

DAVID EVANS & ASSOCIATES, INC

Project : [New Job]

Task :

Job No. :

Client:

File: Four Sided.etcx

Sht ____ of ____

By:

Ck:

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Spec.: LRFD 9th ed.

Type of Culvert: Cast-in-Place

Physical Dimensions

Clear Span: 12'-0"
Clear Height: 12'-0"
Top Slab: 1'-0"
Bottom Slab: 1'-0"
Ext. Wall: 1'-0"
Fill Depth: 0.00 ft
Length: 12'-0"
Skew Angle: 0.00 deg
Left Skew Angle: 90.00 deg
Right Skew Angle: 90.00 deg
Bottom Slab Support: Full Slab
Top Haunch, Width: 0"
Top Haunch, Height: 0"
Bottom Haunch, Width: 0"
Bottom Haunch, Height: 0"

Material Properties

Concrete
Strength, f_c: 5.000 ksi
Density: 0.150 kcf
Elasticity, E_c: 4287 ksi
Type: Normal wt
Steel
Yield, f_y: 60 ksi
Allow Stress: 36 ksi
Elasticity, E_s: 29000 ksi
Soil
Density: 0.120 kcf
Exposure Factor
Class 2 Exposure
Reinforcement Covers
Ext. Cover Top Slab: 2"
Ext. Cover Bottom Slab: 1"
Ext. Cover Walls: 1"
Int. Cover Walls: 1"
Int. Cover Top Slab: 1"
Int. Cover Bottom Slab: 1"

Controlling Ratings

Inventory Rating: 1.24

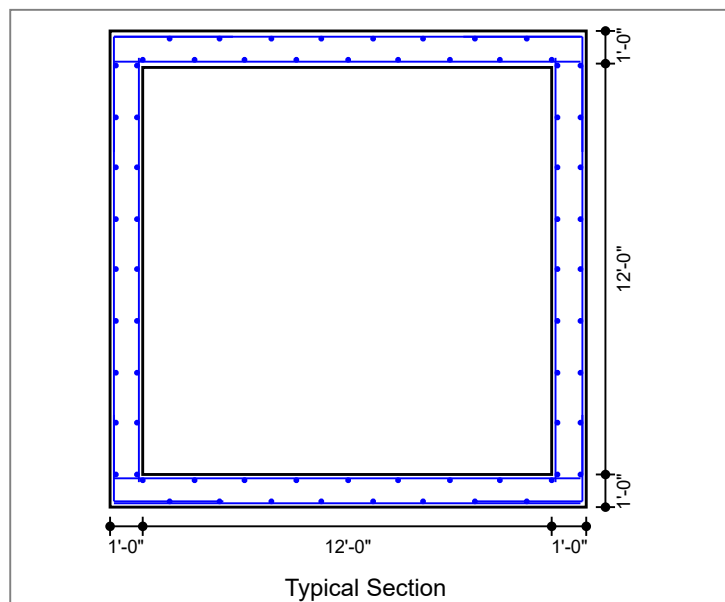
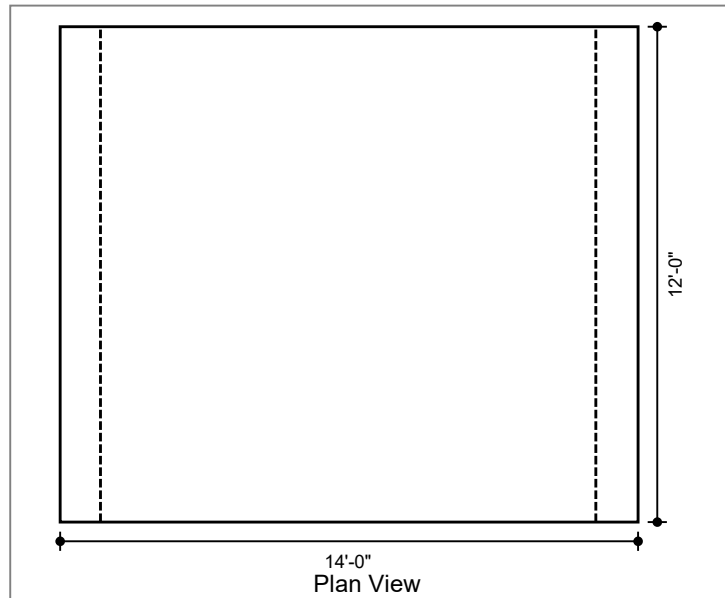
Operating Rating: 1.61

Loads

Live Load
Vehicle Names: HL-93
Traffic Direction: Parallel
Eq. Height of Soil: 2.60 ft (Calc'd)
Dead Load
Future Wearing Surface: 0.000 klf
Additional Dead Load: 0.000 klf
Concentrated Loads: none

Interior Water Pressure: no

Exterior Water Pressure: no



Lateral Soil Loads

Eq. Fluid Press. Max:

60.00 pcf

Eq. Fluid Press. Min:

30.00 pcf

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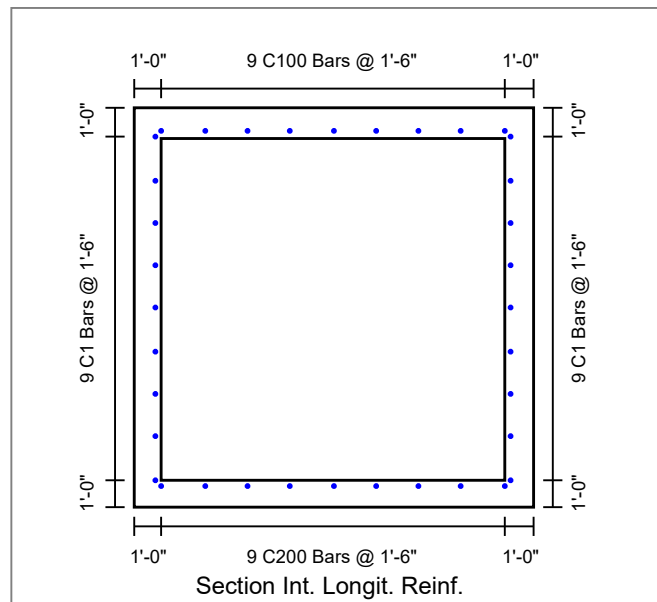
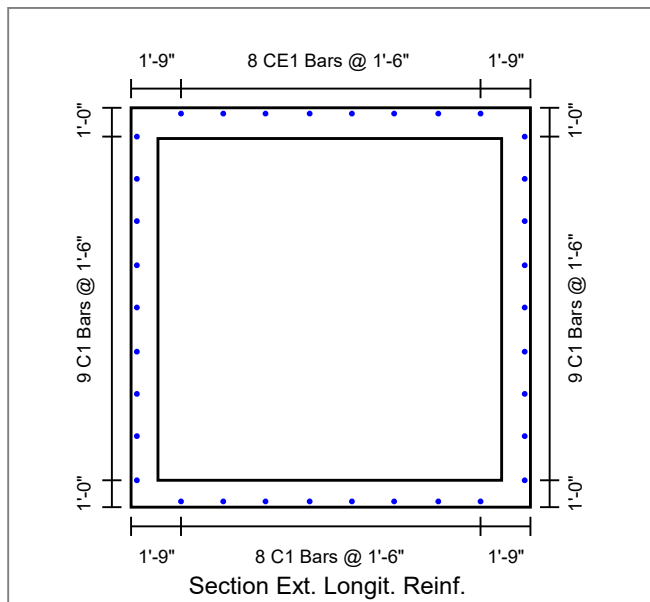
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Concrete Summary

Volume of Concrete: 1.926 cy/ft Total Volume of Concrete: 23.111 cy

Reinforcing Steel Bar Schedule (lb)

Location	Mark	Qty	Size	Spacing	Type	Length	Hor.Leg	Ver.Leg	Tot.Weight
Top Slab(Int)	A100 (AS2)	18	6	8"	S	13'-9"	--	--	372.0
Bot Slab(Int)	A200 (AS3)	16	6	9"	S	13'-9"	--	--	330.0
Top Slab(Ext)	AE300 (AS7)	13	3	11"	S	13'-9"	--	--	67.0
Bot Slab(Ext)	A400 (AS8)	13	3	11"	S	13'-9"	--	--	67.0
Corner(Top)	AE1 (AS1)	36	5	8"	L	6'-11"	3'-6"	3'-5"	260.0
Corner(Bot)	A2 (AS1)	36	5	8"	L	5'-10"	3'-3"	2'-7"	219.0
Wall(Int)	B1 (AS4)	36	4	8"	S	12'-6"	--	--	301.0
Wall(Ext)	B2 (AS1)	36	4	8"	S	12'-0"	--	--	289.0
Longit. Top (Ext)	CE1 (AS6)	8	3	1'-6"	S	11'-9"	--	--	35.0
Longit. Top (Int)	C100 (AS5)	9	6	1'-6"	S	11'-9"	--	--	159.0
Longit. Bot (Int)	C200	9	3	1'-6"	S	11'-9"	--	--	40.0
Longit. Bot (Ext)	C1 (AS6)	8	3	1'-6"	S	11'-9"	--	--	35.3
Longit. Wall (Ext)	C1 (AS6)	18	3	1'-6"	S	11'-9"	--	--	79.4
Longit. Wall (Int)	C1 (AS6)	18	3	1'-6"	S	11'-9"	--	--	79.4
									2333



Project : [New Job]

Task :

Job No. :

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File: Four Sided.etcx

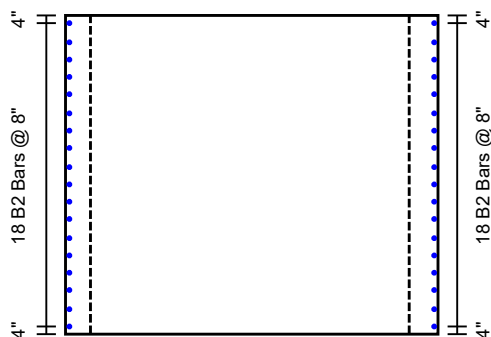
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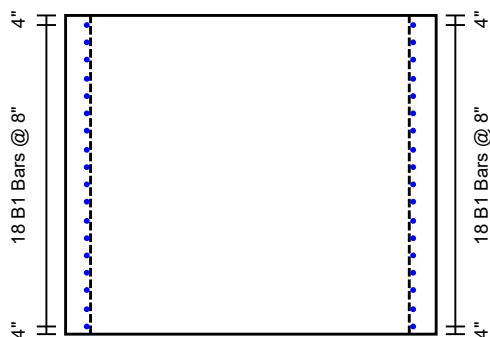
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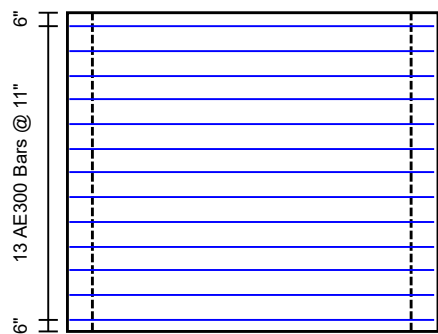
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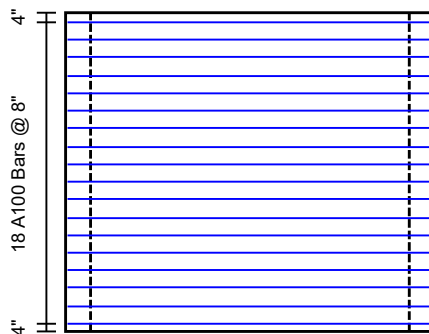
Ext. Wall Reinf.



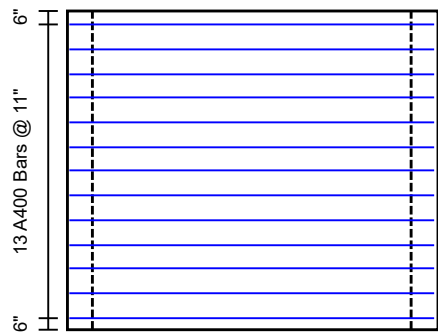
Int. Wall Reinf.



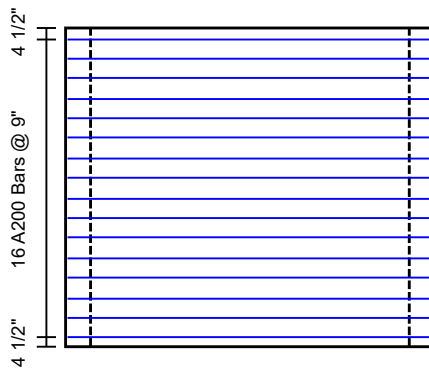
Top Slab Ext. Reinf.



Top Slab Int. Reinf.

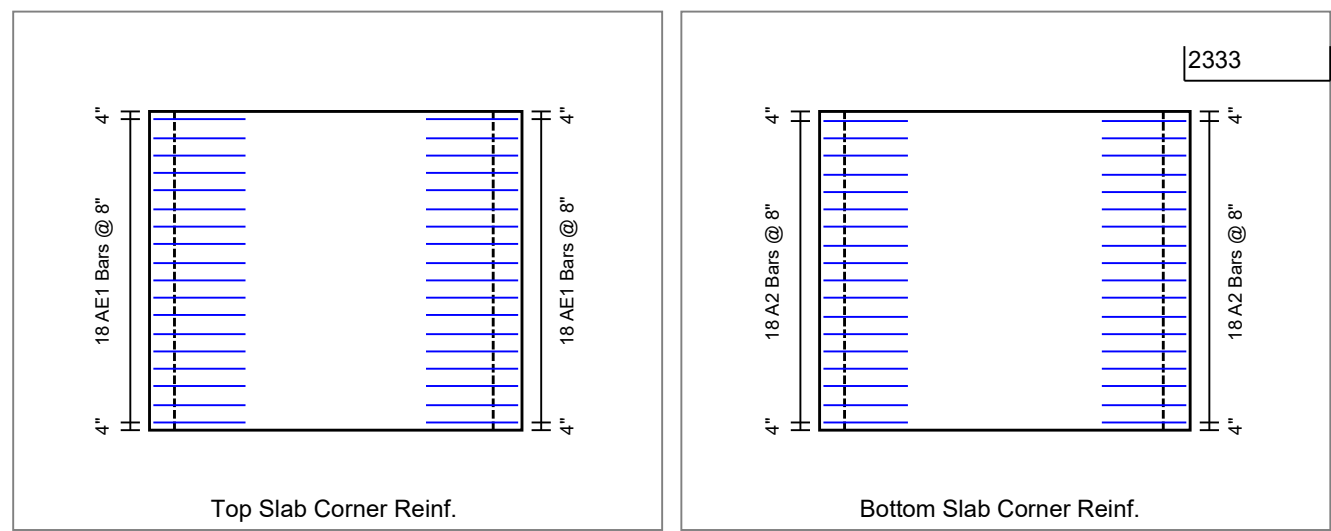


Bottom Slab Ext. Reinf.



Bottom Slab Int. Reinf.

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Project: [New Job]
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CULVERT PROPERTIES

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Type of Culvert: Cast-in-Place	Specification : LRFD 9th Edition
Operating Mode : Analysis	

Physical Dimensions

No. of Boxes: 1	Name: BoxCulvert		
Clear Span : 12.0000 ft	Fill Depth : 0.00 ft		
Clear Height: 12.0000 ft	Center Skew : 0.00 deg	Left Skew: 90.00 deg	Right Skew: 90.00 deg
Length : 12.0000 ft	Bottom Slab Support: Full Slab		
Haunches: Top, Length: 0.0000 in	Height: 0.0000 in		
Bottom, Length: 0.0000 in	Height: 0.0000 in		
Member Thicknesses:	Top Slab: 12.0000 in	Bot Slab: 12.0000 in	
	Ext wall: 12.0000 in		

Wall Joint: None

Material Properties

Concrete: Strength, f'c :	5.000 ksi	Density :	0.150 kcf	Elasticity, Ec:	4287 ksi
Type :	Normal	Weight :		Density Modification Factor :	1.00
Fr Factor :	0.24	Gamma1 :	1.60	Gamma3 :	0.75 (user defined)
Steel: Yield, fy :	60.00 ksi	fss Limit :	0.60fy	Elasticity, Es:	29000 ksi
Yield, fyv :	60.00 ksi	Diameter :	1.000 in	Type :	Rebar
Soil: Density :	0.120 kcf	Slope Factor:	1.150		
Poisson's :	0.5				
Fe Factor :	1.150 (Maximum for Compacted Fill)				
Serviceability, Gamma-e:	0.75				

Loads

Live Load: Vehicle: (AA) HL-93 - Design Vehicle

Axle No.	Weight(k)	Dist. From Previous(ft)
1	8.00	0.00
2	32.00	14.00
3	32.00	14.00

Gage width: 6.00 ft, Tread width: 20.00 in, Tread Length: 10.00 in
Include Tandem: yes
Tandem: Axle 1: 25.00 k, Axle 2: 25.00 k, Axle Spacing: 4.00 ft
Lane Load: 0.00 klf, P-Moment: 0.00 k, P-Shear: 0.00 k
Combine: Truck + Lane Or Tandem + Lane
Inventory Rating Load Factor: 1.75 Operating Rating Load Factor: 1.35
Design Load Combinations: Strength I
Override MPF: no
Override DLA: no
Include Lane Load : yes Max. No. of Lanes: Computed by Program
Traffic Direction : Lanes Parallel to Main Reinforcement
Neglect Live Load for Large Fill Depths: no
Apply Surcharge at Fill Depths > 2 ft : yes
Compute Surcharge Depth: yes

Dead Load: Future wearing Surface : 0.00 klf Add. Dead Load : 0.00 klf
Concentrated Loads : none

Lateral Soil Loads: Max. Equiv. Fluid Press.: 60.00 pcf Min. Equiv. Fluid Press. : 30.00 pcf
Include Additional Uniform Horiz. Load: no
Include Additional Uniform Vert. Load: no
Buoyancy Check : no
Fluid Pressures : Apply Water Press. : no
Foundation Model : Uniform Loads
Seismic Analysis : Do not include

Load and Resistance Factors

Max	Min		
DC: 1.250	0.900		
DW: 1.500	0.650		
EV: 1.300	0.900		
EH: 1.350	0.900		
WA: 1.000			
EQ: 1.000			
LL I : 1.750	LL II : 1.350	LL Legal : 1.750	LL Extreme : 0.500
Ductility: 1.000	Importance: 1.000	Redundancy, non-earth: 1.000	Redundancy, earth: 1.000
Condition: 1.000	System : 1.000		
Phi Shear: 0.900	Phi Moment: 1.000	PM Compression: 0.750	PM Tension : 0.900
Load Factor Multipliers, Design Mode: 1.00	Analysis Mode: 1.00		

Reinforcement Covers :	Exterior	Interior
Top Slab:	2.0000 in	1.0000 in
Walls :	1.0000 in	1.0000 in
Bot Slab:	1.0000 in	1.0000 in

Assigned reinforcement:			
Location	Mark	Size	Spacing (in)
Top Slab Inside	A100 (AS2)	6	8.0000
Bottom Slab Inside	A200 (AS3)	6	9.0000
Top Slab Outside	AE300(AS7)	3	11.0000
Bottom Slab Outside	A400 (AS8)	3	11.0000
Top Corner	AE1 (AS1)	5	8.0000
Bottom Corner	A2 (AS1)	5	8.0000
Ext. Wall Inside	B1 (AS4)	4	8.0000
Ext. wall Outside	B2 (AS1)	4	8.0000
Longitudinal	C1 (AS6)	3	18.0000
Top Distribution	C100 (AS5)	6	18.0000
Bottom Distribution	C200	3	18.0000

Analysis Options

LL Analysis : Automatically Set Traffic Direction to Account for Skew Effects: no
 Limit LL Distribution Width to Culvert Length for: None
 Combine Longitudinal Axle Distribution Overlaps: Yes, Max of 2 Axles
 Combine Transverse Axle Distribution Overlaps: No
 Axle Placement Increment for Moving Load Analysis: 20
 Include Impact on Bottom Slab: yes
 Always Distribute wheel Load: yes
 Deflection Criteria : 1/800
 Approach Slab will be Used: no

Reinforcement : Always Include Distribution Steel: no
 Distribution Slab Provided: no
 User Defined Longitudinal Steel: no, Follow Specification
 Max. AS used in Vc Calcs: 2.00 in2/ft
 Distribute Minimum Reinforcement per Face: yes
 Use individual Member Thicknesses for Min Steel: no
 Epoxy coat steel: top bars, if fill < 2'
 Use M-dimension for bar length calcs.: no

Slenderness : Checked K Factor: 2.00

Analysis Modeling : Use Haunches in the Structural Analysis Model: no

Critical Sections : Flexure critical section location: 1.5 member depth
 Shear critical section location: dv beyond support
 Use Max. Moment with Max. Shear at the Critical Section for Shear: yes
 Include depth of haunch for critical sections: no

Flexure : Ignore Axial Thrust: no
 Use Eq. 12.10.4.2.4a-1: no

Shear : Always Check Iterative Beta Method

Environmental : Apply durability factors: no

ANALYSIS RESULTS

=====

Top Slab Thickness = 12.00 in
 Bottom Slab Thickness = 12.00 in
 Exterior Wall Thickness = 12.00 in

Modular Ratio (N) = 6.76 Max. Steel Ratio = 0.025
 Design Span = 13.00 ft Design Height = 13.00 ft
 Design Fill Depth = 0.00 ft

Volume of Concrete: 1.926 cy/ft weight of Steel: 194 lb/ft

Edge beams or shear connection to adjacent slab not required per LRFD 4.6.2.10.4

M dimension = 4' 6" (method of equivalent capacity)

Reinforcing Steel Schedule

Location	Bar Mark	Qty	Size	Type	Spacing (in)	As,prv (in2/ft)	Length (ft-in)	Wgt (lbs)	H Leg (ft-in)	V Leg (ft-in)
Top Slab (int)	A100 (AS2)	18	6	STR	8.00	0.660	13- 9	372		
Bot Slab (int)	A200 (AS3)	16	6	STR	9.00	0.587	13- 9	330		
Top Slab (ext)	AE300(AS7)	13	3	STR	11.00	0.120	13- 9	67		
Bot Slab (ext)	A400 (AS8)	13	3	STR	11.00	0.120	13- 9	67		
Corner (Top)	AE1 (AS1)	36	5	L-BAR	8.00	0.465	6-11	260	3- 6	3- 5
Corner (Bottom)	A2 (AS1)	36	5	L-BAR	8.00	0.465	5-10	219	3- 3	2- 7
Ext wall (int)	B1 (AS4)	36	4	STR	8.00	0.300	12- 6	301		
Ext wall (ext)	B2 (AS1)	36	4	STR	8.00	0.300	12- 0	289		
Temperature (1)	CE1 (AS6)	8	3	STR	18.00	0.073	11- 9	35		
Top Slab (int- 1)	C100 (AS5)	9	6	STR	18.00	0.293	11- 9	159		
Bot Slab (int- 1)	C200	9	3	STR	18.00	0.073	11- 9	40		
Temperature (1)	C1 (AS6)	8	3	STR	18.00	0.073	11- 9	35		
Temperature (1)	C1 (AS6)	18	3	STR	18.00	0.073	11- 9	79		
Temperature (1)	C1 (AS6)	18	3	STR	18.00	0.073	11- 9	79		
Total								2333		

Note: A denotes flexural steel, B denotes vertical steel, C denotes longitudinal steel

AS Bar Marks

Location	As prv in2/ft
Transverse Side Wall - Outside Face (AS1)	0.465
Transverse Top Slab - Inside Face (AS2)	0.660
Transverse Bottom Slab - Inside Face (AS3)	0.587
Transverse Side wall - Inside Face (AS4)	0.300
Distribution Top Slab - Inside Face (AS5)	0.293
Distribution Top Slab - Outside Face (AS6)	0.073
Transverse Top Slab - Outside Face (AS7)	0.120
Transverse Bottom Slab - Outside Face (AS8)	0.120

Notes: 1.) Final areas of steel provided must be checked in analysis mode

Splice Lengths Table:

Bar Mark	Size	Splice Length (ft-in)
B1	4	1- 5
C1	3	1- 4
CE1	3	1- 7
C100	6	2- 2
C200	3	1- 4

Summary of Ratings Table:

Truck	Flexure					Shear				
	Fill	Member	Location	IR	OR	Fill	Member	Location	IR	OR
(AA) HL-93	0.00	2	MID	1.28	1.66	0.00	2	LT	1.24	1.61

Critical Sections Summary: Flexure

Member 1: (Exterior wall), Thickness = 12.00 in

Loc	Dist. (in)	Design Moment (k-ft)	Corr. A. F. (k)	Mu (k-ft)	ds (in)	Ma (k-ft)	phi	As (in2)	Mcr (k-ft)	Load Ratings		Truck	Fill Depth (ft)
										IR	OR		
BOT	6.00	-17.04	13.35	24.21	10.69	25.92	0.90	0.47	15.46	1.91	2.48	AA	0.00

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	MID	MID-	TOP	Dist.	78.00	78.00	6.00	10.00	-8.22	-15.69	0.88	13.35	13.35	15.86	15.86	24.21	10.75	10.75	10.69	14.55	18.49	25.92	0.90	0.90	0.90	0.30	0.30	0.47	15.46	15.46	15.46	NC	NC	1.81	1.81	AA	AA	AA	0.00	0.00	0.00

Member 2: (Top Slab), Thickness = 12.00 in

Loc	Dist.	Design Moment	Corr. A. F.	Mu	ds	Ma	phi	As	Mcr	Load Ratings IR	OR	Truck	Fill Depth
	(in)	(k-ft)	(k)	(k-ft)	(in)	(k-ft)		(in2)	(k-ft)				(ft)
LT	6.00	-14.02	4.29	21.89	9.69	21.07	0.90	0.47	15.46	1.69	2.19	AA	0.00
MID	78.00	24.15	0.46	33.78	10.63	30.54	0.90	0.66	15.46	1.28	1.66	AA	0.00
RT	6.00	-14.02	4.29	21.89	9.69	21.07	0.90	0.47	15.46	1.69	2.19	AA	0.00

Member 4: (Bottom Slab), Thickness = 12.00 in

Loc	Dist.	Design Moment	Corr. A. F.	Mu	ds	Ma	phi	As	Mcr	Load Ratings IR	OR	Truck	Fill Depth
	(in)	(k-ft)	(k)	(k-ft)	(in)	(k-ft)		(in2)	(k-ft)				(ft)
LT	6.00	-15.10	7.44	24.21	10.69	24.09	0.90	0.47	15.46	2.16	2.79	AA	0.00
MID	78.00	21.82	2.42	30.15	10.63	27.87	0.90	0.59	15.46	1.36	1.77	AA	0.00
RT	6.00	-15.10	7.44	24.21	10.69	24.09	0.90	0.47	15.46	2.16	2.79	AA	0.00

Critical Sections Summary: Vertical Shear

Member 1: (Exterior Wall), Thickness = 12.00 in

Loc	Dist.	Design Shear	Corr. Moment	Corr. A. F.	Dv	phi*Vn	Beta	Vc	Vs	Av	Max. Spac	Load Ratings IR	OR	Truck	Fill Depth
	(in)	(k)	(k-ft)	(k)	(in)			(k)	(k)	(in2)	(in)				(ft)
BOT	15.45	5.75	-17.0	13.35	10.41	16.46	2.071	18.28 a	0.00	0.00	0.00	6.62	8.58	AA	0.00
MID	78.00	0.53	10.0	0.88	10.57	16.17	2.004	17.97 a	0.00	0.00	0.00	99.99	99.99	AA	0.00
MID-	78.00	0.53	-8.2	13.35	10.57	26.16	3.242	29.06 a	0.00	0.00	0.00	79.47	99.99	AA	0.00
TOP	15.45	-3.82	-15.7	13.35	10.41	17.51	2.203	19.46 a	0.00	0.00	0.00	10.80	13.99	AA	0.00

Member 2: (Top Slab), Thickness = 12.00 in

Loc	Dist.	Design Shear	Corr. Moment	Corr. A. F.	Dv	phi*Vn	Beta	Vc	Vs	Av	Max. Spac	Load Ratings IR	OR	Truck	Fill Depth
	(in)	(k)	(k-ft)	(k)	(in)			(k)	(k)	(in2)	(in)				(ft)
LT	14.64	11.74	-14.0	4.29	9.41	14.37	2.000	15.96 b	0.00	0.00	0.00	1.24	1.61	AA	0.00
MID	78.00	4.55	24.2	0.46	10.24	15.62	2.000	17.36 b	0.00	0.00	0.00	3.43	4.45	AA	0.00
RT	14.64	11.74	-14.0	4.29	9.41	14.37	2.000	15.96 b	0.00	0.00	0.00	1.24	1.61	AA	0.00

Member 4: (Bottom Slab), Thickness = 12.00 in

Loc	Dist.	Design Shear	Corr. Moment	Corr. A. F.	Dv	phi*Vn	Beta	Vc	Vs	Av	Max. Spac	Load Ratings IR	OR	Truck	Fill Depth
	(in)	(k)	(k-ft)	(k)	(in)			(k)	(k)	(in2)	(in)				(ft)
LT	15.45	8.97	-15.1	7.44	10.41	15.89	2.000	17.66 b	0.00	0.00	0.00	2.15	2.79	AA	0.00
MID	78.00	0.11	21.8	2.42	10.28	15.69	2.000	17.43 b	0.00	0.00	0.00	99.99	99.99	AA	0.00
RT	15.45	8.97	-15.1	7.44	10.41	15.89	2.000	17.66 b	0.00	0.00	0.00	2.15	2.79	AA	0.00

Vc Calculation By: a - Iterative Beta, b - Constant Beta, c - Box Culvert, d - Standard/Arema

Analysis Results: Fill Depth = 0.00 ft

Load Parameters:

Fe = 1.00 Surcharge Depth : 2.60 ft

Applied Horizontal Loads: (k/ft)

Load Description	Bottom of wall	Top of wall
Live Load Surcharge	0.156	0.156
Internal Water Pressure	0.000(0.0in)	0.000(0.0in)
External Water Pressure	0.000(0.0in)	0.000(0.0in)
Horizontal Earth Load	0.810	0.030

Applied Uniform Bottom Slab Loads: (k/ft)

Load Description	
Dead Load	0.450
Vertical Earth	0.000
Wearing Surface	0.000

Unfactored Moments due to All Loads: (k-ft)

M-PT	Mdc	Mev	Mdw	Meh	Mls	Mwa	Mgw
Member 1: (Exterior wall)							
Bottom							
1- 0	-3.69	0.00	0.00	-3.22	-1.10	0.00	0.00
1- 1	-3.38	0.00	0.00	0.83	0.09	0.00	0.00
1- 2	-3.06	0.00	0.00	3.64	1.01	0.00	0.00
1- 3	-2.75	0.00	0.00	5.34	1.67	0.00	0.00
1- 4	-2.43	0.00	0.00	6.08	2.07	0.00	0.00
1- 5	-2.11	0.00	0.00	5.97	2.20	0.00	0.00
1- 6	-1.80	0.00	0.00	5.15	2.07	0.00	0.00
1- 7	-1.48	0.00	0.00	3.76	1.67	0.00	0.00
1- 8	-1.16	0.00	0.00	1.91	1.01	0.00	0.00
1- 9	-0.85	0.00	0.00	-0.24	0.09	0.00	0.00
1-10	-0.53	0.00	0.00	-2.58	-1.10	0.00	0.00
Top							

Unfactored Shears due to All Loads: (k)

M-PT	Vdc	Vev	Vdw	Veh	Vls	Vwa	Vgw
Member 1: (Exterior wall)							
Bottom							
1- 0	0.24	0.00	0.00	3.62	1.01	0.00	0.00
1- 1	0.24	0.00	0.00	2.61	0.81	0.00	0.00
1- 2	0.24	0.00	0.00	1.71	0.61	0.00	0.00
1- 3	0.24	0.00	0.00	0.91	0.41	0.00	0.00
1- 4	0.24	0.00	0.00	0.22	0.20	0.00	0.00
1- 5	0.24	0.00	0.00	-0.38	0.00	0.00	0.00
1- 6	0.24	0.00	0.00	-0.88	-0.20	0.00	0.00
1- 7	0.24	0.00	0.00	-1.27	-0.41	0.00	0.00
1- 8	0.24	0.00	0.00	-1.56	-0.61	0.00	0.00
1- 9	0.24	0.00	0.00	-1.75	-0.81	0.00	0.00
1-10	0.24	0.00	0.00	-1.84	-1.01	0.00	0.00
Top							

Member 2: (Top Slab)

Left														
2- 0	-0.53	0.00	0.00	-2.69	-1.10	0.00	0.00	0.98	0.00	0.00	0.00	0.00	0.00	0.00
2- 1	0.61	0.00	0.00	-2.69	-1.10	0.00	0.00	0.78	0.00	0.00	0.00	0.00	0.00	0.00
2- 2	1.50	0.00	0.00	-2.69	-1.10	0.00	0.00	0.59	0.00	0.00	0.00	0.00	0.00	0.00
2- 3	2.13	0.00	0.00	-2.69	-1.10	0.00	0.00	0.39	0.00	0.00	0.00	0.00	0.00	0.00
2- 4	2.51	0.00	0.00	-2.69	-1.10	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00
2- 5	2.64	0.00	0.00	-2.69	-1.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2- 6	2.51	0.00	0.00	-2.69	-1.10	0.00	0.00	-0.20	0.00	0.00	0.00	0.00	0.00	0.00
2- 7	2.13	0.00	0.00	-2.69	-1.10	0.00	0.00	-0.39	0.00	0.00	0.00	0.00	0.00	0.00
2- 8	1.50	0.00	0.00	-2.69	-1.10	0.00	0.00	-0.59	0.00	0.00	0.00	0.00	0.00	0.00
2- 9	0.61	0.00	0.00	-2.69	-1.10	0.00	0.00	-0.78	0.00	0.00	0.00	0.00	0.00	0.00
2-10	-0.53	0.00	0.00	-2.69	-1.10	0.00	0.00	-0.98	0.00	0.00	0.00	0.00	0.00	0.00
Right														

Member 4: (Bottom Slab)

Left														
4- 0	-3.69	0.00	0.00	-3.22	-1.10	0.00	0.00	2.93	0.00	0.00	0.00	0.00	0.00	0.00
4- 1	-0.27	0.00	0.00	-3.22	-1.10	0.00	0.00	2.34	0.00	0.00	0.00	0.00	0.00	0.00
4- 2	2.39	0.00	0.00	-3.22	-1.10	0.00	0.00	1.76	0.00	0.00	0.00	0.00	0.00	0.00
4- 3	4.29	0.00	0.00	-3.22	-1.10	0.00	0.00	1.17	0.00	0.00	0.00	0.00	0.00	0.00
4- 4	5.43	0.00	0.00	-3.22	-1.10	0.00	0.00	0.59	0.00	0.00	0.00	0.00	0.00	0.00
4- 5	5.81	0.00	0.00	-3.22	-1.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4- 6	5.43	0.00	0.00	-3.22	-1.10	0.00	0.00	-0.59	0.00	0.00	0.00	0.00	0.00	0.00
4- 7	4.29	0.00	0.00	-3.22	-1.10	0.00	0.00	-1.17	0.00	0.00	0.00	0.00	0.00	0.00
4- 8	2.39	0.00	0.00	-3.22	-1.10	0.00	0.00	-1.76	0.00	0.00	0.00	0.00	0.00	0.00
4- 9	-0.27	0.00	0.00	-3.22	-1.10	0.00	0.00	-2.34	0.00	0.00	0.00	0.00	0.00	0.00
4-10	-3.69	0.00	0.00	-3.22	-1.10	0.00	0.00	-2.93	0.00	0.00	0.00	0.00	0.00	0.00
Right														

Unfactored Thrusts due to All Loads: (k)

Member	Pdc	Pev	Pdw	Peh	Pls	Pwa
1	0.98	0.00	0.00	0.00	0.00	0.00
2	-0.24	0.00	0.00	1.84	1.01	0.00
4	0.24	0.00	0.00	3.62	1.01	0.00

Analysis Truck, HL-93

Vehicle	Axle No.	Weight (k/ft)	Length (ft)	Dist. From Previous (ft)
Truck	1	1.623	0.83	
	2	6.492	0.83	14.00
	3	6.492	0.83	14.00

Tandem	1	5.072	0.83	
	2	5.072	0.83	4.00

Live Load Parameters:

Traffic Direction is Parallel to Main Reinforcement
 Distribution Width : 4.72 ft
 Note: Distribution width is calculated for one wheel only.
 Impact Factor : 1.33
 Truck MPF : 1.20 Tandem MPF : 1.20
 Lane Load Distribution Width : 10.72 ft
 Lane Load: 0.000 k/ft

Truck Positions That Cause Maximum Results:

Maximum +Moment in Top Slab					Maximum -Moment in Top Slab				
Vehicle	Axle No.	Weight (klf)	Length (ft)	Dist. From Left End (ft)	Vehicle	Axle No.	Weight (klf)	Length (ft)	Dist. From Left End (ft)
Truck	1	1.623	0.83	20.50	Truck	1	1.623	0.83	19.85
	2	6.492	0.83	6.50		2	6.492	0.83	5.85
	3	6.492	0.83	-7.50		3	6.492	0.83	-8.15
Maximum +Moment : 12.27 k-ft					Maximum -Moment : -4.80 k-ft				
Corresponding Moment at End : -4.75 k-ft					Corresponding Moment at Mid : 11.13 k-ft				
Coincident Bottom Slab Load : 0.42 k/ft					Coincident Bottom Slab Load : 0.42 k/ft				
Maximum +Shear in Top Slab					Maximum -Shear in Top Slab				
Truck	1	1.623	0.83	14.42	Truck	1	1.623	0.83	26.58
	2	6.492	0.83	0.42		2	6.492	0.83	12.58
	3	6.492	0.83	-13.58		3	6.492	0.83	-1.42
Maximum +Shear : 5.25 k					Maximum -Shear : -5.25 k				
Corresponding Shear at Mid : -0.16 k					Corresponding Shear at Mid : 0.16 k				
Coincident Bottom Slab Load : 0.42 k/ft					Coincident Bottom Slab Load : 0.42 k/ft				
Maximum +Moment in Top Slab					Maximum -Moment in Top Slab				
Tandem	1	5.072	0.83	10.27	Tandem	1	5.072	0.83	8.97
	2	5.072	0.83	6.27		2	5.072	0.83	4.97
Maximum +Moment : 12.95 k-ft					Maximum -Moment : -6.65 k-ft				
Corresponding Moment at End : -5.69 k-ft					Corresponding Moment at Mid : 12.45 k-ft				
Coincident Bottom Slab Load : 0.65 k/ft					Coincident Bottom Slab Load : 0.65 k/ft				
Maximum +Shear in Top Slab					Maximum -Shear in Top Slab				
Tandem	1	5.072	0.83	4.42	Tandem	1	5.072	0.83	12.58
	2	5.072	0.83	0.42		2	5.072	0.83	8.58
Maximum +Shear : 6.93 k					Maximum -Shear : -6.93 k				
Corresponding Shear at Mid : -1.52 k					Corresponding Shear at Mid : 1.52 k				
Coincident Bottom Slab Load : 0.65 k/ft					Coincident Bottom Slab Load : 0.65 k/ft				

Unfactored Moments and Shears due to Truck Loads: (k-ft, k)

M-PT	M11+	Truck M11-	V11+	V11-	M11+	Tandem M11-	V11+	V11-	M11+	Lane M11-	V11+	V11-
Member 1: (Exterior wall)												
Bottom												
1- 0	0.00	-3.62	0.28	-0.17	0.00	-5.16	0.22	-0.19	0.00	0.00	0.00	0.00
1- 1	0.00	-3.37	0.28	-0.17	0.00	-5.00	0.22	-0.19	0.00	0.00	0.00	0.00
1- 2	0.00	-3.35	0.28	-0.17	0.00	-4.97	0.22	-0.19	0.00	0.00	0.00	0.00
1- 3	0.00	-3.44	0.28	-0.17	0.00	-5.09	0.22	-0.19	0.00	0.00	0.00	0.00
1- 4	0.00	-3.60	0.28	-0.17	0.00	-5.28	0.22	-0.19	0.00	0.00	0.00	0.00
1- 5	0.00	-3.78	0.28	-0.17	0.00	-5.49	0.22	-0.19	0.00	0.00	0.00	0.00
1- 6	0.00	-3.97	0.28	-0.17	0.00	-5.71	0.22	-0.19	0.00	0.00	0.00	0.00
1- 7	0.00	-4.17	0.28	-0.17	0.00	-5.94	0.22	-0.19	0.00	0.00	0.00	0.00
1- 8	0.00	-4.38	0.28	-0.17	0.00	-6.18	0.22	-0.19	0.00	0.00	0.00	0.00
1- 9	0.01	-4.59	0.28	-0.17	0.01	-6.42	0.22	-0.19	0.00	0.00	0.00	0.00
1-10	0.21	-4.80	0.28	-0.17	0.17	-6.65	0.22	-0.19	0.00	0.00	0.00	0.00
Top												
Member 2: (Top Slab)												
Left												
2- 0	0.21	-4.80	5.25	0.00	0.17	-6.65	6.93	0.00	0.00	0.00	0.00	0.00
2- 1	4.29	-1.57	4.75	-0.33	3.35	-1.75	6.09	-0.26	0.00	0.00	0.00	0.00
2- 2	7.67	0.00	4.22	-0.85	7.70	0.00	5.23	-0.66	0.00	0.00	0.00	0.00
2- 3	10.19	0.00	3.66	-1.39	11.02	0.00	4.35	-1.09	0.00	0.00	0.00	0.00
2- 4	11.74	0.00	3.09	-1.95	12.78	0.00	3.47	-1.76	0.00	0.00	0.00	0.00
2- 5	12.27	0.00	2.52	-2.52	12.95	0.00	2.60	-2.60	0.00	0.00	0.00	0.00
2- 6	11.74	0.00	1.95	-3.09	12.78	0.00	1.76	-3.47	0.00	0.00	0.00	0.00
2- 7	10.19	0.00	1.39	-3.66	11.02	0.00	1.09	-4.35	0.00	0.00	0.00	0.00

Sht: ____ of ____
By: Chk: ____
3/8/2023 1:21:35 PM
Culvert p. 7 of 9

Serviceability Check: Crack Control

Bar Mark	Location	Moment (k-ft)	Thrust (k)	Fss (ksi)	Spacing (in)	Allow (in)
A1	Top Corner Bar	-9.5	7.91	16.50	8.00	24.45
A2	Bot Corner Bar	-11.2	7.91	20.68	8.00	18.98
A100	Top Slab (int)	14.2	0.40	26.12	8.00	14.21
A200	Bot Slab (int)	13.8	1.86	27.03	9.00	13.64
B1	Ext wall (int)	6.1	0.98	22.17	8.00	17.80
B2	Ext wall (ext)	-4.7	7.91	6.25	8.00	69.51

Strength Limit State at Critical Sections: Flexure

Member 1: (Exterior wall), Thickness = 12.00 in

Loc	Dist. (in)	Design Moment (k-ft)	Corr. A. F. (k)	Mu (k-ft)	ds (in)	Ma (k-ft)	phi	As (in2)	Mcr (k-ft)	Load Ratings IR	OR
BOT	6.00	-17.04	13.35	24.21	10.69	25.92	0.90	0.47	15.46	1.91	2.48
MID	78.00	10.00	0.88	15.86	10.75	14.55	0.90	0.30	15.46	NC	NC
MID-	78.00	-8.22	13.35	15.86	10.75	18.49	0.90	0.30	15.46	1.81	2.35
TOP	6.00	-15.69	13.35	24.21	10.69	25.92	0.90	0.47	15.46	1.81	2.35

Member 2: (Top Slab), Thickness = 12.00 in

Loc	Dist. (in)	Design Moment (k-ft)	Corr. A. F. (k)	Mu (k-ft)	ds (in)	Ma (k-ft)	phi	As (in2)	Mcr (k-ft)	Load Ratings IR	OR
LT	6.00	-14.02	4.29	21.89	9.69	21.07	0.90	0.47	15.46	1.69	2.19
MID	78.00	24.15	0.46	33.78	10.63	30.54	0.90	0.66	15.46	1.28	1.66
RT	6.00	-14.02	4.29	21.89	9.69	21.07	0.90	0.47	15.46	1.69	2.19

Member 4: (Bottom Slab), Thickness = 12.00 in

Loc	Dist. (in)	Design Moment (k-ft)	Corr. A. F. (k)	Mu (k-ft)	ds (in)	Ma (k-ft)	phi	As (in2)	Mcr (k-ft)	Load Ratings IR	OR
LT	6.00	-15.10	7.44	24.21	10.69	24.09	0.90	0.47	15.46	2.16	2.79
MID	78.00	21.82	2.42	30.15	10.63	27.87	0.90	0.59	15.46	1.36	1.77
RT	6.00	-15.10	7.44	24.21	10.69	24.09	0.90	0.47	15.46	2.16	2.79

Notes: Mu - Resisting moment under pure flexure, Ma - Allowable moment under applied axial load

Strength Limit State at Critical Sections: Vertical Shear

Member 1: (Exterior wall), Thickness = 12.00 in

Loc	Dist. (in)	Design Shear (k)	Corr. Moment (k-ft)	Corr. A. F. (k)	Dv (in)	phi*Vn (k)	Beta	Theta	Vc (k)	Vs (k)	Av (in2)	Max. Spac (in)	Load Ratings IR	OR
BOT	15.45	5.75	-17.0	13.35	10.41	16.46	2.071	41.52	18.28	a	0.00	0.00	6.62	8.58
MID	78.00	0.53	10.0	0.88	10.57	16.17	2.004	42.12	17.97	a	0.00	0.00	99.99	99.99
MID-	78.00	0.53	-8.2	13.35	10.57	26.16	3.242	34.97	29.06	a	0.00	0.00	79.47	99.99
TOP	15.45	-3.82	-15.7	13.35	10.41	17.51	2.203	40.52	19.46	a	0.00	0.00	10.80	13.99

Member 2: (Top Slab), Thickness = 12.00 in

Loc	Dist. (in)	Design Shear (k)	Corr. Moment (k-ft)	Corr. A. F. (k)	Dv (in)	phi*Vn (k)	Beta	Theta	Vc (k)	Vs (k)	Av (in2)	Max. Spac (in)	Load Ratings IR	OR
LT	14.64	11.74	-14.0	4.29	9.41	14.37	2.000	45.00	15.96	b	0.00	0.00	1.24	1.61
MID	78.00	4.55	24.2	0.46	10.24	15.62	2.000	45.00	17.36	b	0.00	0.00	3.43	4.45
RT	14.64	11.74	-14.0	4.29	9.41	14.37	2.000	45.00	15.96	b	0.00	0.00	1.24	1.61

Member 4: (Bottom Slab), Thickness = 12.00 in

Loc	Dist. (in)	Design Shear (k)	Corr. Moment (k-ft)	Corr. A. F. (k)	Dv (in)	phi*Vn (k)	Beta	Theta	Vc (k)	Vs (k)	Av (in2)	Max. Spac (in)	Load Ratings IR	OR
LT	15.45	8.97	-15.1	7.44	10.41	15.89	2.000	45.00	17.66	b	0.00	0.00	2.15	2.79
MID	78.00	0.11	21.8	2.42	10.28	15.69	2.000	45.00	17.43	b	0.00	0.00	99.99	99.99
RT	15.45	8.97	-15.1	7.44	10.41	15.89	2.000	45.00	17.66	b	0.00	0.00	2.15	2.79

Vc Calculation By: a - Iterative Beta, b - Constant Beta, c - Box Culvert, d - Standard/Arema

	M-PT	+Moment	-Moment	+Axial	-Axial	+Shear	-Shear
Member 1: (Exterior wall)							
Bottom							
1- 0		-5.501	-19.930	0.877	13.347	7.442	2.416
1- 1		-1.772	-12.419	0.877	13.347	5.734	1.740
1- 2		3.924	-10.067	0.877	13.347	4.163	1.132
1- 3		7.667	-8.732	0.877	13.347	2.729	0.592
1- 4		9.633	-8.166	0.877	13.347	1.432	0.121
1- 5		10.003	-8.215	0.877	13.347	0.529	-0.539
1- 6		8.953	-8.764	0.877	13.347	0.194	-1.563
1- 7		6.661	-9.715	0.877	13.347	-0.071	-2.450
1- 8		3.305	-10.974	0.877	13.347	-0.269	-3.199
1- 9		-0.926	-12.459	0.877	13.347	-0.398	-3.812
1-10		-2.033	-17.715	1.219	13.347	-0.458	-4.288
Top							
Member 2: (Top slab)							
Left							
2- 0		-2.107	-17.864	0.458	4.288	13.347	0.877
2- 1		6.460	-7.857	0.458	4.288	11.639	0.389
2- 2		13.537	-4.208	0.458	4.045	9.883	-0.755
2- 3		20.128	-3.638	0.458	4.045	8.102	-1.946
2- 4		23.681	-3.295	0.458	4.045	6.318	-3.169
2- 5		24.151	-3.181	0.458	4.045	4.552	-4.552
2- 6		23.681	-3.295	0.458	4.045	3.169	-6.318
2- 7		20.128	-3.638	0.458	4.045	1.946	-8.102
2- 8		13.537	-4.208	0.458	4.045	0.755	-9.883
2- 9		6.460	-7.857	0.458	4.288	-0.389	-11.639
2-10		-2.107	-17.864	0.458	4.288	-0.877	-13.347
Right							
Member 4: (Bottom slab)							
Left							
4- 0		-5.501	-19.930	2.660	7.442	11.154	2.632
4- 1		-0.973	-7.384	2.416	7.442	8.944	2.106
4- 2		9.008	-4.124	2.416	6.875	6.733	1.580
4- 3		16.131	-2.413	2.416	6.875	4.523	1.053
4- 4		20.402	-1.386	2.416	6.875	2.312	0.526
4- 5		21.825	-1.044	2.416	6.875	0.109	-0.109
4- 6		20.402	-1.386	2.416	6.875	-0.526	-2.312
4- 7		16.131	-2.413	2.416	6.875	-1.053	-4.523
4- 8		9.008	-4.124	2.416	6.875	-1.580	-6.733
4- 9		-0.973	-7.384	2.416	7.442	-2.106	-8.944
4-10		-5.501	-19.930	2.660	7.442	-2.632	-11.154
Right							