ICNAAM 2022
14th Symposium on Recent Trends in the Numerical Solution of Differential Equations

Solving 2D exterior soft scattering elastodynamic problems by BEM and by FEM-BEM coupling using potentials

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Abstract

In nearly incompressible media such as soft tissues, the simulation of elastic wave propagation based on displacement formulations are penalized by the fact that shear waves propagate much more slowly than pressure waves. In the case of homogeneous media, by applying a classical Helmholtz decomposition, the splitting of the displacement field as the sum of the gradient and of the rotational of two scalar potentials allows for decoupling the two dynamics and for constructing discretization spaces adapted, in principle, to each type of wave. In this presentation, we consider the decomposition into scalar potentials for the simulation of transient 2D soft scattering elastic wave propagation problems in unbounded isotropic homogeneous media. The two corresponding wave equations are coupled by the Dirichlet boundary conditions and are reformulated in terms of their associated space-time boundary integral equation representations. The corresponding Boundary Element Method (BEM) is obtained by combining a time convolution quadrature formula with a classical space collocation method (see [1]). Then, the same boundary integral representation and its discretization are used to define a non-reflecting condition to be imposed on an artificial boundary delimiting the exterior computational domain of interest. In this latter a Finite Element Method (FEM) is applied (see [2]). We present numerical results in which the proposed BEM and the FEM-BEM approaches are compared with the corresponding standard vector ones, both in terms of accuracy and stability.

References

[1] S. Falletta, G. Monegato, L. Scuderi, *Two boundary integral equation methods for linear elastodynamics problems on unbounded domains*, Comput. Math. Appl. 78 (2019), pp. 3841–3861.

[2] S. Falletta, G. Monegato, L. Scuderi, *Two FEM-BEM methods for the numerical solution of 2D transient elastodynamics problems in unbounded domains*, Comput. Math. Appl. 114 (2022), pp. 132–150.

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