



Designation: C1840/C1840M – 22

Standard Practice for Inspection and Acceptance of Installed Reinforced Concrete Culvert, Storm Drain, and Storm Sewer Pipe¹

This standard is issued under the fixed designation C1840/C1840M; 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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

1. Scope

1.1 This practice covers the requirements for inspection and acceptance of installed reinforced concrete pipe by either person-entry, or remote inspection as shown in Figs. 1 and 2, respectively.

1.2 The scope of this specification is intended for installation related observations and assumes that pre-installation inspection has been completed.

1.3 The reinforced concrete culvert, storm drain and storm sewer pipe shall be manufactured in accordance with Specification C76, C506, C507, C655, C1417, or C1846/C1846M and accepted in accordance with AASHTO R 73. This specification shall only be used for gravity, non-pressure storm drainage applications.

1.4 Person Entry shall be used unless extenuating circumstances preclude this type inspection. Remote inspection is acceptable for use for pipe diameters of 30 in. [750 mm] and smaller unless otherwise specified by owner or engineer.

1.5 Access of installed pipe for manual inspection shall follow OSHA 29 CFR PART 1926 SUBPART AA regulations for confined space entry. *However, this standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 This practice does not cover deformation or deflection assessment. Concrete pipe is classified as a rigid structure because they do not bend or deflect appreciably under load before cracking. Due to these facts shape evaluation are of little or no value when evaluating concrete pipe.

1.7 The values stated in either Imperial/US or [SI units] are to be regarded separately as standard. The SI units are shown

in brackets. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other.

1.8 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 ASTM Standards:

- C76 Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
- C506 Specification for Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe
- C507 Specification for Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe
- C655 Specification for Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe
- C822 Terminology Relating to Concrete Pipe and Related Products
- C1417 Specification for Manufacture of Reinforced Concrete Sewer, Storm Drain, and Culvert Pipe for Direct Design
- C1846/C1846M Specification for Performance Based Manufacture of Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
- D932 Practice for Filamentous Iron Bacteria in Water and Water-Formed Deposits

2.2 AASHTO Standards:

- AASHTO LRFD Bridge Design Specification
- AASHTO LRFD Bridge Construction Specification, Section 27
- AASHTO R 82 Standard Practice for Pipe Joint Selection for Highway Culvert and Storm Drains
- AASHTO R 73 Standard Practice for Evaluation of Precast Concrete Drainage Products

2.3 Occupational Safety and Health Standards:

- OSHA 29 CFR Part 1926 Subpart AA for the Construction Industry

¹ This test method is under the jurisdiction of ASTM Committee C13 on Concrete Pipe and is the direct responsibility of Subcommittee C13.05 on Special Projects.

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FIG. 1 Person Entry Inspection



FIG. 3 Calcium Carbonate Filled Crack



FIG. 2 Remote Inspection Camera

2.4 ISO/IEC Standards:

ISO/IEC 17025 General Requirements for the Competence of Testing and Calibration Laboratories

3. Terminology

3.1 For definitions of other terms relating to concrete pipe not defined in this specification, see Terminology C822.

3.2 Definitions:

3.2.1 *calcium carbonate crystals*—as shown in Fig. 3, crystals are formed when the carbon dioxide in the surrounding soil, air and water carbonates the free (un-hydrated) calcium oxide in the cement and the calcium hydroxide liberated by the hydration of the tricalcium silicate of the cement. This chemical process results in white crystals along the pipe wall at a crack location and if it fills the crack is commonly referred to as autogenous healing.

3.2.2 *clock positions*—the relative circumferential position, direction or location of an observation on the pipe interior is described using the analogy of a 12-hour clock as shown in Fig. 4. For example, 12 o'clock is the pipe crown; 3 o'clock the spring line right; 6 o'clock the invert; and 9 o'clock the spring line left. The viewing orientation (upstream or downstream) of the clock position observations must be identified to establish the spring line positions. When two clock positions are utilized to characterize the location or relative size of an anomaly within the pipe, the clock positions should be entered clockwise (for example, circumferential crack begins at 10 o'clock and ends at 2 o'clock).

3.2.3 *quadrant*—descriptor for one fourth of the circumference of the pipe, or a circumferential 90-degree arc. An example quadrant shown in Fig. 5.

3.2.4 *crack*—a measurable surface separation found in concrete indicating stress is being transferred from the concrete to the reinforcement.

3.2.4.1 *circumferential crack*—a crack aligned with the circumference of the pipe and perpendicular to the longitudinal axis of the pipe as shown in Fig. 6.

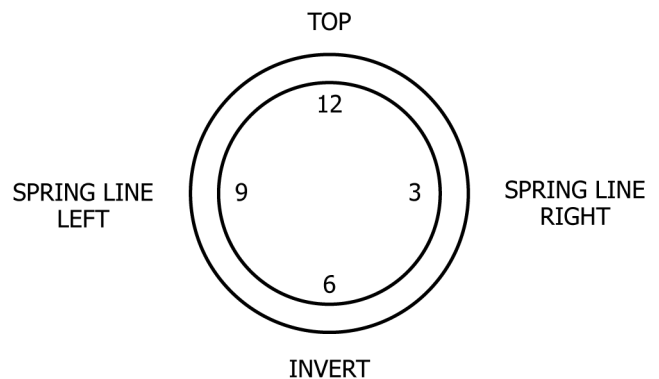


FIG. 4 Clock Positions

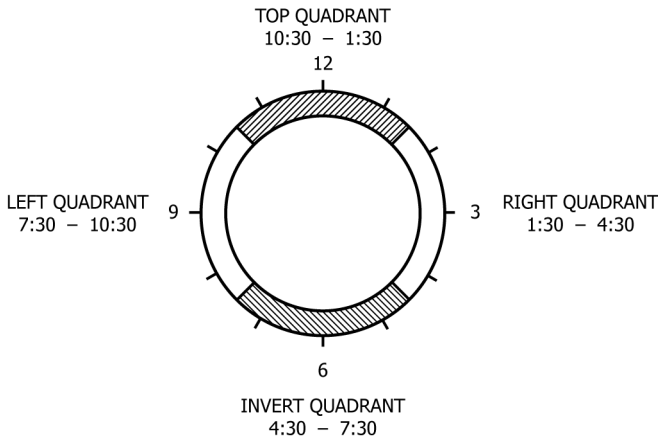


FIG. 5 Pipe Wall Quadrants

3.2.4.3 *longitudinal crack*—a crack aligned with the axis of the pipe as shown in Fig. 8.

3.2.4.4 *multi-directional crack*—a combination of longitudinal and circumferential cracks that intersect at one point as shown in Fig. 9.

3.2.4.5 *diagonal tension crack*—longitudinal cracks ± 30 to 60 degrees from the invert or obvert of the pipe (1-2 o'clock, 4-5 o'clock, 7-8 o'clock, or 10-11 o'clock) with a visible vertical offset across the crack.

3.2.4.6 *Discussion*—Normal load induced longitudinal cracks can be present in the same locations but will not have a vertical offset across the crack.

3.2.5 *engineer*—The qualifications for an engineer involved in the evaluation of installed RCP shall be established by the owner. Engineer designation as noted in this standard can be the design engineer of record for the subject project, an engineer working for or on behalf of the owner, or an engineer specializing in the evaluation of installed RCP.

3.2.6 *infiltration*—ground water entering the pipe.

3.2.6.1 *Level 1 Infiltration*—moisture visible on the surface of the pipe wall without any observable active water movement such as drips or water traveling along the surface as shown in Fig. 10.

3.2.6.2 *Level 2 Infiltration*—the slow entry of water identified by visible drips or a constant flow of water traveling along the surface. See Fig. 11.

3.2.6.3 *Level 3 Infiltration*—a continuous stream of water running into the pipe or spraying through the pipe “under pressure.” See Fig. 12.

3.2.7 *joint offset*—when the inside surface of the spigot (tongue) is not in alignment or centered with the interior pipe surface on the Bell (groove) end of the installed joint. See Fig. 13.

3.2.8 *joint separation*—the space from the end of the spigot (tongue) to the face (shoulder) of the bell (groove) of the installed joint. See Fig. 14.



FIG. 6 Circumferential Crack

3.2.4.2 *hinge cracks*—when more than one longitudinal crack (at 12, 3, 6, or 9 o'clock) occurs at the same cross section location in the pipe as shown in Fig. 7.

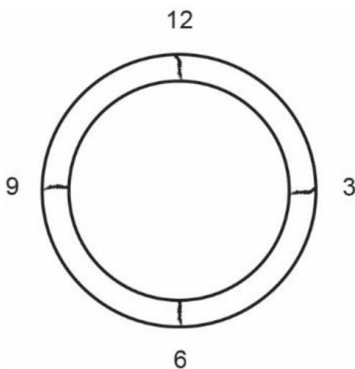


FIG. 7 Hinged Cracks (Multiple Longitudinal Cracks)

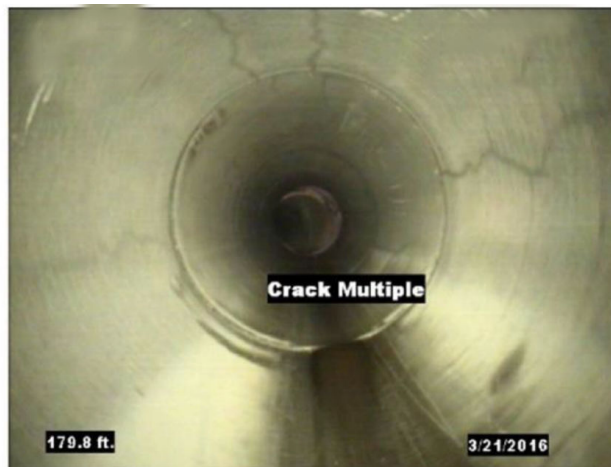




FIG. 8 Longitudinal Crack



FIG. 9 Multi-Directional Crack

3.2.14 *slabbing*—a radial tension failure of the concrete wall which occurs from straightening of the reinforcement cage due to tension in the reinforcing as shown in Fig. 15.

3.2.15 *spalling*—a fracture of the concrete inclined to the surface resulting in pieces of concrete detaching from the pipe wall, as shown in Fig. 16, or along a crack.

3.2.16 *soil tight joint*—a joint that is resistant to infiltration of particles larger than those retained on a No. 200 sieve.

3.2.17 *stain/efflorescence*—deposits left by the partial evaporation of infiltrating groundwater containing dissolved salts or minerals. These deposits will often be concentrated at or alongside infiltration locations.

3.2.18 *soil/watermark*—discoloration(s) on the pipe interior left by the evaporation of water containing minerals or soil fines contained in the pipe effluent or surrounding groundwater. This type of discoloration is often observed longitudinally along the pipe wall coincident with the effluent water line level.

3.2.19 *rust colored staining*—a rust colored stain may occur due to iron ochre bacteria as determined by Practice D932, iron-oxide, or other mineral accumulation on the pipe surface. In the absence of cracks and infiltration in excess of those permitted in 8.5, or spalling that exposes the primary steel reinforcement, rust colored staining is not indicative of structural distress and does not require remediation. See Fig. 17.

4. Significance and Use

4.1 The inspection of installed reinforced concrete pipe verifies proper installation of the product and establishes thresholds for comparison further evaluation.

4.2 This practice is useful as a reference by an owner in preparing project specifications and to identify, evaluate and interpret observations during post installation inspections of pipe.

5. Pipe Inspection Equipment and Procedures

5.1 Pipe inspections may be made using person-entry, remote equipment, or a combination thereof. In general, pipe diameters 30 in. [750 mm] and smaller are not considered to be person-entry and typically require the use of remote equipment.

5.2 Remote Inspection Equipment:

5.2.1 The remote inspection system shall be equipped with adjustable or variable lighting suitable to allow a clear color image of the entire interior perimeter of the pipe.

5.2.2 The system shall produce a video image with a resolution to properly classify any observed features on the pipe wall. The image shall be clear, focused, and free from roll, static, or other image distortion qualities that would prevent the reviewer from evaluating the condition of the pipe.

5.2.3 The pipe shall be free from debris and other obstructions to allow for a reasonable view of the pipe during inspection. Standing water in the bottom of the pipe is common. Acceptable water depth or water volume limits for inspection shall be established in the project specifications, or for existing lines in the inspection protocol. Pipe with water volume or depth that exceeds acceptable limits must be dewatered.

3.2.9 *leak resistant joint*—according to AASHTO R 82 and for the purpose of this specification, a joint that limits water leakage at a maximum rate of 200 gallons/(inch of internal diameter) (mile of pipeline) (24h) [18.5 L/(mm of internal diameter) (km of pipeline) (24h)] for the pipeline system.

3.2.10 *non-corrosive environments*—according to AASHTO Section 27 and for the purpose of this specification, “a pH level of the soil surrounding the pipe or effluent water running through the pipe greater than 5.5” or less than a pH of 10 or environments established by the engineer or owner.

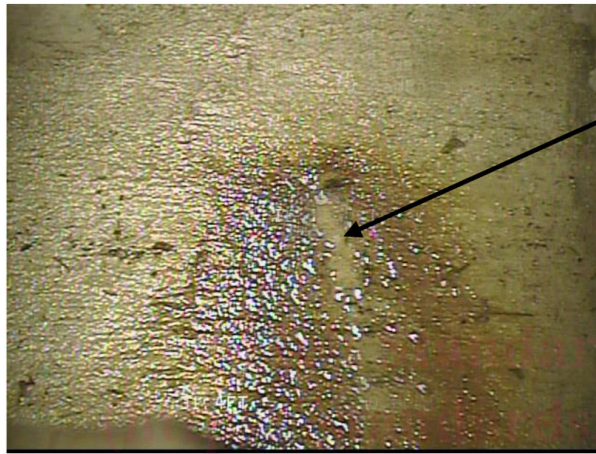
3.2.11 *owner*—the person or entity that owns or has maintenance and operation responsibility of the pipeline or storm system being inspected.

3.2.12 *scaling*—surface damage that appears as local flaking of poor concrete. Scaling is often associated with exposure to freezing and thawing cycles.

3.2.13 *silt-tight joint*—according to AASHTO R 82 and for the purpose of this specification, a joint that is resistant to infiltration of particles smaller than those retained on the No. 200 sieve.



FIG. 10 Level 1 Infiltration



Video clearly indicated water flowing along surface of the pipe wall

FIG. 11 Level 2 Infiltration



Video clearly indicated water spraying out from the pipe wall

FIG. 12 Level 3 Infiltration

5.2.4 The remote inspection video equipment shall be able to accurately measure and verify in accordance with Section 6, crack width and or other observable items as small as 0.05 in. [1.5 mm] \pm 0.01 in [0.3 mm], or be so equipped that the image can be analyzed by computer software to accurately determine observation measurement and distances as small as 0.05 in. [1.5 mm] \pm 0.01 in [0.3 mm]. For purposes of evaluation, visible cracks less than 0.05 in. [1.5 mm] shall be reported as less than 0.05 in. [1.5 mm].

NOTE 1—Equipment limitations may preclude measurements less than

0.05 in. [1.5 mm]. Therefore, measurements less than 0.05 in. are only expected to be made during person-entry inspections.

5.2.5 The inspection equipment shall have a distance counter so as to accurately locate the observations made along the pipe run.

5.2.6 The video equipment shall be calibrated in accordance with the manufacturer's recommendation within one year prior to the inspection date.

5.3 Remote Inspection Procedures: