ARC '16

مؤتمر مؤسسة قطر
السنوي للبحوث

QATAR FOUNDATION
ANNUAL RESEARCH
CONFERENCE

Towards World-class
Research and Innovation

Energy and Environment Pillar

http://dx.doi.org/10.5339/qfarc.2016.EEPP2700

Vibration Wave Characteristics in Conventional and Periodic Drill String Models

Fesmi Abdul Majeed, Sadok Sassi

Qatar University, QA

Email: fmajeed@qu.edu.qa

Drill string models are of two major types- Conventional and Periodic. Conventional drill string models are widely used due to their simplicity in manufacturing and dynamics analysis. Drill strings are affected mainly by torsional, lateral and axial vibrations. The dispersive or propagative nature of these vibrations can only be analyzed by using periodic drill string models. Drill pipe makes up the majority of the drill string. In reality, at each end of the drill pipe, tubular, larger-diameter portions called the tool joints are located. Since the dimensions of the tool joint are negligible when compared to the drill pipe, conventional drill string models assume drill strings to be uniform structures. The tool joints in drill strings introduce a geometrical periodicity in the structure.

A periodic structural component is comprised of a repeating array of cells, which are themselves an assembly of elements. The elements may have differing material properties as well as geometric variations. The periodic structures act as mechanical filters for the wave propagation. A material or geometrical change in the structure causes a disruption to the continuous propagation of vibration waves.

There are three types of waves propagating in rotating structures: torsional, flexural (bending) and longitudinal. Of these waves, torsional and longitudinal waves are dispersive while flexural waves are non- dispersive. The proportions of the waves which are dispersed vary according to the Wavenumber. The wavenumber is a property of the wave and depends on the structural, material and geometrical properties of the wave guide. Waveguide is the medium through which a wave travels. The wave number, and hence the dispersion and propagation characteristics of waves can be tuned by varying the material and geometrical periodicity in the drill strings.

This paper presents the vibration propagation and attenuation characteristics in conventional and periodic drill string models. The periodic drill string model is developed such that it can be easily scaled to a real drilling rig model. The research also features a laboratory setting which comprises a mini drilling rig and actual drilling samples. These features ensure robustness of the dynamics analyzed for the periodic drill string model.

Cite this article as: Abdul Majeed F, Sassi S. (2016). Vibration Wave Characteristics in Conventional and Periodic Drill String Models. Qatar Foundation Annual Research Conference Proceedings 2016: EEPP2700 http://dx.doi.org/10.5339/qfarc.2016.EEPP2700.

The research findings are analyzed under zero and non-zero borehole drill string interactions. Vibration information is collected from upper and lower parts of the drill string models to compare the propagation and attenuation characteristics. Proximity sensors are used for the data acquisition which is then analyzed using frequency and power spectrum graphs. The time and frequency domain vibration propagation characteristics are investigated for both the conventional and periodic drill string models. Laboratory testing analyzes (1) introduction of stop and pass band regions in frequency spectra by periodic drill string models, and (2) vibration attenuation in torsional and lateral vibration modes. The tests confirm the introduction of stop bands in frequency spectra for the periodic drill strings, while they were absent and had an all pass-band for conventional drill string models.

The research opens up a new method of passive control of drilling vibrations-by introducing tool joint designs which could be tuned to efficiently dampen out the harmful vibrations affecting the drilling rigs.