Lifting: where two is better than one

In the previous article in this series, Richard Krabbendam discussed the lifting with two cranes of horizontal pressure vessels or beams. He continues with the discussion of erecting a pressure vessel from the horizontal position into the vertical by means of one main lift crane and a tail crane.

The specific points that should be considered and can be advantageous to the lifting contractor include:
- Decreasing tail load due to offset of tail lift point,
- Position of tail crane,
- Capacity of tail crane,
- Type of tail crane – for instance crawler crane or truck crane,
- Type and capacity of main lift crane (crawler or truck crane),
- Position and type of lifting points (lifting lugs or lifting trunnions).

Figure 1 shows a pressure vessel of 150 tonnes in weight and an overall length of approximately 36.6 m. The lifting point A at the base ring (skirt) of the vessel is positioned three metres above the centre line of the vessel.

Case study

Let us look at the plot plan of the foundation on which the pressure vessel must be erected. The foundation is a concrete plinth at ground level and we assume there is ample room to position the main lift crane and tail crane. In order to prepare the most competitive bid, the rigging engineer should study the most economic erection method. It should be noted that there are a lot more
**SPOTCHECK SAFETY**

![Diagram](image)

**TABLE 1**

<table>
<thead>
<tr>
<th>Load variation</th>
<th>0°</th>
<th>15°</th>
<th>30°</th>
<th>45°</th>
<th>60°</th>
<th>70°</th>
<th>80°</th>
<th>85°</th>
<th>90°</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lift crane 'B'</td>
<td>67.6 t</td>
<td>71.3 t</td>
<td>73.9 t</td>
<td>77.9 t</td>
<td>82.8 t</td>
<td>93.8 t</td>
<td>107.5 t</td>
<td>150 t</td>
<td></td>
</tr>
<tr>
<td>Tail crane 'A'</td>
<td>82.4 t</td>
<td>80.6 t</td>
<td>78.7 t</td>
<td>76.1 t</td>
<td>72.1 t</td>
<td>67.2 t</td>
<td>56.2 t</td>
<td>42.5 t</td>
<td>0.0 t</td>
</tr>
</tbody>
</table>

**Case study**

Let us get back to our case study. It is the task of the rigging engineer to select the most economic cranes and positions of both cranes. We have already decided that the main lift crane ('B') will be a truck crane. For the 150 tonne pressure vessel, a 1,200-tonne capacity telescopic crane with a guided main boom will be sufficient (e.g the Liebherr LTM11200 with Spanlift attachment could do the job). With a boom length of 47.5 m and guided main boom, the crane has a rated lifting capacity of 196 tonnes at 12 m radius, which is more than sufficient to carry out the lift. However, you still need to add the weight of the main lift block and rigging gear to the load.

The selection of the tail crane is a bit more complex. For tailing work, one usually selects a crawler crane that can travel towards the main crane during the erection procedure. When a crawler crane is selected, the main consideration is the required lifting capacity at minimum boom length and a good travel path for the crane. If a truck crane is selected, the lifting capacity of the tailing truck crane greatly depends on the position of the tail crane in relation to the main lift crane.

By selecting the most economic position of lifting lugs and main lift crane, as well as tail crane, one can greatly influence the overall rigging cost for a particular pressure vessel. For example some possible crane positions are shown in Figure 2:

- Behind the vessel's base ring (the same position as tailing crawler crane).
- Both cranes at the side of the vessel are as close as possible to each other.

The best position for the tail crane is selected by calculating the decrease of the tail load when the vessel is lifted from horizontal into vertical position. This tail load decrease is caused by the offset of the tail point in relation to the centre line of the column. By means of a mathematical formula one can calculate the decrease of tail load in relation to the angle with the horizontal, when the vessel is erected from a horizontal into a vertical position. If we calculate the tail load and main lift load in relation to the angle of the vessel's centre line with the horizontal, one gets results as tabulated in Table 1.

As can be seen from Table 1, the decrease in tail load becomes significant when the vessel reaches an angle of approximately 70° with the horizontal. This tail load decrease can be used to our advantage and in some cases could lead to a smaller tail crane compared with the one originally selected.

When the main lift crane and tail crane are as configured in position one of Figure 2, then crane 'A' as well as crane 'B' needs to luff out.

![Diagram](image)

**TABLE 2**

<table>
<thead>
<tr>
<th>Load variation</th>
<th>0°</th>
<th>15°</th>
<th>30°</th>
<th>45°</th>
<th>60°</th>
<th>70°</th>
<th>80°</th>
<th>85°</th>
<th>90°</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lift crane 'B'</td>
<td>119.6 t</td>
<td>120.7 t</td>
<td>121.9 t</td>
<td>123.4 t</td>
<td>125.7 t</td>
<td>128.2 t</td>
<td>133.3 t</td>
<td>138.5 t</td>
<td>150 t</td>
</tr>
<tr>
<td>Tail crane 'A'</td>
<td>30.4 t</td>
<td>29.3 t</td>
<td>28.1 t</td>
<td>26.6 t</td>
<td>24.3 t</td>
<td>21.8 t</td>
<td>16.7 t</td>
<td>11.5 t</td>
<td>0.0 t</td>
</tr>
</tbody>
</table>

72 January/February 2013  www.heavyliftpfi.com
much more – as shown in position two of Figure 2. Even position two is not the best position with regards to crane capacity.

**Better main lifting lugs position**

A more significant reduction in tail load (thus crane capacity) can be achieved by a change of position of the main lifting lugs. The shape of this pressure vessel makes it relatively easy to install the main lifting lugs in the conical shaped transition zone approximately 4.2 m above the CoG. See Figure 3.

Position one is not the ideal location for both cranes. When both cranes are placed as shown in position two, one gets the best results. The optimal position can be established by comparing the crane capacity charts and decrease in tail load.

Due to the position of the main lifting lugs we greatly reduce the tail load and therefore the capacity of the tail crane. The capacity of the main lift crane remains the same as the total weight of the pressure vessel does not change. In case the offset of the tail point is increased, the decrease in tail load during erection will be greater as well.

With main lifting lugs only 4.2 m above the CoG, the change in tail load and main lift load during the erection procedure are as tabulated in Table 2.

Instead of the required 200-tonne capacity telescopic crane (such as a Liebherr LTM-1200) for tailing, one can now do the job with a 70-tonne telescopic crane such as a Krupp KMK 4070, with significant cost reductions in mobilisation and demobilisation costs, as well as rental costs.

It should be emphasised that lifting jobs, as described, allow a very small margin of error and can only be carried out under expert supervision and with detailed load calculations and rigging studies. At all times the lifting blocks should remain exactly above the lifting points – and do not forget to check the verticality of the lifting tackle.

The case study described is just an example of how a lifting lug and tail lifting lugs can influence the positions and sizes of the cranes needed to execute the job. The same principles can be used for larger and longer columns.

In the next issue of HLPFI, we will look at important points when lifting a heavy pressure vessel in the 400 to 500-tonne range, with two main lift cranes and one tail crane. HLPFI

*Please note, this article is intended for guidance only. Whilst every care has been taken to ensure the accuracy of the contents, no responsibility will be accepted by the publishers for any errors.*

Richard Krobbendam has been a heavy lift specialist during his whole working career after which he formed Krobbendam Advies Service. A Master of Mechanical Engineering from Delft University of Technology, he has worked with BigLift and Mammoet, and was a co-founder of IITREC. He helped to set up Jumbo Offshore and was involved in the development of its super heavy lift carrier fleet, the J-Class, which uses two 900-tonne mast cranes for subsea installation works. Since his retirement from Jumbo he has been working as a freelance trainer/engineering consultant.