WAVE CLIMATE STUDIES OFF DAMAN ON THE WEST COAST OF INDIA

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ABSTRACT

A Dutch wave-rider buoy was deployed in the coastal waters off Daman at about 27 m water depth and waves were recorded for 20 minutes at every 3 hours from 14 May 1982 to 26 November 1982. The measurement also includes the waves occurring during a cyclonic storm passing off this region in 6 - 10 November 1982. The analog data recorded on chart paper were analysed using Tucker's Method. From the study, it is found that the southwest monsoon waves during June to August were high and steeper than those occurring during the fair weather season. Distribution of various wave parameters such as time history and cumulative distributions of significant wave height (H_S), maximum wave height (H_{max}), zero-up crossing wave period(T_Z) and wave period corresponding to maximum wave height($T_{H_{max}}$) and joint distribution of $H_S$and T_Z are presented and discussed.

INTRODUCTION

The offshore region off Daman in South Gujarat is of particular importance owing to the extension of offshore oil and gas production activities in the west coast as well as the location of the proposed submarine gas pipeline leading to Umbrat on the northern coast of Gujarat. The coast in this region is low-lying, fringed with bushes and sandy pocket beaches with intermittent rocky outcrops (West Coast of India Pilot, 1961). The nearshore off Daman is very shallow with an average slope of 1 : 1000 upto 30 m water depth. Beyond this depth it attains still flatter slope as a result of shoals, spits and banks present at the entrance of the Gulf of Cambay. The sea bed in the nearshore region mostly consists of clay and silt. The tides at Daman are semidiurnal with spring tide having a range of about 5.5 m and neap tide about 2.5 m (Indian Tide Table, 1982). The tide-dominant currents measured in the area varied from 0.50 to 1.75 m/sec. The winds have seasonal characteristics with strong monsoon wind blowing from west to southwest during May to August. The study of the wave climate in this region is of paramount importance for the offshore development. This paper presents some important results of wave data analysis carried out based on wave rider

data of a limited period.

METHOD OF STUDY

A Datawell waverider buoy was deployed at 27 m depth measured at high tide at the location shown in Fig. 1. The waves were recorded in analog form on chart paper roll and also in digitized form for every 0.5 sec on a magnetic tape cassette. The recording was done for 20 min. duration for every 3 hour intervals from 14 May 1982 to 26 November 1982 covering the entire southwest monsoon season and beyond.

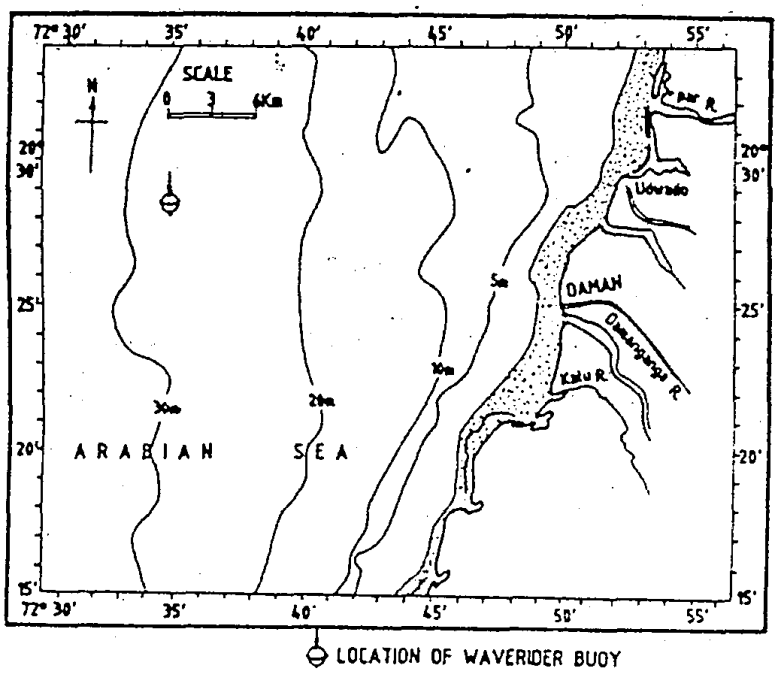

Fig. 1 Location map

The analog records were analysed using the following equations (Tucker 1963) in order to compute the significant wave height (H_S) and zero-up crossing period (T_Z).

$$\frac{H_1}{\sqrt{m_o}} = 2\,(2\ln N_z)^{\frac{1}{2}}\left(1 + \frac{0.289}{\ln N_z} - \frac{0.247}{(\ln N_z)^2}\right) \quad \ldots\ldots\ 1$$

$$\frac{H_2}{\sqrt{m_o}} = 2\,(2\ln N_z)^{\frac{1}{2}}\left(1 - \frac{0.211}{\ln N_z} - \frac{0.103}{(\ln N_z)^2}\right) \quad \ldots\ldots\ 2$$

The highest m_o obtained from equations 1 and 2 above is used to compute H_s

$$H_s = 4\sqrt{m_o}$$

$$H_1 = A + C$$

$$H_2 = B + D$$

$$T_z = \frac{1200}{N_z}$$

where A = The height of highest crest from MWL.
B = The height of second highest crest from MWL.
C = The depth of deepest trough from MWL.
D = The depth of second deepest trough from MWL.
N_z = Number of zero up-crossing waves.
m_o = Root mean square of the water surface elevation.

RESULTS AND DISCUSSIONS

Distribution of wave heights:

Variations in the daily maximum significant wave height (H_s) and maximum wave height (H_{max}) during the study period are shown in Fig. 2.

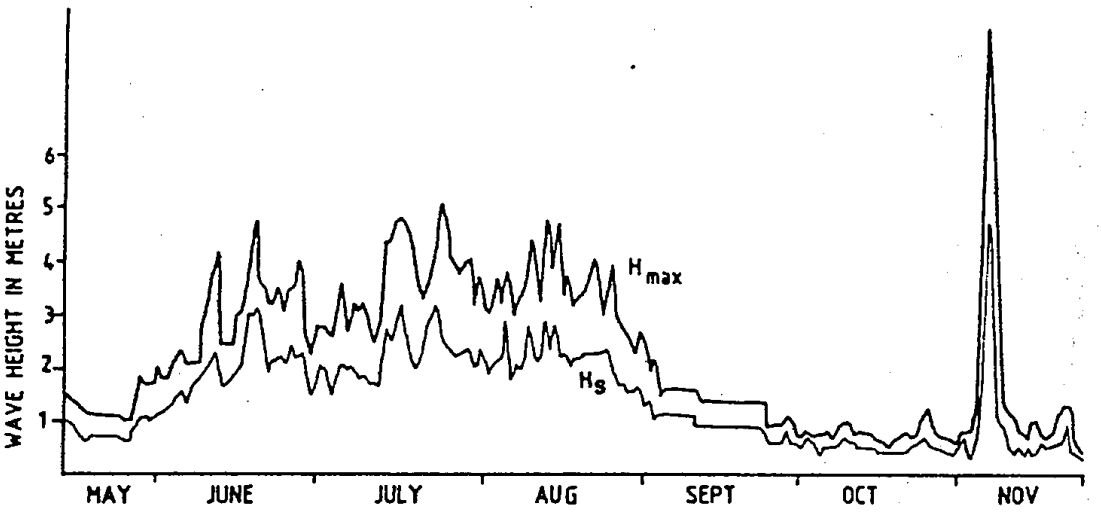

Fig. 2 Daily variation of H_s and H_{max}

The daily maximum significant wave height (H_s) varied from 0.62 m to 1.13 m in May, 1.13 m to 3.08 m during June, 1.61 m to 3.22 m during July, 1.62 m to 2.99 m in August, 0.56 m to 1.45 m September, 0.37 m to 0.74 m in October and 0.25 m to 0.88 m in November other than cyclonic days.

During the cyclonic period of 6 - 10 November 82, it varied from 1.00 m to 5.97 m.

Similarly, the daily maximum wave height H_{max} varied between 1.00 m and 1.80 m in May, 1.85 m and 5.13 m in June, 2.50 m and 5.15 m in July, 2.35 m and 4.80 m in August, 0.72 m and 2.20 m in September, 0.55 m and 1.25 m in October and 0.35 m and 1.30 m in November for period other than the cyclonic days. During the cyclonic days it varied between 1.5 m and 8.40 m.

In general, the waves were high during June, July and August than other period as can be expected due to the monsoon effects. Except for the cyclonic period of November 82, the highest significant wave height of 3.22 m occurred in July with the corresponding highest maximum wave height being 5.15 m. The highest significant wave and maximum wave of heights 5.97 m and 8.40 m respectively occurred during the cyclonic days in November 82.

Distribution of wave period:

The daily variation of zero-up-crossing period (T_z) corresponding to the maximum significant wave of each day is shown in Fig. 3.

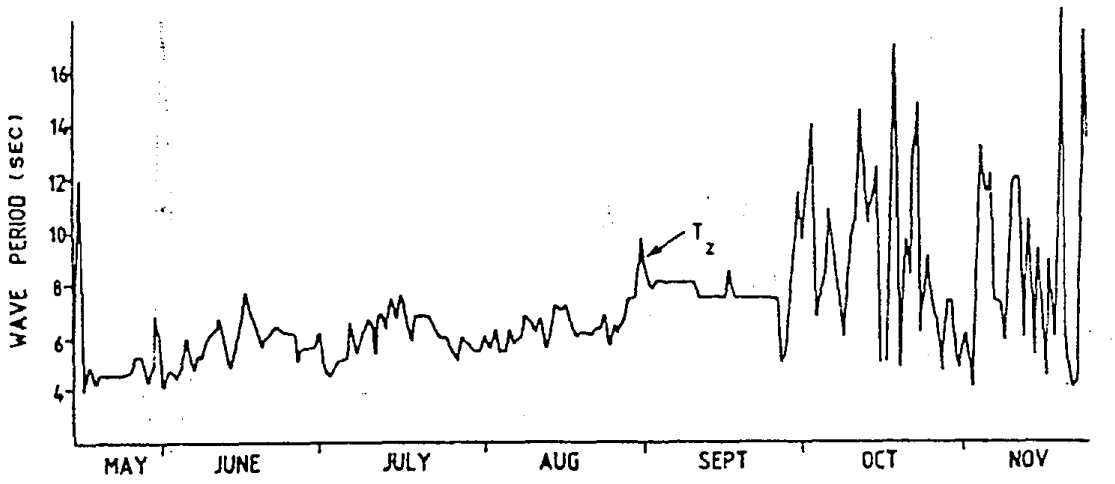

Fig. 3 Daily variation of T_z

It varied from 4.1 sec to 11.9 sec in May, 4.4 sec to 7.5 sec in June, 4.6 sec to 7.7 sec in July, 5.5 sec to 7.5 sec in August, 4.9 sec to 9.5 sec in September, 4.8 sec to 16.7 sec in October and 4.0 sec to 18.2 sec in November.

The daily variation of wave period corresponding to the maximum

wave height (T_{Hmax}) of each day is shown in Fig. 4. It varied from 3 to 11 sec in May, 5 to 10 sec in June and July, 6 to 10 sec in August and September, 3 to 16 sec in October and 3 to 14 sec in November.

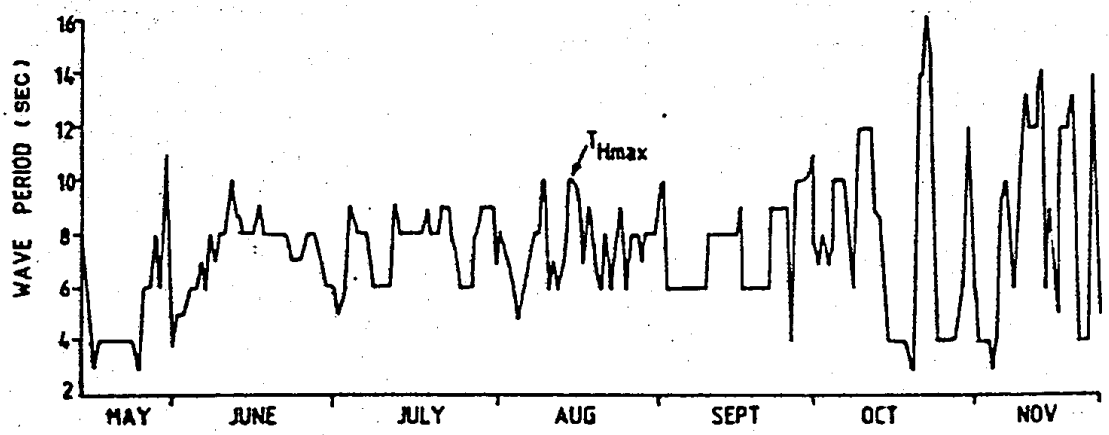

Fig. 4 Daily variation of T_{Hmax}

Joint distribution of H_S and T_Z:

Joint distribution of significant wave height and zero up-crossing period for the southwest monsoon period (May-Sept) and for the remaining period (Oct-Nov) are shown in Fig. 5. During May to September, the

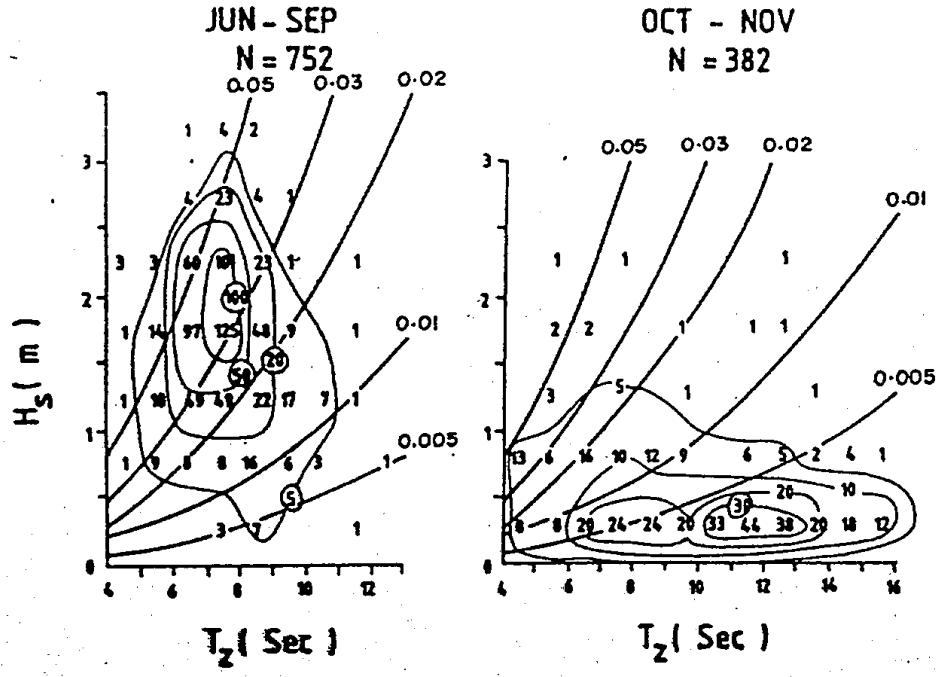

Fig. 5 Joint distribution of H_S and T_Z

waves were found to be steeper, mostly distributed with the steepness parameter H_s/T_z^2 lying between 0.02 to 0.5. In November and December, they were observed to be comparatively flatter having distributed around the wave steepness parameter H_s/T_z^2) of 0.002.

Cumulative distribution of H_s and H_{max}

The percentage exceedence of significant wave height and the maximum wave height observed during the study period are shown in Fig. 6.

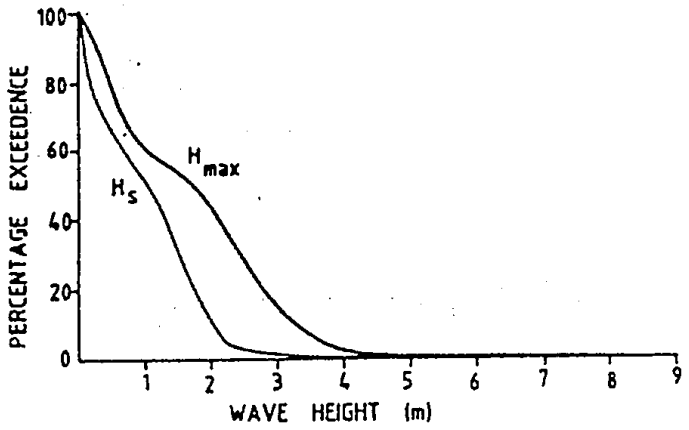

Fig. 6 Cumulative distribution of H_s and H_{max}

The significant wave height exceeded 2 m for 4% of the time, 1.5 m for 20% of the time, 1.0 m for 44% of the time and 0.5 m for 58% of the time. The maximum wave height exceeded 3 m for 10% of the time, 2 m for 37% of the time, 1 m for 50% of the time and 0.5 m for 65% of the time.

CONCLUSION

The wave climate off Daman is dominated by southwest monsoon giving rise to high waves associated with short periods during June to August. During the remaining period, other than cyclonic days, the waves were comparatively small with longer periods. The study area is prone to frequent occurrence of cyclone during which the wave height could increase enormously as was observed during the November 1982 cyclone giving a maximum wave height of 8.4 m. Collection of additional wave data during the cyclones can give very useful information on extreme wave conditions to evaluate realistic design wave parameters for ocean engineering applications.

ACKNOWLEDGEMENT

The financial support and encouragement given by the Oil and Natural Gas Commission, Bombay Offshore Project for undertaking the project on wave measurement and analysis are deeply appreciated.

The authors would also like to express their gratitude to Dr. H. N. Siddiquie, Director, N.I.O. for his keen interest and whole-hearted encouragement during the course of this work. The assistance rendered by the Ocean Engineering staff at N.I.O in the project is gratefully acknowledged.

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