

ALDOT 364-89

PROCEDURE FOR INSPECTION OF CONCRETE PIPE, PRECAST MANHOLES, PRECAST BOX CULVERTS AND MISCELLANEOUS PRECAST PRODUCTS

1. Scope

- 1.1. The purpose of this procedure is to establish guidelines for acceptance of precast concrete products by the Alabama Department of Transportation, herein referred to as ALDOT or the Department. This procedure outlines guidelines for producers to help ensure all precast concrete products purchased by the Department, directly or through its contractors and subcontractors, meet Department specifications. Qualified producers of precast concrete products will be placed on LIST I-8, "*PRECAST CONCRETE PIPE AND MISCELLANEOUS PRECAST CONCRETE PRODUCTS*", in the Materials, Sources, and Devices with Special Acceptance Requirements (MSDSAR) Manual.
- 1.2. The Department hereby establishes the Quality Control Program for Production, Inspection and Acceptance of Concrete Pipe, Precast Manholes, Precast Box Culverts and Miscellaneous Precast Concrete Products. This program, also known as the Precast Concrete Products Program, assigns Quality Control responsibilities to the precast concrete product producer and Quality Assurance responsibilities to the Department.
- 1.3. Miscellaneous precast concrete products include items manufactured under one of the following categories:
 - Right-of-Way Markers
 - Concrete Pipe End Treatments
 - Portable Concrete Barrier Rails
 - Precast Wall Panels
 - Precast Inlets
- 1.4. This program is not applicable to precast non-prestressed concrete bridge members. SECTION 512, "*PRECAST NON-PRESTRESSED CONCRETE BRIDGE MEMBERS*", in the Department's Standard Specifications for Highway Construction, and ALDOT -367, "*PRODUCTION AND INSPECTION OF PRECAST NON-PRESTRESSED AND PRESTRESSED CONCRETE*", in the Department's Testing Manual, cover the production, inspection and acceptance of precast non-prestressed concrete bridge members.

2. Referenced Documents

- 2.1. Requirements for the materials, processes and documentation required for the production, inspection and acceptance of precast concrete products are given in the following documents:

2.1.1. ALDOT Standard Specifications for Highway Construction – (Web link: [ALDOT SPECIFICATIONS](#))

106	Control of Materials
501	Structural Portland Cement Concrete
512	Precast Non-Prestressed Concrete Bridge Members
524	Reinforced Concrete Box Culverts
726	Portable Concrete Safety Barriers and Impact Attenuators
807	Water

2.1.2. Material, Sources, & Devices with Special Acceptance Requirements (MSDSAR) Manual – (Web link: [MSDSAR Manual](#))

I-1	Sources of Coarse and Fine Aggregates
I-2	Portland and Blended Cements
I-3	Mineral Admixtures for Portland Cement Concrete
I-8	Precast Concrete Pipe and Miscellaneous Precast Concrete Products
II-1	Chemical Admixtures for Portland Cement Concrete
II-22	MSE Wall Systems

2.1.3. ALDOT Procedures – (Web link: [ALDOT PROCEDURES](#))

170	Method of Controlling Concrete Operations of Structural Portland Cement Concrete
355	General Information Concerning Materials, Sources, and Devices with Special Acceptance Requirements
358	Jack Calibration Procedure
367	Production and Inspection of Precast Non-Prestressed and Prestressed Concrete
377	Certification Program for Precast Concrete Products Technician

2.1.4. BMT Forms – (Web link: [BMT FORMS](#))

45	Annual Certification and Guarantee for Precast Concrete Products
47	Concrete Pipe and Culvert Test and Inspection Report
53	Precast Manhole, Precast Box Culvert, and Miscellaneous Precast Inspection Report
72	Precast Concrete Products Shipping Report
75	Concrete Mix Design
197	Precast Concrete Products Program Monthly Checklist
199	Precast Products Annual Plant Inspection Report

2.1.5. AASHTO/ASTM Standards

M 86/C 14	Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe
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M 170/C 76	Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
M 175/C 444	Perforated Concrete Pipe
M 176/C 654	Porous Concrete Pipe
M199/C478	Precast Reinforced Concrete Manhole Sections
M 206/C 506	Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe
M 207/C 507	Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe
M 242/C 655	Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe
M259/C789	Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers
C1372	Dry-Cast Segmental Retaining Wall Units
C913	Precast Concrete Water and Wastewater Structures
R 73	Evaluation of Precast Concrete Drainage Products
T 22/C 39	Compressive Strength of Cylindrical Concrete Specimens
T 23/C 31	Making and Curing Concrete Test Specimens in the Field
T 231/C 617	Capping Cylindrical Concrete Specimens
T 280/C 497	Concrete Pipe, Manhole Sections, or Tile

3. Producer Initial Qualification Requirements

- 3.1. Any producer of precast concrete products covered under this procedure wishing to furnish products for use in highway construction shall submit to the Materials and Tests Engineer; Attention: Aggregate Control Section, the following documentation:
 - 3.1.1. Written request to be considered for inclusion on List I-8.
 - 3.1.2. Copy of Current Plant Certification:
 - 3.1.2.1. For concrete pipe producers: American Concrete Pipe Association (ACPA) QCast Plant Certification and/or National Precast Concrete Association (NPCA) Plant Certification
 - 3.1.2.2. Other precast concrete products: American Concrete Pipe Association (ACPA) QCast Plant Certification, National Precast Concrete Association (NPCA) Plant Certification, and/or Prestress/Precast Concrete Institute (PCI) Plant Certification. For PCI Plant Certification, the appropriate certification must be obtained. For example, if producing wall panels, then at least an A1 plant certification would be required. If producing "PreCast Concrete Products", at least a C1 plant certification would be required.
 - 3.1.3. Quality Control Plan – See requirements in Section 6 of this procedure.
 - 3.1.4. Evidence of having on staff a licensed Professional Engineer registered in the state where the precast products are manufactured. The licensed Professional Engineer shall not be employed by ALDOT.

- 3.1.5. A written statement by a Professional Engineer accepting overall responsibility for the plant's Quality Control Program. The Professional Engineer must be licensed in the State where the plant is located within and may not be employed by the ALDOT. The written statement must be signed, dated, notarized and include the following language:

I Print Name, do hereby accept overall responsibility for the Quality Control Program for all Precast Concrete Products produced at Producer & Plant Name and supplied to an Alabama Department of Transportation project.

<u>Printed Name</u>	<u>Date</u>
<u>Signature</u>	<u>P.E. License No.</u> <u>State of <u>State Name</u></u>

- 3.1.6. Evidence of having on staff a Precast Concrete Products Technician certified by the Department as per ALDOT-377.
- 3.1.7. A BMT-45 signed by a company Officer and notarized by a Notary Public.
- 3.1.8. A list of all precast concrete products to be manufactured at the precast concrete products plant.
- 3.1.9. The source and type of all materials used in the manufacturing of precast concrete products.
- 3.1.10. Concrete Mix Designs:
- Concrete mix designs to be used in the manufacture of precast products produced through the wet-cast method will be submitted to the Concrete Engineer for review and approval and shall be designed in accordance with ALDOT-170 and Appendix 1 of this procedure.
 - Concrete mix designs to be used in the manufacture of precast products produced through the dry-cast method will be submitted to the Concrete Engineer for review and approval and shall satisfy the requirements set forth in Appendix 2 of this procedure.
- NOTE: Approved concrete mix designs will be issued to the Precast Concrete Products Producer on a BMT-75 Form. The Precast Concrete Products Producers must have approved concrete mix designs
- 3.1.11. Shop Drawings for all precast concrete products proposed for ALDOT Qualification showing specific details (i.e. reinforcement, concrete cover over reinforcement, dimensions of product, etc.)
- 3.1.12. Required fees as per ALDOT-355. Submit fees to:

Alabama Department of Transportation
Attention: Aggregate Control Section
3700 Fairground Road
Montgomery, AL 36110

- 3.2. Only after all documentation required in Article 3.1 has been received, reviewed and determined to be acceptable, will a plant inspection be scheduled.
- 3.3. After all requirements set forth in Article 3.1 and Article 3.2 have been met and approved, the Aggregate Control Section will recommend approval of the source and inclusion in List I-8 to the Product Evaluation Board.
- 3.4. A precast concrete producer, currently on List I-8, may request the addition of new products by submitting a written request to the Aggregate Control Section. Included with the request shall be updated copies of documents required in Article 3.1.

4. Producer Re-Qualification Requirements

- 4.1. Qualified producers of precast concrete products shall be re-qualified annually.
- 4.2. At the time of re-qualification, the producer shall submit updated copies of all documentation outlined in Article 3.1.

5. Responsibilities

- 5.1. The Department, in conjunction with the Precast Concrete Industry, will administer a viable program to train Precast Concrete Product Technicians in accordance with ALDOT-377.
- 5.2. The **Producer's Precast Concrete Products Technician** shall be responsible for the following:
 - Compliance with the Quality Control Program.
 - Be present during all production and shipment of precast concrete products.
 - Test precast concrete products as required in this procedure.
 - Ensure all equipment is calibrated and maintained in accordance with this procedure.
 - Utilizing the criteria detailed in AASHTO R 73, visually inspect each joint, section, unit, etc. after form removal, before loading, after loading and before shipment leaves the plant.
 - Ensure that all precast concrete products are properly cured as per the applicable specification.
 - Ensure that all manufacturing materials are from ALDOT qualified sources.
 - Maintain a daily production log.
 - Ensure all products are marked and stored in accordance with this procedure.
 - Fill out, submit, and maintain test reports (BMT 47 or BMT 53) and production documentation.

- Prepare and maintain documentation files of sampling, testing, and material sources.
- Complete and transmit shipping reports (BMT 72).
- Provide a completed BMT-47 or BMT-53 as required, and a BMT-72 with each shipment sent to the project site.
- Submitting to the Materials and Tests Engineer a copy of the current plant certification (i.e. NPCA, ACPA, or PCI). Also submit any documentation pertaining to the producer's successful completion of the annual inspection.
- Maintain a library of all applicable ALDOT and AASHTO/ASTM documents.

5.3. The **ALDOT Area Precast Technician** will be responsible for the following:

- Visit each precast concrete producer in the Area's jurisdiction at least once a month.
- Monitor the producer's Quality Control program.
- Review the BMT-47, BMT-53 and BMT-72 forms for completeness and accuracy. If acceptable, enter the information into CAMMS. If not acceptable, instruct the producer to correct the forms.
- Maintain required BMT forms at the Area office.
- Ensure tests are done in accordance with this procedure.
- Utilizing the criteria detailed in AASHTO R 73, visually inspect precast concrete products that have been accepted and stenciled by the producer's technician.
- Perform required tests in accordance with this procedure and provide the producer's precast technician with a copy of the test reports.
- Perform monthly inspections and complete form BMT-197. Submit a copy of the BMT-197 to the Aggregate Engineer.
- Inspect Three-Edge Bearing apparatus as per AASHTO T 280 and submit original calibration test report to the Aggregate Control Section of the Bureau of Materials and Tests.
- Ensure that a current plant certification (i.e. NPCA, ACPA, or PCI) is displayed at the plant.

5.4. The **Aggregate Control Section** of the Bureau of Materials and Tests will be responsible for the following:

- Administer the Precast Concrete Products Program and monitor its effectiveness.
- Assist the precast industry with classroom and hands-on training.
- Provide classroom space as required.
- Certify Precast Concrete Products Technicians.
- Perform new source initial plant inspections.
- Review and Approve the producer's Quality Control Plan.
- Submit new source recommendations to the Product Evaluation Board for approval.

- Maintain master files for all qualified producers.
- Assist in the identification and solution of problems related to precast concrete products and/or the Precast Concrete Products Program.
- Maintain the list of qualified precast concrete producers.
- Perform annual inspections of out of state producers that are not under the jurisdiction of an Area office.
- Visit Area offices that have precast concrete products manufacturers in their jurisdiction once a year to ensure compliance with the Precast Concrete Products Program. The yearly visit will include a visit with an Area representative to one (1) of the producer's facility in the Area. The Aggregate Control Section of the Bureau of Materials and Tests will generate a written report documenting the visit.
- Initiate actions to remove any producer failing to adhere to the requirements given in this procedure.

6. Producer Quality Control Plan

- 6.1. Each producer of precast concrete products shall submit a Quality Control Plan to the Materials and Tests Engineer, attention of the Aggregate Control Section. The Quality Control Plan shall include, but is not limited to, the following:
- A statement summarizing the producer's Quality Control Plan.
 - Procedures for controlling and monitoring the quality of the precast concrete during production.
 - Name, mailing address, plant address and telephone number of company.
 - Names of company officers, i.e., owner, president, etc.
 - Name of key plant personnel and specific duties, i.e., superintendent, general manager, technician, production foreman, etc.
 - Name and specific duties of person(s) who will perform quality control duties.
 - Name and registration number of the licensed Professional Engineer who will be responsible for the overall Quality Control Program.
 - List of all products being produced including sizes.
 - List of all major production equipment.
 - If applicable, name, address, telephone number, and services of the independent testing laboratory.
 - List of testing equipment for "in-house" testing.
 - Documentation of plant certification.
 - Shipping Procedures for Department projects.
- 6.2. The producer shall update the Quality Control Plan annually, and any time there is a significant change in personnel, production, materials, or Quality Control Procedures. Updates shall be submitted to the Materials and Tests Engineer, to the attention of the Aggregate Control Section for review.

7. Materials

- 7.1. Materials used in the production of Precast Concrete Products shall meet the requirements of the appropriate Sections of the Department's Specifications and shall be purchased from qualified sources listed in the Materials, Sources, and Devices with Special Acceptance Requirements manual.
- Coarse/Fine Aggregate - List I-1.
 - Cement - List I-2.
 - Mineral Admixtures – List I-3.
 - Chemical Admixtures – List II-1.
 - Reinforcing steel shall be traceable to a certified mill test report and meet all requirements of the Department's Specifications, Section 106.
 - Water used shall meet the requirements in Section 807 (Water for Cement Concrete).
- 7.2. The producer must maintain all documentation necessary to substantiate the purchase and use of all qualified materials for at least three (3) years. The documentation shall be available to the Department upon request.

8. Acceptance

- 8.1. Acceptance of all precast concrete pipe shall be in accordance with Department Specifications and the following AASHTO/ASTM Specifications:
- AASHTO M 86
 - AASHTO M 170
 - AASHTO M 175
 - AASHTO M 176
 - AASHTO M 206
 - AASHTO M 207
 - AASHTO M 242
 - AASHTO R 73
 - Concrete pipe in all diameters and classes shall be accepted on strength test results determined by the Three-Edge Bearing test described in AASHTO T 280. Precast producers have the option to cut cores from pipe with wall thickness of 4 in. (100 mm) and greater. Cores may be tested in accordance with AASHTO T 280 or AASHTO T 22. Concrete cylinders shall be tested in accordance with AASHTO T 22.
- 8.2. Precast concrete box culvert sections shall be accepted in accordance with Department Specifications, Section 524.

- Precast concrete box culvert sections shall be accepted on compressive strength test results of concrete cylinders in accordance with AASHTO T 22.
 - Any precast product that attaches to the end of a precast box culvert becomes part of the culvert, and therefore requires Department approval for precast producers to supply these products.
- 8.3. Precast concrete manholes shall be accepted in accordance with Department Specifications and AASHTO M 199/ASTM C 478.
- Precast concrete manholes shall be accepted on compressive strength test results of concrete cylinders in accordance with AASHTO T 22.
- 8.4. Precast concrete pipe end treatments shall be accepted on compressive strength test results in accordance with AASHTO T 22 or AASHTO T 280.
- 8.5. Precast concrete barrier rail units shall be accepted in accordance with Department Specifications, Section 726.
- Precast concrete barrier rail shall be accepted on compressive strength test results of concrete cylinders in accordance with AASHTO T 22.
- 8.6. Precast concrete wall panels shall be accepted in accordance with the following:
- Precast concrete wall panels shall be accepted on compressive strength test results of concrete cylinders in accordance with AASHTO T 22.
 - Companies with approved designs that are included in List II-22, and supply precast wall panels for their design, must be included in List I-8.
- 8.7. Precast concrete right-of-way markers shall be accepted on visual inspection.
- 8.8. Precast concrete products that have been cored and found to meet compressive strength requirements will be accepted for use if the core holes have been repaired in accordance with ALDOT-170.
- 8.9. Visual inspections for defects and imperfections shall be made immediately after form removal. The producer shall follow the guidance provided in AASHTO R 73 and perform only cosmetic repairs to enhance the finish and appearance of the precast concrete product.
- 8.10. Concrete Cylinders shall be made and cured in accordance with AASHTO T 23. Capping of cylindrical specimens, if performed, shall be done in accordance with AASHTO T 231.
- 8.11. Independent testing laboratories identified in the Producer's Quality Control Plan shall be inspected and qualified by the Department, prior to the producer being qualified. The independent testing lab shall meet the following requirements:
- Curing methods required for precast concrete products shall be in accordance with the applicable AASHTO/ASTM Specification referenced in Subarticle 2.1.4 of this procedure.

- Concrete compressive strength testing machines shall be calibrated annually. Producers are required to furnish a copy of the certified calibration report to the Department.
- 8.12. The producer's testing laboratory shall be inspected and qualified by the Department. Any testing equipment used by the producer for "in-house" testing shall be inspected by the Department on an annual basis or as often as necessary. The producer shall meet the following requirements:
- The producer shall have the three-edge bearing jacks calibrated annually in accordance to ALDOT-358. The producer/independent testing laboratory performing the calibration shall submit a copy of the calibration certificate to the appropriate Area Materials Engineer or the Aggregate Control Section of the Bureau of Materials and Tests
 - Curing methods required for precast concrete products shall be in accordance with the applicable AASHTO/ASTM Specification referenced in Subarticle 2.1.4 of this procedure.
 - Concrete compressive strength testing machines shall be calibrated annually. Producers are required to furnish a copy of the certified calibration report to the Department.
- 8.13. For every lot of precast concrete products, at least one joint or unit shall be tested. A "Lot" is defined as follows:
- Pipe (all diameters and classes), 1-day's production or a maximum of 300 joints.
 - Box culvert sections, 1-day's production or a maximum of 15 units.
 - Manholes (wet cast), 1-week's production or a maximum of 50 units.
 - Manholes (dry cast), 1-day's production or a maximum of 100 units.
 - Pipe end sections, 1-week's production or a maximum of 50 joints.
 - Right-of-way markers, 100 units.
 - Barrier rail units, 1-day's production or a maximum 50 units.
 - Precast wall panels, 1-day's production or a maximum 50 units per panel type.
 - Miscellaneous precast structures, 1-week's production or a maximum of 50 units.

9. Reporting

- 9.1. The completed BMT-47 or BMT-53, as required, and BMT-72 forms shall accompany each shipment to the project site. These forms shall be delivered to the Contractor.
- The Contractor shall review the forms, print name, sign, and date the forms, then deliver to the Project Engineer.

- The Project Engineer will review the forms, print name, sign, and date the forms, then deliver to the ALDOT Area Precast technician.
 - The Area Precast Technician will review the forms for accuracy and completion. If the forms are acceptable, Area personnel will then print name, sign, and date the forms and enter into CAMMS.
 - If the BMT forms are not acceptable at any step in this process, the precast producer shall submit new BMT forms that are complete and accurate.
- 9.2 The Department recognizes that portable concrete barrier rail may be re-used on multiple projects over the life of the rail. When portable barrier rail is re-used, the forms that accompanied the original shipment of new rail may not be available on subsequent projects. In these cases, the Department will accept a written statement from the Contractor certifying that the rail was fabricated by an approved producer and was fabricated in accordance with the applicable drawings at the time of production. All units shall be inspected prior to use for the requirements given in Section 10 of this procedure. The certified written statement shall be provided to the Project Manager prior to the rail being used on the project.

10. Marking, Shipping, Handling and Storage

- 10.1. Utilizing criteria detailed in AASHTO R 73, the producer's technician shall visually inspect each precast unit before and after loading, before shipment leaves the plant, to ensure no damage has occurred and that each precast unit is properly marked.
- 10.2. Precast concrete products shall be marked as follows:
- Concrete pipe, precast manholes and precast box culvert sections shall be marked as per the applicable AASHTO/ASTM Specification referenced in Subarticle 2.1.5.
 - Concrete pipe end treatments shall be marked with the class, date of manufacture, name or trademark, and lot number.
 - Right-of-way markers shall be marked with the date of manufacture and lot number.
- 10.3. In addition to the above marking requirements, the producer's technician shall stencil the letters "ALDOT", the technician number, and lot number on the inside or outside of each precast unit. For precast block retaining wall units, the required markings shall be placed directly on the pallet. All markings must be visible when the pallet is loaded.
- 10.4. Precast concrete products shall be stored in a manner that will not damage the product and will allow easy access for inspecting, marking, and handling.
- 10.5. Precast concrete products shall not be shipped until four (4) days after casting and the minimum compressive strength requirements are met.
- 10.6. The Project Manager will accept precast concrete products at the job site provided the product is properly marked and a visual inspection reveals no damage due to shipping

and handling. Any precast unit found to be damaged to the extent that serviceability is impaired, will be rejected and shall not be used in the project.

11. Revocation of Source

- 11.1. A precast producer will be removed from Precast Concrete Products Program if quality problems persist after a previous written warning has been issued, or severe quality problems hinder the structural integrity of the product. Precast producers will be notified in writing of such action and requested to surrender the inspection stamp and any test report forms.
- 11.2. Failure to maintain a current ACPA or NPCA certification will result in removal of the precast producer from the Precast Concrete Products program. Upon receiving due written notice, the producer will surrender the inspection stamp and any test report forms.
- 11.3. Additional reasons for removing a precast producer from the Precast Concrete Products Program include, but is not limited to, the following:
 - Failing to employ a Precast Concrete Products Technician certified by the Department.
 - Failing to employ a Licensed Professional Engineer responsible for the plant's Quality Control Program.
 - Using materials that are not on the Department's qualified sources lists.
 - Supplying products to an ALDOT project produced from concrete which does not conform to the mix design approved by the Department.
 - Failing to correct any deficiency related to any requirement in this procedure and/or the Quality Control Program within 30 days after receiving a written notice from the Department indicating the non-compliance issues.
 - Failing to comply with the requirements of the Precast Concrete Products Program.
 - Deviating from the requirements in the Quality Control Plan without Department's approval.
 - Falsification of reports, test results, records, etc. will result in permanent disqualification by the ALDOT and the producer will not be allowed to supply precast concrete products to any ALDOT project.
- 11.4. The Department will provide guidance and assistance to producers in identifying and correcting problems which may arise.

Appendix 1

PRECAST PRODUCT	MINIMUM CEMENTITIOUS MATERIAL	MAXIMUM WATER TO CEMENTITIOUS RATIO	MINIMUM COMPRESSIVE STRENGTH	REFERENCE SPECIFICATION
PIPE	470 lb/yd ³	0.53	SEE DESIGN TABLES IN AASHTO M 170	AASHTO M 170
BOX CULVERT	470 lb/yd ³	0.53	5000 psi	AASHTO M 259
MANHOLES	470 lb/yd ³	0.53	4000 psi	AASHTO M 199
PRECAST WALL PANELS		SEE SECTION 501 PREQUALIFICATION REQUIREMENTS FOR CONCRETE MIXTURE DESIGNS	3000 psi	ASTM C 1372
BARRIER RAILS		SEE SECTION 501 PREQUALIFICATION REQUIREMENTS FOR CONCRETE MIXTURE DESIGNS	3000 psi	SEE SECTION 501
INLETS		0.45 (AIR-ENTRAINED) 0.48 (NON AIR-ENTRAINED) 0.40 (CORROSIVE ENVIRONMENT)	3000 psi	ASTM C 913
BASES		0.45 (AIR-ENTRAINED) 0.48 (NON AIR-ENTRAINED) 0.40 (CORROSIVE ENVIRONMENT)	3000 psi	ASTM C 913
RISERS		0.45 (AIR-ENTRAINED) 0.48 (NON AIR-ENTRAINED) 0.40 (CORROSIVE ENVIRONMENT)	3000 psi	ASTM C 913

Appendix 2

- The producer shall submit the sources and proportions of one (1) cubic yard of concrete to the Concrete Engineer. Only sources and materials qualified by ALDOT may be used in the production of concrete pipe. Changes in cement, mineral admixture, aggregate or chemical admixture type or source shall require a new mix design.
- In addition, the producer shall submit three-edge bearing test data for a minimum of three (3) pipe samples, manufactured using the proposed mix design. This test data may come from production, as long as the materials and proportions are the same.