Evaluating the Undrained Shear Iso-Velocity Hypothesis

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ABSTRACT

The Full Effective Stress (FES) method developed for pore pressure prediction assumes that compressional wave velocity is uniquely related to porosity. The Iso-Velocity hypothesis is evaluated in the laboratory during undrained shear triaxial tests. The effective stress paths followed during an undrained shear test is an iso-porosity contour. Having a proper understanding of wave velocity behavior during undrained shearing provides insight into the stiffness behavior and possibly the stress state relative to failure.

I have conducted undrained shearing tests on resedimented mudrock (GoM-EI) specimens and measured \( V_p \) and \( V_s \) throughout the shearing process. Test results show that \( V_p \) is mainly controlled by porosity and relatively insensitive to undrained shear. \( V_s \) reduces significantly with shear, suggesting a softening of the mudrock shear modulus. As a result, the velocity ratio \( (V_p/V_s) \) and the poisson’s ratio are dependent on shear stress level. In the later stages of shearing, there seems to be a change in material behavior.

Fig 1: Normalized P and S velocities for GoM-EI plotted against normalized average stress during undrained shear

Fig 2: Undrained stress paths compared to Modified Cam Clay yield surfaces for three tests on GoM-EI. Compressional velocities are average values during shear
Fig. 1: Normalized P and S velocities during undrained shear
Fig. 2: Experimental effective stress paths compared to Modified Cam Clay curves