An automatic rotating annular flume for cohesive sediment erosion experiments: Calibration and preliminary results

Steven Figueroa*, Minwoo Son**

Abstract

Flows of water in the environment (e.g. in a river or estuary) generally occur in complex conditions. This complexity can hinder a general understanding of flows and their related sedimentary processes, such as erosion and deposition. To gain insight in simplified, controlled conditions, hydraulic flumes are a popular type of laboratory research equipment. Linear flumes use pumps to recirculation water. This isn't appropriate for the investigation of cohesive sediments as pumps can break fragile cohesive sediment flocs. To overcome this limitation, the rotating annular flume (RAF) was developed. While not having pumps, a side-effect is that unwanted secondary circulations can occur. To counteract this, the top and bottom lid rotate in opposite directions. Furthermore, a larger flume is considered better as it has less curvature and secondary circulation. While only a few RAFs exist, they are important for theoretical research which often underlies numerical models. Many of the first-generation of RAFs have come into disrepair. As new measurement techniques and models become available, there is still a need to research cohesive sediment erosion and deposition in facilities such as a RAF. New RAFs also can have the advantage of being automatic instead of manually operated, thus improving data quality. To further advance our understanding of cohesive sediment erosion and deposition processes, a large, automatic RAF (1.72 m radius, 0.495 m channel depth, 0.275 m channel width) has been constructed at the Hydraulic Laboratory at Chungnam National University (CNU), Korea. The RAF has the ability to simulate both unidirectional (river) and bidirectional (tide) flows with supporting instrumentation for measuring turbulence, bed shear stress, suspended sediment concentraiton, floc size, bed level, and bed density. Here we present the current status and future prospect of the CNU RAF. In the future, calibration of the rotation rate with bed shear stress and experiments with unidirectional and bidirectional flow using cohesive kaolinite are expected. Preliminary results indicate that the CNU RAF is a valuable tool for fundamental cohesive sediment transport research.

Keywords : Rotating annular flume, Cohesive sediment, Bed shear stress, Erosion, Floc

* Member · Post-doctoral Researcher, Dept. of Civil Eng., Chungnam National University

· E-mail : stevenmiguelfigueroa@gmail.com

** Member · Associate Professor, Dept. of Civil Eng., Chungnam National University