

1 Materials

1.1 Pipe

The type of pipe used for the pipe jacking method shall be capable of transmitting the required jacking forces from the thrust plate in the jacking shaft to jacking field or Tunnel Boring Machine (TBM).

1.2 Allowable Forces

The allowable jacking strength capacity of pipe shall be capable of withstanding the maximum jacking forces imposed by the operation.

1.3 Pipe Characteristics

- (a) Steel pipe shall have a minimum wall thickness of $\frac{1}{4}$ inch or as specified in section 909 of the current MDOT Standard Specifications for Construction, whichever is larger. Concrete pipe shall have a minimum wall thickness as specified in section 909 of the current MDOT Standard Specifications for Construction. Likewise, CCFRPM and PCP shall have similar minimum wall thickness specifications.
- (b) Steel pipe shall have a roundness tolerance, so that the difference between the major and minor outside diameters shall not exceed 1% of the specified nominal outside diameter, or 0.25 inch, whichever is less. Likewise, concrete pipe, CCFRPM and PCP shall have a similar roundness tolerance.
- (c) Pipe shall have square and machine beveled ends. The pipe end maximum out-of-square tolerance shall be 0.04 inch, (measured across the diameter).
- (d) Pipe shall be straight.
- (e) Pipe shall be without any significant dimensional or surface deformities. All pipes shall be free of visible cracks, holes, foreign material, foreign inclusions, blisters, or other deleterious or injurious faults or defects. Any section of the pipe with a gash, blister, abrasion, nick, scar, or other deleterious fault greater in depth than ten percent (10%) of the wall thickness, shall not be used.

1.4 Pipe Joint Cushion

A cushioning material shall be used between pipe segments to assist in distributing the jacking loads evenly across the section of the pipe, and to prevent chipping or breaking of the pipe ends due to concentrated pressure caused by any slight irregularity of the pipe ends.

2 Construction

2.1 Minimum Allowable Depths

Minimum allowable depth of cover shall be as specified in the approved plans.

In locations where the road surface is super elevated, the minimum depth of the bore shall be measured from the lowest side of the pavement surface. In addition, a minimum 3 foot depth shall be maintained in all other features including ditch bottoms.

2.2 Equipment

- (a) Jacking Frame - A jacking frame shall be constructed of guide timbers, backstop and pushing or jacking head. Guide timbers or rails shall be constructed to the exact line and grade of the pipeline and shall be anchored in such a manner as to be capable of maintaining the alignment and gradient throughout the jacking operations.
- (b) Backstop - The backstop shall be constructed as to provide a bearing area capable of supporting no less than 200% of the estimated maximum jacking pressure and shall be perpendicular to the alignment of the pipe. It shall be anchored and braced in a manner to assure that this position will be maintained throughout the jacking operation.
- (c) Jacking Head - The pushing or jacking head shall be constructed to fit the pipe to be jacked and to assure that the pressure developed by the jacks will be evenly distributed on the pipe. An opening large enough to permit the entrance of workers and materials shall be left and maintained in the jacking head.

2.3 Method

- (a) After the excavation is completed, the placing and jacking of the pipe shall follow immediately to avoid unnecessarily disturbing the stability of the embankment and roadbed.
- (b) The Contractor shall dewater the pit excavation in a manner appropriate for the conditions.
- (c) The leading section of the pipe shall be equipped with a jacking head securely anchored to prevent any wobble or variation in alignment during the operation.
- (d) The driving end of the pipe shall be properly protected against damage, and the intermediate joints shall be similarly protected by the use of sufficient bearing shims to properly distribute the jacking stresses. Any section of pipe showing sign of damage shall be removed and replaced, or repaired.
- (e) Efforts shall be made to avoid loss of earth near the cutting head. Excavated material shall be removed from the conduit as excavation progresses, with no accumulation of such material within the conduit.
- (f) Once the jacking operation has commenced, it shall be continued uninterrupted, (24 hours a day/7 days a week), until the pipe has been jacked between the specified limits.
- (g) Should appreciable loss of soil occur during the operation, the voids shall be packed promptly to the greatest extent practicable with flowable fill (see MDOT flowable fill requirements).

2.4 Access Pits

- (a) Location - A minimum distance, from the edge of the paved shoulder or curb, to the face of any access pit, equipment, and supplies, shall be 35 feet along freeways and limited access roadways and 25 feet along free access roadways. Any deviation from these distances shall require prior approval from the MDOT Engineer/Inspector.
- (b) Sheet piling and Bracing - Sheet piling and bracing shall be required whenever any part of the access pit excavation is located within the roadbed influence area. Steel sheet piling shall be furnished and installed as indicated in the current MDOT Standard Specifications for Construction, section 704. An additional earth retention structure shall be required above and

- below the bore hole on the drilling face of all access pits to prevent loss of material during construction.
- (c) Protection - Fencing barriers shall be installed adjacent to access pits, open excavations, equipment and supplies with suitable fencing and plastic drums to prohibit pedestrian access to the work site. Equipment shall not be used as fencing to protect access pits.

2.5 Overcut Allowance

When using this method, the allowable overcut is one inch greater than the outside diameter of the pipe.

2.6 Watertight Joints

Water tight pipe joints are required to ensure the integrity of the roadbed. Pipe shall be constructed to prevent water leakage or earth infiltration throughout its entire length.

2.7 Lubrication fluids - Lubrication fluids are required for this method of pipe installation to reduce jacking forces.

2.8 Pipe Locating and Tracking

- (a) During construction, continuous monitoring and plotting boring progress shall be undertaken to ensure compliance with the proposed installation alignment and allow for appropriate course corrections to be undertaken.
- (b) Pipe installed by this method shall be located as shown on the drawings. The Contractor shall grant the Engineer/ Inspector access to all data and readout pertaining to the position of the TBM, the fluid pressures, and the jacking forces.

2.9 Settlement/Heaving Monitoring

- (a) This method shall be performed in a manner that will minimize the movement of the ground in front of TBM and surrounding the boring operation; and will minimize subsidence of the surface above and in the vicinity of the boring.
- (b) Potential heave or settlement shall be monitored at each edge of right of way, each shoulder point, each edge of pavement, the edge of each lane (or centerline for two lane roads), and otherwise at 50 foot intervals along the pipe centerline.
- (c) A survey shall be performed one day prior to initiating this operation at each required monitoring location. A similar survey shall then be performed at each location, on a daily basis, until the permitted activity has been completed. All survey readings shall be recorded to the nearest one-hundredth (0.01) of a foot. Digital photographs of the pavement conditions shall also be taken prior and after the pipe installation.
- (d) All operations shall stop immediately whenever monitored points indicate a vertical change in elevation of 1/2 inch or more, or any surface disruption is observed. The Contractor shall then immediately report the amount of settlement to the MDOT Engineer/ Inspector.

2.10 Ground Water Control

- (a) Dewatering shall be conducted whenever there is a high ground water table level to prevent flooding and facilitate the operation. The water table elevation shall be maintained at least 2 feet below the bottom of the casing at all times. When needed, dewatering *may* be initiated prior to any excavation.
- (b) Minor water seepage or pockets of saturated soil may be effectively controlled through bailing or pumping. This control shall be accomplished without removing any adjacent soil that could weaken or undermine any access pit, its supports, or other nearby structure.
- (c) Larger volumes of ground water shall be controlled with one or more well points or with staged deep wells. Well points and staged deep well pumping systems shall be installed and operated without damage to property or structures, and without interference with the rights of the public, owners of private property, pedestrians, vehicular traffic, or the work of other contractors. Any pumping methods used for de-watering and control of ground water and seepage shall have properly designated filters to ensure that the adjacent soil is not pumped along with the water. Well diameter, well spacing and the pump's pumping rate, shall provide adequate draw down of the water level. Wells shall be located to intercept ground water that otherwise would enter the access pit excavation and interfere with the work. Upon removal of a well, the hole shall be filled and grouted according to the specifications identified in MDOT's flowable fill special provision, and MDOT's Plugging Drill Holes special provision.
- (d) Existing storm sewers shall only be used to discharge water from the dewatering operation in accordance with a permit obtained from the appropriate storm sewer owner. Filters or sediment control devices shall be required to ensure that the existing system is not adversely affected by construction debris or sediment.
- (e) If grouting is used to prevent ground water from entering the area of the access pit, the grouting shall be installed without damage to property or structures and without interference with the rights of the public, owners of private property, pedestrians, vehicular traffic, or the work of other contractors. The material properties of the grout shall conform to the specifications identified in MDOT's flowable fill special provision.

2.11 Failure

- (a) Should anything prevent completion of this operation, the remainder of the pipe shall be constructed by methods approved by the MDOT Engineer/Inspector.
- (b) Abandonment of any component of the installation shall only be allowed as approved by the MDOT Engineer/Inspector.

2.12 Contamination - When an area of contaminated ground is encountered, all operations shall stop immediately, and shall not proceed until approved by the MDOT Engineer/Inspector. Any slurry shall be tested for contamination and disposed of in a manner, which meets Local, State and/or Federal requirements.

2.13 Bulkhead - Pipe ends shall be temporarily sealed until the drive and receiving shafts are made permanent or other manholes are installed, to prevent water of earth infiltration.

2.14 Work Site Restoration

- (a) Access pits and excavations shall be backfilled with suitable material, and in a method approved by the MDOT Engineer/Inspector. Any embedded supports shall be removed to 10

- feet below the original ground surface. The disturbed work site area shall be restored to existing grades and original material condition.
- (b) The disturbed grass-surface area shall be topsoiled, seeded, fertilized, mulched, and anchored according the current MDOT Standard Specifications for construction, sections 816 and 917.
 - (c) Upon completion of the work, the contractor shall remove and properly dispose of all excess materials and equipment from the work site.