PROGRESS REPORT ON WAVE TANK STUDY AT THE UNIVERSITY OF OKLAHOMA

O. F. EVANS
University of Oklahoma

Changes that take place on the subaqueous terrace and at the shoreline are most rapid when the wind is the strongest and the waves the highest. Hence, direct observation of the formation of such structures as offshore bars, spits, tombolos, etc., and the methods by which the sediments are transported are often based merely on deductions resulting from observations of the finished structures. As a result there is no part of geological literature so full of contradictions and inconsistencies as that relating to shore processes and shoreline development.

It was with the need of more exact observational studies in mind that the author visited the U. S. Waterways Experiment Station at Vicksburg, Mississippi in the autumn of 1937.

Here the engineers of the Mississippi River Commission are making studies of rivers and harbors by means of scale models and successfully solving the involved problems of sedimentation. Observation of their methods and of the results obtained in the solution of special engineering problems led to the conclusion that similar tank studies might be expected to lead to a better understanding of the broader problems of erosion, transportation and deposition on the terraces and along the shores of lakes and oceans.

Consequently it was decided to attempt the building of a tank for such study at the University of Oklahoma. This was fortunately made possible by the securing of a grant from the Faculty Research Fund. The Oklahoma State Geological Survey co-operated by furnishing a sheltered space for the apparatus. The University Utilities Department also aided by furnishing material and labor at cost.

The tank is 20 feet long, 4 feet wide and 20 inches deep. It is made of rough lumber and lined with several layers of paper and tar roofing. This has proved fairly satisfactory as a temporary construction. The wave machine was copied to some extent from those used at the Experiment Station although it is, of course, much smaller. Its principal part is a V-shaped trough with a 30° opening. The waves are formed by this trough as it is moved up and down in the water; a wave being formed with each downward stroke. The machine operating the trough is driven by a ½ H.P. electric motor running at 1850 r.p.m. By means of suitable gearing this motor action is changed to 50 reciprocating strokes per minute. By varying the length of the levers that drive the wave trough it is possible to produce waves of four different sizes varying in height from ¾ of an inch to 3½ inches.

Sand was used in constructing the artificial beach. For this purpose a sand was obtained whose upper limit in size is 0.25 mm. Unfortunately this also contains much fine material that is easily kept in suspension in the water. Probably a well washed sand ranging in size from about 0.35 mm to 0.65 mm would be better since it is desirable to keep the water as free from suspended sediment as possible for convenience of observation.

The stated purpose of the study is to determine, if possible, the depth of effective wave base for waves of various sizes. Of course it was not expected in a problem of this degree of difficulty to reach a definite solution at once. Rather it was hoped to determine whether the tank offers a feasible method of attack and, if so, to learn something as to the proper methods of procedure.

As yet the work has not progressed far enough to give results that are more than suggestive. It was early discovered that the presence of a beach is necessary, or at least very helpful, in the production of uniform and regular waves. When waves are thrown against the vertical end wall of the tank, or even against a bank of sand that has not yet been worked into the beach form, waves are reflected back the whole length of the tank producing what appears to be a generally disordered surface similar to what can be seen when storm waves are reflected from the face of a nearly vertical breakwater. However, as soon as the sand becomes arranged into the form of a typical beach and underwater terrace the waves become breakers as they approach the shore and as the backwash meets each succeeding wave its energy is reduced and wave reflection from the shore ceases.

With the waves two inches or less in height and 28 inches long a nearly uniformly sloping subaqueous terrace was built, but with three inch waves a ridge of sand formed about 30 inches out from the shoreline. The top of this ridge was 2½ inches below the water surface and the trough just to the shoreward side of it was 4½ inches deep. Each wave broke on this ridge at the same time it met the returning water from the shore. In one case a similar ridge 1½ inches high with trough two to 2½ inches deep was formed eight inches from the shoreline as the result of using waves just over two inches high. It seems that conditions prevailing in this tank are such that waves need to be more than two inches high before their energy is sufficient to build a ridge. This ridge is evidently a protection to the beach by causing the waves to break and be reduced in size before reaching the shoreline.

It was also noticed that if a run of two hours with a three inch wave was followed by a two hour run with a 1½ inch wave that some material that had been taken from the shore during the first run was returned to the shore during the second run and the shore rebuilt to some extent. This is probably analogous to the erosion of beaches during storms and their rebuilding later by waves of smaller size.

The tank runs as made varied in length according to circumstances from two hours to six hours. In all cases a subaqueous terrace was built but it is not thought that in any run a condition of equilibrium of the terrace was reached. At the end of a six hour run with a two inch wave the edge of the subaqueous terrace was 34 inches from the shoreline and seven inches beneath the water surface. After a six hour run with a 3¼ inch wave the edge of the terrace was 68 inches from the shoreline but only 6½ inches deep. The previously mentioned ridge was in this case 28 inches from the edge of the terrace and was evidently a factor in controlling the depth of the terrace edge.

During all the runs numerous ripple marks were formed. Two important points regarding ripple marks were found to agree with the author's investigations in the field. First, with a given size of wave oscillation ripples decrease in size with depth. Second, at a given depth the size of oscillation ripples varies with the size of the waves, being smaller when the waves are smaller. On these two points previous investigators have not been entirely clear.

As a result of the studies to date it is believed that a tank built for the purpose of studying bottom conditions should be much deeper than the present one and perhaps narrower. The sediments used should contain very little material blow 0.25 mm in diameter. Probably well washed dune sand would be satisfactory. Also if the tank were built with glass sides it would greatly facilitate observation of the processes taking place beneath the water.