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Study on Shoreline Variation and Incident Wave at Ida Beach of Shichiri-Mihama Coast

STUDY ON SHORELINE VARIATION AND INCIDENT WAVE AT IDA BEACHOF SHICHIRI-MIHAMA COAST

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ABSTRACT

This paper is intended to investigate the beach profile change at Ida Beach. Investigation has been done based on the results of shoreline observation, incident wave observation, beach profile survey. As a result, wave height and direction affects the shoreline change significantly. It has been found that an installation of artificial reef influences the beach profile.

Keywords: shoreline change, beach erosion, HF radar, artificial reef

1. INTRODUCTION

Schichiri-mihama coast locates the southern end of Mie Prefecture, Japan and it suffers from beach erosion. Particularly, beach erosion is very severe at Ida beach, southern part of Shichiri-mihama coast. Yamamoto et al. (1999) investigated beach profile change in relation to the dam construction of Kumano river, sand extraction and construction of breakwaters of Udono port which locates near the river mouth of Kumano river adjacent to the Ida beach. They suggested that the decrease of sediment supply from Kumano river could be due to the constructions of dams and gravel extraction, and also the trap of sediment transport due to breakwaters of the Udono port. After the regulation of the sediment

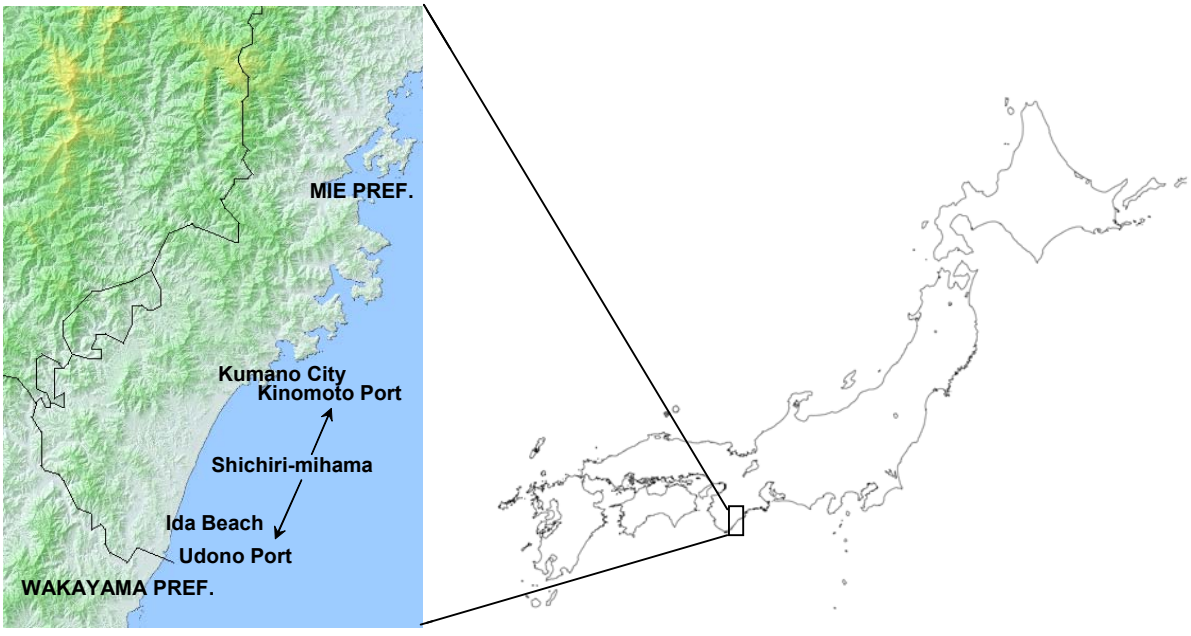

Fig. 1 Location of Ida Beach

extraction, width of Ohji beach which locates opposite side of Ida beach is increased, whereas the beach is still eroded in Ida beach. Considering these facts, the effect of the breakwater of Udono port may have a significant effect on the beach erosion of Ida beach. In order to understand the current situation of the beach erosion, authors have measured the location of the shoreline of Ida beach using handy GPS system for several years. In the offshore of the Ida beach, waves have been measured using the HF radar system by Mie prefectural government. Based on these results, this paper discusses the effect of incident wave properties on the shoreline variation in on- and offshoreward direction.

2. FIELD OBSERVATION

Shoreline change at Ida beach had been observed 28 times for the period from May 2001 to October 2005 using a handy GPS system (Garmin eTrex Summit). In the measurement, location of the berm was measured to avoid the strong up- and down rushes in the swash zone. Then, the location of the shoreline was obtained using the mean beach slope and tide level. In the sea area off the Shichiri-mihama coast, waves have been recorded using the HF radar system. In the present analysis, wave records from December 2001 to December 2005 were used.

3. WAVE PROPERTIES

Table 1 shows monthly significant wave heights, periods and directions. In summer season, wave heights are larger than other season. In summer season, typhoons often approach to Japan and their effects increase the average wave heights in summer season. On the other hand, wave conditions in winter to beginning of summer are generally mild. However, even in winter, high waves often incident to the beach as shown in Fig.2 although the average wave condition is mild. Fig.3 shows distribution of wave direction. Dominant wave directions are E, ESE, SE and SSE. Normal direction of the Ida beach is in between E and ESE, and therefore the waves toward north direction with respect to the Ida beach are dominating over the other directions. This suggests that the northward longshore current is developed in this area and sediment transport in this direction is encouraged. This result

Table 1 Monthly wave condition

	Height (m)	Period (s)	Direction (deg.)
Jan.	1.18	6.85	115.1
Feb.	1.06	6.86	114.7
Mar.	1.24	7.35	120.5
Apr.	1.33	7.58	123.3
May	1.14	7.13	125.9
Jun.	1.17	6.99	132.1
Jul.	1.57	7.56	139.0
Aug.	1.67	7.45	133.3
Sep.	1.60	7.49	124.5
Oct.	1.38	7.31	119.9
Nov.	1.16	7.2	114.9
Dec.	1.14	7.13	113.4

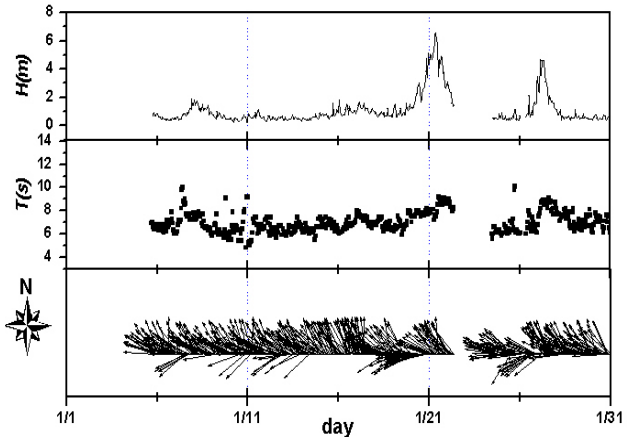

Fig. 2 Wave conditions in January 2003

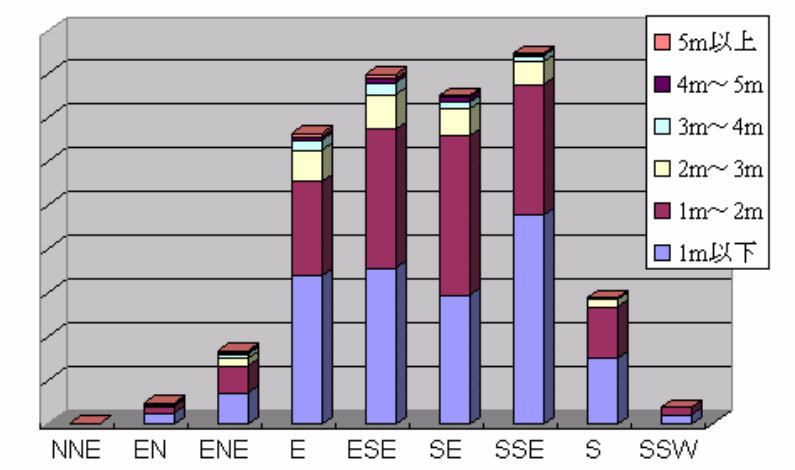

Fig. 3 Distribution of wave direction

is consistent with the result of Yamamoto et al.(1999).

4. BEACH PROFILE CHANGE

4.1 Shoreline Change

Characteristics of shoreline change are discussed here in relation to the wave property. In this study, differences of shorelines between two successive measurements are discussed. Based on the analysis of these results, it is found that the shoreline change pattern can be classified into the following four types.

Case (1): Shoreline change is small.
Case (2): Shoreline retreat dominates over forward.
Case (3): Shoreline forward dominates over retreat.
Case (4): Both shoreline retreat and forward are observed.

Typical examples of Case (1) are shown in Fig.4 and Fig.5. In these periods, wave height is less than 4m except a few day and wave condition is generally mild.

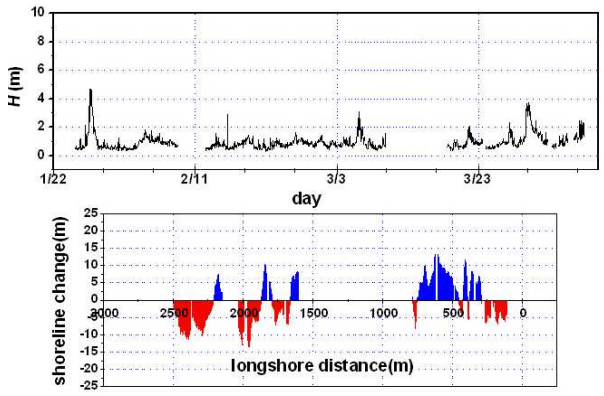

Fig.4 Shoreline change between Jan.25, 2002 to Apr.6, 2002 and wave height variation

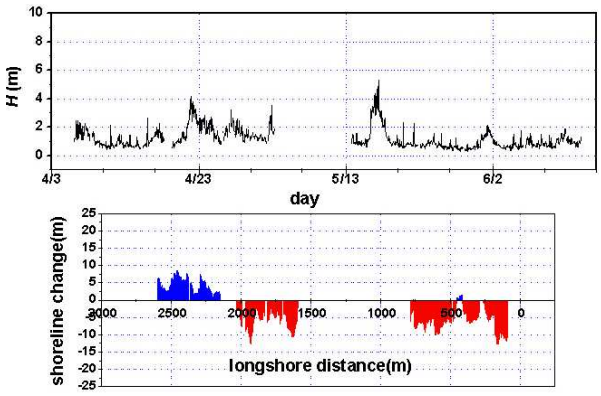

Fig.5 Shoreline change between Apr. 6, 2002 to Jun.13, 2002 and wave height variation

Fig. 6 and Fig. 7 show similar variations to Fig.4 for the period when the typical shoreline retreat is observed (Case (2)). This case is often observed in summer and winter. In these seasons, high waves often attack the beach. Particularly in summer, high waves more than 6m often attack the beach due to typhoons. In the summer in 2003, there were seven typhoons and Typhoon 0310 passed off the Ida beach. The HF radar system missed to observe waves during this season and we can not discuss more in detail about the shoreline retreat in this season, but the high waves due to typhoon could affect the shoreline change.

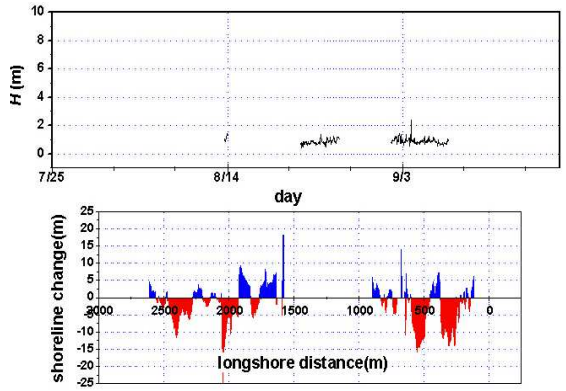

Fig.6 Shoreline change between Jul.25, 2002 to Sep.28, 2002 and wave height variation

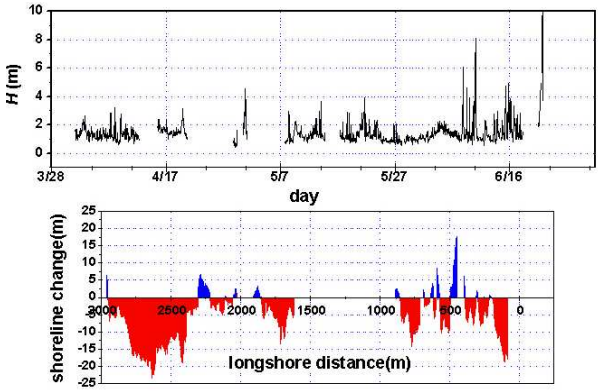

Fig.7 Shoreline change between Mar. 28, 2003 to Jul.2, 2003 and wave height variation

Fig.8 and Fig.9 show the shoreline changes of Case (3). In the period in which this pattern is observed, moderate waves with the height of 4 to 5m often incident to the beach. It is difficult to determine the border wave height between Case (1) and Case (3), however, a certain have height is required to move sediment to forward the shoreline.

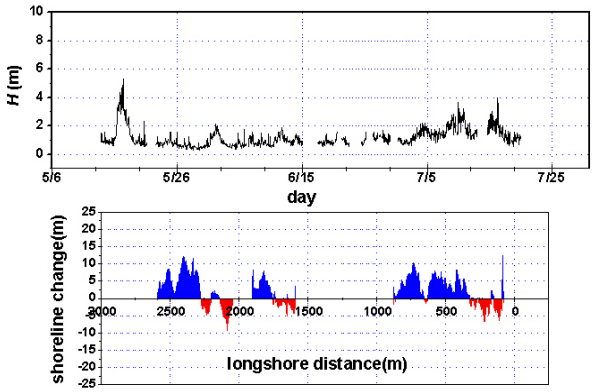

Fig.8 Shoreline change between May5, 2003 to Jul.28, 2003 and wave height variation

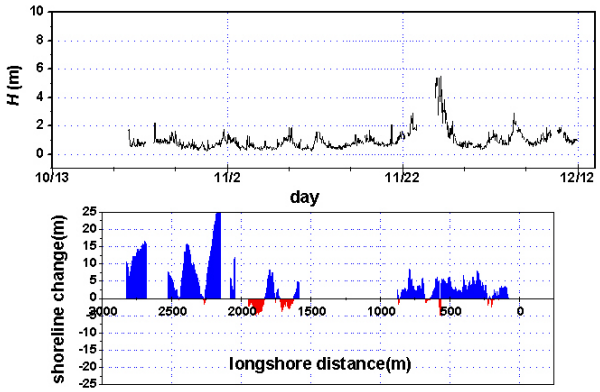

Fig.7 Shoreline change between Oct. 16, 2003 to Dec.10, 2003 and wave height variation

In the period of Case (4), high waves with the height of 6m attach the beach and similar to the Case (2), however, the shoreline moves forward in some part of the beach. This local difference in the shoreline movement may be due to the difference of wave directions. This pattern seems to increase in 2004 and 2005. In the sea area of Ida beach, the artificial reefs have been constructed. Considering this fact, occurrence of Case (4) may be influenced by the construction of the artificial reef.

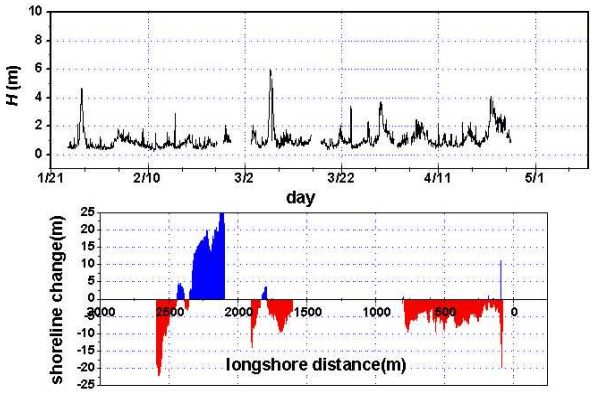

Fig.9 Shoreline change between Jun. 8, 2004 to Aug.4, 2004 and wave height variation

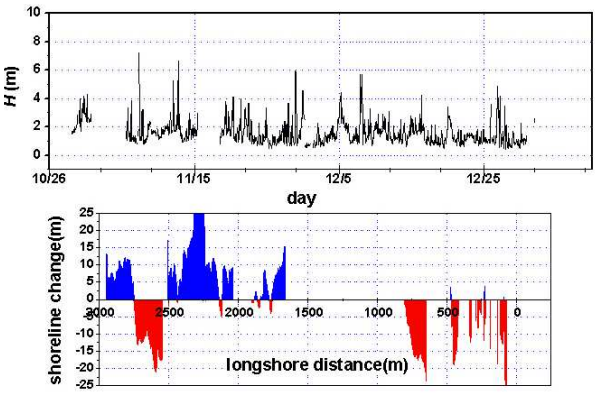

Fig.10 Shoreline change between Jul. 1, 2005 to Aug.5, 2005 and wave height variation

4.2 Volume of Beach Matetial

Cross-section survey of foreshore has been conducted five times during the period from 2004 to 2005. Cross-section has been measured using the total station (SOKKIA SET610S) and height from the crown of the sea wall installed in backshore of the beach. Because of the limited time for survey, cross-section of limited area of the beach has been measured as shown in Fig.11 (marked A and B).

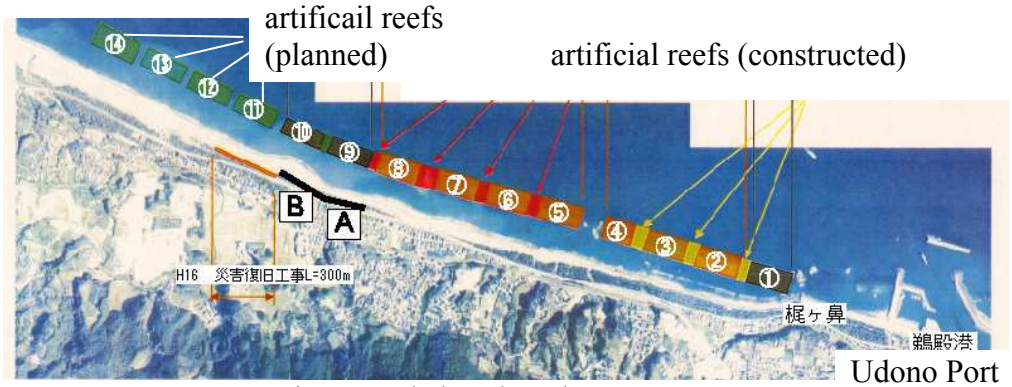

Fig.11 Ida beach and survey areas

Fig.12 shows the change of the beach height from Jul. 1, 2005 to Aug.4, 2005. Survey was conducted in the area where the shoreline retreat was observed as shown in Fig.10. As seen in Fig.12, beach height becomes lower for almost whole area. This suggests that the beach erosion occurs in whole of the foreshore, not only near the shoreline. Fig.13 shows a typical example of the time variation of the beach profile. Once the beach accretion is observed but after Dec. 2003 the beach has been eroded and retreat of the beach is observed.

In the sea area in front of the survey area, artificial reefs have been installed to control the beach erosion. Considering the beach profile change observed in this study, beach erosion is still going on and countermeasures due to the artificial reefs may not be sufficient. As discussed above, beach tends to move forward under certain wave condition. Thus, there may be possibility to reduce beach erosion by controlling the wave condition so that the Case (3) type shoreline change occurs.

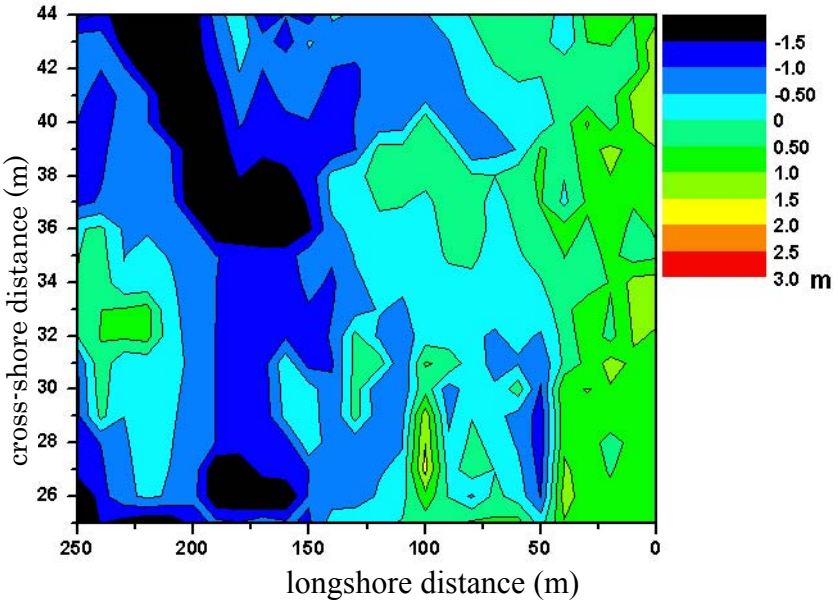

Fig.12 Beach height change from Jul. 1, 2005 to Aug.4, 2005.

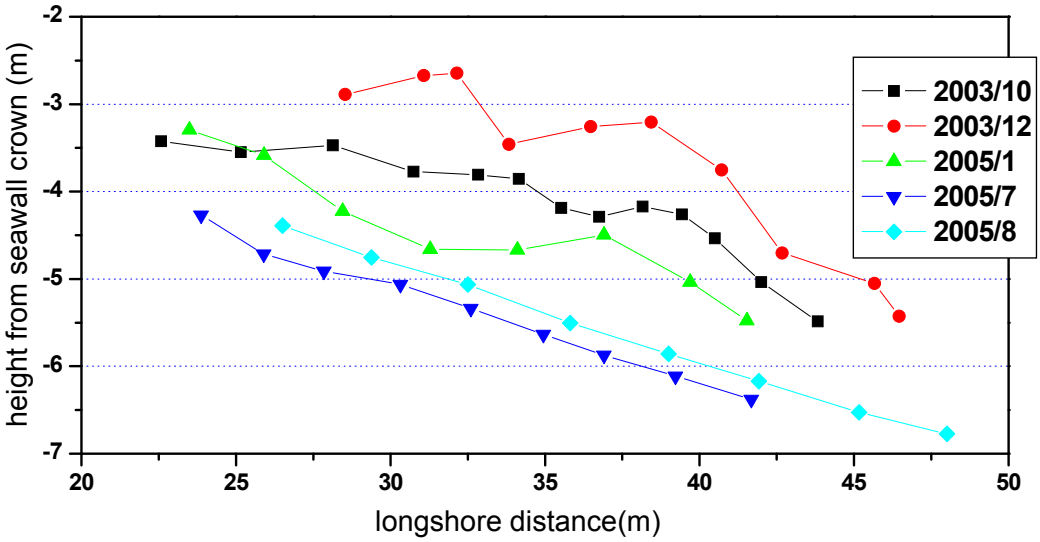

Fig. 13 Time variation of beach profile

5. CONCLUSIONS

In this study, beach profiles of the Ida beach of Shitiri-mihama coast have been discussed based on the measured data. Wave properties show the dominating wave direction is relatively northward to the normal direction of the beach. This may encourage the northward sediment transportation and consistent with the previous study. Characteristics of the shoreline change indicate that waves in a certain condition forward the shoreline. The artificial reefs installed in the sea area in front of the Ida beach seems not to be enough to control the beach erosion and additional countermeasure may be necessary considering these characteristics of shoreline change.

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