08.14: A critical state model for mudrock behavior over large stress range

Mahdi Heidari

ABSTRACT

Recent experimental tests over the stress range of 1-100 MPa on resedimented mudrock samples from Eugene Island, Gulf of Mexico, (Casey et al., 2015) show that mudrock properties including the slope of the compression curve, friction angle, lateral effective stress ratio (k_0), and undrained strength ratio (S_u/σ'_{vc}) vary substantially with the stress level. Present mudrock models, however, assume linear failure envelope and compression curve, hence predicting constant values for the stress and strength ratios. We enhance Modified-Cam-Clay (MCC) model to represent the stress-level-dependency of mudrock properties by using power-law forms for the failure envelope (Fig. 1) and the compression curve. We show that these minimal enhancements enable prediction of the significant increase of the stress ratio and decrease of the strength ratio with the stress level (Fig. 2). Enhancing the failure envelope is the major source for the improved predictions. The enhanced model also predicts that the ovality of the iso-porosity surfaces increases with the stress level, implying higher contribution of shear stress to sediment compaction at high stress levels. Our study helps better representation of mudrock behavior and estimation of stresses in geomechanical models.

Casey, B., Germaine, J.T., Flemings, P.B., Fahy, B.P., 2015. Estimating horizontal stresses for mudrocks under one-dimensional compression. Mar. Pet. Geol. 65, 178-186.

CLICK ON IMAGE FOR LARGER VIEW

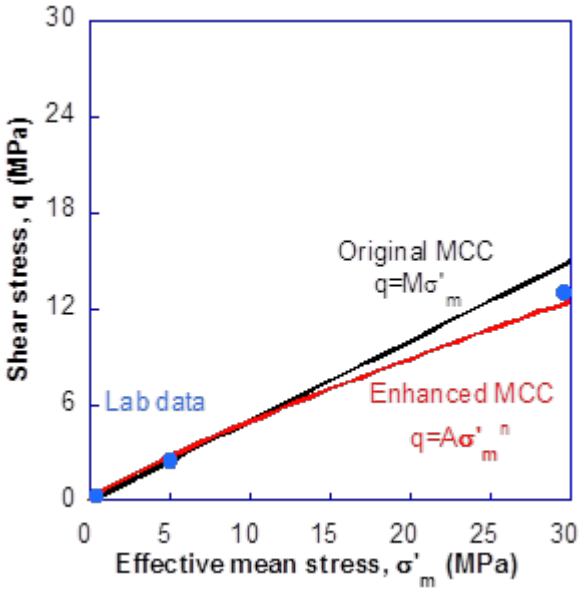

Fig. 1: Stress points measured at failure vs. fitted failure envelopes: linear (original MCC) and power-law (enhanced MCC). Power-law envelope better fits measured data points.

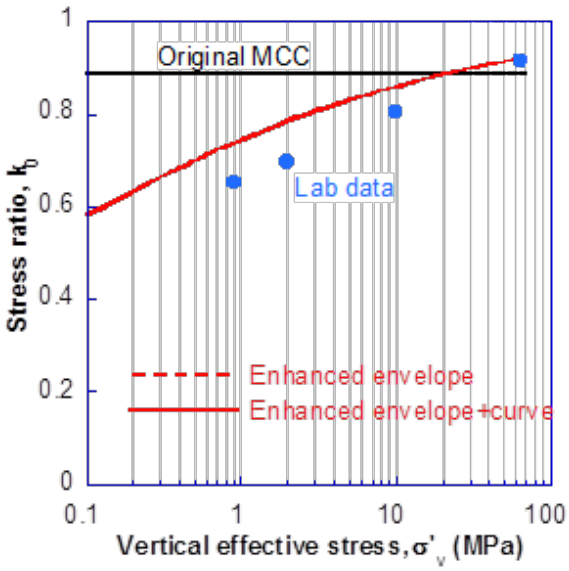

Fig. 2: Stress ratios (k_0) measured at different stress levels vs. predictions of original MCC and enhanced MCC. Enhancing failure envelope enables MCC to predict k0 increase with stress level.

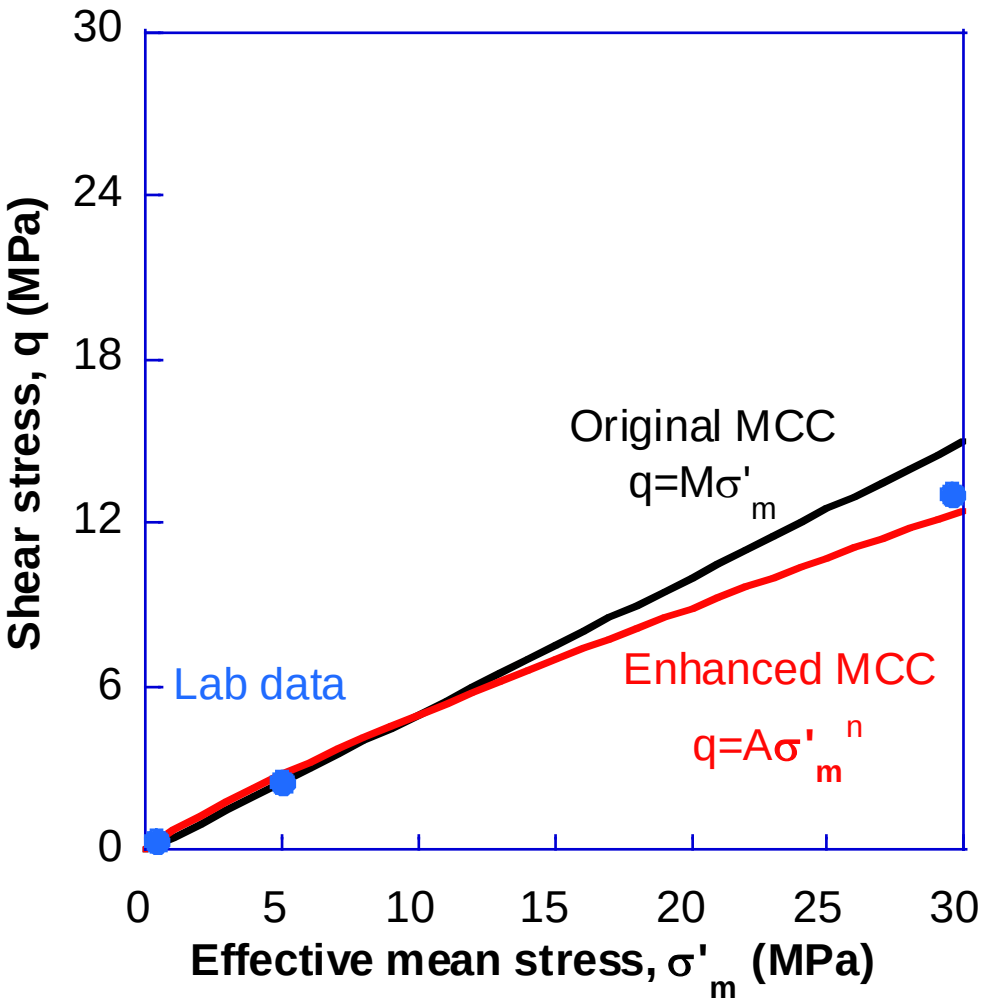

Figure 1: Stress points measured at failure vs. fitted failure envelopes: linear (original MCC) and power-law (enhanced MCC). Power-law envelope better fits measured data points.

Back

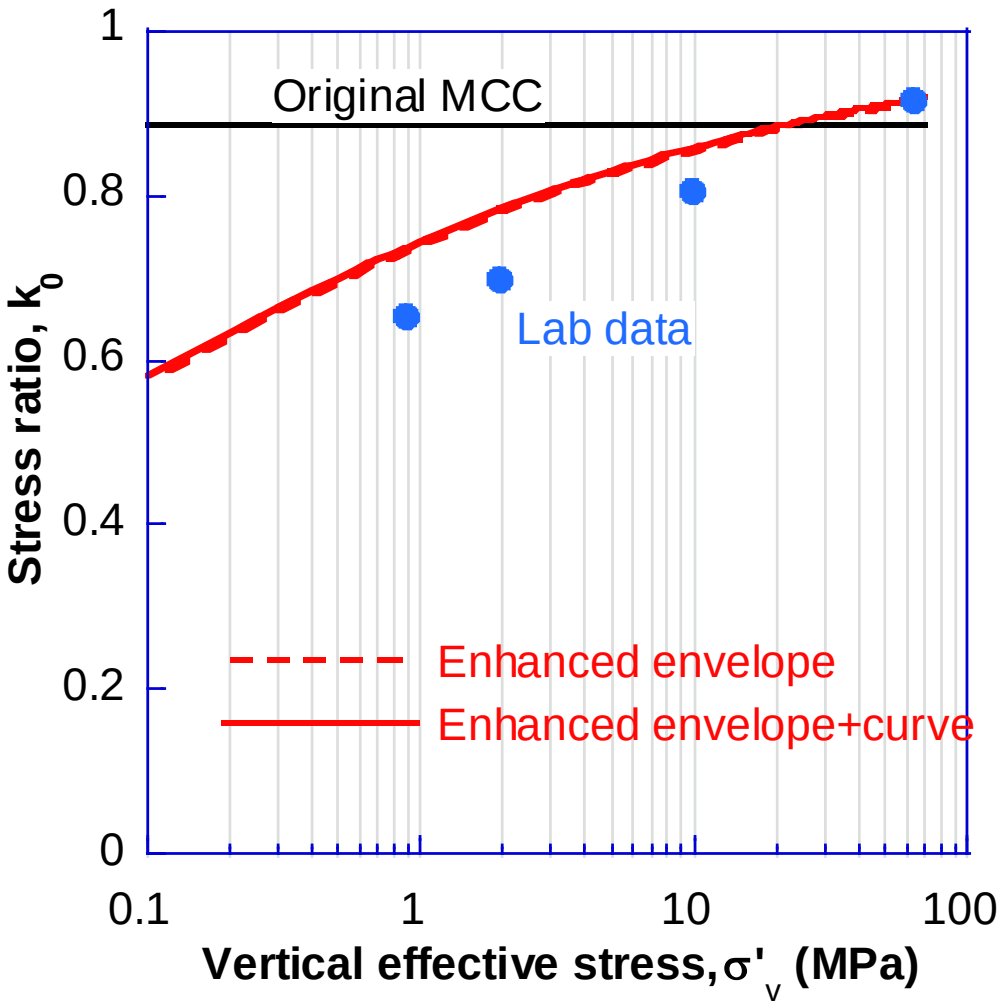

Figure 2: Stress ratios (k_0) measured at different stress levels vs. predictions of original MCC and enhanced MCC. Enhancing failure envelope enables MCC to predict k_0 increase with stress level.

Back