. It is the arrival of these enormous cruise ships that played a major role in this article's case study.

When Aruba began to develop as a tourist destination it made sense to have the first cruise ships berth close to the already operational cargo port. Over time the number of cruise ships increased across the entire Caribbean and Aruba found itself competing for the business. As the number of ships and tourists increased, the activities of the cargo port also increased. A negative aspect of this was that at times there was not enough berth length available for multiple cruise and cargo vessels. Another was that the first impression for cruise ship tourists when they arrived was to see a cargo port in operation.

A possible move of the cargo port has been in the making for many years but in 2014 the final decisions were taken for this move. This case study only highlights a small part of the entire project. A project that is still underway at the time of writing this article.

FIGURE 1



ABOUT THE AUTHOR

Marco van Daal has been in the heavy lift and transport industry since 1993. He started at Mammoet Transport from the Netherlands and later with Fagioli PSC from Italy, both leading companies in the industry. His 20-year plus experience extends to five continents and more than 55 countries. It resulted in a book *The Art of Heavy Transport*, available at: www.khl-infostore.com/books Van Daal has a real passion for sharing knowledge and experience and holds seminars around the world.

Liebherr LHM 400

A mobile harbour crane, a Liebherr LHM 400, was to be transported from its current location, the Oranjestad Container Terminal, to its new location, the Barcadera Terminal – a distance of only 7 km.

The LHM 400, as with other harbour cranes, is designed for specific purposes. In this case it is the loading and unloading of container vessels with a rapid turn around time.

This type of crane is less suitable for carrying out "other lifts" although it is possible. The high boom hinge point means that it can still pick-up a fully loaded container from a vessel stacked 7 high and 13 containers wide. The operator's cabin is at 23 metres above ground level, designed to give the operator a full view of his work area even when containers are indeed stacked 7 high. See **FIGURE 1**.

FIGURE 2

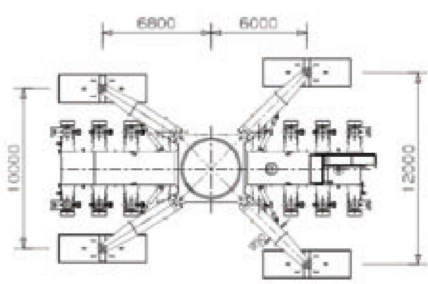


FIGURE 4

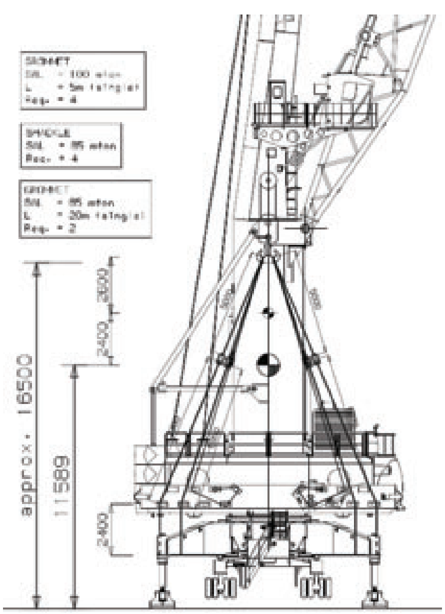
The outrigger base is 12 x 12 m while the overall length of the undercarriage is just over 23 m. The LHM 400 has 16 hydraulic axles, similar to the axles of hydraulic platform transporters, of which 6 axles are driven. Total weight of the crane in operation is 390 tonnes.

Feasibility

As the distance between origin and destination was only 7 km the first option that was investigated was to drive the crane to its new location. This option, however, was quickly removed from the table. The size and weight of the crane meant that it soon became clear that the Aruban infrastructure was unsuitable for such a transport. Even without the boom the LHM 400 still stands 32.7 m tall.

Moving the crane by barge was the second possibility reviewed. To move the crane in one piece, with boom and

FIGURE 3



Right: Biglift's *mv Tracer* at Oranjestad Container Terminal in Aruba prior to moving the Liebherr LHM 400 to its new location

One of two spreader beams used for the lifts

counterweights, a barge of at least 100 m was required. It may come as no surprise that barges of such size are not readily available in Aruba. Mobilisation of such equipment became cost prohibitive.

The option that was chosen was to divert a Heavy Lift vessel that was already (somewhat) in the area and have it lift the LHM 400 on board and discharge it the next day 7 km south of its origin.

Weather conditions

Aruba is known for its calm seas on the south side of the island and the Caribbean Sea between Aruba and Venezuela is the reason many tourists choose it. If it wasn't for the continuous blowing "trade winds", Aruba would be an unpleasant and very hot and humid place. The trade winds offer a chill factor that makes the weather feel comfortable. These trade winds, however, are also a challenge when it comes to lifting operations. For one reason or another, the trade winds are lower and more constant speed in the early hours of the day. After lunch they pick up and wind gusts become more frequent and more severe. It is therefore better to perform the loading and offloading in the morning.

Lift operation

The goal for this operation was to lift the entire LHM 400 and position it on board. The vessel performing the operation, BigLift's *mv Tracer*, has a forward crane on the starboard side and an aft crane on the port side, each with a capacity of 275 tonnes. Outreach limitations meant that the LHM 400 could not be lifted in its entirety. A number of counter weight slabs had to be removed to reduce the weight from 390 to 360 tonnes. With the counterweight slabs removed the LHM 400 was manoeuvred alongside the vessel with a clearance between the vessel and the rigging arrangement of less than 1 m (see **FIGURE 4**).

Prior to the lift the boom of the LHM 400 was set at an angle of 70 degrees as directed by manufacturer Liebherr, who played a critical role in this operation. As the LHM 400 was lifted off the ground, it became clear that that the machine was not entirely level, reason enough to set it back down and slightly alter the boom angle. This change made the machine lift perfectly level the second time around.

On completion of the lift, the LHM 400 was positioned on the vessel's deck but not in its final position. Once the rigging was disconnected, the LHM 400 was driven to its final location and the boom was lowered onto the deck. This was a recommendation from Liebherr. Although the 7 km voyage was considered a coastal voyage, Liebherr recommended to lower the boom down to the deck to avoid any dynamic forces from vessel movements.

At the destination the reverse operation was performed and the LHM was safely discharged. **FIGURE 6** shows the lift operation.

Rigging

The LHM 400 was raised in a tandem lift where both ship's cranes were used, one with a 275 tonne spreader beam and one with a 500 tonne spreader beam. As the smaller spreader has an effective length of 10 m, the outrigger base was required to be reduced from its regular 12 x 12 m to 10 x 13.6 m. See **FIGURE 2**.

Knowing that this is a tandem lift and knowing that the centre of gravity is at 11.5 m above ground level, the stability of the load during the lift becomes critical. **FIGURE 3** shows the rigging used on the side of the 275 tonne spreader beam.

As the outrigger beams are 1.8 m above ground level, the sling angle can be calculated:

Sling angle = arctan ((16,500 – 1,800 – 2,400) / 500) = 87 degrees.

The LHM 400 weighs 360 tonnes (after counter weight slabs have been removed), therefore each of the ship's cranes lifts 180 tonnes. This 180 tonnes is divided over the rigging on the left and right side of the spreader beam, taking into account the 87 degree sling angle, each side is exposed to (180 / 2) / sin 87 = 91 tonnes (rounded up). Each side of the rigging arrangement consisted of double slings with shackles. The bill of material as listed in **FIGURE 3** shows that the rigging capacity is more than sufficient.

FIGURE 3 also shows the centre of gravity of the crane, in fact it shows two centres of gravity, one slightly larger than the other. The larger one is the actual crane CoG. The smaller one takes into account the 2.4 m between the bottom of the outrigger beam and the trunnion on the spreader beam. Effectively this CoG is a measure for the stability of the load. Generally the lift triangle (from hook block to trunnion) is moved down by 2.4 m to the "pick points" of the lift (the bottom of the outrigger beams) to check the stability of the load. In this lift plan the CoG is moved up by the same distance. Both methods are equally correct. As the smaller CoG is still located within the lift triangle, this lift is considered a stable lift.

>

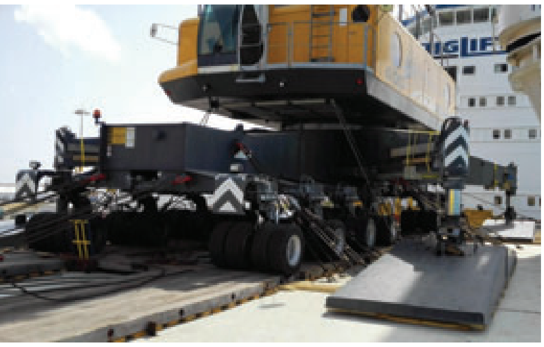


FIGURE 5

Sea fastening

Securing the load to the vessel is done to counter the acceleration forces encountered during a voyage. Acceleration forces are the result of a vessel's roll and pitch movements in a certain time. The shorter the time (the period) the higher the acceleration force. Even though this was a coastal voyage, the securing considerations have to be made. Based on the vessel's movements (roll and pitch calculations are outside the scope of this article but were determined in accordance with DNV rules) the following accelerations were determined.

$a_x = 1.55\ m/s^2$
$a_y = 4.92\ m/s^2$
$a_z = 11.56\ m/s^2$

Furthermore, the wind area of the crane's side (A_y) was established to be 300 m², the crane's front (A_x) 200 m².

Wind force (F_w) as per IMO is 0.10 tonnes per square metre (m²).

Once the crane was in position the remaining counterweight slabs were removed, herewith reducing the crane weight to 290 tonnes. The acceleration

FIGURE 6

forces are determined as per the calculation below:

$F_x = m * a_x = 290 * 1.55 = 449.5$ kN
or 45.8 tonnes
$F_y = m * a_y = 290 * 4.92 = 1{,}426.8$ kN
or 145.4 tonnes
$F_z = m * a_z = 290 * 11.56 = 3{,}352.4$ kN
or 431.7 tonnes

THE WIND FORCES ARE:
Fwx = Fw * Ax = 0.10 * 200 = 20.0 tonnes
Fwy = Fy * Ay = 0.10 * 300 = 30.0 tonnes

THE TOTAL FORCES ARE:
Fx = 45.8 + 20.0 = 65.8 tonnes
Fy = 145.4 + 30.0 = 175.4 tonnes
Fz = 431.7 tonnes

For the sea fastening, steel wires were used with a capacity of 10 tonnes. These wires are used double (total capacity 20 tonnes). In the longitudinal direction (X) the lashing angle with the deck is 30 degrees, in transverse direction (Y) this angle is 40 degrees.

LONGITUDINAL LASHING
= (65.8 tonne / cos 30) / 20 tonne
= 3.8 lashings - round up to 4 lashing
TRANSVERSE LASHING
= (175.4 tonne / cos 40) / 20 tonne
= 11.4 lashings - round up to 12 lashing
VERTICAL LASHING FORCE
= 4 lashings * 20 tonne * sin 30
+ 12 lashings * 20 tonne * sin 40
= 40 + 154.3 = 194.3 tonnes
TOTAL VERTICAL FORCE
= Vertical lashing force + Weight of LHM 400
= 194.3 + 290 = 484.3 tonnes
This is more than the required F_z = 431.7 tonnes

It can be concluded, therefore, that the lashing arrangement is adequate. See **FIGURE 5** for the lashing arrangement.

Parties involved

Recognition should be given to the following parties:

- ASTEC (Aruba Stevedoring company) as the owner of the LHM 400
- ALTUIS (Spain) as the contractor
- Liebherr as the manufacturer of the LHM 400
- BigLift as the shipping company

Things don't always get easier when multiple parties are involved in the execution of a project. This project was completed with co-operation and communication between the parties and without incidents, damage or lost time. ■

WORLD CRANE AND TRANSPORT SUMMIT 2015

www.khl.com/wcts

WHAT
Conference and networking dinner

WHERE
Hotel Krasnapolsky, Amsterdam, the Netherlands

WHEN
Wednesday 4 November:
Full day conference and networking gala dinner

Thursday 5 November:
Full day conference

SAVE THE DATE

4 AND 5 NOVEMBER 2015

AMSTERDAM THE NETHERLANDS

The key meeting place for users and buyers of cranes and transport equipment as well as manufacturers and distributors. The event regularly attracts audiences in excess of 250 people, from all over the world, including many of the largest crane and transport equipment owning companies.

GOLD SPONSORS

TEREX®
ZOOMLION

SILVER SPONSORS

LIEBHERR
Manitowoc
SCHEUERLE
NICOLAS
KAMAG
TADANO

SUPPORTING SPONSORS

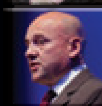
Goldhofer
HOOKCAM Europe
Compact Lifting Group
LSI Robway A Trimble Company
Modulift® working between the hook and the load
TSL Tech Safety Lines
WireCo WorldGroup

SUPPORTING ORGANISATIONS

ALATRANS
ASSOCIPESA
CCO
CICA
ESTA
SINDIPESA
SOBRATEMA
SC&RA Specialized Carriers & Rigging Association

CONFIRMED SPEAKERS

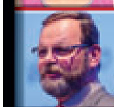
KEYNOTE SPEAKER:
Jan Kleijn
CEO, Mammoet Holding



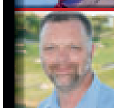
David Collett
Managing director, Collett & Sons Ltd & president, ESTA

Marco van Daal
Owner, The Works International

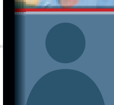
Judy Goh Zhu Di
Senior consultant, Matcor Technology & Services Pte Ltd



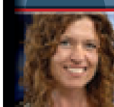
Ton Klijn
Managing director, Wagenborg Nedlift & board director, ESTA



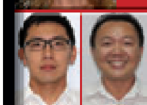
Mathias Rehe
Chief executive officer, Daco Heavy Lift



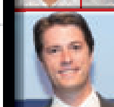
Norbert van Schaik
Project specialist transport/crane/installations, Siemens Wind Power



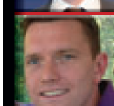
Natasja Sesink
Operational partner, BeOne Development



Vincent Teo & Steven Tan
Senior director & health and safety manager, Bok Seng Logistics



Alexandre-Jacques Vernazza
President, Mediaco



Chris Wilson
Senior project manager – decommissioning, Sellafield

SEE THE FULL LINE UP OF SPEAKERS AND ROUND TABLE PARTICIPANTS ON THE WEBSITE www.khl.com/wcts

CREATED AND ORGANISED BY

International Cranes and Specialized Transport
American Cranes & Transport ACT
khl