Behrang Niroomand
Reza Kamalian
Mohsen Soltanpour
Mohammad Reza Allahyar

Civil Eng. Dept., K. N. Toosi University of Technology, Iran. b.niroomand@pmo.ir
Water Research Institute, Iran. ur.kamalian@wri.ac.ir
Civil Eng. Dept., K. N. Toosi University of Technology, Iran. soltanpour@kntu.ac.ir
Ports and Maritime Organization, Iran. allahyar@pmo.ir

STUDY OF THE WAVE SPECTRA IN THE PERSIAN GULF

Introduction

The Persian Gulf is a nearly 1000 km long water body located in the south of Iran with an average depth of 40 meter and a maximum depth of 170 m at its entrance, the Strait of Hormuz. The prevailing wind blows along the axis of the gulf from NW and is known as the Shamal (Persian Gulf Pilot, 1982). However, Shamal wind direction changes from NW in the northwest corner of the Persian Gulf to WNW around Kish Island and then to W at the entrance to the Strait of Hormuz. The north coastline on the Persian Gulf is also exposed to winds from SE which are strong but not as frequent as Shamal winds (Baird and Associate, 2010).

Although the general circulation and currents of the Persian Gulf have been studied in the past, literature shows few researches on its wave characteristics. Analyzing six-months data of two offshore wave stations located in the middle part of the Persian Gulf, Mazaheri and Ghaderi (2011) examined the accuracy of different wave spectra. They concluded that none of the known wave spectra can fully represent their studied area although JONSWAP spectrum can be better fitted to the data.

Field Measurements

Starting from 2005, the Iranian Ports and Maritime Organization (PMO) defined a series of projects called “Monitoring and Modeling Studies” along Iranian Coastlines. The phases 2, 3 and 4 of this undergoing project were conducted along the north coastline of the Persian Gulf and Strait of Hormuz. As a major part of these studies, comprehensive one-year field measurements including continuous data of currents, offshore and nearshore waves at different locations were recorded. Figure 1 shows the study area and the locations of deployed instruments.

Four Nortek instrument AWACs, namely Khark, Taheri, Lavan and Faror, all deployed at 25 m water depths were chosen among wave stations to represent the variety of wave characteristics at the north, center and east parts of the Persian Gulf (Figure 1). The selected stations are not affected by islands or other geomorphological features and there are no fetch limitations through major wind directions.

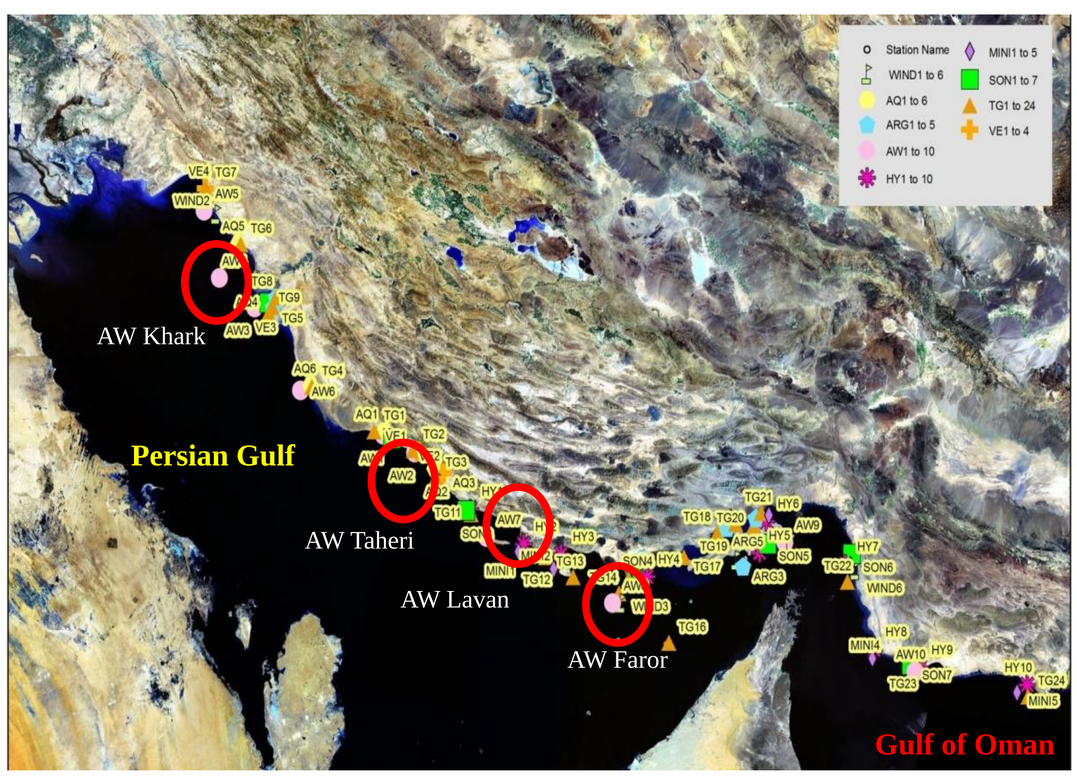

Figure 1. Study area and deployed instruments at monitoring project (phases 2, 3 and 4)

Data Analysis and Discussion

One-year data of four stations were carefully examined to observe the storm events, storm directions and frequency of occurrences. Study of storm events reveals that the most severe storms with longer durations are due to Shamal winds. The wave heights of the storms due to south winds are smaller with less duration, compared to Shamal winds. Interesting cases were also observed where a south wind storm was changing its direction towards Shamal and develops further. There were also cases where two storms from Shamal and south winds occurred at the same time. No severe storm was observed from SE winds, namely Kaus/Cowshee, during one-year measurements.

Comparisons with different wave spectra show that JONSWAP is the only wave spectrum relatively applicable to the Persian Gulf. It was also observed that the fitting accuracy increases if the storms due to Shamal winds and south wind are separated. A new wave spectrum is suggested as:

$$S(f) = AH_s^2 \frac{f_p^4}{f^5} e^{B(f_p/f)^4} \gamma^{e^{-\left[\frac{(f-f_p)^2}{2\sigma^2 f_p^2}\right]}} \qquad \sigma = \begin{cases} \sigma_1 & f < f_p \\ \sigma_2 & f \geq f_p \end{cases} \qquad (1)$$

where parameters A, B, σ_1, σ_2 and γ are defined in table 1.

Table 1. Parameters of the Persian Gulf wave spectrum

Wind/Location	A	B	σ_1	σ_2	γ
Shamal wind at North part of the Persian Gulf	0.19	-1.32	0.19	0.08	3.3
Shamal wind at Middle and East part of the Persian Gulf	0.25				1.8
South wind at North part of the Persian Gulf	0.20	-1.23	0.12	0.12	2.6
South wind at Middle and East part of the Persian Gulf		-1.48			3.8

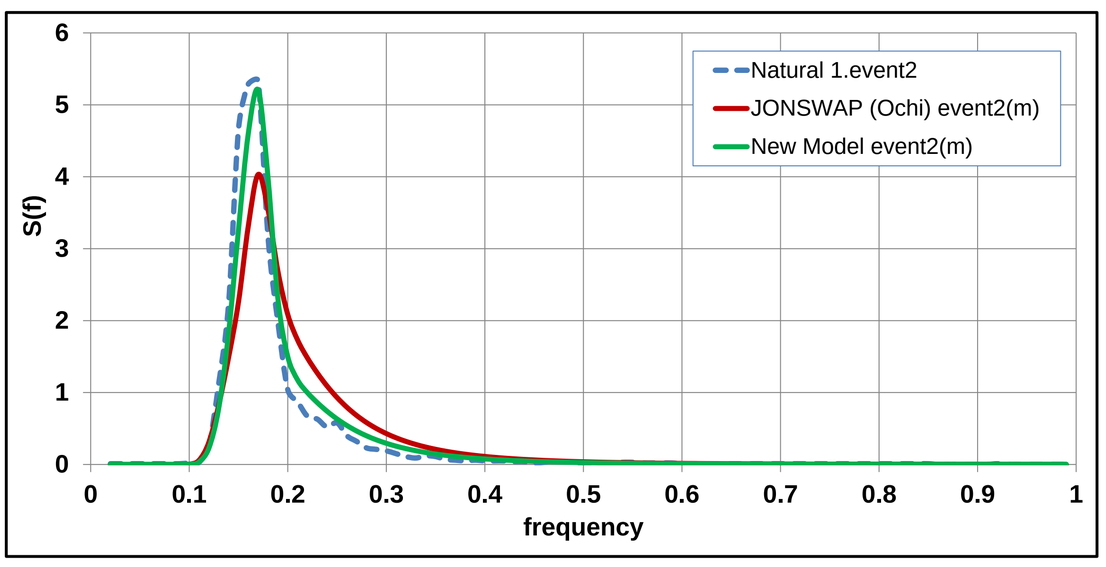

Figure 2. Difference between JONSWAP, new model(PG) and data measurements in the one of the storms in Persian Gulf (Hs=2.26m Tp=5.88s).

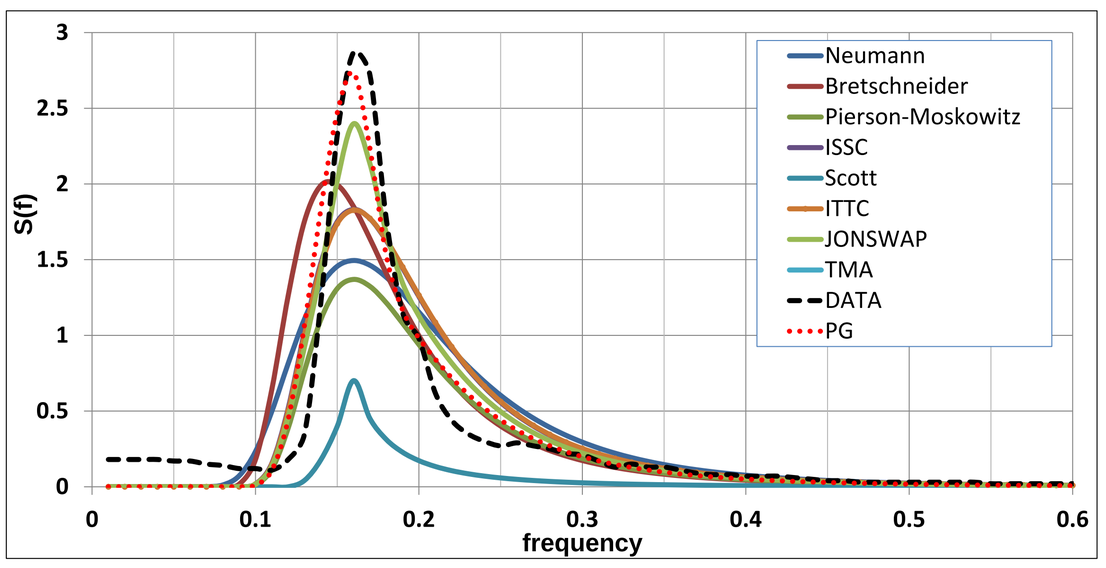

Figure 3. Difference between JONSWAP, new model(PG), other known models and data measurements in the one of the storms (Hs=1.8m Tp=6.25s).

Summary and Conclusion

The present study offers some findings of the analysis of the extensive field data along north part of the Persian Gulf and the Strait of Hormuz. Storms in the Persian Gulf show very complex patterns under the effects of Shamal, south and Kaus winds. Wave spectra of selected stations were extracted and examined to find a proper offshore wave spectrum for the Persian Gulf. The newly proposed wave spectrum shows a better agreement with data compared to the known wave spectra.

References

Baird and Associates, 2010. Development of a Wave Climate for the Persian Gulf and the Strait of Hormuz, Port and Maritime Organization (PMO), 114 p.

United States Hydrographic Office, 1982. Persian Gulf Pilot: Comprising the Persian Gulf, the Gulf of Omán and the Makrán Coast. U.S. Government Printing Office, 333 P.

Mazaheri S., Ghaderi Z., 2011. Shallow water wave characteristics in Persian Gulf, Journal of Coastal Research, Special Issue No. 64, pp. 572-575.