

A Study on the Accuracy of different Wave Forecasting Techniques with reference to the Recorded Waves off Cochin

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ABSTRACT

A comparative study of the three wave forecasting techniques for the deep water off Cochin, India, has been made. After correcting the hindcast values for shallow water effects, the data has been compared with the values obtained from a pressure type wave recorder.

For deep water, the hindcast values of the wave heights obtained by Darbyshire's method are found to be low compared to those by the techniques of Wilson and Pierson-Neumann-James. The hindcast values of significant periods for all the three techniques are, in general, within $\pm 30\%$ error.

For shallow water, the Wilson's technique gives closer values to the recorded values than the other two techniques. The hindcast values of significant periods for all the three techniques are lower than the recorded values: however, Wilson's and Darbyshire's techniques show a better correlation with the recorded values.

INTRODUCTION

The knowledge of wave forecasting is becoming more and more important due to its numerous applications in naval operations, rescue operations, coastal engineering, erosion problems and so on. At present our understanding of the generation and decay of wind waves is not perfect; hence the wave forecast obtained for an area using different wave forecasting techniques may differ from one another. The purpose of this study is to find out which forecasting technique is best suited for the area under study. The three wave forecasting techniques made use of in the present study are Wilson's (Wilson, 1955), Peirson-Neumann-James' (Peirson *et al.*, 1955) and Darbyshire's (Darbyshire, 1952).

COLLECTION AND ANALYSIS OF THE DATA

(a) Wave recording:

A pneumatic pressure type wave recorder was installed at a depth of about 2.5m. at the site shown in Fig. 1. The instrument automatically switches on every hour and records waves for 27 minutes. In the present set up, waves of more than 2 metres height will generally not be recorded, because the waves break at a depth of about 1.3 times the height of the wave. A sample record of 15 minutes duration giving the toughest sea condition was chosen from each 27 minutes record and was processed for computing height (significant, average and highest 10%) and significant period (Srivastava and Vijayarajan, 1967).

(b) Wave windcasting:

Starting from the wave recorder site, three radial lines, each representing about 600 nautical miles in length were drawn on the India Meteorological Department's isobaric charts for the period for which the wave records were available (June 3rd to June 24th, 1966). The central line was chosen in the direction of the most predominant wind, while the other two were drawn at an angle of 30° to this line on either side. Geostrophic wind was determined from the nomogram prepared for this purpose (Srivastava, *et al.*, 1968) for points marked every 60 nautical miles along the radial lines taking the wave recorder site as zero. Surface wind for each point was determined by correcting the geostrophic wind for friction and curvature by using the curves presented in U.S. Army Coastal Engineering Research technical memos (1954). The surface wind so calculated will be at an angle of about 15° to the isobars. The component of the corrected surface wind along the radial lines were determined for each 60 nautical miles. The surface wind velocities thus obtained were plotted on a time versus distance graph (wind field diagram) and contoured for 5 nautical miles interval. While contouring, the ship reported data wherever available was also considered.

The Ht - F - T diagram of Wilson was used to get the significant height, significant period and the time of occurrence of the highest wave by choosing various generating points in the wind field diagram. The effect of decay of the waves while travelling from the generating area to the shallow waters was determined by using Sverdrup-Munk decay curve (1951).

The values of wind speed, duration and fetch for determining the significant height and significant period by using the co-cumulative spectral curves of Pierson-Neumann-James were taken from the wind field diagram. The wave data so obtained was also corrected for decay as mentioned above.

For getting the significant wave height and period using the forecasting curves of Mollie Darbyshire and Draper (1963), the same values of fetch and duration as used for P-N-J method were used. The values were corrected for decay. The times of occurrence of the maximum heights in P-N-J and Darbyshire methods were determined from the wind field diagram.

Refraction diagrams were drawn for different periods and directions using the technique of Arthur *et al.*, (1952). The refraction function, $K(f, \theta)$ for three directions and 12 different periods are presented in table I. The deep water wave characteristics obtained by the three forecasting techniques were corrected for shoaling and refraction using table I. Some of the deep water waves will be breaking before reaching the point of installation of the wave recorder. These waves were eliminated after finding out the depth of breaking of the hindcast waves following the method given in U.S. Navy Hydrographic office Pub. No. 234 (1944).

A few sample records were analysed to determine whether the waves recorded at the site are predominantly waves generated in shallow water or the decayed waves from deep water. It was observed in the record that the low period waves were negligible. Hence, it can be assumed that the waves recorded by the wave recorder are predominantly those that have been generated in deep water. The deep and shallow water wave hindcasts obtained by using various techniques were plotted on graphs. Fig. 2 gives a comparison of different wave forecasting techniques in deep water, while Fig. 3 gives a comparison of various wave forecasting techniques with the recorded values in shallow water.

RESULTS AND DISCUSSIONS

From Fig. 2 and 3, the values of significant wave heights and periods were determined for every two hours from all the curves. Graphs were prepared using these

values, depicting the variations of significant wave heights and periods (Fig. 4 to 11). The dotted lines on the graphs are the $\pm 20\%$ and $\pm 30\%$ error lines. From Fig. 4, it can be seen that Wilson's technique, in general, gives higher values for significant height while Darbyshire's gives lower values. The deep water significant period hindcast for all the three techniques are in general, within $\pm 30\%$ error line (Fig. 5).

The reason for Darbyshire's technique giving lower values for significant height can be that, this technique considers a fetch of 100 nautical miles sufficient to generate a fully developed sea for a wide range of wind speeds, while Wilson's and P-N-J's techniques require higher fetches and durations for higher wind speeds. Therefore, Darbyshire's values of the hindcast significant heights are liable to be low for high wind velocities and durations. At lower wind velocities, the deviations in the hindcast significant heights are generally less.

Figs. 6, 7 and 8 give a comparison of the recorded significant wave heights with Wilson's, P-N-J's and Darbyshire's hindcast values in shallow water. Wilson's technique gives closer values to the recorded values than the other two techniques. Darbyshire's values are in general lower than the recorded values.

Figs. 9, 10 and 11 give a comparison of the recorded values of the significant wave periods with the hindcast values obtained by the three techniques. In all the three cases, the hindcast values are lower than the recorded values and out of the three methods, Darbyshire's and Wilson's show a better correlation with the recorded values (around 30%). No reason can be assigned for this discrepancy at present. However, the wave periods in deep water are generally much lower than that of the breakers on the coasts because of the complex nature of the generating area and the sorting effect at the coasts.

CONCLUSIONS

Wilson's forecasting technique gives a better correlation for the hindcast significant wave height with the recorded values than the other two techniques, in shallow water. To get a better correlation for the significant period with the recorded period using Wilson's and Darbyshire's techniques, it is suggested that the hindcast values of the significant period may be increased by about 30%.

ACKNOWLEDGEMENT

The authors are highly grateful to Shri M.S. Narayanan, Director, Naval, Physical and Oceanographic Laboratory, Cochin and Dr. N.K. Panikkar, Director, National Institute of Oceanography, Goa, for their keen interest in this work.

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TABLE I

Values of $K(f, \theta)$ for Different Periods and Directions off the Wave Recorder site, Cochin

Period.	Deep Water wave direction.		
	240	270	300
3	0.91	0.85	0.91
4	0.93	0.85	0.85
5	1.04	0.61	0.85
6	1.14	0.73	0.69
7	1.26	1.09	0.96
8	1.33	0.75	0.94
9	1.27	0.90	1.16
10	0.78	1.42	1.15
11		1.17	1.14
12		0.76	0.78
13		1.09	0.85
14			1.10