551.466.3:551.553.21(267)

WAVE GENERATION DUE TO MONSOON WINDS IN ARABIAN SEA

With increased off-shore and marine activities in the recent past, the study of ocean waves has assumed importance in India. The main source of high waves in tropical seas is the cyclone. Very strong winds, turbulent in nature, are seen in the storm field. But Indian seas get a steady wind field during monsoons. Even without any cyclone, strong winds are prevalent over Arabian Sea during the period of vigorous monsoon.

Mukherjee and Sivaramakrishnan (1981, 1982a) have studied the wave generation from the storm field over Arabian Sea and the decay of the waves while travelling towards coast. Recently (Mukherjee and Sivaramakrishnan 1982b) the general pattern and behaviour of waves over Arabian Sea during monsoon have been established. However, a quantitative estimate of maximum wave height due to monsoon winds will be of great use to operational meteorologists. Using the wave observations collected during monsoon experiments of 1977 and 1979, an attempt towards this direction was made and the results are presented here.

Regarding steadiness of direction, in this study, so long as the direction has not changed by more than $\pm 22\frac{1}{2}$ degrees in successive observations, the direction of the wave was taken as the same and only such observations were taken into consideration. This has

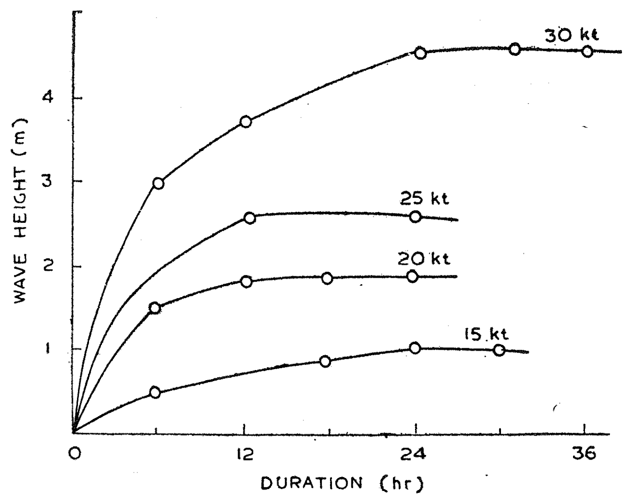

Fig. 1. Heights attained by waves due to wind of given speed acting for different durations

resulted in the number of observations that can be considered for the work to about 80 though actual observations were more. No variation of wave parameters was assumed within 2 degrees square of the ocean area. Infinite fetch was assumed tacitly. The maximum period of waves observed was 12 sec. Hence the maximum wave length encountered is about 223 m ($L = 1.55\,t^2$). Since all observations were from the high seas, the waves are essentially deep water waves.

Fig. 1 gives the graph between the observed wave height and duration of wind for different wind speeds. Wave height is in metres and duration is in hours. It can be seen that a 24-hour period is sufficient for attaining the maximum height of wave corresponding to any wind speed upto 30 kt. The curves suggest a relation of the type, wave height, $H = A \times D^B$ where D is the duration and A and B are constants. Though it takes 24 hours to reach the maximum wave height in case of 15 and 30 kt windspeeds, the maximum waveheight is reached within about 12 hours at 20 and 25 kt speeds which cannot be understood. Since 12 hours is the minimum advance notice required for a wave forecast to originate operationally, no formula connecting H and D was tried for these two windspeeds. However the empirical relations arrived at for 15 and 30 kt speeds are :

$H = 0{\cdot}4 \times D^{0{\cdot}3}$ (valid for 15 kt speed)

$H = 1{\cdot}8 \times D^{0{\cdot}3}$ (valid for 30 kt speed)

where, H is in metres and D is in hours.

TABLE 1

Wave height as per different methods

Wind speed (kt)	Wave height in m for different wind speeds as per			
	This work	Neumann	Groen & Dorrestein	SMB method
15	1.0	0.8	1.3	1.5
20	1.75	1.5	2.4	2.3
25	2.5	2.3	3.5	3.3
30	4.5	4.0	4.8	5.1

The maximum wave heights that are reached at various windspeeds upto 30 kt as taken from Fig. 1 are shown in column 2 of Table 1. Neumann (1953) has conceived the idea of most energetic waves and has calculated the most probable height corresponding to each wind velocity. The earlier methods to compute ocean wave parameters first worked out by Suthens (1945) and by Sverdrup and Munk (1947) were later improved by others (Bretschneider 1957). Groen and Dorrestein (1958) developed a diagram in 1953 and this was revised in 1975 in the light of results of the JONSWAP experiment of 1973 (WMO 1976). Wave heights reached in 24 hours according to Neumann and Groen and Dorrestein are tabulated in columns 3 and 4 of Table 1. Also given in column 5 are the values obtained from SMB method.

It is seen that the difference between the values for the waveheights arrived at by the earlier methods and this work is within ± 1 metre only. While Neumann's method gives a lower estimate, the other two computations give a higher estimate.

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10 December 1982