ANALYSIS OF UNCERTAINTIES IN BRIDGE SCOUR ESTIMATION

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Abstract

Different studies (e.g. Yao et al., 2015; Maddison, 2012; FEHA, 2012; Wardhana and Hadipriono, 2003) indicate that from all natural hazards, scour is the most common cause of the bridge failures worldwide. The EU/FP7 funded project Bridge SMS combines hydraulic, hydrologic, geotechnical and structural expertise and incorporates them into a complete bridge management system. Under the Bridge SMS management system, scour depth is estimated for selected pilot bridges taking into account flow and soil characteristics data. The proposed methodology considers discharge-stage and discharge-velocity rating curves as inputs for scour depth estimation based on empirical models. For most of the bridges the flow parameters are not readily available at the bridge site and are required to be acquired indirectly through numerical models. In many cases, the long-term flow regime is also unknown due to lack of hydrometric stations and detailed field data in the vicinity of the bridge site. For such cases, specific design flow events can be computed with the rainfall run-off models using rainfall Depth Duration Frequency (DDF) curves and catchment characteristics as inputs. Results from the rainfall-runoff models are calculated as flow hydrographs at the designated locations along the catchment/watercourse. However, uncertainties within the proposed methodology arise from unreliable input data and tools that simplify physical processes. This includes complex rainfall and run-off patterns and catchment characteristics, among other reasons. This study focuses on the quantification of the effect of uncertainties for scour depth estimation during flood events (with Annual Exceedance Probability 1%) associated with hydrological and hydraulic input variables. A range of rainfall events with different durations from 100-year return period DDF curves are simulated using different rainfall-runoff model set-up in order to obtain peak hydrographs, the peak hydrograph is then fed-in the hydraulic model and detailed flow environment at the bridge profile is computed. The calibration of the hydraulic model is carried out using water levels recorded during bathymetry survey, i.e. during low flow conditions, and as such might be unsuitable for high water flows. For different combinations of input variables scour depths are obtained from empirical equations. The impact of the uncertainties associated with the input variables at the final scour depth calculation is analysed and quantified for various pilot bridge sites. The quantification of these uncertainties will help to understand the accuracy level required for scour hazard estimation, providing also important information for the implementation of the bridge management system.

Keywords: bridge scour, flood hazard, uncertainty estimation, hydraulic model.

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