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ENGINEERING DIVISION
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Preliminary
STRUCTURAL CALCULATIONS

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

rga engineering corporation

project I-17 ACDC BRIDGES no. 85003
client ADOT design eal date 11/85
subject TABLE OF CONTENTS checked date

PRELIMINARY STRUCTURAL CALCULATIONS

PAGES

1. SOUTHBOUND FRONTAGE ROAD BRIDGE BOX GIRDER 1 – 8

(NOTE: MAINLINE & N.B.F.R. BRIDGES ARE THE SAME BASIC ANALYSIS & HAVE NOT BEEN INCLUDED IN THIS PRELIMINARY ANALYSIS)

2. CHANNEL LINING DESIGN 9

3. DRILLED SHAFT DESIGN 10 – 15

APPENDIX A:

LATERAL LOAD ANALYSIS ON DRILLED SHAFTS by DESERT EARTH ENGINEERING

RECEIVED
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HIGHWAY PLANS SERVICES

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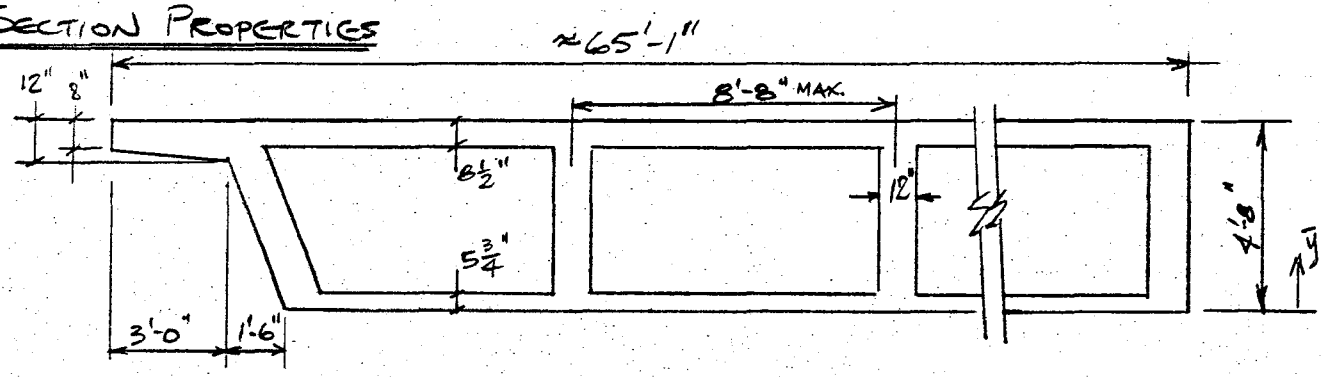
project I-17 ACDC BRIDGES no. 85003
client ADOT design aal date 11/85
subject SOUTHBOUND FRONTAGE ROAD BRIDGE checked _____ date _____

SECTION PROPERTIES



CENTROID

		AREA		$\bar{y}$		$A\bar{y}$
TOP SLAB	65.1' × .708' =	46.09 FT²	×	4.31'	=	198.65 FT³
HAUNCHES	½ × 3.0' × .29' × 2 =	.87	×	3.85	=	3.35 FT³
WEBS	8 × 1.0' × 3.48' =	27.84	×	2.22	=	61.80 FT³
BTM. SLAB	60.6' × .479' =	29.03	×	0.24	=	6.97 FT³
		103.83 FT²				270.77 FT³

$$\therefore \bar{y}_{cg} = \frac{\Sigma A\bar{y}}{\Sigma A} = \frac{270.77}{103.83} = 2.61' \text{ (FROM BTM)}$$
(or 31.32")

MOMENT OF INERTIA

TOP SLAB: $\frac{1}{12}(65.1)(.708)^3 + (46.09)(4.31-2.61)^2$
$= 1.93 + 133.2 = 135.13 \text{ FT}^4$

HAUNCHES: $\frac{2}{36}(3.0)(.29)^3 + (0.87)(3.35-2.61)^2$
$.00 + 0.77 = 0.77$

WEBS: $8 \times \frac{1}{12}(1.0)(3.48)^3 + (27.84)(2.61-2.22)^2$
$28.10 + 4.23 = 32.33$

BTM. SLAB: $\frac{1}{12}(60.6)(.479)^3 + (29.03)(2.61-0.24)^2$
$0.56 + 163.06 = 163.62$

$\therefore I = 332.85 \text{ FT}^4$

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project I-17 ACDC BRIDGES no. 85003
client A.D.O.T. design [illegible] date 11/85
subject S.B. FRONTAGE ROAD BRIDGE checked _____ date _____

SECTION PROP.'S (CONT.)

SECTION MODULI & RADIUS OF GYR.

$$S_{TOP} = 332.84/(4.667-2.61) = 161.3\ FT^3 \ \& \ S_{BTM} = 332.84/2.61 = 127.15\ FT^3$$

$$r = \sqrt{I/A} = \sqrt{\frac{332.84}{103.83}} = \sqrt{3.21} = 1.79$$

STRESS COEFFICIENTS

TOP: $f_t = \frac{M}{S_t} = \frac{1000M}{144(161.3)} = 0.0431\ M$

BTM: $f_b = \frac{M}{S_b} = \frac{1000M}{144(127.15)} = 0.0546\ M$

NOTE: M in FT.K & f in PSI

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client ADOT design gal date 11/85
subject S.B. FRONTAGE ROAD checked _____ date _____

DESIGN LOADS (SERVICE LOAD)

A. DEAD LOAD

BASIC SECTION	103.83 x .150	=	15.57 K/FT
DIAPHRAGMS	≈14(1' x 4' x 8').15/114 = .59, say		.75 K/FT
WEB FLAIRS & FILLETS	≈ 14(½(14' x 2' x 3.5').15)/114 = .90, say		1.0 K/FT
FUTURE WEARING SURFACE	.025 x 65.1	=	1.63 K/FT
BARRIER	≈ 1.58' x 2.7' x .150	=	.64 K/FT

$\Sigma DL = 19.59$ K/FT

USE $DL = 19.6$ K/FT

B. IMPACT LOADING (AASHTO 3.8)

$I = 50/(S+125) = 50/(118+125) = .206$ (S = SPAN LENGTH ℄ PIERS)

C. LIVE LOADS (AASHTO 3.7.4, 3.7.6, & 3.7.1)

HS 20-44 LOADING:
FRONT AXLE: 8000#
REAR AXLE: 32000#

ALT. MILITARY LOADING: 24000#/AXLE (TWO AXLES @ 4' o.c.)

LANE LOADS:
UNIFORM LOAD: 640 PLF OF LOAD LANE
CONC. LOAD: 18,000# (MOMENT DESIGN)
26,000# (SHEAR DESIGN)

D. LIVE LOAD DISTRIBUTION

$LL/GIRDER = \frac{S}{2 \times 7}$ (NOTE ½ CONVERTS LANE FORCES INTO WHEEL FORCES)

EQUIV. FOR ENTIRE STRUCTURE $= \frac{\text{WEB SPACING} \times \text{No. WEBS}}{2 \times 7} = \frac{8.67 \times 8}{14}$

$= 4.95$

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project I-17 ACDC BRIDGES no. 85003
client ADOT design eal date 11/85
subject S.B. FRONTAGE RD. checked date

DESIGN LOADS (SERVICE) - CON'T

E. DESIGN MOMENTS

$M_{DL} = \frac{1}{8}(19.6)(118)^2 = 34{,}110$ FT.K

M_{LL+I} $4.95 \times 1.206 \times 1645 = 9{,}820$ FT.K

USING AASHTO TABLES

$\Big\}\ M_{TL} = 43{,}930$ FT.K.

F. DESIGN SHEARS

$V_{DL} = \frac{1}{2}(19.6)\,118 = 1156$ K

V_{LL+I} $4.95(1.206)\,63.8 = 381$ K

$\Big\}\ V_{TL} = 1537$ K

POST TENSIONING REQUIREMENTS

STRESSES @ MIDSPAN (DL+LL)

$f_t = f_{top} = .0431(43930) = 1894$ PSI (COMP.)

$f_b = f_{btm} = .0546(43930) = 2399$ PSI (TENS.)

ALLOW. STRESSES for $f'_c = 4500$ PSI

COMPR = $0.40 f'_c = 0.40(4500) = 1800$ PSI

TENSION = $6\sqrt{f'_c} = 6\sqrt{4500} = 402$ PSI

APPROX. P/T REQ'D (D/L = 4.67/118 = .0396 ≈ .040)

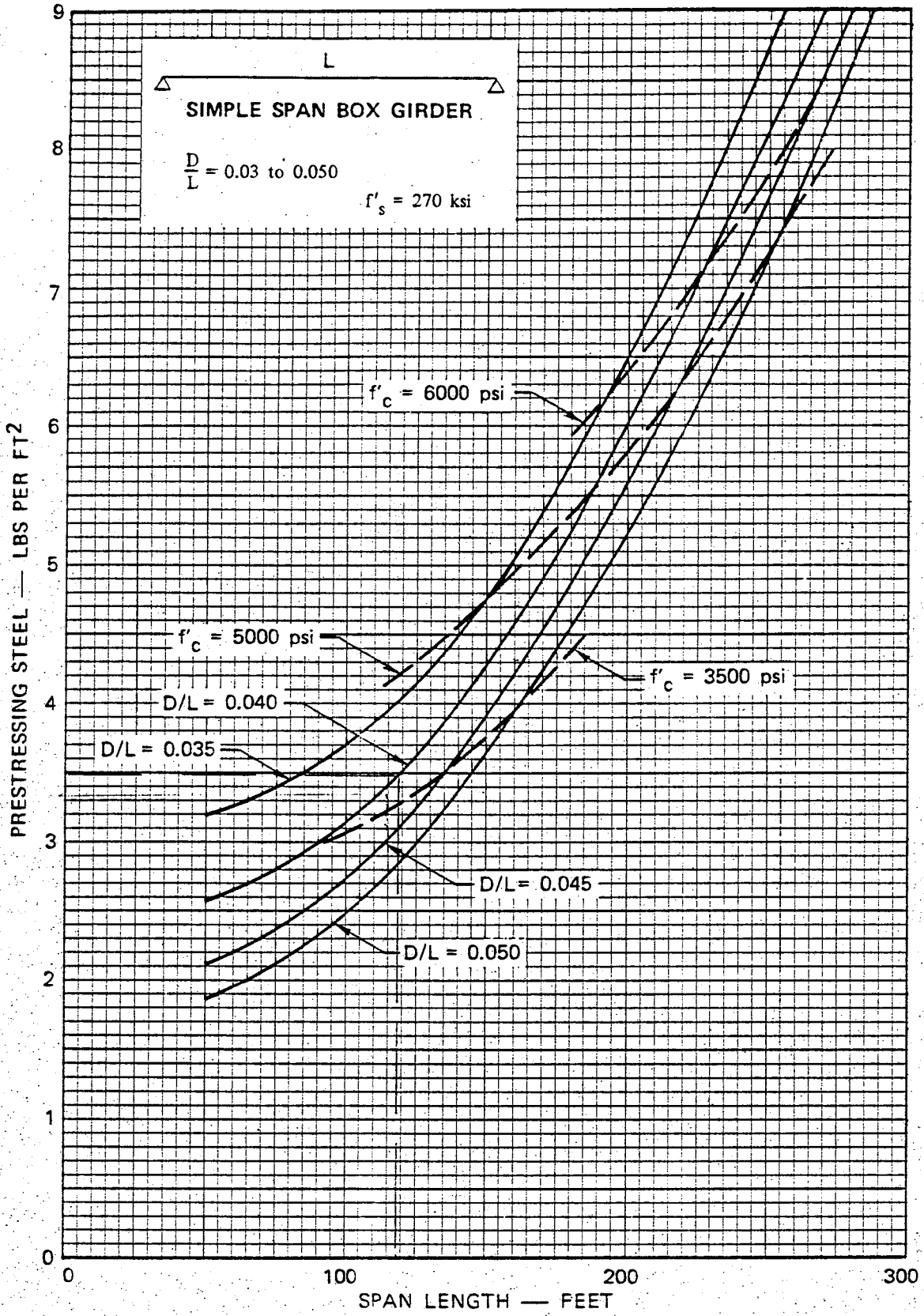
85% × 3.5 psf = 2.98 PSF

$2.98 \times 8 \times 8.67 = 207$ #/FT ⇒ $\frac{207\text{PLF}}{.52\text{PLF}(\frac{1}{2}''\phi\ \text{P/T})} = 398 - \frac{1}{2}''\phi$ STRANDS/BRIDGE

$\therefore P_f$ (APPROX) $= \frac{398(.60).153(270)}{8}$

$= 1233$ K/GIRDER

FOR ALLOWABLE TENSION OF $6\sqrt{f'_c}$
USE 85% OF PRESTRESSING STEEL VALUES SHOWN



CIP PRESTRESSED BOX GIRDER
PRESTRESSING STEEL
HS20

Fig. 2.0

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project I-17 ACDC no. 85003
client ADOT design [illegible] date 11/85
subject S.B. FRONTAGE RD. checked date

POST TENSIONING REQUIREMENTS (CONT.)

TRY MIN 'D' = 5" (SEE CHART)

∴ MAX DIST. FROM CGS to GIRDER BTM = $5+4\frac{1}{2} = 9\frac{1}{2}$"

& $e = 31.32 - 9.5 = 21.82"$ or $1.82'$

P.T. FORCE & CONC. STRENGTH REQ'D.

BTM $f_b - f_{ba} = 2399 - 402 = 1997$ PSI

$$f - f_b = \frac{P_f}{A} + \frac{P_f e}{S_b} = 1997$$

$$\frac{1000 P_f}{144(103.83)} + \frac{1000 P_f (1.82)}{144(127.15)} \Rightarrow P_f = \frac{1997}{.0669 + .0994} = 12010\text{K TOTAL}$$

$$\Rightarrow P_f = \frac{12010}{8} = 1501\text{K/GIRDER}$$

CHECK ASSUMED e (SEE CHART NEXT PG)

for D = 5", $P_f \cong 1500$K/GIRDER ∴ OK

& $D'_{MIN} = 3\frac{1}{2}" < 5" < D'_{MAX} = 5.4"$ ∴ OK

USE D = 5"

TOP STRESS DUE TO P/T

$$f_t = \underbrace{\frac{12010(1000)}{144(103.83)}}_{\text{COMP.}} - \underbrace{\frac{1000(12010)1.82}{144(127.15)}}_{\text{TENS.}}$$

$$= 803 - 1194 = -391 \text{ PSI}$$

FINAL TOP STRESS

$1894 - 391 = 1503$ PSI $\Rightarrow f'_c$ REQ'D $= \frac{1503}{.4} = 3760$ PSI < 4500

∴ OK

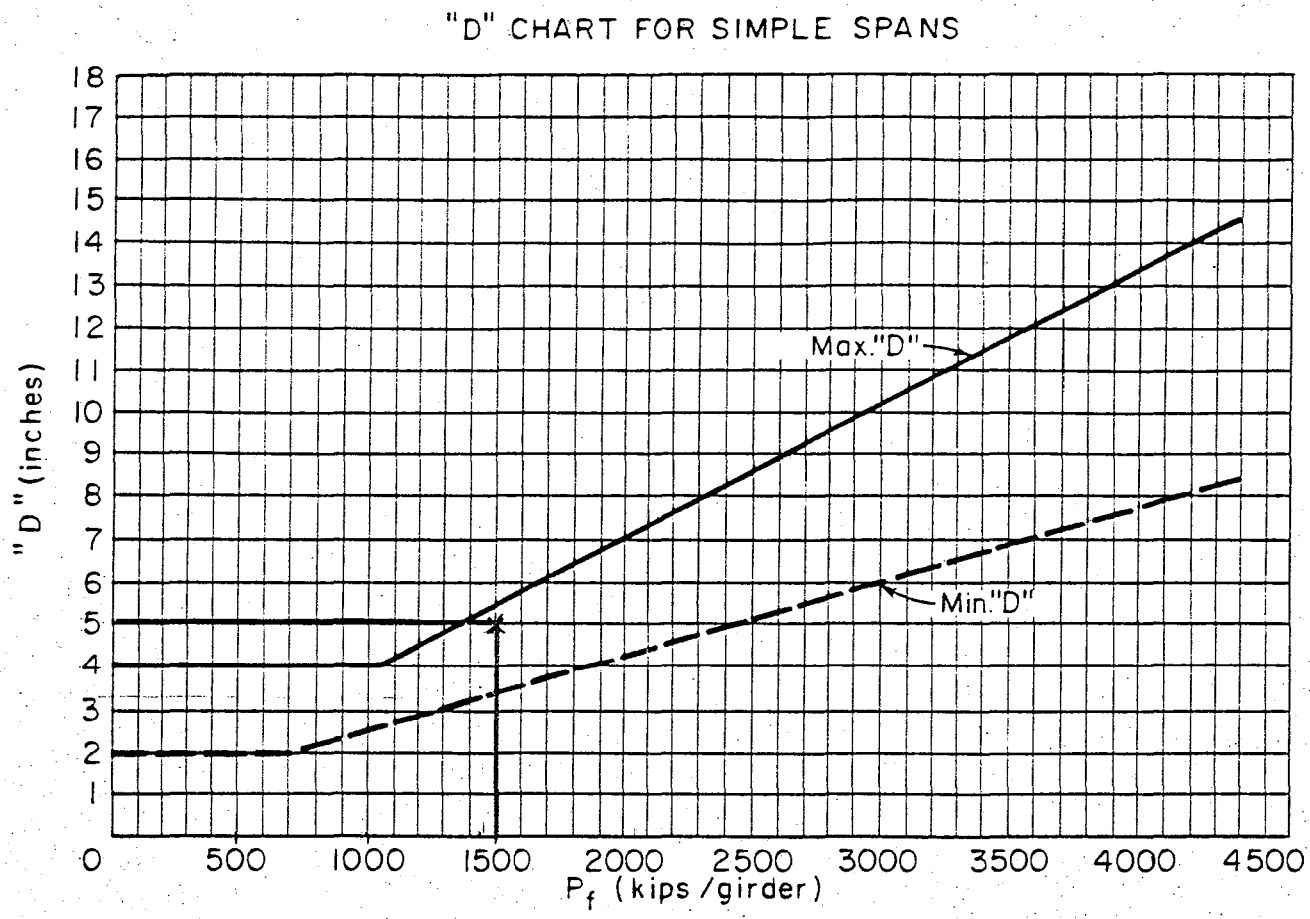
"D" CHART FOR SIMPLE SPANS
"D" (inches)
Max."D"
Min."D"
P_f (kips /girder)
0
500
1000
1500
2000
2500
3000
3500
4000
4500
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18

Fig. 2.7

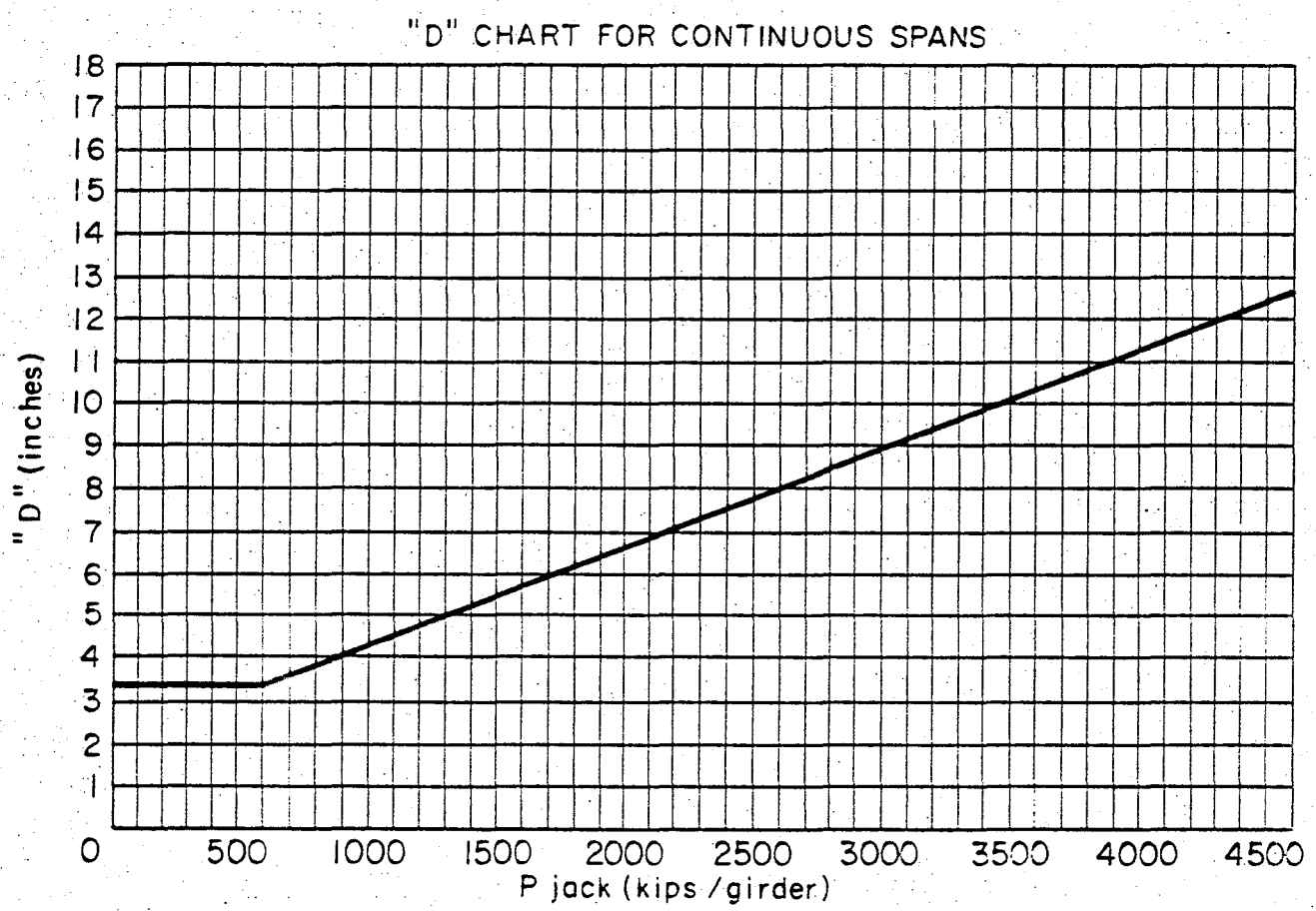
"D" CHART FOR CONTINUOUS SPANS
"D" (inches)
P jack (kips /girder)
0
500
1000
1500
2000
2500
3000
3500
4000
4500
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18

Fig. 2.8

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project I-17 ACDC BRIDGES no. 85003
client ADOT design [illegible] date 11/85
subject S.B. FRONTAGE RD. checked _____ date _____

POST TENSIONING REQ. (CONT.)

PRESTRESS LOSSES (ESTIMATED)

- PER AASHTO 9.16.2.2 ESTIMATED LONG TERM LOSSES = 33,000 PSI
- FRICTION FORCES FOR SIMPLE SPAN STRUCTURE CAN GENERALLY BE NEGLECTED.
- CONSERVATIVELY USE 40,000 PSI LOSSES TO ACCOUNT FOR BOTH

$\therefore f_e = 270(.7) - 40 = 189 - 40 = 149$ KSI

& Nº STRANDS $= \frac{12010}{8 \times 149 \times .153} = 65.9$ STRANDS PER WEB / USE 69 STRANDS FOR ULT. MOMENT

P_f TOTAL (BEFORE LOSSES) $= 69(8 \times 189 \times .153) = 15{,}960$ K

REQ'D CONC. STRENGTH @ STRESSING

DEAD LOAD FIBER STRESS @ MIDSPAN (W/O FUTURE SURFACE OR BARRIER)

TOP $f_t = \frac{17.3}{19.6}(34{,}110) \times 0.0431 = 1300$ PSI (COMP)

BTM $f_B = \frac{17.3}{19.6}(34{,}110) \times 0.0546 = 1643$ PSI (TENS)

PRESTRESSING FIBER STRESS @ MIDSPAN (BEFORE LOSSES)

TOP $f_t = \frac{1000(15960)}{144(103.8)} - 15960(1.82).0431$

$= 1068 - 1252 = -184$ PSI (TENSION)

BTM $f_b = \frac{1000(15960)}{144(103.8)} + 15960(1.82).0546$

$= 1068 + 1586 = 2654$ PSI (COMP.)

NET STRESSES

TOP $f_t = 1300 - 184 = 1116$ PSI (COMP) $< .55 f'_{ci} = .55(3000) = 1650$ PSI

& BTM $f_b = -1643 + 2654 = 1011$ PSI (COMP) < 1650 PSI $\therefore$ OK

$\therefore$ ANCHORAGE BEARING STRESSES WILL GOV'N

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client ADOT design aal date 11/85
subject S.B. FRONTAGE RD. BRIDGE checked date

ULTIMATE LOAD CHECK

$$M_u = \frac{1.3}{.9}\left(DL + \frac{5}{3}(LL+I)\right)$$
$$= \frac{1.3}{.9}\left(34{,}110 + \frac{5}{3}(9{,}820)\right) = 72{,}910 \text{ FT.K}$$

CAPACITY

$$f^*_{su} = f'_s\left(1 - \frac{.5p^* f'_s}{f'_c}\right) \quad ; \quad A^*_s = \frac{15960}{.75 \times 270} = 78.8$$

$$p^* = \frac{A^*_s}{bd} = \frac{78.8}{65.1'(4.0')144} = .00210$$

$$\therefore f^*_{su} = 270\left(1 - \frac{.5(.00210)270}{4.5}\right)$$
$$= 253 \text{ KSI}$$

LOCATE N.A.

$$1.4dp^* f^*_{su}/f'_c = 1.4(4.0 \times 12).00210(253)/4.5 = 7.9 \text{ IN} < 8.5 \text{ IN}$$

$\therefore$ N.A. FALLS IN THE FLANGE & THE SECTION IS CONSIDERED RECTANGULAR

M_{ULT}

$$M_u \text{ (PROVIDED)} = A^*_s f^*_{su} d\left(1 - \frac{.6p^* f^*_{su}}{f'_c}\right)$$
$$= 78.8(253)(4.0)\left(1 - \frac{.6(.00210)253}{4.5}\right) = 74{,}100 \text{ FTK} > M_u$$

$\therefore$ OK

CHECK $\% A_s$: $p^* \frac{f^*_{su}}{f'_c} = .00210\left(\frac{253}{4.5}\right) = .12 < .30 \therefore$ OK (STEEL WILL YIELD BEFORE CONC.)

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client ADOT design aal date 11/85
subject S.B. FRONTAGE RD. checked date

CHECK SHEAR @ ABUTMENT

$$V_u = \frac{1.3}{.9}\left[1156 + \frac{5}{3}(381)\right] = 2550\text{ K}$$

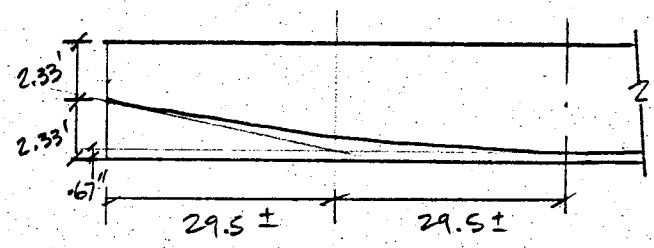
CABLE SHEARS

$$\text{CABLE SLOPE} \approx \frac{2.33-.67}{29.5}$$

$$= .056 \text{ RAD.}$$

$$V_{CABLE} = .056(.70 \times 15960)$$

$$= 630\text{K}$$



CONC. SHEAR RESISTANCE (8-12" WEBS)

$$V_{CONC} = 180\,bjd = 180(12''\times 8)(.90)(.8\times 4.67\times 12)/1000$$

(# WEBS; ASSUME; $d = 44.8''$)

$$= 697\text{K}$$

STIRRUP SPACING (ASSUME #5 STIRRUPS)

$$S_{MAX}\text{ (ENDS)} = \frac{1.8\,A_v f_y d}{V_u - V_c} \quad ; A_v = 8\text{ WEBS}(2\times .31) = 4.96\text{ IN}^2$$

$$= \frac{1.8(4.96)60(44.8)}{2550-(697+630)} = 19.6''$$

USE #5 STIRRUPS @ 12" o.c.

$$\text{or } S_{MAX} = \frac{A_v f_y}{100\,b'} = \frac{4.96(60{,}000)}{100(8\times 12)} = 31''$$

$$\text{or } S_{MAX} = .75(4.67) = 3.51' = 42''$$

$$\text{or } S_{MAX} = 4(5.75) = 23''$$

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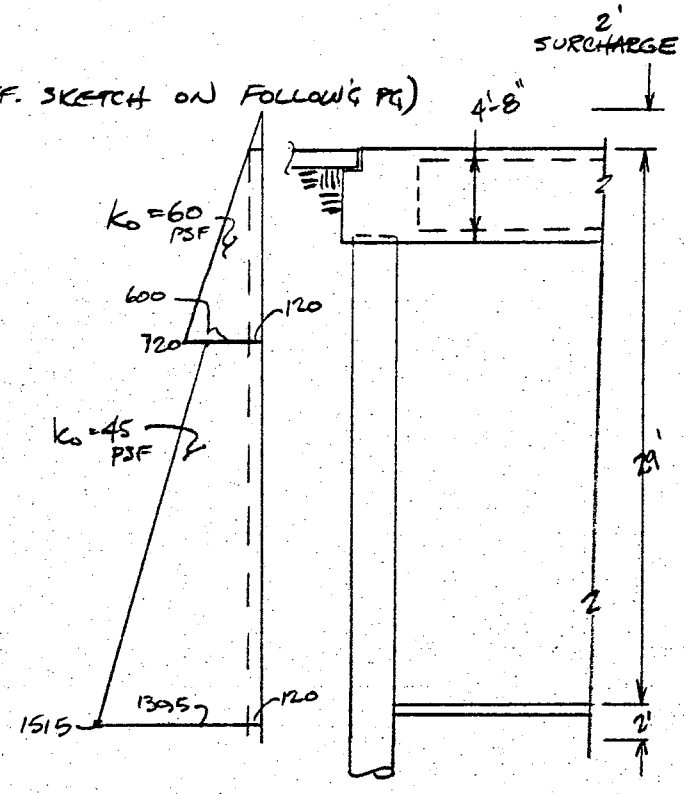
project I-17 ACDC BRIDGES no. 85003
client ADOT design sal date 11/85
subject CHANNEL LINING DESIGN checked date

CHANNEL WALL LINING DESIGN (REF. SKETCH ON FOLLOW'G PG)



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

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

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

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

$= 0.83$ IN²/FT

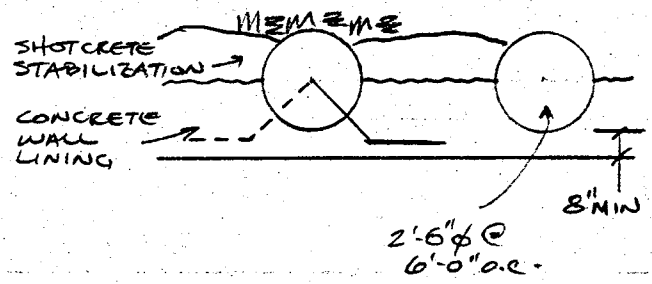
$\boxed{\text{USE \#6's @ 6" o.c. @ BTM. OF 8" WALL}}$

CHANNEL WALL ANCHORAGE DESIGN (REF. SKETCH FOLLOWING)

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

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

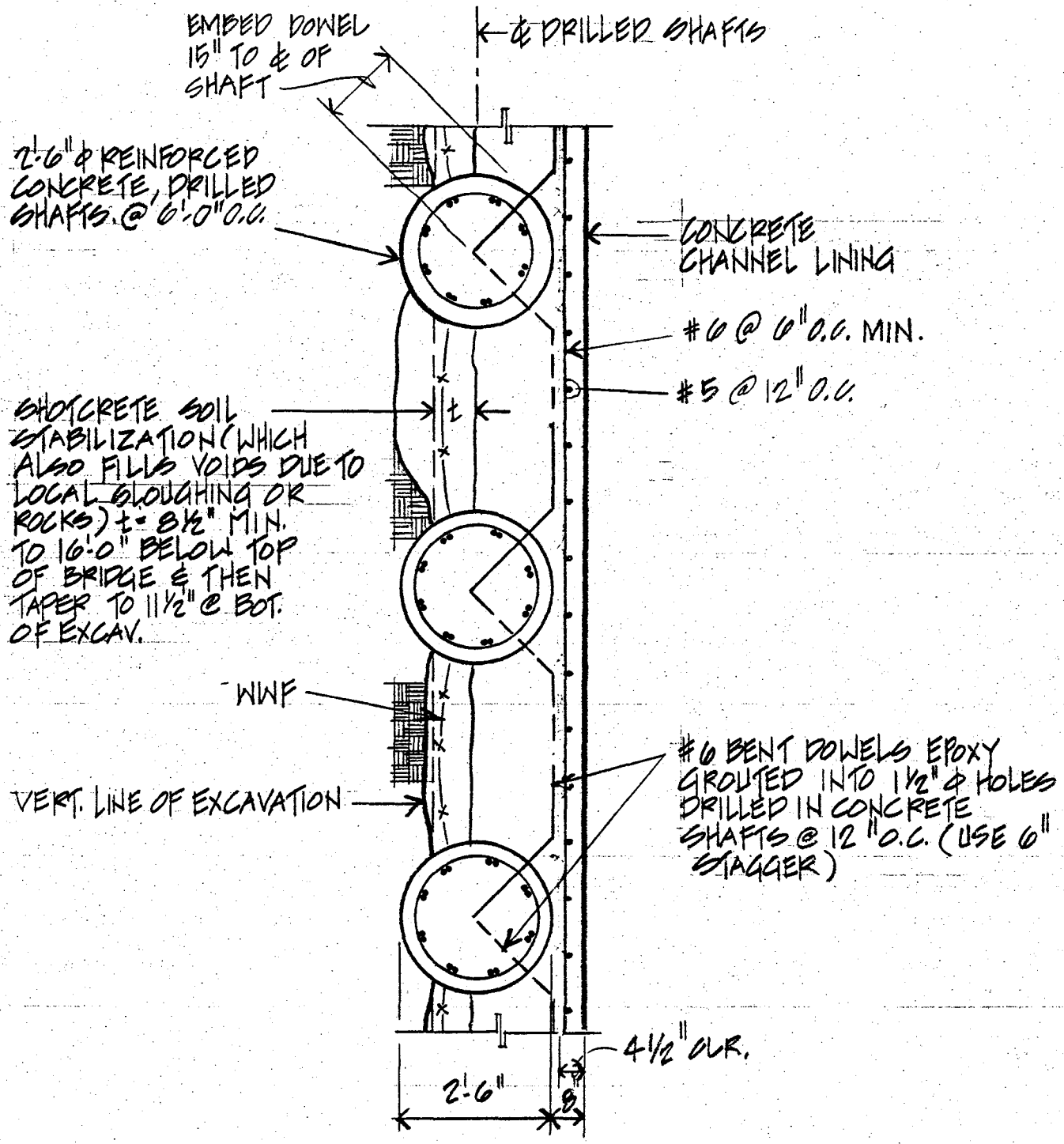
l_{prov} = 15"

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

∴ OK

rga 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

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project I-17 ACDC BRIDGES no. 85003
client ADOT design cal date 11/85
subject DRILLED SHAFT DESIGN checked date

DRILLED SHAFT SUPPORTING BRIDGE & EARTH

- 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)

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TUCSON, ARIZONA

PROJECT NUMBER 05003
PROCESSED ON 11/13/85

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

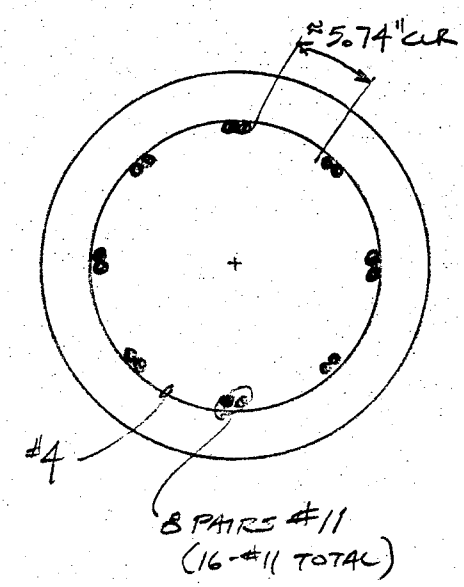
NUMBER OF VERTICALS 16

** 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	-	



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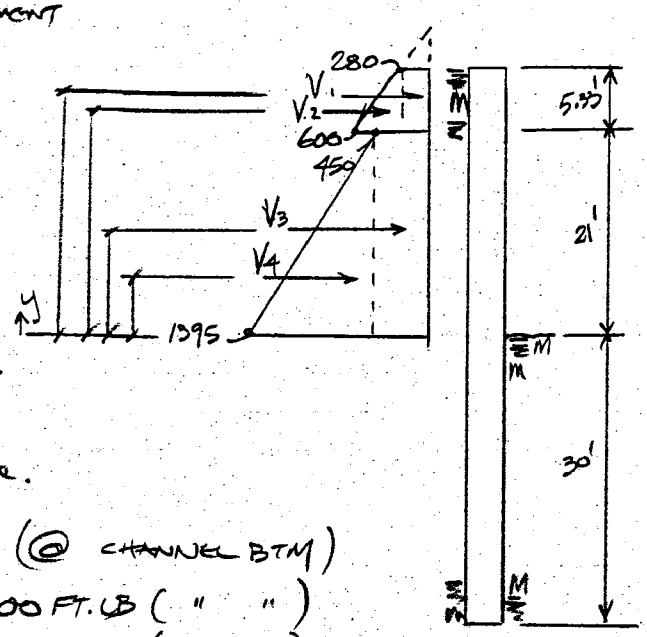
project I-17 ACDC BRIDGES no. 85003
client ADOT design [illegible] date 11/85
subject DRILL SHAFT DESIGN checked date

DRILLED SHAFT SUPPORTING EARTH (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

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

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

RGA CONSULTING ENGINEERS
TUCSON, ARIZONA

PROJECT NUMBER: 5002
PROCESSED ON 11/12/85
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	0.009386
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	-5.833	-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	0.004126
18.00	-0.186	-2.930	-11.720	-162.370	1881.21	0.003823
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	-190.347	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	0.002476
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

PGA CONSULTING ENGINEERS
TUCSON, ARIZONA

PROJECT NUMBER: 3500
PROCESSED ON 11/12/85
PAGE 2

LATERAL LOADS ON PILES

I-17 BRIDGE @ ADOC - 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	-49.808	109.15	0.002354
29.00	0.184	12.444	49.776	-54.567	29.65	0.002343
30.00	0.212	14.839	59.358	0.0	0.0	0.002341

RGA CONSULTING ENGINEERS — PROJECT NUMBER 85003
TUCSON, ARIZONA — PROCESSED ON 11/12/85

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	# 3 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
	5169.5	1450.0	3.37
	4663.7	2023.4	5.21
	4063.9	2555.7	7.55
	3373.2	3012.2	10.72
	3223.4	3093.6	11.52
	3069.2	3171.8	12.40
	2910.4	3247.0	13.39
	2746.8	3319.4	14.50
	2577.9	3389.3	15.78
	2403.5	3457.0	17.26
	2222.8	3522.9	19.02
	2035.9	3587.1	21.14
	1859.8	3620.7	23.36
	1691.1	3630.5	25.76
	1526.1	3622.7	28.49
	1363.7	3599.4	31.67
	1203.1	3561.9	35.53
	1044.0	3510.8	40.35
	886.1	3446.8	46.68
	728.9	3370.1	55.48
	727.7	3369.5	55.57
	726.4	3368.8	55.65
0.1F'C*AG			
	723.8	3367.4	55.83
BALANCED			
	2050.1	3582.7	20.97
PURE BENDING			
	0.0	3661.1	-

engineering corporation

project I-17 ACDC BRIDGES no. 85003
client ADOT design eal date 11/85
subject checked date

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

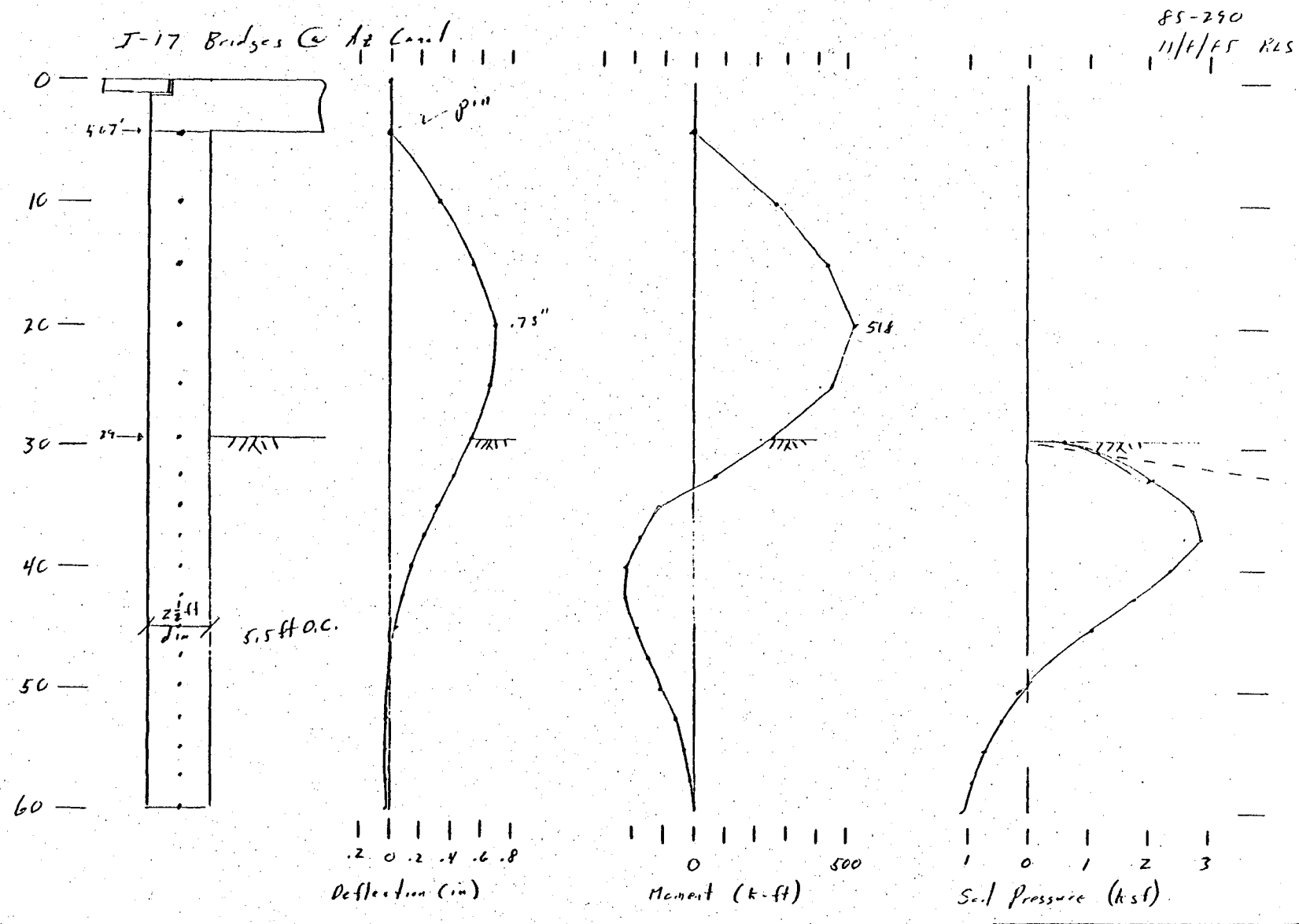
We thank you for the opportunity to help you on short notice. We are available if further work or clarification is desired.

Submitted by:

Registered Professional Engineer (Civil)
CERTIFICATE NO.
10296
ROBERT L.
SOGGE
Date Signed 1/4/85
ARIZONA, U.S.A.

R. L. Sogge P.E.

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

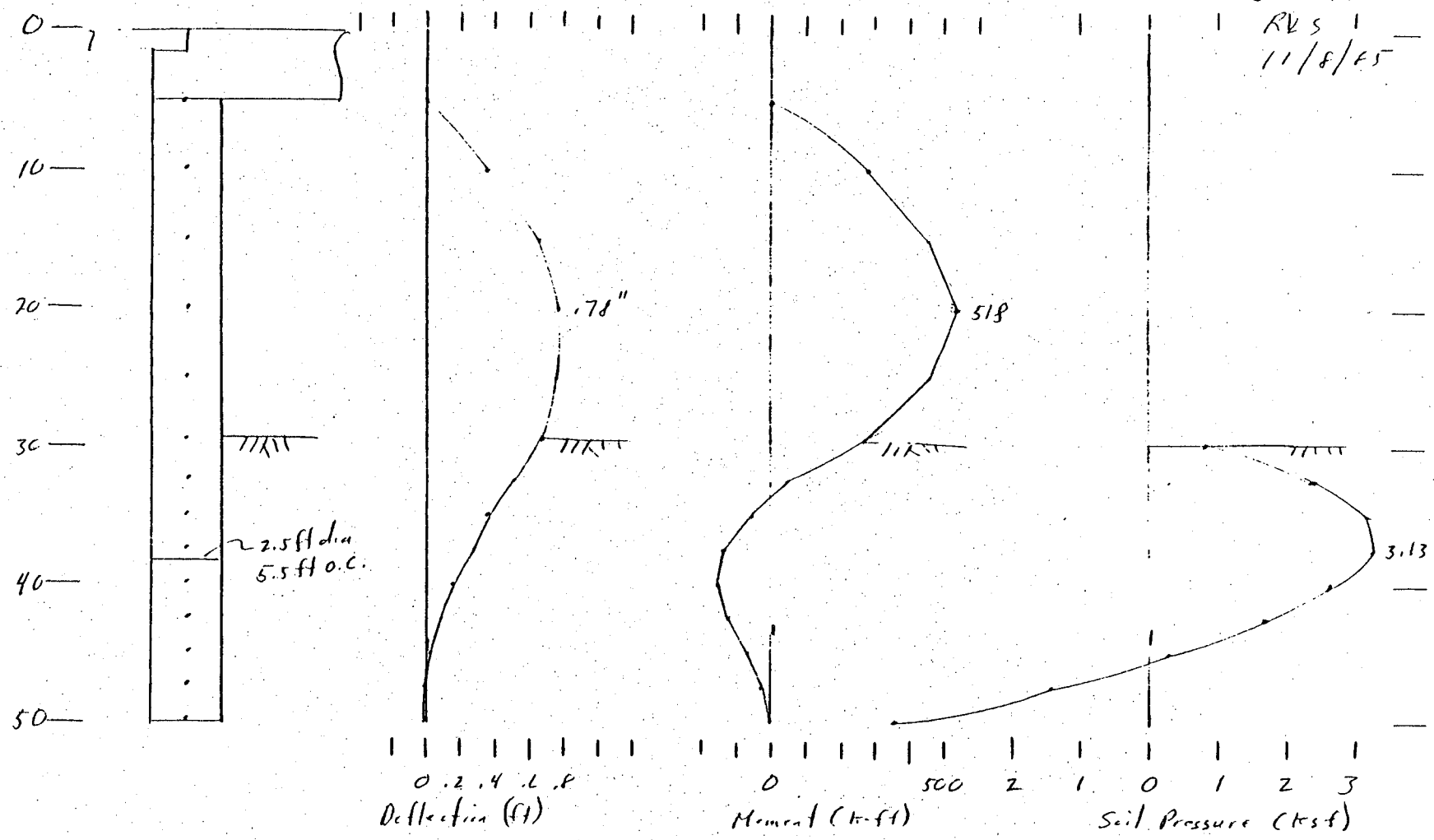


Desert Earth Engineering

consulting geotechnical engineers

Drawn by: RJ	Date 11/8/85	Checked by:	Date
Sheet of	Job No. 85-290	Figure No. 1	

85-290
RKS
11/8/85



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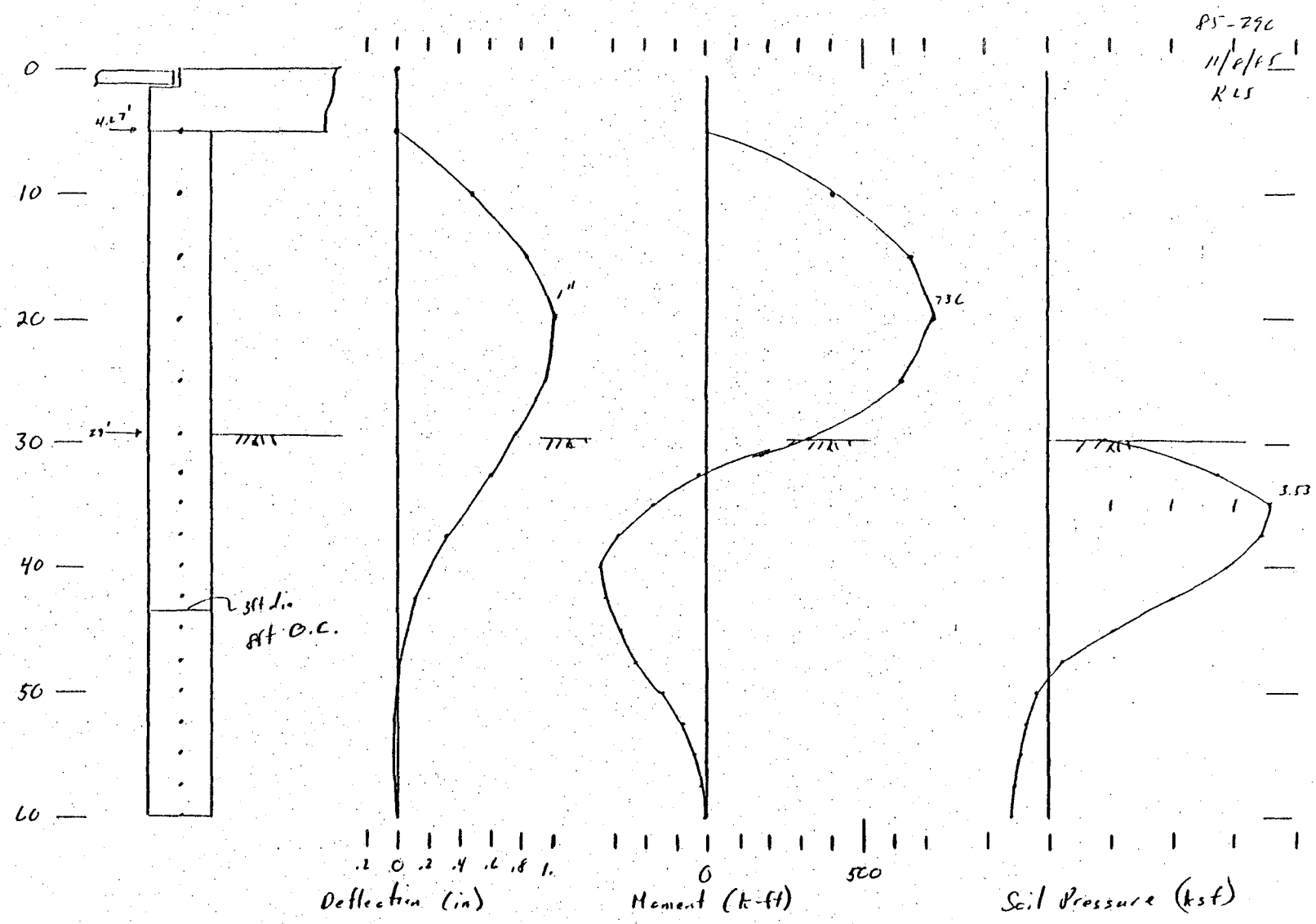
Drawn by: RYL	Date 11/8/85	Checked by:	Date
Sheet of	Job No. 85-290	Figure No. 2	



Desert Earth Engineering
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Drawn by:	Date	Checked by:	Date
RLA	11/8/85		

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

CALCULATION COVER SHEET

Job No. 85-296 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:
KCA Preliminary design
WTI Soil Report dated Oct 1, 1985

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

Calculation By: R. L. Sogge

Date:

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

desert earth engineering

I-17 Bridges @ AZ Canal

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85-290

1/7

Material Properties

Concrete

f'_c = 4000 psi

f_y = 60 ksi

Uncracked section used.

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2/7

I-17 Bridges at Az Canal

Composite Soil Log

	N	
21 1234		Clayey Sand Sandy Clay
1230	6-14	
[illegible]	9-23	
[illegible]	25-81	
[illegible]	15-57	Gravelly Sand med dense
3[illegible]	20-44	
[illegible]	17-48	
[illegible]	22-92	
[illegible]	36-70	Gravelly Sand
[illegible]90	37-100	
		Clayey Sand
[illegible]5	>100	

I-17 Bridges @ Arizona Canal

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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.

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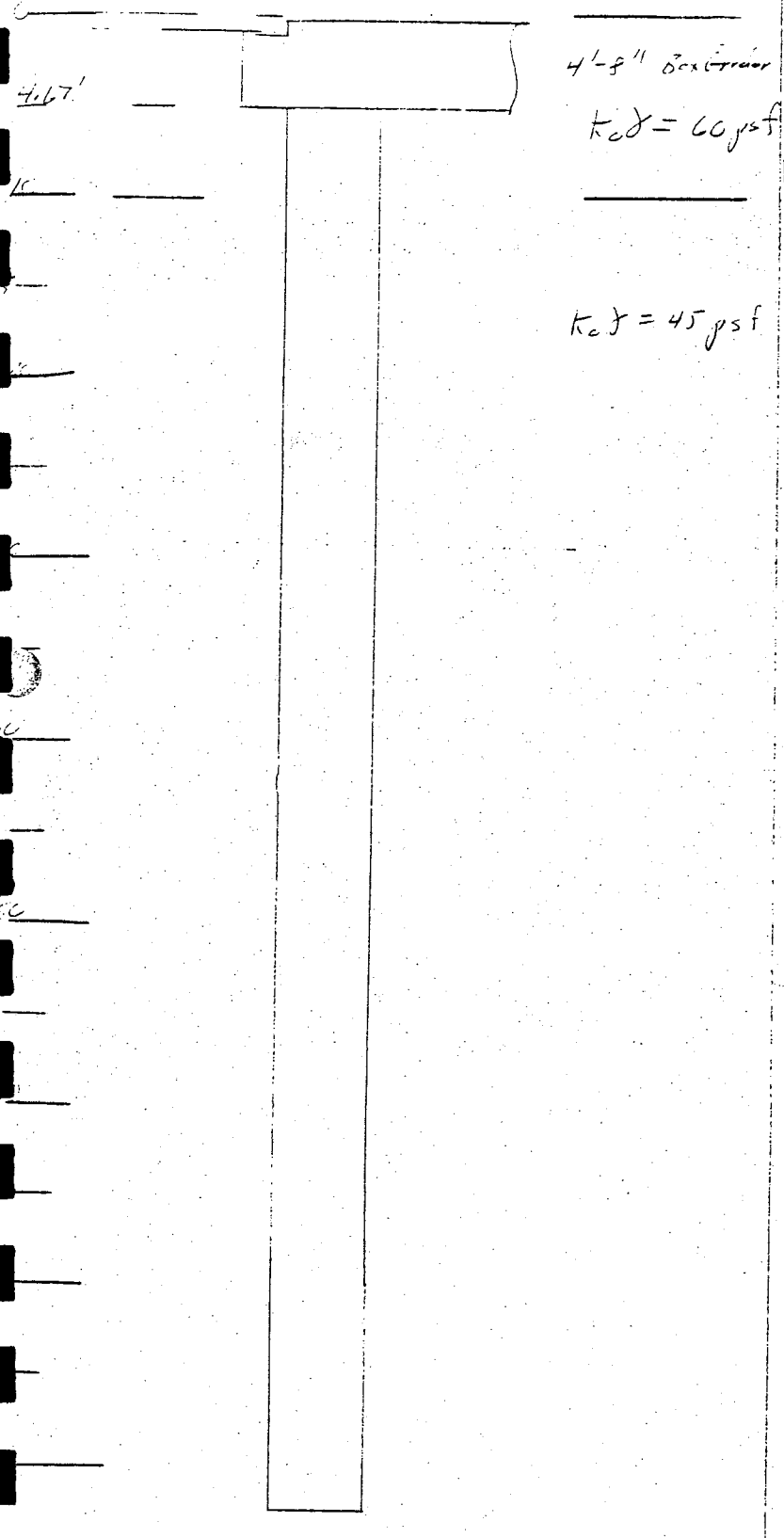
4/7

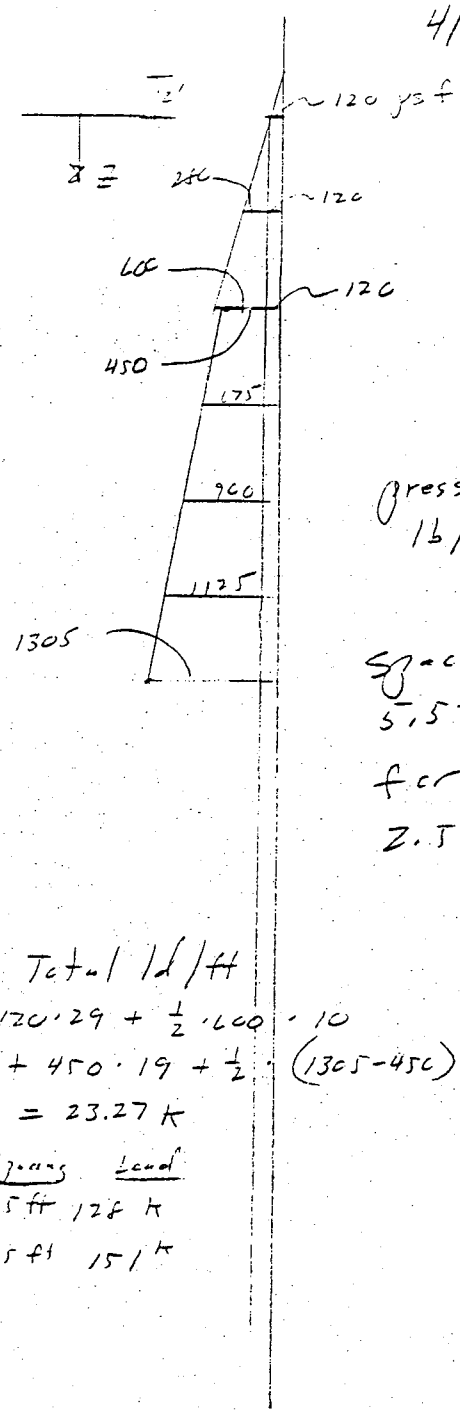
I-17 Bridges @ Az Canal

Soil Pressures

2 ft Surcharge @ 120 psf = q_s

=> w/ k_o ≈ ½ 60 psf E.F.P.





pressures lb/ft out of page.

Spacing 5.5 ft OC for 2.5 ft dia piers

Total lb/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

FEM Model

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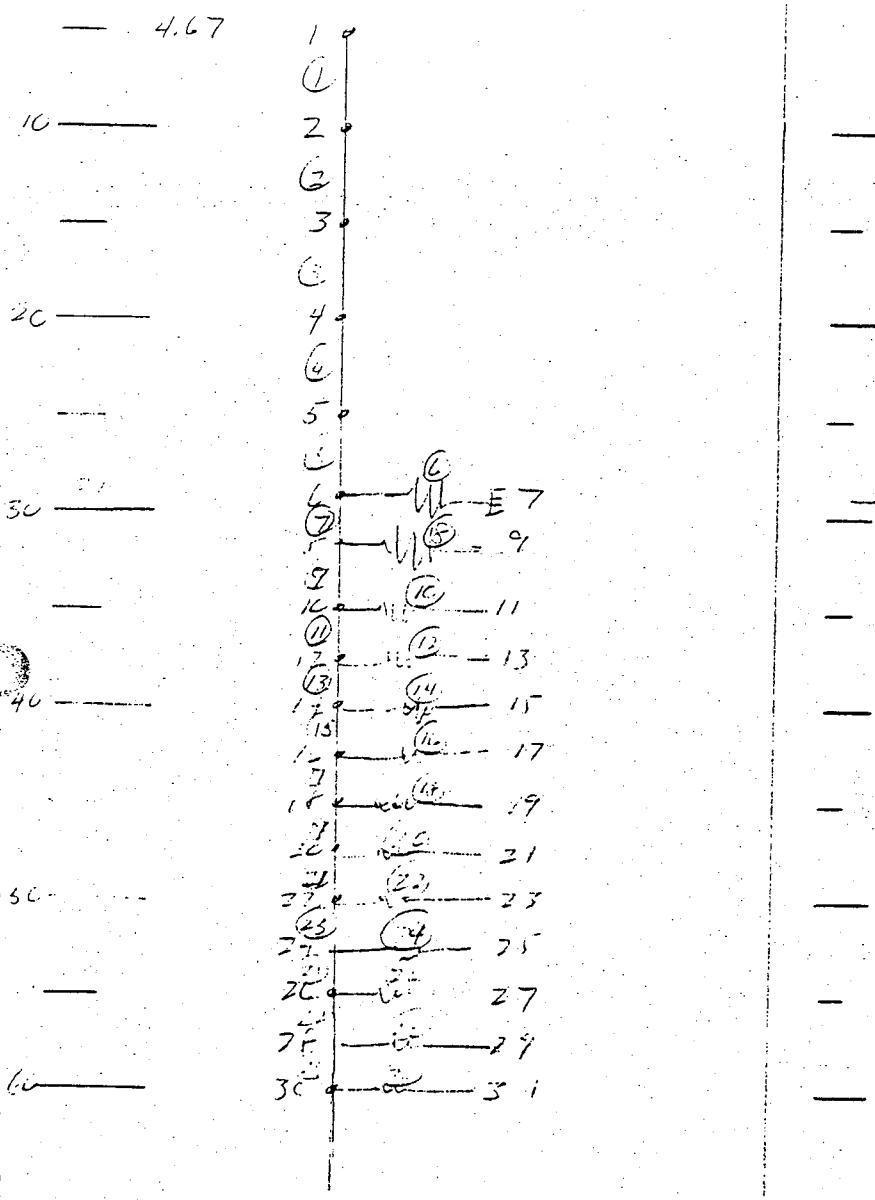
5/1

Load
2½ ft dia



I-17 Bridges @ AZ Canal

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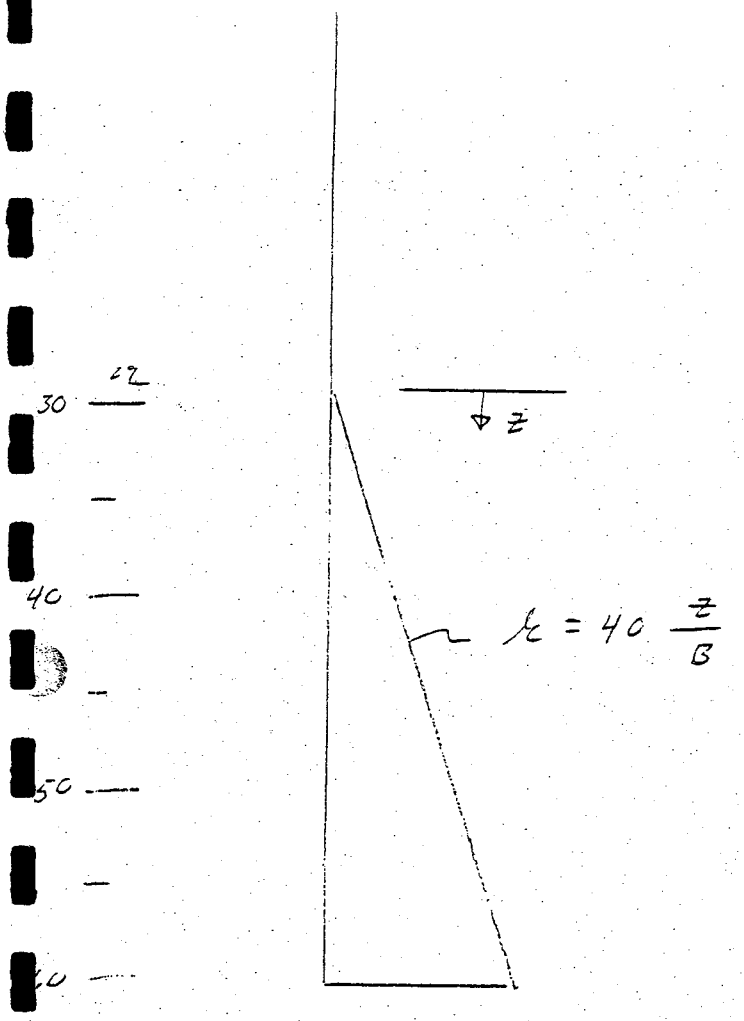
85-290

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 Cw A2 Canal

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

Soil Pressures
Alternate Spacing

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

A = 7.069 I = [illegible]

	100
0	
10	25.8
	31.8
20	40.8
	49.8
30	27.6
	165

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)
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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 OF

NO OF JTS	MEMBERS	MATLS	SUPTD JTS	LODED JTS	REF MBRS	LDD MBRS
23	22	10	11	5	0	0

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

50 ft long

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	4.375	[illegible]	

[illegible]	.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

UPPORT 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

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EMBER	MOMENTS		SHEARS		AXIAL FORCES		AXL STRS
NO.	P-END	Q-END	P-END	Q-END	P-END	Q-END	
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]	[illegible]	[illegible]	[illegible]

7	.173E+03	.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	[illegible]
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	[illegible]
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****     *     *     *     *
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 AD DATA FILE (RESPONSE = 0) OR CREATE DATA FILE (=1)
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INPUT DRIVE:INPUT FILENAME =
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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
EMBER   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	.4663E-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	.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** * * * *
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 =
a:85-290
TITLE
85-290 I-17 Bridges across Az Canal - Lateral Load Analysis, 3 ft dia, 6 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

60 ft long

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
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

JOINT	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	-.9224E-03

	[illegible]	.0000E+00	.4930E-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:PFO

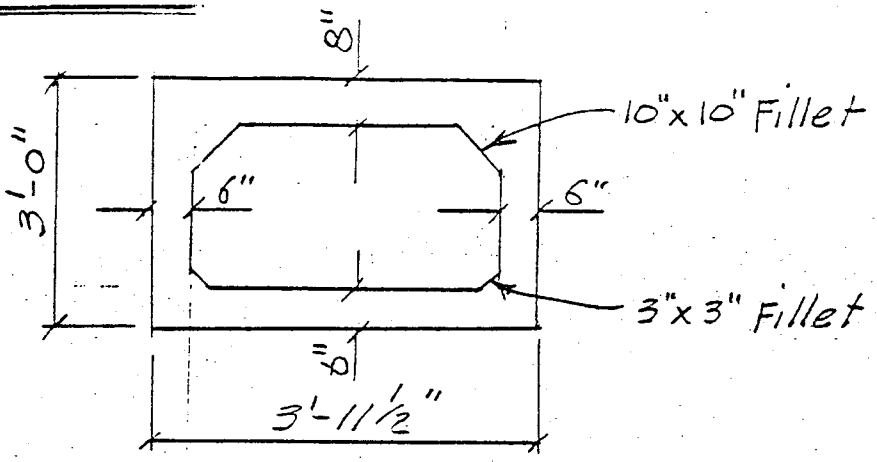
MEMBER	MOMENTS		SHEARS		AXIAL FORCES		AXL STRS
NO.	P-END	Q-END	P-END	Q-END	P-END	Q-END	
1	.000E+00	.401E+03	-.752E+02	.752E+02	.000E+00	.000E+00	.000E+00
2	-.401E+03	.648E+03	-.494E+02	.494E+02	.000E+00	.000E+00	.000E+00
3	-.648E+03	.736E+03	-.176E+02	.176E+02	.000E+00	.000E+00	.000E+00
4	-.736E+03	.620E+03	.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

JNT	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

21	.[illegible]E+01	.000E+00	.000E+00
23	.268E+01	.000E+00	.000E+00
25	.560E+01	.000E+00	.000E+00
27	.724E+01	.000E+00	.000E+00
29	.811E+01	.000E+00	.000E+00
31	.834E+01	.000E+00	.000E+00
33	-.496E-04	.000E+00	-.187E-03

TOTAL WEIGHT OF STRUCTURE = 40.723

BEAM DESIGN



SECTION PROPERTIES

Item	Area	y	Ay
Top slab - 47.5x8 =	380 in²	32"	12,160 in³
Stems - 2(6x22) =	264	17	4,488
Bottom slab - 47.5x6 =	285	3	855
Top Fillets - 10x10 =	100	24.67	2467
Bottom Fillets - 3x3 =	9	7	63
	$\Sigma A = 1038\ in^2$		$\Sigma Ay = 20{,}033\ in^3$

$$y_b = \frac{20{,}033}{1038} = \underline{\underline{19.30''}} \quad ; \quad y_t = 36.00 - 19.30 = \underline{\underline{16.70''}}$$

MOMENT OF INERTIA

$$I_{xx} = I_{oo} + Ad^2$$

Item	I_{o-o}	d	Ad^2
Top slab - $47.5(8)^3 \div 12 =$	2026.67	12.70"	63,317 in^4
Stems - $2x6(22)^3 \div 12 =$	10,648.00	2.30	12,045
Bottom slab - $47.5(6)^3 \div 12 =$	855.00	16.30	76,577
Top Fillets - $10(10)^3 \div 18 =$	555.55	5.37	3,439
Bottom Fillets - $3(3)^3 \div 18 =$	4.50	12.30	1,366

$I_{x-x} = 156,744\ in^4$

$$S_T = \frac{156,744}{16.70} = 9384\ in^3$$

$$S_B = \frac{156,744}{19.30} = 8121\ in^3$$

LOADS - BM. LENGTH = 80'-0" ; 78'-0" E/E Brg's

$$w_D = 1038 \times \frac{150}{144} + 31 = 1112\ \#/ft$$

diaphragms

$$M_D = \frac{1112(78)^2}{8} = 845,676\ ft\text{-}\# = 10,148,112\ in\text{-}lbs$$

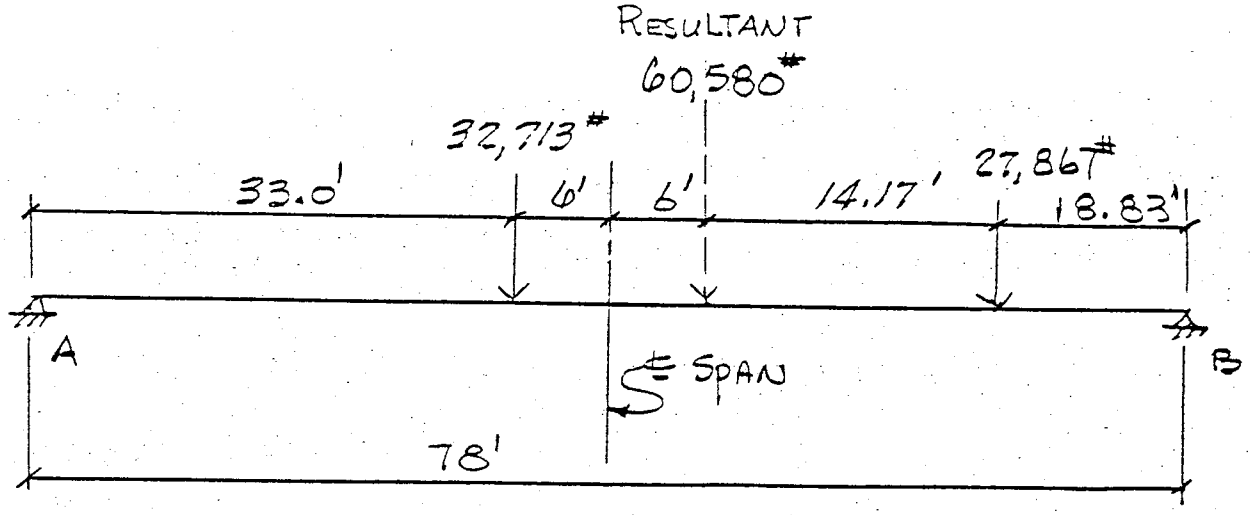
Live Load - 623B Scraper Ken Gustafson Tannier Corp. 437-7873

LOADS per AXLE

71,160# Scraper
50,000 Load
121,160# TOTAL

121,160 x .54 = 65,426# on Front axle
121,160 x .46 = 55,734# " Rear axle

ASSUME FULL WHEEL LOAD PER BM



LOADING FOR MAX LL MOM.

$\Sigma M_B = 0$

$78 R_A = (32{,}317 \times 45) + (27{,}867 \times 18.83)$

$R_A = 25{,}372^{\#}$

$M_{MAX} = 25{,}372 \times 33' = 837{,}276$ '-#

$M_{L+I} = 837{,}276 \times 1.25 = 1{,}046{,}595$ '-# $= 12{,}559{,}140$ in-#

STRESS W/O PRETRESS

DL GIRDER:

$\frac{M}{S_T} = \frac{10{,}148{,}112}{9386} = 1081$ psi (TOP) $\quad \frac{M}{S_B} = \frac{10{,}148{,}112}{8121} = 1250$ (BOTTOM)

LIVE LOAD + IMPACT

$\frac{M}{S_T} = \frac{12{,}559{,}140}{9386} = 1338 \quad \frac{M}{S_B} = \frac{12{,}559{,}140}{8121} = 1546$

$f_t = 2419$ psi $\quad f_b = 2796$ psi

PRESTRESSING FORCE

$e = y_b - y_s$; assume two layers of strand (36 TOTAL)
20 on bottom
16 @ 2" above

$\therefore e = 19.30'' - 2.89'' = 16.41''$

$r^2 = \frac{I}{A} = \frac{156,744}{1038} = 151.00$;

$\frac{e y_t}{r^2} = \frac{16.41 \times 16.70}{151.00} = 1.81$; $\frac{e y_b}{r^2} = \frac{16.41 \times 19.30}{151.00} = 2.10$

$P_F = \frac{f_b A}{\frac{e y_b}{r^2} + 1} = \frac{(2796 - 424)\,1038}{3.10} = 794,237^{\#}$

$A_s = \frac{794,237}{144,000} = 5.515 \text{ in}^2$; 36 strands ($A_s = 5.508$)

794,237
247,860 = (45,000 × 5.508)
1,042,097# = P_i ;
-82,860 = 15,000 × 5.508
959,237# = P_e transfer
-165,240 = 30,000 × 5.508
793,997# = P_F

USE :

$P_i = 1042^K$

P_e transfer $= 959^K$ (26,639#/str)

$P_F = 794^K$

$f_{ci} = \frac{959,000}{1038} = 924$ psi

$f_{cF} = \frac{794,000}{1038} = 765$ psi

STRESSES W/ PRESTRESS

TOP

Initial: $f_{ti} = f_{ci}\left(1 - \frac{e y_T}{r^2}\right) + f_t$ (DL Girder)

$$f_{ti} = 924(1-1.81) + 1081 = +333 \text{ psi}$$

Full Design Load: $f_{t_T} = f_{c_F}\left(1 - \frac{e y_t}{r^2}\right) + f_t$ (D+L+I)

$$f_{t_T} = 765(1-1.81) + 2419 = \underline{+1799} \text{ psi}$$

Bottom

Initial: $f_{bi} = f_{ci}\left(1 + \frac{e y_b}{r^2}\right) - f_b$ (DL Girder)

$$f_{bi} = 924(1+2.10) - 1250 = \underline{+1614} \text{ psi}$$

Full Design Load: $f_{b_F} = f_{c_F}\left(1 + \frac{e y_b}{r^2}\right) - f_b$ (D+L+I)

$$f_{b_T} = 765(1+2.10) - 2796 = \underline{-424} \text{ psi}$$

CONC. Strength Req'd

Temp. Compr.

$$f'_{ci} = \frac{f_{bi}}{.60} = \frac{1614}{.60} = 2690 \text{ psi}$$

Design Load Compr.

$$f'_c = \frac{1814}{.40} = 4498 \text{ psi}$$

SPECIFY:

$f'_{ci} = 4000$ psi

ULTIMATE FLEX. STRENGTH

$$M_u = A_s f_{su} d\left(1 - \frac{0.6\rho f_{su}}{f'_c}\right) : \rho = \frac{5.508\ m^2}{47.5'' \times 33.11''} = .0035$$

$$f_{su} = f'_s\left(1 - \frac{0.5\rho \frac{f'_s}{f'_c}}{f'_c}\right) = 270(1-27\rho) = 270(1-27\times.0035) = 244.5\ ksi$$

$$\therefore M_u = 5.508 \times 244.5 \times 33.11\left(1 - \frac{0.6 \times .0035 \times 244.5}{5}\right) = 40{,}010''\text{-}K$$

$$= 40{,}010{,}000''\text{-}lbs$$

Applied M_u:

$$M_u = \frac{1.30}{\phi}\left[D + 5/3(L+I)\right] = 1.30\left[10{,}148{,}112 + \frac{5}{3}(12{,}559{,}140)\right]$$

$$M_u = 40{,}404{,}016 \approx 40{,}010{,}000 \therefore \underline{OK} \quad (1\%\ o.s.)$$

$\therefore$ USE 36" x 48" BOX BEAMS W/ 36 STRANDS

CHECK STRESSES @ 50 STRAND ϕ's FROM END OF BM

$50 \times 1/2'' = 25'' \approx 2'$ from end of Beam or 1' from Brg ℄.

$\therefore$ Check stresses @ 1' from ℄ Brgs:

$$f_{ti} = f_{ci}\left(1 - \frac{e y_t}{r^2}\right) + f_t\ (DL\ Bm.)$$

M_D @ 1' from ℄ Brgs:

$$M_D = \frac{1112 \times 78}{2} \times 1' - \left(1112 \times \frac{1^2}{2}\right) = 42{,}812\ ft\text{-}lbs$$

$$= 513{,}744\ in\text{-}lbs$$

$$f_t = \frac{513{,}744}{9386} = 55\ psi \quad ; f_b = \frac{513{,}744}{8121} = -63\ psi$$

$$\therefore f_{ti} = 924(1-1.81) + 55 = -693\ psi > -475\ allow.\ (7.5\sqrt{4000})$$

∴ LIMIT CONC. TENSILE STRESS TO −475 psi @ 1' FROM ℄ BRG'S.
THIS WILL REQUIRE REBAR IN TOP OF BM

ASSUME y_s W/ DEBONDED STRAND = 3.00"

$\therefore e = 19.30 - 3.00 = 16.30"$

$$\frac{e\,y_t}{r^2} = \frac{16.30 \times 16.70}{151.00} = 1.80 \; ; \; \frac{e\,y_b}{r^2} = \frac{16.30 \times 19.30}{151.00} = 2.08$$

$\therefore f_{ti} = f_{ci}(1 - 1.80) + 55 = -475$

$$\therefore f_{ci} = \frac{-475 - 55}{-0.80} = 662 \text{ psi, Max. @ transfer w/ } e = 16.30"$$

$\therefore P = 662 \times 1038 = 687{,}156^{\#}$ Max @ transfer

$$\text{No. strands} = \frac{687{,}156^{\#}}{26{,}639^{\#}/\text{str}} = 25.8 \text{ STR. MAX} \; ; \; \underline{\text{TRY 26 STRANDS}}$$

$P = 26 \times 26{,}639 = \underline{692{,}614}$

∴ <u>DEBOND 10 STRANDS - ALL ON BOTTOM ROW</u>

$\therefore y_s = 3.23"$ & $e = 19.30 - 3.23 = 16.07"$

$$\frac{e\,y_t}{r^2} = \frac{16.07 \times 16.70}{151.00} = 1.78 \; ; \; \frac{e\,y_b}{r^2} = \frac{16.07 \times 19.30}{151.00} = 2.05$$

$\therefore f_{ti} = f_{ci}(1 - 1.78) + 55 = -475$

$$\therefore f_{ci} = \frac{-475 - 55}{-0.78} = 679 \text{ psi, Max. @ transfer w/ } e = 16.07"$$

$\therefore P_{MAX} = 679 \times 1038 = 704{,}802^{\#} > 26 \times 26{,}639 = \underline{692{,}614}^{\#}$ ∴ <u>OK</u>

$$f_{ci} = P/A = \frac{692{,}614}{1038} = \underline{667} \text{ psi} < 679 \; \therefore \underline{\text{OK}}$$

$f_{ti} = 667(1 - 1.78) + 55 = \underline{-465}$ psi < -475 ∴ <u>OK</u>

∴ <u>USE 10 DEBONDED STRANDS ON BOTTOM ROW</u>

BOND BREAKER LENGTH

Allow. f_t w/o rebar $= 3\sqrt{4000} = 190$ psi ; 475 psi w/rebar

f_{ci} w/all strands working $= 924$ psi

$f_{ti} = -475 = 924(1-1.81) + f_t$ (DL Bm.)

$\therefore f_t$ (DL Bm) $= -475 + 748 = 273$ psi @ pt. "y" on Bm.

Solve for "y":

$$f_t \text{ (DL Bm.)} = \frac{M}{S} = \frac{wy(\ell - y)12}{2S} = \frac{1112y(78-y)12}{2 \times 9386} = 273$$

$y = 5.3'$ from ℄ Brgs or $6.3'$ from end of beam

USE 6'-6"

∴ BREAK BOND 6'-6" @ Ea. end of Beam

CALC. DEFLECTIONS

$E_{c_i} = 57{,}000\sqrt{4000} = 3{,}605{,}000$

$E_{c_F} = 57{,}000\sqrt{5000} = 4{,}030{,}500$

@ Transfer:

$$\Delta_{DL} = \frac{5(1112 \times 78)(78 \times 12)^3}{384 \times 3{,}605{,}000 \times 156{,}744} = 1.64'' \downarrow$$

Δ due to P_i @ Bm. ends:

$$\Delta_p = \frac{Pe\,l^2}{8EI} = \frac{26{,}639 \times 26 \times 16.07\,(78 \times 12)^2}{8 \times 3{,}605{,}000 \times 156{,}744} = 2.16'' \uparrow$$

Δ due to P_i @ 6'-6" from each end:

$$\Delta_{p_i} = \frac{26{,}639 \times 10 \times 16.41\,(65 \times 12)^2}{8 \times 3{,}605{,}000 \times 156{,}744} = 0.59'' \uparrow$$

TOTAL Δ @ transfer $= (2.16 + 0.59) - 1.64 = 1.11'' \uparrow$

Δ_{P_F} (DL): Assume 50% of Bm. creep takes place prior to application of L+I.

$$\therefore \Delta_{P_F} = 1.11 + \frac{(2.5-1)1.11}{2} = 1.94'' \uparrow$$ = GIRDER CAMBER
Ref. PCA-ST 84

LIVE +I Δ:

Δ @ Point of Resultant Load:

$$\Delta = \frac{Pa^2b^2}{3EIl} = \frac{60{,}580^{\#}(33 \times 12)^2(45 \times 12)^2}{3 \times 4{,}030{,}500 \times 156{,}744\,(78 \times 12)} = 1.56'' \downarrow = \frac{l}{600}$$

$\therefore \Delta_D + \Delta_{L+I} = 1.94'' \uparrow + 1.56'' \downarrow = 0.38'' \uparrow$

REBAR DESIGN

CALC. LENGTH OF REBAR:

$f_{ti} = -190$ psi w/o rebar

$f_{ti} = -190 = 924(1-1.81) + f_t\,(DL\ Bm)$

$\therefore f_t\,(DL\ Bm) = -190 + 748 = 558$ psi @ pt "ψ" on Bm.

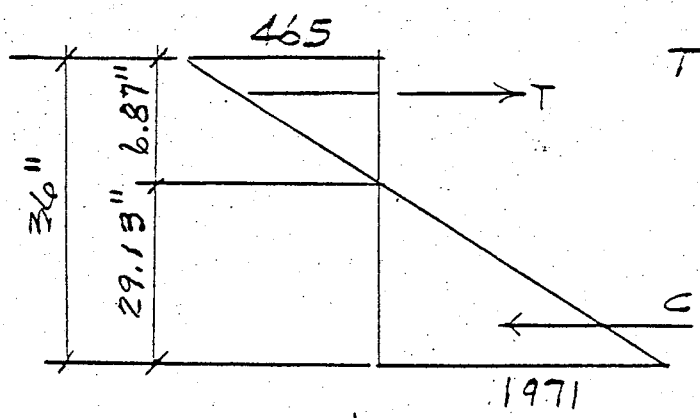
$$f_t\,(DL\ Bm) = \frac{1112\,\psi\,(78-\psi)\,12}{2 \times 9038} = 558$$

$\therefore \psi = 11.3'$ USE 13'-0" to allow for rebar development

DESIGN TENSILE STRESS REBAR

@ 1' from Brg ℄ (2' from Bm end):

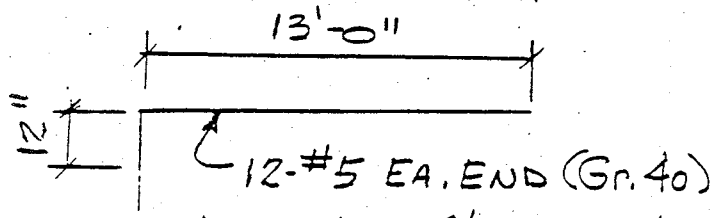
$$f_{bi} = f_{ci}\left(1 + \frac{e\,y_b}{r^2}\right) - f_b\,(DL\ Bm.) = 667(1+2.05) - 63 = 1971 \text{ psi}$$



$$T = \frac{465 \times 6.87 \times 47.5}{2} = 75{,}870^{\#}$$

$$A_s = \frac{75{,}870}{20{,}000} = 3.79 \text{ in}^2$$

USE:
12-#5 bars = 3.72 in²
WWF 4X4-8/8 = 0.23 (11 wires
3.95 in²



WWF 4x4-8/8 is Continuous over Bm. length & width

CHECK ρ MAX.

$\frac{\rho f_{su}}{\ldots} \leq .30$; $\rho = \frac{3.95}{\ldots} = .0044$; $.0044 \times \frac{244.5}{\ldots} = 0.215 < 0.3$ OK

CHECK ρ_{MIN}.

Mod. of Rupture $= 7.5\sqrt{5000} = 530$ psi = Cracking stress $= f_{bT}$

$\therefore f_{bT} = 530 = 765(3.10) - f_b(D+L+I)$

$\therefore f_b(D+L+I) = 1842$ psi

$\therefore M_{(D+L+I)} = fS = 1842 \times 8121 = 14{,}985{,}882$ in-lbs

$1.2(M_{D+L+I}) = 1.2 \times 14{,}985{,}882 = 17{,}950{,}658 < 40{,}010{,}000 \therefore$ OK

CHECK SHEAR @ 1/4 PTS (11.6.13, 1980 Supplement)

$V_D = \frac{1112 \times 80}{2} - 1112 \times \frac{78}{4} = 22{,}769^{\#}$

V_{L+I} : Heavy wheel @ L/4

$R_{L+I} = 1.25\left[\left(24{,}535 \times \frac{58.5}{78}\right) + \left(20{,}900 \times \frac{32.33}{78}\right)\right] = 33{,}830^{\#}$

$\therefore V_{L+I}$ @ L/4 $= 33{,}830^{\#}$

$V_u = \frac{1.30}{.90}\left[22{,}769 + \frac{5}{3}(33{,}830)\right] = 114{,}331^{\#}$

Shear Strength Provided by Concrete : (V_c)

$V_{ci} = 1.7\sqrt{f'_c}\, b'd = 1.7\sqrt{5000}\,(2\times6'')(33.11) = 47{,}761^{\#}$

$V_{cw} = (3.5\sqrt{f'_c} + 0.3 f_{pc})\, b'd + V_p > V_{ci}$ by inspection

$\therefore V_c = V_{ci} = 47{,}761^{\#} < 114{,}331 \therefore$ stirrups req'd

$114{,}331 - 47{,}761 = 66{,}570^{\#} = V_s < 8\sqrt{5000}\,(12'')(33.11) = 224{,}758^{\#} \therefore$ OK

$V_s = \frac{A_v f_{sy} d}{s} \quad \therefore s = \frac{A_v f_{sy} d}{V_s} = \frac{(2\times.31)(40{,}000)33}{66{,}570} = 12.33''$

use 12"

$S_{MAX} = 0.75\,h = 0.75 \times 36'' = 27''$ USE 24" Max

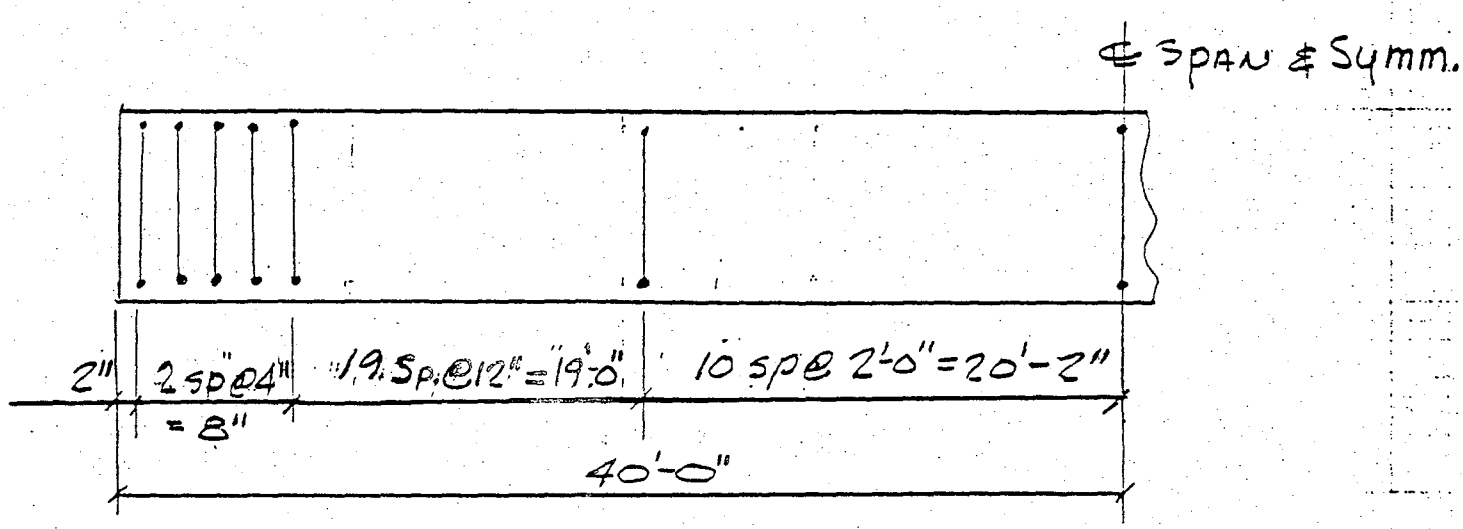
∴ <u>USE #5 stirrups (Gr. 40)</u>

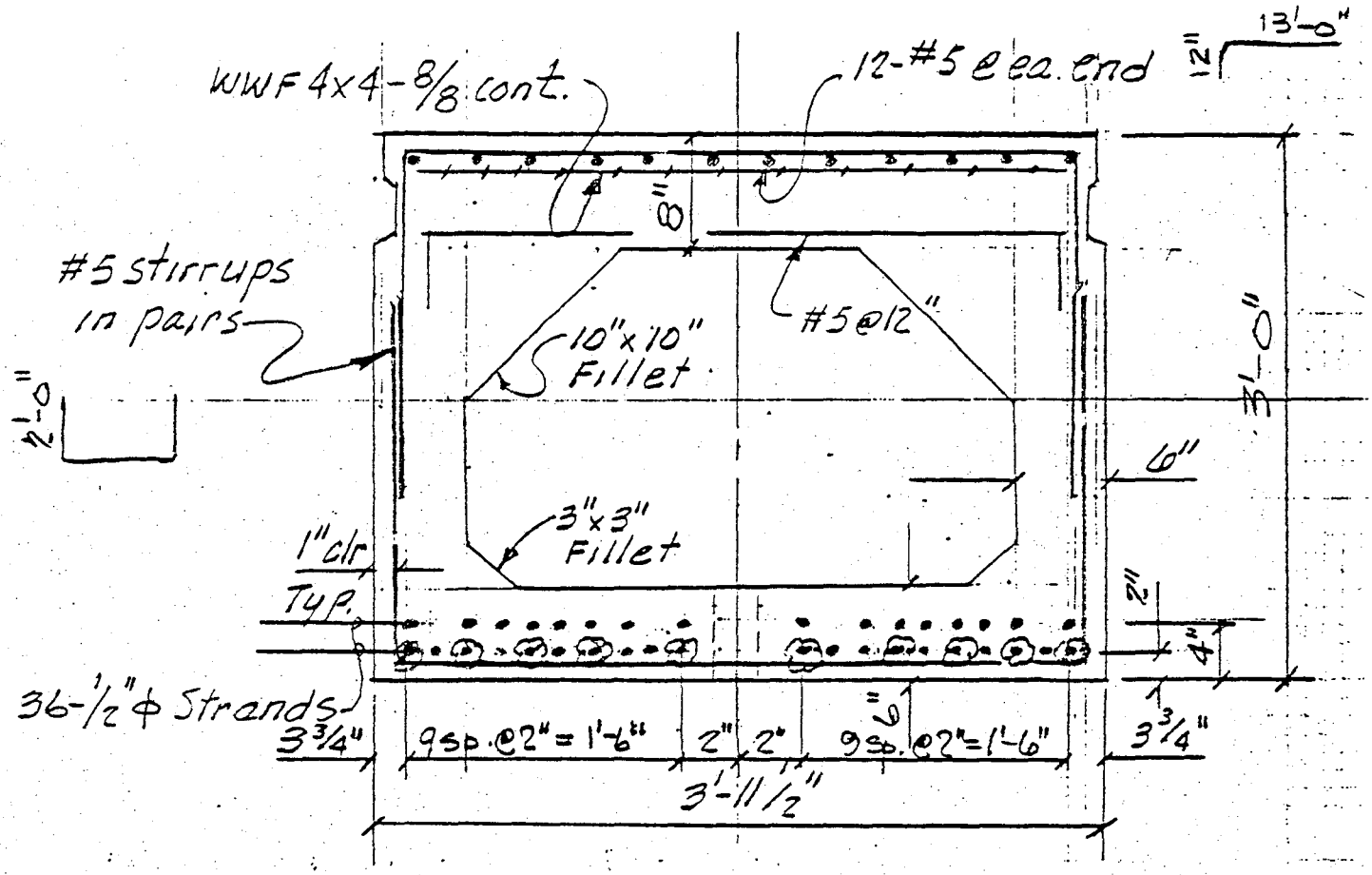
Pe transfer @ end of Beam = 692,614#

$d/4 = 36/4 = 9''$

$692{,}614 \times 4\% = 27{,}705^{\#}$ (1.6.15)

$\frac{27{,}705}{20{,}000} = 1.38\ in^2$ req'd ; 3 stirrups ($A_s = 1.86$) within $h/4 = 9''$





Break Bond on 10 strands shown @ 6'-6" from each end of Beam.