BEHAVIOR OF DRIFTWOOD-SEDIMENT-WATER MIXTURE FLOWS AT CHECK DAM

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1. INTRODUCTION

Hofu City in Yamaguchi Prefecture, Japan had heavy rain on July 21, 2009. This rainfall caused debris flows with a large amount of driftwoods in the Tsurugi and Hachimandani River. There are two successive closed check dams in the Tsurugi River and two successive open check dams in the Hachimandani River. These check dams deposited a large amount of sediment from the debris flows. In particular, the open check dams trapped a large amount of driftwoods in their opening (***Fig. 1***) and then a large amount of sediment in their back. It is pointed out that driftwoods play the important role in the debris flow deposition by open check dams (e.g. Shibuya et. al., 2009). The purpose of this study is to investigate experimentally the depositional process of sediment and driftwoods in the open check dams.

Fig. 1. *Check dam in the Hachimandani River.*

2. EXPERIMENTAL METHOD

The experiments are conducted to examine the depositional process of debris flow in the check dam models (***Fig. 2***). In the experiments, a rectangular flume is used as shown in ***Fig. 3***. It is 12 m long, 30 cm wide, and 32.8 cm high with smooth glass on the both lateral sides and a roughened bottom surface. The flume bed is composed of movable and fixed parts. The bed sediment and driftwood model are placed on the movable bed part and the check dam model is on the fixed bed part.

The mixture of three kinds of sediment grains, whose diameter d_{50} shows 22mm, 7.4 mm and 3.6 mm, is used as the movable bed material. The mixing ratio of the gravel, fine gravel and very coarse sand are 1: 2.5: 5. Their specific weight is σ/ρ=2.65. The representative diameter of the mixture is d_{50} =4.4 mm. The driftwood models are placed with their different directions on the movable bed surface. Number density of the model woods is 1 piece/(10cm*10cm). Four kinds of wooden cylinder are used as driftwood models; their diameter is 2.0 mm, 3.0 mm, 4.1 mm and 5.2 mm, respectively. Their length is set equal to 10 cm. Their specific weight is σ/ρ=0.76~0.65.

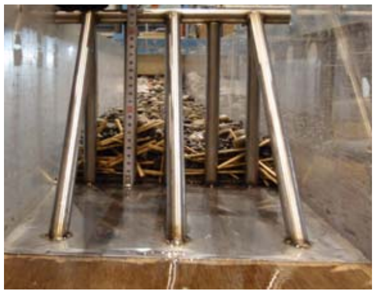

Fig. 2. *Check dam model in the flume.*

The stainless tubes with the diameter of 18 mm are used for the open check dam model (***Fig. 2***). The reduced size of the prototype is 1/50.

VCR cameras are installed on the top and right-hand side of the flume to record the depositional process of driftwoods and sediment. The flume is set at the slope angle of 8^{o}. The mixture flow of sediment, driftwoods and water can be triggered by the quick water inflow from the upstream end and then move downstream along the flume bed. Most of the driftwoods accumulate at the flow front and then arrive at the check dam model. Sediment follows the driftwoods accumulating at the flow front. Some amount of the driftwoods and sediment are trapped by the check dam and the other can passes through it.

The experimental conditions are shown in ***Tab.1***. For comparison, the experiment in the case of the closed type is also made. The duration of the water inflow from the upstream end is around 20 seconds. After stopping the water inflow, we measure the number of driftwood and the volume of sediment stopping and passing at the check dam model. The sediment bed elevation behind the check dam is also measured by the point gage.

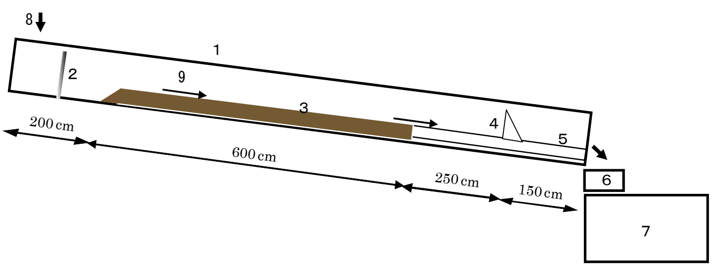

Fig. 3. *Laboratory flume: (1)Flume; (2)Filter; (3)* Movable bed; *(4) Check dam model; (5) Fixed bed; (6) Trap; (7) Water* tank; *(8) Inflow;(9) Surface flow*

3. EXPERIMENTAL RESULTS

Fig. 4 shows the ratios of driftwoods stopping and passing at the check dam model to total woods on the movable bed. It is found that about 30% of the all driftwoods pass through the check dam model and about 70% of the all driftwoods are trapped by the check dam model. In the case of the closed type, however, all the driftwoods can pass through the check dam model. ***Fig. 5*** shows the weight of sediment material deposited and passing at the check dam.

Tab. 1. Experimental condition

No.	Type	q^p_{wo} (cm^2/s)	q_g (cm^2/s)	θ_0 (°)	T` (s)	N_T Number of woods	L_t (m)	Note
1	Open type	101	-	8°	20.92	90	3	Without Stopper
2	Open type	104	9	8°	20.00	120	4	Without Stopper
3	Open type	101	5	8°	20.04	60	2	Without Stopper
4	Open type	102	8	8°	20.03	0	0	With Stopper
5	Open type	100	6	8°	20.09	180	6	With Stopper
6	Open type	102	8	8°	20.07	120	4	With Stopper
7	Open type	101	8	8°	20.26	60	2	With Stopper
8	Closed type	100	8	8°	21.32	120	4	With Stopper

Note :
q^p_{wo} = water discharge per unit width at the upstream
q_g = ground water flow per unit width
θ_0 = slope of flume
T` = Duration of experiments
N_T = Number of woods placed in the movable bed
L_t = length of the moveble bed with woods

The weight of sediment material deposited and passing at the check dam is around 15 kg and 4 kg, respectively. In the case without driftwoods, however, most of all the sediments can pass through the check dam model. Therefore, if the flow contains the driftwoods, 70~80% of the mixture flow can be trapped by the check dam model and its rest can pass through the check dam. ***Fig. 6*** shows the final longitudinal profiles of sediment deposition behind the check dam model. ***Fig. 7*** shows the final bed elevation at the check dam model. Although sediment bed elevation z_d at the check dam model increases slightly with the number of woods on the bed, the gross amount of deposited sediment becomes almost constant versus the number of woods.

4. CONCLUSION

The flume tests have shown that 70~80% of the mixture flow can be trapped by the open check dam model, if the flow contains the driftwoods. The open check dam effectively stops partially the driftwoods accumulated at the flow front. The mesh structure of the driftwoods at the open check dam deposits sediment in the subsequent mixture flow.

REFERENCES

Shibuya et.al. : Experimental study on trap performance of grid shape check dam on debris flow with woody debris, Journal of the Japan Society of Erosion Control Engineering, vol.62, No.1, p.66-73, 2009.

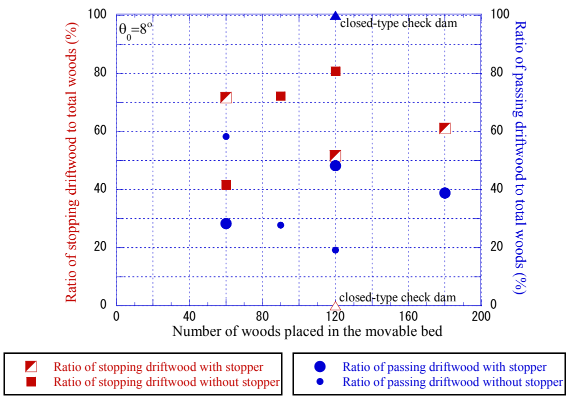

Fig. 4. *Ratio of driftwood stopping and passing at the check dam to total woods on the bed.*

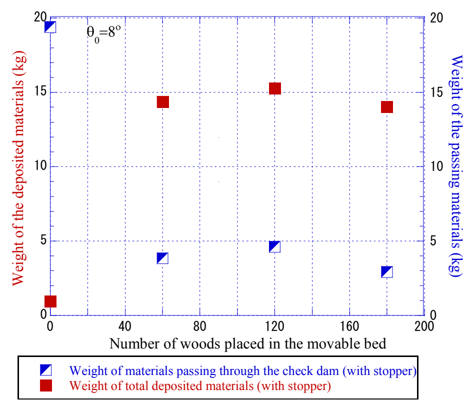

Fig. 5. *Sediment materials deposited and passing at the check dam model.*

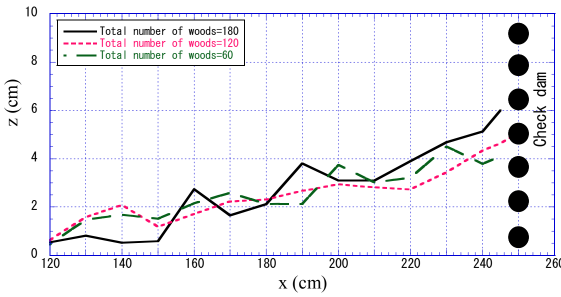

Fig. 6. *Longitudinal profiles of sediment deposition behind the check dam model.*

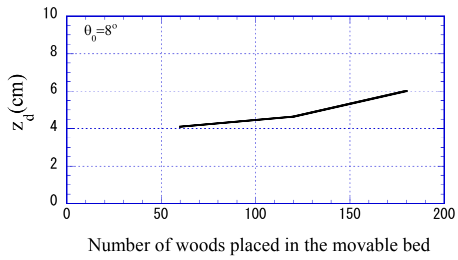

Fig. 7. *Final sediment bed elevation at the check dam*