Transient Ground Surface Displacements of a Poroelastic Half Space Subjected to an Impulsive Point Sink

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Abstract

The axial symmetric ground surface deformations and distribution of excess pore water pressures of the stratum caused by impulsive pumping in a homogeneous isotropic poroelastic half space are presented in this paper. The formulations of the mathematical model are based on Biot's three-dimensional consolidation theory of porous media. Closed-form solutions are obtained by using Laplace and Hankel integral transforms. The consolidation effected by the consolidation parameters are illustrated and discussed. The results show that the maximum ground surface horizontal displacement is around 38.5% of the maximum vertical displacement for the pervious ground surface. It's observed that the negative excess pore water pressure increases to a wider region of the stratum initially and then gradually decreased. The impulsive pumping induced negative excess pore water pressure finally full dissipated. The elastic deformations of the stratum caused by groundwater extraction are fully recovered after the excess pore water pressures dissipated. The study concludes that horizontal displacement is significant and should be considered in prediction of the transient deformation induced by impulsive groundwater withdrawal. The solutions may be used to test numerical models and numerical simulations of the consolidation deformations near the point sink.

Keyword：Point Sink, Impulsive Pumping, Closed-form Solution, Half Space