

China Scholarship Council

Thesis title

Development of a coupling strategy between Discrete Elements Methods (DEM) and Finite Element Method (FEM) for environmental Fluid-structure interaction problems: Application to Wave impacts and breakwater stability

Keywords: Computational Fluid Dynamic (CFD), Fluid-Structure, FEM, DEM, hydrodynamic, breakwater stability

1) Summary

The main goal of this proposal is to set up a 3D numerical tool to deal with coupled problems of fluid-structure interaction to study the wave impacts and breakwater stability. The breakwaters are used for the protection of harbours and beaches against wave actions. However their design is traditionally based on empirical approaches which do not take into account important factors such as nonlinear wave-structure interaction, the contact forces between blocks, the shape of the breakwater system, etc.. These factors are known to play an important role in the overall stability of such structures, because more generally, they are composed of a concrete caisson and of a rubble mound structure, and also of an assembly of deformable blocks of arbitrary shape moving independently of each other. Their failure may be due the motion of caissons or to global stability of blocs and to scouring of the rubble mound. Therefore, some computational study based on the Discrete Element Method (DEM) have been proposed to examine the stability of such breakwaters but the caisson and blocs are represented by particles and beam elements, and does not represents neither the shape of the blocks, nor the contact between them and neither the rubble mound which is in reality a porous medium.

This PhD proposal focuses on the analysis of the stability of breakwater under wave impacts by coupling the Computational Fluid Dynamics (CFD) and the Discontinuous Deformation Analysis (DDA) methods. (i) First, we plan to built a coupled Fluid-Porous model to describe the flow in the rubble mound foundation and rear structures by coupling the Reynolds Averaged Navier Stokes (RANS) model with a porous medium model. (ii) Second we construct a weakly coupled Fluid-Structure model to simulate the movement of the breakwater and the blocks that constitute it, by coupling the previous Fluid-Porous model with a Solid model, based on Discret Elements Method (DEM). Discontinuous Deformation Analysis (DDA) is expected to be used as a DEM method, since is makes it possible to determine the displacements of any type of regular or irregular blocs shape without meshing procedure of blocks.

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