Extended Abstract

Introduction

The purpose of this postgraduate thesis is to draw up a manual of geometrical characteristics to engineers who have as their object the study and construction of cross-shore structures. The change in the morphology of a shoreline is affected in the short and long term by the ripples and currents that contribute to it. The cross-shore structures are built with the first aim of protecting against erosion and secondly the advancement of the shoreline. For this reason, it is being investigated that optimization of groyne system in order to maximize efficiency in the transport of sediment to the coast. Different types of groyne system (different length and space between them) are designed and the regime of sediment transport is being investigated in detail. Different types of groyne system (different space between them) are designed and the regime of sediment transport is being investigated in detail. Moreover, the computational program MIKE21 of Danish Hydraulic Institute (DHI) is used for the simulation of wave propagation, current flow and sediment transport and the comparison of the results as well.

Theoretical background

Wave action is the main factor of the sediment transport, while afterwards the longshore currents are responsible for their horizontal transport, because the longshore currents generated by wave breaking. Sediment transport can be divided into three modes, the suspended load, which involves the sediment in suspension, the bed load which is in continuous contact with the bed and the wash load that consist of very small particles transported with water motion.

Groyne System

Groynes are the oldest type of coastal protection structures, effective against erosion in areas where longshore sediment transport rate is great. The optimization of the groynes system for sediment transport will be explored by the effect of the groynes geometry change, keeping the length (L_g) of the groynes stable, the research focuses on the variation of the distance between the goynes (L_f). The results from different scenarios are presented in figures which can be used for the selection of the most optimum system. This will result in the differentiation of the flow types that develop into the hydrodynamic field within the groynes from the flow of the long-shore current entering it. In turn, the flows are the ones that direct the suspended load and the sediment bed load to the various locations on the coast. The range of distances L_f was selected from 20 to 130 meters, with the basic criterion being the ability to construct all the systems to be explored on the respective beach. Table 1 shows the ratio R = L_g / L_f ,which eventually range from 0.3 to 2.

Table 1: Geometric values of coefficient R

L_g (m)	L_f (m)	$R=L_g/L_f$
40	20	2.00
40	30	1.33
40	40	1.00
40	50	0.80
40	60	0.66
40	70	0.57
40	80	0.50
40	90	0.44
40	100	0.40
40	110	0.36
40	120	0.33
40	130	0.30

Description of the calculations

Input Data

The input data in the sediment transport model are as follows:

Wave model: The waves characteristics are T=6s, H_S=1m and 1.5m, with a northwest wind direction 45° and slope=4% of the shore.

Sediment model: It consist of lowest size particles of sand, with d_{50}=0.2 mm and ρ_s=2650kg/m^3

Results

Based on the analysis of MIKE 21 HD, the values of the long shore current were calculated, which affect the coast for the two analyzed waveforms H_s = 1 m and H_s = 1.5 m, as shown in Figure 1 their cross-sectional distribution. With these results, the average velocity of the long-shore current V_c were calculated for each of the two cross-profiles, where for H_s = 1 m the mean velocity of the long-shore current produced the shore was V_c = 0.23 m / s and for H_s = 1.5 m the average speed of the current produced along the shore is V_c = 0.45 m / s.

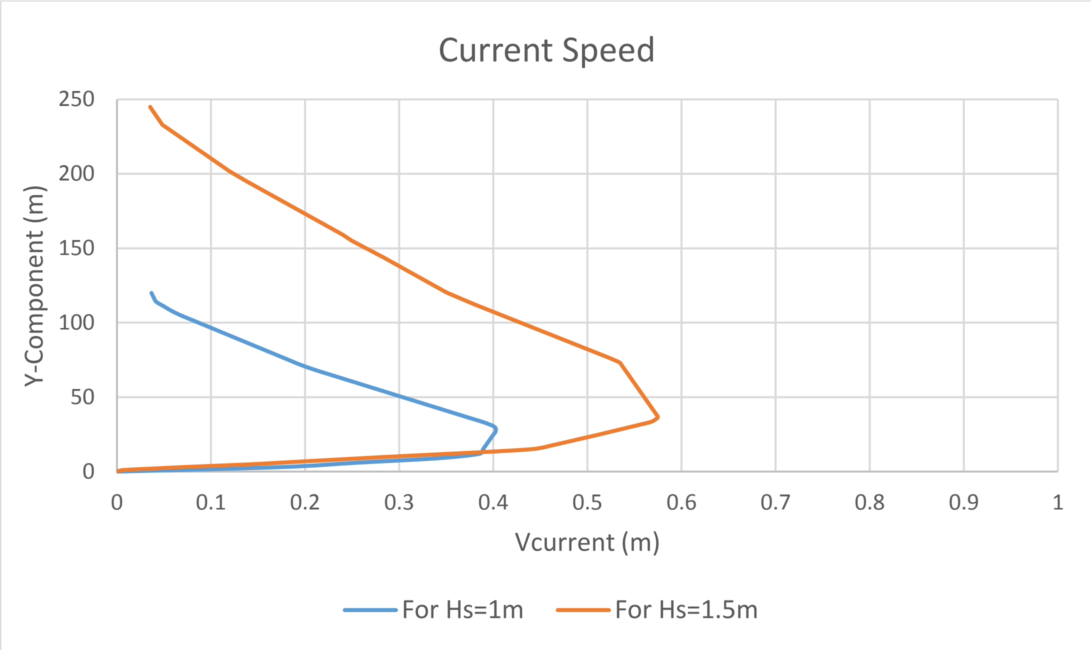

Figure 1: Cross-shore profile for the long-shore current

The Figures 2, 3, and 4 presents the results obtained from the analysis the MIKE 21 sediment transport model. The values on the horizontal axis relate to the geometric coefficient R (length of Groyne divided with the distance from the downstream Groyne), while on the vertical axis the average coastline advancement in meters, where the mean advancement was calculated based on the cross-sections made at the bottom of the shore per 10 meters.

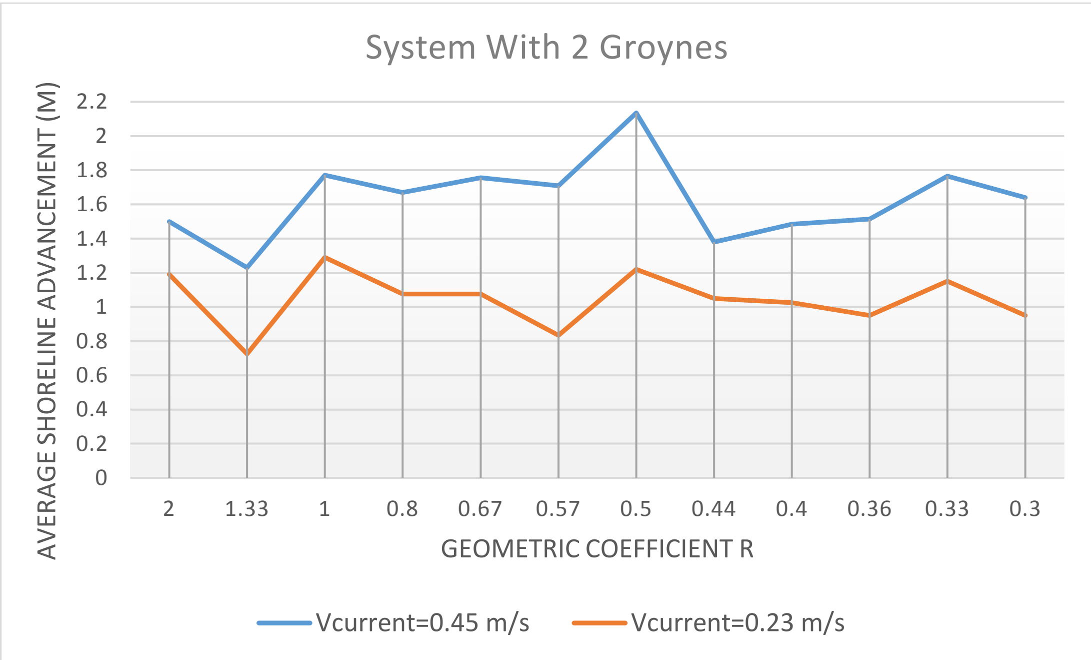

Figure 2: Average shoreline advancement for system with 2 groynes

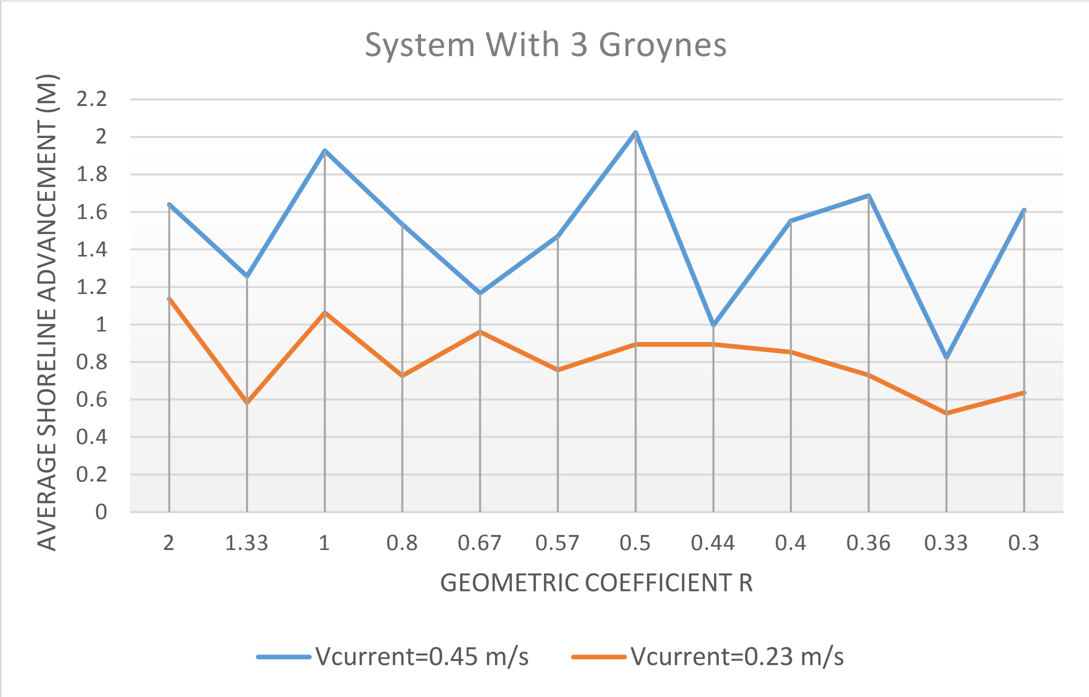

Figure 3: Average shoreline advancement for system with 3 groynes

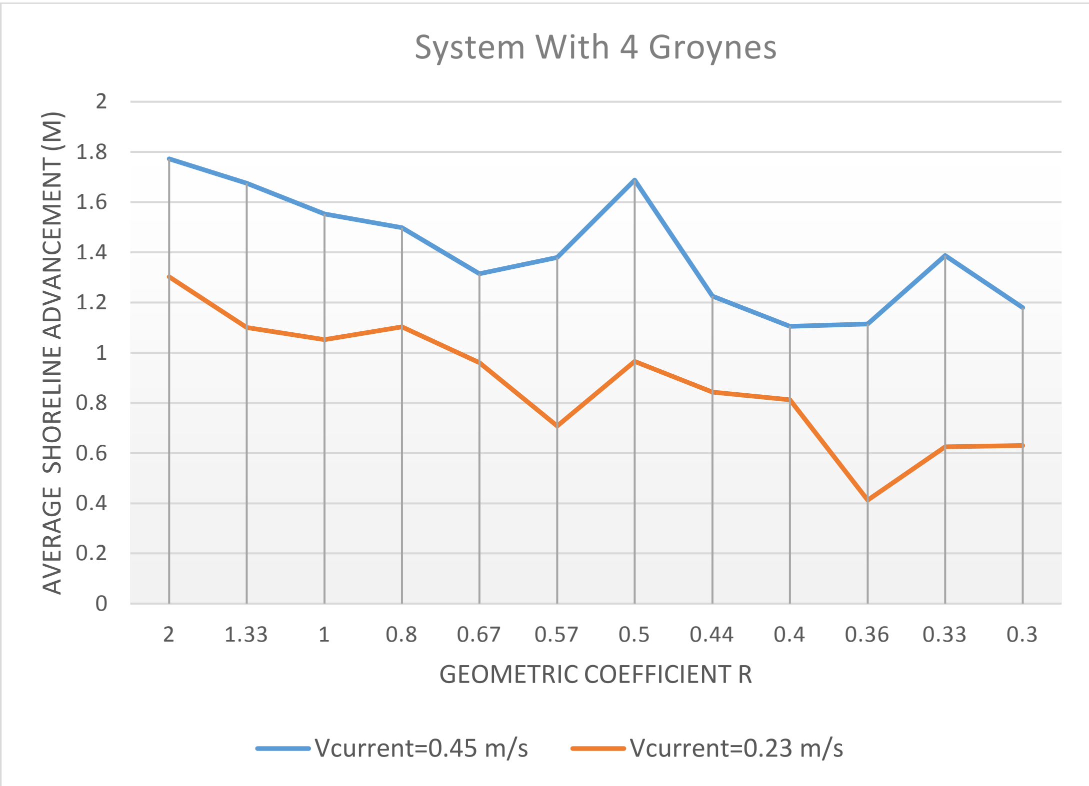

Figure 4: Average shoreline advancement for system with 4 groynes

The analysis of MIKE 21 ST revealed the new bathymetry of the systems following the wave events that took place, based on the cross-sections made along the coastline (Figure 5), the mean advancement of the coastline to the shallows was calculated. The comparisons of the displacement shoreline values for each system, resulted in the degree of efficiency for each geometry coefficient R. The table 2 summarizes the degree of efficiency of the systems, which is classified into low, medium and high efficiency classes according to the number of the Groynes and the R factor.

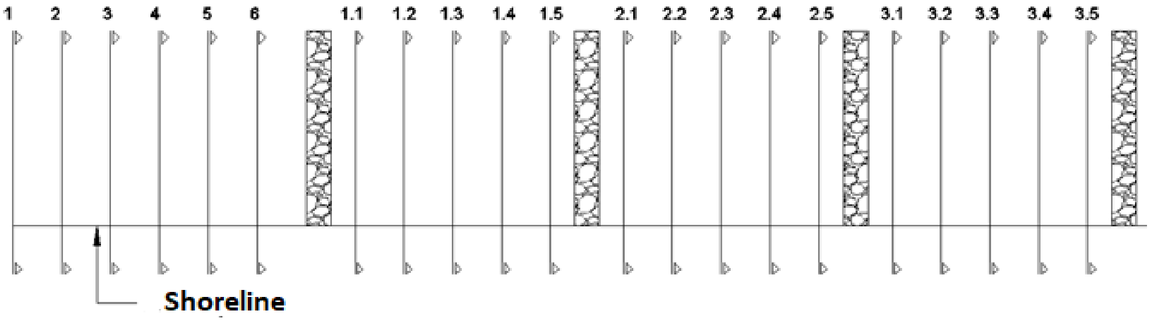

Figure 5: Cross-sections made along the coastline

Table 2: Degree of the efficiency for groynes system

Efficiency Measure	Low Efficiency		Medium Efficiency		High Efficiency	
Geometric Coefficient $R=L_g/L_d$	System with 2 Groynes		System with 3 Groynes		System with 4 Groynes	
	Hs=1m	Hs=1.5m	Hs=1m	Hs=1.5m	Hs=1m	Hs=1.5m
R= 0.30	Low	Medium	Low	Medium	Low	Low
R=0.33	High	Medium	Low	Low	Low	Medium
R=0.36	Low	Low	Low	High	Low	Low
R=0.4	Medium	Low	Medium	Medium	Medium	Low
R=0.44	Medium	Low	Medium	Low	Medium	Low
R=0.5	High	High	High	High	Medium	High
R=0.57	Low	High	Medium	Medium	Low	Medium
R=0.67	Medium	High	High	Low	Medium	Medium
R=0.8	Medium	Medium	Medium	Medium	High	Medium
R=1	High	High	High	High	High	High
R=1.33	Low	Low	Low	Low	High	High

R=2	High	Medium	High	High	High	High

Conclusion

The optimization of the groynes system arrangements was carried out in order to achieve as much efficiency as possible in the transport of sediment to the shore. Highest efficiency rates for most of the system and wave characteristics are observed when the distance between the groyne ranges from 2 to 0.5 times the length of groynes. In the majority of systems, when the distance between the groynes exceeds twice the length of their, the system ceases to behave as a single one and each groynes operates individual. There is no uniformity between adjacent values of the R coefficient in terms of the degree of sediment transport efficiency. Tand because all of the arrangements do not form satisfactorily one of the three types of flow (Figure 6) in their hydrodynamic field (Figure 7) in order for the sediment to be trapped in the gaps of the brackets (Figure 8) and do not move downstream. Finally, the closer the distances between the groynes are, the better distribution exists in the sharing of sediment within their fields.

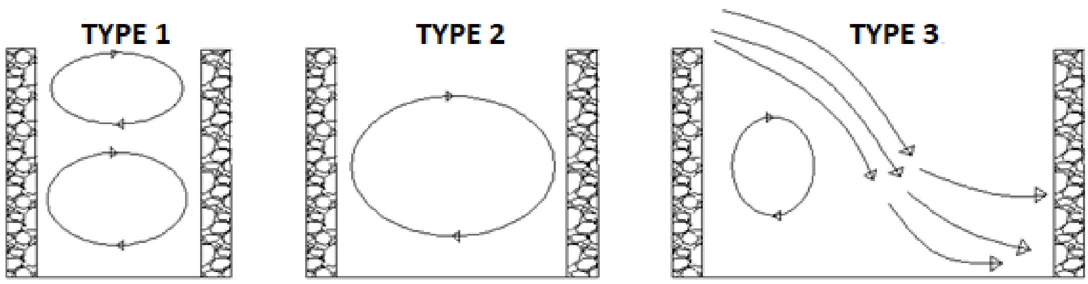

Figure 6: Types of flow inside the fields

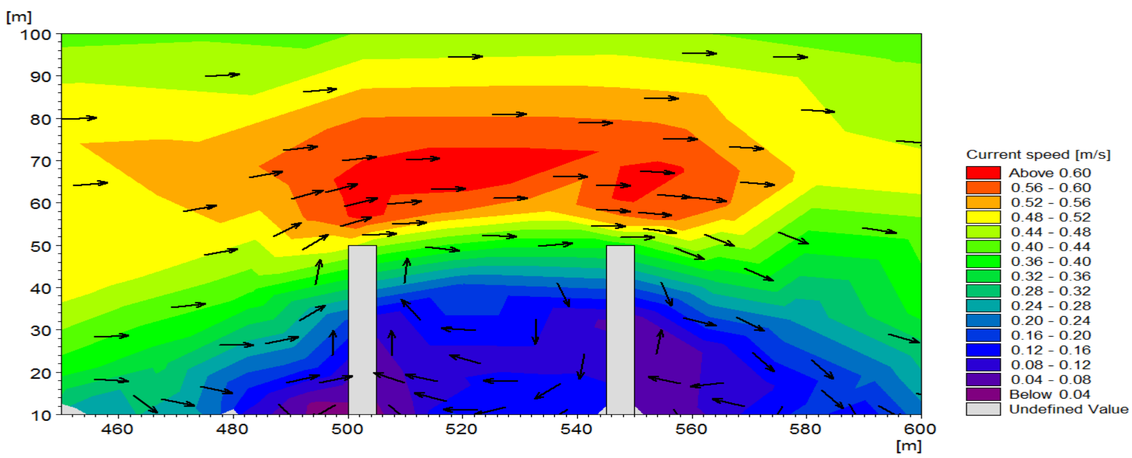

Figure 7: Hydrodynamic field with second type of flow

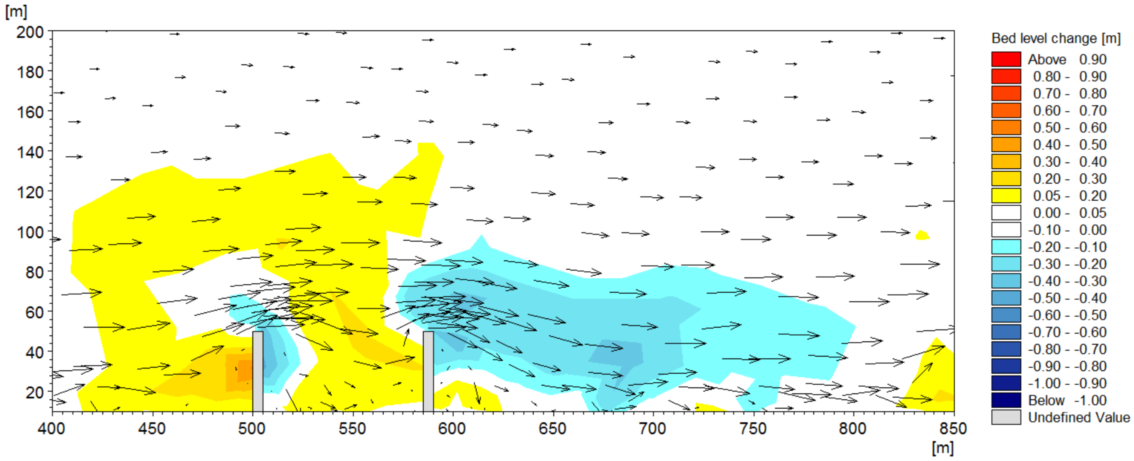

Figure 8: Bed level change and sediment transport produced by second type flow of hydrodynamic field