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Investigation of Transverse Distribution of Pollutant and Flow Pattern in the Present of Triangular Vane in the Straight Channels

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1. Introduction

The transport of pollutants in the large rivers especially in the lowest downstream reach of a river, in which the velocity and the intensity of flow turbulent becomes very low, are mostly performed to a great extent by dispersion. Any measure to enhance the turbulent intensity by generating the vortices in the flow field will increase both longitude and transverse diffusive coefficients which in turn will accelerate the transfer of pollutants. The study of Sharma and Ahmad (2012) showed that the submerged vane increases the transverse mixing of pollutants in the streams. In the present study the effect of triangular vane on of transverse distribution of pollutant is investigated. Triangular vanes are structures which are installed at an angle of 20°–30° to the flow and inclined into the stream bed for banks protection. Bahrami-Yarahmadi and Shafai-Bejestan (2016) studied the application of triangular vanes attached to the bed in a 90-degree river bend and concluded that this measure modifies the sediment pattern in such a way to protect the banks from erosion. In their study the 3D components of flow velocity were also measured in tests with and without an installed single vane. The results show that the triangular vanes create a clockwise counter secondary flow cell near the bank, which counteracts the clockwise main secondary flow cell in the bend for a distance of about 5*le* (*le* is the vane's effective length) downstream of the vane's position. Therefore in this study the effect of triangular vane on transverse mixing is investigated.

2. Experimental phase

Based on the purpose of the present study, the experiment is performed in a rectangular flume of 0.8 m width and 10m length. A salt solution was used as a tracer, and a concentration tool measuring equipments consisted of conductivity probes to measure concentration in four cross sections at the same time (figure 1). The velocity and depth of flow were respectively 0.2, 0.25, 0.3 0.35 m/s and .15m. The vane was triangular and made of plexiglass with a thickness of 4 mm. The effect length of vane is 30% of width of the flume and angle between the vane and the main flow directions 45 (figure 2).

The three-dimensional (3D) velocity components were measured using the electromagnetic velocity meter JFE ALEC model ACM3-RS. The flow pattern is measured in 14 points in transverse of flume and seven points of depth of flow. The sampling rate was 20 Hz and the minimum time of sampling was 10 seconds.

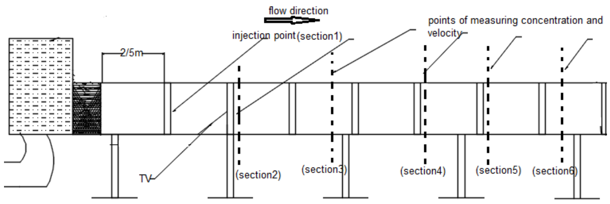

Fig. 1. Layout flume

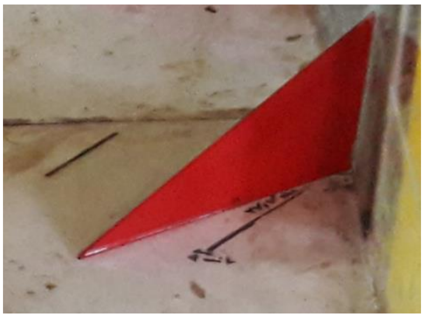

Fig. 2. Traingular vane

3. Results and discussion

3.1. Effect of triangular vane on distribution of concentration

The results about distribution of concentration of tracer for two conditions with vane and no vane are depicted (Figures 3 and 4). As it is shown, the distribution of concentration is more disperse in the transverse direction when the triangular vane is installed and it causes the distribution of concentration to be more uniformed in transvers direction. Also, figure 5 shows the effect of triangular vane on variance for four cross sections. As it is shown, the triangular vane increases the variance of concentration about 30% compared to the case of no vane and the effect of triangular increases in distance far from vane.

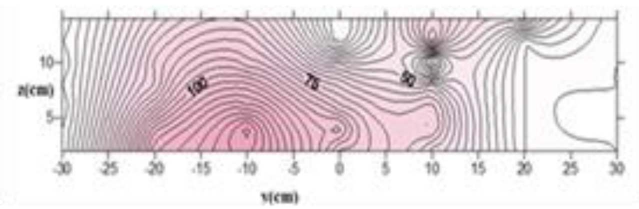

Fig. 3. Tracer distribution at a section for no vane

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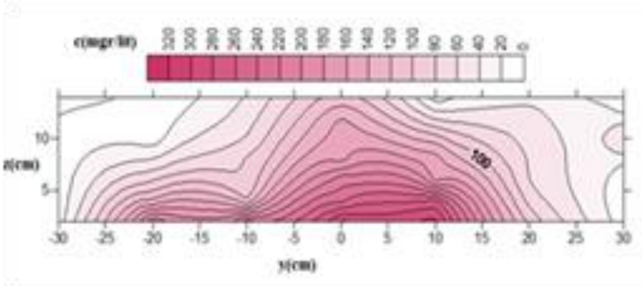

Fig. 4. Tracer distribution at a section for with vane

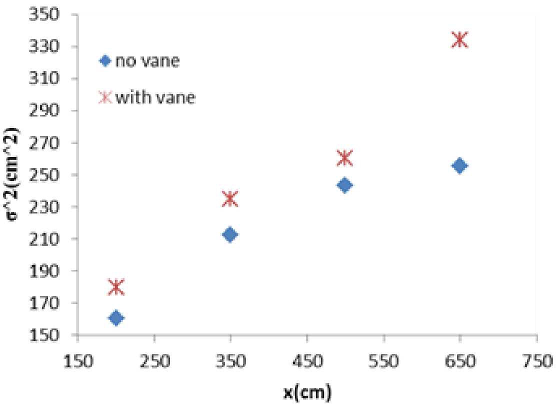

Fig. 5. Variance of concentration for four cross sections

4. Conclusion

Three important parameters that enhance the transverse mixing in the flow are turbulence, shear velocity, and secondary currents. As the flow pattern shows, the presence of the triangular vane in the flow, guidance the near-bed flow to moves from the middle of the flume toward the bank and the near-water surface flow guidance from the bank toward the middle of the flume clearly indicate the formation of a counterclockwise secondary flow cell. Because of such a pattern the transverse mixing is increased. The results also show that the variance of concentration increases about 30% compared to when there is no vane. Also, the peak point of mean concentration decreases about 80% compared to when there is no vane.