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Evaluation of poro-elastic responses of porous media by the use of fibre optic sensors.

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To address questions arising from the theory of poro-elasticity, we investigated three important poro-elastic parameters (porosity φ, Biot coefficient α and Skempton coefficient B) by means of laboratory experiments. To show the effective pressure dependency of porosity, Biot and Skempton coefficients an effective pressure range between 0 and 70 MPa was applied, though the temperature was kept constant at 30°C. All parameters were determined by two different methods: 1st, an indirect measurement, relating the three parameters to the fluid, solid and bulk compressibility of the sample, respectively and 2nd, a direct measurement to prove the primary results. Two experiments on the same specimen are required to calculate porosity φ and Biot coefficient α by the indirect method. In the first experiment, the bulk modulus of the framework Kb is measured by performing a hydrostatic compression test on a jacketed specimen using a drained pore pressure condition. In the second experiment, the bulk modulus of solid grains Ks is measured by performing a hydrostatic compression test on an unjacketed specimen. For calculating the Skempton coefficient B the bulk modulus of the pore fluid Kf is required in addition. Skempton's coefficient B is used to predict the change in pore pressure due to changes in external confining pressure loading. The direct measurement of the Skempton coefficient is performed on an undrained specimen by increasing the confining pressure pc while measuring the change in pore pressure pp. The pore fluid volume in the tubing between the specimen and the shutoff valve must be small otherwise the pore fluid mass will change, violating the undrained condition. Therefore, we tested a fibre optic sensor to measure the pore pressure response of the sample under simulated in situ conditions. The sensor consists of a miniature all-silica fibre optic Extrinsic Fabry-Perot Interferometer (EFPI) sensor which has a novel embedded Fibre Bragg Grating (FBG) reference sensor element. The sensor was embedded in a drill-hole within the sample reducing the void volume to less than 0.1 percent of the pore fluid volume. In this contribution we will present the fibre optic sensor technique used for determining the poro-elastic response of porous media and the comparison of the indirect determination of porosity, Biot coefficient and Skempton coefficient with the direct measurement.