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of Maricopa County

Design Calculations, Quantities

Bush Highway Box Culvert at Spook Hill Floodway

Contract No. 91-22

August 8, 1991

Registered Professional Engineer (Civil)
CERTIFICATE NO. 21872
MARK E. WAVERING
Date Signed 8-8-91
ARIZONA, U.S.A.

Prepared by

INCA ENGINEERS INC.

A300.802

INCA ENGINEERS INC.

BUSH HIGHWAY BOX CULVERT AT SPOOKHILL FLOODWAY

Contract 91-22

August 8, 1991

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II. CONSTRUCTION QUANTITIES

Registered Professional Engineer (Civil)
CERTIFICATE NO. 21872
MARK E. WAWERING
Date Signed 8-8-91
ARIZONA, U.S.A.

INCA ENGINEERS INC.

I. DESIGN CALCULATIONS

INCA ENGINEERS INC.

Sheet No 0 of

Job Number 691202

TITLE BUSH HIGHWAY BOX CULVERT

SUBJECT CALCULATION INDEX

MADE BY MME DATE 6/7/91 CHECKED BY [illegible] DATE 6/11/91

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Sheet No 1 of _____
Job Number 691202

TITLE BUSH HIGHWAY BOX CULVERT
SUBJECT COVER SHEET
MADE BY MME DATE 6/7/91 CHECKED BY RG DATE 6/11/91

DESCRIPTION:

EXPANSION OF EXISTING CAST-IN-PLACE 2-BARREL BOX CULVERT INTO 4-BARREL. USE OF PRECAST SEGMENTS AND CAST-IN-PLACE END SECTIONS. REMOVAL AND REPLACEMENT OF WINGWALLS. ADD NEW OUTLET APRON AND HEADWALLS. USE OF DIRECT MOUNT GUARDRAIL WHEN COVER DEPTH LESS THAN 2'-0".

DESIGN CRITERIA:

AASHTO "STANDARD SPECIFICATIONS FOR HIGHWAY BRIDGES," 14TH EDITION (INTERIMS THROUGH 1990)

TRAFFIC: HS20-44
SOIL: $\gamma = 120$ PCF (MAX DEPTH = 6'-0")
$\gamma K_a = 30$ PSF/FT RETAINING WALLS
$= 50$ PSF/FT CULVERT WALLS

ALLOWABLE TOE BEARING PRESSURE $= 1.33(2200)$
$= 2926$ PSF

MATERIALS:

CONCRETE - $f'_c = 3$ KSI @ 28 DAYS

REINFORCING - #6 BAR & SMALLER $f_y = 40$ KSI
#7 BAR & LARGER $f_y = 60$ KSI

RETAINING WALL ANALYSIS ver 3.0

DESCRIPTION: INLET WINGWALLS
PROJECT: BUSH HIGHWAY BOX CULVERT
FILE: 691202
BY: WRE
DATE: 6-2-91

CHECKED: blf
DATE: 6/11/91

1. SOIL DATA

soil density =	120	pcf
active pressure =	30	psf/ft
passive pressure =	250	psf/ft
coeff. friction =	0.30	@H<20'
coeff. friction =	0.45	@H>=20'

2. LOAD DATA

soil retained =	10.00	ft
equiv surcharge =	0.00	ft
ht above soil =	0.25	ft
wind pressure =	0.00	psf
unif lat load =	0.00	klf
dist above soil =	0.000	ft
conc lat force =	0.00	kip
dist above soil =	0.000	ft
unif vert load =	0.000	klf
conc vert load =	0.000	kip

3. WALL DATA

stem thk @ top =	9.00	in
stem thk @ bot =	9.00	in
grnd - batr dist =	0.000	ft
length of toe =	0.750	ft
length of heel =	3.667	ft
ftg length =	5.167	ft
ftg thickness =	1.250	ft
key depth =	2.750	ft
key length =	0.750	ft
toe - key dist =	0.000	ft

4. LOAD CALCULATIONS (UNITS - K,FT)

A) Vertical Loads (plf) - per linear ft

element	wt.	arm	moment
conc	0.000	1.125	0.000
unif	0.000	1.125	0.000
ftg	0.969	2.584	2.503
stem	1.153	1.125	1.297
add stem	0.000	1.500	0.000
key	0.309	0.375	0.116
soil	4.400	3.334	14.669
sub soil	0.000	1.500	0.000
total	6.832		18.585

B) Lateral Loads (plf) - per linear ft.

loading	force	arm	moment
soil	1.898	3.750	7.119
surcharge	0.000	5.625	0.000
wind	0.000	11.375	0.000
unif	0.000	11.250	0.000
conc	0.000	11.250	0.000
total	1.898		7.119

passive = 2.000 klf

5. STABILTY & SOIL PRESSURE SUMMARY

F.S. sliding =	2.13	(pass)
F.S. overturn =	2.61	(pass)
resultant loc =	1.68 ft	(fail)
	+2.6%	SA 1
Qmax =	2.714 ksf	- OK -
Qmin =	0.000 ksf	
gradient =	0.539 ksf/ft	

RETAINING WALL ANALYSIS ver 3.0

DESCRIPTION: INLET WINGWALLS
PROJECT: BUSH HIGHWAY BOX CULVERT
FILE: 691202
BY: WRE
DATE: 6-2-91

CHECKED: [illegible]
DATE: 6/11/91

6. MEMBER DESIGN FORCES (Service loads)

A) Toe Forces -

effective depth = 11.00 in

shear force = 0.00 klf (@ distance 'd')
shear stress = 0.0 psi
bending moment = 0.73 k-ft/ft (@ front face of stem)

B) Heel Forces - (@ back face of stem)

effective depth = 12.00 in

shear force = 4.40 klf
shear stress = 30.6 psi
bending moment = 8.07 k-ft/ft
-- neglecting upward soil pressure

shear force = 1.03 klf
shear stress = 7.2 psi
bending moment = 4.10 k-ft/ft
-- including upward soil pressure

C) Stem Forces -

design section location	dist from ftg (ft)	thk (in)	shear (klf)	fv (psi)	moment (k-ft/ft)
finish grade	10.00	9.00	0.00	0.0	0.00
0.90*ht	9.00	9.00	0.02	0.2	0.00
0.80*ht	8.00	9.00	0.06	0.8	0.04
0.70*ht	7.00	9.00	0.14	1.9	0.14
0.60*ht	6.00	9.00	0.24	3.3	0.32
0.50*ht	5.00	9.00	0.38	5.2	0.63
0.40*ht	4.00	9.00	0.54	7.5	1.08
0.30*ht	3.00	9.00	0.74	10.2	1.72
0.20*ht	2.00	9.00	0.96	13.3	2.56
0.10*ht	1.00	9.00	1.22	16.9	3.65
top of ftg	0.00	9.00	1.50	20.8	5.00

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Sheet No 4 of

Job Number 69/202

TITLE BUSH HWY. BOX CULVERT

SUBJECT INLET WINGWALLS

MADE BY MME DATE 6/2/91 CHECKED BY blf DATE 6/11/91

@ $f_c' = 3$ ksi ; $F_v = .95\sqrt{3000} = 52$ psi

∴ SHEAR STRESSES -OK-

$M_{HEEL} = 4.10$ K-FT/FT

$A_s = 0.44$ IN²/FT, $d = 11''$, $b = 12''$, $n = 9$, $k = .217$, $j = .928$

∴ @ $f_s = 20$ ksi, $f_c = .62$ ksi } $M_{ALLOW} = A_s f_s j d = 7.48$ K-FT/FT

∴ HEEL REINF. -OK-

M_{STEM} (@ BASE) $= 5.00$ K-FT/FT

$A_s = 0.62$ IN²/FT, $d = 6\frac{1}{2}''$, $b = 12''$, $n = 9$, $k = .313$, $j = .896$

∴ @ $f_s = 20$ ksi, $f_c = 1.01$ ksi } $M_{ALLOW} = A_s f_s j d = 6.01$ K-FT/FT

M_{STEM} (@ $h = 3'$) $= 1.72$ K-FT/FT

$A_s = 0.31$ IN²/FT, $d = 6\frac{1}{2}''$, $b = 12''$, $n = 9$, $k = .234$, $j = .922$

@ $f_s = 20$ ksi, $f_c = 0.68$ ksi } $M_{ALLOW} = A_s f_s j d = 3.10$ K-FT/FT

∴ STEM REINF. -OK-

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Sheet No 5 of

Job Number 691202

TITLE BUSH HWY. BOX CULVERT

SUBJECT INLET WINGWALLS

MADE BY ME DATE 6/2/91 CHECKED BY bly DATE 6/11/91

* CHECK KEY.

$$V = \tfrac{1}{2}\left[1.25(.25) + 4(.25)\right](2.75)$$
$$= 1.81 \text{ K/FT}$$

$$\therefore f_v = 1810/(12)(6.5)$$
$$= 23 \text{ PSI} < F_v$$

$\therefore$ SHEAR STRESS -OK-

$$M = \tfrac{1}{2}(1.25)(.25)(2.75)^2 + \tfrac{1}{3}(.25)(2.75)^3$$
$$= 2.92 \text{ K-FT/FT}$$

* BY COMPARISON TO BENDING CALCULATION FOR STEM @ 3' ABOVE BASE, $M_{ALLOW} = 3.10$ K-FT/FT

KEY REINF. -OK-

Min. Reinforcement Criteria (AASHTO 8.17.1) is satisfied with the above r/f.

RETAINING WALL ANALYSIS ver 3.0

DESCRIPTION:OUTLET WINGWALLS
PROJECT:BUSH HIGHWAY BOX CULVERT
FILE:691202
BY:WRE
DATE:6-2-91

CHECKED: bly
DATE: 6/11/91

1. SOIL DATA

soil density =	120 pcf
active pressure =	30 psf/ft
passive pressure =	250 psf/ft
coeff. friction =	0.30 @H<20'
coeff. friction =	0.45 @H>=20'

2. LOAD DATA

soil retained =	11.00 ft
equiv surcharge =	0.00 ft
ht above soil =	0.25 ft
wind pressure =	0.00 psf
unif lat load =	0.00 klf
dist above soil =	0.000 ft
conc lat force =	0.00 kip
dist above soil =	0.000 ft
unif vert load =	0.000 klf
conc vert load =	0.000 kip

3. WALL DATA

stem thk @ top =	9.00 in
stem thk @ bot =	9.00 in
grnd - batr dist =	0.000 ft
length of toe =	0.750 ft
length of heel =	4.500 ft
ftg length =	6.000 ft
ftg thickness =	1.250 ft
key depth =	4.750 ft
key length =	0.750 ft
toe - key dist =	0.000 ft

4. LOAD CALCULATIONS (UNITS - K,FT)

A) Vertical Loads (plf) - per linear ft

element	wt.	arm	moment
conc	0.000	1.125	0.000
unif	0.000	1.125	0.000
ftg	1.125	3.000	3.375
stem	1.266	1.125	1.424
add stem	0.000	1.500	0.000
key	0.534	0.375	0.200
soil	5.940	3.750	22.275
sub soil	0.000	1.500	0.000
total	8.865		27.274

B) Lateral Loads (plf) - per linear ft

loading	force	arm	moment
soil	2.251	4.083	9.191
surcharge	0.000	6.125	0.000
wind	0.000	12.375	0.000
unif	0.000	12.250	0.000
conc	0.000	12.250	0.000
total	2.251		9.191

passive = 4.500 klf

5. STABILTY & SOIL PRESSURE SUMMARY

F.S. sliding =	3.18	(pass)
F.S. overturn =	2.97	(pass)
resultant loc =	2.04 ft	(pass)
Qmax =	2.896 ksf	
Qmin =	0.059 ksf	
gradient =	0.473 ksf/ft	

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RETAINING WALL ANALYSIS ver 3.0

DESCRIPTION:OUTLET WINGWALLS
PROJECT:BUSH HIGHWAY BOX CULVERT
FILE:691202
BY:WRE
DATE:6-2-91

CHECKED: CLJ
DATE: 6/11/91

6. MEMBER DESIGN FORCES (Service loads)

A) Toe Forces -

effective depth = 11.00 in

shear force = 0.00 klf (@ distance 'd')
shear stress = 0.0 psi
bending moment = 0.78 k-ft/ft (@ front face of stem)

B) Heel Forces - (@ back face of stem)

effective depth = 12.00 in

shear force = 5.94 klf
shear stress = 41.3 psi
bending moment = 13.37 k-ft/ft
-- neglecting upward soil pressure

shear force = 0.89 klf
shear stress = 6.2 psi
bending moment = 5.59 k-ft/ft
-- including upward soil pressure

C) Stem Forces -

design section location	dist from ftg (ft)	thk (in)	shear (klf)	fv (psi)	moment (k-ft/ft)
finish grade	11.00	9.00	0.00	0.0	0.00
0.90*ht	9.90	9.00	0.02	0.3	0.01
0.80*ht	8.80	9.00	0.07	1.0	0.05
0.70*ht	7.70	9.00	0.16	2.3	0.18
0.60*ht	6.60	9.00	0.29	4.0	0.43
0.50*ht	5.50	9.00	0.45	6.3	0.83
0.40*ht	4.40	9.00	0.65	9.1	1.44
0.30*ht	3.30	9.00	0.89	12.4	2.28
0.20*ht	2.20	9.00	1.16	16.1	3.41
0.10*ht	1.10	9.00	1.47	20.4	4.85
top of ftg	0.00	9.00	1.81	25.2	6.65

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RETAINING WALL ANALYSIS ver 3.0

page 1

DESCRIPTION:OUTLET WINGWALLS (W/O CUTOFF WALL)
PROJECT:BUSH HIGHWAY BOX CULVERT
FILE:691202
BY:WRE
DATE:6-2-91

CHECKED: [illegible]
DATE: 8/2/91

1. SOIL DATA

soil density =	120 pcf
active pressure =	30 psf/ft
passive pressure =	250 psf/ft
coeff. friction =	0.30 @H<20'
coeff. friction =	0.45 @H>=20'

2. LOAD DATA

soil retained =	11.00 ft
equiv surcharge =	0.00 ft
ht above soil =	0.25 ft
wind pressure =	0.00 psf
unif lat load =	0.00 klf
dist above soil =	0.000 ft
conc lat force =	0.00 kip
dist above soil =	0.000 ft
unif vert load =	0.000 klf
conc vert load =	0.000 kip

3. WALL DATA

stem thk @ top =	9.00 in
stem thk @ bot =	9.00 in
grnd - batr dist =	0.000 ft
length of toe =	0.750 ft
length of heel =	4.500 ft
ftg length =	6.000 ft
ftg thickness =	1.250 ft
key depth =	0.000 ft
key length =	0.000 ft
toe - key dist =	0.000 ft

4. LOAD CALCULATIONS (UNITS - K,FT)

A) Vertical Loads (plf) -

element	wt.	arm	moment
conc	0.000	1.125	0.000
unif	0.000	1.125	0.000
ftg	1.125	3.000	3.375
stem	1.266	1.125	1.424
add stem	0.000	1.500	0.000
key	0.000	0.375	0.000
soil	5.940	3.750	22.275
sub soil	0.000	1.500	0.000
total	8.331		27.074

B) Lateral Loads (plf) -

loading	force	arm	moment
soil	2.251	4.083	9.191
surcharge	0.000	6.125	0.000
wind	0.000	12.375	0.000
unif	0.000	12.250	0.000
conc	0.000	12.250	0.000
total	2.251		9.191

passive = 0.195 klf

5. STABILTY & SOIL PRESSURE SUMMARY

F.S. sliding =	1.20	(fail)
F.S. overturn =	2.95	(pass)
resultant loc =	2.15 ft	(pass)

SAY -OK- SINCE APRON STRUCTURALLY ATTACHED

Qmax =	2.573 ksf
Qmin =	0.204 ksf
gradient =	0.395 ksf/ft

::

RETAINING WALL ANALYSIS ver 3.0

DESCRIPTION: OUTLET WINGWALLS (W/O CUTOFF WALL)
PROJECT: BUSH HIGHWAY BOX CULVERT
FILE: 691202
BY: WRE CHECKED: [illegible]
DATE: 6-2-91 DATE: 8/2/91

6. MEMBER DESIGN FORCES (Service loads)

A) Toe Forces -

effective depth = 11.00 in

shear force = 0.00 klf (@ distance 'd')
shear stress = 0.0 psi
bending moment = 0.70 k-ft/ft (@ front face of stem)

B) Heel Forces - (@ back face of stem)

effective depth = 12.00 in

shear force = 5.94 klf
shear stress = 41.3 psi
bending moment = 13.37 k-ft/ft
-- neglecting upward soil pressure

shear force = 1.03 klf
shear stress = 7.1 psi
bending moment = 5.36 k-ft/ft
-- including upward soil pressure

C) Stem Forces -

design section location	dist from ftg (ft)	thk (in)	shear (klf)	fv (psi)	moment (k-ft/ft)
finish grade	11.00	9.00	0.00	0.0	0.00
0.90*ht	9.90	9.00	0.02	0.3	0.01
0.80*ht	8.80	9.00	0.07	1.0	0.05
0.70*ht	7.70	9.00	0.16	2.3	0.18
0.60*ht	6.60	9.00	0.29	4.0	0.43
0.50*ht	5.50	9.00	0.45	6.3	0.83
0.40*ht	4.40	9.00	0.65	9.1	1.44
0.30*ht	3.30	9.00	0.89	12.4	2.28
0.20*ht	2.20	9.00	1.16	16.1	3.41
0.10*ht	1.10	9.00	1.47	20.4	4.85
top of ftg	0.00	9.00	1.81	25.2	6.65

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RETAINING WALL ANALYSIS ver 3.0

DESCRIPTION:OUTLET WINGWALLS (W/O CUTOFF WALL)
PROJECT:BUSH HIGHWAY BOX CULVERT
FILE:691202
BY:WRE
DATE:6-2-91

CHECKED: Bly
DATE: 8/2/91

1. SOIL DATA

soil density =	120	pcf
active pressure =	30	psf/ft
passive pressure =	250	psf/ft
coeff. friction =	0.30	@H<20'
coeff. friction =	0.45	@H>=20'

2. LOAD DATA

soil retained =	8.20	ft
equiv surcharge =	0.00	ft
ht above soil =	0.25	ft
wind pressure =	0.00	psf
unif lat load =	0.00	klf
dist above soil =	0.000	ft
conc lat force =	0.00	kip
dist above soil =	0.000	ft
unif vert load =	0.000	klf
conc vert load =	0.000	kip

3. WALL DATA

stem thk @ top =	9.00	in
stem thk @ bot =	9.00	in
grnd - batr dist =	0.000	ft
length of toe =	0.750	ft
length of heel =	3.667	ft
ftg length =	5.167	ft
ftg thickness =	1.250	ft
key depth =	0.000	ft
key length =	0.000	ft
toe - key dist =	0.000	ft

4. LOAD CALCULATIONS (UNITS - K,FT)

A) Vertical Loads (plf) -

element	wt.	arm	moment
conc	0.000	1.125	0.000
unif	0.000	1.125	0.000
ftg	0.969	2.584	2.503
stem	0.951	1.125	1.069
add stem	0.000	1.500	0.000
key	0.000	0.375	0.000
soil	3.608	3.334	12.028
sub soil	0.000	1.500	0.000
total	5.528		15.601

B) Lateral Loads (plf) -

loading	force	arm	moment
soil	1.340	3.150	4.220
surcharge	0.000	4.725	0.000
wind	0.000	9.575	0.000
unif	0.000	9.450	0.000
conc	0.000	9.450	0.000
total	1.340		4.220

passive = 0.195 klf

5. STABILTY & SOIL PRESSURE SUMMARY

F.S. sliding =	1.38	(fail)
F.S. overturn =	3.70	(pass)
resultant loc =	2.06 ft	(pass)
Qmax =	1.722 ksf	
Qmin =	0.418 ksf	
gradient =	0.252 ksf/ft	

::

RETAINING WALL ANALYSIS ver 3.0

DESCRIPTION:OUTLET WINGWALLS (W/O CUTOFF WALL)
PROJECT:BUSH HIGHWAY BOX CULVERT
FILE:691202
BY:WRE CHECKED: bly
DATE:6-2-91 DATE: 8/2/91

6. MEMBER DESIGN FORCES (Service loads)

A) Toe Forces -

effective depth = 11.00 in

shear force = 0.00 klf (@ distance 'd')
shear stress = 0.0 psi
bending moment = 0.47 k-ft/ft (@ front face of stem)

B) Heel Forces - (@ back face of stem)

effective depth = 12.00 in

shear force = 3.61 klf
shear stress = 25.1 psi
bending moment = 6.62 k-ft/ft
-- neglecting upward soil pressure

shear force = 0.38 klf
shear stress = 2.6 psi
bending moment = 1.91 k-ft/ft
-- including upward soil pressure

C) Stem Forces -

design section location	dist from ftg (ft)	thk (in)	shear (klf)	fv (psi)	moment (k-ft/ft)
finish grade	8.20	9.00	0.00	0.0	0.00
0.90*ht	7.38	9.00	0.01	0.1	0.00
0.80*ht	6.56	9.00	0.04	0.6	0.02
0.70*ht	5.74	9.00	0.09	1.3	0.07
0.60*ht	4.92	9.00	0.16	2.2	0.18
0.50*ht	4.10	9.00	0.25	3.5	0.34
0.40*ht	3.28	9.00	0.36	5.0	0.60
0.30*ht	2.46	9.00	0.49	6.9	0.95
0.20*ht	1.64	9.00	0.65	9.0	1.41
0.10*ht	0.82	9.00	0.82	11.3	2.01
top of ftg	-0.00	9.00	1.01	14.0	2.76

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Sheet No 12 of

Job Number 691202

TITLE BUSH HWY. BOX CULVERT

SUBJECT OUTLET WINGWALLS

MADE BY MME DATE 6/2/91 CHECKED BY bly DATE 6/11/91

* AS W/ INLET WINGWALLS, $F_v = 52$ PSI

∴ SHEAR STRESSES -OK-

$M_{HEEL} = 5.59$ K-FT/FT

* BY COMPARISON TO BENDING CALCULATION FOR INLET WINGWALL HEEL, $M_{ALLOW} = 7.48$ K-FT/FT

∴ HEEL REINF. -OK-

M_{STEM} (@ BASE) $= 6.65$ K-FT/FT

$A_s = 0.75$ IN²/FT, $d = 6\frac{1}{2}''$, $b = 12''$, $n = 9$, $k = .338$, $j = .887$

∴ @ $f_s = 20$ KSI, $f_c = 1.14$ KSI } $M_{ALLOW} = A_s f_s j d = 7.21$ K-FT/FT

M_{STEM} (@ $h = 3'$) $= 2.28$ K-FT/FT

* BY COMPARISON TO BENDING CALCULATION FOR INLET WINGWALL STEM @ $h = 3'$, $M_{ALLOW} = 3.10$ K-FT/FT

∴ STEM REINF. -OK-

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Sheet No 13 of
Job Number 691202

TITLE BUSH HWY. BOX CULVERT
SUBJECT OUTLET WINGWALLS
MADE BY MME DATE 6/2/91 CHECKED BY bly DATE 6/11/91

* CHECK KEY.

$$V = \tfrac{1}{2}[1.25(.25) + 6(.25)](4.75)$$
$$= 4.31 \text{ K/FT}$$

$$\therefore f_v = 4310/(12)(6.5)$$
$$= 55 \text{ PSI} \rightsquigarrow (\text{SAY -OK-})$$

$\therefore$ SHEAR STRESSES -OK-

$$M = \tfrac{1}{2}(1.25)(.25)(4.75)^2 + \tfrac{1}{3}(.25)(4.75)^3$$
$$= 12.46 \text{ K-FT/FT}$$

* THIS VALUE CAN BE REDUCED SINCE F.S. AGAINST SLIDING IS GREATER THAN 1.5. THIS APPROACH ALSO JUSTIFIES ALLOWING SLIGHT OVERSTRESS IN SHEAR.

$\therefore$ @ $F.S._{SLIDING} = 1.5$ & $\mu = 0.30$:

$$F_{PASSIVE} = 2.251(1.5) - 8.365(.3)$$
$$= 0.72 \text{ K}$$

$$\therefore q_{PASSIVE} = (.72/4.50)(.250)$$
$$= 0.04 \text{ PSF/FT}$$

$$\therefore M = (.04/.25)(12.46)$$
$$= 1.99 \text{ K-FT/FT}$$

* BY COMPARISON TO BENDING CALCULATION FOR INLET WINGWALL STEM @ $h = 3'$, $M_{ALLOW} = 3.10$ K-FT/FT

$\therefore$ KEY REINF. -OK-

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Sheet No 14 of _____
Job Number 691202

TITLE BUSH HWY. BOX CULVERT
SUBJECT C.I.P. CULVERT
MADE BY ME DATE 6/3/91 CHECKED BY bly DATE 6/11/91

ASSUMPTIONS:

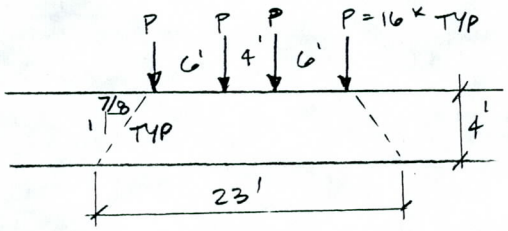
1. FILL THICKNESS ABOVE BOX ALWAYS EXCEEDS 2'-0". USE DESIGN THICKNESS = 4'-0"

2. SOIL WEIGHT = 120 PCF, LATERAL SOIL PRESSURE ON SIDEWALLS = 50 PSF/FT

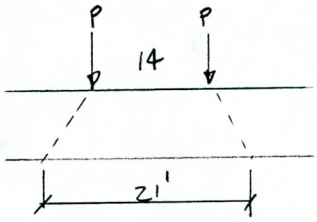
3. AASHTO SECTION 6.4 GOVERNS LIVE LOADS.

4. USE SERVICE LOAD DESIGN.

* DETERMINE TRAFFIC LOADS.



TRANS. SECTION
(2 LANES OF TRAFFIC)



LONG. SECTION
(14' AXLE SPACING)

$$\therefore \; p = \frac{8(16)}{23(21)} = 0.265 \text{ KSF}$$

IMPACT = 30%

$$\therefore \text{ USE } p_{LL+I} = 1.30(.265) = 0.345 \text{ KSF}$$

* DETERMINE SOIL LOADS. USE FULL SOIL WEIGHT.

$$\therefore \; W_{SOIL} = 4(.12) = 0.48 \text{ KSF}$$

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Sheet No 15 of

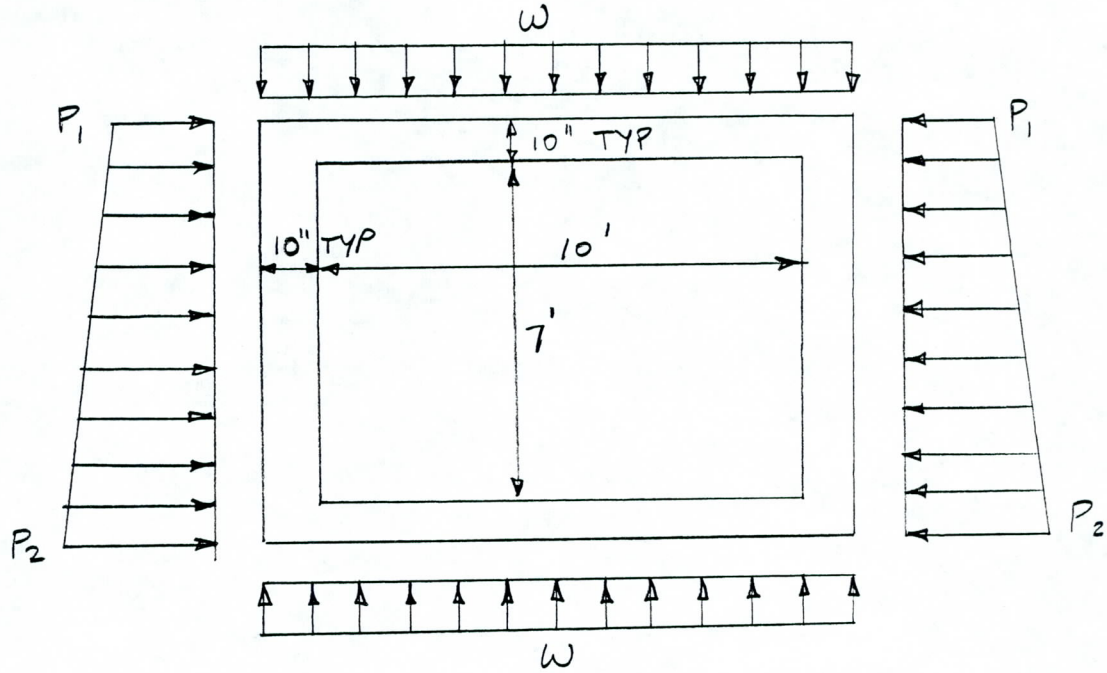
Job Number 691202

TITLE BUSH HWY. BOX CULVERT

SUBJECT C.I.P. CULVERT

MADE BY ME DATE 6/3/91 CHECKED BY [illegible] DATE 6/11/91

* CHECK AASHTO LOAD COMBINATION X. USE $\beta_E = 1.0$ FOR VERTICAL & LATERAL LOADS. ANALYZE BOX SECTION.

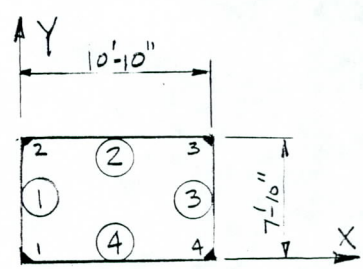


$$w = (10/12)(.15) + .48 + .345$$
$$= 0.95 \text{ KLF}$$

$$P_1 = 6(.050)$$
$$= 0.30 \text{ KLF}$$

$$P_2 = (6 + 8.67)(.050)$$
$$= 0.733 \text{ KLF}$$

INCLUDES EQUIV. 2' SURCHARGE



$$E = 60.62\sqrt{3000} = 3320 \text{ KSI}$$
$$A = 10(12) = 120 \text{ IN}^2$$
$$I = (10)^3 = 1000 \text{ IN}^4$$

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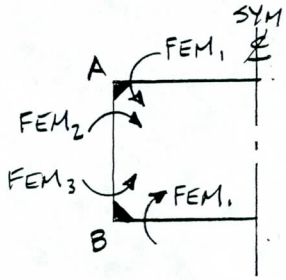
Sheet No 16 of _____
Job Number 691203

TITLE BUSH HWY. BOX CULVERT
SUBJECT C.I.P. CULVERT
MADE BY ME DATE 7/18/91 CHECKED BY ly DATE 7/29/91

* USE MOMENT DISTRIBUTION. ONLY MODEL 1/2 OF CULVERT DUE TO SYMMETRY OF GEOMETRY AND LOADING.

$FEM_1 = .95(10.83)^2/12 = 9.29$ K-FT (-/+)
$FEM_2 = (.3/12 + .433/30)(7.83)^2 = 2.42$ K-FT (+)
$FEM_3 = (.3/12 + .433/20)(7.83)^2 = 2.86$ K-FT (-)



$(I/L)_{SLAB} = (10)^3/10.83 = 92.31$
$(I/L)_{WALL} = (10)^3/7.83 = 127.7$
$\Rightarrow$ $K_s = .420$, $K_w = .580$

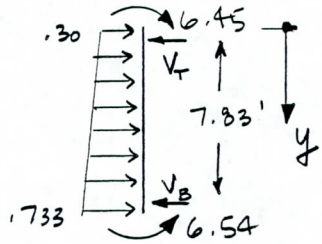
	A	AB		BA	B	
↓ -1/2	.42	.58	1/2 →	← 1/2	.58	.42	-1/2 ↓
	-9.29	2.42		-2.86	9.29	
	2.89	3.98		-3.73	-2.70	
	-1.45	-1.87		1.99	1.35	
	1.39	1.92		-1.94	-1.40	
	-0.70	-0.97		0.96	0.70	
	0.70	0.97		-0.96	-0.70	
	-6.46	6.45		-6.54	6.54	

$\therefore$ USE (-)M = 6.54 K-FT/FT

@ SLABS (+)M = $.95(10.83)^2/8 - 6.54$
= 7.40 K-FT/FT

TITLE BUSH HWY. BOX CULVERT
SUBJECT C.I.P. CULVERT
MADE BY MME DATE 7/18/91 CHECKED BY BB DATE 7/29/91

@ WALLS:



$$\therefore V_T = \left[.3(7.83)^2/2 + .433(7.83)^2/6 + \cdots + 6.45 - 6.54\right]/7.83$$
$$= 1.73 \text{ K/FT}$$

$$V_B = \tfrac{1}{2}(.3 + .733)(7.83) - 1.73$$
$$= 2.32 \text{ K/FT}$$

$$\therefore V_T = y\left[.30 + \frac{y}{2(7.83)}(.433)\right]$$

$$y^2 + 10.85y - 36.18V_T = 0$$

$$\therefore y = 4.17' \quad @ \ (+)M_{MAX}$$

$$\therefore (+)M_{MAX} = -6.45 + .3(4.17)^2/2 + .433(4.17)^3/(7.83)(3)$$
$$= -2.51 \text{ K-FT/FT}$$

$\therefore$ SECTION MOMENT ALWAYS NEGATIVE

* DESIGN REINFORCING.

$$@ \ (+)M_{SLAB} = 7.40 \text{ K-FT/FT}$$

$$A_s = 0.587 \text{ IN}^2/\text{FT}, \ d = 8\tfrac{1}{2}'', \ b = 12'', \ n = 9'', \ k = .274, \ j = .909$$

$$\therefore @ \left.\begin{array}{l} f_s = 20 \text{ ksi} \\ f_c = 0.84 \text{ ksi} \end{array}\right\} M_{ALLOW} = A_s f_s j d = 7.55 \text{ K-FT/FT}$$

$\therefore$ <u>USE #6 @ 9" O.C.</u>

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Sheet No 18 of

Job Number 691202

TITLE BUSH HWY. BOX CULVERT

SUBJECT C.I.P. CULVERT

MADE BY MME DATE 7/18/91 CHECKED BY CLG DATE 7/29/91

@ (-)M = 6.54 K-FT/FT

A_s = 0.754 IN^2/FT, d = 6 1/2", b = 12", n = 9", k = .339, j = .887

$\therefore$ @ f_s = 20 ksi, f_c = 1.14 ksi } $M_{ALLOW} = A_s f_s j d$ = 7.25 K-FT/FT

$\therefore$ USE #6 @ 7" O.C.

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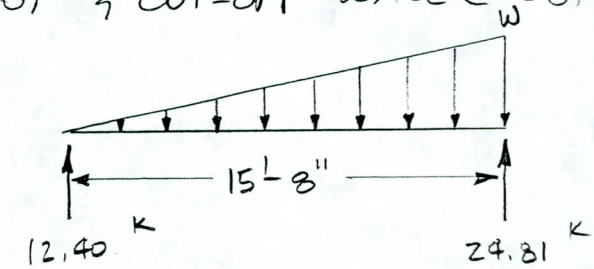
Sheet No 19 of _____
Job Number 691202

TITLE BUSH HWY. BOX CULVERT
SUBJECT C.I.P. CULVERT
MADE BY MKE DATE 6/3/91 CHECKED BY bly DATE 7/29/91

* DESIGN SKEWED BEAM INTEGRAL W/ TOP & BOTTOM SLABS. USE HEADWALL @ TOP & CUT-OFF WALL @ BOTTOM.

SPAN = $11.083\sqrt{2}$
= 15'-8"



$w = 10(0.95)/2$
= 4.75 KLF

$M_{MAX} = .1283(4.75)(15.67)^2/2$
= 74.8 K-FT

CONSERVATIVE

$A_s = 1.76\ in^2$, $d = 36''$, $b = 9''$, $n = 9$, $k = .268$, $j = .911$

@ $f_s = 20$ ksi, $f_c = .81$ ksi } $M_{Allow} = 96.2$ K-FT ∴ USE **4#6** @ TOP OF INLET & OUTLET SIDES @ BOTTOM OF INLET SIDE

$A_s = 3.16\ in^2$, $d = 20''$, $b = 12''$, $n = 9$, $k = .383$, $j = .872$

@ $f_s = 17.43$ ksi, $f_c = 1.2$ ksi } $M_{Allow} = 80.1$ K-FT ∴ USE **4#8** @ BOTTOM OF OUTLET SIDE

$V_c = .95\sqrt{3000}\,bd$ ($b = 9''$, $d = 36''$ & $b = 12''$, $d = 20''$)
= 16.86 K @ TOP OF BOTH SIDES, BOTTOM OF INLET SIDE
= 12.49 K @ BOTTOM OF OUTLET SIDE

∴ $V_s = 24.81 - 16.86 = 7.95$ K
$= 24.81 - 12.49 = 12.32$ K } RESPECTIVELY

∴ $A_v = 7.95(12)/(36)(20) = 0.13\ in^2$ @ 12" o.c.
(REQ'D) $= 12.32(12)/(20)(20) = 0.37\ in^2$ @ 12" o.c.

∴ USE #4 @ 9" o.c.
#4 @ 9" o.c. } RESPECTIVELY (1/2 SPACING CONTROLS)

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Sheet No 20 of

Job Number 691202

TITLE BUSH HWY. BOX CULVERT

SUBJECT HEADWALL

MADE BY MLE DATE 6/4/91 CHECKED BY [illegible] DATE 7/29/91

* DESIGN HEADWALL AS RETAINING WALL SUPPORTING 4'-0" OF FILL. ADD 2'-0" EQUIVALENT SURCHARGE FOR TRAFFIC.

$\therefore \quad M = .03(2)(4)^2/2 + .03(4)^3/6$
$= 0.80 \text{ K-FT/FT}$

— TRY #4 @ 12" O.C. — ($A_s = .20 \text{ in}^2/\text{FT}$, $d = 6\frac{1}{2}$", $b = 12$")
$k = 0.193$, $j = 0.936$

$\therefore M_{ALLOW} = 2.03 \text{ K-FT/FT}$ (@ $f_s = 20$ ksi, $f_c = 0.53$ ksi)

$\therefore$ DOUBLE LEGGED STIRRUPS ALREADY PROVIDED FOR SHEAR HAVE EXCESS AREA TO RESIST BENDING

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II. CONSTRUCTION QUANTITIES

Job No. 6917.02 Date: 5/30/91 By: JLL Checked By: (Date)

Client: Maricopa Co. Flood Project: Bush Hwy. Box Culvert
FCD Project No. 91-22

Subject: ROADWAY EXCAVATION

EARTHWORK COMPUTATIONS

Item No. 205

Station	Distance	EXCAVATION End Area Sq. Ft.	EXCAVATION Sum End Areas Sq. Ft.	EXCAVATION Sum End Areas Corrected For Distance	EXCAVATION Cubic Yards	EMBANKMENT End Area Sq. Ft.	EMBANKMENT Sum End Areas Sq. Ft.	EMBANKMENT Sum End Areas Corrected For Distance	EMBANKMENT Cubic Yards	Mass Diagram Ordinate
214+90		0								
	10		3.1		0.57					
215+00		3.1								
	50		6.2		5.74					
+50		3.1				0				
	100		3.1		5.74		31.0		57.41	
216+50		0				31.0				
	50		0		0		62.0		57.41	
217+00		0				31.0				
	50						37.2		34.44	
217+50		0				6.2				
	50		0		0		15.5		14.35	
218+00		0				9.3				
	25		66.8		30.93		27.9		12.92	
+25		66.8				18.6				
	25		97.8		45.28		23.3		10.79	
+50		31.0				4.7				
	25		61.8		28.61		44.9		20.79	
+75		30.8				40.2				
	25		43.2		20.00		40.2		18.61	
219+00		12.4				0				
	25		18.6		8.61		45.0		20.83	
+25		6.2				45.0				
	25		63.5		29.40		45.0		20.83	
+50		57.3				0				
	25		57.3		26.53		0		0	
+75		0				0				
		Sub TOTALS			201.4				268.4	
+ From Pg. 2					+ 28.0				+ 53.4	
		TOTALS			229.4				321.8	

Job No. 691702 Date: 7/22/91 By: JLL Checked By: ____ (Date)

Client: Maricopa Co. Flood Project: Bush Hwy Box Culvert
FCD Project No. 91-22

Subject: Roadway Excavation - Additional Cross-sections

Item No. 205

EARTHWORK COMPUTATIONS

Pg. 2 of 3

Station	Distance	EXCAVATION End Area Sq. Ft.	EXCAVATION Sum End Areas Sq. Ft.	EXCAVATION Sum End Areas Corrected For Distance	EXCAVATION Cubic Yards	EMBANKMENT End Area Sq. Ft.	EMBANKMENT Sum End Areas Sq. Ft.	EMBANKMENT Sum End Areas Corrected For Distance	EMBANKMENT Cubic Yards	Mass Diagram Ordinate
218+75		0				0				
	9						112		18.67	
+84		0				112				
	7		0				159		20.61	
+91		0				47				
	9		22		3.67		64		10.67	
219+00		22				17				
	11		60		12.22		17		3.46	
+11		38				0				
	14		46		11.93		0		0	
+25		8				0				
	1		8		0.15					
+26		0								
		Subtotal			27.97cy				53.41cy	

Job No. 691702 Date: 5/31/91 By: JLL Checked By: (Date)

Client: Maricopa C. Flood Project: Bush Hwy. Box Culvert
FCD Project No. 91-22

Subject: Drainage Excavation

EARTHWORK COMPUTATIONS

Item No. 215

Station	Distance	EXCAVATION End Area Sq. Ft.	EXCAVATION Sum End Areas Sq. Ft.	EXCAVATION Sum End Areas Corrected For Distance	EXCAVATION Cubic Yards	EMBANKMENT End Area Sq. Ft.	EMBANKMENT Sum End Areas Sq. Ft.	EMBANKMENT Sum End Areas Corrected For Distance	EMBANKMENT Cubic Yards	Mass Diagram Ordinate
Outlet										
218+65		0				0				
	10		119.0		44.07					
+75		119.0								
	25		192.0		177.78					
219+00		73.0								
	25		101.0		93.52					
+25		28.0								
	22		28.0		22.81					
+47		0				0				
			SubTotal		338.18					
Inlet										
7+70	30	0	76.0		42.22	0				
8+00	10	76.0	177.0		32.78					
8+10		101.0								
	60		197.0		218.89					
+70		96.0								
	30		192.0		106.67					
9+00		96.0								
	36		144.8		96.53					
+36		48.8								
	14		90.8		47.08					
+50		42.0								
	19		42.0		14.78					
+69		0								
	31		164.0		94.15					
10+00		164.0								
	26		240.0		115.56					
+26	Ext.	76.0								
	11		156.5		31.88					
+37	Ext.	80.5								
	13		80.5		19.88					
+50	Ext.	0	Subtotal		819.92	0				

TOTAL = 1158.1 cy.

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Sheet No 1 of _____
Job Number 691702

TITLE Bush Hwy. Box Culvert FCD Project No. 91-22
SUBJECT Quantity Calculations
MADE BY JLL DATE 6/3/91 CHECKED BY MLE DATE 6/10/91

Item No. 205 - Roadway Excavation (Including Exist. AC + ABC)
See Cross-sections : Excav. = 230. cy., Embankment = 322 cy.
Difference will be made up by - Earthwork for Open Channels

Item No. 215 - Excavation For Open Channels
See Cross Sections : Excavation = 1160 cy (rounded)

Item No. 220 - Type Grouted Riprap (Drainage)
By Planimetering of Grouted Riprap Areas (Sht. 4) = 5077 sf x 2' deep = 376.1 cy.
Edge : 272.5' x 10' x 2' = 5,450. cf
Ends: (2'+4') x 2' x 41' = 492 cf + 5450 = 220.1 cy
Total = 596.2 cy.

Item No. 220 - Type Grouted Riprap (Rdwy. Shoulder)
Inlet Side: (2.12' x 65' + 9' x 2') x 1' + Outlet Side: (3.83' x 65' + 5' x 4') x 1' = 15.7 cy

Item No. 310 - Aggregate Base Course
Under AC Pavement - Sta. 213+03.91 to 218+81.21
77.3' x (30' w x 10" deep + 2' x 3" deep) = 1971.2 cf

Bedding Under New Dbl. Box - 24.67' wide x 80' long x 12" deep = 1973.3 cf
Total = 3944.5 cf x 130 lbs/cf = 256.4 Tons

Item No. 321 - Asphalt Concrete Pavement (C 3/4)
Sta. 218+03.91 to 218+81.21 = 77.3' x 28' x 3" deep = 541.1 cf x 145 #/cf = 39.2 Tons

Item No. 329 - Emulsified Asphalt for Tack Coat (Type SS-1h)
Combine with Item No. 321

Item No. 415 - Guard Rail (MAG Std. 135-4, Detail No. 1) : Exist. Box, 3' wide - 50' ÷ 6.25' = 5.1 use 5 posts

Item No. 505 - Structural Concrete
Inlet - South Wing Wall : Footing - 1.25' deep x (2.75' + 5.17'/2) wide x 50.0' long = [illegible]
Cut-off Wall - 0.75' wide x (0' + 2.75')/2 deep x 50.0' long = 61.9 cy
Retain. Wall - 0.75' wide x (1.0' + 10.97')/2 high x 50.0' long
+ 0.75' x (10.97' + 12.50')/2 high x 10.0' long = 31[illegible].5
Wedge - (3.67' x 4.42')/2 x 1.25' deep = 10.1
South Wing Wall Subtotal = 631.5 cy

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Sheet No 2 of _____
Job Number 691702

TITLE Bush Hwy. Box Culvert FCD Project No. 91-22
SUBJECT Quantity Calculations
MADE BY JLC DATE 6/1/91 CHECKED BY MME DATE 6/10/91

Item No. 505 - Structural Concrete (cont'd.)

Inlet - North Wing Wall:

Footing - 1.25' deep x ((2.75'+5.17')/2 wide x 16.0' long = 77.2 cf
Cut-off Wall - 0.75' wide x (0'+2.75')/2 deep x 16.0' long = 16.5 cf
Retain. Wall - 0.75' wide x (1.0'+8.36')/2 high x 16.0' long = 56.2 cf
North Wing Wall Subtotal = 151.9 cf

Headwall: (0.75')(1.47+3.67')(½) x 56.07' long + 1.0' x 1.0' x 53.07' = 105.6 cf

Cutoff Wall: 0.75' wide x 4.0' high x 57.49' long = 112.5 cf

Box Culvert Extensions:

Top & Bottom - [(12.17' x 11.67')(½) + (11.67' x 1.08')] x 0.83' x 2 x 2 boxes = 277.3
Sides - [(1.08' x 0.83' + 13.25' x 0.83')] + 7.0' high x 2 boxes = 166.5 cf
Fillets - (0.83')²(½)(4)(13.25'+1.08') x 2 boxes = 59.5 cf
6" Space Between New Boxes - ((0.5')²/2 + (13.25' x 0.50')) x 8.83' high = 59.6 cf

10" Space Between New & Exist. Boxes
[(1.83'+0.23')(½) x 1.83' x 8.83' = 16.6

Box Culvert Extensions Subtotal = 559.5 cf

Inlet Total = 1611.3 cf = 59.7 cy

Outlet - South Wing Wall: Footing - 1.25' deep [2.75'(8.75') + ½(2.75'+6.0')(24.0') + ½(4.5)(4.42)] = 173.3 cf
Cut-off Wall - 1.0' wide x 4.75' high x (3.0 + 26.0') long = 114.0 cf
Retaining Wall - 0.75' wide x ((1.0'+5.0')/2 high x 3.0' long) + ((13.15-5.58 - 1.84.49)/2) + 5.0' high x 2.0' long) = 174.9 cf

South Wing Wall Subtotal = 462.7 cf

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Sheet No 3 of _____

Job Number 691702

TITLE Bush Hwy. Box Culvert FCD Project No. 91-22

SUBJECT Quantity Calculations

MADE BY JLL DATE 6/1/91 CHECKED BY MME DATE 6/10/91

Item No. 505 - Structural Concrete (Cont'd.)

Outlet - North Wing Wall: Footing - 1.25' deep x $\left(\frac{2.75' + 5.17'}{2}\right)$ wide x 22.0' long + 5.17' wide x 10.0' long) = 173.5 cf

Cut-off Wall - 1.0' wide x 4.75' high x 22.0' long = 104.5 cf

Retaining Wall - 0.75' wide x (½)(1.0' + 8.19') high x 32.1' long = 110.3 cf

Wedge - $\frac{3.67' \text{ wide} \times 4.42' \text{ long}}{2}$ x 1.25' deep = [illegible]

North Wing Wall Subtotal = 5[illegible]3.[illegible] cf

Headwall: ½(1.46' + 3.26') high x 36.08' long x 0.75' wide + 1' high x 1' wide x 36.08' long = 99.9 cf

Apron: (0.50' deep x 7.58' wide) x 61.07' long = 231.5 cf

Cut-off Wall: 1.0' deep x 5.5' high x 61.07' long = 335.9 cf

Apron + Headwall Subtotal = 667.[illegible] cf

Box Culvert Extensions:

Top & Bottom (See Pg. 2): [illegible]

Sides (See Pg. 2): 166.5

Fillets (See Pg. 2): [illegible]

6" Space Between New Boxes (See Pg. [illegible]): [illegible]

10" Space Between New & Exist. Boxes:

[(0.83' wide x 13.25' long + (0.83')²(½) + (0.42')(0.83') + (0.5' + 0.35')(½)] x 3.33' = [illegible] cf

Box Culvert Extensions Subtotal = 65[illegible].5

Outlet Total = 1718.0 cf = 63.7 cy

STRUCTURAL CONCRETE TOTAL = 123.4 cy

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Sheet No 4 of _____
Job Number 691702

TITLE Bush Hwy. Box Culvert FCD Project No. 91-22
SUBJECT Quantity Calculations
MADE BY WE DATE 7/17/91 CHECKED BY dLL DATE 7/24/91

Item No. 727 - Reinforcing Steel

INLET - South Wing Wall:

#4: 2 x (60+55+45+36+28+18+8) = 500. lf
6 x 60 = 360. lf
(60/1.5 +1) x (½)(2+12.5) = 297.25 lf

#5: (60+1) x (½)(3.08 + 13.58) = 508.13 lf
(60+1) x 4.08 = 248.88 lf
(60+1) x 1.50 = 91.50 lf
(60+1) x (½)(3.50) = 106.75 lf

#6: (60+1) x (½)(2.75+5.17) = 241.56 lf
2 x 60 = 120.00 lf

Subtotals: #4 = 1157.25 lf x 0.668 #/lf = 773.0 #
#5 = 955.26 lf x 1.043 #/lf = [illegible] #
#6 = 361.56 lf x 1.502 #/lf = 545.1 #
South Wing Wall Subtotal: [illegible] #

North Wing Wall:

#4: 2 x (16+15+12+9+6+3) = 122. lf
6 x 16 = 96. lf
(16/1.5 +1) x (½)(2+9.4) = 66.5 lf

#5: (16+1) x (½)(3.08 + 10.48) = 115.26 lf
(16+1) x 4.08 = 69.36 lf
(16+1) x 1.5 = 25.50 lf
(16+1) x (½)(3.5) = 29.75 lf

#6: (16+1) x (½)(2.75+5.17) = 67.32 lf
2 x 16 = 32. lf

Subtotals: #4 = 284.50 lf x 0.668 #/lf = 190.0 #
#5 = 239.37 lf x 1.043 #/lf = [illegible] #
#6 = 99.32 lf x 1.502 #/lf = [illegible] #
North Wing Wall Subtotal: [illegible] #

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Sheet No 5 of _____
Job Number 691702

TITLE Bush Hwy. Box Culvert FCD Project No. 91-22
SUBJECT Quantity Calculations
MADE BY WE DATE 7/17/91 CHECKED BY JLC DATE 7/22/91

Item No. 727 - Reinforcing Steel (cont'd.)

INLET - Headwall:

#4: 4 x 37.33' = 149.32 lf
(37.33/1+1) x [2(3) + 0.58 + 2(.5)] = 290.54 lf

#6: 6 x 37.33' = 223.98 lf

Subtotals: #4 = 439.86 lf x 0.668 #/lf = 294.3 #
#6 = 223.98 lf x 1.502 #/lf = 336.1 #
Headwall Subtotal: 630.4 #

Box Culvert Extensions:

#4: 2 x 37.33 + (37.33/.67 + 1)(5+3) = 528.33 lf
(6.5 x 13 + 4.5 + 3.5 + 2.5) x 2 = 190.00 lf
(11.67/1 + 1) x 2 x (½)(1.08 + 13.25) x 2 = 1563.12 lf
(7/1.5 + 1) x 2 x (½)(1.08 + 13.25) x 2 = 162.41 lf

#5: (1.08 + 13.25/1 + 1)(8) x 2 = 215.23 lf

#6: [(1.08 + 13.25)/.5 + 4)(9.83)(2) + ((1.08 + 13.25)/0.58 + 1)(11.35)(2)]
= 1039.01 lf

#7: 4 x 37.33 = 149.32 lf

Subtotals: #4 = 1243.92 lf x 0.668 #/lf = 831.0 #
#5 = 215.23 lf x 1.044 #/lf = 225.9 #
#6 = 1039.01 lf x 1.502 #/lf = 1560.6 #
#7 = 149.32 lf x 2.044 #/lf = 305.2 #
Box Culvert Extensions Subtotal: 2922.3 #

INLET Totals: #4 = 2087.8 lbs
#5 = 1502.5 lbs
#6 = 2537.2 lbs
#7 = 305.2 lbs
6434.7 lbs

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Sheet No 6 of _____
Job Number 691702

TITLE Bush Hwy. Box Culvert FCD Project No. 91-22
SUBJECT Quantity Calculations
MADE BY WE DATE 7/17/91 CHECKED BY LLL DATE 7-25-91

Item No. 727 - Reinforcing Steel (Cont'd)
OUTLET - South Wing Wall

#4: (27+30+33+34+21+15+9+3) x 2 = 344.00 lf
11 x 34 = 374.00 lf
(34/1.5+1) x (½)(2+13.1) = 178.68 lf
(34/1+1) x 7 x 2 = 490.00 lf

#5: (34/1+1) x ½ (3.08+14.2) = 302.40 lf

#6: (34/1+1) x 4.08 = 142.80 lf
4 x 34 = 136.00 lf
(34/1+1) x ½(2.75x5.17) = 138.60 lf

Subtotals: #4 = 1386.68 lf x 0.668 #/lf = 926.3 #
#5 = 302.40 lf x 1.043 #/lf = 315.4 #
#6 = 417.40 lf x 1.502 #/lf = 627.0 #
South Wing Wall Subtotal: 1868.7 #

North Wing Wall
#4: (32+30+24+18+11+4) x 2 = 233.0 lf
11 x 32 = 352.0 lf
(32/1.5+1) x ½ (2+10.2) = 136.53 lf
(32/1+1) x 7 x 2 = 462.00 lf

#5: (32/1+1) x (½) (3.08+11.28) = 236.94 lf

#6: (32/1+1) x 4.08 = 134.64 lf
4 x 32 = 128.00 lf
(32/1+1) x ½ (2.75+5.17) = 130.68 lf

Subtotals: #4 = 1188.23 lf x 0.668 #/lf = 795.3 #
#5 = 236.94 lf x 1.043 #/lf = 247.2 #
#6 = 393.32 lf x 1.502 #/lf = 590.8 #
North Wing Wall Subtotal: 1631.8 #

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Sheet No 7 of _____
Job Number 691702

TITLE Bush Hwy. Box Culvert FCD Project No. 91-22
SUBJECT Quantity Calculations
MADE BY WE DATE 9/17/91 CHECKED BY JLL DATE 7/25/91

Item No. 727 - Reinforcing Steel (cont'd)

OUTLET - Headwall

#4: 36.3 x 2 = 72.60 lf
(36.3/1+1) x [2(3) + 0.58 + 2(0.5)] = 282.73 lf

#6: 36.3 x 6 = 217.80 lf

Subtotals: #4 = 355.33 lf x 0.668 #/lf = 237.4 #
Headwall #6 = 217.80 lf x 1.502 #/lf = 327.2 #
Subtotal: 564.6 #

Apron

#4: (68/1+1) x 8 = 552.00 lf
(8/1+1) x 68 = 612.00 lf
(6/1.5+1) x 68 x 2 = 680.00 lf
(68/1+1) x 9 = 621.00 lf
(68/2+1) x 9 = 315.00 lf

Apron Subtotal: #4 = 2780.00 lf x 0.668 #/lf = 1857.0 #

Box Culvert Extension (Same as sht. 5): 2952.5 #

OUTLET Totals: #4 = 4645.5 lbs
#5 = 818.5 lbs
#6 = 3114.8 lbs
#7 = 305.3 lbs
8884.1 lbs

Item No. 727 - Reinforcing Steel:
15369.0 lbs
- Dowels & Wall Corner Ears (2%) = 307.4 lbs

Reinforcing Steel TOTAL 15,677. lbs.

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Sheet No 8 of

Job Number 691702

TITLE Bush Hwy. Box Culvert FCD Project No. 91-22

SUBJECT Quantity Calculations

MADE BY JLL DATE 6/3/91 CHECKED BY MG DATE 6/10/91

Item No. 776 - Grout

From Sht. 5 of the plans: 0.5' wide x 8.83' high x 54.5' long + (0.83' wide x 7.83' high + 0.5' x 1.0' x 66.67') = 26.0 cy.

Item No. 801 - Structural Concrete Removal

From Sht. 5 of the plans:

Exist. Wing Walls (Use ADOT Stds.): Inlet - 14.5 cy

Outlet - 20.1 cy.

Total 34.6 cy.

Item No. 802 - Guard Rail - Straight Section (MCHD - Detail "A")

From Sht. 3: W. Side - Sta. 217+47.2 to Sta. 219+22.8 = 175.6 LF

E. Side - Sta 215+98.2 to Sta. 218+98.8 = 300.6 LF

Total 476.2 LF

Item No. 803 - Guard Rail - Flare Section (MCHD - Detail "A")

From Sht. 3: There are 4 Terminal Sections

Item No. 804 - Precast 10'x7' Concrete Box Culvert

From Sht. 6: 2 new boxes @ 66'-8" each = 133.3 LF