**LARGE EDDY SIMULATIONS OF BREAKING WAVE IMPACT ON A VERTICAL WALL ATTACHED WITH PARAPET**

Rajendran Ravindar, IIT Madras, India, [send2ravindar@alumni.iitm.ac.in](mailto:send2ravindar@alumni.iitm.ac.in)

Aristos Christou, University College London, United Kingdom, [aristos.christou.18@ucl.ac.uk](mailto:aristos.christou.18@ucl.ac.uk)

Venkatachalam Sriram, IIT Madras, India, [vsriram@iitm.ac.in](mailto:vsriram@iitm.ac.in)

Thorsten Stoesser, University College London, United Kingdom, [t.stoesser@ucl.ac.uk](mailto:t.stoesser@ucl.ac.uk)

INTRODUCTION

Wave return seawalls are structures designed to protect the leeward side from overtopping due to the action of waves. The numerical modelling of breaking waves on fully reflective structures like wave return seawalls are challenging due to the complex fluid dynamics involved, air-water mixture's interaction due to air entrapment and air entrainment and the dominant change in the ambient pressure as an effect of the hydrodynamic flow, which leads to compression and expansion of the air pocket. In this study, the vertical wall with parapet is considered since existing vertical walls are convenient to be retrofitted with such attachments to increase their efficiency in overtopping reduction. Very few numerical studies exist of violent breaking wave impacts on a vertical wall with parapets or curved structures, to the authors' knowledge. In addition, no direct numerical study discusses breaking wave impact on such structures and validated with experimental data.

NUMERICAL MODEL

Hydro3D solves the unsteady, incompressible, viscous spatially filtered Navier-Stokes equation. In Hydro3D, large energetic eddies are resolved while small, dissipative turbulence, smaller than the grid size, is modelled using the Wall-Adapting Local Eddy viscosity (WALE) SGS model to obtain the eddy viscosity. Spatial derivatives are discretized using finite differences schemes on uniform staggered Cartesian grids. Convective and diffusive terms are decomposed using fourth and second-order central differences, respectively. Time advancement is achieved by the fractional-step method coupled with a 3rd-order Runge-Kutta scheme. In the present model, Immerse Boundary Method (IBM) has been implemented to generate complex geometries and Poisson equation is used to couple the velocity with pseudo-pressure and solved using an iterative multi-grid technique until the intermediate velocity satisfies the continuity equation. In the present LES code, Level Set Method (LSM) is employed to capture the evolution of water-surface in the numerical wave tank (NWT). The location of the free-surface at each time-step is discretised using a 5th-order weighted non-oscillatory (WENO) scheme. Dirichlet boundary conditions for water surface elevation and the three components of the fluid velocity are prescribed to generate the waves at the inlet of the NWT. At the domain's outlet, Hydro3D waves are absorbed using the relaxation method. The NWT is validated in Christou et al. (2021).

RESULTS AND DISCUSSIONS

The numerical results are validated using experiments results of Ravindar and Sriram (2021). The Hydro3D NWT model can accurately produce the surface-elevation for breaking waves at incident location and 1m away from the structure for pulsating and impulsive loading conditions. Figure 1 shows the comparison of surface elevation from experimental and numerical results for test case with parameters wave height, H=0.086, wave period T=2.5s and deep water depth d=0.51m. The impact pressures at vertical and curved part of wave return wall are compared at seven pressure transducer locations. The model is further extended to study the variation of impact pressure for different breaking scenarios. The results will be discussed in full paper providing validation and insights into variation of velocity and pressure fields for various breaking scenarios.

D:\LES_results\LCW\LCW_H0.086_T2.5_doubleZ\slope_Large_x\slope_LCW_Large_x_nsol\nsol_run3\WG6_paper_H086T2_5.emfD:\LES_results\LCW\LCW_H0.086_T2.5_doubleZ\slope_Large_x\slope_LCW_Large_x_nsol\nsol_run3\WG1_paper_H086T2_5.emf

Figure 1 - Comparison of surface elevation obtained from experiments and numerical simulations at incident and 1m away from the structure.

REFERENCES

1. Christou, Stoesser, Xie (2021): A large-eddy-simulation-based numerical wave tank for three-dimensional wave-structure interaction. Computers & Fluids, 231:105179.
2. Ravindar, Sriram (2021): Impact pressure and forces on vertical wall with different types of parapet, Journal of Waterway, Port, Coastal and Ocean Engineering, 147(3), p.04021007.