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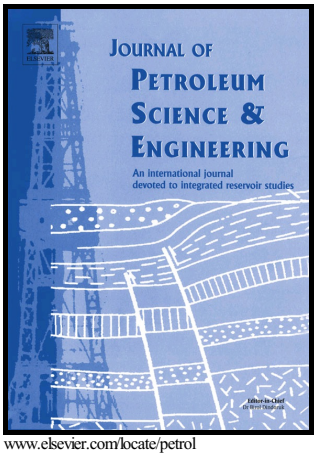

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An easy and efficient way to evaluate mechanical properties of gas hydrate-bearing sediments: The direct shear test

Zhichao Liu[a], Houzhen Wei[b*], Li Peng[a], Changfu Wei[b], Fulong Ning[a*]

[a]Faculty of Engineering, China University of Geoscience, Wuhan 430074, China

[b]State Key Laboratory of Geomechanics and Geotechnical Engineering, Institute of Rock and Soil Mechanics, Chinese Academy of Sciences, Wuhan 430071, China

nflzx@cug.edu.cn

weihouzhen@163.com

[*]Corresponding authors

Abstract

Understanding the mechanical behaviours of gas hydrate-bearing sediments (GHBS) is important for their associated applications in wellbore stability, stratum deformation during exploitation, geological disaster prevention, and the risk assessment of the exchange of CH_4 with CO_2 in hydrate reservoirs and CO_2 sequestration in oceans. However, triaxial tests on mechanical properties of GHBS are taxing and time-consuming. Here, we presented an easy and efficient way to evaluate these by using a self-developed direct shear apparatus. Then a series of direct shear tests on GHBS represented by CO_2 hydrate-bearing silt were performed to investigate their mechanical behaviours and strength indices by changing the axial pressure, CO_2 hydrate saturation, shear rate and hydrate synthesis temperature. Our results indicate that CO_2 hydrate significantly strengthens specimens by cementing silt grains. In addition, when hydrate saturation increases, the cohesions are enhanced from 0.09 MPa to 2.39 MPa, and the internal friction angles increase and decrease at the range from 28.6 to 43.3° under the experimental conditions. These findings have direct implications for evaluating the stability and safety of natural gas hydrate reservoirs, CO_2 replacement to extract CH_4 and CO_2 sequestration.

Keywords: gas hydrate; CO_2; direct shear; sediment; mechanical property

1. Introduction

Natural gas hydrate in nature is an unconventional energy resource that is mainly found in onshore permafrost and offshore regions (Kvenvolden, 1988; Sloan, 1997; Mahajan et al, 2007) which