Analysis of Flow in Combined Channels

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1. Introduction

Channels are often in need to combine with each other in the practical life. So that, we have been considered such study to simulate 2-dimensional flow and 2-dimensional bed variation. In this study, different types(different angles) of combination have been considered. In this simulation we have found a satisfied results. The property of bed variation and the flow pattern have been investigated carefully through this study.

2. Conditions of calculation

The calculation conditions are shown as follows: slope of the main channel = 1/1000; slope of the tributary channel = 1/500; calculation time = 10 hr; Manning roughness = 0.025; main channel width = 100m; tributary channel width = 50m; Δt = 0.1sec; the combination angles = 90°(Type1),30°(Type2) and 45°(Type3) respectively as shown in Fig.1; finally the most critical condision on discharge have been considered with main channel discharge = $100m^3/s$ and tributary channel discharge = $200m^3/s$.

3. Basic equation of flow motion and bed evolution[1]

$$\frac{\partial M}{\partial t}+\frac{\partial}{\partial x}(u_0M)+\frac{\partial}{\partial y}(v_0M)=-gh\frac{\partial H}{\partial x}-\frac{\tau_{bx}}{\rho} \quad (1)$$

$$\frac{\partial N}{\partial t}+\frac{\partial}{\partial x}(u_0N)+\frac{\partial}{\partial y}(v_0N)=-gh\frac{\partial H}{\partial y}-\frac{\tau_{by}}{\rho} \quad (2)$$

$$\frac{\partial h}{\partial t}+\frac{\partial M}{\partial x}+\frac{\partial N}{\partial y}=0 \quad (3)$$

$$\frac{\partial Z}{\partial t}+\frac{1}{1-\lambda}\left(\frac{\partial q_{bx}}{\partial x}+\frac{\partial q_{by}}{\partial y}\right)=0 \quad (4)$$

where M and N are discharge flux = uh and vh respectively; h is water depth; H is water level; g is the gravity acceleration; u_o, v_o are depth average velocity in x and y direction respectively; z is the bed elevation; q_{bx} and q_{by} are bed load transport in x and y directions respectively and λ is the porosity of bed materials.

4. Initial and boundary conditions

(a) Initial Conditions: u=v=w=0 and h=constant(horizontal)
(b) Boundary Conditions: $Q_{upstream}$ and $Q_{downstream}$ are known.

5. Results and Discussion

The calculation results have been used for drawing water depth contours and flow velocity vectors as the initial state. Bed contours and flow velocity vectors after 10 hours for each type have been drawn. Also, some cross sections in each type have been drawn. For example Fig.2 and Fig.3 show the bed contours and flow velocity vectors after 10 hours on Type 1. As shown in these figures, the maximum scour depth have been occurred by the end of the tributary channel on the right side and also on the left side of main channel, scouring region occured due to the influence of tributary flow. Also strong eddies just downstream of the joint point have been occured. And due to that eddy, deposition region have been occured on the right side of the main channel. Fig.4(a,b and c) and Fig.5(a,b and c) show the bed levels after 10 hours at Cross section A-A and Cross Section B-B(as shown in Fig.1) respectively. Table 1 shows the scour depth on the left side of the main channel after 10 hours. After 10 hours, the behavior of the system in both main and tributary channels at the joint point have been almost the same in Type 2 and Type 3. But the influence of the combination angle in Type 1 have been stronger than both Type 2 and Type 3. On the other hand, the influence of the tributary flow at the scouring region on the left side of the main channel is decreasing in proportion to the combination angle.

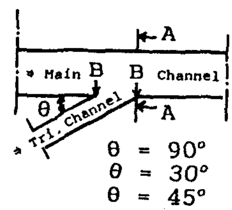

Fig.1 NOTATION

Table 1

Type No.	1	2	3
scour depth (m)	0.82	0.79	0.84

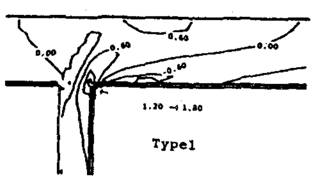

Fig.2

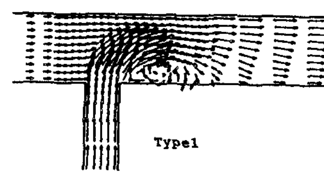

Fig.3

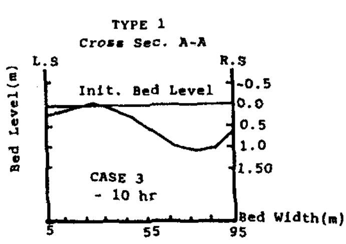

Fig.4(a)

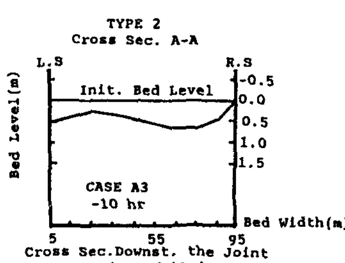

Fig.4(b)

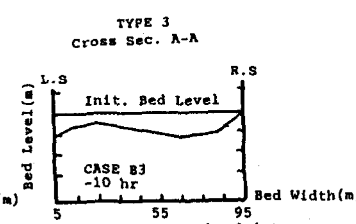

Fig.4(c)

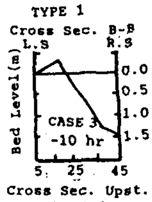

Fig.5(a)

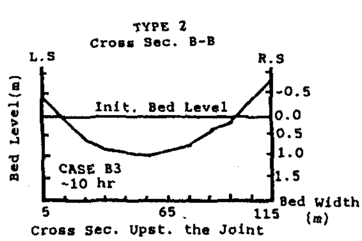

Fig.5(b)

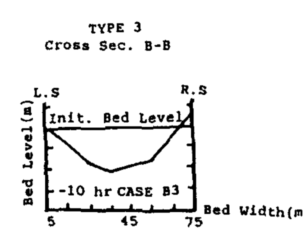

Fig.5(c)

References

1. M. Kida.et al " Prediction Method of Sediment Discharge from 2-D. Bed Variation Model", Proc. of Annual JSCE Meeting, Vol.2, pp.564-565, 1993, in Japanese.