Rock hardness is defined by the compressive force per square inch to crush a core sample of rock. Reports citing the hardness of rock on a project very often are based on estimates, rather than tests of samples. For directional drilling purposes, “soft” rock would be about 5,000 psi and “hard” rock 25,000 psi and higher.

Some contractors are specialists in rock drilling, called in to make difficult installations others don’t want to attempt. They take pride in doing the “impossible.”

Other drilling firms make long bores to install large-diameter pipes and have the equipment and experience to handle most rock bores they encounter, but do projects in a wide range of soil conditions, including rock.

Rock drilling is always difficult and requires a significant amount of planning and communication to meet the project expectations. “Through years of experience in rock drilling and excellent communications with customers, H&H has successfully completed thousands of rock drills.”

H&H Enterprises

H&H Enterprises, Andover, OH, is a rock specialist working primarily in the Northeastern United States. “Ninety-five percent of our work is in rock,” said Jason Hockran, vice-president/owner. “We seek out and complete projects in rock and other complex installations that standard HDD contractors are not interested in or are unable to complete. Rock drilling is always difficult and requires a significant amount of planning and communication to meet the project expectations.”

One project near Pittsburgh, PA, required drilling 2,200 feet of approximately 18,000-pound psi rock to install 24-inch diameter steel casing for multiple HDPE gas transmission and water lines. An American Augers DD220 was used for the pilot hole and first reaming pass that was equipped with a 6 ¾-inch Adtech mud motor with an 8 1/2-inch sealed bearing tri-cone bit and multiple low-torque Sharewell hole openers of 22 to 36 inches to complete the opening of the hole. An AA DD440 was used for the final reaming pass and pulling in the pipe.

“Most of our projects are more complex and not ordinary in overall scope,” said Hockran. “Recently we completed a project in Pennsylvania in a moderate-hard shale formation that required an innovative approach to fluid management. A frac-out created the need to drill a vertical intersect to our drilled hole and provide a controlled path for the drilling fluids. This was successfully achieved and provided significant advantages for both the drilling process and most importantly, the environmental impact to a nearby stream.”
Tips From A Rock Drilling Specialist

H&H Enterprises is an HDD contractor specializing in rock with 15 years of experience working primarily in the Northeastern United States.

H&H operates three American Augers HDD units ranging in size from 60,000 to 440,000 pounds of pullback and all required support equipment, including mud pumps, mud recycling systems, vacuum truck, crane trucks, pipe layers, excavators with pipe-handling equipment and haul trucks.

A recent project employed two drills: a 60,000-pound drill unit and a 220,000-pound model to drill 1,200 foot holes. One was for a 16-inch HDPE water line and the other a 12-inch steel gas line. Rock hardness was 25,000 psi. A 4 3/4-inch Adtech mud motor was used with 6-inch sealed bearing tri-cone bit and multiple Sharewell low torque hole openers in sizes ranging from 14 to 30 inches.

The first step in a successful HDD project is understanding its specifications in order to prepare a realistic bid, especially when rock is a factor.

"Standard industry bidding practices and procedures apply to all projects, but rock drilling takes significantly more time to correctly bid compared to projects in dirt," observes Jason Hockran, H&H vice president/owner. "On rock projects, it is crucial to recycle drilling fluids and to include the costs of fluid recovery and disposal. This applies to most HDD projects, but usually is more costly on rock projects."

Hockran emphasized that every successful HDD project should begin with planning, especially in rock.

"The busy rush of almost every directional drilling project may cause contractors to overlook basic planning steps," said Hockran. "Taking the time to think through the steps for the HDD process, utilizing the capabilities of your equipment and knowledge of your crews, and focusing on safety all lead to an effective project plan."

Client communications

Because many customers are not familiar with HDD in general and less with HDD in rock, Hockran said communicating with the customer regarding the specifics and limitations of HDD rock drilling is important.

"Typically, rock projects require longer drill lengths than dirt, so communicating about scheduling and drill path limitations are a key to establishing and meeting expectations for directional drilling in rock," he said.

Matching equipment to project needs is important. Whether or not a job calls for a mud motor is an important decision for the contractor.

"Many factors must be considered when determining the type of rock drilling equipment to utilize," Hockran said. "They include length of crossing, diameter of product, geological conditions (whether rock is consolidate or unconsolidated), drilling rig, environmental considerations for fluid/air use, experience of the drill crew and type of steering tool."

When drilling with a mud motor, one of the critical components is mud pumping capacity, which is determined by the drill string's inside diameter and mud pump and mud recycling system combination.

"For this reason when drilling with a mud motor typically the smallest drill rig used is a 60,000-pound machine," Hockran said. "This size drill typically uses 3 1/2-inch drill pipe which will provide the necessary mud pumping capacity with a minimum 200 gpm pump and mud recycling system. The larger the diameter of the drill pipe, the larger the mud motor, pump and mud recycling system required."

H&H uses tri-cone sealed bearing bits for pilot holes and low torque hole openers to complete the hole opening process in rock.

"In our experience," said Hockran, "the mud motor and traditional hole openers have proven very successful and consistent in the northeastern region of the U.S. Typically, we own the mud motors we use. For a company that drills in rock the majority of the time, it is best to purchase mud motors, but at times we will rent them as needed."

Forrock drilling without a mud motor, Hockran considers two primary options:

- Conventional heads with TCI inserts for cutting efficiency and wear; and
- Air hammers.

"The conventional TCI drill head is efficient and effective in rock formations less than roughly 15,000 psi," said Hockran. "Harder rock decreases the ability to steer effectively and reduces production. These drill heads are excellent for gravelly and unconsolidated rock formations as they will not wear out as quickly as a standard 'dirt' drill head."

"Air hammers are increasingly becoming a more popular alternative in the HDD rock drilling market. They are very effective for drilling plus-or-minus 6-inch pilot holes in hard rock more than 15,000 psi, and in certain very hard rock exceeding 25,000 psi, an air hammer will be more effective and efficient than a mud motor. A limitation with air hammers is that steering is not very effective in unconsolidated formations, and it is sometimes very tricky to keep the drilled hole clean."

"While air hammers are great for pilot holes, the hole-opening capabilities of hammers are very limited and do not seem to be as efficient and effective as traditional hole openers that require fluid."

Hockran emphasizes that each of the methods described are project specific — no one tool or method is suited to all types of rock drilling.

In closing, Hockran said failure to properly plan is the most serious mistake to avoid for rock drilling projects. It also is important to have a "Plan B" for unforeseen circumstances, including weather.

"Proper planning and contingency design are the most important steps in minimizing mistakes or unknown obstacles for successfully completing a project," Hockran concluded.