To: SUPERSEDED BY EB 05-057 EFFECTIVE 09/07/06 eau		New York State Department of Transportation ENGINEERING INSTRUCTION	EI 98-009

Title: **PRECAST CONCRETE BOX CULVERTS**

Distribution:

- ☐ Manufacturers (18)
- ☒ Main Office (30)
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- ☐ Surveyors (33)
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- ☐ _____( )

Approved:

P. J. Mack, Deputy Chief Engineer, Technical Services Division — Date: 3/13/98

This Engineering Instruction partially supersedes EI 95-010.

EFFECTIVE DATE:

This Engineering Instruction is effective with Department contracts let on or after September 10, 1998.

PURPOSE:

To revise the material and construction specifications for precast concrete box culverts to implement changes in the joint requirements, allow the optional use of corrosion inhibitor in lieu of epoxy coated reinforcing steel and implement new pay item numbers based on the culvert size and fill height. Also, the NYSDOT Reinforced Concrete Box Culvert Design Guide Lines have been revised to add load rating requirements for bridge size box culverts.

BACKGROUND:

Joint Detail - The Materials Bureau has done a field evaluation and canvassed regional construction personnel regarding the installation procedures and joint details for precast concrete box culverts. This investigation was the result of concerns expressed by some regions that the joints on some culvert installations were not watertight. Although culvert joints do not have to be completely watertight for the culvert to function satisfactorily, proper fabrication and installation of the culvert should minimize the number of joints which do leak. To accomplish this, §706-17 Precast Concrete Box Culverts has been revised to include the following:

1) Type and size of material to be used for the joint gasket.
2) Location in the joint where the gasket is to be installed.
3) Joint gasket is to be installed by the precaster.
4) A requirement on how the joints are to fit together.

The special specification for Precast Concrete Box Culvert, Items 15603.63XXYY M, 15603.64XXYY M, 15603.65XXYY M and 15603.66XXYY M, has been written to include specific requirements for joint openings and the number of mechanical connectors to be supplied for culvert installation. A requirement that the precast manufacturer have a representative available to assist in the culvert installation has also been added to the specification. Chapter 19 of the Highway Design Manual contains additional guidance on waterproofing joints.

Corrosion Inhibitor Option - Corrosion inhibiting admixtures are used in portland cement concrete to delay corrosion of the reinforcing steel. Corrosion protection, in the form of epoxy coated reinforcing steel, is currently required in the roof slab of culverts with less than 600 mm of cover. Because box culverts are not in an environment with severe exposure to deicing salts they are a good candidate for the use of corrosion inhibitor. The Precast Concrete Association of New York (PCANY) has indicated that in some cases corrosion inhibitor will be less expensive to use than epoxy coated reinforcing steel. Specification §706-17 has been revised to give the contractor the option of using corrosion inhibitor in lieu of epoxy coated reinforcing steel.

Pay Item Numbers - The design requirements for culverts vary depending on the fill height over the culvert and whether or not the culvert is considered, by definition, to be a bridge. Many of the box culverts on Department projects have fill heights, measured from the top of the culvert roof slab to the top of the pavement, of approximately 600 mm. The design requirements for culverts with fill heights less than 600 mm are different than those for culverts with fill heights of 600 mm or more. Designs done with fill heights less than 600 mm typically result in thicker culvert walls and slabs and require corrosion protection of the reinforcing in the top mat of the roof slab (epoxy coating or corrosion inhibitor). A culvert designed for a fill height of 590 mm will, in most cases, have a higher unit cost than the same culvert designed with a fill height of 600 mm. It is sometimes difficult for the contractor to determine the fill height to be used for design purposes accurately enough from the contract plans. Also, culverts which meet the definition of a bridge, due to their span length or orientation relative to the centerline of the highway, have an additional design requirement for load ratings and a requirement for reproducible drawings. This information is important for the contractor, who is responsible for providing the precast culvert design and drawings, to accurately bid on the culvert item.

In order to provide the contractor with better information for bidding culverts, the special specification for precast concrete box culverts has been given four pay item numbers. The item numbers are based on the culvert being bridge size or non bridge size and the fill height over the culvert being less than 600 mm or greater than or equal to 600 mm. It is imperative that the designer identify the appropriate pay items. For English units, interpret 600 mm as 2'-0" in the above discussion.

Design Guidelines - The NYSDOT Reinforced Concrete Box Culvert Design Guidelines (Guidelines) have been revised. The Reinforcement Requirements section has been revised to include the Corrosion Inhibitor Option. Please see description above. The Guidelines have also introduced Load Rating Requirements for bridge size culverts. Finally, a metric version of the revised Guidelines has been introduced and will be distributed with this issuance.

TRANSMITTED SPECIFICATIONS AND GUIDELINES:

1. 706-17 PRECAST CONCRETE BOX CULVERTS

2. 706-17 PRECAST CONCRETE BOX CULVERTS (Metric)

3. 15603.63XXYY PRECAST CONCRETE BOX CULVERT (Fill Height Less Than 2'-0")
   15603.64XXYY PRECAST CONCRETE BOX CULVERT (Fill Height 2'-0" or Greater)
   15603.65XXYY PRECAST CONCRETE BOX CULVERT (Bridge Size, Fill Height Less Than 2'-0")
   15603.66XXYY PRECAST CONCRETE BOX CULVERT (Bridge Size, Fill Height 2'-0" or Greater)

4. 15603.63XXYY M PRECAST CONCRETE BOX CULVERT (Fill Height Less Than 0.6 m)
   15603.64XXYY M PRECAST CONCRETE BOX CULVERT (Fill Height 0.6 m or Greater)
   15603.65XXYY M PRECAST CONCRETE BOX CULVERT (Bridge Size, Fill Height Less Than 0.6 m)
   15603.66XXYY M PRECAST CONCRETE BOX CULVERT (Bridge Size, Fill Height 0.6 m or Greater)

5. NYSDOT REINFORCED CONCRETE BOX CULVERT DESIGN GUIDELINES

6. NYSDOT REINFORCED CONCRETE BOX CULVERT DESIGN GUIDELINES (Metric)

DISCONTINUED SPECIFICATIONS:

1. 15603.80XXYY PRECAST CONCRETE BOX CULVERTS

2. 15603.80XXYY M PRECAST CONCRETE BOX CULVERTS

SUPERSEDED SPECIFICATIONS AND GUIDELINES:

1. 706-17 PRECAST CONCRETE BOX CULVERTS, Issued with EI 95-010

2. 706-17 PRECAST CONCRETE BOX CULVERTS, contained in the Standard Specifications dated January 2, 1995.

3. NYSDOT REINFORCED CONCRETE BOX CULVERT DESIGN GUIDELINES, contained in Revision # 26 to Chapter 19, "Highway Design Manual".

DESIGNER INFORMATION:

The special specification for precast concrete culverts has been given four pay item numbers. The culvert size and fill height govern which of the item numbers should be used. The two categories for culvert size, Box Culvert (Bridge Size) and Box Culvert, are defined as follows:

Box Culvert (Bridge Size) - A bridge size culvert is defined as having an opening, measured along the center of the roadway, of more than 6.1 m, as measured between the inside faces of the walls. Multiple culvert configurations will qualify as bridge size when the clear distance between openings is less than half of the smaller adjacent opening and the total length, measured along the center of the roadway, is greater than 6.1 m. Culverts meeting either definition should be assigned a Bridge Identification Number.

Box Culvert - All culverts not meeting the above definition for bridge size culverts should be considered box culverts.

The two categories for fill height are: less than 600 mm and greater than or equal to 600 mm. The fill height is measured as the minimum distance between the top of the culvert and the top of the pavement. The new item numbers are to be used as follows:

Item no. 15603.63XXYY M - Box Culverts with a minimum fill height of less than 600 mm.

Item no. 15603.64XXYY M - Box Culverts with a minimum fill height of 600 mm or more.
Item no. 15603.65XXYY M - Box Culverts (Bridge Size) with a minimum fill height of less than 600 mm.
Item no. 15603.66XXYY M - Box Culverts (Bridge Size) with a minimum fill height of 600 mm or more.

Cast-in-place culverts are rarely used and as such are not addressed in this issuance. Designers, who want to allow corrosion inhibitor as an option to epoxy coated steel in cast-in-place culverts, should contact the Materials Bureau, Field Engineering 1 Section for guidance.

COST IMPACT:

Minimal cost decreases are anticipated with these changes.

ACTIONS BY THE CENTRAL OFFICE DOAB:

The attached specifications and Design Guidelines will be Central Office inserts into contract proposals which contain the referenced item numbers. In addition:

1. When Items 15603.63XXYY, 15603.64XXYY, 15603.65XXYY, and 15603.66XXYY are specified, insert Shelf Note 704-03.

2. Replace the 706-17 Precast Concrete Box Culverts specification issued by EI 95-010 in it's entirety with the English version of 706-17 Precast Concrete Box Culverts contained in this issuance.

3. Incorporate the metric version of 706-17 Precast Concrete Box Culverts, contained in this issuance, into the next revision to the January 2, 1995 Standard Specifications.

4. Incorporate the attached, revised version of the NYSDOT Reinforced Concrete Box Culvert Design Guidelines into Chapter 19, of the Highway Design Manual, Revision # 26.

CONTACT:

Questions on this Engineering Instruction or the attached specifications should be directed to Jim Reidy or Bob Marcucci, Field Engineering I Section of the Materials Bureau, at (518) 457-5956.

706-17 PRECAST CONCRETE BOX CULVERTS

SCOPE. This specification covers the material and quality requirements for precast concrete box culverts.

MATERIAL REQUIREMENTS. The Material Requirements contained in §704-03 shall apply except as noted herein.

The concrete used to fabricate precast concrete box culverts shall have a minimum compressive strength of 35 MPa @ 28 days. Joint gasket material shall meet the requirements of ASTM D 1056, Grade # 2A1 or # 2A2. Additional material listed below shall meet the requirements of the following subsection:

Mechanical Connectors for Reinforcing Bar Splices (Epoxy Coated) 709-10

Fabrication. Fabrication requirements contained in §704-03, along with the following shall apply.

1. **Design.** When the contract plans contain complete design details for the culvert, alternate designs will not be considered. When the contract plans do not contain complete design details for the culvert the contractor shall be responsible for providing them. Precast concrete box culvert designs, submitted by the contractor, shall meet the requirements of the NYSDOT Reinforced Concrete Box Culvert Design Guidelines. Design details for bridge size culverts shall also include load rating information.

All box culvert designs shall be submitted by the contractor, to the Department, for approval. The processing, approval and transmittal of box culvert designs will be in accordance with procedural directives of the Materials Bureau. Designs shall be submitted at least 45 days prior to the start of fabrication and shall include a complete set of working drawings and a complete set of design calculations. The drawings and design calculations shall be stamped by a Professional Engineer licensed, and registered, to practice in New York State. When the contract plans contain a complete design for the culvert, working drawings are still required. However, they do not have to be stamped by a Professional Engineer and design calculations are not required.

2. **Working Drawings.** Working drawings shall include complete and accurate details for connecting headwalls, cut-off walls, wingwalls, apron slabs and when required, bridge railing to the box culvert. Working drawings for bridge size culverts shall also include load rating information. Working drawings, and when required design calculations, shall be submitted to the Department for approval at least 45 days prior to the start of fabrication. The processing, approval and transmittal of working drawings will be in accordance with procedural directives of the Materials Bureau.

3. **Reproducible Drawings.** Reproducible drawings are required for bridge size culverts only. Upon receipt of approved working drawings from the Materials Bureau, the manufacturer shall prepare a reproducible drawing, incorporating all changes and corrections shown on the approved working drawing. Reproducible drawings shall be submitted to the Materials Bureau for final approval.

Reproducible drawings shall be neatly drawn and clearly legible to produce microfilm negatives. The drawings shall be made in ink or reproduced from the working drawings, on tracing cloth or mylar of acceptable quality. Reproducible drawings shall be cut to a standard size of 560 mm x 860 mm (nominal) and arranged to conform to the contract drawings. The margin line shall be drawn 13 mm from the top, bottom, and right-hand edges and 50 mm from the left-hand edge to permit binding. A

space 75 mm by 280 mm, and parallel to the length of the sheet shall be reserved in the lower right-hand corner for title and approval signature. Each reproducible drawing shall have an identical (top right) corner box to the one shown on the contract drawings. The sheets shall be arranged so that, as far as possible, the notes will appear above each other near the right edge of the sheet.

4. General. Unless noted otherwise in the contract plans or approved working drawings the concrete cover over reinforcing steel shall be 25 mm minimum on the walls, floor slab and roof slab. When fill heights over the box culvert are less than 600 mm the concrete cover on the outside face of the roof slab shall be 50 mm minimum and all reinforcing steel in the top mat of the roof slab shall be epoxy coated or the concrete shall contain corrosion inhibitor.

Fill heights shall be measured from the top of pavement to the top of the culvert roof slab. Details for connecting headwalls, cut-off walls, wingwalls, apron slabs and when required, bridge railing to the box culvert shall be as shown in the contract plans or approved working drawings. Precast concrete box culvert sections shall be fabricated with a female joint on the upstream end and male joint on the downstream end. Joint depth shall be a minimum of 50 mm and a maximum of 105 mm. The ends of longitudinal reinforcing steel shall have 15 mm minimum concrete cover at the mating surface of the joint. The circumferential reinforcing steel shall have 25 mm minimum concrete cover, as measured to the outermost bars, at the mating surface of the joint. When interferences occur which prevent this, the concrete cover shall be increased accordingly as shown on the approved working drawings. Joints shall be fabricated such that when box culvert sections are fully drawn together the gap between adjacent culvert sections is 20 mm maximum. The outside mating surface of the joint shall have a continuous 25 mm x 25 mm gasket installed at the precast plant.

5. Corrosion Inhibitor. Corrosion inhibitor may be used in lieu of epoxy coated reinforcing. When corrosion inhibitor is selected for use, it shall be clearly noted on the working drawings and shall be used in all precast units produced to those drawings.

The corrosion inhibitor shall consist of a calcium nitrite solution as approved by the Director, Materials Bureau, containing 30 ±1% calcium nitrite solids by weight and weighing 1.27 ±0.01 kilograms per liter. A representative one liter sample, from each delivery of corrosion inhibitor intended for Department use, shall be taken at the precast plant for acceptance testing. Samples shall be taken by the Department's representatives as directed by the Materials Bureau. The Materials Bureau shall be permitted 14 days to complete the evaluation of each sample.

The calcium nitrite, which acts as an accelerator, may be used in conjunction with compatible retarding admixtures to control setting time and workability of the concrete, however the use of a formulation of calcium nitrite solution which includes a set control ingredient may be used if setting times and increased water demands are of concern, consult the manufacturer of the product. The corrosion inhibitor must be added to the mix immediately after air entraining and retarding admixtures have been introduced into the batch. The corrosion inhibitor shall be added to the concrete as an aqueous solution at a dosage rate of 20.0 liters per cubic meter.

An automated corrosion inhibitor dispensing system shall be required. The dispensing system shall meet the following requirements:

Delivery accuracy of ±3% (by weight or volume)
Program Quantity (liters, nearest tenth)
System interlocks
Print requirements:
Project number and/or batch number
Date and time
Delivered quantity (liters, nearest tenth)

Calibration shall be in accordance with procedures approved by the Director, Materials Bureau.

When a batching problem exists or is perceived the Department reserves the right to test the hardened concrete at any time to verify the quantity of calcium nitrite present. Units with less than the specified amount of calcium nitrite shall be subject to rejection. If hardened concrete is tested, 100 mm diameter cores shall be drilled by the manufacturer under the supervision of a Department representative. Cores shall be a minimum of 100 mm in length unless otherwise approved by the Materials Bureau. Core holes shall be plugged and repaired in accordance with the requirements of repair indicated below.

6. **Dimensional Tolerances.** The dimensional tolerances contained in §704-03 shall apply except as noted herein.

a. Internal and external unit dimensions shall not vary by more than 10 mm from the design dimensions.

b. Slab and wall thickness shall not vary from the design dimension by more than 5 mm for thicknesses less than 250 mm or 10 mm for thicknesses of 250 mm or greater.

c. The length of section shall not vary more than 10 mm from the design dimension.

d. Variations in laying lengths of two opposite surfaces of the box section shall not be more than 10 mm.

Curing. The Curing requirements contained in §704-03 shall apply.

Repair. The Repair requirements contained in §704-03 shall apply, except as noted herein. Minor defects in the mating surface of the joint, that do not come in contact with the joint gasket material and are 5 mm or less in depth, do not require repair.

Sampling and Testing. The Sampling and Testing requirements contained in §704-03 shall apply.

Shipping. The Shipping requirements contained in §704-03 shall apply.

BASIS OF ACCEPTANCE. The Basis of Acceptance requirements contained in §704-03 shall apply.

706-17 PRECAST CONCRETE BOX CULVERTS

SCOPE. This specification covers the material and quality requirements for precast concrete box culverts.

MATERIAL REQUIREMENTS. The Material Requirements contained in §704-03 shall apply except as noted herein.

The concrete used to fabricate precast concrete box culverts shall have a minimum compressive strength of 5000 psi @ 28 days. Joint gasket material shall meet the requirements of ASTM D 1056, Grade # 2A1 or # 2A2. Additional material listed below shall meet the requirements of the following subsection:

Mechanical Connectors for Reinforcing Bar Splices (Epoxy Coated) 709-10

Fabrication. Fabrication requirements contained in §704-03, along with the following shall apply.

1. **Design.** When the contract plans contain complete design details for the culvert, alternate designs will not be considered. When the contract plans do not contain complete design details for the culvert the contractor shall be responsible for providing them. Precast concrete box culvert designs, submitted by the contractor, shall meet the requirements of the NYSDOT Reinforced Concrete Box Culvert Design Guidelines. Design details for bridge size culverts shall also include load rating information.

All box culvert designs shall be submitted by the contractor, to the Department, for approval. The processing, approval and transmittal of box culvert designs will be in accordance with procedural directives of the Materials Bureau. Designs shall be submitted at least 45 days prior to the start of fabrication and shall include a complete set of working drawings and a complete set of design calculations. The drawings and design calculations shall be stamped by a Professional Engineer licensed, and registered, to practice in New York State. When the contract plans contain a complete design for the culvert, working drawings are still required. However, they do not have to be stamped by a Professional Engineer and design calculations are not required.

2. **Working Drawings.** Working drawings shall include complete and accurate details for connecting headwalls, cut-off walls, wingwalls, apron slabs and when required, bridge railing to the box culvert. Working drawings for bridge size culverts shall also include load rating information. Working drawings, and when required design calculations, shall be submitted to the Department for approval at least 45 days prior to the start of fabrication. The processing, approval and transmittal of working drawings will be in accordance with procedural directives of the Materials Bureau.

3. **Reproducible Drawings.** Reproducible drawings are required for bridge size culverts only. Upon receipt of approved working drawings from the Materials Bureau, the manufacturer shall prepare a reproducible drawing, incorporating all changes and corrections shown on the approved working drawing. Reproducible drawings shall be submitted to the Materials Bureau for final approval.

Reproducible drawings shall be neatly drawn and clearly legible to produce microfilm negatives. The drawings shall be made in ink or reproduced from the working drawings, on tracing cloth or mylar of acceptable quality. Reproducible drawings shall be cut to a standard size of 22" x 36" (nominal) and arranged to conform to the contract drawings. The margin line shall be drawn one-half inch from the

top, bottom, and right-hand edges and two inches from the left-hand edge to permit binding. A space 3 inches by 11 inches, and parallel to the length of the sheet shall be reserved in the lower right-hand corner for title and approval signature. Each reproducible drawing shall have an identical (top right) corner box to the one shown on the contract drawings. The sheets shall be arranged so that, as far as possible, the notes will appear above each other near the right edge of the sheet.

4. **General.** Unless noted otherwise in the contract plans or approved working drawings the concrete cover over reinforcing steel shall be 1" minimum on the walls, floor slab and roof slab. When fill heights over the box culvert are less than 2'-0", the concrete cover on the outside face of the roof slab shall be 2" minimum and all reinforcing steel in the top mat of the roof slab shall be epoxy coated or the concrete shall contain corrosion inhibitor.

Fill heights shall be measured from the top of pavement to the top of the culvert roof slab. Details for connecting headwalls, cut-off walls, wingwalls, apron slabs and when required, bridge railing to the box culvert shall be as shown in the contract plans or approved working drawings. Precast concrete box culvert sections shall be fabricated with a female joint on the upstream end and male joint on the downstream end. Joint depth shall be a minimum of 2" and a maximum of 4". The ends of longitudinal reinforcing steel shall have ½" minimum concrete cover at the mating surface of the joint. The circumferential reinforcing steel shall have 1" minimum concrete cover, as measured to the outermost bars, at the mating surface of the joint. When interferences occur which prevent this, the concrete cover shall be increased accordingly as shown on the approved working drawings. Joints shall be fabricated such that when box culvert sections are fully drawn together the gap between adjacent culvert sections is ¾" maximum. The outside mating surface of the joint shall have a continuous 1" x 1" gasket installed at the precast plant.

5. **Corrosion Inhibitor.** Corrosion inhibitor may be used in lieu of epoxy coated reinforcing. When corrosion inhibitor is selected for use, it shall be clearly noted on the working drawings and shall be used in all precast units produced to those drawings.

The corrosion inhibitor shall consist of a calcium nitrite solution as approved by the Director, Materials Bureau, containing 30 ±1% calcium nitrite solids by weight and weighing 10.6 ±0.1 pounds per gallon. A representative one quart sample, from each delivery of corrosion inhibitor intended for Department use, shall be taken at the precast plant for acceptance testing. Samples shall be taken by the Department's representatives as directed by the Materials Bureau. The Materials Bureau shall be permitted 14 days to complete the evaluation of each sample.

The calcium nitrite, which acts as an accelerator, may be used in conjunction with compatible retarding admixtures to control setting time and workability of the concrete, however the use of a formulation of calcium nitrite solution which includes a set control ingredient may be used if setting times and increased water demands are of concern, consult with the manufacturer of the product. The corrosion inhibitor must be added to the mix immediately after air entraining and retarding admixtures have been introduced into the batch. The corrosion inhibitor shall be added to the concrete as an aqueous solution at a dosage rate of 4.0 gal./cy.

An automated corrosion inhibitor dispensing system shall be required. The dispensing system shall meet the following requirements:

Delivery accuracy of ±3% (by weight or volume)
Program Quantity (gallons, nearest tenth)
System interlocks
Print requirements:
Project number and/or batch number
Date and time
Delivered quantity (gallons, nearest tenth)

Calibration shall be in accordance with procedures approved by the Director, Materials Bureau.

When a batching problem exists or is perceived the Department reserves the right to test the hardened concrete at any time to verify the quantity of calcium nitrite present. Units with less than the specified amount of calcium nitrite shall be subject to rejection. If hardened concrete is tested, 4" diameter cores shall be drilled by the manufacturer under the supervision of a Department representative. Cores shall be a minimum of 4" in length unless otherwise approved by the Materials Bureau. Core holes shall be plugged and repaired in accordance with the requirements of repair indicated below.

6. **Dimensional Tolerances.** The dimensional tolerances contained in §704-03 shall apply except as noted herein.

a. Internal and external unit dimensions shall not vary by more than ½" from the design dimensions.

b. Slab and wall thickness shall not vary from the design dimension by more than ¼" for thicknesses less than 10", or ½" for thicknesses of 10" or greater.

c. The length of section shall not vary more than ½" from the design dimension.

d. Variations in laying lengths of two opposite surfaces of the box section shall not be more than ½".

Curing. The Curing requirements contained in §704-03 shall apply.

Repair. The Repair requirements contained in §704-03 shall apply, except as noted herein. Minor defects in the mating surface of the joint, that do not come in contact with the joint gasket material and are ¼ " or less in depth, do not require repair.

Sampling and Testing. The Sampling and Testing requirements contained in §704-03 shall apply.

Shipping. The Shipping requirements contained in §704-03 shall apply.

BASIS OF ACCEPTANCE. The Basis of Acceptance requirements contained in §704-03 shall apply.

ITEM 15603.63XXYY M PRECAST CONCRETE BOX CULVERT (Fill Height Less Than 0.6 m)
ITEM 15603.64XXYY M PRECAST CONCRETE BOX CULVERT (Fill Height 0.6 m or Greater)
ITEM 15603.65XXYY M PRECAST CONCRETE BOX CULVERT (Bridge Size, Fill Height Less Than 0.6 m)
ITEM 15603.66XXYY M PRECAST CONCRETE BOX CULVERT (Bridge Size, Fill Height 0.6 m or Greater)

DESCRIPTION

This work shall consist of furnishing and placing single or multi-cell precast reinforced concrete box culvert sections of the type indicated in the plans in accordance with these specifications in the locations indicated and in a manner approved by the Engineer.

MATERIALS

Precast concrete box culvert shall meet the requirements of Section 706-17 Precast Concrete Box Culverts.

CONSTRUCTION DETAILS

A. Inspection, Storage and Handling - Precast box sections will be inspected at the construction site to determine any damage during shipment and for conformance to the dimensional tolerances. An additional inspection will be made prior to placement of precast box sections to determine any damage during storage.

B. Installation

1. Excavation. The requirements specified in Section 206 Trench, Culvert and Structure Excavation, that apply to culverts and storm drains shall govern, except as modified in the plans.

2. Placement. The precast manufacturer shall have a representative available to assist in the installation of the box culvert. Precast box sections shall be installed, true to line and grade, in accordance with the contract plans. Placement of the box sections shall start at the downstream end and proceed upstream, unless otherwise indicated in the contract plans.

3. Joints. Precast box sections shall be installed with the female end upstream and the male joints fully entered therein. The joint openings between adjacent precast units shall not exceed 20 mm. The joints shall be sealed with a continuous gasket installed at the precast plant. Joints shall be drawn together with mechanical connectors, as shown on the approved working drawings. Culverts with a clear rise greater than 1.3 m shall have a minimum of four connectors per joint. Smaller culverts shall have a minimum of two connectors per joint. The number of mechanical connectors supplied shall be equal to the number of connectors required per joint multiplied by the number of joints unless otherwise approved by the Engineer. After installation, connectors may be left on or removed at the contractor's option, unless otherwise noted in the contract plans. When the contract plans require, or the contractor chooses to leave the connectors in place, they shall be located so that they do not create an obstruction inside the culvert.

ITEM 15603.63XXYY M PRECAST CONCRETE BOX CULVERT (Fill Height Less Than 0.6 m)
ITEM 15603.64XXYY M PRECAST CONCRETE BOX CULVERT (Fill Height 0.6 m or Greater)
ITEM 15603.65XXYY M PRECAST CONCRETE BOX CULVERT (Bridge Size, Fill Height Less Than 0.6 m)
ITEM 15603.66XXYY M PRECAST CONCRETE BOX CULVERT (Bridge Size, Fill Height 0.6 m or Greater)

Gaps which occur on the interior surfaces of the culvert due to misalignment or grade difference shall be filled as ordered by the Engineer, with an approved concrete repair material so as to produce a smooth continuous surface.

4. Backfilling. The types of materials to be used in backfilling and the procedure of placement shall conform to the contract plans and the applicable provisions of Subsection 203-3.15.

METHOD OF MEASUREMENT

The quantity to be measured for concrete box culvert sections shall be the number of meters (laying length) furnished and installed in the work. Meters (laying length) shall be measured by multiplying the number of whole units by the nominal length of each unit and adding thereto to the length of any fractional units incorporated in the work. The nominal length of a unit or fractional unit shall be the inside measured length from one butting end to the other butting end measured along the bottom centerline of the unit.

BASIS OF PAYMENT

The quantity to be paid for shall be the number of meters of each size box culvert section incorporated in the work. The unit price bid shall include the cost of furnishing all labor, materials, equipment and installation supervision by the precast manufacturers representative, necessary to satisfactorily complete the work. The cost of furnishing and installing headwalls and cut off walls shall also be included in the unit price bid.

Payment shall be made under Item 15603.63XXYY M, 15603.64XXYY M, 15603.65XXYY M and 15603.66XXYY M, where XX and YY, as indicated in the itemized proposal shall mean the inside span and rise dimensions respectively in meters and tenths of a meter, of the precast section.

ITEM 15603.63XXYY PRECAST CONCRETE BOX CULVERT (Fill Height Less Than 2'-0")
ITEM 15603.64XXYY PRECAST CONCRETE BOX CULVERT (Fill Height 2'-0" or Greater)
ITEM 15603.65XXYY PRECAST CONCRETE BOX CULVERT (Bridge Size, Fill Height Less Than 2'-0")
ITEM 15603.66XXYY PRECAST CONCRETE BOX CULVERT (Bridge Size, Fill Height 2'-0" or Greater)

DESCRIPTION

This work shall consist of furnishing and placing single or multi-cell precast reinforced concrete box culvert sections of the type indicated in the plans in accordance with these specifications in the locations indicated and in a manner approved by the Engineer.

MATERIALS

Precast concrete box culvert shall meet the requirements of Section 706-17 Precast Concrete Box Culverts.

CONSTRUCTION DETAILS

A. Inspection, Storage and Handling - Precast box sections will be inspected at the construction site to determine any damage during shipment and for conformance to the dimensional tolerances. An additional inspection will be made prior to placement of precast box sections to determine any damage during storage.

B. Installation

1. Excavation. The requirements specified in Section 206 Trench, Culvert and Structure Excavation, that apply to culverts and storm drains shall govern, except as modified in the plans.

2. Placement. The precast manufacturer shall have a representative available to assist in the installation of the box culvert. Precast box sections shall be installed, true to line and grade, in accordance with the contract plans. Placement of the box sections shall start at the downstream end and proceed upstream, unless otherwise indicated in the contract plans.

3. Joints. Precast box sections shall be installed with the female end upstream and the male joints fully entered therein. The joint openings between adjacent precast units shall not exceed ¾". The joints shall be sealed with a continuous gasket installed at the precast plant. Joints shall be drawn together with mechanical connectors, as shown on the approved working drawings. Culverts with a clear rise greater than 4' shall have a minimum of four connectors per joint. Smaller culverts shall have a minimum of two connectors per joint. The number of mechanical connectors supplied shall be equal to the number of connectors required per joint multiplied by the number of joints unless otherwise approved by the Engineer. After installation, connectors may be left on or removed at the contractor's option, unless otherwise noted in the contract plans. When the contract plans require, or the contractor chooses to leave the connectors in place, they shall be located so that they do not create an obstruction inside the culvert. Gaps which occur on the interior surfaces of the culvert due to misalignment or grade difference shall be filled as ordered by the Engineer, with an approved concrete repair material so as to produce a smooth continuous surface.

ITEM 15603.63XXYY PRECAST CONCRETE BOX CULVERT (Fill Height Less Than 2'-0")
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ITEM 15603.65XXYY PRECAST CONCRETE BOX CULVERT (Bridge Size, Fill Height Less Than 2'-0")
ITEM 15603.66XXYY PRECAST CONCRETE BOX CULVERT (Bridge Size, Fill Height 2'-0" or Greater)

4. Backfilling. The types of materials to be used in backfilling and the procedure of placement shall conform to the contract plans and the applicable provisions of Subsection 203-3.15.

METHOD OF MEASUREMENT

The quantity to be measured for concrete box culvert sections shall be the number of linear feet (laying length) furnished and installed in the work. Linear feet (laying length) shall be measured by multiplying the number of whole units by the nominal length of each unit and adding thereto to the length of any fractional units incorporated in the work. The nominal length of a unit or fractional unit shall be the inside measured length from one butting end to the other butting end measured along the bottom centerline of the unit.

BASIS OF PAYMENT

The quantity to be paid for shall be the number of linear feet of each size box culvert section incorporated in the work. The unit price bid shall include the cost of furnishing all labor, materials, equipment and installation supervision by the precast manufacturer's representative, necessary to satisfactorily complete the work. The cost of furnishing and installing headwalls and cut off walls shall also be included in the unit price bid.

Payment shall be made under Item 15603.63XXYY, 15603.64XXYY, 15603.65XXYY, and 15603.66XXYY, where XX and YY, as indicated in the itemized proposal shall mean the inside span and rise dimensions respectively in feet, of the precast section.

NYSDOT REINFORCED CONCRETE BOX CULVERT DESIGN GUIDELINES

Reinforced concrete box culverts (precast or cast-in-place) subjected to either earth fill and/or highway vehicle loading shall be designed in accordance with the following:

DESIGN METHOD

The design method shall be either the Service Load Design Method (Allowable Stress Design) or the Strength Design Method (Load Factor Design) as described in Articles 8.15 and 8.16 of the AASHTO Standard Specifications for Highway Bridges - Fifteenth Edition (AASHTO) with NYSDOT modifications described herein.

ANALYSIS METHOD

The analysis of reinforced concrete box culverts shall be in accordance with AASHTO Article 8.8.2 and modified as follows:

> In analysis, distance to the geometric centers of members shall be used in the determination of moments. Moments at faces of support, however, may be used for member design. When a fillet is built monolithic with the member and support, no portion of the fillet shall be considered as adding to the shear and moment capacity of the member.

LOAD FACTORS

The product of the load factors ($\gamma \times \beta$) for the Strength Design Method (Load Factor Design) shall be equal to 1.3 for Dead and Earth Loads and 2.17 for Live Loads in accordance with AASHTO Article 3.22 and Table 3.22.1A Group X.

DEAD LOAD AND EARTH PRESSURE

The Dead Load on the top slab shall consist of the soil plus concrete slab weight.

The following Dead Load and Earth Pressure parameters shall be used in design:

Soil mass density	= 1925 kg/m^3
Concrete mass density	= 2400 kg/m^3
Lateral earth pressure	= 960 kg/m^3 max., 480 kg/m^3 min.

Maximum and minimum values of lateral earth pressure shall be investigated in accordance with AASHTO Articles 3.20.2 and 6.2.1.B.

Soil mass density shall be modified when using the Strength Design Method (Load Factor Design) in accordance with AASHTO Articles 17.6.4.2 and 17.7.4.2 Modification of Earth Loads for Soil Structure Interaction (Embankment Installations).

LIVE LOAD

Reinforced concrete box culverts shall be designed for MS23 vehicle live load.

When the minimum depth of fill is less than 600 mm, wheel loads shall be distributed in accordance with AASHTO Article 3.24.3.2 Case B and modified as follows:

Wheel loads shall be distributed over a distribution slab width, E measured in meters, equal to 1.22 + 0.06S, where S is the perpendicular distance in meters between wall centerlines.

When the culvert is skewed relative to the over roadway, the distribution width, E, shall be reduced by multiplying E by the cosine of the skew angle. In no instance shall the distribution width exceed 2.13 meters nor the section length of precast units.

For fill heights less than 600 mm, the lateral earth pressure shall have added to it a live load surcharge pressure equivalent to 600 mm of earth fill.

When the depth of fill is 600 mm or more, wheel loads shall be distributed in accordance with AASHTO Articles 6.4.1 and 6.4.2:

Wheel loads shall be considered as uniformly distributed over a square with sides equal to 1.75 times the depth of fill. When such areas from several concentrations overlap, the total load shall be uniformly distributed over the area defined by the outside limits of the individual areas, but the total width of distribution shall not exceed the total width of the supporting slab.

LIVE LOAD IMPACT FACTOR

The Live Load Impact Factor, I, described in AASHTO Article 3.8.2 shall be modified as follows:

For fill heights less than 900 mm, the Impact Factor, I, shall be equal to $1 + 15.24/(S + 38.10) \leq 1.3$, where S has been previously defined.

For fill heights greater than or equal to 900 mm, the Impact Factor shall be equal to 1.0.

WALL THICKNESS REQUIREMENTS

Minimum exterior wall thickness requirements for reinforced concrete box culverts have been established to allow for a better distribution of negative moment corner reinforcement as follows:

For clear spans less than 2.45 m, exterior wall thickness no less than 150 mm.

For clear spans greater than or equal to 2.45 m but less than 4.25 m, exterior wall thickness no less than 200 mm.

For clear spans greater than or equal to 4.25 m but less than 6.10 m, exterior wall thickness no less than 250 mm.

For clear spans greater than or equal to 6.10 m, exterior wall thickness no less than 300 mm.

Interior wall thickness, in multi-cell applications, shall be controlled by design but in no instance shall be less than 150 mm.

CONCRETE STRENGTH

Reinforced concrete box culverts shall be designed for the following concrete strengths:

Precast	$f'_c = 35$ MPa
Cast-in-place	$f'_c = 21$ MPa

REINFORCEMENT REQUIREMENTS

Reinforcement shall be either bar reinforcement, welded wire fabric (plain) or welded wire fabric (deformed). Designs shall use a yield strength of 415 MPa for bar reinforcement and 450 MPa for welded wire fabric in accordance with AASHTO Articles 17.6.2.2 and 17.7.2.2.

When the fill height over the box culvert is less than 600 mm, all reinforcing steel in the top mat of the top slab shall be epoxy coated or the concrete shall contain corrosion inhibitor.

The maximum service load stress in the design reinforcing steel for crack control shall be in accordance with AASHTO Articles 17.6.4.7 and 17.7.4.7.

For culverts designed using the Strength Design Method (Load Factor Design) design reinforcement stresses at service loads shall be limited to satisfy the requirements for fatigue in accordance with AASHTO Article 8.16.8.3.

Minimum reinforcement shall be provided in accordance with AASHTO Article 8.17.1 at all cross sections subject to flexural tension, including the inside face of walls.

Distribution reinforcement as described in AASHTO Article 3.24.10 shall be modified as follows:

To provide for the lateral distribution of loads, steel reinforcement shall be placed transverse to the main design steel in both the top and bottom slabs of reinforced concrete box culverts for fill heights less than 600 mm.

The amount of distribution reinforcement required shall be in accordance with AASHTO Article 3.24.10.2 Equation (3-21).

All faces of reinforced concrete box culverts not requiring design or distribution steel shall be reinforced with the equivalent of #13 rebar at 300 mm centers in each direction. Under no circumstances shall any reinforcement be spaced greater than 300 mm.

Shear reinforcement shall not be used in reinforced concrete box culverts. Slab and wall thickness shall be designed to have adequate shear capacity in accordance with AASHTO Articles 8.15.5 or 8.16.6.

SKEWED PRECAST CULVERT SECTIONS

Skewed precast culvert sections shall be designed for the skewed end clear span.

DETAILING REQUIREMENTS

The minimum reinforcing bar cover requirements for precast box culverts shall be as follows:

Exterior concrete cover top slab	50 mm (Fill < 600 mm) 25 mm (Fill ≥ 600 mm)
Exterior concrete cover bottom slab	25 mm
Exterior concrete cover walls	25 mm
Interior concrete cover	25 mm

The minimum reinforcing bar cover requirements for cast-in-place box culverts shall be as follows:

Exterior concrete cover top slab	50 mm
Exterior concrete cover bottom slab	75 mm
Exterior concrete cover walls	50 mm
Interior concrete cover	50mm

The minimum bending radius of negative moment reinforcing steel (outside corners top and bottom slabs) shall be in accordance with AASHTO Article 8.23.2 Minimum Bend Diameters.

Top and bottom slab outside face transverse steel shall be full length bars unless spliced to top and bottom slab corner reinforcing steel.