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# Investigation of Groins Construction on Beach Deformation

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**Abstract**

Groins are often used in river engineering for navigation improvement or bank support, as well as in coastal engineering for bank or beach protection. Groins are 'hard' engineering structures specifically deployed for shoreline protection and/or stabilization. In some specifically-designed cases, they are employed to facilitate enhancement of navigation channel tidal flows, in order to promote sediment scouring. In recent years there is growing interest in using groins for stream corridor restoration projects. The embayment region between successive groins acts as a dead water zone where the local residence time of suspended particulate matter is much larger under certain condition groin fields can provide condition necessary for natural growth of the vegetation in the river or coast. first in the article the groyne impact on beach was investigated, however design criteria in to other coastal's books has been observed, The Scour criteria at this structure is paid less. At the end of the paper to the Scour risk of coast predicted.

**Keywords:** Groins- Beach Deformation- coastal engineering

## Introduction

The groin is important sea engineering adopted much to protect beaches and the silt project in the present coast of many countries. The object of construction a groin or groin system is to stabilize a stretch of beach against erosion where that erosion is due primarily to a net alongshore loss of sand. The design and construction of groins requires the services of a professional engineer and a contractor to construct the coastal protective structures, it is necessary to estimate the scouring depth and bed level changing in the vicinity of such structures. Due to the construction on the Caspian Sea coastal especially Anzali and Astara beaches in the Guilan province, which are used as commercial banks and recreational beaches, groins application can have an important role in stabilizing these beaches. Several investigations have been conducted in the past to study the effects of groin parameters on shoreline change some of the most important studies are summarized as follows:

Investigation of sediment transport Pattern and beach morphology in the vicinity of groin (case study: Dahane SAR Sefid rood) is done; in this research The simulations were obtained using a one-line model which can be used as a first approximation of shoreline prediction in the vicinity of groin. The results of propose model are compared with experimental formula to determine the shape of the coast. Finally, the result of the present study show that using submerged groin can have a good efficiency to control the sediment and beach erosion without causing severe environmental impact to the coast. The important outcome from this study may be employed in optimum designing of groin in marine projects (Afsoos Biria et al, 2014). The effects of straight groin parameters on amount of accretion in a physical model in wave basin using regular waves are investigated. They also carried out a numerical model which depends primarily on a CERC model is employed to examine the effects of some of the various groin parameters (length and spacing) and wave parameters (wave height, wave period and wave angle) on the accretion of area protected by straight groin were studied in a physical model. Finally the results of a numerical model are compared with data that were obtained by deep sounding measurements at carsibasi coasts, Trabzon province turkey (Ozolcer et al, 2006). A numerical simulation model of the waves is done by Mike 21 around the submerged groins and comparison with the non-submerged groins is performed and variation of height of the waves around the groins is discussed. Also, the main objective of this study has been focused on crest height impact of groins on wave heights (Afsoos Biria et al, 2015).

## Type of Groyne

Groins can be built with different plan view shapes. Examples are straight groins, T head, L head, hockey stick, and inverted hockey stick groins, straight groins with pier head, wing, and tail groins. Groins can be submerged or not under normal conditions. Usually impermeable groins are non-submerged, since flow over the top of solid groins may cause severe erosion along the shanks. Submerged groins, on the other hand, may be permeable depending on the degree of flow disturbance needed. Groins are routinely constructed of sheet piling, Older groins made with timber or steel sheet-pile, recent ones constructed with armor stone and concrete blocks (Short, 1999). At exposed Caspian coast; groins are most often of rubble-mound construction. Because the rubble-mound groins are advantageous with respect to the steel, concrete and wooden ones, as they better dissipate energy of waves and currents. For economic reasons, Groins are often constructed of riprap and are commonly designed to be submerged during high flows.

**Fig1. Rock groins with temporary additional crest layer in place (Crossman et al, 2003).**

**Fig2.Sand-filled Groins Stabilizing a Florida Beach (Harris, 2003).**

**Fig3.Timber groin (site).**

## Impact of Groins on the Shoreline

Appropriate choice of shapes, dimensions and location of groins is crucial for effectiveness of shore protection. Groins length is usually related to mean width of the surf zone and on the other hand to their long shore spacing. An active length of the groin basically increases together with the growth of wave-to-shoreline angle. While designing groins, one should remember that they should not trap the whole long shore sediment flux. Numerous investigations and observations suggest that within optimal solutions the groins spread seawards not further than to 40-50% of the storm surf zone width. Effectiveness of the groins depends also on their permeability. The groins which are either structurally permeable or submerged (permanently or during high water levels) allow more sediment to pass alongshore through them, in comparison to impermeable or high Groin (Pilarczyk and Zeidler, 1996).

Stabilize a beach that is subject to severe storms or excessive seasonal shoreline recession by reducing the rate of sand loss by longshore transport; reduce the rate of longshore transport out of an area by locally reorienting the shoreline so that it is more nearly parallel with the predominant incoming wave crests; reduce longshore losses of sand from an area by compartmenting the beach; and prevent sedimentation or accretion in a down coast area by acting as a barrier to longshore transport. Groyne do nothing for the lack of sediment supply which is applicable not only in surf zone but also in the offshore region. Thuse, beyond these structurs erosion continues and the bed deepens and steepens. Protection of the shore by use of one groyne only is most often inefficient. Therefore, shore protection by groynes is designed as a group comprising from a few to tens of individual structures. A scheme of a system of interacting groynes is given in [Figure 4]. A single groyne, besides its positive influence on the shore, causes numerous side effects, mainly in the form of coastal erosion on the lee side of the structure. In the case of a group of groynes, the above effect appears on the lee side of the whole system. The erosion is also observed in direct vicinity of the structures, particularly when waves approaching the shore perpendicularly predominate. Between the groins, huge mass of water is accumulated which in turn leads to appearance of compensating flows along the structures, causing local erosion of the seabed. With respect to the surf zone width, during severe storms the groynes are "short" structures, with frequently occurring erosion around them, while under weak wave conditions they become "long", thus helping in sand accumulation and widening of the beach. Loss of contact between a groyne and the shore in an unfavourable effect. In such a case, longshore flows are generated between the shoreline and the groyne root. These flows are the reason for washing out of the beach. The use of a series of groyne is one of the most effective means of stabilizing or realigning channel banks (Short, 1999). The graphs and tables contained in (Silvester, 1997) for determining shapes of static equilibrium bays can be used to predict the shoreline between groins.

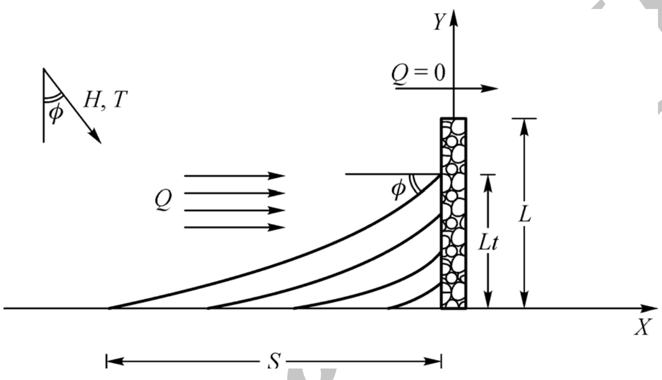


**Fig 4. Beach deformation behind groins (Afsoos Biria et al, 2014).**

A 'groin's length'(refer (Us Army, 1990)), and elevation, and the' spacing between groins' (refer (Us Army, 1990)) is determined according to local wave energy and beach slope. Groins that are too long or too high tend to accelerate down drift erosion because they trap too much sediment. Groins that are too short, too low, or too permeable are ineffective because they trap too little sediment. When a groin is used in conjunction with other structures or is the last groin in a groin field, it is referred to as a terminal groin. In the case of a groin used with other shore structures, the intention is to provide added protection to the beach formed by the additional structures. The most significant impact of groins the capturing of sand. Sand builds up on the up drift side of a groin, coupled with a loss of sediment on the down drift side. In most cases, the longer the groin, or the greater the number of groins in a groin field, the greater the loss of sand down drift. To counter these effects, nourishment, or placement, of sand in the amount that is estimated to be trapped by the structure under average water levels is required during the construction of all groin projects.

**Fig 5. Beach deformation in the vicinity of groin at Guilan Beach (Afsoos Biria et al, 2014).**

## Functions of Groyne

Effects of a bank protection by installation of groin depend on main factors of groin, which are hydraulic characteristics (the water level, velocity, flow of main stream, and etc.), topographic features of beach. Also, effects depend on design factors, which are the length, interval degree and arrangement of groin. For instance, as the. Length of groin increases the range of a bank protected extends. However, at the same time as the velocity of a main channel and head of groin changes considerably, it would have dangerousness causing serious local scours around structures. In addition, the installation of groin series causes recirculation flow between groins. In this area it is very important to design a groin with proper intervals for security of a bank as a strong reverse flow causing erosion of bank can occur according to intervals of groin. Groin is suitable option for erosion control, but such structures generate scour at their heads. It is important that they are designed to resist scour or they may be rapidly washed away (Thompson, 2002). In designs for general structures occurrence of scour is a defensive, and it is required to identify the scale of scour for the stability of structures. However, holes created by scours can function as ecological habitats. Measuring the show, the impermeable groin was remarkably larger than the permeable one and the permeable groin showed little change against varying permeability, showing overall decrease whereas permeability increased.

## Groyne design construction

The design of groins should be completed by an experience coastal engineer familiar with coastal structure design. Once it is decided that groin is required, preliminary design considerations should include the length, location, spacing [figure 9] and number of groins.

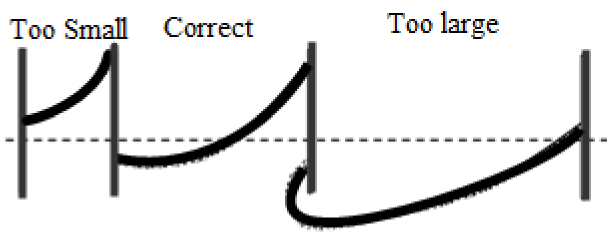


**Fig. 9 spacing of groins**

Design constraints are listed below:
• Scour
• Beach morphology
• Hydrology and flow regulation
• Wind generated waves
• Local currents and turbulence
• Water level changes due to tides and wind
• Ship -induced currents and waves
• Ice loads
• Geotechnical boundary condition

Experience has shown that in the design of marine structures there is less attention to scour problem, therefore regarded criteria design for marine structures and not considering scour depth can result in damage to the structures. At the shores of the Caspian Sea in spite of proper design of structure at such marine phenomenon, i.e. scouring, had not been considered by structural designers, therefore tilting and toppling of such structures occurred, without any changes in their shapes or any other structural deformation, and finally these structures lasted their workability as stabilizers of the beaches. Although other parameter design given in to reference (Us Army, 1990) we pay to scour in the part:
Beach training works should be designed to resist scour, in particular erosion of the bed adjacent to the river training structure. Scour can be localized, general or a combination of both. Different terms

are used to describe the various forms of scour such as bend scour, constriction scour, etc. The use of these terms can be inconsistent

And the designer should carefully check the physical phenomenon behind the wording. The designer is recommended to adopt the terms used in a particular reference document such as Manual on scour at bridges and other hydraulic structures (CIRIA, 2002) or Scour manual (Hoffmans and Verheij, 1997).

The expected scour near the structure during construction and during service one of the most important aspects to consider during design. Most failures of beach training structures result from an underestimation of the depth of scour. Joint occurrence of local scour and critical morphological condition should be considered.

## Impact of Geotechnical properties on Scour depth

The geotechnical stability of the structure, including slop angle, is the primary geotechnical factor influencing the design of marine works. Depth and slop angle of local scour holes at the toe are important design boundary condition that should be considered for overall bank stability as well as local stability of the toe.

Structures at cohesive sea-beds are less at risk of scour, because the cohesive forces slow down the scour process. Non-cohesive sea bed is widely spread and common in the model test (Haddorp, 2005).

## Introduction of scouring at the Caspian Sea

The Caspian Sea is the largest included of water in earth by surface area of 372000 square kilometers (about 11.2 times that of the five great lakes combined) and a volume f 78200 cubic kilometers. Its latitude are $40^0\ 0^/\ 0^{//}$ and $51^0\ 0^/\ 0^{//}$ respectively. The lake accounts for 40 to 44 percent of the total lacustrine waters of the world. It has maximum depth of about 1025 meters. The Caspian is divided into three distance physical regions: northern, middle and southern Caspian. The southern Caspian is the deepest, with a depth that reaches over 1000 meters also the southern Caspian account 66 percent of the total water volume, respectively.

As the result of the measurements on coast lines of Caspian Sea especially Anzali and Astra region which located in Guilan state in Iran is confirmer to a parabolic behavior of sandy coasts in this region. Several issues to invent the variation of equilibrium beach profiles such as mechanism of transportation sediment, wave characteristic and Geotechnical properties of sea bed soil. In this paper Geotechnical properties of sea bed soil clarified.

Study of beach profile evolution and scouring effect due to the wave and current impacts in the coastal zone has been one of the most important issues in coastal engineering research projects during the past decades. TO construct the coastal protective structures, it is necessary to estimate the scouring depth and in the vicinity of structures. Despite the groin construction can have an important role in stabilizing the Caspian coast. Study of scour prediction in coastal can be most important issues for design purposes and beach establishing. In this present paper Anzali and Astara Coasts have been studied. Due to the lake of classified data in the present study, samples based on being original data in Anzali and Astara Coast collected which distributed uniformly [Table1]. In this process, the coast which near to mountain have larger particle average size and with faraway of mountain this amount is reduced. If each of four geotechnical parameters, particle average size (D50), porosity (e), specific gravity (G.S) and internal friction angle (Ø) increases, the result in bed deformation and erosion would be decreased. Among the studied coasts, Astara coast has the least of erosion. Therefore, designers should be subject of scour for Coastal structures in Anzali coast due to geotechnical parameters obtained with more seriously consider.

**Table 1: Sea bed Specifications**

| Region | $D_{50}$ (mm) | G.S (ton/m$^3$) | e (kg/m$^3$) | Ø (rad) |
|---|---|---|---|---|
| Astara | .53 | 2.75 | .5 | .65 |
| Anzali | .2 | 2.71 | .43 | .58 |


**Fig. 10 Beaches studied**

## Conclusion

Groins reduce long shore transport by trapping beach material and causing the beach orientation to change relative to the dominant wave directions. They mainly influence bed load transport and are most effective on shingle or gravel beaches. Sand is carried in temporary suspension during higher energy wave or current conditions and will therefore tend to be carried over or around any cross-shore structures. Groins can also be used successfully in estuaries to alter near shore tidal flow patterns. Due to the groin construction on the Caspian Sea coast designers should be subject of scour for Coastal structures in Anzali coast due to geotechnical parameters obtained with more seriously consider. Coastal engineering is a new knowledge in Iran, therefore better recognition of coastal structures and beaches helps the designers to design correctly in order to the structure to have suitable function in stabilizing the beaches.

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