



DIRECTIONAL WAVERIDER BUOY IN INDIAN WATERS - EXPERIENCES OF NIO

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SYNOPSIS : Information on directional waves is extremely important in the design of harbour structures, such as breakwaters and jetties and to study the sediment transport pattern. Till recent days our country has been using waverider buoys which give all wave parameters except the wave direction. Using the advanced technology, M/s Datawell bv, Netherlands, has developed directional waverider buoy which enables to measure the wave direction in addition to wave height and period. To augment this latest measurement technology, National Institute of Oceanography, Goa has procured such buoys in 1990 and during the subsequent years, it has carried out directional wave measurement programme in Indian waters. This paper discusses regarding directional waverider buoy, receiving/ recording unit, NIO's experience in mooring, deployment and retrieval operations etc. The paper also highlights various operational problems during the data collection programme. Suggestions and conclusions pertaining to operation, maintenance etc., have been included.

INTRODUCTION

India has about 7000 km. long coastline. It has many offshore facilities and many more offshore and onshore marine structures are expected to be installed in near future. To design the structures such as harbour, breakwater, jetty, offshore platform, Single Buoy Mooring (SBM) etc., knowledge on waves and its various statistical parameters at the desired location is necessary. The time-series information on waves in shallow or deep waters can be obtained by using a wave measuring instrument at the desired location. National Institute of Oceanography, Goa has started the wave measurement programme in 1977 by using wave measuring instrument called waverider buoy manufactured by Datawell bv, Netherlands. This instrument gives all wave parameters excluding wave direction. As wave direction information is important for applications such as harbour and structure design, coastal erosion prevention, sediment transport studies and wave refraction studies, with advent of instrumental technology, M/s Datawell bv, developed relatively small size (0.9 m dia.) directional waverider buoy (DWRB) in early nineties. NIO procured this type of buoy in 1990 and started long-term directional wave data collection programme in Indian waters off Gopalpur and Nagapattinam in the east coast, and Vadinar and Goa in the west coast of India (Fig. 1).

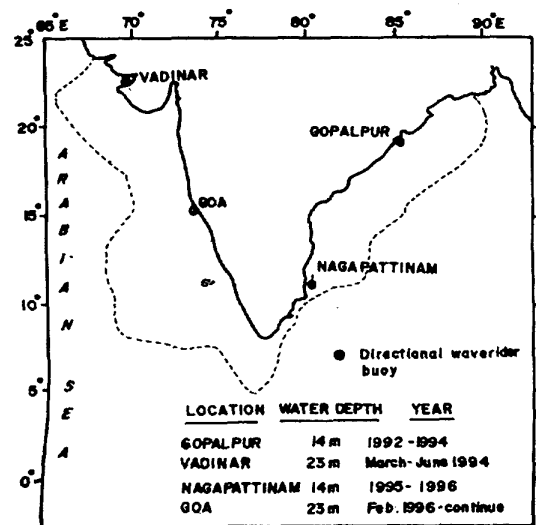


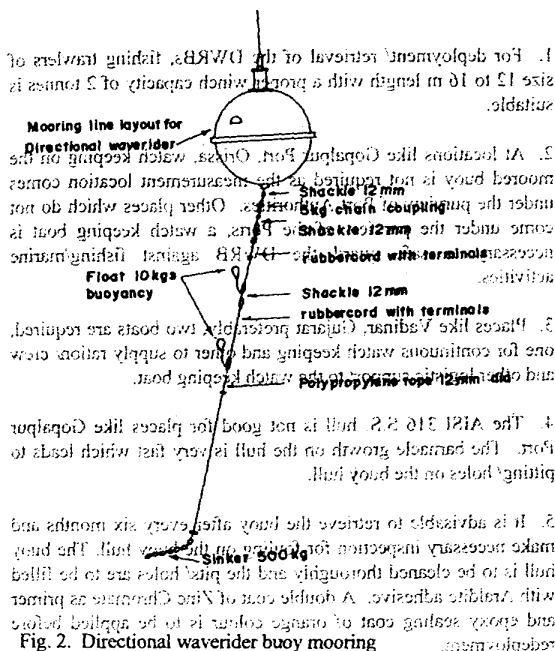
Fig. 1. Directional waverider buoy locations

WAVE MEASURING SYSTEM

The complete system consists of DWRB, Wave direction REceiver (WAREC) and a Personal Computer.

Directional waverider buoy

The wave direction measurement is based on the translational principle which means that horizontal motions instead of wave slopes are measured. As a consequence the measurements are independent on buoy roll motions and therefore a relatively small spherical buoy can be used (Fig. 2).



The DWRB hull is made up of AISI 316 stainless steel (S.S) (3 mm thick), spherical in shape, 1.2 m high and weighing 190 kg. The buoy is powered by 85 Leclanche cells and has a 12 month battery life. It has a flash light for navigation purpose and a whip antenna for continuous transmission of waves and wave direction information over 27-40 MHz band width. The transmitter output power is 150 to 200 mw and it has a maximum range of 50 km. The buoy has 2000 N buoyancy and works safely in currents upto 6 knots. The buoy contains heave-pitch-roll sensor Hippy-40, three axis fluxgate compass, two fixed X and Y accelerometers and a temperature sensor. The buoy has onboard microprocessor based electronics which enables calculations in the buoy. From the accelerations measured in the X and Y directions of the moving buoy reference frame, the accelerations along the fixed, horizontal, north and west axis are calculated. All three accelerations vortical, north and west are then digitally integrated to displacement and filtered to a high frequency cut-off at 0.6 Hz. Finally, every half an hour, FFT of 8 series of 256 data points (200 sec) are added to get 16 degrees of freedom per frequency on 1600 seconds of data. To save transmitter power, the real time data are compressed to motion vertical, motion north and motion west. On-board data reduction computes energy density, main direction, directional spread and normalized second harmonic of the directional distribution. The manufacturers deliver directional waverider buoys in satellite version in which only Argos message is transmitted. As Argos can keep track of the buoy position, with a moored buoy Argos facilitates a drift alarm.

WAREC

The receiving unit WAREC consists of wave data receiver, demodulator, processor, and communication RGBs. The front panel has power switch, RS232 communication LEDs, Error indication LEDs and a speaker to identify the receiving signal quality. The rear panel has Power cord, DC Power supply connector, RS 232 communication 25 pin D-type connectors and antenna input socket. The antenna amplification output available in WAREC can be used to connect another WAREC in order to receive signals from two DWRBs with different transmitting/receiving frequencies, using a single quarter wave ground plane antenna. The receiving unit WAREC is installed on land or offshore platform/ship within a distance of 50 km from the moored buoy location. The location of receiving station should be free from radio interference at the operating frequency of the DWRB. This can be achieved by positioning the quarter wave ground plane antenna within a distance of 100 m from the receiver unit at an elevated place (The distance is limited by the coaxial cable length of 100 m). The WAREC communicates with an IBM compatible PC through RS232 interface.

Personal Computer

An IBM compatible personal computer with RS232 communication is interfaced with the WAREC. The data received by the WAREC are transferred into the PC. The software WAVIDR to run the system is supplied by the manufacturer. The PC receives the data and processes for energy spectrum, wave direction, wave period, sea surface temperature and other statistical parameters and displays and stores in the hard disc for every pre-determined intervals. In general the data are collected for every three hours or whenever the threshold wave height exceeds.

MOORING AND HANDLING OF DIRECTIONAL WAVE-RIDER BUOY

The DWRB is fitted with 5 kg chain ballast attached to the mooring eye. This provides stability when only a small vertical mooring force is present. A single point vertical mooring with two standard rubber cords ensures sufficient symmetrical horizontal buoy response and also for small motions at low frequencies (Fig.2). The low stiffness of the rubber cords allows the DWRB to follow waves upto 40 m. For mooring in depths less than 35 m each rubber cord terminal has to be attached with 10 kg buoyancy floats. The end of the second rubber cord will follow polypropylene rope, multiplait 12 mm diameter, mounted on polypropylene terminals with rope length of twice the water depth. The rope terminals are fitted with sinker of approximately 500 kg of chain used as dead weight.

A locally available mechanised boat, usually a fishing trawler having a derrick boom and a 2 tonnes winch is generally selected

for handling of the mooring components and the buoy. The length of the boat varies from 12 to 16 m. Most of the time the same trawler is used for keeping a watch on the moored buoy, which is essential in severe fishing activity areas. Anchor last method is adopted for the DWRB deployment. Before paying out the mooring gear, the boat is made to proceed towards the buoy location. Opposing the sea surface current/ wind, whichever is dominant at the time of deployment, first the buoy is dropped in the sea from the stern of the boat, cruising at about 2 knots speed. Then the connected mooring line is paid out manually under moderate tension. Ultimately, the anchor is dropped from the stern of the boat. The accurate positioning of the DWRB is taken by the GPS (Global Positioning System). During recovery operation, first the DWRB is hauled up and kept on the deck of the boat. Then the upper slack part of the mooring including the rubber cord, buoyancy float and polypropylene rope is manually pulled up on the deck. Finally, winch is operated for hauling up the dead weights on the deck. Proper manoeuvring of the boat is very important particularly when the sea is rough.

MEASURES FOR SAFEGUARDING DWRB

Before installing the DWRB, the nearby fishing community has to be informed for keeping away from the moored buoy location. Also information has to be given to the Chief Hydrographer, Dehradun, who intern informs all the mariners operating in that area. Good results can be obtained by circulating the printed literature in local language among the mariners/ fishermen. The advertisement in local news papers also enables in educating the people. It is also suggested to inform the port office, police department and other concern authorities regarding the operational location of the DWRB.

PROBLEMS FACED AND MEASURES ADOPTED

The long term wave data collection programme faced some problems as outlined in Table. 1. Remedial measures taken to these problems are also reported. The measures taken have enhanced the success of data collection programme. In general the recording/receiving station will also have problems, but they can be eliminated in short time as compared to time taken to rectify problems in the DWRB. Table. 2 gives a glimpse of wave data collection by NIO at various locations. The proper planning and safety measures taken by NIO resulted to an extent of 100 % operation of the DWRB at few places.

CONCLUSIONS

NIO has about 20 years experience in using the Datawell waverider buoys. The DWRBs are being used for past six years. With the experience gained by using the DWRBs the following conclusions are drawn.

1. For deployment/ retrieval of the DWRBs, fishing trawlers of size 12 to 16 m length with a proper winch capacity of 2 tonnes is suitable.
2. At locations like Gopalpur Port, Orissa, watch keeping on the moored buoy is not required as the measurement location comes under the purview of Port Authorities. Other places which do not come under the purview of the Ports, a watch keeping boat is necessary to safe guard the DWRB against fishing/marine activities.
3. Places like Vadinar, Gujarat preferably, two boats are required, one for continuous watch keeping and other to supply ration/ crew and other logistic support to the watch keeping boat.
4. The AISI 316 S.S. hull is not good for places like Gopalpur Port. The barnacle growth on the hull is very fast which leads to pitting/ holes on the buoy hull.
5. It is advisable to retrieve the buoy after every six months and make necessary inspection for fouling on the buoy hull. The buoy hull is to be cleaned thoroughly and the pits/ holes are to be filled with Araldite adhesive. A double coat of Zinc Chromate as primer and epoxy sealing coat of orange colour is to be applied before redeployment.
6. Scrap ship chain is most suitable anchor weight.
7. The receiving units should be installed at an elevated place where minimum radio interference occurs.
8. As the receiver units/ PC are sensitive for high temperature, they are to be installed in air conditioned environment.
9. To obtain the continuous wave data, it is advisable to use an uninterrupted power supply in the receiving station.
10. An electronic back ground person is required to operate/ monitor the receiving/ recording station throughout the wave measurement programme.

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Table 1. Problems occurred and remedial measures taken

TYPE OF FAILURE	POSSIBLE CAUSE	MEASURES TAKEN	REMARKS
a) Failures in directional waverider buoy			
Flash light not working.	Leakage of sea water damaging electronics in top dome.	Replaced flash light PCB.	This fault occurred in the buoy off Gopalpur.
The heave recording shows 40 Second wave period.	Problem with the Hippy-40 sensor.	A new buoy deployed at the same location to continue the long term wave measurement programme.	It is not possible to repair the buoy with damage of Hippy-40 sensor in India. Hence the faulty buoy is sent to manufacturers for repairs.
Pitting and holes around the buoy hull.	Heavy Barnacle growth bottom side of the hull.	The pitting/holes were found after recovery of the buoy at Gopalpur Port. These pitting/ holes were thoroughly cleaned and filled with Araldite adhesive. A double coating of Zinc chromate as primer and epoxy sealing coat (with Orange colour for visibility)was applied.	The buoy worked for more than one year at Nagapattinam. After recovery of the buoy, it was observed that the Araldite adhesive could protect the buoy hull during the operational period.
The buoy drifted away from moored location at Vadinar, Gujarat.	Buoy adrift might be due to fishing activities in the moored location.	Search operation was made by boats in the sea and along the land.	The buoy was found in totally damaged condition and hence could not be used further. New wave measuring device was installed.
b) Failures in receiving system			
SYNC/DATA error LED's glowing continuously.	No communication with personal computer The DWRB got adrift. DWRB data transmission problem.	WAREC was checked with DIWACO test kit. WAREC OK. Checked the DWRB at the moored location: Buoy in position.	The error LED's extinguished automatically after 24 hr. and started working normal. It shows that local radio signals interfered with the buoy signals which showed in WAREC, SYNC/DATA errors.
Total failure of WAREC receiver.	Failure in WAREC power supply.	AC mains fuse (0.1Amp) was blown off due to high voltage. Replaced the fuse. WAREC started functioning normal.	This problem occurred quite frequently at Gopalpur recording station.
c) Failures in Personal computer			
PC not communicating with WAREC.	PC hanging due to SYNC/DATA errors in WAREC.	PC restarted.	The PC hangs continuously even though SYNC/DATA errors extinguishes in WAREC. Hence program is to be restarted.
Virus problem.	PC infected due to other floppies used while coping the files.	Virus removed in PC.	PC working normal.
3.5" floppy disc faulty.	Manufacturing format defect.	Replaced with new diskettes discarding the old ones.	PC working normal.
HP Vectra Portable PC not working.	HP Vectra PC backup battery burnt.	Replaced the HP Vectra PC with Toshiba PC.	PC working normal.

Table 2. DWRB performance off east and west coasts of India

Sr. No.	Location	Period of study Start Finish	No. of buoy days possible X	Actual no of buoy days Y	(Y/X)*100 %	No. of deployments	Adrift
1.	Gopalpur	5-12-92 31-12-94	757	672	89	3	Nil
2.	Nagapattinam	11-3-95 6-3-96	360	358	99.4	2	Nil
3.	Vadinar	27-3-94 24-6-94	90	90	100	1	1
4.	Goa	15-2-96 30-6-96	137	93	68	2	1

* Total loss of data at Gopalpur is 85 days. Data loss for 76 days was due to the non-availability of a new buoy. Data loss for 9 days was due to routine maintenance of the buoy.

** Data loss for 2 days was due to routine maintenance of the buoy.

*** The buoy off Goa was drifted on 1-4-96. The redeployment was delayed due to non availability of the buoy. (The data collection is on going. However, the information given here is upto 30th June 1996)

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