CHAPTER 140

Beachwalls for Beach Erosion Protection

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Introduction

Many shoreline property owners, in an effort to protect the beaches from erosion, have constructed sea walls. In many situations, these sea walls have caused an increase in beach erosion forcing, by "domino effect", adjoining properties to construct sea walls to protect their shoreline. The construction of a sea wall often causes erosion on the adjacent property. Unfortunately, more often than not, where beaches once existed, the construction of sea walls in addition to causing beach erosion to adjacent property has caused the disappearance of the beaches.

Because of the concern for the eroding beaches and the proliferation of sea walls, the design of a "beachwall" was proposed over four years ago by the author. Several of these beachwalls have been constructed, and the beaches fronting these structures have thus far been preserved or restored.

The design of a beachwall emulates nature's construction of a typical beach profile terminating with a sand dune or berm (figure 1). The design of the beachwall

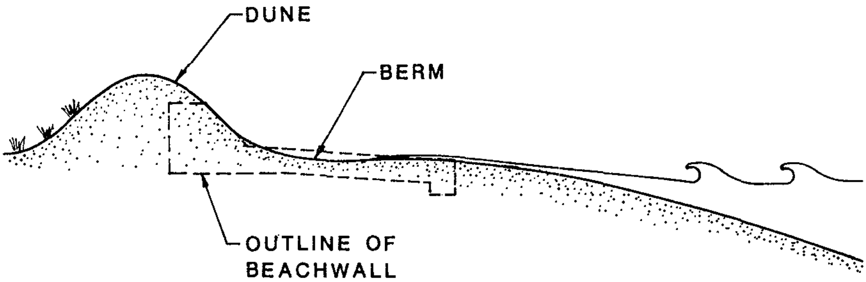

Figure 1. Typical Beach

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accommodates the energy forces of waves, minimizes wave rebound and scouring, and allows the deposition of sand, thus encouraging beach build up. The design of the beachwall addresses the problem of erosion at the toe of seawalls.

Protection of Beach Property

In the effort to protect beach property from existing or potential failures, sea walls with vertical or nearly vertical wall faces are often constructed along the property lines. By a "domino effect", property owners adjacent to such sea walls are sometimes forced to construct sea walls for protection of their property. Often, one sea wall causes the construction of another sea wall, which causes the construction of yet another, and so forth.

In many cases, because of the wave energy interaction with sea walls, there is erosion at the toe of the wall ultimately leading to wall failure. Additionally, the wave energy interaction with these walls will not allow beach build up and causes the disappearance of the beach. Thus, although the shoreline and property are saved and preserved by the wall, the beach is lost.

Over four years ago, the author felt a better approach to the then present concept of "protect the shoreline property in spite of losing the beach" would be to "first preserve the beach and in doing so protect the shoreline property". With this in mind, the beachwall design was developed.

Beachwall Design

The design of a beachwall begins with the selection of a design wave and design water level or wave run up as the controlling parameters for the wall design height. Other factors to consider in determining the wall height are the amount of damages that might occur from overtopping of the structure, the littoral drift and amount of sand in suspension in the water, and determination of optimum beachwall slopes, along with seasonal variations of the shoreline and offshore processes.

A practical method for designing the height of a beachwall is to observe wave run up during a high wave action or storm episode. The design high water level may be determined by noting the debris line <u>after</u> the high wave episode. Once the high water level has been determined, a freeboard height is to be selected. The freeboard height is determined to eliminate or minimize overtopping of the structure during extraordinary high wave action, with consideration to property damages that may be suffered by overtopping of the beachwall.

The face of a beachwall (figure 2) is composed of two sections of different slopes. The first section allows for wave run up, and experiences have shown that a slope of twenty percent (20%), 1:5, is satisfactory. The optimum slope for the run up section of the beachwall may be determined by using the slope of the sand existing in the vicinity where the beachwall is to be constructed. The length of the run up section is a function of a) the amount of wave run up (wave energy) to be accommodated by this section of the beachwall, and b) the amount of area available in which the beachwall can be constructed.

The second section is the freeboard portion of the beachwall. Experiences show that this section can have a slope of 1:1 or even steeper as its function, in addition to providing protection, is to eliminate or minimize overtopping. This section must also take care of the wave energy that is not accommodated by the run up section of the beachwall. Experiences show that the wave run up section of the beachwall can be about ten to twelve feet in length. Thus, any wave run up in excess of ten to twelve feet will have to be accommodated by the freeboard section. Of course, the length of the run up section is a function of the wave design height and will vary from one locale to another.

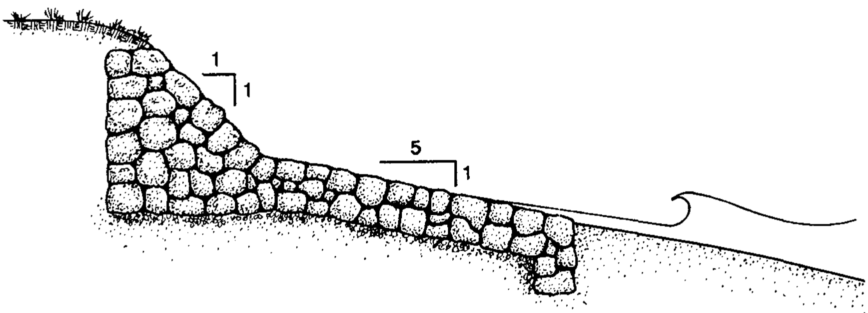

Figure 2. Beachwall

Setting of the beachwall, elevation wise, requires knowing tide levels of the area. Usually historical records of the elevations of high and low tides are available through government sources. In absence of such records, measurements should perhaps be taken through at least one year of seasonal shoreline water level variations. The elevation of the toe of the beachwall is set at or below low water elevation to make certain that toe erosion will not occur. This elevation, along with the beachwall design accommodating the energy forces of waves, eliminates or minimizes wave rebound and scour thus addressing the problem of toe erosion of the structure.

Wave Energy on Structures

Normally beaches cannot form or reform because of the lack of suspended sand in the water or erosive velocity of the waves. This condition occurs when, following a high wave episode, sand that has been eroded from the beach is, displaced far off shore, trapped behind some reef or seaweed or both, or not allowed to be deposited because of successive high wave episodes. These conditions, especially when successive high wave episodes occur, often lead to the construction of sea walls.

Observations of vertical or nearly vertically faced sea walls and other similar types of structures show that beaches fronting such sea walls often erodes and do not return. The sand beach erodes or cannot form because of the wave forces. This erosion, often noted at the seaward footing of the wall, leads ultimately to wall failure.

When waves approach the shore, most of its energy is in the form of a velocity gradient. If there is sand off shore, the wave may be carrying sand in suspension. When the wave runs up the shore of a beach, its velocity begins to diminish due to slope of the beach and also friction with the shoreline. As the wave's velocity approaches zero, sand held in suspension will drop out because of gravity. This condition causes sandy beaches to form, or in the case of existing beaches, replenishes sand to the beach.

When waves approach a hard structure such as a seawall, it's velocity upon impact with the seawall is directed upward and downward about parallel with the face of the wall. The portion of the wave energy that is directed upward is usually visible as sea spray. The downward portion of the wave energy, often unseen, causes erosion at the base of the seawall. Because of this downward energy force, any sand or loose material at the base of such structures will eventually erode and wash away. This oftentimes leads to structural failure, and also causes the loss of the beach that may have once fronted the structure (figure 3).

Wave Energy on Beachwalls

The design of a beachwall emulates nature's construction of a typical beach profile which is composed of a run up slope section (beach) and terminating with the freeboard section (sand dune). The beachwall by design offers little, if any, wave reflection surfaces and rebound

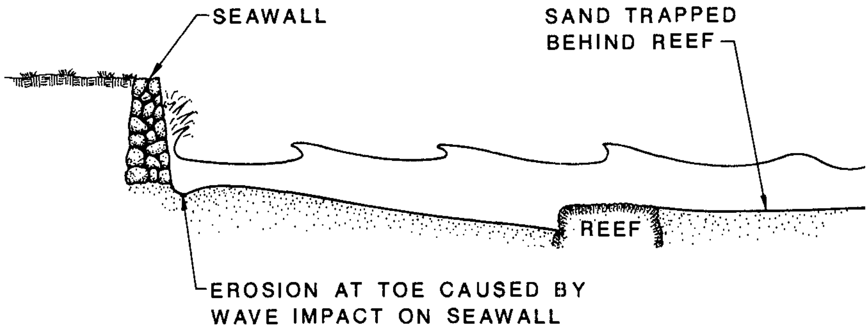

Figure 3. Loss of Beaches

of wave forces. The design effectively emulates a naturally occurring shoreline process. As the approaching wave flows up the run up face of the beachwall, the velocity gradient of the wave diminishes because of friction and slope, similar to the wave run up on a beach. As the velocity gradient approaches zero, sand held in suspension will settle out because of gravity and will be deposited on the beachwall. This action allows sand to accumulate and encourages the build up of a beach in a method similar to that which naturally occurs on sand beaches.

Summary

While it may sometimes be important to protect the shoreline and property from erosion due to wave action, it is equally if not more important to protect the shoreline against the loss of beaches. The task of saving property from erosion is simpler than the task of saving beaches and encouraging the formation of beaches. When the shorelines need to be protected, site conditions both on-shore and off-shore must be assessed before designs and construction of structures are undertaken. Poorly designed and improperly constructed erosion protection devices are oftentimes worse than doing nothing.

There are situations in which erosion control devices such as seawalls, revetments, groins and other hard structural techniques are required. However, erosion control should, whenever possible, begin by considering and utilizing natural shoreline defenses such as encouraging the growth of vegetation. If this is not possible or practical, then softer techniques such as beach fills or perhaps devices such as offshore sandbars should be considered.

Experiences over a three year period have indicated that a beachwall may be considered a soft device. While the beachwall is a "hard" structure, it behaves as a "soft" device by allowing the build up of sand. The beachwall shows promise in preserving and restoring beaches. Keep in mind however, that this beachwall may not necessarily be successful in all applications of preventing beach erosion or encouraging beach restoration.