8th National Congress on Civil Engineering, 7-8 May 2014
Babol Noshirvani University of Technology, Babol, Iran

Numerical simulation of Thick-Walled-Cylinder (TWC) test for study of Wellbore Instability Mechanism in Clayey Formation

Hadi Shahir[1], Behzad Rouhbakhsh[2]
1- Assistant Professor, School of Engineering, Kharazmi University, Tehran, Iran
2- M.Sc. Student, School of Engineering, Kharazmi University, Tehran, Iran

shahir@khu.ac.ir, b.rouhbakhsh@yahoo.com

Abstract

Shallow oil reservoirs at depths less than 1,000 m are found within weak rock formations. Most of these formations are typically consisting of hard clays and soft shale. The stability of boreholes in shales is a major problem. In this paper, nonlinear elasto-plastic model are used to investigate the influence of strain rate and consolidation stress level on deformations of a Thick-walled hollow cylinder (TWC) of resedimented Boston blue clay (RBBC) during undrained shearing that have been performed to study wellbore instability mechanism under simulated wellbore in situ conditions in clayey formation. The investigation shows that the Modified Cam-Clay constitutive model can adequately predict the deformation in thick-walled hollow cylinders of shale in high pressure. Results indicate that for normally consolidated clays most of the change in cavity pressure occurs at volumetric strains less than 5% after which the borehole becomes unstable.

Keywords: Wellbore Stability, TWC test, Modified Cam Clay, 2D Simulation, Clayey Formation.

1. INTRODUCTION

There is no doubt that oil has been one of the most important raw materials since the beginning of the 20th century. The growing demand for cheaper energy and cutting operating costs has made borehole stability a key issue for the oil industry. Geomechanics has an important role to play in the mechanical simulation of reservoir deformations and the performance of wellbores. Efforts to expand oil resources and explore new territories are vital to sustain energy production in the next few decades. Part of these efforts includes oil production at very shallow depths.

Shallow oil reservoirs at depths less than 1,000 m are found within weak rock formations. Most of these formations are typically consisting of hard clays and soft shale. The stability of boreholes in this formation is a major problem. For example in the oil and gas industry, wellbore instability problems cost the industry many millions of dollars annually. One of the important experimental studies on the mechanical behavior of saturated clayey soils, is a Thick-Walled Hollow Cylinder tests called TWC conducted by Abdulhadi et al. [1-2], which their results have been used in this study.

In this paper, nonlinear elasto-plastic model are used to investigate the influence of strain rate and consolidation stress level on deformations of a Thick-walled hollow cylinder (TWC) of resedimented Boston blue clay (RBBC) during undrained shearing that have been performed to study wellbore instability mechanism under simulated wellbore in situ conditions in clayey formation.

2. THICK-WALLED HOLLOW CYLINDER TEST

In order to develop a better understanding of the mechanical behavior and the stability of a borehole drilled into saturated clayey soils and shales, a borehole collapse test on a thick- walled hollow cylinder tests was conducted by Abdulhadi et al.[1-2].

2.1. TEST CONDITIONS

Two thick-walled hollow cylinder samples of resedimented Boston blue clay (RBBC) under undrained shearing were conducted by Abdulhadi et al. [1-2] to study wellbore instability mechanism under simulated wellbore in- situ conditions in clayey formation. The smaller device has an external diameter of 76 mm, internal diameter of 25 mm and a length of 150 mm. The large TWC model has the same boundary conditions and geometric aspect ratio with outer diameter of 152 mm, and length of 228 mm, leading to a diametric ratio of Do/Di = 6. These dimensions provide aspect ratios that are consistent with