CALIFORNIA DEPARTMENT OF TRANSPORTATION
STRUCTURAL AND SEISMIC ANALYSIS SECTION

COLUMN DESIGN BY YIELD SURFACE

"YIELD"

Instructions for Users

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State of California

Business, Transportation and Housing Agency

MEMORANDUM

To: Bridge Computer Manual Holders

Date: January 24, 1992

File: 395.

From: DEPARTMENT OF TRANSPORTATION
Division of Structures
Office of Earthquake Engineering

Subject: Change in YIELD (5-3) program input data

The load data panel for the YIELD program now requires the user to input Effective Length K-Factors instead of moment distribution factors. These K-Factors are used to calculate critical buckling loads and moment magnification factors. The longitudinal K-Factor (Kx) may be obtained from the BDS program and the transverse K-Factor (Ky) may be obtained from the BENT program. BDS and Bent computer programs calculate more "accurate" K-Factors as opposed to the "approximate" K-Factors that YIELD previously calculated using moment distribution factors.

These K-Factors may also be calculated using the nomograph (Table C-2) and procedures oulined in Appendix C of the CALTRANS Bridge Design Specifications.

Additionally the load panel now requires the column end conditions (TOPY,TOPX,BOTY,BOTX). Input a '0' for a pinned end condition or a '1' for a fixed end condition. The load panel defaults to both ends fixed ('1').

By not using the panels (XEDIT), the user may still run the YIELD program the old way. The program will use the moment distribution factors to calculate "approximate" K-Factors. However, a note will be printed in the output recommending the user update the YIELD input file with the K-Factors from the BDS and BENT programs.

Steven B. McBride
Senior Bridge Engineer
Office of Earthquake Engineering (4-2666)

NEW INPUT PANEL FORMAT

```
*****************************************************************************
*                                                                           *
*                                                                           *
*   LOAD PAGE __ OF __                          FOOTING DATA FILE ? (YES/NO) = ___   *
*   LOAD NAME *** NEW INPUT PANEL FORMAT ***  FOOTING TYPE (SPREAD) (PILE) = _____   *
*   EFFECTIVE LENGTH FACTORS  PERCENT   COLUMN   1=TIE      1=TOP      DUCTILITY   *
*   KY (TRANS)      KX (LONG)   IMPACT   LENGTH   0=SPIRAL   0=BOTTOM   FACTOR (Z)   *
*       1.84            1.90    _____   _____        _          _          ___      *
*                                                                           *
*   COLUMN END CONNECTION (TOPY TYPX BOTY BOTX) (1=FIX 0=PIN) 1 1 1 1                *
*   SERVICE LOADS:          :---- LL+IMPACT -----:                    UNITS K-FT   *
*                           CASE 1  CASE 2  CASE 3                                  *
*        DEAD      PRE      TRANS    LONG    AXIAL                                  *
*        LOAD   STRESS     MY-MAX  MX-MAX   N-MAX    WIND     WL     LF  CF-MV   TEMP *
*   MY  _____  _____  _____  _____  _____  _____  _____  _____  _____  _____  *
*   MX  _____  _____  _____  _____  _____  _____  _____  _____  _____  _____  *
*   N   _____  _____  _____  _____  _____  _____  _____  _____  _____  _____  *
*   PMY                 _____  _____  _____                        _____          *
*   PMX                 _____  _____  _____                        _____          *
*   PN                  _____  _____  _____                        _____          *
*          :-UNREDUCED SEISMIC -:-- ARBITRARY LOADS --:-- ARBITRARY LOADS --:     *
*              CASE 1     CASE 2    SERVICE    SERVICE   FACTORED   FACTORED      *
*            MAX TRANS   MAX LONG      AL-1       AL-2       AL-1       AL-2      *
*        MY  _____  _____  _____  _____  _____  _____  _____  _____  _____  *
*        MX  _____  _____  _____  _____  _____  _____  _____  _____  _____  *
*        N   _____  _____  _____  _____  _____  _____  _____  _____  _____  *
*                                                                           *
*                                                                           *
*                                                                           *
*****************************************************************************
```

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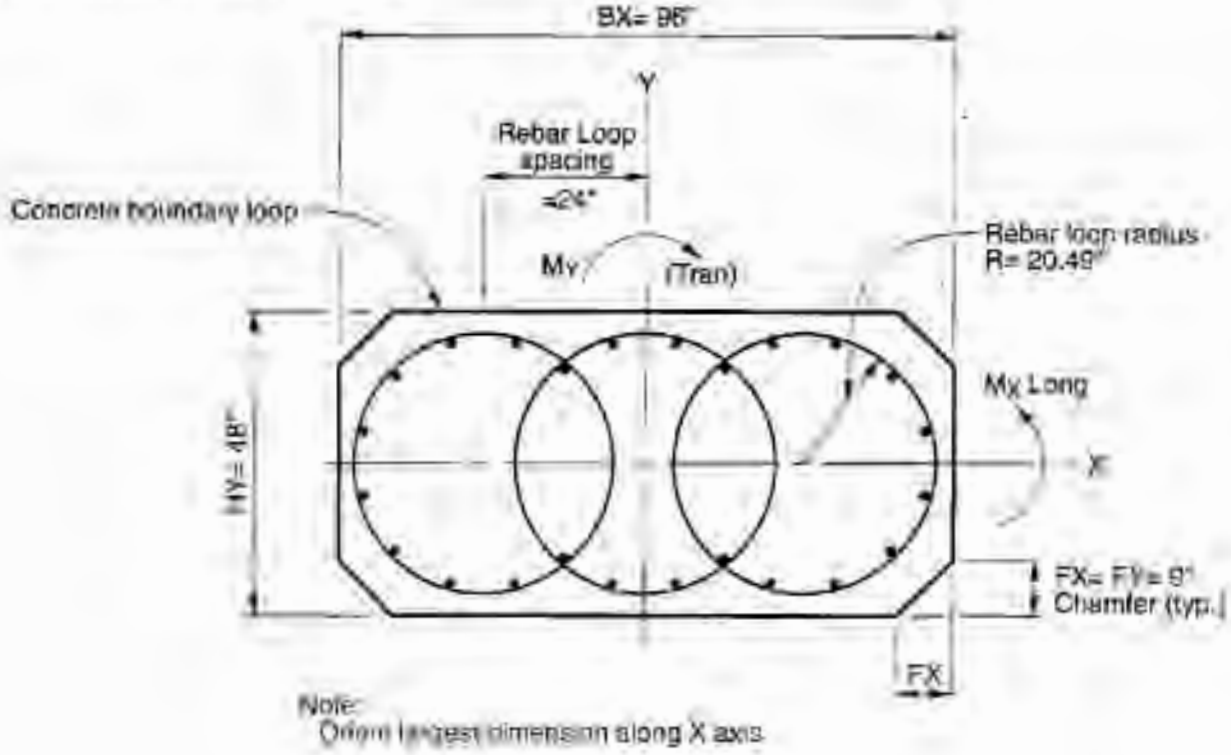
Column Design by Yield Surface (YIELD) Instructions for Users

Introduction

This program will analyze, check or design concrete columns for biaxial bending and axial load by the ultimate strength theory. Computation of ultimate strength is based on the satisfaction of the applicable conditions of equilibrium and compatibility of strains. The program uses the *Bridge Design Specifications* of the California Department of Transportation, hereafter referred to as the Code. The basic 'YIELD' program is the result of "Analytical Investigations of the Seismic Response of Long, Multiple Span Highway Bridges," by W. S. Tseng and J. Penzien (EERC 73-12) U.C. Berkeley 1973.

General Description



Column Section

```
                         GENERAL DATA PANEL - 1
*****************************************************************************
*                                                                           *
*                                                                           *
*                      YIELD GENERAL INFORMATION - 1                        *
*                                                                           *
*              TITLE: ____________________________________                  *
*                                                                           *
*   1 = MANUAL                  6 = HEXAGON                  COLUMN   TYPE = _ *
*   2 = RECTANGLE               8 = OCTAGON                                 *
*   3 = RECTANGLE/FILLETS       9 = ROUND                                   *
*   4 = SEMI-CIRCULAR ENDS                                                  *
*                                                                           *
*                                                                           *
*   1 = MANUAL                  4 = CONCENTRIC LOOPS          REBAR    TYPE = _ *
*   2 = INTERSECTING LOOPS      5 = NONE                                    *
*   3 = SEMI-CIRCULAR ENDS                                                  *
*                                                                           *
*                                                                           *
*   0 = NO PLOT                 3 = PN VS MNY                 PLOT     TYPE = _ *
*   1 = PN VS MN                4 = MNX VS MNY                              *
*   2 = PC VS MNX                                                           *
*                                                                           *
*                                                                           *
*   0 = ANALYZE                 2 = CHECK                     PROBLEM  TYPE = _ *
*   1 = DESIGN                                                              *
*                                                                           *
*                      PRESS <ENTER> TO CONTINUE ...                        *
*                                                                           *
*                                                                           *
*****************************************************************************
```

```
                         GENERAL DATA PANEL - 2
*****************************************************************************
*                                                                           *
*                                                                           *
*                                                                           *
*                      YIELD GENERAL INFORMATION - 2                        *
*                                                                           *
*                                                                           *
*                                                                           *
*   STEEL LIMITS:        MINIMUM PERCENT LONGITUDINAL STEEL   =    ____ PERCENT *
*                        MAXIMUM PERCENT LONGITUDINAL STEEL   =    ____ PERCENT *
*                                                                           *
*                                                                           *
*   MATERIAL PROPERTIES: ULT CONCRETE COMPRESSIVE STRESS (FC) =    ____ PSI   *
*                        YOUNG'S MODULUS FOR STEEL REBARS (ES) =  _____ PSI   *
*                        ULT CONCRETE COMPRESSIVE STRAIN (EC) =    ____ IN/IN *
*                        YIELDING STRESS FOR STEEL REBARS (FY) =   ____ PSI   *
*                                                                           *
*                                                                           *
*   BENT DATA:           NUMBER OF COLUMNS IN THE BENT        =     __ COLS  *
*                        OUT TO OUT DIAMETER OF SPIRAL        =   ____ INCHES *
*                        DISTANCE FROM TOP PLASTIC HINGE TO                 *
*                        CENTER OF GRAVITY OF SUPERSTRUCTURE  =    ____ FEET  *
*                        CENTER TO CENTER SPACING OF COLUMNS  =    ____ FEET  *
*                                                                           *
*                                                                           *
*                                                                           *
*                      PRESS <ENTER> TO CONTINUE ...                        *
*                                                                           *
*                                                                           *
*****************************************************************************
```

```
                    MANUAL CONCRETE PANEL  (TYPE = 1)

                    CONCRETE COORDINATES - MANUAL INPUT
   COORDINATE (0,0) AT COLUMN CENTROID - ENTER COORDINATES FROM LEFT TO RIGHT.
      COUNTERCLOCKWISE DIRECTION FOR SOLID AREAS AND CLOCKWISE FOR VOIDS.
 TOTAL NO. OF CONCRETE BOUNDARY LOOPS -      TOTAL NO. OF CONCRETE COORDINATES __
                  THIS LOOP NUMBER 1         NUMBER OF COORDINATES IN THIS LOOP __

   X(IN)     Y(IN)  |  X(IN)     Y(IN)  |  X(IN)     Y(IN)  |  X(IN)     Y(IN)

                    PRESS <ENTER> TO CONTINUE ...
```

```
                    MANUAL STEEL PANEL  (TYPE = 1)

                    STEEL COORDINATES (MANUAL INPUT)
              ENTER COORDINATES FROM LEFT TO RIGHT, TOP TO BOTTOM.
                    COORDINATE (0,0) AT COLUMN CENTROID

 TOTAL NUMBER OF STEEL LOOPS _          TOTAL NUMBER OF STEEL COORDINATES ___
 LOOP NUMBER 1 HAS ___ COORDINATES & AREA OF STEEL AT EACH COORDINATE IS _____

   X(IN)     Y(IN)  |  X(IN)     Y(IN)  |  X(IN)     Y(IN)  |  X(IN)     Y(IN)

                    PRESS <ENTER> TO CONTINUE ...
```

```
                    CONCRETE - RECTANGLE/FILLETS  PANEL (TYPE = 3)
                       STEEL - INTERSECTING LOOPS PANEL (TYPE = 2)
*****************************************************************************
*                                                                           *
*                                                                           *
*                        COLUMN DIMENSIONS (INCHES)                         *
*                  ORIENT LARGEST DIMENSION IN X-DIRECTION                  *
*                                                                           *
*                           X-WIDTH  = ____                                 *
*                           Y-THICK  = ____                                 *
*                           X-FILLET = ____                                 *
*                           Y-FILLET = ____                                 *
*   ***************************************************************************
*                                                                           *
*                          REBAR LAYOUT (INCHES)                            *
*                                                                           *
*                       INTERSECTING LOOPS (TYPE 2)                         *
*                                                                           *
*                                                                           *
*                    NUMBER OF STEEL REBAR LOOPS  =    __                   *
*                    TOTAL NUMBER OF STEEL REBARS =    __                   *
*                    LOOP RADIUS                  =  ____                   *
*                    LOOP SPACING                 =  ____                   *
*                    AREA OF EACH BAR             =  ____                   *
*                                                                           *
*   LOOP RADIUS  = RADIUS OF A CIRCLE THAT PASSES THROUGH THE CENTER OF EACH BAR.  *
*   LOOP SPACING = DISTANCE FROM CENTER TO CENTER OF ADJACENT CIRCLES.       *
*                                                                           *
*                       PRESS <ENTER> TO CONTINUE ...                       *
*                                                                           *
*                                                                           *
*****************************************************************************
```

```
                    CONCRETE - RECTANGLE/FILLETS    PANEL (TYPE = 3)
                       STEEL - SEMI - CIRCULAR ENDS PANEL (TYPE = 3)
*****************************************************************************
*                                                                           *
*                                                                           *
*                        COLUMN DIMENSIONS (INCHES)                         *
*                  ORIENT LARGEST DIMENSION IN X-DIRECTION                  *
*                                                                           *
*                           X-WIDTH  = ____                                 *
*                           Y-THICK  = ____                                 *
*                           X-FILLET = ____                                 *
*                           Y-FILLET = ____                                 *
*   ***************************************************************************
*                                                                           *
*                          REBAR LAYOUT (INCHES)                            *
*                                                                           *
*                       SEMI-CIRCULAR ENDS (TYPE 3)                         *
*                                                                           *
*                                                                           *
*                    TOTAL NUMBER OF STEEL REBARS =    __                   *
*                    LOOP RADIUS                  =  ____                   *
*                    LOOP SPACING                 =  ____                   *
*                    AREA OF EACH BAR             =  ____                   *
*                                                                           *
*   LOOP RADIUS  = RADIUS OF A CIRCLE THAT PASSES THROUGH THE CENTER OF EACH BAR.  *
*   LOOP SPACING = DISTANCE FROM CENTER TO CENTER OF ADJACENT CIRCLES.       *
*                                                                           *
*                       PRESS <ENTER> TO CONTINUE                           *
*                                                                           *
*                                                                           *
*****************************************************************************
```

```
                    CONCRETE - RECTANGLE/FILLETS PANEL (TYPE = 1)
                      STEEL - CONCENTRIC LOOPS  PANEL (TYPE = 4)
*****************************************************************************
*                                                                           *
*                                                                           *
*                        COLUMN DIMENSIONS (INCHES)                         *
*                    ORIENT LARGEST DIMENSION IN X-DIRECTION                *
*                                                                           *
*                              X-WIDTH  =  ____                             *
*                              Y-THICK  =  ____                             *
*                              X-FILLET =  ____                             *
*                              Y-FILLET =  ____                             *
*                                                                           *
*   ***********************************************************************  *
*                                                                           *
*                          REBAR LAYOUT (INCHES)                            *
*                                                                           *
*                        CONCENTRIC LOOPS (TYPE 4)                          *
*                                                                           *
*                                                                           *
*                  LOOP      LOOP       AREA OF      NUMBERS                *
*                  NO        RADIUS     EACH BAR     OF BARS                *
*                  1         ______     ______       ___                    *
*                  2         ______     ______       ___                    *
*                  3         ______     ______       ___                    *
*                                                                           *
*   LOOP RADIUS  = RADIUS OF A CIRCLE THAT PASSES THROUGH THE CENTER OF EACH BAR.  *
*                                                                           *
*                        PRESS <ENTER> TO CONTINUE ...                      *
*                                                                           *
*****************************************************************************
```

```
                    CONCRETE - RECTANGLE/FILLETS PANEL (TYPE = 3)
                      STEEL - ROWS              PANEL (TYPE = 5)
*****************************************************************************
*                                                                           *
*                                                                           *
*                        COLUMN DIMENSIONS (INCHES)                         *
*                    ORIENT LARGEST DIMENSION IN X-DIRECTION                *
*                              X-WIDTH  =  ____                             *
*                              Y-THICK  =  ____                             *
*                              X-FILLET =  ____                             *
*                              Y-FILLET =  ____                             *
*   ***********************************************************************  *
*                                                                           *
*                  REBAR COORDINATES (INCHES)   ROWS (TYPE 5)               *
*      LOW   X-COOR      Y-COOR       X-COOR      Y-COOR      AREA OF     NUMBER  *
*      NUM   START ROW   START ROW    END ROW     END ROW     EACH BAR    OF BARS *
*        1   ______      ______       ______      ______      ____        ___     *
*        2   ______      ______       ______      ______      ____        ___     *
*        3   ______      ______       ______      ______      ____        ___     *
*        4   ______      ______       ______      ______      ____        ___     *
*        5   ______      ______       ______      ______      ____        ___     *
*        6   ______      ______       ______      ______      ____        ___     *
*        7   ______      ______       ______      ______      ____        ___     *
*        8   ______      ______       ______      ______      ____        ___     *
*        9   ______      ______       ______      ______      ____        ___     *
*       10   ______      ______       ______      ______      ____        ___     *
*       11   ______      ______       ______      ______      ____        ___     *
*       12   ______      ______       ______      ______      ____        ___     *
*       13   ______      ______       ______      ______      ____        ___     *
*                        PRESS <ENTER> TO CONTINUE ...                      *
*                                                                           *
*****************************************************************************
```

```
                                   LOAD PANEL
*****************************************************************************
*                                                                           *
*                                                                           *
*   LOAD PAGE  1 OF  1                          POOLING DATA FILE ? (YES/NO) = ___   *
*   LOAD NAME _____________________             POOLING TYPE (SPIRAL) (FILE) = _____ *
*   EFFECTIVE LENGTH FACTORS  PERCENT  COLUMN      TIE=1      TOP=1     FUCTILITY *
*   KY (TRANS)     KX (LONG)  INPACT   LENGTH   SPIRAL=2   BOTTOM=2    FACTOR (Y) *
*   __________     _________  ____    ______       =          -          ____    *
*                                                                           *
*   COLUMN END CONNECTION (COLY TOP COLY BOTY BOTX)  (1=FIX 0-PIN)          *
*   SERVICE LOADS:          |-- SLENDERNESS --|                   DESIGN K-FT *
*                           CASE 1  CASE 2  CASE 3                          *
*        DEAD      PRE      TRANS   LONG    AXIAL                           *
*        LOAD    STRESS    MY-MAX  MX-MAX   N-MAX    WIND    WL     LF   CR-MS   PMSF *
*   MY  ______  ______    ______  ______  ______  ______  ____   ____  ____   ____ *
*   MX  ______  ______    ______  ______  ______  ______  ____   ____  ____   ____ *
*   N   ______  ______    ______  ______  ______  ______  ____   ____  ____   ____ *
*   PMY                   ______  ______  ______                        ____       *
*   PMX                   ______  ______  ______                        ____       *
*   PU                    ______  ______  ______                        ____       *
*                                                                           *
*            -UNREDUCED SEISMIC -|  ARBITRARY LOADS -|-- ARBITRARY LOADS --|  *
*            CASE 1     CASE 2    SERVICE   SERVICE   FACTORED   FACTORED    *
*          MAX TRANS  MAX LONG     AL-1      AL-2      AL-1       AL-2       *
*       MY ________  ________  ________  ________  ________  ________        *
*       MX ________  ________  ________  ________  ________  ________        *
*       N  ________  ________  ________  ________  ________  ________        *
*   <ENTER>:CONT F7:<ESC> F6:<CEN> F5:<CON> F4:<ESC> F3:<FIX> F2:<ADD LOAD> F1:<DEL LOAD>  *
*                                                                           *
*****************************************************************************
```

Input Panel Instructions

General Data Panel – 1

Title

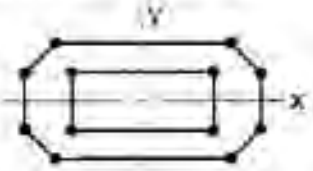
Enter up to 40 characters to name your problem.

Column Type

Enter the I.D. number for the Column type desired. Use numbers 1-9 as shown. Columns with voids must be entered as Column Type 1 (Manual). Column Types 6 & 8 are regular geometric shapes only (BX=HY).

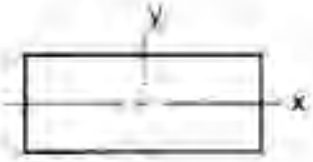
1 = Manual

A column described by user defined x and y boundary coordinates.



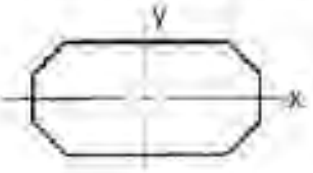
2 = Rectangle

A rectangular or square shaped column.



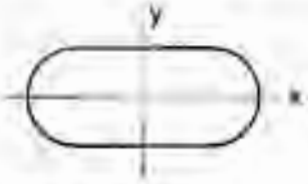
3 = Rectangle/Fillets

A rectangular or square shaped column with fillets.



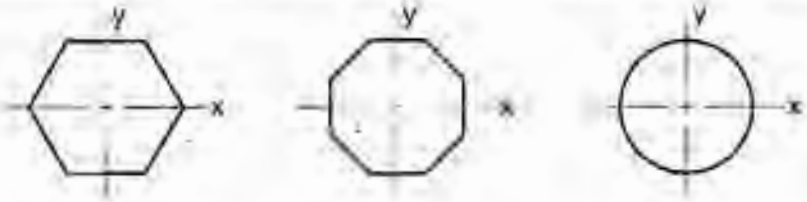
4 = Semi-Circular Ends

A rectangular shaped column with semi-circular ends.



6 = Hexagon, 8 = Octagon, 9 = Round

A column that has a regular hexagon, regular octagon or round shape.



Rebar Type

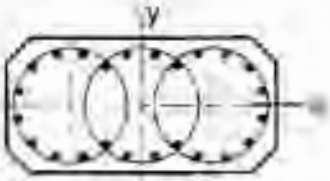
Enter the I.D. number of the rebar pattern required. Use numbers 1-5 as shown. If rebar patterns 2 or 3 are used, the rebars will be generated with their long dimension along the X-axis to match the generated concrete section.

1 = Manual

Enter the x and y coordinates of each bar.

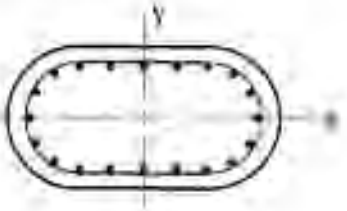
2 = Intersecting Loops

Bars are equally spaced around the total exterior perimeter with bars always located at the intersections.



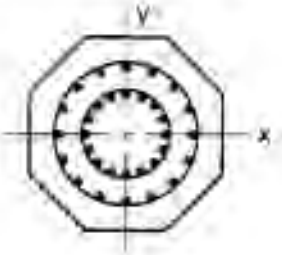
3 = Semi-Circular Ends

Bars are equally spaced around loop



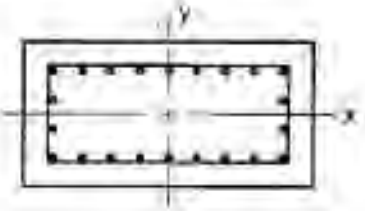
4 = Connecting Loops

Bars are equally spaced around each loop.



5 = Rows

Bars are equally spaced between end bars.



Plot Type

Enter the I.D. number of the type of plot desired in the output. Use numbers 0-4 as shown. (No plots will be generated for design type = 1)

0 = No Plot
1 = Pn Vs Mn - Axial Load Vs Resultant Moment
2 = Pn Vs Mnx - Axial Load Vs Longitudinal Moment
3 = Pn Vs Mny - Axial Load Vs Transverse Moment
4 = Mny Vs Mnx - Transverse Moment Vs Longitudinal Moment

The angle of the resultant moment varies from 90 degrees to 0 degrees in 15 degree increments.

@ 0 degrees:	Mnx = Maximum	(Longitudinal Moment)
	Mny = 0	(Transverse Moment)
@ 90 degrees:	Mnx = 0	(Longitudinal Moment)
	Mny = Maximum	(Transverse Moment)

The nominal axial load P varies from 0.8Po TO -0.1Po in increments of 0.1Po (Po = Nominal Axial load Strength).

Design Type

Enter the I.D. number of the analysis mode the program is to use. Use numbers 0-2 as shown.

0 = Analyze Mode

The program determines the nominal strength of the column (i.e., no design). A table of nominal strength values; MNX, MNY, MN and PN is produced.

Plots of the moment interaction diagrams are available with this option.

1 = Design Mode

Group loads are entered at the service level and the loads are factored in accordance with section 3.22 of the Code. When required, moments are magnified for slenderness in accordance with section 8.16.5 of the code (see appendix A). Applied axial loads are checked against the critical buckling load. Seismic group VII loads are not magnified for slenderness effects. The program iterates to determine the controlling group loading and the corresponding required area of steel. The column shape and rebar pattern are maintained while the area of steel is varied. No plots are available with this option.

The value for PHI varies linearly from .70 for tied or .75 for spiral columns to .90, when the design axial load strength, Pn, decreases from $.10 f'_c$ Ag to zero. For seismic group VII loads PHI varies from .90 for ties or 1.00 for spiral columns to 1.2 when the design axial load strength, Pn, decreases from $.10 f'_c$ Ag to zero. The designer should check to make sure $.10 f'_c$ Ag is less than Phi x Pb (Code 8.16.12).

2 = Check Mode

Group loads are input and the column is checked (no design). Again moments are magnified for slenderness and axial loads checked against the critical buckling load (see appendix A). The program determines the moment capacity (Phi × Mn) of the column for the applied axial load. The applied resultant moment is checked against the moment capacity of the column to determine if the section is adequate.

In the "CHECK" mode the program provides an option to create a "FOOT" input data file that contains the service loads, factored loads, unreduced ARS seismic and probable plastic loads for the footing design.

Plots of the moment interaction diagrams are available with this option.

Key Design

In the "CHECK" mode, the program calculates the required key area and reinforcement for the pinned bottom condition in accordance with section 8.16.4.5 and 8.16.6.4 of the code. The loads must be described at the top of the column. If the unreduced ARS + dead load shear is less than the probable plastic shear the key design is based on group loads I to VII. The unreduced ARS + dead load shear is used for group VII. When the unreduced ARS forces control, the ARS axial load for case I (max transverse) is assumed to be negative in sign and a minimum axial load (uplift) is calculated.

If the column is input as pinned in one direction and fixed in the other direction the key design is based on the loads in the direction of the pin only. The designer must check the key design for the loads in the fixed direction.

TYPICAL OUTPUT FOR KEY DESIGN - CHECK MODE ONLY

```
**************
* KEY DESIGN *
*****************************************************************************
NOTE:  THE KEY DESIGN IS BASED ON PLASTIC HINGING.

*********************************
* SHEAR FRICTION (CODE 8.16.6.4) *
*****************************************************************************
MAXIMUM SHEAR              (VU) =     821. KIPS
AREA OF KEY   REQUIRED   (ACF) =  1485.95 SQ IN
AREA OF STEEL REQUIRED   (AVF) =    16.10 SQ IN

*************************************************
* MINIMUM (UPLIFT) AXIAL LOAD (CODE 8.16.4.5.3) *
*****************************************************************************
MINIMUM AXIAL LOAD              =    -935. KIPS
AREA OF STEEL REQUIRED (AST)    =    15.46 SQ IN

ASSOCIATED SHEAR                =     379. KIPS
AREA OF STEEL REQUIRED (AVF)    =     7.43 SQ IN

TOTAL AREA OF STEEL REQUIRED    =    22.89 SQ IN

*************************************************
* MINIMUM AREA OF STEEL REQUIRED (CODE 4.4.9.4) *
*****************************************************************************
MINUMUM STEEL AREA REQUIRED     =     7.43 SQ IN

*****************************************************
* MAXIMUM COMPRESSIVE AXIAL LOAD (CODE 8.16.4.5.2) *
*****************************************************************************
AREA OF STEEL                   =    22.89 SQ IN

MAXIMUM AXIAL LOAD (FACTORED)   =    1445. KIPS
AREA OF KEY REQUIRED            =   273.01 SQ IN

MAXIMUM AXIAL LOAD (SEISMIC)    =    2132. KIPS
AREA OF KEY REQUIRED            =   327.81 SQ IN

***********
* SUMMARY *
*****************************************************************************
AREA OF KEY REQUIRED            =  1485.95 SQ IN
TOTAL AREA OF STEEL REQUIRED    =    22.89 SQ IN
```

General Data Panel – 2

Steel Limits

Minimum Percent Longitudinal Steel

Enter the lower limit of main longitudinal steel rebars as a percent of the gross area of the column. The default is 1% steel.

Maximum Percent Longitudinal Steel

Enter the upper limit of main longitudinal steel rebars as a percent of the gross area of the column. The default is 6% steel.

Note

These steel limits are only used in the "DESIGN" mode (Design Type = 1). The computational effort of the program can be minimized by keeping these limits as close together as possible.

Material Properties

ULT Concrete Compressive Stress (FC)

Enter the ultimate concrete compressive stress (psi). The default is 3250 psi.

Young's Modulus for Steel Rebars (ES)

Enter young's modulus of elasticity for the steel rebars (psi). The default is 29,000,000 psi.

ULT Concrete Compressive Strain (EO)

Enter the ultimate concrete compressive strain (in/in). The default is .003 in/in.

Yielding Stress for Steel Rebars (FY)

Enter the yielding stress for the steel rebars (psi). The default is 60,000 psi.

Bent Data

Number of Columns in the Bent

Enter the total number of columns in the bent. To suppress the plastic hinging analysis enter a zero or leave blank. The maximum number of columns in a bent is 15.

Out to Out Diameter of Spiral

Enter the out to out (outside) diameter (in) of the spiral reinforcement. For intersecting loops (Rebar Type = 2), use the outside diameter of one loop. For concentric loops (Rebar Type = 4), use the outside diameter of the outermost loop.

Distance from Top Plastic Hinge to Center of Gravity of Superstructure

Enter the distance (ft) from the plastic hinge at the top of the column to the center of gravity of the superstructure.

Center to Center Spacing of Columns

Enter the distance (ft) between the center lines of the columns. For a single column bent enter a zero or leave blank.

Design Assumptions

1. All columns are the same i.e., prismatic, equal length, equal spacing.
2. Plastic hinges form at the top and bottom of the columns.
3. The distance between the plastic hinges is taken as the column length.
4. The overturning force acts through the center of gravity of the superstructure.
5. The columns are numbered from left to right and the displacement acts to the right.
6. A plastic hinge analysis is only performed for Rebar Types 2 or 4, with spiral reinforcement.

Concrete Panels

Column Dimensions (Type 1 – Manual Input)

This option may be used to describe a column with an unusual or non-symmetric cross-section.

Total No. of Concrete Boundary Loops

Enter the total number of concrete boundary loops used to describe the concrete section. The column cross-section may be bounded by one or more boundary loops which is described by a series of coordinates. Coordinates are entered sequentially in a counterclockwise sense for the outermost boundary loop and in a clockwise sense for cutouts or voids. The maximum number of concrete boundary loops is five (5).

Total No. of Concrete Coordinates

Enter the total number of concrete coordinates used to describe the section. This would be the sum of the number of coordinates in all the concrete loops used to describe the section. The maximum number of concrete coordinates is 150.

This Loop Number

The program generates the number of the current concrete boundary loop being described. You cannot write over this number, it is for your information only.

Number of Coordinates in this Loop

Enter the number of concrete coordinates in this loop. If there is only one concrete boundary loop the program will default to the value of "TOTAL NO. OF CONCRETE COORDINATES" entered above. The input panel allows up to 60 concrete coordinates per loop.

X(IN) & Y(IN)

Enter the x and y coordinates (inches), for each point described on a boundary loop. The reference axes of the section are taken as the principle axes of the section. All coordinates of the cross-section are referenced with the origin (0,0) at the centroid of the cross-section so the lower left-hand corner will have negative x and y coordinates. Do not repeat the beginning coordinates to close the loop.