Mine Site Exploration and Ore Delineation

Paper 94

Drilling Parameters and Their Application in Mining and Exploration

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Within the context of the development of new instrumentation technologies in destructive drilling (Measurement While Drilling, MWD) stemming from the oil industry and from civil engineering, the recording of drilling parameters as a function of depth (for each centimeter) is one of the most promising solutions in mining technologies at the exploratory as well as the developmental phase (surface or underground mining).

The installation of devices for recording drilling parameters on drilling machines and the real-time processing of the data provided by these devices makes it possible to improve the cost effectiveness of destructive drilling. This is achieved by the supply of information not previously employed, and the final cost of a drilling facility can be lowered through an improved management of the machine parameters and the related expendable tools.

Finally, these recording devices make it possible to keep track of the operating time of the machines.

In particular, the recording of drilling parameters allows:

- a mechanical characterization and therefore a geological/tectonic identification of the rock units encountered by the drilling tool, after correlation with a core drill;
- enhanced value of the drill tools (down-the-hole hammer, reverse flushing, OD and ODEX methods) through truly "customized" drilling;
- optimization of machine parameters and a better control of the wear on the drill tools;
- real on-site management of the drilling through the use of the information provided by the equipment (drill name, date and time of start of drilling, date and time of end of drilling, incidents, lengths drilled, pitch tilt (X, Y), etc.);
- safety for development in the tunnel through prevention and detection of geotechnical problems during progress; and
- rationalization of the blasting pattern for ore extraction (distribution and type of explosive charges).

Three areas of application are concerned by the use of drilling parameters in the mining industry.

GEOLOGICAL EXPLORATION

The combination of destructive drilling and the recording of drilling parameters makes it possible, in a large number of cases, to identify the different geological units encountered by the bit and thus can locate anomalous areas.

This technology may be used either in an unworked site to determine the contours of the levels that contain ore by their geomechanical differentiation, or in reserve evaluation to supplement core drills and increase the density of information.

PLANNING THE DEVELOPMENT

The recording of drilling parameters allows the operations manager to better plan the development at the drilling level, in both open pit as well as underground operations while making it safer for the personnel inside the tunnel as they are progressing.

Beyond the purely geological or geotechnical aspect, the recording of drilling parameters allows information management related to drilling production:

- Start and end date and time, start and end depths in meters of each drill referenced with their real names (A28.a for example), allowing the calculation of an average drilling speed for each drill, station or day.
- Possibility of marking drilling incidents on the depth curve by using an events button.
- Possibility of facilitating the setting up of the drilling angle by using a 2-D tilt, with or without a reference azimuth.

RATIONALIZATION OF DRILLING

The recording of drilling parameters can also help the driller manage his machine parameters in order to optimize them according to the ground variables, e.g. a significant deviation of the rod train or untimely wear of

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a drilling tool. This also makes it possible to best manage the depth of the drills according to the target to be reached.

Finally, the recording can also help provide evidence of certain factors, whose choice and interpretation are essential for an optimal use of this method. These include:

- the Instantaneous Advance Speed (IAS), also called the rate of penetration, is an indication of "drillability" and not a real hardness value of the units encountered;
- the Tool Pressure (TP) makes it possible to check the regularity of the drilling operations; and
- the Injection Pressure of the drilling fluid (IP). For this parameter, there are two possible cases, depending on whether there is injection of air by a compressor or water with or without an additive (e.g., foam, bentonite, polymers, etc.). With air drilling, this parameter allows recording the presence of homogenous areas without loss of air and heterogeneous areas with air loss. In the case of water drilling or an equivalent thereof, this parameter makes it possible to provide good indication as to the variation of the plasticity of the ground. An increase in plasticity translates into a rise in pressure of the drilling fluid and, in particular, makes it possible to locate clay rich zones.

The Torque (TQ) expresses the work necessary for the tool to rotate into the ground and represents a degree of heterogeneity of the soil. The more heterogeneous the ground is (blocks, faults, etc.), the more the torque will increase, with significant surges.

The Rotation Speed (RPM) makes it possible to assess the degree of heterogeneity of the ground as a supplement to the torque but with greater precision because measurements are taken by a proximity sensor placed directly underneath the drilling head. The Rotation Speed information is used less than the torque in destructive drilling because it is not as easy to implement. Nevertheless this parameter remains an excellent marker of fractured areas.

The Instantaneous Drilling Time (TIME) makes it possible to confirm the IAS, of which it is the inverse, but with a graphical sensitivity that is certainly better on low speeds, allowing a better interpretation on ground with low "drillability."

The Reflected Vibration or VIBRALIM makes it possible to show differences in hardness of the ground. This parameter represents the instantaneous energy reflected by the ground under the action of the drilling tool and complements the IAS by adding the hardness of the ground to the "drillability."

This parameter has no unit and requires a special electronic and metrological processing at the level of the recorder of the signal originating from an accelerometer positioned on the drilling head.

Other parameters can be measured, such as: the Strike Pressure (SP), the Hold Pressure (HP), the Rate of Flow of the drilling fluid (water or air)or the Temperature of the drilling fluid as a function of depth (geothermal drilling).

To sum up, the drilling parameters can be classified into two major families: the "interpretive" drilling parameters in which the ground variable is considered, such as the IAS, IP, TQ, RPM, and VIBRALIM, and the "corrective" parameters which are used to correct the former, and which result from machine variables such as hydraulic pressures (TP, SP, HP).

This drilling data can be supplemented by the recording of the angle of the drilling booms in 2-D with or without the reference azimuth at the start or end of the drilling.

The drilling parameters recording device of the LIM SA company incorporate all of these possibilities and reproduce the results on a storage device and/or an on-site thermal printer in real time, each centimeter. Any type of drilling rig can be fitted with our equipment from the largest (oil-type) to the smallest (pneumatic, kroll-type) drill.

These devices have been designed and manufactured to resist difficult operating conditions (humidity, vibrations, temperature –20°C to +70°C) that are encountered in professional drilling.

Since 1985 our company has manufactured and sold more than 150 drilling parameter recorders and thus possesses a reliable store of knowledge in this area.

The different data processing tools available (such as the GEO-LOG 2 software for Windows and ACCESS 2 database) make it possible to develop various corrected or compound parameters by means of a mathematical interpreter.