The subset of boundary conditions approximation in large scale wave propagation problems

Adam Glema and Wojciech Sumelka*

Poznan University of Technology
Institute of Structural Engineering, Department of Computer Aided Design
ul. Piotrowo 5, 60-965 Poznań, Poland, e-mail: Wojciech.Sumelka@ikb.poznan.pl

Abstract

The problems of solid mechanics and acoustics are discussed. The interest is focused on wave effects. Small size elements and short time increments generate large computational model. It is often too large in comparison with accessible computer power. The computations of limited part of whole domain are considered. The omitted part of large problem is not neglected, but recompensed. A surrounding area is introduced for local region of mechanical or acoustic response. The subset of boundary conditions defined for surrounding area is verified to give adequate wave propagation, dissipation and dispersion.

The problems of mechanics and acoustic are studied in the paper from the point of view of wave propagation effects. For numerical computations the space and time domains undergo discretization into many elements and time increments. Such the discretization generates large computational model. The motivation of research comes from constrains in obtaining the numerical solution. The number of nodes, degree of freedom are too huge to finish computations in reasonable time or to use data storage devices. The same questions rise for multiscale analysis.

In the paper there is a proposition to reduce the size of computational model. The subject of interest is limited to relatively small part of whole domain. The main attention is concentrated on the question, how to implement the influences coming from large domain. The substitution of omitted part is proposed by area surrounding the local region of interest. The idea is presented in Fig. 1. The local region with the same characteristic as in original problem is surrounded by the region with postulated geometry and material properties. We are motivated to clarify how to define the additional region to substitute wave effects of mechanical or acoustic process and to identify the material behavior of solid in additional region with its dissipative and dispersive parameters. The intention of replacement is to provide adequate boundary conditions for local region.

The problem of dynamic tension of steel specimen is presented. The viscoplastic material is applied for surrounding region. There are two main parameters of subset: dimension (width) and viscosity. The parametric study of those variables is carried out. The results show wide range of wave behavior (Fig. 1). The viscosity of surrounding area is the parameter controlling wave reflections and energy transmitted outside the local region.
Figure 1: The subset of large scale to local region (top) and plots of material point velocities at center of local region for five different boundary conditions a) infinite elements, b) local region, c) surrounding-subset (low, medium and large viscosity)

Acknowledgements The support of Poznan University of Technology Grant 11-606/2005-BW is gratefully acknowledged.

References


