2004P066

Indian Bend Road Improvements

Scottsdale Road to Hayden Road
Project No. 410-S-0402

Structures Report

Prepared for:
City of Scottsdale
Capital Project Management
7447 East Indian School Road
Suite 205
Scottsdale, AZ 85251

Registered Professional Engineer (Civil)
CERTIFICATE NO.
32342
RUSSELL A.
STUART
Date Signed 6/29/07
ARIZONA U.S.A.

Prepared by:
URS Corporation
7720 North 16th Street, Suite 100
Phoenix, AZ 85020
(602) 371-1100

June 2007

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LIST OF APPENDICES

1.0 INTRODUCTION

The City of Scottsdale "Indian Bend Road Improvement Project" begins at Scottsdale Road, extends east across Indian Bend Wash, and ends at Hayden Road. The project has an overall length of 1.07 miles and will upgrade Indian Bend Road to a minor arterial with a typical right-of-way width of 110 feet. The roadway will consist of two lanes in each direction with a 16-foot raised median. Pedestrian facilities will include an 8 to 10-foot wide multi-use path on the north side of the roadway and an 8-foot sidewalk on the south side. The project will include widening and realignment of the existing roadway. The location of the project is shown on the Vicinity Map, Figure 1.

This Structures Report describes the primary structural elements within Indian Bend Wash: drop structure, arched culverts and retaining walls.

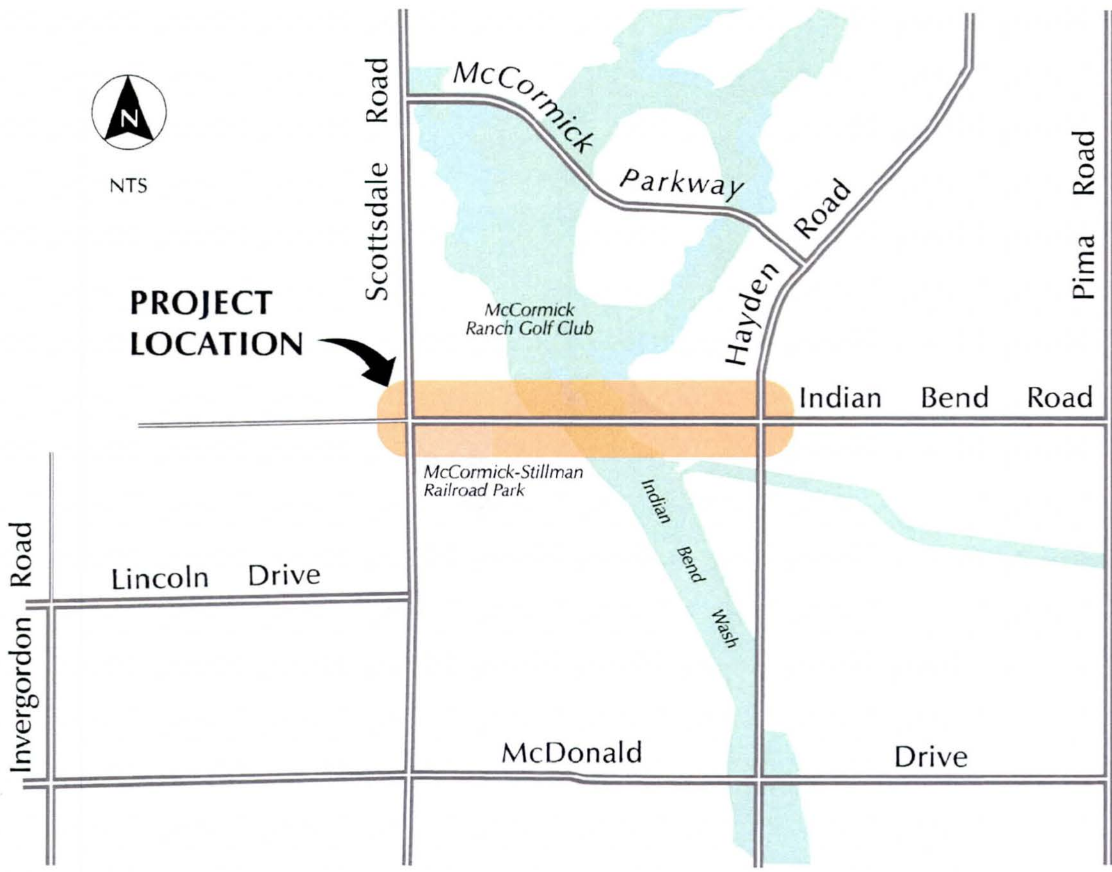

Figure 1 - Vicinity Map

2.0 DROP STRUCTURE

Drop structure is a collective term that includes a spillway, access ramps and channel linings. It is an expansive 8" thick reinforced concrete pavement that functions as a broad-crested weir and an erosion protection slab for floodwater flowing in Indian Bend Wash. Design of the pavement is based on ADOT Urban Highways "Channel Lining Design Guidelines," February 1989.

The spillway at the upstream (northern) end of the drop structure consists of a 6-feet deep toe-down, a 12-feet wide bench and a 3:1 slope down to the channel lining. The top of the spillway is set at Elevation 1282.00 in accordance with hydraulic design criteria and the slope has a maximum drop of approximately 11-feet.

Access ramps on the east and west sides of the drop structure accommodate a multi-use path. The ramps, which are ADA compliant, provide access to the wash for recreational users and maintenance vehicles.

Channel linings are provided on the upstream and downstream sides of the roadway. On the upstream side, the lining is sloped to direct floodwater toward the two arched culverts. On the downstream side, the lining extends 50-feet beyond the roadway and ends with a 6-feet deep toe-down.

Due to the drop structure's large area, construction joints and contraction joints are needed to help control cracking. Joint details are based on the recommendations provided in Department of the Army Technical Manual No. 5-809-12 "Concrete Floor Slabs on Grade Subjected to Heavy Loads," August 1987.

All surfaces of the drop structure will have an exposed aggregate finish, except that a medium broom finish will be used at the multi-use path. Additional details for the drop structure are provided in Appendix A.

3.0 ARCHED CULVERTS

Two reinforced concrete arched culverts, each with five spans, are provided to pass floodwater under Indian Bend Road. All spans are 36-feet wide and have a maximum vertical opening of 9.5-feet at midspan of the arch. The walls of the western culvert are skewed in a southeasterly direction and the walls of the eastern culvert are skewed in a southwesterly direction so that floodwater will be directed toward the center of the wash. Concrete headwalls at the ends of the culverts retain the soil beneath the roadway. An architectural treatment applied to the headwalls will indicate the depth of water flowing through the culverts. The westernmost span of the western culvert will have a multi-use path passing through it. Additional details for the arched culverts are provided in Appendix B.

4.0 RETAINING WALLS

Six reinforced concrete retaining walls (Walls D, F, G, H, I and J) are required to support the new roadway embankment in the wash and one additional wall (Wall E) is required along a maintenance path that leads into the wash. A Layout Plan showing the locations of the walls is provided in Appendix C. All of these walls will conform to the ADOT standard detail B-18.10. Based on recommendations provided in the "Geotechnical Investigation Report" by AMEC Earth & Environmental, August 15, 2007, walls within the wash will have the bottoms of footings 5-feet minimum below grade. An architectural treatment applied to the six walls along the roadway will indicate the depth of water flowing in front of the walls.

APPENDIX A
DROP STRUCTURE

PLOT DATE:6/29/2007 8:24:27 AM

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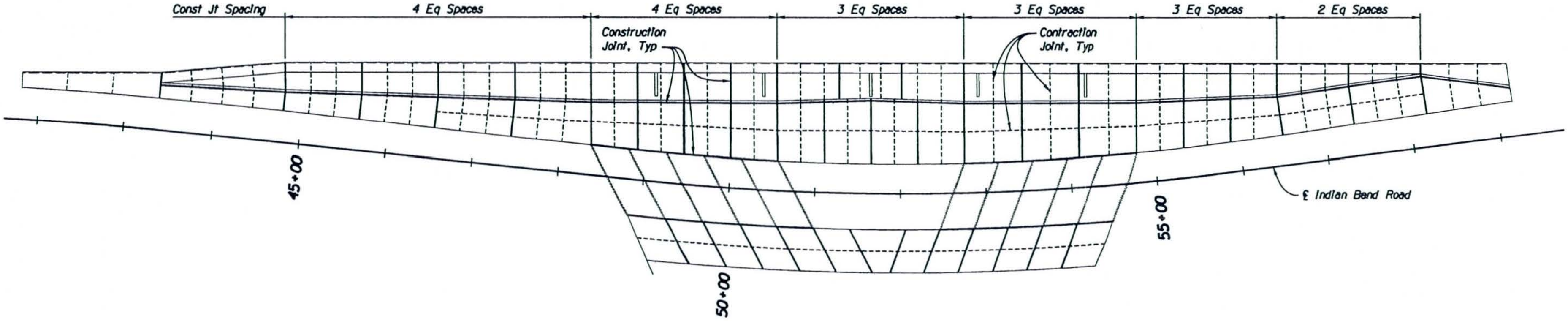


DROP STRUCTURE PLAN
Scale: 1"=60'

DROP STRUCTURE NOTES

1. Materials:
   Concrete.................MAg Class 'A' f'c=3000 PSI
   Reinforcement...........ASTM A615, Grade 60

2. Concrete Lining Shall be 8" Thick with #5 Reinforcing Bars Spaced at 12" Centers Each way. Reinforcing Shall Have 3" Clear Cover From The Top Lining.

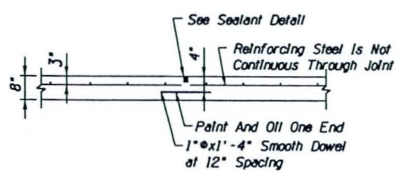
3. Construction Joints Shall be Located as Shown on The Plan. Contraction Joints Shall be Evenly Spaced Between Construction Joints.

4. Provide ½" Bituminous Joint Filler Where Drop Structure Abuts Retaining Walls.

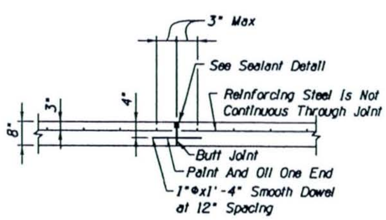
5. Drop Structure Shall Have an Exposed Aggregate Finish, Except That a Medium Broom Finish Shall be Provided at the Multi-Use Paths. See Special Provisions.

6. See Sheets DS11 and DS13 For Typical Drop Structure Sections.

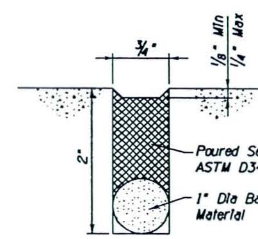
7. The Cost To Provide Construction Joints, Contraction Joints, and Poured Sealant Is Included With The Cost Of Drop Structure.



TYPICAL CONTRACTION JOINT



TYPICAL CONSTRUCTION JOINT



SEALANT DETAIL

Two working days before you dig, CALL FOR THE BLUE STAKES 1-800-782-5348 Blue Stake Center

DROP STRUCTURE LAYOUT

DATE	REVISION	BY

ENGINEER: REGISTERED PROFESSIONAL ENGINEER, CERTIFICATE NO. 22851, RANDALL D. BECK, ARIZONA, U.S.A.

CITY OF SCOTTSDALE ARIZONA

MUNICIPAL SERVICES DEPARTMENT

CAPITAL PROJECT MANAGEMENT

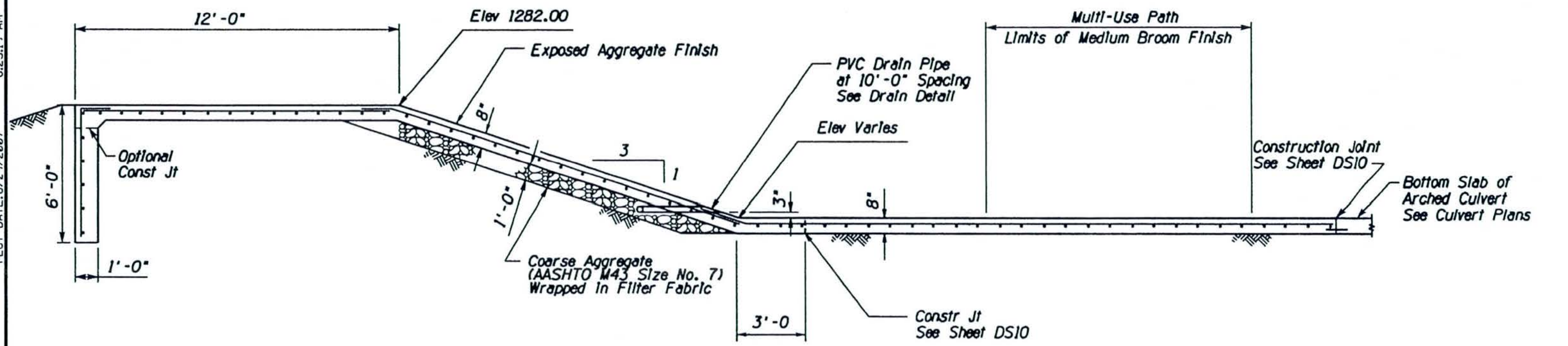
7447 E. INDIAN SCHOOL RD. SCOTTSDALE, ARIZONA 85251

PROJECT TITLE
Indian Bend Road Improvements
Scottsdale Rd To Hayden Rd

SCALE	DESIGNED	DATE	BID NO.	SHT.
HORIZ. 1"=60'	RAS	06/07		DS10
VERT.	DRAWN AG	AS-BUILT	PROJECT NO. 410-S-0402	OF

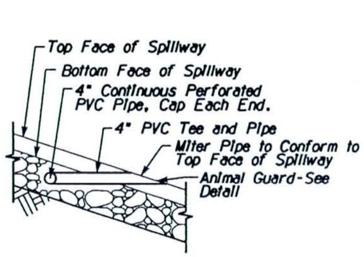
DESIGN FILE:P:\City_of_Scottsdale\23444553\CADD\Plans\h4553ds10.dgn

PLOT DATE:6/29/2007 8:23:19 AM



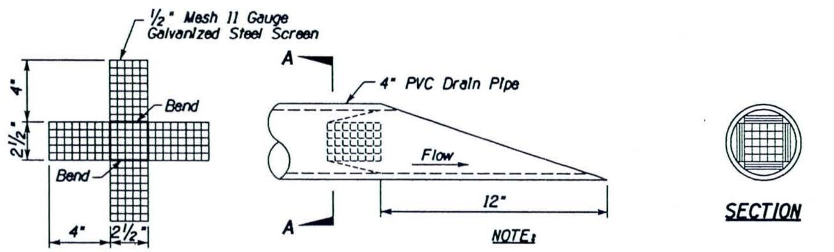
TYPICAL DROP STRUCTURE SECTION UPSTREAM OF ROADWAY

Scale 3/8" = 1'-0"



DRAIN DETAIL

N.T.S.

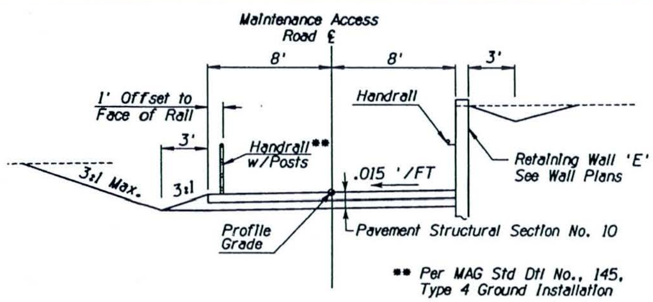


NOTE:

An Animal Guard Shall Be Installed In Each 4" PVC Drain Pipe. A Commercial Animal Guard May be Substituted for Approval.

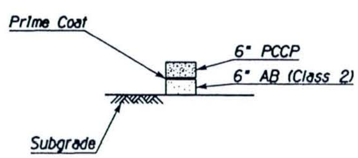
ANIMAL GUARD DETAIL

N.T.S.



** Per MAG Std Dtl No., 145, Type 4 Ground Installation

TYPICAL MAINTENANCE ROAD SECTION



Total Thickness = 12"

SECTION NO. 10

DESIGN FILE:P:\City_of_Scottsdale\23444553\CADD\Plans\h4553ds11.dgn

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CONSTRUCTION NOTES

Description	Unit	Quan

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TYPICAL SECTIONS

DATE	REVISION	BY

ENGINEER

MUNICIPAL SERVICES DEPARTMENT

CAPITAL PROJECT MANAGEMENT

7447 E. INDIAN SCHOOL RD. SCOTTSDALE, ARIZONA 85251

PROJECT TITLE

Indian Bend Road Improvements
Scottsdale Rd To Hayden Rd

SCALE	DESIGNED	DATE	BID NO.	SHT.
HORIZ. :	RAS	06/07		DS11
VERT.	DRAWN AG	AS-BUILT	PROJECT NO. 410-S-0402	OF

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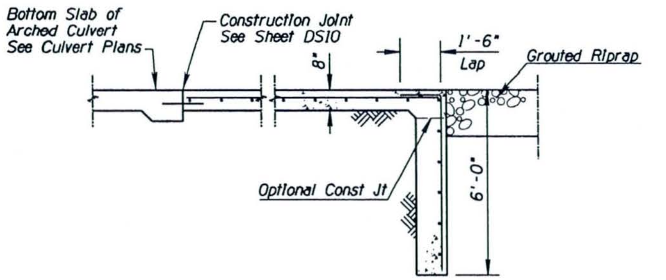
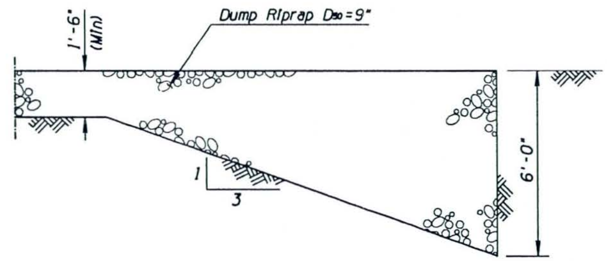


TYPICAL DROP STRUCTURE SECTION DOWNSTREAM OF ROADWAY
Scale: 1/2"=1'-0"



GROUTED RIPRAP TOE DOWN DETAIL
Scale: 1/2"=1'-0"

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Phoenix, AZ. 85020
(602) 371-1100

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CALL FOR THE BLUE STAKES
1-800-782-5348
Blue Stake Center

DATE	REVISION	BY

ENGINEER
22051 RANDALL D. BECK

MUNICIPAL SERVICES DEPARTMENT
CAPITAL PROJECT MANAGEMENT
7447 E. INDIAN SCHOOL RD. SCOTTSDALE, ARIZONA 85251

PROJECT TITLE
Indian Bend Road Improvements
Scottsdale Rd To Hayden Rd

SCALE	DESIGNED	DATE	BID NO.	SHT.
HORIZ. 1/2"=1'		06/07		DS13
VERT.	DRAWN	AS-BUILT	PROJECT NO. 410-S-0402	OF

APPENDIX B
ARCHED CULVERTS

STRUCTURAL CALCULATIONS

PROJECT NO.	6138
PROJECT NAME:	Indian Bend Road
PROJECT LOCATION:	City of Scottsdale, Arizona
DESCRIPTION:	**Con-Arch 5 barrel 36'-0" span by 9'-6" length varies from 82 LF to 90 LF @ Station 49+68 and 53+62 Indian Bend Road**
	fill:= 1.0 Foot (min fill controls)
	length := 82 feet
DRAWINGS:	Sacra Engineering (6138)
GEOTECH REPORT:	Geotech report by AMEC job no. 5-117-001077 dated August 15, 2006
APPROVING AGENCY:	City of Scottsdale, Arizona
CALCULATIONS BY:	Allen Sacra

Allen Sacra

Registered Professional Engineer (Civil)
CERTIFICATE NO.
36676
ALLEN T.
SACRA
Date Signed 6/27/07
ARIZONA, U.S.A.

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SCOPE OF WORK

- Design of a 5 barrel 36' X 9'-6" Con-Arch reinforced concrete culvert based on AASHTO LRFD Design Specifications, 3rd Edition, 2004 w/ 2005 interim by means of a finite element analysis of a 2-D model using MSC.Nastran.
- Design of headwalls attached to the culvert.

AASHTO SPECIFICATIONS

AASHTO(2004) LRFD Bridge Design Specifications, 3rd Edition

Chapter	Topic	Sections
2	General Design and Location Features	2.5.2.6
3	Loads and Loads Factors	3.1 - 3.6, 3.10
4	Structural Analysis and Evaluation	4.1 - 4.6
5	Concrete Structures	5.1 -5.8, 5.10 - 5.14
9	Decks and Deck Systems	9.7
10	Foundations	10.1 - 10.6
11	Abutment, Piers and Walls	11.1 - 11.6
12	Buried Structures and Tunnel Liners	12.1 - 12.6, 12.11

AASHTO LOAD FACTORS :

STRENGTH 1 - Basic load combination relating to the normal vehicular use of the bridge without wind.

SERVICE 1 - Related to deflection control and to control crack width in reinforced concrete structures.

LOAD FACTORS	**STRENGTH 1**		**SERVICE 1**	
	MAX	MIN		
PERMANENT				
DC-dead load & components	1.25	0.90	1.00	AASHTO 3.5.1
DW-wearing surface	1.50	0.65	1.00	AASHTO 3.5.1
EV- vertical earth pressure	1.30	0.90	1.00	AASHTO 3.5.1
		0.50*		AASHTO 3.11.7
EL-locked-in erection stresses	1.00		1.00	AASHTO 3.5.1
* Reduction allowed due to earth pressure.				
LIVE				
LL-live load	1.75		1.00	AASHTO 3.6.1.2
PL-pedestrian live load	1.75		1.00	AASHTO 3.6.1.6
(Small since the added 0.075 ksf only applied to sidewalk width-Ignored)				
IM-dynamic	1.75		1.00	AASHTO 3.6.2
CE-centrifugal force	1.75		1.00	AASHTO 3.6.3
(no radius of curvature to traffic lane-ignored)				
BR-braking	1.75		1.00	AASHTO 3.6.4
(taken out by soil-Ignored)				
CONSTRUCTION				
Construction Loads	1.50 max			AASHTO 3.4.2
(small-Ignored)				
WATER				
WA-water	1.00		1.00	AASHTO 3.7
(buoyancy,stream pressure & scour easily resisted in longitudinal direction-Ignored)				
WIND				
WS-wind on structure	-		0.3	AASHTO 3.8.1.2
WL-wind on LL	-		1.00	AASHTO 3.8.1.3
(load is in strong longitudinal direction-Ignored)				
EARTH PRESSURE				
EH-horizontal earth pressure at rest	1.35	0.90	1.00	AASHTO 3.11.5.2
EH-horizontal earth pressure active	1.50	0.90	1.00	AASHTO 3.11.5.3
(accounted for in the finite element analysis)				
ES-earth surcharge	1.50	0.75	1.00	AASHTO 3.11.6
(no mounding of earth on structure-Ignored)				
LS-live load surcharge	1.75		1.00	AASHTO 3.11.6
(applies to wingwalls only-Ignored)				
DD-downdrag	1.80	0.45	1.00	AASHTO 3.11.8
(considered in finite element analysis by using "no-slip" condition between soil and structure)				

SUPERIMPOSED DEFORMATIONS

TU-uniform temp	0.5/1.2	1.00/1.20	AASHTO 3.12.2
(Structure buried-Ignored)			
TG-temp gradient	0.00	0.5/1.0	AASHTO 3.12.3 & 3.4.1
(Structure buried-Ignored)			
SH-shrinkage differential	0.5/1.2	1.0/1.2	AASHTO 3.12.4
(same material-Ignored)			
CR-creep	0.5/1.2	1.0/1.2	AASHTO 3.12.5
(small due to low stresses-Ignored)			
SE-settlement	**	**	AASHTO 10.7.2.3
**To be considered on a specific project basis			AASHTO 3.12.6

FRICTION

FR-friction	1.00	1.00	AASHTO 3.13
(does not control-Ignored)			

FATIGUE

"Buried structures have been shown not to be controlled by fatigue" AASHTO C.12.5.3

EXTREME EVENT-I

EQ not considered in buried structure AASHTO 3.10

"Seismic forces are normally not considered in soil-structure interaction systems. Underground structures must move with the surrounding soil during earthquakes and usually will be supported by the interacting earth against crushing or collapse even if the structure joints are strained." (Ref: Caltrans (1994), Bridge Design Practice Manual, p.6-2)

IC-ice	AASHTO 3.9
(warm clilmate-Ignored)	
CT-vehicular collision	AASHTO 3.6.5
(protection provided-Ignored)	
CV-vessel collision	AASHTO 3.14
(not waterway-Ignored)	

LOAD CASES:

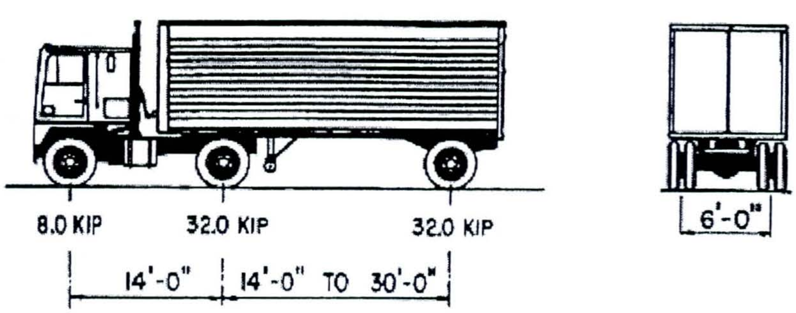
- Since the structures are cast-in-place, a load case for the stresses resulting from handling, transportation, or installation is not considered.
- An uneven backfilling of the structure is not allowed, the differential fill height for opposites sides of the arch is less than two feet.
- The lateral loads of the soil on the structure are computed and applied by the finite element analysis. Therefore such loads are not applied externally to the structure.
- Load cases involving the 0.9 D.L do not control.

	L O A D F A C T O R S				
	S T R E N G T H - 1		S E R V I C E - 1		
LOAD CASE	**1**	**2**	**3(bearing)**	**4(Tot defl.)**	**5**
TRUCK LOAD	**2-25k**	**2-32k**	**2-25k**	**2-32k**	**Buckling**
Applied @	**crown**	**crown**	**edge**	**crown**	**crown**
LANE LOAD	**0.64k/f**	**0.64k/f**	**0.64k/f**	**none**	**none**
DC	1.25	1.25	1	1	1
EV	1.3	1.3	1	1	1
LL	1.75	1.75	1	1	1
IM	1.75	1.75	1	1.75	1

2-25k = 2-25 kip axles separated by 4 feet (Tandem Loading) (AASHTO 3.6.1.2.1-4)
2-32k = 2-32 kip axle + 1-8 kip axle separated all by 14 feet (Truck Loading)
Lane Load = 0.64 k/ft
DC= concrete dead load
EV= soil dead load
LL= live load
IMF=Dynamic Load Factor $IMF := 33[1 - 0.125(De)]$ $IMF = 28.875$

Loading for optional live load deflection evaluation:Deflection should be taken as the larger of : (AASHTO 3.6.1.3.2)

- That resulting from the design truck alone, or
- That resulting from 25% of the design truck taken together with the design lane load.



LANE WIDTH (E) :

For Fills < 2 feet The multiple presence factors have been included in these equations. (AASHTO C3.6.1.1.2)

$\text{fill} = 1$ foot

- The equivlent width "E" of longitudinal strip per lane for both shear and moment with <u>one lane loaded</u> may be determined as: (Includes a presence factor = 1.2)

$s1 := 36$ feet s1=culvert span length (AASHTO 12.11.2)

(AASHTO 4.6.2.10.2-1)

$$E1 := \frac{(96 + 1.44 \cdot s1)}{12 \cdot 1.2} \qquad E1 = 10.3 \text{ feet}$$

For Fills . ≥ . 2 Feet The provisions of Articles 3.6.1.1.2 (Multiple Presence Factors) shall apply. (AASHTO 3.6.1.2.6)

Where the depth of fill exceeds 2 FT, wheel loads may be considered to be uniformly distributed over a rectangular area with sides equal to the dimension of the tire contact area, as specified in article 3.6.1.2.5, and increased by either 1.15 times the depth of the fill in select granular backfill, or the depth of the fill in all other cases. Where such areas from several wheel overlap, the total load shall be uniformly distributed over the area. (Axle length = 6 FT)
For single-span culverts, the effect of live load may be neglected where the depth of fill is more than 8.0 FT and exceeds the span length; for multiple span culverts the effects may be neglected where the depth of fill exceeds the distance between faces of end walls.
Where the live load and impact moment in concrete slabs, based in the distribution of the wheel load through earth fills, exceeds the live load and impact moment calculated according to Articles 4.6.2.10.2-1 (Fills less than 2 feet) the latter moment shall be used.

2 feet . ≤ . For Fills . ≤ . 3.0 Feet (AASHTO 3.6.1.2.6)

$$E_2 := \frac{(1.667 + 1.15 \cdot \text{fill}) \cdot 2}{1.2} \qquad E_2 = 4.7 \text{ feet}$$

(For a Fill = 3.76' E=10')

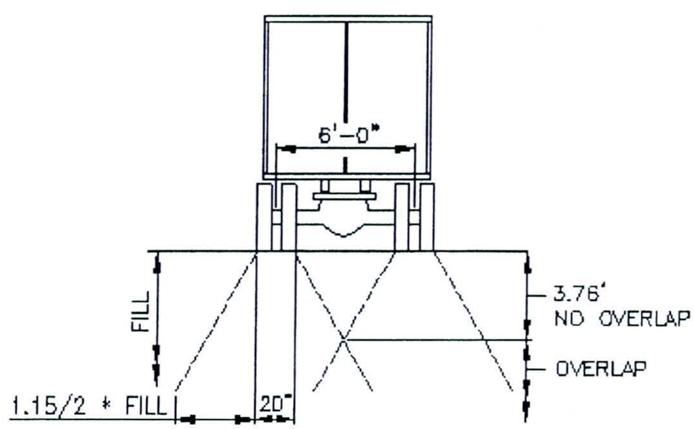
E = The greater of E1 or E2 = 10.9

For Fills > 3.76 Feet (AASHTO 3.6.1.2.6)

$$E_3 := \frac{(6 + 1.667 + 1.15 \cdot \text{fill})}{1.2} \qquad E_3 = 7.3 \text{ feet}$$

E = The greater of E3 or E1 = 10.3'

therefore E=10.3'



FACTORED LINE LOADS & LANE LOADS :

Factored line load = (Axle load * Dynamic Factor * LL Factor) / Lane Width

USED IN LOAD CASE	**#1**	**#2**	**#2**	**#3 Soil Bearing**	**#3 Soil Bearing**	**#4 Deflection**	**#4 Deflection**	**#5 Buckling**
Axle load (Kips)	25	32	8	25	32	25	32	25
Dynamic Factor	1.29	1.29	1.29	1.00	1.00	1.29	1.29	1.29
Live Load Factor	1.75	1.75	1.75	1.00	1.00	1.00	1.00	1.00
Lane Width (Feet)	10.30	10.30	10.30	10.30	10.30	10.30	10.30	10.30
Factored line load (K/ft)	**5.5**	**7.0**	**1.8**	**2.4**	**3.1**	**3.1**	**4.0**	**3.1**

Factored Lane Load = (0.64 k/f) (1.75) / 10 feet = 0.112 kip/feet

Unfactored Lane Load = (0.64 k/f) / 10 feet = 0.064 kip/feet

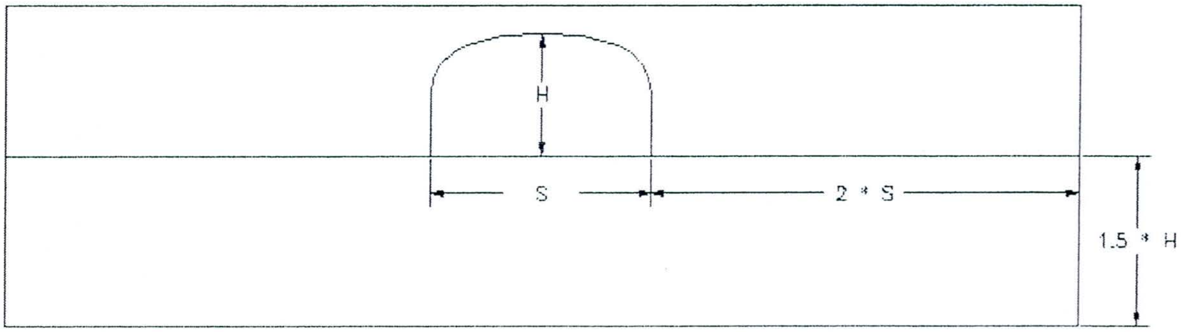
DESIGN ASSUMPTIONS

- 2-D plane-strain finite element soil-structure interaction model of transverse section, perpendicular to the longitudinal axis of arch structure.
- Single step load of body forces and concentrated traffic loads
- 1-step increment of backfill soil around the arch, 1 foot max differential.
- Linear representation of soil strength
- Conservatively ignores the distribution of non-uniform loads parallel to to the longitudinal axis of the arch
- No-slip condition at the interface soil and the concrete arch - arch outer surface is rough Esser (1974) has shown that for shallow-buried rigid conduits the largest angle of friction developed at the interface is 10 degrees. Since < friction angle available, no slip occurs.
- Burns and Richard solution (1964) showed that:
  - -moments for no-slip condition are 10% < full-slip condition
  - -max normal forces for no-slip condition are 20% > full-slip condition.

- As the applied surface traffic LL travels through the structure to the floor/slab footing it is, in actuality, distributed and thus attenuated in the longitudinal direction.
- The Lane Width (E) used for distribution of concentrated wheel loads, shall also be used for the determination of moments, shears, and axial loads in the side walls and the bottom slab." (AASHTO 12.11.2.3)
- Distribution of the LL, in the transverse direction perpendicular to the arch longitudinal direction is determined directly by the finite element analysis and not by load attenuation distribution.

MODEL GEOMETRY

- Model geometry per Sacra Engineering drawings, the arch and footings were modeled by taking the centerline of their cross sections.
- Boundries below and to the sides of the structures were taken as shown in the next figure.



MESH SIZE

- The soil and concrete structures were modeled using a mesh size of 1 foot. This size is small enough to capture the structure behavior.
- No stress concentrations were found in the analysis where a finer mesh would have been necessary.

MATERIAL PROPERTIES

Concrete: (AASHTO 5.4.2.4-5)

F'c=3000 psi $\quad$ $Ec = 33000 * Wc^{1.5}\sqrt{(Fc)} * 144$

$Ec = 478161 \frac{k}{ft^2}$ $\quad \mu = 0.2$ $\quad Weight = 0.150 \frac{k}{ft^2}$ (AASHTO 3.5.1-1)

Backfill:

$E = 800 \frac{k}{ft^2}$ $\quad \mu = 0.3$ $\quad Weight = 0.120 \frac{k}{ft^2}$ (AASHTO 3.5.1-1)

Soil in-situ:

$E = 800 \frac{k}{ft^2}$ $\quad \mu = 0.3$ $\quad Weight = 0.000 \frac{k}{ft^2}$ (below floor slab)

- In analysis soil in-situ unit weight = 0 below the arch footing so calculated deflections do not include any contribution caused by the self weight of soil below the foundation level.
- Fully saturated conditions are assumed not to exist in the specified free-draining backfill material. The culvert is partially covered by an impervious roadway surface.
- Backfill soils must be type: A-1, A-2, A-3 (GW,GP,SW,SP,GM,SM,SC,GC) AASHTO M145 AASHTO 12.4.1.3

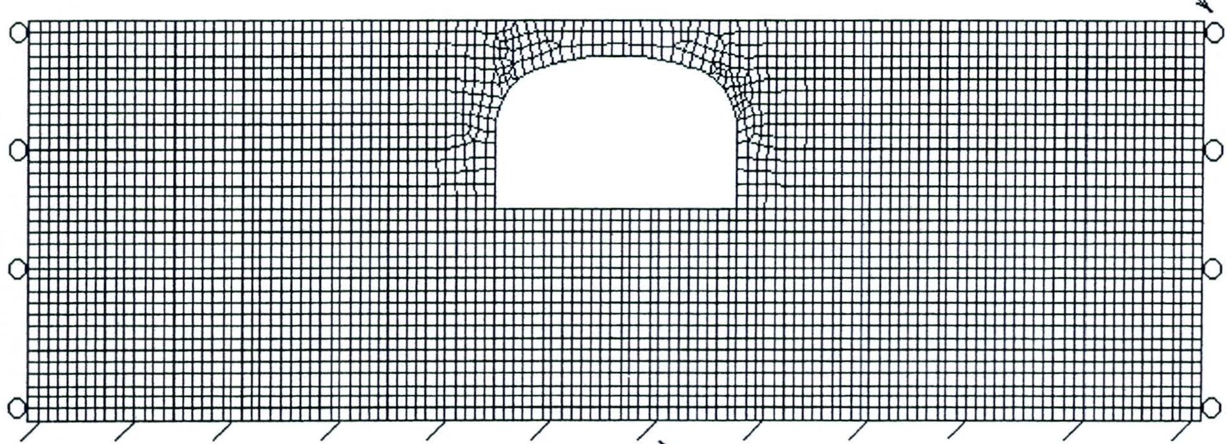
ELEMENT TYPES

Arch-Crown	Beam element
Arch-Haunch	Beam element
Floor-Footing	Beam element
Backfill	Plane Strain element
Soil in-situ	Plane Strain element

- Bending stiffness depends on the cross-section configuration and reinforcement properties, flexible sections have lower moment capacities and transfer loads to other members.
- Cracking of concrete or shotcrete below the neutral axis causes a reduction in the Moment of Inertia. Per previous analysis it has been found that calculations of the Effective Moment of Inertia using equation 5.7.3.6.2-1 give results in the range between 20% to 30% of the Gross Moment of Inertia. This analysis has assumed a fully cracked section and therefore Ie to be 25% of Gross Moment of Inertia. (AASHTO 5.7.3.6.2)

BOUNDRY CONDITIONS :

- Bottom of model - fixed
- Sides of model-roller
- Top and entire model-restrain out the page (z-direction)



Sketch not to scale
for conceptual purposes only.

RESULTS FROM LOAD CASES: (See Appendix I for Load Case Diagrams)

Load Case		Fill Cvr	Crown	Haunch	Footing outside	Footing inside	Wall	Floor
1	Moment (k-ft)	1'-0"	18.2	-15.3	7.5	22.4	20.2	0.8
	Axial (kip)		-23.2	-32.0	3.0	9.0	-31.7	10.2
	Shear (kip)		4.0	4.6	5.5	11.5	6.1	0.6
2	Moment (k-ft)	1'-0"	15.1	-14.9	8.4	24.4	10.2	0.8
	Axial (kip)		-21.2	-30.5	3.5	7.2	-36.0	7.4
	Shear (kip)		3.2	4.8	5.0	11.5	4.8	0.6

Moments: + bottom fiber tension
- top fiber tension

Load Case		Fill Cover	bearing	Live Load Deflection	Buckling Critical Load
3	Soil Bearing ksf	1'-0"	3.2ksf< 3.45 ksf ok		
4	Live Load Deflection*	1'-0"		0.0427'=L/843 < L/800* ok	
5	Buckling Kips	1'-0"			24.7 k>>4.0K OK

*Deflection Criteria for vehicular load = span / 800 (AASHTO 2.5.2.6.2)

SINGLE SHEAR CHECK:

(AASHTO 5.8.3.3-1)
(AASHTO 5.5.4.2.1)

Vn=Vc+Vs Vs=0 Vn=Vc

Vc=0.0316 β $\sqrt{F'c}$ bv dv where: β=2 and Φ=0.85 dv= the greater of (0.9 d or 0.72 H) (AASHTO 5.8.2.9)

	H in.	dv in.	bv in.	ΦVn kip	Vu kip	ΦVn/Vu
Crown	10.0	7.2	12.0	8.0	4.0	2.0
Haunch	10.0	7.2	12.0	8.0	4.8	1.7
Wall	12.0	8.6	12.0	9.6	6.1	1.6
Footing outside	15.0	10.8	12.0	12.1	5.5	2.2
Footing inside	15.0	10.8	12.0	12.1	11.5	1.0
Floor	8.0	5.8	12.0	6.4	0.6	10.7

PUNCHING SHEAR CHECK (with 12" of fill over arch)

V_u= (16 kip for design truck)(1.75 Live Load Factor)(1.29 Dynamic Factor) = 36.1 kips

Tire contact width = $w := 20$ in (AASHTO 3.6.1.2.5)

Tire contact length $L_2 := 10$ in

For Arch: $dv := 7.2$

$b_o := 2\cdot(w + dv) + 2\cdot(L_2 + dv)$

$b_o = 88.8$

Vn=Vc+Vs Vs=0 Vn=Vc Vc=0.0316 β $\sqrt{F'c}$ b_o dv where: β=2 and Φ=0.85

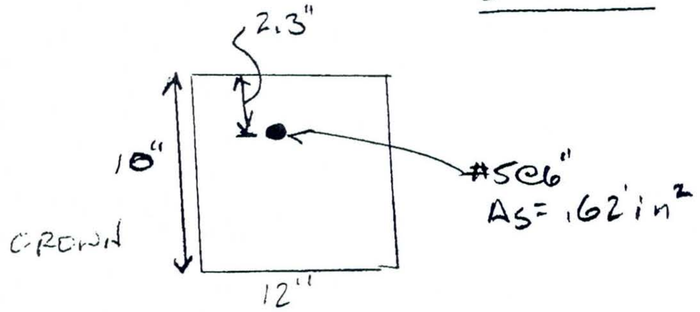
$V_c := 0.0316\cdot2\cdot\sqrt{4}\cdot b_o\cdot dv$ $V_c = 80.815$

$\Phi V_n := 0.85\cdot V_c$

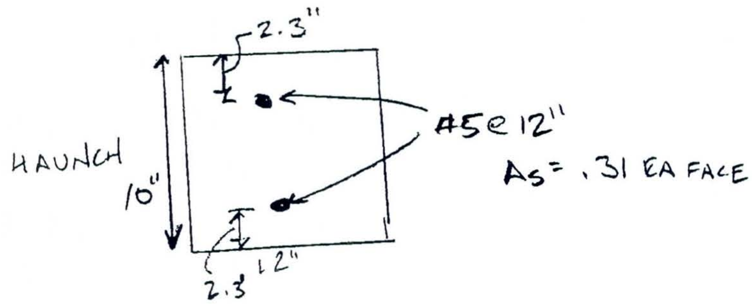
$\Phi V_n = 68.693$ > V_u = 34.4 kip (design Truck) **o.k.**

SECTIONS (NTS)

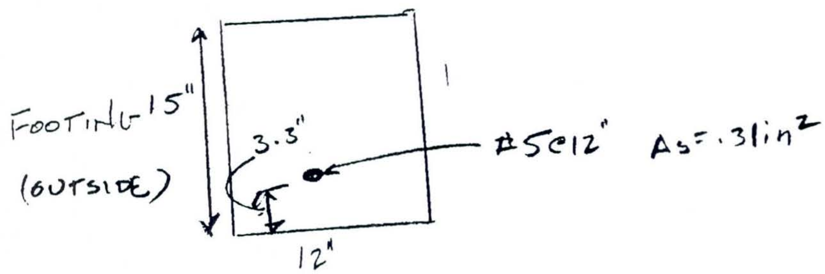
$d_v \geq \begin{cases} .9d \\ .72H \end{cases}$



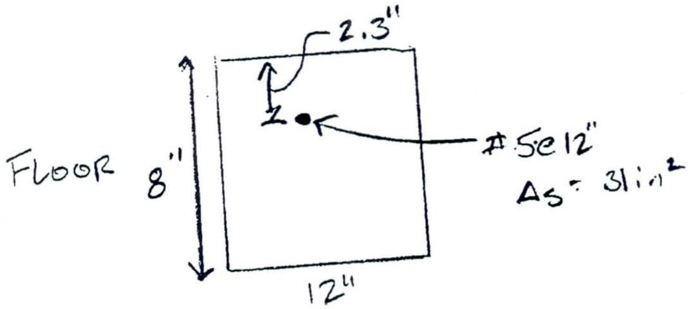
dv = 7.2"



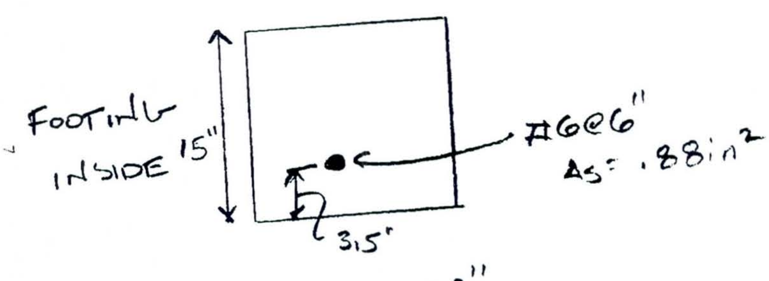
dv = 7.2"



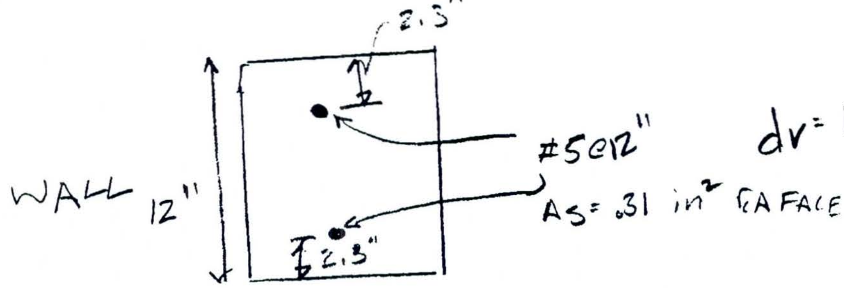
dv = 8.6"



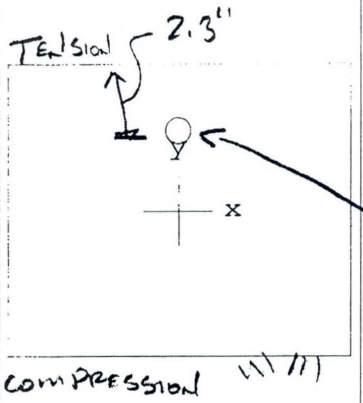
dv = 4.3"

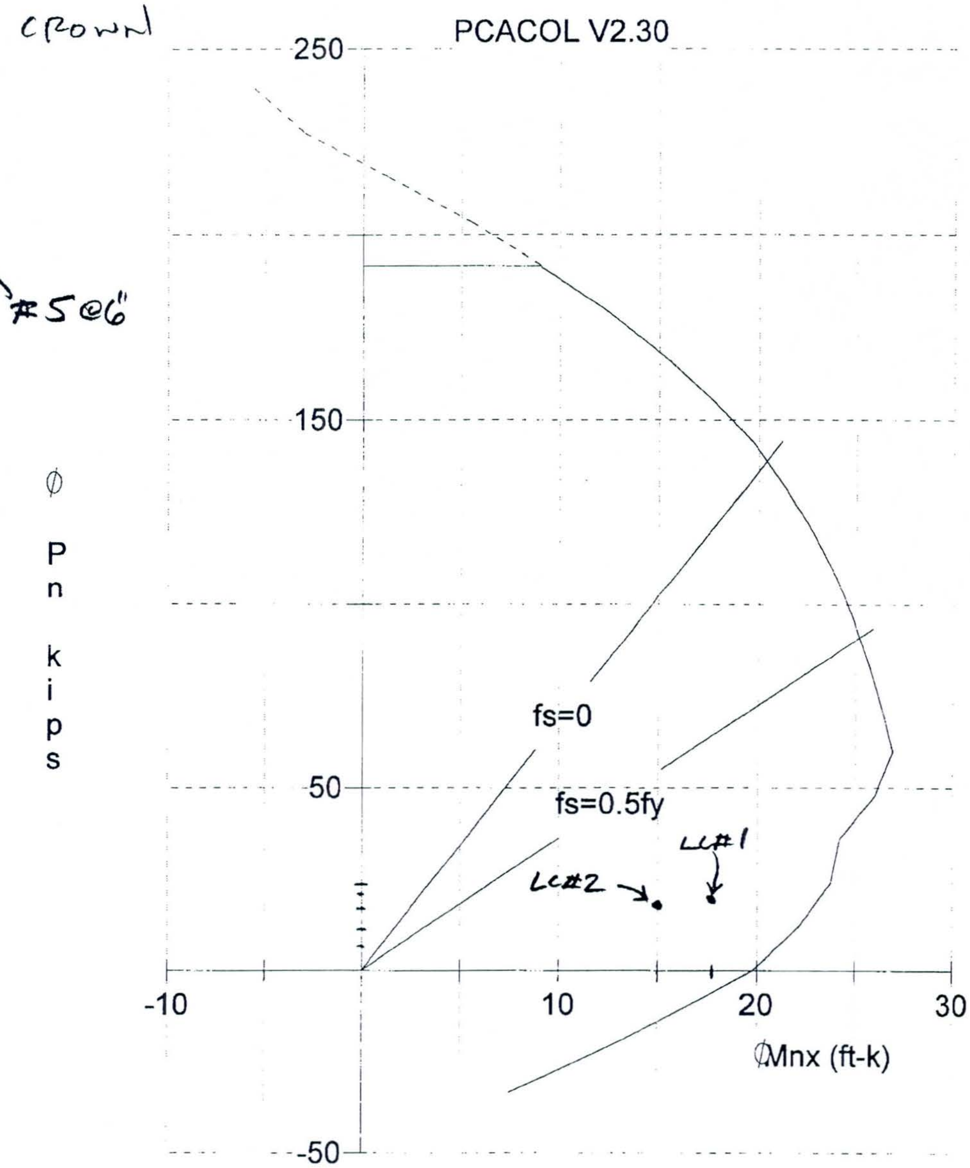


dv = 10.1"



dv = 17.3"





12.0 x 10.0 inch

f'c = 3.0 ksi

fy = 60.0 ksi

Confinement: Tied

clr cover = 1.86 in

spacing = 5.70 in

1 bars at 0.52%

As = ~~1 in^2~~ .62 in^2

Ix = 1000 in^4

Iy = 1440 in^4

Xo = 0.00 in

Yo = 0.00 in

File name: C:\SACRAE~1\PCACOL\4126\36CROWN.COL

Project:

Column Id:

Engineer:

Date: 10/20/01 Time: 22:20:26

Code: ACI 318-89

Units: in-lb

X-axis slenderness is not considered.

Material Properties:

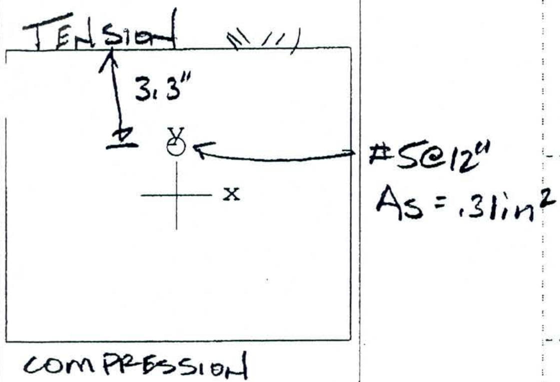
Ec = 3321 ksi eu = 0.003 in/in

fc = 2.55 ksi Es = 29000 ksi

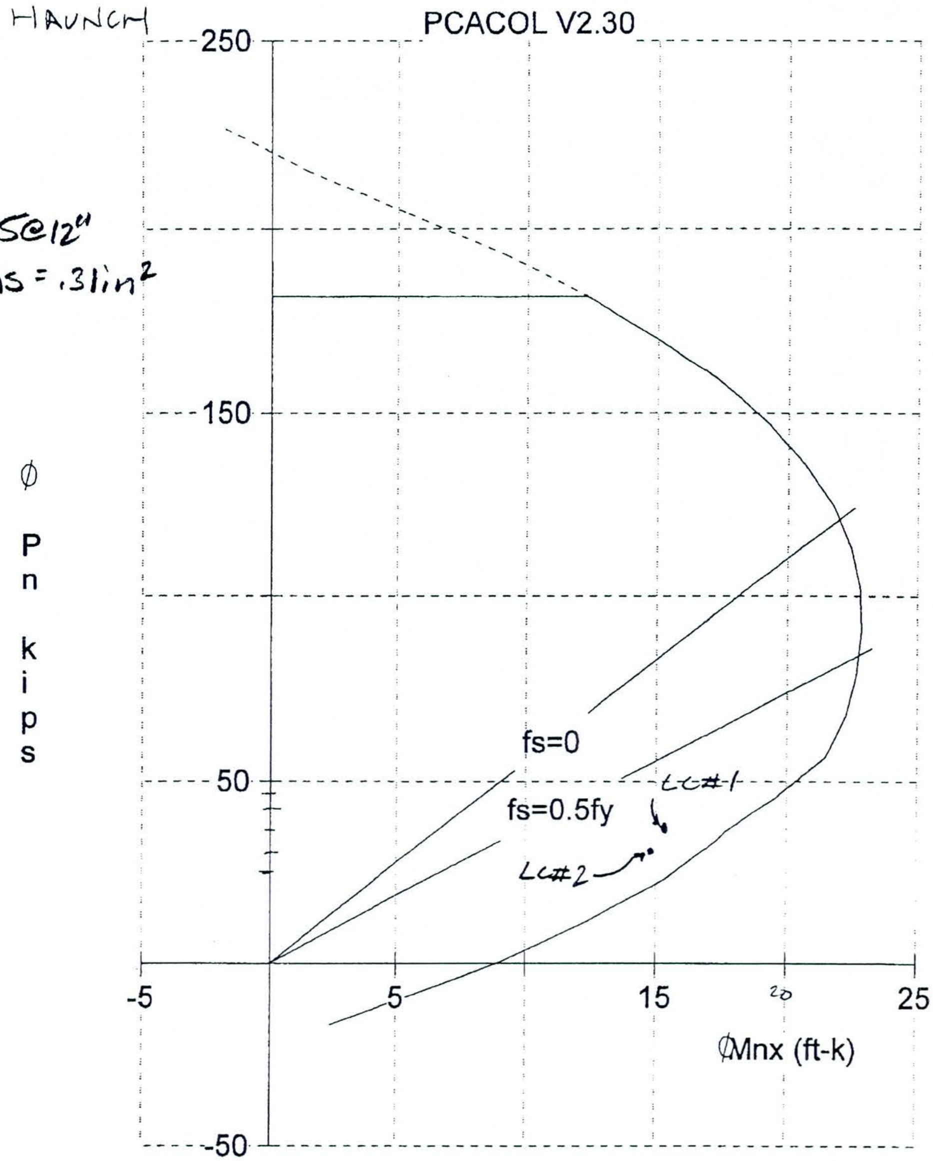
Beta1 = 0.85

Stress Profile: Block

phi(c) = 0.70, phi(b) = 0.90



12.0 x 10.0 inch



f'c = 3.0 ksi

fy = 60.0 ksi

Confinement: Tied

clr cover = 2.99 in

spacing = 4.83 in

1-#5 at 0.26%

As = ~~0 in^2~~ .31 in²

Ix = 1000 in^4

Iy = 1440 in^4

Xo = 0.00 in

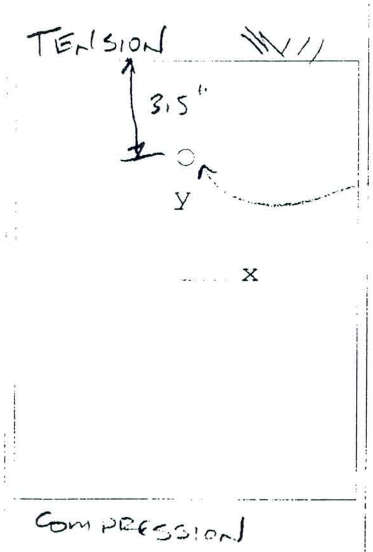
Yo = 0.00 in

Licensed To: Licensee name not yet specified.

~~File name = C:\SACRAE~1\PCACOL\4126\36CROWN.COL~~

Project:	Material Properties:
Column Id:	Ec = 3321 ksi eu = 0.003 in/in
Engineer:	fc = 2.55 ksi Es = 29000 ksi
Date: 10/20/01 Time: 22:20:26	Beta1 = 0.85
Code: ACI 318-89	Stress Profile: Block
Units: in-lb	phi(c) = 0.70, phi(b) = 0.90

X-axis slenderness is not considered.



12.0 x 15.0 inch

f'c = 3.0 ksi

fy = 60.0 ksi

Confinement: Tied

clr cover = 2.99 in

spacing = 7.27 in

1-#5 at 0.17%

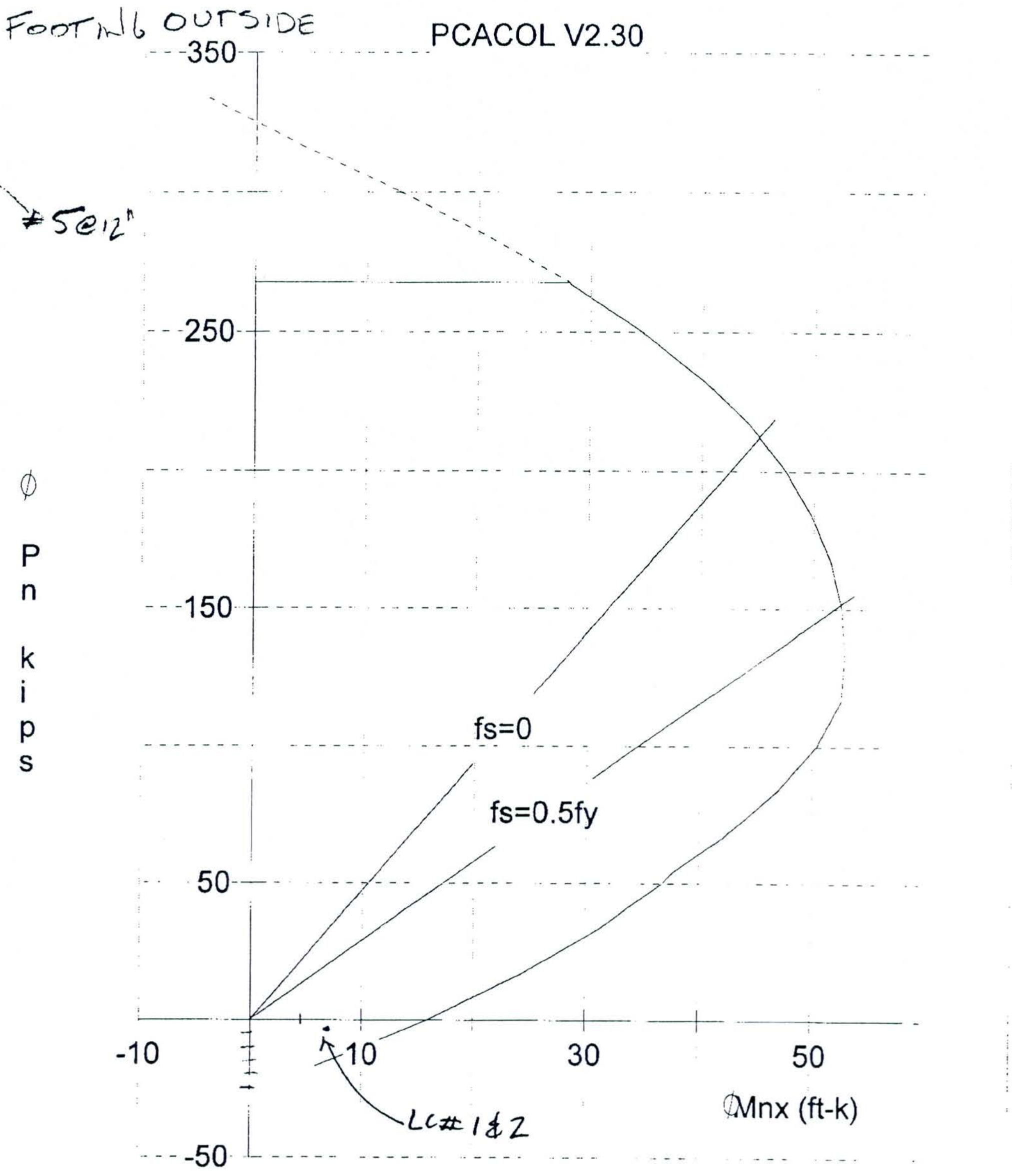
As = ~~0 in^2~~ .31 in^2

Ix = 3375 in^4

Iy = 2160 in^4

Xo = 0.00 in

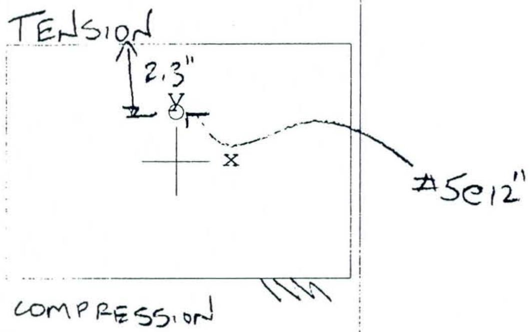
Yo = 0.00 in

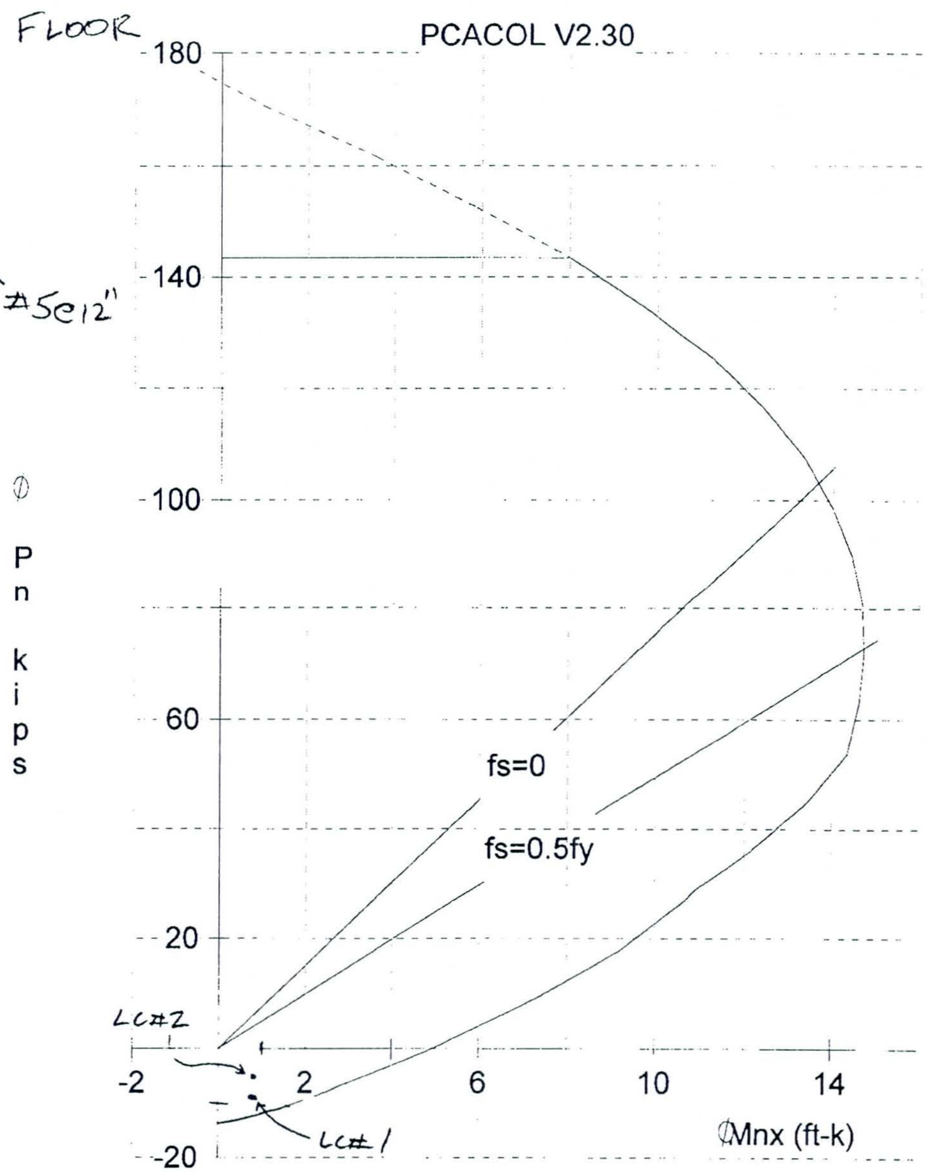


File name: C:\SACRAE~1\PCACOL\4126\36CROWN.COL

Project:	Material Properties:
Column Id:	Ec = 3321 ksi eu = 0.003 in/in
Engineer:	fc = 2.55 ksi Es = 29000 ksi
Date: 10/20/01 Time: 22:20:26	Beta1 = 0.85
Code: ACI 318-89	Stress Profile: Block
Units: in-lb	phi(c) = 0.70, phi(b) = 0.90

X-axis slenderness is not considered.





12.0 x 8.0 inch

f'c = 3.0 ksi

fy = 60.0 ksi

Confinement: Tied

clr cover = 2.05 in

spacing = 4.83 in

1-#4 at 0.21%

As = .31 in^2

Ix = 512 in^4

Iy = 1152 in^4

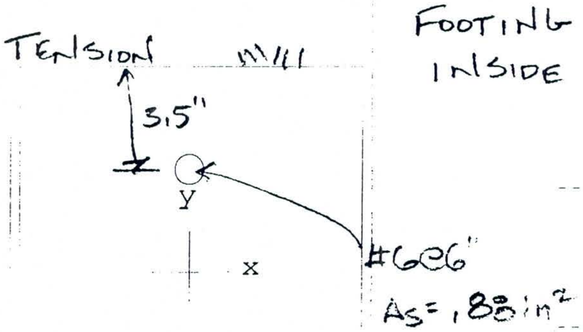
Xo = 0.00 in

Yo = 0.00 in

File name: C:\SACRAE~1\PCACOL\4126\36CROWN.COL

Project:	Material Properties:
Column Id:	Ec = 3321 ksi eu = 0.003 in/in
Engineer:	fc = 2.55 ksi Es = 29000 ksi
Date: 10/20/01 Time: 22:20:26	Beta1 = 0.85
Code: ACI 318-89	Stress Profile: Block
Units: in-lb	phi(c) = 0.70, phi(b) = 0.90

X-axis slenderness is not considered.



COMPRESSION

12.0 x 14.0 inch

f'c = 3.0 ksi

fy = 60.0 ksi

Confinement: Tied

clr cover = 2.97 in

spacing = 5.23 in

1 bars at 0.52%

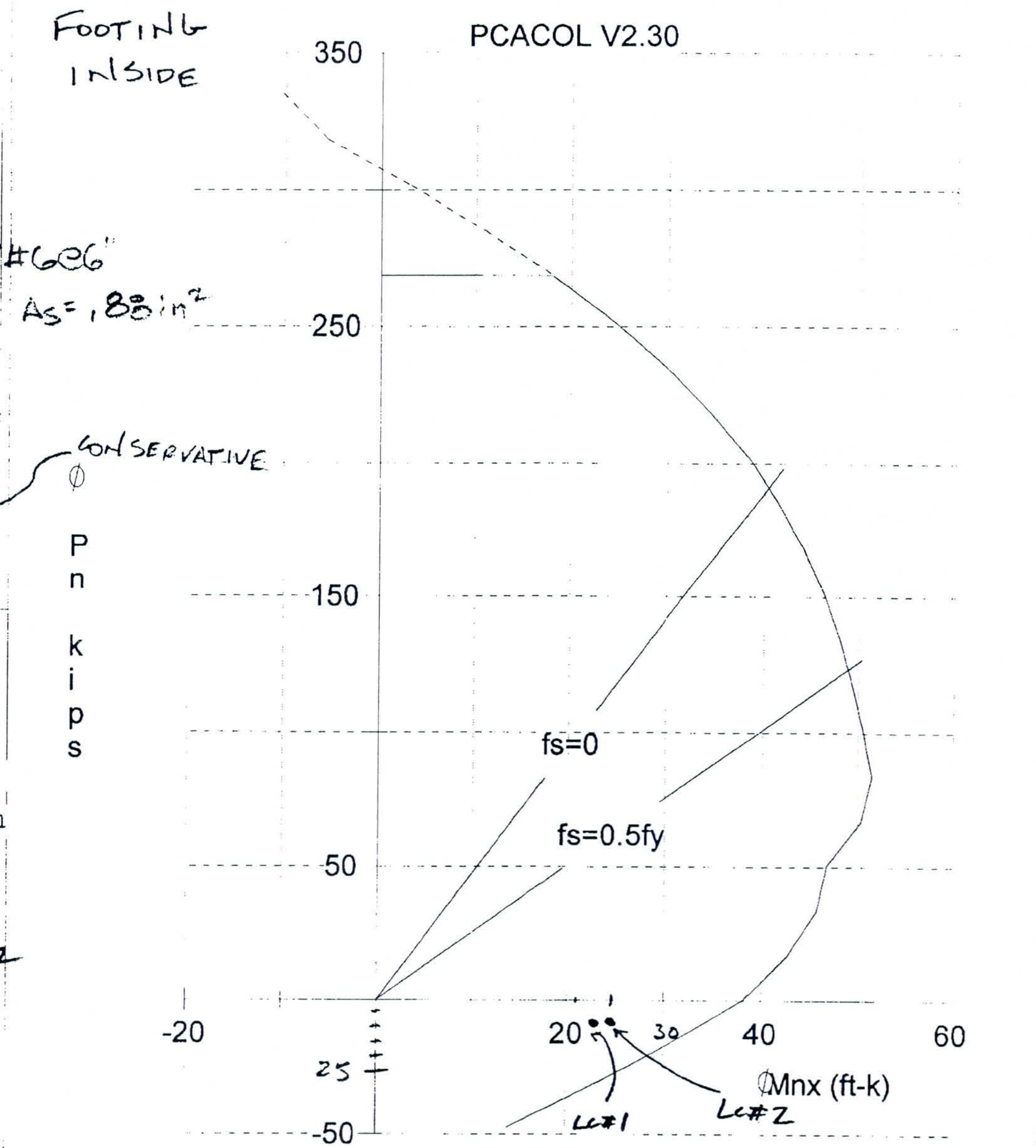
As = ~~1 in^2~~ .88in^2

Ix = 2744 in^4

Iy = 2016 in^4

Xo = 0.00 in

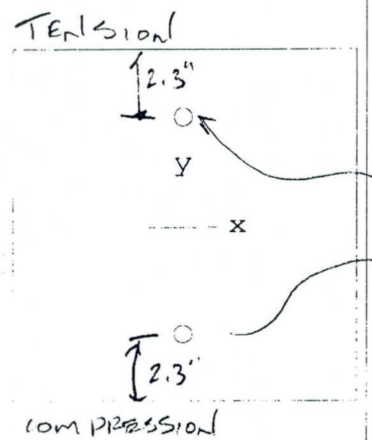
Yo = 0.00 in



File name: C:\SACRAE~1\PCACOL\4126\36CROWN.COL

Project:	Material Properties:
Column Id:	Ec = 3321 ksi eu = 0.003 in/in
Engineer:	fc = 2.55 ksi Es = 29000 ksi
Date: 10/20/01 Time: 22:20:26	Beta1 = 0.85
Code: ACI 318-89	Stress Profile: Block
Units: in-lb	phi(c) = 0.70, phi(b) = 0.90

X-axis slenderness is not considered.



12.0 x 12.0 inch

f'c = 3.0 ksi

fy = 60.0 ksi

Confinement: Tied

clr cover = 1.99 in

spacing = 6.77 in

2-#5 at 0.43%

As = .62 in^2

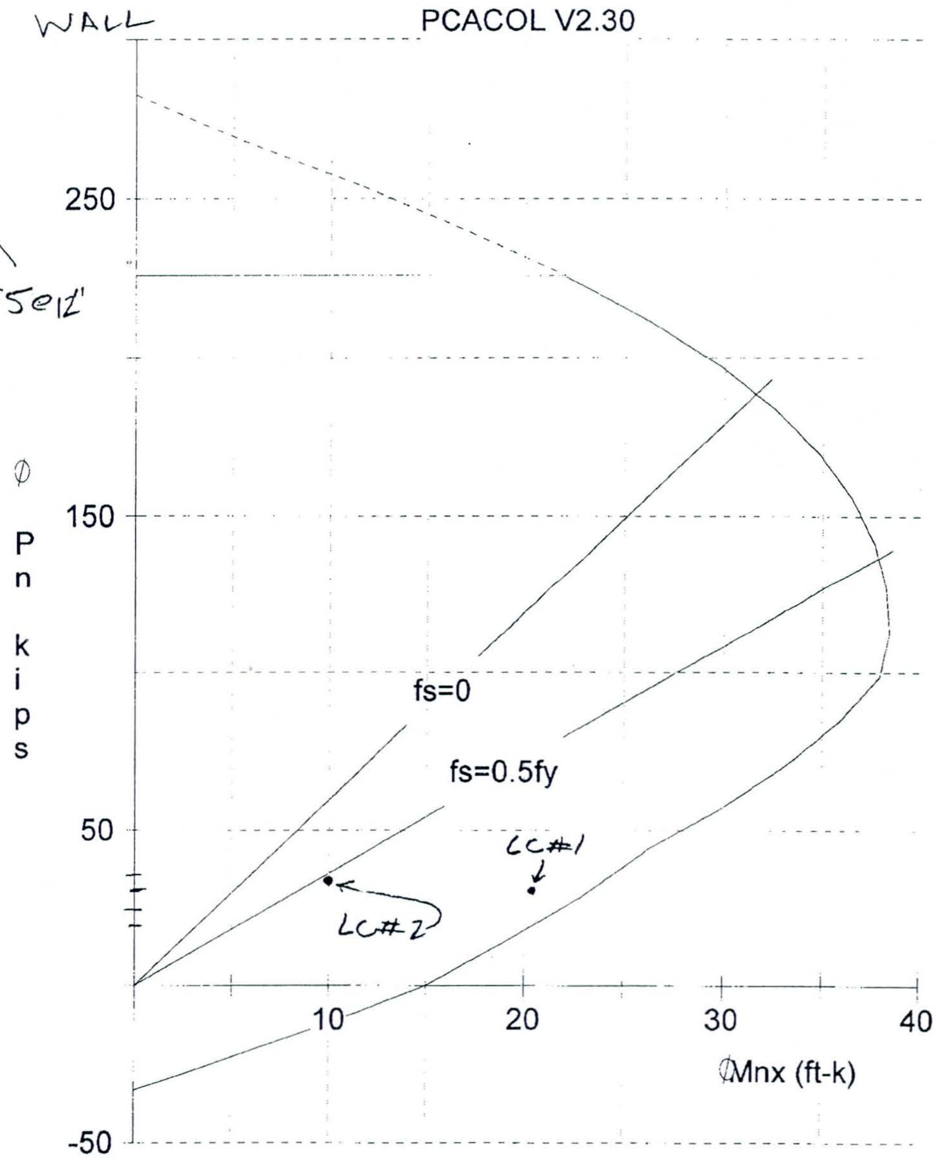
Ix = 1728 in^4

Iy = 1728 in^4

Xo = 0.00 in

Yo = 0.00 in

© 1993 PCA



Licensed To: Licensee name not yet specified.

File name: C:\SACRAE~1\PCACOL\4126\36CROWN.COL

Project:	Material Properties:
Column Id:	Ec = 3321 ksi eu = 0.003 in/in
Engineer:	fc = 2.55 ksi Es = 29000 ksi
Date: 10/20/01 Time: 22:20:26	Beta1 = 0.85
Code: ACI 318-89	Stress Profile: Block
Units: in-lb	phi(c) = 0.70, phi(b) = 0.90

X-axis slenderness is not considered.

APPENDIX I

LOAD CASE DIAGRAMS
Moment, axial force, shear force

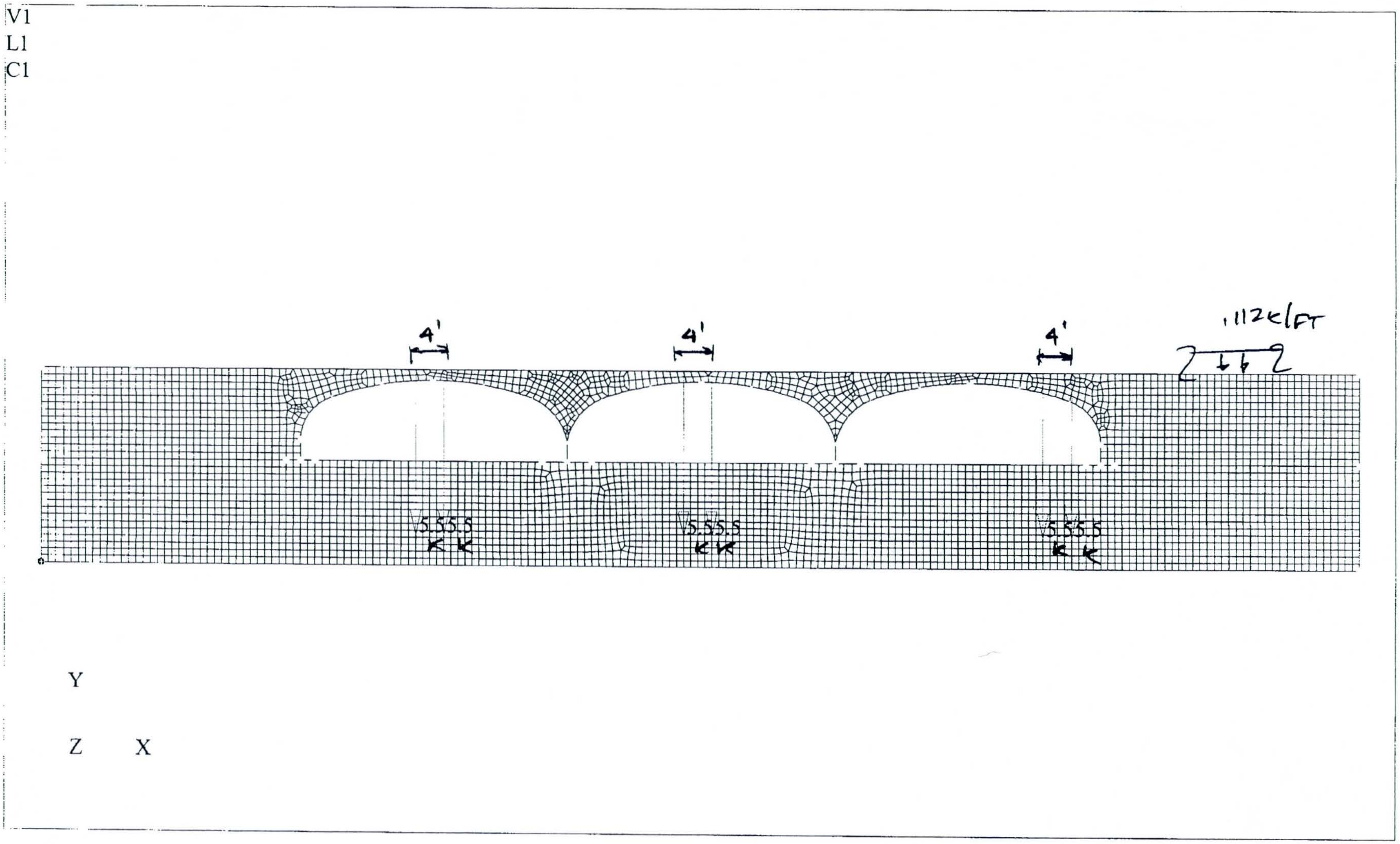
NOTES ON ALL LOAD CASE DIAGRAMS:

- In shear diagrams, the shear was taken from the support a distance d (the distance from the invert to the top of the bottom footing reinf).

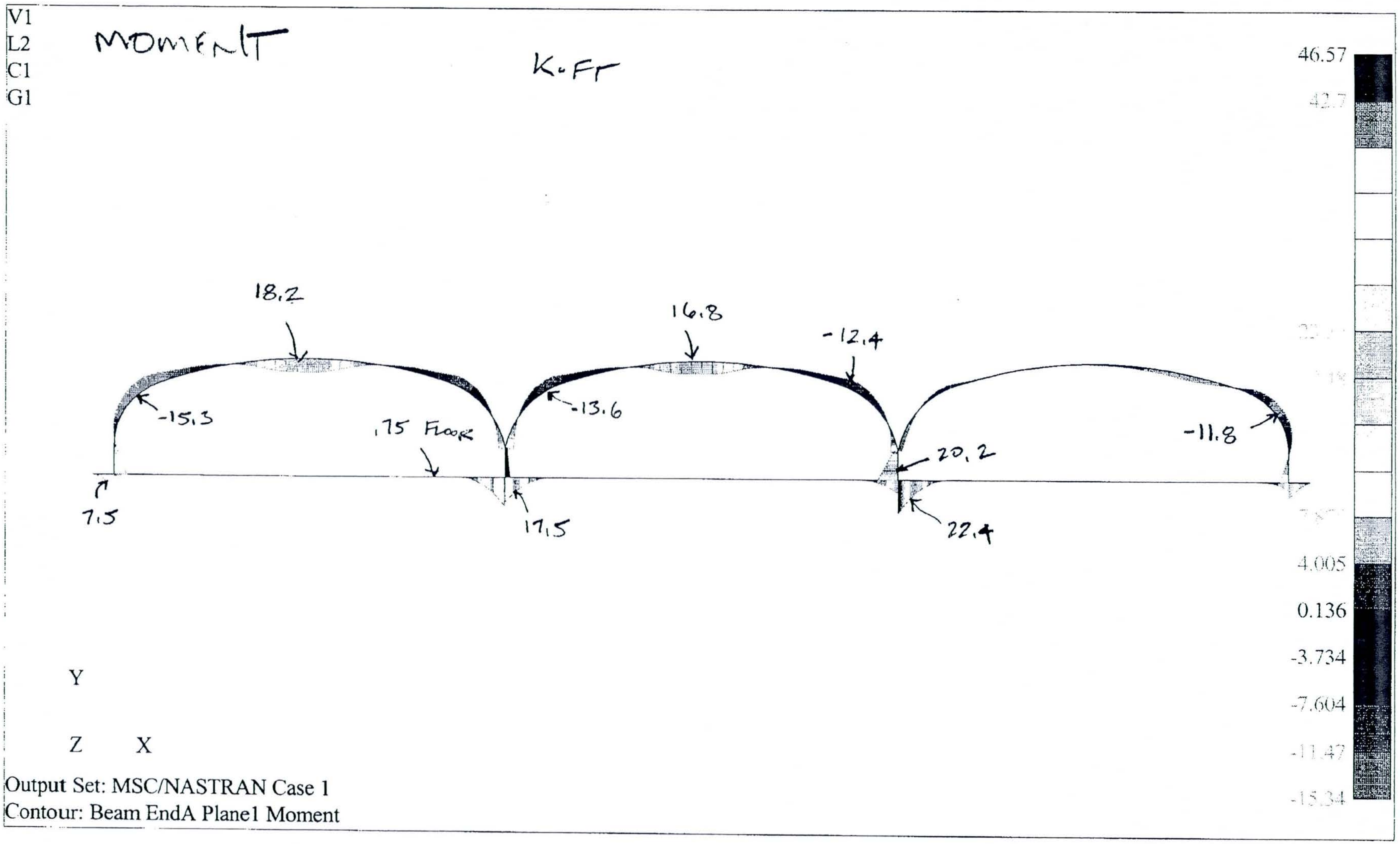
LOAD CASE #1

TANDEM LOADING @ CENTER SPAN

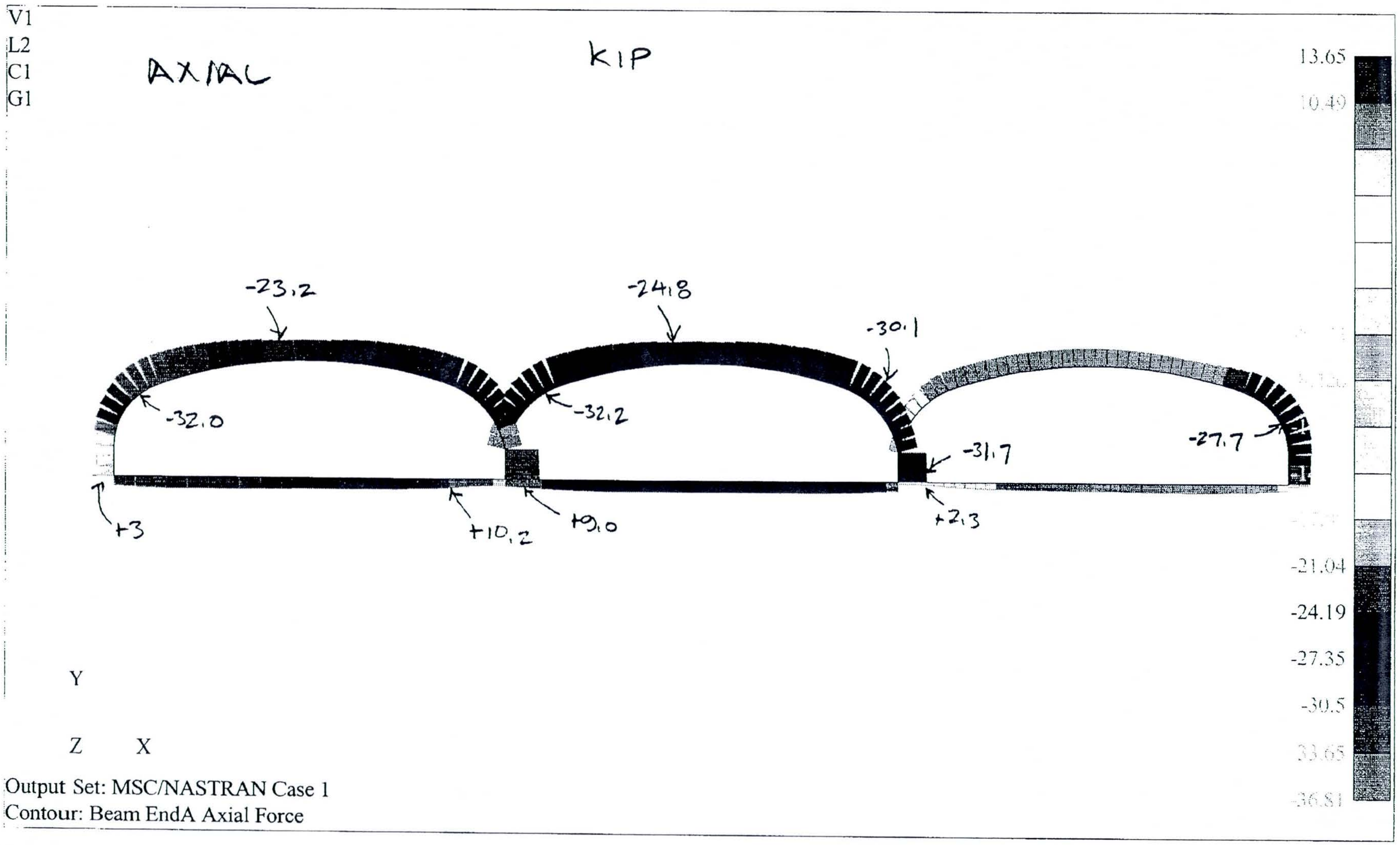
LC #1



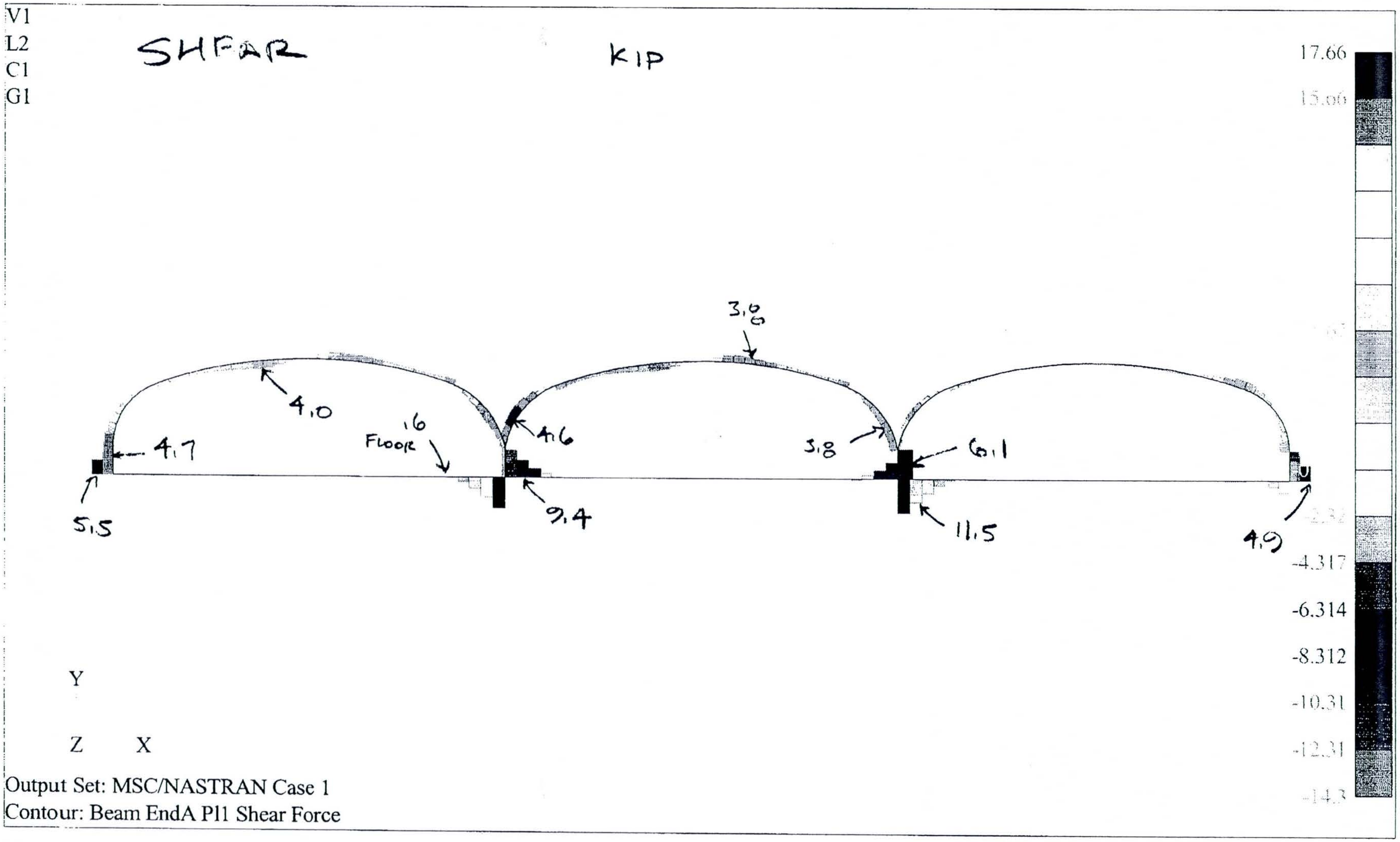
LC #1


V1
L2
C1
G1
MOMENT
K-FT
18.2
16.8
-12.4
-15.3
-13.6
.75 FLOOR
20.2
-11.8
7.5
17.5
22.4
46.57
42.7
4.005
0.136
-3.734
-7.604
-11.47
-15.34
Y
Z
X
Output Set: MSC/NASTRAN Case 1
Contour: Beam EndA Plane1 Moment

LC #1


V1
L2
C1
G1
AXIAL
KIP
-23.2
-24.8
-30.1
-32.0
-32.2
-31.7
-27.7
+3
+10.2
+9.0
+2.3
13.65
10.49
-21.04
-24.19
-27.35
-30.5
-33.65
-36.81
Y
Z
X
Output Set: MSC/NASTRAN Case 1
Contour: Beam EndA Axial Force

LC #1

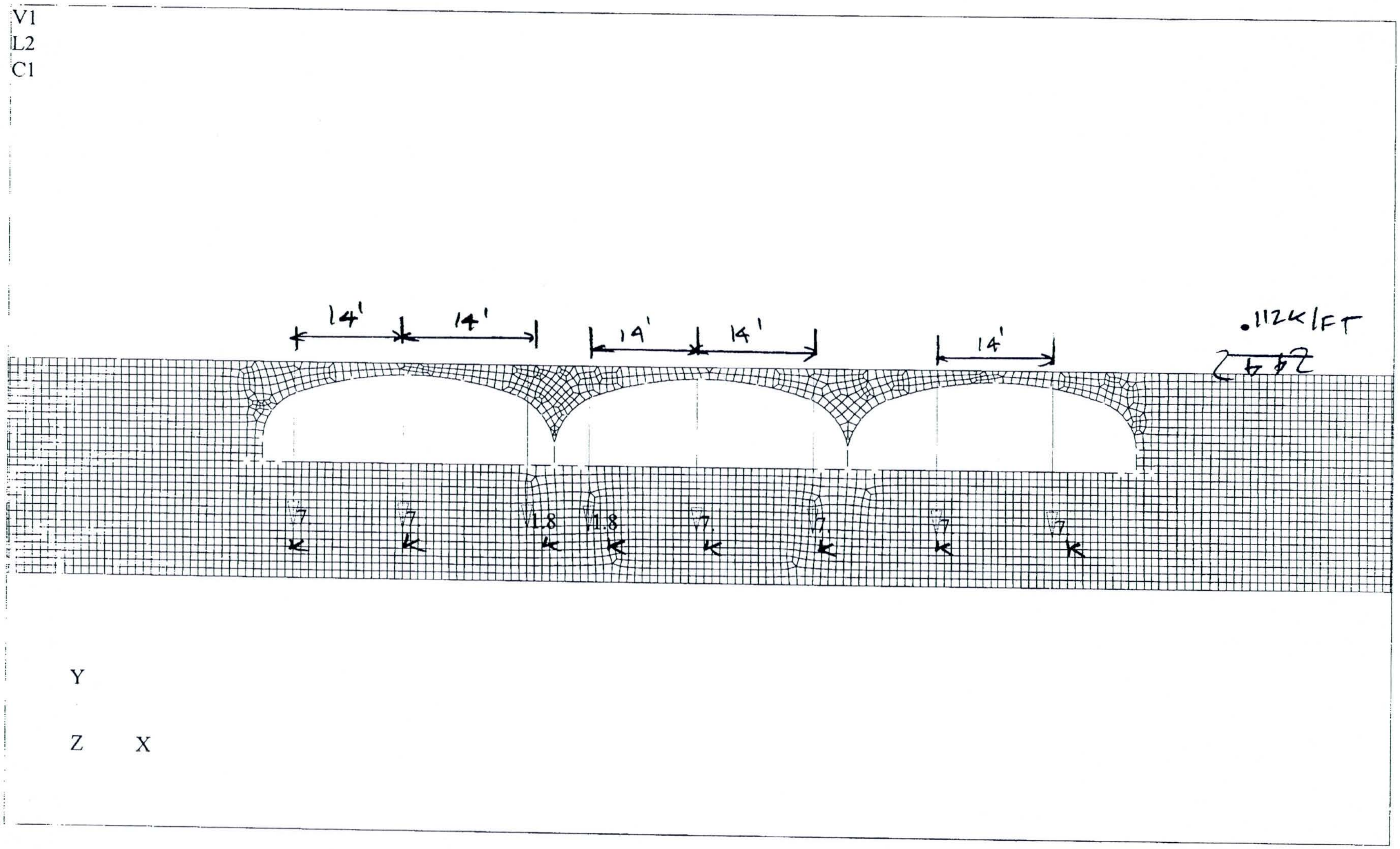


V1
L2
C1
G1
SHEAR
KIP
17.66
15.66
-4.317
-6.314
-8.312
-10.31
-12.31
-14.3
3.8
4.0
4.7
.16
FLOOR
4.6
3.8
6.1
5.5
9.4
11.5
4.9
Y
Z X
Output Set: MSC/NASTRAN Case 1
Contour: Beam EndA Pl1 Shear Force

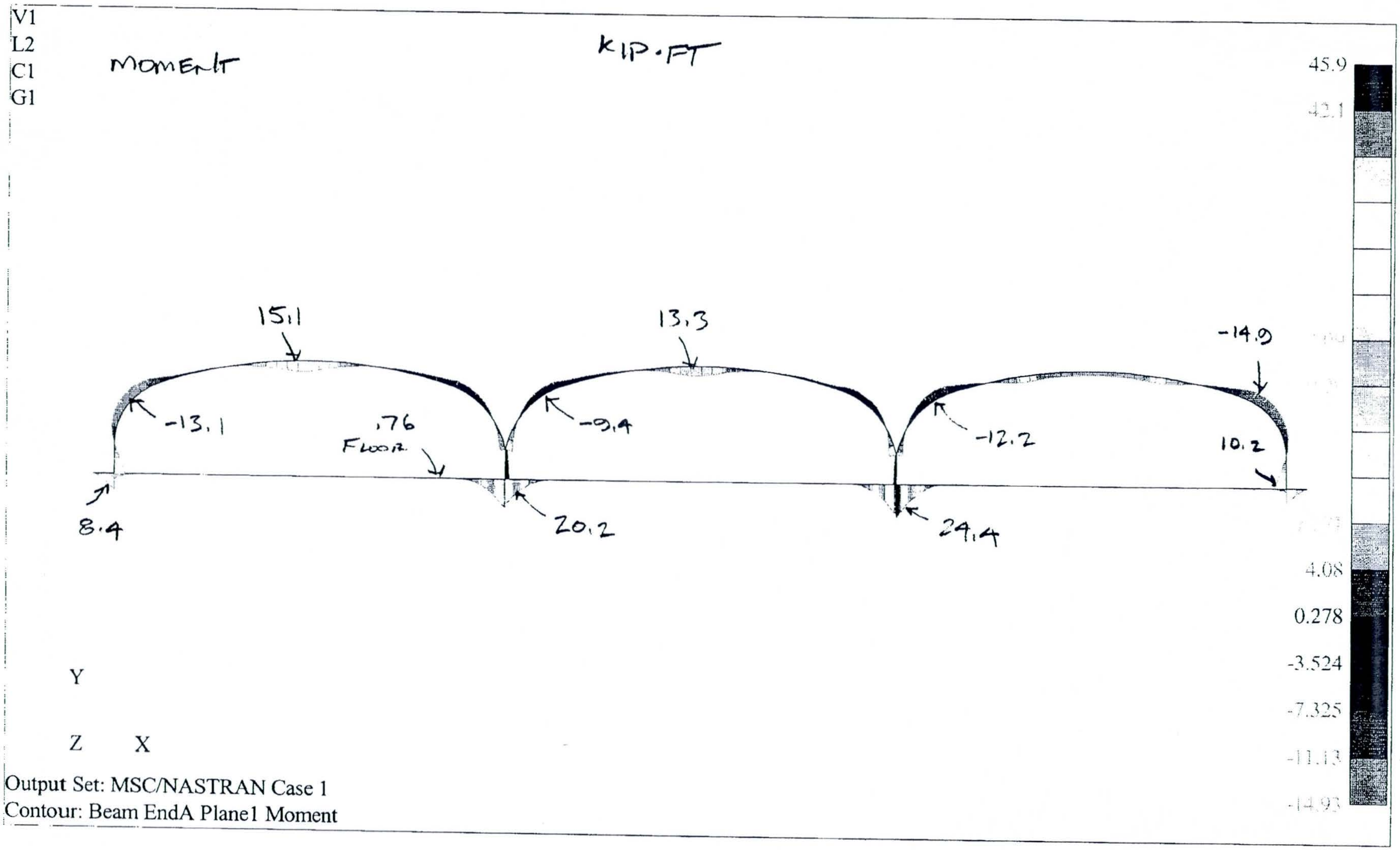
LOAD CASE #2

TRUCK LOADING @ CENTER SPAN

LC #2

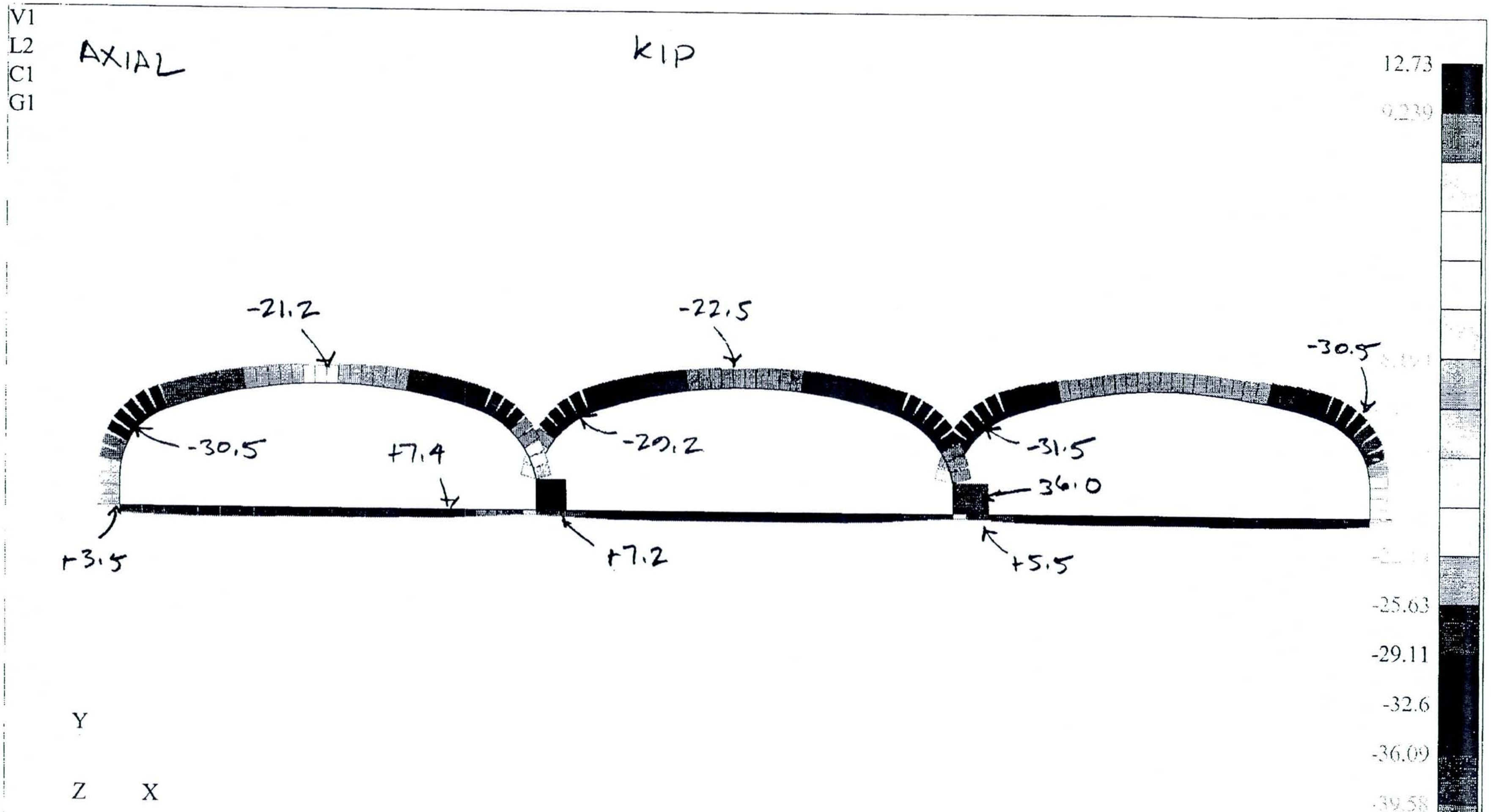


LC #2



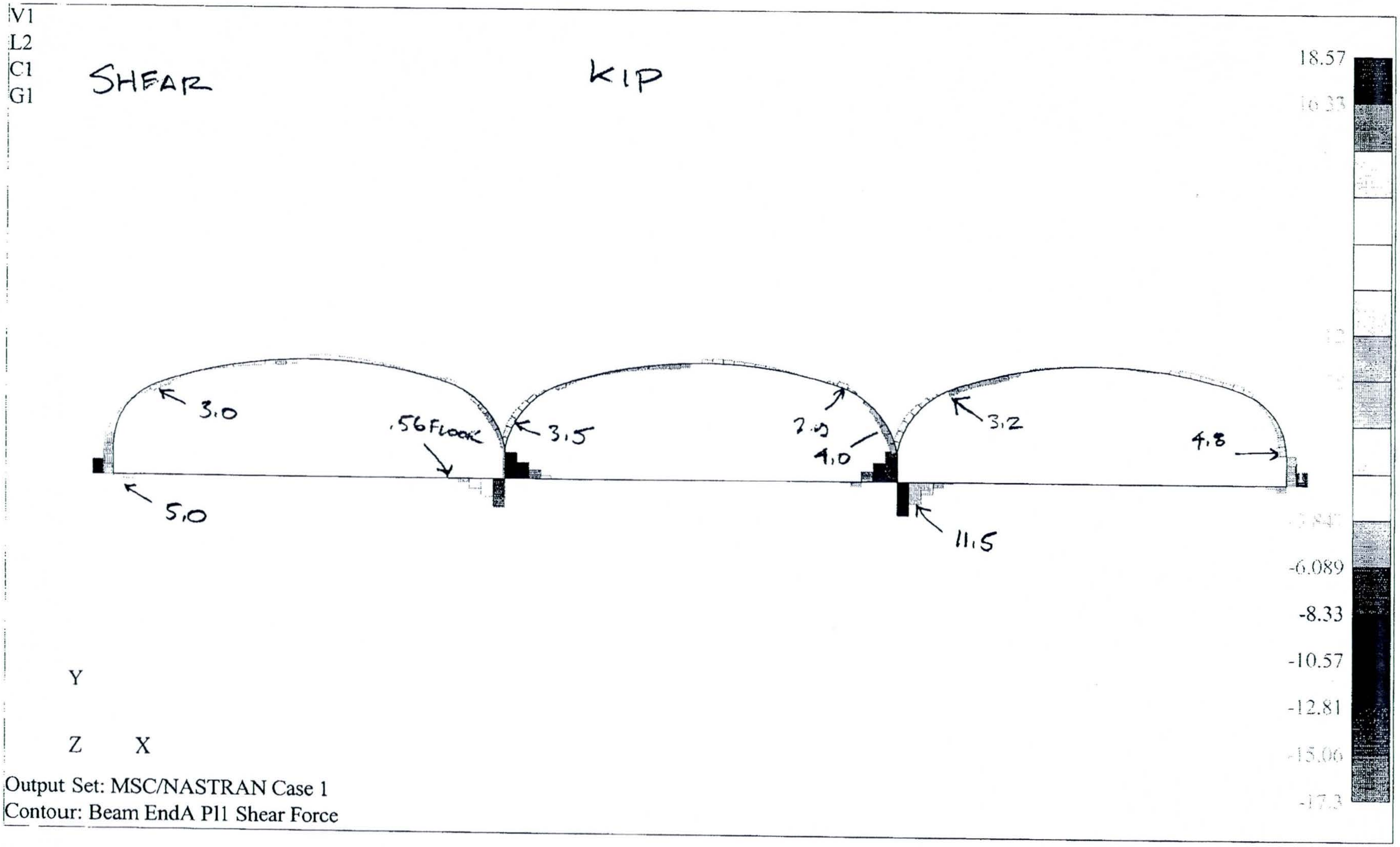
V1
L2
C1
G1
MOMENT
KIP·FT
15.1
13.3
-14.9
-13.1
.76
FLOOR
-9.4
-12.2
10.2
8.4
20.2
24.4
45.9
42.1
4.08
0.278
-3.524
-7.325
-11.13
-14.93
Y
Z X
Output Set: MSC/NASTRAN Case 1
Contour: Beam EndA Plane1 Moment

LC #2



Output Set: MSC/NASTRAN Case 1
Contour: Beam EndA Axial Force

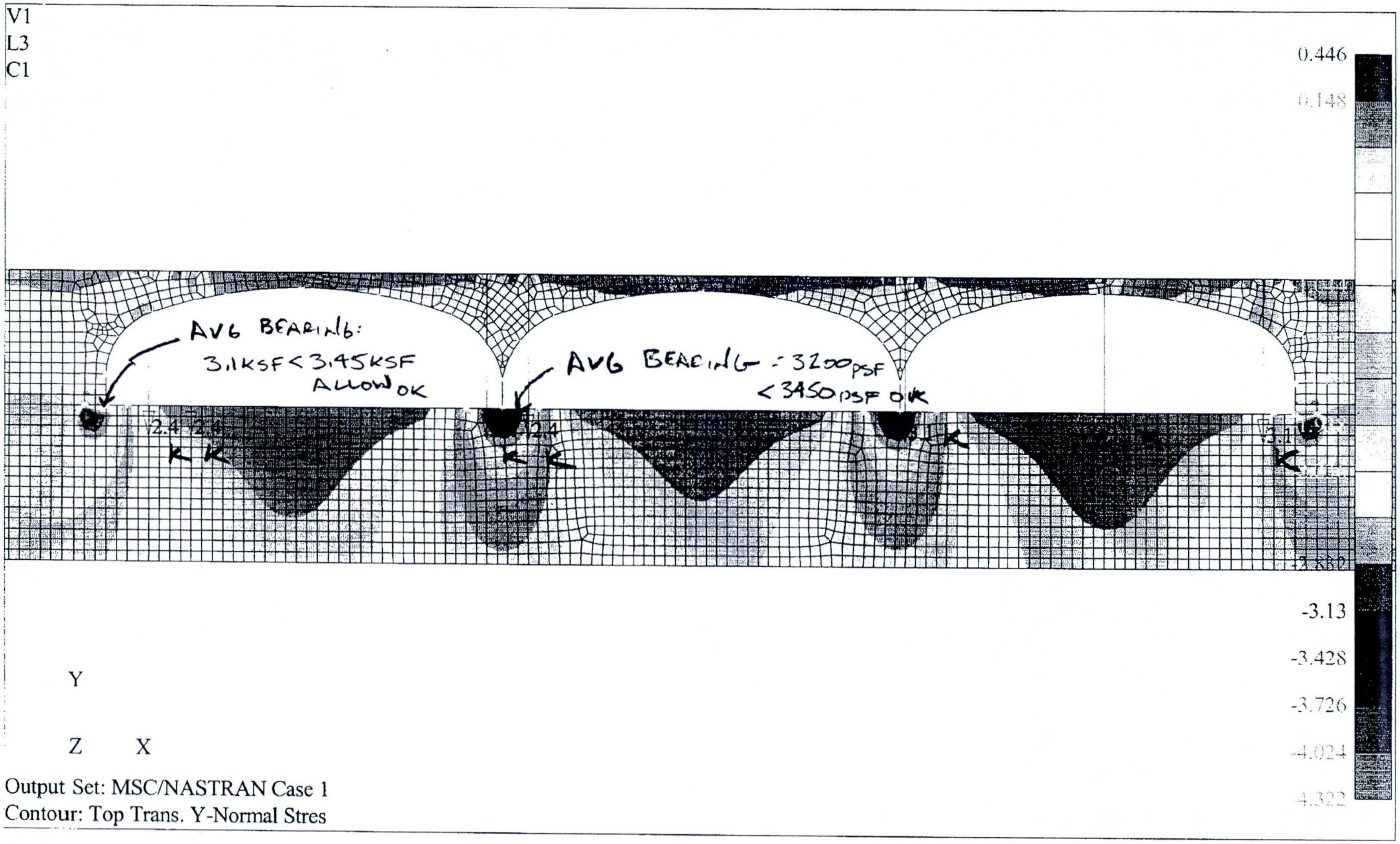
LC #2


V1
L2
C1
G1
SHEAR
KIP
18.57
16.33
-6.089
-8.33
-10.57
-12.81
-15.06
-17.3
3.0
.56 FLOOR
3.5
4.0
3.2
4.8
5.0
11.5
Y
Z X
Output Set: MSC/NASTRAN Case 1
Contour: Beam EndA Pl1 Shear Force

LOAD CASE #3

SOIL BEARING CHECK

LC #3 bearing

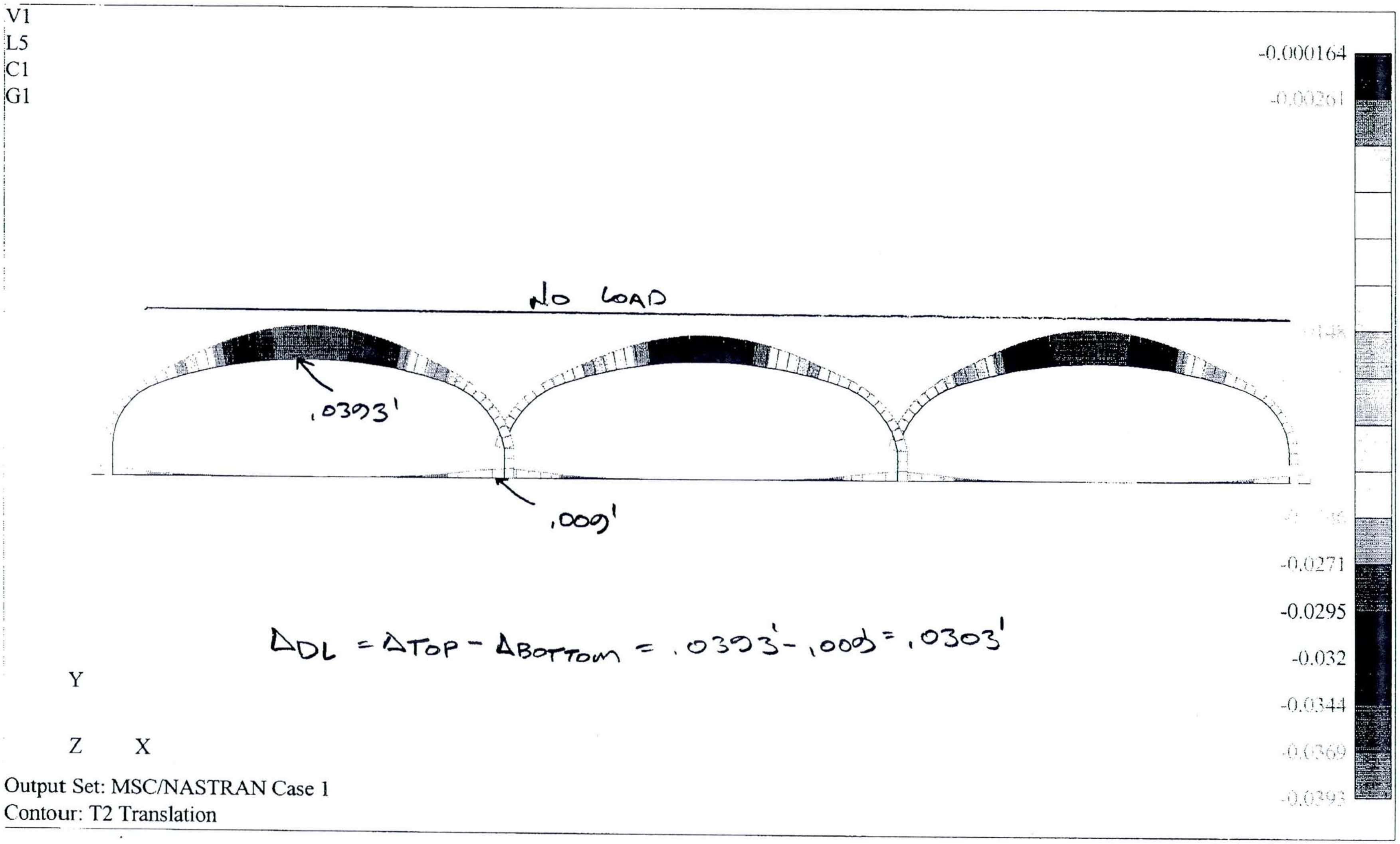

V1
L3
C1
0.446
0.148
-3.13
-3.428
-3.726
-4.024
-4.322
AVG BEARING:
3.1KSF < 3.45KSF
ALLOW OK
AVG BEARING = 3200psf
< 3450psf OK
2.4
2.4
2.4
3.1
3.1
Y
Z
X
Output Set: MSC/NASTRAN Case 1
Contour: Top Trans. Y-Normal Stres

LOAD CASE #4

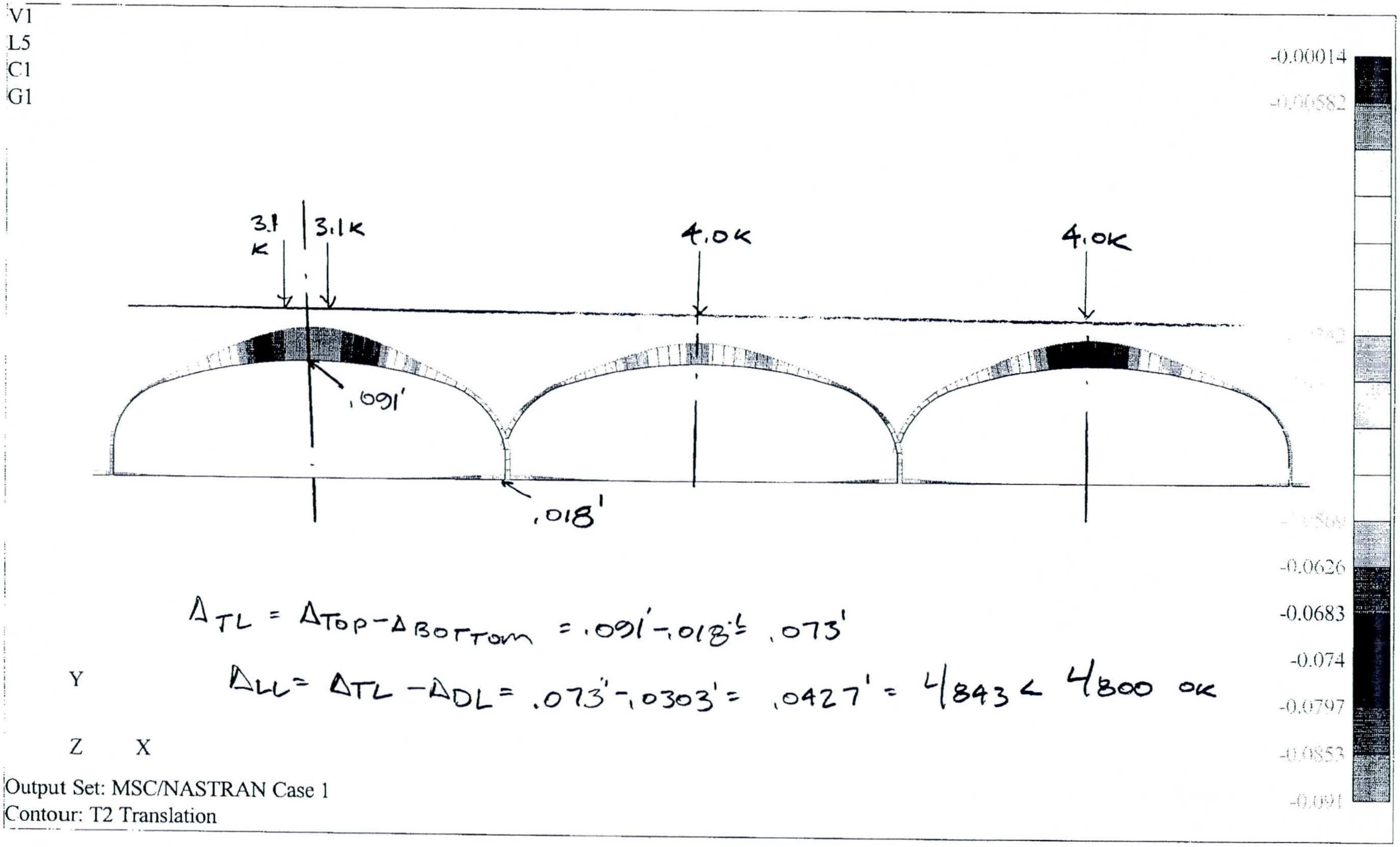
TRUCK LOADING @ CENTER SPAN

(DEAD LOAD AND LIVE LOAD)
DEFLECTION

LC #4 DEFLECTION NO LOAD



LC #4 DEFLECTION WITH LOAD



$\Delta_{TL} = \Delta_{Top} - \Delta_{Bottom} = .091' - .018' = .073'$

$\Delta_{LL} = \Delta_{TL} - \Delta_{DL} = .073' - .0303' = .0427' = L/843 < L/800$ OK

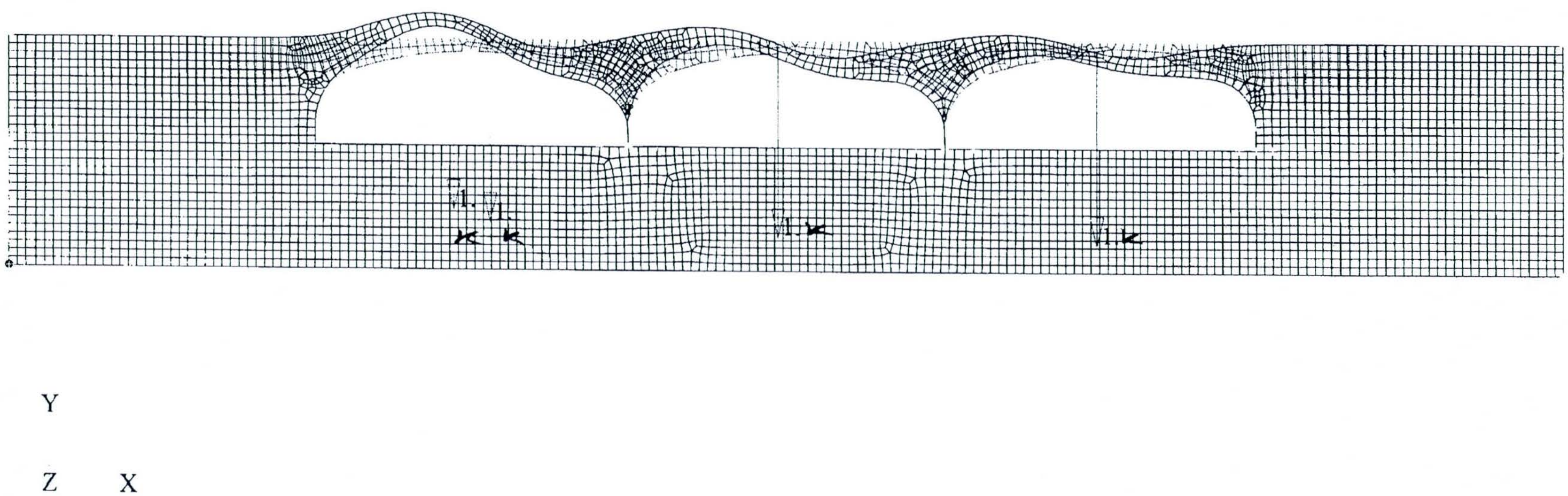
LOAD CASE #5

BUCKLING CHECK FOR TANDEM LOADING

LC #5 buckling

V1
L5
C1

$P_{critical}$ = $P_{applied}$ x Eigenvalue = (1k)(24.7) = 24.7 >> 4 k OK



Output Set: Eigenvalue 1 24.71892
Deformed(1.042): Total Translation

APPENDIX II

Sacra Engineering Plans

GENERAL NOTES

I. GENERAL:

A. DESIGN SPECIFICATIONS:
1. GENERAL: AASHTO "STANDARD SPECIFICATIONS FOR HIGHWAY BRIDGES," 16TH ED. AND REVISIONS THERETO.
2. ARCH: "AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS, 3RD ED.," 2004

B. CONSTRUCTION SPECIFICATIONS: ADOT STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION CURRENT EDITION UNLESS NOTED OTHERWISE.

C. DESIGN METHODOLOGY: REINFORCED CONCRETE ARCH DESIGN IS BASED ON FINITE ELEMENT, SOIL-STRUCTURE INTERACTION COMPUTER MODEL ANALYSIS.

D. DESIGN LOADS:
1. DEAD LOADS: SELF WEIGHT OF STRUCTURE CONCRETE = 150 PCF SOIL BACKFILL = 120 PCF.
2. LIVE LOADS: HS20-44 LOADING CLASS

E. VERIFY ALL CONDITIONS, DIMENSIONS, AND ELEVATIONS PRIOR TO START OF WORK. ESTABLISH AND VERIFY ALL OPENINGS, BLOCKOUTS, AND INSERTS. RESOLVE ALL DISCREPANCIES PRIOR TO START OF CONSTRUCTION.

F. DIMENSIONS SHALL TAKE PRECEDENCE OVER SCALES SHOWN ON DRAWINGS.

G. DETAILS ON CONSTRUCTION DRAWINGS ARE TYPICAL WHETHER SPECIFICALLY INDICATED BY CUTS, REFERENCES, TITLES, OR NOT. IN CASE OF CONFLICTS, CONTACT THE ENGINEER FOR DIRECTION BEFORE PROCEEDING.

II. FOUNDATIONS AND EARTHWORK:

A. EXCAVATION:
1. INSTALL CRIBBING, SHEATHING, AND SHORING TO SAFELY RETAIN ALL EARTH EMBANKMENTS PER OSHA.
2. ALL FOOTINGS SHALL BE FOUNDED AT THE DEPTHS INDICATED ON CONSTRUCTION DRAWINGS. BOTTOM OF FOOTING ELEVATION TOLERANCE SHALL BE +0" AND -1/2".
3. PROVIDE POSITIVE, TEMPORARY DRAINAGE AWAY FROM THE BRIDGE CONSTRUCTION SITE.

B. WATER SOFTENED MATERIALS MUST BE REMOVED FROM BENEATH ALL FOUNDATIONS AND SLABS.

C. BACKFILLING (ARCH ONLY)
1. ARCH BACKFILLING MAY TAKE PLACE WHEN THE CONCRETE HAS REACHED A MINIMUM STRENGTH OF F'C = 1500 PSI.
2. BACKFILL SHALL BE PLACED IN ONE FOOT MAXIMUM LIFTS AND IN ACCORDANCE WITH THE PROJECT GEOTECHNICAL REPORT. BACKFILL SHALL BE COMPACTED TO 95% DENSITY IN ACCORDANCE WITH ASTM-D698.
3. BACKFILL SHALL BE APPROVED BY THE ENGINEER.
4. ARCH BACKFILL SHALL BE BROUGHT UP EVENLY WITH BOTH SIDES OF THE ARCH BEING BACKFILLED. ELEVATIONS ON EITHER SIDE SHALL AT NO TIME HAVE A GREATER DIFFERENTIAL THAN ONE FOOT BETWEEN THEM.
5. BACKFILL EQUIPMENT THAT WILL PASS OVER THE ARCH SHALL NOT BE HEAVIER THAN A THREE-YARD CAPACITY, RUBBER TIRED FRONT END LOADER UNTIL ALL THE SPECIFIED BACKFILL MATERIAL IS COMPLETELY IN PLACE. SCRAPERS AND OTHER HEAVY CONSTRUCTION EQUIPMENT SHALL NOT BE ALLOWED TO PASS OVER THE ARCH UNLESS SPECIFIC PERMISSION IS ISSUED IN WRITING BY THE ENGINEER. VIBRATORY COMPACTORS (EXCEPT FOR THE WALK-BEHIND TYPE) SHALL NOT BE USED AS BACKFILLING EQUIPMENT.
6. FOR DETAILS SEE EXCAVATION & BACKFILL DIAGRAM, ON SHEET 1.

D. GEOTECHNICAL REPORT:
1. REFER TO GEOTECHNICAL REPORT BY AMEC, JOB NO 5-117-001077 DATED AUGUST 15, 2006 AND ALL ADDENDA THEREAFTER.

III. CONCRETE

A. CONCRETE
1. ALL CONCRETE IN FLOORS, WINGWALLS AND HEADWALLS SHALL HAVE A MINIMUM 28 DAY STRENGTH OF F'C = 3000 PSI @ 28 DAYS USING TYPE I-II CEMENT.
2. ALL CONCRETE IN ARCH BARREL SHALL HAVE A MINIMUM 28 DAY STRENGTH OF F'C = 4000 PSI USING TYPE I-II CEMENT.
3. ALL CONCRETE SHALL BE READY MIX CONFORMING WITH ASTM C-94.

B. CONCRETE FOOTINGS MAY BE PLACED AGAINST NEAT EXCAVATIONS, PROVIDED PLAN DIMENSIONS ARE ADHERED TO.

C. REINFORCING STEEL (MATERIALS):
1. ALL REINFORCING STEEL SHALL BE DEFORMED BARS CONFORMING TO ASTM A615, GRADE 60.

GENERAL NOTES CONT:

D. REINFORCING STEEL (PLACEMENT & INSTALLATION):
1. ALL REINFORCING SHALL BE PLACED AND INSTALLED IN ACCORDANCE WITH ACI 318.
2. ALL BENDS AND HOOKS SHALL CONFORM TO ACI 315 U.N.O. BEND DIMENSIONS ARE MEASURED FROM OUT TO OUT. BARS SHALL NOT BE UNBENT AND RE-BENT EXCEPT AS NOTED.
3. REINFORCING BARS SHALL BE CONTINUOUS OR LAPPED NOT LESS THAN 40 BAR DIAMETERS. LAPS SHALL BE STAGGERED A MINIMUM OF ONE LAP LENGTH U.N.O.
4. MINIMUM CONCRETE COVER OVER REINFORCING BARS SHALL BE AS FOLLOWS, UNLESS OTHERWISE SHOWN ON DRAWINGS:
   a. CONCRETE PLACED DIRECTLY AGAINST EARTH 3 INCHES.
   b. FORMED CONCRETE 2 INCHES.

E. ALL REINFORCING BARS, ANCHOR BOLTS, LIGHTING CONDUITS, AND CONCRETE INSERTS SHALL BE SECURED IN POSITION PRIOR TO PLACING CONCRETE.

F. FINISHING
1. CHAMFER EXPOSED CORNERS 3/4" U.N.O.

G. CURING (EXTERIOR - TOP OF ARCH)

1. ALL EXTERIOR CONCRETE SURFACES SHALL BE CURED USING LIQUID-MEMBRANE CURING COMPOUND, TYPE I, CONFORMING TO THE REQUIREMENTS OF ASTM C 309 AND APPLICATION RATE SHALL BE 100 SQUARE FEET (MIN) PER GALLON.

2. THE TOP EXTERIOR SURFACE OF THE CON-ARCH STRUCTURE SHALL BE CURED BY BOTH THE CURING COMPOUND METHOD AND THE WATER CURE METHOD.

3. THE WATER CURE SHALL BE APPLIED AS SOON AS THE SURFACE HAS SET SUFFICIENTLY TO AVOID MARRING THE SURFACE BUT NOT LATER THAN 4 HOURS AFTER COMPLETION OF ARCH FINISHING. THE CONCRETE SHALL BE KEPT WET CONTINUOUSLY FOR SEVEN DAYS.

4. MOIST BURLAP, RUGS, CARPETS, EARTH OR SAND BLANKETS MAY BE USED AS A CURING MEDIUM TO RETAIN THE MOISTURE DURING THE CURING PERIOD.

H. CURING (INTERIOR - UNDERSIDE ARCH SURFACE)

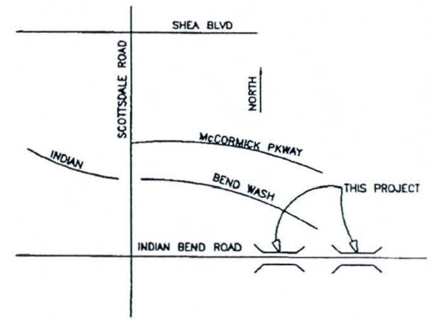
1. FORMED SURFACES OF CONCRETE MAY BE CURED BY LEAVING THE FORMS IN PLACE FOR A MINIMUM OF SEVEN DAYS.

2. IF THE FORMS ARE TO BE REMOVED, THE INTERIOR SURFACE SHALL BE KEPT MOIST FOR A MINIMUM OF SEVEN DAYS. OPEN ENDS OF THE ARCH BARREL SHALL BE SEALED WITH A BULKHEAD ARRANGEMENT IN ORDER TO PREVENT AIR CIRCULATION THROUGH THE ARCH BARREL. A WATER SPRAY OR FOG SYSTEM SHALL BE USED AS NECESSARY TO PREVENT THE SURFACES FROM DRYING OUT.

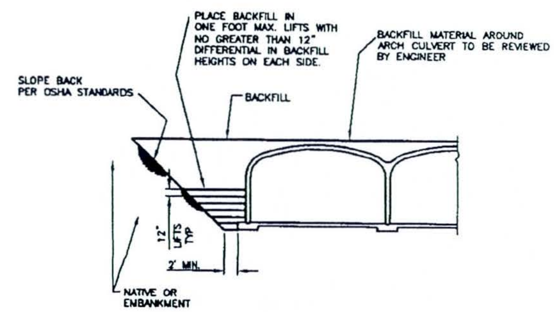
J. EXTERIOR WATERPROOFING

1. APPLY WATCHDOG WATERPROOFING BY TREMCO TO ARCH BARRELS, HEADWALLS AND WINGWALLS PRIOR TO BACKFILLING. APPLY WHERE CONCRETE SURFACES COME INTO CONTACT WITH SOIL. APPLY WATERPROOFING PER THE MANUFACTURER'S RECOMMENDATIONS.

NOTE: WHEN USING REINF. WITH METRIC BAR NUMBERS:
#3 = #10 (METRIC)
#4 = #13 (METRIC)
#5 = #16 (METRIC)
#6 = #19 (METRIC)



LOCATION MAP



EXCAVATION & BACKFILL DIAGRAM
NOT TO SCALE

CON-ARCH

APPROVED: DIRECTOR OF PUBLIC WORKS DATE

SEAL PERTAINS ONLY TO WORK RELATED TO CON-ARCH STRUCTURE. SURVEY DATA, INVERT ELEVATIONS & HYDRAULIC ANALYSIS PROVIDED BY OTHERS.

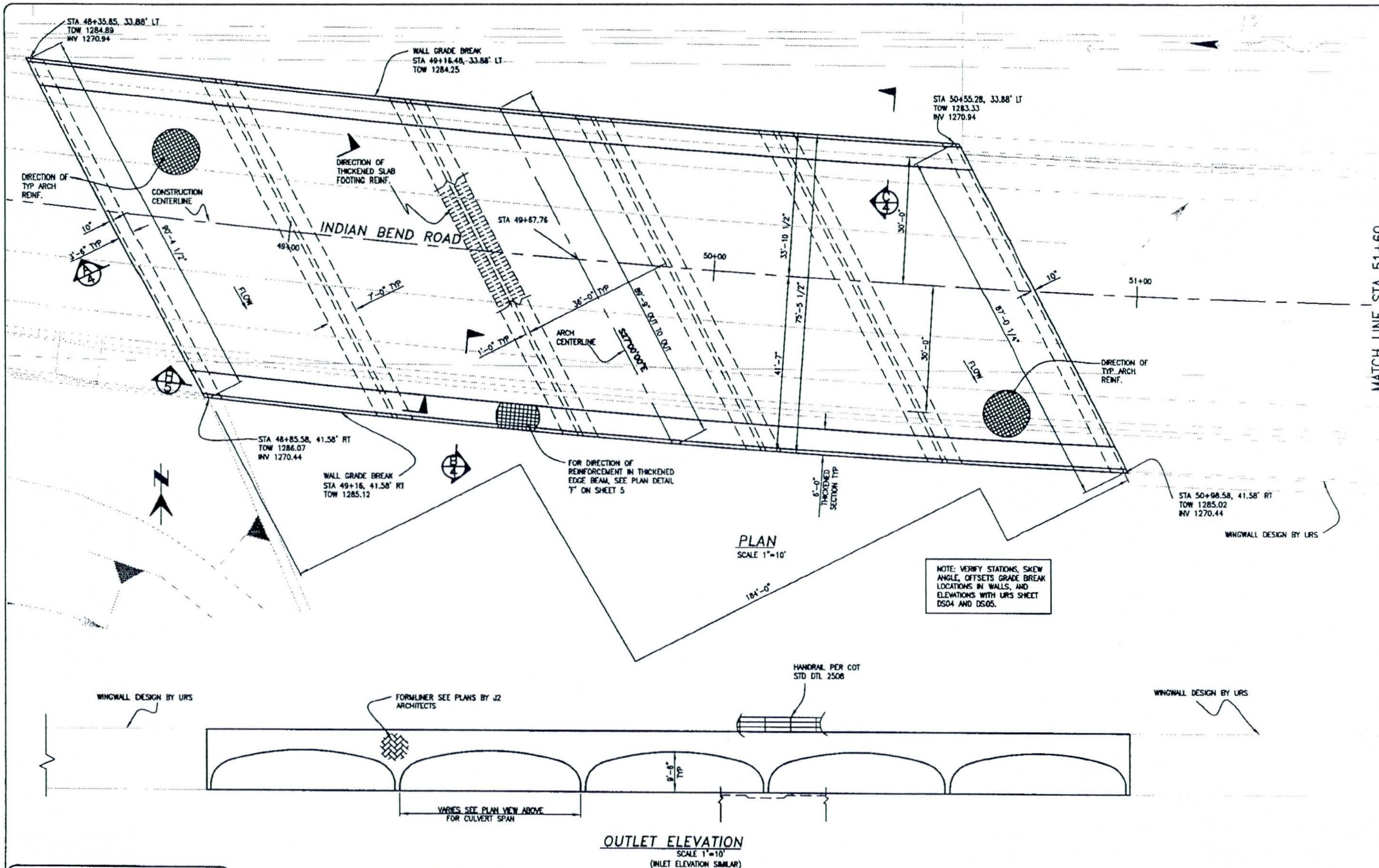
NO	DATE	BY	COMMENTS
1 (in triangle)			

SACRA ENGINEERING
CONSULTING ENGINEERS
5940 CAMINO DE FRAY MARCOS
TUCSON, ARIZONA 85719
PH: (520) 742-3858

HUNTER CONTRACTING
6930 N. CAMINO MARTIN
TUCSON, AZ 85741
CONTACT: TODD JACKSON
PH: (520) 744-0722

INDIAN BEND ROAD
CON-ARCH CULVERT DETAILS
SCOTTSDALE, AZ

Dsgn:	ATS
Drwn:	ATS
Rvsd:	–
Chk:	TAS
Date:	6/27/07
SCALE:	AS NOTED
SHEET NO.	Proj. No.
1 OF 5	6138



5 BARREL 36' SPAN X 9'-6" RISE CON-ARCH CULVERT

WESTERN CULVERT @ STA 49+67.76

CON-ARCH

SEAL PERTAINS ONLY TO WORK RELATED TO CON-ARCH STRUCTURE. SURVEY DATA, INVERT ELEVATIONS & HYDRAULIC ANALYSIS PROVIDED BY OTHERS.

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1			

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INDIAN BEND ROAD
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SCOTTSDALE, AZ

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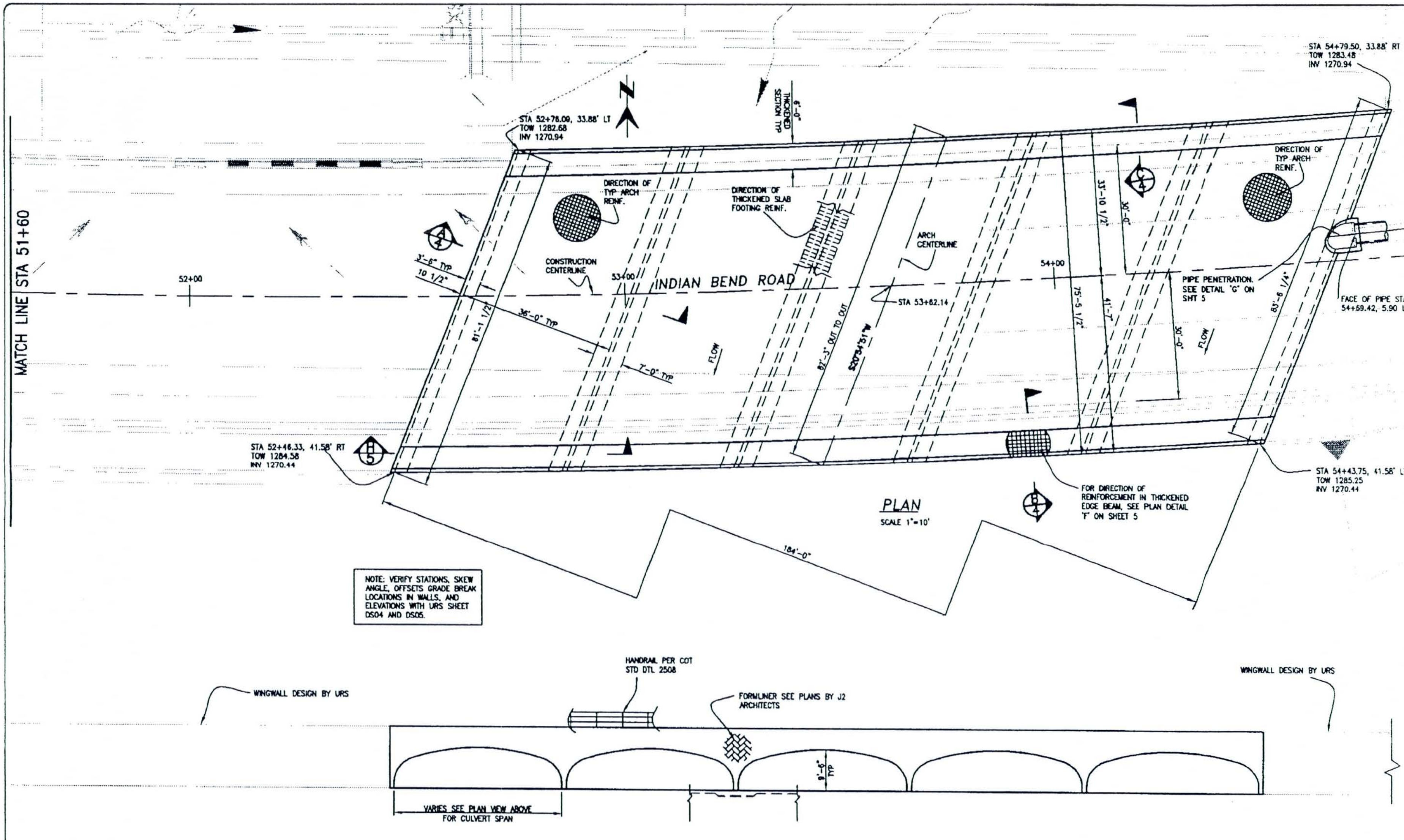

NOTE: VERIFY STATIONS, SKEW ANGLE, OFFSETS GRADE BREAK LOCATIONS IN WALLS, AND ELEVATIONS WITH URS SHEET DS04 AND DS05.

OUTLET ELEVATION
SCALE 1"=10'
(INLET ELEVATION SIMILAR)

5 BARREL 36' SPAN X 9'-6" RISE CON-ARCH CULVERT

EASTERN CULVERT @ STA 53+62.14

CON-ARCH

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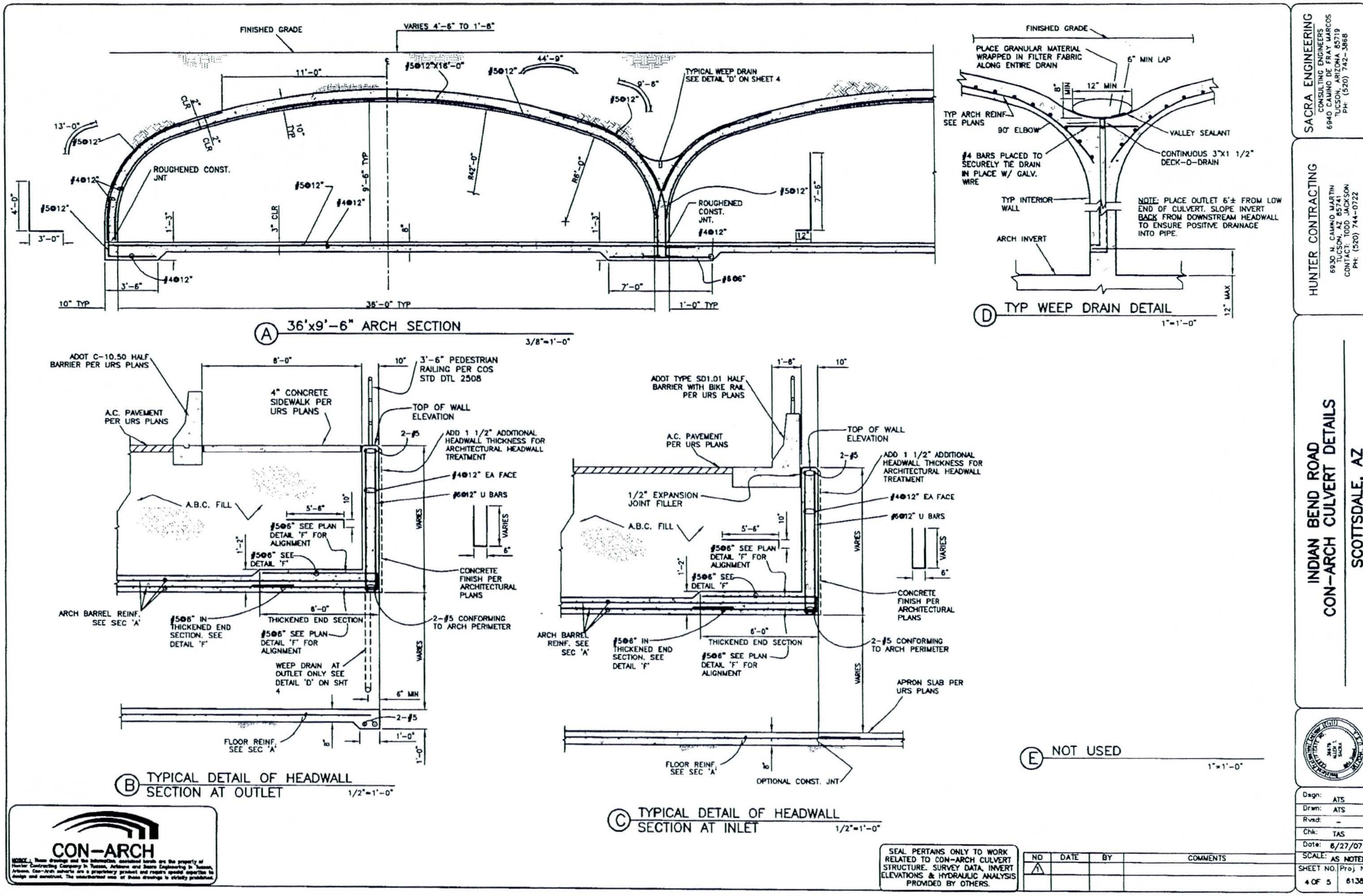

FINISHED GRADE
VARIES 4'-6" TO 1'-8"
11'-0"
#5@12"X16'-0"
44'-9"
#5@12"
TYPICAL WEEP DRAIN SEE DETAIL 'D' ON SHEET 4
9'-6"
#5@12"
13'-0"
#5@12"
2" CLR
2" CLR
10" TYP
ROUGHENED CONST. JNT
#4@12"
#5@12"
9'-6" TYP
R42'-0"
R6'-0"
4'-0"
#5@12"
3'-0"
1'-3"
3" CLR
#5@12"
#4@12"
8"
1'-3"
ROUGHENED CONST. JNT.
#4@12"
#5@12"
7'-6"
12"
3'-6"
#4@12"
7'-0"
#5@6"
10" TYP
36'-0" TYP
1'-0" TYP
A 36'x9'-6" ARCH SECTION
3/8"=1'-0"
FINISHED GRADE
PLACE GRANULAR MATERIAL WRAPPED IN FILTER FABRIC ALONG ENTIRE DRAIN
6" MIN LAP
8" MIN
12" MIN
TYP ARCH REINF. SEE PLANS
90° ELBOW
VALLEY SEALANT
#4 BARS PLACED TO SECURELY TIE DRAIN IN PLACE W/ GALV. WIRE
CONTINUOUS 3"X1 1/2" DECK-O-DRAIN
TYP INTERIOR WALL
NOTE: PLACE OUTLET 6'± FROM LOW END OF CULVERT. SLOPE INVERT BACK FROM DOWNSTREAM HEADWALL TO ENSURE POSITIVE DRAINAGE INTO PIPE.
ARCH INVERT
12" MAX
D TYP WEEP DRAIN DETAIL
1"=1'-0"
ADOT C-10.50 HALF BARRIER PER URS PLANS
8'-0"
10"
3'-6" PEDESTRIAN RAILING PER COS STD DTL 2508
A.C. PAVEMENT PER URS PLANS
4" CONCRETE SIDEWALK PER URS PLANS
TOP OF WALL ELEVATION
2-#5
ADD 1 1/2" ADDITIONAL HEADWALL THICKNESS FOR ARCHITECTURAL HEADWALL TREATMENT
#4@12" EA FACE
#6@12" U BARS
A.B.C. FILL
5'-6"
10"
VARIES
VARIES
6"
#5@6" SEE PLAN DETAIL 'F' FOR ALIGNMENT
1'-2"
#5@6" SEE DETAIL 'F'
CONCRETE FINISH PER ARCHITECTURAL PLANS
ARCH BARREL REINF. SEE SEC 'A'
#5@6" IN THICKENED END SECTION. SEE DETAIL 'F'
6'-0"
THICKENED END SECTION
2-#5 CONFORMING TO ARCH PERIMETER
#5@6" SEE PLAN DETAIL 'F' FOR ALIGNMENT
WEEP DRAIN AT OUTLET ONLY SEE DETAIL 'D' ON SHT 4
VARIES
6" MIN
2-#5
1'-0"
FLOOR REINF. SEE SEC 'A'
1'-0"
B TYPICAL DETAIL OF HEADWALL SECTION AT OUTLET
1/2"=1'-0"
ADOT TYPE SD1.01 HALF BARRIER WITH BIKE RAIL PER URS PLANS
1'-6"
10"
TOP OF WALL ELEVATION
A.C. PAVEMENT PER URS PLANS
2-#5
ADD 1 1/2" ADDITIONAL HEADWALL THICKNESS FOR ARCHITECTURAL HEADWALL TREATMENT
1/2" EXPANSION JOINT FILLER
#4@12" EA FACE
#6@12" U BARS
A.B.C. FILL
5'-6"
10"
VARIES
VARIES
6"
#5@6" SEE PLAN DETAIL 'F' FOR ALIGNMENT
1'-2"
#5@6" SEE DETAIL 'F'
CONCRETE FINISH PER ARCHITECTURAL PLANS
ARCH BARREL REINF. SEE SEC 'A'
#5@6" IN THICKENED END SECTION. SEE DETAIL 'F'
6'-0"
THICKENED END SECTION
2-#5 CONFORMING TO ARCH PERIMETER
#5@6" SEE PLAN DETAIL 'F' FOR ALIGNMENT
VARIES
APRON SLAB PER URS PLANS
FLOOR REINF. SEE SEC 'A'
OPTIONAL CONST. JNT
C TYPICAL DETAIL OF HEADWALL SECTION AT INLET
1/2"=1'-0"
E NOT USED
1"=1'-0"
CON-ARCH
SEAL PERTAINS ONLY TO WORK RELATED TO CON-ARCH CULVERT STRUCTURE. SURVEY DATA, INVERT ELEVATIONS & HYDRAULIC ANALYSIS PROVIDED BY OTHERS.
NO
DATE
BY
COMMENTS
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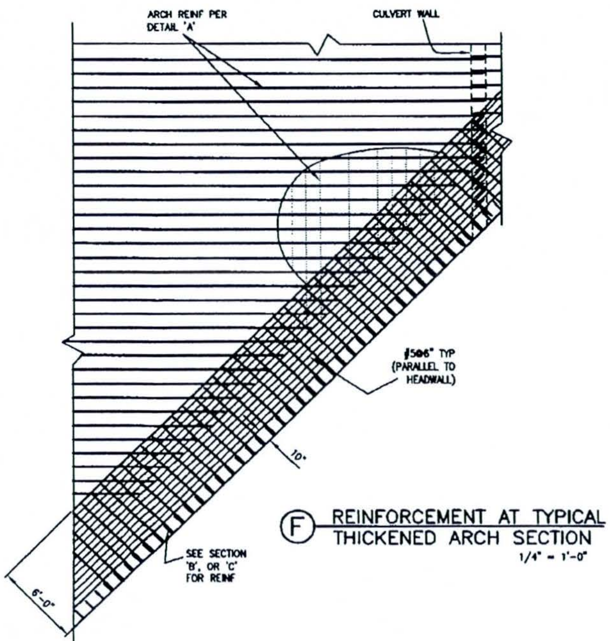
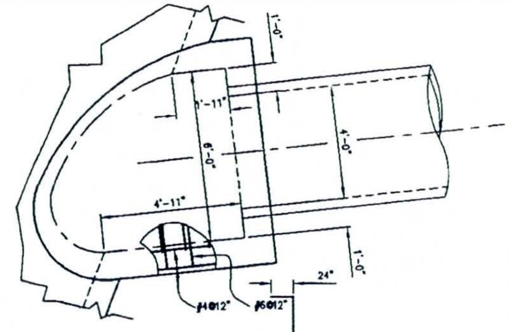
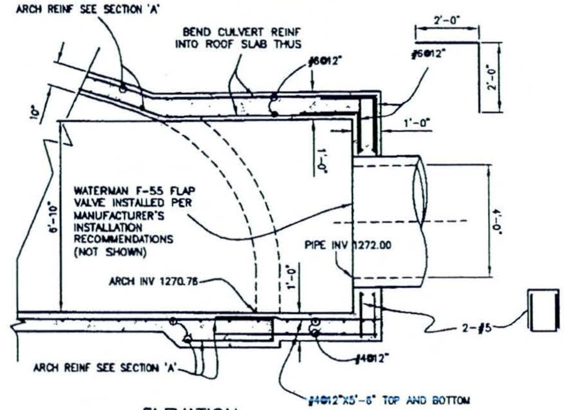
Proj. No. 6138



(F) REINFORCEMENT AT TYPICAL THICKENED ARCH SECTION
1/4" = 1'-0"

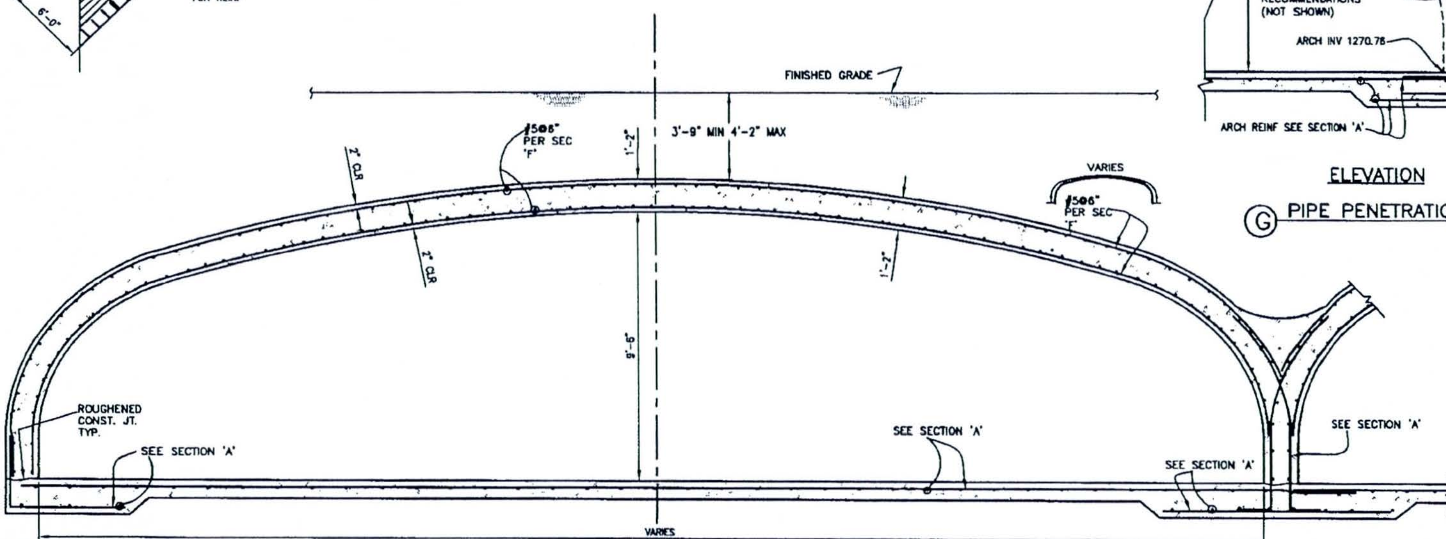


PLAN VIEW



ELEVATION

(G) PIPE PENETRATION



(H) SKEWED ARCH SECTION
1/2" = 1'-0"

CON-ARCH

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NO	DATE	BY	COMMENTS
1 (triangle)			

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INDIAN BEND ROAD CON-ARCH CULVERT DETAILS

SCOTTSDALE, AZ

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APPENDIX III

FIELD LOAD TEST RESULTS SHOWN HERE FOR REFERENCE ONLY, ON THE PERFORMANCE OF CON-ARCH CULVERTS BUILT BY C.L. RIDGEWAY IN THE PAST

CON-ARCH LOAD TEST DATA (page 1 of 2)

Location	# Brls	Span S (ft)	Thick t (in.)	S/t	Cover (ft)	Equipmt Load	Axle Load (kips)	Measured Deflection (in.)	Allow Deflection Span/800	FS
Camino de la Canca, AZ (89-111)	1	32 Circ	9	43	7.5	CAT 988B Loader	60	0.012	0.48	61
	4	25 Circ	8	38	2	CAT 988B Loader	60	0.008	0.38	59
Sun City Las Vegas, NV (92-301)	2	22	8-12	26	2.5	CAT 631D Scraper	91	0.050	0.33	13
Rancho Vistoso, AZ (95-46)	2	20	7-9	30	2.5	CAT 623 Scraper	67	0.034	0.30	13
	2	16	7-9	24	3	CAT 966E Loader	27	0.032	0.24	4
Pinnacle Reserve II, AZ (96-28)	4	28	9	37	1	CAT 966F Loader	27	0.044	0.42	5
ASARCO Ray Mine, AZ (96-27)	1	47	11	51	17	HaulPak 830E Truck	555	0.030	0.71	340
Rio Cancion, AZ (96162)	1	16	7	27	5	CAT 615C Scraper	46	0.008	0.24	33
	2	12	6	24	2	CAT 613C Scraper	30	0.017	0.18	7
Red Hawk, AZ (96146)	2	24 Circ	6	48	3	Concrete Truck	72	0.035	0.36	16
4th Ave, AZ (97-56)	1	8	6	16	0	Concrete Truck	72	0.007	0.12	24
Silverbell Hills AZ (98-22)	3	12	6	24	1.5	CAT 966E Loader	49	0.057	0.18	3
	3	12	6	24	1.5	CAT 627B Scraper	56	0.067	0.18	3
Lowe Reserve C-1 CA, (98-14)	1	42	12	42	2	CAT 970F Loader	49	0.057	0.63	11
	1	42	12	42	4	CAT 970F Loader	49	0.027	0.63	26
	1	24	6.5	44	7	Deere 624 Loader	20	0.010	0.36	18
Gowan I, NV (98-17)	2	20	8	30	1	CAT 923E Scraper	66	0.022	0.30	18

Allowable Deflection of Span/800 is defined for Service LL

Service LL = LL * Impact Factor * Presence Factor — LL = 32 kips

Presence Factor, m = 1.2 for single lane loading — AASHTO 3.6.1.1.2

Impact Factor, IM = 1 + 0.33(1 - 0.125 * Fill Ht) — AASHTO 3.6.2.2

CON-ARCH LOAD TEST DATA (page 2 of 2)										
Location	# Brls	Span S (ft)	Thick t (in.)	S/t	Cover (ft)	Equipmt Load	Axle Load (kips)	Measured Deflection (in.)	Allow Deflection Span/800	FS
Benson Airport AZ	1	16	6	32	3	CAT 631F Scraper	96	0.040	0.24	12
(99-13)	1	12	5	29	2	CAT 623F Scraper	79	0.130	0.16	2
	1	16	6	32	4	CAT 623F Scraper	72	0.025	0.24	15
	1	8	5	19	2	CAT 623F Scraper	72	0.024	0.12	8
	1	12	5	29	2	CAT 623F Scraper	72	0.050	0.18	5
	3	12	7	21	2	CAT 623F Scraper	72	0.033	0.18	8
	2	12	7	21	4	CAT 623F Scraper	70	0.025	0.16	11
	3	12	7	21	1.5	CAT 623F Scraper	70	0.030	0.18	9
Thomp Pk Pkwy (99-12)	2	28	9	37	2	10,000 g Water Tank	56	0.160	0.42	3
Daimler-Chrysler (99054)	6	11	6	22	0.2	Concrete Truck	45	0.026	0.17	6
Anthem (99-18)	1	80	12	80	1	CAT 621F Scraper	68	0.089	1.20	19
S. 12th Avenue (99-25)	1	8	6	16	1	Concrete Truck	64	0.020	0.12	6
Tapo Canyon (99-34)	2	20	8	30	5	Concrete Truck	44	0.005	0.30	69
Ld Test - Concrete (00031)	1	28	6.5	52	1	Jack	187	0.420	0.42	3.8
Ld Test- Shotcrete	1	28	6.5	52	1	Jack	159	0.420	0.42	3.2

APPENDIX IV

REFERENCES

REFERENCES

1. AASHTO (1998); LRFD Bridge Design Specifications, 2nd Edition

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5. CALTRANS, (1994), Bridge Design Practice Manual

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11. Reese, L.C. (1984), Handbook on Design of Piles and Drilled Shafts Under Lateral Loads. FHWA-IP-84-11, July, 360 pp.

APPENDIX V

HEADWALL

DESIGN

SACRA ENGINEERING
215 W Giaconda Way
Tucson, Az
Ph: 520 622 3484
Fax: 520 622 0412

Title : headwall for indian bend
Job # : 6138 Dsgnr: ats
Description....

Page: ______
Date: AUG 7,2005

This Wall in File: D:\6000\6138 indian bend scottsdale\6138

Tapered Stem Concrete Retaining Wall Design

Code: AASHTO

Criteria

Retained Height	=	8.50 ft
Wall height above soil	=	0.00 ft
Slope Behind Wal	=	0.00 : 1
Height of Soil over Toe	=	0.00 in
Water height over heel	=	0.0 ft
Wind on Stem	=	0.0 psf

Vertical component of active lateral soil pressure options:
USED for Soil Pressure.
USED for Sliding Resistance.
USED for Overturning Resistance.

Soil Data

Allow Soil Bearing	=	3,450.0 psf
Equivalent Fluid Pressure Method		
Heel Active Pressure	=	35.0 psf/ft
Toe Active Pressure	=	35.0 psf/ft
Passive Pressure	=	0.0 psf/ft
Soil Density	=	120.00 pcf
Footing||Soil Frictior	=	0.500
Soil height to ignore for passive pressure	=	0.00 in

Footing Strengths & Dimensions

Toe Width	=	0.00 ft
Heel Width	=	6.00
Total Footing Widtr	=	6.00
Footing Thickness	=	14.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	0.00 ft

f'c = 3,000 psi Fy = 60,000 psi
Footing Concrete Density = 150.00 pcf
Min. As % = 0.0018
Cover @ Top = 3.25 in @ Btm.= 2.25 in

Surcharge Loads

Surcharge Over Heel = 240.0 psf
>>>Used To Resist Sliding & Overturning
Surcharge Over Toe = 0.0 psf
Used for Sliding & Overturning

Lateral Load Applied to Stem

Lateral Load	=	0.0 #/ft
...Height to Top	=	0.00 ft
...Height to Bottom	=	0.00 ft

Adjacent Footing Load

Adjacent Footing Load	=	0.0 lbs
Footing Width	=	0.00 ft
Eccentricity	=	0.00 in
Wall to Ftg CL Dist	=	0.00 ft
Footing Type		Line Load
Base Above/Below Soil at Back of Wall	=	0.0 ft
Poisson's Ratio	=	0.300

Axial Load Applied to Stem

Axial Dead Load	=	0.0 lbs
Axial Live Load	=	0.0 lbs
Axial Load Eccentricity	=	0.0 in

Earth Pressure Seismic Load

Design Kh = 0.120 g

Kae for seismic earth pressure = 0.000
Ka for static earth pressure = 0.000
Difference: Kae - Ka = 0.000

Added seismic base force 0.0 lbs
<<----- Note! These are horizontal components

Using Mononobe-Okabe / Seed-Whitman procedure

Stem Weight Seismic Load

F_p / W_p Weight Multiplier = 0.120 g

Added seismic base force 0.0 lbs

Design Summary

Total Bearing Load	=	9,111 lbs	
...resultant ecc.	=	9.35 in	
Soil Pressure @ Toe	=	2,701 psf	OK
Soil Pressure @ Heel	=	336 psf	OK
Allowable	=	3,450 psf	

Soil Pressure Less Than Allowable

ACI Factored @ Toe	=	3,324 psf	
ACI Factored @ Heel	=	413 psf	
Footing Shear @ Toe	=	0.0 psi	OK
Footing Shear @ Heel	=	20.9 psi	OK
Allowable	=	93.1 psi	

Sliding Calcs Slab Resists All Sliding !
Lateral Sliding Force = 2,288.1 lbs

ARCH RESISTS ALL SLIDING

Load Factors

Building Code	AASHTO
Dead Load	1.300
Live Load	2.170
Earth, H	1.690
Wind, W	1.300
Seismic, E	1.000

Tapered Concrete Stem Design Data

Thickness at TOP = 10.00 in Fy = 60,000 psi
Thickness at BOTTOM = 10.00 in f'c = 3,000 psi
Rebar Cover (rebar center to concrete face) 2.40 in

		@ Height #1	@ Height #2	@ Base of Wall
		Stem OK	Stem OK	Stem OK
Design Height Above Ftg	=	6.25 ft	2.00 ft	0.00 ft
Rebar Size	=	# 6	# 6	# 6
Rebar Spacing	=	12.00 in	12.00 in	12.00 in
Rebar Depth 'd'	=	7.10 in	7.10 in	7.10 in
Design Data				
Mu....Actual	=	411.7 ft-#	5,206.4 ft-#	10,327.8 ft-#
Mn * Phi.....Allowable	=	13,201.3 ft-#	13,201.3 ft-#	13,201.3 ft-#
Shear Force @ this height	=	415.9 lbs	2,018.5 lbs	3,142.3 lbs
Vu.....Actual	=	4.88 psi	23.69 psi	36.88 psi
Vn * Phi.....Allowable	=	82.16 psi	82.16 psi	82.16 psi
Rebar Lap Required	=	25.63 in	25.63 in	
Hooked embedment into footing	=			11.50 in

SACRA ENGINEERING
215 W Giaconda Way
Tucson, Az
Ph: 520 622 3484
Fax: 520 622 0412

Title : headwall for indian bend
Job # : 6138 Dsgnr: ats
Description....

Page: ______
Date: AUG 7,2005

This Wall in File: D:\6000\6138 indian bend scottsdale\6138

Tapered Stem Concrete Retaining Wall Design

Code: AASHTO

Footing Design Results

		Toe	Heel
Factored Pressure	=	3,324	413 psf
Mu' : Upward	=	0	16,661 ft-#
Mu' : Downward	=	0	31,624 ft-#
Mu: Design	=	0	14,962 ft-#
Actual 1-Way Shear	=	0.00	20.92 psi
Allow 1-Way Shear	=	0.00	93.11 psi

Toe Reinforcing = # 5 @ 6.00 in
Heel Reinforcing = # 5 @ 6.00 in
Key Reinforcing = None Spec'd

Other Acceptable Sizes & Spacings

Toe: Not req'd, Mu < S * Fr
Heel: #4@ 6.00 in, #5@ 9.25 in, #6@ 13.00 in, #7@ 17.75 in, #8@ 23.25 in, #9@ 2
Key: No key defined

Summary of Overturning & Resisting Forces & Moments

.....OVERTURNING.....

Item		Force lbs	Distance ft	Moment ft-#
Heel Active Pressure	=	2,311.9	3.69	8,539.8
Toe Active Pressure	=	-23.8	0.39	-9.3
Surcharge Over Toe	=			
Adjacent Footing Load	=			
Added Lateral Load	=			
Load @ Stem Above Soil	=			
Seismic Load	=			
Total	=	2,288.1	**O.T.M.** =	8,530.5

Resisting/Overturning Ratio = **3.37**

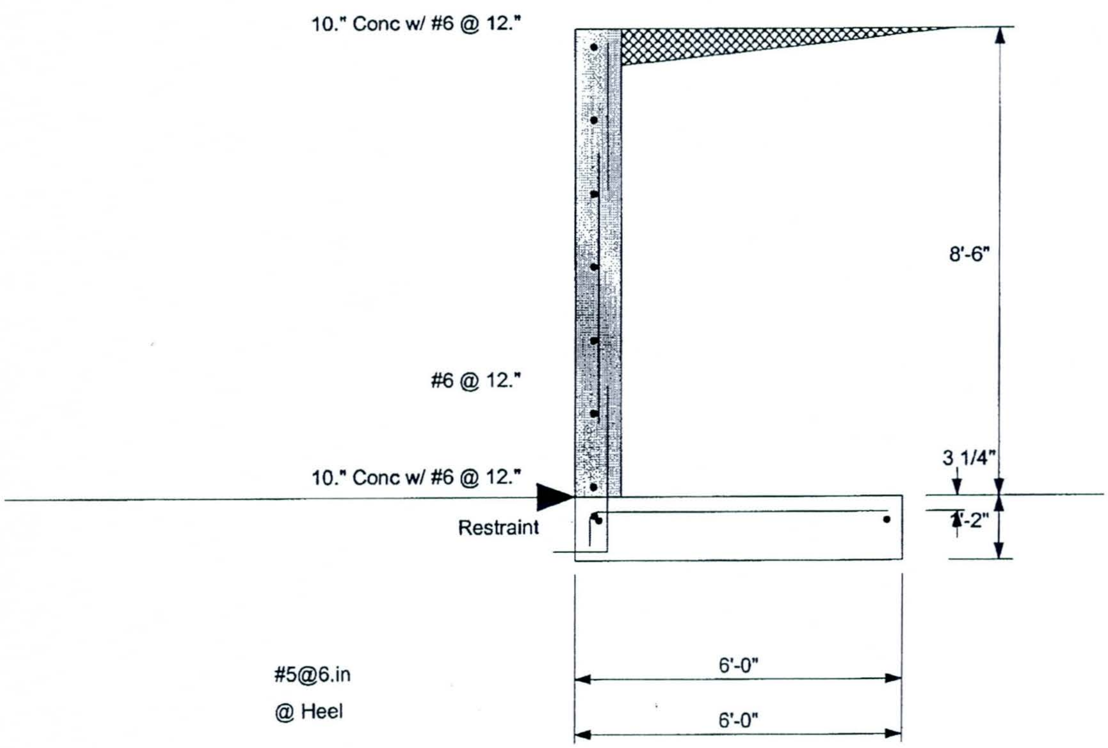
Vertical Loads used for Soil Pressure = 9,110.9 lbs

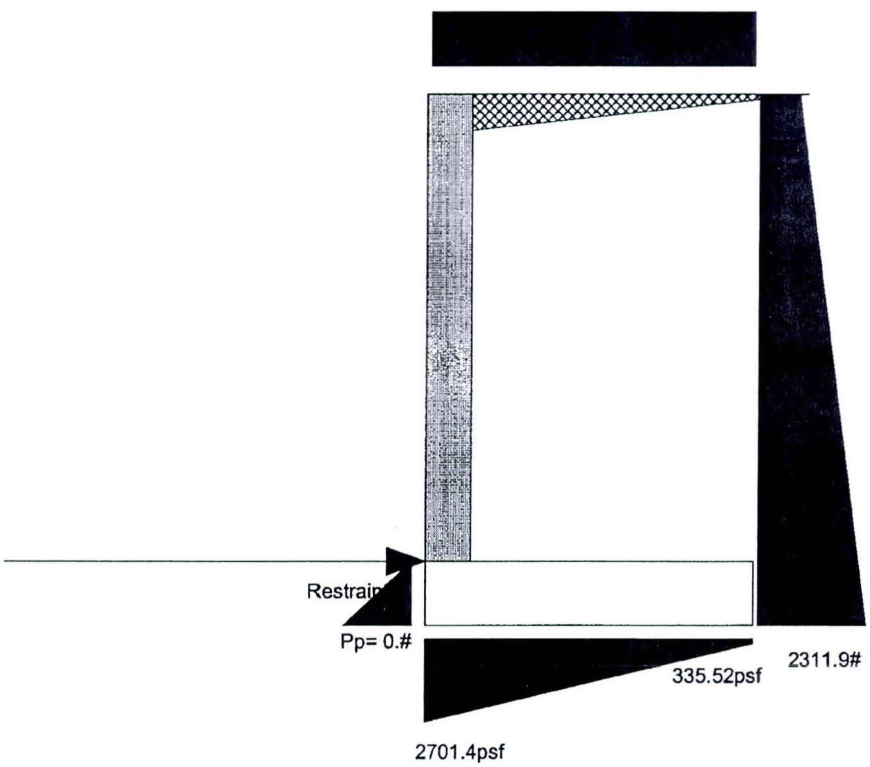
.....RESISTING.....

Item		Force lbs	Distance ft	Moment ft-#
Soil Over Heel	=	5,270.0	3.42	18,005.8
Sloped Soil Over Heel	=			
Surcharge Over Heel	=	1,240.0	3.42	4,236.7
Adjacent Footing Load	=			
Axial Dead Load on Stem	=		0.00	
Soil Over Toe	=			
Surcharge Over Toe	=			
Stem Weight	=	1,062.5	0.42	442.7
Earth above Sloping Stem	=			
Footing Weight	=	1,050.0	3.00	3,150.0
Key Weight	=			
Vert. Component	=	488.4	6.00	2,930.1
Total =		9,110.9 lbs	**R.M.**=	28,765.4

Vertical component of active pressure used for soil pressure

DESIGNER NOTES:


10." Conc w/ #6 @ 12."
8'-6"
#6 @ 12."
3 1/4"
10." Conc w/ #6 @ 12."
Restraint
1'-2"
6'-0"
#5@6.in
@ Heel
6'-0"

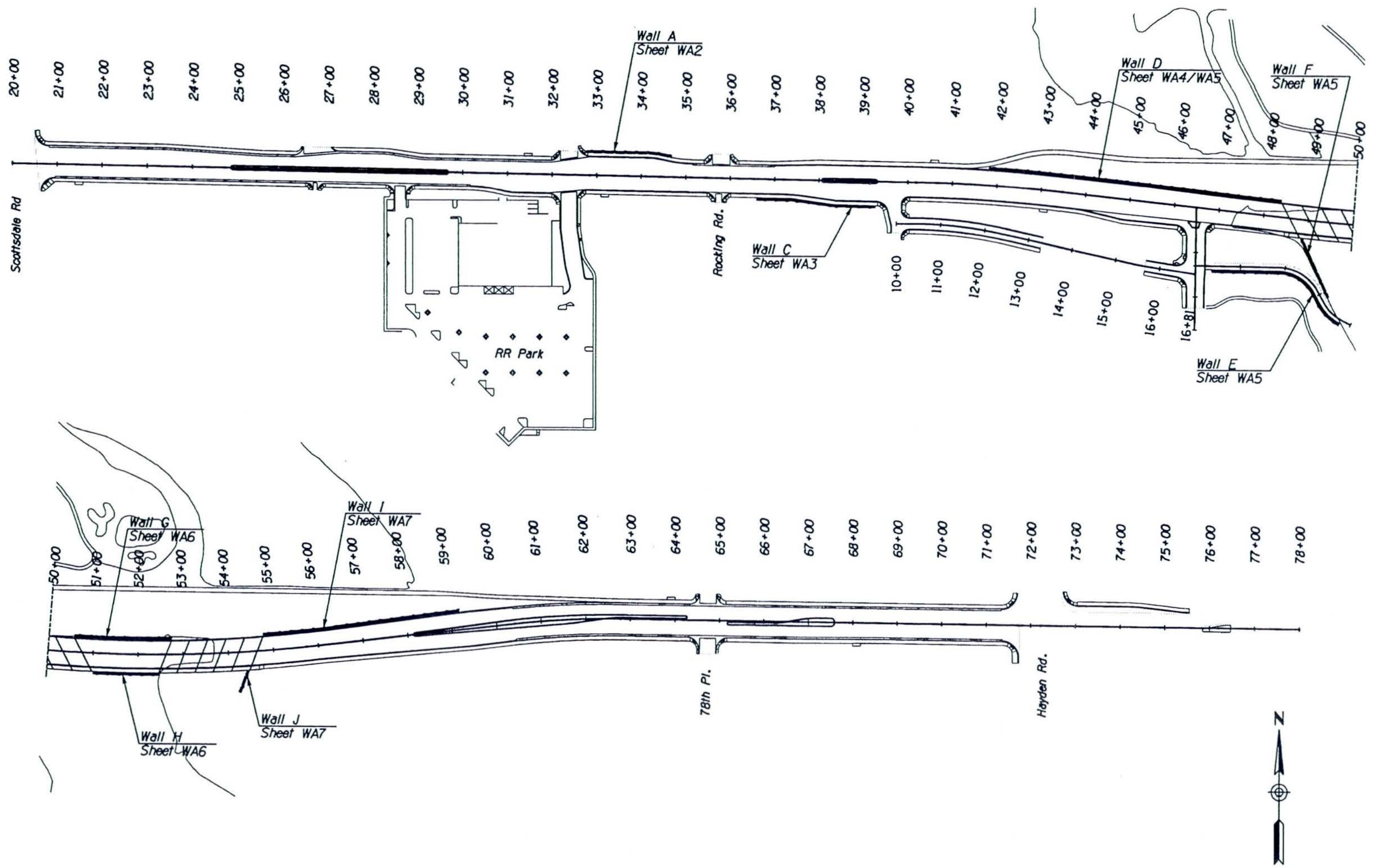


Restrai
Pp= 0.#
335.52psf
2311.9#
2701.4psf

APPENDIX C
RETAINING WALLS

PLOT DATE:6/29/2007 8:25:08 AM

DESIGN FILE:P:\City of Scottsdale\23444553\CADD\Plans\h4553wall-01_keymap.dgn



URS

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WALL PLANS LOCATION PLAN

DATE	REVISION	BY

ENGINEER

Registered Professional Engineer — CERTIFICATE NO. 32342 — RUSSELL A. STUART — ARIZONA, U.S.A.

CITY OF SCOTTSDALE ARIZONA

MUNICIPAL SERVICES DEPARTMENT

CAPITAL PROJECT MANAGEMENT

7447 E. INDIAN SCHOOL RD.
SCOTTSDALE, ARIZONA 85251

PROJECT TITLE

Indian Bend Road Improvements
Scottsdale Rd To Hayden Rd

SCALE	DESIGNED	DATE	BID NO.	SHT.
HORIZ.	RAS	06/07		WA1
VERT.	DRAWN AG	AS-BUILT	PROJECT NO. 410-S-0402	OF