

CRANES TO SERVE SHIP IN THE SLIP CERES PARAGON TERMINAL, AMSTERDAM

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Introduction

The Ceres Paragon terminal in Amsterdam has been getting a lot of attention because of its unique indented berth. Much has been written on the terminal; this paper will focus on the cranes that will serve the terminal. The indented berth, the first of its kind in the world, poses many special requirements and challenges for the cranes.

The indented berth is capable of serving ship from both sides. As many as nine cranes can operate on the ship in the slip at one time. Operating cranes on both sides of the ship introduces the potential of collision of cranes and boxes over the ship. This requires a reliable collision avoidance system.

Because the Port of Amsterdam is located within close proximity of a residential neighborhood, the container cranes at the terminal are subject to a noise abatement requirement. This requirement had a big impact on the design of the crane, resulting in some design changes. For example, the trolley design was changed from machinery trolley to rope-towed trolley. We believe that many ports will follow Port of Amsterdam and impose noise abatement requirements on new cranes. We will present the Port's noise abatement requirement, the methods to reduce noise, and the impact of the requirements on the cranes.

In addition to the collision avoidance system and noise abatement features, these cranes are among the biggest and the fastest container cranes. Each crane has an outreach of 61 m, capable of serving the future 22-wide vessel, and a lift capacity of 65 metric tons under the spreader and 100 metric tons under the cargo beam. The gantry frame of the crane leans back 6 m toward landside in order to clear the long boom from the other side of the slip. For a detailed listing of the main characteristics of the crane, see Appendix A.

This paper will present the challenges, special requirements, and design solutions for these cranes. We will also present some of their special features, including semi-automatic operation, corner transitioning, and intermittent rope supports. The features presented here are based on the cranes for the Ceres terminal, but many of these features will eventually be required for future cranes.



Fig. 1: Ceres terminal under construction



Fig. 2: Cranes are built in P. R. China

Collision avoidance systems

Since cranes from opposite sides of the ship will operate on adjacent holds, booms from opposite cranes may be within 10 m of each other. A double redundant safety system is provided to prevent boom-to-boom and spreader-to-spreader collision.

Three levels of collision avoidance protection are provided:

- 1. Central computer control
- 2. Protection equipment on the crane
- 3. Crane operator intervention

CENTRAL COMPUTER CONTROL

The central computer monitors the position and attitude of each crane and the crane system as a whole, to prevent the operator or the automated control from allowing any crane to interfere with any other crane on the terminal.

The central computer will be located in the terminal and linked to each dockside container crane by fiber optics. Sensors on each crane determine the positions of gantry, boom, trolley, hoist, and flipper. These positions are fed to the central computer through the fiber optic cable in the cable reel feed cable. The crane position is determined from dock-mounted transponders, magnetic reference points, and gantry wheel encoders.

The computer screens will show the real-time position of each crane as well as the position or attitude of the boom, trolley, hoist, flippers and twist locks of each crane. Collision avoidance functions monitored by the central computer are:

Crane-to-crane on both the straight and indented berths Crane-to-crane at the 90 degree corner Boom-to-boom clearances for cranes operating on opposite sides of the ship Boom-to-boom clearances for cranes passing on opposite sides of the ship Adjacent cell spreader protection for cranes operating on opposite sides of the ship. Curved rail switch orientation and interlock

All slow-down and safety zones can be adjusted from the terminal with controlled access to the computer programs.

A dedicated video screen in each operator's cab will show the relative position and crane number of each adjacent crane. When on the indented berth, the information will also include the relative position of the cranes on the opposite side of the berth. The operator will be able to compare the data of onboard distance sensors with visual observation for backup collision avoidance and system verification.

To support current and future automation, the computer will store ship-loading plans and show real-time loading and unloading of the ship, including weights and sizes of handled containers. In addition, enhanced software under development will allow container numbers to be entered from another source.

PROTECTION EQUIPMENT ON CRANE

In the event that the central computer fails or malfunctions, each crane is equipped with protection systems described below.

Gantry Bumpers

Time-proven hydraulic gantry bumpers, capable of absorbing full gantry speed impact, provide protection from crane-to-crane collision along the same gantry rail.

Boom-to-Boom Distance Sensors

A scanning laser system will measure the distance between booms in the operating position on all cranes working across from each other on the indented berth. The lasers can be adjusted for scanning angle and distance.

The boom-to-boom distance parallel to the gantry rail will be displayed in the operator's cab for verification of the laser data with the central computer position control data and the visual observation by the operator. If an out-of-tolerance error is detected, a position alert will be signaled to all operators and to the central computer for management action.

Dock Corner Permissive Limit Switching

Behind the operator's normal field of vision, there is a common area of the indented berth and the adjacent right angle berth where the backreach of one crane could collide with the other crane. In this blind spot, the laser system and operator intervention are considered unreliable.

In addition to central computer position control, a corner protection system is provided. The system consists of magnets buried in the dock and three-way switches on the cranes. The crane switches can be set to one of the following positions:

Position A, only the indented berth cranes have access to the corner. Position B, no crane has access to the corner Position C, only the marginal berth cranes have access to the corner

Normally, the switches on all cranes are set to position A.

Flipper Protection

When cranes on opposite sides of the ship are operating on adjacent cells or stacks, flipper action will be permitted only when the trolley is over the dock. This will prevent the spreader flippers from contact with each other or the load.

An exception is made when the operator needs to adjust the flippers to handle above deck containers, or when the operator wants to go into the ship's cell and finds the flippers down. In these cases, the central computer checks the hoist and trolley locations and the directions of travel of adjacent cranes prior to permitting flipper action.

CRANE OPERATOR INTERVENTION

Although the central computer position control will monitor boom positions on cranes on the opposite side of the indented berth, the most reliable system is for crane operators to observe their neighbor cranes. An operator should be able to identify the opposite crane visually by crane number and inform his intent to raise the boom by radio to the operators on the opposite crane.

Each crane is equipped with a light system that can operate on the indented berth. When the boom is fully raised, a green light will be visible on the crane at all times, even when the crane is stowed and not operational. The light is hardwired to a boom-up limit switch.

Semi-Automatic Operation

The intent of shipboard automation is to take the hoist and trolley to the best known position of the next ship interface as quickly and safely as possible and deliver control to the operator for final landing or cell guide entry. It is not intended for automation of entrance into ship cell guides, travel within cell guides, the landing of the spreader on containers, or the landing of containers onto the ship.

To determine the landing elevation of the container or spreader, two methods will be used:

- 1. Equipping the trolley with look-down sensors to map the profile of the containers on deck and in the ship's cell
- 2. Using an operator-initiated "learn cycle" to confirm the mapping

Based on the sensors and learning cycles provided, a display near the operating line of sight will show the remaining vertical and horizontal distance to the landing position. This will allow the operator to interact with the automation if an error is observed.

The automated system will locate the container or spreader within 600 mm vertically and 50 mm horizontally from the landing spot. The operator will then confirm the proper location, manually continue the landing and unlatching, and initiate the raising motion before the semi-automatic operation takes over.

Noise Abatement

A significant element of the crane design is the need to meet stringent noise abatement requirements due to the proximity of the terminal to a residential neighborhood. The specification requires that the equivalent sound power level of the crane shall not exceed 100 dB(A) for simultaneous main hoist motion and trolley motion. A sound power level of 100 dB(A) is equivalent to a noise pressure level of 55 dB(A) at a distance of 60 meter from the center of the crane trolley runway. A crane without any noise abatement treatment was measured at around 72 dB(A) at 60 m away for trolley travelling at full speed.

Noise reduction techniques used are:

- 1. Insulated machinery house: insulated walls and roof, second floor with noise insulation panels, special vents with sound absorbing material, plugs for the hatch opening, narrow insulated rope opening covers, isolation pads for machinery
- 2. Trolley: Rope-towed instead of machinery trolley, with eight wheels with buffers to reduce trolley wheel load and noise
- 3. Polyurethane festoon trolley wheels. Isolate festoon supports
- 4. Merford cab: less than 70 dB(A) inside the cab

Trolley

ROPE-TOWED TROLLEY

The noise abatement requirement resulted in the decision to use a rope-towed trolley instead of the initially specified machinery trolley. With the machinery trolley design, the biggest noise source is the trolley, either from the machinery inside the trolley or from the trolley wheels rolling on the rail. Noise-absorbing panels and vibration-isolation pads would reduce the noise from the machinery inside the trolley. However, the weight of these materials would significantly increase the trolley wheel load. The higher wheel load would then increase the rolling noise. Because of the complications involved in quieting the machinery trolley, the contractors were more confident meeting the noise-abatement requirement with a rope-towed trolley design. After considering noise abatement requirements, productivity and maintenance, the owners and their engineer agreed with the contractor's proposal to use the rope-towed trolley.

INTERMITTENT ROPE SUPPORT

With the rope-towed trolley design, there was concern that the rope would stretch and that catenary effect would reduce productivity. The catenary trolley is the typical solution for reducing the catenary effect. But even with the catenary trolley, the long runway will result in a big catenary effect. Intermittent rope supports spaced at about 25 m are used to control the rope catenary. The advantages of the rope supports are improved productivity, and no catenary trolleys are needed. The disadvantages include a more complex reeving system, more sheaves, and a potential shorter life of rope.





Fig. 3: Main Hoist Reeving

Fig. 4: Trolley Hoist Reeving

Transiting corner

RAIL TRANSITION

The cranes on the south side of the indented berth will also serve the marginal berth. Curved rails with compound geometry, switches, and frogs are provided to permit the cranes to work in the corner as well as go around the corner.

ROTATING GANTRY SYSTEM.

The gantry equalizer system articulation is designed in conjunction with the curved rail geometry to optimize the offset of each wheel with the rail. Main equalizer, sub equalizer, and tracks at each of the four corners are designed to rotate relative the each other about the vertical axis.

POWER CABLE MANEUVERING, CABLE REEL QUICK RELEASE

During corner travel, the power cable will be manually released from the cable guide. The cable reel will be controlled from the crane at ground level. The cable will be laid out, pulled to the corner and laid in the trench. A special cable with increased wear resistance will be used, since it may be dragged on concrete pavement.

RAIL GAUGE ADJUSTING FEATURE TO DEAL WITH POTENTIAL SPREAD OF GANTRY RAILS

The waterside rail girder is expected to move out approximately 40 mm during the first 10 years. The gantry equalizer system is provided with capability to adjust the rail gage in the future. The rails in the corner will be adjustable.

Status

The terminal and the cranes are expected to be operational on July 1, 2001. The status will be provided in the final paper with up-to-date information.

The Ceres Paragon terminal and the cranes are expected to handle the future 22-wide vessels in record time.

Credits

Amsterdam Port Authority – Tiddo Winkel Buiter, Chris van Velzen Ceres Terminals – Chris Kritikos, Calvin Whidden McKay International Engineers – Mechanical Engineers ZPMC – Crane Contractor ABB – Drive Supplier JWD – Terminal Planner

APPENDIX A

Main Characteristics

Manufacturer:

ZPMC, Shanghai, P. R. China

Drives and Supplier	·s:	
Full AC d	rives, motors	ABB
Reducers		
	Main Hoist, Boom Hoist, Trolley	Flenders
	Gantry	ZPMC
Brakes		Siegerland

Capacity:

Under spreader	65 t
Under cargo beam	up to 100 t

Size:

Gantry rail gage	30.48 m
Backreach from landside rail	15.00 m
Outreach from waterside rail	61.0 m
Lift height above waterside rail	36.0 m
Lift height, total	50.0 m
Clear height under portal beam	17.0 m
Overall height, boom down	71 m
Overall height, boom up	112 m
Out to out gantry bumpers	26.5 m

Speeds and Accelerations:

Main Hoist:

Mode	Speed	Acceleration Times	Deceleration Times
Hoisting with rated load	70 m/min	2.0 s	1.5 s
Hoisting with 40 t container	100 m/min	2.0 s	1.5 s

Hoisting with spreader	only 180 m/min	4.0 s	3.0 s
Trolley Drive			
	250 m/min	5.0 s	5.0 s

Weight:

Crane weight 1250 t

Factored wheel loads:

	Landside	Waterside
	t/wheel	t/wheel
Operating	78	130
Stowed	90	98

Note: eight wheels per corner





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