The New Panamax and jumbo ships are coming!

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The Panama Canal is being expanded to handle "New Panamax" containerships with 19 containers across the deck. Shipping lines are ordering 18,000 TEU jumbo ships, sometimes called "Ultra Large Container Ships" (ULCS) with 23 containers across the deck (Jumbo-23). Many existing quay cranes are not capable of servicing these larger ships. The choice is either to purchase new larger cranes, or enlarge existing cranes.

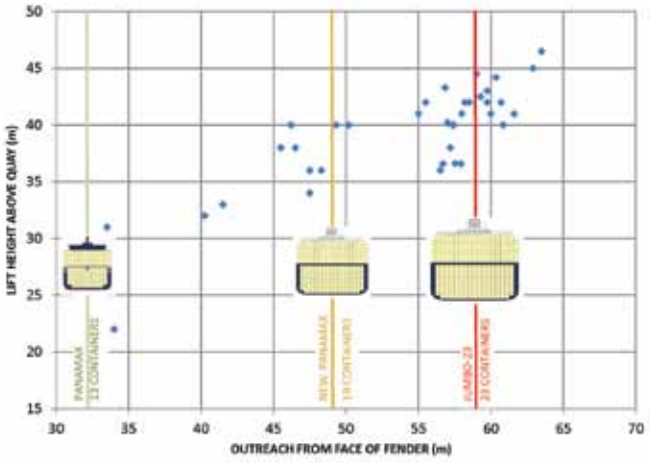

Figure 1. Outreach requirements and recently purchased crane sizes (Liftech 2011 data).

This article discusses enlarging existing cranes: how much, enlarging methods, conceptual cost and schedule estimates, and other considerations. Even some recently purchased cranes would require enlarging. Figure 1 presents the outreach demand of Panamax, New Panamax, and Jumbo-23 cranes, and the lift height and outreach of some recently purchased cranes.

In many cases, cranes can be modified for less cost and in less time than procuring a new crane. The cost of a new crane ranges from US$8–10 million. Enlarging and upgrading costs vary from 25% to 60% of the cost of a new crane, and the time required to enlarge a crane is sometimes half that of procuring a new crane.

Wheel loads for larger cranes may exceed the stated allowable wheel loads. Often, this is not a problem since increased capacity can usually be justified using modern analysis methods and considering the as-built crane girders.

Ship sizes: Panamax, New Panamax, and Jumbo-23

Increasing lift height and outreach

Larger ship sizes demand more crane lift height and outreach.

There are many ways to enlarge a crane. Figure 2 presents issues and examples of modifications required for a typical 17-wide post-Panamax crane to service a 19-wide New Panamax ship.

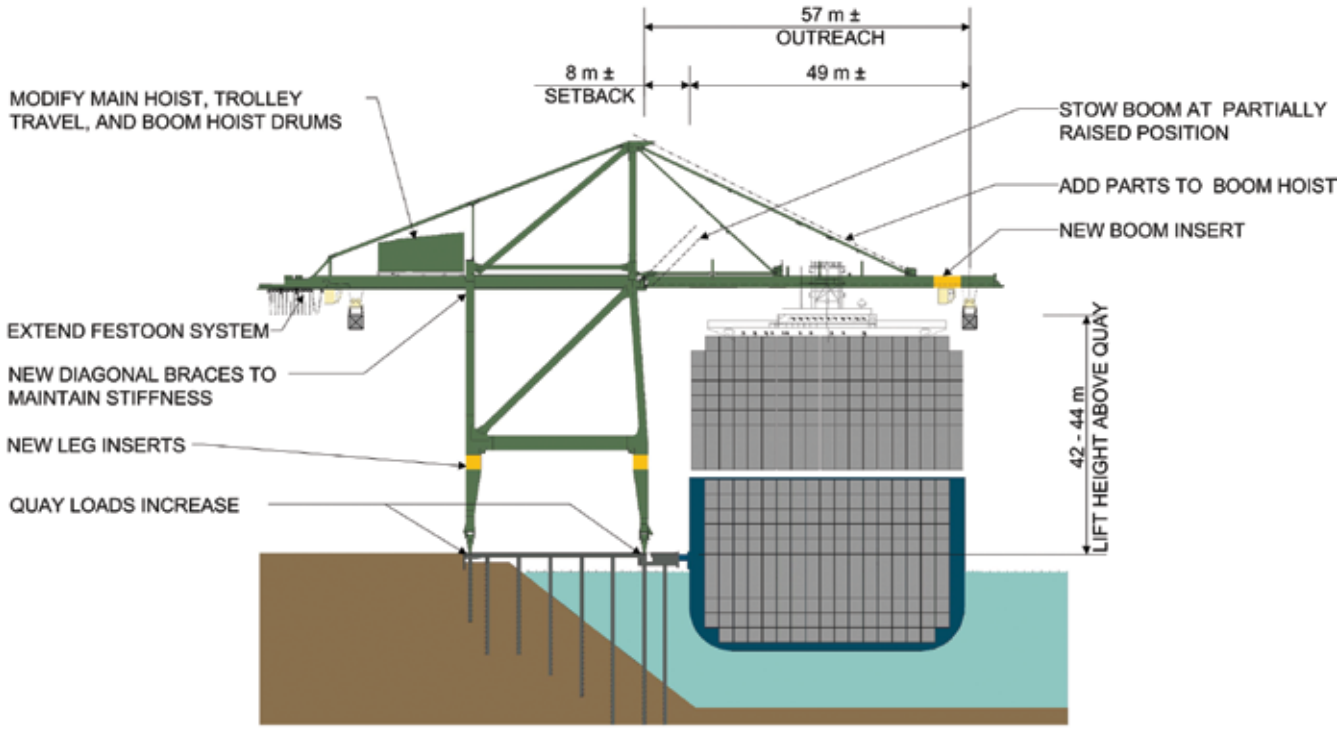

Figure 2. Crane modifications for 17-wide crane for the New Panamax ship.

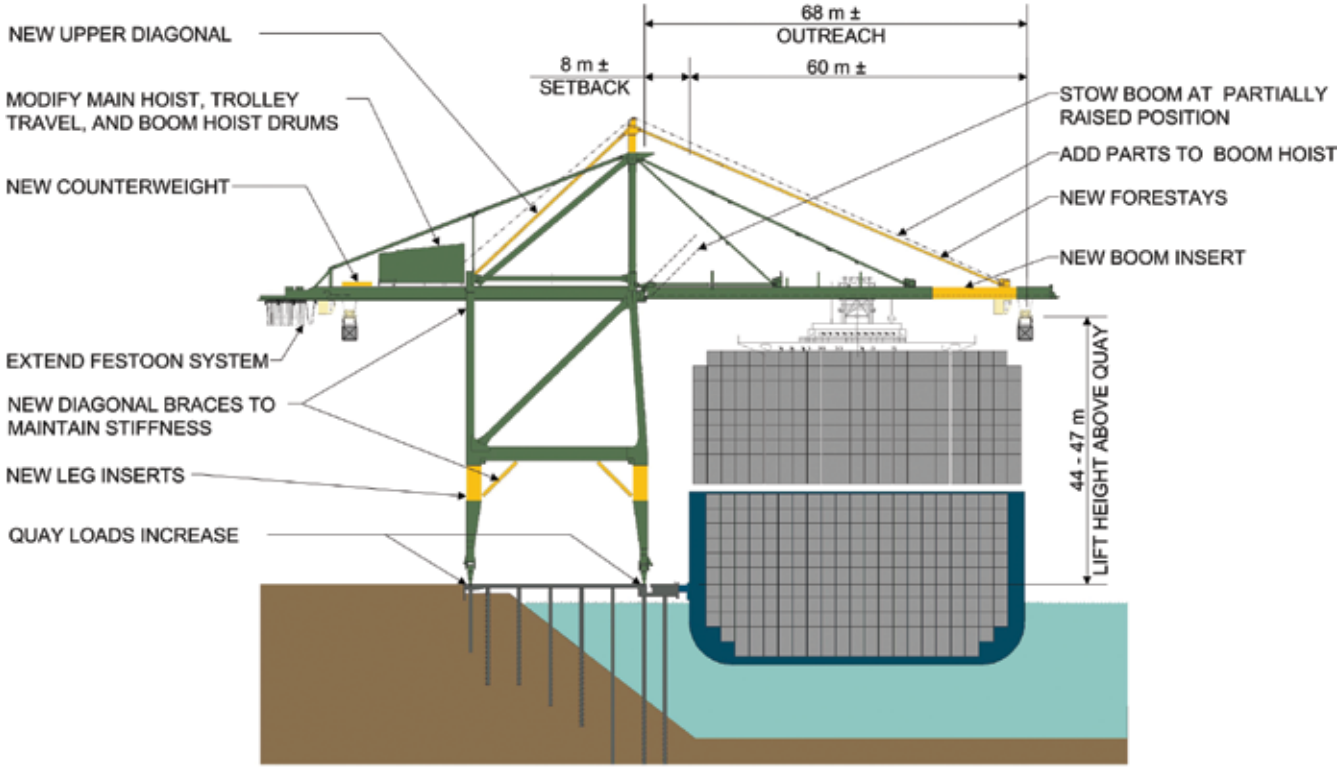

Figure 3. Crane modifications for 17-wide crane for the Jumbo-23 ship.

Figure 3 presents issues and examples of modifications required for a 17-wide post-Panamax crane to service the Jumbo-23 ship.

Increase lift height

Increasing the lift height is a common modification. Often, new leg sections are inserted. Diagonal braces may be added to the portal frame to maintain the crane stiffness in the trolley travel direction. Small diagonal braces may be added at the top of the landside and waterside O-frames to maintain stiffness in the gantry travel, and for strengthening. In areas of high seismicity, the seismic performance of the crane should be evaluated. It is practical to strengthen or provide ductile details for adequate seismic performance.

Many contractors have specialized jacking systems that can raise a crane in one day. Additional time is required for preparation, fabrication of inserts, and modification of non-structural elements such as the elevator, electrical components, stairs and platforms, and for other structural modifications such as stiffening the portal frame. Specialized jacking frames, shown in Figure 4, rest on the sill beam of the crane and maintain a load path through the crane's wheels onto the wharf.

The cost to raise a crane varies, however a standard raise is around $1 million including associated modifications.

Ship Class	Panamax	New Panamax	Jumbo-23
# CONTAINERS WIDE	13	19	23
VESSEL WIDTH	32.3 m	49 m	59 m

Panamax: The largest ship that can navigate the current Panama Canal.
New Panamax: The largest ship that can navigate the expanded Panama Canal to be operational in 2014.
Jumbo-23: 18,000 TEU capacity ship based on the Triple-E class ships ordered by Maersk, delivery in 2014.

Table 1. Ship sizes.

Increase outreach

Recently, many owners have purchased container cranes that can service ships with 22 containers across, "22-wide ships." The outreach may be a little too short for the larger Jumbo-23 ships. Usually little effort is required to increase the outreach by one container. For increases up to about two meters, it is often practical to make modifications to the trolley, trolley runway, stops, bumpers, the platform at the boom tip, and runway support structures.

For larger increases, more significant modifications are required. Outreach is often increased by removing the end of the boom, modifying it on the quay, and reinstalling it on the boom tip. Sometimes it is necessary to remove the entire boom and modify it on the quay. Other structural modifications may include replacing the forestays with stronger stays and strengthening the upper diagonal and apex structure.

The boom hoist capacity may not be capable of lifting a heavier boom. Sheaves are often added to the existing hoist system without changing the motor or the drum. The increased length of hoist rope is often double-wrapped on the existing drum. To avoid double wrapping, the boom may be stowed in a partially raised position. Unlike the boom hoist drum, it is not practical to double-wrap the main hoist or the trolley tow ropes. If the existing drum grooves cannot accommodate the increased rope length, the dead wraps can be moved to the ungrooved portion of the drum. If there is no room for the additional rope, a new drum would be required.

The cost to increase the outreach varies. If only localized modifications are required, the cost can be less than $200,000. If major structural and mechanical modifications are required, the cost can be $1 million–$1.5 million.

Figure 4. Crane raise and leg insert installation.

Increased wind loading

The increased wind loading on the modified crane may require strengthening of the crane frame. Diagonal knee braces may be added to the O-frames, as noted above. The crane and wharf stowage hardware may also need to be strengthened. The wharf strength may prove to be adequate by new calculations.

Upgrades

Making major modifications presents an opportunity for upgrading crane systems. Common upgrades include replacing the crane drives and controls, and repainting. Increasing the crane lift capacity to convert from single to twin-40 lift capability is becoming a common consideration. Upgrading drives and controls typically costs around $1 million.

Approach and considerations

The first step in purchasing a new crane or modifying an existing crane is to establish the design criteria.

To decide whether to modify an existing crane, it is worthwhile to perform a study to determine the scope of modifications (including upgrades), estimate the cost, evaluate the wheel loads, and consider improving seismic performance. The scope of modifications is often underestimated.

If the existing wheel load capacities are an issue, an engineering evaluation of the wharf capacity usually justifies additional capacity. If additional capacity cannot be justified, it is best to perform an engineering evaluation to determine if it is practical to procure new cranes with acceptable wheel loads; otherwise,

Figure 5. Boom extension insert.

wharf modifications may be required.

After deciding to modify, a decision on how to construct the modifications must be made. Design-build is often preferred so the contractor is responsible for the design. Regardless of approach, a thorough specification should be developed. Even with design-build contracts, it is often worthwhile to perform engineering and provide design drawings to potential contractors. This eliminates the cost of redundant engineering required for bidding, and clarifies more complex engineering issues, for example, what modifications are required to upgrade the crane's seismic performance. A more complete bid document will reduce the contingency amount the contractor will add.

As a rule, better documents produce uniformity and lower bids. Allowing the contractors to submit alternative concept designs may also lower the bid price.

ABOUT THE AUTHORS AND COMPANY

Erik Soderberg is a Liftech structural engineer and vice president with 17 years of experience in the design, review, and modification of a variety of structures, including container cranes, wharves, buildings, heavy lift equipment, and various rigging structures. He has consulted on hundreds of cranes, participated in the design of several wharf structures, and has designed many crane transfer systems ranging from curved rails to shuttle systems. He has engineered repairs for dozens of container crane structures and for several bulk loaders. His field skills include an understanding of heat straightening techniques and the ability to develop repair procedures on site.

Derrick Lind is a Liftech structural engineer and associate with 15 years of experience designing and evaluating various structural systems for commercial, industrial, and transportation facilities, including buildings, marine structures, wharves, bridges, and container cranes. His work includes structural analysis and design, supervising engineers, coordinating subconsultants' work, and managing project budgets and schedules.

Liftech Consultants Inc. is a consulting engineering firm, founded in 1964, with special expertise in the design of dockside container handling cranes and other complex structures. Liftech's experience includes structural design for wharves and wharf structures, heavy lift structures, buildings, container yard structures, and container handling equipment. National and international clients include owners, engineers, operators, manufacturers, and riggers.

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