

Property	Test Method	Requirement
Compressive Strength	ASTM D 695	8,000 to 9,000 psi
Coefficient of Linear Expansion	ASTM D 696	7.62×10^{-4} mm/mm/°C to 1.27×10^{-3} mm/mm /°C

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The high density bearing strip shall be covered by a type B certification in accordance with 916.

SECTION 907 – CONCRETE, CLAY, AND PLASTIC DRAINAGE COMPONENTS

907.01 Non-Reinforced Concrete Pipe

This pipe shall be in accordance with AASHTO M 86 for the specified diameter and strength classes. When used for underdrain, each section of pipe shall not exceed 3 ft in length.

907.02 Reinforced Concrete Pipe

10 This pipe shall be in accordance with AASHTO M 170 for the specified diameters and strength classes. Precast concrete units shall be from a source listed in the Department’s List of Certified Precast Concrete Producers, in accordance with ITM 813. Unless otherwise specified, pipe wall design and use of elliptical reinforcement in circular pipe are optional.

The pipe provided shall be in accordance with the class and D-load rating shown in the plans.

20 When the pipe listed below is specified or allowed, it shall be in accordance with the class noted.

- Extra Strength Reinforced Concrete Pipe..... Class IV
- Heavy Duty Reinforced Concrete Pipe..... Class V
- Reinforced Concrete Pipe..... Class III
- Reinforced Concrete Sewer Pipe..... Class II.

Precast reinforced concrete end sections shall be in accordance with the cited specifications to the extent to which they apply.

30 The manufacturer of the steel reinforcement shall furnish to the pipe manufacturer a mill test report. The pipe manufacturer shall certify, on furnished forms that:

- (a) The placement of the steel reinforcement is in accordance with the Standard Specifications.

- (b) The area of steel reinforcement per linear foot of pipe is in accordance with or exceeds the specification requirements.
- 40 (c) Based on the steel reinforcement manufacturer's mill test report, the steel used in the pipe is in accordance with the specification requirements.
- (d) Copies of the steel reinforcement manufacturer's mill test reports shall be on file and available to review for five years.

907.03 Reinforced Concrete Horizontal Elliptical Pipe

This pipe shall be in accordance with AASHTO M 207. Certification shall be in accordance with 907.02.

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907.04 Precast Concrete Manholes, Inlets, and Catch Basins

These units shall be in accordance with AASHTO M 199. References to diameter are applicable to corresponding dimensions in other than circular sections. Absorption tests will not be required for flat top or base slabs. Certification shall be in accordance with 907.02.

No more than three holes shall be cast or drilled in each section for the purpose of handling.

- 60 In addition to the requirements of AASHTO M 199, the manhole steps shall be permanently marked with the specific step designation, and the manufacturer's identification. This marking shall remain exposed after installation.

- 70 Steps shall be selected from the list of approved Manhole Steps. Requests for adding steps to the list shall be accompanied by: a certified test report demonstrating compliance with AASHTO M 199; instruction for proper installation; complete product description including the ancillary equipment required for installation; and a sample step. The Department may perform a laboratory evaluation of specific steps and may not add steps to the list which are not furnished with ancillary installation equipment.

907.05 Precast Reinforced Concrete Structure Sections

Precast reinforced concrete structure sections shall be from a source listed in the Department's List of Certified Precast Concrete Producers, in accordance with ITM 813. A water-reducing admixture from the Department's list of approved Water-Reducing Admixtures may be used.

- 80 Handling devices or holes will be allowed in each structure section. Holes for handling shall be filled with material in accordance with 901.07, 901.08, or with precast concrete plugs which shall be secured with portland cement mortar or other approved adhesive before backfilling. Drilled handling holes shall be filled with

portland cement mortar. Prior to backfilling the structure, all holes shall be covered with joint wrap material with a minimum width of 9 in.

90 The section ends shall be of such design and shall be so formed that when the structure sections are erected, they shall make a continuous line of structure with a smooth interior free of irregularities. The ends of the structure sections shall be normal to the walls and centerline, except where beveled ends are specified. The surface of the structure sections shall be cast from a smooth steel form or troweled surface. Trapped air pockets causing surface defects shall be considered as part of a smooth steel form finish.

(a) Box

Box structure sections shall be in accordance with ASTM C 1577 and the exceptions to ASTM C 1577 listed in 714.04. Not more than four holes may be cast, drilled, or otherwise made in each box section for the purpose of handling or laying.

(b) Three-Sided

100 Three-sided structure sections shall be in accordance with ASTM C 1504 and the exceptions to ASTM C 1504 listed in 723.04. Not more than six holes shall be cast, drilled, or otherwise made in each section for the purpose of handling or laying.

907.06 Precast Reinforced Concrete Headwalls, Wingwalls, Footings and Spandrel Walls

Precast concrete units shall be from a source listed in the Department's List of Certified Precast Concrete Producers, in accordance with ITM 813. A water-reducing admixture from the Department's list of approved Water-Reducing Admixtures may be used.

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Handling devices or holes will be allowed in each wingwall and spandrel wall section. Not more than four holes shall be cast or drilled in each section for the purpose of handling or setting. Weep holes shall be provided in all wingwalls. Headwalls, wingwalls, and spandrel walls shall be free of fractures and shall be given a finish in accordance with 702.21.

120 The concrete compressive strength for headwalls, wingwalls, and spandrel walls shall have a minimum 28-day compressive strength of 4,000 psi, as determined by compressive strength testing of concrete cylinders. The concrete compressive strength for footings shall have a minimum 28-day compressive strength of 2,000 psi, as determined by compressive strength testing of concrete cylinders.

Structural steel used in bolted connections of headwalls or wingwalls to a box-structure section, or of wingwalls to a three-sided-structure section or spandrel wall, shall be in accordance with 910.02(a), and zinc coated after fabrication in accordance with ASTM A 153.

- 130 Bolts and studs shall be hot dipped in accordance with 910.02(g)1. Nuts shall be in accordance with ASTM A 563, grade A, Hex style; unless specified otherwise. Washers shall be in accordance ASTM F 844, unless specified otherwise. Bolts, nuts and washers shall be hot dip zinc coated.

907.07 Joint Membrane System for Precast Reinforced Concrete Box Structure Sections

The Contractor may elect to use an approved self-adhering membrane system in lieu of the detail shown on the plans.

Joint membrane systems shall be in accordance with the following requirements.

	PROPERTY	TEST METHOD	REQUIREMENTS
140	Thickness	ASTM D 3767, Procedure A	59 mil, min.
	Tensile Strength	Grab Tensile Strength, ASTM D 4632	650 N, min.
	Elongation	Grab Tensile Strength, ASTM D 4632	20%, min.
150	Bursting Strength	Mullen Burst, ASTM D 3786	290 psi, min.
	Peel Strength	ASTM D 903	850 N/m, min.
	Permeance	ASTM E 96, Water Method	1.05 Perm, max.

- 160 The membrane system shall be supplied in roll widths of at least 12 in. The membrane shall be a composite sheet material composed of a non-woven fabric and a polymer membrane material. The membrane shall be protected by a release paper.

Material furnished under this specification shall be covered by a type B certification in accordance with 916.

907.08 Clay Pipe

This pipe shall be in accordance with ASTM C 700 for the specified diameters and strength classes for circular non-perforated pipe. When specified, the bell shall have integral spacer lugs to provide for an annular opening and self centering feature. The pipe may be glazed or unglazed, unless otherwise specified.

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907.09 Perforated Clay Pipe

This pipe shall be in accordance with ASTM C 700 for the specified dimensions and strength classes. It may be glazed or unglazed, unless otherwise specified. Where

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vitrified clay culvert pipe is furnished, a pipe end section compatible to that as required for concrete or metal pipe shall be used.

907.10 Drain Tile

180 This pipe shall be in accordance with AASHTO M 178 for concrete or ASTM C 4 for clay for the specified material, diameters, and quality classes. Standard quality drain tile shall not be used. When specified, the pipe spigot shall have integral spacer lugs to provide for an annular opening and self centering feature. Material furnished under this specification shall be covered by a type C certification in accordance with 916.

907.11 Pipe Joint Sealant

190 Material for sealing the joints of bell and spigot or tongue and groove concrete or clay pipe or culverts furnished under this specification shall not contain asbestos fibers, shall be covered by a type B certification in accordance with 916, and shall be in accordance with one of the following:

(a) Preformed Flexible Joint Sealants

Joint sealants shall be either bitumen or butyl rubber in accordance with ASTM C 990. The results of the following tests shall be shown on the type B certification.

PROPERTY	TEST METHOD
Hydrocarbon Blends	ASTM D 4 (bitumen) or D 297 (butyl)
Ash-Inert Mineral Matter	AASHTO T 111
Volatile Matter	ASTM D 6
Specific Gravity @ 77°F	ASTM D 71
Ductility @ 77°F	AASHTO T 51 or ASTM D 113
Flash Point	ASTM D 92
Fire Point	ASTM D 92
Softening Point	ASTM D 36
Compression Index@ 77°F & 32°F	ASTM C 972
Cone Penetration @ 77°F & 32°F, 150 g, 5 s, mm/10	ASTM D 217
Chemical Resistance	ASTM C 990

(b) Bituminous Mastic Sealant

200 A cold applied, mineral filled, bituminous joint sealing compound that can be applied to the joints with a trowel when the air temperature is between 20° and 100° F. The bituminous material shall adhere to the concrete or clay pipe so as to make a watertight seal and shall not flow, crack, or become brittle when exposed to the atmosphere.

The mastic shall also be in accordance with the following. The results of the tests shall be shown on the type B certification.

PROPERTY	MINIMUM	MAXIMUM
Grease cone penetration unworked, 77°F, 150 g, 5 s, ASTM D 217, mm/10	125	275
Non-Volatile, 10 g, 220°-230°F, 24 hr	75%	
Loss on Heating, 325°F, 5 hr, 50 g		20%
Inorganic Content (complete burn, 1200° to 1400°F)	15%	45%
Flash Point, ASTM D 92 or D 1310	100°F	
Fire Point, ASTM D 92 or D 1310	150°F	
High Temperature Resistance to Flow	No sag	
Cold Temperature Flexibility	No cracks	

The test for high temperature resistance to flow shall be as follows: trowel joint mastic approximately 1/2 in. thick on a porous concrete slab or piece of concrete block. Place in oven at 140°F for 10 h.

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The test for cold temperature flexibility shall be as follows: trowel joint mastic approximately 1/4 in. on heavy kraft paper or very light gage sheet metal. Condition in a freezer at 10°F for 3 h. Bend the sample over a 1 in. diameter pin or mandrel.

907.12 Joint Mortar

Pipe joint mortar shall consist of 1 part portland cement and 2 parts sand with water as necessary to obtain the required consistency. Mortar shall be used within 30 minutes after its preparation.

220 907.13 Rubber Type Gaskets

Ring gaskets for pipe shall be in accordance with ASTM C 1619, class C. Material furnished under this specification shall be covered by a type B certification in accordance with 916. The results of the following tests shall be provided on the type B certification.

PROPERTY	TEST METHOD
Tensile Strength and Elongation	ASTM D 412
Hardness	ASTM D 2240
Oven-age tensile reduction, of original	ASTM D 573 and D 412
Oven-age elongation reduction, of original	ASTM D 573 and D 412
Compression Set	ASTM D 395
Water Absorption	ASTM D 471
Ozone resistance	ASTM D 1149
Splice Strength Classification	ASTM D 2527

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907.16 Thermoplastic Pipe Requirements

A list of approved thermoplastic pipe and liner pipe will be maintained by the Department. The list will specify the manufacturer and thermoplastic pipe designation. All of these materials shall comply with the applicable AASHTO or ASTM requirements listed in the following table and will only be accepted from qualified manufacturers. The manufacturer is defined as the plant which produces the thermoplastic pipe. The manufacturer shall become qualified by establishing a history of satisfactory quality control of these materials as evidenced by the test results performed by the manufacturer's testing laboratory.

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SUMMARY OF THERMOPLASTIC PIPE SPECIFICATION REQUIREMENTS				
Pipe Material	Standard Specifications	AASHTO	ASTM	Manufacturer Requirements
Corrugated Polyethylene Drainage Tubing	907.17(a)	M 252		ITM 806, Procedure O
Corrugated Polyethylene Pipe	907.17(b)	M 294		ITM 806, Procedure O
Corrugated Polypropylene Pipe	907.19	M 330		ITM 806, Procedure O
Perforated PVC Semicircular Pipe	907.18		D 3034	ITM 806, Procedure A
Profile Wall PVC Pipe	907.22	M 304	F 949	ITM 806, Procedure O
Ribbed Polyethylene Pipe	907.20		F 894	ITM 806, Procedure A
Schedule 40 PVC Pipe	907.24(b)		D 1785 or D 2665	916, Type C Cert.
Smooth Wall Polyethylene Pipe	907.21		F 714	ITM 806, Procedure A
Smooth Wall PVC Pipe	907.23	M 278	F 679	ITM 806, Procedure A
Type PSM PVC Pipe and Fittings	907.24(a)		D 3034	ITM 806, Procedure A

907.17 Corrugated Polyethylene Drainage Tubing and Pipe

(a) Corrugated Polyethylene Tubing

Tubing and fittings shall be in accordance with AASHTO M 252. Perforations shall be required for tubing used as a longitudinal underdrain. Qualification requirements for the manufacturers shall be in accordance with ITM 806, Procedure O.

250 **(b) Corrugated Polyethylene Pipe**

Pipe and fittings shall be in accordance with AASHTO M 294. Qualification requirements for the manufacturers shall be in accordance with ITM 806, Procedure O.

907.18 Perforated PVC Semicircular Pipe

260 Perforated PVC semicircular pipe may be used as an alternate to 6 in. or less diameter pipe or tile. Pipe shall be in accordance with ASTM D 3034, SDR 35. This semicircular pipe shall have a smooth top and a smooth, semicircular bottom, nominally 4 5/8 in. in diameter, with perforations uniformly distributed along the top of the bottom section in accordance with AASHTO M 252 perforation requirements. The top section shall extend a minimum of 1/2 in. beyond the top of the semicircular section. The top section shall be approximately 6 3/8 in. wide including the sloping overhangs on each side. Qualification requirements for the manufacturers shall be in accordance with ITM 806, Procedure A.

907.19 Corrugated Polypropylene Pipe

270 Pipe and fittings shall be in accordance with AASHTO M 330. Qualification requirements for the manufacturers shall be in accordance with ITM 806, Procedure O.

907.20 Ribbed Polyethylene Pipe

Pipe and fittings shall be in accordance with ASTM F 894. Qualification requirements for the manufacturers shall be in accordance with ITM 806, Procedure A.

907.21 Smooth Wall Polyethylene Pipe

280 Pipe shall be in accordance with ASTM F 714 for nominal diameters of 39 in. or less. Fittings shall be in accordance with ASTM F 1055. The pipe sizes shall be in accordance with ISO sizing system. The pipe dimension ratio shall be 26 or less. The resin used in manufacturing this type of pipe shall have a minimum cell classification of 335434C in accordance with ASTM D 3350 or a minimum grade of PE4710 in accordance with ASTM F 714. Qualification requirements for the manufacturers shall be in accordance with ITM 806, Procedure A.

907.22 Profile Wall PVC Pipe

290 Pipe and fittings shall be in accordance with AASHTO M 304 or ASTM F 949. Perforations shall be required when used as a longitudinal underdrain or end bent drain pipe. Qualification requirements for the manufacturers shall be in accordance with ITM 806, Procedure O.

907.23 Smooth Wall PVC Pipe

Pipe and fittings shall be in accordance with AASHTO M 278 for pipe sizes 4 in. through 15 in., and ASTM F 679 for pipe sizes 18 in. through 27 in. Qualification requirements for the manufacturers shall be in accordance with ITM 806, Procedure A.

907.24 Smooth Wall Pipe for Outlets

Pipe and pipe fittings shall be smooth wall, non-perforated plastic pipe. Qualification requirements for the manufacturers shall be in accordance with ITM 806, Procedure A.

(a) Type PSM PVC Pipe and Fittings

Pipe and fittings shall be in accordance with ASTM D 3034, SDR 23.5.

(b) Schedule 40 PVC Pipe

Pipe shall be in accordance with ASTM D 1785 or D 2665 and shall have a minimum pipe stiffness of 150 psi at 5% deflection when determined in accordance with ASTM D 2412. Material furnished under this specification shall be covered by a type C certification in accordance with 916 and shall reference ASTM D 1785 or D 2665 in the product print line.

907.25 Thermoplastic Liner Pipe

Thermoplastic liner pipe shall be HDPE or PVC pipe with sufficient rigidity to withstand the installation operation and shall exhibit a minimum amount of distortion. The liner pipe shall be free from visible cracks, holes, foreign inclusions, or other defects. A certification addressing all of the required information for HDPE liner pipe shall be prepared by the manufacturer, when required. A sample certification is included in ITM 804.

(a) Solid Wall HDPE Liner Pipe

Solid wall HDPE liner pipe shall be in accordance with ASTM F 714. The maximum standard dimension ratio, SDR, as defined in ASTM F 412 for the liner pipe shall be 32.5. The actual calculated minimum dimension ratio, DR, as defined in ASTM F 412 for the liner pipe shall be 30.0. The resin used in the manufacture of the liner pipe shall have a minimum cell classification of 345464C in accordance with ASTM D 3350 or a minimum grade of PE4710 in accordance with ASTM F 714. A 12 in. section of the liner pipe shall show no evidence of splitting, cracking, or breaking when compressed between parallel plates to 40% of its outside diameter within 2 to 5 minutes. Thermoplastic liner pipe may be added to the Department's approved list by completing the requirements of ITM 806, Procedure Q.

(b) Profile Wall HDPE Liner Pipe

Profile wall HDPE liner pipe shall be in accordance with ASTM F 894. The minimum liner ring stiffness constant, RSC, shall be 160 for circular installations and 250 for deformed installations. Thermoplastic liner pipe may be added to the Department's approved list by completing the requirements of ITM 806, Procedure A.

(c) Profile Wall PVC Liner Pipe

340 Profile wall PVC liner pipe shall be in accordance with ASTM F 949. Thermoplastic liner pipe may be added to the Department's approved list by completing the requirements of ITM 806, Procedure A.

907.26 Solvent Cements for PVC Pipe and Pipe Fittings

Solvent cement for PVC pipe and fittings shall be in accordance with ASTM D 2564. Material furnished under this specification shall be covered by a type C certification in accordance with 916.

907.27 Elastomeric Seals

350 Elastomeric seals for joining plastic pipe shall be in accordance with ASTM F 477. Material furnished under this specification shall be covered by a type B certification in accordance with 916. The results of the following tests shall be provided on the type B certification.

TEST	ASTM
Tensile Strength	D 412 or D 1414
Ultimate Elongation	D 412 or D 1414
100% Modulus	D 412 or D 1414
Hardness (Durometer)	D 2240 or D 1414
Low-Temperature Hardness	D 2240 or D 1414
Compression Set	D 395 Method B, or D 1414
Accelerated Aging	D 573
Water Immersion	D 471
Ozone Resistance	D 1149
Elastomer Compound Effect on Pipe	F 477
Force Decay (Stress Relaxation)	F 913

907.28 Reinforced Thermosetting Resin Pipe and Pipe Fittings

360 Reinforced thermosetting resin pipe and accompanying fittings shall be in accordance with ASTM D 2996 for the specified sizes. The short-term rupture strength hoop tensile stress shall be a minimum of 30,000 psi. All pipes shall be pigmented resin throughout the wall thickness. The color of the pipe shall match color No. 26400 of Federal Standard 595. Painting, gel-coating, or exterior coating of the pipe to obtain the specified color shall not be done. Pipe shall be tested in accordance with ASTM G 154 for 2,500 h of accelerated weathering following cycle 2 as defined in Appendix X2. After testing, the surface of the pipe shall show no fiber exposure, crazing, or checking, and may have only a slight chalking or color change. An adhesive recommended by the manufacturer shall be used for joining pipe and fittings. Material furnished shall be covered by a type A certification in accordance with 916. The results of the following tests shall be provided on the type A certification.

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TEST	ASTM
Wall Thickness and Diameter	D 3567
Short-Term Hydrostatic Failure Strength	D 1599
Stiffness Factor (for direct-bury only)	D 2412, based on 5% deflection

A lot will be defined as the production quantity in a given calendar month for each pipe diameter, not to exceed 10,000 lft. The accelerated weathering test shall be performed once for each pipe material formulation that is provided. A new accelerated weathering test will be required if the pipe material formulation changes. Test results shall be provided to the Engineer at the time of delivery and shall be from tests performed on the formulation representative of the pipe delivered.

SECTION 908 – METAL PIPE

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908.02 Corrugated Steel Pipe and Pipe-Arches

Corrugated steel pipe and pipe-arches shall be type I, IA, II, or IIA in accordance with AASHTO M 36.

10 Corrugated steel pipe, pipe-arches, and coupling bands shall be zinc coated steel or aluminum coated steel in accordance with AASHTO M 36, except as noted herein. They may be fabricated with circumferential corrugations and riveted lap joint construction or with helical corrugations with continuous lock or welded seam extending from end to end of each length of pipe. Reforming the ends of helical corrugated pipe to form circumferential corrugations will be allowed to enable use of circumferential corrugated coupling bands. The reforming shall be limited to the length required to accommodate the coupling bands and in such a manner that there is not appreciable slippage of the seam or a plane of weakness created.

20 Polymer precoated galvanized corrugated steel pipe type IA and pipe-arch type IIA have an outer shell of corrugated sheet with helical corrugations and an inner liner of smooth sheet attached to the shell with a helical lock seam.

Fittings, including stub-tee connections and saddle connectors specified in 715.06, shall be shop fabricated. Damage to the coating on fittings shall be repaired in accordance with AASHTO M 36.

If the pipe or pipe-arch invert is to be paved, it shall first be coated over half its circumference in accordance with 908.07. The paved invert shall then be constructed in accordance with 908.07.

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Sheet metal used to fabricate pipe shall be the same brand from the same manufacturer in any one length of finished pipe.