Replicating channel bottom morphology of meandering fluvial channels: an experimental approach

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Understanding morphodynamic evolution of meandering fluvial systems, along with internal architecture of related deposits have remarkable implication for landscape management and subsurface exploration. Laboratory experiments provided remarkable insights to these research issues, by contributing to understand hydrodynamics of meander bends along with controls on their initiation, planform evolution and abandonment. Experimental studies were mainly structured in order to have a fixed-bed, which have non-erodible boundaries and no sediment transport, or movable-bed where the substrate can be remobilized by a flow. Fixed- and movable-bed experiments contributed mainly to hydrodynamic and morphodynamic investigations, respectively.

Mobile sediment in fixed meander planforms has been sporadically used in laboratory experiments. In this work, we explore the effectiveness of this approach to reproduce channel bottom morphologies, including spatial distribution of pool and riffle zones. In order to achieve this goal, we planned a comparison between bottom morphology of two meander bends of the Wabash River (Illinois, USA), and experimental topographies obtained through a number of experiments at the Department of Geoscience, University of Padova. The two meander bends of the Wabash River are sited ca. 6 km upstream from Grayville, where the river is ca. 300 m wide and up to 10–12 m deep. Channel-bottom morphology of these two bends was depicted by Konsoer et al. (2016). The experimental scaled model of this reach of the Wabash River occupied a tiltable platform, that was 3.0 m long and 1.5 m wide. The experimental channel belt included a total of four bends, named 1 to for moving downstream. Bends 2 and 4 were used for the comparison. The width of experimental channels was scaled at 0.08 m, and the total length of the channel reach to ~7 m. Meander bend planforms were milled in wood with a pantograph on the base of the CAD-extrapolated Wabash River centerline. The river banks were made by two 0.1 m high metal sheets which were placed vertically, screwed to the pantographed wooden path and sealed to it by smeared silicone. This apparatus was located on top of the platform. Experimental channel was filled with sediment up to 6 cm from its bottom, and water and sediment were supplied to the upstream termination of the channels. Water was fed through recirculating system, and sediment was delivered by means of an adjustable sediment feeder.

Eight experiments were performed with grain sizes varying from fine to very coarse sand and lasted from 1 to 5 hours according to the run suites. Sediment supply rate was defined in accordance with water discharge and basin slope by applying the solid transport laws as revised by Bathurst et al. (1987), which proved to better suit the boundary conditions of our experimental setup. Preliminary results highlight that experimental channel bottom morphology is comparable with that of the study prototype, especially in relation with spatial distribution of pool erosional depressions and riffle topographic highs in the bend inflection zones.