Avoiding Problems in HDD Projects with Accurate Subsurface Investigations

Soil & Bedrock Abrasivity for HDD Projects

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Successful trenchless installations rely on a thorough and accurate subsurface investigation and characterization for design, planning and construction of the project. The drill geometry, project cost and schedule estimates, drilling fluid and selection of drilling tools are all heavily dependent on the anticipated subsurface conditions. Among the potential hazards are the risk of inadvertent releases (IR) of drilling fluid (frac-outs), or fractures of the surrounding soil or adjacent bedrock resulting from excessive down-hole pressure. This can be caused by uninformed design, poor choice of drilling fluids or by unsuitable drilling practices, all of which may be a result of an inadequate understanding of the subsurface conditions. It is imperative that a subsurface investigation be made that provides relevant information for the planned construction method and is commensurate with the scope of the project.

In addition, excessive tool wear from abrasive soil and bedrock materials is a leading cause of cost and schedule overruns associated with HDD projects.

Understanding the factors that cause abrasion and identifying their presence through a geotechnical investigation is necessary to avoid unforeseen costs and schedule delays. Subsurface investigations and laboratory testing typically focus on density, strength and gradation, for soil, and for bedrock help determine lithology, fracture patterns, weathering, hardness, and compressive strength. The frequency of trips, or retracting the drill string out of the hole, to inspect the drill bit or other components, is an unappreciated reality in HDD. One trip to inspect and possibly change a bit, motor, or guidance instrument may take two or more shifts and is often the result of limited or the absence of subsurface information. This situation can easily add days or even weeks to the duration of the project.

A variety, and often a combination, of methods to evaluate hardness (measuring a material's relative abrasivity in relation to the drill tools), and toughness (which measures a mineral's resistance to fracture) can be used to define and potentially avoid adverse impacts, reduce cost and schedule over-runs, and help the contractor with the appropriate selection of means and methods. Some of the traditional ways to evaluate soil abrasivity include mineralogical composition identification by petrographic examination of samples, following impregnation with a bonding agent and X-ray diffraction. Although less common (and more expensive) scanning electron microprobing may also be used. Two other soil testing options are Soil Abrasion Test (SAT™), and the Penn State Soil Abrasion Index (PSAI). Currently, neither test method is well established. The textural characteristics of soil can be visually identified using hand sample and microscopic analysis. Thin

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section petrographic analysis and Cerchar Abrasivity are common rock evaluation techniques. If thin section petrographic analysis is used, characteristics such as total content of hard, tough minerals, microcracking and weathering should also be documented.

Using the results of soil and rock testing along with other subsurface data, three types of abrasion damage should be evaluated for each project: Primary abrasion which occurs when rotation and movement of the drill tool against the face and sidewall of the bore results in abrasion of the drag bits and buttons. Secondary abrasion is associated with the degradation of the steel housing or body of the drill tool. Tertiary abrasion is caused by suspended soil and rock particles in the bentonite-based drilling fluid which can impact the pump impellor blades and other fluid transport mechanics. To mitigate this from occurring, the drill fluid recycling system needs to efficiently remove these particles so that mud motor components and jet assemblies are not unduly damaged.

HDD design elements can be modified to reduce adverse impacts. These may include avoiding compound curves and tight drill path curve radii, which can increase the rate of tool wear. The designer should consider whether subsurface zones of suspected or confirmed abrasive zones within the proposed drill path can be avoided altogether. When a drill path is planned in bedrock, large radii are beneficial, not only to reduce tool wear, but to improve the steering accuracy and allow larger inclination and azimuth tolerances. A design radius should be specified as well as a minimum single joint radius and three joint radius.

The rate of tool advance must be carefully balanced with the drill fluid pumping rate to ensure that abrasive materials are efficiently removed from the face and transported away from the drill tool. Requesting that the contractor reduce or minimize the pumping rate to reduce annular pressures (and IR risk) is common. However, this may result in additional tool wear, requiring more frequent trips to replace or condition tools, and more time downhole, which may ultimately increase IR risk. This may also affect hole cleaning which is the primary purpose of the drilling fluid.

During design or during tooling selection by HDD contractors, equipment manufacturers are a good resource and should be able to provide recommendations with regard to suitable tooling and its corresponding optimal RPM, weight on tool, reasonable reamer diameter steps, and pump rate to help reduce tool wear potential and maximize efficiency. The recommended life expectancy of the tooling can also be used to determine the length of the hole it can drill or ream. For example, if a drill bit has an estimated life span of 100 hours and the penetration rate is expected to be 50 feet/hour for a 2,000 foot crossing, 40 hours are anticipated for the pilot hole and the selected bit should easily complete the entire pilot hole. In some cases, two or more bits or hole openers are needed to complete a single pass due to the wear on the tooling.

A successful HDD installation begins with the subsurface investigation and evaluation of the conditions underground. Having a Trenchless Specialist and experienced HDD contractor on your team who understand the effects of geological conditions and characteristics and know how to develop solutions for design and construction challenges will deliver a successful project.

ABOUT THE AUTHORS:

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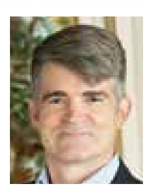

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