Meander Flume Outlet Sediment Scour Analysis of a Boxed Culvert

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Abstract

The main reason for its instability is sediment scouring downstream of hydraulic structures. Both physical and numerical models have been used to investigate the influence of soil properties on scour hole geometry. Nevertheless, no research has been conducted on resistance parameters that affect sedimentation and erosion. In addition, auxiliary structures like wing walls, which are prevalent in many real-world applications, have rarely been studied for their impact on morphology. The hydraulic characteristics of steady flow through a boxed culvert are calibrated using a 3D Computational Fluid Dynamics model compared with experimental data in this study, which shows a good agreement between water depth, velocity, and pressure profiles. Test cases showed that 0.015 m grid cells had the lowest NRMSE and MAE values. It is also possible to quantify sediment scour numerically by testing roughness/d_{50} ratios (c_s) and diversion walls at a meander flume outlet. According to the findings, c_s = 2.5 indicates a close agreement between numerical and analytical results of maximum scour depth after the culvert; four types of wing walls influence geometrical deformation of the meander flume outlet, resulting in erosion at the concave bank and deposition at the convex bank; two short headwalls are the most appropriate solution for accounting for small changes in morphology. A numerical model can be used to estimate sediment scour at the meander exit channel of hydraulic structures based on the roughness parameter of soil material and headwall type.

Keywords: sediment scour, numerical model, roughness, wing walls, meander channel