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Tower crane growth continues

The tower crane market has been one of the more dynamic crane sectors over the past year or two, following a dire period during and after the last recession. A flood of new high rise construction in major cities around the world played a role in the change of course, but the market might also have been helped along by more American contractors using tower cranes on projects where they would have previously used crawler cranes.

This take up has continued in spite of some horrific incidents over the years that caused many US cities to implement new regulations while increasing and tightening inspection levels. The growth has also been helped by an increase in the number of rental companies offering tower cranes alongside mobiles, promoting their benefits while improving availability.

The use of tower cranes in applications where they would not previously have been considered - such as wind turbine installation, not to mention the growth in modular construction - provides encouragement that the growth will continue. It could also be said that using a tower crane is a 'greener' solution, which reduces mobile cranes on the road and traffic in and out of job sites.

Chinese production dominating

In terms of tower crane production China has become far and away the dominant producer, with most western manufacturers owning and operating plants in the country, while domestic manufacturers continue to expand adding capacity and become ever more competitive thanks to heavy investment in automation. This year, China's market leader Zoomlion claimed to be the world's largest tower crane manufacturer, having sold cranes to the value of $1.43 billion in 2019, mostly to a strong local and regional market. The company also owns German company Wilbert which is recovering from its financial difficulties prior to the acquisition.

First Potain MDTm809 in the US at work in DC

Large crane growth and PPVC

Other interesting trends include the introduction of a steady stream of new, increasingly large tower cranes, both fixed and luffing jib models. In the past heavy lift tower cranes were the domain of specialist companies such as Krøll. While this remains true for models over 150 tonnes, the number of manufacturers offering tower cranes with maximum capacities from 60 to 120 tonnes has grown significantly in the past year or two. One factor driving this trend is the growing adoption of Prefabricated Prefinished Volumetric Construction (PPVC), which is becoming increasingly popular for both residential and industrial projects. The prefabricated modules are also becoming both larger and heavier. and with the manufacturing of building modules in a factory said to offer 40 percent gains in productivity, this trend looks set to gain momentum, especially as the method is said to result in a higher and more consistent quality product, with less time spent onsite and possibly less working at height.

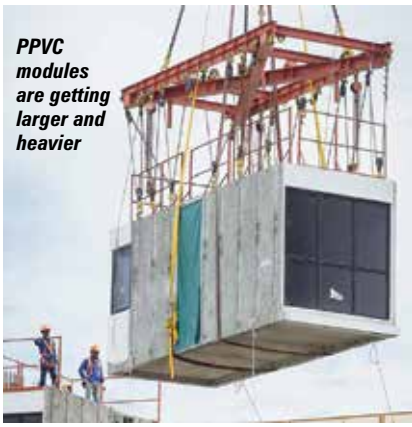
Hydraulic luffers on the up

The adoption of hydraulic luffing jib tower cranes - once the sole domain of the hydraulic luffer pioneer Jost - is also growing rapidly with every major manufacturer - apart from Liebherr - now offering at least one model. This factor alone will help ensure that the concept becomes increasingly widely accepted, supported by its simplicity and practicality.

The past 12 months have seen a large number of new product launches, new developments and interesting applications - here are just a few of them.

Uncomfortable timing for Jaso

Spanish tower crane company Jaso was in the process of finalising the details for the launch of the second crane in its new high capacity range - the 48 tonne J800.48 - when Covid-19 hit Spain hard, upsetting some elements of its launch plans. We can however provide details



PPVC modules are getting larger and heavier

The Jaso J800.48 Low Top crane is similar to a flat top dimensionally

of the new crane, the company's second largest tower crane behind the 64 tonne J1400 unveiled last year at Bauma.

The J800 can take its 48 tonne maximum capacity out to a radius of 23 metres or handle up to 5.1 tonnes on its 80 metre jib tip. Jaso refers to the new models as 'Low Top' cranes, as they are clearly not flat tops, however the tower head is a great deal shorter than a typical hammerhead crane, being just 4.7 metres high, and protrudes just over 2.2 metres above the top chords of the jib. The heavy duty pendants are also very short, running from the tower head to an attachment point at the end of the second jib section just under 23 metres from the front of the tower.

The company claims that as such it is dimensionally similar to a true flat top, saying: "When you compare like with like there is actually no difference in the clearance heights of flat tops and our Low-Top, because flat top designs need deeper jibs to compensate for the pendant height in order to maintain the same strength. Maintaining the separate pendants provides improved performance and less deflection thanks to the extremely short but strong pendants."

The rest of the jib can be built up with a variety of jib sections, as short as 2.5 metres, for a wide range of jib lengths. The counter jib is made up of four modular sections and can be configured with lengths of 18.6 to 28 metres.

The maximum free standing height with the standard 2.16 x 2.16 metre tower system is 73.6 metres, with the tower built in 5.6 metre sections. The stronger TSP20-5.6 tower can also be used, it has the same cross section but can be built to a free standing height of 101.7 metres for jib lengths up to 23 metres or 90.5 metres with the full 80 metres of jib.

The J800 trolley can be single reeved - for a maximum capacity of 24 tonnes and 4.1 tonnes at 80 metres - or double reeved for the maximum 48 tonnes and 3.3 tonnes at 80 metres. A special single reeved trolley is used for the maximum jib tip capacity of 5.1 tonnes at 80 metres.

A choice of 150hp or 180hp motors offer line speeds up 150 metres a minute, while Lebus grooved hoist drum can store enough cable for 455 metre hook heights with single reeving 277 metres when double reeved.

The Jaso J1400

Launched last year at Bauma, Jaso's largest crane, the J1400 is also a Low Top unit and offers a maximum capacity of 64 tonnes with jib lengths to 80 metres at which the maximum capacity is 10.5 tonnes. The tower head is just 5.57 metres high but stands just three metres proud of the jib's top chords and less than a metre above the substantial counter jib which can be rigged with lengths of between 18 and 29 metres. It also folds for easy transport, allowing the entire crane to ship in standard 40ft shipping containers.

The Jaso J800 modular back mast

The 64 tonne Jasso J1400

The 66t Comansa 21LC1400

Singapore based rental company Crane World Asia (CWA), took delivery of the first four units to be shipped, with the first working on construction of a light industrial unit, while the other three are working on a large government housing project lifting 32 tonne PPVC housing modules.

Two big Comansa flat tops

The other Spanish tower crane manufacturer Comansa has also launched high capacity models in the past nine months. The first being the 66 tonne 21LC1400 Flat top crane, which began shipping in September. The crane has an 85 metre jib as standard which can be extended to 90 metres. It is aimed at infrastructure and PPVC projects, but the company says that it has also generated interest from other sectors where heavy loads are common, such as shipyards and mining.

The crane includes a new single compact trolley hook in place of the company's single/double trolley system used on its other models, given that the new crane will mainly work on jobs where almost every lift involves loads close to the crane's maximum capacity. Comansa's new 'Quick Set' overload and lift operation system, which according to the company reduces configuration set up time from three hours to 45 minutes is standard as is the Cube cab.

Comansa's 50 tonne Asian

In December Comansa also launched the 21CM750 flat top tower crane, the largest model to be manufactured at its plant in Hangzhou, China. The new crane is available with maximum capacities of 37.5 and 50 tonnes and while it has CE certification to EN14439, it is largely aimed at the Asian market. Maximum jib length is 80 metres,

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One of the first Potain Hup C 40-30 tracked self erecting tower cranes


Three of the Hup C 40-30 tracked cranes are working on a rail flyover bridge at Renens VD station, close to Lausanne

with a jib tip capacity of 7,300kg for the 35 tonner and 6,700kg for the 50 tonne version. The maximum free standing height is 78.8 metres. The new crane shares several jib sections with the wider 2100 series, while the modular design of the jib and counter jib provides up to six different configurations. Features include Comansa's Cube Cab, automatic changing of the double trolley and high speed hoists. The 37.5 tonne model can be converted to handle 50 tonnes by changing the front trolley and hooks.

Tracked Potain self-erector

Swiss sales and rental company Stirnimann has taken delivery of the first six units of Potain's Hup C 40-30 crawler mounted self-erecting tower crane. Developed in partnership with Stirnimann, the four tonne Hup C 40-30 is Potain's first crawler mounted self-erecting tower crane and offers a hook height of up to 30 metres, while handling 1,000kg at its 40 metre jib tip. An onboard generator provides power for travel and set up and also enables it to reposition while fully erected.

The crane has an overall transport length of 13.5 metres, a width of 2.55 metres and a stowed height of just over 3.7 metres. It can travel up or down slopes of 30 percent and manage side slopes of up to 12 percent when stowed. Once fully erected the crane can still manage inclines of up to five percent longitudinally and two percent laterally although the travel speed cuts from 25 to 10 metres a minute. Once in position the hydraulic beam & jack outriggers can be set in minutes.

Three new cranes from Terex

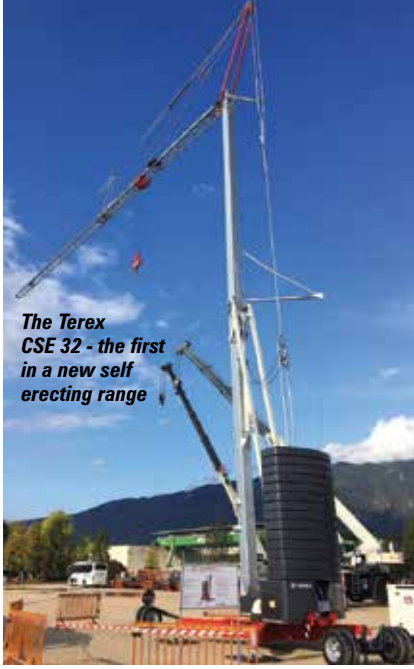
Terex Cranes now focuses entirely on tower and Rough Terrain cranes and introduced a number of new cranes towards the end of last year, including its first hydraulic luffer - the CTLH 192-12 - the first of a new generation of self-erecting tower cranes - the CSE 32 - and the CTT 172-8 flat top.

The all new 12 tonne CTLH 192-12 hydraulic luffer has a maximum jib length of 55 metres, with a jib tip capacity of 2.35 tonnes. The crane can be used with any of the manufacturer's HD23, TS23, TS21 or HD20 towers and has an out of service radius of eight metres with a minimum working radius of three metres. Terex says that the jib luffs from horizontal to almost vertical in two minutes. Shipments from the Terex plant in Italy were due to start earlier this year.

The new 4.4 tonne CSE 32 self-erecting tower crane can handle 1.05 tonnes at its maximum 32 metre jib tip, with a maximum hook height of 21.5 metres, while the maximum hoist speed is 56 metres a minute. The crane is the first in the first in a new range of self-erectors, shipment are due to begin this summer.

The new eight tonne CTT 172-8 flat top replaces the CTT 162 and features a maximum jib lengths from 25 to 65 metres in five metre increments. The jib tip capacity at 65 metres is 1.71 tonnes. The TPP 'Terex Power Plus' system provides a controlled 10 percent temporary boost to capacity, while other standard features include the 'Easy Setup' function and 'Terex Power Match'. The crane can be used with either of Terex's exiting TS21 and TS16 towers. Shipments began at the start of the year.

Finally the company has also launched its own "easy to install" operator hoist - the T-Lift - an external mounted rack and pinion operator elevator with a 200kg capacity, maximum lift height of 160 metres and a maximum lift speed of 40 metres a minute.


The Terex CSE 32 - the first in a new self erecting range

New Potain MDT

Potain announced its new MDT 569 flat top tower crane in March, with maximum capacities of between 20 and 32 tonnes and a maximum jib length of 80 metres with jib tip capacities of up to 4.2 tonnes. Maximum hoist speed is 195 metres a minute, while the crane incorporates the Manitowoc CCS control system and latest technology. It can be used with the manufacturer's new eight metre cross shaped base, which is said to be easier to assemble than its previous bases, while the crane's modular design allows for more efficient transport and faster, easier erection. Shipments of the new crane were scheduled to begin at the end of the summer.


The new 32 tonne Potain 569.


The first Terex hydraulic luffer, the 12t CTLH 192-12


The new 8t Terex CTT 172-8 flat top

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First Wolffkran baby luffers delivered

Wolffkran has completed delivery of the first four units of its new eight tonne Wolffkran 133.8B which was unveiled at Bauma last year. The new cranes were sold to the Plant Services division of UK retirement home developer Churchill Retirement Living. The 113.8B is the larger of a two model family - along with the 6.2 tonne 133.6B - the smallest luffing cranes in the Wolffkran range. Maximum jib length is 45 metres with a jib tip capacity of 2.3 tonnes. As with the company's larger 166 B, the new crane can be operated in single or two fall mode, while the modular tower system allows a freestanding height of 95 metres. The HW 845 FU hoist - from the 166B - provides maximum speeds of 158 metres a minute.

Mark Church, manager of Churchill Retirement Living's Plant Services, said: "The smooth erection and commissioning of the crane delivered directly to the job site has proved the quality of the product."

Based in Ringwood, Churchill took delivery of the first Wolff 133.8B last year. The latest three went straight to sites in Burnham, Hythe and Taunton. The purchase is part of the company's plan to convert its entire saddle jib crane fleet to luffing jib models.

Churchill's new 8t Wolfkrann 133.8B

Zoomlion's 'Intelligent' tower crane plant - Phase 2

In January Chinese manufacturer Zoomlion broke ground on phase two of its new 950 million Yuan ($135.9 million) 'Intelligent' tower crane plant in Changde City and announced the new 'Cross Generation' W series of cranes. The new facility will include 16 new production lines, equipped with 150 robots and 10,000 data sensors operated with 'networked, intelligent production management and smart decision making'. The phase two buildings will be dedicated to the company's higher capacity tower cranes alongside its smallest cranes and hoists.

Global market leader?

At the same time the company announced that its tower crane sales had exceeded 10 billion yuan ($1.43 billion) in 2019, claiming to be the first manufacturer to achieve this level of sales, thus making it the worldwide market leader.

In terms of new products, the company unveiled its new 120 tonne LH3350-120 luffing jib tower crane with a 73 metre internal climbing shaft allowing few climbs for ultra-high buildings and uses a relatively compact 3.25m x 3.25m cross section tower.

The new 120t Zoomlion LH3350-120

Five luffers for Las Vegas landmark

US-based tower crane rental company Morrow has installed five 36 tonne capacity Liebherr 542 HC-L 18/36 luffing jib tower cranes - all erected with hook heights of 210 metres - to handle steelwork, place concrete and install/move formwork on the $4.5 billion Resorts World, Las Vegas's latest and most expensive landmark venue, located on the former site of the Stardust Resort and Casino. The resort will include a 3,500 room hotel with two towers and 32,500 square metres of meeting and banquet space.

The cranes, which can handle 4,300kg at the maximum radius of 65 metres, were chosen, says Morrow, for their capacities, fast line speeds and level luffing feature, where the controller automatically adjusts the hoist gear so that the hook and load move horizontally on the single control movement. The client is local contractor W. A. Richardson.

Five Liebherr 542 HC-L 18/36 luffing jib tower cranes on the Resorts World hotel & Casino in Las Vegas

Zoomlion has started construction of phase two of its new Intelligent tower crane plant in Changde

Zoomlion has delivered eight 120t T2850-120V flat top tower cranes for construction of the new terminal at Kuwait International Airport

Standing cranes up

The Tower Crane Interest Group of the UK's Construction Plant-Hire Association - the CPA - issued a safety alert at the end of March regarding tower cranes left on site in an 'Out of Service' condition for extended periods and includes advice and considerations on how tower cranes should be left and managed for long out of service periods, due to long term site closures relating to the Covid-19 pandemic. *See page 59*

Jaso J1400

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Blowing in the wind

Could an improved understanding of the aerodynamics involving high winds help reduce tower crane failures in hurricane force gales?

When the remnants of Hurricane Dorian passed through Halifax, Nova Scotia last September one of several cranes in the city collapsed onto adjacent buildings causing considerable damage but fortunately no injuries.

When the provincial labour ministry published its report, many hoped it would offer an explanation. However, the report by John Richardson or BMR Engineering was almost totally redacted and a number of lawsuits filed in relation to the mishap have hindered an open discussion of events and causes. To gain some insight, Saul Chernos spoke to a locally based specialist engineer about potential causes and the lessons that might be learnt.

It was late afternoon on September 7th last year when crews battened down the hatches to wait out Hurricane Dorian. With wind gusts reaching 140kph, the hurricane had moved into the tropical storm category yet was soon toppling trees and power lines and causing widespread damage. Despite measures to safeguard the stricken crane, strong winds eventually brought it down onto adjacent buildings. Thankfully, no injuries were reported and so forensics were limited to the crane and structures.

Old tower, new top

It was established that due to a previous failure in the slew ring area, the top kit of the crane had been replaced a few months prior to the incident. BMR Engineering had designed a transition section allowing the new Potain top to be fitted to the existing tower. There has been no suggestion, at least publicly, that this modification had any bearing on the collapse. Nor is it known what role the hurricane played as the crane and installation were reported to have been designed to withstand winds and gusts stronger than the storm.

A local engineering view

Dr. Fadi Oudah - an assistant professor of civil and resource engineering at Dalhousie University in Halifax - has not been involved in the investigation nor privy to any behind the scenes information or the report's redacted content. However he does see wind related factors as a likely contributing factor.

"It is a difficult question to answer without being involved in the details of the project," he said, "but there are three possible contributing factors."

"First, not properly designing the crane in accordance to the design provisions outlined in the Canadian Standard for Tower Cranes (CSA Z248), particularly the provisions related to crane stability under wind load. The crane seems to have had a large unbraced length (height) which tends to be more flexible under wind load and may cause structural instability and thus collapse under high winds," he said. "The structural instability may be triggered by what we call 'low-cyclic fatigue' - a small number of load cycles, but with high amplitude."

Halifax crane before it fell

Crane falling

Second, operation related items such as not letting the crane slew freely prior to and during the Hurricane. And third, the applicable tower crane codes and standards.

"It is possible that CSA Z248 may not properly account for extreme loadings such as Hurricane Dorian," he said. "Hurricanes are associated with both high wind speeds and complex wind dynamics. Wind pressures applied on structures vary as a function of the square of the wind speed with wind pressure increasing by a factor of four as the wind speed doubles. Cranes are designed to withstand high winds as per CSA Z248. The design wind speed is based on established wind records and statistical analysis. It is true that hurricanes come with high wind, but these winds typically fall within the allowable range used in calibrating CSA Z248."

"What really can adversely affect the stability of the tower crane in a hurricane is not the high wind speed, but the complex aerodynamics associated with the high wind speeds. Structural design codes generally assume that winds are applied uniformly on structures, but this is not the case with hurricanes. Hurricane aerodynamics are very complex and can cause collapse of structures that were originally designed to withstand high winds. The collapsed crane was positioned in the corner of two adjacent buildings (in an 'L shape). The wind aerodynamics in such a configuration may have contributed to the collapse of the crane. The aerodynamics near the corner of a building are complex and may not be suitability accounted for in design standards. A thorough dynamic analysis would be needed to confirm this," he said.

The crane's original top had been replaced a few months earlier with a locally designed tapered adaptor to allow the new crane to fit onto the old tower. Could this have been a factor in the collapse?

"It is not clear to me if there was a problem associated with the new top," said Oudah. "This typically should not be a problem if the installation was conducted properly."

Nova Scotia experiences the tail end of many Atlantic hurricanes

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and a lot of very powerful winds, so are there lessons to be learned and what measures should tower crane companies take to avoid such problems?

Planning for high winds

In addition to the points Oudah has already raised, he offers two recommendations to help mitigate crane collapse in future Atlantic hurricanes.

"Limit the unbraced length of the tower," he said. "Some contractors tend to build their tower crane to full height while the construction is still at basement level. This means the crane is unbraced for almost the full height. The higher the unbraced length, the more flexible the crane when subjected to high winds, the higher the lateral drift and the more adverse the effect of low cyclic fatigue. I suggest restraining the allowable crane height as a function of the number of storeys that have already been built. Research should address the maximum allowable unbraced length."

"Secondly, study the aerodynamic behaviour of tower cranes subjected to Atlantic hurricanes. The location of the crane within the site may influence its ability to withstand hurricane loads. Placing the crane near the corner or 'L' shape configuration may have contributed to the collapse of this crane due to a complex wind profile near the corner. Perhaps future research can tell us where to place the crane within the site to mitigate adverse wind effects."

But are there lessons to be learnt from other recent tower crane failures and is the use of aging tower cranes or components an issue?

"If there is one thing that should be learned from recent collapses is the importance of proper crane inspection," he said. "The word 'aging' in structural engineering typically refers to loss of strength over time. Aging of steel structures such as cranes manifests in increased section loss due to corrosion. Part of the inspection process is to identify possible corrosion spots however, if the crane is properly painted this should not be a major concern."

Ultimately, Oudah thinks wind aerodynamics are likely to have played a role in the mishap. However, even if this is not the case, he considers wind to be an area deserving further investigation by the crane industry and standards bodies.

"Current research looks at evaluating the structural performance of cranes in hurricanes," he said. "Although there is an urgent need for such research, efforts in this area are limited. This is an area of research that I am interested in and plan to expand on in the near future. Perhaps structural related guidelines can be developed to assess and evaluate cranes for hurricane type loads."