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NUMERICAL ANALYSIS OF FLOW CHARACTERISTICS IN CONFULENT CHANNELS

Il Won Seo[1], Inhwan Park[2], Hyun Saing Mun[3], and In Gu Ryu[4]

Most natural rivers are consisted of the main stream and tributaries of various types. At the confluence of main stream and tributary channel, flow becomes complex due to geomorphologic change and difference of flow rate. At the downstream of junction, stagnation region occurs which is formed due to the centrifugal force induced flow change. Also, secondary currents occur in the opposite direction at both bank, and a skewed shear plane is developed between counter rotating secondary currents. Therefore, flow characteristics of confluent channel are very complex and thus pose a hydrodynamic importance in river engineering aspects. The dredging in the main channel causes the difference of the river bed elevation, and usually causes river bed erosion and sandbank creation at the junction. These problems may increase turbidity of the river due to suspended solids, and risk of collapse exists at the confluence of rivers.

In this research, a 3D hydrodynamic model, EFDC, was used to analysis the complex flow behavior in confluent channels with bed elevation difference. Furthermore, to prevent the scour problems that occur with the fall, a stair type bed sill was installed like as shown in Figure 1. The flow analysis was conducted to investigate the effect of the structure according to the difference of cascade fall size and slope. Confluent channel of Figure 1 has 0.9 m width for both main channel and tributary channel, and height H_b, length l of cascade fall were changed to investigate the variation of the vertical velocity at the confluence. The simulation conditions are listed in Table 1. Series TD in Table1 means simulation cases according to the dredging depth of main channel without cascade fall, series TDH is expermiments according to difference of cascade fall height, and series TDSL indicates experiments with change of cascade fall slope.

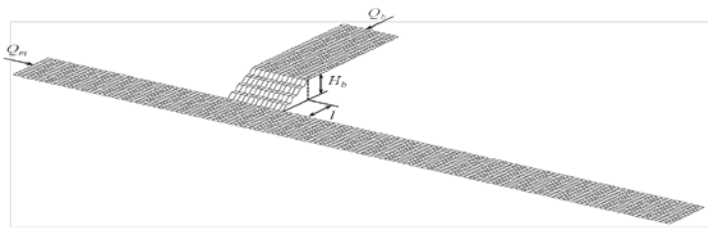

Figure 1 Computational mesh of confluent channel with stair type cascade fall

Table 1 Simulation conditions of EFDC

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Case	H_b (m)	S	l (m)	Q_m (m^3/s)	Q_b (m^3/s)
TD00	0.00	-	-	0.043	0.127
TD15	0.15				
TD30	0.30				
TDH1	0.27	0.25	1.10		
TDH2	0.37		1.46		
TDH3	0.46		1.83		
TDH4	0.55		2.19		
TDSL1	0.27	0.1	2.74		
TDSL2		0.2	1.37		
TDSL3		0.4	0.69		

The analysis results of Case TD showed that the water elevation increases while magnitude of velocity decreases as increasing dredging depth of main channel. The vertical velocity component goes up at the upstream of junction and goes down at the downstream region. Therefore, there is possibility that turbidity is increased by suspended solid at river-bed due to upwelling flow, thus river-bed maintenance structure is necessary. Magnitude of vertical velocity of series TDH increases as increasing H_b at junction. Results of series TDSL indicated that the steeper slope produces the higher vertical velocity when H_b is constant (Figure 2). For this reason, cascade fall of gradual slope is preferred to decrease turbidity and erosion at channel bed when dredging depth is determined.

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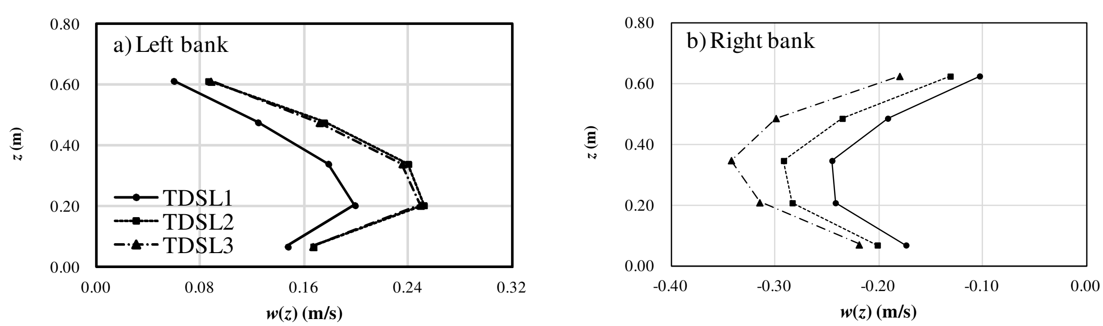

Figure 2 Vertical velocity distribution at the confluence according to cascade fall slope