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Submerged Reef Structures for Beach Erosion Control

by Lee E. Harris, Ph.D., P.E.[1]

Abstract

This paper presents the use of submerged artificial reef structures as submerged breakwaters, providing both wave attenuation for shoreline erosion abatement, as well as artificial reef structures for habitat enhancement. An example of this technology is presented for a project constructed using Reef Ball™ artificial reef units (shown in Figure 1) along the southern shore of the Dominican Republic near Bayahibe (east of Santo Domingo and LaRomano) during the summer 1998.

Approximately 450 Reef Ball™ artificial reef units were installed to form a submerged breakwater for shoreline stabilization, environmental enhancement and eco-tourism (Figure 2). The individual units used for the breakwater were 1.2m high Reef Ball™ units and 1.3m high Ultra Ball units, with base diameters of 1.5 and 1.6 meters, respectively, and masses of 1600 to 2000 kilograms. Figure 1 shows an individual Reef Ball™ unit, which is fabricated to provide void spaces and surface areas for habitat and biological growth.

Figure 1. Individual Reef Ball™ Unit.

Figure 2. Three-Row Submerged Breakwater.

The design of the submerged breakwater system consisted of three segmented breakwater sections, using three rows of Reef Ball™ units for each segment. The breakwater was installed in water depths of 1.6m to 2.0m, so that the units were 0.3m to 0.8m below the mean water level (the tide range in the project area is approximately 0.4m). In the fall of 1998 shortly after the installation of the breakwater system, a direct hit by Hurricane Georges (Category 3) and large waves from Hurricane Mitch (Category 5) impacted the project area, but not a single Reef Ball™ unit was displaced or damaged. As shown in Figure 3, the beach and shoreline in the lee of the submerged breakwater system has been stabilized and has accreted sand, with no adverse impacts on adjacent beaches.

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Figure 4 shows the location of three profile lines surveyed to document the performance of the submerged breakwater system. Shoreline and sand volume calculations are shown in Table 1. The beach profile shown in Figure 5 shows that the Reef Ball™ breakwater has been very effective in stabilizing the beach, with a significant increase in beach width and elevation along the project shoreline. In addition, the use of artificial reef units for the breakwater provides habitat enhancement for the marine life, which can be enjoyed by divers and snorkelers.

The submerged breakwater project presented in this paper demonstrates the technology available to provide shoreline stabilization due to wave attenuation at sites with low tidal range and low to moderate wave climate (except during tropical storms and hurricanes). Application of this technology to other sites must consider the particular site specific conditions.

Figure 3. Increased Beach Width 1998 to 2001 at Center of Project - looking west.

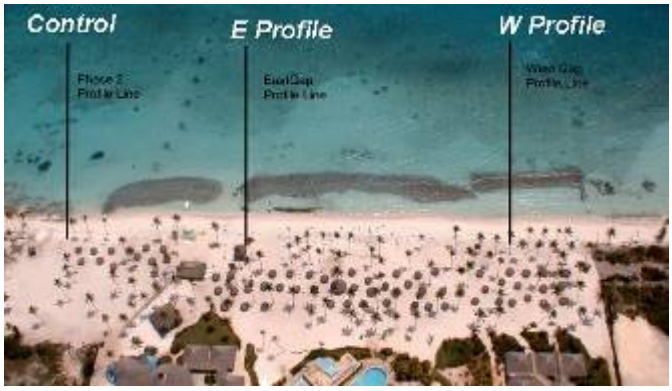

Figure 4. April 2001 Aerial Photograph.

Table 1. Changes in Shoreline and Sand Volume Calculations 1998 to 2001

Profile Line	Shoreline Change (meters)	Sand Volume Change (m^3/m)
West	+10 m	+25.65 m^3/m
East	+13 m	+44.25 m^3/m
Control	0 m	+2.0 m^3/m

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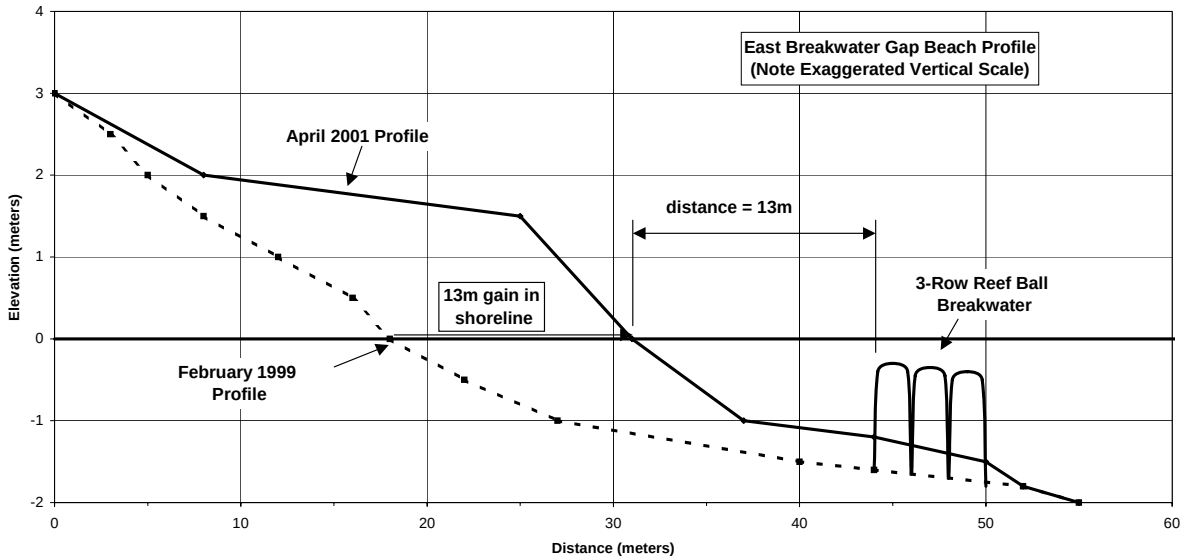

Figure 5. Beach Profile across Breakwater near East Gap

References:

Harris, 2003. Correlation between the physical structure of the nearshore reefs and the historical beach erosion/accretion in Indian River County, FL. . *Coastal Sediments '03*, USGS, St. Petersburg, FL.

Harris, 2002. Submerged artificial reef structures for environmental enhancement and coastal erosion control. *California and World Ocean '02*, Coastal Zone Foundation, Middletown, CA.

Harris, 2002. Submerged reef structures for habitat enhancement and shoreline erosion abatement. *U.S. Army Corps of Engineers Coastal & Hydraulic Engineering Technical Note* (CHETN), Vicksburg, MS.

Harris and Woodring, 2001. Artificial reefs for submerged and subaerial habitat protection, mitigation and restoration. *54th Institute of the Gulf and Caribbean Fisheries Institute (GCFI)*, Turks & Caicos, Is., pp. 386-395.

Harris, 1998. Engineering design aspects of artificial reefs. *Florida Artificial Reef Summit '98*, edited by William Horn, Florida Department of Environmental Protection, Tallahassee, FL, pp. 104-110.

Smith, J.T., Harris, L.E., and Tabar, J., 1998. Preliminary evaluation of the Vero Beach, FL prefabricated submerged breakwater. *Beach Preservation Technology '98*, FSBPA, Tallahassee, FL.

Harris, L.E., Mostkoff, B.J., and Zadikoff, G., 1996. Artificial reefs: from waste to resources. *Oceans '96*, Marine Technology Society, Washington, D.C.

Harris, L.E., 1995. Engineering design of artificial reefs. *Oceans '95*, Marine Technology Society, Washington, D.C., Vol. 2, pp. 1139-1148.

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