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CONTRIBUTION OF T-HEAD GROINS TO BEACH FORMATION

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ABSTRACT

First time, T-head groins were built to protect the shore in 1998-2000 during the double highway construction, along the Black Sea Coast in Turkey. Between the years 2000-2018 the contribution of T-head shaped groins to beach formation and their positive or negative effects on the change of coast and submarine topography were examined in addition to protecting the coast the possibility of used as a beach has also been investigated. As a research methods the T-head groins were marked on the map then obtained measurements of bathymetric depth by taking echo sounders, for the survey area so bathymetric maps were prepared. Afterwards, bathymetric depth measurements were repeated at the winter and summer. What kind of materials fill in T-head groins? Can be used T-head groins as beach? Does T-head groins have positive or negative contributions along the seashore to beach formation? In this study, such questions answers have been searched. As a result of the research, it was observed that the T-head groins were seen to have formed a sandy area along the coast where could be used as beach and it was found provided very positive contributions to the seacoast.

KEYWORDS:
T-head groin, sediment, beach formation, filling, Eastern Black sea

INTRODUCTION

The coasts; the sediments dragged by the creeks, streams, and rivers, the coastal structures and coastal currents are effected by the wind and waves. As long as there is no intervention, it will reach the state of equilibrium after a long period. Each intervention affects the coastal dynamics and contributes the movement to reach the state of equilibrium.

The coasts, sediments dragged by the creeks, streams, and rivers, the coastal structures and coastal currents are under the effect of the wind and waves. As long as there is no Intervention, it will reach the state of equilibrium after a long period time. Each intervention affects the coastal dynamics and continues the movement to reach the state of equilibrium. The impacts of wind, currents and the sediment transport should be take into consideration in order to ensure that the coastal structures do not disturb the coastal equilibrium. The project designer should make project with the best approach that will not disturb the balance by analysing these effects thoroughly. These works should done before the project starts. The new situations, which occurred after the project should be monitored and if necessary, the balance of the coast should be protected through adjustments [1].

For the establishment of a coastal-human relationship, the best way to protect the coast is to build sandbanks on the coast. The groins are the most important engineering constructions made within the scope of the coastal protection [2].

The groins are coastal protection structures built generally perpendicular to the shore in order to create a shoreline along the coast that keeps the sediment and prevents the coastal erosion. T-head groins also have functions such as holding the moving material on the shore, preserving the balance of the existing beach, keeping the large items on the upper part of the beach, preventing the harbour and the fishermen's shelters from being filled [3].

The groins, which are constructed because of the analysis of the coastal parameters, ensure the formation of the beach in a short time and accelerate the coastal-human relationship [4-7]

When coastal structures are to be constructed, the conditions of the region should be carefully examined. The direction of the dominant wave and accordingly the direction of the sediment transport along the coast should be determined [8-10].

When a coastal structure is built on any coast the followings factors affect the shoreline changes; the height of the wave (H), wave period (T), the angle of the wave (α), bottom slope (tan β), grain diameter (d50), the size of the structure (Lx), the distance between the structures (Lg), the amount of the sediment transport along the coastline (Q).

It is understood from the literature studies that when a structure is constructed along the shoreline, the balance of the shore changes and the shoreline

is affected. If there is not any structure, the shore remains in balance [11,12].

The interaction between the groins and the sediment transport along the shoreline has a very complex structure. Therefore, the ability to set very precise guidelines for projecting can be only the results of a very long work.

MATERIALS AND METHODS

The coastal erosion is one of the most frequent serious consequences that disrupt the coastal-human relations. The classic coastal protection structures, which are made to prevent this are very large and cost a fortune. Moreover, they can be completely disrupt the ecological balance of the place where they are built and causing environmental disasters.



FIGURE 1
The location of the T- head groins which are 13 T-head groins within the study area and measurement grid (5x5) for the bathymetric depth.

In this context it can be easily said that the natural beaches are the best coastal protection structures. Therefore, the way of protection natural beaches goes through building especially T-head groins. In this study examined the T-groins built on the coast of Trabzon of - Kıyıcık for protection within the scope of the Black Sea Double Highway. The coast which was selected as the study area is a seven km-long part of the of coast whose total length is 11 km. There have been 13 T-groins along the coast route

The construction of the T-head groins are started in 2000 and by combining them into groups were completed in the same year and they are named from west to east T1, T2.....T13. All of the constructed groins are in the same size and the space between the groins (a) in the group is usually twice the size of the groin length. The groin's length is b=75m, the width of the head is c=37.5 m, the space between the groins is a=150m, the body width is 10 m, while the altitude of the groin is +1 m from sea level. Study 5 x5 m grid sea sounding line was made on the area whose length is 60 x 80m (Fig. 1).

The contour lines of the groins were obtained by processing the obtained sounding value in a CAD program and was made separately according values years of 2000 and 2018. As a result, it has investigated whether there was material accumulation around the groins depending on the sediment motion and the groins were subjected to functional evaluation [16].

THEORY AND CALCULATION

The length of a groin determines the amount of the coastal sediment transport, it is used to determine the gap between the groins, and length of the groins varies from about 30 to 200 meters. The average interval is taken approximately as Eq. (1),

$$L_G = (1-3).L_x \qquad (1)$$

(Lg: T-head groins interval, Lx: T-head groins length).

Although the groins, which were examined in this study were made of stones and T-head shaped. The "T" head groins hold the shore materials from both sides and provide better protection according to the straight groins. A series of groins, that work together in order to protect a long part of the shore is called the groin system.

In the simplest sense, it can be said that wave is a mess that distorts and turns upside-down the balance of the hydraulic system. The waves seen in the seas, lakes and gulfs occur due to dependent forces such as tides and wind. Since the measurement of the wind waves is difficult and expensive, the observations are rather short. In Turkey, a regular wave measurement network new has been established. Therefore, the data, which is required for the project with the help of the wind records and have been, estimated from meteorological wind data or from the synoptic wind maps. Therefore, the data, which is required for the project, are estimated with the help of the wind records. The wind data, which is used in the estimation of the wave, are obtained from the meteorological wind data or from the synoptic wind maps [13].

The dominant wave direction of the shore region is N, NNW and NW and the significant wave heights vary between 1.5 m and 7.5 m. Also in some extreme sea storm values, this can reach 11.5 m.

Note: Since, the wave data obtained from the meteorological data are smaller than those obtained from the synoptic maps, the data obtained from the SMB data were used for the safety of the structure.

In terms of sediment, the rivers in the Eastern Black Sea Regions are wild as their slopes are quite large due to the topographic structure of the region. Therefore, their flow rates are very high. This leads to significant sediment transport. This amount is estimated to be about 3-5 million tons / years. The general formula is above. The general substance transport formula had developed by (Electrical Works Etude and Management) EWEM, Equation (2).

$$Q_t = 14.153.101.26016.\log \mathbf{A} \qquad (2)$$

(A: Basin area km^2; Q_t: Flow rate of the sediment tons / year)

In addition, an equation was developed according to the data taken from the rivers in the Eastern Black Sea region Eq. (3).

$$Q_t = a.Q_{avr}^{b} \qquad (3)$$

a and b are regression coefficient, Q_{avr} is the daily average flow rate m^3/ sec. Q_t : the flow rate of the sediment transport tons / day. The sediment transport made by the rivers in the Eastern Black Sea region is estimated to be 3-5 million tones / year [14].

The source of the sediment transport is the material, which occurs as the result of the erosion of the land and the breakdowns of the rocks is transported to the shore with the help of the rivers. The sediment, which reaches the sea in this way, is constantly moving in the coastal zone. This movement continues after adding the existing sediments.

The movement of the sediments in the coasts has been examined on the cross section of the coastal unit width, which is taken perpendicular to the shore these sections are called the coastal profile. The coastal profiles are, also classified according to the wave effects among themselves. The profile of the waves when they are small and less is called the “Normal Profile” or “Summer Profile” and when the waves are more and high then it is called the “Storm Profile” or “Winter Profile”. Although the main parameter, which affects the coastal profile, is the transport, which is perpendicular to the coast, the effect of the parallel transport is also excessive. Here the effective factors are the settling velocity of the deep-sea particle (w), mean wave stiffness (H_o/ L_o) diameter of the sediment (d_{50}). In addition, the sand-gravel, which is taken randomly from the coast or from the coastal areas in improper manner, can also change the coastal profile. The transport, which is parallel to the shore is the transport caused by the coastal currents [15].

The figure below shows how the coastal profile has changed over a period of 13 years (year of 2007-2020) (Fig 2).



FIGURE 2
Study area, the resort town of Trabzon/Of/Kıyıcık area, Turkey (view of year 2007 and 2020)

RESULTS AND DISCUSSION

T-head groins have been built along the Black Sea coast, which in parallel to the shore in most places where coastal protection is necessary according to the project criteria. The T-head groins are successfully implemented where forming or following in a logical order or sequence. Unlike the plain and L-groins they hold the sediment and do not leave it back during the transport which is upright or parallel to the shore.

The sand and gravel, which constitutes the majority of the transport along the coast, are kept by the groins built sequentially and as a result, great sanding occurs on the shore. This new sanding creates a new shoreline and sea line acquires a natural beach view. Thus, it contributes to the development of the coastal tourism and to the acceleration of the coastal-human relationship and allows the people to benefit from the coast to the maximum extent.

The sanding caused by the T-groins provides the opportunity to obtain a wide beach by continuing the coastal circulation. The coast ensures the balanced distribution of the sediment transport. The coast ensures the hydrodynamic balance as well as it helps to protect the highway from the wave effects and reinforces the coastal-human relationship. It creates environmental health.

On the other hand, the T-head groins, which are not built sequentially in a system along with the L and I-groins, may cause undesirable results such as damaging the shore. On one side, they fill the shore (by holding the sand-gravel); while on the other side, they may cause (carving) erosion.

Because of the research and investigation, the groins were measured and evaluated and the following results were obtained. In addition, the fullness has been given percentage according to the inside area of the T-head groin. The sediment

transport, which is parallel to the coast, is also from west to east direction. Therefore, the direction of the maximum sediment transport wave is north-west (NW). This means that the results of the investigation, measurement and observation are in agreement with the theoretical information. This shows that the approach is correct.

According to this: There is a 35% fullness up to +2.5 altitudes on the heels in the Kıyıcık T5 and T6 groins. These groins had filled with suitable materials such as sand and fine sand filled in these groins and have the most fullness so far, they are can be used as beaches (Fig. 1, 3 a.b.c). There are 50% fullness with fine material (fine sand) in the Kıyıcık T7 and T8 groins. These over filled groins are also go on using as beaches in summer days (Fig.1, 4 a,b,c).

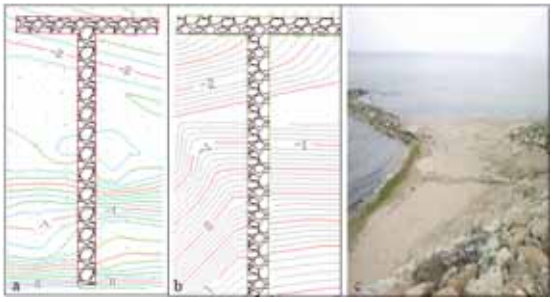


FIGURE 3
Kıyıcık T5 (a) July 2000, (b) July 2018, (c) Current view (At the study area T5-head groin is given before construct (2000) and after (2018) bathymetric curves with a photograph of the current view in Kıyıcık).

The groins, which were constructed along Kıyıcık, are a group of 13 groins; an amount of material (sand, thin sand etc.) was accumulated on the heel at the No. T1, T2, T3 groins. On the right heel of the T4 spur, at an altitude of +2, an approximate 20% occupancy rate was observed, in Kıyıcık.

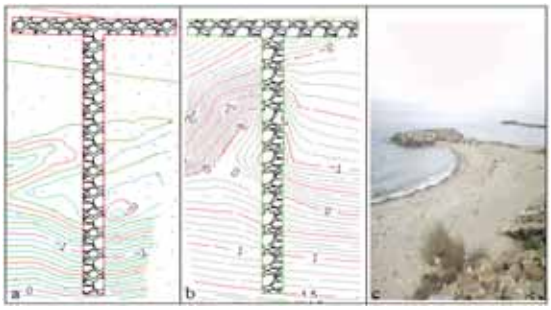


FIGURE 4
Kıyıcık T8 (a) July 2000, (b) July 2018, (c) Current view (At the study area T8-head groin is given before construct (2000) and after (2018) bathymetric curves with a photograph of the current view in Kıyıcık).

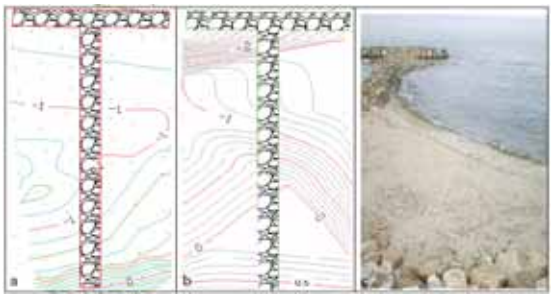


FIGURE 5
Kıyıcık T10 (a) July 2000, (b) July 2018, (c) Current view (At the study area T10-head groin is given before construct (2000) and after (2018) bathymetric curves with a photograph of the current view in Kıyıcık).

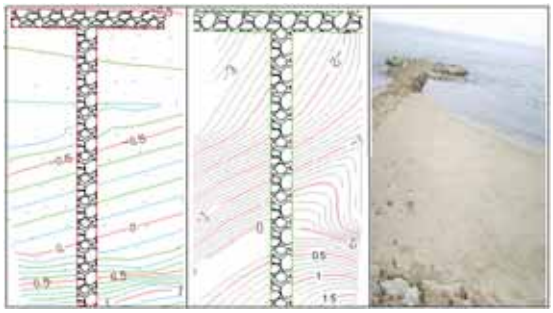


FIGURE 6
Kıyıcık T11 (a) July 2000, (b) July 2018, (c) Current view (At the study area T11-head groin is given before construct (2000) and after (2018) bathymetric curves with a photograph of the current wiev in Kıyıcık).

There are 40% fullness with fine materials like sand and thin sand at the Kıyıcık T9 and T10 groins. Their fullness rate is increasingly growing, they can be used as beaches (Fig. 1, 4 a,b,c). There are 80% fullness with fine material like sand and thin sand at the Kıyıcık T11 and T12 and T13 groins. These are the most filled groins according to the other groins. They have very high environmental contribution and can be used as beaches (Fig. 1, 5, 6 a,b,c).

CONCLUSION

When the study area was investigated by walking along the coast, it was seen that the selection of the size was right, however the selection of the place was not done properly, because attention was not paid to the geometry of the groins and the building height (+1,5-2m) was too high .

When these will be constructed in groups, it should be considered to calculate the distance between groins as 3 times of the length of the T and the height of the construction should not be exceed +0,5m.

Over time the T-head groins will completely covered with sand and will disappear and a natural beach will be created. In this way, an environment will be occurred which can be used by the people more easily. At the same time, tourism activities will gain momentum and human environment relation will be provided, people will benefit from the beach, so the environment will naturally be protected.

In addition, the coastal change should be monitored periodically, the occurred damages should be repaired, sand-gravel should be removed from the over filled groins, and artificial filling can be done on some groins which need to be used as beaches. The coast must be monitored continuously and data bank should be established. In this way data, based feedback will be ensured and the information reinforcement about the land and observation results will be realized. This data will increase the approach rate in the results after it is supported by empirical studies.

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