Designation: C505 – 15

Standard Specification for Nonreinforced Concrete Irrigation Pipe with Rubber Gasket Joints[1]

This standard is issued under the fixed designation C505; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification covers nonreinforced concrete pipe with rubber gasket joints to be used for the conveyance of irrigation water with working pressures, including hydraulic transients, as shown in Table 1.

1.2 A complete metric companion to Specification C505 has been developed—C505M; therefore, no SI equivalents are presented in this specification.

NOTE 1—This specification is for manufacturing and purchase only and does not include requirements for bedding, backfill, installation, or field repairs. The owner is cautioned that he must correlate field conditions with the characteristics of the pipe specified and provide inspection during installation.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C33/C33M Specification for Concrete Aggregates
C150/C150M Specification for Portland Cement
C260/C260M Specification for Air-Entraining Admixtures for Concrete
C494/C494M Specification for Chemical Admixtures for Concrete
C497 Test Methods for Concrete Pipe, Manhole Sections, or Tile
C595/C595M Specification for Blended Hydraulic Cements
C618 Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
C822 Terminology Relating to Concrete Pipe and Related Products
C989/C989M Specification for Slag Cement for Use in Concrete and Mortars
C1017/C1017M Specification for Chemical Admixtures for Use in Producing Flowing Concrete
C1116/C1116M Specification for Fiber-Reinforced Concrete
C1602/C1602M Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
D395 Test Methods for Rubber Property—Compression Set
D412 Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension
D471 Test Method for Rubber Property—Effect of Liquids
D573 Test Method for Rubber—Deterioration in an Air Oven
D1149 Test Methods for Rubber Deterioration—Cracking in an Ozone Controlled Environment
D1415 Test Method for Rubber Property—International Hardness
D2240 Test Method for Rubber Property—Durometer Hardness

3. Terminology

3.1 *Definitions*—For definitions of terms relating to concrete pipe, see Terminology C822.

4. Classification

4.1 Pipe manufactured in accordance with this specification shall be known as "Standard Nonreinforced Concrete Irrigation Pipe with Rubber Gasket Joints."

5. Basis of Acceptance

5.1 The acceptability of the pipe, joint design, and gaskets shall be determined by the results of the tests prescribed in this specification, if and when required, and by inspection to determine whether the pipe and gaskets conform to the specification as to design and freedom from defects.

6. Materials and Manufacture

6.1 *Concrete*—The concrete shall consist of cementitious materials, mineral aggregates, admixtures, if used, and water.

6.2 *Cementitious Materials:*

6.2.1 *Cement*—Cement shall conform to the requirements for portland cement of Specification C150/C150M or shall be portland blast-furnace slag cement, portland-limestone cement, or portland-pozzolan cement conforming to the requirements of Specification C595/C595M, except that the pozzolan constituent in the Type IP portland-pozzolan cement shall be fly ash.

[1] This specification is under the jurisdiction of ASTM Committee C13 on Concrete Pipe and is the direct responsibility of Subcommittee C13.01 on Non-Reinforced Concrete Sewer, Drain and Irrigation Pipe.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

TABLE 1 Standard Dimensions, Working Pressures, and Test Requirements

Internal Designated Diameter, in.	Wall Thickness,[A] in.	Working Pressure,[B] ft	Required Hydrostatic Test Pressure,[C] psi	Minimum Three-Edge-Bearing Load, lbf/linear ft
6	¾	30	40	1300
8	1	30	40	1350
10	1¼	30	40	1400
12	1½	30	40	1500
15	1⅞	30	40	1650
18	2¼	30	40	1800
21	2⅝	30	40	1900
24	3	30	40	2000

[A] Thinner walls are not prohibited on pipe units not over 4 ft in length, but the thickness of such walls shall not be less than the internal diameter divided by 10.
[B] With the exception of 21 and 24-in. pipe, higher working pressures are not prohibited to be used up to a maximum of 50 ft for 6 through 12-in. diameters, and 40 ft for 15 through 18-in. diameters. In these cases the strength of the pipe shall be increased to give minimum internal hydrostatic test pressures of at least three times the design working pressure when tested as specified in 10.4.
[C] For hydrostatic test requirements, refer to 10.4.

6.2.2 *Fly Ash*—Fly ash shall conform to the requirements of Specification C618, Class F or Class C.

6.2.3 *Slag Cement*—Slag cement shall conform to the requirements of Grade 100 or 120 of Specification C989/C989M.

6.2.4 *Allowable Combinations of Cementitious Materials*—The combination of cementitious materials used in the concrete shall be one of the following:

6.2.4.1 Portland cement only,

6.2.4.2 Portland blast-furnace slag cement only,

6.2.4.3 Portland-pozzolan cement only,

6.2.4.4 Portland-limestone cement only,

6.2.4.5 A combination of portland cement or portland-limestone cement and fly ash,

6.2.4.6 A combination of portland cement or portland-limestone cement and slag cement,

6.2.4.7 A combination of portland cement or portland-limestone cement, fly ash and slag cement, or

6.2.4.8 A combination of portland-pozzolan cement and fly ash.

6.3 *Aggregates*—Aggregates shall conform to the requirements of Specification C33/C33M, except that the requirements for gradation shall not apply.

6.4 *Admixtures*—The following admixtures and blends are allowable:

6.4.1 Air-entraining admixture conforming to Specification C260/C260M;

6.4.2 Chemical admixture conforming to Specification C494/C494M;

6.4.3 Chemical admixture for use in producing flowing concrete conforming to Specification C1017/C1017M; and

6.4.4 Chemical admixture or blend approved by the owner.

6.5 *Gaskets:*

6.5.1 *Composition*—The rubber compound used in the manufacture of the gasket shall be compounded from natural rubber, synthetic rubber, or a mixture of the two fabricated as prescribed in 6.5.2 to 6.5.6, inclusive.

6.5.2 *Fabrication*—Gaskets shall be extruded or molded and cured in such a manner that they will be dense and homogeneous at any cross section, and have uniform dimensions. They shall be free from porosity, blisters, pitting, and other defects, which will affect their serviceability.

6.5.3 *Tolerances*—Commercial tolerances A3-F3, T.032 for molded gaskets and A3-F3 for extruded gaskets in accordance with the *Rubber Handbook*[3] shall be permitted. The tolerances in gasket and joint dimensions shall be such as not to exceed permissible deformations prescribed in Section 8.

6.5.4 *Physical Properties of Gaskets*—The rubber from which the gaskets are fabricated shall have the following physical properties:

Ultimate elongation at break, min, %	350
Ultimate elongation at break after aging, min, % of elongation before aging	80
Hardness, International Rubber Hardness Degrees or Durometer[A]	40 to 60
Compression set, max, %	25
Water absorption, %	10
Ozone resistance	no cracks in accordance with Test Method D1149

[A] Allowable variation ±5 from manufacturer's specified hardness.

6.5.4.1 Testing shall be in accordance with Section 9.

6.5.5 *Strength of Splice*—If a splice is used in the manufacture of the gasket, the strength shall be such that the gasket shall withstand 100 % elongation over the part of the gasket that includes the splice with no visible separation of the splice. While in the stretched position, the gasket shall be rotated in the spliced area a minimum of 180° in each direction in order to inspect for separation. Any portion of the splice shall be capable of passing a bend test without visible separation. The bend test for circular gaskets is defined as wrapping the portion of the unstretched gasket containing the splice a minimum of 180° and a maximum of 270° around a rod of a diameter equal to the cross section diameter of the gasket.

6.5.6 *Storage*—The gaskets shall be stored in a cool, clean, and shaded place, preferably at 70°F or less and in no case shall the gaskets be exposed to the direct rays of the sun for more than 72 h.

6.6 *Fibers*—Synthetic fibers and nonsynthetic fibers shall be allowed to be used, at the manufacturer's option, in concrete pipe as a nonstructural manufacturing material. Synthetic fibers (Type II and Type III) and nonsynthetic fiber (Type I) designed and manufactured specifically for use in concrete and conforming to the requirements of Specification C1116/C1116M shall be accepted.

6.7 *Water*—Water used in the production of concrete shall be potable or non-potable water that meets the requirements of Specification C1602/C1602M.

7. Design

7.1 *Design Tables*—The standard dimensions shall be as given in Table 1. Wall thicknesses furnished shall be not less than those given in Table 1, except as affected by the tolerance specified in Section 12.

[3] Available from the Rubber Manufacturers Assn., Inc., 1400 K St., NW, suite 900, Washington DC, 20005.

7.2 *Modified Design*—Manufacturers shall submit to the owner for approval prior to manufacture, wall thicknesses other than those shown in Table 1. Such pipe shall meet all of the test and performance requirements specified by the owner in accordance with 5.1.

8. Joints

8.1 Pipe units shall be manufactured with male- and female-type joints of such design that the rubber gasket applied thereto shall be the sole element depended upon to make the joints flexible and watertight.

8.2 The slope on the conic surfaces of the gasket seat on the inside of the female portion and on the outside of the male portion shall be not more than 3.5° measured from a longitudinal trace on the inside surface of the pipe. The female or the male portions, or both, shall form a proper gasket positioning area or "seat." The joint design shall be such that, when the joint has been fully closed and is off center sufficiently to cause the outer concrete surface of the male portion and the inner concrete surface of the female portion to come into contact at some place in the joint periphery, the deformation of the gasket adjacent to that point shall not exceed 50 % of the stretched diameter for O-ring gaskets, or 75 % of the uncompressed radial thickness for all other types. At the diametrically opposite side, the gasket deformation shall be not less than 15 % of the stretched diameter for O-ring gaskets, or 25 % of the uncompressed radial thickness for all other types. O-ring gaskets are defined as solid gaskets of circular cross section. Stretched gasket diameters shall be calculated as being $\sqrt{1/(1+x)}$ times the original gasket diameter where x equals the percent of gasket stretch divided by 100.

8.3 The joint design shall provide for the deflection of each pipe unit by opening one side of the outside perimeter of the joint, wider than the fully closed position, a distance no less than ½ in. or 25 % of the wall thickness, whichever is less, without reducing its watertightness.

8.4 The joint shall be of such design that it will withstand, without cracking or fracturing, the forces caused by the compression of the gasket, and the required hydrostatic test pressure.

8.5 All surfaces of the joint upon or against which the gasket bear shall be smooth, free of spall, cracks, or fractures, and imperfections that would adversely affect performance.

8.6 *Alternative Joint Designs*—Manufacturers shall submit to the owner, detailed designs for joints and gaskets other than those described in 8.2, 8.3, 8.4, and 8.5. Design submissions shall include joint geometry tolerances, gasket characteristics, proposed plant tests, gasket splice bend tests, and such other information as required by the owner to evaluate the joint design for field performance. Joints and gaskets of alternative joint designs shall meet all test requirements of this specification unless waived by the owner. Alternative joint designs shall be acceptable provided the designs are approved by the owner prior to manufacture and provided the test pipe comply with the specified test.

9. Concrete Mixture

9.1 The aggregates shall be sized, graded, proportioned, and thoroughly mixed with such proportions of cementitious materials and water as will produce a homogeneous concrete mixture of such quality that the pipe will conform to the test and design requirements of this specification. Cementitious materials shall be as specified in 6.2 and shall be added to the mix in a proportion not less than 470 lb/yd, unless mix designs with a lower cementitious materials content demonstrate that the quality and performance of the pipe meet the requirements of this specification.

10. Physical Requirements

10.1 *Test Specimens:*

10.1.1 Specimens for test shall be full-size pipe units and gaskets that conform in every respect to the inspection requirements of this specification, shall be selected at random by the owner at the place of manufacture of the pipe, and shall be tested in advance of shipment to the site of installation.

10.1.2 Test specimens of pipe shall be selected from dated lots and the manufacturer shall furnish manufacturing data for the lot tested if so required by the owner.

10.2 *Number and Type of Tests Required*—The manufacturer shall furnish specimens for the test without charge up to 1 % of the number of pipe units of each dated lot, except that in no case shall fewer pipe units be furnished than necessary to perform the tests herein specified. Specimens shall be proportioned equally to the test to which they are to be subjected except that the owner can specify different proportions prior to purchase. The manufacturer shall bear all the expense of testing such pipe. Should a larger number of specimens be tested upon demand of the owner or manufacturer, then the cost of such additional test specimens and the expense of testing shall be borne by the party making such demand.

10.3 *External Load Test Requirement*—The minimum three-edge-bearing strength shall be as given in Table 1 and shall be made in accordance with Test Methods C497. If mutually agreed upon between the manufacturer and the owner, other types of bearings such as hard rubber blocks or sand-filled, high-pressure hose are acceptable.

10.3.1 It is not prohibited to fill depressions of exterior surface irregularities with plaster of paris to equalize the bearing surfaces. The user of this specification is advised that sand or other loose fine material may be spread along the length of the crown of the pipe to equalize the upper bearing.

10.3.2 The load shall be applied continuously until the strength specified in Table 1 is reached. The pipe shall not be allowed to stand under load longer than is required to apply the load and to observe and record it. The pipe shall be surface dry when tested. Tests shall not be made on frozen pipe.

10.4 *Hydrostatic Test Requirements*—Maximum hydrostatic test pressures shall be as given in Table 1, and shall be made in accordance with 10.7. There shall be no leakage of pipe or joints at one third of this pressure when pipes are in straight alignment or in maximum deflected position. Moisture appearing on the surface of the pipe in the form of patches, or beads, adhering to the surface, will not be considered as leakage. In

event the pipe is tested dry, slow-forming beads of water that result in minor dripping, and slight pinhole spurts that can be proven to seal and dry up within 1 week when kept continuously under the prescribed 10-min test pressure will be considered acceptable.

10.5 *Rubber Gasket Compound Tests:*

10.5.1 *General*—Laboratory tests to determine the physical properties of the rubber gaskets to be furnished under this specification shall be performed on test specimens taken from the finished rubber product, except that at the option of the pipe manufacturer specimens shall be furnished in accordance with the appropriate ASTM method or specification.

10.5.2 *Tensile Strength and Elongation*—Test Methods D412.

10.5.3 *Aging*—Test Method D573, aged for 96 h at 158°F.

10.5.4 *Hardness*—Test Method D1415 or Test Method D2240.

10.5.5 *Compression Set*—Method B of Test Methods D395, 22 h at 158 ± 2°F.

10.5.6 *Water Absorption*—Test Method D471. Soak in distilled water for 48 h at 158 ± 2°F. When a 1-in. test specimen cannot be obtained, use the greatest width obtainable from the test sample.

10.5.7 *Ozone Resistance*—Determine the resistance to ozone in accordance with Test Method D1149.

10.5.7.1 Specimens shall be the test specimen length of the finished gasket cross section.

10.5.7.2 Conduct test for 72 h in 50 PPHM concentration at 104 ± 4°F stressed to 20 % extension.

10.6 *Retests*—Pipe shall be considered as meeting the strength test requirements when all initial test specimens conform to the test requirements. Should any of the initial test specimens fail to meet the test requirements, the manufacturer shall be allowed a retest on two additional specimens for each specimen that failed, and the pipe shall be acceptable only when all of these retest specimens meet the strength requirements. Pipe for retest shall be selected from pipe of the same dated lot as the specimen that failed. If any of the retest specimens fail, then each of the remaining pipe units produced in that dated lot shall be tested and will be accepted only after it has satisfactorily passed the tests.

10.7 *Hydrostatic Test Method:*

10.7.1 Make the hydrostatic test on specimens selected as specified. At the option of the manufacturer, the pipe (*1*) shall be surface dry, (*2*) shall have been completely immersed in water for 7 days, or (*3*) shall have been completely soaked from the inside at the working pressure for up to 7 days prior to test.

10.7.2 The test shall be made first on two or more units of pipe in straight alignment between bulkheads, and secondly on the same units of pipe with the joint between them deflected as specified in 8.3. No mortar or concrete coatings, fillings, or packings other than the gasket itself shall be placed in the joint during or prior to either part of the test.

10.7.3 Properly connect the pipe units together and to bulkheads at either end in accordance with joint design and jig to prevent movement during the test.

10.7.4 Make provision to fill the pipe units with water to the exclusion of air. Connect a standardized pressure gage close to the specimens, and bring the water pressure up to a value of one third of the required hydrostatic test pressure in about 1 min and hold at that pressure for 10 min. Then increase the pressure until the required hydrostatic test pressure is reached, and hold at that pressure for a period of time not to exceed 1 min.

10.7.5 At no time during the test, or during a prior immersion period, subject the pipe to freezing temperature.

11. Gasket Lubricants

11.1 Where the particular joint design utilizing a rubber gasket dictates the use of a lubricant to facilitate assembly, the lubricant composition shall have no detrimental effect on the performance of the gasket and joint due to prolonged exposure.

11.2 The lubricant shall be stored in accordance with the lubricant manufacturer's recommended temperature range.

11.3 When requested by the owner, the manufacturer shall furnish written certification that the joint lubricant conforms to all requirements of this specification for the specific gaskets supplied.

12. Permissible Variations

12.1 *Internal Diameter*—The internal diameter at any point shall be not more than 3⁄16 in. or 1½ %, whichever is the greater, less than the value shown in Table 1.

12.2 The minimum wall thickness of the pipe shall be not more than 5 % or 1⁄16 in., whichever is the greater, less than the value shown in Table 1.

12.3 *Square Ends*—The planes formed by the ends of the pipe units shall not vary from the perpendicular to the longitudinal trace on the inside surface of the pipe by more than 3⁄16 in. across the inside diameter of the pipe.

13. Workmanship, Finish, and Appearance

13.1 Pipe shall be substantially free of fractures and surface roughness.

14. Repairs

14.1 Pipe repaired because of occasional imperfections in manufacturing or accidental injury during handling will be acceptable if, in the opinion of the owner, the repairs are sound and properly finished and cured and the repaired pipe conforms to the requirements of this specification.

15. Inspection

15.1 The quality of all materials and the finished pipe and gaskets shall be subject to inspection and approval by the owner.

16. Rejection

16.1 *Rejection of Pipe*—Pipe shall be subject to rejection on account of failure to conform to any of the specification requirements or on account of fractures or cracks passing through the wall of the pipe, or end cracks and fractures, that might interfere with proper seating of the gasket.

16.2 *Rejection of Gaskets*—Gaskets that do not conform to this specification or that show surface checking, weathering, or other deterioration prior to installation in the work will be rejected. All gaskets are subject to inspection.

17. Product Marking

17.1 The following information shall be clearly marked on the surface of the pipe units:

17.1.1 Date of manufacture,

17.1.2 Name or trademark of the manufacturer,

17.1.3 Pipe Class (NR), and

17.1.4 The working pressure designed for, if higher than that given in Table 1.

17.2 *Lubricant*—The following information shall be clearly marked on each container of lubricant.

17.2.1 Name of lubricant manufacturer.

17.2.2 Usable temperature range for application and storage.

17.2.3 Shelf life.

17.2.4 Lot or batch number.

18. Keywords

18.1 absorption; acceptance criteria; concrete; design; drainage; gasket tests; gaskets; hydrostatic; irrigation; joints; manufacture; nonreinforced; pipe; pressure; rubber gaskets; tests; three-edge bearing