S.D. Ireland Companies

Precast Division

193 Industrial Ave. Williston, VT 05495
P.O. Box 2286 South Burlington, VT 05407
p: 802-863-6222 f: 802-860-1528
www.sdireland.com

Attention:	Sam Anderson	Date:	2/13/2015
Company:	Peckham Road Corp.	Job Name:	Bridport STP CULV (29)
Address:	375 Bay Rd. Suite 100	Job Number:	#15428
City, St, Zip:	Queensbury, NY 12804	Regarding:	BR#5 Box Culvert Calculations
Ph: / Fax:	518-792-3157		

WE ARE SENDING:

- [ ] Quote
- [x] Details
- [ ] Other: ______________
- [x] Submittals
- [ ] Prints
- [ ] Plans
- [ ] Specifications
- [ ] Copy Of Letter
- [ ] Change Order
- [ ] Samples
- [ ] Revised Submittals

Copies	Date	Pages	Description
1	2/13/2015	1	Cover Page
1	2/12/2015	67	Box Culvert Calculations
1	2/12/2015	19	Wingwall Calculations

These Are Submitted as Checked Below:

- [x] For Approval
- [ ] Approved as Submitted
- [ ] Resubmit __ Copies for Approval
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- [ ] As Requested
- [ ] Returned for Corrections
- [ ] Return __ Corrected Prints
- [ ] For Review and Comment
- [ ] Prints Returned After Loan to Us
- [ ] For Bids Due: ______________________
- [ ] Other:

Notes/Remarks:

Sam,

Please pass on for approvals.

Thank you.

Eric Barendse x265

APPROVED: Approval of drawings and/or procedures indicates concurrence with the information presented and does not relieve the Contractor or Fabricator of compliance with all specifications and code requirements		Stantec
APPROVED AS NOTED		
REVISE AND RESUBMIT	X	
NOT REVIEWED		

Date: 3/09/2015

By: Michael J. Chenette

This review by Stantec Consulting Services Inc. is for the sole purpose of ascertaining conformance with the general design concept. This review shall not mean that Stantec Consulting Services Inc approves the detail design inherent in the shop drawings, responsibility for which shall remain with the Contractor. Submitting same, and such review shall not relieve the Contractor of his responsibility for errors or omissions in the shop drawing or of his responsibility for meeting all requirements of the Contract Documents. The contractor is responsible for dimensions to be confirmed and correlated at the job site, for information that pertains solely to the fabrication processes or to techniques of construction and installation and for coordination of the work of all subtrades.

Copy To: ______________________

Signed: Eric Barendse

If enclosures are not as noted, kindly notify us at once.

Telephone 215-855-8713 FAX 215-855-8714

GARY K. MUNKELT & ASSOCIATES

Consulting Engineers
Precast Concrete, Structural, Civil

1180 Welsh Rd. Suite 190 North Wales, PA 19454

2/12/15

PROJECT: DESIGN PRECAST CONCRETE BOX CULVERT
12'-0" SPAN x 9'-0" RISE

CLIENT: S. D. IRELAND COMPANIES
WILLISTON, VT

JOB: BRIDGE NO. 5 (STA 22 + 80.82)
STATE OF VERMONT PROJECT – STP. CULV 29
BRIDPORT, VT

STATE OF VERMONT GARY K. MUNKELT NO. 6291 REGISTERED PROFESSIONAL ENGINEER

TABLE OF CONTENTS

Include soil bearing calcs

GKM Job No. 150216

Dated: 02/12/15

GENERAL SPECIFICATIONS

1. Precast Concrete shall be designed to obtain a strength of 5,000 psi 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 A615. Reinforcing steel for welded wire fabric shall be Grade 65 (obtain yield strength of 65,000 psi) and meet requirements of A185.

3. Weight of Concrete – 150b/ft^3

4. Weight of Soil – 120 lb/ft^3

5. AASHTO HL-93 live load at surface.

6. Top slab is 2.00 ft. maximum below grade.

7. Soil is assumed to have properties such that Ka = 0.33

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 318-10 titled "Building Code Requirements for Reinforced Concrete".

3. AASHTO LRFD Bridge Design Specifications 2012 Edition.

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

Proposed Bridge Improvement Project

Bridport STP CULV(29)

Bridge #5

SHEET 2A

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 2012 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 Cover: ±1'-9" Soil Cover

Installation:

1. Sub Base for Box Culvert / Cut Off Walls to be Compacted and Level
2. Precast Cut Off Walls + Wing 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. Applied by Site Contractor.
7. ASTM C1675-11 Box culvert installation guidelines shall be followed.

Reinforcing:

General Notes:
1. Reinforing Steel -
   a. Precast box sections, headwalls, wing walls, & cut off walls shall be level I uncoated bar ASTM A615
2. Materials and manufacturing shall conform to ASTM C1433

Tolerances:
1. Spacing ±1"
2. Clearance ±1/4"

Lap Lengths:
1. Per AASHTO 5.11.2.1.1 & 5.11.5.3.1

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. Silane sealer applied in precast yard on all exposed surfaces (headwalls and top of wingwalls.)

Miscellaneous:

1. All bolt pocket hardware & wingwall hardware to be uncoated, black steel & shall remain in place.
2. All exposed edges of concrete shall be chamfered.
3. Concrete leveling pad for the cutoff walls is to be poured on site by the site contractor.

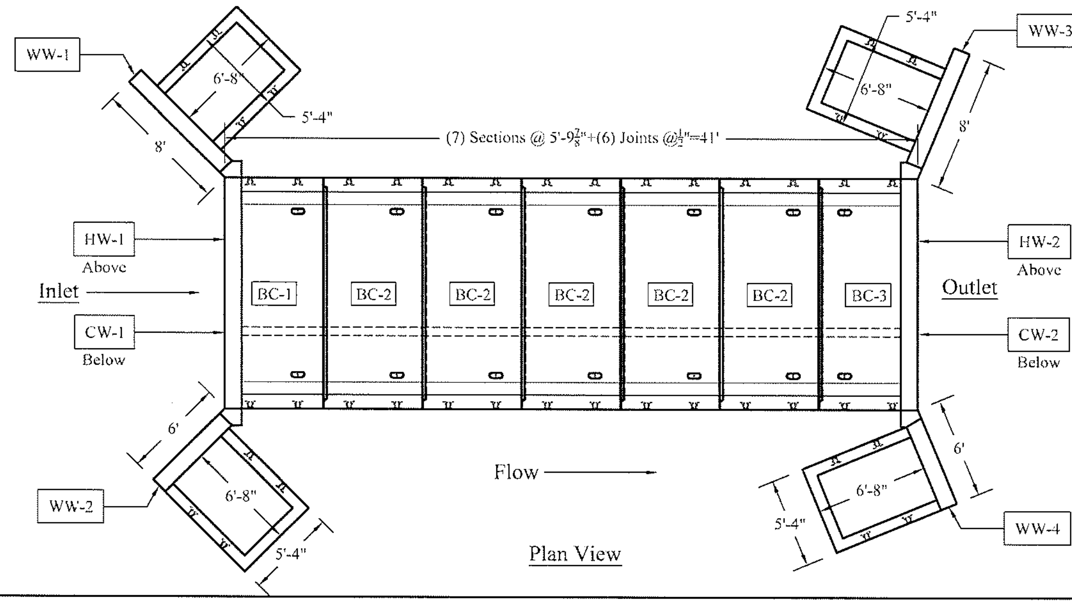
Legend:

- (A) 3"Ø PVC Sleeve
- (B) 4"Ø PVC Sleeve
- (C) Mechanical Bolt Pocket (A.L. Patterson w/ 1"Ø Coil Rod)
- (D) Oxford A750-7 Lifting Device
- (E) 1"Ø x 12" CX-9 Coil Loop Insert
- (F) 1 1/2" x 3 1/2" Continuous Keyway
- (G) Solid Lines Indicate ¼" Chamfer
- (H) ⅝" FI 42 Ferrule Insert

CONTRACTORS VTSPE:	PRECAST CONCRETE BOX CULVERT SHOP DRAWINGS (SDI JOB #15428)		Peckham Road Corp. 1557 St. Rt. 9, #3 Lake George, NY 12845 Ph: (518) 747-3353	FABRICATOR: 193 INDUSTRIAL AVE. WILLISTON, VT 05495 Ph: (802) 658-0201	SD Ireland PRECAST
	SUPERVISOR: E. Barendse DETAILER: I. ADAMS CHECKER: E. Barendse ENGINEER: G. K. Munkelt	PROJECT NAME: Bridport PROJECT #: CULV(29) Br.#5 LOCATION: Bridport, VT	02/12/15	COVER_PAGE	1_OF_7

Sheet 3

Plan View



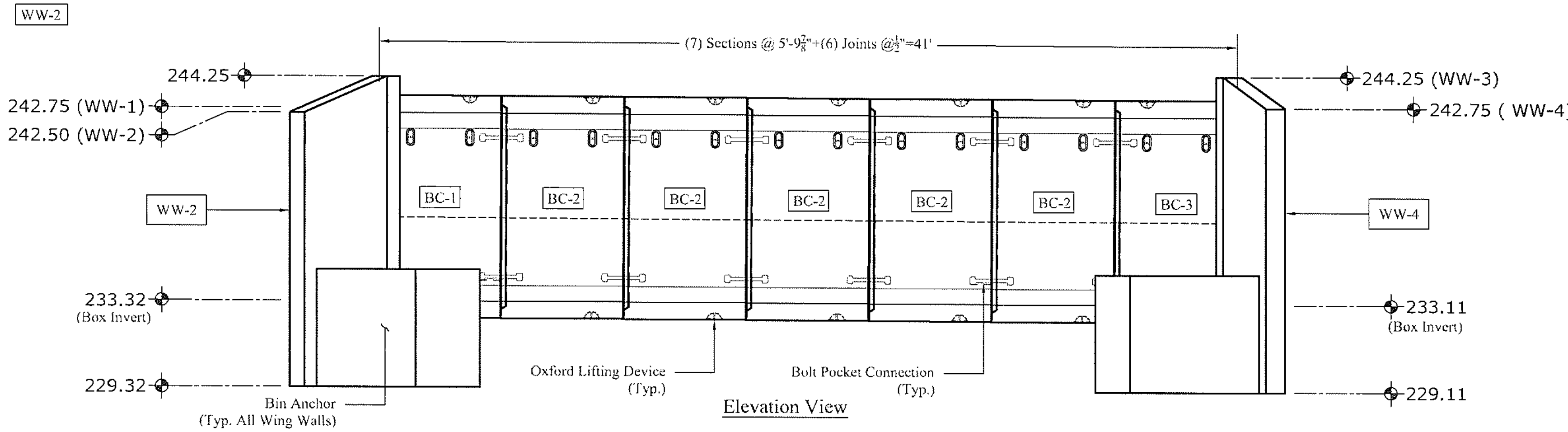
Plan View

Table of Units				
Name	Qty	Length	Vol.(CY)	Wt.(lbs.)*
BC-1*	1	5'-9⅞"	9.13	36,525
BC-2	5	5'-9⅞"	8.81	35,215
BC-3*	1	5'-9⅞"	9.29	37,145
WW-1	1	8'-0"	6.69	26,760
WW-2	1	6'-0"	5.57	22,280
WW-3	1	8'-0"	6.82	27,280
WW-4	1	6'-0"	5.51	22,040
CW-1	1	13'-8"	1.69	6,750
CW-2	1	13'-8"	1.69	6,750

* Headwall Included in BC-1 and BC-3

Culvert Specifications	
Inside Dimensions	12'-0"Wx9'-0"H
Waterway Area	76 Sq. Ft.
Top Slab Thickness	10"
Side Wall Thickness	10"
Bottom Slab Thickness	10"

WW-2

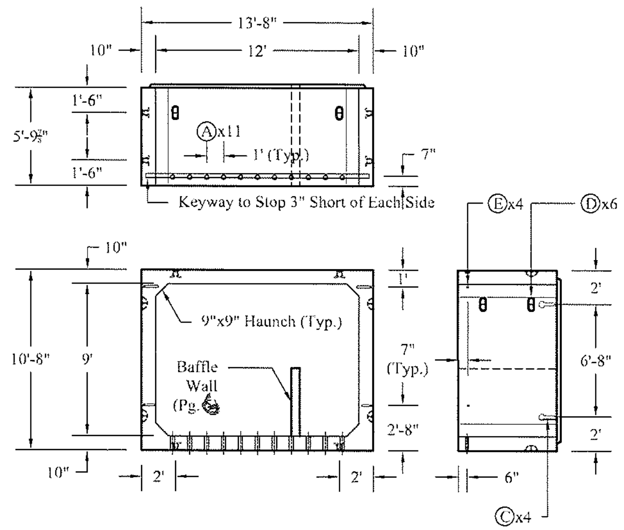


Elevation View

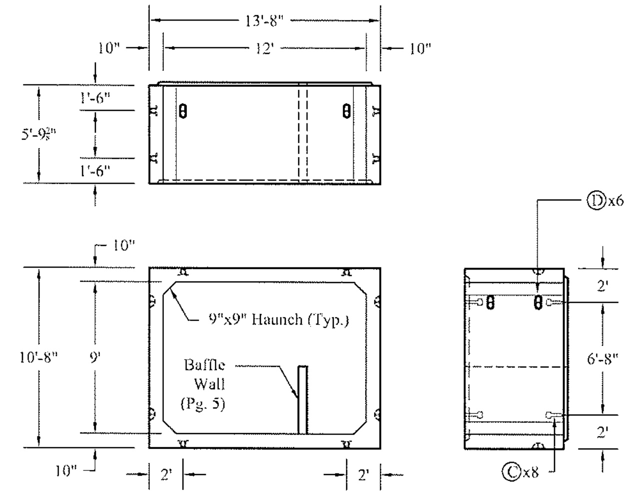
CONTRACTORS VTSPE:	PRECAST CONCRETE BOX CULVERT SHOP DRAWINGS (SDI JOB #15428)		Peckham Road Corp.	FABRICATOR:
	SUPERVISOR: E. Barendse DETAILER: I. ADAMS CHECKER: E. Barendse ENGINEER: G. K. Munkelt	PROJECT NAME: Bridport PROJECT #: CULV(29) Br.#5 LOCATION: Bridport, VT	1557 St. Rt. 9, #3 Lake George, NY 12845 Ph: (518) 747-3353	193 INDUSTRIAL AVE. WILLISTON, VT 05495 Ph: (802) 658-0201
			02/12/15	PLAN_ELEVATION 2_OF_7

SD Ireland PRECAST

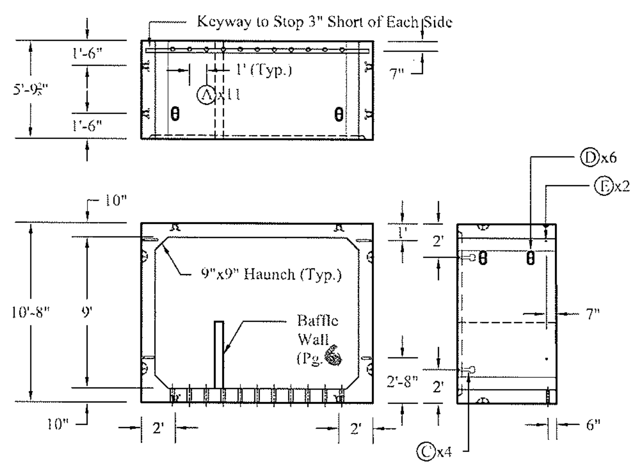
BC-1 Detail



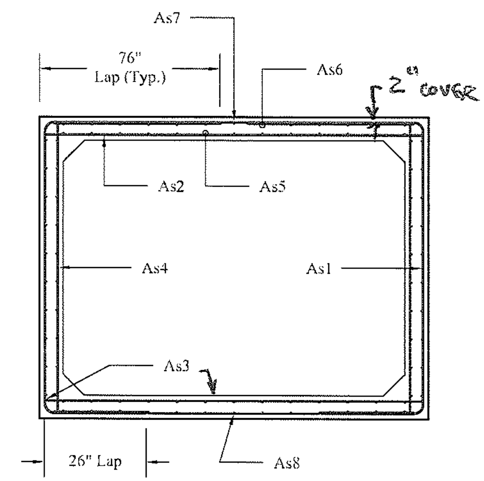
BC-2 Detail



BC-3 Detail



Box Secion Reinforcement Detail



Rebar Schedule							
Mark	Size	Max Spacing	Length	Type	A	B	
As1	#5	6"	228"	Bent	26"	126"	76"
As2	#5	6"	162"	Str	162"		
As3	#5	7"	162"	Str	162"		
As4	#4	9"	126"	Str	126"		
As5	#5	12"	68"	Str	68"		
As6	#4	9"	68"	Str	68"		
As7	#4	9"	162"	Str	162"		
As8	#4	9"	162"	Str	162"		
As9	#4	12"	68"	Str	68"		

Notes: 1" Clear Typical Unless Noted Otherwise

SHEET 4

CONTRACTORS VTSPE:

- Ⓐ 3"Ø PVC Sleeve
- Ⓑ 4"Ø PVC Sleeve
- Ⓒ Mechanical Bolt Pocket (A.L. Patterson w/ 1"Ø Coil Rod)
- Ⓓ Oxford A750-7 Lifting Device
- Ⓔ 1"Øx12" CN-9 Coil Loop Insert
- Ⓕ 1 1/2" x 3 1/2" Continuous Keyway
- Ⓖ Solid Lines Indicate ¾" Chamfer
- Ⓗ ⅝" FI 42 Ferrule Insert

PRECAST CONCRETE BOX CULVERT SHOP DRAWINGS (SDI JOB #15428)

SUPERVISOR: E. Barendse
DETAILER: I. ADAMS
CHECKER: E. Barendse
ENGINEER: G. K. Munkelt

PROJECT NAME: Bridport
PROJECT #: CULV(29) Br.#5
LOCATION: Bridport, VT

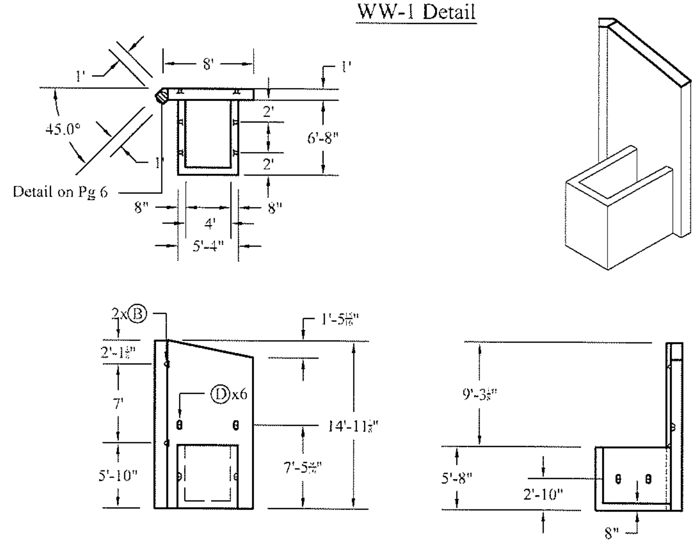
Peckham Road Corp.
1557 St. Rt. 9, #3
Lake George, NY 12845
Ph: (518) 747-3353

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

SD Ireland PRECAST

02/12/15 | BOX_SECTIONS_1 | 3_OF_7

WW-1 Detail



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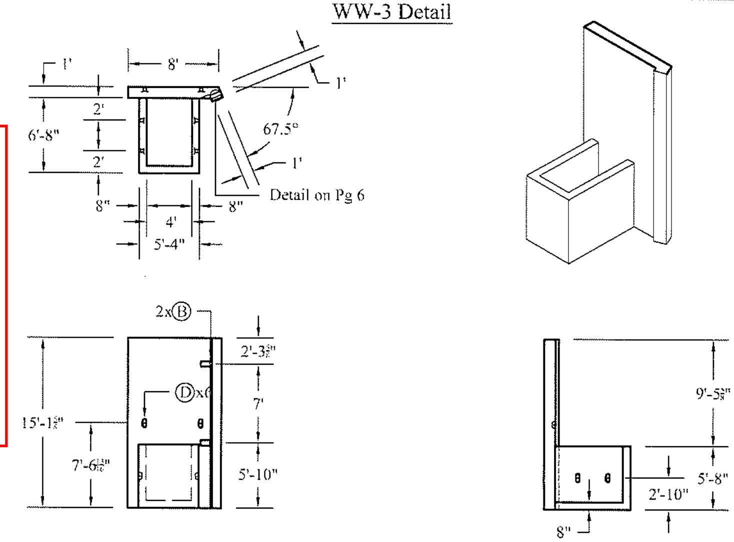
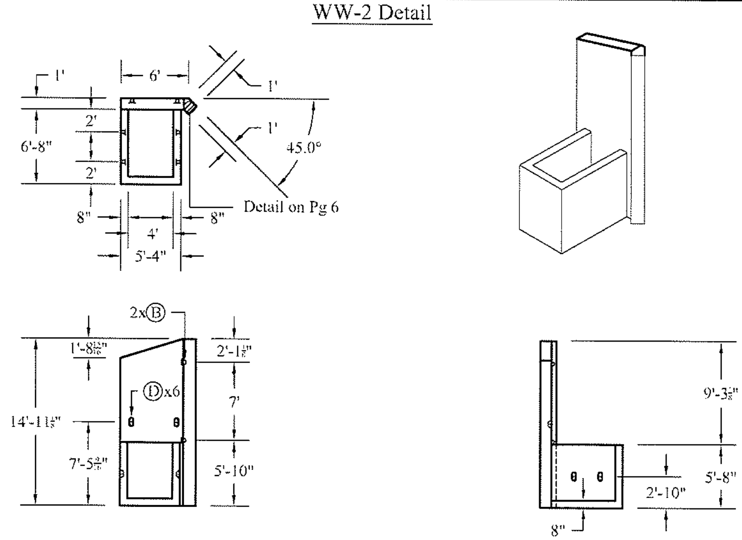


In some places (here) the box is said to have a 6'-8" dimension and others (stability calcs) it is said to have a 8'-8" dimension

WW-2 Detail



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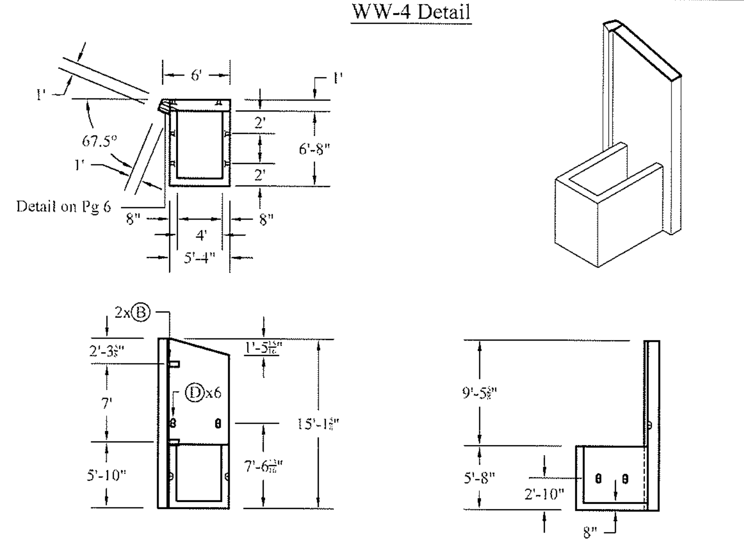

Sheet 5

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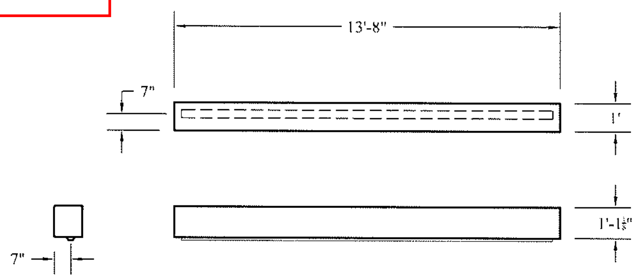
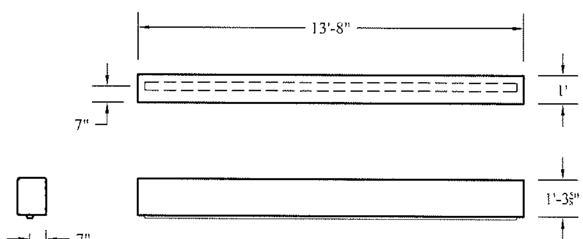
SUPERVISOR: E. Barendse DETAILER: I. ADAMS CHECKER: E. Barendse ENGINEER: G. K. Munkelt	PROJECT NAME: Bridport PROJECT #: CULV(29) Br.#5 LOCATION: Bridport, VT	02/12/15	WING_WALLS_1 — 4_OF_7

Call out headwall reinforcing

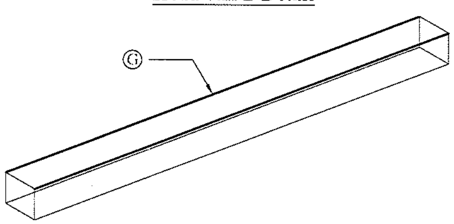
Headwall 1 Detail



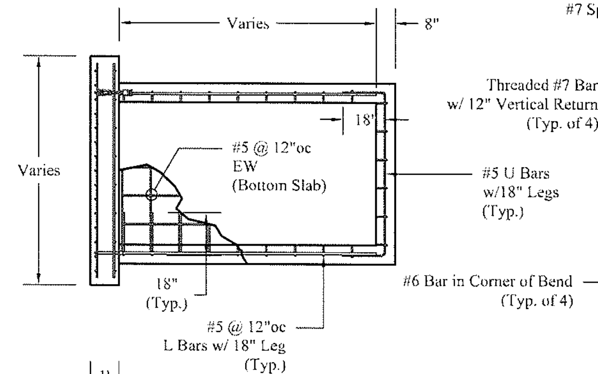
Headwall 2 Detail

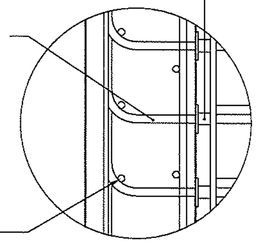


Headwall 2 Detail

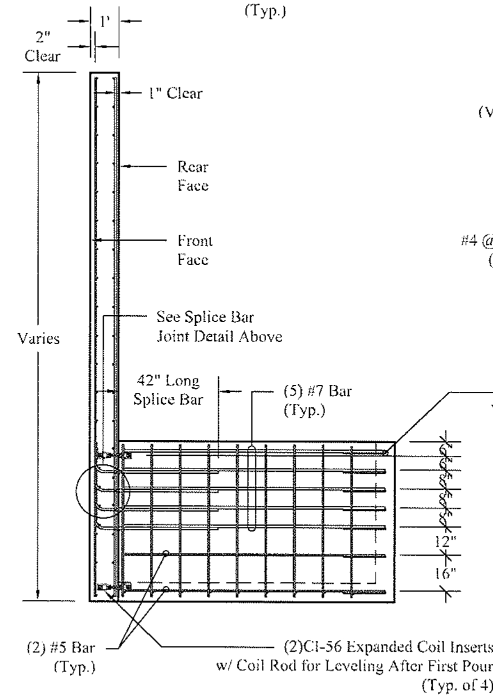


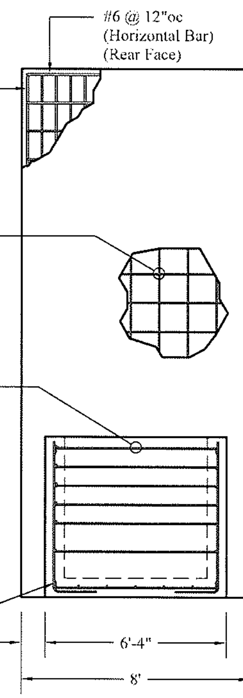
WW-Reinfocing Detail





Splice Bar Joint Detail





Sheet 6

CONTRACTORS VTSPE:

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PRECAST CONCRETE BOX CULVERT SHOP DRAWINGS (SDI JOB #15428)

SUPERVISOR: E. Barendse	PROJECT NAME: Bridport
DETAILER: I. ADAMS	PROJECT #: CULV(29) Br.#5
CHECKER: E. Barendse	LOCATION: Bridport, VT
ENGINEER: G. K. Munkelt	

Peckham Road Corp.
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WILLISTON, VT 05495
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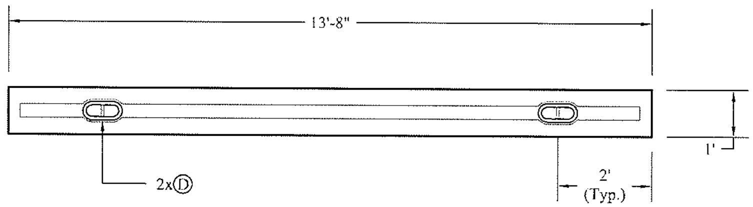
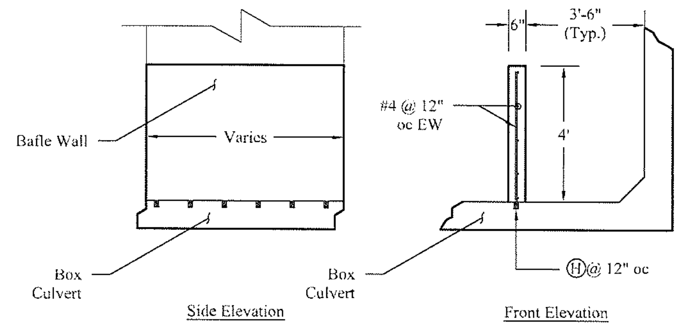
SD Ireland PRECAST

02/12/15 | HW_CW_DETAILS | 5_OF_7

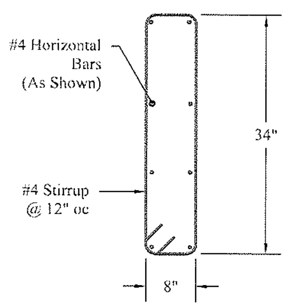
CW-1/2 Detail



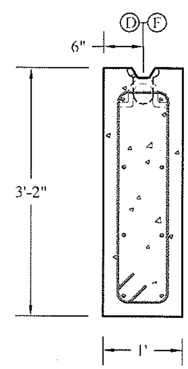
Baffle Wall Detail



Cutoff Wall Reinforcement Detail



CW-1 Detail



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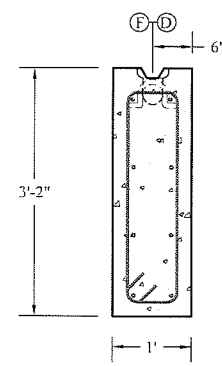

SHEET 7

CONTRACTORS VTSPE:

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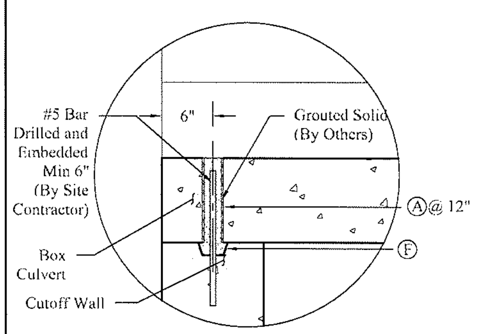
PRECAST CONCRETE BOX CULVERT SHOP DRAWINGS (SDI JOB #15428)		Peckham Road Corp. 1557 St. Rt. 9, #3 Lake George, NY 12845 Ph: (518) 747-3353	FABRICATOR: 193 INDUSTRIAL AVE. WILLISTON, VT 05495 Ph: (802) 658-0201 SD Ireland PRECAST
SUPERVISOR: E. Barendse DETAILER: I. ADAMS CHECKER: E. Barendse ENGINEER: G. K. Munkelt	PROJECT NAME: Bridport PROJECT #: CULV(29) Br.#5 LOCATION: Bridport, VT	02/12/15	HW_CW_DETAILS 6_OF_7

CW to BC Connection Detail



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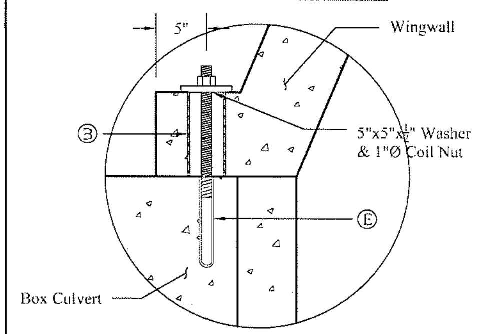
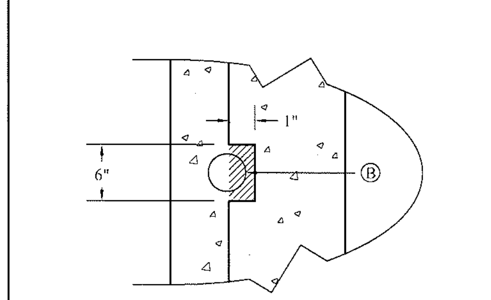
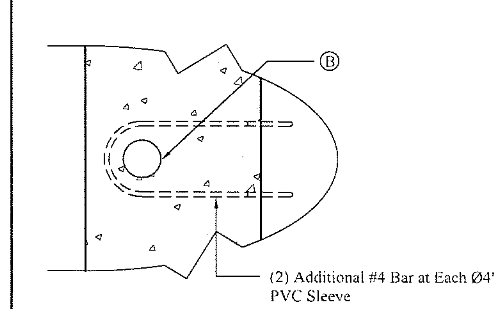


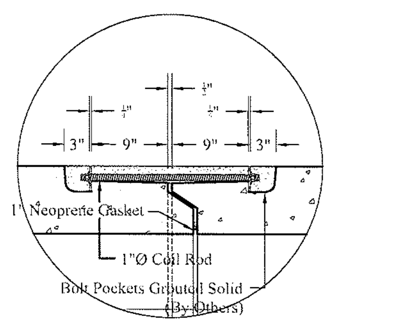
WW Sleeve Blockout Elevation Detail



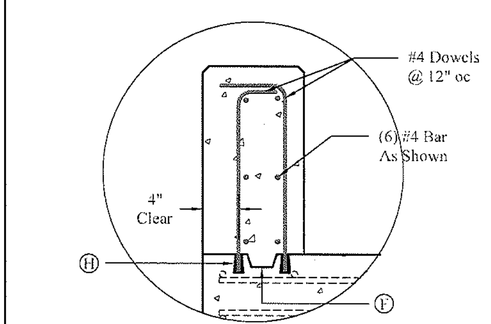
WW Sleeve Reinfrocement Detail



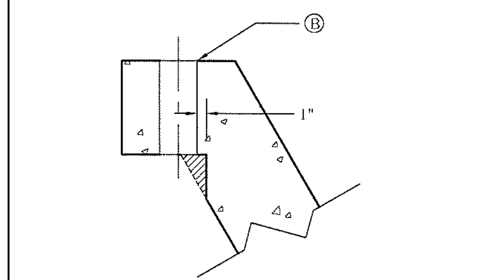
Bolt Pocket Connetion Detail



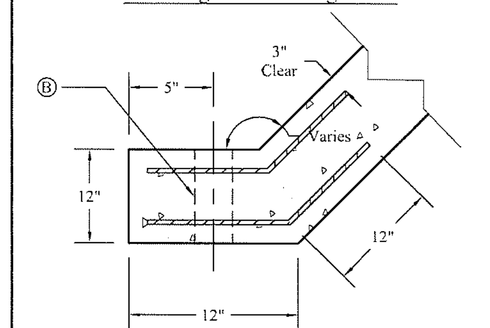
HW to BC Connection Detail



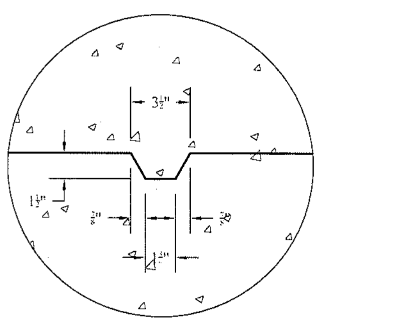
WW Sleeve Blockout Plan Detail



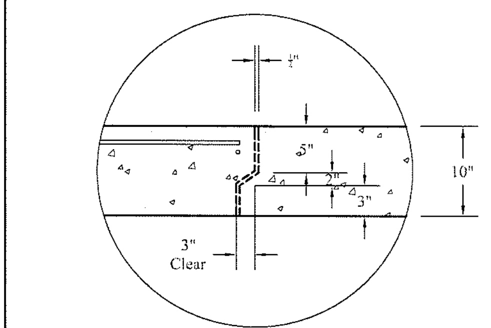
WW Angle Reinforcing Detail



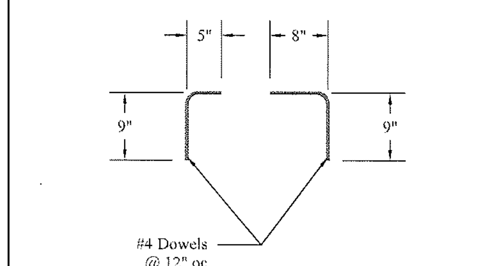
Keyway Connection Detail



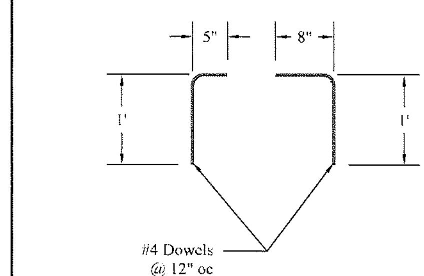
BC Vertical Shear Key Detail



HW-1 Reinforcement Detail



HW-2 Reinforcement Detail



SHEET 8

CONTRACTORS VTSPE:

- Ⓐ 3"Ø PVC Sleeve
- Ⓑ 4"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
- Ⓕ 1 1/2" x 3 1/2" Continuous Keyway
- Ⓖ Solid Lines Indicate ¾" Chamfer
- Ⓗ ⅝" FI 42 Ferrule Insert

PRECAST CONCRETE BOX CULVERT SHOP DRAWINGS (SDI JOB #15428)		Peckham Road Corp. 1557 St. Rt. 9, #3 Lake George, NY 12845 Ph: (518) 747-3353	FABRICATOR: 193 INDUSTRIAL AVE. WILLISTON, VT 05495 Ph: (802) 658-0201 SD Ireland PRECAST
SUPERVISOR: E. Barendse DETAILER: I. ADAMS CHECKER: E. Barendse ENGINEER: G. K. Munkelt	PROJECT NAME: Bridport PROJECT #: CULV(29) Br.#5 LOCATION: Bridport, VT	02/12/15	CONNECTION_DETAILS — 7_OF_7

BRASS-CULVERT

```
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 Input Filename                  : C:\Brass 2.3.0\CULVERT\Examples\SD Ireland - Bridport 5.DAT
 Output Filename                 : C:\Brass 2.3.0\CULVERT\Examples\SD Ireland - Bridport 5.xml
 Output Filename for Live Loads  : C:\Brass 2.3.0\CULVERT\Examples\SD Ireland - Bridport 5_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 - Bridport 5_INF.OUT
 Drawing                          File name : C:\Brass 2.3.0\CULVERT\Examples\SD Ireland - Bridport 5.drw
 Live Load Influence Ordinates    File name : C:\Brass 2.3.0\CULVERT\Examples\SD Ireland - Bridport 5.ill
 Live Load Actions (w/o DF or IM) File name : C:\Brass 2.3.0\CULVERT\Examples\SD Ireland - Bridport 5.oll
 Intermediate Computations        File name : C:\Brass 2.3.0\CULVERT\Examples\SD Ireland - Bridport 5.ooo
 Data Modelling                   File name : C:\Brass 2.3.0\CULVERT\Examples\SD Ireland - Bridport 5.tmp

COMMENTS             THIS FILE WAS CREATED BY THE BRASS-CULVERT GUI.
COMMENTS             DO NOT EDIT THIS FILE!
COMMENTS             JOB DESCRIPTION:
TITLE                S.D. IRELAND - BRIDPORT
STRUCTID             12-0 X 9-0
AGENCY
COMMENTS
UNITSIN              US
UNITSOUT             US
COMMENTS             ANALYSIS CONTROL:
TYPE                 PC
FUNCT                DESREV
LRFR                 NO
IRELEASE             NO
IDSN                 LRFD
KBASE                FULL
KHACH                YES
EPOXY                NO
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                 120.000
AWGT                 145.000
FYST                 60000.000
CN                   7.1178
COMMENTS             BOX GEOMETRY:
```

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NBOX	1
NSPAN	12.0000
NHITE	9.0000
LENG	5.8200
BWIDTH	41.0000
CBWIDTH	36.0000
TSLAB	10.0000
KFXTS	F
BSLAB	10.0000
KFXBS	F
WALLR	10.0000
KFXW	F
COMMENTS	SKEW:
CSKEW	0.0000
COMMENTS	HAUNCHES:
TFILT	9.0000
BFILT	9.0000
COMMENTS	CONCRETE COVER:
COVS	2.0000
COVB	1.0000
COVW	1.0000
COVIN	1.0000
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:

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DESREV	YES
TCBSZ	5
TCBSP	6.0000
BCBSZ	5
BCBSP	6.0000
TSIFTSZ	5
TSIFTSP	6.0000
TSOFTSZ	4
TSOFTSP	9.0000
BSIFTSZ	5
BSIFTSP	7.0000
BSOFTSZ	4
BSOFTSP	9.0000
EWIFVSZ	4
EWIFVSP	9.0000
EWOFVSZ	5
EWOFVSP	6.0000

End of Input File No. 1

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)	=	12.0
NHITE:	Clear Height (Ft)	=	9.0
NFILL:	Design Fill Measured from Top of Top Slab(Ft)	=	2.0
LENG:	Section length(PC)-Culvert Length(CIP)(Ft)	=	5.8

Geometry - Slab Thickness Variables			
TSLAB:	Thickness of top Slab (In)	=	10.0
BSLAB:	Thickness of Bottom Slab(In)	=	10.0
WALLR:	Thickness of Exterior Wall (In)	=	10.0

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)	=	0.0
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)	=	1.0
COVW:	Exterior Concrete Cover Walls (In)	=	1.0
COVIN:	Interior Concrete Cover (In)	=	1.0

Material Properties Variables			
EWGT:	Weight of Soil (Pcf)	=	120.0
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 - BRIDPORT
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: NO
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.	120.	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	12.00	9.00	5.82

Bridge Width (Ft)	Clear Bridge Width (Ft)	Number of Traffic Lanes
41.00	36.00	3

Slab and Wall Information

Top Slab (In)	Bottom Slab (In)	Exterior Wall (In)	Interior Wall (In)
10.00 Fixed	10.00 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	0.0

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	1.00	1.00	1.00

Bar sizes and spacings with computed areas of steel

Areas of steel are in in2/ft

```
                          Top slab
LEFT SIDE                  CENTER                          RIGHT SIDE
area  0.6200 in2           area  0.6200 in2                area  0.6200 in2
size  5 spaced at   6.00 in.  size  5 spaced at   6.00 in.  size  5 spaced at   6.00 in.
***************************************************************************

 Exterior wall
TOP
area  0.6200 in2
size  5 spaced at   6.00 in.


OUTSIDE FACE
area  0.6200 in2
size  5 spaced at   6.00 in.

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


BOTTOM
area  0.6200 in2
size  5 spaced at   6.00 in.
***************************************************************************

                          Bottom slab
LEFT SIDE                  CENTER                          RIGHT SIDE
area  0.6200 in2           area  0.5314 in2                area  0.6200 in2
size  5 spaced at   6.00 in.  size  5 spaced at   7.00 in.  size  5 spaced at   6.00 in.
```

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LRFD Live Load Distribution Factor Computation

Input Values

Depth of Fill	= 1.99 ft.	
Span Length	= 12.00 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	= 41.00 ft.	
Length	= 5.82 ft.	

Compute Strip Width by 4.6.2.10.2-1

E = 96 + 1.44 S ft
E = 96 + 1.44 (12.00 ft.)
E = 9.44 ft.

Controlling Distribution Factor

Final Strip Width = 9.44 ft.
Final Distribution Factor = 1/Final Strip Width = **0.11** Lanes per ft. of width
Multiple Presence Factor = 1.20
Distribution Factor * Multiple Presence Factor = **0.13**

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	=	10.0000 In.
Bottom Slab thickness	=	10.0000 In.
Exterior Wall thickness	=	10.0000 In.
Design Span(c-c walls)	=	12.8333 Ft.
Design Height(c-c slabs)	=	9.8333 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	=	0.1380 Kcf
Weight of Fill without wearing surface	=	0.2746 Klf
Weight of Wearing Surface	=	0.0000 Klf
Weight of Top Slab	=	0.1250 Klf
Weight of Extra Uniform Dead Load	=	0.0000 Klf
Uniform Dead Load on Top Slab	=	0.3996 Klf
Weight of Walls divided by culvert width	=	0.1646 Klf
Uniform Dead Load on Bottom Slab	=	0.5643 Klf
Soil pressure at center of top slab	=	0.1444 Klf
Soil pressure at center of bottom slab	=	0.7344 Klf
Soil pressure due to live load surcharge	=	0.0820 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.

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

   Axle Weights      Spacing
         (kips)        (ft)

          8.00       14.000
         32.00       14.000
         32.00        0.000

         ------      ------
Totals   72.00       28.000
```

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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 Pos Kft	LOADS Neg Kft
EXTERIOR WALL BOTTOM							
1- 0	-4.64	-1.62	-0.81	-0.29	0.00	0.00	-3.68
1- 1	-4.46	0.65	0.33	0.07	0.00	0.00	-3.32
1- 2	-4.28	2.27	1.14	0.35	0.00	0.00	-3.21
1- 3	-4.10	3.29	1.65	0.55	0.00	0.00	-3.43
1- 4	-3.92	3.77	1.89	0.67	0.00	0.00	-3.71
1- 5	-3.74	3.77	1.89	0.70	0.00	0.00	-3.98
1- 6	-3.57	3.35	1.68	0.67	0.00	0.00	-4.26
1- 7	-3.39	2.56	1.28	0.55	0.00	0.00	-4.53
1- 8	-3.21	1.46	0.73	0.35	0.00	0.00	-4.81
1- 9	-3.03	0.10	0.05	0.07	0.00	0.22	-5.09
1-10	-2.85	-1.45	-0.73	-0.29	0.00	0.66	-5.36
EXTERIOR WALL TOP							
TOP SLAB LEFT SIDE							
2- 0	-2.85	-1.45	-0.73	-0.29	0.00	0.66	-5.36
2- 1	0.11	-1.45	-0.73	-0.29	0.00	3.66	-1.66
2- 2	2.42	-1.45	-0.72	-0.29	0.00	6.64	0.00
2- 3	4.06	-1.45	-0.72	-0.29	0.00	9.12	0.00
2- 4	5.05	-1.45	-0.72	-0.29	0.00	10.76	0.00
2- 5	5.38	-1.44	-0.72	-0.29	0.00	11.31	0.00
2- 6	5.05	-1.44	-0.72	-0.29	0.00	10.75	0.00
2- 7	4.07	-1.44	-0.72	-0.29	0.00	9.14	0.00
2- 8	2.42	-1.44	-0.72	-0.29	0.00	6.65	0.00
2- 9	0.12	-1.44	-0.72	-0.29	0.00	3.66	-1.67
2-10	-2.84	-1.43	-0.72	-0.29	0.00	0.67	-5.37
TOP SLAB RIGHT SIDE							
BOTTOM SLAB LEFT SIDE							
4- 0	-4.64	-1.62	-0.81	-0.29	0.00	0.00	-3.68
4- 1	-0.46	-1.62	-0.81	-0.29	0.00	0.31	-0.74
4- 2	2.79	-1.62	-0.81	-0.29	0.00	2.53	0.00
4- 3	5.12	-1.62	-0.81	-0.29	0.00	4.12	0.00
4- 4	6.51	-1.63	-0.81	-0.29	0.00	5.06	0.00
4- 5	6.97	-1.63	-0.81	-0.29	0.00	5.38	0.00
4- 6	6.51	-1.63	-0.82	-0.29	0.00	5.07	0.00
4- 7	5.11	-1.63	-0.82	-0.29	0.00	4.12	0.00
4- 8	2.79	-1.63	-0.82	-0.29	0.00	2.54	0.00
4- 9	-0.46	-1.64	-0.82	-0.29	0.00	0.32	-0.77
4-10	-4.65	-1.64	-0.82	-0.29	0.00	0.00	-3.71
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 Pos	LOADS Neg
	K	K	K	K	K	K	K
EXTERIOR WALL BOTTOM							
1- 0	0.18	2.66	1.33	0.40	0.00	0.43	-0.28
1- 1	0.18	1.97	0.98	0.32	0.00	0.43	-0.28
1- 2	0.18	1.33	0.67	0.24	0.00	0.43	-0.28
1- 3	0.18	0.76	0.38	0.16	0.00	0.43	-0.28
1- 4	0.18	0.24	0.12	0.08	0.00	0.43	-0.28
1- 5	0.18	-0.23	-0.11	0.00	0.00	0.43	-0.28
1- 6	0.18	-0.63	-0.31	-0.08	0.00	0.43	-0.28
1- 7	0.18	-0.97	-0.49	-0.16	0.00	0.43	-0.28
1- 8	0.18	-1.26	-0.63	-0.24	0.00	0.43	-0.28
1- 9	0.18	-1.49	-0.74	-0.32	0.00	0.43	-0.28
1-10	0.18	-1.66	-0.83	-0.40	0.00	0.43	-0.28
EXTERIOR WALL TOP							
TOP SLAB LEFT SIDE							
2- 0	2.56	0.00	0.00	0.00	0.00	5.05	0.00
2- 1	2.05	0.00	0.00	0.00	0.00	4.47	-0.35
2- 2	1.54	0.00	0.00	0.00	0.00	3.97	-0.80
2- 3	1.03	0.00	0.00	0.00	0.00	3.40	-1.33
2- 4	0.51	0.00	0.00	0.00	0.00	2.80	-1.92
2- 5	0.00	0.00	0.00	0.00	0.00	2.19	-2.53
2- 6	-0.51	0.00	0.00	0.00	0.00	1.58	-3.14
2- 7	-1.03	0.00	0.00	0.00	0.00	1.03	-3.73
2- 8	-1.54	0.00	0.00	0.00	0.00	0.54	-4.26
2- 9	-2.05	0.00	0.00	0.00	0.00	0.17	-4.71
2-10	-2.56	0.00	0.00	0.00	0.00	0.00	-5.06
TOP SLAB RIGHT SIDE							
BOTTOM SLAB LEFT SIDE							
4- 0	3.62	0.00	0.00	0.00	0.00	2.60	0.00
4- 1	2.90	0.00	0.00	0.00	0.00	2.09	0.00
4- 2	2.17	0.00	0.00	0.00	0.00	1.58	0.00
4- 3	1.45	0.00	0.00	0.00	0.00	1.08	0.00
4- 4	0.72	0.00	0.00	0.00	0.00	0.57	0.00
4- 5	0.00	0.00	0.00	0.00	0.00	0.06	-0.06
4- 6	-0.72	0.00	0.00	0.00	0.00	0.00	-0.57
4- 7	-1.45	0.00	0.00	0.00	0.00	0.00	-1.08
4- 8	-2.17	0.00	0.00	0.00	0.00	0.00	-1.58
4- 9	-2.90	0.00	0.00	0.00	0.00	0.00	-2.09
4-10	-3.62	0.00	0.00	0.00	0.00	0.00	-2.60
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 K	Soil Press (Max) K	Soil Press (Min) K	Surch Hgt. K	Water Press (Max) K	LIVE Pos K	LOADS Neg K
EXTERIOR WALL BOTTOM							
1- 0	-2.56	0.00	0.00	0.00	0.00	0.00	-4.97
1- 1	-2.56	0.00	0.00	0.00	0.00	0.00	-4.97
1- 2	-2.56	0.00	0.00	0.00	0.00	0.00	-4.97
1- 3	-2.56	0.00	0.00	0.00	0.00	0.00	-4.97
1- 4	-2.56	0.00	0.00	0.00	0.00	0.00	-4.97
1- 5	-2.56	0.00	0.00	0.00	0.00	0.00	-4.97
1- 6	-2.56	0.00	0.00	0.00	0.00	0.00	-4.97
1- 7	-2.56	0.00	0.00	0.00	0.00	0.00	-4.97
1- 8	-2.56	0.00	0.00	0.00	0.00	0.00	-4.97
1- 9	-2.56	0.00	0.00	0.00	0.00	0.00	-4.97
1-10	-2.56	0.00	0.00	0.00	0.00	0.00	-4.97
EXTERIOR WALL TOP							
TOP SLAB LEFT SIDE							
2- 0	0.18	-1.66	-0.83	-0.40	0.00	0.42	-0.28
2- 1	0.18	-1.66	-0.83	-0.40	0.00	0.42	-0.28
2- 2	0.18	-1.66	-0.83	-0.40	0.00	0.42	-0.28
2- 3	0.18	-1.66	-0.83	-0.40	0.00	0.42	-0.28
2- 4	0.18	-1.66	-0.83	-0.40	0.00	0.42	-0.28
2- 5	0.18	-1.66	-0.83	-0.40	0.00	0.42	-0.28
2- 6	0.18	-1.66	-0.83	-0.40	0.00	0.42	-0.28
2- 7	0.18	-1.66	-0.83	-0.40	0.00	0.42	-0.28
2- 8	0.18	-1.66	-0.83	-0.40	0.00	0.42	-0.28
2- 9	0.18	-1.66	-0.83	-0.40	0.00	0.42	-0.28
2-10	0.18	-1.66	-0.83	-0.40	0.00	0.42	-0.28
TOP SLAB RIGHT SIDE							
BOTTOM SLAB LEFT SIDE							
4- 0	-0.18	-2.66	-1.33	-0.40	0.00	0.28	-0.42
4- 1	-0.18	-2.66	-1.33	-0.40	0.00	0.28	-0.42
4- 2	-0.18	-2.66	-1.33	-0.40	0.00	0.28	-0.42
4- 3	-0.18	-2.66	-1.33	-0.40	0.00	0.28	-0.42
4- 4	-0.18	-2.66	-1.33	-0.40	0.00	0.28	-0.42
4- 5	-0.18	-2.66	-1.33	-0.40	0.00	0.28	-0.42
4- 6	-0.18	-2.66	-1.33	-0.40	0.00	0.28	-0.42
4- 7	-0.18	-2.66	-1.33	-0.40	0.00	0.28	-0.42
4- 8	-0.18	-2.66	-1.33	-0.40	0.00	0.28	-0.42
4- 9	-0.18	-2.66	-1.33	-0.40	0.00	0.28	-0.42
4-10	-0.18	-2.66	-1.33	-0.40	0.00	0.28	-0.42
BOTTOM SLAB RIGHT SIDE							

Factors for Ductility 1.00
Redundancy 1.00
Operations 1.00

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Fatigue Checks

$f_s <= f_f = 24 - 0.33f_{min}$ (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	-91.93	24030.34	10491.82	**Pass**
TOP SLAB	Left	1067.13	24352.15	6105.86	**Pass**
TOP SLAB	Middle -	1067.13	24352.15	6123.17	**Pass**
BOTTOM SLAB	Left	1041.01	24343.53	2990.13	**Pass**
BOTTOM SLAB	Middle -	1041.01	24343.53	3017.13	**Pass**

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	0.75	10.00	1.00	1.16	10.47	6.00	56.64	36.34
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	0.75	10.00	1.00	1.16	12.84	7.00	50.34	30.53
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.							

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Lateral Distribution Steel:
  Span Length                              =   12.833 feet
  Percentage of main reinforcement required =   27.915% , less than or equal to 50%
  Main reinforcement area (top slab)        =    0.620 in^2
  Required lateral distribution area        =    0.173 in^2
  Because the required area is less than the minimum, an area of steel of   0.200 in^2 is used.
  Main reinforcement area (bottom slab)     =    0.531 in^2
  Required lateral distribution area        =    0.148 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  0.6200 in2             area  0.6200 in2              area  0.6200 in2
size  5 spaced at   6.00 in. size  5 spaced at   6.00 in.  size  5 spaced at   6.00 in.
****************************************************************************

 Exterior wall
TOP
area  0.6200 in2
size  5 spaced at   6.00 in.


OUTSIDE FACE
area  0.6200 in2
size  5 spaced at   6.00 in.

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


BOTTOM
area  0.6200 in2
size  5 spaced at   6.00 in.
****************************************************************************

                           Bottom slab
LEFT SIDE                    CENTER                        RIGHT SIDE
area  0.6200 in2             area  0.5314 in2              area  0.6200 in2
size  5 spaced at   6.00 in. size  5 spaced at   7.00 in.  size  5 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	10.00	0.00	0.6200	0.6200	5	6.0	76
A2	8.55	36.34	0.6200	0.6200	5	6.0	37
A100	36.34	56.64	0.6200	0.6200	5	6.0	
A200	30.53	50.34	0.5314	0.5314	5	7.0	
B1	3.82	30.53	0.2667	0.2667	4	9.0	
B2	13.29	30.53	0.6200	0.6200	5	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	=	1.00 (in)
Clear cover at middle	=	1.00 (in)
Bar diameter (bot)	=	0.62 (in)
Bar diameter (mid+)	=	0.50 (in)
Bar diameter (mid-)	=	0.62 (in)
Bar diameter (top)	=	0.62 (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	-8.9	11.0	4.0	27.5	380.5	25.8	50.3	138.1	0.6200	26.1	8.69	n/a
MID	3.9	11.0	0.7	39.6	368.8	11.5	45.3	156.2	0.2667	11.7	8.75	0.3
MID-	-7.0	11.0	0.7	33.3	380.5	25.8	50.3	138.1	0.6200	26.1	8.69	n/a
TOP	-11.3	11.0	2.9	25.9	380.5	25.8	50.3	138.1	0.6200	26.1	8.69	n/a

Member No. = 2 TOP SLAB

Thickness	=	10.00 (in)
Clear cover at end	=	2.00 (in)
Clear cover at middle	=	1.00 (in)
Bar diameter (lt)	=	0.62 (in)
Bar diameter (mid)	=	0.62 (in)
Bar diameter (rt)	=	0.62 (in)

LT	-6.1	3.3	9.9	20.0	380.5	22.7	46.0	118.7	0.6200	22.8	7.69	n/a
MID	22.7	3.3	3.8	16.3	380.5	25.8	50.3	138.1	0.6200	25.9	8.69	0.9
RT	-6.1	3.3	9.9	13.2	380.5	22.7	46.0	118.7	0.6200	22.8	7.69	n/a

Member No. = 4 BOTTOM SLAB

Thickness	=	10.00 (in)
Clear cover at end	=	1.00 (in)
Clear cover at middle	=	1.00 (in)
Bar diameter (lt)	=	0.62 (in)
Bar diameter (mid)	=	0.62 (in)
Bar diameter (rt)	=	0.62 (in)

LT	-5.2	5.2	6.4	27.2	380.5	25.8	50.3	138.1	0.6200	25.9	8.69	n/a
MID	13.6	5.2	0.1	22.1	377.5	22.3	49.0	142.3	0.5314	22.4	8.69	0.6
RT	-5.3	5.2	6.4	19.9	380.5	25.8	50.3	138.1	0.6200	25.9	8.69	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.

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 - Bridport 5.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	-5.142	-13.344	-1.637	-11.027	5.215	2.013
1- 1	-1.839	-9.288	-1.637	-11.026	4.138	1.389
1- 2	0.944	-7.467	-1.637	-11.026	3.140	0.818
1- 3	2.784	-6.777	-1.637	-11.026	2.220	0.298
1- 4	3.758	-6.659	-1.637	-11.026	1.378	-0.169
1- 5	3.942	-6.978	-1.637	-11.026	0.715	-0.685
1- 6	3.414	-7.680	-1.637	-11.026	0.353	-1.370
1- 7	2.251	-8.713	-1.637	-11.026	0.042	-1.977
1- 8	0.529	-10.025	-1.637	-11.026	-0.216	-2.506
1- 9	-1.286	-11.566	-1.637	-11.026	-0.422	-2.956
1-10	-2.629	-14.446	-1.637	-11.027	-0.576	-3.328
EXTERIOR WALL TOP						
TOP SLAB LEFT SIDE						
2- 0	-2.629	-14.446	-1.384	-3.276	11.167	1.636
2- 1	4.546	-5.295	-1.334	-3.326	9.689	0.693
2- 2	11.854	-0.919	-1.334	-3.326	8.347	-0.417
2- 3	17.706	0.000	-1.334	-3.326	6.888	-1.677
2- 4	21.465	0.000	-1.334	-3.326	5.364	-3.030
2- 5	22.731	0.000	-1.334	-3.326	3.827	-4.421
2- 6	21.470	0.000	-1.334	-3.326	2.449	-5.960
2- 7	17.754	0.000	-1.334	-3.326	1.145	-7.454
2- 8	11.907	-0.900	-1.334	-3.326	-0.035	-8.849
2- 9	4.582	-5.283	-1.334	-3.326	-1.013	-10.112
2-10	-2.576	-14.428	-1.384	-3.276	-1.632	-11.192
TOP SLAB RIGHT SIDE						
BOTTOM SLAB LEFT SIDE						
4- 0	-5.142	-13.344	-3.213	-5.205	7.842	2.305
4- 1	-1.939	-4.409	-3.213	-5.205	6.295	1.844
4- 2	4.782	-0.911	-3.263	-5.155	4.748	1.382
4- 3	9.667	0.000	-3.263	-5.155	3.201	0.921
4- 4	12.588	0.000	-3.263	-5.155	1.654	0.459
4- 5	13.560	0.000	-3.263	-5.155	0.107	-0.111
4- 6	12.586	0.000	-3.263	-5.155	-0.463	-1.658
4- 7	9.661	0.000	-3.263	-5.155	-0.925	-3.205
4- 8	4.774	-0.930	-3.263	-5.155	-1.386	-4.752
4- 9	-1.952	-4.484	-3.213	-5.205	-1.848	-6.299
4-10	-5.173	-13.428	-3.213	-5.205	-2.310	-7.846
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	= 12.00 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	= 41.00 ft.	
Length	= 5.82 ft.	

Compute Strip Width by 4.6.2.10.2-1

E = 96 + 1.44 S ft
E = 96 + 1.44 (12.00 ft.)
E = 9.44 ft.

Controlling Distribution Factor

Final Strip Width = 9.44 ft.

Final Distribution Factor = 1/Final Strip Width = **0.11** Lanes per ft. of width

Multiple Presence Factor = 1.20

Distribution Factor * Multiple Presence Factor = **0.13**

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


  Axle Weights      Spacing
        (kips)        (ft)

        25.00        4.000
        25.00        0.000

        ------       ------
Totals  50.00        4.000
```

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 Kft	Soil Press (Max) Kft	Soil Press (Min) Kft	Surch Hgt. Kft	Water Press (Max) Kft	LIVE Pos Kft	LOADS Neg Kft
EXTERIOR WALL BOTTOM							
1- 0	-4.64	-1.62	-0.81	-0.29	0.00	0.00	-5.39
1- 1	-4.46	0.65	0.33	0.07	0.00	0.00	-5.05
1- 2	-4.28	2.27	1.14	0.35	0.00	0.00	-4.95
1- 3	-4.10	3.29	1.65	0.55	0.00	0.00	-5.19
1- 4	-3.92	3.77	1.89	0.67	0.00	0.00	-5.47
1- 5	-3.74	3.77	1.89	0.70	0.00	0.00	-5.76
1- 6	-3.57	3.35	1.68	0.67	0.00	0.00	-6.04
1- 7	-3.39	2.56	1.28	0.55	0.00	0.00	-6.33
1- 8	-3.21	1.46	0.73	0.35	0.00	0.00	-6.62
1- 9	-3.03	0.10	0.05	0.07	0.00	0.11	-6.90
1-10	-2.85	-1.45	-0.73	-0.29	0.00	0.44	-7.19
EXTERIOR WALL TOP							
TOP SLAB LEFT SIDE							
2- 0	-2.85	-1.45	-0.73	-0.29	0.00	0.44	-7.19
2- 1	0.11	-1.45	-0.73	-0.29	0.00	2.86	-1.87
2- 2	2.42	-1.45	-0.72	-0.29	0.00	6.12	0.00
2- 3	4.06	-1.45	-0.72	-0.29	0.00	9.45	0.00
2- 4	5.05	-1.45	-0.72	-0.29	0.00	11.24	0.00
2- 5	5.38	-1.44	-0.72	-0.29	0.00	11.45	0.00
2- 6	5.05	-1.44	-0.72	-0.29	0.00	11.38	0.00
2- 7	4.07	-1.44	-0.72	-0.29	0.00	9.67	0.00
2- 8	2.42	-1.44	-0.72	-0.29	0.00	6.36	0.00
2- 9	0.12	-1.44	-0.72	-0.29	0.00	2.61	-1.88
2-10	-2.84	-1.43	-0.72	-0.29	0.00	0.53	-7.22
TOP SLAB RIGHT SIDE							
BOTTOM SLAB LEFT SIDE							
4- 0	-4.64	-1.62	-0.81	-0.29	0.00	0.00	-5.39
4- 1	-0.46	-1.62	-0.81	-0.29	0.00	0.23	-0.76
4- 2	2.79	-1.62	-0.81	-0.29	0.00	3.75	0.00
4- 3	5.12	-1.62	-0.81	-0.29	0.00	6.26	0.00
4- 4	6.51	-1.63	-0.81	-0.29	0.00	7.76	0.00
4- 5	6.97	-1.63	-0.81	-0.29	0.00	8.26	0.00
4- 6	6.51	-1.63	-0.82	-0.29	0.00	7.76	0.00
4- 7	5.11	-1.63	-0.82	-0.29	0.00	6.26	0.00
4- 8	2.79	-1.63	-0.82	-0.29	0.00	3.76	0.00
4- 9	-0.46	-1.64	-0.82	-0.29	0.00	0.24	-0.75
4-10	-4.65	-1.64	-0.82	-0.29	0.00	0.00	-5.38
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 K	Soil Press (Max) K	Soil Press (Min) K	Surch Hgt. K	Water Press (Max) K	LIVE LOADS Pos K	LIVE LOADS Neg K
EXTERIOR WALL BOTTOM							
1- 0	0.18	2.66	1.33	0.40	0.00	0.35	-0.29
1- 1	0.18	1.97	0.98	0.32	0.00	0.35	-0.29
1- 2	0.18	1.33	0.67	0.24	0.00	0.35	-0.29
1- 3	0.18	0.76	0.38	0.16	0.00	0.35	-0.29
1- 4	0.18	0.24	0.12	0.08	0.00	0.35	-0.29
1 5	0.10	0.23	0.11	0.00	0.00	0.35	0.29
1- 6	0.18	-0.63	-0.31	-0.08	0.00	0.35	-0.29
1- 7	0.18	-0.97	-0.49	-0.16	0.00	0.35	-0.29
1- 8	0.18	-1.26	-0.63	-0.24	0.00	0.35	-0.29
1- 9	0.18	-1.49	-0.74	-0.32	0.00	0.35	-0.29
1-10	0.18	-1.66	-0.83	-0.40	0.00	0.35	-0.29
EXTERIOR WALL TOP							
TOP SLAB LEFT SIDE							
2- 0	2.56	0.00	0.00	0.00	0.00	6.74	0.00
2- 1	2.05	0.00	0.00	0.00	0.00	5.59	-0.28
2- 2	1.54	0.00	0.00	0.00	0.00	4.71	-0.63
2- 3	1.03	0.00	0.00	0.00	0.00	3.80	-1.04
2- 4	0.51	0.00	0.00	0.00	0.00	2.90	-1.74
2- 5	0.00	0.00	0.00	0.00	0.00	2.05	-2.56
2- 6	-0.51	0.00	0.00	0.00	0.00	1.37	-3.44
2- 7	-1.03	0.00	0.00	0.00	0.00	0.83	-4.36
2- 8	-1.54	0.00	0.00	0.00	0.00	0.45	-5.25
2- 9	-2.05	0.00	0.00	0.00	0.00	0.13	-6.08
2-10	-2.56	0.00	0.00	0.00	0.00	0.00	-6.82
TOP SLAB RIGHT SIDE							
BOTTOM SLAB LEFT SIDE							
4- 0	3.62	0.00	0.00	0.00	0.00	4.02	0.00
4- 1	2.90	0.00	0.00	0.00	0.00	3.23	0.00
4- 2	2.17	0.00	0.00	0.00	0.00	2.44	0.00
4- 3	1.45	0.00	0.00	0.00	0.00	1.64	0.00
4- 4	0.72	0.00	0.00	0.00	0.00	0.85	0.00
4- 5	0.00	0.00	0.00	0.00	0.00	0.06	-0.06
4- 6	-0.72	0.00	0.00	0.00	0.00	0.00	-0.85
4- 7	-1.45	0.00	0.00	0.00	0.00	0.00	-1.64
4- 8	-2.17	0.00	0.00	0.00	0.00	0.00	-2.44
4- 9	-2.90	0.00	0.00	0.00	0.00	0.00	-3.23
4-10	-3.62	0.00	0.00	0.00	0.00	0.00	-4.02
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 K	Soil Press (Max) K	Soil Press (Min) K	Surch Hgt. K	Water Press (Max) K	LIVE Pos K	LOADS Neg K
EXTERIOR WALL BOTTOM							
1- 0	-2.56	0.00	0.00	0.00	0.00	0.00	-6.74
1- 1	-2.56	0.00	0.00	0.00	0.00	0.00	-6.74
1- 2	-2.56	0.00	0.00	0.00	0.00	0.00	-6.74
1- 3	-2.56	0.00	0.00	0.00	0.00	0.00	-6.74
1- 4	-2.56	0.00	0.00	0.00	0.00	0.00	-6.74
1- 5	-2.56	0.00	0.00	0.00	0.00	0.00	-6.74
1- 6	-2.56	0.00	0.00	0.00	0.00	0.00	-6.74
1- 7	-2.56	0.00	0.00	0.00	0.00	0.00	-6.74
1- 8	-2.56	0.00	0.00	0.00	0.00	0.00	-6.74
1- 9	-2.56	0.00	0.00	0.00	0.00	0.00	-6.74
1-10	-2.56	0.00	0.00	0.00	0.00	0.00	-6.74
EXTERIOR WALL TOP							
TOP SLAB LEFT SIDE							
2- 0	0.18	-1.66	-0.83	-0.40	0.00	0.31	-0.29
2- 1	0.18	-1.66	-0.83	-0.40	0.00	0.31	-0.29
2- 2	0.18	-1.66	-0.83	-0.40	0.00	0.31	-0.29
2- 3	0.18	-1.66	-0.83	-0.40	0.00	0.31	-0.29
2- 4	0.18	-1.66	-0.83	-0.40	0.00	0.31	-0.29
2- 5	0.18	-1.66	-0.83	-0.40	0.00	0.31	-0.29
2- 6	0.18	-1.66	-0.83	-0.40	0.00	0.31	-0.29
2- 7	0.18	-1.66	-0.83	-0.40	0.00	0.31	-0.29
2- 8	0.18	-1.66	-0.83	-0.40	0.00	0.31	-0.29
2- 9	0.18	-1.66	-0.83	-0.40	0.00	0.31	-0.29
2-10	0.18	-1.66	-0.83	-0.40	0.00	0.31	-0.29
TOP SLAB RIGHT SIDE							
BOTTOM SLAB LEFT SIDE							
4- 0	-0.18	-2.66	-1.33	-0.40	0.00	0.29	-0.31
4- 1	-0.18	-2.66	-1.33	-0.40	0.00	0.29	-0.31
4- 2	-0.18	-2.66	-1.33	-0.40	0.00	0.29	-0.31
4- 3	-0.18	-2.66	-1.33	-0.40	0.00	0.29	-0.31
4- 4	-0.18	-2.66	-1.33	-0.40	0.00	0.29	-0.31
4- 5	-0.18	-2.66	-1.33	-0.40	0.00	0.29	-0.31
4- 6	-0.18	-2.66	-1.33	-0.40	0.00	0.29	-0.31
4- 7	-0.18	-2.66	-1.33	-0.40	0.00	0.29	-0.31
4- 8	-0.18	-2.66	-1.33	-0.40	0.00	0.29	-0.31
4- 9	-0.18	-2.66	-1.33	-0.40	0.00	0.29	-0.31
4-10	-0.18	-2.66	-1.33	-0.40	0.00	0.29	-0.31
BOTTOM SLAB RIGHT SIDE							

Factors for Ductility 1.00
Redundancy 1.00
Operations 1.00

Fatigue Checks

$f_s \le f_f = 24 - 0.33 f_{min}$ (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	-46.32	24015.29	14556.88	Pass
TOP SLAB	Left	1472.41	24485.89	7410.41	Pass
TOP SLAB	Middle -	1472.41	24485.89	7447.85	Pass
BOTTOM SLAB	Left	1436.35	24474.00	3724.46	Pass
BOTTOM SLAB	Middle -	1436.35	24474.00	3697.17	Pass

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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	0.75	10.00	1.00	1.16	10.36	6.00	56.64	36.66
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	0.75	10.00	1.00	1.16	9.87	7.00	50.34	38.16
Bottom slab, outside face	$0.8*f_r > f_c$, therefore no check necessary.							
Ext. wall, outside face	0.75	10.00	1.00	1.16	24.14	6.00	56.64	17.33
Ext. wall, inside face	$0.8*f_r > f_c$, therefore no check necessary.							

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 Lateral Distribution Steel:
   Span Length                              =   12.833 feet
   Percentage of main reinforcement required =   27.915% , less than or equal to 50%
   Main reinforcement area (top slab)       =    0.620 in^2
   Required lateral distribution area       =    0.173 in^2
   Because the required area is less than the minimum, an area of steel of   0.200 in^2 is used.
   Main reinforcement area (bottom slab)    =    0.531 in^2
   Required lateral distribution area       =    0.148 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  0.6200 in2           area  0.6200 in2           area  0.6200 in2
    size  5 spaced at   6.00 in.  size  5 spaced at   6.00 in.  size  5 spaced at   6.00 in.
***************************************************************************

 Exterior wall
TOP
area  0.6200 in2
size  5 spaced at   6.00 in.


OUTSIDE FACE
area  0.6200 in2
size  5 spaced at   6.00 in.

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


BOTTOM
area  0.6200 in2
size  5 spaced at   6.00 in.
***************************************************************************

                           Bottom slab
    LEFT SIDE                  CENTER                     RIGHT SIDE
    area  0.6200 in2           area  0.5314 in2           area  0.6200 in2
    size  5 spaced at   6.00 in.  size  5 spaced at   7.00 in.  size  5 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	10.91	30.53	0.6200	0.6200	5	6.0	76
A2	8.94	36.66	0.6200	0.6200	5	6.0	37
A100	36.66	56.64	0.6200	0.6200	5	6.0	
A200	38.16	50.34	0.5314	0.5314	5	7.0	
B1	3.82	17.33	0.2667	0.2667	4	9.0	
B2	17.33	56.64	0.6200	0.6200	5	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 = 1.00 (in)
Clear cover at middle = 1.00 (in)
Bar diameter (bot) = 0.62 (in)
Bar diameter (mid+) = 0.50 (in)
Bar diameter (mid-) = 0.62 (in)
Bar diameter (top) = 0.62 (in)

	Moment Kft	Coin. Axial Force Kips	Shear Force Kips	Shear Cap Kips	Resistance Po Cap Kips	Mu Cap Kft	Mbal Cap Kft	Pbal Cap Kips	Steel Area In2	Mom. Cap Kft	Des. Thk in	Design Ratio
BOT	-12.0	14.1	3.8	25.8	380.5	25.8	50.3	138.1	0.6200	26.3	8.69	n/a
MID	3.9	14.1	0.6	47.6	368.8	11.5	45.3	156.2	0.2667	11.8	8.75	0.3
MID-	-10.1	14.1	0.7	30.5	380.5	25.8	50.3	138.1	0.6200	26.3	8.69	n/a
TOP	-14.5	14.1	2.9	24.2	380.5	25.8	50.3	138.1	0.6200	26.3	8.69	n/a

Member No. = 2 TOP SLAB

Thickness = 10.00 (in)
Clear cover at end = 2.00 (in)
Clear cover at middle = 1.00 (in)
Bar diameter (lt) = 0.62 (in)
Bar diameter (mid) = 0.62 (in)
Bar diameter (rt) = 0.62 (in)

LT	-6.8	3.3	12.0	18.2	380.5	22.7	46.0	118.7	0.6200	22.8	7.69	n/a
MID	23.0	3.3	3.6	16.3	380.5	25.8	50.3	138.1	0.6200	25.9	8.69	0.9
RT	-6.8	3.3	12.0	11.5	380.5	22.7	46.0	118.7	0.6200	22.8	7.69	n/a

ok 9th

Member No. = 4 BOTTOM SLAB

Thickness = 10.00 (in)
Clear cover at end = 1.00 (in)
Clear cover at middle = 1.00 (in)
Bar diameter (lt) = 0.62 (in)
Bar diameter (mid) = 0.62 (in)
Bar diameter (rt) = 0.62 (in)

LT	-5.5	5.0	8.5	25.0	380.5	25.8	50.3	138.1	0.6200	25.9	8.69	n/a
MID	18.6	5.0	0.1	18.5	377.5	22.3	49.0	142.3	0.5314	22.3	8.69	0.8
RT	-5.5	5.0	8.5	17.2	380.5	25.8	50.3	138.1	0.6200	25.9	8.69	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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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	-5.142	-16.343	-1.637	-14.138	5.082	1.997
1- 1	-1.839	-12.301	-1.637	-14.137	4.005	1.373
1- 2	0.944	-10.510	-1.637	-14.137	3.006	0.801
1- 3	2.784	-9.857	-1.637	-14.137	2.086	0.282
1- 4	3.758	-9.748	-1.637	-14.137	1.244	-0.186
1- 5	3.942	-10.086	-1.637	-14.137	0.582	-0.702
1- 6	3.414	-10.807	-1.637	-14.137	0.219	-1.387
1- 7	2.251	-11.858	-1.637	-14.137	-0.092	-1.994
1- 8	0.529	-13.190	-1.637	-14.137	-0.350	-2.523
1- 9	-1.479	-14.750	-1.637	-14.137	-0.556	-2.973
1-10	-3.007	-17.643	-1.637	-14.138	-0.710	-3.345
EXTERIOR WALL TOP						
TOP SLAB LEFT SIDE						
2- 0	-3.007	-17.643	-1.582	-3.292	14.138	1.636
2- 1	3.145	-5.661	-1.533	-3.341	11.644	0.827
2- 2	10.951	-0.919	-1.533	-3.341	9.652	-0.116
2- 3	18.284	0.000	-1.533	-3.341	7.593	-1.173
2- 4	22.314	0.000	-1.533	-3.341	5.551	-2.723
2- 5	22.979	0.000	-1.533	-3.341	3.599	-4.484
2- 6	22.561	0.000	-1.533	-3.341	2.078	-6.492
2- 7	18.671	0.000	-1.533	-3.341	0.806	-8.555
2- 8	11.392	-0.900	-1.533	-3.341	-0.199	-10.577
2- 9	2.744	-5.659	-1.533	-3.341	-1.077	-12.504
2-10	-2.825	-17.661	-1.582	-3.292	-1.632	-14.257
TOP SLAB RIGHT SIDE						
BOTTOM SLAB LEFT SIDE						
4- 0	-5.142	-16.343	-3.198	-5.006	10.332	2.305
4- 1	-2.074	-4.439	-3.198	-5.006	8.285	1.844
4- 2	6.912	-0.911	-3.247	-4.957	6.239	1.382
4- 3	13.411	0.000	-3.247	-4.957	4.192	0.921
4- 4	17.306	0.000	-3.247	-4.957	2.145	0.459
4- 5	18.605	0.000	-3.247	-4.957	0.099	-0.102
4- 6	17.307	0.000	-3.247	-4.957	-0.463	-2.149
4- 7	13.405	0.000	-3.247	-4.957	-0.925	-4.195
4- 8	6.908	-0.930	-3.247	-4.957	-1.386	-6.242
4- 9	-2.086	-4.441	-3.198	-5.006	-1.848	-8.289
4-10	-5.173	-16.361	-3.198	-5.006	-2.310	-10.335
BOTTOM SLAB RIGHT SIDE						

Output complete for a HL-93-TANDEM vehicle

LRFD Live Load Distribution Factor Computation

Input Values

Depth of Fill	= 1.99 ft.	
Span Length	= 12.00 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	= 41.00 ft.	
Length	= 5.82 ft.	

Compute Strip Width by 4.6.2.10.2-1

E = 96 + 1.44 S ft
E = 96 + 1.44 (12.00 ft.)
E = 9.44 ft.

Controlling Distribution Factor

Final Strip Width = 9.44 ft.

Final Distribution Factor = 1/Final Strip Width = **0.11** Lanes per ft. of width

Multiple Presence Factor = 1.20

Distribution Factor * Multiple Presence Factor = **0.13**

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


   Axle Weights      Spacing
         (kips)        (ft)


         ------      ------
Totals    0.00        0.000
```

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.

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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 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	-4.64	-1.62	-0.81	-0.29	0.00	0.00	0.00
1- 1	-4.46	0.65	0.33	0.07	0.00	0.00	0.00
1- 2	-4.28	2.27	1.14	0.35	0.00	0.00	0.00
1- 3	-4.10	3.29	1.65	0.55	0.00	0.00	0.00
1- 4	-3.92	3.77	1.89	0.67	0.00	0.00	0.00
1- 5	-3.74	3.77	1.89	0.70	0.00	0.00	0.00
1- 6	-3.57	3.35	1.68	0.67	0.00	0.00	0.00
1- 7	-3.39	2.56	1.28	0.55	0.00	0.00	0.00
1- 8	-3.21	1.46	0.73	0.35	0.00	0.00	0.00
1- 9	-3.03	0.10	0.05	0.07	0.00	0.00	0.00
1-10	-2.85	-1.45	-0.73	-0.29	0.00	0.00	0.00
EXTERIOR WALL TOP							
TOP SLAB LEFT SIDE							
2- 0	-2.85	-1.45	-0.73	-0.29	0.00	0.00	0.00
2- 1	0.11	-1.45	-0.73	-0.29	0.00	0.00	0.00
2- 2	2.42	-1.45	-0.72	-0.29	0.00	0.00	0.00
2- 3	4.06	-1.45	-0.72	-0.29	0.00	0.00	0.00
2- 4	5.05	-1.45	-0.72	-0.29	0.00	0.00	0.00
2- 5	5.38	-1.44	-0.72	-0.29	0.00	0.00	0.00
2- 6	5.05	-1.44	-0.72	-0.29	0.00	0.00	0.00
2- 7	4.07	-1.44	-0.72	-0.29	0.00	0.00	0.00
2- 8	2.42	-1.44	-0.72	-0.29	0.00	0.00	0.00
2- 9	0.12	-1.44	-0.72	-0.29	0.00	0.00	0.00
2-10	-2.84	-1.43	-0.72	-0.29	0.00	0.00	0.00
TOP SLAB RIGHT SIDE							
BOTTOM SLAB LEFT SIDE							
4- 0	-4.64	-1.62	-0.81	-0.29	0.00	0.00	0.00
4- 1	-0.46	-1.62	-0.81	-0.29	0.00	0.00	0.00
4- 2	2.79	-1.62	-0.81	-0.29	0.00	0.00	0.00
4- 3	5.12	-1.62	-0.81	-0.29	0.00	0.00	0.00
4- 4	6.51	-1.63	-0.81	-0.29	0.00	0.00	0.00
4- 5	6.97	-1.63	-0.81	-0.29	0.00	0.00	0.00
4- 6	6.51	-1.63	-0.82	-0.29	0.00	0.00	0.00
4- 7	5.11	-1.63	-0.82	-0.29	0.00	0.00	0.00
4- 8	2.79	-1.63	-0.82	-0.29	0.00	0.00	0.00
4- 9	-0.46	-1.64	-0.82	-0.29	0.00	0.00	0.00
4-10	-4.65	-1.64	-0.82	-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 K	Soil Press (Max) K	Soil Press (Min) K	Surch Hgt. K	Water Press (Max) K	LIVE Pos K	LOADS Neg K
EXTERIOR WALL BOTTOM							
1- 0	0.18	2.66	1.33	0.40	0.00	0.00	0.00
1- 1	0.18	1.97	0.98	0.32	0.00	0.00	0.00
1- 2	0.18	1.33	0.67	0.24	0.00	0.00	0.00
1 3	0.18	0.76	0.38	0.16	0.00	0.00	0.00
1- 4	0.18	0.24	0.12	0.08	0.00	0.00	0.00
1- 5	0.18	-0.23	-0.11	0.00	0.00	0.00	0.00
1- 6	0.18	-0.63	-0.31	-0.08	0.00	0.00	0.00
1- 7	0.18	-0.97	-0.49	-0.16	0.00	0.00	0.00
1- 8	0.18	-1.26	-0.63	-0.24	0.00	0.00	0.00
1- 9	0.18	-1.49	-0.74	-0.32	0.00	0.00	0.00
1-10	0.18	-1.66	-0.83	-0.40	0.00	0.00	0.00
EXTERIOR WALL TOP							
TOP SLAB LEFT SIDE							
2- 0	2.56	0.00	0.00	0.00	0.00	0.00	0.00
2- 1	2.05	0.00	0.00	0.00	0.00	0.00	0.00
2- 2	1.54	0.00	0.00	0.00	0.00	0.00	0.00
2- 3	1.03	0.00	0.00	0.00	0.00	0.00	0.00
2- 4	0.51	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	-0.51	0.00	0.00	0.00	0.00	0.00	0.00
2- 7	-1.03	0.00	0.00	0.00	0.00	0.00	0.00
2- 8	-1.54	0.00	0.00	0.00	0.00	0.00	0.00
2- 9	-2.05	0.00	0.00	0.00	0.00	0.00	0.00
2-10	-2.56	0.00	0.00	0.00	0.00	0.00	0.00
TOP SLAB RIGHT SIDE							
BOTTOM SLAB LEFT SIDE							
4- 0	3.62	0.00	0.00	0.00	0.00	0.00	0.00
4- 1	2.90	0.00	0.00	0.00	0.00	0.00	0.00
4- 2	2.17	0.00	0.00	0.00	0.00	0.00	0.00
4- 3	1.45	0.00	0.00	0.00	0.00	0.00	0.00
4- 4	0.72	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	-0.72	0.00	0.00	0.00	0.00	0.00	0.00
4- 7	-1.45	0.00	0.00	0.00	0.00	0.00	0.00
4- 8	-2.17	0.00	0.00	0.00	0.00	0.00	0.00
4- 9	-2.90	0.00	0.00	0.00	0.00	0.00	0.00
4-10	-3.62	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 K	Soil Press (Max) K	Soil Press (Min) K	Surch Hgt. K	Water Press (Max) K	LIVE LOADS Pos K	LIVE LOADS Neg K
EXTERIOR WALL BOTTOM							
1- 0	-2.56	0.00	0.00	0.00	0.00	0.00	0.00
1- 1	-2.56	0.00	0.00	0.00	0.00	0.00	0.00
1- 2	-2.56	0.00	0.00	0.00	0.00	0.00	0.00
1- 3	-2.56	0.00	0.00	0.00	0.00	0.00	0.00
1- 4	-2.56	0.00	0.00	0.00	0.00	0.00	0.00
1- 5	-2.56	0.00	0.00	0.00	0.00	0.00	0.00
1- 6	-2.56	0.00	0.00	0.00	0.00	0.00	0.00
1- 7	-2.56	0.00	0.00	0.00	0.00	0.00	0.00
1- 8	-2.56	0.00	0.00	0.00	0.00	0.00	0.00
1- 9	-2.56	0.00	0.00	0.00	0.00	0.00	0.00
1-10	-2.56	0.00	0.00	0.00	0.00	0.00	0.00
EXTERIOR WALL TOP							
TOP SLAB LEFT SIDE							
2- 0	0.18	-1.66	-0.83	-0.40	0.00	0.00	0.00
2- 1	0.18	-1.66	-0.83	-0.40	0.00	0.00	0.00
2- 2	0.18	-1.66	-0.83	-0.40	0.00	0.00	0.00
2- 3	0.18	-1.66	-0.83	-0.40	0.00	0.00	0.00
2- 4	0.18	-1.66	-0.83	-0.40	0.00	0.00	0.00
2- 5	0.18	-1.66	-0.83	-0.40	0.00	0.00	0.00
2- 6	0.18	-1.66	-0.83	-0.40	0.00	0.00	0.00
2- 7	0.18	-1.66	-0.83	-0.40	0.00	0.00	0.00
2- 8	0.18	-1.66	-0.83	-0.40	0.00	0.00	0.00
2- 9	0.18	-1.66	-0.83	-0.40	0.00	0.00	0.00
2-10	0.18	-1.66	-0.83	-0.40	0.00	0.00	0.00
TOP SLAB RIGHT SIDE							
BOTTOM SLAB LEFT SIDE							
4- 0	-0.18	-2.66	-1.33	-0.40	0.00	0.00	0.00
4- 1	-0.18	-2.66	-1.33	-0.40	0.00	0.00	0.00
4- 2	-0.18	-2.66	-1.33	-0.40	0.00	0.00	0.00
4- 3	-0.18	-2.66	-1.33	-0.40	0.00	0.00	0.00
4- 4	-0.18	-2.66	-1.33	-0.40	0.00	0.00	0.00
4- 5	-0.18	-2.66	-1.33	-0.40	0.00	0.00	0.00
4- 6	-0.18	-2.66	-1.33	-0.40	0.00	0.00	0.00
4- 7	-0.18	-2.66	-1.33	-0.40	0.00	0.00	0.00
4- 8	-0.18	-2.66	-1.33	-0.40	0.00	0.00	0.00
4- 9	-0.18	-2.66	-1.33	-0.40	0.00	0.00	0.00
4-10	-0.18	-2.66	-1.33	-0.40	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.							

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  Lateral Distribution Steel:
    Span Length                              =   12.833 feet
    Percentage of main reinforcement required =   27.915% , less than or equal to 50%
    Main reinforcement area (top slab)       =    0.620 in^2
    Required lateral distribution area       =    0.173 in^2
    Because the required area is less than the minimum, an area of steel of   0.200 in^2 is used.
    Main reinforcement area (bottom slab)    =    0.531 in^2
    Required lateral distribution area       =    0.148 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  0.6200 in2            area  0.6200 in2              area  0.6200 in2
  size  5 spaced at   6.00 in. size  5 spaced at   6.00 in. size  5 spaced at   6.00 in.
***************************************************************************

 Exterior wall
TOP
area  0.6200 in2
size  5 spaced at   6.00 in.


OUTSIDE FACE
area  0.6200 in2
size  5 spaced at   6.00 in.

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


BOTTOM
area  0.6200 in2
size  5 spaced at   6.00 in.
***************************************************************************

                           Bottom slab
  LEFT SIDE                   CENTER                        RIGHT SIDE
  area  0.6200 in2            area  0.5314 in2              area  0.6200 in2
  size  5 spaced at   6.00 in. size  5 spaced at   7.00 in. size  5 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	4.87	17.33	0.6200	0.6200	5	6.0	76
A2	6.25	17.33	0.6200	0.6200	5	6.0	37
A100	10.60	17.33	0.6200	0.6200	5	6.0	
A200	16.30	17.33	0.5314	0.5314	5	7.0	
B1	3.82	17.33	0.2667	0.2667	4	9.0	
B2	4.64	17.33	0.6200	0.6200	5	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	=	1.00 (in)
Clear cover at middle	=	1.00 (in)
Bar diameter (bot)	=	0.62 (in)
Bar diameter (mid+)	=	0.50 (in)
Bar diameter (mid-)	=	0.62 (in)
Bar diameter (top)	=	0.62 (in)

	Moment Kft	Coin. Axial Force Kips	Shear Force Kips	Shear Cap Kips	Resistance Po Cap Kips	Mu Cap Kft	Mbal Cap Kft	Pbal Cap Kips	Steel Area In2	Mom. Cap Kft	Des. Thk in	Design Ratio
BOT	-3.2	2.3	3.2	31.3	380.5	25.8	50.3	138.1	0.6200	25.8	8.69	n/a
MID	3.9	2.3	0.0	29.0	368.8	11.5	45.3	156.2	0.2667	11.5	8.75	0.3
MID-	-0.2	2.3	0.2	41.2	380.5	25.8	50.3	138.1	0.6200	25.8	8.69	n/a
TOP	-2.5	2.3	2.4	33.3	380.5	25.8	50.3	138.1	0.6200	25.8	8.69	n/a

Member No. = 2 TOP SLAB

Thickness	=	10.00 (in)
Clear cover at end	=	2.00 (in)
Clear cover at middle	=	1.00 (in)
Bar diameter (lt)	=	0.62 (in)
Bar diameter (mid)	=	0.62 (in)
Bar diameter (rt)	=	0.62 (in)

LT	-2.6	2.8	1.9	29.3	380.5	22.7	46.0	118.7	0.6200	22.8	7.69	n/a
MID	2.9	2.8	0.0	35.7	380.5	25.8	50.3	138.1	0.6200	25.9	8.69	0.1
RT	-2.6	2.8	1.9	25.2	380.5	22.7	46.0	118.7	0.6200	22.8	7.69	n/a

Member No. = 4 BOTTOM SLAB

Thickness	=	10.00 (in)
Clear cover at end	=	1.00 (in)
Clear cover at middle	=	1.00 (in)
Bar diameter (lt)	=	0.62 (in)
Bar diameter (mid)	=	0.62 (in)
Bar diameter (rt)	=	0.62 (in)

LT	-3.5	4.5	2.7	32.6	380.5	25.8	50.3	138.1	0.6200	25.9	8.69	n/a
MID	4.1	4.4	0.0	34.1	377.5	22.3	49.0	142.3	0.5314	22.3	8.69	0.2
RT	-3.5	4.5	2.7	27.3	380.5	25.8	50.3	138.1	0.6200	25.9	8.69	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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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	-5.142	-6.906	-1.637	-2.335	4.463	2.510
1- 1	-1.839	-3.470	-1.637	-2.334	3.386	1.887
1- 2	0.944	-1.852	-1.637	-2.334	2.388	1.315
1- 3	2.784	-0.769	-1.637	-2.334	1.467	0.796
1- 4	3.758	-0.172	-1.637	-2.334	0.625	0.328
1- 5	3.942	-0.009	-1.637	-2.334	-0.037	-0.188
1- 6	3.414	-0.228	-1.637	-2.334	-0.400	-0.873
1- 7	2.251	-0.778	-1.637	-2.334	-0.710	-1.480
1- 8	0.529	-1.608	-1.637	-2.334	-0.969	-2.009
1- 9	-1.674	-2.666	-1.637	-2.334	-1.175	-2.459
1-10	-3.780	-5.057	-1.637	-2.335	-1.329	-2.831
EXTERIOR WALL TOP						
TOP SLAB LEFT SIDE						
2- 0	-3.780	-5.057	-2.125	-2.782	2.335	1.636
2- 1	-1.858	-2.391	-2.076	-2.831	1.869	1.309
2- 2	0.241	-0.919	-2.076	-2.831	1.402	0.982
2- 3	1.741	0.000	-2.076	-2.831	0.936	0.656
2- 4	2.642	0.000	-2.076	-2.831	0.469	0.329
2- 5	2.945	0.000	-2.076	-2.831	0.003	0.002
2- 6	2.649	0.000	-2.076	-2.831	-0.324	-0.465
2- 7	1.754	0.000	-2.076	-2.831	-0.651	-0.931
2- 8	0.261	-0.900	-2.076	-2.831	-0.978	-1.398
2- 9	-1.831	-2.365	-2.076	-2.831	-1.305	-1.864
2-10	-3.748	-5.024	-2.125	-2.782	-1.632	-2.331
TOP SLAB RIGHT SIDE						
BOTTOM SLAB LEFT SIDE						
4- 0	-5.142	-6.906	-3.708	-4.463	3.291	2.305
4- 1	-2.479	-3.106	-3.708	-4.463	2.633	1.844
4- 2	0.351	-0.911	-3.757	-4.414	1.974	1.382
4- 3	2.461	0.000	-3.757	-4.414	1.315	0.921
4- 4	3.726	0.000	-3.757	-4.414	0.657	0.459
4- 5	4.145	0.000	-3.757	-4.414	-0.002	-0.003
4- 6	3.719	0.000	-3.757	-4.414	-0.463	-0.661
4- 7	2.448	0.000	-3.757	-4.414	-0.925	-1.320
4- 8	0.331	-0.930	-3.757	-4.414	-1.386	-1.979
4- 9	-2.505	-3.133	-3.708	-4.463	-1.848	-2.637
4-10	-5.173	-6.940	-3.708	-4.463	-2.310	-3.296
BOTTOM SLAB RIGHT SIDE						

Output complete for a HL-93-LANE vehicle

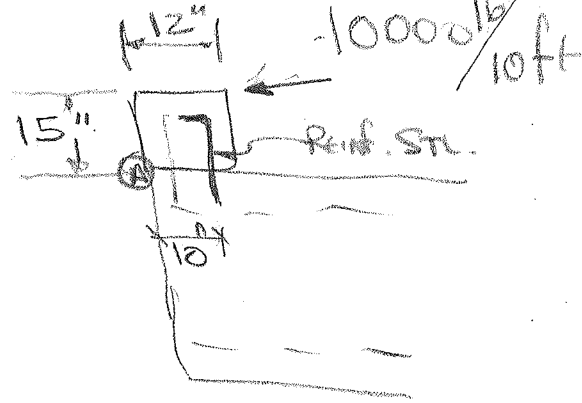
CALC BY:_______ CHECK BY:_______ APPENDIX A

DATE:_______ REV:_______ PROJECT: 12 x 9

PROBLEM: DESIGN HEADWALL

AASHTO SUGGESTS

$10000 \, lb / 10 \, ft = 1000 \, lb/ft$



$M^u_{(A)} = 1.7 \times 1000^{lb} \times 1.25^{ft}$

$= 2125 \, ft.lb/ft$

FIND ALLOW MOMENT:

$f'_c = 5000 \, psi$ $\quad f_y = 60000 \, psi$

$b = 12^{in}$ $\quad d = 10^{in}$ $\quad$ Use #4@12"

$A_s = 0.2 \, in^2$

TENSION CAPACITY of REBAR

$= 36000^{psi} \times 0.2^{in^2} = 7200 \, lb$

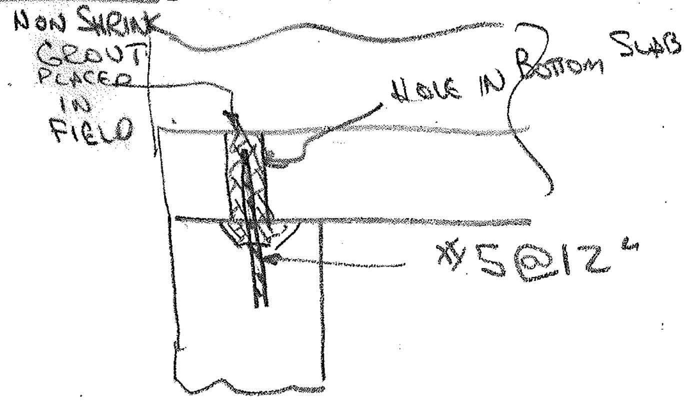
$M_{RESISTING} = 0.9 \times 7200^{lb} \times \frac{10}{12}^{ft} = 5400 \, ft.lb$

#4 @ 12" ok SINCE $5400 > 2125$.

CALC BY:__________ CHECK BY:__________ APPENDIX B

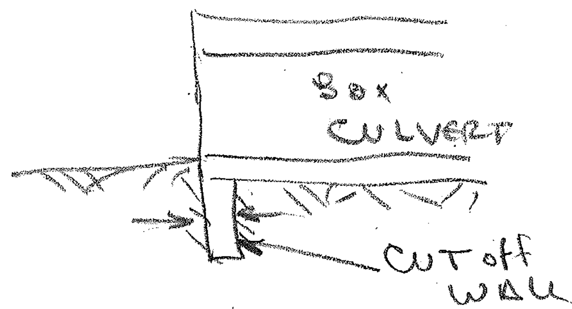
DATE:__________ REV:__________ PROJECT:__________

PROBLEM DESIGN CUTOFF WALL



A CUT OFF WALL IS PLACED BELOW BOTTOM SLAB OF BOX CULVERT

THE PURPOSE IS TO PREVENT WATER FROM PASSING UNDER THE CULVERT. THERE IS NO REAL LOAD ON THE CO WALL BECAUSE SOIL WILL BE ON BOTH SIDES OF WALL.



THE CONNECTION WILL ONLY PREVENT RELATING MOVEMENT OF WALL / CULVERT SURFACE DURING BACKFILL.

#5 AT 12" CC W/ NON SHRINK GROUT WILL BE SATISFACTORY

Telephone 215-855-8713 FAX 215-855-8714

GARY K. MUNKELT & ASSOCIATES

Consulting Engineers
Precast Concrete, Structural, Civil

1180 Welsh Rd. Suite 190 North Wales, PA 19454

2/12/15

STATE OF VERMONT
GARY K. MUNKELT
NO. 6291
REGISTERED
PROFESSIONAL ENGINEER

PROJECT: DESIGN BIN TYPE WINGWALL

CLIENT: S. D. IRELAND
WILLISTON, VT

LOCATION: BRIDGE NO. 2 AND NO. 5
STATE OF VERMONT PROJECT - STP. CULV 29
BRIDPORT, VT

TABLE OF CONTENTS

Job No. 150196 **Dated: 2/10/15**

SCOPE OF WORK

It is proposed to install 2 box culverts with wing walls at Sta. 22+80.82 and Sta. 12+82.2 on Vt. Rte. 125. This report will address the design of the wing walls.

There are wing walls at each end of both box culverts. The wing walls will be termed 'Bin Type' wing walls because the leg behind the wall will be in the shape of a bin. This leg is necessary to provide support to the wall and prevent overturning.

The concrete wall and bin will be precast at the fabricator's plant and shipped as one piece. Overturning, design of wall and design of base are included in this report.

There are two types of bins:

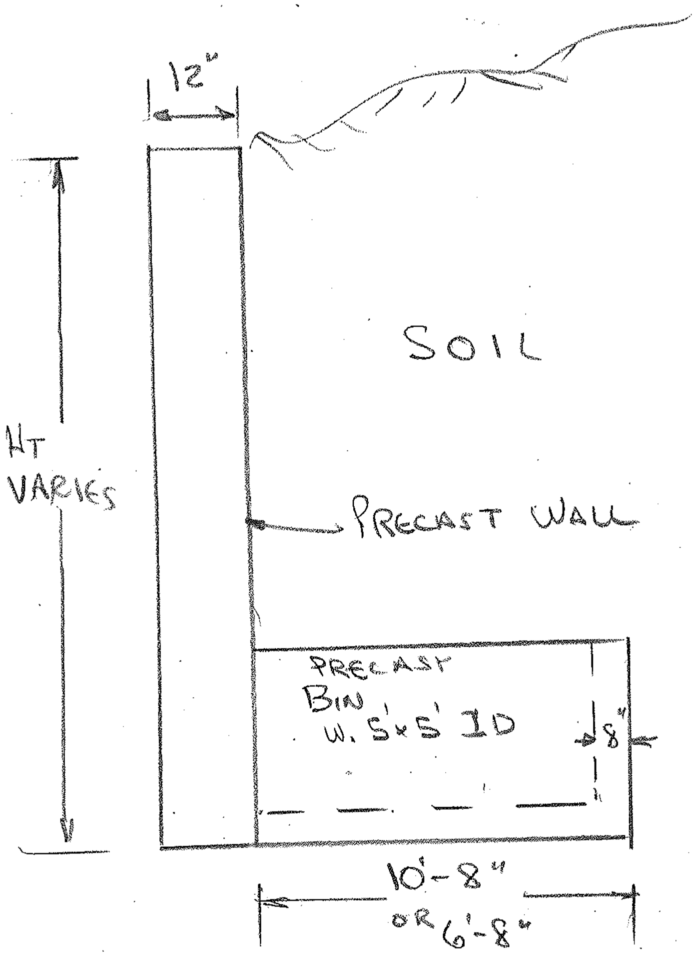
Type I Bin is almost as wide as the wall and 10'-8" long. It is designed to stand alone.

Type II Bin is only half as wide as the wall and 8'-8" long. These walls lean against the box culvert walls, which provides a great amount of help resisting overturning.

Calculations will demonstrate that overturning and sliding are resisted. Global stability of soil below must be certified by others.

CALC BY:__________ CHECK BY:__________ SHEET NO. 3 OF________

DATE:__________ REV:__________ PROJECT:__________



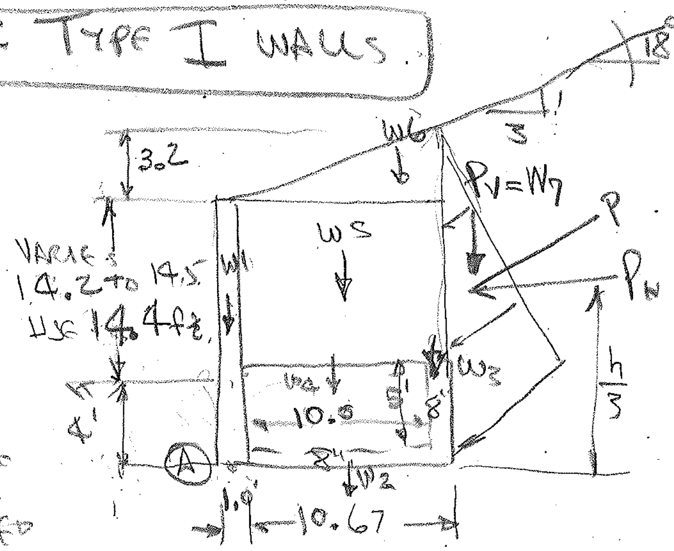
DESCRIPTION of PRODUCT

CALC BY:_____ CHECK BY:_____ SHEET NO. 4 OF _____

DATE:_____ REV:_____ PROJECT:_____

PROBLEM CHECK STABILITY of TYPE I WALLS.

SOME of THESE WALLS MUST STAND ALONE.



SIDE VIEW WALL No 3B & No 4B

OVERTURNING FORCES

USE $K_a = 0.42$ $\gamma_s = 120$ $\phi = 30°$

$P = (0.42 \times 120^{pcf} \times 21.6^{ft}) \frac{21.6}{2} = 11757.$ lb/ft

$P_{HOR} = 11757 \times \cos 18 = 11200$ lb/ft

$P_{VERT} = 11757 \times \sin 18 = 3633.$ lb/ft

LOAD TO BE RESISTED BY BINS

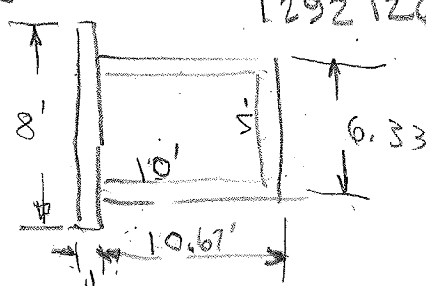
$P_{HOR} = 11200$ lb/ft $\times 8^{ft} = 89600^{lb}$

$M_{OT} = 89600^{lb} \times \frac{21.6}{3}$ ft $= 645120.$ ft lb

RESISTING FORCES:

	WT		M RESIST
$W1 = 8 \times 1 \times 18.4 \times 150$	= 22080. lb	× 0.5 ft	= 11040. ft lb
$W_2 = 10.67 \times 6.33 \times 0.67 \times 150$	= 6788. lb	× 6.33	= 42967.
$W_3 = 0.67 \times 6.33 \times 5 \times 150$	= 3181. lb	× 11.33	= 36039.
$W_4 = 2(0.67 \times 10 \times 5 \times 150)$	= 10050. lb	× 6.0	= 60300.
$W_5 = (10 \times 5^2 + 14.4 \times 10.67 \times 6.33)120$	= 146711. lb	× 5.84	= 856792.
$W_6 = \frac{1}{2} \times 10.67 \times 3.2 \times 120$	= 2049. lb	× 8.11	= 16614.
$W_7 = 3633^{lb/ft} \times 6.33^{ft}$	22997.	× 11.67	= 268374
	213856 lb		1292126 ft lb

F.S. AGAINST O.T. $= \frac{1292126}{645120} = 2$ ok.



F.S AGAINST SLIDING

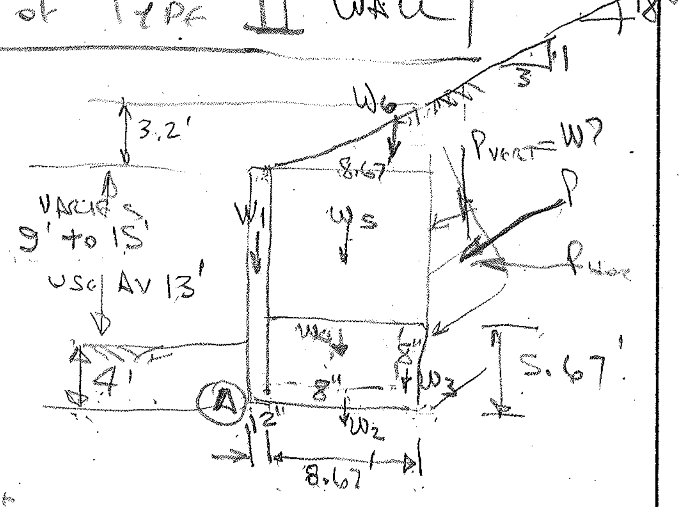
$= \frac{(17854 + 213856) \tan 30}{89600} = 1.5$ ok.

CALC BY: ________ CHECK BY: ________ SHEET NO. 5 OF ________

DATE: ________ REV: ________ PROJECT: ________

PROBLEM CHECK STABILITY of TYPE II WALL

WALL WILL LEAN AGAINST BOX CULVERT WITH 1/2 of LOAD CARRIED TO BOX CULVERT. CONSIDER REMAINDER of LOAD TO BE RESISTED BY BIN & SOIL ABOVE



SIDE VIEW WALL No1 & No.2

OVERTURNING FORCES

USE $K_a = 0.42$ $\gamma_s = 120$ pcf $\phi = 30°$

$P = (0.42 \times 120_{pcf} \times 20_{ft}) \frac{20^{ft}}{2} = 10080.$ lb/ft

$P_{HOR} = 10080 \times \cos 18 = 9587.$ lb/ft

$P_{VERT} = 10080 \times \sin 18 = 3115.$ lb/ft

LOAD TO BE RESISTED BY BINS

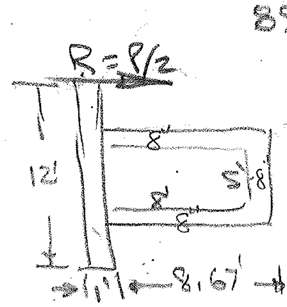
$P_{HOR} = 1/2 \times 9587$ lb/ft $\times 12$ ft $= 57522$ lb.

$M_{OT} = 57522^{lb} \times \frac{20}{3}^{ft} = 383480$ ft lb

RESISTING FORCES:

		W_T		M_{RESIST}
W1 =	12 × 1 × 17 × 150 =	30600. lb.	× 0.5 ft =	15300. ft lb
W_2 =	8.67 × 6.33 × 0.67 × 150 =	5516. lb.	× 5.34 ft =	29455. ft lb
W_3 =	0.67 × 6.33 × 5 × 150 =	3181. lb.	× 8.33 ft =	26500. ft lb
W_4 =	2[0.67 × 8 × 5 × 150] =	8040. lb.	× 5 ft =	40200. ft lb
W_5 =	$(8 \times 5^2 + 8.67 \times 6.33 \times 13)120$ =	109615. lb.	× 5.33 ft =	584245. ft lb
W_6 =	1/2 × 8.67 × 3.2 × 120 =	1665. lb	× 6.8 ft =	11322. ft lb
W_7 =	3115 lb/ft × 6.33 ft =	19718. lb.	× 9.67 ft =	190673. ft lb
		178335. lb		897695 ft lb

F.S. AGAINST O.T. $= \frac{897695}{383480} = 2.3$ OK.



PLAN VIEW

F.S. AGAINST SLIDING

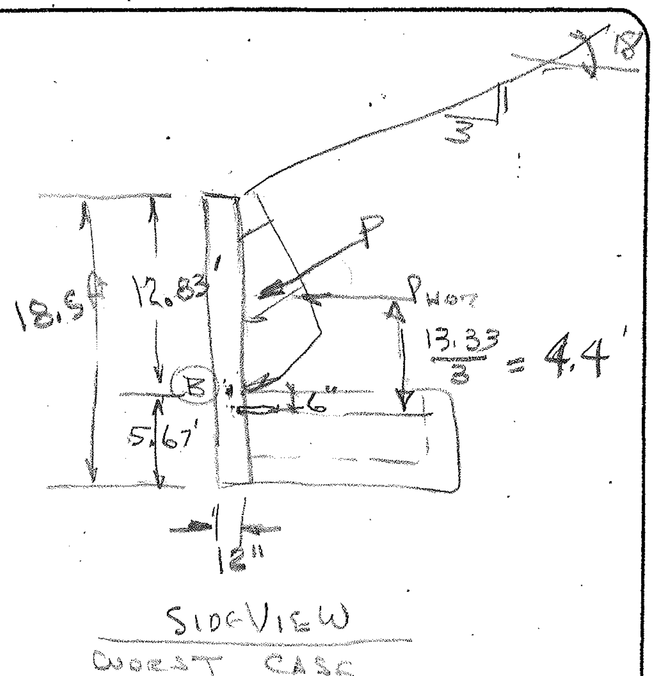
$\frac{178335 \tan 30}{57522} = 1.8$ OK.

CALC BY: CHECK BY: SHEET NO. 6 OF

DATE: REV: PROJECT:

PROB. DESIGN WALL

CHECK MOM. @ (B)



For $\phi = 30°$, $k_a = 0.42$ $\gamma_s = 120$ pcf

$P = (0.42 \times 120^{pcf} \times 13.33^{ft}) \frac{13.33^{ft}}{2}$

$= 4478$ lb/ft

$P_{HOR} = 4478 \cos 18° = 4258$. lb/ft

$M_U^{(B)} = (1.7 \times 4258)^{lb} \times 4.4^{ft} = 31850$. ft.lb

$V_u = (1.7 \times 4258)^{lb} = 7240$. lb PER ft WIDTH of PANEL

FIND ALLOW MOM & SHEAR:

USE #6 @ 6" VERT. STL

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

$A_s = 0.88$

$b = 12$ in $d = 12 - 1" - 1/4 = 10.75$ in

$q = \frac{60}{5} \times \frac{0.88}{12 \times 10.75} = 0.082$

$\phi M_n = 0.9 \times 12 \times 10.75^2 \times 5000 \times 0.082 (1 - 0.59 \times 0.082) \div 12$

$= 40580$. ft. lb $> M_u$ ok

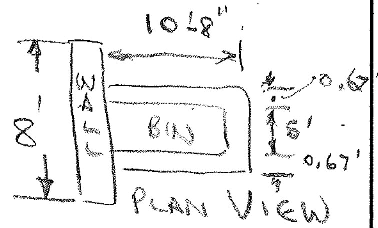
$\phi V_n = 0.85 \times 2\sqrt{5000} \times 12 \times 10.75 = 15507$ lb, $> V_u$ OK

MIN STL. $A_s = .0018 \times 12 \times 12 = 0.26$ in^2

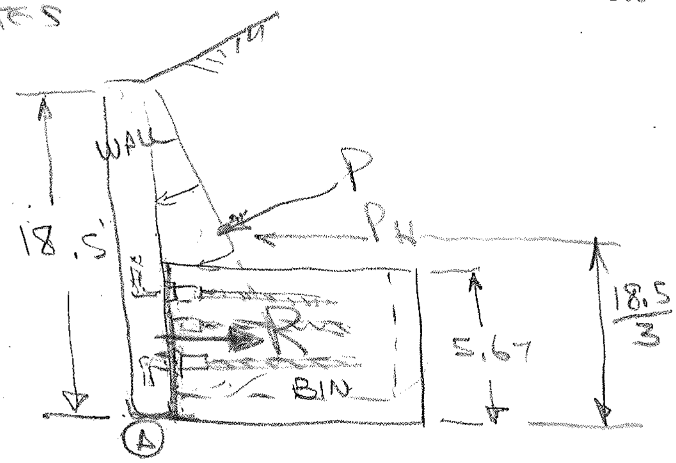
For 12" WALL USE 2 LAYERS – USE #4 @ 12" BOTH WAYS FRONT FACE

USE #6 @ 12" HOR STL REAR FACE

PROBLEM: DESIGN CONNECTION BETWEEN WALL AND BIN



THE HORIZONTAL FORCE P_H AGAINST THE WALL GENERATES A MOMENT AT (A) THAT NEEDS TO BE RESISTED BY A MOMENT GENERATED BY THE CONNECTION BETWEEN WALL & BIN.



$P = (0.42 \times 120^{pcf} \times 18.5)\frac{18.5}{2}$

$= 8625$ lb/ft WIDE SECT.

$P_{HOR} = 8625 \cos 18 = 8202$ lb/ft

TOTAL $P_{HOR} = 8$ ft $\times$ 8202 lb/ft $= 65623$ lb

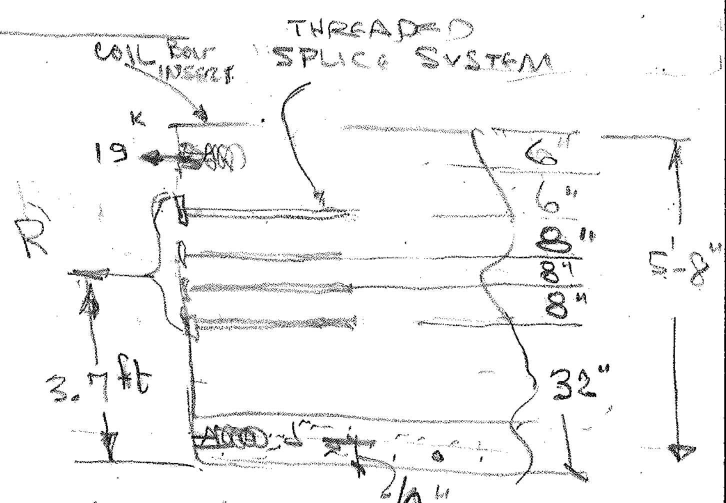
MOMENT AT (A) $= 65623^{lb} \times \frac{18.5^{ft}}{3} = 404675$ ft. lb.

TO SUPPORT MOMENT AT (A)

$R = \frac{404675^{ft\,lb} - 19000^{lb} \times 5.2^{ft}}{3.7\ ft}$

$= 82670$ lb

USE 4 COUPLERS WITH ALLOWABLE CAPACITY > 20600 lb



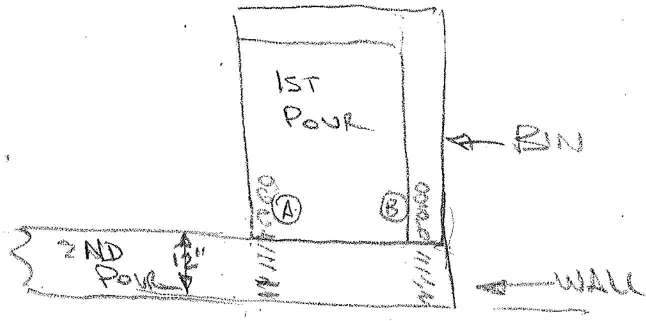
connection design cont.

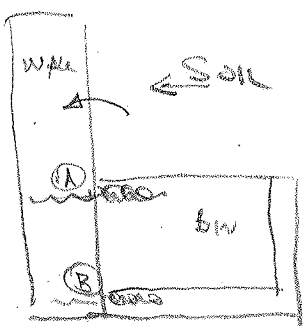
TOP & BOTTOM CONNECTORS WILL BE 1" DIA. EXPANDED COIL INSERT.

THEY WILL SERVE 2 PURPOSES

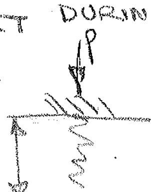
1. THEY WILL SUPPORT THE BIN WHILE THE 2ND POUR IS PERFORMED.

2. THEY WILL PROVIDE SOME CAPACITY TO THE BIN/WALL CONNECTION





CHECK COMPRESSION ABILITY of 1" DIA. COIL BOLT DURING FAB. of WALL



P = WT of BIN IN UPRIGHT COND.

WORST CASE IS AT (B) — P = 7K. COMPRESSION

$I = \frac{3.14 \times 1^4}{64} = 0.049 \, in^4$

$L = 12 \, in$

$K = 1.0$

$P_{CR} = \frac{\pi^2 E I}{K L^2} = \frac{3.14^2 \times 29 \times 10^6 \times 0.049}{1.0 \times 12^2} = 9700 \text{ lb}$

$P_{allow} = \frac{9700 \text{ lb}}{400} = 24 \, k$ — 1" DIA COIL BOLT O.K IN COMP.

CHECK TENSION CAPACITY AT (A) WHEN SOIL IS BEARING AGAINST WALL

1" DIA COIL BOLT IN TENSION HAS CAPACITY of 25^k (APPENDIX A)

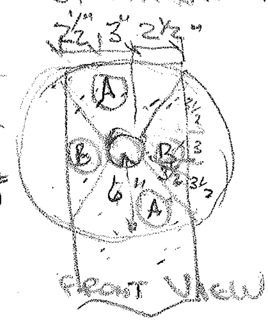
ALLOW. TENSION CAP. of CONCRETE USING DIAG. SHEAR FORMULA $2\sqrt{5000} = 141$ psi

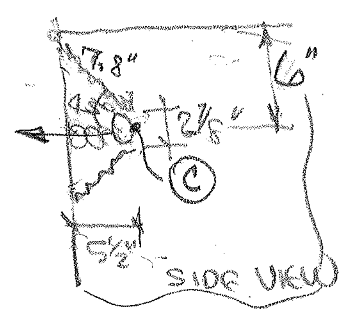
AREA (A) $[(3" \times 7.8") + \frac{1}{2} \times 7.8" \times 5"]\, 2 = 86 \, in^2$

AREA (B) $[(3" \times 3\frac{1}{2}") + (\frac{1}{2} \times 3\frac{1}{2}" \times 7")]\, 2 = 46 \, in^2$

AREA (C) $3.14/4 \times 2.875^2 = 6 \, in^2$

$= 138 \, in^2$





CONCRETE TENSION CAPACITY ALLOWED

$= 138 \, in^2 \times \frac{141 \text{ psi}}{1000} = 19.5^K$

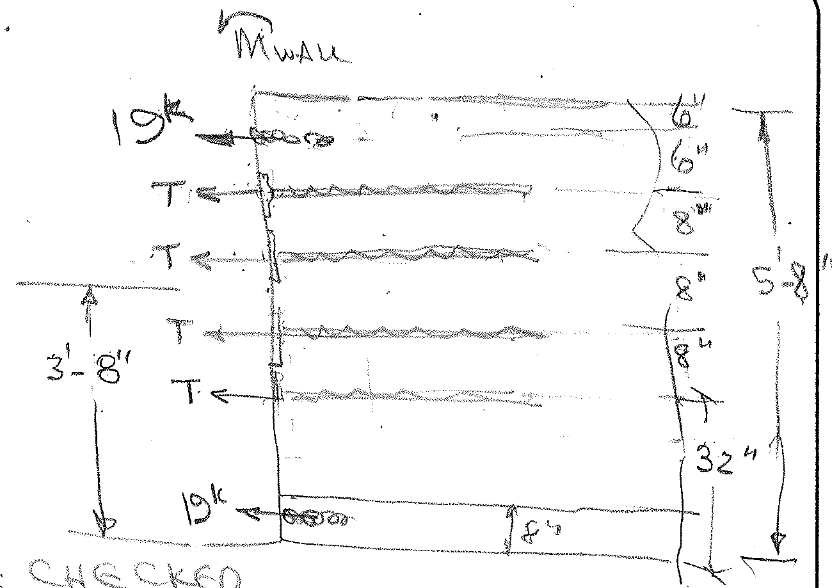
USE 19^K

CALC BY: CHECK BY: SHEET NO. 9 OF

DATE: REV: PROJECT:

connection design cont.

PROVIDE 4 THREADED SPLICING SYSTEMS (APPENDIX B) w. CENTER AT 3'-8" ABOVE BOTTOM OF BASE.



THESE UNITS WILL ALSO RESIST MOMENT FROM PRESSURE OF SOIL ON WALL.

TWO ITEMS TO BE CHECKED

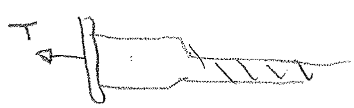
1. CAPACITY of UNIT IN WALL
2. " of REBAR THREADED INTO SPLICE

TYP. #7 REBAR

TENSION CAPAC — at GRADE 100 ||

#7 BAR $0.6^{in^2} (0.6 \times 60000^{psi}) = 21600^{lb.}$

TENSION CAPACITY of DOWEL BAR



FROM APPENDIX B3 $P_y = 36000$ lb

USE 0.6×36000 lb $= 21600^{lb}$

EMBEDMENT LENGTH REQD. FOR TENSION

$$42 \times \frac{7}{8} = 37^{in}$$

MOMENT CAPACITY of CONNECTION

$$= 19^k \times 5.2^{ft} + 4 \times 21.6^k \times 3.67^{ft}$$

$$= 416^{k \cdot ft} > 405^{k \cdot ft} \quad \text{O.K.}$$

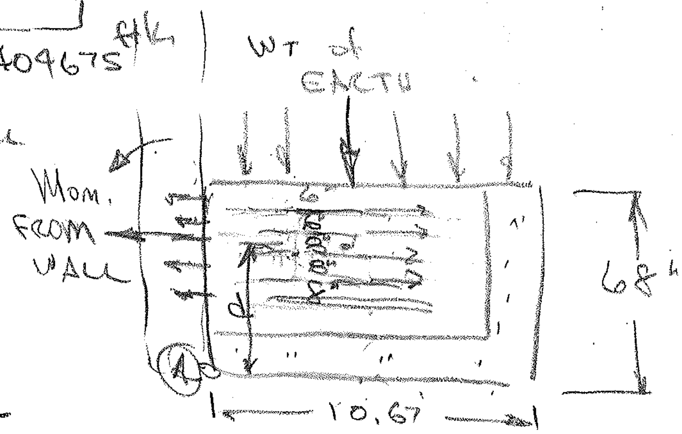
PROBLEM DESIGN BIN

FROM SHEET 7 MOM. ON WALL $= 404675^{ft\,lb}$

$M_{Ⓐ} = \frac{404675^{ft\,lb}}{2\text{ WALLS}} = 202337\ ^{ft\,lb}/_{WALL}$

$M_u^{Ⓐ} = 1.7 \times 202337$

$= 344000.\ ft^{lb}/_{WALL}$



SIDE VIEW

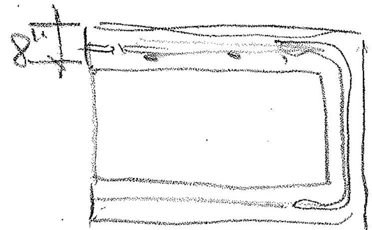
PROVIDE #7 SPLICED TO TENSION MEMBER & COIL

$A_s = 5 \times 0.6^{in^2} = 3.0^{in^2}$

$b = 8\ in$

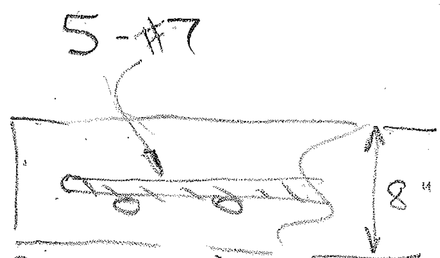
$d = 68 - 6 - 6 - 8 = 48^{in}$

$f'_c = 5000\,psi \quad f_y = 60000\,psi$



PLAN VIEW

$q = \frac{60}{5} \times \frac{3.0}{8 \times 48} = 0.094$



$\Phi M_u = 0.9 \times 8 \times 48^2 \times 5000 \times 0.094(1 - 0.59 \times 0.094) \div 12$

$= 613694.\ ft.\ lb \quad > \quad M_u^{Ⓐ} = 344000.\ ^{ft\,lb}$

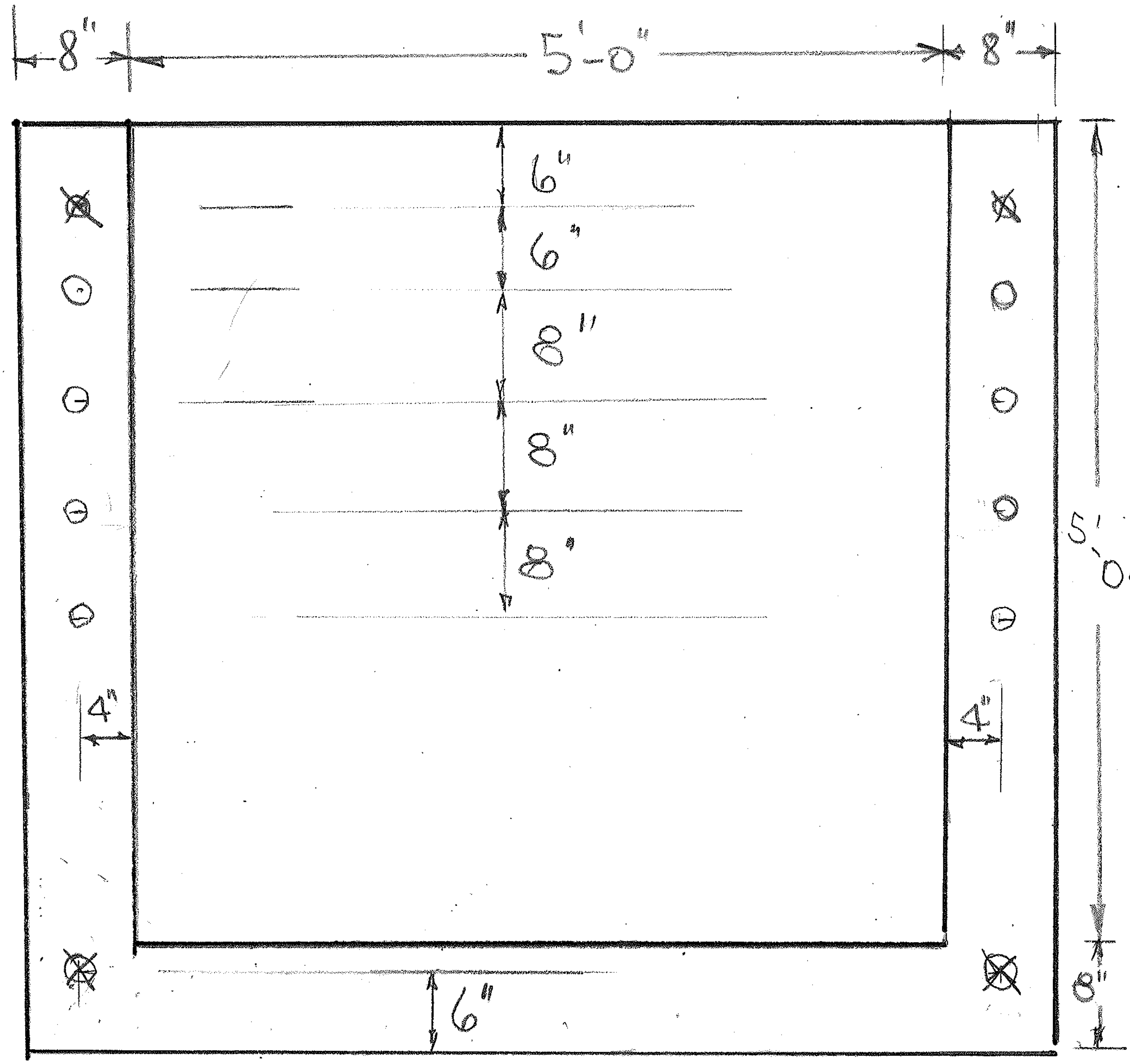
OK

CALC BY:________ CHECK BY:________ SHEET NO. 11 OF________

DATE:________ REV:________ PROJECT:________

LEGEND: ⊗ 1" DIA C156 EXPANDED COIL, COIL INSERT (APPENDIX A)

○ #7 REBAR, THREADED SPLICING SYSTEM (APPENDIX B)

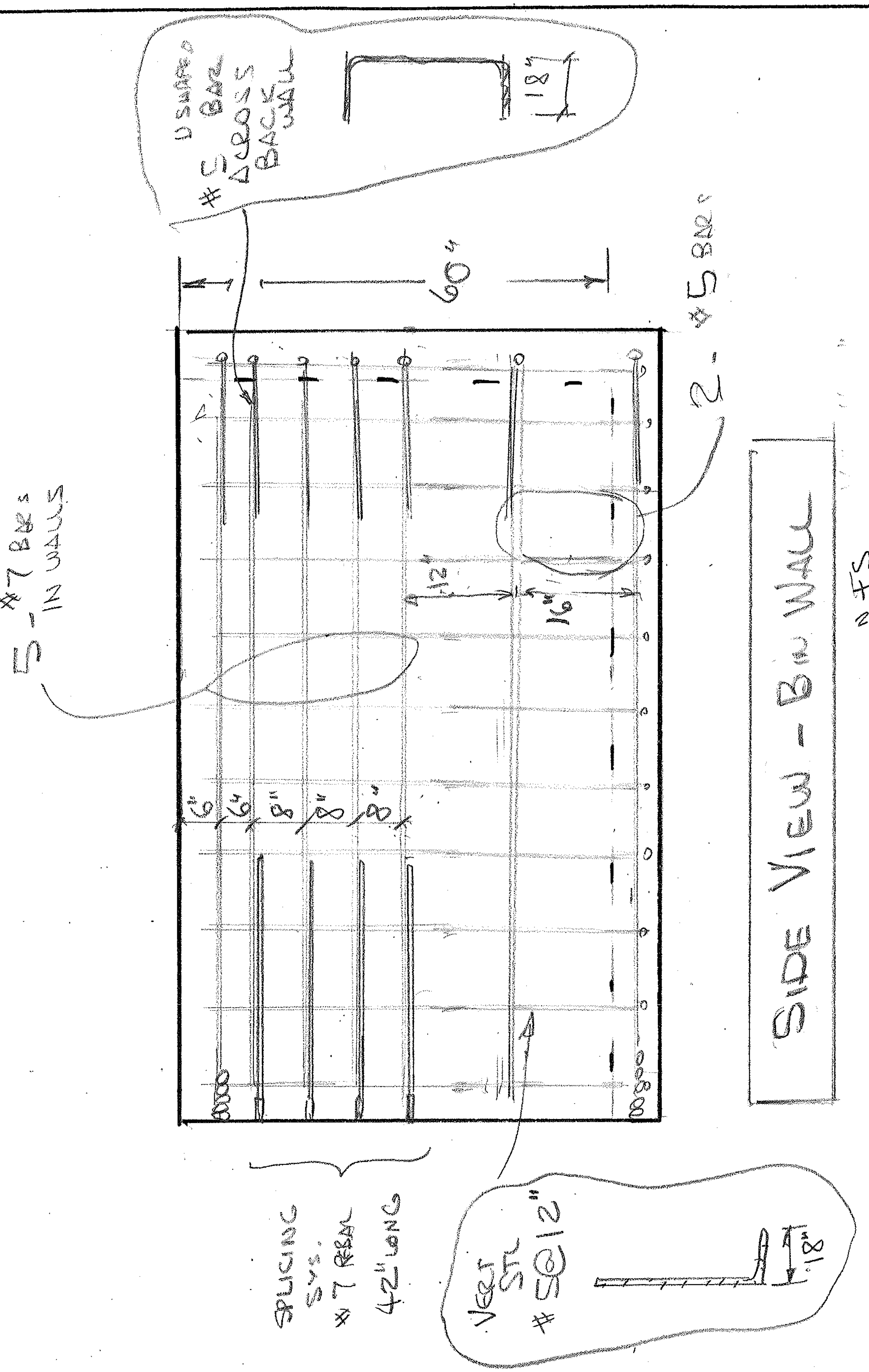


END VIEW - BIN

SCALE 1"=1'-0"

CALC BY:__________ CHECK BY:__________ SHEET NO. 12 OF__________

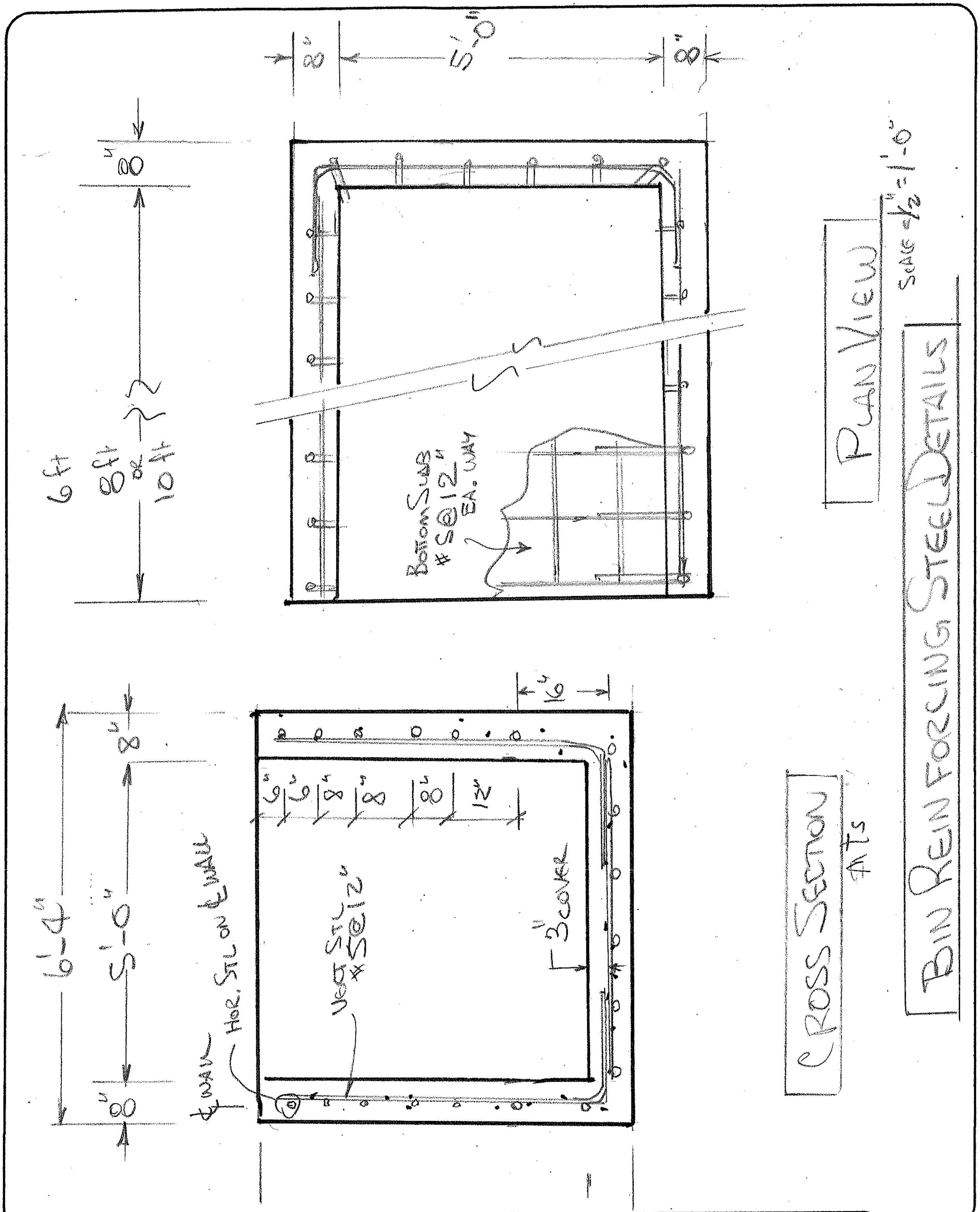
DATE:__________ REV:__________ PROJECT:__________



GARY K. MUNKELT & ASSOC. Structural Engineers Fax 215-855-8714

CALC BY:______ CHECK BY:______ SHEET NO. 13 OF______

DATE:______ REV:______ PROJECT:______



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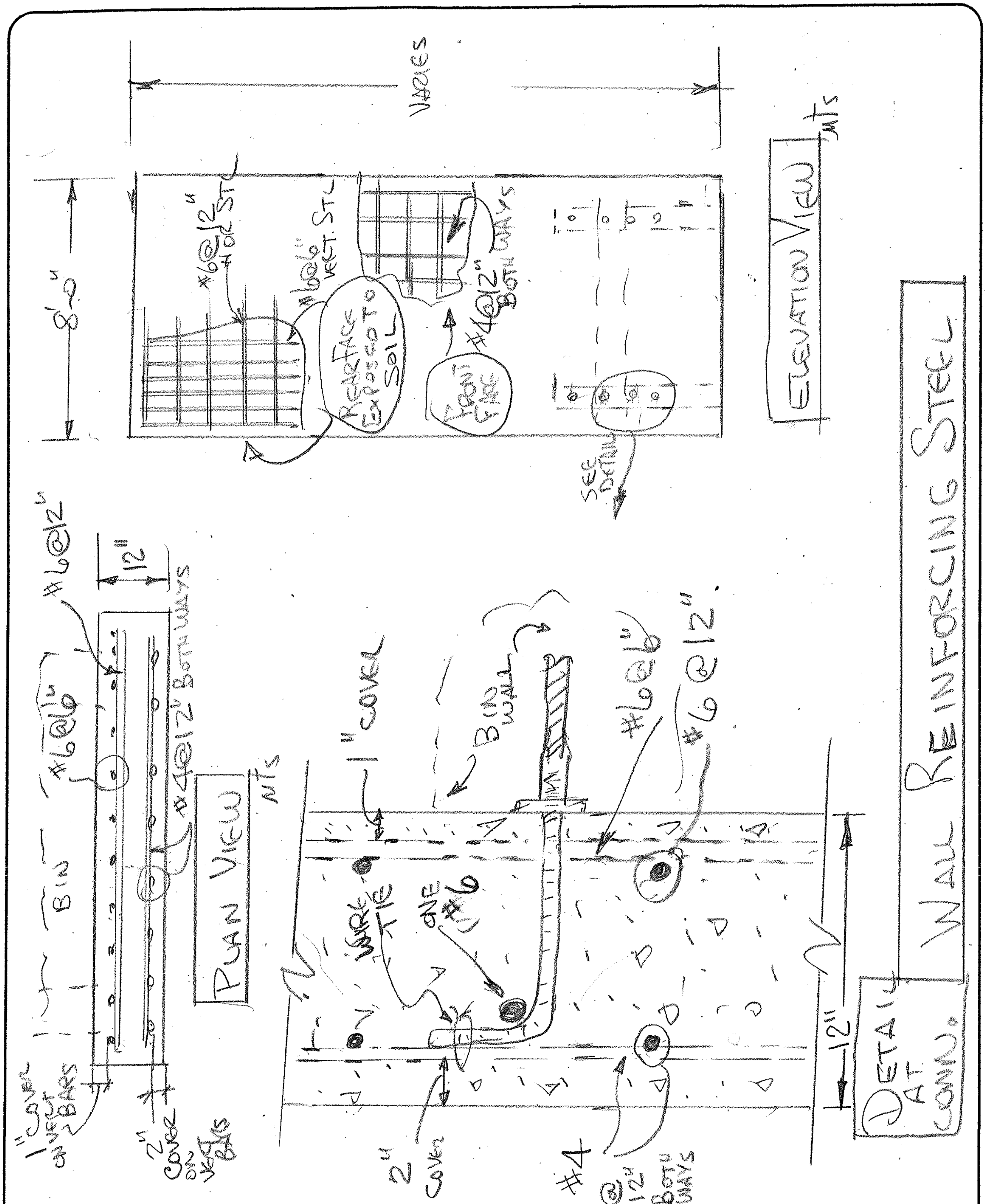
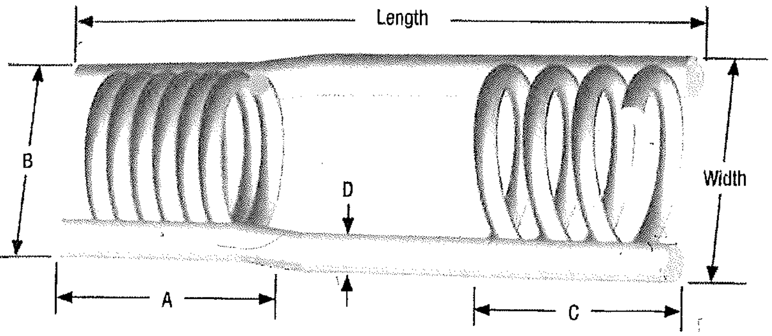


APPENDIX A

INSERTS

CI-56: EXPANDED COIL, COIL INSERT



In fabricating the Coil Threaded, Expanded Coil Insert, an expanded pitch coil is welded to the end of the insert. This serves to distribute applied loads over a larger volume of concrete. Available in plated finish.

-for use in each corner of the bin anchor, threaded to match thickness of the wing wall

EXPANDED COIL, COIL INSERT DIMENSIONS AND LOAD CHART

Part Number	Bolt Diameter	# of Struts	Length	Width	A	B	C	D Wire Diameter	Insert Ultimate Mechanical Capacity (lbs)
CI5634412P	3/4"	2	4-1/2"	2-3/8"	1-3/4"	1-7/8"	1-5/8"	0.375"	17,000
CI561512P	1"	2	5-1/2"	2-7/8"	2-1/16"	2-3/8"	2-1/4"	0.440"	25,000

- In concrete capacity is based on min. concrete strength of 3,000 psi.
- Inserts must be set back 1/2" from concrete surface and have sufficient coil penetration by lifting bolt

CR-12: COIL ROD - HIGH TENSILE

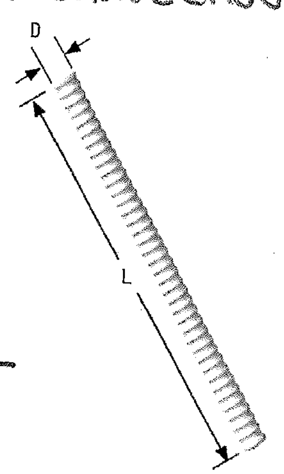
5:1 SWL REQUIRED FOR LIFTING PER OSHA

3:1 SWL REQUIRED FOR FIXED CONDITION SUCH AS WALL TO BIN CONNECTION

INSERTS

The Coil Rod is stocked in high-tensile strength in 12 ft standard lengths, in 1/2", 3/4", 1", 1-1/4" and 1-1/2" diameters. Coil rod is also available cut to length per order.

$15000 \times \frac{5}{3} = 25000^{lb}$



COIL ROD DIMENSIONS AND LOAD CHART

Part Number	Diameter D	Length	Standard Finish	Coil Rod Ultimate Mechanical Tension Load (lbs)	5:1 SWL Tension (lbs)	5:1 SWL Shear (lbs)
CR1212	1/2"	144" (12 ft.)	Plain	18,000	3,600	2,400
CR1234	3/4"	144" (12 ft.)	Plain	36,000	7,200	4,800
CR1201	1"	144" (12 ft.)	Plain	75,000	15,000	10,000
CR12114	1-1/4"	144" (12 ft.)	Plain	120,000	24,000	16,000
CR12112	1-1/2"	144" (12 ft.)	Plain	140,000	28,000	18,000

- Coil rod requires 2 coil nuts or 1 H.D. coil nut on each end to develop safe working loads
- All data is based on a 5:1 SWL for lifting applications. Safety factor can be adjusted to a 3:1 SWL for connections by multiplying the published loads by 5, then dividing by 3

DBDI® Splice System

IAPMO Evaluation Report ER-0321

The Dayton Superior DBDI Splice System is a two-piece, standard mechanical splicing product that eliminates protruding dowels. Typical applications include splicing reinforcement bars in monolithic structures, rebar anchorages, future expansion, and dowel bar substitution at construction joints.

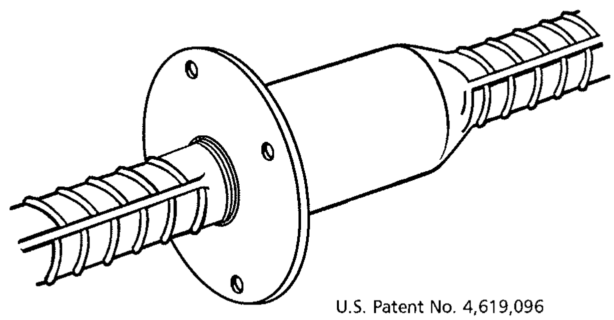
The components of the system, the Dowel Bar (DB) and Dowel-In (DI), are manufactured from standard rebar material. Basic fabrication consists of forging and threading operations. No welding or machining is required and the threading operation does not reduce the nominal cross-sectional area of the bar. The completed splice obtains ultimate bar strengths and meets or exceeds all existing code requirements.

System Advantages

The patented DBDI Splice System has been engineered, tested, and proven to meet or exceed all field standards and design/engineering practices. The system is easy to use and readily identified as rebar material. The easy installation requires no special tools or machinery and simplifies the forming operations. There are no "extras," such as wedges, nuts, collars or couplers required and routine cutting, bending, etc., can be easily handled in the field, if required.

The Dayton Superior DBDI Splice System Advantages:

- Strong
- Safe
- Easy to Use
- Eliminates Protruding Dowels
- Improves Forming Costs
- Reduces Forming and Stripping Hassles
- Saves Forms By Eliminating Drilling Holes
- No Forming Required



U.S. Patent No. 4,619,096

System Compliance

The DBDI Splice System complies with the following standards/specifications:

- ACI 318 Type 2
- IAPMO Evaluation Report ER-0321
- State Departments of Transportation
- Ministries of Transportation (Canada)
- Caltrans Ultimate Splice
- City of Los Angeles Department of Building and Safety
- Army Corps of Engineers CW03210
- AASHTO
- International Building Code (IBC)

Typical Splicing Specification

The Dayton Superior DBDI Splice System, consisting of the Dowel Bar and Dowel-In, shall be used in splicing of rebar. The DBDI System shall be forged from deformed rebar material, free of external welding and machining. It shall be furnished with an integral nailing flange and threaded with UNC or UN thread to a depth, at minimum, equal to the nominal thread diameter. The Dowel-In shall be fabricated from deformed rebar material with thread corresponding to the Splicer. The completed splice shall meet Type 2 tensile requirements of American Concrete Institute Specification 318, Building Code Requirements for Reinforced Concrete and the Corps of Engineers Specification CW03210, Civil Works Construction Guide Specification for Steel Bars, Welded Steel Wire Fabric and Accessories for Concrete Reinforcement.

Specific:

- Mechanical connections shall be the DBDI® Splice System as manufactured by Dayton Superior Corporation.

Generic:

- The mechanical connection shall meet building code requirements of developing in tension and compression as required by__________ (insert name here). The mechanical connection shall be the forged and parallel threaded type coupler manufactured from high quality steel. All couplers shall be installed per the manufacturer's approved procedures.

APPENDIX B2

Recommended Dowel Bar and Dowel-In Sizes

Specified or Required Dowel Bar					Recommended Dowel Bar Splicer and Dowel-In						
Bar Size			Grade 60 Rebar Loads (lbs.)		System Thread Size*	DB-SAE Bar Size	Dowel-InBar Size	System Stress Area (min.)	Completed Splice (lbs.)		
US	Metric (mm)	CN (M)	P_y	1.25 P_y					P_y	1.25 P_y	100% P_u
#4	[13]	[10]	12,000	15,000	5/8" - 11	#4	#4	.20	12,000	15,000	18,000
#5	[16]	[15]	18,600	23,250	3/4" - 10	#5	#5	.31	18,600	23,250	27,900
~~#6~~	~~[19]~~	~~[20]~~	~~26,400~~	~~33,000~~	~~7/8" - 9~~	~~#6~~	~~#6~~	~~.44~~	~~26,400~~	~~33,000~~	~~39,600~~
#7	[22]	—	36,000	45,000	1" - 8	#7	#7	.60	36,000	45,000	54,000
~~#8~~	~~[25]~~	~~[25]~~	~~47,400~~	~~59,250~~	~~1-1/8" - 8~~	~~#8~~	~~#8~~	~~.79~~	~~47,400~~	~~59,250~~	~~71,100~~
#9	[29]	[30]	60,000	75,000	1-1/4" - 8	#9	#9	1.00	60,000	75,000	90,000
#10	[32]	—	76,200	95,250	1-7/16" - 8	#10	#10	1.27	76,200	95,250	114,000
#11	[36]	[35]	93,600	117,000	1-9/16" - 8	#11	#11	1.56	93,600	117,000	140,400

P_y=Minimum Yield Strength of bar.

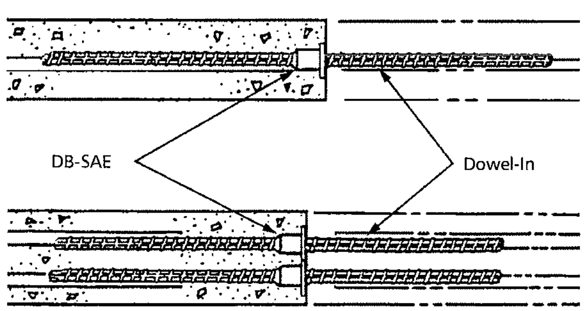
P_u=Minimum Tensile Strength of bar.

*5/8", 3/4", 7/8" and 1" sizes have UNC Threads. 1-1/8" and larger sizes are equipped with UN Threads.

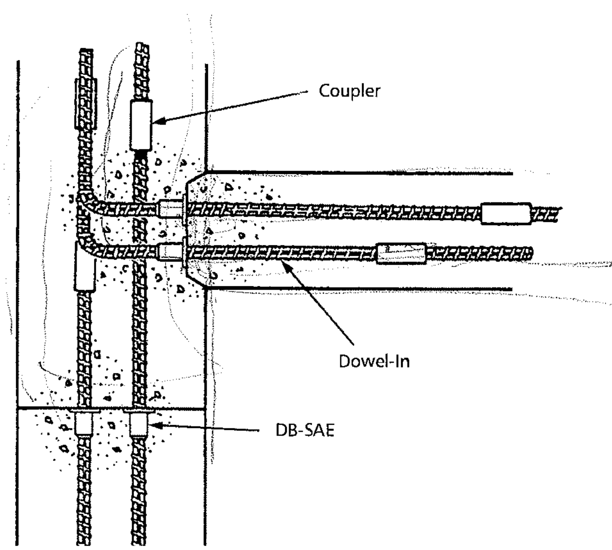
Required Development and Lap Lengths for Grade 60, Uncoated Bottom Reinforcement in Normal Weight Concrete

Typical Threaded Splicing Applications

Application	f'_c psi	#6 and Smaller Bars	#7 and Larger Bars
Clear spacing of bars being developed or spliced not less than d_b, clear cover not less than d_b, and beam stirrups or column ties throughout ℓd not less than the code minimum or Clear spacing of bars being developed or spliced not less that $2d_b$ and clear cover not less than d_b	3,000	$44d_b$	$55d_b$
	4,000	$38d_b$	$47d_b$
	5,000	$34d_b$	$42d_b$
	6,000	$31d_b$	$39d_b$
	8,000	$27d_b$	$34d_b$
	10,000	$24d_b$	$30d_b$
Other cases	3,000	$66d_b$	$82d_b$
	4,000	$57d_b$	$71d_b$
	5,000	$51d_b$	$64d_b$
	6,000	$46d_b$	$58d_b$
	8,000	$40d_b$	$50d_b$
	10,000	$36d_b$	$44d_b$



Typical Dowel Bar Splicer/Dowel-In Applications

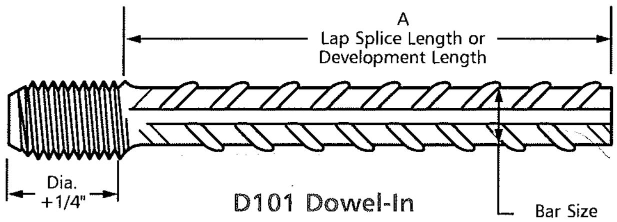


APPENDIX B3

DBDI Splice System

D101 Dowel-In, D102 90° Hooked Dowel-In, D103 180° Hooked Dowel-In, D104 Double-Ended Dowel-In

The Dayton Superior Dowel-In is available Straight (D101), 90° and 180° Hooked (D102 and D103) and Double-Ended (D104). Each is manufactured from deformed rebar material and is available in rebar sizes #4 through #11. The threaded end of the Dowel-In is enlarged by forging, before threading, to ensure that the cross-sectional area of the bar is not reduced by the threading operation. This design feature assures full ultimate strength of the rebar. Dowel-Ins are configured to facilitate easy installation and can be easily assembled by hand. On larger projects, such as highway paving, a centrifugal chuck on an electric or air-powered drill motor can be employed to speed installation. See D49 Magna Jaw.



D101 Dowel-In

To Order:

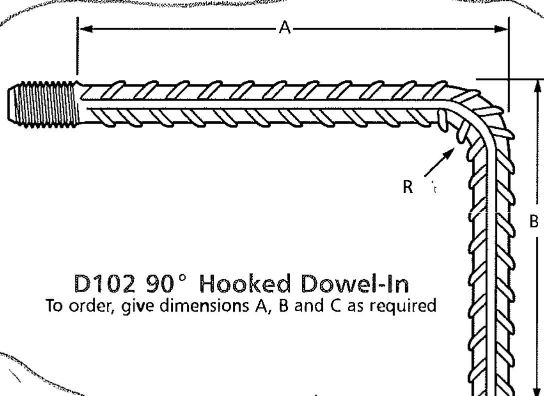
Specify: (1) quantity, (2) name, (3) bar size (should be equivalent to the rebar being substituted for on the structural drawings), (4) dimensions required (see below).

Example:

600, D102 90° Hooked Dowel-Ins, #5 rebar, A=14", B=8"

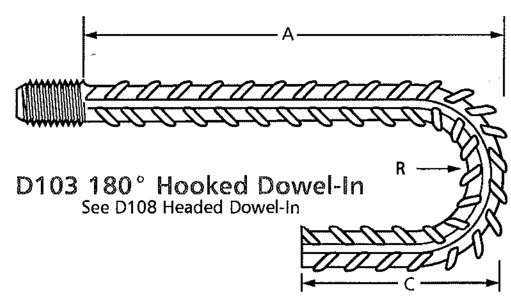
Specified or Required Dowel Bar					Recommended Dowel Bar and Dowel-In						
Bar Size			Grade 60 Rebar Loads (lbs.)		System Thread Size*	DB-SAE Bar Size	Dowel-In Bar Size	System Stress Area (min.)	Completed Splice (lbs.)		
US	Metric (mm)	CN (M)	P_y	1.25 P_y					P_y	1.25 P_y	100% P_{ult}
#4	[13]	[10]	12,000	15,000	5/8" - 11	#4	#4	.20	12,000	15,000	18,000
#5	[16]	[15]	18,600	23,250	3/4" - 10	#5	#5	.31	18,600	23,250	27,900
#6	[19]	[20]	26,400	33,000	7/8" - 9	#6	#6	.44	26,400	33,000	39,600
#7	[22]	—	36,000	45,000	1" - 8	#7	#7	.60	36,000	45,000	54,000
#8	[25]	[25]	47,400	59,250	1-1/8" - 8	#8	#8	.79	47,400	59,250	71,100
#9	[29]	[30]	60,000	75,000	1-1/4" - 8	#9	#9	1.00	60,000	75,000	90,000
#10	[32]	—	76,200	95,250	1-7/16" - 8	#10	#10	1.27	76,200	95,250	114,000
#11	[36]	[35]	93,600	117,000	1-9/16" - 8	#11	#11	1.56	93,600	117,000	140,400

P_y=Minimum Yield Strength of bar.
P_u=Minimum Tensile Strength of bar.

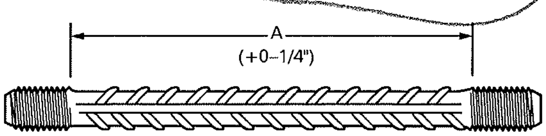


D102 90° Hooked Dowel-In
To order, give dimensions A, B and C as required

*5/8", 3/4", 7/8" and 1" sizes have UNC Threads. 1-1/8" and larger sizes are equipped with UN Threads.



D103 180° Hooked Dowel-In
See D108 Headed Dowel-In



D104 Double-Ended Dowel-In

Bar Size Designation			D101 Minimum Mfg. Length DI DOWEL INS	D102/D103 Minimum Mfg. Length	D104 Minimum Length Double End Dowel Ins.
US	Metric (mm)	CN (M)			
#4	[13]	[10]	9"	4" *	8" **
#5	[16]	[15]	9"	5" *	8" **
#6	[19]	[20]	9-1/4"	6" *	8" **
#7	[22]	—	9-1/4"	7" *	8" **
#8	[25]	[25]	15-1/2"	8" *	14" **
#9	[29]	[30]	15-1/2"	9" *	14" **
#10	[32]	—	15-3/4"	10" *	14" **
#11	[36]	[35]	16"	11" *	14" **

NOTE: To be manufactured as Single End
* Tolerance on Bending Plus 0/ Minus 1" on "A" Dim.
** Plus thread each end.

DAYTON SUPERIOR

DBDI Splice System

D101A Dowel Bar, D102A 90° Hooked Dowel Bar, D103A 180° Hooked Dowel Bar, D104A Double-Ended Dowel Bar

The Dayton Superior Dowel Bar is a one-piece unit, integrally forged from deformed rebar material. The splicers are available in #4 through #11 rebar sizes to be used in conjunction with the corresponding size Dowel-In to accomplish a mechanical splice designed to achieve full mechanical ultimate.

The splicer can be furnished straight (D101A) cut to length, 90° and 180° hooked (D102A and D103A) and double-ended (D104A). The splicer can also be special-ordered with a reduced diameter washer flange or with the washer flange clipped (in more than one direction, if required) to provide adequate concrete cover, or to avoid interference.

The D104A Double-Ended Dowel Bar is used to establish a direct load path through a concrete section, thus avoiding multiple hooked rebar and eliminating rebar congestion. The double-ended unit can be configured in a "U" shape for special applications.

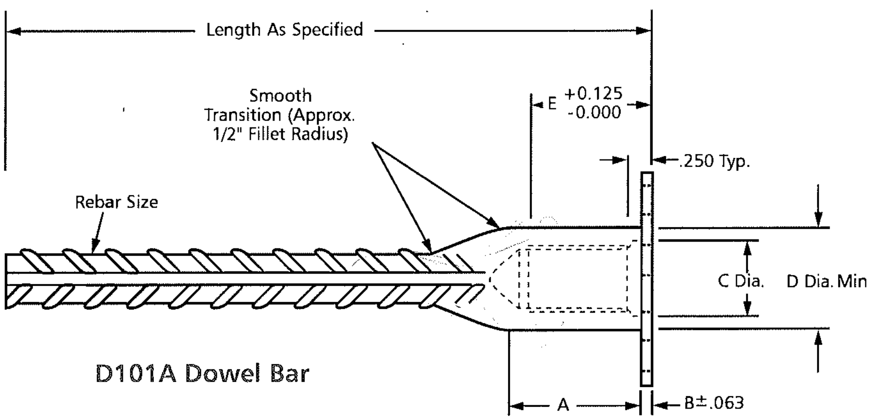
Bar Size Designation			Thread Size	A	B	C	D	E	Flange Diameter	100% P_u
US	Metric (mm)	CN (M)								
#4	[13]	[10]	5/8" – 11 UNC	1-1/16"	1/8"	11/16"	55/64"	1"	1-7/8"	18,000
#5	[16]	[15]	3/4" – 10 UNC	1-9/16"	1/8"	13/16"	1-3/64"	1-1/8"	2-1/16"	27,900
#6	[19]	[20]	7/8" – 9 UNC	1-11/16"	1/8"	15/16"	1-15/64"	1-1/4"	2-1/4"	39,600
#7	[22]	—	1" – 8 UNC	1-27/32"	1/8"	1-1/16"	1-27/64"	1-3/8"	2-7/16"	54,000
#8	[25]	[25]	1-1/8" – 8 UN	2-1/16"	1/8"	1-3/16"	1-19/32"	1-1/2"	2-5/8"	71,100
#9	[29]	[30]	1-1/4" – 8 UN	2-3/16"	1/8"	1-5/16"	1-25/32"	1-5/8"	2-13/16"	90,000
#10	[32]	—	1-7/16" – 8 UN	2-7/16"	1/8"	1-1/2"	2"	1-13/16"	3"	114,000
#11	[36]	[35]	1-9/16" – 8 UN	2-9/16"	1/8"	1-5/8"	2-7/32"	1-15/16"	3-1/4"	140,400

P_u=Minimum Tensile Strength of bar.

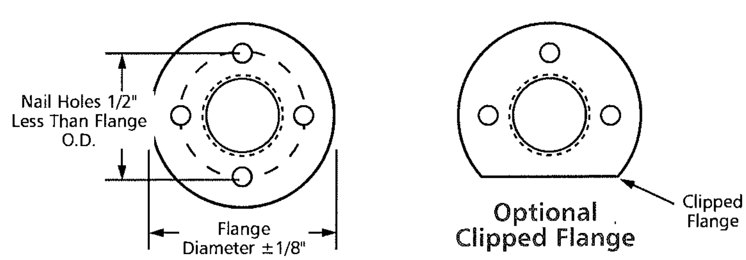
Bar Size Designation			D101A Minimum MFG. Length DB-SAE
US	Metric (mm)	CN (M)	
#4	[13]	[10]	12"
#5	[16]	[15]	14"
#6	[19]	[20]	16"
#7	[22]	—	16"
#8	[25]	[25]	16"
#9	[29]	[30]	16"
#10	[32]	—	16"
#11	[36]	[35]	16"

NOTE: To be manufactured as Single End

NOTE: No. 4, 5 and 6 splicers, 18", 24" and 36" long will usually have a stamped metal plug to protect threads; all other sizes will have a plastic cap plug.



D101A Dowel Bar



Optional Clipped Flange