Development of New Design Guidelines for Protection Against Erosion at Bridge Abutments

Presentation Topic

A numerically-based approach is used to obtain a size selection formula for the riprap stone part of the apron used to protect wing-wall and spill-through abutments against erosion. The mean flow fields and the bed shear stress distributions are obtained from fully three-dimensional, non-hydrostatic RANS simulations. Series of simulations with a given mean riprap diameter are conducted to estimate the maximum bed shear stress over the riprap apron and then the maximum (critical) Froude number at which riprap stones will resist shear failure by the flow for cases where the abutment is placed in straight and curved channels with or without a floodplain. For abutments placed in straight channels, the numerically predicted critical value of the Froude number corresponding to shear failure of the riprap is in between values where no riprap entrainment and, respectively, riprap entrainment were observed in laboratory experiments for a given riprap size. Simulation results also show that some of the existing design formulas (Lagasse et al., Pagan-Ortiz) for wing-wall and spill-through abutments placed in straight river channels are not conservative enough for relatively large floodplain widths.

These design formulas also do not account for the increase in the erosive capability of the flow near the outer-bank abutment for cases where the bridge is situated in a region of significant channel curvature. Using data from numerical experiments, two-parameter design formulas for riprap size selection are proposed. These new formulas account for the effects of bank curvature, floodplain width and relative abutment length.

About the Speaker

Dr. George Constantinescu is a Professor in the Civil and Environmental Engineering Department at the University of Iowa and a Research Engineer at IIHR-Hydroscience and Engineering. Dr. Constantinescu got his Ph.D. at the University of Iowa in 1998. Following this, he occupied various research positions at Arizona State University and at the Center for Turbulence Research and the Center for Integrated Turbulence Simulations at Stanford University where he worked on the development of novel numerical algorithms for simulation of complex turbulent flows. He then joined the University of Iowa as an Assistant Professor in 2004. His research program is based on the use of numerical simulations to understand hydrodynamics and transport processes in rivers and lakes. Dr. Constantinescu's current research focuses on turbulence, sediment transport and local scour, stratified flows, shallow flows, eco-hydraulics, numerical modeling of floods and flow in porous media. He published over 100 journal papers and is the co-author of a monography on Large Eddy Simulations in Hydraulics.

Join us via livestream:

October 23, 2020
2:00 PM Central Time

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