Boskalis
Dredging & Marine Experts

PROJECT SHEET

CHANGI OUTFALL CONSTRUCTION
SEABED PREPARATION FOR FLOWLINE INSTALLATION AND BURIAL

INTRODUCTION

The Public Utilities Board implemented the Deep Tunnel Sewerage System as a long-term solution to meet the needs for sewerage water collection, treatment and disposal to help maintain Singapore's clean and healthy environment.
In phase one of the Deep Tunnel Sewerage System, the Changi Water Reclamation Plant was constructed in the east of Singapore, from which the Changi Outfall was subsequently constructed. Treated effluent from the water treatment plant will flow through outfall pipelines and be discharged through series of diffusers, dispersing the effluent in the seawater.

Boskalis International was awarded the contract for the Changi Outfall in 2002 and formed a joint venture with Archirodon to construct the project.

PROJECT DESCRIPTION

The Changi Outfall consists of two discharge pipelines, each five kilometers in length and a third pipeline of one kilometer in length for future extension. The pipelines consist of reinforced concrete pipes of which the largest pipes have an internal diameter of 3 meters, a length of 8.4 meters and weigh 105 tons. The land section of the outfall is 180 meters in length and is sloping from 8 to 16 meters in depth. A reinforced concrete slab on piles supports the pipelines.
The marine section of the outfall is approximately 5 kilometers in length and reaches a water depth of 50 meters. The pipelines are situated directly next to each other in a trench, supported on a bedding of rock and backfilled with three layers of rock for protection against dragging and dropping anchors. Series of diffusers are located at the end of the two discharge pipelines and rise above the existing seabed at a water depth of 40 meters. The diffusers are protected by reinforced concrete structures.

The main components of the project were:

- Manufacture of the concrete elements
- Construction of the land section
- Construction of the marine section

FEATURES

Client	Public Utilities Board
Location	Singapore
Period	2002 - 2005
Engineer	MWH Consultants

A Location map
B Casting of the foundation slab
C Overview casting and curing area

MANUFACTURE OF THE CONCRETE ELEMENTS

The pipes were manufactured on-site in a purpose build casting yard including a batch plant, a covered cage manufacture area and a pipe storage and a joint testing area. The casting area consisted of 15 pipe casting pits and an area for casting of the diffuser elements and protective structures.

A caging machine was used to bend galvanized rebar coils into cages. The cage and mould were placed in a casting pit and a mobile concreting tower was used for casting of the pipe in one pour. A mobile hot water curing system was then installed to optimize the early strength development of the high-density concrete. The pipes were transported from the casting area to the curing area 3 days after casting. Two 120 tons capacity rubber tired gantry cranes were used to transport the pipes. The pipes were tilted to the horizontal position after 14 days of curing and then jointly tested to check the water tightness of the joint. The casting yard allowed a continuous casting process

whereby 30 pipes were produced in a 6 day week. A total of 1465 elements were manufactured using 9,000 tons of rebar and 44,000 cubic meters of high grade concrete.

CONSTRUCTION OF THE LAND SECTION

The construction of the land section started with the installation of the bored piles followed by the construction of the cofferdam. After excavation of the cofferdam and subsequent strutting of the sheet pile walls, the reinforced concrete foundation slab was constructed above the bored piles. The cofferdam was subsequently flooded and the end wall was removed. A reinforced underwater concrete slab of 35 meters in length was constructed to ensure a fluent transition from the land slab to the marine rock bedding. The pipes were installed from offshore into the cofferdam. A concrete end wall was constructed, the pipes were plugged and the cofferdam dewatered and extended up to the effluent junction chamber of the water treatment plant. Installation of the pipes was carried out with a 650 tons crawler crane and at a later stage with a gantry crane. In total 2,500 tons of rebar and 16,000 cubic meters of concrete were used.

CONSTRUCTION OF THE MARINE SECTION

The construction of the marine section started with the dredging of the trench at 8 meters in depth, 16 meters in width and 5 kilometers in length. The Trailing Suction Hopper Dredger 'Cornelis Zanen' removed the softer topsoil, whereas the Grab Dredger 'WH Goomai' removed the harder Old Alluvium. In addition, the weak material below the required trench level was removed. In total 4.2 million cubic meters of soil was dredged and discharged at various dumping sites.

The rock bedding was installed using the Fall Pipe Pontoon 'Zinkoon VI' and the Boskalis scrading® technology. All the rock placed during the project was imported from various quarries in Indonesia and transported to the site using up to 9 barges with a loading capacity of 3,500 tons each.

The purpose build Installation Pontoon 'Arta' was used for the installation of the concrete elements up to a water depth of 50 meters without the aid of divers. Highly advanced electronic positioning systems were developed to fulfill the stringent installation tolerances. The 400 tons gantry crane on board of the 'Arta' lowered the installation frame with two pipes onto the rock bedding. A remotely operated hydraulic system joined the pipes with the previously installed pipes. Then rock bunkers were opened and gravel embedded the pipes and the installation frame was retrieved. The diffuser elements and protective structures were installed in a similar way. The three protective layers of rock were also placed with the 'Zinkoon VI'. In some areas additional rock was placed to restore the original seabed level. About 2.3 million tons of rock was placed during the marine construction.


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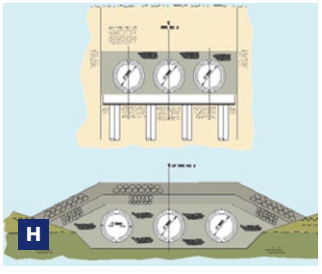
H


F

D Fall Pipe Pontoon Zinkoon VI
E Pipe Installation Pontoon Arta
F Trailing Suction Hopper Dredger Cornelis Zanen and Grab Dredger WH Goomai
G Preparation of rebar cage
H Typical Outfall cross sections
I Demoulding a concrete pipe

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