PREDICTION OF LOCAL PIER SCOUR UNDER LIVE-BED CONDITIONS

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Abstract

This paper presents a formula developed for predicting local scour depth around a bridge pier in cohesionless soil based on field data. The semi-theoretical equation for scour prediction proposed by Nghien [1] is considered and improved by incorporating Froude number into the calculation of the hydrodynamic drag force coefficient C_d. By performing field data-based analysis and comparing the results with ten formulas published in the literature, it is concluded that the proposed formula for predicting local scour depth under live-bed conditions could provide the closest prediction to the measurement and observation data.

Introduction

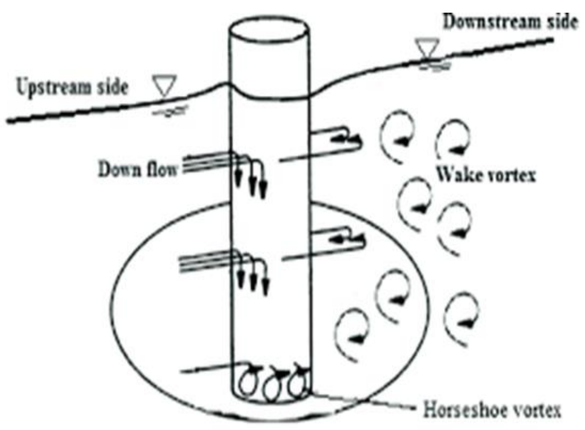
- [1] introduced a semi-theoretical equation for predicting scour at bridge pier in cohesionless soils in Eq. (1).

$$h_s = \frac{1,13}{\sqrt{C_d}} K_1 \sqrt{Dh} (V/V_c)^n \quad (1)$$

- This equation is applicable to both clearwater and live-bed conditions with different power values of n and cohesionless bed materials.

- The article focuses on using actual field data with the desire to find a certain agreement with the hypothesis of the theoretical model of the local scour mechanism around piers and the predictive derivative expression h_s used in design.

- The drag coefficient Cd in Eq. (1) will be analyzed in more detail.



Methodology

In the equation (1), the drag coefficient C_d of the hydrodynamic force acting on the circular pier can be written as follows:

$$C_d = F_D / \left[(1/2) \rho (DhV) \right] \quad (2)$$

This coefficient is not constant. In a rectangular channel, the dimensional analysis for drag coefficient Cd is a function of the following seven parameters:

$$C_d = \left(Sh, Re_p, \frac{k_p}{D}, Fr, I_t, \frac{D}{B}, \frac{D}{h} \right) \quad (3)$$

For cylindrical piers in subcritical flow, drag coefficient can be assumed:

$$\frac{1}{\sqrt{C_d}} = C_1 Fr^m \quad (4)$$

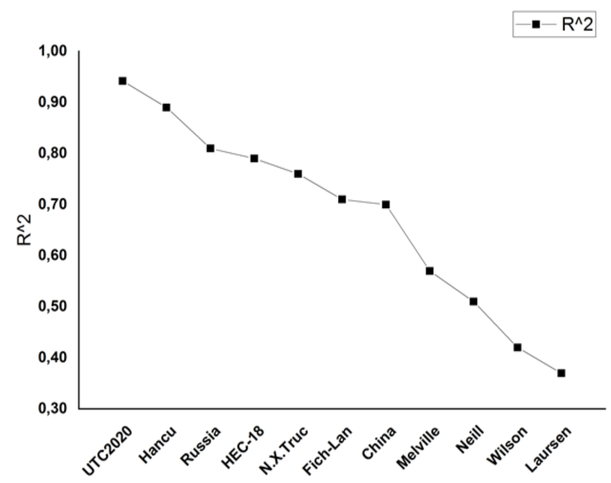
Combining Eq. (4) with Eq. (1) gives an expression in which the three parameters including m, n powers, and K coefficient can be determined based on the field data.

Results

- The proposed formula predicts the local scour hs at the circular cylinder under the live-bed with the correlation coefficient R = 0.9. Scatter and statistical evaluation criteria for expression Eq. (6) are given K = 1.06; m = 0.52; n = 0.8; R = 0.9

$$h_s = 1.06 (Dh)^{0.5} Fr^{0,52} \left(V / \sqrt[3]{gh\omega} \right)^{0.8} \quad (5)$$

- Comparison of different approaches for predicting local scour depth.



Conclusion

- The results of previous studies on the calculation of local scour at bridge piers show that there is a significant difference that seems to be smaller than reality measures.

- A formula for local scour calculation (Eq. (6)) has been developed by adding the drag coefficient Cd into the equation proposed by Nghien [1] to improve this distinction.

- Based on the analyses and comparison of a total of 119 real measured data, it is concluded that the current formula for local scour calculation could give better results than the ten considered approaches existing in the literature in the same conditions.

Acknowledgements

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