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Spreader bars and lift beams in practice

For this, the second article on spreader beams, MARCO VAN DAAL presents a rigging case study on some of the figures that are shown in last month's article

FIGURE 1

Feedback on the first spreader beam article, published last month, suggested that a rigging case study would be beneficial in further explaining the principles discussed.

The first lift, see Figure 1, concerns a 185 metric ton (407,500 pound) vessel with an approximate length of 65 metres (213 feet). This article will show how certain decisions led to the chosen crane configurations and why. For the sake of completeness I mention here that this vessel was transported from the fabrication yard to site (both in Dubai, United Arab Emirates) on a dolly configuration of 2 x 12 Cometto self propelled axle lines with turntables. The road was not particularly long but it was a road with many turns and a number of roundabouts which made it an extremely slow moving transport. The site was a grass roots site and this vessel was one of the first vessels to be erected.

The centre of gravity (CoG) of this vessel was some 10 m below the centre line and, therefore, at the initial pick off the transporters, the head lugs carried the following:

FIGURE 2

EQUATION 1

$$Load_{HEAD} = \frac{Dist_{TAIL}}{Dist_{HEAD} + Dist_{TAIL}} * W_{VESSEL} = \frac{74}{139+74} * 185 = 64\ ton \text{ or } 141{,}000 \text{ LBS}$$

And the tail lug carried the following: (See also Figure 3)

EQUATION 2

$$Load_{TAIL} = \frac{Dist_{HEAD}}{Dist_{HEAD} + Dist_{TAIL}} * W_{VESSEL} = \frac{139}{139+74} * 185 = 121\ ton \text{ or } 266{,}500 \text{ LBS}$$

The main lift crane was a Demag CC 2400 lattice boom crawler with superlift attachment. As we know from last month's article the tail arrangement consisted of two Manitowoc 4000 crawlers with a lift beam. Figure 2 shows the entire lift arrangement with both the main lift crane and the two tailing cranes. For the tail crane arrangement, both Manitowoc 4000s were rigged with the shortest possible boom of 70 feet (21.3 m). Figure 4 shows the outline dimensions of a >

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 esteemed companies and leading authorities 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.com/books/the-art-of-heavy-transport/

Van Daal has a real passion for sharing knowledge and experience – the primary reason for the seminars that he frequently holds around the world. He lives in Aruba, in the Dutch Caribbean.

FIGURE 3

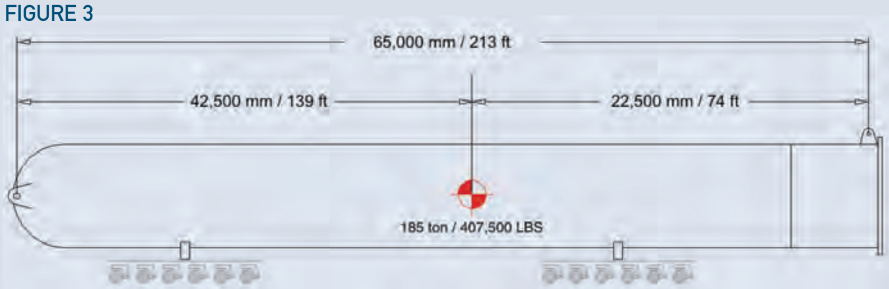


FIGURE 4

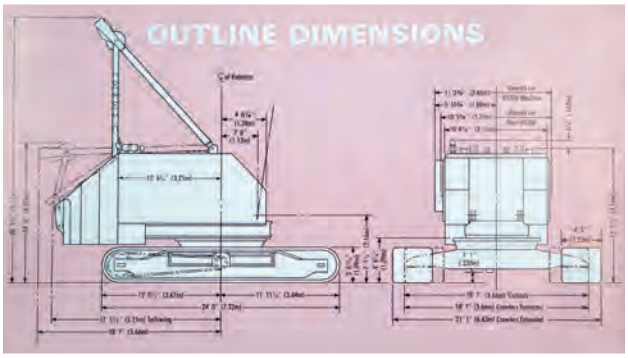
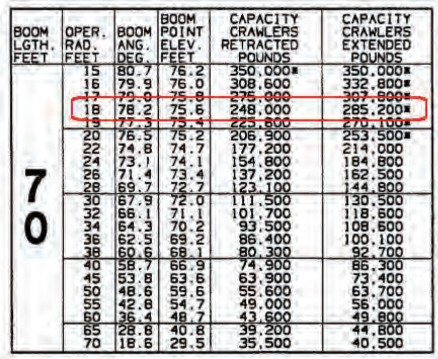


FIGURE 5



BOOM LGTH. FEET	OPER. RAD. FEET	BOOM ANG. DEG.	BOOM POINT ELEV. FEET	CAPACITY CRAWLERS RETRACTED POUNDS	CAPACITY CRAWLERS EXTENDED POUNDS
70	15	80.7	76.2	350,000■	350,000■
	16	79.9	76.0	308,600	332,800■
	17	79.0	75.8	275,000	307,800■
	18	78.2	75.6	248,000	285,200■
	19	77.3	75.4	225,800	270,100■
	20	76.5	75.2	206,900	253,500■
	22	74.8	74.7	177,200	214,000
	24	73.1	74.1	154,800	184,800
	26	71.4	73.4	137,200	162,500
	28	69.7	72.7	123,100	144,800
	30	67.9	72.0	111,500	130,500
	32	66.1	71.1	101,700	118,600
	34	64.3	70.2	93,500	108,600
	36	62.5	69.2	86,400	100,100
	38	60.6	68.1	80,300	92,700
	40	58.7	66.9	74,900	86,300
	45	53.8	63.6	63,900	73,400
	50	48.6	59.6	55,600	63,700
	55	42.8	54.7	49,000	56,000
	60	36.4	48.7	43,600	49,800
	65	28.8	40.8	39,200	44,800
	70	18.6	29.5	35,500	40,500

Manitowoc 4000 and in this outline we can see that the minimum radius, from centre of rotation to the end of the crawlers, is almost 12 feet (3.65 m). To allow for some degree of motion or swinging during the initial lift and the tailing or walking operation, a 6 foot (1.8 m) gap between the crane and the vessel skirt was allowed for. This brought the total radius to 12 + 6 = 18 feet.

The Manitowoc 4000 chart in Figure 5 indicates a capacity of 285,200 pounds (129 tonnes) at 18 feet (5.5 m) radius with fully extended crawlers. This does not include the weight of the hook block and rigging.

Vessel	266,500 pounds
Hook block	4,900 pounds
Rigging	1,500 pounds
Total	272,900 pounds

This is at 96 % of the chart and does not yet include an allowance for dynamic impact during the walk of the tailing operation. The Manitowoc 4000 does not walk as smoothly as modern crawler cranes so dynamic impact is definitely a factor to reckon with.

The call was made that this was too close for comfort and as there was an additional Manitowoc 4000 at our disposal, not too far from the lift site, so this second crane was mobilised for the tailing part of the lift.

The load per crane now became as follows:

Vessel	133,250 pounds
Hook block	4,900 pounds
Rigging	1,500 pounds
Total	139,650 pounds

This is at 49 % of the load chart and was deemed a better solution than a single tail crane. The distance that both the tail cranes had to walk was approximately the length of the vessel or, roughly, 200 feet. A travel path was prepared for the tail cranes.

Main crane arrangement

Once fully vertical, the entire weight of the vessel (185 metric ton / 407,500 pounds) is suspended in the hook block of the CC 2400. Figure 6 shows the chart of this 236 foot boom (72 m) with superlift configuration. With the hook block weighing 14,110 pounds (6.4 tonnes) and the rigging estimated at 10,000 pounds (4.5 tonnes), the capacities inside the red box are all sufficient to execute this lift. In reality the radius never exceeded 59 feet (18 m) and this was for a very specific reason.

MAIN CRANE LOAD

Vessel	407,500 pounds
Hook block	14,110 pounds
Rigging	10,000 pounds
Total	431,610 pounds

With the vessel being 213 feet (65 m) long there was a risk of running out of lifting height (boom point elevation) if the radius would pass 60 feet (18 m). The crane was positioned in such a way that the vessel could be set at 59 feet radius. A longer boom, 275 feet (84 m), was initially considered but the reduction in capacity made this not a feasible option. A shorter radius was also considered. There was not much margin for error or unforeseen. At the set radius of 59 feet (18 m) the crane capacity is 480,600 pounds (218 tonnes); this lift is at 89 % of the load chart.

The capacity of the crane was less worrisome than the available lift height. To create some additional margin and to ensure sufficient lift height, a civil contractor was brought in to create a crane pad that was elevated by 3 feet. On top of the crane pad, 1 foot thick crane mats were placed. This created an additional lift height of 4 feet (1.2 m).

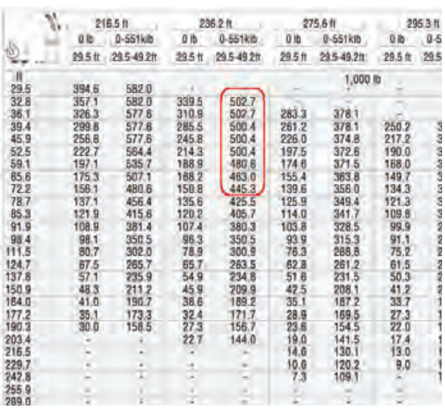
All dimensions and radii were laid out in such a way that the CC 2400 never had to travel an inch, it remained stationary.

Once the vessel touched down on the foundation, the superlift tray sits down on the ground behind the crane as well. The engineering study and lift plan brought the critical point to light so that the appropriate mitigating action could be taken.

The lift was well orchestrated and execution, despite the challenges, went smoothly. See Figure 7. ■

NOTE: Every effort is made to ensure the accuracy of the contents of these articles. If you find any mistakes, a brief notification and explanation would be appreciated.

FIGURE 6



	216.5 ft		236.2 ft		275.6 ft		295.3 ft	
	0 lb	0-551klb	0 lb	0-551klb	0 lb	0-551klb	0 lb	0-5
ft	29.5 ft	29.5-49.2ft	29.5 ft	29.5-49.2ft	29.5 ft	29.5-49.2ft	29.5 ft	29.5
						1,000 lb		
29.5	394.6	582.0	-		-	-	-	
32.8	357.1	582.0	339.5	502.7	-	-	-	
36.1	326.3	577.6	310.9	502.7	283.3	378.1	-	
39.4	299.8	577.6	285.5	500.4	261.2	378.1	250.2	3
45.9	256.8	577.6	245.8	500.4	226.0	374.8	217.2	3
52.5	222.7	564.4	214.3	500.4	197.5	372.6	190.0	3
59.1	197.1	535.7	188.9	480.6	174.6	371.5	168.0	3
65.6	175.3	507.1	168.2	463.0	155.4	363.8	149.7	3
72.2	156.1	480.6	150.8	445.3	139.6	356.0	134.3	3
78.7	137.1	456.4	135.6	425.5	125.9	349.4	121.3	3
85.3	121.9	415.6	120.2	405.7	114.0	341.7	109.8	3
91.9	108.9	381.4	107.4	380.3	103.8	328.5	99.9	2
98.4	98.1	350.5	96.3	350.5	93.9	315.3	91.1	2
111.5	80.7	302.0	78.9	300.9	76.3	288.8	75.2	2
124.7	67.5	265.7	65.7	263.5	62.8	261.2	61.5	2
137.8	57.1	235.9	54.9	234.8	51.6	231.5	50.3	2
150.9	48.3	211.2	45.9	209.9	42.5	208.1	41.2	2
164.0	41.0	190.7	38.6	189.2	35.1	187.2	33.7	1
177.2	35.1	173.3	32.4	171.7	28.9	169.5	27.3	1
190.3	30.0	158.5	27.3	156.7	23.6	154.5	22.0	1
203.4	-	-	22.7	144.0	19.0	141.5	17.4	1
216.5	-	-	-	-	14.6	130.1	13.0	1
229.7	-	-	-	-	10.6	120.2	9.0	1
242.8	-	-	-	-	7.3	109.1	-	1
255.9	-	-	-	-	-	-	-	
269.0	-	-	-	-	-	-	-	

FIGURE 7