

SECTION 610—PIPE UNDERDRAIN AND PAVEMENT BASE DRAIN

610.1 DESCRIPTION—This work is construction of pipe underdrains, of the type indicated, and pavement base drains.

610.2 MATERIAL—

(a) Pipes, [Section 601.2\(a\)1](#) and as follows:

1. General.

1.a Type. Use the type indicated. If not indicated, use any one of the types listed below.

1.b Size. For circular pipe, unless otherwise indicated, use pipe with a minimum inside diameter of 100 mm (4 inches) and sized in not less than 25 mm (1-inch) increments. For semi-circular pipe, unless otherwise indicated, use pipe with a smooth-walled bottom section and an average inside diameter of 117 mm (4 5/8 inches).

1.c Perforations. Perforate a pipe to provide a minimum water inlet area of 3000 mm²/m (1.4 square inches per linear foot) of pipe and, unless otherwise specified, as follows:

- Cut perforations cleanly so as not to restrict the flow of water.
- Provide either circular or slotted perforations, except do not use slotted perforations in smooth walled pipe.
- For circular perforations, provide holes with a nominal diameter not less than 5 mm (3/16 inch) or greater than 10 mm (3/8 inch). Also, provide similar rows of perforations on both sides of the pipe's vertical centerline, with the lower most rows separated by an arc of 60 degrees minimum.
- For slotted perforations, provide slots not exceeding 3 mm (1/8 inch) wide and a length not more than 10% of the average inside circumference for 100 mm to 200 mm (4-inch to 8-inch) diameter pipe and not exceeding 64 mm (2 1/2 inches) for pipes larger than 200 mm (8 inches). Additionally, center the slots in the corrugation valleys and at maximum 120 degree intervals about the pipe circumference.

1.d Strength Test. As specified, except for plastic pipe test using the parallel plate load test, according to [ASTM D 2412](#).

1.e Infiltration Rate. For perforated or porous pipe, provide a minimum infiltration rate of 2 (L/s)/m (10 (gallons per minute) per linear feet) of pipe, as determined according to AASHTO M 176M.

1.f Pipe Length. Flexible plastic pipe, 150 mm (6 inches) or less in diameter, may be supplied in specified coiled lengths or standard increments agreeable to the Department. The use of long coils, 900 m to 1200 m (3,000 feet to 4,000 feet) in length, is allowed, provided placement is by equipment recommended by the manufacturer and the pipe is not stretched or damaged during handling or placement. Furnish flexible plastic pipe, larger than 150 mm (6 inches) in diameter, and all sizes of rigid pipe in maximum lengths of 6 m (20 feet). Furnish lengths not less than 99% of the stated quantity. Measure with any suitable device accurate to 6 mm (1/4 inch) in 3 m (10 feet) (0.2%) while the pipe is stress-free and at rest on a flat surface in a straight line.

1.g Plastic Pipe. Extrude or mold plastic pipe using high density, flexible plastic.

Permanently mark, stencil, or label pipe with manufacturer's name, pipe trade name, or type, average size the specification designates, the plant designation code, and the date of manufacture all at intervals of no more than 3 m (10 feet).

2. Porous Concrete Pipe. AASHTO M 176M

3. Corrugated Polyethylene (PE) Pipe. AASHTO M 252 (pipes 100 mm through 250 mm (4 inches through 10 inches)) and AASHTO M 294 (pipes 300 mm through 375 mm (12 inches through 15 inches)), modified as follows:

- The Department will determine the lot size for acceptance.
- Minimum pipe stiffness for pipes 100 mm through 250 mm (4 inches through 10 inches) to be 210 kPa (30 pounds per square inch) at 10% deflection, when tested according to [ASTM D 2412](#). Minimum pipe stiffness for pipes 300 mm through 375 mm (12 inches through 15 inches) to be 310 kPa (45 pounds per square inch) at 5% deflection and 280 kPa (40 pounds per square inch) at 10% deflection, when tested according to [ASTM D 2412](#).

4. Polyvinyl Chloride (PVC) Pipe. [ASTM D 3034](#), [ASTM F 758](#), Type PS46 or [ASTM F 949](#) modified as follows:

- Minimum pipe stiffness for pipes 100 mm through 250 mm (4 inches through 10 inches), 241 kPa (35 pounds per square inch) at 5% deflection, when tested according to [ASTM D 2412](#). Minimum pipe stiffness for pipes 300 mm through 375 mm (12 inches through 15 inches), 310 kPa (45 pounds per square inch) at 5% deflection, when tested according to [ASTM D 2412](#).
- Capable of being flattened to 40% of the original pipe O.D. without splitting, cracking, or breaking.

5. Acrylonitrile-Butadiene Styrene (ABS) Pipe. [ASTM D 2751](#), modified as follows:

- Minimum pipe stiffness for pipes 100 mm through 250 mm (4 inches through 10 inches), 241 kPa (35 pounds per square inch) at 5% deflection, when tested according to [ASTM D 2412](#). Minimum pipe stiffness for 300 mm pipe (12 inches), 310 kPa (45 pounds per square inch) at 5% deflection, when tested according to [ASTM D 2412](#).
- Capable of being flattened to 60% of the original pipe O.D. without splitting, cracking, or breaking.

6. Perforated Plastic Semicircular Pipe. AASHTO M 278 or AASHTO M 264, modified as follows:

- Smooth or corrugated top and a smooth semicircular bottom.
- Minimum pipe stiffness (PS), 241 kPa (35 pounds per square inch) at 5% deflection, when tested according to [ASTM D 2412](#).
- Capable of being flattened to 40% of the original pipe outside-to-outside height for PVC or 60% for ABS without splitting, cracking, or breaking.

7. Corrugated Steel Pipe, Metallic Coated. AASHTO M 36/M 36M, Type III with Class 1 perforations or Type IIIA; AASHTO M 218; AASHTO M 274; and AASHTO M 289.

8. Corrugated Aluminum Alloy Pipe. AASHTO M 196/M 196M, Type III with Class 1 perforations or Type IIIA.

9. Prefabricated Pavement Base Drains.

9.a General. Use prefabricated pavement base drains consisting of an inert, plastic core, designed to carry water flow, wrapped in geotextile fabric for filtering purposes. Select from a manufacturer listed in [Bulletin 15](#).

9.b Backfill. As indicated, fine aggregate, Type A, except limestone sand, [Section 703.1](#).

9.c Core Materials. An inert, plastic material resistant to commonly encountered chemicals and substances, having the following properties:

- Tensile strength, [ASTM D 638/D 638M](#)—8300 kPa (1,200 pounds per square inch), minimum
- Water absorption, [ASTM D 570](#)—0.01% after 24 hours
- Fungus resistance, [ASTM G 21](#)—no growth
- Crush strength, *GRI-GC4—280 kPa (40 pounds per square inch), minimum
- Flow rate, [ASTM D 4716](#)—0.0031 m³/s-m (15 gallons per minute feet) minimum
- Provide a minimum of 6% open core area on the pavement side face of the base drain and a minimum of 3% on the shoulder side face.
- Provide unobstructed inflow through a minimum of 50% of the geotextile area on the pavement side face of the base drain and 12% of the geotextile area on the shoulder side face, when stretched across the face of the core.

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9.d Geotextile Fabric. Provide Class 1 geotextile, except slit film and heat bonded materials, conforming to the requirements of [Section 735](#), modified as follows:

- Apparent Opening Size (AOS), [ASTM D 4751](#)—U. S. Standard Sieve 212 mm (No. 70), minimum
- Permeability, k, [ASTM D 4491](#)—0.01 mm/s (0.001 cm/sec), minimum

Resins are to be virgin materials, unless otherwise approved, and identified as such in the certification statement.

9.e Approval. Approval will be based on certified test data submitted by the manufacturer or testing by MTD, or both, before being listed in [Bulletin 15](#).

9.f Certification and Shipment to Project. Certify each shipment as specified in [Section 106.03\(b\)3](#).

Clearly identify each roll of pavement base drain by affixing a tag or sticker containing the following information:

- Lot number
- Manufacturer's name and address
- Product type and designation
- Product identification including thickness, height, roll length, and roll mass (weight)
- Geotextile type and designation

9.g Wrapping of the Core. Wrap the geotextile completely around the drainage core with the seam along the length of the drain, on the shoulder side face, and preferably near the midpoint. Fabricate the seam using a non water-soluble adhesive, if adhesive is used. Firmly attach geotextile to the protrusions on the pavement side face of the drainage core and spot-bond on the shoulder side face, or submit results of flow tests on the drain under loading with the geotextile unattached, to ensure that the geotextile will not deform under continuous loading to the point where flow capacity is diminished and the specified minimum flow rate is not achieved.

9.h Splice Connections and Fittings. Provide standard fittings and splice connections along the pavement base drain, as indicated or as directed, of sufficient strength to withstand construction handling and permanent loading. Obtain approval for any nonstandard fittings and connections.

9.i Outlets. [Section 615.2](#)

(b) Aggregates.

1. Fine Aggregate. Type II backfill, natural or manufactured Type A sand, [Section 703.1](#); rock, gravel, or blast furnace slag sand prepared from Type C, or better, coarse aggregate as specified in [Section 703.2](#); except conform to the size and grading requirements for Type A sand, [Section 703.1](#), with a maximum loss in soundness test not exceeding 20%.

2. Coarse Aggregate. Type C or better, [Section 703.2](#), except that the percentage of crushed fragments for gravel is not required. Use No. 57 for Type I backfill and No. 8 for Type II backfill.

(c) Mortar. [Section 705.7\(a\)](#)

(d) Geotextiles, Class 1. [Section 735](#)

(e) Open Graded Subbase. [Section 350](#)

610.3 CONSTRUCTION—As shown on the [Standard Drawings](#) and as follows:

(a) Pipe, Trench, and Backfill. Place pipe underdrain after fine grading is completed.

Place pavement base drain after the adjacent roadway pavement is constructed, except when it is placed under curb sections or other special locations. Excavate pavement base drain trench without disturbing subbase under the roadway pavement.

Join underdrain or base drain to new or existing drainage structures with satisfactory connections. Use fittings with deflection angles of 45 degrees or less.

After completing the trench and the lower 50 mm (2 inches) of compacted backfill, lay the pipe and make the joints according to the manufacturer's recommendations.

For perforated pipe, place the perforations down, unless otherwise directed. Lay semicircular pipe with the smooth, circular portion at the bottom.

Do not leave trenches open during periods of precipitation or overnight.

Seal the upgrade end of pipe underdrain or base drain to prevent entry of foreign material.

Complete backfilling after having the pipe inspected by the Inspector-in-Charge.

(b) Geotextiles, Class 1. Use Class 1 geotextile, as specified in [Section 212.3\(b\)](#), for all pavement base drain construction and if indicated for pipe underdrain construction.

(c) Prefabricated Pavement Base Drains.

1. General. At least 2 weeks before beginning installation, submit the proposed installation method to the Representative, in writing, and note any deviation from the plans or from the manufacturer's approved drawings. Upon request by the Representative, have a technical representative from the manufacturer present during installation.

2. Shipping and Storage. Ship drainage materials with protective covering and store in a manner so as not to damage or contaminate them. Visually inspect all materials, before placement, to ensure they are free from damage. Damaged drainage material will not be accepted. Store drainage material on an elevated platform and protect from weather and ultraviolet exposure. Do not remove material from the manufacturer's protective covering until ready to be installed. If material is rerolled and stored, use an approved protective covering equivalent to the manufacturer's original wrapping.

3. Excavation. Place prefabricated pavement base drain in a trench constructed adjacent to the roadway pavement edge as shown on the [Standard Drawings](#). Construct trench without disturbing the pavement structure or subbase. Unless otherwise indicated or directed, provide trench having a width as shown on the [Standard Drawings](#) and a depth extending to at least 50 mm (2 inches) into the subgrade.

4. Placement and Backfilling. Place prefabricated pavement base drain vertically in the trench as shown on the [Standard Drawings](#). Place the first lift of backfill material simultaneously with drain install to ensure complete contact with the geotextile and the trench wall. Repair any tears in the geotextile according to the manufacturer's recommendation. If raised core projections protrude from only one side of the drain, place the projections toward the pavement side of the trench.

Backfill the trench with fine aggregate, Type A using 230 mm (9-inch) (maximum) hydraulically compacted lifts. Spray each lift with water at 12.4 L/m (1.0 gallon per linear foot).

Ensure that excavation, drain placement, and backfill operations are performed in sequence, with a minimum amount of trench open at all times. Do not leave trenches greater than 50 mm (2 inches) in depth open overnight. Barricade trenches at all times according to the requirements of 67 PA Code, Chapter 203.

5. Connections, Fittings, and Outlets. Fit splice connectors into the drainage core so that they do not restrict flow. Follow the manufacturer's approved connection details. Do not allow backfill material to enter the connector at any point. For drainage cores that splice using male-to-female overlapping, roll back the geotextile onto the in-place drainage core, make the splice, and rewrap the geotextile over the completed joint. Provide a minimum of 150 mm (6 inches) of geotextile overlap from one section to the next.

Install subsurface drain outlet pipe and fittings as specified in [Section 615.3](#), concurrently with the pavement base drain, to establish positive drainage within 24 hours of the beginning of trenching for the installation of a given section of base drain. The Representative may restrict installation of additional sections of base drain until acceptable outlet installations are completed. Ensure transitions are smooth and nonrestricting to flow. Do not use "home-made" connections.

Install all fittings and connections to preclude soil intrusion into the drainage core or outlet piping and to provide continuity of drainage flow. Install fittings for positive, gravity flow, and outlet the drainage system as indicated or as directed. Furnish outlet pipes with galvanized wire mesh shields as shown on the [Standard Drawings](#). If the drain is terminated without an outlet, provide a fitting to prevent soil intrusion into the end of the drainage core. Protect all joints and fittings from damage during construction.

610.4 MEASUREMENT AND PAYMENT—

(a) **Pipe Underdrain, Types I and II Backfill.** Meter (Linear Foot)

(b) **Pavement Base Drain.** Meter (Linear Foot)

(c) **Class 4 Excavation.** Cubic Meter (Cubic Yard)

For extra-depth pipe underdrain and extra-depth pavement base drain excavation in excess of that shown on the [Standard Drawings](#).

(d) **Fine Aggregate for Extra-Depth Pipe Underdrain.** Cubic Meter (Cubic Yard)

(e) **Additional Coarse Aggregate for Extra-Depth Pipe Underdrain.** Cubic Meter (Cubic Yard)

(f) **Additional Coarse Aggregate for Extra-Depth Pavement Base Drain.** Cubic Meter (Cubic Yard)

610.4(g)

610.4(i)

(g) **Geotextiles, Class 1.** [Section 212.4\(a\)](#)

(h) **Prefabricated Pavement Base Drains.** Meter (Linear Foot)

(i) **Subsurface Drain Outlets.** [Section 615.4](#)