Remote Real-time Riprap Protection Erosion AssessmenT on large rivers – R3PEAT

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Introduction

Large number of bridges in Europe are at the end of their life span, while the frequency of occurrence for extreme climatic events, driven by climate change, is increasing. Floods influence morphodynamic changes in the riverbed, such as scouring of the riverbed next to the bridge substructure, that can undermine the overall stability of the bridge.

Placement of riprap protection around bridge piers is an approach that doesn't solve scouring problem, it rather displaces the scour hole elsewhere in the river channel. Most frequent cause of degradation of riprap protection next to the bridge piers is undermining of its toe, which causes washing away of individual stones from riprap, in turn leading to displacement of scour hole.

Traditional approach to scour monitoring is effective only if surveys are conducted during the flood conditions, while the data acquired post-flood can underestimate the full potential of flood hazard. Detailed field surveys of hydraulic parameters during floods are essential in the understanding of morphodynamic evolution of the river channel, but are often scarce because they are time consuming and require extensive resources (e.g. the survey equipment).

Objective

The goal of the R3PEAT project (Remote Real-time Riprap Protection Erosion AssessmenT on large rivers) is to bridge the gap between the real-time scour hole development and flow environment through development of real-time scour monitoring system.

Hydraulic laboratory

Current flume in hydraulics laboratory is being refurbished and equipped with pumps, measuring devices, etc.

Flume is 18 m in overall length, with 10 m of working length, and 0.9 m of both height and width.

Figure 1. Refurbishment of the hydraulic flume

Methodology

The research focus of the project is investigation of scouring processes next to the riprap protection around bridge piers - existing structures whose stability and safety are unknown in the hydraulic environment under the influence of climate change.

Research methodology combines experimental investigations on scaled physical model (Phase I) with 3D numerical model (Phase II) into hybrid modelling approach, calibrated and validated with field surveys.

The research objectives of the project are:

(1) develop ScourBuoy prototype;
(2) calibrate the physical model with field surveys;
(3) improve existing empirical equations for equilibrium scour hole development using hybrid modelling approach;
(4) investigate the dependence between turbulent flow characteristics and temporal scour hole development;
(5) investigate dependence between turbulent conditions and incipient motion of sediment particles.

Physical model will be verified against the data acquired during field surveys on selected pilot locations.

3D numerical model will be used to simulate flow conditions on wider river reach. Numerical model will be calibrated using physical model data.

Pilot locations

For field surveys several well-known pilot locations have been selected:

(1) Railroad bridge Osijek
(2) Railroad bridge Jasenovac
(3) Railroad bridge Varaždin
(4) Railroad bridge Botovo

Pilot bridges have been selected for detailed analyses because they are located in morphodynamically active environment that is expected to cause rapid scour hole development under flood conditions.

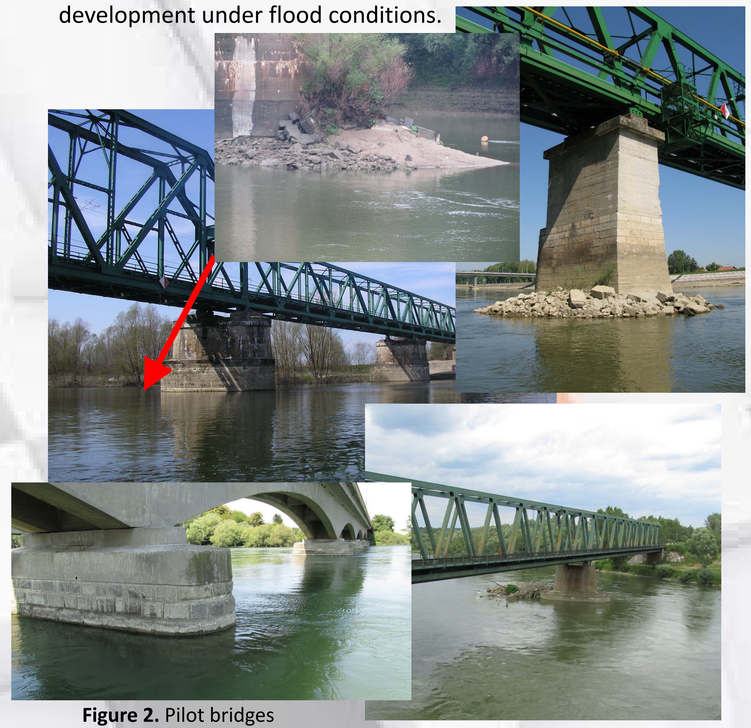

Figure 2. Pilot bridges

Conclusion

The impact of the proposed project on the bridge management systems is expected through the development of a practical remote real-time system for erosion estimation around the riprap protection on large rivers that can be basis for the real-time decision support system.

Under the project two young researchers will develop their careers, each of them developing skills and conducting research ultimately leading to the PhD degree.