Numerical simulation of the two-dimensional sloshing problem using a multi-scaling Trefftz method

[1]Yung-Wei Chen, [2] Wei-Chung Yeih, [3] Chein-Shan Liu and [1*] Jiang-Ren Chang

1 Department of Systems Engineering and Naval Architecture, National Taiwan Ocean University, Keelung 20224, Taiwan, R.O.C.

2 Department of Harbor and River Engineering & Computation and Simulation Center, National Taiwan Ocean University, Keelung 20224, Taiwan, R.O.C.

3 Department of Civil Engineering, National Taiwan University, Taipei 10617, Taiwan, R.O.C.

[*] Corresponding author: Jiang-Ren Chang, Department of Systems Engineering and Naval Architecture, National Taiwan Ocean University, 2 Pei-Ning Road, Keelung 202, Taiwan, R. O. C.

Tel.: +886-2-24622192 ext. 6031; Fax: +886-2-24625945; E-mail: cjr@mail.ntou.edu.tw

Abstract

Here, we develop a multi-scaling Trefftz method (MSTM) for the Laplace equation associated with the group-preserving scheme (GPS) to describe nonlinear sloshing behavior of the incompressible, non-viscous, and irrotational fluid. Chen et al. [29] proposed that the characteristic length of the Trefftz method and the concept of controlled volume could be used to overcome numerical errors and dissipation in the simulation of the sloshing problem. However, the nonlinear dependence of the characteristic length on initial conditions was neglected in the numerical development. In addition, this study presents a numerical method with automatically adaptive computational steps for describing the nonlinear sloshing behavior as well as for satisfying the conservation of mass at each time step. A comparison of the results of the present study with those in the literature shows that the numerical results are better than those obtained using previously reported methods. The method developed here presents a simple and stable way to cope with the nonlinear sloshing problem.

***Keyword*:** Laplace equation; Multi-scaling Trefftz method; Mixed-boundary value problem; Sloshing.