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Numerical Analysis of Cutting of Shear Ram Blades through High Strength Drill Pipes

by

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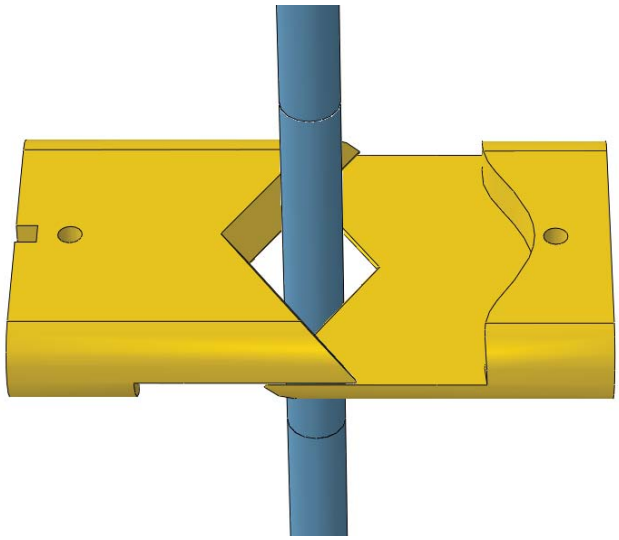

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Abstract

The human, economic and environmental disaster that followed the Deepwater Horizon catastrophe at the Gulf of Mexico in April 2010 revealed how much the offshore drilling industry relies on the Blowout Preventer (BOP) as the primary means of controlling a 'well kick' or 'blowout'. One of the most important components of the BOP are the shear rams which are tasked with cutting the drilling string in case of an emergency, allowing the blind rams and the annular type blowout preventer to seal the wellbore and prevent things from becoming unmanageable. The increased drill pipe material strength, the fact that their diameter and wall thickness are eventually optimized (larger and heavier pipe sizes) and the greater water depths in combination with the high drilling fluid density, affect the BOP's ability to shear. This study investigates all stages of the shearing process and attempts to optimize the geometry of the shear blades. In order to do that, simulations are conducted with Finite Element Models (FEM) by utilizing the Impact and Crashworthiness Lab's (ICL) fracture methodology, the backbone of which is the Modified Mohr-Coulomb (MMC) fracture criterion. Nine cases involving three different angles defining the sharpness (cutting angle) and three angles characterizing the shape of the blade are evaluated. The optimum configurations for the shear blades are investigated based on the maximum required cutting force and the sealing capability. The simulations are performed taking the fracture and plasticity parameters for TRIP 690 material, which is similar to the X100 grade of steel. Finally, recommendations for shearing the tool joints, the connections of the drill pipes, are made based on the Finite Element (FE) simulations.

Keywords: Multi-axial loading; shear ductile fracture; advanced high strength steels; heavy-wall pipes; shear rams; drill pipe; Mohr-Coulomb.