The Floaterm Concept: Reducing Terminal Congestion with Waterside Cranes

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Introduction

Container terminals are becoming increasingly more congested and expensive to operate. Highways and railways are already congested by container traffic and this congestion will worsen.

In 2006, Secretary of Transportation Norman Mineta, and the U.S. Department of Transportation expressed serious concerns about congestion. Norman Mineta called congestion one of the single largest threats to the economy. He further emphasized, “We need a new approach and we need it now.” The USDOT issued the National Strategy to Reduce Congestion that provides a plan for federal, state, and local officials to tackle congestion.[1] Pollution from port operations is also a rising concern. These factors create a growing need for new, more economical terminal operation methods. Floaterm is a concept that could help reduce pollution and congestion at ports and the arteries feeding them.

The Floaterm concept utilizes waterside container cranes on a barge to form, in effect, an offshore wharf. The container ship is moored to the crane barge or vice versa. Containers are transferred from the ship to the barge deck or to feeder barges.

The concept was originally developed by Liftech in 2000 at the suggestion of the Port of Oakland Executive Director Charles Foster. Simultaneously, Dr. Asaf Ashar of Louisiana State University developed a parallel concept. Investigators at Delft University studied the Floaterm concept in 2005. Although the concept may

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[1] AAPA Seaports Magazine Fall 2006

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not be economically viable at this time, the costs of conventional waterfront terminal development and operations combined with the associated congestion and pollution, will eventually justify full development of the Floaterm concept.

Arrangement and Applications

This paper presents two applications of Floaterm concepts: midstream and two-sided operations. Engineering calculations have been prepared to verify the technical feasibility of the concepts, but are not included here.

Midstream Application

General

For the Floaterm midstream application, shown in Figures 1 and 2, ships berth at the crane barge offshore, and cranes move containers between the ship and smaller feeder barges. The containers are not sorted as they are unloaded; they are simply transferred between the ship and the feeder barges. The containers would be sorted upstream at a remote terminal.

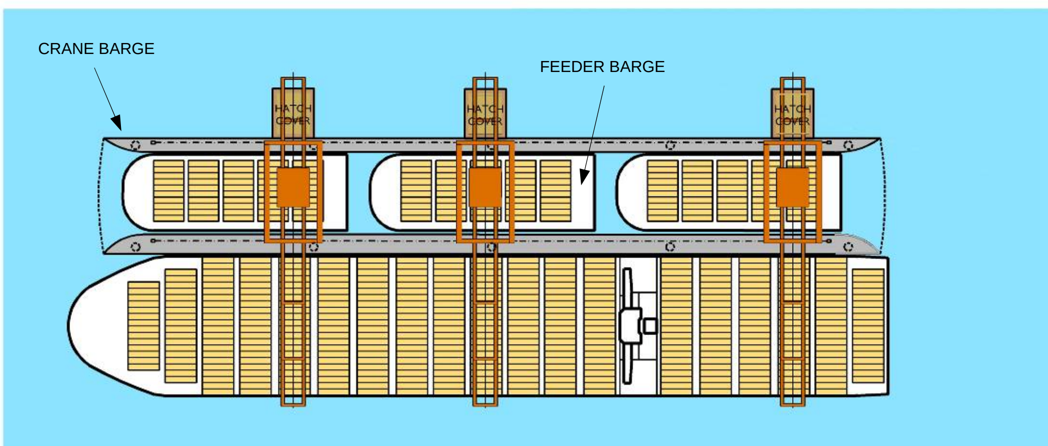

Figure 1. Plan—Midstream application

The midstream application saves berthing space and removes traffic from the wharf and from the yard off terminal to the hinterlands. Containers are transported to shore facilities by feeder barges that are much smaller than the ship. The feeder barges may travel to nearby shallow-draft terminals that provide minimal vessel clearance.

The midstream ship berthing process is similar to that at a marginal wharf. The ship berths alongside the barge and is held by Cavotec-style suction fenders.

Feeder barges are pushed or towed to a channel built into the crane barge. The feeder barges are moved along the channel by automated Cavotec-style fenders

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that grip the ship and maintain its position relative to the barge. These fenders "walk" the feeder barge within the channel to adjust relative longitudinal feeder barge-to-crane barge position. The ship-to-"shore" (STS) cranes and the crane barge are electrically powered by cables from a dolphin stationed near the stability spuds, shown in Figure 2. The dolphin also provides sufficient power for cold-ironing, which further reduces pollution.

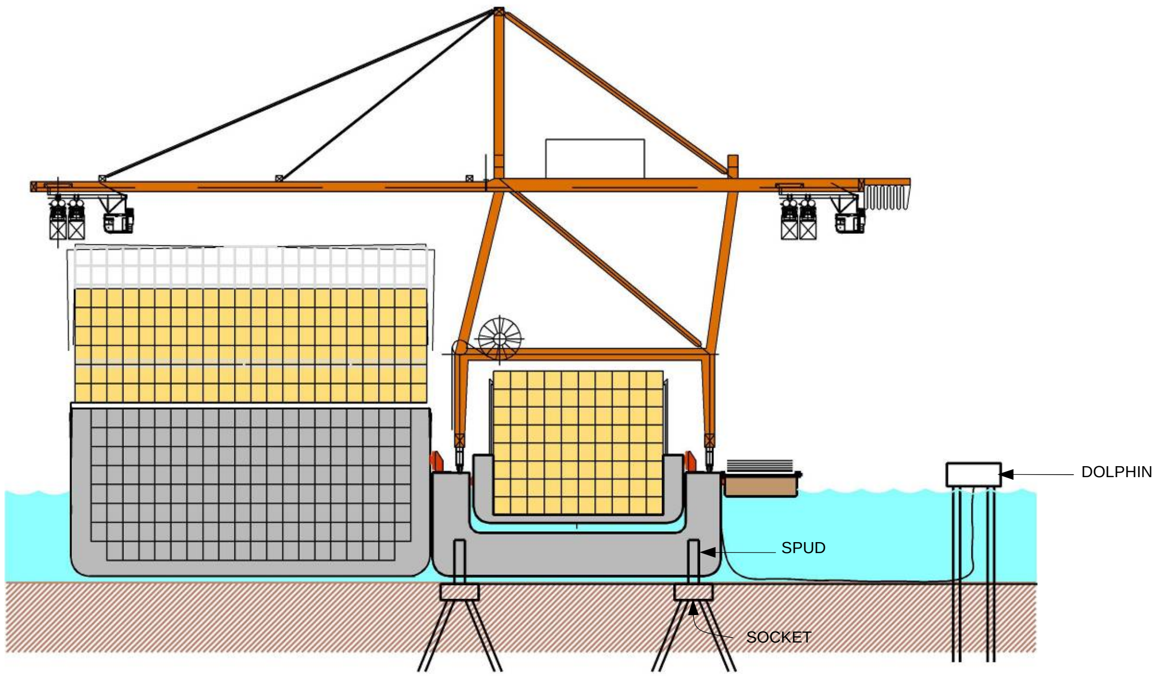

Figure 2. Section—Midstream application

Crane Barge

The crane barge is fixed in the midstream location by either retractable spuds or by a mooring system. Self-propulsion is not necessary on the crane barge, since it is not relocated often. Tugs move the crane barge on the rare occasion that it must be relocated.

STS Operations

The STS cranes operate over each ship hatch in the conventional way. A space between the bow and stern of adjacent barges allows for some adjustment so that one ship hatch can be unloaded without moving the adjacent barge. Occasionally, some of the cranes may need to wait while the first crane in line finishes loading its barge.

Cranes

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Up to four STS container cranes operate on a barge. These cranes are the same as conventional landside quay-side cranes. The productivity of these cranes is comparable to landside cranes.

Operating and Maintenance Personnel

Workers are transported to and from the barge by work boats instead of vans. No permanent personnel are required when the barge is not operating. All maintenance is performed on the barge in same way it is performed ashore. No special workers or equipment are required except for the work boat and the work boat staff.

Propulsion and Power

The barge is self-propelled by propeller pods located at the corners. A diesel engine on the barge is sufficient to power the pods and miscellaneous equipment. During vessel operations the barge engine is off and electrical power is transmitted by cable from shore. The cable may be disconnected when the barge is relocated.

Stability

Without stabilization spuds the barge is very stable, listing less than one degree due to trolley loads, even during vessel operations. However, to further improve stability, retractable stability spuds extend from the barge and insert into foundation sockets, as was shown in Figure 2. Jets on the bottom of the spuds clean the socket as the spud is inserted. This eliminates all list and trim but allows for vertical translation due to tidal variations. The spuds also hold the barge in position.

Feeder Barge Operations with Midstream Application

Feeder barges travel through a channel in the hull of the crane barge as was shown in Figure 2. Tugs maneuver the feeder barges into the hull channel. Once in the channel, automated fenders grip the feeder barges and move them along the channel. The feeder barge size and function are determined by the specific upstream conditions.

The largest feeder barge carries five rows of ten-wide by eight-high stacks of 40- to 45-foot containers. To avoid excessive labor costs, IBCs are not used. Instead, full height cell guides restrain the stacks. The restraints are able to handle 20-, 40-, and 45-foot containers. The details of the restraint of 40 and 45 depend on the expected mix of lengths. Since the containers above the ship’s main deck may be 45-footers and those below may be 40-footers, the cell guides are adjustable to suit both container sizes. Automatically adjustable fore and aft stops are provided.

The feeder barges are either towed or pushed upstream, depending on the specific conditions.

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Midstream Application Variations

Instead of feeder barges traveling within the crane barge hull, the hull could be designed to have a flat deck where containers are stored until feeder barges come along side. The feeder barge can be designed without a crane, to be loaded and unloaded by the crane barge cranes, or with a crane on the feeder barge itself. The latter design allows the containers to be sorted on the crane barge deck and routed to specific destination from the feeder barges. This idea is discussed below in the remote terminal operations section.

Midstream Application and the Remote Terminal

Upstream, the feeder barges are unloaded/loaded at remote terminals, either by landside cranes or cranes mounted on the feeder barges. One landside crane arrangement allows the feeder barge to berth in a slip, shown in Figures 3 and 4. Another landside crane arrangement, shown in Figure 5, allows the feeder barges to berth at a marginal wharf.

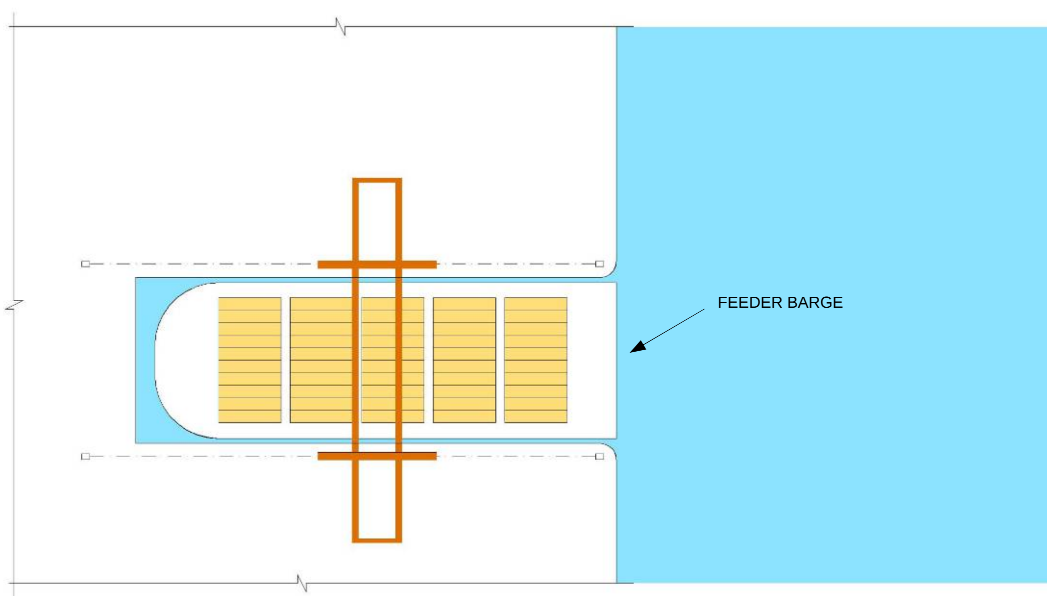

Figure 3. Plan—Feeder barge at remote terminal

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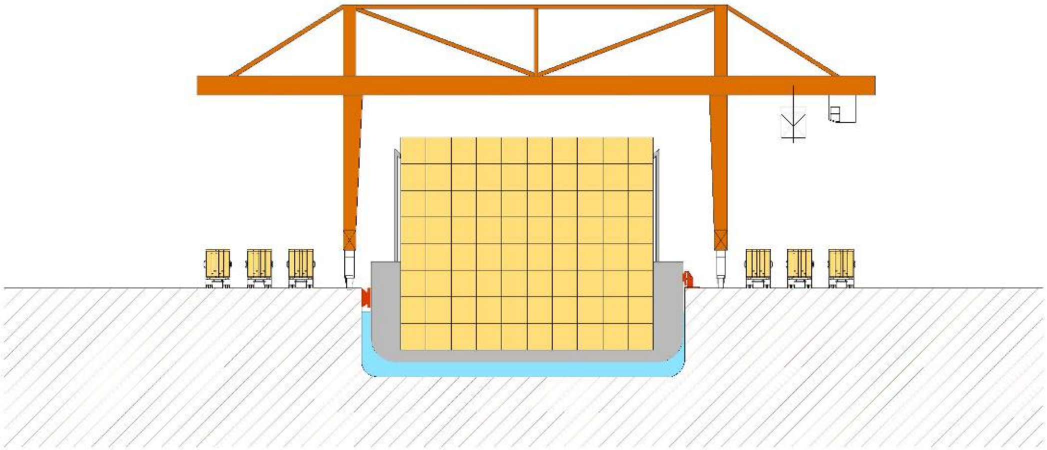

Figure 4. Section—Feeder barge at remote terminal

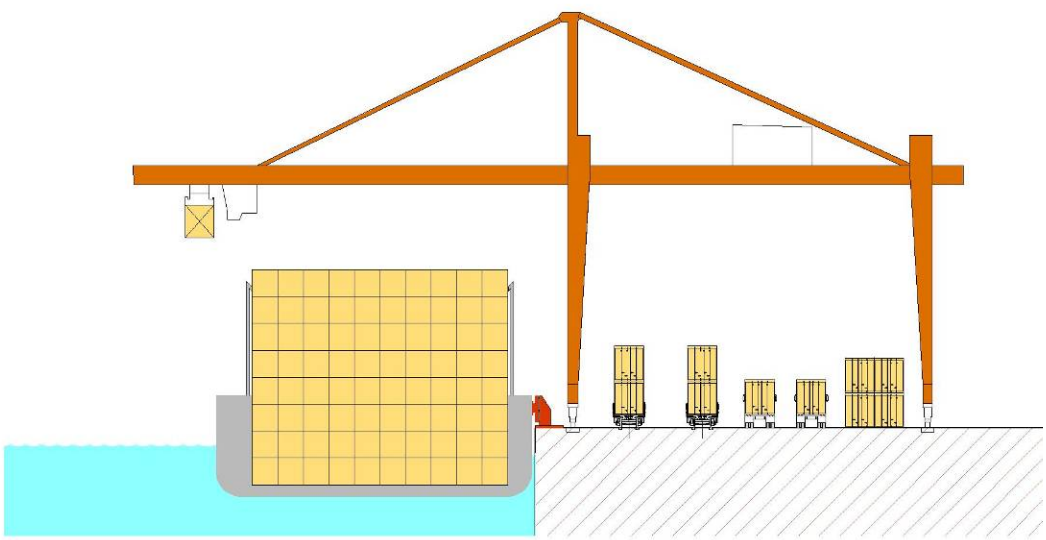

Figure 5. Section—Feeder barge at remote marginal wharf

Regardless of the landside crane arrangement, the containers come to the remote terminal in the inverse order that they come off the ship. Just as the containers in a conventional shore side operation are sorted in the yard, the container in the remote yard will be sorted in the yard. The inverse order will not effect yard operations.

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In Hawaii, Matson currently operates feeder barges with barge-mounted cranes. A similar arrangement is shown in Figure 6. The Matson barges can load and unload at wharves without shore side cranes. There are two advantages to the barge-mounted crane variation: shore side cranes are not required, and the containers on the feeder barges can be sorted for each destination. Feeder barges designed with cranes must load/unload both at the Floaterm and at the remote terminal, since cranes loading/unloading at the remote terminal would be in the way.

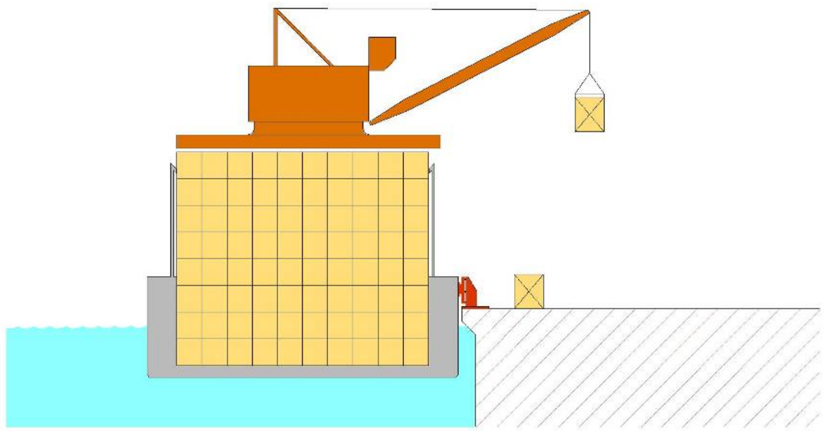

Figure 6. Section—Crane-Mounted feeder barge at remote terminal

Two-Sided Application

General

The two-sided concept was originally applied at the Ceres Terminal in Amsterdam. A ship berths in a slip with cranes on both sides. The terminal was completed in 2002 but has only recently begun operations.

The ship is berthed between a marginal wharf and a movable offshore crane barge, as shown in Figures 7 and 8. The ships may be berthed the normal way, since the barge can move out of the way under its own power. The arrangement in Figure 7 also shows the option of feeder barge service at the crane backreach.

The primary advantage of the Floaterm offshore crane barge is the availability of more lanes underneath the cranes, which reduces congestion on the wharf. Congestion in the yard may increase. However, a suitable backlands operation combined with the additional lanes, allows production to nearly double. With dual hoist tandem-40 cranes on both the wharf and the barge, production would be expected to more than double that of a conventional terminal system. Based on reports from Asian ports, six cranes on one ship could produce over 300 moves per hour.

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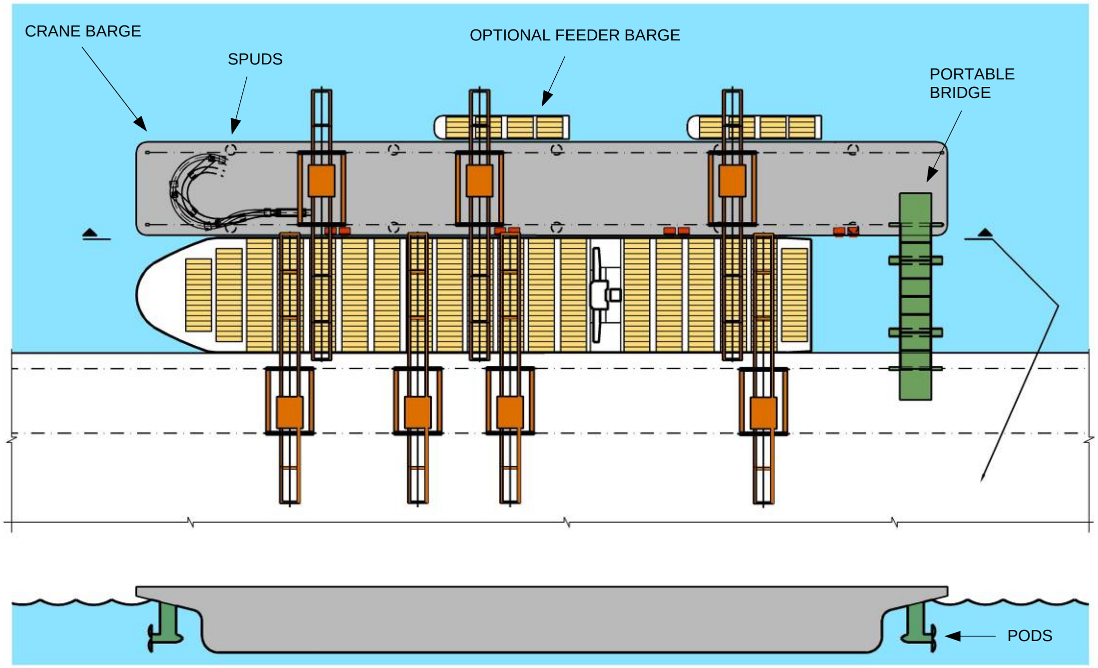

Figure 7. Plan—Two-Sided application

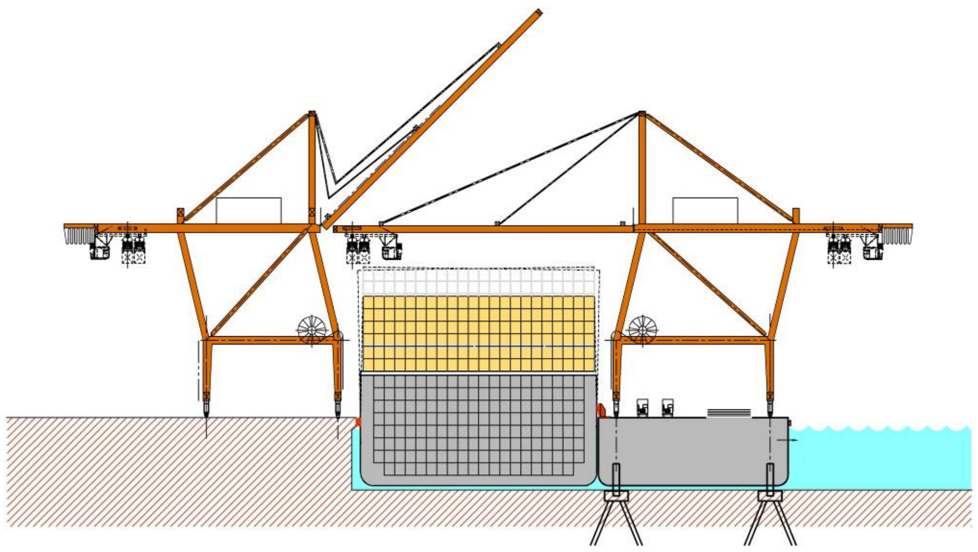

Figure 8. Section—Two-Sided application

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Mooring and Positioning

Cavotec-style automated mooring devices are used to hold the crane barge against the ship. The pneumatic fenders walk along the ship's hull to the control relative longitudinal barge-ship position.

Bridge

A bridge, shown in Figure 9, provides traffic lanes to the shore. The bridge is similar to the Matson RoRo bowstring bridges, which are relatively light. During normal operations, the bridge is supported at each end by a header and wheels resting on the crane rails. The bridge supports allow for all six potential barge motions. When the bridge is moved, submerged tanks are filled with air. The buoyancy of the tanks lifts the bridge off of the barge and wharf. The waterline cross section of pedestals connecting the tanks and the bridge provides stability so that the floating bridge may be moved by tugs or other equipment.

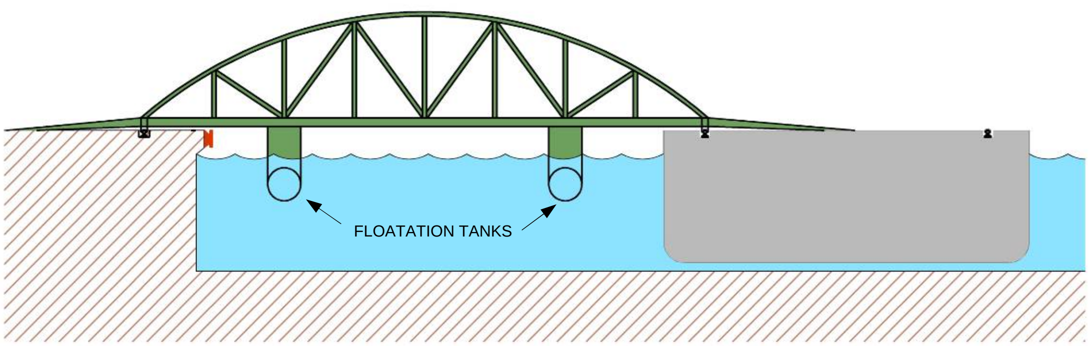

Figure 9. Bridge section

Conclusion

The Floaterm concept can alleviate increasing congestion and pollution at container terminals by expanding the wharf—either from the land to the water or to midstream. The midstream application reduces pollution and yard and urban traffic by using waterways instead of highways and railways. The two-sided application reduces under-crane traffic and increases productivity. With increased production, the ship spends less time at the port, and more berths are available.

Waterside barge-mounted cranes are good options for overly-congested and polluted ports that need to expand but have limited land available. Although Floaterm may not be economically viable today, the escalating costs of conventional operations, the off port traffic congestion, and the damage from pollution will one day compel Floaterm from conception to development stage.

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Acknowledgements

For their comments and assistance, the authors would like to thank Dr. Asaf Ashar, Louisiana State University; Charles Foster, Port of Oakland; David Olsen, American President Lines, Limited; Mark Sisson, JWD Group/DMJM Harris; and Ed Stephens, Matson Navigation Company.

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