```
TITLE CAP DESIGN WITH TRANSVERSE DECT STEEL    17:55:28  03/24/93 PAGE  1

*****************************************************************
*                          CONC                                 *
*                   CONCRETE DESIGN PROGRAM                     *
*                 (RC) REINFORCED CONCRETE                      *
*                 (PP) PARTIALLY PRESTRESSED                    *
*                 (FP) FULLY PRESTRESSED                        *
*            CALIFORNIA DEPARTMENT OF TRANSPORTATION            *
*                 VERSION  2    06.01.87                        *
*****************************************************************


***************
* GENERAL DATA *
*****************************************************************

TYPE OF STRUCTURE   (REINFORCED CONCRETE)  =      RC

TYPE OF ANALYSIS                           =  DESIGN

CONSIDER FATIGUE?                          =     YES
CONSIDER SERVICE - CRACK CONTROL?          =     YES

ULTIMATE CONCRETE COMPRESSIVE STRESS  (FC) =    3.25 KSI
ULTIMATE CONCRETE COMPRESSIVE STRAIN  (EO) =   0.003 IN/IN
YOUNGS MODULUS FOR CONCRETE           (EC) =   3249. KSI

YOUNGS MODULUS FOR STEEL REBARS       (ES) =  29000. KSI
YIELD STRESS FOR STEEL REBARS         (FS) =    60.0 KSI

YOUNGS MODULUS FOR PRESTRESS STEEL    (EP) =  28000. KSI
ULTIMATE STRESS FOR PRESTRESS STEEL   (FP) =   270.0 KSI
LOW-LAX PRESTRESS STEEL                    =     YES

MODULAR RATIO MILD STEEL (ES/EC)      (NS) =    8.92
MODULAR RATIO PRESTRESS STEEL (EP/EC) (NP) =    8.62

ENVIRONMENTAL FACTOR                   (Z) =   170.0 K/IN



****************
* STRUCTURE DATA *
*****************************************************

TOTAL DEPTH                  =   5.50 FT

TOP FLANGE WIDTH (COMP)      =  11.00 FT
TOP FLANGE WIDTH (TEN)       =   6.00 FT
TOP FLANGE THICKNESS         =   8.25 IN

WIDTH OF WEB                 =   6.00 FT

BOTTOM FLANGE WIDTH (COMP)   =  11.00 FT
BOTTOM FLANGE WIDTH (TEN)    =   6.00 FT
BOTTOM FLANGE THICKNESS      =   6.63 IN
```

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TITLE CAP DESIGN WITH TRANSVERSE DECT STEEL     17:55:28  03/24/93 PAGE  2

*************
* STEEL DATA *
*****************************************************************************

REBAR  REBAR   TOTAL   BAR    COVER    BUNDLE   SKEW     EFFECTIVE
LOC    LAYER   BARS    SIZE   [INCH]   PATTERN  DEGREES  AREA
-----  -----   -----   ----   ------   -------  -------  ---------

TOP     MAIN     0      11     4.13       1      0.00      0.00
TOP    OTHER     7       6     2.00       1      0.00      3.08

TOTAL AREA OF PRESTRESS STEEL (AP) =   0.00 SQ IN
DIST. FROM SECTION BOTTOM TO C.G. OF PRESTRESS STEEL (DP) =   0.00 IN

*********************
* LOAD DATA (KIP-FT) *
*****************************************************************************

LOAD TITLE = MAXIMUM NEGATIVE MOMENT

          TOTAL
        DEAD LOAD    H-MAX    H-MIN    P-MAX   OTHER   SECONDARY
          (DL)      (LL+I)   (LL+I)   (LL+I)  MOMENT    MOMENT
                                                (O-MOM)   (S-MOM)

MOMENT    -2146.     -706.      0.    -2155.     0.        0.
AXIAL        0.        0.      0.       0.      0.
LOAD
FACTORS     1.30      2.17             1.30     1.00      1.00

STRENGTH REDUCTION FACTOR (PHI) = 0.90

FINAL PRESTRESS FORCE AFTER ALL LOSSES (PF) =    0.00 KIPS

***************
* DESIGN LOADS *
*****************************************************************************

          MAX      MIN      MAX      MAX
         H-SER    H-SER    H-FAC    P-FAC

MOMENT   -2052.   -2146.   -4322.   -5591.
AXIAL       0.       0.       0.       0.

LOAD COMBINATIONS:
------------------

MAX H-SER = (DL) + (H-MAX) + (O-MOM) + (S-MOM)
MIN H-SER = (DL) + (H-MIN)           + (S-MOM)

MAX H-FAC = 1.30 X (DL) + 2.17 X (H-MAX) + 1.00 X (O-MOM) + 1.00 X (S-MOM)
MAX P-FAC = 1.30 X (DL) + 1.30 X (P-MAX) + 1.00 X (O-MOM) + 1.00 X (S-MOM)
```

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TITLE CAP DESIGN WITH TRANSVERSE DECT STEEL     17:55:28  03/24/93 PAGE  3

************************
* INTERMEDIATE RESULTS *
************************************************************************

MAIN STEEL AREA BASED ON FOLLOWING LOAD TYPES:

S-AS  = SERVICE STRESS IN MILD STEEL (AS) (MAX H-SER)
        (CRACK CONTROL)
F-AS  = FATIGUE STRESS IN MILD STEEL (AS) (MAX & MIN H-SER)
H-FAC = H-FACTORED MOMENT
P-FAC = P-FACTORED MOMENT
MIN1  = MINIMUM REINFORCEMENT (8.17.1.1)
        BASED ON 1.2 X THE CRACKING MOMENT
MIN2  = WAIVER OF MINIMUM REINFORCEMENT (8.17.1.2)
        BASED ON STEEL AREA ONE THIRD GREATER THAN REQUIRED BY ANALYSIS.
MAX   = MAXIMUM REINFORCEMENT (8.16.3.1)
        BASED ON .75 X BALANCED STEEL RATIO.

EFFECTIVE DEPTH = 61.05 IN

YNA = DISTANCE FROM EXTREME COMPRESSIVE FIBER TO NEUTRAL AXIS.
```

BAR SIZE	TYPE LOAD	BAR SPACING (IN)	YNA (IN)	APPLIED MOMENT (K-FT)	MAIN STEEL REQUIRED (SQ IN)	MAIN BARS REQ
11	S-AS	7.40	11.66	-2852.	15.38	10
11	F-AS	11.10			9.81	7
11	H-FAC	8.33	3.09	-4322.	12.87	9
11	P-FAC	6.06	4.03	-5591.	17.73	12
11	MIN1	22.21	1.75	-2483.	5.94	4
11	MIN2	4.44	5.17	-7111.	23.64	16
11	MAX	1.04	30.04	-23185.	99.87	65
***** CONTROL *****						
11	P-FAC	6.06	4.03	-5591.	17.73	12

ULTIMATE MOMENT CAPACITY.

TOTAL COMP AREA (SQ IN)	TOTAL TEN AREA (SQ IN)	OTHER TEN AREA (SQ IN)	MAIN TEN AREA (SQ IN)	ULT TENDON STRESS (KSI)	ULT MOMENT CAPACITY (K-FT)	YNA (IN)
0.00	21.80	3.08	18.72	0.0	-5848.	4.22
0.00	18.06	3.08	14.98	0.0	-4875.	3.50
0.00	14.31	3.08	11.23	0.0	-3891.	2.77
0.00	10.57	3.08	7.49	0.0	-2897.	2.05
0.00	6.82	3.08	3.74	0.0	-1892.	1.32
0.00	3.08	3.08	0.00	0.0	-877.	0.60

```
TITLE CAP DESIGN WITH TRANSVERSE DECT STEEL    17:55:28  03/24/93 PAGE  4


*****************************************
* SECTION PROPERTIES AND CONCRETE STRESSES *
*****************************************************************
(AFTER ALL LOSSES)


SECTION PROPERTES
-----------------

MAIN STEEL AREA  =   18.72 IN**2

                                  UNCRACKED     CRACKED
                        GROSS     TRANSFORMED   TRANSFORMED
                      ---------   -----------   -----------
AREA     (FT**2)        35.8        37.0          10.4
INERTIA  (FT**4)        98.9       106.5          26.4
YCG      (IN)           30.7        31.7          12.7
YNA      (IN)           30.7        31.7          12.7


CONCRETE STRESSES (PSI)
-----------------------

                UNCRACKED          UNCRACKED          CRACKED
                  GROSS           TRANSFORMED        TRANSFORMED
              :-- STRESSES --:  :-- STRESSES --:  :-- STRESSES --:
LOAD TYPE      TOP     BOTTOM    TOP     BOTTOM    TOP     BOTTOM
---------     -----   -------   -----   -------   -----   -------
MIN H-SER      443.    -386.     400.    -370.      0.     -595.
MAX H-SER      589.    -513.     532.    -491.      0.     -791.

CONCRETE MODULUS OF RUPTURE                (7.5 X SQRT FC) =   428. PSI
                                                 6


NOTES:

YCG = DISTANCE FROM EXTREME COMPRESSION FIBER TO CENTER OF GRAVITY.
YNA = DISTANCE FROM EXTREME COMPRESSION FIBER TO NUETRAL AXIS.
[+] = TENSION
[-] = COMPRESSION
```

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TITLE CAP DESIGN WITH TRANSVERSE DECT STEEL    17:55:28  03/24/93 PAGE  5


*************************
* FINAL RESULTS - DESIGN *
*************************************************************************

(AREA OF STEEL REQUIRED FOR DIFFERENT BAR SIZES)

            :--SERVICE--:--FATIGUE--:
BAR   LOAD    MAX  ALLOW  STRESS  ALLOW    EFF    BAR     REQ TOTAL SPACE
SIZE  CONT STRESS STRESS  RANGE  RANGE  DEPTH  SPACE   STEEL  BARS  CODE
           (KSI)  (KSI)  (KSI)  (KSI)   (IN)   (IN) (SQ IN)   REQ
____  ____ ______ ______ ______ _____  _____  _____ ______  ____ _____

 18  S-AS  22.04                        60.62  13.15  21.32    6
  6        23.43  26.62   5.80  17.58  63.56  11.23   3.08    7

 14  P-FAC 27.90                        60.93   9.48  17.77    8
  6        29.42  30.40   7.28  16.10  63.56  11.23   3.08    7

 11  P-FAC 26.99                        61.05   6.06  17.73   12
  6        28.39  34.97   7.03  16.35  63.56  11.23   3.08    7

 10  P-FAC 28.12                        61.15   5.14  17.70   14
  6        29.51  36.00   7.30  16.07  63.56  11.23   3.08    7

  9  P-FAC 27.81                        61.24   3.94  17.67   18   2
  6        29.13  36.00   7.21  16.17  63.56  11.23   3.08    7

  8  P-FAC 27.58                        61.30   3.05  17.65   23   1
  6        28.86  36.00   7.14  16.23  63.56  11.23   3.08    7

SPACE CODES:

1 = BAR SPACING LESS THAN THE AASHTO MINIMUM. (8.21)
2 = BAR SPACING LESS THAN THE PREFERRED CALTRANS MINIMUM. (BR. DES. DET.)
3 = BAR SPACING MORE THAN THE AASHTO MAXIMUM (18"). (8.20)
```

TITLE HIGH CANTILEVER ABUTMENT H = 27 FT 11:15:34 09/18/89 PAGE 5

****
* SERVICE PILE LOADS (SER) FOR ABUTMENT DESIGN (K,FT) *
****

		:— VERTICAL —:		:— LATERAL —:		:— HEEL —:		:— TOE —:		
GRP	CA	TOTAL	ECCEN	TOTAL	CAP	MAX	CAP	MAX	CAP	
IH	1	4379.	0.21	1337.	1550.	96.	140.	109.	133.	OK
IH	2	4379.	-0.59	1003.	1434.	127.	140.	91.	133.	OK
IH	3	4286.	-0.20	1179.	1471.	109.	140.	98.	133.	OK
IH	4	4286.	-0.88	884.	1375.	135.	140.	82.	133.	OK
II	1	3978.	0.38	1337.	1480.	81.	140.	103.	133.	OK
II	2	3978.	-0.50	1003.	1365.	112.	140.	84.	133.	OK
III	1	2568.	-0.25	966.	1369.	67.	210.	58.	199.	OK
III	2	2568.	-1.08	724.	1298.	86.	210.	46.	199.	OK
IV	1	4379.	0.61	1406.	1743.	81.	175.	118.	166.	OK
IV	2	4379.	-0.20	1072.	1627.	112.	175.	100.	166.	OK
IV	3	3885.	0.38	1248.	1595.	79.	175.	100.	166.	OK
IV	4	3885.	-0.37	953.	1499.	105.	175.	85.	166.	OK
V	1	2366.	-1.58	0.	1221.	89.	210.	37.	199.	OK

SUMMARY OF CONTROLLING LOAD CASES
(RATIO = CAP / LOAD)

GRP	CA	DESCRIPTION	LOAD	CAP	RATIO	
II	1	TOTAL LATERAL LOAD	1337.	1480.	1.11	OK
IH	4	MAX HEEL LOAD	135.	140.	1.04	OK
IH	1	MAX TOE LOAD	109.	133.	1.22	OK

Rebar Data - (I10)

Columns	Entry	Variable	Units
1 - 10	NUMBER OR REBAR LAYERS	NBAR	

Rebar Data - (7F10.0)

Note: The number of lines in this section is equal to the NUMBER OF REBAR LAYERS (NBAR).

Columns	Entry	Variable	Units
1 - 10	REBAR LOCATION	LOC(I)	
11 - 20	REBAR LAYER	LAY(I)	
21 - 30	TOTAL BARS	NB(I)	
31 - 40	BAR SIZE		
41 - 50	COVER	COVER(I)	In
51 - 60	BUNDLE PATTERN	BUND(I)	
61 - 70	SKEW ANGLE	SKEW(I)	Degrees

Prestress Data - (2F10.0)

Columns	Entry	Variable
1 - 10	TOTAL AREA PRESTRESS STEEL	AS(I)
11 - 20	DIST BOTTOM TO C.G. P/S STEEL	DYS(I)

Load Data - (A40)

Columns	Entry	Variable
1 - 40	LOAD TITLE	LHEAD

Load Data - (6F10.0)

Columns	Entry	Variable	Units
1 - 10	MAX MOMENT DEAD LOAD (DL)	DM	Kip-ft
11 - 20	MAX MOMENT H-LOAD (LL+I)	HMAX	Kip-ft
21 - 30	MIN MOMENT H-LOAD (LL+I)	HMIN	Kip-ft
31 - 40	MAX MOMENT P-LOAD (LL+I)	PMAX	Kip-ft
41 - 50	OTHER MOMENTS	AM	Kip-ft
51 - 60	SECONDARY MOMENT	SECM	Kip-ft

Load Data - (5F10.0,10x,F10.0)

Columns	Entry	Variable	Units
1 - 10	AXIAL DEAD LOAD (DL)	DMP	Kip
11 - 20	MAX AXIAL H-LOAD (LL+I)	HMAXP	Kip
21 - 30	MIN AXIAL H-LOAD (LL+I)	HMINP	Kip

TITLE HIGH CANTILEVER ABUTMENT H = 27 FT 11:15:34 09/18/89 PAGE 7

****
* STEM MOMENT ENVELOPE AND REQUIRED STEEL AREAS (BAR CUT-OFFS) *
****

(APPLIED MOMENT - GROUP IV CASE 1)
(BACKFILL, SURCHARGE, BEARING PAD SHEAR AND OTHER LATERAL LOAD)

DISTANCE FROM TOP OF FOOTING (FT)	APPLIED MOMENT (K-FT)	:--- STRESS ---: FC (KSI)	FS (KSI)	STEEL AREA (SI)	BAR SIZE (IN)	BAR SPACE	BARS REQ	ERROR CODE
0.00	10681.	1.16	23.8	198.1	11	7.0	127	
1.00	9605.	1.09	24.0	176.3	11	7.9	113	
2.00	8603.	1.02	23.9	157.6	11	8.8	101	
3.00	7672.	0.95	23.8	140.4	11	9.9	90	
4.00	6811.	0.89	24.0	123.2	11	11.3	79	
5.00	6017.	0.82	23.8	109.2	11	12.8	70	
6.00	5287.	0.76	23.9	95.2	11	14.7	61	
7.00	4618.	0.71	23.9	82.7	11	17.0	53	
8.00	4007.	0.65	23.8	71.8	11	19.6	46	3

Strength Design (Load Factor Design) (H-FAC, P-FAC) (Code 8.16)

The theory is based on the assumptions outlined in article 8.16 of the Code and on satisfaction of the applicable conditions of equilibrium of internal stresses and compatibility of strains. This allows the engineer to input multiple layers of steel which may be in tension or compression depending on the applied loads.

Strength Design Equations for a Single Tension Layer:

Mu < = Phi Mn

Mn = As fy (d -a/2) (8-16)

a = As fy / .85 f'_c b (8-17)

pb = (.85 B1 f'_c / fy) (87000 / 87000 + fy) (8-18)

Mcr = 7.5 (f'_c)**.5 (I/Yt)

Definitions

A = Effective tension area of concrete surrounding the flexural tension reinforcement and having the same centroid as that reinforcement, divided by the number of bars.
As = Area of tension reinforcement.
b = Width of compression face of member.
bw = Web width.
d = Distance from extreme compression fiber to centroid of rebar layer.
dc = Thickness of concrete cover from extreme tension fiber to center of tensile reinforcement closest to the tension face.
Ec = Modulus of elasticity of concrete (57000 x (f'_c) **.5).
Eo = Ultimate concrete compressive strain (.003 in/in).
Es = Modulus of elasticity of the steel rebars (29000 ksi).
f'_c = Ultimate concrete compressive stress.
fs = Allowable steel stress.
fy = Yield stress of reinforcement.
I = Moment of inertia of the section.
p = Tension reinforcement ratio.
pb = Reinforcement ratio producing balanced strain conditions.
M = Moment at service level (SER).
Mn = Nominal moment strength of section.
Mu = Factored moment at section.
Mcr = Cracking moment (Code 8.13.3 Equation 8-2)
n = Modular ratio of elasticity (Es/Ec)
Phi = Strength reduction factor.
Yt = distance from the neutral axis to the extreme tension fiber.
Z = Factor related to exposure conditions and a maximum crack width permitted.

****
YOUR ABUT FILENAME IS: SPREAD
****

SHORT SEAT ABUTMENT 2.00

SS	YES	SPREAD	DESIGN	SLD		
3.25	60.00	40.00	40.00			
2.00	10.60	2.00	170.00	0.30	3.00	33.00
34.00	10.60	1.00	2.00	2.00	1.00	
5.60	10.00	0.39	0.00	0.00		
2	15.00	1.00	3.00			
35.50	6.00	2.00	0.00	0.00	0.00	
5	0	2.00				
5	0	2.00				
6	0	2.00				
6	0	6.00				
6	0	6.00				
308	120	200	.54		0	0
1.30	2.17	1.30	1.30	1.69	1.30	1.30
0.00	YYYYY					
0.00	YYYYY					

TITLE SHORT SEAT ABUTMENT 11:25:22 09/18/89 PAGE 1

```
*****************************************************************************
*                                ABUT                                       *
*                     ABUTMENT DESIGN PROGRAM                               *
*                          (SS) SHORT SEAT                                  *
*                        (HC) HIGH CANTILEVER                               *
*              CALIFORNIA DEPARTMENT OF TRANSPORTATION                      *
*                       VERSION 2.00   09.06.88                             *
*****************************************************************************

*******************
* GENERAL DATA    *
*******************
```

TYPE ABUTMENT	(HIGH CANTILEVER) =	SS	
TYPE SUPERSTRUCTURE	(CIP/PS?) =	YES	
TYPE FOOTING	=	SPREAD	
TYPE ANALYSIS	=	DESIGN	
TYPE DESIGN	(SERVICE LOAD DESIGN) =	SLD	

MATERIAL PROPERTIES:

ULTIMATE CONCRETE COMPRESSIVE STRESS	(FC) =	3.25	KSI
YIELD STRESS FOR STEEL REBARS	(FY) =	60.0	KSI
ALLOWABLE CONCRETE STRESS	(% FC) =	40.0	%
	=	1.3	KSI
ALLOWABLE STEEL STRESS	(% FY) =	40.0	%
	=	24.0	KSI
YOUNGS MODULUS FOR CONCRETE	(EC) =	3249.	KSI
YOUNGS MODULUS FOR STEEL REBARS	(ES) =	29000.	KSI
MODULAR RATIO (ES/EC)	(N) =	8.92	

BACKFILL SOIL DATA:

DEPTH OF FILL ON TOE	=	2.00	FT
DEPTH OF FILL ON HEEL	=	10.60	FT
DEPTH OF SURCHAGE ON HEEL	=	2.00	FT
ENVIRONMENTAL FACTOR	(Z) =	170.00	K/IN
COEF OF ACTIVE EARTH PRESSURE	(KA) =	0.30	

FOUNDATION SOIL DATA:

MAX BEARING CAPACITY - SERVICE	=	3.00	TONS/SF
FRICTION ANGLE	(PHI) =	33.00	DEGREES

TITLE SHORT SEAT ABUTMENT 11:25:22 09/18/89 PAGE 2

****
* STRUCTURAL DATA *
****

ABUTMENT DATA:

LENGTH	=	34.00	FT
HEIGHT FROM TOP OF FOOTING	=	10.60	FT
BACKWALL THICKNESS	=	1.00	FT
SEAT WIDTH	=	2.00	FT
DISTANCE FROM FOOTING TOE TO SEAT FACE	=	2.00	FT
DISTANCE FROM SEAT FACE TO C.L. OF BEARING	=	1.00	FT
BACKWALL HEIGHT ABOVE SEAT LEVEL	=	5.60	FT
WEIGHT OF EXTERIOR SHEAR KEYS	=	10.00	K
UNIFORM WEIGHT OF BARRIER	=	0.39	K/FT

WING WALL DATA:

NUMBER	=	2	WALLS
LENGTH	=	16.00	FT
THICKNESS	=	1.00	FT
END WALL DIMENSION	=	3.00	FT

FOOTING DATA:

LENGTH	=	35.50	FT
WIDTH	=	6.00	FT
DEPTH	=	2.00	FT
WIDTH OF FOOTING KEY	=	0.00	FT
DEPTH OF FOOTING KEY	=	0.00	FT
DISTANCE FROM TOE TO KEY	=	0.00	FT

TITLE SHORT SEAT ABUTMENT 11:25:22 09/18/89 PAGE 3

****
* REBAR AND LOAD DATA *
****

REBAR LOCATION	BAR SIZE	NO. OF BARS	COVER(IN)
BACKWALL	5	0	2.00
STEM	5	0	2.00
FOOTING TOP	6	0	2.00
FOOTING BOTTOM (HEEL)	6	0	6.00
FOOTING BOTTOM (TOE)	6	0	6.00

SERVICE LOAD DATA (KIPS):

	TOTAL DEAD LOAD	:- LIVE LOAD -: TOTAL H-LOAD	1.15P+H P-LOAD	TOTAL BEARING PAD SHEAR	LATERAL EARTH PRESSURE	OTHER LATERAL LOAD	OTHER VERTICAL LOAD
LOADS	308.	120.	200.	54.		0.	0.
FACTORS	1.30	2.17	1.30	1.30	1.69	1.30	1.30

DISTANCE ABOVE SEAT TO OTHER LATERAL LOAD = 0.00
DISTANCE FROM HEEL TO OTHER VERTICAL LOAD = 0.00

CONSIDER OTHER LOADS IN LOAD GROUP (Y/N)	1 2 3 4 5	1 2 3 4 5
	Y Y Y Y Y	Y Y Y Y Y

TITLE SHORT SEAT ABUTMENT 11:25:22 09/18/89 PAGE 4

****
* MOMENTS ABOUT TOE OF FOOTING (K,FT) * (SERVICE)
****

LATERAL EARTH LOADS (BACKFILL TO TOP OF BACKWALL)	FORCE	ARM	MOMENT
EARTH PRESSURE (KA =0.300)	91.4	4.20	384.
EARTH PRESSURE (KA =0.225)	68.6	4.20	288.
SURCHARGE PRESSURE (KA =0.300)	29.0	6.30	183.
SURCHARGE PRESSURE (KA =0.225)	21.8	6.30	137.
EARTHQUAKE	0.0	0.00	0.
LATERAL EARTH LOADS			
(CIP/PS CASE III - BACKFILL TO SEAT LEVEL)			
EARTH PRESSURE (KA =0.300)	28.2	2.33	66.
EARTH PRESSURE (KA =0.225)	21.2	2.33	49.
SURCHARGE PRESSURE (KA =0.300)	16.1	3.50	56.
SURCHARGE PRESSURE (KA =0.225)	12.1	3.50	42.
SUPERSTRUCTURE LOADS			
DEAD LOAD	308.	3.00	-924.
H-LIVE LOAD	120.	3.00	-360.
P-LIVE LOAD	200.	3.00	-600.
BEARING PAD SHEAR	54.	7.00	378.
OTHER LOADS			
OTHER LATERAL LOAD	0.0	7.00	0.
OTHER VERTICAL LOAD	0.0	6.00	0.
ABUTMENT DEAD LOADS			
BACKWALL	28.6	4.50	-129.
SEAT	76.5	3.50	-268.
FOOTING	63.9	3.00	-192.
FOOTING KEY	0.0	0.00	0.
WINGWALL TOP RECTANGULAR SECTION	12.6	12.00	-151.
WINGWALL BOT TRIANGULAR SECTION	16.0	9.67	-154.
BARRIER	11.7	11.50	-135.
SIDE KEYS	10.0	11.50	-30.
SOIL DEAD LOADS			
SOIL ON HEEL (BACKFILL TO TOP OF BACKWALL)	40.7	5.50	-224.
SOIL ON HEEL (CIP/PS BACKFILL TO SEAT LEVEL)	19.2	5.50	-106.
SOIL ON TOE	17.0	1.00	-17.
SURCHARGE ON HEEL	7.7	5.50	-42.

TITLE SHORT SEAT ABUTMENT 11:25:22 09/18/89 PAGE 5

****
* SERVICE LOADS (SER) FOR ABUTMENT DESIGN (K,FT) *
****

		:—— APPLIED LOADS ——:			SAFTEY FACTOR		:—— STRESSES ——:				
GRP	CA	LAT	VERT	ECCEN	SLIDE	OVER	HEEL	TOE	ALLOW	RATIO	
IH	1	120.	713.	0.11	2.4	4.6	3.0	3.7	6.0	1.6	
IH	2	90.	713.	-0.09	3.2	6.2	3.6	3.1	6.0	1.6	OK
IH	3	91.	705.	-0.12	3.1	6.7	3.7	2.9	6.0	1.6	OK
IH	4	69.	705.	-0.26	4.2	9.0	4.2	2.5	6.0	1.4	OK
II	1	120.	593.	0.13	2.0	4.0	2.4	3.2	6.0	1.9	OK
II	2	90.	593.	-0.10	2.6	5.3	3.1	2.5	6.0	2.0	OK
III	1	44.	223.	-0.76	2.0	7.8	1.8	0.3	9.0	4.9	OK
III	2	33.	223.	-0.89	2.7	10.5	2.0	0.1	9.0	4.5	OK
IV	1	174.	713.	0.64	1.7	2.8	1.2	5.5	7.5	1.4	OK
IV	2	144.	713.	0.44	2.0	3.3	1.9	4.8	7.5	1.6	OK
IV	3	145.	585.	0.50	1.6	2.9	1.4	4.1	7.5	1.8	OK
IV	4	123.	585.	0.34	1.9	3.3	1.8	3.7	7.5	2.0	OK
V	1	0.	527.	-0.76	0.0	0.0	4.4	0.6	9.0	2.1	OK

SUMMARY OF CONTROLLING LOAD CASES

LOADS GRP	CA	(A) DESCRIPTION		(B) DESCRIPTION		RATIO (B/A)	
IV	3	SLIDING FORCE	= 145.	FRICTION FORCE	= 236.	1.62	OK
IV	1	OVERTURN MOMENT	= 945.	RESTORE MOMENT	= -2625.	2.78	OK
IH	4	MAX HEEL STRESS	= 4.2	ALLOW HEEL STRESS	= 6.0.	1.44	OK
IV	1	MAX TOE STRESS	= 5.5	ALLOW TOE STRESS	= 7.5.	1.36	OK

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****
* STEEL REQUIRED - SERVICE LOAD DESIGN (SLD) *
****

KEY TO REBAR LOCATIONS (BAR-LOC)

1 = BACKWALL
2 = STEM
3 = FOOTING TOP
4 = FOOTING BOTTOM (HEEL)
5 = FOOTING BOTTOM (TOE)

BAR LOC	LOADS GRP	LOADS CA	APPLIED MOMENT (K-FT)	:--- STRESS---: FC (KSI)	FS (KSI)	EFF DEPTH (IN)	STEEL AREA (SI)	BAR SIZE	BAR SPC (IN)	BARS REQ	ERROR CODE
1			70.	0.36	22.5	9.7	4.0	5	33.6	13	3
2			628.	1.35	29.8	33.7	7.8	5	16.8	25	
3	III	2	-16.	0.07	20.1	21.6	0.4	6	213.0	1	3
4	IH	4	46.	0.14	18.4	17.6	1.8	6	140.4	4	3
5	IV	1	318.	0.47	28.7	17.6	7.9	6	24.8	18	3

ERROR CODES:

1 = BAR SPACING LESS THAN AASHTO MINIMUM. (CODE 8.21)
2 = BAR SPACING LESS THAN PREFERRED CALTRANS MINIMUM. (BR. DES. DET.)
3 = BAR SPACING MORE THAN THE AASHTO MAXIMUM (18"). (CODE 8.20)

INPUT DATA FORMAT (XEDIT)

GENERAL DATA - (A40,10X,F5.0)

Columns	Entry	Variable
1 - 40	PROJECT TITLE	HEAD
51 - 55	VERSION (enter 2.00)	VERS

GENERAL DATA - (8X,A2,7X,A3,4X,A6,4X,A6,7X,A3)

Columns	Entry		Variable
9 - 10	TYPE ABUTMENT	(SS/HC)	TABUT
18 - 20	TYPE SUPERSTRUCTURE	(YES/NO)	TSUP
25 - 30	TYPE FOOTING	(PILE/SPREAD)	TFOOT
35 - 40	TYPE ANALYSIS	(DESIGN/CHECK)	TDES
48 - 50	TYPE DESIGN	(SLD/LFD)	TANAL

MATERIAL PROPERTIES - (4F10.0)

Columns	Entry	Variable	Units
1 - 10	ULT CONCRETE COMPRESSIVE STRENGTH	FC	Ksi
11 - 20	YIELD STRESS FOR STEEL REBARS	FY	KSI
21 - 30	ALLOWABLE CONCRETE STRESS	FCA	%
31 - 40	ALLOWABLE STEEL STRESS	FSA	%

BACKFILL & FOUNDATION SOIL DATA - (7F10.0)

Columns	Entry	Variable	Units
1 - 10	DEPTH OF FILL ON TOE	DTOE	Ft
11 - 20	DEPTH OF FILL ON HEEL	DB	Ft
21 - 30	DEPTH OF SURCHARGE ON HEEL	DHEEL	Ft
31 - 40	ENVIRONMENTAL FACTOR	Z	K/In
41 - 50	COEF OF ACTIVE EARTH PRESSURE	KA	
51 - 60	MAX BEARING CAPACITY - SERVICE	SCAPS	Tons/sf
61 - 70	FRICTION ANGLE	FANG	°

ABUTMENT DATA - (6F10.0)

Columns	Entry	Variable	Units
1 - 10	LENGTH	AL	Ft
11 - 20	HEIGHT FROM TOP OF FOOTING	AH	Ft
21 - 30	BACKWALL THICKNESS	BT	Ft
31 - 40	SEAT WIDTH	SW	Ft
41 - 50	DISTANCE FROM FOOTING TOE TO SEAT	DTS	Ft
51 - 60	DISTANCE FROM SEAT TO C.L. BEARING	DSB	Ft

ABUTMENT DATA - (5F10.0)

Columns	Entry	Variable	Units
1 - 10	BACKWALL HEIGHT ABOVE SEAT LEVEL	BH	Ft
11 - 20	WEIGHT OF EXTERIOR SHEAR KEYS	PSK	Kips
21 - 30	UNIFORM WEIGHT OF BARRIER	UB	Kips/Ft
31 - 40	VERTICAL DIST. FROM SEAT TO FILLET	DSF	Ft
41 - 50	STEM THICKNESS	ST	Ft

WING WALL DATA - (I10,3F10.0)

Columns	Entry	Variable	Units
1 - 10	NUMBER	NW	
11 - 20	LENGTH	WL	Ft
21 - 30	THICKNESS	WT	Ft
31 - 40	END WALL DIMENSION	WE	Ft

FOOTING DATA - (6F10.0)

Columns	Entry	Variable	Units
1 - 10	LENGTH	FL	Ft
11 - 20	WIDTH	FW	Ft
21 - 30	DEPTH	FD	Ft
31 - 40	WIDTH OF FOOTING KEY	KW	Ft
41 - 50	DEPTH OF FOOTING KEY	KD	Ft
51 - 60	DISTANCE FROM TOE TO KEY	DTK	Ft

PILE DATA - (I10,5F10.0)

If type of footing is SPREAD, skip PILE DATA sections and go to REBAR DATA section.

Columns	Entry	Variable	Units
1 - 10	NUMBER OF ROWS	NROW	
11 - 20	VERTICAL PILE CAPACITY - SERVICE	PCAPS	Tons
21 - 30	LATERAL PILE CAPACITY - SERVICE	VCAPS	Kips
31 - 40	LATERAL PILE CAPACITY - ULTIMATE	VCAPF	Kips
41 - 50	PILE DIAMETER	PDIA	In
51 - 60	BATTER FACTOR	BF	Ft

PILE DATA - NROW(F10.0,2I10)

The number of lines in this section is equal to the NUMBER OF ROWS of piles (NROW).

Columns	Entry	Variable	Units
1 - 10	DISTANCE TO TOE	XP(I)	Ft
11 - 20	NO. OF PILES IN ROW	NP(I)	
21 - 30	NO. OF PILES BATTERED	NB(I)	

REBAR DATA - 5(2I10,F10.0)

There are 5 lines in this section that correspond to the 5 bar locations considered.

Key to Rebar Locations

1	Backwall at seat level
2	Stem at top of footing
3	Top of footing
4	Bottom of footing on heel side
5	Bottom of footing on toe side

Columns	Entry	Variable	Units
1 - 10	BAR SIZE	IBAR(I)	
11 - 20	NO. OF BARS	NBAR(I)	
21 - 30	COVER	COVER(I)	In

LOAD DATA - (4F10.0,10X,2F10.0)

Columns	Entry	Variable	Units
1 - 10	DEAD LOAD	DL	Kips
11 - 20	H-LOAD	HL	Kips
21 - 30	P-LOAD	PL	Kips
31 - 40	BEARING PAD SHEAR	VL	Kips
51 - 60	OTHER LATERAL LOAD	OL	Kips
61 - 70	OTHER VERTICAL LOAD	OV	Kips

LOAD FACTOR DATA - (7F10.0)

Columns	Entry	Variable
1 - 10	DEAD LOAD	FDL
11 - 20	H-LOAD	FHL
21 - 30	P-LOAD	FPL
31 - 40	BEARING PAD SHEAR	FVL
41 - 50	LATERAL EARTH PRESSURE	FEP
51 - 60	OTHER LATERAL LOAD	FOL
61 - 70	OTHER VERTICAL LOAD	FOV

OTHER LATERAL LOAD DATA - (F10.0,5X,5A1)

Columns	Entry	Variable	Units
1 - 10	DISTANCE ABOVE SEAT TO OTHER LATERAL LOAD	DOL	Ft
16 - 20	CONSIDER OTHER LOAD IN GROUP LOADS (Y/N)	GRL(1) - GRL(5)	

OTHER VERTICAL LOAD DATA - (F10.0,5X,5A1)

Columns	Entry	Variable	Units
1 - 10	DISTANCE FROM HEEL TO OTHER VERTICAL LOAD	DOV	Ft
16 - 20	CONSIDER OTHER LOAD IN GROUP LOADS (Y/N)	GRV(1) - GRV(5)	

FLEXURE DESIGN THEORY

SERVICE LOAD DESIGN (SLD) (Code 8.15)

For investigation of stresses at the service level, the straight-line theory of stress and strain is used as outlined in article 8.15.3 of the Code.

Working Stress equations for a Single Tension Layer:

$M = A_s f_s jd$

$j = 1 - k/3$

$k = \sqrt{2pn + (pn)^2} - pn$

$n = E_s/E_c$

$p = A_s/bd$

$f_c = \frac{2M}{kjbd^2}$

LOAD FACTOR DESIGN (LFD) (Code 8.16)

The theory is based on the assumptions outlined in article 8.16 of the Code and on satisfaction of the applicable conditions of equilibrium of internal stresses and compatibility of strains. This allows the engineer to input multiple layers of steel which may be in tension or compression depending on the applied loads.

Strength Design Equations for a Single Tension Layer:

$$M_u <= \phi M_n$$

$$M_n = A_s f_y (d - a/2) \qquad (8\text{-}16)$$

$$a = \frac{A_s f_y}{.85 f'_c b} \qquad (8\text{-}17)$$

$$p_b = \left(\frac{.85(\beta_1) f'_c}{f_y}\right)\left(\frac{87000}{87000 + f_y}\right) \qquad (8\text{-}18)$$

$$M_{cr} = \left(\sqrt{7.5(f'_c)}\right)\left(\frac{I}{Y_t}\right)$$

Distribution of Flexural Reinforcement (Crack Control)
(Code 8.16.8.4)

$$f_s = \frac{z}{\sqrt[3]{(d_c A)}} \qquad (8\text{-}61)$$

$$f_s <= .6(f_y)$$

$$f_s >= 20 \text{ Ksi, for Grade 40 Steel}$$

$$f_s >= 24 \text{ Ksi, for Grade 60 Steel}$$

DEFINITIONS

A	=	Effective tension area of concrete surrounding the flexural tension reinforcement and having the same centroid as that reinforcement, divided by the number of bars.
A_s	=	Area of tension reinforcement.
b	=	Width of compression face of member.
b_w	=	Web width.
d	=	Distance from extreme compression fiber to centroid of rebar layer.
d_c	=	Thickness of concrete cover from extreme tension fiber to center of tensile reinforcement closest to the tension face.
E_c	=	Modulus of elasticity of concrete $57000 \times \sqrt{f'_c}$
E_o	=	Ultimate concrete compressive strain (.003 in/in).
E_s	=	Modulus of elasticity of the steel rebars (29000 ksi).
f'_c	=	Ultimate concrete compressive stress.
f_s	=	Allowable steel stress.
f_y	=	Yield stress of reinforcement.
I	=	Moment of inertia of the section.
p	=	Tension reinforcement ratio.
p_b	=	Reinforcement ratio producing balanced strain conditions.
M	=	Moment at service level (SER).
M_n	=	Nominal moment strength of section.
M_u	=	Factored moment at section.
M_{cr}	=	Cracking moment (Code 8.13.3 Equation 8-2)
n	=	Modular ratio of elasticity (E_s/E_c)
ϕ	=	Strength reduction factor.
Y_t	=	distance from the neutral axis to the extreme tension fiber.
Z	=	Factor related to exposure conditions and a maximum crack width permitted.