CHAPTER 63

LABORATORY TESTS ON ARTIFICIAL SEAWEED

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ABSTRACT

Tests are described in which the effect of artificial seaweed on bed sediment movements due to waves was studied in a model Water velocities near the bed and coal particle velocities on the bed, within the seaweed array, were measured over a range of wave conditions and densities of packing of the seaweed The water velocity measurements were erratic, probably due to additional turbulence caused by the seaweed Coal particle movements on the bed were slowed down in the presence of seaweed

Introduction

A paper was presented to the 11th Conference on Coastal Engineering entitled, "The Effect of Artificial Seaweed in Promoting the Build-up of Beaches", see Ref 1 This paper described tests conducted in a laboratory wave channel using a beach of crushed coal, in addition to full-scale tests on the beach at Bournemouth, England Anchorage problems stopped the full-scale tests before meaningful results could be obtained although some accretion had occurred inshore of the seaweed array In the model, the presence of artificial seaweed offshore caused a build-up of the beach levels An explanation of this build-up was suggested from the theory of wave propagation in a two-layered liquid of differing viscosities

Since that time further laboratory investigations have been carried out to attempt to find an optimum arrangement of seaweed, and to test the applicability of the viscosity theory over a range of wave heights, periods and densities of seaweed packing

Test Procedure and Results

The artificial seaweed was a white polypropylene ribbon 3 mm wide having a specific gravity of 0 93 Twenty strands of this, 0 30 m long, formed a clump which was stapled to the plywood floor of a wave channel Clump spacing was varied to make three seaweed arrays, each 4 60 m long and 0 61 m wide

Clumps at 150 mm x 150 mm = 120 clumps
Clumps at 75 mm x 75 mm = 420 clumps
Clumps at 50 mm x 50 mm = 990 clumps

The wave channel was 28 5 m long and 0 61 m wide, with a mean water depth at the seaweed of 0 43 m At the offshore end a paddle generated single-frequency waves The tests were carried out with a fixed bed and landward of the seaweed installation was a pebble spending beach, 10 m long parabolic in shape

Fourteen wave conditions, with periods from 1 5 sec to 2 5 sec and heights from 50 mm to 150 mm were generated for the channel bed without seaweed and for each seaweed installation Observations were made of the wave orbital velocities near the bed and of the movement of coal particles along the bed

1 Wave orbital velocities near the bed A miniature propeller current meter was placed 10 mm above the bed and connected to an instantaneous ratemeter to give a continuous record of orbital velocities during one wave period This record was integrated to obtain the net wave induced drift, and divided by the wave period to give the mean drift velocity at the point of measurement It was assumed that an increase in the landward drift velocity offshore might be expected to produce an increased landward sediment transport, and hence a build-up of levels inshore and on the beach

The results are shown in Fig la, b and c It is apparent that there is little correlation between the density of seaweed packing and drift velocity Some tests were repeated, and the net drift velocities were found to vary by as much as $\pm$ 300% Differences of 200% were found with only a 75 mm change in the horizontal position of the propeller The instruments were checked frequently to ensure that they were operating correctly

The conclusion was reached, therefore, that the seaweed created additional turbulence, making velocity readings at a single point unrepresentative of water movements over the entire array In order to study conditions over the array as a whole, the movement of coal particles along the bed was also measured

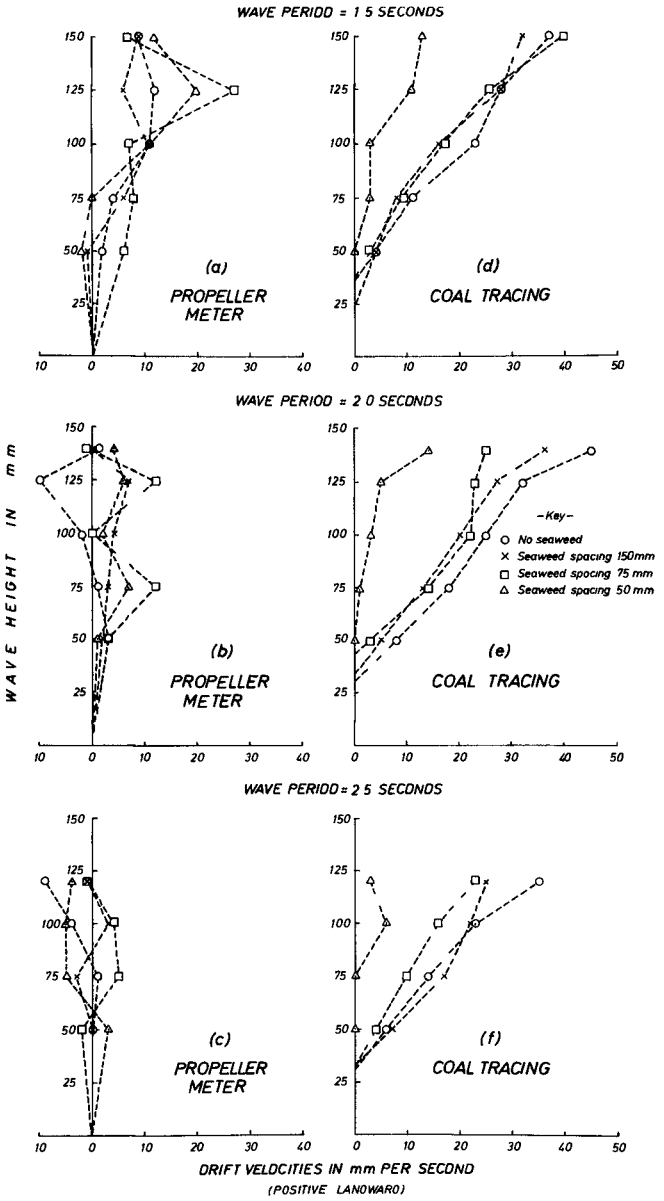
WAVE PERIOD = 1 5 SECONDS
(a)
PROPELLER METER
(d)
COAL TRACING
WAVE PERIOD = 2 0 SECONDS
(b)
PROPELLER METER
(e)
COAL TRACING
WAVE PERIOD = 2 5 SECONDS
(c)
PROPELLER METER
(f)
COAL TRACING
WAVE HEIGHT IN mm
DRIFT VELOCITIES IN mm PER SECOND
(POSITIVE LANDWARD)
-Key-
No seaweed
Seaweed spacing 150mm
Seaweed spacing 75 mm
Seaweed spacing 50 mm

FIG 1

2 Movement of coal particles along the bed Coal particles were injected on the bed, and the number of waves required to move a particle over a known distance was counted The net drift velocities found in this way are plotted on Fig 1d, e and f

These figures show a trend towards lower net drift velocities with denser seaweed packing, and with the exception of one seaweed installation, the results were repeatable For the exception, seaweed at a clump spacing of 50 mm, turbulence was markedly greater with larger waves even the boundary layer behaved turbulently, and the coal dispersed in all onshore directions rather than parallel to the channel axis, with lower waves, the coal collected at scattered points in the array where bed shear was insufficient to move it

Discussion

In interpreting the results of the propeller meter tests, the method of analyzing the data must be considered Wave induced drifts towards and away from the beach were calculated by integrating the velocity records and these were subtracted to obtain the net drift The net drift so obtained was of the same order as the probable error in the velocity measurements In addition, there were obvious differences in the shape of the velocity record for repeated tests The lack of correlation between drift velocity and seaweed packing was probably due to the combined effects of computational error and turbulence

The coal particle experiments, however, gave some interesting results Of the fourteen wave conditions tested, all but three showed drift velocities with seaweed less than or equal to those without seaweed Furthermore, in seven cases there was a definite trend towards lower drift velocities with denser seaweed packing, and only for a clump spacing of 150 mm with 1 5 sec waves was there a large incongruity These results are not consistent with those predicted from the theory of wave propagation in a two-layered liquid of differing viscosities

The results of the present series of tests suggest that the presence of artificial seaweed inhibits the transport of sand from the offshore seabed towards the beach This appears to contradict the findings of the earlier tests in which a build-up of the beach was measured shoreward of the seaweed installation However, the earlier build-up may not have been due to increased shoreward bed-load transport, but caused by a reduction in wave steepness due to attenuation of the wave height by the seaweed In addition, the two series of tests were not truly comparable first, the response of the instruments dictated wave periods for the most recent series greater than the 1 33 sec of the first series, and second, the use of a coal beach in the

original tests introduced the factors of beach slope, grain size distribution and suspended sediment load, none of which were present in the tests reported here

The results of the coal tracing indicate that artificial seaweed may have an application in uni-directional flow as a sediment trap, reducing the velocity gradient and bed shear and causing accretion within the array

Reference

1 PRICE, W.A , TOMLINSON, K W , and HUNT, J N The effect of artificial seaweed in promoting the build-up of beaches Proceedings 11th Conference on Coastal Engineering, London, 1969, Vol 1 pp 570-578

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