

# **An Introduction to Drilling Vibration**

George P. Schivley, Jr.  
Principal Consultant  
DRILLING TECHNOLOGIES  
Richardson, TX

## **Abstract**

When drilling blast holes, with roller cone bits, a phenomenon known as drilling vibration can occur. It is characterized by either axial or lateral modes of periodic motion of the drill pipe; superimposed on the time-average angular motion of the drill pipe provided by the drill rig rotary head and the vertical motion associated with the penetration rate of the tricone bit into the rock being drilled. This periodic motion can be very severe and, if appropriate action is not initiated by the drill rig operator, could lead to structural damage to the drill rig. Ultimately, the occurrence of drilling vibration limits the productivity potential of a rotary drill.

To better understand this phenomenon, one must look beyond the drilling system and consider the environment in which the drilling system is operating. The rock formations typically encountered in open pit mining applications, rather than being large monolithic rock masses, can involve significant variations in rock properties occurring over short local distances...of the order of inches. In a given blast hole the bottom can have asymmetrical hardness or be physically fractured. This potential asymmetrical nature of the bottom of blast holes plays a key role in the occurrence of drilling vibration. This paper views drilling vibration by considering the periodic loading of the tricone bit, due to hole bottom asymmetries, and how that can excite the drill string to vibrate in different modes.

For the lateral mode of periodic motion of the drill string, a model is presented that predicts the set of resonant frequencies for any drill string that are possible; as the hole is drilled. These resonant frequencies can then be related to the frequency of periodic loading of the tricone bit based on the bit angular speed to see if severe drilling vibration is likely to occur.

Whenever there is drilling vibration there is the issue of how the drill rig itself reacts. To address that point, the interface between the drill string and the drill rig and any resonant coupling must be considered. Various aspects of drill rig design that relate to this matter are reviewed. Also there is a discussion of the various optional features that are available on rotary drill rigs to deal with drilling vibration.

Finally, the issue of how a drill rig operator can best deal with drilling vibration is discussed.