Inspection Manual for Precast Concrete Pipe and Structures

INDIANA DEPARTMENT OF TRANSPORTATION
INDOT

May 2014

Table of Contents

Chapter Five – Precast Concrete Cracks

Chapter Six – Pipe Post-Installation Inspection

Appendix A

1 Precast Concrete Pipe and Structures

Certified Precast Concrete Producer Program

Materials
Material Testing
Quality Control Plan
Certification
Department Responsibilities
Decertification

Acceptance

Frequency Manual
Approved Sources
Product Marking

Rejection

Non-Reinforced Concrete Pipe
Reinforced Concrete Pipe
Reinforced Concrete Horizontal Elliptical Pipe
Precast Concrete Manholes, Inlets, and Catch Basins
Precast Reinforced Concrete Structure Sections
Repairs

CHAPTER ONE:
Precast Concrete Pipe and Structures

All precast concrete pipe and structures are required to be produced by a Certified Precast Concrete Producer meeting the requirements of **ITM 813**.

CERTIFIED PRECAST CONCRETE PRODUCER

ITM 813 requires a Precast Producer to be certified by the American Concrete Pipe Association (ACPA), the National Precast Concrete Association (NPCA), or the Precast/Prestressed Concrete Institute (PCI) B1 certification programs prior to becoming an INDOT Certified Precast Concrete Producer. The program requires the Producer to take responsibility for the production of quality precast products in accordance with contract requirements, and INDOT monitors the Producer's quality control procedures.

MATERIALS

The precast manufacturer is required to use INDOT approved materials in the construction of the concrete products intended for INDOT contracts. These materials include:

Admixtures

Chemical admixtures shall be included in the Department List of Approved PCC Admixtures and Admixture Systems.

Aggregates

Aggregates shall be in accordance with **ITM 203**. The aggregate sources are not required to be Certified Aggregate Producers as stated in Section **904.01**; however, the aggregate source is required to maintain current quality approval for all aggregate materials used in the precast product.

Cement

Cement shall be included in the Department List of Approved Cement Sources.

Manhole Steps

Manhole steps shall be included in the Department List of Approved Manhole Steps.

Pozzolans

Pozzolans shall be included in the Department List of Approved Pozzolans Sources.

Reinforcing Steel and Welded Wire Reinforcement (WWR)

Reinforcing steel and WWR shall be included in the Department List of Approved Certified Uncoated Reinforcing Bar Manufacturers.

MATERIAL TESTING

Material testing by the Producer is required by the certification programs and depending on the type of pipe shall include tests for strength, absorption, permeability, hydrostatic properties, permeability, and structural capability of the joints. Tests of the concrete shall be in accordance with the following test procedures:

Test	AASHTO Test Method	ASTM Test Method
Absorption	T 280	C 497
Air Content (Pressure Method)	T 152	C 231
Air Content (Volumetric Method)	T 196	C 173
Compressive Strength	T 22	C 39
Concrete Cores	T 24	C 42
Making and Curing Concrete Specimens	T 23	C 31
Sampling Concrete	R 60	C 172
Slump	T 119	C 143
Three-Edge Bearing	T 280	C 497
Unit Weight	T 121	C 138

Compressive Strength

Compressive strength of pipe is a very critical property of the concrete pipe and is determined by testing pieces of pipe in a three-edge-bearing machine (Figure 1-1) in accordance with **AASHTO T 280** or by breaking concrete cylinders in accordance with **AASHTO T 22**. Compressive strength determined by the three-edge bearing machine is expressed in pounds force per lineal foot (lb/ft) for all non-reinforced concrete pipe. Compressive strength determined by the three-edge bearing machine for reinforced concrete pipe is expressed as the D-load. D-load is defined in **AASHTO M 262** as the supporting strength of a pipe loaded under three-edge bearing test conditions expressed in pounds per linear foot of inside diameter or horizontal span.

The three-edge-bearing machine is required to meet the requirements of **AASHTO T 280**. The machine is certified every 12 months, but not to exceed 18 months, in accordance with **AASHTO T 67**.

Figure 1-1. Three-Edge-Bearing Machine

Minimum compressive strength requirements for non-reinforced concrete pipe are included in **AASHTO M 86**, reinforced concrete pipe in **AASHTO M 170**, and reinforced concrete horizontal elliptical pipe in **AASHTO M 207**.

The ultimate load or the load to produce a 0.01 in. crack is required depending on the size of the pipe. The ultimate load is reached when the pipe sustains no greater load. The 0.01 in. crack load is the maximum load applied to a concrete pipe before a crack having a width that permits the point of the measuring gauge to penetrate 1/16 in., without forcing at close intervals throughout the specified distance of 1 ft. The width of the crack is measured by means of a gauge made from a leaf 0.01 in. in thickness and ground to a point 1/16 in. (Figure 1-2).

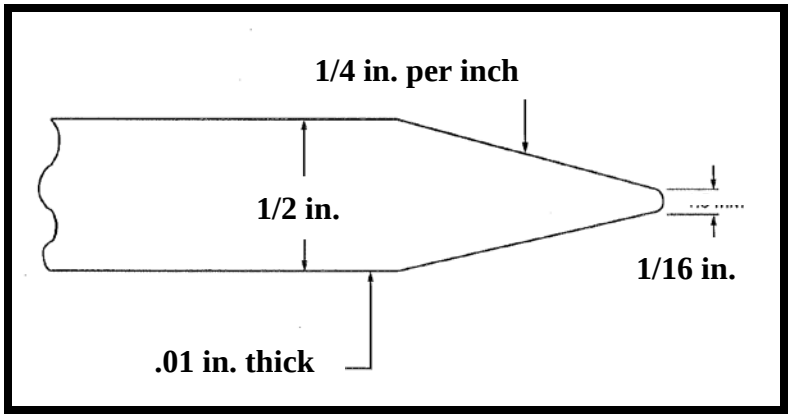


Figure 1-2. Gauge Leaf

The 0.01 in. crack measurement is a test criterion for pipe tested in the three-edge-bearing test and is not intended as an indication of overstressed or failed pipe under installed conditions.

QUALITY CONTROL PLAN

Each Producer providing precast concrete products under the Certified Precast Producer Program shall have a written Quality Control plan (QCP) that shall be plant specific and be the basis of control. The QCP shall contain, but not be limited to, the methods of production and quality control policies and procedures used by the plant. The QCP shall be in accordance with ACPA, NPCA, or PCI Plant Certification requirements and the Certified Precast Producer Program (**ITM 813**).

CERTIFICATION

Each plant requesting to become a Certified Precast Concrete Producer shall do so in writing to the Manager, Office of Materials Management. The request shall include a copy of the compliance certificate issued by the ACPA, NPCA, or PCI, a copy of the most recent audit conducted in accordance with the ACPA, NPCA, or PCI certification programs, a copy of the response to deficiencies of the audit, if applicable, a copy of the QCP, and the designated Management Representative for the plant. The plant will be certified upon verification of these required documents.

Each Certified Precast Concrete Producer is required to submit to the Office of Materials Management a copy of the annual audit and the response to deficiencies of the audit, if applicable, to verify compliance with the ACPA, NPCA, or PCI certification programs. The audits for pipe include several items concerning materials, production, testing, and final inspection requirements for the pipe. A typical audit for a precast pipe by the ACPA would include the following:

1. Product Documentation
    a. Quality Control Documents and Information
    b. Raw Materials
    c. Calibration of Equipment
    d. Mix Designs

2. Joints
    a. Joint Design Drawings
    b. Joint Design Calculations
    c. Spigot Gauge system
    d. Gasket Quality Control & Testing

3. Equipment
    a. Forms
    b. Joint Forming Equipment Inspection

4. Pre-Pour Product Inspection
    a. Reinforcing
    b. Pre-Pour Inspection
    c. Concrete Testing
    d. Compressive Strength Testing

5. Post-Pour Product Inspection
    a. Curing
    b. Repairs and Finishing
    c. Product Visual Inspection
    d. Dimensional Test Reports
    e. Sanitary Joint Dimensional Inspection
    f. Product Marking

6. Product Testing
    a. Water Tightness Test
    b. Three Edge Bearing Test
    c. Off Center Joint Test
    d. Differential Joint Shear Test
    e. Storm and Sewer Joint Test

7. Storage, Handling, Shipping, and Final Inspection
    a. Storage and Handling
    b. Shipping Policy
    c. Final Inspection

In the event of a change in ownership of the Certified Precast Concrete Producer, the certification shall expire on the date of such change. The new ownership may avoid expiration by submitting a statement to the Office of Materials Management indicating recognition of the details of the Program and verification that the plant is in accordance with the ACPA, NPCA or PCI certification program requirements.

DEPARTMENT RESPONSIBILITIES

The Department may conduct annual audits on a random basis of each Certified Precast Plant. For inspection of pipe at the plant, the audit will include as a minimum the following items.

Materials

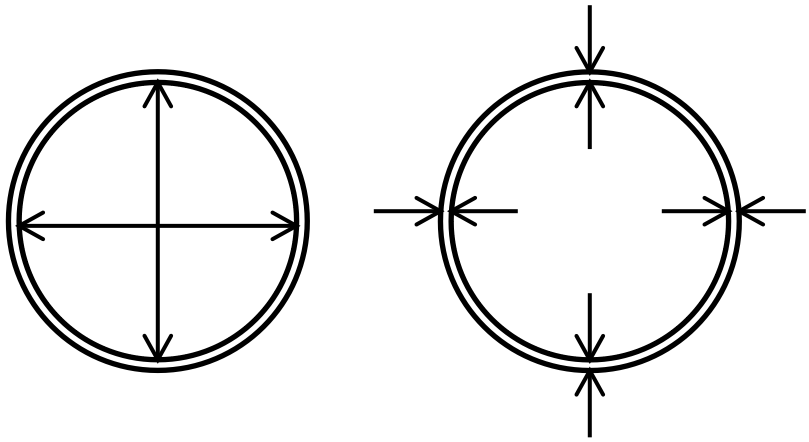
Verification that the materials used in the precast item are INDOT approved materials and that the steel meets the Buy America requirements of Section **106.01(c)** are made at the inspection of the plant. The material list contains the INDOT contract, Purchase Order, or material to be added to stock, kinds, diameters, classes, etc. This information is necessary to determine the requirements for physical testing. The precast items will be inspected to determine if the markings on the items meet the requirements of **ITM 813**.

Internal Diameter

Both ends of the pipe are checked for the internal diameter with a tape measure. Two measurements at 90 degrees to each other are made and the two measurement are averaged (Figure 1-2).

Wall Thickness

Both ends of the pipe are measured for wall thickness with calipers or micrometers. Four measurements are taken at 90 degree opposing points (Figure 1-2).



Diameter: 2 Directions **Thickness: 4 Points**

Figure 1-2. Pipe Diameter and Wall Thickness

Straightness

Straightness for non-reinforced concrete pipe is measured by placing a straightedge on the concave side of the pipe for the full length of the barrel, being sure not to include spigot joint material or socket, and measuring the maximum distance between the straightedge and the concave side of the pipe.

Laying Length

A length measurement of the pipe is taken at the top and bottom of the specimen.

Other Visual Checks

The workmanship and finish of the precast product is checked. Outside irregularities are not considered for rejection unless the irregularity affects the strength.

Special shapes such as wyes, tees, bends, and adapters are checked for workmanship. Dimensional tolerance is required to be the same as for straight pipe and conform to specifications. The special shape is required to be securely and completely fastened to the barrel of the pipe. Socket and ball sections are required to permit proper fit and seating capabilities.

Reinforcement Steel

AASHTO M 170 and **M 207** define the reinforcing steel placement requirements for reinforced concrete pipe. The placement, clearance, splices, and size of reinforcement steel are items that are checked.

DECERTIFICATION

The removal of a plant from the Department's List of Approved Certified Precast Concrete Producers will be the responsibility of the Manager, Office of Materials Management. The Producer shall have the right to appeal the removal from the Department's List of Approved Certified Precast Concrete Producers to the Director, Construction Management Division.

ACCEPTANCE

FREQUENCY MANUAL

Acceptance and information for precast concrete products are found under References 57, 58, and 59 of the Frequency Manual. The basis of use for the precast concrete product is the approval number.

APPROVED SOURCES

Sources of both reinforced and unreinforced precast concrete pipe and structures are found on the Certified Precast Producers List. Precast items will be visually inspected for workmanship. Further guidance for joints, surface defects, reinforcement, and cracks is given in subsequent chapters within this manual.

PRODUCT MARKING

Precast concrete pipe and structures bear a stencil or product marking in accordance with **ITM 813**, which includes the certification agency, the date of manufacture, any applicable Standard Specification required marking, and the INDOT ID number for the source. For the ACPA, the stencil and product marking is the “QCast” emblem (Figure 1-3) or the words “ACPA Certified Product”. For NPCA, product marking is the words “NPCA Certified Product” (Figure 1-5). For PCI, product marking is the words “PCI Certified Product”.

Figure 1-3. QCast Emblem

Figure 1-4. QCast Product Markings

Figure 1-5. NPCA Product Markings

REJECTION

The Construction Technician is required to visually inspect the precast concrete product received on the project for any quality deficiencies that may be apparent. The list of items that are cause for rejection of precast pipe or structures prior to installation are included in the appropriate AASHTO or ASTM Standard as follows:

NON-REINFORCED CONCRETE PIPE

Non-reinforced concrete pipe is covered by Section **907.01**, which references **AASHTO M 86**. The reasons for rejection prior to installation include:

1. Fractures or cracks passing through the wall or joints. However, a single crack not exceeding 2 in. in length at either end of a pipe or a single fracture or spall in the joints not exceeding 3 in. around the circumference of the pipe nor 2 in. in length into the joint shall not be considered cause for rejection unless these defects exist in more than 5 percent of the entire shipment or delivery.

2. The planes of the ends of the pipe are not perpendicular to the longitudinal axis. The length of two opposite sides of any section of pipe shall vary not more than 1/4 in. or 2 percent of the designated diameter, whichever is larger.

3. Defects that indicate mixing and molding is not in accordance with the manufacturing requirements.

4. Cracks sufficient to impair the strength, durability, or serviceability of the pipe.

REINFORCED CONCRETE PIPE

Circular reinforced concrete pipe is covered by Section **907.02,** which references **AASHTO M 170**. The reasons for rejection prior to installation include:

1. Fractures or cracks passing through the wall, except for a single end crack that does not exceed the depth of the joint.

2. Defects that indicate mixing and molding is not in accordance with the manufacturing requirements or surface defects indicating honey-combed or open texture that would adversely affect the function of the pipe.

3. The ends of the pipe are not normal to the walls and the centerline of the pipe as follows:

Length of Two Opposite Sides -- Variations in the laying length of two opposite sides of the pipe shall not be more than 1/4 in. for all sizes through 24 in. internal diameter. For all sizes larger, the variation shall not be more than 1/8 in./ft. with a maximum of 5/8 in. in any length of pipe through 84 in. internal diameter, and a maximum of 3/4 in. for 90 in. internal diameter or larger, except where beveled-end pipe for laying on curves is specified.

Length of Pipe -- The underrun in length of a section of pipe shall not be more than 1/8 in./ft with a maximum of 1/2 in. in any length of pipe. Regardless of the underrun or overrun in any section of the pipe, the end cover requirements of the specification shall apply.

4. Damaged or cracked ends where such damage would prevent making a satisfactory joint.

5. Any continuous crack having a surface width of 0.01 in. or more and extending for a length of 12 in. or more, regardless of position in the wall of the pipe.

REINFORCED CONCRETE HORIZONTAL ELLIPTICAL PIPE

Concrete Horizontal Elliptical Pipe is covered by Section **907.03**, which references **AASHTO M 207**. The reasons for rejection prior to installation include:

1. Fractures or cracks passing through the wall, except for a single end crack that does not exceed the depth of the joint.

2. Defects that indicate mixing and molding is not in accordance with the manufacturing requirements or surface defects indicating honey-combed or open texture that would adversely affect the function of the pipe.

3. The ends of the pipe are not normal to the walls and centerline of the pipe as follows:

   Length of Two Opposite Sides -- Variations in the laying length of two opposite sides of the pipe shall not be more than 1/4 in. for all sizes through 24 in. internal diameter. For all sizes larger, the variation shall not be more than 1/8 in./ft. of internal equivalent diameter with a maximum of 5/8 in. in any length of pipe through 84 in. internal equivalent diameter, and a maximum of 3/4 in. for 90 in. internal equivalent diameter or larger, except where beveled-end pipe for laying on curves is specified.

Length of Pipe -- The underrun in length of a section of pipe shall not be more than 1/8 in./ft with a maximum of 1/2 in. in any length of pipe.

4. Damaged or cracked ends where such damage would prevent making a satisfactory joint.

5. Any continuous crack having a surface width of 0.01 in. or more and extending for a length of 12 in. or more, regardless of position in the wall of the pipe for pipe not installed or under load.

PRECAST CONCRETE MANHOLES, INLETS, and CATCH BASINS

Concrete Manholes, Inlets, and Catch Basins are covered by **Section 907.04**, which references **AASHTO M 199**. The reasons for rejection prior to installation for the grade rings, flat slab tops, risers, conical tops, and base sections include:

1. Fractures or cracks passing through the wall, except for a single end crack that does not exceed the depth of the joint.

2. Defects that indicate mixing and molding is not in accordance with the manufacturing requirements or surface defects indicating honey-combed or open texture that would adversely affect the function of the unit.

3. The planes of the ends are not perpendicular to the longitudinal axis of the unit within the permissible variations of the specifications.

4. Damaged or cracked ends where such damage would prevent making a satisfactory joint.

5. Any continuous crack having a surface width of 0.01 in. or more and extending for a length of 12 in. or more, regardless of position in the unit.

PRECAST REINFORCED CONCRETE STRUCTURE SECTIONS

Concrete Structure Sections are covered by **Section 907.05**, which references **ASTM C 1577** for box sections and **ASTM C 1504** for three-sided sections. The reasons for rejection prior to installation for box sections and three-sided sections include:

1. Fractures or cracks passing through the wall, except for a single end crack that does not exceed the depth of the joint.

2. Defects that indicate mixing and molding is not in accordance with the manufacturing requirements or surface defects indicating honey-combed or open texture that would adversely affect the function of the unit.

3. The ends are not normal to the walls and center line of the structure within the permissible variations of the specifications, except where beveled ends are specified.

4. Damaged ends where such damage would prevent making a satisfactory joint.

5. Any continuous crack having a surface width of 0.01 in. or more and extending for a length of 12 in. or more, regardless of position in the unit.

REPAIRS

Repairs for workmanship and finish for all precast concrete pipe and structures may be made for occasional imperfections in manufacture or accidental damage during handling. The Technician is required to determine that the repairs are sound, properly finished, cured, and the repaired pipe or structure conforms to the requirements of the specifications. The Technician should examine the pipe before and after the repairs are made.

The PE/PS has the right to reject any unit upon arrival to the contract in accordance with Section **106.01(a)**, regardless of pre-approval. This manual should be consulted before rejection of any pipe or structure products. Information on precast units that are not acceptable, units that are acceptable, and units that are not acceptable but can be repaired is included.

2 Precast Concrete Joints

Broken and Chipped Bells and Spigots

Cracks Related to Joint Performance

Non-Reinforced Concrete Pipe

Reinforced Concrete Pipe, Manholes, Inlets and Catch Basins

Reinforced Concrete Structure Sections

Fins

CHAPTER TWO:
Precast Concrete Joints

Precast concrete joint problems include ends of pipe and structures that are not normal to the walls and centerline of the pipe within the limits of variation given in the appropriate AASHTO or ASTM specifications, and damaged or cracked ends where such damage would prevent making a satisfactory joint. Damage may be excessive that requires rejection of the unit or minor that may be repaired to allow the unit to perform satisfactorily. Within this section are examples of precast joint problems that may or may not be corrected

---

BROKEN AND CHIPPED BELLS AND SPIGOTS

Spalled areas, manufacturing imperfections, or damage during handling of each pipe or structure end are not prohibited from being repaired. These units are acceptable provided the circumferential length of a single area to be repaired does not exceed one fourth of the inside diameter or equivalent diameter of the pipe or the circumferential length of several areas combined does not exceed one half of the inside diameter or equivalent diameter of the pipe (**ASTM C443**). Figure 2-1 is an example of a concrete pipe damaged spigot that cannot be repaired and would **not** be acceptable for use.

Figure 2-1. Chipped and Damaged Spigot End of Reinforced Concrete Pipe – Not Acceptable

Figures 2-2 to 2-9 are examples of damaged bells and spigots that **can be repaired.**

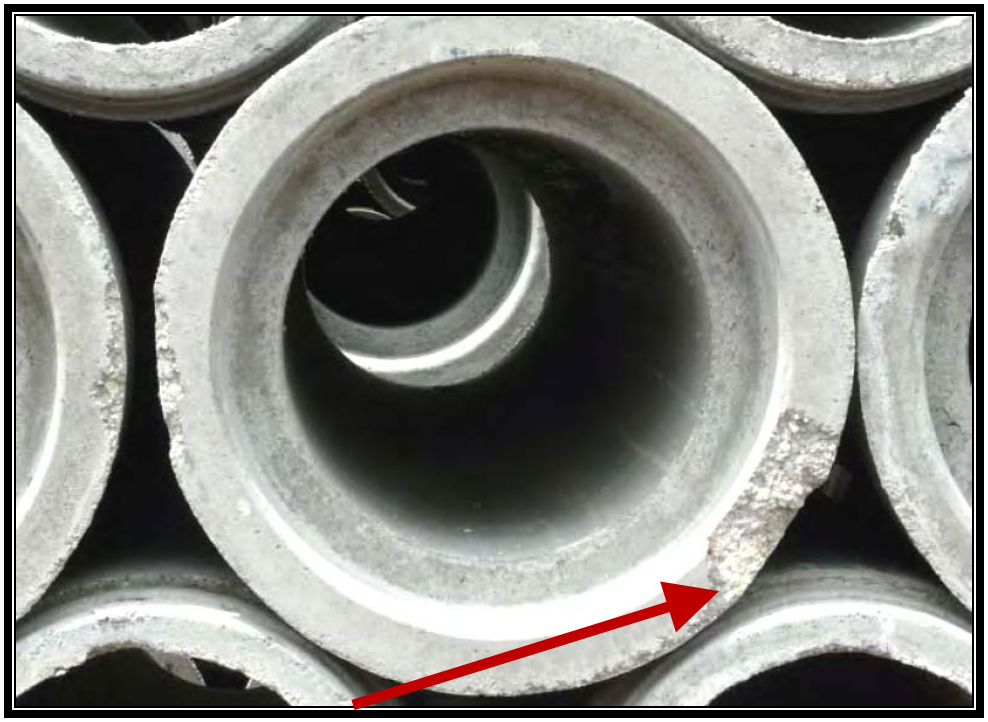


Figure 2-2. Bell End Chipped – Repairable

Figure 2-3. Chipped Spigot End – Repairable

Figure 2-4. Chipped Spigot End – Repairable

Figure 2-5. Chipped Spigot End – Repairable

Figure 2-6. Damaged Flared End Section – Repairable.

Figure 2-7. Shipping and Handling Damage – Repairable

Figure 2-8. Shipping and Handling Damage – Repairable

Figure 2-9. Bell Surface Roughness - Acceptable

Included in Figures 2-10 to 2-15 are examples of joint problems that have been repaired.

Before **After**

Figure 2-10. Plant Bell Repair - Acceptable

Before **After**

Figure 2-11. Pipe Spigot Repair - Acceptable

Before **After**

Figure 2-12. Box Culvert Spigot Repair - Acceptable

Before **After**

Figure 2-13. Bell Chip Repair - Acceptable

Before **After**

Figure 2-14. Pipe Spigot Repair - Acceptable

Before **After**

Figure 2-15. Manhole Spigot Repair - Acceptable

CRACKS RELATED TO JOINT PERFORMANCE

Cracks related to joint performance that are cause for rejection are defined in each AASHTO or ASTM specification as follows:

NON-REINFORCED CONCRETE PIPE

Fractures or cracks passing through the joints are not considered reason for rejection by the following guidelines:

1. A single crack not exceeding 2 in. in length at either end of a pipe

2. A single fracture or spall in the joints not exceeding 3 in. around the circumference of the pipe nor 2 in. in length into the joint

If these defects exist in more than 5% of the entire shipment or delivery, the concrete pipe will be rejected.

REINFORCED CONCRETE PIPE, MANHOLES, INLETS, AND CATCH BASINS

A single end crack (Figure 2-16) that does not exceed the depth of the joint is not cause for rejection. Damaged or cracked ends where such damage would prevent making a satisfactory joint are not acceptable.

REINFORCED CONCRETE STRUCTURE SECTIONS

A single end crack that does not exceed the depth of the joint is not cause for rejection. Damaged or cracked ends where such damage would prevent making a satisfactory joint are not acceptable.

Figure 2-16. Single End Crack – Acceptable

FINS

Fins or featheredge caused by the forms that could restrict jointing of the pipe or structure are required to be removed and if removed would allow the pipe or structure to be used.

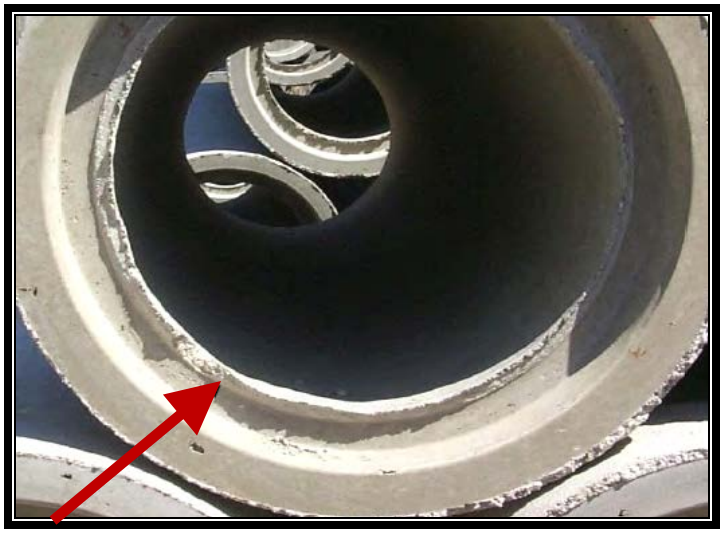


Figure 2-17. Fin or Featheredge – Not Acceptable

Before **After**

Figure 2-18. Spigot Finning Repair – Acceptable

3 Precast Concrete Surface Defects

Form Bleeding

Honeycombing

Entrapped Air

Form Marks

CHAPTER Three:
Precast Concrete Surface Defects

Precast concrete surface problems include form bleeding, honeycombing, small air pockets or "bug holes", small surface chips, handling scrapes, and scratches. These defects indicate proportioning, mixing, and molding not in compliance with specifications and if they adversely affect the function of the pipe or structure are reasons for rejection. Within this section are examples of precast surface problems that may or may not be corrected

---

FORM BLEEDING

Form bleeding resulting in excessive bleed out normally is not reason for rejection; however, the bleed out should be filled in prior to shipment.

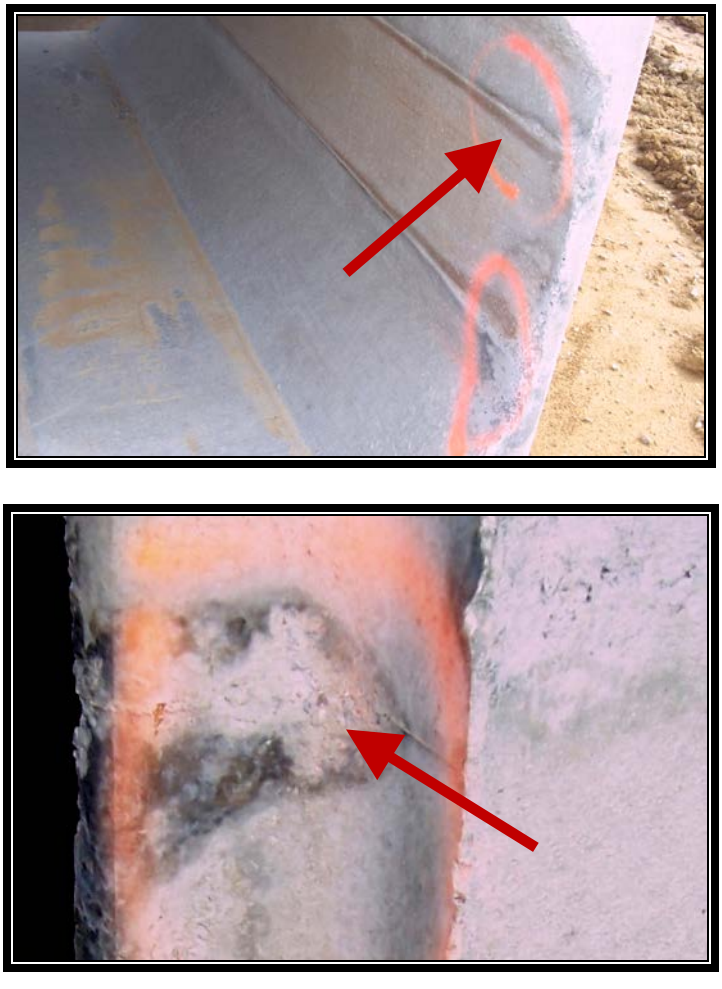


Figure 3-1. Box Culverts with Bleed Out – Acceptable If Filled In

Before **After**

Figure 3-2. Form Bleed Repair – Acceptable

HONEYCOMBING

Honeycombing is an accumulation of voids caused by improper proportioning, mixing and molding of the concrete and is in most cases repairable.

Figure 3-3. Honeycombing – Repairable

ENTRAPPED AIR

Entrapped air that results in “bug holes” and shallow pitting is the result of the vibration process and is not reason for rejection of the concrete pipe or structure (Figure 3-4).

Figure 3-4. Bug Holes and Shallow Pitting – Acceptable

FORM MARKS

Surface defects may be caused by stripping forms and often are minor in nature and are acceptable without repair (Figure 3-5).

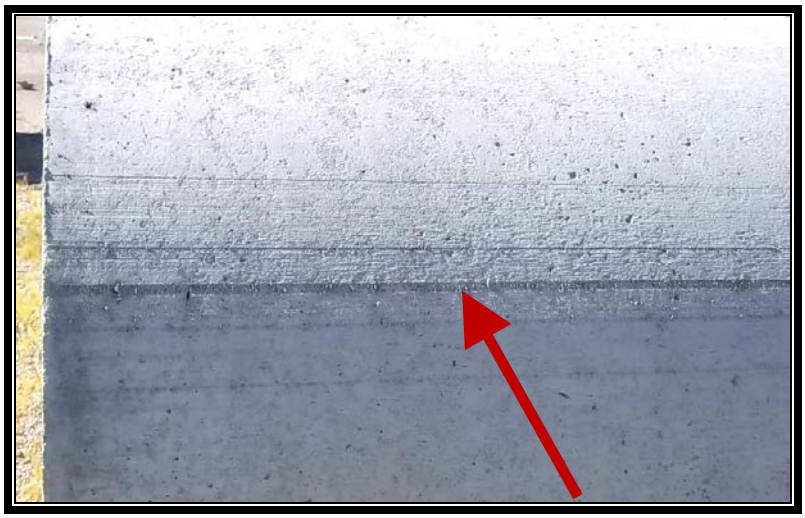


Figure 3-5. Line Caused by Form Jacket During Stripping – Acceptable

4 Precast Concrete Reinforcement Defects

Permissible Variations

Wall Shadowing

Insufficient Concrete Cover

Exposed Ends of Reinforcement or Spacers

CHAPTER Four:
Precast Concrete Reinforcement Defects

Precast concrete reinforcement defects include misplaced steel and exposed reinforcement due to insufficient protective cover. These defects indicate problems with the manufacture of the precast unit and are not acceptable. Within this section are examples of precast concrete reinforcement defects that may not be corrected and exposed ends of reinforcement or spacers that are acceptable.

PERMISSIBLE VARIATIONS

The covering for reinforced concrete culvert, storm drain, and sewer pipe for circumferential reinforcement is required to be a minimum of 1/4 in. as measured to the end of the spigot or 1/2 in. as measured to any other surface. These cover limitations do not apply to mating surfaces on non-rubber gasket joints or gasket grooves in rubber joints. If convoluted reinforcement is used, the convoluted circumferential end wire may be at the end surface of the joint providing the alternate convolutions have at least 1 in. cover from the end surface of the joint.

The covering for reinforced concrete manhole sections is required to be 3/4 in. or greater for the grade rings, flat slab tops, and the base sections.

The covering for reinforced concrete elliptical culvert, storm drain, and sewer pipe at the vertical and horizontal diameters of the pipe is required to be as follows:

1. 1 in. from the inside and outside surfaces of the pipe when one line of reinforcement is used.

2. 3/4 in. when the wall thickness is less than 2 1/2 in.

3. 1 in. when two lines of reinforcement of elliptical shape corresponding to the contour of the pipe are used

4. 1/2 in. near the spigot shoulder when the wall reinforcement does not extend into the joint

5. 1/2 in. when the reinforcement is in the bell and 1/4 in. when the reinforcement is in the spigot

WALL SHADOWING

Wall shadowing of the reinforcement is the result of insufficient concrete cover and may or may not be the result of misplaced steel.

Figure 4-1. Wall Shadowing – Not Acceptable

Figure 4-2. Wall Shadowing – Not Acceptable

INSUFFICIENT CONCRETE COVER

Figure 4-3. Exposed Pipe Reinforcement – Not Acceptable

Figure 4-4. Exposed Pipe Reinforcement – Not Acceptable

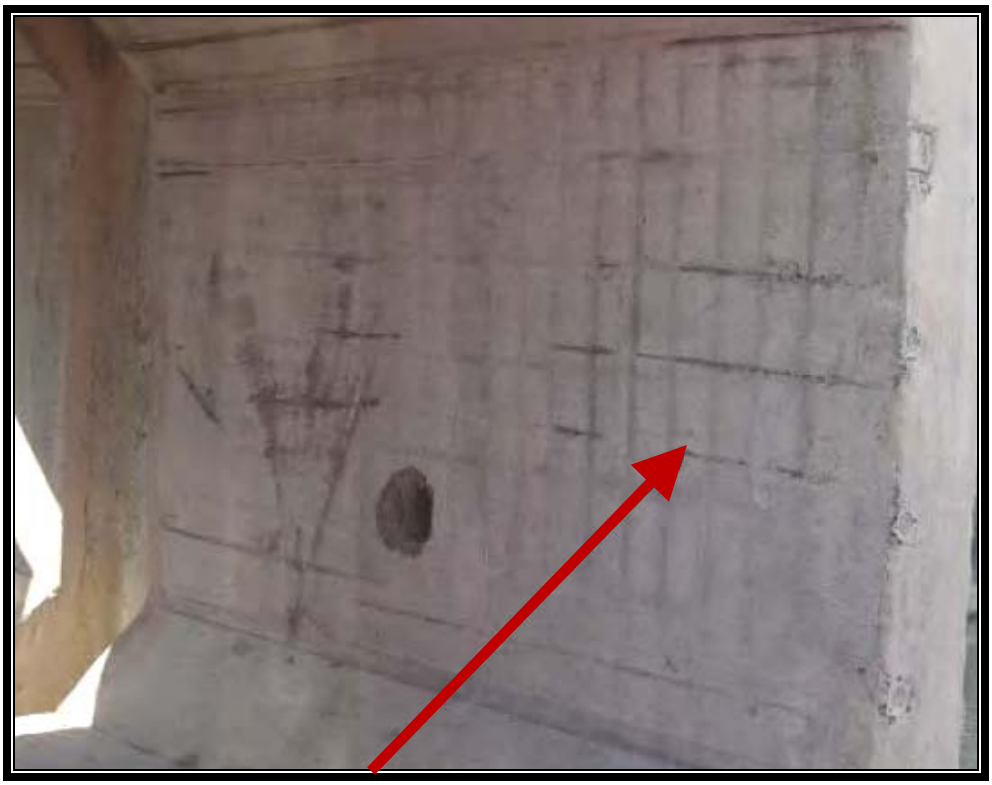


Figure 4-5. Exposed Box Culvert Reinforcement – Not Acceptable

Figure 4-6. Exposed Conical Top Reinforcement – Not Acceptable

Figure 4-7. Exposed Elliptical Pipe Reinforcement – Not Acceptable

EXPOSED ENDS OF REINFORCEMENT OR SPACERS

The exposure of the ends of reinforcement, stirrups, or spacers used to position the reinforcement during placement of the concrete shall not be cause for rejection (Figures 4-8 and 4-9).

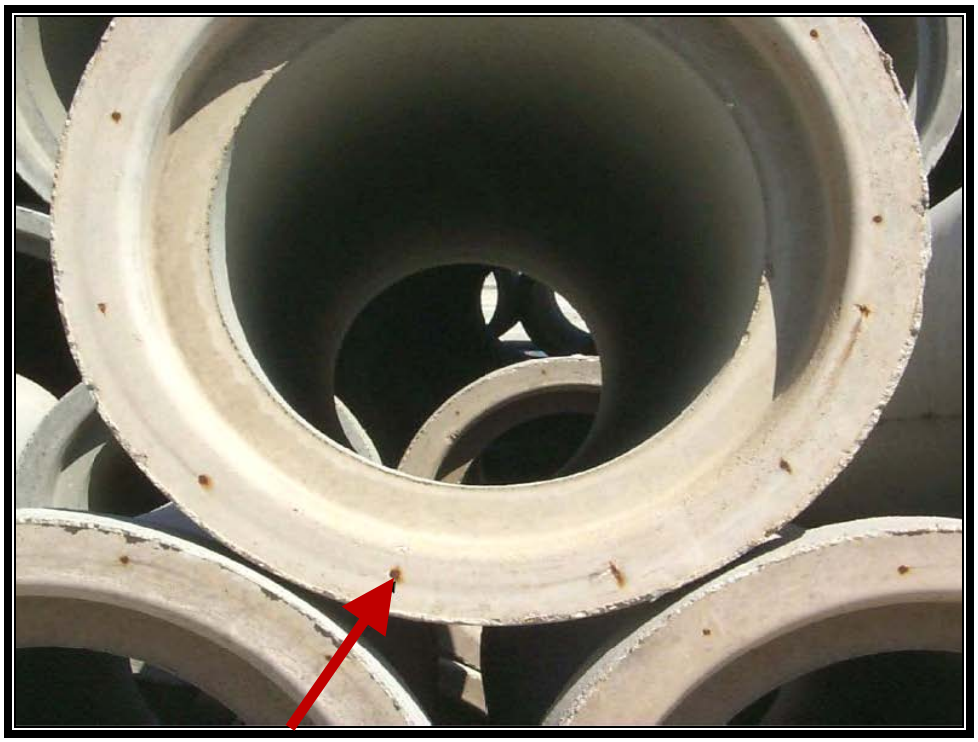


Figure 4-8. Exposed Longitudinal Reinforcement – Acceptable

Figure 4-9. Exposed Cage Spacer – Acceptable

5 Precast Concrete Cracks

Rejection Criteria

Measurement

Examples

CHAPTER Five:
Precast Concrete Cracks

REJECTION CRITERIA

Precast concrete pipe and structures that **have not been installed** or under load shall not be accepted if there is a continuous crack having a surface width of 0.01 in. or more and the crack extends for a length of 12 in. or more, regardless of the position in the wall of the pipe or structure. Fractures or cracks passing through the wall are also cause for rejection.

MEASUREMENT

The width of the crack is measured by means of a gauge leaf or other device capable of measuring 0.01 in.

EXAMPLES

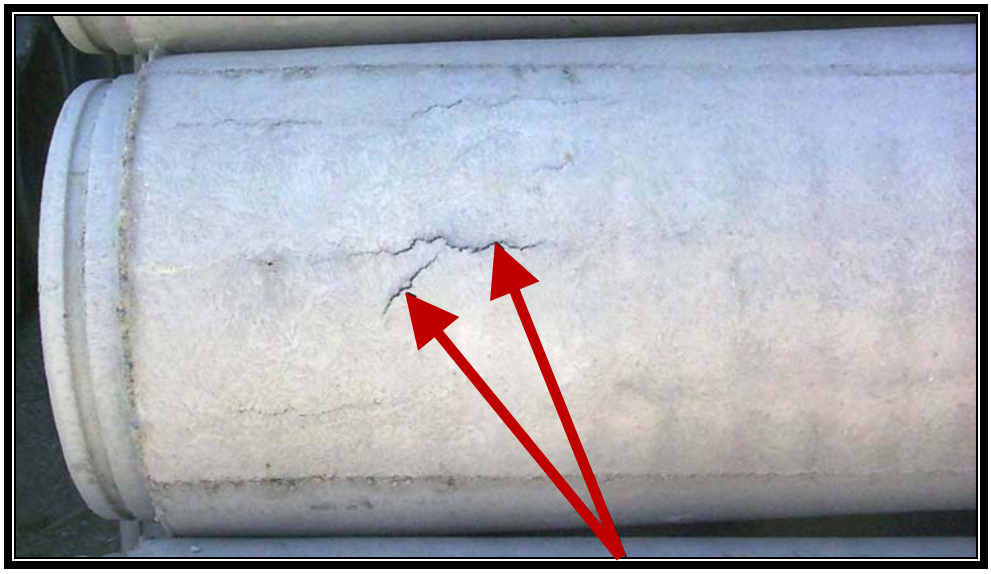


Figure 5-2. Crack Exceeding 0.01 in. and 12 in. in Length – Not Acceptable

Figure 5-3. Crack Exceeding 0.01 in. and 12 in. in Length – Not Acceptable

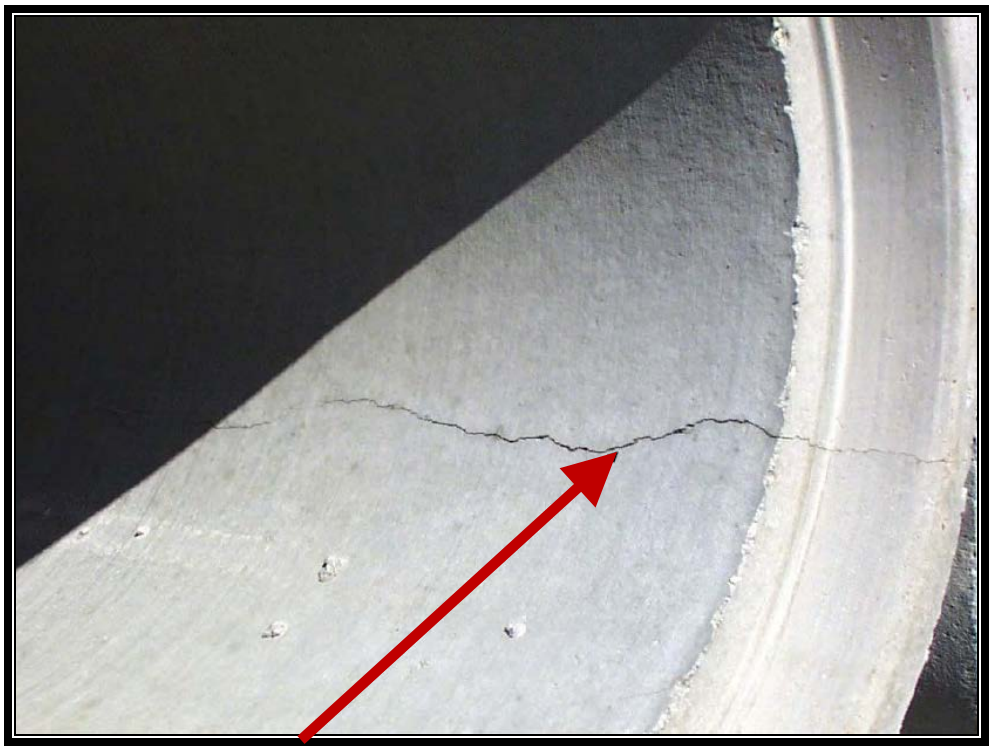


Figure 5-4. Crack Exceeding 0.01 in. and 12 in. in Length – Not Acceptable

6 Pipe Post-Installation Inspection

Pipe Installation Inspection

Manual Inspection

Non-Permit Space
Confined Space
Inspection

Video Inspection

Equipment

Evaluation Criteria

Misalignment
Joint Defects
Longitudinal Cracks
Transverse Cracks
Spalls
Slabbing
End Section Drop-Off

Remediation/Replacement

CHAPTER Six:
Pipe Post-Installation Inspection

PIPE INSTALLATION INSPECTION

Post-installation inspection of precast concrete pipes is required on all pipes, except underdrains, a minimum of 30 days after completion of backfill operations. Where paving operations are conducted in less than 30 days after pipe installation, a preliminary inspection of the pipe prior to paving shall be performed to ensure the pipe in areas to be paved meets all of the evaluation criteria prior to paving operations. Performing a preliminary inspection does not relieve the Contractor from the requirement of completing the post-installation inspection after the prescribed 30 day period.

MANUAL INSPECTION

NON-PERMIT SPACE

A manual inspection is done for precast concrete pipes with a vertical rise of 36 in. or greater. Pipe with open ends with means of egress are classified as IOSHA non-permit space and as such do not have confined space regulations. The Inspector performing the manual inspection should be tethered and required to maintain communication with another person outside of the pipe or structure.

CONFINED SPACE

A confined space is defined by IOSHA as any space having a limited means of egress, which is subject to the accumulation of toxic or flammable contaminants or has oxygen deficient atmosphere. If the pipe is considered a confined space, the pipe should only be entered by inspection personnel trained in working within confined spaces and using procedures in full compliance with applicable State, Local, and Federal OSHA regulations.

INSPECTION

A manual inspection is done by entering the pipe to document the pipe condition and to record any required measurements. The Inspector performing the manual inspection shall use a high quality hand held video camera or a digital camera capable of clearly documenting any observed deficiencies.

Pictures, still images, and/or video recording of areas of the pipe with noted deficiencies are required. Any deficiency noted shall include information necessary to locate the pipe and the noted deficiencies in the field at a future date. Such factors shall at a minimum include the contract number, the station number, the structure number, size of pipe, the date and time of inspection, direction of travel from a given landmark, distance from given landmark for all noted deficiencies, and any other identifying data. The Contractor shall provide a source of light that allows all deficiencies to be readily observed on the camera or video recording. Still images or video recording in a digital, reproducible format approved by the Engineer shall be furnished.

The crack width or the width of any separation of the pipe wall shall be measured using a device or technology capable of measuring cracks from 0.01 inch to 0.10 inch on an accurate and repeatable basis. A gauge made from a leaf 0.01 in. in thickness and ground to a point 1/16 in. (Figure 6-1) is one device that is used to measure this width of crack.

Cracks or tears greater than 0.10 inch, and joint gaps may be measured with either a metal or a fabric tape capable of measuring to the nearest 1/16 inch. Other measuring devices may be used if approved by the Engineer.

Figure 6-1. Measuring Crack with Leaf Gauge

VIDEO INSPECTION

If the structure cannot be manually inspected, video inspection shall be performed in accordance with Section **715.09**. The Engineer will determine the runs of the pipe to be inspected. Video inspection shall be conducted after guardrail, lighting, sign installation, and final seeding or sodding operations are completed. Commercial and private drive pipes are excluded from video inspection requirements.

For pipes that are video inspected, a copy of the video inspection shall be provided in a format acceptable to the Engineer. The Contractor shall provide project personnel with the inspection video prior to acceptance of the pipe.

EQUIPMENT

Concrete pipe shall be inspected using high resolution, high sensitivity, waterproof color video camera/recording equipment in accordance with Section **718.06** (Figure 6-2).

The camera/recording equipment shall be specifically designed for continuous viewing/recording of detailed images of the interior wall of pipes and transitions of the specified sizes. The equipment shall have the capability of viewing a minimum of 450 ft into the pipes and shall be designed to include sufficient lighting to view the entire periphery of the pipe. The camera shall be moved through the pipe at a speed not greater than 30 feet per minute. The equipment shall have appropriate attachments to maintain a position in the center of the pipe and an electronic counter to continuously record the location of the equipment in the pipe. The recording equipment shall record video of a quality and in a format acceptable to the Engineer. A color video printer shall be included in the equipment for printing observations during inspection.

Figure 6-2. Video Inspection Equipment

Cracks may appear larger in the video inspection. Cameras produce some distortion and unavoidably magnify hairline cracks. The crack in Figure 6-3 obtained by video inspection is a 0.01 in. crack.

Figure 6-3. 0.01 in. Crack Obtained by Video Inspection

A video recording of 100% of the pipe with information at the beginning of the video which clearly identifies the pipe being inspected shall be furnished. The identification shall include the contract number, the structure number corresponding to the structure number from project documents, size of pipe, the date and time of inspection, direction of travel from a given landmark, distance from given landmark for all noted deficiencies, and any other identifying factors needed to locate the pipe in the field at a future date. A source of light that allows all areas of concern to be readily observed on the video recording shall be furnished. The video recording shall be in a digital, reproducible format approved by the Engineer.

EVALUATION CRITERIA

Internal inspections are needed to evaluate issues that may affect long-term performance, such as cracks, joint quality, and alignment. **AASHTO LRFD Bridge Construction Specification 27** provides guidance for the field inspection of concrete culverts.

Soil consolidation continues with time after installation of the pipe. While 30 days will not encompass the time frame for complete consolidation of the soil surrounding the pipe, the period of 30 days is intended to give sufficient time to observe some of the effects that this consolidation will have.

Reinforced concrete pipe, like other reinforced concrete structures, is designed to crack. The 0.01 in. criteria for acceptance of reinforced concrete pipe is intended as a service load design criteria and plant test procedure; however, the 0.01 in. acceptance criteria is not intended to determine the failure of installed reinforced concrete pipe.

A phenomenon known as autogenous healing often occurs between two surfaces of cracks in buried pipe. Autogenous healing (Figure 6-4) is the ability of concrete to heal itself in the presence of moisture and air. Calcium carbonate forms when moisture reacts with unhydrated cement powder and regenerates the curing process resulting in a monolithic structure. This is common in concrete pipe where moist conditions are higher than those of other concrete structures.

Figure 6-4. Autogenous Healing in Concrete Pipe

For video inspection of pipe, there is a calibration device within the camera that will clearly indicate the actual size of the crack, resulting in an accurate assessment of the severity of the crack (Figure 6-5). When there is a question of the severity of cracking in a buried pipe, this device should be requested.

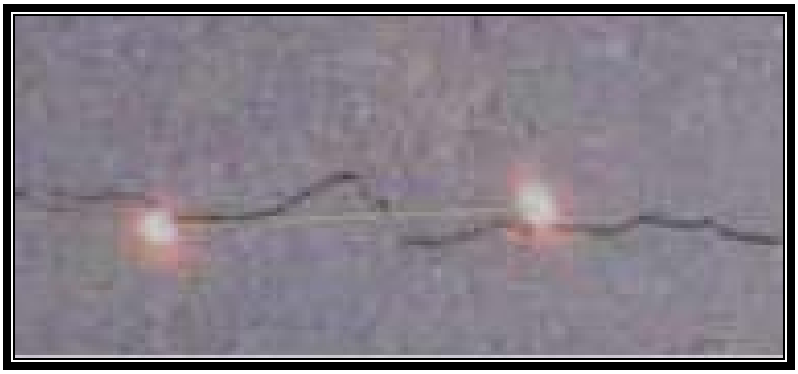


Figure 6-5. Crack Measurement Using Laser Micrometer

MISALIGNMENT

Misalignment (Figure 6-6) may be taken to indicate the presence of problems in the supporting soil or Contractor grade control. The vertical and horizontal alignment of the pipe barrel shall be checked by sighting along the crown, invert, and sides of the pipe, and by checking for differential movement or settlement at joints between pipe sections. The inspector shall take into account pipes laid with camber or a grade change. Horizontal alignment shall be checked for straightness or smooth curvature. Vertical alignment shall be checked for faulting, sagging, and invert heaving defined as follows:

1. Faulting – the differential alignment between joints of the pipe, which creates a non-uniform profile of the pipe

2. Sagging – the ponding of water in invert due to vertical misalignment

3. Invert heaving – heaving that would prevent proper functioning of the system

Precast concrete pipe do not deflect appreciably before cracking or fracturing. As a result, shape inspections are of little value in inspecting precast concrete pipe.

Sags, which trap water, may aggravate settlement problems by saturating the supporting soil, or lead to sediment buildup in the pipe reducing pipe efficiency. Improper installation, undermining, or uneven settlement of fill may cause alignment problems.

Figure 6-6. Misalignment

JOINT DEFECTS

Joint performance is evaluated to determine if the joints meet the design joint performance criteria of silt-tight or leak resistant. Most storm culverts and storm drains are designed or required to meet silt-tight performance criteria. Items to be noted and evaluated include excessive differential movement, cracks greater than 0.10 in. in the joint sealing surface portion of the pipe wall, spalling of areas that expose reinforcement or expose the joint sealing material, improper gasket placement, and any soil migration.

Joint defects may range from minor problems to problems that are serious in nature. Typical joint defects include leakage (exfiltration and infiltration), cracks, and joint separation. Exfiltration occurs when leaking joints allow water flowing through the pipe to leak into the supporting material. Many pipes are constructed with joints that are not watertight or with mortar joints that may crack with minor deflection, movement, or settlement of the pipe. Minor leakage may not be a significant problem unless soils are quite erosive. However, if leaking joints contribute to or cause piping, serious misalignment of the culvert or even failure may result.

Infiltration is the reverse of exfiltration. Many culverts are essentially empty except during peak flows. When the water table is higher than the pipe invert, water may seep into the culvert. An infiltration of water that carries soil particles from the surrounding backfill may cause settlement and misalignment problems.

Infiltration may be difficult to detect visually in the early stages although the infiltration may be indicated by open joints, staining at the joints on the sides and top of the pipe, deposits of soil in the pipe, or by depressions over the culvert.

Silt-Tight Joints

Silt-tight joints in accordance with **AASHTO PP 63** are intended to be resistant to infiltration of particles that are smaller than particles passing the No. 200 sieve. Silt-tight joints provide protection against infiltration of backfill material containing a high percentage of fines. Joint separation greater than the pipe manufactures recommended allowable joint gap shall be remediated. If joint separation is less than the pipe manufactures allowable joint gap and there is no evidence of soil migration through the joint, no corrective action is necessary. If soil migration is apparent, the joint shall be sealed. Vertical or horizontal variations at the joint of a concrete pipe do not require remediation unless they exceed allowable manufacturing tolerances for the pipe and significantly reduce the flow characteristics of pipe system. Chipped or spalls at the face of the joint

shall not require remediation unless reinforcement is exposed or the chipped area is large enough to allow backfill material to migrate through the joint.

When video inspection is used, any joint with the following defects or damage is require to be remediated:

1. Joints allowing soil infiltration

2. Joints with vertical offset where the pipe wall at the joint area also exhibits large open cracks with vertical offset

3. Joints with damage that exposes the primary steel of the pipe

4. A joint with joint gap that exposes backfill material (Figure 6-7)

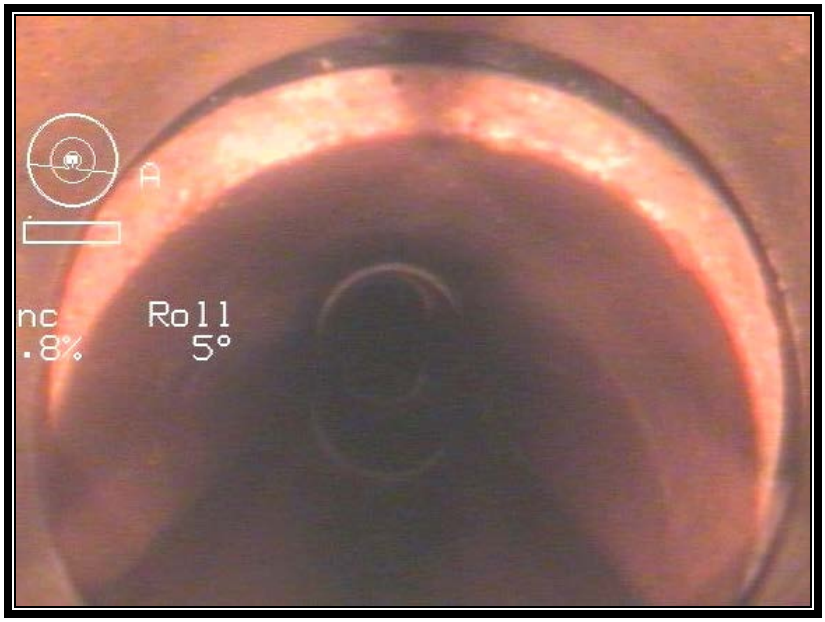


Figure 6-7. Joint Gap (courtesy of NASSCO)

Leak Resistant Joints

Leak resistant joints in accordance with **AASHTO PP 63** are intended to limit water leakage at a maximum rate of 200 gallons/inch-diameter/mile/day for the pipeline system for the project specified head or pressure. Joint separation greater than pipe manufactures recommended allowable joint gap shall require remediation. Pipe lines shall be tested to determine leakage rate or a plant test certifying each producers joint for each specific pipe size may be established. Pipe lines with Infiltration/Exfiltration exceeding 200 gal/inch- diameter/mile/day shall require evaluation as to which joints or areas of leakage shall require

remediation. Any joint with continuous flow observed, or with evidence of soil migration through the joint, shall require remediation. Retesting and subsequent remediation shall be required as necessary to satisfy the leakage rate requirement. Vertical or horizontal variations at the joint of a concrete pipe do not require remediation unless they exceed allowable manufacturing tolerances and significantly decreases flow characteristics of the pipe system. Chips or spalls at the face of the joint shall not require remediation unless reinforcement is exposed or the chipped area is large enough to allow a continuous flow of water to migrate through the joint.

When video inspection is used, remediate any joint with the following defects or damage;

1. Joints allowing soil infiltration

2. Joints allowing a continuous flow of water into the pipe

3. Joints with vertical offset where the pipe wall at the joint area also exhibits open cracks

4. Joints with damage at the joint that exposes primary steel of the pipe

5. Joint gaps that expose backfill material

6. Joints with a chip area that exposes a portion of the gasket

Leaking joints may be detected during low flows by visual observation of the joints, by checking around the ends of the culvert for evidence of piping, and by special testing methods typically employed for sanitary sewers. Severe joint cracks are similar in significance to separated joints. Joint separations greater than the pipe manufacturer's maximum limit shall be considered significant because they accelerate damage caused by exfiltration and infiltration resulting in the erosion of the backfill material. Evidence of any soil migration through the joint shall require further investigation to determine the source of the problem and if a repair or replacement is required.

Improper handling during installation, improper gasket placement, and movement or settlement of pipe sections may cause cracks in the joint area.

If no other problems are evident, such as differential movement between pipe sections, cracks not wider than 0.1 in. or spalling or sheared, the cracks may be considered a minor problem. Cracked joints are more than likely soil tight, but may not be watertight even if gaskets were used.

Separated joints are often found when severe misalignment is found. Either problem may cause or aggravate the other. Movement of the soil in the general direction of the pipe centerline may cause sections to gradually pull apart. Embankment slippage may also cause separations to occur.

LONGITUDINAL CRACKS

Hairline longitudinal cracks in the crown or invert indicate that the steel has accepted part of the load. Other signs of distress, such as differential movement, efflorescence, spalling, or rust stains may occur. Cracking may also be caused by the improper use of construction equipment to push on the pipe to obtain proper grade.

Displacement across the crack is shown by a differential movement or unevenness of the crack and is indicative of a high shear condition. While flexural cracks appear at the invert and crown locations of the pipe, cracks resulting from shear or spalling are more likely found in the haunch area of the pipe.

When cracks are wider than 0.01 in., measurements shall be taken of the width, length, and locations of the cracks and diameter of the pipe, both horizontally and vertically. If these cracks are determined to be detrimental by the Engineer, the cracks shall be sealed.

Cracks < 0.05 .in.

Longitudinal cracks with a width less than 0.05 in. are considered minor and are not a cause for remediation. Cracks of 0.05 in. or less do not penetrate through the pipe wall and are the smallest crack that can be measured with reasonable accuracy.

Cracks ≥ 0.05 .in. and ≤ 0.10 in.

Longitudinal cracks having a width equal to or greater than 0.05 in. but equal to or less than 0.10 in. shall be evaluated by the Engineer to determine if any remediation is required. Pipes with these size cracks in areas where the soil and or runoff Ph is 5.5 or greater generally are considered acceptable. Pipes with these size cracks in areas where the soil and or runoff Ph is less than 5.5 shall require remediation.

Cracks > 0.10 in.

Pipes having longitudinal crack widths larger than 0.10 in. shall be remediated or replaced (Figure 6-8). Prior to remediation or replacement, an engineering review shall be conducted to verify the class of pipe installed was adequate for the actual parameters of the project, such as, burial depth, additional loading requirements, and installation type.

Longitudinal cracking in excess of 0.10 in. in width may indicate overloading or poor bedding. If the pipe is placed on hard material and the backfill is not adequately compacted around the pipe or under the haunches of the pipe, loads will be concentrated along the bottom of the pipe and may result in flexure or shear cracking. Use of hydraulic compaction equipment without adequate soil cover may result in longitudinal cracks in the crown of the pipe.

Figure 6-8. Longitudinal Crack > 0.10 in. (courtesy of NASSCO)

Video Inspection

When video inspection is used, two longitudinal cracks the length of the pipe section are acceptable when the cracks are within 15 degrees of any quarter point of pipe, i.e 11 o-clock to 1 o-clock, 2 – 4 o-clock, 5 – 7 o-clock, and 8-10 o-clock (Figure 6-9). Cracks at these points are signs of acceptable stress load cracks and are typically small cracks that do not allow soil infiltration and are not cause for concern unless the pipe is in an acidic condition (Ph of soil/runoff less than 5.5).

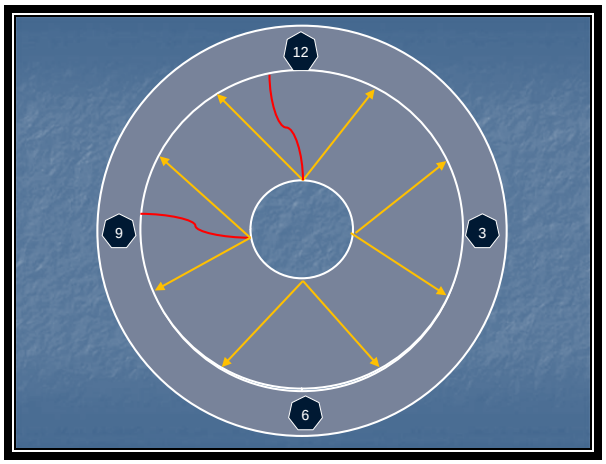


Figure 6-9. Cracks within 15° of any Quarter Point

Pipes with more than two longitudinal cracks the length of the pipe (Figure 6-10) at the quarter points should be further evaluated.

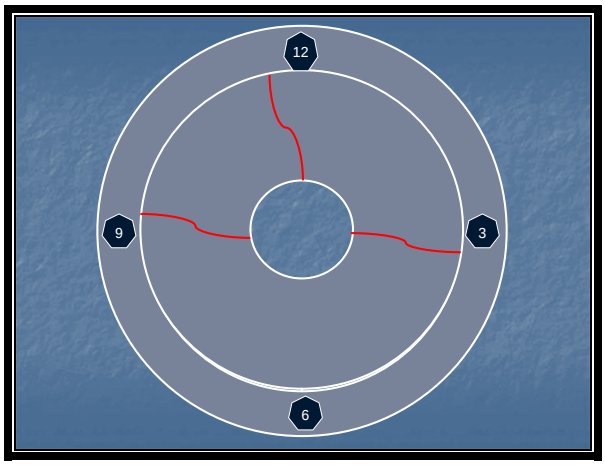


Figure 6-10. Cracks the Length of the Pipe at Quarter Points

Pipes with cracks at 30 degrees ± from invert i.e. 4-5 o-clock and or 7-8 o-clock should be further evaluated (Figure 6-11). Any crack exhibiting significant vertical offset should be remediated.

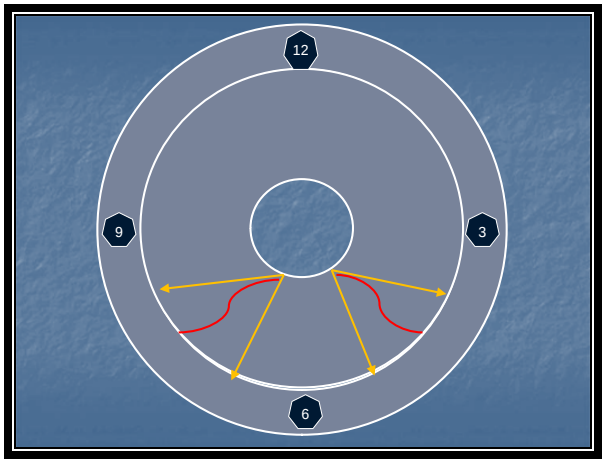


Figure 6-11. Cracks at 30 ° ± from invert

TRANSVERSE CRACKS

Where transverse (circumferential) cracks (Figure 6-12) are observed, the cracks shall be monitored as longitudinal cracks are monitored. Transverse cracks with no sign of backfill infiltration do not need remediation. If migration of backfill material is evident, the transverse crack shall require remediation.

Figure 6-12. Transverse Crack (courtesy of NASSCO)

Poor bedding may cause transverse cracks. Cracks may occur across the bottom of the pipe (broken belly) when the pipe is only supported at the ends of each section. This is generally the result of poor installation practices such as not providing indentations (bell holes) in hard foundation material for the end of the bell and spigot-type pipe or not providing a sufficient depth of suitable bedding material.

Cracks may occur across the top of pipe (broken back) when settlement occurs and rocks or other areas of hard foundation material near the midpoint of a pipe section are not adequately covered with suitable bedding material.

SPALLS

Spalling is defined as a localized delamination of concrete along the wall of the pipe or at the edges of longitudinal or transverse cracks (Figure 6-13). Spalling may be detected by visual examination of the concrete along the edges of cracks. Tapping with a hammer shall be performed along the cracks to check for areas that have fractured but are not visibly separated. Such areas will produce a hollow sound when tapped. These areas may be referred to as delaminations or incipient spalls. Pipe experiencing this type of problem shall be repaired or replaced.

Minor or isolated spalls are not a problem and are easily repaired to prevent corrosion of the steel. In precast concrete pipe, spalls often occur along the edges of either longitudinal or transverse cracks when the crack is due to overloading or poor support rather than simple tension cracking.

Figure 6-13. Spalling Along Edge of Crack

SLABBING

The terms slabbing, shear slabbing, or slab shear refer to a radial failure of the concrete which occurs from straightening of the reinforcement cage due to excessive tension. Slabbing (Figure 6-14) is characterized by large slabs of concrete "peeling" away from the sides of the pipe and a straightening of the reinforcing steel.

Any pipe experiencing slabbing shall be repaired or replaced. Slabbing is a serious problem that can occur under high fills.

Figure 6-14. Concrete Slabbing

END SECTION DROP-OFF

End drop-offs are caused by erosion of the material supporting the pipe sections on the outlet end of the pipe barrel. This type of distress is usually due to outlet soil erosion. The end section is required to be reset.

REMEDIATION/REPLACEMENT

All necessary remediation or replacement of pipe determined to be necessary by the Engineer in conformance with the specifications shall be the responsibility of the Contractor at no additional expense to the owner. All supplemental work items that are affected by the remediation or replacement of pipe shall also be the responsibility of the Contractor. The Engineer shall approve all corrective actions before the work is performed and work shall be completed to the Engineers satisfaction. Pipes requiring remediation or replacement shall be re-inspected after the remediation or replacement has been completed.

Appendix A

Precast Concrete Pipe and Structures

PRECAST CONCRETE PIPE AND STRUCTURES

Box Sections – 907.05

1. Precast concrete units shall be in accordance with ASTM C 1577 and shall be from the source listed in the Department's List of Certified Precast Concrete Producers, in accordance with ITM 813.

2. Not more than four holes may be cast or drilled, or otherwise neatly made in the shell of each piece of box section, for the purpose of handling or laying. The holes shall be tapered unless cored.

Catch Basins – 907.04

1. Catch basins shall be in accordance with AASHTO M 199M. References to diameter are applicable to corresponding dimensions in other circular sections.

2. Absorption tests will not be required for flat top or base slabs.

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

End Sections – 715.10

1. Pipe end sections shall be constructed as shown on the plans or as directed.

2. Straps or hook bolts required for anchors shall be as shown on the plans.

Grated Box End Sections – 715.02 & 715.10

1. Grated box end sections shall be constructed as shown on the plans or as directed.

2. Units shall be cast as a single complete unit except for the toewall which shall be cast in place.

3. Straps or hook bolts required for anchors shall be as shown on the plans.

4. The concrete shall be class A concrete.

5. Steel pipe and steel tubing shall be in accordance with ASTM A 53, Grade B or ASTM A 501. Such pipe and tubing shall be galvanized in accordance with ASTM A 123. All other related hardware shall be galvanized in accordance with ASTM A 153.

6. Structural steel grates shall be ASTM A 36 for end sections having widths less than or equal to 3 ft and shall be ASTM A 572 grade 50 for widths greater than 3

ft. Threaded inserts shall have a minimum pull-out capacity of 6,000 lb. The 1/2 in. round bolts shall have hex heads, cut washers, and where necessary, shall be furnished with the grating. The hardware cloth used to cover the weep holes, may be plastic with 1/4 in. mesh or galvanized steel wire No. 4 mesh with a minimum wire diameter of 1/32 in. It shall be firmly anchored to the outside of the structure and shall be centered on the holes.

Pipe with a 4 in. outside diameter and in accordance with ASTM A 513, Type 5, may be used as an alternate to the 4 in. outside diameter pipe specified. The pipe used as an alternate shall have a minimum wall thickness of 5/16 in. and a minimum yield strength of 50,000 psi. Steel tube of 4 in. by 4in. by 3/8 in., and in accordance with ASTM A 500, Grade B, will also be permitted as an alternate to the 4 in. outside diameter pipe specified.

7. Inserts for approved lifting devices may be cast in the bottom slab of the precast sections. The number and location of lifting devices needed for handling shall be determined by the fabricator.

8. All reinforcing steel shall have a minimum cover of 1 ½ in. and shall have a minimum lap of 21 in.

Inlets – 907.04

1. Inlets, shall be in accordance with AASHTO M 199. References to diameter are applicable to corresponding dimensions in other circular sections.

2. Absorption tests will not be required for flat top or base slabs.

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

Manholes – 907.04

1. Manholes, shall be in accordance with AASHTO M 199. References to diameter are applicable to corresponding dimensions in other circular sections.

2. Absorption tests will not be required for flat top or base slabs.

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

4. Manhole steps shall be permanently marked with the specific step designation and the manufacturer’s identification. This marking shall remain exposed after installation.

5. Manhole steps shall be selected from the list of approved Manhole Steps.

Non-Reinforced Concrete Pipe – 907.01

1. Non-reinforced concrete pipe shall be in accordance with AASHTO M 86M for the specified diameter and strength classes.

2. When used for underdrain, each section of pipe shall not exceed 3 ft in length.

Reinforced Concrete Pipe – 907.02

1. Reinforced concrete pipe shall be in accordance with AASHTO M 170 for the specified diameters and strength classes.

2. Unless otherwise specified, the pipe wall design and the use of elliptical reinforcement in circular pipe are optional.

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

4. When specified or permitted, the pipe shall be in accordance with the following classes:

    a) Extra Strength Reinforced Concrete Pipe –Class IV
    b) Heavy Duty Reinforced Concrete Pipe – Class V
    c) Reinforced Concrete Pipe – Class III
    d) Reinforced Concrete Sewer Pipe – Class II

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

6. The manufacturer of the steel reinforcement shall furnish to the pipe manufacturer a mill test report.

7. The pipe manufacturer shall certify 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 the Standard Specifications.
    c) Based on the steel reinforcement manufacturer’s 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.

Reinforced Concrete Horizontal Elliptical Pipe – 907.03

Reinforced concrete horizontal elliptical pipe shall be in accordance with AASHTO M 207.

Reinforced Concrete Three-Sided Structures – 723

1. For three-sided structures, the manufacturer's representative shall provide technical instruction and on-site technical assistance to the Contractor during the erection of the members.

2. A three-sided structure shall be designed for HL-93 loading in accordance with AASHTO LRFD Bridge Design Specifications.

3. The three-sided structure, headwalls, wingwalls, footings, and spandrel walls shall be designed in accordance with the soil parameters shown in the contract documents.

4. Weep holes shall be provided in all wingwalls. Horizontal pressures shall be increased for sloping backfill surfaces and live load surcharge. Headwall connections, wingwall footings, and spandrel walls shall be checked for sliding and for overturning.

5. For three-sided arch-topped or true arch shape structure sections, the concrete cover over the outside circumferential reinforcement shall be a minimum of 2 in. The cover over the inside circumferential reinforcement shall be a minimum of 1 1/2 in. The clear distance of the end circumferential reinforcement shall not be less than 1 in. and no more than 2 in. from the ends of the structure section. The ends of the longitudinal distribution reinforcement shall be no more than 3 in. from the ends of the structure section.

6. For flat-topped structure sections, the cover dimension over the top mat of reinforcement shall be a minimum of 2 in. The cover over the lower mat of reinforcement in the structure top shall be a minimum of 1 1/2 in. The cover in the legs shall be a minimum of 2 in. The clear distance of the end circumferential reinforcement shall not be less than 1 in. and no more than 2 in. from the ends of the structure section. The ends of the longitudinal distribution reinforcement shall be no more than 2 in. from the ends of the structure section.

7. Cover for headwall, wingwall, spandrel wall, and pedestal reinforcement shall be a minimum of 2 in. Cover for footing and base slab reinforcement shall be 3 in. for the top and sides and 4 in. for the bottom.

8. Reinforcement splicing and spacing shall be in accordance with the AASHTO LRFD Bridge Design Specifications except as indicated herein. Tension splices in circumferential reinforcement shall be made by means of lapping. Where reinforcing bars are used for longitudinal distribution reinforcement, the

reinforcing bars shall have a center to center spacing not to exceed 12 in. in flat-topped structure sections or 16 in. in arch-topped or true arch shape structure sections.

9. Where reinforcing bars are used in wingwalls, the maximum spacing for wingwall reinforcing bars shall be 18 in. for horizontal bars and 12 in. for vertical bars.

10. Exterior corner reinforcement for flat-topped structure sections shall be fully developed beyond the point where it is no longer required to resist flexure.

11. Working drawings shall be submitted in accordance with 105.02 and shall include all details, dimensions, and quantities necessary to construct the structure, headwalls, wingwalls, or spandrel walls.

12. The structure sections, headwalls, wingwalls, footings and spandrel walls shall be free of fractures. Headwalls, wingwalls, and spandrel walls shall be given a finish in accordance with 702.21.

13. The structure units shall not be stored in an upright position until the designated handling and storage compressive strength, as shown on the working drawings, has been achieved.

14. Structure sections, wingwalls, footings, or spandrel walls will be rejected due to the following conditions.

    a) fractures or cracks passing through the section or wall, except for a single end crack which does not exceed one-half the thickness of the section or wall;
    b) defects which indicate proportioning, mixing, or molding which are not in accordance with this specification;
    c) honeycombed or open texture; or
    d) damaged section ends, where such damage prevents making a satisfactory joint.

15. Structure sections, headwalls, wingwalls, footings or spandrel walls shall be repaired, if necessary, due to imperfections in manufacture, handling damage, or construction. Repairs will be acceptable if it is determined that the repairs are sound, properly finished and cured, and if the repaired structure section headwall, wingwall, footing, or spandrel wall is in accordance with the requirements herein.

16. All footings shall be given a smooth float finish. Footing concrete shall reach a compressive strength of 2,000 psi or flexural strength in accordance with 702.24(c) prior to placement of the structure sections or wingwalls. The surface shall not vary more than 1/4 in. in 10 ft when tested with 10 ft straightedge.