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"Studying the effect of applying different breakwaters on Alxandria coastline"

Akram Soliman, Ph.D.[1]; Mohamed Reda, Ph.D.[2]; and Ahmed Awad[3]

1. Professor, Department of Construction and Building Engineering, Arab Academy for Science Technology and Maritime Transport, Alexandria, Egypt.
2. Professor, Department of Construction and Building Engineering, Arab Academy for Science Technology and Maritime Transport, Alexandria, Egypt.
3. Graduate Teaching Assistant, Department of Construction and Building Engineering, Arab Academy for Science Technology and Maritime Transport, Alexandria, Egypt.

الملخص: مدينة الاسكندرية احد اقدم الدن المطلة علي ساحل البحر المتوسط و تعتبر مركز سياحي و اقتصادي و صناعي مهم. ساحلها يمتد بطول 140 كم علي البحر المتوسط من منطقة ابو قير في الشرق الي العلمين و سيدس عبد الرحمن في الغرب. في السنوات السابقة, الاسكندرية تعاني من العديد من مشاكل النحر علي ساحلها الناتجة من التشاط الطبيعي و البشري في المنطقة الساحلية. شواطيء الاسكندرية تاكلت بسبب التيارات و ارتفاع منسوب البحر. الغرض الرئيسي من الدراسة هو دراسة تاثير طرق استخدام الحواجز الصناعية الغاطسة لتقليل مشاكل النحر الناتجة عن حركة الامواج و التيارات البحرية.

Abstract: Alexandria city is one of the oldest cities on the Mediterranean coast, and is an important tourist, industrial and economic center. Its coastline extends for 140 km along the Mediterranean Sea, from Abu Qir in the east to Al-Alamein and Sidi Abdul Rahman in the west. In the recent years, Alexandria suffers from many erosion problems along its coastline, which result from natural and human activities in the coastal zone. Alexandria's beaches have been eroded due to the coastal processes and sea level rise. The main objective of this research is to study the effect of using Submerged Artificial Reefs (SARs) techniques to reduce the erosion problems due to wave action and wave induced current.

Keywords
Shoreline Protection, Beach Profile Change, Alexandria Coastline, Submerged Breakwater, Geotextile Breakwater, Coastal Engineering and Management.

Introduction
Egypt is a coastal country with a coastline length of 3500 km where 40% of the population lives, which makes it facing many coastal problems like, storm waves, flooding by overtopping, erosion and sedimentation and beach profile change along its coastlines as shown in figure (1). Coastal protection could be achieved by several means either by hard or soft structures. Groins, Revetments, Submerged Artificial Reefs and seawalls are examples of the hard structures. Soft structural methods are like beach nourishment, building sand dunes and revegetation. Submerged artificial reefs are used as a mean of shore protection against eroding. They decrease the energy of the incident wave reaching the shoreline by reducing wave energy over the structure and reducing the sediment transport and so the erosion. Submerged artificial reefs, and generally low crested structures, have the most significant advantage which is keeping an open and clear sight for the sea while standing on the beach as shown in figure (2). (Soliman, 2007)

Figure (1) Flooding at the Alexandrian coastline (Soliman, 2007)

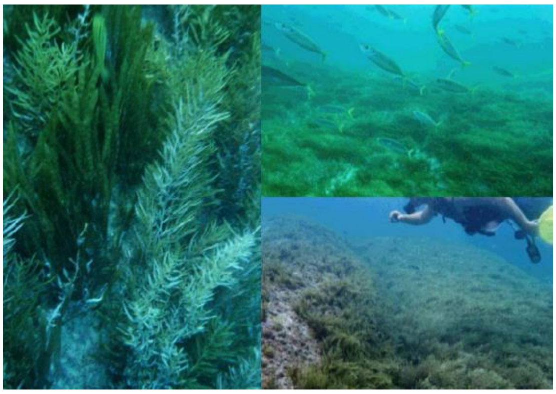

Figure (2) Shows the RP geo-textile greatly encourages marine life and growth (EL-Dakkak,2009

Literature Review

The sand making up this profile as shown in figure (3) is shaped by waves coming from the offshore and breaking in the near-shore zone, where sandbars may exist. The foreshore, or swash zone, is the region of the profile that is alternately wet or dry as the waves rush up this steep portion of the profile. The dry beach may have one or more berms, caused by wave action. The landward portion of the beach may have sand dunes created by winds blowing sand off the beach into these features or a cliff (particularly on elevated eroding shorelines) (Dean and Dalrymple, 2001).

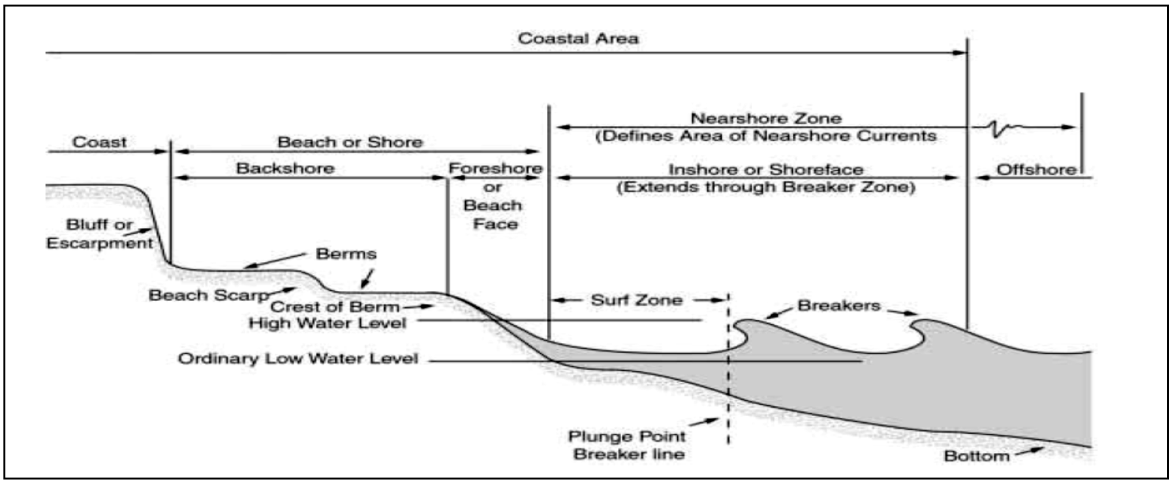

Figure (3): Beach profile (Dean and Dalrymple, 2001)

The breaking of the waves within the surf zone is responsible for the transformation of organized wave motion into chaotic turbulence, which mobilizes and suspends the sediments composing the beach. In addition, the breaking waves create near-shore currents that flow along the shoreline and in the cross-shore direction. These currents can transport large quantities of sediment in both directions in volumes as large as hundreds of thousands of cubic meters of sand per year in some places. (Dean and Dalrymple, 2001)

Waves are the prime movers for the littoral processes at the shoreline. For the most part, they are generated by the action of the wind over water but also by moving objects such as passing boats and ships. The waves transport the energy imparted to them over vast distances, for dissipative effects, such as viscosity, play only a small role. Energies dissipated within the surf zone can be quite large. The energy of a wave is related to the square of its height. If we define the wave height as H, the average total energy per unit surface area is:

$$E = \frac{1}{8}\rho g H^2 \quad (1)$$

Where: ρ = the water density; and g =the acceleration of gravity are important parameters. (Dean and Dalrymple, 2001)

Sediment transport can be defined as the movement of sediment particles through a plane over a certain period of time. The transport rate depends on the characteristics of the transported material and on the forces, which induce such a transport. The primary force behind sediment transport is the bed shear stress exerted by the water motion on the bed.

Sediment particles will tend to move when a certain critical bed shear stress is reached. The local bed shear stress can be induced by wind, wave, tide and by a combination of currents and waves. The waves are mostly accounted for stirring up the sediment, while the currents transport it (Van der Hout, 2008). The beach profile shape is a result of the action of waves and currents at the shoreline. The waves not only suspend the sediments but give rise to near-shore currents that carry the suspended sediment alongshore or cross-shore. The sediment carried by the waves and currents is referred to as “the littoral drift”, and the amount of sediment moved along the coast is “the littoral transport”, or long-shore sediment transport, which is usually measured in units such as cubic meters per year. As the wave environment changes during the year, the transport can change directions; however, at most coastlines there is a dominant direction of sediment

transport. “Down-drift” refers to a direction of waves coincident with this dominant transport direction, whereas “up-drift” is the opposite direction.
The cross-shore transport, which is caused by wave- or wind-induced mean cross-shore flows, is largely responsible for the existence of sandbars and other beach profile changes. These changes can be slow, on the order of years in duration, or they can occur rapidly during storms with time scales on the order of hours (Dean and Dalrymple, 2001).

Options for combating coastal erosion are traditionally twofold, namely hard structural/engineering options and soft structural/engineering options. These solutions have at least two hydraulic functions to control waves and littoral sediment transport, and a combination of hard and soft options has become more popular recently for optimum results (Kawata, 1989).

Groins are the oldest and most common shore-connected, beach stabilization structure. Groins constructed perpendicular to the coastline from the shore into the sea to trap long-shore sediment transport or control long-shore currents. This type of structure is easy to construct from a variety of materials such as wood, rock and is normally used on sandy coasts. (El-Sharnouby and Soliman, 2009).

The primary purpose of a seawall is to prevent inland flooding from major storm events accompanied by large, powerful waves. The key functional element in design is the crest elevation to minimize the overtopping from storm surge and wave run-up. A seawall is typically a massive, concrete structure with its weight providing stability against sliding forces and overturning moments. (El-Sharnouby and Soliman, 2011).

Revetments are a cover or facing of erosion resistant material placed directly on an existing slope, embankment or dike to protect the area from waves and strong currents. The revetment protected the shoreline against further erosion but the beach profile was completely reinforced. (El-Sharnouby and Soliman, 2009).

Near-shore detached breakwaters are generally shore-parallel structures that reduce the amount of wave energy reaching a protected area. They are similar to natural bars, reefs or near-shore islands that dissipate wave energy. The reduction in wave energy slows the littoral drift, produces sediment deposition and a shoreline bulge or salient feature in the sheltered area behind the breakwater. (Coastal Engineering Manual, 2008)

The aim of beach nourishment is to create a wider beach by artificially increasing the quantity of sediment on a beach experiencing sediment loss, improving the amenity and recreational value of the coast and replicating the way that natural beaches dissipate wave energy. Offshore sediment can be used as a source for sand and is typically obtained from dredging operations. This method requires regular maintenance with a constant source of sediment and is unlikely to be economical in severe wave climates or where sediment transport is rapid. It has been used in conjunction with hard structural/engineering options, i.e. offshore breakwaters and groins to improve efficiency. (Clark, 1995; French, 2001).

The European Artificial Reef Research Network (EARRN) defined artificial reefs as a submerged structure placed on the seabed deliberately, to mimic some characteristics of a natural reef. Artificial reefs refer to man-made structures that serve as shelter and habitat; they are also used for shoreline protection or as surf-wave generating devices.

Artificial reefs, in the form of rocks and logs have been used for thousands of years as an enhancement device by attracting fishes. More recently, their applications have varied widely, including: aquaculture production; coastal protection, and habitat protection. The types of materials used to construct artificial reefs, and some of their uses include: natural rocks and concrete for habitat for abalone sea urchins and seaweed, plastic, Fiber-glass, wood, geo-textile and steel framed structures to attract of fish. Artificial reef materials must last a minimum of 30 years to provide ecological services economically, and also be non-toxic to the marine environment. (Armono, 2004).

Types of Numerical Modeling Softwares

- **MIKE 21 ST**

MIKE 21 Sediment Transport (ST) is designed for the assessment of the sediment transport rates and related initial rates of bed level changes of non-cohesive sediment (sand) due to currents or combined wave-current flow.

- **MIKE 21 NSW**

MIKE 21 NSW is a Near-shore spectral wind-wave model, which describes the propagation, growth and decay of short-period waves (between 0.21s and 21s) in near-shore areas. The model includes the effects of refraction and shoaling due to varying depth, wave generation due to wind and energy dissipation due to bottom friction and wave breaking.

- **MIKE 21 BW**

MIKE 21 Boussinesq Wave (BW) module is mainly used to study wave dynamics (significant wave height, wave disturbance coefficient, water surface elevation and the depth-averaged particle velocity) in ports and harbors and in small coastal areas. The model is capable of reproducing the combined effects of most wave phenomena of interest in coastal and harbour engineering, including shoaling, refraction, diffraction and partial reflection of irregular short-crested and long-crested finite amplitude waves propagating over complex bathymetries.

- **Simulating Wave Near-shore (SWAN)**

The SWAN (Simulating Waves Nearshore) model is a spectral wave model developed at the Delft University of Technology, The Netherlands SWAN models the energy contained in waves as they travel over the ocean surface towards the shore. In the model, waves change height, shape and direction as a result of wind, white capping, wave breaking, energy transfer between waves, and variations in the ocean floor and currents. (European Commission, 2004).

- **SBEACH**

SBEACH (Storm-induced Beach Change Model) is a model developed by the US Army's Corps of Engineers to simulate cross-shore beach, berm, and dune erosion produced by storm waves and water levels. The latest version allows simulation of dune erosion in the presence of a hard bottom (European Commission, 2004).

- **GENESIS**

GENESIS (Generalized Model for Simulating Shoreline Change) is a model developed by the US Army's Corps of Engineers. It is a system of models for calculating shoreline change caused primarily by wave action. The system is based on the one-line theory, whereby it is assumed the beach profile remains unchanged permitting beach change to be described uniquely in terms of the shoreline position. The model can be applied to a diverse variety of situations involving almost arbitrary numbers, locations, and combinations of groins, jetties, detached breakwaters, seawalls, and beach fills. (European Commission, 2004).

Conclusion

Using the suitable software is a critical point to determine also having the suitable data to work with. Determine the suitable software for each case study differs from case to another as each software may include certain modules that are not suitable with the study case. Researchers should be thinking of Combining submerged breakwater and nourishment to improve the efficiency of the breakwater and provide an environmentally and economically acceptable coastal protection system. Continuous observations of bathymetries behind the reefs are required to study any changes along the life of the structure.

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