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Acoustic emission source modeling

P. Hora, O. Červená

Institute of Thermomechanics of the ASCR, v.v.i., Veleslavínova 11, 301 14 Plzeň, Czech Republic

The paper deal with the acoustic emission (AE) source modeling by means of FEM system COMSOL Multiphysics [3]. The following types of sources are used: the spatially concentrated force and the double forces (dipole). The pulse excitation is studied in both cases. As a material is used iron. The computed displacements are compared with the exact analytical solution of point sources [1, 2, 5] under consideration.

Growth of cracks is important acoustic emission source, and the study of the waves they generate has played a major role in our understanding of the inner structure of the materials and the nature of the AE source. Energy release during growth of crack can be simulated by the concentrated force or concentrated force moment. This work focuses on modeling a concentrated source located in an infinite domain. The steel cylinder (radius 50 mm, height 100 mm) is used for the infinite domain simulation, see fig. 1. Four kinds of the time dependence loading are studied, see fig. 2. To provide a point of comparison for the finite element models, an analytical solutions for displacements in unbounded media excited a concentrated sources are also computed. MATLAB [4] is used for these computations, scripting of COMSOL tasks and figure creating.

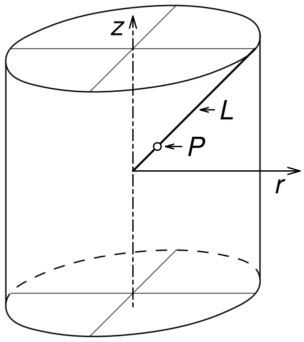

Fig. 1 Geometry.

Several various shapes are used to FEM–modeling of point force. In comparison with the analytical solution, the circle area exciting gives the smallest absolute error. The effect of the exciting pulse width is analyzed. The computed displacements show the ability of COMSOL Multiphysics to represent accurately the wave propagation, see fig. 3. There are a minor variations at the peak of the waves and at neighbourhood of suddenly changes. These differences are due to the mesh size, which is not able propagate the higher frequency items of displacements. To FEM–modeling of dipol forces are also used several various shapes. The influence of the dipol arm length is studied for the cylindrical loading. Four cases of the dipol arm length are computed in FEM simulations.

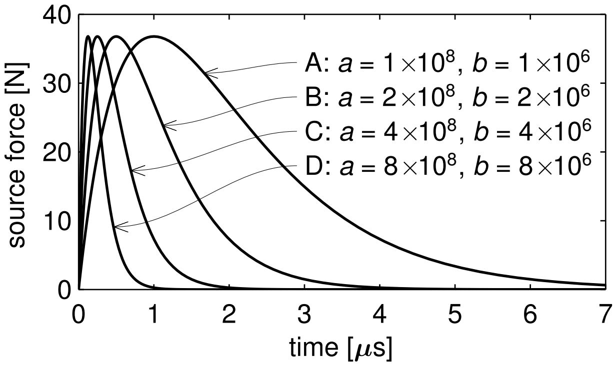

Fig. 2 The source force $f_0(t) = at\exp(-bt)$.

The difference between analytical (the arm length of dipol is infinitesimal) and FEM solution is decreasing with the decreasing length of arm. FEM solution very good represents the wave arrival, especially for the smallest arm length, see fig. 4.

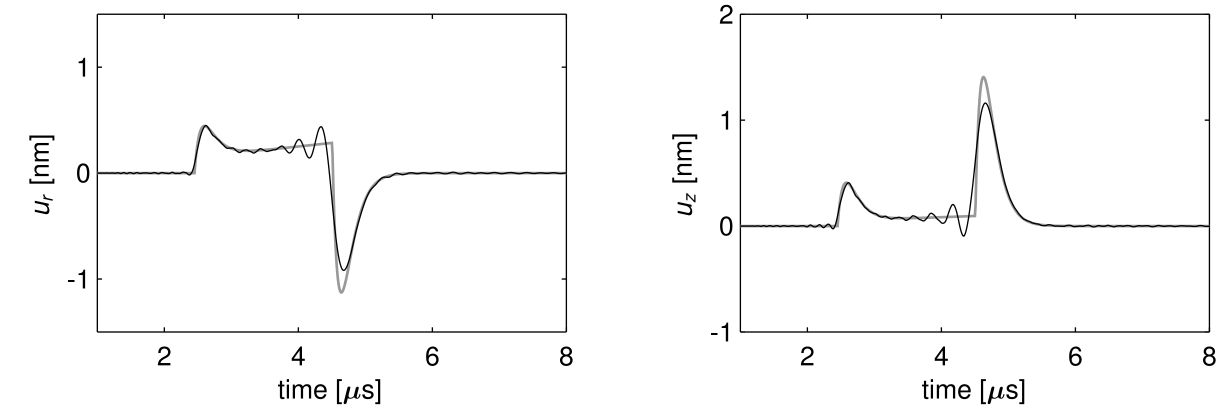

Fig. 3 Comparison of radial (u_r) and vertical (u_z) displacements for a FE–axisymmetric model to an analytical solution for the circle source with the time function type D (see fig. 2) in point P (see fig. 1). Analytical: gray; FEM: black.

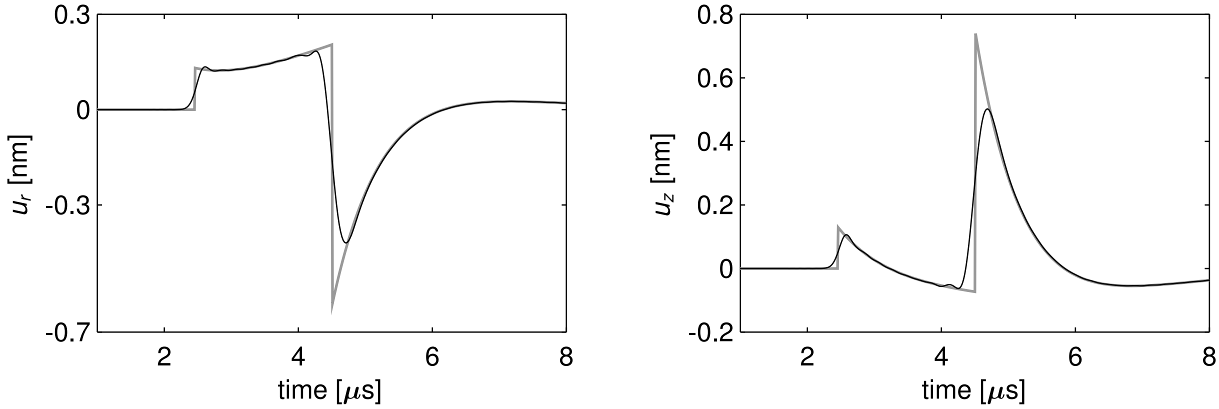

Fig. 4 Comparison of radial (u_r) and vertical (u_z) displacements for a FE–axisymmetric model to an analytical solution for the cylindrical dipol source with the time function type A (see fig. 2) in point P (see fig. 1) for arm length 1 mm. Analytical: gray; FEM: black.

All computations are performed on HP xw6600 Workstation with two processors Intel Xeon E5430/2.67GHz (Quad Core) and 32GB RAM.

Acknowledgements

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