



CONSTRUCTION, TOWING, LAYING AND BURIAL OF THE EFFLUENT DISPOSAL PIPELINE OFF KARWAR

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ABSTRACT

Environmental studies were carried out in the Binaga bay, Karwar for one full year by the National Institute of Oceanography, Goa, for the location of discharge point and the selection of a suitable pipeline route for the disposal of effluents coming out from the caustic soda and chlorine plant of the Ballarpur Industries Limited, Karwar. About 3800 m of 315 mm O. D, high density polyethylene pipeline was assembled, weighted by R. C. C. collars, carefully laid and buried along the pre-determined alignment off Binaga north beach, Karwar. This paper presents the different phases of construction of the outfall which include pre-fabrication and pressure testing of the assembled pipeline, mounting of the weight collars, towing, aligning and submersion of the assembled sections of the pipeline, connection of the pipe sections by flange joints at sea and finally the burial of the pipeline by divers using powerful air jets.

INTRODUCTION

The ocean has long been used as a receptacle for the convenient disposal of the liquid wastes. Due to increasing awareness of environmental protection and ecological preservation, better standards are being developed for the disposal of effluents. It has been a general practice in recent years to discharge the liquid wastes, after some preliminary treatment, into the sea using marine outfalls for better dispersion, dilution and degradation of the pollutants under the influence of the environmental forces. As a result, the design, construction, operation and maintenance of pipelines in the sea is becoming increasingly important to the engineering profession.

Physical, chemical, biological and geological oceanographic studies were carried out by the National Institute of Oceanography, Goa, for the selection of the most suitable pipeline route and location of

the outlet for discharging effluents coming out of the caustic soda and chlorine plant of M/s. Ballarpur Industries Limited (BILT), Karwar. The company requested the Institute to act as their consultant for advising the contractors M/s. Hydronauts Private Ltd., during the different phases of construction of the marine outfall. The projected effluent discharge through the marine outfall is 300 m^3 per hour or $0.083 \text{ m}^3/\text{sec}$. The effluent is being treated to fulfil the I. S. I. standards before discharging into the sea.

DESCRIPTION OF THE AREA

Geomorphological Conditions:

The coastline in the area is highly indented with a series of bays and pocket beaches occurring between rocky headlands. The Binaga north beach is a pocket beach confined between Binaga and Baitkal Points (Fig. 1). The

prominent offshore islands in the area are Anjadip and Mogeraguda islands as shown in Fig. 1.

Environmental Conditions:

The climate follows the broad pattern of the west coast of India and is highly influenced by the southwest monsoon occurring from June to September. The rainfall is mostly restricted to the southwest monsoon period ranging from 2300 to 3400 mm. The annual variation in temperature is from 23.7°C to 30.5°C.

Winds, waves, currents and tides:

The strong winds blow from the west and southwest during the monsoon period, with the strongest winds blowing from the west during July. The predominant direction from which waves approach the area is the west-southwest in June, the west in July and the north during October. The coastal currents are strong during August flowing in a south-southeasterly direction. The currents are very weak in September. In the nearshore areas the currents are highly influenced by the tides and the breaking of waves. The tides in this region are of a mixed type with predominantly semi-diurnal in character. The spring tide range is 1.58 m between mean higher high water and mean lower low water.

Other oceanographic conditions:

The nearshore water in the area is biologically rich and abundant in phyto and zooplankton populations. Rich commercial fishery exists in the area. Both traditional and mechanized crafts are employed for fishing. During the one year oceanographic survey, the National Institute of Oceanography, Goa, carried out studies on various physical parameters like temperature, salinity, surface and sub-surface currents; chemical parameters like pH, alkalinity, dissolved oxygen and carbon dioxide; and biological parameters like benthos, zooplankton and fisheries.

Nearshore Sea-bed Topography:

Extensive seabed surveys were conducted by

the National Institute of Oceanography, Goa, which included echosounding, side scan sonar and shallow seismic profiling followed by sampling by grab and piston gravity samplers. The sea-bed in general is marked by even topography except in the vicinity of the Binaga and Baitkal Points, and offshore islands. The average slope of the sea-bed upto a distance of 0.6 to 0.7 km from the shore where the depth of water is about 8 m varies from 1 : 35 to 1 : 200 (Fig. 2). Farther offshore, beyond a line connecting the Binaga and Baitkal headlands, the sea-bed slopes are very gentle varying from 1 : 550 to 1 : 750. The nearshore region of the beach is largely covered by sand with a maximum thickness upto 20 m. The sand layer thins out towards the headlands. In the offshore area beyond 5 to 9 m water depth, the sea-bed is covered by sand-clay mixture and soft clay. The thickness of this clay layer increases seawards and reaches about 5 m. The sediments are underlain by rock which is exposed near the headlands and offshore islands. In areas deeper than 12 m the seismic profiles clearly indicated the presence of rock below the clay layer.

Location of the Marine Outfall:

Based on various environmental parameters including fisheries, and considerations related to dispersion and dilution of the effluents including laying and burial of the pipeline, it was found necessary to locate the discharge point at a distance of about 3.8 km from the shore at a depth of about 13 m as shown in Fig. 2. The pipeline route was slightly deviated at a distance of about 0.7 km from the shore to avoid hard strata which could have made the burial operation very difficult (Fig. 2).

ASSEMBLY OF THE PIPELINE

The high density polyethylene (HDPE) pipes manufactured by Polyolefins Industries Ltd. (PIL), Bombay at their Thana plant were delivered to Karwar in 5 m lengths. The main contractor for this project was M/s. Hydronauts Private Ltd., Bombay, who had sub-contracted the laying and burial operation to M/s. Marinecrete (India), Goa. The 315 mm O. D., 5 m long sections of the HDPE pipes were welded together at the creek on the northern end of the beach to form about

400 m long sections (Fig. 2). The welding was carried out using a patented butt fusion welding machine. Each pre-fabricated pipe section was pressure-tested using air compressors from its both ends maintaining a pressure of about 1.3 times the working pressure.

The pressure tested pipes were fitted with end plugs and mild steel towing clamps. The pipeline was progressively launched out on the shallow water of the creek as it was welded up (Fig. 3). Two half-rectangular R. C. C. weight collars with an approximate weight of 55 kg each were bolted on to the pipeline in the creek at an interval of 1 m centre to centre (Fig. 4). The weight collars were so arranged that the empty pipe section would just float in the sea.

INSTALLATION OF REACTION BLOCK

A 6 tonne R. C. C. reaction block with embedded pipe outlets was loaded on to a pontoon and towed by means of a fishing trawler and was properly anchored at the position of the discharge point. A 100 m HDPE pipe section mounted with the R.C.C. weight collars was fixed to this reaction block by means of a flange joint. The reaction block along with the 100 m pipe section was then lowered with the help of the chain pulley block mounted on the "A" frame of the pontoon and carefully placed on the sea-bed at 13 m water depth and checked by divers. The divers then fixed the diffuser section to the outlets of the pipeline using a pre-fabricated bracket, bolts and nuts.

TOWING AND LAYING OF THE PIPELINE

The assembled pipeline in lengths of about 400 m mounted with concrete weight collars was carefully towed out of the creek at favourable tide levels and anchored in position above the pre-determined pipeline route. The free end of the submerged pipe section was lifted up above the surface of the water with the help of divers and a pulley block. One end of the 400 m pipe section just brought into the position was fixed to this pipe by divers using a flange joint. Care was taken to insert water tight gaskets and

the joining work was done above the water surface so that water was not permitted to enter the pipe. After the completion of the flange joint the pipeline was allowed to float assuming the shape of a S-curve from the diffuser end to the floating end.

The submersion of the pipeline was commenced from the diffuser end of the pipeline by letting out the air from the pipe at the shoreward end of the floating section of the pipe. This in turn controlled the inflow of water at the diffuser end of the pipeline. The sinking of the pipeline could be closely controlled. The sinking was stopped at intervals to check and adjust the alignment of the pipeline. Boats were used to pull the pipeline sideways into the correct position during the submersion operation. The flexibility of the HDPE pipes was a great advantage in controlling the pipeline alignment during its submersion. Towing, aligning, jointing and submersion of the pipe sections were progressively extended in the shoreward direction. For about 10 m section of the pipeline on either side of the flange joint, weight collars were mounted and fixed by means of J-bolts by the divers working on the sea-bed.

BURIAL OF THE PIPELINE

Burial of the pipeline in the seabed was necessary to ensure that the pipeline is not exposed to the action of waves and currents. Proper burial would also ensure the safety of the pipeline from possible future damage which could occur due to the direct impact of anchors or trawl doors of the fishing vessels in the area. High powered air jets were used to trench and fluidize the material below the pipeline as indicated in Fig. 5. The pipeline could sink considerably below the sea-bed. Air jets were also used to push the material from either side towards the pipeline to fill the trench and increase the overburden over the pipeline. Since a major portion of the submarine pipeline was laid over the soft clay, it could sink in the material due to its own weight. The diver operated air jets facilitated further penetration of the pipeline into this material. The jets were effective in the nearshore sandy area upto a distance of about 0.7 km from the shoreline. However, it was very difficult for the divers to work in this area because of

shallowness, high turbulence and currents generated by tides and breaking waves.

In the nearshore region upto a depth of about 4 m, additional weight collars were used for increasing the negative buoyancy of the pipeline and to increase its safety against the disturbing forces of the sea. The nearshore section of the pipeline is generally subjected to worst sea conditions due to breaking of waves, strong nearshore currents, turbulence and large variations in the sea-bed levels particularly during the monsoon season. Figs. 6 and 7 show erosion due to monsoonal waves leading to the deep vertical cut in the beach exposing the top portion of the buried pipeline along with the concrete weight collars. During the fair weather season, however, the onshore transport of sand would build the beach causing the beach elevation and width to increase considerably, leading to the burial of the pipeline again by natural forces.

CONCLUSIONS

Using the available expertise, indigenous technology, equipment and manpower, it is possible to undertake and successfully complete the construction of marine outfalls in India. The high density polyethylene pipeline, because of its flexibility and lightness, could easily be assembled, towed, aligned and submerged at a predetermined pipeline route. Necessary negative buoyancy could be obtained by fixing specially designed R. C. C. weight collars around the pipeline at a desired interval.

Further improvements in the design as well as in the construction techniques are required in future marine outfalls to be constructed of the HDPE pipes. Serious thought should also be given to develop better weight coating techniques to uniformly increase the weight of the pipeline to counteract the buoyancy effects. Considerable research and developmental work is required for developing better techniques and facilities for laying and burial of the submarine pipelines in India.

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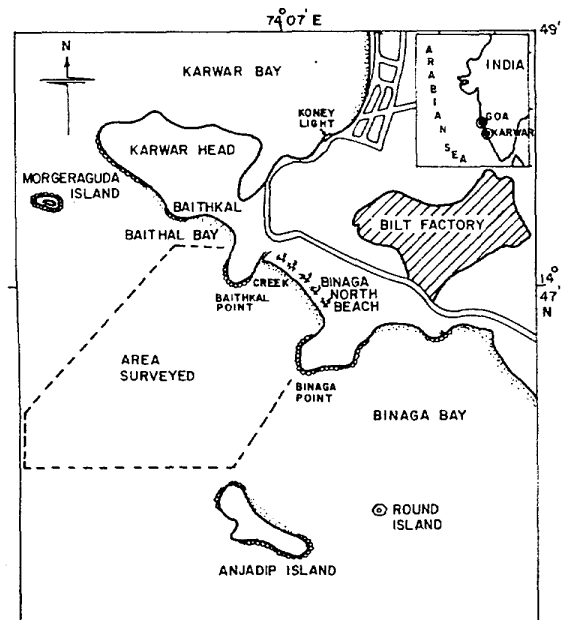


Fig.1 Location Map of the Project Area

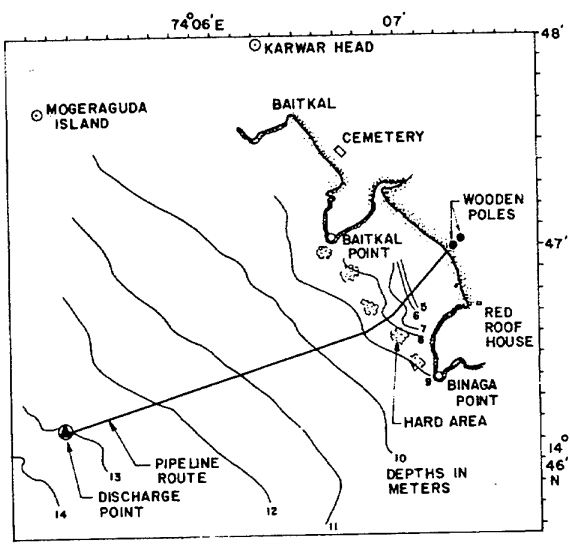


Fig. 2 Pipeline Route and the Discharge Point

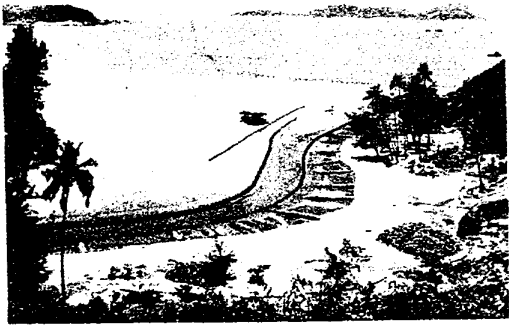


Fig. 3 Assembled Pipe Sections in the Creek

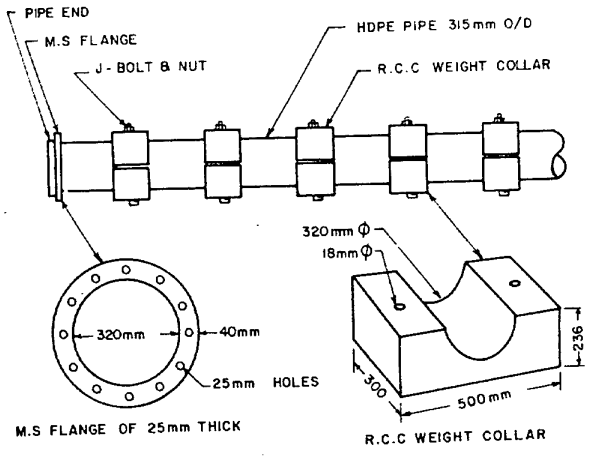


Fig. 4 Fixing of R.C.C. Weight Collars

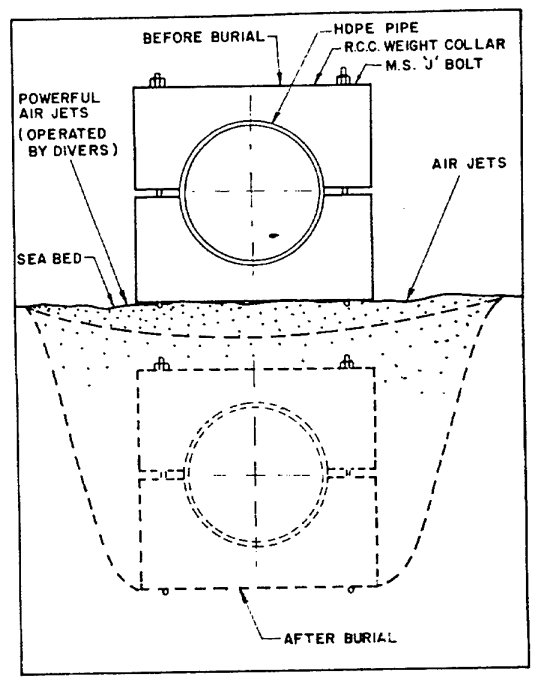


Fig. 5 Schematic Showing the Burial Operation

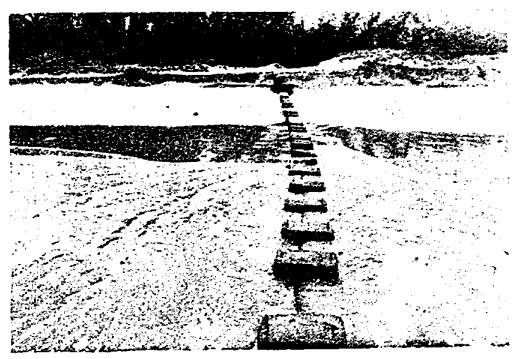


Fig. 6 Photograph taken in July 1980 Looking Shoreward--Shows the Eroded Beach Exposing the Pipeline in the Nearshore Region

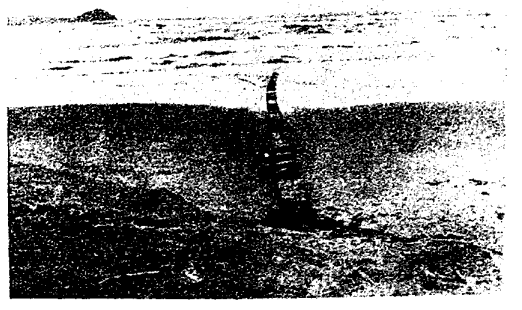


Fig. 7 Photograph Taken in July 1980 Looking Seaward--Shows the Monsoon Waves and the Exposed Pipeline Section