II-168 FLOW MEASUREMENTS AT A 60-DEGREE CONFLUENCE

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1.Introduction

The three-dimensional complex flow in an alluvial river confluence is characterised by the presence of secondary flow, flow separation, depth rise, superelevation and confluence scour or complex bed topography. And these interrelated features which are undesirable in general, mainly depend on confluence angle, bed material, discharge ratio and Froude numbers. The complete understanding of such real river confluence flow is extremely difficult and yet far ahead although important in river engineering. Thus at this stage, at first, it is practicable to attempt a simplified confluence flow similar to limited previously reported studies both analytical and experimental (eg.1-3). Accordingly, present paper describes the laboratory experimental results of mean flow in a confluence of 60 under clean water and plane bed conditions. The recirculation zone, the secondary flow are exhibited by the results and also the results documented here will be usefull in analytical model verificaton in future.

2.Experimental apparatus

The experimental facility is shown in fig.1. The main channel of 15.5m long, post-confluence length being 8.5m, has a cross-section of 0.5m wide and 0.2m deep. The branch channel is 4m long and its cross-sectional dimensions are width of.3m and height of .2m. The confluence angle is fixed to 60 degrees. The joint at the bed is smooth and plane whereas joints at the wall are sharp and verical. The traverse above the confluence makes it possible to reach any point in the confluence region convieniently. The water is recirculated by a centrifugal pump connected between the downstream spillway box and the upstream feeders of both channels. The two valves provided enable to control inflow to both channels and also to reproduce the same flow conditions easily at any time. The main channel discharge is monitered by a V-notch and the branch channel discharge by an orifice manometer. Screens and bell-mouths provided at the entrances allow flows to develop fast in the upstreams. A beam of 12cmX12cm, which runs continuously under the main channel, firmly supports it, and the branch channel are supported by the jacks placed throughout at 1.8m intervals. Moreover regular side supports are provided to have a twist-free channel sections.

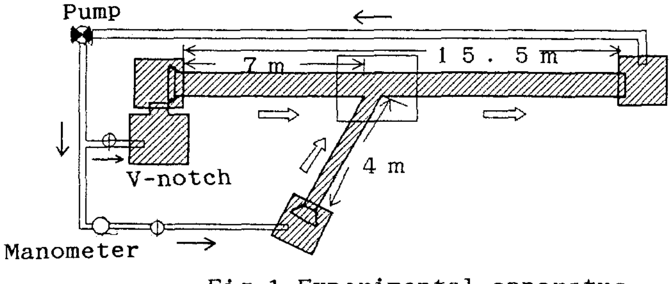

Fig.1 Experimental apparatus

Thereby in the present case the bed slope was adjusted to 1/1000 throughout. The discharge ratio was 0.6 and the post confluence discharge was 16 l/s. The water depth was adjusted by the downstream control so that constant water depth(8.9cm) appeared before the control or uniform flow prevailed. The measurements of two velocity components, longitudinal and lateral, were then carried out by an electromagnetic currentmeter utilising an AD converter.

3.Results and discussion

Figs. 2(a) to 2(d) depict the velocity vectors of the mean flow at four different levels. The prominent feature is the existence of recirculation zone due to the separation caused by steep pressure curve at the the left bank corner. Also it can be justified the existence of two counter rotating secondary flow vortices in confluences, namely strong vortex that prevails in the branch channel to the left bank of the main channel and relatively weak vortex toward the right bank of the main channel, as demonstrated by numerical models(2,3). The measurements were possible only upto 2cm from the bed and the walls due to the restriction of the currentmeter, but near flows were observed by visualization techniques. Hence, the secondary flow at the near bed was observed to be stronger than, about twice of, that in fig.2(a). The size of recirculation zone becomes smaller at lower depths as seen. And this fact is mainly due to the entraintment of water from the branch channel caused by the strong secondary flow directed towards the left bank at lower depths. Measurements also show the larger velocities experienced by the water from branch at the confluence before mixing takes place. Figures also show the occurence of maximum velocity below the surface due to strong secondary flow in the region. Deceleration of velocity at inner banks of both channels before the corner is also seen. In fact, flow separation due to the adverse pressure gradient was observed very close to the wall in this corner. On the contrary, flow is accelerated along the rigt bank of the main channel.

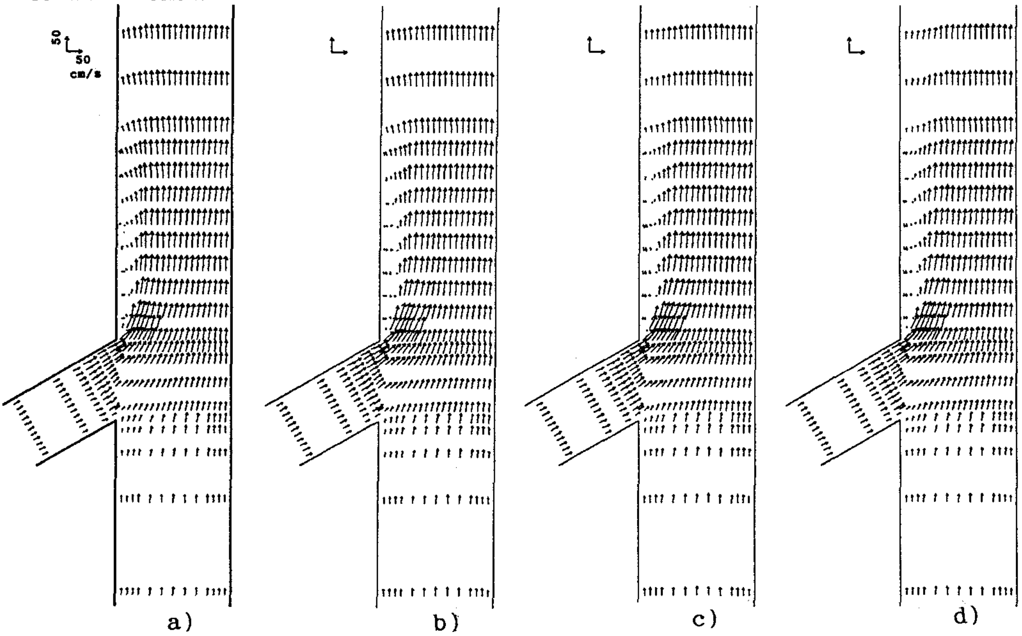

Fig.2 Velocity vectors a) At 2cm from bottom b) At 4cm from bottom c) At 6cm from bottom d) At 1.5cm from surface

4.Conclusions

1. The recirculation zone in a confluence becomes smaller as the distance from the bottom decreases.
2. Strong secondary flows in a confluence region cause maximum velocity to dip considerably from the free surface.

5.References

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