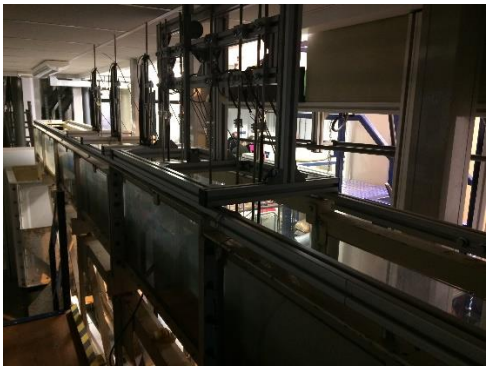
UK Fluids Network Short Research Visits

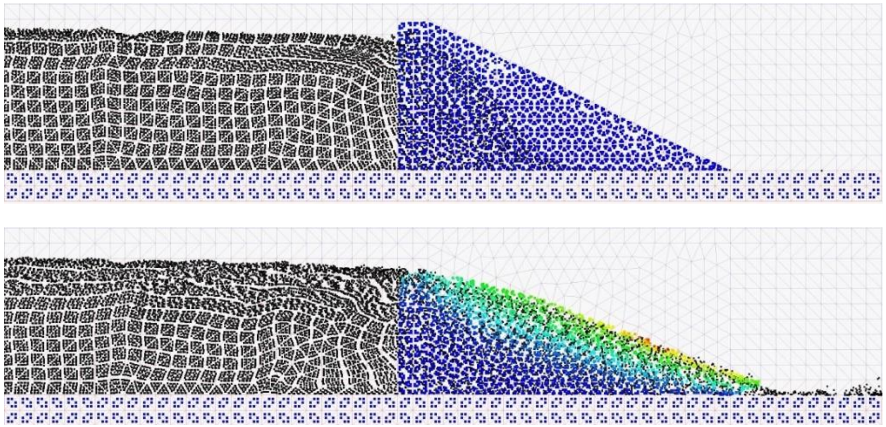
Modelling sediment transport in an integrated free-surface and subsurface water flow framework

Dr. Liang from Cambridge University Engineering Department visited the University of Sheffield in late 2017 and early 2018 to collaborate with Prof. Tait and Dr. Shao in the development a novel sediment transport model, which takes into account the forces acting on the sand grains induced by both the free-surface flows and subsurface water flows. Two separate visits were made to avoid clashing with teaching, and Dr. Liang spent a total of 14 days in the University of Sheffield. The host has contributed to part of the subsistence and travelling costs at Sheffield.



During the visit, Dr. Liang participated in an experimental study of rough turbulent boundary-layer flows, where the bed of an open channel is covered with glass beads. Most of the time, however, was spent with Dr. Shao in developing a novel sediment transport model using a Lagrangian computational technique. We have dynamically coupled the free-surface and subsurface flows, and included the stresses at the soil/water interface, the seepage force and pore pressure's influences on the soil deformation and sediment transport.

An illustration of the developed model is given below. Water, represented by black particles, is bounded by a trapezoidal-shaped embankment on the right. As water seeps through the embankment, the rise in the pore-pressure and hydraulic gradient in the soil structure gradually causes the embankment to collapse.



We are now simulating the initiation of scour around an offshore pipeline partially embedded in the seabed. When the pipeline is subject to ocean currents, the stagnation pressure upstream of the pipe and the relatively low pressure downstream of the pipe drives seepage flow underneath the pipe. If the pressure difference is sufficiently large, then soil beneath pipe loses stability and scour

initiates. With the present Lagrangian modelling framework, we are able to simulate both the onset of scour and the development of scour, which has never been achieved before.