

North Carolina International Terminal Conceptual Wharf Design

PREPARED FOR: Bill Bennett, P.E.
North Carolina State Ports Authority

PREPARED BY: Max Mozo, CH2M HILL

DATE: March 18, 2008

Purpose

A conceptual design of the wharf structure at the North Carolina International Terminal was performed for the purposes of conceptual-level cost estimation. The wharf drawings were the result of this conceptual design. Table 1 presents a summary of the design criteria used to perform the conceptual-level design of the wharf structure at the North Carolina International Terminal.

TABLE 1
Wharf Configuration^a

Configuration Criteria	
Deck Elevation (ft).	+18.00 ft NGVD.
Dredge Depth (ft).	-52.5 ft plus 2.0 ft over-dredge allowance MLLW.
Container Crane Gage (ft).	100 ft-0 inch.
Fender and Bollard Spacing (ft).	60 ft-0 inch.

^a Vertical elevations would be referenced to NGVD. The specific datum would be identified in later phases of work. MLLW = -2.25 National Geodetic Vertical Datum (NGVD) 1929.

Wharf Configuration

Drawing No. 7, Wharf Conceptual Cross Section, shows a pile-supported wharf structure, with a sloping bottom from the berthing line up to a vertical bulkhead behind the land-side crane rail beam. The slope of the mudline from the berthing line up to the wall was assumed as 5 to 1. The top of deck elevation was assumed to be +18.00 ft. NGVD. The nominal operating dredge depth is -52.5 ft. MLLW, with a 2-ft over-dredge allowance, making the maintenance dredge depth -54.5 ft. MLLW. Under these assumptions, the overall height of the wharf at the dredge line is 74.75 ft. With an under-wharf slope of 5 to 1, the height of the land-side bulkhead is approximately 50 ft.

The majority of the wharf is assumed to be designed for a 1,000-pound-per-square-foot (psf) live load. The wharf is also configured to have a travel or service lane outboard of the water-side crane rail beam. This portion of the wharf is assumed to be designed for 400 psf.

An isolated electrical service trench is located outboard of the water-side crane rail beam for the container crane Panzer belt system.

Fenders and bollards would be spaced to accommodate container vessels ranging from barges to the 12,000-TEU project design vessel.

Foundation

The foundation of the wharf is assumed to be an open pile system consisting of 24-inch-square pre-stressed concrete piles. The capacity of these driven piles is estimated at approximately 250 tons each. Pre-stressed concrete piles are commonly used in this type of wharf construction due to their high capacity, lower cost, and superior serviceability characteristics compared with other foundation alternatives. Also, considering the height of the top of deck structure, 24-inch piles were chosen due to the relatively long unbraced length of the piles. Drawing No. 8, Wharf Conceptual Pile Plan, shows a conceptual pile plan.

Substructure

The substructure of the wharf is assumed to be cast-in-place concrete. The use of cast-in-place crane rail beams and piles caps would serve to create a structure with redundant load paths and continuity that would allow for dispersal of berthing energy and mooring line forces.

Superstructure

The superstructure is assumed to be simply supported concrete slabs supported by the cast-in-place crane rail beams. The superstructure slabs are ideally constructed from precast concrete slabs with a composite concrete topping. The use of precast concrete would greatly reduce the amount of construction over water. A variation of this system includes full-depth precast concrete slabs with non-composite asphalt or concrete wearing surface. The structure depth in the service lane is assumed to be 18 inches, with the remainder of the wharf assumed to be 24 inches.

Wharf Loads

The wharf deck (between rails) is assumed to carry a 1,000-psf minimum uniform live load distributed to produce maximum stress. Piles are assumed to be designed for 80 percent of uniform live load.¹

The deck (outboard of water-side rail) is assumed to carry a 400-psf uniform live load distributed to produce maximum stress and/or HS25 truck loading. Alternatively, based on actual conditions, HS20 truck loading could be used (Figure 1).

The bollard load for a 22/23 wide vessel is assumed to carry 150 metric tons.

Water-side rail setback is assumed to result from superimposing a 2.5-degree list on the design vessel and determining necessary clearance dimensions.

¹ Uniform load should not be considered within 5 ft of crane rails when combined with crane wheel loads. Uniform load should also not be considered when loadings such as truck loading, stacked containers, or other equipment are not considered.

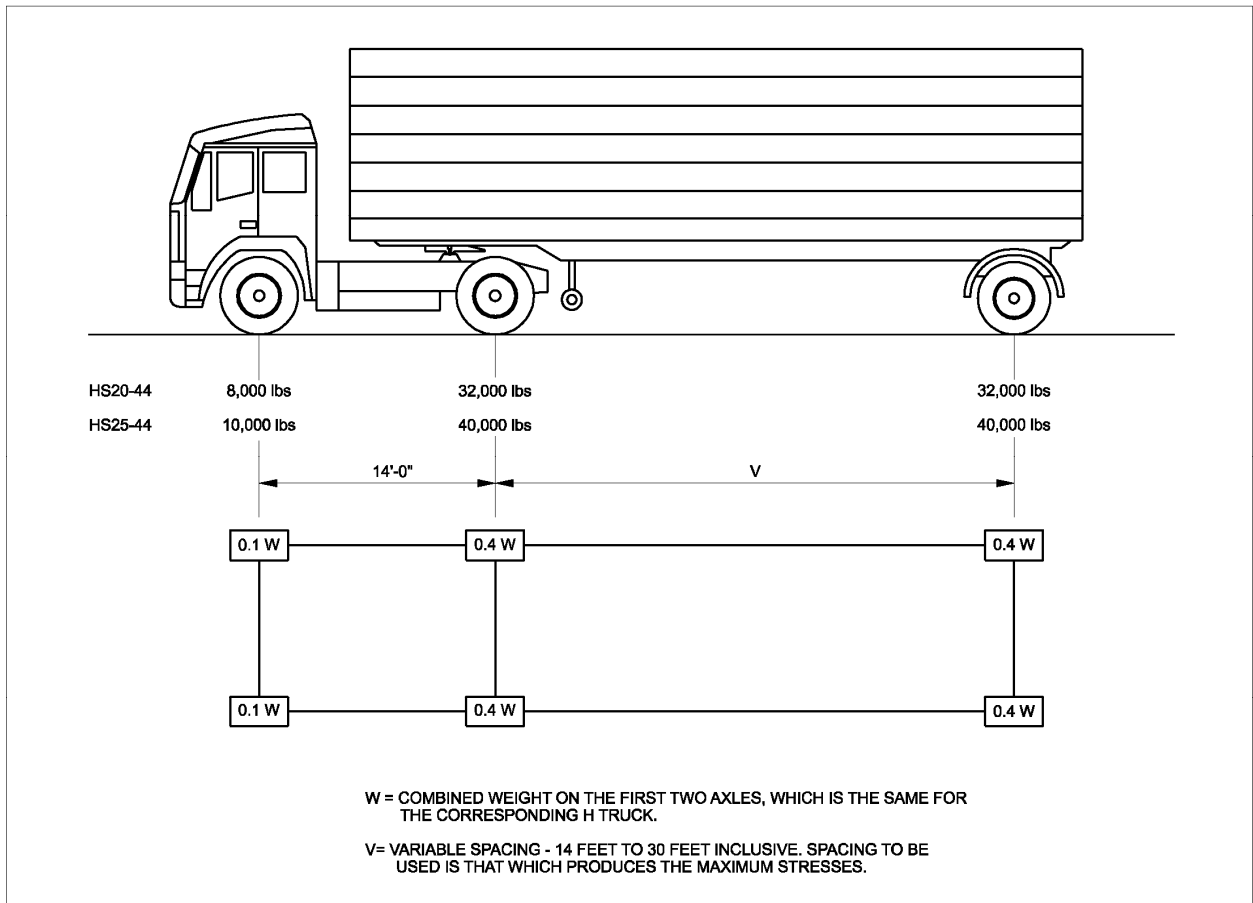


FIGURE 1
Description of Load Application for HS25 and HS20

Gantry Crane Loads

For purposes of this study, the following gantry crane characteristics have been assumed: 22 wide, 80 LT (tandem lift), 135-ft under-spreader, 100-ft gage, 60 miles per hour (mph) operating wind, 130 mph non-operating wind.

Wind Loading

The criteria for the extreme wind speed are based on the requirements in American Society of Civil Engineers (ASCE)-7-05, Minimum Design Loads for Building and Other Structures. The selection of an appropriate design wind speed is critical to the performance of structures in the operating wind condition. Figure 2 is the basic wind speed map used for the Eastern Gulf of Mexico and Southeastern US Hurricane Coastline. The appropriate project return period would be investigated in future studies and compared with the basic wind speed map.

Crane Rails/Support

Crane loadings are dependent upon the type of equipment and their capacity envisioned to be used during the lifetime of the facility. Below are loadings for cranes currently in use at other facilities worldwide, and are the assumed loadings for this study (“machinery-on-trolley” cranes are not considered).

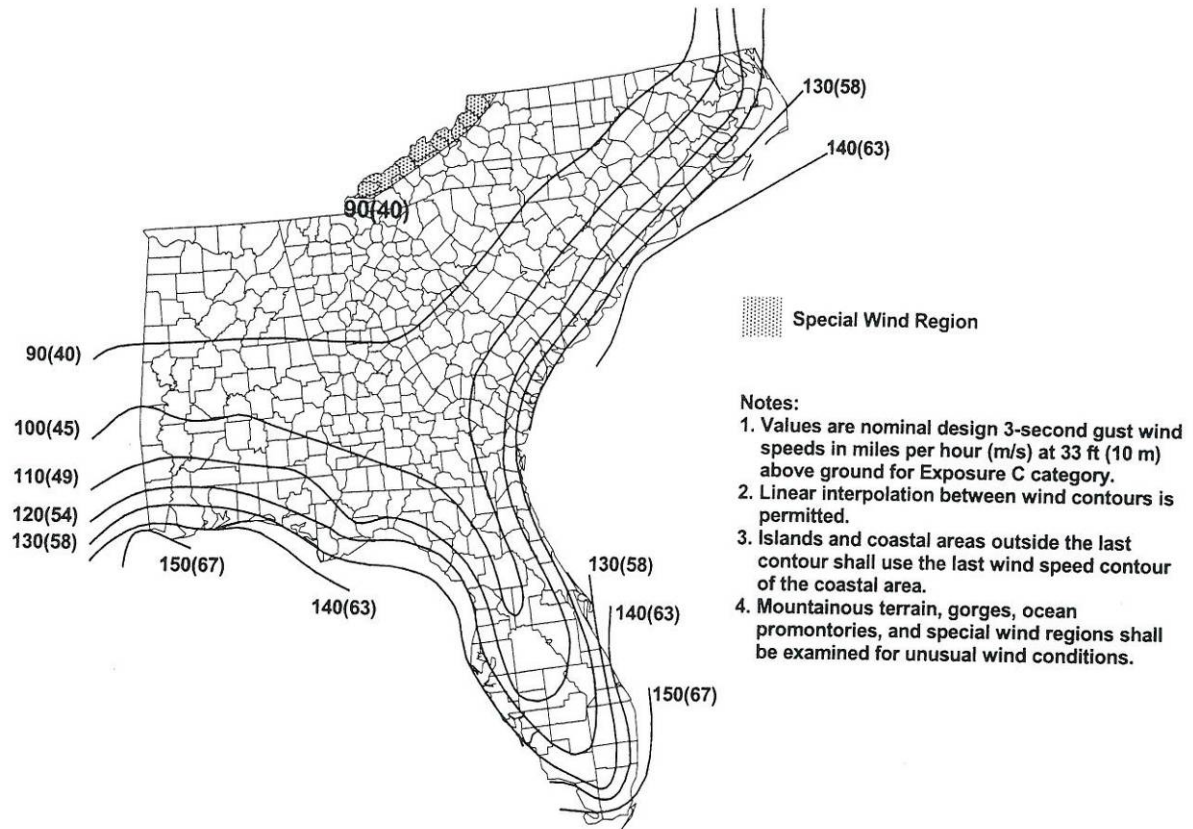


FIGURE 2
Basic Wind Speed Map – Eastern Gulf of Mexico and Southeastern US Hurricane Coastline

Assumed Vertical Loading

Loads are based on 10 wheels per corner.

Water-side Operating Equivalent Load: 72.0 ton/wheel.

Land-side Operating Equivalent Load: 60.3 ton/wheel.

Water-side Stowed Equivalent Load: 76 ton/wheel.

Land-side Stowed Equivalent Load: 73.2 ton/wheel.

Horizontal (Perpendicular to Rail)

Water-side Operating Equivalent Load = 1.6 kips/ft (Based on normal operating load)
(Earthquake must be considered).

Land-side Operating Equivalent Load = 1.6 kips/ft (Based on normal operating load)
(Earthquake must be considered).

Water-side Stowed Equivalent Load = 6.25 kips/ft.

Land-side Stowed Equivalent Load = 6.25 kips/ft.

Horizontal (Longitudinal)

Water-side Operating Equivalent Load = 50% [0.10(TL + DL) + 0.05(LL)].

Land-side Operating Equivalent Load = 50% [0.10(TL + DL) + 0.05(LL)].

Vertical Jacking 1100 kips/Corner.

Crane beam design should allow an unloaded crane to pass over a broken pile with the crane boom in the most favorable position.

Equipment Loadings

Shuttle Carrier: (Inboard of Water-side Rail)

Capacity = 60 LT (New Machine/Loading to be obtained from Manufacturers).

Reach Stacker

Load Capacity: 45 LT.

Empty Drive Axle Load: 95 kips.

Empty Steering Axle Load: 85 kips.

Loaded Drive Axle Load: 230 kips.

Loaded Steering Axle Load: 65 kips.

Mobile Crane

Not considered currently; to be determined at a future date.

Stacked Container Loadings

Height: 5 containers high

Average Weight: TEU: 18-20 tons, Max: 24 tons; forty-foot equivalent unit (FEU): 30 tons

ARMG Crane Rails/Support

65 LT Capacity, 111.5-ft gage.

Vertical

Starboard Operating Equivalent Load = 21 kips/ft.

Port Operating Equivalent Load = 21 kips/ft.

Starboard Stowed Equivalent Load = 21 kips/ft.

Port Stowed Equivalent Load = 21 kips/ft.

Horizontal (Perpendicular)

Starboard Operating Equivalent Load = 1.25 kips/ft (for 17-ft line load).

Port Operating Equivalent Load = 1.25 kips/ft (for 17-ft line load).

Starboard Stowed Equivalent Load = 6.25 kips/ft (for 17-ft line load).

Port Stowed Equivalent Load = 6.25 kips/ft (for 17-ft line load).

Horizontal (Longitudinal)

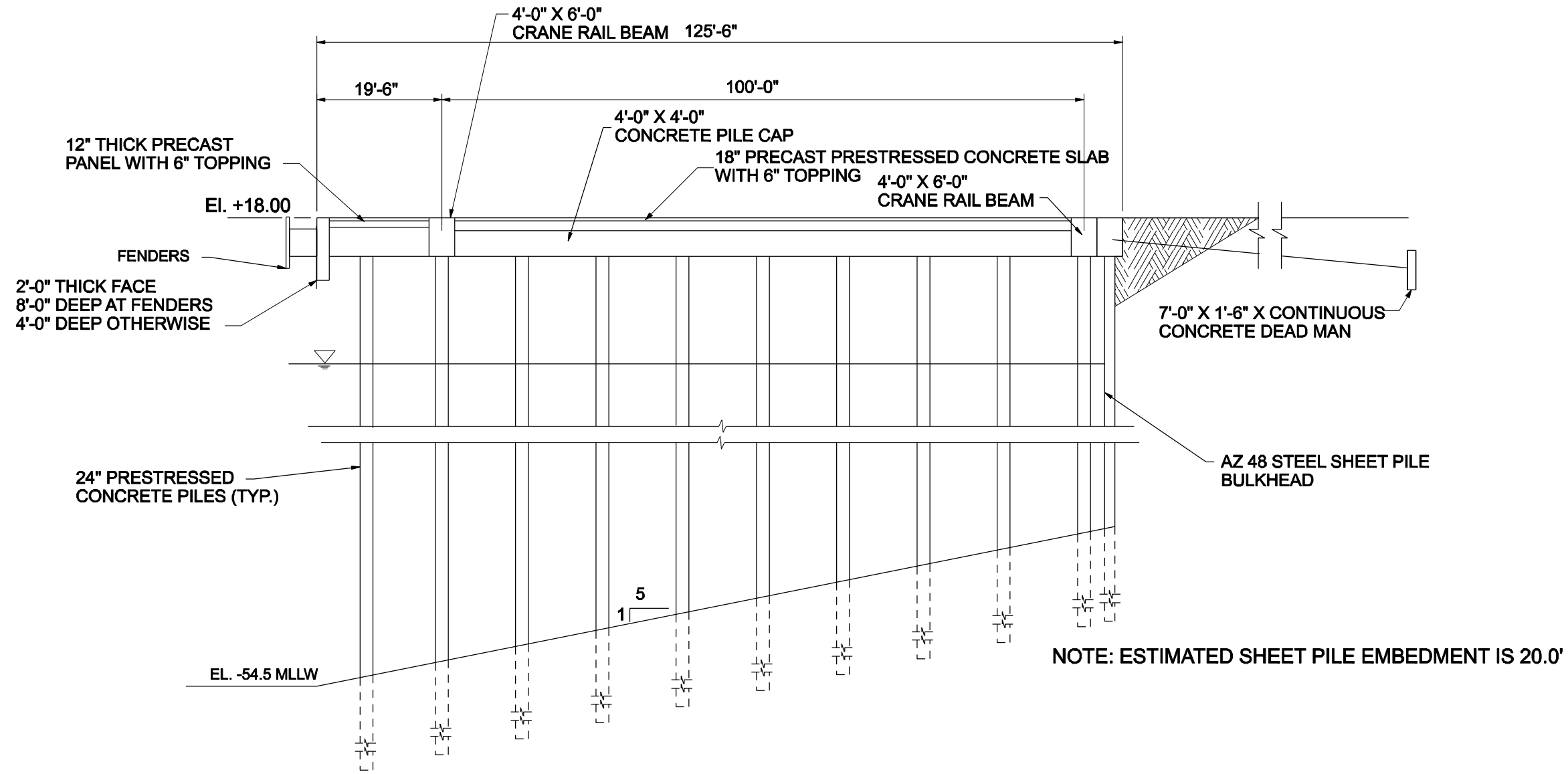
Starboard Operating Equivalent Load = 50% [0.10(TL+DL) + 0.05(LL)].

Port Operating Equivalent Load = 50% $[0.10(TL+DL) + 0.05(LL)]$.

Vertical Tie-Down: SB = 105 kips/ Port = 105 kips (W 1.2 Factor on Wind Load).

Longitudinal Stowage Pin: 300 kips/rail (W 1.0 Factor on Earthquake Load).

Vertical Jacking: 225 kips/corner.



NOTE: ESTIMATED PILE EMBEDMENT IS 40.0'
WHARF SECTION
 NTS

NOTE: ESTIMATED SHEET PILE EMBEDMENT IS 20.0'

CH2MHILL

WHARF CONCEPTUAL
 CROSS SECTION

NORTH CAROLINA
 INTERNATIONAL TERMINAL
 NORTH CAROLINA STATE PORTS AUTHORITY
 WILMINGTON, NORTH CAROLINA

VERIFY SCALE	
BAR IS ONE INCH ON ORIGINAL DRAWING.	
DATE	JANUARY 2008
PROJ	346181
DWG	7
SHEET	

ENGINEER	CHECKED-BY	APPROVED-BY
NO.	REVISION	BY
DATE		APVD

REUSE OF DOCUMENTS: THIS DOCUMENT, AND THE IDEAS AND DESIGNS INCORPORATED HEREIN, AS AN INSTRUMENT OF PROFESSIONAL SERVICE, IS THE PROPERTY OF CH2M HILL AND IS NOT TO BE USED, IN WHOLE OR IN PART, FOR ANY OTHER PROJECT WITHOUT THE WRITTEN AUTHORIZATION OF CH2M HILL. © CH2M HILL 2004. ALL RIGHTS RESERVED.

