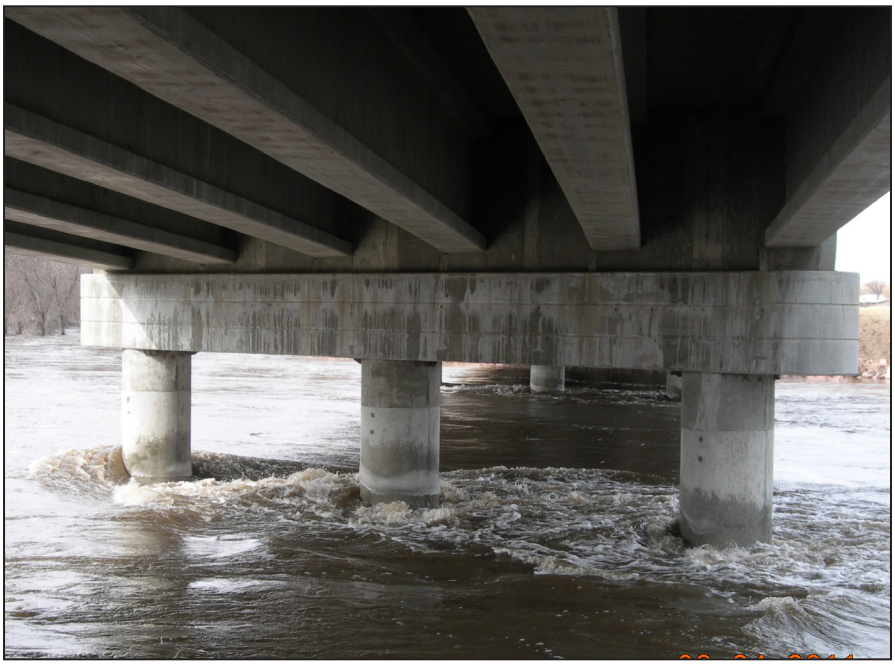
MOUNTAIN-PLAINS CONSORTIUM

RESEARCH BRIEF | MPC 22-459 (project 531) | May 2022

Flood Hydrograph Generation for Predicting Bridge Scour in Cohesive Soils



the ISSUE

The method currently used by the South Dakota Department of Transportation for designing bridge foundations assumes that the bed material is sand and designs for a single (worst-case) flood event, such as the 100-year or 500-year flood using the peak flow magnitude. This approach is generally regarded as conservative because the duration of flooding events in many watersheds in South Dakota is not long enough to generate equilibrium scour, and the bed material is more likely to be cohesive. An improved method could reduce foundation costs in cohesive soils and increase the confidence level of foundation designs for some bridge sites and projects.

the RESEARCH

Scour rates in cohesive soils (SRICOS) simulations were conducted for pier scour at the SD13 bridge over the Big Sioux River and Interstate 90 bridges over the Split Rock Creek, and for contraction scour at the SD37 bridges over the James River. The scour analysis was conducted by varying the soil critical shear stress and erosion rates over a range of values representative of cohesive and non-cohesive soils. The results were analyzed to better understand the relationship between time sequence of flows, rate of scour, and final scour depth to answer the fundamental question of how the characteristics of a hydrograph, such as flood magnitude and duration, and the order of flood occurrence would influence scour development in cohesive soils. Researchers also developed a hydrograph generation method for using the SRICOS method and a screening tool to determine whether use of the SRICOS method is beneficial for a given project.

MOUNTAIN-PLAINS CONSORTIUM REGION 8

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Project Title

Flood Hydrograph Generation for Predicting Bridge Scour in Cohesive Soils

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the FINDINGS

SRICOS simulations show that significant reduction in the predicted scour depth occurred only in regions III (medium erodibility) and IV (low erodibility) of the soil erodibility charts by Briaud et al. (2011), and that a continuous hydrograph may be replaced by a sequence of maximum annual floods for the purpose of scour prediction. Three levels of assessment are proposed for evaluating pier and contraction scour in cohesive soils. The level I assessment is a basic analysis like the procedure for scour evaluation in traditional approach. In the level II assessment, scour histories of past floods are computed using a measured soil erosion function to assess the potential of floods of different return periods to produce scour. In the level III assessment, the LP-III distribution is used to generate annual maximum series for SRICOS simulations, and a design scour depth is selected by examining the risk value of the predicted scour depth.

the IMPACT

The results of this research are directly applicable to practice, first by giving the design engineer a screening tool to identify bridge sites where the SRICOS method may be beneficial or more appropriate than the traditional methods, and second by providing a step-by-step procedure to generate flood hydrographs for scour prediction using the SRICOS method and assessing the scour risk. When use of the SRICOS method is advisable, substantial savings in foundation costs and scour countermeasures may result, and this can be measured by the dollars saved in bridges built over waterways.

For more information on this project, download the Main report at https://www.ugpti.org/resources/reports/details.php?id=1082

For more information or additional copies, visit the Web site at www.mountain-plains.org, call (701) 231-7767 or write to Mountain-Plains Consortium, Upper Great Plains Transportation Institute, North Dakota State University, Dept. 2880, PO Box 6050, Fargo, ND 58108-6050.