DESIGN REPORT

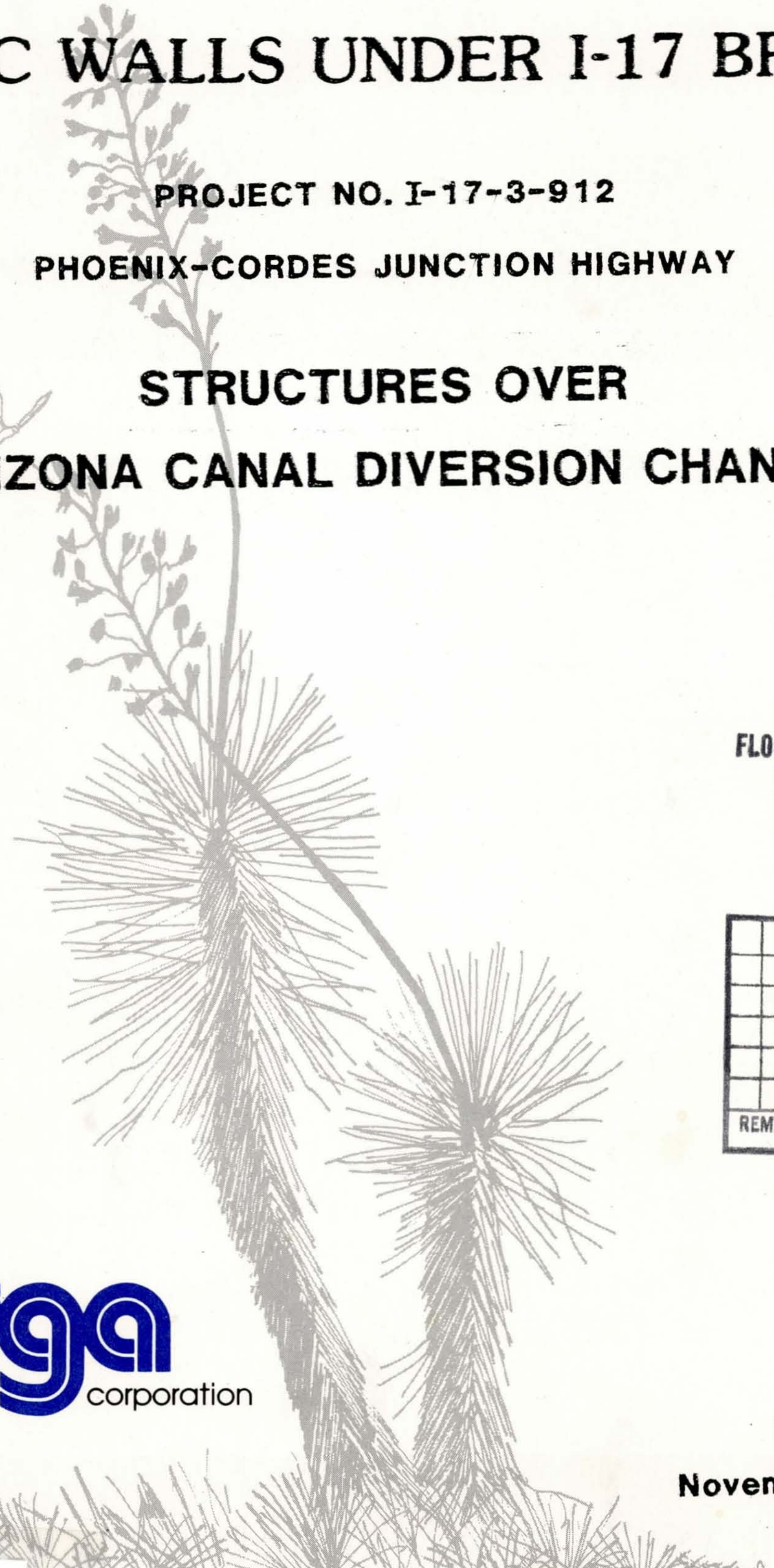
For

ACDC WALLS UNDER I-17 BRIDGE

PROJECT NO. I-17-3-912

PHOENIX-CORDES JUNCTION HIGHWAY

STRUCTURES OVER
ARIZONA CANAL DIVERSION CHANNEL



rga engineering corporation

RGA #85003

November 14, 1985

877 South Alvernon Way • Tucson, Arizona 85711 • (602) 881-4309

930.010

engineering rga corporation

November 14, 1985

Mr. John Lohr, P.E.
Consultant Liaison
Arizona Department of Transportation
Highway Plan Services
205 South 17th Avenue, Room 108E
Phoenix, Arizona 85007

Re: I-17 Bridge over the ACDC
RGA #85003

Dear Mr. Lohr:

The purpose of this letter and attached set of structural calculations is to respond to Los Angeles Corps of Engineers (COE) comments noted in their September 13, 1985, letter to the Flood Control District of Maricopa County.

These comments were directed at the conceptual sketches dated August 1983, which employed a scheme to drill 2'-6" diameter shafts a 5'-6" o.c., excavate the channel, shotcrete the vertical earth surfaces between the drilled shafts, and then construct a finish wall to match the alignment of the channel walls. The structural intent of this scheme was to design the shotcrete thickness to transmit the potential lateral earth pressures to the drilled shafts without the use of welded wire fabric. This shotcrete layer would also act as an earth stabilizer and aid in preventing sloughing. The drilled shafts were considered to act as piles that were pinned at the top; therefore, transmitting only axial loads into the bridge superstructure. The finish wall was to achieve final channel alignment requirements. This wall was tied into the drilled shafts for its stability using steel dowels.

We have know modified this scheme to incorporate certain COE preferences. This earth retainage scheme still employs the use of the drilled shafts as previously noted but now uses the finish wall as the main element for transmitting lateral earth pressure loads to the drilled shafts instead of the shotcrete elements. (Note that the shaft spacing has increased to 6'-0" o.c. based on the final geotechnical report.) The shotcrete now becomes mainly an earth stabilizer to prevent sloughing and will act as a filler between the earth and the finish wall.

We are in concurrence with the COE that the lateral stability of the drilled shaft is a very critical part of the design and have therefore provided additional pile design analysis supporting the present scheme in the attached calculations. Other COE concerns and/or preferences have been accounted for in the modification of the structural wall scheme.

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Please see the attached sketches and calculations for further information. We hope this satisfies the concerns of the COE and ask that you please call us if any questions should arise.

Very truly yours,

RGA ENGINEERING CORPORATION

Salvatore E. Caccavale

Salvatore E. Caccavale, P.E.
Project Engineer

SEC:kjw

cc: J.D. Brown, RGA
Harold Ditzler, RGA
File

PRELIMINARY STRUCTURAL CALCULATIONS

LATERAL STABILITY OF THE
REINFORCED CONCRETE WALL SYSTEM

TABLE OF CONTENTS

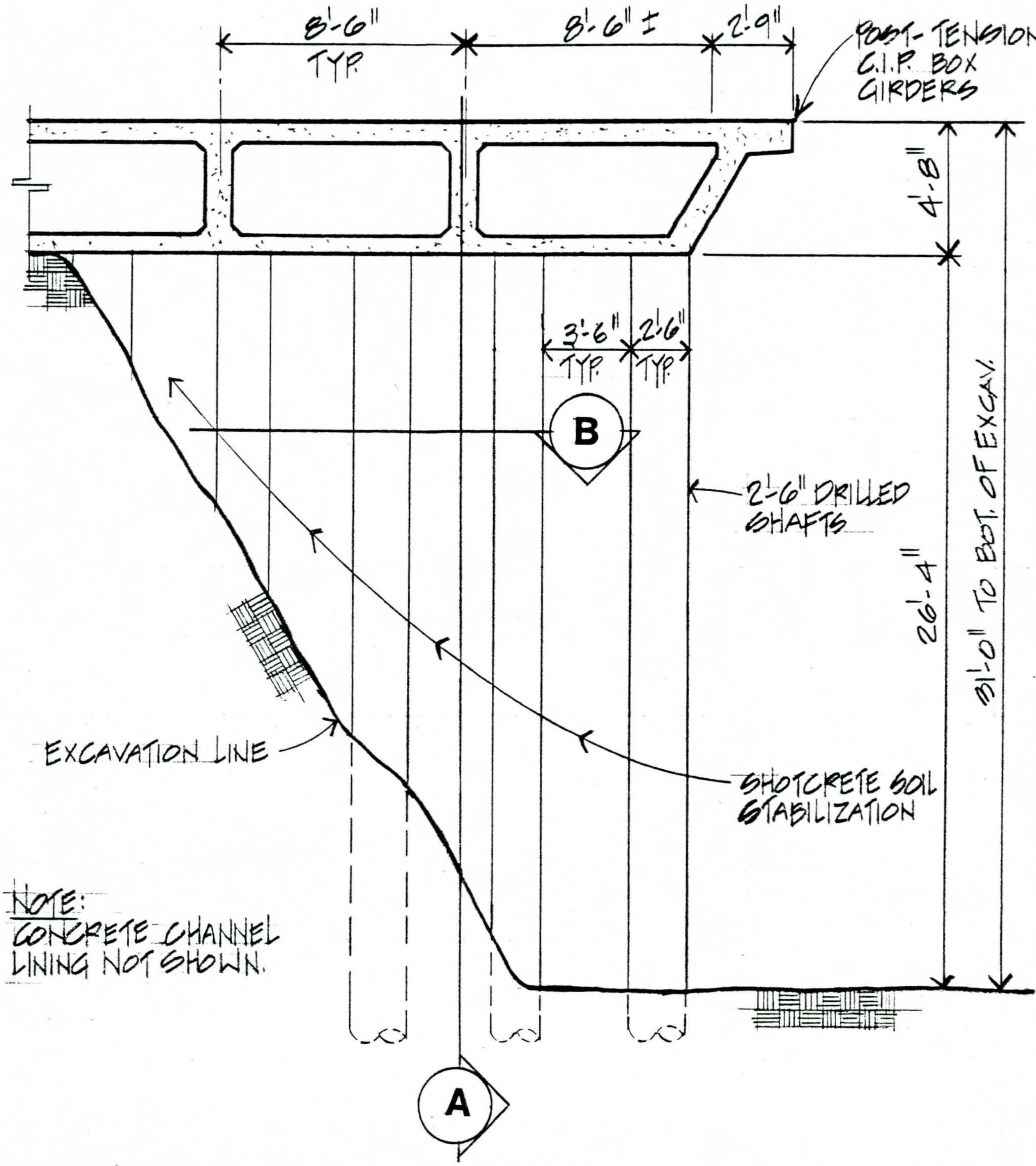
SKETCHES

rga consulting engineers

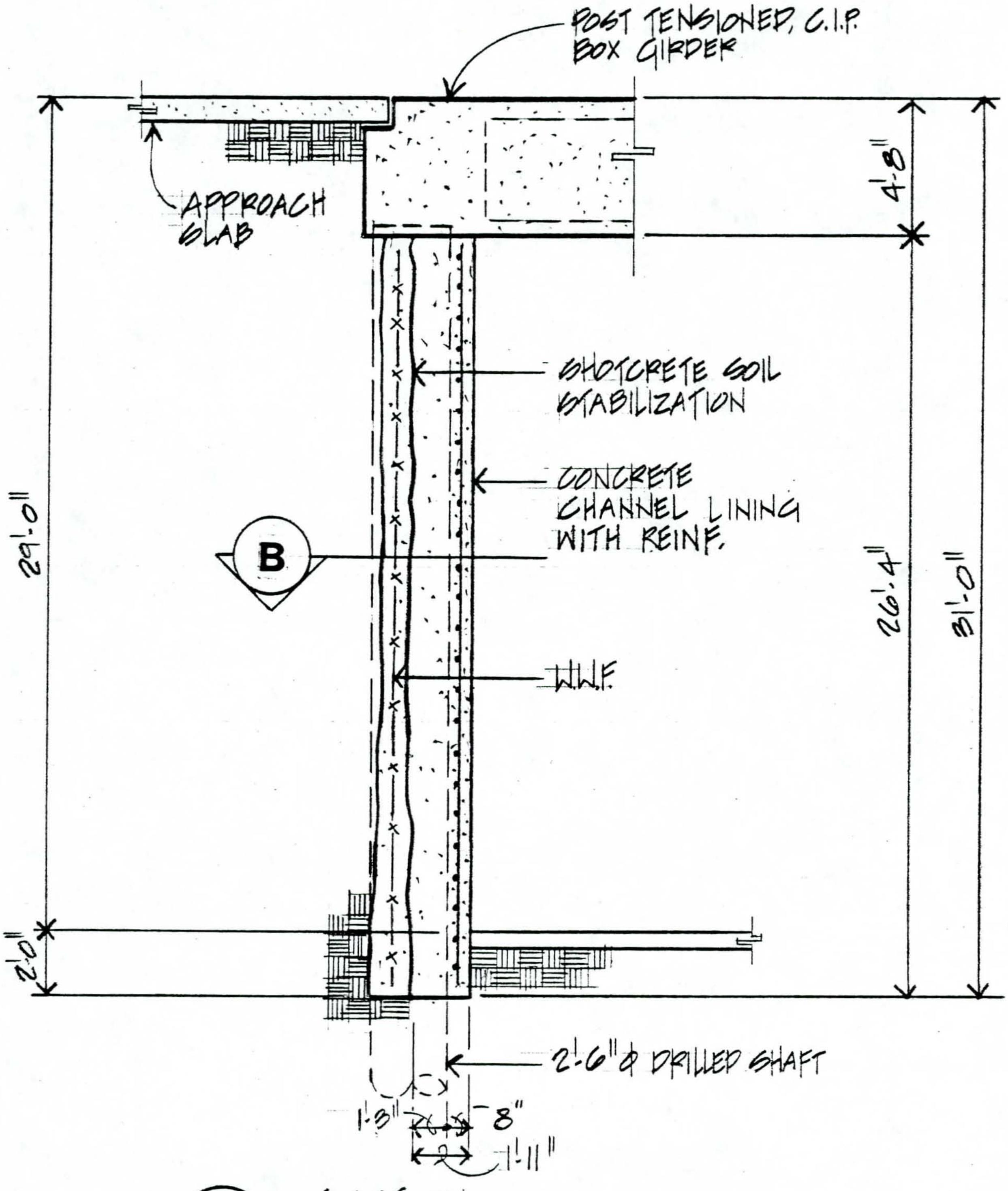
project I-17 BRIDGES @ A.C.D.C. no. 85003

client A.D.O.T. design GAL date 8/85

subject DRILLED SHAFTS AND CHANNEL LINING checked D.R.L. date 8/85



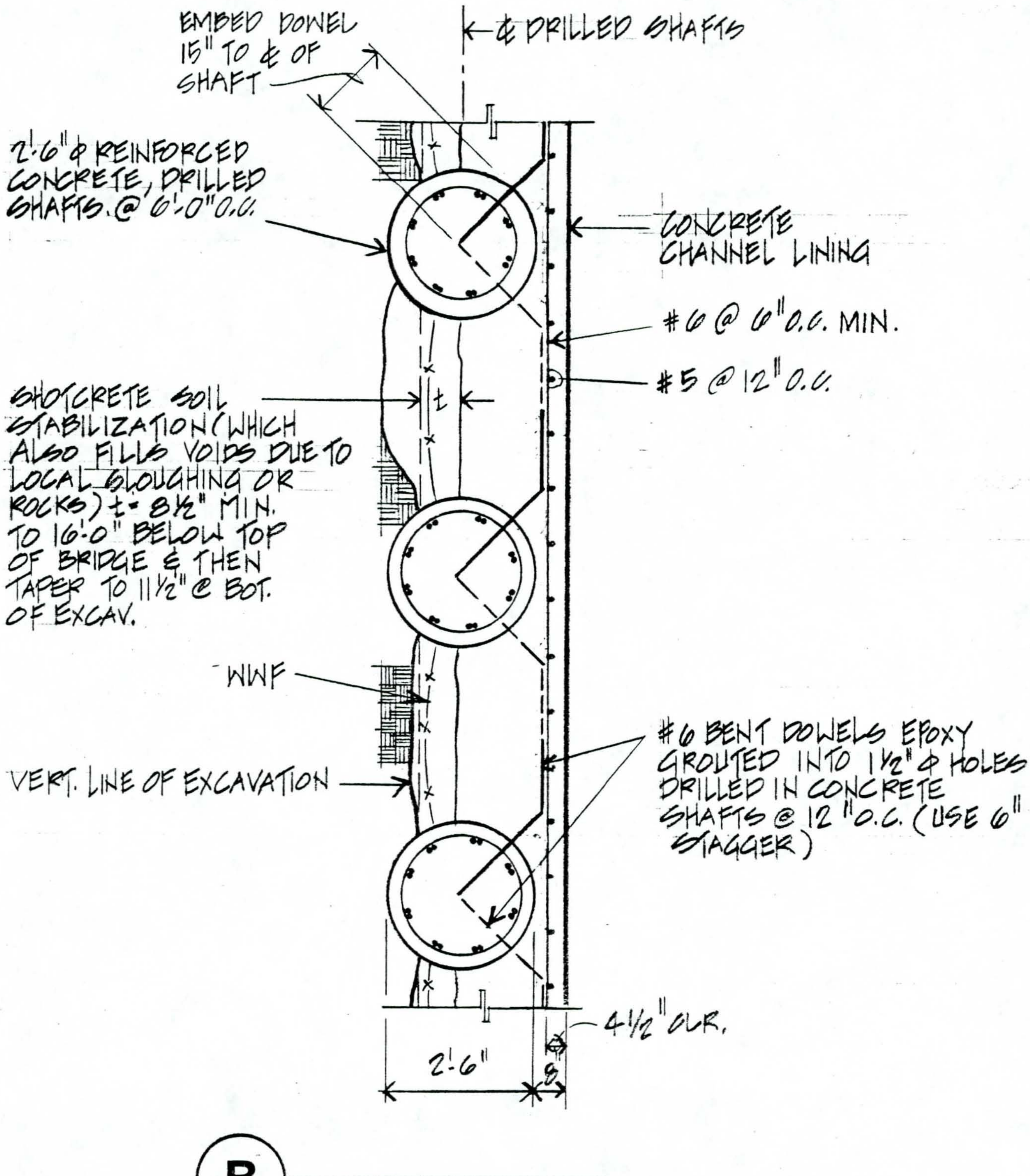
project I-17 BRIDGES @ A.C.D.C. no. 85003
client A.D.O.T. design SAL date 8/85
subject DRILLED SHAFTS AND CHANNEL LINING checked D.R.L. date 8/85



A SECTION
3/16" = 1'-0"

rga consulting engineers

project I-17 BRIDGES @ A.C.D.C. no. 85003
client A.D.O.T. design SAL date 8/85
subject DRILLED SHAFTS AND CHANNEL LINING checked D.R.L. date 8/85



B

NO SCALE

CALCULATIONS

rga engineering corporation

project: I-17 ACDC BRIDGES — no. 85003
client: ADOT — design: sal — date: 11/85
subject: CHANNEL LINING DESIGN — checked: [illegible] — date: 11/85

CHANNEL WALL LINING DESIGN (REF. APPENDIX B FOR SOIL PROFILE)

for 6'-0" MAX SPACING ON DRILLED SHAFTS

$M_{MAX} \approx \frac{wl^2}{10}$ (CONSERV)

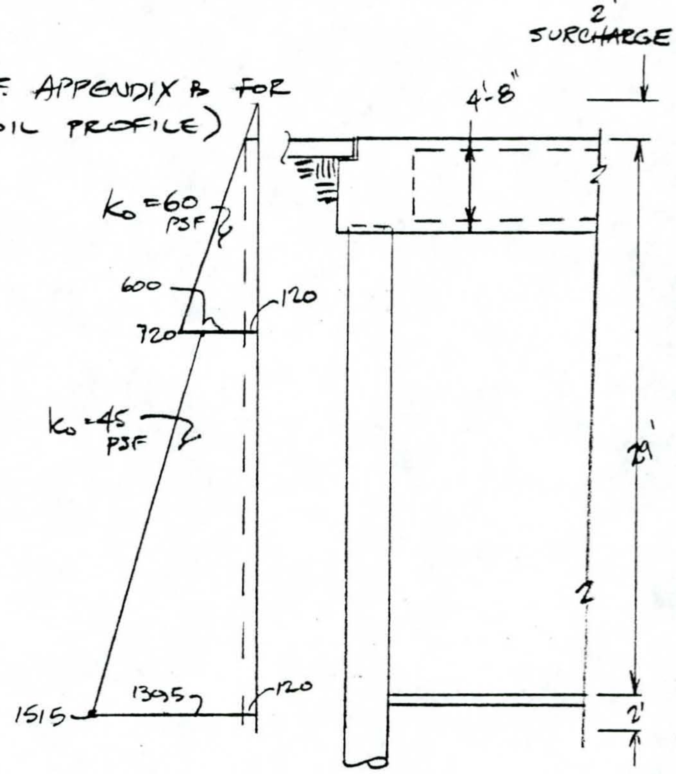
$= \frac{1515(6.0)^2}{10} = 5450$ FT.LB/FT

& $R = \frac{wl}{2}$

$= \frac{1515(6.0)}{2} = 4550^{\#}/FT$

$A_s(req'd) = \frac{M}{jF_yd} \Rightarrow \frac{5450(12)}{.88(20000)4.5}$

$= 0.83$ IN²/FT



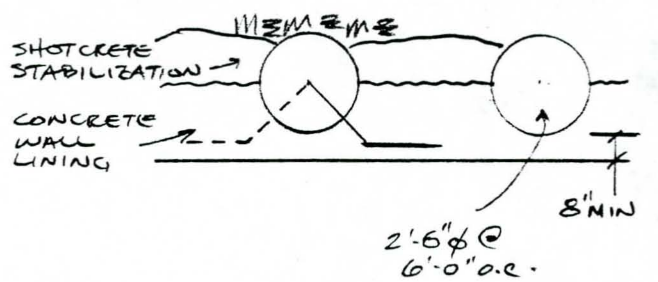
USE #6's @ 6" o.c. @ BTM. OF 8" WALL

CHANNEL WALL ANCHORAGE DESIGN (REF. SKETCH FOLLOWING)

WALL TO BE ANCHORED TO PIERS, $R = 4550^{\#}/FT$ (SEE ABOVE)

$A_s(req'd) = \frac{4550\sqrt{2}}{20000}$ ← for 45°

$= .32$ IN²/FT



USE #6 DOWELS @ 12" o.c (E.W.) w/ 15" MIN. EMBED.

CHECK EMBEDMENT

$l_d = 18"$ for 100% DEVELOPMENT for #6

$l_{prov} = 15"$

$T_{PULLOUT}(ALLOW) = .44(20000)\frac{15"}{18"} = 7330^{\#} > 4550\sqrt{2} = 6430^{\#}$ REQ'D

∴ OK

rga engineering corporation

project: I-17 ACDC BRIDGES — no. 85003
client: ADOT — design: [illegible] — date: 11/85
subject: DRILLED SHAFT DESIGN — checked: [illegible] — date: 11/85

DRILLED SHAFT (SUPPORTING BRIDGE & EARTH) DESIGN

- FOR EARTH PRESSURE LOADING CONFIG. SEE PREVIOUS PAGE
- FOR LATERAL ANALYSIS SEE APPENDIX A ATTACHED (ANALYSIS by DESERT EARTH ENGINEERING)

$M_{SHAFT} = 518$ KFT @ 5.5' o.c.

$\therefore M_{SHAFT} = 518\left(\frac{6.0}{5.5}\right) = 565$ KFT. @ 6'-0" o.c.

& $M_U = \frac{1.3}{.9}(565) = 816$ KFT

$P_U = V_U(\text{TOTAL}) / 8\,\text{WEBS}$ (ASSUMES ONE WEB DIRECTLY OVER ONE SHAFT, CONSERVATIVE)

$= 2550/8 = 320\,K\ (TL)$

$P_{U(DL)} = \frac{1.3}{.9}(1156)/8 = 209\,K\ (DL)$

USE 2'-6" φ DRILLED SHAFT (4 KSI CONC) @ 6'-0" o.c. w/ 16-#11 & #4 TIES

(REF. NEXT PAGE)

ROUND COLUMN ANALYSIS

DATA INPUT BY: SAL

CHECKED BY: ________

** COLUMN MARK 2.5',4KSI

** INPUT CRITERIA:

COLUMN DIAMETER	30.0 IN	COVER TO TIES	3.00 IN
SIZE OF VERTICALS	# 11 BARS	CONCRETE F'C	4.0 KSI
SIZE OF TIES	# 4 BARS	REINFORCEMENT FY	60. KSI

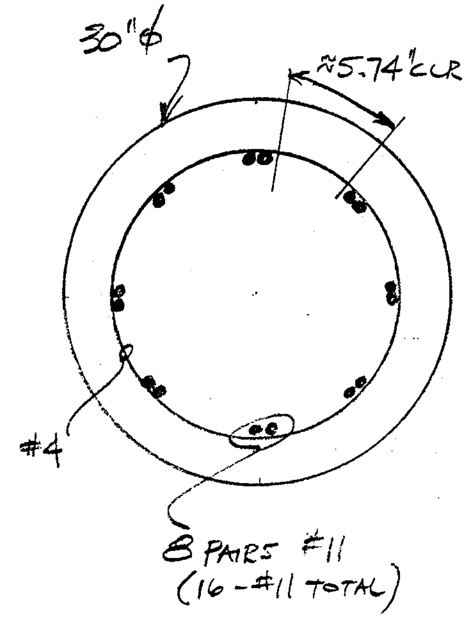
NUMBER OF VERTICALS 16

** RESULTS OF CALCULATIONS:

TOTAL REINFORCEMENT 24.98 SQ IN - 3.53% OF COLUMN

INTERACTION CURVE POINTS

	P-ULTIMATE KIPS	MOMENT FT-K	ECCENTRICITY INCHES	
	2672.2	0.0	0.0	
	2175.0	360.3	1.99	
	1967.0	497.1	3.03	
	1714.8	626.4	4.38	
	1419.8	737.4	6.23	
	1355.1	757.1	6.70	
	1288.2	776.1	7.23	
	1219.1	794.2	7.82	
	1147.5	811.6	8.49	
	1073.3	828.3	9.26	
	996.2	844.4	10.17	
	915.9	860.0	11.27	
	832.1	875.2	12.62	
	744.5	890.0	14.34	
	655.4	902.1	16.52	
	572.9	904.1	18.94	
	492.9	899.6	21.90	
	413.6	889.4	25.81	
	335.1	874.6	31.32	
	319.5	871.1	32.72	← TL
	303.9	867.5	34.25	
	288.4	863.7	35.94	
	285.3	863.0	36.30	← DL only
0.1F'C*AG	282.8	862.3	36.60	
BALANCED	694.0	898.1	15.53	
PURE BENDING	0.0	982.9	-	

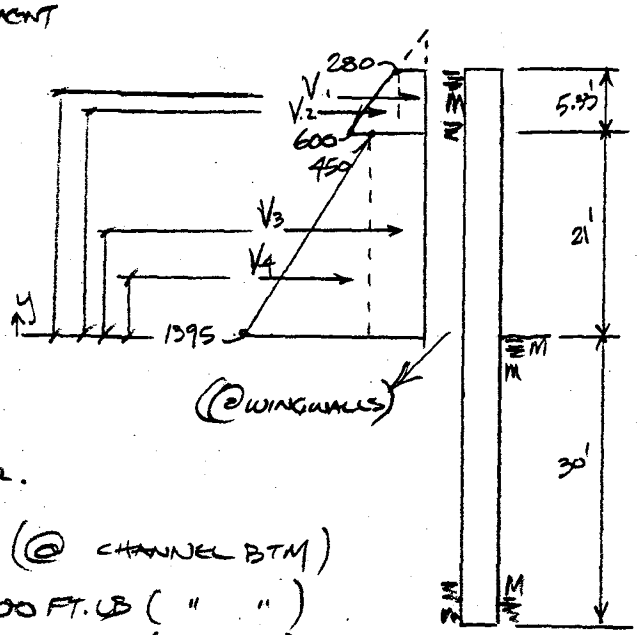


project I-17 ACDC BRIDGES no. 85003
client ADOT design [initials] date 11/85
subject DRILL SHAFT DESIGN checked [initials] date 11/85

DRILLED SHAFT SUPPORTING EARTH @ WINGWALLS (PRELIMINARY)

THESE SHAFTS TO RETAIN EARTH SIMILAR TO THOSE @ BRIDGE SPPT; HOWEVER, THEY MUST CANTILEVER FROM CHANNEL BTM. USE 3'-6" MAX. CLR.

	V (LBS)	y (FT.)	Vy (FT.LB) = MOMENT
1	1492	23.7	35360
2	852	22.8	19410
3	9450	10.5	99230
4	9920	7	69440
	ΣV = 21714 LB/FT		ΣM = 223440 FT.LB/FT.



TRY 4'-0" ϕ SHAFTS @ 7.5' o.c.

$V_{TOTAL} = 7.5(21714) = 163K$ (@ CHANNEL BTM)

$M_{TOTAL} = 7.5(223440) = 1{,}676{,}000$ FT.LB (" ")

$= 1680$ KFT (" ")

ANALYZE SHAFT USING LATERAL LOAD ON PILES COMPUTER PROGRAM (SEE PGS FOLLOWING)

$M_{MAX} = 2640$ KFT

$M_U = 1.3(2640) = 3432$ KFT

∴ USE 4'-0"ϕ SHAFT w/ 32-#11 BARS

(REF. PG. 15 COMP. RUN)

CHECK SHEAR

$V_{MAX} \cong 202K \quad \therefore V_U \cong 1.3(202) = 263K$

$v = \frac{263}{(48)^2 \pi/4} = .145$ ksi (OK USING TIES AS STIRRUPS)

RGA CON[illegible]
TUCSON, ARIZONA

JECT NUMBER: 85003 10
PROCESSED ON 11/27/85
PAGE 1

LATERAL LOADS ON PILES

INPUT BY: SAL

CHECKED BY:__________

I_17 BRIDGE @ ACDC - 4' DRILLED SHAFT (7.5'OC) @ WINGWALLS

** INPUT CRITERIA:

FREE HEAD PILE
NUMBER OF DIVISIONS - - - - - - - - - - 30
LENGTH OF PILE IN FEET- - - - - - - - - 30.000
MODULUS OF ELASTICITY IN KIPS/IN2 - - 3605.000
HORIZONTAL LOAD IN KIPS - - - - - - - 163.000
MOMENT AT GROUND SURFACE IN FT-KIPS - 1680.000

PT	SOIL VALUES IN TONS/FT3	WIDTH IN FEET	MOMENT OF INERTIA IN FT4
1	-56.00000	4.00000	0.0
11	-21.00000	4.00000	0.0

** RESULTS OF CALCULATIONS:

DISTANCE FROM TOP IN FEET	DEFLECTION IN INCHES	EARTH PRESSURE KIPS/FT2	EARTH LOAD KIPS/FT	SHEAR KIPS	MOMENT FT-KIPS	SLOPE RADIANS
0.0	-1.720	0.0	0.0	163.000	1680.00	0.010271
1.00	-1.598	-1.399	-5.594	160.203	1843.00	0.010001
2.00	-1.480	-2.590	-10.360	152.225	2000.41	0.009706
3.00	-1.365	-3.584	-14.337	139.877	2147.45	0.009388
4.00	-1.255	-4.392	-17.566	123.925	2280.16	0.009049
5.00	-1.148	-5.024	-20.094	105.094	2395.30	0.008691
6.00	-1.046	-5.492	-21.970	84.062	2490.35	0.008316
7.00	-0.949	-5.811	-23.242	61.457	2563.43	0.007929
8.00	-0.856	-5.991	-23.964	37.853	2613.26	0.007532
9.00	-0.768	-6.047	-24.189	13.777	2639.13	0.007130
10.00	-0.685	-5.992	-23.967	-10.301	*2640.81*	0.006725
11.00	-0.606	-5.838	-23.350	-33.959	2618.53	0.006322
12.00	-0.533	-5.597	-22.388	-56.828	2572.90	0.005924
13.00	-0.464	-5.282	-21.127	-78.586	2504.87	0.005535
14.00	-0.400	-4.903	-19.610	-98.954	2415.72	0.005158
15.00	-0.341	-4.470	-17.879	-117.699	2306.96	0.004796
16.00	-0.285	-3.992	-15.967	-134.621	2180.33	0.004452
17.00	-0.234	-3.476	-13.905	-149.557	2037.72	0.004128
18.00	-0.186	-2.930	-11.720	-162.370	1881.21	0.003828
19.00	-0.142	-2.358	-9.432	-172.947	1712.98	0.003552
20.00	-0.101	-1.764	-7.055	-181.190	1535.32	0.003303
21.00	-0.063	-3.065	-12.260	-190.847	1350.60	0.003082
22.00	-0.027	-1.376	-5.504	-199.729	1153.62	0.002890
23.00	0.007	0.366	1.463	-201.750	951.14	0.002729
24.00	0.039	2.167	8.667	-196.685	750.12	0.002599
25.00	0.069	4.036	16.143	-184.280	557.77	0.002498
26.00	0.099	5.985	23.939	-164.239	381.56	0.002426
27.00	0.127	8.027	32.109	-136.215	229.29	0.002380

LATERAL LOADS ON PILES

I_17 BRIDGE @ ACDC - 4' DRILLED SHAFT (7.5'OC) @ WINGWALLS

** RESULTS OF CALCULATIONS:

DISTANCE FROM TOP IN FEET	DEFLECTION IN INCHES	EARTH PRESSURE KIPS/FT2	EARTH LOAD KIPS/FT	SHEAR KIPS	MOMENT FT-KIPS	SLOPE RADIANS
28.00	0.156	10.176	40.705	-99.808	109.13	0.002354
29.00	0.184	12.444	49.776	-54.567	29.68	0.002343
30.00	0.212	14.839	59.358	0.0	0.0	0.002341

ROUND COLUMN ANALYSIS

DATA INPUT BY: SAL CHECKED BY: ________

** COLUMN MARK 4' W/32#11

** INPUT CRITERIA:

COLUMN DIAMETER	48.0 IN	COVER TO TIES	3.00 IN
SIZE OF VERTICALS	# 11 BARS	CONCRETE F'C	4.0 KSI
SIZE OF TIES	# 4 BARS	REINFORCEMENT FY	60. KSI

NUMBER OF VERTICALS 32

** RESULTS OF CALCULATIONS:

TOTAL REINFORCEMENT 49.97 SQ IN - 2.76% OF COLUMN

INTERACTION CURVE POINTS

	P-ULTIMATE KIPS	MOMENT FT-K	ECCENTRICITY INCHES
	6286.4	0.0	0.0
	5171.4	1442.2	3.35
	4665.8	2014.0	5.18
	4066.3	2544.5	7.51
	3375.9	2998.8	10.66
	3226.0	3079.6	11.46
	3071.9	3157.3	12.33
	2913.1	3231.8	13.31
	2749.5	3303.6	14.42
	2580.7	3372.8	15.68
	2406.2	3439.7	17.15
	2225.6	3504.9	18.90
	2038.3	3568.7	21.01
	1860.7	3604.1	23.24
	1691.1	3614.5	25.65
	1525.5	3606.9	28.37
	1362.4	3583.7	31.56
	1201.3	3546.1	35.42
	1041.7	3495.0	40.26
	883.1	3430.8	46.62
0.1F'C*AG			
	723.8	3353.0	55.59
BALANCED			
	2038.2	3568.7	21.01
PURE BENDING			
	0.0	3644.1	-

APPENDICES

APPENDIX A

LATERAL LOAD ANALYSIS ON DRILLED SHAFTS
By Desert Earth Engineering

November 8, 1985
85-290

RGA Consulting Engineers
877 South Alvernon Way
Tucson, Arizona 85711

ATTN: Sal Caccavale P.E.

RE: Lateral Load Analysis
I-17 Bridges Across Arizona Canal
RGA Job #85003

Gentlemen:

Enclosed are our analyses for the lateral loads applied to the drilled piers at the above-captioned location.

The following three pier configurations have been analyzed.

Figure #	Pier Diameter (ft)	Pier Spacing (ft)	Pier Depth Below Grade (ft)
1	2.5	5.5	60
2	2.5	5.5	50
3	3.0	8.0	60

Moment, deflection, and soil pressure are presented on Figures 1, 2, and 3 for each ease.

Based on our analysis either of the configurations would be economical and feasible. The ability of the soil to bridge a 5 ft span between piers should be checked if an 8 ft O.C. spacing is used.

An earthquake loading of 8k/pier superimposed on the at-rest-soil pressure loading has not been added.

DESERT EARTH ENGINEERING
524 North Sixth Avenue
Tucson, Arizona 85705

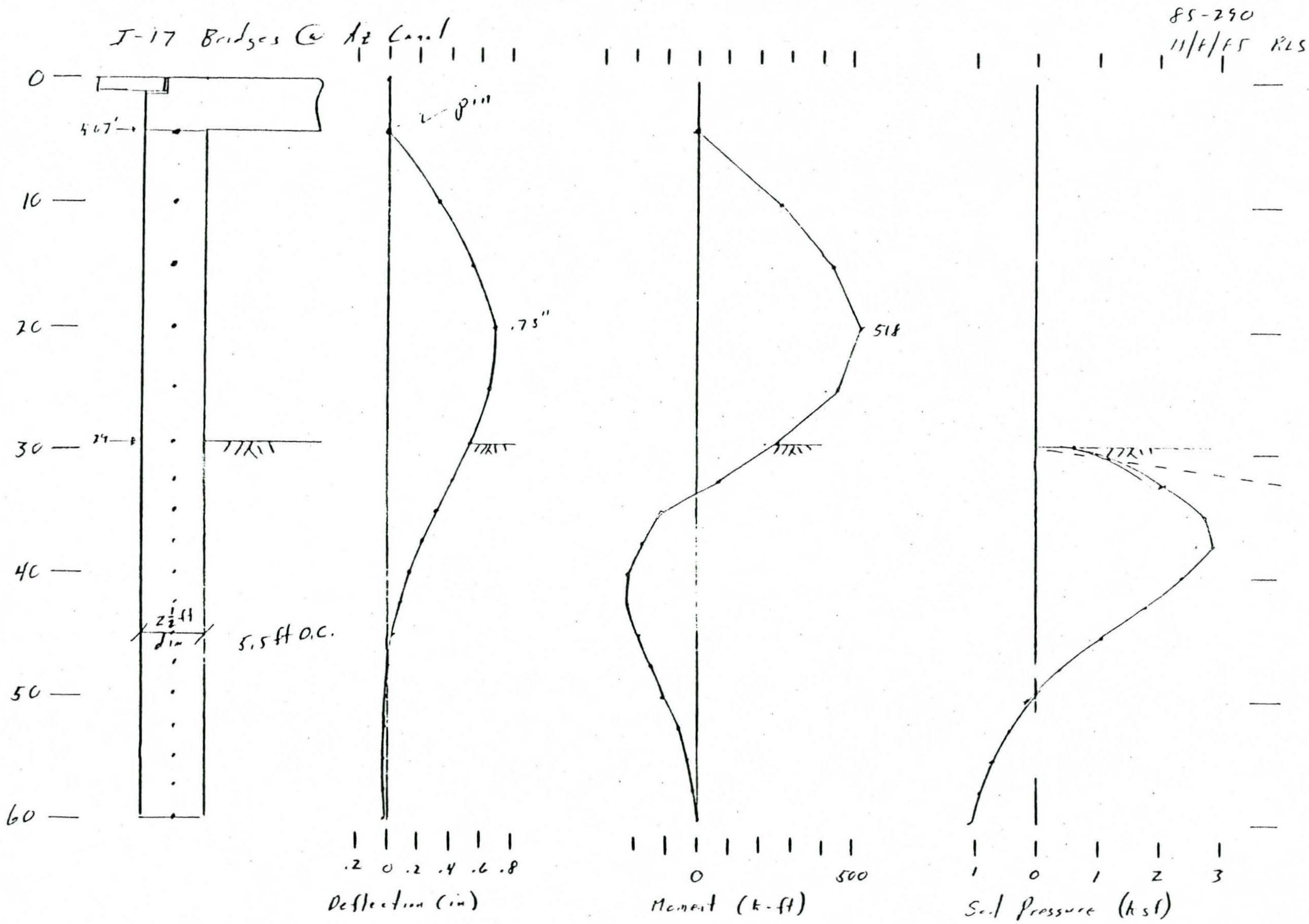
We thank you for the opportunity to help you on short notice. We are available if further work or clarification is desired.

Submitted by:

Registered Professional Engineer (Civil)
CERTIFICATE NO.
10296
ROBERT L.
SOGGE
Date Signed
ARIZONA, U.S.A.

R. L. Sogge P.E.

RLS/jmh
Copies: (1) Addressee
Enclosures: (3) Figures

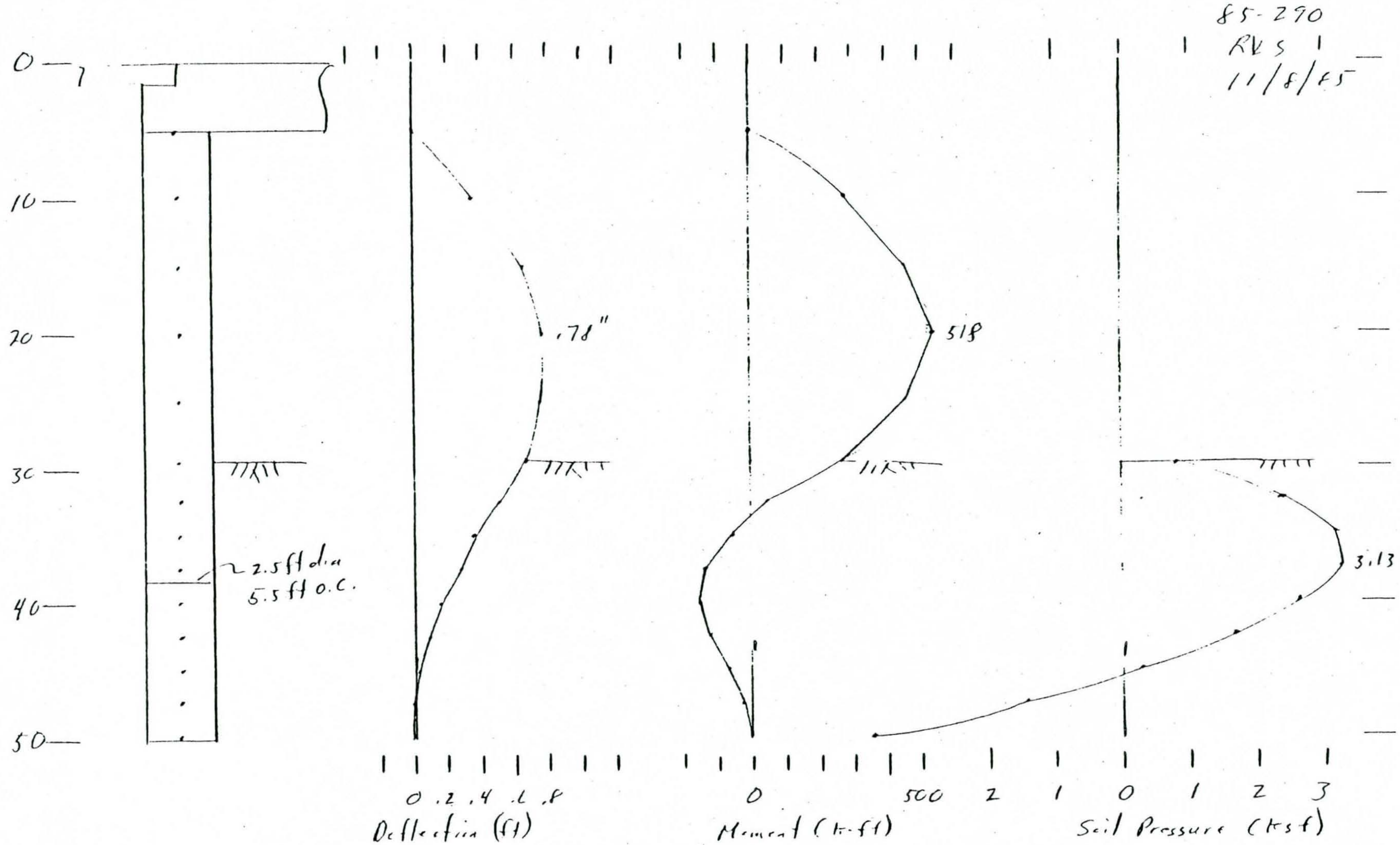


Desert Earth Engineering

consulting geotechnical engineers

Drawn by:	Date	Checked by:	Date
RLS	11/8/85		

Sheet of	Job No.	Figure No.
	85-290	1



Desert Earth Engineering

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RVS	11/8/85		

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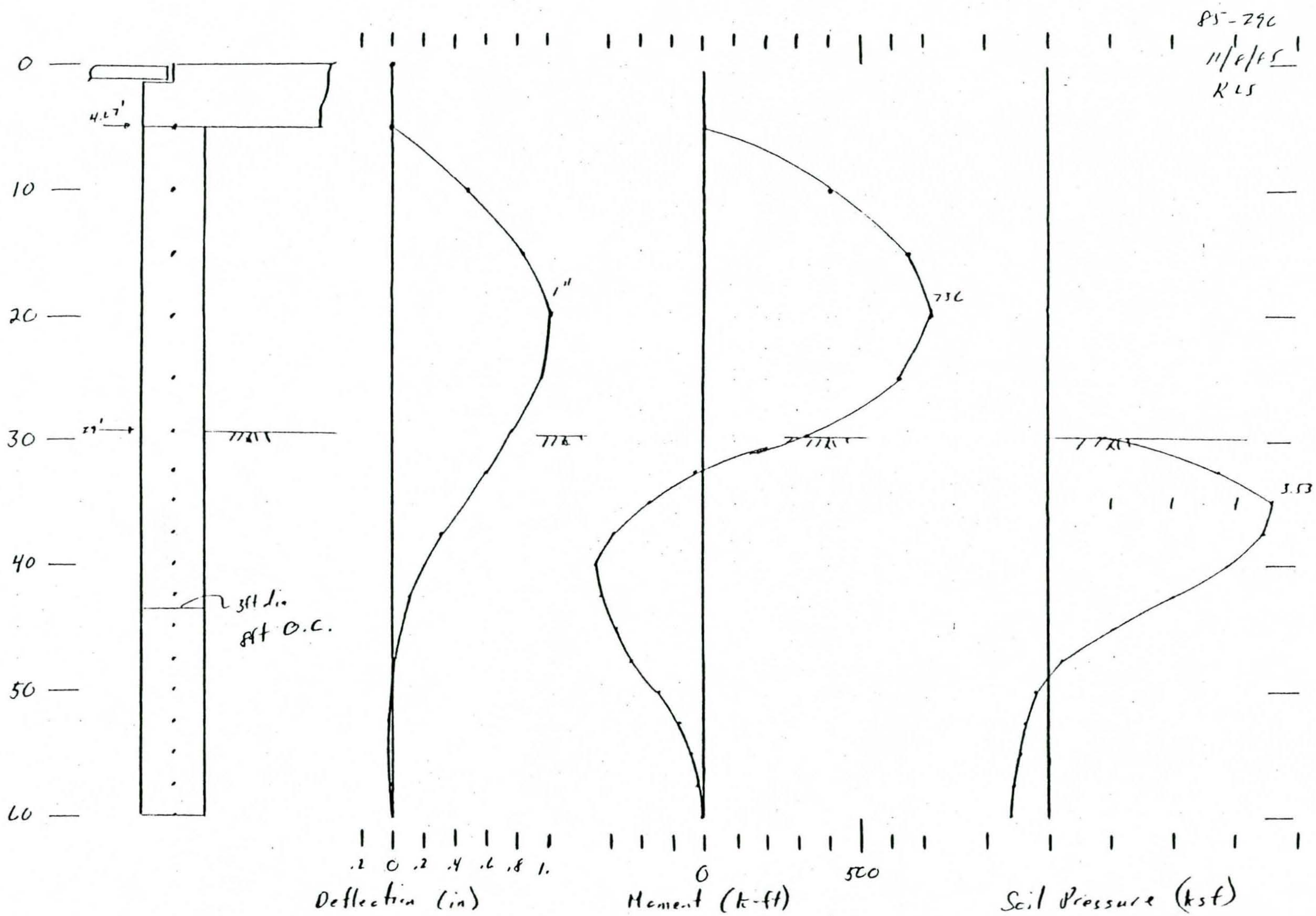


Desert Earth Engineering

consulting geotechnical engineers

Drawn by:	Date	Checked by:	Date
RLL	11/8/85		

Sheet of	Job No.	Figure No.
	85-296	3

CALCULATION COVER SHEET

Job No. 85-290 | No. of Sheets 7

PROJECT: I-17 Bridges Across Arizona Canal

FEATURE: Lateral loads on Piers

ITEM: Pier Deflections, Moments + Soil Pressures

SOURCE OF DATA:
RGA Preliminary design
WTI Soil Report dated Oct 1, 1985

REFERENCES:
Laterally Loaded Pile Design
J of the Geol. Engr Div. Sept 81, pp 1179-1199

Calculation By: R. L. Sogge

Date:

Registered Professional Engineer (Civil)
CERTIFICATE NO.
10296
ROBERT L.
SOGGE
Date Signed 11/8/...
ARIZONA, U.S.A.

desert earth engineering

I-17 Bridges @ AZ Canal

RLS
11/8/85
85-29C

Material Properties

1/7

Concrete

f'_c = 4000 psi

f_y = 60 ksi

Uncracked section used.

RLS
11/7/85
85-290

2/7

I-17 Bridges at Az Canal

Composite Soil Log

	N	
El 1234		Clayey Sand Sandy Clay
1230	6-14	
[illegible]	9-23	
[illegible]	25-81	
[illegible]15	15-57	Gravelly Sand med dense
[illegible]10	20-44	
[illegible]	17-48	
[illegible]	22-92	
[illegible]	36-70	Gravelly Sand
[illegible]90	37-100	
		Clayey Sand
[illegible]85	>100	

I-17 Bridges @ Arizona Canal

RLS
11/8/85
85-290

Construction Sequence

3/7

Piers will be drilled, rebar placed, concrete cast box girders cast on grade before any excavation

Excavation will then take place below the bridge box girders

The piers will be in a pinned-end support condition and the soil will be in an at-rest condition

$K_o \gamma = 60$ pcf   0-10 ft depth

$K_o \gamma = 45$ pcf   below 10 ft

Top of box girder is essentially at existing grade.

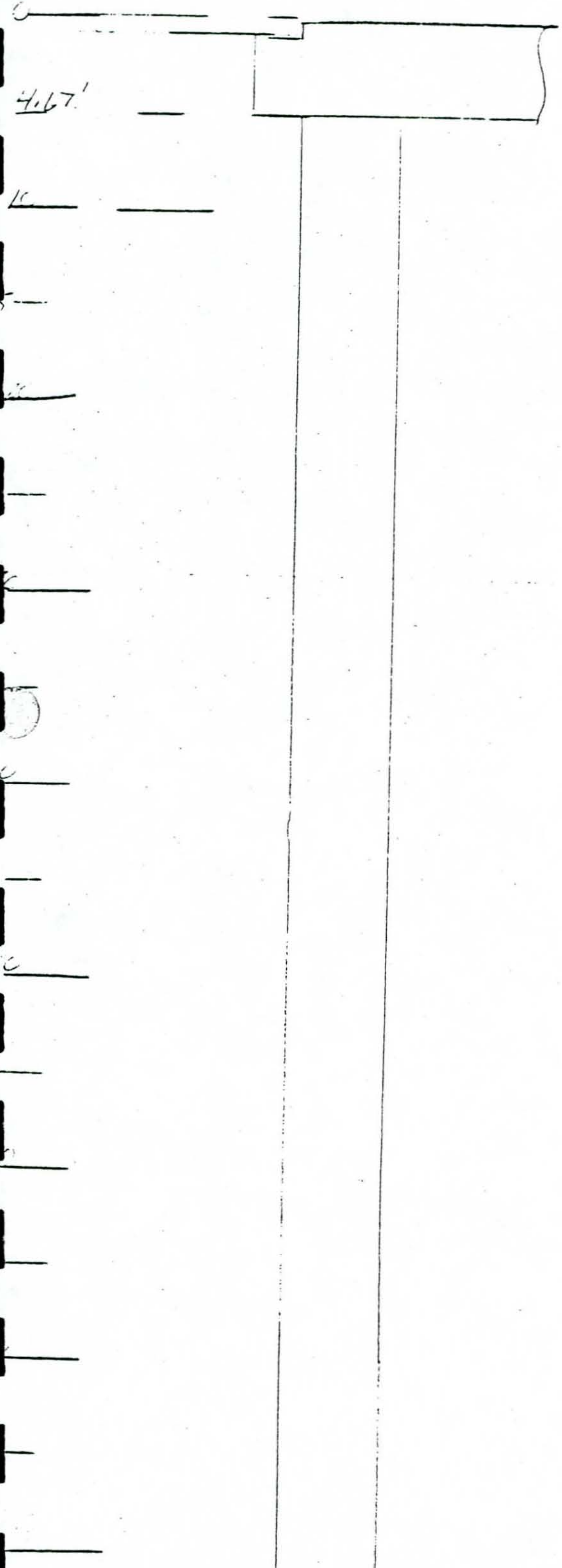
RLS
11/7/85
85-290
4/7

I-17 Bridge @ Az Canal

Soil Pressures

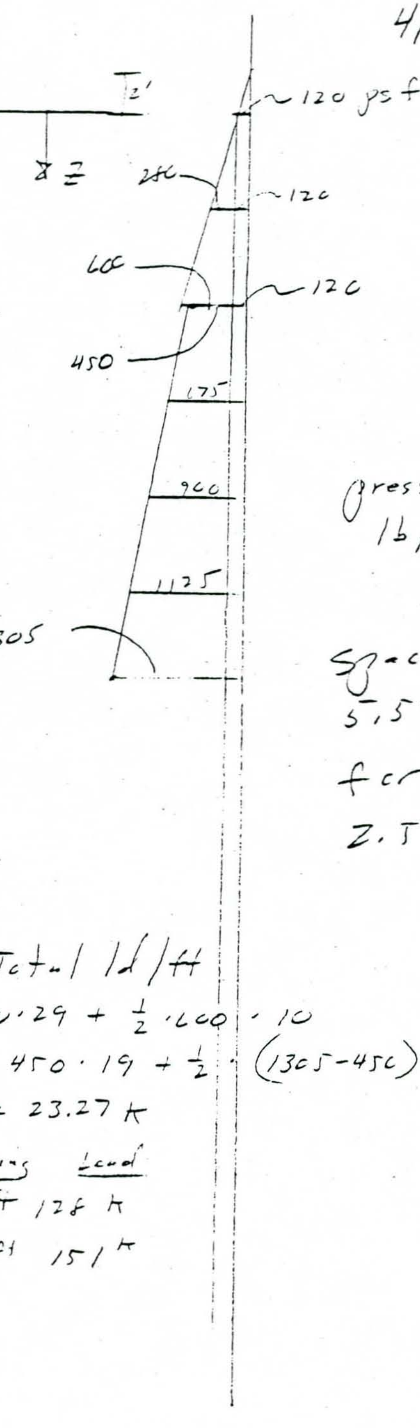
2 ft Surcharge @ 120 psf = q_s

=> w/ $K_o \approx \frac{1}{2}$ 60 psf E.F.P.



$K_o \gamma = 60$ psf

$K_o \gamma = 45$ psf



Pressures lb/ft out of page

Spacing 5.5 ft OC for 2.5 ft dia piers

Total ld/ft

$120 + 120 \cdot 29 + \frac{1}{2} \cdot 600 \cdot 10$

$+ 450 \cdot 19 + \frac{1}{2} \cdot (1305 - 450)\, 19$

$= 23.27$ K

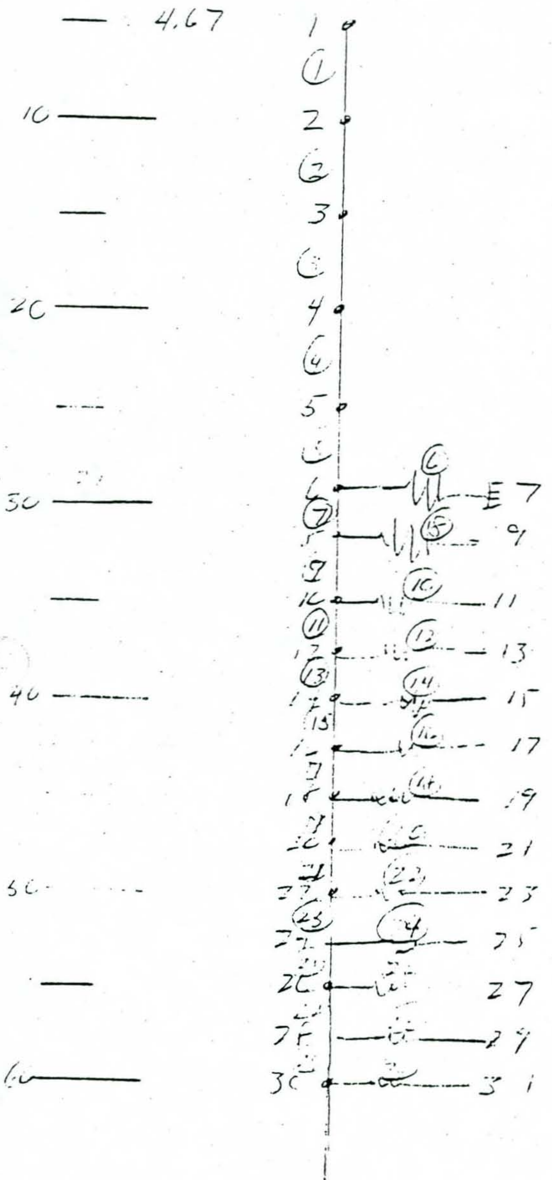
Spacing	Load
5.5 ft	128 K
6.5 ft	151 K

$p = K_o q_s + K_o \gamma z$

I-17 Bridges @ Az Canal

RLS
11/7/85
85-290
5/7

FEM Model



Load
2 ½ ft dia

3 ft dia

17.7

21.9

28.1

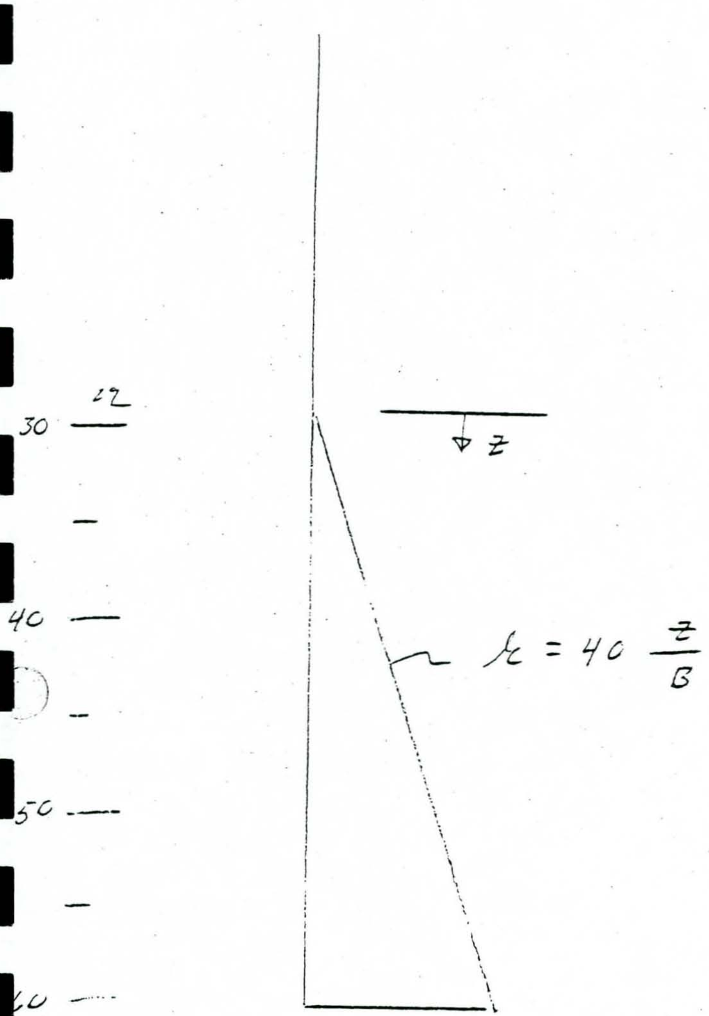
34.2

19.0

I-17 Bridges @ AZ Canal

RLS
11/8/85
85-290
6/7

Soil Stiffness



dia 2.5	3.5
14	10
56	40
96	69
136	97
176	126
216	154
256	183
296	211
336	240
376	269
416	297
456	326
496	354

I-17 Bridges @ Az Canal

RLS
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Soil Pressures
Alternate Spacing

3 ft dia piers
5 ft clear spacing
8 ft o.c.

A = 7.069 I = 3.98

100'

0	
10	25.8
	31.8
20	40.8
	49.8
30	27.6

105

11/5/85

```
*Program PFRAME by R L SOGGE - Desert Earth Engineering****    *    *    *    *
 FORTRAN Vs 1.12 Copyright (C)1982 Desert Earth Engr.
READ DATA FILE (RESPONSE = 0) OR CREATE DATA FILE (=1)
0
INPUT DRIVE:INPUT FILENAME =
 85-290-1
TITLE
85-290 I-17 Bridges across Az Canal - Lateral Load Analysis, 2.5 ft dia, 5.5 OC
NO OF     JTS       MEMBERS      MATLS     SUPTD JTS   LODED JTS   FEF MBRS   LDD MBRS
          23          22          10          11           5           0          0
   SELF LOADS    INT MBR FRCES (0=NO, 1=YES)
       0              0
JOINT      X-COORDINATE  Y-COORDINATE
    1            .00          -4.67
    2            .00         -10.00
    3            .00         -15.00
    4            .00         -20.00
    5            .00         -25.00
    6            .00         -29.00
    7           1.00         -29.00
    8            .00         -32.50
    9           1.00         -32.50
   10            .00         -35.00
   11           1.00         -35.00
   12            .00         -37.50
   13           1.00         -37.50
   14            .00         -40.00
   15           1.00         -40.00
   16            .00         -42.50
   17           1.00         -42.50
   18            .00         -45.00
   19           1.00         -45.00
   20            .00         -47.50
   21           1.00         -47.50
   22            .00         -50.00
   23           1.00         -50.00
MEMBER   P-JOINT   Q-JOINT   MATL TYPE   MEMBER TYPE
    1        1         2          1            1
    2        2         3          1            1
    3        3         4          1            1
    4        4         5          1            1
    5        5         6          1            1
    6        6         7          2            1
    7        6         8          1            1
    8        8         9          3            1
    9        8        10          1            1
   10       10        11          4            1
   11       10        12          1            1
   12       12        13          5            1
   13       12        14          1            1
   14       14        15          6            1
   15       14        16          1            1
   16       16        17          7            1
   17       16        18          1            1
   18       18        19          8            1
   19       18        20          1            1
   20       20        21          9            1
   21       20        22          1            1
   22       22        23         10            1
MATL TYPE  ELASTIC MOD        AREA    MOM INRTA    WT/UNIT L
    1       .5190E+06        4.909      1.917         .736
    2       .1400E+02        [illegible]
```

50 ft long

6	.1760E+03	6.250	.000	.000
7	.2160E+03	6.250	.000	.000
8	.2560E+03	6.250	.000	.000
9	.2960E+03	6.250	.000	.000
10	.3360E+03	3.125	.000	.000

SUPPORT DIRECTIONS (INDICATED BY 1)

JOINT	HORZ	VERT	ROTATION
1	1	0	0
7	1	1	1
9	1	1	1
11	1	1	1
13	1	1	1
15	1	1	1
17	1	1	1
19	1	1	1
21	1	1	1
23	1	1	1
22	0	1	0

APPLIED JOINT LOADS

JOINT	HORZ LOAD	VERT LOAD	MOMENT
2	17.70	.00	.00
3	21.90	.00	.00
4	28.10	.00	.00
5	34.20	.00	.00
6	19.00	.00	.00

APPLIED FIXED-END FORCES

MEMBER	MOMENT-P	MOMENT-Q	SHEAR-P	SHEAR-Q	AXIAL-P	AXIAL-Q

THERE ARE NO MEMBER FIXED-END FORCES APPLIED

APPLIED DISTRIBUTED AND POINT MEMBER LOADS

MEMBER	DSTRB LD-P	DSTRB LD-Q	PT LOAD-1	DIST-1	PT LOAD-2	DIST-2

THERE ARE NO MEMBER LOADS APPLIED

NO. EQNS = 69 BANDWIDTH = 9 JOINT SEP = 2

JOINT	HORZ DISP	VERT DISP	ROTATION
1	.6831E-11	.0000E+00	-.6130E-02
2	.3131E-01	.0000E+00	-.5361E-02
3	.5374E-01	.0000E+00	-.3464E-02
4	.6489E-01 .78	.0000E+00	-.9329E-03
5	.6306E-01	.0000E+00	.1603E-02
6	.5339E-01	.0000E+00	.3107E-02
7	.5253E-09	.0000E+00	.0000E+00
8	.4126E-01	.0000E+00	.3692E-02
9	.4116E-09	.0000E+00	.0000E+00
10	.3198E-01	.0000E+00	.3683E-02
11	.3193E-09	.0000E+00	.0000E+00
12	.2304E-01	.0000E+00	.3444E-02
13	.2301E-09	.0000E+00	.0000E+00
14	.1486E-01	.0000E+00	.3094E-02
15	.1484E-09	.0000E+00	.0000E+00
16	.7564E-02	.0000E+00	.2748E-02
17	.7558E-10	.0000E+00	.0000E+00
18	.1043E-02	.0000E+00	.2488E-02
19	.1043E-10	.0000E+00	.0000E+00
20	-.4980E-02	.0000E+00	.2352E-02
21	-.4978E-10	.0000E+00	.0000E+00
22	-.1080E-01	.0000E+00	.2317E-02
23	-.1079E-09	.0000E+00	.0000E+00

OUTPUT DRIVE:OUTPUT FILENAME = B:PFO

MEMBER NO.	MOMENTS P-END	MOMENTS Q-END	SHEARS P-END	SHEARS Q-END	AXIAL FORCES P-END	AXIAL FORCES Q-END	AXL STRS
1	.000E+00	.287E+03	-.539E+02	.539E+02	.000E+00	.000E+00	.000E+00
2	-.287E+03	.468E+03	-.362E+02	.362E+02	.000E+00	.000E+00	.000E+00
3	-.468E+03	[illegible]	[illegible]	[illegible]	.000E+00	.000E+00	.000E+00

[illegible]	[illegible]	.547E+02	.638E+02	-.638E+02	.000E+00	.000E+00	.000E+00
8	.000E+00	.000E+00	.000E+00	.000E+00	-.173E+02	-.173E+02	-.231E+01
9	-.547E+02	-.614E+02	.464E+02	-.464E+02	.000E+00	.000E+00	.000E+00
10	.000E+00	.000E+00	.000E+00	.000E+00	-.192E+02	-.192E+02	-.307E+01
11	.614E+02	-.129E+03	.272E+02	-.272E+02	.000E+00	.000E+00	.000E+00
12	.000E+00	.000E+00	.000E+00	.000E+00	-.196E+02	-.196E+02	-.313E+01
13	.129E+03	-.149E+03	.766E+01	-.766E+01	.000E+00	.000E+00	.000E+00
14	.000E+00	.000E+00	.000E+00	.000E+00	-.163E+02	-.163E+02	-.261E+01
15	.149E+03	-.127E+03	-.867E+01	.867E+01	.000E+00	.000E+00	.000E+00
16	.000E+00	.000E+00	.000E+00	.000E+00	-.102E+02	-.102E+02	-.163E+01
17	.127E+03	-.797E+02	-.189E+02	.189E+02	.000E+00	.000E+00	.000E+00
18	.000E+00	.000E+00	.000E+00	.000E+00	-.167E+01	-.167E+01	-.267E+00
19	.797E+02	-.284E+02	-.206E+02	.206E+02	.000E+00	.000E+00	.000E+00
20	.000E+00	.000E+00	.000E+00	.000E+00	.921E+01	.921E+01	.147E+01
21	.284E+02	.000E+00	-.113E+02	.113E+02	.000E+00	.000E+00	.000E+00
22	.000E+00	.000E+00	.000E+00	.000E+00	.113E+02	.113E+02	.363E+01

JOINT	HORZ REACTION	VERT REACTION	MOMENT
1	-.539E+02	.000E+00	.000E+00
7	-.327E+01	.000E+00	.000E+00
9	-.173E+02	.000E+00	.000E+00
11	-.192E+02	.000E+00	.000E+00
13	-.196E+02	.000E+00	.000E+00
15	-.163E+02	.000E+00	.000E+00
17	-.102E+02	.000E+00	.000E+00
19	-.167E+01	.000E+00	.000E+00
21	.921E+01	.000E+00	.000E+00
23	.113E+02	.000E+00	.000E+00
22	.277E-03	.000E+00	.000E+00

TOTAL WEIGHT OF STRUCTURE = 33.363

11/8/85

```
C>pframe
**Program PFRAME by R L SOGGE - Desert Earth Engineering****     *     *     *     *
 FORTRAN Vs 1.12 Copyright (C)1982 Desert Earth Engr.
 RD DATA FILE (RESPONSE = 0) OR CREATE DATA FILE (=1)
0
INPUT DRIVE:INPUT FILENAME =
b:85-290-1
TITLE
85-290 I-17 Bridges across Az Canal - Lateral Load Analysis, 2.5 ft dia, 5.5 OC
NO OF      JTS      MEMBERS      MATLS    SUPTD JTS  LODED JTS  FEF MBRS   LDD MBRS
            31         30          14        15          5          0          0
   SELF LOADS   INT MBR FRCES (0=NO, 1=YES)
         0           0
JOINT     X-COORDINATE  Y-COORDINATE
    1          .00          -4.67
    2          .00         -10.00
    3          .00         -15.00
    4          .00         -20.00
    5          .00         -25.00
    6          .00         -29.00
    7         1.00         -29.00
    8          .00         -32.50
    9         1.00         -32.50
   10          .00         -35.00
   11         1.00         -35.00
   12          .00         -37.50
   13         1.00         -37.50
   14          .00         -40.00
   15         1.00         -40.00
   16          .00         -42.50
   17         1.00         -42.50
   18          .00         -45.00
   19         1.00         -45.00
   20          .00         -47.50
   21         1.00         -47.50
   22          .00         -50.00
   23         1.00         -50.00
   24          .00         -52.50
   25         1.00         -52.50
   26          .00         -55.00
   27         1.00         -55.00
   28          .00         -57.50
   29         1.00         -57.50
   30          .00         -60.00
   31         1.00         -60.00
MEMBER   P-JOINT  Q-JOINT  MATL TYPE  MEMBER TYPE
   1        1        2        1           1
   2        2        3        1           1
   3        3        4        1           1
   4        4        5        1           1
   5        5        6        1           1
   6        6        7        2           1
   7        6        8        1           1
   8        8        9        3           1
   9        8       10        1           1
  10       10       11        4           1
  11       10       12        1           1
  12       12       13        5           1
  13       12       14        1           1
  14       14       15        6           1
```

60 ft long

[illegible]	[illegible]	[illegible]	8	1
19	18	20	1	1
20	20	21	9	1
21	20	22	1	1
22	22	23	10	1
23	22	24	1	1
24	24	25	11	1
25	24	26	1	1
26	26	27	12	1
27	26	28	1	1
28	28	29	13	1
29	28	30	1	1
30	30	31	14	1

MATL TYPE	ELASTIC MOD	AREA	MOM INRTA	WT/UNIT L
1	.5190E+06	4.909	1.917	.736
2	.1400E+02	4.375	.000	.000
3	.5600E+02	7.500	.000	.000
4	.9600E+02	6.250	.000	.000
5	.1360E+03	6.250	.000	.000
6	.1760E+03	6.250	.000	.000
7	.2160E+03	6.250	.000	.000
8	.2560E+03	6.250	.000	.000
9	.2960E+03	6.250	.000	.000
10	.3360E+03	6.250	.000	.000
11	.3760E+03	6.250	.000	.000
12	.4160E+03	6.250	.000	.000
13	.4560E+03	6.250	.000	.000
14	.4960E+03	3.125	.000	.000

SUPPORT DIRECTIONS (INDICATED BY 1)

JOINT	HORZ	VERT	ROTATION
1	1	0	0
7	1	1	1
9	1	1	1
11	1	1	1
13	1	1	1
15	1	1	1
17	1	1	1
19	1	1	1
21	1	1	1
23	1	1	1
25	1	1	1
27	1	1	1
29	1	1	1
31	1	1	1
30	0	1	0

APPLIED JOINT LOADS

JOINT	HORZ LOAD	VERT LOAD	MOMENT
2	17.70	.00	.00
3	21.90	.00	.00
4	28.10	.00	.00
5	34.20	.00	.00
6	19.00	.00	.00

APPLIED FIXED-END FORCES

MEMBER	MOMENT-P	MOMENT-Q	SHEAR-P	SHEAR-Q	AXIAL-P	AXIAL-Q

THERE ARE NO MEMBER FIXED-END FORCES APPLIED

APPLIED DISTRIBUTED AND POINT MEMBER LOADS

MBER	DSTRB LD-P	DSTRB LD-Q	PT LOAD-1	DIST-1	PT LOAD-2	DIST-2

THERE ARE NO MEMBER LOADS APPLIED

NO. EQNS = 93 BANDWIDTH = 9 JOINT SEP = 2

JOINT	HORZ DISP	VERT DISP	ROTATION
1	.6659E-11	.0000E+00	-.5800E-02
2	.2958E-01	.0000E+00	[illegible]

6	.4865E-01	.0000E+00	.3032E-02
7	.4787E-09	.0000E+00	.0000E+00
8	.3700E-01	.0000E+00	.3490E-02
9	.3692E-09	.0000E+00	.0000E+00
10	.2836E-01	.0000E+00	.3373E-02
11	.2831E-09	.0000E+00	.0000E+00
12	.2035E-01	.0000E+00	.2996E-02
13	.2033E-09	.0000E+00	.0000E+00
14	.1350E-01	.0000E+00	.2468E-02
15	.1349E-09	.0000E+00	.0000E+00
16	.8059E-02	.0000E+00	.1888E-02
17	.8053E-10	.0000E+00	.0000E+00
18	.4040E-02	.0000E+00	.1338E-02
19	.4038E-10	.0000E+00	.0000E+00
20	.1300E-02	.0000E+00	.8717E-03
21	.1300E-10	.0000E+00	.0000E+00
22	-.4117E-03	.0000E+00	.5179E-03
23	-.4115E-11	.0000E+00	.0000E+00
24	-.1386E-02	.0000E+00	.2809E-03
25	-.1386E-10	.0000E+00	.0000E+00
26	-.1903E-02	.0000E+00	.1480E-03
27	-.1902E-10	.0000E+00	.0000E+00
28	-.2192E-02	.0000E+00	.9326E-04
29	-.2191E-10	.0000E+00	.0000E+00
30	-.2405E-02	.0000E+00	.8155E-04
31	-.2404E-10	.0000E+00	.0000E+00

OUTPUT DRIVE:OUTPUT FILENAME = B:PFO

MEMBER	MOMENTS		SHEARS		AXIAL FORCES		AXL STRS
NO.	P-END	Q-END	P-END	Q-END	P-END	Q-END	
1	.122E-03	.280E+03	-.525E+02	.525E+02	.000E+00	.000E+00	.000E+00
2	-.280E+03	.454E+03	-.348E+02	.348E+02	.000E+00	.000E+00	.000E+00
3	-.454E+03	.518E+03	-.129E+02	.129E+02	.000E+00	.000E+00	.000E+00
4	-.518E+03	.442E+03	.152E+02	-.152E+02	.000E+00	.000E+00	.000E+00
5	-.442E+03	.245E+03	.494E+02	-.494E+02	.000E+00	.000E+00	.000E+00
6	.000E+00	.000E+00	.000E+00	.000E+00	-.298E+01	-.298E+01	-.681E+00
7	-.245E+03	.158E+02	.654E+02	-.654E+02	.000E+00	.000E+00	.000E+00
8	.000E+00	.000E+00	.000E+00	.000E+00	-.155E+02	-.155E+02	-.207E+01
9	-.158E+02	-.109E+03	.499E+02	-.499E+02	.000E+00	.000E+00	.000E+00
10	.000E+00	.000E+00	.000E+00	.000E+00	-.170E+02	-.170E+02	-.272E+01
11	.109E+03	-.191E+03	.329E+02	-.329E+02	.000E+00	.000E+00	.000E+00
12	.000E+00	.000E+00	.000E+00	.000E+00	-.173E+02	-.173E+02	-.277E+01
13	.191E+03	-.230E+03	.156E+02	-.156E+02	.000E+00	.000E+00	.000E+00
14	.000E+00	.000E+00	.000E+00	.000E+00	-.149E+02	-.149E+02	-.238E+01
15	.230E+03	-.232E+03	.704E+00	-.704E+00	.000E+00	.000E+00	.000E+00
16	.000E+00	.000E+00	.000E+00	.000E+00	-.109E+02	-.109E+02	-.174E+01
17	.232E+03	-.206E+03	-.102E+02	.102E+02	.000E+00	.000E+00	.000E+00
18	.000E+00	.000E+00	.000E+00	.000E+00	-.646E+01	-.646E+01	-.103E+01
19	.206E+03	-.165E+03	-.166E+02	.166E+02	.000E+00	.000E+00	.000E+00
20	.000E+00	.000E+00	.000E+00	.000E+00	-.241E+01	-.241E+01	-.385E+00
21	.165E+03	-.117E+03	-.190E+02	.190E+02	.000E+00	.000E+00	.000E+00
22	.000E+00	.000E+00	.000E+00	.000E+00	.864E+00	.864E+00	.138E+00
23	.117E+03	-.716E+02	-.182E+02	.182E+02	.000E+00	.000E+00	.000E+00
24	.000E+00	.000E+00	.000E+00	.000E+00	.326E+01	.326E+01	.521E+00
25	.716E+02	-.343E+02	-.149E+02	.149E+02	.000E+00	.000E+00	.000E+00
26	.000E+00	.000E+00	.000E+00	.000E+00	.495E+01	.495E+01	.792E+00
27	.343E+02	-.932E+01	-.997E+01	.997E+01	.000E+00	.000E+00	.000E+00
28	.000E+00	.000E+00	.000E+00	.000E+00	.625E+01	.625E+01	.999E+00
29	.932E+01	-.107E-03	-.373E+01	.373E+01	.000E+00	.000E+00	.000E+00
30	.000E+00	.000E+00	.000E+00	.000E+00	.373E+01	.373E+01	.119E+01

JOINT	HORZ REACTION	VERT REACTION	MOMENT
1	-.525E+02	.000E+00	.122E-03
7	-.298E+01	.000E+00	.000E+00
9	-.155E+02	.000E+00	[illegible]

[illegible]	[illegible]	.000E+00	.000E+00
19	-.646E+01	.000E+00	.000E+00
21	-.241E+01	.000E+00	.000E+00
23	.864E+00	.000E+00	.000E+00
25	.326E+01	.000E+00	.000E+00
27	.495E+01	.000E+00	.000E+00
29	.625E+01	.000E+00	.000E+00
31	.373E+01	.000E+00	.000E+00
30	-.570E-04	.000E+00	-.107E-03

TOTAL WEIGHT OF STRUCTURE = 40.723

pframe

11/8/85

Program PFRAME by R L SOGGE - Desert Earth Engineering** * * * *

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READ DATA FILE (RESPONSE = 0) OR CREATE DATA FILE (=1)

0

INPUT DRIVE:INPUT FILENAME =

b:85-290

TITLE

85-290 I-17 Bridges across Az Canal - Lateral Load Analysis, 3 ft dia, 8 ft OC

NO OF	JTS	MEMBERS	MATLS	SUPTD JTS	LODED JTS	FEF MBRS	LDD MBRS
	31	30	14	15	5	0	0

SELF LOADS	INT MBR FRCES (0=NO, 1=YES)
0	0

JOINT	X-COORDINATE	Y-COORDINATE
1	.00	-4.67
2	.00	-10.00
3	.00	-15.00
4	.00	-20.00
5	.00	-25.00
6	.00	-29.00
7	1.00	-29.00
8	.00	-32.50
9	1.00	-32.50
10	.00	-35.00
11	1.00	-35.00
12	.00	-37.50
13	1.00	-37.50
14	.00	-40.00
15	1.00	-40.00
16	.00	-42.50
17	1.00	-42.50
18	.00	-45.00
19	1.00	-45.00
20	.00	-47.50
21	1.00	-47.50
22	.00	-50.00
23	1.00	-50.00
24	.00	-52.50
25	1.00	-52.50
26	.00	-55.00
27	1.00	-55.00
28	.00	-57.50
29	1.00	-57.50
30	.00	-60.00
31	1.00	-60.00

60 ft long

MEMBER	P-JOINT	Q-JOINT	MATL TYPE	MEMBER TYPE
1	1	2	1	1
2	2	3	1	1
3	3	4	1	1
4	4	5	1	1
5	5	6	1	1
6	6	7	2	1
7	6	8	1	1
8	8	9	3	1
9	8	10	1	1
10	10	11	4	1
11	10	12	1	1
12	12	13	5	1
13	12	14	1	1
14	14	15	6	1
15	14	16	1	1
16	16	17	7	1

21	20	22	1	1
22	22	23	10	1
23	22	24	1	1
24	24	25	11	1
25	24	26	1	1
26	26	27	12	1
27	26	28	1	1
28	28	29	13	1
29	28	30	1	1
30	30	31	14	1

MATL TYPE	ELASTIC MOD	AREA	MOM INRTA	WT/UNIT L
1	.5190E+06	4.909	1.917	.736
2	.1400E+02	5.250	.000	.000
3	.5600E+02	9.000	.000	.000
4	.9600E+02	7.500	.000	.000
5	.1360E+03	7.500	.000	.000
6	.1760E+03	7.500	.000	.000
7	.2160E+03	7.500	.000	.000
8	.2560E+03	7.500	.000	.000
9	.2960E+03	7.500	.000	.000
10	.3360E+03	7.500	.000	.000
11	.3760E+03	7.500	.000	.000
12	.4160E+03	7.500	.000	.000
13	.4560E+03	7.500	.000	.000
14	.4960E+03	3.750	.000	.000

SUPPORT DIRECTIONS (INDICATED BY 1)

JOINT	HORZ	VERT	ROTATION
1	1	0	0
7	1	1	1
9	1	1	1
11	1	1	1
13	1	1	1
15	1	1	1
17	1	1	1
19	1	1	1
21	1	1	1
23	1	1	1
25	1	1	1
27	1	1	1
29	1	1	1
31	1	1	1
30	0	1	0

APPLIED JOINT LOADS

JOINT	HORZ LOAD	VERT LOAD	MOMENT
2	25.80	.00	.00
3	31.80	.00	.00
4	40.80	.00	.00
5	49.80	.00	.00
6	27.60	.00	.00

APPLIED FIXED-END FORCES

EMBER MOMENT-P MOMENT-Q SHEAR-P SHEAR-Q AXIAL-P AXIAL-Q

THERE ARE NO MEMBER FIXED-END FORCES APPLIED

APPLIED DISTRIBUTED AND POINT MEMBER LOADS

EMBER DSTRB LD-P DSTRB LD-Q PT LOAD-1 DIST-1 PT LOAD-2 DIST-2

THERE ARE NO MEMBER LOADS APPLIED

. EQNS = 93 BANDWIDTH = 9 JOINT SEP = 2

DINT	HORZ DISP	VERT DISP	ROTATION
1	.9536E-11	.0000E+00	-.8107E-02
2	.4130E-01	.0000E+00	-.7033E-02
3	.7040E-01	.0000E+00	-.4399E-02
4	.8389E-01	.0000E+00	[illegible]

[illegible]	[illegible]	.0000E+00	.4950E-02
9	.4883E-09	.0000E+00	.0000E+00
10	.3676E-01	.0000E+00	.4708E-02
11	.3671E-09	.0000E+00	.0000E+00
12	.2569E-01	.0000E+00	.4101E-02
13	.2566E-09	.0000E+00	.0000E+00
14	.1642E-01	.0000E+00	.3297E-02
15	.1640E-09	.0000E+00	.0000E+00
16	.9245E-02	.0000E+00	.2444E-02
17	.9239E-10	.0000E+00	.0000E+00
18	.4140E-02	.0000E+00	.1659E-02
19	.4138E-10	.0000E+00	.0000E+00
20	.8350E-03	.0000E+00	.1013E-02
21	.8346E-11	.0000E+00	.0000E+00
22	-.1065E-02	.0000E+00	.5365E-03
23	-.1064E-10	.0000E+00	.0000E+00
24	-.1987E-02	.0000E+00	.2277E-03
25	-.1986E-10	.0000E+00	.0000E+00
26	-.2321E-02	.0000E+00	.6032E-04
27	-.2321E-10	.0000E+00	.0000E+00
28	-.2373E-02	.0000E+00	-.6092E-05
29	-.2372E-10	.0000E+00	.0000E+00
30	-.2335E-02	.0000E+00	-.1973E-04
31	-.2334E-10	.0000E+00	.0000E+00

OUTPUT DRIVE:OUTPUT FILENAME = B:PFD

MEMBER	MOMENTS		SHEARS		AXIAL FORCES		AXL STRS
NO.	P-END	Q-END	P-END	Q-END	P-END	Q-END	
1	.000E+00	.401E+03	-.752E+02	.752E+02	.000E+00	.000E+00	.000E+00
2	-.401E+03	.648E+03	-.494E+02	.494E+02	.000E+00	.000E+00	.000E+00
3	-.648E+03	.736E+03	-.176E+02	.176E+02	.000E+00	.000E+00	.000E+00
4	-.736E+03	.620E+03	.232E+02	-.232E+02	.000E+00	.000E+00	.000E+00
5	-.620E+03	.328E+03	.730E+02	-.730E+02	.000E+00	.000E+00	.000E+00
6	.000E+00	.000E+00	.000E+00	.000E+00	-.482E+01	-.482E+01	-.919E+00
7	-.328E+03	-.764E+01	.958E+02	-.958E+02	.000E+00	.000E+00	.000E+00
8	.000E+00	.000E+00	.000E+00	.000E+00	-.247E+02	-.247E+02	-.274E+01
9	.764E+01	-.185E+03	.711E+02	-.711E+02	.000E+00	.000E+00	.000E+00
10	.000E+00	.000E+00	.000E+00	.000E+00	-.265E+02	-.265E+02	-.353E+01
11	.185E+03	-.297E+03	.447E+02	-.447E+02	.000E+00	.000E+00	.000E+00
12	.000E+00	.000E+00	.000E+00	.000E+00	-.262E+02	-.262E+02	-.349E+01
13	.297E+03	-.343E+03	.185E+02	-.185E+02	.000E+00	.000E+00	.000E+00
14	.000E+00	.000E+00	.000E+00	.000E+00	-.217E+02	-.217E+02	-.289E+01
15	.343E+03	-.335E+03	-.321E+01	.321E+01	.000E+00	.000E+00	.000E+00
16	.000E+00	.000E+00	.000E+00	.000E+00	-.150E+02	-.150E+02	-.200E+01
17	.335E+03	-.290E+03	-.182E+02	.182E+02	.000E+00	.000E+00	.000E+00
18	.000E+00	.000E+00	.000E+00	.000E+00	-.795E+01	-.795E+01	-.106E+01
19	.290E+03	-.224E+03	-.261E+02	.261E+02	.000E+00	.000E+00	.000E+00
20	.000E+00	.000E+00	.000E+00	.000E+00	-.185E+01	-.185E+01	-.247E+00
21	.224E+03	-.155E+03	-.280E+02	.280E+02	.000E+00	.000E+00	.000E+00
22	.000E+00	.000E+00	.000E+00	.000E+00	.268E+01	.268E+01	.358E+00
23	.155E+03	-.913E+02	-.253E+02	.253E+02	.000E+00	.000E+00	.000E+00
24	.000E+00	.000E+00	.000E+00	.000E+00	.560E+01	.560E+01	.747E+00
25	.913E+02	-.420E+02	-.197E+02	.197E+02	.000E+00	.000E+00	.000E+00
26	.000E+00	.000E+00	.000E+00	.000E+00	.724E+01	.724E+01	.966E+00
27	.420E+02	-.109E+02	-.125E+02	.125E+02	.000E+00	.000E+00	.000E+00
28	.000E+00	.000E+00	.000E+00	.000E+00	.811E+01	.811E+01	.108E+01
29	.109E+02	-.187E-03	-.434E+01	.434E+01	.000E+00	.000E+00	.000E+00
30	.000E+00	.000E+00	.000E+00	.000E+00	.434E+01	.434E+01	.116E+01

NT	HORZ REACTION	VERT REACTION	MOMENT
1	-.752E+02	.000E+00	.000E+00
7	-.482E+01	.000E+00	.000E+00
9	-.247E+02	.000E+00	.000E+00
11	-.265E+02	.000E+00	.000E+00
13	-.262E+02	.000E+00	.000E+00

[illegible]	[illegible]	[illegible]	[illegible]
19	-.646E+01	.000E+00	.000E+00
21	-.241E+01	.000E+00	.000E+00
23	.864E+00	.000E+00	.000E+00
25	.326E+01	.000E+00	.000E+00
27	.495E+01	.000E+00	.000E+00
29	.625E+01	.000E+00	.000E+00
31	.373E+01	.000E+00	.000E+00
30	-.570E-04	.000E+00	-.107E-03

TOTAL WEIGHT OF STRUCTURE = 40.723

APPENDIX B

Excerpts, Final Geotechnical Report
By Western Technologies, Inc.

WESTERN
TECHNOLOGIES
INC.

3737 East Broadway Road
P.O. Box 21387
Phoenix, Arizona 85036
(602) 437-3737

RGA Consulting Engineers
1102 West Indian School Road
Phoenix, Arizona 85013

October 1, 1985

Attn: Mr. Harold Ditzler

Re: Final Report
Arizona Canal Diversion Channel Bridges
at Interstate 17
Phoenix, Arizona

Job No. 2125J066
Revised 11/8/85

Our final geotechnical report for the above project is attached. The work was performed according to our proposal of November 15, 1984. The scope of the field work was modified as the result of discussions with Mr. Dick Bruce of ADOT. The modified scope included drilling two borings to a depth of 100 feet and six borings to a depth of 40 feet.

Soils at the site consisted of firm to stiff sandy clays and clayey sands underlain by dense to very dense clayey sands, gravelly sands, sandy gravels, clayey sandy gravels and sandy clays. We recommend that the main bridge structure be founded on drilled shafts. The in-fill structures for the existing bridges may be founded on spread footings. Pavement design recommendations were transmitted in the Materials Design Memorandum under separate cover.

The final report completes Western Technologies Inc.'s current services. We are prepared to review your plans and specifications for consistency with the recommendations.

Sincerely,

WESTERN TECHNOLOGIES INC.
Geotechnical Services

Kenneth L. Ricker, P.E.

jh

Copies to: Addressee (1)
RGA (Tucson) (5)

RGA Consulting Engineers
Job No. 2125J066

TABLE OF CONTENTS

NOT INCLUDED

INCLUDED

NOT INCLUDED

RGA Consulting Engineers
Job No. 2125J066

Geotechnical Investigation
Final Report
Arizona Canal Diversion Channel Bridges
at Interstate 17
Phoenix, Arizona
October 1, 1985

INTRODUCTION

This report contains the results of our geotechnical investigation for the proposed bridges over the Arizona Canal Diversion Canal to be located along Interstate-17 in Phoenix, Arizona. The bridges will be located along the existing I-17 right-of-way just north of the Arizona Canal. The purpose of these services is to provide information and recommendations relative to foundation design, lateral earth pressures, and approach fill grading.

PROPOSED CONSTRUCTION

Based on information provided by RGA, the proposed project will include a bridge on the east frontage road, the west frontage road, and the north and south bound freeway to be located on the north side of the existing canal. The bridges will span a 110 foot wide channel, skewed 15° to the channel centerline. The clear height under the bridges will be at least 21 feet. The channel under the bridge will be concrete lined and rectangular in shape. The bridges will be supported on 30-inch diameter drilled shafts constructed 5.5 feet on center. In addition to the main bridges, the project includes in-fill structures to be constructed between the existing canal bridges along the freeway and frontage roads, a temporary frontage road bridge which will be an 80 foot long single span structure east of the exit frontage road and various detour roads. The existing canal is approximately 10 to 15 feet deep. Structural foundation loads will be on the order of:

Structure	Total Vertical Load	Moment
Main Bridges	109 kips/shaft	578 kip ft/shaft
In-fill Structure	6.8 klf/abutment	--
In-fill Structure	9.8 klf/pier	--
Temporary Bridge	12 to 18 klf/abutment	--

SITE CONDITIONS

At the time of our exploration, the site was occupied by the existing freeway, adjoining frontage roads, canal and canal bridges. The area contained landscaping and underground and overhead utilities.

SCOPE OF SERVICES

Eight borings were drilled to depths of 41 to 100 feet at the locations shown on the site plan. During exploration, subsoils were examined visually and sampled at selected intervals.

The following tests were performed on selected soil samples:

- Water content
- Dry density
- Consolidation
- Expansion
- Shear strength
- Gradation
- Plasticity
- R-Value

Test results were used in the development of foundation and earthwork recommendations.

INTERPRETATION OF SUBSURFACE CONDITIONS

Exploration: As presented on Logs of Borings, surface and subsoils to the full depth of exploration were found to be alluvial soils consisting of interbedded deposits of sandy clay, clayey sand, sandy gravel, gravelly sand, clayey sand and gravel, and silty sand. In Borings 1, 2, and 7 the upper 2 to 3 feet of the material is fill. In Borings 5, 6, and 8 these soils are overlain by 3 to 4 inches of asphalt concrete and 12 to 15 inches of aggregate base material. The soils to depths of 9 to 16 feet are medium dense (firm to stiff). Below these depths the soils are dense to very dense (very stiff to hard) except at Boring 2. In Boring 2, the soil becomes denser below a depth of 30 feet. A groundwater table was not encountered in any boring at the time of exploration.

Testing: Laboratory test results indicate that native subsoils at shallow foundation level are slightly to moderately compressible at existing water contents. Slight additional compression occurs when the water content is increased. When water is added to compacted near-surface clay soils, moderate expansion occurs. The soils at shallow foundation level have moderate shear strengths.

CONCLUSIONS AND RECOMMENDATIONS

General: The recommendations presented in this report are based on the final design concepts and on the assumption that the soil conditions do not deviate appreciably from those disclosed by the borings. If variations are encountered during construction or if changes are made in project plans, structural loads or foundations types, we should be notified for supplemental recommendations.

Foundations: Because of variations in the nature of bearing soils, foundation types to be used, and structural loads, we considered the following foundation systems:

- shallow foundations on undisturbed subsoils for support of the in-fill structure
- deep foundations consisting of drilled shaft founded on undisturbed subsoils for support of the main structures and the temporary bridge

- Shallow - In-fill Structure: We recommend the in-fill structure be supported on spread foundations bearing upon undisturbed subsoils below the bottom of the existing canal.

  The recommended footing depth and design bearing capacity are presented in the following tabulation:

Footing Depth Below Canal Bottom Grade (ft)	Design Bearing Capacity (psf)*
4.0	3500

*Design bearing capacities assume footings founded at least 2 feet below existing footing (as per the request of ADOT).

Total or differential settlements resulting from the assumed loads are estimated to be less than 1/2 inch provided that:

- Foundations are constructed as we recommend, and
- Essentially no changes occur in water contents of foundation soils.

Additional foundation movements of less than 1/4 inch could occur if water from any source infiltrates the foundation soils; therefore, proper drainage should be provided in the final design and during construction.

Finished grade is the lowest adjacent canal bottom grade for abutment and pier footings. The design bearing capacity applies to dead loads plus design live load conditions. The design bearing capacity may be increased by one-third when considering total loads that include wind or seismic or toe pressures provided the resultant of all forces acts in the center one-third of the footing. Recommended minimum width of footings is 24 inches.

Foundation excavations into undisturbed soils should be inspected by the geotechnical engineer. If the soil conditions encountered differ significantly from those presented in this report, supplemental recommendations will be required.

- Drilled Shafts - Main Structure and Temporary Bridge: We understand that a drilled shaft foundation system will be used for support of the main structures and the temporary bridge. The following capacities should be used in design for straight, shaft, machine-cleaned, 2-foot and 2.5-foot diameter shafts. The design is based on a combination of friction along the shaft length and end-bearing.

Depth* (ft)	Total Capacity (kips) 2.0' Dia.	2.5' Dia.
10	109	175
16	165	265
17	185	280

*Depth measured from bottom of channel

Bearing capacity may be increased one-third when considering total loads including wind and seismic.

Estimated settlements for drilled shafts are 1/2 inch or less for maximum loads.

Drilling to design depths should be possible with conventional rotary or bucket augers. Shafts will probably remain open without stabilizing measures. However, caving and sloughing should be anticipated in the relatively clean granular soils. Due to potential sloughing and raveling, foundation concrete quantities may exceed calculated geometric volumes.

The bearing surface must be machine cleaned prior to concrete placement. A representative of the geotechnical engineer should inspect the bearing surface and pier configuration without entering the drilled element.

Lateral Earth Pressures: For soils above any free water surface, recommended equivalent fluid pressures (triangular distribution) and coefficients of base friction for unrestrained elements for use in preliminary design are:

- Active:
  - Undisturbed subsoil -------------------- 35 psf/ft
  - Compacted granular backfill ------------ 30 psf/ft
- Passive:
  - Shallow wall footings ------------------ 350 psf/ft
  - Drilled Shafts ------------------------- 500 psf/ft
- Coefficient of base friction ------------- 0.40*

*The coefficient of base friction should be reduced to 0.30 when used in conjunction with passive pressure.

Where the design includes restrained elements, the following equivalent fluid pressures are recommended:

- At-rest:

  Undisturbed subsoil -------------------- 60* psf/ft
  (0 to 10 feet of depth)

  Undisturbed subsoil ----------------------45* psf/ft
  (10 feet and greater depth)

  Compacted granular backfill ------------ 55 psf/ft

  *See calculation in Appendix A.

The lateral earth pressures herein are not applicable for submerged soils. We should be consulted for additional recommendations if such conditions are to be included in the design.

Fill against footings, stem walls, abutment walls, and retaining walls should be compacted to densities specified in "Earthwork." Medium to high plasticity clay soils should not be used as backfill against retaining walls. Compaction of each lift adjacent to walls should be accomplished with hand-operated tampers or other lightweight compactors. Overcompaction may cause excessive lateral earth pressures which could result in wall movements.

Earthwork:

- General: The conclusions contained in this report for the proposed construction are contingent upon compliance with recommendations presented in this section.

- Excavation: We anticipate that excavations for the proposed construction can be accomplished with conventional equipment.

- Foundation Preparation: Specialized treatment of existing soils within foundation areas is not required.

- Materials:

1. On-site soils may be used as backfill against abutments or retaining walls.

2. Imported soils should conform to the following:

   - Gradation (ASTM C136): percent finer by weight

6"	100
4"	70-100
No. 4 Sieve	50-100
No. 200 Sieve	60 (max)

   - Maximum expansive potential(%)* 1.5

   - Maximum soluble sulfates(%) 0.10

*Measured on a sample compacted to approximately 95 percent of the ASTM D698 maximum dry density at about 3 percent below optimum water content. The sample is confined under a 100 psf surcharge and submerged.

3. Aggregate base should conform to ADOT specifications.

- Placement and Compaction:

1. Place and compact fill in horizontal lifts, using equipment and procedures that will produce recommended water contents and densities throughout the lift.

2. Uncompacted fill lifts should not exceed 6 inches.

3. Materials should be compacted to the following:

Material	Minimum Percent Compaction (ASTM D698)
On-site soils:	
Below pavement	95
Against subsurface walls	95
Imported fill:	
Below pavement	95
Against subsurface walls	95
Aggregate base	95
Miscellaneous backfill	90

4. On-site clay soils should be compacted within a water content range of 1 percent below to 4 percent above optimum. On-site granular soils and imported soils should be compacted within a moisture range of 3 percent below to 3 percent above optimum.

- Compliance: Recommendations for backfill and pavement elements supported on compacted fills or prepared subgrade depend upon compliance with "Earthwork" recommendations. To assess compliance, observation and testing should be performed under the direction of a geotechnical engineer.

Temporary Shoring Requirements: We understand that construction sequence for the main structures will include excavation of the channel after the abutment drilled shafts and the bridge super structure has been constructed. The channel excavation will be approximately 26 feet deep as measured from the bottom of the bridge super structure. The channel excavation can be expected to encounter clayey sands and sandy clays underlain by dense to very dense gravelly sands/sandy gravels underlain by dense clayey sands. During excavation the soils should bridge between drilled shafts provided a clear distance between the edge of the piers does not exceed 4 feet (see calulations in Appendix A). Some sloughing or raveling of relatively clean and dry granular soils may occur. This sloughing or raveling may be controlled by the installation of lagging or by guniting the exposed surfaces prior to the placement of the permanent channel wall.

CLOSURE

Our conclusions and recommendations assume observation and testing of the earthwork and foundation preparations by a representative of a registered engineer. During construction, the engineer will have the responsibility of assuring that construction complies with our recommendations. The engineer also will be responsible for decisions/recommendations should unanticipated conditions occur.

If plans, specifications, or field applications deviate from our recommendations, we shall be relieved of responsibility unless our written concurrence has been obtained.

INTERNAL WORK SHEETS

Project/Subject: BRIDGING OF THE SOIL BETWEEN DRILLED PIERS DURING CONSTRUCTION — Job. No. 2145J066 — Date 10/15/85 — Sheet 1 of 1 — By [signature]

PIERS ARE 5.5' C TO C

MIN. PIER DIA. 2.5'

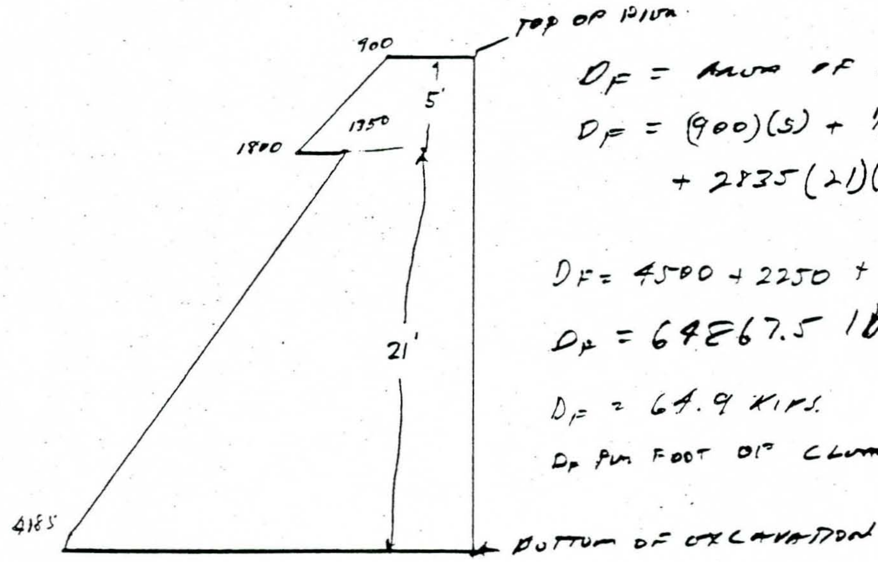
CLEAR DISTANCE BETWEEN PIERS 3.0'

— DRIVING FORCE ON SOIL IS AT REST PRESSURE = D_F
SAME AS CALC. FOR LATERAL CAPACITY OF PIER.

— RESISTING FORCE IS SHEAR STRENGTH OF SOIL ALONG FACES OF PIER = R_F

AT REST PRESSURE

0 – 10	P_o = 60 PSF/FT	FOR 3' WIDE SECTION P_{OT} = 180 PSF
10 – 31	P_o = 45 PSF/FT	FOR 3' WIDE SECTION P_{OT} = 135 PSF



D_F = AREA OF FORCE

$D_F = (900)(5) + \frac{1}{2}(900)(5) + 1350(21) + 2835(21)(\frac{1}{2})$

$D_F = 4500 + 2250 + 28350 + 29767.5$

$D_F = 64867.5$ lbs

D_F = 64.9 KIPS

D_F PER FOOT OF CLEAR DISTANCE = 21.6 KIPS/FT

SHEAR STRENGTH PARAMETER.

@ 5' c = 1.09 KSF — USE 1.09 FOR 0 TO 5'

@ 25' c = 1.8 KSF ϕ = 40° — USE 1.80 FOR 5' TO 26'

ASSUME COHESION ONLY

$R_F = [5'(1.09 \text{ KSF}) + 21'(1.8 \text{ KSF})]\,2 = 86.5$ KIPS.

$FS = \frac{R_F}{D_F} = \frac{86.5}{64.9} = 1.33$ ∴ WITH ϕ ADDED, FACTOR OF SAFETY WOULD BE EVEN HIGHER.

IN ADDITION SHEAR STRENGTH ALONG HORIZONTAL PLANES AT BOTTOM OF EXCAVATION AND BOTTOM OF BRIDGE DECK NOT INCLUDED THUS FACTOR OF SAFETY WOULD BE HIGHER.

FOR F.S. = 1 $R_F = D_F$

x (21.6 KIP/FT) = 86.5

x = 4.0' MAX.