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Protection of bridge foundations against scour using partially grouted riprap

Many of the rivers in India and Pakistan have flood velocities exceeding 10 ft/sec. Both hydraulics and geology of the river bed and banks play an important role in erosion of soil for peak floods. Sediment deposit (aggradation) and scour (degradation) determine the rate of flood flow at the bridge site. Sand supporting the bridge foundation is more vulnerable to scour compared to non-weathering rock such as igneous and sedimentary rock. There are several types of countermeasures recommended by FHWA HEC-23, depending upon the type of scour. These include, river training, hydraulic (armoring), structural and monitoring using instrumentations and sensors. The depth of scour at foundations is computed by HEC-18 scour analysis for peak flood conditions for probability of maximum flood which is intense (50-year), more intense (100-year) and most intense (500-year). Due to the large number of bridges on a given river, cost of the foundations and scour protection is kept as low as possible. All important aspects specific to scour conditions need to be identified through an in-depth review of inspection reports of scour critical bridges. A detailed review of all available resources on scour countermeasure design, including HEC 11, 18, 20 and 23, CIRIA Manual (2002), NCHRP 24-07 report, scour countermeasure drawings by Maryland State Highway Administration and numerous research articles on scour countermeasure design, should be carried out to recommend effective countermeasures suitable to river conditions. The design calculations for selected countermeasures should consider besides cost, constructability and environmental constraints specific to hydrogeology conditions. The engineers should refer to specific Hydraulic Engineering Circular, in case of more detailed information on specific aspects of scour countermeasure design. The most widely used armoring countermeasures are riprap of varying sizes. However for fast flowing rivers, due to high kinetic energy of flood water passing though a narrow bridge opening the stone tends to be displaced and washed downstream causing foundation failure. The alternative is to use partial grouting of the top most layers by converting the dumped stones to stone masonry. Full grouting will be expensive and with cement powder polluting the river during construction is not acceptable for environmental permit. Guidelines for partially grouted riprap countermeasures are given.

Biography

Mohiuddin Ali Khan studied at Imperial College and Southampton University, England. He performed research at Northwestern University, USA. He is an expert on flood control at highways and bridges and has designed many important bridges to resist floods. He is the author of several textbooks with McGraw-Hill and Elsevier Science and many technical papers in journals. As founder Chairman of ASCE Structural Engineering Institute Philadelphia, his chapter received best U.S. Chapter award. In the Hydrology 2013 Raleigh Conference, he chaired the second day session and presented a paper on flood scour analysis.

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