Acoustic problems in layered media

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The study of wave propagation in layered media is very important in seismology. There are many known methods for studying propagation processes of such waves in various media, including viscous media. For the averaged acoustic problems in poroelastic media, an algorithm for the numerical solution using the Fourier transformation is used.

Our area of study is divided into three blocks, where each block simulates different formulations, such as limestone, oil-containing sandstone and shale. The acoustics problem in a poroelastic medium is described by the averaged equation in [1]-[2].

We consider a simple model where the solid skeleton is an elastic body and the fluid is assumed to be viscous. The model is described by the following system of differential equations.The model is described by the following system of differential equations:

$$\begin{cases} \left(\frac{m}{c_f^2} + \frac{(1-m)}{c_s^2} \right) \frac{\partial p}{\partial t} + div\, \upsilon = 0 \qquad (1) \\ \left(m\rho_f + (1-m)\rho_s \right) \frac{\partial \upsilon}{\partial t} = -\nabla \left(p + \frac{m\nu_0}{c_f^2} \frac{\partial p}{\partial t} \right) \qquad (2) \end{cases}$$

where p - pressure of the mixture, υ - speed of the mixture, $\rho = m\rho_f + (1-m)\rho_s$ - average density of the mixture, m - porosity, ρ_f - density of the fluid, ρ_s - density of the solid skeleton, $c^2 = \frac{1}{\frac{m}{c_f^2} + \frac{(1-m)}{c_s^2}}$ speed of sound in mixture. Problem is closed following initial conditions

$$\upsilon(x,0) = \upsilon_0(x), \quad x \in Q \qquad (3)$$

$$p(x,0) = p_0(x), \quad x \in Q \qquad (4)$$

As a result, we obtain the following system of algebraic equations for finding the coefficient, solving the system. After applying to the resulting solution of the inverse Fourier transform, we obtain the solution of the original problem (1) - (4).

References

1. Meirmanov A. M. A description of sesmic acoustic wave propagation in porous media via homogeniziation // SIMA journal of Mathematical Analysis. 2008. V.40, № Issue3. C. 1279- 1289.
2. Meirmanov A. M. Neguteseng's two – scale convergence method for filtration and sesmic acoustic problems in elastic porous media //Siberian Mathematical journal. 2007. V . 48, C .519-538.