

WAVE CLIMATE OFF TRIVANDRUM (KERALA)*

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ABSTRACT

The analysis of the wave data revealed that the coastal region ordinarily has a wide-band (6 to 15 sec), low-energy spectrum of waves (H_s less than 80 cm). During the southwest monsoon period, i.e., May-September, a spectrum of narrow-band (10-13 sec) and high-energy waves (H_s exceeding 1 m) were observed.

The refraction of waves and the breaker characteristics are described here for a two kilometre stretch of the Trivandrum coast (Kerala). Wave refraction studies revealed that for the directions of approach of the waves (8 to 14 sec); from west to west-north-west, the concentration of energy along the 2 km stretch of the Trivandrum beach is higher as compared to other directions of approach.

INTRODUCTION

This work was carried out to study the environmental conditions prevailing at a beach in Trivandrum where severe erosion was experienced. The main objective of the project was to suggest suitable remedial measures to protect this part of the coast from erosion. Since an adequate knowledge of the wave data was required for the coastal engineering work, surface waves were recorded off this region for one year during 1976-77. Wave refraction analysis was also carried out to estimate the concentration of wave-orthogonals and the resulting longshore sediment transport. The results of the wave studies are reported in this paper.

METHODS OF STUDY

Waves were recorded using an OSPOS (Off-Shore Pressure Operated Suspended) Wave Recorder (Anon., 1968). The wave recorder was installed at a location where the water depth was 20 m, off Trivandrum (See Fig. 5A, wave refraction diagram). The method of installation and operation of the wave recorder has been described elsewhere (Swamy, Das and Varkey, 1976). Continuous wave records for varying duration (2-6 hours) were obtained for a period of one year from April, 1976 to March, 1977. In all, 93 wave-records of 10-minute duration were considered for the analysis following the procedure suggested by Tucker (1963) and Draper (1967).

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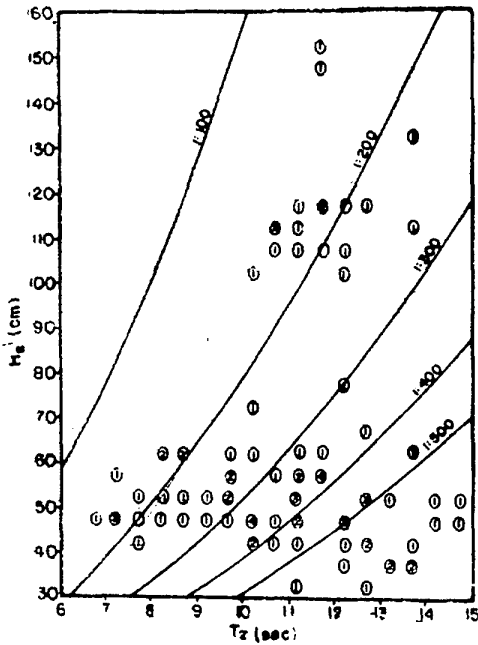


Fig. 1. Scatter diagram showing the relationship between significant wave height (H_s) and zero-crossing period (T_z). The number in the circles indicates the frequency of occurrence; and the isolines correspond to wave steepness (pertaining to H_s & T_z) at the point of observation. (Total number of 10 min record-pieces : 93).

Percentage occurrence of the waves from different directions in the area (Lat. 5° - 10° and Long. 75° - 80°) off Trivandrum and the monthly distribution of the percentage frequency of the occurrence of wave heights and periods were computed based on the wave data reported in the Indian Daily Weather Reports (1968-73). The monthly resultant wave directions were also calculated for this area following the method suggested by Silvester (1974).

Wave-refraction diagrams were prepared using the Admiralty Chart No. 751 of the West Coast of India (Malabar coast). In the light of the general wave climate data available, the waves with periods 8, 10, 12 and 14 sec approaching the shore from WNW, W, SW and S were selected for the present analysis.

RESULTS AND DISCUSSION

The inter-relationship between the significant wave height (H_s) and the zero-crossing period (T_z) is presented in the form of a scatter dia-

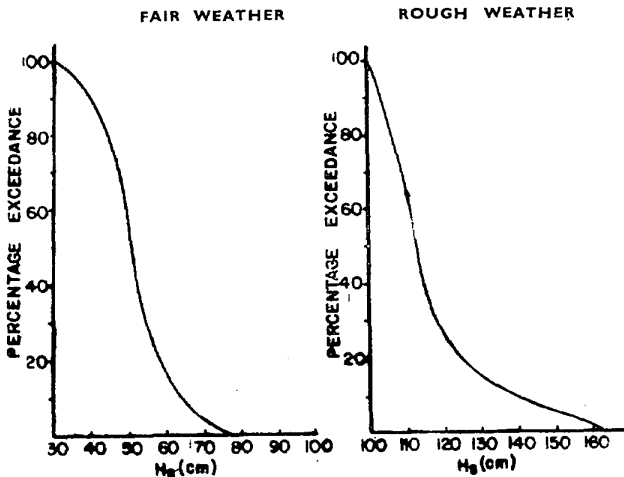


Fig. 2. Percentage exceedance curves for significant wave height (H_s) for fair weather and rough weather.

gram (Fig. 1). The diagram reveals two distinct categories of waves at Trivandrum. The first category of waves is characteristic of fair-weather conditions. The waves have a wide range of zero-crossing periods (6 to 15 sec) with significant wave height of less than about 80 cm. The second category representing south-west monsoon months, comprising of waves with periods (T_z) ranging from 10 to 14 sec and H_s greater than 1 m. The wave steepness (pertaining to H_s and T_z values) was generally low and only a few waves exceeded the steepness of 1: 200 (Fig. 1).

During the rough weather period which extends from May to September, H_s exceeds 1 m as shown in Fig. 2. H_s value varied mostly between 1.0 and 1.2 m and the predominant period was 10 to 13 sec, as illustrated in Figs. 1 & 2. The percentage occurrence of zero-crossing period as per the records obtained during the year of study is shown in Fig. 3.

The distribution of spectral width parameter (ϵ) for the entire period of observation is presented in Fig. 4. The significance of ϵ is that the wave components cover a wide range of frequencies, ϵ will be nearly zero (Draper, 1967). Fig. 4 shows that the ϵ value ranges between 0.2 and 0.8 in the region under study (off Trivandrum). The predominant values are between 0.5 and 0.6 indicating the combined occurrence of sea and swell waves in this area most of the time in a year.

Monthly resultant wave directions calculated for the area (Lat 5° - 10° N and Long 75° - 80° E) are shown in Table I. From April to October, the resultant wave directions are mostly W to SW with percentage constancy ranging from 38 to 78: in

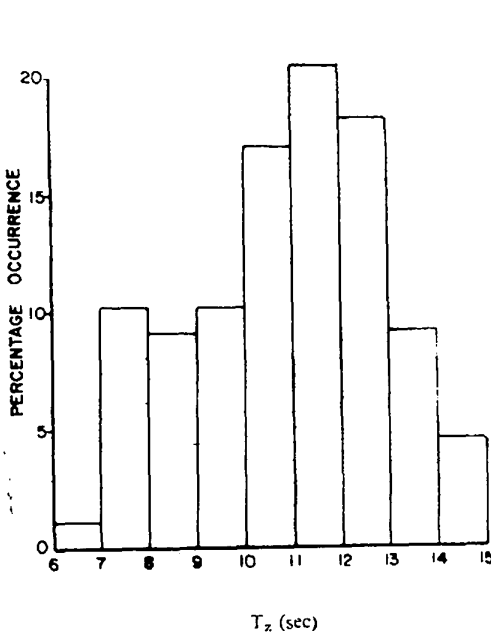


Fig. 3. Percentage occurrence of zero-crossing period (T_z).

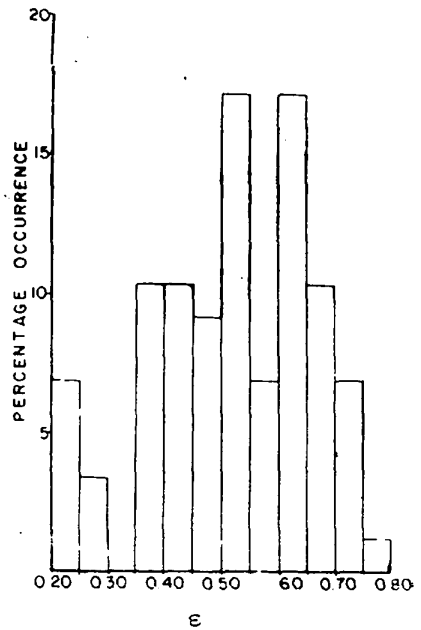


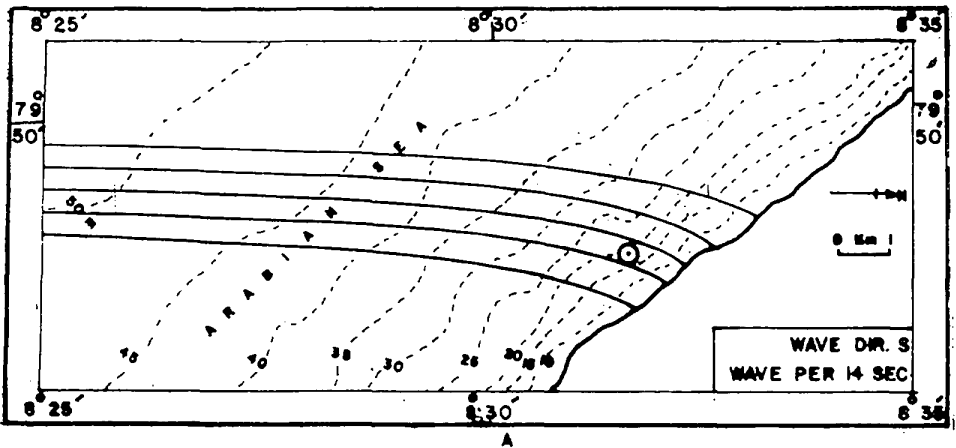
Fig. 4. Distribution of spectral width parameter (ϵ)

November, the direction is SSE with 10 percent constancy; and from December to March it is NE with the percentage constancy ranging between 21 and 70.

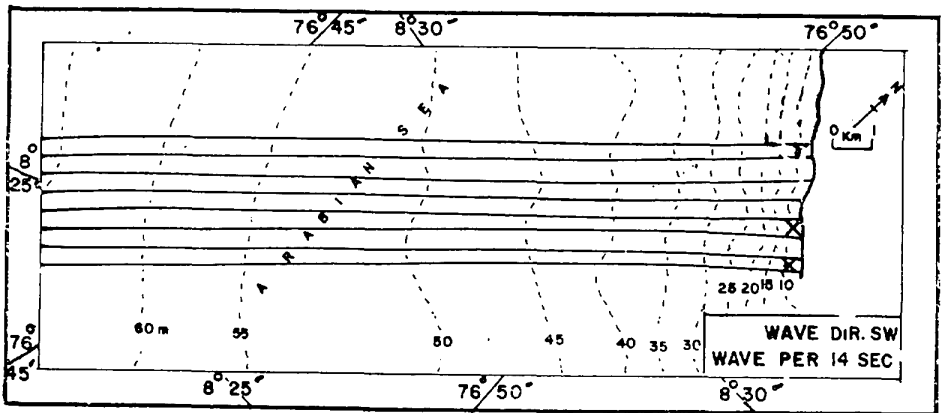
Table 1. Computed resultant wave direction off Trivandrum (Lat. 5°-10°N, Long. 75°-80°E)

Month	Resultant wave direction (deg.)*	Percentage constancy	Month	Resultant wave direction (deg.)*	Percentage constancy
January	061	70	July	260	78
February	016	36	August	246	38
March	030	21	September	252	78
April	222	42	October	231	65
May	250	73	November	150	10
June	256	77	December	051	44

*w.r.t. True North (000°).



A



B

The average values of the height of ten breakers and the angles subtended by the breaker lines with the coastline in the anticlockwise direction were visually estimated at the beach under study in conjunction with the wave recording. These are tabulated in Table II. The maximum breaker height of 2.5 m and the minimum breaker height of 0.5 m were observed in August (1976) and February (1977) respectively. Most of the breaker heights observed were between 1 and 2 m. The breaker periods generally varied between 8 and 15 sec, the predominant period being 10-15 sec.

The direction of the littoral transport largely depends on the breaker angle. The breaker angles were generally 5° - 10° from October to May. But in August and September the angles were around 170° suggesting a reversal in the probable direction of the associated littoral transport. In June and July, the waves were observed to break at extreme angles (5° - 10° and 160° - 170°). The predominant angle, however, was 160° - 170° .

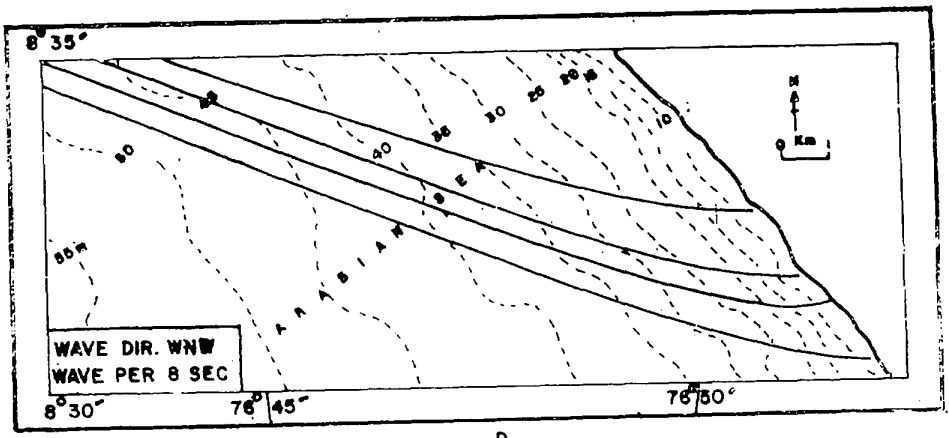
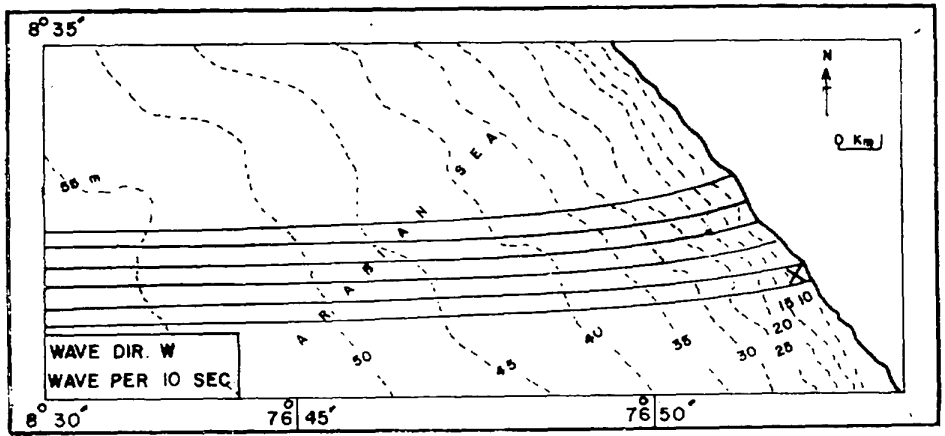


Fig. 5. (A-D). Typical refraction diagrams obtained at Trivandrum. The site where OSPOS wave recorder was installed is shown by open circle in 5A.

The wave-refraction diagrams (Fig. 5 A-D) showed that wave-energy concentration would occur at the Trivandrum beach for waves approaching from deep water directions of south-west and west (See X in Fig. 5B & C).

The results of the wave studies bring to light the following environmental characteristics in relation to the stability of this coastal region. During monsoon season, waves of higher period (10-13 sec) with H_s above 1 m occur along the coast. The resultant directions of approach of the waves during May to July vary between 250° and 260° with a high percentage constancy (75%). For these directions of approach and periods, the longshore transport of sediment in the surf zone should be towards

Table II. Breaker characteristics along Trivandrum beach based on visual observations.

Month	Observed breaker characteristics (Average)		
	Height (m)	Period (sec)	Angle* (deg)
April 1976	1.5	11-15	5-10
May	1-2	10-12	5-10
June	1.5-2	10-13	Variable
July	1-2	8-15	Variable
August	2-2.5	10-11	170
September	1-2	8-10	160
October	1	—	5-10
November	0.5-1	8-10	Variable
December	1-1.5	10-12	5-10
January 1977	1-2	10-13	5-10
February	0.5	3-5	5-10
March	1-1.5	10-12	5-10

*Measured anticlockwise with reference to the coastline.

southeast leading to localised erosion along this sector of the beach. During the fair weather months, the low and long period waves would help in building up the beach. It may be pertinent to note that these results were successfully utilized in designing remedial measures to check erosion of this particular beach.

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