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PROJECT: DESIGN PRECAST CONCRETE BOX CULVERT
14'-0" x 8'-0" & WING WALLS

CLIENT: S. D. IRELAND COMPANIES
WILLISTON, VT

JOB: VT ROUTE 100, RURAL MINOR ARTERIAL.
CULVERT NO: 70
TOWN OF WARDSBORO, VT

6/27/14

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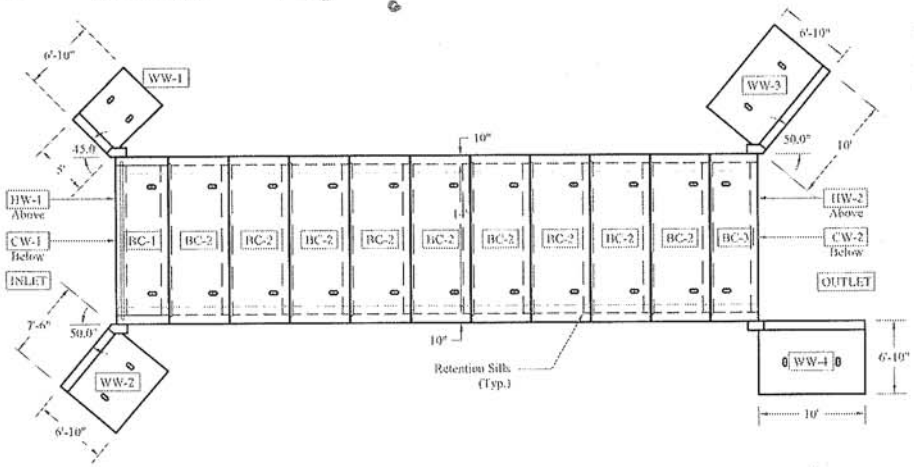
GKM Job No. 140642

Dated: 06/26/14

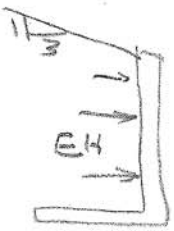
SCOPE of WORK

PRECAST CONCRETE WING WALLS WILL BE PLACED AT END of CULVERT

PLAN VIEW IS:



CROSS SECTION WILL BE "L" SHAPE
EARTH SLOPED 1:3 BEHIND



PROVIDE CALCULATIONS:

MATLS - wt. of conc = 150 pcf
wt of soil = 120 pcf

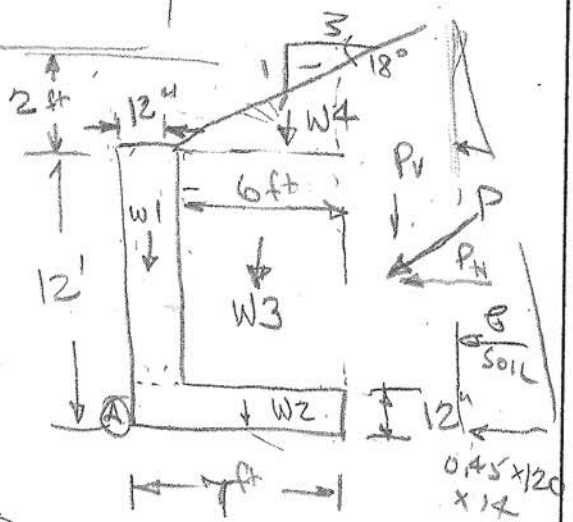
1. TO DEMONSTRATE RESISTANCE TO OVERTURNING USING LRFD - STRENGTH I LOAD COMB. LIMIT STATE

LOAD FACTORS γ_i
EH = 1.5

2. TO DEMONSTRATE RESISTANCE of CONCRETE USING LRFD - SERVICE I LOAD COMB. LIMIT STATE

LOAD FACTORS γ_i = 1.0 ALL FACTORS

PROBLEM CHECK WALL FOR O.T. & SLIDING



Use $K_A = 0.45$

$P = \left(\frac{0+756}{2}\right) \times 14 = 5300.\text{ lb}$

$P_V = 5300 \times \sin 18^\circ = 1638\text{ lb.}$

$P_H = 5300 \cdot \cos 18 = 5040\text{ lb.}$

$W_1 = 150^{pcf} \times 11^{ft} \times 1^{ft} = 1650\text{ lb}$

$W_2 = 150^{pcf} \times 7^{ft} \times 1^{ft} = 1050$

$W_3 = 120 \times 6 \times 11 = 7920$

$W_4 = 120 \times \left(\frac{6 \times 2}{2}\right) \times = 720\text{ lb}$

11340 lb

$M_{OVERTURNING}^{(A)} = 5040\text{ lb} \times \frac{14^{ft}}{3} = 23520.\text{ ft. lb}$

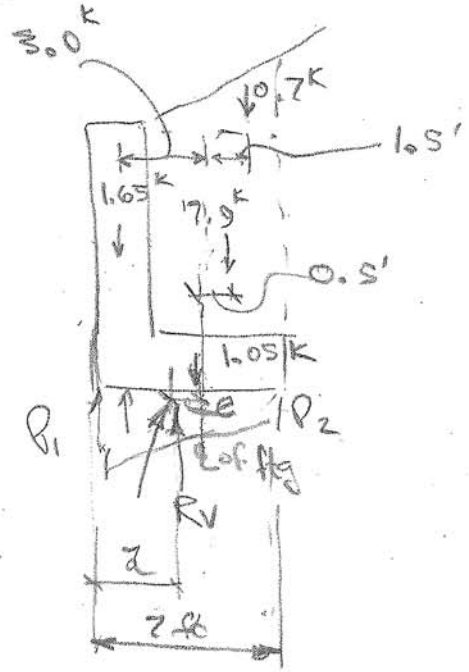
$M_{RESTRAINING}^{(A)} = 1650^{lb} \times 0.5^{ft} + 1050^{lb} \times \frac{7}{2}^{ft} + 7920^{lb} \times 4^{ft}$

$+1638 \times 7 + 720\text{ lb} \times 5^{ft} = 51246\text{ ft. lb}$

F.S. AGAINST OVERTURNING $= \frac{51246}{23520} = 2.2 > 2$ ok

F.S AGAINST SLIDING $= \frac{(11340+1638)\tan 30}{5040} = 1.5 = 1.5$ ok

PROBLEM FIND LOAD ON SOIL



$R_V = 1.65 + 1.05 + 7.9 + 0.7$

$= 11.3$ kips

$L/6 = 7/6 = 1.17$ ft

$\bar{a} = \frac{7}{2} - 0 = 3.5$

$\Sigma M_{\text{ftg}} = 0 = 11.3e + 7.9 \times 0.5 + 0.7 \times 1.5 - 1.65 \times 3$

$e = \frac{0.05}{11.3} = -0-$

$P_1 = (4 \times 7 - 6 \times 3.5)\frac{11.3^{k}}{7^2} = 1.6$ ksf

$P_2 = (6 \times 3.5 - 2 \times 7)\frac{11.3}{7^2} = 1.6$ ksf

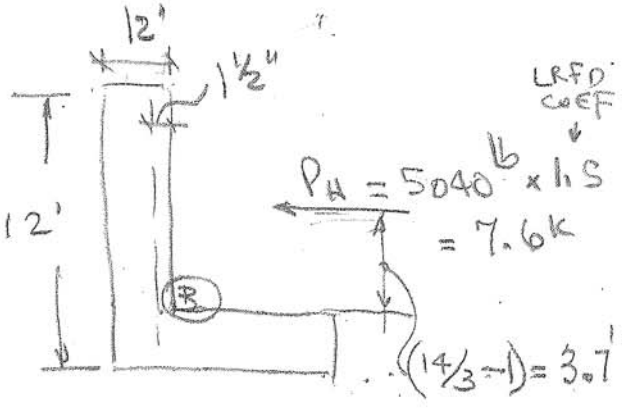
$= 0.8$ tsf

PROBLEM DESIGN STEM

$M_u^{(B)} = 7.6^k \times 5.7^{ft}$

$= 28.\ k.ft$

$V_{u(B)} = 7.6^k$



For $f'_c = 5000$ psi $f_y = 60000$ psi

$b = 12^{in}$ $d = 12 - 2 - \frac{1}{2} = 9\frac{1}{2}$ in

USE #6@8".

$A_s = 0.66\ in^2$

$q = \frac{60}{5} \times \frac{0.66}{12 \times 9.5}$

$= 0.07$

$\phi M_n = 0.9 \times 12 \times 9.5^2 \times 5000 \times 0.07 \left(1 - .59 \times 0.07\right) \div 12000$

$= 28 \quad k.ft = M_{(B)} - o.k.$

$\phi V_n = 0.9\left(0.0316 \beta \sqrt{f'_c}\ b.\ d_v\right)$ (f'_c in ksi)

$\beta = 2.0$ for $t < 16"$

$= 0.9 \times 0.0316 \times 2.0\sqrt{5} \times 12 \times 9.5$

$= 14.5\ k. > V_{u(B)}$ o.k.

USE SAME STEEL IN BOTTOM SLAB.

GENERAL SPECIFICATIONS

1. Concrete for box culvert shall be designed to obtain a strength of 5,000 psi minimum in 28 days. Material shall meet requirements of ACI 318.

2. Reinforcing steel for rebar shall be Grade 60 (obtain yield strength of 60,000 psi and meet requirements of ASTM A82

3. Weight of Concrete – 150 lb/ft^3

4. Weight of Soil – 130 lb/ft^3

5. AASHTO LRFD HL93 live load at surface with less than 2.00 feet of cover on top of top slab.

REFERENCES

1. ASTM C 1577-10 titled "Standard Specification for Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers Designed According to AASHTO LRFD".

2. ACI 318-08 titled "Building Code Requirements for Reinforced Concrete".

3. BRASS-CULVERT Version 2.3.0 by Wyoming Department of Transportation.

4. AASHTO LRFD – Bridge Design Specifications, 5th Edition.

BRASS-CULVERT

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                BRASS-CULVERT(LRFD)  Version 2.3.0


 DATE :  6/17/2014        TIME : 10: 9: 3                    PAGE  1

Input Filename                 : C:\Brass 2.3.0\CULVERT\Examples\SD Ireland - Wardsboro Bridge No 70.DAT
Output Filename                : C:\Brass 2.3.0\CULVERT\Examples\SD Ireland - Wardsboro Bridge No 70.xml
Output Filename for Live Loads : C:\Brass 2.3.0\CULVERT\Examples\SD Ireland - Wardsboro Bridge No 70_LL.OUT

The following filenames may be used in this run
Live Load Influence Values       File name : C:\Brass 2.3.0\CULVERT\Examples\SD Ireland - Wardsboro Bridge No 70_INF.OUT
Drawing                          File name : C:\Brass 2.3.0\CULVERT\Examples\SD Ireland - Wardsboro Bridge No 70.drw
Live Load Influence Ordinates    File name : C:\Brass 2.3.0\CULVERT\Examples\SD Ireland - Wardsboro Bridge No 70.ill
Live Load Actions (w/o DF or IM) File name : C:\Brass 2.3.0\CULVERT\Examples\SD Ireland - Wardsboro Bridge No 70.oll
Intermediate Computations        File name : C:\Brass 2.3.0\CULVERT\Examples\SD Ireland - Wardsboro Bridge No 70.ooo
Data Modelling                   File name : C:\Brass 2.3.0\CULVERT\Examples\SD Ireland - Wardsboro Bridge No 70.tmp

COMMENTS             THIS FILE WAS CREATED BY THE BRASS-CULVERT GUI.
COMMENTS             DO NOT EDIT THIS FILE!
COMMENTS            JOB DESCRIPTION:
TITLE               S.D. IRELAND - WARDSBORO BRIDGE NO. 70
STRUCTID            14-0 X 8-0
AGENCY
COMMENTS
UNITSIN             US
UNITSOUT            US
COMMENTS            ANALYSIS CONTROL:
TYPE                PC
FUNCT               DESREV
LRFR                NO
IRELEASE            NO
IDSN                LRFD
KBASE               FULL
KHACH               YES
EPOXY               YES
EDGE-STRIP          NO
LRFD-SHEAR          0
DNEG                0.0000
COMMENTS            OUTPUT CONTROL:
MTEN                YES
IBSH                NO
IINFN               NO
LIVELO              NO
DEFAULTS            YES
LOOPS               NO
INTERMEDIATE        NO
COMMENTS            MATERIAL PROPERTIES:
FCONC               5000.000
CE                  4074280.000
CWGT                150.000
ZEE                 98.000
EXP_FACTOR          0.750
EWGT                130.000
AWGT                145.000
FYST                60000.000
CN                  7.1178
COMMENTS            BOX GEOMETRY:
```

BRASS-CULVERT(LRFD) Version 2.3.0
S.D. IRELAND - WARDSBORO BRIDGE NO. 70

NBOX	1
NSPAN	14.0000
NHITE	8.0000
LENG	4.5000
BWIDTH	60.0000
CBWIDTH	40.0000
TSLAB	12.0000
KFXTS	F
BSLAB	12.0000
KFXBS	F
WALLR	10.0000
KFXW	F
COMMENTS	SKEW:
CSKEW	30.0000
COMMENTS	HAUNCHES:
TFILT	9.0000
BFILT	9.0000
COMMENTS	CONCRETE COVER:
COVS	2.0000
COVB	2.0000
COVW	2.0000
COVIN	2.0000
COMMENTS	DEAD LOADS:
PRESS	60.000
PMIN	30.000
PWAT	0.000
NFILL	1.9900
NWEAR	0.0000
FILLFA	1.1500
SIFACT	1.1500
COMMENTS	LIVE LOADS:
LVLD	HL-93-TRUCK
LVLD	HL-93-TANDEM
LVLD	HL-93-LANE
LVOMT	YES
LLPATCH	PL
SURCH_USE	YES
NLANES	0
LIMIT_DIST	NO
LRFDDF	YES
COMMENTS	REBAR REVIEW:

DESREV	YES
TCBSZ	6
TCBSP	6.0000
BCBSZ	6
BCBSP	6.0000
TSIFTSZ	6
TSIFTSP	6.0000
TSOFTSZ	4
TSOFTSP	9.0000
BSIFTSZ	5
BSIFTSP	5.0000
BSOFTSZ	4
BSOFTSP	9.0000
EWIFVSZ	4
EWIFVSP	9.0000
EWOFVSZ	6
EWOFVSP	6.0000

End of Input File No. 1

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Note:
The following list of variables are used in the application. They are shown in US units because that is the internal computational mode.

The first set are the variables defaulted from input and the second set are system variables.

Units			
USSI_UNITS:	Input Units	=	US
USSI_UNITS_OU:	Output Units	=	US

Design Variables			
LRFDDF:	Use LRFD method for bot slab load distrib.	=	T
CUTYPE:	Precast(PC) or Cast in Place(CIP) Culvert	=	PC
IDSN:	Design Method	=	LRFD
FUNCT:	Design (DESIGN) or Design Review (DESREV)	=	DESREV
IRELEASE:	Moment Continuity Released (@ end of walls)	=	F
DNEG:	Distance to Neg. Moment Computation Point	=	0.00

Output Control Variables			
MTEN:	Output Moment-Shears	=	T
IINFN:	Output Influence Line	=	F
IBSH:	Output Bar Schedule	=	F

Standard Load Variables			
LVLD:	Live Load Vehicle Name	=	HL-93-TRUCK
LVLD:	Live Load Vehicle Name	=	HL-93-TANDEM
LVLD:	Live Load Vehicle Name	=	HL-93-LANE
LVOMT:	Neglect LL for Fill > 8Ft & Fill > Span	=	T

Uniform Dead Load Variable			
EDLU:	Extra Uniform Dead Load (Lbs/Ft)	=	0.0
NWEAR:	Thickness of Wearing Surface (in)	=	0.0
Concentrated Dead Load Variables			
EDLC1:	Extra Concentrated Dead Load (Lbs)	=	0.0
EDLX1:	Position of Load from CL of Left Wall (Ft)	=	0.0
EDLC2:	Extra Concentrated Dead Load (Lbs)	=	0.0
EDLX2:	Position of Load from CL of Left Wall (Ft)	=	0.0
EDLC3:	Extra Concentrated Dead Load (Lbs)	=	0.0
EDLX3:	Position of Load from CL of Left Wall (Ft)	=	0.0
Soil and Water Pressure Variables			
SURCH:	Depth of Surcharge	=	2.0
PRESS:	Maximum Soil Equiv. Fluid Pressure(Pcf)	=	60.0
PMIN:	Minimum Soil Equiv. Fluid Pressure(Pcf)	=	30.0
PWAT:	Internal Water Pressure	=	0.0
Geometry - Box Dimension Variables			
NBOX:	Number of Boxes (1 TO 4)	=	1
NSPAN:	Clear Span (Ft)	=	14.0
NHITE:	Clear Height (Ft)	=	8.0
NFILL:	Design Fill Measured from Top of Top Slab(Ft)	=	2.0
LENG:	Section length(PC)-Culvert Length(CIP)(Ft)	=	4.5
Geometry - Slab Thickness Variables			
TSLAB:	Thickness of top Slab (In)	=	12.0
BSLAB:	Thickness of Bottom Slab(In)	=	12.0
WALLR:	Thickness of Exterior Wall (In)	=	10.0

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S.D. IRELAND - WARDSBORO BRIDGE NO. 70

Geometry - Skew and Haunch Variables		
LSKEW: Left End Skew Angle(Deg)	=	90.0
RSKEW: Right End Skew Angle (Deg)	=	90.0
CSKEW: Culvert Skew Angle (Deg)	=	30.0
TFILT: Top Haunch (In)	=	9.0
BFILT: Bottom Haunch (In)	=	9.0
KHACH: Haunches used in Analysis (YES/NO)	=	YES

Geometry - Clear Concrete Cover		
COVS: Exterior Concrete Cover Top Slab (In)	=	2.0
COVB: Exterior Concrete Cover Bottom Slab (In)	=	2.0
COVW: Exterior Concrete Cover Walls (In)	=	2.0
COVIN: Interior Concrete Cover (In)	=	2.0

Material Properties Variables		
EWGT: Weight of Soil (Pcf)	=	130.0
FYST: Yield Strength of Reinf. Steel (Psi)	=	60000.0
FSTL: Allowable Stress of Reinf. Steel(Psi)(ASD)	=	36000.0
FCONC: Compressive Strength of Concrete (Psi)	=	5000.0
FSHR: Shear in Concrete (Psi)(ASD)	=	0.0
FSTIR: Allowable Stress in Stirrups (Psi)(ASD)	=	0.0
CWGT: Weight of Concrete (Pcf)	=	150.0
AWGT: Weight of Wearing Surface (Pcf)	=	145.0

ZEE:	Crack Width Parameter from AASHTO	=	98.0
CN:	Modular Ratio of Concrete	=	7.1
CE:	Modulus of Elasticity of Concrete(ksi)	=	4074.3
ZEE:	Crack Width Parameter from AASHTO	=	1.0
CN:	Modular Ratio of Concrete	=	0.9
CE:	Modulus of Elasticity of Concrete(ksi)	=	

Service-I load and resistance factors		
EV: Vertical Earth Pressure max-min	1.00	1.00
DC: Components max-min	1.00	1.00
DW: Wearing Surfaces max-min	1.00	1.00
EH: Horizontal Earth Pressure At-Rest	1.00	
LS: Live load surcharge	1.00	
WA: Water load and stream pressure	1.00	
LL: Vehicular live load	1.00	
Strength-I load and resistance factors		
EV: Vertical Earth Pressure max-min	1.30	0.90
DC: Components max-min	1.25	0.90
DW: Wearing Surfaces max-min	1.50	0.65
EH: Horizontal Earth Pressure At-Rest	1.35	
LS: Live load surcharge	1.75	
WA: Water load and stream pressure	1.00	
LL: Vehicular live load	1.75	
Strength-II load and resistance factors		
EV: Vertical Earth Pressure max-min	1.30	0.90
DC: Components max-min	1.25	0.90
DW: Wearing Surfaces max-min	1.50	0.65
EH: Horizontal Earth Pressure At-Rest	1.35	
LS: Live load surcharge	1.35	
WA: Water load and stream pressure	1.00	
LL: Vehicular live load	1.35	
Fatigue load and resistance factors		
EV: Vertical Earth Pressure max-min	0.00	0.00
DC: Components max-min	0.00	0.00
DW: Wearing Surfaces max-min	0.00	0.00
EH: Horizontal Earth Pressure At-Rest	0.00	
LS: Live load surcharge	0.75	
WA: Water load and stream pressure	0.00	
LL: Vehicular live load	0.75	

B1:	Ratio Depth Compressive Zone AASHTO 5.7.2.2	=	0.85
BB:	Factor Load Factor Po and Pb AASHTO	=	0.80
BETAD:	Dead Load Multiplier for Load Factor	=	1.0000
BETAL:	Live Load Multiplier for Load Factor	=	0.0000
PHIMOM:	Phi Factor for Moment	=	1.0000
PHISHR:	Phi Factor for Shear	=	0.9000
GAMMA:	Load Factor Actions Multiplier	=	1.3000

```
IFATIG:  Check Fatigue                                =       F
IHAUCH:  Code for Considering Haunch in Analysis      =       F
ILES5:   Code for Span Less Than 5 ft                 =       F
ISHR:    Code for Shear Stress Check                  =       F
```

```
KBASE:  Bottom Slab Support Code(FULL,FIXED,HINGED)   =     FULL
LDPASS: Bypass Live Load if no vehicle input          =       F
LONGB:  Longitudinal Bar Code                         =       F
MESSGE: Code for Message Printout                     =       T
```

JOB DESCRIPTION

```
Title        : S.D. IRELAND - WARDSBORO BRIDGE NO. 70
Structure ID :
Agency name  :

Input units  : US
Output units : US
```

ANALYSIS CONTROL

Construction Type	Design/ Review	Moment Continuity Released	Bottom Slab Support Code	Negative Moment Position
PRECAST	DESREV	NO	FULL	0.00

```
Consider Haunches in Analysis                    :  YES
Perform Edge Beam reinforcement computations     :  NO
Use epoxy coated bars in top mat of reinforcement:  YES
     in top slab
```

Design Method	Limit State Load and Resistance Factors Ductility	Redundant	Operations
LOAD & R	1.0000	1.0000	1.00

OUTPUT CONTROLS

Drawing File:	NO
Actions at tenth Points:	YES
Bar Schedule:	NO
Live Load Influence Ordinates:	NO
Live Load Actions Envelope:	NO
Default Output:	YES
Intermediate Design Iteration Computations:	NO
Intermediate Computations	NO

MATERIAL PROPERTIES

Concrete f'c (Psi)	Concrete Ec (Psi)	Crack Width Gamma E (Kip/in)	Steel Fy (Psi)	Steel n
5000.	4074280.	0.75	60000.	7.12

Note:
1. The concrete unit weight used for the Ec computation is 5 pcf less than used for load computations

2. The crack width coefficient is the coefficient in Eq. 5.7.3.4-2 for the crack width parameter Z

Unit Weights

Concrete (Pcf)	Soil Fill (Pcf)	Wearing Surface (Pcf)
150.	130.	145.

Note:
1. The soil structure interaction factor has been entered by the user. The value of 1.15 will be used.

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BOX GEOMETRY

Culvert Cells	Span Length (Ft)	Clear Height (Ft)	Centerline Length (Ft)
SINGLE	14.00	8.00	4.50

Bridge Width (Ft)	Clear Bridge Width (Ft)	Number of Traffic Lanes
60.00	40.00	3

Slab and Wall Information

Top Slab (In)	Bottom Slab (In)	Exterior Wall (In)	Interior Wall (In)
12.00 Fixed	12.00 Fixed	10.00 Fixed	0.00 n/a

LIVE LOADS

Vehicle Designation
HL-93-TRUCK
HL-93-TANDEM
HL-93-LANE

Live Load Control: YES
(Neglect Live Load if fill is greater than 8 ft.
and fill is greater than culvert span)

Tire application model: patch load
Live Load Surcharge: 2.0 Ft

DEAD LOADS

Concentrated Loads

Wgt. (Kips)	Dis. (Ft)	Wgt. (Kips)	Dis. (Ft)	Wgt. (Kips)	Dis. (Ft)
0.0	0.0	0.0	0.0	0.0	0.0

Soil Pressure Max (Pcf)	Soil Pressure Min (Pcf)	Water Density (Pcf)
60.0	30.0	0.0

Uniform Load (plf)	Wearing Surface Thickness (in)	Fill Height (Ft)
0.0	0.00	1.99

SKEW

Skew Left (Deg)	Skew Right (Deg)	Skew Center (Deg)
90.0	90.0	30.0

HAUNCHES

Top Haunch Height (In)	Bottom Haunch Height (In)
9.0	9.0

CONCRETE COVER to face of bar

Top Slab (In)	Bottom Slab (In)	Exterior Wall (In)	Interior Wall (In)
2.00	2.00	2.00	2.00

Bar sizes and spacings with computed areas of steel

Areas of steel are in in2/ft

Top slab

LEFT SIDE	CENTER	RIGHT SIDE
area 0.8800 in2	area 0.8800 in2	area 0.8800 in2
size 6 spaced at 6.00 in.	size 6 spaced at 6.00 in.	size 6 spaced at 6.00 in.

****

Exterior wall

TOP
area 0.8800 in2
size 6 spaced at 6.00 in.

OUTSIDE FACE
area 0.8800 in2
size 6 spaced at 6.00 in.

INSIDE FACE
area 0.2667 in2
size 4 spaced at 9.00 in.

BOTTOM
area 0.8800 in2
size 6 spaced at 6.00 in.

****

Bottom slab

LEFT SIDE	CENTER	RIGHT SIDE
area 0.8800 in2	area 0.7440 in2	area 0.8800 in2
size 6 spaced at 6.00 in.	size 5 spaced at 5.00 in.	size 6 spaced at 6.00 in.

EXTERIOR WALL Minimum Thickness Based on Cover and Layer Clearance
AASHTO LRFD Section 5.10.3.1 (minimum thickness)
Equation 2 = exterior wall cover plus the diameter of two #6 bars and
two #4 bars plus the inside wall/slab cover plus 1 in clearance

Required Thickness is 8.00 Inches

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S.D. IRELAND - WARDSBORO BRIDGE NO. 70

LRFD Live Load Distribution Factor Computation

Input Values

Depth of Fill	= 1.99 ft.	
Span Length	= 14.00 ft.	$= D_i$
Truck Gage	= 6.00 ft.	$= s_w$
Soil Distribution Factor	= 1.15	
Tire Patch Width	= 20.00 in.	$= w_t$
Bridge Width	= 60.00 ft.	
Length	= 4.50 ft.	

Compute Strip Width by 4.6.2.10.2-1

$E = 96 + 1.44\ S$ ft
$E = 96 + 1.44\ (\ 14.00$ ft. $)$
$E = 9.68$ ft.

Controlling Distribution Factor

Final Strip Width = 9.68 ft.

Final Distribution Factor = 1/Final Strip Width = **0.10** Lanes per ft. of width

Multiple Presence Factor = 1.20

Distribution Factor * Multiple Presence Factor = **0.12**

Notes:

1. Only the one lane loaded case is considered for 4.6.2.10, which provides an upper bound on the distribution plus multiple presence factor for all cases. The one lane loaded multiple presence factor is used.

See 12.11.2.1, 3.6.1.3.3, and 4.6.2.10.

2. Lane loads are not applied. See 3.6.1.3.3. This applies to all approximate strip methods.
3. The distribution factor for fills of 2 feet or greater is bounded by the distribution factor computed in 4.6.2.10. See 3.6.1.2.6.

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Number of cells	=	1
Top Slab thickness	=	12.0000 In.
Bottom Slab thickness	=	12.0000 In.
Exterior Wall thickness	=	10.0000 In.
Design Span(c-c walls)	=	14.8333 Ft.
Design Height(c-c slabs)	=	9.0000 Ft.
Fill Height(top of slab)	=	1.9900 Ft.
Wearing surface thickness	=	0.0000 In.
Loads based on 1 foot unit width		
Soil Structure Interaction Factor	=	1.1500
Earth Weight for fill computations	=	0.1495 Kcf
Weight of Fill without wearing surface	=	0.2975 Klf
Weight of Wearing Surface	=	0.0000 Klf
Weight of Top Slab	=	0.1500 Klf
Weight of Extra Uniform Dead Load	=	0.0000 Klf
Uniform Dead Load on Top Slab	=	0.4475 Klf
Weight of Walls divided by culvert width	=	0.1277 Klf
Uniform Dead Load on Bottom Slab	=	0.5752 Klf
Soil pressure at center of top slab	=	0.1494 Klf
Soil pressure at center of bottom slab	=	0.6894 Klf
Soil pressure due to live load surcharge	=	0.0840 Klf
Impact Factor on Top Slab & Walls	=	0.2479
Impact Factor on Bottom Slab	=	0.0000
Axle Load Distribution Factor on:		
Top Slab & Walls	=	0.0000
on Bottom Slab	=	0.0000

Note:

1. The weight of the walls is computed by taking the interior wall thickness plus twice the exterior wall thickness and multiplying by the clear height of the culvert and the weight of concrete. That result is divided by the span length times the number of cells plus the wall thicknesses.

2. The soil pressure computations use the fill height and the culvert height for appropriate values for lateral earth pressures. Wearing surface, fill height, and slab thickness are used in vertical dead load computations.

3. The distribution width and associated distribution factor for the top slab is computed according to AASHTO LRFD 4.6.2.10 for fill depth less than 2 ft. and AASHTO LRFD 3.6.1.2.6 for fill depths over 2 ft. Also, see 3.6.1.3.3.

For a HL-93-TRUCK Vehicle
Description AASHTO LRFD HL-93 Design Truck (US)
The Number of axles = 3

	Axle Weights (kips)	Spacing (ft)
	8.00	14.000
	32.00	14.000
	32.00	0.000
	---	---
Totals	72.00	28.000

For a HL-93-TRUCK Vehicle
Description AASHTO LRFD HL-93 Design Truck (US)

The number of simulated axles based on fill = 3

The number of simulated axles is calculated based on the longitudinal distribution length of each axle divided by the simulated axle spacing of 1 foot and the simulated axle weights are calculated by dividing the vehicle axle weights by the number of simulated axles per vehicle axle.

	Truck facing backwards		Truck facing forward	
	Axle wts. (kips)	Spacing (ft)	Axle wts. (kips)	Spacing (ft)
	8.00	0.000	32.00	0.000
	32.00	14.000	32.00	14.000
	32.00	14.000	8.00	14.000
Totals	72.00	28.000	72.00	28.000

Note: Impact or distribution is not included in the above table.

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Current Live Load: HL-93-TRUCK

Unfactored MOMENTS (per unit design width)
due to Dead and Live Loads including Distribution and Impact

M-PT	Dead Load Kft	Soil Press (Max) Kft	Soil Press (Min) Kft	Surch Hgt. Kft	Water Press (Max) Kft	LIVE LOADS Pos Kft	Neg Kft
EXTERIOR WALL BOTTOM							
1- 0	-5.44	-1.53	-0.76	-0.29	0.00	0.00	-7.44
1- 1	-5.26	0.28	0.14	0.02	0.00	0.00	-6.61
1- 2	-5.09	1.57	0.79	0.25	0.00	0.00	-5.77
1- 3	-4.92	2.39	1.20	0.42	0.00	0.00	-5.01
1- 4	-4.75	2.79	1.39	0.53	0.00	0.00	-4.32
1- 5	-4.58	2.80	1.40	0.56	0.00	0.00	-3.85
1- 6	-4.41	2.47	1.23	0.53	0.00	0.00	-4.13
1- 7	-4.23	1.84	0.92	0.42	0.00	0.00	-4.41
1- 8	-4.06	0.97	0.48	0.25	0.00	0.00	-4.70
1- 9	-3.89	-0.12	-0.06	0.02	0.00	0.34	-4.98
1-10	-3.72	-1.37	-0.69	-0.29	0.00	0.94	-5.26
EXTERIOR WALL TOP							
TOP SLAB LEFT SIDE							
2- 0	-3.72	-1.37	-0.69	-0.29	0.00	0.94	-5.26
2- 1	0.71	-1.37	-0.68	-0.29	0.00	4.56	-1.24
2- 2	4.16	-1.37	-0.68	-0.29	0.00	8.13	0.00
2- 3	6.62	-1.36	-0.68	-0.29	0.00	10.98	0.00
2- 4	8.10	-1.36	-0.68	-0.29	0.00	12.81	0.00
2- 5	8.60	-1.36	-0.68	-0.29	0.00	13.45	0.00
2- 6	8.10	-1.36	-0.68	-0.29	0.00	12.80	0.00
2- 7	6.63	-1.36	-0.68	-0.29	0.00	10.94	0.00
2- 8	4.17	-1.35	-0.68	-0.29	0.00	8.11	0.00
2- 9	0.72	-1.35	-0.68	-0.29	0.00	4.56	-1.25
2-10	-3.71	-1.35	-0.67	-0.29	0.00	0.99	-5.28
TOP SLAB RIGHT SIDE							
BOTTOM SLAB LEFT SIDE							
4- 0	-5.44	-1.53	-0.76	-0.29	0.00	0.00	-7.44
4- 1	0.26	-1.53	-0.76	-0.29	0.00	0.83	-0.80
4- 2	4.69	-1.53	-0.77	-0.29	0.00	4.61	0.00
4- 3	7.85	-1.53	-0.77	-0.29	0.00	8.24	0.00
4- 4	9.75	-1.54	-0.77	-0.29	0.00	10.40	0.00
4- 5	10.38	-1.54	-0.77	-0.29	0.00	11.10	0.00
4- 6	9.74	-1.54	-0.77	-0.29	0.00	10.39	0.00
4- 7	7.84	-1.54	-0.77	-0.29	0.00	8.23	0.00
4- 8	4.68	-1.54	-0.77	-0.29	0.00	4.59	0.00
4- 9	0.25	-1.55	-0.77	-0.29	0.00	0.84	-0.83
4-10	-5.45	-1.55	-0.77	-0.29	0.00	0.00	-7.47
BOTTOM SLAB RIGHT SIDE							

Current Live Load: HL-93-TRUCK

Unfactored SHEARS (per unit design width)
due to Dead and Live Loads including Distribution and Impact

M-PT	Dead Load	Soil Press (Max)	Soil Press (Min)	Surch Hgt.	Water Press (Max)	LIVE LOADS Pos	Neg
	K	K	K	K	K	K	K
EXTERIOR WALL BOTTOM							
1- 0	0.19	2.31	1.15	0.38	0.00	0.93	-0.31
1- 1	0.19	1.71	0.86	0.30	0.00	0.93	-0.31
1- 2	0.19	1.17	0.58	0.23	0.00	0.93	-0.31
1- 3	0.19	0.67	0.33	0.15	0.00	0.93	-0.31
1- 4	0.19	0.22	0.11	0.08	0.00	0.93	-0.31
1- 5	0.19	-0.19	-0.09	0.00	0.00	0.93	-0.31
1- 6	0.19	-0.54	-0.27	-0.08	0.00	0.93	-0.31
1- 7	0.19	-0.84	-0.42	-0.15	0.00	0.93	-0.31
1- 8	0.19	-1.10	-0.55	-0.23	0.00	0.93	-0.31
1- 9	0.19	-1.31	-0.65	-0.30	0.00	0.93	-0.31
1-10	0.19	-1.47	-0.73	-0.38	0.00	0.93	-0.31
EXTERIOR WALL TOP							
TOP SLAB LEFT SIDE							
2- 0	3.32	0.00	0.00	0.00	0.00	5.14	0.00
2- 1	2.66	0.00	0.00	0.00	0.00	4.36	-0.37
2- 2	1.99	0.00	0.00	0.00	0.00	3.87	-0.82
2- 3	1.33	0.00	0.00	0.00	0.00	3.33	-1.31
2- 4	0.66	0.00	0.00	0.00	0.00	2.76	-1.87
2- 5	0.00	0.00	0.00	0.00	0.00	2.18	-2.45
2- 6	-0.66	0.00	0.00	0.00	0.00	1.60	-3.03
2- 7	-1.33	0.00	0.00	0.00	0.00	1.07	-3.59
2- 8	-1.99	0.00	0.00	0.00	0.00	0.58	-4.10
2- 9	-2.65	0.00	0.00	0.00	0.00	0.18	-4.56
2-10	-3.32	0.00	0.00	0.00	0.00	0.00	-5.11
TOP SLAB RIGHT SIDE							
BOTTOM SLAB LEFT SIDE							
4- 0	4.27	0.00	0.00	0.00	0.00	4.97	0.00
4- 1	3.41	0.00	0.00	0.00	0.00	3.98	0.00
4- 2	2.56	0.00	0.00	0.00	0.00	2.99	0.00
4- 3	1.71	0.00	0.00	0.00	0.00	2.00	0.00
4- 4	0.85	0.00	0.00	0.00	0.00	1.01	0.00
4- 5	0.00	0.00	0.00	0.00	0.00	0.06	-0.06
4- 6	-0.85	0.00	0.00	0.00	0.00	0.00	-1.02
4- 7	-1.71	0.00	0.00	0.00	0.00	0.00	-2.01
4- 8	-2.56	0.00	0.00	0.00	0.00	0.00	-3.00
4- 9	-3.41	0.00	0.00	0.00	0.00	0.00	-3.99
4-10	-4.27	0.00	0.00	0.00	0.00	0.00	-4.98
BOTTOM SLAB RIGHT SIDE							

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Current Live Load: HL-93-TRUCK

Unfactored AXIAL FORCES (per unit design width)
due to Dead and Live Loads including Distribution and Impact

M-PT	Dead Load	Soil Press (Max)	Soil Press (Min)	Surch Hgt.	Water Press (Max)	LIVE LOADS Pos	Neg
	K	K	K	K	K	K	K
EXTERIOR WALL BOTTOM							
1- 0	-3.32	0.00	0.00	0.00	0.00	0.00	-4.96
1- 1	-3.32	0.00	0.00	0.00	0.00	0.00	-4.96
1- 2	-3.32	0.00	0.00	0.00	0.00	0.00	-4.96
1- 3	-3.32	0.00	0.00	0.00	0.00	0.00	-4.96
1- 4	-3.32	0.00	0.00	0.00	0.00	0.00	-4.96
1- 5	-3.32	0.00	0.00	0.00	0.00	0.00	-4.96
1- 6	-3.32	0.00	0.00	0.00	0.00	0.00	-4.96
1- 7	-3.32	0.00	0.00	0.00	0.00	0.00	-4.96
1- 8	-3.32	0.00	0.00	0.00	0.00	0.00	-4.96
1- 9	-3.32	0.00	0.00	0.00	0.00	0.00	-4.96
1-10	-3.32	0.00	0.00	0.00	0.00	0.00	-4.96
EXTERIOR WALL TOP							
TOP SLAB LEFT SIDE							
2- 0	0.19	-1.47	-0.73	-0.38	0.00	0.84	-0.31
2- 1	0.19	-1.47	-0.73	-0.38	0.00	0.84	-0.31
2- 2	0.19	-1.47	-0.73	-0.38	0.00	0.84	-0.31
2- 3	0.19	-1.47	-0.73	-0.38	0.00	0.84	-0.31
2- 4	0.19	-1.47	-0.73	-0.38	0.00	0.84	-0.31
2- 5	0.19	-1.47	-0.73	-0.38	0.00	0.84	-0.31
2- 6	0.19	-1.47	-0.73	-0.38	0.00	0.84	-0.31
2- 7	0.19	-1.47	-0.73	-0.38	0.00	0.84	-0.31
2- 8	0.19	-1.47	-0.73	-0.38	0.00	0.84	-0.31
2- 9	0.19	-1.47	-0.73	-0.38	0.00	0.84	-0.31
2-10	0.19	-1.47	-0.73	-0.38	0.00	0.84	-0.31
TOP SLAB RIGHT SIDE							
BOTTOM SLAB LEFT SIDE							
4- 0	-0.19	-2.31	-1.15	-0.38	0.00	0.31	-0.84
4- 1	-0.19	-2.31	-1.15	-0.38	0.00	0.31	-0.84
4- 2	-0.19	-2.31	-1.15	-0.38	0.00	0.31	-0.84
4- 3	-0.19	-2.31	-1.15	-0.38	0.00	0.31	-0.84
4- 4	-0.19	-2.31	-1.15	-0.38	0.00	0.31	-0.84
4- 5	-0.19	-2.31	-1.15	-0.38	0.00	0.31	-0.84
4- 6	-0.19	-2.31	-1.15	-0.38	0.00	0.31	-0.84
4- 7	-0.19	-2.31	-1.15	-0.38	0.00	0.31	-0.84
4- 8	-0.19	-2.31	-1.15	-0.38	0.00	0.31	-0.84
4- 9	-0.19	-2.31	-1.15	-0.38	0.00	0.31	-0.84
4-10	-0.19	-2.31	-1.15	-0.38	0.00	0.31	-0.84
BOTTOM SLAB RIGHT SIDE							

Factors for Ductility 1.00
Redundancy 1.00
Operations 1.00

Fatigue Checks

$f_s <= f_f = 24 - 0.33 f_{min}$ (5.5.3.2-1)

where:

f_s = actual stress range in the reinforcement

f_f = maximum allowable stress range

Member	Location	f_{min} (kip)	f_f (kip)	f_s (kip)	Result
EXTERIOR WALL	Top	-175.42	24057.89	8104.83	Pass
TOP SLAB	Left	-39.68	23986.90	2937.68	Pass
TOP SLAB	Middle -	-39.68	23986.90	2953.58	Pass
BOTTOM SLAB	Left	-39.68	23986.90	2679.04	Pass
BOTTOM SLAB	Middle -	-39.68	23986.90	2572.06	Pass

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LRFD Crack Control Computation

Current Vehicle: AASHTO LRFD HL-93 Design Truck (US)

Location	γ_e	h (in.)	d_c (in.)	β_s	Max Spacing ()	Current Spacing (in.)	Allowable Stress ()	Actual Stress (kip)
Top slab, outside corner	$0.8*f_r > f_c$, therefore no check necessary.							
Top slab, inside face	0.75000000	12.00000000	2.00000000	1.28571427	9.16352463	6.00000000	40.83333969	31.02006149
Top slab, outside face	$0.8*f_r > f_c$, therefore no check necessary.							
Bottom slab, outside corner	$0.8*f_r > f_c$, therefore no check necessary.							
Bottom slab, inside face	0.75000000	12.00000000	2.00000000	1.28571427	7.53264618	5.00000000	45.37036896	35.40673447
Bottom slab, outside face	$0.8*f_r > f_c$, therefore no check necessary.							
Ext. wall, outside face	0.75000000	10.00000000	2.00000000	1.35714281	23.59597588	6.00000000	38.68421173	14.01806259
Ext. wall, inside face	$0.8*f_r > f_c$, therefore no check necessary.							

```
Lateral Distribution Steel:
  Span Length                              =   14.833 feet
  Percentage of main reinforcement required =   25.965% , less than or equal to 50%
  Main reinforcement area (top slab)       =    0.880 in^2
  Required lateral distribution area       =    0.228 in^2
  Main reinforcement area (bottom slab)    =    0.744 in^2
  Required lateral distribution area       =    0.193 in^2
  Because the required area is less than the minimum, an area of steel of   0.200 in^2 is used.


 Bar sizes and spacings with computed areas of steel

 Areas of steel are in in2/ft

                              Top slab
LEFT SIDE                     CENTER                        RIGHT SIDE
area  0.8800 in2              area  0.8800 in2             area  0.8800 in2
size  6 spaced at   6.00 in.  size  6 spaced at   6.00 in.  size  6 spaced at   6.00 in.
*******************************************************************************

 Exterior wall
TOP
area  0.8800 in2
size  6 spaced at   6.00 in.


OUTSIDE FACE
area  0.8800 in2
size  6 spaced at   6.00 in.

INSIDE FACE
area  0.2667 in2
size  4 spaced at   9.00 in.


BOTTOM
area  0.8800 in2
size  6 spaced at   6.00 in.
*******************************************************************************

                            Bottom slab
LEFT SIDE                     CENTER                        RIGHT SIDE
area  0.8800 in2              area  0.7440 in2             area  0.8800 in2
size  6 spaced at   6.00 in.  size  5 spaced at   5.00 in.  size  6 spaced at   6.00 in.
```

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Serviceability, Fatigue, and Other Checks

Based on crack control check
AASHTO 5.7.3.4 LRFD

Slenderness check on walls passed
Eccentricity check on walls passed

Reinforcing Bar Stresses Sizes and Spacing

Note: Bar stresses are based on bending and axial stress only
Stresses are in ksi
Area of steel in square inches per ft
Spacing and H and V legs are in inches

Bar Mark	Description
A1	Top Corner Outside face Max Neg Moment
A100	Top Slab Inside face Max Pos Moment
A300	Top Slab Outside face Max Neg Moment Interior support
A2	Bottom Corner Outside face Max Neg Moment
A200	Bottom Slab Inside face Max Pos Moment
A400	Bottom Slab Outside face Max Neg Moment Interior support
B2	Exterior Wall Outside face Max Neg Moment
B1	Exterior Wall Inside face Max Pos Moment
B3	Interior Wall Both faces

Bar Type	Fs Act. (Ksi)	Fs All. (Ksi)	Area steel Input (In2)	Area steel Provided (In2)	Size US Bars	Spacing (In)	H (In)
A1	5.79	0.00	0.8800	0.8800	6	6.0	68
A2	7.25	31.02	0.8800	0.8800	6	6.0	41
A100	31.02	40.83	0.8800	0.8800	6	6.0	
A200	35.41	45.37	0.7440	0.7440	5	5.0	
B1	0.00	14.02	0.2667	0.2667	4	9.0	
B2	14.02	38.68	0.8800	0.8800	6	6.0	

Notes:

1. Area of steel is the maximum required for all limit states. The strength computations are shown in the results at critical sections table.

2. Design thickness shown in the following table is based on the appropriate cover minus half the diameter of the bar in the above table or one-half the diameter of a #6 bar. The actual half bar diameter is used once the steel has been selected and the #6 bar is used in design iterations.

3. For a Design review run the actual bar stresses shown can be the stress at either side of a member corner or the stress at the middle of the slab for a multiple cell group. The required As is actual in a Design review.

4. If the user wishes to ignore crack control the allowable steel stress is set at 0.95 Fy. This limit will likely not control the design, but it if should, this will control yielding under service loads.

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Output at Critical Sections (per unit design width)

Member No. = 1 EXTERIOR WALL
Thickness = 10.00 (in)
Clear cover at end = 2.00 (in)
Clear cover at middle = 2.00 (in)
Bar diameter (bot) = 0.75 (in)
Bar diameter (mid+) = 0.50 (in)
Bar diameter (mid-) = 0.75 (in)
Bar diameter (top) = 0.75 (in)

	Moment	Coin. Axial Force	Shear Force	Shear Cap	Resistance Po Cap	Mu Cap	Mbal Cap	Pbal Cap	Steel Area	Mom. Cap	Des. Thk	Design Ratio
	Kft	Kips	Kips	Kips	Kips	Kft	Kft	Kips	In2	Kft	in	
BOT	-15.5	12.0	4.4	20.2	389.0	31.3	48.5	105.1	0.8800	31.7	7.62	n/a
MID	1.6	12.0	1.6	46.0	368.8	10.1	42.4	136.9	0.2667	10.4	7.75	0.1
MID-	-9.8	12.0	0.7	26.1	389.0	31.3	48.5	105.1	0.8800	31.7	7.62	n/a
TOP	-12.2	12.0	2.6	23.0	389.0	31.3	48.5	105.1	0.8800	31.7	7.62	n/a

Member No. = 2 TOP SLAB
Thickness = 12.00 (in)
Clear cover at end = 2.00 (in)
Clear cover at middle = 2.00 (in)
Bar diameter (lt) = 0.75 (in)
Bar diameter (mid) = 0.75 (in)
Bar diameter (rt) = 0.75 (in)

LT	-6.4	3.0	10.6	27.7	461.0	40.1	70.4	143.7	0.8800	40.1	9.62	n/a
MID	30.3	3.1	3.8	19.5	461.0	40.1	70.4	143.7	0.8800	40.1	9.62	0.8
RT	-6.4	3.0	10.6	15.8	461.0	40.1	70.4	143.7	0.8800	40.1	9.62	n/a

Member No. = 4 BOTTOM SLAB
Thickness = 12.00 (in)
Clear cover at end = 2.00 (in)
Clear cover at middle = 2.00 (in)
Bar diameter (lt) = 0.75 (in)
Bar diameter (mid) = 0.62 (in)
Bar diameter (rt) = 0.75 (in)

LT	-7.5	5.4	10.8	28.2	461.0	40.1	70.4	143.7	0.8800	40.2	9.62	n/a
MID	27.7	5.4	0.1	20.4	456.6	34.4	68.8	151.4	0.7440	34.5	9.69	0.8
RT	-7.6	5.4	10.8	16.3	461.0	40.1	70.4	143.7	0.8800	40.2	9.62	n/a

Warnings:

1. For exterior corners, BRASS-CULVERT does not perform a check on both the exterior wall and top or bottom slab. BRASS-CULVERT only checks the location that it has determined requires a greater area of steel. Because of this, BRASS-CULVERT may check one location for a particular culvert (e.g. top of the wall) and a different location (e.g. left end of top slab) for the same culvert with a different depth of fill.

2. If the flexural resistance is zero and rebar has been entered, it could be due to the axial load being higher than the tensile capacity of the rebar provide. For example, the axial load is greater than the area of steel times the yield strength of the bars.

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Notes:

1. Flexure rating value of n/a indicates no live load effect on the member

2. SS value adjacent to steel area indicates a simply supported culvert and a steel area is not required

3. AASHTO LRFD Sec. 5.7.4 with 94-99 Interims
   - Po -- Axial capacity at zero eccentricity (no moment)
   - Mu -- Flexural Capacity without an axial load
   - Pbal -- Axial load at balanced strain
   - Mbal -- Moment at balanced state of strain

4. Coin. is the coincident axial force

5. The plane of computation for shear is a "d" distance from the face of the supporting member

6. The plane of computation for moment if haunches are used is based on AASHTO 8.8.2

7. The plane of computation for moment if haunches are not used is based on the user input

8. An asterisk next to the Design Moment indicates the Moment is greater than the All Mom. Value

9. An asterisk next to the Shear Value indicates the Shear is greater than the Allowable Shear

10. Rating factors computations consider the effect of axial force. The Allowable Moment value is used with the maximum soil pressure.

11. The load combinations and envelope of critical action combinations are shown in the C:\Brass 2.3.0\CULVERT\Examples\SD Ireland - Wardsboro Bridge No 70.ooo file.

12. For fills less than 2.0 feet, Article 5.14.4.1 applies, and shear is assumed to adequate because the section has been designed for moment.

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Factored Actions for Load and Resistance Factor Design at Tenth Points (per unit design width)

M-Pt	+Moment (Kft)	-Moment (Kft)	+A.F. (Kips)	-A.F. (Kips)	+Shear (Kips)	-Shear (Kips)
EXTERIOR WALL BOTTOM						
1- 0	-5.867	-21.017	-2.327	-12.004	5.595	1.662
1- 1	-3.280	-16.563	-2.327	-12.003	4.658	1.125
1- 2	-0.998	-13.766	-2.327	-12.003	3.786	0.632
1- 3	0.528	-11.525	-2.327	-12.003	2.980	0.183
1- 4	1.359	-9.801	-2.327	-12.003	2.240	-0.222
1- 5	1.552	-8.794	-2.327	-12.003	1.648	-0.667
1- 6	1.169	-9.410	-2.327	-12.003	1.331	-1.276
1- 7	0.266	-10.294	-2.327	-12.003	1.056	-1.820
1- 8	-1.096	-11.405	-2.327	-12.003	0.826	-2.298
1- 9	-2.262	-12.759	-2.327	-12.004	0.639	-2.710
1-10	-2.806	-15.277	-2.327	-12.004	0.497	-3.057
EXTERIOR WALL TOP						
TOP SLAB LEFT SIDE						
2- 0	-2.806	-15.277	-0.367	-2.998	12.306	2.326
2- 1	6.847	-4.023	-0.310	-3.055	10.277	1.214
2- 2	16.540	0.000	-0.310	-3.055	8.765	-0.040
2- 3	23.988	0.000	-0.310	-3.055	7.154	-1.364
2- 4	28.668	0.000	-0.310	-3.055	5.494	-2.806
2- 5	30.285	0.000	-0.310	-3.055	3.810	-4.280
2- 6	28.659	0.000	-0.310	-3.055	2.343	-5.960
2- 7	23.941	0.000	-0.310	-3.055	0.947	-7.604
2- 8	16.524	0.000	-0.310	-3.055	-0.373	-9.168
2- 9	6.871	-4.009	-0.310	-3.055	-1.546	-10.626
2-10	-2.679	-15.263	-0.367	-2.998	-2.322	-12.251
TOP SLAB RIGHT SIDE						
BOTTOM SLAB LEFT SIDE						
4- 0	-5.867	-21.017	-2.702	-5.448	12.962	2.985
4- 1	-0.352	-3.785	-2.759	-5.391	10.377	2.387
4- 2	10.671	0.000	-2.759	-5.391	7.793	1.790
4- 3	20.180	0.000	-2.759	-5.391	5.209	1.192
4- 4	25.856	0.000	-2.759	-5.391	2.624	0.595
4- 5	27.703	0.000	-2.759	-5.391	0.097	-0.102
4- 6	25.840	0.000	-2.759	-5.391	-0.599	-2.635
4- 7	20.148	0.000	-2.759	-5.391	-1.197	-5.219
4- 8	10.621	0.000	-2.759	-5.391	-1.794	-7.804
4- 9	-0.365	-3.876	-2.759	-5.391	-2.392	-10.388
4-10	-5.905	-21.104	-2.702	-5.448	-2.989	-12.973
BOTTOM SLAB RIGHT SIDE						

Output complete for a HL-93-TRUCK vehicle

LRFD Live Load Distribution Factor Computation

Input Values

Depth of Fill	= 1.99 ft.	
Span Length	= 14.00 ft.	$= D_i$
Truck Gage	= 6.00 ft.	$= s_w$
Soil Distribution Factor	= 1.15	
Tire Patch Width	= 20.00 in.	$= w_t$
Bridge Width	= 60.00 ft.	
Length	= 4.50 ft.	

Compute Strip Width by 4.6.2.10.2-1

E = 96 + 1.44 S ft
E = 96 + 1.44 (14.00 ft.)
E = 9.68 ft.

Controlling Distribution Factor

Final Strip Width = 9.68 ft.

Final Distribution Factor = 1/Final Strip Width = **0.10** Lanes per ft. of width

Multiple Presence Factor = 1.20

Distribution Factor * Multiple Presence Factor = **0.12**

Notes:

1. Only the one lane loaded case is considered for 4.6.2.10, which provides an upper bound on the distribution plus multiple presence factor for all cases. The one lane loaded multiple presence factor is used.

See 12.11.2.1, 3.6.1.3.3, and 4.6.2.10.

2. Lane loads are not applied. See 3.6.1.3.3. This applies to all approximate strip methods.
3. The distribution factor for fills of 2 feet or greater is bounded by the distribution factor computed in 4.6.2.10. See 3.6.1.2.6.

For a HL-93-TANDEM Vehicle
Description AASHTO LRFD HL-93 Design Tandem (US)
The Number of axles = 2

	Axle Weights (kips)	Spacing (ft)
	25.00	4.000
	25.00	0.000
Totals	50.00	4.000

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For a HL-93-TANDEM Vehicle
Description AASHTO LRFD HL-93 Design Tandem (US)

The number of simulated axles based on fill = 2

The number of simulated axles is calculated based on the longitudinal distribution length of each axle divided by the simulated axle spacing of 1 foot and the simulated axle weights are calculated by dividing the vehicle axle weights by the number of simulated axles per vehicle axle.

	Truck facing backwards		Truck facing forward	
	Axle wts. (kips)	Spacing (ft)	Axle wts. (kips)	Spacing (ft)
	25.00	0.000	25.00	0.000
	25.00	4.000	25.00	4.000
Totals	50.00	4.000	50.00	4.000

Note: Impact or distribution is not included in the above table.

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Current Live Load: HL-93-TANDEM

Unfactored MOMENTS (per unit design width)
due to Dead and Live Loads including Distribution and Impact

M-PT	Dead Load	Soil Press (Max)	Soil Press (Min)	Surch Hgt.	Water Press (Max)	LIVE LOADS Pos	LIVE LOADS Neg
	Kft	Kft	Kft	Kft	Kft	Kft	Kft
EXTERIOR WALL BOTTOM							
1- 0	-5.44	-1.53	-0.76	-0.29	0.00	0.00	-5.43
1- 1	-5.26	0.28	0.14	0.02	0.00	0.00	-5.04
1- 2	-5.09	1.57	0.79	0.25	0.00	0.00	-4.80
1- 3	-4.92	2.39	1.20	0.42	0.00	0.00	-5.04
1- 4	-4.75	2.79	1.39	0.53	0.00	0.00	-5.36
1- 5	-4.58	2.80	1.40	0.56	0.00	0.00	-5.69
1- 6	-4.41	2.47	1.23	0.53	0.00	0.00	-6.02
1- 7	-4.23	1.84	0.92	0.42	0.00	0.00	-6.35
1- 8	-4.06	0.97	0.48	0.25	0.00	0.00	-6.67
1- 9	-3.89	-0.12	-0.06	0.02	0.00	0.21	-7.00
1-10	-3.72	-1.37	-0.69	-0.29	0.00	0.55	-7.33
EXTERIOR WALL TOP							
TOP SLAB LEFT SIDE							
2- 0	-3.72	-1.37	-0.69	-0.29	0.00	0.55	-7.33
2- 1	0.71	-1.37	-0.68	-0.29	0.00	3.45	-1.41
2- 2	4.16	-1.37	-0.68	-0.29	0.00	8.59	0.00
2- 3	6.62	-1.36	-0.68	-0.29	0.00	12.43	0.00
2- 4	8.10	-1.36	-0.68	-0.29	0.00	14.47	0.00
2- 5	8.60	-1.36	-0.68	-0.29	0.00	14.61	0.00
2- 6	8.10	-1.36	-0.68	-0.29	0.00	14.30	0.00
2- 7	6.63	-1.36	-0.68	-0.29	0.00	12.28	0.00
2- 8	4.17	-1.35	-0.68	-0.29	0.00	8.44	0.00
2- 9	0.72	-1.35	-0.68	-0.29	0.00	3.59	-1.42
2-10	-3.71	-1.35	-0.67	-0.29	0.00	0.57	-7.35
TOP SLAB RIGHT SIDE							
BOTTOM SLAB LEFT SIDE							
4- 0	-5.44	-1.53	-0.76	-0.29	0.00	0.00	-5.43
4- 1	0.26	-1.53	-0.76	-0.29	0.00	1.09	-0.31
4- 2	4.69	-1.53	-0.77	-0.29	0.00	5.05	0.00
4- 3	7.85	-1.53	-0.77	-0.29	0.00	7.88	0.00
4- 4	9.75	-1.54	-0.77	-0.29	0.00	9.57	0.00
4- 5	10.38	-1.54	-0.77	-0.29	0.00	10.14	0.00
4- 6	9.74	-1.54	-0.77	-0.29	0.00	9.58	0.00
4- 7	7.84	-1.54	-0.77	-0.29	0.00	7.89	0.00
4- 8	4.68	-1.54	-0.77	-0.29	0.00	5.06	0.00
4- 9	0.25	-1.55	-0.77	-0.29	0.00	1.10	-0.30
4-10	-5.45	-1.55	-0.77	-0.29	0.00	0.00	-5.47
BOTTOM SLAB RIGHT SIDE							

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Current Live Load: HL-93-TANDEM

Unfactored SHEARS (per unit design width)
due to Dead and Live Loads including Distribution and Impact

M-PT	Dead Load	Soil Press (Max)	Soil Press (Min)	Surch Hgt.	Water Press (Max)	LIVE Pos	LOADS Neg
	K	K	K	K	K	K	K
EXTERIOR WALL BOTTOM							
1- 0	0.19	2.31	1.15	0.38	0.00	0.45	-0.37
1- 1	0.19	1.71	0.86	0.30	0.00	0.45	-0.37
1- 2	0.19	1.17	0.58	0.23	0.00	0.45	-0.37
1- 3	0.19	0.67	0.33	0.15	0.00	0.45	-0.37
1- 4	0.19	0.22	0.11	0.08	0.00	0.45	-0.37
1- 5	0.19	-0.19	-0.09	0.00	0.00	0.45	-0.37
1- 6	0.19	-0.54	-0.27	-0.08	0.00	0.45	-0.37
1- 7	0.19	-0.84	-0.42	-0.15	0.00	0.45	-0.37
1- 8	0.19	-1.10	-0.55	-0.23	0.00	0.45	-0.37
1- 9	0.19	-1.31	-0.65	-0.30	0.00	0.45	-0.37
1-10	0.19	-1.47	-0.73	-0.38	0.00	0.45	-0.37
EXTERIOR WALL TOP							
TOP SLAB LEFT SIDE							
2- 0	3.32	0.00	0.00	0.00	0.00	6.81	0.00
2- 1	2.66	0.00	0.00	0.00	0.00	5.70	-0.28
2- 2	1.99	0.00	0.00	0.00	0.00	4.87	-0.63
2- 3	1.33	0.00	0.00	0.00	0.00	3.99	-1.12
2- 4	0.66	0.00	0.00	0.00	0.00	3.12	-1.86
2- 5	0.00	0.00	0.00	0.00	0.00	2.27	-2.65
2- 6	-0.66	0.00	0.00	0.00	0.00	1.48	-3.52
2- 7	-1.33	0.00	0.00	0.00	0.00	0.83	-4.40
2- 8	-1.99	0.00	0.00	0.00	0.00	0.46	-5.26
2- 9	-2.65	0.00	0.00	0.00	0.00	0.14	-6.06
2-10	-3.32	0.00	0.00	0.00	0.00	0.00	-6.78
TOP SLAB RIGHT SIDE							
BOTTOM SLAB LEFT SIDE							
4- 0	4.27	0.00	0.00	0.00	0.00	3.93	0.00
4- 1	3.41	0.00	0.00	0.00	0.00	3.15	0.00
4- 2	2.56	0.00	0.00	0.00	0.00	2.38	0.00
4- 3	1.71	0.00	0.00	0.00	0.00	1.61	0.00
4- 4	0.85	0.00	0.00	0.00	0.00	0.83	0.00
4- 5	0.00	0.00	0.00	0.00	0.00	0.06	-0.06
4- 6	-0.85	0.00	0.00	0.00	0.00	0.00	-0.83
4- 7	-1.71	0.00	0.00	0.00	0.00	0.00	-1.61
4- 8	-2.56	0.00	0.00	0.00	0.00	0.00	-2.38
4- 9	-3.41	0.00	0.00	0.00	0.00	0.00	-3.15
4-10	-4.27	0.00	0.00	0.00	0.00	0.00	-3.93
BOTTOM SLAB RIGHT SIDE							

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Current Live Load: HL-93-TANDEM

Unfactored AXIAL FORCES (per unit design width)
due to Dead and Live Loads including Distribution and Impact

M-PT	Dead Load	Soil Press (Max)	Soil Press (Min)	Surch Hgt.	Water Press (Max)	LIVE Pos	LOADS Neg
	K	K	K	K	K	K	K
EXTERIOR WALL BOTTOM							
1- 0	-3.32	0.00	0.00	0.00	0.00	0.00	-6.81
1- 1	-3.32	0.00	0.00	0.00	0.00	0.00	-6.81
1- 2	-3.32	0.00	0.00	0.00	0.00	0.00	-6.81
1- 3	-3.32	0.00	0.00	0.00	0.00	0.00	-6.81
1- 4	-3.32	0.00	0.00	0.00	0.00	0.00	-6.81
1- 5	-3.32	0.00	0.00	0.00	0.00	0.00	-6.81
1- 6	-3.32	0.00	0.00	0.00	0.00	0.00	-6.81
1- 7	-3.32	0.00	0.00	0.00	0.00	0.00	-6.81
1- 8	-3.32	0.00	0.00	0.00	0.00	0.00	-6.81
1- 9	-3.32	0.00	0.00	0.00	0.00	0.00	-6.81
1-10	-3.32	0.00	0.00	0.00	0.00	0.00	-6.81
EXTERIOR WALL TOP							
TOP SLAB LEFT SIDE							
2- 0	0.19	-1.47	-0.73	-0.38	0.00	0.39	-0.37
2- 1	0.19	-1.47	-0.73	-0.38	0.00	0.39	-0.37
2- 2	0.19	-1.47	-0.73	-0.38	0.00	0.39	-0.37
2- 3	0.19	-1.47	-0.73	-0.38	0.00	0.39	-0.37
2- 4	0.19	-1.47	-0.73	-0.38	0.00	0.39	-0.37
2- 5	0.19	-1.47	-0.73	-0.38	0.00	0.39	-0.37
2- 6	0.19	-1.47	-0.73	-0.38	0.00	0.39	-0.37
2- 7	0.19	-1.47	-0.73	-0.38	0.00	0.39	-0.37
2- 8	0.19	-1.47	-0.73	-0.38	0.00	0.39	-0.37
2- 9	0.19	-1.47	-0.73	-0.38	0.00	0.39	-0.37
2-10	0.19	-1.47	-0.73	-0.38	0.00	0.39	-0.37
TOP SLAB RIGHT SIDE							
BOTTOM SLAB LEFT SIDE							
4- 0	-0.19	-2.31	-1.15	-0.38	0.00	0.37	-0.39
4- 1	-0.19	-2.31	-1.15	-0.38	0.00	0.37	-0.39
4- 2	-0.19	-2.31	-1.15	-0.38	0.00	0.37	-0.39
4- 3	-0.19	-2.31	-1.15	-0.38	0.00	0.37	-0.39
4- 4	-0.19	-2.31	-1.15	-0.38	0.00	0.37	-0.39
4- 5	-0.19	-2.31	-1.15	-0.38	0.00	0.37	-0.39
4- 6	-0.19	-2.31	-1.15	-0.38	0.00	0.37	-0.39
4- 7	-0.19	-2.31	-1.15	-0.38	0.00	0.37	-0.39
4- 8	-0.19	-2.31	-1.15	-0.38	0.00	0.37	-0.39
4- 9	-0.19	-2.31	-1.15	-0.38	0.00	0.37	-0.39
4-10	-0.19	-2.31	-1.15	-0.38	0.00	0.37	-0.39
BOTTOM SLAB RIGHT SIDE							

Factors for Ductility 1.00
Redundancy 1.00
Operations 1.00

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Fatigue Checks

$f_s <= f_f = 24 - 0.33 f_{min}$ (5.5.3.2-1)

where:

f_s = actual stress range in the reinforcement

f_f = maximum allowable stress range

Member	Location	f_{min} (kip)	f_f (kip)	f_s (kip)	Result
EXTERIOR WALL	Top	-145.45	24048.00	11674.01	Pass
TOP SLAB	Left	-56.65	23981.31	3743.64	Pass
TOP SLAB	Middle -	-56.65	23981.31	3754.09	Pass
BOTTOM SLAB	Left	-56.65	23981.31	1677.61	Pass
BOTTOM SLAB	Middle -	-56.65	23981.31	1679.51	Pass

LRFD Crack Control Computation

Current Vehicle: AASHTO LRFD HL-93 Design Tandem (US)

Location	γ_e	h (in.)	d_c (in.)	β_s	Max Spacing ()	Current Spacing (in.)	Allowable Stress ()	Actual Stress (kip)
Top slab, outside corner	$0.8*f_r > f_c$, therefore no check necessary.							
Top slab, inside face	0.75000000	12.00000000	2.00000000	1.28571427	8.48390961	6.00000000	40.83333969	32.70877075
Top slab, outside face	$0.8*f_r > f_c$, therefore no check necessary.							
Bottom slab, outside corner	$0.8*f_r > f_c$, therefore no check necessary.							
Bottom slab, inside face	0.75000000	12.00000000	2.00000000	1.28571427	8.09125423	5.00000000	45.37036896	33.77096558
Bottom slab, outside face	$0.8*f_r > f_c$, therefore no check necessary.							
Ext. wall, outside face	0.75000000	10.00000000	2.00000000	1.35714281	19.90759468	6.00000000	38.68421173	16.18072128
Ext. wall, inside face	$0.8*f_r > f_c$, therefore no check necessary.							

Lateral Distribution Steel:
Span Length = 14.833 feet
Percentage of main reinforcement required = 25.965% , less than or equal to 50%
Main reinforcement area (top slab) = 0.880 in^2
Required lateral distribution area = 0.228 in^2
Main reinforcement area (bottom slab) = 0.744 in^2
Required lateral distribution area = 0.193 in^2
Because the required area is less than the minimum, an area of steel of 0.200 in^2 is used.

Bar sizes and spacings with computed areas of steel

Areas of steel are in in2/ft

Top slab

LEFT SIDE	CENTER	RIGHT SIDE
area 0.8800 in2	area 0.8800 in2	area 0.8800 in2
size 6 spaced at 6.00 in.	size 6 spaced at 6.00 in.	size 6 spaced at 6.00 in.

****

Exterior wall
TOP
area 0.8800 in2
size 6 spaced at 6.00 in.

OUTSIDE FACE
area 0.8800 in2
size 6 spaced at 6.00 in.

INSIDE FACE
area 0.2667 in2
size 4 spaced at 9.00 in.

BOTTOM
area 0.8800 in2
size 6 spaced at 6.00 in.

****

Bottom slab

LEFT SIDE	CENTER	RIGHT SIDE
area 0.8800 in2	area 0.7440 in2	area 0.8800 in2
size 6 spaced at 6.00 in.	size 5 spaced at 5.00 in.	size 6 spaced at 6.00 in.

Serviceability, Fatigue, and Other Checks

Based on crack control check
AASHTO 5.7.3.4 LRFD

Slenderness check on walls passed
Eccentricity check on walls passed

Reinforcing Bar Stresses Sizes and Spacing

Note: Bar stresses are based on bending and axial stress only
Stresses are in ksi
Area of steel in square inches per ft
Spacing and H and V legs are in inches

Bar Mark	Description
A1	Top Corner Outside face Max Neg Moment
A100	Top Slab Inside face Max Pos Moment
A300	Top Slab Outside face Max Neg Moment Interior support
A2	Bottom Corner Outside face Max Neg Moment
A200	Bottom Slab Inside face Max Pos Moment
A400	Bottom Slab Outside face Max Neg Moment Interior support
B2	Exterior Wall Outside face Max Neg Moment
B1	Exterior Wall Inside face Max Pos Moment
B3	Interior Wall Both faces

Bar Type	Fs Act. (Ksi)	Fs All. (Ksi)	Area steel Input (In2)	Area steel Provided (In2)	Size US Bars	Spacing (In)	H (In)
A1	6.63	14.02	0.8800	0.8800	6	6.0	68
A2	6.07	32.71	0.8800	0.8800	6	6.0	41
A100	32.71	40.83	0.8800	0.8800	6	6.0	
A200	33.77	45.37	0.7440	0.7440	5	5.0	
B1	0.00	16.18	0.2667	0.2667	4	9.0	
B2	16.18	38.68	0.8800	0.8800	6	6.0	

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Output at Critical Sections (per unit design width)

Member No. = 1 EXTERIOR WALL

Thickness = 10.00 (in)
Clear cover at end = 2.00 (in)
Clear cover at middle = 2.00 (in)
Bar diameter (bot) = 0.75 (in)
Bar diameter (mid+) = 0.50 (in)
Bar diameter (mid-) = 0.75 (in)
Bar diameter (top) = 0.75 (in)

	Moment	Coin. Axial Force	Shear Force	Shear Cap	Resistance Po Cap	Mu Cap	Mbal Cap	Pbal Cap	Steel Area	Mom. Cap	Des. Thk	Design Ratio
	Kft	Kips	Kips	Kips	Kips	Kft	Kft	Kips	In2	Kft	in	
BOT	-13.1	15.2	3.6	22.8	389.0	31.3	48.5	105.1	0.8800	31.9	7.62	n/a
MID	1.6	15.2	0.8	53.9	368.8	10.1	42.4	136.9	0.2667	10.5	7.75	0.1
MID-	-12.0	15.2	0.8	25.1	389.0	31.3	48.5	105.1	0.8800	31.9	7.62	n/a
TOP	-15.7	15.2	2.7	21.4	389.0	31.3	48.5	105.1	0.8800	31.9	7.62	n/a

Member No. = 2 TOP SLAB

Thickness = 12.00 (in)
Clear cover at end = 2.00 (in)
Clear cover at middle = 2.00 (in)
Bar diameter (lt) = 0.75 (in)
Bar diameter (mid) = 0.75 (in)
Bar diameter (rt) = 0.75 (in)

LT	-7.4	3.1	13.0	25.4	461.0	40.1	70.4	143.7	0.8800	40.2	9.62	n/a
MID	32.3	3.2	4.0	18.8	461.0	40.1	70.4	143.7	0.8800	40.2	9.62	0.8
RT	-7.4	3.1	13.0	13.6	461.0	40.1	70.4	143.7	0.8800	40.2	9.62	n/a

Member No. = 4 BOTTOM SLAB

Thickness = 12.00 (in)
Clear cover at end = 2.00 (in)
Clear cover at middle = 2.00 (in)
Bar diameter (lt) = 0.75 (in)
Bar diameter (mid) = 0.62 (in)
Bar diameter (rt) = 0.75 (in)

LT	-6.0	4.6	9.3	29.6	461.0	40.1	70.4	143.7	0.8800	40.2	9.62	n/a
MID	26.0	4.6	0.1	21.0	456.6	34.4	68.8	151.4	0.7440	34.5	9.69	0.8
RT	-6.1	4.6	9.3	17.9	461.0	40.1	70.4	143.7	0.8800	40.2	9.62	n/a

Warnings:

1. For exterior corners, BRASS-CULVERT does not perform a check on both the exterior wall and top or bottom slab. BRASS-CULVERT only checks the location that it has determined requires a greater area of steel. Because of this, BRASS-CULVERT may check one location for a particular culvert (e.g. top of the wall) and a different location (e.g. left end of top slab) for the same culvert with a different depth of fill.

2. If the flexural resistance is zero and rebar has been entered, it could be due to the axial load being higher than the tensile capacity of the rebar provide. For example, the axial load is greater than the area of steel times the yield strength of the bars.

Factored Actions for Load and Resistance Factor Design at Tenth Points (per unit design width)

M-Pt	+Moment (Kft)	-Moment (Kft)	+A.F. (Kips)	-A.F. (Kips)	+Shear (Kips)	-Shear (Kips)
EXTERIOR WALL BOTTOM						
1- 0	-5.867	-17.507	-2.327	-15.232	4.754	1.568
1- 1	-3.280	-13.820	-2.327	-15.231	3.817	1.031
1- 2	-0.998	-12.063	-2.327	-15.231	2.945	0.538
1- 3	0.528	-11.579	-2.327	-15.231	2.139	0.089
1- 4	1.359	-11.617	-2.327	-15.231	1.399	-0.316
1- 5	1.552	-12.004	-2.327	-15.231	0.807	-0.761
1- 6	1.169	-12.705	-2.327	-15.231	0.490	-1.370
1- 7	0.266	-13.672	-2.327	-15.231	0.215	-1.914
1- 8	-1.096	-14.866	-2.327	-15.231	-0.015	-2.392
1- 9	-2.496	-16.303	-2.327	-15.232	-0.202	-2.804
1-10	-3.486	-18.904	-2.327	-15.232	-0.344	-3.151
EXTERIOR WALL TOP						
TOP SLAB LEFT SIDE						
2- 0	-3.486	-18.904	-1.170	-3.094	15.232	2.326
2- 1	4.909	-4.326	-1.113	-3.151	12.631	1.365
2- 2	17.343	0.000	-1.113	-3.151	10.513	0.287
2- 3	26.530	0.000	-1.113	-3.151	8.319	-1.021
2- 4	31.564	0.000	-1.113	-3.151	6.124	-2.788
2- 5	32.321	0.000	-1.113	-3.151	3.978	-4.641
2- 6	31.283	0.000	-1.113	-3.151	2.132	-6.822
2- 7	26.281	0.000	-1.113	-3.151	0.530	-9.024
2- 8	17.105	0.000	-1.113	-3.151	-0.594	-11.185
2- 9	5.173	-4.306	-1.113	-3.151	-1.619	-13.257
2-10	-3.413	-18.886	-1.170	-3.094	-2.322	-15.176
TOP SLAB RIGHT SIDE						
BOTTOM SLAB LEFT SIDE						
4- 0	-5.867	-17.507	-2.607	-4.644	11.131	2.985
4- 1	0.101	-2.934	-2.664	-4.587	8.925	2.387
4- 2	11.449	0.000	-2.664	-4.587	6.720	1.790
4- 3	19.556	0.000	-2.664	-4.587	4.515	1.192
4- 4	24.411	0.000	-2.664	-4.587	2.309	0.595
4- 5	26.029	0.000	-2.664	-4.587	0.104	-0.109
4- 6	24.412	0.000	-2.664	-4.587	-0.599	-2.314
4- 7	19.551	0.000	-2.664	-4.587	-1.197	-4.520
4- 8	11.443	0.000	-2.664	-4.587	-1.794	-6.725
4- 9	0.087	-2.953	-2.664	-4.587	-2.392	-8.931
4-10	-5.905	-17.603	-2.607	-4.644	-2.989	-11.136
BOTTOM SLAB RIGHT SIDE						

Output complete for a HL-93-TANDEM vehicle

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LRFD Live Load Distribution Factor Computation

Input Values

Depth of Fill	= 1.99 ft.	
Span Length	= 14.00 ft.	$= D_i$
Truck Gage	= 6.00 ft.	$= s_w$
Soil Distribution Factor	= 1.15	
Tire Patch Width	= 20.00 in.	$= w_t$
Bridge Width	= 60.00 ft.	
Length	= 4.50 ft.	

Compute Strip Width by 4.6.2.10.2-1

E = 96 + 1.44 S ft
E = 96 + 1.44 (14.00 ft.)
E = 9.68 ft.

Controlling Distribution Factor

Final Strip Width = 9.68 ft.

Final Distribution Factor = 1/Final Strip Width = **0.10** Lanes per ft. of width

Multiple Presence Factor = 1.20

Distribution Factor * Multiple Presence Factor = **0.12**

Notes:

1. Only the one lane loaded case is considered for 4.6.2.10, which provides an upper bound on the distribution plus multiple presence factor for all cases. The one lane loaded multiple presence factor is used.

See 12.11.2.1, 3.6.1.3.3, and 4.6.2.10.

2. Lane loads are not applied. See 3.6.1.3.3. This applies to all approximate strip methods.
3. The distribution factor for fills of 2 feet or greater is bounded by the distribution factor computed in 4.6.2.10. See 3.6.1.2.6.

For a HL-93-LANE Vehicle
Description AASHTO LRFD HL-93 Design Lane (US)
The Number of axles = 0

	Axle Weights (kips)	Spacing (ft)
Totals	0.00	0.000

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For a HL-93-LANE Vehicle
Description AASHTO LRFD HL-93 Design Lane (US)

The number of simulated axles based on fill = 1

The number of simulated axles is calculated based on the longitudinal distribution length of each axle divided by the simulated axle spacing of 1 foot and the simulated axle weights are calculated by dividing the vehicle axle weights by the number of simulated axles per vehicle axle.

	Truck facing backwards		Truck facing forward	
	Axle wts. (kips)	Spacing (ft)	Axle wts. (kips)	Spacing (ft)
	0.00	0.000	0.00	0.000
Totals	0.00	0.000	0.00	0.000

Note: Impact or distribution is not included in the above table.

Current Live Load: HL-93-LANE

Unfactored MOMENTS (per unit design width)
due to Dead and Live Loads including Distribution and Impact

M-PT	Dead Load	Soil Press (Max)	Soil Press (Min)	Surch Hgt.	Water Press (Max)	LIVE LOADS Pos	Neg
	Kft	Kft	Kft	Kft	Kft	Kft	Kft
EXTERIOR WALL BOTTOM							
1- 0	-5.44	-1.53	-0.76	-0.29	0.00	0.00	0.00
1- 1	-5.26	0.28	0.14	0.02	0.00	0.00	0.00
1- 2	-5.09	1.57	0.79	0.25	0.00	0.00	0.00
1- 3	-4.92	2.39	1.20	0.42	0.00	0.00	0.00
1- 4	-4.75	2.79	1.39	0.53	0.00	0.00	0.00
1- 5	-4.58	2.80	1.40	0.56	0.00	0.00	0.00
1- 6	-4.41	2.47	1.23	0.53	0.00	0.00	0.00
1- 7	-4.23	1.84	0.92	0.42	0.00	0.00	0.00
1- 8	-4.06	0.97	0.48	0.25	0.00	0.00	0.00
1- 9	-3.89	-0.12	-0.06	0.02	0.00	0.00	0.00
1-10	-3.72	-1.37	-0.69	-0.29	0.00	0.00	0.00
EXTERIOR WALL TOP							
TOP SLAB LEFT SIDE							
2- 0	-3.72	-1.37	-0.69	-0.29	0.00	0.00	0.00
2- 1	0.71	-1.37	-0.68	-0.29	0.00	0.00	0.00
2- 2	4.16	-1.37	-0.68	-0.29	0.00	0.00	0.00
2- 3	6.62	-1.36	-0.68	-0.29	0.00	0.00	0.00
2- 4	8.10	-1.36	-0.68	-0.29	0.00	0.00	0.00
2- 5	8.60	-1.36	-0.68	-0.29	0.00	0.00	0.00
2- 6	8.10	-1.36	-0.68	-0.29	0.00	0.00	0.00
2- 7	6.63	-1.36	-0.68	-0.29	0.00	0.00	0.00
2- 8	4.17	-1.35	-0.68	-0.29	0.00	0.00	0.00
2- 9	0.72	-1.35	-0.68	-0.29	0.00	0.00	0.00
2-10	-3.71	-1.35	-0.67	-0.29	0.00	0.00	0.00
TOP SLAB RIGHT SIDE							
BOTTOM SLAB LEFT SIDE							
4- 0	-5.44	-1.53	-0.76	-0.29	0.00	0.00	0.00
4- 1	0.26	-1.53	-0.76	-0.29	0.00	0.00	0.00
4- 2	4.69	-1.53	-0.77	-0.29	0.00	0.00	0.00
4- 3	7.85	-1.53	-0.77	-0.29	0.00	0.00	0.00
4- 4	9.75	-1.54	-0.77	-0.29	0.00	0.00	0.00
4- 5	10.38	-1.54	-0.77	-0.29	0.00	0.00	0.00
4- 6	9.74	-1.54	-0.77	-0.29	0.00	0.00	0.00
4- 7	7.84	-1.54	-0.77	-0.29	0.00	0.00	0.00
4- 8	4.68	-1.54	-0.77	-0.29	0.00	0.00	0.00
4- 9	0.25	-1.55	-0.77	-0.29	0.00	0.00	0.00
4-10	-5.45	-1.55	-0.77	-0.29	0.00	0.00	0.00
BOTTOM SLAB RIGHT SIDE							

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Current Live Load: HL-93-LANE

Unfactored SHEARS (per unit design width)
due to Dead and Live Loads including Distribution and Impact

M-PT	Dead Load	Soil Press (Max)	Soil Press (Min)	Surch Hgt.	Water Press (Max)	LIVE LOADS Pos	Neg
	K	K	K	K	K	K	K
EXTERIOR WALL BOTTOM							
1- 0	0.19	2.31	1.15	0.38	0.00	0.00	0.00
1- 1	0.19	1.71	0.86	0.30	0.00	0.00	0.00
1- 2	0.19	1.17	0.58	0.23	0.00	0.00	0.00
1- 3	0.19	0.67	0.33	0.15	0.00	0.00	0.00
1- 4	0.19	0.22	0.11	0.08	0.00	0.00	0.00
1- 5	0.19	-0.19	-0.09	0.00	0.00	0.00	0.00
1- 6	0.19	-0.54	-0.27	-0.08	0.00	0.00	0.00
1- 7	0.19	-0.84	-0.42	-0.15	0.00	0.00	0.00
1- 8	0.19	-1.10	-0.55	-0.23	0.00	0.00	0.00
1- 9	0.19	-1.31	-0.65	-0.30	0.00	0.00	0.00
1-10	0.19	-1.47	-0.73	-0.38	0.00	0.00	0.00
EXTERIOR WALL TOP							
TOP SLAB LEFT SIDE							
2- 0	3.32	0.00	0.00	0.00	0.00	0.00	0.00
2- 1	2.66	0.00	0.00	0.00	0.00	0.00	0.00
2- 2	1.99	0.00	0.00	0.00	0.00	0.00	0.00
2- 3	1.33	0.00	0.00	0.00	0.00	0.00	0.00
2- 4	0.66	0.00	0.00	0.00	0.00	0.00	0.00
2- 5	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2- 6	-0.66	0.00	0.00	0.00	0.00	0.00	0.00
2- 7	-1.33	0.00	0.00	0.00	0.00	0.00	0.00
2- 8	-1.99	0.00	0.00	0.00	0.00	0.00	0.00
2- 9	-2.65	0.00	0.00	0.00	0.00	0.00	0.00
2-10	-3.32	0.00	0.00	0.00	0.00	0.00	0.00
TOP SLAB RIGHT SIDE							
BOTTOM SLAB LEFT SIDE							
4- 0	4.27	0.00	0.00	0.00	0.00	0.00	0.00
4- 1	3.41	0.00	0.00	0.00	0.00	0.00	0.00
4- 2	2.56	0.00	0.00	0.00	0.00	0.00	0.00
4- 3	1.71	0.00	0.00	0.00	0.00	0.00	0.00
4- 4	0.85	0.00	0.00	0.00	0.00	0.00	0.00
4- 5	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4- 6	-0.85	0.00	0.00	0.00	0.00	0.00	0.00
4- 7	-1.71	0.00	0.00	0.00	0.00	0.00	0.00
4- 8	-2.56	0.00	0.00	0.00	0.00	0.00	0.00
4- 9	-3.41	0.00	0.00	0.00	0.00	0.00	0.00
4-10	-4.27	0.00	0.00	0.00	0.00	0.00	0.00
BOTTOM SLAB RIGHT SIDE							

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Current Live Load: HL-93-LANE

Unfactored AXIAL FORCES (per unit design width)
due to Dead and Live Loads including Distribution and Impact

M-PT	Dead Load	Soil Press (Max)	Soil Press (Min)	Surch Hgt.	Water Press (Max)	LIVE LOADS Pos	Neg
	K	K	K	K	K	K	K
EXTERIOR WALL BOTTOM							
1- 0	-3.32	0.00	0.00	0.00	0.00	0.00	0.00
1- 1	-3.32	0.00	0.00	0.00	0.00	0.00	0.00
1- 2	-3.32	0.00	0.00	0.00	0.00	0.00	0.00
1- 3	-3.32	0.00	0.00	0.00	0.00	0.00	0.00
1- 4	-3.32	0.00	0.00	0.00	0.00	0.00	0.00
1- 5	-3.32	0.00	0.00	0.00	0.00	0.00	0.00
1- 6	-3.32	0.00	0.00	0.00	0.00	0.00	0.00
1- 7	-3.32	0.00	0.00	0.00	0.00	0.00	0.00
1- 8	-3.32	0.00	0.00	0.00	0.00	0.00	0.00
1- 9	-3.32	0.00	0.00	0.00	0.00	0.00	0.00
1-10	-3.32	0.00	0.00	0.00	0.00	0.00	0.00
EXTERIOR WALL TOP							
TOP SLAB LEFT SIDE							
2- 0	0.19	-1.47	-0.73	-0.38	0.00	0.00	0.00
2- 1	0.19	-1.47	-0.73	-0.38	0.00	0.00	0.00
2- 2	0.19	-1.47	-0.73	-0.38	0.00	0.00	0.00
2- 3	0.19	-1.47	-0.73	-0.38	0.00	0.00	0.00
2- 4	0.19	-1.47	-0.73	-0.38	0.00	0.00	0.00
2- 5	0.19	-1.47	-0.73	-0.38	0.00	0.00	0.00
2- 6	0.19	-1.47	-0.73	-0.38	0.00	0.00	0.00
2- 7	0.19	-1.47	-0.73	-0.38	0.00	0.00	0.00
2- 8	0.19	-1.47	-0.73	-0.38	0.00	0.00	0.00
2- 9	0.19	-1.47	-0.73	-0.38	0.00	0.00	0.00
2-10	0.19	-1.47	-0.73	-0.38	0.00	0.00	0.00
TOP SLAB RIGHT SIDE							
BOTTOM SLAB LEFT SIDE							
4- 0	-0.19	-2.31	-1.15	-0.38	0.00	0.00	0.00
4- 1	-0.19	-2.31	-1.15	-0.38	0.00	0.00	0.00
4- 2	-0.19	-2.31	-1.15	-0.38	0.00	0.00	0.00
4- 3	-0.19	-2.31	-1.15	-0.38	0.00	0.00	0.00
4- 4	-0.19	-2.31	-1.15	-0.38	0.00	0.00	0.00
4- 5	-0.19	-2.31	-1.15	-0.38	0.00	0.00	0.00
4- 6	-0.19	-2.31	-1.15	-0.38	0.00	0.00	0.00
4- 7	-0.19	-2.31	-1.15	-0.38	0.00	0.00	0.00
4- 8	-0.19	-2.31	-1.15	-0.38	0.00	0.00	0.00
4- 9	-0.19	-2.31	-1.15	-0.38	0.00	0.00	0.00
4-10	-0.19	-2.31	-1.15	-0.38	0.00	0.00	0.00
BOTTOM SLAB RIGHT SIDE							

Factors for Ductility 1.00
Redundancy 1.00
Operations 1.00

No Fatigue Checks Required for this Live Load

LRFD Crack Control Computation

Current Vehicle: AASHTO LRFD HL-93 Design Lane (US)

Location	γ_e	h (in.)	d_c (in.)	β_s	Max Spacing ()	Current Spacing (in.)	Allowable Stress ()	Actual Stress (kip)
Top slab, outside corner	$0.8*f_r > f_c$, therefore no check necessary.							
Top slab, inside face	$0.8*f_r > f_c$, therefore no check necessary.							
Top slab, outside face	$0.8*f_r > f_c$, therefore no check necessary.							
Bottom slab, outside corner	$0.8*f_r > f_c$, therefore no check necessary.							
Bottom slab, inside face	$0.8*f_r > f_c$, therefore no check necessary.							
Bottom slab, outside face	$0.8*f_r > f_c$, therefore no check necessary.							
Ext. wall, outside face	$0.8*f_r > f_c$, therefore no check necessary.							
Ext. wall, inside face	$0.8*f_r > f_c$, therefore no check necessary.							

Lateral Distribution Steel:

Span Length	=	14.833 feet
Percentage of main reinforcement required	=	25.965% , less than or equal to 50%
Main reinforcement area (top slab)	=	0.880 in^2
Required lateral distribution area	=	0.228 in^2
Main reinforcement area (bottom slab)	=	0.744 in^2
Required lateral distribution area	=	0.193 in^2

Because the required area is less than the minimum, an area of steel of 0.200 in^2 is used.

Bar sizes and spacings with computed areas of steel

Areas of steel are in in2/ft

Top slab

LEFT SIDE	CENTER	RIGHT SIDE
area 0.8800 in2	area 0.8800 in2	area 0.8800 in2
size 6 spaced at 6.00 in.	size 6 spaced at 6.00 in.	size 6 spaced at 6.00 in.

****

Exterior wall

TOP
area 0.8800 in2
size 6 spaced at 6.00 in.

OUTSIDE FACE
area 0.8800 in2
size 6 spaced at 6.00 in.

INSIDE FACE
area 0.2667 in2
size 4 spaced at 9.00 in.

BOTTOM
area 0.8800 in2
size 6 spaced at 6.00 in.

****

Bottom slab

LEFT SIDE	CENTER	RIGHT SIDE
area 0.8800 in2	area 0.7440 in2	area 0.8800 in2
size 6 spaced at 6.00 in.	size 5 spaced at 5.00 in.	size 6 spaced at 6.00 in.

Serviceability, Fatigue, and Other Checks

Based on crack control check
AASHTO 5.7.3.4 LRFD

Slenderness check on walls passed
Eccentricity check on walls passed

Reinforcing Bar Stresses Sizes and Spacing

Note: Bar stresses are based on bending and axial stress only
Stresses are in ksi
Area of steel in square inches per ft
Spacing and H and V legs are in inches

Bar Mark	Description
A1	Top Corner Outside face Max Neg Moment
A100	Top Slab Inside face Max Pos Moment
A300	Top Slab Outside face Max Neg Moment Interior support
A2	Bottom Corner Outside face Max Neg Moment
A200	Bottom Slab Inside face Max Pos Moment
A400	Bottom Slab Outside face Max Neg Moment Interior support
B2	Exterior Wall Outside face Max Neg Moment
B1	Exterior Wall Inside face Max Pos Moment
B3	Interior Wall Both faces

Bar Type	Fs Act. (Ksi)	Fs All. (Ksi)	Area steel Input (In2)	Area steel Provided (In2)	Size US Bars	Spacing (In)	H (In)
A1	2.75	16.18	0.8800	0.8800	6	6.0	68
A2	4.03	16.18	0.8800	0.8800	6	6.0	41
A100	11.49	16.18	0.8800	0.8800	6	6.0	
A200	16.43	16.18	0.7440	0.7440	5	5.0	
B1	0.00	16.18	0.2667	0.2667	4	9.0	
B2	6.12	16.18	0.8800	0.8800	6	6.0	

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DATE 06/17/2014
BRASS-CULVERT(LRFD) Version 2.3.0
S.D. IRELAND - WARDSBORO BRIDGE NO. 70

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Output at Critical Sections (per unit design width)

Member No. = 1 EXTERIOR WALL
Thickness = 10.00 (in)
Clear cover at end = 2.00 (in)
Clear cover at middle = 2.00 (in)
Bar diameter (bot) = 0.75 (in)
Bar diameter (mid+) = 0.50 (in)
Bar diameter (mid-) = 0.75 (in)
Bar diameter (top) = 0.75 (in)

	Moment	Coin. Axial Force	Shear Force	Shear Cap	Resistance Po Cap	Mu Cap	Mbal Cap	Pbal Cap	Steel Area	Mom. Cap	Des. Thk	Design Ratio
	Kft	Kips	Kips	Kips	Kips	Kft	Kft	Kips	In2	Kft	in	
BOT	-4.5	3.3	2.8	27.5	389.0	31.3	48.5	105.1	0.8800	31.4	7.62	n/a
MID	1.6	3.3	0.0	33.8	368.8	10.1	42.4	136.9	0.2667	10.2	7.75	0.2
MID-	-2.2	3.3	0.1	32.4	389.0	31.3	48.5	105.1	0.8800	31.4	7.62	n/a
TOP	-3.7	3.3	2.0	28.9	389.0	31.3	48.5	105.1	0.8800	31.4	7.62	n/a

Member No. = 2 TOP SLAB
Thickness = 12.00 (in)
Clear cover at end = 2.00 (in)
Clear cover at middle = 2.00 (in)
Bar diameter (lt) = 0.75 (in)
Bar diameter (mid) = 0.75 (in)
Bar diameter (rt) = 0.75 (in)

LT	-2.8	2.5	2.8	38.0	461.0	40.1	70.4	143.7	0.8800	40.1	9.62	n/a
MID	6.7	2.5	0.0	35.7	461.0	40.1	70.4	143.7	0.8800	40.1	9.62	0.2
RT	-2.7	2.5	2.8	31.2	461.0	40.1	70.4	143.7	0.8800	40.1	9.62	n/a

Member No. = 4 BOTTOM SLAB
Thickness = 12.00 (in)
Clear cover at end = 2.00 (in)
Clear cover at middle = 2.00 (in)
Bar diameter (lt) = 0.75 (in)
Bar diameter (mid) = 0.62 (in)
Bar diameter (rt) = 0.75 (in)

LT	-3.6	3.9	3.5	36.9	461.0	40.1	70.4	143.7	0.8800	40.2	9.62	n/a
MID	8.3	3.9	0.0	33.8	456.6	34.4	68.8	151.4	0.7440	34.5	9.69	0.2
RT	-3.6	3.9	3.5	29.0	461.0	40.1	70.4	143.7	0.8800	40.2	9.62	n/a

Warnings:

1. For exterior corners, BRASS-CULVERT does not perform a check on both the exterior wall and top or bottom slab. BRASS-CULVERT only checks the location that it has determined requires a greater area of steel. Because of this, BRASS-CULVERT may check one location for a particular culvert (e.g. top of the wall) and a different location (e.g. left end of top slab) for the same culvert with a different depth of fill.

2. If the flexural resistance is zero and rebar has been entered, it could be due to the axial load being higher than the tensile capacity of the rebar provide. For example, the axial load is greater than the area of steel times the yield strength of the bars.

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DATE 06/17/2014
BRASS-CULVERT(LRFD) Version 2.3.0
S.D. IRELAND - WARDSBORO BRIDGE NO. 70

Factored Actions for Load and Resistance Factor Design at Tenth Points (per unit design width)

M-Pt	+Moment (Kft)	-Moment (Kft)	+A.F. (Kips)	-A.F. (Kips)	+Shear (Kips)	-Shear (Kips)
EXTERIOR WALL BOTTOM						
1- 0	-5.867	-7.996	-2.327	-3.317	3.970	2.212
1- 1	-3.280	-5.004	-2.327	-3.316	3.033	1.676
1- 2	-0.998	-3.669	-2.327	-3.316	2.161	1.183
1- 3	0.528	-2.759	-2.327	-3.316	1.356	0.734
1- 4	1.359	-2.233	-2.327	-3.316	0.615	0.329
1- 5	1.552	-2.052	-2.327	-3.316	0.024	-0.116
1- 6	1.169	-2.177	-2.327	-3.316	-0.294	-0.726
1- 7	0.266	-2.568	-2.327	-3.316	-0.568	-1.269
1- 8	-1.096	-3.186	-2.327	-3.316	-0.798	-1.747
1- 9	-2.859	-4.046	-2.327	-3.317	-0.985	-2.159
1-10	-4.455	-6.072	-2.327	-3.317	-1.128	-2.506
EXTERIOR WALL TOP						
TOP SLAB LEFT SIDE						
2- 0	-4.455	-6.072	-1.844	-2.449	3.317	2.326
2- 1	-1.136	-1.857	-1.787	-2.506	2.654	1.861
2- 2	2.309	0.000	-1.787	-2.506	1.991	1.396
2- 3	4.771	0.000	-1.787	-2.506	1.328	0.932
2- 4	6.250	0.000	-1.787	-2.506	0.666	0.467
2- 5	6.746	0.000	-1.787	-2.506	0.003	0.002
2- 6	6.258	0.000	-1.787	-2.506	-0.462	-0.661
2- 7	4.788	0.000	-1.787	-2.506	-0.927	-1.323
2- 8	2.334	0.000	-1.787	-2.506	-1.392	-1.986
2- 9	-1.103	-1.826	-1.787	-2.506	-1.857	-2.649
2-10	-4.417	-6.030	-1.844	-2.449	-2.322	-3.312
TOP SLAB RIGHT SIDE						
BOTTOM SLAB LEFT SIDE						
4- 0	-5.867	-7.996	-3.251	-3.970	4.257	2.985
4- 1	-1.806	-2.391	-3.308	-3.913	3.405	2.387
4- 2	2.612	0.000	-3.308	-3.913	2.553	1.790
4- 3	5.767	0.000	-3.308	-3.913	1.702	1.192
4- 4	7.658	0.000	-3.308	-3.913	0.850	0.595
4- 5	8.285	0.000	-3.308	-3.913	-0.002	-0.003
4- 6	7.649	0.000	-3.308	-3.913	-0.599	-0.855
4- 7	5.750	0.000	-3.308	-3.913	-1.197	-1.706
4- 8	2.587	0.000	-3.308	-3.913	-1.794	-2.558
4- 9	-1.839	-2.422	-3.308	-3.913	-2.392	-3.410
4-10	-5.905	-8.037	-3.251	-3.970	-2.989	-4.262
BOTTOM SLAB RIGHT SIDE						

Output complete for a HL-93-LANE vehicle

Proposed Bridge Improvement Project

Wardsboro BF 013-1(21)

Bridge #70

Concrete:

Mix Designation: P60TER

1. Specified Mix Design -	5000 PSI
2. Proposed Mix Design -	6000 PSI
3. Striping Strength -	3000 PSI
4. Handling Strength -	3000 PSI
5. Shipping Strength -	5000 PSI
6. Install Strength -	5000 PSI
7. Traffic Loading -	5000 PSI

Fabrication Tolerances:

1. Width	±1/4"
2. Height	±1/4"
3. Length	±1/2"
4. Rebar Cover	2" Min. (Unless Noted Otherwise)
5. Rebar Spacing	±1"
6. Rebar Clearance	±1/4"
7. Insert Placement	±1/4"

Design Notes:

1. Design is in accordance w/ ASTM C1577, PCI MNL135, VAOT540 & AASHTO 2010 LRFD Bridge Design Specs Fifth Edition
2. Any conflict between tolerances listed above shall result in the usage of the stricter tolerance
3. Design Live Load = HL-93
4. Materials and manufacturing shall conform to ASTM C1433
5. Earth Fill Design: 0'-0" to 2'-0"
6. Soil Weight: 130 pcf

Installation Sequence:

1. Sub base for box culvert / cut off walls to be compacted and set to appropriate grades/slopes
2. Precast cut off walls to be installed
3. All elevations are to be checked and verified they match those of plan set
4. Begin sequence of installing all box culvert sections
5. Clean granular backfill for structures used for backfill of footers & of box culvert so water can reach weep holes if applicable
6. Fill all lifting holes, bolt pockets and box culvert grooves and seams w/ non-shrink grout or repair mortar
7. ASTM C1675-11 box culvert installation guidelines shall be followed.

Reinforcing:

General Notes:

1. Reinforing Steel -
   a. Precast box sections, headwalls, & cut off walls shall be level I epoxy coated bar ASTM A615
2. Materials and manufacturing shall conform to ASTM C1433
3. Bar tied at every intersection.

Tolerances:

1. Spacing ±1"
2. Clearance ±1/4"

Lap Lengths:

1. Per AASHTO 5.11.2.1.1 & 5.11.5.3.1
   Lap Length:
   #4 Bar=21"
   #5 Bar=26"
   #6 Bar=31"

Joint Treatment:

Vertical Seams:
Per VTrans Approved Product List 780.02
Overhead & Vertical Concrete Repair Mortar
Applied by Site Contractor

Horizontal Seams / Grout:
Per VTrans Approved Product List 707.03
Mortar, Type IV
Applied by Site Contractor

Waterproofing:

1. By others if applicable

Miscellaneous:

1. All exposed wingwall hardware to be zinc plate galvanized.
2. All box culvert bolt pocket hardware to be plain steel
3. All Exposed Edges of Concrete Shall be Chamfered

Legend:

- (A) 2"Ø PVC Sleeve
- (B) 4"Ø PVC Sleeve
- (C) Mechanical Bolt Pocket (A.L. Patterson w/ 1"Ø Galv. Coil Rod)
- (D) Oxford A750-7 Lifting Device
- (E) 1"Ø x 12" CX-9 Coil Loop Insert
- (F) 5/8" FI-42 Flared Loop Ferrule Insert
- (G) Continuous Keyway (See Detail on Page 5 of 6)
- (H) Solid Lines Indicate $\frac{3}{4}$" Chamfered Edge (Isometrics)

CONTRACTORS VTSPE:	PRECAST CONCRETE BOX CULVERT SHOP DRAWINGS (#14442)			FABRICATOR: 193 INDUSTRIAL AVE. WILLISTON, VT 05495 Ph: (802) 658-0201 SD Ireland PRECAST
	SUPERVISOR: M. WHEELER DETAILER: I. ADAMS CHECKER: E. Barendse ENGINEER: Gary K. Munkelt & Assoc.	PROJECT NAME: Wardsboro PROJECT #: BF 013-1(21) LOCATION: Wardsboro, VT	06/27/2014	COVER_PAGE 1_OF_6

APPENDIX A-2

Plan View

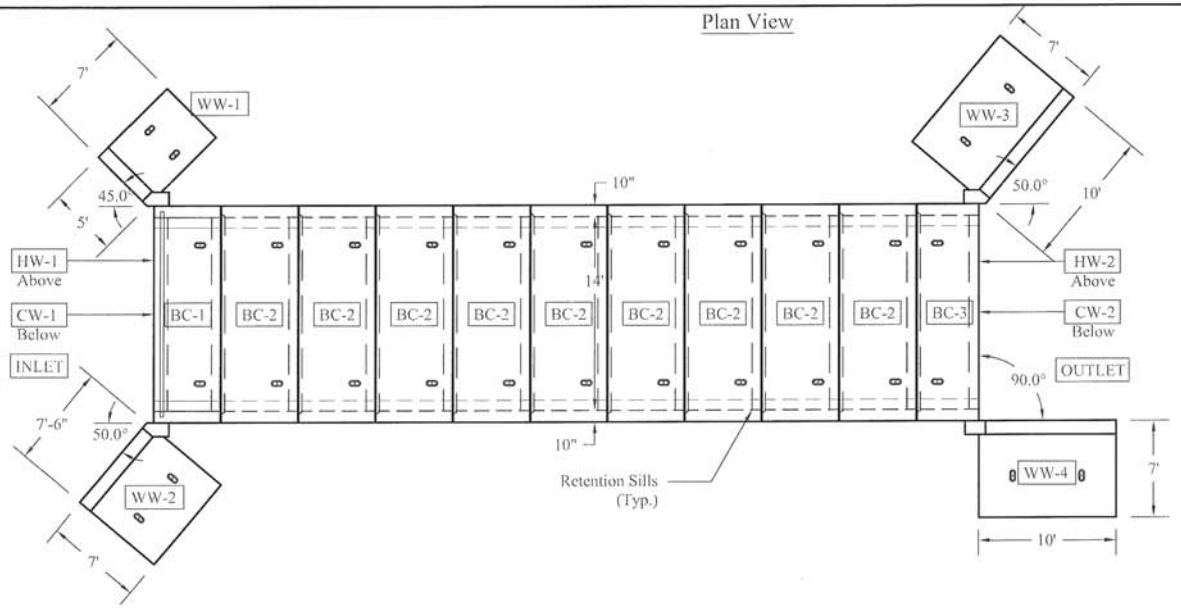
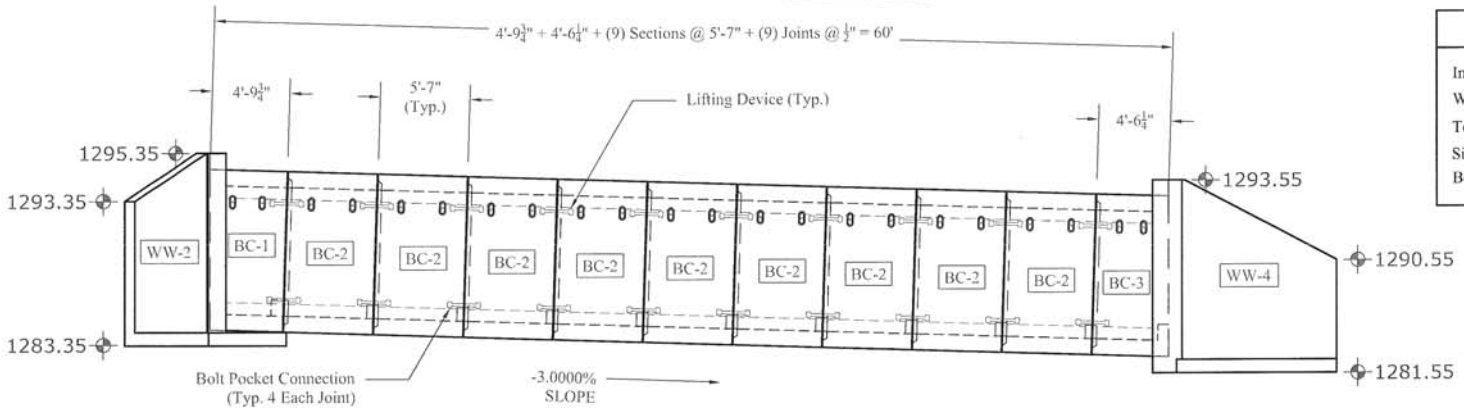


Table of Units				
Name	Qty	Length	Vol.(CY)	Wt.(lbs.)*
BC-1**	1	4'-9¾"	9.72	38,900
BC-2*	9	5'-7"	9.24	36,950
BC-3**	1	4'-6¼"	9.37	37,500
WW-1	1	5'-0"	3.47	13,880
WW-2	1	7'-6'	5.23	20,920
WW-3	1	10'-0"	6.64	26,560
WW-4	1	10'-0"	6.23	24,920
CW-1	1	15'-8"	.57	2,280
CW-2	1	15'-8"	.59	2,360

* Baffle Weight Included in BC-2
** Baffle and Headwall Included in BC-1 and BC-3

Elevation View



Culvert Specifications	
Inside Dimensions	8'-0"x14'-0"
Waterway Area	84 Sq. Ft.
Top Slab Thickness	12"
Side Wall Thickness	10"
Bottom Slab Thickness	12"

CONTRACTORS VTSPEC:

Ⓐ 2"Ø PVC Sleeve
Ⓑ 4"Ø PVC Sleeve
Ⓒ Mechanical Bolt Pocket (A.L. Patterson w/ 1"Ø Coil Rod)
Ⓓ Oxford A750-7 Lifting Device
Ⓔ 1"Ø x12" CX-9 Coil Loop Insert
Ⓕ ¾" FI-42 Flared Loop Ferrule Insert
Ⓖ 1 1/2" x 3 1/2" Continuous Keyway
Ⓗ Solid Lines Indicate ¾" Chamfer

PRECAST CONCRETE BOX CULVERT SHOP DRAWINGS (#14442)

SUPERVISOR: M. WHEELER
DETAILER: I. ADAMS
CHECKER: E. Barendse
ENGINEER: Gary K. Munkelt & Assoc.

PROJECT NAME: Wardsboro
PROJECT #: BF 013-1(21)
LOCATION: Wardsboro, VT

06/27/2014

FABRICATOR:
193 INDUSTRIAL AVE.
WILLISTON, VT 05495
Ph: (802) 658-0201

SD Ireland PRECAST

PLAN_ELEVATION

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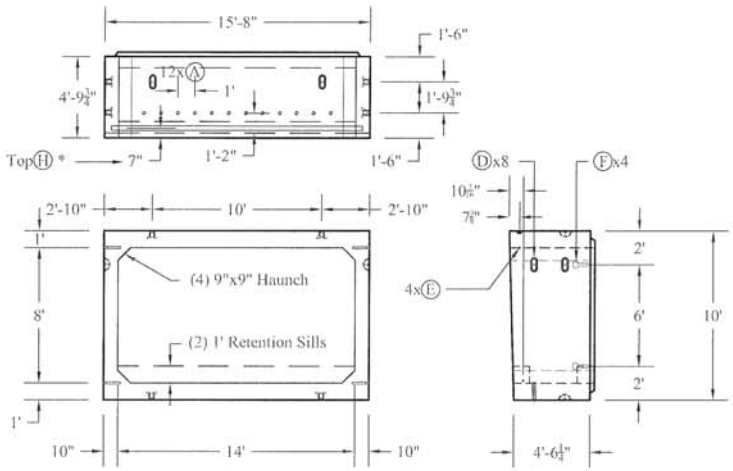
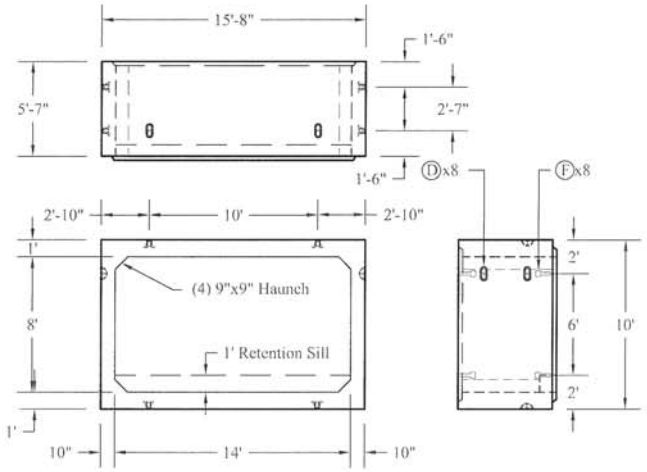
APPENDIX A-3

BC-1 Detail

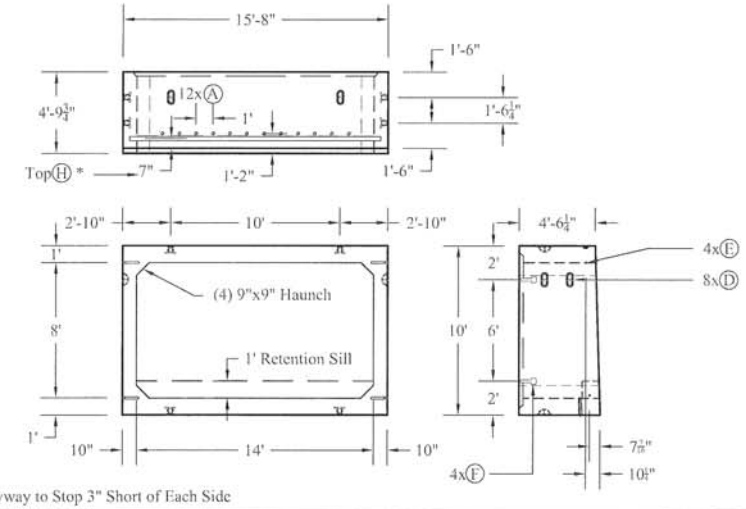


*Keyway to Stop 3" Short of Each Side

BC-2 Detail

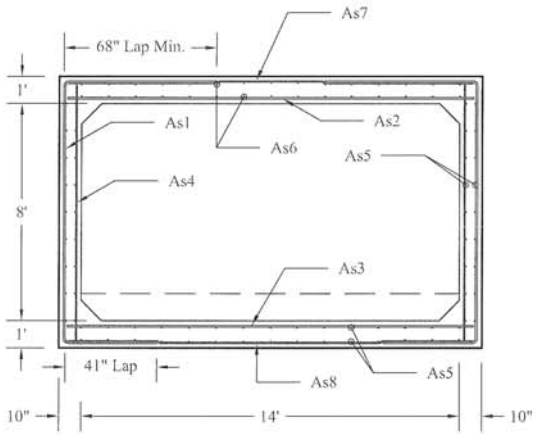


BC-3 Detail



*Keyway to Stop 3" Short of Each Side

Box Secion Reinforcement Detail



Rebar Schedule

Mark	Size	Max Spacing	Length	Type	A	B	C
As1	#6	6"	225"	Bent	68"	116"	41"
As2	#6	6"	184"	Str.	184"		
As3	#5	5"	184"	Str.	184"		
As4	#4	9"	116"	Str.	116"		
As5	#4	12"	Varies	Str.	Varies		
As6	#5	12"	Varies	Str.	Varies		
As7	#4	9"	184"	Str.	184"		
As8	#4	9"	184"	Str.	184"		

Notes: 2" Clear Typical Unless Noted Otherwise

CONTRACTORS VTSPEC:

- (A) 2"ϕ PVC Sleeve
- (B) 4"ϕ PVC Sleeve
- (C) Mechanical Bolt Pocket (A.L. Patterson w/ 1"ϕ Coil Rods)
- (D) Oxford A750-7 Lifting Device
- (E) 1"x6x12" CX-9 Coil Loop Insert
- (F) 2" FI-42 Flared Loop Ferrule Insert
- (G) 1 1/2" x 3 1/2" Continuous Keyway
- (H) Solid Lines Indicate ¾" Chamfer

PRECAST CONCRETE BOX CULVERT SHOP DRAWINGS (#14442)

SUPERVISOR: M. WHEELER
DETAILER: I. ADAMS
CHECKER: E. Barendse
ENGINEER: Gary K. Munkelt & Assoc.

PROJECT NAME: Wardsboro
PROJECT #: BF 013-1(21)
LOCATION: Wardsboro, VT

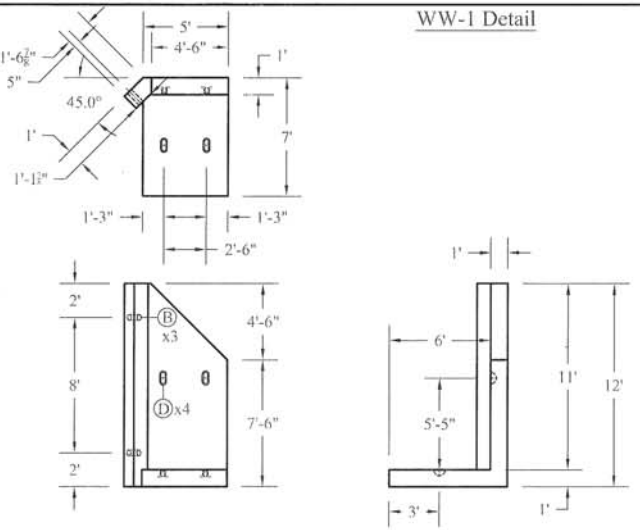
FABRICATOR:
193 INDUSTRIAL AVE.
WILLISTON, VT 05495
Ph: (802) 658-0201

SD Ireland PRECAST

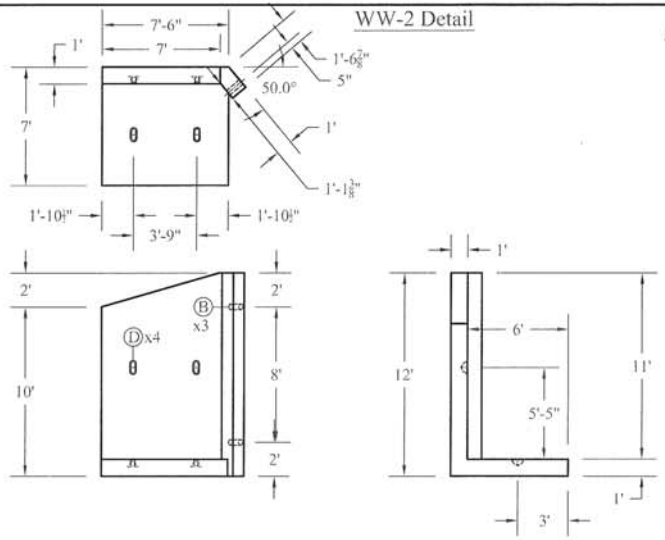
06/27/2014 | BOX_SECTIONS | 3_OF_6

APPENDIX A-4

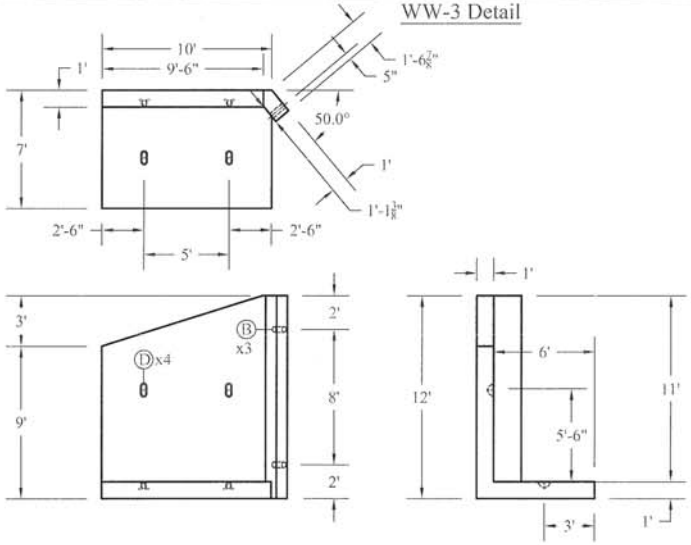
WW-1 Detail



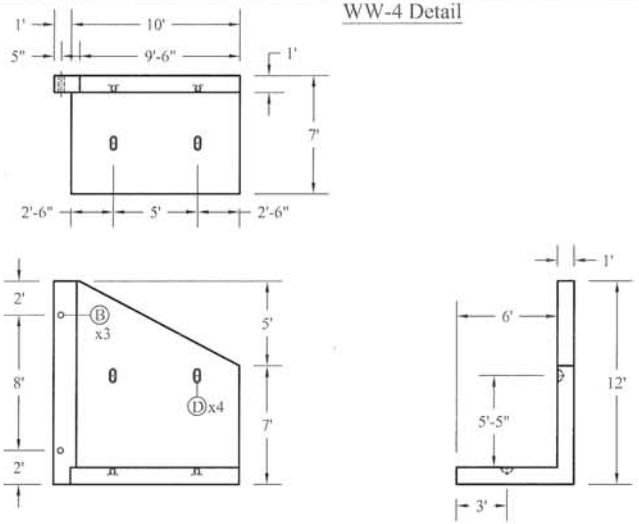
WW-2 Detail



WW-3 Detail



WW-4 Detail



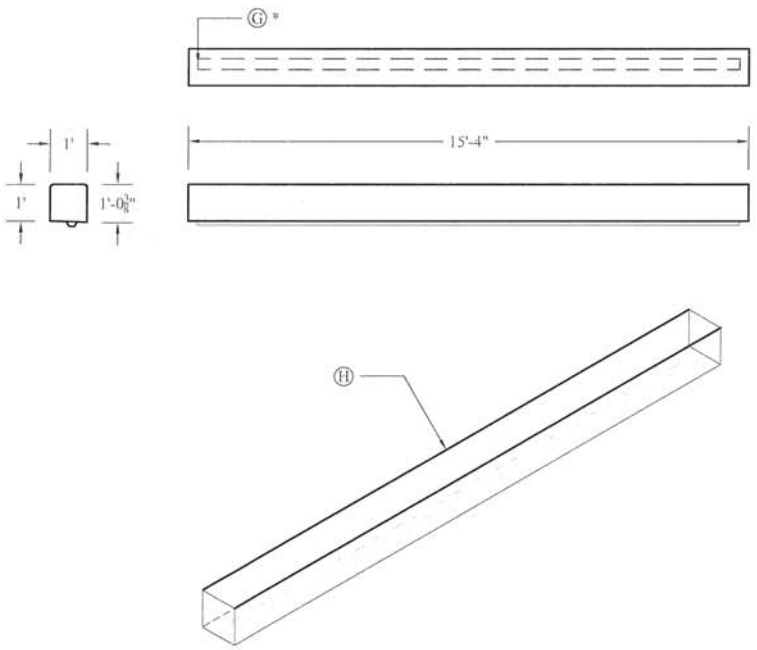
CONTRACTORS VTSPEC:

Ⓐ 2"ø PVC Sleeve
Ⓑ 4"ø PVC Sleeve
Ⓒ Mechanical Bolt Pocket 1A.L. Patterson w/ 1"ø Coil Rod
Ⓓ Oxford A750-7 Lifting Device
Ⓔ 1"dx12" CX-9 Coil Loop Insert
Ⓕ 2" FI-42 Flared Loop Ferrule Insert
Ⓖ 1 1/2" x 3 1/2" Continuous Keyway
Ⓗ Solid Lines Indicate 2" Chamfer

PRECAST CONCRETE BOX CULVERT SHOP DRAWINGS (#14442)			
SUPERVISOR: M. WHEELER	PROJECT NAME: Wardsboro	FABRICATOR: 193 INDUSTRIAL AVE. WILLISTON, VT 05495 Ph: (802) 658-0201	SD Ireland PRECAST
DETAILER: I. ADAMS	PROJECT #: BF 013-1(21)		
CHECKER: E. Barendse	LOCATION: Wardsboro, VT		
ENGINEER: Gary K. Munkelt & Assoc.	06/27/2014	WINGWALLS	4_OF_6

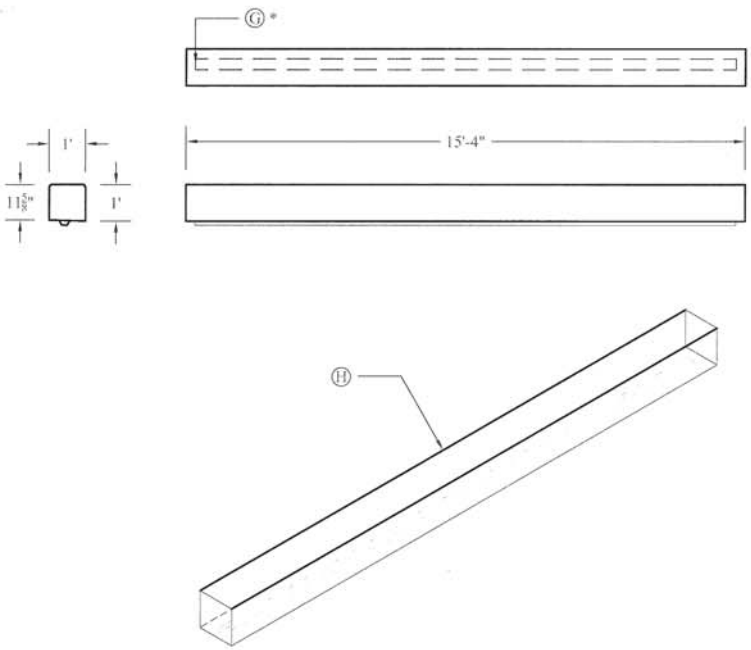
APPENDIX A-5

HW-1 Detail



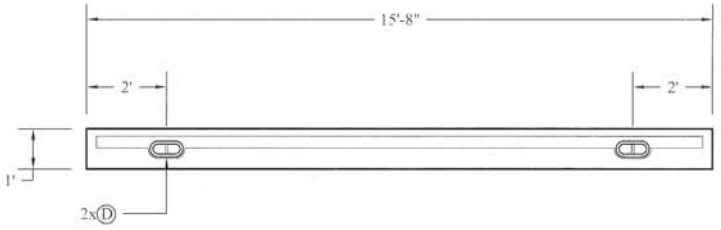
*Keyway to Stop 3" Short of Each Side

HW-2 Detail

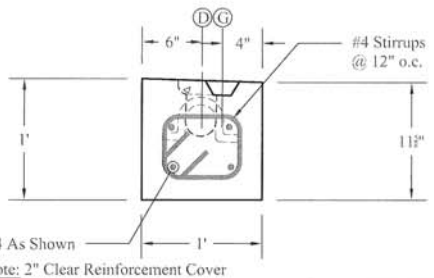


*Keyway to Stop 3" Short of Each Side

CW-1/2 Detail

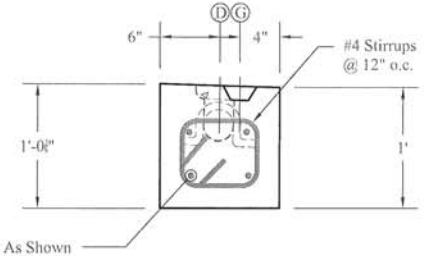


CW-1 Detail



Note: 2" Clear Reinforcement Cover

CW-2 Detail



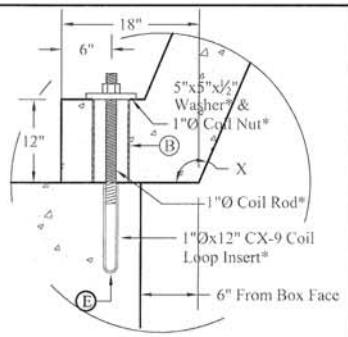
Note: 2" Clear Reinforcement Cover

CONTRACTORS VISPEC

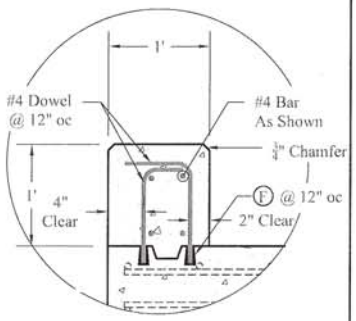
Ⓐ 2"ø PVC Sleeve
Ⓑ 4"ø0 PVC Sleeve
Ⓒ Mechanical Bolt Pocket (A.L. Patterson w/ 1"ø0 Coil Rod)
Ⓓ Oxford A750-7 Lifting Device
Ⓔ 1"0x12" CX-9 Coil Loop Insert
Ⓕ 2" FI-47 Flared Loop Ferrule Insert
Ⓖ 1 1/2" x 3 1/2" Continuous Keyway
Ⓗ Solid Lines Indicate 6" Chamfer

PRECAST CONCRETE BOX CULVERT SHOP DRAWINGS (#14442)			
SUPERVISOR: M. WHEELER	PROJECT NAME: Wardsboro		FABRICATOR: 193 INDUSTRIAL AVE. WILLISTON, VT 05495 Ph: (802) 658-0201 SD Ireland PRECAST
DETAILER: I. ADAMS	PROJECT #: BF 013-1(21)		
CHECKER: E. Barendse	LOCATION: Wardsboro, VT		
ENGINEER: Gary K. Munkelt & Assoc.	06/27/2014	HEADWALLS_CUTOFFWALLS	5_OF_6

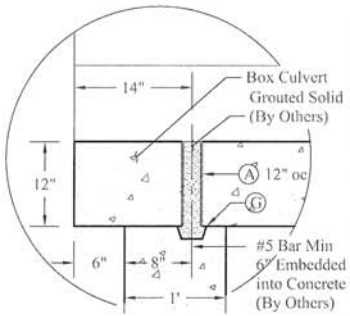
APPENDIX A-6



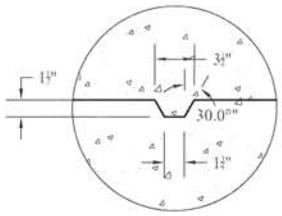
Wing Wall to Box Culvert Connection



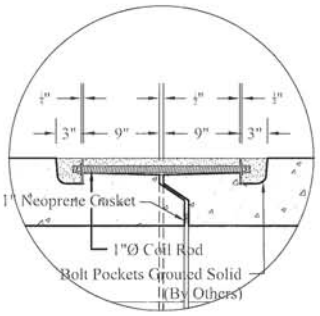
Head Wall to Box Culvert Connection



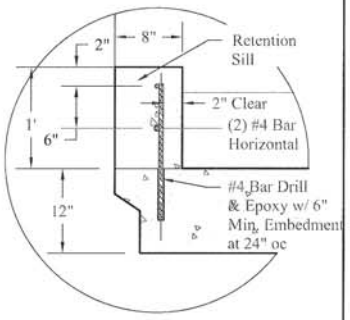
Culvert to Cut Off Wall Connection



Keyway Detail

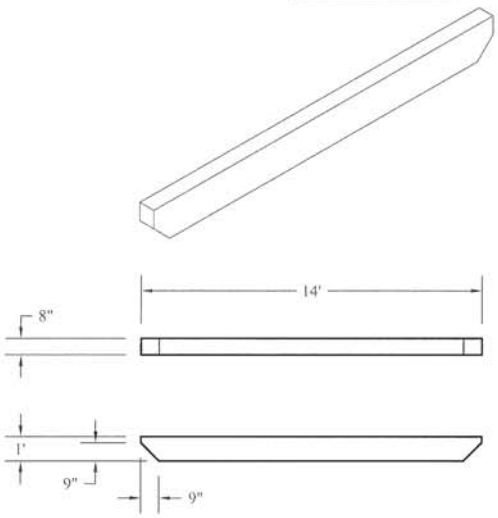


Bolt Pocket Connection Detail

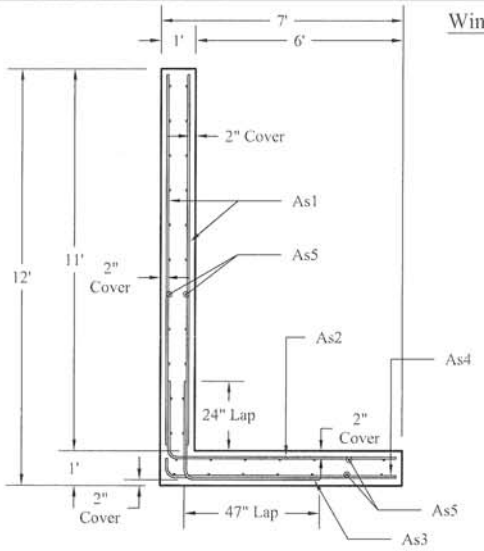


Retention Sill Reinforcing Detail

Baffle Wall Detail



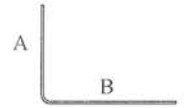
Wing Wall Reinforcement



Rebar Schedule						
Mark	Size	Max Spacing	Length	Type	A	B
As1	#6	8"	Varies	Str		
As2	#6	8"	108"	Bent	26"	82"
As3	#6	8"	81"	Bent	34"	47"
As4	#6	8"	88"	Bent	8"	80"
As5	#5	12"	Varies	Str		

Notes: 2" Clear Typical Unless Noted Otherwise

Bent Bar Guide



CONTRACTORS VISPE-

Ⓐ 2"Ø PVC Sleeve
Ⓑ 1"Ø PVC Sleeve
Ⓒ Mechanical Bolt Pocket (A.L. Patterson w/ 1"Ø Coil Rod)
Ⓓ Oxford A750-7 Lifting Device
Ⓔ 1"Øx12" CX-9 Coil Loop Insert
Ⓕ 2" FI-42 Flared Loop Ferrule Insert
Ⓖ 1 1/2" x 3 1/2" Continuous Keyway
Ⓗ Solid Lines Indicate ¾" Chamfer

PRECAST CONCRETE BOX CULVERT SHOP DRAWINGS (#14442)			
SUPERVISOR: M. WHEELER	PROJECT NAME: Wardsboro		
DETAILER: I. ADAMS	PROJECT #: BF 013-1(21)		
CHECKER: E. Barendse	LOCATION: Wardsboro, VT		
ENGINEER: Gary K. Munkelt & Assoc.		06/27/2014	CONNECTIONS 6_OF_6

FABRICATOR:
193 INDUSTRIAL AVE.
WILLISTON, VT 05495
Ph: (802) 658-0201

SD Ireland PRECAST

APPENDIX B

S.D. Ireland
Concrete Construction Corporation
802-863-6222 • Fax: 802-860-1528
www.sdireland.com

CONCRETE MIX DESIGN

6000 psi

SCC

SDI MIX CODE: P60TER

DATE: March 28, 2014 PLANT: Burlington/Williston, VT

PROJECT: General DOT Precast - 2014

FINE AGGREGATE: ASTM C 33	Source:	Hinesburg Sand & Gravel
	Specific Gravity:	2.67 (Abs.: 1.3%)
	Fineness Modulus:	≥ 2.6
COARSE AGGREGATE: ASTM C 33	Source:	S.D. Ireland, Brownell Quarry
	Specific Gravity:	2.80 (Abs.: 0.30%)
	Description	3/4" 100% Crushed Stone (Size #67)
CEMENT:	Ternary Blend Cement; Lefarge North America Lakes and Seaway Re St. Constant, Quebec (Sp. Gvty. 3.02)	
ADMIXTURES:	Water Reducer (HRWR): Glenium 7500; BASF Air Entraining Agent: Darex II AEA; Grace Concrete Chemicals	

CONSTITUENTS (LBS. /YD³)

		Abs.Vol.
Coarse Aggregate (SSD)	1750	10.02
Fine Aggregate (SSD)	1017	6.10
Cement	800	4.25
Water	304.6	4.88
Air Content (Entrained)	6.5%	1.75
Total	3872	27.00ft³

MIX PROPERTIES

Water Cement Ratios: 0.38
Entrained Air Content: 5.0 % – 9.0%
Dry Unit Weight: 144.2 ± pcf
Spread: 20" to 28"
VSI ≤ 1

ADMIXTURE(S) DOSEAGE (OZ. /YD³)

Glenium 7500 (HRWR)	56 - 64
Darex II AEA	2.8

BREAK HISTORY±

24-HR.	3400 PSI
7-DAYS	6000 PSI
28-DAYS	6700 PSI

Approved by Jason Wild, VAOT Composite Materials Engineer 7/17/14

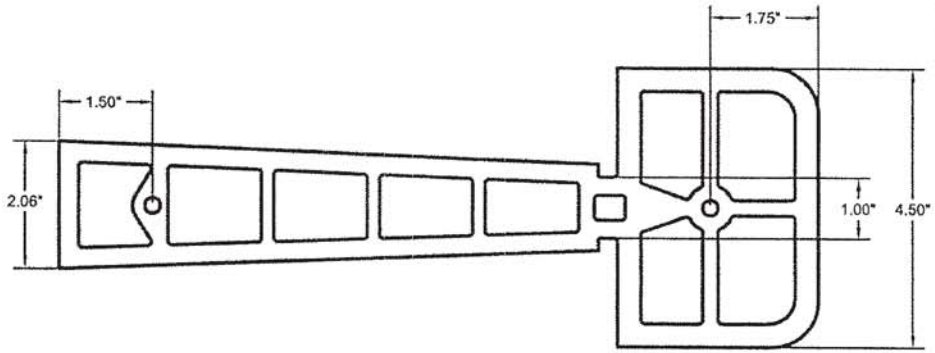
*Admixture dosage rates are subject to change.

Fax to:	Customer		Approved/Notes
Fax#	Project		
From	Job#	Ship Date	
Date	PA Insert Quote/Order#	Page _____of _____	

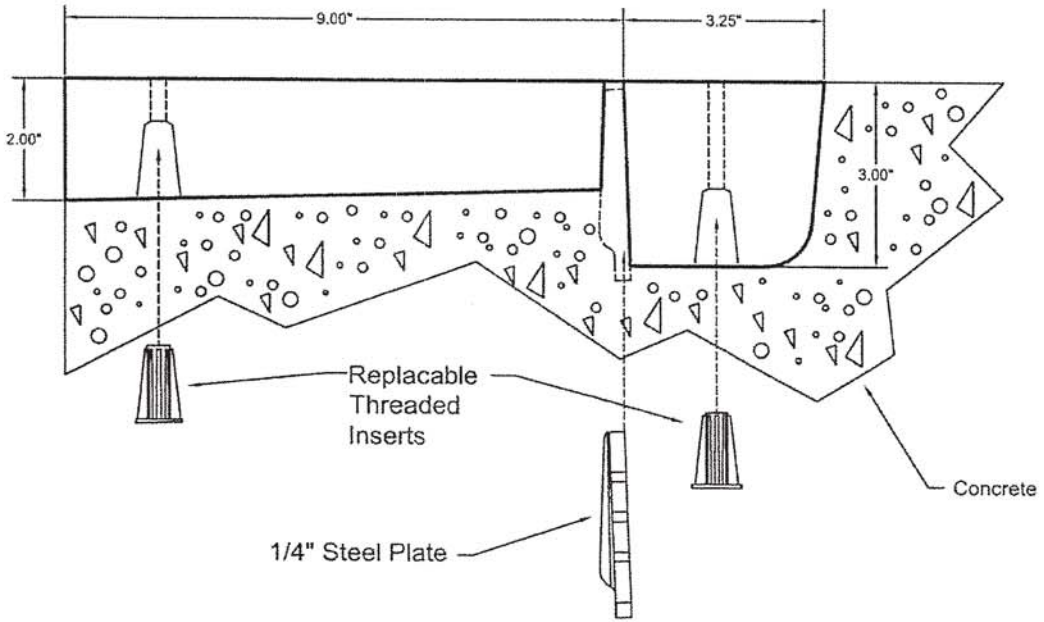
Pennsylvania Insert Corp
PO Box 199
Spring City PA 19475
tel: 610-948-9688
fax: 610-948-4975

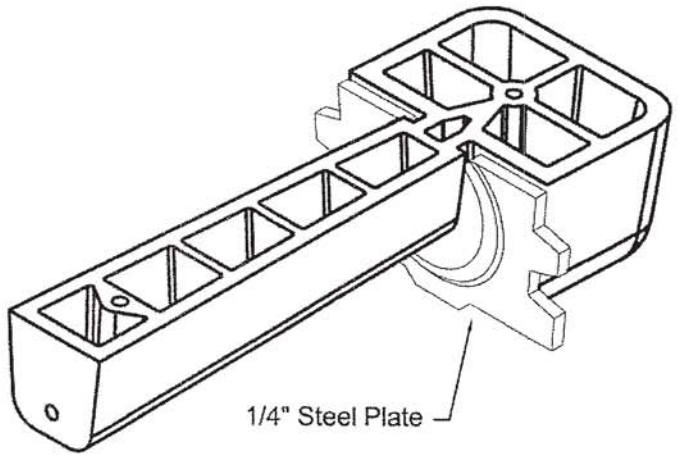
email: sales@pennsylvaniainsert.com
web: www.pennsylvaniainsert.com

BOLT POCKET FORMER (for up to 1" bolt)



- Made from durable Urethane for reusability
- Ribbed construction increases strength
- *Replacable 1/4" Threaded Inserts
- **1/4" Galvanized Steel Plate Standard
- Available with magnets to attach to form





*Threaded Inserts sold separately (Part Number 1200)
**Steel Plate stays in concrete, sold separately (Part Number 4024)

06/03/04

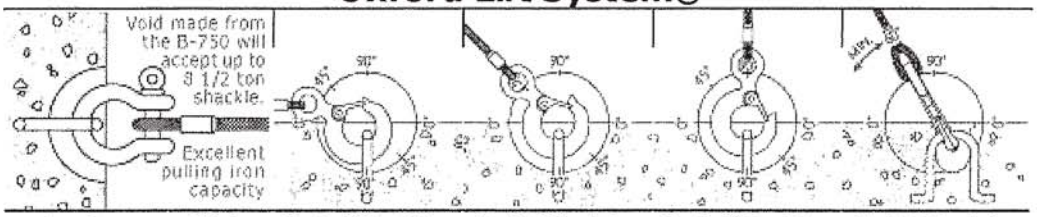
APPENDIX C-1

APPENDIX C-2

OXFORD Industrial Technologies, LLC

PO Box 736 • Stevenson, CT 06491
www.oxfordtechusa.com
Phone: (203) 268-6030
Fax: (203) 445-1240
info@oxfordtechusa.com

Oxford Lift System®



Anchor Product Code	Slab Min. Inches	Safe Working Load @ 90 degree Shear-0 degree Pull	Safe Working Load @ 90 degree Shear-45 degree Pull	Safe Working Load @ 90 degree Tension-90 degree Pull	Safe Working Load @ 90 degree Shear-60 degree Pull
A 500-3	4.00"	4,500	4,000	3,500	4,000
A 500-4	5.00"	8,000	5,500	4,000	5,000
A 500-5	6.00"	10,500	6,500	5,000	5,500
A 750-5	6.00"	12,500	8,000	7,000	7,000
A 750-7	8.00"	15,000	12,500	10,000	10,000

Note: Safe Working Load provides a factor of safety of approximately 4:1

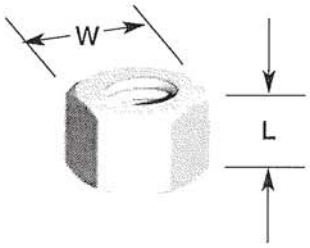
Test Results are based on a minimum concrete compressive strength of 4,000 psi.

<back next>

Home | B-500 & B-750 | S-150 | S-300 | Lift Anchor & Order Form | Concrete Products
Pull Iron Capacity | Anchors & Accessories | Toggle-Lok | Insert/Lift Anchor | Grid-Lok/ Rebar Chair | Helpful Calculations

Coil Lifting Insert Accessories

(2060) CN-5 COIL NUT



The CN-5 Standard Coil Nut is manufactured from hex stock and is available in 1/2" through 1-1/2" diameters. Dimensions are displayed in the table.

The Standard Coil Nut safe working loads are based on an approximate 5:1 safety factor for lifting applications.

NOTE: Coil Nut – Heavy page 86

CN-5 STANDARD COIL NUT DATA

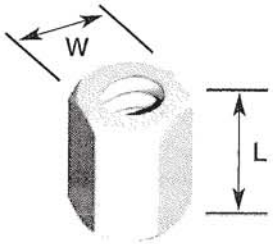
Bolt Size		Safe Work Load (Tension) One CN-5		Safe Work Load (Tension) Two CN-5 or One CN-25		Nut Length L		Width Across Flats W	
in.	mm	lbs.	kN	lbs.	kN	in.	mm	in.	mm
1/2	13	1800	8	3600	16	1/2	13	7/8	22
3/4	19	3600	16	7200	32	5/8	15	1 1/8	28
1	25	7200	32	15,000	67	1	25	1 5/8	41
1 1/4	32	10,800	48	22,500	100	1 1/4	32	2	50
1/1/2	38	16,200	72	27,000	120	1 1/2	38	2 3/8	60

Table is based on a 5:1 safety factor for lifting applications.

1) Note that in order to achieve the published safe working loads of Coil Bolts, Coil Rods, etc., two (2) Standard Coil Nuts tightly locked together are required when using the Standard Coil Nut.

To Order, Specify: quantity, name and bolt diameter.

(2062) CN-25 COIL NUT – HEAVY



The CN-25 Heavy Coil Nut is manufactured from hex stock like the Standard Coil Nut, but is of sufficient length to develop the safe working load required for heavy form tying systems and precast lifting applications.

The Heavy Coil Nut safe working loads are based on an approximate 5:1 safety factor for lifting applications.

CN-25 HEAVY COIL NUT DATA

Bolt Size		Safe Work Load (Tension) Two CN-5 or One CN-25		Nut Length L		Width Across Flats W	
in.	mm	lbs.	kN	in.	mm	in.	mm
1/2"	13	3600	16	1	25	7/8	28
3/4"	19	7200	32	1 1/2	38	1 1/8	28
1"	25	15,000	67	2	50	1 5/8	41
1 1/4"	32	22,500	100	2 1/2	64	2	50

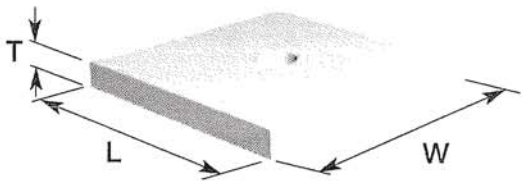
Table is based on a 5:1 safety factor for lifting applications.

To Order, Specify: quantity, name and bolt diameter.

Coil Lifting Insert Accessories

(2080) CW-4 FLAT WASHER

The CW-4 Flat Washers are manufactured from high carbon flat steel plate and are designed to provide the required bearing against the form members. Flat Washers are available in many sizes in both standard and heavy versions. Refer to the table for dimensions and safe working loads.



Flat Washer Safe working loads are based on an approximate 5:1 safety factor for lifting applications.

CW-4 FLAT WASHER DATA

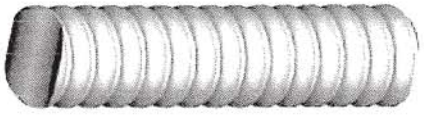
Bolt Size		Type	T		L		W	
in.	mm		in.	mm	in.	mm	in.	mm
1/2	13	Standard	1/4	6	4	100	3	75
3/4	19	Standard	1/4	6	4	100	5	125
1	25	Standard	1/2	13	5	125	5	125
1 1/4	32	Standard	1/2	13	5	125	5	125
1 1/2	38	Standard	3/4	19	5	125	5	125
1/2	13	Heavy	1/4	6	4	100	5	125
3/4	19	Heavy	1/2	13	5	125	5	125
1	25	Heavy	3/	19	7	175	7	175
1 1/4	32	Heavy	3/4	19	7	175	7	175
1 1/2	38	Heavy	3/4	19	7	175	7	175

To Order, Specify: quantity, name and bolt diameter.

(2102) CR-4 COIL ROD

CR-4 Continuous Coil Rod is manufactured and stocked in 12'-0" lengths. Special lengths are available up to 20'-0".

Requires minimum two (2) Standard CN-5 Coil Nuts or one (1) Heavy CN-25 Coil Nut to develop full safe work load. Minimum coil thread penetration is same as shown for coil bolts. See Table on page 88 to assure minimum coil penetration. May be cut with carborundum blades without thread damage. Do not use cutting torch to cut coil rod.



CR-4 HI-STRENGTH CONTINUOUS COIL ROD SELECTION TABLE

Bolt Diameter		Safe Work Load			
		Tension		Shear	
In.	mm.	lbs.	kN.	lbs.	kN.
1/2	13	3600	16	2400	11
3/4	19	7200	32	4800	21
1	25	15000	67	10000	44
1-1/4	32	24000	107	16000	71
1-1/2	38	28000	124	18000	83

Table is based on a 5:1 safety factor for lifting applications.

To Order, Specify: quantity, name, bolt diameter and length.

All bar, including dowel ends for head walls, will be level 1 epoxy coated.

Table 3, "Basic Development Length of Standard Hooks for Grade 60 Rebar" identifies basic development lengths of hooked rebar embedded in various specified compressive strength normal weight concrete.

Table 4, "Recommended DB-SAE-3 Headed Splicer and Dowel-in Sizes", displays information pertaining to splices utilizing the DB-SAE-3 Headed Splicer shown in the detail below.

Table 5, "Reinforcing Steel Data", shows the ASTM Standards for reinforcing bars.

Rebar Size	NORMAL WEIGHT CONCRETE (psi)		
	3,000	4,000	5,000
#3	8.2	7.1	6.4
#4	11.0	9.5	8.5
#5	13.7	11.9	10.6
#6	16.4	14.2	12.7
#7	19.2	16.6	14.8
#8	21.9	19.0	17.0
#9	24.7	21.4	19.1
#10	27.8	24.1	21.6
#11	30.9	26.8	23.9
#14	37.1	32.1	28.7
#18	49.4	42.8	38.3

Table 3: Basic Development Length of Standard Hooks for Grade 60 Rebar

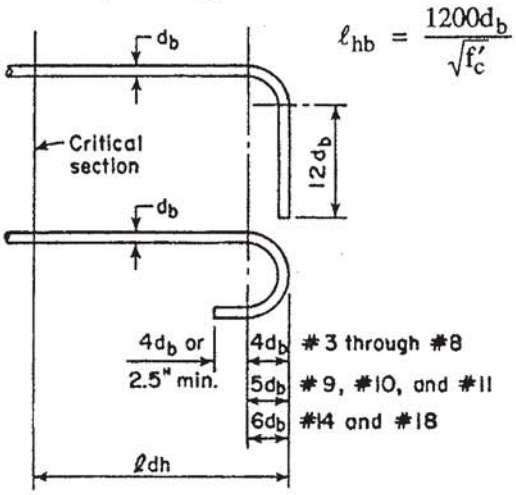
System Thread Size	DB-SAE-3 Headed Splicer	Embed Length (12D)	Load Capacity	
			1.25 Py	1.6 Py
5/8"-11unc	#4	6"	15,000	19,200
3/4"-10unc	#5	7-1/2"	23,250	29,760
7/8"-9unc	#6	9"	33,000	42,400
1"-8unc	#7	10-1/2"	45,000	57,600
1-1/8"-8un	#8	12"	59,250	75,840

Table 4: Recommended DB-SAE-3 Headed Splicer Sizes - Grade 60 Rebar

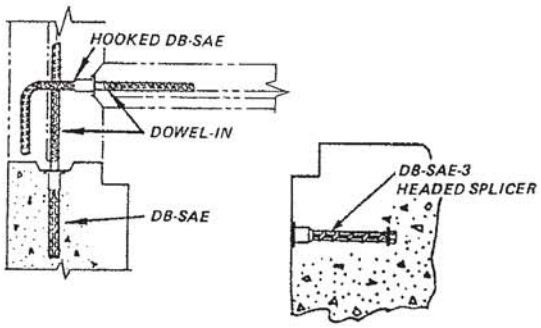
Bar Size Designation	Weight (lbs. per ft.)	Nominal Diameter	
		Diameter (in)	Cross-Section Area (sq. in.)
#4	0.668	0.500	0.20
#5	1.043	0.625	0.31
#6	1.502	0.750	0.44
#7	2.044	0.875	0.60
#8	2.670	1.000	0.79
#9	3.400	1.128	1.00
#10	4.303	1.270	1.27
#11	5.313	1.410	1.56

Table 5: ASTM Standard Rebar Data

Development ℓ_{dh} of Standard Hooks



The details displayed show a few of the many, many applications where the versatile Dayton Richmond Dowel Bar Splicer System can be used.

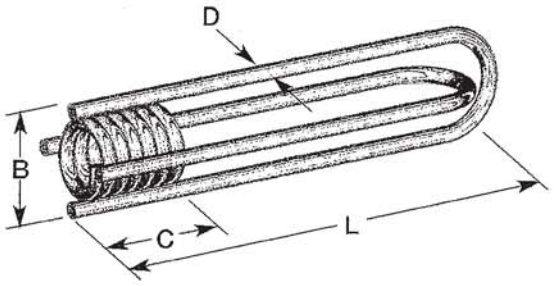


Coil Lifting Inserts

CRISS-CROSS COIL INSERT – STRAIGHT (2178)

The Criss-Cross Coil Insert – Straight (2178) is a high strength four strut insert ideally suited for precast concrete edge lift applications. The four strut design and high safe working loads make this insert a good, safe choice for preventing panel failures. The The Criss-Cross Coil Insert – Straight is available in plain or hot dip galvanize finish.

To Order, Specify: quantity, name, bolt diameter, length (L dimension) and finish.



CRISS-CROSS COIL INSERT - STRAIGHT DATA

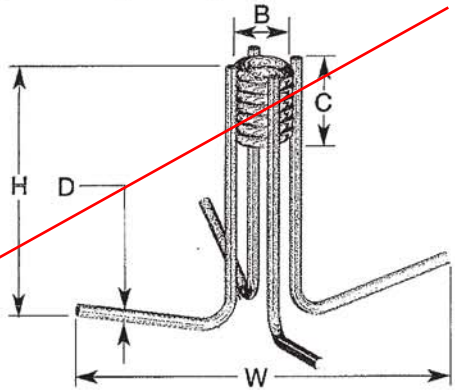
Bolt Diameter		Insert Length L		Minimum Slab Thickness		Safe Work Load for Edge Lift				Minimum Corner Distance		B		Coil Length C		Wire Diameter D	
						Tension		Shear									
in.	mm	in.	mm	in.	mm	lbs.	kN	lbs.	kN	in.	mm	in.	mm	in.	mm	in.	mm
3/4"	19	9"	229	4"	100	3700	16.4	1500	6.7	24"	600	1 11/16"	43	1 5/8"	41	.306"	7.8
3/4"	19	12"	305	4"	100	4600	20.4	1500	6.7	24"	600	1 11/16"	43	1 5/8"	41	.306"	7.8
1"	25	9"	229	5 1/2"	140	4500	20.0	2000	8.9	24"	600	2 1/8"	54	2 1/16"	52	.306"	7.8
1"	25	12"	305	5 1/2"	140	6500	28.9	2500	11.1	24"	600	2 1/8"	54	2 1/16"	52	.306"	7.8
1"	25	9"	229	5 1/2"	140	4500	20.0	2000	8.9	24"	600	2 1/8"	54	2 1/16"	52	.375"	9.5
1"	25	12"	305	5 1/2"	140	6500	28.9	2500	11.1	24"	600	2 1/8"	54	2 1/16"	52	.375"	9.5
1 1/4"	32	9"	229	6"	150	4700	20.9	3500	15.6	24"	600	2 1/2"	63	2 1/16"	52	.440"	11.2
1 1/4"	32	12"	305	6"	150	7500	33.3	3500	15.6	24"	600	2 1/2"	63	2 1/16"	52	.440"	11.2

Table is based on minimum concrete strength of 3,000 psi and a 4:1 safety factor.
Inserts must have a 1/2" setback from the surface of the concrete and sufficient coil penetration by the lifting bolt. See minimum bolt penetration information on page 87.

THIN SLAB COIL INSERT (2185)

The Thin Slab Coil Insert (2185) is a four strut insert fabricated with a wire coil and four deformed (ribbed) wire legs. This insert is applicable for face lift handling of precast panels, slabs and other similar types of precast elements. The Thin Slab Coil Insert is available in plain or hot dip galvanize finish.

To Order, Specify: quantity, name, bolt diameter and finish.

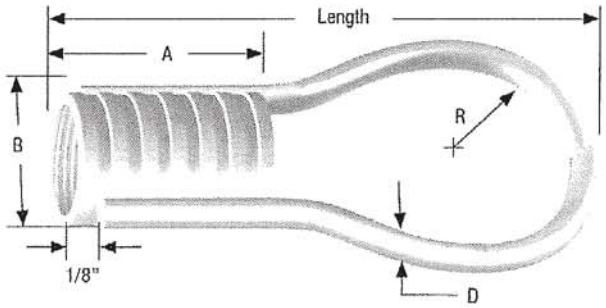


THIN SLAB COIL INSERT DATA

Bolt Diameter		Insert Height H		Safe Work Load (Tension		B		Coil Length C		Wire Diameter D		W		Minimum Edge Distance	
in.	mm	in.	mm	lbs.	kN	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm
3/4"	19	3"	76	2500	11.1	1 5/8"	41	1 3/4"	44	.306"	7.8	7 1/8"	181	9"	230
1"	25	4"	100	3500	15.6	1 7/8"	47	2 1/16"	52	.306"	7.8	9 1/2"	241	12"	305
1 1/4"	31	4"	100	4000	17.8	2 1/4"	57	2 1/16"	52	.375"	9.5	9 3/4"	248	12"	305
1 1/2"	38	4"	100	4000	17.8	2 1/2"	63	2 1/16"	52	.375"	9.5	10"	254	12"	305

Table is based on minimum concrete strength of 3,000 psi and a 4:1 safety factor.
Inserts must have a 1/2" setback from the surface of the concrete and sufficient coil penetration by the lifting bolt. See minimum bolt penetration information on page 87.

FI-42: FLARED LOOP FERRULE INSERT



Fabricated by welding a looped strut to a closed-end ferrule, this versatile insert is commonly used to make structural connections and to suspend pipes and other mechanical equipment. Available in 3/8", 1/2", 5/8", 3/4", 7/8" and 1" sizes. Insert available in plated finish.

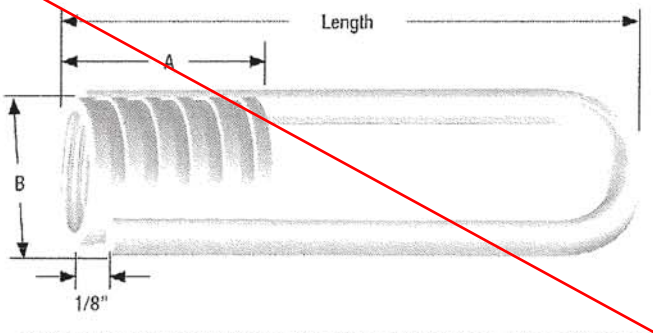
*Standard inserts not designed for use with hot dip galvanized bolts.

FLARED LOOP FERRULE INSERT DIMENSIONS AND LOAD CHART

									In-Concrete Capacity. 3:1 SWL	
Part Number	Bolt Diameter (N.C. Thread)	Threads per Inch (N.C.)	Length	A	B	R	Wire Diameter D	Insert Ultimate Mechanical Capacity (lbs)	Min. Edge Distance	Tension (lbs)
FI4238P	3/8"	16	2-3/4"	1-1/4"	1"	9/16"	0.243"	6,000	5"	2,000
FI4212P	1/2"	13	2-3/4"	1-3/8"	1-1/8"	9/16"	0.243"	6,000	5"	2,000
FI4258P	5/8"	11	3-1/2"	1-5/8"	1-3/8"	13/16"	0.262"	6,900	5"	2,300
FI4234P	3/4"	10	3-1/2"	1-5/8"	1-5/8"	13/16"	0.262"	7,500	5"	2,500
FI4278P	7/8"	9	6"	1-5/8"	2-1/16"	1-3/8"	0.375"	15,900	8"	5,300
FI421P	1"	8	6"	1-5/8"	2-1/16"	1-3/8"	0.375"	15,900	8"	5,300

- Safe Working Load is based on 3,000 psi concrete and insert setback 1/2" from the concrete surface.
- Minimum spacing of inserts is 2 x (edge distance).

FI-64: STRAIGHT LOOP FERRULE INSERT



The Straight Loop Ferrule Insert is typically used to attach a precast wall panel to a building frame, as well as to provide attachment of other structural elements that may be required. Available in 1/2", 5/8", 3/4" and 1" sizes. Insert available in plated finish.

*Standard inserts not designed for use with hot dip galvanized bolts.

STRAIGHT LOOP FERRULE INSERT DIMENSIONS AND LOAD CHART

								In-Concrete Capacity. 3:1 SWL	
Part Number	Bolt Diameter	Threads per Inch (N.C.)	Length	A	B	Wire Diameter D	Insert Ultimate Mechanical Capacity (lbs)	Min. Edge Distance	Tension (lbs)
FI64124P	1/2"	13	4-1/8"	1-3/8"	1-1/8"	0.225"	9,000	5"	3,000
FI64126P	1/2"	13	6-1/8"	1-3/8"	1-1/4"	0.306"	15,000	8"	5,000
FI64584P	5/8"	11	4-1/8"	1-5/8"	1-1/4"	0.225"	9,000	5"	3,000
FI64586P	5/8"	11	6-1/8"	1-5/8"	1-5/8"	0.375"	15,000	8"	5,000
FI64344P	3/4"	10	4-1/8"	1-5/8"	1-3/8"	0.225"	9,000	5"	3,000
FI64346P	3/4"	10	6-1/8"	1-5/8"	1-3/4"	0.375"	15,000	9"	5,000
FI6416P	1"	8	6-1/8"	1-5/8"	2-1/8"	0.375"	15,000	9"	5,000

- Safe Working Load is based on 3,000 psi concrete and insert setback 1/2" from the concrete surface.
- Minimum spacing of inserts is 2 x (edge distance).