Modern Breakwater Solution of Geotextile Tube in UAE

Abstract: In 2011, the UAE Government announced the construction of a new fishing port in Ras Al Khaimah City including new breakwater structure with a total length of 700m. The breakwater encloses and protects the entire area of the new fishing port. Due to the economic slowdown which started in 2009, the Government was looking for ways to reduce cost spending and started to look for alternatives based on value engineering. Considering all factors, a design using geo-textile tubes filled with dredged sand from the seabed as core material for the breakwater, was proposed. The circumference of the geotextile tubes varies between 8.6m to 12.9m and lengths between 10m to 50m long to form 4 layers of barriers as a breakwater. Currently this is the largest scale geo-textile tube breakwater application in the UAE.

A breakwater is a man-made structure protecting a shoreline area, port or anchorage from waves and tidal currents. Some breakwaters are built towards the seaward limit of the intertidal zone some are parallel (or nearly parallel) to the shore which are called offshore breakwater. Breakwaters may be either fixed or floating and its choice depends on water depth and tidal range. Breakwater construction is usually parallel or perpendicular to the coastline to maintain tranquil condition in the port. Most breakwater construction depends upon wave condition and considering some other environmental parameters. There are many alternative methods to consider in order to construct the breakwater such as caisson type, rubble mound, precast concrete blocks, etc. Each one of these methods has its own unique characteristics as well as its building process. The appointed consultant chose one of the above mentioned conventional methods and estimated the cost of construction of a fishing harbor for 250 berths. This estimate was used as a base for establishing the budget for the project, due to the economic slowdown which started in 2009, the UAE Government was looking for cost-effective and innovative engineering solution and as such a geotextile tube breakwater was chosen.

Project Description

In 2011, the UAE Government announced that they would construct a new fishing port in Ras Al Khaimah for 250 berths including a quay wall, slipway, breakwater and relational structure. This new fishing port project is located at the in-shore beside an existing groin as highlighted in blue in Figure 1 below.

The UAE Government require a fishing port that is designed in such a way to shield protection area, maintain the stability of the fairway, anchorage, basin, slip in the harbor, and keep the harbor depth in order to make the boats stay safe with easy access and smooth anchor handling.

Design Solution and Construction Process

Ras Al Khaimah new fish port project is located at the in-shore beside an existing groin. The existing groin was left as it prevents canal silt up and provides calm conditions inside the new port. From a local wave study it was recommended to have the port access from the existing access channel hence the reason for the breakthrough of the existing groin. Existing water depths were insufficient which required dredging of the harbor basin to the specified depth. After considering all requirements the first draft design shown below in Figure 2 was prepared. The breakwater extends 147m from the existing coastline and turns 90 degree to the northeast direction with a length of 524m connecting to the existing groin. Total length of the breakwater is approximately 700m.

Government authorities assessed the construction cost, constructability and method statement for building this unique breakwater and concluded that the most appropriate breakwater structure was the geotextile tube type breakwater.
breakwater construction: geotextile tube

The geotextile tubes vary on lengths between 10m to 50m. In order to prevent erosion during construction a scour apron and anchor tube is placed below the bottom geotextile tube. Two layers of rock i.e. filter rock layer and armour rock layer are used to protect geotextile tube. Filter layer is placed to prevent the rock damaging the geotextile tubes during placement a armour rock including an additional layer of geotextile. In total 4 layers of geotextile tubes stacked on top of each other to reach 6 m height including aforementioned rock layers. Total quantity of geotextile tubes used in the breakwater is 286 units including 33 geotextile apron units.

As can be seen in Figure 6, construction sequence started from the shoreline towards the 90 degree corner. Each section must be surveyed prior to installation to avoid the geotextile tube damage or wrong installation location.

Highest water level at the new fishing port ranges is +2.5 m H.A.T.. During stormy conditions a maximum wave height of +3.5m can occur. The design engineer considered many factors as overtopping, wave runup, wave angle, slope, tidal and local current. Based on all design parameters involved a breakwater profile with a crest height of +6m was deemed sufficient to protect the port from extreme weather conditions.

Breakwater is build up out of 4 layers i.e. geotextile tubes filled with dredged sand from the seabed used as core material for the breakwater. Between geotextile tubes dredge sand is placed and compacted covered up with geotextile mats. Reference is made to Figure 4 for typical cross section of the breakwater.

The top layer of geotextile tube has a circumference of 8.6 m and the remaining layers of geotextile tubes have a circumference of 12.9 m. Due to the long and bend structure,
After completing 4 layers of geotextile tube and core filled layers with geotextile mats placed a layer of rock with 50 ~500Kg to be the under layer of protection. Finally the rock with 300~1000Kg armour rock was installed, Figure 8.

Figure 7. Placing rock armor

Performance

After completing construction in July 2013 we can conclude that the constructability of geotextile tubes for breakwater construction is easy and fast. Furthermore with this cost effective method the contractor managed not only to construct a harbor for half the construction cost but also to double the size of the harbour up to 500 boat capacity as compared to the 250 berths of the consultant’s design. After completing the project the breakwater looks identical to the traditional rubble mound breakwater, reference is made to Figure 8 to 11. There are almost no differences between the two construction methods. This project proved that using the geotextile tubes to replace the expensive rock is a very effective way to cut down construction cost.

References

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