Complex Dynamics of Drill-String and BHA

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Abstract:

Despite a significant effort devoted to studying complexity of drill-string vibrations, robust and reliable models are yet to be developed. This is due to inherently nonlinear nature of the interactions occurring in a drill-string, where different types of vibrations are coupled to each other. Therefore, to gain a deeper insight into the complexity of the drill-string vibrations, a novel experimental rig has been developed at the Centre for Applied Dynamics Research, the University of Aberdeen.

We investigate complex dynamics of a drill-string and Bottom Hole Assembly (BHA) by theoretical and experimental means. Experiments are carried out on our newly developed rig, which is capable of reproducing all major types of drill-string vibrations. One of the most important features of this versatile setup is the fact that commercial drill-bits, employed in the drilling industry, and real rock-samples are used. The rig allows for different configurations, which enables experimental studies of various phenomena, such as stick-slip oscillations, whirling and drill-bit bounce.

We constructed and calibrated both FEM based and low dimensional dynamic models to predict complex responses of drill-strings and to avoid their undesired dynamic behaviours. The nonlinear dynamics modelling and stability analysis tools were employed to investigate global and local dynamic behaviours. These models can be used at the borehole planning stage and also to support dynamic analysis and control of deep-hole drilling processes.

In the lecture we will describe the new experimental drilling rig, identify its system parameters, build mathematical models and investigate dangerous dynamic phenomena such as stick-slip and whirling. A special attention will be paid to the onset of helical bucking.