

CHAPTER 34

TRENDS IN SAND TRANSFER SYSTEMS

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ABSTRACT

The purpose of this paper is to discuss some of the factors that have been influential in the change of functional design of sand transfer systems. The more common man-made littoral barriers are presented with types of sand transfer systems employed at each type of barrier.

INTRODUCTION

For many years engineers have recognized that a partial or complete barrier to littoral material movement may significantly affect shores adjacent to the barrier. The need to mechanically transfer the impounded littoral drift past the barrier was also recognized; however, little positive action was actually undertaken on this subject until perhaps 30 to 40 years ago (at least in the United States). Rapid development of coastal areas by public and private interests has been a very important factor in focusing greater attention on this general subject. This factor, as well as many other factors, has greatly influenced the technical and general concept of sand transfer systems. It is clear that the trend in design is to have a system that will transfer 100 percent of dominantly moving littoral drift past the barrier.

The planning, design, construction, operation, and maintenance of certain sand transfer systems over the past 15 to 20 years has provided some quantitative and qualitative data for use in gaining a better understanding of the overall problem and developing a more rational solution to sand transfer problems. However, much more empirical data on this general subject are needed.

Although littoral barriers may be constructed to serve other purposes, generally the interest is that of minimizing shoaling conditions in an entrance channel for navigation. In earlier years very little planning was incorporated in a project to transfer littoral drift past an entrance channel. The principal objective was to maintain an entrance channel of specific dimensions. Of course, the objective of maintaining project channel dimensions has not changed, but with the increased importance of maintaining shore stability adjacent to the entrance channel it is now essential that some means of transferring the impounded drift to down-drift shores be incorporated in the overall plan. Examples are numerous where erosion downdrift of the man-made barrier became critical before

corrective measures were taken. In some cases, complete corrective action was beyond economic capability of interests involved and the measures actually taken only served to check the problem against intensification. It is clear that deferment of action to maintain shore stability adjacent to a littoral barrier may, and generally does, lead to a substantial increase in the annual cost of the overall project.

Hydrographic conditions, various aspects of littoral forces, and resulting littoral material movement differ widely along the coastline of the United States. Obviously this has considerable bearing on the planning, design, construction, operation, and maintenance of sand transfer systems in each area in question. In general, bottom slopes along the Pacific shoreline are steeper than those along the Atlantic coast; and the slopes along the Gulf of Mexico shoreline are flatter than the Atlantic coast. Wave climates in the respective areas differ considerably. Thus, the width of the area of most active littoral material movement is, in general, different on each coast. Of course, many exceptions to this generality may be cited. The basic point is that standardization of sand transfer systems for all coastal areas is not possible. Although a sand transfer system at one location may provide valuable guidance toward planning of a system at another location, the success and effectiveness of the later system will be dependent on how accurately the engineer has assessed the shore processes in that area.

The functional and structural design of a sand transfer system is very much dependent on knowledge of the magnitude of the littoral material movement and, of course, the dominant direction of material movement. Movement in both updrift and downdrift directions are important as predicted annual maintenance (dredging) of an entrance channel for navigation purposes may be substantially in error if recognition is not given to the total littoral materials in transit (i.e., material movement toward both sides of the entrance channel).

It is somewhat difficult to define an "existing" or "active" sand transfer system. For example, if the plan involves periodic transfer of the impounded drift to the downdrift shores (as is frequently the case) and the sand transfer operation is not carried out on the pre-planned schedule, then it leaves some conjecture as to classification of the sand transfer system. At this time, there are about 10 systems in "active" operation in the United States. In terms of additionally "planned" sand transfer systems, there are at least 15. The number of "planned" sand transfer systems is also difficult to establish. It should be recognized there may be more than 15 as for nearly every harbor presently under study for possible improvement (or wherein planning is being carried out for a new harbor) sand bypassing is nearly always an integral part of the planning, and such studies are being initiated virtually every day.

BASIC TYPES OF LITTORAL BARRIERS AND TRANSFER SYSTEMS UTILIZED

Figure 1 illustrates the basic types of littoral barriers (man-made) in which sand transfer systems have been employed. It must be recognized the design and operation of a system is very much dependent on the physical aspects of the structure and shore conditions adjacent thereto. In some cases, the sand transfer systems may have been adapted to the existing littoral barrier. Where opportunity is afforded, the sand transfer system and the littoral barrier are designed as a complete unit; thus the function of the structure and operation of the transfer system are inter-dependent.

The Type I barrier shown in Figure 1 is a typical jettied inlet wherein the updrift jetty is the principal littoral barrier. The impounded drift has been transferred to downdrift shores by various means. One method has been to employ a fixed dredging plant (hydraulic) near the outer end of the updrift jetty. This type of system tends to transfer only a portion of the drift reaching the updrift jetty. The drift rate is quite variable, being very high during periods of high wave intensity and, of course, low during calms. Thus, there must be a compromise on the design of the dredge plant so it will operate with optimum efficiency relative to the littoral reservoir it is capable of creating. The plant is generally designed in terms of the average annual rate of drift moving towards the barrier from the updrift direction. Examples utilizing this method are South Lake Worth Inlet, Florida⁽¹⁾; Palm Beach Inlet, Florida⁽²⁾; and Rudee Inlet, Virginia⁽³⁾. For this type of barrier conventional truck hauling of the impounded drift past the inlet was carried out at Shark River, N. J.⁽⁴⁾ Also the impounded zone was dredged by a conventional hydraulic pipeline dredge at Port Hueneme, California⁽⁵⁾. These latter two methods would obviously transfer a high percent of the drift reaching the barrier if the operation is carried out with sufficient frequency.

Type II barrier shown in Figure 1 is a typical jettied inlet but contains an offshore breakwater, the latter serving to impound the drift upcoast of the entrance channel, to reduce wave action within the channel area leading into the jettied inlet for benefit of vessel negotiation, and to create favorable conditions in the lee of the breakwater for a conventional hydraulic pipeline dredge to transfer the impounded drift to the downdrift shores. This sand transfer system is designed to transfer virtually 100 percent of the drift arriving at the littoral barrier. An example of this type barrier and employed sand transfer technique is Channel Island Harbor, California⁽⁶⁾. Although only an offshore breakwater is involved (no inlet channel), this same sand transfer technique is employed at Santa Monica, California.

Type III barrier in Figure 1 is a typical shore-connected breakwater wherein the drift is impounded in the lee of the outer end of the breakwater and thence transferred to downdrift shores by conventional pipeline

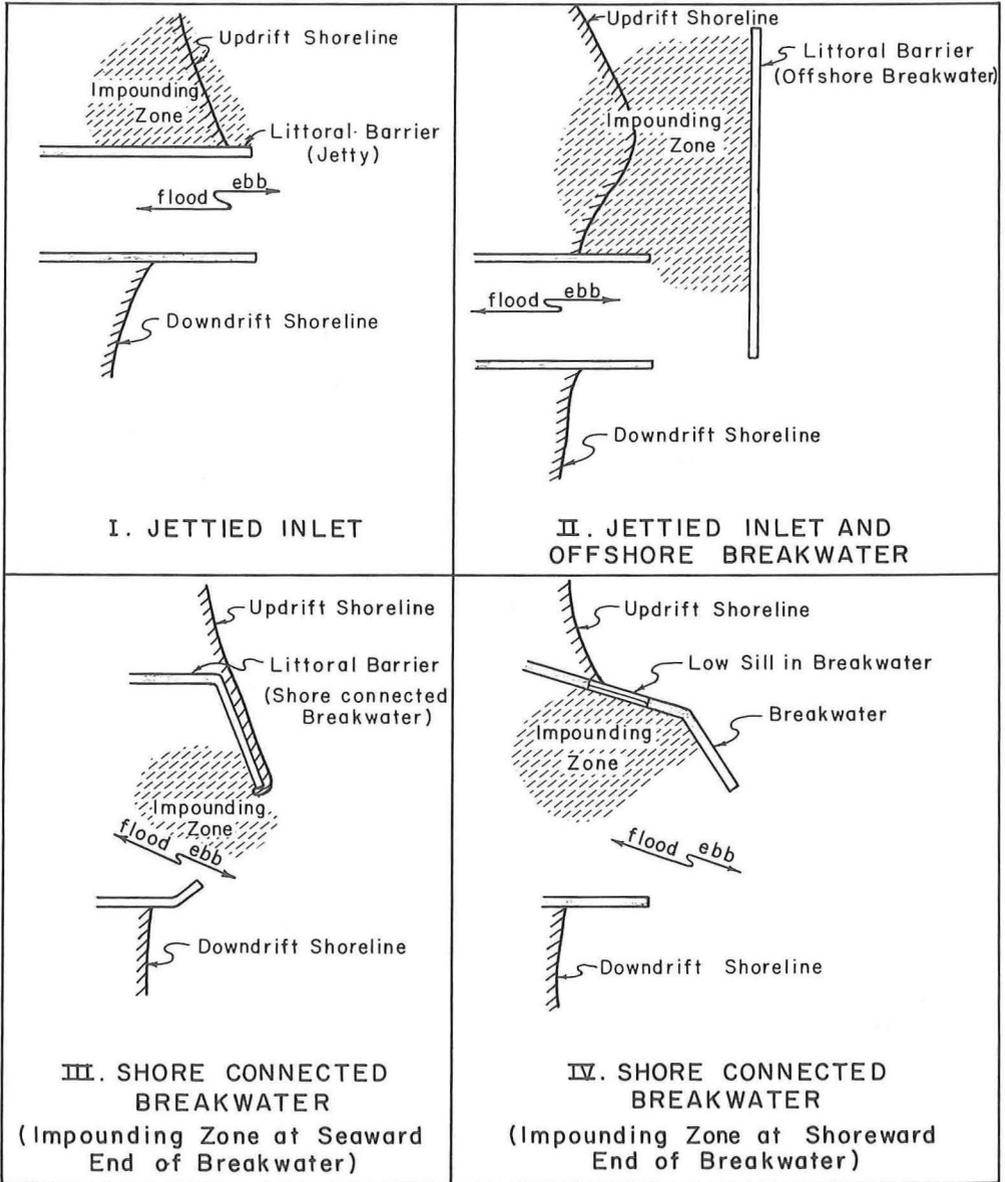


FIGURE I. TYPES OF LITTORAL BARRIERS WHERE SAND TRANSFER SYSTEMS HAVE BEEN EMPLOYED

dredge plant. This system is designed to transfer virtually 100 percent of the drift arriving at the updrift littoral barrier. Examples of this are Santa Barbara, California⁽⁷⁾; and Oceanside, California. The Fire Island Inlet, New York, jetty is not exactly of this type but use of sand transfer techniques fundamentally the same as utilized at Santa Barbara and Oceanside have been employed at this location.

Type IV barrier in Figure 1 is similar to Type III except the drift is allowed to pass over a low sill near the landward end of the updrift jetty and deposit in a reservoir in the lee of the jetty at that point. Transfer of the impounded drift to downdrift shores may be accomplished by conventional pipeline dredge or by the most economical means. As far as it is understood, this transfer system will handle 100 percent of the drift moving to the barrier from the updrift direction. It should be recognized, however, that this is a new approach. Projects presently under construction will provide very valuable data on the efficiency and needed refinements in design of this system. This technique has been employed at Hillsboro Inlet, Florida⁽⁸⁾ wherein a unique natural rock formation acts as a low sill near the shoreward end of the updrift littoral barrier. Construction of a jetty with a low sill is essentially complete at Masonboro Inlet, N. C. Preliminary planning, utilizing this principle, is being carried out for a number of other inlets along the Atlantic and Gulf coasts.

CONCLUDING REMARKS ON TRENDS IN SAND TRANSFER SYSTEMS

It is significant to note that until the late 1950's no sand transfer system was constructed (or implemented) in the United States having a design which would handle 100 percent of the dominant moving drift, exclusive of the systems utilized at Santa Barbara and Santa Monica, California. Since the late 1950's, many systems have been designed and constructed to handle 100 percent of the drift moving to the barrier from the updrift direction. This trend shows that mechanical transfer of sand past littoral barriers and/or stabilization of shores adjacent to the barriers is necessary and one of the very important considerations of any project involving structures which will interrupt the natural littoral material movement. The trend, then, is clear - the present and future design of sand transfer systems is to handle 100 percent of the littoral material movement in question. This points out the necessity of having reliable data and/or information on the character and magnitude of along-shore moving drift for the area in question. As new or different techniques of sand transfer past a barrier are tried, it is very important that a systematic data collection program be incorporated so engineers will have the benefit of documented data on the behavior and effectiveness of the system.

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