

# RESEARCH ACTIVITIES OF THE BEACH EROSION BOARD

## Chapter 16

### RESEARCH ACTIVITIES OF THE BEACH EROSION BOARD

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The purpose of this paper is to describe the research program of the Beach Erosion Board and to discuss the reasons which led to the establishment of this program. Introductory statements are given as to the functions of the Beach Erosion Board and the necessity of research activities to support these functions.

The Beach Erosion Board - The Congress has given the Corps of Engineers certain civil functions in addition to its military duties; among these functions is the making of studies and recommendations relative to the prevention of erosion by wave action of the shores of the Atlantic, Pacific, Gulf, and Great Lakes. These studies may be made directly for a Federal agency relative to the protection of Government-owned land, or cooperatively with states, municipalities, or other political sub-divisions.

The Beach Erosion Board was created some 20 years ago and since that time has worked out solutions to many shore protection problems in specific areas. Early in its work, however, the Board recognized that beach processes were imperfectly understood and that the correctness of the solutions to the problems at the specific beach areas studied by the Board were subject to question as a result of this imperfect understanding. Accordingly the Board was given funds to make general investigations in order to gain a more correct and thorough understanding of beach processes and the effect on these processes of various types of protective works, leading to the design of more effective and more economical plans of shore protection and improvement.

The Classification Table - In order to formalize the general investigation, or research, program of the Board it was found desirable to classify the various factors (excluding economic factors) which are believed to play a significant part in the understanding and solution of beach erosion problems. The resulting table is presented on the following page.

# COASTAL ENGINEERING

TABLE 1

## CLASSIFICATION OF FACTORS INVOLVED IN SOLUTIONS OF SHORE PROTECTION PROBLEMS.

1. Waves in Deep Water
  - A. Mechanics of Internal Movement
  - B. Origin, Propagation, and Dimensions
  - C. Effect of Certain Factors on Waves
2. Waves in Shallow Water
  - A. Mechanics of Internal Movement
  - B. Transformation Without Energy Loss
  - C. Transformation With Energy Loss
  - D. Origin, Propagation, and Dimensions
3. Currents in Shallow Water
  - A. Internal Wave Currents
  - B. Long-period Currents
4. Factors Affecting Supply & Movement of Beach Material to Littoral Zone
  - A. Sources of Beach Material
  - B. Rate of Transportation of Material to and from Littoral Zone
  - C. Physical Characteristics of Beach Material Affecting Material Movement
  - D. Long-period Water Level Fluctuations
5. Significance of Natural Formations
  - A. Hydrographic Formations Higher than Surrounding Hydrography
  - B. Hydrographic Formations Lower than Surrounding Hydrography
  - C. Shore Line Formations
  - D. Miscellaneous Formations
6. Beach Processes
  - A. Mechanics of Material Transport in the Littoral Zone
  - B. Rate and Result of Onshore-offshore Material Movement
  - C. Rate and Result of Alongshore Drift.
  - D. Creation and Alteration of Shore Forms
  - E. Rate and Result of Wind Transport of Beach Material
7. Functional Design and Effect of Man-made Structures
  - A. Structures Perpendicular to the Shore
  - B. Structures Parallel to Shore
  - C. Navigation Channels
  - D. Artificial Fill
  - E. Sand By-passing Plants

## RESEARCH ACTIVITIES OF THE BEACH EROSION BOARD

8. Structural Design of Man-made Structures
  - A. Structures Perpendicular to the Shore
  - B. Structures Parallel to Shore
  - C. Sand By-passing Plants
  - D. Resistance of Structural Materials
9. Supporting Investigations and Activities
  - A. New Instrument Developments
  - B. New Test Facilities
  - C. New or Improved Test Methods and Procedures
  - D. Preparation of Bibliographies and Reference Data

The factors listed in the Classification Table are not considered to be of equal importance to the solution of shore protection problems and additional factors may be added to the table in the future as more light is gained on the subject. It can be seen that the Classification Table has 9 categories with several headings under each category for a total of 36 headings. Actually the 36 headings are further divided into 99 additional subheadings; however, for the sake of brevity these subheadings are not shown at this time, except those for Category 2, "Waves in Shallow Water," which are shown on Table 2 as an example.

TABLE 2

### 2. WAVES IN SHALLOW WATER

- A. Mechanics of Internal Movement
  1. Between deepwater and breaker zone
  2. At time of breaking
  3. After breaking
  4. Coalescence and interference of waves
- B. Transformation Without Energy Loss
  1. By depth changes
  2. By refraction
  3. By diffraction
  4. By currents
- C. Transformation With Energy Loss
  1. At breaking
  2. By bottom friction
  3. By bottom permeability
  4. By viscosity and turbulence
  5. By reflection
- D. Origin, Propagation, and Dimensions
  1. Generation
  2. Forecasting including decay
  3. Opposing and cross winds
  4. Opposing and cross wave trains
  5. Statistical record accumulation
  6. Statistical record analysis

## COASTAL ENGINEERING

It is recognized that a classification table of factors relating to wave action on shores could be drawn up in forms other than the one presented. However, the table as shown was arrived at as being of practical application as a guide to the work of the Board.

The Priority Table - Once the Classification Table had been drawn up, a priority list or table was drafted. This Priority Table is, in effect, a statement, in order of priority, of the ten questions or problems most frequently encountered in specific shore protection studies for which adequate, quantitative answers are not generally available based on the present knowledge of beach processes. The Priority Table is shown below as Table 3. It is recognized that the order of priority as given is subject to question and might be re-arranged in significantly different order or some of the questions replaced by others depending on the past experience and immediate needs of the user. However, the questions and order given in Table 2 are the ones finally arrived at as best suited to the immediate needs of the Board. It is to be noted that the table is labeled as "Priority Table for Fiscal Year 1952;" this shows the table to be temporal and in practice it will be reviewed each spring for possible revision before drawing up the research program for the next fiscal year. The Classification Table presented as Table 1 is, on the other hand, considered to be a fairly permanent statement of the factors involved in the solution of shore protection problems.

TABLE 3

### PRIORITY TABLE FOR FISCAL YEAR 1952

1. Rate and result of alongshore drift.
2. Functional design of shore-connected structures. (Groins and groin fields including length, height, and spacing)
3. Functional design of structures parallel to shore near the mean water line (bulkheads and seawalls) which special reference to criteria for setting crest heights.
4. Functional design of artificial fill as to elevation and width.
5. Functional design of sand by-passing plants.
6. Significance of inlets in shore processes.
7. Significance of horizontal breaks in shore line including headlands with special reference to littoral drift compartments.
8. Rate and result of wind transport of beach material.
9. Structural design of man-made structures.
10. Effect of offshore structures (particularly submerged breakwaters) on shore processes.

It can be seen that in general a complete answer to any one of the ten priority questions requires a quantitative understanding of several of the factors listed in the Priority Table. Thus a matching up of a given priority question with factors needed to answer the questions points up the directions in which the research program should move. A listing of the principal items involved in gaining a quantitative understanding of question #1 is shown in Table 4; the fifteen items shown appear among the ninety-nine subheadings of the Classification Table as described above and illustrated in part as Table 2

# RESEARCH ACTIVITIES OF THE BEACH EROSION BOARD

TABLE 4

## STATEMENT OF PRINCIPAL FACTORS INVOLVED IN ANSWER TO PRIORITY QUESTION #1

1. Rate and Result of Alongshore Drift.
  - a. Wave forecasting, including decay, in deep water.
  - b. Wave forecasting, including decay, in shallow water.
  - c. Statistical record analysis in both deep and shallow water.
  - d. Wave transformation by refraction.
  - e. Statistical record accumulation in both deep and shallow water.
  - f. Wave-generated currents in shallow water, including rips.
  - g. Coalescence and interference of waves.
  - h. Wave transformation by loss of energy from bottom friction and permeability.
  - i. Wave transformation by loss of energy at breaking.
  - j. Mechanics of littoral transport in the littoral zone.
  - k. Physical characteristics of beach material affecting material movement.
  - l. Supply of material to problem area from littoral deposits outside of area.
  - m. Supply of material to beach from offshore area.
  - n. Supply of material to beaches from inland areas by stream flow.
  - o. Supply of material to beaches by marine life deposits.

The Research Program - With the Priority Table and the Classification Table at hand, a research program geared to the recognized needs of the Board can be prepared. In preparing this program, the research personnel available, the funds allocated to general investigations, and the available test equipment are considered in addition to the priority and classification tables. The resulting research program is presented in Table 5 and is considered to represent a realistic program based on the needs, funds, personnel and equipment available to the Board for research purposes. Generally, the projects selected have been limited sufficiently in scope to enable the results to be reported within a year after the study is initiated. The relation of the projects to the Classification Table and the Priority Table is indicated in that order in parentheses following each project title. Table 5 appears on the following page.

# COASTAL ENGINEERING

TABLE 5

## BLACH EROSION BOARD RESEARCH PROGRAM FOR FY 1952

- A. Projects on which the collection of data has been completed and on which reports will be prepared in FY 1952.
- (1) Study of quantity of sand in suspension in coastal waters (6A-1)
  - (2) Study of equilibrium profiles on beaches (4C-1)
  - (3) Study of model scale effect in movable-bed wave models (9C)
  - (4) Study of wave generation in inland waters (2D-1)
  - (5) Study of pressures developed by waves breaking against vertical structures (8B-9)
  - (6) Correlation of waves and alongshore currents (5B-1)
  - (7) Effect of Mission Bay jetties on adjacent beaches (7A-2)
  - (8) Preparation of charts showing effect of submerged breakwaters on waves (7B-10)
  - (9) Preparation of reports based on Mission Bay field data (6B, C, D-6)
  - (10) Use of radio-active material for tracers in beach studies (9C)
- B. Projects scheduled to be undertaken and completed during FY 1952.
- (1) Measurement of deep-water ocean waves by an airborne wave recorder (1B-1)
  - (2) Measurement of deep-water ocean wave by a spar-buoy wave gage (1B-1)
  - (3) Wave tank study of wave energy loss by bottom friction and permeability (2C-1)
  - (4) Wave tank study of wave run-up on shore structures (7B-1)
  - (5) Wave tank study of sand sorting due to wave action on sand beds (6B-1)
  - (6) Study of effect on beach profiles of varying wave periods (6B-4)
  - (7) Preparation of selected list of references pertaining to beach erosion (9D)
  - (8) Establishment and maintenance of wave recording stations in coastal waters. (This is a continuing project)
  - (9) Study of the stability of rubble mound structures in wave action.
  - (10) Study to determine the effective height of seawalls and bulkheads.
  - (11) Development of a settling velocity tube to provide a rapid means of analyzing sand under dynamic conditions.
  - (12) Study to improve the techniques of photographing tracers of the same density as water in wave action.
  - (13) Study of the economic life of shore protection structures - South Atlantic (Cape Charles, Va. to Florida Keys).
  - (14) Study of the composition, sorting, source and disposition of littoral material.

# RESEARCH ACTIVITIES OF THE BEACH EROSION BOARD

TABLE 5 (continued)

- C. Projects being conducted by outside agencies under contract to the Beach Erosion Board.
- (1) Study of methods of analysis of wave records by electronic speech analyzers (1B-1)
  - (2) Study of methods of computing wave refraction over complex hydrography (2B-1)
  - (3) Development of method of computing refraction coefficients from one orthogonal (2B-1)
  - (4) Study to improve methods of forecasting alongshore currents (3B-1)
  - (5) Investigations of historic source and travel of sand found on existing beaches (4A-1)
  - (6) Geological study of San Nicolas Island beaches (4A-1)
  - (7) Study of submarine canyons as traps for littoral drift (5B-7)
  - (8) Development of instruments (9A)

Of the studies listed under A and B above, the first 17 are being carried on by the Research Division of the Board and the last 8 by the Engineering Division. In addition to the 8 projects listed, the Engineering Division is also preparing a manual for the design of shore protection structures. The manual will be based almost completely on existing data and will be presented in five chapters as follows: Definitions; Functional Design; Structural Design; Economic Life; and Design Analysis. It is planned to publish each chapter as a technical memorandum as it is completed, and the completed manual as a technical report. For this task the Engineering Division will be augmented temporarily by obtaining the services of well-qualified personnel, recruited from within the Corps of Engineers and educational institutions, who have specialized in the various phases of work covered in the manual.

General Investigations - In addition to the programs of the Research Division and Engineering Division, the Reports and Publications Division of the Board is compiling existing data on the shorelines of the United States in such a form that it will be of maximum aid in the solution of specific shore problems. These reports will be compiled on a regional basis rather than a local basis and will serve to improve, simplify and speed investigations of local problem areas. The existing data pertinent to shore processes in a selected shore region will be analyzed and interpreted to the extent justified and the data and conclusions published in the form of technical reports. The ultimate program contemplates the publication of twenty-three such reports covering the continental shores of the United States and three covering the territorial possessions.

## COASTAL ENGINEERING

Assuming that the services of competent personnel can be obtained, eight such reports are to be compiled during the next two years. The eight regions selected for coverage are as follows:

1. The South Shore of Long Island
2. The New Jersey Shore from Sandy Hook to Cape May Point
3. The Peninsular Gulf Coast of Florida, from Cedar Keys to Cape Sable
4. The Gulf Coast of Texas
5. The Coast of Southern California from Pt. Fermin to the Mexican Border
6. The Coast of Southern California from Pt. Conception to Pt. Fermin
7. The Shores of Lake Michigan
8. The United States Shore of Lake Erie

Each report will consist of five chapters entitled:

1. Geomorphology
2. Littoral Forces
3. Littoral Materials
4. Littoral Measurements
5. Summary and Conclusions

The Research Division and Engineering Division of the Board will contribute to the preparation of the several chapters. Also, competent engineers and scientists both within and without the government service will be engaged, when possible and advisable, on a temporary basis to assist in the preparation of certain portions of the material.

Concluding Statement - The current research program of the Beach Erosion Board has been described. This entire program is pointed toward the accumulation and clarification of knowledge which will enable the Board to more effectively solve the various shore protection problems brought to it for advice and solution. The greater portion of the findings resulting from these investigations will be of interest to engineers and scientists engaged in professional activities dealing with wave action in coastal waters. The findings of the Board will be published in such a form as will make them available to all persons and agencies confronted with coastal engineering problems.