A Numerical Study of Effective Stress and Groundwater Level Changes in Poroelastic Aquifer Under Dynamic Excitations

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The abnormal change of groundwater level has often been accompanied with earthquake events. In order to understand the relationship between change of groundwater level and earthquake, many studies have indicated that a poroelastic model would be a feasible approach. This study attempts to consider a dynamic poroelastic model. The poroelastic theory features the coupling relationship of stress-strain-pore pressure change. Thus, the physical mechanism of groundwater level change due to earthquake can be interpreted. A finite element analysis software PDEase2D is employed to carry out the numerical study.

There are three main topics in this study. The first part is sensitivity analysis. The effects of various parameters on the coseismic changes of groundwater level are discussed. The second part discussed the effect of stratum environment on the coseismic changes of groundwater level, which assumes different types of boundary conditions. The third part is stratum analysis of composite layers. It discussed the effect of different sediment models on the coseismic changes of groundwater level. Furthermore, this study took Choshui River fan as a case study, fitting the changes of groundwater level that caused by Chi-Chi earthquake, and evaluating the regional correction coefficient of each observation station.

The numerical results shows that hydraulic conductivity, Young's modulus, volumetric strain amplifying coefficient, damping coefficient and excitations have significant effect on coseismic groundwater level. This study shows that imposing different types of excitations lead to different types of seismic waves, and further affect the trend of changes of groundwater level. For homogeneous stratum, the changes of coseismic groundwater level become more severe if getting closer to the

imposed location of applied excitations, and the low permeable condition also have a significant effect on coseismic groundwater level. For heterogeneous stratum, the composition, thickness, and sedimental type of different geology materials also have significant effects on the extent and trend of the coseismic groundwater level. The case study suggests a correction coefficient be necessary for fitting in the trend of realistic changes of on-the-spot groundwater level.