Durban Harbour Entrance Widening

The widening and deepening of the entrance to the Durban Harbour was undertaken in a 'brown-fields' environment, with work being carried out in and around the fully operational shipping lane. Much of the work entailed dealing with existing structures built up over many decades, with little or no record of the construction or materials used. The R2,9 billion project was completed in February 2010, allowing access to post-panamax vessels

DURBAN HARBOUR ENTRANCE WIDENING

Technical Excellence category

KEY PLAYERS

Client Transnet Capital Projects
acting on behalf of Transnet National Ports Authority
Professional Team Hatch Mott MacDonald Goba Joint Venture
Prestedge Retief Dresner Wijnberg
Main Contractor Dredging International Group 5 Consortium
Major Subcontractors and Suppliers Sub-Tech, Afrisam

PROJECT DESCRIPTION

At the confluence of many trade routes, the Port of Durban has developed into Africa's busiest multi-service port handling up to 32 million tonnes of cargo and on average 4 000 ships per annum. For the port to remain globally competitive, Transnet has embarked on a series of large-scale infrastructural developments within the port, one of the first being the deepening and widening of the entrance channel to the port.

In 2006 Transnet appointed the Hatch Mott MacDonald Goba Joint Venture (HMG JV) to help with the Durban Harbour Entrance Widening.

The primary objective of the project was to provide the Port of Durban with a new entrance channel which allows safe access to all vessels up to a size equivalent to a 9 200 TEU (twenty-foot equivalent unit) container ship (length = 350 m, beam width = 45,6 m and draught = 14,5 m) under most weather conditions.

A consortium, comprising the Belgian firm Dredging International and Group Five from South Africa, was appointed in May 2007 to undertake the main marine works, with main subcontractors Subtech and Afrisam in support.

The works included the construction of a new north groyne, the strengthening of the existing south breakwater and dredging, aimed at increasing the depth and width of the port entrance.

1 North bank during early stages
2 Old and new north groynes, with north bank excavation in background
3 Back hoe dredger Pinocchio and support barge on north bank

PRIMARY PROJECT STATISTICS ARE AS FOLLOWS:

Increased channel width	from 125 m to 225 average bottom width
Increased channel depth	from -12,8 m CD to a depth varying from -16,0 m CD in the basin to -19,0 m CD in the outer channel
Channel and sand trap dredging	9 800 000 m^3
Demolition of concrete structures	28 000 m^3
Demolition of major buildings	12 No
Length of the new north groyne	550 m
Length of the north bank	500 m
Length of the south breakwater	700 m
Production and placement of rock on the breakwaters	500 000 m^3
Production and placement of primary armour:	
45 t concreteAntifer units:	3961 No
30 t concrete Antifer units:	1024 No
10 t concrete Antifer units:	1688 No
5 t concrete antifer units:	1119 No
20 t concrete dolosse units:	552 No
Production and placement of in-situ concrete (mainly breakwater cap structures):	20 500 m^3
Navigation aids	2 x breakwater towers 1 x temporary PEL light 1 x permanent PEL light 2 x other light towers various channel marker buoys
Final project cost	R2,85 billion

DESIGN ASPECTS AND CONSTRUCTION TECHNIQUES

Marine works

Dredging

The Contractor opted to dredge the bulk of the outer and inner channel by trailer suction hopper dredger (TSHD) – a logical choice, as these vessels are less sensitive to wave conditions than other dredger types – and allowed offshore disposal at an existing marine disposal area using the same vessel.

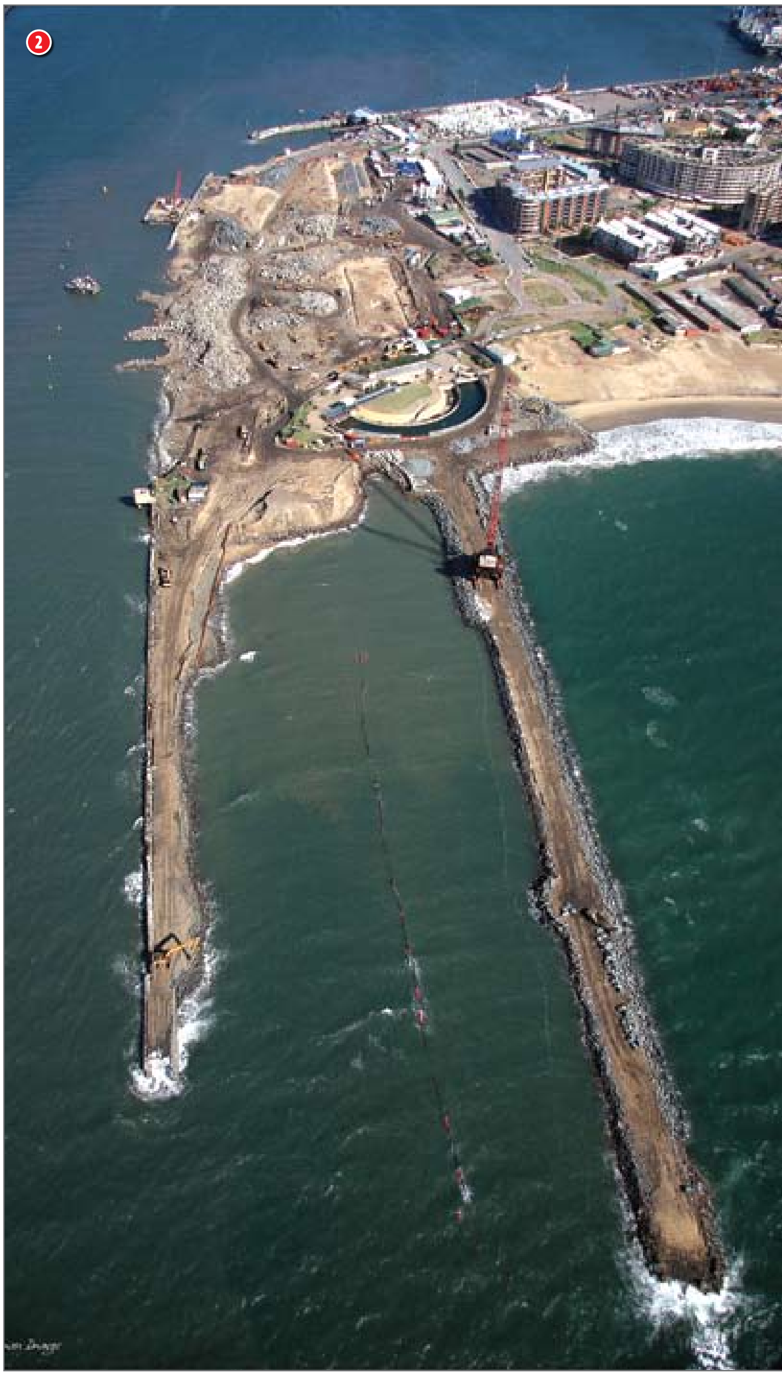
Underwater excavations

For the dredging of material which was too shallow and/or too hard for excavation by TSHD, the Contractor mobilised one of the largest backhoe dredgers (BHD) in the world, Pinocchio, a very powerful machine with a large bucket capacity of 14 m^3, and a reach of approximately 21 m under water.

The Pinocchio was also used to demolish much of the old north groyne. Land-based excavation was used down to 6 m CD and BHD Pinocchio then excavated further down to sea-bed level, approximately 12 m CD. All suitable excavated material was stockpiled and graded prior to being placed for the construction of the new north groyne.

Excavation of south breakwater toe

The dredging scope included careful exposure of the foundation of the south breakwater under the seabed, in the absence of reliable as-built drawings of the century-old structure. As the strengthening of the south breakwater had been designed



as an additional new outer skin of antifer cubes, it was important to found the new protection layer at a level commensurate with the existing foundation. This was achieved by a three-prong approach. The slopes of the old breakwater were explored by means of jet probing into the remaining overlaying sand masses after bulk dredging. Points of refusal were mapped to provide an indication of the cross section of the existing structure. Finally, the remaining sand on the breakwater slopes was removed by dredge sand pumps.

Channel dredging

Channel dredging had to be carried out in two stages, in order to allow safe and unobstructed shipping in one lane at all times. This required close cooperation with the port control authorities, and was carried out very successfully.

BREAKWATERS

New north groyne

The new north groyne comprises graded rock, concrete armour units and a mass concrete cap with crest height of +4,5 m CD. It was constructed approximately 100 m north of the old groyne in parallel with the demolition of the old groyne, to allow the handling for re-use of recovered suitable construction material. This part of the operation involved large-scale sorting and breaking up of larger elements. Waste was loaded onto barges and dumped at the designated dump site off-shore.

After pre-dredging of the north groyne footprint area to remove the unsuitable top layer, rubble material in a wide grading (5 kg – 3 000 kg) was placed at the core of the breakwater by way of end-tipping, using a fleet of articulated tipper trucks, and then trimmed to its design slope before the toe and underlayer for the armour could be placed. The primary armour consisted of 5 t and 10 t antifer cubes on the channel side, supplemented by 20 t dolosse at the head of the groyne. The northern slope of the groyne is protected by lighter armour due to its sheltered position (graded rock, 2 – 4 t). A concrete cap with a splash wall at the channel-side complements the above-water structure.

New north bank revetment

The new north bank revetment comprises a geotextile filter and graded rock layers. The revetment down to a level of 4 m CD was constructed in the dry when the area was still surrounded by land. This entailed constructing a trench 35 m wide at the top, 8 m wide at the base and 9 m deep, using a system of well points sunk into the sides of the excavation to keep the water level below the bottom of the excavation. This enabled the placing of the revetment rock, sized between 0,7 t and 1,4 t, by land-based equipment. This methodology proved successful and was applied in stages to almost the entire length of the north bank.

Dredge slope revetments

The underwater slopes on both sides of the channel were shaped in a precisely controlled manner after bulk dredging had taken place, by means of rock-dumping from split barges.

South breakwater

The original south breakwater structure comprised mainly 30 t rectangular concrete units, protected on the seaward face and roundhead by 20 t dolos armour units from 0 m CD level to the crest of the structure. The reinforcement of the south breakwater comprised 30 t and 45 t antifer cubes placed on the existing armouring in order to withstand increased wave attack resulting from wave-focusing on the new dredge slopes.

SAND SUPPLY SYSTEM TO THE ADJACENT BEACHES

The eThekwini (Durban) Municipality sand pumping facility, previously situated on the north bank of the old north groyne, had to be demolished as part of the Durban Harbour Entrance Widening Project. Transnet undertook to replace this sand pumping system to continue the beach nourishment programme. The system currently in place is a temporary system that mimics that of the previous operation in that it is a sand reclaim and pumping system and has been constructed using primarily refurbished components of the old system.

4 Completed new north groyne
5 Completed south breakwater

The system comprises four major components, namely a reclaim connection, a slurry discharge pipeline, a sand storage bund and a booster pump station.

A permanent system is currently being designed and will be implemented under a separate project.

AIDS TO NAVIGATION: PEL LIGHT SYSTEM

As a result of widening the entrance channel to the north, the previously installed leading lights could no longer be used by ships to guide them down the centre line of the new channel. Unfortunately, due to the location of existing land-based port infrastructure and buildings, a conventional two (front/rear) light system could not be used.

A Precision Entry Light (PEL) system was therefore selected, consisting of six synchronised lights installed on a tower some 44 metres above mean sea level. The lights work on a system known as an oscillating boundary. This essentially means that when the light source is viewed from the centre line of the channel it appears to be a white light but when viewed from more than 1,5 degrees either side of the centre line it appears to be red when too far to the left (port) side and green when seen from the right-hand (starboard) side.

CONCLUSION

The construction of Durban's new harbour entrance commenced in May 2007 and was completed in February 2010, one month ahead of schedule and under budget. The Port of Durban can now safely accommodate post-panamax vessels and is well positioned on the north-south global trade routes for future growth of the regional and national economies of the subcontinent. ☐

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