JUNE 2015
www.craneworld.com
A KHL Group publication

# INTERNATIONAL cranes AND SPECIALIZED TRANSPORT


SC&RA jobs of the year

Wind power transport

Prangl site report

Dockside lifting

ITC review

IC 50 CRANES

## The world's leading crane companies

S&RA
OFFICIAL MAGAZINE

THE MAGAZINE FOR EQUIPMENT USERS AND BUYERS

# Reference time

**This second anniversary article in The Knowledge series is a case study of how the reference card, as highlighted in last month's article, can save time and can help in case of field modifications. MARCO VAN DAAL reports**

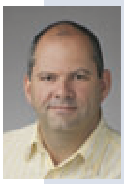

Vessel 1

For this example showing the benefits of the reference cards discussed last month we go to Ras Laffan in Qatar. This case study plays quite a while ago when Qatar was in the process of building multiple LNG plants. The situation as depicted below is applicable to construction sites around the world.

In our case ocean-going vessels carrying bulk as well as heavy and oversized cargo were arriving on a more or less continuous basis. The planning of these vessels (their ETA), the transport of the cargo and the logistics on the laydown area were of the utmost importance. Multiple contractors were carrying out their part of the construction scope and it required more than the usual effort to make it all go as planned.


Vessel 2

## 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.

In the midst of this huge project, we, the heavy transport and lifting company, performed only a small part of the actual activities, we had the smallest crew of personnel on site. However, our work, as is often the case with heavy transport and lifting, were major milestones on the planning as it usually meant that roads could be made available once we had crossed. Excavations could actually be dug once we were gone from an area. Likewise, as long as we occupied the area, either with transport equipment or because of the crane's footprint, this area was not available for any other construction activity.

It goes without saying that planning becomes crucial when multiple parties are waiting to enter an area or unit and the pressure builds up when things do not go according to plan.

This article highlights the transport of five large and critical vessels that were part of a shipment that contained much more cargo of a less critical nature.


Vessel 3

To make the discharge and transport process to laydown area as smooth as possible we had agreed on the discharge sequence and had chosen transport equipment configurations and combinations that would have the fewest time-consuming changes.

The road from the Ras Laffan port to the LNG plant was 10 km and specially built for (heavy) transport, this road was not accessible by the public.

The available axle lines for this transport were 8 x 6 axle lines plus 2 x 4 axle lines Cometto, total 56 axle lines.

In addition, there were 4 x 4 axle lines plus 1 x 8 axle lines of Scheuerle modular, total 24 axle lines.

Overall total axle lines were 56 plus 24 which equals 80 axle lines.

## Original sequence

### DAY 1

| | |
|---|---|
| Vessel 1 | 700 ton<br>double 12 axle line Cometto +<br>double 12 axle line Scheuerle<br>(24 + 24 = 48) |
| Vessel 2 | 400 ton<br>double 16 axle line Cometto (32) |

### DAY 2

| | |
|---|---|
| Vessel 3 | 300 ton<br>double 16 axle line Cometto (32) |
| Vessel 4 | 400 ton<br>double 16 axle line Cometto (32) |
| Vessel 5 | 325 ton<br>double 6 axle line Cometto and<br>double 8 axle line Scheuerle<br>(12 + 16 = 28) |

>


Vessel 4


Vessel 5

The original plan was to have the combinations for Vessel 1 and Vessel 2 ready for day 1. The double 16 axle line Cometto would continue on day two while the combination used for Vessel 1 was reconfigured for Vessel 5.

Then things changed. A seemingly small change with huge impact. The discharge sequence of Vessel 3 and Vessel 5 swapped.

## New sequence

DAY 1

Vessel 1 700 ton
double 12 axle line Cometto +
double 12 axle line Scheuerle
(24 + 24 = 48)

Vessel 2 400 ton
double 16 axle line Cometto (32)

DAY 2

Vessel 5 325 ton
double 6 axle line Cometto and
double 8 axle line Scheuerle
(12 + 16 = 28)

Vessel 4 400 ton
double 16 axle line Cometto (32)

Vessel 3 300 ton
double 16 axle line Cometto (32)

The combination for Vessel 5 (double 16 axles) could not be configured until the transport of Vessel 1 was completed. We only had one set of turntables. Consequently the Cometto double 16 axle for Vessel 3 and Vessel 4 was idle until the discharge of Vessel 5 was completed.

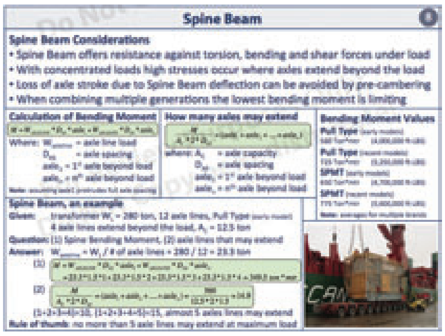
The chart below gives a graphical overview of the required configurations.

## How could the reference card have helped?

In situations like this a field change could have made things easier and could have resulted in less waiting time and fewer configuration changes. A qualified engineer, however, is not always available on site and communication with the engineering department, when under time pressure, is not always satisfactory or even possible.

## OVERVIEW OF THE REQUIRED CONFIGURATIONS

| | VESSEL 1 | VESSEL 2 | VESSEL 3 | VESSEL 4 | VESSEL 5 |
|---|---|---|---|---|---|
| Cometto 6 axle lines | X | | | | X |
| Cometto 6 axle lines | X | | | | X |
| Cometto 6 axle lines | X | | | | |
| Cometto 6 axle lines | X | | | | |
| Cometto 6 axle lines | | X | X | X | |
| Cometto 6 axle lines | | X | X | X | |
| Cometto 6 axle lines | | X | X | X | |
| Cometto 6 axle lines | | X | X | X | |
| Cometto 4 axle lines | | X | X | X | |
| Cometto 4 axle lines | | X | X | X | |
| | | | | | |
| Scheuerle 8 axle lines | X | | | | |
| Scheuerle 4 axle lines | X | | | | X |
| Scheuerle 4 axle lines | X | | | | X |
| Scheuerle 4 axle lines | X | | | | X |
| Scheuerle 4 axle lines | X | | | | X |
| Turntables | | | | | |
| TOTAL 80 AXLES | | | | | |



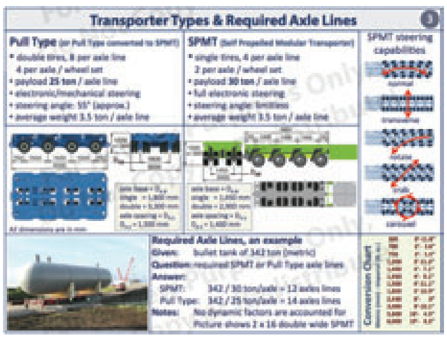
Panel 8

FOR VESSEL 5

Panel 8 could provide information that the combination for Vessel 1 (2 x double 12) could have been used for Vessel 5 without having to change it. Mostly the engineering studies base the transport combination on “minimum required number of axles”. These engineering studies are often created long in advance of knowing the shipping sequence, let alone the discharge sequence and often this recommended combination is followed blindly.

A consideration when using longer dolly combinations is the bending moment in the transporter due to the concentrated load from the turntable. Vessel 5 had a weight of 325 tonnes that was equally divided between the front and the rear

>



Panel 3

saddle. The transport beam and turntable combined weighed 15 tonnes each. Each transporter therefore carried a total weight of 177.5 tonnes.

In case of 2 x double 12 axle lines the axle line load ($W_{AXLELINE}$) would be 177.5 tonnes / 24 axle lines = 7.4 tonnes/ axle line. With the turntable having a diameter of 4.5 metres, 4 axle lines extend beyond the load spreading capacity of the turntable at each end. The axle spacing ($D_{AS}$) of a pull type transporter is 1.5 m (see Panel 3).

A simple calculation, as indicated on Panel 8, shows that the maximum bending moment in the transporter is as follows:

$$M = W_{AXLELINE}*D_{AS}*axle_1 + W_{AXLELINE}*D_{AS}*axle_2 + W_{AXLELINE}*D_{AS}*axle_3 + W_{AXLELINE}*D_{AS}*axle_4$$
$$M = 7.4 * 1.5 * 1 + 7.4 * 1.5 * 2 + 7.4 * 1.5 * 3 + 7.4 * 1.5 * 4$$
$$M = 111 \text{ tonne*metre}$$

Panel 8 shows that this bending moment is well within the limits of even the older types of transporters.

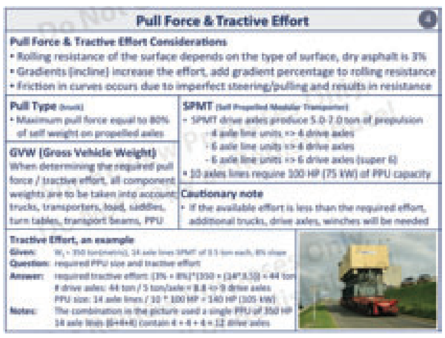
Another consideration for using a longer dolly combination is the possibility of this combination physically not fitting underneath Vessel 5 as the individual transporters would touch each other. This is a matter of simply measuring the saddle distances and comparing that to the transporter lengths. In addition, the longer front dolly would have avoided the need to remove the rear ballast box, as shown on the picture. This would have saved additional time.

As the configuration has changed, a quick check on the required pull force needs to be carried out. Panel 3 and 4 of the reference card lead the way. The GVW of this new combination is now as follows:

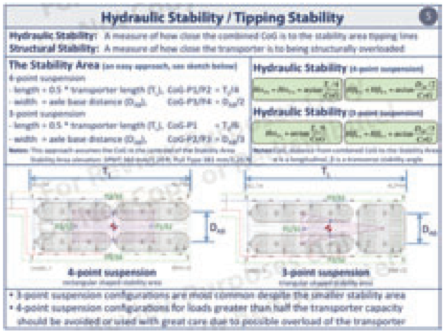
GVW = (24*2 axle lines) * 3.5 tonnes/ axle line + 325 tonnes (vessel) + 2 * 15 tonnes (turntable) + 50 tonnes (truck) = 573 tonnes.

With a rolling resistance of 3 % for dry asphalt the required pull force is 573 * 0.03 = 17.1 tonnes.

The truck in the picture is an MAN 8 x 8 tractor with a 50 tonne weight.




Panel 4




Panel 5

Generally a truck can pull 80 % of its self weight on the driven axles. As this truck has all axles driven, it can generate 0.8 * 50 tonne = 40 tonnes of pull force which is more than enough to pull this transport.

### FOR VESSEL 3

With the new discharge sequence, Vessel 3 is the last vessel to be discharged and, with its 300 tonnes, also the lightest vessel. Now that Vessel 1 and Vessel 5 have both been transported on 2 x double 12 axle line combinations it deserved recommendation to check if Vessel 3 could be transported on a double 12 axle line combination instead of a double 16 axle line combination as originally planned.

As it turned out, the saddle distance was only 7.5 m which made it physically fit on a double 12 axle line combination.

With the smaller and-or shorter transport combination the hydraulic stability (sometimes called tipping stability) and the structural stability (sometimes called the structural capacity) need to be checked as the combined centre of gravity is now different. Panels 3, 5 and 6 offer the easy formulas to determine the required stability angles.

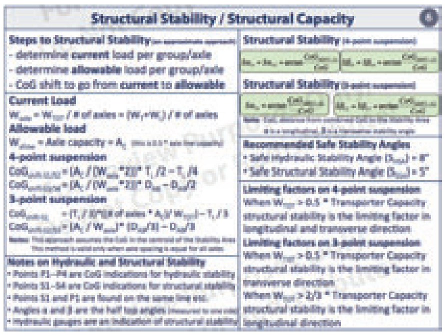
Knowing that Vessel 3 has a diameter of 7 m, its CoG is 4 m above the transporter deck (including transport beams).

The combined CoG of Vessel 3 and double 12 axle line transporter is 4.5 m. The chosen configuration would be a 3-point suspension with 8 axle lines per suspension group. The axle base ($D_{AB}$) of a double wide pull type transporter is 3.3 m (see Panel 3). With this information the transverse hydraulic stability can be determined, see Panel 5.

$$\text{Hydr. Trans.Stab} = \arctan((D_{AB} / 3) / CoG) = \arctan((3.3 / 3) / 4.5) = 13.7 \text{ degrees}.$$

As per Panel 6 the minimum recommended safe hydraulic stability angle is 8 degrees, the 12 axle line combination is safe to use.

Note: this quick check assumes the Stability Area to be at grade. In reality it is at half the axle height which would result in a larger stability angle. The reference card builds in a safety buffer.




Panel 6

As per Panel 3 the payload/capacity ($A_C$) of a pull type axle line is 25 tonnes or 12.5 tonnes / axle.

The total axle load as per Panel 6 is:

$$W_{AXLE} = (W_{TRANSPORTER}+W_{LOAD}) / \text{\# of axles (note: \# of axles} = 2 * \text{\# of axle lines)}$$
$$W_{AXLE} = (12*2*3.5 + 300) / (12 * 2 * 2)$$
$$W_{AXLE} = 8 \text{ tonnes / axle}$$

With this information the transverse structural stability can be determined, see Panel 6.

This is done in two steps.

Step 1 (determine the transverse horizontal CoG shift that would cause an axle overload)

$$COG_{SHIFT-S2/S3} = (A_C / W_{AXLE}) * (D_{AB} / 3) - D_{AB}/3$$
$$COG_{SHIFT-S2/S3} = (12.5 / 8) * (3.3 / 3) - (3.3 / 3)$$
$$COG_{SHIFT-S2/S3} = 0.62 \text{ metre}$$

Step 2 (determine the angle that caused the transverse horizontal shift)

$$\text{Struc. Trans.Stab} = \arctan((COG_{SHIFT-S2/S3} / CoG) = \arctan(0.62 / 4.5) = 7.8 \text{ degrees}.$$

As per Panel 6 the minimum recommended safe structural stability angle is 5 degrees, the 12 axle line combination is safe to use.

In this case study the Panels 3, 4, 5, 6 and 8 have provided information to make a justified site decision and transport Vessel 3 and Vessel 5 on different combination than originally intended. Herewith greatly simplifying the transport process and saving time in the execution by minimising the number of transport combination changes.

Note that the reference card is not meant to perform a complete engineering study, it is a reference card for quick (field) checks if the transport parameters are within the limits. When the outcome of these quick (field) checks are "too close for comfort" a qualified engineer needs to get involved.

This reference card is available at www.store.iti.com ■