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New access platforms and mooring hooks for the Port of Saldanha

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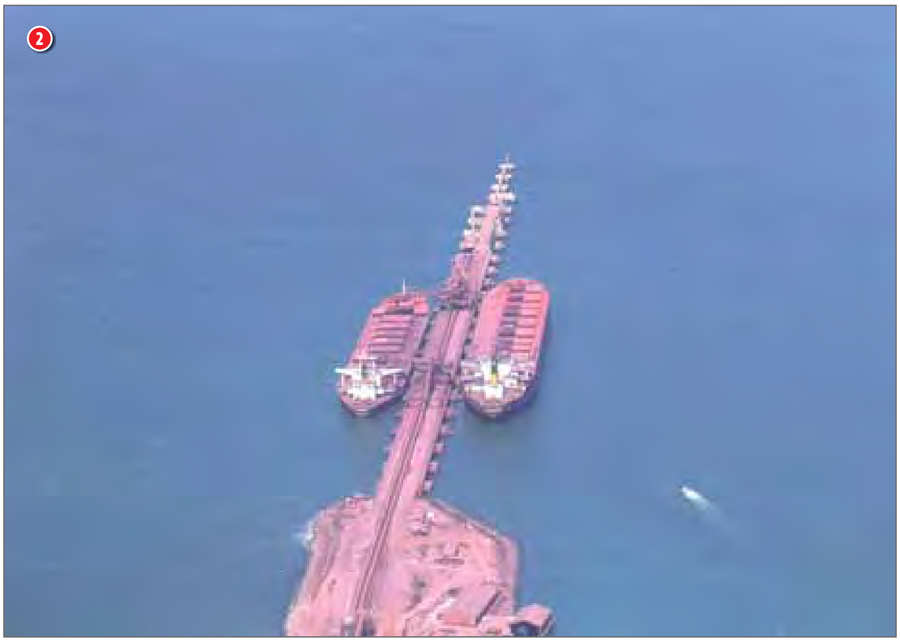

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BACKGROUND

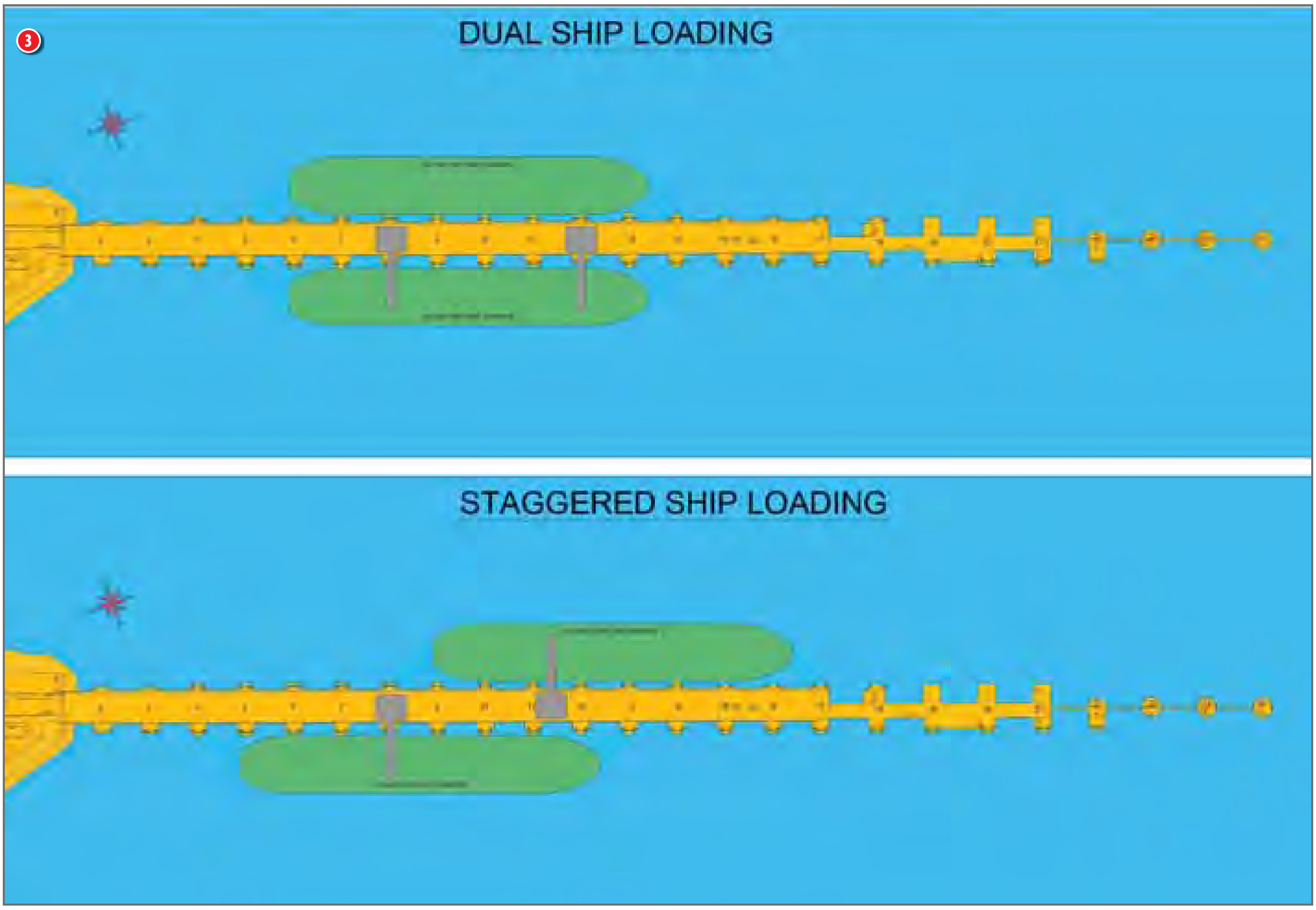
Due to a growing demand for iron ore and the subsequent need to increase export capacity at Saldanha's iron ore facility, Transnet initiated an expansion plan to increase the capacity of the bulk terminal from 28 million tons per annum (mtpa) to 60 mtpa. This was done in three phases, with phase 1a increasing capacity to 36 mtpa, phase 1b to 45 mtpa and phase 1c to 60 mtpa (Figure 1).

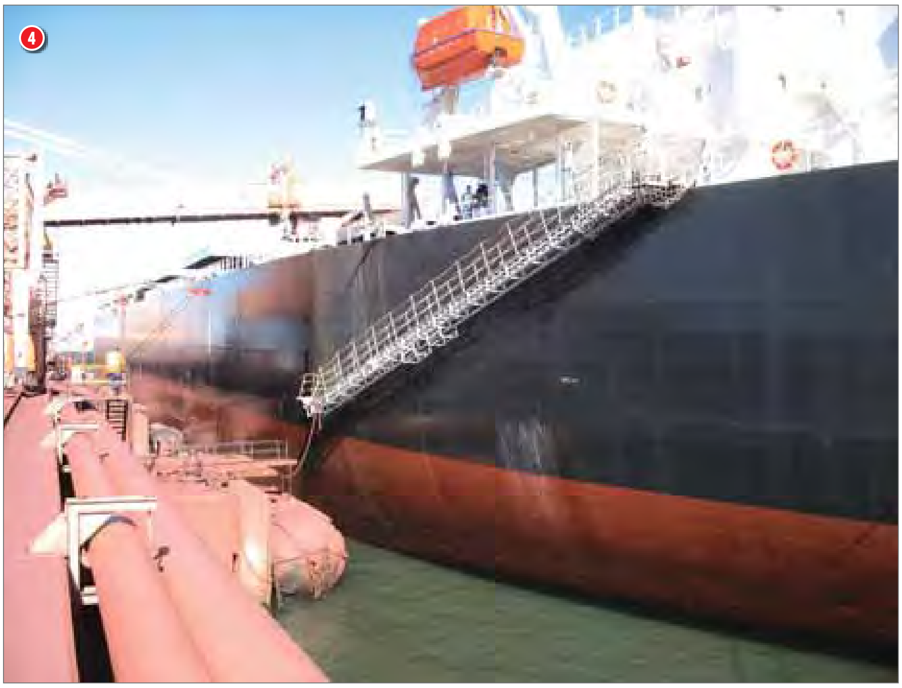
The original berthing arrangement on the export jetty allowed for two vessels to be berthed opposite each other on either side of the jetty, with only one vessel being loaded at a time (Figure 2). In order to achieve the increased phase 1 capacities, the simultaneous loading of two vessels would be required and Transnet therefore decided to upgrade the existing facility to accommodate a staggered berthing arrangement that would allow the jetty's two ship loaders to simultaneously load both ships (Figure 3).

In 2007 Prestedge Retief Dresner Wijnberg (Pty) Ltd (PRDW) was appointed by Transnet to undertake the marine engineering for phase 1b. This work included the upgrading of access platform and mooring hook equipment to facilitate the required staggered berthing.

Description of existing facility

The jetty was designed in the mid-1970s as a combined facility for the export of iron ore from Sishen, and the import of crude oil to storage tanks at Saldanha. Construction was completed in 1977. The existing structure comprises 25 reinforced concrete gravity caissons





1 The Saldanha Iron Ore Terminal
2 Side-by-side berthing arrangement
3 Comparison of side-by-side berthing arrangement with proposed staggered berthing arrangement
4 Existing access platform system

with a post-tensioned concrete superstructure, which has a total length of approximately 1 000 m, connected to the northern shore of Saldanha Bay by a 3,2 km long causeway.

NEW ACCESS PLATFORMS

Description

There is very little open deck available on the jetty superstructure, due to the space taken up by the ship loaders and the quick release hooks used to moor the ships.

Dedicated landing platforms are therefore provided for personnel to access the ship's accommodation ladder. These access platforms have to extend outwards to reach the accommodation ladder due to the large diameter floating fenders that are used on the jetty and retract during ship berthing manoeuvres so that they do not get damaged.

The locations of the existing access platforms did not suit the berthing positions for staggered ship loading and two new platforms have been constructed to suit the new layout.

Option assessment and selection

The existing access platform systems were reviewed and, in consultation with the port authorities and berth users, the requirements for a new platform system were determined. It was decided that it would be advantageous to provide as much adjustability as possible in the platform position along the length of the jetty. The height of the ship relative to the jetty changes due to the tides and the amount of iron ore loaded, and this causes the position of the inclined accommodation ladder to move along the jetty. Once a ship is moored it is not easy to move it and therefore it is preferable to move the platform to match the ladder position.

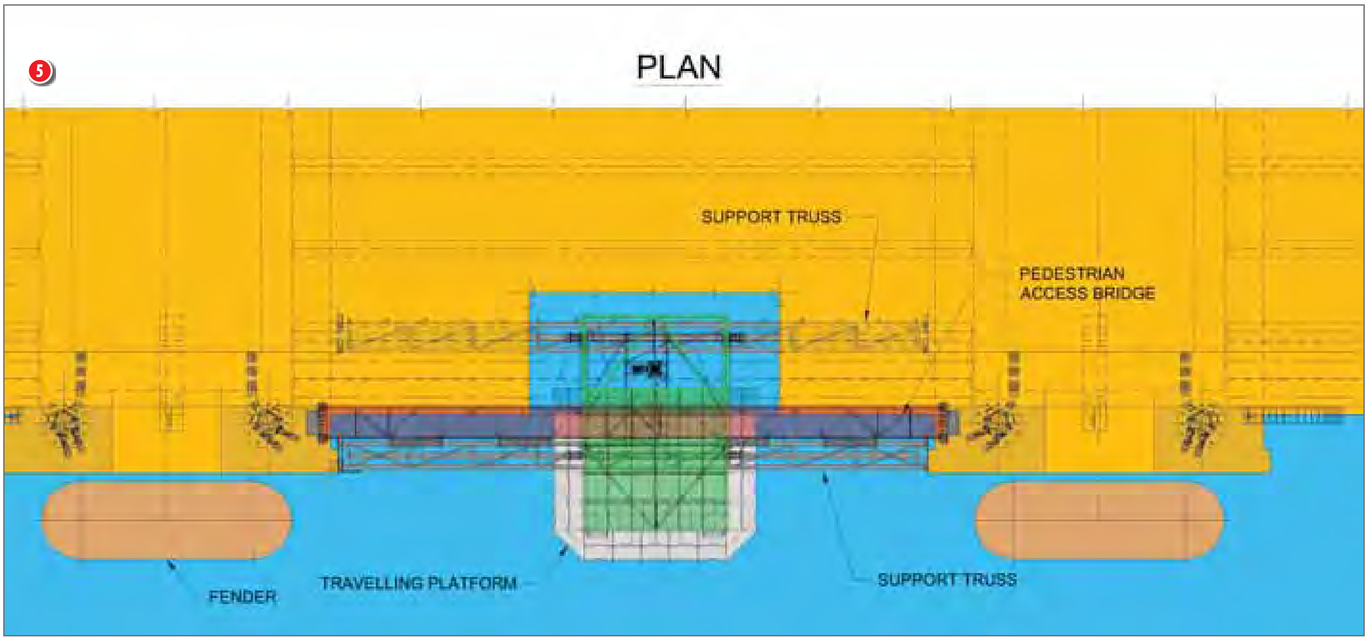
5 Plan view of the access platform system
6 Elevation of the access platform system
7 Cross-sectional view of the access platform system – platform retracted
8 Cross-sectional view of the access platform system – platform extended

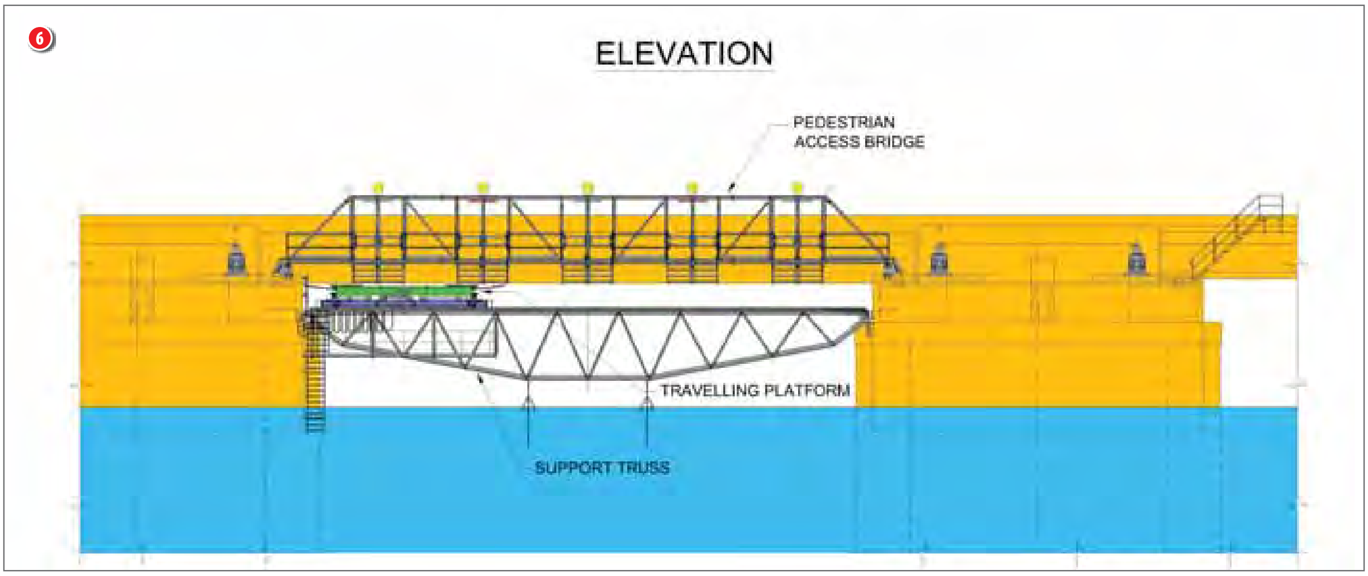
After a number of concepts were investigated and tested it was decided that the most practical solution would be a platform mounted between a pair of caissons and able to travel longitudinally in the available gap.

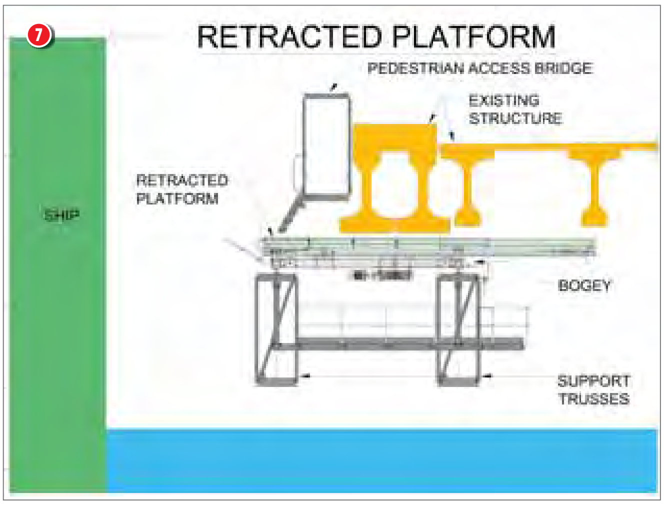
Description of the access platform system

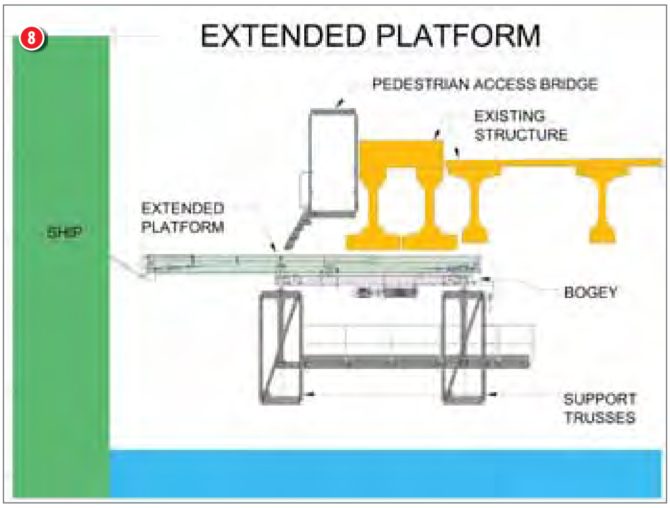
Each access platform system includes the following primary system components:

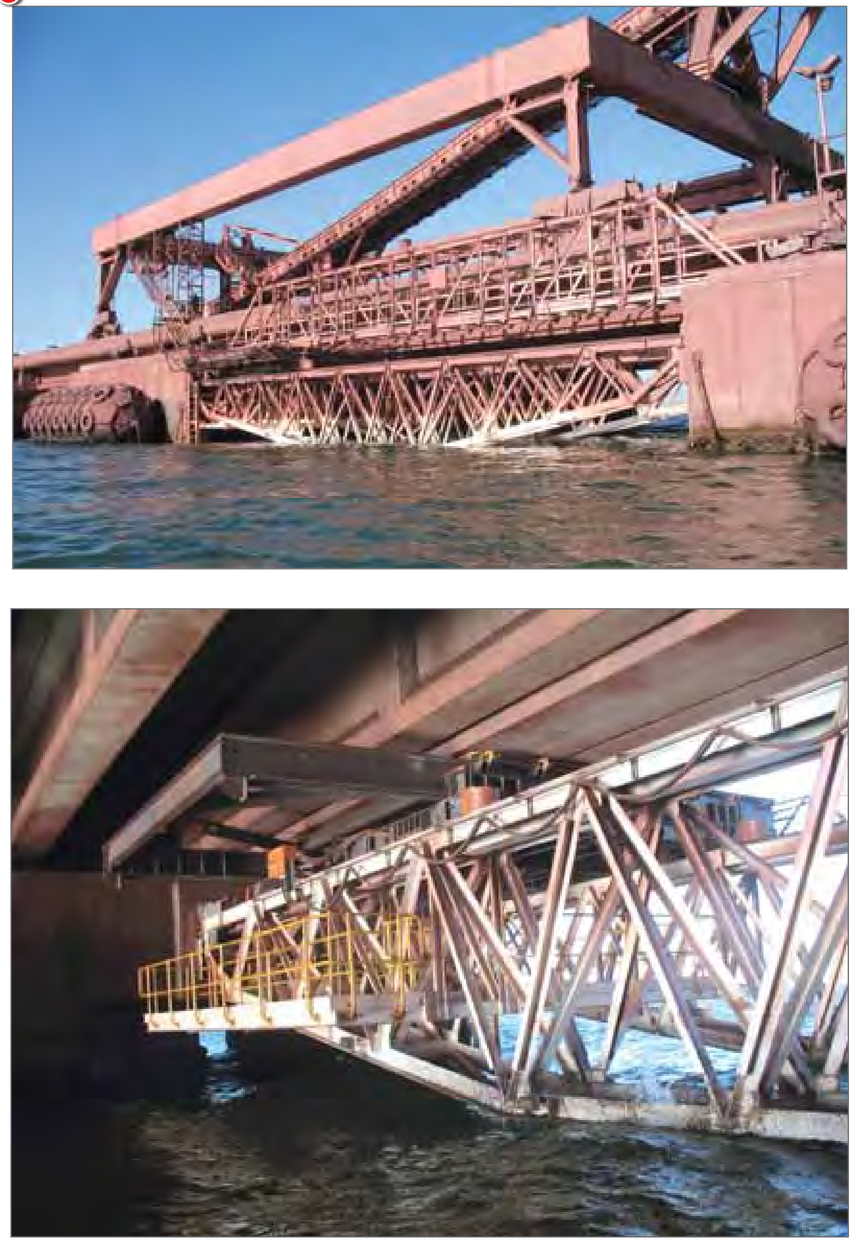
- The access platform, driven by a motorised rope winch, which extends outwards to the vessel when in use, and











9 The access platform system

is retracted when not in use. The winch is not braked so that the platform can move inwards in case a berthed ship pushes against it (the wave conditions in Saldanha Bay are not as calm as in a conventional harbour and at times there is ship movement due to sea action and therefore there is a real risk of the ship impacting the platform).

- The bogey supports the platform and moves longitudinally, driven by a motorised rope winch, so that the platform can be positioned to suit the location of the vessel's personnel accommodation ladder. The bogey winch is braked when not in use.
- The bogey runs on a pair of support trusses that span between the caissons.
- A pedestrian bridge spans between the caissons above the platform and is used for personnel access to the platform at whichever location it is.
- The control station for operating the platform and bogey is located at the mid-span of the bridge.
- The platform is equipped with safety nets and ladders, and grab chains are provided to assist anyone who is unfortunate enough to fall into the water.

Design challenges

The access platform provided some design challenges to the consultant team. These included the following:

Wave loading

The lower parts of the support trusses sit within the tidal zone and are exposed to wave loading under storm and high wind conditions. The trusses are designed for two loading conditions: a maximum survival wave load without any live load on the platform and a smaller more frequent wave load combined with the full live load on the platform.

There is one support truss for each bogey rail. These trusses are braced together in order to maintain the rail gauge should there be differential horizontal wave loading on them.

Dealing with iron ore debris

During ship loading operations, iron ore debris often falls onto the jetty and there is the potential for a build-up of the debris which could interfere with the operation of machinery such as the access platforms. The existing ship loaders on the jetty are equipped with timber and rubber scrapers to remove iron ore from the crane rails as the loader travels along the deck. Similar devices were fitted to the bogey to clear the rails on the support trusses, but for the platform the rails were mounted on its underside with the wheels fixed onto the top of the bogey. In this way it is not possible for iron ore to build up on the platform rails and interfere with its operation.

The build-up of iron ore debris also had to be taken into consideration in the design of the drive system. It was felt that a motorised wheel system for driving the bogey and platform would be vulnerable to jamming or slipping due to iron ore on the rails. A winch and rope system was therefore selected which gives a positive drive that is not reliant on friction or grip on the rails.

The bogey winch pulls the combined bogey and access platform along the support truss rails between caissons. This winch has two steel wire ropes that are fixed to the caissons at both ends and wound onto the split winch drum. As the drum rotates, one wire rope is paid out and the other one is simultaneously paid in, moving the bogey between caissons in either direction. The winch is powered by an electric motor fitted with a spring-applied, electrically-released fail-safe brake and a planetary gearbox. The wire ropes are connected to the caissons via rope end tensioners that are pre-tensioned in order to reduce the hanging catenary and to absorb shock loads due to sudden stops. A similar winch system is also used to drive the platform in and out.

QUICK-RELEASE MOORING HOOKS

Existing mooring hooks

The original mooring hook equipment on the jetty consisted of single and double Kimman quick release hooks with 100 tonne capacity per hook (Figure 10). Historically there have been a number of failures of these mooring hooks, many of which are considered to be due to the incident long waves which result in resonant responses of moored ships and large forces in the mooring lines. Combined with the fact that the 30-year old existing hooks were severely degraded, as well as the requirement to facilitate staggered ship loading, Transnet decided to replace the existing quick release mooring hooks with new ones.

10 Old mooring hook
11 The old mooring hooks on the caisson caps
12 New mooring hook
13 Adaptor plate for new mooring hook
14 New mooring hooks cast into concrete plinths on the caisson caps

Upgrading of mooring hook infrastructure

Mooring hook layout

The long-term mooring hook layout was developed by taking into account various berthing scenarios and mooring line configurations that could reasonably be anticipated during future operation of the berths. The mooring hook layout incorporated both the existing and the future staggered loading configurations to provide optimum flexibility for future operation of the berths (Figure 3).

Determination of hook design capacity

A dynamic mooring analysis was carried out by the CSIR using the numerical model VESDYN. This numerical model was calibrated against historical monitored ship motion data for vessels berthed at the Saldanha iron ore jetty. The objective of the analysis was to determine the design loads on the mooring hooks for 225 000 dwt and 350 000 dwt bulk carriers. This was done for both fully laden and ballast conditions for a 5% exceedance wave condition. A design capacity of 150 t was subsequently recommended for each hook.

PRDW also undertook its own mooring analysis study, using TERMSIM II, as an extension of the work by the CSIR, using alternative mooring layouts and updated design vessel dimensions. The two analyses showed a good correlation and confirmed the 150 t hook requirement. An optimum arrangement of mooring lines was also recommended, with the distribution and orientation of the mooring hooks adjusted accordingly.

A review of the original design calculations determined that the jetty structure had in fact been designed for 150 t hooks, even though 100 t units were fitted.

Description of new mooring hooks

The new mooring hooks were manufactured by Trelleborg. Sixteen 150 t single hooks and thirty-eight 150 t double hooks were supplied. Each new hook is equipped with an integrated 2 t capstan, as well as load-monitoring and remote-release functionality.

The mooring hook has a steel body with an 850 mm diameter circular base plate drilled for M56 holding-down bolts. The holding-down bolts from the old hooks were unsuitable for the new hooks and so the mounting of the hooks onto the existing jetty provided a challenge to the design team.

Hook installation

From the outset it was realised that all hook installation work would have to be undertaken in the quickest way possible in order to minimise disruption to the ore export operations and, as the berths had to remain operational, only a few hooks could be released at a time for installation. Any preparation activities for the installation of a new hook had to maintain a safe working environment for the berthing crew until the existing hook was decommissioned and handed over to the contractor.

A pre-fabricated steel adaptor plate was designed to mount the mooring hooks onto the caisson caps (Figures 11 and 12). The adaptor has a top plate drilled to accept the mooring hook base plate and the 2 m wide bottom plate gives a holding-down bolt pattern outside the envelope of the existing bolts. This was chosen so that coring for the new bolts would be well away from the anchor plates of the old ones and to help spread the loads and minimise the bolt forces. The adaptor was encased in a concrete plinth to give a level working surface around the hook (Figure 13).

The new bolts consisted of straight shafts of EN24 steel with the surface roughened by grit blasting to give a good bond to the grout. At the start of the hook installation contract, a pull-out test was performed on one of the holding-down bolts to verify that the specified installation method worked under the site conditions. This test was successful and regular pull-out tests were also conducted during the contract as part of the quality monitoring.

Load monitoring system

With the integration of a load monitoring system for the mooring hooks, the tension in all mooring lines can be monitored and maintained by taking corrective action during loading of the vessel. This will ensure improved load distribution between all the mooring lines. In addition, monitoring of the line loads will assist in deciding when to un-berth the vessel during storm conditions to prevent damage to the mooring equipment.

ACKNOWLEDGEMENTS

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PROJECT TEAM

New access platforms

Client Transnet National Ports Authority
Lead design consultants Prestedge Retief Dresner Wijnberg (Pty) Ltd
Sub-consultants IHC Marine and Mineral Projects (mechanical, electrical, control and instrumentation)
Construction management HMG JV
Main contractor SA Five / Stefanutti Stocks JV

Mooring hooks

Client Transnet National Ports Authority
Design consultant Prestedge Retief Dresner Wijnberg (Pty) Ltd
Construction management HMG JV
Contractor Prestedge Retief Dresner Wijnberg (Pty) Ltd

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