Concept High Productivity STS Cranes

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ABSTRACT

Ships 23 containers abeam, with approximately 20,000 TEU containers, are now in operation and larger ships are in the works. These "ultra large container ships" carry 50% more containers than those in operation just a few years ago. Ship-to-shore container crane production levels need to be increased to meet the needs of the new ships.

This paper presents an array of crane concepts and systems that can provide the productivity required to quickly service large ships in, or soon to be in, service. The paper also discusses existing and future systems, unique aspects of the systems, advantages and disadvantages, and expected wharf loads.

Systems presented range from traditional cranes that can simultaneously lift multiple containers, to revolutionary cranes on elevated girders with multiple hoist systems that can move containers from the vessel directly into the yard.

INTRODUCTION

Container ship sizes are continually growing. While ship volumes have increased drastically over time, ship lengths and the number of cranes that can fit along the ship have only increased slightly.

Crane production has historically exceeded yard production, but with the larger ships and improved yard productivity, there is a much greater demand for more productive ship-to-shore crane systems. To address the demand for more productive cranes, recent designs have incorporated significant changes. There has also been increasing consideration and development of concept systems to improve productivity.

This paper provides an overview of existing recent and future high-productivity ship-to-shore container handling systems. Refer to Liftech's related paper on crane load considerations for these systems, "Crane Loads – Triple E Class and Beyond," ASCE Ports 2016.

RECENT SYSTEMS

Tandem and Triple Lift Main Hoists

One of the significant changes in crane systems is the ship trolley's ability to lift more than two twenty foot containers at once. Tandem dual hoist or single hoist systems capable of hoisting two forty foot containers or four twenty foot containers were developed around 2000, and many have been built since. Figure 1 shows a dual hoist tandem lift crane. The productivity of these systems has been improving as the design has evolved. The operational challenges include alignment of multiple spreaders with multiple containers and removing the inter box connectors.

Figure 1. Tandem hoist system.

A dual hoist trolley capable of handling six twenty foot containers has been built by ZPMC, as shown in Figure 2. Three spreaders hang from the trolley. The operational problems encountered with the double spreader system are compounded with the triple spreader system.

Figure 2. Dual hoist – triple spreader system.

Traditional crane structural, mechanical, and electrical systems are suitable for the tandem and triple main hoist systems. The headblock and (sometimes) spreader systems, however, are drastically different from traditional systems.

The main hoist or multiple hoists are usually located in the machinery house and not on the trolley. Crane wheel gages are often 35 m to 40 m to increase the truck lanes between the crane legs. The greater gage reduces the leverage at full outreach and backreach and the ballast needed for stability.

Semi-Automated Systems with Added Shore Hoists

Cranes with both ship and shore hoists were conceived and developed in the late 1970s and 1980s to increase production. See Figure 3.

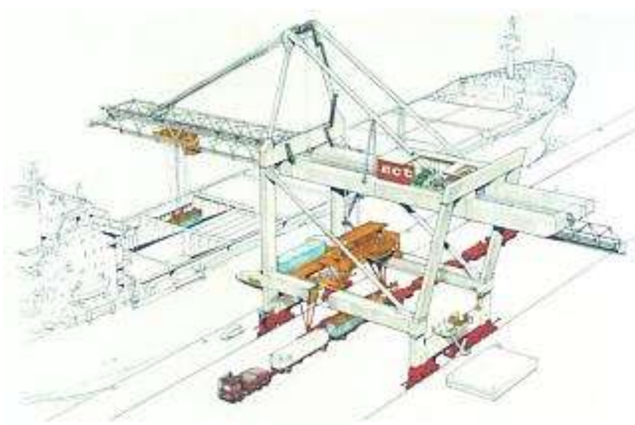

Figure 3. ECT dual hoist system by Nelcon in the 1970s.

These systems had limited use when first developed but are now more popular because of the development of automated shore hoist controls and other control improvements. See Figure 4.

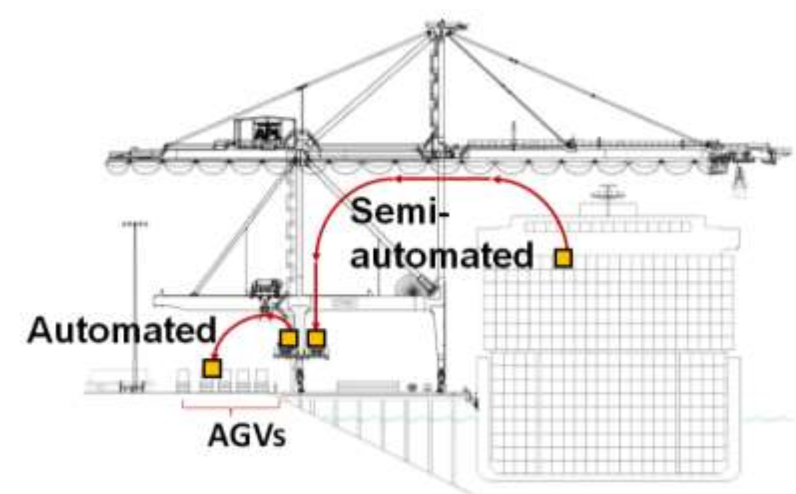

Figure 4. Automated dual hoist systems.

These cranes use modern control systems but otherwise use traditional structural, mechanical, and electrical systems. Increased costs are primarily associated with the shore hoist system. Landside wheel loads are significantly greater.

Cranes on Either Side

Ideally, cranes would be able to work every container row on a ship simultaneously. This was achieved with cranes on either side of a slip at the Ceres facility in Amsterdam, as shown in Figures 5 and 6.

Figures 5 and 6. Ship in a slip – Ceres Amsterdam.

Many technical issues relating to closely spaced cranes were resolved during this project. Primarily, advanced anti-collision systems were developed to make it practical for the cranes to work so close together. Traditional crane systems are used, but the slip is unusual infrastructure and also requires unusual ship handling.

Due to factors unrelated to the cranes, the Ceres Amsterdam ship in a slip project was eventually abandoned and the cranes relocated to other terminals.

FUTURE SYSTEMS

The following section presents some future crane concepts for increased productivity.

Floaterm

Floating terminals have been considered by designers and planners for many years. In addition to the advantage of not needing new land to service ships, when the terminal is located waterside of a berthed ship as shown in the figures above, the vessel can be worked from both sides similar to the ship in a slip of Ceres Amsterdam.

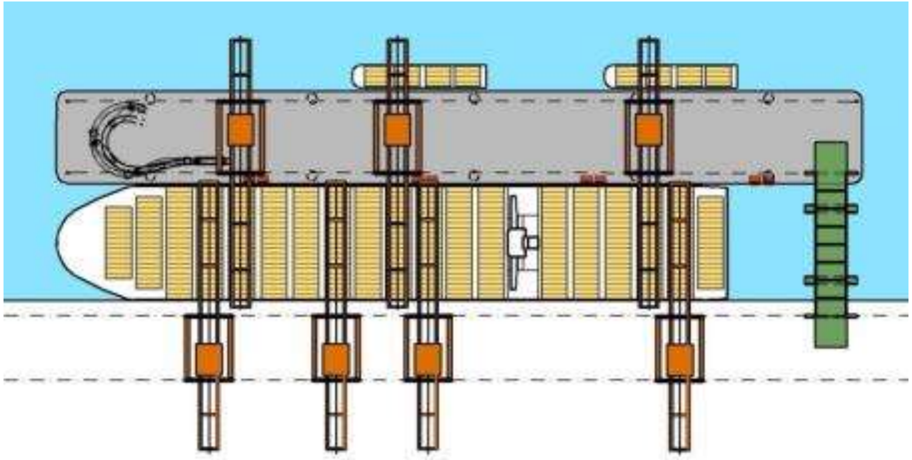

Figure 7. Floaterm – plan view.

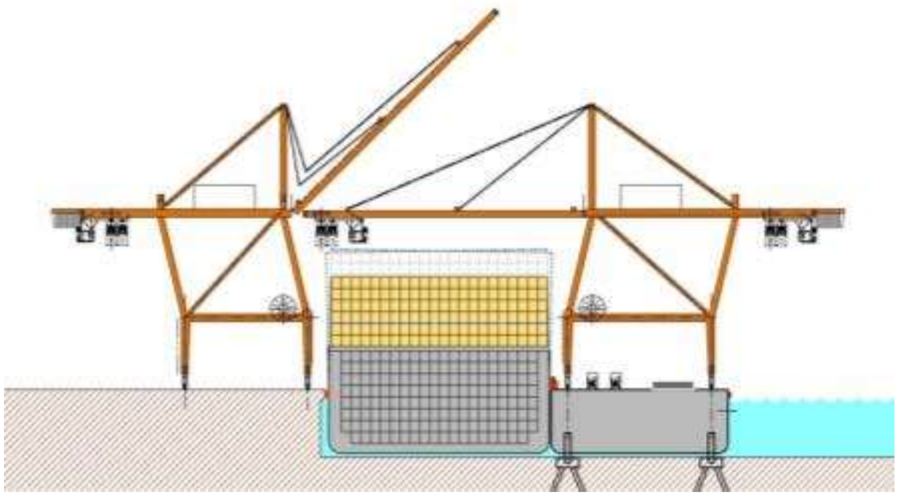

Figure 8. Floaterm – elevation.

Traditional crane systems can be used combined with already developed anti-collision systems. The float support is conventional. Float movements can be controlled with moving counterweights inside the float, assist spuds, by controlling the trolley movements of the various cranes on the float, or by providing a wide enough float. Cavotec Moormaster-type mooring systems can be used to adjust the float and vessel elevation without ballasting. Other significant issues to be addressed include stowing the float system, power delivery, and traffic flow to and from the barge.

Linear Systems

A variety of linear system concepts that involve multiple trolleys, multiple hoists, container conveyance carts, non-typical container systems, or combinations of these have been presented over the years. Some of these systems are presented below. The costs and wheel loads for these systems vary but are typically much larger than traditional systems.

Liftech Supercrane

The Liftech Supercrane concept is that of a conveyor with a continuous unloading cycle.

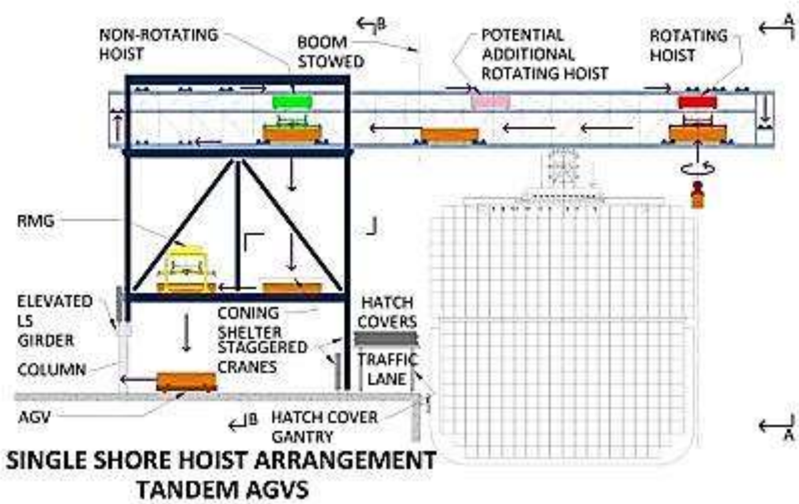

Figure 9. Liftech Supercrane – single shore hoist.

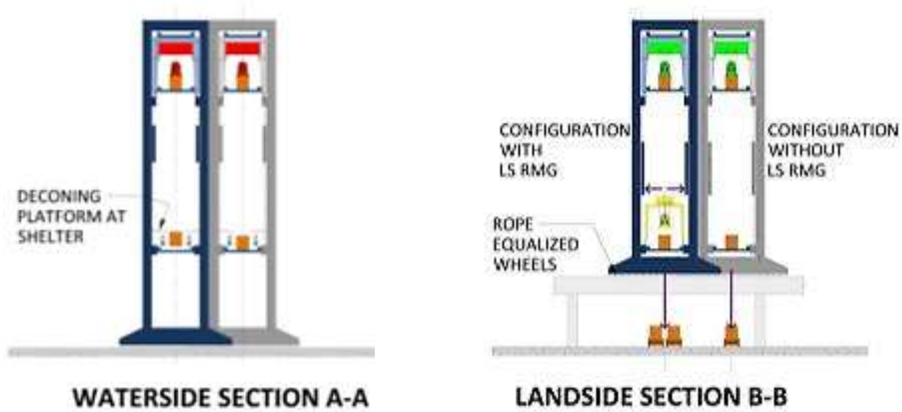

Figure 10. Liftech Supercrane – end view.

A hoist trolley parks over a hatch or lane and does not travel during normal operation. The trolley is relocated when a hatch is completed. A hoist is on each trolley. Additional trolley and hoist systems can be added. The trolley rotates the lifted container and sets it onto to two small rail mounted carts that carry the container to the parked landside hoists. The hoist sets the container on a deconing platform at the portal beam level, and then lowers the container to the wharf level.

After bringing a container to the landside hoists, each narrow cart is lifted to an upper runway on the top chord of the crane boom and then returns to the waterside end of the boom. There is no waiting of one container to be finished before the next can be loaded. By rotating the containers, narrow cranes can work adjacent hatches.

The system requires transporting the containers from the crane into the yard perpendicular to the gantry rails, a significant change from current practices. The expectation is that this movement will be practical with computer controlled automated guided vehicles. The landside of the cranes must be supported on elevated girders to provide access. Adjacent cranes run on offset rails to permit the close crane spacing. Special wheel load equalizing systems that have been developed on recent projects can be used to limit the height of the sill beam and improve clearance.

Paceco Supertainer

The Paceco Supertainer concept is a traditional crane structure that has a movable hoist over the ship that sets containers onto a carrier at boom level, which carries containers to a shore hoist that sets containers through a funnel guide onto vehicles below.

Figure 11. Paceco Supertainer.

Carrier Crane - Delft University

The Carrier crane concept is similar to the Liftech Supercrane in having multiple hoists dedicated over the ship and over landside and carts to convey containers between ship and shore hoists. It does not rotate the containers, so the cranes will not work adjacent container rows and require a wide trolley girder and boom spacing. The carts return from landside to the waterside on a lower rail system requiring coordination with the hoists to avoid conflict. The carts are slightly wider than those of the Liftech Supercrane, each carrying an entire container instead of container ends.

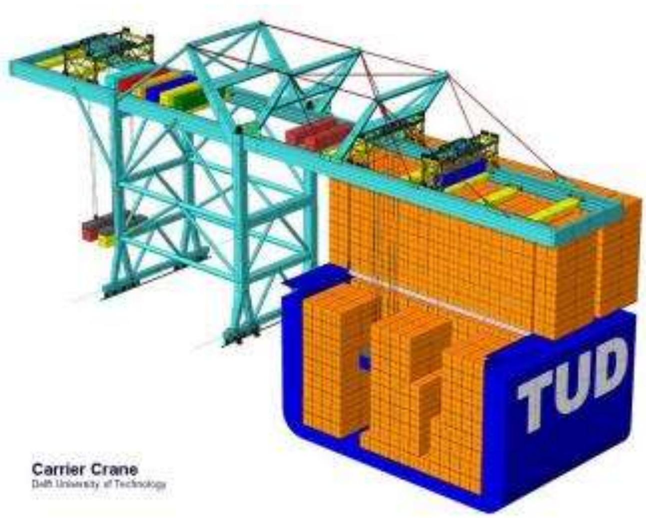

Figure 12. Carrier crane – Delft University.

APMT FastNet

The APMT FastNet system includes unconventional crane and support structures with mostly conventional mechanical and electrical systems. The crane supports permit working on adjacent hatches except at the movable waterside girder support columns. The closely spaced cranes and substantial moving supports result in very large wharf loads. The large wheel loads and clearance requirements resulted in the development of a wheel load equalization method that will be useful for similar systems with large wheel loads.

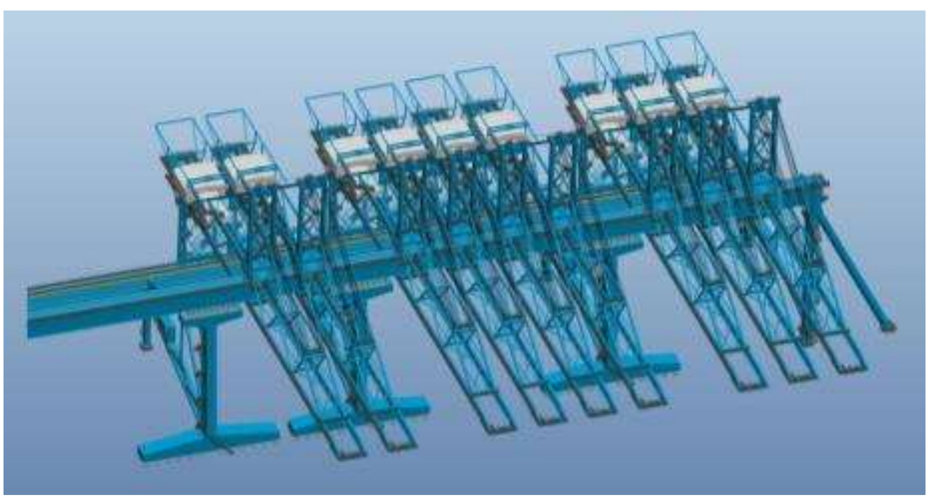

Figure 13. APMT FastNet system.

NGICT Crane System

The NGICT crane system includes narrow cranes on elevated girders that can service adjacent container rows. The waterside girder is back from the edge of the wharf as the trolley does not pass this girder. Yard storage exists under part of the crane system. This concept is similar to the Reggiane 'Octopus' concept.

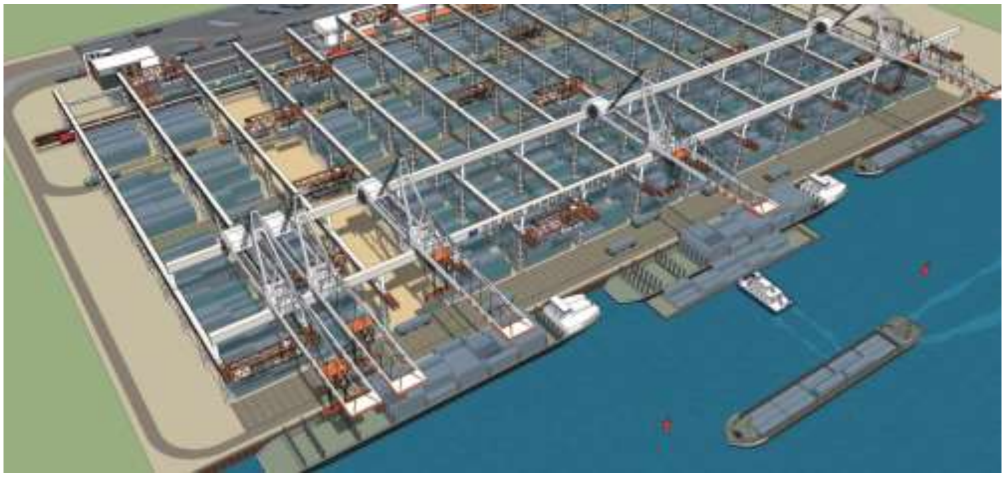

Figure 14. NGICT crane system.

CONCLUSION

Ultra large container ships have resulted in demand for increased ship-to-shore crane productivity. A variety of recent design changes have occurred including lifting multiple twenty foot containers, increased automation, and increased use of shore hoist systems.

Concepts have been developed for a variety of potential future systems that could drastically improve productivity. Many design issues for these potential future systems have been resolved in the past decade while others remain. As demand increases, so does the probability of an unconventional system being built that dramatically improves productivity.

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