PILOT TUBE MAINTENANCE AND BEST PRACTICES

Guided Boring Machine (GBM) systems have countless project applications, and each year brings new accounts of contractor ingenuity with their machines. Integral to the GBM system's performance is the integrity of its pilot tube inventory. Pilot tubes are used for many miles of linear footage, and proper maintenance intervals and use in the recommended geological profiles will see contractors through to this end. However, there comes a time when it is necessary to cycle out pilot tube inventory to achieve the most accuracy and success. Terry Fisher, GBM Product Manager with pipe jacking and tunneling equipment manufacturer Akkerman, Brownsdale, Minnesota, shares the indicators of when it may be time to rejuvenate your pilot tube supply.

PILOT TUBE DESIGN

Akkerman's dual-walled pilot tubes allow for fluid passage to the steering head through a 1.3-in. (33 mm) outside ring and visibility of the illuminated target in the 2-in. (51 mm) inner tube. When connected, O-rings prevent water from entering the inner tube and a corrosion-resistant coating on the interior helps maintain visibility of the target.

The pilot tubes are designed for up to 10,500 lbf-ft of rotational torque. The ability to withstand high rotational torque, combined with proper steering head selection and lubrication has greatly extended the average drive distances, and thus furthered industry expectations. Fisher comments, "Today, the average pilot tube drive length is around 500 lf (152 m) and in ideal ground conditions, lengths in excess of 600 lf (183 m) have been achieved. Compare this to the early days following our GBM system's introduction in 2001 where 200 lf (61 m) was considered a great accomplishment."

At installation, a steering head mounted on the steering head adapter connects to the lead pilot tube's male end. The first tube is threaded onto the female end of the steering head adapter and houses the guidance system's LED target.

As pilot tubes are added and advance along the bore path, the jacking frame's cylinders advance and retract. Line and grade is maintained when the operator views the LED target image on the guidance system monitor, which is mounted on the jacking frame, and the operator makes steering corrections as necessary. The pilot tubes are followed by the application's upsizing process to form a continuous string. As the tooling string advances, pilot tubes are simultaneously unthreaded in the reception pit and placed in storage racks.

At the conclusion of the drive and before debris has a chance to solidify, the pilot tube racks are hoisted to the surface and then prepared for the next drive. This preparation includes a visual inspection, washing, drying, O-ring replacement (if applicable) and lubrication.

THREAD CONNECTION

Thread wear and ballooning is what transpires over time and is caused by excessive side-loading and high torque. Ballooning reduces the thread's engagement and this loss of face adds additional stress to the female end of the pilot tube.

When pilot tubes are in good condition, the exterior joint region should be smooth. Fisher states, "When running your finger along this area there should be no step or overlap. When threads are worn and ballooning has occurred, there will be a noticeable overlap in this region. If you look at a cutaway view of two mated pilot tubes where ballooning has occurred, you will notice that the thread teeth show rounding at each crest. The rounding diminishes the rigidity of the connection, lessens the maximum rotational torque capacity and could fatigue the tube to failure." He added, "A thread gauge tool is available from Akkerman to compare the threads to new pilot tubes, making thread wear more apparent."

Another tell-tale indicator of worn threads is noticed when separating them at breakout. If the tube does not thread apart easily during removal in the reception shaft, it may simply require lubrication, however, this could also be an indicator of excessive wear and it may have the potential for ballooning. When tubes are difficult to separate, Fisher recommends that the crew mark and set these pilot tubes aside for further inspection, cleaning and lubrication following the bore.

STEERING HEAD SELECTION

Pilot tube side loading and ballooning is most likely to occur when the tubes are used in hard geology requiring high jacking forces. Therefore, proper selection of the steering head is key to reducing side loading and rotation torque.

Akkerman's steering head kit provides four steering head configurations for a range of ground conditions. The bullet steering head has the least amount of surface area and is used in high blow counts situations. Conversely, the blunt 30-degree head is used in soft geology. When turned, a more refined tip will excavate and displace hard soil and in softer conditions, the blunt tip will force its way through the ground.

The project's soil report should determine which steering head to select but when in doubt, Fisher suggests starting with 45-degree or medium range steering head. Once contractors become more familiar with their GBM system, appropriate steering selection will become second nature.

MAINTENANCE

A solid practice of cleaning pilot tubes at the end of each bore will ensure that they are ready to facilitate the most productive installation rate on the next drive. The operator should simultaneously rotate the tube and flush the annular space to prevent settlement of contaminants, then allow them to dry at an angled or vertical position.

After the tubes are clean and dry, the next step is to inspect the threads and relubricate with Baker Hughes Copper Guard-4, or equivalent, on a regular basis. The lubricant deters dirt from settling in the threads to reduce seizing. Lubricant should be applied directly to the threads or sprayed into the caps and plugs before storage.

The pilot tubes contain two O-rings on the female end. If they are in place, they should be sprayed with the lubricant, if not, new ones must be inserted then sprayed. It is advised that contractors keep a plentiful inventory of O-rings on hand.

The last maintenance interval is to replace each tube's cap and plug prior to rack storage. As mentioned, this is also an opportunity to lubricate by spraying into the caps and plugs in lieu of spraying directly onto the threads. During storage, caps and plugs keep the pilot tube threads clean, minimize moisture to ensure a clean line of site to the target and keep containments out of the inner tube.

When the pilot tubes are installed on the next drive, Fisher suggests that operators visually inspect each one for moisture in the inner tube and lubrication on the threads. Moisture build up in the inner tube will impede the visibility of the target. The operator may clean the inner tube with a cleaning tool, which is a simple combination of a cloth attached to a sturdy rod.

RACK ROTATION

Another good practice for GBM operators to assume is rack rotation. Fisher explains, "The first 10 ft (3 m) of pilot tubes in the string are susceptible to the most stress, and therefore the most likely to sustain thread damage and ballooned joints." The best way to overcome this situation is to rotate the lead rack of tubes. One way to do this is to number all the pilot tube racks. Operators should keep track of their rack's cycling in their project notes. This first rack should be used last on the subsequent drive. This rotation will extend the life of the pilot tubes by distributing wear equally throughout the complete inventory.

Fisher concludes, "Over time, seasoned operators will become familiar with the indicators for pilot tube replacement based on performance and visual inspection. Following these recommendations and consistent observation of maintenance intervals will help contractors realize great distances to foster further GBM innovation."

THIS ARTICLE WAS CONTRIBUTED BY AKKERMAN, WHICH HAS BEEN DESIGNING AND MANUFACTURING EQUIPMENT FOR UNDERGROUND INFRASTRUCTURE INSTALLATION SINCE 1973.