STRUCTURAL PRECAST DESIGN SUBMITTAL
LUNSFORD DRAINAGE IMPROVEMENTS PROJECT
MADISONVILLE, KENTUCKY

8'X4' PRECAST BOX CULVERT

NOTE: THIS DOCUMENT INCLUDES STRUCTURAL DESIGN CALCULATIONS AND DETAILS.
THE DESIGN CALCULATIONS AND DETAILS PRESENTED HEREIN ARE BASED UPON THE WORKING DRAWINGS PREPARED FOR THE PROJECT BY ICAST, INC. OF BEAVERDAM, KENTUCKY.

CONSULTANT: WINFORD A. PETRONE COMPANY, PLLC
FABRICATOR: INFRASTRUCTURE PRECAST, INC. (ICAST)

PRECAST DESIGN SUBMITTALS, CONCRETE COMPONENTS

LUNSFORD DRAINAGE IMPROVEMENTS: 8'X4' PRECAST BOX CULVERT

DESIGN CODES:

1. AASHTO LRFD BRIDGE DESIGN CODE.
2. KYTC BOX CULVERT DESIGN PROCEDURES AS INDICATED IN KYTC "TABLE 1"

MATERIALS:

1. CONCRETE: TO BE IN ACCORDANCE WITH PROJECT SPECIFICATIONS.
2. MINIMUM 28 DAY CONCRETE STRENGTH f'_c= 6,500 P.S.I.
3. REINFORCING STEEL TO BE IN ACCORDANCE WITH ASTM A615.
4. MINIMUM REQUIRED YIELD STRENGTH, F_Y, FOR REINFORCING STEEL= 60,000 P.S.I.
5. BAR BENDS TO BE IN CONFORMANCE WITH CRSI STANDARD DETAILS. HOOK DIMENSIONS SHALL BE IN ACCORDANCE WITH CRSI STANDARDS UNLESS OTHERWISE NOTED.

DESIGN LOADS:

1. DESIGN LIVE LOAD = KYHL-93 (AASHTO HL93 x 1.25)
2. DESIGN DEAD LOADS, EARTH PRESSURE, AND INTERNAL FLUID LOADS:
   CONCRETE: 150 P.C.F.
   BACKFILL: 120 P.C.F,
3. LOADS APPLIED IN ACCORDANCE WITH KYTC TABLE 1.

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8'x4' PRECAST BOX CULVERT, LUNSFORD STREET, MADISONVILLE, KY.

FEATURES: * THE proposed culvert is 30' total in length.

THE CULVERT STATIONING RUNS FROM "E" TOWARD "A"

Sections are "A" @ 4'-10"
"B" THRU "D" @ 5'-9" EA. } 29.833' + 4 joints @ .0313'EA = 29.96 ~ 30'
"E" @ 7'-9" PREC.

* Section "A" has a 22"ϕ HOLE FOR AN 18"ϕ CMP. THE CONTRACT PLANS SHOW A DEMOLITION LENGTH OF 5' OF EXISTING 18" CMP AT THIS LOCATION. IT IS ASSUMED THAT THERE WILL BE SUFFICIENT GAP TO BE ABLE TO CUT A SECTION OF NEW CMP APPROXIMATELY 8" LONGER THAN THE SCHEDULED GAP AND PUSH THIS SECTION THRU THE 22"ϕ HOLE. ALTERNATIVELY THIS SECTION, WHICH SHOULD WEIGH AROUND 100# COULD BE INSERTED FROM THE INSIDE AND PUSHED OUTWARD TOWARD THE EXISTING CMP.

@ Section "A"; Assume the new 18" CMP is inserted thru the box culvert wall and grouted in. ICAST has shown the ℄ of this 22"ϕ opening as 24" up from bott. of box, which appears correct working from plans elevations.

* Sections "B" thru "D" have no openings.

* Section "E" has 2 side openings for approaching existing drainage features. Exact entrance locations & inverts not given in plans. Will not be able to preform openings for these.

→ For the Left side opening for the existing brick storm sewer:

- Scaling from plans, it appears to be centered at 47" ± the beginning of box.
- At this location, plans call for removal of 3' ± of existing brick arch + damaged internal CMP. That limit would place the remaining end of brick arch & exist. CMP @ approx. 2' from the outside wall of the proposed box culvert.
- The plans call for a 12" THICKNESS of C.I.P. collar to be placed on outside of brick arch, but does not show how far it extends onto the length of the arch, nor show any reinforcement.
- The diameter of the internal existing CMP is assumed as 36"ϕ CMP (by scaling off plans).
- It is assumed that a new short length of CMP will be connected to end of existing and extended to the box culvert wall.
- Due to the short working length & weight of the new CMP section, it's not likely the new CMP can be inserted into the box wall and grouted in. For that reason, the CIP collar in this area will need special considerations and be attached by drilled-in anchors to the side of box culvert.

the invert is not known exactly, but from the elevation view the brick arch invert appears close to the bott/culvert invert elev. The assumption would be that the internal CMP invert is likely close to that same location.

Features, cont'd:

Section "E" - cont'd:

→ For the right side of section "E", there is a existing 22" elliptical storm drain (CMP) entering the side wall at approximately 67" from the start of wall.

- Plans call for remove of 4' end of this existing CMP which would leave approx. 3' to the outside face of box culvert.
- It's assumed here again, due to uncertainties that the opening will have to be field-cored.
- Due to short length of new CMP, it's assumed it won't be easy to push it into the wall and grout around.
- Will show a CIP joining collar for this side as well.

★ Design procedure:

- For design loading, use the KYTC KYHL-93 truck which is 25% more than AASHTO HL93 truck.
- Generally, will use BOXCAR 3.1 program for the typical sections which is the program the KYTC table 1 is developed from. Cannot directly use KYTC Table 1 since I-CAST uses re-bar (60ksi) instead of WWR (65kksi).
- To account for the large opening in segment "E", will manipulate BOXCAR to reflect a 36" strip interupted by the large side opening. For the top slab spanning to the opening, will evaluate w/ truck load applied on a simple span to account for the interruption of the box. For shear design, since the same resisting slab will be present as in the typical segments, shear design will be satisfied if other segments work out by increasing concrete strength.
- other openings are relatively small
  - Additional reinf can be placed around the opening for the 18" CMP that has a preformed opening with that pipe inserted & grouted in.
  - For the 22" elliptical additional reinf will be provided the entire length of sidewall as dictated by the large opening design on the opposite side since its exact location is indeterminate.
  - For both the 22" elliptical & the 36"± CMP on segment "E" a CIP collar will be poured adjacent & attached w/ re-bar dowels to resist shear running long. Ydirl due to truck loads and also stabilize these butt-type entrances.

From BoxCAR 3.1 program w/ $F_{y\,Rebar} = 60$; assumed bar dia. = .625"; assume spacing = 6"
From KYTC Table 1; Conc. cover = 1" except for top slab when fill < 2'; top cover = 2"
; For soil load, use 120 pcf w/ min $K_a = 0.25$
max = 0.50
; Vertical arching factor → "Embankment / Compacted"
; HS series magnitude → "25" tons
Interstate / Tandem → "25" tons
; Fluid loads; Depth = 1* Ht. of box @ 62.5 pcf
; Surcharge loads; use 90 #/Ft lateral to top & bott. of culvert

"Expected" results → approx. result should = Table 1 * $\frac{60\,ksi}{60\,ksi}$ = Table 1 * 1.083
(For re-steel defined by flexural stress)

	AS1	AS2	AS3	AS4	AS5	AS6	AS7	AS8
From KYTC Table 1;	.327	.478	.323	.192	.192	.192	.192	.192
estimated as Rebar:	.354	.518	.350	.192	.192	.192	.192	.192

THESE MAY BE CODE MINIMUMS NOT CONTROLLED BY FLEXURE.

From BoxCAR Run: → @ 5 ksi Conc.; SLAB STIRRUPS REQ'D @ END of 8" TOP SLAB.
→ @ 6500 " "; No Stirrups required.

As req'd	↓	↓	↓	.192 for the REST. →
By BoxCAR →	.321	.452	.305	

Conclusion, the BoxCAR run gets slightly less than expected when ratioing up the KYTC Tabular Values. provide the ratioed-up reinf:

↓	↓	↓	.192 →
.354	.518	.350	

.518; #5's @ 5". provides .744 in²/F > .518 For AS2 TOP Bott/SLAB
#5 @ 2#5 provides .372 in²/F > .354 For AS1 & AS3
= 10" spac. ↳ OUTSIDE ↳ TOP of BOTT. SLAB OF WALLS

ALL OTHER AREAS; provide #4 @ 10" = 0.240 in²/F > .192

(PLACING SPACES BASED UPON 10" cc OR 1/2 10" cc simplifies bar placement)

Summary for typical box sections where openings not expected to influence design:

F'c req'd = 6500 ksi to avoid stirrups.

Bott. of Top Slab; #5 @ 5" (CLR = 2")
Top of Bott Slab; #5 @ 10" (CLR = 1")
Sidewall outside faces; #5 @ 10" (CLR = 1")
ALL OTHER FACES; #4 @ 10" (CLR = 1")

SPECIAL Consideration for the largeside opening, left wall of Section "E"

It appears the CMP to tie onto inside the adjacent brick storm drain is 36" max. This CMP will not be inserted into the sidewall and, therefore will not be grouted in. The side opening needs To be large enough to match the CMP flow area, but does not need To be large enough for the CMP to push into wall. Assume the sidewall opening will be 36" ϕ.

Invert elevs are not given, but it would seem likely that the CMP invert would be near the top of the bott. slab of box culvert.

Design the length of precast box on either side to absorb the live loads neglecting the contribution of the 36" width.

The design opening is approx. 3.917' from beginning end of a 7.75' section.

remaining "whole" rigid box = 7.75' - 3.00' = 4.75' to carry the live load effect of the whole segment.

RATIO up HS magnitude by 7.75/4.75 = 1.632 * 25T = 40.8T HS AXLE LOADS

Tandem by " " * 25T = 40.8 KIPS AXLE.

For top slab shear, the top slab is not interrupted by openings between walls and any shear requirements due to the extra load can be ignored.

This section "E" has to have generally enhanced re-steel since the exact location of opening is unknown.

	AS1	AS2	AS3	AS4	AS5	AS6	AS7	AS8
As req'd:	.511	.738	.455	.192	.261 + Bott. of Top Slab	.192	.192	.192

AS1	.511	#5 @ 8 = .465	#5 @ 7 = .531 ✓
AS2	.738	#5 @ 4 = .93	#5 @ 3½ = 1.063 ✓
AS3	.455	#5 @ 8 = .465	#5 @ 7 = .531 ✓
AS4, AS6, AS7		#4 @ 7"	
AS5		#4 @ 7" = .343 > .291	

Summary for the beginning 7'-9" Section considering influence of a large dia. opening in one side:

Bott. of Top Slabs #5 @ 3½"

Top of bott. slabs: #5 @ 7"

outside Face of sidewall; #5 @ 7"

all others: #4 @ 7" → later changed bott/top slab bars to #5 @ 7" in collar considerations.

Concrete Collar on Outside of Box Culvert:

- Collar should support the CMP & provide closure against the outside wall.
- Collar should also provide vertical end support to edge of slab since a portion of haunch may be removed.

Dimensions: • assume 1' min outside of CMP on sides & top.
• assumed width out from side of box culvert = 20" WHL WIDTH + 12 = 32"
base area ≈ (3' + 1' + 1' X 2) = 10 ft² @ 2.5 ksf ALLOWABLE = 25k bearing Capa.

Assume an 8" THK Section of slab edge has to 'span' 3' for the opening width.
assumed resisting width = 2'
$M_{wheel} = PL/4 = 20(3)/4 = 15^{k}$
$15 * 1.75 * 1.33 = 34.92^{k}$

w/ "d" = 8 - 1 - .625 - .50 = 5.875"
#9's @ 7 currently scheduled for the longit precast slab: A_s
assuming 2" to 1ST BAR: 2" + 7" + 7" + 7" + 7" = 5-#4 ea

$\phi M_n = 25.42^{k}$

→ CHANGE DISTR. STL. TO #5@7 5-#5's = 1.55 in²

$\phi M_n = 38.5 > 34.9$

How many rebar dowels to resist a shear diffence of one 20k WHEEL LOAD?
#5 in G5 Redhead epoxy adhesive @ 6" embed ≈ 4.4k allowable load.
(20)(1.33) = 26.60^{k} ÷ 4.4 = 6 bars (EA. SIDE)
preferred edge dist: 9"
preferred c-c = 9"

- Will provide a series of drilled anchors ea. side as primary resisting elements
- Will provide

BOXCAR

Version 3.1 for Windows
15 September 2010

A Computer Program for the Structural
Design of Reinforced Concrete Box
Culverts

Developed by

Simpson Gumpertz & Heger Inc.
in cooperation with

The Federal Highway Administration
and
The American Concrete Pipe Association

The successful application and use of this software product is dependent on the application of skilled engineering judgment and is the responsibility of the user. The user must select input values suitable to his specific installation. The information presented in the computer output is for review, interpretation, application and approval by a qualified engineer.

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Date: 01-06-2026
Time: 20:46:47
Filename - KYTCbox8X4

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Filename - KYTCbox8X4
Job Description - 8x4Boxwith0to2fill

GEOMETRY

Span	8. ft	Top Slab Thickness	8. in.
Rise	4. ft	Bottom Slab Thickness	8. in.
Min. Depth of Fill	0. ft	Sidewall Thickness	8. in.
Max. Depth of Fill	2. ft	Length of Precast Section	5.75 ft
Depth Increment	1. ft		

HAUNCH DIMENSIONS

Top Vertical	9. in.
Top Horizontal	9. in.
Bottom Vertical	9. in.
Bottom Horizontal	9. in.

CONCRETE COVERS

Top Outside	2.00 in.
Bottom Outside	1.00 in.
Sidewall Outside	1.00 in.
Top Inside	1.00 in.
Bottom Inside	1.00 in.
Sidewall Inside	1.00 in.

MATERIAL PROPERTIES

Main Reinforcing Yield Stress	60000. psi
Total Service Stress Limit, % of Yield Stress	100 %
Design Concrete Strength	6500. psi
Concrete Density	150. pcf

DESIGN SPECIFICATION AASHTO LRFD

REINFORCING DATA

	DIAMETER	SPACING
Top Slab Outside Face(AS7)	0.625 in.	6 in.
Bottom Slab Outside Face(AS8)	0.625 in.	6 in.
Sidewall Outside Face(AS1)	0.625 in.	6 in.
Top Slab Inside Face(AS2)	0.625 in.	6 in.
Bottom Slab Inside Face(AS3)	0.625 in.	6 in.
Sidewall Inside Face(AS4)	0.625 in.	6 in.

The diameters are used to estimate depth to tension reinforcing from compression face. They do not represent required reinforcing diameters.

SOIL LOAD DATA

Soil Density	120 pcf
Minimum Lateral Pressure Coefficient	0.25
Maximum Lateral Pressure Coefficient	0.50
Installation Type	Embankment/Compacted

Soil-Structure Interaction Factor varies with depth of fill
(See reinforcing data for individual values)

LIVE LOAD DATA AASHTO - LRFD

Live Load: 1

Live Load Type	HS-Series
Live Load Magnitude	25 tons
Footprint specification	by Code
Tire Footprint Length	10 in.
Tire Footprint Width	20 in.
Live Load Distribution Factor	1.15
Direction of Travel	Parallel to Span
Impact Factor	Variable - See Table
Lane Load	0 lb/ft

Live Load: 2

Live Load Type	Interstate - Tandem
Live Load Magnitude	25 kips
Footprint specification	by Code
Tire Footprint Length	10 in.
Tire Footprint Width	20 in.
Live Load Distribution Factor	1.15
Direction of Travel	Parallel to Span
Impact Factor	Variable - See Table
Lane Load	0 lb/ft

SURCHARGE LOADS

Vertical Pressure	0.0 lb/sq. ft
Horiz. Pressure at Culvert Top	90.0 lb/sq. ft
Horiz. Pressure at Culvert Bottom	90.0 lb/sq. ft
Application Code	Additional Dead Load

FLUID LOADS

Depth of Fluid	4.0 ft
Fluid Density	62.5 pcf

LOAD COMBINATIONS

Load Factors:Std

	Self Weight	V. Earth	L. Earth	Water	Live
Max	1.25	1.30	1.35	1.00	1.75
Min	0.90	0.90	0.90	0.00	0.00

Load Modifiers:

Self Weight	V. Earth	L. Earth	Water	Live
1.00	1.05	1.05	1.00	1.00

Load Factor for Axial Thrust:
1.00

Number of Load Combinations:

4

Load Combinations: Std

Purpose	Self W	Earth	Lat E.	Fluid	V Live	AppVeh	Surch	V Sur	H Sur
MaxV/MaxH	Max	Max	Max	0.00	Max	Max	A	Max	Max
MaxV/MinH	Max	Max	Min	Max	Max	0.00	A	Max	0.00
MinV/MaxH	Min	Min	Max	0.00	0.00	Max	A	0.00	Max
Fatigue					0.00				

STRENGTH REDUCTION FACTORS

Flexure	1.00
Shear	0.90

x

BOX CULVERT DESIGN SUMMARY SHEET
8.00 ft Span x 4.00 ft Rise

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I N S T A L L A T I O N D A T A

Height of Fill Over Culvert,	Multiple Depths See Reinf. Data
Soil Unit Weight, pcf	120.
Minimum Lateral Soil Pressure Coefficient	0.250
Maximum Lateral Soil Pressure Coefficient	0.500
Soil-Structure Interaction Factor,	Multiple Depths See Reinf. Data
Installation Type	Embankment/Compacted

M A T E R I A L P R O P E R T I E S

Minimum Specified Reinforcing Yield Strength, ksi	60.00
Concrete - Specified Compressive Strength, ksi	6.50

G E O M E T R Y

Top Slab Thickness, in.	8.0
Side Wall Thickness, in.	8.0
Bottom Slab Thickness, in.	8.0
Top Horizontal Haunch Dimension, in.	9.0
Bottom Horizontal Haunch Dimension, in.	9.0
Top Vertical Haunch Dimension, in.	9.0
Bottom Vertical Haunch Dimension, in.	9.0
Concrete Cover Over Steel, in.	
Top Slab - Outside Face	2.00
Bottom Slab - Outside Face	1.00
Side Wall - Outside Face	1.00
Top Slab - Inside Face	1.00
Bottom Slab - Inside Face	1.00
Side Wall - Inside Face	1.00

Height of Fill SOIL-STRUCTURE INTERACTION AND IMPACT FACTORS

Over Culvert (ft)	Soil-Structure Interaction Factor	Impact Factor
0.00	1.000	1.330
1.00	1.021	1.289
2.00	1.043	1.248

x

R E I N F O R C E M E N T R E Q U I R E M E N T S

Height of Fill Over Culvert (ft)	REINFORCEMENT AREAS (in.²/ft) Transverse Member / Location						Distribution	
	out side AS1	in top AS2	in bott AS3	in side AS4	out top AS7	out bott AS8	in top AS5	out top AS6
0.00	0.313	0.452	0.280	0.192	0.192	0.192	0.192	0.192
1.00	0.319	0.411	0.293	0.192	0.192	0.192	0.192	0.192
2.00	0.321	0.379	0.305	0.192	0.192	0.192	0.192	0.192
Single Design Adequate for the Above Depths of Fill								
	0.321	0.452	0.305	0.192	0.192	0.192	0.192	0.192

** STIRRUP REINFORCING MAY BE REQUIRED - CHECK PRINTOUT BELOW **

EXTENSION OF AS1 REINFORCEMENT INTO OUTSIDE FACE OF TOP AND BOTTOM SLABS (in.) measured from the bend point see note 1

Height of Fill Over Culvert (ft)	Extension from Bend Point (Note 1) Top Slab	Bottom Slab	Location of Zero Moment (Note 2) Top Slab	Bottom Slab
0.00	16	0	43	33
1.00	16	0	30	30
2.00	16	0	30	28
Single Design Adequate for the Above Depths of Fill				
	16	0	43	33

Note 1: Sidewall outside face steel (AS1) must be bent at the corner and extended into the outside face of the top/bottom

slab. The extension length assumes that the AS7 and AS8 reinforcing is provided. To obtain the total AS1 extension into the slabs, a tension lap splice length must be calculated and added to the extension lengths given above.

Note 2: Sidewall outside face steel (AS1) must be bent at the corner and extended into the outside face of the top/bottom slabs. AS7 and AS8 may be eliminated provided that the As1 extends to the point of zero moment. Development lengths for the As1 reinforcing must be added past the location of zero moment.

'---' indicates that negative moment may exist across the full width of the slab.

******** Stirrups are not required ********

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Date: 01-06-2026
Time: 20:50:23
Filename - KYTCbox8X4SPECIAL

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    Filename - KYTCbox8X4SPECIAL
    Job Description - 8x4Boxwith0to2fill
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GEOMETRY
  Span                  8. ft |   Top Slab Thickness       8. in.
  Rise                  4. ft |   Bottom Slab Thickness    8. in.
  Min. Depth of Fill    0. ft |   Sidewall Thickness       8. in.
  Max. Depth of Fill    2. ft |   Length of Precast      7.75 ft
  Depth Increment       1. ft |   Section
-------------------------------------------------------------------------
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HAUNCH DIMENSIONS             | CONCRETE COVERS
  Top Vertical          9. in.|   Top Outside            2.00 in.
  Top Horizontal        9. in.|   Bottom Outside         1.00 in.
  Bottom Vertical       9. in.|   Sidewall Outside       1.00 in.
  Bottom Horizontal     9. in.|   Top Inside             1.00 in.
                              |   Bottom Inside          1.00 in.
                              |   Sidewall Inside        1.00 in.
-------------------------------------------------------------------------
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MATERIAL PROPERTIES
  Main Reinforcing Yield Stress                        60000.  psi
  Total Service Stress Limit, % of Yield Stress          100   %
  Design Concrete Strength                              6500.  psi
  Concrete Density                                       150.  pcf
-------------------------------------------------------------------------
--
DESIGN SPECIFICATION                                AASHTO LRFD
-------------------------------------------------------------------------
--
REINFORCING DATA
                                        DIAMETER       SPACING
  Top Slab Outside Face(AS7)          0.625 in.         6 in.
  Bottom Slab Outside Face(AS8)       0.625 in.         6 in.
  Sidewall Outside Face(AS1)          0.625 in.         6 in.
  Top Slab Inside Face(AS2)           0.625 in.         6 in.
  Bottom Slab Inside Face(AS3)        0.625 in.         6 in.
  Sidewall Inside Face(AS4)           0.625 in.         6 in.

  The diameters are used to estimate depth to tension
  reinforcing from compression face. They do not represent
  required reinforcing diameters.
-------------------------------------------------------------------------
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SOIL LOAD DATA
  Soil Density                                          120 pcf
  Minimum Lateral Pressure Coefficient                    0.25
  Maximum Lateral Pressure Coefficient                    0.50
  Installation Type                       Embankment/Compacted
  Soil-Structure Interaction Factor varies with depth of fill
         (See reinforcing data for individual values)
-------------------------------------------------------------------------
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LIVE LOAD DATA AASHTO - LRFD

Live Load: 1

Live Load Type	HS-Series
Live Load Magnitude	40.8 tons
Footprint specification	by Code
Tire Footprint Length	10 in.
Tire Footprint Width	20 in.
Live Load Distribution Factor	1.15
Direction of Travel	Parallel to Span
Impact Factor	Variable - See Table
Lane Load	0 lb/ft

Live Load: 2

Live Load Type	Interstate - Tandem
Live Load Magnitude	40.8 kips
Footprint specification	by Code
Tire Footprint Length	10 in.
Tire Footprint Width	20 in.
Live Load Distribution Factor	1.15
Direction of Travel	Parallel to Span
Impact Factor	Variable - See Table
Lane Load	0 lb/ft

SURCHARGE LOADS

Vertical Pressure	0.0 lb/sq. ft
Horiz. Pressure at Culvert Top	90.0 lb/sq. ft
Horiz. Pressure at Culvert Bottom	90.0 lb/sq. ft
Application Code	Additional Dead Load

FLUID LOADS

Depth of Fluid	4.0 ft
Fluid Density	62.5 pcf

LOAD COMBINATIONS

Load Factors:Std

	Self Weight	V. Earth	L. Earth	Water	Live
Max	1.25	1.30	1.35	1.00	1.75
Min	0.90	0.90	0.90	0.00	0.00

Load Modifiers:

Self Weight	V. Earth	L. Earth	Water	Live
1.00	1.05	1.05	1.00	1.00

Load Factor for Axial Thrust:
1.00

Number of Load Combinations:

4

Load Combinations: Std

Purpose	Self W	Earth	Lat E.	Fluid	V Live	AppVeh	Surch	V Sur	H Sur
MaxV/MaxH	Max	Max	Max	0.00	Max	Max	A	Max	Max
MaxV/MinH	Max	Max	Min	Max	Max	0.00	A	Max	0.00
MinV/MaxH	Min	Min	Max	0.00	0.00	Max	A	0.00	Max
Fatigue					0.00				

STRENGTH REDUCTION FACTORS

Flexure	1.00
Shear	0.90

x

BOX CULVERT DESIGN SUMMARY SHEET
8.00 ft Span x 4.00 ft Rise

****

I N S T A L L A T I O N D A T A

Height of Fill Over Culvert,	Multiple Depths See Reinf. Data
Soil Unit Weight, pcf	120.
Minimum Lateral Soil Pressure Coefficient	0.250
Maximum Lateral Soil Pressure Coefficient	0.500
Soil-Structure Interaction Factor,	Multiple Depths See Reinf. Data
Installation Type	Embankment/Compacted

M A T E R I A L P R O P E R T I E S

Minimum Specified Reinforcing Yield Strength, ksi	60.00
Concrete - Specified Compressive Strength, ksi	6.50

G E O M E T R Y

Top Slab Thickness, in.	8.0
Side Wall Thickness, in.	8.0
Bottom Slab Thickness, in.	8.0
Top Horizontal Haunch Dimension, in.	9.0
Bottom Horizontal Haunch Dimension, in.	9.0
Top Vertical Haunch Dimension, in.	9.0
Bottom Vertical Haunch Dimension, in.	9.0
Concrete Cover Over Steel, in.	
Top Slab - Outside Face	2.00
Bottom Slab - Outside Face	1.00
Side Wall - Outside Face	1.00
Top Slab - Inside Face	1.00
Bottom Slab - Inside Face	1.00
Side Wall - Inside Face	1.00

Height of Fill SOIL-STRUCTURE INTERACTION AND IMPACT FACTORS

Over Culvert (ft)	Soil-Structure Interaction Factor	Impact Factor
0.00	1.000	1.330
1.00	1.021	1.289
2.00	1.043	1.248

x
R E I N F O R C E M E N T R E Q U I R E M E N T S

Height of Fill Over Culvert (ft)	REINFORCEMENT AREAS (in.²/ft) Transverse Member / Location						Distribution	
	out side AS1	in top AS2	in bott AS3	in side AS4	out top AS7	out bott AS8	in top AS5	out top AS6
0.00	0.511	0.738	0.443	0.192	0.192	0.192	0.261	0.192
1.00	0.507	0.654	0.449	0.192	0.192	0.192	0.231	0.192
2.00	0.498	0.586	0.455	0.192	0.192	0.192	0.207	0.192
Single Design Adequate for the Above Depths of Fill								
	0.511	0.738	0.455	0.192	0.192	0.192	0.261	0.192

** STIRRUP REINFORCING MAY BE REQUIRED - CHECK PRINTOUT BELOW **

EXTENSION OF AS1 REINFORCEMENT INTO OUTSIDE FACE OF TOP AND BOTTOM SLABS (in.) measured from the bend point see note 1

Height of Fill Over Culvert (ft)	Extension from Bend Point (Note 1) Top Slab	Bottom Slab	Location of Zero Moment (Note 2) Top Slab	Bottom Slab
0.00	16	0	43	33
1.00	16	0	32	30
2.00	16	0	30	28
Single Design Adequate for the Above Depths of Fill				
	16	0	43	33

Note 1: Sidewall outside face steel (AS1) must be bent at the corner and extended into the outside face of the top/bottom

slab. The extension length assumes that the AS7 and AS8 reinforcing is provided. To obtain the total AS1 extension into the slabs, a tension lap splice length must be calculated and added to the extension lengths given above.

Note 2: Sidewall outside face steel (AS1) must be bent at the corner and extended into the outside face of the top/bottom slabs. AS7 and AS8 may be eliminated provided that the As1 extends to the point of zero moment. Development lengths for the As1 reinforcing must be added past the location of zero moment.

'---' indicates that negative moment may exist across the full width of the slab.

STIRRUP REINFORCING DATA

Height of Fill Over Culvert (ft)	Location	Area Per Line of Stirrups ($in.^2/ft$)	No. of Lines of Stirrups	Stirrup Spacing (in.)	Location of First Line of Stirrups
0.00	Top Slab	0.137	11	2.50	Tip of Haunches
0.00	Bottom Slab	0.048	5	3.00	Tip of Haunches
1.00	Top Slab	0.137	9	2.50	Tip of Haunches
2.00	Top Slab	0.106	7	2.50	Tip of Haunches
Single Design Adequate for the Above Depths of Fill					
	Top Slab	0.137	11	2.50	Tip of Haunches
	Bottom Slab	0.048	5	3.00	Tip of Haunches

NOTE: SEE "PRECAST CONCRETE JUNCTION BOXES AND PRECAST BOX CULVERTS" SHEET FOR SUMMARY OF BUILDING AND DESIGN CODES, MATERIALS REQUIREMENTS, AND DESIGN LOADS.

NOTE: ICAST WORKING DRAWINGS FOR ADDITIONAL INFORMATION.

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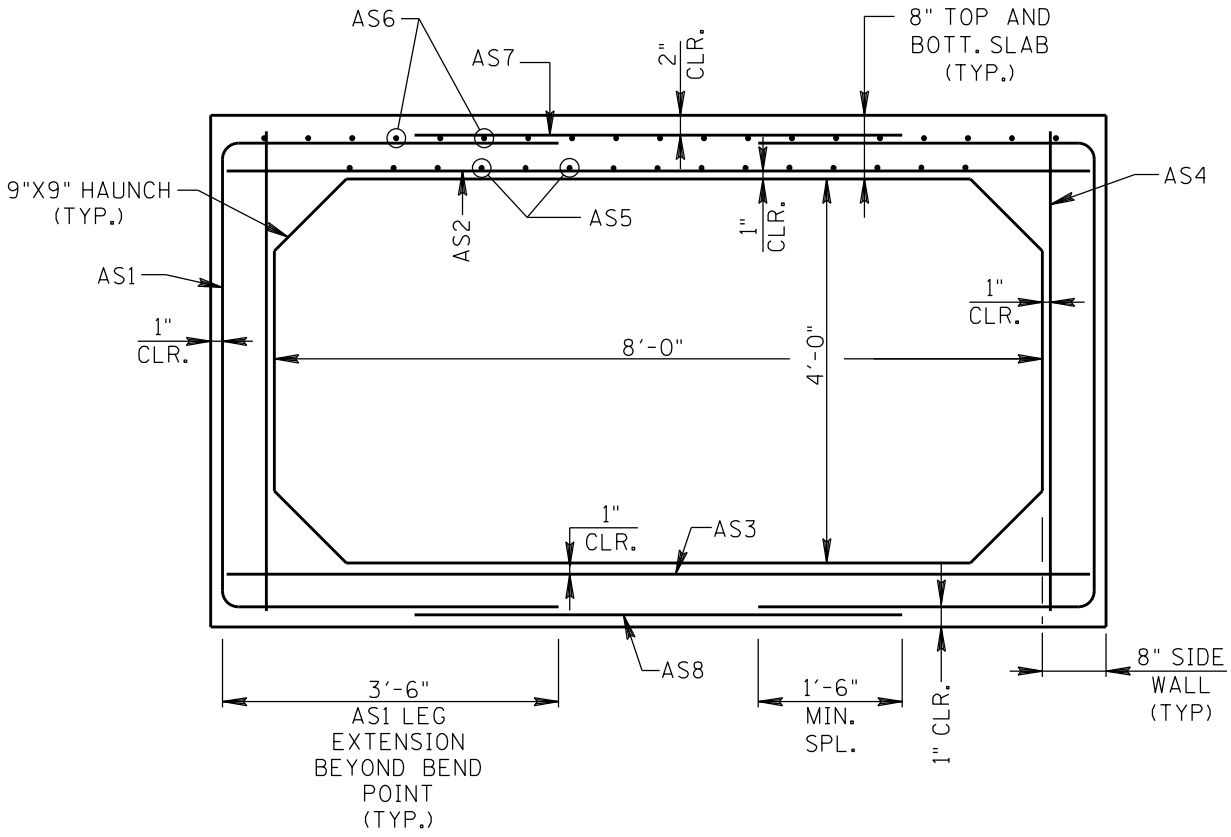

8'X4' PRECAST BOX CULVERT SECTION: SECTIONS "A" THRU "D"

NOTE: F'c-min=6,500 P.S.I.

NOT TO SCALE

	AREA OF STEEL (IN2)	
LOCATION	MAX. REQ'D.	TO BE PROVIDED
AS1	.354	NO. 5'S @ 10", AS=.372
AS2	.518	NO. 5'S @ 5", AS=.744
AS3	.350	NO. 5'S @ 10", AS=.372
AS4	.192	NO. 4'S @ 10", AS=.240
AS5	.192	NO. 4'S @ 10", AS=.240
AS6	.192	NO. 4'S @ 10", AS=.240
AS7	.192	NO. 4'S @ 10", AS=.240
AS8	.192	NO. 4'S @ 10", AS=.240

NOTE: SEE ICAST DRWGS. FOR LOCATIONS OF PRECAST SECTIONS.
NOTE: A 22"ø OPENING IN RIGHT SIDE WALL IS TO BE PROVIDED BY THE PRECAST PLANT. SEE DETAIL REGARDING ADDITIONAL REINFORCEMENT FOR PRECAST OPENING.

AREAS REINFORCING STEEL

Fy-min=60 K.S.I.

SK-1/4

8'X4' PRECAST CONCRETE BOX CULVERT: SECTIONS "A" THRU "D"

LUNSFORD DRAINAGE REPAIRS PROJECT: MADISONVILLE, KENTUCKY

NOTE: SEE "PRECAST CONCRETE JUNCTION BOXES AND PRECAST BOX CULVERTS" SHEET FOR SUMMARY OF BUILDING AND DESIGN CODES, MATERIALS REQUIREMENTS, AND DESIGN LOADS.

NOTE: ICAST WORKING DRAWINGS FOR ADDITIONAL INFORMATION.

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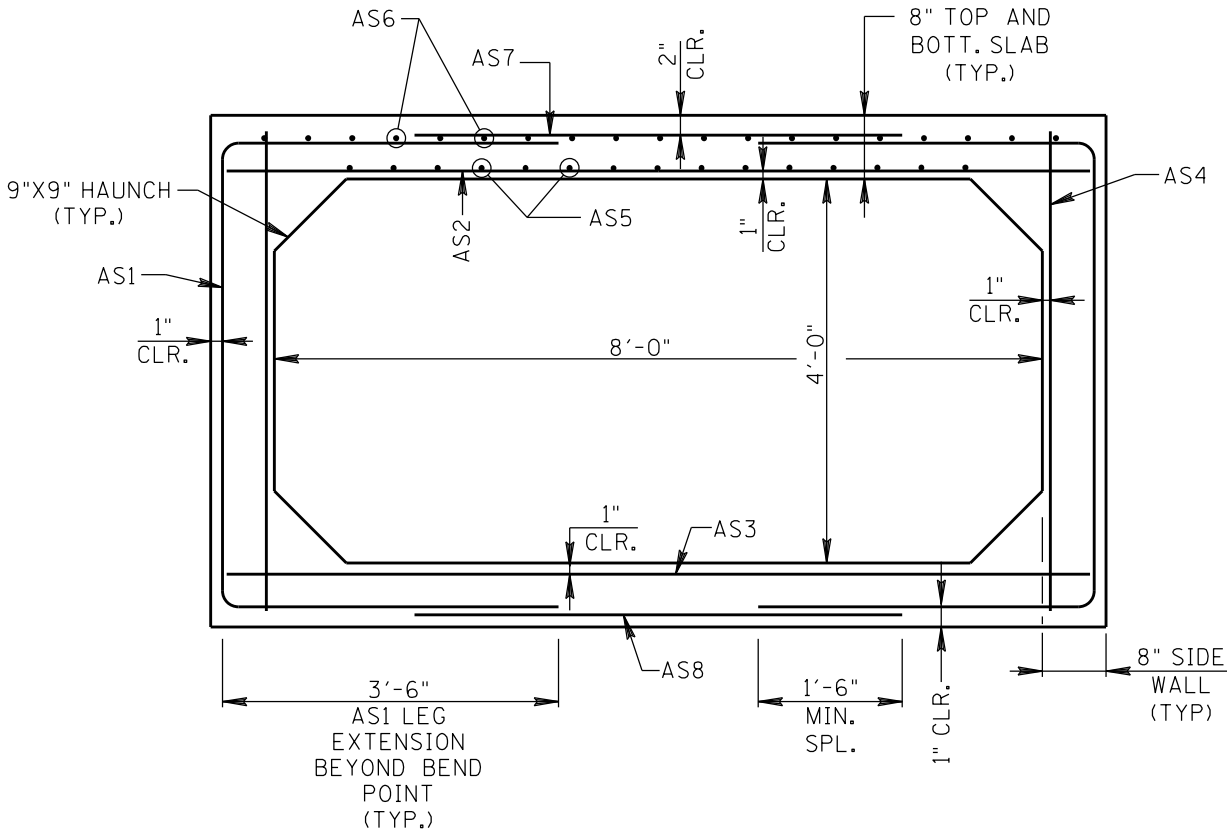


8'X4' PRECAST BOX CULVERT SECTION: SECTION "E"

NOTE: F'c-min=6,500 P.S.I.

NOT TO SCALE

	AREA OF STEEL (IN2)	
LOCATION	MAX. REQ'D.	TO BE PROVIDED
AS1	.511	NO. 5'S @ 7", AS=.531
AS2	.738	NO. 5'S @ 3½, AS=1.062
AS3	.455	NO. 5'S @ 7", AS=.531
AS4	.192	NO. 4'S @ 7", AS=.343
AS5	.261	NO. 5'S @ 7", AS=.531
AS6	.192	NO. 4'S @ 7", AS=.343
AS7	.192	NO. 4'S @ 7", AS=.343
AS8	.192	NO. 4'S @ 7", AS=.343

NOTE: SEE ICAST DRWGS. FOR LOCATIONS OF PRECAST SECTIONS.
NOTE: OPENINGS FOR A 22"ø ELLIPTICAL CMP AND APPROX. 36"ø CMP IN SIDE WALLS ARE TO BE FIELD-CORED, AND A C.I.P. COLLAR IS REQUIRED IN THOSE LOCATIONS.
SEE COLLAR DETAIL FOR ADDITIONAL INFORMATION.

AREAS REINFORCING STEEL

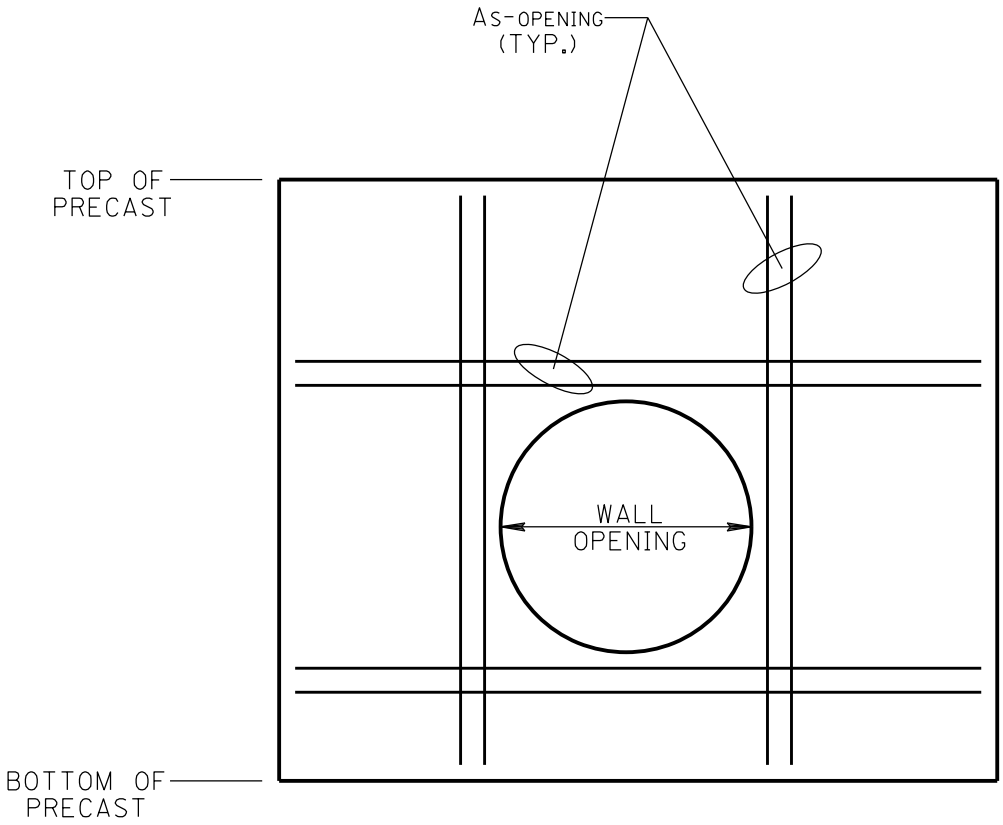
Fy-min=60 K.S.I.

SK-2/4

8'X4' PRECAST CONCRETE BOX CULVERT: SECTION "E"

LUNSFORD DRAINAGE REPAIRS PROJECT: MADISONVILLE, KENTUCKY

ADDITIONAL REINFORCEMENT REQUIRED ON EACH FACE
ALONG EACH SIDE OF OPENING:
2- #5'S HORIZONTAL TOP AND BOTTOM
AND 2-#5'S VERTICAL EACH SIDE



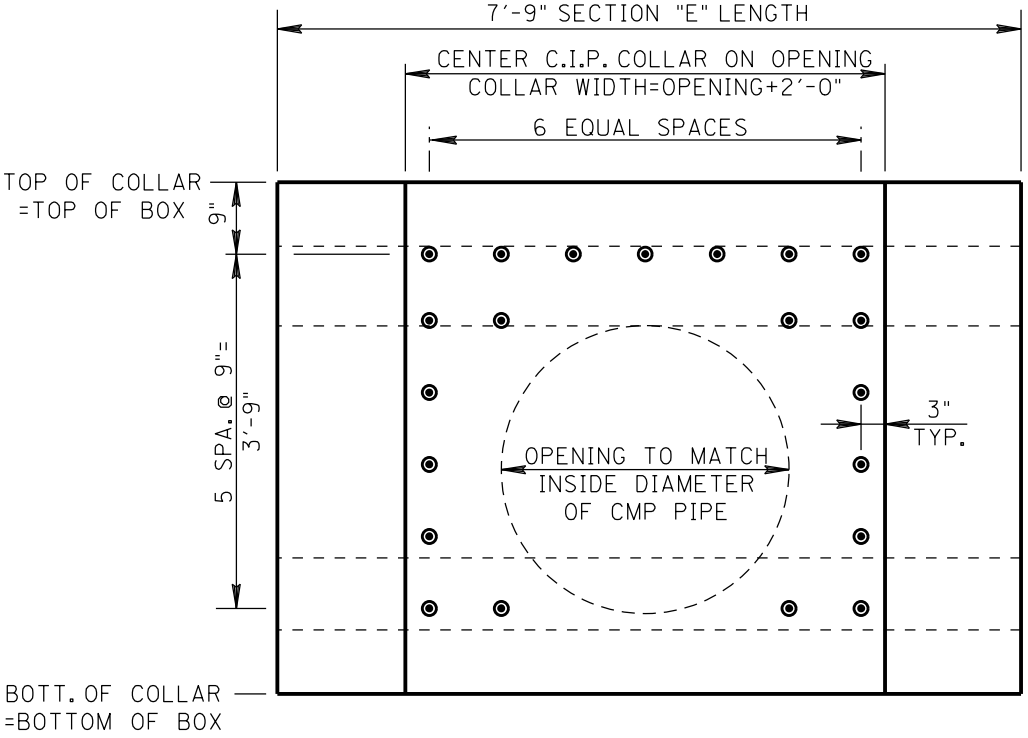
ADDITIONAL REINFORCMENT @ WALL OPENINGS

NOTE: ADDITIONAL OPENING BARS ARE SUPPLEMENTAL TO SCHEDULED WALL REINFORCEMENT FOR EACH WALL OPENING. ADDITIONAL BARS MAY BE TERMINATED AT A DISTANCE OF 1'-6" BEYOND THE LIMITS OF OPENING OR AT 2" FROM THE INTERSECTING EDGE OF CONCRETE WHEN THE 1'-6" DIMENSION INTERSECTS A WALL.
BAR SIZES MAY BE UPSIZED TO PROVIDE THE SAME AREA OF STEEL WHEN THE NUMBER OF BARS CANNOT BE ACCOMMODATED.

ADDITIONAL REINFORCEMENT AT PRECAST WALL OPENING FOR 22"ø PRECAST OPENING IN SECTION "A"

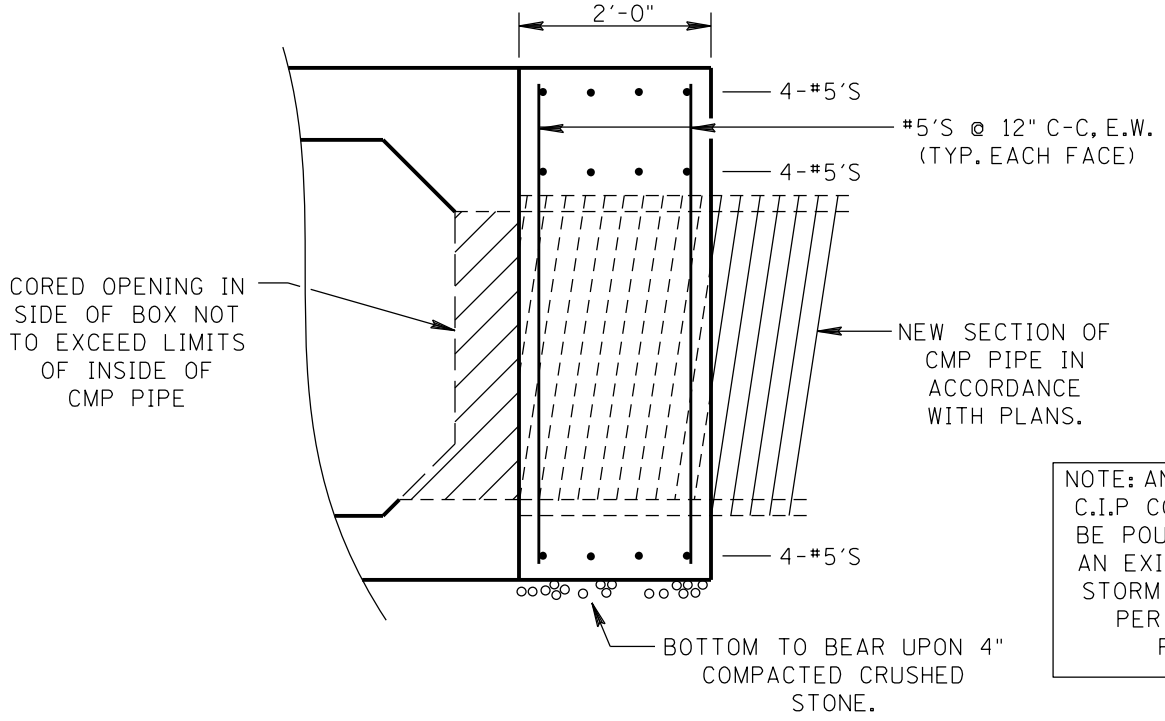
SK-3/4

8'X4' PRECAST CONCRETE BOX CULVERT: PRECAST OPENING RE-BAR
LUNSFORD DRAINAGE REPAIRS PROJECT: MADISONVILLE, KENTUCKY



NOTE: DRILLED-IN RE-BAR SHALL BE #5'S 2'-0" IN LENGTH, EMBEDMENT=6" PROJECTION=1'-6"
RE-BAR SHALL BE ANCHORED UTILIZING TYPE G5 EPOXY ADHESIVE AS MANUFACTURED BY ITW REDHEAD.
INSTALLATION PROCEDURES SHALL BE IN ACCORDANCE WITH MANUFACTURER'S REQUIREMENTS.

C.I.P. COLLAR ELEVATION SHOWING DRILLED AND ANCHORED RE-BAR



NOTE: AN ADDITIONAL C.I.P COLLAR IS TO BE POURED AROUND AN EXISTING BRICK STORM STRUCTURE PER PROJECT PLANS.

C.I.P. COLLAR SECTION SHOWING REINFORCEMENT

C.I.P. COLLAR DETAILS FOR CORED WALL OPENINGS IN SECTION "E"

SK-4/4

8'X4' PRECAST CONCRETE BOX CULVERT: COLLARS FOR SECTION "E"

LUNSFORD DRAINAGE REPAIRS PROJECT: MADISONVILLE, KENTUCKY