Dynamics of the Bottom Hole Assembly during drilling operations

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ABSTRACT

A lower portion of the drill string used in drilling for oil and gas is called bottom hole assembly (BHA). The BHA consists of a combination of very sophisticated (and expensive) equipment that is designed to stabilize and direct (navigate) the drill bit to a specific target depth and horizontal deviation (directional drilling) while simultaneously performing real time geophysical measurements (logging-while-drilling). A typical BHA could range between 500-600 feet in length. The configuration of the BHA and the characteristics of the surrounding drilling fluid govern the dynamic behaviour of the system, which is crucial for the stability and for an effective drilling process. An incorrect configuration of the BHA, in terms of the dynamic stability, produces dangerous effects inducing severe damage in the BHA components and the ability to reach target zones.

A number of structural and fluid-structure-interaction numerical computations have been carried out to analyse the possible appearance of excessive vibrations in the BHA. These computations assume the BHA as a combination of beam segments and rigid bodies (different components of the BHA), and take into account the contact with the walls of the borehole. Also, the damping effect of fluids on the vibrational response of the BHA is investigated.

Two different scenarios have been considered:

- The computation of the BHA dynamics considering possible contacts with the borehole walls with no presence of drilling fluid. Both the beams and the rigid bodies are affected by the contact with the walls (see fig.1).
- The computation of the BHA dynamics considering a surrounding drilling fluid (water) and the contact with the walls. The skin of the BHA is embedded in a fixed fluid mesh, and used as a boundary condition by the fluid solver.

The comparison between the results of both scenarios shows the damping effect of the drilling fluid, and the relative importance of the fluids when choosing the BHA components.

The analysis was performed using the structural and fluid solvers included in Kratos, an open source Multiphysics code developed at CIMNE, featuring embedded structures in fluids. Comparative studies on the vibration of the BHA without fluid were also performed using Abaqus FEA.

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