Study on liquid sloshing in arbitrary shaped containers by SBFEM approach

Gao Lin, Jun Liu

(Faculty of Infrastructural Engineering, Dalian University of Technology, Dalian 116024,China)

Abstract

Problems of liquid sloshing have great significances for the design of industrial facilities, marine engineering structures and space transportation systems. In non-deformable rectangular and vertical-cylindrical liquid storage tanks analytical solutions exist. However, in most cases analytical expressions of sloshing frequencies and sloshing modes for containers of different geometry do not generally exist, such problems should be solved numerically. A SBFEM approach is proposed for the sloshing analysis of arbitrary-shaped containers. SBFEM is a promising numerical method, which has successfully applied in many fields. It offers more than combining the advantages of FEM and BEM with unique features of its own. The modelled spatial-dimension is reduced by one, only the boundary of the domain needs to be discretized. By employing SBFEM approach sloshing frequencies and sloshing modes can be evaluated thoroughly and the computational effort can be reduced to a great extent. Numerical examples are provided. Various type containers such as cylindrical, cylindrical-shaped annulus, arbitrary shaped annulus are studied and results are compared. Solution to axisymmetrical spherical and conical liquid vessels can be greatly simplified. Since only linear discretization is needed, containers with diaphragm for energy dissipation also can be handled simply and conveniently. In the literature, sloshing dynamics in a toroid is regarded as much more difficult to predict

than sloshing dynamites in a cylinder or sphere, the problem was solved with the aid of experiment. In the proposed approach, sloshing analysis in a toroid can be solved conveniently. In addition, method for time-domain earthquake response analysis including the effect of soil-structure interaction for containers anchored to the foundation is suggested.