Anisotropy in soft rocks

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In this work, the mechanically induced compaction process in highly porous rocks is studied with experimental investigations and constitutive modeling. The focus of the study is on the influence of the inherent anisotropy on the mechanical properties. From a practical point of view, such behavior is of particular interest when considering reservoirs in soft, porous rocks. The reduction in pore pressure, which is linked to the production, leads to the possibility of compaction in the vicinity of the borehole. One effect is the risk of the loss of stability or of increased sand production. Another is the reduction of the permeability locally. The probability of such occurrences and the magnitude of such effects is currently under debate.

Although the formation of compaction bands in porous rocks has already been investigated in several studies, both in the laboratory and in situ, the extent data about the influence of the inherent anisotropy on the mechanical properties of porous rocks is limited. Baud et al. [1] documented an influence of the orientation of the bedding plane on the mechanical behavior of Diemelstadt sandstone and Louis et al. [2] documented an influence of the bedding plane on the formation of discrete and continuous compaction bands in Rothbach Sandstone.

On the basis of an extensive experimental program of triaxial and isotropic compression, triaxial extension tests as well as investigations with ultrasonic pulse method, the mechanical behavior of a highly porous rock (Maastricht Calcarenite) is analyzed with a special focus on the formation of compaction bands. The test program is performed with samples cored under different inclinations to the bedding plane to study the influence of the inherent anisotropy on the mechanical properties.

Based on the experimental results, the applicability of a constitutive model for the description of the mechanical properties is tested. Furthermore it is examined how the inherent anisotropy may be considered in the constitutive model and different approaches are discussed.

For the numerical simulation a nonlocal model is suggested to simulate the formation of compaction bands. Finally, conclusions are drawn and an outlook on experimental investigations of the influence of compaction banding on the hydraulically properties is given.
