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Flocculation and settling characteristics of mixed sediment suspensions

Farzin Samsami and Alan J.S. Cuthbertson
Heriot-Watt University, School of the Built Environment, United Kingdom (f.samsami@hw.ac.uk, a.cuthbertson@hw.ac.uk)

Estuaries and nearshore coastal areas are amongst the most productive, dynamic and complex ecosystems in the world. Many of these estuaries and sheltered inshore waters (e.g. tidal inlets and embayments) have bed sediments consisting of mixtures of cohesive mud and non-cohesive sands. Whilst extensive studies have been conducted on transport processes associated with sand- or mud-only sediments, there remains limited knowledge on the physical behavior (e.g. flocculation and settling) of sand-mud mixtures. Because of important differences in cohesive and non-cohesive sediment behavior, it is essential to investigate the small-scale processes associated with mixed sediments, which typically occur under strongly time-dependent flow conditions and concentration gradients generated by tidal cycles and/or unsteady wave fields. The aim of this study is thus to quantify the fundamental dynamic processes for cohesive and non-cohesive sediment mixtures over a wide range of steady and unsteady (cyclic) turbulent flow conditions.

The experimental studies are performed in a 2.1 m long by 0.25 m diameter settling column installation in the School of the Built and Environment at Heriot-Watt University, UK. Controlled and repeatable hydrodynamic forcing conditions (i.e. zero-mean shear turbulence) can be generated in the column through the oscillation of a fixed, regular array of grids. Within the experimental runs, pure kaolin clay and superfine, well-sorted silica sand are used to represent the cohesive and non-cohesive sediment fractions, respectively.

Results are presented herein from a series of parametric experimental runs investigating temporal variations in the flocculation and settling characteristics for both purely cohesive sediment suspensions (i.e. kaolin clay) and cohesive and non-cohesive sediment mixtures (i.e. kaolin clay-sand). These results include physical descriptions of mixed sediment flocculation under steady and unsteady (cyclic) grid-generated turbulence, quantification of flocculation and settling time scales for these mixtures and their temporal response to changes in background grid-generated turbulence levels.