

MINNESOTA DEPARTMENT OF TRANSPORTATION

Bridge Office

Bridge Standard Plans Manual

MnDOT BRIDGE OFFICE

Bridge Standards Plan Manual

Box Culverts

Minnesota Department of Transportation
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Last Date Revised: October 09, 2015

Figure 5-395.100(A)
Precast Concrete Box Culvert-Basis of Design

Approved, and signed, March 24, 2011. Last date revised: October 9, 2015.

Revised 10-09-2015

Under BASIS OF DESIGN:

- Changed the year designation from “2012” to “2014” and edition from “Fifth” to “Seventh” in the first note.

Under MATERIAL PROPERTIES:

- Changed “Welded Wire Fabric Reinforcement, Minimum” to “Welded Wire Reinforcement, Minimum”.

Under SOIL DATA:

- Added new line: “Internal Friction Angle of Backfill . . . 30 Degrees”.
- Changed “roadway” to “pavement” and expanded definition of “H” to “H = Fill Height, Defined as the Distance From the Top of the Culvert to the Top of the Pavement *or to Top of Fill if There is No Pavement.*” to the right of SOIL STRUCTURE INTERACTION FACTOR, F_e .

Added new section: LOAD RATING:

- All standard concrete box culverts were designed to meet the 2014 AASHTO LRFR requirements with a minimum LRFR bridge operating rating factor = 1.3 for HL-93, MnDOT standard permit trucks G-80, and MnDOT standard permit trucks G-07. HL-93 was the governing load.

Under STRUCTURAL ARRANGEMENT:

- Changed mentions of “Welded Wire Fabric” to “Welded Wire Reinforcement” in the second and third sentences of the first paragraph.
- Changed “. . . the area of reinforcement shall be increased by 8% and contractor shall submit . . .” to “. . . increase the area of reinforcement by 8% and submit . . .” in the third sentence of the first paragraph.
- Changed “The spacing center to center of the transverse wires shall not be less than 2 in. nor more than 4in. the spacing center to center of the longitudinal sires shall not be more than 8 in.” to “Space center to center of transverse wires not less than 2” nor more than 4”. Space center to center of longitudinal wires not more than 8”.” to the right of REINFORCEMENT SPACING.
- Changed note under circled note ③ “Culverts constructed without haunches require special design not included in these standards.” to be on one line instead of two.
- Corrected the note next to AXIAL THRUST from “. . . However was . . .” to “. . . However it was . . .”

Revised 09-11-2014

Under BASIS OF DESIGN:

Added new section: **MINIMUM DISTANCE BETWEEN ADJACENT LINES OF BOX CULVERTS:**

The use of “U Bolt Ties” (refer to Roadway Std Plate 3145) to secure culvert sections requires approximately 18” of room between adjacent lines of box culverts to allow for installation of the tie. This distance can be reduced to as little as 6” by using a “Double Connection Tie” (refer to Roadway Std Plate 3145) and placing the tie on the interior side of the second (and third) culvert line. Provide a nut and washer at each end of the double connection tie rod. In no case shall the distance between adjacent boxes be less than 6”.

Revised 11-06-2013

Under BASIS OF DESIGN:

- Changed the year designation *from* “2010” *to* “2012” and removed the “/” in Mn/DOT in the first note.
- At **APPROACHING VEHICLE LOAD** - EQUIVALENT FILL HEIGHT table: Changed the (FT.) to lower case (ft.).
- At **WATER**: Changed the “Equal to inside Height” *to* “Equal to inside Rise”.
- At **STRUCTURAL ARRANGEMENT** Changed the word “AREAS” *to* “AREA” in the fourth sentence of the paragraph. Also added to the end of the paragraph : “and contractor shall submit design calculations verifying compliance with AASHTO 5.7.3.4 "control of cracking by distribution of reinforcement".”

At BOX CULVERT CROSS SECTION: Changed the dimensions “H” to “RISE” and “W” to “SPAN”.

Revised 06-06-2011

Added the year designation “2010” to the following note: Designed in accordance with 2010 AASHTO LRFD Bridge Design Specifications.

Expanded the Axial Thrust criteria to: “The benefit of axial thrust was not included in the box culvert design for the strength limit state, however was included in the service limit state crack control check.”

Added the Crack Control criteria: “Crack control check per AASHTO 5.7.3.4 assuming class 2 exposure conditions. The stress in the steel reinforcement calculated per AASHTO C12.11.3 and limited to $0.6 \cdot f_y$. Include axial thrust in service limit state analysis.”

Changed the last sentence of the shear excerpt to: “For slabs of boxes with 2 ft. of fill or greater the shear resistance was calculated per AASHTO 5.14.5.3. up to a maximum thickness of 12 inches. For such slabs with thicknesses exceeding 12 in., contact the Bridge Standards Unit for shear provisions.”

Re-Approved 03-24-2011

The previous Standard Figure 5-395.100(A) “*Precast Concrete Box Culvert Tables*” has been completely eliminated. The new Standard Figure 5-395.100(A) is “*Precast Concrete Box Culvert – Basis of Design*”.

The *Precast Concrete Box Culvert - Basis of Design* sheet was added to document all major design criteria including assumed parameters, load combinations, load factors, load distribution, detailing assumptions, etc.

Per the LRFD code, the design live load configuration was changed from HS25 to HL93 (modified for precast box culverts). The live load distribution was changed from the application of wheel “point” loads to the application of wheel “patch” loads per the code. The load distribution spread was also updated.

Added: Box Culvert Cross Section.

Note: “Precast Concrete Box Culvert Tables” are now included on Standard Figures 5-395.100(B), (C), (D), and (E).

06-30-2003

At BOX CULVERT CROSS SECTION: Added © symbol.

Under GENERAL NOTES: Added note © AS AN ALTERNATE, REBAR MESH CAN BE USED AS ONE COMMON SHEET FOR As1/As5 OR As2/As3/As4.

Approved, and signed, December 11, 2000

Figure 5-395.100(B)
Precast Concrete Box Culvert Tables

Approved, and signed, March 24, 2011. Last date revised: October 9, 2015.

Revised 10-09-2015

Under GENERAL NOTES:

- Changed and expanded the second sentence of the first paragraph from “. . . top of the roadway.” to “. . . top of the pavement or to top of fill if there is no pavement.”
- Changed the second sentence of paragraph five from “The width of the distribution slab shall extend between the outside edges of the shoulders unless directed by the engineer.” to “Extend the width of the distribution slab to the outside edges of the roadway shoulders unless directed by the engineer.”
- Changed concrete mix “3Y43” to “3S52” in sixth note, as per 2016 spec. book.
- Changed “Cast-in-place distribution slabs to be 6” thick with . . .” to “Place 6” thick cast-in-place distribution slabs with . . .” in first sentence of seventh paragraph.
- Changed second sentence in seventh paragraph from “All distribution slab reinforcement shall be epoxy coated.” to “Epoxy coat all distribution slab reinforcement.”
- Changed second sentence in eighth paragraph from “Distribution slab joints must be centered over barrel segments.” to “Center distribution slab joints over barrel segments.”
- Changed ninth note from “If distribution slab is used as pavement surface it must be redesigned per the MnDOT pavement design manual.” to “Redesign distribution slab per the MnDOT pavement design manual if it is used as pavement surface.”
- Changed “welded wire fabric” to “welded wire reinforcement” in the third and fourth sentences of circled note ①.
- Changed “. . . the area of reinforcement shall be increased by 8%, and contractor shall submit design . . .” to “. . . increase the area of reinforcement by 8%, and submit design . . .” in the fourth sentence of circled note ①.
- Changed circled note ② from “Longitudinal reinforcement denoted as As5 and As6 must be placed in all slabs and walls and must be .06 in²/ft. minimum.” to “Place longitudinal reinforcement denoted as As5 and As6 in all slabs and walls with a minimum of .06 in²/ft.”

Revised 09-11-2014

Under GENERAL NOTES:

- Changed the 5th note: Added “Roadway or Shoulder” to the beginning of the note.
- Changed the spec. number *From:* 3149.2B2 *To:* 3149.2.B.2 in the 7th and 8th notes.

Revised 11-06-2013

In the TABLE: Changed the title of the first column *from* SIZE W x H (ft.) *to* SIZE SPAN x RISE (ft.)

At BOX CULVERT CROSS SECTION: Changed the dimensions “H” *to* “RISE” and “W” *to* “SPAN”.

Under GENERAL NOTES:

- Added the word “Standard” to precede the figure number in all instances.
- Removed the “slash” (/) from the Mn/DOT in all instances.
- Removed the term “Mn/DOT” from all of the locations referencing a Mn/DOT spec.
- Changed the 5th note to read: Fill heights of less than 2'-0" require a distribution slab. The width of the distribution slab shall extend between the outside edges of the shoulders unless directed by the engineer.
- Changed the 6th note to read: Use concrete mix 3Y43 for the distribution slab.
- Added in the 7th note: All distribution slab reinforcement shall be epoxy coated.
- Added to numbered note ①: If bar reinforcement is substituted for welded wire fabric, the area of reinforcement shall be increased by 8%, and contractor shall submit design calculations verifying

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compliance with AASHTO 5.7.3.4 "control cracking by distribution of reinforcement".

Revised 04-17-2013

This standard was updated to convert reinforcing bar marks from metric to U.S. customary bar designations.

Revised 06-06-2011

Modified As7 /As8 lengths so that they don't extend into the radius bend of the box culvert corner.

Changed the minimum "M" length for As1 to 32" min. or a wall thickness + 12" + max (dv or d) + 6". The total length As1 was modified accordingly.

The total length As1, was measured on the outside edge of the bar.

The As1 development length was updated and is now based on a W23 in situations when two layers of welded wire fabric (stacked) are required.

The development length modifier of (65ksi/60ksi) was removed from the development length calculation. M lengths and As7/As8 lengths were modified accordingly.

Re-Approved 03-24-2011

The Standard Figure changes are:

- The reinforcement table, culvert section properties, and classes have been updated based on LRFD design methodology. Standard Figure 5-395.100(B) includes culvert sizes ranging from 6'x4' to 10'x10'. See new Standard Figures 5-395.100(C), (D), and (E) for additional culvert sizes.
- The "General Notes" have been updated to match the new LRFD design methodology. Added clarification for class 1 culverts and distribution slabs, "Fill heights of less than 2'-0" require a distribution slab over the fill area of roadway and shoulders. Class 1 culverts with 2' to 3' of fill and all class 2, 3, and 4 culverts do not require a distribution slab."
- Added: "Transverse reinforcement is parallel to the culvert span. Longitudinal reinforcement is perpendicular to the culvert span."
- Changed distribution slab reinforcement to, "No.16 bars at 1'-0" transversely and No. 16 bars at 1'-0" longitudinally."
- Changed distribution slab bedding requirements to, "Provide 3" minimum granular material between barrel and distribution slab for cast-in-place slab and 6" minimum granular between barrel and distribution slab for a precast slab."
- Added: "If distribution slab is used as pavement surface it must be redesigned per the Mn/DOT pavement design manual."
- Reinforcement labeled As5 in the previous table is now labeled As7 (top) slab and As8 (bottom) slab.
- A "Box Culvert Cross Section" reflecting the updated reinforcement and haunch dimensions has been added to the sheet.

Deleted: The "Basis of Design" notes previous located on this sheet have been enhanced and moved to Standard Figure 5-395.100(A).

Approved, and signed, December 11, 2000.

Figure 5-395.100(C)
Precast Concrete Box Culvert Tables

Approved, and signed, March 24, 2011. Last date revised: October 9, 2015.

Revised 10-09-2015

Under GENERAL NOTES:

- Changed and expanded the second sentence of the first paragraph from “. . . top of the roadway.” to “. . . top of the pavement or to top of fill if there is no pavement.”
- Changed the second sentence of paragraph five from “The width of the distribution slab shall extend between the outside edges of the shoulders unless directed by the engineer.” to “Extend the width of the distribution slab to the outside edges of the roadway shoulders unless directed by the engineer.”
- Changed concrete mix “3Y43” to “3S52” in sixth note, as per 2016 spec. book.
- Changed “Cast-in-place distribution slabs to be 6” thick with . . .” to “Place 6” thick cast-in-place distribution slabs with . . .” in first sentence of seventh paragraph.
- Changed second sentence in seventh paragraph from “All distribution slab reinforcement shall be epoxy coated.” to “Epoxy coat all distribution slab reinforcement.”
- Changed second sentence in eighth paragraph from “Distribution slab joints must be centered over barrel segments.” to “Center distribution slab joints over barrel segments.”
- Changed ninth note from “If distribution slab is used as pavement surface it must be redesigned per the MnDOT pavement design manual.” to “Redesign distribution slab per the MnDOT pavement design manual if it is used as pavement surface.”
- Changed “welded wire fabric” to “welded wire reinforcement” in the third and fourth sentences of circled note ①.
- Changed “. . . the area of reinforcement shall be increased by 8%, and contractor shall submit design . . .” to “. . . increase the area of reinforcement by 8%, and submit design . . .” in the fourth sentence of circled note ①.
- Changed circled note ② from “Longitudinal reinforcement denoted as As5 and As6 must be placed in all slabs and walls and must be .06 in²/ft. minimum.” to “Place longitudinal reinforcement denoted as As5 and As6 in all slabs and walls with a minimum of .06 in²/ft.”

Revised 09-11-2014

Under GENERAL NOTES:

- Changed the 5th note: Added “Roadway or Shoulder” to the beginning of the note.
- Changed the spec. number *From:* 3149.2B2 *To:* 3149.2.B.2 in the 7th and 8th notes.

Revised 11-06-2013

In the TABLE: Changed the title of the first column *from* SIZE W x H (ft.) *to* SIZE SPAN x RISE (ft.)

At BOX CULVERT CROSS SECTION: Changed the dimensions “H” *to* “RISE” and “W” *to* “SPAN”.

Under GENERAL NOTES:

- Added the word “Standard” to precede the figure number in all instances.
- Removed the “slash” (/) from the Mn/DOT in all instances.
- Removed the term “Mn/DOT” from all of the locations referencing a Mn/DOT spec.
- Changed the 5th note to read: Fill heights of less than 2'-0" require a distribution slab. The width of the distribution slab shall extend between the outside edges of the shoulders unless directed by the engineer.
- Changed the 6th note to read: Use concrete mix 3Y43 for the distribution slab.
- Added in the 7th note: All distribution slab reinforcement shall be epoxy coated.

Added to numbered note ①: If bar reinforcement is substituted for welded wire fabric, the area of reinforcement shall be increased by 8%, and contractor shall submit design calculations verifying compliance with AASHTO 5.7.3.4 "control cracking by distribution of reinforcement".

Revised 04-17-2013

This standard was updated to convert reinforcing bar marks from metric to U.S. customary bar designations.

Revised 06-06-2011

Modified As7 /As8 lengths so that they don't extend into the radius bend of the box culvert corner.

Changed the minimum "M" length for As1 to 32" min. or a wall thickness + 12" + max (dv or d) + 6". The total length As1 was modified accordingly.

The total length As1, was measured on the outside edge of the bar.

The As1 development length was updated and is now based on a W23 in situations when two layers of welded wire fabric (stacked) are required.

The development length modifier of (65ksi/60ksi) was removed from the development length calculation. M lengths and As7/As8 lengths were modified accordingly.

New Standard

New Standard Figure 5-395.100(C) is a continuation of the Precast Concrete Box Culvert Tables started on Figure 5-395.100(B). Standard Figure 5-395.100(C) includes culvert sizes ranging from 12'x4' to 12'x12'. See new Standard Figures 5-395.100(B), (D), and (E) for additional culvert sizes.

- The reinforcement table, culvert section properties, and classes have been updated based on LRFD design methodology.
- The "General Notes" have been updated to match the new LRFD design methodology. Added clarification for class 1 culverts and distribution slabs, "Fill heights of less than 2'-0" require a distribution slab over the fill area of roadway and shoulders. Class 1 culverts with 2' to 3' of fill and all class 2, 3, and 4 culverts do not require a distribution slab."
- Added: "Transverse reinforcement is parallel to the culvert span. Longitudinal reinforcement is perpendicular to the culvert span."
- Changed distribution slab reinforcement to, "No.16 bars at 1'-0" transversely and No. 16 bars at 1'-0" longitudinally."
- Changed distribution slab bedding requirements to, "Provide 3" minimum granular material between barrel and distribution slab for cast-in-place slab and 6" minimum granular between barrel and distribution slab for a precast slab."
- Added: "If distribution slab is used as pavement surface it must be redesigned per the Mn/DOT pavement design manual."
- Reinforcement labeled As5 in the previous table is now labeled As7 (top) slab and As8 (bottom) slab.

A "Box Culvert Cross Section" reflecting the updated reinforcement and haunch dimensions has been added to the sheet.

Figure 5-395.100(D)
Precast Concrete Box Culvert Tables

Approved, and signed, March 24, 2011. Last date revised: October 9, 2015.

Revised 10-09-2015

Under GENERAL NOTES:

- Changed and expanded the second sentence of the first paragraph from “. . . top of the roadway.” to “. . . top of the pavement or to top of fill if there is no pavement.”
- Changed the second sentence of paragraph five from “The width of the distribution slab shall extend between the outside edges of the shoulders unless directed by the engineer.” to “Extend the width of the distribution slab to the outside edges of the roadway shoulders unless directed by the engineer.”
- Changed concrete mix “3Y43” to “3S52” in sixth note, as per 2016 spec. book.
- Changed “Cast-in-place distribution slabs to be 6” thick with . . .” to “Place 6” thick cast-in-place distribution slabs with . . .” in first sentence of seventh paragraph.
- Changed second sentence in seventh paragraph from “All distribution slab reinforcement shall be epoxy coated.” to “Epoxy coat all distribution slab reinforcement.”
- Changed second sentence in eighth paragraph from “Distribution slab joints must be centered over barrel segments.” to “Center distribution slab joints over barrel segments.”
- Changed ninth note from “If distribution slab is used as pavement surface it must be redesigned per the MnDOT pavement design manual.” to “Redesign distribution slab per the MnDOT pavement design manual if it is used as pavement surface.”
- Changed “welded wire fabric” to “welded wire reinforcement” in the third and fourth sentences of circled note ①.
- Changed “. . . the area of reinforcement shall be increased by 8%, and contractor shall submit design . . .” to “. . . increase the area of reinforcement by 8%, and submit design . . .” in the fourth sentence of circled note ①.
- Changed circled note ② from “Longitudinal reinforcement denoted as As5 and As6 must be placed in all slabs and walls and must be .06 in²/ft. minimum.” to “Place longitudinal reinforcement denoted as As5 and As6 in all slabs and walls with a minimum of .06 in²/ft.”

Revised 09-11-2014

Under GENERAL NOTES:

- Changed the 5th note: Added “Roadway or Shoulder” to the beginning of the note.
- Changed the spec. number *From:* 3149.2B2 *To:* 3149.2.B.2 in the 7th and 8th notes.

Revised 11-06-2013

In the TABLE: Changed the title of the first column *from* SIZE W x H (ft.) *to* SIZE SPAN x RISE (ft.)

At BOX CULVERT CROSS SECTION: Changed the dimensions “H” *to* “RISE” and “W” *to* “SPAN”.

Under GENERAL NOTES:

- Added the word “Standard” to precede the figure number in all instances.
- Removed the “slash” (/) from the Mn/DOT in all instances.
- Removed the term “Mn/DOT” from all of the locations referencing a Mn/DOT spec.
- Changed the 5th note to read: Fill heights of less than 2'-0" require a distribution slab. The width of the distribution slab shall extend between the outside edges of the shoulders unless directed by the engineer.
- Changed the 6th note to read: Use concrete mix 3Y43 for the distribution slab.
- Added in the 7th note: All distribution slab reinforcement shall be epoxy coated.

Added to numbered note ①: If bar reinforcement is substituted for welded wire fabric, the area of reinforcement shall be increased by 8%, and contractor shall submit design calculations verifying compliance with AASHTO 5.7.3.4 "control cracking by distribution of reinforcement".

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Revised 04-17-2013

This standard was updated to convert reinforcing bar marks from metric to U.S. customary bar designations.

Revised 06-06-2011

Modified As7 /As8 lengths so that they don't extend into the radius bend of the box culvert corner.

Changed the minimum "M" length for As1 to 32" min. or a wall thickness + 12" + max (dv or d) + 6". The total length As1 was modified accordingly.

The total length As1, was measured on the outside edge of the bar.

The As1 development length was updated and is now based on a W23 in situations when two layers of welded wire fabric (stacked) are required.

The development length modifier of (65ksi/60ksi) was removed from the development length calculation. M lengths and As7/As8 lengths were modified accordingly.

New Standard

New Standard Figure 5-395.100(D) is a continuation of the Precast Concrete Box Culvert Tables started on Figures 5-395.100(B) and 5-395.100(C). Standard Figure 5-395.100(D) includes culvert sizes ranging from 14'x4' to 14'x14'. See new Standard Figures 5-395.100(B), (C), and (E) for additional culvert sizes.

- The reinforcement table, culvert section properties, and classes have been updated based on LRFD design methodology.
- The "General Notes" have been updated to match the new LRFD design methodology. Added clarification for class 1 culverts and distribution slabs, "Fill heights of less than 2'-0" require a distribution slab over the fill area of roadway and shoulders. Class 1 culverts with 2' to 3' of fill and all class 2, 3, and 4 culverts do not require a distribution slab."
- Added: "Transverse reinforcement is parallel to the culvert span. Longitudinal reinforcement is perpendicular to the culvert span."
- Changed distribution slab reinforcement to, "No.16 bars at 1'-0" transversely and No. 16 bars at 1'-0" longitudinally."
- Changed distribution slab bedding requirements to, "Provide 3" minimum granular material between barrel and distribution slab for cast-in-place slab and 6" minimum granular between barrel and distribution slab for a precast slab."
- Added: "If distribution slab is used as pavement surface it must be redesigned per the Mn/DOT pavement design manual."
- Reinforcement labeled As5 in the previous table is now labeled As7 (top) slab and As8 (bottom) slab.

A "Box Culvert Cross Section" reflecting the updated reinforcement and haunch dimensions has been added to the sheet.

Figure 5-395.100(E)
Precast Concrete Box Culvert Tables

Approved, and signed, March 24, 2011. Last date revised: October 9, 2015.

Revised 10-09-2015

Under GENERAL NOTES:

- Changed and expanded the second sentence of the first paragraph from “. . . top of the roadway.” to “. . . top of the pavement or to top of fill if there is no pavement.”
- Changed the second sentence of paragraph five from “The width of the distribution slab shall extend between the outside edges of the shoulders unless directed by the engineer.” to “Extend the width of the distribution slab to the outside edges of the roadway shoulders unless directed by the engineer.”
- Changed concrete mix “3Y43” to “3S52” in sixth note, as per 2016 spec. book.
- Changed “Cast-in-place distribution slabs to be 6” thick with . . .” to “Place 6” thick cast-in-place distribution slabs with . . .” in first sentence of seventh paragraph.
- Changed second sentence in seventh paragraph from “All distribution slab reinforcement shall be epoxy coated.” to “Epoxy coat all distribution slab reinforcement.”
- Changed second sentence in eighth paragraph from “Distribution slab joints must be centered over barrel segments.” to “Center distribution slab joints over barrel segments.”
- Changed ninth note from “If distribution slab is used as pavement surface it must be redesigned per the MnDOT pavement design manual.” to “Redesign distribution slab per the MnDOT pavement design manual if it is used as pavement surface.”
- Changed “welded wire fabric” to “welded wire reinforcement” in the third and fourth sentences of circled note ①.
- Changed “. . . the area of reinforcement shall be increased by 8%, and contractor shall submit design . . .” to “. . . increase the area of reinforcement by 8%, and submit design . . .” in the fourth sentence of circled note ①.
- Changed circled note ② from “Longitudinal reinforcement denoted as As5 and As6 must be placed in all slabs and walls and must be .06 in²/ft. minimum.” to “Place longitudinal reinforcement denoted as As5 and As6 in all slabs and walls with a minimum of .06 in²/ft.”

Revised 09-11-2014

Under GENERAL NOTES:

- Changed the 5th note: Added “Roadway or Shoulder” to the beginning of the note.
- Changed the spec. number *From:* 3149.2B2 *To:* 3149.2.B.2 in the 7th and 8th notes.

Revised 11-06-2013

In the TABLE: Changed the title of the first column *from* SIZE W x H (ft.) *to* SIZE SPAN x RISE (ft.)

At BOX CULVERT CROSS SECTION: Changed the dimensions “H” *to* “RISE” and “W” *to* “SPAN”.

Under GENERAL NOTES:

- Added the word “Standard” to precede the figure number in all instances.
- Removed the “slash” (/) from the Mn/DOT in all instances.
- Removed the term “Mn/DOT” from all of the locations referencing a Mn/DOT spec.
- Changed the 5th note to read: Fill heights of less than 2'-0" require a distribution slab. The width of the distribution slab shall extend between the outside edges of the shoulders unless directed by the engineer.
- Changed the 6th note to read: Use concrete mix 3Y43 for the distribution slab.
- Added in the 7th note: All distribution slab reinforcement shall be epoxy coated.

Added to numbered note ①: If bar reinforcement is substituted for welded wire fabric, the area of reinforcement shall be increased by 8%, and contractor shall submit design calculations verifying compliance with AASHTO 5.7.3.4 "control cracking by distribution of reinforcement".

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Revised 04-17-2013

This standard was updated to convert reinforcing bar marks from metric to U.S. customary bar designations.

Revised 06-06-2011

Modified As7 /As8 lengths so that they don't extend into the radius bend of the box culvert corner.

Changed the minimum "M" length for As1 to 32" min. or a wall thickness + 12" + max (dv or d) + 6". The total length As1 was modified accordingly.

The total length As1, was measured on the outside edge of the bar.

The As1 development length was updated and is now based on a W23 in situations when two layers of welded wire fabric (stacked) are required.

The development length modifier of (65ksi/60ksi) was removed from the development length calculation. M lengths and As7/As8 lengths were modified accordingly.

New Standard

New Standard Figure 5-395.100(E) is a continuation of the Precast Concrete Box Culvert Tables started on Figures 5-395.100(B), 5-395.100(C) and 5-395.100(D). Standard Figure 5-395.100(E) includes culvert sizes ranging from 16'x4' to 16'x12'. See new Standard Figures 5-395.100(B), (C), and (D) for additional culvert sizes.

- The reinforcement table, culvert section properties, and classes have been updated based on LRFD design methodology.
- The "General Notes" have been updated to match the new LRFD design methodology. Added clarification for class 1 culverts and distribution slabs, "Fill heights of less than 2'-0" require a distribution slab over the fill area of roadway and shoulders. Class 1 culverts with 2' to 3' of fill and all class 2, 3, and 4 culverts do not require a distribution slab."
- Added: "Transverse reinforcement is parallel to the culvert span. Longitudinal reinforcement is perpendicular to the culvert span."
- Changed distribution slab reinforcement to, "No.16 bars at 1'-0" transversely and No. 16 bars at 1'-0" longitudinally."
- Changed distribution slab bedding requirements to, "Provide 3" minimum granular material between barrel and distribution slab for cast-in-place slab and 6" minimum granular between barrel and distribution slab for a precast slab."
- Added: "If distribution slab is used as pavement surface it must be redesigned per the Mn/DOT pavement design manual."
- Reinforcement labeled As5 in the previous table is now labeled As7 (top) slab and As8 (bottom) slab.

A "Box Culvert Cross Section" reflecting the updated reinforcement and haunch dimensions has been added to the sheet.

Figure 5-395.101(A)
Barrel Details

Approved, and signed, March 24, 2011. Last date revised: October 9, 2015

Revised 10-09-2015

At TRANSVERSE BARREL SECTION:

- Changed note: “1’-0” MAX., 7” MIN. RADIUS OR 7” MAX., 4” MIN. CHAMFER (TYP.)” to “RADIUS (7” MIN., 1’-0” MAX.) OR CHAMFER (4” MIN., 7” MAX.) (TYP.)”

At FABRIC LAYER DETAIL:

- Changed the title of the “FABRIC LAYER DETAIL” to “REINFORCEMENT LAYER DETAIL”.
- Changed all cases of “welded wire fabric” to “welded wire reinforcement” in notes and text.
- Changed “. . . the wires of the welded wire fabric shall be placed as shown” to “. . . place the wires of the welded wire reinforcement as shown” in the text under the diagram.

At BARREL INFORMATION TABLE:

- Changed “Welded Wire Fabric Reinforcement” to “Welded Wire Reinforcement”.

Under CONSTRUCTION NOTES:

- Changed first note from “Culverts to be constructed as per spec. 2412 except as noted.” to “Construct culverts per spec. 2412 except as noted.”
- Changed third note from “The welded wire fabric, shear reinforcement and reinforcement and reinforcement bars shall conform to applicable requirements of AASHTO M259.” to “Provide welded wire reinforcement, shear reinforcement and reinforcement bars per the applicable requirements of AASHTO M259.”
- Changed “welded wire fabric” to “welded wire reinforcement” in parts a) and b) of the fifth note.
- Changed paragraph in the fifth note from “The reinforcement shall be developed in accordance with AASHTO ‘LRFD Bridge Design Specifications’. If bar reinforcement is substituted for welded wire fabric, the area of reinforcement shall be increased by 8%, and contractor shall submit design calculations verifying compliance with AASHTO 5.7.3.4. ‘Control of Cracking by Distribution of Reinforcement’.” to “Develop reinforcement in accordance with AASHTO ‘LRFD Bridge Design Specification’. If bar reinforcement is substituted for welded wire reinforcement, increase the area of reinforcement by 8% and submit design calculations verifying compliance with AASHTO 5.7.3.4. ‘Control of Cracking by Distribution of Reinforcement’.”
- Changed both instances of “shall be” to “is” and “welded wire fabric” to “welded wire reinforcement” in note six.
- Changed both instances of “The spacing” to “Space” in note seven.
- Changed note eight from “Welding will not be allowed on reinforcement bars or welded wire fabric, except that the original welding required to manufacture wire fabric is acceptable.” to “Welding is not permitted on reinforcement bars or welded wire reinforcement, except that the original welding required to manufacture wire reinforcement is acceptable.”
- Changed “. . . additional reinforcement shall be added . . .” to “. . . place additional reinforcement . . .” in note nine.
- Changed note ten from “Concrete shall be mix no. 3W36 with no calcium chloride allowed.” to “Use concrete mix no. 3W82 with no calcium chloride added.” Concrete mix designation changed to match 2016 spec. book.
- Changed first sentence of circled note ① from “Culvert ties are to be 1” diameter rods.” to “Use 1” diameter culvert ties.”
- Changed circled note ② from “Haunch sizes are to be 12” vertical, 12” horizontal on all box sizes.” to “Use 12” vertical, 12” horizontal haunches on all box sizes.”
- Changed circled note ③ from “Longitudinal reinforcement denoted as As5 and As6 must be placed in all slabs and walls and must be 0.06 sq. in./ft. min.” to “Place longitudinal reinforcement denoted as As5 and As6 in all slabs and walls with a minimum of 0.06 sq. in./ft.”
- Changed concrete mix designation in the first note under circled note ④ from “3Y43” to “3S52” to match 2016 spec. book.

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- Changed the first sentence of the second note under circled note ④ from “Cast-in-place distribution slabs shall be 6” thick.” to “Place 6” thick cast-in-place distribution slabs.”
- Changed the third note under circled note ④ from “Precast distribution slabs shall be 6” thick and may . . .” to “6” thick precast distribution slabs may . . .”
- Changed circled note ④ from “The width of the distribution slab shall extend between the outside edges of the shoulders unless directed by the engineer.” to “Extend the width of the distribution slab to the outside edges of the roadway shoulders unless directed by the engineer.”
- Changed “shall be” to “is” in the fifth note under circled note ④.
- Changed the sixth note under circled note ④ from “If distribution slab is used as pavement surface it must be redesigned per the MnDOT pavement design manual.” to “Redesign the distribution slab per the MnDOT pavement design manual if it is used as pavement surface.”

Revised 09-11-2014

Changed all instances throughout the standard sheet *From: Granular Material To: Select Granular Material.*

Changed all instances throughout the standard sheet *From: Spec. 3149.2B2 To: Spec. 3149.2.B.2.*

Changed the sheet title name. *From: BARREL DETAILS To: PRECAST CONCRETE BARREL DETAILS.*

Under CONSTRUCTION NOTES:

- Changed the 2nd note to read: Refer to the general plan and elevation sheet for the distance between barrels of adjacent boxes and to standard figure 5-395.115 for material requirements for fill between adjacent boxes.
- Changed the spec. number in the 11th note *From: 3238.2A To: 3238.2.A*
- Changed numbered note ④: Added “Roadway or Shoulder” to the beginning of the note.

Revised 11-06-2013

Throughout the sheet:

- Removed the “slash” (/) from the Mn/DOT in all instances.
- Removed the term “Mn/DOT” from all of the locations referencing a Mn/DOT spec.

At the DISTRIBUTION SLAB SECTION and DISTRIBUTION SLAB-LONGITUDINAL SECTION:

- Added “(EPOXY COATED)” to all references to the reinforcement in the distribution slab.

At the TRANSVERSE BARREL SECTION:

- Changed the dimensions “H” to “RISE” and “W” to “SPAN”.
- Changed the haunch bar note to identify the length of the haunch bar based on wall or slab thickness.

At the LONGITUDINAL BARREL SECTION:

- Changed the dimensions “H” to “RISE”.

At the BARREL INFORMATION TABLE, under the column DIMENSIONS:

- Changed the SUB-COLUMN “H” to “RISE” and “W” to “SPAN”.

At the notes for the BARREL INFORMATION TABLE, the note defined by the double asterisk (**):

- Removed the MnDOT reference and changed the plate number *from 3145F to 3145.*

Updated the signature block to make it similar to other standards.

At CONSTRUCTION NOTES:

- Changed the word “Areas” to “Area” in the 6th note.
- Also added to the end of the 6th note: “and contractor shall submit design calculations verifying compliance with AASHTO 5.7.3.4 “control of cracking by distribution of reinforcement”.”
- At numbered note ④: Changed the 2nd note to read: Use concrete mix 3Y43 for the distribution slab.
- At numbered note ④: Added note: “The width of the distribution slab shall extend between the outside edges of the shoulders unless directed by the engineer.”
- At numbered note ④: Added note: “Payment for the distribution slab and granular material beneath the slab shall be considered incidental.”

Revised 04-17-2013

This standard was updated to convert reinforcing bar marks from metric to U.S. customary bar designations.

Re-Approved 03-24-2011

At the TRANSVERSE BARREL SECTION:

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- Shortened the No. 10 haunch bars in the view to more accurately show the length. Also added a circled leader line at the end of one of the haunch bars with the note, “Haunch bar to extend to, but not past, outside reinforcing (typ.)”
- Added a large circled leader to the lower right corner labeled as, “Tongue and Groove Shown.” Within the circle the tongue and groove faces were added. Removed all reinforcement within the circle and added a leader line with note, “Reinforcement not shown for clarity.”
- Top transverse bar was changed from As5 to As7. Bottom transverse bar was changed from As5 to As8. All outside longitudinal bars are labeled as As5 with ③. All inside longitudinal bars are labeled as As6 with ③.

Added to the sheet: “DISTRIBUTION SLAB SECTION” above the Transverse Barrel Section.

At the LONGITUDINAL BARREL SECTION:

- Changed note from: “As4 cut as necessary to achieve cover requirements” To: “Cut or bend inside reinforcement as necessary to achieve cover requirements”
- Changed the dimension distances from the tongue and groove to the transverse barrel reinforcement from 2½” to 2” max.
- Changed the dimension labeling from: “No. 10 bars @ 1’-0” max spacing” To “No. 10 haunch bars @ 1’-0” max spacing”

Added to the sheet: “DISTRIBUTION SLAB-LONGITUDINAL SECTION” above the Longitudinal Barrel Section.

At the FABRIC LAYER DETAIL:

- Changed the words “MESH” or “STEEL FABRIC” to “WELDED WIRE FABRIC” throughout the detail.

At the FORMING DETAIL:

- Changed the note in the SECTION and PLAN views from: “Nylon boot on every fourth wire. Bottom of form only.” To: “Nylon boots on every fourth wire. Plastic spacers may be utilized in lieu of nylon boots when spaced at a maximum of 48 inches.”
- Changed the note in the PLAN view from: “Perimeter Reinforcement” To: Transverse Reinforcement”

At the TONGUE AND GROOVE JOINT DETAIL:

- The reinforcement, leader lines and note saying “Additional longitudinal steel of 0.06 sq. in/ft. 1’-3” min. lap” have been removed from the detail.
- Changed the outside transverse reinforcement labeled “As1, As5” To “As1, As7, As8”

At the BARREL INFORMATION :

- Changed the “BARREL INFORMATION ” To “BARREL INFORMATION TABLE ***”
- The As5 column has been removed. As7 and As8 columns have been added.
- Changed reinforcement columns title from: “Steel Fabric Reinforcement” To: “Welded Wire Fabric Reinforcement”
- Added two new columns to the table “Distribution Slab Required *” with “YES” in each row and “Recessed Tie Rods Required ***” with “NO” in each row.

At the BARREL INFORMATION (cont’d):

Additional notes added under the Barrel Information Table : “* All class 1 culverts with fill heights of less than 2’-0” require a distribution slab. If a distribution slab is not required, indicate “NO” in this box.”

“*** For pedestrian culvert applications hide-away or recessed tie connections are required, see Mn/DOT standard plate 3145F. If required, indicate “YES” in this box.”

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“***Box culverts with spans from 6 to 14 ft. are designed for HL-93 live loads (AASHTO LRFD 3.6.2.1) not including the design lane load. Boxes with spans of 16 ft. are designed for HL-93 live loads including the design lane load.”

Under CONSTRUCTION NOTES:

- The note “Fill heights of less than 2’-0” require distribution slab... has been moved to numbered note ④ and has additional information added to the note.
- Changed 2nd note to read: “If the distance between double barrels is less than 2’-0” use either pea rock or lean mix backfill (Mn/DOT spec. 2520) between the culvert as approved by the engineer. If pea rock is used provide approved grout seepage cutoff core, minimum 12” thick, between the culvert’s two ends. See standard figure 5-395.115 for details.” Minimum distance between the two barrels is 6”.
- The 3rd note: The wording “steel fabric” has changed to: “welded wire fabric”.
- The 5th note: The wording “mesh” and “wire mesh” has changed to: “welded wire fabric.” Also “Standard Specifications for Highway Bridges” has changed to: “LRFD Bridge Design Specifications”
- The 6th note: The wording “mesh” has changed to: “welded wire fabric”. Also the “1/2” Dia.” has changed to “a w23”.
- The 8th note: The wording “steel fabric” has changed to: “welded wire fabric.”
- Two notes have been added to the end of the Construction notes. The 1st note reads: “Compact the first 1.5’ (loose) of fill above the box with light compaction equipment such as plate compactors or walk behind rollers.” The 2nd note reads: “Transverse reinforcement is parallel to the culvert span. Longitudinal reinforcement is perpendicular to the culvert span.”
- Numbered note ② has changed From: “Haunch size as follows.....To: “Haunch sizes are to be 12” vertical, 12” horizontal on all box sizes.”
- Numbered note ③ has changed To: “Longitudinal reinforcement denoted as As5 and As6 must be placed in all slabs and walls and must be 0.06 sq. in./ft. min.”
- Added numbered note ④: “Fill heights of less than 2’-0” require a distribution slab.

Use 3Y43 concrete for the distribution slab.

Cast-in-place distribution slabs shall be 6" thick. Provide 3" minimum granular material per Mn/DOT spec. 3149.2B2 between barrel and distribution slab.

Precast distribution slabs shall be 6" thick and may be used for fill heights over 1'-0". Provide 6" minimum granular material per Mn/DOT spec 3149.2B2 between barrel and distribution slab.

If distribution slab is used as pavement surface it must be redesigned per the Mn/DOT Pavement Design Manual.

Approved, and signed, December 11, 2000.

Figure 5-395.101(B)
Barrel Details (Special Design)

Approved, and signed, March 24, 2011. Last date revised: October 9, 2015.

Revised 10-09-2015

At TRANSVERSE BARREL SECTION:

- Added note regarding the exterior corners: “RADIUS (7” MIN., 1’-0” MAX.) OR CHAMFER (4” MIN., 7” MAX.) (TYP.)”

At FABRIC LAYER DETAIL:

- Changed the title of the “FABRIC LAYER DETAIL” to “REINFORCEMENT LAYER DETAIL”.
- Changed all cases of “welded wire fabric” to “welded wire reinforcement” in notes and text.
- Changed “. . . the wires of the welded wire fabric shall be placed as shown” to “. . . place the wires of the welded wire reinforcement as shown” in the text under the diagram.

At BARREL INFORMATION TABLE:

- Changed “Welded Wire Fabric Reinforcement” to “Welded Wire Reinforcement”.

Under CONSTRUCTION NOTES:

- Changed first note from “Culverts to be constructed as per spec. 2412 except as noted.” to “Construct culverts per spec. 2412 except as noted.”
- Changed third note from “The welded wire fabric, shear reinforcement and reinforcement and reinforcement bars shall conform to applicable requirements of AASHTO M259.” to “Provide welded wire reinforcement, shear reinforcement and reinforcement bars per the applicable requirements of AASHTO M259.”
- Changed “welded wire fabric” to “welded wire reinforcement” in parts a) and b) of the fifth note.
- Changed paragraph in the fifth note from “The reinforcement shall be developed in accordance with AASHTO ‘LRFD Bridge Design Specifications’. If bar reinforcement is substituted for welded wire fabric, the area of reinforcement shall be increased by 8%, and contractor shall submit design calculations verifying compliance with AASHTO 5.7.3.4. ‘Control of Cracking by Distribution of Reinforcement’.” to “Develop reinforcement in accordance with AASHTO ‘LRFD Bridge Design Specification’. If bar reinforcement is substituted for welded wire reinforcement, increase the area of reinforcement by 8% and submit design calculations verifying compliance with AASHTO 5.7.3.4. ‘Control of Cracking by Distribution of Reinforcement’.”
- Changed both instances of “shall be” to “is” and “welded wire fabric” to “welded wire reinforcement” in note six.
- Changed both instances of “The spacing” to “Space” in note seven.
- Changed note eight from “Welding will not be allowed on reinforcement bars or welded wire fabric, except that the original welding required to manufacture wire fabric is acceptable.” to “Welding is not permitted on reinforcement bars or welded wire reinforcement, except that the original welding required to manufacture wire reinforcement is acceptable.”
- Changed “. . . additional reinforcement shall be added . . .” to “. . . place additional reinforcement . . .” in note nine.
- Changed note ten from “Concrete shall be mix no. 3W36 with no calcium chloride allowed.” to “Use concrete mix no. 3W82 with no calcium chloride added.” Concrete mix designation changed to match 2016 spec. book.
- Changed eleventh note from “Shop drawing approval per spec. 3238.2.A is required.” to “Provide shop drawing approval per spec. 3238.2.A.”
- Changed first sentence of circled note ① from “Culvert ties are to be 1” diameter rods.” to “Use 1” diameter culvert ties.”
- Changed circled note ② from “Haunch sizes are to be 12” vertical, 12” horizontal on all box sizes.” to “Use 12” vertical, 12” horizontal haunches on all box sizes.”
- Changed circled note ③ from “Longitudinal reinforcement denoted as As5 and As6 must be placed in all slabs and walls and must be 0.06 sq. in./ft. min.” to “Place longitudinal reinforcement denoted as As5 and As6 in all slabs and walls with a minimum of 0.06 sq. in./ft.”

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- Changed concrete mix designation in the first note under circled note ⑤ from “3Y43” to “3S52” to match 2016 spec. book.
- Changed the first sentence of the second note under circled note ⑤ from “Cast-in-place distribution slabs shall be 6” thick.” to “Place 6” thick cast-in-place distribution slabs.”
- Changed the third note under circled note ⑤ from “Precast distribution slabs shall be 6” thick and may . . .” to “6” thick precast distribution slabs may . . .”
- Changed circled note ⑤ from “The width of the distribution slab shall extend between the outside edges of the shoulders unless directed by the engineer.” to “Extend the width of the distribution slab to the outside edges of the roadway shoulders unless directed by the engineer.”
- Changed “shall be” to “is” in the fifth note under circled note ⑤.
- Changed the sixth note under circled note ⑤ from “If distribution slab is used as pavement surface it must be redesigned per the MnDOT pavement design manual.” to “Redesign the distribution slab per the MnDOT pavement design manual if it is used as pavement surface.”

Revised 09-11-2014

Changed all instances throughout the standard sheet *From:* Granular Material *To:* Select Granular Material.

Changed all instances throughout the standard sheet *From:* Spec. 3149.2B2 *To:* Spec. 3149.2.B.2.

Changed the sheet title name. *From:* BARREL DETAILS (Special Design) *To:* PRECAST CONCRETE BARREL DETAILS (Special Design).

Under CONSTRUCTION NOTES:

- Changed the 2nd note to read: Refer to the general plan and elevation sheet for the distance between barrels of adjacent boxes and to standard figure 5-395.115 for material requirements for fill between adjacent boxes.
- Changed the spec. number in the 11th note *From:* 3238.2A *To:* 3238.2.A
- Changed numbered note ⑤: Added “Roadway or Shoulder” to the beginning of the note.

Revised 11-06-2013

Throughout the sheet:

- Removed the “slash” (/) from the Mn/DOT in all instances.
- Removed the term “Mn/DOT” from all of the locations referencing a Mn/DOT spec.

At the DISTRIBUTION SLAB SECTION and DISTRIBUTION SLAB-LONGITUDINAL SECTION:

- Added “(EPOXY COATED)” to all references to the reinforcement in the distribution slab.

At the TRANSVERSE BARREL SECTION:

- Changed the dimensions “H” to “RISE” and “W” to “SPAN”.
- Changed the haunch bar note to identify the length of the haunch bar based on wall or slab thickness.

At the LONGITUDINAL BARREL SECTION:

- Changed the dimensions “H” to “RISE”.

At the BARREL INFORMATION TABLE, under the column DIMENSIONS:

- Changed the SUB-COLUMN “H” to “RISE” and “W” to “SPAN”.

At the notes for the BARREL INFORMATION TABLE, the note defined by the double asterisk (**):

- Removed the MnDOT reference and changed the plate number *from* 3145F *to* 3145.

Updated the signature block to make it similar to other standards.

At CONSTRUCTION NOTES:

- Changed the word “Areas” to “Area” in the 6th note.
- Also added to the end of the 6th note: “and contractor shall submit design calculations verifying compliance with AASHTO 5.7.3.4 “control of cracking by distribution of reinforcement”.”
- At numbered note ⑤: Changed the 2nd note to read: Use concrete mix 3Y43 for the distribution slab.
- At numbered note ⑤: Added note: “The width of the distribution slab shall extend between the outside edges of the shoulders unless directed by the engineer.”
- At numbered note ⑤: Added note: “Payment for the distribution slab and granular material beneath the slab shall be considered incidental.”

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Revised 04-17-2013

This standard was updated to convert reinforcing bar marks from metric to U.S. customary bar designations.

Re-Approved 03-24-2011

At the TRANSVERSE BARREL SECTION:

- Shortened the No. 10 haunch bars in the view to more accurately show the length. Also added a circled leader line at the end of one of the haunch bars with the note, “Haunch bar to extend to, but not past, outside reinforcing (typ.)”
- Added a large circled leader to the lower right corner labeled as, “Tongue and Groove Shown.” Within the circle the tongue and groove faces were added. Removed all reinforcement within the circle and added a leader line with note, “Reinforcement not shown for clarity.”
- Top transverse bar was changed from As5 to As7. Bottom transverse bar was changed from As5 to As8. All outside longitudinal bars are labeled as As5 with Ⓣ. All inside longitudinal bars are labeled as As6 with Ⓣ.

Added to the sheet: “DISTRIBUTION SLAB SECTION” above the Transverse Barrel Section.

At the LONGITUDINAL BARREL SECTION:

- Changed note from: “As4 cut as necessary to achieve cover requirements” To: “Cut or bend inside reinforcement as necessary to achieve cover requirements”
- Changed the dimension distances from the tongue and groove to the transverse barrel reinforcement from 2½” to 2” max.
- Changed the dimension labeling from: “No. 10 bars @ 1’-0” max spacing” To “No. 10 haunch bars @ 1’-0” max spacing”

Added to the sheet: “DISTRIBUTION SLAB-LONGITUDINAL SECTION” above the Longitudinal Barrel Section.

At the FABRIC LAYER DETAIL:

- Changed the words “MESH” or “STEEL FABRIC” to “WELDED WIRE FABRIC” throughout the detail.

At the FORMING DETAIL:

- Changed the note in the SECTION and PLAN views from: “Nylon boot on every fourth wire. Bottom of form only.” To: “Nylon boots on every fourth wire. Plastic spacers may be utilized in lieu of nylon boots when spaced at a maximum of 48 inches.”
- Changed the note in the PLAN view from: “Perimeter Reinforcement” To: “Transverse Reinforcement”

At the TONGUE AND GROOVE JOINT DETAIL:

- The reinforcement, leader lines and note saying “Additional longitudinal steel of 0.06 sq. in/ft. 1’-3” min. lap” have been removed from the detail.
- Changed the outside transverse reinforcement labeled “As1, As5” To “As1, As7, As8”

At the BARREL INFORMATION :

- Changed the “BARREL INFORMATION ” To “BARREL INFORMATION TABLE ****”
- The As5 column has been removed. As7 and As8 columns have been added.
- Changed reinforcement columns title from: “Steel Fabric Reinforcement” To: “Welded Wire Fabric Reinforcement”
- Added two new columns to the table “Distribution Slab Required *” with “YES” in each row and “Recessed Tie Rods Required **” with “NO” in each row.

At the BARREL INFORMATION (cont’d):

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Additional notes added under the Barrel Information Table : “* All class 1 culverts with fill heights of less than 2’-0” require a distribution slab. If a distribution slab is not required, indicate “NO” in this box.”

“** For pedestrian culvert applications hide-away or recessed tie connections are required, see Mn/DOT standard plate 3145F. If required, indicate “YES” in this box.”

“***Box culverts with spans from 6 to 14 ft. are designed for HL-93 live loads (AASHTO LRFD 3.6.2.1) not including the design lane load. Boxes with spans of 16 ft. are designed for HL-93 live loads including the design lane load.”

Under CONSTRUCTION NOTES:

- The note “Fill heights of less than 2’-0” require distribution slab... has been moved to numbered note ④ and has additional information added to the note.
- Changed 2nd note to read: “If the distance between double barrels is less than 2’-0” use either pea rock or lean mix backfill (Mn/DOT spec. 2520) between the culvert as approved by the engineer. If pea rock is used provide approved grout seepage cutoff core, minimum 12” thick, between the culvert’s two ends. See standard figure 5-395.115 for details.” Minimum distance between the two barrels is 6”.
- The 3rd note: The wording “steel fabric” has changed to: “welded wire fabric”.
- The 5th note: The wording “mesh” and “wire mesh” has changed to: “welded wire fabric.” Also “Standard Specifications for Highway Bridges” has changed to: “LRFD Bridge Design Specifications”
- The 6th note: The wording “mesh” has changed to: “welded wire fabric”. Also the “1/2” Dia.” has changed to “a w23”.
- The 8th note: The wording “steel fabric” has changed to: “welded wire fabric.”
- Two notes have been added to the end of the Construction notes. The 1st note reads: “Compact the first 1.5’ (loose) of fill above the box with light compaction equipment such as plate compactors or walk behind rollers.” The 2nd note reads: “Transverse reinforcement is parallel to the culvert span. Longitudinal reinforcement is perpendicular to the culvert span.”
- Numbered note ② has changed From: “Haunch size as follows.....To: “Haunch sizes are to be 12” vertical, 12” horizontal on all box sizes.”
- Numbered note ③ has changed To: “Longitudinal reinforcement denoted as As5 and As6 must be placed in all slabs and walls and must be 0.06 sq. in./ft. min.”
- Added numbered note ④: “Fill heights of less than 2’-0” require a distribution slab.

Use 3Y43 concrete for the distribution slab.

Cast-in-place distribution slabs shall be 6” thick. Provide 3” minimum granular material per Mn/DOT spec. 3149.2B2 between barrel and distribution slab.

Precast distribution slabs shall be 6” thick and may be used for fill heights over 1’-0”. Provide 6” minimum granular material per Mn/DOT spec 3149.2B2 between barrel and distribution slab.

If distribution slab is used as pavement surface it must be redesigned per the Mn/DOT Pavement Design Manual.

Approved, and signed, December 11, 2000.

Figure 5-395.102

Precast Concrete End Section Type I – Single or Double Barrel For Skews Up To 7¹/₂°

Approved, and signed, March 24, 2011. Last date revised: October 9, 2015.

Revised 10-09-2015

At PLAN VIEW:

- Changed note above diagram from “Culvert ties are to be 1” dia. rods. See standard plate no. 3145 for connection details (typ.). Two ties are required per joint where h is greater than 4’.” to “Use 1” dia. Culvert ties. See standard plate no. 3145 for connection details (typ.). Use two ties per joint where h is greater than 4’.”

At SECTION A-A:

- Changed note: “1’-0” MAX. RADIUS (TYP.)” to “RADIUS (7” MIN., 1’-0” MAX.) OR CHAMFER (4” MIN., 7” MAX.) (TYP.)”

At FABRIC LAYER DETAIL:

- Changed the title of “FABRIC LAYER DETAIL” to “REINFORCEMENT LAYER DETAIL”.
- Changed all cases of “welded wire fabric” to “welded wire reinforcement” in notes and text.

Under CONSTRUCTION NOTES:

- Added second note “Use concrete mix no. 3W82 with no calcium chloride allowed.
- Added seventh note: “Maximum size of reinforcement bars is no. 6, except no. 7 or 8 bars may be used for Atb on spans greater than 14’. The maximum welded wire reinforcement size is W23 per layer (maximum of two layers).”
- Changed third and fourth sentences of circled note ① from “Limits of excavation for dropwall to be approximately the same as dropwall dimensions. Dropwall to be concrete mix no. 1A43 or mix no. 3Y43.” to “Limits of excavation for dropwall are approximately the same as dropwall dimensions. Dropwall concrete mix is 3S52, or 3Y82 if precast.” Concrete mix designations changed to match 2016 spec. book.
- Changed circled note ③ from “Fill hole with grout. Grout shall consist of 1 part cement and 2 parts sand. Use type 1A air entrained Portland cement. Grout mix shall have a maximum slump of 4’.” to “Fill hole with grout. Grout consists of 1 part cement and 2 parts sand. Use type 1A air entrained Portland cement. Grout mix maximum slump is 4’.”
- Changed “welded wire fabric” to “welded wire reinforcement” both times it appears in circled note ⑤.
- Changed “Longitudinal reinforcement perpendicular to the culvert span shall have a minimum . . .” to “Place longitudinal reinforcement perpendicular to the culvert span with a minimum . . .” in circled note ⑧.

Revised 11-06-2013

At PLAN VIEW:

- Added to the tie bar note: “Two ties are required per joint where h is greater than 4’.”
- Changed the dimensions “W” to “SPAN”.

At SECTION A-A and SECTION B-B:

- Changed the haunch bar note to identify the length of the haunch bar based on wall or slab thickness.

At SECTION A-A:

- Changed the dimensions “H” to “RISE” and “W” to “SPAN”.

At the TOUNGE and GROOVE JOINT DETAIL:

- Added “Bottom Slab Only” to the end of the welded wire fabric note.

At SIDE ELEVATION:

- Changed the dimensions “H” to “RISE”.
- Removed two notes from the detail at the culvert tie locations: (note 1) “Not required if height h is less than 4’-0”. (note 2) Two culvert ties are required.

At CONSTRUCTION NOTES:

- Added the word “Standard” to precede the figure number in all instances.

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- Changed numbered note ④ to read: 3'-6" min. tongue and 3'-7" min. groove for culverts with 6'-0" spans. 5'-0" min. tongue and 5'-1" min. groove for culverts with spans greater than 6'-0". Center tongue and groove on centerline of each apron joint. Tongue and groove joint on all three sides of apron is permissible.
- Added to numbered note ⑥: Bottom slab thickness may be increased up to 2" max. provided concrete cover is 1 ½" min., 2" max.

At the APRON DIMENSIONS & Ah REINFORCENENT table:

- Added to the table, an option in parenthesis for a 4'-0" end section when spans are 14'-0" and 16'-0".
- Added to the note below the table: Values in () may be used for end sections with spans of 14' and 16' only.

At the "Att, Atb Reinforcement and Abt Reinforcement tables:

- Changed the "WIDTH" column to "SPAN".

Updated the signature block to make it similar to other standards.

Revised 04-17-2013

This standard was updated to convert reinforcing bar marks from metric to U.S. customary bar designations.

Re-Approved 03-24-2011

Under CONSTRUCTION NOTES:

- Numbered note ⑥ was added: "Apron top and bottom slab thickness may be 8" for culverts with 6' spans only."
- Numbered note ⑦ was added: "10" minimum top slab for 14' and 16' spans."
- The 4th general note was moved and is now numbered note ⑧. It was changed to read: "Longitudinal reinforcement perpendicular to the culvert span shall have a minimum of 0.06 square inches per peripheral foot on all faces of the barrel."

At PLAN VIEW:

- The note: "3" dia. hole in lintel beam ③" has changed To: "3" dia. hole in curb ③.
- Added the note: "No. 13 bent bars (typ.)" with circle and leader line.
- Lengthened the culvert ties at the apron to box location to match the other ties in the view.

At the TONGUE AND GROOVE JOINT DETAIL:

- Changed the note from: "0.192 sq. in.²/ft. " To: "Abt"
- Added numbered note ⑥ to the 10" dimension.

At the SIDE ELEVATION:

- Added the word "CURB" under the 1'-0" dimension line at the curb.
- Added the numbered notes ⑥ and ⑦ under the 9" dimension line at the lintel beam.
- Added the numbered note ⑥ under the 10" bottom of the apron dimension on both ends.
- Changed the note from: "No 13 dowels 1'-0" long" To: "No 19 dowels 1'-0" long" at the apron/drop wall location. Also added the note: "May drill and grout ③" at the apron/drop wall location.
- Lengthened the culvert tie at the apron to box location to represent the actual size.

At the FABRIC LAYER DETAIL:

- Changed the words "MESH" or "STEEL FABRIC" to "WELDED WIRE FABRIC" throughout the detail.

At SECTION A-A:

- Shortened the No. 10 haunch bars in the view to more accurately show the length. Also added a circled leader line at the end of one of the haunch bars with the note "Haunch bar to extend to, but not past, outside reinforcing (typ.)."
- Added numbered note ⑧ with leader lines circling the longitudinal reinforcement.
- Changed the designation of the top/outside transverse reinforcement from: "At" To: "Att"
- Changed the designation of the top/inside transverse reinforcement from: "Ab" To: "Atb"
- Changed the designation of the bottom/inside transverse reinforcement from: "0.192 in.²/ft." To: "Abt"

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- Added the word “CURB” to the right side of the view.
- Added the numbered notes ⑥ and ⑦ under the 9” dimension line at the lintel beam.
- Added the numbered note ⑥ adjacent to the 10” bottom of the apron dimension.

At SECTION B-B:

- Shortened the No. 10 haunch bars in the view to more accurately show the length. Also added a circled leader line at the end of one of the haunch bars with the note “Haunch bar to extend to, but not past, outside reinforcing (typ.)”
- Added numbered note ⑧ with leader lines circling the longitudinal reinforcement.

At SECTION B-B (cont’d):

- Changed the designation of the bottom/inside transverse reinforcement from: “0.192 in.²/ft.” To: “Abt”
- Added the numbered note ⑥ adjacent to the 10” bottom of the apron dimension.

At the At, Ab Reinforcement Table:

- Changed the title of the table from: “At, Ab Reinforcement” To: “Att, Atb Reinforcement”. Also added an additional row to the table : Width = 16’, Att = 1.52 and Atb = 2.09

Added: A new table labeled “Abt Reinforcement” with reinforcement areas based on fabricator input.

06-30-2003

At SECTION B-B: Drew chamfer at top-outside edges.

Approved, and signed, December 11, 2000

Figure 5-395.104(A)

Precast Concrete End Section Type III – Single or Double Barrel For Skews Up To 7¹/₂°

Approved, and signed, March 24, 2011: Last date revised: October 9, 2015.

Revised 10-09-2015

At TONGUE AND GROOVE JOINT DETAIL:

- Changed “welded wire fabric” to “welded wire reinforcement” in the note below the diagram.

At SECTION A-A:

- Changed note: “1’-0” MAX. RADIUS (TYP.)” to “RADIUS (7” MIN., 1’-0” MAX.) OR CHAMFER (4” MIN., 7” MAX.) (TYP.)”

At FABRIC LAYER DETAIL:

- Changed the title of “FABRIC LAYER DETAIL” to “REINFORCEMENT LAYER DETAIL”.
- Changed all cases of “welded wire fabric” to “welded wire reinforcement” in notes and text.

Under CONSTRUCTION NOTES:

- Added second note “Use concrete mix no. 3W82 with no calcium chloride allowed.
- Changed third and fourth sentences of circled note ① from “Limits of excavation for dropwall to be approximately the same as dropwall dimensions. Dropwall to be concrete mix no. 1A43 or mix no. 3Y43.” to “Limits of excavation for dropwall are approximately the same as dropwall dimensions. Dropwall concrete mix is 3S52, or 3Y82 if precast.” Concrete mix designations changed to match 2016 spec. book.
- Changed circled note ④ from “Fill hole with grout. Grout shall consist of 1 part cement and 2 parts sand. Use type 1A air entrained Portland cement. Grout mix shall have a maximum slump of 4”.” to “Fill hole with grout. Grout consists of 1 part cement and 2 parts sand. Use type 1A air entrained Portland cement. Grout mix maximum slump is 4”.”
- Changed “welded wire fabric” to “welded wire reinforcement” both times it appears in circled note ⑦.
- Changed “Longitudinal reinforcement perpendicular to the culvert span shall have a minimum . . .” to “Place longitudinal reinforcement perpendicular to the culvert span with a minimum . . .” in circled note ⑨.

Revised 11-06-2013

At PLAN VIEW:

- Added to the tie bar note: “Two ties are required per joint where h is greater than 4’.”
- Changed the dimensions “W” to “SPAN”.

At SECTION A-A and SECTION B-B:

- Changed the haunch bar note to identify the length of the haunch bar based on wall or slab thickness.

At SECTION A-A:

- Changed the dimensions “H” to “RISE” and “W” to “SPAN”.

At the TOUNGE and GROOVE JOINT DETAIL:

- Added “Bottom Slab Only” to the end of the welded wire fabric note.

At SIDE ELEVATION:

- Changed the dimensions “H” to “RISE”.
- Removed two notes from the detail at the culvert tie locations: (note 1) “Not required if height h is less than 4’-0”.” (note 2) Two culvert ties are required.

At CONSTRUCTION NOTES:

- Added the word “Standard” to precede the figure number in all instances.
- Changed numbered note ⑥ to read: 3’-6” min. tongue and 3’-7” min. groove for culverts with 6’-0” spans. 5’-0” min. tongue and 5’-1” min. groove for culverts with spans greater than 6’-0”. Center tongue and groove on centerline of each apron joint. Tongue and groove joint on all three sides of apron is permissible.
- Changed numbered note ⑧ to read: Apron bottom slab thickness may be 8” for culverts with 6’ spans only. Bottom slab thickness may be increased up to 2” max. provided cover is 1 ½” min., 2” max.

At the APRON DIMENSIONS & Ah REINFORCENENT table:

- Added to the table, an option in parenthesis for a 4’-0” end section when spans are 14’-0” and 16’-0”.

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- Added to the note below the table: Values in () may be used for end sections with spans of 14' and 16' only. Changed the "WIDTH" column to "SPAN" on the "Abt Reinforcement" table.

Updated the signature block to make it similar to other standards.

Revised 04-17-2013

This standard was updated to convert reinforcing bar marks from metric to U.S. customary bar designations.

Re-Approved 03-24-2011

Under CONSTRUCTION NOTES:

- Numbered note ⑦ was changed: The word "MESH" or "WIRE MESH" was changed to "WELDED WIRE FABRIC"
- Numbered note ⑧ was added: "Apron bottom slab thickness may be 8" for culverts with 6' spans only. The slab may be thickened at contractor/fabricator request".
- The 3rd general note was moved and is now numbered note ⑨. It was changed to read: "Longitudinal reinforcement perpendicular to the culvert span shall have a minimum of 0.06 square inches per peripheral foot on all faces of the barrel."

At the TONGUE AND GROOVE JOINT DETAIL:

- Changed the note from: "0.192 sq. in.²/ft. " To: "Abt"
- Added numbered note ⑩ to the 10" dimension.

At PLAN VIEW:

- Lengthened the culvert ties at the apron to box location to match the other ties in the view.

At the SIDE ELEVATION:

- Added numbered note ⑩ under the 10" bottom of the apron dimension on both ends.
- Changed the note from: "No 13 dowels 1'-0" long" To: "No 19 dowels 1'-0" long" at the apron/drop wall location. Also added the note: "May drill and grout ④" at the apron/drop wall location.
- Lengthened the culvert tie at the apron to box location to represent the actual size.

At the FABRIC LAYER DETAIL:

- Changed the words "MESH" or "STEEL FABRIC" to "WELDED WIRE FABRIC" throughout the detail.

At SECTION A-A:

- Shortened the No. 10 haunch bars in the view to more accurately show the length. Also added a circled leader line at the end of one of the haunch bars with the note, "Haunch bar to extend to, but not past, outside reinforcing (typ.)."
- Added numbered note ⑩ with leader lines circling the longitudinal reinforcement.
- Changed the designation of the bottom/inside transverse reinforcement from: "0.192 in.²/ft." To: "Abt."
- Added the numbered note ⑩ adjacent to the 10" bottom of the apron dimension.

At SECTION B-B:

- Shortened the No. 10 haunch bars in the view to more accurately show the length. Also added a circled leader line at the end of one of the haunch bars with the note, "Haunch bar to extend to, but not past, outside reinforcing (typ.)."
- Added numbered note ⑩ with leader lines circling the longitudinal reinforcement.
- Changed the designation of the bottom/inside transverse reinforcement from: "0.192 in.²/ft." To: "Abt."
- Added numbered note ⑩ adjacent to the 10" bottom of the apron dimension.

Added table labeled "Abt Reinforcement". Reinforcement areas based on fabricator input.

06-30-2003

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At SECTION B-B: Drew chamfer at top-outside edges.

Approved, and signed, December 11, 2000

Figure 5-395.104(B)

Precast Concrete End Section Type III – Single or Double Barrel For Skews Up To 7¹/₂°

Approved, and signed, March 24, 2011. Last date revised: October 9, 2015

Revised 10-09-2015

At PLAN VIEW OF SQUARE LINTEL BEAM:

- Changed note from “B401 & NO.4 BARS-INTEGRAL CURB” to “NO. 4 BENT BAR & NO. 4 BARS-INTEGRAL CURB”.

At B401:

- Changed title for “B401” diagram to “NO. 4 BENT BAR”.

At B401 ALTERNATE:

- Changed title for “B401 ALTERNATE” diagram to “NO. 4 BENT BAR ALTERNATE”.

At SECTION C-C:

- Changed “B401” label to “NO. 4 BENT BAR” in diagram.

Under CONSTRUCTION NOTES:

- Changed third paragraph from “Grout shall consist of 1 part cement and 2 parts sand. Use type 1A air entrained Portland cement. Grout mix shall have a maximum slump of 4”.” to “Grout consists of 1 part cement and 2 parts sand. Use type 1A air entrained Portland cement. Grout mix maximum slump is 4”.”
- Changed “B401” to “No. 4 bent bar” in circled note ④.

Revised 11-06-2013

At CONSTRUCTION NOTES: Added the word “Standard” to precede the figure number.

At the LINTEL BEAM BOTTOM REINFORCEMENT table: Changed the “WIDTH W” column to “SPAN”.

At the PLAN VIEW OF SQUARE LINTEL BEAM: Changed the “W” column to “SPAN”.

Updated the signature block to make it similar to other standards.

Revised 04-17-2013

This standard was updated to convert reinforcing bar marks from metric to U.S. customary bar designations.

Re-Approved 03-24-2011

Under CONSTRUCTION NOTES:

- Removed numbered note ②: “3” dia. hole through curb and 2” dia. hole in lintel beam. Place no. 25 dowel, 1’-0” long, in hole and fill with grout.” from the standard. The other numbered notes were re-numbered throughout the sheet. (numbered note ③ to ②, ④ to ③ and ⑤ to ④)
- Changed ③ to read: “For spans under 10’-0” use no. 25 bars. For spans of 10’-0” to 12’-0” use no. 29 bars. For 14’-0” and 16’-0” span, Use no. 32 bars.”

Removed Section C-C option “Separate Curb Option with Groove”.

At the remaining Section C-C “Integral Curb Option with Tongue”:

- Changed the numbering of the circled numbered notes to match the Construction Notes.

At the Bar Bending Details:

- Removed the “B1302” bar bend detail. (Section C-C removal)

Under PLAN OF SQUARE LINTEL BEAM:

- Changed title to “PLAN VIEW OF SQUARE LINTEL BEAM”
- Removed the sub title, “Tongue option shown.”

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- Removed the 1'-0" dimension, 6" dimension, the holes through the lintel beam, the note "Separate Curb Option Only" and the dimensioned note "B1302 & No. 13 Bars-Separate Curb" from the detail.
- Changed the numbering of the circled numbered notes to match the Construction Notes.

At the LINTEL BEAM BOTTOM REINFORCEMENT Table:

- Added an additional row to the table : Width = 16, $A_1 = \text{No.19 @ 6"}$ and $A_2 = \text{No.22 @ 6"}$

Approved, and signed, December 11, 2000

Figure 5-395.110(A)

Precast Concrete End Section Type III – Single or Double Barrel For Skews $7\frac{1}{2}^\circ$ To 45°

Approved, and signed, March 24, 2011. Last date revised: October 9, 2015.

Revised 10-09-2015

At END VIEW:

- Changed note: “1’-0” MAX. RADIUS (TYP.)” to “RADIUS (7” MIN., 1’-0” MAX.) OR CHAMFER (4” MIN., 7” MAX.) (TYP.)”

At FABRIC LAYER DETAIL:

- Changed the title of “FABRIC LAYER DETAIL” to “REINFORCEMENT LAYER DETAIL”.
- Changed all cases of “welded wire fabric” to “welded wire reinforcement” in notes and text.

At SECTION A-A:

- Changed “welded wire fabric” to “welded wire reinforcement”.

Under CONSTRUCTION NOTES:

- Fourth note changed from “Precast concrete shall be mix no. 3W36 with no calcium chloride allowed.” to “Use concrete mix 3W82 with no calcium chloride allowed.” Concrete mix designation updated to match 2016 spec. book.
- Changed “Dropwall concrete shall be mix no. 1A43 or 3Y43.” to “Use dropwall concrete mix 3S52, or 3Y82 if precast.” in the fifth note.
- Changed sixth note from “Longitudinal reinforcement shall be a minimum of 0.06 sq. in. per ft. on both faces.” to “Place longitudinal reinforcement with a minimum of 0.06 sq. in. per ft. on both faces.”
- Changed “Except as noted, culvert ties are to be 1” dia. rods.” to “Except as noted, use 1” dia. culvert ties.” in circled note ④.
- Changed both instances of “welded wire fabric” to “welded wire reinforcement” in circled note ⑩.
- Changed circled note ⑬ from “Fill hole with grout. Grout shall consist of 1 part cement and 2 parts sand. Use 1A air entrained Portland cement. Grout mix shall have a maximum slump of 4”.” to “Fill hole with grout. Grout consists of 1 part cement and 2 parts sand. Use type 1A air entrained Portland cement. Grout mix maximum slump is 4”.”

Revised 09-11-2014

Under CONSTRUCTION NOTES:

- Changed/Corrected the Fig. number in the first note *From: 5.393.101(B) To: 5-395.101(B)*
- Changed numbered note ⑨ to read: Refer to the general plan and elevation sheet for the distance between barrels of adjacent boxes and to standard figure 5-395.115 for material requirements for fill between adjacent boxes.

At PLAN VIEW - DOUBLE BARREL OPTION:

- Added the 3’-0” (TYP.) dimension, detailing the outside end of the drop wall.

Revised 11-06-2013

At END VIEW:

- Changed the haunch bar note to identify the length of the haunch bar based on wall or slab thickness.
- Changed the dimensions “H” to “RISE” and “W” to “SPAN”.
- Changed the bottom slab reinforcement note *from 0.24 IN 2/FT. to Abt*②

At ELEVATION:

- Added numbered note ⑭ to the 10” dimension at the end of the apron.
- Changed the dimensions “H” to “RISE” at the tie hole location.
- Changed the look of the dimension at the tie hole location to better represent the actual dimension.

At SECTION A-A:

- Added “Bottom Slab Only” to the end of the welded wire fabric note.
- Added numbered note ⑭ to the 10” dimension.

At CONSTRUCTION NOTES:

- Added the word “Standard” to precede the figure number in all instances.
- Changed numbered note ③ to read: Number of sections varies with culvert rise.
- Added to the end of numbered note ④: Tongue and Groove Joint on All Three Sides of Apron is Permissible.
- Changed numbered note ⑤ to read: 3'-6" min. tongue and 3'-7" min. groove for culverts with 6'-0" spans. 5'-0" min. tongue and 5'-1" min. groove for culverts with spans greater than 6'-0". Center tongue and groove on centerline of each apron joint. Tongue and groove joint on all three sides of apron is permissible.
- Added numbered note ⑭: Apron bottom slab thickness may be 8" for culverts with 6' spans only. Bottom slab thickness may be increased up to 2" max. provided cover is 1 ½" min., 2" max

Changed the first column on the LENGTH P and LENGTH Q tables from “WIDTH W (FT.)” to “SPAN”(FT.).

Changed the first column on the MIN. LENGTH L table from “HEIGHT” H (FT.) to “RISE” (FT.).

Updated the signature block to make it similar to other standards.

Revised 04-17-2013

This standard was updated to convert reinforcing bar marks from metric to U.S. customary bar designations.

Re-Approved 03-24-2011

Under CONSTRUCTION NOTES:

- Removed 9th note: “Grout shall consist of one part.....”
- Changed numbered note ⑨ to read: “If the distance between double barrels is less than 2’-0” use either pea rock or lean mix backfill (Mn/DOT spec. 2520) between the culvert as approved by the engineer. If pea rock is used provide approved grout seepage cutoff core, minimum 12” thick, between the culvert’s two ends. See standard figure 5-395.115 for details. Minimum distance between the two barrels is 6”.
- Within the numbered note ⑩. Changed the words “MESH” or “WIRE MESH” to “WELDED WIRE FABRIC” .
- Added numbered note ⑫, “For box culverts with spans of 16’ the maximum skew shall be 30°.
- Added numbered note ⑬, “Fill hole with grout. Grout shall consist of 1 part cement and 2 parts sand. Use type 1A air entrained Portland cement. Grout mix shall have a maximum slump of 4”.

At END VIEW:

- Removed note: “Haunch to match that of barrel (typ.)”
- Changed note from: “0.192 in²/ft. (typ.)” to: “0.24 in²/ft. (typ.)” for the inside transverse wall reinforcement.
- Changed note from: “0.192 in²/ft.” to: “0.24 in²/ft.” for the inside bottom slab transverse reinforcement.
- Added 12” TYP. to the haunch in the vertical and horizontal directions.

At PLAN VIEW (single barrel option):

- Added note: “Curb ends may be fabricated parallel to skew” with circled leader line to end of curb.
- Added additional leader line pointing to the culvert ties from numbered note ⑦.
- Added numbered note ④ with leader line pointing to the culvert tie.
- Added circled numbered note ⑫ to the skew dimension at the end of the apron.

At the ELEVATION:

- Added numbered note ④ to the culvert ties at the interior segment locations.
- Added numbered note ④ & ⑦ to the culvert ties.
- Added note: “⑦ Only required on the outside of the high fill side.” to the lower tie on the high fill side along with a circled leader line.
- Added a dimension line from the bottom of the lintel beam to the culvert tie that reads: “Tie hole (H/2)-6”

At SECTION A-A:

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- Changed note *from*: “0.192 in²/ft.” to: “Abt”

At SECTION B-B:

- Changed note *from*: “No.13 dowel bar, 1’-0” long. Grout in place.” *to*: “No.19 dowel bar, 1’-0” long. Grout in place.”
- Changed the dimension *from* 1’-2” embedment *to* 6” embedment for the No.19 dowel in the drop wall.
- Changed the dimension *from* “1” dia. formed hole” *to* “3” dia. formed hole” and changed the dimension limits to the bottom slab depth.
- Added note: “May drill and grout” with numbered note ③ showing the hole for the dowel in the drop wall.

At PLAN VIEW: (double barrel option)

- Added circled numbered note ④ pointing to the culvert ties.
- Added circled numbered note ⑫ to the skew dimension at the end of the apron.
- Changed the note pointing to the 3” dia. holes at the end of the apron. Removed the words “Fill Holes With Grout” and replaced them with numbered note ③.

At the FABRIC LAYER DETAIL:

- Changed the words “MESH” or “STEEL FABRIC” to “WELDED WIRE FABRIC” throughout the detail.

At the “LENGTH P” TABLE:

- Added another row to the table for 16 ft. width.

At the “LENGTH Q” TABLE:

- Added another row to the table for 16 ft. width.

09-17-2004

At SECTION B-B: changed 1" DIA. FORMED HOLE WITH PVC PIPE note to 1" DIA. FORMED HOLE dimension

Approved, and signed, December 11, 2000

Figure 5-395.110(B)

Precast Concrete End Section Type III – Single or Double Barrel For Skews $7\frac{1}{2}^\circ$ To 45°

Approved, and signed, March 24, 2011. Last date revised: October 9, 2015.

Revised 10-09-2015

At PLAN VIEW:

- Changed “B401-SPACED 1’-0” MAX.” note to “NO. 4 BENT BAR-SPACED 1’-0” MAX.” and “B401” note to “NO. 4 BAR”.

At SECTION C-C:

- Changed “B401” note to “NO. 4 BENT BAR”.

At B401:

- Changed the title for diagram “B401” to “NO. 4 BENT BAR”.

At B401 ALTERNATE:

- Changed the title for diagram “B401 ALTERNATE” to “NO. 4 BENT BAR ALTERNATE”.

Under CONSTRUCTION NOTES:

- Added first note “See standard FIG. 5-395.101(A) and FIG. 5-395.101(B) for additional dimensions and construction notes.”
- Changed note three from “Grout shall consist of 1 part cement and 2 parts sand. Use 1A air entrained Portland cement. Grout mix shall have a maximum slump of 4”.” to “Grout consists of 1 part cement and 2 parts sand. Use type 1A air entrained Portland cement. Grout mix maximum slump is 4”.”
- Changed second sentence of circled note ⑤ from “Lintel beams shall contain 5000 psi concrete unless otherwise specified.” to “Use lintel beams with 5000 psi 3W82 concrete unless otherwise specified.”
- Changed “B401” to “no. 4 bent bars” in circled note ⑥.
- Changed “. . . the maximum skew shall be 30° .” to “. . . the maximum skew is 30° .” in circled note ⑦.

Revised 11-06-2013

Throughout the sheet:

- Removed the term “Mn/DOT” from all of the locations referencing a Mn/Dot spec.

Added the Abt REINFORCEMENT table to the sheet.

Changed the first column in the Lintel Beam Reinforcement, Length N and the Lintel Beam Thickness tables from “WIDTH” to “SPAN”.

At the Lintel Beam Reinforcement table:

- Changed multiple spacing and reinforcement sizes in columns “A1” and “A2”

Updated the signature block to make it similar to other standards.

Revised 04-17-2013

This standard was updated to convert reinforcing bar marks from metric to U.S. customary bar designations.

Re-Approved 03-24-2011

Under CONSTRUCTION NOTES:

- Changed numbered note ⑤ to read: “See lintel beam thickness table on this sheet. Lintel beams shall contain 5000 PSI concrete unless otherwise specified.”
- Added numbered note ⑦ “For culverts with spans of 16’ the maximum skew shall be 30° .”
- Added numbered note ⑧ “Alternatively a 9” thickness may be used with 6500 PSI concrete.”

At PLAN VIEW:

- Added note: “Curb ends may be fabricated parallel to skew” with circled leader line to the end of curb.

At SECTION C-C:

- Added sub-title, “Lintel Beam with Integral Curb”

At “LINTEL BEAM REINFORCEMENT” TABLE:

- Added another row to the table for 16 ft. width.

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At “LENGTH N” TABLE:

- Added another row to the table for 16 ft. width.

Added “LINTEL BEAM THICKNESS” table to the standard.

09-17-2004

At EXTRA STRONG CONNECTION DETAILS – PLAN VIEW:

- Changed drawing of bolt head to hex nut.
- Changed note: *from* Mn/DOT SPEC. 3385, TYPE C, $\frac{7}{8}$ " DIA. THREADED ROD WITH HEX NUTS AND... *to* Mn/DOT SPEC. 3385, TYPE C, $\frac{7}{8}$ " DIA. THREADED ROD WITH TWO HEX NUTS AND ...

At EXTRA STRONG CONNECTION DETAILS – SECTION E-E: showed plate washers at hex nuts.

At EXTRA STRONG CONNECTION DETAILS – PLATE DETAIL: changed detail to show $1\frac{1}{2}$ " (TYP.) is to slotted hole radius not edge of slotted hole.

Approved, and signed, December 11, 2000

Figure 5-395.111
Alternate Dropwalls for Box Culverts

Approved, and signed, March 24, 2011. Last date revised: October 9, 2015.

Revised 10-09-2015

Added to right hand side of sheet: “Designer Note (Remove prior to plotting final plan): Before culvert plans are prepared, take samples from the drainage area for pH determination. The soil and water should have a pH of 6.5 or more if sheet steel is used.”

Under CONSTRUCTION NOTES:

- Changed first note from: “Galvanize all fasteners per spec. 3392.” to “Galvanize all fasteners and anchors per spec. 3392.”
- Removed note: “Before culvert plans are prepared, samples shall be taken from the drainage area for pH determination. The soil and water should have a pH of 6.5 or more if sheet steel is used.”
- Added note: “Galvanize steel angles per spec. 3394.”

Revised 11-06-2013

Throughout the sheet:

- Removed the term “Mn/DOT” from all of the locations referencing a Mn/Dot spec.

Updated the signature block to make it similar to other standards.

Re-Approved 03-24-2011

This Standard Figure 5-395.111 was re-approved with all the other Precast Concrete Box Culvert Standard Figures even though there were no changes.

Approved, and signed, December 11, 2000.

Figure 5-395.115
Embankment Protection For Box Culverts

Approved, and signed, September 11, 2014. Last date revised: October 9, 2015.

Revised 10-09-2015

Under CONSTRUCTION NOTES:

- Changed second note from “Riprap shall comply with specs. 2511 and 3601.” to “Provide riprap per specs. 2511 and 3601.”
- Changed circled note ① from “For type of geotextile filter material required, see spec. 3733. Geotextile strips should be continuous without overlaps, except for the top strip, which should shingle vertical strips. The top edge should be buried to prevent undermining.” to “For type of geotextile filter material required, see spec. 3733. Provide geotextile strips continuous without overlaps, except for the top strip, which should shingle vertical strips. Bury the top edge to prevent undermining.”

Re-Approved 09-11-2014

Added: RIPRAP CLASS table with option to be selected based on Riprap class type.

Changed the Designer Note to read: “Designer to select either class III or IV riprap using check box above” and moved the designer note under the RIPRAP CLASS table.

At all Plan Views of barrels:

- Changed the look of the riprap at the bottom of the apron to better represent the riprap placement.
- Changed the Class II, Class III and Class IV riprap dimensions *To*: “W” to represent the width.

At the Plan Views of multiple barrels:

- Changed the dimension between the barrels *From*: “Variable” *To*: numbered note “③”.

Changed the detail name at the Elevation *From*:

- DOUBLE BARREL Class III or IV shown (for skews up to 7 ½°) *To*: MULTIPLE BARREL For skews up to 7 ½° Class III or IV Shown, Double Barrel Shown

Changed the detail name at the (skewed) Elevation *From*:

- SKEWS OVER 7 ½° Class III or IV shown (Double Barrel Shown, Single Barrel Similar) *To*: MULTIPLE BARREL For skews up to 7 ½° Class III or IV Shown, Double Barrel Shown, Other Barrel Configurations Similar.

At the skewed Elevation view:

- Changed the look of the riprap at the bottom of the apron to better represent the riprap placement.

At sections A-A, B-B, C-C and E-E:

- Changed the Class II, Class III and Class IV riprap dimensions *To*: “W” to represent the width or to “T” to represent the thickness.
- Also at section B-B, Changed the dimension *From*: “Variable” *To*: numbered note “③”.
- Also at section C-C, Removed the Gabion note.

At section D-D:

- Removed the Class II Riprap in Gabions Option and combined the Class III and Class IV Riprap Options into a new section D-D.

At the CONSTRUCTION NOTES:

- Replaced the 1st note, new note reads: This plan sheet is for culvert embankment protection only. Refer to the grading plans for additional riprap or other scour protection measures.
- Added 2nd note, new note reads: Riprap shall comply with specs. 2511 and 3601.
- Removed the “(Spec.2511.3B)” from the end of the numbered note ①.
- Removed the last sentence “Minimum distance between the barrels is 6’.” From numbered note ②.
- Added numbered note ③ Refer to the general plan and elevation sheet for the distance between barrels of adjacent boxes.

Revised 11-06-2013

At the CONSTRUCTION NOTES:

- Removed the term “Mn/DOT” from all of the locations referencing a Mn/Dot spec.

Minnesota Department of Transportation – Bridge Office
REVISION LOG for Figure 5-395.115

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Added: DESIGNER NOTE to the sheet.

Added “CLASS IV RIPRAP OPTION” detail to the sheet.

Renamed detail from “DOUBLE BARREL” (for skews over $7\ 1/2^\circ$) to “SKEWS OVER $7\ 1/2^\circ$ ”. Also changed the sub-title to “CLASS III OR IV SHOWN (DOUBLE BARREL SHOWN, SINGLE BARREL SIMILAR)”.

At the “PLAN VIEW” for SINGLE BARREL, DOUBLE BARREL and SKEWS OVER $7\ 1/2^\circ$ options:

- Added: leader line with riprap options “Class II or III” to the existing dimensions.
- Added a: 4'-0” dimension with leader line to “Class IV” riprap option.

At the SINGLE BARREL and DOUBLE BARREL option subtitles:

- Changed the subtitles to read: “CLASS III OR IV SHOWN”

At sections A-A, B-B, C-C and E-E:

- Added: leader line with riprap options “Class II or III” to the existing dimensions.
- Added a: 4'-0” or 2'-0” dimension with leader line to “Class IV” riprap option.

Updated the signature block to make it similar to other standards.

Re-Approved 03-24-2011

At CLASS III RIPRAP OPTION:

- Removed the step ground line note. Replaced the stepped ground line with a sloped ground line.
- Removed the numbered note ③ from the “Geotextile Filter Material” note and adjusted the leader line to the sloped ground line.
- Adjusted the 1'-6” dimension line to line up with the top of the riprap.

At the DOUBLE BARREL PLAN VIEWS:

- Added section arrows E-E, numbered note ②, and the hatched area showing the Approved Grout Seepage Cutoff Core between the barrels.

At the DOUBLE BARREL ELEVATION VIEWS:

- Added a dashed line between the barrels showing the “Approved Grout Seepage Cutoff Core ②”.

Added SECTION E-E detailing the Approved Grout Seepage Cutoff Core, riprap and fills.

At CONSTRUCTION NOTES:

- Changed numbered note ② to read: “If the distance between double barrels is less than 2'-0” use either pea rock or lean mix backfill (Mn/DOT spec. 2520) between the culvert as approved by the Engineer. If pea rock is used provide approved grout seepage cutoff core, minimum 12” thick between the culvert’s two ends and provide class I grouted riprap in lieu of class III riprap. Minimum distance between the two barrels is 6”.
- Removed numbered note ③.

Approved, and signed, December 11, 2000

- Added a: 4'-0" dimension with leader line to "Class IV" riprap option.

At the SINGLE BARREL and DOUBLE BARREL option subtitles:

- Changed the subtitles to read: "CLASS III OR IV SHOWN"

At sections A-A, B-B, C-C and E-E:

- Added: leader line with riprap options "Class II or III" to the existing dimensions.
- Added a: 4'-0" or 2'-0" dimension with leader line to "Class IV" riprap option.

Updated the signature block to make it similar to other standards.

Re-Approved 03-24-2011

At CLASS III RIPRAP OPTION:

- Removed the step ground line note. Replaced the stepped ground line with a sloped ground line.
- Removed the numbered note ③ from the "Geotextile Filter Material" note and adjusted the leader line to the sloped ground line.
- Adjusted the 1'-6" dimension line to line up with the top of the riprap.

At the DOUBLE BARREL PLAN VIEWS:

- Added section arrows E-E, numbered note ②, and the hatched area showing the Approved Grout Seepage Cutoff Core between the barrels.

At the DOUBLE BARREL ELEVATION VIEWS:

- Added a dashed line between the barrels showing the "Approved Grout Seepage Cutoff Core ②".

Added SECTION E-E detailing the Approved Grout Seepage Cutoff Core, riprap and fills.

At CONSTRUCTION NOTES:

- Changed numbered note ② to read: "If the distance between double barrels is less than 2'-0" use either pea rock or lean mix backfill (Mn/DOT spec. 2520) between the culvert as approved by the Engineer. If pea rock is used provide approved grout seepage cutoff core, minimum 12" thick between the culvert's two ends and provide class I grouted riprap in lieu of class III riprap. Minimum distance between the two barrels is 6".
- Removed numbered note ③.

Approved, and signed, December 11, 2000

BRIDGE STANDARD PLANS MANUAL *
(BOX CULVERTS)

October 09, 2015

Index (1)

FIGURE NO.	DESCRIPTION	DATE APPROVED	DATE REVISED
5-395.100(A)	Precast Concrete Box Culvert - Basis of Design	Mar. 24, 2011	Oct. 09, 2015
5-395.100(B)	Precast Concrete Box Culvert Tables	Mar. 24, 2011	Oct. 09, 2015
5-395.100(C)	Precast Concrete Box Culvert Tables	Mar. 24, 2011	Oct. 09, 2015
5-395.100(D)	Precast Concrete Box Culvert Tables	Mar. 24, 2011	Oct. 09, 2015
5-395.100(E)	Precast Concrete Box Culvert Tables	Mar. 24, 2011	Oct. 09, 2015
5-395.101(A)	Precast Concrete Barrel Details	Mar. 24, 2011	Oct. 09, 2015
5-395.101(B)	Precast Concrete Barrel Details (Special Design)	Mar. 24, 2011	Oct. 09, 2015
5-395.102	Precast Concrete End Section Type I – Single or Double Barrel For Skews Up To 7 ¹ / ₂ °	Mar. 24, 2011	Oct. 09, 2015
5-395.104(A)	Precast Concrete End Section Type III – Single or Double Barrel For Skews Up To 7 ¹ / ₂ °	Mar. 24, 2011	Oct. 09, 2015
5-395.104(B)	Precast Concrete End Section Type III – Single or Double Barrel For Skews Up To 7 ¹ / ₂ °	Mar. 24, 2011	Oct. 09, 2015
5-395.110(A)	Precast Concrete End Section Type III – Single or Double Barrel For Skews 7 ¹ / ₂ ° To 45°	Mar. 24, 2011	Oct. 09, 2015
5-395.110(B)	Precast Concrete End Section Type III – Single or Double Barrel For Skews 7 ¹ / ₂ ° To 45°	Mar. 24, 2011	Oct. 09, 2015
5-395.111	Alternate Dropwalls for Box Culverts	Mar. 24, 2011	Oct. 09, 2015
5-395.115	Embankment Protection for Box Culverts	Sept. 11, 2014	Oct. 09, 2015

* Refer to <http://www.dot.state.mn.us/bridge/> for current Bridge CADD Standards

BASIS OF DESIGN

DESIGNED IN ACCORDANCE WITH 2014 AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS, SEVENTH EDITION AND MNDOT BRIDGE DESIGN MANUAL.

MATERIAL PROPERTIES:

WELDED WIRE REINFORCEMENT, MINIMUM SPECIFIED YIELD STRESS	65 KSI
REBAR REINFORCEMENT, MINIMUM SPECIFIED YIELD STRESS	60 KSI
CONCRETE, MINIMUM SPECIFIED COMPRESSIVE STRENGTH	5 OR 6 KSI (SEE TABLES)

SOIL DATA:

UNIT WEIGHT	120 lb/ft ³
RATIO OF LATERAL TO VERTICAL PRESSURE FROM WEIGHT OF EARTH	0.50 MAX TO 0.25 MIN
INTERNAL FRICTION ANGLE OF BACKFILL	30 DEGREES
SOIL STRUCTURE INTERACTION FACTOR, F _o	F _o = 1 + 0.20(H/B) ^c
	B _c = OUTSIDE WIDTH OF CULVERT
	H = FILL HEIGHT, DEFINED AS THE DISTANCE FROM THE TOP OF THE CULVERT TO THE TOP OF THE PAVEMENT OR TO TOP OF FILL IF THERE IS NO PAVEMENT.

RESISTANCE FACTORS

(FROM AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS):

FLEXURE	1.0
SHEAR	0.90

LOADING DATA:

LOAD MODIFIERS:

DUCTILE STRUCTURES	η = 1.0
FOR EARTH FILL: NON-REDUNDANT MEMBER	η = 1.05
FOR LIVE LOAD: REDUNDANT MEMBER	η = 1.0

LOAD FACTORS: (STRENGTH)

DEAD LOAD	MAX DC = 1.25, MIN DC = 0.90
EARTH LOAD (VERTICAL)	MAX EV = 1.30, MIN EV = 0.90
EARTH LOAD (HORIZONTAL)	MAX EH = 1.35, MIN EH = 0.90
LIVE LOAD	LL = 1.75
APPROACHING VEHICLE LOAD	LS = 1.75
WATER	WA = 1.0

LOAD COMBINATIONS

STRENGTH LIMIT STATE	
MAX V/MAX H	1.25DC + 1.30EV + 1.75(LL+IM) + 1.35EH + 1.75LS
MAX V/MIN H	1.25DC + 1.30EV + 1.75(LL+IM) + 1.00WA + 0.9EH
MIN V/MAX H	0.9DC + 0.9EV + 1.35EH + 1.75LS

SERVICE LIMIT STATE	
MAX V/MAX H	1.0DC + 1.0EV + 1.0(LL+IM) + 1.0EH + 1.0LS
MAX V/MIN H	1.0DC + 1.0EV + 1.0(LL+IM) + 1.0WA + 1.0EH
MIN V/MAX H	1.0DC + 1.0EV + 1.0EH + 1.0LS

LIVE LOAD

GREATER OF:

TRUCK AXLE LOAD	32 kips
TANDEM AXLE LOAD	2 AT 25 kips EACH

LIVE LOAD DISTRIBUTION

IF DEPTH OF FILL, H < 2 FT.	
DIRECTION PERPENDICULAR TO SPAN	E = 96 (ln.) + 1.44SPAN (ft.)
DIRECTION PARALLEL TO SPAN	Espan = 10 (ln.) + 1.15H (ln.)

IF DEPTH OF FILL, H ≥ 2 FT.	
DIRECTION PERPENDICULAR TO SPAN	W = 20 (ln.) + 1.15H (ln.)
DIRECTION PARALLEL TO SPAN	L = 10 (ln.) + 1.15H (ln.)

CONSTRUCTION COMPACTOR LOAD	55 kips DISTRIBUTED OVER 84 ln. X 24 ln.
MULTIPLE PRESENCE FACTOR	MPF = 1.2 (FOR ONE LANE)

DYNAMIC LOAD ALLOWANCE (VARIABLE WITH DEPTH)	IM = 0.33(1-0.125H), H ≤ 8, IF H > 8 IM = 0
LANE LOAD (APPLIED TO BOXES WITH SPANS OF 15 ft. OR GREATER)	640 plf DISTRIBUTED PER AASHTO 3.6.1.2.4

APPROACHING VEHICLE LOAD (PARALLEL TO SPAN) (TRAPEZOIDAL PRESSURE) ②	LS = K * Y _s * heq
	K = 0.33 ②
	Y _s = 120 lb/ft ³

EQUIVALENT FILL HEIGHT	
ABUTMENT HEIGHT (ft.) ①	heq (ft.)
< 5.0	4.0
5.0 TO 10.0	5- 0.2*(ABUTMENT HEIGHT)
10.0 TO 20.0	4- 0.1*(ABUTMENT HEIGHT)
> 20.0	2.0

① THE ABUTMENT HEIGHT CORRESPONDING TO THE LATERAL PRESSURE AT THE TOP OF THE CULVERT IS THE DISTANCE FROM THE TOP OF THE TOP SLAB TO THE TOP OF THE PAVEMENT OR FILL.

THE ABUTMENT HEIGHT CORRESPONDING TO THE LATERAL PRESSURE AT THE BOTTOM OF THE CULVERT IS THE DISTANCE FROM THE BOTTOM OF THE BOTTOM SLAB TO THE TOP OF THE PAVEMENT OR FILL.

② TRAPEZOIDAL LATERAL LIVE LOAD PRESSURE METHODOLOGY WAS USED TO APPROXIMATE A BOUSSINESQ DISTRIBUTION.

WATER

DEPTH OF WATER IN BOX SECTION EQUAL TO INSIDE RISE

MINIMUM DISTANCE BETWEEN ADJACENT LINES OF BOX CULVERTS:

THE USE OF "U BOLT TIES" (REFER TO ROADWAY STD PLATE 3145) TO SECURE CULVERT SECTIONS REQUIRES APPROXIMATELY 18" OF ROOM BETWEEN ADJACENT LINES OF BOX CULVERTS TO ALLOW FOR INSTALLATION OF THE TIE. THIS DISTANCE CAN BE REDUCED TO AS LITTLE AS 6" BY USING A "DOUBLE CONNECTION TIE" (REFER TO ROADWAY STD PLATE 3145) AND PLACING THE TIE ON THE INTERIOR SIDE OF THE SECOND (AND THIRD) CULVERT LINE. PROVIDE A NUT AND WASHER AT EACH END OF THE DOUBLE CONNECTION TIE ROD. IN NO CASE SHALL THE DISTANCE BETWEEN ADJACENT BOXES BE LESS THAN 6".

LOAD RATING

ALL STANDARD CONCRETE BOX CULVERTS WERE DESIGNED TO MEET THE 2014 AASHTO LRFR REQUIREMENTS WITH A MINIMUM LRFR BRIDGE OPERATING RATING FACTOR = 1.3 FOR HL-93, MNDOT STANDARD PERMIT TRUCKS G-80, AND MNDOT STANDARD PERMIT TRUCKS G-07. HL-93 WAS THE GOVERNING LOAD.

STRUCTURAL ARRANGEMENT:

REINFORCEMENT AREAS SHOWN ON FIGURES 5-395.100(B)-(E) ARE IN SQUARE INCHES PER LINEAL FOOT OF BARREL. ALL REINFORCEMENT LENGTHS AND AREAS ARE MINIMUM REQUIREMENTS. REINFORCEMENT REQUIREMENTS AND AREAS ARE FOR WELDED WIRE REINFORCEMENT. IF BAR REINFORCEMENT IS SUBSTITUTED FOR WELDED WIRE REINFORCEMENT, INCREASE THE AREA OF REINFORCEMENT BY 8%, AND SUBMIT DESIGN CALCULATIONS VERIFYING COMPLIANCE WITH AASHTO 5.7.3.4 "CONTROL OF CRACKING BY DISTRIBUTION OF REINFORCEMENT".

TRANSVERSE REINFORCEMENT IS PARALLEL TO THE CULVERT SPAN.

LONGITUDINAL REINFORCEMENT IS PERPENDICULAR TO THE CULVERT SPAN.

REINFORCEMENT SPACING 4.0 ln. MAX.
SPACE CENTER TO CENTER OF TRANSVERSE WIRES NOT LESS THAN 2" NOR MORE THAN 4". SPACE CENTER TO CENTER OF LONGITUDINAL WIRES NOT MORE THAN 8".

CONCRETE COVER OVER REINFORCEMENT (ALL FACES) 1/2 ln. MIN., 2 ln. MAX.
③ HAUNCH DIMENSIONS 12 ln. VERTICAL, 12 ln. HORIZONTAL (ALL SPANS AND RISES)

CULVERTS CONSTRUCTED WITHOUT HAUNCHES REQUIRE SPECIAL DESIGN NOT INCLUDED IN THESE STANDARDS.

MINIMUM REINFORCING PARALLEL TO SPAN,

INCLUDING As1, As2, As3, As4, As7, As8 0.002 * b * h, (b = THICKNESS OF SLAB, h = 12 ln.)
PERPENDICULAR TO SPAN, INCLUDING As5, As6 0.06 ln²/ft

SKEW

BOX CULVERT SECTIONS WERE DESIGNED ASSUMING TRAFFIC TRAVELING PARALLEL TO THE SPAN AND UP TO A SKEW ANGLE OF 45°. IF CULVERT SECTIONS ARE PLACED IN A DIFFERENT ARRANGEMENT, THEY MAY NEED TO BE REDESIGNED. BOX CULVERT END SECTIONS WERE DESIGNED FOR SKEW EFFECTS AND ARE LOCATED ON FIG. 5-395.102 THROUGH 5-395.110(B).

AXIAL THRUST

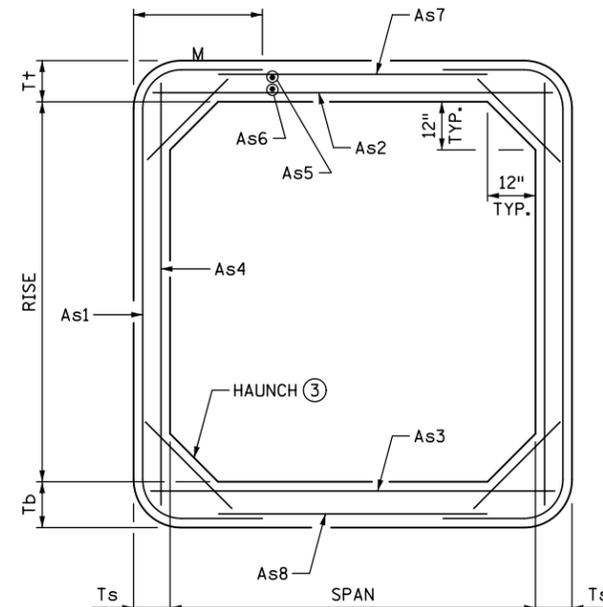
THE BENEFIT OF AXIAL THRUST WAS NOT INCLUDED IN THE BOX CULVERT DESIGN FOR THE STRENGTH LIMIT STATE, HOWEVER IT WAS INCLUDED IN THE SERVICE LIMIT STATE CRACK CONTROL CHECK.

SHEAR

SHEAR CHECKED AT 1.0 d_v FROM TIP OF HAUNCH PER AASHTO 5.13.3.6.1. FOR SLABS OF BOXES WITH LESS THAN 2.0 ft. OF FILL AND FOR WALLS OF BOXES OF ALL FILL HEIGHTS SHEAR RESISTANCE CALCULATED PER AASHTO 5.8, SECTIONAL METHOD GENERAL PROCEDURE. FOR SLABS OF BOXES WITH 2 FT. OF FILL OR GREATER THE SHEAR RESISTANCE WAS CALCULATED PER AASHTO 5.14.5.3. UP TO A MAXIMUM THICKNESS OF 12 INCHES. FOR SUCH SLABS WITH THICKNESSES EXCEEDING 12 IN., CONTACT THE BRIDGE STANDARDS UNIT FOR SHEAR PROVISIONS.

CRACK CONTROL

CRACK CONTROL CHECK PER AASHTO 5.7.3.4 ASSUMING CLASS 2 EXPOSURE CONDITIONS. THE STRESS IN THE STEEL REINFORCEMENT CALCULATED PER AASHTO C12.11.3 AND LIMITED TO 0.6*f_y. INCLUDE AXIAL THRUST IN SERVICE LIMIT STATE ANALYSIS.



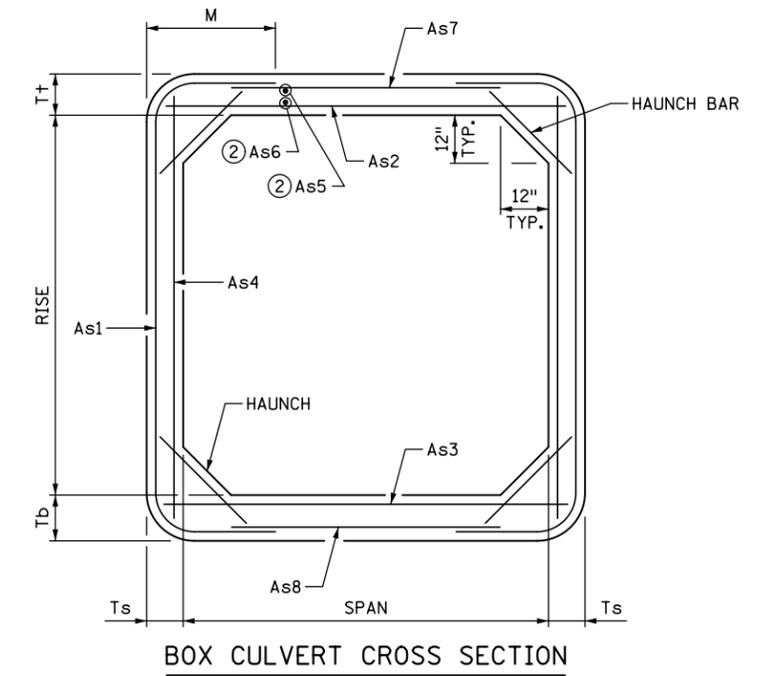
BOX CULVERT CROSS SECTION

REVISION: 10-09-2015
APPROVED: MARCH 24, 2011
Nancy Subenberger
STATE BRIDGE ENGINEER

DO NOT INCLUDE WITH PLAN

FIG. 5-395.100(A)
TITLE:
PRECAST CONCRETE BOX CULVERT-
BASIS OF DESIGN

								REINFORCEMENT REQUIREMENTS ①										
SIZE SPAN x RISE (ft.)	CLASS	f' _c (psi)	FILL HEIGHT RANGE (ft.)	T ₊ (in.)	T _b (in.)	T _s (in.)	WEIGHT (lbs./ft.)	As1			As2		As3		As4		As7/As8	
								As	LENGTH	M	As	LENGTH	As	LENGTH	As	LENGTH	As	LENGTH
6x4	1	5000	<3	8	8	8	2575	0.29	10'-2"	2'-8"	0.36	6'-6"	0.30	6'-6"	0.20	4'-6"	0.20	4'-6"
	2	5000	3 - 9	8	8	8	2575	0.24	10'-2"	2'-8"	0.27	6'-6"	0.28	6'-6"	0.20	4'-6"	0.20	4'-6"
	3	5000	9 - 25	8	8	8	2575	0.52	10'-2"	2'-8"	0.59	6'-6"	0.60	6'-6"	0.20	4'-6"	0.20	4'-6"
6x5	1	5000	<3	8	8	8	2775	0.26	11'-2"	2'-8"	0.40	6'-6"	0.35	6'-6"	0.20	5'-6"	0.20	4'-6"
	2	5000	3 - 9	8	8	8	2775	0.22	11'-2"	2'-8"	0.30	6'-6"	0.31	6'-6"	0.20	5'-6"	0.20	4'-6"
	3	5000	9 - 25	8	8	8	2775	0.46	11'-2"	2'-8"	0.64	6'-6"	0.66	6'-6"	0.20	5'-6"	0.20	4'-6"
6x6	1	5000	<3	8	8	8	2975	0.24	12'-2"	2'-8"	0.43	6'-6"	0.39	6'-6"	0.20	6'-6"	0.20	4'-6"
	2	5000	3 - 9	8	8	8	2975	0.20	12'-2"	2'-8"	0.32	6'-6"	0.34	6'-6"	0.20	6'-6"	0.20	4'-6"
	3	5000	9 - 25	8	8	8	2975	0.41	12'-2"	2'-8"	0.67	6'-6"	0.69	6'-6"	0.20	6'-6"	0.20	4'-6"
8x4	1	5000	<3	9	10	8	3325	0.43	10'-8"	2'-10"	0.38	8'-6"	0.38	8'-6"	0.20	4'-6"	0.24	6'-3"
	2	5000	3 - 8	9	10	8	3325	0.36	10'-8"	2'-10"	0.35	8'-6"	0.36	8'-6"	0.20	4'-6"	0.24	6'-3"
	3	5000	8 - 17	9	10	8	3325	0.59	10'-8"	2'-10"	0.60	8'-6"	0.61	8'-6"	0.20	4'-6"	0.24	6'-3"
	4	5000	17 - 25	9	10	8	3325	0.85	10'-8"	2'-10"	0.83	8'-6"	0.85	8'-6"	0.20	4'-6"	0.24	6'-3"
8x5	1	5000	<3	9	10	8	3525	0.38	11'-8"	2'-10"	0.42	8'-6"	0.43	8'-6"	0.20	5'-6"	0.24	6'-3"
	2	5000	3 - 8	9	10	8	3525	0.31	11'-8"	2'-10"	0.39	8'-6"	0.41	8'-6"	0.20	5'-6"	0.24	6'-3"
	3	5000	8 - 17	9	10	8	3525	0.51	11'-8"	2'-10"	0.65	8'-6"	0.68	8'-6"	0.20	5'-6"	0.24	6'-3"
	4	5000	17 - 25	9	10	8	3525	0.74	11'-8"	2'-10"	0.91	8'-6"	0.93	8'-6"	0.20	5'-6"	0.24	6'-3"
8x6	1	5000	<3	9	10	8	3725	0.35	12'-8"	2'-10"	0.46	8'-6"	0.47	8'-6"	0.20	6'-6"	0.24	6'-3"
	2	5000	3 - 8	9	10	8	3725	0.28	12'-8"	2'-10"	0.41	8'-6"	0.44	8'-6"	0.20	6'-6"	0.24	6'-3"
	3	5000	8 - 17	9	10	8	3725	0.46	12'-8"	2'-10"	0.69	8'-6"	0.72	8'-6"	0.20	6'-6"	0.24	6'-3"
	4	5000	17 - 25	9	10	8	3725	0.66	12'-8"	2'-10"	0.96	8'-6"	0.99	8'-6"	0.20	6'-6"	0.24	6'-3"
8x7	1	5000	<3	9	10	8	3925	0.31	13'-8"	2'-10"	0.49	8'-6"	0.51	8'-6"	0.20	7'-6"	0.24	6'-3"
	2	5000	3 - 8	9	10	8	3925	0.26	13'-8"	2'-10"	0.43	8'-6"	0.47	8'-6"	0.20	7'-6"	0.24	6'-3"
	3	5000	8 - 17	9	10	8	3925	0.42	13'-8"	2'-10"	0.72	8'-6"	0.75	8'-6"	0.20	7'-6"	0.24	6'-3"
	4	5000	17 - 25	9	10	8	3925	0.60	13'-8"	2'-10"	0.99	8'-6"	1.02	8'-6"	0.20	7'-6"	0.24	6'-3"
8x8	1	5000	<3	9	10	8	4125	0.29	14'-8"	2'-10"	0.52	8'-6"	0.54	8'-6"	0.20	8'-6"	0.24	6'-3"
	2	5000	3 - 8	9	10	8	4125	0.24	14'-8"	2'-10"	0.45	8'-6"	0.49	8'-6"	0.20	8'-6"	0.24	6'-3"
	3	5000	8 - 17	9	10	8	4125	0.39	14'-8"	2'-10"	0.73	8'-6"	0.77	8'-6"	0.20	8'-6"	0.24	6'-3"
	4	5000	17 - 25	9	10	8	4125	0.55	14'-8"	2'-10"	1.01	8'-6"	1.04	8'-6"	0.20	8'-6"	0.24	6'-3"
10x4	1	5000	<3	9	10	8	3800	0.66	10'-8"	2'-10"	0.50	10'-6"	0.48	10'-6"	0.20	4'-6"	0.24	8'-3"
	2	5000	3 - 7	9	10	8	3800	0.55	10'-8"	2'-10"	0.47	10'-6"	0.48	10'-6"	0.20	4'-6"	0.24	8'-3"
	3	5000	7 - 15	9	10	8	3800	0.90	10'-8"	2'-10"	0.78	10'-6"	0.79	10'-6"	0.20	4'-6"	0.24	8'-10"
	4	6000	15 - 25	10	10	8	3950	1.33	11'-9"	3'-4"	1.17	10'-6"	1.19	10'-6"	0.20	4'-6"	0.24	8'-11"
10x5	1	5000	<3	9	10	8	4000	0.59	11'-8"	2'-10"	0.56	10'-6"	0.54	10'-6"	0.20	5'-6"	0.24	8'-3"
	2	5000	3 - 7	9	10	8	4000	0.50	11'-8"	2'-10"	0.52	10'-6"	0.54	10'-6"	0.20	5'-6"	0.24	8'-3"
	3	5000	7 - 15	9	10	8	4000	0.79	11'-8"	2'-10"	0.86	10'-6"	0.88	10'-6"	0.20	5'-6"	0.24	8'-6"
	4	6000	15 - 25	10	10	8	4150	1.15	12'-3"	3'-1"	1.29	10'-6"	1.31	10'-6"	0.20	5'-6"	0.24	8'-11"
10x6	1	5000	<3	9	10	8	4200	0.54	12'-8"	2'-10"	0.61	10'-6"	0.59	10'-6"	0.20	6'-6"	0.24	8'-3"
	2	5000	3 - 7	9	10	8	4200	0.45	12'-8"	2'-10"	0.56	10'-6"	0.59	10'-6"	0.20	6'-6"	0.24	8'-3"
	3	5000	7 - 15	9	10	8	4200	0.71	12'-8"	2'-10"	0.92	10'-6"	0.94	10'-6"	0.20	6'-6"	0.24	8'-3"
	4	6000	15 - 25	10	10	8	4350	1.02	12'-10"	2'-10"	1.37	10'-6"	1.40	10'-6"	0.20	6'-6"	0.24	8'-11"
10x7	1	5000	<3	9	10	8	4400	0.50	14'-4"	3'-2"	0.66	10'-6"	0.63	10'-6"	0.20	7'-6"	0.24	7'-8"
	2	5000	3 - 7	9	10	8	4400	0.42	13'-8"	2'-10"	0.59	10'-6"	0.63	10'-6"	0.20	7'-6"	0.24	8'-3"
	3	5000	7 - 15	9	10	8	4400	0.65	13'-8"	2'-10"	0.97	10'-6"	1.00	10'-6"	0.20	7'-6"	0.24	8'-3"
	4	6000	15 - 25	10	10	8	4550	0.92	13'-9"	2'-10"	1.43	10'-6"	1.46	10'-6"	0.20	7'-6"	0.24	8'-8"
10x8	1	5000	<3	9	10	8	4600	0.46	14'-8"	2'-10"	0.69	10'-6"	0.66	10'-6"	0.20	8'-6"	0.24	8'-3"
	2	5000	3 - 7	9	10	8	4600	0.39	14'-8"	2'-10"	0.62	10'-6"	0.66	10'-6"	0.20	8'-6"	0.24	8'-3"
	3	5000	7 - 15	9	10	8	4600	0.60	14'-8"	2'-10"	1.00	10'-6"	1.04	10'-6"	0.20	8'-6"	0.24	8'-3"
	4	6000	15 - 25	10	10	8	4750	0.85	14'-9"	2'-10"	1.52	10'-6"	1.57	10'-6"	0.20	8'-6"	0.24	8'-5"
10x9	1	5000	<3	9	10	8	4800	0.43	15'-8"	2'-10"	0.73	10'-6"	0.70	10'-6"	0.20	9'-6"	0.24	8'-3"
	2	5000	3 - 7	9	10	8	4800	0.36	15'-8"	2'-10"	0.65	10'-6"	0.70	10'-6"	0.20	9'-6"	0.24	8'-3"
	3	5000	7 - 15	9	10	8	4800	0.56	15'-8"	2'-10"	1.03	10'-6"	1.07	10'-6"	0.20	9'-6"	0.24	8'-3"
	4	6000	15 - 25	10	10	8	4950	0.79	17'-1"	3'-6"	1.54	10'-6"	1.60	10'-6"	0.20	9'-6"	0.24	6'-11"
10x10	1	5000	<3	9	10	8	5000	0.42	16'-8"	2'-10"	0.77	10'-6"	0.74	10'-6"	0.20	10'-6"	0.24	8'-3"
	2	5000	3 - 7	9	10	8	5000	0.42	16'-8"	2'-10"	0.68	10'-6"	0.73	10'-6"	0.20	10'-6"	0.24	8'-3"
	3	5000	7 - 15	9	10	8	5000	0.56	18'-0"	3'-6"	1.05	10'-6"	1.09	10'-6"	0.22	10'-6"	0.24	6'-11"
	4	6000	15 - 25	10	11	9	5575	0.74	18'-4"	3'-7"	1.34	10'-6"	1.43	10'-6"	0.22	10'-6"	0.27	6'-11"



GENERAL NOTES

SEE STANDARD FIG. 5-395.100(A) FOR BASIS OF DESIGN. FILL HEIGHT IS DEFINED AS THE DISTANCE FROM THE TOP OF THE CULVERT TO THE TOP OF THE PAVEMENT OR TO TOP OF FILL IF THERE IS NO PAVEMENT.

DESIGNS FOR FILL HEIGHTS GREATER THAN SHOWN IN THE TABLES ARE AVAILABLE FROM THE MDOT BRIDGE OFFICE.

SEE STANDARD FIG. 5-395.101(A) AND FIG. 5-397.101(B) FOR ADDITIONAL INFORMATION. TRANSVERSE REINFORCEMENT IS PARALLEL TO THE CULVERT SPAN. LONGITUDINAL REINFORCEMENT IS PERPENDICULAR TO THE CULVERT SPAN.

IF THE FILL HEIGHT RANGE EXTENDS INTO MORE THAN ONE CLASS, USE THE CLASS WITH THE LARGEST STEEL AREAS. CHECK MAXIMUM AND MINIMUM FILL HEIGHTS OVER THE FULL AREA OF ROADWAY AND SHOULDERS.

ROADWAY OR SHOULDER FILL HEIGHTS OF LESS THAN 2'-0" REQUIRE A DISTRIBUTION SLAB. EXTEND THE WIDTH OF THE DISTRIBUTION SLAB TO THE OUTSIDE EDGES OF THE ROADWAY SHOULDERS UNLESS DIRECTED BY THE ENGINEER.

USE CONCRETE MIX 3552 FOR THE DISTRIBUTION SLAB.

PLACE 6" THICK CAST-IN-PLACE DISTRIBUTION SLABS WITH NO. 5 BARS AT 1'-0" TRANSVERSELY AND NO. 5 BARS AT 1'-0" LONGITUDINALLY. EPOXY COAT ALL DISTRIBUTION SLAB REINFORCEMENT. CENTER DISTRIBUTION SLAB JOINTS OVER BARREL SEGMENTS. PROVIDE 3" MINIMUM GRANULAR MATERIAL PER SPEC. 3149.2.B.2 BETWEEN BARREL AND DISTRIBUTION SLAB.

PRECAST DISTRIBUTION SLABS WITH THE SAME REINFORCEMENT MAY BE USED FOR FILL HEIGHTS OVER 1'-0". CENTER DISTRIBUTION SLAB JOINTS OVER BARREL SEGMENTS. PROVIDE 6" MIN GRANULAR MATERIAL PER SPEC. 3149.2.B.2 BETWEEN BARREL AND DISTRIBUTION SLAB.

REDESIGN DISTRIBUTION SLAB PER THE MDOT PAVEMENT DESIGN MANUAL IF IT IS USED AS PAVEMENT SURFACE.

CULVERT WEIGHT IS BASED ON 150 P.C.F. WITH A HAUNCH SIZE OF 12 INCHES.

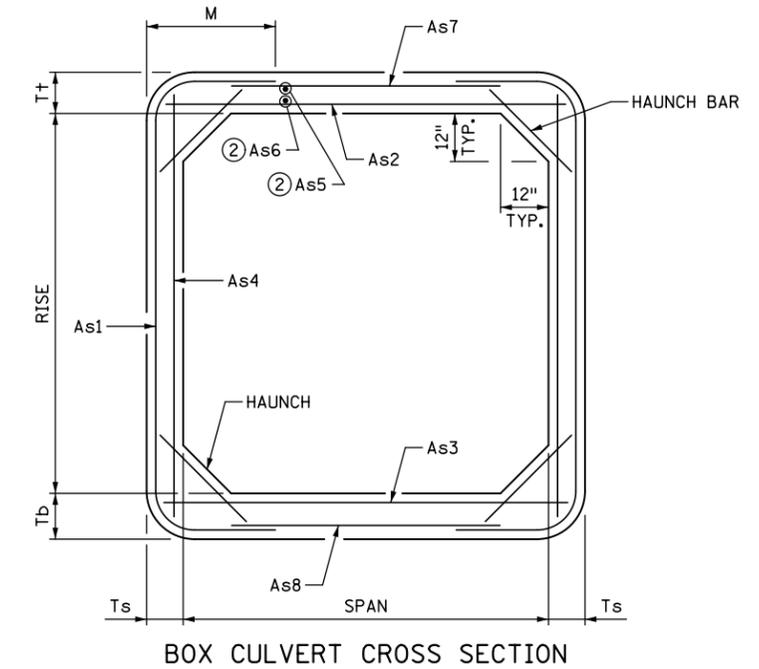
① REINFORCEMENT AREAS ARE IN SQUARE INCHES PER LINEAL FOOT OF BARREL. ALL REINFORCEMENT LENGTHS AND AREAS ARE MINIMUM REQUIREMENTS. REINFORCEMENT REQUIREMENTS ARE FOR WELDED WIRE REINFORCEMENT WITH MINIMUM SPECIFIED YIELD STRESS OF 65 ksi. IF BAR REINFORCEMENT IS SUBSTITUTED FOR WELDED WIRE REINFORCEMENT, INCREASE THE AREA OF REINFORCEMENT BY 8%, AND SUBMIT DESIGN CALCULATIONS VERIFYING COMPLIANCE WITH AASHTO 5.7.3.4 "CONTROL CRACKING BY DISTRIBUTION OF REINFORCEMENT".

② PLACE LONGITUDINAL REINFORCEMENT DENOTED AS As5 AND As6 IN ALL SLABS AND WALLS WITH A MINIMUM OF .06 IN²/FT.

REVISION: 10-09-2015
 APPROVED: MARCH 24, 2011
Nancy Subenberger
 STATE BRIDGE ENGINEER

FIG. 5-395.100(B)
 PRECAST CONCRETE
 BOX CULVERT TABLES
 DO NOT INCLUDE TABLES WITH PLAN

								REINFORCEMENT REQUIREMENTS ①										
SIZE SPAN x RISE (ft.)	CLASS	f'c (psi)	FILL HEIGHT RANGE (ft.)	T+ (in.)	Tb (in.)	Ts (in.)	WEIGHT (lbs./ft.)	As1			As2		As3		As4		As7/As8	
								As	LENGTH	M	As	LENGTH	As	LENGTH	As	LENGTH	As	LENGTH
12x4	1	5000	<3	9	10	8	4275	0.91	12'-9"	3'-10"	0.65	12'-6"	0.63	12'-6"	0.20	4'-6"	0.24	8'-10"
	2	5000	3 - 7	9	10	8	4275	0.83	12'-5"	3'-8"	0.63	12'-6"	0.63	12'-6"	0.20	4'-6"	0.24	8'-11"
	3	5000	7 - 15	10	10	9	4575	1.21	13'-11"	4'-5"	0.92	12'-6"	0.94	12'-6"	0.22	4'-6"	0.24	8'-11"
	4	6000	15 - 22	11	11	9	4925	1.57	14'-4"	4'-6"	1.25	12'-6"	1.26	12'-6"	0.22	4'-6"	0.27	8'-11"
12x5	1	5000	<3	9	10	8	4475	0.83	13'-6"	3'-9"	0.72	12'-6"	0.71	12'-6"	0.20	5'-6"	0.24	8'-10"
	2	5000	3 - 7	9	10	8	4475	0.74	13'-1"	3'-6"	0.70	12'-6"	0.71	12'-6"	0.20	5'-6"	0.24	8'-11"
	3	5000	7 - 15	10	10	8	4650	1.16	12'-7"	3'-3"	1.13	12'-6"	1.15	12'-6"	0.20	5'-6"	0.24	10'-11"
	4	6000	15 - 22	11	11	9	5150	1.36	13'-3"	3'-6"	1.37	12'-6"	1.39	12'-6"	0.22	5'-6"	0.27	10'-11"
12x6	1	5000	<3	9	10	8	4675	0.77	14'-3"	3'-7"	0.78	12'-6"	0.77	12'-6"	0.20	6'-6"	0.24	8'-10"
	2	5000	3 - 7	9	10	8	4675	0.66	12'-8"	2'-10"	0.75	12'-6"	0.77	12'-6"	0.20	6'-6"	0.24	10'-3"
	3	5000	7 - 15	10	10	8	4850	1.04	13'-2"	3'-0"	1.21	12'-6"	1.24	12'-6"	0.20	6'-6"	0.24	10'-11"
	4	6000	15 - 22	11	11	9	5375	1.23	13'-10"	3'-3"	1.49	12'-6"	1.52	12'-6"	0.22	6'-6"	0.27	10'-11"
12x7	1	5000	<3	9	10	8	4875	0.71	15'-1"	3'-6"	0.83	12'-6"	0.82	12'-6"	0.20	7'-6"	0.24	8'-11"
	2	5000	3 - 7	9	10	8	4875	0.61	13'-8"	2'-10"	0.80	12'-6"	0.82	12'-6"	0.20	7'-6"	0.24	10'-3"
	3	5000	7 - 15	10	10	8	5050	0.95	13'-9"	2'-10"	1.27	12'-6"	1.31	12'-6"	0.20	7'-6"	0.24	11'-0"
	4	6000	15 - 22	11	11	9	5600	1.12	14'-6"	3'-1"	1.56	12'-6"	1.60	12'-6"	0.22	7'-6"	0.27	10'-11"
12x8	1	5000	<3	9	10	8	5075	0.67	16'-0"	3'-6"	0.88	12'-6"	0.87	12'-6"	0.20	8'-6"	0.24	8'-11"
	2	5000	3 - 7	9	10	8	5075	0.57	14'-8"	2'-10"	0.84	12'-6"	0.87	12'-6"	0.20	8'-6"	0.24	10'-3"
	3	5000	7 - 15	10	10	8	5250	0.87	14'-9"	2'-10"	1.32	12'-6"	1.37	12'-6"	0.20	8'-6"	0.24	10'-9"
	4	6000	15 - 22	11	11	9	5825	1.04	15'-3"	3'-0"	1.62	12'-6"	1.67	12'-6"	0.22	8'-6"	0.27	10'-11"
12x9	1	5000	<3	9	10	8	5275	0.62	17'-0"	3'-6"	0.92	12'-6"	0.92	12'-6"	0.20	9'-6"	0.24	8'-11"
	2	5000	3 - 7	9	10	8	5275	0.53	15'-8"	2'-10"	0.87	12'-6"	0.92	12'-6"	0.20	9'-6"	0.24	10'-3"
	3	5000	7 - 15	10	10	8	5450	0.82	15'-9"	2'-10"	1.36	12'-6"	1.42	12'-6"	0.20	9'-6"	0.24	10'-7"
	4	6000	15 - 22	11	11	9	6050	0.97	16'-3"	3'-0"	1.66	12'-6"	1.72	12'-6"	0.22	9'-6"	0.27	10'-8"
12x10	1	5000	<3	9	10	8	5475	0.59	18'-0"	3'-6"	0.97	12'-6"	0.96	12'-6"	0.20	10'-6"	0.24	8'-11"
	2	5000	3 - 7	9	10	8	5475	0.50	16'-8"	2'-10"	0.90	12'-6"	0.96	12'-6"	0.20	10'-6"	0.24	10'-3"
	3	5000	7 - 15	10	10	8	5650	0.77	18'-3"	3'-7"	1.39	12'-6"	1.52	12'-6"	0.20	10'-6"	0.24	8'-11"
	4	6000	15 - 22	11	11	9	6275	0.92	18'-10"	3'-9"	1.69	12'-6"	1.76	12'-6"	0.22	10'-6"	0.27	8'-11"
12x11	1	5000	<3	9	10	8	5675	0.59	19'-0"	3'-6"	1.01	12'-6"	1.00	12'-6"	0.23	11'-6"	0.24	8'-11"
	2	5000	3 - 7	9	10	8	5675	0.51	19'-0"	3'-6"	0.93	12'-6"	1.00	12'-6"	0.23	11'-6"	0.24	8'-11"
	3	5000	7 - 15	10	10	8	5850	0.80	19'-4"	3'-7"	1.41	12'-6"	1.56	12'-6"	0.23	11'-6"	0.24	8'-11"
	4	6000	15 - 22	11	11	9	6500	0.92	19'-10"	3'-9"	1.71	12'-6"	1.79	12'-6"	0.23	11'-6"	0.27	8'-11"
12x12	1	5000	<3	9	10	8	5875	0.60	20'-0"	3'-6"	1.05	12'-6"	1.04	12'-6"	0.31	12'-6"	0.24	8'-11"
	2	5000	3 - 7	9	10	8	5875	0.60	21'-4"	4'-2"	0.96	12'-6"	1.04	12'-6"	0.31	12'-6"	0.24	7'-7"
	3	5000	7 - 15	10	10	9	6375	0.76	21'-7"	4'-3"	1.33	12'-6"	1.43	12'-6"	0.31	12'-6"	0.24	7'-9"
	4	6000	15 - 22	11	11	10	7075	0.89	20'-11"	3'-10"	1.62	12'-6"	1.71	12'-6"	0.31	12'-6"	0.27	8'-11"



GENERAL NOTES

SEE STANDARD FIG. 5-395.100(A) FOR BASIS OF DESIGN. FILL HEIGHT IS DEFINED AS THE DISTANCE FROM THE TOP OF THE CULVERT TO THE TOP OF THE PAVEMENT OR TO TOP OF FILL IF THERE IS NO PAVEMENT.

DESIGNS FOR FILL HEIGHTS GREATER THAN SHOWN IN THE TABLES ARE AVAILABLE FROM THE MnDOT BRIDGE OFFICE.

SEE STANDARD FIG. 5-395.101(A) AND FIG. 5-397.101(B) FOR ADDITIONAL INFORMATION. TRANSVERSE REINFORCEMENT IS PARALLEL TO THE CULVERT SPAN. LONGITUDINAL REINFORCEMENT IS PERPENDICULAR TO THE CULVERT SPAN.

IF THE FILL HEIGHT RANGE EXTENDS INTO MORE THAN ONE CLASS, USE THE CLASS WITH THE LARGEST STEEL AREAS. CHECK MAXIMUM AND MINIMUM FILL HEIGHTS OVER THE FULL AREA OF ROADWAY AND SHOULDERS.

ROADWAY OR SHOULDER FILL HEIGHTS OF LESS THAN 2'-0" REQUIRE A DISTRIBUTION SLAB. EXTEND THE WIDTH OF THE DISTRIBUTION SLAB TO THE OUTSIDE EDGES OF THE ROADWAY SHOULDERS UNLESS DIRECTED BY THE ENGINEER.

USE CONCRETE MIX 3S52 FOR THE DISTRIBUTION SLAB.

PLACE 6" THICK CAST-IN-PLACE DISTRIBUTION SLABS WITH NO. 5 BARS AT 1'-0" TRANSVERSELY AND NO. 5 BARS AT 1'-0" LONGITUDINALLY. EPOXY COAT ALL DISTRIBUTION SLAB REINFORCEMENT. CENTER DISTRIBUTION SLAB JOINTS OVER BARREL SEGMENTS. PROVIDE 3" MINIMUM GRANULAR MATERIAL PER SPEC. 3149.2.B.2 BETWEEN BARREL AND DISTRIBUTION SLAB.

PRECAST DISTRIBUTION SLABS WITH THE SAME REINFORCEMENT MAY BE USED FOR FILL HEIGHTS OVER 1'-0". CENTER DISTRIBUTION SLAB JOINTS OVER BARREL SEGMENTS. PROVIDE 6" MIN GRANULAR MATERIAL PER SPEC. 3149.2.B.2 BETWEEN BARREL AND DISTRIBUTION SLAB.

REDESIGN DISTRIBUTION SLAB PER THE MnDOT PAVEMENT DESIGN MANUAL IF IT IS USED AS PAVEMENT SURFACE.

CULVERT WEIGHT IS BASED ON 150 P.C.F. WITH A HAUNCH SIZE OF 12 INCHES.

① REINFORCEMENT AREAS ARE IN SQUARE INCHES PER LINEAL FOOT OF BARREL. ALL REINFORCEMENT LENGTHS AND AREAS ARE MINIMUM REQUIREMENTS. REINFORCEMENT REQUIREMENTS ARE FOR WELDED WIRE REINFORCEMENT WITH MINIMUM SPECIFIED YIELD STRESS OF 65 ksi. IF BAR REINFORCEMENT IS SUBSTITUTED FOR WELDED WIRE REINFORCEMENT, INCREASE THE AREA OF REINFORCEMENT BY 8%, AND SUBMIT DESIGN CALCULATIONS VERIFYING COMPLIANCE WITH AASHTO 5.7.3.4 "CONTROL CRACKING BY DISTRIBUTION OF REINFORCEMENT".

② PLACE LONGITUDINAL REINFORCEMENT DENOTED AS As5 AND As6 IN ALL SLABS AND WALLS WITH A MINIMUM OF .06 IN²/FT.

REVISION: 10-09-2015

APPROVED: MARCH 24, 2011

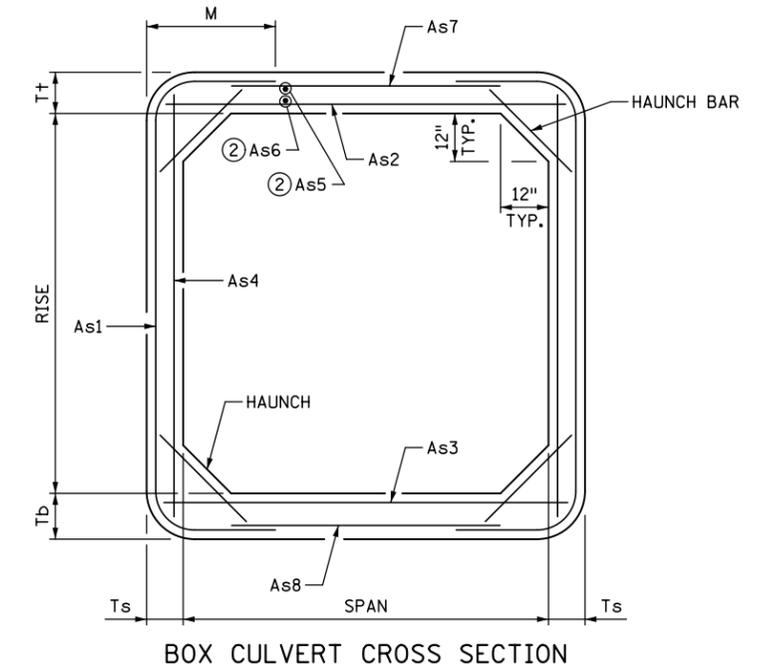
Nancy Dubenberger
STATE BRIDGE ENGINEER

FIG. 5-395.100(C)

DO NOT INCLUDE TABLES WITH PLAN

TITLE
PRECAST CONCRETE
BOX CULVERT TABLES

								REINFORCEMENT REQUIREMENTS ①										
SIZE SPAN x RISE (ft.)	CLASS	f'c (psi)	FILL HEIGHT RANGE (ft.)	Tt (in.)	Tb (in.)	Ts (in.)	WEIGHT (lbs./ft.)	As1			As2		As3		As4		As7/As8	
								As	LENGTH	M	As	LENGTH	As	LENGTH	As	LENGTH	As	LENGTH
14x4	1	5000	<3	10	10	8	4950	1.11	13'-5"	4'-2"	0.76	14'-6"	0.73	14'-6"	0.20	4'-6"	0.24	10'-11"
	2	5000	3 - 6	10	10	8	4950	1.05	13'-2"	4'-0"	0.73	14'-6"	0.73	14'-6"	0.20	4'-6"	0.24	10'-11"
	3	5000	6 - 11	10	10	9	5075	1.33	15'-8"	5'-3"	0.94	14'-6"	0.95	14'-6"	0.22	4'-6"	0.24	9'-7"
	4	6000	11 - 16	11	12	10	5825	1.49	14'-7"	4'-7"	1.11	14'-6"	1.13	14'-6"	0.24	4'-6"	0.29	10'-11"
14x5	1	5000	<3	10	10	8	5150	0.99	14'-2"	4'-0"	0.84	14'-6"	0.81	14'-6"	0.20	5'-6"	0.24	10'-10"
	2	5000	3 - 6	10	10	8	5150	0.93	13'-10"	3'-10"	0.81	14'-6"	0.81	14'-6"	0.20	5'-6"	0.24	10'-11"
	3	5000	6 - 11	10	10	9	5300	1.22	15'-0"	4'-5"	1.03	14'-6"	1.06	14'-6"	0.22	5'-6"	0.24	10'-11"
	4	6000	11 - 16	11	12	10	6075	1.34	15'-5"	4'-6"	1.21	14'-6"	1.25	14'-6"	0.24	5'-6"	0.29	10'-11"
14x6	1	5000	<3	10	10	8	5350	0.90	14'-8"	3'-9"	0.91	14'-6"	0.88	14'-6"	0.20	6'-6"	0.24	10'-11"
	2	5000	3 - 6	10	10	8	5350	0.84	12'-9"	2'-10"	0.87	14'-6"	0.88	14'-6"	0.20	6'-6"	0.24	12'-8"
	3	5000	6 - 11	10	10	9	5525	1.13	15'-8"	4'-3"	1.11	14'-6"	1.14	14'-6"	0.22	6'-6"	0.24	10'-11"
	4	6000	11 - 16	11	12	10	6325	1.23	16'-1"	4'-4"	1.30	14'-6"	1.35	14'-6"	0.24	6'-6"	0.29	10'-11"
14x7	1	5000	<3	10	10	8	5550	0.83	15'-7"	3'-9"	0.97	14'-6"	0.94	14'-6"	0.20	7'-6"	0.24	10'-10"
	2	5000	3 - 6	10	10	8	5550	0.77	13'-9"	2'-10"	0.92	14'-6"	0.94	14'-6"	0.20	7'-6"	0.24	12'-5"
	3	5000	6 - 11	10	10	9	5750	1.06	16'-5"	4'-2"	1.18	14'-6"	1.22	14'-6"	0.22	7'-6"	0.24	10'-11"
	4	6000	11 - 16	11	12	10	6575	1.15	16'-9"	4'-2"	1.39	14'-6"	1.44	14'-6"	0.24	7'-6"	0.29	10'-11"
14x8	1	5000	<3	10	10	8	5750	0.76	16'-4"	3'-7"	1.02	14'-6"	1.00	14'-6"	0.20	8'-6"	0.24	10'-10"
	2	5000	3 - 6	10	10	8	5750	0.71	14'-9"	2'-10"	0.97	14'-6"	1.00	14'-6"	0.20	8'-6"	0.24	12'-3"
	3	5000	6 - 11	10	10	9	5975	1.00	17'-3"	4'-1"	1.24	14'-6"	1.29	14'-6"	0.22	8'-6"	0.24	10'-11"
	4	6000	11 - 16	11	12	10	6825	1.08	17'-7"	4'-1"	1.43	14'-6"	1.53	14'-6"	0.24	8'-6"	0.29	10'-11"
14x9	1	5000	<3	10	10	8	5950	0.70	17'-2"	3'-6"	1.07	14'-6"	1.05	14'-6"	0.20	9'-6"	0.24	10'-11"
	2	5000	3 - 6	10	10	8	5950	0.66	15'-9"	2'-10"	1.01	14'-6"	1.05	14'-6"	0.20	9'-6"	0.24	12'-3"
	3	5000	6 - 11	10	10	9	6200	0.95	18'-0"	3'-11"	1.29	14'-6"	1.35	14'-6"	0.22	9'-6"	0.24	10'-11"
	4	6000	11 - 16	11	12	10	7075	1.01	18'-4"	4'-0"	1.50	14'-6"	1.59	14'-6"	0.24	9'-6"	0.29	10'-11"
14x10	1	5000	<3	10	10	8	6150	0.68	18'-1"	3'-6"	1.12	14'-6"	1.09	14'-6"	0.20	10'-6"	0.24	10'-11"
	2	5000	3 - 6	10	10	8	6150	0.62	16'-9"	2'-10"	1.05	14'-6"	1.09	14'-6"	0.20	10'-6"	0.24	12'-3"
	3	5000	6 - 11	10	10	9	6425	0.90	18'-11"	3'-11"	1.33	14'-6"	1.40	14'-6"	0.22	10'-6"	0.24	10'-11"
	4	6000	11 - 16	11	12	10	7325	0.96	19'-2"	3'-11"	1.54	14'-6"	1.64	14'-6"	0.24	10'-6"	0.29	10'-11"
14x11	1	5000	<3	10	10	8	6350	0.67	19'-1"	3'-6"	1.15	14'-6"	1.14	14'-6"	0.20	11'-6"	0.24	10'-11"
	2	5000	3 - 6	10	10	8	6350	0.60	19'-1"	3'-6"	1.08	14'-6"	1.14	14'-6"	0.20	11'-6"	0.24	10'-11"
	3	5000	6 - 11	10	10	9	6650	0.86	19'-9"	3'-10"	1.37	14'-6"	1.52	14'-6"	0.22	11'-6"	0.24	10'-11"
	4	6000	11 - 16	11	12	10	7575	0.91	20'-1"	3'-10"	1.58	14'-6"	1.69	14'-6"	0.24	11'-6"	0.29	10'-11"
14x12	1	5000	<3	10	10	8	6550	0.67	20'-1"	3'-6"	1.29	14'-6"	1.19	14'-6"	0.26	12'-6"	0.24	10'-11"
	2	5000	3 - 6	10	10	8	6550	0.62	20'-1"	3'-6"	1.11	14'-6"	1.19	14'-6"	0.26	12'-6"	0.24	10'-11"
	3	5000	6 - 11	10	10	9	6875	0.83	21'-10"	4'-4"	1.40	14'-6"	1.57	14'-6"	0.26	12'-6"	0.24	9'-9"
	4	6000	11 - 16	11	12	10	7825	0.90	21'-0"	3'-10"	1.61	14'-6"	1.73	14'-6"	0.26	12'-6"	0.29	10'-11"
14x13	1	5000	<3	10	10	8	6750	0.69	22'-5"	4'-2"	1.57	14'-6"	1.23	14'-6"	0.36	13'-6"	0.24	9'-7"
	2	5000	3 - 6	10	10	8	6750	0.69	23'-3"	4'-7"	1.14	14'-6"	1.23	14'-6"	0.36	13'-6"	0.24	8'-9"
	3	5000	6 - 11	10	10	9	7100	0.85	22'-10"	4'-4"	1.43	14'-6"	1.62	14'-6"	0.36	13'-6"	0.24	9'-10"
	4	6000	11 - 16	11	12	10	8075	0.91	23'-5"	4'-6"	1.64	14'-6"	1.77	14'-6"	0.36	13'-6"	0.29	9'-7"
14x14	1	6000	<3	10	10	8	6950	0.73	26'-9"	5'-10"	1.83	14'-6"	1.27	14'-6"	0.47	14'-6"	0.24	6'-3"
	2	5000	3 - 6	10	10	8	6950	0.73	25'-11"	5'-5"	1.17	14'-6"	1.27	14'-6"	0.47	14'-6"	0.24	7'-1"
	3	5000	6 - 11	10	10	10	7725	0.81	24'-10"	4'-10"	1.36	14'-6"	1.55	14'-6"	0.47	14'-6"	0.24	8'-10"
	4	6000	11 - 16	11	12	11	8725	0.87	24'-7"	4'-7"	1.56	14'-6"	1.71	14'-6"	0.47	14'-6"	0.29	9'-6"



GENERAL NOTES

SEE STANDARD FIG. 5-395.100(A) FOR BASIS OF DESIGN. FILL HEIGHT IS DEFINED AS THE DISTANCE FROM THE TOP OF THE CULVERT TO THE TOP OF THE PAVEMENT OR TO TOP OF FILL IF THERE IS NO PAVEMENT.

DESIGNS FOR FILL HEIGHTS GREATER THAN SHOWN IN THE TABLES ARE AVAILABLE FROM THE MNDOT BRIDGE OFFICE.

SEE STANDARD FIG. 5-395.101(A) AND FIG. 5-397.101(B) FOR ADDITIONAL INFORMATION. TRANSVERSE REINFORCEMENT IS PARALLEL TO THE CULVERT SPAN. LONGITUDINAL REINFORCEMENT IS PERPENDICULAR TO THE CULVERT SPAN.

IF THE FILL HEIGHT RANGE EXTENDS INTO MORE THAN ONE CLASS, USE THE CLASS WITH THE LARGEST STEEL AREAS. CHECK MAXIMUM AND MINIMUM FILL HEIGHTS OVER THE FULL AREA OF ROADWAY AND SHOULDERS.

ROADWAY OR SHOULDER FILL HEIGHTS OF LESS THAN 2'-0" REQUIRE A DISTRIBUTION SLAB. EXTEND THE WIDTH OF THE DISTRIBUTION SLAB TO THE OUTSIDE EDGES OF THE ROADWAY SHOULDERS UNLESS DIRECTED BY THE ENGINEER.

USE CONCRETE MIX 3S52 FOR THE DISTRIBUTION SLAB.

PLACE 6" THICK CAST-IN-PLACE DISTRIBUTION SLABS WITH NO. 5 BARS AT 1'-0" TRANSVERSELY AND NO. 5 BARS AT 1'-0" LONGITUDINALLY. EPOXY COAT ALL DISTRIBUTION SLAB REINFORCEMENT. CENTER DISTRIBUTION SLAB JOINTS OVER BARREL SEGMENTS. PROVIDE 3" MINIMUM GRANULAR MATERIAL PER SPEC. 3149.2.B.2 BETWEEN BARREL AND DISTRIBUTION SLAB.

PRECAST DISTRIBUTION SLABS WITH THE SAME REINFORCEMENT MAY BE USED FOR FILL HEIGHTS OVER 1'-0". CENTER DISTRIBUTION SLAB JOINTS OVER BARREL SEGMENTS. PROVIDE 6" MIN GRANULAR MATERIAL PER SPEC. 3149.2.B.2 BETWEEN BARREL AND DISTRIBUTION SLAB.

REDESIGN DISTRIBUTION SLAB PER THE MNDOT PAVEMENT DESIGN MANUAL IF IT IS USED AS PAVEMENT SURFACE.

CULVERT WEIGHT IS BASED ON 150 P.C.F. WITH A HAUNCH SIZE OF 12 INCHES.

① REINFORCEMENT AREAS ARE IN SQUARE INCHES PER LINEAL FOOT OF BARREL. ALL REINFORCEMENT LENGTHS AND AREAS ARE MINIMUM REQUIREMENTS. REINFORCEMENT REQUIREMENTS ARE FOR WELDED WIRE REINFORCEMENT WITH MINIMUM SPECIFIED YIELD STRESS OF 65 ksi. IF BAR REINFORCEMENT IS SUBSTITUTED FOR WELDED WIRE REINFORCEMENT, INCREASE THE AREA OF REINFORCEMENT BY 8%, AND SUBMIT DESIGN CALCULATIONS VERIFYING COMPLIANCE WITH AASHTO 5.7.3.4 "CONTROL CRACKING BY DISTRIBUTION OF REINFORCEMENT".

② PLACE LONGITUDINAL REINFORCEMENT DENOTED AS As5 AND As6 IN ALL SLABS AND WALLS WITH A MINIMUM OF .06 IN²/FT.

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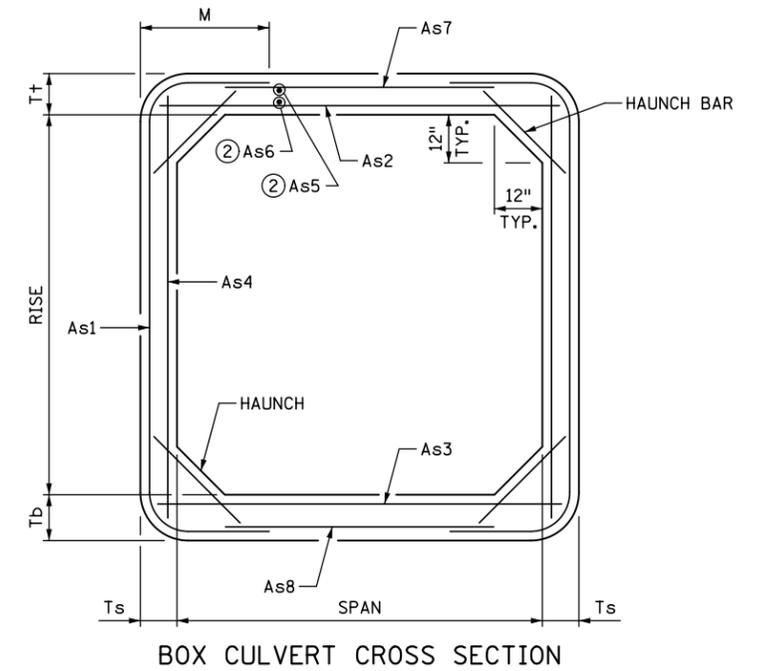
Nancy Dubenberger
STATE BRIDGE ENGINEER

FIG. 5-395.100(D)

DO NOT INCLUDE TABLES WITH PLAN

TITLE
PRECAST CONCRETE
BOX CULVERT TABLES

									REINFORCEMENT REQUIREMENTS ①									
SIZE SPAN x RISE (ft.)	CLASS	f' _c (psi)	FILL HEIGHT RANGE (ft.)	T _t (in.)	T _b (in.)	T _s (in.)	WEIGHT (lbs./ft.)	As1			As2		As3		As4		As7/As8	
								As	LENGTH	M	As	LENGTH	As	LENGTH	As	LENGTH	As	LENGTH
16x4	1	5000	<3	10	11	9	5800	1.33	16'-11"	5'-10"	0.87	16'-6"	0.81	16'-6"	0.22	4'-6"	0.27	10'-5"
	2	5000	3 - 6	10	11	9	5800	1.24	15'-7"	5'-2"	0.83	16'-6"	0.81	16'-6"	0.22	4'-6"	0.27	11'-5"
	3	5000	6 - 10	10	11	10	5950	1.48	17'-4"	6'-1"	1.01	16'-6"	1.00	16'-6"	0.24	4'-6"	0.27	10'-5"
	4	6000	10 - 16	12	12	11	6750	1.85	16'-8"	5'-7"	1.30	16'-6"	1.32	16'-6"	0.27	4'-6"	0.29	11'-1"
16x5	1	5000	<3	10	11	9	6025	1.23	17'-7"	5'-8"	0.95	16'-6"	0.90	16'-6"	0.22	5'-6"	0.27	10'-5"
	2	5000	3 - 6	10	11	9	6025	1.14	16'-3"	5'-0"	0.91	16'-6"	0.90	16'-6"	0.22	5'-6"	0.27	11'-5"
	3	5000	6 - 10	10	11	10	6200	1.36	17'-4"	5'-7"	1.09	16'-6"	1.11	16'-6"	0.24	5'-6"	0.27	11'-3"
	4	6000	10 - 16	12	12	10	6850	1.84	15'-10"	4'-8"	1.55	16'-6"	1.57	16'-6"	0.24	5'-6"	0.29	12'-9"
16x6	1	5000	<3	10	11	9	6250	1.15	17'-3"	5'-0"	1.01	16'-6"	0.98	16'-6"	0.22	6'-6"	0.27	11'-5"
	2	5000	3 - 6	10	11	9	6250	1.06	17'-0"	4'-11"	0.98	16'-6"	0.98	16'-6"	0.22	6'-6"	0.27	11'-5"
	3	5000	6 - 10	10	11	9	6250	1.38	18'-1"	5'-5"	1.27	16'-6"	1.32	16'-6"	0.22	6'-6"	0.27	11'-5"
	4	6000	10 - 16	12	12	10	7100	1.69	16'-10"	4'-8"	1.66	16'-6"	1.69	16'-6"	0.24	6'-6"	0.29	12'-9"
16x7	1	5000	<3	10	11	8	6250	1.13	16'-10"	4'-4"	1.17	16'-6"	1.16	16'-6"	0.20	7'-6"	0.27	12'-9"
	2	5000	3 - 6	10	11	8	6250	1.05	16'-6"	4'-2"	1.14	16'-6"	1.16	16'-6"	0.20	7'-6"	0.27	12'-10"
	3	5000	6 - 10	10	11	9	6475	1.29	17'-5"	4'-7"	1.34	16'-6"	1.41	16'-6"	0.22	7'-6"	0.27	12'-10"
	4	6000	10 - 16	12	12	10	7350	1.57	17'-10"	4'-8"	1.76	16'-6"	1.80	16'-6"	0.24	7'-6"	0.29	12'-9"
16x8	1	5000	<3	10	11	8	6450	1.05	17'-6"	4'-2"	1.23	16'-6"	1.23	16'-6"	0.20	8'-6"	0.27	12'-9"
	2	5000	3 - 6	10	11	8	6450	0.97	17'-2"	4'-0"	1.20	16'-6"	1.23	16'-6"	0.20	8'-6"	0.27	12'-9"
	3	5000	6 - 10	10	11	9	6700	1.20	18'-2"	4'-6"	1.41	16'-6"	1.50	16'-6"	0.22	8'-6"	0.27	12'-10"
	4	6000	10 - 16	12	12	10	7600	1.47	18'-10"	4'-8"	1.84	16'-6"	1.89	16'-6"	0.24	8'-6"	0.29	12'-9"
16x9	1	5000	<3	10	11	8	6650	0.98	18'-4"	4'-1"	1.29	16'-6"	1.28	16'-6"	0.20	9'-6"	0.27	12'-9"
	2	5000	3 - 6	10	11	8	6650	0.90	17'-11"	3'-10"	1.24	16'-6"	1.28	16'-6"	0.20	9'-6"	0.27	12'-9"
	3	5000	6 - 10	10	11	9	6925	1.13	18'-11"	4'-4"	1.53	16'-6"	1.57	16'-6"	0.22	9'-6"	0.27	12'-9"
	4	6000	10 - 16	12	12	10	7850	1.36	19'-8"	4'-7"	1.90	16'-6"	1.97	16'-6"	0.24	9'-6"	0.29	12'-9"
16x10	1	5000	<3	10	11	8	6850	0.93	19'-1"	3'-11"	1.34	16'-6"	1.34	16'-6"	0.20	10'-6"	0.27	12'-9"
	2	5000	3 - 6	10	11	8	6850	0.84	18'-9"	3'-9"	1.29	16'-6"	1.34	16'-6"	0.20	10'-6"	0.27	12'-9"
	3	5000	6 - 10	10	11	9	7150	1.07	19'-8"	4'-3"	1.58	16'-6"	1.64	16'-6"	0.22	10'-6"	0.27	12'-10"
	4	6000	10 - 16	12	12	10	8100	1.29	20'-6"	4'-6"	1.96	16'-6"	2.06	16'-6"	0.24	10'-6"	0.29	12'-9"
16x11	1	5000	<3	10	11	8	7050	0.91	20'-0"	3'-11"	1.39	16'-6"	1.39	16'-6"	0.20	11'-6"	0.27	12'-9"
	2	5000	3 - 6	10	11	8	7050	0.83	19'-8"	3'-9"	1.33	16'-6"	1.39	16'-6"	0.20	11'-6"	0.27	12'-9"
	3	5000	6 - 10	10	11	9	7375	1.02	20'-6"	4'-2"	1.63	16'-6"	1.70	16'-6"	0.22	11'-6"	0.27	12'-9"
	4	6000	10 - 16	12	12	10	8350	1.23	21'-3"	4'-5"	2.03	16'-6"	2.12	16'-6"	0.24	11'-6"	0.29	12'-9"
16x12	1	5000	<3	10	11	8	7250	0.90	21'-1"	3'-11"	1.43	16'-6"	1.44	16'-6"	0.24	12'-6"	0.27	12'-7"
	2	5000	3 - 6	10	11	8	7250	0.83	20'-9"	3'-9"	1.37	16'-6"	1.44	16'-6"	0.24	12'-6"	0.27	12'-9"
	3	5000	6 - 10	10	11	9	7600	0.99	22'-7"	4'-8"	1.67	16'-6"	1.75	16'-6"	0.24	12'-6"	0.27	11'-7"
	4	6000	10 - 16	12	12	11	8950	1.20	22'-2"	4'-4"	1.92	16'-6"	2.02	16'-6"	0.24	12'-6"	0.29	12'-11"



GENERAL NOTES

SEE STANDARD FIG. 5-395.100(A) FOR BASIS OF DESIGN. FILL HEIGHT IS DEFINED AS THE DISTANCE FROM THE TOP OF THE CULVERT TO THE TOP OF THE PAVEMENT OR TO TOP OF FILL IF THERE IS NO PAVEMENT.

DESIGNS FOR FILL HEIGHTS GREATER THAN SHOWN IN THE TABLES ARE AVAILABLE FROM THE MDOT BRIDGE OFFICE.

SEE STANDARD FIG. 5-395.101(A) AND FIG. 5-397.101(B) FOR ADDITIONAL INFORMATION. TRANSVERSE REINFORCEMENT IS PARALLEL TO THE CULVERT SPAN. LONGITUDINAL REINFORCEMENT IS PERPENDICULAR TO THE CULVERT SPAN.

IF THE FILL HEIGHT RANGE EXTENDS INTO MORE THAN ONE CLASS, USE THE CLASS WITH THE LARGEST STEEL AREAS. CHECK MAXIMUM AND MINIMUM FILL HEIGHTS OVER THE FULL AREA OF ROADWAY AND SHOULDERS.

ROADWAY OR SHOULDER FILL HEIGHTS OF LESS THAN 2'-0" REQUIRE A DISTRIBUTION SLAB. EXTEND THE WIDTH OF THE DISTRIBUTION SLAB TO THE OUTSIDE EDGES OF THE ROADWAY SHOULDERS UNLESS DIRECTED BY THE ENGINEER.

USE CONCRETE MIX 3S52 FOR THE DISTRIBUTION SLAB.

PLACE 6" THICK CAST-IN-PLACE DISTRIBUTION SLABS WITH NO. 5 BARS AT 1'-0" TRANSVERSELY AND NO. 5 BARS AT 1'-0" LONGITUDINALLY. EPOXY COAT ALL DISTRIBUTION SLAB REINFORCEMENT. CENTER DISTRIBUTION SLAB JOINTS OVER BARREL SEGMENTS. PROVIDE 3" MINIMUM GRANULAR MATERIAL PER SPEC. 3149.2.B.2 BETWEEN BARREL AND DISTRIBUTION SLAB.

PRECAST DISTRIBUTION SLABS WITH THE SAME REINFORCEMENT MAY BE USED FOR FILL HEIGHTS OVER 1'-0". CENTER DISTRIBUTION SLAB JOINTS OVER BARREL SEGMENTS. PROVIDE 6" MIN GRANULAR MATERIAL PER SPEC. 3149.2.B.2 BETWEEN BARREL AND DISTRIBUTION SLAB.

REDESIGN DISTRIBUTION SLAB PER THE MDOT PAVEMENT DESIGN MANUAL IF IT IS USED AS PAVEMENT SURFACE.

CULVERT WEIGHT IS BASED ON 150 P.C.F. WITH A HAUNCH SIZE OF 12 INCHES.

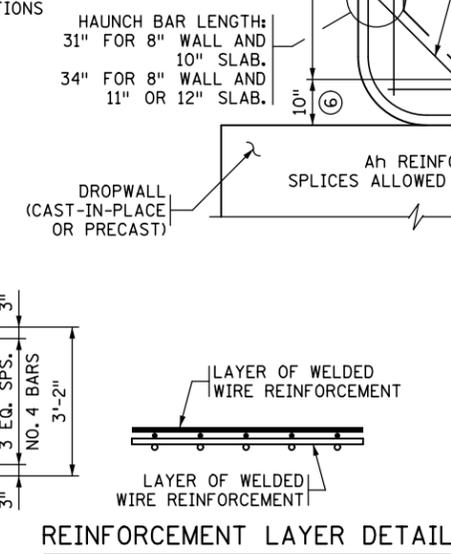
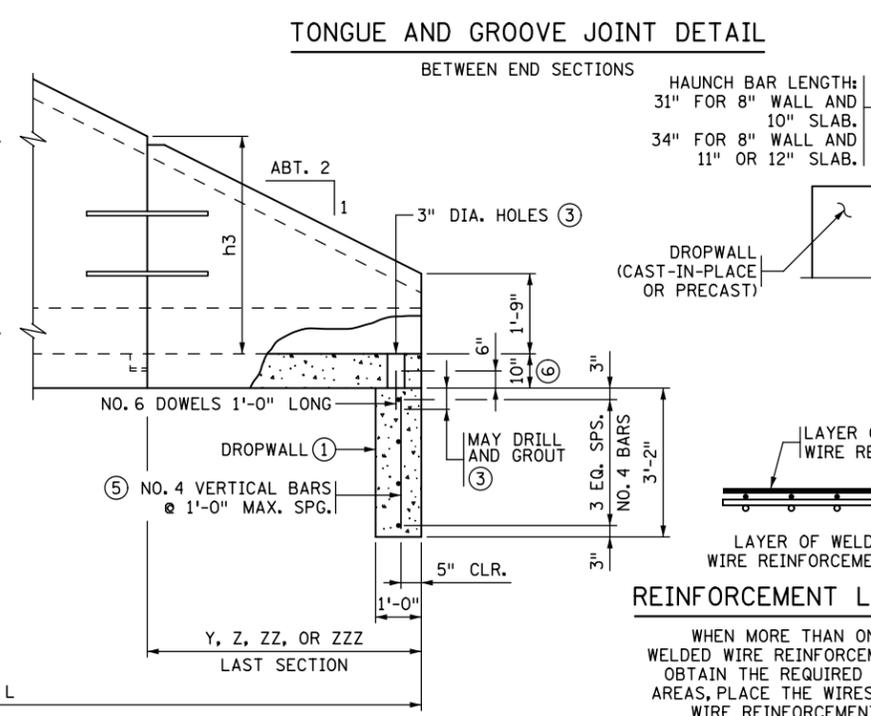
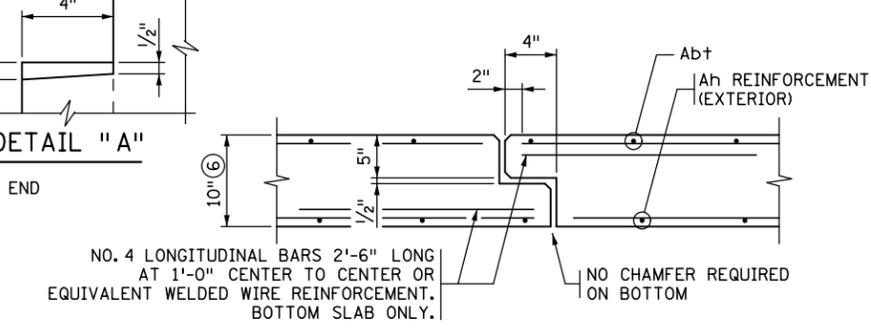
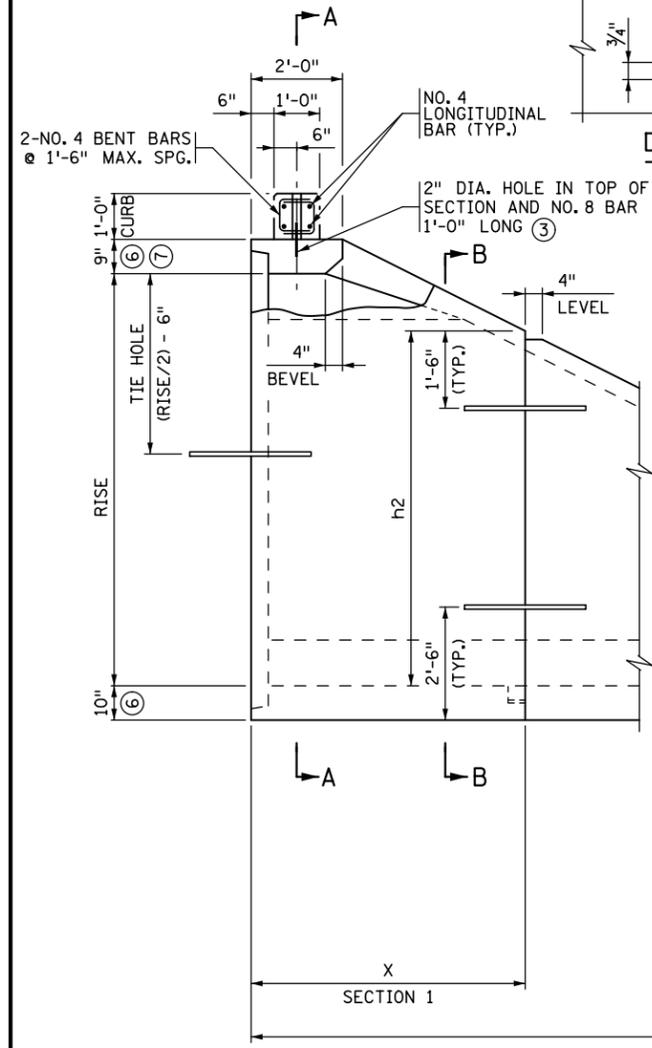
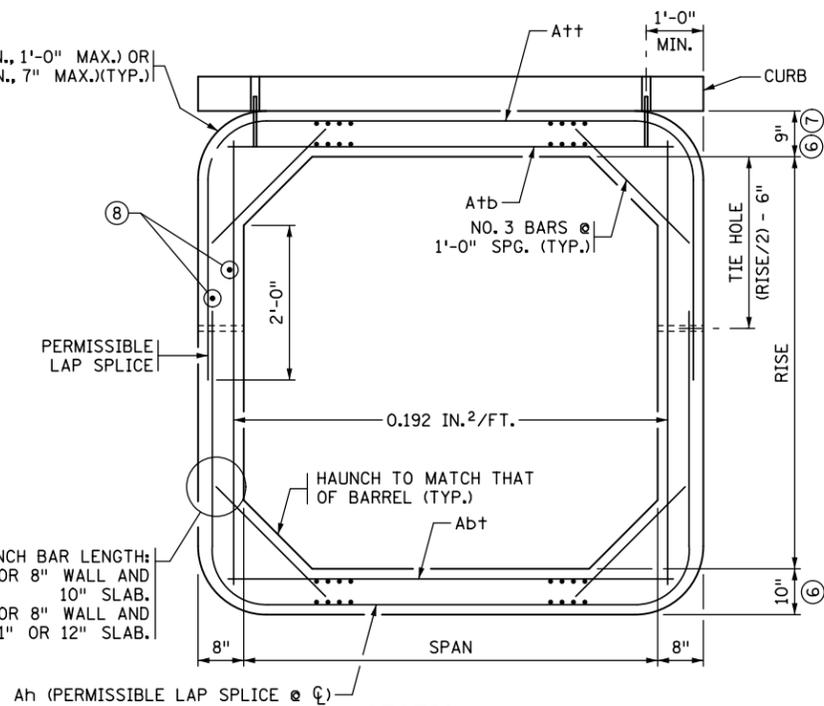
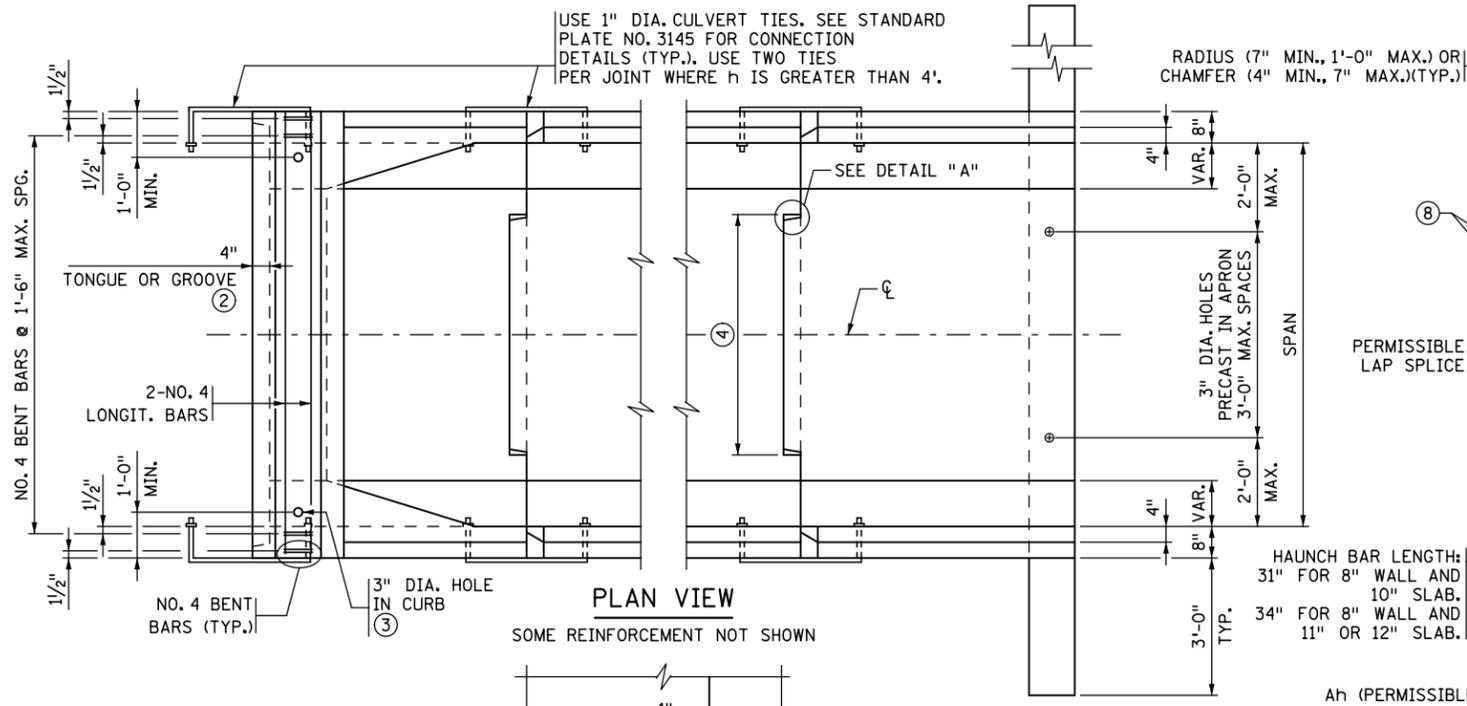
① REINFORCEMENT AREAS ARE IN SQUARE INCHES PER LINEAL FOOT OF BARREL. ALL REINFORCEMENT LENGTHS AND AREAS ARE MINIMUM REQUIREMENTS. REINFORCEMENT REQUIREMENTS ARE FOR WELDED WIRE REINFORCEMENT WITH MINIMUM SPECIFIED YIELD STRESS OF 65 ksi. IF BAR REINFORCEMENT IS SUBSTITUTED FOR WELDED WIRE REINFORCEMENT, INCREASE THE AREA OF REINFORCEMENT BY 8%, AND SUBMIT DESIGN CALCULATIONS VERIFYING COMPLIANCE WITH AASHTO 5.7.3.4 "CONTROL CRACKING BY DISTRIBUTION OF REINFORCEMENT".

② PLACE LONGITUDINAL REINFORCEMENT DENOTED AS As5 AND As6 IN ALL SLABS AND WALLS WITH A MINIMUM OF .06 IN²/FT.

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 APPROVED: MARCH 24, 2011
Nancy Subenberger
 STATE BRIDGE ENGINEER

DO NOT INCLUDE TABLES WITH PLAN

FIG. 5-395.100(E)
 PRECAST CONCRETE
 BOX CULVERT TABLES



- ### CONSTRUCTION NOTES
- SEE STANDARD FIG. 5-395.101(A) AND FIG. 5-395.101(B) FOR ADDITIONAL DIMENSIONS AND CONSTRUCTION NOTES.
- USE CONCRETE MIX NO. 3W82 WITH NO CALCIUM CHLORIDE ALLOWED.
 - ALL END SECTIONS REQUIRE CURB ON LINTEL BEAM.
 - ON ALL END SECTIONS FOR WATERWAYS, USE DROPWALLS ON INLET AND OUTLET ENDS.
 - SEE STANDARD FIG. 5-395.115 FOR EMBANKMENT PROTECTION.
 - FINISH ALL EXPOSED EDGES OF CONCRETE WITH 1/2" OR 3/4" CHAMFER OR RADIUS UNLESS OTHERWISE NOTED.
 - MAXIMUM SIZE OF REINFORCEMENT BARS IS NO. 6, EXCEPT NO. 7 OR 8 BARS MAY BE USED FOR A+b ON SPANS GREATER THAN 14'. THE MAXIMUM WELDED WIRE REINFORCEMENT SIZE IS W23 PER LAYER (MAXIMUM OF 2 LAYERS).
 - WITH DOUBLE BOXES LOCATE DROPWALL JOINTS BETWEEN END SECTIONS. SEE STANDARD FIG. 5-395.111 FOR ALTERNATE DROPWALLS. LIMITS OF EXCAVATION FOR DROPWALL ARE APPROXIMATELY THE SAME AS DROPWALL DIMENSIONS. DROPWALL CONCRETE MIX IS 3S52, OR 3Y82 IF PRECAST. FURNISHING AND INSTALLATION OF DROPWALL TO BE INCLUDED IN PRICE BID FOR END SECTIONS. DROPWALL NOT REQUIRED FOR NON-WATERWAY USE.
 - CHECK LOCATION TO DETERMINE WHETHER A TONGUE OR A GROOVE IS USED.
 - FILL HOLE WITH GROUT. GROUT CONSISTS OF 1 PART CEMENT AND 2 PARTS SAND. USE TYPE 1A AIR ENTRAINED PORTLAND CEMENT. GROUT MIX MAXIMUM SLUMP IS 4".
 - 3'-6" MIN. TONGUE AND 3'-7" MIN. GROOVE FOR CULVERTS WITH 6'-0" SPANS. 5'-0" MIN. TONGUE AND 5'-1" MIN. GROOVE FOR CULVERTS WITH SPANS GREATER THAN 6'-0". CENTER TONGUE AND GROOVE ON $\frac{1}{2}$ OF EACH APRON JOINT. TONGUE AND GROOVE JOINT ON ALL THREE SIDES OF APRON IS PERMISSIBLE.
 - AS AN ALTERNATE TO THE ONE LAYER WELDED WIRE REINFORCEMENT, PROVIDE TWO LAYERS OF REBAR OR WELDED WIRE REINFORCEMENT WITH THE STEEL AREA EQUAL TO HALF OF THE TEMPERATURE STEEL PER CODE REQUIREMENTS IN EACH FACE OF THE DROPWALL.
 - APRON TOP AND BOTTOM SLAB THICKNESS MAY BE 8" FOR CULVERTS WITH 6' SPANS ONLY. BOTTOM SLAB THICKNESS MAY BE INCREASED UP TO 2" MAX. PROVIDED CONCRETE COVER IS 1/2" MIN., 2" MAX.
 - 10" MINIMUM TOP SLAB FOR 14' AND 16' SPANS.
 - PLACE LONGITUDINAL REINFORCEMENT PERPENDICULAR TO THE CULVERT SPAN WITH A MINIMUM OF 0.06 SQUARE INCHES PER PERIPHERAL FOOT ON ALL FACES OF THE BARREL.

A++ , A+b REINFORCEMENT		
SPAN (FT.)	A++ (IN ² /FT.)	A+b (IN ² /FT.)
6	0.27	0.44
8	0.47	0.60
10	0.62	0.74
12	0.88	1.06
14	1.20	1.58
16	1.52	2.09

Ab+ REINFORCEMENT	
SPAN (FT.)	Ab+ (IN ² /FT.)
6-10	0.20
12	0.30
14	0.39
16	0.39

APRON DIMENSIONS & Ah REINFORCEMENT																
RISE FT.	L FT.	SECTION 1		SECTION 2		SECTION 3		SECTION 4		SECTION 5		SECTION 6				
		X	Ah	h2	Y	Ah	h3	Z	Ah	h4	ZZ	Ah	h5	ZZZ	Ah	h6
4	8	8' (4')	0.192	1'-9" (3'-9")	(4')	(0.192)	(1'-9")									
5	10	6'	0.192	3'-9"	4'	0.192	1'-9"									
6	12	6'	0.192	4'-9"	6'	0.192	1'-9"									
7	14	6'	0.192	5'-9"	8' (4')	0.192	1'-9" (3'-9")	(4')	(0.192)	(1'-9")						
8	16	6'	0.20	6'-9"	6'	0.192	3'-9"	4'	0.192	1'-9"						
9	18	6'	0.29	7'-9"	6'	0.20	4'-9"	6'	0.192	1'-9"						
10	20	6'	0.42	8'-9"	6'	0.29	5'-9"	8' (4')	0.192	1'-9" (3'-9")	(4')	(0.192)	(1'-9")			
11	22	6'	0.60	9'-9"	6'	0.42	6'-9"	6'	0.192	3'-9"	4'	0.192	1'-9"			
12	24	6'	0.78	10'-9"	6'	0.60	7'-9"	6'	0.20	4'-9"	6'	0.192	1'-9"			
13	26	6'	1.03	11'-9"	6'	0.78	8'-9"	6'	0.28	5'-9"	8' (4')	0.192	1'-9" (3'-9")	(4')	(0.192)	(1'-9")
14	28	6'	1.38	12'-9"	6'	1.03	9'-9"	6'	0.40	6'-9"	6'	0.192	3'-9"	4'	0.192	1'-9"

NOTE: Ah IS AREA OF REINFORCEMENT PER FOOT OF LENGTH (IN²/FT.) VALUES IN () MAY BE USED FOR END SECTIONS WITH SPANS OF 14' AND 16' ONLY.

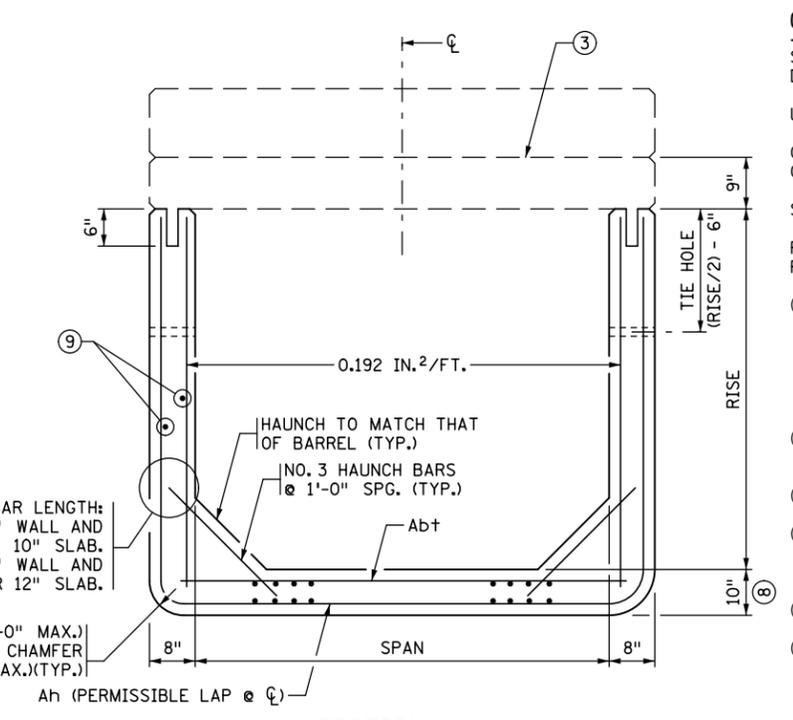
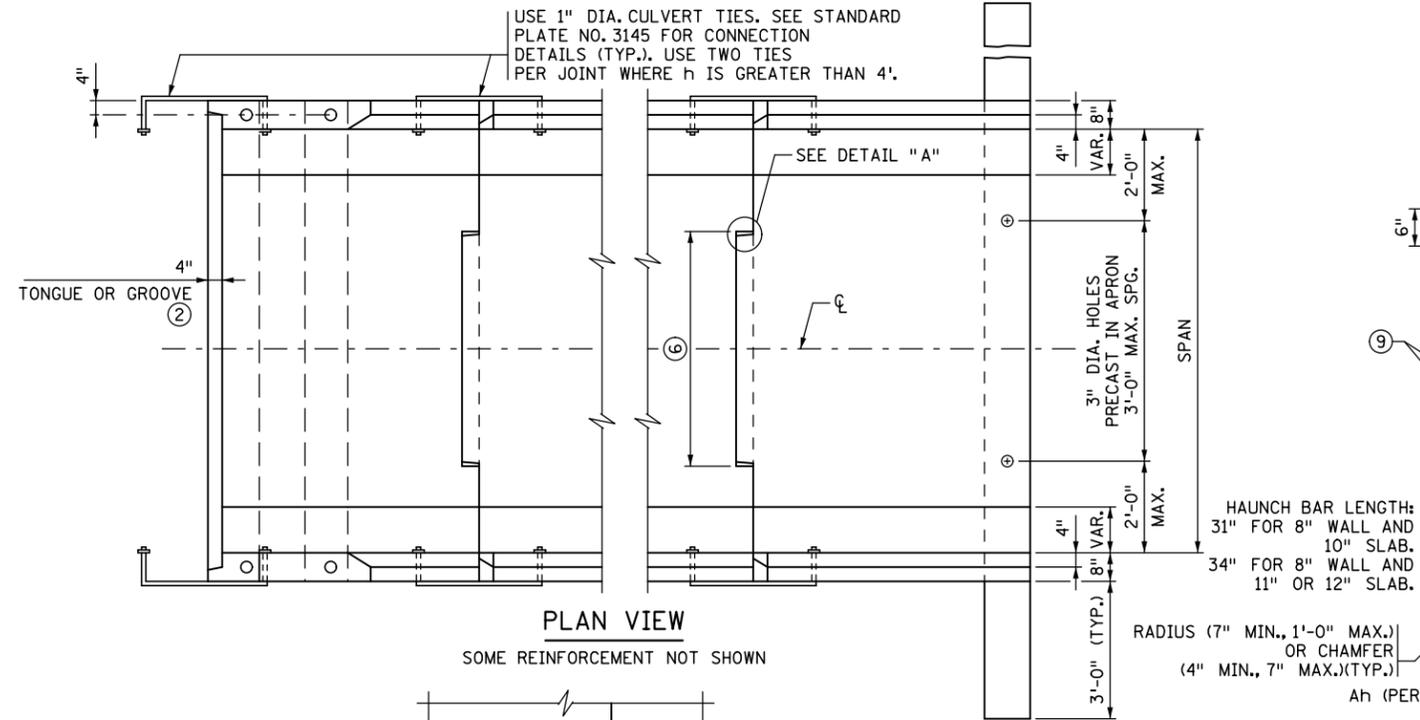
REVISION: 10-09-2015
 APPROVED: MARCH 24, 2011
 Nancy A. Suberberger
 STATE BRIDGE ENGINEER

STATE PROJ. NO - (T.H.) STA. + . FIG. 5-395.102

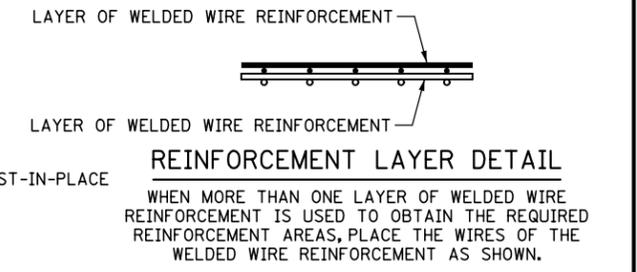
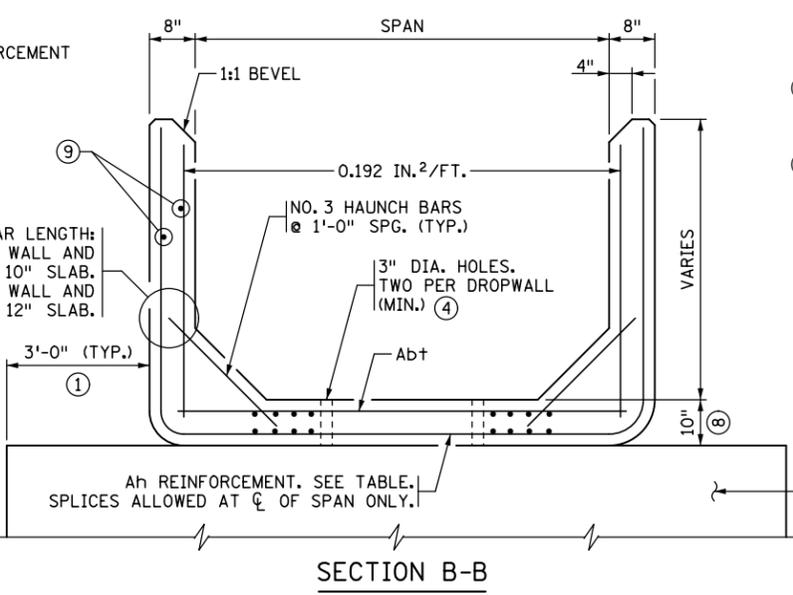
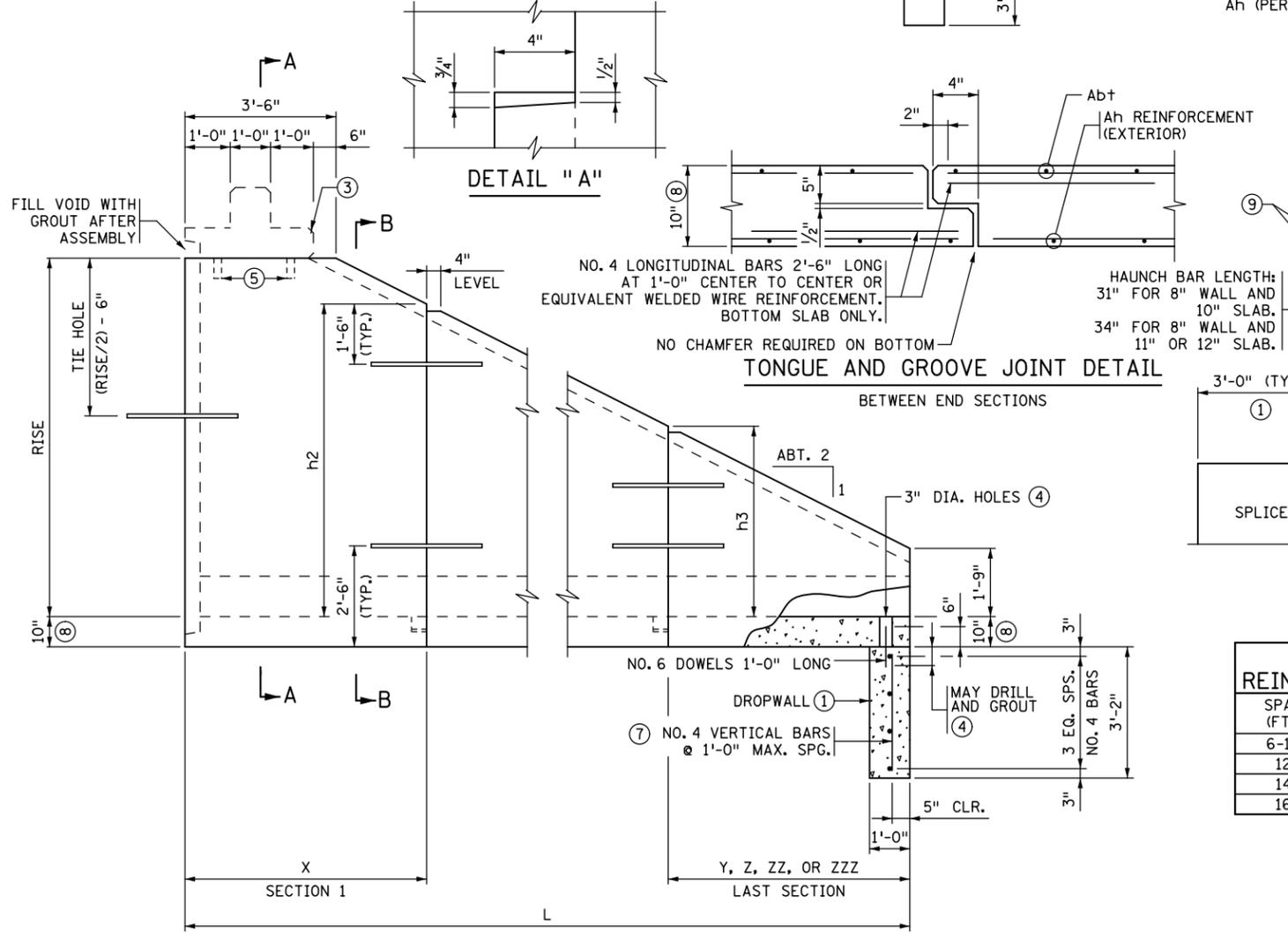
CERTIFIED BY _____ TITLE: PRECAST CONCRETE END SECTION TYPE I - SINGLE OR DOUBLE BARREL FOR SKEWS UP TO 7 1/2'

DES: _____ DR: _____ APPROVED: _____
 CHK: _____ CHK: _____ BRIDGE NO. _____

NAME: _____ LIC. NO. _____ SHEET NO. OF SHEETS



- ### CONSTRUCTION NOTES
- SEE STANDARD FIG. 5-395.101(A) AND FIG. 5-395.101(B) FOR ADDITIONAL DIMENSIONS AND CONSTRUCTION NOTES.
- USE CONCRETE MIX NO. 3W82 WITH NO CALCIUM CHLORIDE ALLOWED.
- ON ALL END SECTIONS FOR WATERWAYS, USE DROPWALLS ON INLET AND OUTLET ENDS.
- SEE STANDARD FIG. 5-395.115 FOR EMBANKMENT PROTECTION.
- FINISH ALL EXPOSED EDGES OF CONCRETE WITH 1/2" OR 3/4" CHAMFER OR RADIUS UNLESS OTHERWISE NOTED.
- WITH DOUBLE BOXES LOCATE DROPWALL JOINTS BETWEEN END SECTIONS. SEE STANDARD FIG. 5-395.111 FOR ALTERNATE DROPWALLS. LIMITS OF EXCAVATION FOR DROPWALL ARE APPROXIMATELY THE SAME AS DROPWALL DIMENSIONS. DROPWALL CONCRETE MIX IS 3S52, OR 3Y82 IF PRECAST. FURNISHING AND INSTALLATION OF DROPWALL TO BE INCLUDED IN PRICE BID FOR END SECTIONS. DROPWALL NOT REQUIRED FOR NON-WATERWAY USE.
 - CHECK LOCATION TO DETERMINE WHETHER A TONGUE OR A GROOVE IS USED.
 - SEE STANDARD FIG. 5-395.104(B) FOR LINTEL BEAM DETAILS.
 - FILL HOLE WITH GROUT. GROUT CONSISTS OF 1 PART CEMENT AND 2 PARTS SAND. USE TYPE 1A AIR ENTRAINED PORTLAND CEMENT. GROUT MIX MAXIMUM SLUMP IS 4".
 - 2" DIAMETER HOLE, 6" DEEP IN TOP OF THE SECTION WALL.
 - 3'-6" MIN. TONGUE AND 3'-7" MIN. GROOVE FOR CULVERTS WITH 6'-0" SPANS. 5'-0" MIN. TONGUE AND 5'-1" MIN. GROOVE FOR CULVERTS WITH SPANS GREATER THAN 6'-0". CENTER TONGUE AND GROOVE ON C OF EACH APRON JOINT. TONGUE AND GROOVE JOINT ON ALL THREE SIDES OF APRON IS PERMISSIBLE.
 - AS AN ALTERNATE TO THE ONE LAYER WELDED WIRE REINFORCEMENT, PROVIDE TWO LAYERS OF REBAR OR WELDED WIRE REINFORCEMENT WITH THE STEEL AREA EQUAL TO HALF OF THE TEMPERATURE STEEL PER CODE REQUIREMENTS IN EACH FACE OF THE DROPWALL.
 - APRON TOP AND BOTTOM SLAB THICKNESS MAY BE 8" FOR CULVERTS WITH 6' SPANS ONLY. BOTTOM SLAB THICKNESS MAY BE INCREASED UP TO 2" MAX. PROVIDED CONCRETE COVER IS 1/2" MIN., 2" MAX.
 - PLACE LONGITUDINAL REINFORCEMENT PERPENDICULAR TO THE CULVERT SPAN WITH A MINIMUM OF 0.06 SQUARE INCHES PER PERIPHERAL FOOT ON ALL FACES OF THE BARREL.



SPAN (FT.)	Ab+ (IN ² /FT.)
6-10	0.20
12	0.30
14	0.39
16	0.39

RISE FT.	L FT.	SECTION 1		SECTION 2		SECTION 3		SECTION 4		SECTION 5		h6				
		X	Ah	h2	Y	Ah	h3	Z	Ah	h4	ZZ		Ah			
4	8	8' (4')	0.192	1'-9" (3'-9")	(4')	(0.192)	(1'-9")									
5	10	6'	0.192	3'-9"	4'	0.192	1'-9"									
6	12	6'	0.192	4'-9"	6'	0.192	1'-9"									
7	14	6'	0.192	5'-9"	8' (4')	0.192	1'-9" (3'-9")	(4')	(0.192)	(1'-9")						
8	16	6'	0.20	6'-9"	6'	0.192	3'-9"	4'	0.192	1'-9"						
9	18	6'	0.29	7'-9"	6'	0.20	4'-9"	6'	0.192	1'-9"						
10	20	6'	0.42	8'-9"	6'	0.29	5'-9"	8' (4')	0.192	1'-9" (3'-9")	(4')	(0.192)	(1'-9")			
11	22	6'	0.60	9'-9"	6'	0.42	6'-9"	6'	0.192	3'-9"	4'	0.192	1'-9"			
12	24	6'	0.78	10'-9"	6'	0.60	7'-9"	6'	0.20	4'-9"	6'	0.192	1'-9"			
13	26	6'	1.03	11'-9"	6'	0.78	8'-9"	6'	0.28	5'-9"	8' (4')	0.192	1'-9" (3'-9")	(4')	(0.192)	(1'-9")
14	28	6'	1.38	12'-9"	6'	1.03	9'-9"	6'	0.40	6'-9"	6'	0.192	3'-9"	4'	0.192	1'-9"

NOTE: Ah IS AREA OF REINFORCEMENT PER FOOT OF LENGTH (IN²/FT.) VALUES IN () MAY BE USED FOR END SECTIONS WITH SPANS OF 14' AND 16' ONLY.

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 STATE BRIDGE ENGINEER

STATE PROJ. NO		- (T.H.) STA. +		FIG. 5-395.104(A)	
CERTIFIED BY	DATE	TITLE: PRECAST CONCRETE END SECTION TYPE III - SINGLE OR DOUBLE BARREL FOR SKEWS UP TO 7 1/2'	DES: _____	DR: _____	APPROVED: _____
NAME:	LIC. NO.		CHK: _____	CHK: _____	BRIDGE NO.
			SHEET NO. OF SHEETS		

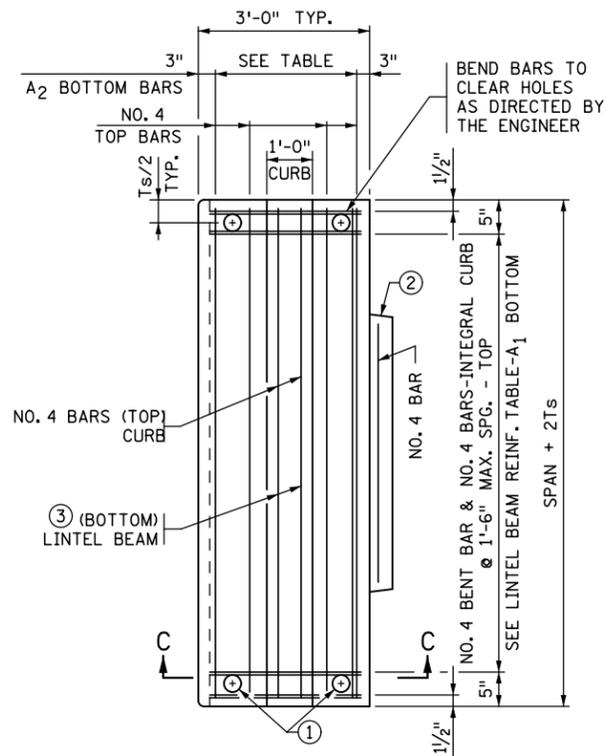
CONSTRUCTION NOTES

SEE STANDARD FIG. 5-395.101(A) AND FIG. 5-395.101(B) FOR ADDITIONAL DIMENSIONS AND CONSTRUCTION NOTES.

ALL END SECTIONS REQUIRE CURB ON LINTEL BEAM.

GROUT CONSISTS OF 1 PART CEMENT AND 2 PARTS SAND. USE TYPE 1A AIR ENTRAINED PORTLAND CEMENT. GROUT MIX MAXIMUM SLUMP IS 4".

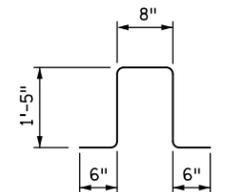
- ① 3" DIA. HOLE THROUGH LINTEL BEAM AND 2" DIA. HOLE IN TOP OF WALL SECTION. PLACE NO. 8 DOWEL, 1'-0" LONG, IN HOLE AND FILL HOLE WITH GROUT.
- ② CHECK THE LOCATION TO DETERMINE WHETHER A TONGUE OR A GROOVE IS USED. TONGUE AND GROOVE TO TERMINATE AT HAUNCH.
- ③ FOR SPANS UNDER 10'-0" USE NO. 8 BARS. FOR SPANS OF 10'-0" TO 12'-0" USE NO. 9 BARS. FOR 14'-0" AND 16'-0" SPAN, USE NO. 10 BARS.
- ④ ALTERNATE BAR BEND MAY BE USED FOR NO. 4 BENT BAR.



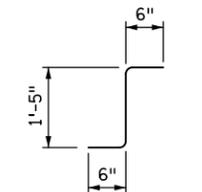
PLAN VIEW OF SQUARE LINTEL BEAM

LINTEL BEAM BOTTOM REINFORCEMENT		
SPAN (FT.)	A ₁	A ₂
6	NO. 4 @ 1'-2"	NO. 4 @ 9/2"
8	NO. 4 @ 8"	NO. 5 @ 8"
10	NO. 5 @ 8"	NO. 6 @ 7 1/2"
12	NO. 5 @ 6"	NO. 6 @ 6"
14	NO. 6 @ 6"	NO. 7 @ 6"
16	NO. 6 @ 6"	NO. 7 @ 6"

NOTE: MAXIMUM BAR SPACING GIVEN, REDUCE AS NECESSARY

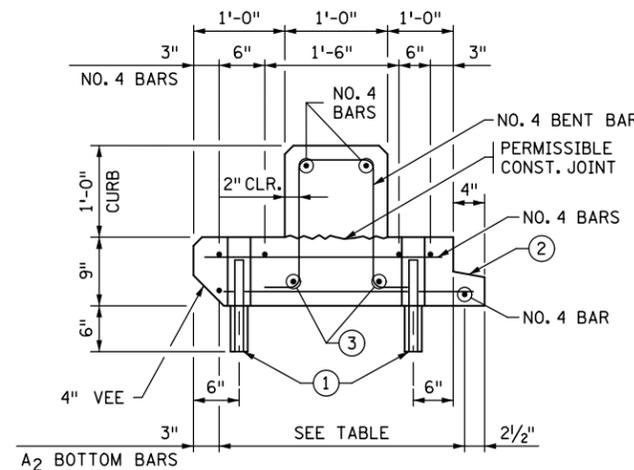


NO. 4 BENT BAR



**NO. 4 BENT BAR
ALTERNATE**

④
2 REQUIRED

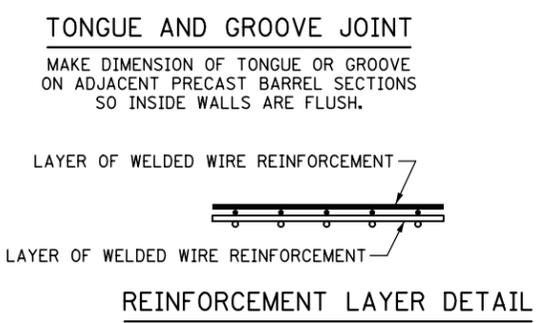
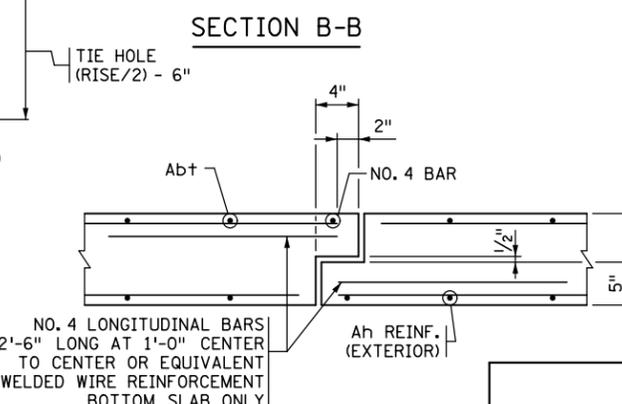
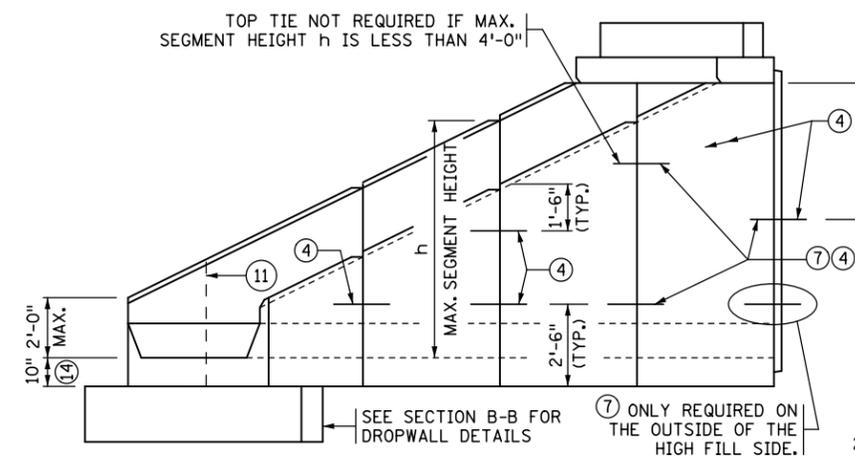
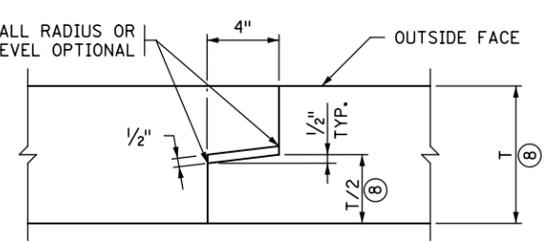
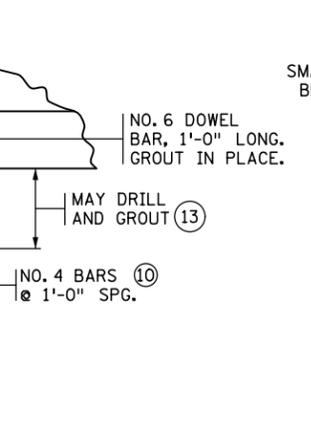
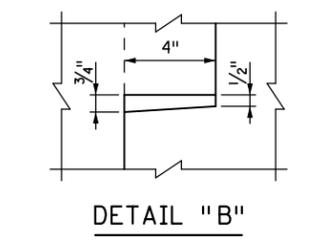
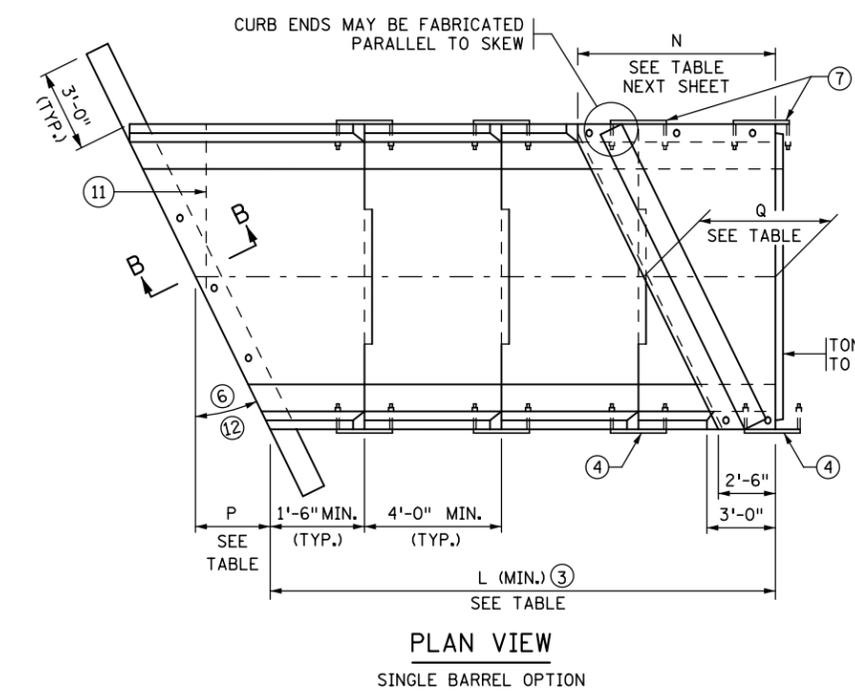
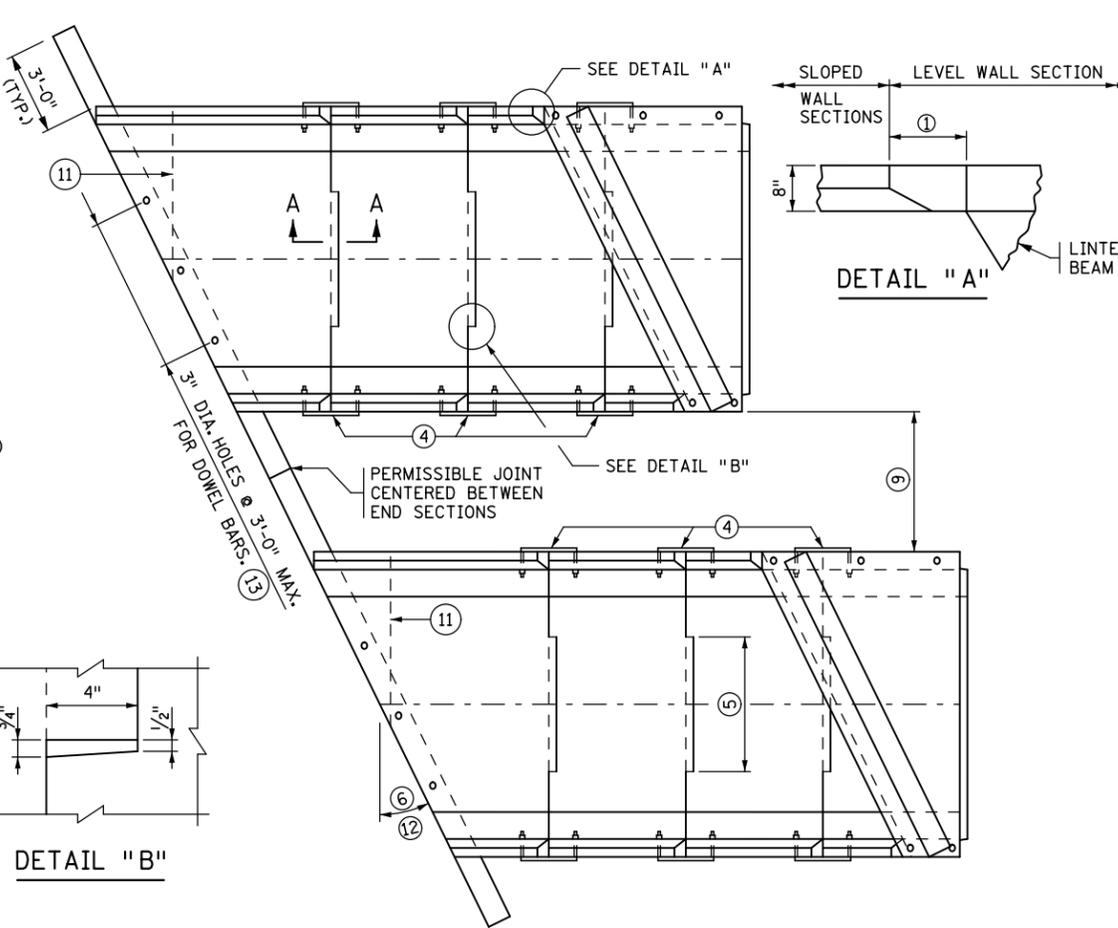
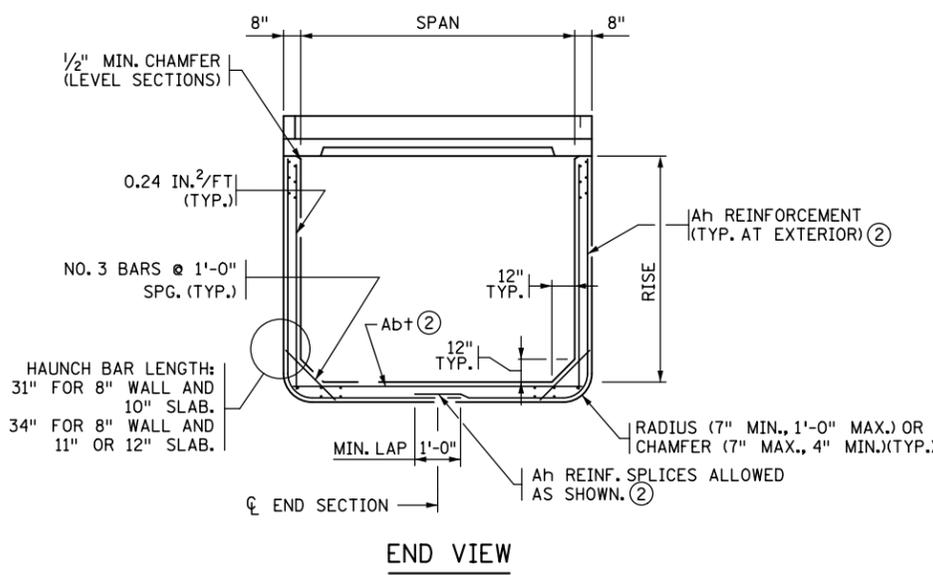


SECTION C-C

INTEGRAL CURB WITH TONGUE.
ADDITIONAL REINFORCEMENT IN TONGUE NOT SHOWN.

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Nancy Subenberger
STATE BRIDGE ENGINEER

STATE PROJ. NO		- (T.H.) STA. + .		FIG. 5-395.104(B)	
CERTIFIED BY	DATE	TITLE: PRECAST CONCRETE END SECTION	DES: _____	DR: _____	APPROVED: _____
NAME:	LIC. NO.	TYPE III - SINGLE OR DOUBLE BARREL	CHK: _____	CHK: _____	BRIDGE NO. _____
		FOR SKEWS UP TO 7 1/2°	SHEET NO. OF SHEETS		



CONSTRUCTION NOTES

- SEE STANDARD FIG. 5-395.101(A) AND FIG. 5-395.101(B) FOR ADDITIONAL DIMENSIONS AND CONSTRUCTION NOTES.
- ON ALL END SECTIONS FOR WATERWAYS, USE DROPWALLS ON INLET AND OUTLET ENDS.
- FINISH ALL EXPOSED EDGES OF CONCRETE WITH 1/2" OR 3/4" CHAMFER OR RADIUS UNLESS OTHERWISE NOTED.
- USE CONCRETE MIX 3W82 WITH NO CALCIUM CHLORIDE ALLOWED.
- USE DROPWALL CONCRETE MIX 3S52, OR 3Y82 IF PRECAST. LIMITS FOR DROPWALL EXCAVATION TO BE APPROXIMATELY THE SAME AS DROPWALL DIMENSIONS. FURNISHING AND INSTALLATION OF DROPWALL IS INCLUDED IN PRICE BID FOR END SECTIONS.
- PLACE LONGITUDINAL REINFORCEMENT WITH A MINIMUM OF 0.06 SQ. IN. PER FT. ON BOTH FACES.
- NO TONGUE OR GROOVE REQUIRED IN WALLS BETWEEN END SECTIONS.
- SEE STANDARD FIG. 5-395.115 FOR EMBANKMENT PROTECTION.
- ① 8 1/8" @ 15"; 10 5/8" @ 30"; 1'-2" @ 45°
 - ② SEE STANDARD FIG. 5-395.110(B) FOR REINFORCEMENT TABLES.
 - ③ NUMBER OF SECTIONS VARIES WITH CULVERT RISE.
 - ④ EXCEPT AS NOTED, USE 1" DIA. CULVERT TIES. SEE STANDARD PLATE NO. 3145 FOR DETAILS. TWO TIES ARE REQUIRED PER JOINT WHERE h IS GREATER THAN 4'.
 - ⑤ 3'-6" MIN. TONGUE AND 3'-7" MIN. GROOVE FOR CULVERTS WITH 6'-0" SPANS. 5'-0" MIN. TONGUE AND 5'-1" MIN. GROOVE FOR CULVERTS WITH SPANS GREATER THAN 6'-0". CENTER TONGUE AND GROOVE ON C OF EACH APRON JOINT. TONGUE AND GROOVE JOINT ON ALL THREE SIDES OF APRON IS PERMISSIBLE.
 - ⑥ FOR SKEW ANGLES OVER 7 1/2° UP TO 22 1/2°, USE A 15° SKEW END SECTION. FOR SKEW ANGLES OVER 22 1/2° UP TO 37 1/2°, USE A 30° SKEW END SECTION. FOR SKEW ANGLES OVER 37 1/2° UP TO 45°, USE A 45° SKEW END SECTION.
 - ⑦ PROVIDE EXTRA STRONG CONNECTION AT LOCATION SHOWN; REQUIRED ONLY ON HIGH FILL SIDE FOR 45° SKEW END SECTIONS OVER 6'-0" HIGH. FOR MULTIPLE BARREL OPTION, ONLY INCLUDE EXTRA STRONG TIES ON THE OUTSIDE OF THE HIGH FILL SIDE. SEE STANDARD FIG. 5-395.110(B) FOR DETAILS.
 - ⑧ DIMENSION "T" IS EQUAL TO Tt, Tb OR Ts.
 - ⑨ REFER TO THE GENERAL PLAN AND ELEVATION SHEET FOR THE DISTANCE BETWEEN BARRELS OF ADJACENT BOXES AND TO STANDARD FIGURE 5-395.115 FOR MATERIAL REQUIREMENTS FOR FILL BETWEEN ADJACENT BOXES.
 - ⑩ AS AN ALTERNATE TO THE ONE LAYER OF WELDED WIRE REINFORCEMENT CONTRACTOR MAY PROVIDE TWO LAYERS OF REBAR OR WELDED WIRE REINFORCEMENT WITH THE STEEL AREA EQUAL TO HALF OF THE TEMPERATURE STEEL PER CODE REQUIREMENTS IN EACH FACE OF THE DROPWALL.
 - ⑪ ON THE LAST SEGMENT OF THE 45° SKEWED APRONS, A TRANSVERSE JOINT IN THE BOTTOM IS PERMITTED. A SPECIAL TIE, SIMILAR TO THE SIDE TIE, MUST BE PROVIDED. THE TIE SHALL BE INSET AND THE SPACE FILLED WITH AN APPROVED GROUT.
 - ⑫ FOR BOX CULVERTS WITH SPANS OF 16' THE MAXIMUM SKEW SHALL BE 30°.
 - ⑬ FILL HOLE WITH GROUT. GROUT CONSISTS OF 1 PART CEMENT AND 2 PARTS SAND. USE TYPE 1A AIR ENTRAINED PORTLAND CEMENT. GROUT MIX MAXIMUM SLUMP IS 4".
 - ⑭ APRON BOTTOM SLAB THICKNESS MAY BE 8" FOR CULVERTS WITH 6' SPANS ONLY. BOTTOM SLAB THICKNESS MAY BE INCREASED UP TO 2" MAX. PROVIDED COVER IS 1/2" MIN., 2" MAX.

LENGTH P			
SPAN (FT.)	15° SKEW	30° SKEW	45° SKEW
6	0'-11 3/4"	2'-1 1/8"	3'-8"
8	1'-3"	2'-8 3/8"	4'-8"
10	1'-6 1/4"	3'-3 1/4"	5'-8"
12	1'-9 3/8"	3'-10 1/4"	6'-8"
14	2'-0 5/8"	4'-5 1/8"	7'-8"
16	2'-3 7/8"	5'-0"	(12)

MIN. LENGTH L			
RISE (FT.)	15° SKEW	30° SKEW	45° SKEW
4	7'-1 3/4"	7'-7 3/8"	8'-7 7/8"
5	9'-2 1/2"	9'-11 1/8"	11'-5 5/8"
6	11'-3 3/8"	12'-2 7/8"	14'-3 3/4"
7	13'-4 1/4"	14'-6 5/8"	17'-1 3/4"
8	15'-5 1/8"	16'-10 1/4"	19'-11 5/8"
9	17'-5 7/8"	19'-2"	22'-9 5/8"
10	19'-6 3/4"	21'-5 3/4"	25'-7 1/2"
11	21'-7 5/8"	23'-9 3/8"	28'-5 1/2"
12	23'-8 1/2"	26'-1 1/8"	31'-3 3/8"
13	25'-9 3/8"	28'-4 7/8"	34'-1 3/8"
14	27'-10 1/8"	30'-8 1/2"	36'-11 1/4"

LENGTH Q			
SPAN (FT.)	15° SKEW	30° SKEW	45° SKEW
6	3'-5 3/4"	4'-7 3/8"	6'-2"
8	3'-9"	5'-2 3/8"	7'-2"
10	4'-0"	5'-9 1/4"	8'-2"
12	4'-3 3/8"	6'-4 1/8"	9'-2"
14	4'-6 5/8"	6'-11 1/8"	10'-2"
16	4'-9 7/8"	7'-6 1/8"	(12)

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ELEVATION

STATE PROJ. NO - (T.H.) STA. + .

CERTIFIED BY _____ DATE _____

NAME: _____ LIC. NO. _____

TITLE: PRECAST CONCRETE END SECTION TYPE III - SINGLE OR DOUBLE BARREL FOR SKEWS 7 1/2° TO 45°

DES: _____ DR: _____

CHK: _____ CHK: _____

APPROVED: _____

SHEET NO. OF SHEETS

BRIDGE NO. _____

FIG. 5-395.110(A)

Ah REINFORCEMENT		
HEIGHT h (FT.)	Ah (IN ² /FT.)	
	15° & 30° SKEW	45° SKEW
7 OR LESS	0.192	0.192
8	0.20	0.24
9	0.29	0.36
10	0.42	0.53
11	0.60	0.75
12	0.78	0.98
13	1.03	1.36
14	1.38	1.85

Ab† REINFORCEMENT	
SPAN (FT.)	Ab† (IN ² /FT.)
6-10	0.20
12	0.30
14	0.39
16	0.39

LINTEL BEAM REINFORCEMENT		
SPAN (FT.)	BOTTOM REINFORCEMENT	
	A1	A2
6	NO. 4 @ 1'-0"	NO. 4 @ 9"
8	NO. 4 @ 1'-1"	NO. 4 @ 6"
10	NO. 4 @ 9"	NO. 5 @ 6"
12	NO. 5 @ 9"	NO. 6 @ 6"
14	NO. 6 @ 9"	NO. 8 @ 6"
16	NO. 6 @ 9"	NO. 8 @ 6"

LENGTH N			
SPAN (FT.)	15° SKEW	30° SKEW	45° SKEW
6	4'-3 ³ / ₈ "	6'-4 ¹ / ₄ "	9'-2"
8	4'-9 ⁷ / ₈ "	7'-6"	11'-2"
10	5'-4 ¹ / ₄ "	8'-7 ⁷ / ₈ "	13'-2"
12	5'-10 ³ / ₄ "	9'-9 ³ / ₄ "	15'-2"
14	6'-5 ¹ / ₈ "	10'-11 ⁵ / ₈ "	17'-2"
16	6'-11 ⁵ / ₈ "	12'-1 ¹ / ₂ "	NA (7)

LINTEL BEAM THICKNESS			
SPAN (FT.)	15° SKEW	30° SKEW	45° SKEW
≤ 12	9"	9"	9"
14	10" (8)	10" (8)	10" (8)
16	10" (8)	10" (8)	NA (7)

CONSTRUCTION NOTES

SEE STANDARD FIG. 5-395.101(A) AND FIG. 5-395.101(B) FOR ADDITIONAL DIMENSIONS AND CONSTRUCTION NOTES.

ALL END SECTIONS REQUIRE CURB ON LINTEL BEAM.

GROUT CONSISTS OF 1 PART CEMENT AND 2 PARTS SAND. USE TYPE 1A AIR ENTRAINED PORTLAND CEMENT. GROUT MIX MAXIMUM SLUMP IS 4".

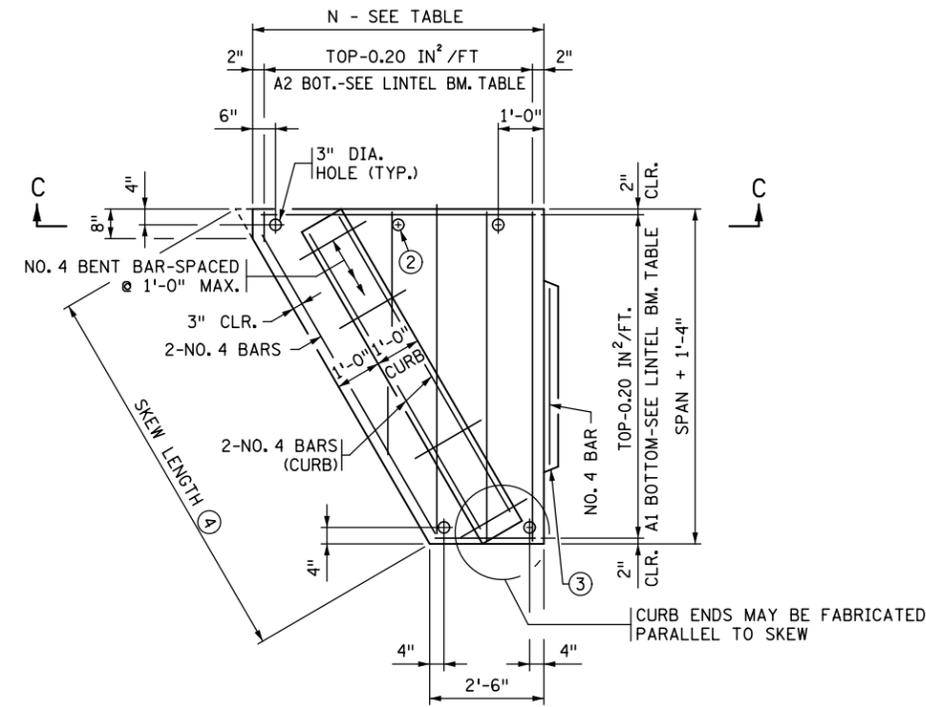
STRUCTURAL STEEL PER SPEC. 3306.

WELDING PER SPEC. 2471.

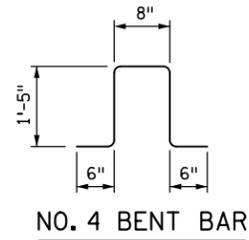
GALVANIZE STRUCTURAL STEEL PER SPEC. 3394.

GALVANIZE BOLTS, NUTS AND WASHERS PER SPEC. 3392.

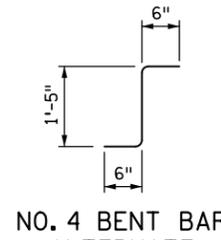
- NO. 8 DOWEL, 1'-0" LONG, 2" DIA. HOLE IN THE TOP OF THE WALL SECTION AND 3" DIA. HOLE IN THE LINTEL. FILL HOLE WITH GROUT.
- PROVIDE ADDITIONAL 3" HOLES AT 4'-0" MAXIMUM SPACING WHEN SIDE OF LINTEL BEAM IS OVER 6 FT.
- CHECK THE LOCATION TO DETERMINE WHETHER A TONGUE OR A GROOVE IS USED. TONGUE AND GROOVE TO TERMINATE AT CULVERT RADIUS.
- FOR SKEW LENGTH UNDER 10' USE NO. 8 BARS. FOR SKEW LENGTH OF 10' TO 14' USE NO. 9 BARS. FOR SKEW LENGTH OVER 14' TO 18' USE NO. 10 BARS. FOR SKEW LENGTH OVER 18' TO 22' USE NO. 11 BARS OR EQUAL. SKEW LENGTH IS DISTANCE BETWEEN OUTSIDE FACES OF END SECTION ALONG LINTEL BEAM.
- SEE LINTEL BEAM THICKNESS TABLE ON THIS SHEET. USE LINTEL BEAMS WITH 5000 PSI 3W82 CONCRETE UNLESS OTHERWISE SPECIFIED.
- ALTERNATE BAR BEND MAY BE USED FOR NO. 4 BENT BARS.
- FOR CULVERTS WITH SPANS OF 16' THE MAXIMUM SKEW IS 30°.
- ALTERNATIVELY A 9" THICKNESS MAY BE USED WITH 6500 PSI 3W82 CONCRETE.



PLAN VIEW
LINTEL BEAM WITH INTEGRAL CURB

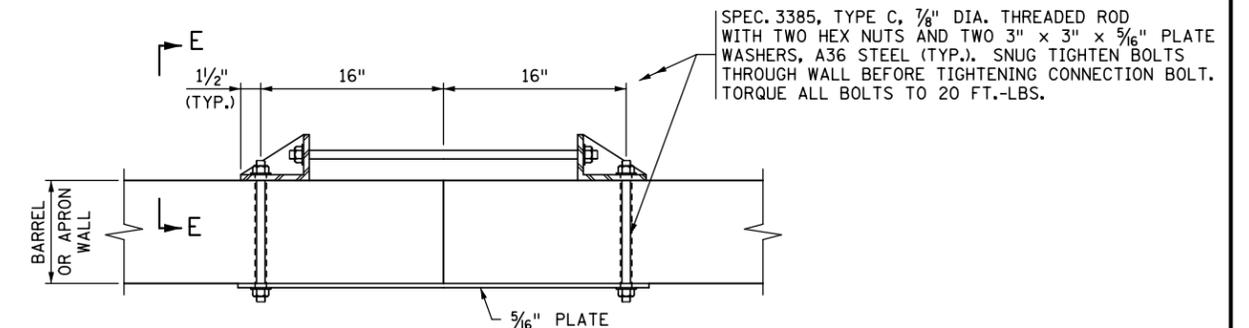


NO. 4 BENT BAR

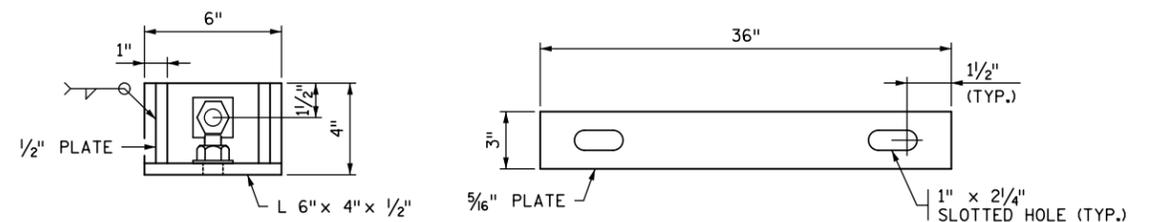


NO. 4 BENT BAR ALTERNATE

(6)
2 REQUIRED



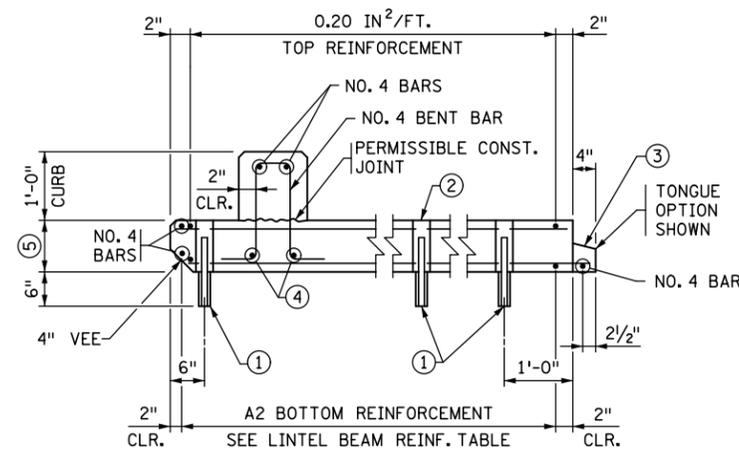
PLAN VIEW



SECTION E-E

PLATE DETAIL

EXTRA STRONG CONNECTION DETAILS



SECTION C-C

LINTEL BEAM WITH INTEGRAL CURB

REVISION: 10-09-2015

APPROVED: MARCH 24, 2011

Nancy Subenberger
STATE BRIDGE ENGINEER

STATE PROJ. NO - (T.H.) STA. + .

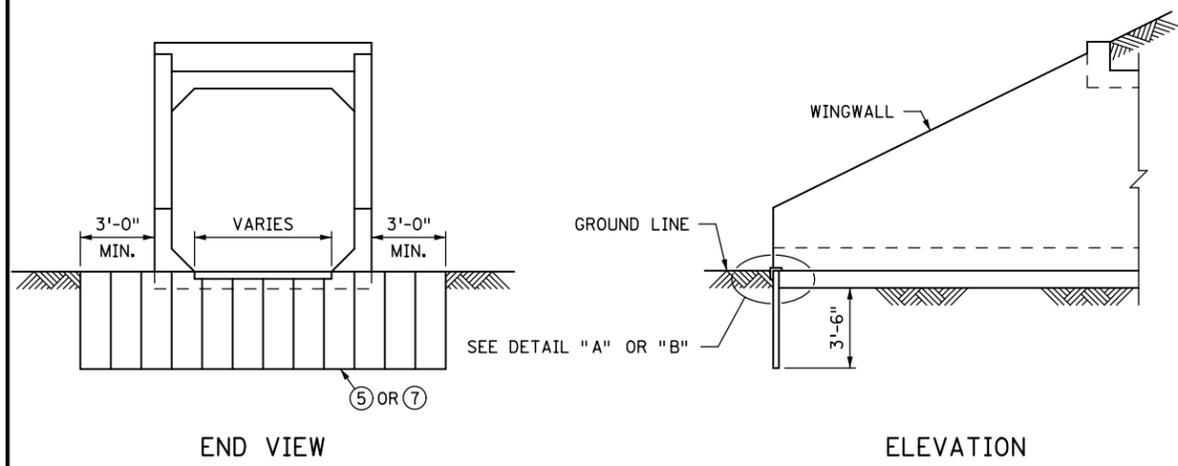
FIG. 5-395.110(B)

CERTIFIED BY _____
LICENSED PROFESSIONAL ENGINEER DATE _____
NAME: _____ LIC. NO. _____

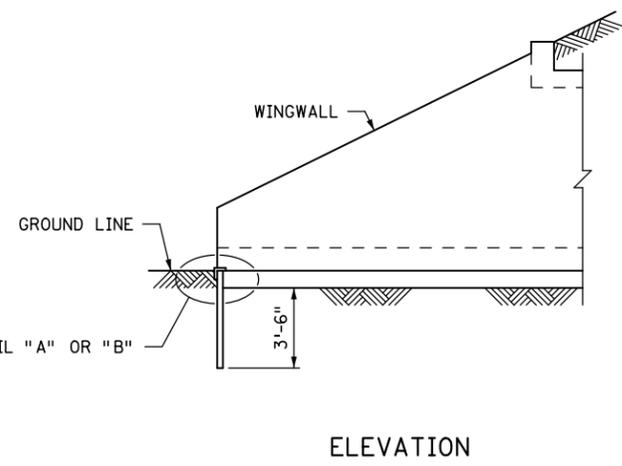
TITLE: PRECAST CONCRETE END SECTION
TYPE III - SINGLE OR DOUBLE BARREL
FOR SKEWS 7¹/₂' TO 45'

DES: _____ DR: _____ APPROVED: _____
CHK: _____ CHK: _____
SHEET NO. OF SHEETS

BRIDGE NO.

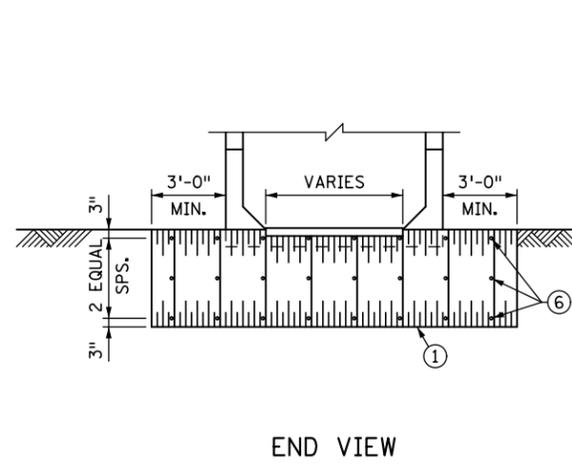


END VIEW

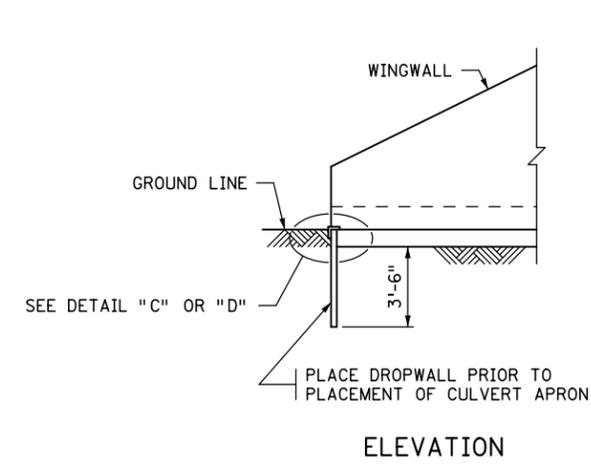


ELEVATION

ALTERNATES 1 & 2 (STEEL SHEET PILING)

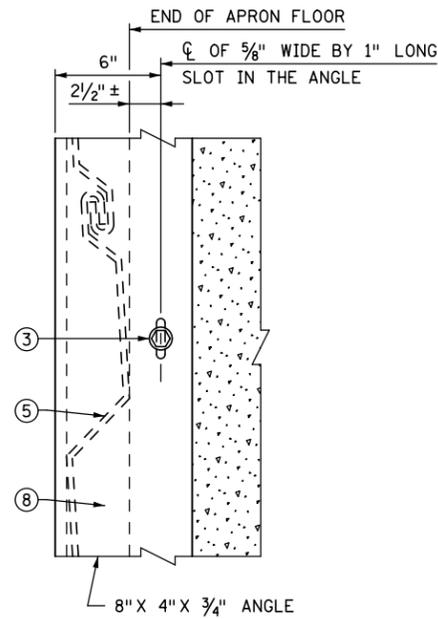


END VIEW

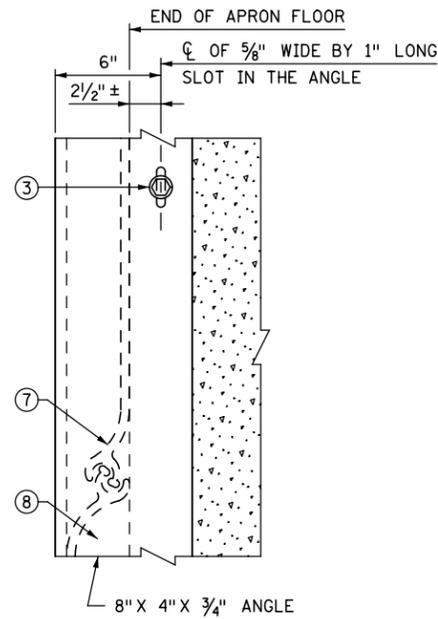


ELEVATION

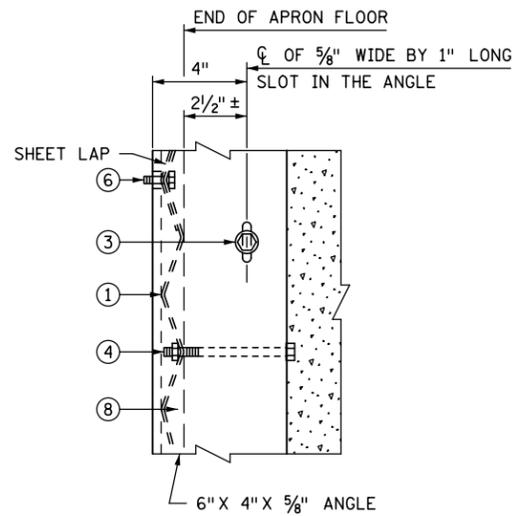
ALTERNATES 3 & 4 (GALVANIZED STEEL SHEETS)



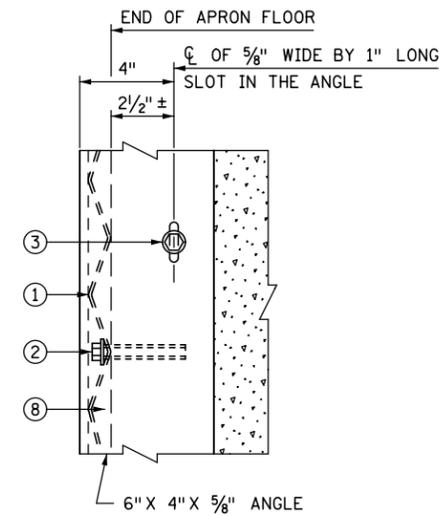
PLAN



PLAN

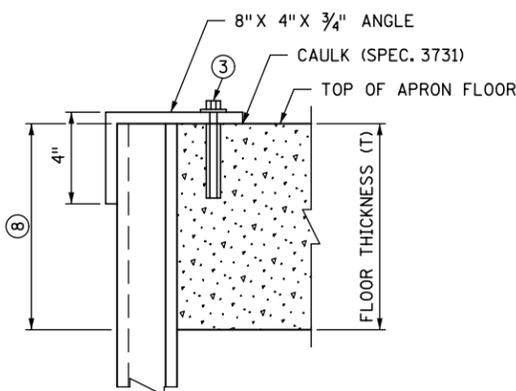


PLAN



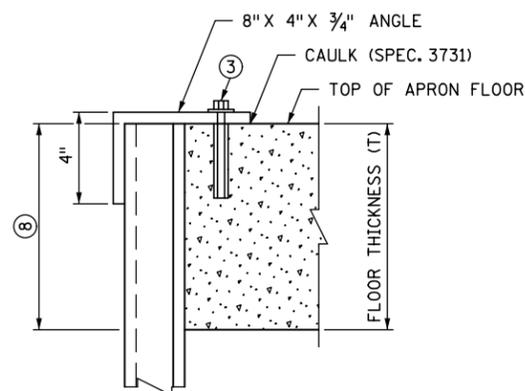
PLAN

DESIGNER NOTE
 (REMOVE PRIOR TO PLOTTING FINAL PLAN):
 BEFORE CULVERT PLANS ARE PREPARED, TAKE
 SAMPLES FROM THE DRAINAGE AREA
 FOR PH DETERMINATION. THE SOIL AND WATER SHOULD
 HAVE A PH OF 6.5 OR MORE IF SHEET STEEL IS USED.



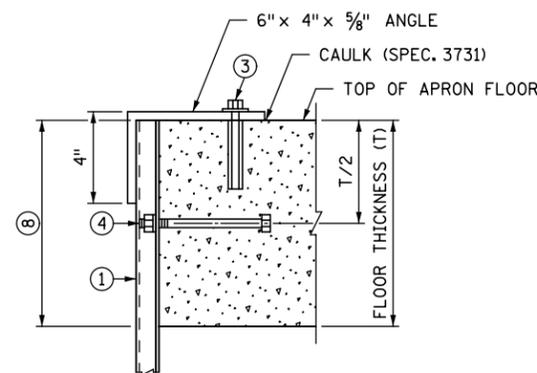
ELEVATION

DETAIL "A" - ALTERNATE 1
 STEEL SHEET PILING SHOWN



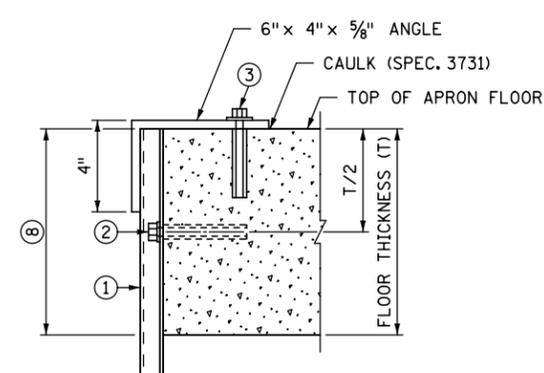
ELEVATION

DETAIL "B" - ALTERNATE 2
 STEEL SHEET PILING SHOWN



ELEVATION

DETAIL "C" - ALTERNATE 3
 ON NEW CONSTRUCTION ONLY



ELEVATION

DETAIL "D" - ALTERNATE 4
 ON NEW OR OLD CONSTRUCTION

CONSTRUCTION NOTES

GALVANIZE ALL FASTENERS AND ANCHORS PER SPEC. 3392.

GALVANIZE STEEL ANGLES PER 3394.

- ① 2 1/2" x 1/2" OR 2 2/3" x 1/2" CORRUGATED (12 GAGE) OR HEAVIER GALVANIZED STEEL SHEETS.
- ② FASTEN THE STEEL SHEETS TO THE FRONT EDGE OF THE APRON WITH 3/8" DIAMETER BY 4" LONG BOLTS AND APPROVED ANCHORAGES (10" ± CENTER TO CENTER, TO THE NEAREST VALLEY).
- ③ FASTEN THE 8" x 4" x 3/4" OR 6" x 4" x 5/8" ANGLE WITH 3/8" DIAMETER 4" LONG BOLTS, 1" O.D. WASHER AND AN APPROVED ANCHORAGE (2'-0" SPACING).
- ④ FASTEN THE STEEL SHEETS TO THE FRONT EDGE OF THE APRON WITH 3/8" DIAMETER 5" LONG BOLTS, NUT AND LOCK WASHER (10" ± CENTER TO CENTER, TO THE NEAREST VALLEY).
- ⑤ (12 GAGE) GALVANIZED CORRUGATED STEEL SHEET PILING, INTERLOCKING TYPE A.
- ⑥ 3/8" DIA. x 1" LONG BOLT WITH NUT, TO LAP STEEL SHEETS.
- ⑦ STEEL SHEET PILING, SECTION NO. MP-112 OR EQUAL.
- ⑧ FILL THE VOIDS AS SHOWN, WITH CONCRETE OR CONCRETE GROUT, AS APPROVED BY THE ENGINEER.

REVISION: 10-09-2015
 APPROVED: MARCH 24, 2011
 Nancy Subenberger
 STATE BRIDGE ENGINEER

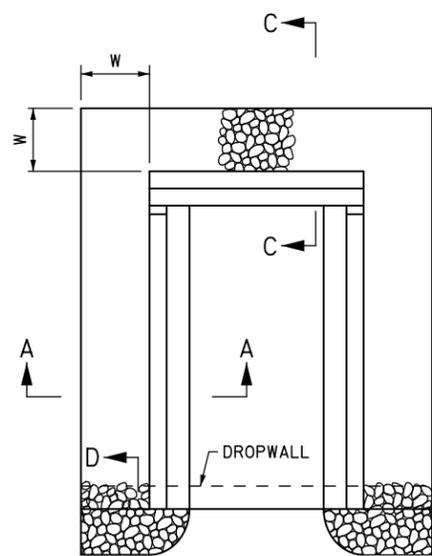
STATE PROJ. NO		- (T.H.) STA. +		FIG. 5-395.111	
CERTIFIED BY	DATE	TITLE:	DES:	DR:	APPROVED:
NAME:	LIC. NO.	ALTERNATE DROPWALLS FOR BOX CULVERTS	CHK:	CHK:	BRIDGE NO.
			SHEET NO. OF SHEETS		

CONSTRUCTION NOTES

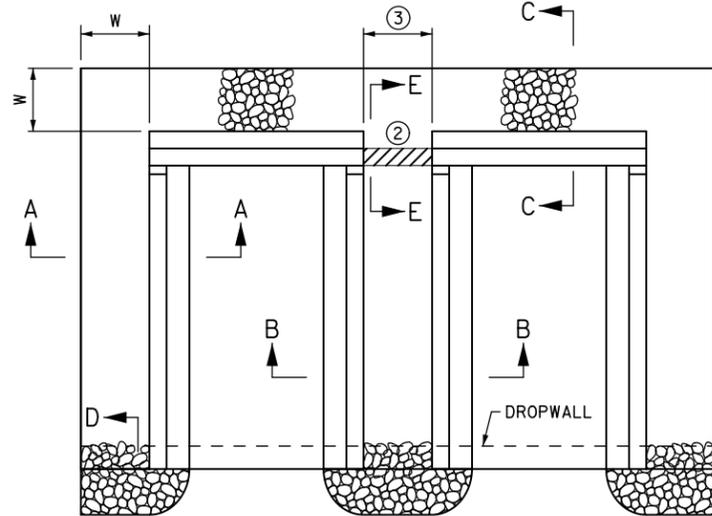
THIS PLAN SHEET IS FOR CULVERT EMBANKMENT PROTECTION ONLY. REFER TO THE GRADING PLANS FOR ADDITIONAL RIPRAP OR OTHER SCOUR PROTECTION MEASURES.

PROVIDE RIPRAP PER SPECS. 2511 AND 3601.

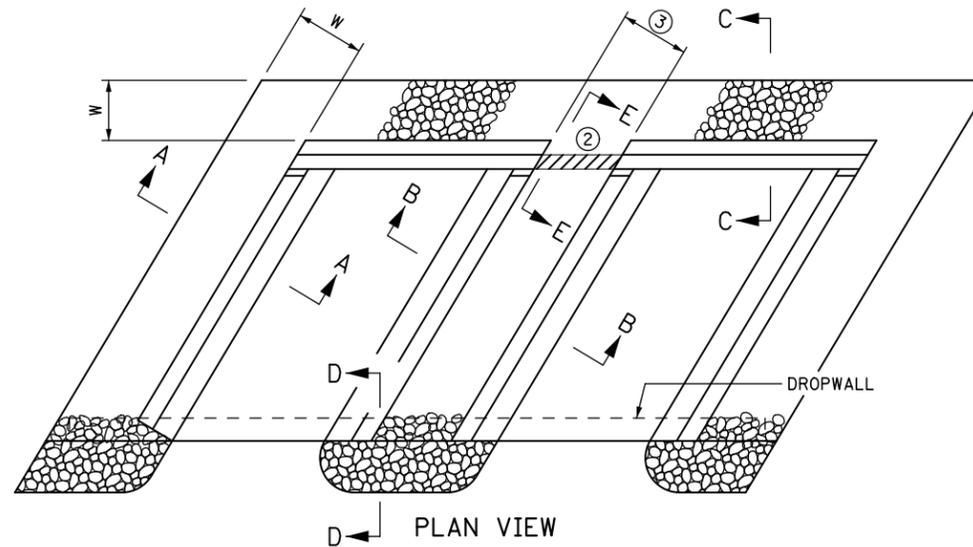
- ① FOR TYPE OF GEOTEXTILE FILTER MATERIAL REQUIRED, SEE SPEC. 3733. PROVIDE GEOTEXTILE STRIPS CONTINUOUS WITHOUT OVERLAPS, EXCEPT FOR THE TOP STRIP, WHICH SHOULD SHINGLE VERTICAL STRIPS. BURY THE TOP EDGE TO PREVENT UNDERMINING.
- ② IF THE DISTANCE BETWEEN DOUBLE BARRELS IS LESS THAN 2'-0" USE EITHER PEA ROCK OR LEAN MIX BACKFILL (SPEC. 2520) BETWEEN THE CULVERTS AS APPROVED BY THE ENGINEER. IF PEA ROCK IS USED PROVIDE APPROVED GROUT SEEPAGE CUTOFF CORE, MINIMUM 12" THICK BETWEEN THE CULVERT'S TWO ENDS AND PROVIDE CLASS I GROUTED RIPRAP IN LIEU OF CLASS III RIPRAP.
- ③ REFER TO THE GENERAL PLAN AND ELEVATION SHEET FOR THE DISTANCE BETWEEN BARRELS OF ADJACENT BOXES.



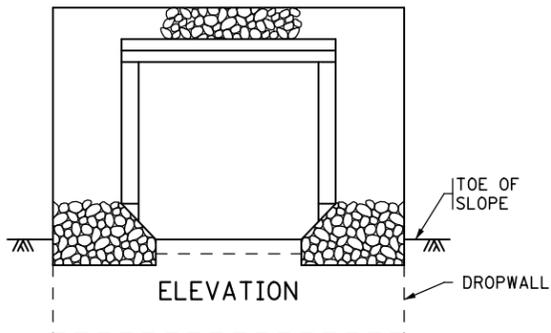
PLAN VIEW



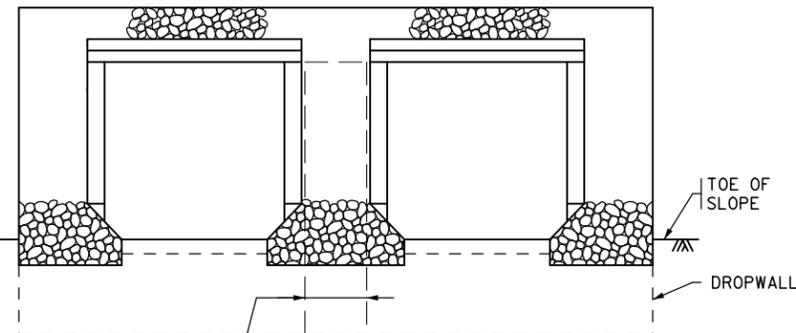
PLAN VIEW



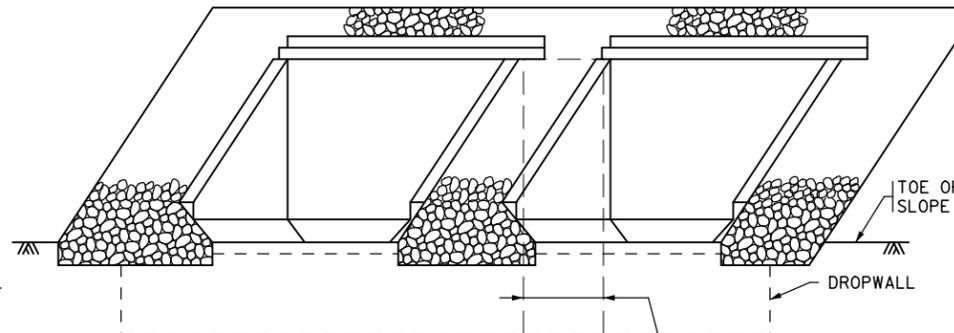
PLAN VIEW



ELEVATION



ELEVATION



ELEVATION

SINGLE BARREL

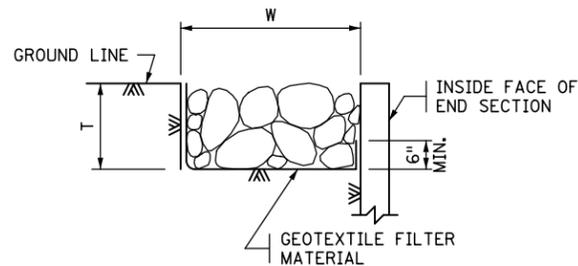
CLASS III OR IV SHOWN FOR SKEWS UP TO 7 1/2°

MULTIPLE BARREL

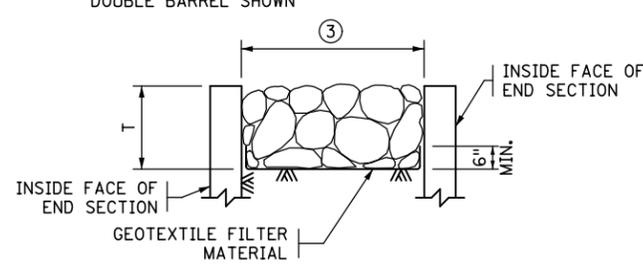
FOR SKEWS UP TO 7 1/2° CLASS III OR IV SHOWN DOUBLE BARREL SHOWN

MULTIPLE BARREL

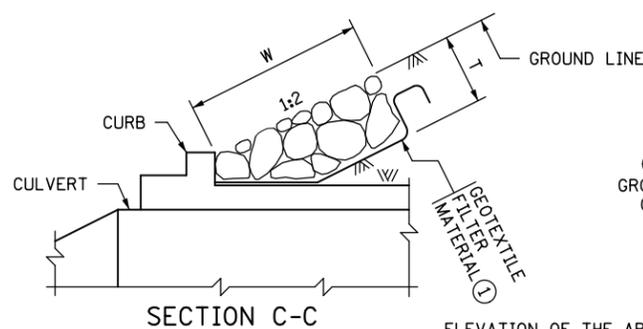
FOR SKEWS OVER 7 1/2° CLASS III OR IV SHOWN DOUBLE BARREL SHOWN, OTHER BARREL CONFIGURATIONS SIMILAR.



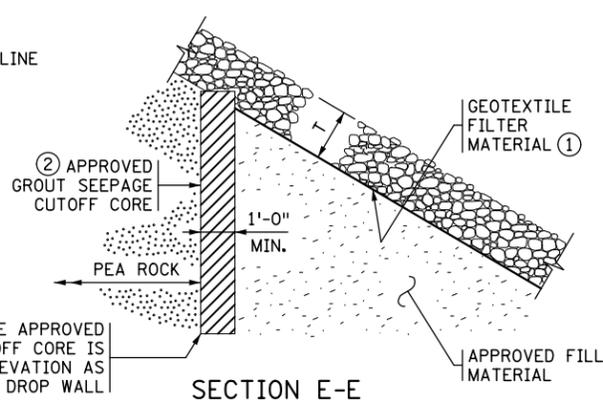
SECTION A-A



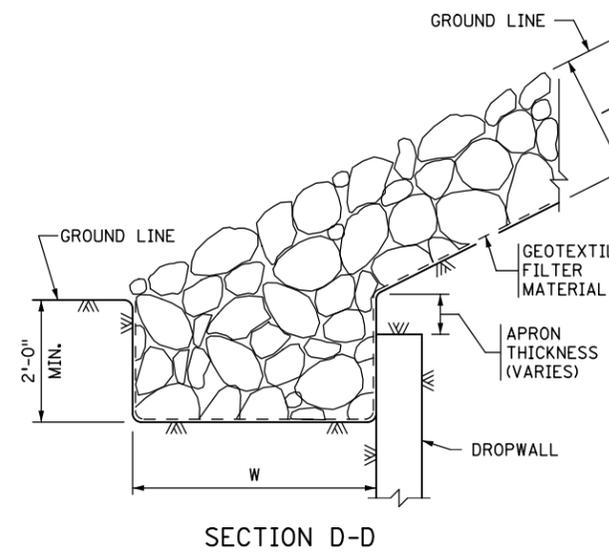
SECTION B-B



SECTION C-C



SECTION E-E



SECTION D-D

RIPRAP CLASS

RIPRAP CLASS	RIPRAP CLASS	T	W
<input type="checkbox"/>	III	1'-6"	3'-0"
<input type="checkbox"/>	IV	2'-0"	4'-0"

DESIGNER NOTE:
REMOVE PRIOR TO PLOTTING FINAL PLAN
DESIGNER TO SELECT EITHER CLASS III OR IV RIPRAP USING CHECK BOX ABOVE.

REVISION: 10-09-2015

APPROVED: SEPTEMBER 11, 2014

Nancy Subenberger
STATE BRIDGE ENGINEER

STATE PROJ. NO - (T.H.) STA. + .

FIG. 5-395.115

CERTIFIED BY _____ DATE _____
LICENSED PROFESSIONAL ENGINEER
NAME: _____ LIC. NO. _____

TITLE: **EMBANKMENT PROTECTION FOR BOX CULVERTS**

DES: _____ DR: _____ APPROVED: _____
CHK: _____ CHK: _____
SHEET NO. OF SHEETS

BRIDGE NO.