LABORATORY EXPERIMENT STUDY ON BARRIER ISLAND RESPONSES CAUSED BY THE STORM

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1. INTRODUCTION

Every year, there have been many severe storms occurred around the world in general and in Japan in particular. The occurrence of storms is expected to increase because of the global warming effects. The study on a barrier island responses caused by the storm is therefore become very importance in terms of beach morphology change, sediment transport as well as near-shore structures destroyed due to overtopping wave and inundation overwash. However, the changes of beach profile and in-sight sediment transport mechanisms during a real event are impossible to obtain. Thus, the laboratory study is more appreciated.

This study presents a laboratory experiment on the impacts of storms to a sandy barrier island. The aims are to investigate the whole barrier island or sand spit responses due to a storm condition with considering to the increase of storm surge height.

2. LABORATORY EXPERIMENT SET-UP

A series of experiments were carried out in a two-dimensional wave flume, as shown in **Fig.1**. The length of the flume is 11.3m with 50cm height and 30 cm width. The flume was equipped a monochromatic wave generator, a filter was installed in front of the wave generator and wave absorbing works at the other end of the flume to filter out reflection wave. A typical triangular barrier island profile was set in the flume with a nearshore beach slope of 1/25, sub-aerial beach slope of 1/4 and rear beach slope of 1/30 covered by sand with the grain size of 0.26mm. On behind of barrier island there was a sand trap to measure the deposited overwashing sediment. The initial beach crest height was set at 150cm long. A profiler, moving on the top of flume, was used to measure changes of bed profile surface, and a wave gauge was installed at the toe of slope to measure wave parameters before acting the slope. Eight cases of the experiment in connection with storm conditions have been carried out at the difference of water level and wave height as can be seen in **Table 1**. In which, WL is the water level, H_C beach crest height, H_0 the height of deep water wave, T is the wave period, and t_D is the storm duration. NC means the natural condition; LRO is the little runup overwash, IO is the inundation overwash and SC is the storm condition.

Table 1 Experimental conditions

Cases	WL(cm)	H_C(cm)	H_0(cm)	T(s)	t_D (h)
NC	23	7	7.2	1.45	2.0
LRO	26	4	7.5	1.45	2.0
RO-1	27	3	7.6	1.45	2.0
RO-2	28	2	7.7	1.45	2.0
RO/IO	29	1	7.8	1.45	2.0
IO-1	30	0	7.9	1.45	2.0
IO-2	31	0	8.0	1.45	2.0
SC	23-27	7	7.2-7.6	1.45	8.0

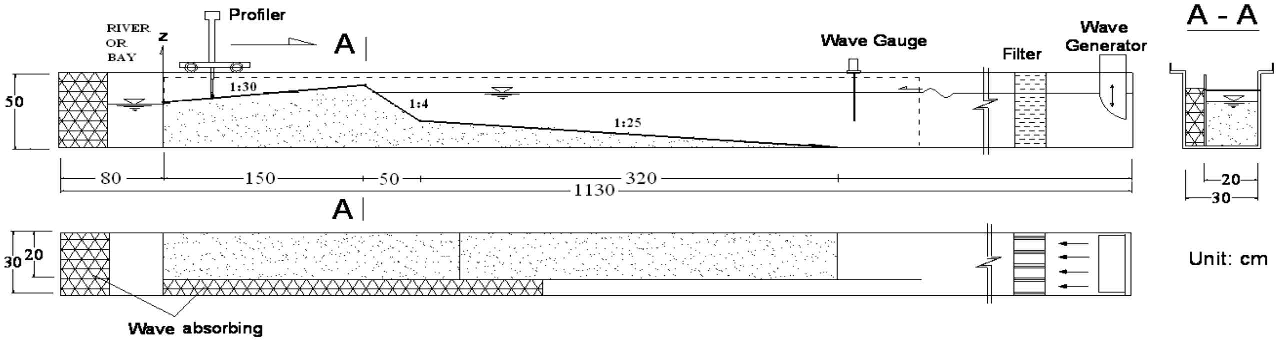

Fig.1 Experiment equipment

3. RESULTS AND DISCUSSIONS

3.1. Experiment results

The barrier island was tested in eight different cases varying from natural condition where the wave does not overtop the beach crest until the cases of inundation overwash, in which the still water level is higher than the crest. In the storm condition case, the water level was continue increased from 23cm to 27cm by an extra inflow valve at the other end of flume. Consequently, the wave height was raised from 7.2cm to 7.6cm. The whole system was stopped to measure the barrier island profile changes at 10, 20, 30, 60, 90 and 120 minutes respectively. **Fig.2** shows the measured results for the case of runup overwash 1 (RO-1). It is clearly see that the barrier crest height was getting higher by the storm duration.

3.2. Data analysis

There have been many researchers such as Shallenger at el. 2000, Donnelly at el.2006 and Nguyen X.T. 2006 studying to answer the question that what are the sediment transport rate induced by a storm event and how these related with the wave parameters? Thus,

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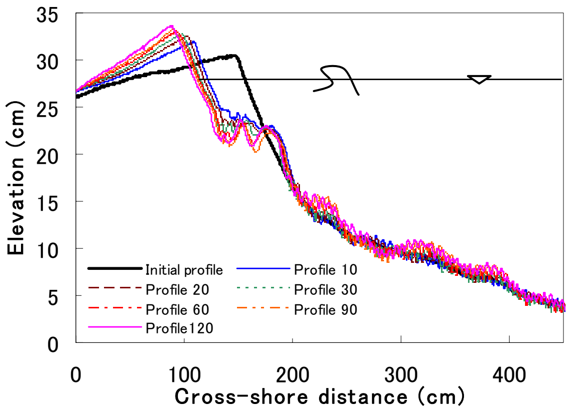

Fig.2 Time variation of the cross-shore beach profile for the Case RO-1.

a beach profile is classified into four different zones as shown in **Fig.3**. Where, zone 1 is the bay deposition, zone 2 is the washover deposition, zone 3 is the barrier erosion and zone 4 is the offshore deposition. The deposited and eroded sediment can be calculated by integrating the area between pre- and post-profiles. The estimation of erosion and washover sediment as well as its length are significant for coastal engineers to give mobilise equipment for cleaning up sediment after a storm and for evaluating sediment budgets of sand beach which are migrating due to overwash. The relationship between washover sediment rate and erosion rate is shown in **Fig.4**. The eroded sediment volume is almost equal to two times of washover sediment volume.

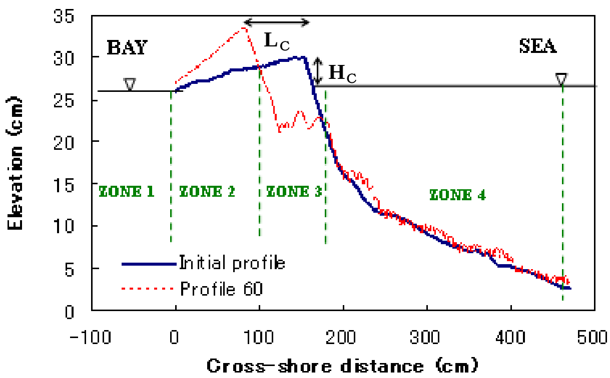

Fig.3 Definition sketch for typical beach profile zone.

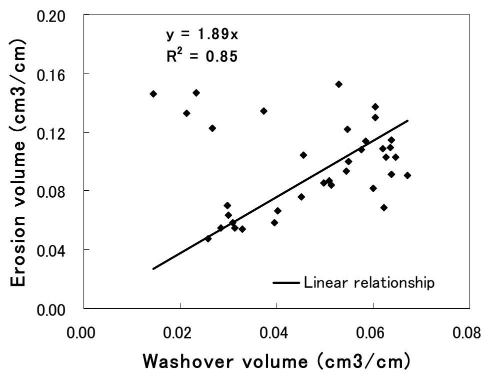

Fig.4 Relationship between erosion and washover rate

The evolution of barrier crest height and location are also need to be analyzed in order to see the impacts of storm to the beach. The results for all cases are illustrated in **Fig.5**. In natural condition, the beach face was eroded by wave acting then caused the lower crest. However, the beach crest is always accumulated in runup overwash cases. The more runup height is, the crest location will transport further inland direction. At the beginning state of inundation overwash, the beach crest is a little bit higher and quickly getting lower because of the second breaking wave occurred due to a sand bar formation at the nearshore. There was obtained a lot of deposited sediment on the bay side area in the inundation case. During the storm condition, it is in fact included two phrases. When the still water level is low the wave just eating the beach as same as in natural condition case, but as storm surge height increases by the time it made the wave can overtop the beach crest and deposit the sediment on the top of barrier by runup process (**Fig.5**).

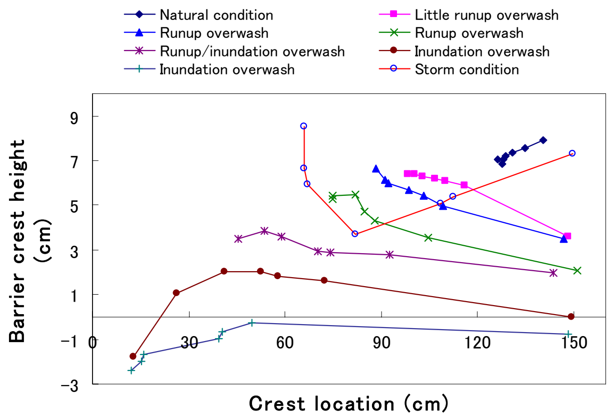

Fig.5 Barrier crest location evolution for al the cases.

4. CONCLUSION

This study has carried out a laboratory experiment on the impacts of storms to a sandy barrier island. The results have shown that the barrier crest height is often getting higher during the runup overwash cases. There a big amount of sediment was transported and deposited far on the back side of barrier island in the inundation cases and this state usually caused the barrier breaching. The erosion rate is in the factor of two compared with the washover rate.

ACKOWNLEGEMENTS

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