Twin Reinforced Concrete Box Culvert Standards

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Standard Design

Twin Reinforced Concrete Box Culverts

July, 2020

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TWRCB G1-20

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Twin Reinforced Concrete Box Culvert Standards

General Notes:

1. The RCB culvert sections are designed for HL-93 live load and earth fills of varying heights.
2. Vertical earth pressure, EV=0.120 kcf.
   Horizontal earth pressure, EHmax = 0.060 kcf max, EHmin = 0.030 kcf.
3. The RCB culvert sections are designed for Class 1 exposure conditions except:
   Class 2 exposure condition is utilized for the slab design in 0' fill instances.
4. All slab and floor reinforcing steel is to be supported at intervals of not more than 3'-0" in either direction as outlined in the Standard Specifications.
5. The clear distance from face of concrete to near edge or end of reinforcing bar to be 2" unless otherwise noted.
6. Except for dowel bars 5r1 in slab, longitudinal reinforcing is not to extend thru the construction joints.
7. Floor of barrel is to be finished smooth. Sides of footing are to be formed to insure correct line and grade.
8. The permissible construction joint at the top of the walls may be lowered at the Contractor's option with Engineer's approval.
9. The reinforcement supplied for this structure shall be Grade 60 reinforcement in accordance with the Standard Specifications. The design stresses are based on ASTM A706 Grade 60 reinforcement.
10. The vertical bars in the walls may be spliced above the footing at the Contractor's option as follows:

Bar Size Number	4	5	6	7	8	9
Minimum Splice Length	20"	24"	29"	34"	38"	47"

    This splice, if used, will be at the Contractor's expense.
11. Reinforcing bar clearances will be as follows:
    Edge clearances: 2" except
    Top of floor 2¼" to near transverse reinforcing bar
    Bottom of floor 3½" to near transverse reinforcing bar
    End clearances:
    Vertical top 2"
    Vertical bottom 3" or 3½" if overall height of the culvert is not to a full inch
    Transverse 2"
12. All construction joints shall be formed with a beveled keyway except at bell joints.
13. All beveled keyways shall be centered.
14. Keyway size shall be 2"x4" except as follows:
    Keyway between the floor and wall shall be 2"x6" when the wall is greater than 10 inches wide.
15. Keyway dimensions shown on the plans are based on nominal dimensions unless stated otherwise. In addition, the bevel used on the keyway shall be limited to a maximum of 10 degrees from vertical.
16. If 0' of fill is specified, details for paving notch and reference to epoxy coating of slab reinforcing steel, if applicable, shall be included in the final plans.
17. All dimensions are in feet and inches unless otherwise noted or shown.
18. See current Standard Specifications regarding concrete form removal.
19. These culvert standards label all reinforcing steel with English notation (5a1 is ⅝ inch diameter bar). English reinforcing steel received in the field may display the following "bar designation". The "bar designation" is the stamped impression on the reinforcing bars, and is equivalent to the bar diameter in millimeters.

English Size	4	5	6	7	8	9
Bar Designation	13	16	19	22	25	29

20. In the event the slab thickness at the barrel end section exceeds 18 inches, the culvert parapet shall extend a minimum of 6 inches above the top of the culvert slab. Refer to the Culvert Design Manual for instructions. These details are to be included in the design plans to address these situations.

Specifications:

Design:
AASHTO LRFD Bridge Design Specifications, 8th Ed., Series of 2017.

Construction:
Iowa Department of Transportation Standard Specifications for Highway and Bridge Construction, current series, plus applicable General Supplemental Specifications, Developmental Specifications, Supplemental Specifications and Special Provisions

Design Stresses:

Design stresses for the following materials are in accordance with the AASHTO LRFD Bridge Design Specifications, 8th Ed., Series of 2017:
Reinforcing steel in accordance with AASHTO LRFD Section 5, Grade 60.
Concrete in accordance with AASHTO LRFD Section 5, f'c = 4.0 ksi.

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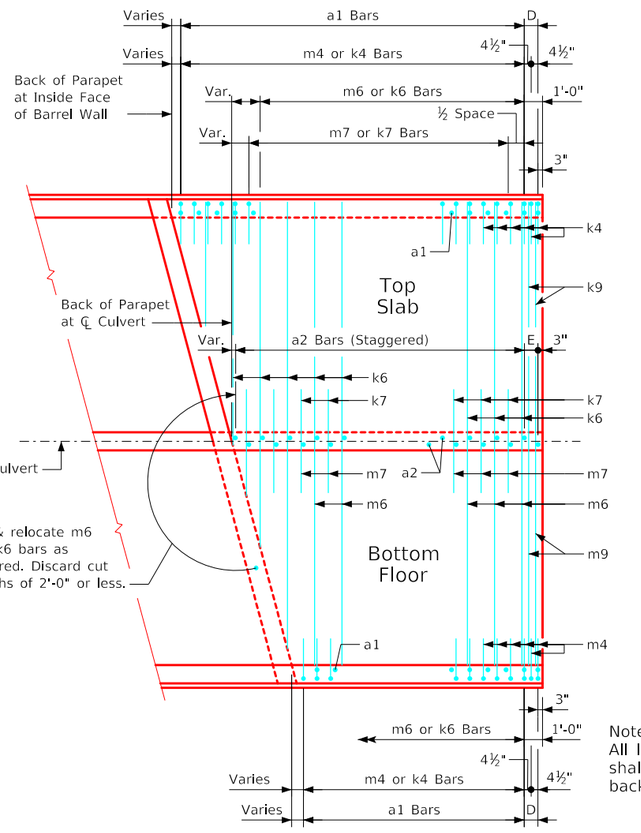
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Twin Reinforced Concrete Box Culverts
July, 2020

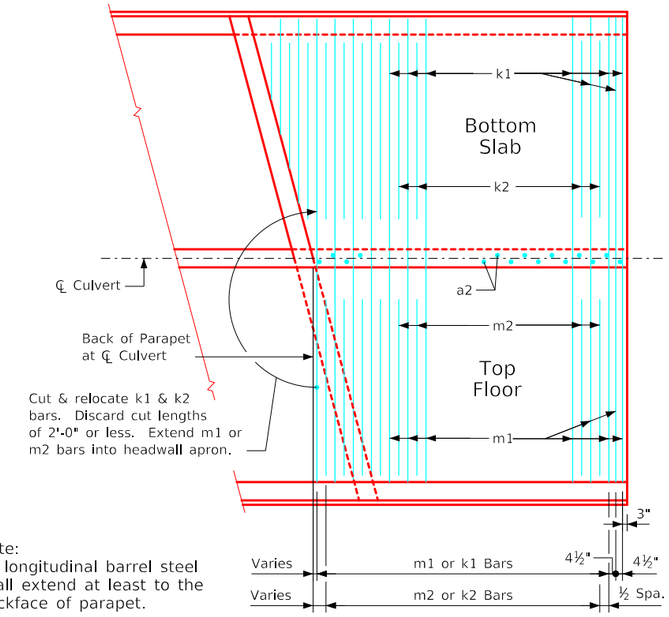
General Notes & Specifications

TWRCB G2-20

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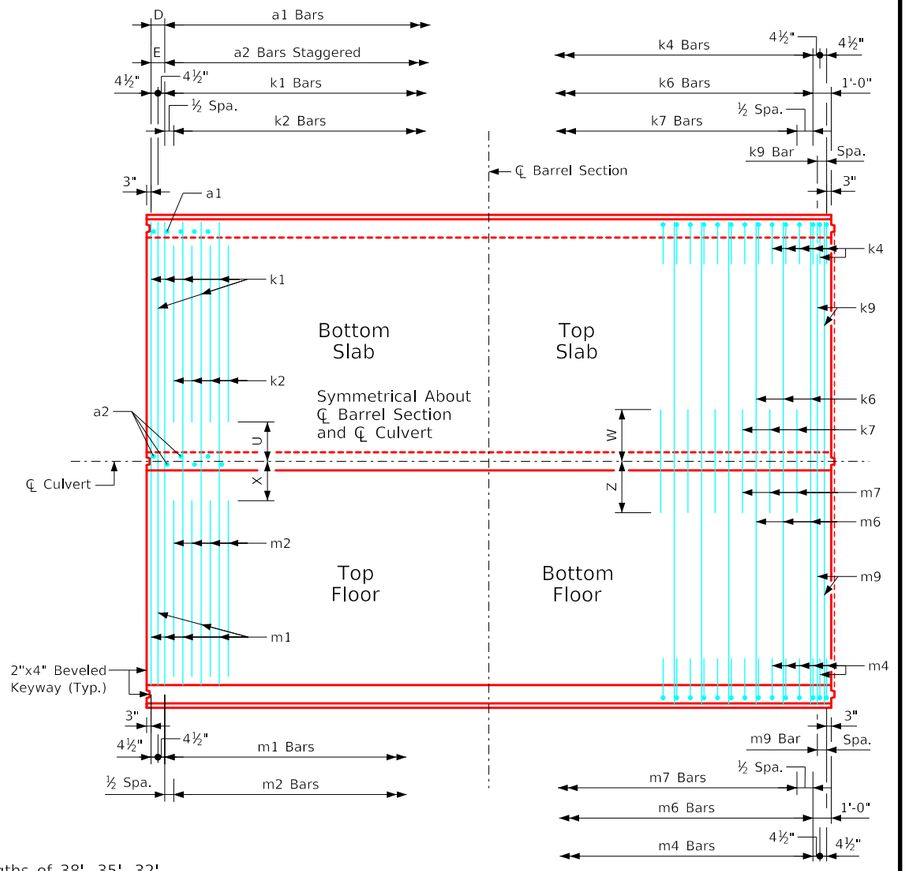
Note:
All longitudinal barrel steel shall extend at least to the backface of parapet.



End Section Plan Views

(Keyways not shown)

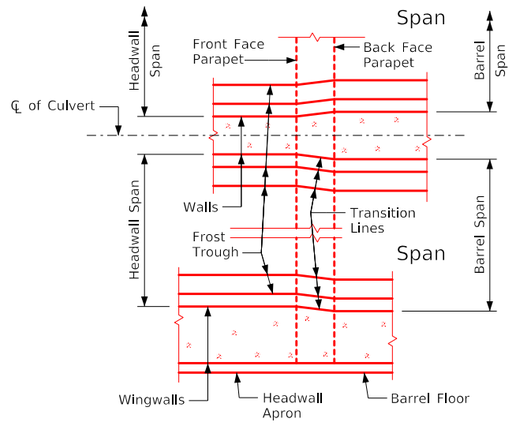
Note:
End section details shown are for a 15° skew barrel. Use for skews of 30° & 45° by increasing the number of transverse reinforcing bars required to be cut and relocated.



Note:
Typical for lengths of 38', 35', 32', 29', and 26'. These lengths are shown as typical because all transverse and vertical reinforcing steel spacing repeats in 3'-0" intervals.

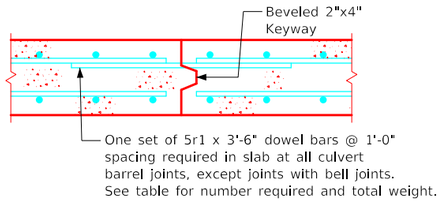
Standard Section Plan View

(Keyway is to be omitted when bell joints are used)



Transition Wall Details

5r1 Bars - One Const. Jt.		
Span	No.	Weight (LB)
8'-0"	18	66
10'-0"	22	80
12'-0"	26	95



Top Slab Construction Joint Detail

Note:
Dimensions listed on this sheet to be used in conjunction with dimensions and quantities for barrel section sheets.

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Twin Reinforced Concrete Box Culverts

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Typical Culvert Barrel Details

TWRCB G3-20

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Variable Dimensions and Quantities for Twin 12' x 10' Barrel Sections

Dimensions

Fill	S	H	A	B	C	D	E	U	W	X	Z
0	12	10	14	12.5	10	9	9	0'-3	7'-5	3'-0	7'-8
1	12	10	13.5	12.5	10	9	9	0'-10	7'-3	2'-5	7'-10
2	12	10	10	10.5	10	6	9	2'-2	7'-2	2'-10	4'-10
3	12	10	9.5	10	10	9	9	2'-8	5'-6	3'-3	4'-6
4	12	10	9	10	10	9	9	2'-9	4'-9	3'-3	4'-2
5-7	12	10	10	11.5	10	9	9	2'-7	4'-8	3'-3	4'-3
8-10	12	10	11	13.5	10	9	9	3'-1	4'-2	3'-1	4'-2
11-13	12	10	13	15	10	6	9	2'-10	4'-3	2'-11	4'-3
14-16	12	10	14.5	17	10.5	9	9	2'-5	4'-4	2'-6	4'-5
17-19	12	10	16.5	18.5	11	6	9	2'-3	4'-6	2'-3	4'-7
20-22	12	10	18.5	20	12	6	9	1'-8	4'-7	1'-10	4'-8
23-25	12	10	20	22	12.5	6	9	1'-5	4'-9	1'-5	4'-11

Bar List

Fill	a1 Size	a1 Sp.	a1 L	a2 Size	a2 Sp.	a2 L	b1 Size	b1 Sp.	b1 No.	b2 Size	b2 Sp.	b2 No.	e1 Size	e1 Sp.	e1 No.	e2 Size	e2 Sp.	e2 No.	f1 Size	f1 Sp.	f1 No.	f2 Size	f2 Sp.	f2 No.
0	4	9	12'-1	7	9	12'-1	4	6	40	4	6	21	4	12	22	4	17	20	4	12	26	4	17	20
1	4	9	12'-1	7	9	12'-1	4	6	40	4	6	21	4	12	22	4	17	20	4	12	26	4	17	20
2	4	6	11'-7	7	9	11'-7	4	6	40	4	6	21	5	12	22	4	17	20	4	12	26	4	17	20
3	4	9	11'-6	7	9	11'-6	4	6	40	4	6	21	4	12	22	4	17	20	4	12	26	4	17	20
4	4	9	11'-6	7	9	11'-6	4	6	40	4	6	21	4	12	22	4	17	20	4	12	26	4	17	20
5-7	4	12	11'-8	7	9	11'-8	4	6	40	4	6	21	4	12	22	4	17	20	4	12	26	4	17	20
8-10	5	12	11'-11	7	9	11'-11	4	6	40	4	6	21	4	12	22	4	17	20	4	12	26	4	17	20
11-13	4	6	12'-3	7	9	12'-3	4	6	40	4	6	21	4	12	22	4	17	20	4	12	26	4	17	20
14-16	4	9	12'-6	7	9	12'-6	4	6	40	4	6	21	4	12	22	4	17	20	4	12	26	4	17	20
17-19	4	6	12'-10	7	9	12'-10	4	6	40	4	6	21	4	12	22	4	17	20	4	12	26	4	17	20
20-22	4	6	13'-1	7	9	13'-1	4	6	40	4	6	21	4	12	22	4	17	20	4	12	26	4	17	20
23-25	4	6	13'-5	7	9	13'-5	4	6	40	4	6	21	4	12	22	4	17	20	5	12	26	4	17	20

Fill	k1 Size	k1 Sp.	k1 L	k2 Size	k2 Sp.	k2 L	k4 Size	k4 Sp.	k4 L	k4 H	k4 V	k6 Size	k6 Sp.	k6 L	k7 Size	k7 Sp.	k7 L	k9 Size	k9 Sp.	k9 L
0	6	18	26'-2	6	18	12'-10	6	9	11'-8	7'-8	4'-0	4	12	26'-2	5	12	14'-10	5	4.5	26'-2
1	6	18	26'-2	6	18	12'-3	6	9	11'-4	7'-5	3'-11	4	9	26'-2	4	9	14'-6	4	4.5	26'-2
2	6	12	26'-2	5	12	10'-0	6	9	9'-1	5'-5	3'-8	5	12	26'-2	6	12	14'-4	6	4.5	26'-2
3	5	9	26'-2	4	9	9'-1	6	9	8'-4	4'-8	3'-8	5	12	26'-2	6	12	11'-0	6	4.5	26'-2
4	5	9	26'-2	4	9	8'-7	6	9	7'-11	4'-4	3'-7	5	9	26'-2	5	9	9'-6	5	4.5	26'-2
5-7	5	12	26'-2	5	12	9'-5	7	12	8'-6	4'-3	4'-3	5	12	26'-2	7	12	9'-4	7	4.5	26'-2
8-10	5	9	26'-2	4	9	8'-5	6	9	7'-6	3'-9	3'-9	5	9	26'-2	6	9	8'-4	6	4.5	26'-2
11-13	5	9	26'-2	4	9	9'-2	6	9	7'-10	3'-11	3'-11	5	9	26'-2	6	9	8'-6	6	4.5	26'-2
14-16	7	18	26'-3	6	18	10'-4	5	6	7'-4	3'-8	3'-8	4	9	26'-3	7	9	8'-8	7	4.5	26'-3
17-19	6	12	26'-5	5	12	10'-7	6	9	8'-4	4'-2	4'-2	4	9	26'-5	7	9	9'-0	7	4.5	26'-5
20-22	6	12	26'-8	5	12	11'-8	6	9	8'-4	3'-11	4'-5	4	9	26'-8	7	9	9'-2	7	4.5	26'-8
23-25	6	12	26'-9	5	12	11'-11	6	9	9'-0	4'-6	4'-6	4	9	26'-9	7	9	9'-6	7	4.5	26'-9

Bar List

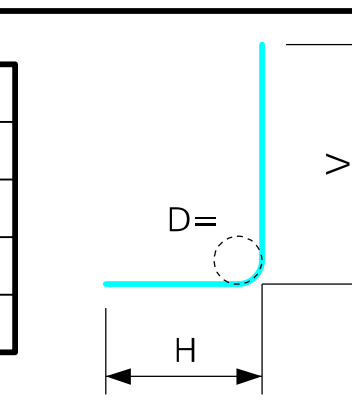
Fill	m1 Size	m1 Sp.	m1 L	m2 Size	m2 Sp.	m2 L	m4 Size	m4 Sp.	m4 L	m4 H	m4 V	m6 Size	m6 Sp.	m6 L	m7 Size	m7 Sp.	m7 L	m9 Size	m9 Sp.	m9 L
0	5	9	26'-8	4	9	8'-5	6	9	18'-4	7'-10	10'-6	4	12	26'-8	6	12	15'-4	6	4.5	26'-8
1	5	12	26'-8	5	12	9'-9	6	9	18'-2	7'-8	10'-6	5	18	26'-8	7	18	15'-8	7	4.5	26'-8
2	5	9	26'-8	5	9	8'-6	6	9	15'-0	4'-8	10'-4	4	9	26'-8	6	9	9'-8	6	4.5	26'-8
3	5	9	26'-8	5	9	7'-11	7	9	14'-8	4'-5	10'-3	5	12	26'-8	7	12	9'-0	7	4.5	26'-8
4	5	9	26'-8	5	9	7'-11	7	9	14'-6	4'-3	10'-3	5	9	26'-8	6	9	8'-4	6	4.5	26'-8
5-7	6	12	26'-8	5	12	7'-11	8	12	14'-9	4'-4	10'-5	5	9	26'-8	6	9	8'-6	6	4.5	26'-8
8-10	5	9	26'-8	4	9	8'-10	6	9	14'-5	3'-10	10'-7	5	9	26'-8	6	9	8'-4	6	4.5	26'-8
11-13	6	12	26'-8	5	12	9'-2	6	9	14'-5	3'-9	10'-8	4	9	26'-8	7	9	8'-6	7	4.5	26'-8
14-16	6	12	26'-9	5	12	10'-3	5	6	14'-8	3'-10	10'-10	4	9	26'-9	7	9	8'-10	7	4.5	26'-9
17-19	6	12	26'-11	5	12	10'-10	6	9	14'-10	3'-10	11'-0	5	12	26'-11	8	12	9'-2	8	4.5	26'-11
20-22	7	18	27'-2	7	18	11'-6	6	9	15'-1	4'-0	11'-1	5	9	27'-2	7	9	9'-4	7	4.5	27'-2
23-25	7	18	27'-3	7	18	12'-0	6	9	15'-4	4'-1	11'-3	5	9	27'-3	7	9	9'-10	7	4.5	27'-3

Quantities

Fill	Concrete (CY/FT) Slab	Floor	Walls	Total	Steel (LB/FT)
0	1.206	1.104	0.887	3.197	464.39
1	1.165	1.104	0.887	3.156	460.39
2	0.879	0.937	0.887	2.703	490.37
3	0.838	0.895	0.887	2.620	479.00
4	0.797	0.895	0.887	2.579	485.32
5-7	0.879	1.020	0.887	2.786	482.53
8-10	0.961	1.187	0.887	3.035	465.61
11-13	1.124	1.312	0.887	3.323	479.13
14-16	1.255	1.485	0.934	3.674	474.76
17-19	1.427	1.619	0.978	4.024	503.76
20-22	1.611	1.763	1.067	4.441	524.74
23-25	1.746	1.943	1.111	4.800	544.53

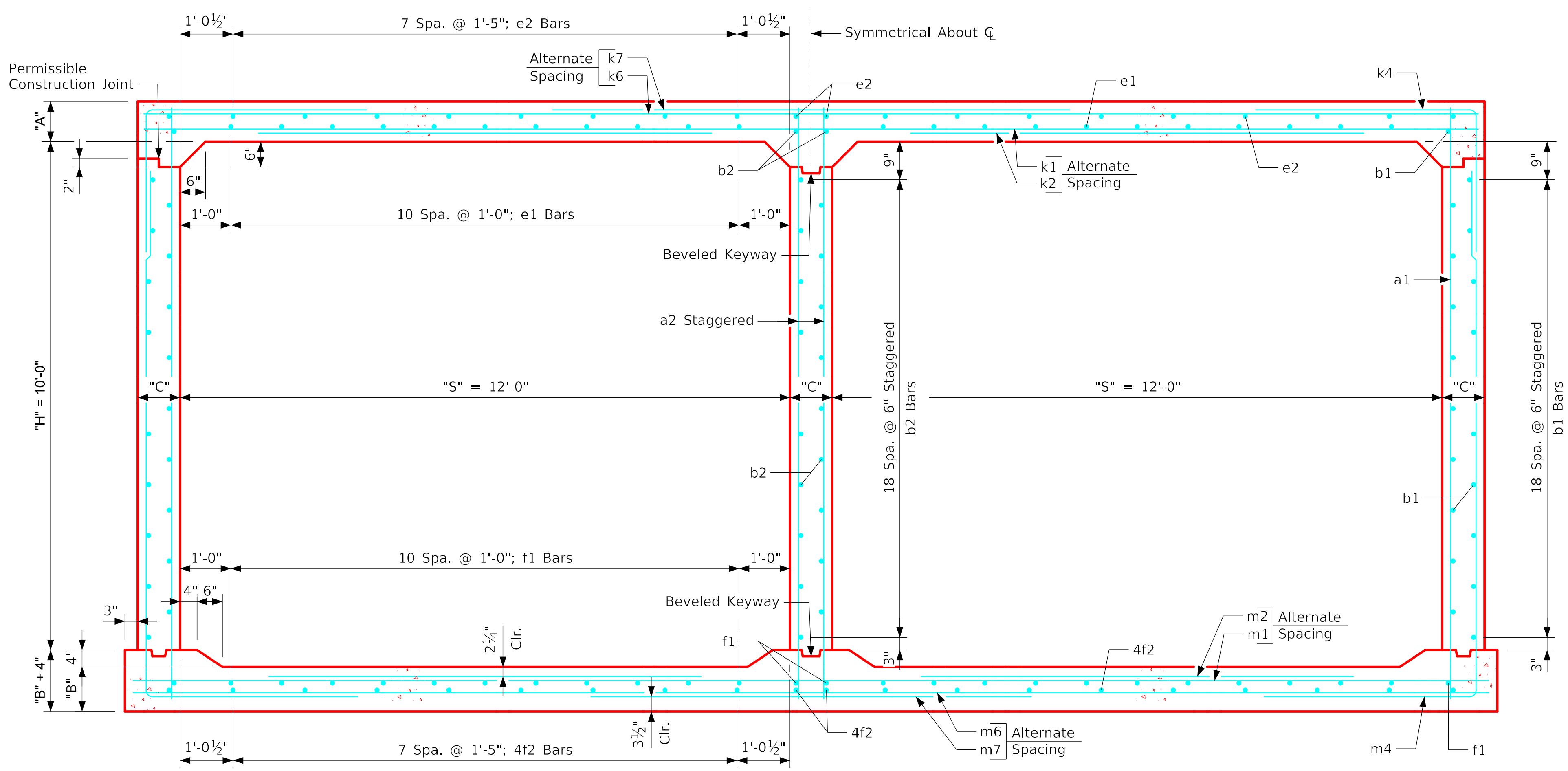
Bent Bar Detail

Bars	D
5	3¾"
6	4½"
7	5¼"
8	6"



k4 & m4

Note:
All dimensions are out to out.
D = pin diameter.



Twin 12' x 10' Barrel Section

Notes:

1. Dimensions listed on this sheet to be used in conjunction with Sheet TWRCB G3-20.
2. Fill, dimensions "S" and "H" are in feet.
3. Dimensions "A", "B", "C", "D", and "Sp." listed in the bar list are in inches.
4. Dimensions "L", "H", "V" are in feet and inches.

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Standard Design
Twin Reinforced Concrete Box Culverts
July, 2020

Culvert Barrel Details
12' x 10' Barrel Sections

TWRCB 12-10-20

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Twin Reinforced Concrete Box Culvert Standards - Flared Wing Headwalls

General Notes:

1. The RCB culvert sections are designed for HL-93 live load and earth fills of varying heights.
2. Vertical earth pressure, EV=0.120 kcf.
   Horizontal earth pressure, EHmax = 0.060 kcf max, EHmin = 0.030 kcf.
3. The RCB culvert sections are designed for Class 1 exposure conditions except:
   Class 2 exposure condition is utilized for the slab design in 0' fill instances.
4. All slab and floor reinforcing steel is to be supported at intervals of not more than 3'-0" in either direction as outlined in the Standard Specifications.
5. The clear distance from face of concrete to near edge or end of reinforcing bar to be 2" unless otherwise noted.
6. Except for dowel bars 5r1 in slab, longitudinal reinforcing is not to extend thru the construction joints.
7. Floor of barrel is to be finished smooth. Sides of footing are to be formed to ensure correct line and grade.
8. The permissible construction joint at the top of the walls may be lowered at the Contractor's option with Engineer's approval.
9. The reinforcement supplied for this structure shall be Grade 60 reinforcement in accordance with the Standard Specifications. The design stresses are based on ASTM A706 Grade 60 reinforcement.
10. The vertical bars in the walls may be spliced above the footing at the Contractor's option as follows:

Bar Size Number	4	5	6	7	8	9
Minimum Splice Length	20"	24"	29"	34"	38"	47"

    This splice, if used, will be at the Contractor's expense.
11. Reinforcing bar clearances will be as follows:
    - Edge clearances: 2" except
      - Top of floor 2¼" to near transverse reinforcing bar
      - Bottom of floor 3½" to near transverse reinforcing bar
    - End clearances:
      - Vertical top 2"
      - Vertical bottom 3" or 3½" if overall height of the culvert is not to a full inch
      - Transverse 2"
12. All construction joints shall be formed with a beveled keyway except at bell joints.
13. All beveled keyways shall be centered.
14. Keyway size shall be 2"x4" except as follows:
    Keyway between the floor and wall shall be 2"x6" when the wall is greater than 10 inches wide.
15. Keyway dimensions shown on the plans are based on nominal dimensions unless stated otherwise. In addition, the bevel used on the keyway shall be limited to a maximum of 10 degrees from vertical.
16. If 0' of fill is specified, details for paving notch and reference to epoxy coating of slab reinforcing steel, if applicable, shall be included in the final plans.
17. All dimensions are in feet and inches unless otherwise noted or shown.
18. Dimensions with parenthesis () indicate a reference dimension.
19. See current Standard Specifications regarding concrete form removal.
20. These culvert standards label all reinforcing steel with English notation (5a1 is ⅝ inch diameter bar). English reinforcing steel received in the field may display the following "bar designation". The "bar designation" is the stamped impression on the reinforcing bars, and is equivalent to the bar diameter in millimeters.

English Size	4	5	6	7	8	9
Bar Designation	13	16	19	22	25	29

21. In the event the slab thickness at the barrel end section exceeds 18 inches, the culvert parapet shall extend a minimum of 6 inches above the top of the culvert slab. Refer to the Culvert Design Manual for instructions. These details are to be included in the design plans to address these situations.
22. For barrel details used in conjunction with these flared wing headwall standards, see the Twin Reinforced Concrete Box Culvert Stardards (TWRCB).

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Specifications:

Design:
AASHTO LRFD Bridge Design Specifications, 8th Ed., Series of 2017.

Construction:
Iowa Department of Transportation Standard Specifications for Highway and Bridge Construction, current series, plus applicable General Supplemental Specifications, Developmental Specifications, Supplemental Specifications and Special Provisions

Design Stresses:

Design stresses for the following materials are in accordance with the AASHTO LRFD Bridge Design Specifications, 8th Ed., Series of 2017:
Reinforcing steel in accordance with AASHTO LRFD Section 5, Grade 60.
Concrete in accordance with AASHTO LRFD Section 5, f'c = 4.0 ksi.

LATEST REVISION DATE

APPROVED BY BRIDGE ENGINEER

IOWA DOT Highway Administration

Standard Design - Twin Reinforced Concrete Box Culverts

Flared Wing Headwalls

February, 2021

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