DISSOLUTION INDUCED STRAIN LOCALIZATION IN GEOMATERIALS

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Deformation bands play an important role in reservoir engineering, geological storage, underwater landslides and slow geological procedures. Various mechanisms can be involved at different scales and may be responsible for deformation bands. Mechanical and chemical degradation of the grain skeleton is a softening factor that can lead to compaction, shear or even dilation band formation [1,2]. The present study is twofold. On one hand it focuses on the mathematical modeling of chemically induced strain localization instabilities in porous rocks and on the other hand it explores the conditions for their creation [1,3]. The post localization regime is then studied by numerically integrating the governing equations of the system.

In a saturated porous rock, the progressive mechanical damage of the solid skeleton during deformation, results in the increase of the interface area of the reactants and consequently in the acceleration of the dissolution rate of the solid phase [4]. Under the presence of dissolving fluids the solid skeleton is degraded more rapidly (mass removal because of dissolution), the overall mechanical properties of the system diminish (contraction of the elastic domain – chemical softening), deformations increase and the solid skeleton is further damaged (intergranular fractures, debonding, breakage of the porous network etc.). By accounting for (a) the mass diffusion of the system, (b) a macroscopic failure criterion with dissolution softening and (c) the reaction kinetics at the micro level, a micromechanical model is proposed to account for the above positive feedback process. The conditions for deformation band triggering are investigated analytically through linear stability analysis by considering the strong chemo-poro-mechanical coupling due to chemical dissolution. The heterogeneity of the microstructure in terms of chemical reactivity of the constituents of the REV is taken into account resulting in a characteristic internal length of the system. The post bifurcation behavior is finally studied both analytically and numerically revealing the localization thickness. The effect of various parameters on the localization zone thickness is then explored.

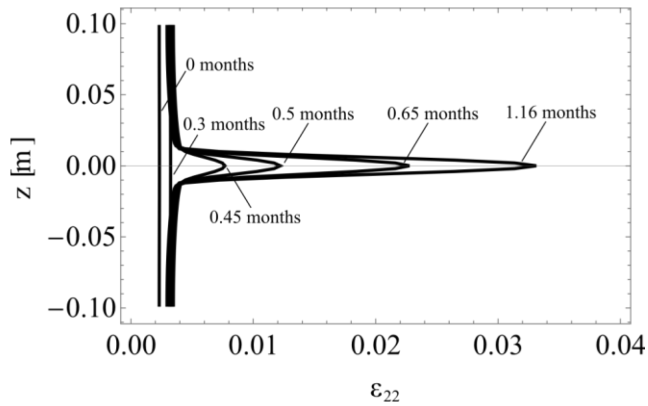

Figure 1. Profile of the vertical deformation at various times of a specimen under oedometric conditions. After a creep phase the deformation localizes into a narrow band, i.e. a compaction band.

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