Study of spectral wave transformation over muddy beds

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Introduction

A prerequisite for the reliable estimation of waves on maritime structures is a detailed understanding of how waves transform during their propagation (Goda, 2000). Considerable decay of wave energy along the wave trajectory over muddy beds makes a different wave transformation in comparison to sandy environments. The role of soft mud to dissipative waves has been investigated through modelling and laboratory experiments by many researchers (e.g., Sakakiyama and Bijker, 1989; Ross and Mehta, 1990; and de Boer *et al.*, 2009). The present study offers two sets of data for interacting waves with soft muddy beds; one is a large set of wave basin experiments on a general three-dimensional bathymetry under both regular and irregular waves, and the other one is a one-month period of field measurements at two stations in Hendijan mud coast on the Iranian coastline of the Persian Gulf. They have been utilizing a two-dimensional numerical model for better understanding of the complex spectral wave transformation on conditions where the combined effects of shoaling, refraction and diffraction as well as the wave energy dissipations due to mud bed existence and wave breaking exist.

Laboratory experiments

Wave basin experiments were carried out at the hydraulic laboratory of Yokohama National University. The basin was measured 10.5m in length by 9.0m wide with a bottom slope of 1:30. Commercial kaolinite was used to prepare the fluid mud bed. A mud sample was put in a box in the middle of the basin measured 2.7m in both directions and 10cm in height. Regular and irregular waves were generated by the wave paddles at the edge of the basin. The mud bed was subjected to wave action for the duration of 300s. The characteristics of incident wave approaching the mud section and the waves at five points over the mud box were recorded.

Field measurements

The north-west part of the Persian Gulf is covered with mud originating mainly from Arvand River. Mud deposits up to 20 metres thickness are observed at the very shallow coast of Hendijan Fishery Port. A set of field measurements was performed at the field site. Directional wave spectra and vertical current velocity profiles were simultaneously recorded at two stations. Mud samples from the top 1-metre layer were also collected to define mud characteristics. Fig. 1 shows the wave energy spectra in two stations during an extreme storm event.

Numerical model

The REF/DIF S wave model is employed in the present study to simulate spectral wave propagation over the physical model domain and also Hendijan muddy coast. A multi layered fluid system is employed to simulate the wave attenuation rate. The calculated values of the energy dissipation rates in the area covered by fluid mud are finally introduced to REF/DIF S wave transformation model to simulate wave propagation over the muddy beds.

Results and discussion

Introducing incident wave spectrum to the numerical model, Fig. 1 illustrates an example of the measured and simulated irregular wave spectra at one of the six stations in the wave basin as well as measured wave spectra in both stations at Hendijan mud coast together with the simulated wave spectrum in the nearshore station through REF/DIF S modified model. Comparisons between the measured and simulated wave spectra presented in Fig. 1 show fair agreements.

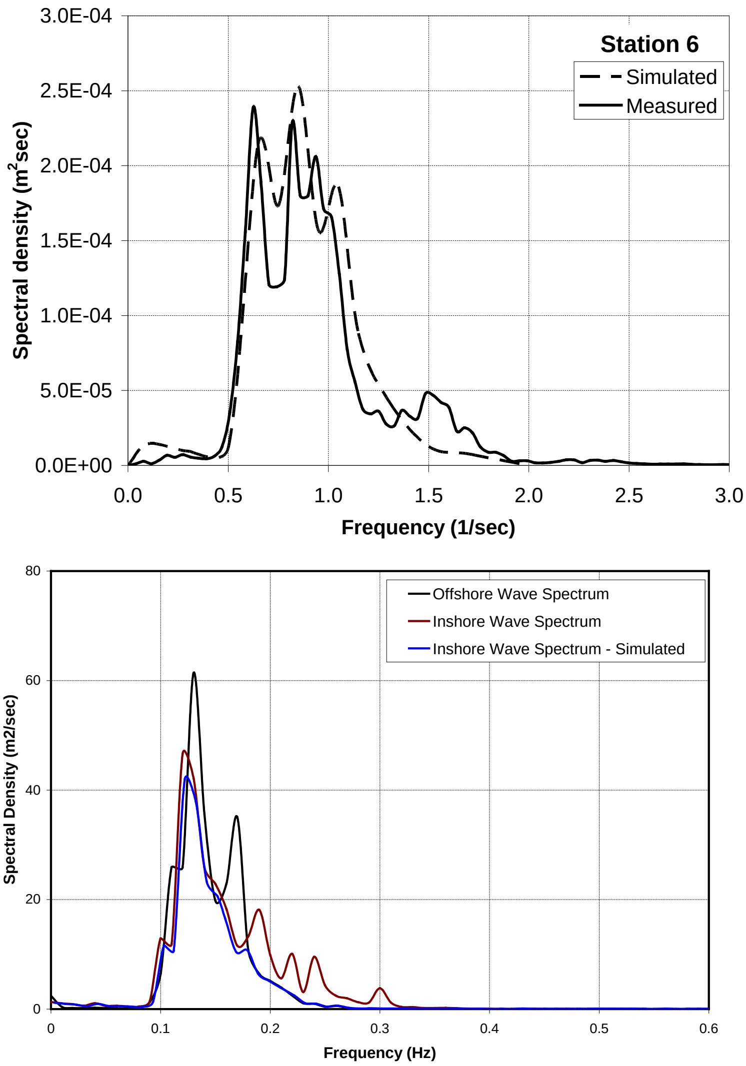

Fig. 1. Measured and simulated wave spectra, wave basin data (top) and Hendijan mud coast field data (bottom).

References

de Boer G.J., J.C. Winterwerp and Ap. van Dongeren. 2009. Flume experiments of wave damping by fluid mud. Proc. of INTERCOH 2009, Brazil.

Goda Y. 2000. Random seas and design of maritime structures. World Scientific Publishing Co.. 443p.

Ross M.A. and A.J. Mehta. 1990. Fluidization of soft estuarine mud by waves. p.185-191. In: The Microstructure of Fine Grained Sediments: From Mud to Shale. Bennett R.H. (Ed.). Springer-Verlag, New York.

Sakakiyama T. and E.W. Bijker. 1989. Mass transport velocity in mud layer due to progressive waves. Journal of Waterway, Port, Coastal and Ocean Engineering. ASCE 115(5):614-633.