RESULTS OF SHORELINE EROSION DEMONSTRATION PROGRAM

B. L. Edge[1] M. ASCE and J. G. Housley[2] M. ASCE

1. Introduction

Very little has been done in the United States to assist the private landowner when his property has been threatened by coastal erosion. Primarily, efforts have been concentrated on large scale shoreline protection efforts which cover municipalities or large regions. These efforts have been basically Federal or large state projects. Between 1974 and 1980, the United States government conducted a national program to fill this void by demonstrating a low cost technology for shoreline defense. The objective of this paper is to report on the program itself and its results.

2. The Section 54 Program

The United States Congress in 1974 authorized in Section 54 of Public Law 93-251, 93rd Congress, a program to develop and demonstrate low cost methods of shore protection. Further the Act specified that the Chief of the U.S. Army Corps of Engineers was to conduct this program and appoint a Shoreline Erosion Advisory Panel (SEAP) to advise him on its execution. Members of the Panel represented various geographic areas, professional disciplines, employers, and environmental groups. All of the members however, had knowledge and experience in some aspect of shoreline erosion and protection. The legislation specifically stated that the program would include a minimum of sixteen sites from around the shoreline of the United States. Six of these sites were to be in Delaware Bay, as mandated by the legislation, and the other ten sites were to be selected based upon the criteria provided by the SEAP. The selection of devices or systems of devices to be demonstrated at the specific sites was made by the Chief of Engineers, based on the recommendation of the Panel.

[1]President, Cubit Engineering Limited, P.O. Box 1271, Clemson SC 29631

[2]Office of the Chief of Engineers, HQ(DAEN-CWP-F), Washington DC 20314

Additionally the Act allowed that non-Federal lands could be used for demonstration sites as long as the non-Federal owner had a sponsor which was willing to pay at least 25% of the construction cost. Also as a part of the program, a number of low cost, shore protection systems, already installed at other sites, were included in the monitoring program. Including these additional sites allowed observation and evaluation of a greater number of devices and environmental conditions than would have been possible with only the sixteen mandated sites.

Another important feature of the legislation was that the effectiveness of vegetation was to be demonstrated wherever it could be employed. Often it was necessary to employ vegetation in conjunction with a protective structure until it was able to sustain itself under the environmental conditions. The Soil Conservation Service of the Department of Agriculture was involved in much of the vegetative work, selecting indigenous vegetative species, assisting to plant the materials, and in evaluating the response of the plants to the environmental conditions.

Each of the sites was monitored intensively by the Corps of Engineers. Monitoring included wind, wave and current data on a daily basis as well as bathymetric surveys, ground photographs and aerial photography flown at about three-month intervals. Sediment samples were collected from the beach and offshore. A Corps engineer would visit a site at least monthly to report on its status. A special monitoring program was used for the vegetative aspects of each site. The monitoring program was very comprehensive although few quantitative measurements were taken. The results of the monitoring were assimilated and analyzed by the Coastal Engineering Research Center.

3. Results

Originally the program was to have continued for five years, however, few projects were tested for more than two years. Thus interpretation of the performance of these structures is limited by the short life of the program. A summary, by generic system, of the performance of the devices that were installed and monitored under this program is included in Table I. Those that were "possibly successful" are devices which did not fully succeed at the particular installation that was monitored, but the devices could have succeeded if they were either in a more appropriate environmental location or had minor changes to the initially designed structure. Table II gives specific comments on the modifications which could be made to make some devices successful.

TABLE I

PERFORMANCE OF SYSTEMS INVESTIGATED

Type of System	Successful	Could be successful*	Failed
A. Bulkheads and Seawalls	Treated timber, Steel and timber, Concrete sheetpile	Rubber tire and piles, Longard tube, Earth-filled concrete pipe, Rubber tire stack, Untreated timber	Welded-wire fence and sand bags, Concrete and timber
B. Revetments	Stone riprap, Sand-cement bags	Concrete blocks, Gabions, Concrete rubble, Steel barrels	Concrete slabs, Sandfilled-bags, Fabric, Tires and fabric
C. Breakwaters and Sills	Stone riprap, Timber sheet piles, Rubber tires on piles, Sand-cement bags	Floating tire, Longard tube, Gabions, Concrete bags, Z-wall Surgebreaker, Sandgrabber	Sta-pods, Sand-filled bags, Brush dike
D. Groins	Timber, Timber and stone, Riprap, Concrete rubble, Sand-cement bags, Corrugated steel pipe, Rock with asphaltmastic	Longard tube, Gabions, Steel fuel barrels	Sandfilled bags
E. Nonstructural	Perched beach, Beach fill	Vegetation, Vegetation with protective structure	

*These could be made successful with minor changes or use in a more appropriate environment than used in the program

TABLE II

MODIFICATIONS REQUIRED FOR CERTAIN DEVICES

Type of System	Device	Comments
A. Bulkheads and Seawalls	Rubber tire and piles	Fair performance; needs good filter; tire fill material washed out; good way to dispose of used tires
	Longard tube	Tube must be away from bluff to prevent displacement by slides; sand-epoxy coating helps protect against vandal and debris damage
	Earthfilled concrete pipe	Fair performance; some pipes tipped over; needs stock pile of used pipe
	Rubber tire stack	Fair performance, but fasteners failed; system needs improvement; good way to dispose of used tires
	Untreated timber logs	System failed due to filter wash out; useful where logs are plentiful; boring insects could be a problem; needs good filter system
B. Revetments	Concrete blocks	Good performance when blocks are sized and shaped to match wave environment; easy to install, but subgrade must remain even; good small project system
	Gabions	Good performance, but broken basket wires may be a problem; needs proper sized stone fill; good substitute for stone riprap on small projects
	Concrete rubble	Good performance but failed where improperly designed; good way to dispose of large amounts of rubble

TABLE II (continued)

MODIFICATIONS REQUIRED FOR CERTAIN DEVICES

Type of System	Device	Comments
C. Breakwaters and Sills	Floating tires	Fair performance, but some systems pull apart; better interconnections needed; good way to dispose of used tires; use limited to short-period wave climate
	Longard tubes	Good performance if tubes are not damaged; requires special equipment; vandalism of tubes made demonstrations inconclusive
	Gabions	Good performance, but structural failure seemed imminent at demonstration site
	Concrete boxes	Fair performance, but requires special equipment; covers needed to keep sandfill in boxes
	Z-wall	Good performance, but structure deteriorated; system not recommended until hinging of modules is improved
	Sandgrabber	System locally effective but depletes downdrift beaches; structures deteriorated; probably could be improved, but other shore protection systems are available that perform better
D. Groins	Longard tubes	Good performance until structure failure; vandalism and debris damage is a problem
	Gabions	Good performance, but deterioration of outer ends exposed to high waves is a problem
	Steel fuel barrels	Good performance, but use is limited to Arctic regions

Of the materials tested in the program, it was found that quarry stone rubble performed well and survived longer than any other type of device. However, it was seldom one of the lowest cost devices employed. On the other hand, concrete rubble was only satisfactory when used with adequate filter material and shaped appropriately to eliminate flat and elongated pieces. In areas of the country where timber was an abundant material, it proved to be very successful because of its cost and the ease with which it could be shaped and fastened together. In the Alaskan environment, the steel drum proved to be one of the most effective and lowest cost devices available. Although these would ordinarily not be the first choice for shore protection, because of the abundance in that area, they have proved to be quite useful. Gorrosion was a problem however, whenever they were used south of the Arctic Circle.

Generally only those Gabion structures which were filled with stone larger than four inches in diameter proved useful in sites exposed to even moderate wave energy. The Gabion basket is a low cost device which is easy to install and will perform well functionally. Many baskets, however, were ripped open either from vandals, floating debris or movement of stone inside the baskets during wave action. Similarly Longard tubes were effective functionally as breakwaters, bulkheads, revetments and groins. However, at every site they were badly damaged by vandals or floating debris. When built in the dry, the Longard tubes could be coated with a sand-epoxy coating which would help to minimize damage. However, when the structures were installed in the water, no protective coating proved successful. Sand bags proved very effective functionally, but they were subject to the same damages by vandals and debris as the Longard tubes. Bags filled with a sand-cement mixture hardened into concrete modules that generally hold their shape together well after the fabric deteriorates.

In practically every demonstration project, a device was built with and without filter cloth to illustrate the importance of a filter. Although it is quite common knowledge among the coastal engineering community that a filter material is necessary, it was important that this should be emphasized.

Used rubber tires were successfully employed in several structures, although they were somewhat unsuccessful in others. In general they functioned very well as floating breakwaters, but did not function well as a revetment even when filled with concrete. Although the tires were never aesthetically pleasing, they tended to be both functionally and structurally successful on many occasions.

Vegetation was used primarily as a shore protection device only in very low wave energy environments when the underlying soil was adequate for their growth. Often the vegetation was employed in conjunction with another type of device which would provide appropriate shelter for the plant material to begin growth. Best results occurred when an underlying layer of loam or peat existed beneath a veneer of sand. Vegetation varied considerably around the country according to the locally available and adequate species. In all regions efforts were made to employ intertidal, supertidal and upland plant materials wherever appropriate.

4. Dissemination

One of the important aspects of the program was the dissemination of the results to the public. A dissemination program was planned by a team of SEAP members, Corps representatives and a private contractor. The basic document which summarized the entire project including all devices at each site was that prepared for the U.S. Congress (2). That publication has a history and compilation of all data at each site.

The basic components of the dissemination program which were prepared for the public are:

Low Cost Shore Protection: A Property Owners Guide - This report is intended for owners of property who face the decisions of dealing with their erosion problems. It contains information on the shoreline processes, explains available alternatives, reviews the decision process leading to a choice among solution options, and identifies sources of additional help.

Low Cost Shore Protection: A Guide for Engineers and Contractors - This report was prepared to familiarize engineers and contractors with established methods of low cost protection. It is written for those familiar with traditional civil engineering design and construction but who are not specialists in coastal engineering or shoreline protection.

Low Cost Shore Protection: A Guide for Local Government Officials - This report was prepared to assist and inform those government officials who have some involvement in shoreline erosion control through planning, permitting regulation or other function. The report includes a description of shoreline processes, devices available for use as solutions, guidance for selection from alternatives, permitting

requirements and a directory of information sources.

These three volumes provide the basic information for non-specialists to understand the erosion process, protection techniques and available devices. Although these references are oriented to low wave energy environments, the information is useful for all waterfront property owners. Each of these documents are available by contacting J. G. Housley, Office of the Chief of Engineers, HQ(DAEN-CWP-F), Washington DC 20314.

The program also developed brochures describing each demonstration site for those who could visit the area. At the conclusion of the program four regional workshops were held to acquaint the Corps district offices and state and local government officials with the results of the program. A 50-minute slide presentation is also available to present the results of the program to local groups. It presents a summary of coastal processes, available alternatives, and requirements for a successful project. The slide presentation can be obtained by contacting a Corps of Engineers district office or through the address given above.

5. Conclusions

Although low cost shore protection is amenable to only select sites, it certainly is a concept that has to be explored for the thousands of miles of eroding shoreline which are in the hands of private citizens. The results of this program will be helpful to the landowner in identifying the type of solution which he may employ and how to go about designing those solutions for his own particular problem.

6. References

1. Edge, B.L., J.G. Housley and G.M. Watts (1977). A Review of the National Shoreline Erosion Control Program, Journal of the Marine Technology Society, Vol. 11, No. 3.

2. U.S. Army Corps of Engineers (1981). Low Cost Shore Protection: Final Report of Shoreline Erosion Control Demonstration Program (Section 54). Office of the Chief of Engineers, Washington DC.

3. U.S. Army Corps of Engineers (1982). Low Cost Shore Protection: A Property Owners Guide. Office of the Chief of Engineers, Washington DC.