Influence of Fluid Compressibility on Pore Water Pressure Response in Shanghai Soils Under Complex Stress Paths

Jia-Bin Li[1], Ming-Guang Li[1, *], Liang Zhen[2]

[1]School of Ocean and Civil Engineering, Shanghai Jiao Tong University. Shanghai, China

[2]Shanghai Road and Bridge (Group) Co., Ltd. Shanghai, China

Email address:

jiabinli@sjtu.edu.cn (Jia-Bin Li), lmg20066028@sjtu.edu.cn (Ming-Guang Li), zhengliang@srbg.com (Liang Zhen)

[*]Corresponding author

Abstract

Fluid compressibility is a critical parameter that plays an important role in the generation of excess pore water pressure and is significantly influenced by soil saturation. A slight decrease in saturation leads to a marked increase in fluid compressibility. Strata characterized by high groundwater levels present a high degree of saturation, referred to as quasi-saturated strata. However, previous studies have typically considered engineering practices involving complex stress paths, such as pile driving and CPTU testing, within the framework of full saturation. The influence of fluid compressibility on the pore water pressure response in Shanghai soils under such complex stress paths remains unexplored. This study characterizes the complex stress path as a combination of compression and shear, approximating the triaxial shear state, and accounts for fluid compressibility via the fluid bulk modulus. Building on previous work on Ningbo clay, this study extends the investigation to the pore water pressure response of Shanghai soft clay and sand through undrained triaxial shear tests. Complementary numerical analyses are performed to assess the influence of fluid compressibility on the pressure response under complex stress paths. The results indicate that when the fluid compressibility is 2×10^6 Pa, the resulting pore water pressure response is markedly lower than that under low-compressibility conditions. For compressibility values ranging from 2×10^7 Pa to 2×10^9 Pa, the effect on the pressure response becomes negligible, which is consistent with earlier observations in Ningbo clay. Moreover, the fluid compressibility of clay in quasi-saturated strata is considered to range from 2×10^7 Pa to 2×10^8 Pa. Consequently, the influence of quasi-saturated characteristics on the pressure response under complex stress paths can be reasonably disregarded, and the fully saturated assumption remains valid for engineering practices in Shanghai areas subjected to complex compression–shear stress states. This abstract presents a further extension of a portion of the work from a separate manuscript that is currently under review.

Keywords

Fluid Compressibility, CPTU, Excess Pore Water Pressure, Shanghai Soil, Quasi-saturated Strata