Time-domain numerical modeling of wave propagation in poroelastic media with rational approximation of the fractional attenuation

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Abstract

n this work, we investigate the poroelastic waves by solving the time-domain Biot-JKD equation with an efficient numerical method. The viscous dissipation occurring in the pores depends on the square root of the frequency and is described by the Johnson-Koplik-Dashen (JKD) dynamic tortuosity/permeability model. The temporal convolutions of order 1/2 shifted fractional derivatives are involved in the time-domain Biot-JKD model, causing the problem to be stiff and challenging to be implemented numerically. Based on the best relative approximation of the square-root function, we design an efficient algorithm to approximate and localize the convolution kernel by introducing a finite number of auxiliary variables that satisfy a local system of ordinary differential equations. The imperfect hydraulic contact condition is used to describe the interface boundary conditions and the Runge-Kutta discontinuous Galerkin (RKDG) method together with the splitting method is applied to compute the numerical solutions. Several numerical examples are presented to show the accuracy and efficiency of our approach.

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