RIMROCKENGINEERING
9080 W. Cheyenne Ave., Ste. 120
Las Vegas, NV 89129
Ph: (702) 838-5311
Fx: (702) 838-5339
www.RimRockEngineering.com

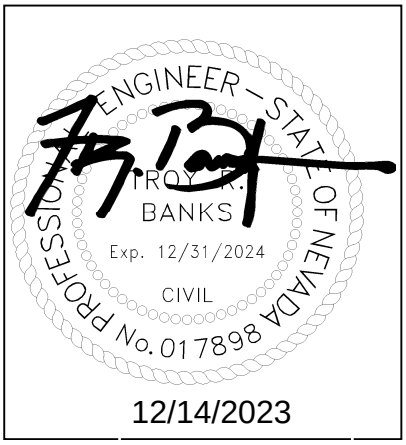
Structural Calculations

Project: MONTALADO NORTH
LAS VEGAS, NV

Project No.: 21-481-08
Date: December 14, 2023

Sheet Index

Troy Banks
Digitally signed by Troy Banks
DN: C=US, E=troy.banks@gmail.com, CN=Troy Banks
Date: 2023.12.14 22:07:46-07'00'



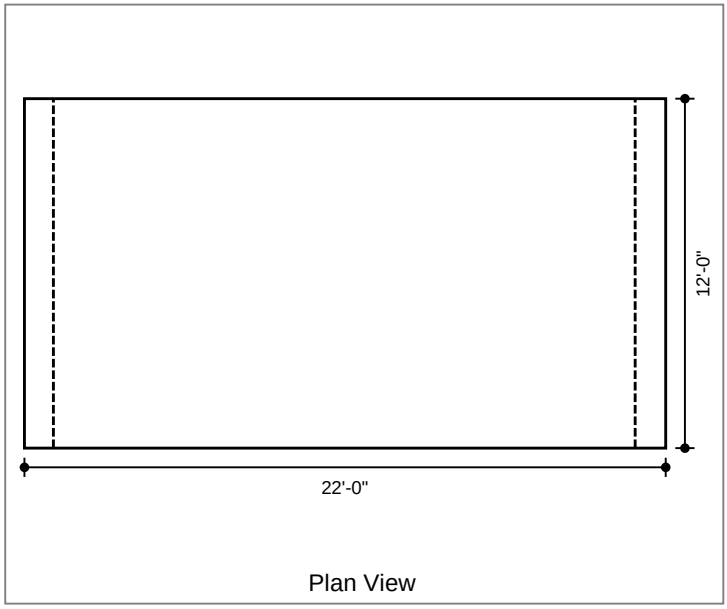
12/14/2023

TRB ENGINEERING LLC
TROY.BANKS@GMAIL.COM 801-786-9292

Spec.: LRFD 8th ed.
Type of Culvert: Cast-in-Place

Physical Dimensions

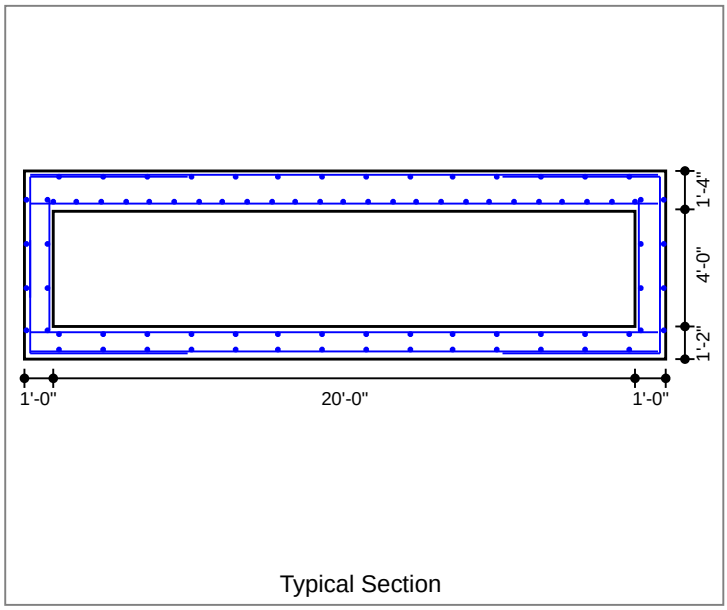
Clear Span:	20'-0"
Clear Height:	4'-0"
Top Slab:	1'-4"
Bottom Slab:	1'-2"
Ext. Wall:	1'-0"
Fill Depth Range	
Maximum:	1.99 ft
Minimum:	0.50 ft
Increment:	2.00 ft
Length:	12'-0"
Skew Angle:	0.00 deg
Left Skew Angle:	90.00 deg
Right Skew Angle:	90.00 deg
Bottom Slab Support:	Full Slab
Top Haunch, Width:	0"
Top Haunch, Height:	0"
Bottom Haunch, Width:	0"
Bottom Haunch, Height:	0"



Plan View

Material Properties

Concrete	
Strength, f'c:	5.000 ksi
Density:	0.150 kcf
Elasticity, Ec:	4592 ksi
Type:	Normal wt
Steel	
Yield, fy:	60 ksi
Allow Stress:	54 ksi
Elasticity, Es:	29000 ksi
Soil	
Density:	0.135 kcf
Exposure Factor	
Class 2 Exposure	
Reinforcement Covers	
Ext. Cover Top Slab:	2"
Ext. Cover Bottom Slab	3"
Ext. Cover Walls	2"
Int. Cover Walls	2"
Int. Cover Top Slab	2"
Int. Cover Bottom Slab	2"



Typical Section

Controlling Ratings

Inventory Rating: 1.11
Operating Rating: 1.44

Loads

Live Load	
Vehicle Names:	HL-93
Traffic Direction:	Parallel
Eq. Height of Soil:	Calculated
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

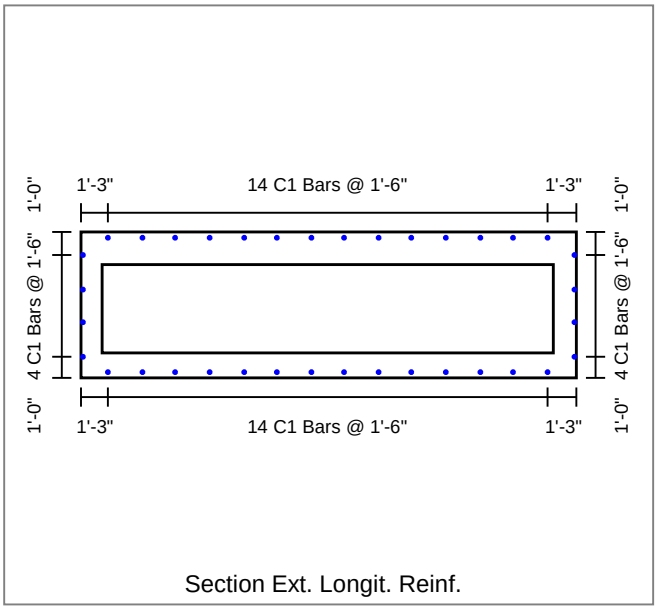
Lateral Soil Loads

Eq. Fluid Press. Max:	60.00 pcf
Eq. Fluid Press. Min:	35.00 pcf

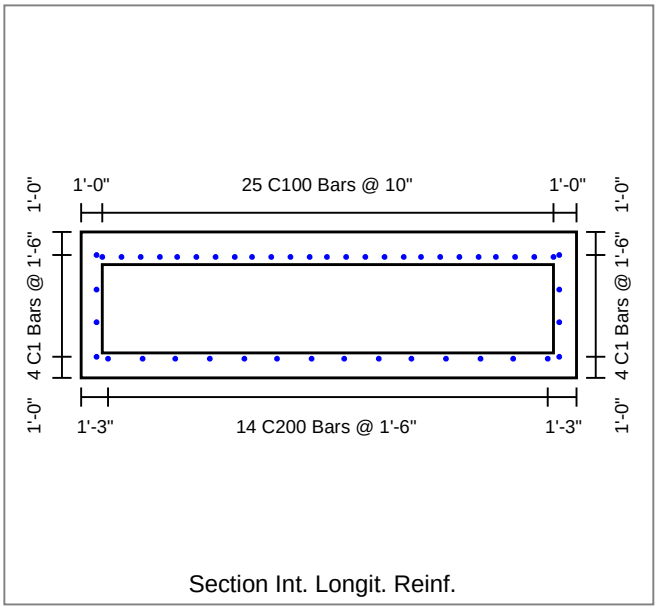
Concrete Summary
Volume of Concrete: 2.333 cy/ft Total Volume of Concrete: 28.000 cy

Reinforcing Steel Bar Schedule (lb)

Location	Mark	Qty	Size	Spacing	Type	Length	Hor.Leg	Ver.Leg	Tot.Weight
Top Slab(Int)	A100 (AS2)	24	6	6"	S	21'-7"	--	--	778.0
Bot Slab(Int)	A200 (AS3)	24	6	6"	S	21'-7"	--	--	778.0
Top Slab(Ext)	A300 (AS7)	12	5	1'-0"	S	21'-7"	--	--	270.0
Bot Slab(Ext)	A400 (AS8)	12	5	1'-0"	S	21'-7"	--	--	270.0
Corner(Top)	A1 (AS1)	48	6	6"	L	9'-7"	5'-5"	4'-2"	691.0
Corner(Bot)	A2 (AS1)	48	6	6"	L	9'-4"	5'-5"	3'-11"	673.0
Wall(Int)	B1 (AS4)	48	5	6"	S	4'-6"	--	--	225.0
Longit. Top (Int)	C100 (AS5)	25	5	10"	S	11'-9"	--	--	306.0
Longit. Bot (Int)	C200	14	4	1'-6"	S	11'-9"	--	--	110.0
Longit. Top (Ext)	C1 (AS6)	14	4	1'-6"	S	11'-9"	--	--	109.8
Longit. Bot (Ext)	C1 (AS6)	14	4	1'-6"	S	11'-9"	--	--	109.8
Longit. Wall (Ext)	C1 (AS6)	8	4	1'-6"	S	11'-9"	--	--	62.7
Longit. Wall (Int)	C1 (AS6)	8	4	1'-6"	S	11'-9"	--	--	62.7
									4446



Section Ext. Longit. Reinf.

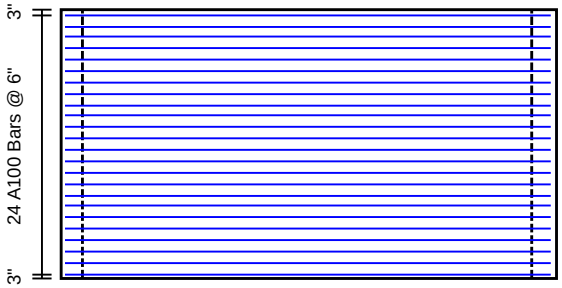


Section Int. Longit. Reinf.

Ext. Wall Reinf.

Int. Wall Reinf.

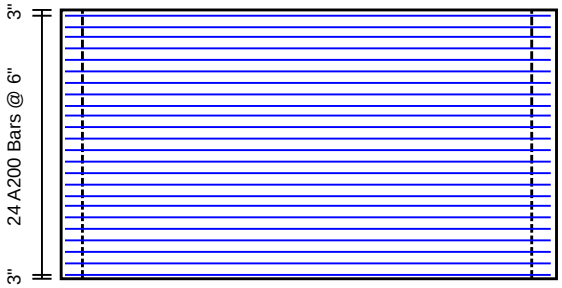
Top Slab Ext. Reinf.



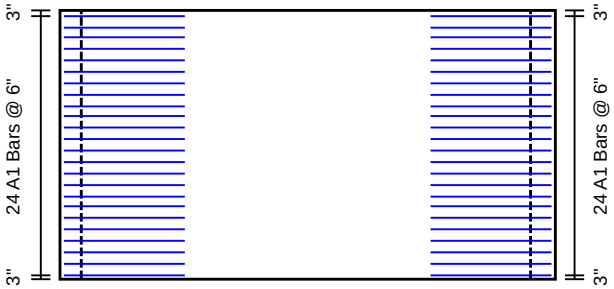
Top Slab Int. Reinf.

Bottom Slab Ext. Reinf.

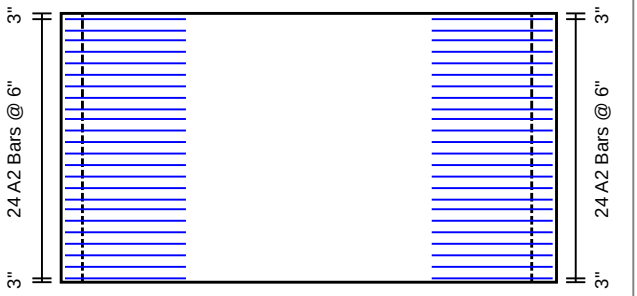
4446



Bottom Slab Int. Reinf.



Top Slab Corner Reinf.



Bottom Slab Corner Reinf.

Project: Montalado Transition Structure
Task : Transition Structure
Client : KB Home
Job No.: 21-481-08

CULVERT PROPERTIES
==========
Type of Culvert: Cast-in-Place Specification : LRFD 8th Edition
Operating Mode : Analysis

Physical Dimensions

No. of Boxes: 1 Name: BoxCulvert
Clear Span : 20.0000 ft
Clear Height: 4.0000 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
Fill Depth Range: Maximum : 1.99 ft Minimum : 0.50 ft Increment : 2.00 ft
Haunches: Top, Length: 0.0000 in Height: 0.0000 in
Bottom, Length: 0.0000 in Height: 0.0000 in
Member Thicknesses: Top Slab: 16.0000 in Bot Slab: 14.0000 in
Ext Wall: 12.0000 in
Wall Joint: None

Material Properties

Concrete: Strength,f'c : 5.000 ksi Density : 0.150 kcf Elasticity,Ec: 4592 ksi
Type : Normal Weight Density Modification Factor : 1.00
Fr Factor : 0.24 Gamma1 : 1.60 Gamma3 : 1.00 (user defined)
Steel: Yield,fy : 60.00 ksi fss Limit : 0.90fy Elasticity,Es: 29000 ksi
Yield,fyv : 60.00 ksi Diameter : 1.000 in Type : Rebar
Soil: Density : 0.135 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 : no Max. No. of Lanes: Computed by Program
Traffic Direction : Lanes Parallel to Main Reinforcement
Neglect Live Load if: Fill > 8 ft and Fill > Clear Span
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. : 35.00 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: 1.050
Condition: 1.000 System : 1.000
Phi Shear: 0.900 Phi Moment: 1.000 PM Compression: 0.750 PM Tension : 0.900

Reinforcement

Reinforcement Covers :	Exterior	Interior
Top Slab:	2.0000 in	2.0000 in
Walls :	2.0000 in	2.0000 in
Bot Slab:	3.0000 in	2.0000 in

Assigned reinforcement:

Location	Mark	Size	Spacing (in)
Top Slab Inside	A100 (AS2)	6	6.0000
Bottom Slab Inside	A200 (AS3)	6	6.0000
Top Slab Outside	A300 (AS7)	5	12.0000
Bottom Slab Outside	A400 (AS8)	5	12.0000
Top Corner	A1 (AS1)	6	6.0000
Bottom Corner	A2 (AS1)	6	6.0000
Ext. Wall Inside	B1 (AS4)	5	6.0000
Longitudinal	C1 (AS6)	4	18.0000
Top Distribution	C100 (AS5)	5	10.0000
Bottom Distribution	C200	4	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: no
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: yes
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: no
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: no
Include depth of haunch for critical sections: no
Flexure : Ignore Axial Thrust: no
Use Eq. 12.10.4.2.4a-1: yes Nu Multiplier: 1.00
Shear : Always Check Iterative Beta Method
Environmental : Apply duribility factors: no
Load Combinations : LRFD min/min: no

ANALYSIS RESULTS
==========

Top Slab Thickness = 16.00 in
Bottom Slab Thickness = 14.00 in
Exterior Wall Thickness = 12.00 in

Modular Ratio (N) = 6.32 Max. Steel Ratio = 0.025
Design Span = 21.00 ft Design Height = 5.25 ft

Volume of Concrete: 2.333 cy/ft Weight of Steel: 370 lb/ft

Note: Design and analysis results do not include force effects from stipping and handling stages

M dimension = 3' 7" (method of equivalent capacity)
= 5' 9" (method of contraflexure - ASTM)

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)	24	6	STR	6.00	0.880	21- 7	778		
Bot Slab (int)	A200 (AS3)	24	6	STR	6.00	0.880	21- 7	778		
Top Slab (ext)	A300 (AS7)	12	5	STR	12.00	0.310	21- 7	270		
Bot Slab (ext)	A400 (AS8)	12	5	STR	12.00	0.310	21- 7	270		
Corner (Top)	A1 (AS1)	48	6	L-BAR	6.00	0.880	9- 7	691	5- 5	4- 2
Corner (Bottom)	A2 (AS1)	48	6	L-BAR	6.00	0.880	9- 4	673	5- 5	3-11
Ext Wall (int)	B1 (AS4)	48	5	STR	6.00	0.620	4- 6	225		
Top Slab (int- 1)	C100 (AS5)	25	5	STR	10.00	0.372	11- 9	306		
Bot Slab (int- 1)	C200	14	4	STR	18.00	0.133	11- 9	110		
Temperature (1)	C1 (AS6)	14	4	STR	18.00	0.133	11- 9	110		
Temperature (1)	C1 (AS6)	14	4	STR	18.00	0.133	11- 9	110		
Temperature (1)	C1 (AS6)	8	4	STR	18.00	0.133	11- 9	63		
Temperature (1)	C1 (AS6)	8	4	STR	18.00	0.133	11- 9	63		
							Total	4446		

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)	0.880
Transverse Top Slab - Inside Face (AS2)	0.880
Transverse Bottom Slab - Inside Face (AS3)	0.880
Transverse Side Wall - Inside Face (AS4)	0.620
Distribution Top Slab - Inside Face (AS5)	0.372
Distribution Top Slab - OutSide Face (AS6)	0.133
Transverse Top Slab - Outside Face (AS7)	0.310
Transverse Bottom Slab - Outside Face (AS8)	0.310

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

Splice Lengths Table:

Bar Mark	Size	Splice Length (ft-in)
B1	5	1- 9
C1	4	1- 5
C100	5	1- 9
C200	4	1- 5

Summary of Ratings Table:

	Flexure					Shear				
Truck	Fill	Member	Location	IR	OR	Fill	Member	Location	IR	OR
(AA) HL-93	1.99	2	MID	1.11	1.44	1.99	2	LT	1.67	2.17

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 IR	OR	Truck	Fill Depth (ft)
BOT	7.00	-35.17	17.15	40.07	9.63	46.93	1.00	0.88	20.61	1.71	2.21	AA	1.99
MID	31.50	0.00	2.50	28.90	9.69	29.99	1.00	0.62	20.61	NC	NC	AA	0.50

TOP	8.00	-34.36	17.15	40.07	9.63	46.93	1.00	0.88	20.61	1.63	2.11	AA	1.99

Member 2: (Top Slab), Thickness = 16.00 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	Truck	Fill Depth (ft)
LT	6.00	-29.66	2.59	57.67	13.63	59.17	1.00	0.88	36.64	2.60	3.37	AA	1.99
MID	126.00	53.10	-1.63	57.67	13.63	56.72	1.00	0.88	36.64	1.11	1.44	AA	1.99
RT	6.00	-29.66	2.59	57.67	13.63	59.17	1.00	0.88	36.64	2.60	3.37	AA	1.99

Member 4: (Bottom Slab), Thickness = 14.00 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	Truck	Fill Depth (ft)
LT	6.00	-30.53	4.41	44.47	10.63	46.65	1.00	0.88	28.05	2.13	2.76	AA	1.99
MID	126.00	37.56	0.06	48.87	11.63	48.90	1.00	0.88	28.05	1.65	2.13	AA	1.99
MID-	126.00	0.35	2.99	16.28	10.69	17.93	1.00	0.31	28.05	NC	NC	AA	1.99
RT	6.00	-30.53	4.41	44.47	10.63	46.65	1.00	0.88	28.05	2.13	2.76	AA	1.99

Critical Sections Summary: 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	Beta	Vc (k)		Vs (k)	Av (in2)	Max. Spac (in)	Load Ratings IR	OR	Truck	Fill Depth (ft)
BOT	15.64	3.16	33.7	17.15	9.11	13.90	2.000	15.44	b	0.00	0.00	0.00	8.03	10.41	AA	1.99
MID	31.50	2.10	8.9	4.35	9.32	19.80	2.783	22.00	a	0.00	0.00	0.00	17.61	22.83	AA	1.99
MID-	31.50	1.27	26.6	15.25	9.17	15.53	2.219	17.26	a	0.00	0.00	0.00	7.39	9.57	AA	0.50
TOP	16.64	-2.07	28.1	15.25	9.11	14.96	2.152	16.62	a	0.00	0.00	0.00	5.56	7.21	AA	0.50

Member 2: (Top Slab), Thickness = 16.00 in

Loc	Dist. (in)	Design Shear (k)	Corr. Moment (k-ft)	Corr. A. F. (k)	Dv (in)	phi*Vn	Beta	Vc (k)		Vs (k)	Av (in2)	Max. Spac (in)	Load Ratings IR	OR	Truck	Fill Depth (ft)
LT	18.15	15.31	17.7	2.59	13.11	21.81	2.181	24.24	a	0.00	0.00	0.00	1.67	2.17	AA	1.99
MID	126.00	4.79	45.8	-2.02	13.11	16.36	1.635	18.17	a	0.00	0.00	0.00	3.41	4.42	AA	0.50
RT	18.15	15.31	17.7	2.59	13.11	21.81	2.181	24.24	a	0.00	0.00	0.00	1.67	2.17	AA	1.99

Member 4: (Bottom Slab), Thickness = 14.00 in

Loc	Dist. (in)	Design Shear (k)	Corr. Moment (k-ft)	Corr. A. F. (k)	Dv (in)	phi*Vn	Beta	Vc (k)		Vs (k)	Av (in2)	Max. Spac (in)	Load Ratings IR	OR	Truck	Fill Depth (ft)
LT	16.08	12.25	19.9	4.41	10.11	16.52	2.142	18.36	a	0.00	0.00	0.00	1.75	2.27	AA	1.99
MID	126.00	0.17	29.7	-0.59	11.11	16.89	1.992	18.76	a	0.00	0.00	0.00	97.10	99.99	AA	0.50
MID-	126.00	0.17	0.0	2.61	10.51	39.17	4.886	43.52	a	0.00	0.00	0.00	99.99	99.99	AA	0.50
RT	16.08	12.25	19.9	4.41	10.11	16.52	2.142	18.36	a	0.00	0.00	0.00	1.75	2.27	AA	1.99

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

Analysis Results: Fill Depth = 0.50 ft

Load Parameters:

Fe = 1.00 Surcharge Depth : 3.60 ft

Applied Horizontal Loads: (k/ft)

Load Description	Bottom of Wall	Top of Wall
Live Load Surcharge	0.216	0.216
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	0.385	0.070

Applied Uniform Bottom Slab Loads: (k/ft)

Load Description	
Dead Load	0.275
Vertical Earth	0.068
Wearing Surface	0.000

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

M-PT	Mdc	Mev	Mdw	Meh	Mls	Mwa	Mgw	Vdc	Vev	Vdw	Veh	Vls	Vwa	Vgw
Member 1: (Exterior Wall)														
Bottom														
1- 0	-7.53	-1.81	0.00	-0.15	-0.13	0.00	0.00	0.63	0.05	0.00	0.72	0.56	0.00	0.00
1- 1	-7.20	-1.78	0.00	0.18	0.13	0.00	0.00	0.63	0.05	0.00	0.53	0.44	0.00	0.00
1- 2	-6.87	-1.75	0.00	0.42	0.33	0.00	0.00	0.63	0.05	0.00	0.35	0.33	0.00	0.00
1- 3	-6.54	-1.73	0.00	0.56	0.47	0.00	0.00	0.63	0.05	0.00	0.19	0.22	0.00	0.00
1- 4	-6.21	-1.70	0.00	0.62	0.56	0.00	0.00	0.63	0.05	0.00	0.05	0.10	0.00	0.00
1- 5	-5.88	-1.67	0.00	0.62	0.58	0.00	0.00	0.63	0.05	0.00	-0.08	-0.01	0.00	0.00
1- 6	-5.55	-1.64	0.00	0.54	0.54	0.00	0.00	0.63	0.05	0.00	-0.19	-0.12	0.00	0.00
1- 7	-5.22	-1.62	0.00	0.42	0.45	0.00	0.00	0.63	0.05	0.00	-0.28	-0.24	0.00	0.00
1- 8	-4.89	-1.59	0.00	0.25	0.30	0.00	0.00	0.63	0.05	0.00	-0.36	-0.35	0.00	0.00
1- 9	-4.56	-1.56	0.00	0.04	0.08	0.00	0.00	0.63	0.05	0.00	-0.42	-0.46	0.00	0.00
1-10	-4.23	-1.53	0.00	-0.19	-0.19	0.00	0.00	0.63	0.05	0.00	-0.47	-0.58	0.00	0.00
Top														
Member 2: (Top Slab)														
Left														
2- 0	-4.23	-1.53	0.00	-0.20	-0.19	0.00	0.00	2.10	0.71	0.00	0.00	0.00	0.00	0.00
2- 1	-0.26	-0.19	0.00	-0.20	-0.19	0.00	0.00	1.68	0.57	0.00	0.00	0.00	0.00	0.00
2- 2	2.83	0.86	0.00	-0.20	-0.19	0.00	0.00	1.26	0.43	0.00	0.00	0.00	0.00	0.00
2- 3	5.03	1.61	0.00	-0.20	-0.19	0.00	0.00	0.84	0.28	0.00	0.00	0.00	0.00	0.00
2- 4	6.35	2.06	0.00	-0.20	-0.19	0.00	0.00	0.42	0.14	0.00	0.00	0.00	0.00	0.00
2- 5	6.80	2.21	0.00	-0.20	-0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2- 6	6.35	2.06	0.00	-0.20	-0.19	0.00	0.00	-0.42	-0.14	0.00	0.00	0.00	0.00	0.00
2- 7	5.03	1.61	0.00	-0.20	-0.19	0.00	0.00	-0.84	-0.28	0.00	0.00	0.00	0.00	0.00
2- 8	2.83	0.86	0.00	-0.20	-0.19	0.00	0.00	-1.26	-0.43	0.00	0.00	0.00	0.00	0.00
2- 9	-0.26	-0.19	0.00	-0.20	-0.19	0.00	0.00	-1.68	-0.57	0.00	0.00	0.00	0.00	0.00
2-10	-4.23	-1.53	0.00	-0.20	-0.19	0.00	0.00	-2.10	-0.71	0.00	0.00	0.00	0.00	0.00
Right														
Member 4: (Bottom Slab)														
Left														
4- 0	-7.53	-1.81	0.00	-0.15	-0.13	0.00	0.00	2.89	0.71	0.00	0.00	0.00	0.00	0.00
4- 1	-2.07	-0.46	0.00	-0.15	-0.13	0.00	0.00	2.31	0.57	0.00	0.00	0.00	0.00	0.00
4- 2	2.17	0.58	0.00	-0.15	-0.13	0.00	0.00	1.73	0.43	0.00	0.00	0.00	0.00	0.00
4- 3	5.21	1.33	0.00	-0.15	-0.13	0.00	0.00	1.16	0.28	0.00	0.00	0.00	0.00	0.00
4- 4	7.02	1.78	0.00	-0.15	-0.13	0.00	0.00	0.58	0.14	0.00	0.00	0.00	0.00	0.00
4- 5	7.63	1.93	0.00	-0.15	-0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4- 6	7.02	1.78	0.00	-0.15	-0.13	0.00	0.00	-0.58	-0.14	0.00	0.00	0.00	0.00	0.00
4- 7	5.21	1.33	0.00	-0.15	-0.13	0.00	0.00	-1.16	-0.28	0.00	0.00	0.00	0.00	0.00
4- 8	2.17	0.58	0.00	-0.15	-0.13	0.00	0.00	-1.73	-0.43	0.00	0.00	0.00	0.00	0.00
4- 9	-2.07	-0.46	0.00	-0.15	-0.13	0.00	0.00	-2.31	-0.57	0.00	0.00	0.00	0.00	0.00
4-10	-7.53	-1.81	0.00	-0.15	-0.13	0.00	0.00	-2.89	-0.71	0.00	0.00	0.00	0.00	0.00
Right														

Unfactored Thrusts due to All Loads: (k) (Fill Depth = 0.50 ft)

Member	Pdc	Pev	Pdw	Peh	Pls	Pwa
1	2.10	0.71	0.00	0.00	0.00	0.00
2	-0.63	-0.05	0.00	0.47	0.58	0.00
4	0.63	0.05	0.00	0.72	0.56	0.00

Analysis Truck, HL-93

Vehicle	Axle No.	Weight (k/ft)	Length (ft)	Dist. From Previous (ft)
Truck	1	0.858	1.41	
	2	3.433	1.41	14.00

Tandem	1	2.682	1.41		
	2	2.682	1.41	4.00	

Live Load Parameters:

Traffic Direction is Parallel to Main Reinforcement
Distribution Width : 5.20 ft
Note: Distribution width is calculated for one wheel only.
Impact Factor : 1.31
Truck MPF : 1.20 Tandem MPF : 1.20
Lane Load Distribution Width : 0.00 ft
Lane Load: 0.000 k/ft

Truck Positions That Cause Maximum Results:

Maximum +Moment in Top Slab

Vehicle	Axle No.	Weight (klf)	Length (ft)	Dist. From Left End (ft)
Truck	1	0.858	1.41	24.50
	2	3.433	1.41	10.50
	3	3.433	1.41	-3.50

Maximum +Moment : 16.08 k-ft
Corresponding Moment at End : -8.45 k-ft
Coincident Bottom Slab Load : 0.18 k/ft

Maximum -Moment in Top Slab

Vehicle	Axle No.	Weight (klf)	Length (ft)	Dist. From Left End (ft)
Truck	1	0.858	1.41	31.85
	2	3.433	1.41	17.85
	3	3.433	1.41	3.85

Maximum -Moment : -8.80 k-ft
Corresponding Moment at Mid : 8.17 k-ft
Coincident Bottom Slab Load : 0.35 k/ft

Maximum +Shear in Top Slab

Vehicle	Axle No.	Weight (klf)	Length (ft)	Dist. From Left End (ft)
Truck	1	0.858	1.41	28.70
	2	3.433	1.41	14.70
	3	3.433	1.41	0.70

Maximum +Shear : 6.08 k
Corresponding Shear at Mid : 1.24 k
Coincident Bottom Slab Load : 0.35 k/ft

Maximum -Shear in Top Slab

Vehicle	Axle No.	Weight (klf)	Length (ft)	Dist. From Left End (ft)
Truck	1	0.858	1.41	34.30
	2	3.433	1.41	20.30
	3	3.433	1.41	6.30

Maximum -Shear : -6.08 k
Corresponding Shear at Mid : -1.24 k
Coincident Bottom Slab Load : 0.35 k/ft

Maximum +Moment in Top Slab

Vehicle	Axle No.	Weight (klf)	Length (ft)	Dist. From Left End (ft)
Tandem	1	2.682	1.41	11.00
	2	2.682	1.41	7.00

Maximum +Moment : 19.66 k-ft
Corresponding Moment at End : -12.79 k-ft
Coincident Bottom Slab Load : 0.27 k/ft

Maximum -Moment in Top Slab

Vehicle	Axle No.	Weight (klf)	Length (ft)	Dist. From Left End (ft)
Tandem	1	2.682	1.41	13.45
	2	2.682	1.41	9.45

Maximum -Moment : -12.82 k-ft
Corresponding Moment at Mid : 19.54 k-ft
Coincident Bottom Slab Load : 0.27 k/ft

Maximum +Shear in Top Slab

Vehicle	Axle No.	Weight (klf)	Length (ft)	Dist. From Left End (ft)
Tandem	1	2.682	1.41	4.70
	2	2.682	1.41	0.70

Maximum +Shear : 6.66 k
Corresponding Shear at Mid : -0.90 k
Coincident Bottom Slab Load : 0.27 k/ft

Maximum -Shear in Top Slab

Vehicle	Axle No.	Weight (klf)	Length (ft)	Dist. From Left End (ft)
Tandem	1	2.682	1.41	20.30
	2	2.682	1.41	16.30

Maximum -Shear : -6.66 k
Corresponding Shear at Mid : 0.90 k
Coincident Bottom Slab Load : 0.27 k/ft

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

	Truck				Tandem				Lane			
M-PT	Mll+	Mll-	Vll+	Vll-	Mll+	Mll-	Vll+	Vll-	Mll+	Mll-	Vll+	Vll-
Member 1: (Exterior Wall)												
Bottom												
1- 0	0.00	-9.89	0.86	-0.80	0.00	-8.28	0.68	-1.14	0.00	0.00	0.00	0.00
1- 1	0.00	-9.69	0.86	-0.80	0.00	-8.29	0.68	-1.14	0.00	0.00	0.00	0.00
1- 2	0.00	-9.50	0.86	-0.80	0.00	-8.56	0.68	-1.14	0.00	0.00	0.00	0.00
1- 3	0.00	-9.30	0.86	-0.80	0.00	-8.97	0.68	-1.14	0.00	0.00	0.00	0.00
1- 4	0.00	-9.18	0.86	-0.80	0.00	-9.45	0.68	-1.14	0.00	0.00	0.00	0.00
1- 5	0.00	-9.10	0.86	-0.80	0.00	-9.98	0.68	-1.14	0.00	0.00	0.00	0.00
1- 6	0.00	-9.03	0.86	-0.80	0.00	-10.53	0.68	-1.14	0.00	0.00	0.00	0.00
1- 7	0.00	-8.97	0.86	-0.80	0.00	-11.09	0.68	-1.14	0.00	0.00	0.00	0.00
1- 8	0.00	-8.91	0.86	-0.80	0.00	-11.66	0.68	-1.14	0.00	0.00	0.00	0.00
1- 9	0.00	-8.85	0.86	-0.80	0.00	-12.24	0.68	-1.14	0.00	0.00	0.00	0.00
1-10	0.10	-8.80	0.86	-0.80	0.08	-12.82	0.68	-1.14	0.00	0.00	0.00	0.00
Top												
Member 2: (Top Slab)												
Left												
2- 0	0.10	-8.80	6.08	0.00	0.08	-12.82	6.66	0.00	0.00	0.00	0.00	0.00
2- 1	5.22	-3.70	5.15	-0.28	4.08	-5.32	5.93	-0.22	0.00	0.00	0.00	0.00
2- 2	9.76	-0.64	4.21	-0.73	10.92	-0.60	5.15	-0.57	0.00	0.00	0.00	0.00
2- 3	13.83	0.00	3.31	-1.22	15.98	0.00	4.35	-1.20	0.00	0.00	0.00	0.00
2- 4	15.35	0.00	2.76	-1.72	18.93	0.00	3.54	-1.95	0.00	0.00	0.00	0.00
2- 5	16.08	0.00	2.24	-2.24	19.66	0.00	2.74	-2.74	0.00	0.00	0.00	0.00
2- 6	15.35	0.00	1.72	-2.76	18.93	0.00	1.95	-3.54	0.00	0.00	0.00	0.00

2- 8	9.76	-0.64	0.73	-4.21	10.92	-0.60	0.57	-5.15	0.00	0.00	0.00	0.00
2- 9	5.22	-3.70	0.28	-5.15	4.08	-5.32	0.22	-5.93	0.00	0.00	0.00	0.00
2-10	0.10	-8.80	0.00	-6.08	0.08	-12.82	0.00	-6.66	0.00	0.00	0.00	0.00
Right												

Member 4: (Bottom Slab)

Left												
4- 0	0.00	-9.89	3.74	0.00	0.00	-8.28	2.98	0.00	0.00	0.00	0.00	0.00
4- 1	0.00	-2.82	3.00	0.00	0.00	-2.65	2.41	0.00	0.00	0.00	0.00	0.00
4- 2	3.26	0.00	2.26	0.00	3.35	0.00	1.83	0.00	0.00	0.00	0.00	0.00
4- 3	7.04	0.00	1.52	0.00	6.21	0.00	1.25	0.00	0.00	0.00	0.00	0.00
4- 4	9.32	0.00	0.78	0.00	7.90	0.00	0.68	0.00	0.00	0.00	0.00	0.00
4- 5	10.09	0.00	0.08	-0.08	8.45	0.00	0.10	-0.10	0.00	0.00	0.00	0.00
4- 6	9.32	0.00	0.00	-0.78	7.90	0.00	0.00	-0.68	0.00	0.00	0.00	0.00
4- 7	7.04	0.00	0.00	-1.52	6.21	0.00	0.00	-1.25	0.00	0.00	0.00	0.00
4- 8	3.26	0.00	0.00	-2.26	3.35	0.00	0.00	-1.83	0.00	0.00	0.00	0.00
4- 9	0.00	-2.82	0.00	-3.00	0.00	-2.65	0.00	-2.41	0.00	0.00	0.00	0.00
4-10	0.00	-9.89	0.00	-3.74	0.00	-8.28	0.00	-2.98	0.00	0.00	0.00	0.00
Right												

Serviceability Check: Crack Control

Bar Mark	Location	Moment (k-ft)	Thrust (k)	Fss (ksi)	Spacing (in)	Allow (in)
A1	Top Corner Bar	-18.2	9.47	22.61	6.00	12.42
A2	Bot Corner Bar	-18.5	9.47	22.99	6.00	12.14
A100	Top Slab (int)	28.5	-1.27	31.68	6.00	8.52
A200	Bot Slab (int)	19.6	-0.04	25.01	6.00	11.50

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	7.00	-28.15	15.25	40.07	9.63	46.19	1.00	0.88	20.61	2.07	2.68
MID	31.50	0.00	2.50	28.90	9.69	29.99	1.00	0.62	20.61	NC	NC
MID-	31.50	-26.63	15.25	40.35	9.69	46.47	1.00	0.88	20.61	2.11	2.74
TOP	8.00	-29.02	15.25	40.07	9.63	46.19	1.00	0.88	20.61	1.81	2.35

Member 2: (Top Slab), Thickness = 16.00 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	-25.69	2.82	57.67	13.63	59.30	1.00	0.88	36.64	2.71	3.51
MID	126.00	45.76	-2.02	57.67	13.63	56.50	1.00	0.88	36.64	1.31	1.70
RT	6.00	-25.69	2.82	57.67	13.63	59.30	1.00	0.88	36.64	2.71	3.51

Member 4: (Bottom Slab), Thickness = 14.00 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	-24.62	4.37	44.47	10.63	46.63	1.00	0.88	28.05	2.51	3.25
MID	126.00	29.71	-0.59	48.87	11.63	48.58	1.00	0.88	28.05	2.07	2.68
MID-	126.00	0.30	2.61	16.28	10.69	17.72	1.00	0.31	28.05	NC	NC
RT	6.00	-24.62	4.37	44.47	10.63	46.63	1.00	0.88	28.05	2.51	3.25

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	15.64	3.24	26.9	15.25	9.11	15.13	2.177	39.77	16.81 a	0.00	0.00	0.00	6.96	9.03
MID	31.50	2.31	4.8	2.50	9.32	23.21	3.262	34.18	25.78 a	0.00	0.00	0.00	14.98	19.42
MID-	31.50	1.27	26.6	15.25	9.17	15.53	2.219	39.52	17.26 a	0.00	0.00	0.00	7.39	9.57
TOP	16.64	-2.07	28.1	15.25	9.11	14.96	2.152	39.94	16.62 a	0.00	0.00	0.00	5.56	7.21

Member 2: (Top Slab), Thickness = 16.00 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	18.15	13.81	16.1	2.82	13.11	22.71	2.271	41.47	25.24 a	0.00	0.00	0.00	1.83	2.37
MID	126.00	4.79	45.8	-2.02	13.11	16.36	1.635	46.80	18.17 a	0.00	0.00	0.00	3.41	4.42
RT	18.15	13.81	16.1	2.82	13.11	22.71	2.271	41.47	25.24 a	0.00	0.00	0.00	1.83	2.37

Member 4: (Bottom Slab), Thickness = 14.00 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	16.08	9.71	16.2	4.37	10.11	18.00	2.334	39.51	20.00 a	0.00	0.00	0.00	2.45	3.18
MID	126.00	0.17	29.7	-0.59	11.11	16.89	1.992	42.52	18.76 a	0.00	0.00	0.00	97.10	99.99
MID-	126.00	0.17	0.0	2.61	10.51	39.17	4.886	29.46	43.52 a	0.00	0.00	0.00	99.99	99.99
RT	16.08	9.71	16.2	4.37	10.11	18.00	2.334	39.51	20.00 a	0.00	0.00	0.00	2.45	3.18

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

Load Combination Results at Tenth Points: (k-ft, k)(Fill Depth = 0.50 ft)

M-PT	+Moment	-Moment	+Axial	-Axial	+Shear	-Shear
Member 1: (Exterior Wall)						
Bottom						
1- 0	-8.768	-29.624	2.500	15.248	4.371	-0.594
1- 1	-7.521	-28.252	2.500	15.248	3.898	-0.740
1- 2	-6.517	-27.286	2.500	15.248	3.448	-0.873
1- 3	-5.743	-26.387	2.500	15.248	3.021	-0.993
1- 4	-5.186	-26.157	2.500	15.248	2.618	-1.101
1- 5	-4.835	-26.633	2.500	15.248	2.311	-1.269
1- 6	-4.677	-27.195	2.500	15.248	2.228	-1.625
1- 7	-4.699	-27.824	2.500	15.248	2.157	-1.958
1- 8	-4.890	-28.502	2.500	15.248	2.098	-2.267
1- 9	-5.238	-29.218	2.500	15.248	2.052	-2.553
1-10	-5.729	-30.426	2.500	15.248	2.018	-2.815
Top						
Member 2: (Top Slab)						
Left						
2- 0	-5.739	-30.436	1.067	2.815	15.248	2.500
2- 1	8.405	-10.515	-2.018	2.815	13.247	2.000
2- 2	23.675	2.662	-2.018	1.067	11.174	0.877
2- 3	36.307	5.287	-2.018	1.067	9.057	-0.690
2- 4	43.726	6.862	-2.018	1.067	6.921	-2.698
2- 5	45.763	7.387	-2.018	1.067	4.793	-4.793
2- 6	43.726	6.862	-2.018	1.067	2.698	-6.921
2- 7	36.307	5.287	-2.018	1.067	0.690	-9.057
2- 8	23.674	2.662	-2.018	1.067	-0.877	-11.174
2- 9	8.405	-10.515	-2.018	2.815	-2.000	-13.247
2-10	-5.739	-30.436	1.067	2.815	-2.500	-15.248
Right						
Member 4: (Bottom Slab)						
Left						
4- 0	-8.768	-29.624	2.611	4.371	11.120	3.209
4- 1	-2.703	-8.591	2.611	4.371	8.911	2.567
4- 2	9.267	2.015	-0.594	2.611	6.703	1.925
4- 3	20.541	5.384	-0.594	2.611	4.494	1.284
4- 4	27.416	7.406	-0.594	2.611	2.286	0.642
4- 5	29.715	8.080	-0.594	2.611	0.174	-0.174
4- 6	27.416	7.406	-0.594	2.611	-0.642	-2.286
4- 7	20.541	5.384	-0.594	2.611	-1.284	-4.494
4- 8	9.267	2.015	-0.594	2.611	-1.925	-6.703
4- 9	-2.703	-8.591	2.611	4.371	-2.567	-8.911
4-10	-8.768	-29.624	2.611	4.371	-3.209	-11.120
Right						

Analysis Results: Fill Depth = 1.99 ft

Load Parameters:

Fe = 1.02 Surcharge Depth : 3.30 ft

Applied Horizontal Loads: (k/ft)

Load Description	Bottom of Wall	Top of Wall
Live Load Surcharge	0.198	0.198
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	0.474	0.159

Applied Uniform Bottom Slab Loads: (k/ft)

Load Description	
Dead Load	0.275
Vertical Earth	0.274
Wearing Surface	0.000

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

M-PT	Mdc	Mev	Mdw	Meh	Mls	Mwa	Mgw	Vdc	Vev	Vdw	Veh	Vls	Vwa	Vgw
Member 1: (Exterior Wall)														
Bottom														
1- 0	-7.53	-7.29	0.00	-0.20	-0.12	0.00	0.00	0.63	0.21	0.00	0.96	0.51	0.00	0.00
1- 1	-7.20	-7.18	0.00	0.24	0.12	0.00	0.00	0.63	0.21	0.00	0.71	0.41	0.00	0.00
1- 2	-6.87	-7.07	0.00	0.55	0.30	0.00	0.00	0.63	0.21	0.00	0.49	0.30	0.00	0.00
1- 3	-6.54	-6.96	0.00	0.76	0.43	0.00	0.00	0.63	0.21	0.00	0.28	0.20	0.00	0.00
1- 4	-6.21	-6.85	0.00	0.85	0.51	0.00	0.00	0.63	0.21	0.00	0.09	0.09	0.00	0.00
1- 5	-5.88	-6.74	0.00	0.86	0.53	0.00	0.00	0.63	0.21	0.00	-0.08	-0.01	0.00	0.00
1- 6	-5.55	-6.63	0.00	0.77	0.50	0.00	0.00	0.63	0.21	0.00	-0.24	-0.11	0.00	0.00
1- 7	-5.22	-6.52	0.00	0.61	0.41	0.00	0.00	0.63	0.21	0.00	-0.38	-0.22	0.00	0.00
1- 8	-4.89	-6.40	0.00	0.37	0.27	0.00	0.00	0.63	0.21	0.00	-0.51	-0.32	0.00	0.00
1- 9	-4.56	-6.29	0.00	0.08	0.07	0.00	0.00	0.63	0.21	0.00	-0.62	-0.43	0.00	0.00
1-10	-4.23	-6.18	0.00	-0.27	-0.18	0.00	0.00	0.63	0.21	0.00	-0.71	-0.53	0.00	0.00
Top														
Member 2: (Top Slab)														
Left														
2- 0	-4.23	-6.18	0.00	-0.28	-0.18	0.00	0.00	2.10	2.87	0.00	0.00	0.00	0.00	0.00
2- 1	-0.26	-0.75	0.00	-0.28	-0.18	0.00	0.00	1.68	2.30	0.00	0.00	0.00	0.00	0.00
2- 2	2.83	3.47	0.00	-0.28	-0.18	0.00	0.00	1.26	1.72	0.00	0.00	0.00	0.00	0.00
2- 3	5.03	6.48	0.00	-0.28	-0.18	0.00	0.00	0.84	1.15	0.00	0.00	0.00	0.00	0.00
2- 4	6.35	8.29	0.00	-0.28	-0.18	0.00	0.00	0.42	0.57	0.00	0.00	0.00	0.00	0.00
2- 5	6.80	8.90	0.00	-0.28	-0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2- 6	6.35	8.29	0.00	-0.28	-0.18	0.00	0.00	-0.42	-0.57	0.00	0.00	0.00	0.00	0.00
2- 7	5.03	6.48	0.00	-0.28	-0.18	0.00	0.00	-0.84	-1.15	0.00	0.00	0.00	0.00	0.00
2- 8	2.83	3.47	0.00	-0.28	-0.18	0.00	0.00	-1.26	-1.72	0.00	0.00	0.00	0.00	0.00
2- 9	-0.26	-0.75	0.00	-0.28	-0.18	0.00	0.00	-1.68	-2.30	0.00	0.00	0.00	0.00	0.00
2-10	-4.23	-6.18	0.00	-0.28	-0.18	0.00	0.00	-2.10	-2.87	0.00	0.00	0.00	0.00	0.00
Right														
Member 4: (Bottom Slab)														
Left														
4- 0	-7.53	-7.29	0.00	-0.20	-0.12	0.00	0.00	2.89	2.87	0.00	0.00	0.00	0.00	0.00
4- 1	-2.07	-1.87	0.00	-0.20	-0.12	0.00	0.00	2.31	2.30	0.00	0.00	0.00	0.00	0.00
4- 2	2.17	2.36	0.00	-0.20	-0.12	0.00	0.00	1.73	1.72	0.00	0.00	0.00	0.00	0.00
4- 3	5.21	5.37	0.00	-0.20	-0.12	0.00	0.00	1.16	1.15	0.00	0.00	0.00	0.00	0.00
4- 4	7.02	7.18	0.00	-0.20	-0.12	0.00	0.00	0.58	0.57	0.00	0.00	0.00	0.00	0.00
4- 5	7.63	7.78	0.00	-0.20	-0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4- 6	7.02	7.18	0.00	-0.20	-0.12	0.00	0.00	-0.58	-0.57	0.00	0.00	0.00	0.00	0.00
4- 7	5.21	5.37	0.00	-0.20	-0.12	0.00	0.00	-1.16	-1.15	0.00	0.00	0.00	0.00	0.00
4- 8	2.17	2.36	0.00	-0.20	-0.12	0.00	0.00	-1.73	-1.72	0.00	0.00	0.00	0.00	0.00
4- 9	-2.07	-1.87	0.00	-0.20	-0.12	0.00	0.00	-2.31	-2.30	0.00	0.00	0.00	0.00	0.00
4-10	-7.53	-7.29	0.00	-0.20	-0.12	0.00	0.00	-2.89	-2.87	0.00	0.00	0.00	0.00	0.00
Right														

Unfactored Thrusts due to All Loads: (k) (Fill Depth = 1.99 ft)

Member	Pdc	Pev	Pdw	Peh	Pls	Pwa
1	2.10	2.87	0.00	0.00	0.00	0.00
2	-0.63	-0.21	0.00	0.71	0.53	0.00
4	0.63	0.21	0.00	0.96	0.51	0.00

Analysis Truck, HL-93

Vehicle	Axle No.	Weight (k/ft)	Length (ft)	Dist. From Previous (ft)
Truck	1	0.369	3.12	
	2	1.476	3.12	14.00

Tandem	1	1.153	3.12		
	2	1.153	3.12	4.00	

Live Load Parameters:

Traffic Direction is Parallel to Main Reinforcement
Distribution Width : 5.20 ft
Note: Distribution width is calculated for one wheel only.
Impact Factor : 1.25
Truck MPF : 1.20 Tandem MPF : 1.20
Lane Load Distribution Width : 0.00 ft
Lane Load: 0.000 k/ft

Truck Positions That Cause Maximum Results:

Maximum +Moment in Top Slab

Vehicle	Axle No.	Weight (klf)	Length (ft)	Dist. From Left End (ft)
Truck	1	0.369	3.12	24.50
	2	1.476	3.12	10.50
	3	1.476	3.12	-3.50

Maximum +Moment : 14.43 k-ft
Corresponding Moment at End : -7.97 k-ft
Coincident Bottom Slab Load : 0.18 k/ft

Maximum -Moment in Top Slab

Vehicle	Axle No.	Weight (klf)	Length (ft)	Dist. From Left End (ft)
Truck	1	0.369	3.12	31.15
	2	1.476	3.12	17.15
	3	1.476	3.12	3.15

Maximum -Moment : -8.22 k-ft
Corresponding Moment at Mid : 7.96 k-ft
Coincident Bottom Slab Load : 0.35 k/ft

Maximum +Shear in Top Slab

Vehicle	Axle No.	Weight (klf)	Length (ft)	Dist. From Left End (ft)
Truck	1	0.369	3.12	29.56
	2	1.476	3.12	15.56
	3	1.476	3.12	1.56

Maximum +Shear : 5.43 k
Corresponding Shear at Mid : 0.82 k
Coincident Bottom Slab Load : 0.35 k/ft

Maximum -Shear in Top Slab

Vehicle	Axle No.	Weight (klf)	Length (ft)	Dist. From Left End (ft)
Truck	1	0.369	3.12	33.44
	2	1.476	3.12	19.44
	3	1.476	3.12	5.44

Maximum -Shear : -5.43 k
Corresponding Shear at Mid : -0.82 k
Coincident Bottom Slab Load : 0.35 k/ft

Maximum +Moment in Top Slab

Vehicle	Axle No.	Weight (klf)	Length (ft)	Dist. From Left End (ft)
Tandem	1	1.153	3.12	11.89
	2	1.153	3.12	7.89

Maximum +Moment : 18.67 k-ft
Corresponding Moment at End : -12.07 k-ft
Coincident Bottom Slab Load : 0.27 k/ft

Maximum -Moment in Top Slab

Vehicle	Axle No.	Weight (klf)	Length (ft)	Dist. From Left End (ft)
Tandem	1	1.153	3.12	13.45
	2	1.153	3.12	9.45

Maximum -Moment : -12.09 k-ft
Corresponding Moment at Mid : 18.60 k-ft
Coincident Bottom Slab Load : 0.27 k/ft

Maximum +Shear in Top Slab

Vehicle	Axle No.	Weight (klf)	Length (ft)	Dist. From Left End (ft)
Tandem	1	1.153	3.12	5.56
	2	1.153	3.12	1.56

Maximum +Shear : 6.06 k
Corresponding Shear at Mid : -1.14 k
Coincident Bottom Slab Load : 0.27 k/ft

Maximum -Shear in Top Slab

Vehicle	Axle No.	Weight (klf)	Length (ft)	Dist. From Left End (ft)
Tandem	1	1.153	3.12	19.44
	2	1.153	3.12	15.44

Maximum -Shear : -6.06 k
Corresponding Shear at Mid : 1.14 k
Coincident Bottom Slab Load : 0.27 k/ft

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

	Truck				Tandem				Lane			
M-PT	Mll+	Mll-	Vll+	Vll-	Mll+	Mll-	Vll+	Vll-	Mll+	Mll-	Vll+	Vll-
Member 1: (Exterior Wall)												
Bottom												
1- 0	0.00	-9.70	0.62	-0.70	0.00	-8.23	0.49	-0.99	0.00	0.00	0.00	0.00
1- 1	0.00	-9.52	0.62	-0.70	0.00	-8.20	0.49	-0.99	0.00	0.00	0.00	0.00
1- 2	0.00	-9.34	0.62	-0.70	0.00	-8.42	0.49	-0.99	0.00	0.00	0.00	0.00
1- 3	0.00	-9.16	0.62	-0.70	0.00	-8.76	0.49	-0.99	0.00	0.00	0.00	0.00
1- 4	0.00	-8.99	0.62	-0.70	0.00	-9.18	0.49	-0.99	0.00	0.00	0.00	0.00
1- 5	0.00	-8.84	0.62	-0.70	0.00	-9.63	0.49	-0.99	0.00	0.00	0.00	0.00
1- 6	0.00	-8.71	0.62	-0.70	0.00	-10.10	0.49	-0.99	0.00	0.00	0.00	0.00
1- 7	0.00	-8.59	0.62	-0.70	0.00	-10.59	0.49	-0.99	0.00	0.00	0.00	0.00
1- 8	0.00	-8.46	0.62	-0.70	0.00	-11.08	0.49	-0.99	0.00	0.00	0.00	0.00
1- 9	0.00	-8.34	0.62	-0.70	0.00	-11.58	0.49	-0.99	0.00	0.00	0.00	0.00
1-10	0.00	-8.22	0.62	-0.70	0.00	-12.09	0.49	-0.99	0.00	0.00	0.00	0.00
Top												
Member 2: (Top Slab)												
Left												
2- 0	0.00	-8.22	5.43	0.00	0.00	-12.09	6.06	0.00	0.00	0.00	0.00	0.00
2- 1	4.12	-3.45	4.54	-0.13	3.30	-4.95	5.35	-0.11	0.00	0.00	0.00	0.00
2- 2	8.44	-0.54	3.65	-0.52	9.93	-0.46	4.60	-0.41	0.00	0.00	0.00	0.00
2- 3	12.15	0.00	2.94	-0.97	14.83	0.00	3.83	-0.88	0.00	0.00	0.00	0.00
2- 4	13.77	0.00	2.43	-1.44	17.77	0.00	3.06	-1.57	0.00	0.00	0.00	0.00
2- 5	14.43	0.00	1.93	-1.93	18.67	0.00	2.30	-2.30	0.00	0.00	0.00	0.00
2- 6	13.77	0.00	1.44	-2.43	17.77	0.00	1.57	-3.06	0.00	0.00	0.00	0.00

2- 8	8.44	-0.54	0.52	-3.65	9.93	-0.46	0.41	-4.60	0.00	0.00	0.00	0.00
2- 9	4.12	-3.45	0.13	-4.54	3.30	-4.95	0.11	-5.35	0.00	0.00	0.00	0.00
2-10	0.00	-8.22	0.00	-5.43	0.00	-12.09	0.00	-6.06	0.00	0.00	0.00	0.00
Right												

Member 4: (Bottom Slab)

Left												
4- 0	0.00	-9.70	3.72	0.00	0.00	-8.23	2.98	0.00	0.00	0.00	0.00	0.00
4- 1	0.00	-2.67	2.98	0.00	0.00	-2.60	2.40	0.00	0.00	0.00	0.00	0.00
4- 2	3.17	0.00	2.24	0.00	3.25	0.00	1.82	0.00	0.00	0.00	0.00	0.00
4- 3	6.99	0.00	1.50	0.00	6.13	0.00	1.25	0.00	0.00	0.00	0.00	0.00
4- 4	9.27	0.00	0.77	0.00	7.82	0.00	0.67	0.00	0.00	0.00	0.00	0.00
4- 5	10.03	0.00	0.07	-0.07	8.38	0.00	0.09	-0.09	0.00	0.00	0.00	0.00
4- 6	9.27	0.00	0.00	-0.77	7.82	0.00	0.00	-0.67	0.00	0.00	0.00	0.00
4- 7	6.99	0.00	0.00	-1.50	6.13	0.00	0.00	-1.25	0.00	0.00	0.00	0.00
4- 8	3.17	0.00	0.00	-2.24	3.25	0.00	0.00	-1.82	0.00	0.00	0.00	0.00
4- 9	0.00	-2.67	0.00	-2.98	0.00	-2.60	0.00	-2.40	0.00	0.00	0.00	0.00
4-10	0.00	-9.70	0.00	-3.72	0.00	-8.23	0.00	-2.98	0.00	0.00	0.00	0.00
Right												

Serviceability Check: Crack Control

Bar Mark	Location	Moment (k-ft)	Thrust (k)	Fss (ksi)	Spacing (in)	Allow (in)
A1	Top Corner Bar	-22.3	11.03	28.00	6.00	9.12
A2	Bot Corner Bar	-23.7	11.03	30.09	6.00	8.15
A100	Top Slab (int)	34.2	-1.05	37.67	6.00	6.41
A200	Bot Slab (int)	25.3	0.41	32.11	6.00	7.91

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	7.00	-35.17	17.15	40.07	9.63	46.93	1.00	0.88	20.61	1.71	2.21
MID	31.50	0.00	4.35	28.90	9.69	30.80	1.00	0.62	20.61	NC	NC
MID-	31.50	-32.76	17.15	40.35	9.69	47.20	1.00	0.88	20.61	1.82	2.36
TOP	8.00	-34.36	17.15	40.07	9.63	46.93	1.00	0.88	20.61	1.63	2.11

Member 2: (Top Slab), Thickness = 16.00 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	-29.66	2.59	57.67	13.63	59.17	1.00	0.88	36.64	2.60	3.37
MID	126.00	53.10	-1.63	57.67	13.63	56.72	1.00	0.88	36.64	1.11	1.44
RT	6.00	-29.66	2.59	57.67	13.63	59.17	1.00	0.88	36.64	2.60	3.37

Member 4: (Bottom Slab), Thickness = 14.00 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	-30.53	4.41	44.47	10.63	46.65	1.00	0.88	28.05	2.13	2.76
MID	126.00	37.56	0.06	48.87	11.63	48.90	1.00	0.88	28.05	1.65	2.13
MID-	126.00	0.35	2.99	16.28	10.69	17.93	1.00	0.31	28.05	NC	NC
RT	6.00	-30.53	4.41	44.47	10.63	46.65	1.00	0.88	28.05	2.13	2.76

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	15.64	3.16	33.7	17.15	9.11	13.90	2.000	45.00	15.44 b	0.00	0.00	0.00	8.03	10.41
MID	31.50	2.10	8.9	4.35	9.32	19.80	2.783	36.35	22.00 a	0.00	0.00	0.00	17.61	22.83
MID-	31.50	0.79	32.8	17.15	9.17	14.22	2.033	40.83	15.80 a	0.00	0.00	0.00	7.64	9.90
TOP	16.64	-1.71	33.7	17.15	9.11	13.90	2.000	45.00	15.44 b	0.00	0.00	0.00	5.88	7.62

Member 2: (Top Slab), Thickness = 16.00 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	18.15	15.31	17.7	2.59	13.11	21.81	2.181	42.13	24.24 a	0.00	0.00	0.00	1.67	2.17
MID	126.00	4.03	53.1	-1.63	13.11	15.32	1.532	47.81	17.03 a	0.00	0.00	0.00	3.80	4.93
RT	18.15	15.31	17.7	2.59	13.11	21.81	2.181	42.13	24.24 a	0.00	0.00	0.00	1.67	2.17

Member 4: (Bottom Slab), Thickness = 14.00 in

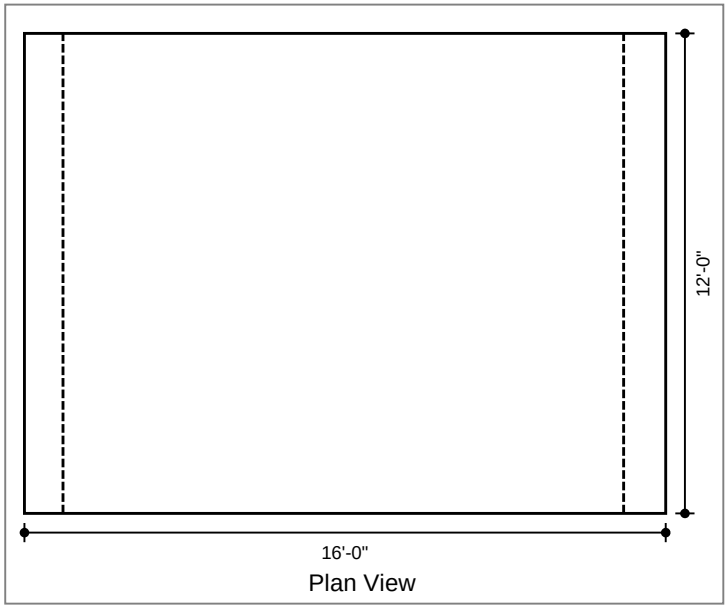
Loc	Dist. (in)	Design Shear (k)	Corr. Moment (k-ft)	Corr. A. F. (k)	Dv (in)	phi*Vn (k)	Beta	Theta	Vc (k)	Vs (k)	Av (in2)	Max. Spac (in)	Load Ratings IR	OR
LT	16.08	12.25	19.9	4.41	10.11	16.52	2.142	40.81	18.36 a	0.00	0.00	0.00	1.75	2.27
MID	126.00	0.16	37.6	0.06	11.11	16.95	2.000	45.00	18.84 b	0.00	0.00	0.00	99.99	99.99
MID-	126.00	0.16	0.0	2.99	10.51	39.19	4.889	29.45	43.55 a	0.00	0.00	0.00	99.99	99.99
RT	16.08	12.25	19.9	4.41	10.11	16.52	2.142	40.81	18.36 a	0.00	0.00	0.00	1.75	2.27

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

Load Combination Results at Tenth Points: (k-ft, k)(Fill Depth = 1.99 ft)

M-PT	+Moment	-Moment	+Axial	-Axial	+Shear	-Shear
Member 1: (Exterior Wall)						
Bottom						
1- 0	-13.529	-36.851	4.352	17.155	4.409	0.061
1- 1	-12.095	-35.290	4.352	17.155	3.885	-0.119
1- 2	-10.930	-34.171	4.352	17.155	3.385	-0.288
1- 3	-10.021	-33.137	4.352	17.155	2.909	-0.443
1- 4	-9.355	-32.530	4.352	17.155	2.456	-0.587
1- 5	-8.922	-32.755	4.352	17.155	2.100	-0.791
1- 6	-8.708	-33.083	4.352	17.155	1.981	-1.197
1- 7	-8.701	-33.492	4.352	17.155	1.875	-1.580
1- 8	-8.888	-33.965	4.352	17.155	1.781	-1.939
1- 9	-9.259	-34.500	4.352	17.155	1.700	-2.275
1-10	-9.799	-35.568	4.352	17.155	1.631	-2.588
Top						
Member 2: (Top Slab)						
Left						
2- 0	-9.809	-35.578	1.185	2.588	17.155	4.352
2- 1	5.647	-10.726	-1.631	2.588	14.595	3.481
2- 2	25.436	4.812	-1.631	1.185	11.978	2.611
2- 3	40.875	9.381	-1.631	1.185	9.328	0.921
2- 4	50.150	12.123	-1.631	1.185	6.671	-1.433
2- 5	53.104	13.037	-1.631	1.185	4.031	-4.031
2- 6	50.150	12.123	-1.631	1.185	1.433	-6.671
2- 7	40.875	9.381	-1.631	1.185	-0.921	-9.328
2- 8	25.436	4.812	-1.631	1.185	-2.611	-11.978
2- 9	5.647	-10.726	-1.631	2.588	-3.481	-14.595
2-10	-9.809	-35.578	1.185	2.588	-4.352	-17.155
Right						
Member 4: (Bottom Slab)						
Left						
4- 0	-13.529	-36.851	2.993	4.409	14.040	5.060
4- 1	-3.965	-10.306	2.993	4.409	11.241	4.048
4- 2	11.470	3.473	0.061	2.993	8.443	3.036
4- 3	25.914	8.787	0.061	2.993	5.645	2.024
4- 4	34.648	11.975	0.061	2.993	2.847	1.012
4- 5	37.563	13.037	0.061	2.993	0.161	-0.161
4- 6	34.648	11.975	0.061	2.993	-1.012	-2.847
4- 7	25.914	8.787	0.061	2.993	-2.024	-5.645
4- 8	11.470	3.473	0.061	2.993	-3.036	-8.443
4- 9	-3.965	-10.306	2.993	4.409	-4.048	-11.241
4-10	-13.529	-36.851	2.993	4.409	-5.060	-14.040
Right						

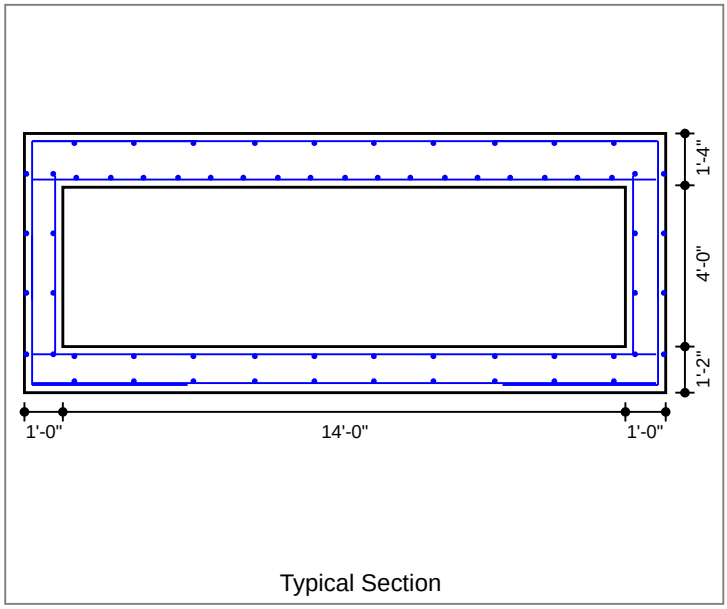
Spec.: LRFD 8th ed.
Type of Culvert: Cast-in-Place



Plan View

Physical Dimensions

Clear Span:	14'-0"
Clear Height:	4'-0"
Top Slab:	1'-4"
Bottom Slab:	1'-2"
Ext. Wall:	1'-0"
Fill Depth Range	
Maximum:	1.99 ft
Minimum:	0.50 ft
Increment:	2.00 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"



Typical Section

Material Properties

Concrete	
Strength, f'c:	5.000 ksi
Density:	0.150 kcf
Elasticity, Ec:	4592 ksi
Type:	Normal wt
Steel	
Yield, fy:	60 ksi
Allow Stress:	54 ksi
Elasticity, Es:	29000 ksi
Soil	
Density:	0.135 kcf
Exposure Factor	
Class 2 Exposure	
Reinforcement Covers	
Ext. Cover Top Slab:	2"
Ext. Cover Bottom Slab	3"
Ext. Cover Walls	2"
Int. Cover Walls	2"
Int. Cover Top Slab	2"
Int. Cover Bottom Slab	2"

Controlling Ratings

Inventory Rating: 1.22
Operating Rating: 1.58

Loads

Live Load	
Vehicle Names:	HL-93
Traffic Direction:	Parallel
Eq. Height of Soil:	Calculated
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

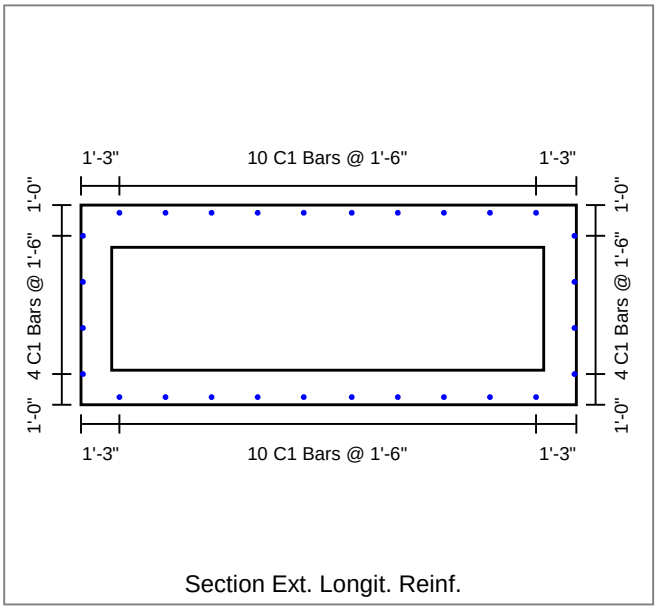
Lateral Soil Loads

Eq. Fluid Press. Max:	60.00 pcf
Eq. Fluid Press. Min:	35.00 pcf

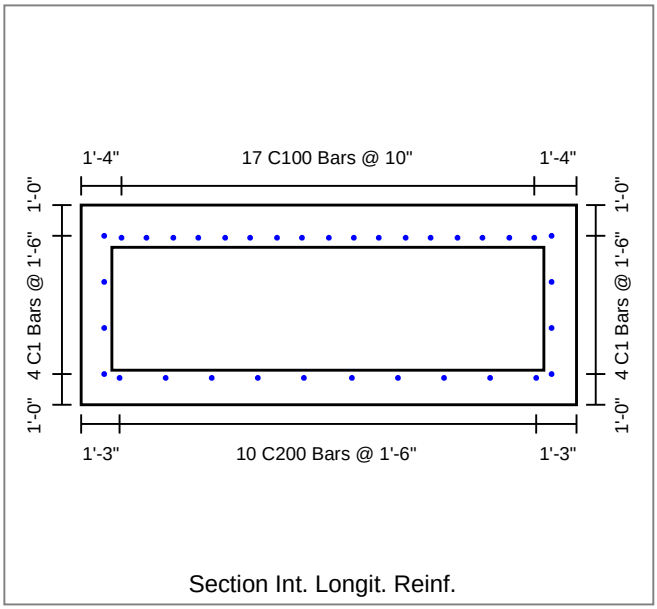
Concrete Summary
Volume of Concrete: 1.778 cy/ft Total Volume of Concrete: 21.333 cy

Reinforcing Steel Bar Schedule (lb)

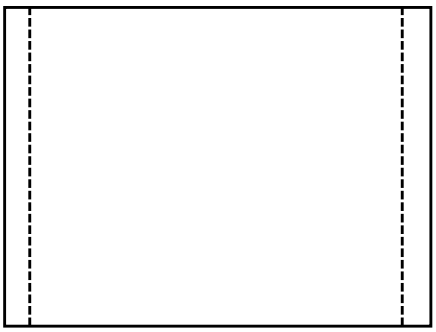
Location	Mark	Qty	Size	Spacing	Type	Length	Hor.Leg	Ver.Leg	Tot.Weight
Top Slab(Int)	A100 (AS2)	24	5	6"	S	15'-7"	--	--	390.0
Bot Slab(Int)	A200 (AS3)	24	5	6"	S	15'-7"	--	--	390.0
Top Slab(Ext)	A300 (AS7)	12	5	1'-0"	S	15'-7"	--	--	195.0
Bot Slab(Ext)	A400 (AS8)	12	5	1'-0"	S	15'-7"	--	--	195.0
Corner(Top)	A1 (AS1)	48	5	6"	L	8'-2"	4'-2"	4'-0"	409.0
Corner(Bot)	A2 (AS1)	48	5	6"	L	7'-8"	3'-11"	3'-9"	384.0
Wall(Int)	B1 (AS4)	24	5	1'-0"	S	4'-6"	--	--	113.0
Longit. Top (Int)	C100 (AS5)	17	5	10"	S	11'-9"	--	--	208.0
Longit. Bot (Int)	C200	10	4	1'-6"	S	11'-9"	--	--	78.0
Longit. Top (Ext)	C1 (AS6)	10	4	1'-6"	S	11'-9"	--	--	78.6
Longit. Bot (Ext)	C1 (AS6)	10	4	1'-6"	S	11'-9"	--	--	78.6
Longit. Wall (Ext)	C1 (AS6)	8	4	1'-6"	S	11'-9"	--	--	62.9
Longit. Wall (Int)	C1 (AS6)	8	4	1'-6"	S	11'-9"	--	--	62.9
									2645



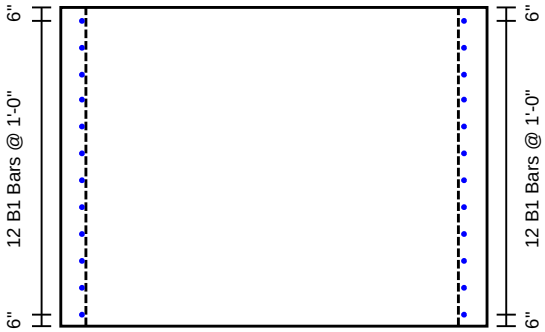
Section Ext. Longit. Reinf.



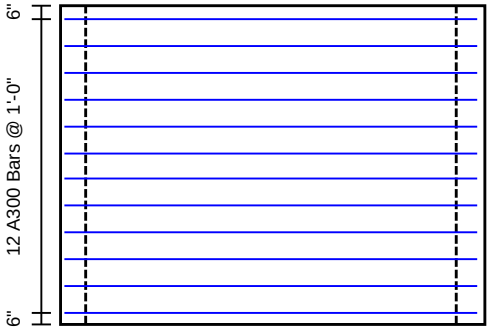
Section Int. Longit. Reinf.



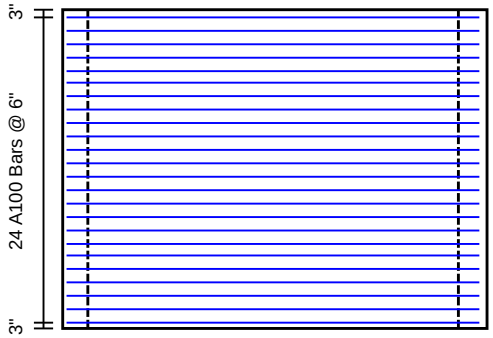
Ext. Wall Reinf.



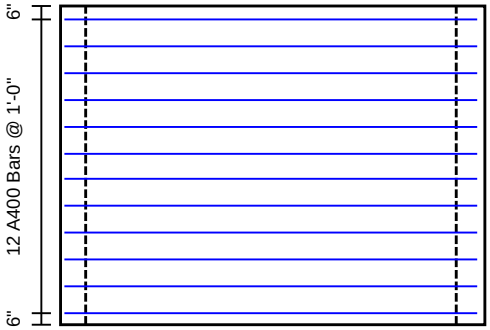
Int. Wall Reinf.



Top Slab Ext. Reinf.

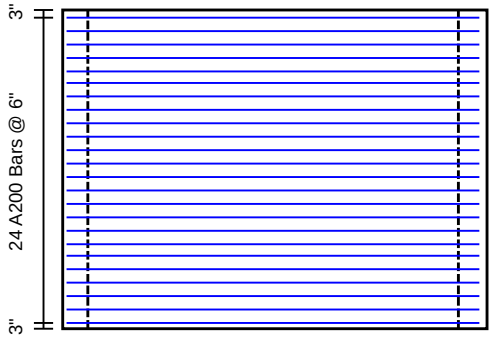


Top Slab Int. Reinf.

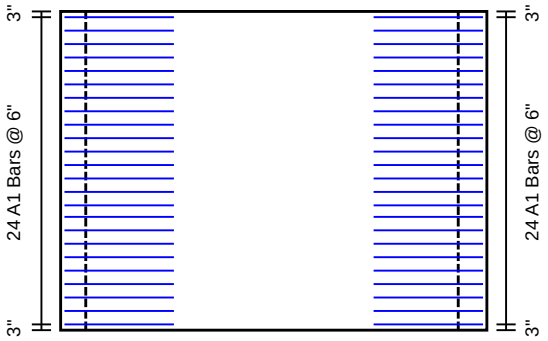


Bottom Slab Ext. Reinf.

2645

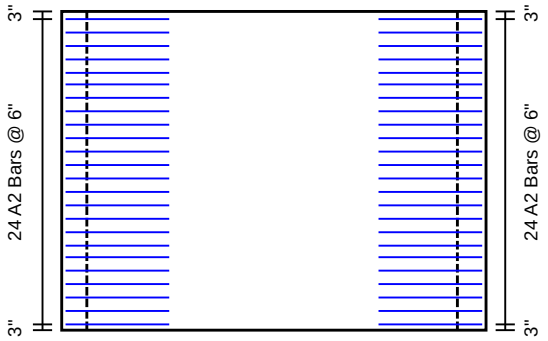


Bottom Slab Int. Reinf.



Top Slab Corner Reinf.

2645



Bottom Slab Corner Reinf.

Project: Montalado Transition Structure
Task : Transition Structure
Client : KB Home
Job No.: 21-481-08

CULVERT PROPERTIES
==========
Type of Culvert: Cast-in-Place Specification : LRFD 8th Edition
Operating Mode : Analysis

Physical Dimensions

No. of Boxes: 1 Name: BoxCulvert
Clear Span : 14.0000 ft
Clear Height: 4.0000 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
Fill Depth Range: Maximum : 1.99 ft Minimum : 0.50 ft Increment : 2.00 ft
Haunches: Top, Length: 0.0000 in Height: 0.0000 in
Bottom, Length: 0.0000 in Height: 0.0000 in
Member Thicknesses: Top Slab: 16.0000 in Bot Slab: 14.0000 in
Ext Wall: 12.0000 in
Wall Joint: None

Material Properties

Concrete: Strength,f'c : 5.000 ksi Density : 0.150 kcf Elasticity,Ec: 4592 ksi
Type : Normal Weight Density Modification Factor : 1.00
Fr Factor : 0.24 Gamma1 : 1.60 Gamma3 : 1.00 (user defined)
Steel: Yield,fy : 60.00 ksi fss Limit : 0.90fy Elasticity,Es: 29000 ksi
Yield,fyv : 60.00 ksi Diameter : 1.000 in Type : Rebar
Soil: Density : 0.135 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 : no Max. No. of Lanes: Computed by Program
Traffic Direction : Lanes Parallel to Main Reinforcement
Neglect Live Load if: Fill > 8 ft and Fill > Clear Span
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. : 35.00 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: 1.050
Condition: 1.000 System : 1.000
Phi Shear: 0.900 Phi Moment: 1.000 PM Compression: 0.750 PM Tension : 0.900

Reinforcement

Reinforcement Covers	Exterior	Interior
Top Slab:	2.0000 in	2.0000 in
Walls :	2.0000 in	2.0000 in
Bot Slab:	3.0000 in	2.0000 in

Assigned reinforcement:

Location	Mark	Size	Spacing (in)
Top Slab Inside	A100 (AS2)	5	6.0000
Bottom Slab Inside	A200 (AS3)	5	6.0000
Top Slab Outside	A300 (AS7)	5	12.0000
Bottom Slab Outside	A400 (AS8)	5	12.0000
Top Corner	A1 (AS1)	5	6.0000
Bottom Corner	A2 (AS1)	5	6.0000
Ext. Wall Inside	B1 (AS4)	5	12.0000
Longitudinal	C1 (AS6)	4	18.0000
Top Distribution	C100 (AS5)	5	10.0000
Bottom Distribution	C200	4	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: no
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: yes
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: no
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: no
Include depth of haunch for critical sections: no
Flexure : Ignore Axial Thrust: no
Use Eq. 12.10.4.2.4a-1: yes Nu Multiplier: 1.00
Shear : Always Check Iterative Beta Method
Environmental : Apply duribility factors: no
Load Combinations : LRFD min/min: no

ANALYSIS RESULTS
==========

Top Slab Thickness = 16.00 in
Bottom Slab Thickness = 14.00 in
Exterior Wall Thickness = 12.00 in

Modular Ratio (N) = 6.32 Max. Steel Ratio = 0.025
Design Span = 15.00 ft Design Height = 5.25 ft

Volume of Concrete: 1.778 cy/ft Weight of Steel: 220 lb/ft

Note: Design and analysis results do not include force effects from stipping and handling stages

M dimension = 2' 1" (method of equivalent capacity)
= 4' 5" (method of contraflexure - ASTM)

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)	24	5	STR	6.00	0.620	15- 7	390		
Bot Slab (int)	A200 (AS3)	24	5	STR	6.00	0.620	15- 7	390		
Top Slab (ext)	A300 (AS7)	12	5	STR	12.00	0.310	15- 7	195		
Bot Slab (ext)	A400 (AS8)	12	5	STR	12.00	0.310	15- 7	195		
Corner (Top)	A1 (AS1)	48	5	L-BAR	6.00	0.620	8- 2	409	4- 2	4- 0
Corner (Bottom)	A2 (AS1)	48	5	L-BAR	6.00	0.620	7- 8	384	3-11	3- 9
Ext Wall (int)	B1 (AS4)	24	5	STR	12.00	0.310	4- 6	113		
Top Slab (int- 1)	C100 (AS5)	17	5	STR	10.00	0.372	11- 9	208		
Bot Slab (int- 1)	C200	10	4	STR	18.00	0.133	11- 9	78		
Temperature (1)	C1 (AS6)	10	4	STR	18.00	0.133	11- 9	79		
Temperature (1)	C1 (AS6)	10	4	STR	18.00	0.133	11- 9	79		
Temperature (1)	C1 (AS6)	8	4	STR	18.00	0.133	11- 9	63		
Temperature (1)	C1 (AS6)	8	4	STR	18.00	0.133	11- 9	63		
							Total	2645		

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)	0.620
Transverse Top Slab - Inside Face (AS2)	0.620
Transverse Bottom Slab - Inside Face (AS3)	0.620
Transverse Side Wall - Inside Face (AS4)	0.310
Distribution Top Slab - Inside Face (AS5)	0.372
Distribution Top Slab - OutSide Face (AS6)	0.133
Transverse Top Slab - Outside Face (AS7)	0.310
Transverse Bottom Slab - Outside Face (AS8)	0.310

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

Splice Lengths Table:

Bar Mark	Size	Splice Length (ft-in)
B1	5	1- 9
C1	4	1- 5
C100	5	1- 9
C200	4	1- 5

Summary of Ratings Table:

Truck	Flexure Fill	Flexure Member	Flexure Location	Flexure IR	Flexure OR	Shear Fill	Shear Member	Shear Location	Shear IR	Shear OR
(AA) HL-93	1.99	2	MID	1.22	1.58	0.50	2	LT	1.86	2.41

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 IR	Load Ratings OR	Load Ratings Truck	Fill Depth (ft)
BOT	7.00	-18.51	15.13	28.90	9.69	35.36	1.00	0.62	20.61	2.77	3.59	AA	1.99
MID	31.50	0.00	1.79	14.73	9.69	15.57	1.00	0.31	20.61	NC	NC	AA	0.50

TOP	8.00	-19.16	15.13	28.90	9.69	35.36	1.00	0.62	20.61	2.26	2.93	AA	1.99

Member 2: (Top Slab), Thickness = 16.00 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	Truck	Fill Depth (ft)
LT	6.00	-15.12	2.26	41.30	13.69	42.66	1.00	0.62	36.64	3.54	4.58	AA	1.99
MID	90.00	35.31	-1.30	41.30	13.69	40.51	1.00	0.62	36.64	1.22	1.58	AA	1.99
RT	6.00	-15.12	2.26	41.30	13.69	42.66	1.00	0.62	36.64	3.54	4.58	AA	1.99

Member 4: (Bottom Slab), Thickness = 14.00 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	Truck	Fill Depth (ft)
LT	6.00	-14.67	4.07	32.00	10.69	34.12	1.00	0.62	28.05	3.66	4.74	AA	1.99
MID	90.00	23.80	0.39	35.10	11.69	35.31	1.00	0.62	28.05	1.94	2.52	AA	1.99
MID-	90.00	0.32	2.73	16.28	10.69	17.78	1.00	0.31	28.05	NC	NC	AA	1.99
RT	6.00	-14.67	4.07	32.00	10.69	34.12	1.00	0.62	28.05	3.66	4.74	AA	1.99

Critical Sections Summary: 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	Beta	Vc (k)	Vs (k)	Av (in2)	Max. Spac (in)	Load Ratings IR	OR	Truck	Fill Depth (ft)
BOT	15.64	3.25	15.1	14.32	9.32	17.78	2.499	19.76 a	0.00	0.00	0.00	7.34	9.52	AA	0.50
MID	31.50	2.32	1.4	1.79	9.51	23.96	3.303	26.62 a	0.00	0.00	0.00	13.05	16.91	AA	0.50
MID-	31.50	0.79	15.6	14.32	9.39	18.37	2.565	20.41 a	0.00	0.00	0.00	14.63	18.96	AA	0.50
TOP	16.64	-1.59	16.5	14.32	9.32	17.45	2.453	19.39 a	0.00	0.00	0.00	9.44	12.24	AA	0.50

Member 2: (Top Slab), Thickness = 16.00 in

Loc	Dist. (in)	Design Shear (k)	Corr. Moment (k-ft)	Corr. A. F. (k)	Dv (in)	phi*Vn	Beta	Vc (k)	Vs (k)	Av (in2)	Max. Spac (in)	Load Ratings IR	OR	Truck	Fill Depth (ft)
LT	18.15	12.80	5.9	2.26	13.32	20.99	2.064	23.32 a	0.00	0.00	0.00	1.91	2.47	AA	1.99
MID	90.00	4.43	31.5	-2.03	13.32	16.62	1.635	18.46 a	0.00	0.00	0.00	3.75	4.86	AA	0.50
RT	18.15	12.80	5.9	2.26	13.32	20.99	2.064	23.32 a	0.00	0.00	0.00	1.91	2.47	AA	1.99

Member 4: (Bottom Slab), Thickness = 14.00 in

Loc	Dist. (in)	Design Shear (k)	Corr. Moment (k-ft)	Corr. A. F. (k)	Dv (in)	phi*Vn	Beta	Vc (k)	Vs (k)	Av (in2)	Max. Spac (in)	Load Ratings IR	OR	Truck	Fill Depth (ft)
LT	16.08	9.23	6.3	4.07	10.32	19.89	2.525	22.10 a	0.00	0.00	0.00	3.34	4.33	AA	1.99
MID	90.00	0.12	19.5	-0.11	11.32	17.84	2.064	19.82 a	0.00	0.00	0.00	99.99	99.99	AA	0.50
MID-	90.00	0.12	0.0	2.40	10.51	39.17	4.886	43.52 a	0.00	0.00	0.00	99.99	99.99	AA	0.50
RT	16.08	9.23	6.3	4.07	10.32	19.89	2.525	22.10 a	0.00	0.00	0.00	3.34	4.33	AA	1.99

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

Analysis Results: Fill Depth = 0.50 ft

Load Parameters:

Fe = 1.01 Surcharge Depth : 3.60 ft

Applied Horizontal Loads: (k/ft)

Load Description	Bottom of Wall	Top of Wall
Live Load Surcharge	0.216	0.216
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	0.385	0.070

Applied Uniform Bottom Slab Loads: (k/ft)

Load Description	
Dead Load	0.305
Vertical Earth	0.068
Wearing Surface	0.000

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

M-PT	Mdc	Mev	Mdw	Meh	Mls	Mwa	Mgw	Vdc	Vev	Vdw	Veh	Vls	Vwa	Vgw
Member 1: (Exterior Wall)														
Bottom														
1- 0	-3.93	-0.84	0.00	-0.18	-0.17	0.00	0.00	0.42	0.03	0.00	0.72	0.55	0.00	0.00
1- 1	-3.71	-0.82	0.00	0.15	0.09	0.00	0.00	0.42	0.03	0.00	0.53	0.44	0.00	0.00
1- 2	-3.49	-0.80	0.00	0.38	0.29	0.00	0.00	0.42	0.03	0.00	0.35	0.33	0.00	0.00
1- 3	-3.27	-0.79	0.00	0.52	0.44	0.00	0.00	0.42	0.03	0.00	0.19	0.21	0.00	0.00
1- 4	-3.05	-0.77	0.00	0.58	0.52	0.00	0.00	0.42	0.03	0.00	0.05	0.10	0.00	0.00
1- 5	-2.83	-0.75	0.00	0.58	0.54	0.00	0.00	0.42	0.03	0.00	-0.08	-0.01	0.00	0.00
1- 6	-2.61	-0.74	0.00	0.50	0.51	0.00	0.00	0.42	0.03	0.00	-0.19	-0.13	0.00	0.00
1- 7	-2.39	-0.72	0.00	0.38	0.41	0.00	0.00	0.42	0.03	0.00	-0.29	-0.24	0.00	0.00
1- 8	-2.17	-0.71	0.00	0.21	0.25	0.00	0.00	0.42	0.03	0.00	-0.36	-0.35	0.00	0.00
1- 9	-1.95	-0.69	0.00	0.00	0.04	0.00	0.00	0.42	0.03	0.00	-0.42	-0.47	0.00	0.00
1-10	-1.73	-0.67	0.00	-0.23	-0.24	0.00	0.00	0.42	0.03	0.00	-0.47	-0.58	0.00	0.00
Top														
Member 2: (Top Slab)														
Left														
2- 0	-1.73	-0.67	0.00	-0.24	-0.24	0.00	0.00	1.50	0.51	0.00	0.00	0.00	0.00	0.00
2- 1	0.29	0.02	0.00	-0.24	-0.24	0.00	0.00	1.20	0.41	0.00	0.00	0.00	0.00	0.00
2- 2	1.87	0.55	0.00	-0.24	-0.24	0.00	0.00	0.90	0.31	0.00	0.00	0.00	0.00	0.00
2- 3	2.99	0.93	0.00	-0.24	-0.24	0.00	0.00	0.60	0.20	0.00	0.00	0.00	0.00	0.00
2- 4	3.67	1.16	0.00	-0.24	-0.24	0.00	0.00	0.30	0.10	0.00	0.00	0.00	0.00	0.00
2- 5	3.89	1.24	0.00	-0.24	-0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2- 6	3.67	1.16	0.00	-0.24	-0.24	0.00	0.00	-0.30	-0.10	0.00	0.00	0.00	0.00	0.00
2- 7	2.99	0.93	0.00	-0.24	-0.24	0.00	0.00	-0.60	-0.20	0.00	0.00	0.00	0.00	0.00
2- 8	1.87	0.55	0.00	-0.24	-0.24	0.00	0.00	-0.90	-0.31	0.00	0.00	0.00	0.00	0.00
2- 9	0.29	0.02	0.00	-0.24	-0.24	0.00	0.00	-1.20	-0.41	0.00	0.00	0.00	0.00	0.00
2-10	-1.73	-0.67	0.00	-0.24	-0.24	0.00	0.00	-1.50	-0.51	0.00	0.00	0.00	0.00	0.00
Right														
Member 4: (Bottom Slab)														
Left														
4- 0	-3.93	-0.84	0.00	-0.18	-0.17	0.00	0.00	2.29	0.51	0.00	0.00	0.00	0.00	0.00
4- 1	-0.84	-0.15	0.00	-0.18	-0.17	0.00	0.00	1.83	0.41	0.00	0.00	0.00	0.00	0.00
4- 2	1.56	0.39	0.00	-0.18	-0.17	0.00	0.00	1.37	0.31	0.00	0.00	0.00	0.00	0.00
4- 3	3.28	0.77	0.00	-0.18	-0.17	0.00	0.00	0.92	0.20	0.00	0.00	0.00	0.00	0.00
4- 4	4.31	1.00	0.00	-0.18	-0.17	0.00	0.00	0.46	0.10	0.00	0.00	0.00	0.00	0.00
4- 5	4.65	1.07	0.00	-0.18	-0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4- 6	4.31	1.00	0.00	-0.18	-0.17	0.00	0.00	-0.46	-0.10	0.00	0.00	0.00	0.00	0.00
4- 7	3.28	0.77	0.00	-0.18	-0.17	0.00	0.00	-0.92	-0.20	0.00	0.00	0.00	0.00	0.00
4- 8	1.56	0.39	0.00	-0.18	-0.17	0.00	0.00	-1.37	-0.31	0.00	0.00	0.00	0.00	0.00
4- 9	-0.84	-0.15	0.00	-0.18	-0.17	0.00	0.00	-1.83	-0.41	0.00	0.00	0.00	0.00	0.00
4-10	-3.93	-0.84	0.00	-0.18	-0.17	0.00	0.00	-2.29	-0.51	0.00	0.00	0.00	0.00	0.00
Right														

Unfactored Thrusts due to All Loads: (k) (Fill Depth = 0.50 ft)

Member	Pdc	Pev	Pdw	Peh	Pls	Pwa
1	1.50	0.51	0.00	0.00	0.00	0.00
2	-0.42	-0.03	0.00	0.47	0.58	0.00
4	0.42	0.03	0.00	0.72	0.55	0.00

Analysis Truck, HL-93

Vehicle	Axle No.	Weight (k/ft)	Length (ft)	Dist. From Previous (ft)
Truck	1	0.922	1.41	
	2	3.688	1.41	14.00

Tandem	1	2.881	1.41		
	2	2.881	1.41	4.00	

Live Load Parameters:

Traffic Direction is Parallel to Main Reinforcement
Distribution Width : 4.84 ft
Note: Distribution width is calculated for one wheel only.
Impact Factor : 1.31
Truck MPF : 1.20 Tandem MPF : 1.20
Lane Load Distribution Width : 0.00 ft
Lane Load: 0.000 k/ft

Truck Positions That Cause Maximum Results:

Maximum +Moment in Top Slab

Vehicle	Axle No.	Weight (klf)	Length (ft)	Dist. From Left End (ft)
Truck	1	0.922	1.41	21.50
	2	3.688	1.41	7.50
	3	3.688	1.41	-6.50

Maximum +Moment : 12.84 k-ft
Corresponding Moment at End : -5.72 k-ft
Coincident Bottom Slab Load : 0.26 k/ft

Maximum -Moment in Top Slab

Vehicle	Axle No.	Weight (klf)	Length (ft)	Dist. From Left End (ft)
Truck	1	0.922	1.41	20.75
	2	3.688	1.41	6.75
	3	3.688	1.41	-7.25

Maximum -Moment : -5.78 k-ft
Corresponding Moment at Mid : 11.87 k-ft
Coincident Bottom Slab Load : 0.26 k/ft

Maximum +Shear in Top Slab

Vehicle	Axle No.	Weight (klf)	Length (ft)	Dist. From Left End (ft)
Truck	1	0.922	1.41	28.70
	2	3.688	1.41	14.70
	3	3.688	1.41	0.70

Maximum +Shear : 5.09 k
Corresponding Shear at Mid : -0.11 k
Coincident Bottom Slab Load : 0.45 k/ft

Maximum -Shear in Top Slab

Vehicle	Axle No.	Weight (klf)	Length (ft)	Dist. From Left End (ft)
Truck	1	0.922	1.41	28.30
	2	3.688	1.41	14.30
	3	3.688	1.41	0.30

Maximum -Shear : -5.09 k
Corresponding Shear at Mid : 0.11 k
Coincident Bottom Slab Load : 0.45 k/ft

Maximum +Moment in Top Slab

Vehicle	Axle No.	Weight (klf)	Length (ft)	Dist. From Left End (ft)
Tandem	1	2.881	1.41	8.20
	2	2.881	1.41	4.20

Maximum +Moment : 14.38 k-ft
Corresponding Moment at End : -8.19 k-ft
Coincident Bottom Slab Load : 0.41 k/ft

Maximum -Moment in Top Slab

Vehicle	Axle No.	Weight (klf)	Length (ft)	Dist. From Left End (ft)
Tandem	1	2.881	1.41	10.05
	2	2.881	1.41	6.05

Maximum -Moment : -8.29 k-ft
Corresponding Moment at Mid : 14.14 k-ft
Coincident Bottom Slab Load : 0.41 k/ft

Maximum +Shear in Top Slab

Vehicle	Axle No.	Weight (klf)	Length (ft)	Dist. From Left End (ft)
Tandem	1	2.881	1.41	4.70
	2	2.881	1.41	0.70

Maximum +Shear : 6.71 k
Corresponding Shear at Mid : -1.40 k
Coincident Bottom Slab Load : 0.41 k/ft

Maximum -Shear in Top Slab

Vehicle	Axle No.	Weight (klf)	Length (ft)	Dist. From Left End (ft)
Tandem	1	2.881	1.41	14.30
	2	2.881	1.41	10.30

Maximum -Shear : -6.71 k
Corresponding Shear at Mid : 1.40 k
Coincident Bottom Slab Load : 0.41 k/ft

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

	Truck				Tandem				Lane			
M-PT	Mll+	Mll-	Vll+	Vll-	Mll+	Mll-	Vll+	Vll-	Mll+	Mll-	Vll+	Vll-
Member 1: (Exterior Wall)												
Bottom												
1- 0	0.00	-6.16	1.04	-0.54	0.00	-5.55	0.45	-0.70	0.00	0.00	0.00	0.00
1- 1	0.00	-5.62	1.04	-0.54	0.00	-5.49	0.45	-0.70	0.00	0.00	0.00	0.00
1- 2	0.00	-5.07	1.04	-0.54	0.00	-5.63	0.45	-0.70	0.00	0.00	0.00	0.00
1- 3	0.00	-4.53	1.04	-0.54	0.00	-5.89	0.45	-0.70	0.00	0.00	0.00	0.00
1- 4	0.00	-4.17	1.04	-0.54	0.00	-6.19	0.45	-0.70	0.00	0.00	0.00	0.00
1- 5	0.00	-4.42	1.04	-0.54	0.00	-6.53	0.45	-0.70	0.00	0.00	0.00	0.00
1- 6	0.00	-4.68	1.04	-0.54	0.00	-6.87	0.45	-0.70	0.00	0.00	0.00	0.00
1- 7	0.00	-4.95	1.04	-0.54	0.00	-7.22	0.45	-0.70	0.00	0.00	0.00	0.00
1- 8	0.00	-5.23	1.04	-0.54	0.00	-7.57	0.45	-0.70	0.00	0.00	0.00	0.00
1- 9	0.00	-5.51	1.04	-0.54	0.00	-7.93	0.45	-0.70	0.00	0.00	0.00	0.00
1-10	0.07	-5.78	1.04	-0.54	0.05	-8.29	0.45	-0.70	0.00	0.00	0.00	0.00
Top												
Member 2: (Top Slab)												
Left												
2- 0	0.07	-5.78	5.09	0.00	0.05	-8.29	6.71	0.00	0.00	0.00	0.00	0.00
2- 1	4.25	-2.16	4.49	-0.25	3.27	-2.76	5.91	-0.19	0.00	0.00	0.00	0.00
2- 2	7.85	-0.03	3.97	-0.74	8.16	-0.02	5.08	-0.57	0.00	0.00	0.00	0.00
2- 3	10.59	0.00	3.44	-1.25	11.94	0.00	4.23	-1.00	0.00	0.00	0.00	0.00
2- 4	12.27	0.00	2.89	-1.79	14.03	0.00	3.37	-1.71	0.00	0.00	0.00	0.00
2- 5	12.84	0.00	2.34	-2.34	14.38	0.00	2.53	-2.53	0.00	0.00	0.00	0.00
2- 6	12.27	0.00	1.79	-2.89	14.03	0.00	1.71	-3.37	0.00	0.00	0.00	0.00

2- 8	7.85	-0.03	0.74	-3.97	8.16	-0.02	0.57	-5.08	0.00	0.00	0.00	0.00
2- 9	4.25	-2.16	0.25	-4.49	3.27	-2.76	0.19	-5.91	0.00	0.00	0.00	0.00
2-10	0.07	-5.78	0.00	-5.09	0.05	-8.29	0.00	-6.71	0.00	0.00	0.00	0.00

Right

Member 4: (Bottom Slab)

Left

4- 0	0.00	-6.16	3.40	0.00	0.00	-5.55	3.17	0.00	0.00	0.00	0.00	0.00
4- 1	0.03	-1.56	2.73	0.00	0.00	-1.27	2.55	0.00	0.00	0.00	0.00	0.00
4- 2	2.12	0.00	2.05	0.00	3.01	0.00	1.93	0.00	0.00	0.00	0.00	0.00
4- 3	4.65	0.00	1.37	0.00	5.27	0.00	1.31	0.00	0.00	0.00	0.00	0.00
4- 4	6.16	0.00	0.69	0.00	6.61	0.00	0.69	0.00	0.00	0.00	0.00	0.00
4- 5	6.65	0.00	0.06	-0.06	7.06	0.00	0.07	-0.07	0.00	0.00	0.00	0.00
4- 6	6.16	0.00	0.00	-0.69	6.61	0.00	0.00	-0.69	0.00	0.00	0.00	0.00
4- 7	4.65	0.00	0.00	-1.37	5.27	0.00	0.00	-1.31	0.00	0.00	0.00	0.00
4- 8	2.12	0.00	0.00	-2.05	3.01	0.00	0.00	-1.93	0.00	0.00	0.00	0.00
4- 9	0.03	-1.56	0.00	-2.73	0.00	-1.27	0.00	-2.55	0.00	0.00	0.00	0.00
4-10	0.00	-6.16	0.00	-3.40	0.00	-5.55	0.00	-3.17	0.00	0.00	0.00	0.00

Right

Serviceability Check: Crack Control

Bar Mark	Location	Moment (k-ft)	Thrust (k)	Fss (ksi)	Spacing (in)	Allow (in)
A1	Top Corner Bar	-10.5	8.72	15.21	6.00	21.12
A2	Bot Corner Bar	-10.0	8.72	14.18	6.00	22.98
A100	Top Slab (int)	19.4	-1.21	30.33	6.00	9.32
A200	Bot Slab (int)	12.7	0.17	22.42	6.00	13.63

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	7.00	-15.42	14.32	28.90	9.69	35.02	1.00	0.62	20.61	2.99	3.88
MID	31.50	0.00	1.79	14.73	9.69	15.57	1.00	0.31	20.61	NC	NC
MID-	31.50	-15.56	14.32	29.09	9.75	35.22	1.00	0.62	20.61	2.70	3.50
TOP	8.00	-17.13	14.32	28.90	9.69	35.02	1.00	0.62	20.61	2.31	2.99

Member 2: (Top Slab), Thickness = 16.00 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	-13.96	2.34	41.30	13.69	42.71	1.00	0.62	36.64	3.46	4.48
MID	90.00	31.55	-2.03	41.30	13.69	40.07	1.00	0.62	36.64	1.34	1.74
RT	6.00	-13.96	2.34	41.30	13.69	42.71	1.00	0.62	36.64	3.46	4.48

Member 4: (Bottom Slab), Thickness = 14.00 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	-13.11	4.38	32.00	10.69	34.27	1.00	0.62	28.05	3.52	4.57
MID	90.00	19.50	-0.11	35.10	11.69	35.04	1.00	0.62	28.05	2.26	2.93
MID-	90.00	0.28	2.40	16.28	10.69	17.61	1.00	0.31	28.05	NC	NC
RT	6.00	-13.11	4.38	32.00	10.69	34.27	1.00	0.62	28.05	3.52	4.57

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	15.64	3.25	15.1	14.32	9.32	17.78	2.499	37.89	19.76 a	0.00	0.00	0.00	7.34	9.52
MID	31.50	2.32	1.4	1.79	9.51	23.96	3.303	34.13	26.62 a	0.00	0.00	0.00	13.05	16.91
MID-	31.50	0.79	15.6	14.32	9.39	18.37	2.565	37.55	20.41 a	0.00	0.00	0.00	14.63	18.96
TOP	16.64	-1.59	16.5	14.32	9.32	17.45	2.453	38.17	19.39 a	0.00	0.00	0.00	9.44	12.24

Member 2: (Top Slab), Thickness = 16.00 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	18.15	12.38	7.7	2.34	13.32	21.25	2.090	42.91	23.61 a	0.00	0.00	0.00	1.86	2.41
MID	90.00	4.43	31.5	-2.03	13.32	16.62	1.635	46.93	18.46 a	0.00	0.00	0.00	3.75	4.86
RT	18.15	12.38	7.7	2.34	13.32	21.25	2.090	42.91	23.61 a	0.00	0.00	0.00	1.86	2.41

Member 4: (Bottom Slab), Thickness = 14.00 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	16.08	7.82	5.9	4.38	10.32	21.40	2.716	37.36	23.77 a	0.00	0.00	0.00	3.77	4.89
MID	90.00	0.12	19.5	-0.11	11.32	17.84	2.064	42.08	19.82 a	0.00	0.00	0.00	99.99	99.99
MID-	90.00	0.12	0.0	2.40	10.51	39.17	4.886	29.46	43.52 a	0.00	0.00	0.00	99.99	99.99
RT	16.08	7.82	5.9	4.38	10.32	21.40	2.716	37.36	23.77 a	0.00	0.00	0.00	3.77	4.89

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

Load Combination Results at Tenth Points: (k-ft, k)(Fill Depth = 0.50 ft)

M-PT	+Moment	-Moment	+Axial	-Axial	+Shear	-Shear
Member 1: (Exterior Wall)						
Bottom						
1- 0	-4.808	-17.387	1.787	14.320	4.376	-0.113
1- 1	-3.672	-15.473	1.787	14.320	3.903	-0.258
1- 2	-2.779	-15.036	1.787	14.320	3.453	-0.391
1- 3	-2.115	-15.077	1.787	14.320	3.026	-0.511
1- 4	-1.670	-15.264	1.787	14.320	2.623	-0.620
1- 5	-1.429	-15.556	1.787	14.320	2.319	-0.791
1- 6	-1.382	-15.913	1.787	14.320	2.236	-1.147
1- 7	-1.516	-16.321	1.787	14.320	2.165	-1.480
1- 8	-1.817	-16.767	1.787	14.320	2.107	-1.789
1- 9	-2.276	-17.258	1.787	14.320	2.060	-2.074
1-10	-2.878	-18.337	1.787	14.320	2.027	-2.337
Top						
Member 2: (Top Slab)						
Left						
2- 0	-2.888	-18.348	1.278	2.337	14.320	1.787
2- 1	7.649	-5.199	-2.027	2.337	12.397	1.429
2- 2	17.179	1.400	-2.027	1.278	10.424	0.255
2- 3	25.723	2.740	-2.027	1.278	8.424	-1.162
2- 4	30.539	3.544	-2.027	1.278	6.419	-2.616
2- 5	31.546	3.812	-2.027	1.278	4.433	-4.433
2- 6	30.539	3.544	-2.027	1.278	2.616	-6.419
2- 7	25.723	2.740	-2.027	1.278	1.162	-8.424
2- 8	17.179	1.400	-2.027	1.278	-0.255	-10.424
2- 9	7.649	-5.199	-2.027	2.337	-1.429	-12.397
2-10	-2.888	-18.348	1.278	2.337	-1.787	-14.320
Right						
Member 4: (Bottom Slab)						
Left						
4- 0	-4.808	-17.387	2.400	4.376	9.511	2.495
4- 1	-1.343	-4.544	-0.113	4.376	7.613	1.996
4- 2	7.612	1.181	-0.113	2.400	5.715	1.497
4- 3	14.225	3.053	-0.113	2.400	3.817	0.998
4- 4	18.183	4.176	-0.113	2.400	1.919	0.499
4- 5	19.496	4.550	-0.113	2.400	0.121	-0.121
4- 6	18.183	4.176	-0.113	2.400	-0.499	-1.919
4- 7	14.225	3.053	-0.113	2.400	-0.998	-3.817
4- 8	7.612	1.181	-0.113	2.400	-1.497	-5.715
4- 9	-1.343	-4.544	-0.113	4.376	-1.996	-7.613
4-10	-4.808	-17.387	2.400	4.376	-2.495	-9.511
Right						

Analysis Results: Fill Depth = 1.99 ft

Load Parameters:

Fe = 1.03 Surcharge Depth : 3.30 ft

Applied Horizontal Loads: (k/ft)

Load Description	Bottom of Wall	Top of Wall
Live Load Surcharge	0.198	0.198
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	0.474	0.159

Applied Uniform Bottom Slab Loads: (k/ft)

Load Description	
Dead Load	0.305
Vertical Earth	0.275
Wearing Surface	0.000

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

M-PT	Mdc	Mev	Mdw	Meh	Mls	Mwa	Mgw	Vdc	Vev	Vdw	Veh	Vls	Vwa	Vgw
Member 1: (Exterior Wall)														
Bottom														
1- 0	-3.93	-3.40	0.00	-0.25	-0.15	0.00	0.00	0.42	0.13	0.00	0.95	0.51	0.00	0.00
1- 1	-3.71	-3.33	0.00	0.18	0.08	0.00	0.00	0.42	0.13	0.00	0.71	0.40	0.00	0.00
1- 2	-3.49	-3.26	0.00	0.50	0.27	0.00	0.00	0.42	0.13	0.00	0.49	0.30	0.00	0.00
1- 3	-3.27	-3.20	0.00	0.70	0.40	0.00	0.00	0.42	0.13	0.00	0.28	0.20	0.00	0.00
1- 4	-3.05	-3.13	0.00	0.80	0.48	0.00	0.00	0.42	0.13	0.00	0.09	0.09	0.00	0.00
1- 5	-2.83	-3.06	0.00	0.80	0.50	0.00	0.00	0.42	0.13	0.00	-0.08	-0.01	0.00	0.00
1- 6	-2.61	-2.99	0.00	0.71	0.46	0.00	0.00	0.42	0.13	0.00	-0.24	-0.12	0.00	0.00
1- 7	-2.39	-2.93	0.00	0.55	0.38	0.00	0.00	0.42	0.13	0.00	-0.38	-0.22	0.00	0.00
1- 8	-2.17	-2.86	0.00	0.31	0.23	0.00	0.00	0.42	0.13	0.00	-0.51	-0.32	0.00	0.00
1- 9	-1.95	-2.79	0.00	0.02	0.04	0.00	0.00	0.42	0.13	0.00	-0.62	-0.43	0.00	0.00
1-10	-1.73	-2.73	0.00	-0.33	-0.22	0.00	0.00	0.42	0.13	0.00	-0.71	-0.53	0.00	0.00
Top														
Member 2: (Top Slab)														
Left														
2- 0	-1.73	-2.73	0.00	-0.34	-0.22	0.00	0.00	1.50	2.07	0.00	0.00	0.00	0.00	0.00
2- 1	0.29	0.06	0.00	-0.34	-0.22	0.00	0.00	1.20	1.65	0.00	0.00	0.00	0.00	0.00
2- 2	1.87	2.23	0.00	-0.34	-0.22	0.00	0.00	0.90	1.24	0.00	0.00	0.00	0.00	0.00
2- 3	2.99	3.78	0.00	-0.34	-0.22	0.00	0.00	0.60	0.83	0.00	0.00	0.00	0.00	0.00
2- 4	3.67	4.71	0.00	-0.34	-0.22	0.00	0.00	0.30	0.41	0.00	0.00	0.00	0.00	0.00
2- 5	3.89	5.02	0.00	-0.34	-0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2- 6	3.67	4.71	0.00	-0.34	-0.22	0.00	0.00	-0.30	-0.41	0.00	0.00	0.00	0.00	0.00
2- 7	2.99	3.78	0.00	-0.34	-0.22	0.00	0.00	-0.60	-0.83	0.00	0.00	0.00	0.00	0.00
2- 8	1.87	2.23	0.00	-0.34	-0.22	0.00	0.00	-0.90	-1.24	0.00	0.00	0.00	0.00	0.00
2- 9	0.29	0.06	0.00	-0.34	-0.22	0.00	0.00	-1.20	-1.65	0.00	0.00	0.00	0.00	0.00
2-10	-1.73	-2.73	0.00	-0.34	-0.22	0.00	0.00	-1.50	-2.07	0.00	0.00	0.00	0.00	0.00
Right														
Member 4: (Bottom Slab)														
Left														
4- 0	-3.93	-3.40	0.00	-0.25	-0.15	0.00	0.00	2.29	2.07	0.00	0.00	0.00	0.00	0.00
4- 1	-0.84	-0.61	0.00	-0.25	-0.15	0.00	0.00	1.83	1.65	0.00	0.00	0.00	0.00	0.00
4- 2	1.56	1.56	0.00	-0.25	-0.15	0.00	0.00	1.37	1.24	0.00	0.00	0.00	0.00	0.00
4- 3	3.28	3.11	0.00	-0.25	-0.15	0.00	0.00	0.92	0.83	0.00	0.00	0.00	0.00	0.00
4- 4	4.31	4.04	0.00	-0.25	-0.15	0.00	0.00	0.46	0.41	0.00	0.00	0.00	0.00	0.00
4- 5	4.65	4.35	0.00	-0.25	-0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4- 6	4.31	4.04	0.00	-0.25	-0.15	0.00	0.00	-0.46	-0.41	0.00	0.00	0.00	0.00	0.00
4- 7	3.28	3.11	0.00	-0.25	-0.15	0.00	0.00	-0.92	-0.83	0.00	0.00	0.00	0.00	0.00
4- 8	1.56	1.56	0.00	-0.25	-0.15	0.00	0.00	-1.37	-1.24	0.00	0.00	0.00	0.00	0.00
4- 9	-0.84	-0.61	0.00	-0.25	-0.15	0.00	0.00	-1.83	-1.65	0.00	0.00	0.00	0.00	0.00
4-10	-3.93	-3.40	0.00	-0.25	-0.15	0.00	0.00	-2.29	-2.07	0.00	0.00	0.00	0.00	0.00
Right														

Unfactored Thrusts due to All Loads: (k) (Fill Depth = 1.99 ft)

Member	Pdc	Pev	Pdw	Peh	Pls	Pwa
1	1.50	2.07	0.00	0.00	0.00	0.00
2	-0.42	-0.13	0.00	0.71	0.53	0.00
4	0.42	0.13	0.00	0.95	0.51	0.00

Analysis Truck, HL-93

	Vehicle	Axle No.	Weight (k/ft)	Length (ft)	Dist. From Previous (ft)
	Truck	1	0.396	3.12	
		2	1.586	3.12	14.00

Tandem	1	1.239	3.12		
	2	1.239	3.12	4.00	

Live Load Parameters:

Traffic Direction is Parallel to Main Reinforcement
Distribution Width : 4.84 ft
Note: Distribution width is calculated for one wheel only.
Impact Factor : 1.25
Truck MPF : 1.20 Tandem MPF : 1.20
Lane Load Distribution Width : 0.00 ft
Lane Load: 0.000 k/ft

Truck Positions That Cause Maximum Results:

Maximum +Moment in Top Slab

Vehicle	Axle No.	Weight (klf)	Length (ft)	Dist. From Left End (ft)
Truck	1	0.396	3.12	21.50
	2	1.586	3.12	7.50
	3	1.586	3.12	-6.50

Maximum +Moment : 11.28 k-ft
Corresponding Moment at End : -5.35 k-ft
Coincident Bottom Slab Load : 0.26 k/ft

Maximum -Moment in Top Slab

Vehicle	Axle No.	Weight (klf)	Length (ft)	Dist. From Left End (ft)
Truck	1	0.396	3.12	20.81
	2	1.586	3.12	6.81
	3	1.586	3.12	-7.19

Maximum -Moment : -5.41 k-ft
Corresponding Moment at Mid : 10.95 k-ft
Coincident Bottom Slab Load : 0.26 k/ft

Maximum +Shear in Top Slab

Vehicle	Axle No.	Weight (klf)	Length (ft)	Dist. From Left End (ft)
Truck	1	0.396	3.12	29.56
	2	1.586	3.12	15.56
	3	1.586	3.12	1.56

Maximum +Shear : 4.52 k
Corresponding Shear at Mid : -0.43 k
Coincident Bottom Slab Load : 0.35 k/ft

Maximum -Shear in Top Slab

Vehicle	Axle No.	Weight (klf)	Length (ft)	Dist. From Left End (ft)
Truck	1	0.396	3.12	27.44
	2	1.586	3.12	13.44
	3	1.586	3.12	-0.56

Maximum -Shear : -4.52 k
Corresponding Shear at Mid : 0.43 k
Coincident Bottom Slab Load : 0.35 k/ft

Maximum +Moment in Top Slab

Vehicle	Axle No.	Weight (klf)	Length (ft)	Dist. From Left End (ft)
Tandem	1	1.239	3.12	10.06
	2	1.239	3.12	6.06

Maximum +Moment : 13.62 k-ft
Corresponding Moment at End : -7.53 k-ft
Coincident Bottom Slab Load : 0.41 k/ft

Maximum -Moment in Top Slab

Vehicle	Axle No.	Weight (klf)	Length (ft)	Dist. From Left End (ft)
Tandem	1	1.239	3.12	10.06
	2	1.239	3.12	6.06

Maximum -Moment : -7.74 k-ft
Corresponding Moment at Mid : 13.62 k-ft
Coincident Bottom Slab Load : 0.41 k/ft

Maximum +Shear in Top Slab

Vehicle	Axle No.	Weight (klf)	Length (ft)	Dist. From Left End (ft)
Tandem	1	1.239	3.12	5.56
	2	1.239	3.12	1.56

Maximum +Shear : 5.96 k
Corresponding Shear at Mid : -1.77 k
Coincident Bottom Slab Load : 0.41 k/ft

Maximum -Shear in Top Slab

Vehicle	Axle No.	Weight (klf)	Length (ft)	Dist. From Left End (ft)
Tandem	1	1.239	3.12	13.44
	2	1.239	3.12	9.44

Maximum -Shear : -5.96 k
Corresponding Shear at Mid : 1.77 k
Coincident Bottom Slab Load : 0.41 k/ft

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

	Truck				Tandem				Lane			
M-PT	Mll+	Mll-	Vll+	Vll-	Mll+	Mll-	Vll+	Vll-	Mll+	Mll-	Vll+	Vll-
Member 1: (Exterior Wall)												
Bottom												
1- 0	0.00	-4.81	0.65	-0.47	0.00	-5.43	0.28	-0.58	0.00	0.00	0.00	0.00
1- 1	0.00	-4.52	0.65	-0.47	0.00	-5.44	0.28	-0.58	0.00	0.00	0.00	0.00
1- 2	0.00	-4.22	0.65	-0.47	0.00	-5.54	0.28	-0.58	0.00	0.00	0.00	0.00
1- 3	0.00	-3.93	0.65	-0.47	0.00	-5.75	0.28	-0.58	0.00	0.00	0.00	0.00
1- 4	0.00	-4.03	0.65	-0.47	0.00	-6.00	0.28	-0.58	0.00	0.00	0.00	0.00
1- 5	0.00	-4.25	0.65	-0.47	0.00	-6.27	0.28	-0.58	0.00	0.00	0.00	0.00
1- 6	0.00	-4.47	0.65	-0.47	0.00	-6.56	0.28	-0.58	0.00	0.00	0.00	0.00
1- 7	0.00	-4.70	0.65	-0.47	0.00	-6.85	0.28	-0.58	0.00	0.00	0.00	0.00
1- 8	0.00	-4.93	0.65	-0.47	0.00	-7.14	0.28	-0.58	0.00	0.00	0.00	0.00
1- 9	0.00	-5.17	0.65	-0.47	0.00	-7.44	0.28	-0.58	0.00	0.00	0.00	0.00
1-10	0.03	-5.41	0.65	-0.47	0.02	-7.74	0.28	-0.58	0.00	0.00	0.00	0.00
Top												
Member 2: (Top Slab)												
Left												
2- 0	0.03	-5.41	4.52	0.00	0.02	-7.74	5.96	0.00	0.00	0.00	0.00	0.00
2- 1	3.22	-1.97	4.00	-0.11	2.43	-2.49	5.18	-0.08	0.00	0.00	0.00	0.00
2- 2	6.55	0.00	3.50	-0.44	7.16	0.00	4.37	-0.34	0.00	0.00	0.00	0.00
2- 3	9.14	0.00	2.98	-0.91	10.86	0.00	3.56	-0.72	0.00	0.00	0.00	0.00
2- 4	10.74	0.00	2.45	-1.41	13.02	0.00	2.76	-1.25	0.00	0.00	0.00	0.00
2- 5	11.28	0.00	1.93	-1.93	13.62	0.00	1.97	-1.97	0.00	0.00	0.00	0.00
2- 6	10.74	0.00	1.41	-2.45	13.02	0.00	1.25	-2.76	0.00	0.00	0.00	0.00

2- 8	6.55	0.00	0.44	-3.50	7.16	0.00	0.34	-4.37	0.00	0.00	0.00	0.00
2- 9	3.22	-1.97	0.11	-4.00	2.43	-2.49	0.08	-5.18	0.00	0.00	0.00	0.00
2-10	0.03	-5.41	0.00	-4.52	0.02	-7.74	0.00	-5.96	0.00	0.00	0.00	0.00

Right

Member 4: (Bottom Slab)

Left

4- 0	0.00	-4.81	2.65	0.00	0.00	-5.43	3.16	0.00	0.00	0.00	0.00	0.00
4- 1	0.00	-1.22	2.13	0.00	0.00	-1.15	2.54	0.00	0.00	0.00	0.00	0.00
4- 2	1.97	0.00	1.61	0.00	2.92	0.00	1.92	0.00	0.00	0.00	0.00	0.00
4- 3	3.81	0.00	1.08	0.00	5.19	0.00	1.30	0.00	0.00	0.00	0.00	0.00
4- 4	4.94	0.00	0.56	0.00	6.54	0.00	0.68	0.00	0.00	0.00	0.00	0.00
4- 5	5.28	0.00	0.06	-0.06	6.99	0.00	0.06	-0.06	0.00	0.00	0.00	0.00
4- 6	4.94	0.00	0.00	-0.56	6.54	0.00	0.00	-0.68	0.00	0.00	0.00	0.00
4- 7	3.81	0.00	0.00	-1.08	5.19	0.00	0.00	-1.30	0.00	0.00	0.00	0.00
4- 8	1.97	0.00	0.00	-1.61	2.92	0.00	0.00	-1.92	0.00	0.00	0.00	0.00
4- 9	0.00	-1.22	0.00	-2.13	0.00	-1.15	0.00	-2.54	0.00	0.00	0.00	0.00
4-10	0.00	-4.81	0.00	-2.65	0.00	-5.43	0.00	-3.16	0.00	0.00	0.00	0.00

Right

Serviceability Check: Crack Control

Bar Mark	Location	Moment (k-ft)	Thrust (k)	Fss (ksi)	Spacing (in)	Allow (in)
A1	Top Corner Bar	-12.1	9.53	18.01	6.00	17.11
A2	Bot Corner Bar	-12.3	9.53	18.44	6.00	16.61
A100	Top Slab (int)	22.3	-0.78	34.45	6.00	7.65
A200	Bot Slab (int)	15.8	0.52	27.77	6.00	10.12

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	7.00	-18.51	15.13	28.90	9.69	35.36	1.00	0.62	20.61	2.77	3.59
MID	31.50	0.00	3.12	14.73	9.69	16.19	1.00	0.31	20.61	NC	NC
MID-	31.50	-18.09	15.13	29.09	9.75	35.55	1.00	0.62	20.61	2.56	3.31
TOP	8.00	-19.16	15.13	28.90	9.69	35.36	1.00	0.62	20.61	2.26	2.93

Member 2: (Top Slab), Thickness = 16.00 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	-15.12	2.26	41.30	13.69	42.66	1.00	0.62	36.64	3.54	4.58
MID	90.00	35.31	-1.30	41.30	13.69	40.51	1.00	0.62	36.64	1.22	1.58
RT	6.00	-15.12	2.26	41.30	13.69	42.66	1.00	0.62	36.64	3.54	4.58

Member 4: (Bottom Slab), Thickness = 14.00 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	-14.67	4.07	32.00	10.69	34.12	1.00	0.62	28.05	3.66	4.74
MID	90.00	23.80	0.39	35.10	11.69	35.31	1.00	0.62	28.05	1.94	2.52
MID-	90.00	0.32	2.73	16.28	10.69	17.78	1.00	0.31	28.05	NC	NC
RT	6.00	-14.67	4.07	32.00	10.69	34.12	1.00	0.62	28.05	3.66	4.74

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	15.64	2.82	18.1	15.13	9.32	16.44	2.311	39.03	18.27 a	0.00	0.00	0.00	9.66	12.52
MID	31.50	1.77	3.2	3.12	9.51	22.78	3.141	34.82	25.32 a	0.00	0.00	0.00	19.91	25.82
MID-	31.50	0.46	18.1	15.13	9.39	17.20	2.401	38.54	19.11 a	0.00	0.00	0.00	16.27	21.09
TOP	16.64	-1.38	18.7	15.13	9.32	16.48	2.317	38.99	18.32 a	0.00	0.00	0.00	14.18	18.39

Member 2: (Top Slab), Thickness = 16.00 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	18.15	12.80	5.9	2.26	13.32	20.99	2.064	43.12	23.32 a	0.00	0.00	0.00	1.91	2.47
MID	90.00	3.45	35.3	-1.30	13.32	15.98	1.572	47.55	17.75 a	0.00	0.00	0.00	4.64	6.01
RT	18.15	12.80	5.9	2.26	13.32	20.99	2.064	43.12	23.32 a	0.00	0.00	0.00	1.91	2.47

Member 4: (Bottom Slab), Thickness = 14.00 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	16.08	9.23	6.3	4.07	10.32	19.89	2.525	38.43	22.10 a	0.00	0.00	0.00	3.34	4.33
MID	90.00	0.11	23.8	0.39	11.32	17.28	2.000	45.00	19.20 b	0.00	0.00	0.00	99.99	99.99
MID-	90.00	0.11	0.0	2.73	10.51	39.19	4.888	29.45	43.54 a	0.00	0.00	0.00	99.99	99.99
RT	16.08	9.23	6.3	4.07	10.32	19.89	2.525	38.43	22.10 a	0.00	0.00	0.00	3.34	4.33

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

Load Combination Results at Tenth Points: (k-ft, k)(Fill Depth = 1.99 ft)

M-PT	+Moment	-Moment	+Axial	-Axial	+Shear	-Shear
Member 1: (Exterior Wall)						
Bottom						
1- 0	-7.076	-19.675	3.121	15.126	4.074	0.394
1- 1	-5.781	-18.560	3.121	15.126	3.551	0.213
1- 2	-4.755	-18.137	3.121	15.126	3.051	0.045
1- 3	-3.986	-17.980	3.121	15.126	2.574	-0.111
1- 4	-3.460	-17.979	3.121	15.126	2.121	-0.254
1- 5	-3.167	-18.095	3.121	15.126	1.769	-0.462
1- 6	-3.092	-18.292	3.121	15.126	1.650	-0.868
1- 7	-3.225	-18.556	3.121	15.126	1.544	-1.251
1- 8	-3.552	-18.883	3.121	15.126	1.451	-1.610
1- 9	-4.062	-19.264	3.121	15.126	1.369	-1.946
1-10	-4.742	-20.285	3.121	15.126	1.300	-2.258
Top						
Member 2: (Top Slab)						
Left						
2- 0	-4.752	-20.295	1.451	2.258	15.126	3.121
2- 1	5.837	-4.765	-1.300	2.258	12.817	2.497
2- 2	17.665	2.738	-1.300	1.451	10.473	1.873
2- 3	27.653	5.078	-1.300	1.451	8.116	0.281
2- 4	33.553	6.483	-1.300	1.451	5.766	-1.533
2- 5	35.308	6.951	-1.300	1.451	3.447	-3.447
2- 6	33.553	6.483	-1.300	1.451	1.533	-5.766
2- 7	27.653	5.078	-1.300	1.451	-0.281	-8.116
2- 8	17.665	2.738	-1.300	1.451	-1.873	-10.473
2- 9	5.837	-4.765	-1.300	2.258	-2.497	-12.817
2-10	-4.752	-20.295	1.451	2.258	-3.121	-15.126
Right						
Member 4: (Bottom Slab)						
Left						
4- 0	-7.076	-19.675	2.727	4.074	11.211	3.830
4- 1	-1.906	-4.649	2.727	4.074	8.991	3.064
4- 2	9.015	2.116	0.394	2.727	6.770	2.298
4- 3	17.237	4.988	0.394	2.727	4.549	1.532
4- 4	22.160	6.711	0.394	2.727	2.329	0.766
4- 5	23.797	7.286	0.394	2.727	0.108	-0.108
4- 6	22.160	6.711	0.394	2.727	-0.766	-2.329
4- 7	17.237	4.988	0.394	2.727	-1.532	-4.549
4- 8	9.015	2.116	0.394	2.727	-2.298	-6.770
4- 9	-1.906	-4.649	2.727	4.074	-3.064	-8.991
4-10	-7.076	-19.675	2.727	4.074	-3.830	-11.211
Right						

TRB Engineering

9207 Kelley Drive
Huntsville, UT 84317 PHONE: 801-786-9292

ANALYSIS & DESIGN OF SIDE WALL

PROJECT:	Montalado North
STRUCTURE:	Transition Structure (5 x 5 x 7)

LOADING AND DESIGN

- LOADING ON STRUCTURE PER AASHTO LRFD
- DESIGN LIVE LOAD IS 1 LANE(S) OF HL-93 (32 KIP AXLE MAX) WITH IMPACT AND A LATERAL SURCHARGE PER AASHTO LRFD
- SOIL FILL ON TOP OF THE STRUCTURE IS APPLIED AT A MIN. OF 0 TO A MAX. OF 2 FT
- SOIL UNIT WEIGHT IS ASSUMED TO BE 135 PCF WITH A DRAINED EQUIVALENT LATERAL FLUID PRESSURE OF 60 PCF HORIZONTAL
- THE DESIGN WATER TABLE IS ASSUMED TO BE BELOW THE BOTTOM OF THE STRUCTURE
- STRUCTURAL DESIGN FOLLOWS AASHTO LRFD - 2017

MATERIALS

- THE CONCRETE COMPRESSIVE DESIGN STRENGTH IS 5000 PSI
- THE REINFORCING YIELD STRENGTH IS 60000 PSI

Soil Recommendations per:
Soils report No 210132 Dated March 4, 2021 and upate letter dated December 7, 2022

DESIGNED BY:	Troy Banks, PE

PROJECT NAME: Montalado North
STRUCTURE NAME: Transition Structure
LOCATION 210

GEOMETRY:

WIDTH	5	ft
INSIDE LENGTH	5	ft
	0	in
	0	ft
	0	ft
SECTION HEIGHT	7	ft
BOTTOM SLAB THICKNESS	14	in
WALL THICKNESS	12	in

OUTSIDE DIMENSIONS	OD WIDTH	OD LENGTH	OD HEIGHT	SPAN RATIO	WEIGHT
	7.00 ft	7.00 ft	8.17 ft	1.00	33775 lbs

MATERIAL DATA:

CONCRETE 28-DAY COMP. STRENGTH	f'_c =	5000	psi	ε_{cu} =	0.003	in/in
REINFORCED CONCRETE UNIT WEIGHT	γ_c =	150	pcf	E_c =	4286826	psi
REINFORCING YIELD STRENGTH	f_y =	60000	psi	E_s =	29000000	psi
WHITNEY STRESS BLOCK FACTOR	β_1 =	0.8		n =	6.76	

LOADING DATA: USE AASHTO LRFD

FILL DEPTH ON TOP OF STRUCTURE	MIN OF	0	ft TO	2	ft MAX
SOIL UNIT WEIGHT			135		pcf
SOIL EQUIVALENT FLUID PRESSURE			60		pcf DRY
WATER TABLE			NO		

LIVE LOAD: HL-93

DESCRIPTION MAX AXLE WEIGHT = 32 kip WHEEL PATCH OF 20 in X 10 in
DISTRIBUTION DISTRIBUTE AFTER 2 ft FILL WITH A 1.15 DISTRIBUTION FACTOR
LANES LANE WIDTH = 10 ft 1 DESIGN LANES MP FACT. 1.2
UNIFORM LOAD 64 PSF
SURCHARGE PER AASHTO LRFD
TRIANGULAR SEISMIC LATERAL STATIC PRESS 405.1 PSF @ GRADE 0 PSF AT BOTTOM

Feq 24.8 H^2

DESIGN CODE: AASHTO LRFD 2017 EDITION

LIVE LOAD FACTOR: PER AASHTO LRFD 3.4	1.75	
DEAD LOAD FACTOR: PER AASHTO LRFD 3.4	1.25	1.25 W SEISMIC
HORIZONTAL SOIL LOAD FACTOR: PER AASHTO LRFD 3.4	1.5	1.5 W SEISMIC
VERTICAL SOIL LOAD FACTOR: PER AASHTO LRFD 3.4	1.3	1.3 W SEISMIC
LL SURCHARGE LOAD FACTOR: PER AASHTO LRFD 3.4	1.75	0 W SEISMIC
EXPOSURE (FOR REINF. SERVICEABILITY REQ.)	NORMAL / CLASS 1	

SUMMARY OF DESIGN ISSUES: **NONE**

DESIGN DEPTH OF FILL (ON TOP OF STRUCTURE) 2 ft FOR THIS SECTION DESIGN

SECTION WEIGHT = 33.78 kip

th = 12 IN

GEOMETRY SPAN	**VERTICAL**	**HORIZ.**	
DESIGN SPAN	7.00	6.00	ft
% LOAD DISTRIBUTION	100.0%	0.0%	
OVERRIDE DISTRIBUTION	100% Vert.		

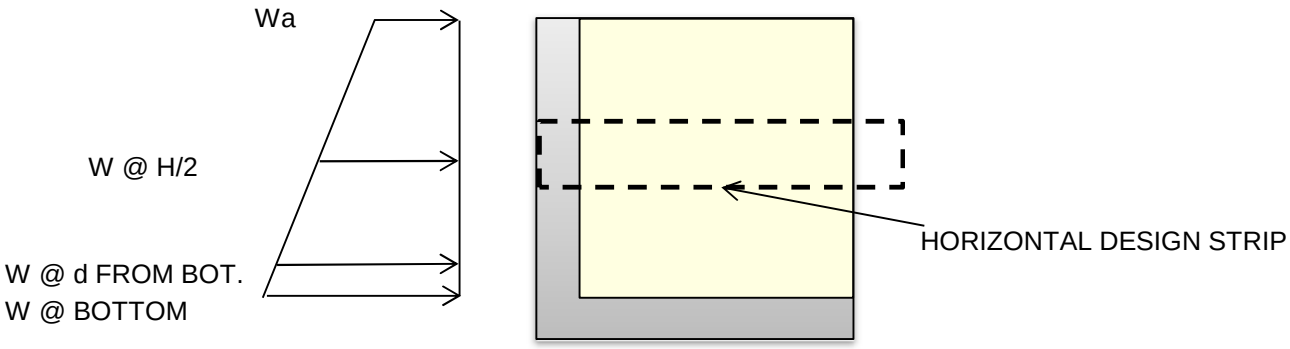
$$\delta_c = \frac{w_{bot} \cdot L_c^4}{30 \cdot E \cdot I} + \frac{(w_{top} - w_{bot}) \cdot L_c^4}{8 \cdot E \cdot I} \qquad \delta_h = \frac{w \cdot L_l^4}{384 \cdot L \cdot I}$$

LATERAL LOADS (FACTORED)

DEPTH TO TOP OF SECTION 2.00 ft

DOESN'T CONTROL

	Depth (Ft)	LLSURCH	SOIL + SAT	SEISMIC	
Wa =	2.00	0.336	0.180	0.325	ksf
W @ H/2	5.50	0.336	0.495	0.186	ksf
W @ d FROM BOTTOM	8.19	0.336	0.737	0.079	ksf
W @ BOTTOM	9.00	0.336	0.810	0.046	ksf



SHEAR FORCES (FACT.) SPAN	**CANTILEVER**	**CORNER**	**LONG**	**SHORT**	
Vu @ end	5.82	0.00	0.00	0.00	kip
Vu @ DESIGN POINT	**4.92**	**0.00**	**0.00**	**0.00**	**kip**

$$V_{cant} = w_{top} \cdot L + (w_{bot} - w_{top}) \cdot \frac{L}{2} \qquad V_{horiz} = \frac{w \cdot (L - 2 \cdot x)}{2}$$

MOMENTS (FACT.)

INFLECTION POINT	N/A	N/A	N/A	N/A	ft FROM CL OF WALL
Mu Max	**17.79**	**0.00**	**0.00**	**0.00**	**ft-kip**
Ms Max	11.07	0.00	0.00	0.00	ft-kip

$$M_{cant} = \frac{w_{top} \cdot L^2}{2} + \frac{2 \cdot (w_{bot} - w_{top}) \cdot L^2}{3} \qquad M_{corner} = \frac{w}{12} \cdot \frac{L_l^3 + L_s^3}{L_l + L_s} \qquad M_{mid} = \frac{w \cdot L^2}{8} \qquad M_{Long}$$

SECTION WALLS DESIGN

REINFORCING IS: AS SHOWN

		HORIZONTAL DESIGN SPANS			
SPAN	**CANT.**		**LONG**	**SHORT**	NOTES/REFERENCES
REINFORCING SIZE	**5**	**4**	**4**	**4**	
SPACING (s)	**8**	**12**	**12**	**12**	in
CLEARANCE (cl)	**2**	**2**	**2**	**2**	in FROM TENSION FACE
DESIGN SECTION WIDTH (b)	12	12	12	12	in
DIAMETER OF STEEL (dia)	0.625	0.500	0.500	0.500	in
AREA OF STEEL (As)	0.460	0.196	0.196	0.196	in^2
APPROX. (As req.)	0.376	0.000	0.000	0.000	in^2
COMP. FACE TO STEEL CENT. (c	9.69	9.75	9.75	9.75	in

SHEAR	@d from face	@d from face	@Inflection	@d from face		
Mu @ Vu	17.19	0.00	0.00	0.00	ft-kip	
RESISTANCE FACTOR (ϕ_v)	0.9	0.9	0.9	0.9		AASHTO LRFD 5.5.4.2
CONC. SHEAR STRENGTH (Vc)	15.97	39.21	39.21	39.21	kip	AASHTO LRFD 5.7.3.3
STIRRUP AREA (Av) PER b	0	0	0	0	in^2	
STIRRUP SPACING (sv)	0	0	0	0	in	
STEEL SHEAR STRENGTHVs	0.00	0.00	0.00	0.00	kip	
FACT. SHEAR STRENGTH fVn	**14.37**	**35.29**	**35.29**	**35.29**	**kip**	CAPACITY
FACT SHEAR STRESS Vu @ d	**4.92**	**0.00**	**0.00**	**0.00**	**kip**	DEMAND
OVERDESIGN	192%	100%	100%	100%		

MOMENT						
STEEL STRAIN (ε_s)	0.040	0.098	0.098	0.0983		LINEAR STRAIN
RESISTANCE FACTOR (ϕ_b)	1.00	1.00	1.00	1.00		AASHTO LRFD 12.5.5
STRESS BLOCK HEIGHT (a)	0.54	0.23	0.23	0.23	in	AASHTO LRFD 5.6.2.2
NOM. FLEX. RESIST. (Mn)	21.67	9.46	9.46	9.46	ft-kip	AASHTO LRFD 5.6.3
FACT. FLEX. RESISTANCE fMn	**21.67**	**9.46**	**9.46**	**9.46**	**ft-kip**	CAPACITY
FACT. BENDING MOMENT (Mu)	**17.79**	**0.00**	**0.00**	**0.00**	**ft-kip**	DEMAND
OVERDESIGN	22%	100%	100%	100%		

SERVICEABILITY						
c SERVICE	2.00	1.36	1.36	1.36	in	
fs max	36.00	36.00	36.00	36.00	ksi	LRFD 5.6.7-1
fs	32.01	0.00	0.00	0.00	ksi	
s max	11.68	18.00	18.00	18.00	in	5.10.3.2, 5.6.7, 5.10.6
As MIN	0.290	0.000	0.000	0.000	in^2	LRFD 5.6.3.3
As TEMP	0.110	0.110	0.110	0.110	in^2	LRFD 5.10.6
OVERDESIGN	12%	50%	50%	50%		

Summary OK

NOTE: ANALYSIS METHOD IS BASED ON PLATE ANALYSIS
(RECTANGULAR CONCRETE TANKS BY PCA)

DESIGN DEPTH OF FILL (ON TOP OF STRUCTURE) 2 ft FOR THIS SECTION DESIGN

SLAB WEIGHT = 8.575 kip
th = 14 IN

GEOMETRY	SPAN	**SHORT**	**LONG**	
DESIGN SPAN		6.00	6.00	ft
% LOAD DISTRIBUTION		50.0%	50.0%	EQUAL DEFLECTIONS
OVERRIDE DISTRIBUTION		No Change		

$$\delta_{uniform} = \frac{5 \cdot w \cdot L^4}{384 \cdot E \cdot I}$$

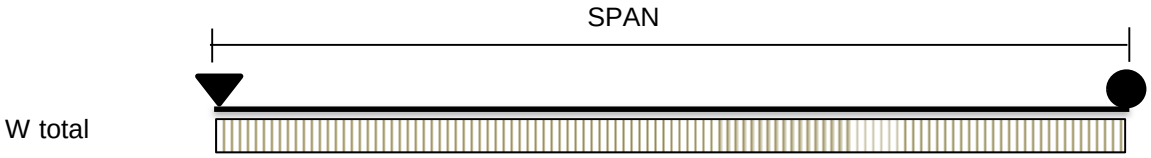
LIVE LOADS (FACTORED)

CONTROLLING CASE	2.451 WHEELS TOTAL ON TOP		
TOTAL WHEEL LOAD	64.34	kip	AASHTO LRFD 3.6.1.2.5
INCLUDED IMPACT	0%		
DISTRIBUTION AREA	49.00	ft^2	
ADDITIONAL UNIFORM LOAD	0.112	ksf	
WuLL	1.425	ksf	

PERMANENT LOADS (FACTORED)

STRUCTURE WEIGHT	42.22	kip
DISTRIBUTED	0.862	ksf
OVERBURDEN WuSL	0.351	ksf

UNFACTORED BEARING PRESSURE 1.77 ksf



NOTE: ADDITIONAL CORNER MOMENTS MAY BE ADDED
FOR WALLS OF BOTTOM SECTIONS

SHEAR FORCE (FACTORED)	SPAN	**SHORT**	**LONG**	
SHEAR COEFFICIENT		0.335	0.335	V = c*w*l
Vu @ end		5.29	5.29	kip
Vu @ d from the face of support		**2.69**	**2.78**	**kip**

$$v(x) = \frac{w \cdot (L - 2 \cdot x)}{2}$$

BENDING MOMENT (FACTORED)

MOMENT COEFFICEINT		0.044	0.044	
Mu @ CENTER		**2.09**	**2.09**	**ft-kip**
Ms @ CENTER		1.41	1.41	ft-kip
M (FACTORED) @ CENTER (NO FIXITY)		4.19	4.19	ft-kip M = c*w*l^2
M corner (NO SURCHARGE, NO WATER TABLE, NO FACTORS)		6.37		ft-kip MAX OF 1/2 UTILIZED
REDUCTION FACTOR FOR MID SPAN MOMENT		0.50	0.50	SOME FIXITY

$$M_{mid} = M_{plane} \quad M_{corner}$$

(NO FIXITY = SIMP. SUPPORTS)

BOTTOM SLAB DESIGN

SPAN	SHORT	LONG		NOTES/REFERENCES
REINFORCING SIZE	5	5		
SPACING (s)	12	12	in	
CLEARANCE (cl)	2	2.625	in	
DESIGN SECTION WIDTH (b)	12	12	in	
DIAMETER OF STEEL (dia)	0.625	0.625	in	
AREA OF STEEL (As)	0.307	0.307	in^2	
APPROX. (As req.)	0.036	0.038	in^2	
COMP. FACE TO STEEL CENT. (d)	11.69	11.06	in	

SHEAR

Mu @ Vu	6.37	6.19	ft*kip	
RESISTANCE FACTOR (ϕ_v)	0.9	0.9		AASHTO LRFD 5.5.4.2
CONC. SHEAR STRENGTH (Vc)	26.21	24.46	kip	AASHTO LRFD 5.7.3.3
STIRRUP AREA (Av) PER b	0	0	in^2	
STIRRUP SPACING (sv)	0	0	in	
STEEL SHEAR STRENGTHVs	0.00	0.00	kip	
FACT. SHEAR STRENGTH (fVn)	**23.59**	**22.02**	**kip**	CAPACITY
FACT SHEAR STRESS Vu @ d	**2.69**	**2.78**	**kip**	DEMAND
OVERDESIGN	776%	691%		

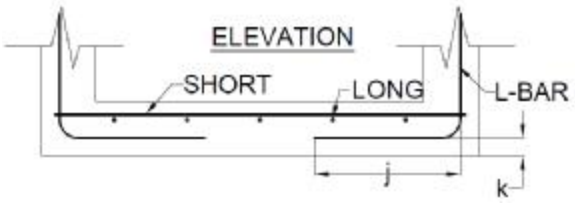
MOMENT

STEEL STRAIN (ε_s)	0.075	0.071		LINEAR STRAIN
RESISTANCE FACTOR (ϕ_b)	1.00	1.00		AASHTO LRFD 12.5.5
STRESS BLOCK HEIGHT (a)	0.36	0.36	in	AASHTO LRFD 5.6.2.2
NOM. FLEX. RESISTANCE (Mn)	17.65	16.69	ft-kip	AASHTO LRFD 5.6.3
FACT. FLEX. RESISTANCE (fMn)	**17.65**	**16.69**	**ft-kip**	CAPACITY
FACT. BENDING MOMENT (Mu)	**2.09**	**2.09**	**ft-kip**	DEMAND
OVERDESIGN	743%	697%		

SERVICEABILITY

c SERVICE (COMPRESSION FACE TO NEUTRAL AXIS)	1.85	1.79	in	
fs max	36.00	36.00	ksi	LRFD 5.6.7-1
fs	4.97	5.26	ksi	
s max	18.00	18.00	in	5.10.3.2, 5.6.7, 5.10.6
As MIN	0.048	0.050	in^2	LRFD 5.6.3.3
As TEMP	0.110	0.110	in^2	LRFD 5.10.6
OVERDESIGN	50%	50%		

Summary OK



j min = FULL U ft EVERY OTHER j = N/A ft MIN

k max allowed = 4.63 in