International Journal of Scientific Research and Engineering Development-– Volume 4 Issue 2, Mar- Apr 2021

Available at www.ijsred.com

RESEARCH ARTICLE OPEN ACCESS

# Precast Concrete Breakwater Units

Mehmet Faruk Yanik*

*(Doruk Muhendislik, Design Center, Istanbul, Turkey)

----------**********----------

## Abstract:

Breakwaters are one of the most important structures in the field of Coastal Engineering. Breakwaters, while preventing waves from entering the harbor or basin, must maintain its own stability at the same time. The high wind load of the coasts, especially in the winter months can damage the houses. In this study, a modern precast concrete breakwater that is easy to transport and install is proposed to reduce the impact of waves hitting the coast. Breakwater unit has concrete quality minimum 40 Mpa. Sulfate resistant admixture EN197-1 cem I42,5 R-SR5 is used in mix design to resist sea water salt effects. As a result, a low cost, easy to manufacture, corrosion and salt water resistant, long lasting breakwater has been developed.

*Keywords* **—Precast concrete, high strength concrete, breakwater, coastal engineering.**

----------**********----------

## I. INTRODUCTION

Breakwaters, which are important in Coastal Engineering, are structures that are used to prevent sandblasting and coastal erosion in coastal areas, to direct currents, to allow ships to navigate and shelter safely and to carry out activities in the port safely. It is necessary to reach an optimum value between the efficiency and economy of these structures, which have very high construction costs[1].

Breakwaters are constructed as bevelled, vertical or composite depending on factors such as material, sea, coastal conditions, machinery park. The most widely used type of breakwater jetty in Turkey are faced bevelled. Bevelled-faced breakwaters require high tonnage, qualified quarry stones in their outer protective layers in order to withstand the effects of open sea waves. Therefore, even in the construction of a small breakwater, thousands of tons of quarry stones are needed and the desired stone weight for stability cannot be achieved. In addition, the need for large quantities of qualified quarries causes many quarry operations demands and therefore environmental problems. Nowadays, with the difficulty of operating the quarries and the awareness of the environmental damage of these facilities, different materials are being sought. For this reason, the use of special concrete blocks instead of large quarries (7-8 tons or larger each) in the outer protective layer has started to be increasingly preferred [2].

The high content of NaCl in seawater makes it more destructive for concrete [3]. For this reason, breakwater concrete must have a friction-preventing and long-lasting structure. Considering the high production cost, assembly and transportation process of the existing breakwaters, a low-cost precast concrete breakwater model was produced, which is easy to install and transport. For this work, a sulphate-resistant mixture is also used for the longevity of the concrete.

The rest of this paper is organized as follows. In Section 2, literature review on breakwatersis discussed; then proposed method is presented in Section 3. Finally, we conclude the paper with some future research directions in Section 4.

 ©IJSRED:All Rights are Reserved 

## II. LITERATURE REVIEW

The types of breakwaters used in the world are generally divided into four classes. The first is inclined breakwaters protected by stone or concrete blocks of various shapes, the second is caisson type vertical-faced breakwaters, the third is mixed breakwaters containing the first and second types together, and the fourth is a special type of breakwaters. In the first type of breakwaters, although the use of stone-filled breakwaters is primarily advantageous, concrete blocks consisting of various units are preferred when large-sized stones are not available. However, in such breakwaters, great care should be taken in placing the blocks in order to ensure that the blocks are locked within themselves. In addition, it is necessary to be equipped in terms of equipment and equipment and experienced personnel to perform this process [4].

Stepped breakwaters are more advantageous than traditional breakwaters. Some of the most important of these advantages are to reduce wave penetration and the size of the stone to be used and to significantly increase the stability of the structure. Stepped breakwater is a type of stone fill breakwater with a lower and upper slope. Upper and lower slopes are very important factors when designing. For example, the upper slope is very effective in reducing the size of the stone. However, the main parameters that are effective are the slope angle, the step width, the level of the rung and the steepness of the wave [5].

The presence of the step-in breakwaters is particularly effective on transcending. In the long term, it is more advantageous in terms of cost to increase the level of the step instead of increasing the height of the Kronman wall. The step on the sea side not only reduces wave transcendence but also increases the stability in the breakwater protection layer.

There has not been much work done on the cascading breakwater. The Rock Manual [6] defined structures with a slope below the step 1: 6. Dijkstra [7] looked at the rung and the stability in the lower slope of the rung. Van Gent et al. [8] examined the situation where the slope above the step was 1:2.

Breakwaters are generally designed as permanent. This situation increases the cost in case of initial assembly and replacement. Therefore, prefabricated structures are needed in some places.

Prefabricated building systems are defined as the most advanced stage industrialized building production systems have reached today. Prefabricated construction systems have brought many advantages such as the rational use of materials, time, labour and capital in the transition from raw materials to finished products. In order to construct the relationship between the needs and demands of the society, it aims to produce more, higher quality and more economical buildings with less labour force in the industrial production process. As standardized dimensions and quality, low fault tolerant elements are used in prefabricated construction systems, the building quality is high [9].

Concrete prefabrication, an industrial building production method, is the most intensely used prefabricated production technique worldwide. Prefabricated building elements are widely applied as structural, decorative and infrastructure elements from large-scale constructions to small-scale projects [10]. In this direction, the concrete industry tries to offer concrete solutions by adopting modern construction methods and innovations in order to save costs by reducing construction time and to encourage sustainable development [11].

In this study, a long-lasting precast concrete breakwater design, which is low in cost, easy to maintain, install and transport is proposed.

## III. PROPOSED METHOD

Most of the seaside of Istanbul City exposed to excessive high southeast wind loads especially in winter. Sea waves gives many harms to coastal houses.

Precast concrete modular unit are designed to protect these types of harms. Modular units are designed as small as possible and to remain constant during transportation and erection by arranging the unit center of gravity at center to prevent overturning.

 ©IJSRED: All Rights are Reserved 

Breakwater unit has concrete quality minimum 40 Mpa. Sulphate resistant admixture EN197-1 cem I42,5 R-SR5 is used in mix design to resist sea water salt effects. Breakwater unit section and connection details are given in Figure 1,2,3,4,5,6. Modular unit side section is designed with overlapping section to have sealing effect.

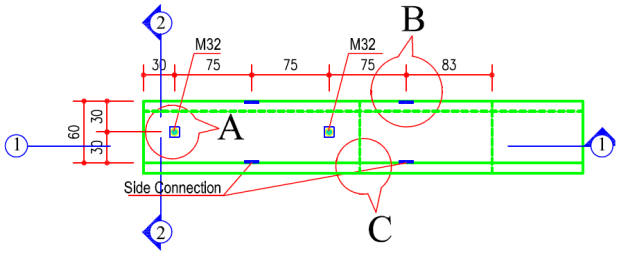


Fig. 1Precast concrete breakwater unit section 3-3

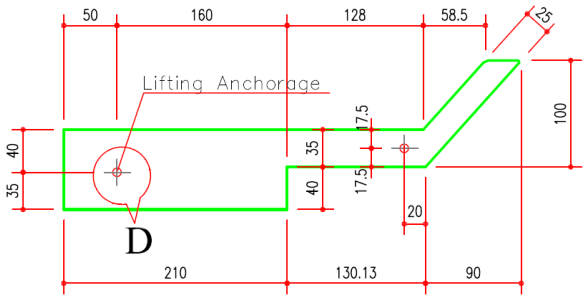


Fig. 2 Lifting point details (Side view)

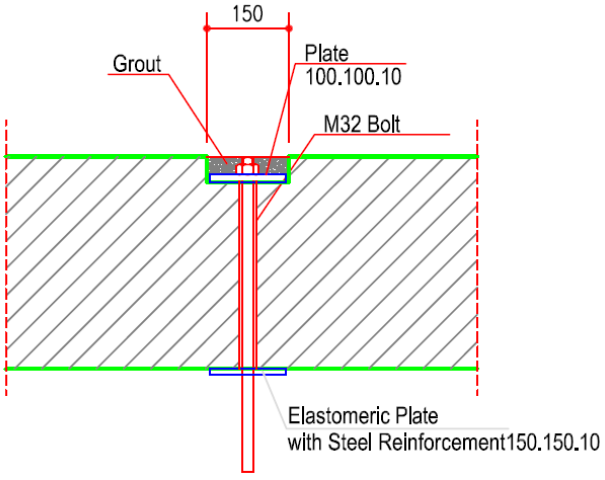


Fig. 3 Connection detail A

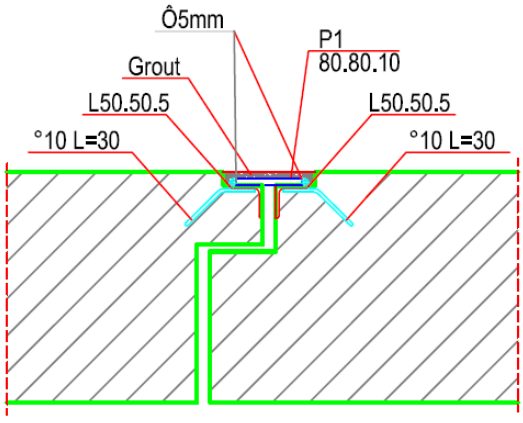


Fig. 4 Connection detail B

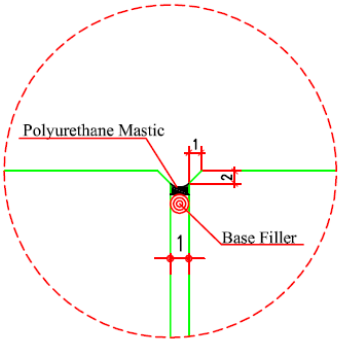


Fig. 5 Connection detail C

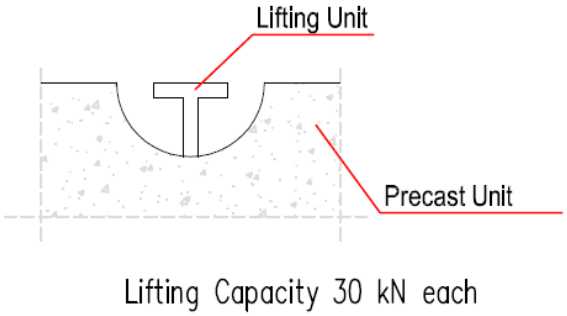


Fig. 6 Connection detail D

Modular precast concrete breakwater units give advantage on cost, time and durability according to alternative solutions. Units can be fixed to the base floor with chemical anchorage. Each unit also are connected each other with embedded fix connection. Unit joints are sealed with durable polyurethane mastic. Connection gaps are filled with non-shrink high quality grout mortar (min 40 Mpa)

 ©IJSRED: All Rights are Reserved 

## IV. CONCLUSIONS

Prefabrication includes construction activities with pre-manufactured elements or compounds. The prefabricated building system, which emerged with the building industrialization, obtains many advantages in the building life cycle.Prefabricated systems constitute an important place in meeting the basic requirements expected in the construction industry such as lightness, recyclability, total low cost, quality and performance.

As a result of this study, it was observed that the proposed new prefabricated concrete breakwater design reduced costs, facilitated the production, assembly, transportation and maintenance process, and the EN197-1 cem I42,5 R-SR5 mixture used in concrete increased the resistance to salt water.

## REFERENCES

[1] Arukan, Ş. (2019).Basamaklı Dalgakıranlarda Dalga Aşmasının Deneysel Araştırılması, Yıldız Teknik Üniversitesi İnşaat Mühendisliği Anabilim Dalı Kıyı ve Liman Mühendisliği Programı,Yüksek Lisans Tezi.

[2] Akman, S. (2020).Dalgakıranların Koruyucu Tabakalarında Kullanılan Özel Beton Blokların Yapısal Analizi, Dokuz Eylül Üniversitesi İnşaat Mühendisliği Anabilim Dalı, Hidrolik - Hidroloji ve Su Kaynakları Yüksek Lisans Tezi.

[3] Sarıışık, A., Kalsiyum Karbonat Kökenli Mermerlerin Çevre Etkileşimi İle Fiziko-Mekanik Özelliklerindeki Değişim Karakteristiklikleri, Süleyman Demirel Üniversitesi Fen Bilimleri Enstitüsü,Doktora Tezi1998.

[4] OCDI, Technical Standards For Port and Harbour Facilities in Japan, Tokyo, 1991, p.203.

[5] Gülver, M. (2017).Basamaklı Dalgakıranlarda StabiliteAraştırılması,Yıldız Teknik Üniversitesi İnşaat Mühendisliği Anabilim Dalı Kıyı ve Liman Mühendisliği Programı, Yüksek Lisans Tezi.

[6] CIRIA, CUR, CETMEF C683, (2007). Rock Manual, CIRIA, 2nd edition, London.

[7] Dijkstra, O.P.J., (2008). Armour Stability on a Bermed Slope Breakwater, M. Sc. thesis, Delft University of Technology and Department of Hydraulic, Delft

[8] Van Gent, M.R.A., Smith, G.M. ve Van der Werf, I.M., (2011). "Stability of Rock Slopes with a Berm: The Upper Slope", Coastal Structures Conference, 4-6 Eylül 2011, Yokohama, Japan.

[9] Arieff, A. ve Burkhart, B. (2002). Prefab. ISBN 10: 1586851322 / ISBN 13: 9781586851323, Published by Gibbs Smith.

[10] Mtech Consult Limited. (2008). Waste reduction potential of precast concrete manufactured offsite (was 003-003: offsite construction case study). Waste & Resources Action Programme. Banbury: Oxon.

[11] Koca, S. (2010). Prefabrike Beton Endüstrisinde Atık Yönetimi Ve Geri Dönüşüm Olanakları, Gazi Üniversitesi Fen Bilimleri Enstitüsü, Yüksek Lisans Tezi.

 ©IJSRED: All Rights are Reserved 