PREDICTING TRANSVERSE DISPERSION COEFFICIENT IN NATURAL STREAMS

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Determining the transverse dispersion coefficient (TDC) is essential for analysis of 2-D mixing in natural streams. However, because of the difficulty in performing the tracer tests in natural streams, the empirical and theoretical equations are necessary to predict the value of TDC without tracer tests. In this study, a new dispersion coefficient equation that can estimate the TDC by using only hydraulic and geometric data in natural streams has been developed. Seo et al. (2004) performed the tracer tests and proposed the TDC using concentration data. However, to propose more precise and general empirical equation, the results of tracer tests in foreign countries were collected. Total 32 cases in 16 streams were collected, and among those cases, 16 cases were used for proposing the new empirical equation, and the other 16 cases were used for verifying the proposed equation.

In this study, the form of function, which was derived by the relationship between TDC and hydraulic and geometric parameters, hypothesizes as a form of the standard nonlinear multiple models.

$$D_T / HU_* = a_0 \left(S_n\right)^{a_1} \left(\frac{U}{U_*}\right)^{a_2} \left(\frac{W}{H}\right)^{a_3} \quad (1)$$

where D_T is the transverse dispersion coefficient; H is a cross-sectional mean depth; and U_* is the shear velocity; U is a mean velocity; W is a width; S_n is a sinuosity. To represent the characteristics of meandering in natural stream, sinuosity was used, because sinuosity takes the radius of curvature, central angle, and meandering amplitude into consideration (Chang, 1988). Taking logarithms of Eq. (1) and considering the dimensionless TDC as α , the linear multiple form can be derived as follow;

$$\ln(\alpha) = \ln(a_0) + a_1 \ln(S_n) + a_2 \ln\left(\frac{U}{U_*}\right) + a_3 \ln\left(\frac{W}{H}\right) \quad (2)$$

The solution of the transformed model is usually obtained by a least-squares method in which a sum of the squares of the residuals is minimized. The main disadvantage of least squares fitting is its sensitivity to outliers. Outliers have a large influence on the fit because squaring the residuals magnifies the effects of these extreme data points. To minimize the influence of outliers, robust least squares regression method was used. The new regression equation derived by using the robust regression method is given as

$$D_T / HU_* = 0.0291 \left(\frac{U}{U_*}\right)^{0.463} \left(\frac{W}{H}\right)^{0.299} \left(S_n\right)^{0.733} \quad (3)$$

The 16 data sets are used to verify the newly proposed equation. The predicted TDC through Eq. (14) and the predicted TDC through Bansal (1971)'s equation and Gharbi and Verrette (1998)'s equation are plotted in Fig. 1 with the measured TDC. As shown in Fig.

1, the proposed equation predicts the values of TDC very well, while Bansal's equation and Gharbi and Verrette's equation overestimate the values of TDC because these equations were developed using the result of field tests in which the values of TDC are relatively large. Verifying the new proposed equation using several methods, it is shown that the proposed equation is better than any other equations.

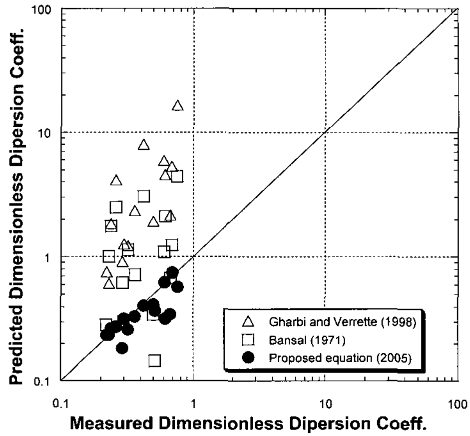

Fig. 1 Comparison of the TDC equations

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