Numerical modelling the hydromechanical behavior of undrained triaxial tests on saturated concrete

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Abstract

Concrete structures constitute a large portion of civil engineering constructions, such as building, hydroelectric dams and bridges, etc. Due to the relatively small permeability of concrete, the cores of these structures could remain quasi-saturated during most of their lifetime even though their facings dry very quickly. A heterogenetic distribution of free water content is then observed. Numerous research exhibit mechanical behaviour of concrete depends strongly on the free water content. During the lifetime of these structures, they may be subjected to some accidental or intentional extreme loadings, such as ballistic impact, earthquake, vehicle shocking or explosion. As a result, concrete is subjected to very high triaxial compression. Moreover, the duration of these extreme loadings is quite short, the interstitial water in concrete cannot escape quickly due to the low permeability of concrete. In order to evaluate the vulnerability of concrete infrastructure subjected to near-field detonations or impacts, it is necessary to understand the undrained triaxial behaviour of concrete with the presence of free water. By using the poromechanical approach, an elastoplastic model is adopted to described mechanical behaviour of concrete. The model's parameters are identified by using one hydrostatic compression test and one triaxial compression test. Finally, a series of triaxial compression tests under a wide range of confining pressure (from 0 to 650 MPa) are simulated. The comparison of numerical results exhibit that an important increase of pore pressure and volumetric stiffness is observed when the confining pressure increases. The numerical predictions and discussions can help engineers to enhance their understandings on the influence of interstitial pore pressure on structural vulnerability of concrete structures subjected to near-field detonations or impacts.

Keywords: Mechanical behaviour, Triaxial compression, Elastoplastic model, Saturated concrete, Pore pressure

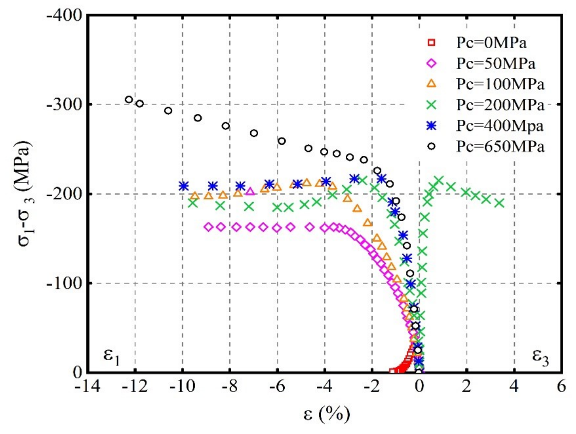

Figure 1: Comparison of triaxial compression tests performed with saturated concrete under different confining pressure

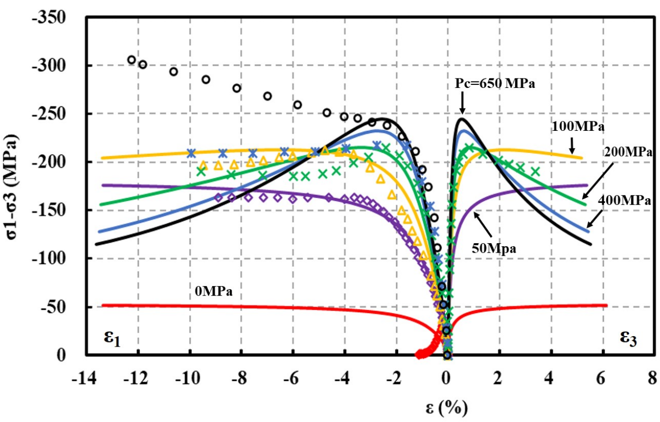

Figure 2: Simulation of the deviatroric stress $\sigma_1 - \sigma_3$versus axial/lateral strain $\varepsilon_1/\varepsilon_3$ curves in triaxial compression tests performed with saturated concrete under different confining pressure (Continuous line: numerical prediction; Cloud points: experimental data)

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