8th. World Congress on Computational Mechanics (WCCM8)
5th European Congress on Computational Methods in Applied Sciences and Engineeering (ECCOMAS 2008)
June 30 –July 5, 2008
Venice, Italy

SPECTRAL ELEMENT METHODS FOR ACOUSTIC WAVE MODELS IN NONSTANDARD DOMAINS.

*** E. Zampieri[1], L. Ghezzi[2] and L.F. Pavarino[1]**

[1] Università di Milano
Dipartimento di Matematica
via Saldini 50, 2011 Milano Italy
elena.zampieri{luca.pavarino}@mat.unimi.it
http://www.mat.unimi.it/∼zampieri{pavarino}

[2] ABB SACE S.P.A.
Viale dell'Industria, 18
20010, Vittuone, MI, Italy
luca.ghezzi@it.abb.com

Key Words: *Spectral elements, Gauss-Lobatto-Legendre nodes, Newmark's methods, Acoustic waves.*

ABSTRACT

In recent years, there has been an increased attention to the accurate simulation of wave propagation in acoustic models. In this presentation, we consider the numerical approximation of acoustic wave problems by the spectral element method (SEM) in space, and Newmark's or Houbolt's finite difference schemes in time, both explicit and implicit.

The SEM was developed more than 20 years ago in computational fluid dynamics and has been later validated in the context of acoustic and elastic wave propagation. It has the advantage of combining the flexibility of the finite element method (FEM) with the exponential convergence rate of the pseudo-spectral method, and shares with the family of hp-version FEM the basic idea of improving accuracy by increasing the polynomial degree of the basis functions as well as the number of elements. We present a SEM approximation based on Gauss-Lobatto-Legendre points for acoustic wave problems with first-order absorbing boundary conditions of Clayton and Engquist type.

The main objectives of this work are: 1) the evaluation of the SEM performance for problems posed on nonstandard computational domains presenting curved boundaries, holes, obstacles; 2) the validation of these methods when dealing with inhomogeneous media with piecewise constant material properties.

We also consider domain decomposition solvers based on overlapping Schwarz preconditioning techniques for the numerical solution of discrete linear systems arising at each time step when employing implicit time advancing schemes.

Several numerical examples illustrate the properties and effectiveness of the proposed numerical methods with respect to the discretization parameters, the different nonstandard geometries and the inhomogeneities of the material properties.

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