測定砂岩有效應力係數及影響因子研究

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摘要

岩石變形行為受有效應力控制，學理上最早認為圍壓與孔隙壓力之差為有效應力，即圍壓與孔隙壓力對有效應力之貢獻權重相等。然部分研究發現，黏土質砂岩會因為孔隙被黏土填充，使得孔隙壓力對應變之影響較圍壓顯著，顯示孔隙壓力與圍壓對有效應力貢獻之權重其實不相等，故定義有效應力係數 n 表達孔隙壓力與圍壓對有效應力貢獻之權重關係。由於有效應力控制岩石應變，而應變又影響孔隙率/滲透率，故量測岩石於不同圍壓與孔隙壓力下之孔隙率/滲透率可反推有效應力係數 n。本研究欲了解黏土含量、黏土礦物種類對有效應力係數 n 之影響。選定越南產黏土質砂岩為試體，並以氦氣作為孔隙流體，於不同應力及孔隙壓力下量測孔隙率/滲透率，藉此計算有效應力係數 n。初步結果顯示，利用孔隙率計算之有效應力係數為 0.87。為了解此結果對實際工程之影響，本研究透過假定不同岩性具有不同有效應力係數 n，重新預測孔隙率隨應力變化之結果，並與過去不考慮有效應力係數 n 之模擬結果做比較，孔隙率模擬結果有 7% 的差異。未來會對更多黏土質砂岩進行實驗及黏土礦物分析。

Determination of Sandstone Effective Stress Coefficient and Factor Analysis

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Abstract

The deformation behavior of rock is controlled by effective stress. At first it is considered that the difference between confining pressure and pore pressure is effective stress, that is, the contribution weight of confining pressure to effective stress is equal to pore pressure. However, some studies have found that the pores of the clayey sandstone will be filled, so that the influence of pore pressure is more obvious than the confining pressure. It shows that the weight of the pore pressure and the confining pressure on the effective stress are not equal, so the effective stress coefficient n is defined as the relationship between the contribution of the pore pressure and the contribution of the confining pressure to the effective stress. Since the effective stress controls the rock strain, and the strain affects the porosity/permeability, measuring the porosity/permeability of the rock under different confining pressure and pore pressure can back-calculate the effective stress coefficient n. This study sought to understand the effect of clay content and clay mineral species on the effective stress coefficient n. The clayey sandstone from Vietnam was selected as the testing sample, and the porosity/permeability was measured under different stress and pore pressure with helium gas as the pore fluid, thereby calculating the effective stress coefficient n. Preliminary results show that the effective stress coefficient calculated using porosity is 0.87. In order to understand the effect of this result on the real project, this study re-predicts the porosity as a function of stress by assuming that different lithologies have different effective stress coefficients n, and compares them with the simulation results that did not consider the effective stress coefficient. There is a 7% difference in the simulation results. In the future, more clayey sandstone samples will be tested and clay minerals will be analyzed.