

Constructing and equipping India's deepest all-weather private sea port

Built as an integrated bulk terminal, primarily for coal and iron ore handling, the construction of Dhamra Port was not without its challenges

K. Sridharan, with **Pabak Mukhopadhyay**, **Sutanu Ganguly**, **Deepak Kumar**, **Ramkumar**, **Debashis Ghosh** and **Kuntal Pakhira**, Larsen & Toubro Ltd. – ECC Division, Manapakkam, Chennai, India

Introduction

The Dhamra-Chandbali Port is located north of the river Dhamra, about 68 km from Bhadrak District in Orissa, between Haldia and Paradip, India.

The port is being developed by Dhamra Port Company Limited (DPCL) as a 50:50 joint venture between Larsen & Toubro (L&T) and Tata Steel, on Build, Own, Operate, Share and Transfer (BOOST) basis. The Port Company has been given a concession to operate the port for a period of 34 years, including a period of four years for construction.

With a draft of 18 meters, Dhamra is one of the deepest ports in India, and can accommodate super-capesize vessels up to 180,000 DWT, and has a total cargo handling capacity of 25 million tons per annum. The master plan for the overall port when completed provides for 13 berths, capable of handling more than 100 million tons per annum of dry bulk, liquid bulk, breakbulk, containerized and general cargo.

The location of Dhamra is in close proximity to the mineral belt of Orissa, Jharkhand and West Bengal, and its deep draft is for large vessels that will make the port one of the most cost-effective and efficient on the eastern coast of India.

Integrated Port Project

DPCL entrusted the contract for Phase-I construction of the port to Larsen & Toubro covering a wide gamut of operations such as civil, mechanical and electrical works, as well as construction of the railway network which will connect the port with the Indian Railways' network at Bhadrak on the Howrah-Bhubaneswar route.

Various operating companies (OCs) and Business Units within L&T took up different construction activities under phase-I. Scott Wilson Kirkpatrick India Pvt. Ltd, the Indian arm of the UK-based Scott Wilson Kirkpatrick, has been appointed the project management consultant. L&T's scope of work for the construction of Dhamra Integrated Port Project included the following facilities:

- A fully mechanized 700-meter-long jetty
- Material handling system with 7.2km long conveyor network for handling imports of coal, limestone and export of iron ore.
- Construction of railway embankments and bridges from Bhadrak to Dhamra; as well as autosignalling, telecommunication and electrification for the railway itself.



Overall view of the jetty with its approach.



Coal conveying system at Dhamra. Inset: coal being conveyed through the conveyor.

The construction of Phase-I, which commenced in April 2007, was completed in all respects by July 31, 2010 and has been in commercial operation since December 2010. The port has received all necessary clearances including environmental clearance from Government of India, consent from Orissa Pollution Control Board and rail traffic clearance from Indian Railways.

Dhamra Port is expected to become an infrastructural hub on the east coast of India that will boost the industrial and economic development of the region and the country. At the peak of construction more than 250 staff and 5000 workmen were employed at the project, and the site clocked more than 26 million injury-free man-hours as on May 12, 2010 on its safety record, which led to winning the coveted RoSPA gold award for 2010.

Major challenges

Apart from braving the waves and cyclonic storms, L&T engineers had to fight against several odds to meet the stringent deadlines set by the client, such as:

Site access – The most critical problem everyone faced during the construction of the project was the long temporary single-lane access road. Since there was a delay in land clearance, settlement and handing over of the land for road construction, everyone had to use this only access route, which was a real ordeal for every member of staff and vendor visiting the site. In order to avoid daytime road congestion, all goods and materials were transported only during night-time, with adequate safety and security measures.

Turtle-friendly lighting – As per environmental protection guidelines issued by IUCN, a turtle-friendly lighting system was adopted so that turtles would not be attracted towards the project construction lighting. This was a conditional requirement and project authorities, including all contractors, had to abide by the same in order not to disturb the nesting and hatching habits of Olive Ridley Turtles. For this purpose, sodium vapor lamps with protective covers were used in place of halogen and metal halide lamps.

Bulk materials scarcity – The project continuously faced bulk materials scarcity throughout its construction phase, so alternative materials were constantly tried out. For example, extensive use of

ordinary Portland cement was replaced with slag cement. Crusher dust and weather rocks were used for plant road construction work.

A proper Disaster Management Plan was prepared and kept in place to meet exigencies during cyclonic storms. This outlined a clear evacuation plan for labor, staff and materials; and the resources were reinstated at the end of the season.

There was a shortage of skilled manpower too; however, local workmen were trained to mitigate this situation.

Plant & machinery

The following plant and machinery were deployed for executing the work, under inclement weather condition on the sea-front:

- One 30m³ batching plant
- One boom-placer
- 150-ton capacity P&H crane
- 80-ton capacity Fushun crane
- Four 75-ton cranes
- Six 18-ton cranes
- Movax & HPH 200 sheet pile-driving hammer on PC 300 excavator
- Integrated piling rig
- METCO and BG 15 piling rigs
- BSP piling hammer
- 23 piling pinches
- 78 welding machines
- Bridge-launching girder
- Two 30m-span gantries
- Eight trailers.

Safety

afety was given the highest priority and everyone had to strictly adhere to all safety practices. This included a daily safety pledge and pep talk among all the workmen and staff, 100 percent



Stacker-reclaimer installed at Dhamra.

screening and daily medical check-up of workmen; new joiners were exposed to training and E-learning with respect to usage of personal protective equipment. Specialized emergency and safety training was undertaken by all staff and workmen.

In order to monitor safety practices, a committee was formed to review systems and practices. A mobile safety inspection team was formed to visit places and check the safety practices at different locations. In addition, periodical health check, a physical fitness and awareness program of all job-related diseases was conducted among workmen and staff. All these practices led to achieving ROSPA gold award for the year 2010.

Construction of the Jetty

L&T designed and constructed the 700-meter long open-sea jetty with a draft of 18 meters depth, including a fully dredged and unobstructed navigational channel for 17 kilometers for berthing super-capesize vessels up to 180,000 DWT. Since the site selected for the jetty falls within the naturally protected Kanika sand island on the Orissa coast, no breakwater was considered for the construction. However, the orientation of the jetty has been aligned in such a way that the draught of 18 meters is maintained throughout the year.

L&T Ramboll provided the design for the construction of the jetty supported by Infrastructure Engineering and Technology (IET) for construction methods. Work on the jetty commenced in April 2007 and the entire works were completed by March 31, 2010.

Dredging at Dhamra Port was undertaken by International Seaport Dredging Ltd, a joint venture between L&T and Belgium's Dredging International, and the scope of work involved dredging of an 18-kilometer-long channel and removal of about 65 million cubic meters of dredged material.

Construction

The Main Jetty was designed and built with a 600-meter-long berthing face, 24 meters wide. In addition to this a 100-meter-long Port craft berth with a width of 37.5 meters, was built as an extension to the Main Jetty.

The Main Jetty is connected to the shore by an Approach Bridge that is 186 meters long and 12 meters wide, supported on approach trestles 126 meters long and 12 meters wide. The berth is provided with two 375-meter-long structural steel conveyors that are 8 meters wide.

Unlike the normal jetties that jut out into the sea perpendicular to the shore, the jetty at Dhamra Port is constructed parallel to the shore in alignment with availability of the deep draft throughout the stretch for better navigation of heavy vessels.

Marine piling was adopted for construction of the substructure for the main jetty, which involved 627 piles, each 1.4 meters long and 1.2 meters in diameter, driven to a depth of 48 meters. A travelling platform carrying a row of conventional piling rigs/winchies was used for constructing the bored cast-in-situ piles.

In this method of marine pile construction, a travelling platform (called a piling gantry) would be supported on piles already completed. The pile steel liners would be pitched in the next row of piles (called a 'bent'), followed by boring to the required depth, lowering the reinforcement barge and concreting the piles. The gantry will then move to the next location once all the piles are concreted in the particular bent, using winches mounted on the gantry with its anchorage on the already completed piles, ensuring safety of the entire operation.



Side view of the jetty, showing ship loader, unloader, conveyors and transfer point.



Top view of the jetty with its conveyors.

The platform was used to carry heavy loads of piling rigs and winches, concrete pipelines, compressor, pumps, and DG set. By adopting this technique, dependency on floating modes was reduced, thus optimizing the utilization of resources. At the peak of construction, 12 sets of piling gantries and 20 piling rigs were used for the marine piling operation.

In total, construction of the jetty consumed 40,951m³ of pile concrete, 5,488 tons of pile reinforcement and 4,788 tons of steel liners.

Superstructure

The superstructure works involved erection of pre-cast elements as well as in-situ construction. Extensive use of pre-cast elements eliminated the cumbersome process of shuttering operations in the sea. Pre-cast elements, which were cast at a yard two kilometers away from the jetty, were transported to the jetty on trailers and then erected in place using a crane mounted on the completed jetty (as an end-on method), or otherwise using a crane barge followed by in-situ concreting, which was done mainly in three stages. This involved erection of 126 different types of pre-cast elements – 3,829 in number, 7,083m³ of concrete and 1,470 tons of reinforcement, including 12,445m³ of concrete and 1,723 tons of reinforcement for in-situ works.

Material handling system

Dhamra Port has been built as an integrated bulk terminal, therefore DPCL has incorporated comprehensive modern facilities for efficient operation and management of the port, from safe berthing to automatic unloading and loading of coal; fuelling the vessel, replenishing fresh water, boarding and lodging for the crew, up to and including many other port infrastructure facilities onshore for stocking and loading railway wagons for transportation to various destinations and so on.

Panorama

For material handling of various cargoes, as well as for shipping movements and marine operation within and outside the port, much equipment is needed to support the services to port users – right from entry of the vessel into the port and anchoring at the



Yard conveyor with stacker-reclaimer.

berth, to the exit of the vessel from the port limit. This includes:

- Continuous unloading of the raw material at the coal jetty via ship unloaders at the berth
- Transportation to the stock pile through a long conveyor network, which runs the entire length of the stockpile, and giant stacker-reclaimers
- Loading of inland transport through rail wagons with the help of the mechanized conveyor system, stacker-reclaimers, and open-wagon loading system in the rapid loading system, hopper/bin machines and so on.

Similarly separate areas are earmarked for the proper receipt of iron ore from the mines, unloading through wagon tippler, and stocking at the stock pile/reclamation area until it is transported and loaded into vessels. The following equipment was installed by L&T at Dhamra port:

- Two 2,800 tons per hour capacity ship unloaders for coal
- One 5,000 tons per hour capacity ship unloader for iron ore
- One wagon tippler with 25 tips per hour capacity, including sidearm charger, indexer, apron feeder, etc.
- Two stacker-reclaimers for coal handling, each with capacity to stack 5,500 tons per hour and reclaim 3,500 tons per hour
- Two reclaimers and stacker-reclaimers for handling iron, each with capacity to stack 3,750 tons per hour and reclaim 5,000 tons per hour
- Two conveyors each with a length of 7.24 kilometers, with a handling speed of 5,500 tons per hour of coal and 3,500 tons per hour of iron ore
- Two rapid wagon loading systems, which can load 60 tons (one rake of 58 wagons each with a payload of 1.5 hours)
- Two rapid loading silos were constructed using the slip-form technique of continuous construction.

With all this mechanized materials handling equipment, the port is designed to handle a daily berth throughput of around 60,000 tons for unloading and 70,000 tons for loading, so that a large ship of 150,000 to 180,000 tons can be loaded or unloaded within three days.

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ABOUT THE COMPANY

The construction division of **Larsen & Toubro Limited, ECC** is India's largest construction organisation. Many of the country's prized landmarks – its exquisite buildings, tallest structures, largest industrial projects, longest flyover, and highest viaducts – have been built by ECC. Leading-edge capabilities cover every discipline of construction: civil, mechanical, electrical and instrumentation. As a division of L&T, ECC has the resources to execute projects of large magnitude and technological complexity in any part of the world.

ENQUIRIES

Headquarters
Mount Poonamallee Road
Manapakkam, P.B.No.979
Chennai – 600 089, India
Tel: +91 44-22526000/8000
Fax: +91 44-2249 3317
Web: www.intecc.com