CITY OF O'FALLON

Winghaven
Saint Charles County

Bridge No. 3210013

Design Calculations

KDG Project No. 980100-0001

CITY OF O'FALLON
Bridge No. 3210013
Design Calculations
Winghaven
K*d*G Project No. 980100-0001

INDEX

CITY OF O'FALLON
Bridge No. 3210013
Design Calculations
Winghaven
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STATE OF MISSOURI
RONALD C.
FAGAN
NUMBER
E-16902
REGISTERED PROFESSIONAL ENGINEER

ENGINEERING CALCULATION COVER SHEET

PROJECT: Bridge No. 3210013
Winghaven

DISCIPLINE: Bridge

CALCULATION NO.: Final

NO. OF SHEETS: See Index

JOB NO.: 980100-0001

CALCULATED BY: JVS RCP

CONTRACT NO.:

CHECKED BY:

DESIGN CODE: AASHTO 1996

APPROVED BY: 20 Jul 98

APPROVED BY:

CALCULATION DESCRIPTION:

Substructure Design

Quantities

DESIGN BASIS OR REFERENCES:

AASHTO 16th Edition, 1996

Missouri Highway & Transportation Department Bridge Manual of Design

DESIGN SCOPE

Structure Type Rigid
- Box Design
- Single Cell
- (10.0 Ft. Wide X 7.0 Ft. High)

Loading:
- HS20-44
- Service Load Design
- Earth 120#/Cu. Ft.
- Equivalent Fluid Pressure 60#/Cu.Ft.

DESIGN CRITERIA

DESIGN SPECIFICATIONS

AASHTO - 1996 Sixteenth Edition

DESIGN LOADING

HS20
Earth 120#/cu.ft.
Equivalent Fluid Pressure 60#/Cu.Ft.

DESIGN UNIT STRESSES

Class B Concrete	(Culverts)	f'c	=	3,000 psi
Reinforcing Steel	(Grade 60)	f'y	=	60,000 psi

REINFORCING STEEL

Minimum clearance to reinforcing steel shall be 1-1/2", unless otherwise shown.

BAR COVER - AASHTO 8.22

Clear Dimensions to be shown on plans:

Top Slab	-	Top Reinforcing	=	2" clear
	-	Bottom Reinforcing	=	2" clear
Bottom Slab	-	Top Reinforcing	=	2" clear
	-	Bottom Reinforcing	=	3" clear
Sidewalls	-	Reinforcement Stream Face	=	2" clear
	-	Reinforcement Fill Face	=	2" clear

MAXIMUM BAR LENGTHS

Longitudinal bars should be made full length without splicing up to about 40'-0"; splice if longer. Bars #5 and larger may be used to a length of 60'-0" without splicing.

BAR SPLICES

See Section 2.4 for minimum bar lap and tension splices in reinforcement. Use a Class C splice for longitudinal bar (22" min.).

JOINT FILLER

All joint filler shall meet requirements of Standard Specification 1057.2.5, except as noted.

DESIGN LAYOUT

Division of Bridges

No. 3210013

Job.

Route Winghaven Drive County Saint Charles Rte. Winghaven Drive

STRUCTURE

SUPERSTRUCTURE One Cell (10.0W x 7.0H) (Rigid)

Skew .... Square

Roadway .... 2 - 12 foot lanes each direction with a 20 foot median.

Loading HS20

Beg. Sta. ....

Alignment .... Tangent

Grade .... P.I. Sta. 26+40.83 (Elev. 604.22) Bk. +2.00%, Ahd. -2.00%, Length = 600.00

SUBSTRUCTURE

Ftg Loads .... 10,000 lbs per square foot

Pile Type .... N/A

Length .... N/A

Elev Ftg, Bott .... 592.0 High 586.0 Low

GENERAL

Revetment/Slope .... Sideslope 3:1 (Normal)

End Fills .... Earth

Traffic Handling ....

Present Bridge .... None

SPECIAL REQUIREMENTS

Profile Grade .... Centerline of Winghaven Drive (Centerline Median)

Rail Road Alignment .... N/A

Tie Station .... 30 + 49.00

Final Allowable Clearances .... N.A.

Estimate includes 10% for Engineering and Contingencies and 5% for Preliminary Engineering

Dated: By: Estm. $

Date: Initials:	Notes or Revisions in Conference

Notes and Revisions after Conference (All revisions to be dated and initialed)

DRAWING LIST

Sheet No.	Title
1	Plan, Elevation, General Notes, and Quanities
2	Reinforcement
3	Cross Section and Wing Wall Details

CORRESPONDENCE

PICKETT RAY & SILVER

CIVIL ENGINEERS • PLANNERS • LAND SURVEYORS

July 14, 1998
Revised July 15, 1998

KDG. MH FILE 980100

JUL 16 1998

Mr. Ron Pagan
Kuhlmann Design Group, Inc
66 Progress Parkway
St Louis, Missouri 63043

RE WINGHAVEN - BOX CULVERT
PR&S PROJECT NO 97-034

Dear Ron

Per our meeting today, I am sending you "sealed" confirmation of box culvert information

	"S"	"H"	Elev 1	Elev 2	A Rt	A Lt	B	Des-Fill	Des-Fill
Winghaven Station 17+15	10	7	575 42	574 58	60	60	24	1	4
Winghaven Station 30+49	10	7	580.68	579.92	60	60	24	1	7
Winghaven Station 59+00	12	10	516 39	517 11	70	70	30	1	5
Charlie (Phoenix) Station 62+53.89	12	12	488 91	490 09	43	43	37	1	4
David (Red Hawk) Station 5+29 73	8	7	511.20	510 45	60	60	30	1	7

We will send Winghaven Station 30+49 as soon as the street is revised back to the previous grade. If you need anything else, please contact me or Mr Jim Cannady

Very truly yours,
PICKETT, RAY & SILVER, INC

Tanya J. Dietz
Project Design Supervisor

HAROLD J. BARTELS
NUMBER E-17751
7/14/98

bjs
cc Mr. Joe McKee, Paric Corporation
Mr. Dave Rogers, Fred Weber

PICKETT RAY & SILVER

CIVIL ENGINEERS • *PLANNERS* • *LAND SURVEYORS*

KDG. MH FILE 980100

JUL 16 1998

FAX

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PLEASE DELIVER THE FOLLOWING PAGES:

TO: Ron 434 8280

FROM: Tony

PROJECT: Winghaven

PR&S PROJECT NO.: 97034

DATE AND TIME: 7.~~14~~.98

TOTAL NO. OF PAGES, INCLUDING COVER SHEET: 2

TELECOPY OPERATOR: 15

3:40 pm

PLEASE NOTIFY US IMMEDIATELY IF THE MESSAGE IS INCOMPLETE OR UNCLEAR. THANK YOU.

PICKETT RAY & SILVER

CIVIL ENGINEERS • PLANNERS • LAND SURVEYORS

KDG, MH FILE 980100

JUL 15 1998

July 14, 1998
Revised July 15, 1998

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Winghaven Station 59+00	12	10	516.39	517.11	70	70	30	1	5
Charlie (Phoenix) Station 62+53.89	12	12	488.91	490.09	43	43	37	1	4
David (Red Hawk) Station 5+29.73	8	7	511.20	510.45	60	60	30	1	7

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Project Design Supervisor

STATE OF MISSOURI
HAROLD J. BART[illegible]
NUMBER
E-17751
REGISTERED PROFESSIONAL ENGINEER

7/14/98

bjs
cc Mr Joe McKee, Paric Corporation
Mr Dave Rogers, Fred Weber

333 MID RIVERS MALL DRIVE • ST PETERS, MISSOURI 63376 • 314-397-1211 / 397-1104 FAX

PICKETT RAY & SILVER

CIVIL ENGINEERS • *PLANNERS* • *LAND SURVEYORS*

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CIVIL ENGINEERS • PLANNERS • LAND SURVEYORS

July 14, 1998

KDG, MH FILE 980100

JUL 15 1998

Mr. Ron Pagan
Kuhlmann Design Group, Inc.
6[illegible] Progress Parkway
St. Louis, Missouri 63043

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PR&S PROJECT NO. 97-034

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Winghaven Station [illegible]	10	7							
Winghaven Station [illegible]	12	10	516.39	517.11	70	70		1	5
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CIVIL ENGINEERS • PLANNERS • LAND SURVEYORS

July 14, 1998

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ADG. MH FILE 980100

JUL 1 _ 1998

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PICKETT RAY & SILVER

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FAX

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PICKETT RAY & SILVER

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PLEASE DELIVER THE FOLLOWING PAGES:

TO: RON PAGAN (434 8280)

FROM: TANYA

PROJECT: WINGHAVEN

PR&S PROJECT NO.: 97034

DATE AND TIME: 7.10.98

TOTAL NO. OF PAGES, INCLUDING COVER SHEET: 5

TELECOPY OPERATOR:

COPY TO MIKE HARMON - WEBER 3440970

PLEASE NOTIFY US IMMEDIATELY IF THE MESSAGE IS INCOMPLETE OR UNCLEAR. THANK YOU.

PICKETT RAY & SILVER

333 Mid Rivers Mall Dr
St. Peters, MO 63376

Civil Engineers
Planners
Land Surveyors

397-1211

PROJECT NAME
PROJECT #/JOB ORDER #
DATE
DESIGNER
PAGE

RON -

7.10.98

- BM @ Box(s): HAS NOT BEEN SET.

- HW ELEV - PER MY CALC:

WINGHAVEN	524.3
PHOENIX	496.3
RED HAWK	520.6

F.P.

WINGHAVEN	522.0
PHOENIX	496.3
RED HAWK	N/A

UTILITY SURVEY - DELIVERED (THIS WK)
COMPLETE SET PLANS - READY FRI. (7-10-98)
HW CALCS - ENCLOSED
" ELEV'S ABOVE

PROJECT: Winghaven · Charlie Dr.

STATION: 62+50

SHEET ______ OF ______

CULVERT DESIGN FORM

DESIGNER/DATE: Edy. / 12/22/97

REVIEWER/DATE: ______ / ______

HYDROLOGICAL DATA

SEE ADD'L SHTS

☐ METHOD: ______

☒ DRAINAGE AREA: ______ ☐ STREAM SLOPE: ______

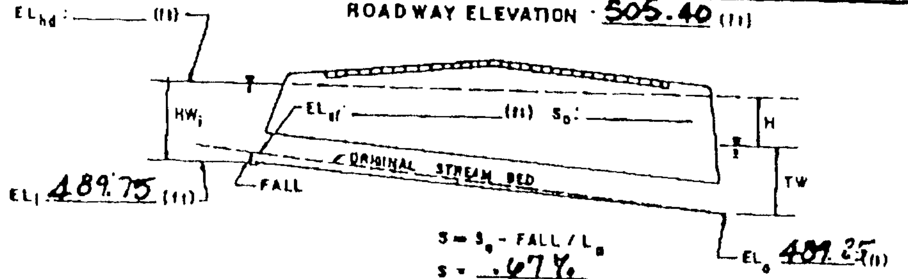
☐ CHANNEL SHAPE: ______

☐ ROUTING ______ ☐ OTHER ______

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
15	3671.5	
100	5102.7	

ROADWAY ELEVATION: 505.40 (ft)



S = S$_o$ - FALL / L$_a$

S = .67%

L$_a$ = 75

F.P. = 496.5 ±

CULVERT DESCRIPTION: MATERIAL - SHAPE - SIZE - ENTRANCE	TOTAL FLOW Q (cfs)	FLOW PER BARREL Q/N (1)	HEADWATER CALCULATIONS											CONTROL HEADWATER ELEVATION	OUTLET VELOCITY	COMMENTS
			INLET CONTROL				OUTLET CONTROL									
			HW$_i$/D (2)	HW$_i$	FALL (3)	EL$_{hi}$ (4)	TW (5)	d_c	$\frac{d_c+D}{2}$	h_o (6)	k_e	H (7)	EL$_{ho}$ (8)			
5 - 12'x 12' Box.	3672	734	.70	9.4	-	498.2	-	4.8	8.4	8.4	0.5	.7	498.4	498.4		Outlet
5 · 12'x 12' Box.	5103	1021	0.86	10.3	-	5000	-	6.1	9.0	9.0	0.5	1.4	499.6	500.0		inlet control
Use FEMA Q.																
5 - 12'x 12' Box	2495	499	.54	6.5	—	496.3		3.7	7.9	7.9	0.5	.3	4.943	496.3		inlet control

5/4/98 using Q from FEMA chart (in file)

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

(2) HW$_i$/D = HW/D OR HW$_i$/D FROM DESIGN CHARTS

(3) FALL = HW$_i$ - (EL$_{hd}$ - EL$_{sf}$); FALL IS ZERO FOR CULVERTS ON GRADE

(4) EL$_{hi}$ = HW$_i$ + EL$_i$ (INVERT OF INLET CONTROL SECTION)

(5) TW BASED ON DOWN STREAM CONTROL OR FLOW DEPTH IN CHANNEL

(6) h_o = TW or $(d_c + D/2)$ (WHICHEVER IS GREATER)

(7) $H = \left[1 + k_e + (29 n^2 L)/R^{1.33}\right] V^2/2g$

(8) EL$_{ho}$ = EL$_o$ + H + h_o

SUBSCRIPT DEFINITIONS:

- a. APPROXIMATE
- f. CULVERT FACE
- hd. DESIGN HEADWATER
- hi. HEADWATER IN INLET CONTROL
- ho. HEADWATER IN OUTLET CONTROL
- i. INLET CONTROL SECTION
- o. OUTLET
- sf. STREAMBED AT CULVERT FACE
- tw. TAILWATER

COMMENTS / DISCUSSION:

CULVERT BARREL SELECTED:

SIZE: 5-12x12 Box

SHAPE: Square

MATERIAL: Concrete n .013

ENTRANCE: ______

PROJECT: Winghaven - David Dr.

STATION: 5+30

SHEET ______ OF ______

CULVERT DESIGN FORM

DESIGNER/DATE: [illegible] / 12/22/97

REVIEWER/DATE: ______ / ______

HYDROLOGICAL DATA

SEE ADD'L SHTS

☐ METHOD: ______

☒ DRAINAGE AREA: ______ ☐ STREAM SLOPE: ______

☐ CHANNEL SHAPE: ______

☐ ROUTING: ______ ☐ OTHER: ______

72W

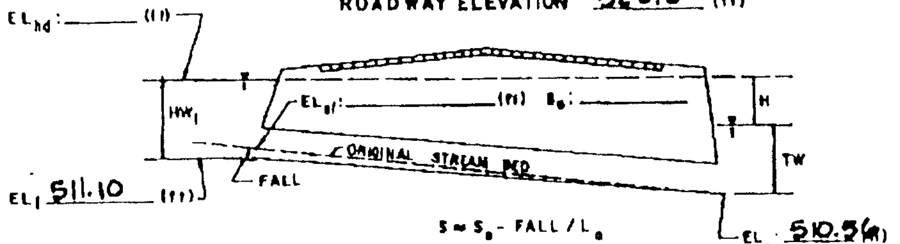
33

240 Ac

DESIGN FLOWS/TAILWATER

R I (YEARS)	FLOW (cfs)	TW (ft)
15	780.8	
100	1085	

ROADWAY ELEVATION 525.6 (ft)



EL$_{hd}$: ______ (ft)

EL$_i$ 511.10 (ft)

EL$_o$: 510.56 (ft)

S ≈ S$_o$ - FALL / L$_a$

S = ______

L$_a$ = 108

CULVERT DESCRIPTION: MATERIAL - SHAPE - SIZE - ENTRANCE	TOTAL FLOW Q (cfs)	FLOW PER BARREL Q/N (1)	HEADWATER CALCULATIONS: INLET CONTROL HW$_i$/D (2)	HW$_i$	FALL (3)	EL$_{hi}$ (4)	OUTLET CONTROL TW (5)	d_c	$\frac{d_c+D}{2}$	h_o (6)	k_e	H (7)	EL$_{ho}$ (8)	CONTROL HEADWATER ELEVATION	OUTLET VELOCITY	COMMENTS
2 · 7'h × 8'w (15yr)	780.8	390.4	1.2	8.4	-	519.5		4.2	5.6	5.6	.5	1.32	517.4			Inlet control
2 · 7×8 (100yr.)	1085	542.5	1.36	9.52	-	520.6		5.2	6.1	6.1	.5	2.58	519.2			Inlet control

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

(2) HW$_i$/D = HW /D OR HW$_i$/D FROM DESIGN CHARTS

(3) FALL = HW$_i$ - (EL$_{hd}$ - EL$_{sf}$); FALL IS ZERO FOR CULVERTS ON GRADE

(4) EL$_{hi}$ = HW$_i$ + EL$_i$ (INVERT OF INLET CONTROL SECTION)

(5) TW BASED ON DOWN STREAM CONTROL OR FLOW DEPTH IN CHANNEL.

(6) h_o = TW or $(d_c + D/2)$ (WHICHEVER IS GREATER)

(7) $H = \left[1 + k_e + (29 n^2 L) / R^{1.33}\right] V^2/2g$

(8) EL$_{ho}$ = EL$_o$ + H + h_o

SUBSCRIPT DEFINITIONS:

a. APPROXIMATE
f. CULVERT FACE
hd. DESIGN HEADWATER
hi. HEADWATER IN INLET CONTROL
ho. HEADWATER IN OUTLET CONTROL
i. INLET CONTROL SECTION
o. OUTLET
sf. STREAMBED AT CULVERT FACE
tw. TAILWATER

COMMENTS / DISCUSSION:

CULVERT BARREL SELECTED:

SIZE: 7'H × 8'W · 2

SHAPE: ______

MATERIAL: Conc. n.013

ENTRANCE: ______

PROJECT: Winghaven - Winghaven Dr.

STATION 59+00

SHEET ______ OF ______

CULVERT DESIGN FORM

DESIGNER / DATE: ______ / 12/22/97

REVIEWER / DATE: ______ / ______

HYDROLOGICAL DATA

SEE ADD'L SHTS

☐ METHOD: ______

☑ DRAINAGE AREA: ______ ☐ STREAM SLOPE ______

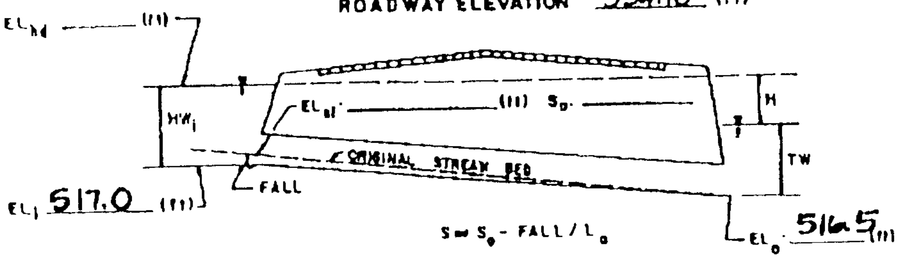
☐ CHANNEL SHAPE: ______

☐ ROUTING: ______ ☐ OTHER ______

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
15	3019	
100	4196	

ROADWAY ELEVATION: 534.10 (ft)



$S = S_o - FALL / L_o$

S = ______

L_o = 150.0'

(FP: 522.2)

CULVERT DESCRIPTION: MATERIAL - SHAPE - SIZE - ENTRANCE	TOTAL FLOW Q (cfs)	FLOW PER BARREL Q/N (1)	HEADWATER CALCULATIONS											CONTROL HEADWATER ELEVATION	OUTLET VELOCITY	COMMENTS
			INLET CONTROL				OUTLET CONTROL									
			HW_i/D (2)	HW_i	FALL (3)	EL_{hi} (4)	TW (5)	d_c	$\frac{d_c+D}{2}$	h_o (6)	k_e	H (7)	EL_{ho} (8)			
4-10'h x 12'w (15)	3019	755	0.85	8.5		525.5		4 9	7 45	7.45	0.5	1.1	524.1	526.5		Inlet Control
4-10'h x 12'w (100)	4196	1049	1.08	10.8		527.8		6.2	8.1	8.1	0.5	2.01	526.6	527.8		"
Use # from FEMA																
4-10'h x 12'w	244	603^{5}	.73	7.3		524^{3}										

6/4/98

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

(2) $HW_i/D = HW/D$ OR HW_i/D FROM DESIGN CHARTS

(3) $FALL = HW_i - (EL_{hd} - EL_{sf})$; FALL IS ZERO FOR CULVERTS ON GRADE

(4) $EL_{hi} = HW_i + EL_i$ (INVERT OF INLET CONTROL SECTION)

(5) TW BASED ON DOWN STREAM CONTROL OR FLOW DEPTH IN CHANNEL

(6) $h_o = TW$ or $(d_c + D/2)$ (WHICHEVER IS GREATER)

(7) $H = \left[1 + k_e + (29 n^2 L) / R^{1.33}\right] v^2/2g$

(8) $EL_{ho} = EL_o + H + h_o$

SUBSCRIPT DEFINITIONS:

- ≈ APPROXIMATE
- ℓ CULVERT FACE
- hd DESIGN HEADWATER
- hi HEADWATER IN INLET CONTROL
- ho HEADWATER IN OUTLET CONTROL
- i INLET CONTROL SECTION
- o OUTLET
- sf STREAMBED AT CULVERT FACE
- tw TAILWATER

COMMENTS / DISCUSSION:

CULVERT BARREL SELECTED:

SIZE: 4-10'h x 12'w

SHAPE: ______

MATERIAL: Concrete n.013

ENTRANCE: ______

PICKETT RAY & SILVER

CIVIL ENGINEERS • PLANNERS • LAND SURVEYORS

FAX

CONFIDENTIALITY NOTE

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PLEASE DELIVER THE FOLLOWING PAGES:

TO: RON PAGAN (434 8280)

FROM: TANYA

PROJECT: WINGHAVEN

PR&S PROJECT NO.: 97034

DATE AND TIME. 7.10.98

TOTAL NO. OF PAGES, INCLUDING COVER SHEET: 5

TELECOPY OPERATOR:

COPY TO MIKE HARMON - WEBER 3440970

PLEASE NOTIFY US IMMEDIATELY IF THE MESSAGE IS INCOMPLETE OR UNCLEAR. THANK YOU.

333 MID RIVERS MALL DRIVE • ST. PETERS, MISSOURI 63376 • 314-397-1211/314-397-1104 FAX

PICKETT RAY & SILVER

322 Mid Rivers Mall Dr
St. Peters, MO 63376

Civil Engineers
Planners
Land Surveyors

397-1211

PROJECT NAME
PROJECT #/JOB ORDER #
DATE
DESIGNER
PAGE

RON -

7.10.98

- BM @ BOX(S): HAS NOT BEEN SET.

- HW ELEV - PER MY CALC:

WINGHAVEN	521.3
PHOENIX	496.3
RED HAWK	520.6

F.P.

WINGHAVEN	522.0
PHOENIX	496.3
RED HAWK	N/A

UTILITY SURVEY - DELIVERED (THIS WK)
COMPLETE SET PLANS - READY FRI. (7.10.98)
HW CALCS - ENCLOSED
" ELEV: ABOVE

PROJECT: Winghaven - Charlie Dr.

STATION: 62+50

SHEET ____ OF ____

CULVERT DESIGN FORM

DESIGNER/DATE: Edy, 12/22/97

REVIEWER/DATE: ____ / ____

HYDROLOGICAL DATA

SEE ADD'L SHTS

☐ METHOD: ____

☒ DRAINAGE AREA: ____ ☐ STREAM SLOPE: ____

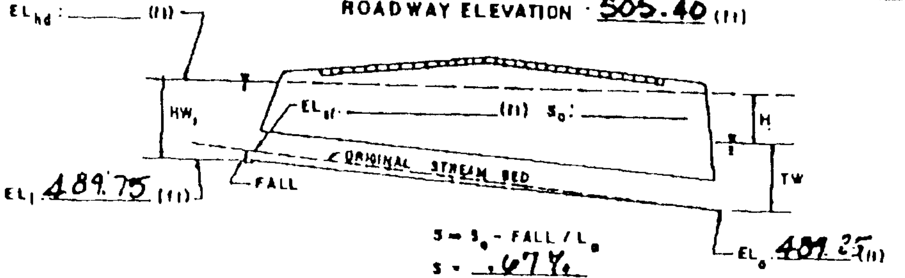
☐ CHANNEL SHAPE: ____

☐ ROUTING ____ ☐ OTHER ____

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
15	3671.5	
100	5102.7	

ROADWAY ELEVATION: 505.40 (ft)



EL_{hd}: ____ (ft)

EL_i: 489.75 (ft)

EL_o: 489.25 (ft)

$S = S_o - FALL / L_a$

S = .67%

L_a = 75

F.P. = 496.5±

CULVERT DESCRIPTION: MATERIAL - SHAPE - SIZE - ENTRANCE	TOTAL FLOW Q (cfs)	FLOW PER BARREL Q/N (1)	HEADWATER CALCULATIONS: INLET CONTROL				OUTLET CONTROL							CONTROL HEADWATER ELEVATION	OUTLET VELOCITY	COMMENTS
			HW_i/D (2)	HW_i	FALL (3)	EL_{hi} (4)	TW (5)	d_c	$\frac{d_c+D}{2}$	h_o (6)	k_e	H (7)	EL_{ho} (8)			
5 - 12'x12' Box.	3672	734	.70	9.4	-	498.2	-	4.8	8.4	8.4	0.5	.7	498.9	498.4		Outlet!
5 - 12'x12' Box.	5103	1021	0.86	10.3	-	500.0	-	6.1	9.0	9.0	0.5	1.4	499.6	500.0		inlet [illegible]
Use FEMA Q.																
5 - 12'x12' Box	2495	499	.54	6.5	—	496.3		3.7	7.9	7.9	0.5	.3	494.3	496.3		inlet control

5/4/98 using Q from FEMA chart (in file)

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

(2) $HW_i/D = HW/D$ OR HW_i/D FROM DESIGN CHARTS

(3) $FALL = HW_i - (EL_{hd} - EL_{sf})$; FALL IS ZERO FOR CULVERTS ON GRADE

(4) $EL_{hi} = HW_i + EL_i$ (INVERT OF INLET CONTROL SECTION)

(5) TW BASED ON DOWN STREAM CONTROL OR FLOW DEPTH IN CHANNEL

(6) $h_o = TW$ or $(d_c + D/2)$ (WHICHEVER IS GREATER)

(7) $H = \left[1 + k_e + (29 n^2 L) / R^{1.33}\right] V^2 / 2g$

(8) $EL_{ho} = EL_o + H + h_o$

SUBSCRIPT DEFINITIONS:

- a. APPROXIMATE
- f. CULVERT FACE
- hd. DESIGN HEADWATER
- hi. HEADWATER IN INLET CONTROL
- ho. HEADWATER IN OUTLET CONTROL
- i. INLET CONTROL SECTION
- o. OUTLET
- sf. STREAMBED AT CULVERT FACE
- tw. TAILWATER

COMMENTS / DISCUSSION:

CULVERT BARREL SELECTED:

SIZE: 5-12x12 Box

SHAPE: Square

MATERIAL: Concrete n .013

ENTRANCE: ____

CULVERT DESIGN FORM

PROJECT: Winghaven - David Dr.

STATION: 5+30

SHEET ______ OF ______

DESIGNER / DATE: [illegible] / 12/22/97

REVIEWER / DATE: ______ / ______

P2W

33

HYDROLOGICAL DATA

SEE ADD'L SHTS

☐ METHOD: ______

☒ DRAINAGE AREA: ______ ☐ STREAM SLOPE: ______

☐ CHANNEL SHAPE: ______

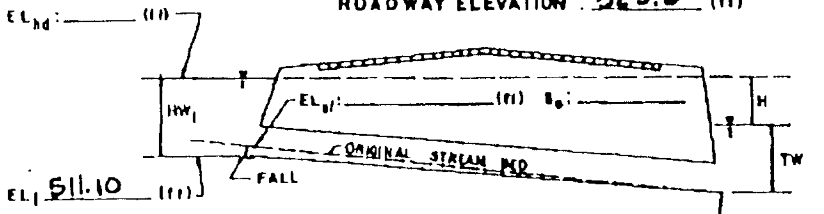
☐ ROUTING: ______ ☐ OTHER: ______

210 Ac

DESIGN FLOWS/TAILWATER

R I (YEARS)	FLOW (cfs)	TW (ft)
15	780.8	
100	1085	

ROADWAY ELEVATION: 525.6 (ft)



EL_i 511.10 (ft)

EL_o 510.56 (ft)

$S = S_o - FALL / L_o$

S = ______

L_o = 108

CULVERT DESCRIPTION: MATERIAL - SHAPE - SIZE - ENTRANCE	TOTAL FLOW Q (cfs)	FLOW PER BARREL Q/N (1)	HEADWATER CALCULATIONS: INLET CONTROL HW_i/D (2)	HW_i	FALL (3)	EL_hi (4)	OUTLET CONTROL TW (5)	d_c	$\frac{d_c+D}{2}$	h_o (6)	k_e	H (7)	EL_ho (8)	CONTROL HEADWATER ELEVATION	OUTLET VELOCITY	COMMENTS
2 - 7'h x 8'w (15yr)	780 8	3904	1.2	8.4	-	519.5		4.2	5.6	5.6	.5	1.32	517.4			Inlet control
2 - 7x8 (100yr)	1085	5423	1.36	9.52	-	520.6		5.2	6.1	6 1	.5	2 58	519.2			Inlet Control

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

(2) $HW_i/D = HW/D$ OR HW_i/D FROM DESIGN CHARTS

(3) $FALL = HW_i - (EL_{hd} - EL_{sf})$; FALL IS ZERO FOR CULVERTS ON GRADE

(4) $EL_{hi} = HW_i + EL_i$ (INVERT OF INLET CONTROL SECTION)

(5) TW BASED ON DOWN STREAM CONTROL OR FLOW DEPTH IN CHANNEL.

(6) $h_o = TW$ or $(d_c + D/2)$ (WHICHEVER IS GREATER)

(7) $H = \left[1 + k_e + (29 n^2 L) / R^{1.33}\right] V^2 / 2g$

(8) $EL_{ho} = EL_o + H + h_o$

SUBSCRIPT DEFINITIONS:

- a. APPROXIMATE
- f. CULVERT FACE
- hd. DESIGN HEADWATER
- hi. HEADWATER IN INLET CONTROL
- ho. HEADWATER IN OUTLET CONTROL
- i. INLET CONTROL SECTION
- o. OUTLET
- sf. STREAMBED AT CULVERT FACE
- tw. TAILWATER

COMMENTS / DISCUSSION:

CULVERT BARREL SELECTED:

SIZE: 7'H x 8'W - 2

SHAPE: ______

MATERIAL: Conc. n .013

ENTRANCE: ______

PROJECT: Winghaven - Winghaven Dr.

STATION 59+00

SHEET ____ OF ____

CULVERT DESIGN FORM

DESIGNER / DATE: [illegible] / 12/22/97

REVIEWER / DATE: ______ / ______

HYDROLOGICAL DATA

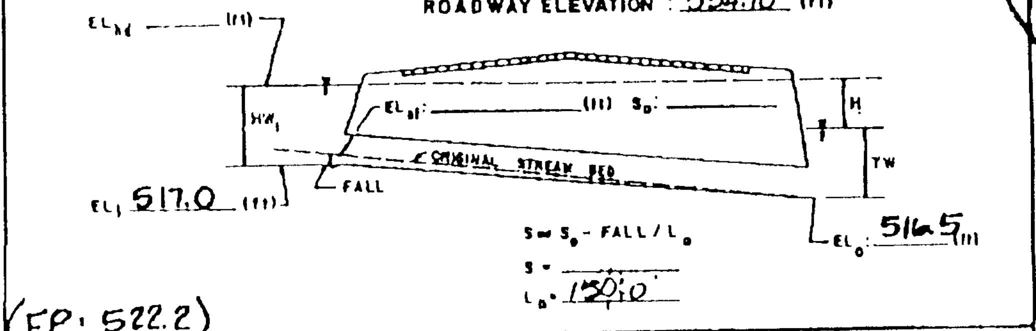
SEE ADD'L SHTS

- ☐ METHOD: ______
- ☑ DRAINAGE AREA: ______ ☐ STREAM SLOPE: ______
- ☐ CHANNEL SHAPE: ______
- ☐ ROUTING: ______ ☐ OTHER: ______

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
15	3019	
100	4196	

ROADWAY ELEVATION: 534.10 (ft)



S = S_o - FALL / L_o

S = ______

L_o = 150.0'

(FP: 522.2)

CULVERT DESCRIPTION: MATERIAL - SHAPE - SIZE - ENTRANCE	TOTAL FLOW Q (cfs)	FLOW PER BARREL Q/N (1)	HEADWATER CALCULATIONS INLET CONTROL HW_i/D (2)	HW_i	FALL (3)	EL_hi (4)	OUTLET CONTROL TW (5)	d_c	$\frac{d_c+D}{2}$	h_o (6)	k_e	H (7)	EL_ho (8)	CONTROL HEADWATER ELEVATION	OUTLET VELOCITY	COMMENTS
4-10'h x 12'w (15)	3019	755	0.85	9.5		525.5		4.9	7.45	7.45	0.5	1.1	524.1	525.5		Inlet Control
4-10'h x 12'W (100)	4196	1049	1.08	10.8		527.8		6.2	8.1	8.1	0.5	2.01	526.6	527.8		" "
use # from FEMA																
4-10'h x 12'w	244	605.5	.73	7.3		524.3										

6/4/98

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

(2) $HW_i/D = HW/D$ OR HW_i/D FROM DESIGN CHARTS

(3) $FALL = HW_i - (EL_{hd} - EL_{sf})$; FALL IS ZERO FOR CULVERTS ON GRADE

(4) $EL_{hi} = HW_i + EL_i$ (INVERT OF INLET CONTROL SECTION)

(5) TW BASED ON DOWN STREAM CONTROL OR FLOW DEPTH IN CHANNEL

(6) $h_o = TW$ or $(d_c + D/2)$ (WHICHEVER IS GREATER)

(7) $H = \left[1 + k_e + (29n^2 L)/R^{1.33}\right] V^2/2g$

(8) $EL_{ho} = EL_o + H + h_o$

SUBSCRIPT DEFINITIONS:

- a APPROXIMATE
- f CULVERT FACE
- hd DESIGN HEADWATER
- hi HEADWATER IN INLET CONTROL
- ho HEADWATER IN OUTLET CONTROL
- i INLET CONTROL SECTION
- o OUTLET
- sf STREAMBED AT CULVERT FACE
- tw TAILWATER

COMMENTS / DISCUSSION:

CULVERT BARREL SELECTED:

SIZE: 4-10'h x 12'W

SHAPE: ______

MATERIAL: Concrete n=.013

ENTRANCE: ______

KDG. MH FILE 980100

JUL 02 1998

Kuhlmann *design* ~~Group, Inc.~~

6 Westbury Drive, St. Charles, MO 63301-2571
Phone 314.946.5566 • Fax 314.946.6713

Post-it® Fax Note 7671
Date 7-2-98 # of pages ▶ 1
To JIM CANNADY From SAL ELKOTT
Co/Dept PRS Co KdG
Phone # Phone #
Fax # Fax #

FACSIMILE TRANSMISSION

PLEASE DELIVER IMMEDIATELY

CORRECTION JULY 2, 98

DATE [illegible] 2 1998
TO Mr. Ron Pagan
COMPANY
FROM Sal Elkott Sal

TIME
FAX #
PROJECT # 970231
SENT BY

[illegible]

[illegible] are the floor elevations for the Winghaven Drive tunnel as designed by Pickett Ray and Silver (PRS). These [illegible] based on PRS plans dated December 1997 and last revised on March 27, 1998. Mr. Jim Cannady verified these elevations for me this morning. In addition, He said that even though the tunnel floor elevations are not called out on [illegible] you have correctly stated), PRS' intent is for the tunnels to slope at one half of one percent (0.005 foot per [illegible]). By using this slope and the centerline tunnel floor elevation that is shown on the roadway profile one can verify these elevations.

North Tunnel: Length = 128' Centerline floor elevation = 575.00

West Side floor elevation = 574.68 (measured at end of tunnel ~~75'~~ 64' away from roadway centerline)

East Side floor elevation = 575.32 (measured at end of tunnel ~~75'~~ 64' away from roadway centerline)

South Tunnel: length = 100' centerline floor elevation = 580.30

West Side floor elevation = 580.05 (measured at end of tunnel 50' away from roadway centerline)

East Side floor elevation = 580.55 (measured at end of tunnel 50' away from roadway centerline)

[illegible] understands that you may need to change these lengths by few feet and the elevations by few tenths. It would be necessary to let Jim and us know of these changes. We at the St. Charles office have to design for the drainage of these tunnels.

Copy: Jim Cannady, Frank Bauer, Jim Poole

[illegible] COVER PAGE One

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PLEASE CALL 314 946.5566

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Kuhlmann *design* Group, Inc.
kdc
Transportation Department
66 Progress Parkway
St. Louis, Missouri 63043

Telephone: (314) 434-8898
Fax: (314) 434-8280
E-Mail: kdgmh@kdginc.com

FAX TRANSMITTAL COVER SHEET

TO: MR. FRANK GODWIN P.E.
CITY OF OFALLON
138 SOUTH MAIN STREET
OFALLON MISSOURI 63366

FAX NO. 314 240 5511
DATE: 25 JUNE 1998
PHONE 314 240 2000

FROM: RONALD C. PAGAN, P.E.

PROJECT NO. 980100

MESSAGE: ATTACHED IS CULVERT DESIGN CRITERIA WE DISCUSSED.

THANK YOU

TOTAL NUMBER OF PAGED TRANSMITTED INCLUDING COVER PAGE: 2

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Thank you

Golf Course Structures

REINFORCEMENT

BAR COVER - AASHTO 8.22

CLEAR DIMENSIONS TO BE SHOWN ON PLANS:

TOP SLAB - TOP REINFORCING = 2" CL.
BOTTOM REINFORCING ~~= 1" CL.~~ 2"

BOTTOM - TOP REINFORCING = ~~1-1/2" CL~~. 2"
BOTTOM REINFORCING = 3" CL.

SIDEWALLS - REINFORCEMENT STREAM FACE = ~~1-1/2" CL.~~ 2"
REINFORCEMENT FILL FACE = 2" CL.

MAXIMUM BAR LENGTHS

LONGITUDINAL BARS SHOULD BE MADE FULL LENGTH WITHOUT SPLICING UP TO ABOUT 40'-0"; SPLICE IF LONGER. BARS #5 AND LARGER MAY BE USED TO A LENGTH OF 60'-0" WITHOUT SPLICING.

BAR SPLICES

SEE SECTION 2.4 FOR MINIMUM BAR LAP AND TENSION SPLICES IN REINFORCEMENT. USE A CLASS C SPLICE FOR LONGITUDINAL BAR (22" MIN.).

BOX CULVERTS ON ROCK

VERTICAL BARS IN THE WALLS SHALL SET ON ROCK. E1 & E2 BARS IN THE WING SHALL BE SET 12" INTO ROCK AND GROUTED (SEE SEC. 4 F1 FOR NOTE FOR PLANS).

REINFORCEMENT

BAR COVER - AASHTO 8.22

CLEAR DIMENSIONS TO BE SHOWN ON PLANS:

TOP SLAB - TOP REINFORCING = 2" CL.
BOTTOM REINFORCING = 1" CL.

1 1/2"

BOTTOM - TOP REINFORCING = 1-1/2" CL.
BOTTOM REINFORCING = 3" CL.

SIDEWALLS - REINFORCEMENT STREAM FACE = 1-1/2" CL.
REINFORCEMENT FILL FACE = 2" CL.

MAXIMUM BAR LENGTHS

LONGITUDINAL BARS SHOULD BE MADE FULL LENGTH WITHOUT SPLICING UP TO ABOUT 40'-0"; SPLICE IF LONGER. BARS #5 AND LARGER MAY BE USED TO A LENGTH OF 60'-0" WITHOUT SPLICING.

BAR SPLICES

SEE SECTION 2.4 FOR MINIMUM BAR LAP AND TENSION SPLICES IN REINFORCEMENT. USE A CLASS C SPLICE FOR LONGITUDINAL BAR (22" MIN.).

BOX CULVERTS ON ROCK

VERTICAL BARS IN THE WALLS SHALL SET ON ROCK. E1 & E2 BARS IN THE WING SHALL BE SET 12" INTO ROCK AND GROUTED (SEE SEC. 4 F1 FOR NOTE FOR PLANS).

GENERAL NOTES:

CONSTRUCTION SPECIFICATIONS:

All materials and methods of construction shall meet the requirements of MoDot Standard Specifications for Highway Construction 1996

DESIGN SPECIFICATIONS:

A.A.S.H.T.O. – 1996
Service Load Design

DESIGN LOADING:

HS20
Earth 120#/Cu. Ft.,
Equivalent Fluid Pressure 30#/Cu Ft.

DESIGN UNIT STRESSES:

Class B Concrete (Substructure) f'c = 3,000 psi
Reinforcing Steel (Grade 60) fy = 60,000 psi

JOINT FILLER:

All Joint Filler shall meet the requirements of Std Spec. 1057.2.4, except as noted.

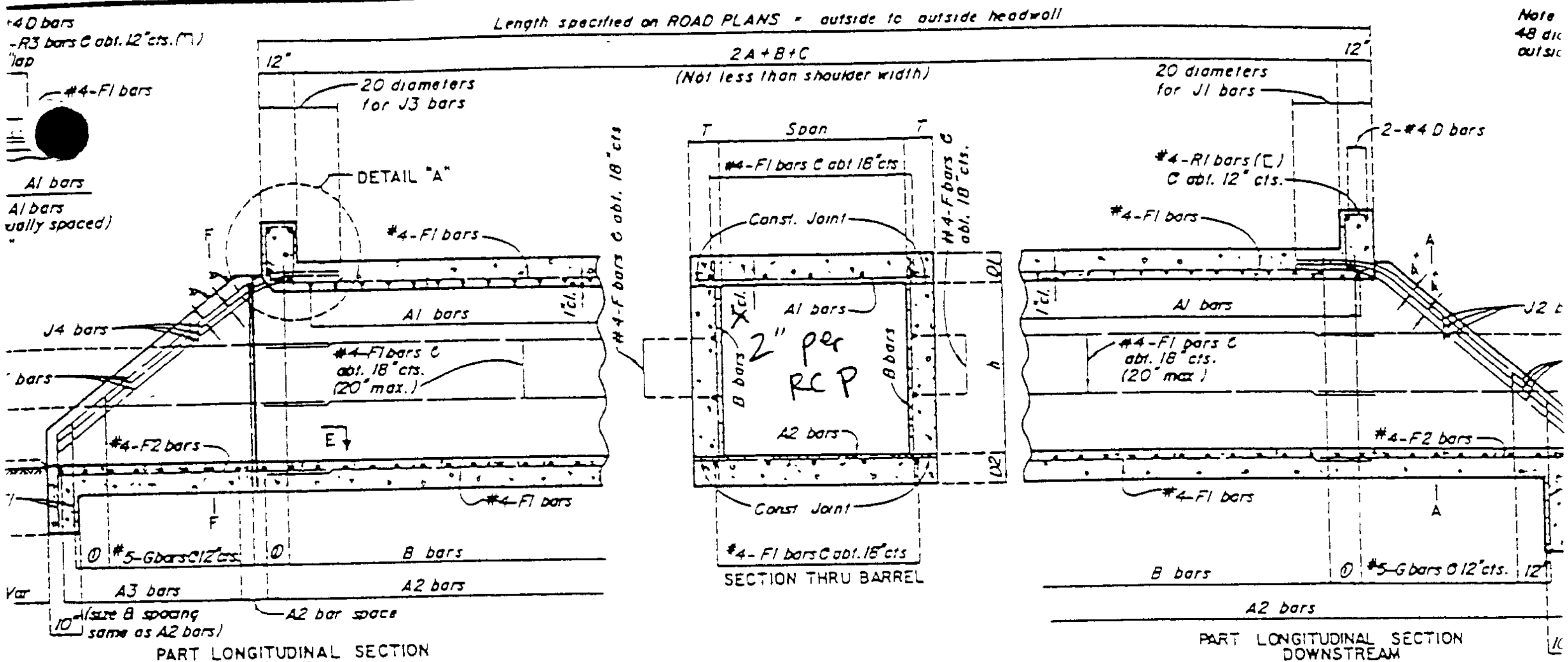
Joint filler shall be securely stitched to one face of the concrete with No. 10 gage copper wire or No. 12 gage soft drawn galvanized steel wire.

REINFORCING STEEL:

Minimum clearance to reinforcing steel shall be 1–1/2", unless otherwise shown.

Lap all reinforcing 24 bar diameters unless otherwise noted.

ST. LOUIS COUNTY A100

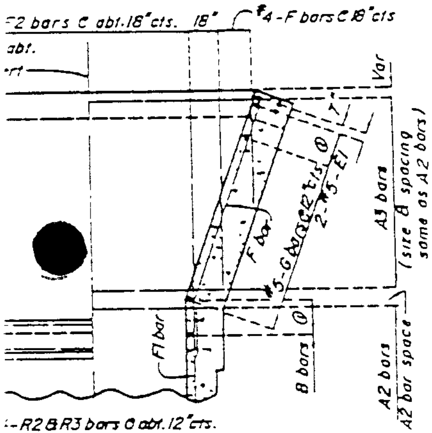


2" per RCP

PART LONGITUDINAL SECTION UPSTREAM

SECTION THRU BARREL

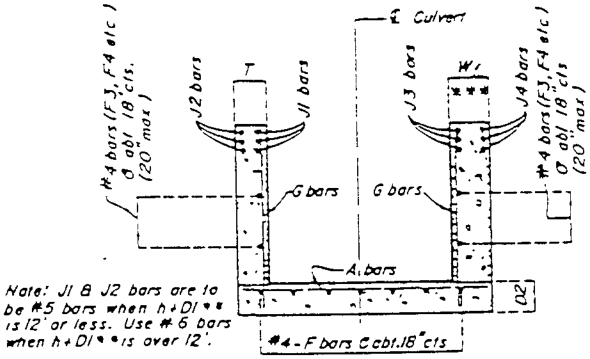
PART LONGITUDINAL SECTION DOWNSTREAM



PART HALF PLAN

PART HALF SECTION E-E

WING WALL UPSTREAM



Note: J1 & J2 bars are to be #5 bars when h+D1** is 12' or less. Use #6 bars when h+D1** is over 12'.

HALF SECTION A-A

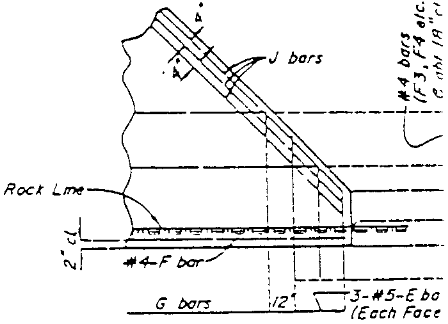
HALF SECTION F-F

MINIMUM WING BEAM THICKNESS FOR FLARED WINGS

h + D1 **	2:1 SLOPE						1½:1 SLOPE				
	4	5	6	7	8	9	9	10	11	12	13
J3 & J4 bars	3-#5						3-#5		3-#6		3-#7
***W1	6.5	6.5	6.5	6.5	8.5	10.0	8.5	9.5	11.0	12.0	14.0

** D1 for 1' fill

*** Not less than T

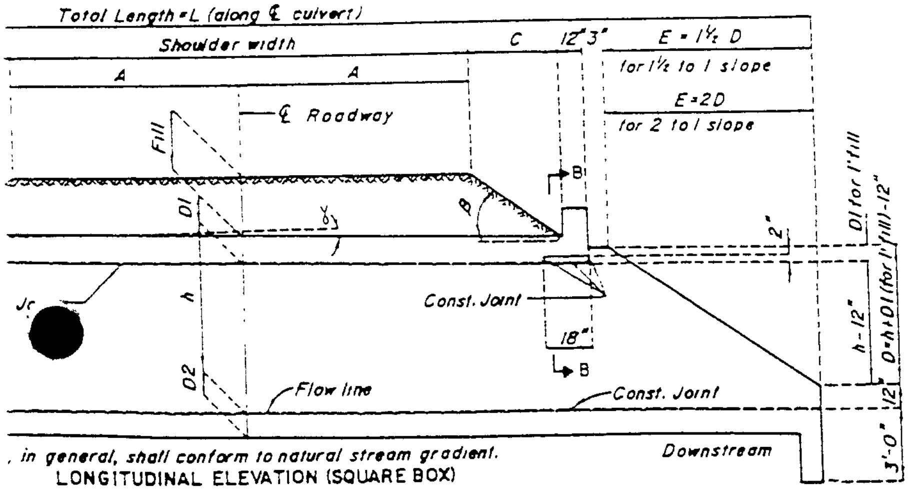


Notes: Holes to be drilled 12" into solid rock a grouted in.

Omit bottom slab and carry full len and wings 6" into and cast against vertic solid undisturbed rock.

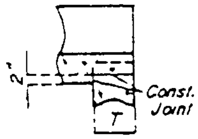
Details not shown are same as for box slab.

MODIFICATIONS REQUIRED FOR BOX ON

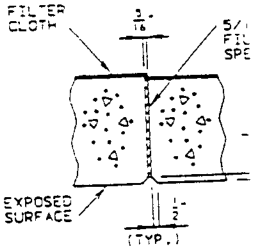


, in general, shall conform to natural stream gradient.

LONGITUDINAL ELEVATION (SQUARE BOX)



SECTION B-B



DETAIL OF TRANSVERSE THRU BARREL OF CULV

NOTE: USE A TRANSVERSE JOINT IS OVER 75' LONG BETWEEN HEAD ON ROCK.

A FILTER CLOTH THREE FO AND DOUBLE THICKNESS SHALL BE ALL TRANSVERSE JOINTS IN THE SIDEWALLS. THE MATERIAL SHAL ON THE JOINT AND THE EDGES SE MASTIC OR WITH TWO SIDED TAPE CLOTH SHALL BE A GEOTEXTILE APPROVAL OF THE ENGINEER AND TENSILE STRENGTH OF 180 LBS. APPARENT OPENING SIZE OF 50 D-4751). NO DIRECT PAYMENT FOR FURNISHING AND INSTALLIN CLOTH.

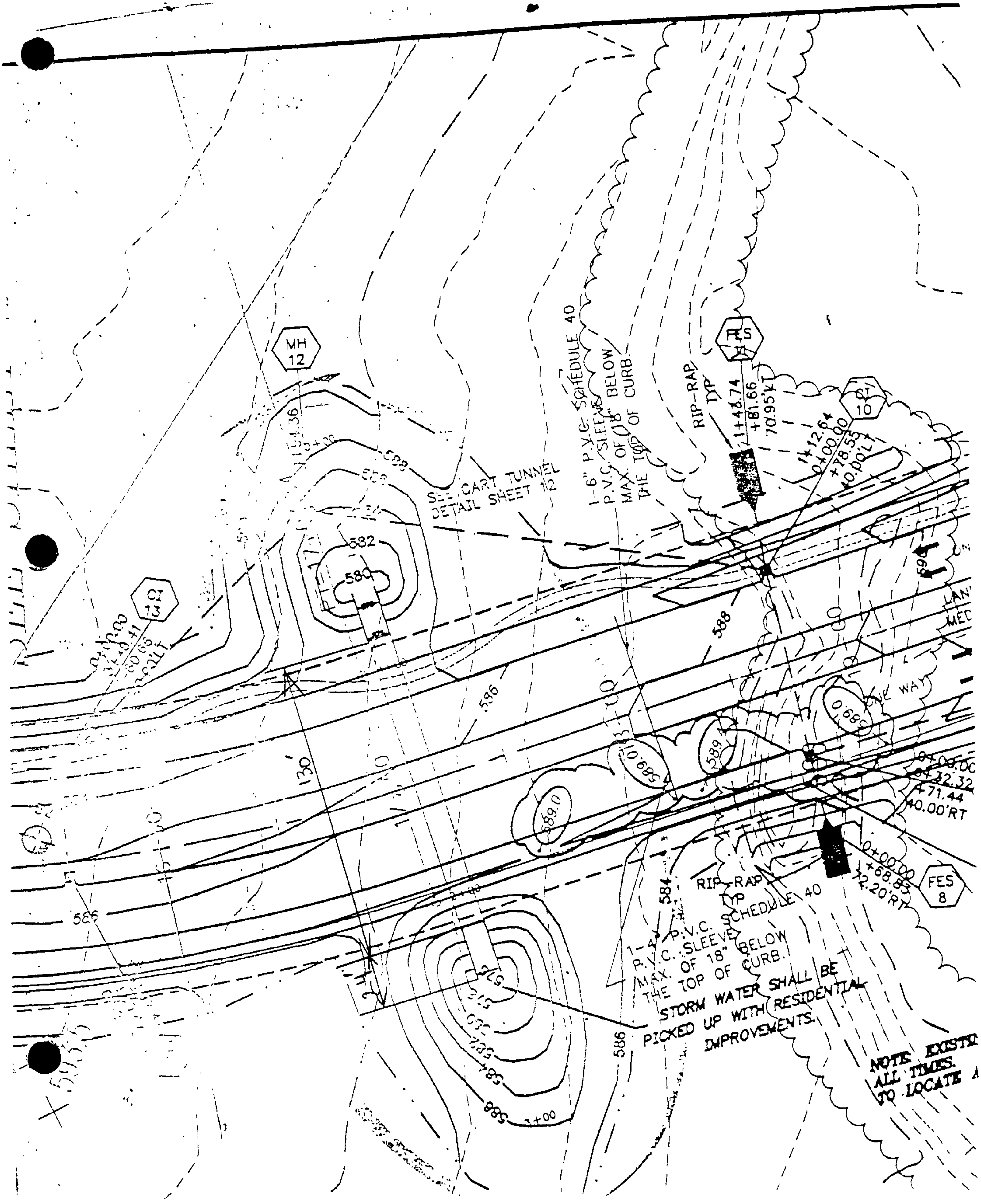
USE ADDITIONAL TRANSVE PROVIDE 50' MAXIMUM SPACING

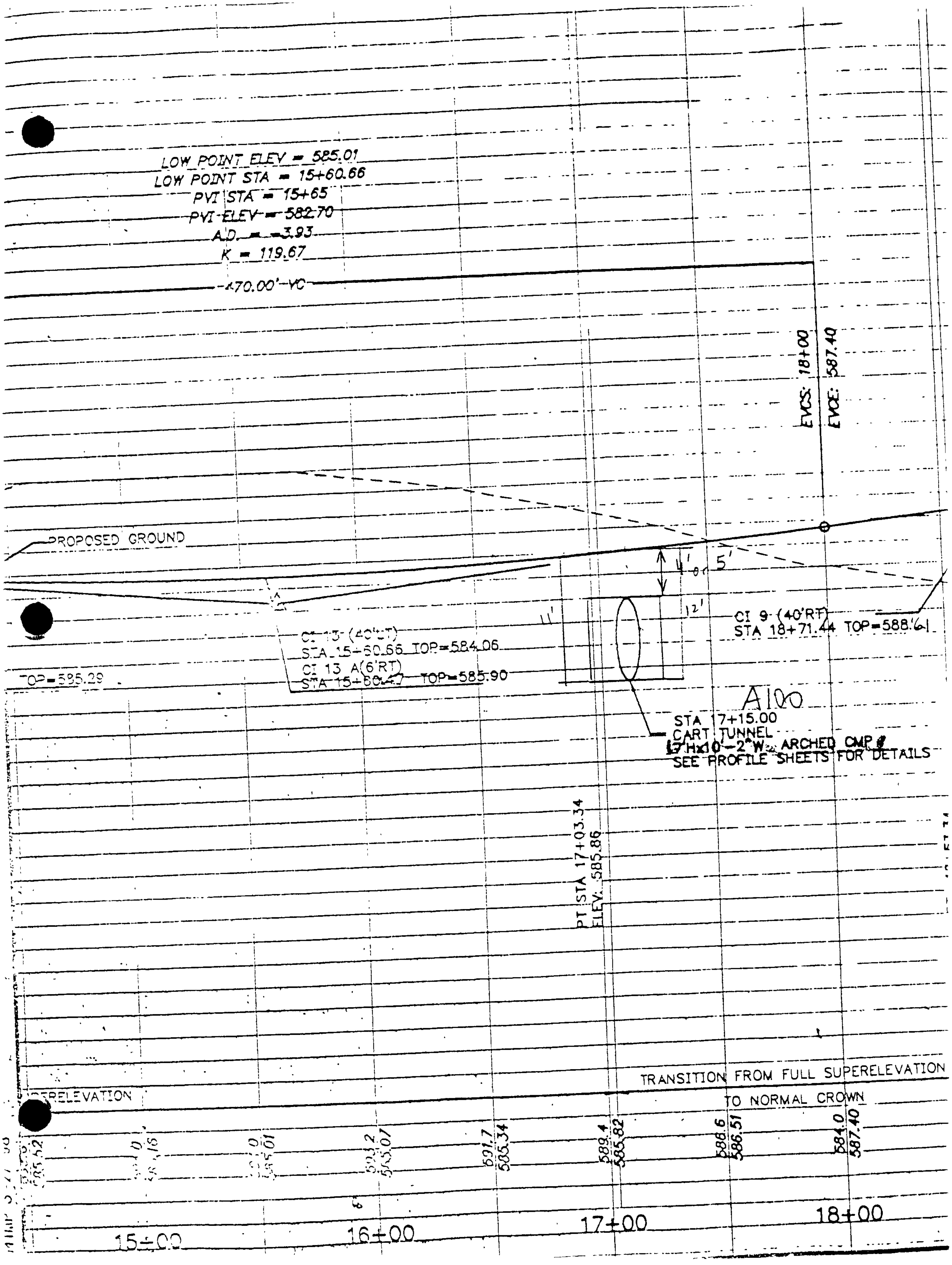
ALLEN LAFOON NUMBER E-10903

12/27/96

(For longitudinal elevation and plan of skewed box see other drawings.)

A100


MH 12
CI 13
FES
CI 10
FES 8
SEE CART TUNNEL DETAIL SHEET 12
1-6" P.V.C. SCHEDULE 40 P.V.C. SLEEVE MAX. OF 18" BELOW THE TOP OF CURB.
RIP-RAP TYP
1+48.74 +81.66 70.95'LT
1+12.64 0+00.00 +78.55 40.00'LT
0+00.00 +32.32 +71.44 40.00'RT
0+00.00 +68.83 72.20'RT
RIP-RAP TYP
1-4" P.V.C. SCHEDULE 40 P.V.C. SLEEVE MAX. OF 18" BELOW THE TOP OF CURB.
STORM WATER SHALL BE PICKED UP WITH RESIDENTIAL IMPROVEMENTS.
NOTE: EXIST
ALL TIMES.
TO LOCATE A
588
582
580
586
584
589.0
589
130'
ONE WAY
LAN
MED


LOW POINT ELEV = 585.01
LOW POINT STA = 15+60.66
PVI STA = 15+65
PVI ELEV = 582.70
A.D. = 3.93
K = 119.67
470.00' VC
EVCS: 18+00
EVCE: 587.40
PROPOSED GROUND
4' or 5'
12'
11'
CI 9 (40'RT)
STA 18+71.44 TOP=588.61
CI 13 (40'LT)
STA 15+60.66 TOP=584.06
CI 13 A(6'RT)
STA 15+60.47 TOP=585.90
TOP=585.29
A100
STA 17+15.00
CART TUNNEL
17'Hx10'-2"W ARCHED CMP
SEE PROFILE SHEETS FOR DETAILS
PT STA 17+03.34
ELEV. 585.86
TRANSITION FROM FULL SUPERELEVATION
TO NORMAL CROWN
SUPERELEVATION
585.52
585.18
585.01
593.2
585.07
591.7
585.34
589.4
585.82
588.6
586.51
584.0
587.40
15+00
16+00
17+00
18+00

GEOTECHNICAL REPORT

SCI
GEOTECHNICAL • ENVIRONMENTAL • WETLANDS • MATERIAL TESTING

July 9, 1998

KDG. MH FILE 980100

JUL 7 1998

Mr. David Rogers
Fred Weber, Inc.
% Mr. Ronald C. Pagan, P.E.
Kuhlmann Design Group, Inc.
66 Progress Parkway
Maryland Heights, MO 63043-3706

RE: Addendum Nº 1
Winghaven Box Culverts
O'Fallon, Missouri
SCI Nº 980495.11

Dear Mr. Pagan:

This letter provides the additional geotechnical information for the Winghaven Box Culverts you requested to supplement our letter to you dated June 29,1998. Three specific items presented herein pertain to the following:

1) Rock mats for structural slab base footings.

2) Anticipated settlements.

3) Backfill and fluid pressures for below-grade walls.

We understand that the bearing capacity required for the box culverts in the lowland areas will be 1,500 pounds per square foot (psf) and we provided an allowable bearing capacity of 1,200 psf for one box culvert that will pass under Charlie Drive near station 62+50. We recommend that 2 feet of soil be removed below the footing subgrade elevation and replaced with compacted granular material for this culvert. The replacement material should consist of a 3-inch minus gradation crushed stone. This rock mat will help to bridge the soft and wet foundation soils. A similar procedure of varying depths may be utilized for the other culverts in the lowland areas since we anticipate construction difficulties due to the high groundwater elevations.

The box culverts in the highland areas (culverts A and B) will likely be constructed on excavated rock. We anticipate negligible settlements of the foundation rock due to the weight of the structures and fills. In the lowland areas, however, we anticipate total settlement of the foundation soils due to the weight of the structure and fill to be placed to be about 3 to 6 inches. Some of this settlement will likely occur during construction. If construction of the culverts in the lowland areas is not delayed until after the settlement due to the fill has occurred, the structure will likely settle. However, we anticipate this settlement will likely be relatively uniform across the footprint due to the rigidity of the reinforced concrete base mat and structure. A differential settlement of less than 1½ inches can be anticipated across the whole footprint for these structures.

Our letter dated June 29, 1998 states that to use the "granular" values of equivalent fluid unit weight for earth pressures that the granular backfill material should extend horizontally from the

333 Mid Rivers Mall Drive • St. Peters, MO 63376 • (314) 397-6600 • FAX (314) 397-2600
Fairview Heights, IL • St. Clair, MO • Arnold, MO

wall at least half of the wall height. This distance is not required to provide positive foundation drainage to prevent buildup of hydrostatic pressures. A minimum horizontal distance of about 18 inches with a perforated drain pipe should be sufficient to provide this drainage. Therefore, an equivalent fluid unit weight of 60 pounds per cubic foot may be used to design the below-grade walls assuming the hydrostatic pressures are relieved through proper drainage.

We appreciate the opportunity to be of service to you on this project. If you have any questions or comments, please call.

Respectfully,

SCI

Fred H Held III

Fred H. Held III
Project Engineer

Jerry Thacker, P.E.
Manager

FHH/GGT/tal

c: Mr. Dave Rogers, Fred Weber, Inc. (1)

STATE OF MISSOURI
GUY G.
THACKER
NUMBER
EN 011189
REGISTERED PROFESSIONAL ENGINEER

SCI
GEOTECHNICAL • ENVIRONMENTAL • WETLANDS • MATERIAL TESTING

July 9, 1998

ADG. MR FILE 980100

JUL 10 1998

Mr. David Rogers
Fred Weber, Inc.
Mr. Ronald C. Pagan, P.E.
Kuhlmann Design Group, Inc.
[illegible] Progress Parkway
Maryland Heights, MO 63043-3706

RE: Addendum Nº 1
Winghaven Box Culverts
O'Fallon, Missouri
SCI No. 980495.11

Dear Mr. Pagan:

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1. Rock mats for structural slab base footings.

2. Anticipated settlements.

3. Backfill and fluid pressures for below-grade walls.

We understand that the bearing capacity required for the box culverts in the lowland areas will be 1,500 pounds per square foot (psf) and we provided an allowable bearing capacity of 1,[illegible]00 psf for the one box culvert that will pass under Charlie Drive near station 62+50. We recommend that 2 feet of soil be removed below the footing subgrade elevation and replaced with compacted granular material for this culvert. The replacement material should consist of a 3-inch minus gradation crushed stone. This rock mat will help to bridge the soft and wet foundation soils. A similar procedure of varying depths may be utilized for the other culverts in the lowland areas since we anticipate construction difficulties due to the high groundwater elevation.

The box culverts in the highland areas (culverts A and B) will likely be constructed on excavated rock. We anticipate negligible settlements of the foundation rock due to the weight of the structures and fills. In the lowland areas, however, we anticipate total settlement of the foundation soils due to the weight of the structure and fill to be placed to be about 3 to 6 inches. Some of this settlement will likely occur during construction. If construction of the culverts in the lowland areas is not delayed until after the settlement due to the fill has occurred, the structure will likely settle. However, we anticipate this settlement will likely be relatively uniform across the footprint due to the rigidity of the reinforced concrete base mat and structure. A differential settlement of less than 1½ inches can be anticipated across the whole footprint for these structures.

Our letter dated June 29, 1998 states that to use the "granular" values of equivalent fluid unit weight for earth pressures that the granular backfill material should extend horizontally from the width at least half of the wall height. This distance is <u>not</u> required to provide positive foundation drainage to prevent buildup of hydrostatic pressures. A minimum horizontal distance of about 18 inches with a perforated drain pipe should be sufficient to provide this drainage. Therefore, an equivalent fluid unit weight of 60 pounds per cubic foot may be used to design the below-grade walls assuming the hydrostatic pressures are relieved through proper drainage.

We appreciate the opportunity to be of service to you on this project. If you have any questions or comments, please call.

Respectfully,

SCI

Fred H Held III

Fred H. Held III
Project Engineer

Guy Thacker

Guy G. Thacker, P.E.
Manager

STATE OF MISSOURI
GUY G. THACKER
NUMBER
E-011189
REGISTERED PROFESSIONAL ENGINEER

FHH/GCT:tc

cc: Mr. Dave Rogers, Fred Weber, Inc. (1)

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333 Mid Rivers Mall Drive
St. Peters, MO 63376
Tele: (314) 397-6600
Fax: (314) 397-2600

FAX COVER SHEET

Please deliver the following pages to:

FIRM NAME Kuhlmann Design Group DATE: 07/09/98
ATTENTION Mr. Ron Pagan TIME: 3:27 PM
FAX NO 434-8280
FROM Fred Held SCI PROJECT NO: 980495
PROJECT Winghaven Box Culverts SCI FAX NO: 397-2600
TOTAL NO PAGES (INCLUDING COVER SHEET): 3

Please notify us immediately if the message is incomplete or unclear.
Thank you.

FAX OPERATOR Terry Lynett

MESSAGE:

ORIGINAL:
will be mailed X
will not be mailed ____

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The information contained in this facsimile transmission is legally privileged and confidential information intended only for the use of the individual or entity above. If the reader of this transmission is not the intended recipient, you are hereby notified that any dissemination, distribution or copying of this transmission is strictly prohibited. If you have received this transmission in error, please immediately notify us by telephone. THANK YOU

980100

SCI

SCI
GEOTECHNICAL • ENVIRONMENTAL • WETLANDS • MATERIAL TESTING

June 29, 1998

Mr. David Rogers
Fred Weber, Inc.
℅ Mr. Ronald C. Pagan, P.E.
Kuhlmann Design Group, Inc.
66 Progress Parkway
Maryland Heights, MO 63043-3706

RE: Winghaven Box Culverts
O'Fallon, Missouri
SCI Nº 980495.11

Dear Mr. Pagan:

At the request of Mr. David Rogers with Fred Weber, Inc., this letter provides geotechnical design recommendations for five box culverts planned for the Winghaven development roadways. Plan and Profile sheets prepared by Picket, Ray & Silver, Inc. (PRS), revised March 25 or 27, 1998, depict the locations and elevations of the culverts. Three of the culverts will cross under Winghaven Drive near stations 17+00, 30+50, 59+00. One culvert will pass under David Drive near station 5+50, and one culvert will pass under Charlie Drive near station 62+50. In this letter the box culverts will be named A, B, C, D and E, respectively. Culverts A and B will be tunnels for golf carts to underpass Winghaven Drive in the uplands part of the Winghaven development. The remaining will be multiple cell box culverts for existing creeks in lowland areas to pass under planned roadways. We understand that these culverts will be cast-in-place, reinforced concrete structures that will have light to moderate loads.

We previously explored parts of the Winghaven development in our report, "Preliminary Exploration of Subsurface Conditions and Foundation Recommendations - WINGHAVEN PROJECT SITE COMMERCIAL, RESIDENTIAL, AND GOLF COURSE COMMUNITY - O'FALLON, MISSOURI," dated July 1997 (Revised January 1998). In that exploration we drilled B2 and B3 in the uplands near the golf cart underpasses, B21 in the lowland area near culvert C, and B14 in the bottoms land near culvert E. The four boring logs are included in the Appendix of this letter. These borings indicate that excavations for culverts A and B will encounter rock in the form of weathered siltstone or shale for the full depths of the structures. Also, B2 encountered auger refusal near El. 576.5 and the planned bottom of culvert A is near El. 574. Some or all of this rock may be removed in open-cut excavations with bull dozers equipped with rippers. However, intact ledges of hard rock, boulders, or sound bedrock may be encountered that could require blasting.

SCI explored the subsurface conditions near culverts C, D and E on June 25, 1998 using hand auger methods. The hand auger borings, TH1, TH2, and TH3, were located near culverts C, D and E, respectively, by measuring from existing site features and improvements shown of the plans prepared by PRS. The hand augers were advanced to termination depths of 5, 6, and 7½ feet in TH1, TH2, and TH3, respectively. The soils generally encountered were soft to medium stiff, low plastic silty clays and clayey silts. TH1 terminated in a mixture of silty clay, gravel and sand at a depth of 5 feet, which is about 3 feet above the anticipated bearing elevation of culvert C. TH2 and TH3 terminated at depths of 6 and 7½ feet, respectively, due to caving conditions in the holes. We estimate the termination elevations were near the bearing elevations of culverts D and E. Groundwater was encountered in the hand auger borings at depths of 4 or 5 feet. The nature and thickness of the soils encountered and the results of the field sampling and testing are shown on the Borings Logs, Figures 1-1 through 1-3.

The varied conditions at the culvert locations require different allowable bearing capacities for the locations. An allowable bearing capacity of 10,000 pounds per square foot (psf) may be used to design the structural base slab for culverts A and B if they bear on the weathered siltstone or shale as indicated by B2 and B3 or if they encounter bedrock. An allowable bearing capacity of 3,000 psf may be used to design culvert C if it bears on the anticipated mixture of gravel and sand with some or no clay. An allowable bearing capacity of 1,500 psf may be used to design culvert D if it bears on the silty clay encountered in TH2. An allowable bearing capacity of 1,200 psf may be used to design culvert E.

We understand that higher bearing capacities will be required for culverts D and E. The soft soils below the base of the culverts may be removed and replaced with compacted, crushed rock, such as MODOT Type I Aggregate. The area of removal should extend down and outside the base footprint at an angle of 45 degrees to form a larger area to bear on the soft soils. The depth of removal will vary depending on the allowable bearing capacity required. We anticipate about 5 feet of soft soil will need to be removed and replaced with crushed rock to increase the allowable bearing capacity of the culverts to 2,000 or 3,000 psf.

In the lowland areas, placing fill to raise the roadway above existing grade will result in settlement as consolidation of the soft, underlying soils occurs. A delay in construction is anticipated to allow some or most of that settlement to occur prior to construction. We anticipate this delay to be about 30 to 120 days. This delay will likely not apply to culvert C since we anticipate it will bear on sand and gravel near bedrock elevations. Culverts D and E should not be constructed until most of the settlement due to the weight of the fills has occurred. Surcharging can be used as a means to accelerate consolidation due to the weight of fill. Deep fill in the lowland areas should be monitored with settlement plates to assess when most of the settlement has occurred and construction can continue.

The below-grade walls of the box culverts will be required to resist earth pressures. These include the outside walls of the culverts and the wing-walls that may extend from the culverts designed to accommodate surface grade changes.

The equivalent fluid unit weights tabulated below provide recommended lateral earth pressures for design of these walls. Values for granular material should only be used if the granular backfill extends from the wall a lateral distance of at least one-half the wall height. This table assumes that positive foundation drainage is provided to prevent buildup of hydrostatic pressure. The below-grade walls should be designed to resist an additional uniform lateral load of one-half of the surface loads.

Backfill Type	Fixed-Headed Walls (pcf)	Free-Headed Walls (pcf)
Cohesive Soil	60	50
Granular Material	45	40

A fixed-headed wall is a wall which is not permitted to deflect at the top after backfilling. A free-headed wall is designed to deflect at the top and remain fixed at the base, such as a retaining wall. A wing-wall attached to a fixed-headed wall should be considered fixed-headed unless the structural design permits independent rotation.

The maximum toe pressures for wing-walls should not exceed the bearing capacities recommended in this letter. Walls bearing in soil can be designed with a coefficient of friction between the base of a concrete footing and the subgrade soil of 0.3. A passive soil resistance equal to a uniform pressure of 300 psf may be used for natural soil against the face of the exterior base or a key below the base of a retaining wall. Soil backfilled against the exterior face of a retaining wall should not be assumed to provide any lateral resistance.

We recommend that all below-grade walls and retaining walls be provided with a foundation drainage system. A typical below-grade wall drain detail is shown in Figure 2. It should consist of a perforated pipe to transport the fluids collected from the granular backfill to daylight. Granular drainage material around the pipe should consist of 1-inch clean, "GP" classified crushed rock. A synthetic filter fabric indicated on Figure 2 should be Mirafi 140N or equivalent. A minimum 4-inch diameter perforated drain pipe should be used.

We appreciate the opportunity to be of service to you on this project. If you have any questions or comments, please call.

Respectfully,

SCI

Fred H Held III

Fred H. Held III
Project Engineer

Jerry Thacker

Jerry Thacker, P.E.
Manager

FHH/GGT/tal

c: Mr. Dave Rogers, Fred Weber, Inc. (1)

STATE OF MISSOURI
GUY G.
THACKER
NUMBER
EN 011189
REGISTERED PROFESSIONAL ENGINEER

BORING LOG

LEGEND AND NOMENCLATURE

Items shown in Boring Logs refer to the following:
(Where shown in parenthesis, sampling and testing were performed in general accordance with applicable ASTM standard methods or practices.)

1. **Depth** - Depth below ground surface (feet).

2. **Sample** - Types designated by letters.

   SS - Split-spoon sample, disturbed, obtained by driving 2-inch O.D. split-spoon sampler (ASTM D 1586).

   NX - Diamond core bit sample, nominal 2-inch diameter rock sample (ASTM D 2113).

   ST - Thin-walled tube sample, undisturbed, obtained by penetration of a 3-inch diameter tube (ASTM D 1587).

   CS - Continuous sample tube system, undisturbed, obtained by split barrel sampler in conjunction with auger advancement.

   SV - Shear vane, field test to determine strength of cohesive soil by pushing or driving a 2-inch diameter vane then shearing by torquing soil in existing and remolded states (ASTM D 2573).

   AS - Disturbed samples obtained from auger cuttings.

   Recovery - Recovery is expressed as a ratio of the length recovered to the total length pushed, driven, or cored (inches), e.g. - 9/12.

   Blows - Numbers indicate blows per six inches of sampler penetration when driven by a 140-pound hammer falling freely 30 inches (ASTM D 1586). When number of blows reaches 50 without six inches of sampler penetration, the result is shown as a ratio of 50 to the actual penetration, e.g. - 50/2 inches.

   Vane Shear Strength - Shear strength of soil expressed as the peak strength (existing state)/residual strength (remolded state).

3. **Description** - Description according to the Unified Soil Classification: Description indicates soil constituents and other classification characteristics (ASTM D 2488). A solid line indicates approximate location of stratigraphic change between soil types and the transition may be gradual.

4. **Laboratory Test Results**

   - Natural moisture content in percent (ASTM D 2216).
   - Dry density of sample tested in pounds per cubic foot (pcf).
   - Unconfined compressive strength (ASTM D 2166) in kips per square foot (ksf).
   - Liquid limit (ASTM D 4318) in percent.
   - Plastic limit (ASTM D 4318) in percent.

5. **Remarks/Other Data** - See notation at bottom of log for description of data entries.

   RQD Rock Quality Designation; the ratio between the total length of core segments greater than 4 inches in length and the total length of core drilled (expressed as percentage).

SCI TEST PIT LOG

PROJECT WINGHAVEN BOX CULVERTS
TEST PIT NO. TH-1
LOCATION O'Fallon, Missouri
SHEET 1 OF 1
EXCAVATOR SCI
PROJECT NO. 980495.11
SURFACE ELEVATION 524+/-
EQUIPMENT Hand auger
DATE EXCAVATED 6-25-98

DEPTH (FT.)	FIELD SAMPLE / TEST				DESCRIPTION	UNIFIED SOIL CLASSIFICATION	SEE REMARK NO.	LABORATORY TEST RESULTS					DEPTH (FT.)
	NUMBER	SAMPLE TYPE	FIELD TEST TYPE	SHEAR STRENGTH (KSF)				MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	LIQUID LIMIT	PLASTIC LIMIT	
0					Grayish brown, low plastic SILTY CLAY with trace of fine roots	CL							0
	1	BS						29					
2.5	2	BS			Brown, low plastic SILTY CLAY with trace of fine gravel	CL		19					2.5
	3	BS			Brown, low plastic SILTY CLAY and coarse SAND to fine GRAVEL	CL,GC		19					
5					Hand auger refusal at 5.0 ft.								5
7.5													7.5
10													10
12.5													12.5
15													15
17.5													17.5

WATER LEVEL:

_____ NO GROUNDWATER NOTED AT TIME OF EXCAVATION
5 FT WHILE EXCAVATING
_____ FT _____ HRS AFTER EXCAVATING
_____

REMARKS:

FIGURE 1-1

SCI TEST PIT LOG

PROJECT WINGHAVEN BOX CULVERTS

LOCATION O'Fallon, Missouri

EXCAVATOR SCI

SURFACE ELEVATION 516+/-

EQUIPMENT Hand auger

TEST PIT NO. TH-2

SHEET 1 OF 1

PROJECT NO. 980495.11

DATE EXCAVATED 6-25-98

DEPTH (FT.)	FIELD SAMPLE / TEST: NUMBER	SAMPLE TYPE	FIELD TEST TYPE	SHEAR STRENGTH (KSF)	DESCRIPTION	UNIFIED SOIL CLASSIFICATION	SEE REMARK NO.	LABORATORY TEST RESULTS: MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	LIQUID LIMIT	PLASTIC LIMIT	DEPTH (FT.)
0					4 inches TOPSOIL								0
	1	BS			Brown with gray, low plastic SILTY CLAY with some gray, silt and trace of organics	CL		23					
2.5	2	BS	SV	2.8/ 1.4	Brown and gray, low plastic CLAYEY SILT with trace of fine sand and organics	ML		25					2.5
	3	BS						21					
	4	BS			Gray with brown, low plastic SILTY CLAY with trace of fine gravel	CL		24					
5													5
					Hand auger terminated at 6.0 ft.								
7.5													7.5
10													10
12.5													12.5
15													15
17.5													17.5

WATER LEVEL:

_____ NO GROUNDWATER NOTED AT TIME OF EXCAVATION

4 FT WHILE EXCAVATING

_____ FT _____ HRS AFTER EXCAVATING

_____

REMARKS:

FIGURE 1-2

SCI **TEST PIT LOG**

PROJECT WINGHAVEN BOX CULVERTS
TEST PIT NO. TH-3
LOCATION O'Fallon, Missouri
SHEET 1 OF 1
EXCAVATOR SCI
PROJECT NO. 980495.11
SURFACE ELEVATION 494+/-
EQUIPMENT Hand auger
DATE EXCAVATED 6-25-98

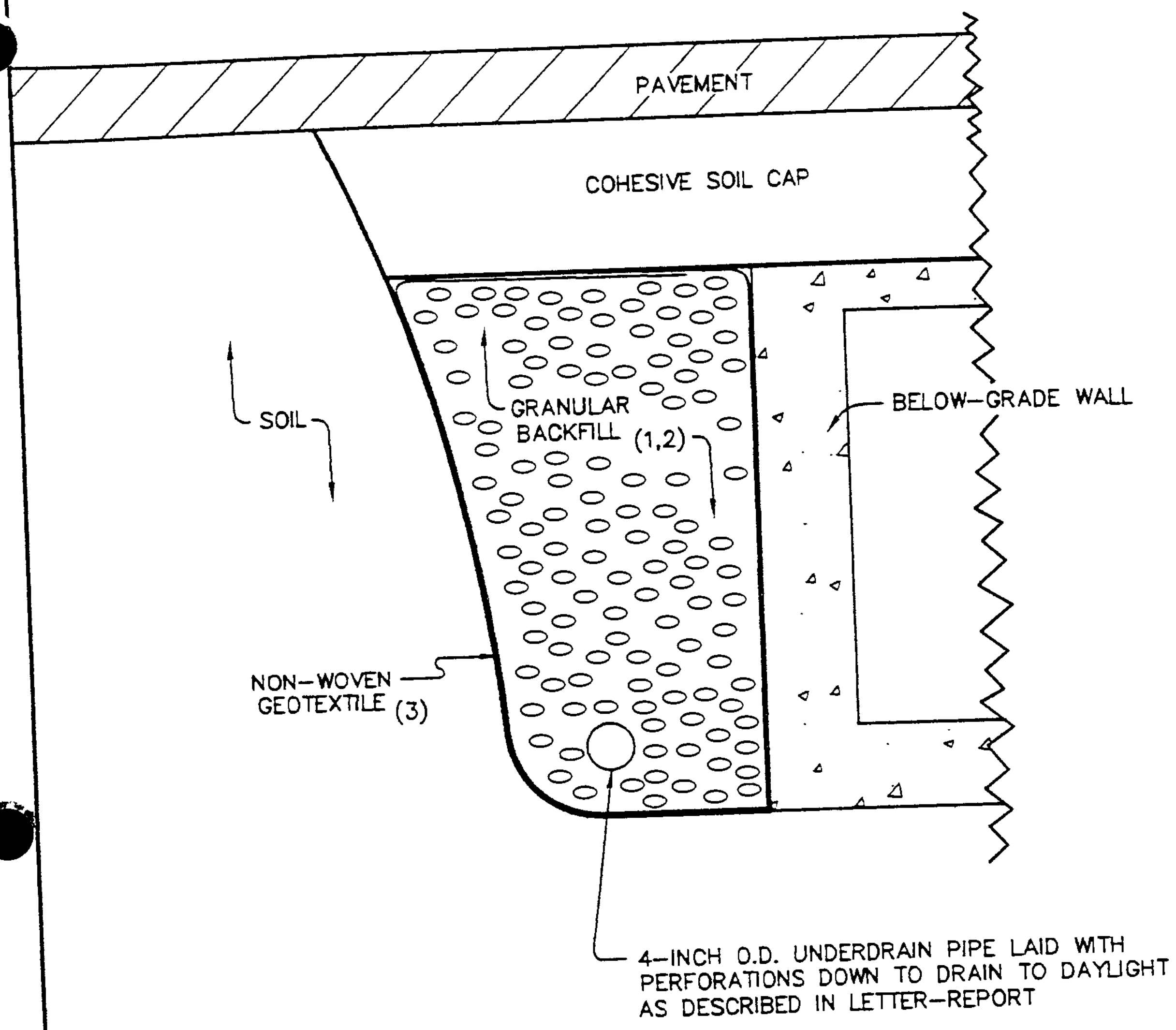
	FIELD SAMPLE / TEST							LABORATORY TEST RESULTS					
DEPTH (FT.)	NUMBER	SAMPLE TYPE	FIELD TEST TYPE	SHEAR STRENGTH (KSF)	DESCRIPTION	UNIFIED SOIL CLASSIFICATION	SEE REMARK NO.	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	LIQUID LIMIT	PLASTIC LIMIT	DEPTH (FT.)
0					Brown, low plastic SILTY CLAY	CL							0
	1	BS			Grayish brown, fine SANDY SILTY CLAY with some fine gravel	SC		21					
2.5	2	BS			Grayish brown, low plastic CLAYEY SILT with fine sand	ML		19					2.5
5	3	BS			Brown and gray, low plastic CLAYEY SILT with some fine sand to fine gravel	ML		35					5
7.5	4	BS			Gray, low plastic CLAYEY SILT with trace of fine gravel	ML		29					7.5
					Hand auger terminated at 7.5 ft.								
10													10
12.5													12.5
15													15
17.5													17.5

WATER LEVEL:

_______ NO GROUNDWATER NOTED AT TIME OF EXCAVATION
4 FT WHILE EXCAVATING
_______ FT _____ HRS AFTER EXCAVATING
____

REMARKS:

FIGURE 1-3



NOTES:

1. MINIMUM 6" FILTER MATERIAL AROUND PIPE.
2. 1" CLEAN CRUSHED LIMESTONE.
3. TYPICALLY FOUR-OUNCE PER SQUARE YARD

SCI
333 MID RIVERS MALL DRIVE
ST. PETERS, MISSOURI 63376

WINGHAVEN BOX CULVERT
O'FALLON, MISSOURI

BELOW-GRADE WALL DRAIN DETAIL

JUNE 1998 SCI NO. 980495.11

FIGURE 2

APPENDIX

SCI

BORING LOG

PROJECT WINGHAVEN PROJECT SITE

LOCATION O'Fallon, Missouri

DRILLER Midwest Drilling, Inc.

SURFACE ELEVATION 595+/-

DRILLING METHOD 4" CFA

BORING NO. B-2

SHEET 1 OF 1

PROJECT NO. 97-384-411

DATE DRILLED 6-11-97

DEPTH (FT.)	SAMPLE				DESCRIPTION	UNIFIED SOIL CLASSIFICATION	SEE REMARK NO.	LABORATORY TEST RESULTS					DEPTH (FT.)
	NUMBER	TYPE	RECOVERY (IN/IN)	BLOWS (PER 6 IN.)				MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	LIQUID LIMIT	PLASTIC LIMIT	
0					6 inches TOPSOIL								0
2	1	SS		2 3 3	Brown and gray, medium plastic SILTY CLAY	CL/CH		26					2
4	2	SS		2 2 3	Brown with some gray, low plastic SILTY CLAY	CL		28					4
6	3	SS		2 2 3	Brown with some gray, medium plastic SILTY CLAY	CL/CH		25					6
8 10	4	SS		3 5 7	Brown with some gray, high plastic CLAY	CH		29					8 10
12 14	5	SS		50/3	Tan, WEATHERED SILTSTONE			10					12 14
16	6	AS			Gray with some brown, SILTSTONE								16
18 20					Auger refusal at 17.5 ft.								18 20

WATER LEVEL:

X NO GROUND WATER NOTED AT TIME OF DRILLING

____ FT WHILE DRILLING

____ FT ____ HRS AFTER DRILLING

____ FT ____ HRS AFTER DRILLING

REMARKS:

FIGURE 2-2

BORING LOG

PROJECT WINGHAVEN PROJECT SITE
LOCATION O'Fallon, Missouri
DRILLER Midwest Drilling, Inc.
SURFACE ELEVATION 602+/-
DRILLING METHOD 4" CFA

BORING NO. B-3
SHEET 1 OF 2
PROJECT NO. 97-384-411
DATE DRILLED 6-11-97

DEPTH (FT.)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE RECOVERY (IN/IN)	SAMPLE BLOWS (PER 6 IN.)	DESCRIPTION	UNIFIED SOIL CLASSIFICATION	SEE REMARK NO.	LABORATORY TEST RESULTS MOISTURE CONTENT (%)	LABORATORY TEST RESULTS DRY DENSITY (PCF)	LABORATORY TEST RESULTS UNCONFINED COMPRESSIVE STRENGTH (KSF)	LABORATORY TEST RESULTS LIQUID LIMIT	LABORATORY TEST RESULTS PLASTIC LIMIT	DEPTH (FT.)
0					1 inch TOPSOIL		1						0
					Brown with some gray, medium plastic SILTY CLAY	CL/CH							
2	1	SS		3 3 4				26					2
					Brown with some gray, low plastic SILTY CLAY	CL							
4	2	SS		2 3 3				25					4
6	3	SS		2 3 4				22					6
8					Brown with some gray, high plastic CLAY	CH							8
	4	SS		3 3 5				33					
10													10
12													12
					Tan, high plastic SHALEY CLAY	CH							
14	5	SS		3 6 15				30					14
					Brown, WEATHERED SHALE								
16													16
18													18
	6	SS		27 50/3				10					
20					Continued on sheet 2 of 2								20

WATER LEVEL:
x NO GROUND WATER NOTED AT TIME OF DRILLING
____ FT WHILE DRILLING
____ FT ____ HRS AFTER DRILLING
____ FT ____ HRS AFTER DRILLING

REMARKS:
1) Driller's observation

FIGURE 2-3a

SCI BORING LOG

PROJECT WINGHAVEN PROJECT SITE
LOCATION O'Fallon, Missouri
DRILLER Midwest Drilling, Inc.
SURFACE ELEVATION 595+/- DRILLING METHOD 4" CFA

BORING NO. B-2
SHEET 1 OF 1
PROJECT NO. 97-384-411
DATE DRILLED 6-11-97

DEPTH (FT.)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE RECOVERY (IN/IN)	SAMPLE BLOWS (PER 6 IN.)	DESCRIPTION	UNIFIED SOIL CLASSIFICATION	SEE REMARK NO.	LABORATORY TEST RESULTS MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	LIQUID LIMIT	PLASTIC LIMIT	DEPTH (FT.)
0					6 inches TOPSOIL								0
					Brown and gray, medium plastic SILTY CLAY	CL/CH							
2	1	SS		2 3 3				26					2
					Brown with some gray, low plastic SILTY CLAY	CL							
4	2	SS		2 2 3				28					4
6					Brown with some gray, medium plastic SILTY CLAY	CL/CH							6
	3	SS		2 2 3				25					
8					Brown with some gray, high plastic CLAY	CH							8
	4	SS		3 5 7				29					
10													10
12					Tan, WEATHERED SILTSTONE								12
14	5	SS		50/3				10					14
16					Gray with some brown, SILTSTONE								16
	6	AS											
18					Auger refusal at 17.5 ft.								18
20													20

WATER LEVEL:
X NO GROUND WATER NOTED AT TIME OF DRILLING
____ FT WHILE DRILLING
____ FT ____ HRS AFTER DRILLING
____ FT ____ HRS AFTER DRILLING

REMARKS:

FIGURE 2-2

SCI BORING LOG

PROJECT WINGHAVEN PROJECT SITE
LOCATION O'Fallon, Missouri
DRILLER Midwest Drilling, Inc.
SURFACE ELEVATION 602+/-
DRILLING METHOD 4" CFA

BORING NO. B-3
SHEET 1 OF 2
PROJECT NO. 97-384-411
DATE DRILLED 6-11-97

DEPTH (FT.)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE RECOVERY (IN/IN)	SAMPLE BLOWS (PER 6 IN.)	DESCRIPTION	UNIFIED SOIL CLASSIFICATION	SEE REMARK NO.	LABORATORY TEST RESULTS MOISTURE CONTENT (%)	LABORATORY TEST RESULTS DRY DENSITY (PCF)	LABORATORY TEST RESULTS UNCONFINED COMPRESSIVE STRENGTH (KSF)	LABORATORY TEST RESULTS LIQUID LIMIT	LABORATORY TEST RESULTS PLASTIC LIMIT	DEPTH (FT.)
0					1 inch TOPSOIL		1						0
					Brown with some gray, medium plastic SILTY CLAY	CL/CH							
2	1	SS		3 3 4				26					2
					Brown with some gray, low plastic SILTY CLAY	CL							
4	2	SS		2 3 3				25					4
6	3	SS		2 3 4				22					6
8					Brown with some gray, high plastic CLAY	CH							8
	4	SS		3 3 5				33					
10													10
12													12
					Tan, high plastic SHALEY CLAY	CH							
14	5	SS		3 6 15				30					14
					Brown, WEATHERED SHALE								
16													16
18													18
	6	SS		27 50/3				10					
20					Continued on sheet 2 of 2								20

WATER LEVEL:

__X__ NO GROUND WATER NOTED AT TIME OF DRILLING
_____ FT WHILE DRILLING
_____ FT ____ HRS AFTER DRILLING
_____ FT ____ HRS AFTER DRILLING

REMARKS:
1) Driller's observation

FIGURE 2-3a

SCI BORING LOG

PROJECT WINGHAVEN PROJECT SITE
LOCATION O'Fallon, Missouri
DRILLER Midwest Drilling, Inc.
SURFACE ELEVATION 602+/- DRILLING METHOD 4" CFA

BORING NO. B-3
SHEET 2 OF 2
PROJECT NO. 97-384-411
DATE DRILLED 6-11-97

	SAMPLE							LABORATORY TEST RESULTS					
DEPTH (FT.)	NUMBER	TYPE	RECOVERY (IN/IN)	BLOWS (PER 6 IN.)	DESCRIPTION	UNIFIED SOIL CLASSIFICATION	SEE REMARK NO.	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	LIQUID LIMIT	PLASTIC LIMIT	DEPTH (FT.)
22					Brown, WEATHERED SHALE								22
24	7	SS		50/3				12					24
					Drilling terminated at 25.0 ft.								
26													26
28													28
30													30
32													32
34													34
36													36
38													38
40													40
42													42

WATER LEVEL:
x NO GROUND WATER NOTED AT TIME OF DRILLING
_____ FT WHILE DRILLING
_____ FT _____ HRS AFTER DRILLING
_____ FT _____ HRS AFTER DRILLING

REMARKS:

FIGURE 2-3b

SCI

BORING LOG

PROJECT WINGHAVEN PROJECT SITE

LOCATION O'Fallon, Missouri

DRILLER Midwest Drilling, Inc.

SURFACE ELEVATION 494+/-

DRILLING METHOD 4" CFA

BORING NO. B-14

SHEET 1 OF 1

PROJECT NO. 97-384-411

DATE DRILLED 6-9-97

DEPTH (FT.)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE RECOVERY (IN/IN)	SAMPLE BLOWS (PER 6 IN.)	DESCRIPTION	UNIFIED SOIL CLASSIFICATION	SEE REMARK NO.	LABORATORY TEST RESULTS MOISTURE CONTENT (%)	LABORATORY TEST RESULTS DRY DENSITY (PCF)	LABORATORY TEST RESULTS UNCONFINED COMPRESSIVE STRENGTH (KSF)	LABORATORY TEST RESULTS LIQUID LIMIT	LABORATORY TEST RESULTS PLASTIC LIMIT	DEPTH (FT.)
0					5 inches TOPSOIL		1						0
					Gray and brown, low plastic SILTY CLAY	CL							
2	1	SS		3 2 2				23					2
4	2	SS		2 2 4				22					4
6	3	SS		0 1 2				28					6
8	4	SS		0 1 1				31					8
10					Drilling terminated at 10.0 ft.								10
12													12
14													14
16													16
18													18
20													20

WATER LEVEL:

_____ NO GROUND WATER NOTED AT TIME OF DRILLING

5.5 FT WHILE DRILLING

_____ FT _____ HRS AFTER DRILLING

_____ FT _____ HRS AFTER DRILLING

REMARKS:

1) Driller's observation

FIGURE 2-14

SCI

BORING LOG

PROJECT WINGHAVEN PROJECT SITE
BORING NO. B-21
LOCATION O'Fallon, Missouri
SHEET 1 OF 1
DRILLER Midwest Drilling, Inc.
PROJECT NO. 97-384-411
SURFACE ELEVATION 524+/-
DRILLING METHOD 4" CFA
DATE DRILLED 6-10-97

DEPTH (FT.)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE RECOVERY (IN/IN)	SAMPLE BLOWS (PER 6 IN.)	DESCRIPTION	UNIFIED SOIL CLASSIFICATION	SEE REMARK NO.	LABORATORY TEST RESULTS MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	LIQUID LIMIT	PLASTIC LIMIT	DEPTH (FT.)
0					3 inches TOPSOIL		1						0
					Brown and gray, low plastic CLAYEY SILT to SILTY CLAY	ML/CL							
2	1	SS		3 2 1				25					2
4	2	SS		3 2 5				22					4
					Brown and gray, low plastic SILTY CLAY with some rock fragments	CL							
6	3	SS		15 18 8	ROCK FRAGMENTS with some brown and gray, low plastic silty clay	GC		21					6
8													8
	4	SS		50/1	ROCK and ROCK FRAGMENTS		2						
10					Drilling terminated at 10.0 ft.								10
12													12
14													14
16													16
18													18
20													20

WATER LEVEL:

_____ NO GROUND WATER NOTED AT TIME OF DRILLING
6 FT WHILE DRILLING
_____ FT _____ HRS AFTER DRILLING
_____ FT _____ HRS AFTER DRILLING

REMARKS:

1) Driller's observation
2) Driller's observation

FIGURE 2-21

BOX CULVERT DESIGN

JVS 15JUL98

17 July 98

```
OM
OM                     CULVERT BR#A200
OM                     File: A206LRF1.pol
OM                     Date: 15Jul98
OM                     Golf Cart Design
OM                     Single Box Culvert (No Haunch)
OM                     1-Cell Box 10'x  7'
OM                     Load Factor Design
OM                     Rigid Frame Method
OM                     Top and Bot Slab Different
OM
OM                     Minumum Fill Ht Condition (1.0 Ft)
OM
STDLOD       2, 0, 0, 0, 0
SWPRES       1, 2, 60, 15, 62.4
BOXDIM       1, 1, 10,  7, 1, 10
SLBTHK       1, 11.5, 11, 8, 8, 1111
H&SKEW       1, 90, 90, 0, 0, 0
REEBAR       18, 9, 1, 11, 4, .016
CONCOV       2, 3, 2, 2, .5, .5
MATPRP       120, 60, 24, 3, 0, 0
PRTCTL       1, 1, 1, 0
F&HCTL       1, 1, 1
DESCTL       1, 0, 1, 0, 0, 9
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                  WYOMING DEPARTMENT OF TRANSPORTATION        PAGE  1
                             BRIDGE BRANCH                    DATE 07/15/98
                             CULVERT DESIGN


CONSTANT DATA

   STANDARD LIVE LOAD          -  DESIGN METHOD    -        PRINT CONTROL
TRUCK  OMIT  STRESS  OVERLD  -  SERVICE    LOAD    -   10th Pt  INFL   LOC. NEG
CODE   L.L.  0-FILL   AXLE   -   LOAD     FACTOR   -   MOMENT   LINE    MOMENT
HS20    NO     NO      0.         NO        YES          YES     YES       1.00

                 MATERIAL PROPERTIES                          -  THICKNESS
  SOIL    STEEL   STEEL   CONCRETE   CONCRETE   CON.SHEAR   -  INCREMENTS
 WEIGHT    Fy      Fs     STRENGTH    SHEAR     W/ STIRRUP  -  SLAB  WALL
  120.   60000.  24000.    3000.        0.          0.         0.50  0.50

      CONCRETE COVER         -  DESIGN    -  PRINT  -         REINFORCING
   EXTERIOR        INTERIOR  -   SAME     -   BAR   -  BAR SPACING    BAR SIZE
TOP   BOT   WALL    (ALL)    - THICKNESS  -  TABLE  -   MAX    MIN    MAX  MIN
SLAB  SLAB                   - SLAB WALL  -         -
2.00  3.00  2.00    2.00        NO   NO       YES       18.0    9.0    11    4

CRACK PARAMETER Z =   98.0
MODULAR  RATIO  N =    9.0



      SUPERIMPOSED DEAD LOADS                          -    SPECIAL LIVE LOADS
 UNIFORM            CONCENTRATED LOAD                  - WHEEL    FILL    OVERSTRESS
  LOAD      WT.   X1      WT.   X2      WT.   X3       - LOAD     HEIGHT    FACTOR
  0.000     0.00  0.0     0.00  0.0     0.00  0.0        0.000    0.000      1.00



DATA FOR STRUCTURE NUMBER  1

CULVERT  -  SPAN   - CLEAR  -  DESIGN - CENTERLINE -  SKEW  -  SKEW  - FLOOR
 TYPE    - LENGTH - HEIGHT -   FILL   -   LENGTH   -  LEFT  -  RIGHT - TYPE
SINGLE      10.00     7.00       1.00      10.00        90       90     FULL

      SLAB THICKNESSES          -   LIVE     -     SOIL     -    WATER
 TOP     BOT.    EXT.    INT.   -   LOAD     -   PRESSURE   -   PRESSURE
 SLAB    SLAB    WALL    WALL   -  SURCHARGE -  MAX    MIN  -
11.50F  11.00F  8.00F   8.00F        2.00       60.0   15.0       62.4

 TOP HAUNCH    BOTTOM HAUNCH  -  RIGID OR  -  CHECK    - BAR SPACING
   HEIGHT         HEIGHT      -  FLEXIBLE  - MILITARY  -  INCREMENT
    0.0            0.0            RIGID        NO           1 INCH
BOTH HEADWALLS ELIMINATED.
```

```
               *****      LOAD FACTOR DESIGN        *****
               ***** STRESSES AT CRITICAL SECTIONS  *****


 ***  MAXIMUM REINFORCEMENT RATIO (As/bd) = .016

MEMBER NUMBER    =  1
MEMBER THICKNESS =  8.00
EXTERIOR WAL

  -MOMENT--AXIAL--SHEAR- -Po-  -Mu- -Mbal- -Pbal- -STEEL- -SHEAR- -ALL.- -ALL.-
           FORCE                                    AREA    STRESS  MOM.  SHEAR

LT    -7.1    1.0   2.5  191.2   7.1  16.0   53.2   0.30    48.2    7.3  109.5
MID    1.3    9.8   0.9  186.8   4.6  15.0   58.5   0.19    17.9    6.3  109.5
MID-  -6.5    6.9   0.9  190.1   6.5  16.0   54.5   0.32    17.9    7.7  109.5
RT    -6.8    6.4   1.5  190.7   6.8  16.0   53.8   0.35    27.6    7.9  109.5


MEMBER NUMBER    =  2
MEMBER THICKNESS = 11.50
TOP SLAB

  -MOMENT--AXIAL--SHEAR- -Po-  -Mu- -Mbal- -Pbal- -STEEL- -SHEAR- -ALL.- -ALL.-
           FORCE                                    AREA    STRESS  MOM.  SHEAR

LT    -5.6    1.6   9.6  268.5  10.8  38.0  103.7   0.28   104.5   11.3  110.5
MID   24.4*  -0.2   4.9  283.5  24.4  43.0   84.7   0.75    52.9   24.3  109.5
RT    -5.6    1.6   9.6  268.5  10.8  38.0  103.7   0.28   104.5   11.3  110.5


MEMBER NUMBER    =  4
MEMBER THICKNESS = 11.00
BOTTOM SLAB

  -MOMENT--AXIAL--SHEAR- -Po-  -Mu- -Mbal- -Pbal- -STEEL- -SHEAR- -ALL.- -ALL.-
           FORCE                                    AREA    STRESS  MOM.  SHEAR

LT    -5.6    2.5   5.7  256.9   8.6  31.0   84.7   0.26    74.9    9.3  109.5
MID   19.9   -0.9   0.1  270.9  21.8  38.0   80.0   0.64     0.7   21.6  109.5
RT    -5.6    2.5   5.7  256.9   8.6  31.0   84.7   0.26    74.9    9.3  109.5


  NOTE:  ASTERISK IMPLIES DESIGN VALUES EXCEED CRITICAL VALUES

  ***** ATTENTION: OVERSTRESS DUE TO FIXED THICKNESS
```

```
                   ** REINFORCING STEEL BAR SCHEDULE **
                   ------------------------------------

      *  LOCATN  *    BAR  * NO. * SZ * TYP * LNGTH *  WT. * H LEG * V LEG

TOP SLAB POSV    MAIN A100   14      8   STR   10-11    408
BOT SLAB POSV    MAIN A200   14      8   STR   10-11    408
    CORNER  (TOP)     A1     28      5     6    6- 1    178   3-11    2- 2
    CORNER  (BOTTOM)  A2     28      6     6    5- 9    242   3- 2    2- 7
    EXTWALL IN        B1     20      5   STR    8- 4    174
    EXTWALL OUT       B2     28      5   STR    6- 4    185
    LONGTD      ( 1)  C1     40      4   STR    9- 8    258

                                          TOTAL        1853


                   *****   SPLICE LENGTHS CHART   *****
                        BAR   SIZE   SPLICE LENGTH
                        A200   8         3-11
                        B1     5         1- 8
                        C1     4         2- 2
```

```
A CORNER BAR(T)   A CORNER BAR(B)   A TSLAB+   A TSLAB-
 H   V  SZ  SPG    H   V  SZ  SPG   SZ  SPG    SZ   SPG
47  26   5  9.0   38  31   6  9.0    8  9.0     0   0.0

A BSLAB+   A BSLAB-   B EXTIN   B EXTOUT   B INTWL   C1
SZ   SPG   SZ   SPG   SZ  SPG   SZ  SPG    SZ  SPG   BARS
 8   9.0    0   0.0    5 12.0    5  9.0     0  0.0    40


  ** T.SLAB * B.SLAB * WALL * INWALL *** VOLUME *** STEEL **
       IN        IN      IN      IN        CY/FT      LB/FT
      11.50     11.00   8.00    0.00      1.133       179
```

```
** MOMENT * AXIAL FORCE * SHEAR FOR LOAD FACTOR DESIGN AT TENTH POINT **

     M-PT    +MOMENT    -MOMENT     +A.F.      -A.F.     +SHEAR     -SHEAR

     1- 0    -0.901     -8.287      3.741      1.037      3.259     -1.008
     1- 1    -1.393     -6.197      3.741      1.037      2.636     -0.735
     1- 2    -0.233     -6.278     12.712      8.859      2.062     -0.496
     1- 3     0.660     -6.369     11.266      7.881      1.537     -0.289
     1- 4     1.155     -6.467      9.796      6.888      1.062     -0.115
     1- 5     1.293     -6.399      9.796      6.888      0.947     -0.285
     1- 6     1.112     -6.298      9.057      6.388      1.055     -0.662
     1- 7     0.651     -6.090      9.057      6.388      1.131     -0.990
     1- 8     0.131     -5.835      9.057      6.388      1.174     -1.269
     1- 9     0.517     -6.316      9.057      6.388      1.184     -1.499
     1-10     1.450     -7.513      9.057      6.388      1.161     -1.679

     2- 0     1.450     -7.513     -0.327      1.670     10.739      1.031
     2- 1     9.506     -1.281     -0.830      1.532      9.608      0.361
     2- 2    15.923     -0.262     -0.573      1.430      8.446     -0.786
     2- 3    20.587      0.288     -0.388      1.430      7.262     -1.959
     2- 4    23.418      0.618     -0.278      1.430      6.063     -3.152
     2- 5    24.367      0.728     -0.241      1.430      4.856     -4.356
     2- 6    23.418      0.618     -0.278      1.430      3.650     -5.563
     2- 7    20.587      0.288     -0.388      1.430      2.451     -6.767
     2- 8    15.923     -0.262     -0.573      1.430      1.267     -7.960
     2- 9     9.506     -1.281     -0.830      1.532      0.105     -9.133
     2-10     1.450     -7.513     -0.327      1.670     -1.026    -10.281

     4- 0    -0.901     -7.503     -0.088      2.588      6.977      2.063
     4- 1     3.972     -1.384     -0.881      2.375      5.593      1.651
     4- 2    10.963      0.156     -0.922      2.348      4.209      1.238
     4- 3    15.935      1.257     -0.922      2.348      2.825      0.825
     4- 4    18.913      1.917     -0.922      2.348      1.441      0.413
     4- 5    19.921      2.137     -0.936      2.339      0.057     -0.057
     4- 6    18.913      1.917     -0.922      2.348     -0.413     -1.441
     4- 7    15.935      1.257     -0.922      2.348     -0.825     -2.825
     4- 8    10.963      0.156     -0.922      2.348     -1.238     -4.209
     4- 9     3.972     -1.384     -0.881      2.375     -1.651     -5.593
     4-10    -0.901     -7.503     -0.088      2.588     -2.063     -6.977
```

```
          *****  INFLUENCE LINES FOR MOMENT  *****

          *****        MEMBER NO.  1         *****

       .0    .1    .2    .3    .4    .5    .6    .7    .8    .9   1.0

100  -0.42 -0.37 -0.31 -0.26 -0.20 -0.15 -0.09 -0.04  0.02  0.07  0.13
105  -0.40 -0.36 -0.32 -0.28 -0.24 -0.20 -0.16 -0.12 -0.08 -0.04  0.00
110  -0.39 -0.36 -0.33 -0.30 -0.28 -0.25 -0.22 -0.19 -0.16 -0.14 -0.11
115  -0.37 -0.35 -0.33 -0.32 -0.30 -0.29 -0.27 -0.25 -0.24 -0.22 -0.20
120  -0.35 -0.34 -0.34 -0.33 -0.32 -0.32 -0.31 -0.30 -0.30 -0.29 -0.28
125  -0.33 -0.33 -0.33 -0.34 -0.34 -0.34 -0.34 -0.34 -0.34 -0.34 -0.35
130  -0.31 -0.32 -0.33 -0.34 -0.35 -0.35 -0.36 -0.37 -0.38 -0.39 -0.40
135  -0.30 -0.31 -0.32 -0.34 -0.35 -0.36 -0.38 -0.39 -0.40 -0.42 -0.43
140  -0.28 -0.30 -0.32 -0.33 -0.35 -0.37 -0.38 -0.40 -0.42 -0.44 -0.45
145  -0.27 -0.29 -0.31 -0.33 -0.35 -0.37 -0.39 -0.41 -0.43 -0.44 -0.46
150  -0.26 -0.28 -0.30 -0.32 -0.34 -0.36 -0.38 -0.40 -0.42 -0.44 -0.46
155  -0.25 -0.27 -0.29 -0.31 -0.33 -0.35 -0.37 -0.39 -0.41 -0.43 -0.45
160  -0.25 -0.27 -0.28 -0.30 -0.32 -0.34 -0.35 -0.37 -0.39 -0.41 -0.42
165  -0.25 -0.26 -0.28 -0.29 -0.30 -0.32 -0.33 -0.35 -0.36 -0.37 -0.39
170  -0.26 -0.27 -0.27 -0.28 -0.29 -0.30 -0.31 -0.32 -0.32 -0.33 -0.34
175  -0.27 -0.27 -0.27 -0.27 -0.27 -0.28 -0.28 -0.28 -0.28 -0.28 -0.28
180  -0.29 -0.28 -0.27 -0.27 -0.26 -0.25 -0.25 -0.24 -0.23 -0.23 -0.22
185  -0.31 -0.29 -0.28 -0.26 -0.24 -0.23 -0.21 -0.19 -0.18 -0.16 -0.15
190  -0.34 -0.31 -0.29 -0.26 -0.23 -0.20 -0.17 -0.15 -0.12 -0.09 -0.06
195  -0.38 -0.34 -0.30 -0.26 -0.22 -0.18 -0.14 -0.10 -0.06 -0.01  0.03
200  -0.43 -0.37 -0.32 -0.26 -0.21 -0.15 -0.10 -0.04  0.01  0.07  0.12

          *****        MEMBER NO.  2         *****

       .0    .1    .2    .3    .4    .5    .6    .7    .8    .9   1.0

100   0.13  0.13  0.13  0.13  0.13  0.13  0.12  0.12  0.12  0.12  0.12
105   0.00  0.48  0.43  0.38  0.33  0.28  0.23  0.18  0.13  0.08  0.03
110  -0.11  0.86  0.75  0.65  0.55  0.45  0.35  0.24  0.14  0.04 -0.06
115  -0.20  0.71  1.09  0.93  0.78  0.63  0.47  0.32  0.16  0.01 -0.15
120  -0.28  0.58  1.44  1.23  1.02  0.82  0.61  0.40  0.20 -0.01 -0.22
125  -0.35  0.46  1.27  1.54  1.28  1.02  0.76  0.50  0.24 -0.02 -0.28
130  -0.40  0.36  1.11  1.86  1.55  1.23  0.92  0.60  0.29 -0.03 -0.34
135  -0.43  0.27  0.96  1.66  1.83  1.46  1.09  0.72  0.35 -0.02 -0.39
140  -0.45  0.19  0.83  1.48  2.12  1.69  1.27  0.85  0.42  0.00 -0.42
145  -0.46  0.12  0.71  1.30  1.89  1.94  1.47  0.99  0.51  0.03 -0.45
150  -0.46  0.07  0.60  1.14  1.67  2.20  1.67  1.14  0.60  0.07 -0.46
155  -0.45  0.03  0.51  0.99  1.47  1.94  1.89  1.30  0.71  0.12 -0.46
160  -0.42  0.00  0.42  0.85  1.27  1.69  2.12  1.48  0.83  0.19 -0.45
165  -0.39 -0.02  0.35  0.72  1.09  1.46  1.83  1.66  0.96  0.27 -0.43
170  -0.34 -0.03  0.29  0.60  0.92  1.23  1.55  1.86  1.11  0.36 -0.40
175  -0.28 -0.02  0.24  0.50  0.76  1.02  1.28  1.54  1.27  0.46 -0.35
180  -0.22 -0.01  0.20  0.40  0.61  0.82  1.02  1.23  1.44  0.58 -0.28
185  -0.15  0.01  0.16  0.32  0.47  0.63  0.78  0.93  1.09  0.71 -0.20
190  -0.06  0.04  0.14  0.24  0.35  0.45  0.55  0.65  0.75  0.86 -0.11
195   0.03  0.08  0.13  0.18  0.23  0.28  0.33  0.38  0.43  0.48  0.00
200   0.12  0.12  0.12  0.12  0.12  0.13  0.13  0.13  0.13  0.13  0.13

          *****        MEMBER NO.  4         *****

       .0    .1    .2    .3    .4    .5    .6    .7    .8    .9   1.0

100   0.42 -0.06 -0.43 -0.70 -0.86 -0.91 -0.86 -0.70 -0.43 -0.05  0.43
105   0.40 -0.08 -0.45 -0.72 -0.89 -0.94 -0.89 -0.73 -0.47 -0.10  0.38
110   0.39 -0.10 -0.48 -0.75 -0.91 -0.97 -0.92 -0.77 -0.50 -0.13  0.34
```

115	0.37	-0.12	-0.50	-0.77	-0.94	-0.99	-0.95	-0.79	-0.53	-0.16	0.31
120	0.35	-0.14	-0.52	-0.79	-0.96	-1.02	-0.97	-0.81	-0.55	-0.19	0.29
125	0.33	-0.16	-0.54	-0.81	-0.97	-1.03	-0.99	-0.83	-0.57	-0.21	0.27
130	0.31	-0.17	-0.55	-0.82	-0.99	-1.05	-1.00	-0.85	-0.59	-0.22	0.26
135	0.30	-0.19	-0.57	-0.84	-1.00	-1.06	-1.01	-0.86	-0.59	-0.23	0.25
140	0.28	-0.20	-0.58	-0.85	-1.01	-1.07	-1.02	-0.86	-0.60	-0.23	0.25
145	0.27	-0.21	-0.59	-0.86	-1.02	-1.07	-1.02	-0.86	-0.60	-0.23	0.25
150	0.26	-0.22	-0.59	-0.86	-1.02	-1.07	-1.02	-0.86	-0.59	-0.22	0.26
155	0.25	-0.23	-0.60	-0.86	-1.02	-1.07	-1.02	-0.86	-0.59	-0.21	0.27
160	0.25	-0.23	-0.60	-0.86	-1.02	-1.07	-1.01	-0.85	-0.58	-0.20	0.28
165	0.25	-0.23	-0.59	-0.86	-1.01	-1.06	-1.00	-0.84	-0.57	-0.19	0.30
170	0.26	-0.22	-0.59	-0.85	-1.00	-1.05	-0.99	-0.82	-0.55	-0.17	0.31
175	0.27	-0.21	-0.57	-0.83	-0.99	-1.03	-0.97	-0.81	-0.54	-0.16	0.33
180	0.29	-0.19	-0.55	-0.81	-0.97	-1.02	-0.96	-0.79	-0.52	-0.14	0.35
185	0.31	-0.16	-0.53	-0.79	-0.95	-0.99	-0.94	-0.77	-0.50	-0.12	0.37
190	0.34	-0.13	-0.50	-0.77	-0.92	-0.97	-0.91	-0.75	-0.48	-0.10	0.39
195	0.38	-0.10	-0.47	-0.73	-0.89	-0.94	-0.89	-0.72	-0.45	-0.08	0.40
200	0.43	-0.05	-0.43	-0.70	-0.86	-0.91	-0.86	-0.70	-0.43	-0.06	0.42

```
                *****  INFLUENCE LINES FOR SHEAR AND AXIAL FORCE  *****

                *****        MEMBER NO.  1         *****

        .0    .1    .2    .3    .4    .5    .6    .7    .8    .9   1.0     A.F.

 100   0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07   -1.00
 105   0.05  0.05  0.05  0.05  0.05  0.05  0.05  0.05  0.05  0.05  0.05   -0.95
 110   0.03  0.03  0.03  0.03  0.03  0.03  0.03  0.03  0.03  0.03  0.03   -0.90
 115   0.02  0.02  0.02  0.02  0.02  0.02  0.02  0.02  0.02  0.02  0.02   -0.86
 120   0.01  0.01  0.01  0.01  0.01  0.01  0.01  0.01  0.01  0.01  0.01   -0.81
 125   0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00   -0.76
 130  -0.01 -0.01 -0.01 -0.01 -0.01 -0.01 -0.01 -0.01 -0.01 -0.01 -0.01   -0.71
 135  -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02   -0.65
 140  -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02   -0.60
 145  -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02   -0.55
 150  -0.03 -0.03 -0.03 -0.03 -0.03 -0.03 -0.03 -0.03 -0.03 -0.03 -0.03   -0.50
 155  -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02   -0.45
 160  -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02   -0.40
 165  -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02   -0.35
 170  -0.01 -0.01 -0.01 -0.01 -0.01 -0.01 -0.01 -0.01 -0.01 -0.01 -0.01   -0.29
 175   0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00   -0.24
 180   0.01  0.01  0.01  0.01  0.01  0.01  0.01  0.01  0.01  0.01  0.01   -0.19
 185   0.02  0.02  0.02  0.02  0.02  0.02  0.02  0.02  0.02  0.02  0.02   -0.14
 190   0.03  0.03  0.03  0.03  0.03  0.03  0.03  0.03  0.03  0.03  0.03   -0.10
 195   0.05  0.05  0.05  0.05  0.05  0.05  0.05  0.05  0.05  0.05  0.05   -0.05
 200   0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07    0.00

                *****        MEMBER NO.  2         *****

        .0    .1    .2    .3    .4    .5    .6    .7    .8    .9   1.0     A.F.

 100   1.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00    0.07
 105   0.95 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05    0.05
 110   0.90  0.90 -0.10 -0.10 -0.10 -0.10 -0.10 -0.10 -0.10 -0.10 -0.10    0.03
 115   0.86  0.86 -0.14 -0.14 -0.14 -0.14 -0.14 -0.14 -0.14 -0.14 -0.14    0.02
 120   0.81  0.81  0.81 -0.19 -0.19 -0.19 -0.19 -0.19 -0.19 -0.19 -0.19    0.01
 125   0.76  0.76  0.76 -0.24 -0.24 -0.24 -0.24 -0.24 -0.24 -0.24 -0.24    0.00
 130   0.71  0.71  0.71  0.71 -0.29 -0.29 -0.29 -0.29 -0.29 -0.29 -0.29   -0.01
 135   0.65  0.65  0.65  0.65 -0.35 -0.35 -0.35 -0.35 -0.35 -0.35 -0.35   -0.02
 140   0.60  0.60  0.60  0.60  0.60 -0.40 -0.40 -0.40 -0.40 -0.40 -0.40   -0.02
 145   0.55  0.55  0.55  0.55  0.55 -0.45 -0.45 -0.45 -0.45 -0.45 -0.45   -0.02
 150   0.50  0.50  0.50  0.50  0.50  0.50 -0.50 -0.50 -0.50 -0.50 -0.50   -0.03
 155   0.45  0.45  0.45  0.45  0.45  0.45 -0.55 -0.55 -0.55 -0.55 -0.55   -0.02
 160   0.40  0.40  0.40  0.40  0.40  0.40  0.40 -0.60 -0.60 -0.60 -0.60   -0.02
 165   0.35  0.35  0.35  0.35  0.35  0.35  0.35 -0.65 -0.65 -0.65 -0.65   -0.02
 170   0.29  0.29  0.29  0.29  0.29  0.29  0.29  0.29 -0.71 -0.71 -0.71   -0.01
 175   0.24  0.24  0.24  0.24  0.24  0.24  0.24  0.24 -0.76 -0.76 -0.76    0.00
 180   0.19  0.19  0.19  0.19  0.19  0.19  0.19  0.19  0.19 -0.81 -0.81    0.01
 185   0.14  0.14  0.14  0.14  0.14  0.14  0.14  0.14  0.14 -0.86 -0.86    0.02
 190   0.10  0.10  0.10  0.10  0.10  0.10  0.10  0.10  0.10  0.10 -0.90    0.03
 195   0.05  0.05  0.05  0.05  0.05  0.05  0.05  0.05  0.05  0.05 -0.95    0.05
 200   0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00    0.07

                *****        MEMBER NO.  4         *****

        .0    .1    .2    .3    .4    .5    .6    .7    .8    .9   1.0     A.F.

 100  -0.50 -0.40 -0.30 -0.20 -0.10  0.00  0.10  0.20  0.30  0.40  0.50   -0.07
 105  -0.50 -0.40 -0.30 -0.20 -0.10  0.00  0.10  0.20  0.30  0.40  0.50   -0.05
 110  -0.50 -0.40 -0.30 -0.20 -0.10  0.00  0.10  0.20  0.30  0.40  0.50   -0.03
```

115	-0.51	-0.41	-0.31	-0.21	-0.11	-0.01	0.09	0.19	0.29	0.39	0.49	-0.02
120	-0.51	-0.41	-0.31	-0.21	-0.11	-0.01	0.09	0.19	0.29	0.39	0.49	-0.01
125	-0.51	-0.41	-0.31	-0.21	-0.11	-0.01	0.09	0.19	0.29	0.39	0.49	0.00
130	-0.51	-0.41	-0.31	-0.21	-0.11	-0.01	0.09	0.19	0.29	0.39	0.49	0.01
135	-0.50	-0.40	-0.30	-0.20	-0.10	0.00	0.10	0.20	0.30	0.40	0.50	0.02
140	-0.50	-0.40	-0.30	-0.20	-0.10	0.00	0.10	0.20	0.30	0.40	0.50	0.02
145	-0.50	-0.40	-0.30	-0.20	-0.10	0.00	0.10	0.20	0.30	0.40	0.50	0.02
150	-0.50	-0.40	-0.30	-0.20	-0.10	0.00	0.10	0.20	0.30	0.40	0.50	0.03
155	-0.50	-0.40	-0.30	-0.20	-0.10	0.00	0.10	0.20	0.30	0.40	0.50	0.02
160	-0.50	-0.40	-0.30	-0.20	-0.10	0.00	0.10	0.20	0.30	0.40	0.50	0.02
165	-0.50	-0.40	-0.30	-0.20	-0.10	0.00	0.10	0.20	0.30	0.40	0.50	0.02
170	-0.49	-0.39	-0.29	-0.19	-0.09	0.01	0.11	0.21	0.31	0.41	0.51	0.01
175	-0.49	-0.39	-0.29	-0.19	-0.09	0.01	0.11	0.21	0.31	0.41	0.51	0.00
180	-0.49	-0.39	-0.29	-0.19	-0.09	0.01	0.11	0.21	0.31	0.41	0.51	-0.01
185	-0.49	-0.39	-0.29	-0.19	-0.09	0.01	0.11	0.21	0.31	0.41	0.51	-0.02
190	-0.50	-0.40	-0.30	-0.20	-0.10	0.00	0.10	0.20	0.30	0.40	0.50	-0.03
195	-0.50	-0.40	-0.30	-0.20	-0.10	0.00	0.10	0.20	0.30	0.40	0.50	-0.05
200	-0.50	-0.40	-0.30	-0.20	-0.10	0.00	0.10	0.20	0.30	0.40	0.50	-0.07

JVS 17JUL98

```
OM
OM                      CULVERT BR#A200
OM                      File: A206LRF7.pol
OM                      Date: 17Jul98
OM                      Golf Cart Design
OM                      Single Box Culvert (No Haunch)
OM                      1-Cell Box 10'x  7'
OM                      Load Factor Design
OM                      Rigid Frame Method
OM                      Top and Bot Slab Different
OM
OM                      Maximum Fill Ht Condition (7.0 Ft)
OM
STDLOD       2, 0, 0, 0, 0
SWPRES       1, 2, 60, 15, 62.4
BOXDIM       1, 1, 10,  7, 7, 10
SLBTHK       1, 11.5, 11, 8, 8, 1111
H&SKEW       1, 90, 90, 0, 0, 0
REEBAR       18, 9, 1, 11, 4, .016
CONCOV       2, 3, 2, 2, .5, .5
MATPRP       120, 60, 24, 3, 0, 0
PRTCTL       1, 1, 1, 0
F&HCTL       1, 1, 1
DESCTL       1, 0, 1, 0, 0, 9
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17 July 98

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CONSTANT DATA

   STANDARD LIVE LOAD        -  DESIGN METHOD    -         PRINT CONTROL
TRUCK  OMIT  STRESS  OVERLD  -  SERVICE    LOAD   -    10th Pt  INFL   LOC. NEG
CODE   L.L.  O-FILL   AXLE   -   LOAD     FACTOR  -    MOMENT   LINE   MOMENT
HS20    NO     NO      0.         NO       YES          YES     YES       1.00

                 MATERIAL PROPERTIES                          -  THICKNESS
  SOIL    STEEL   STEEL   CONCRETE  CONCRETE   CON.SHEAR   -  INCREMENTS
 WEIGHT    Fy      Fs     STRENGTH   SHEAR     W/ STIRRUP  -  SLAB  WALL
  120.   60000.  24000.    3000.       0.          0.         0.50  0.50

     CONCRETE COVER         -  DESIGN    -  PRINT  -        REINFORCING
   EXTERIOR         INTERIOR  -   SAME      -   BAR   -  BAR SPACING     BAR SIZE
TOP   BOT   WALL     (ALL)    - THICKNESS  -  TABLE  -   MAX    MIN      MAX  MIN
SLAB  SLAB                    - SLAB WALL  -          -
2.00  3.00  2.00     2.00        NO   NO        YES       18.0   9.0      11   4

CRACK PARAMETER Z =   98.0
MODULAR  RATIO  N =    9.0



       SUPERIMPOSED DEAD LOADS                     -    SPECIAL LIVE LOADS
 UNIFORM           CONCENTRATED LOAD               - WHEEL    FILL   OVERSTRESS
  LOAD      WT.   X1     WT.   X2      WT.   X3    - LOAD     HEIGHT    FACTOR
  0.000     0.00  0.0    0.00  0.0     0.00  0.0     0.000    0.000     1.00


DATA FOR STRUCTURE NUMBER  1

CULVERT  -  SPAN  - CLEAR  -  DESIGN - CENTERLINE -  SKEW  -  SKEW  - FLOOR
 TYPE    - LENGTH - HEIGHT -   FILL  -   LENGTH   -  LEFT  -  RIGHT - TYPE
SINGLE     10.00     7.00      7.00      10.00       90        90      FULL

      SLAB THICKNESSES          -    LIVE     -     SOIL     -    WATER
 TOP     BOT.    EXT.    INT.   -    LOAD     -   PRESSURE   -   PRESSURE
 SLAB    SLAB    WALL    WALL   -  SURCHARGE  -  MAX    MIN  -
11.50F  11.00F  8.00F   8.00F        2.00        60.0   15.0        62.4

 TOP HAUNCH    BOTTOM HAUNCH  -  RIGID OR  -  CHECK    - BAR SPACING
   HEIGHT         HEIGHT      -  FLEXIBLE  - MILITARY  -  INCREMENT
    0.0            0.0           RIGID        NO           1 INCH
BOTH HEADWALLS ELIMINATED.
```

```
          *****       LOAD FACTOR DESIGN        *****
          ***** STRESSES AT CRITICAL SECTIONS   *****


 ***  MAXIMUM REINFORCEMENT RATIO (As/bd) = .016

MEMBER NUMBER     =  1
MEMBER THICKNESS =  8.00
EXTERIOR WAL

  -MOMENT--AXIAL--SHEAR- -Po-   -Mu- -Mbal- -Pbal- -STEEL- -SHEAR- -ALL.- -ALL.-
          FORCE                                     AREA    STRESS  MOM.  SHEAR

LT    -7.9    8.6    3.4  192.7   7.9  16.0   51.5   0.34    64.4    9.2  121.9
MID    0.5    6.0    0.4  186.8   4.6  15.0   58.5   0.19     7.3    5.7  121.9
MID-  -5.8    8.6    0.4  188.9   5.8  16.0   56.1   0.38     7.3    7.3  117.7
RT    -6.4    8.6    2.6  190.0   6.4  16.0   54.7   0.27    49.1    7.9  120.7


MEMBER NUMBER     =  2
MEMBER THICKNESS = 11.50
TOP SLAB

  -MOMENT--AXIAL--SHEAR- -Po-   -Mu- -Mbal- -Pbal- -STEEL- -SHEAR- -ALL.- -ALL.-
          FORCE                                     AREA    STRESS  MOM.  SHEAR

LT    -5.6    3.2    7.0  268.5  10.8  38.0  103.7   0.28    76.4   11.7  128.3
MID   18.8*  -0.1    0.1  277.1  18.8  40.0   92.8   0.49     1.4   18.7  117.3
RT    -5.5    3.2    7.0  268.5  10.8  38.0  103.7   0.28    76.4   11.7  128.4


MEMBER NUMBER     =  4
MEMBER THICKNESS = 11.00
BOTTOM SLAB

  -MOMENT--AXIAL--SHEAR- -Po-   -Mu- -Mbal- -Pbal- -STEEL- -SHEAR- -ALL.- -ALL.-
          FORCE                                     AREA    STRESS  MOM.  SHEAR

LT    -7.1    4.5    7.9  257.8   9.4  32.0   83.4   0.29   103.6   10.6  126.6
MID   19.7*  -0.2    0.0  268.4  19.7  38.0   83.2   0.55     0.1   19.7  117.2
RT    -7.1    4.5    7.9  257.8   9.4  32.0   83.4   0.29   103.6   10.6  126.6


   NOTE:  ASTERISK IMPLIES DESIGN VALUES EXCEED CRITICAL VALUES

   ***** ATTENTION: OVERSTRESS DUE TO FIXED THICKNESS
```

```
A CORNER BAR(T)   A CORNER BAR(B)   A TSLAB+   A TSLAB-
 H   V  SZ  SPG    H   V  SZ  SPG   SZ  SPG    SZ   SPG
31  26   5  9.0   38  31   6  9.0    7  9.0     0   0.0

A BSLAB+   A BSLAB-   B EXTIN   B EXTOUT   B INTWL    C1
SZ   SPG   SZ   SPG   SZ  SPG   SZ  SPG    SZ  SPG   BARS
 8   9.0    0   0.0    5 12.0    5  9.0     0  0.0    40


  ** T.SLAB * B.SLAB * WALL * INWALL *** VOLUME *** STEEL **
       IN        IN      IN      IN        CY/FT      LB/FT
      11.50     11.00   8.00    0.00      1.133        166
```

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                 ** REINFORCING STEEL BAR SCHEDULE **
                 ------------------------------------

    *  LOCATN  *    BAR  * NO. * SZ * TYP * LNGTH *  WT. * H LEG * V LEG

TOP SLAB POSV    MAIN A100    14     7   STR   10-11    312
BOT SLAB POSV    MAIN A200    14     8   STR   10-11    408
    CORNER  (TOP)     A1      28     5     6    4- 9    139   2- 7    2- 2
    CORNER  (BOTTOM)  A2      28     6     6    5- 9    242   3- 2    2- 7
    EXTWALL IN        B1      20     5   STR    8- 4    174
    EXTWALL OUT       B2      28     5   STR    6- 4    185
    LONGTD      ( 1)  C1      40     4   STR    9- 8    258

                                       TOTAL       1718


                  *****   SPLICE LENGTHS CHART   *****
                       BAR   SIZE   SPLICE LENGTH
                       A200   8          3-11
                       B1     5          1- 8
                       C1     4          2- 2
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** MOMENT * AXIAL FORCE * SHEAR FOR LOAD FACTOR DESIGN AT TENTH POINT **

    M-PT   +MOMENT    -MOMENT     +A.F.      -A.F.     +SHEAR     -SHEAR

    1- 0    -4.426     -9.719     6.023      8.633      4.542     -0.246
    1- 1    -4.542     -6.529     6.023      8.633      3.547     -0.066
    1- 2    -2.524     -6.115     6.023      8.633      2.602      0.081
    1- 3    -0.861     -5.973     6.023      8.633      1.706      0.195
    1- 4     0.111     -5.754     6.023      8.633      0.859      0.276
    1- 5     0.430     -5.483     6.023      8.633      0.385      0.001
    1- 6     0.136     -5.187     6.023      8.633      0.400     -0.748
    1- 7    -0.734     -4.892     6.023      8.633      0.383     -1.447
    1- 8    -2.139     -4.623     6.023      8.633      0.333     -2.098
    1- 9    -2.998     -5.450     6.023      8.633      0.251     -2.699
    1-10    -2.885     -7.799     6.023      8.608      0.135     -3.251

    2- 0    -2.885     -7.799    -0.081      3.240      8.633      6.023
    2- 1     4.032     -0.618    -0.111      3.245      7.037      4.819
    2- 2    10.464      3.879    -0.113      3.245      5.310      3.614
    2- 3    15.068      7.092    -0.113      3.245      3.583      2.409
    2- 4    17.831      9.019    -0.113      3.245      1.857      1.205
    2- 5    18.752      9.662    -0.113      3.245      0.130     -0.512
    2- 6    17.831      9.019    -0.113      3.245     -1.205     -2.005
    2- 7    15.068      7.092    -0.113      3.245     -2.409     -3.551
    2- 8    10.464      3.879    -0.113      3.245     -3.614     -5.150
    2- 9     4.019     -0.618    -0.113      3.245     -4.819     -6.801
    2-10    -2.885     -7.787    -0.081      3.240     -6.023     -8.502

    4- 0    -4.426     -9.719    -0.208      4.488      9.664      7.055
    4- 1     3.216     -1.310    -0.239      4.520      7.732      5.644
    4- 2    10.432      3.958    -0.239      4.520      5.799      4.233
    4- 3    15.586      7.721    -0.239      4.520      3.866      2.822
    4- 4    18.679      9.978    -0.239      4.520      1.933      1.411
    4- 5    19.710     10.731    -0.239      4.520      0.010      0.000
    4- 6    18.679      9.978    -0.239      4.520     -1.411     -1.933
    4- 7    15.586      7.721    -0.239      4.520     -2.822     -3.866
    4- 8    10.432      3.958    -0.239      4.520     -4.233     -5.799
    4- 9     3.216     -1.310    -0.239      4.520     -5.644     -7.732
    4-10    -4.426     -9.719    -0.208      4.488     -7.055     -9.664
```

```
       *****  INFLUENCE LINES FOR MOMENT  *****

       *****       MEMBER NO.  1         *****

       .0    .1    .2    .3    .4    .5    .6    .7    .8    .9   1.0

100  -0.42 -0.37 -0.31 -0.26 -0.20 -0.15 -0.09 -0.04  0.02  0.07  0.13
105  -0.40 -0.36 -0.32 -0.28 -0.24 -0.20 -0.16 -0.12 -0.08 -0.04  0.00
110  -0.39 -0.36 -0.33 -0.30 -0.28 -0.25 -0.22 -0.19 -0.16 -0.14 -0.11
115  -0.37 -0.35 -0.33 -0.32 -0.30 -0.29 -0.27 -0.25 -0.24 -0.22 -0.20
120  -0.35 -0.34 -0.34 -0.33 -0.32 -0.32 -0.31 -0.30 -0.30 -0.29 -0.28
125  -0.33 -0.33 -0.33 -0.34 -0.34 -0.34 -0.34 -0.34 -0.34 -0.34 -0.35
130  -0.31 -0.32 -0.33 -0.34 -0.35 -0.35 -0.36 -0.37 -0.38 -0.39 -0.40
135  -0.30 -0.31 -0.32 -0.34 -0.35 -0.36 -0.38 -0.39 -0.40 -0.42 -0.43
140  -0.28 -0.30 -0.32 -0.33 -0.35 -0.37 -0.38 -0.40 -0.42 -0.44 -0.45
145  -0.27 -0.29 -0.31 -0.33 -0.35 -0.37 -0.39 -0.41 -0.43 -0.44 -0.46
150  -0.26 -0.28 -0.30 -0.32 -0.34 -0.36 -0.38 -0.40 -0.42 -0.44 -0.46
155  -0.25 -0.27 -0.29 -0.31 -0.33 -0.35 -0.37 -0.39 -0.41 -0.43 -0.45
160  -0.25 -0.27 -0.28 -0.30 -0.32 -0.34 -0.35 -0.37 -0.39 -0.41 -0.42
165  -0.25 -0.26 -0.28 -0.29 -0.30 -0.32 -0.33 -0.35 -0.36 -0.37 -0.39
170  -0.26 -0.27 -0.27 -0.28 -0.29 -0.30 -0.31 -0.32 -0.32 -0.33 -0.34
175  -0.27 -0.27 -0.27 -0.27 -0.27 -0.28 -0.28 -0.28 -0.28 -0.28 -0.28
180  -0.29 -0.28 -0.27 -0.27 -0.26 -0.25 -0.25 -0.24 -0.23 -0.23 -0.22
185  -0.31 -0.29 -0.28 -0.26 -0.24 -0.23 -0.21 -0.19 -0.18 -0.16 -0.15
190  -0.34 -0.31 -0.29 -0.26 -0.23 -0.20 -0.17 -0.15 -0.12 -0.09 -0.06
195  -0.38 -0.34 -0.30 -0.26 -0.22 -0.18 -0.14 -0.10 -0.06 -0.01  0.03
200  -0.43 -0.37 -0.32 -0.26 -0.21 -0.15 -0.10 -0.04  0.01  0.07  0.12

       *****       MEMBER NO.  2         *****

       .0    .1    .2    .3    .4    .5    .6    .7    .8    .9   1.0

100   0.13  0.13  0.13  0.13  0.13  0.13  0.12  0.12  0.12  0.12  0.12
105   0.00  0.48  0.43  0.38  0.33  0.28  0.23  0.18  0.13  0.08  0.03
110  -0.11  0.86  0.75  0.65  0.55  0.45  0.35  0.24  0.14  0.04 -0.06
115  -0.20  0.71  1.09  0.93  0.78  0.63  0.47  0.32  0.16  0.01 -0.15
120  -0.28  0.58  1.44  1.23  1.02  0.82  0.61  0.40  0.20 -0.01 -0.22
125  -0.35  0.46  1.27  1.54  1.28  1.02  0.76  0.50  0.24 -0.02 -0.28
130  -0.40  0.36  1.11  1.86  1.55  1.23  0.92  0.60  0.29 -0.03 -0.34
135  -0.43  0.27  0.96  1.66  1.83  1.46  1.09  0.72  0.35 -0.02 -0.39
140  -0.45  0.19  0.83  1.48  2.12  1.69  1.27  0.85  0.42  0.00 -0.42
145  -0.46  0.12  0.71  1.30  1.89  1.94  1.47  0.99  0.51  0.03 -0.45
150  -0.46  0.07  0.60  1.14  1.67  2.20  1.67  1.14  0.60  0.07 -0.46
155  -0.45  0.03  0.51  0.99  1.47  1.94  1.89  1.30  0.71  0.12 -0.46
160  -0.42  0.00  0.42  0.85  1.27  1.69  2.12  1.48  0.83  0.19 -0.45
165  -0.39 -0.02  0.35  0.72  1.09  1.46  1.83  1.66  0.96  0.27 -0.43
170  -0.34 -0.03  0.29  0.60  0.92  1.23  1.55  1.86  1.11  0.36 -0.40
175  -0.28 -0.02  0.24  0.50  0.76  1.02  1.28  1.54  1.27  0.46 -0.35
180  -0.22 -0.01  0.20  0.40  0.61  0.82  1.02  1.23  1.44  0.58 -0.28
185  -0.15  0.01  0.16  0.32  0.47  0.63  0.78  0.93  1.09  0.71 -0.20
190  -0.06  0.04  0.14  0.24  0.35  0.45  0.55  0.65  0.75  0.86 -0.11
195   0.03  0.08  0.13  0.18  0.23  0.28  0.33  0.38  0.43  0.48  0.00
200   0.12  0.12  0.12  0.12  0.12  0.13  0.13  0.13  0.13  0.13  0.13

       *****       MEMBER NO.  4         *****

       .0    .1    .2    .3    .4    .5    .6    .7    .8    .9   1.0

100   0.42 -0.06 -0.43 -0.70 -0.86 -0.91 -0.86 -0.70 -0.43 -0.05  0.43
105   0.40 -0.08 -0.45 -0.72 -0.89 -0.94 -0.89 -0.73 -0.47 -0.10  0.38
110   0.39 -0.10 -0.48 -0.75 -0.91 -0.97 -0.92 -0.77 -0.50 -0.13  0.34
```

115	0.37	-0.12	-0.50	-0.77	-0.94	-0.99	-0.95	-0.79	-0.53	-0.16	0.31
120	0.35	-0.14	-0.52	-0.79	-0.96	-1.02	-0.97	-0.81	-0.55	-0.19	0.29
125	0.33	-0.16	-0.54	-0.81	-0.97	-1.03	-0.99	-0.83	-0.57	-0.21	0.27
130	0.31	-0.17	-0.55	-0.82	-0.99	-1.05	-1.00	-0.85	-0.59	-0.22	0.26
135	0.30	-0.19	-0.57	-0.84	-1.00	-1.06	-1.01	-0.86	-0.59	-0.23	0.25
140	0.28	-0.20	-0.58	-0.85	-1.01	-1.07	-1.02	-0.86	-0.60	-0.23	0.25
145	0.27	-0.21	-0.59	-0.86	-1.02	-1.07	-1.02	-0.86	-0.60	-0.23	0.25
150	0.26	-0.22	-0.59	-0.86	-1.02	-1.07	-1.02	-0.86	-0.59	-0.22	0.26
155	0.25	-0.23	-0.60	-0.86	-1.02	-1.07	-1.02	-0.86	-0.59	-0.21	0.27
160	0.25	-0.23	-0.60	-0.86	-1.02	-1.07	-1.01	-0.85	-0.58	-0.20	0.28
165	0.25	-0.23	-0.59	-0.86	-1.01	-1.06	-1.00	-0.84	-0.57	-0.19	0.30
170	0.26	-0.22	-0.59	-0.85	-1.00	-1.05	-0.99	-0.82	-0.55	-0.17	0.31
175	0.27	-0.21	-0.57	-0.83	-0.99	-1.03	-0.97	-0.81	-0.54	-0.16	0.33
180	0.29	-0.19	-0.55	-0.81	-0.97	-1.02	-0.96	-0.79	-0.52	-0.14	0.35
185	0.31	-0.16	-0.53	-0.79	-0.95	-0.99	-0.94	-0.77	-0.50	-0.12	0.37
190	0.34	-0.13	-0.50	-0.77	-0.92	-0.97	-0.91	-0.75	-0.48	-0.10	0.39
195	0.38	-0.10	-0.47	-0.73	-0.89	-0.94	-0.89	-0.72	-0.45	-0.08	0.40
200	0.43	-0.05	-0.43	-0.70	-0.86	-0.91	-0.86	-0.70	-0.43	-0.06	0.42

```
                 *****  INFLUENCE LINES FOR SHEAR AND AXIAL FORCE  *****

                 *****       MEMBER NO.  1          *****

        .0    .1    .2    .3    .4    .5    .6    .7    .8    .9   1.0     A.F.

 100   0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07   -1.00
 105   0.05  0.05  0.05  0.05  0.05  0.05  0.05  0.05  0.05  0.05  0.05   -0.95
 110   0.03  0.03  0.03  0.03  0.03  0.03  0.03  0.03  0.03  0.03  0.03   -0.90
 115   0.02  0.02  0.02  0.02  0.02  0.02  0.02  0.02  0.02  0.02  0.02   -0.86
 120   0.01  0.01  0.01  0.01  0.01  0.01  0.01  0.01  0.01  0.01  0.01   -0.81
 125   0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00   -0.76
 130  -0.01 -0.01 -0.01 -0.01 -0.01 -0.01 -0.01 -0.01 -0.01 -0.01 -0.01   -0.71
 135  -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02   -0.65
 140  -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02   -0.60
 145  -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02   -0.55
 150  -0.03 -0.03 -0.03 -0.03 -0.03 -0.03 -0.03 -0.03 -0.03 -0.03 -0.03   -0.50
 155  -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02   -0.45
 160  -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02   -0.40
 165  -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02   -0.35
 170  -0.01 -0.01 -0.01 -0.01 -0.01 -0.01 -0.01 -0.01 -0.01 -0.01 -0.01   -0.29
 175   0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00   -0.24
 180   0.01  0.01  0.01  0.01  0.01  0.01  0.01  0.01  0.01  0.01  0.01   -0.19
 185   0.02  0.02  0.02  0.02  0.02  0.02  0.02  0.02  0.02  0.02  0.02   -0.14
 190   0.03  0.03  0.03  0.03  0.03  0.03  0.03  0.03  0.03  0.03  0.03   -0.10
 195   0.05  0.05  0.05  0.05  0.05  0.05  0.05  0.05  0.05  0.05  0.05   -0.05
 200   0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07  0.07    0.00

                 *****       MEMBER NO.  2          *****

        .0    .1    .2    .3    .4    .5    .6    .7    .8    .9   1.0     A.F.

 100   1.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00    0.07
 105   0.95 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05    0.05
 110   0.90  0.90 -0.10 -0.10 -0.10 -0.10 -0.10 -0.10 -0.10 -0.10 -0.10    0.03
 115   0.86  0.86 -0.14 -0.14 -0.14 -0.14 -0.14 -0.14 -0.14 -0.14 -0.14    0.02
 120   0.81  0.81  0.81 -0.19 -0.19 -0.19 -0.19 -0.19 -0.19 -0.19 -0.19    0.01
 125   0.76  0.76  0.76 -0.24 -0.24 -0.24 -0.24 -0.24 -0.24 -0.24 -0.24    0.00
 130   0.71  0.71  0.71  0.71 -0.29 -0.29 -0.29 -0.29 -0.29 -0.29 -0.29   -0.01
 135   0.65  0.65  0.65  0.65 -0.35 -0.35 -0.35 -0.35 -0.35 -0.35 -0.35   -0.02
 140   0.60  0.60  0.60  0.60  0.60 -0.40 -0.40 -0.40 -0.40 -0.40 -0.40   -0.02
 145   0.55  0.55  0.55  0.55  0.55 -0.45 -0.45 -0.45 -0.45 -0.45 -0.45   -0.02
 150   0.50  0.50  0.50  0.50  0.50  0.50 -0.50 -0.50 -0.50 -0.50 -0.50   -0.03
 155   0.45  0.45  0.45  0.45  0.45  0.45 -0.55 -0.55 -0.55 -0.55 -0.55   -0.02
 160   0.40  0.40  0.40  0.40  0.40  0.40  0.40 -0.60 -0.60 -0.60 -0.60   -0.02
 165   0.35  0.35  0.35  0.35  0.35  0.35  0.35 -0.65 -0.65 -0.65 -0.65   -0.02
 170   0.29  0.29  0.29  0.29  0.29  0.29  0.29  0.29 -0.71 -0.71 -0.71   -0.01
 175   0.24  0.24  0.24  0.24  0.24  0.24  0.24  0.24 -0.76 -0.76 -0.76    0.00
 180   0.19  0.19  0.19  0.19  0.19  0.19  0.19  0.19  0.19 -0.81 -0.81    0.01
 185   0.14  0.14  0.14  0.14  0.14  0.14  0.14  0.14  0.14 -0.86 -0.86    0.02
 190   0.10  0.10  0.10  0.10  0.10  0.10  0.10  0.10  0.10  0.10 -0.90    0.03
 195   0.05  0.05  0.05  0.05  0.05  0.05  0.05  0.05  0.05  0.05 -0.95    0.05
 200   0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00    0.07

                 *****       MEMBER NO.  4          *****

        .0    .1    .2    .3    .4    .5    .6    .7    .8    .9   1.0     A.F.

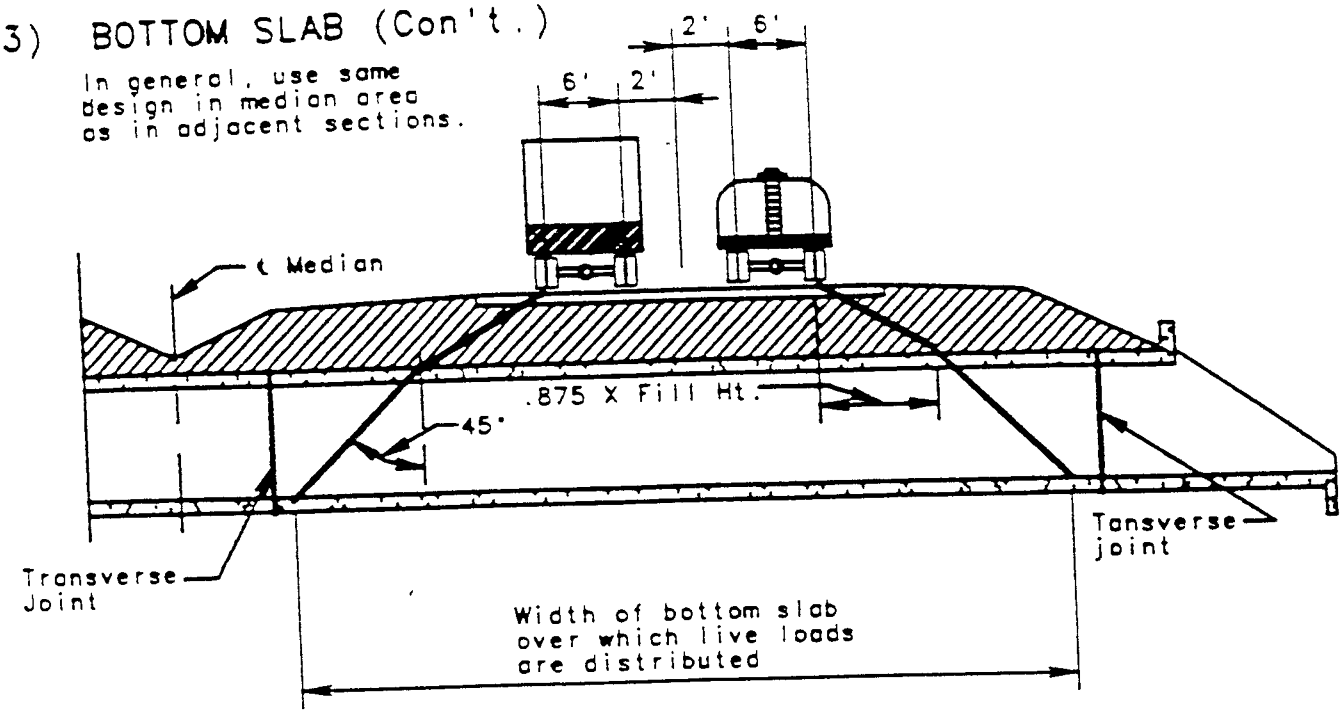
 100  -0.50 -0.40 -0.30 -0.20 -0.10  0.00  0.10  0.20  0.30  0.40  0.50   -0.07
 105  -0.50 -0.40 -0.30 -0.20 -0.10  0.00  0.10  0.20  0.30  0.40  0.50   -0.05
 110  -0.50 -0.40 -0.30 -0.20 -0.10  0.00  0.10  0.20  0.30  0.40  0.50   -0.03
```

115	-0.51	-0.41	-0.31	-0.21	-0.11	-0.01	0.09	0.19	0.29	0.39	0.49	-0.02
120	-0.51	-0.41	-0.31	-0.21	-0.11	-0.01	0.09	0.19	0.29	0.39	0.49	-0.01
125	-0.51	-0.41	-0.31	-0.21	-0.11	-0.01	0.09	0.19	0.29	0.39	0.49	0.00
130	-0.51	-0.41	-0.31	-0.21	-0.11	-0.01	0.09	0.19	0.29	0.39	0.49	0.01
135	-0.50	-0.40	-0.30	-0.20	-0.10	0.00	0.10	0.20	0.30	0.40	0.50	0.02
140	-0.50	-0.40	-0.30	-0.20	-0.10	0.00	0.10	0.20	0.30	0.40	0.50	0.02
145	-0.50	-0.40	-0.30	-0.20	-0.10	0.00	0.10	0.20	0.30	0.40	0.50	0.02
150	-0.50	-0.40	-0.30	-0.20	-0.10	0.00	0.10	0.20	0.30	0.40	0.50	0.03
155	-0.50	-0.40	-0.30	-0.20	-0.10	0.00	0.10	0.20	0.30	0.40	0.50	0.02
160	-0.50	-0.40	-0.30	-0.20	-0.10	0.00	0.10	0.20	0.30	0.40	0.50	0.02
165	-0.50	-0.40	-0.30	-0.20	-0.10	0.00	0.10	0.20	0.30	0.40	0.50	0.02
170	-0.49	-0.39	-0.29	-0.19	-0.09	0.01	0.11	0.21	0.31	0.41	0.51	0.01
175	-0.49	-0.39	-0.29	-0.19	-0.09	0.01	0.11	0.21	0.31	0.41	0.51	0.00
180	-0.49	-0.39	-0.29	-0.19	-0.09	0.01	0.11	0.21	0.31	0.41	0.51	-0.01
185	-0.49	-0.39	-0.29	-0.19	-0.09	0.01	0.11	0.21	0.31	0.41	0.51	-0.02
190	-0.50	-0.40	-0.30	-0.20	-0.10	0.00	0.10	0.20	0.30	0.40	0.50	-0.03
195	-0.50	-0.40	-0.30	-0.20	-0.10	0.00	0.10	0.20	0.30	0.40	0.50	-0.05
200	-0.50	-0.40	-0.30	-0.20	-0.10	0.00	0.10	0.20	0.30	0.40	0.50	-0.07

13 JUL 98
KSW 14 JULY 98

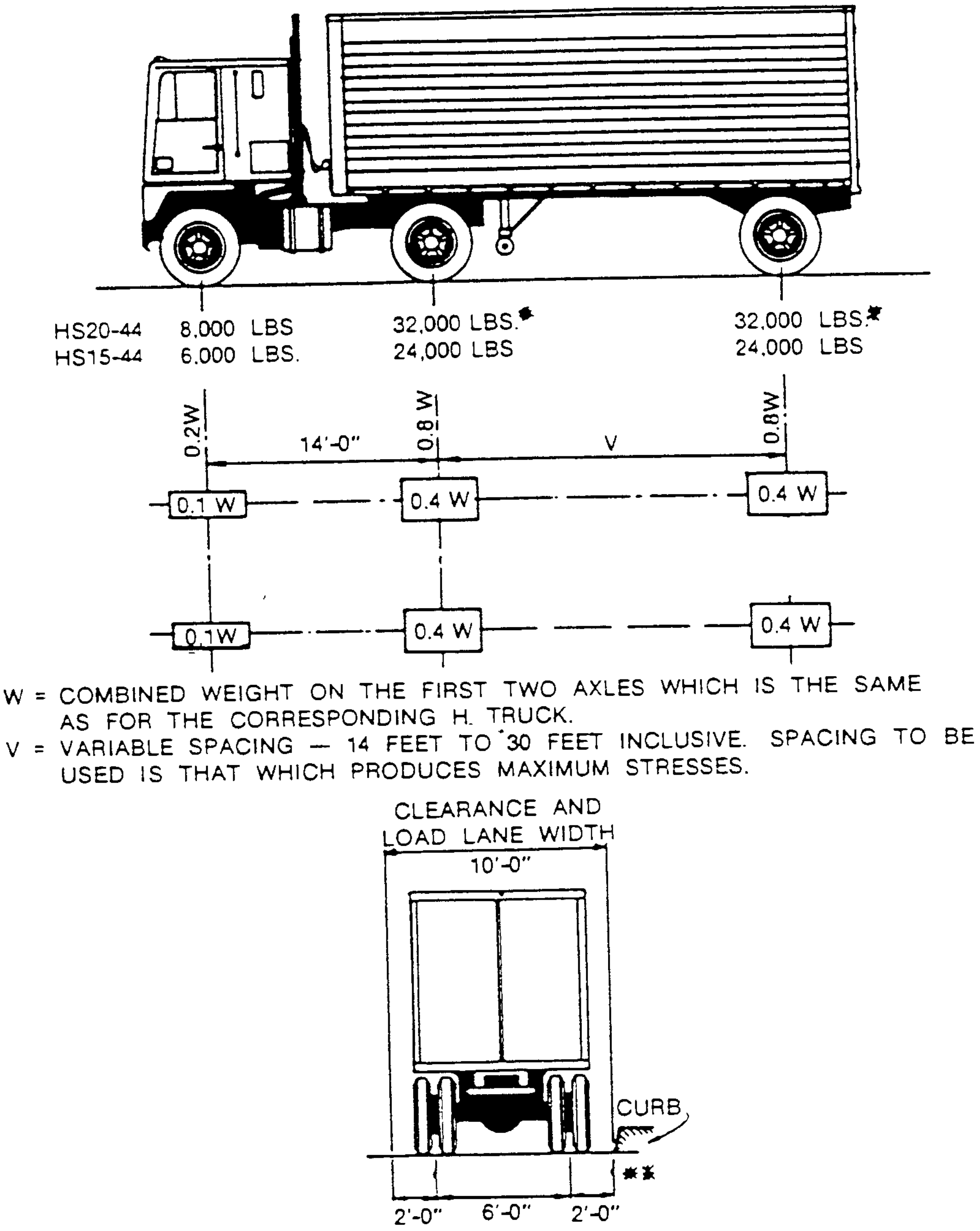
WINGHAVEN		BEARING PRESSURES (MAX FILL)					(MIN FILL)				
	BRIDGE #	A3210012	A3210013	A3210014	A3210015	A3210016	A3210012	A3210013	A3210014	A3210015	A3210016
		1 CELL	1 CELL	4 CELL	5 CELL	2 CELL	1 CELL	1 CELL	4 CELL	5 CELL	2 CELL
CULVERTP 13-Jul-98											
LIVE LOAD	TWO HS20 AXLE	64000	64000	64000	64000	64000	64000	64000	64000	64000	64000
	LBS PER SQ FT	57	57	44	31	43	92	92	60	47	96
	LANE LOAD	64	64	64	64	64	64	64	64	64	64
	FILL HEIGHT (FT)	5	5	4	6	8	1	1	1	1	1
CULVERT DIMENSIONS											
	NUMBER OF CELLS N =	1	1	4	5	2	1	1	4	5	2
	OPENING WIDTH (FT) S =	10	10	12	12	8	10	10	12	12	8
	OPENING HEIGHT (FT) H =	7	7	10	12	7	7	7	10	12	7
	TOP SLAB THICK (IN) D1 =	11.5	11.5	11.5	11.5	10.5	11.5	11.5	11.5	11.5	10.5
	BOTTOM SLAB THICK (IN) D2 =	11	11	12.5	11.5	9.5	11	11	12.5	11.5	9.5
	EXTERIOR WALL THICK (IN) T =	8	8	8	8.5	7	8	8	8	8.5	7
	INTERIOR WALL THICK (IN)TI =	0	0	8	7	6	0	0	8	7	6
	TOTAL WIDTH(IN) C =	136	136	616	765	212	136	136	616	765	212
	TOTAL WIDTH(FT) C =	11.333	11.333	51.333	63.750	17.667	11.333	11.333	51.333	63.750	17.667
WEIGHT PER FT OF LENGTH											
	LIVE LOAD	64	64	64 ✓	64 ✓	64 ✓	92 ✓	92	64	64	96
	FILL	600	600	480 ✓	720 ✓	960 ✓	120 ✓	120 ✓	120 ✓	120 ✓	120 ✓
	CULVERT	405	405	397	393	349 ✓	405 ✓	405	397	393	349
		------	------	------	------	------	------	------	------	------	------
TOTAL	LBS PER SQ FT	1069	1069	941	1177	1373	617 ✓	617	581	577	565

(3) BOTTOM SLAB (Con't.)



LOADING CONDITION - INTERIOR SECTION OF BOXES WITH TRANSVERSE JOINTS

REVISED: MARCH 1988



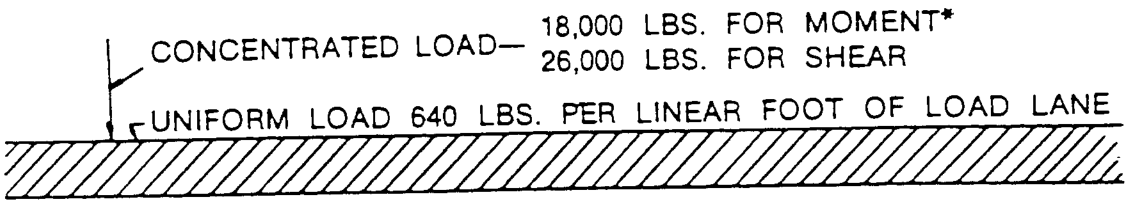
W = COMBINED WEIGHT ON THE FIRST TWO AXLES WHICH IS THE SAME AS FOR THE CORRESPONDING H. TRUCK.

V = VARIABLE SPACING — 14 FEET TO 30 FEET INCLUSIVE. SPACING TO BE USED IS THAT WHICH PRODUCES MAXIMUM STRESSES.

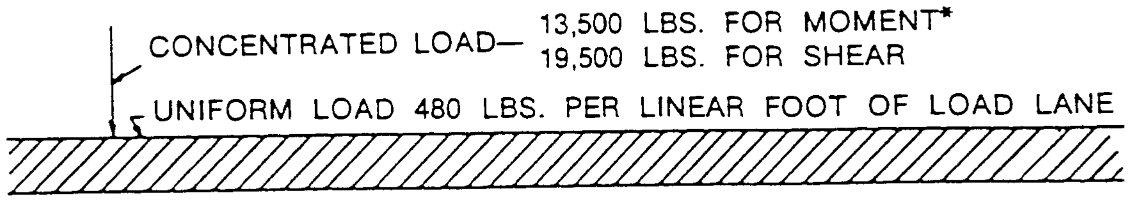
FIGURE 3.7.7A. **Standard HS Trucks**

*In the design of timber floors and orthotropic steel decks (excluding transverse beams) for H 20 loading, one axle load of 24,000 pounds or two axle loads of 16,000 pounds each, spaced 4 feet apart may be used, whichever produces the greater stress, instead of the 32,000-pound axle shown.

**For slab design, the center line of wheels shall be assumed to be 1 foot from face of curb (See Article 3.24.2.)



H20-44 LOADING
HS20-44 LOADING



H15-44 LOADING
HS15-44 LOADING

FIGURE 3.7.6B. Lane Loading

*For the loading of continuous spans involving lane loading refer to Article 3.11.3 which provides for an additional concentrated load.

L = length in feet of the portion of the span that is loaded to produce the maximum stress in the member.

3.8.2.2 For uniformity of application, in this formula, the loaded length, L, shall be as follows:

(a) For roadway floors: the design span length.
(b) For transverse members, such as floor beams: the span length of member center to center of supports.
(c) For computing truck load moments: the span length, or for cantilever arms the length from the moment center to the farthermost axle.
(d) For shear due to truck loads: the length of the loaded portion of span from the point under consideration to the far reaction; except, for cantilever arms, use a 30 percent impact factor.
(e) For continuous spans: the length of span under consideration for positive moment, and the average of two adjacent loaded spans for negative moment.

3.8.2.3 For culverts with cover
0′0″ to 1′-0″ inc. I = 30%
1′-1″ to 2′-0″ inc. I = 20%
2′-1″ to 2′-11″ inc. I = 10%

3.9 LONGITUDINAL FORCES

Provision shall be made for the effect of a longitudinal force of 5 percent of the live load in all lanes carrying traffic headed in the same direction. All lanes shall be loaded for bridges likely to become one directional in the future. The load used, without impact, shall be the lane load plus the concentrated load for moment specified in Article 3.7, with reduction for multiple-loaded lanes as specified in Article 3.12. The center of gravity of the longitudinal force shall be assumed to be located 6 feet above the floor slab and to be transmitted to the substructure through the superstructure.

WYOMING DEPARTMENT OF TRANSPORTATION
Program for the Design of Reinforced Concrete Box Culverts

BRASS - CULVERT

Version 1

User Manual
January, 1995

BRASS-CULVERT	COMMAND DESCRIPTION
COMMAND NAME	STDLOD
PURPOSE	STDLOD defines the standard truck loads to be used.

5 COMMAND PARAMETERS

2	Truck Code (1-8)	Enter the code for the desired truck load to be applied. The codes are: 1) HS 25 [✓ 2) HS 20] ~~3) H 20~~ 4) HS 15 5) H 15 6) HS 10 7) H 10 8) Special Live Load Only 9) No Live Load Special live loads are defined with the SPLLOD command.
1	Check Military Load (0,1)	When HS 25 or HS 20 truck loading is specified, the standard military load in two adjacent lanes will be checked if specified here. Enter 1 to check military load as a separate load case, else enter 0.
0	Neglect Live Load (0,1)	Live load may be neglected for single culverts if fill depth is more than 8 feet and exceeds barrel span length. For multiple culverts, it may be neglected if fill depth exceeds the distance between end supports or abutments. (See AASHTO 6.4.2.) Enter 1 to neglect live load according to AASHTO 6.4.2. Enter 0 to use live load regardless of fill height.
0	Stress at Zero Fill (0,1)	Enter 1 for stress check at zero fill (top of top slab) to be performed, else enter 0.
0	Overload Axle Weight, kip	Enter the axle weight for the overload standard truck, kips.

EXAMPLE

To define an HS 25 truck load to be applied to the culvert with live load distribution based on AASHTO 6.4.2, no stress check at zero fill or overload truck effects to be calculated, and military load will not be checked as a separate load case, code:

```
STDLOD 1, 0, 0, 0, 0
```

FIGURES

NOTES

BRASS-CULVERT	COMMAND DESCRIPTION
COMMAND NAME	SWPRES
PURPOSE	SWPRES defines soil and water pressure parameters.

5 COMMAND PARAMETERS

1	Structure Number (1-10)	Enter the reference number for the culvert to be described by the following data. Culverts must be numbered sequentially beginning with 1, 2, 3 ...etc.
2	Live Load Surcharge, ft.	Enter the depth of surcharge to be used for calculating the effects of lateral earth pressure. Surcharge load is applied as a uniform load on the exterior walls and is calculated as the depth of surcharge times the maximum or minimum soil pressure as applicable.
45	Maximum Soil Pressure, pcf	Enter the maximum soil equivalent fluid pressure for lateral earth pressure calculations. Standard maximum is 30 pcf by AASHTO 6.2.1.
15	Minimum Soil Pressure, pcf	Enter the minimum soil equivalent fluid pressure for lateral earth pressure calculations. A minimum of 15 pcf is used for checking positive moments unless otherwise defined.
62.4	Water Pressure, pcf	Enter the unit weight of water (62.4 pcf standard). Enter 0 for no water pressure to be considered. When considered, BRASS-CULVERT uses full height of water and no water as two loading cases.

EXAMPLE

For standard values:

```
SWPRES 1, 2.0, 30.0, 15.0, 62.4
```

FIGURES

NOTES

BRASS-CULVERT	COMMAND DESCRIPTION
COMMAND NAME	BOXDIM
PURPOSE	BOXDIM defines the geometry of the box culvert.

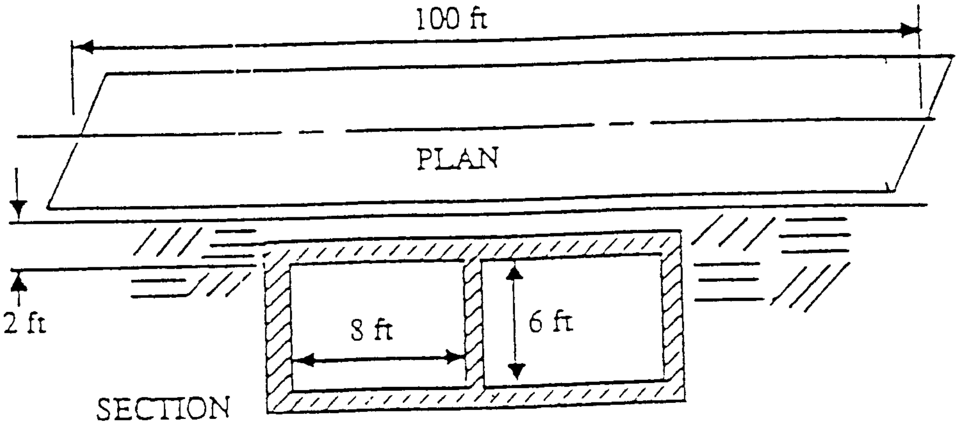
6 COMMAND PARAMETERS

1	Structure Number (1-10)	Enter the reference number for the culvert to be described by the following data. Culverts must be numbered sequentially beginning with 1, 2, 3 ...etc.
1, 1, 2, 4, 5	Number of Barrels (1-4)	Enter the number of barrels for the culvert, four maximum.
10, 10, 8, 12, 12	Clear Span, ft.	Enter the clear span of the barrels, feet. All barrels have the same span.
7 7, 7. 10, 12	Clear Height, ft.	Enter the clear height of the barrels, feet. All barrels have the same height.
4, 10, 8, 8, 6	Design Fill, ft.	Enter the depth of fill to be used for design. Fill is measured from the bottom of the top slab to the top of fill, feet. Live loads will be applied to the top of this fill.
30, 105, 108, 150, 78	Centerline Length, ft.	Enter the length of the culvert along its centerline, feet.

EXAMPLE

BOXDIM 1, 2, 8, 6, 2, 100

FIGURES



NOTES

BRASS-CULVERT	COMMAND DESCRIPTION
COMMAND NAME	SLBTHK
PURPOSE	SLBTHK defines the thickness for the top and bottom slabs, and the exterior and interior walls.

6 COMMAND PARAMETERS

1	Structure Number (1-10)	Enter the reference number for the culvert to be defined by the following data. Culverts must be numbered sequentially beginning with 1, 2, 3 ...etc.
6	Top Slab Thickness, in.	Enter the thickness for the top slab. Unless this value is specified as fixed value (see below), BRASS-CULVERT uses this value as minimum thickness.
6	Bottom Slab Thickness, in.	Enter the thickness for the bottom slab. Unless this value is specified as fixed value (see below), BRASS-CULVERT uses this value as minimum thickness.
6	Exterior Wall Thickness, in.	Enter the thickness for the exterior wall. Unless this value is specified as fixed value (see below), BRASS-CULVERT uses this value as minimum thickness.
6	Interior Wall Thickness, in.	Enter the thickness for the interior wall. Unless this value is specified as fixed value (see below), BRASS-CULVERT uses this value as minimum thickness.
0000	Fixed Thickness Code (0 - 1111)	BRASS-CULVERT will use the thicknesses defined above as minimum values unless otherwise specified here. Each digit of the code is for the top slab, bottom slab, exterior walls, and interior walls respectively. Enter 1 to fix the thickness, else enter 0. For example to fix the top slab and exterior wall thicknesses only, enter a code of 1010.

EXAMPLE

For a culvert with a fixed slab and wall thickness of 7 inches, code:

```
SLBTHK 1,   7,   7,   7,   7, 1111
```

For a culvert with a fixed top slab of 8 inches and fixed exterior walls of 10 inches, bottom slab and interior wall thicknesses are used as minimum values, code:

```
SLBTHK 1,   8,   8, 10, 10, 1010
```

For a culvert with no fixed thicknesses and it is desired for the program to set the thicknesses as required, code:

```
SLBTHK 1,   0,  0,   0,    0, 0000
```

FIGURES

NOTES

BRASS-CULVERT	COMMAND DESCRIPTION
COMMAND NAME	H&SKEW
PURPOSE	H&SKEW defines haunches and end skews.

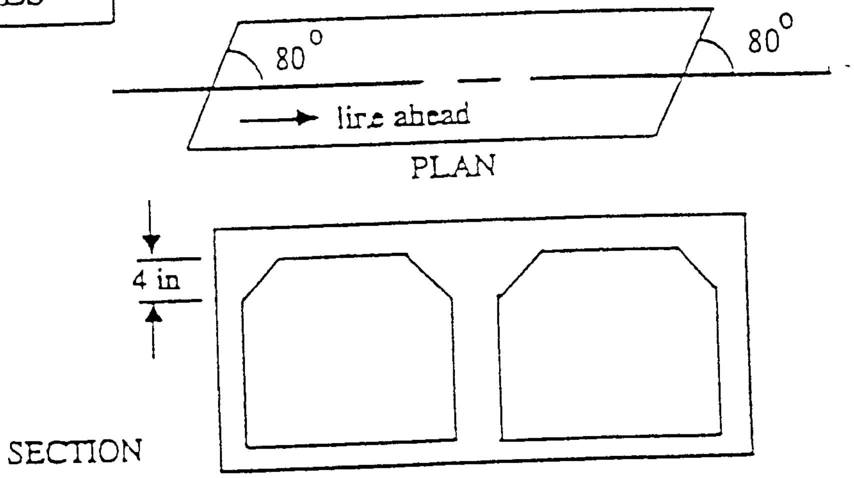
6 COMMAND PARAMETERS

1	Structure Number (1-10)	Enter the reference number for the culvert to be described by the following data. Culverts must be numbered sequentially beginning with 1, 2, 3 ...etc.
90	Skew Angle Left, deg.	Enter the skew angle at the left end of the culvert, degrees. See Note.
90	Skew Angle Right, deg.	Enter the skew angle at the right end of the culvert, degrees. See Note.
0	Top Haunch Height, in.	Enter the height of the top haunch, inches. Enter 0 for no top haunch.
0	Bottom Haunch Height, in.	Enter the height of the bottom haunch, inches. Enter 0 for no bottom haunch.
0	Haunches by AASHTO 0 or 1	Enter 1 for haunches to be considered in effective span length calculations, as per AASHTO Section 8.8, else enter 0.

EXAMPLE

H&SKEW 80, 80, 4, 0, 1

FIGURES



NOTES

Skew angles are measured from line ahead to skew as shown above. Positive angles only.

BRASS-CULVERT	COMMAND DESCRIPTION
COMMAND NAME	REEBAR
PURPOSE	REEBAR defines allowable bar sizes and spacings, and maximum steel ratio.

6 COMMAND PARAMETERS

12	Maximum Bar Spacing, in. Default = 12	Enter the maximum allowable bar spacing.
9	Minimum Bar Spacing, in. Default = 12	Enter the minimum allowable bar spacing.
1	Bar Spacing Increment (0,1)	Steel design bar spacings will be rounded to the increment defined here. Enter 1 to round spacings to 1 inch increments, or enter 0 to round bar spacings to ½ inch increments.
11	Maximum Bar Size (#) Default = 11	Enter the maximum bar size to be used in design.
4	Minimum Bar Size (#) Default = 4	Enter the minimum bar size to be used in design.
.016	Maximum Steel Ratio Default = 0.012	Enter the maximum ratio of area of steel to area for concrete (A_s / bd) in decimal form.

$$\rho_{MAX} = .75\,\rho_b = \frac{.85(.85)3000}{60000}\left(\frac{87000}{87000+60000}\right)$$

$$= .016$$

EXAMPLE

For a culvert with a maximum bar spacing of 12 inches, a minimum bar spacing of 4 inches, bar spacing increments of ½ inch, a maximum bar size of #11, a minimum bar size of #4, and a maximum reinforcement ratio of 0.012, code:

11
REEBAR 12, 4, 0, 4, 0.012
12 0.016

FIGURES

NOTES

BRASS-CULVERT	COMMAND DESCRIPTION
COMMAND NAME	CONCOV
PURPOSE	CONCOV defines the depth of concrete cover for reinforcement and the slab thickness round off increment.

6 COMMAND PARAMETERS

2	Exterior Top Slab, in.	Enter the distance from the face of steel bars to the face of concrete for the top steel of the top slab, inches. See Note.
3	Exterior Bottom Slab, in.	Enter the distance from the face of steel bars to the face of concrete for the bottom steel of the bottom slab, inches. See Note.
2	Exterior Wall, in.	Enter the distance from the face of steel bars to the exterior face of the exterior walls, inches. See Note.
HYDR GULF 2, 2	Interior Cover, in.	Enter the distance from the face of steel bars to the face of concrete for the interior faces of slabs and walls, inches. See Note. NOTE: Default values are 3 inches for bottom slab cover and 2 inches for all other covers.
1/2	Slab Thickness Increment, in.	BRASS-CULVERT "rounds up" slab thickness to the nearest increment defined. Default values are ½ inch.
1/2	Wall Thickness Increment, in.	BRASS-CULVERT "rounds up" wall thickness to the nearest increment defined. Default values are ½ inch.

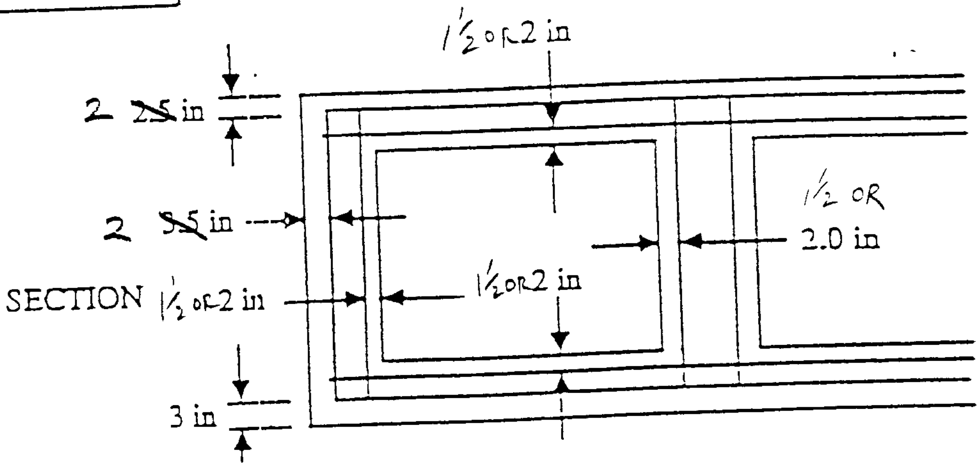
EXAMPLE

CONCOV ~~2.5~~ 2.0, 3.0, ~~3.5~~ 2.0, 2.0, 0.5, 0.5

→ 1.5

HYDR
ONLY

FIGURES



NOTES

All covers are measured from the outer face of steel to face of slab.

BRASS-CULVERT	COMMAND DESCRIPTION
COMMAND NAME	MATPRP
PURPOSE	MATPRP defines material properties for steel and concrete.

6 COMMAND PARAMETERS

120	Soil Unit Weight, pcf	Enter the unit weight of the soil fill in pounds per cubic foot. BRASS-CULVERT uses 100% of soil weight for both rigid and flexible box designs.
60	Reinforcing Yield, Fy, ksi	Enter the yield strength for steel reinforcement, ksi.
24	Allowable Steel Stress, ksi	Enter the allowable steel stress, ksi.
3	Concrete Strength, ksi	Enter the 28 day compressive strength for concrete, ksi.
0	Allowable Concrete Shear, ksi	Enter the allowable concrete shear stress, ksi. Enter 0 for BRASS-CULVERT to calculate the concrete shear strength according to AASHTO 8.16.
0	Allowable Concrete Shear, with Stirrups, ksi	Enter the allowable concrete shear stress when stirrups are used. Enter 0 for no stirrups.

EXAMPLE

For a culvert with a soil unit weight of 120 pcf, 40 ksi reinforcing steel, an allowable steel stress of 20 ksi, a concrete strength of 3000 psi, and to have the program calculate the allowable concrete shear stress, code:

```
MATPRP 120, 40, 20, 3, 0, 0
            60  24
```

FIGURES

NOTES

COMMAND NAME	PRTCTL
PURPOSE	PRTCTL controls the output produced.

4 COMMAND PARAMETERS

0	1	Bar Schedule (0,1)	Enter 1 for printing the bar schedule, else enter 0.
0	1	Tenth Point Actions (0,1)	Enter 1 for printing moments, shears, and axial forces at tenth points, else enter 0. These are factored actions for ultimate strength design.
0	1	Influence Lines (0,1)	Enter 1 for printing live load influence line ordinates at tenth points, else enter 0.
0	0	Debug Printout (0,1)	This parameter is to be used for debugging purposes only. Enter 1 for special printout of dead load, soil pressure, and live load moments and shears, else enter 0. These are unfactored actions for ultimate strength design.

↑
FINAL RUN

EXAMPLE

To print the bar schedule, tenth point actions, and influence line ordinates, code:

```
PRTCTL 1, 1, 1, 0
          0  0  0
```

FIGURES

NOTES

BRASS-CULVERT	COMMAND DESCRIPTION
COMMAND NAME	F&HCTL
PURPOSE	F&HCTL defines floor type and headwall configuration.

3 COMMAND PARAMETERS

1 Structure Number (1-10)	Enter the reference number for the culvert to be described by the following data. Culverts must be numbered sequentially beginning with 1, 2, 3 ...etc.
1 Floor Type (1,2,3)	Enter 1 for full floor. Enter 2 for no floor with fixed end supports. Enter 3 for no floor with pinned end supports.
2 Headwall Steel (0-3)	Enter 0 to generate headwall steel as per North Carolina standard. Enter 1 to suppress headwall steel generation. Enter 2 to generate left headwall steel only. Enter 3 to generate right headwall steel only.

EXAMPLE

To suppress a full floor and headwall steel design, code:

F&HCTL 1, 1, ~~1~~
2

FIGURES

NOTES

BRASS-CULVERT	COMMAND DESCRIPTION
COMMAND NAME	DESCTL
PURPOSE	DESCTL defines design control parameters.

6 COMMAND PARAMETERS

0, 1	Design Method (0,1)	Enter 0 for service load design method, or enter 1 for load factor design method.
1, 0	Rigid or Flexible (0,1)	Enter 0 for rigid box culvert design, else enter 1 for flexible box culvert design.
0	Design Negative Moment Position (0.0 - 1.0)	The position of design negative moment is defined by a value from zero to one where 0.0 represents the centerline of the wall or slab, 0.5 represents half way between center of the wall or slab and face of the wall or slab, and 1.0 represents the face of the wall or slab.
0	Design Same Slabs (0,1)	Enter 1 for BRASS-CULVERT to design the same thicknesses and steel for top and bottom slabs, else enter 0. See Note.
0	Design Same Walls (0,1)	Enter 1 for BRASS-CULVERT to design the same exterior and interior wall thicknesses, else enter 0. See Note.
9	Modular Ratio (N) Default = 9	Enter the ratio of the modules of elasticity of steel to that of concrete.

QUANTITIES

Kuhlmann *design* Group

BRIDGE NO. A3210012

7/13/98
11:35 AM
A100QUAN.XLS

HEG 7-13-98
JVS 13JUL98

[illegible]NCRETE QUANTITIES

DESCRIPTION	QUANT.	WIDTH	LENGTH	DEPTH	FACTOR	TOTAL (CU. FT.)	TOTAL (CU. YD.)
TOP SLAB	1.00	11.33	123.00	0.96	1.00	1335.92	49.48
EXTERIOR WALL	2.00	0.67	123.50	7.00	1.00	1152.67	42.69
INTERIOR WALL	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BOTTOM SLAB	1.00	11.33	168.00	0.92	1.00	1745.33	64.64
BOTTOM SLAB TRIANGLE	4.00	8.09	22.25	0.92	0.50	330.16	12.23
HEADWALL	2.00	11.33	1.50	0.50	1.00	17.00	0.63
CUT OFF WALL DOWNSTREAM	1.00	27.36	0.83	1.08	1.00	24.70	0.91
CUT OFF WALL UPSTREAM	1.00	27.36	0.83	1.08	1.00	24.70	0.91
INT. WING DOWNSTREAM	0 00	0.00	0.00	0.00	0.00	0.00	0.00
[illegible]T. WING DOWNSTREAM DEDUCT	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EXT. WING DOWNSTREAM	2.00	0.67	23.44	7.96	1.00	248.70	9.21
EXT. WING DOWNSTREAM DEDUCT	2.00	0.67	23.19	6.96	-0.50	-107.56	-3.98
INT. WING UPSTREAM	0.00	0.00	0.00	0.00	0.00	0.00	0.00
INT. WING UPSTREAM DEDUCT	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EXT. WING UPSTREAM	2.00	0.67	23.44	7.96	1.00	248.70	9.21
EXT. WING UPSTREAM DEDUCT	2.00	0.67	23.19	6.96	-0.50	-107.56	-3.98
						4912.75	181.95

NOT TOP BARS

2.4.11.3. Development and Tension Lap Splice Lengths -

<u>Other Than Top Bars</u> (Fy = 60 ksi)

Step 1	Step 2	Step 3	Step 4	Step 5								
		f'c	Bars	#3	#4	#5	#6	#7	#8	#9	#10	#11
< 6 in. on Center (Dir. of Spacing ● ⟶)	• NON-EPOXY	• 3 ksi	ld	12	12	15	20	27	35	44	56	69
			B	12	16	20	26	35	45	57	73	89
			C	16	21	26	33	45	59	75	95	117
		• 4 ksi	ld	12	12	15	18	23	30	38	49	60
			B	12	16	20	24	30	39	50	63	76
			C	16	21	26	31	39	51	65	82	101
	• EPOXY 1 (<6db Clear spacing OR <3db Cover (any direction))	• 3 ksi	ld	14	18	23	30	40	52	66	84	103
			B	18	24	30	38	52	68	86	109	134
			C	23	31	39	50	68	88	112	142	175
		• 4 ksi	ld	14	18	23	27	35	45	57	73	89
			B	18	24	30	36	45	59	74	94	116
			C	23	31	39	46	59	76	97	123	152
	• EPOXY 2 (All Other Situations)	• 3 ksi	ld	12	14	18	23	31	40	51	64	79
			B	14	18	23	29	40	52	66	83	103
			C	18	24	30	38	52	68	86	109	134
		• 4 ksi	ld	12	14	18	21	27	35	44	56	69
			B	14	18	23	27	35	45	57	72	89
			C	18	24	30	36	45	59	75	94	116

		f'c	Bars	#3	#4	#5	#6	#7	#8	#9	#10	#11
>= 6 in. on Center (Dir. of Spacing ● ⟶)	• NON-EPOXY	• 3 ksi	ld	12	12	12	16	22	28	36	45	55
			B	12	13	16	21	28	36	46	58	72
			C	13	17	21	27	36	47	60	76	94
		• 4 ksi	ld	12	12	12	15	19	24	31	39	48
			B	12	13	16	19	24	31	40	50	62
			C	13	17	21	25	32	41	52	66	81
	• EPOXY 1 (<6db Clear spacing OR <3db Cover (any direction))	• 3 ksi	ld	12	15	18	24	32	42	53	67	83
			B	15	19	24	31	42	54	69	87	107
			C	19	25	31	40	54	71	90	114	140
		• 4 ksi	ld	12	15	18	22	28	36	46	58	72
			B	15	19	24	29	36	47	60	75	93
			C	19	25	31	37	47	61	78	99	121
	• EPOXY 2 (All Other Situations)	• 3 ksi	ld	12	12	14	18	25	32	41	52	63
			B	12	15	18	24	32	42	53	67	82
			C	15	19	24	31	42	54	69	87	108
		• 4 ksi	ld	12	12	14	17	21	28	35	45	55
			B	12	15	18	22	28	36	46	58	71
			C	15	19	24	29	36	47	60	76	93

Use development and tension lap splices of f'c = 4 ksi for concrete strengths greater than 4 ksi.

AREA OF STEEL

SPACING

SIZE	4"	4½"	5"	5½"	6"	6½"	7"	7½"	8"	8½"	9"	9½"	10"	10½"	11"	11½"	12"	SIZE
3	.332	.295	.265	.241	.221	.204	.189	.177	.166	.156	.147	.140	.133	.126	.121	.115	.111	3
4	.589	.524	.471	.429	.393	.363	.337	.314	.295	.277	.262	.248	.236	.224	.214	.205	.196	4
5	.920	.818	.736	.669	.614	.566	.526	.491	.460	.433	.409	.388	.368	.351	.335	.320	.307	5
6	1.325	1.178	1.050	.964	.884	.816	.757	.707	.663	.624	589	.558	.530	.505	.482	.461	.442	6
7	1.804	1.603	1.443	1.312	1.203	1.110	1.031	.962	.902	.849	.802	.760	.722	.687	.656	.627	.601	7
8	2.356	2.094	1.885	1.714	1.571	1.450	1.346	1.257	1.178	1.109	1.047	.992	.942	.898	.857	.820	.785	8
9	3.00	2.67	2.40	2.18	2.00	1.85	1.71	1.60	1.50	1.41	1.33		1.20		1.09		1.00	9
10		3.37	3.04	2.76	2.53	2.34	2.17	2.02	1.90	1.79	1.69		1.52		1.38		1.27	10
11			3.75	3.41	3.13	2.88	2.63	2.50	2.34	2.21	2.08		1.88		1.70		1.56	11

NUMBER OF BARS

SIZE	Perimeter	Wt. Per Ft.	Diameter (inches)	1	2	3	4	5	6	7	8	9	10	SIZE
3	1.178	.376	.375	.1105	0.22	0.33	0.44	0.55	0.66	0.77	0.88	0.99	1.105	3
4	1.571	.668	.500	.1963	0.39	0.59	0.79	0.98	1.18	1.37	1.57	1.77	1.96	4
5	1.963	1.043	.625	.3068	0.61	0.92	1.23	1.53	1.84	2.15	2.45	2.76	3.07	5
6	2.356	1.502	.750	.4418	0.88	1.33	1.77	2.21	2.65	3.09	3.53	3.98	4.42	6
7	2.749	2.044	.875	.6013	1.20	1.80	2.41	3.01	3.61	4.21	4.81	5.41	6.01	7
8	3.142	2.670	1.000	.7854	1.57	2.36	3.14	3.93	4.71	5.50	6.28	7.07	7.85	8
9	3.544	3.400	1.128	1.0000	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00	9
10	3.990	4.303	1.270	1.2656	2.53	3.80	5.06	6.33	7.59	8.86	10.12	11.39	12.66	10
11	4.430	5.313	1.410	1.5625	3.12	4.69	6.25	7.81	9.37	10.94	12.50	14.06	15.63	11
14S	5.32	7.65	1.693	2.2500	4.50	6.75	9.00	11.25	13.50	15.75	18.00	20.25	22.50	14S
18S	7.09	13.60	2.257	4.0000	8.00	[illegible]00	16.00	20.00	24.00	28.00	32.00	36.00	[illegible]0	18S

WINGHAVEN CULVERT DIMENSIONS PROJ NO. 980100
LDG 14-Jul-98 CULVERTD

A LT	CULVERT DISTANCE LEFT
A RT	CULVERT DISTANCE RIGHT
B	CL CULVERT FROM INSIDE FACE OF HEADWALL TO DOWNSTREAM END OF SLAB
C	DISTANCE WIDTH OF CULVERT ALONG ROADWAY
D	DISTANCE FROM END OF UPSTREAM END OF SLAB TO OUTSIDE OF HEADWALL
D1	TOP SLAB THICKNESS
D2	BOT SLAB THICKNESS
E	PERPENDICULAR TO ROADWAY FROM OUTSIDE FACE OF HEADWALL TO BEND
F	SKEW ANGLE
G	CL CULVERT FROM END OF WING 3" TO DOWNSTREAM END OF SLAB
H	OPENING HEIGHT
I	DISTANCE FROM DOWNSTREAM OUTSIDE FACE OF HEADWALL TO START OF WING
J	HAUNCH
K LT	ROADWAY DISTANCE LEFT
K RT	ROADWAY DISTANCE RIGHT
L	CL CULVERT FROM UPSTREAM CL CULVERT TO OUTSIDE EDGE FO WINGWALL
M	CL CULVERT FROM END OF UPSTREAM END OF SLAB TO END OF WING 3"
N	WINGWALL FROM OUTSIDE FACE OF WING TO BEND ALONG CL CULVERT
P	WINGWALL DISTANCE ALONG UPSTREAM WINGWALL TO BEND
R	BOT SLAB FROM UPSTREAM END OF SLAB TO INSIDE FACE OF HEADWALL
S	OPENING SPAN
T	WALL EXTERIOR WIDTH
TI	WALL INTERIOR WIDTH
U	WIDTH DISTANCE FROM STRAIGHT TO INSIDE FACE OF WING
V	VERTICAL FROM TOP OF END OF WING TO TOP OF WING
W	WIDTH FROM INSIDE FACE OF WINGWALL TO OUTSIDE FACE OF WINGWALL
X	LENGTH DISTANCE ALONG DOWNSTREAM WINGWALL TO BEND
Y	LENGTH FROM END OF SLAB TO OUTSIDE FACE OF WINGWALL

DES FILL
DES FILL

SPECIFICATIONS

SEE PLAN SHEETS