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*fy. 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 ② symbol.

Under GENERAL NOTES: Added note ② 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