

Study of flow bifurcation at the 30° open channel junction with the various width ratios of the main and the branch channel

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1) Introduction

Junction flow characteristics of the open channel bifurcation for the small width ratio of main and the branch channel have been extensively researched in past¹⁾. In order to find out the effect of large width ratio in change in flow characteristics, experiments were performed in the hydraulic flume having 30° intersection with the width ratio of 1:17⁵⁾. It was understood that bottom and surface dividing streamlines didn't end at the point of the left wall of the branch channel entrance edge but extend little ahead along the main channel extension and then return back to the branch channel causing flow to separate along the left wall of the branch channel. In the case of junctions of the small width ratio (1:1, 1:2) with the equal or less flow division at the branch channel, separation zone always formed along the right wall of the branch channel. In the present research the effect of the change of the width ratios on the flow characteristics were analyzed.

2) Experimental set up

Experiment were carried out in the hydraulic flume with the rough bed having Manning's coefficient $n = 0.012$ and 4.5 cm wide branch channel with smooth bottom and junction intersection of 30° . The slope of the main channel and the branch channel was kept to be almost horizontal. The width of the main

channel was changed to 45.00 cm, 31.50 cm and 18.00 cm in order to make the junction width ratio 1:10, 1:7 and 1:4 respectively. Water surface profiles are measured with the point gauges and dividing streamlines and the separation zones were pointed out with the dye injection. Flow conditions were varied at the junction by manipulating the gate provided at the end of the main channel. Discharges were measured with the bucket and stopwatch.

3) Experimental output

(1) For the junctions with the width ratios greater than 1:7 and the flow conditions at the main channel with Froude Number up to 0.4, the change pattern of the bottom and surface dividing streamlines were found to be almost similar. Separation zone were always found to be forming along the left wall of the branch channel. (Fig. 1)

(2) Water surface profile along the surface dividing streamline and along the main and the branch channel walls were also found to be not much varying up to the above-mentioned flow conditions and the junction width ratios.

(3) For the junction with the width ratio less than 1:4 and flow condition with the small Froude Number at the main channel, separation zone formed along both the sides of the branch channel and with the increase of the Froude Number, separation zone formed only along the right wall of the branch channel. (Fig 1)

Key words: flow separation, dividing stream line, junction width ratio, discharge division, water surface profile
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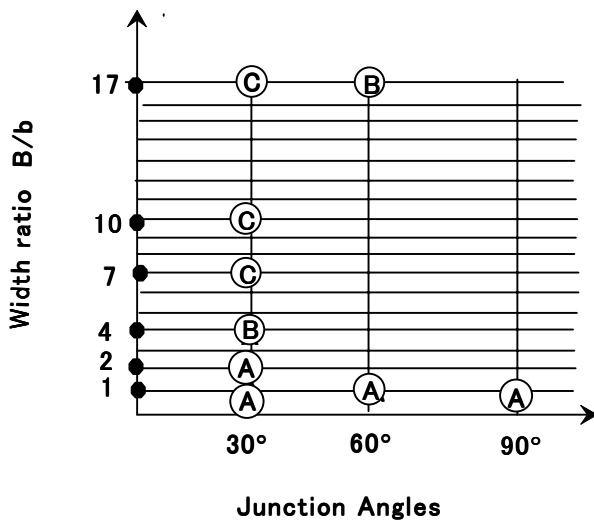
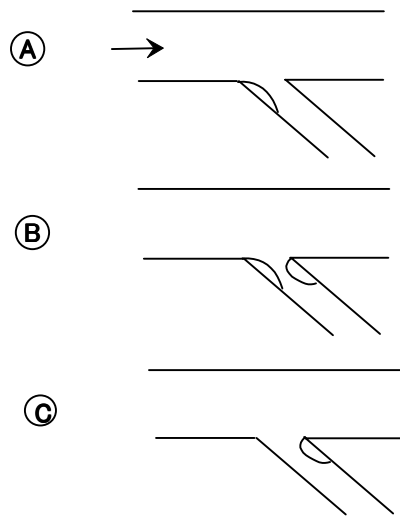


Figure 1. Formation pattern of separation zone at the Branch Channel
B–Main Channel width, b– Branch Channel width



4) Analysis of the results

As the water surface profiles and the flow characteristics are found to be not much varying for the junction flow with the width ratios greater than 1:7, theoretical relationship for the calculation of discharge division for the junction of width ratio 1:17⁵⁾, was also checked for the other width ratios. The calculated discharge agreed well with the measured one for all the cases. (Fig. 2)

5) Conclusion

At the junctions with the width ratios greater than 1:7 and approaching Froude Number at the main channel up to 0.4, separation zone always formed along the left wall of the branch channel. Flow characteristics and water surface profile are found to be similar, which would allow generalizing flow characteristics at such junction width ratios and flow condition.

6) References

- 1)Shiu Wai Lai, Allen J Reynolds, "Dividing Flow in Open Channel"Proceeding ASCE,1966
- 2) Lakshmana R.N.S, Sridharan K." Division of Flow in open Channels" Journal of the Central Board of the Irrigation and Power, India, Vol 24, No. 4, 1967

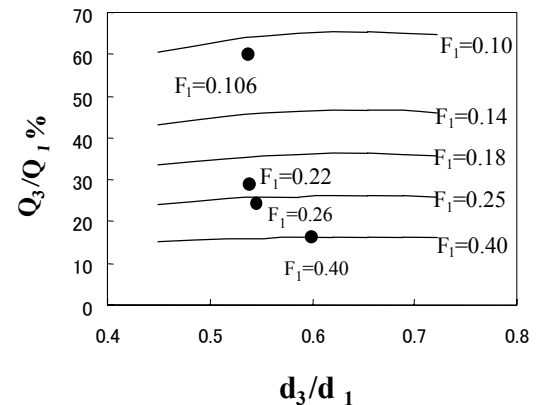


Figure 2. Theoretical relationship for the discharge division for Branch Channel with free flow condition (1:7 width ratio and 30° intersection)

- Q_1, d_1 – Discharge and water depth at Main Channel
 Q_3, d_3 – Discharge and water depth at Branch Channel
 • – Measured discharge division

- 3) Vincent S. Neary, A. Jacob Odgaard "Three Dimension Flow structures at Open Channel Junction" Journal of Hydr. Engineers ASCE, 1993, 119(11)
- 4) Lakshmana R.N.S., Sridharan K., Baig M.Y.A. " Experimental study of the division of flow in an open channel" Australian Conf. on Hydraulic Mechanics, Sydney Australia
- 5) Lama Sunil Kumar "Study of flow bifurcation at the 30° open channel junction when the width ratio of branch channel to main channel is large". Annul Journal of Hydraulic Engineering, JSCE, Vol. 46, 2002, February.