EFFECT OF NON-COHESIVE SEDIMENT TRANSPORT ON EROSION RATE OF COHESIVE MATERIAL

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1. INTRODUCTION

In the bank of the natural river, some layers of the bank material are composed of cohesive material (ex. the Mekong River in Vietnam). Cohesive sediment is a mixture of clay particles, silt, (fine) sand, organic material and so on. The cohesive properties arise from electrochemical forces in the clay-water medium. These forces usually dominate and larger than the weight force of individual particles[1)]. Therefore, this will have a certain effect to erosion on river bed. Hence, in order to understand the channel and bed deformation phenomena, erosion rate of cohesive sediment has been investigated by many researchers.

Bed material in river is non-uniform sediment. And non-cohesive coarse material and cohesive material coexist in rivers. For example, the coarse non-cohesive material in the Mekong River flows on the fine cohesive material in the Tonle Sap River during the flood season around Phnom Penh in Cambodia. This fact indicates that the cohesive material can be eroded by both non-cohesive material and water. Laboratory and in situ experimental have been conducted by many researchers (e.g. Parchure, TM., et al., Chapalain, G., et al., Roberts, J., Sekine, M. and Iizuka N. [2)], Aberle, J.). However, suggested erosion rate equations of cohesive material in these studies are the erosion rate by water only.

In this study, the erosion characteristics of cohesive sediment by both non-cohesive sediment and clear water are discussed. Flume tests are performed under various sediment supply conditions and two kinds of the sediment size are used.

2. FLUME TESTS

(1). Experimental Apparatus

Experimental setup is shown in Fig. 1. The experiments were carried out in the flume with 800 cm long, 15 cm wide and 25 cm deep. The base cohesive sediment used in this study was prepared from dry kaolin powder. Two types of feeding sediment are used in the experiment. The cohesive sediment was laid on the bed with 700 cm long, 15 cm width and 5 cm thickness. The water content was designed around 50%.

(2) Measurement Method

In order to evaluate the bed elevation change on the surface of cohesive sediment, bed elevations before and after each experiment were measured. Two high speed cameras set on the side wall and on the top of the flume to measure the water level changing, bed level changing and water velocity. Water velocity on the water surface was measured by floating material tracking method. Water temperature and water content also measure at every experiment.

(3) Hydraulics Condition

The slope of the channel is 0.004. Water discharge is 1.47 l/s. Water temperature was about 24 degree centigrade. In order to produce sediment transport of non-cohesive coarse sediment, non-cohesive coarse sediment was fed from the upstream of the flume during the experiments. Supplied sediment discharge is widely distributed from 0 to 1.5 times as equilibrium sediment transport rate. Fig. 3 and fig. 4 show the grain size distribution of the coarse sand number 4 and coarse sand number 6, separately. Mean diameter of sand number 4 is 0.88 mm and sand number 6 is 0.324 mm.

Key Words: Cohesive sediment, erosion rate, sediment feeding rate, non-cohesive material

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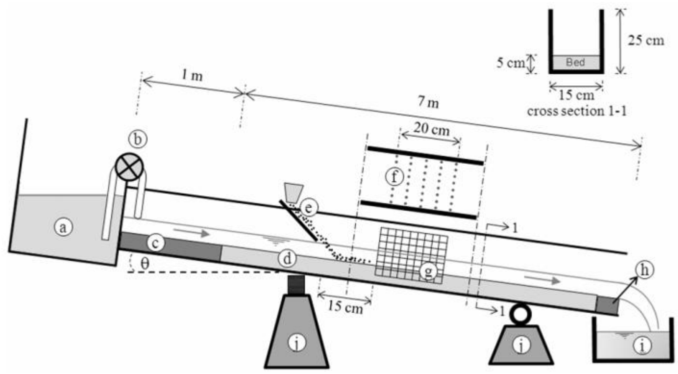

Fig. 1 Experimetal setup (a. water tank, b. pump, c. rigid bed, d.cohesive sediment, e. sediment feeding location, f. horizontal view of cross sections, g. screen grid, h. downstream weir, i. downstream tank, j. tilting machine)

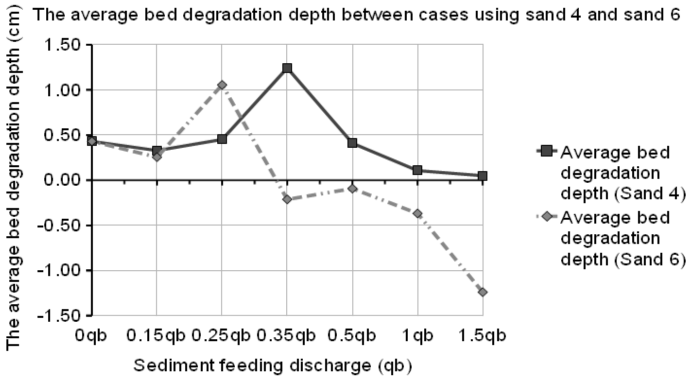

Fig. 2 Compare average bed degradation depth between cases using sand number 4 and 6.

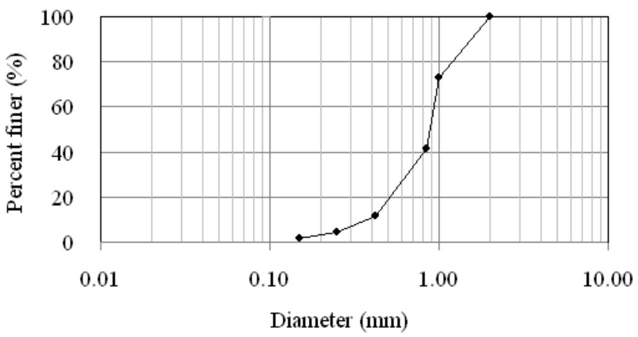

Fig. 3 Grain size sand number 4

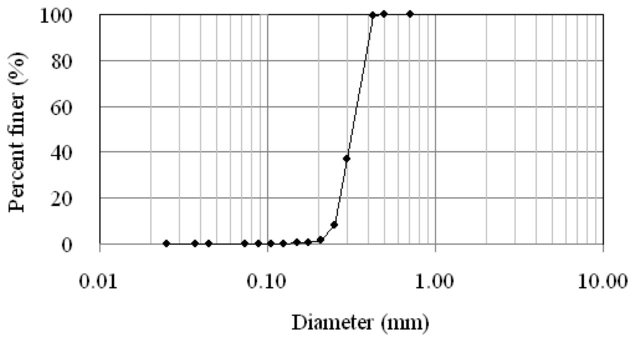

Fig. 4 Grain size sand number 6

3. RESULTS AND DISCUSSIONS

Fig. 2 show the average bed degradation depth for cases using sand number 4 and sand number 6, and the sediment feeding discharge is: 0qb, 0.15qb, 0.25 qb, 0.35qb, 0.5qb, 1qb, 1.5qb (qb is equilibrium sediment transport rate). The effect of sediment discharge is compared by use of the average bed degradation depth values. Bed degradation depth increases at 0.25qb for Sand 6 and at 0.35qb for Sand 4 as shown in Fig. 2. Furthermore, the bed degradation depth is smaller at 0.5qb, 1qb, 1.5qb in spite of the large sediment transport rate. This result indicates that bed erosion rate is increased with increase in sediment transport rate. However, the velocity of the transported sediment on the surface of the cohesive material becomes slower at 0.5qb, 1qb, 1.5qb comparing to 0.25qb for Sand 6 and at 0.35qb for Sand 4.

In cases using with sand 4 (for sediment feeding), erosion is reduced at 0.5qb, 1qb, 1.5qb but there is no deposition while deposition was happened too much in cases using with sand 6.

4. CONCLUSIONS

The erosion characteristics of cohesive sediment by both non-cohesive sediment and clear water are discussed by use of the flume tests. Obtained results are summarized as follows.

(1) This experiment proved that the maximum of erosion is happened when sediment feeding discharge is around 25%qb for Sand 6 to 35%qb for Sand 4 (qb is equilibrium sediment transport rate).

(2) Bed erosion rate is increased with increase in sediment transport rate, when the sediment transport rate is small. However, the bed degradation depth becomes smaller, when sediment transport rate is around the equilibrium sediment transport rate in spite of the large sediment transport rate.

5. REFERENCES

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