Solution of Poroelastic Equations with Different Base Variables Using Equation-based Modeling

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Abstract

Poroelasticity equations describe the interaction between fluid flow and solids deformation within a porous medium. As porous medium is everywhere around us, poroelasticity has numerous real world applications such as in reservoir engineering, bioengineering, environmental engineering etc. Modeling of poroelasticity is coupling between elastic deformation of porous materials and Darcy's law. We use quasi-static poroelastic equations [1]with two sets of base variables for our simulation, namely stress-displacement-pressure and increment of fluid content-rotation variables-pressure gradients. In real life situation, sometimes a set of base variables is more advantageous than other one, because of its easy availability of data on the boundary in some particular situation. So, the main advantage of using different base variables is to enforce different boundary conditions and give us greater flexibility to handle real life applications. For each case, different admissible boundary conditions are provided knowing its well-posedness [2] associated with those boundary conditions. While using different base variables, it is difficult to use traditional application modules (such as Structural Mechanics Module, Geomechanics Module etc.) for simulation as they only allow us to use predetermined unknown variables. For the adaptation of all unknown variables, we have used equation based modeling in our simulation. Simulation results are presented for each case with their own variables and corresponding boundary conditions.

Reference

1. R. E. Showalter, "Diffusion in Poro-Elastic Media",Journal of Mathematical Analysis and Applications 251 , 310-340(2000).

2. Mohammad H Akanda et. al., “A Few Model Problems as Symmetric Positive Systems” ,SIAM-SEAS 2015, Birmingham, AL, USA

Figures used in the abstract

Figure 1: \sigma_{11} at different times

Figure 2: u_{1} at different times

Figure 3: \eta at different times

Figure 4: w_{12} at different times