```
TITLE CAP DESIGN WITH TRANSVERSE DECT STEEL    17:55:18  03/20/93 PAGE  1

*****************************************************************************
*                              CONC                                         *
*                      CONCRETE DESIGN PROGRAM                              *
*                     (RC) REINFORCED CONCRETE                              *
*                     (PP) PARTIALLY PRESTRESSED                            *
*                     (FP) FULLY PRESTRESSED                                *
*                CALIFORNIA DEPARTMENT OF TRANSPORTATION                    *
*                     VERSION  2    08.01.87                                *
*****************************************************************************


****************
* 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                   (E) =   270.0 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      =   8.62 IN
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**************
* STEEL DATA *
*************************************************************************

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

TOP     MAIN      6     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                                          OTHER  SECONDARY
         DEAD LOAD     H-MAX      H-MIN      P-MAX       MOMENT    MOMENT
           (DL)       (LL+I)     (LL+I)     (LL+I)      (O-MOM)   (S-MOM)
         ---------   ---------  ---------  ---------   ---------  ---------

MOMENT     -2146.      -706.        0.     -2135.         0.         0.
AXIAL          0.         0.        0.         0.         0.
LOAD
FACTORS      1.30       2.17                  1.30       1.00       1.00

STRENGTH REDUCTION FACTOR (PHI) = 0.50

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      -2852.     -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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* 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 = 51.05 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	11.56	-2852.	15.38	10
11	F-AS	11.10			9.81	7
11	H-FAC	8.33	3.09	-4323.	12.87	5
11	P-FAC	6.06	4.03	-5591.	17.73	12
11	MIN1	22.21	1.75	-2483.	3.44	4
11	MIN2	4.44	5.17	-7111.	23.84	16
11	MAX	1.04	30.04	-23185.	59.87	85

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***** CONTROL ***********************************************
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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	22.80	3.08	18.72	0.0	-5040.	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.	3.77
0.00	10.57	3.08	7.49	0.0	-2897.	2.02
0.00	6.82	3.08	3.74	0.0	-1992.	1.22
0.00	7.08	3.08	0.00	0.0	-877.	0.50

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


SECTION PROPERTIES
------------------

MAIN STEEL AREA  =   18.77 IN**2

                                  UNCRACKED    CRACKED
                       GROSS      TRANSFORMED  TRANSFORMED
                    ----------   ----------   ----------
AREA     (FT**2)        35.8         37.0         18.6
INERTIA  (FT**4)        98.9        106.5         15.4
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.      490.     -370.       0.      -595.
MAX H-SER         569.    -513.      532.     -491.       0.      -791.

CONCRETE MODULUS OF RUPTURE                  [7.5 X SQRT (C)] =  [illegible] PSI
                                                    *

NOTES:

YCG = DISTANCE FROM EXTREME COMPRESSION FIBER TO CENTER OF GRAVITY.
YNA = DISTANCE FROM EXTREME COMPRESSION FIBER TO NEUTRAL AXIS.
(+) = TENSION
(-) = COMPRESSION
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*************************
* 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         27.43   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   35.00   7.30  16.07  63.56  11.23    3.08    7

  9  P-FAC  27.61                         61.24   3.94   17.67   18   2
  5         29.13   35.00   7.21  16.17  63.56  11.23    3.08    7

  8  P-FAC  27.56                         61.30   3.05   17.65   23   1
  6         28.86   35.00   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)
```

Input Data Format (Xedit)

General Data - (A40,14X,I1)

Columns	Entry	Variable
1 - 40	PROJECT TITLE	HEAD
55	VERSION (enter 1)	IVERS

General Data - (8X,A2,4X,A6,7X,A3,7X,A3)

Columns	Entry	Variable
5 - 10	TYPE OF STRUCTURE (RC,PP,FP))	STYPE
15 - 20	TYPE OF ANALYSIS (DESIGN/CHECK)	ATYPE
28 - 30	CONSIDER FATIGUE? (YES/NO)	FAT
38 - 40	CONSIDER CRACK CONTROL? (YES/NO)	DIS

General Data - (5F10.0, 7X, A3, F10.0)

Columns	Entry	Variable	Units
1 - 10	ULT CONCRETE COMPRESSIVE STRENGTH	FC	Ksi
11 - 20	ULT CONCRETE COMPRESSIVE STRAIN	EO	In/In
21 - 30	YOUNG'S MODULUS FOR STEEL REBARS	FC	Ksi
31 - 40	YIELD STRESS FOR STEEL REBARS	FY	Ksi
41 - 50	ULT STRESS PRESTRESS STEEL	FP	Ksi
51 - 60	LOW-LAX PRESTRESS STEEL	LOW	
61 - 70	ENVIRONMENTAL FACTOR	Z	K/In

Structure Data - (F10.0)

Columns	Entry	Variable	Units
1 - 10	TOTAL DEPTH	DEPTH	Ft

Structure Data - (7F10.0)

Columns	Entry	Variable	Units
1 - 10	TOP FLANGE EFFECTIVE WIDTH COMP	BTOPC	Ft
11 - 20	TOP FLANGE EFFECTIVE WIDTH TEN	BTOPT	Ft
21 - 30	TOP FLANGE THICKNESS	TTOP	In
31 - 40	WIDTH OF WEB	BG	Ft
41 - 50	BOTTOM FLANGE EFFECTIVE WIDTH COMP	BBOTC	Ft
51 - 60	BOTTOM FLANGE EFFECTIVE WIDTH TEN	BBOTT	Ft
61 - 70	BOTTOM FLANGE THICKNESS	TBOT	In

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

31 - 40	MAX AXIAL P-LOAD (PLL+I)	PMAXP	Kip
41 - 50	OTHER AXIAL LOAD	AMP	Kip
61 - 70	FINAL P/S FORCE AFTER LOSSES	PE	Kip

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

Columns	Entry	Variable
1 - 10	LOAD FACTOR FOR DEAD LOAD	FACD
11 - 20	LOAD FACTOR FOR H-LOAD	FACH
31 - 40	LOAD FACTOR FOR P-LOAD	FACP
41 - 50	LOAD FACTOR FOR OTHER MOMENT	FACA
51 - 60	LOAD FACTOR FOR SECONDARY MOMENT	FACS
61 - 70	STRENGTH REDUCTION FACTOR (PHI)	PHI

Flexure Design Theory

Serviceability Requirements (F-SER, C-SER) (Code 8.16.8)

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 = As fs j d
j = 1 - k/3
k = (2pn + (pn)**2)**.5 - pn
n = Es/Ec
p = As/bd

Fatigue Stress Limits (Code 8.16.8.3)

fs = 21.0 - .33 Fmin + 8 (r/h) (8-60)
where: r/h = .3
fs = 23.4 - .33Fmin

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

fs = z/(dc A)**.333 (8-61)
fs < = .6 fy
fs > = 20 Ksi, for Grade 40 Steel
fs > = 24 Ksi, for Grade 60 Steel

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.