ESTIMATION OF TRANSVERSE DISPERSION COEFFICIENT BASED ON SECONDARY FLOW IN SINUOUS CHANNEL

KYONG OH BAEK [1] and IL WON SEO [2]

[1] Post Doctoral Research Associate, School of Civil, Urban, Geosystem Engrg., Seoul National University. San 56-1 Shinlim-Dong Gwanak-Gu, Seoul, Korea.
(Tel: +82-2-880-8355, Fax: +82-2-873-2684, e-mail: kopaek1@ snu.ac.kr)
[2] Professor, School of Civil, Urban, Geosystem Engrg., Seoul National University. San 56-1 Shinlim-Dong Gwanak-Gu, Seoul, Korea.
(Tel: +82-2-880-7345, Fax: +82-2-873-2684, e-mail: seoilwon@snu.ac.kr)

When a two-dimensional analysis of the tracer mixing is performed in sinuous channels, it is essential to determine the transverse dispersion coefficient with the secondary flow taken into consideration. Due to the geometric complexities caused by the sinuosity and varying cross-section shape, secondary flow, which plays an important role as the hydrodynamic effect on the transverse mixing, is developed. Even though the secondary flow is weak compared to the primary flow, this helical motion can increase the transverse mixing rate significantly. The effect of the secondary flow on the transverse mixing of a tracer is illustrated in Figure 1. This figure shows the spreading of the vertical line source at various distances downstream from the injection point. The secondary flow distorts the tracer plume and generates significant concentration gradients in the vertical direction (Figure 1b). The vertical mixing then tends to mix this distorted tracer distribution from top to bottom (Figure 1c). Thus, as shown in Figure 1d), exiting from the bend, the tracer plume may be considerably wider than the corresponding plume in the straight channel. This result indicates significant additional transverse mixing due to the secondary flow (Almquist and Holley, 1985).

In this study, the theoretical formula for the transverse dispersion coefficient based on the secondary flow was newly proposed. To validate the theoretical prediction, both flow and tracer experiments were conducted in the S-curved laboratory channel having a rectangular cross section. The experimental results for secondary flow showed that the growth and decay of the helical motion repeated along the channel, and two-cell system of the helical motion was observed at certain sections. In order to consider the longitudinal variation of the shear effects on the transverse velocity, the shear factor was introduced. The transverse dispersion coefficients based on the shear factor were predicted and compared with the observed transverse dispersion coefficient. The results showed that the predictions by the proposed equation were in good agreement with the observed values, whereas, other existing equation did not predict well.

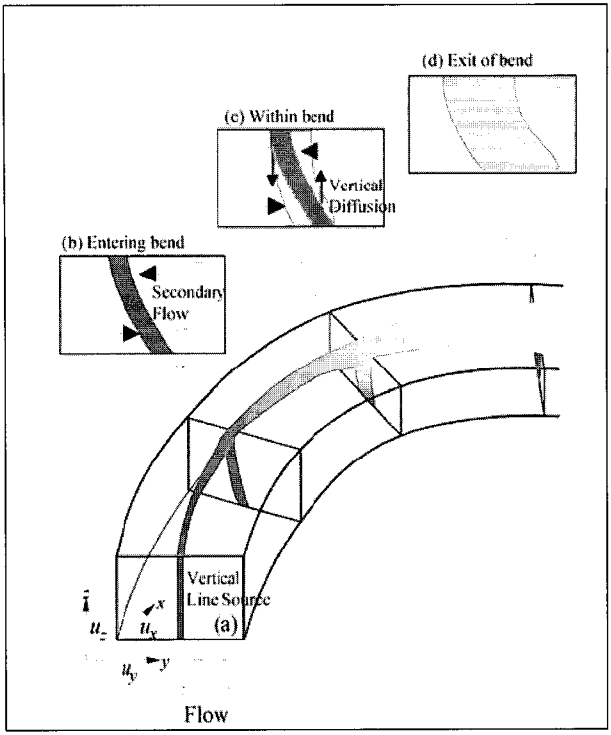

Fig. 1 Effect of Secondary Flow on Transverse Mixing

REFERENCES

Almquist, C. W., and Holley, E. R. (1985). "Transverse mixing in meandering laboratory channels with rectangular and naturally varying cross sections." *Technical Report CRWR-205*, Univ. of Texas, Austin, Texas.