FIELD OBSERVATIONS OF SHORELINE CHANGE BY FREQUENCY-BANDED WAVE ENERGY FLUX AND FORESHORE SHAPE

Takayuki Suzuki 1 and Yoshiaki Kuriyama 2

1 Civil Engineering Department, Yokohama National University, Tokiwadai 7-5, Hodogaya, Yokohama, Kanagawa 240-8501, Japan. E-mail: suzuki-t@ynu.ac.jp
2 Special Researcher, Port and Airport Research Institute (PARI), Nagase 3-1-1, Yokosuka, Kanagawa 239-0826, Japan. E-mail: kuriyama@pari.go.jp

1. Introduction

The correlation between longterm shoreline change and wave forcing has been the subject of many research works. When considering the effects of wave period, researchers often divide the spectrum into two parts, one characterized by the peak period and a second for the low frequency motion less than approximately 30 s. In this paper, we analyzed the relation between shoreline change and wave energy flux by dividing the wave forcing into six energy bands. Furthermore, we consider the foreshore shape and relative starting location of the shoreline position in our analysis of the shoreline recession rate.

2. Data Description and Method

Beach profile data were obtained at Hasaki Oceanographical Research Station (HORS, Fig. 1, Plc. 1), which conducts field measurements of various phenomena in the nearshore zone on the Hasaki coast of Japan. HORS has a 427 m long pier, which is located perpendicularly to the shore. The cross-shore distance along the pier is defined relative to the reference point of HORS, and the seaward side is set as being positive. An ultrasonic wave gage (USWG) sensor was mounted at a water depth of 23.4 m offshore of the Port of Kashima (Fig. 1). In this study, the beach profile data and wave data from Jan. 2001 to Dec. 2005 were used. During the investigation period, the averaged offshore significant wave height and period were 1.65 m (varied from 0.37 to 6.49 m) and 8.51 s (varied from 4.88 s to 17.2 s), respectively.

The shoreline position was defined at the cross-shore location where the elevation is equal to the high water level, D.L., +1.25 m. Figure 2 shows the fluctuation of the shoreline position. Relatively small erosion events occurred seasonally from the end of February to March and were mostly caused by large atmospheric depressions. Moreover, large beach erosion events occurred during the typhoon season, which is from the end of August to September. During the rest of the year, the shoreline retained its position or moved seaward.

3. Results and Discussions

(a) Relationship between the shoreline position and frequency-band wave energy flux:

Figure 5 shows the relationship between the shoreline position and the wave energy flux (Ef: calculated by using Hs and Tt) for each event. The solid line in the figure is used to distinguish the backward movement (shoreline retreat) from the data using the discrimination analysis, and this line has a predictive skill of 89.5 %. However, it seems that the separation between forward (accretion) movement and even (no erosion/accretion) events are harder to define.

By using frequency-band wave energy fluxes, the predictive skills were calculated in the same way as Fig. 5. The figures of the skills (Fig. 6) indicates that the skills are high at Ef1 (T > 32 s) and Ef3 (10.7 s > T > 14.2 s), where the spectrum densities are most energetic. From these results, it is possible to separate shoreline erosion events from shoreline advance events and shoreline neutral events by using frequency-band wave energy fluxes.

(b) Relationship between backward events and foreshore shape:

We turn our attention to large events with backward (erosion) movement speed faster than -3.0 m/day. For these cases, all of the starting shoreline positions of the events were located seaward of x = 20 m and the 69 % of them include berm erosion (Fig. 7).

Table 1 shows the averaged shoreline position and backward speed of with and without berm shape. With the berm shape, the shoreline located relatively offshore and the backward speed increased 1.6 times compared to without the berm shape. These results reveal that both the shoreline position and foreshore shape affect shoreline backward movement speed.

4. Conclusions

• shorelines erosion events can be separated from shoreline advance and shoreline neutral events by using Ef (wave energy flux calculated using Hs and Tt), Ef1 and Ef3 (frequency-band wave energy flux; the spectrum densities are high). The predictive skills are over 85 %.

• For the estimation of the shoreline change rate, we need to consider not only wave conditions but also shoreline position and foreshore shape (berm shape).

Acknowledgements

The authors thank all the staff members at HORS for conducting the field surveys. They also thank the Marine Information Division, Port and Airport Research Institute and Kashima Port and Airport Construction Office for allowing use of the wave data of the Port of Kashima. This research was partially supported by the Ministry of Education, Culture, Sports, Science and Technology, Japan, through Grant-in-Aid for Young Scientists (B).

References

The references are cited in the main text.