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

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

WE ARE SENDING:

- [ ] Quote
- [x] Details
- [ ] Other: ______________
- [x] Submittals
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- [ ] Plans
- [ ] Specifications
- [ ] Copy Of Letter
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Copies	Date	Pages	Description
1	2/13/2015	1	Cover Page
1	2/12/2015	22	Box Culvert Calculations
1	2/13/2015	19	WingWalls with Bin Anchor Calculations

These Are Submitted as Checked Below:

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- [ ] Other:

Notes/Remarks:

Sam,

Please pass on for approvals.

Thank you.

Eric Barendse x265

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

Stantec

Date: 3/09/2015

By: Michael J. Chenette

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

Copy To: ____________________

Signed: Eric Barendse

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

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

GARY K. MUNKELT & ASSOCIATES

Consulting Engineers
Precast Concrete, Structural, Civil

1180 Welsh Rd. Suite 190 North Wales, PA 19454

PROJECT: **DESIGN 2 PIECE BOX CULVERT**
20 FOOT SPAN X 10 FOOT RISE

CLIENT: **S. D. IRELAND**
WILLISTON, VT

LOCATION: **BRIDGE NO. 2 (STA 12 + 82.2)**
STATE OF VERMONT PROJECT - STP. CULV 29
BRIDPORT, VT

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

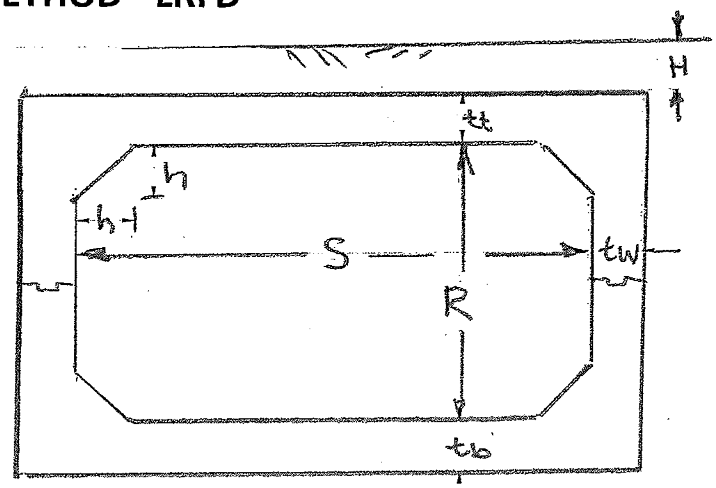
2/12/15

TABLE OF CONTENTS

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

INPUT SHEET:

DESIGN METHOD - LRFD



Span (S) = 20.0 ft.
Rise (R) = 10.0 ft
Top Slab Thickness (tt) = 15 in. ok
Wall Thickness (tw) = 12 in.
Bottom Slab Thickness (tb) = 15 in.
Haunch (h) = 9 in.

Soil Cover (H) = 2 ft.

Wearing Surface = 20 psf
Soil Weight (ws) = 120 pcf
Concrete weight (wc) = 150 pcf
Concrete Capacity in Compression (f'c) = 5000 psi
Reinforcing Steel Yield Strength (fy) = 65000 psi 60 ksi?

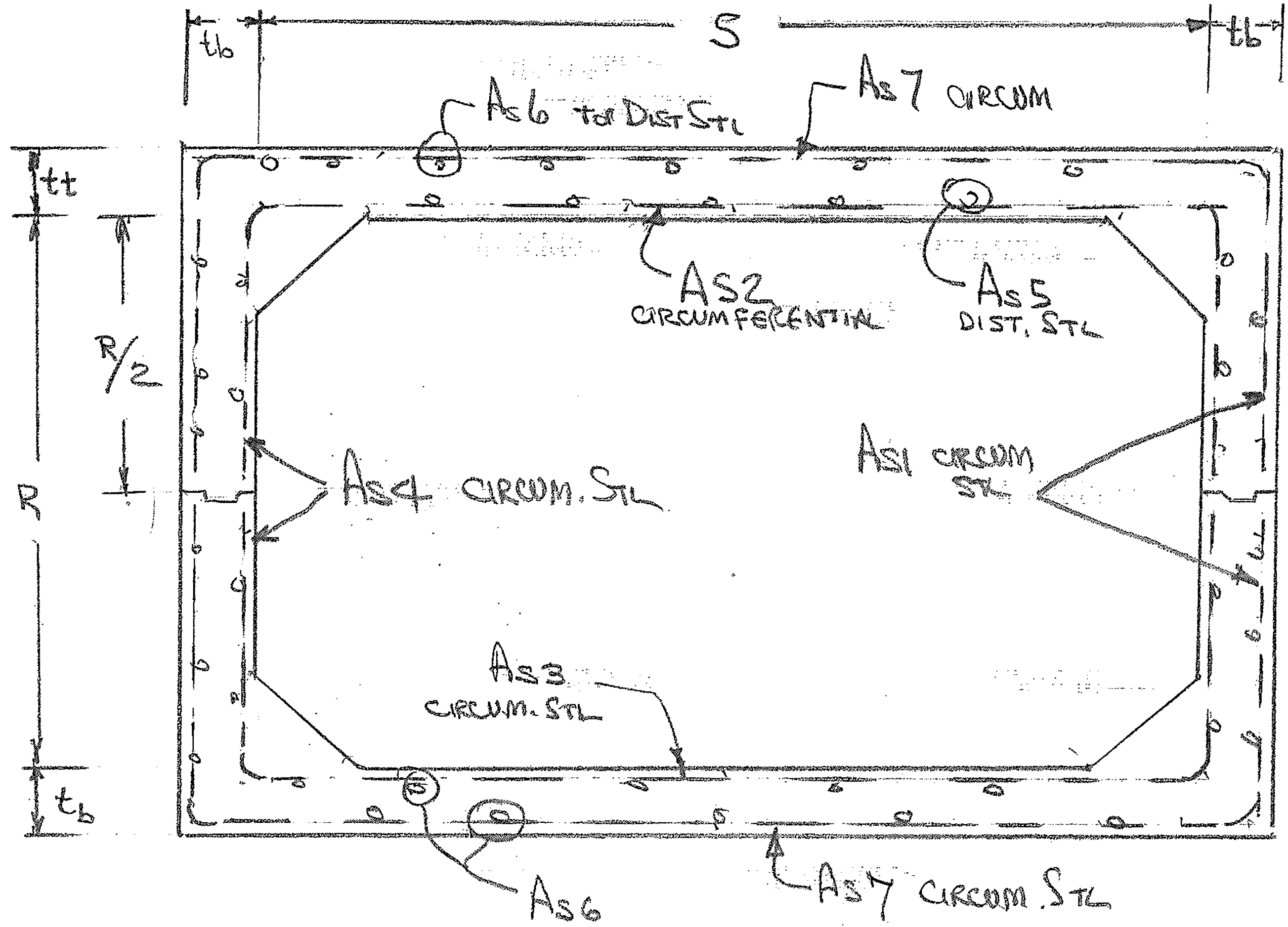
Live Load (LL) = HL93
Lane load not required per Reference 1 Section 3.6.1.3.3

Lateral Load From Soil on Walls
Minimum = 30 pcf
Maximum = 60 pcf

Cover on Rebar:
Top Slab Outside c1 = 2 in.
Top Slab Inside c2 = 1 in.
Walls In & Out c3 = 1 in.
Bottom Slab In & Out c4 = 1 in.

beam width, b = 12 in.
Dia. of rod, Dr = 0.25 in. 0.5" for #4

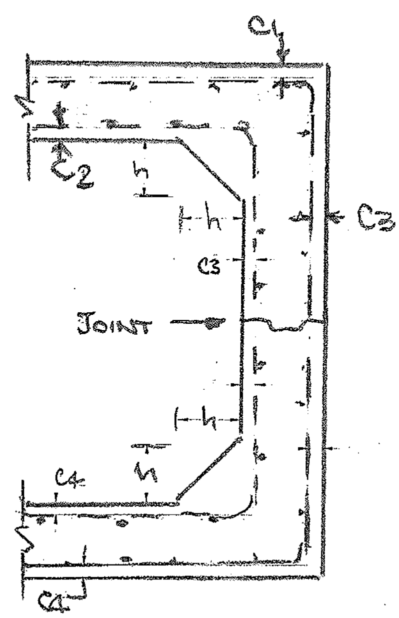
Description of Product



	SUPPLIED	REQ'D		
A_{s1}	0.30	0.29	in^2	ok
A_{s2}	1.80	1.40	in^2	ok
A_{s3}	1.20	1.00	in^2	ok
A_{s4}	0.30	0.15	in^2	ok
A_{s5}	0.46	0.46	in^2	ok
A_{s6}	0.46	0.35	in^2	ok
A_{s7}	0.30	0.29	in^2	

Number of Layers
of Reinforcing Steel:
2

Spacing of
Longitudinal Steel:
8 in. ok



DESIGN NOTES:

1. BOX CULVERT IS DESIGNED TO WITHSTAND AASHTO HL93 (DESIGN TRUCK OR DESIGN TANDEM) LOADS USING LRFD DESIGN
2. LIFTING INSERTS FOR HANDLING TO BE AS RECCOMMENDED BY INSERT MANUFACTURER

PROBLEM: Discuss Load Factors

This page contains load factors that are required by AASHTO Tables 3.4.1-1 and 3.4.1-2. In some cases more conservatism is required and the numbers below will be different.

Section 3.4.1 Total Factored Force effect shall be $Q = \Sigma (\eta \Upsilon Q)$

Where: η = load modifier

Q = force effects

Υ = load factors

Section 1.3.2 Load Modifiers: $\eta = \eta_D \ \eta_R \ \eta_F$

Where: η_D = 0.95 for ductile components

η_R = 0.95 for redundant members

η_F = 1.00 for operational importance

η = 0.90 use 1.0

Tables 3.4.1-1 & 3.4.1-2 Applicable Load Factors:

LOAD FACTOR DESIGNATION	MAX FACTOR	MIN FACTOR	
DC	1.25	0.90	(Component Dead Load)
DW	1.50	0.65	(Wearing Surface Dead Load)
EH (active)	1.50	0.90	(Horizontal Earth Pressure)
EV	1.30	0.90	(Vertical Earth Pressure)
ES	1.50	0.75	(Earth Surcharge)
LLF	1.75	-NA-	(Vehicular Live Load)
IMF	1.75	-NA-	(Impact)
LSF	1.75	-NA-	(Live Load Surcharge)

12.11.2.1 Soil Interaction Factor (F) = 1 + (0.2 * H) / (S + 2 * tw)

$F \leq$ 1.15 for Compacted Fill

Table 12.5.5-1 Resistance Factors:

For Precast Box Structures

ϕ_v = 0.9 for shear

ϕ_f = 1.0 for flexure

For Precast 3 Sided Structures

ϕ_v = 0.95 for shear

ϕ_f = 0.9 for flexure

Section 1.3.2 Limit States

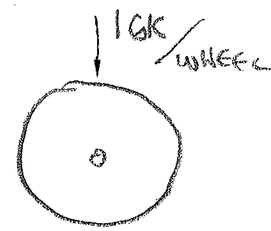
1. Strength Limit States - Use Load Factors listed above.
2. Service Limit State - Use Load Factors = 1

PROBLEM: Find Moment/Shear on Top Slab for DL (Slab + Earth) + LL
For Strength Limit State

HL93 TRUCK 32K/AXLE

S = 20.0 ft. h = 9 in. tt = 15 in.

LL = 32,000 lb/axle



Soil weight (ws) = 120 pcf
Concrete weight (wc) = 150 pcf
Soil Cover (D_E) for IM = 0 ft.
Soil Cover (H) for DL = 2 ft.

See Page 4 for Load Factor Designation and Values and Soil Interaction Factor (F).

AASHTO SUGGESTS FOR 0 -2 ft. COVER THAT WHEEL LOAD BE APPLIED AS A CONCENTRATED LOAD SPREAD OVER A WIDTH OF:

Formula 4.6.2.10.2-1 (Reference 1)

E per axle = (96+ 1.44 S) / 12 = 10.4 ft.

For IMPACT use Formula 3.6.2.2-1 (Reference 1)

IM = 33 (1-0.125 D_E) = 33%

For Multiple Presence Factor use m = 1.2 (Section 4.6.2.10.2)

CONCENTRATED LOAD (LL)

Pu = LLF * m (32,000 lb * (1 + IM/100)) / E =
1.75 * 1.2 (32,000 * (1 + 33/100)) / 10.4 = 8594 lb

UNIFORM LOAD (DL)

Wu = EV (H * ws * F) + DC ((tt/12) * wc)) + DW * Wearing Surface
.3 (2 * 120 * 1 + (0.2 * H) / (S + 2 * tw)) + 1.25 ((15/12) *150)) + 1.5 * 20 = 623 psf

FROM AASHTO BRIDGE DESIGN MANUAL:

SPAN FOR POSITIVE MOMENT = **S2** = S - 2[(h/12)-(0.5*(tt/12))] = 19.75 ft.

WORST CASE IS 16K WHEEL AT MIDSPAN:

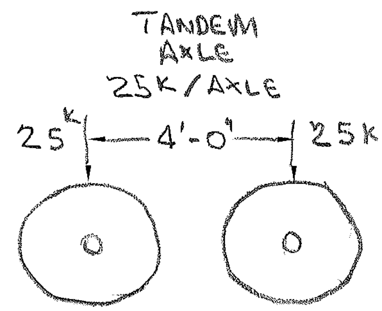
Mu+ = ((Wu * $S2^2$)/8000) + ((Pu * S2)/4000) = **72.8 K.ft.**

VERTICAL SHEAR AT SUPPORT:

Vu = (Wu * (S/2)) + (Pu / 2) = **10529 lb**

PROBLEM: Find Moment/Shear on Top Slab for DL (Slab + Earth) + LL
For Strength Limit State

S = 20.0 ft. h = 9 in. tt = 15 in.



LL = Tandem Axle @ 25,000 lb/axle

USE 2 WHEELS 4 ft. CENTER TO CENTER

Soil weight (ws) = 120 pcf
Concrete weight (wc) = 150 pcf
Soil Cover (D_E) for IM = 0 ft.
Soil Cover (H) for DL = 2 ft.

See Page 4 for Load Factor Designation and Values and Soil Interaction Factor (F).

AASHTO SUGGESTS FOR 0 -2 ft. COVER THAT WHEEL LOAD BE APPLIED AS A CONCENTRATED LOAD SPREAD OVER A WIDTH OF:

Formula 4.6.2.10.2-1 (Reference 1)

E per axle = (96+ 1.44 S) / 12 = 10.4 ft.

For IMPACT use Formula 3.6.2.2-1 (Reference 1)

IM = 33 (1-0.125 D_E) = 33%

For Multiple Presence Factor use m = 1.2 (Section 4.6.2.10.2) (Reference 1)

<u>CONCENTRATED LOAD (LL)</u>

Pu = LLF * m (25,000 lb * (1 + IM/100)) / E =
1.75 * 1.2 (25,000 * (1 + 33/100)) / 10.4 = 6714 lb

<u>UNIFORM LOAD (DL)</u>

Wu = EV (H * ws * F) + DC ((tt/12) * wc)) + DW * Wearing Surface
= 1.3 (2 * 120 * 1 + (0.2 * H) / (S + 2 * tw)) + 1.25 ((15/12) * 150)) + 1.5 * 20 = 623 psf

FROM AASHTO BRIDGE DESIGN MANUAL:

SPAN FOR POSITIVE MOMENT = **S2** = S - 2[(h/12) - (0.5(tt/12))] = 19.75 ft.

WORST CASE IS CENTERLINE of TANDEM AXLE AT MIDSPAN:

Mu+ = ((Wu * $S2^2$)/8000) + ((Pu * ((S2/2) - 2))/1000) = **83.3 K.ft.**

VERTICAL SHEAR AT SUPPORT:

Vu = (Wu * (S/2)) + Pu = **12946 lb**

PROBLEM: Find Moment/Shear on Walls for Single Axle & Tandem Truck
For Strength Limit State

LATERAL PRESSURE FROM LIVE LOAD SURCHARGE (LS) - Formula 3.11.6.4-1

$\Delta_p = k * \gamma_s * heq$

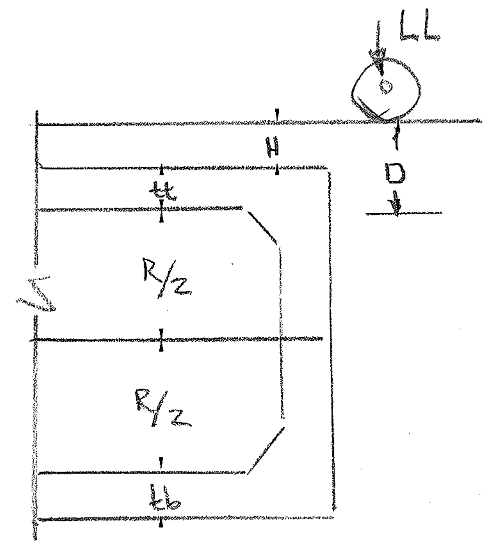
where, k = ka = 0.33

γ_s = ws = 120 pcf

heq = 2.6

Δp = 0.33 * 120 * 2.6 = 103 psf

LATERAL PRESSURE FROM SOIL (DL) = 60 pcf



R/2 = 5.0 ft.

TO GET MAXIMUM MOMENT / SHEAR ON WALLS

$p = (LSF * \Delta_p + EH * DL * D)\ F$

AT TOP SLAB TO WALL CONNECTION (a) D = 3.3 ft.

p_a =1.75 * 103 + 1.5 * 60 * 3.25) * 1 + (0.2 * H) / (S + 2 * tw) = 544 psf

AT JOINT (b) D = 8.3 ft.

p_b =1.75 * 103 + 1.5 * 60 * 8.25) * 1 + (0.2 * H) / (S + 2 * tw) = 1061 psf

AT BOTTOM SLAB TO WALL CONNECTION (c) D = 13.3 ft.

p_c = 75 * 103 + 1.5 * 60 * 13.25) * 1 + (0.2 * H) / (S + 2 * tw) = 1579 psf

<u>MAXIMUM MOMENT AT POINT "a" IN TOP SECTION</u>

AVERAGE ULT. LOAD = p_{ab} = (544 + 1061) / 2 = 802 psf

Mu- @ a = - $p_{ab} * (R/2)^2 / 2000$ = **-10.0 K.ft.**

Vu @ a = p_{ab} * (R/2) = **4012 lb**

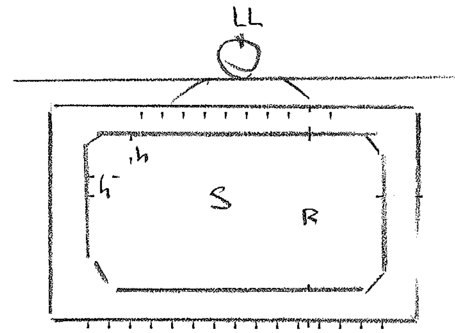
<u>MAXIMUM MOMENT AT POINT "c" IN BOTTOM SECTION</u>

AVERAGE ULT. LOAD = p_{cb} = (1061 + 1579) / 2 = 1320 psf

Mu- @ c = - $p_{cb} * (R/2)^2 / 2000$ = **-16.5 K.ft.**

Vu @ c = p_{cb} * (R/2) = **6599 lb**

PROBLEM: Find Moment/Shear on Bottom Slab for HL93 Truck
For Strength Limit State



Pu from Sheet 5 = 8594 lb

Wu = DL (Top Slab + Earth) from Sheet 5 = 623 psf

S =	20.0 ft.	tw =	12 in.
R =	10.0 ft.	tb =	15 in.
wc =	150 pcf	h =	9 in.

Wu on Bottom Slab = Wu + [Pu / (S + (2 * (tw/12)))] + 1.25 *[(wc *2 (tw/12) * R) / (S + 2(tw/12))]
Wubs1 = 1184 psf

SPAN FOR POSITIVE MOMENT= S2 = S - 2[(h/12) - (0.5(tb/12))] = 19.75 ft.

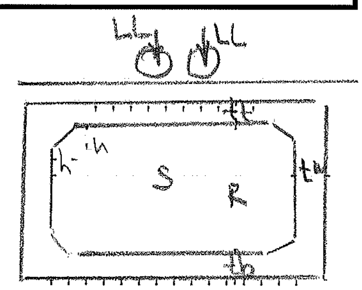
<u>MOMENT AT MIDSPAN</u>

Mu = + (Wubs1 * $S2^2$)/ 8000 = **57.7 K.ft.**

<u>SHEAR AT SUPPORT</u>

Vu = Wubs1 * S/2 = **11843 lb**

PROBLEM: Find Moment/Shear on Bottom Slab for Tandem Truck
For Strength Limit State



Pu from Sheet 6 = 6714 lb

Wu = DL (Top Slab + Earth) from Sheet 6 = 623 psf

Wu on Bottom Slab = Wu + [2 wheels * Pu / (S + (2 * (tw/12)))] + 1.25 *[(wc *2 (tw/12) * R) / (S + 2(tw/12))]
Wubs2 = 1404 psf

SPAN FOR POSITIVE MOMENT= S2 = S - 2[(h/12) - (0.5(tb/12))] = 19.75 ft.

<u>MOMENT AT MIDSPAN</u>

Mu = + (Wubs2 * $S2^2$)/ 8000 = **68.5 K.ft.**

<u>SHEAR AT SUPPORT</u>

Vu = Wubs2 * S/2 = **14040 lb**

PROBLEM: Determine Reinforcing Steel (Strength Limit State)

TOP SLAB MAXIMUM POSITIVE MOMENT (As2)

As2 = 1.40 in^2
tt = 15 in.
beam width, b = 12 in.
steel cover, c2 = 1 in.
Dia. of rod, Dr = 0.25 in.

Mu+ = **83.3 K.ft.** (Maximum Moment from Sheet 5 or Sheet 6)

Bar diameters do not match actual measurements

d = tt - c2 - Dr/2 = 13.875 in.
q = (fy / f'c) * (As2 / b*d) = 0.109
$\phi Mn = \phi_f * b * d^2 * f'c * q * (1 - 0.59 * q) / 12000 =$ **98.4 K.ft.** ok

WALL MAXIMUM NEGATIVE MOMENT (As1)(As7)(As8)

As1 = 0.29 in^2
tw = 12 in.
beam width, b = 12 in.
steel cover, c3 = 1 in.
Dia. of rod, Dr = 0.25 in.

Mu- = **-16.5 K.ft.** (Maximum Moment from Sheet 7)

d = tw - c3 - Dr/2 = 10.875 in.
q = (fy / f'c) * (As1 / b*d) = 0.029
$\phi Mn = \phi_f * b * d^2 * f'c * q * (1 - 0.59 * q) / 12000 =$ **-16.8 K.ft.** ok

BOTTOM SLAB MAXIMUM POSITIVE MOMENT (As3)

As3 = 1.00 in^2
tb = 15 in.
beam width, b = 12 in.
steel cover, c4 = 1 in.
Dia. of rod, Dr = 0.25 in.

Mu+ = **68.5 K.ft.** (Maximum Moment from Sheet 8)

d = tb - c4 - Dr/2 = 13.875 in.
q = (fy / f'c) * (As3 / b*d) = 0.078
$\phi Mn = \phi_f * b * d^2 * f'c * q * (1 - 0.59 * q) / 12000 =$ **71.7 K.ft.** ok

PROBLEM: Check Diagonal Shear in Top Slab (Strength Limit State)

USE SHEAR AT DISTANCE, d, FROM SUPPORT

d = tt - c2 - Dr/2 = 13.875 in.

Vu @ d from support = Vu (from sheet 5 or 6) - (d/12) * Wu = 12225 lb

$\phi Vn = \phi_v$ * 2 * SQRT(f'c) * b * d = **21192 lb** ok

PROBLEM: Check Diagonal Shear in Walls (Strength Limit State)

USE SHEAR AT DISTANCE, d, FROM SUPPORT

d = tw - c3 - Dr/2 = 10.875 in.

TOP SECTION

Vu @ d from support = Vu (from sheet 7) - (d/12) * pab = 3285 lb

$\phi Vn = \phi_v$ * 2 * SQRT(f'c) * b * d = **16610 lb** ok

BOTTOM SECTION

Vu @ d from support = Vu (from sheet 7) - (d/12) * pcb = 5403 lb

$\phi Vn = \phi_v$ * 2 * SQRT(f'c) * b * d = **16610 lb** ok

PROBLEM: Check Diagonal Shear in Bottom Slab (Strength Limit State)

USE SHEAR AT DISTANCE, d, FROM SUPPORT

d = tb - c4 - Dr/2 = 13.875 in.

Vu @ d from support = Vu (from sheet 8) - (d/12) * Wubs2 = 12417 lb

$\phi Vn = \phi_v$ * 2 * SQRT(f'c) * b * d = **21192 lb** ok

DISTRIBUTION STEEL (TRANSVERSE STEEL)

(As5) ≥ As2 * 1/SQRT(S) ≥ 0.31 in^2

but not more than 0.5 * As2 = 0.70 in^2 ok

$As_{REQD}5$ = 0.31 in^2 (Based on Distribution Steel)

TRANSVERSE STEEL (Walls) (As4) ≥ 0.10 in^2

TRANSVERSE STEEL (Slabs) (As6) ≥ 0.0018 * b * tt = 0.32 in^2 (Based on Temperature Steel)

11/05/12

Stress in Steel at Service Load - Top Slab (Service Limit State)

$fs \leq 36$ ksi

$P_{SERVICE}$ = Pu (From Sheet 5) / 1.75 = 4911 lb / wheel

M_{LL} = ($P_{SERVICE}$ * S2) / 4000 = 24.2 K.ft.

OR

$P_{SERVICE}$ = Pu (From Sheet 6) / 1.75 = 3837 lb / wheel

M_{LL} = $P_{SERVICE}$ ((S2/2) - 2) / 1000 = 30.2 K.ft.

$W_{SERVICE}$ = (H * ws) + ((tt/12) * wc) + Wearing Surface = 448 psf / ft.

M_{DL} = $W_{SERVICE}$ * $S2^2$ / 8000 = 21.8 K.ft.

Let n = ES / EC = 29,000,000 psi / 57,000 *SQRT(f'c) = 7.2

As2 = 1.40 in^2 S2 = 19.75 ft.

b = 12 in. d = 13.875 in.

pn = As2 * n / b * d = 0.060

k = SQRT((2 * pn) + (pn^2)) - pn = 0.293

j = 1 - k / 3 = 0.90

fs = 12 (M_{LL} + M_{DL}) / As2 * j * d = 36 ksi ok

Control of Cracking - Top Slab (Service Limit State)

Mimimum Thickness = (S + 10) / 30 = ((20ft. + 10) / 30) *12 in./ft. = 12.0 in. ok

Maximum Spacing of Reinforcing Rods:

$s \leqq (700 / (\beta_s * fs)) - 2 * d_c$

Where:

d_c = c2+ rod diameter / 2 = 1.125 in.

$\beta_s = 1 + d_c / (0.7 (tt - d_c))$ = 1.12

s = (700 / (1.12 * 36)) - (2 * 1.125) = 15 in. ok since greater than 8

Top Slab Minimum Flexural Reinforcing Steel (Strength Limit State)

M_r MUST BE GREATER THAN THE LESSER OF 1.2 M_{cr} OR 1.33Mu

M_r = ϕMn = 98.4 K.ft. (from Sheet 9)

Mu = 83.3 K.ft. (from Sheet 9)

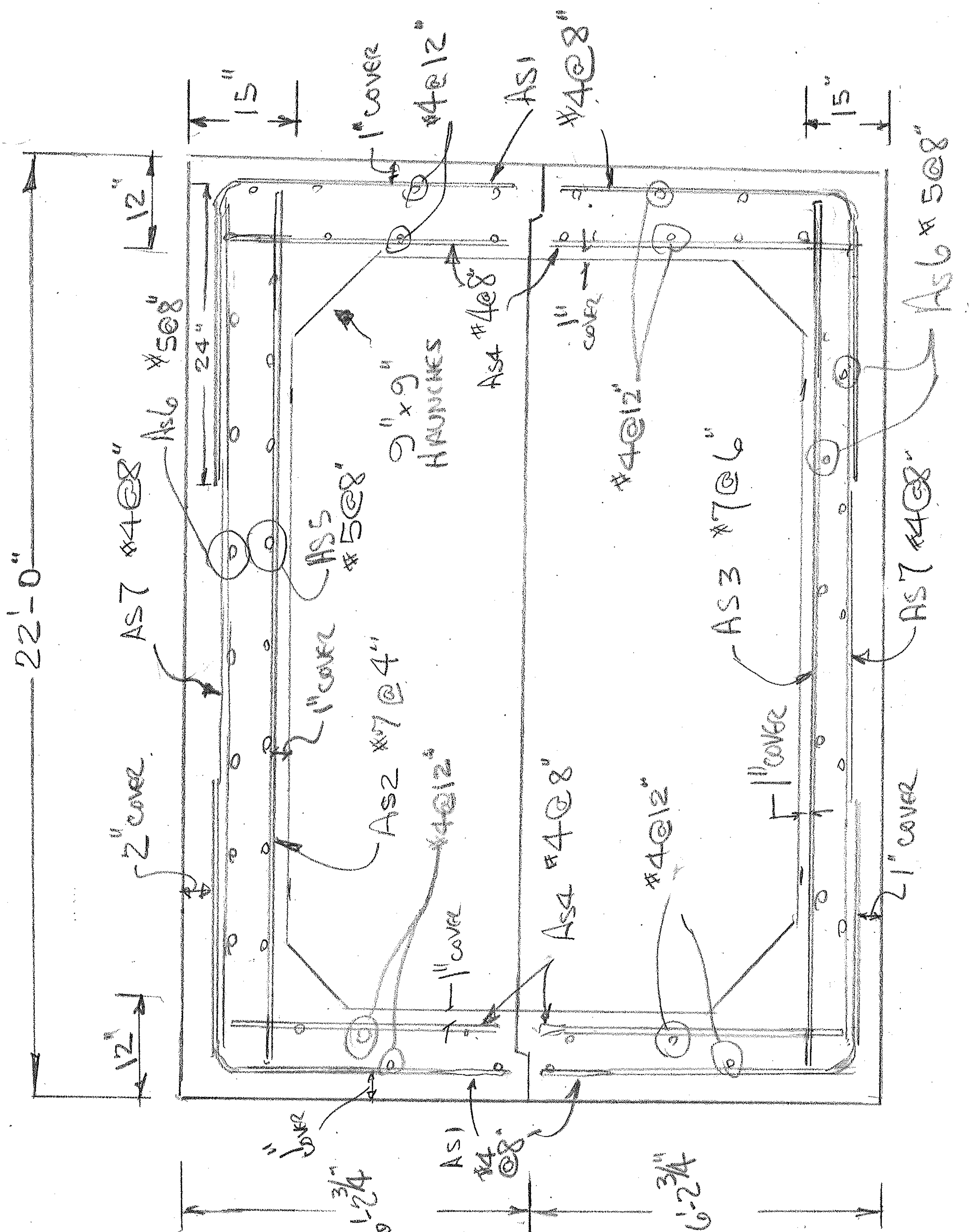
1.33Mu = 110.7 K.ft.

Momemt of Inertia, Ig = (b *tt^3) / 12 = 3375 in^4

Modulus of Rupture, Fr = 0.24 * SQRT(f'c/1000) = 0.537 ksi

1.2 Mcr = 1.2 (Fr * Ig) / (12 * (tt/2)) = 24.1 K.ft.

LESSER OF 1.2 M_{cr} OR 1.33Mu = 24.1 K.ft. ok


22'-0"
15"
12"
24"
1" cover
2" cover
AS1 #4@8"
As2 #7@4"
AS3 #7@6"
As4 #4@8"
AS5 #5@8"
As6 #5@8"
AS7 #4@8"
#4@12"
9"x9" HAUNCHES
6'-2 3/4"

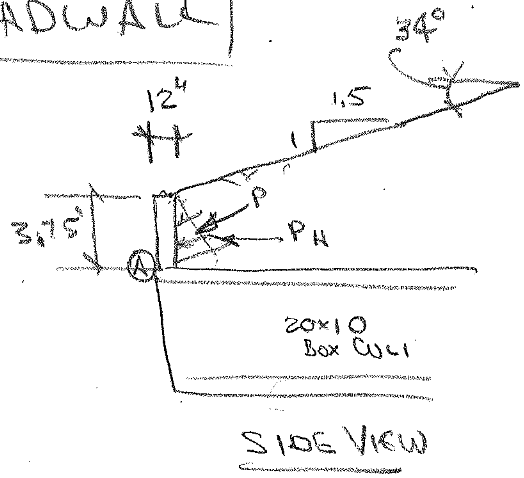
APPENDIX A

CALC BY:__________ CHECK BY:__________

DATE:__________ REV:__________ PROJECT:__________

PROBLEM: DESIGN HEADWALL

FOR $\phi = 30^\circ$ AND 34° SLOPE
USE $K_a = 0.4$

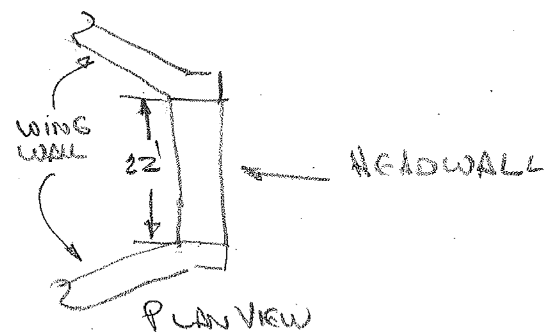


$P = \left(\frac{0.4 \times 120 \times 3.75}{2}\right) 3.75$ (pcf, ft, ft)

$= 340$ lb

$P_H = 340 \times \cos 34^\circ$

$= 282$ lb



$M_u^{(A)}$

$= 282 \text{ lb} \times \frac{3.75}{3} \times 1.7$

$= 598$ ft. lb

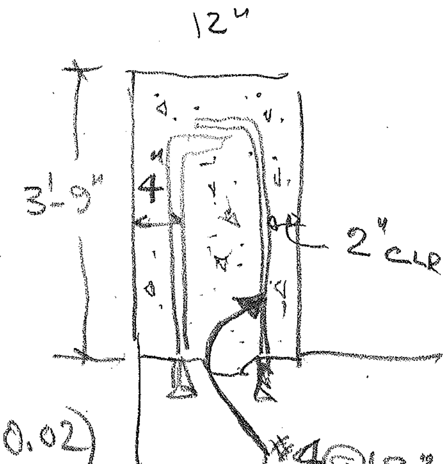
$V_u = 1.7 \times 282 = 480$ lb

FIND ALLOW MOMENT & SHEAR

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

$b = 12"$ $d = 12 - 2 - \frac{1}{4} = 9\frac{3}{4}"$

USE **#4 @ 12" VERT STL.** $A_s = 0.2$ in²



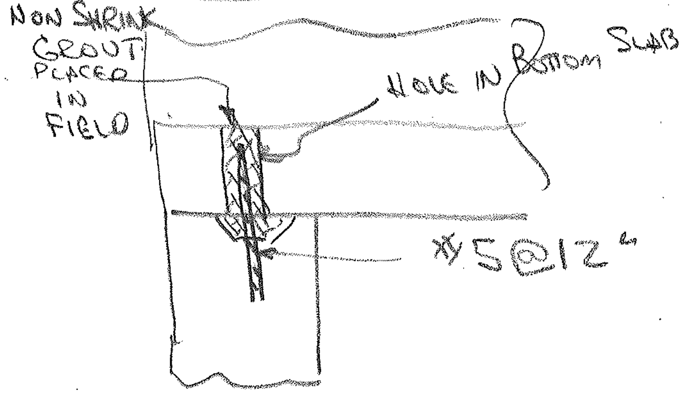
$q = \frac{60}{5} \times \frac{0.2}{12 \times 9.75} = 0.02$

$\phi M_n = 0.9 \times 12 \times 9.75^2 \times 5000 \times 0.02 (1 - 0.59 \times 0.02) \div 12$

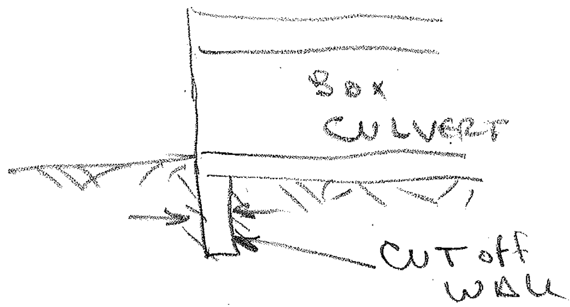
$= 8455$ ft. lb $> M_u^{(A)}$ ok

$\phi V_n = 0.85 \times 2\sqrt{5000} \times 12 \times 9.75 = 14064$ lb $> V_u$ ok

PROBLEM DESIGN CUTOFF WALL



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



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

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

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

Proposed Bridge Improvement Project

Bridport STP CULV(29)

Bridge #2

APPENDIX C1

Concrete:

Mix Designation: P60TER
1. Specified Mix Design - 5000 PSI
2. Proposed Mix Design - 6000 PSI
3. Striping Strength - 3000 PSI
4. Handling Strength - 3000 PSI
5. Shipping Strength - 5000 PSI
6. Install Strength - 5000 PSI
7. Traffic Loading - 5000 PSI

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

Design Notes:
1. Design is in accordance w/ ASTM C1577, PCI MNL135, VAOT540 & AASHTO 2012 LRFD bridge design specs fifth edition
2. Any conflict between tolerances listed above shall result in the usage of the stricter tolerance
3. Design live load = HL-93
4. Materials and manufacturing shall conform to ASTM C1433
5. Earth Cover: ± 15'-0"

Installation:

1. Sub Base for Box Culvert / Cut Off Walls to be Compacted and Level
2. Precast Cut Off Walls + Wing Walls to be installed
3. All Elevations are to be Checked and Verified they Match Those of Plan Set
4. Begin Sequence of Installing All Box Culvert Sections
5. Clean Granular Backfill for structures used for Backfill of Footers & of Box Culvert so water can reach weep holes if applicable
6. Fill all Lifting Holes, Bolt Pockets and Box Culvert grooves and seams w/ non-shrink grout. Applied by Site Contractor.
7. ASTM C1675-11 Box culvert installation guidelines shall be followed.

Reinforcing:

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

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

Lap Lengths:
1. Per AASHTO 5.11.2.1.1 & 5.11.5.3.1

Joint Treatment:

Vertical Seams:
Per VTrans approved product list 780.02
Overhead & vertical concrete repair mortar
Applied by site contractor

Horizontal Seams / Grout:
Per VTrans approved product list 707.03
Mortar, type IV
Applied by site contractor

Waterproofing:

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

Miscellaneous:

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

Legend:

- (A) 3"Ø PVC Sleeve
- (B) 4"Ø PVC Sleeve
- (C) Mechanical Bolt Pocket (A.L. Patterson w/ 1"Ø Coil Rod)
- (D) Oxford A750-7 Lifting Device
- (E) 1"Ø x 12" CX-9 Coil Loop Insert
- (F) 1 1/2" x 3 1/2" Continuous Keyway
- (G) Solid Lines Indicate ¾" Chamfer
- (H) ⅝" FI 64 Ferrule Insert

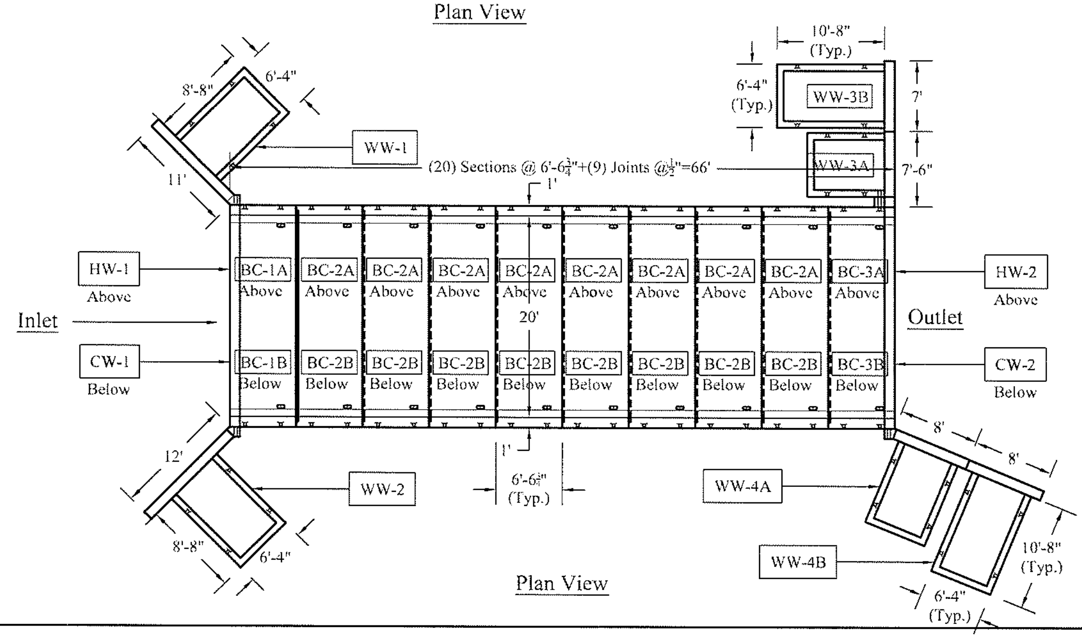
CONTRACTORS VTSPE:	PRECAST CONCRETE BOX CULVERT SHOP DRAWINGS (SDI JOB #15428)		Peckham Road Corp. 1557 St. Rt. 9, #3 Lake George, NY 12845 Ph: (518) 747-3353	FABRICATOR: 193 INDUSTRIAL AVE. WILLISTON, VT 05495 Ph: (802) 658-0201	SD Ireland PRECAST
	SUPERVISOR: E. Barendse DETAILER: I. ADAMS CHECKER: E. Barendse ENGINEER: G. K. Munkelt	PROJECT NAME: Bridport PROJECT #: CULV(29) Br.#2 LOCATION: Bridport, VT	02/12/15	COVER_PAGE	1_OF_8

APPENDIX C2

Table of Units

Name	Qty	Length	Vol.(CY)	Wt.(lbs.)*
BC-1A*	1	6'-6¾"	12.17	50,000
BC-1B	1	6'-6¾"	9.11	37,500
BC-2A	8	6'-6¾"	9.11	37,500
BC-2B	8	6'-6¾"	9.11	37,500
BC-3A*	1	6'-6¾"	12.17	50,000
BC-3B	1	6'-6¾"	9.11	37,500
WW-1	1	11'-0"	10.94	45,000
WW-2	1	12'-0"	11.81	48,500
WW-3A	1	7'-6"	10.35	42,500
WW-3B	1	7'-0"	9.78	40,100
WW-4A	1	8'-0"	10.80	44,250
WW-4B	1	8'-0"	10.38	42,600
CW-1	1	22'-0"	2.24	9,000
CW-2	1	22'-0"	2.24	9,000

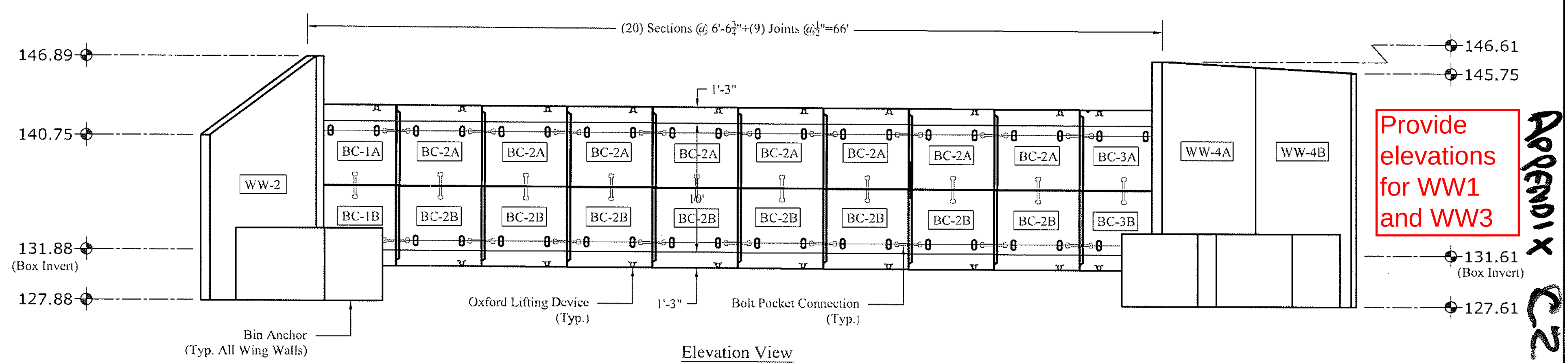
* Headwall Included in BC-1A and BC-3A



Plan View

Culvert Specifications

Inside Dimensions	10'-0"x20'-0"
Waterway Area	160 Sq. Ft.
Top Slab Thickness	15"
Side Wall Thickness	12"
Bottom Slab Thickness	15"



Elevation View

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

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

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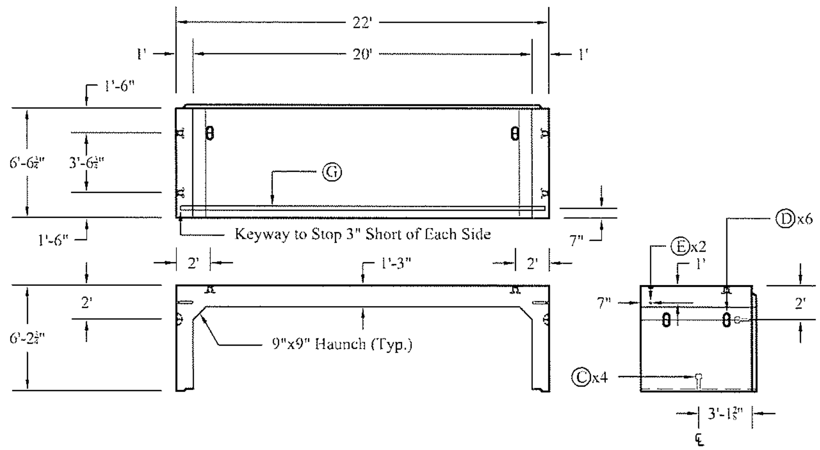
PLAN_ELEVATION

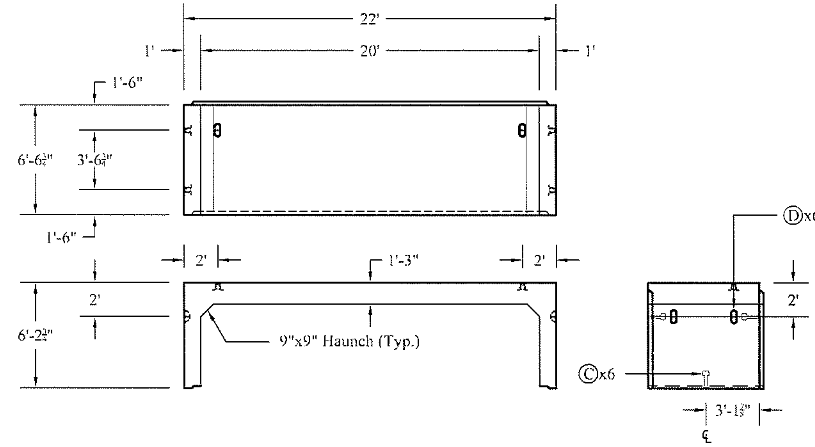
2_OF_8

APPENDIX C3

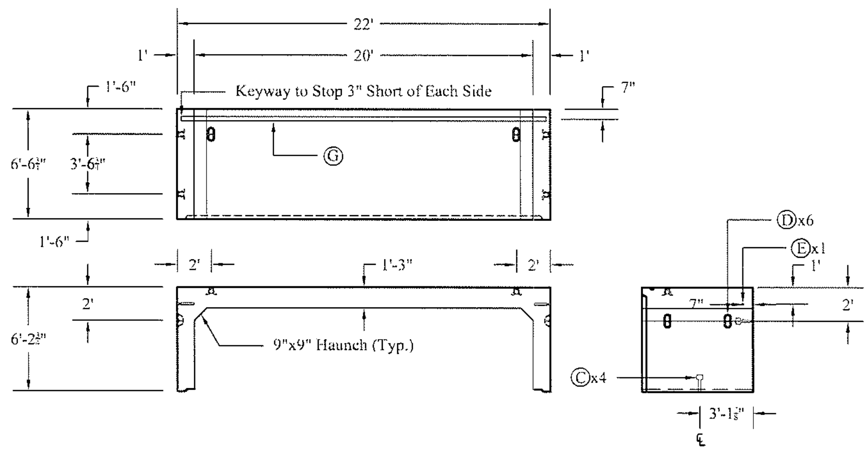
BC-1A Detail



BC-2A Detail

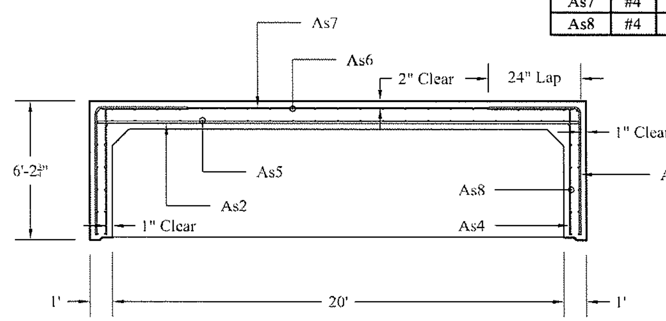


BC-3A Detail



Box Secion Reinforcement Detail

Rebar Schedule							
Mark	Size	Max Spacing	Length	Type	A	B	
As1	#4	8"	94¾"	Bent	24"	70¾"	
As2	#7	4"	262"	Str	262"		
As4	#4	8"	70¾"	Str	70¾"		
As5	#5	8"	74¾"	Str	74¾"		
As6	#5	8"	74¾"	Str	74¾"		
As7	#4	8"	262"	Str	262"		
As8	#4	12"	74¾"	Str	74¾"		



CONTRACTORS VTSPEC

- (A) 3"Ø PVC Sleeve
- (B) 4"Ø PVC Sleeve
- (C) Mechanical Bolt Pocket (A.L. Patterson w/ 1"Ø Coil Rod)
- (D) Oxford A750-7 Lifting Device
- (E) 1"Øx12" CX-9 Coil Loop Insert
- (F) 1 1/2" x 3 1/2" Continuous Keyway
- (G) Solid Lines Indicate ¾" Chamfer
- (H) ⅝" FI 64 Ferrule Insert

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

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

PROJECT NAME: Bridport
PROJECT #: CULV(29) Br.#2
LOCATION: Bridport, VT

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Lake George, NY 12845
Ph: (518) 747-3353

FABRICATOR:
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WILLISTON, VT 05495
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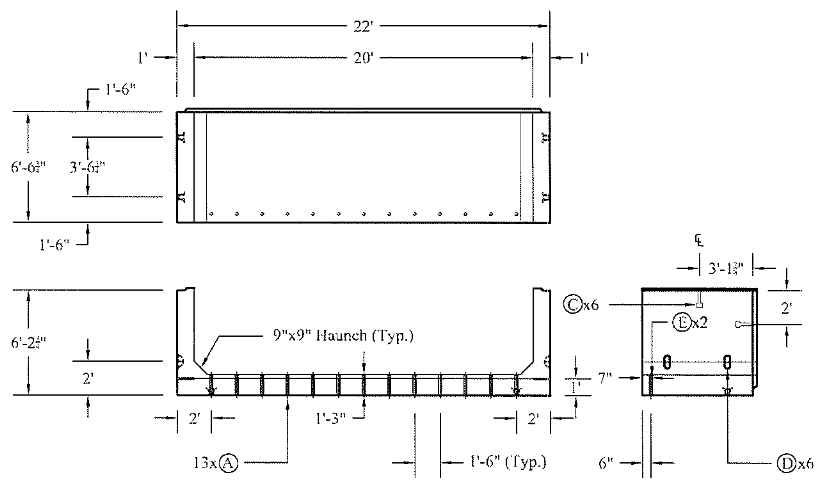
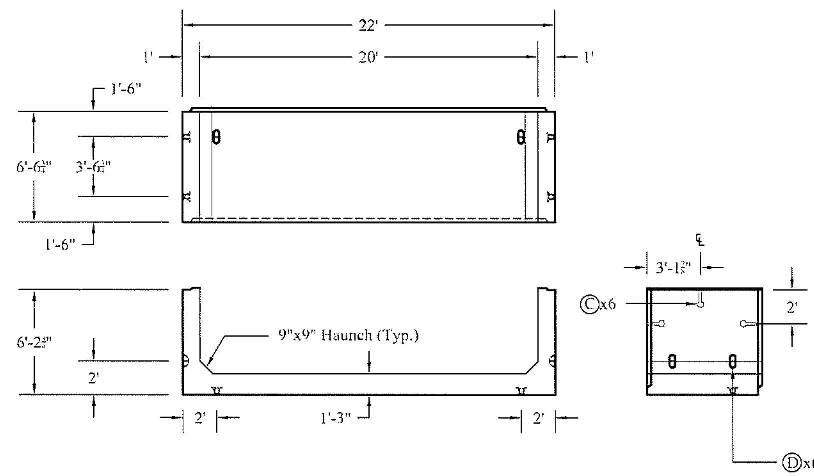
02/12/15 | BOX_SECTIONS_1 | 3_OF_8

APPENDIX C4

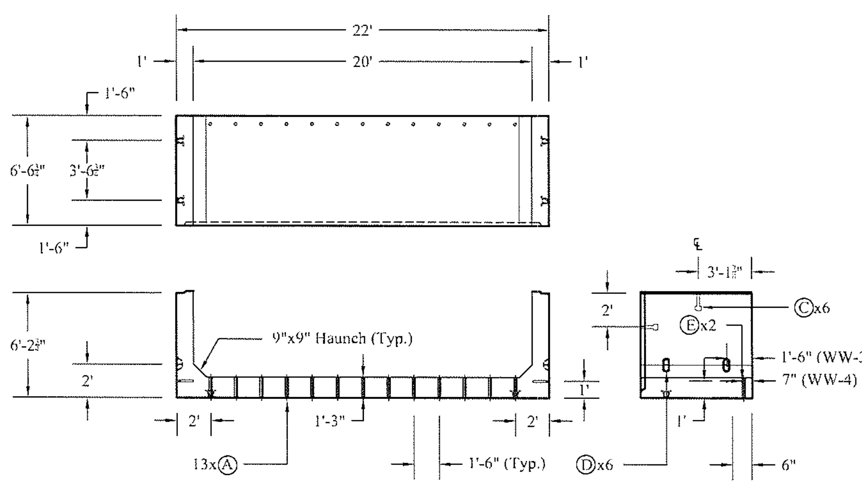
BC-1B Detail



BC-2B Detail



BC-3B Detail



Box Secion Reinforcement Detail

Rebar Schedule

Mark	Size	Max Spacing	Length	Type	A	B
As1	#4	8"	94 3/4"	Bent	24"	70 3/4"
As3	#7	6"	262"	Str	262"	
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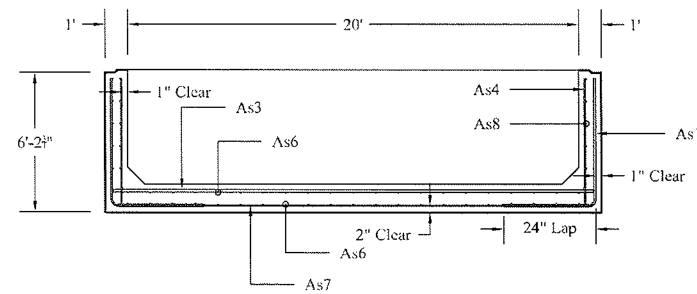
As6	#5	8"	74 3/4"	Str	74 3/4"	
As7	#4	8"	262"	Str	262"	
As8	#4	12"	74 3/4"	Str	74 3/4"	



CONTRACTORS VTSPE:

Ⓐ 3"Ø PVC Sleeve
Ⓑ 4"Ø PVC Sleeve
Ⓒ Mechanical Bolt Pocket (A.L. Patterson w/ 1"Ø Coil Rod)
Ⓓ Oxford A750-7 Lifting Device
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Ⓕ 1 1/2" x 3 1/2" Continuous Keyway
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Ⓗ ¾" FI 64 Ferrule Insert

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

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

PROJECT NAME: Bridport
PROJECT #: CULV(29) Br.#2
LOCATION: Bridport, VT

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1557 St. Rt. 9, #3
Lake George, NY 12845
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WILLISTON, VT 05495
Ph: (802) 658-0201

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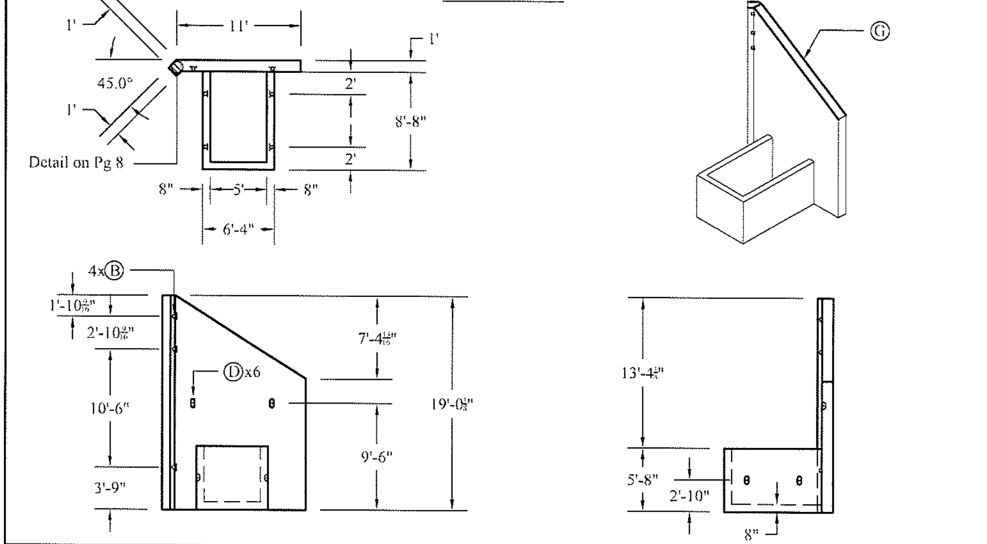
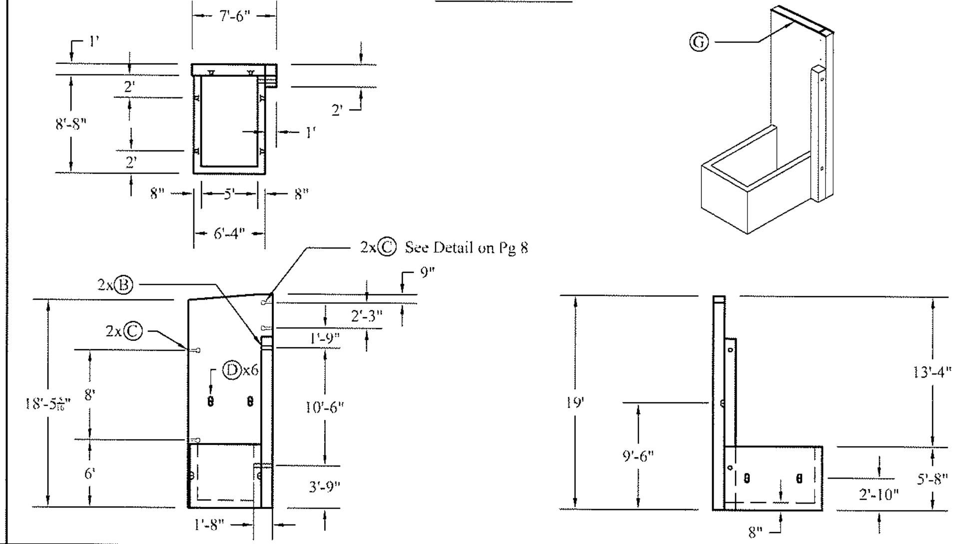
02/12/15 | BOX_SECTIONS_2 | 4_OF_8

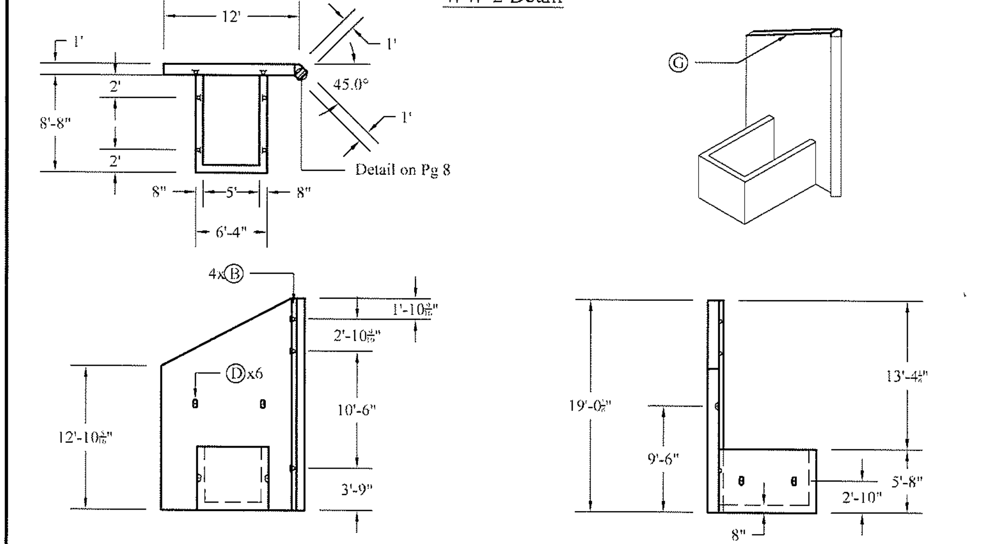
WW-1 Detail



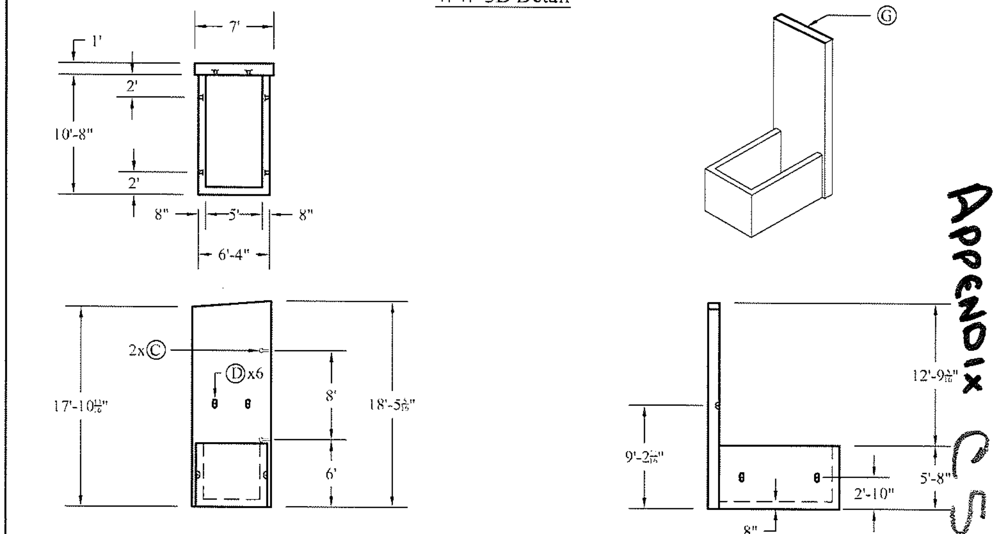
WW-3A Detail



WW-2 Detail



WW-3B Detail



APPENDIX C5

CONTRACTORS VTSPE:

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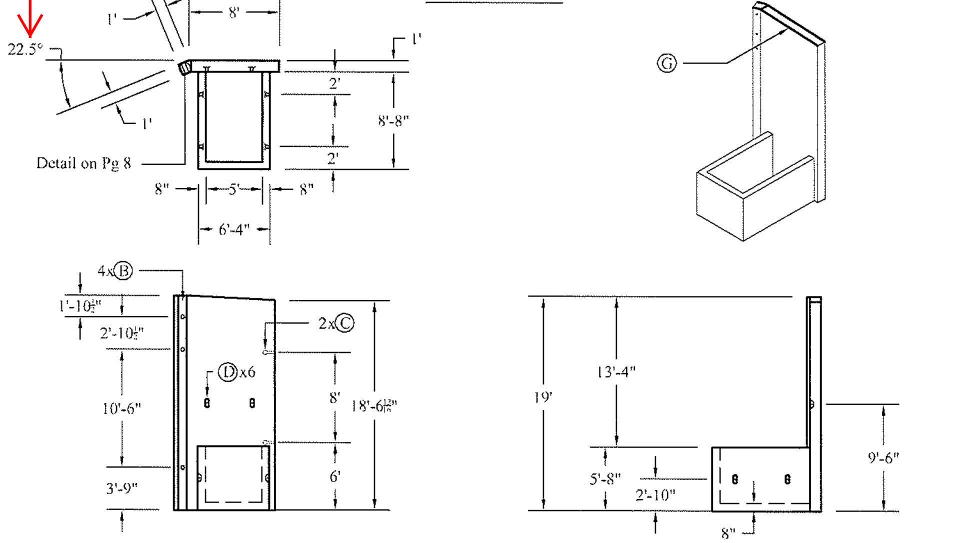
SUPERVISOR: E. Barendse DETAILER: I. ADAMS CHECKER: E. Barendse ENGINEER: G. K. Munkelt	PROJECT NAME: Bridport PROJECT #: CULV(29) Br.#2 LOCATION: Bridport, VT	02/12/15	WING_WALLS_1

SD Ireland PRECAST

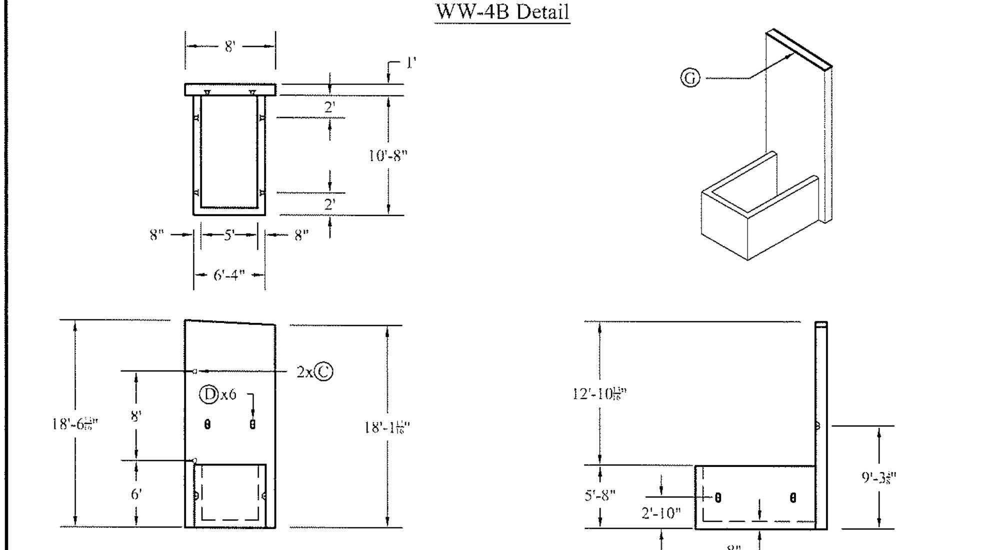
This angle appears to be wrong, should be 67.5

Appendix C6

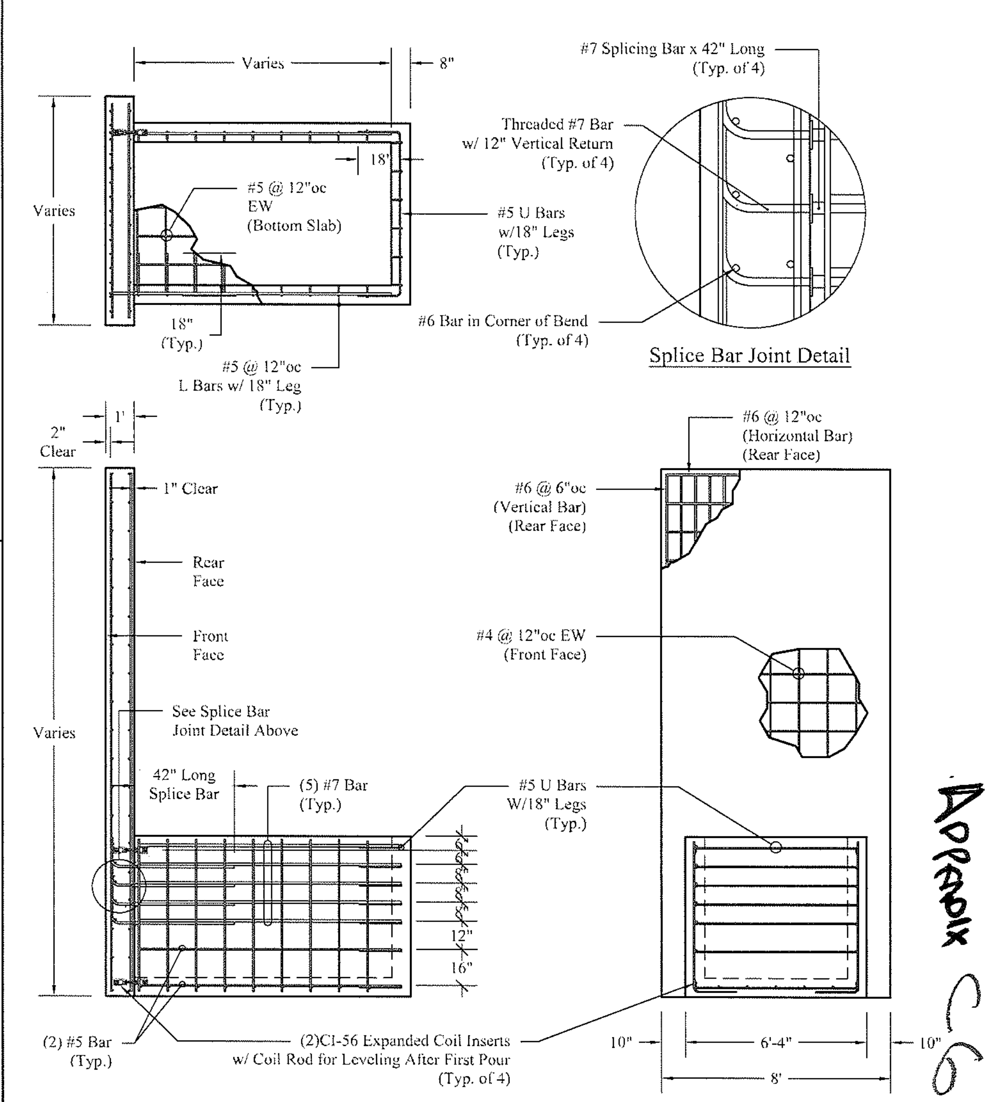
WW-4A Detail



WW-4B Detail



WW-Reinfocing Detail



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ENGINEER: G. K. Munkelt

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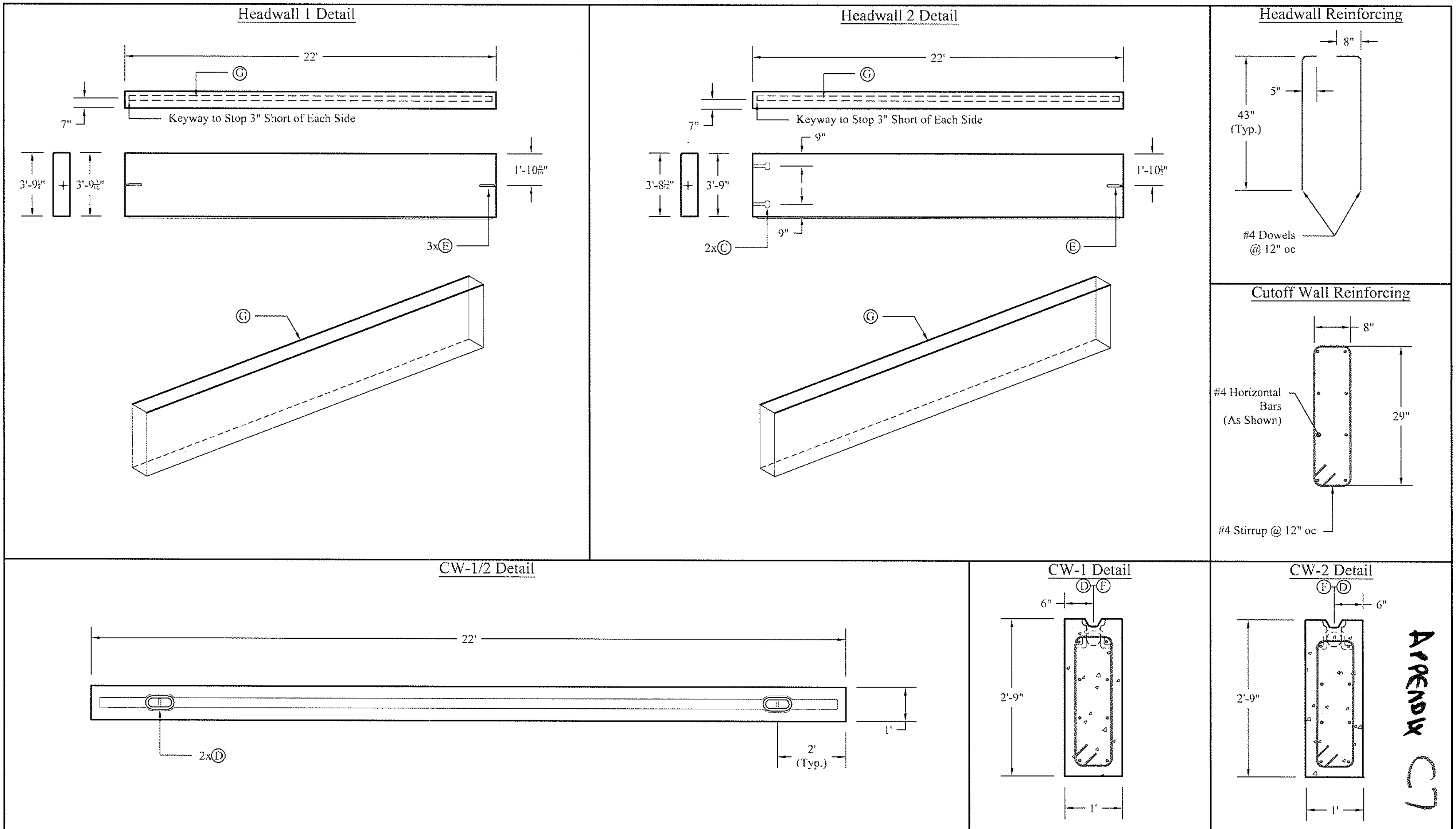
02/12/15 | WING_WALLS_2 | 6_OF_8



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

SUPERVISOR: E. Barendse	PROJECT NAME: Bridport
DETAILER: I. ADAMS	PROJECT #: CULV(29) Br.#2
CHECKER: E. Barendse	LOCATION: Bridport, VT
ENGINEER: G. K. Munkelt	

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02/12/15 | HW_CW_DETAILS | 7_OF_8

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

GARY K. MUNKELT & ASSOCIATES

Consulting Engineers
Precast Concrete, Structural, Civil

1180 Welsh Rd. Suite 190 North Wales, PA 19454

2/12/15

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

PROJECT: **DESIGN BIN TYPE WINGWALL**

CLIENT: **S. D. IRELAND**
WILLISTON, VT

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

TABLE OF CONTENTS

Include soil bearing calculations

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

SCOPE OF WORK

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

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

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

There are two types of bins:

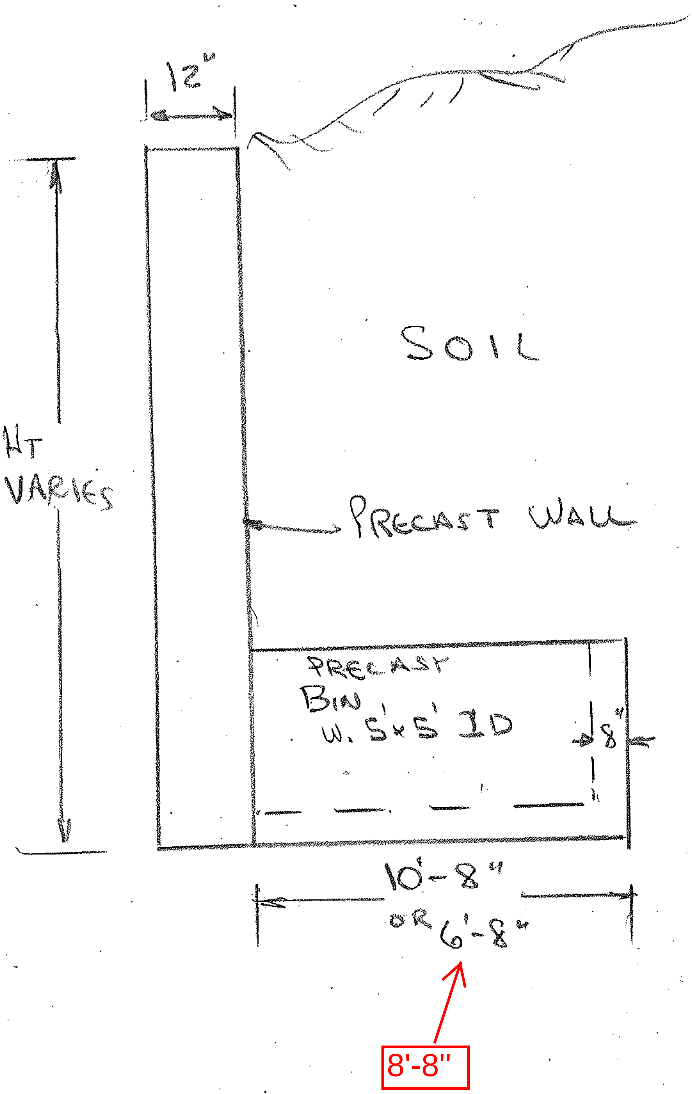
Type I Bin is almost as wide as the wall and 10'-8" long. It is designed to stand alone.

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

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

CALC BY:______ CHECK BY:______ SHEET NO. 3 OF______

DATE:______ REV:______ PROJECT:______

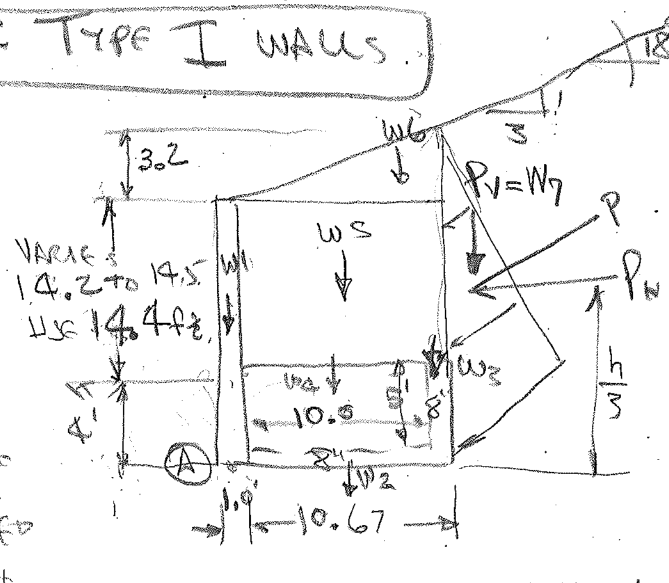


DESCRIPTION of PRODUCT

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

PROBLEM CHECK STABILITY of TYPE I WALLS.

SOME of THESE WALLS MUST STAND ALONE.



SIDE VIEW WALL No 3B & No 4B

OVERTURNING FORCES

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

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

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

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

LOAD TO BE RESISTED BY BINS

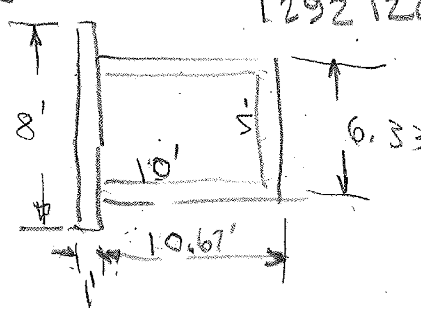
$P_{HOR} = 11200$ lb/ft $\times 8^{ft} = 89600^{lb}$

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

RESISTING FORCES:

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

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



F.S AGAINST SLIDING

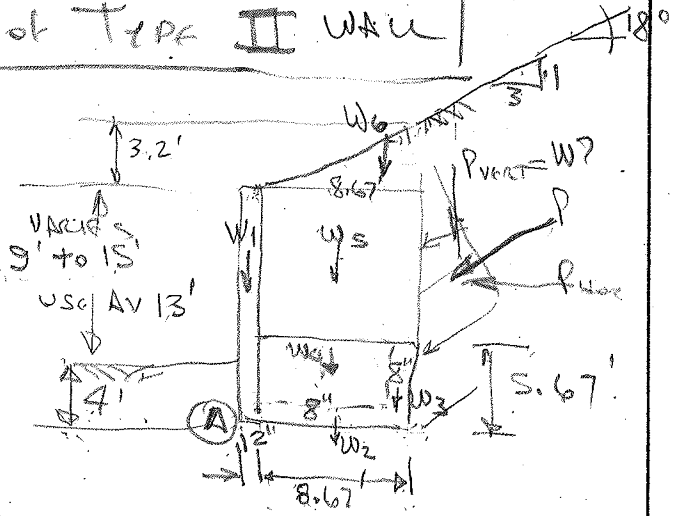
$= \frac{(17854 + 213856) \tan 30}{89600} = 1.5$ ok.

CALC BY: CHECK BY: SHEET NO. 5 OF

DATE: REV: PROJECT:

PROBLEM CHECK STABILITY of TYPE II WALL

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



SIDE VIEW WALL No 1 & No. 2

OVERTURNING FORCES

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

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

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

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

LOAD TO BE RESISTED BY BINS

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

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

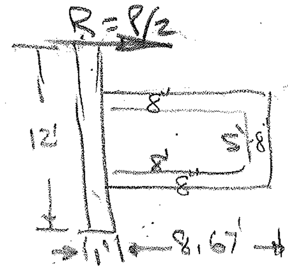
RESISTING FORCES:

		W_T		M_{RESIST}
W1 =	12 × 1 × 17 × 150 =	30600. lb.	× 0.5 ft =	15300. ft lb
W2 =	8.67 × 6.33 × 0.67 × 150 =	5516. lb.	× 5.34 ft =	29455. ft lb
W3 =	0.67 × 6.33 × 5 × 150 =	3181. lb.	× 8.33 ft =	26500. ft lb
W4 =	2[0.67 × 8 × 5 × 150] =	8040. lb.	× 5 ft =	40200. ft lb
W5 =	(8 × 5² + 8.67 × 6.33 × 13) 120 =	109615. lb.	× 5.33 ft =	584245. ft lb
W6 =	1/2 × 8.67 × 3.2 × 120 =	1665. lb	× 6.8 ft =	11322. ft lb
W7 =	3115 lb/ft × 6.33 ft =	19718. lb.	× 9.67 ft =	190673. ft lb
		178335. lb		897695 ft lb

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

F.S. AGAINST SLIDING

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



PLAN VIEW

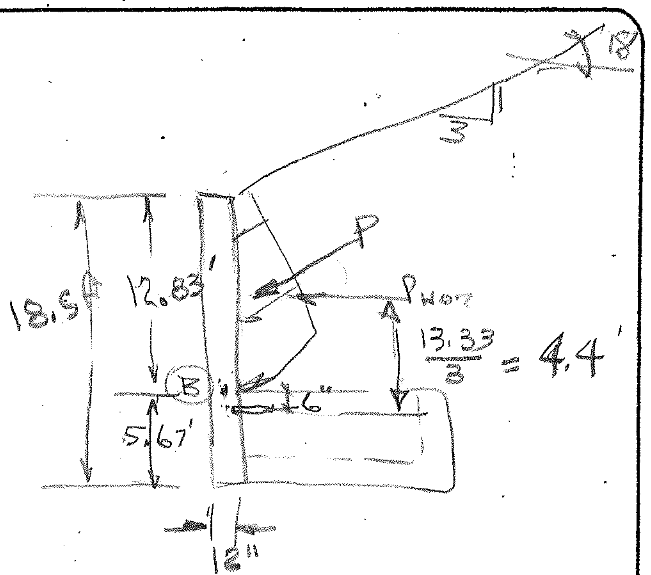
CALC BY: ______ CHECK BY: ______ SHEET NO. 6 OF ______

DATE: ______ REV: ______ PROJECT: ______

PROB. DESIGN WALL

CHECK MOM. @ (B)

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



SIDE VIEW
WORST CASE

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

$= 4478$ lb/ft

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

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

$V_u = (1.7 \times 4258)^{lb} = 7240$. lb per ft width of panel

Find allow mom & shear:

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

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

Use #6 @ 6" VERT. STL

$A_s = 0.88$

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

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

$= 40580$. ft·lb $> M_u$ ok

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

$> V_u$ ok

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

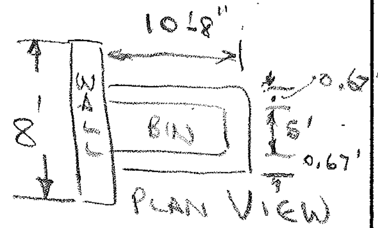
For 12" wall use 2 layers — Use #4 @ 12" both ways front face

Use #6 @ 12" HOR STL REAR FACE

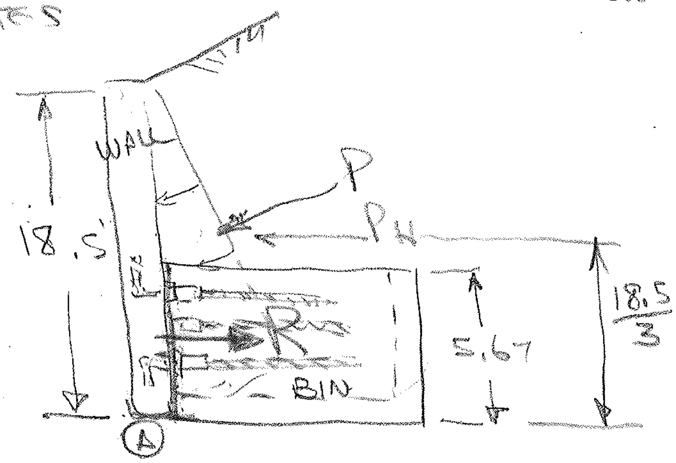
CALC BY:______ CHECK BY:______ SHEET NO. 7 OF______

DATE:______ REV:______ PROJECT:______

PROBLEM: DESIGN CONNECTION BETWEEN WALL AND BIN



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



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

$= 8625$ lb/ft WIDE SECT.

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

TOTAL P_{HOR} = 8 ft. × 8202 lb/ft = 65623 lb

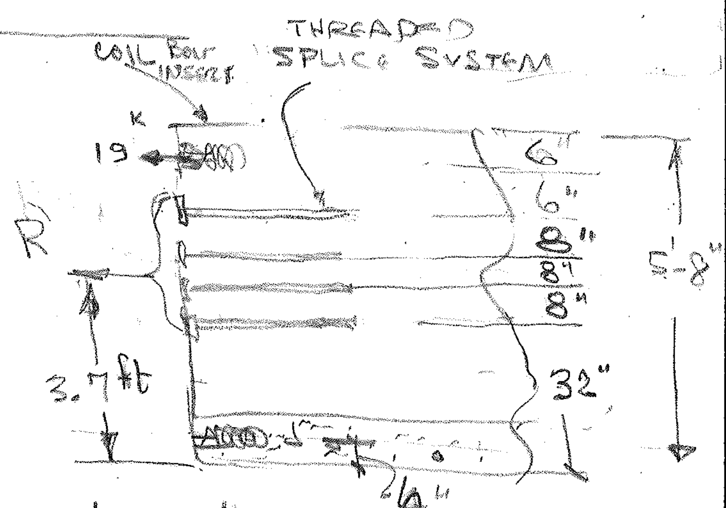
MOMENT AT (A) $= 65623^{lb} \times \frac{18.5^{ft}}{3} = 404675$ ft. lb.

TO SUPPORT MOMENT AT (A)

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

$= 82670$ lb

USE 4 COUPLERS WITH ALLOWABLE CAPACITY > 20600 lb



CALC BY:__________ CHECK BY:__________ SHEET NO. 8 OF__________

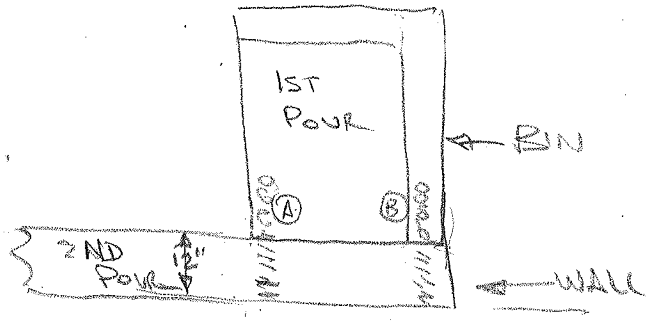
DATE:__________ REV:__________ PROJECT:__________

connection design cont.

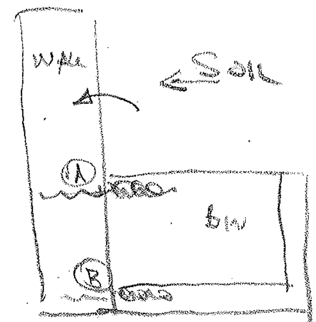
TOP & BOTTOM CONNECTORS WILL BE 1" DIA. EXPANDED COIL INSERT.

THEY WILL SERVE 2 PURPOSES

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



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



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

P = WT of BIN IN UPRIGHT COND.

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

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

$L = 12 \text{ in}$

$K = 1.0$

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

$P_{allow} = \frac{9700 \text{ lb}}{4000} = 2.4 \text{ K}$ — 1" DIA COIL BOLT O.K IN COMP.

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

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

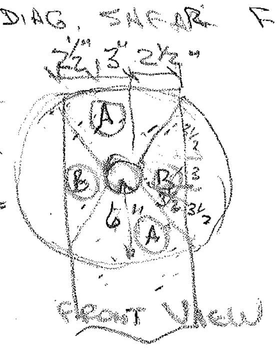
ALLOW. TENSION CAP. of CONCRETE USING DIAG. SHEAR FORMULA $2\sqrt{5000} = 141 \text{ psi}$

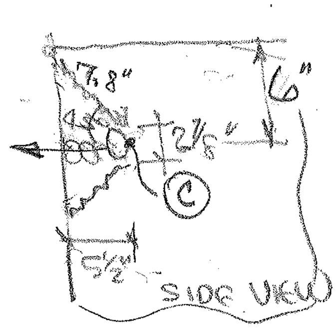
AREA (A) $\left[(3" \times 7.8") + \frac{1}{2} \times 7.8" \times 5"\right] 2 = 86 \text{ in}^2$

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

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

$= 138 \text{ in}^2$





CONCRETE TENSION CAPACITY ALLOWED

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

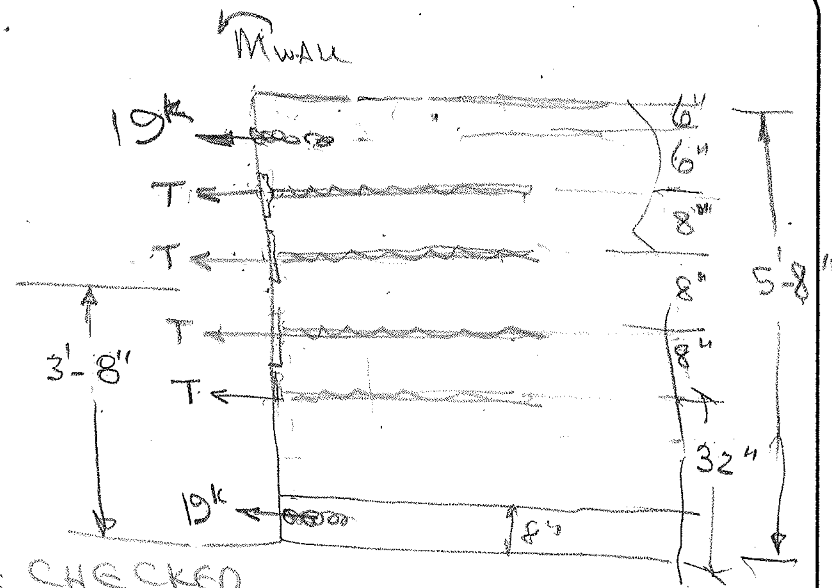
USE 19^K

CALC BY: CHECK BY: SHEET NO. 9 OF

DATE: REV: PROJECT:

connection design cont.

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



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

TWO ITEMS TO BE CHECKED

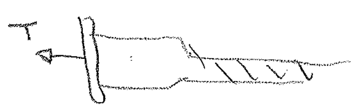
1. CAPACITY of UNIT IN WALL
2. " of REBAR THREADED INTO SPLICE

TYP. #7 REBAR

TENSION CAPAC — at GRADE 100 ...

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

TENSION CAPACITY of DOWEL BAR



FROM APPENDIX B3 $P_y = 36000$ lb

USE 0.6×36000 lb $= 21600^{lb}$

EMBEDMENT LENGTH REQD. FOR TENSION

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

MOMENT CAPACITY of CONNECTION

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

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

PROBLEM DESIGN BIN

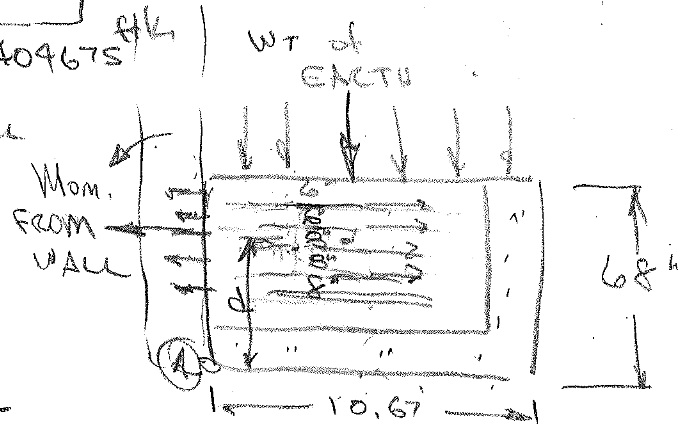
FROM SHEET 7 MOM. ON WALL = 404675 ft k

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

$M_u^{Ⓐ} = 1.7 \times 202337$
$= 344000. \text{ ft lb/WALL}$

PROVIDE #7 SPLICED TO TENSION MEMBER & COIL

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

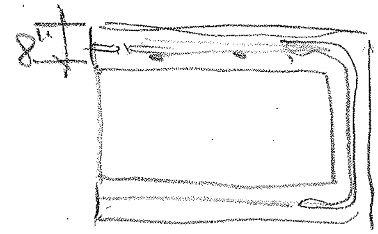


SIDE VIEW

$b = 8 \text{ in}$

$d = 68 - 6 - 6 - 8 = 48 \text{ ins}$

$f'_c = 5000 \text{ psi}$ $f_y = 60000 \text{ psi}$



PLAN VIEW

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

$\phi M_u = 0.9 \times 8 \times 48^2 \times 5000 \times 0.094 (1 - 0.59 \times 0.094) \div 12$
$= 613694. \text{ ft lb}$ $> M_u^{Ⓐ} = 344000. \text{ ft lb}$

OK

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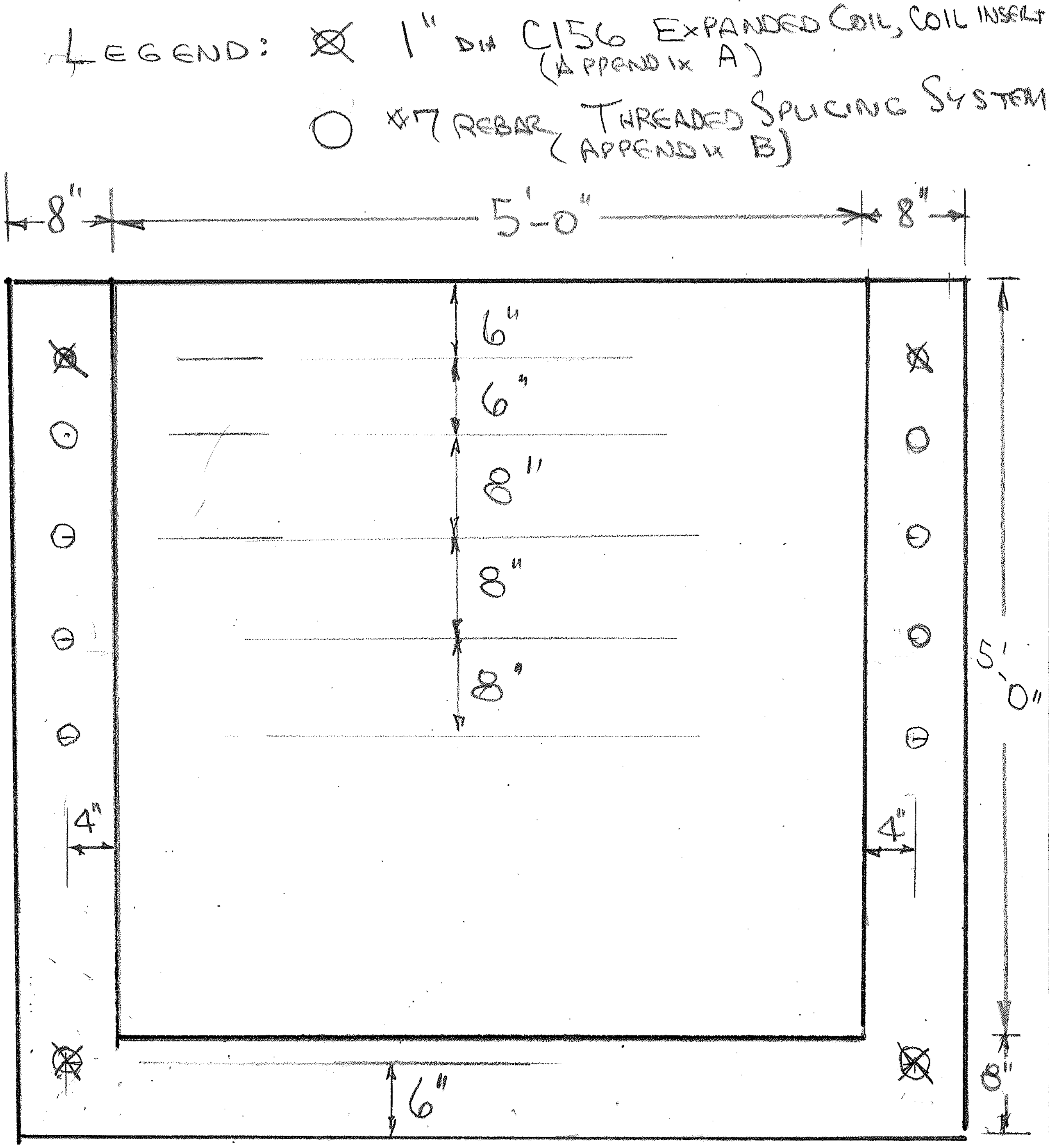
DATE:______ REV:______ PROJECT:______



END VIEW - BIN

SCALE 1"=1'-0"

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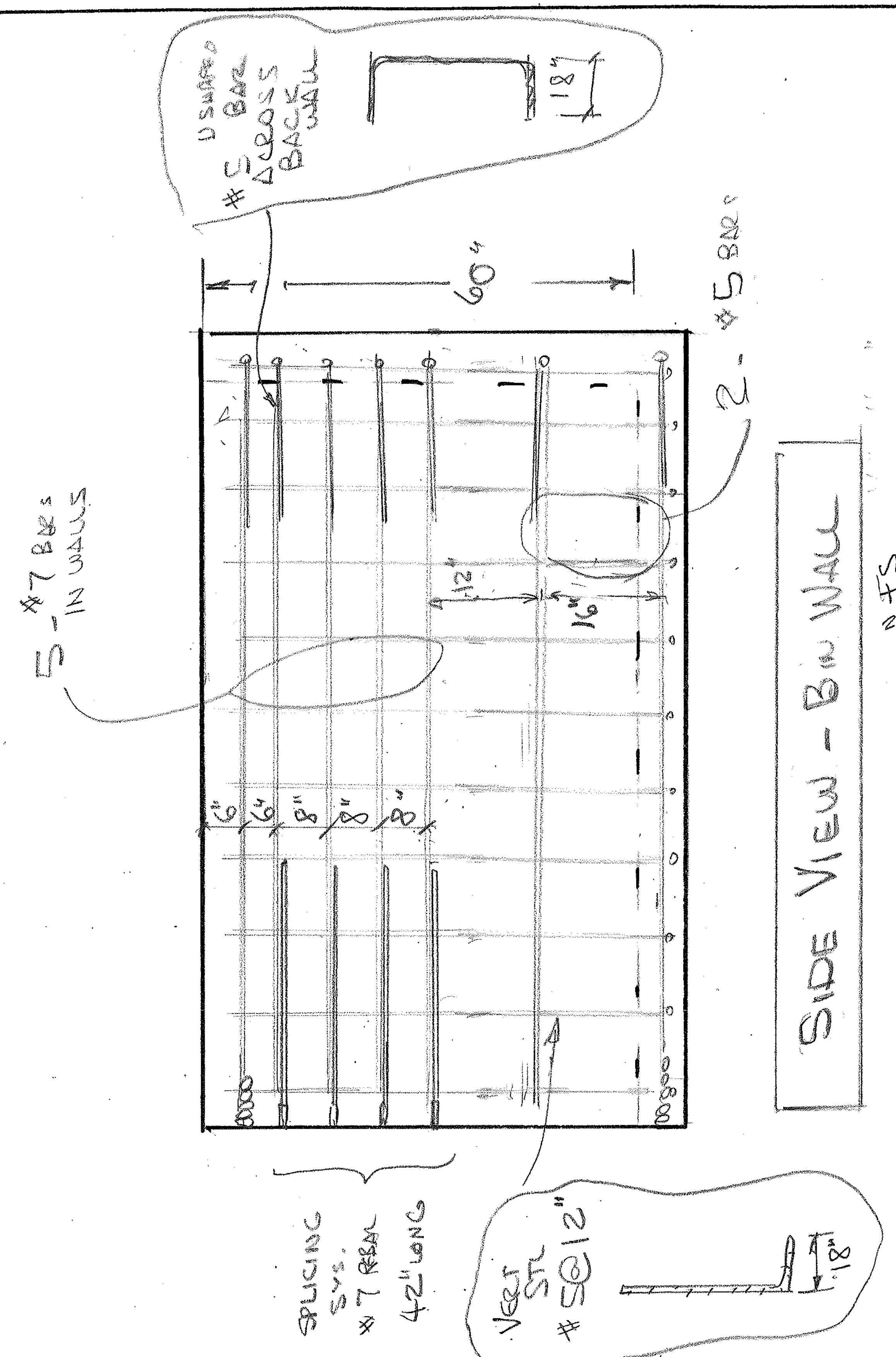
DATE:__________ REV:__________ PROJECT:__________



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

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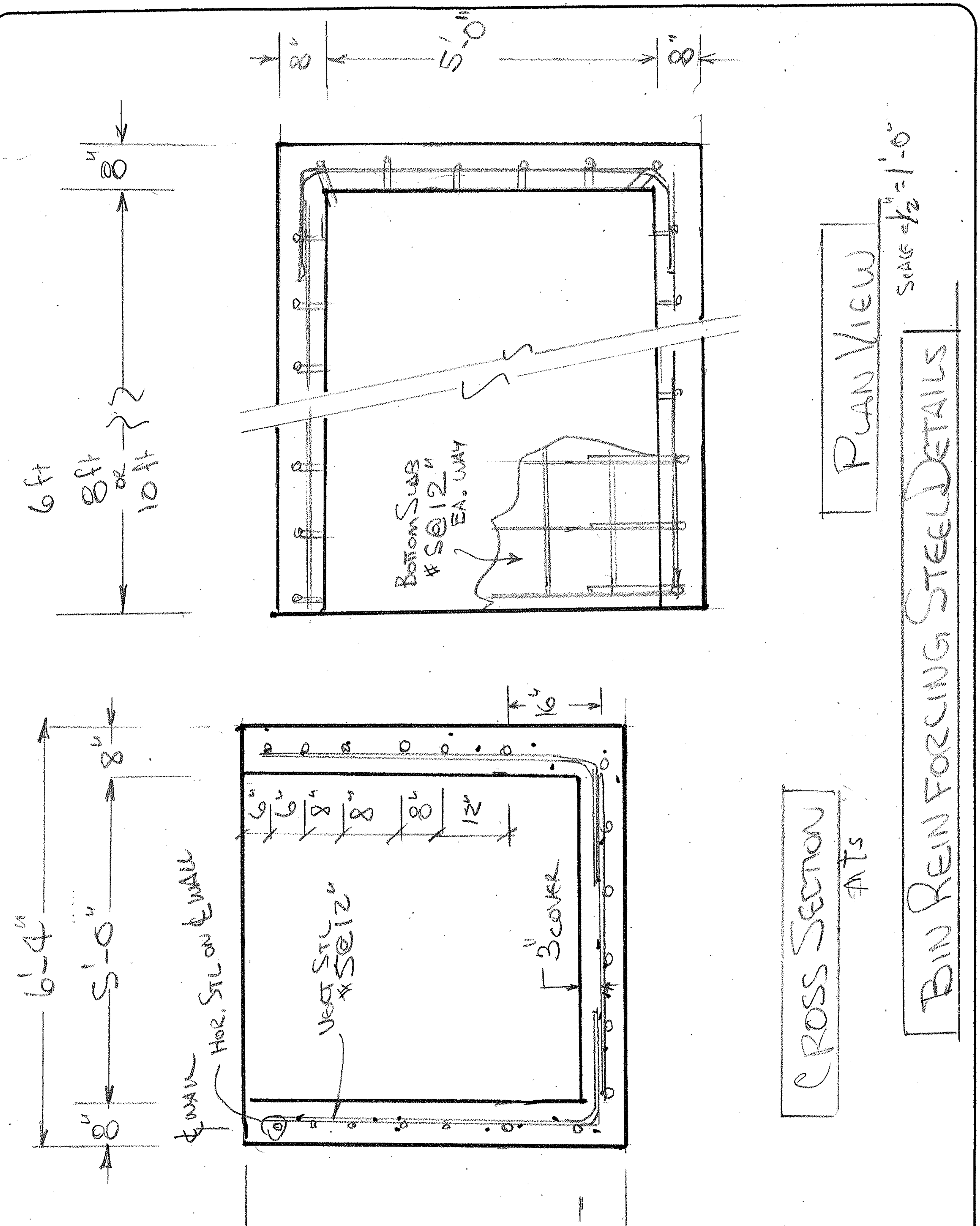
DATE: ______ REV: ______ PROJECT: ______



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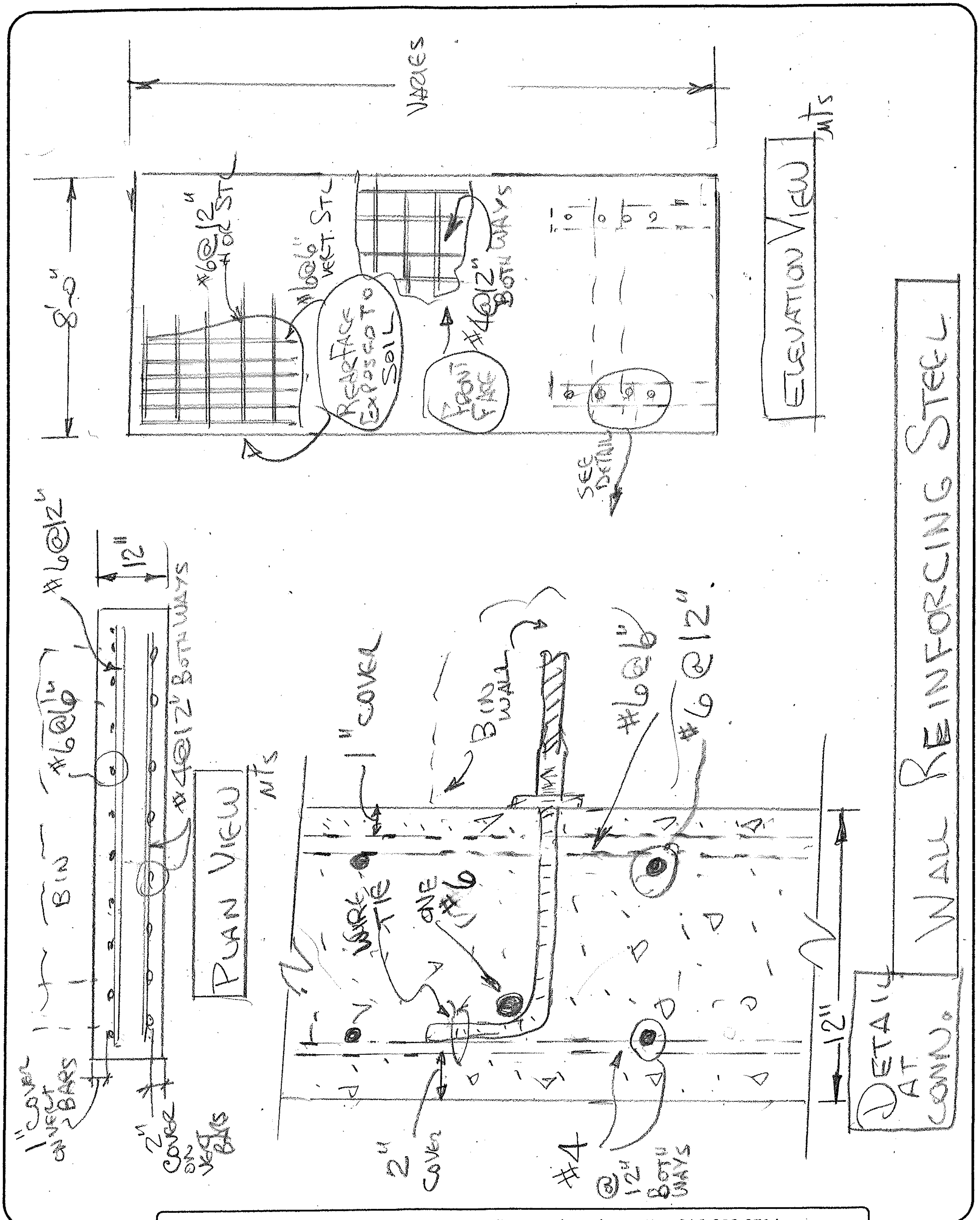
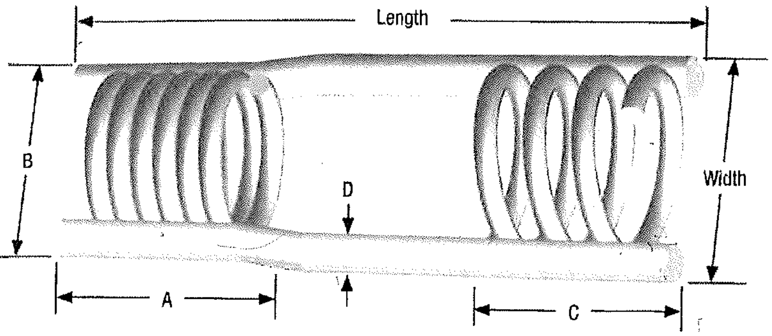
DATE:________ REV:________ PROJECT:________



APPENDIX A

INSERTS

CI-56: EXPANDED COIL, COIL INSERT



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

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

EXPANDED COIL, COIL INSERT DIMENSIONS AND LOAD CHART

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

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

CR-12: COIL ROD - HIGH TENSILE

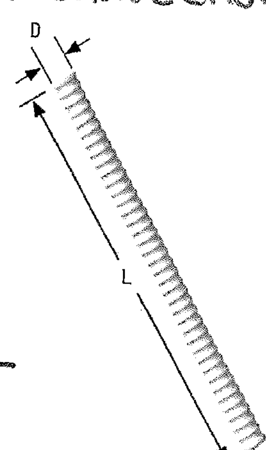
5:1 SWL REQUIRED FOR LIFTING PER OSHA

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

INSERTS

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

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



COIL ROD DIMENSIONS AND LOAD CHART

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

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

DBDI® Splice System

IAPMO Evaluation Report ER-0321

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

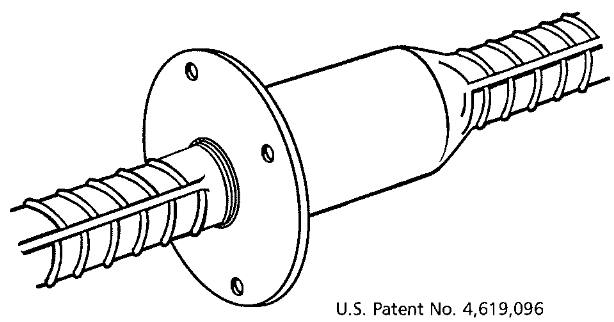
The components of the system, the Dowel Bar (DB) and Dowel-In (DI), are manufactured from standard rebar material. Basic fabrication consists of forging and threading operations. No welding or machining is required and the threading operation does not reduce the nominal cross-sectional area of the bar.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

System Advantages

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

The Dayton Superior DBDI Splice System Advantages:

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



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

System Compliance

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

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

Typical Splicing Specification

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

Specific:

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

Generic:

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

APPENDIX B2

DAYTON® SUPERIOR

Recommended Dowel Bar and Dowel-In Sizes

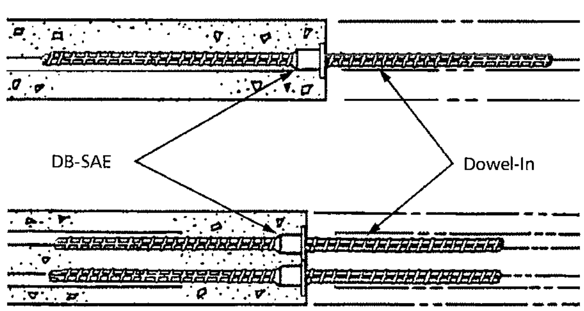
Specified or Required Dowel Bar					Recommended Dowel Bar Splicer and Dowel-In						
Bar Size			Grade 60 Rebar Loads (lbs.)		System Thread Size*	DB-SAE Bar Size	Dowel-InBar Size	System Stress Area (min.)	Completed Splice (lbs.)		
US	Metric (mm)	CN (M)	P_y	1.25 P_y					P_y	1.25 P_y	100% P_u
#4	[13]	[10]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

P_y=Minimum Yield Strength of bar.
P_u=Minimum Tensile Strength of bar.
*5/8", 3/4", 7/8" and 1" sizes have UNC Threads. 1-1/8" and larger sizes are equipped with UN Threads.

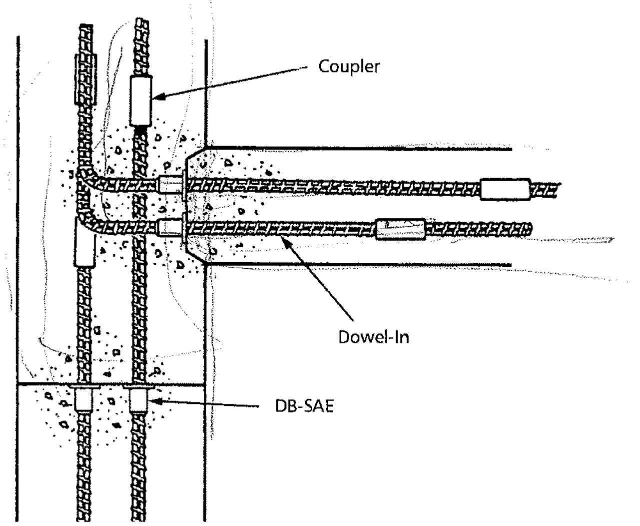
Required Development and Lap Lengths for Grade 60, Uncoated Bottom Reinforcement in Normal Weight Concrete

Typical Threaded Splicing Applications

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



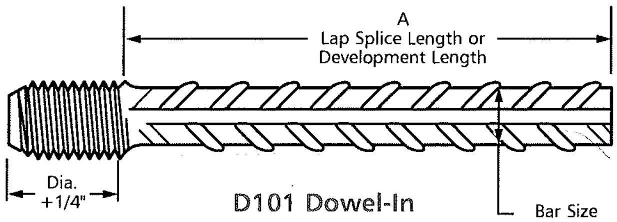
Typical Dowel Bar Splicer/Dowel-In Applications



DBDI Splice System

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

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



D101 Dowel-In

To Order:

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

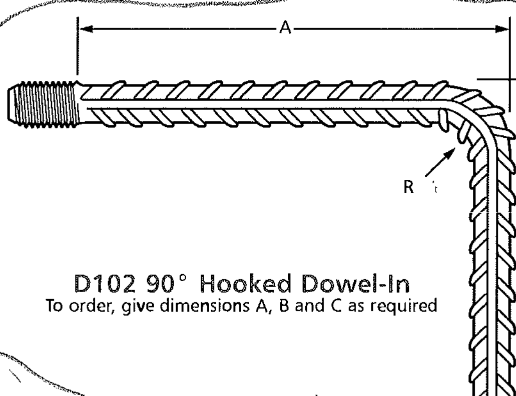
Example:

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

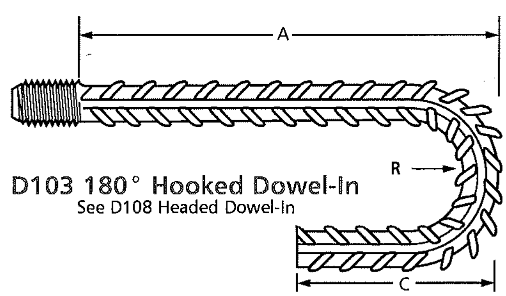
Specified or Required Dowel Bar					Recommended Dowel Bar and Dowel-In						
Bar Size			Grade 60 Rebar Loads (lbs.)		System Thread Size*	DB-SAE Bar Size	Dowel-In Bar Size	System Stress Area (min.)	Completed Splice (lbs.)		
US	Metric (mm)	CN (M)	P_y	1.25 P_y					P_y	1.25 P_y	100% P_{ult}
#4	[13]	[10]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

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

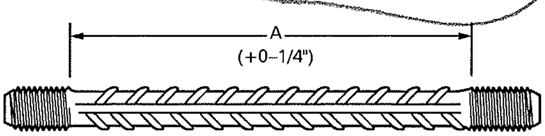
*5/8", 3/4", 7/8" and 1" sizes have UNC Threads. 1-1/8" and larger sizes are equipped with UN Threads.



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



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



D104 Double-Ended Dowel-In

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

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

DBDI Splice System

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

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

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

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

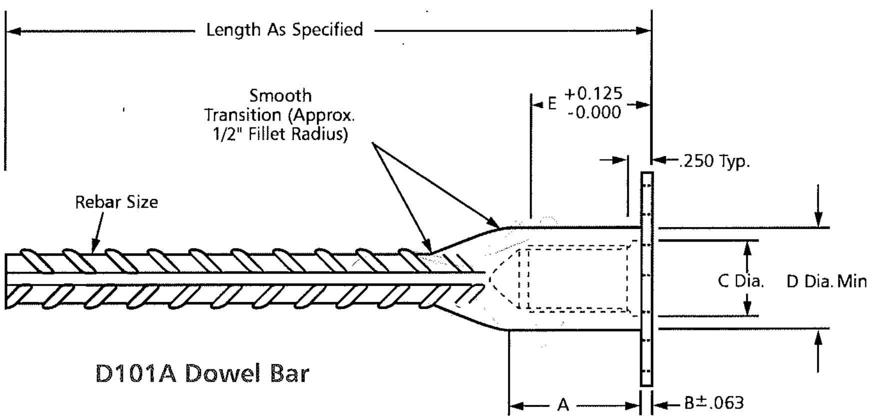
Bar Size Designation			Thread Size	A	B	C	D	E	Flange Diameter	100% P_u
US	Metric (mm)	CN (M)								
#4	[13]	[10]	5/8" – 11 UNC	1-1/16"	1/8"	11/16"	55/64"	1"	1-7/8"	18,000
#5	[16]	[15]	3/4" – 10 UNC	1-9/16"	1/8"	13/16"	1-3/64"	1-1/8"	2-1/16"	27,900
#6	[19]	[20]	7/8" – 9 UNC	1-11/16"	1/8"	15/16"	1-15/64"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

P_u=Minimum Tensile Strength of bar.

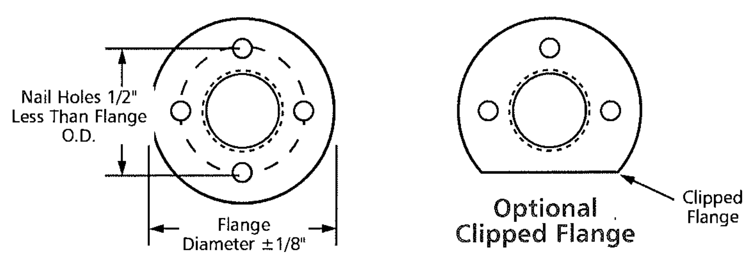
Bar Size Designation			D101A Minimum MFG. Length DB-SAE
US	Metric (mm)	CN (M)	
#4	[13]	[10]	12"
#5	[16]	[15]	14"
#6	[19]	[20]	16"
#7	[22]	—	16"
#8	[25]	[25]	16"
#9	[29]	[30]	16"
#10	[32]	—	16"
#11	[36]	[35]	16"

NOTE: To be manufactured as Single End

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

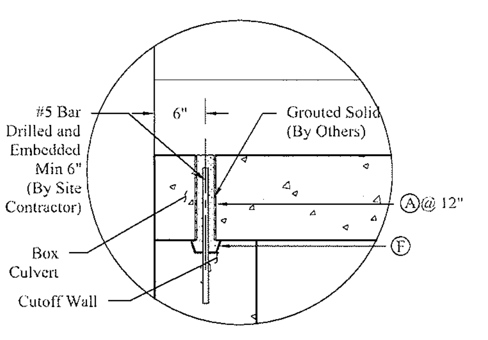


D101A Dowel Bar

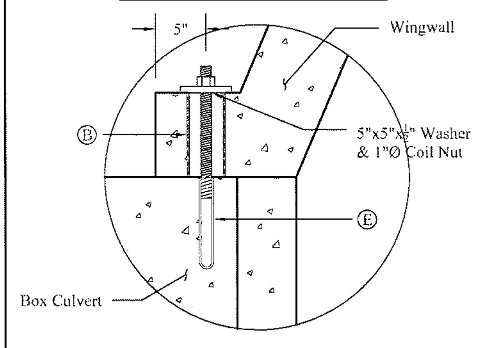


Optional Clipped Flange

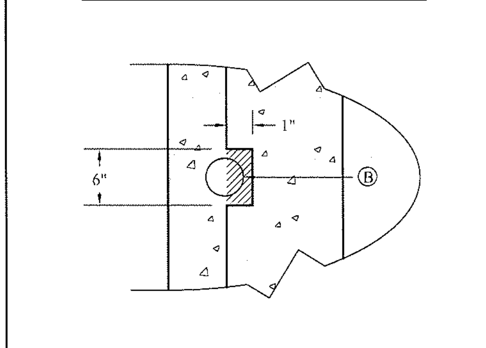
CW to BC Connection Detail



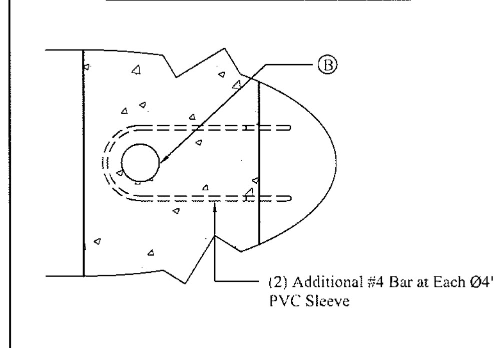
WW to BC Connection Detail



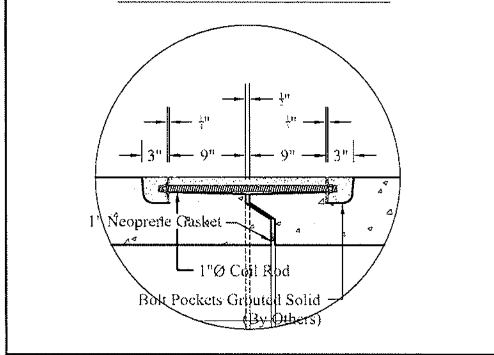
WW Sleeve Blockout Elevation Detail



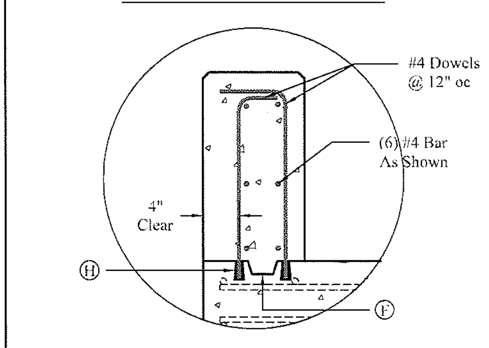
WW Sleeve Reinfrocement Detail



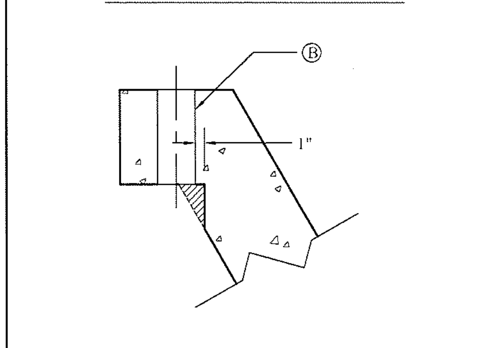
Bolt Pocket Connection Detail



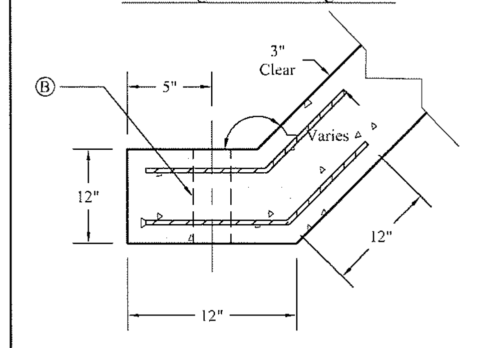
HW to BC Connection Detail



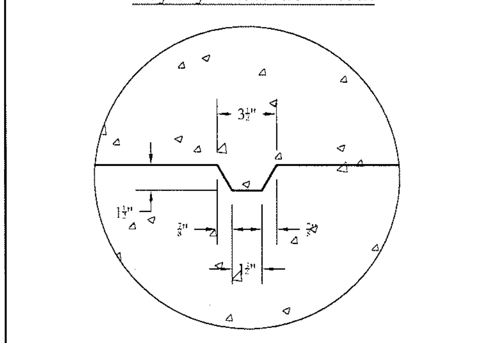
WW Sleeve Blockout Plan Detail



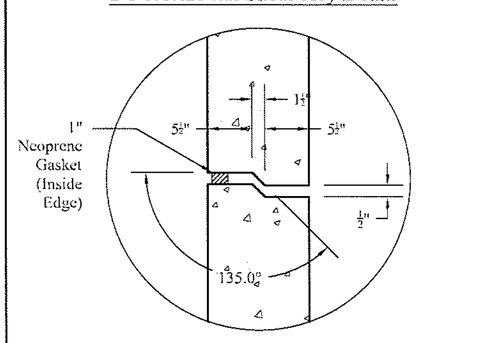
WW Angle Reinforcing Detail



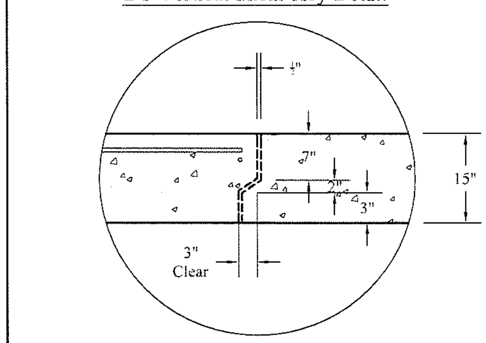
Keyway Connection Detail



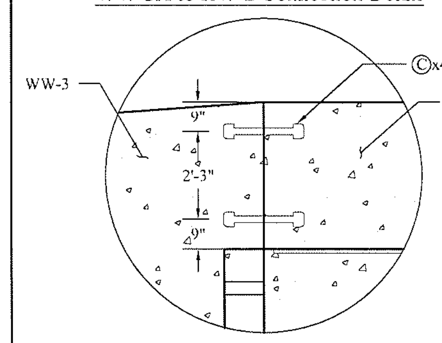
BC Horizontal Shear Key Detail



BC Vertical Shear Key Detail



WW-3A to HW-2 Connection Detail



Approx. Ce

CONTRACTORS VTSPE:

- Ⓐ 3"Ø PVC Sleeve
- Ⓑ 4"Ø PVC Sleeve
- Ⓒ Mechanical Bolt Pocket (A.L. Patterson w/ 1"Ø Coil Rod)
- Ⓓ Oxford A750-7 Lifting Device
- Ⓔ 1"Øx12" CX-9 Coil Loop Insert
- Ⓕ 1 1/2" x 3 1/2" Continuous Keyway
- Ⓖ Solid Lines Indicate ¾" Chamfer
- Ⓗ ¾" FI 64 Ferrule Insert

PRECAST CONCRETE BOX CULVERT SHOP DRAWINGS (SDI JOB #15428)		Peckham Road Corp. 1557 St. Rt. 9, #3 Lake George, NY 12845 Ph: (518) 747-3353	FABRICATOR: 193 INDUSTRIAL AVE. WILLISTON, VT 05495 Ph: (802) 658-0201 SD Ireland PRECAST
SUPERVISOR: E. Barendse DETAILER: I. ADAMS CHECKER: E. Barendse ENGINEER: G. K. Munkelt	PROJECT NAME: Bridport PROJECT #: CULV(29) Br.#2 LOCATION: Bridport, VT	02/12/15	CONNECTION_DETAILS — 8_OF_8