CP&P

CONCRETE PIPE & PRECAST, LLC

# SUBMITTAL

## ENGR# 15108

9'x6' PRECAST DOUBLE MONOLITHIC BOX CULVERT
CENTERLINE ROAD (CULVERT NO. 1)
BERKELEY COUNTY, SC

LANDMARK CONSTRUCTION
01-21-16


| | |
|---|---|
| Title Sheet - | 1p. |
| Box Culvert General Layout - | 1p. |
| Box Culvert General End Configuration - | 1p. |
| Box Culvert Piece Details - | 3p. |
| Box Culvert Reinforcement Details - | 1p. |
| Box Culvert Reinforcement Nomenclature - | 1p. |
| Box Culvert Reinforcement Calculations - | 34p. |
| Box Culvert End Treatment Component Details - | 1p. |
| BWW 21-06-45 Wing Wall Details - | 1p. |
| BWW 21-06-45 Wing Wall Reinforcement Details- | 1p. |
| BWW 21-06-45 Wing Wall Reinforcement Calculations- | 7p. |
| AL Patterson Utility Anchor - | 1p. |
| Double Swivel Lift Plate Assembly Detail - | 1p. |
| ConSeal 1"x1" Mastic Joint Filler - | 2p. |
| MarMac Seal-Wrap Joint Wrap - | 2p. |


1/21/16

SOUTH CAROLINA
LICENSED PROFESSIONAL ENGINEER
No. 30262
EDWARD C. PAGE

☐ NO EXCEPTIONS TAKEN ☐ FURNISH AS CORRECTED
☐ REJECTED ☐ REVISE AND RESUBMIT

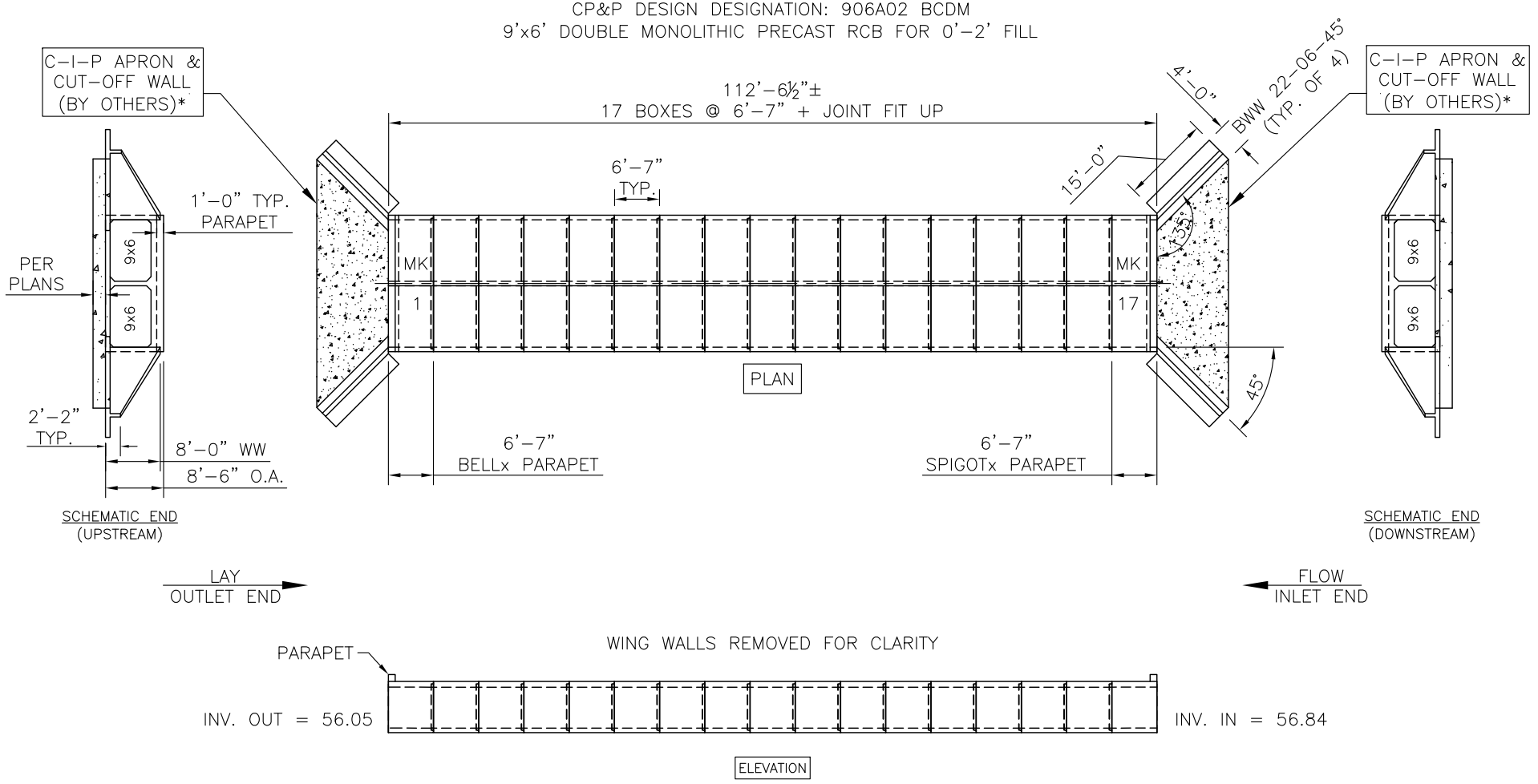
This review was performed only for general conformance with the design concept of the project and general compliance with the information given in the Contract Documents. Modifications or comments made on the shop drawings during this review do not relieve the Contractor from compliance with the requirements of the plans and specifications. Approval of a specific item does not include approval of the assembly of which the item is a component. Contractor is responsible for dimensions to be confirmed and correlated at the jobsite. Information that pertains solely to the fabrication process or to the means, methods, techniques, sequences and procedures of construction, coordination of the work of all trades, and for performing all work in a safe and satisfactory manner remains the responsibility of the Contractor.

THOMAS & HUTTON ENGINEERING CO.

Date 03/11/2016 By SHG

REVIEWED FOR GENERAL CONFORMANCE TO CONTRACT DOCUMENTS ONLY.

CP&P DESIGN DESIGNATION: 906A02 BCDM
9'x6' DOUBLE MONOLITHIC PRECAST RCB FOR 0'–2' FILL




NOTES:
1.) ASTM C1577 LRFD & SCDOT SPECIFICATIONS – HL93 LL
2.) MATERIAL PROPERTIES – SEE INDIVIDUAL COMPONENT DETAILS FOR SPECIFIC MATERIAL PROPERTIES
3.) CONTRACTOR TO VERIFY ALL INVERTS, ELEVATIONS, HEIGHTS, ETC.
4.) THIS LAYOUT PROVIDED AS A GUIDE FOR DISTRIBUTION AND INSTALLATION. FIELD ADJUSTMENTS MUST BE MADE AS NECESSARY.

*CONTRACTOR TO DRILL, DOWEL & CAST–IN–PLACE APRON AND CUT–OFF WALL AS APPROPRIATE

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CONCRETE PIPE & PRECAST, LLC

# 9'x6' PRECAST DOUBLE MONOLITHIC BOX CULVERT LAYOUT

**REDUCED SCALE**

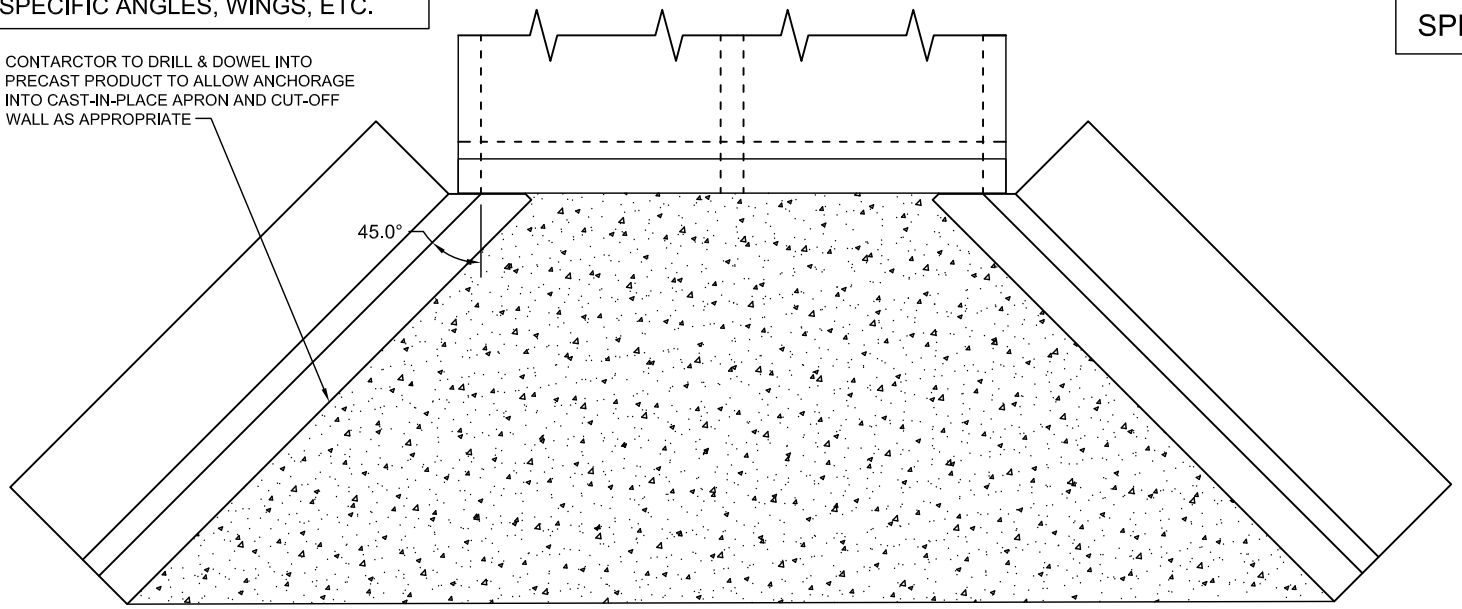
## CENTERLINE ROAD (CULVERT NO. 1)

**BERKELEY COUNTY, SC – LANDMARK CONSTRUCTION**

| ENGR# 15108 | | |
|---|---|---|
| ORIGINAL | 01–21–2016 | RSP |
| REVISION | | |
| LAYOUT 1 OF 1 | | |

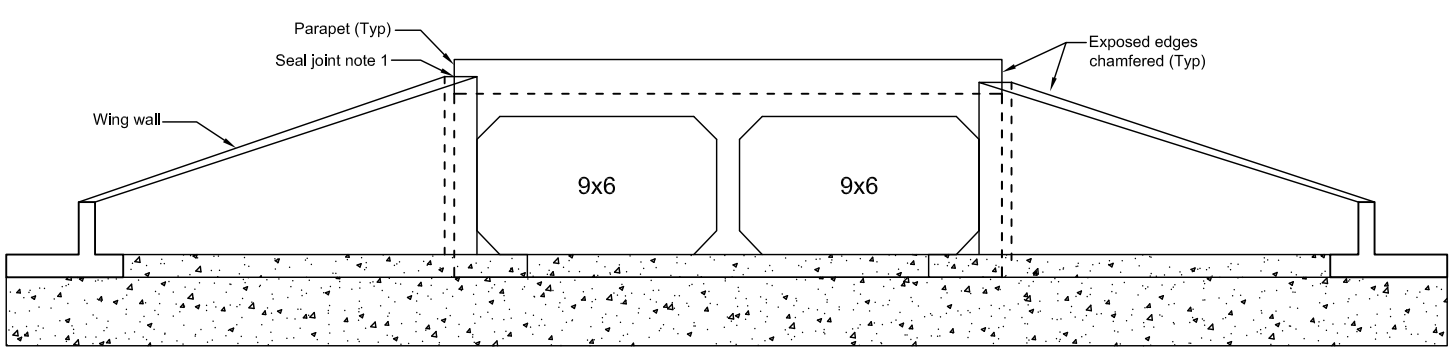
GENERIC END SECTION DETAIL.
PLEASE SEE LAYOUT FOR PROJECT
SPECIFIC ANGLES, WINGS, ETC.

GENERIC END SECTION DETAIL.
PLEASE SEE LAYOUT FOR PROJECT
SPECIFIC ANGLES, WINGS, ETC.



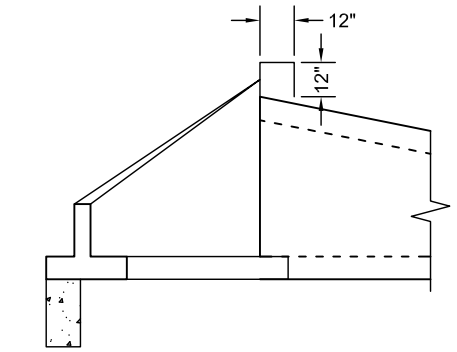

CAST-IN-PLACE APRON & CUT-OFF WALL

PLAN VIEW




CAST-IN-PLACE APRON & CUT-OFF WALL

FRONT VIEW




CAST-IN-PLACE
CUT-OFF WALL

**Notes:-**

1. **Contractor to seal all joining surfaces neatly with state approved sealant.**
2. **See Individual component details for more Information (Box culvert, wingwalls, parapet).**
3. **Wings have to be set on stable foundation so as to not to overstress the connections.**

NOT TO SCALE

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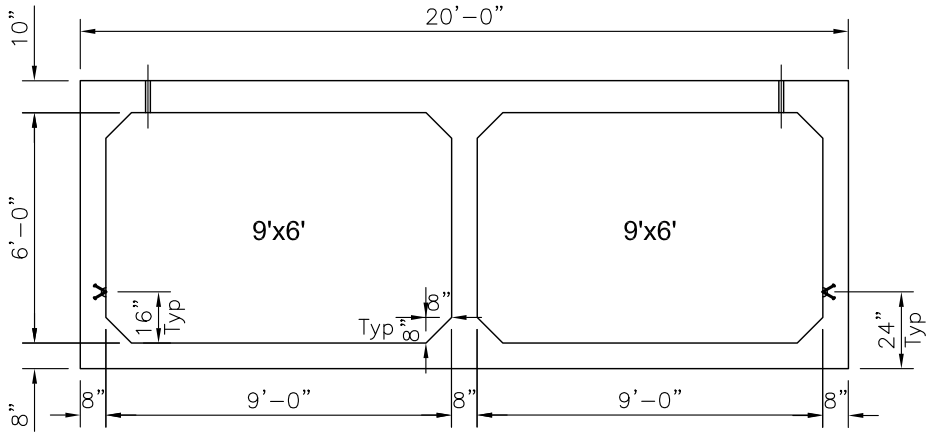
CONCRETE PIPE & PRECAST, LLC

# GENERAL CONFIGURATION INLET/OUTLET
# 9x6 BCDM PRECAST BOX CULVERT

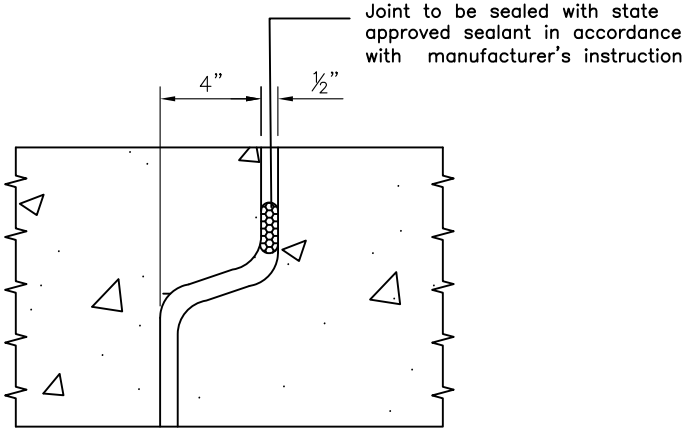
| | | |
|---|---|---|
| ORIGINAL | 01-21-16 | RSP |
| REVISION | | |

CONCRETE PIPE & PRECAST, LLC

SHEET 1 OF 1

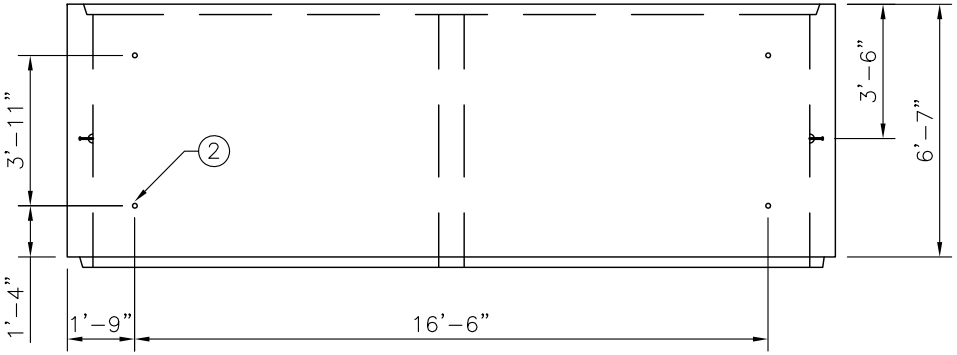



SECTION

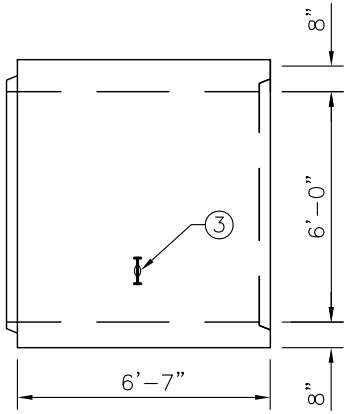



JOINT DETAIL

# 15 STANDARDS REQUIRED




TOP




SIDE

SPREADER BAR REQUIRED: 12' MIN – 20' MAX

| WEIGHT | MATERIAL PROPERTIES |
|---|---|
| 3.28 Tons/ft | f'c = 5ksi |
| 21.58 Tons/box | fy = 65ksi |

Notes:–
1. Dimesnions subject to permissible variations of ASTM C1577, AASHTO M259/M273
2. 1 1/2"ø Lifting Holes
3. Pulling devices LUL818g
4. Alternate 3" Joint may be used depending on producing plant

**REDUCED SCALE**

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CONCRETE PIPE & PRECAST, LLC

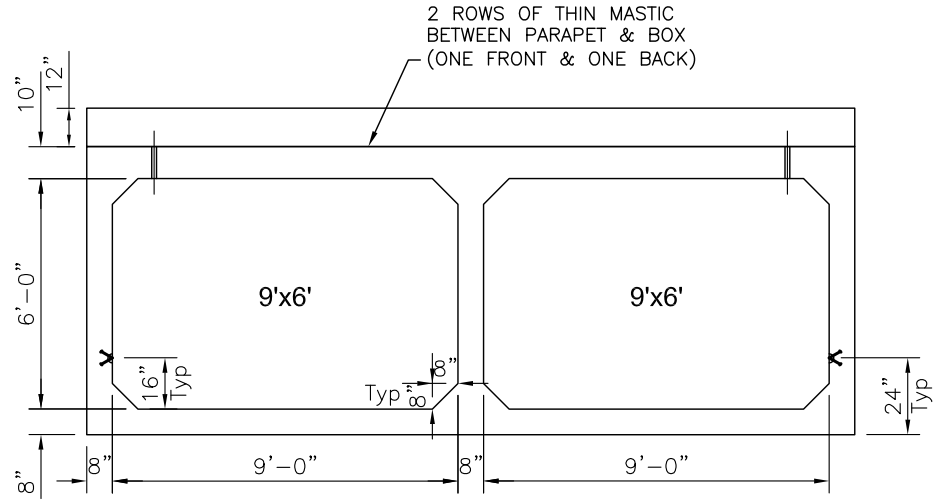
# 9'x6' DBL MONOLITHIC PRECAST BOX CULVERT
# CENTERLINE ROAD

## BERKELEY CO., SC

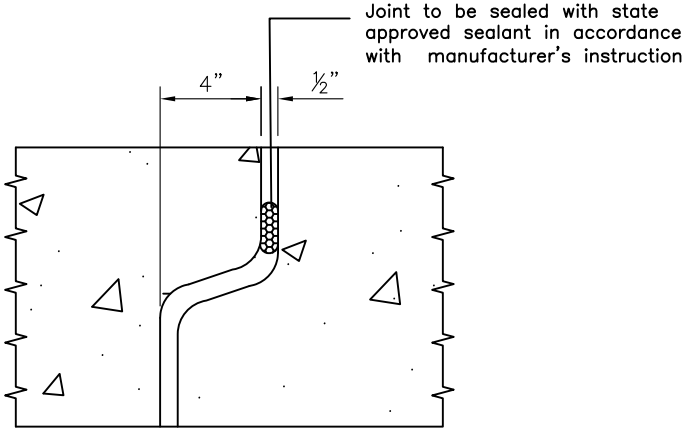
**LANDMARK CONSTRUCTION**

| JOB# 15108 | | |
|---|---|---|
| ORIGINAL | 01–21–16 | RSP |
| REVISION | | |

BOX CULVERT DETAILS 1 of 3

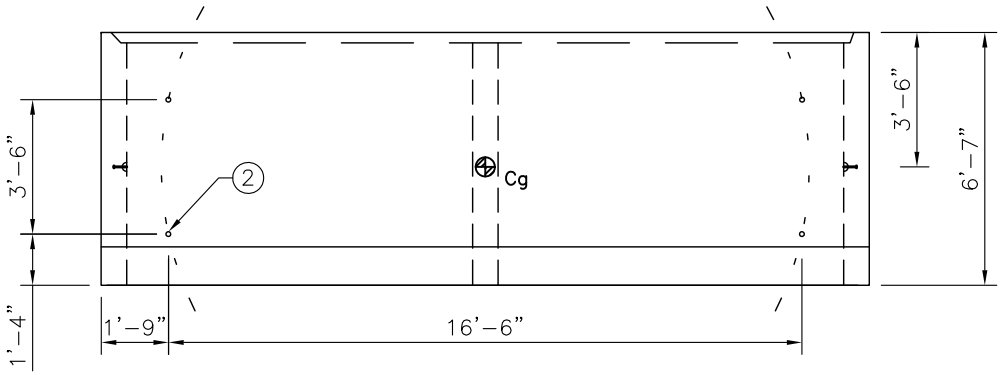



SECTION

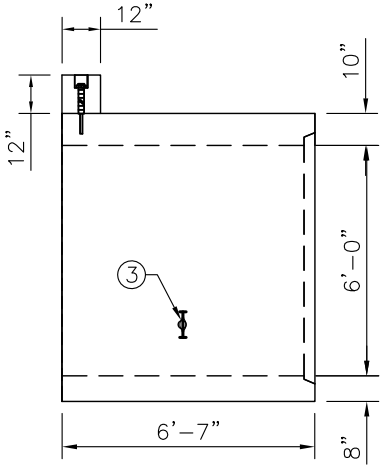



JOINT DETAIL

# MK1 BELLx PARAPET




TOP




SIDE

SPREADER BAR REQUIRED: 12' MIN – 20' MAX

WEIGHT
3.28 Tons/ft
22.58 Tons/box w/ Parapet

MATERIAL PROPERTIES
f'c = 5ksi
fy = 65ksi

Notes:–
1. Dimesnions subject to permissible variations of ASTM C1577, AASHTO M259/M273
2. 1 1/2"ø Lifting Holes
3. Pulling devices LUL818g
4. Alternate 3" Joint may be used depending on producing plant

**REDUCED SCALE**

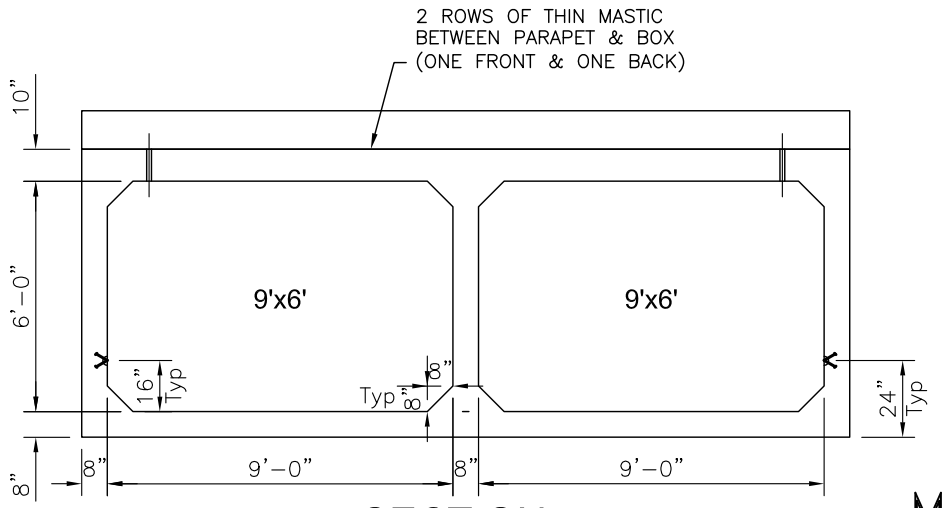
CP&P
CONCRETE PIPE & PRECAST, LLC

## 9'x6' DBL MONOLITHIC PRECAST BOX CULVERT
## CENTERLINE ROAD

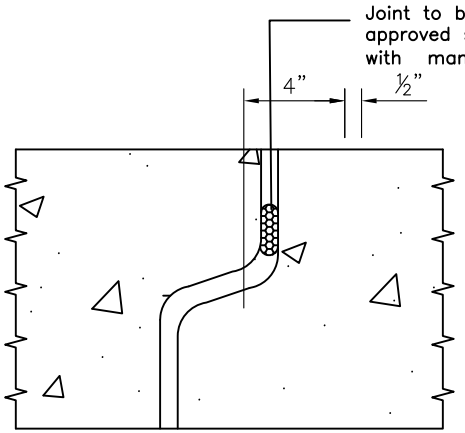
BERKELEY CO., SC

LANDMARK CONSTRUCTION

| | | |
|---|---|---|
| JOB# 15108 | | |
| ORIGINAL | 01–21–16 | RSP |
| REVISION | | |
| BOX CULVERT DETAILS 2 of 3 | | |

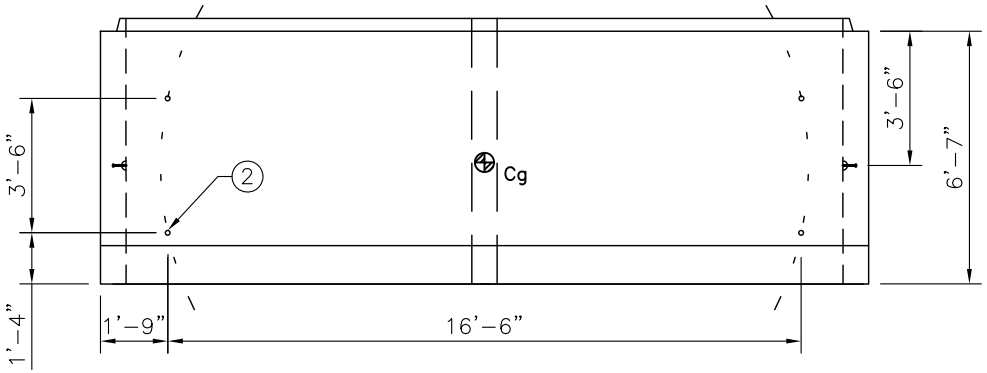



SECTION

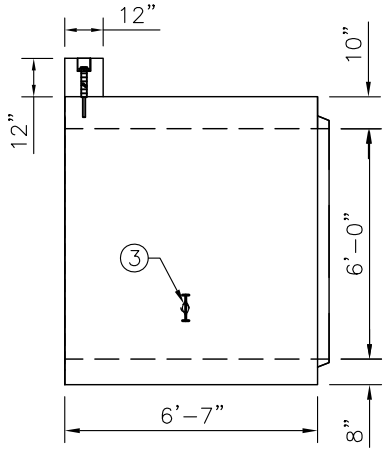



JOINT DETAIL

# MK17 SPIGOTx PARAPET




TOP




SIDE

SPREADER BAR REQUIRED: 12' MIN – 20' MAX

WEIGHT
3.28 Tons/ft
23.08 Tons/box w/ Parapet

MATERIAL PROPERTIES
f'c = 5ksi
fy = 65ksi

Notes:–
1. Dimesnions subject to permissible variations of ASTM C1577, AASHTO M259/M273
2. 1 1/2"ø Lifting Holes
3. Pulling devices LUL818g
4. Alternate 3" Joint may be used depending on producing plant

**REDUCED SCALE**

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CONCRETE PIPE & PRECAST, LLC

## 9'x6' DBL MONOLITHIC PRECAST BOX CULVERT
## CENTERLINE ROAD

BERKELEY CO., SC

LANDMARK CONSTRUCTION

| JOB# 15108 | | |
|---|---|---|
| ORIGINAL | 01–21–16 | RSP |
| REVISION | | |
| BOX CULVERT DETAILS 3 of 3 | | |

# Concrete Pipe & Precast

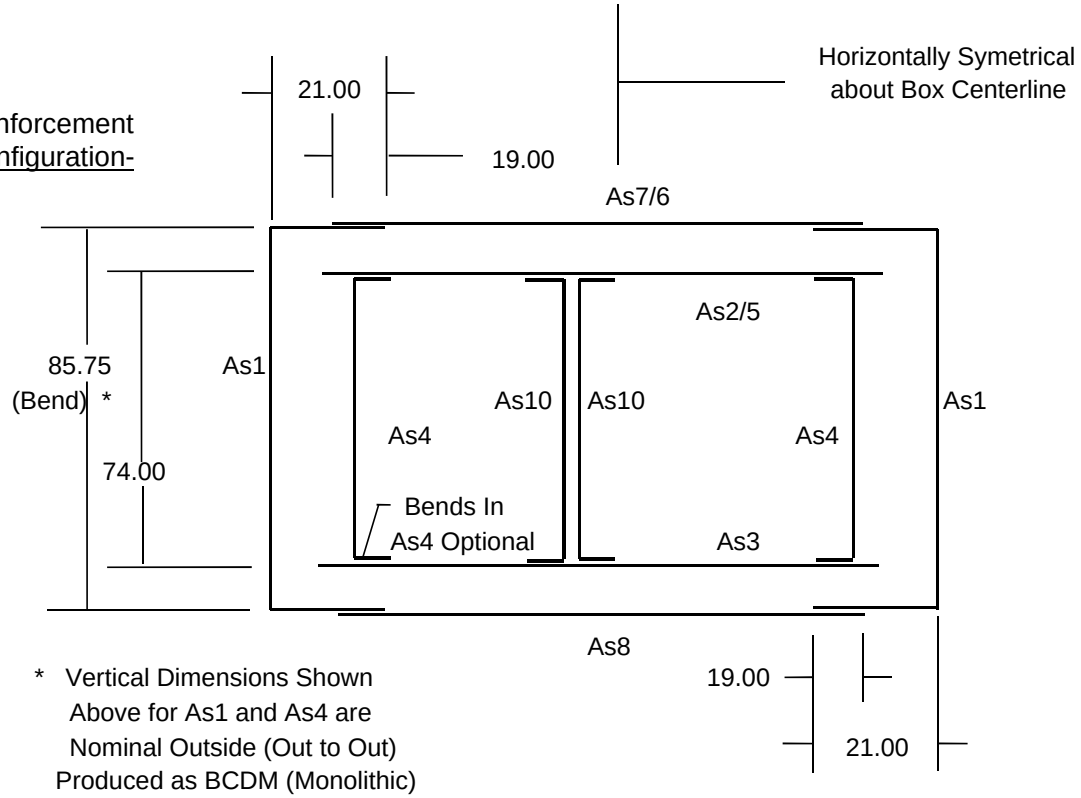
## Precast Reinforced Concrete Box Section Data

1/21/2016

Centerline Road, Berkeley Co., SC; Landmark Construction

## Reinforcement Data

Reinforcement Configuration-




* Vertical Dimensions Shown Above for As1 and As4 are Nominal Outside (Out to Out)
Produced as BCDM (Monolithic)

9' x 6' Box Culvert for 0-2' Earth Cover

C-1577 / LRFD Design
HL93 Live Load
Cc (Concrete Cover)
2 in.TO / 1 in.TI / 1 in.Gen

10in Top Slab, 8in Bottom, 8in Walls, 8in Haunches

| | $A_s$ Req'd | Reinforcement Provided | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| As1 = | 0.391 | 2 | x | 8 | - | W | 6.6 | x | W | 5.0 | 128 | x | 78 | 34 mats |
| As2 = | 0.508 | 2 | x | 4 | - | W | 8.5 | x | W | 8.0 | 234 | x | 78 | 17 mats |
| As3 = | 0.192 | 2 | x | 8 | - | W | 3.2 | x | W | 5.0 | 234 | x | 78 | 17 mats |
| As4 = | 0.192 | 2 | x | 8 | - | W | 3.2 | x | W | 5.0 | 90 | x | 78 | 34 mats |
| As7 = | 0.420 | 2 | x | 4 | - | W | 7.0 | x | W | 8.0 | 234 | x | 78 | 17 mats |
| As8 = | 0.192 | 2 | x | 8 | - | W | 3.2 | x | W | 5.0 | 234 | x | 78 | 17 mats |
| As10 = | 0.192 | 2 | x | 8 | - | W | 3.2 | x | W | 5.0 | 90 | x | 78 | 34 mats |
| As5 = | 0.240 | Sq.in./Ft. | | | | | | | | | | | | |
| As6 = | 0.240 | Sq.in./Ft. | | | | | | | | | | | | |

Lengths (Above) are Tip-to-Tip

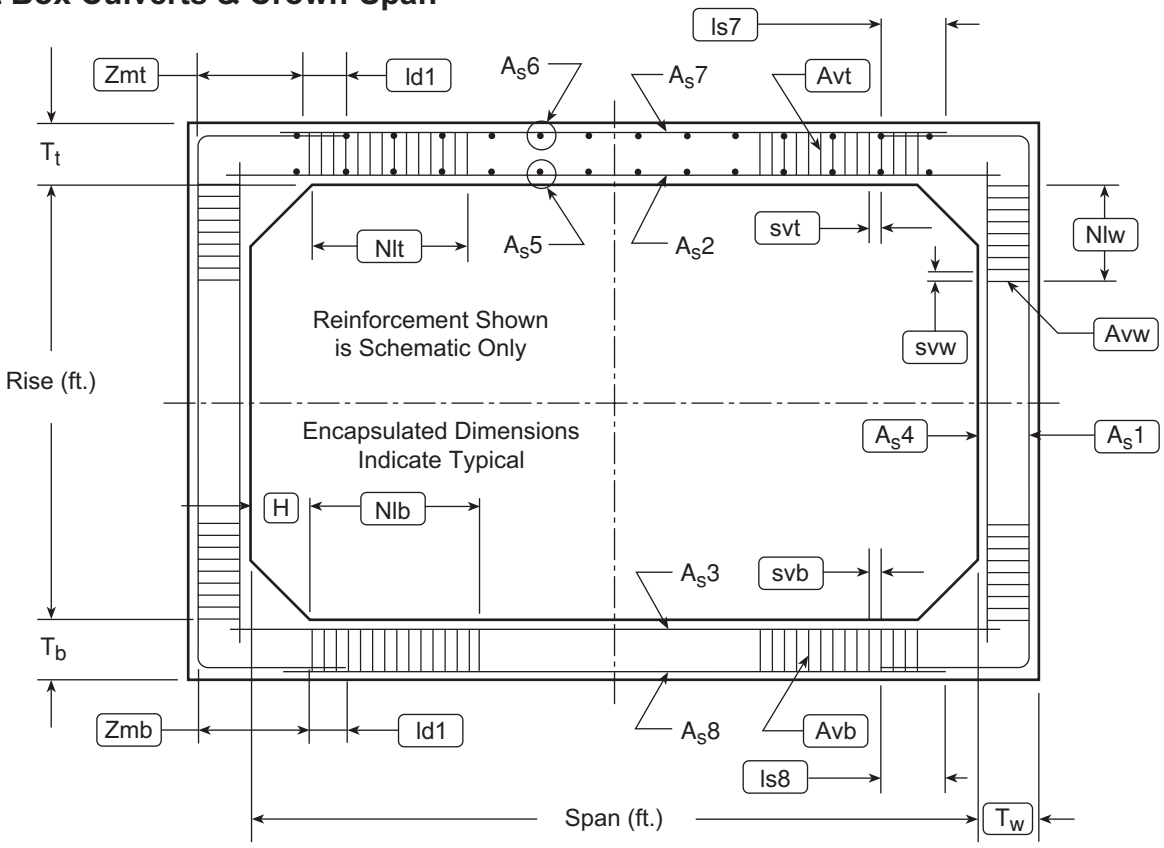
$f_c'$ = 5ksi
fy = 65ksi

Standard (Plain) Reinforcement

17 Box Culverts Req'd @ 21.6 Tons per Box
2 Cells (BCDM)

Note (1) Alternate wire styles producing the required steel areas may be substituted.

## Precast Box Culverts & Crown-Span




## Precast Box Section

(Lift holes not shown.)

**Label Description Key:**

$T_t$ - Thickness of top slab (in.)
$T_b$ - Thickness of bottom slab (in.)
$T_w$ - Thickness of wall (in.)
H - Haunch height and width (in.)
s1, 2 & 3 - Maximum circumferential wire spacing for $A_s1$, $A_s2$ & $A_s3$ (in.) not shown.

$A_s1$ - Wall - outside ..... circumferential reinforcement steel (sq. in. / Lf)
$A_s2$ - Top slab - inside ..... circumferential reinforcement steel (sq. in. / Lf)
$A_s3$ - Bottom slab - inside ..... circumferential reinforcement steel (sq. in. / Lf)
$A_s4$ - Wall - inside ..... circumferential reinforcement steel (sq. in. / Lf)
$A_s7$ - Top slab - outside ..... circumferential reinforcement steel (sq. in. / Lf)
$A_s8$ - Bottom slab - outside ..... circumferential reinforcement steel (sq. in. / Lf)

$A_s5$ - Top slab - inside longitudinal distribution reinforcement steel (sq. in. / ft. of width)
$A_s6$ - Top slab - outside longitudinal distribution reinforcement steel (sq. in. / ft. of width)
Avt - Shear reinforcement steel in the top slab (sq. in. / Lf / line)
Nlt - Number of lines of shear reinforcement in the top slab (in.)
svt - Spacing between the lines of shear reinforcement in the top slab (in.)

Avb - Shear reinforcement steel in the bottom slab (sq. in. / Lf / line)
Nlb - Number of lines of shear reinforcement in the bottom slab
svb - Spacing between the lines of shear reinforcement in the bottom slab (in.)

Avw - Shear reinforcement steel in the side wall (sq. in. / Lf / line)
Nlw - Number of lines of shear reinforcement in the side wall
svw - Spacing between the lines of shear reinforcement in the top side wall (in.)

Zmt - Required extension of As1 in the top slab (in.)
Zmb - Required extension of As1 in the bottom slab (in.)

ls7 - Splice length for As7
ls8 - Splice length for As8

ld1 - Development length for As1

CCORto - Top outside concrete cover over reinforcement steel (in.)
CCORti - Top inside concrete cover over reinforcement steel (in.)
CCOR - All other concrete cover over reinforcement steel (in.)

**-No Scale-**
All dimensions subject to allowable specification tolerances.

| TITLE | STATE | SECTION.PAGE | DATE |
|---|---|---|---|
| **Precast Box Reinforcement Section Details** | | 5.6 | 10-04-12 |

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CONCRETE PIPE & PRECAST, LLC

# BRASS-CULVERT

BRASS-CULVERT(LRFD) Version 2.3.0

DATE : 1/21/2016 TIME : 15:12:14 PAGE 1

Input Filename : C:\Users\rprusak\Documents\BRASS\BRASS 2.3.0 Data\9x6 BCDM C15
Output Filename : C:\Users\rprusak\Documents\BRASS\BRASS 2.3.0 Data\9x6 BCDM C15
Output Filename for Live Loads : C:\Users\rprusak\Documents\BRASS\BRASS 2.3.0 Data\9x6 BCDM C15

The following filenames may be used in this run
Live Load Influence Values File name : C:\Users\rprusak\Documents\BRASS\BRASS 2.3.0 Data\9
Drawing File name : C:\Users\rprusak\Documents\BRASS\BRASS 2.3.0 Data\9
Live Load Influence Ordinates File name : C:\Users\rprusak\Documents\BRASS\BRASS 2.3.0 Data\9
Live Load Actions (w/o DF or IM) File name : C:\Users\rprusak\Documents\BRASS\BRASS 2.3.0 Data\9
Intermediate Computations File name : C:\Users\rprusak\Documents\BRASS\BRASS 2.3.0 Data\9
Data Modelling File name : C:\Users\rprusak\Documents\BRASS\BRASS 2.3.0 Data\9

| | |
|---|---|
| COMMENTS | THIS FILE WAS CREATED BY THE BRASS-CULVERT GUI. |
| COMMENTS | DO NOT EDIT THIS FILE! |
| COMMENTS | JOB DESCRIPTION: |
| TITLE | 9X6 BCDM PER C1577 FOR 0' OF FILL |
| STRUCTID | 9X6 BCDM |
| AGENCY | ASTM |
| COMMENTS | 9X6 BOX CULVERT DOUBLE MONOLITHIC PER C1577 FOR 0' OF FILL |
| UNITSIN | US |
| UNITSOUT | US |
| COMMENTS | ANALYSIS CONTROL: |
| TYPE | PC |
| FUNCT | DESIGN |
| LRFR | NO |
| IRELEASE | NO |
| IDSN | LRFD |
| KBASE | FULL |
| KHACH | YES |
| EPOXY | NO |
| EDGE-STRIP | NO |
| LRFD-SHEAR | 0 |
| DNEG | 0.0000 |
| COMMENTS | DESIGN CONTROL: |
| ISAMS | NO |
| ISAMW | NO |
| ADDS | 1.0000 |
| ADDW | 1.0000 |
| MAXSIZ | 11 |
| MINSIZ | 4 |
| SPCMAX | 12.0000 |
| SPCMIN | 4.0000 |
| ISPCGINC | MAX |
| PAS | 0.012000 |
| CUSTOM | STD |
| COMMENTS | OUTPUT CONTROL: |
| MTEN | YES |
| IBSH | YES |
| IINFN | NO |
| LIVELO | NO |
| DEFAULTS | YES |
| LOOPS | NO |

0'-2' Checked
0' Controls Design

PAGE 2
DATE 01/21/2016
BRASS-CULVERT(LRFD) Version 2.3.0
9X6 BCDM PER C1577 FOR 0' OF FILL

| | |
|---|---|
| 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                65000.000
CN                  7.1178
COMMENTS            BOX GEOMETRY:
NBOX                2
NSPAN               9.0000
NHITE               6.0000
LENG                6.5800
BWIDTH              112.0000
CBWIDTH             100.0000
TSLAB               10.0000
KFXTS               F
BSLAB               8.0000
KFXBS               F
WALLR               8.0000
KFXW                F
IWALLR              8.0000
KFXI                F
COMMENTS            SKEW:
CSKEW               0.0000
COMMENTS            HAUNCHES:
TFILT               8.0000
BFILT               8.0000
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                62.400
NFILL               0.0000
```



```
NWEAR               0.0000
FILLFA              1.1500
TYFILL              COMPACT
COMMENTS            LIVE LOADS:
LVLD                HL-93-TRUCK
LVLD                HL-93-TANDEM
LVLD                HL-93-LANE
LVOMT               NO
LLPATCH             PL
SURCH_USE           YES
NLANES              1
LIMIT_DIST          NO
LRFDDF              YES

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) | = | DESIGN |
| IRELEASE: | Moment Continuity Released (@ end of walls) | = | F |
| DNEG: | Distance to Neg. Moment Computation Point | = | 0.00 |
| CUSTOM: | Default bar spacing and design check control | = | STD |
| ISAMS: | Design Same Top and Bottom Slab | = | F |
| ISAMW: | Design Same Interior-Exterior Wall | = | F |

Output Control Variables

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

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 | = | F |



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 | = | 62.4 |

```
Geometry - Box Dimension Variables
NBOX:   Number of Boxes (1 TO 4)                      =       2
NSPAN:  Clear Span (Ft)                               =     9.0
NHITE:  Clear Height (Ft)                             =     6.0
NFILL:  Design Fill Measured from Top of Top Slab(Ft) =     0.0
LENG:   Section length(PC)-Culvert Length(CIP)(Ft)    =     6.6
```

```
Geometry - Slab Thickness Variables
TSLAB:  Minimum Value for Top Slab (In)               =    10.0
KFXTS:  Code for Top Slab(F=Fixed,V=Variable)         =       F
BSLAB:  Minimum Value for Bottom Slab(In)             =     8.0
KFXBS:  Code for Bottom Slab(F=Fixed,V=Variable)      =       F
WALLR:  Minimum Value for Exterior Wall (In)          =     8.0
KFXW:   Code for Exterior Wall(F=Fixed,V=Variable)    =       F

IWALLR: Minimum Value for Interior Wall(In)           =     8.0
KFXI:   Code for Interior Wall(F=Fixed,V=Variable)    =       F
IWALLR: Minimum Value for Interior Wall(In)           =     8.0
KFXI:   Code for Interior Wall(F=Fixed,V=Variable)    =       F
```



```
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)                               =     8.0
BFILT:  Bottom Haunch (In)                            =     8.0
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
```

```
Reinforcing Bar variables and Thickness Increment
SPCMAX:   Default Max. Bar Spacings (In)              =    12.0
SPCMIN:   Default Min. Bar Spacings (In)              =     4.0
MAXSIZ:   Default Bar Sizes(US)                       =      11
MINSIZ:   Default Bar Sizes(US)                       =       4
ISPCGINC: Reinforcing Bar Minimum Increment           =       T
EPOXY:    Top Reinforcing Mat Epoxy Coated            =       F
ADDS:   Added Slab Thickness Increment(In)            =     1.0
ADDW:   Added Wall Thickness Increment(In)            =     1.0
```

```
Material Properties Variables
EWGT:  Weight of Soil (Pcf)                           =   120.0
FYST:  Yield Strength of Reinf.  Steel (Psi)          = 65000.0
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
```

PAGE 7
DATE 01/21/2016
BRASS-CULVERT(LRFD) Version 2.3.0
9X6 BCDM PER C1577 FOR 0' OF FILL

```
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
```

```
HAFBAR:  Assumed Half a Bar Dia. of #6 Bar (In)      =     0.375
I300:    A300 and A400 Bars to TRUE                  =       T
I400:    A300 and A400 Bars to TRUE                  =       T
ICHANG:  Initial Settings                            =       F
ICUT:    Cut Bars Due to Skew                        =       T
ICUTSM:  Bar Cuts Symmetrical                        =       F
IFIXB:   Defaults for Slab Thickness Incrementing    =       F
IFIXI:   Defaults for Wall Thickness Incrementing    =       F
IFIXT:   Defaults for Slab Thickness Incrementing    =       F
IFIXW:   Defaults for Wall Thickness Incrementing    =       F
```

PAGE 8
DATE 01/21/2016
BRASS-CULVERT(LRFD) Version 2.3.0
9X6 BCDM PER C1577 FOR 0' OF FILL

```
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
```

---

```
ILOOP:   Loop Counter for Design Iterations             =       0
INTERM_SWITCH: Turn on Intermediate Results Output      =       F
ISTORE:  Design Moments to Zero                         =       0
KPASS:  Variable Dimen (use in fixed thickness design)=     VAR
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
PAS:      Maximum AS/BD Desired                         =     0.012
```

---

JOB DESCRIPTION

```
Title        : 9X6 BCDM PER C1577  FOR 0' OF FILL
Structure ID : 9X6
Agency name  :                                                STD

Input units  : US
Output units : US
```

---

ANALYSIS CONTROL

| Construction Type | Design/ Review | Moment Continuity Released | Bottom Slab Support Code | Negative Moment Position |
|---|---|---|---|---|
| PRECAST | DESIGN | 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 |

---

DESIGN CONTROLS

| Design Same Thickness Slabs | Design Same Thickness Walls | Round-up Increment Thicknesses Slabs (In) | Walls (In) | Bar Spacing File |
|---|---|---|---|---|
| NO | NO | 1.00 | 1.00 | Standard |

| Bar Spacing Max (In) | Min (In) | US-Bar Size Bar Spacing Max | Min | Increment |
|---|---|---|---|---|
| 12.0 | 4.0 | 11 | 4 | 1 INCH |

PAGE 9
DATE 01/21/2016

BRASS-CULVERT(LRFD) Version 2.3.0
9X6 BCDM PER C1577 FOR 0' OF FILL

OUTPUT CONTROLS

| | |
|---|---|
| Drawing File: | NO |
| Actions at tenth Points: | YES |
| Bar Schedule: | YES |
| 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 | 65000. | 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 from AASHTO is computed and applied to the weight of earth input


BRASS-CULVERT(LRFD) Version 2.3.0
9X6 BCDM PER C1577 FOR 0' OF FILL

BOX GEOMETRY

| Culvert Cells | Span Length (Ft) | Clear Height (Ft) | Centerline Length (Ft) |
|---|---|---|---|
| DOUBLE | 9.00 | 6.00 | 6.58 |

| Bridge Width (Ft) | Clear Bridge Width (Ft) | Number of Traffic Lanes |
|---|---|---|
| 112.00 | 100.00 | 1 |

Slab and Wall Information

| Top Slab | Bottom Slab | Exterior Wall | Interior Wall |
|---|---|---|---|

| (In) | (In) | (In) | (In) |
|---|---|---|---|
| 10.00 Fixed | 8.00 Fixed | 8.00 Fixed | 8.00 Fixed |

---

LIVE LOADS

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

Live Load Control: NO
(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 | | Water Density |
|---|---|---|
| Max (Pcf) | Min (Pcf) | (Pcf) |
| 60.0 | 30.0 | 62.4 |

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



---

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) |
|---|---|
| 8.0 | 8.0 |

---

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 |

```
Cover requirements of article 5.12.3 not met for:
     Top Slab, Interior
     minimum required cover =  2.00 in
     specified cover        =  1.00 in

Cover requirements of article 5.12.3 not met for:
     Bottom Corner
     minimum required cover =  2.00 in
     specified cover        =  1.00 in

Cover requirements of article 5.12.3 not met for:
     Bottom Slab, Interior
     minimum required cover =  2.00 in
     specified cover        =  1.00 in

Cover requirements of article 5.12.3 not met for:
     Bottom Slab, Exterior
     minimum required cover =  2.00 in
     specified cover        =  1.00 in

Cover requirements of article 5.12.3 not met for:
     Exterior Wall, Exterior
     minimum required cover =  2.00 in
     specified cover        =  1.00 in

Cover requirements of article 5.12.3 not met for:
     Exterior Wall, Interior
     minimum required cover =  2.00 in
     specified cover        =  1.00 in

Cover requirements of article 5.12.3 not met for:
     Interior Wall
     minimum required cover =  2.00 in
     specified cover        =  1.00 in
```



## LRFD Live Load Distribution Factor Computation

**Input Values**

| | | |
|---|---|---|
| Depth of Fill | = 0.00 | ft. |
| Span Length | = 9.00 | ft. |
| Truck Gage | = 6.00 | ft. |
| Soil Distribution Factor | = 1.15 | |
| Tire Patch Width | = 20.00 | in. |
| Bridge Width | = 112.00 | ft. |
| Lay Length | = 6.58 | ft. |

**Compute Strip Width by 4.6.2.10.2-1**

E = 96 + 1.44 S ft
E = 96 + 1.44 ( 9.00 ft. )
E = 9.08 ft.

**Controlling Distribution Factor**

Final Strip Width = 9.08 ft.

Final Distribution Factor = 1/Final Strip Width = **0.110** Lanes per ft. of width

Multiple Presence Factor = 1.20

Distribution Factor * Multiple Presence Factor = **0.132**

Notes:

1. Only the one lane loaded case is considered. 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.

```
                              PAGE 13
                          DATE 01/21/2016
                 BRASS-CULVERT(LRFD)  Version 2.3.0
                        9X6 BCDM PER C1577  FOR 0' OF FILL


  Number of cells                           =     2
  Top Slab thickness                        =    10.0000 In.
  Bottom Slab thickness                     =     8.0000 In.
  Exterior Wall thickness                   =     8.0000 In.
  Interior wall thickness                   =     8.00 In.
              Design Span(c-c walls)        =     9.6667 Ft.
  Design Height(c-c slabs)                  =     6.7500 Ft.
  Fill Height(top of slab)                  =     0.0000 Ft.
  Wearing surface thickness                 =     0.0000 In.

      Loads based on 1 foot unit width
  Soil Structure Interaction Factor         =     1.0000
  Earth Weight for fill computations        =     0.1200 Kcf

  Weight of Fill without wearing surface    =     0.0000 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             =     0.1250 Klf

  Weight of Walls divided by culvert width  =     0.0900 Klf
  Uniform Dead Load on Bottom Slab          =     0.2150 Klf


  Soil pressure at center of top slab       =     0.0250 Klf
  Soil pressure at center of bottom slab    =     0.4300 Klf

  Soil pressure due to live load surcharge  =     0.1050 Klf

  Impact Factor on Top Slab & Walls         =     0.3300
  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.

PAGE 14
DATE 01/21/2016
BRASS-CULVERT(LRFD) Version 2.3.0
9X6 BCDM PER C1577 FOR 0' OF FILL

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

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

PAGE 15
DATE 01/21/2016
BRASS-CULVERT(LRFD) Version 2.3.0
9X6 BCDM PER C1577 FOR 0' OF FILL

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.


 Factors for Ductility   1.00
             Redundancy  1.00
             Operations  1.00

       Design Iteration Loop Number           1


                                  PAGE 16
                              DATE 01/21/2016
                    BRASS-CULVERT(LRFD)  Version 2.3.0
                           9X6 BCDM PER C1577  FOR 0' OF FILL
```

## LRFD Live Load Distribution Factor Computation

**Input Values**

| | | |
|---|---|---|
| Depth of Fill | = 0.00 | ft. |
| Span Length | = 9.00 | ft. |
| Truck Gage | = 6.00 | ft. |
| Soil Distribution Factor | = 1.15 | |
| Tire Patch Width | = 20.00 | in. |
| Bridge Width | = 112.00 | ft. |
| Lay Length | = 6.58 | ft. |

**Compute Strip Width by 4.6.2.10.2-1**

E = 96 + 1.44 S ft
E = 96 + 1.44 ( 9.00 ft. )
E = 9.08 ft.

**Controlling Distribution Factor**

Final Strip Width = 9.08 ft.

Final Distribution Factor = 1/Final Strip Width = **0.110** Lanes per ft. of width

Multiple Presence Factor = 1.20

Distribution Factor * Multiple Presence Factor = **0.132**

Notes:

1. Only the one lane loaded case is considered. 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.

PAGE 17
DATE 01/21/2016
BRASS-CULVERT(LRFD) Version 2.3.0
9X6 BCDM PER C1577 FOR 0' OF FILL

Current Live Load: HL-93-TRUCK

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

| M-PT | Dead Load Kft | Soil Press (Max) Kft | Soil Press (Min) Kft | Surch Hgt. Kft | Water Press (Max) Kft | LIVE LOADS Pos Kft | Neg Kft |
|---|---|---|---|---|---|---|---|
| EXTERIOR WALL BOTTOM | | | | | | | |
| 1- 0 | -0.84 | -0.49 | -0.25 | -0.21 | 0.36 | 0.00 | -2.51 |
| 1- 1 | -0.77 | 0.07 | 0.03 | -0.01 | -0.11 | 0.00 | -2.12 |
| 1- 2 | -0.69 | 0.45 | 0.23 | 0.15 | -0.44 | 0.00 | -2.00 |
| 1- 3 | -0.62 | 0.68 | 0.34 | 0.26 | -0.62 | 0.00 | -2.05 |
| 1- 4 | -0.54 | 0.76 | 0.38 | 0.32 | -0.69 | 0.00 | -2.12 |
| 1- 5 | -0.47 | 0.73 | 0.36 | 0.33 | -0.65 | 0.00 | -2.19 |
| 1- 6 | -0.39 | 0.59 | 0.29 | 0.30 | -0.53 | 0.14 | -2.26 |
| 1- 7 | -0.32 | 0.36 | 0.18 | 0.22 | -0.34 | 0.37 | -2.39 |
| 1- 8 | -0.24 | 0.07 | 0.04 | 0.09 | -0.10 | 0.61 | -2.66 |
| 1- 9 | -0.17 | -0.27 | -0.13 | -0.09 | 0.17 | 0.97 | -2.92 |
| 1-10 | -0.09 | -0.64 | -0.32 | -0.32 | 0.47 | 1.36 | -3.19 |
| EXTERIOR WALL TOP | | | | | | | |
| TOP SLAB LEFT SIDE | | | | | | | |
| 2- 0 | -0.09 | -0.64 | -0.32 | -0.32 | 0.47 | 1.36 | -3.19 |
| 2- 1 | 0.30 | -0.54 | -0.27 | -0.27 | 0.40 | 3.96 | -0.56 |
| 2- 2 | 0.58 | -0.45 | -0.22 | -0.22 | 0.33 | 6.18 | 0.00 |
| 2- 3 | 0.74 | -0.35 | -0.18 | -0.18 | 0.26 | 7.94 | -0.31 |
| 2- 4 | 0.79 | -0.26 | -0.13 | -0.13 | 0.19 | 8.99 | -0.77 |
| 2- 5 | 0.72 | -0.16 | -0.08 | -0.08 | 0.12 | 9.07 | -1.23 |
| 2- 6 | 0.53 | -0.06 | -0.03 | -0.03 | 0.05 | 8.25 | -1.70 |
| 2- 7 | 0.22 | 0.03 | 0.02 | 0.01 | -0.02 | 6.64 | -2.16 |
| 2- 8 | -0.20 | 0.13 | 0.06 | 0.06 | -0.09 | 4.45 | -2.72 |
| 2- 9 | -0.74 | 0.22 | 0.11 | 0.11 | -0.16 | 2.04 | -3.96 |
| 2-10 | -1.40 | 0.32 | 0.16 | 0.16 | -0.23 | 0.00 | -6.38 |
| TOP SLAB RIGHT SIDE | | | | | | | |
| INTERIOR WALL BOTTOM | | | | | | | |
| 3- 0 | 0.01 | 0.02 | 0.01 | 0.00 | -0.02 | 0.65 | -0.64 |
| 3- 1 | 0.00 | 0.01 | 0.01 | 0.00 | -0.01 | 0.33 | -0.32 |
| 3- 2 | 0.00 | 0.01 | 0.00 | 0.00 | -0.01 | 0.06 | -0.07 |
| 3- 3 | 0.00 | 0.01 | 0.00 | 0.00 | -0.01 | 0.33 | -0.33 |
| 3- 4 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.65 | -0.65 |
| 3- 5 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.97 | -0.97 |
| 3- 6 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.29 | -1.29 |
| 3- 7 | 0.00 | -0.01 | 0.00 | 0.00 | 0.01 | 1.61 | -1.61 |
| 3- 8 | 0.00 | -0.01 | -0.01 | 0.00 | 0.01 | 1.93 | -1.93 |
| 3- 9 | -0.01 | -0.01 | -0.01 | 0.00 | 0.01 | 2.25 | -2.25 |
| 3-10 | -0.01 | -0.02 | -0.01 | 0.00 | 0.02 | 2.57 | -2.57 |
| INTERIOR WALL TOP | | | | | | | |

PAGE 18
DATE 01/21/2016
BRASS-CULVERT(LRFD) Version 2.3.0
9X6 BCDM PER C1577 FOR 0' OF FILL

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| BOTTOM SLAB LEFT SIDE | | | | | | | |
| 4- 0 | -0.84 | -0.49 | -0.25 | -0.21 | 0.36 | 0.00 | -2.51 |
| 4- 1 | -0.06 | -0.42 | -0.21 | -0.18 | 0.31 | 0.46 | -0.41 |
| 4- 2 | 0.52 | -0.35 | -0.17 | -0.15 | 0.25 | 1.77 | 0.00 |
| 4- 3 | 0.89 | -0.27 | -0.14 | -0.12 | 0.20 | 2.75 | 0.00 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 4- 4 | 1.07 | -0.20 | -0.10 | -0.08 | 0.15 | 3.20 | 0.00 |
| 4- 5 | 1.05 | -0.13 | -0.06 | -0.05 | 0.09 | 3.13 | 0.00 |
| 4- 6 | 0.82 | -0.05 | -0.03 | -0.02 | 0.04 | 2.51 | 0.00 |
| 4- 7 | 0.39 | 0.02 | 0.01 | 0.01 | -0.02 | 1.34 | 0.00 |
| 4- 8 | -0.23 | 0.10 | 0.05 | 0.04 | -0.07 | 0.00 | -0.94 |
| 4- 9 | -1.06 | 0.17 | 0.09 | 0.07 | -0.12 | 0.00 | -3.20 |
| 4-10 | -2.09 | 0.24 | 0.12 | 0.11 | -0.18 | 0.00 | -6.02 |

BOTTOM SLAB RIGHT SIDE

PAGE 19
DATE 01/21/2016
BRASS-CULVERT(LRFD) Version 2.3.0
9X6 BCDM PER C1577 FOR 0' OF FILL

Current Live Load: HL-93-TRUCK

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

| M-PT | Dead Load | Soil Press (Max) | Soil Press (Min) | Surch Hgt. | Water Press (Max) | LIVE LOADS Pos | Neg |
|---|---|---|---|---|---|---|---|
| | K | K | K | K | K | K | K |
| EXTERIOR WALL BOTTOM | | | | | | | |
| 1- 0 | 0.11 | 0.97 | 0.49 | 0.34 | -0.83 | 0.57 | -0.39 |
| 1- 1 | 0.11 | 0.70 | 0.35 | 0.27 | -0.59 | 0.57 | -0.39 |
| 1- 2 | 0.11 | 0.45 | 0.22 | 0.20 | -0.37 | 0.57 | -0.39 |
| 1- 3 | 0.11 | 0.23 | 0.11 | 0.13 | -0.18 | 0.57 | -0.39 |
| 1- 4 | 0.11 | 0.03 | 0.02 | 0.06 | -0.02 | 0.57 | -0.39 |
| 1- 5 | 0.11 | -0.14 | -0.07 | -0.02 | 0.12 | 0.57 | -0.39 |
| 1- 6 | 0.11 | -0.28 | -0.14 | -0.09 | 0.23 | 0.57 | -0.39 |
| 1- 7 | 0.11 | -0.39 | -0.19 | -0.16 | 0.32 | 0.57 | -0.39 |
| 1- 8 | 0.11 | -0.47 | -0.24 | -0.23 | 0.39 | 0.57 | -0.39 |
| 1- 9 | 0.11 | -0.53 | -0.27 | -0.30 | 0.42 | 0.57 | -0.39 |
| 1-10 | 0.11 | -0.56 | -0.28 | -0.37 | 0.44 | 0.57 | -0.39 |
| EXTERIOR WALL TOP | | | | | | | |
| TOP SLAB LEFT SIDE | | | | | | | |
| 2- 0 | 0.47 | 0.10 | 0.05 | 0.05 | -0.07 | 5.40 | -0.48 |
| 2- 1 | 0.35 | 0.10 | 0.05 | 0.05 | -0.07 | 4.74 | -0.93 |
| 2- 2 | 0.23 | 0.10 | 0.05 | 0.05 | -0.07 | 4.13 | -1.43 |
| 2- 3 | 0.11 | 0.10 | 0.05 | 0.05 | -0.07 | 3.48 | -1.97 |
| 2- 4 | -0.01 | 0.10 | 0.05 | 0.05 | -0.07 | 2.81 | -2.55 |
| 2- 5 | -0.14 | 0.10 | 0.05 | 0.05 | -0.07 | 2.15 | -3.13 |
| 2- 6 | -0.26 | 0.10 | 0.05 | 0.05 | -0.07 | 1.51 | -3.66 |
| 2- 7 | -0.38 | 0.10 | 0.05 | 0.05 | -0.07 | 0.94 | -4.28 |
| 2- 8 | -0.50 | 0.10 | 0.05 | 0.05 | -0.07 | 0.46 | -4.83 |
| 2- 9 | -0.62 | 0.10 | 0.05 | 0.05 | -0.07 | 0.10 | -5.28 |
| 2-10 | -0.74 | 0.10 | 0.05 | 0.05 | -0.07 | 0.00 | -5.47 |
| TOP SLAB RIGHT SIDE | | | | | | | |
| INTERIOR WALL BOTTOM | | | | | | | |
| 3- 0 | 0.00 | -0.01 | 0.00 | 0.00 | 0.00 | 0.47 | -0.48 |
| 3- 1 | 0.00 | -0.01 | 0.00 | 0.00 | 0.00 | 0.47 | -0.48 |
| 3- 2 | 0.00 | -0.01 | 0.00 | 0.00 | 0.00 | 0.47 | -0.48 |
| 3- 3 | 0.00 | -0.01 | 0.00 | 0.00 | 0.00 | 0.47 | -0.48 |
| 3- 4 | 0.00 | -0.01 | 0.00 | 0.00 | 0.00 | 0.47 | -0.48 |
| 3- 5 | 0.00 | -0.01 | 0.00 | 0.00 | 0.00 | 0.47 | -0.48 |
| 3- 6 | 0.00 | -0.01 | 0.00 | 0.00 | 0.00 | 0.47 | -0.48 |
| 3- 7 | 0.00 | -0.01 | 0.00 | 0.00 | 0.00 | 0.47 | -0.48 |
| 3- 8 | 0.00 | -0.01 | 0.00 | 0.00 | 0.00 | 0.47 | -0.48 |
| 3- 9 | 0.00 | -0.01 | 0.00 | 0.00 | 0.00 | 0.47 | -0.48 |
| 3-10 | 0.00 | -0.01 | 0.00 | 0.00 | 0.00 | 0.47 | -0.48 |
| INTERIOR WALL TOP | | | | | | | |

PAGE 20
DATE 01/21/2016
BRASS-CULVERT(LRFD) Version 2.3.0
9X6 BCDM PER C1577 FOR 0' OF FILL

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| BOTTOM SLAB LEFT SIDE | | | | | | | |
| 4- 0 | 0.91 | 0.08 | 0.04 | 0.03 | -0.06 | 2.45 | 0.00 |
| 4- 1 | 0.70 | 0.08 | 0.04 | 0.03 | -0.06 | 1.89 | 0.00 |
| 4- 2 | 0.49 | 0.08 | 0.04 | 0.03 | -0.06 | 1.33 | 0.00 |
| 4- 3 | 0.29 | 0.08 | 0.04 | 0.03 | -0.06 | 0.77 | 0.00 |
| 4- 4 | 0.08 | 0.08 | 0.04 | 0.03 | -0.06 | 0.20 | 0.00 |
| 4- 5 | -0.13 | 0.08 | 0.04 | 0.03 | -0.06 | 0.00 | -0.42 |
| 4- 6 | -0.34 | 0.08 | 0.04 | 0.03 | -0.06 | 0.00 | -0.98 |
| 4- 7 | -0.55 | 0.08 | 0.04 | 0.03 | -0.06 | 0.00 | -1.55 |
| 4- 8 | -0.75 | 0.08 | 0.04 | 0.03 | -0.06 | 0.00 | -2.11 |
| 4- 9 | -0.96 | 0.08 | 0.04 | 0.03 | -0.06 | 0.00 | -2.67 |
| 4-10 | -1.17 | 0.08 | 0.04 | 0.03 | -0.06 | 0.00 | -3.23 |
| BOTTOM SLAB RIGHT SIDE | | | | | | | |

PAGE 21
DATE 01/21/2016
BRASS-CULVERT(LRFD) Version 2.3.0
9X6 BCDM PER C1577 FOR 0' OF FILL

Current Live Load: HL-93-TRUCK

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

| M-PT | Dead Load | Soil Press (Max) | Soil Press (Min) | Surch Hgt. | Water Press (Max) | LIVE LOADS Pos | Neg |
|---|---|---|---|---|---|---|---|
| | K | K | K | K | K | K | K |
| EXTERIOR WALL BOTTOM | | | | | | | |
| 1- 0 | -0.47 | -0.10 | -0.05 | -0.05 | 0.07 | 0.48 | -5.28 |
| 1- 1 | -0.47 | -0.10 | -0.05 | -0.05 | 0.07 | 0.48 | -5.28 |
| 1- 2 | -0.47 | -0.10 | -0.05 | -0.05 | 0.07 | 0.48 | -5.28 |
| 1- 3 | -0.47 | -0.10 | -0.05 | -0.05 | 0.07 | 0.48 | -5.28 |
| 1- 4 | -0.47 | -0.10 | -0.05 | -0.05 | 0.07 | 0.48 | -5.28 |
| 1- 5 | -0.47 | -0.10 | -0.05 | -0.05 | 0.07 | 0.48 | -5.28 |
| 1- 6 | -0.47 | -0.10 | -0.05 | -0.05 | 0.07 | 0.48 | -5.28 |
| 1- 7 | -0.47 | -0.10 | -0.05 | -0.05 | 0.07 | 0.48 | -5.28 |
| 1- 8 | -0.47 | -0.10 | -0.05 | -0.05 | 0.07 | 0.48 | -5.28 |
| 1- 9 | -0.47 | -0.10 | -0.05 | -0.05 | 0.07 | 0.48 | -5.28 |
| 1-10 | -0.47 | -0.10 | -0.05 | -0.05 | 0.07 | 0.48 | -5.28 |
| EXTERIOR WALL TOP | | | | | | | |
| TOP SLAB LEFT SIDE | | | | | | | |
| 2- 0 | 0.11 | -0.56 | -0.28 | -0.37 | 0.44 | 0.60 | -0.39 |
| 2- 1 | 0.11 | -0.56 | -0.28 | -0.37 | 0.44 | 0.60 | -0.39 |
| 2- 2 | 0.11 | -0.56 | -0.28 | -0.37 | 0.44 | 0.60 | -0.39 |
| 2- 3 | 0.11 | -0.56 | -0.28 | -0.37 | 0.44 | 0.60 | -0.39 |
| 2- 4 | 0.11 | -0.56 | -0.28 | -0.37 | 0.44 | 0.60 | -0.39 |
| 2- 5 | 0.11 | -0.56 | -0.28 | -0.37 | 0.44 | 0.60 | -0.39 |
| 2- 6 | 0.11 | -0.56 | -0.28 | -0.37 | 0.44 | 0.60 | -0.39 |
| 2- 7 | 0.11 | -0.56 | -0.28 | -0.37 | 0.44 | 0.60 | -0.39 |
| 2- 8 | 0.11 | -0.56 | -0.28 | -0.37 | 0.44 | 0.60 | -0.39 |
| 2- 9 | 0.11 | -0.56 | -0.28 | -0.37 | 0.44 | 0.60 | -0.39 |
| 2-10 | 0.11 | -0.56 | -0.28 | -0.37 | 0.44 | 0.60 | -0.39 |
| TOP SLAB RIGHT SIDE | | | | | | | |
| INTERIOR WALL BOTTOM | | | | | | | |
| 3- 0 | -1.48 | 0.19 | 0.10 | 0.10 | -0.14 | 0.00 | -5.70 |
| 3- 1 | -1.48 | 0.19 | 0.10 | 0.10 | -0.14 | 0.00 | -5.70 |
| 3- 2 | -1.48 | 0.19 | 0.10 | 0.10 | -0.14 | 0.00 | -5.70 |
| 3- 3 | -1.48 | 0.19 | 0.10 | 0.10 | -0.14 | 0.00 | -5.70 |

```
    3- 4   -1.48    0.19    0.10    0.10   -0.14    0.00   -5.70
    3- 5   -1.48    0.19    0.10    0.10   -0.14    0.00   -5.70
    3- 6   -1.48    0.19    0.10    0.10   -0.14    0.00   -5.70
    3- 7   -1.48    0.19    0.10    0.10   -0.14    0.00   -5.70
    3- 8   -1.48    0.19    0.10    0.10   -0.14    0.00   -5.70
    3- 9   -1.48    0.19    0.10    0.10   -0.14    0.00   -5.70
    3-10   -1.48    0.19    0.10    0.10   -0.14    0.00   -5.70
INTERIOR WALL TOP
```



```
BOTTOM SLAB LEFT SIDE
    4- 0   -0.11   -0.97   -0.49   -0.34    0.83    0.39   -0.60
    4- 1   -0.11   -0.97   -0.49   -0.34    0.83    0.39   -0.60
    4- 2   -0.11   -0.97   -0.49   -0.34    0.83    0.39   -0.60
    4- 3   -0.11   -0.97   -0.49   -0.34    0.83    0.39   -0.60
    4- 4   -0.11   -0.97   -0.49   -0.34    0.83    0.39   -0.60
    4- 5   -0.11   -0.97   -0.49   -0.34    0.83    0.39   -0.60
    4- 6   -0.11   -0.97   -0.49   -0.34    0.83    0.39   -0.60
    4- 7   -0.11   -0.97   -0.49   -0.34    0.83    0.39   -0.60
    4- 8   -0.11   -0.97   -0.49   -0.34    0.83    0.39   -0.60
    4- 9   -0.11   -0.97   -0.49   -0.34    0.83    0.39   -0.60
    4-10   -0.11   -0.97   -0.49   -0.34    0.83    0.39   -0.60
BOTTOM SLAB RIGHT SIDE


Factors for Ductility   1.00
            Redundancy  1.00
            Operations  1.00
```



## 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 | -1.315 | 23999.57 | 21268.16 | **Pass** |
| TOP SLAB | Left | 72.691 | 23976.01 | 23284.56 | **Pass** |
| TOP SLAB | Middle + | -291.499 | 23903.80 | 23148.21 | **Pass** |
| TOP SLAB | Middle - | 74.772 | 24024.68 | 16204.49 | **Pass** |
| INTERIOR WALL | Bottom | -134.486 | 23955.62 | 362.48 | **Pass** |
| INTERIOR WALL | Middle | -105.530 | 23965.18 | 8250.88 | **Pass** |
| INTERIOR WALL | Top | -105.530 | 23965.18 | 14900.78 | **Pass** |

| | | | | | |
|---|---|---|---|---|---|
| BOTTOM SLAB | Left | 104.193 | 23965.62 | 13567.04 | **Pass** |



## LRFD Crack Control Computation

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

| Location | $\gamma_e$ | h ( in.) | $d_c$ ( in.) | $\beta_s$ | Max Spacing () | Current Spacing ( in.) | Allowable Stress () | Actual Stress ( kip ) |
|---|---|---|---|---|---|---|---|---|
| Top slab, outside corner | $0.8*f_r > f_c$, therefore no check necessary. | | | | | | | |
| Top slab, inside face | 0.75000000 | 10.00000000 | 1.31250000 | 1.21582735 | 13.37427998 | 7.00000000 | 44.70881653 | 26.98900986 |
| 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. | | | | | | | |
| Interior wall | $0.8*f_r > f_c$, therefore no check necessary. | | | | | | | |



```
Lateral Distribution Steel:
  Span Length                                =    9.667 feet
  Percentage of main reinforcement required =   32.163% , less than or equal to 50%
  Main reinforcement area (top slab)         =    0.531 in^2
  Required lateral distribution area         =    0.171 in^2
  Because the required area is less than the minimum, an area of steel of   0.200 in^2 is use
  Bar size      (C100)                       =  # 4
```

```
      Spacing       (C100)                    =   12.000 in
      Area of steel (C100)                    =    0.200 in^2
      Main reinforcement area (bottom slab)   =    0.200 in^2
      Required lateral distribution area      =    0.064 in^2
      Because the required area is less than the minimum, an area of steel of   0.200 in^2 is use
      Bar size      (C200)                    =  # 4
      Spacing       (C200)                    =   12.000 in
      Area of steel (C200)                    =    0.200 in^2


     Bar sizes and spacings with computed areas of steel

     Areas of steel are in in2/ft

                              Top slab
    LEFT SIDE                  CENTER                        RIGHT SIDE
    area  0.5314 in2           area  0.5314 in2             area  0.2667 in2
    size  5 spaced at   7.00 in.  size  5 spaced at   7.00 in.  size  4 spaced at   9.00 in.
*************************************************************************

 Exterior wall                                                 Interior wall
TOP                                                           TOP
area  0.5314 in2                                              area  0.2000 in2
size  5 spaced at   7.00 in.                                  size  4 spaced at  12.00 in.



INSIDE FACE                                                   EACH FACE
area  0.2000 in2                                              area  0.2000 in2
size  4 spaced at  12.00 in.                                  size  4 spaced at  12.00 in.

OUTSIDE FACE
area  0.3429 in2
size  4 spaced at   7.00



BOTTOM                                                        BOTTOM
area  0.3429 in2                                              area  0.2000 in2
size  4 spaced at   7.00 in.                                  size  4 spaced at  12.00 in.
*************************************************************************

                         Bottom slab
    LEFT SIDE                  CENTER                        RIGHT SIDE
    area  0.3429 in2           area  0.2000 in2             area  0.2000 in2
    size  4 spaced at   7.00 in.  size  4 spaced at  12.00 in.  size  4 spaced at  12.00 in.



                              PAGE 26
                         DATE 01/21/2016
                  BRASS-CULVERT(LRFD)  Version 2.3.0
                        9X6 BCDM PER C1577  FOR 0' OF FILL

_____________________________________________________________________________

 Reinforcing Steel Bar Schedule
_____________________________________________________________________________


   Location        Mark  Qty   Size   Type   Length   Wgt   H Leg   V Leg
                                             (Ft-In)  (Lbs)  (Ft-In) (Ft-In)
TOP SLAB (Inside)  A100   12     5     STR    0- 0      0
BOT SLAB (Inside)  A200    7     4     STR    0- 0      0
TOP SLAB (Outside) A300    9     4     STR    0- 0      0
BOT SLAB (Outside) A400    7     4     STR    0- 0      0
CORNER  (Top)      A1     24     5   L-BAR    4-11    123   2- 5    2- 6
CORNER  (Bottom)   A2     24     4   L-BAR    4- 6     72   2- 3    2- 3
EXTWALL (Inside)   B1     14     4     STR    6- 6     61
EXTWALL (Outside)  B2     24     4     STR    0- 0      0
INTWALL            B3     14     4     STR    0- 0      0
LONGITUD.( 1)      C1     79     4     STR    6- 4    334
```

| | | | | | | |
|---|---|---|---|---|---|---|
| LONGITUD.( 1) | C100 | 0 | 4 | STR | 6- 4 | 0 |
| LONGITUD.( 1) | C200 | 0 | 4 | STR | 6- 4 | 0 |

| | |
|---|---|
| Total weight black bars | 590 |
| Total weight all bars | 590 |

The minimum temperature and shrinkage steel for the:
Top slab(s) = 0.2031 in2
Bottom slab(s) = 0.1625 in2
Exterior wall(s) = 0.1625 in2

Interior wall(s) = 0.1625 in2

Splice Lengths Chart

| Mark | Size | Splice (Ft-In) | Length (m) |
|---|---|---|---|
| B1 | 4 | 1- 9 | 0.533 |
| B3 | 4 | 1- 9 | 0.533 |
| C1 | 4 | 1- 9 | 0.533 |
| C100 | 4 | 1- 9 | 0.533 |
| C200 | 4 | 1- 9 | 0.533 |



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 | -0.744 | -6.035 | 0.530 | -9.801 | 2.991 | -0.577 |
| 1- 1 | -0.308 | -4.330 | 0.458 | -9.684 | 2.493 | -0.586 |
| 1- 2 | 0.514 | -4.037 | 0.372 | -9.598 | 2.033 | -0.596 |
| 1- 3 | 1.049 | -4.041 | 0.372 | -9.598 | 1.609 | -0.606 |
| 1- 4 | 1.311 | -4.094 | 0.372 | -9.598 | 1.222 | -0.617 |
| 1- 5 | 1.324 | -4.163 | 0.372 | -9.598 | 1.082 | -0.837 |
| 1- 6 | 1.357 | -4.244 | 0.372 | -9.598 | 1.070 | -1.150 |
| 1- 7 | 1.360 | -4.433 | 0.372 | -9.598 | 1.057 | -1.426 |
| 1- 8 | 1.189 | -4.863 | 0.372 | -9.598 | 1.043 | -1.665 |
| 1- 9 | 1.425 | -5.759 | 0.530 | -9.801 | 1.029 | -1.867 |
| 1-10 | 1.933 | -7.062 | 0.530 | -9.801 | 1.014 | -2.033 |
| EXTERIOR WALL TOP | | | | | | |
| TOP SLAB LEFT SIDE | | | | | | |
| 2- 0 | 1.933 | -7.062 | 0.789 | -2.008 | 10.004 | -0.576 |
| 2- 1 | 6.808 | -2.032 | 0.811 | -2.030 | 8.773 | -1.425 |
| 2- 2 | 10.955 | -0.691 | 0.811 | -2.030 | 7.620 | -2.371 |
| 2- 3 | 14.223 | -0.932 | 0.811 | -2.030 | 6.381 | -3.383 |
| 2- 4 | 16.148 | -1.506 | 0.811 | -2.030 | 5.123 | -4.448 |
| 2- 5 | 16.289 | -2.142 | 0.811 | -2.030 | 3.903 | -5.559 |
| 2- 6 | 14.773 | -2.838 | 0.811 | -2.030 | 2.732 | -6.581 |
| 2- 7 | 11.849 | -3.658 | -0.273 | -0.693 | 1.674 | -7.744 |
| 2- 8 | 7.958 | -4.887 | -0.296 | -0.671 | 0.764 | -8.795 |
| 2- 9 | 3.683 | -7.423 | -0.296 | -0.671 | 0.073 | -9.677 |
| 2-10 | -0.027 | -12.124 | -0.296 | -0.671 | -0.167 | -10.092 |
| TOP SLAB RIGHT SIDE | | | | | | |
| INTERIOR WALL BOTTOM | | | | | | |

```
 3- 0      1.168     -1.119     -0.642    -10.716      0.830     -0.843
 3- 1      0.603     -0.562     -0.642    -10.716      0.830     -0.843
 3- 2      0.130     -0.114     -0.642    -10.716      0.830     -0.843
 3- 3      0.590     -0.576     -0.642    -10.716      0.830     -0.843
 3- 4      1.137     -1.131     -0.642    -10.716      0.830     -0.843
 3- 5      1.692     -1.695     -0.954    -10.618      0.830     -0.843
 3- 6      2.251     -2.262     -0.653    -10.618      0.830     -0.843
 3- 7      2.809     -2.830     -0.653    -10.618      0.830     -0.843
 3- 8      3.368     -3.398     -0.653    -10.618      0.830     -0.843
 3- 9      3.926     -3.968     -0.653    -10.618      0.830     -0.843
 3-10      4.485     -4.537     -0.653    -10.618      0.830     -0.843
INTERIOR WALL TOP
```



```
BOTTOM SLAB LEFT SIDE
 4- 0     -0.744     -6.035      0.137     -3.040      5.114      0.489
 4- 1      0.511     -1.641      0.137     -3.040      3.978      0.380
 4- 2      3.263     -0.456      0.114     -3.018      2.843      0.271
 4- 3      5.294     -0.104      0.114     -3.018      1.708      0.162
 4- 4      6.262      0.000      0.114     -3.018      0.572      0.054
 4- 5      6.156      0.000      0.114     -3.018      0.092     -0.819
 4- 6      4.952      0.000      0.114     -3.018     -0.016     -1.954
 4- 7      2.684      0.000     -1.306     -1.160     -0.125     -3.090
 4- 8      0.080     -1.797     -1.283     -1.182     -0.234     -4.225
 4- 9     -0.198     -6.338     -1.283     -1.182     -0.343     -5.360
 4-10     -0.582    -12.016     -1.283     -1.182     -0.451     -6.496
BOTTOM SLAB RIGHT SIDE
```

---

```
Output complete for a HL-93-TRUCK              vehicle
```

---



## LRFD Live Load Distribution Factor Computation

**Input Values**

| | | |
|---|---|---|
| Depth of Fill | = 0.00 | ft. |
| Span Length | = 9.00 | ft. |
| Truck Gage | = 6.00 | ft. |
| Soil Distribution Factor | = 1.15 | |
| Tire Patch Width | = 20.00 | in. |
| Bridge Width | = 112.00 | ft. |
| Lay Length | = 6.58 | ft. |

**Compute Strip Width by 4.6.2.10.2-1**

E = 96 + 1.44 S ft

E = 96 + 1.44 ( 9.00 ft. )
E = 9.08 ft.

**Controlling Distribution Factor**

Final Strip Width = 9.08 ft.

Final Distribution Factor = 1/Final Strip Width = **0.110** Lanes per ft. of width

Multiple Presence Factor = 1.20

Distribution Factor * Multiple Presence Factor = **0.132**

Notes:

1. Only the one lane loaded case is considered. 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.

```
                              PAGE 30
                         DATE 01/21/2016
                BRASS-CULVERT(LRFD)  Version 2.3.0
                       9X6 BCDM PER C1577  FOR 0' OF FILL


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
```

```
                              PAGE 31
                         DATE 01/21/2016
                BRASS-CULVERT(LRFD)  Version 2.3.0
                       9X6 BCDM PER C1577  FOR 0' OF FILL


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.   Spacing       Axle wts.   Spacing
         (kips)        (ft)        (kips)        (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.

```
 Factors for Ductility   1.00
             Redundancy  1.00
             Operations  1.00
```



## 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 | -0.450 | 23999.85 | 23831.92 | **Pass** |
| TOP SLAB | Left | 44.493 | 23985.32 | 23947.74 | **Pass** |
| TOP SLAB | Middle + | -439.061 | 23855.11 | 23572.13 | **Pass** |
| TOP SLAB | Middle - | 113.588 | 24037.48 | 19451.73 | **Pass** |
| INTERIOR WALL | Bottom | -132.481 | 23956.28 | 715.49 | **Pass** |
| INTERIOR WALL | Middle | -106.981 | 23964.70 | 10196.40 | **Pass** |
| INTERIOR WALL | Top | -106.981 | 23964.70 | 18256.53 | **Pass** |
| BOTTOM SLAB | Left | 91.037 | 23969.96 | 12444.96 | **Pass** |



## LRFD Crack Control Computation

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

| Location | $\gamma_e$ | h ( in.) | $d_c$ ( in.) | $\beta_s$ | | | | |
|---|---|---|---|---|---|---|---|---|

| | | | | | Max Spacing () | Current Spacing ( in.) | Allowable Stress () | Actual Stress ( kip ) |
|---|---|---|---|---|---|---|---|---|
| Top slab, outside corner | $0.8*f_r > f_c$, therefore no check necessary. | | | | | | | |
| Top slab, inside face | 0.75000000 | 10.00000000 | 1.31250000 | 1.21582735 | 12.39446640 | 8.00000000 | 40.57035446 | 28.74967194 |
| 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. | | | | | | | |
| Interior wall | $0.8*f_r > f_c$, therefore no check necessary. | | | | | | | |



```
Lateral Distribution Steel:
  Span Length                                =    9.667 feet
  Percentage of main reinforcement required =   32.163% , less than or equal to 50%
  Main reinforcement area (top slab)         =    0.465 in^2
  Required lateral distribution area         =    0.150 in^2
  Because the required area is less than the minimum, an area of steel of   0.200 in^2 is use
  Bar size      (C100)                       =  # 4
  Spacing       (C100)                       =   12.000 in
  Area of steel (C100)                       =    0.200 in^2
  Main reinforcement area (bottom slab)      =    0.200 in^2
  Required lateral distribution area         =    0.064 in^2
  Because the required area is less than the minimum, an area of steel of   0.200 in^2 is use
  Bar size      (C200)                       =  # 4
  Spacing       (C200)                       =   12.000 in
  Area of steel (C200)                       =    0.200 in^2


 Bar sizes and spacings with computed areas of steel

 Areas of steel are in in2/ft

                            Top slab
LEFT SIDE                    CENTER                      RIGHT SIDE
area  0.4650 in2             area  0.4650 in2            area  0.2667 in2
```

```
    size  5 spaced at   8.00 in.  size  5 spaced at   8.00 in.  size  4 spaced at   9.00 in.
*************************************************************************

 Exterior wall                                                    Interior wall
TOP                                                              TOP
area  0.4650 in2                                                 area  0.2000 in2
size  5 spaced at   8.00 in.                                     size  4 spaced at  12.00 in.



INSIDE FACE                                                      EACH FACE
area  0.2000 in2                                                 area  0.2000 in2
size  4 spaced at  12.00 in.                                     size  4 spaced at  12.00 in.

OUTSIDE FACE
area  0.3000 in2
size  4 spaced at   8.00



BOTTOM                                                           BOTTOM
area  0.3000 in2                                                 area  0.2000 in2
size  4 spaced at   8.00 in.                                     size  4 spaced at  12.00 in.
*************************************************************************

                        Bottom slab
    LEFT SIDE                    CENTER                          RIGHT SIDE
    area  0.3000 in2             area  0.2000 in2                area  0.2000 in2
    size  4 spaced at   8.00 in. size  4 spaced at  12.00 in.    size  4 spaced at  12.00 in.
```

## Reinforcing Steel Bar Schedule

| Location | Mark | Qty | Size | Type | Length (Ft-In) | Wgt (Lbs) | H Leg (Ft-In) | V Leg (Ft-In) |
|---|---|---|---|---|---|---|---|---|
| TOP SLAB (Inside) | A100 | 10 | 5 | STR | 0- 0 | 0 | | |
| BOT SLAB (Inside) | A200 | 7 | 4 | STR | 0- 0 | 0 | | |
| TOP SLAB (Outside) | A300 | 9 | 4 | STR | 0- 0 | 0 | | |
| BOT SLAB (Outside) | A400 | 7 | 4 | STR | 0- 0 | 0 | | |
| CORNER (Top) | A1 | 20 | 5 | L-BAR | 4-11 | 103 | 2- 5 | 2- 6 |
| CORNER (Bottom) | A2 | 20 | 4 | L-BAR | 4- 6 | 60 | 2- 3 | 2- 3 |
| EXTWALL (Inside) | B1 | 14 | 4 | STR | 6- 6 | 61 | | |
| EXTWALL (Outside) | B2 | 20 | 4 | STR | 0- 0 | 0 | | |
| INTWALL | B3 | 14 | 4 | STR | 0- 0 | 0 | | |
| LONGITUD.( 1) | C1 | 79 | 4 | STR | 6- 4 | 334 | | |
| LONGITUD.( 1) | C100 | 0 | 4 | STR | 6- 4 | 0 | | |
| LONGITUD.( 1) | C200 | 0 | 4 | STR | 6- 4 | 0 | | |

| | |
|---|---|
| Total weight black bars | 558 |
| Total weight all bars | 558 |

The minimum temperature and shrinkage steel for the:
- Top slab(s) = 0.2031 in2
- Bottom slab(s) = 0.1625 in2
- Exterior wall(s) = 0.1625 in2
- Interior wall(s) = 0.1625 in2

### Splice Lengths Chart

| Mark | Size | Splice (Ft-In) | Length (m) |
|---|---|---|---|
| B1 | 4 | 1- 9 | 0.533 |
| B3 | 4 | 1- 9 | 0.533 |
| C1 | 4 | 1- 9 | 0.533 |
| C100 | 4 | 1- 9 | 0.533 |
| C200 | 4 | 1- 9 | 0.533 |

PAGE 35
DATE 01/21/2016
BRASS-CULVERT(LRFD) Version 2.3.0
9X6 BCDM PER C1577 FOR 0' OF FILL

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 | -0.744 | -5.109 | 0.763 | -12.107 | 2.880 | -0.573 |
| 1- 1 | -0.308 | -3.527 | 0.690 | -11.990 | 2.382 | -0.582 |
| 1- 2 | 0.514 | -3.424 | 0.605 | -11.904 | 1.922 | -0.592 |
| 1- 3 | 1.049 | -3.806 | 0.605 | -11.904 | 1.498 | -0.602 |
| 1- 4 | 1.311 | -4.200 | 0.605 | -11.904 | 1.112 | -0.613 |
| 1- 5 | 1.324 | -4.602 | 0.605 | -11.904 | 0.971 | -0.833 |
| 1- 6 | 1.265 | -5.011 | 0.605 | -11.904 | 0.959 | -1.146 |
| 1- 7 | 1.457 | -5.429 | 0.605 | -11.904 | 0.946 | -1.422 |
| 1- 8 | 1.476 | -5.856 | 0.605 | -11.904 | 0.933 | -1.661 |
| 1- 9 | 1.681 | -6.749 | 0.763 | -12.107 | 0.918 | -1.864 |
| 1-10 | 2.114 | -8.048 | 0.763 | -12.107 | 0.903 | -2.029 |
| EXTERIOR WALL TOP | | | | | | |
| TOP SLAB LEFT SIDE | | | | | | |
| 2- 0 | 2.114 | -8.048 | 0.627 | -2.006 | 12.107 | -0.812 |
| 2- 1 | 4.535 | -1.580 | 0.650 | -2.029 | 9.577 | -0.875 |
| 2- 2 | 9.844 | -0.691 | 0.650 | -2.029 | 7.805 | -1.274 |
| 2- 3 | 13.645 | -0.950 | 0.650 | -2.029 | 6.061 | -2.187 |
| 2- 4 | 15.027 | -1.753 | 0.650 | -2.029 | 4.433 | -3.156 |
| 2- 5 | 14.478 | -2.617 | 0.650 | -2.029 | 3.001 | -4.709 |
| 2- 6 | 13.870 | -3.542 | 0.650 | -2.029 | 1.772 | -6.445 |
| 2- 7 | 10.887 | -4.591 | -0.435 | -0.692 | 0.887 | -8.216 |
| 2- 8 | 5.802 | -5.875 | -0.457 | -0.669 | -0.041 | -9.960 |
| 2- 9 | 0.104 | -7.290 | -0.457 | -0.669 | -0.104 | -11.592 |
| 2-10 | -0.027 | -14.387 | -0.457 | -0.669 | -0.167 | -12.393 |
| TOP SLAB RIGHT SIDE | | | | | | |
| INTERIOR WALL BOTTOM | | | | | | |
| 3- 0 | 1.382 | -1.328 | -0.642 | -15.120 | 1.022 | -1.038 |
| 3- 1 | 0.686 | -0.642 | -0.642 | -15.120 | 1.022 | -1.038 |
| 3- 2 | 0.116 | -0.090 | -0.642 | -15.120 | 1.022 | -1.038 |
| 3- 3 | 0.757 | -0.739 | -0.642 | -15.120 | 1.022 | -1.038 |
| 3- 4 | 1.440 | -1.432 | -0.642 | -15.120 | 1.022 | -1.038 |
| 3- 5 | 2.126 | -2.128 | -0.954 | -15.022 | 1.022 | -1.038 |
| 3- 6 | 2.814 | -2.829 | -0.653 | -15.022 | 1.022 | -1.038 |
| 3- 7 | 3.503 | -3.529 | -0.653 | -15.022 | 1.022 | -1.038 |
| 3- 8 | 4.191 | -4.229 | -0.653 | -15.022 | 1.022 | -1.038 |
| 3- 9 | 4.879 | -4.930 | -0.653 | -15.022 | 1.022 | -1.038 |
| 3-10 | 5.568 | -5.630 | -0.653 | -15.022 | 1.022 | -1.038 |
| INTERIOR WALL TOP | | | | | | |

PAGE 36
DATE 01/21/2016
BRASS-CULVERT(LRFD) Version 2.3.0
9X6 BCDM PER C1577 FOR 0' OF FILL

| | | | | | | |
|---|---|---|---|---|---|---|
| BOTTOM SLAB LEFT SIDE | | | | | | |
| 4- 0 | -0.744 | -5.109 | 0.135 | -2.879 | 4.197 | 0.489 |
| 4- 1 | 0.550 | -1.552 | 0.135 | -2.879 | 3.277 | 0.380 |

```
 4- 2      3.066     -0.456      0.112     -2.856      2.357      0.271
 4- 3      4.708     -0.104      0.112     -2.856      1.437      0.162
 4- 4      5.461      0.000      0.112     -2.856      0.517      0.054
 4- 5      5.328      0.000      0.112     -2.856      0.092     -0.642
 4- 6      4.311      0.000      0.112     -2.856     -0.016     -1.562
 4- 7      2.446      0.000     -1.307     -0.998     -0.125     -2.482
 4- 8      0.080     -1.759     -1.285     -1.021     -0.234     -3.402
 4- 9     -0.198     -5.462     -1.285     -1.021     -0.343     -4.322
 4-10     -0.582    -10.055     -1.285     -1.021     -0.451     -5.242
BOTTOM SLAB RIGHT SIDE
```

---

```
Output complete for a HL-93-TANDEM             vehicle
```

---



## LRFD Live Load Distribution Factor Computation

**Input Values**

| | | |
|---|---|---|
| Depth of Fill | = 0.00 | ft. |
| Span Length | = 9.00 | ft. |
| Truck Gage | = 6.00 | ft. |
| Soil Distribution Factor | = 1.15 | |
| Tire Patch Width | = 20.00 | in. |
| Bridge Width | = 112.00 | ft. |
| Lay Length | = 6.58 | ft. |

**Compute Strip Width by 4.6.2.10.2-1**

E = 96 + 1.44 S ft
E = 96 + 1.44 ( 9.00 ft. )
E = 9.08 ft.

**Controlling Distribution Factor**

Final Strip Width = 9.08 ft.

Final Distribution Factor = 1/Final Strip Width = **0.110** Lanes per ft. of width

Multiple Presence Factor = 1.20

Distribution Factor * Multiple Presence Factor = **0.132**

Notes:

1. Only the one lane loaded case is considered. 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.

PAGE 38
DATE 01/21/2016
BRASS-CULVERT(LRFD) Version 2.3.0
9X6 BCDM PER C1577 FOR 0' OF FILL

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

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

PAGE 39
DATE 01/21/2016
BRASS-CULVERT(LRFD) Version 2.3.0
9X6 BCDM PER C1577 FOR 0' OF FILL

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.

Factors for Ductility 1.00
Redundancy 1.00
Operations 1.00

PAGE 40
DATE 01/21/2016
BRASS-CULVERT(LRFD) Version 2.3.0
9X6 BCDM PER C1577 FOR 0' OF FILL

No Fatigue Checks Required for this Live Load

```
                    PAGE 41
                 DATE 01/21/2016
BRASS-CULVERT(LRFD)  Version 2.3.0
       9X6 BCDM PER C1577  FOR 0' OF FILL
```

## LRFD Crack Control Computation

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

| Location | $\gamma_e$ | h ( in.) | $d_c$ ( in.) | $\beta_s$ | 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. | | | | | | | |
| Interior wall | $0.8*f_r > f_c$, therefore no check necessary. | | | | | | | |

```
                    PAGE 42
                 DATE 01/21/2016
BRASS-CULVERT(LRFD)  Version 2.3.0
       9X6 BCDM PER C1577  FOR 0' OF FILL

    Lateral Distribution Steel:
      Span Length                              =    9.667 feet
      Percentage of main reinforcement required =   32.163% , less than or equal to 50%
      Main reinforcement area (top slab)       =    0.267 in^2
      Required lateral distribution area       =    0.086 in^2
      Because the required area is less than the minimum, an area of steel of   0.200 in^2 is use
      Bar size      (C100)                     =  # 4
      Spacing       (C100)                     =   12.000 in
      Area of steel (C100)                     =    0.200 in^2
      Main reinforcement area (bottom slab)    =    0.200 in^2
      Required lateral distribution area       =    0.064 in^2
      Because the required area is less than the minimum, an area of steel of   0.200 in^2 is use
      Bar size      (C200)                     =  # 4
      Spacing       (C200)                     =   12.000 in
      Area of steel (C200)                     =    0.200 in^2


     Bar sizes and spacings with computed areas of steel

     Areas of steel are in in2/ft

                              Top slab
    LEFT SIDE                 CENTER                        RIGHT SIDE
    area  0.2667 in2          area  0.2667 in2              area  0.2667 in2
    size  4 spaced at   9.00 in.  size  4 spaced at   9.00 in.  size  4 spaced at   9.00 in.
**************************************************************************
```

```
 Exterior wall                                                  Interior wall
TOP                                                            TOP
area  0.2667 in2                                               area  0.2000 in2
size  4 spaced at   9.00 in.                                   size  4 spaced at  12.00 in.


INSIDE FACE                                                    EACH FACE
area  0.2000 in2                                               area  0.2000 in2
size  4 spaced at  12.00 in.                                   size  4 spaced at  12.00 in.

OUTSIDE FACE
area  0.2667 in2
size  4 spaced at   9.00


BOTTOM                                                         BOTTOM
area  0.2667 in2                                               area  0.2000 in2
size  4 spaced at   9.00 in.                                   size  4 spaced at  12.00 in.
*********************************************************************
```

Bottom slab

| LEFT SIDE | CENTER | RIGHT SIDE |
|---|---|---|
| area 0.2667 in2 | area 0.2000 in2 | area 0.2000 in2 |
| size 4 spaced at 9.00 in. | size 4 spaced at 12.00 in. | size 4 spaced at 12.00 in. |

Reinforcing Steel Bar Schedule

| Location | Mark | Qty | Size | Type | Length (Ft-In) | Wgt (Lbs) | H Leg (Ft-In) | V Leg (Ft-In) |
|---|---|---|---|---|---|---|---|---|
| TOP SLAB (Inside) | A100 | 9 | 4 | STR | 0- 0 | 0 | | |
| BOT SLAB (Inside) | A200 | 7 | 4 | STR | 0- 0 | 0 | | |
| TOP SLAB (Outside) | A300 | 9 | 4 | STR | 0- 0 | 0 | | |
| BOT SLAB (Outside) | A400 | 7 | 4 | STR | 0- 0 | 0 | | |
| CORNER (Top) | A1 | 18 | 4 | L-BAR | 4- 7 | 55 | 2- 3 | 2- 4 |
| CORNER (Bottom) | A2 | 18 | 4 | L-BAR | 4- 6 | 54 | 2- 3 | 2- 3 |
| EXTWALL (Inside) | B1 | 14 | 4 | STR | 6- 6 | 61 | | |
| EXTWALL (Outside) | B2 | 18 | 4 | STR | 0- 0 | 0 | | |
| INTWALL | B3 | 14 | 4 | STR | 0- 0 | 0 | | |
| LONGITUD.( 1) | C1 | 79 | 4 | STR | 6- 4 | 334 | | |
| LONGITUD.( 1) | C100 | 0 | 4 | STR | 6- 4 | 0 | | |
| LONGITUD.( 1) | C200 | 0 | 4 | STR | 6- 4 | 0 | | |

Total weight black bars 504
Total weight all bars 504

The minimum temperature and shrinkage steel for the:
Top slab(s) = 0.2031 in2
Bottom slab(s) = 0.1625 in2
Exterior wall(s) = 0.1625 in2

Interior wall(s) = 0.1625 in2

Splice Lengths Chart

| Mark | Size | Splice (Ft-In) | Length (m) |
|---|---|---|---|
| B1 | 4 | 1- 9 | 0.533 |
| B3 | 4 | 1- 9 | 0.533 |
| C1 | 4 | 1- 9 | 0.533 |
| C100 | 4 | 1- 9 | 0.533 |
| C200 | 4 | 1- 9 | 0.533 |

PAGE 43
DATE 01/21/2016
BRASS-CULVERT(LRFD) Version 2.3.0
9X6 BCDM PER C1577 FOR 0' OF FILL

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 | -0.744 | -1.647 | -0.307 | -0.561 | 1.988 | 0.107 |
| 1- 1 | -0.308 | -0.618 | -0.379 | -0.444 | 1.491 | 0.099 |
| 1- 2 | 0.514 | -0.529 | -0.465 | -0.358 | 1.030 | 0.089 |
| 1- 3 | 1.049 | -0.457 | -0.465 | -0.358 | 0.606 | 0.079 |
| 1- 4 | 1.311 | -0.392 | -0.465 | -0.358 | 0.220 | 0.068 |
| 1- 5 | 1.324 | -0.335 | -0.465 | -0.358 | 0.079 | -0.153 |
| 1- 6 | 1.113 | -0.285 | -0.465 | -0.358 | 0.067 | -0.466 |
| 1- 7 | 0.704 | -0.244 | -0.465 | -0.358 | 0.054 | -0.741 |
| 1- 8 | 0.120 | -0.212 | -0.465 | -0.358 | 0.041 | -0.981 |
| 1- 9 | -0.277 | -0.646 | -0.307 | -0.561 | 0.026 | -1.183 |
| 1-10 | -0.446 | -1.487 | -0.307 | -0.561 | 0.012 | -1.348 |
| EXTERIOR WALL TOP | | | | | | |
| TOP SLAB LEFT SIDE | | | | | | |
| 2- 0 | -0.446 | -1.487 | -0.264 | -1.325 | 0.561 | 0.262 |
| 2- 1 | -0.118 | -1.049 | -0.241 | -1.348 | 0.473 | 0.199 |
| 2- 2 | 0.144 | -0.691 | -0.241 | -1.348 | 0.385 | 0.136 |
| 2- 3 | 0.321 | -0.394 | -0.241 | -1.348 | 0.297 | 0.073 |
| 2- 4 | 0.413 | -0.158 | -0.241 | -1.348 | 0.212 | 0.007 |
| 2- 5 | 0.420 | 0.000 | -0.241 | -1.348 | 0.149 | -0.081 |
| 2- 6 | 0.342 | 0.000 | -0.241 | -1.348 | 0.086 | -0.169 |
| 2- 7 | 0.228 | 0.000 | -1.325 | -0.011 | 0.023 | -0.257 |
| 2- 8 | 0.174 | -0.125 | -1.348 | 0.012 | -0.041 | -0.345 |
| 2- 9 | 0.104 | -0.501 | -1.348 | 0.012 | -0.104 | -0.432 |
| 2-10 | -0.027 | -0.961 | -1.348 | 0.012 | -0.167 | -0.520 |
| TOP SLAB RIGHT SIDE | | | | | | |
| INTERIOR WALL BOTTOM | | | | | | |
| 3- 0 | 0.029 | 0.000 | -0.642 | -0.740 | -0.001 | -0.009 |
| 3- 1 | 0.023 | 0.000 | -0.642 | -0.740 | -0.001 | -0.009 |
| 3- 2 | 0.017 | 0.000 | -0.642 | -0.740 | -0.001 | -0.009 |
| 3- 3 | 0.011 | 0.000 | -0.642 | -0.740 | -0.001 | -0.009 |
| 3- 4 | 0.005 | 0.000 | -0.642 | -0.740 | -0.001 | -0.009 |
| 3- 5 | 0.000 | -0.001 | -0.954 | -0.642 | -0.001 | -0.009 |
| 3- 6 | -0.003 | -0.008 | -0.653 | -0.642 | -0.001 | -0.009 |
| 3- 7 | -0.005 | -0.014 | -0.653 | -0.642 | -0.001 | -0.009 |
| 3- 8 | -0.007 | -0.020 | -0.653 | -0.642 | -0.001 | -0.009 |
| 3- 9 | -0.009 | -0.026 | -0.653 | -0.642 | -0.001 | -0.009 |
| 3-10 | -0.012 | -0.032 | -0.653 | -0.642 | -0.001 | -0.009 |
| INTERIOR WALL TOP | | | | | | |

PAGE 44
DATE 01/21/2016
BRASS-CULVERT(LRFD) Version 2.3.0
9X6 BCDM PER C1577 FOR 0' OF FILL

| | | | | | | |
|---|---|---|---|---|---|---|
| BOTTOM SLAB LEFT SIDE | | | | | | |
| 4- 0 | -0.744 | -1.647 | -0.546 | -1.988 | 0.821 | 0.489 |
| 4- 1 | -0.291 | -0.926 | -0.546 | -1.988 | 0.670 | 0.380 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 4- 2 | 0.162 | -0.456 | -0.568 | -1.965 | 0.519 | 0.271 |
| 4- 3 | 0.482 | -0.104 | -0.568 | -1.965 | 0.368 | 0.162 |
| 4- 4 | 0.655 | 0.000 | -0.568 | -1.965 | 0.217 | 0.054 |
| 4- 5 | 0.683 | 0.000 | -0.568 | -1.965 | 0.092 | -0.081 |
| 4- 6 | 0.564 | 0.000 | -0.568 | -1.965 | -0.016 | -0.233 |
| 4- 7 | 0.334 | 0.000 | -1.988 | -0.107 | -0.125 | -0.384 |
| 4- 8 | 0.080 | -0.154 | -1.965 | -0.130 | -0.234 | -0.535 |
| 4- 9 | -0.198 | -0.744 | -1.965 | -0.130 | -0.343 | -0.686 |
| 4-10 | -0.582 | -1.480 | -1.965 | -0.130 | -0.451 | -0.837 |

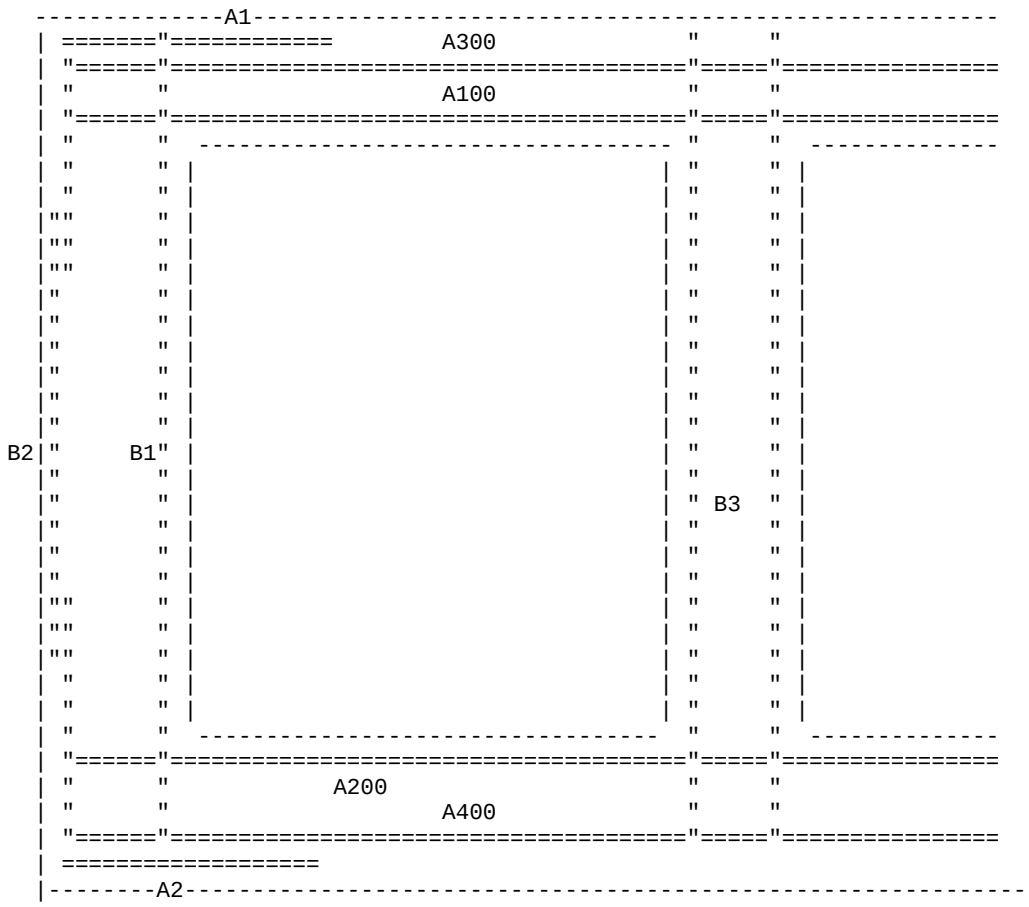
BOTTOM SLAB RIGHT SIDE

---

Output complete for a HL-93-LANE vehicle

---





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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 |

PROVIDED AS SHOWN ON REINFORCEMENT DATA ATTACHED

| Bar Type | Fs Act. (Ksi) | Fs All. (Ksi) | Area steel Required (In2) | Area steel Provided (In2) | Size US Bars | Spacing (In) | H (In) | V (In) |
|---|---|---|---|---|---|---|---|---|
| A1 | 0.45 | 27.44 | 0.3909 | 0.5314 | 5 | 7.0 | 27 | 28 |
| A2 | 0.32 | 36.08 | 0.1920 | 0.3429 | 4 | 7.0 | 27 | 27 |
| A100 | 4.53 | 37.88 | 0.5011 | 0.5314 | 5 | 7.0 | | |
| A300 | 1.28 | 27.44 | 0.2400 | 0.2667 | 4 | 9.0 | | |
| A200 | 10.33 | 28.56 | 0.1920 | 0.2000 | 4 | 12.0 | | |
| A400 | 2.11 | 28.56 | 0.1920 | 0.2000 | 4 | 12.0 | | |
| B1 | 5.51 | 28.56 | 0.1920 | 0.2000 | 4 | 12.0 | | |
| B2 | 5.82 | 28.56 | 0.2082 | 0.3429 | 4 | 7.0 | | |
| B3 | 0.12 | 28.56 | 0.1920 | 0.2000 | 4 | 12.0 | | |



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.

PAGE 48
DATE 01/21/2016
BRASS-CULVERT(LRFD) Version 2.3.0
9X6 BCDM PER C1577 FOR 0' OF FILL

Output at Critical Sections (per unit design width)

Member No. = 1 EXTERIOR WALL
Thickness = 8.00 (in)
Clear cover at end = 1.00 (in)
Clear cover at middle = 1.00 (in)
Bar diameter (bot ) = 0.50 (in)
Bar diameter (mid+) = 0.50 (in)
Bar diameter (mid-) = 0.50 (in)
Bar diameter (top ) = 0.50 (in)

| | Moment | Coin. Axial Force | Shear Force | Shear Cap | Resistance Po Cap | Mu Cap | Mbal Cap | Pbal Cap | Steel Area | Mom. Cap | Des. Thk | Design Ratio |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Kft | Kips | Kips | Kips | Kips | Kft | Kft | Kips | In2 | Kft | in | |
| BOT | -4.2 | 9.6 | 2.3 | 23.0 | 300.3 | 12.3 | 29.9 | 108.3 | 0.3429 | 12.3 | 6.75 | n/a |
| MID | 1.3 | 9.6 | 1.1 | 39.4 | 295.2 | 7.3 | 28.2 | 115.7 | 0.2000 | 7.3 | 6.75 | 0.2 |
| MID- | -4.6 | 11.9 | 0.8 | 25.4 | 300.3 | 12.4 | 29.9 | 108.3 | 0.3429 | 12.4 | 6.75 | n/a |
| TOP | -6.2 | 12.0 | 1.8 | 22.3 | 307.1 | 18.6 | 31.9 | 97.3 | 0.5314 | 18.6 | 6.69 | n/a |

Member No. = 2 TOP SLAB
Thickness = 10.00 (in)
Clear cover at end = 1.00 (in)
Clear cover at middle = 1.00 (in)
Bar diameter (lt ) = 0.50 (in)
Bar diameter (mid ) = 0.50 (in)
Bar diameter (rt ) = 0.50 (in)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LT | -2.0 | 2.0 | 9.5 | 19.6 | 379.1 | 21.2 | 45.0 | 116.0 | 0.5314 | 21.2 | 7.69 | n/a |
| MID | 16.3 | 2.0 | 3.9 | 17.6 | 379.1 | 24.1 | 49.2 | 134.7 | 0.5314 | 24.1 | 8.69 | 0.7 |
| RT | -7.3 | 0.7 | 11.5 | 12.0 | 369.6 | 11.0 | 42.1 | 130.9 | 0.2667 | 11.0 | 7.75 | n/a |

Member No. = 3 INTERIOR WALL
Thickness = 8.00 (in)
Clear cover at end = 1.00 (in)
Clear cover at middle = 1.00 (in)
Bar diameter (bot ) = 0.50 (in)
Bar diameter (mid+) = 0.50 (in)
Bar diameter (mid-) = 0.50 (in)
Bar diameter (top ) = 0.50 (in)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOT | -0.4 | 15.1 | 1.0 | 47.6 | 295.2 | 7.5 | 28.2 | 115.7 | 0.2000 | 7.5 | 6.75 | n/a |
| MID | 2.1 | 15.1 | 1.0 | 47.6 | 295.2 | 7.5 | 28.2 | 115.7 | 0.2000 | 7.5 | 6.75 | 0.3 |
| MID- | -2.1 | 15.0 | 1.0 | 47.6 | 295.2 | 7.5 | 28.2 | 115.7 | 0.2000 | 7.5 | 6.75 | n/a |
| TOP | -4.5 | 15.0 | 1.0 | 28.4 | 295.2 | 7.5 | 28.2 | 115.7 | 0.2000 | 7.5 | 6.75 | n/a |

Member No. = 4 BOTTOM SLAB
Thickness = 8.00 (in)
Clear cover at end = 1.00 (in)
Clear cover at middle = 1.00 (in)
Bar diameter (lt ) = 0.50 (in)
Bar diameter (mid ) = 0.50 (in)
Bar diameter (rt ) = 0.50 (in)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LT | -1.6 | 3.0 | 4.0 | 20.8 | 300.3 | 12.2 | 29.9 | 108.3 | 0.3429 | 12.2 | 6.75 | n/a |
| MID | 6.3 | 3.0 | 0.1 | 13.8 | 295.2 | 7.2 | 28.2 | 115.7 | 0.2000 | 7.2 | 6.75 | 0.9 |
| RT | -6.2 | 1.2 | 5.4 | 10.3 | 295.2 | 7.2 | 28.2 | 115.7 | 0.2000 | 7.2 | 6.75 | n/a |

Warnings:
1. For exterior corners, BRASS-CULVERT does not perform a check on both the exterior wall an BRASS-CULVERT only checks the location that it has determined requires a greater area of

this, BRASS-CULVERT may check one location for a particular culvert (e.g. top of the wall 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 axia load being higher than the tensile capacity of the rebar provide. For example, the axial is greater than the area of steel times the yield strength of the bars.



Volume of Concrete and Weight of Reinforcing Steel

| Thickness Top Slab (In) | Bottom Slab (In) | Exterior Wall (In) | Interior Wall (In) | Volume (Cy/Ft) | Steel (Lb/Ft) |
|---|---|---|---|---|---|
| 10.00 | 8.00 | 8.00 | 8.00 | 1.621 | 233 |

Reinforcing Steel Bar Schedule

| Location | Mark | Qty | Size | Type | Length (Ft-In) | Wgt (Lbs) | H Leg (Ft-In) | V Leg (Ft-In) |
|---|---|---|---|---|---|---|---|---|
| TOP SLAB (Inside) | A100 | 12 | 5 | STR | 19-10 | 248 | | |
| BOT SLAB (Inside) | A200 | 7 | 4 | STR | 19-10 | 93 | | |
| TOP SLAB (Outside) | A300 | 9 | 4 | STR | 19-10 | 119 | | |
| BOT SLAB (Outside) | A400 | 7 | 4 | STR | 19-10 | 93 | | |
| CORNER (Top) | A1 | 24 | 5 | L-BAR | 4- 7 | 115 | 2- 3 | 2- 4 |
| CORNER (Bottom) | A2 | 24 | 4 | L-BAR | 4- 6 | 72 | 2- 3 | 2- 3 |
| EXTWALL (Inside) | B1 | 14 | 4 | STR | 6- 6 | 61 | | |
| EXTWALL (Outside) | B2 | 24 | 4 | STR | 6- 0 | 96 | | |
| INTWALL | B3 | 14 | 4 | STR | 7- 3 | 68 | | |
| LONGITUD.( 1) | C1 | 79 | 4 | STR | 6- 4 | 334 | | |
| LONGITUD.( 1) | C100 | 19 | 4 | STR | 6- 4 | 80 | | |
| LONGITUD.( 1) | C200 | 19 | 4 | STR | 6- 4 | 80 | | |
| | | | | | Total weight black bars | 1459 | | |
| | | | | | Total weight all bars | 1459 | | |

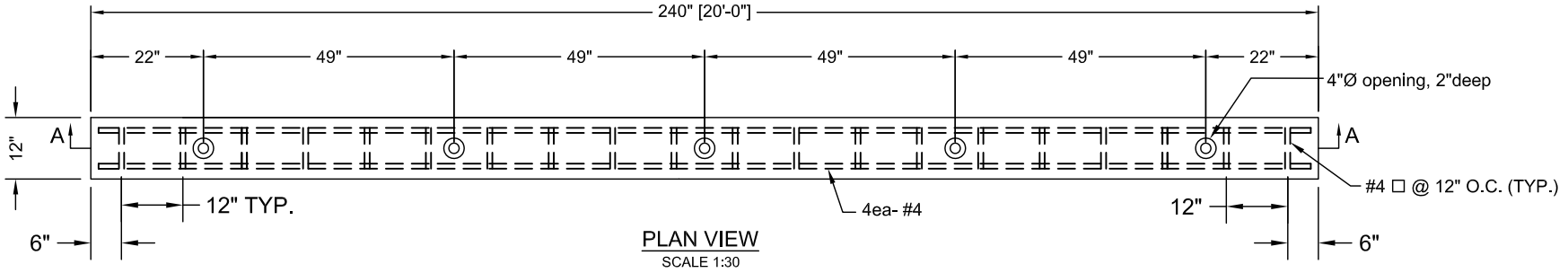
The minimum temperature and shrinkage steel for the:
Top slab(s) = 0.2031 in2
Bottom slab(s) = 0.1625 in2
Exterior wall(s) = 0.1625 in2

Interior wall(s) = 0.1625 in2

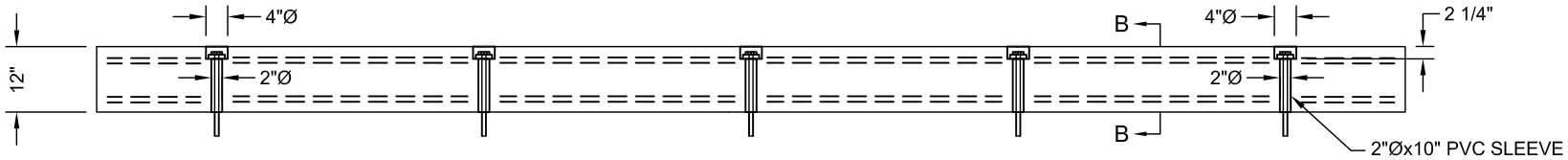
Splice Lengths Chart

| Mark | Size | Splice (Ft-In) | Length (m) |
|---|---|---|---|
| B1 | 4 | 1- 9 | 0.533 |
| B3 | 4 | 1- 9 | 0.533 |
| C1 | 4 | 1- 9 | 0.533 |
| C100 | 4 | 1- 9 | 0.533 |
| C200 | 4 | 1- 9 | 0.533 |

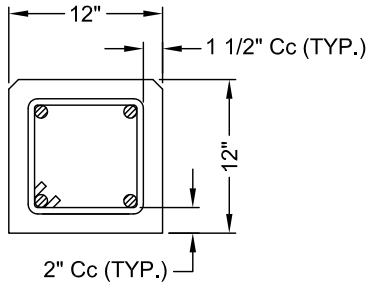
# (1) INLET / (1) OUTLET



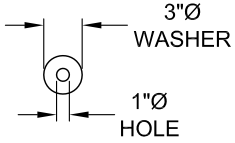

PLAN VIEW
SCALE 1:30



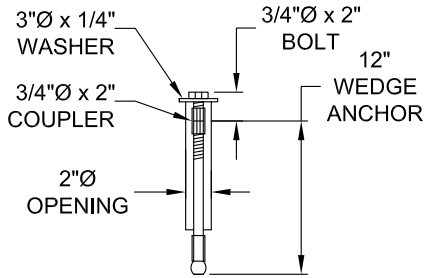

SECTION A-A
SCALE 1:30




SECTION B-B
SCALE 1:15




WASHER
SCALE 1:15




BOLT ASSEMBLY
SCALE 1:15

f'c = 4,000 psi
fy = 60 ksi

Note: Weight - 1.5 Tons

CP&P
CONCRETE PIPE & PRECAST, LLC

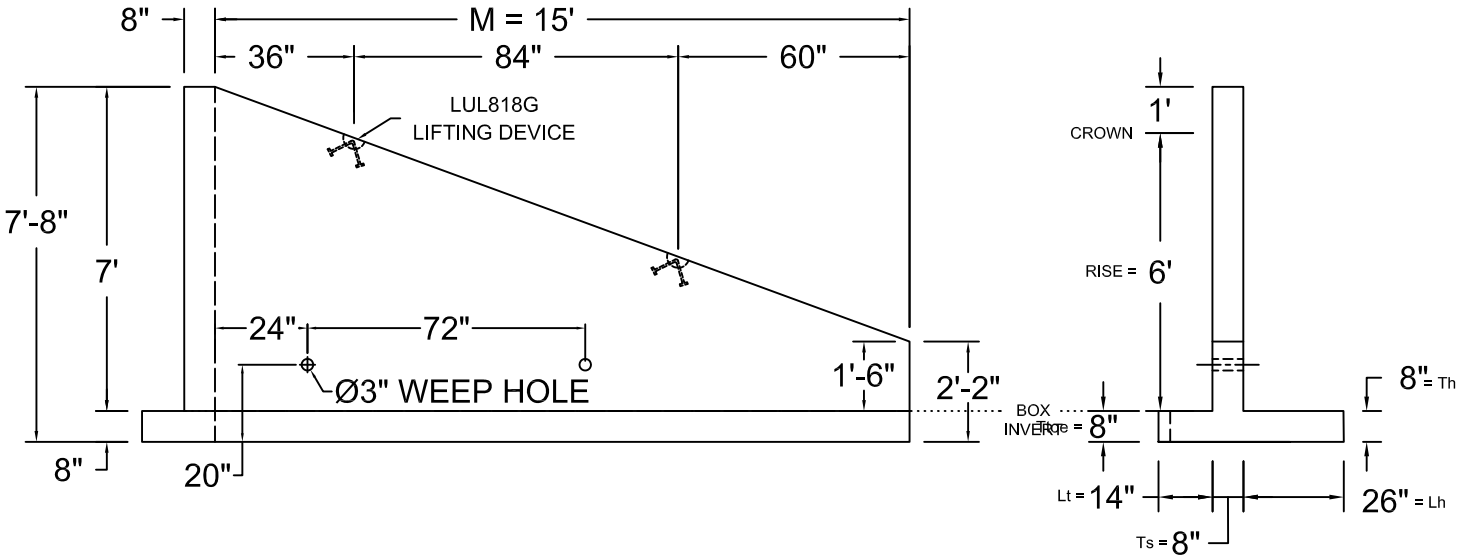
BOLT ON PARAPET FOR DBL 9'x6' BOX CULVERT (8" WALLS)

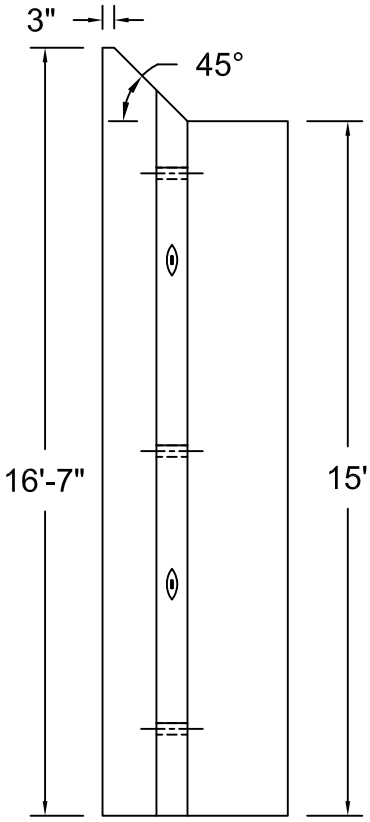
REDUCED SCALE

CENTERLINE ROAD

BERKELEY CO., SC – LANDMARK CONSTRUCTION

| JOB# 15108 | | |
|---|---|---|
| ORIGINAL | 1/21/2016 | RSP |
| REVISION | | |
| SHEET 1 OF 1 | | |




| | |
|---|---|
| WING ANGLE | 45° |
| RISE | 6' |
| FILL SLOPE | 2:1 |
| FRONT BAR@SPACE | #4 @ 8 |
| REAR BAR@SPACE | #4 @ 8 |
| BASE BAR@SPACE | #4 @ 8 |
| WEIGHT | 6.18 Tons |

NOTES:

1.) CONCRETE 4ksi, STEEL GRADE 60 IN ACCORDANCE WITH ASTM A615.

2.) 1.5" MIN. CONCRETE COVER OVER REINFORCING (Cc) UNLESS OTHEWISE NOTED

3.) 3/4" CHAMFER ALL EXPOSED EDGES

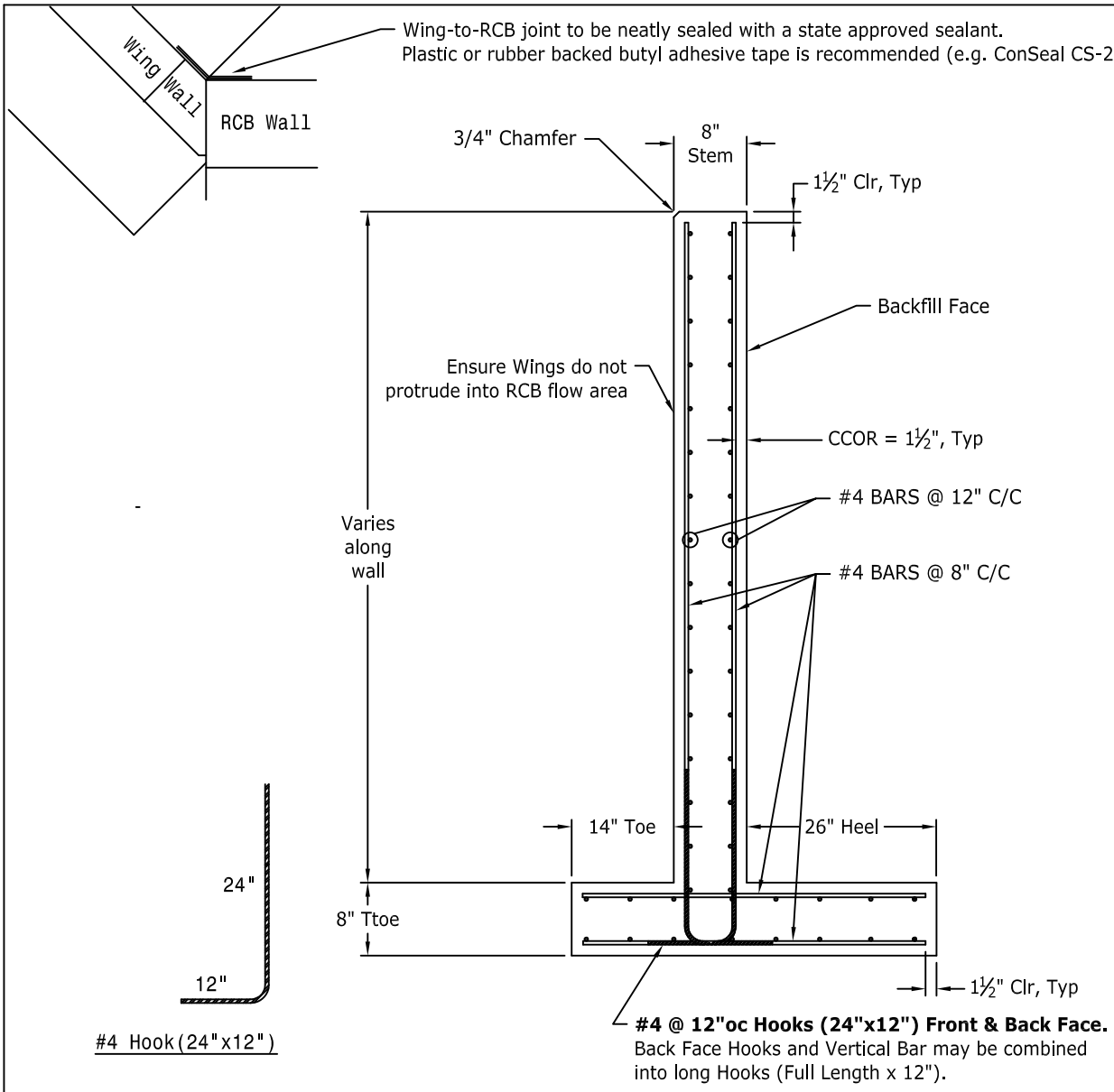
RIGHT WING SHOWN
LEFT WING SIMILAR

CP&P
CONCRETE PIPE & PRECAST, LLC

PRECAST BOX CULVERT WINGWALL
6 FT BOX RISE - 45° ANGLE
BWW-22-06'-45°

CONCRETE PIPE & PRECAST, LLC

| | | |
|---|---|---|
| ORIGINAL DATE | 1/21/16 | RSP |
| LAST REVISION | | |
| SCALE | REDUCED SCALE | |
| DRAWING NO: | BWW-22-03'-45° | |




## Reinforcement Section A-A

Note:

1) Reinforcement to be ASTM A706, A615 Deformed Bars, or ASTM A497 Deformed WWF.
   Material properties: f'c = 4,000 psi; fy = 60,000 psi.
2) Stem wall reinforcement to be tied to footer bottom reinforcement with "L" Hook Bars.
   Horizontal legs to extend from rear face forward into toe and from front face back into heel.
   If stem wall reinforcement is made from rebar, rebar may be bent at bottom and tied to continuous footer bottom reinforcement.
3) 3/4" Chamfer on Top-Front edges.
4) Concrete Cover Over Reinforcement, CCOR = 1.5" unless noted.
5) Wing-to-RCB joint to be neatly sealed with state approved sealant.
   Plastic or rubber backed butyl adhesive tape is recommended (e.g. 12" wide ConSeal CS-212).

BCW Wing Reinforcement Section
Wing for 6' Rise RCB

CP&P
CONCRETE PIPE & PRECAST, LLC

| For: | LANDMARK CONSTRUCTION | | Date | By/Chk |
|---|---|---|---|---|
| | | Original: | 01/21/16 | RSP |
| Project: | CENTERLINE ROAD | Last Rev: | | |
| | BERKELEY CO., SC | Scale: | 1/2" = 1' (1:24) | |
| Order: | 15108 Str: -- | Dwg: | BCW-Rf | |

Reinforced Box Culvert
Wing Wall Design
ECP - 1/21/2016

CP&P Salem

## Lateral Load Data-

BWW 22-6'-45°

Culvert #1 - WW-1, WW-2, WW-3, WW-4

Load Factor Design Method

Unit Foot Basis $b := 12in$

Concrete Density $\gamma c := 150pcf$

Soil Density $\gamma s := 120pcf$

Fill Slope $Slope_{fill} := 2.0$ (eg: 2.0 is for 2.0:1 Fill Slope) $\beta := atan\left(\frac{1}{Slope_{fill}}\right)$ $\beta = 26.565 \cdot deg$

Static Friction $\mu_s := 0.5$

Acive Earth Pr. Coef. $K_a := 0.333$

Passive Earth Pr. Coef. $K_p := 1 \div K_a$ Concrete Apron - CIP

Concrete Cover $C_c := 1.5in$ ACI 7.7.3(a)

Depth to Soil $D_s := 8in$

### AASHTO Load & Phi Factors-

Dead Load Factor- Soil $DLF_s := 1.5$

Dead Load Factor $DLF := 1.3$

Live Load Surcharge $LL_s := 0ft$ AASHTO >h/2

Phi Factor Flexure $\phi_f := 1.0$ AASHTO - Phi Factors for Precast

Phi Factor Shear $\phi_s := 0.9$

### Wing Data-

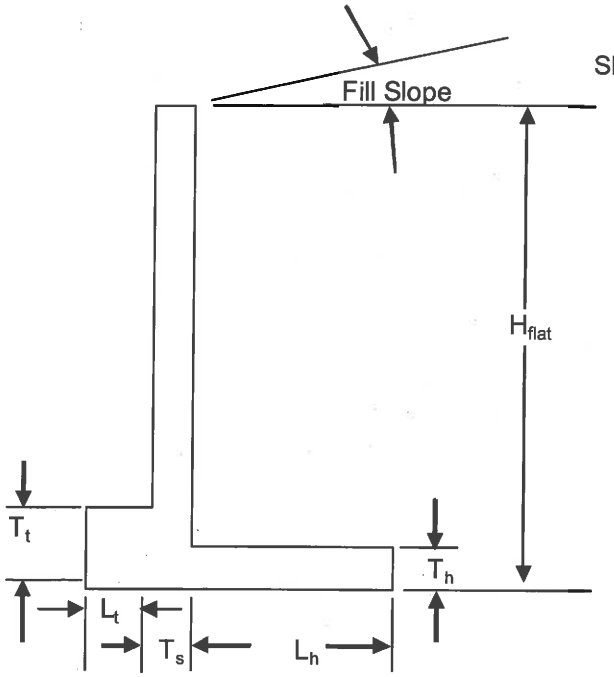
Wing Height $Ht_{wingMax} := 8.0 \cdot ft$

Wing Angle $Ang_{wing} := 45.deg$ $Slope_{wing} := \beta \cdot \cos\left(Ang_{wing}\right)$ $Slope_{wing} = 18.784 \cdot deg$

Wing Length $Len_{wing} := 15.0ft$ $Ht_1 := Ht_{wingMax} - Len_{wing} \cdot \tan\left(Slope_{wing}\right)$ $Ht_1 = 2.898\,ft$

Wing Ht (min) $Ht_{wingMin} := 2.17ft$ $Ht_{wingAvg} := \left(\frac{Ht_{wingMax} + Ht_{wingMin}}{2}\right)$ Θ

CP&P Salem




$L_h := 26in$ $T_h := 8in$ $T_s := 8in$ $L_t := 14in$ $T_t := 8in$ $\Theta$

$Ht_{wing} := Ht_{wingAvg} + LL_s$

$Ht_{wing} = 5.085\,ft$

Stability Data- (per Unit foot)

$W_{toe} := L_t \cdot T_t \cdot \gamma c$ $W_{stem} := T_s \cdot Ht_{wing} \cdot \gamma c$ $W_{heel} := T_h \cdot L_h \cdot \gamma c$

$W_{sheel} := L_h \cdot (Ht_{wing} - T_h) \cdot \gamma s$ $W_{sfsl} := \left(\frac{L_h}{Slope_{fill}}\right) \cdot \frac{L_h}{2} \cdot \gamma s$

$l_{toe} := \frac{L_t}{2}$ $l_s := L_t + \frac{T_s}{2}$ $l_h := L_t + T_s + \frac{L_h}{2}$

$l_{sheel} := L_t + T_s + \frac{L_h}{2}$ $l_{sfsl} := L_t + T_s + \frac{2 \cdot L_h}{3}$ $B := L_h + T_s + L_t$ $B = 4\,ft$

## Lateral Load Calculations-

### Stability Calculations-

$W_{toe} = 0.117 \cdot \frac{kip}{ft}$ $l_{toe} = 0.583\,ft$ $M_{toe} := W_{toe} \cdot l_{toe}$ $M_{toe} = 0.068 \cdot kip \cdot \frac{ft}{ft}$

$W_{stem} = 0.508 \cdot \frac{kip}{ft}$ $l_s = 1.5\,ft$ $M_{stem} := W_{stem} \cdot l_s$ $M_{stem} = 0.763 \cdot kip \cdot \frac{ft}{ft}$

$W_{heel} = 0.217 \cdot \frac{kip}{ft}$ $l_h = 2.917\,ft$ $M_h := W_{heel} \cdot l_h$ $M_h = 0.632 \cdot kip \cdot \frac{ft}{ft}$

$W_{sheel} = 1.149 \cdot \frac{kip}{ft}$ $l_{sheel} = 2.917\,ft$ $M_{sheel} := W_{sheel} \cdot l_{sheel}$ $M_{sheel} = 3.351 \cdot kip \cdot \frac{ft}{ft}$

$W_{sfsl} = 0.141 \cdot \frac{kip}{ft}$ $l_{sfsl} = 3.278\,ft$ $M_{sfsl} := W_{sfsl} \cdot l_{sfsl}$ $M_{sfsl} = 0.462 \cdot kip \cdot \frac{ft}{ft}$

$W_{sum} := W_{toe} + W_{stem} + W_{heel} + W_{sheel} + W_{sfsl}$ $M_{sum} := M_{toe} + M_{stem} + M_h + M_{sheel} + M_{sfsl}$

$W_{sum} = 2.131 \cdot \frac{kip}{ft}$ $M_{sum} = 5.275 \cdot kip \cdot \frac{ft}{ft}$

$$P_s := \frac{\gamma s}{2} \cdot \left( Ht_{wing} + \frac{L_h}{Slope_{fill}} \right)^2 \cdot K_a \qquad P_s = 0.76 \cdot kip \div ft$$

$$P_{slide} := \frac{\gamma s}{2} \cdot \left[ \left( Ht_{wing} + \frac{L_h}{Slope_{fill}} \right)^2 \cdot K_a - (T_t)^2 \cdot K_p \right] \qquad P_{slide} = 0.68 \cdot kip \div ft$$

$$M_{ot} := \frac{P_s}{3} \cdot \left( Ht_{wing} + \frac{L_h}{Slope_{fill}} \right) \qquad M_{ot} = 1.563 \cdot kip \cdot ft \div ft$$

$$FOS_{sl} := \frac{W_{sum} \cdot \mu_s}{P_{slide}} \qquad FOS_{sl} = 1.567 \qquad ck$$

$$FOS_{Mot} := \frac{M_{sum}}{M_{ot}} \qquad FOS_{Mot} = 3.375 \qquad ck$$

**Bearing Pressure Calculations-**

$x1 := \frac{M_{sum}}{W_{sum}}$ $x1 = 2.475 \cdot ft$ $e_B := x1 - \frac{B}{2}$ $e_B = 0.475\,ft$

$\frac{B}{6} = 0.667\,ft$ $\frac{6e_B}{B} = 0.712$ ck

For Rectangular Pressure Distribution:

$q_{maxRect} := \frac{W_{sum}}{B}$ $q_{maxRect} = 0.533 \cdot ksf$ Not Applicable

For Triangular Pressure Distribution:

$q_{maxTri} := \frac{2 \cdot W_{sum}}{B}$ $q_{maxTri} = 1.066 \cdot ksf$ Not Applicable

For Trapezoidal Pressure Distribution: Design Case

$q_{maxTrap} := \frac{W_{sum}}{B} \cdot \left(1 + \frac{6e_B}{B}\right)$ $q_{maxTrap} = 0.912 \cdot ksf$

$q_{max} := q_{maxTrap}$ $q_{max} = 0.912 \cdot ksf$ ck

$q_{min} := \frac{2W_{sum}}{B} - q_{max}$ $q_{min} = 0.153 \cdot ksf$

$q_{stem} := q_{max} - \frac{L_t}{B}(q_{max} - q_{min})$ $q_{stem} = 0.691 \cdot ksf$

$q_{toe} := \frac{q_{max} + q_{stem}}{2}$ $q_{toe} = 0.802 \cdot ksf$

**Stress Calculations-**

$f_y := 60ksi$

$f_c := 4ksi$ $fc := f_c \cdot psi$ Θ

**Toe -**

$d_{bt} := 0.5in$ $Sl_{Toe} := 8in$ Θ

$d_t := \left(T_t - C_c - \frac{d_{bt}}{2}\right)$ $d_t = 6.25 \cdot in$

$A_{sToe} := \pi \cdot \left(\frac{d_{bt}}{2}\right)^2 \cdot \frac{b}{Sl_{Toe}}$ $A_{sToe} = 0.295 \cdot in^2$

Shear at Toe -

$V_{uToe} := L_t \cdot DLF_s \cdot q_{toe} - DLF \cdot W_{toe} + DLF_s \cdot L_t \cdot (D_s - T_t)\gamma s$ $V_{uToe} = 1.251 \cdot kip \div ft$

$\phi Vc_t := \phi_s \cdot d_t \cdot 2\sqrt{(fc)}$ $(\phi Vn)$ $\phi Vc_t = 8.538 \cdot kip \div ft$ ck

Moment at Bottom of Toe -

$M_{uToe} := V_{uToe} \cdot \frac{L_t}{2}$ $M_{uToe} = 0.73\,ft \cdot kip \div ft$

$\phi M_{nToe} := \frac{\phi_f \cdot A_{sToe} \cdot f_y}{12in} \cdot \left(d_t - \frac{0.59 \cdot A_{sToe} \cdot f_y}{f_c \cdot ft}\right)$ $\phi M_{nToe} = 8.884 \cdot ft \cdot kip \div ft$ ck

Check Minimum Steel -

$A_{sToeMin} := 0.0018 \cdot T_t$ $A_{sToeMin} = 0.173 \cdot in^2 \div ft$ $A_{sToe} = 0.295\,ft \cdot in^2 \div ft$ ck

Use #4 Bars @ 8" C/C - Bottom of Toe

Use #4 Bars @ 8" C/C - Top of Toe -

**Heel** -

$d_{bh} := 0.5in$ $Sl_{Heel} := 8in$

$d_{heel} := \left(T_h - C_c - \frac{d_{bh}}{2}\right)$ $d_{heel} = 6.25 \cdot in$

$A_{sHeel} := \pi \cdot \left(\frac{d_{bh}}{2}\right)^2 \cdot \frac{b}{Sl_{Heel}}$ $A_{sHeel} = 0.295 \cdot in^2$

$V_{uHeel} := DLF_s \cdot W_{sheel} + DLF_s \cdot W_{sfsl}$ $V_{uHeel} = 1.934 \cdot kip \div ft$

$\phi Vc_h := \phi_s \cdot d_{heel} \cdot 2\sqrt{(fc)}$ $(\phi Vn)$ $\phi Vc_h = 8.538 \cdot kip \div ft$ ck

Moment at Top of Heel -

$M_{uHeel} := DLF_s \cdot W_{sheel} \cdot \frac{L_h}{2} + DLF_s \cdot W_{sfsl} \cdot \left(\frac{2 \cdot L_h}{3}\right)$ $M_{uHeel} = 2.172 ft \cdot kip \div ft$

$\phi M_{nHeel} := \frac{\phi_f \cdot A_{sHeel} \cdot f_y}{12in} \cdot \left(d_{heel} - \frac{0.59 \cdot A_{sHeel} \cdot f_y}{f_c \cdot ft}\right)$ $\phi M_{nHeel} = 8.884 \cdot ft \cdot kip \div ft$ ck

Moment at Bottom of Heel - (Handling)

$M_{uHeelBot} := 2.5 \cdot \left(W_{toe} + W_{stem} + W_{heel}\right) \cdot \frac{B}{2}$ $M_{uHeelBot} = 4.209 ft \cdot kip \div ft$

$\phi M_{nHeelBot} := \frac{\phi_f \cdot A_{sHeel} \cdot f_y}{12in} \cdot \left(d_{heel} - \frac{0.59 \cdot A_{sHeel} \cdot f_y}{f_c \cdot ft}\right)$ $\phi M_{nHeelBot} = 8.884 ft \cdot kip \div ft$ ck

Check Minimum Steel -

$A_{sheelMin} := 0.0018 \cdot T_h$ $A_{sheelMin} = 0.173 \cdot in^2 \div ft$ $A_{sHeel} = 0.295 \cdot in^2$ ck

Use #4 Bars @ 8" C/C - Top of Heel

Use #4 Bars @ 8" C/C - Bottom of Heel

**Stem-**

$d_{bs} := 0.5in$ $Sl_{Stem} := 8in$

$d_{stem} := \left(T_s - C_c - \frac{d_{bs}}{2}\right)$ $d_{stem} = 6.25 \cdot in$

$A_{sStem} := \pi \cdot \left(\frac{d_{bs}}{2}\right)^2 \cdot \frac{b}{Sl_{Stem}}$ $A_{sStem} = 0.295 \cdot in^2$

$V_{uStem} := DLF_s \cdot P_s$ $V_{uStem} = 1.14 \cdot kip \div ft$

$\phi Vc_s := \phi_s \cdot d_{stem} \cdot 2\sqrt{(fc)}$ $(\phi Vn)$ $\phi Vc_s = 8.538 \cdot kip \div ft$ ck

Moment at Back of Stem-

$M_{uStem} := DLF_s \cdot M_{ot}$ $M_{uStem} = 2.345 ft \cdot kip \div ft$

$\phi M_{nStem} := \frac{\phi_f \cdot A_{sStem} \cdot f_y}{12in} \cdot \left(d_{stem} - \frac{0.59 \cdot A_{sStem} \cdot f_y}{f_c \cdot ft}\right)$ $\phi M_{nStem} = 8.884 ft \cdot kip \div ft$ ck

Moment at Front of Stem- (Hydrostatic) $DLF_w := 1.0$

$M_{uStemFr} := DLF_w \cdot \left(\frac{62.4pcf}{2 \cdot 3}\right) \cdot \left(Ht_{wingAvg}\right)^3$ $M_{uStemFr} = 1.367 ft \cdot kip \div ft$

$\phi M_{nStemFr} := \frac{\phi_f \cdot A_{sStem} \cdot f_y}{12in} \cdot \left(d_{stem} - \frac{0.59 \cdot A_{sStem} f_y}{f_c \cdot ft}\right)$ $\phi M_{nStemFr} = 8.884 ft \cdot kip \div ft$ ck

Check Minimum Steel - Temperature and Shrinkage -

$A_{stemMin} := 0.0018 \cdot T_s$ $A_{stemMin} = 0.173 \cdot in^2 \div ft$ $A_{sStem} = 0.295 \cdot in^2$ ck

Use #4 Bars @ 8" C/C - Vertical Back of Stem

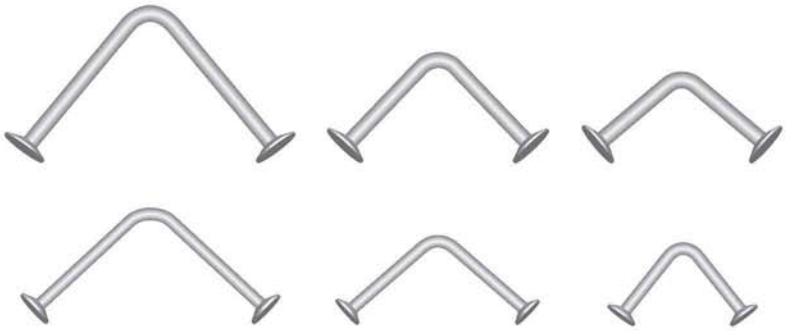
Use #4 Bars @ 8" C/C - Front of Stem

Use #4 Bars @ 12" C/C - Longitudinals (Or Alt. W6.7 @ 4" WWR)

# **UTILITY LIFT ANCHOR** LIFTING SYSTEM

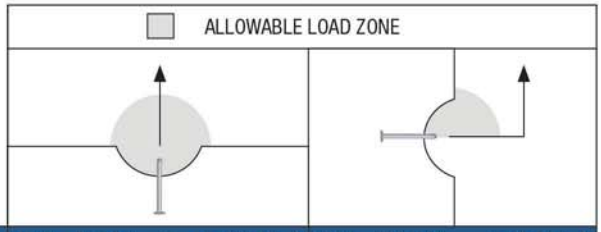


## UTILITY LIFT ANCHORS



Anchors available in two wire diameters: **14MM 18MM**

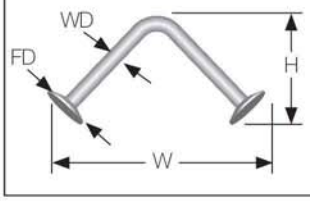
Standard Finish is Hot-Dip Galvanized




### ANCHOR CAPACITIES

| Product Code | Edge Distance | Slab Min. Thickness | SWL at 90° Tension 4:1 SF (lbs) | SWL at 90° Shear 4:1 FS (lbs) |
|---|---|---|---|---|
| LUL414G | 9" | 4" | 3,500 | 5,400 |
| LUL514G | 10" | 5" | 5,500 | 8,500 |
| LUL518G | 10" | 5" | 6,000 | 9,300 |
| LUL614G | 12-1/2" | 6" | 6,500 | 10,100 |
| LUL618G | 12-1/2" | 6" | 7,500 | 11,600 |
| LUL818G | 15-1/2" | 8" | 13,000 | 20,000 |

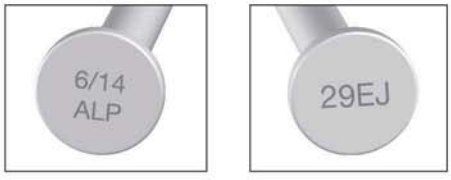
### TECHNICAL SPECIFICATIONS

| Utility-Lift Anchor | Product Code | Anchor Identification | Typical Slab Thickness | WD - Wire Diameter | W- Width | H - Height | FD - Foot Diameter |
|---|---|---|---|---|---|---|---|
|  | LUL414G | 4/14 | 4" | 14MM | 6-5/6" | 3-1/8" | 1-3/16" |
| | LUL514G | 5/14 | 5" | 14MM | 8-1/4" | 3-3/4" | 1-3/16" |
| | LUL518G | 5/18 | 5" | 18MM | 8-5/8" | 3-3/4" | 2" |
| | LUL614G | 6/14 | 6" | 14MM | 10-1/2" | 4-3/4" | 1-9/16" |
| | LUL618G | 6/18 | 6" | 18MM | 9-1/16" | 4-3/4" | 2" |
| | LUL818G | 8/18 | 8" | 18MM | 12-1/4" | 6-3/4" | 2" |

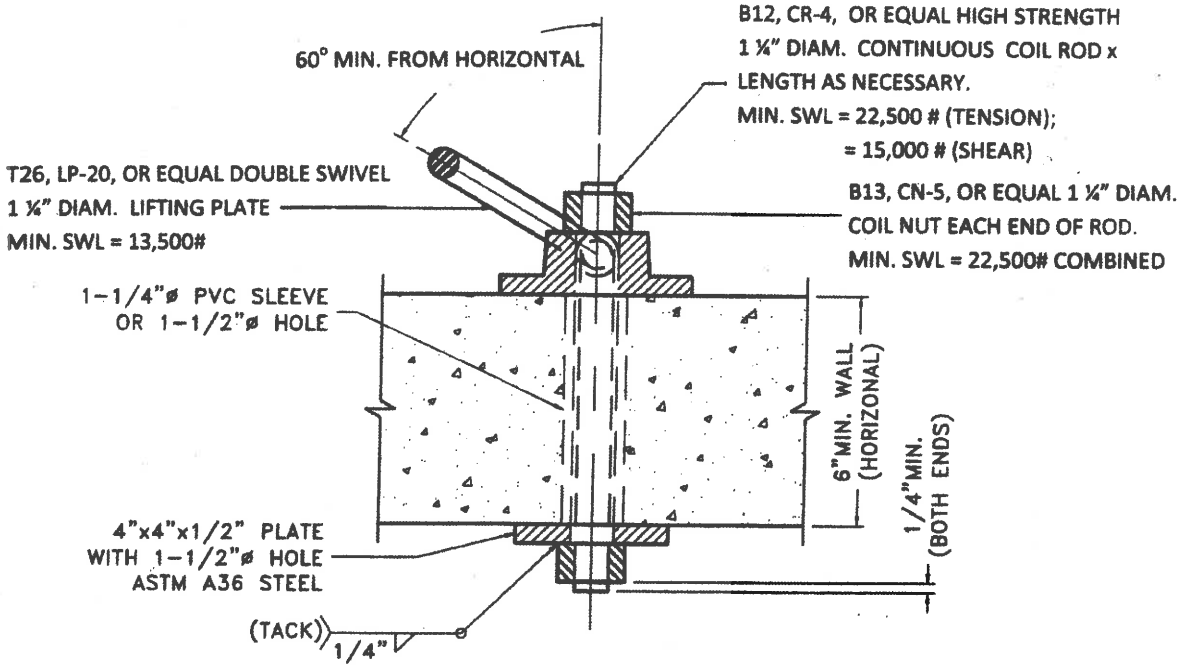


Note: Safe Working Load provides a factor of safety of approximately 4:1. Table is based on a minimum concrete compressive strength of 4,000 psi. When using as a Pulling Iron, loads from this chart may be increased by 33% from a 4:1 safety factor to a 3:1 safety factor.

### FOOT MARKINGS




Anchor Identification | Lot Number




# LIFT PLATE ASSEMBLY DETAIL

NOTES

1. MIN CONCRETE COMPRESSIVE STRENGTH TO BE 4000 PSI CONCRETE BEFORE LIFTING.
2. MINIMUM EDGE DISTANCE 18".
3. MIN. SWL = MINIMUM SAFE WORKING LOAD PER MANUFACTURER.

CP&P
CONCRETE PIPE & PRECAST, LLC



CRL - 3/30/2015

ConSeal™ Concrete Sealants INC.

# CS102

**Butyl Rubber Sealant For All Precast Structures; Meets Specs.**

## APPLICATIONS

For self-sealing joints in: Manholes, Concrete Vaults, Septic Tanks, Concrete Pipe, Box Culverts, Utility Vaults, Burial Vaults, and Vertical Panel Structures.

## SEALING PROPERTIES

- Provides permanently flexible watertight joints.
- Low to high temperature workability: 30°F to 120°F (-1°C to 48°C)
- Rugged service temperature: -30°F to +200°F (-34°C to +93°C)
- Excellent chemical and mechanical adhesion to clean, dry surfaces.
- Sealed Joints will not shrink, harden or oxide upon aging.
- No priming normally necessary. When confronted with difficult installation conditions, such as wet concrete or temperatures below 40°F (4°C), priming the concrete will improve the bonding action. Consult Concrete Sealants for the proper primer to meet your application.

## HYDROSTATIC STRENGTH

ConSeal CS-102 meets the hydrostatic performance requirement as set forth In ASTM C-990 section 10.1 (Performance requirement: 10psi for 10 minutes in straight alignment – in plant, quality control test for joint materials.)

## SPECIFICATIONS

ConSeal CS-102 meets or exceeds the requirements of Federal Specification SS-S-210 (210-A), AASHTO M-198B, and ASTM C-990-91.



P.O. Box 176, New Carlisle OH, 45344 • 937.845.8776 or 800.332.7325
FAX 937-845-3587 • www.conseal.com

ConSeal™ Concrete Sealants INC.

# CS102

**Butyl Rubber Sealant For All Precast Structures; Meets Specs.**

## PHYSICAL PROPERTIES

| | Spec | Required* | CS 102 |
|---|---|---|---|
| Hydrocarbon blend content % by weight | ASTM D4 (mod.) | 50% min. | 51% |
| Inert mineral filler % by weight | AASHTO T111 | 30% min. | 35% |
| Volatile Matter % by weight | ASTM D6 | 2% max. | 1.2 |
| Specific Gravity, 77°F | ASTM D71 | 1.15-1.50 | 1.25 |
| Ductility, 77°F | ASTM D113 | 5.0 min. | 10 |
| Penetration, cone 77°F, 150 gm. 5 sec. | ASTM D217 | 50-100 | 55-60 |
| Penetration, cone 32°F, 150 gm. 5 sec. | ASTM D217 | 40 mm | 40-65 |
| Flash Point, C.O.C., °F | ASTM D92 | 350°F min. | 450°F |
| Fire point, C.O.C., °F | ASTM D92 | 375°F min. | 475°F |

## IMMERSION TESTING

- 30-Day Immersion Testing: No visible deterioration when tested in 5% Caustic Potash, 5% Hydrochloric Acid, 5% Sulfuric Acid, and 5% saturated Hydrogen Sulfide. *

- One Year Immersion Testing: No visible deterioration when tested in 5% Formaldehyde, 5% Formic Acid, 5% Sulfuric Acid, 5% Hydrochloric Acid, 5% Sodium Hydroxide, 5% Hydrogen Sulfide and 5% Potassium Hydroxide.

- Requirements of ASTM C-990 Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.





P.O. Box 176, New Carlisle OH, 45344 • 937.845.8776 or 800.332.7325
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# Mar Mac Mac Wrap...

## Mac Wrap External Collar

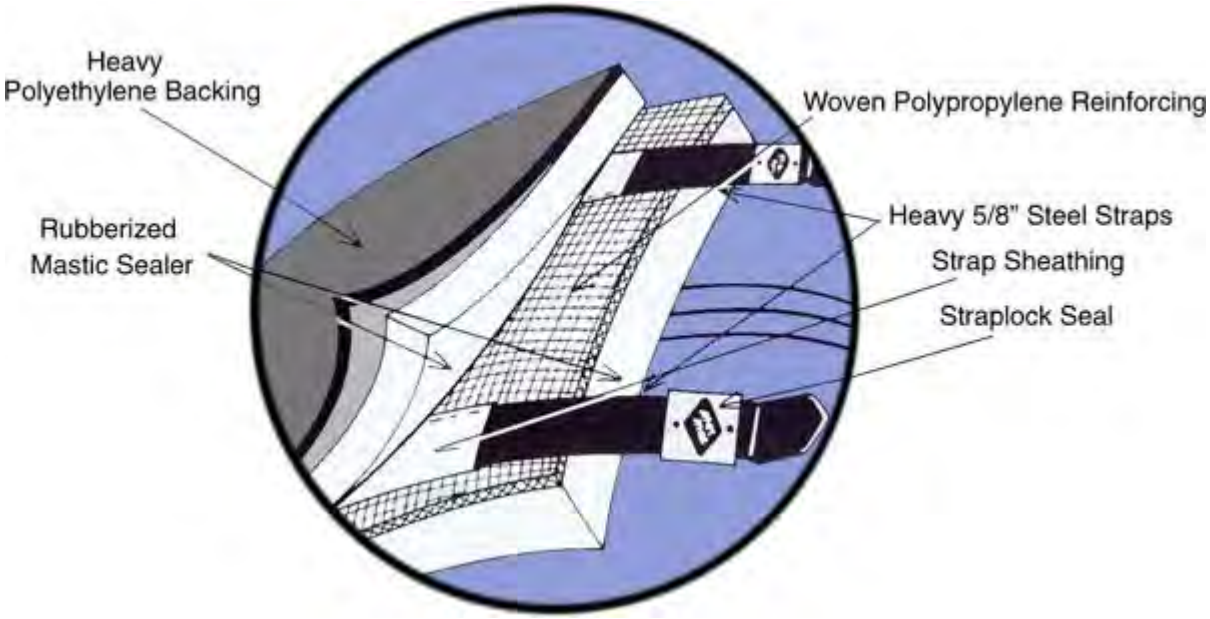
### High-Strength Waterproofing Applications

Mac Wrap is a proven industry leader in watertight solutions for concrete joints. In fact, Mac Wrap has performed so well over the last 25 years that it has set standards for manufacturing and application for external joint wraps.

Mac Wrap is a custom-fit, full perimeter seal that exceeds ASTM C-877 standards for Type II joints and passes the ASTM C-1244 vacuum test. For more information on ASTM standards, click here...

Mac Wrap is a trusted waterproofing solution that was developed when working in conjunction with

federal, state, municipal and private engineers to meet tough infiltration specifications. *Mac Wrap is used nationwide for repair and new installation projects even when the jointing method is not specified.*




Mac Wrap incorporates high-strength, shear and puncture resistant internal reinforcing fabric with an impervious, chemical resistant cross-laminated polyethylene outer cover for optimal performance. Mac Wrap is so durable it will allow the use of joints damaged in handling that would otherwise be unusable.

For assurance of permanent, flexible, soil and watertight joints, securing straps are engineered within the coupler to perform as hose clamps, securing the seal against infiltration.

For details on **how to apply** the collar, click here

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Mar Mac Mac Wrap...