

1 Materials

1.1 Pipe -Pipe used in this method includes an external steel casing pipe and may include an interior carrier pipe.

Casing pipe shall be used within the entire roadbed influence area. The roadbed influence area is defined as the subsurface area located under the road and shoulder surface, between each shoulder point or back of curb; and continues transversely outward and downward from each shoulder point or back of curb on a 1 on 1 slope.

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 Casing Pipe Characteristics

- a) Pipe shall be specifically designed and certified for Pipe Ramming. Steel casing shall be new, smooth wall carbon steel pipe which conforms to ASTM Specifications A139, Grade B.
- (b) Steel casing 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.
- (c) Casing pipe shall be round. Steel casing 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.
- (d) Casing 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).
- (e) Casing pipe shall be straight. The maximum allowable straightness deviation over any 10 foot length of steel casing pipe is $\frac{1}{8}$ inch.
- (f) 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 Carrier Pipe - Carrier pipe material may be constructed with any material. The carrier pipe diameter shall be small enough to insert into the casing pipe in conjunction with the casing spacers.

- 1.5 Casing Spacers** - Casing spacers are required for all carrier pipes. Casing spacers shall be plastic, fiberglass, stainless steel, or carbon steel. Normally, one spacer is adequate to support a carrier pipe length that does not exceed ten feet; otherwise, two spacers are required for longer carrier pipe lengths.

2 Construction

2.1 Minimum Allowable Depths

The minimum allowable installation depth of cover of a PR installed pipe under the road and shoulder surface is correlated to the pipe diameter. Table 1 summarizes the minimum allowable depths:

Table 1 -- Minimum Allowable Depth

Pipe Diameters	Depth of Cover
=<12")	6 ft
13"- 24"	8 ft
> 24"	10 ft

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.

2.3 Method

- (a) Each pipe section shall be rammed forward as the excavation progresses in such a way to provide complete and adequate ground support at all times. Lubrication shall be applied to reduce skin friction. A hammer frame shall be positioned to develop a uniform distribution of ramming forces around the periphery of the pipe. Special care shall be taken by the contractor to insure that the launch seal is properly designed and constructed. Special care shall be taken when setting the pipe guard rails in the pit to ensure a correct alignment.
- (b) In open-end ramming, either a prefabricated soil-cutting shield shall be attached to the front of the casing pipe leading edge, or a casing band shall be welded around the outside or inside edge of the pipe. In closed-end ramming, a cone-shaped attachment shall be welded or threaded to the front of the casing pipe.
- (c) Closed end pipe is not allowed.

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

- (b) 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) Sheeting and Bracing - Sheeting 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.

A watertight specification for each type of pipe material can be obtained through each pipe material industry. Please refer to the appropriate industry specifications for more detailed information.

2.7 Lubrication Fluids

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

2.8 Pipe Installation

Pipe installed by this method shall be located as shown in the drawings.

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, above, 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 dewatering 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 enclosed or bulkheaded with a commercial grade concrete, or approved alternate to seal the ends to prevent water leakage or earth infiltration. The concrete shall extend longitudinally into the pipe end opening to create a minimum one foot thick bulkhead barrier, or as required by permit.

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.