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# Ennore Coal Port Project: Port Basin and Entrance Channel

## Abstract

The Chennai Port on the eastern coast of India is the main port for the transshipment of coal for the nearby power plant. To limit the contamination from coal dust and to relieve the congestion of the Chennai harbour, plans for a new harbour at the small village of Ennore have been developed. The plans are sponsored by the Asian Development Bank. The ECPP/ C6 Contract for the dredging works of the Port Basin and Entrance Channel discussed here is one of several contracts awarded for this project. Within the framework of the same project are also the breakwater and the wharf construction. These contracts are to be executed by other contractors in the same time period.

## Introduction

On July 31 1997 the Jan De Nul Group of Companies was awarded the contract for the Dredging of the Port Basin and Entrance Channel of the Ennore Coal Port Project, which is situated on the Coromandel Coast, 20 km north of Chennai, in the state of Tamil Nadu, India. The project was tendered in several contracts and this paper describes the tender known as Dredging Contract ECPP/ C6, which forms part of a general contract with the aim of developing a new port at Ennore.

The Ennore Port is planned as a multi-functional alternative to the Chennai Port (Figure 1). When completed, the project will be able to take vessels of up to 65,000 dwt, which would decongest the Chennai Port. The primary purpose of the new port is the import of coal for the North Madras Thermal Power Station (NMTPS) which is situated immediately south of the port.

For the time being, all coal shipments are off-loaded in Chennai Harbour and transported by train to the North Madras Thermal Power Station. The off-loading of the vessels must be done slowly because of a lack of

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efficient unloading facilities. This produces a great deal of dust and pollution for the harbour and the surrounding city. Future expansion of the port for mainly bulk cargo, LNG, oil products and chemicals is envisaged.

The Port itself consists of an Outer and Inner Port Basin with a coal wharf. This wharf is equipped with facilities to off-load two coal carriers at the same time. Two rubble mound breakwaters protect the Port, e.g. the South Breakwater with a length of 1.0 km and the North Breakwater with a length of 3.5 km. An Approach channel, which is orientated on the south-east, links the Port Basin to the open sea and enables the coal-carrying vessels to enter the port.

The ECPP/ C6 Contract for the dredging works was signed at Chennai on August 22 1997 and is being sponsored by the Asian Development Bank. Other main contracts awarded within the framework of the same project are the breakwater and the wharf construction. These contracts are to be executed by other contractors in the same time period (see page 9).

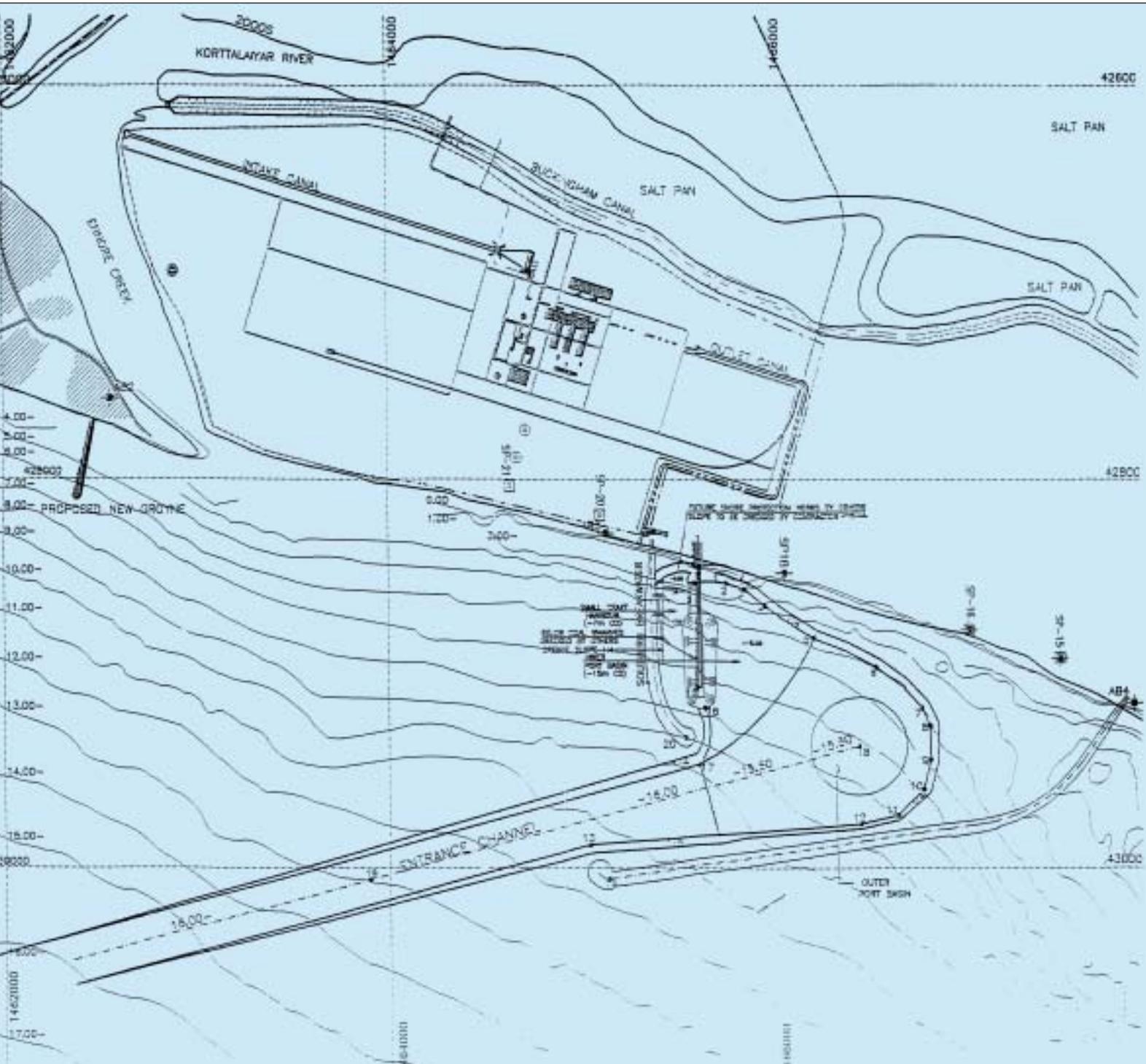


Figure 1. General lay-out plan of the Ennore Port project on the eastern coast of India.

## DREDGING AREAS

For the ECPP/ C6 Dredging Contract, four dredging areas are specified:

- the Inner Port Basin;
- the Outer Port Basin;
- the Small Craft Harbour; and
- the Approach Channel to the Port Basin.

The 3,525 m long Approach Channel links the open sea to the Port Basin. The required dredging depth is –16.0 m CD with a bottom width of 250 m. At both sides a slope with a gradient of 1:8 is foreseen. The seaward limit is the –16.0 m CD level and the landward limit separates the Channel from the Port Basin (Figure 2).

The Port Basin, which is enclosed by the North and South Breakwaters, consists of two areas: the Outer and the Inner Port Basins. The Outer Port Basin has of a turning circle with a diameter of approx. 500 m. That area had to be dredged to a depth of –15.5 m CD with slopes not steeper than 1:4 or gentler than 1: 5.

The Coal Wharf is foreseen at the south side of the Port. In front of the wharf and in connection with the Outer Port Basin, the Inner Port Basin has to be dredged to –15.0 m CD with slopes at the sides of 1:4. The slope at the north of the Coal Wharf has to be protected over 200 m by a stone embankment. The boundary at the south side of this area is the centre line of the Coal Wharf.

South of this line, a Small Craft Harbour is placed with mooring facilities for small craft vessels which are to assist the larger vessels entering the future Port. A depth of –7.0 m CD has to be achieved for navigation of these small craft. Three small craft jetties are foreseen which are, currently under construction.

At the end of the Small Craft Harbour, a cooling water outlet was planned for the NMT Power Station. The dredging depth here would reach –5.0 m CD. But later on, the outlet was shifted to another location, just south of the Northern Breakwater and outside the harbour boundaries.

## QUANTITIES

A total volume of 14 million m<sup>3</sup> has to be dredged to create an Access Channel, a Small Craft Harbour, a Cool Water Outlet, and the Inner and Outer Port Basins. The sand material must be used for beach nourishment, land reclamation and stockpiling for future port construction. The main part of the dredged materials in the Port Basin consists of +/-7.2 million m<sup>3</sup> of sand (fine to silty clayey sand). The remaining parts are soft materials (+/-2.6 million m<sup>3</sup> of silt and clay).

The 4.2 million m<sup>3</sup> from the Approach Channel have almost the same composition as the materials in the Port Basin, and are to be disposed of at sea.

## SOIL INVESTIGATION

Borehole information was presented with the Tender. No additional soil investigation programme was conducted before carrying out the works.

In the Approach Channel, over the first 1,250 m from the Port Basin, a top layer of approx. 3.0 m of loose silty sand was present. Under this layer, soft to firm clay could be found down to the dredge level of –16.0 m CD. In the remaining length of the Approach Channel, the soft to firm clay was present over the entire dredging depth.

According to the borehole information supplied, the material to be dredged in the Port Basin consisted of a top layer of 2.0 to 3.0 m dense coarse sand with many shell fragments. Below this top layer, a layer of very loose to loose silty sand was present to a depth of –15.0 m. This layer became narrower at the –12.0 m water depth towards the Northern Breakwater under which soft to firm sandy silty clay was present down to the design dredge level. All this borehole information appeared to be quite reliable during execution. For the reclamation works however the content of fines, including the very fine sand composition up to +/-100, reached sometimes 85% of the samples, which made reclamation in the confined areas very difficult.

In the Beach Reclamation area, with an open sea disposal, this created no problems as the surplus of fines was easily washed away by the action of the sea.

## DISPOSAL / RECLAMATION OF DREDGED MATERIAL

Initially the dredged materials were to be disposed of via the following five locations:

- sea disposal;
- beach nourishment;
- sand stockpile;
- on-land sand reclamation; and
- on-land reclamation of soft materials (clay).

### Sea disposal

All the dredged materials from the approach channel had to be dumped in the designated offshore disposal area in front of the port at a depth of minimum –23.0 m CD. The total estimated quantity was 4.2 million m<sup>3</sup>.

### Beach nourishment

At the north of the port, a Beach Nourishment area had to be constructed in order to alleviate future beach erosion which was expected to happen during and



Figure 2. Cutter suction dredger Vesalius, working in front of the North Madras Thermal Power Station.

after the development of the Port. Also, approx. 2.5 million m<sup>3</sup> of sand from the Outer Port Basin had to be placed in front of the existing beach.

#### **Sand stockpile**

Another area would consist of a sand stockpile with an original amount of 1,000,000 m<sup>3</sup>.

#### **On-land reclamation of sand and soft materials**

Most of the layers above the -12.0 m CD of the Port Basin were suitable to be pumped into the Beach Nourishment and Sand Stockpile Area (Figure 3). The material originating from the rest of that layer and underneath that layer, were to be reclaimed to on-land clay and sand disposal areas.

During execution of the job, the original reclamation areas were modified. The original sand stockpile of 500,000 m<sup>3</sup> was shifted to another location and two additional stockpiles for sand were created, each containing respectively approx. 160,000 m<sup>3</sup> and 1,000,000 m<sup>3</sup>. The sand from these stockpiles can be used for future port construction works.

The on-land sand and clay areas, which were foreseen on the western side of the Kortalaiyar River, shifted from their original location but remained at the same side of the river. Also the volume of these areas was reduced to 50%. Owing to the non-availability of the clay area at the contractual date and the ongoing

erosion of the beach north of the breakwater, a quite higher volume than figured at tender stage had to be reclaimed in the Beach Nourishment Area.

The sand for the Beach Nourishment, the sand stockpile and the on-land sand reclamation was tested according to BS 1377. All tests were carried out in a Soil Laboratory on site. For the Beach Nourishment, not more than 20% and 8% of the particle size by weight should be smaller than 0.063 mm and 0.002 mm respectively.

The specification demands for the dredged sand after placement at the stockpiles and at the on-land reclamation were much stricter, as the sand in these areas should not have more than 15% by weight of particles smaller than 0.063 mm and not more than 5% by weight particles smaller than 0.002 mm.

All the excess water of the reclamation areas had to be controlled on a regular basis in order to ensure its compliance with the Contractual Specifications. According to these specifications, any water discharged from confined reclamation areas to the neighbouring Buckingham Canal of the Kortalaiyar River must not contain more than 1.5 g/l of soil material.

During the execution of the reclamation works, these criteria could not be accomplished in the sand Stockpile and Clay Areas. Because of problems with the

finer in the excess water, the reclamation in these areas was stopped before reaching the theoretical proposed volume. Samples taken from some materials involved, showed a silt content which was going up to almost 45%.

**WORK PROGRAMME**

The work on site commenced on October 1998 with the clearing of the reclamation areas and the setting out of the works. In the meantime, temporary housing and offices for the Jan De Nul staff had been constructed on site by a local contractor.

**The Vesalius**

For carrying out the dredging works in the Port Basin, the cutter suction dredger *Vesalius* was mobilised from Belgium to Ennore. All equipment arrived on site in February 1999. The usual 500-m-long floating pipeline of the *Vesalius* could not cover the whole of the Port Basin, and extra submersible pipelines were required to connect the dredger and her floating pipeline to the shore pipeline (Figure 4).

Depending on the location of the cutter in the Port Basin, the length of these submersible pipelines varied from 350 m to 650 m. Occasionally they had to be repositioned and even connected to each other for a total length of 1000 m, in order to reach the outer limits of the Port Basin. Onshore, the pipelines were installed to each of the different reclamation areas. For the crossing of the river Kortalaiyar, a submersible pipeline was also used.

The dredging operation took place in horizontal layers in order to facilitate a separate disposal of the sand and the clay-type material.

Average pumping distances were dependent on the location of the various disposal areas. In general these distances varied from 1500 m for the nearest sand stockpile area to 5000 m for the clay disposal area, which is located at the greatest distance from the Port Basin.

**Beach Nourishment Disposal Area**

The Beach Nourishment Disposal Area was reclaimed directly at the seashore (open disposal) with only a bund at the landside, which was meant to prevent the inward land from flooding caused by the dredging waters.

In accordance with the stipulations, Beach Nourishment should be stopped after the dredging of 2,500,000 m<sup>3</sup> of suitable sand. But during execution, it appeared that owing to the continuous erosion at the seaside by the sometimes heavy swell and wave action, not even 50% of the expected volume for the



Figure 3. On-land discharge of the dredged materials.

Figure 4. Cutterhead of cutter suction dredger *Vesalius* during dredging operations.





Figure 5. The 9,000 m<sup>3</sup> trailing suction hopper dredger *Alexander von Humboldt*, has been commissioned to the Ennore Port Project for dredging the 3,525-m-long Access Channel.

beach protection was in place. As a result, the original volume had to be doubled. An extra stockpile of suitable sand was even created on top of the first reclamation for future needs.

All the other on-land reclamation areas, which were confined disposal areas, were constructed with perimeter dykes and equipped with weir boxes for the discharge of the excess dredging waters. Prior to the filling operations in the sand reclamation areas, settlement poles were installed to monitor possible settlement or consolidation of the underlying ground. As these layers also consisted of sand, the measured settlement appeared to be negligible.

#### **Fishing areas**

Problems occurred quite regularly with the local fisherman. They were afraid that the execution of the Beach Nourishment scheme would spoil their fishing grounds. For the same reason, they were also protesting against the outlet of the sand stockpile to the Buckingham Canal. The Client succeeded in solving all these problems within a reasonable period of time through negotiations.

Currently, the 3,525-m-long Access Channel is being dredged to –16 m CD by the trailing suction hopper dredger *Alexander von Humboldt*, a recently built trailing suction hopper of 9,000 m<sup>3</sup>. Her single 1.3 m-

diameter suction pipe, incorporating a very wide drag-head, makes her particularly suitable for these kinds of operations (Figure 5). All dredged material consisting of mud, soft clay and silty sand is being dumped in the offshore disposal area at a distance of approx. 4 km.

#### **Conclusion**

Completion dates of the project have been met as stipulated in the contracts, despite some unusual circumstances. The dredging works of the Small Craft Harbour were handed over on June 30 1999. According to the Contract, Port Basin and On-land Reclamation Area were to be handed over on February 28 2000. The Entrance Channel and Offshore Reclamation were to be handed over on the July 10 2000. However, all the dredging works to be executed by the CSD *Vesalius* were completed by mid-January 2000 and the TSHD *Alexander von Humboldt* completed her part by mid-February 2000. This resulted in the handing over of the whole dredging works at the end of February 2000, which was much earlier than the stipulated date in the contract.

The experience gained working in India, the capabilities of the dredging plant and expertise of the people involved greatly contributed to the success of this project, although circumstances were not always as easy as they seemed to be.