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IC Tower Index

IHI towers

On site with Comansa

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Cranes, a bit of history

In the third article in our new how-to series, MARCO VAN DAAL turns his attention from transport to cranes with a historical perspective on developments in the lifting industry

Looking at today's cranes – computerised complex machines – it is hard to imagine that they have been around for two thousand or more years. It is unknown when the first crane-like machines were used as no documentation from that far back has been found but, looking at certain structures built by, for example, the Romans and Greeks have led scientists and archeologists to believe that some type of lifting mechanism was used.

Initially two types of lifting device could be differentiated. One was a system consisting of two masts (or poles) with a cross beam (gantry beam), on which the load was suspended. The other system was a tilted mast over the load where luffing the mast enabled positioning of the load. Later designs added the possibility of slewing the load. By this time it was already around the 1400 to 1500 era.

Although they are no less significant, this article does not cover gantry type cranes.

In the early 1800s the first commercial crane-like machines were built. Most had excavator shovels and were steam powered because the internal combustion engine did not make its introduction in the crane world for another century.

In the first half of the 20th Century the crane industry evolved relatively slowly. World War II, however, sparked the industry and major leaps were achieved. (See the table opposite).

If this trend is put in a chart we can see the, more or less, steady incline in crane capacity from the manufacturers. In the last two decades, however, a development is taking place where the crane owners are taking the lead in a demand for and manufacturing of higher capacity machines.

Selection process

The development brought with it a potential clash in terminology and the way that crane capacities are interpreted. Crane capacities are expressed in US tons or (metric) tonnes. A 500 tonne crane is bigger and has more capacity than a 250 tonne crane. They are two different category machines. Few 250 tonne cranes, however, can actually lift 250 tonnes at a practical radius because often the outriggers, crawlers or ring is physically in the way of performing such a lift. So the question then becomes, if a 250 tonne load is to be lifted at a certain radius would the crane analysis (selection of the right equipment) start with the 250 tonne machine or with the bigger 500 tonne machine. This largely depends on the radius but it can be stated with fair certainty that the 250 tonne machine will not be able to perform this lift. Therefore, as the planner of a lift, one would not

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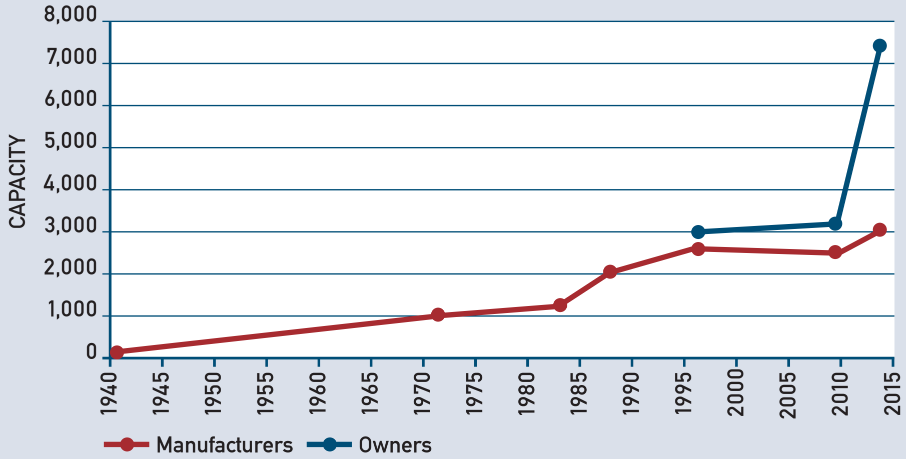
CRANE CAPACITY OVERVIEW

1941	Manitowoc 3900	103.5 tonne	crawler crane
1971	Coles Colossus 6000	225.0 tonne	truck crane
1979	Italgru TGN 5300	300.0 tonne	ring crane
1971	Bohne K10000 (by Demag)	1,000 tonne	truck crane
1982	Gottwald AK 1200	1,200 tonne	crawler crane
1987	Demag CC 12600	2,000 tonne	crawler crane
1995	Lampson LTL-2600	2,600 tonne	crawler crane
2008	Demag CC 8800-Twin	3,200 tonne	crawler crane
2009	Manitowoc 31000	2,300 tonne	crawler crane
2012	Liebherr LR 13000	3,000 tonne	crawler crane
1997	MSG 50 (Mammoet)	3,000 tonne 50,000 tonne-metres	ring crane
2009	AL.SK190 (ALE)	4,300 tonne 190,000 tonne-metres	ring crane
2012	SGC 120 (Sarens)	3,200 tonne 120,000 tonne-metres	ring crane
2012	PTC 200DS (Mammoet)	3,200 tonne 200,000 tonne-metres	ring crane
2011	125D ARFD (Bigge)	7,500 tonne	ring crane

NOTE: This list is not exhaustive.



necessarily be looking for a certain capacity machine but more for a machine with a certain capacity at a given radius. Knowing this, the capacity alone becomes much less important during the planning stage than the capacity of a machine given a certain radius. This introduces a challenge, though, as it is much easier to analyse a crane capacity than is to analyse a crane capacity at a certain radius, especially because this capacity changes with every change in radius.

To avoid that a multitude of charts have to be reviewed, which is a time consuming exercise, so we can make use of a crane chart overview. Such a chart provides a basic indication of what capacity crane is required to perform a certain lift. Crane chart overviews are often separated in hydraulic cranes and lattice boom cranes.

EXAMPLE 1: A jobsite requires an hydraulic crane that needs to make three lifts: 80 tonnes at 10 metres, 10 tonnes at 20 metres and 10 tonnes at 7 metres.

According to the hydraulic crane chart overview the first lift can be performed with a 250 tonne type crane, the second lift can be performed with a 120 tonne type crane and the last lift requires a 35 tonne type machine. In summary, all three lifts could be performed with a 250 tonne type machine. With this knowledge the search for the actual machine that can be planned for this job becomes much easier.


The 125D AFRD from Bigge

Note that the hydraulic crane chart overview does not specify boom length or boom angle or obstructions in the lift path or the use of additional counterweight or a jib, etc. It provides the user with an order of magnitude of the required crane capacity.


Mammoet MSG 50

Radius

The radius of a lift is generally measured from the centre of rotation to the centre of the hook block of the crane. The centre of rotation is (often) the centre of the slew ring. This definition is true for all hydraulic cranes and crawler cranes. The lines started blurring with the introduction of the ring attachment. The radius can now be measured from the centre of the ring or from the edge of the ring. Common sense would indicate that the radius would have to be measured from the centre of rotation but things are not all that straight forward. If the radius of a ring type crane is measured from the centre of the ring (for this example the ring diameter is 10 m),

ALE AL.SK190

the radius would be increased by 5 m as the boom from where the lift takes place sits on the ring. This creates the illusion that the crane is stronger than it is. In addition, a larger ring diameter (with the rest of the crane components remaining equal) would result in a larger radius and could wrongly lead someone to believe that the crane has increased in capacity.

But even when the radius is measured from the edge of the ring, how do we handle twin-ring cranes? Mammoet, Sarens, Bigge and ALE (to name a few) have all designed and built cranes that have an inner and an outer ring. It requires knowledge of those cranes to compare and select the right one for the job.

Here is where the load moment makes its introduction. The load moment does away with centre of rotation and twin-ring confusion. (The load moment is expressed in tonne-metres). It is determined by multiplying the maximum capacity by the distance from the boom butt hinge point to the hook block (or strand jack anchor), where that maximum is measured.

The load moment also does not discriminate between a ring-shaped track or a straight track, a full ring or a partial ring (see figure) and whether the counterweight sits on the opposite site of the ring or is positioned in the middle of the ring or maybe even anchored to the ground (see figure).

Balancing forces

Counterweight is used to keep the crane in balance during a lift. Smart use of counterweight can increase the capacity of a crane in certain cases. The application of super lift counterweight increases the capacity of a crane without having to mobilise or invest in a larger machine. The application of super lift counterweight, however, does not necessarily mean that a 500 tonne crane can now lift 700 tonnes. It is mostly an increase in capacity at larger radii. The boom of a crane is exposed to the highest compression load in a near vertical position. It is calculated and engineered to take a maximum load in that configuration. As the radius increases, the angle of the boom with vertical increases as well and the compression forces in the boom gradually decrease. By adding super lift counterweight, heavier loads can be lifted at larger radii, herewith increasing the compression force in the boom to a value closer to what it was engineered for. This can make a 500 tonne crane behave like a 700 tonne crane without actually having to lift 700 tonnes. ■

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. His experience resulted in a book *The Art of Heavy Transport*, available at: www.khl.com/books/the-art-of-heavy-transport/