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Cape Town Container Terminal Expansion

INTRODUCTION

The Cape Town Container Terminal Expansion Project currently being undertaken within the Port of Cape Town by Transnet involves marine, civil, electrical and mechanical engineering works in order to increase the container handling capacity of the Container Terminal and to accommodate and service larger container vessels.

The Container Terminal capacity is being increased from approximately 0,8 million to 1,4 million TEUs (Twenty Foot Equivalent Units) per annum by reconfiguring the container terminal to maximise stack space, and increasing stack capacity and density by converting from the current straddle carrier to rubber tyred gantry (RTG) operations.

The marine and civil works required to accommodate and service the larger container vessels (the berth deepening and quay works) include deepening of the berths and basin through dredging, the extension of the quay within the Ben Schoeman Dock and the installation of new larger Super Post Panamax ship-to-shore cranes.

BERTH DEEPENING AND QUAY WORKS

Approximately 1 150 m of existing quay wall is currently being strengthened and extended to allow berth deepening to take place. This deepening will accommodate the berthing of larger container vessels that require deeper draughts than is presently provided in the port. This is achieved by dredging the berths to a depth of –16,1 m CD, placing articulating fabric-formed concrete block mat scour protection on the newly exposed sea-bed to provide a berth pocket depth of –15,5 m CD, and extending the cope line forward by 10 metres into the Ben Schoeman basin using a piled deck structure.

The works are being undertaken in an operational four-berth terminal (berths 601 to 604) and, in order to minimise disruption to port and terminal operations, construction access is limited to a single berth of 300 m at a time with the remaining three berths remaining operational.

STABILITY WORKS

Stabilising measures to the existing quay wall were required to ensure that the deepening adjacent to the quay wall, the increased vertical and horizontal loads (from the larger crane, mooring and berthing forces) and the seismic loads did not reduce the factor of safety for the quay wall against a circular slip failure to an unacceptable level.

A series of analyses on the stability of the quay wall in its existing condition, during dredging, and its future condition when the berths are operational, were undertaken using a complex finite element (FE) software package (PLAXIS) to model the global stability of the wall. The use of a finite element program was chosen primarily as it provides an integrated analysis of the new and existing quay structure (including the piles), the sand backfill behind the quay wall, and the existing wall founding and underlying material. It also automatically identifies the least favourable geometry of failure surface (it identifies non-circular slips that may have a lower factor of safety than a circular slip).

New and existing geotechnical data were obtained and the geological profile and quay wall founding condition for the entire quay length were determined. After analysis of the geotechnical profile and existing founding conditions, two distinct types of the founding conditions were identified which required two different stability solutions.

Section 1 – Ground anchor solution

For this section of wall (the first 500 m and last 100 m) the quay is founded on very soft rock. The FE analysis for this section showed a composite failure mechanism incorporating an overturning and bearing failure of the quay wall. For this type of failure mechanism, the installation of inclined ground anchors through the rear of the existing quay wall, tying the wall back to the underlying rock, was chosen as the preferred solution. The ground anchors consist of steel tendons which are bonded to the underlying rock by injected grout with the anchorage capacity derived from the cohesive or frictional bond between the rock and the grout.

▶ The expansion of the Cape Town Container Terminal will not only make it possible to accommodate and service larger vessels, but will also increase the terminal's container capacity from approximately 0,8 m to 1,4 m TEUs per annum

The ground anchors vary in length from approximately 30 m to 50 m depending on the level of the underlying hard rock. These are some of the longest ground anchors to have been installed in South Africa and the anchor length presented a considerable challenge on site. Further challenges experienced on site included advancing the anchors through the sand backfill behind the quay wall with minimal disturbance of the ground, and grouting up of the ground anchors in the highly fractured and fissured hard rock. These challenges were all overcome by close co-operation between the design team and the main contractor with his specialist sub-contractors.

Section 2 – Split deck solution

For this section, the central 550 m of quay, the level of the underlying rock is considerably deeper and therefore the existing structure is actually founded on sand fill. The failure mechanism for this section of wall shows a deeper slip type failure. Ground anchors alone would be insufficient to provide stability and therefore more extensive stabilising measures were required.

A split deck solution was chosen which stabilises the wall by installing an additional pile adjacent to the existing quay wall to support the new suspended deck, thereby removing the suspended deck loads from the existing wall, as well as propping the wall at toe level.

The split deck option requires 1,4 m diameter piles spaced at 6,8 m centres (similar to the seaside piles). The pile props the quay wall at the wall toe level using a precast box which is slid down the pile and then filled under water with tremmie concrete to create the connection between the pile and the toe of the wall. Installation of the 1,4 m piles is currently under way with one of the first activities being a load test of one of the working piles. This is one of the largest (if not the largest) marine pile load tests to have been undertaken in South Africa.

CONCLUSION

The four berths are being deepened and refurbished sequentially in order to minimise disruptions to the port operations. Berth 601 has been completed and handed back, with all the challenges associated with ground anchor installation having been overcome. Construction of Berth 602 is ongoing with 90% of the ground anchors having been successfully installed and the piling for the split deck portion having just commenced. □

PROJECT TEAM

Client Transnet Limited (comprising Transnet National Port Authority & Transnet Port Terminals, Divisions of Transnet Limited)
Project Management Transnet Capital Projects (Specialist Unit of Transnet Limited)
EPCM Consultant Hatch Mott MacDonald Goba Joint Venture (HMG JV)
Specialist designers ZLH Projects & Naval Architecture (Pty) Ltd & Mott MacDonald
Contractor WBHO / Civil & Coastal JV
Specialist sub-contractors Fairbrother / Stefanutti Stocks

Source:
http://www.saice.org.za/downloads/monthly_publications/2010/2010-Civil-Engineering-May/#/0