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River Confluences With Spur-Dike

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1. Introduction

Although many researches in the field of river training have been done, but a little attention has paid at river confluences. Therefore, in the current contribution the authors have tried to introduce spur-dikes as a bank protection to stop migration of fixed channel banks and constrict the channel to increase the depth for other purposes. Accordingly a series of laboratory experiments with impermeable straight spur-dikes are carried out to test a suitable engineering works to solve the mentioned problems at river confluences. Different kinds of angles are performed. Length of dikes, spacing and their positions are considered. Moreover, maximum scour depth as a function of dike inclination angle and dike length are discussed.

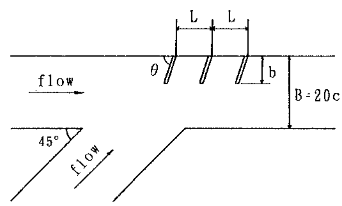

Fig. 1 Notation

Table 1 Experimental conditions

	θ	L (cm)	b (cm)	b/B	L/b	Maximum Scour Depth (cm)		
						Left	Middle	Right
G1R0	90	5	0.6	0.03	8.33	3.35	4.44	3.81
G1R1	90	5	1.0	0.05	5.00	3.78	4.27	3.46
G1R2	90	5	2.0	0.10	2.50	4.29	4.62	3.72
G1R3	90	5	3.0	0.15	1.67	5.74	5.24	4.15
G1R4	90	5	4.0	0.20	1.25	5.94	5.82	4.28
G1R5	90	10	3.0	0.15	3.33	6.23	5.65	3.87
G1R6	90	10	4.0	0.20	2.50	7.54	6.59	4.76
G1R7	90	3	0.6	0.03	5.00	2.89	4.64	3.90
G2R1	45	5	1.0	0.05	5.00	3.66	3.90	3.70
G2R2	45	5	2.0	0.10	2.50	4.00	5.11	4.10
G2R3	45	5	3.0	0.15	1.67	6.98	6.22	7.07
G3R1	135	5	1.0	1.05	5.00	4.60	4.20	3.17
G3R2	135	5	2.0	0.10	2.50	4.44	4.88	4.10
G3R3	135	5	3.0	0.15	1.67	5.15	4.83	3.66
G4R1	60	5	1.0	0.05	5.00	2.67	4.84	5.23
G4R2	60	5	2.0	0.10	2.50	4.07	4.98	3.52
G4R3	60	5	3.0	0.15	1.67	6.41	5.38	3.77
G5R1	120	5	1.0	0.05	5.00	4.68	6.76	4.73
G5R2	120	5	2.0	0.10	2.50	4.36	4.62	4.82
G5R3	120	5	3.0	0.15	1.67	4.71	5.10	3.85

2. Summary of experiments

The experiments are performed at river confluences flume as shown in Fig.1. The channels shape are rectangular, the main channel is 5.0 m long, post-confluence is 3.12 m long. The tributary is 2.10 m long, the cross-section for both main and tributary is 0.2 m wide and 0.2 m height. The confluence angle is fixed 45°. The flume bed is rough movable with uniform sand(dm =0.6 mm), slope is 1/200, water discharge ratio ($Q_{tri.}/Q_{total}$) is 0.5 and total discharge is 3.0 l/s. A series of closed type of spur dikes are set on the left side of the main channel confronted to the confluence as shown in Fig. 1 and Table 1, where θ is dike inclination angle, L is the distance between two neighboring dikes, b is the dike length and B is the channel width. After each run the flume is completely drained and the bed configurations are observed. After fixing the bed and flowing the water with the same previous conditions water depth are measured.

3. Results and discussions

3.1 Bed variation: Bed configuration are studied before establishing spur-dikes by Ahmed et al.[1] In the current contribution the authors carried out test cases under different discharge ratios and series of experiments with spur-dike as in table 1. For example fig.2(a) and (b) show bed contours for Test0 (without spur-dike) and G1R0. From these figures we can see that due to insert spur-dike, the bed level on the left side of main channel slightly

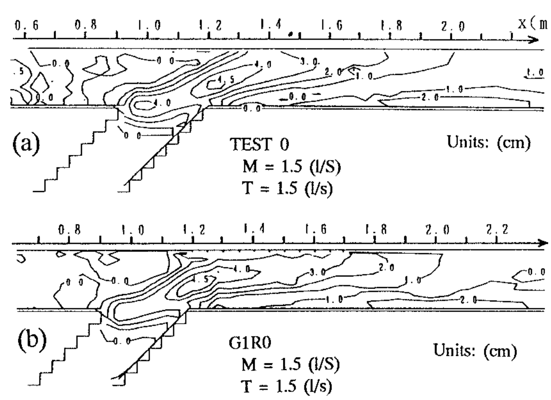

Fig. 2 Bed contours

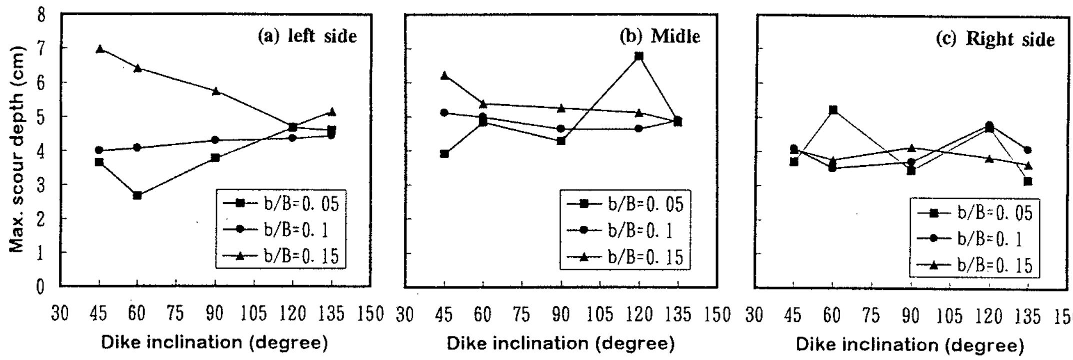

Fig. 3 Inclination angle vs Max. scour depth

rise up and maximum scour region in the middle of main channel is widen. This effectiveness are different with considering other inclination angle and length of spur-dike as explained later.

3.2 Spur-dike inclination angles: The relation between dike angle with different dike length and maximum scour depth are drawn as shown in Fig.3 (a), (b) and (c).

a) at the left side when the angle $\theta=60^\circ$ and b/B=0.05, the lowest scour depth are recorded. At $\theta=45^\circ$, 60° and 90° the maximum scour depth is proportional with b/B. On the other hand, when the angle is greater than 120°, the spur-dike length dose not clearly affect on maximum scour depth.

b) at the middle, the spur-dike inclination angle dose not influence on maximum scour depth and maximum scour depth is proportional to b/B.

c) at right side of main channel, the dike length and dike angle do not occur significant influence except case G4R1. In this case, at the left side, maximum scour depth is lowest. So that, this result caused by the replying of flow due to spur-dike.

3.3 Spur dike lengths for θ=90°: Fig.4 shows the relation between maximum scour depth against b/B on the left, middle and right side of main channel. At left side, maximum scour depth is increasing gradually with increasing b/B. At middle, maximum scour slightly decreased from 3 to 5% and proportionally increased gently with increasing b/B. At right side, the same goes as in the middle with slight difference and lower scour depth.

4. Conclusion

Generally, throughout the current study we can say that the most suitable inclination angle for spur-dike is 90_o and the most safe spur length b/B=0.03 to 0.05 with space between two neighboring dikes about L/B≤0.25.

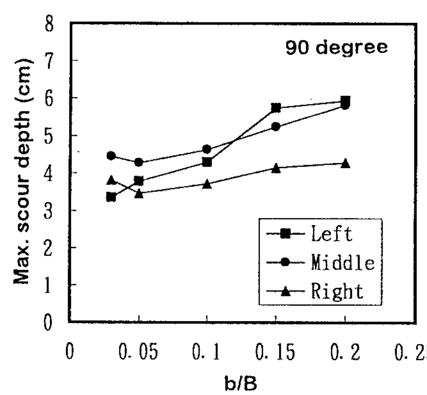

Fig. 4 Dike length vs Max. scour depth

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1. Ahmed A. Rady (1996). River confluences on alluvial streams with equal discharge and equal bed widths. Annual journal of Hydraulic Engineering, JSCE vol. 40, pp 907:913
2. Michiue, M, Hinokidani, O., Ahmed A. Rady and Nakai, K. (1996). Study on effect of spur-dikes on River confluences. Proc. of Annual Conference of Japan Society of Civil Engineering Chugoku Branch, April vol. 48