The management of sediments near infrastructures founded on mobile beds

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Introduction: Infrastructures such as bridges are simultaneously influenced by and influence both the sediment transport and the river or estuarine morphology. The interventions in bridges often have impacts on sediment transport, hence being necessary to consider the mitigation measures technically feasible with an appropriate cost. The management of sediments around infrastructures is focused on their safety and also on safety criteria for navigation, among other river uses.

The present study emphasizes the main situations related with infrastructures founded on mobile beds, in rivers and estuaries, such as predictions of the bed morphology, erosion and sedimentation and time variations of the bed.

Methods: The impact of infrastructures on the sediment transport in rivers can be characterized by some experiments of local scour around complex piers that are being carried out in the framework of a current study. The experimental campaign includes tests run on a 40.0 m long glass-sided rectangular tilting flume at LNEC, having a cross section 2.0 m wide and 1.0 m deep. The study discusses the results obtained in other experimental facilities in two Portuguese Universities within the framework of the research project. In all the experimental campaign the mobile bed was simulated with uniform quartz sand of median size 0.86 mm. Hence, a large set of experiments is obtained, considering different pier geometries and hydraulic flow ratios.

Results: In addition to the observation of local scour around the bridge piers, process in which the eroded material is transported from the obstacle vicinity hole to the downstream area, the study results include data also used to obtain a general understanding of the bed morphology. Both the transported and the deposited materials downstream the piers produce large shallow bars that can be hazardous to navigation. According to Apitz (2012) it is necessary to carry out a sustainable sediment management to maintain the navigational channels. Fig. 1 shows one of the mentioned bars in a flume experiment of local scour around complex piers, where the upper part, a), shows the final result in plan view and the lateral view is included below, b). As confirmed by the study tests, mitigation of this impact can be obtained by means of scour protection procedures, where both conventional or non-conventional methods produce downstream bars with reduced dimensions.

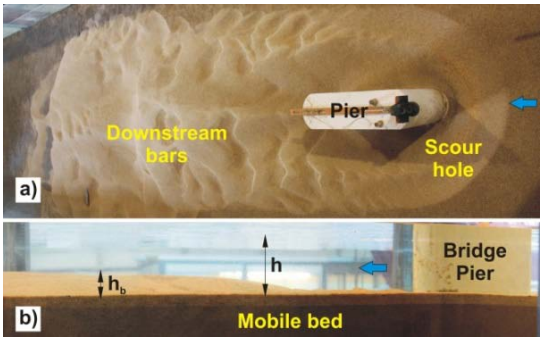

Fig. 1: Laboratory results showing the downstream bars of bridge piers: a) plan view and b) lateral view.

Discussion: Experiments as the example of Fig. 1 make it possible to deduce a new prediction method for evaluating the maximum scour holes developed. This result is used for safety purposes in bridge design criteria and represents the influence of the movable bed changes on the infrastructure. On the other hand, the same tests can produce additional results, in particular when characterizing the influence of the infrastructure on the downstream initial movable bed. This characterization includes the evaluation of the extensions of bars and the induced reduction in the water depth, h, by the bar height, h_b, parameter that becomes relevant when the question is related to evaluating the potential of navigation. The sediment management in this case can be oriented to determine the dredging volumes necessary to the navigation targets.

Experimental results include several geometries and situations, such as closer approximation to real cases. This is the case of obstacles skewed to the main flow direction, which can produce more extended and complex bars. Additionally, some indications can be outlined, such as the case of piers near banks.

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