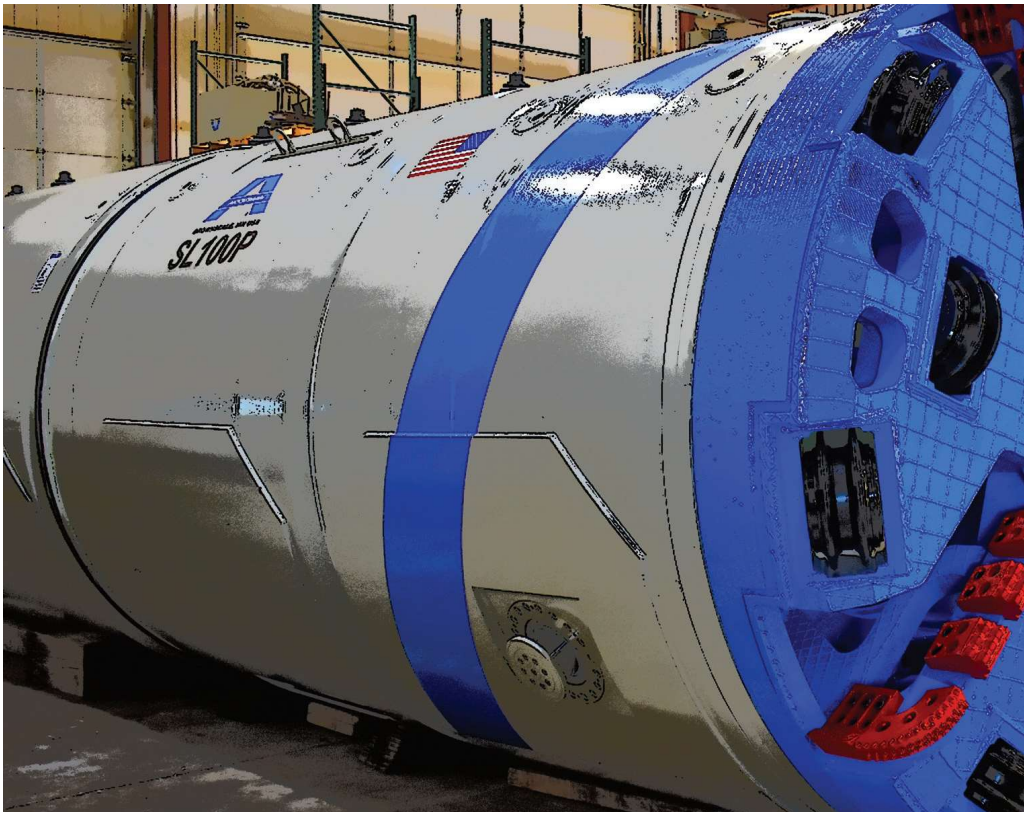
HOW TO EFFECTIVELY MANAGE RISK IN MICROTUNNELING

By Jason Holden



Introduction

Slurry microtunneling equipment has distinct advantages over other trenchless methods due to the ability to perform in a wide range of conditions when property configured. Extreme power-to-diameter ratios and enhanced control systems often allow slurry microtunneling to overcome unknown subsurface challenges, however they are not impervious to risk. Mitigating issues that become apparent on slurry microtunneling projects are often costly.

Preparation

As Benjamin Franklin once wrote, "By failing to prepare, you are preparing to fail."

The cost of microtunneling construction has increased by as much as 33% in just the past 12 months according to Construction Market Data. While it is important to note that there are several variables that determine a project's value, assigning a monetary value to risk is subjective and can have volatile cost implications on a project. With a high percentage of microtunneling contracts exceeding $15 million, it is important for all project stakeholders to be involved in risk management.

The author supports the American Society of Civil Engineers (ASCE) and National Utility Contractors Association (NUCA) position on identifying potential risks associated with trenchless projects and allocating that potential risk to the most qualified and experienced project stakeholder to manage.

Historically, contract documents were drafted with the intention of passing all the inherent risk to the contractor. In today's business climate, prospective bidders routinely only have six to eight weeks to review lengthy project documents and prepare a competitive bid. The more risk interpreted by the contractor will result in the owner paying for risk that "may" occur during bid stage.

Alternatively, prospective bidders that do not recognize the inherent risks may become the "low bidder" and find themselves in peril during the construction phase. This often leads to much higher costs than originally estimated. With limited time for proper assessment and a high burden of risk, it is no wonder bid results can have a high degree of variability with pending differing site condition (DSC) claims and change orders looming early in a project.

Dealing with Risk

Unless you are Elon Musk randomly installing tunnels for tourist attractions in the desert, every trenchless project begins with a need by an owner to bet-

ter serve its community. Over 95% of microtunneling projects in North America are owned by municipal, county, state, or federal agencies that ultimately gain funding from their constituents. It is in the citizens' best interests that the owner receives a final product that is expertly designed and constructed.

To engineer an effective solution, an owner requires the experience of a specialized trenchless engineering firm. These engineering firms are key project stakeholders and critical to project success. They are responsible for the design and must understand the geotechnical conditions in and around the tunnel zone to ensure constructability. A successful design is much more than creating a trenchless profile that meets the requirements of the owner. A trenchless engineer must be well-informed and knowledgeable of suitable trenchless methods, materials, and geotechnical conditions. The engineer must determine the initial and final conditions of the ground, and then develop an alignment that maintains a stable environment for a particular trenchless method. To properly estimate the value of a trenchless project, the engineer must be able to evaluate the geotechnical data and estimate a project value based on an interpreted installation method that mitigates inherent risks.

In trenchless construction, geotechnical investigations are never done until the project is completed. It is impractical to fully understand how the subsurface conditions will interact with the tunneling process prior to construction due to limitations of geotechnical borings. While it is generally accepted within the industry that the owner "owns" the ground, the trenchless contractor is responsible to determine how to best complete the project. To prepare for a bid, the owner must communicate anticipated ground conditions to the contractor. For microtunneling projects, geotechnical data reports (GDR) and geotechnical baseline reports (GBR) must be prepared by competent experts and included in the contract documents for review by prospective bidders. Geotechnical engineers are the most qualified and experienced project stakeholders to manage these efforts.

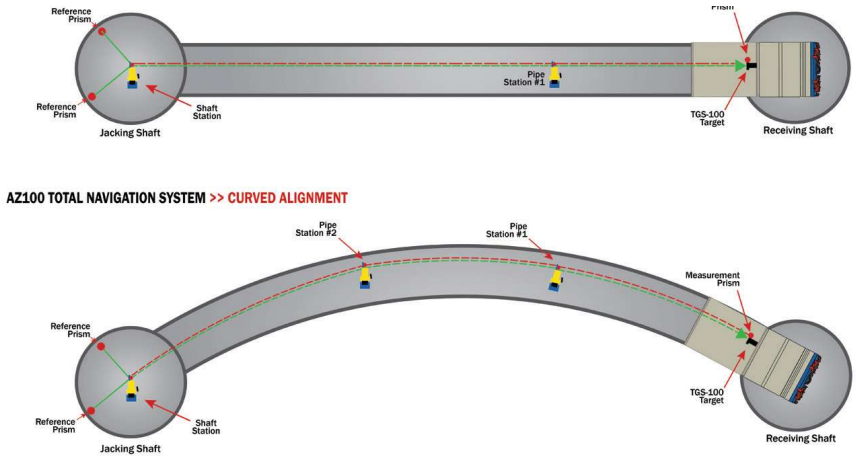


Microtunneling during winter months include additional risk.

Enhanced Microtunneling

Trenchless engineers and contractors must be knowledgeable about available technology that is designed to help mitigate potential project risk. Technical specifications listed within the contract documents define the owner's requirements based on an installation method. While a means and methods can be interpreted from the technical specification, the trenchless contractor must consult both the GDR and GBR to accurately configure their microtunneling equipment, product pipe, lubrication plan, jacking system(s), separation plant and overall power requirements to successfully complete the project.

As microtunneling technology advances, so do trenchless designs and construction practices. As prudent stakeholders begin to work together on a more frequent basis, longer drive distances and complex alignments are becoming more accepted in the industry. Below are some of the key technological advances bringing longer



Akkerman AZ-100 Total Guidance System



Installation of a 100-in OD Lube & Jacking Can for 1,000LF+ tunnel.

and more complex microtunneling projects to the forefront.

Guidance Systems

Laser-to-target based guidance systems have been the trusted system on microtunneling projects for many years. The limitation for a tunnel laser guidance system is distance. Drive lengths greater than 600-LF require the careful use of a laser as refraction becomes more probable as distance increases. Laser refraction is when the tunnel laser "bends" due to changes in the tunnel atmosphere. Several factors can influence tunnel refraction such as laser quality, air temperature, humidity, air quality, and distance to the target.

The best risk management approach for a laser-to-target guidance system is to ensure proper tunnel ventilation and select a tunnel laser with a focal length of at least half the length of the longest drive. While drive lengths have been successfully installed over 1,000-LF with a laser-to-target guidance system, the author recommends researching enhanced guidance systems for any project exceeding 1,000-LF as several types exist on the market today.

In 2015, Akkerman developed the AZ-100 Total Guidance System (TGS) in response to the growing trends of the industry. Integrating proven technologies of a laser-to-target guidance system with a total station guidance system, the AZ-100 TGS incorporates a tunnel mounted total station set at a fixed position behind the MTBM which projects a laser onto the target. A tunnel station receives positional coordinates from a total station permanently affixed inside of the jacking shaft.

The "AZ" referenced in the model's name comes from the use of azimuths that are surveyed at specific locations around the launch site. Providing fixed azimuths positions within the jacking shaft enables guidance system intelligence to communicate and transmit the designed tunnel alignment to the MTBM while performing automatic survey both in and out of the tunnel alignment. The process of "self-surveying" allows the system to automatically correct for risk factors such as drift, which normally requires a manual survey on other enhanced guidance systems. The AZ-100 guidance systems have been successfully used on multiple projects at lengths exceeding 2,200-LF containing complex alignments.

Enhanced Lubrication & Jacking

Engineers and contractors must be mindful of the overall jacking forces required for the trenchless project. Jacking forces can be affected by many factors and are often very difficult to predict with relative accuracy. The drive length, diameter, variations in ground conditions, overcut, lubrication, jacking pipe properties, and installation procedure are just some of the variables that can influence the jacking loads. There are various industry accepted methods to estimate jacking forces. The trenchless engineer and contractor must evaluate how the estimated jacking loads will be distributed within the overall system.

To manage risk, MTBM systems can accommodate an additional lube and jacking system located directly behind the MTBM. As the name implies, the lube and jacking can introduce key features near the excavation that allow the contractor a more controlled operation.

Tunnel lubrication is effectively divided into two separate systems. The lube can is the primary bentonite injection location and includes metered valves that allow the MTBM operator to monitor flow, pressure, and location of the fluid flow to the annulus.



Complex microtunneling projects like this one by Super Excavators, Inc in Pawtucket, Rhode Island takes tremendous amounts of coordinated effort from all project stakeholders.

A secondary automatic bentonite injection system (ABIS) is then used to replenish or "top off" the engineered lubrication mix along the tunnel string. The combination of a primary and secondary lubrication system working together can significantly reduce jacking loads.

Integrating a jacking can immediately behind the MTBM and within the lube can have several benefits for reducing risk on trenchless projects. The MTBM operator will have more control over cutterhead face loading conditions. Since the location of the lube and jacking can is at a fixed position behind the cutterhead, there are fewer unknown variables to decipher in the event jacking loads suddenly increase.

Conclusion

Risk management in trenchless construction begins at project inception and isn't completed until the project is finished. There are several industry articles, white papers, and even entire conferences devoted to risk management. An underlying theme to effective risk management is effective communication between all project stakeholders.

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