Report on the UK Fluids Network Short Research Visits Award for the project:

On alternative approaches to wave-structure interaction problems

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Supported by the UK Fluids Network Short Research Visits, Dr. Masoud Hayatdavoodi of the University of Dundee visited the University of Manchester (UoM) in early May 2018. In this visit, Dr. Hayatdavoodi was hosted by Dr Benedict Rogers of the School of Mechanical, Aerospace and Civil Engineering of UoM. Dr. Hayatdavoodi also met with the academic and research staff and PhD students of UoM and visited the experimental laboratories and facilities (e.g. see Fig. 1). On May 10, Dr. Hayatdavoodi gave a talk at the Water, Ocean, Coastal and Environmental Engineering with Geotechnics (WOCEE-G) Seminar series entitled “Wave Loads on Coastal Structures: The Nonlinear Shallow Water Wave Equations”. The talk was attended by about 25-30 people including professors, postdocs and PhD students.

Interaction of nonlinear water waves with coastal structures is a complex problem, involving fluid-structure interaction, wave breaking and overtopping problems. Possible submergence of the structures and entrapment of air pockets may increase the destructive forces, and add to the complexities of the problem. The wave loads on the coastal structures may be determined by use of several analytical and computational approaches, including Euler's equations (e.g. see Fig. 2, for the effect of air entrapment on the wave-induced loads on a coastal bridge deck), the shallow water wave equations, linear approximations, and simplified, design-type equations.

In this research visit, various possible solutions to the nonlinear wave-structure interaction problems were discussed. Ideas were exchanged on further development of the existing models, and on possible use of new approaches, including SPH, to solve these problems. The mesh-less approaches have some advantages over the Eulerian solutions of the wave-structure interactions, in that (i) wave breaking and over topping can be captured more accurately, (ii) GPUs could be used efficiently to speed up the computations (with low cost), and (iii) it is relatively easy to use the model for various applications. It was agreed that the research teams of the two institutes shall visit each other soon again to enhance the collaborations.

Fig 1: Drs. Hayatdavoodi and Rogers visiting Reynolds’ fluid flow apparatus at the University of Manchester.

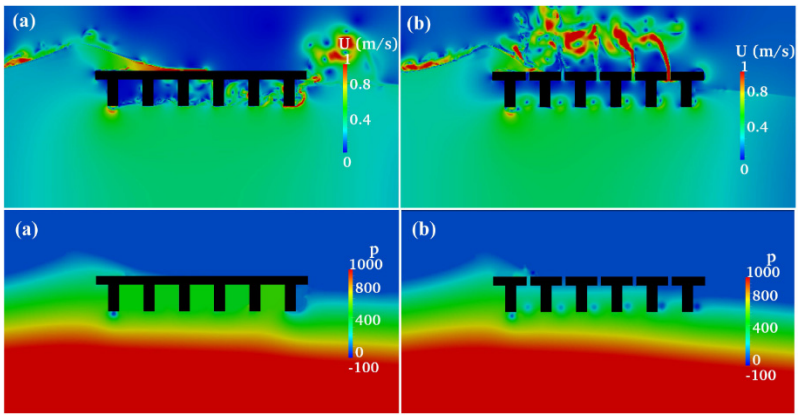

Fig 2: Sample CFD snapshot of the velocity (top row) and pressure (bottom row) fields of wave interaction with horizontal decks with air entrapment (left column) and with no air entrapment (right column).