Two-Dimensional Hydraulic and Scour Analysis of Cohesive Soils at Select Bridges in Illinois

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Abstract

Theoretical predicted scour depths at bridges that assume all soil is cohesionless often leads to an overestimation of scour if cohesive soils are present. To better understand the response of cohesive soils to scour processes at bridges, advanced collection techniques and testing of material are necessary to provide a more realistic evaluation of erodibility. Additionally, hydraulic analysis that accounts for multi-dimensional flow behavior and the distribution of velocity and energy losses specific to hydraulic structures are necessary to provide a better result of estimated scour depths. Currently, the Illinois Department of Transportation (IDOT) is using the Erosion Function Apparatus (EFA) and a scour depth reduction table created through prior research efforts, whereas the Federal Highway Administration (FHWA) has developed new devices, the in-situ scour testing device (ISTD) and the portable scour testing device (PSTD). In cooperation with the IDOT, Southern Illinois University Edwardsville (SIUE) and the U.S. Geological Survey (USGS) will develop a procedure to improve the reliability of estimated scour depths in cohesive soils. SIUE will conduct traditional and advanced collection and testing of material to develop a procedure while the U.S. Geological Survey (USGS) will conduct hydraulic and scour analysis. This procedure is planned to be used at 15 bridge sites across Illinois with hydraulic and scour analysis by the USGS using a modernized approach incorporating the Sediment and River Hydraulics - Two-Dimensional model (SRH-2D) at 6 of the 15 bridge sites. The collected sampling material (ISTD and PSTD) and resulting test data will be incorporated into Hydraulic Engineering Circular No. 18 (Richardson and Davis 2001) equations using the bridge scour tool in Surface-water Modeling Solution (SMS) software (Aquaveo 2019) along with the FWHA Hydraulic Toolbox. In addition, traditional single-point sampled materials will be furnished by SIUE and evaluated by HEC-18 for comparison with the advanced collection methods (ISTD and PSTD) for cohesive soils. A comparison of the current IDOT scour reduction table (Straub et al. 2013) will be made with the new scour analysis procedure.

References

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