Shoushtarizadeh, A.; Allahyar, M.; Kebriaee, A.; Tajalibakhsh, T.

Analytical Comparison Among Oceanographic Instruments Operations

Proceedings of ninth International Conference on Hydro-Science and Engineering (ICHE 2010), IIT Madras, Chennai, India.
2 - 5 August 2010

Analytical Comparison among Oceanographic Instruments operations

A. Shoushtarizadeh [1], M. Allahyar [2], A. Kebriaee [3] and T. Tajalibakhsh [4]

Abstract: *The waves' effects on coastal and marine activities caused to pay attention to understanding the wave parameters by field measurements, theoretical analysis, physical and numerical modeling. In this regard, field measurements are preferred to other methods due to their precision; thus, these measured data are used for verification of other data and calibration of numerical models*
Nowadays, there are different types of instruments to measure wave parameters which record data via different mechanisms like wave buoys, ADCPs and radars. Considering the wide variety of devices and different mechanisms of measurements, it is necessary to recognize the most appropriate mechanism and instrument regarding its accuracy. One of the appropriate and desirable methods is the crosschecked.
The field measurements in the Modeling and Monitoring Studies of Iranian Coasts project in Chabahar bay which is located in the northern coast of Oman sea were recorded for duration in the same region and at the depth of approximately 25 meters by using four different instruments with three measurement mechanisms (discus buoy, spherical buoy, and Acoustic Wave And Current profiler). As Chabahar is located in a specific climate situation where confronts extreme and severe phenomena such as Monsoon, strong winds, swell waves and … gathered data are so important and comparison among them give us useful information on the technical procedure of the system.
On the contrary of our expectation, the wave height has recorded by under water sensor (AWAC) type has been higher than other simultaneous measurements. In this respect, floating Buoys have the best performance

Keywords: *field measurement; wave buoy; underwater sensor; correlation coefficient.*

INTRODUCTION

Waves - disturbances of water - are constant random phenomena in the world's seas and oceans. Because waves travel all across the globe, transmitting vast amounts of energy, understanding their motions and characteristics is essential. The forces generated by waves are the main factor impacting the geometry of beaches, the transport of sand and other sediments in the near shore region, and the stresses and strains on coastal structures. When waves are large, they can also pose a significant threat to marine transportations, recreational boaters, and the beach going public, Thus for ensuring sound coastal planning and public safety, wave measurement and analysis is of great importance.

1 Senior Expert of Coastal Engineering, ports and Maritime Organization of IRAN, Tehran, Iran, E-mail: shoshtarizadeh@pmo.ir
2 Head of Coastal Engineering Dept. , ports and Maritime Organization of IRAN ,Tehran, Iran, E-mail: allahyar@pmo.ir
3 General Directorate of Coasts and Ports Engineering Dept., ports and Maritime Organization of IRAN Tehran, Iran, E-mail: kebriaee@pmo.ir
4 Senior Expert of Coastal Engineering, ports and Maritime Organization of IRAN, Tehran, Iran, E-mail: tajalibakhsh@pmo.ir

Regarding the importance of investigating marine parameters and environment, waves have been recorded by different methods from past: approximate measurements of waves by ships and sailors, or by underwater sensors and wave buoys. Nowadays, the wave characteristics measurements not only provide the needed real time data for coastal and ocean activities, but also due to the development of numerical models, form useful databases to predict future events via statistical techniques and numerical models. The measured data are introduced as boundary conditions or are used to calibrate and verify the accuracy and precision of the outputs in numerical modeling.

There are two main approaches for measuring wave parameters directly: the use of underwater sensors and the use of floating buoys.

Instruments and measurement methods

Nowadays, wave parameters in marine environment directly measured by fixed under water sensors or floating Buoys. Floating Buoys could be categorized as discus, spherical, spar and free buoys.

Discus buoys act like a symmetrical object in water. These buoys have been relied on heavily by ocean observers to provide direct data measurements of waves, and also as reliable methods of calibration for other longer range instrumentation. They measure wave directional spectrum properties by integrating heave, pitch and roll measurements. Buoys must adequately track the surface wave motion, and the mooring configuration must permit unimpeded motion whilst at the same time cope with the highest waves expected at a site and surface currents (for example, due to strong wind or wave drift). The diameter of some kinds of discus buoys reach to 12 meters.

Spherical buoy measures vertical acceleration by means of an accelerometer. The accelerometer is mounted on a gravity-stabilized platform that is suspended in a fluid-filled plastic sphere. The sphere is located at the base of the buoy. This data is then processed to give vertical displacement. The buoy measures horizontal acceleration using 2 accelerometers and an onboard compass to give the directional displacement in 2 horizontal axes. With this information, the north-south and east-west directions are calculated.

Unlike introduced buoys above, accelerometer is not used in spar buoys. In this type of buoys, wave height is measured by using scaled stick resistance - capacitor or pressure sensors. Another type of buoy is free buoy which is used in Oceanographic research activities. This buoy has a short life and has no mooring system. These two types of buoys would not be discussed in this article.

Measured data are stored in the Buoys or transmitted simultaneously via VHF or UHF frequency bands to the (fixed or mobile) coastal stations. Maximum Application Domain of buoys is about 50 km from the receiving station.

Underwater (Acoustic Doppler) sensors

Fixed under water sensors measure three different wave quantities that allow us to estimate the wave height and wave period. These quantities are pressure, wave orbital velocity, and surface position. The pressure is measured with a high resolution piezo-resistive element. The orbital

velocity is measured by the Doppler shift along each beam. The surface position is measured with Acoustic Surface Tracking (AST), a special mode where the instrument acts as an inverted echo sounder.
The fact that waves are a random event requires that measurements are made over defined periods of time, or bursts. Typically these bursts are 512, 1024, or 2048 seconds in length and sampled at 1 4Hz.

Iranian measurement network

Concerning the Lack of sufficient marine information for engineers and others related experts; measurement network consisting of 11 wave buoys is suggested as shown in fig1. It is preferred that meteorological parameters are also measured by wave buoys. The proposed network is designed in order to provide complete coverage of information. Expenses have not been considered as effective factors. In case of budget constraints, the number of buoy can be reduced to the number 7 to provide the minimum needed information. In present time, 3 wave Buoy has been installed in the Persian Gulf and Oman Sea in accordance with designed network.

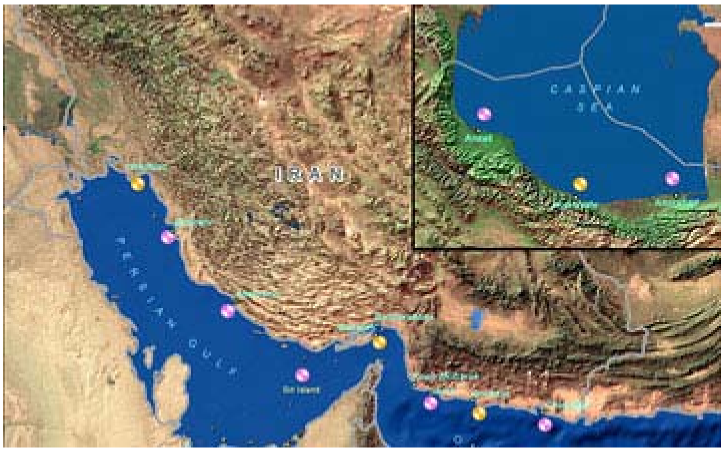

Fig1) suggested buoys network

The study area

The wave parameters are measured simultaneously by various types of instruments located at Northern coast of Oman Sea, close to each other in Chabahar bay. The dominant wave climate is combination of seas and swells. These measurements were some parts of monitoring and modeling studies of Iran coasts project and made the comparison of recorded data and technical performance possible

 underwater sensor (ADCP-AWAC)	 Spherical Buoy(Datawell)	 Discus Buoy(Oceanor)

Fig2) wave measuring instruments in Chabahar Bay

Comparison among recorded data via different instruments

Considering that a comprehensive study about the performance of wave buoys and fixed underwater sensors in marine environment does not exist; comparison of the recorded data by these devices is required. For this purpose, recorded data by discus buoys, spherical buoys and fixed underwater sensors, is analyzed and plotted. These measuring instruments, belonging to Ports and Maritime Organization and Meteorological Organization of Iran, operate at approximately 25 meters depth in Chabahar bay and record data at the same time. The instruments are shown in Fig. 2.

Time series of recorded wave height by discus and spherical buoys and a fixed underwater sensor were plotted as illustrated in Fig. 3 to 5. In these graphs horizontal axes represent time and vertical axes show wave height in meters.

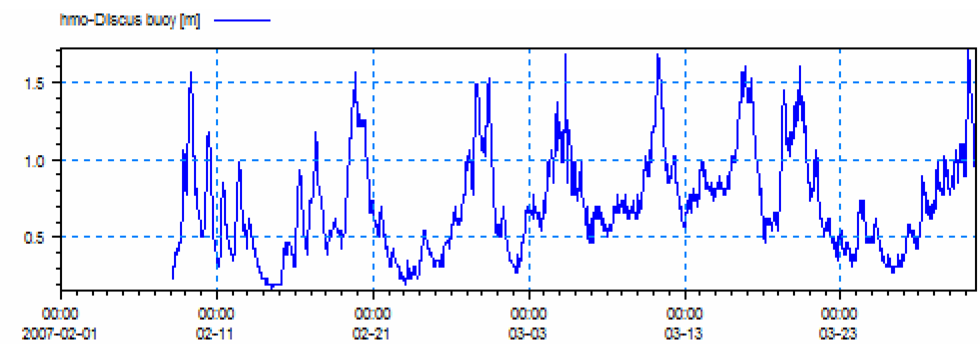

Fig.3. recorded wave height data by discus buoy(Oceanor)

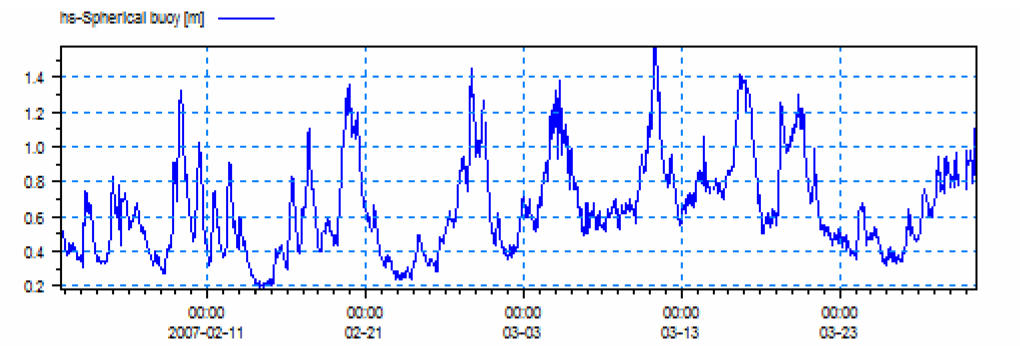

Fig.4. recorded wave height data by spherical buoy(Datawell)

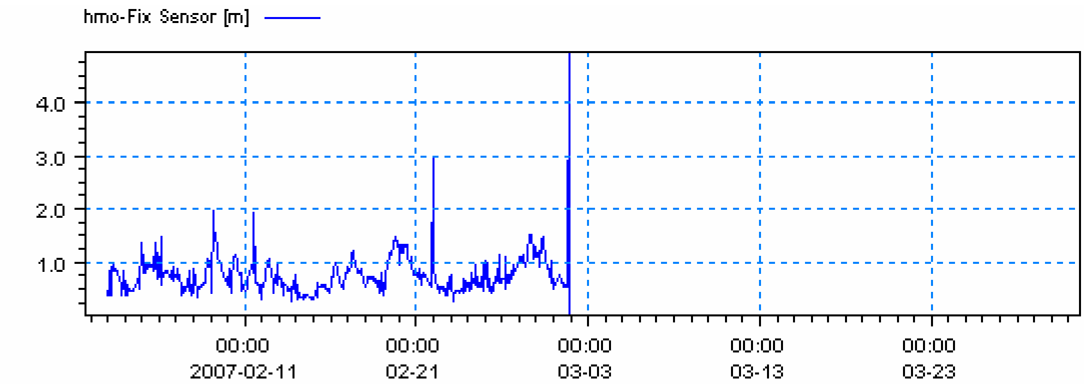

Fig.5. recorded wave height data by underwater Acoustic Doppler sensor (AWAC)

As the above graphs demonstrate just underwater sensors recorded noises in data. Consequently it is necessary to exclude these undesired noises from data in order to compare recorded data from different devices more precisely.

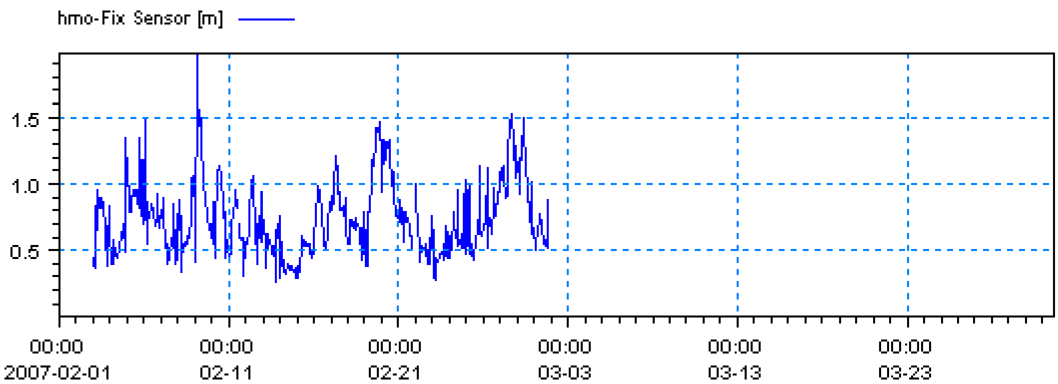

Fig.6.modified wave height data by Acoustic Doppler sensor (AWAC)

Fig .7.displays recorded wave height by different instruments instantaneously. The graph presents that acquisitioned data from different instruments have similar trend.

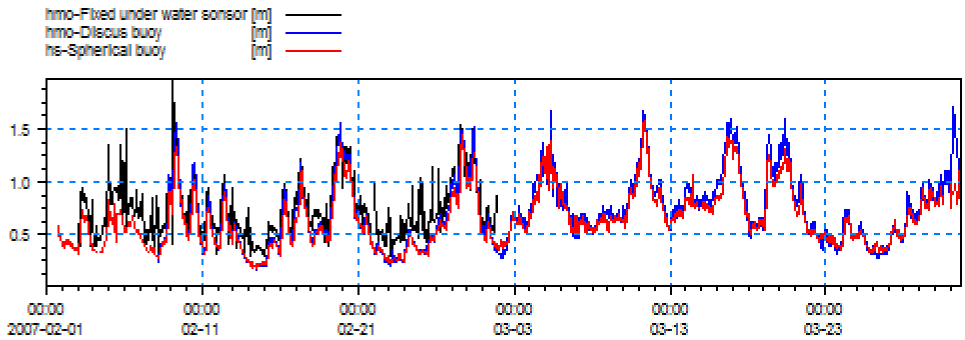

Fig.7. comparison of all acquisitioned data

Statistical properties

Statistical data of wave height recorded by equipment include: minimum, maximum, mean and standard deviation (Table1). There was a 45-cm-difference in maximum wave height. Fixed underwater Sensor recorded the maximum wave height.

Table.1. statistical properties of recorded data

	Min	Max	mean	sd
AWAC	0.0059	1.978	0.7339	0.7339
Discus buoy	0.1562	1.718	0.7184	0.7184
Spherical buoy	0.1813	1.576	0.64754	0.64754

In a closer look to recorded data, it is observed that the measured wave heights by fixed sensor are higher than two other devices' measurements (Discus and spherical buoy). Particularly, a part of recorded data before the noise elimination is shown in Fig.8 which supports this hypothesis. In addition, it is clear that buoys with various functional mechanisms for data acquisition measure the values of wave height close to each other.

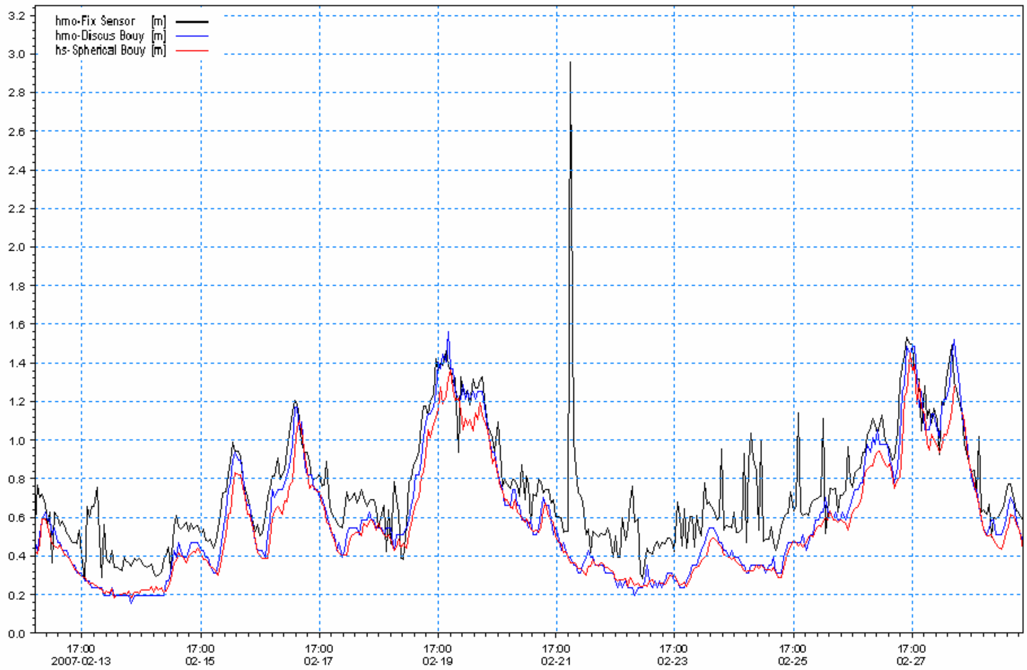

Fig.8. compassion of fixed sensor and floating buoy wave height data

Fig.8. Illustrates correlation coefficients for different instruments. As it shows the correlation coefficients between buoys are greater than the number between buoys-fixed sensor.

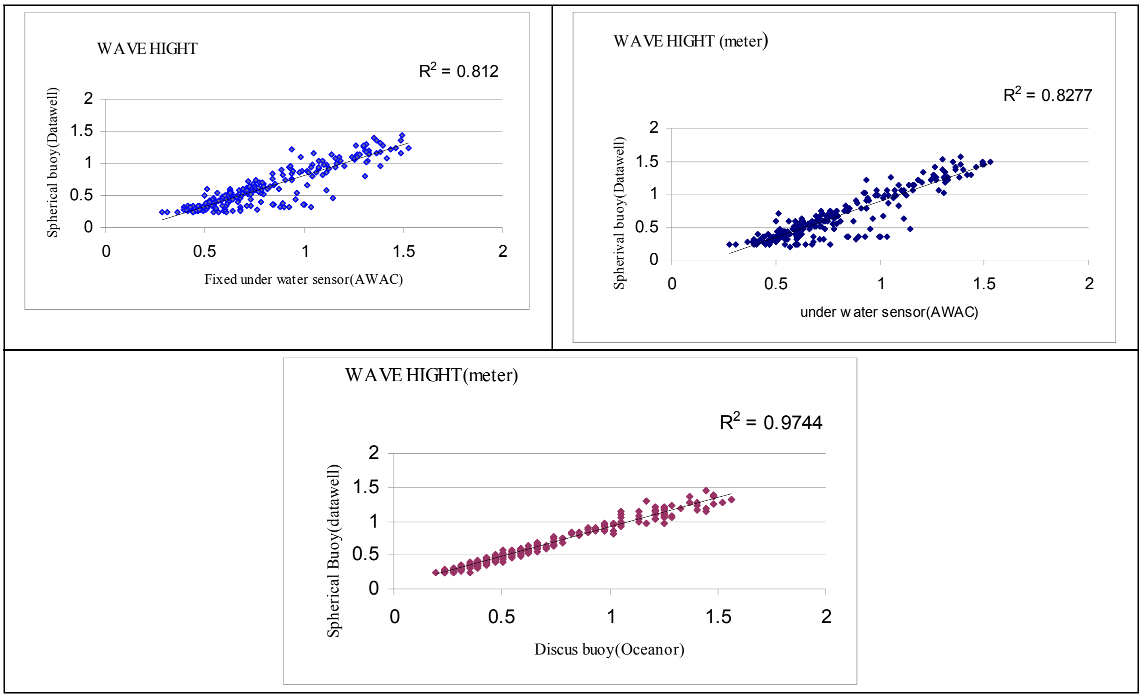

Fig.9.Colation coefficients for different instruments

Conclusion

Investigation of recorded data via floating buoys demonstrated in Fig.8. Manifest that there is no significant difference between wave heights data recorded by discus and spherical buoys, and their correlation coefficient is 0.97, while there is a significant difference between data recorded by fixed sensors and floating Buoy.

the wave height has recorded by fixed under water sensor(AWAC) has been higher than other simultaneous measurements and a number of undesired noises can be seen in gathered data by this device.

In addition, floating buoys have the advantages of measuring meteorological parameters to fixed underwater sensors. Moreover floating buoys have fewer restrictions on power supply, data transmission and deployment depth. The main limitations of benthic devices like AWAC are power supply systems and deployment depth.

REFERENCES

Steele, K.E., Teng, C-C., and D. W-C. Wang, 1992: Wave direction measurements using pitch and roll buoys. Ocean Engineering, 19, 4, 349-375.

Steele, K.E. and T.R. Mettlach, 1993: NDBC wave data - current and planned. Ocean Wave Measurement and Analysis - Proceedings of the Second International Symposium. ASCE, 198-207.

Civil Eng., Vishwakarma Inst. of Inf. Technol., Pune,2008:Development Of Wave Buoy Network Using Soft Computing Techniques-OCEANS 2008 - MTS/IEEE Kobe Techno-Ocean, 978-1-4244-2125-1

M.Allahyar,M.,M.Jandaghi Alaee, H.Mesghali, 2002,Evaluation of gathered data by PMO Buoys,5th Intrnational conference on coasts ports and marine structure,Ramsar, Iran, Book of Extended Abstract, pp99-1.3

M.Hami, A.zamani, M.allahyar. 2009: A field measurement comparison of Iranian wave buoy and Oceanor company one, book of abstracts ,11th national conference on marine industries,Kish Island, Iran