GEOSYNTHETICS ASIA 2012
5th Asian Regional Conference on Geosynthetics
13 to 15 December 2012 | Bangkok, Thailand

SHORE PROTECTION WORKS USING GEOSYSTEM

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ABSTRACT

AHPPL has planned for a reclamation work as a part of port terminal development at Hazira, Gujarat. Towards this end, the area on the southern side of the existing land based drilling platform needed to be reclaimed to create the port back-up facility. To retain the reclamation material as well as to protect the proposed back-up yard from the marine environment, a peripheral shore protection system was planned. Further, as a part of reclamation work, slope of height 10m was to be protected against erosion by the waves. In the process, different shore protection systems were evaluated, which included use of conventional and geo-synthetic materials. Considering the benefits of using geo-synthetics and its wide range of applications in coastal protection works, a shore protection system using geo-synthetic materials was adopted. Based on the design parameters, shore protection system with geo-textile containers as core material and with stone armour layers was designed. Dredged material was used to fill the geo-textile containers which acted as a barrier to prevent egress of dredged material into the sea. Geo-textile containers were manufactured from high strength woven geo-textiles and filled with locally available sand. These containers were stacked one above the other to form the required slope. Polymer rope gabions filled with stones were provided as launching apron to prevent scouring of the toe. Garware-Wall Ropes Ltd. was entrusted with the construction of shore protection system using geo-textile containers. The present paper highlights the use of geo-textile containers as an alternative cost – effective and eco friendly system in coastal protection works and the construction methodology adopted at site.

Keywords: Geotextile containers, polymer rope gabions and shore protection system.

INTRODUCTION

M/s. Adani Hazira Port Pvt Ltd. has been developing a NON LNG terminal in Hazira by reclaiming the part of inter-tidal along the coast. To retain the reclaimed land, it was planned to provide a sea-dike of about 3.5km long surrounding the face of the reclamation region facing the sea (Fig. 1). The sea-dike system consisted of conventional armour and under layers with rubble stones, and the core was designed with sand filled geo-textile containers. The entire system was protected from scour by means of a wide apron made of polymer gabions in front of the core. The width of the apron varied depending on the land level on the shore line.

PROPOSED DEVELOPMENT PLAN

The entire length of the shore protection alignment was divided in small segments (From section 1-1 to 8-8) based on the geometry (Fig. 1), variation in existing contours and other site related issues. In Section 1-1 and 2-2, comprising a length of 1250m, an exposed geo-bag system was already in place since 2003, which was to be strengthened. For the sections (Section 3-3 to 7-7), a geo-system was planned in the core portion of the proposed shore protection on similar lines as section 1-1 and 2-2.
Section 8-8 is located at contour level higher than Mean Higher High Water (MHHW) level.
Subsequently, necessary filter and armor rock layers (Primary armour and secondary armour along with rock toe) were designed to be placed over the geo-system core to safe guard against the harsh marine environment.

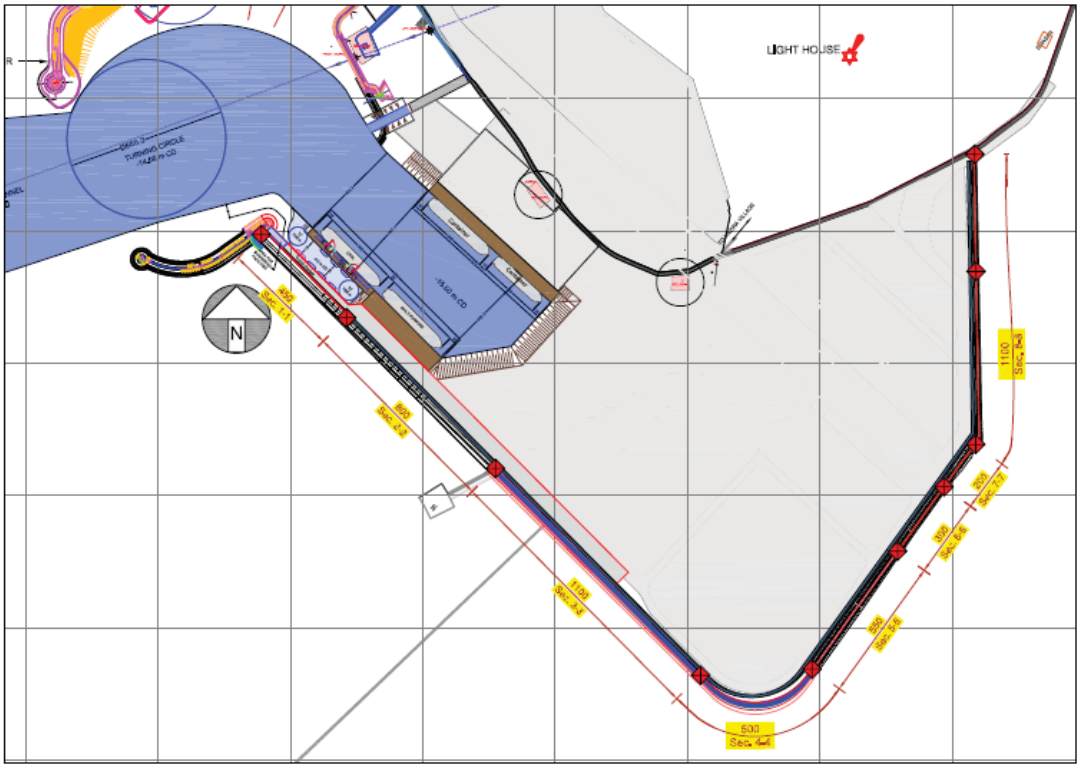

Fig. 1 Proposed shore protection layout plan

DESIGN OF CORE GEO-SYSTEM FOR SHORE PROTECTION WORKS

The overall stability of the revetment under wave attack was checked for the given design input parameters like significant wave height, Maximum water level and Relative density of geotextile bags. The details of the core geo-system extracted from the calculations were,

- The size of 4mx1mx1m the geo-textile container was designed to be provided with a saturated unit weight of approximately 7T. The fill capacity of the container has a significant impact on its stability, it is therefore critical that this fill capacity be maintained for the life of the structure.
  The geo-textile selected for making of geo-textile container was designed based on sand retention capacity which also influences the long term fill capacity of the geo-textile container.
- As with all coastal structures, toe stability was critical in ensuring the survival of the geo-textile container structure. The length of toe protection required was approximately 16m as calculated from the analysis, however site specific assessment was recommended.
- The filter layer was designed based on considerations of specific characteristics of the base soil.

The geotextile containers were laid one above the other to form required slope and height of the geo-system, subsequently, necessary filter and armour rock layers (primary armour and secondary armour along with rock toe) were designed to be placed over the core geo-system to safe guard against the harsh marine environment (Fig. 2).

The environmental and geotechnical conditions are unique for each site. Their characteristics can change with modifications in the proposed functional characteristics, as per the structure.

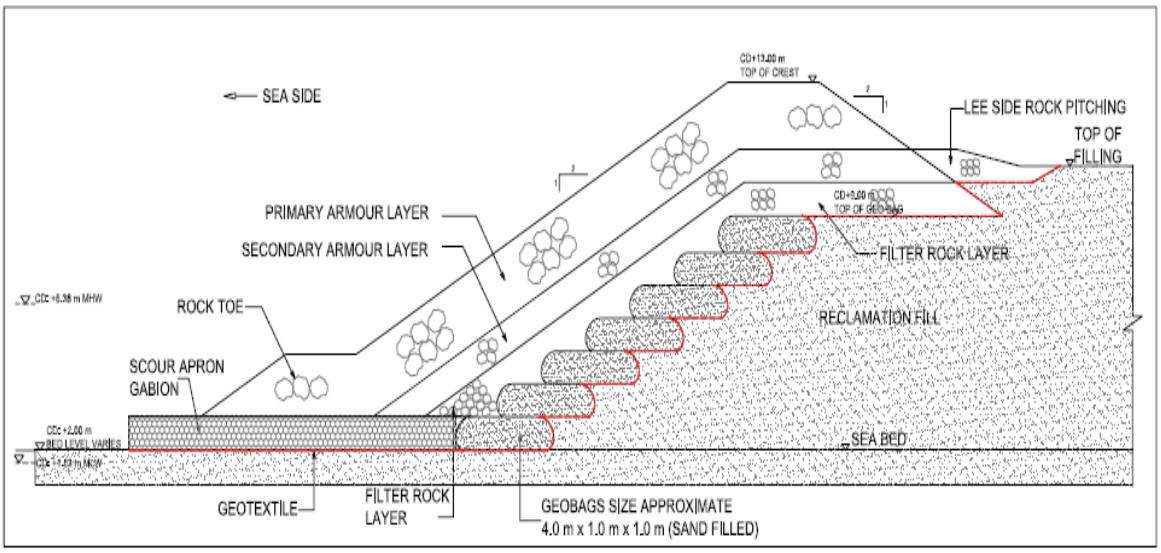

Fig. 2 Typical cross section of shore protection system

INSTALLATION

Overall Construction Sequence Followed

The execution was carried out during low tide period. The following construction sequence was followed (Fig. 3),

1. Bed was prepared for laying of both PP rope gabion and geotextile container.
2. Geo-textile filter layer was placed on the prepared bed surface.
3. The scour apron as per the drawing was constructed by using PP rope gabion.
4. The Geo-textile containers were placed in position by using suitable technique as explained below.
5. Dredged sand slurry was pumped in to the geo-textile containers for filling up to the maximum filling capacity.
6. Simultaneous back filling and compaction of the reclaimed soil up to the geo-textile container level was carried out.

Fig. 3 During construction of apron and geotextile containers

POLY PROPYLENE (PP) ROPE GABION DETAILED INSTALLATION

Methodology

- The land was cleared off of debris and was leveled as per the site requirement. All depressions were backfilled up to the desired grade and compacted manually to the extent possible.
- Geo-textile material with specified properties was then spread over the prepared bed before placing gabions.
- Empty gabions were placed on the prepared land. A steel frame as shown in the Fig. 4 was then inserted through the corners of the gabions to get a firm shape.
- Stones were placed with the help of hands or machine to avoid damage to the polymer rope and to avoid voids between the fillings. Filler stones were hard, durable, and clean. Grading given was 100 to 200 mm.
- In order to avoid localized deformation, the gabion unit was filled in stages consisting of maximum 300 mm courses. Maximum height from which the stone were dropped in to the gabion was not more than 1 m. The outer layer of stone was carefully placed and arranged by hand if required to ensure a neat and compact appearance along all exposed faces. An extra layer of 25 to 50 mm of stone was then filled uniformly to compensate for the future settlement.
- Lids were then stretched tight over the stone fill until the lid met the perimeter edges of the front and end panels and tied with all edges of gabion. The packing of stones done in the gabion is shown in Fig. 4.
- After the boulders were placed in their desired position with the help of steel frames, the frames were removed as shown in Fig. 4 and further reused for installation of the PP Rope gabions.

Fig. 4 During filling of PP rope gabion using steel frames

GEO-TEXTILE CONTAINERS

- Rectangular box shaped Geo-textile containers of size 4 x 1 x 1m were used. One face (lid) of the container was kept unstitched for filling the container with dredged sand. In order to stitch the lid, an extra geo-textile of width 10cm was provided.
- The land was cleared off of the debris. The land was then leveled to place the Geo-textile Containers as per the site requirements. After the placement of one layer of the containers, soil is filled behind the containers and leveled as required for the placement of next layer of the geotextile containers.
- A rectangular shaped steel box or "farm", open at the base and top of appropriate size in order to fit in the Geo-textile Container of size 4 x 1 x 1, was formed using detachable steel frames interlocked into each other. Two holes each were provided at the top corners on two opposite small faces of the steel frame box for assembling and dismantling.
- These steel boxes were assembled on site and then kept in position using proper lifting arrangement. There was a loop arrangement surrounding the open base and two opposite faces along the length of the box.
- The Geo-textile Container was then laid in the steel frame box and was held in position using clamps. Dredged sand was then filled using shovel attached at the end of the jib of the crawler mounted Poclain (Fig. 5). After filling, the three open sides of the lid of the container were stitched.
- The loops lying on the sides of the box were then attached to a steel frame on top. The whole assembly was then carried by the Poclain and placed in the desired position. An overlap of 2m over the previous layer of the geo-textile Containers was provided as per design. After adjusting the position of the container, the steel frames were removed and reused for further filling of the geo-textile containers.

Fig. 5 During filling of the geotextile containers with local available material

An aerial view of the site before and after reclamation by using geo-system is shown in the Figs. 6 and 7. The final arrangement of geo-textile containers along with apron by using PP rope gabion for land reclamation to create the port back-up facility is shown in the Figs. 9 and 10.

Fig. 6 Areal view of the port backup facility before land reclamation (Reference: Google earth)

Fig. 7 Areal view of the port backup facility after land reclamation using geo-system as core material

CONCLUSIONS

Geotextile containers used as core material of shore protection for land reclamation provided an economical and rapid reclamation technique. In general, the overall system was found to be in good condition. The apron, in most places, was found in tact and in addition, the apron since been fully covered by sedimentation (Fig. 8). This is good indication that the coastal stretch is not prone to erosion however regular monitoring needs to be done to evaluate the status of the structure/apron. If there is any exposure of apron over a period of time, submerged toe in front of the apron may be required to be provided on the sea side Subsequently, necessary filter and armor rock layers (primary armour and secondary armour along with rock toe) are to be placed over the core geo-system to safe guard against the harsh marine environment.

Fig. 8 Apron is covered by sediments in most length of the stretches

Fig. 9 Arrangement of geotextile containers and PP rope gabions in progress

Fig. 10 Final arrangement of geotextile containers shore protection system