## ITEM D-701 PIPE FOR STORM DRAINS AND CULVERTS

DESCRIPTION

701-1.1 This item shall consist of the construction of pipe culverts and storm drains according to these Specifications and in reasonably close conformity with the lines and grades shown on the Plans.

MATERIALS

701-2.1 Materials shall meet the requirements shown on the Plans and specified below.

701-2.2 PIPE. The pipe shall be of the type called for on the Plans and shall be according to the following appropriate requirements.

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| --- | --- |
| Metallic Coated Corrugated Steel Pipe (Type I, IR or II) | AASHTO M 36 |
| Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains | ASTM A760 |
| Galvanized Steel Corrugated Structural Plates and Fasteners  for Pipe, Pipe-Arches, and Arches | ASTM A761 |
| Polymer Precoated Corrugated Steel Pipe for Sewers and Drains  Post-Coated and Lined (Bituminous or Concrete) | ASTM A762 |
| Corrugated Steel Sewer and Drainage Pipe | ASTM A849 |
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| Corrugated Aluminum Alloy Culvert Pipe | ASTM B745 |
| Non-Reinforced Concrete Pipe | ASTM C14 |
| Reinforced Concrete Pipe | ASTM C76 |
| Reinforced Concrete D-Load Pipe | ASTM C655 |
| Reinforced Concrete Arch Pipe | ASTM C506 |
| Reinforced Concrete Elliptical Pipe | ASTM C507 |
|  |  |
| Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers | ASTM C1433 |
| Corrugated Polyethylene (PE) Pipe and Fittings | ASTM F667 |
| Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter | ASTM F714 |
| Poly (Vinyl Chloride) Ribbed Drain Pipe & Fittings Based  on Controlled Inside Diameter | ASTM F794 |
| Polyethylene (PE) Large Diameter profile Wall Sewer and Drain Pipe | ASTM F894 |
| Poly (Vinyl Chloride) (PVC) Corrugated Sewer Pipe  With a Smooth Interior and Fittings | ASTM F949 |
| Steel Reinforced Polyethylene (PE) Corrugated Pipe | ASTM F2435 |
| Steel Reinforced Thermoplastic Ribbed Pipe and Fittings for Non-Pressure Drainage and Sewerage | ASTM F2562 |
| Polypropylene (PP) Corrugated Single Wall Pipe and Double Wall Pipe | ASTM F2736 |
| Polypropylene (PP) Triple Wall Pipe and Fittings for Non-Pressure Sanitary Sewer Applications | ASTM F2764 |
| Polypropylene (PP) Dual Wall Pipe and Fittings for Non-Pressure Storm Sewer Applications. | ASTM F2881 |
| Bituminous-Coated Corrugated Metal Pipe and Pipe Arches | AASHTO M 190 |
| Bituminous-Coated Corrugated Aluminum Alloy Culvert Pipe | AASHTO M 190 and M 196 |
| Bituminous-Coated Structural Plate Pipe, Pipe Arch, and Arches | AASHTO M 167 and M 243 |
| Aluminum Alloy Structural Plate for Pipe, Pipe Arch, and Arches | AASHTO M 219 |
| Polyvinyl Chloride (PVC) Pipe | ASTM D3034 |
| Corrugated Polyethylene Drainage Tubing | AASHTO M 252 |
| Corrugated Polyethylene Pipe, 300 mm to 1500 mm Diameter | AASHTO M 294 |
| Poly (Vinyl Chloride) (PVC) Profile Wall Drain Pipe and Fittings |  |
| Based on Controlled Inside Diameter | AASHTO M 304 |

701-2.3 CONCRETE. Concrete for pipe cradles shall have a minimum compressive strength of 2,000 pounds per square inch (psi) at 28 days and conform to the requirements of AASHTO M 157.

701-2.4 RUBBER GASKETS. Rubber gaskets for rigid pipe shall conform to the requirements of ASTM C443. Rubber gaskets for PVC pipe and polyethylene pipe shall conform to the requirements of ASTM F477. Rubber gaskets for zinc-coated steel pipe and precoated galvanized pipe shall conform to the requirements of ASTM D1056, for the ``RE'' closed cell grades. Rubber gaskets for steel reinforced thermoplastic ribbed pipe shall conform to the requirements of ASTM F477.

701-2.5 JOINT MORTAR. Pipe joint mortar shall consist of one part by volume of portland cement and two parts sand. The portland cement shall conform to the requirements of AASHTO M 85, Type I. The sand shall conform to the requirements of AASHTO M 45.

701-2.6 JOINT FILLERS. Poured filler for joints shall conform to the requirements of AASHTO M 324.

701-2.7 PLASTIC GASKETS. Plastic gaskets shall conform to the requirements of AASHTO M 198(Type B).

701-2.8. CONTROLLED LOW-STRENGTH MATERIAL (CLSM). Controlled low-strength material shall conform to the requirements of Item P‑153. When CLSM is used all joints shall have gaskets.

701-2.9 CULVERT MARKER POSTS. Provide posts made of durable glass fiber and resin reinforced material flexible to -40°F, resistant to impact and ultraviolet light. “T” in cross section, 3.75 inch wide x 72 inches long, and color blue. Provide Carsonite CUM-375 utility marker or approved equal.

701-2.10 CLASS B BEDDING. Use one of the following materials:

1. Suitable material as defined in specification subsection P-152-2.3, except that 100% of the material will pass a 1 inch sieve.
2. P-299 Aggregate Surface Course (when included in this contract).
3. P-209 Crushed Aggregate Base Course (when included in this contract).

701-2.11 END SECTIONS. End sections for metal pipe must be of the same material as the pipe.

CONSTRUCTION METHODS

701-3.1 EXCAVATION. The width of the pipe trench shall be sufficient to permit satisfactory jointing of the pipe and thorough tamping of the bedding material under and around the pipe, but it shall not be less than the external diameter of the pipe plus 18 inches on each side. The trench walls shall be approximately vertical.

Where rock, hardpan, or other unyielding material is encountered, the Contractor shall remove it from below the foundation grade for a depth of at least 8 inches or 1/2 inch for each foot of fill over the top of the pipe (whichever is greater) but for no more than 75% of the nominal diameter of the pipe. The width of the excavation shall be at least 1 foot greater than the horizontal outside diameter of the pipe. The excavation below grade shall be backfilled with selected fine compressible material, such as silty clay or loam, and lightly compacted in layers not over 6 inches in uncompacted depth to form a uniform but yielding foundation.

Where a firm foundation is not encountered at the grade established, due to soft, spongy, or other unstable soil, the unstable soil shall be removed and replaced with approved Class B bedding material for the full trench width. The Engineer shall determine the depth of removal necessary. The Class B bedding material shall be compacted to provide adequate support for the pipe.

The excavation for pipes that are placed in embankment fill shall not be made until the embankment has been completed to a height above the top of the pipe as shown on the Plans.

701-3.2 BEDDING. The pipe bedding shall conform to the class specified on the Plans. When no bedding class is specified or detailed on the Plans, the requirements for Class B bedding shall apply. Compact all bedding to 95% of the maximum density determined by ATM 207 or ATM 212.

1. **Rigid Pipe.** Class A bedding shall consist of a continuous concrete cradle conforming to the plan details.

Class B bedding shall consist of a bed of granular material having a thickness of at least 6 inches below the bottom of the pipe and extending up around the pipe for a depth of not less than 30% of the pipe's vertical outside diameter. The layer of bedding material shall be shaped to fit the pipe for at least 10% of the pipe's vertical diameter and shall have recesses shaped to receive the bell of bell and spigot pipe.

Class C bedding shall consist of bedding the pipe in its natural foundation material to a depth of not less than 10% of the pipe’s vertical diameter. The bed shall be shaped to fit the pipe and shall have recesses shaped to receive the bell of bell and spigot pipe.

1. **Flexible Pipe.** For flexible pipe, the bed shall be roughly shaped to fit the pipe, and a bedding blanket of sand or fine granular material shall be provided as follows:

|  |  |
| --- | --- |
| **Pipe Corrugation Depth, in.** | **Minimum Bedding Depth, in.** |
| 1/2 | 1 |
| 1 | 2 |
| 2 | 3 |
| 2-1/2 | 3-1/2 |

1. **PVC and Polyethylene Pipe.** For PVC and polyethylene pipe, the bedding material shall consist of Class B bedding. The bedding shall have a thickness of at least 6 inches below the bottom of the pipe and extend up around the pipe for a depth of not less than 50% of the pipe's vertical outside diameter.

701-3.3 LAYING PIPE. The pipe laying shall begin at the lowest point of the trench and proceed upgrade. The lower segment of the pipe shall be in contact with the bedding throughout its full length. Bell or groove ends of rigid pipes and outside circumferential laps of flexible pipes shall be placed facing upgrade.

Paved or partially lined pipe shall be placed so that the longitudinal center line of the paved segment coincides with the flow line.

Elliptical and elliptically reinforced concrete pipes shall be placed with the manufacturer's reference lines designating the top of pipe within five degrees of a vertical plane through the longitudinal axis of the pipe.

701-3.4 JOINING PIPE. Joints shall be made with (1) portland cement mortar, (2) portland cement grout, (3) rubber gaskets, (4) plastic gaskets, or (5) coupling bands.

Mortar joints shall be made with an excess of mortar to form a continuous bead around the outside of the pipe and shall be finished smooth on the inside. Molds or runners shall be used for grouted joints in order to retain the poured grout. Rubber ring gaskets shall be installed to form a flexible watertight seal.

1. **Concrete Pipe.** Concrete pipe may be either bell and spigot or tongue and groove. The method of joining pipe sections shall be such that the ends are fully entered and the inner surfaces are reasonably flush and even. Joints shall be thoroughly wetted before mortar or grout is applied.
2. **Metal Pipe.** Metal pipe shall be firmly joined by form fitting bands conforming to the requirements of ASTM A760 for steel pipe and AASHTO M 36 for aluminum pipe.
3. **PVC, Polypropylene, and Polyethylene Pipe.** Joints for PVC, polypropylene, and polyethylene pipe shall conform to the requirements of ASTM D3212 when water tight joints are required. Joints for PVC and polyethlyene pipe shall conform to the requirements of AASHTO M 304 when soil tight joints are required. Fittings for polyethylene pipe shall conform to the requirements of AASHTO M 252 or M 294. Fittings for polypropylene pipe shall conform to the requirements of ASTM F2881, ASTM F2736, or ASTM F2764.

701-3.5 BACKFILLING. Pipes shall be inspected before any backfill is placed; any pipes found to be out of alignment, unduly settled, or damaged shall be removed and relaid or replaced at the Contractor's expense.

Use backfill that is suitable material as defined in subsection P-152-2.3 except that:

* 1. 100% of the material placed within 1 foot of the pipe will pass a 3 inch sieve.
  2. If the pipe is placed in or under the structural section, construct the backfill according to the material and construction requirements of the specifications for the applicable lift of material (P-154, P-299, P‑209).

When the top of the pipe is even with or below the top of the trench, the backfill shall be compacted in layers not exceeding 6 inches on both sides of the pipe and shall be brought up 1 foot above the top of the pipe or to natural ground level, whichever is greater. Care shall be exercised to thoroughly compact the backfill material under the haunches of the pipe without displacing the pipe. Material shall be brought up evenly on both sides of the pipe for the full length of the pipe.

When the top of the pipe is above the top of the trench, the backfill shall be compacted in layers not exceeding 6 inches and shall be brought up evenly on both sides of the pipe to 1 foot above the top of the pipe. The width of backfill on each side of the pipe for the portion above the top of the trench shall be equal to twice the pipe's diameter or 12 feet, whichever is less.

For PVC, polypropylene, and polyethylene pipe, the backfill shall be placed in two stages; first to the top of the pipe and then at least 12 inches over the top of the pipe. The backfill material shall meet the requirements of Subsection 701-3.2c.

All backfill shall be compacted to the density required under Item P-152.

It shall be the Contractor’s responsibility to protect installed pipes and culverts from damage due to construction equipment operations. The Contractor shall be responsible for installation of any extra strutting or backfill required to protect pipes from the construction equipment.

701-3.6 CULVERT MARKER POSTS. Install culvert marker posts at each culvert inlet and outlet. Drive posts to 18 inches minimum embedment.

METHOD OF MEASUREMENT

701-4.1 PIPE. The length of pipe will be measured in linear feet of pipe in place, completed, and approved. It will be measured along the centerline of the pipe from end or inside face of structure to the end or inside face of structure, whichever is applicable. The several classes, types and size will be measured separately. All fittings and end sections will be included in the length of the pipe being measured. All trench excavation and backfill associated with pipe installation is subsidiary.

701-4.2 CONCRETE. The volume of concrete for pipe cradles to be paid for will be the number of cubic yards of concrete which is completed in place and accepted.

701-4.3 ROCK. The volume of rock to be paid for will be the number of cubic yards of rock excavated. No payment will be made for the cushion material placed for the bed of the pipe.

701-4.4 CULVERT MARKER POSTS.Culvert marker posts will not be measured for payment.

BASIS OF PAYMENT

701-5.1Payment will be made at the contract unit price per linear foot for each kind of pipe of the type and size designated; at the contract unit price per cubic yard of concrete for pipe cradles; and at the contract unit price per cubic yard for rock excavation. Culvert marker posts will not be paid for directly, but will be subsidiary to pipe items.

Payment will be made under:

Item D701.\_\_\_\_.\_\_\_\_ \_\_\_\_ Pipe, \_\_\_\_-inch – per linear foot

Item D701.070.0000 Concrete for Pipe Cradles – per cubic yard

Item D701.080.0000 Rock Excavation – per cubic yard

REFERENCES

AASHTO M 36 Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains

AASHTO M 45 Aggregate for Masonry Mortar

AASHTO M 85 Portland Cement

AASHTO M 157 Ready-Mixed Concrete

AASHTO M 190 Bituminous-Coated Corrugated Metal Culvert Pipe and Pipe Arches

AASHTO M 196 Corrugated Aluminum Alloy Culverts and Underdrains

AASHTO M 198 Joints for Circular Concrete Sewer and Culvert Pipe Using Flexible Watertight Gaskets

AASHTO M 219 Aluminum Alloy Structural Plate for Pipe, Pipe-Arches, and Arches

AASHTO M 243 Field Applied Coating of Corrugated Metal Structural Plate for Pipe, Pipe-Arches, and Arches

AASHTO M 252 Corrugated Polyethylene Drainage Tubing

AASHTO M 294 Corrugated Polyethylene Pipe, 300 to 1500 mm Diameter

AASHTO M 304 Poly (Vinyl Chloride) (PVC) Profile Wall Drain Pipe and Fittings Based on Controlled Inside Diameter

AASHTO M 324 Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements

ASTM A760 Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains

ASTM A761 Steel Galvanized, Corrugated Structural Plates and Fasteners for Pipe, Pipe-Arches, and Arches

ASTM A762 Precoated (Polymeric) Galvanized Steel Sewer and Drainage Pipe

ASTM A849 Post-Coated and Lined (Bituminous or Concrete) Corrugated Steel Sewer and Drainage Pipe

ASTM B745 Corrugated Aluminum Alloy Culvert Pipe

ASTM C14 Concrete Sewer, Storm Drain, and Culvert Pipe

ASTM C1433 Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers, 3 – 24 in

ASTM C76 Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe

ASTM C443 Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets

ASTM C506 Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe

ASTM C507 Reinforced Concrete Elliptical Culvert, Storm Drain and Sewer Pipe

ASTM C655 Reinforced Concrete D-Load Culvert, Storm Drain and Sewer Pipe

ASTM C700 Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated

ASTM D1056 Flexible Cellular Materials--Sponge or Expanded Rubber

ASTM D3034 Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings

ASTM D3212 Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals

ASTM F477 Elastomeric Seals (Gaskets) for Joining Plastic Pipe

ASTM F667 Corrugated Polyethylene Pipe and Fittings

ASTM F714 Polyethylene (PE) Plastic Pipe (DR PR) Based on Outside Diameter

ASTM F794 Poly (Vinyl Chloride) Ribbed Drain Pipe & Fittings Based on Controlled Inside Diameter

ASTM F894 Polyethylene (PE) Large Diameter profile Wall Sewer and Drain Pipe

ASTM F949 Poly (Vinyl Chloride) (PVC) Corrugated Sewer Pipe With a Smooth Interior and Fittings

ASTM F2435 Steel Reinforced Polyethylene (PE) Corrugated Pipe

ASTM F2562 Steel Reinforced Thermoplastic Ribbed Pipe and Fittings for Non-Pressure Drainage and Sewerage

ASTM F2736 Polypropylene (PP) Corrugated Singe Wall Pipe and Double Wall Pipe

ASTM F2764 Polypropylene (PP) Triple Wall Pipe and Fittings for Non-Pressure Sanitary Sewer Applications

ASTM F2881 Polypropylene (PP) Dual Wall Pipe and Fittings for Non-Pressure Storm Sewer Applications