Modifying Your Cranes to Serve Larger Ships

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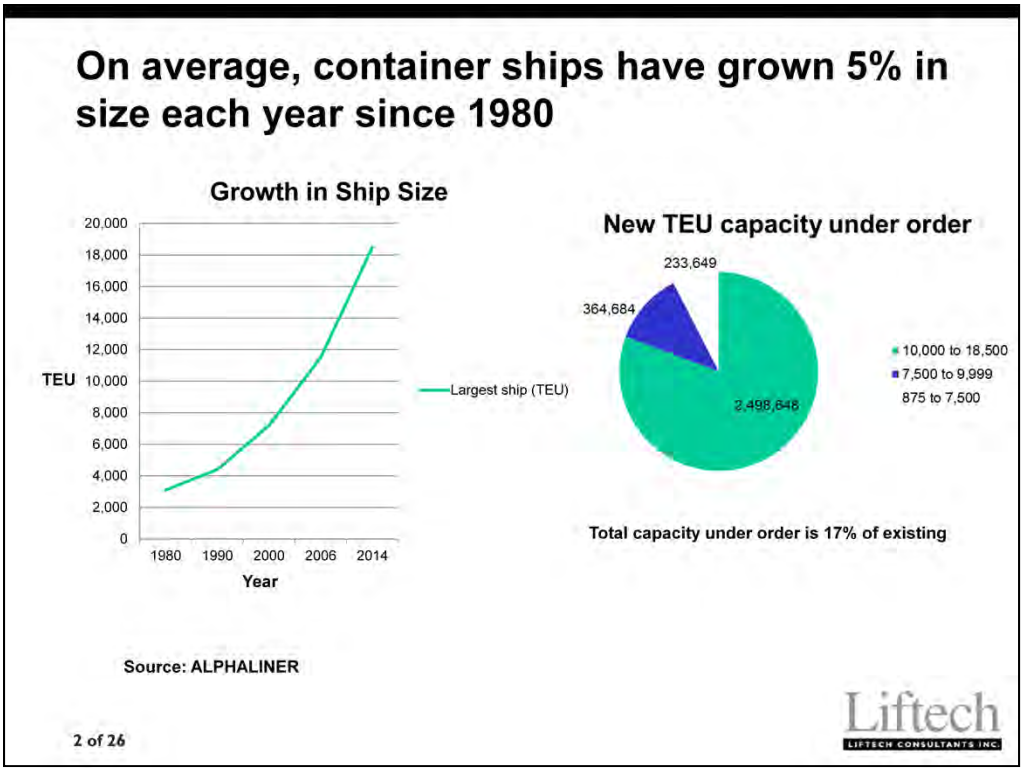
Liftech specializes in container crane design. Liftech engineers designed the structure of the first container crane in 1958 and have been involved in new crane designs since then. We also provide other crane and wharf related design services, including crane modifications.

Mr. Hoite is a registered professional engineer with extensive experience in container crane design, modification, specifications, and procurement. In addition to working with cranes, his responsibilities have included container wharf design, container terminal planning and analysis, container market intelligence and strategy, and development of innovative container terminal equipment and modes of operation. Mr. Hoite joined Liftech in 1991. From 1999 to 2010 he worked for APM Terminals in Copenhagen, Denmark, and The Hague, Netherlands. He rejoined Liftech in January 2013.

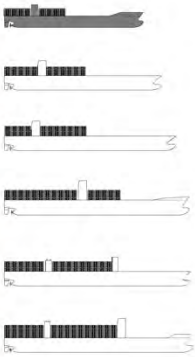


This graph shows the growth in ship size, which is well known. Container shipping has been growing at 9% per year since 1980, but right now the supply of ships is greater than the demand. A large number of big ships have entered service and more are coming. There are about 5,000 container ships in the world. Another 500 ships are about to be delivered, but these ships will make up 17% of the world capacity. Eighty percent of these ships are in the 10,000 to 18,500 TEU capacity range

Margrit Rickmers – 5,050 TEU Biggest Panamax Far East, Panama, US East Coast Service

294 m x 32 m x 13 m draft
13 wide x (5 over + 8 under deck)
Completed 2005

Crane lift height = 32 m



Note: Crane lift height is approximate and conservative, assuming HC containers, 2 m height between crane rail and MHW, 10 m draft, and other clearances.

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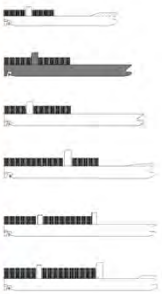
This slide and the following slides present a review of ships calling at US ports and other ships operating elsewhere in the world.

The Margret Rickmers is the largest ship that can pass through the Panama canal. There are many ships this size serving US ports. This size ship has been a work horse of the industry for some time. It is the smallest I will show you but this size was the biggest in the world early in the 1990s. It is nearly 300 m long. Until 2012 no ships of this size had been scrapped. Last year 32 were scrapped. In the first four months of this year 34 ships in this range were scrapped.

NYK Arcadia – 9,200 TEU
Far East, Mediterranean, US East Coast Service

332 m x 45 m x 13 m draft
18 wide x (6 over + 10 under deck)
Completed 2011

Crane lift height = 39 m



Note: Crane lift height is approximate and conservative, assuming HC containers, 2 m height between crane rail and MHW, 12.5 m draft, and other clearances.

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This ship is close to the new Panamax size, which is up to 49 m wide. This is presently the biggest ship calling on US East Coast and Gulf ports. She sails from Asia through the Suez canal and the Mediterranean to the US. The required lift height for this ship is about 39 m

MSC Ivana - 11,700 TEU
Far East, US West Coast Service

364 m x 46 m x 15 m draft
18 wide x (7 over + 10 under deck)
Completed 2008

Crane lift height = 42 m

Note: Crane lift height is approximate and conservative, assuming HC containers, 2 m height between crane rail and MHW, 12.5 m draft, and other clearances.

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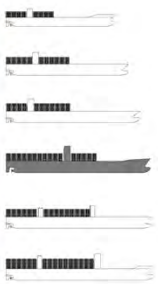
The Ivana is the largest ship calling on the US West Coast today. She is the same size as the Arkadia, but longer, and she can stack more boxes on deck so a lift height of about 42 m is required. The lift height we are showing here is based on fairly conservative numbers, so a lower lift height may be acceptable. When the new Panama Canal opens, it is likely that ships like this will call on the US East Coast.

Emma Maersk - 15,500 TEU
Europe, FE Service

397 m x 56 m x 16 m draft
22 wide x (7 over + 10 under deck)
Completed 2006

Crane lift height = 43 m



Note: Crane lift height is approximate and conservative, assuming HC containers, 2 m height between crane rail and MHW, 12.5 m draft, and other clearances.

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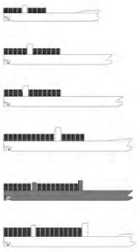
This ship resulted in the biggest increase in the largest ship size when it was introduced in 2006. Fortunately, a lot of ports knew a big ship was coming and they were prepared with big cranes with adequate lift height and outreach. This ship is 10 m wider than earlier ships.

CMA CGM Marco Polo - 16,000 TEU
Europe, FE Service

394 m x 54 m x 16 m draft
21 wide x (7 over + 10 under deck)
Completed 2012

Crane lift height = 43 m



Note: Crane lift height is approximate and conservative, assuming HC containers, 2 m height between crane rail and MHW, 12.5 m draft, and other clearances.

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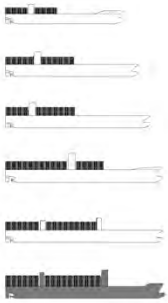
This ship has greater capacity than the Emma Maersk but is the same length and slightly narrower. The difference in capacity is due to the shape of the ship. The Emma Maersk is slimmer for more of its length. Notice that all of the ship photos on the slides are about the same size. The ships look the same size, but the containers keep getting smaller.

The lift height for this ship is 43 m.

Maersk McKinney Moller - 18,300 TEU
Europe, FE Service

400 m x 59 m x 16 m draft
23 wide x (9 over + 10 under deck)
Completed 2013

Crane lift height = 48 m



Note: Crane lift height is approximate and conservative, assuming HC containers, 2 m height between crane rail and MHW, 12.5 m draft, and other clearances.

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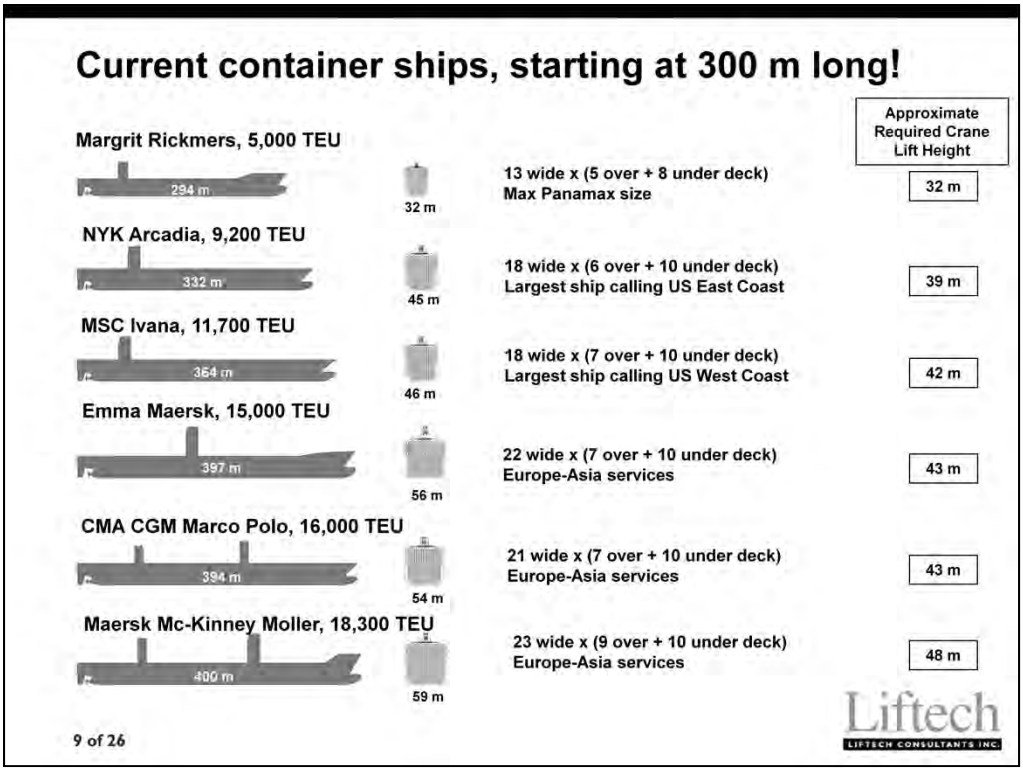
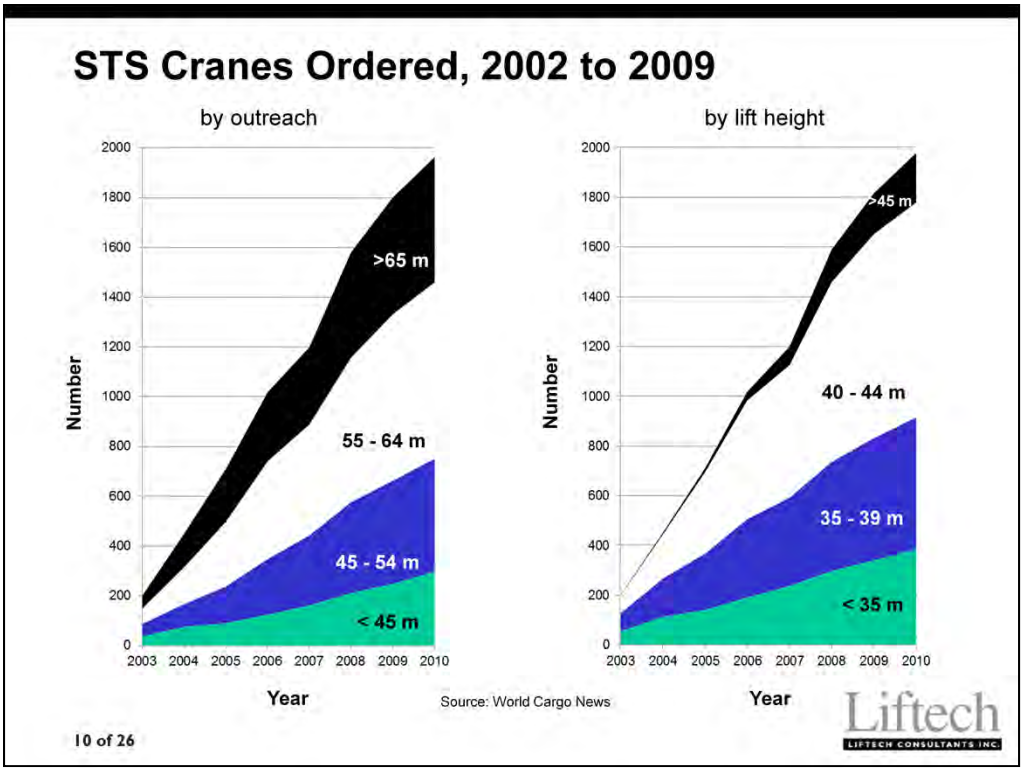
A bigger ship than this will enter service this year, but this is the biggest container ship sailing today. This ship has a total of 19 containers over and under deck.

Maersk suggests that ports design for a ship like this with only 11 m draft and 10 high containers on deck. This results in a total required lift height of about 52.5 m. To our knowledge there are no ships in service today that require 52.5 m lift height.



This is a summary of the ships presented. The main point is that the 5,000 TEU ships will be phased out of service and ships up to the 12,000 TEU size will make regular calls on the US East Coast. We can expect the biggest ships to start calling on the US West Coast.

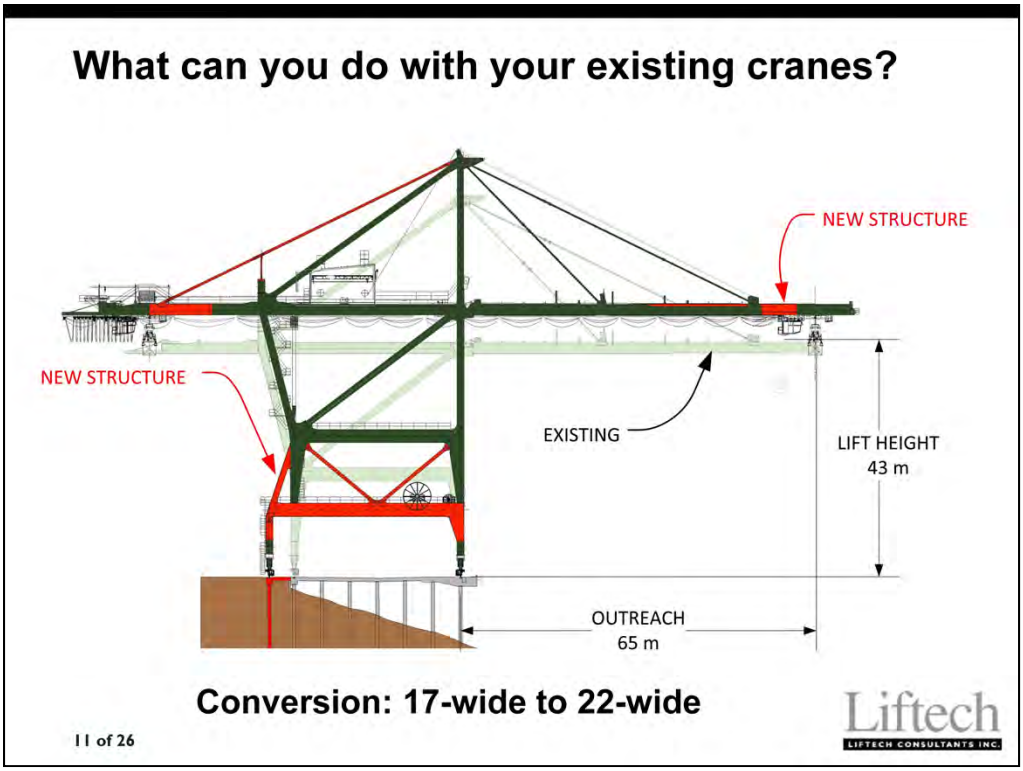


This slide presents the cumulative number of cranes ordered between 2002 and 2009, grouped by outreach and by lift height.

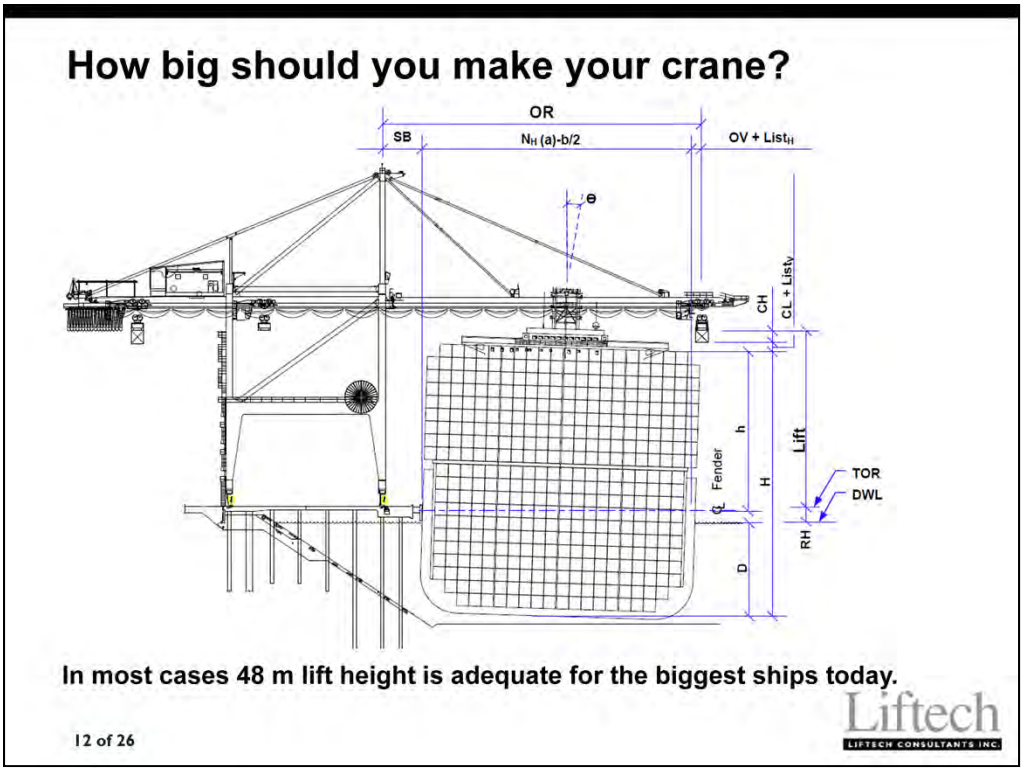
A 22-wide ship needs an outreach of about 62 m. A 23-wide ship needs an outreach of about 65 m. The actual outreach depends on the rail setback and fender depth. The slide shows that there are plenty of cranes ordered with sufficient outreach.

There are also a lot of cranes with a lift height of 40 m or more, which was originally thought sufficient for Maersk E-Class vessels (depending again on wharf configuration). As we understand it, this lift height should also be good for the Triple-E ships.

The blue and white layers show cranes being raised. The target lift height for the biggest ships now appears to be about 46 m.



Looking at the crane only, it is possible to implement any modification. The limitations are cost and wheel loads. This slide shows the result of a Liftech crane study. In this case, the crane would be raised, the boom extended, the backreach extended, and the rail gage changed. These modifications would convert the crane from servicing 17 to 22 container-wide ships.



Here are some of the things to consider when deciding if you want to raise your cranes or make other modifications. To get the total height of the ship, add the number of containers plus the keel and hatch cover heights. To this, add another container and some clearance. Also consider some heeling of the ship. From this height, subtract the draft and the height from the crane rail to the design high water level.

For the outreach, consider that if you can only reach the last box with full outreach, you will have a slower operation at that position as the trolley will be working in its slow-down zone.

Crane Raises – Some Guidance Data

Operating wheel load will typically increase 2 to 5.5 t per meter for a 7-10 m raise.

Cost
US WC: $2M to $4M

US EC: $1.5M to $2.5M

Six weeks out of service per crane--with a proven system and experienced contractor

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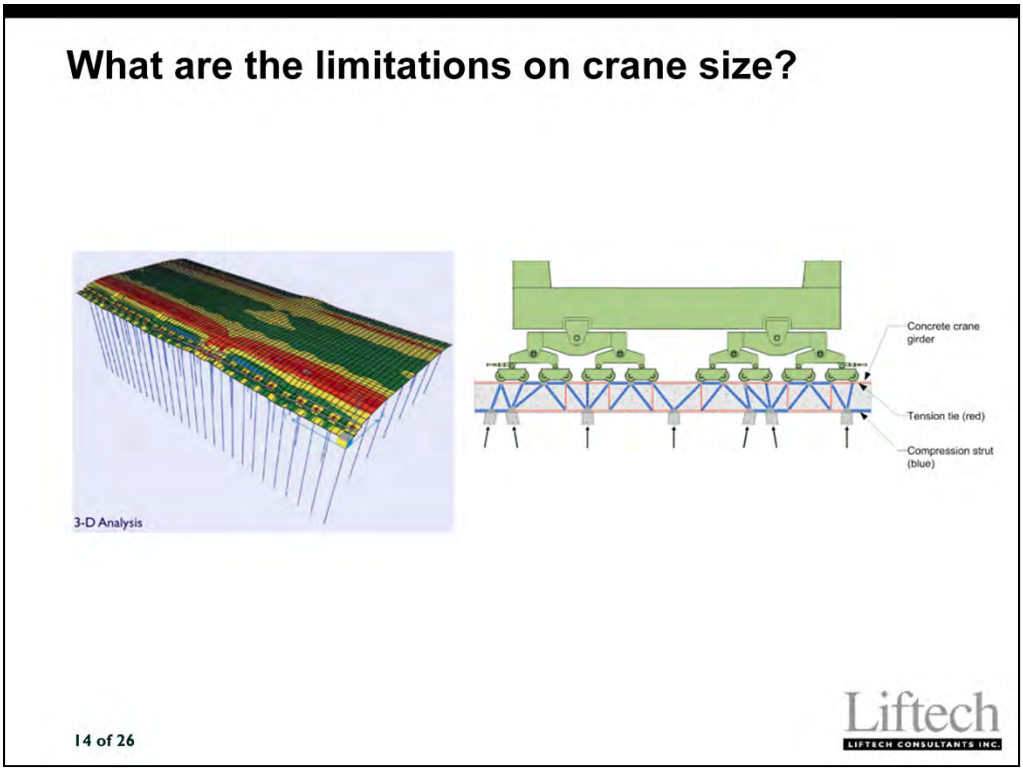
This photograph is from a recent raise in Oakland by Paceco. This project used a crane raise frame Liftech designed for Paceco in the 1990s. With a frame like this and an experienced contractor you can expect each crane to be out of service about six weeks.

When raising later generation cranes with sufficient outreach for the big ships, larger crane lifting frames are required. I will show you examples later.

The cost of these raises on the US West Coast has increased to about $4 million per crane. On the US East Coast we expect the cost will be about $2 million.

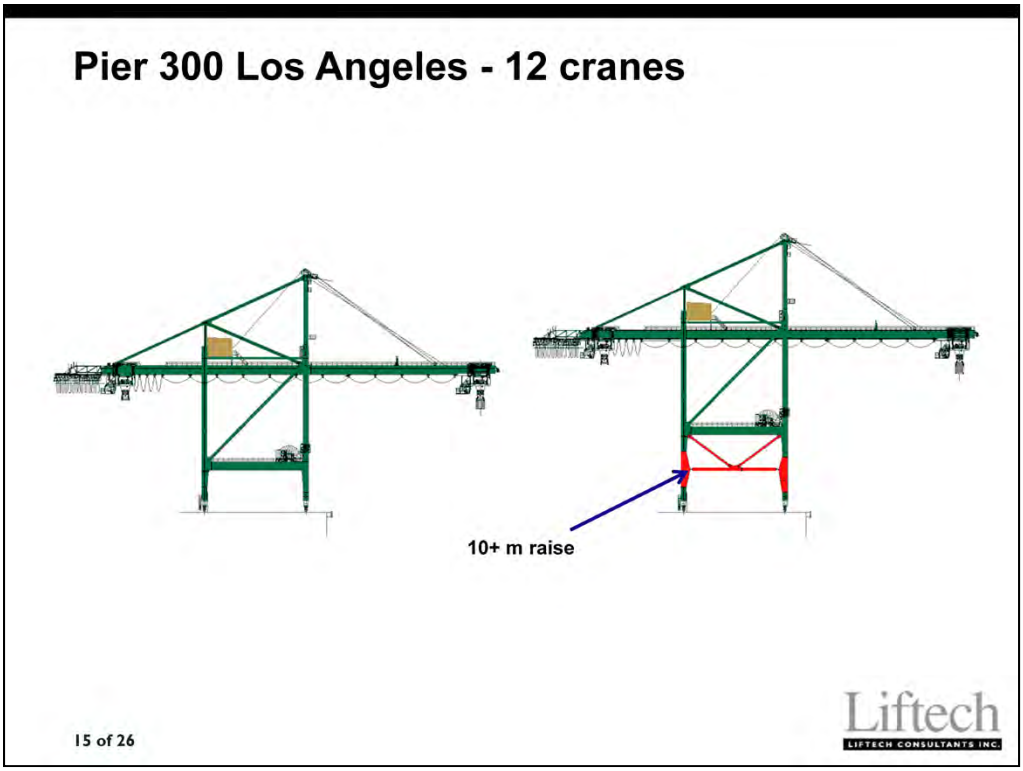
When raising the larger cranes by 7 to 10 m you can expect wheel loads to increase by 2 to 5-1/2 tons per meter from additional dead load and lateral loads.



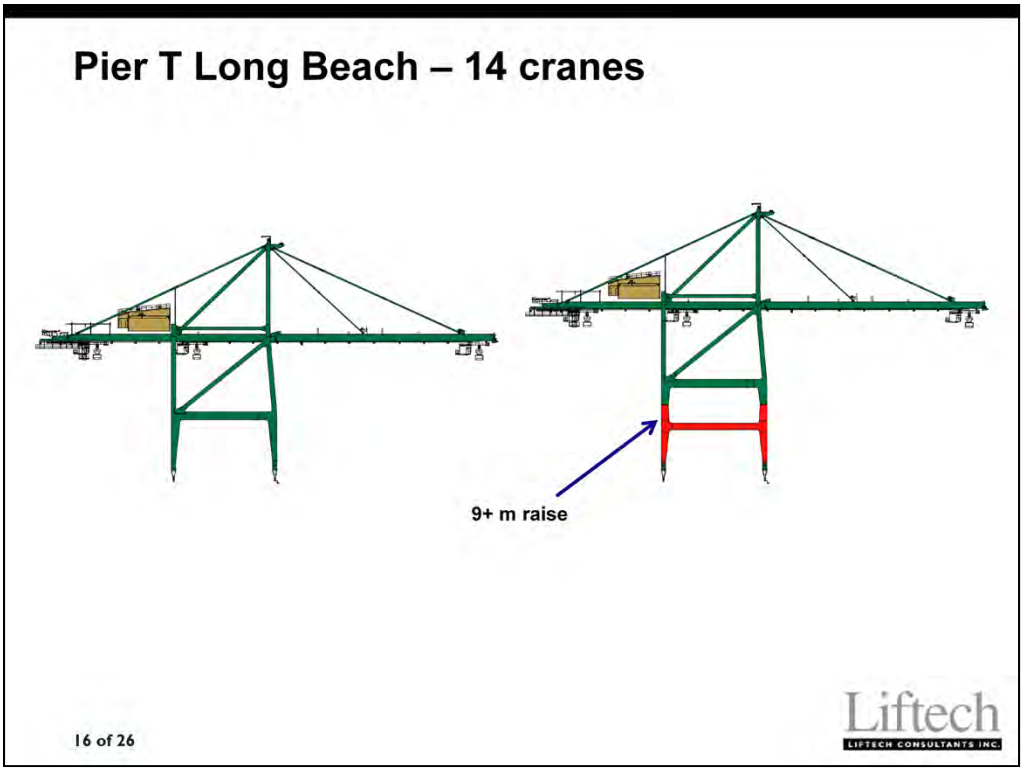
One important limitation the modifications you can make to your cranes is the allowable wheel load.

Typically, a port will have a set of wharf design drawings that define the allowable loads on the wharf. If your new crane loads are larger than this allowable load, you can't proceed.

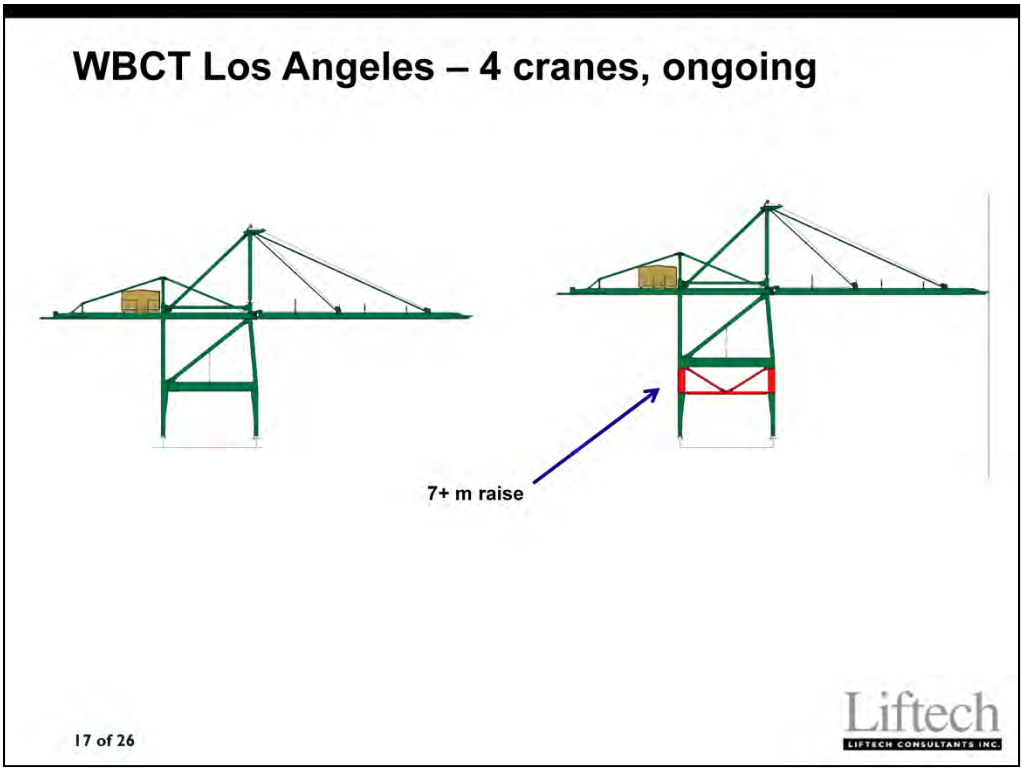
We have found, in more than 15 studies of this type, that an investigation of the actual pile capacities and a recalculation of the as-built wharf capacity, using modern analysis methods, can justify higher wharf capacities in many cases.



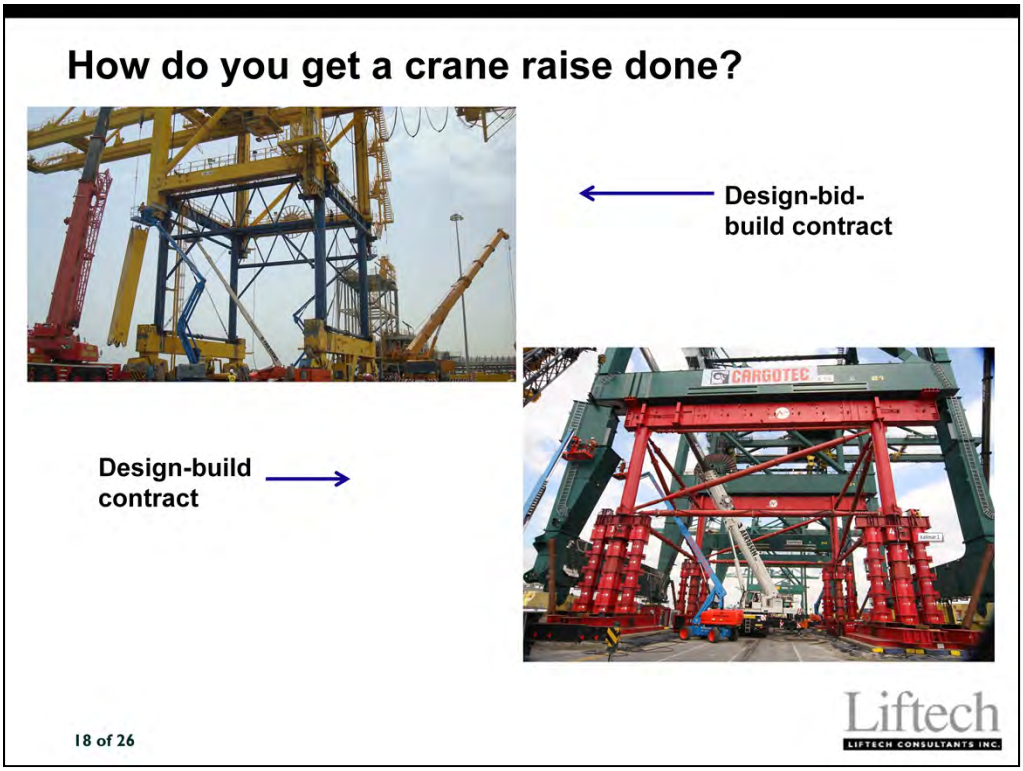
This is an example of a raise project we have been working on. In this case we could reinforce the crane with K-braces to maintain the stiffness of the raised cranes in operation. This solution was possible because the wharf and the seismic design criteria allowed stiff cranes.



This is a different project nearby, but with a different wharf. In this case, K-braces could not be used as the crane would be too stiff and would create problems for the wharf under seismic loading. We developed this solution to provide adequate stiffness for operations, while not resulting in excessive seismic loads from the crane on the wharf.

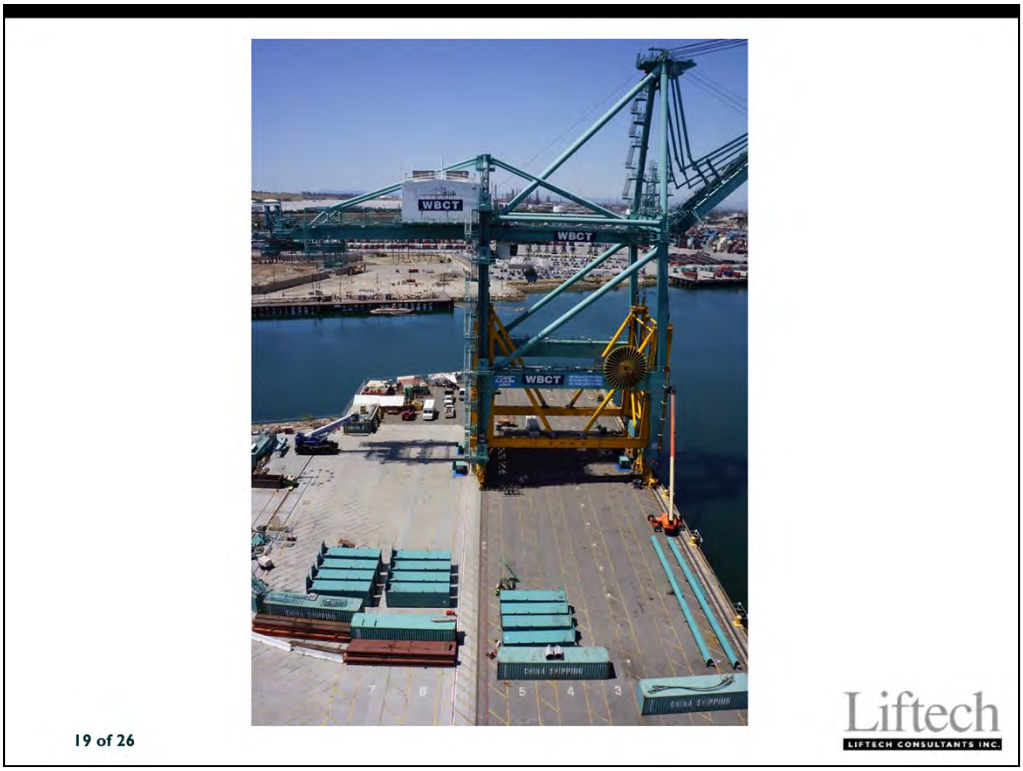


In this project, which I will show photos of later, the wharf is stiff and the cranes were designed to the most recent seismic standards. Therefore, it was possible to use the K-brace design.



When you want to get a crane raise done, you can contract with a design firm such as ours and have us prepare preliminary designs and specifications for the raise, which can be put out to bid with multiple contractors. This is the most common approach in the US.

Another approach, which is common in Europe, is that the owner makes a contract with a turn-key contractor, who performs the design and executes the work.



This is a photograph from the West Basin Container Terminal project shown earlier. You can see the area required to perform a crane raise.

On this project, there is a set of beams and dollies. After each crane is raised, it is moved behind the other cranes to the other end of the wharf and inserted into the operation.

In this picture, there are three sets of crane legs on the ground and some of the pipe bracing. One of four cranes was already raised and put back into operation and this crane is next.

In addition to all of the structure that must be added to the crane, also consider mechanical and access systems when raising your crane. You may need to modify the main hoist system and the gantry cable reel to accommodate the additional height. You will need to modify elevators and access, and there are a number of other considerations.

This is a photograph of the new crane raise frame ZPMC designed as it raised the first crane at this terminal.

This photograph shows the raise completed with the new legs and bracing in place.

This is the same crane relocated and returned to operation.

Boom Extension

Photo courtesy of Terminales Rio de la Plata S.A., Buenos Aires, Argentina

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This slide shows a recent boom extension project. When modifying the boom, typically the crane is rolled back and land-based cranes are used to remove the forestays and the boom so that the cutting and welding work can be done on the ground.

Summary

Bigger ships are on the way to every port

Many cranes have adequate outreach but will need to be raised to serve the big ships

Nearly all modifications are possible, limited by wharf capacity and cost

Different cranes and wharves require different structural solutions for seismic loading

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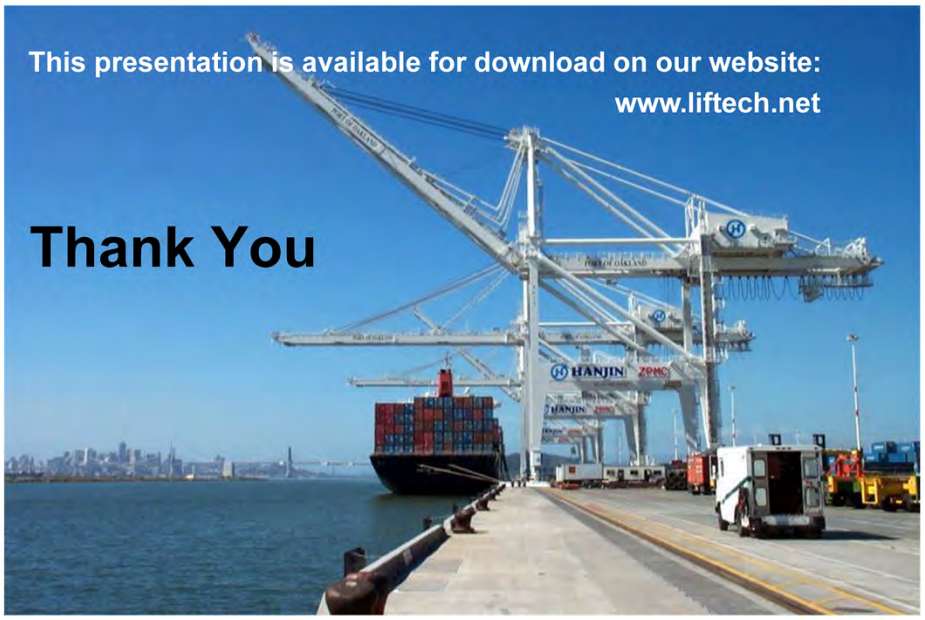

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