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by

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1 INTRODUCTION

An important role exists for systematic field measurements of the suspended sediment component of littoral drift in the development of theories regarding the longshore transport of sand on beaches. Such efforts began, and are predominant, on marine coasts, with the earlier work of Watts (1953), Fairchild (1977), Brenninkmeyer (1976), Kilner (1976), Kana (1978), and are now being supplemented by more recent work by participants in the N.S.T.S. study in the United States.

On non-tidal coasts, such as the Baltic Sea and the Great Lakes, however, little work has been conducted since the pioneering studies of Aibulatov (1957).

The principal aim of this report is to add to the research work cited above, and to illustrate empirical relationships, based on field evidence, between the suspended load portion of the total longshore transport and the breaking wave field in a non-tidal lacustrine environment. By analysing a two-year long record of suspended sediment discharge values and wave data at the study site, correlations between these variables should point the way to a means of predicting sediment transport in analogous areas.

The site of the measurements is at the extreme western end of Lake Ontario on a large bay-mouth bar. The shoreline is regular and tends NNW, perpendicular to the direction of maximum (400 km) fetch. The techniques used in the study have been described elsewhere (Coakley 1978). Briefly they involved the collection of sediment-water suspension samples and flow data at three vertical elevations at positions along a fixed, 100 m transect of the surf zone. Continuous records of incoming waves were collected nearby at a location just outside the surf zone using a linear array of surface-piercing wave gauges, from which wave direction could be determined.

2 RESULTS

During the period September 1977 - December 1979, a total of 32 experimental runs, covering 16 separate storm events, were conducted. The harsh early winter environment resulted in the rejection of about half of the field data because of gaps due to various component malfunctions. After screening of the data to eliminate those records with excessive gaps, 13 runs were retained. for suspended sediment calculations. Longshore discharge values ranged from 1500 to 89000 kg h^{-1}. The corresponding significant wave heights were in the range of 0.6 to 1.9 m, and the peak periods in the range of 3.6 to 6.1 s. The longshore direction of the discharge was generally in agreement with that indicated by the measured wave angle. When indicated and measured discharge direction did not agree, the wave angle relative to the beach normal was extremely small, so that a very small error in wave direction measurement could result in the incorrect indication of sediment discharge direction.

Retaining only those cases where the directions agreed (Table 1), a linear regression was done between the immersed weight discharge of suspended sediment (I_ℓ) and the longshore wave energy flux (P_ℓ) after the method of Komar and Inman (1970). The equation of best fit was found to be $I_\ell = 0.36\ P_\ell$.

The surf zone averaged concentrations of suspended sediment were calculated and found to be in the range 0.08 to 0.64 $g\ell^{-1}$ with a mean of 0.27 $g\ell^{-1}$. This is similar to that measured by Kana (1978) with a mean of 0.33 $g\ell^{-1}$, and somewhat less than the value of about 2.6 $g\ell^{-1}$ "very near the bottom" (Fairchild, 1977), both at locations on the Atlantic coast of the U.S.A.

TABLE I

SUMMARY OF BREAKING WAVE AND SUSPENDED SEDIMENT TRANSPORT CONDITIONS AT VAN WAGNER'S BEACH, LAKE ONTARIO

Run	H_b m	T_p s	α deg.	I_ℓ Ns^{-1}	P_ℓ Ns^{-1}
3/1	1.15	6.1	-2.4	-22	-139
3/2	0.99	6.1	-1.8	-49	- 79
4/2	0.63	4.1	-4.6	- 9	- 66
9/1	0.96	4.9	-1.1	- 7	- 37
10/1	1.27	6.1	-3.5	- 9.3	-206
15/1	0.90	4.9	1.6	8	51
16/1	0.61	3.6	-1.5	- 3	- 18

H_b: significant wave height at breaking

T_p: peak period

α: angle of wave ray with beach normal

I_ℓ: immersed weight discharge of suspended sediment

P_ℓ : $1/16\ \rho g H^2_b\ C_g \cos\alpha \sin\alpha$

ρ: density of water in kg m^{-3}

g: acceleration of gravity in m s^{-2}

C_g: group velocity at breaking in m s^{-1}

3 DISCUSSION AND CONCLUSIONS

Suspended sediment, longshore current, and wave data have been collected during moderate to severe early winter storms at Van Wagner's Beach, Lake Ontario. This data set is distinguished from others in that the site is a non-tidal beach characterized by offshore bars; the wave heights were some of the largest encountered during experiments of this type; the angles of wave approach were relatively small.

The range of suspended sediment concentrations and the range of sediment transport rates encountered are similar to those reported elsewhere. The relation between longshore transport and longshore energy flux derived from this data set suggests that about half the amount of sediment is moved for comparable energy flux as reported by Komar and Inman (1970). Greer and Madsen (1978), in their review of longshore sediment transport data, argue that relations like that in Komar and Inman (1970) should only be used to obtain order of magnitude estimates because of the difficulties in satisfying all of the assumptions made in evaluating the longshore transport. Given that argument, the results of the present study are in remarkably good agreement with those of Komar and Inman, in view of the different techniques used and different condtiions under which the experiments were conducted.

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