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Shear force prediction of blow-out preventer drill pipe

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Abstract

An accurate prediction of blow-out preventer (BOP) drill pipe shearing is of critical importance in the applications of offshore drilling equipment. To simulate the shear process, a ductile failure criterion is clearly needed. In this paper, we employ an extended Mohr-Coulomb (EMC) criterion, which makes validated predictions for shear fracture by including the stress triaxiality T and Lode parameter L. This criterion has six parameters to be calibrated either by experimental tests or by numerical simulations. Here, we present a micromechanics model to calibrate the undetermined parameters via a void coalescence mechanism, and predict the forces for pipe shearing by finite element analyses. The shear force profile for the case where the EMC criterion parameters are micromechanically determined agrees with that for the case where the parameters are experimentally determined. This paper demonstrates the predictive capability of a micromechanics-based ductile fracture model in conjunction with the EMC criteria for BOP drill pipe shearing.

Keywords: Shear force; Blow-Out Preventer; Void coalescence; Stress triaxiality; Lode parameter

1. Introduction

Cutting action, or shearing, is an important failure process in blow-out preventer (BOP) drill pipes [1]. The BOP is an essential element of offshore drilling equipment, sitting just above the well head to prevent a serious disaster at the time of emergency [2, 3]. A shearing BOP has internal rams with blades that can shear drill pipes, and subsequently overlap to seal off the well. As offshore drilling goes deeper, new challenges arise: deep-sea drilling entails a need to withstand extremely high water pressure and thus calls for the use of larger and stronger drill pipes [4, 5]. In practice, major BOP manufacturers have each applied slightly different interpretations of the theory in their calculations to determine the overall force required to shear a given pipe. These predictions sometimes seem conservative when compared to actual shear test data, and there have been considerable variations among test results even for the same grades and dimensions of drill pipe

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