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CONKER®

Design of Concrete Frames

A Postprocessor for ETABS®

by
Ashraf Habibullah

Version 5.4
Revised July, 1992

Developed and written in U.S.A.

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DISCLAIMER

CONSIDERABLE TIME, EFFORT AND EXPENSE HAVE GONE INTO THE DEVELOPMENT AND DOCUMENTATION OF CONKER. THE PROGRAM HAS BEEN THOROUGHLY TESTED AND USED. IN USING THE PROGRAM, HOWEVER, THE USER ACCEPTS AND UNDERSTANDS THAT NO WARRANTY IS EXPRESSED OR IMPLIED BY THE DEVELOPERS OR THE DISTRIBUTORS ON THE ACCURACY OR THE RELIABILITY OF THE PROGRAM.

THE PROGRAM IS A VERY PRACTICAL TOOL FOR THE DESIGN OF CONCRETE FRAME STRUCTURES. PREVIOUS VERSIONS OF THIS PROGRAM HAVE BEEN VERY SUCCESSFULLY USED ON A VARIETY OF BUILDINGS. HOWEVER, THE USER MUST THOROUGHLY READ THE MANUAL AND CLEARLY RECOGNIZE THE ASPECTS OF CONCRETE DESIGN THAT THE PROGRAM ALGORITHMS DO NOT ADDRESS.

THE USER MUST EXPLICITLY UNDERSTAND THE ASSUMPTIONS OF THE PROGRAM AND MUST INDEPENDENTLY VERIFY THE RESULTS.

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I.

INTRODUCTION

CONKER is a concrete design postprocessor for the three-dimensional static and dynamic building analysis computer program ETABS [1].

The program is intended for the automated ACI code design [2,3] of concrete frames that have been modeled for analysis using ETABS. Special seismic provisions in the ACI code and in the UBC91 [4] can be activated. An option for using the Canadian concrete code [5] is also available.

The design is based upon user-specified loading combinations.

Most of the data required by CONKER for the design processing, i. e. material and section properties, member forces and geometry, is recovered directly from the ETABS database. Therefore, the data input typically required by CONKER is very nominal and **if the program defaults are acceptable, no data input is required.**

In the design of the columns, the program calculates the required longitudinal steel or if the longitudinal steel is specified, the column stress condition is reported in terms of a column capacity ratio, which is a factor that gives an indication of the stress condition of the column with respect to the capacity of the column.

The biaxial column capacity check is based upon the generation of consistent three-dimensional interaction surfaces and does not use any empirical formulations that extrapolate uniaxial interaction curves to approximate biaxial action.

Interaction surfaces are generated for user-specified column reinforcing configurations. The column configurations may be rectangular, square or circular. The calculation of moment magnification factors, unsupported lengths and strength reduction factors are automated in the algorithm.

Every beam member is designed for flexure and shear at five stations along the beam span.

All beam-column joints are investigated for existing shear conditions.

For special moment resisting frames (ductile frames), the shear design of the columns, beams and joints is based upon the probable moment capacities of the members.

Also, for special moment resisting frames, the program will produce ratios of the beam moment capacities with respect to the column moment capacities, to investigate the weak beam-strong column aspects of any beam-column intersection. Effects of the axial forces on the column moment capacities are included in the formulation.

The presentation of the output is in a format that not only allows the engineer to quickly study the stress conditions that exist in the structure but also aids the engineer in taking appropriate remedial measures in the event of member overstress. Backup design information for convenient verification of the results produced by the program is also provided.

Changes in structural member section properties is possible at the postprocessor level to study the effects of member changes without rerunning the ETABS analysis.

English as well as SI and MKS metric units are possible.

II.

SYSTEM PREPARATION and EXECUTION PROCEDURE

This chapter deals with the installation and execution of CONKER on an MS-DOS based computer system.

User familiarity with MS-DOS is assumed.

The complete CONKER package includes:

a. This manual

b. Floppy disk, containing the following:
   1. Program Executable, CONKER.EXE
   2. Sample Test Data and Results

Note: the characters <CR> appear repeatedly in the text of this chapter. These characters mean "press the carriage return key." Do not type the characters <, C, R, and >.

A. INSTALLING, CONFIGURING and TESTING

The program provided must first be copied to the hard disk. The program and computer must then be configured before the program can be used. Follow the instructions in the SAP90/ETABS/SAFE Installation Guide (included with the ETABS package) for this procedure.

Before putting the system into a production mode, the user should test the system by running the sample example provided on the disk. The output files produced should be compared with the corresponding output files that are also provided on this disk.

B. INPUT PREPARATION before EXECUTING CONKER

CONKER is a postprocessor for the ETABS analysis program. Therefore, before running CONKER the user must generate an ETABS input data file and execute ETABS to create the ETABS postprocessing file.

Say that the ETABS data associated with the structure the user wishes to analyze has been prepared and entered into a data file called EXCON. A successful execution of ETABS with the data file EXCON will create a postprocessing file EXCON.PST.

The user must then also prepare a CONKER input data file using the text editor EDLIN (or any other MS-DOS compatible editor). This data file must conform to the specifications detailed in Chapter IV of this manual. This data file is not required if all of the program defaults are acceptable. Sample data is provided on the disk (filenames EXCON for ETABS data and DESCON for CONKER data) associated with the complete CONKER package.

C. EXECUTING the CONKER PROGRAM

This section explains how to execute the CONKER program.

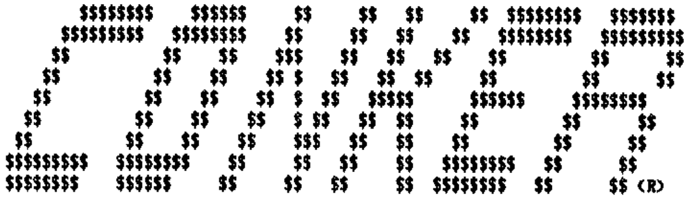
Say that ETABS has been run using an input data file named EXCON, to create the postprocessing file EXCON.PST, and that the data associated with the design of this structure for the CONKER postprocessor has been prepared and entered into a data file called DESCON. In order to execute the CONKER program, proceed as follows:

From the directory where the CONKER input data file is resident, enter the command:

C > **CONKER** <CR>

Note: the CONKER input data file and the ETABS postprocessing file, EXCON.PST, must always exist in the same directory. The CONKER executable must also reside in the same directory unless a path to the CONKER executable has been activated using the MS-DOS **PATH** command.

After a few seconds the following banner will appear on the screen:



```
                  DESIGN OF CONCRETE FRAME BUILDINGS
                            VERSION  5.xx
                                 BY
                          ASHRAF HABIBULLAH

                       Copyright (c) 1984-1992
                    COMPUTERS AND STRUCTURES, INC.
                         All rights reserved

                                                    hit it baby...<CR>
```

Enter <CR>

The program will then display a copyright notice followed by a prompt for the CONKER input data filename as follows:

```
          THE USE OF THIS PROGRAM IS GOVERNED BY THE TERMS
          OF A LICENSE AGREEMENT AND THE PROGRAM IS TO BE
                 USED ONLY BY AUTHORIZED LICENSEES.

           UNAUTHORIZED USE IS UNETHICAL, UNPROFESSIONAL
             AND IN VIOLATION OF FEDERAL COPYRIGHT LAWS.

             ADDITIONAL INFORMATION MAY BE OBTAINED FROM

                    COMPUTERS AND STRUCTURES, INC.
                       1995 UNIVERSITY AVENUE
                     BERKELEY, CALIFORNIA   94704

                         TEL:  (510) 845-2177
                         FAX:  (510) 845-4096

           IT IS THE RESPONSIBILITY OF THE USER TO VERIFY
               ALL RESULTS PRODUCED BY THIS PROGRAM.


ENTER "CONKER" INPUT FILE NAME :
```

Enter **DESCON <CR>**

Note: if program defaults are acceptable, and no CONKER input is required, simply enter a <CR> above.

The program will then ask for the ETABS postprocessing file as follows:

```
ENTER "ETABS" .PST FILE NAME:
```

Enter **EXCON.PST <CR>**

Note: the postprocessing filename must have .PST extension. If the user enters a filename with no extension, the program will append the .PST extension to the filename.

The program will then display the input and output filenames as follows:

```
INPUT DATA------------------- DESCON
ETABS POSTPROCESSING FILE---- EXCON.PST
COLUMN/BEAM/JOINT DESIGN----- DESCON.CHK
COLUMN DESIGN BACK-UP INFO--- DESCON.COL
DESIGN OUTPUT DISPLAY MAPS--- DESCON.MAP

              <CR> TO CONTINUE
```

If all of the filenames are appropriate,

Enter **<CR>**

The program will go into execution mode and a series of progress messages will be flashed to the screen until the job has been completed. The job completion message will read

```
JOB COMPLETED . . . NO CHARGE!!!
```

The output files created by the program are explained in Chapter V. To print an output file the MS-DOS **PRINT** command may be used. Appropriate line counts and page ejects are built into the files.

III.

DESIGN ALGORITHMS

This chapter describes in detail the various aspects of the concrete design procedures that are used by the program CONKER.

Special terminology associated with the input and the output of the program is also described in the following sections.

An engineering background in the general area of multistory reinforced concrete design and user familiarity with References [2] and [3] or [4] or [5] is assumed.

A description of the typical notation used throughout this chapter is presented in Figure III-1. References to pertinent sections of the ACI Code [2] are indicated with the "ACI" prefix and similarly for other codes. For simplicity, all equations and descriptions presented in this chapter correspond to inch-pound-second units unless otherwise noted. Units required by ETABS and CONKER are described in Chapter IV.

The details of the algorithms presented in sections B, C, D and E are all based on the ACI [2] and UBC [4] codes. The two codes are very similar. Where they differ, differences are identified. Section F identifies the differences between these algorithms and those used for the Canadian [5] code.

The program provides options to design or check Ordinary, Intermediate and Special moment resisting space frames as required for seismic design. The details of the design criteria used for the different framing systems are described in the following sections and are summarized in the Design Criteria Table (Figure III-17).

A. DESIGN LOADING COMBINATIONS

The design loading combinations define the various factored combinations of the load conditions for which the structure is to be checked. The user is referred to the ETABS manual for the definition of load conditions (and load cases).

The load combination data that is specified in the CONKER input data is totally independent of the load case data that is specified in the ETABS manual.

The postprocessing file brings across forces and moments associated with the eight independent load conditions (I, II, III, A, B . . .) for each of the members. The load combination multipliers are applied to the forces and moments from the load conditions to form the factored design forces and moments for each load combination. There is one exception to the above. For dynamic analysis and for SRSS combinations, any correspondence between the signs of the moments and axial loads is lost. The program uses two loading combinations for each such loading combination specified, reversing the sign of axial loads in one of them.

If a building is subjected to dead load (DL) and live load (LL) only, the design will need only one loading combination, namely 1.4 DL + 1.7 LL.

However, in addition to the dead load and live load, if the structure is subjected to seismic forces from two mutually perpendicular directions (EQX and EQY), and considering that seismic forces are subject to reversals, the following load combinations may have to be considered when using the UBC91 code:

1. $1.4\ DL + 1.7\ LL$
2. $1.4\ DL + 1.4\ LL + \sqrt{(1.4\ EQX)^2 + (1.4\ EQY)^2}$
3. $1.4\ DL + 1.4\ LL - \sqrt{(1.4\ EQX)^2 + (1.4\ EQY)^2}$
4. $0.9\ DL + \sqrt{(1.4\ EQX)^2 + (1.4\ EQY)^2}$
5. $0.9\ DL - \sqrt{(1.4\ EQX)^2 + (1.4\ EQY)^2}$

For other codes the loading combinations would be different and appropriate combinations must be used.

Further, it must be noted that the program asumes that a P-Delta analysis has been performed in ETABS so that moment magnification factors for moments causing sidesway can be taken as unity. The codes would require that the P-Delta analysis be done at the factored load level [13]. The ETABS program uses the specified story masses to calculate the P for the P-Delta analysis, but allows an input factor to modify it. It is recommended that when using the UBC91 code a factor be used to obtain a P equivalent to (1.4 dead load + 1.4 live load) /0.7. The 0.7 is the understrength factor, φ. This would give amplification of moments similar to using ACI code Equation 10-8.

Similarly, when using ACI318-89, it is recommended that a P-Delta factor in ETABS be used to obtain a P equivalent to 0.75 (1.4 dead load + 1.7 live load)/ 0.7. The necessary P for a P-Delta analysis for the CAN3-A23.2-M84 code would be (1.25 dead load + 1.05 live load)/0.65.

A_{cv}	Area of concrete used to determine shear stress, sq-in, see Figure III-12
A_g	Gross area of concrete, sq-in.
A_s	Area of tension reinforcement, sq-in
A_{st}	Total area of column longitudinal reinforcement, sq-in
A_v	Area of shear reinforcement, sq-in
a	Depth of compression block, in
b	Width of member, in
b_f	Effective width of flange (T-Beam section), in
b_w	Width of web (T-Beam section), in
C_m	Coefficient, dependent upon column curvature, used to calculate moment magnification factor
c	Depth to neutral axis, in
c_b	Depth to neutral axis at balanced conditions, in
d	Distance from compression face to tension reinforcement, in
d '	Concrete cover to center of reinforcing, in
d_s	Thickness of slab (T-Beam section), in
E_c	Modulus of elasticity of concrete, psi
E_s	Modulus of elasticity of reinforcement, assumed as 29,000,000 psi
f'_c	Specified compressive strength of concrete, psi
f_y	Specified yield strength of flexural reinforcement, psi
f_{ys}	Specified yield strength of shear reinforcement, psi
I_g	Moment of inertia of gross concrete section about centroidal axis, neglecting reinforcement, in^4

Abbreviations
Figure III-1

I_{se}	Moment of inertia of reinforcement about centroidal axis of member cross section, in^4
L	Clear unsupported length, in
M_b	Moment capacity at balanced strain conditions, lb-in
M_o	Moment capacity with no axial load, lb-in
P_b	Axial load capacity at balanced strain conditions, lb
P_c	Critical buckling strength of column, lb
P_{max}	Maximum axial load strength allowed, lb
P_o	Axial load capacity at zero eccentricity, lb
r	Radius of gyration of column section, in
V_c	Shear resisted by concrete, lb
α	Reinforcing steel overstrength factor
β_1	Factor for obtaining depth of compression block in concrete
β_d	Absolute value of ratio of maximum factored axial dead load to maximum factored axial total load
δ	Moment magnification factor
ε_c	Strain in concrete
ε_s	Strain in reinforcing steel
φ	Strength reduction factor
ρ_w	A_s/bd

Abbreviations
Figure III-1 (continued)

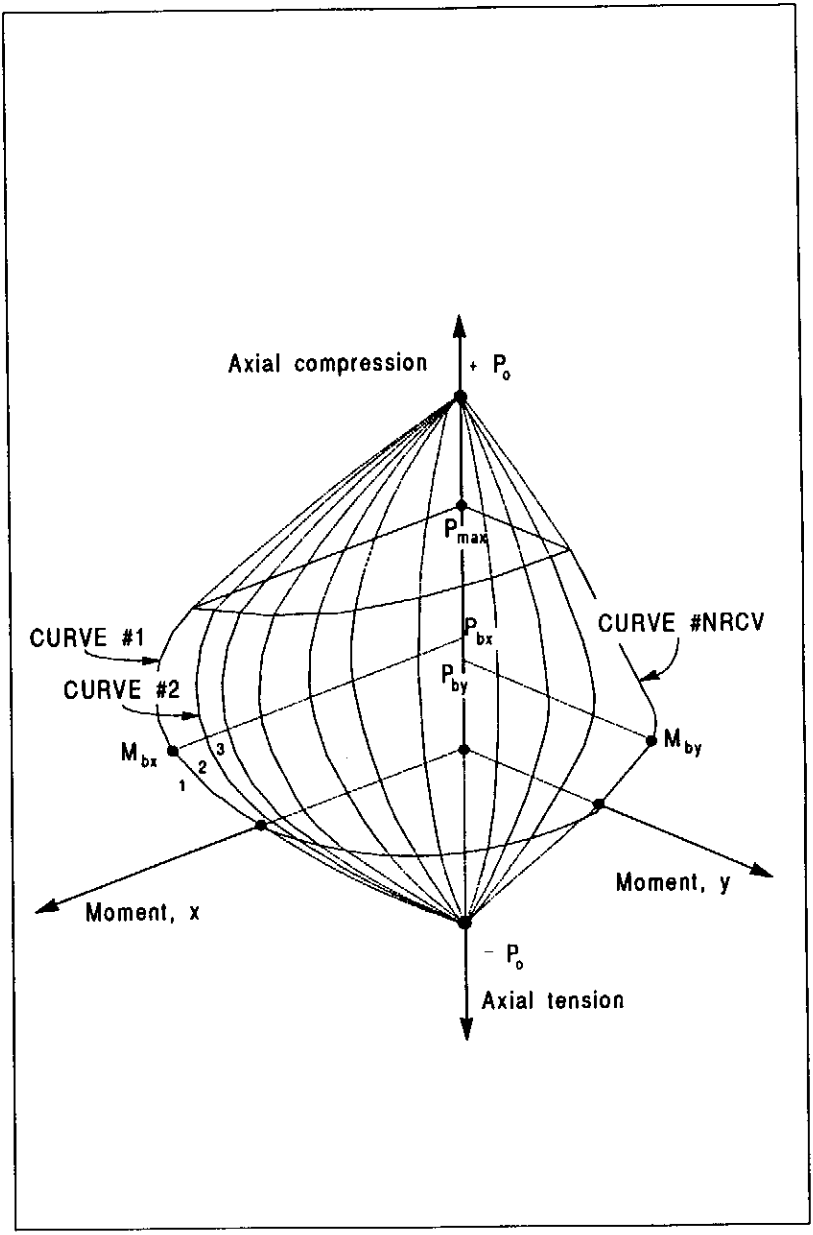
Of the three vertical load conditions I, II or III, one is usually identified as being associated with the dead load and another is identified as the live load condition. By identifying the load conditions in this manner, live load reduction factors as allowed by Reference [4] can be applied to the member forces of the live load condition on a level-by-level basis to reduce the contribution of the live load to the factored loading. Also, the dead load condition needs to be identified to calculate β_d.

B. COLUMN DESIGN

In the column design strategy of CONKER, the user can either define the geometry of the rebar configuration of each different concrete column section type that exists in the structure or let the program calculate the amount of steel required for the individual columns. The design procedure for the reinforced concrete columns of the structure involves the following steps:

1. Generate load-biaxial moment interaction surfaces for all of the different concrete section types of the model. A typical biaxial interaction surface is shown in Figure III-2. When the steel is undefined, the program generates the interaction surfaces for the range of allowable reinforcement (1 to 8 percent, except for special moment resisting frames 1 to 6 percent).

2. Check the capacity of each column for the factored axial force and biaxial (or uniaxial) bending moments obtained from each loading combination at each end of the column. This step is also used to calculate the required reinforcement (if none was specified) that will produce a capacity ratio of 1.0 (0.99 is conservatively used by the program).



Typical Column Interaction Surface
Figure III-2

3. Design the column shear reinforcing.

The following three sections describe in detail the algorithms associated with the above-mentioned steps, 1, 2 and 3.

1. Generation of Biaxial Interaction Surfaces

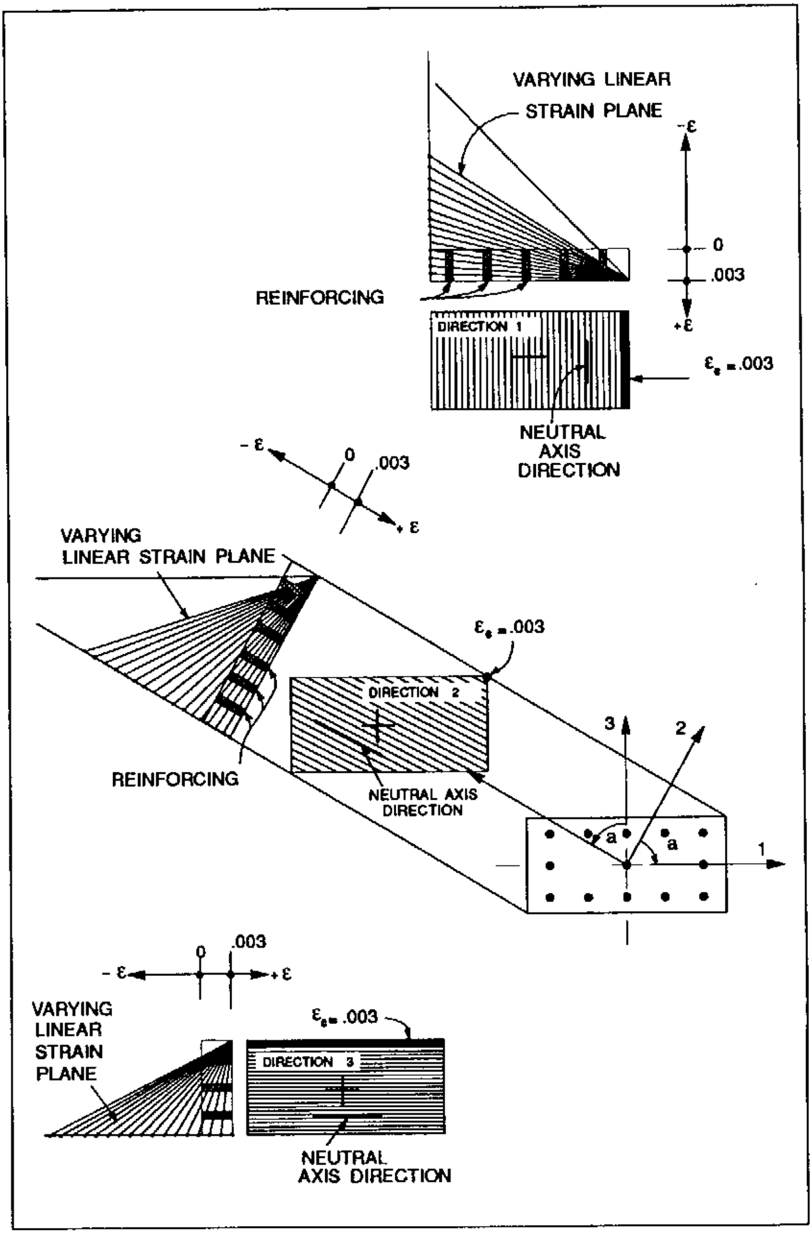
The column capacity interaction volume is numerically described by a series of discrete points that are generated on the three-dimensional interaction failure surface. In addition to axial compression and biaxial bending, the formulation allows for axial tension and biaxial bending considerations as shown in Figure III-2.

The coordinates of these points are determined by rotating a plane of linear strain in three dimensions on the section of the column. See Figure III-3.

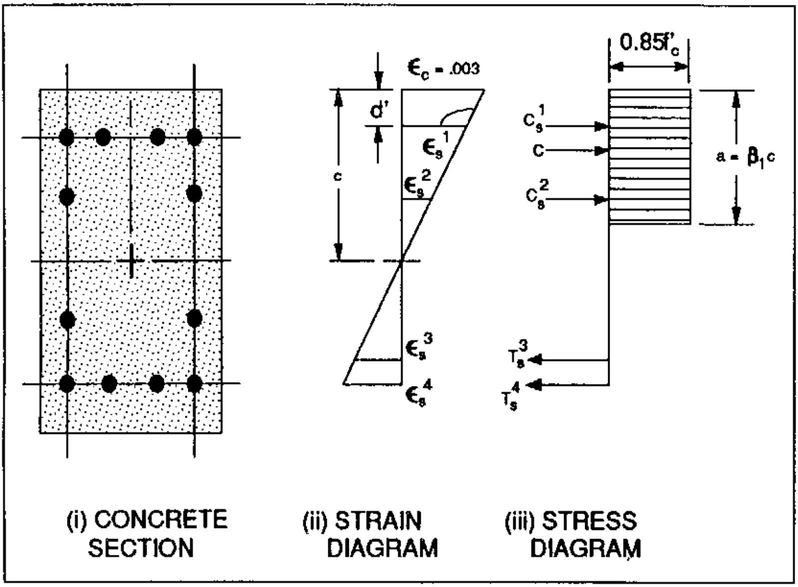
The formulation is based consistently upon the basic principles of ultimate strength design, (ACI 10.3), and allows for rectangular, square or circular, doubly symmetric column sections.

The linear strain diagram limits the maximum concrete strain, ε_c, at the extremity of the section, to .003.

The stress in the steel is given by the product of the steel strain and the steel modulus of elasticity, $\varepsilon_s E_s$, and is limited to the yield stress of the steel, f_y. The area associated with each rebar is placed at the actual location of the center of the bar and the algorithm does not assume any simplifications in the manner in which the area of steel is distributed over the cross section of the column (such as an equivalent steel tube or cylinder).



Generation of Interaction Surfaces
Figure III-3



Concrete Stress-Strain Relationships
Figure III-4

The concrete compression stress block is assumed to be rectangular, with a stress value of 0.85 f'_c. See Figure III-4. The interaction algorithm provides corrections to account for the concrete area that is displaced by the reinforcing in the compression zone.

The effects of the strength reduction factor, ϕ , are included in the generation of the interaction surfaces. The maximum compressive axial load is limited to P_{max}, where

P_{max} = 0.80 P_o for columns with rectangular (or square) reinforcement patterns (i.e. the program assumes tied columns)

P_{max}	=	0.85 P_o for columns with circular reinforcement patterns (i.e. the program assumes spiral reinforcing)

where $P_O = \varphi_{min} [\,0.85\, f'_c\, (A_g - A_{st}) + f_y\, A_{st}]$
and $\varphi_{min} = 0.70$ for tied columns and
$\varphi_{min} = 0.75$ for spirally reinforced columns.

The value of φ used in the interaction diagram varies from φ_{min} to 0.9 based on the axial load. For low values of axial load, φ is increased linearly from φ_{min} to 0.9 as the axial load decreases from the smaller of 0.1 f'_c A_g or P_b to zero. In cases involving axial tension, φ is always 0.9 (ACI 9.3.2.2). See Figure III-5.

2. Checking Column Capacity

The column capacity is checked for each loading combination at the top and bottom ends of each column. In checking a particular column for a particular loading combination at a particular location, the following steps are involved.

a. Determine the factored moments and forces from the analysis load conditions and the specified load combination factors to give P_u, M_{ux} and M_{uy}.

b. Determine moment magnification factors for the column moments.

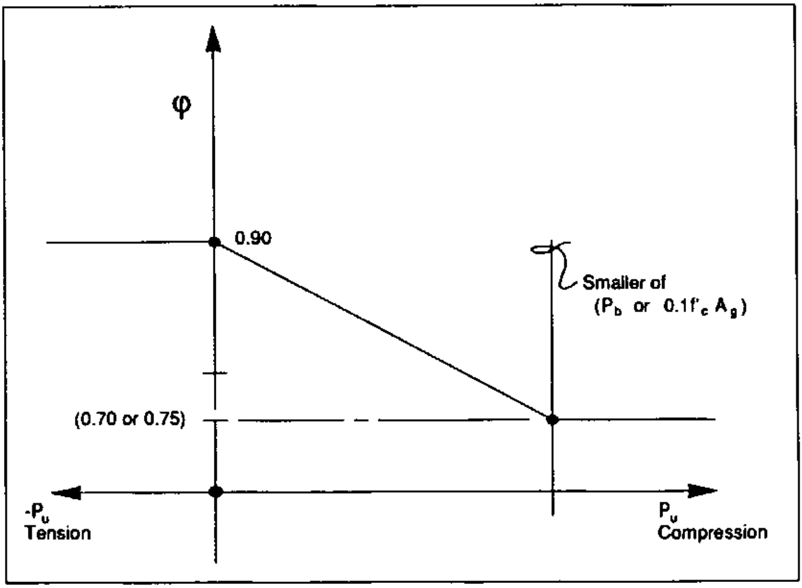
c. Apply the moment magnification factors to the factored loads obtained in Step a. Determine if the point, defined by the resulting axial load and biaxial moment set, lies within the interaction volume.

The following three sections describe in detail the algorithms associated with the above-mentioned steps a, b, and c.

a. Determine factored moments and forces

Each load combination is defined with a set of load factors corresponding to the eight ETABS load conditions. The analysis results associated with the ETABS load conditions are recovered from the postprocessing data file that was created by the corresponding ETABS analysis run. The factored loads for a particular load combination are obtained by applying the corresponding load factors to the ETABS load conditions, giving P_u, M_{ux} and M_{uy}. The factored moments are further increased, if required, to obtain minimum eccentricities of $(0.6 + 0.03h)$ inches , where h is the depth of the column in the corresponding direction (ACI 10.11.5.5). Minimum ecentricity checks are performed for each direction moments separately.

In the design mode for seismic design using special moment resisting frames, the design is carried out for one other moment value about each axis separately. The moment is obtained by distributing to the top and bottom columns at a joint, a moment equal to 6/5ths the sum of the moment capacities of the beams framing into the joint. In calculating the moment capacities of the beams for this purpose, no yield overstrength factors are used and φ values are used. The program assumes point of contraflexure at mid height of the columns to distribute this moment to top and bottom columns at a joint. The design for these moments is done in conjunction with the factored axial loads.



Strength Reduction Factor, φ
Figure III-5

b. Determine moment magnification factors

The moment magnification factors are different for moments causing sidesway and for moments not causing sidesway. Also the moment magnification factors in the major and minor directions can be different.

The moment magnification factors for moments causing sidesway, δ_{sx} and δ_{sy}, can be taken as 1.0 if a P-Delta analysis is carried out [13]. **The program assumes a P-Delta analysis has been made in ETABS and δ_{sx} and δ_{sy} are taken as 1.0.** The user is reminded of the special analysis requirements especially those related to the value of EI used in analysis. (See Sections 10.10.1 and R10.10.1 of References [2 & 3].) If the program assumptions are not valid for a particular member the user can explicitly specify values of δ_{sx} and δ_{sy}.

The moment magnification factors for moments not causing sidesway associated with the major or minor direction of the column is given by

$$\delta_b = \frac{C_m}{1 - \dfrac{P_u}{\varphi P_c}} \qquad \text{(ACI 10.11.5.1 \& 10.11.7)}$$

$$\text{where } P_c = \frac{\pi^2 EI}{(KL)^2} \text{ with } K = 1.0$$

and EI associated with a particular column direction given by the larger of:

$$EI = \frac{\dfrac{E_c I_g}{5} + E_s I_{se}}{1 + \beta_d} \qquad \text{(ACI 10.11.5.2)}$$

$$\text{or } EI = \frac{E_c I_g}{2.5\,(1 + \beta_d)}$$

See Figure III-1 for definition of β_d

$$\text{and } C_m = 0.6 + 0.4\,\frac{M_1}{M_2} \text{ but not less than } 0.4$$

M_1 and M_2 are the moments at the ends of the column and M_2 is numerically larger than M_1.

The magnification factor, δ_b, must be a positive number greater than one. Therefore P_u must be less than φP_c. If P_u is found to be greater than or equal to φP_c, a failure condition is declared.

The above calculations use the unsupported length of the column.

This section outlines the procedures used for the determination of the unsupported lengths of the column elements.

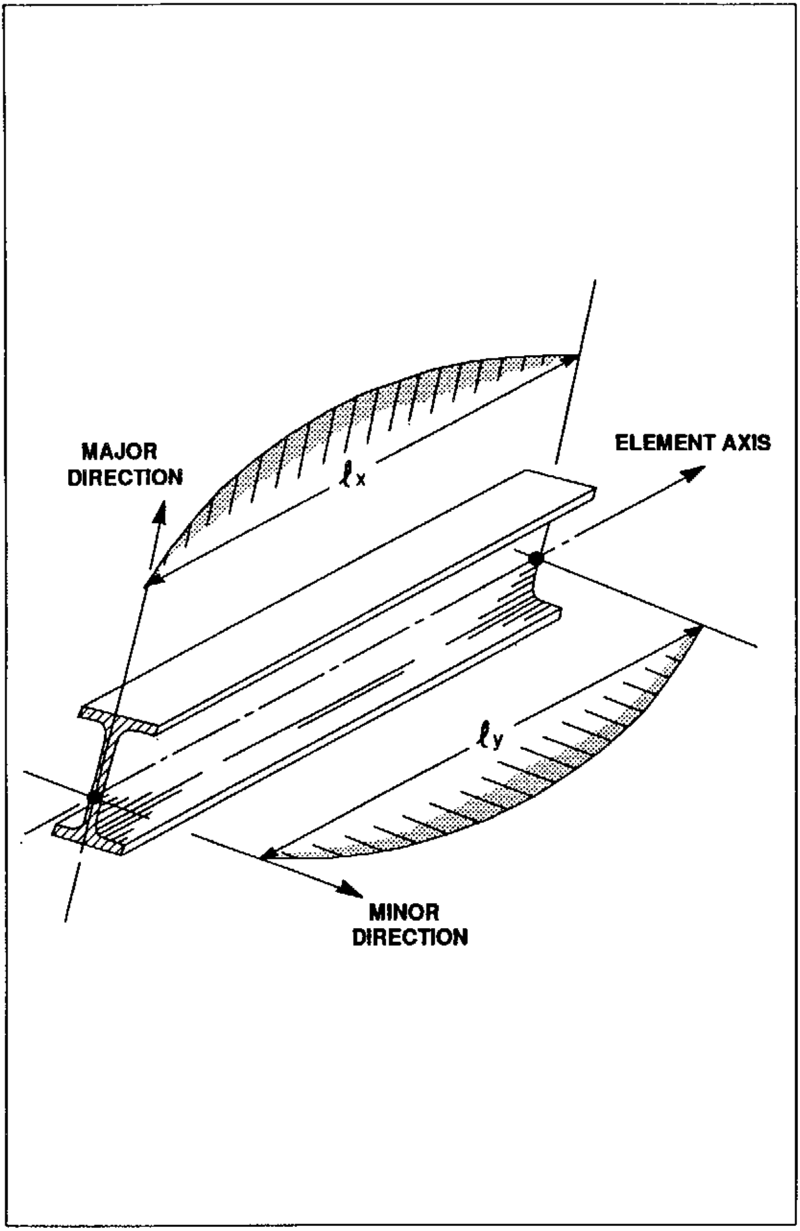
The two unsupported lengths are l_x and l_y, corresponding to instability in the major and minor directions of the element, respectively. See Figure III-6.

These are the lengths between the support points of the element in the corresponding directions.

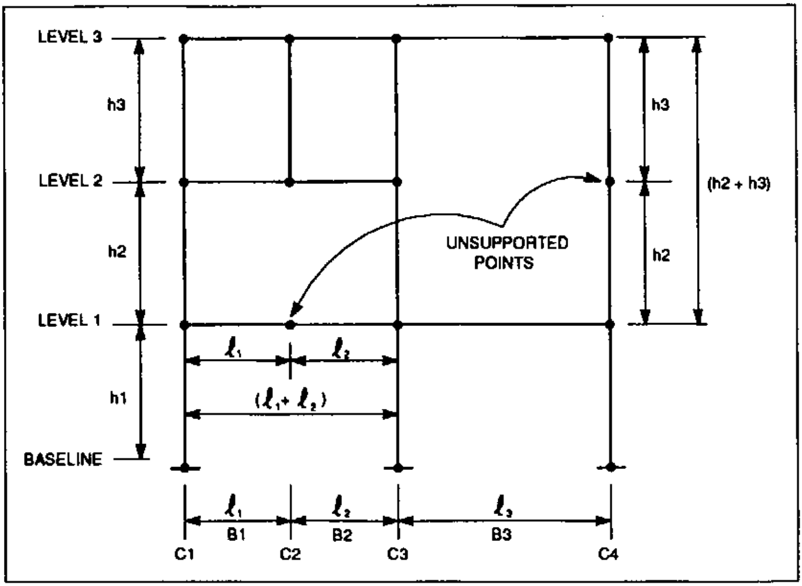
For column elements, the program will actually travel past any unsupported ends of the elements to automatically locate the element support point, and evaluate the corresponding unsupported element length.

Therefore, the unsupported length of a column may actually be evaluated as being greater than the corresponding story height. As shown in Figure III-7 the unsupported length for the column at column line 4 at level 3 will not be h_3, but $(h_2 + h_3)$.

Therefore, in determining the values for l_x and l_y for the column elements, the program recognizes various aspects of the structure that have an effect on these lengths, such as member connectivity and diaphragm disconnections as described in this section.



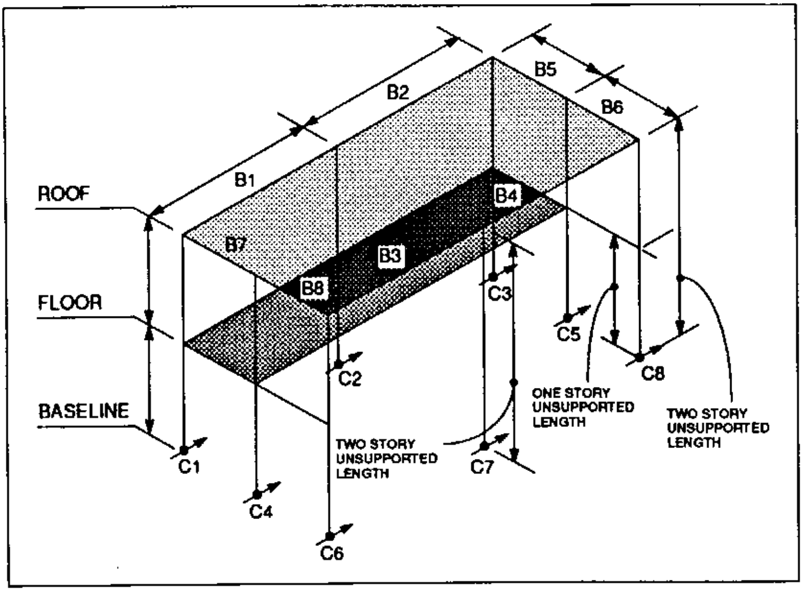
Element Unsupported Lengths
Figure III-6



Tracing Unsupported Element Lengths
Figure III-7

Typically for columns, all floor diaphragms are assumed to be lateral support points, therefore, the unsupported length of a column is equal to the story height associated with the level. However, if a column is disconnected from any level, the unsupported lengths of the column are automatically recognized as being longer as a lateral support point is eliminated.

The program also recognizes that the columns can have different unsupported lengths corresponding to the major and minor directions. For example, beams framing into disconnected column points in the column major or minor directions will give lateral support in the corresponding directions. However, if a beam frames into only one direction of the column at the level where the column has been disconnected from the diaphragm, the beam is assumed to give lateral support only in that direction. As shown in Figure III-8, column line C8 laterally spans two stories in the column major direction and only spans one



Conditions Affecting Unsupported Lengths
Figure III-8

story in the column minor direction. Column line C1 is laterally supported at both levels in both directions and column line C7 is laterally unsupported for two levels in both directions.

In all such situations, lateral support points and associated lateral unsupported lengths in corresponding directions are automatically recognized by the program and included in the calculation of the unsupported lengths of the columns.

c. Capacity check

Before entering the interaction diagram to check the column capacity, the moment amplification factors are applied to the factored loads to obtain P, M_x and M_y, so that:

$$P = P_u$$
$$M_x = \delta_{bx} M_{uxb} + \delta_{sx} M_{uxs}$$
$$M_y = \delta_{by} M_{uyb} + \delta_{sy} M_{uys}$$

where
P_u is the factored axial load;
M_{uxb} and M_{uyb} are factored moments in the major and minor directions caused by gravity loads (Load Conditions I, II, and III) increased if necessary such that total moments satisfy minimum eccentricity requirements;
M_{uxs} and M_{uys} are factored moments in the major and minor directions caused by lateral loads (Load Conditions A, B, Dyn-1, Dyn-2 and Dyn-3);
and
δ_{bx}, δ_{by}, δ_{sx} and δ_{sy} are moment magnification factors as calculated earlier or as specified by the user.

The point P, M_x, M_y is then placed in the interaction space as shown as Point L in Figure III-10. If the point lies within the interaction volume, the column capacity is adequate; however, if the point lies outside of the interaction volume, the column is overstressed.

As a measure of the stress condition of the column, a capacity ratio is calculated.

This ratio is achieved by plotting the point L, defined by P, M_x and M_y, and determining the location of point C. The point C is defined as the point where the line OL (if extended outwards) will intersect the failure surface. This point is determined by three-dimensional linear interpolation between the points that define the failure surface. See Figure III-10.

The capacity ratio, CR, is given by the ratio $\frac{OL}{OC}$.

If OL = OC (or CR=1) the point lies on the interaction surface and the column is stressed to capacity.

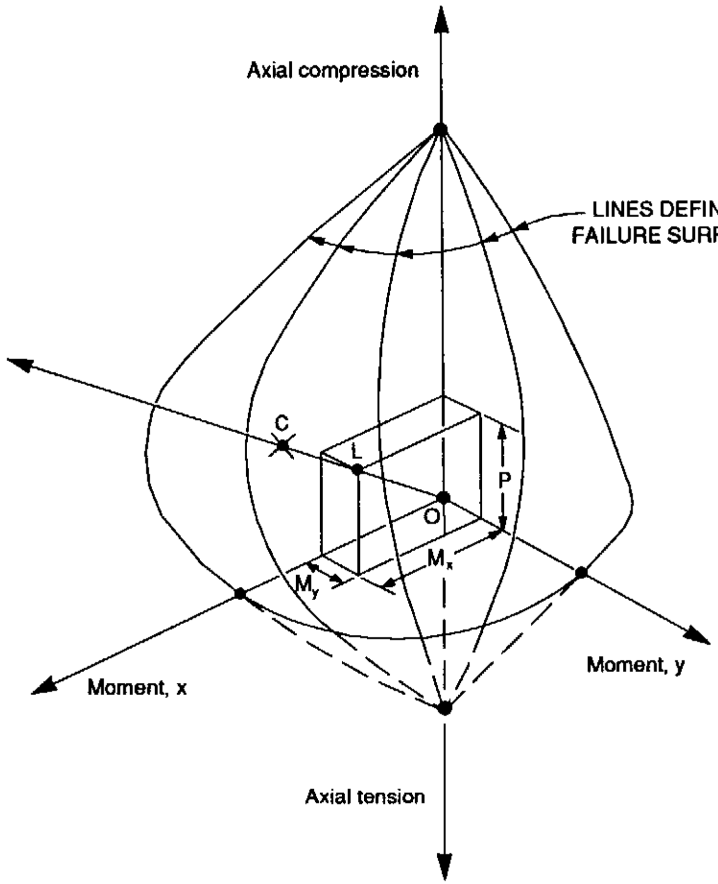
If OL < OC (or CR<1) the point lies within the interaction volume and the column capacity is adequate.

If OL > OC (or CR>1) the point lies outside the interaction volume and the column is overstressed.

The maximum of all the values of CR calculated from each load combination is reported for each end of the column along with the controlling P, M_x and M_y set and associated load combination number.

The capacity ratio is basically a factor that gives an indication of the stress condition of the column with respect to the capacity of the column.

In other words, if the axial force and biaxial moment set for which the column is being checked is divided by the reported capacity ratio, the point defined by the resulting axial force and biaxial moment set will lie on the failure (or interaction volume) surface.



Geometric Representation of the Column Capacity Ratio
Figure III-10

3. Design Column Shear Reinforcing

The shear reinforcing is designed for each loading combination in the major and minor directions of the column. In designing the shear reinforcing for a particular column for a particular loading combination due to shear forces in a particular direction, the following steps are involved:

a. Determine the factored forces acting on the section, P_u and V_u. Note that P_u is needed for the calculation of V_c.

b. Determine the shear force, V_c, that can be resisted by the concrete.

c. Calculate the reinforcing steel required to carry the balance.

The following three sections describe in detail the algorithms associated with the above-mentioned steps, a, b and c.

a. Determine section forces

In the design of the column shear reinforcing of an ordinary moment resisting concrete frame, the forces for a particular load combination, namely, the column axial force, P_u, and the column shear force, V_u, in a particular direction are obtained by factoring the ETABS analysis load conditions with the corresponding load combination factors.

In the shear design of special and intermediate moment resisting frames (seismic design) additional checks are required.

In the design of intermediate moment resisting concrete frames, the shear force V_u in a particular direction is also calculated from the moment capacities of the column associated with the factored axial force acting on the column. For each load combination, the factored axial load P_u is calculated, using the

ETABS analysis load conditions and the corresponding load combination factors.

Then, the moment capacity M_u of the column in a particular direction under the influence of the axial force P_u is calculated, using the uniaxial interaction diagram in the corresponding direction as shown in Figure III-11. The shear force V_u is then calculated as:

$$V_u = \frac{\sum M_u}{H}$$

where
H = the clear height of the column and
$\sum M_u$ is the sum of top and bottom moment capacities.

It should be noted that the program will calculate a column unsupported height that is larger than the story height, if column line disconnects are present. In order to prevent inconsistency, it is strongly recommended that the column section properties between support points of the column be kept constant.

Other values required to be checked for Intermediate moment resisting frames are based on the specified load factors except the earthquake loads are doubled. (The program doubles the factors for Load Conditions A, B, Dyn-1, Dyn-2 and Dyn-3 in the combinations.)

In the design of special moment resisting frames, the force V_u in a particular direction is also calculated from the probable moment capacities of the beams that frame into the column (ACI 21.7.1.2). The probable moment capacities are based on the steel yield overstrength factor, α, and the use of φ of 1.0. To obtain the column shear from the beam moments, the program first calculates column shear for columns above and below a joint (bottom shear for column above and top shear for column below), assuming point of contraflexure in the columns at mid heights. See Figure III-16. Since the top and bottom shear so computed could differ in value, an average of the two is used in design.

The minimum P_u from among the factored loads is used in conjunction with the above V_u.

This completes the required design force set, P_u and V_u.

b. Determine the concrete shear capacity

Given the design force set P_u and V_u, the shear force carried by the concrete, V_c, is calculated as follows:

(i) If the column is subjected to axial compression, P_u is positive, (ACI 11.3.1.2)

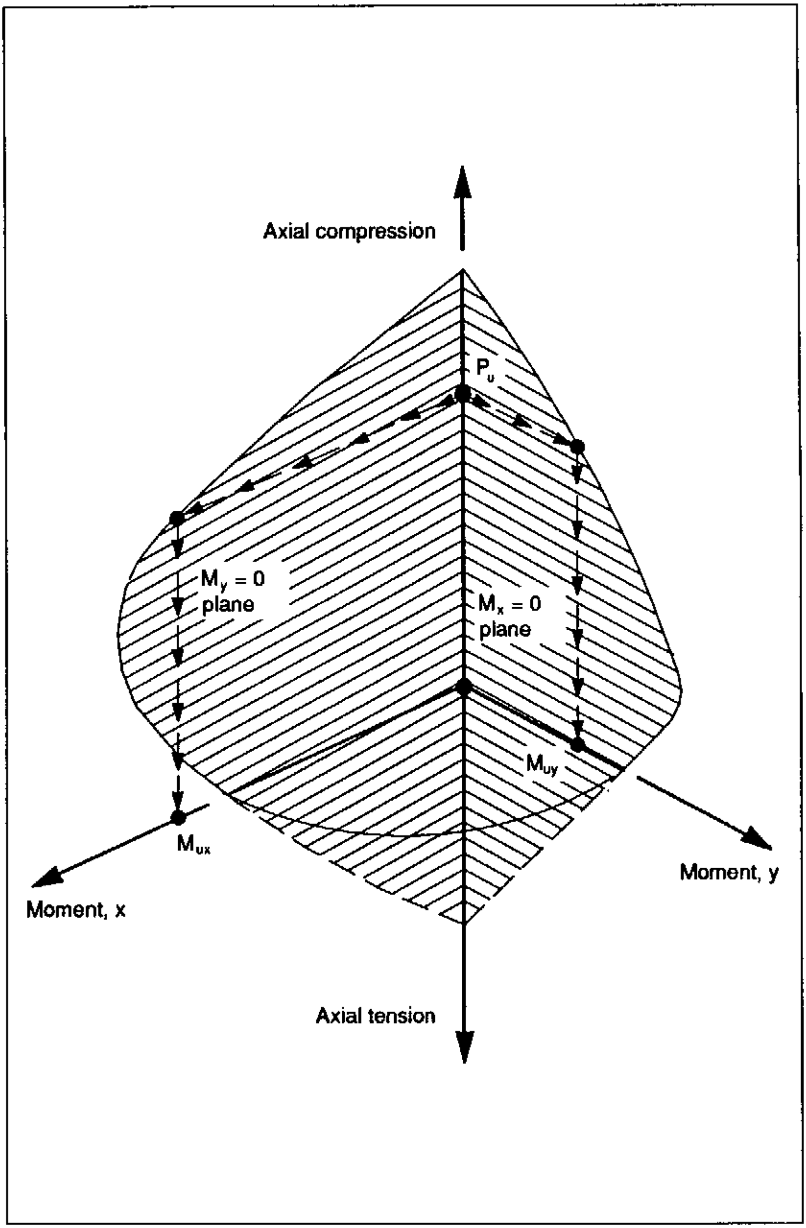
$$V_c = 2\sqrt{f'_c}\left(1 + \frac{P_u}{2000A_g}\right)A_{cv}$$

where V_c may not be greater than

$$V_c = 3.5\sqrt{f'_c}\sqrt{\left(1 + \frac{P_u}{500A_g}\right)}\,A_{cv}$$

(ii) If the column is subjected to axial tension, P_u is negative, (ACI 11.3.2.3)

$$V_c = 2\sqrt{f'_c}\left(1 + \frac{P_u}{500A_g}\right)A_{cv} \geq 0$$



Moment Capacity, M_u, at a Given Axial Load, P_u
Figure III-11

The term $\frac{P_u}{A_g}$ must have psi units.

See Figure III-12 for A_{cv}.

For special moment resisting frame concrete design, V_c is set to zero if $P_u < 0.05 f'_c A_g$ (ACI 21.7.2.1).

c. Determine the required shear reinforcing

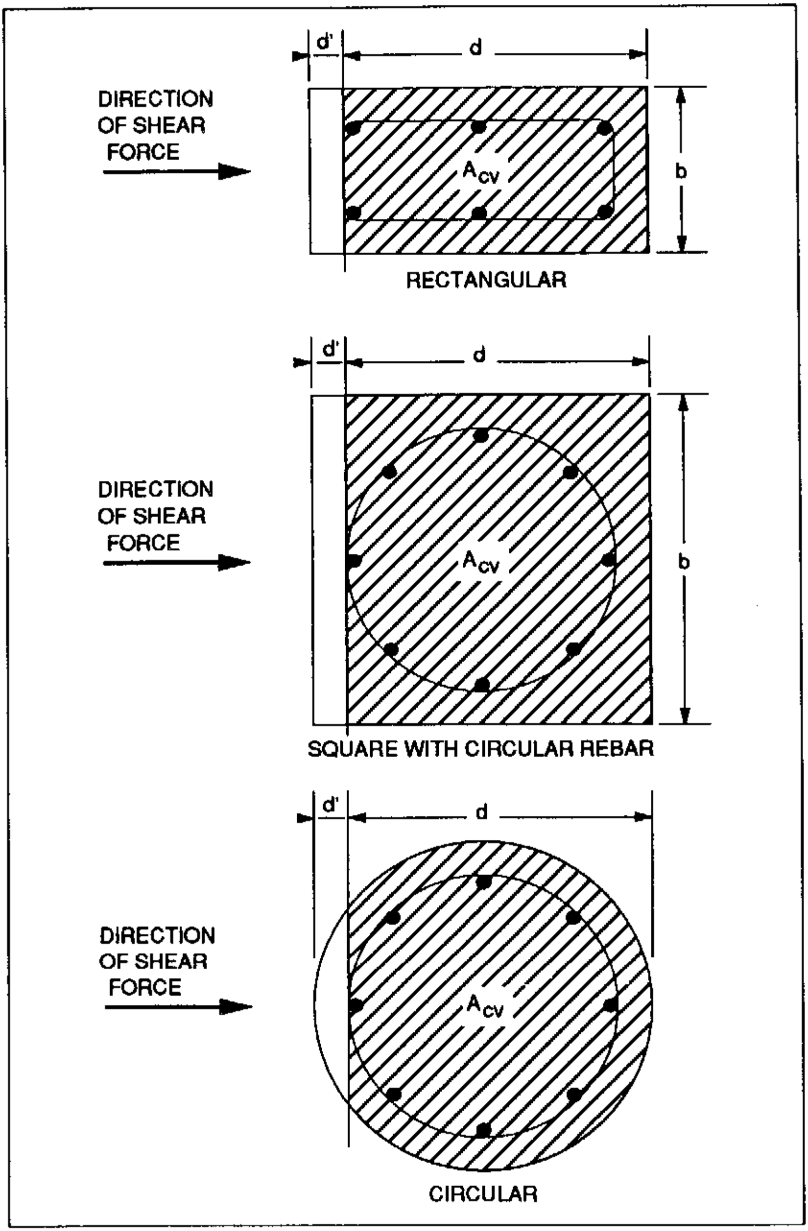
Given V_u and V_c, the required shear reinforcing in area/unit length (e.g. square inches/foot) is given by

$$A_v = \frac{\frac{V_u}{\varphi} - V_c}{f_{ys}\, d} \qquad \text{(ACI 11.5.6.8)}$$

where $\frac{V_u}{\varphi} - V_c$ must not exceed $8\sqrt{f'_c}\, A_{cv}$

where φ, the strength reduction factor, is 0.85 (ACI 9.3.2.3). The maximum of all the calculated A_v values obtained from each load combination are reported for the major and minor directions of the column along with the controlling shear force and associated load condition number.

The column shear reinforcing requirements reported by the program are based purely upon shear strength consideration. Any minimum stirrup requirements to satisfy spacing considerations or transverse reinforcing volumetric considerations must be investigated independently of the program by the user.



Shear Stress Area, Acv
Figure III-12

C. BEAM DESIGN

In the design of concrete beams, the CONKER program will calculate and report the required areas of steel for flexure and shear based upon the beam moments and shears, load combination factors and other criteria described below. The reinforcing requirements are calculated at five stations along the beam span.

All the beams are only designed for major direction flexure and shear. Effects due to any axial forces minor direction bending and torsion that may exist in the beams (e.g. due to column disconnections) must be investigated independently of the program by the user.

The beam design procedure involves the following steps:

1. Design Beam Flexural Reinforcing
2. Design Beam Shear Reinforcing

1. Design Beam Flexural Reinforcing

The beam top and bottom flexural steel is designed at five stations along the beam span, namely END I, 1/4-PT, MIDDLE, 3/4-PT and END J.

In designing the flexural reinforcing for a particular beam for a particular section, for the beam major moment, the following steps are involved:

a. Determine the maximum factored moments
b. Determine the reinforcing steel

a. Determine the factored moments

In the design of flexural reinforcing of special, intermediate or ordinary moment resisting concrete frame beams, the factored moments for each load combination at a particular beam station are obtained by factoring the ETABS analysis load conditions with the corresponding load factors.

The beam section is then designed for the maximum positive M_u^+ and maximum negative M_u^- factored moments obtained from all of the load combinations.

Negative beam moments produce top steel. In such cases the beam is always designed as a rectangular section.

Positive beam moments produce bottom steel. In such cases the beam may be designed as a rectangular section, or T-Beam effects may be included.

b. Determine the required flexural reinforcing

In the flexural reinforcing design process, the program assumes that all sections are singly reinforced. In other words, no compression reinforcing is designed and the effects of any reinforcing in the compression zone of the beam section are neglected.

In designing for a factored negative moment, M_u (i.e. designing top steel) the depth of the compression block is given by

$$a = d - \sqrt{d^2 + \frac{2M_u}{0.85\, f'_c\, \varphi\, b}}$$

where M_u is negative in the above equations.

If $a > 0.75\ \beta_1 c_b$, a concrete compression overstress is declared (ACI 10.3.3), where

$$\beta_1 = 0.85 - 0.05\left(\frac{f'_c - 4000}{1000}\right) \qquad \text{(ACI 10.2.7.3)}$$

with a maximum of 0.85 and a minimum of 0.65, and

$$c_b = \frac{87000}{87000 + f_y}\, d$$

The area of steel is then given by

$$A_s = \frac{M_u}{\varphi\, f_y\left(d - \frac{a}{2}\right)}$$

where the value of φ in the above equation is 0.90, (ACI 9.3.2.1).

In designing for a factored positive moment, M_u, (i.e. designing bottom steel), the formulation for calculating the area of steel is exactly the same as above if the beam section is rectangular, i.e. no T-Beam data has been specified. See Figure III-13.

If the member is a T-Beam, the depth of the compression block is given by

$$a = d - \sqrt{d^2 - \frac{2M_u}{0.85 f'_c\, \varphi\, b_f}}$$

where $a < 0.75\ \beta_1\ c_b$

If $a < d_s$, the subsequent calculations for A_s are exactly as previously defined for the rectangular section design.

If a $> d_s$, calculation for A_s is in two parts. The first part is for balancing the compressive force from the flange, C_f, and the second part is for balancing the compressive force from the web, C_w.

As shown in Figure III-14,

$$C_f = 0.85\, f'_c\, (b_f - b_w)\, d_s$$

Therefore $A_{s1} = \dfrac{C_f}{f_y}$

and the portion of M_u that is resisted by the flange is given by

$$M_{uf} = C_f \left(d - \frac{d_s}{2} \right) \varphi$$

Therefore, the balance of the moment, M_u to be carried by the web is given by

$$M_{uw} = M_u - M_{uf}$$

The web is a rectangular section of dimensions b_w and d, for which the depth of the compression block is recalculated as

$$a_1 = d - \sqrt{d^2 - \frac{2M_{uw}}{0.85\, f'_c\, \varphi\, b_w}}$$

where $a_1 \leq 0.75\ \beta_1 c_b$

from which the second part of the reinforcing is calculated, giving

$$A_{s2} = \frac{M_{uw}}{\varphi\, f_y \left(d - \frac{a_1}{2} \right)}$$

The total required reinforcing for the T-section is then given by

$$A_s = A_{s1} + A_{s2}$$

Again, the value for φ is 0.90.

The minimum flexural steel provided in a section is given by

$$A_s\,(\text{min}) = \frac{200\, b_w\, d}{f_y} \qquad \text{(ACI 10.5.1 and 21.3.2.1)}$$

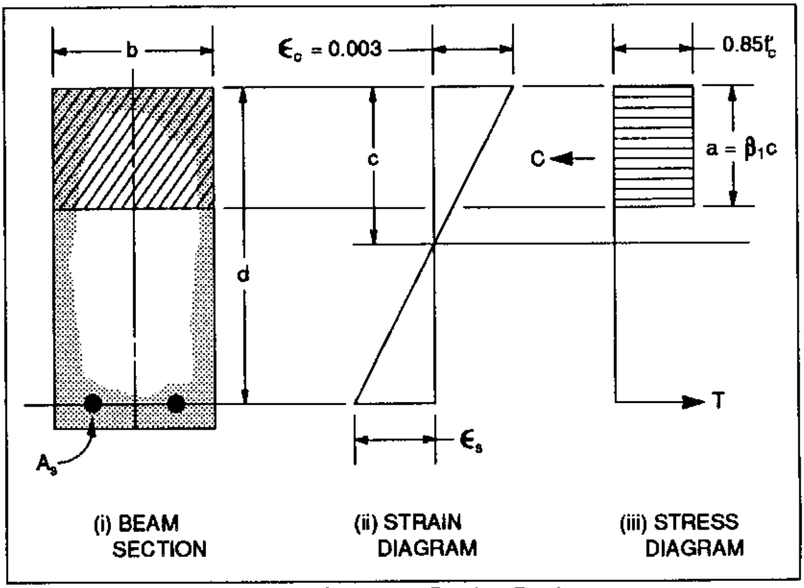
For special moment resisting concrete frames (seismic design), the beam design will satisfy the following conditions:

(i) The beam flexural steel is limited to a maximum given by

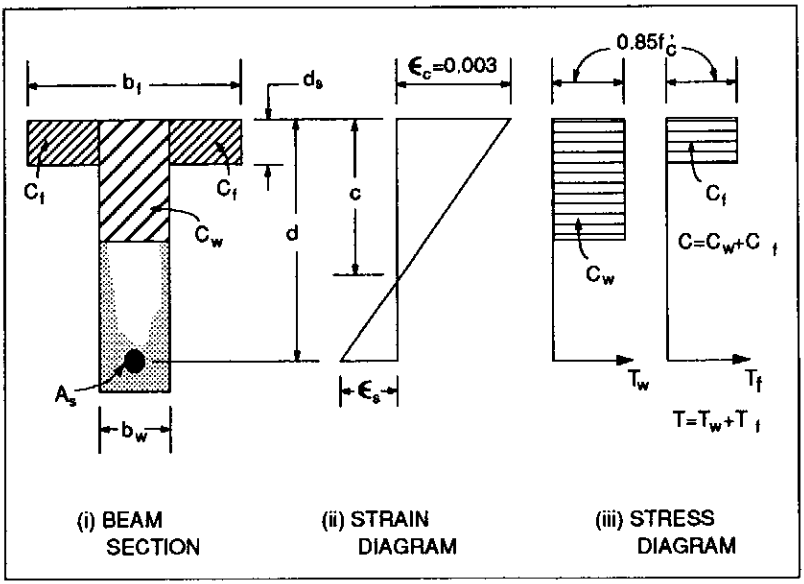
$$A_s\,(\text{max}) = 0.025\, bd \qquad \text{(ACI 21.3.2.1)}$$

(ii) At any end (support) of the beam, the beam positive moment capacity (i.e. associated with the bottom steel) will not be less than 50 percent of the beam negative moment capacity (i.e. associated with the top steel) at that end (ACI 21.3.2.2).

(iii)The negative moment capacity at any of the beam span stations will not be less than one fourth of the negative moment capacity of any of the beam end (support) stations. Similarly, the positive moment capacity of the beam span stations will not be less than one fourth of the positive moment capacity of any of the beam end (support) stations, (ACI 21.3.2.2).



Rectangular Beam Section Design
Figure III-13



T-beam Section Design
Figure III-14

For intermediate moment resisting concrete frames (seismic design), the beam design will satisfy the following conditions:

i) At any support of the beam, the beam positive moment capacity will not be less than 1/3rd of the beam negative moment capacity at that end (ACI 21.9.4.1).

ii) The negative moment capacity at any of the beam span stations will not be less than 1/5th of the negative moment capacity of any beam support stations. Similarly, the positive moment capacity of the beam span stations will not be less than 1/5th of the positive moment capacity of any of the beam support stations (ACI 21.9.4.1.).

2. Design Beam Shear Reinforcing

The shear reinforcing is designed for each loading combination at five stations along the beam span, namely END I, 1/4-PT, MIDDLE, 3/4-PT and END J.

In designing the shear reinforcing for a particular beam for a particular loading combination at a particular station due to the beam major shear, the following steps are involved:

a. Determine the factored shear force, V_u.

b. Determine the shear force, V_c, that can be resisted by the concrete.

c. Determine the reinforcing steel required to carry the balance.

The following three sections describe in detail the algorithms associated with the above-mentioned steps a, b and c.

a. Determine the shear force and moment

In the design of the beam shear reinforcing of an ordinary moment resisting concrete frame, the shear forces and moments for a particular load combination at a particular beam station are obtained by factoring the ETABS analysis load conditions with the corresponding load combination factors, to get the factored design shear V_u.

In the design of special and intermediate moment resisting concrete frames (seismic design), however, the shear force V_u is calculated from the moment capacities of each end of the beam and the gravity shear forces.

Therefore, for each load combination, at every beam station, the gravity beam shear force is calculated using only the ETABS analysis load conditions I, II and III to give unfactored V_{D+L}, for UBC code. However, for ACI code, the factored gravity loads are used to obtain V_{D+L}.

The design shear force V_u is then given by

$$V_p + V_{D+L} \qquad \text{(ACI 21.7.1.1)}$$

where V_P is the shear force obtained by applying the calculated ultimate moment capacities of the beams, acting in opposite directions, at the corresponding ends of the beams.

Therefore, V_P is the maximum of V_{P_1} and V_{P_2}

where $$V_{P_1} = \frac{M_I^- + M_J^+}{L}$$

and $$V_{P_2} = \frac{M_I^+ + M_J^-}{L}$$

where

M_I^-	=	Moment capacity at end I, with top steel in tension, using a steel yield stress value of α f_y and no φ factors.
M_J^+	=	Moment capacity at end J, with bottom steel in tension, using a steel yield stress value of α f_y and no φ factors.
M_I^+	=	Moment capacity at end I, with bottom steel in tension, using a steel yield stress value of α f_y and no φ factors.
M_J^-	=	Moment capacity at end J, with top steel in tension, using a steel yield stress value of α f_y and no φ factors.
L	=	Clear span of beam.

The overstrength factor α is always taken as 1.0 for intermediate moment resisting frames. For special moment resisting frames α is taken as 1.25, but the user has the option of overwriting this value.

It should be noted that the clear span of the beam is calculated by the program as the distance between actual beam support points (i.e. bypassing zero column lines) and may be longer than the bay length of the beam element. See Figure III-7. Similarly, the moment capacities M_I^-, M_J^+, M_I^+, and M_J^-, are evaluated at actual support points for the beam.

For intermediate moment resisting frames, an additional design shear force is calculated based on the specified load factors except the earthquake loads are doubled. (The program doubles the factors for Load Conditions A, B, Dyn-1, Dyn-2 and Dyn-3 in the combinations.)

b. Determine the concrete shear capacity

The allowable concrete shear capacity is given by

$$V_c = 2.0\sqrt{f'_c}\, b_w d \qquad \text{(ACI 11.3.1.1)}$$

For special moment resisting frames, V_c is set to zero if $V_p > 0.5\ V_u$ (ACI 21.7.2.1).

c. Determine the required shear reinforcing

Given V_u and V_c, the required shear reinforcing in area/unit length is calculated as

$$A_v = \frac{\dfrac{V_u}{\varphi} - V_c}{f_{ys}\ d}$$

$$\left(\frac{V_u}{\varphi} - V_c\right) \text{ must not exceed } 8\sqrt{f'_c}\, bd \qquad \text{(ACI 11.5.6.8).}$$

where φ, the strength reduction factor, is 0.85, (ACI 9.3.2.3). The maximum of all the calculated A_v values, obtained from each load combination for each location, are reported along with the controlling shear force and associated load condition number.

The beam shear reinforcing requirements reported by the program are based purely upon shear strength considerations. Any minimum stirrup requirements to satisfy spacing considerations must be investigated independently of the program by the user.

D. JOINT DESIGN

To ensure that the beam-column joint of special moment resisting frames possesses adequate shear strength, the program performs a rational analysis of the beam-column panel zone to determine the shear forces that are generated in the joint. The program then checks this against allowable shear stress.

Only joints having a column below the joint are designed.

The material properties of the joint are assumed to be the same as those of the column below the joint.

The joint analysis is done in the major and the minor directions of the column. The joint design procedure involves the following steps:

a. Determine the panel zone design shear force V_u^h

b. Determine the effective area of the joint

c. Check panel zone shear stress

The following three sections describe in detail the algorithms associated with the above mentioned steps, a, b and c.

a. Determine the panel zone shear force

For a particular column direction, major or minor, the free body stress condition of a typical beam-column intersection is shown in Figure III-15.

The force V_u^h is the horizontal panel zone shear force that is to be calculated.

The forces that act on the joint are P_u, V_u, M_u^L and M_u^R. The forces P_u and V_u are axial force and shear force, respectively, from the column framing into the top of the joint. The moments M_u^L and M_u^R are obtained from the beams framing into the joint. The joint shear force V_u^h is calculated by resolving the moments into C and T forces.

The location of C or T forces is determined by the direction of the moment using basic principles of ultimate strength theory, see Figures III-13 and III-14.

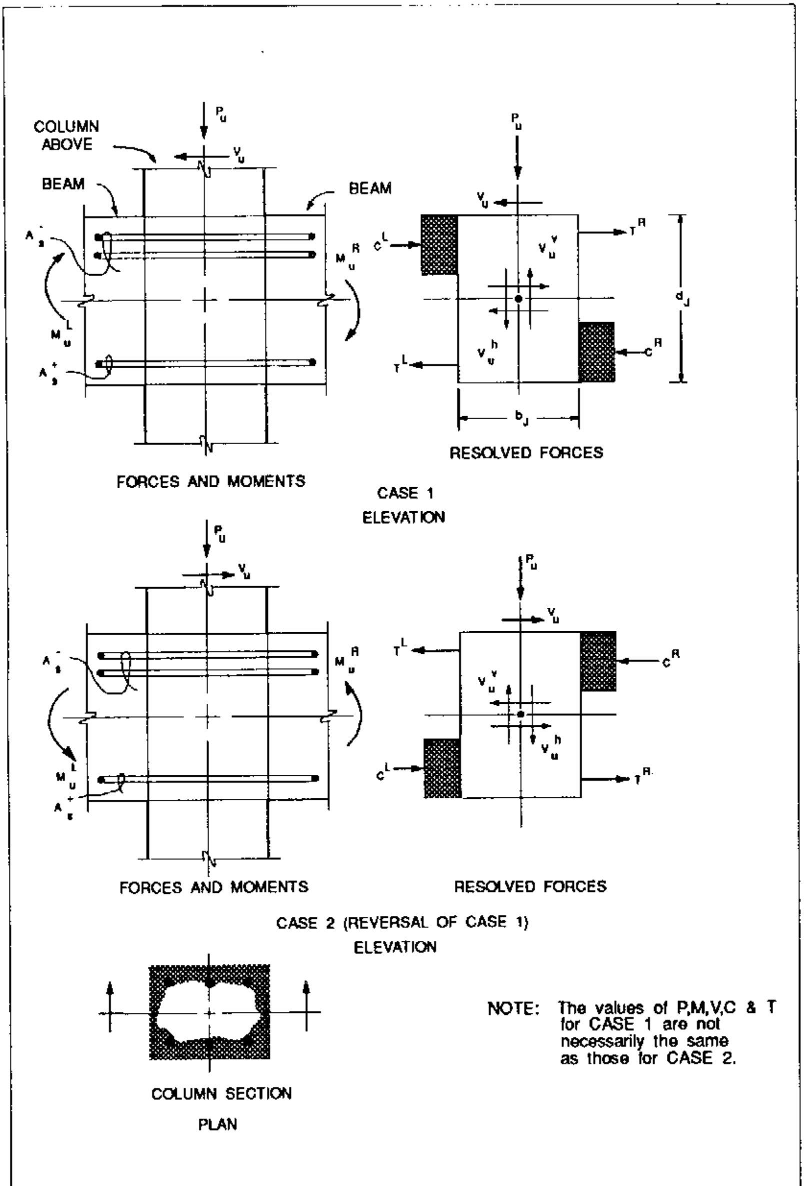
Noting that $T_L = C_L$ and $T_R = C_R$,

$$V_u^h = T_L + T_R - V_u$$

The moments and the C and T forces from beams that frame into the joint in a direction that is not parallel to the major or minor directions of the column are resolved along the direction that is being investigated, thereby contributing force components to the analysis.

In the design of special moment resisting concrete frames, the evaluation of the design shear force is based upon the moment capacities, (with reinforcing steel overstrength factor, α, and no φ factors) of the beams framing into the joint, (ACI 21.6.1.1). The C and T forces are based upon these moment capacities. The column shear force V_u is calculated from the beam moment capacities as follows:

$$V_u = \frac{M_u^L + M_u^R}{H}$$



Beam-Column Joint Analysis
Figure III-15

See Figure III-16.

It should be noted that the points of inflection shown on Figure III-16 are taken as midway between actual lateral support points for the columns, i.e. considering any column line disconnections.

The effects of load reversals, as illustrated in Case 1 and Case 2 of Figure III-15 are investigated and the design is based upon the maximum of the joint shears obtained from the two cases.

b. Determine the effective area of joint

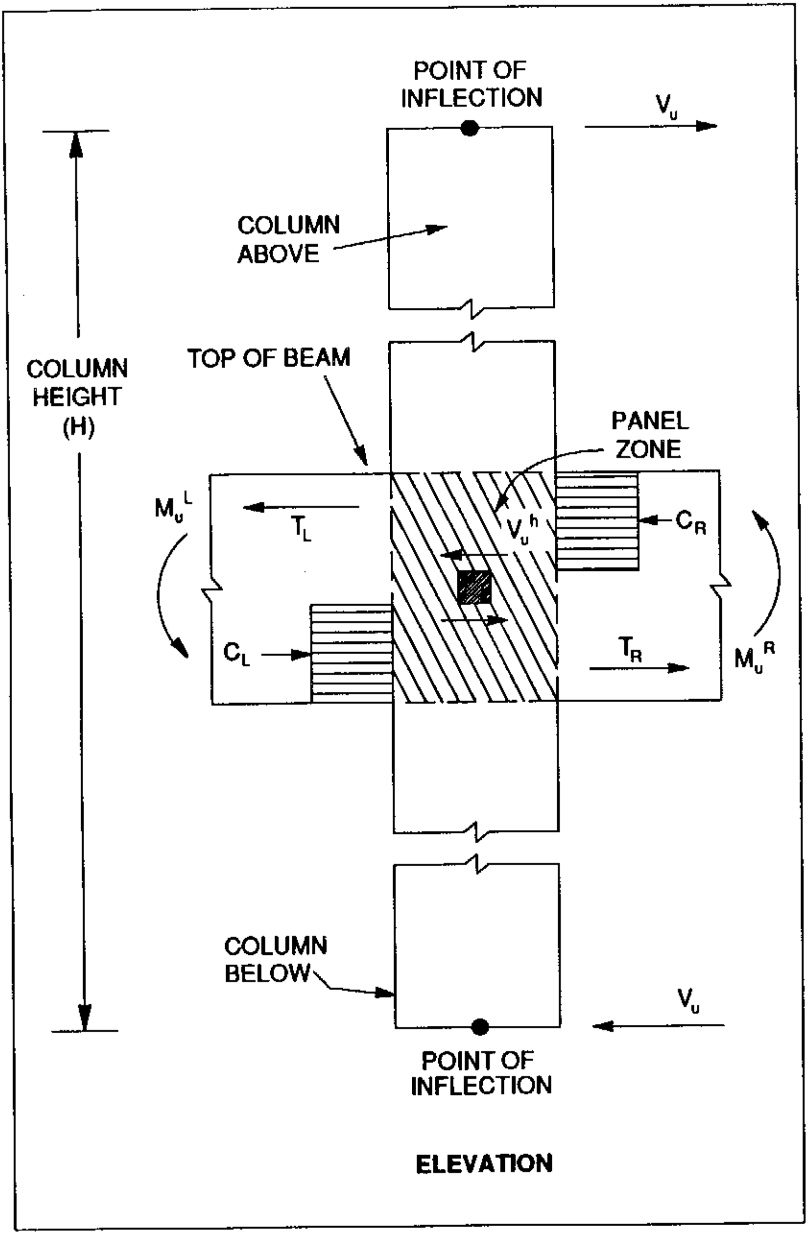
The joint area that resists the shear forces is assummed always to be rectangular. The dimensions of the rectangle correspond to the major and minor dimensions of the column below the joint, except that if the beam framing into the joint is very narrow, the width of the joint is limited to the depth of the joint plus the width of the beam. The area of the joint is assumed not to exceed the area of the column below.

It should be noted that if the beam frames into the joint eccentrically, the above assumptions may be unconservative and the user should investigate the acceptability of the particular joint.

c. Check panel zone shear stress

The panel zone shear stress is evaluated by dividing the shear force V_u^h by the effective area of the joint and comparing it with the following allowables: (ACI 21.6.3)

For joints confined on all four faces $20\,\varphi\sqrt{f'_c}$



Column Shear Force, V_u
Figure III-16

For joints confined on three faces or on two opposite faces	$15\ \varphi \sqrt{f'_c}$
For all other joints	$12\ \varphi \sqrt{f'_c}$

Where $\varphi = 0.85$.

For joint design, the program reports the joint shear, the joint shear stress, the allowable joint shear stress and a capacity ratio.

E. BEAM/COLUMN FLEXURAL CAPACITY RATIOS

At a particular joint for a particular column direction, major or minor, the program will calculate the ratio of the sum of the beam moment capacities to the sum of the column moment capacities, (ACI 21.4.2). The capacities are calculated with no reinforcing overstrength factor, α, and including φ factors.

The beam capacities are calculated for reversed situations (Cases 1 and 2) as illustrated in Figure III-15 and the maximum summation obtained is used.

The moment capacities of beams that frame into the joint in a direction that is not parallel to the major or minor direction of the column are resolved along the direction that is being investigated and the resolved components are added to the summation.

The column capacity summation includes the column above and the column below the joint. For each load combination the axial force, P_u, in each of the columns is calculated from the ETABS analysis load conditions and the corresponding load combination factors. For each load combination, the moment capacity of each column under the influence of the corresponding axial load P_u is then determined for the major and minor directions of the column, using the uniaxial column interaction diagram, see Figure III-11. The moment capacities of the two columns are added to give the capacity summation for the corresponding load combination. The minimum capacity summations obtained from all of the load combinations is used for the beam/column capacity ratio.

The beam/column flexural capacity ratios are only reported for special moment resisting frames (seismic design).

F. CANADIAN CODE differences

Design criteria/algorithms for Canadian standards CAN-A23.3-M84 are the same as ACI-318-89 except for the following modified formulas (expressed in millimeter-Newton units).

1. φ Factors

φ factors are material dependent and are defined as

$$\varphi_c = 0.60 \text{ for concrete} \qquad \text{(CAN 9.3.2)}$$

$$\varphi_s = 0.85 \text{ for steel} \qquad \text{(CAN 9.3.3)}$$

2. Column Design

(i) Maximum factored axial load resistance

for tied columns

$$P_{max} = 0.80\,[0.85\,\varphi_c\,f'_c\,(A_g - A_s) + \varphi_s\,f_y\,A_s] \qquad \text{(CAN 10.3.5.3)}$$

and for columns with spiral reinforcement

$$P_{max} = 0.85\,[0.85\,\varphi_c\,f'_c\,(A_g - A_s) + \varphi_s\,f_y\,A_s]$$

(CAN 10.3.5.2)

(ii) Moment magnification factors

$$\delta_b = \frac{C_m}{1 - \dfrac{P_u}{\varphi_m\,P_c}} \qquad \text{(CAN 10.11.6.1)}$$

where $\varphi_m = 0.65$ and EI (to be used in the calculation of P_c) is given as

$$EI = \frac{0.2\,E_c\,I_g + E_s\,I_{se}}{1 + \beta_d} \qquad \text{(CAN 10.11.6.2)}$$

or $EI = 0.25\,E_c\,I_g$

and $$\beta_d = \frac{\text{Max. factored dead load moment}}{\text{Max. factored total load moment}}$$

(iii)Shear

For axial compression, P_u is positive and

$$V_c = 0.2\,\varphi_c\,\sqrt{f'_c}\left(1 + 3\,\frac{P_u}{A_g\,f'_c}\right)b_w\,d$$

(CAN 11.3.4.3)

For axial tension, P_u is negative and

$$V_c = 0.2\,\varphi_c\,\sqrt{f'_c}\left(1 + \frac{P_u}{0.6\,\varphi_c\,\sqrt{f'_c}\,A_g}\right)b_w\,d$$

(CAN 11.3.4.2)

The shear in the reinforcing, V_s, is not to exceed

$$0.8\,\varphi_c\,\sqrt{f'_c}\,b_w\,d$$

3. Beam Design

(i) Flexure

The depth of the compression block for a rectangular beam is computed as

$$a = d - \sqrt{d^2 - \frac{2\,M_u}{0.85\,f'_c\,\varphi_c\,b}}$$

$$a > \beta_1\,c_b$$

where

$$\beta_1 = 0.85 - \frac{0.08\,(f'_c - 30)}{10} \qquad \text{(CAN 10.2.7.C)}$$

$$(0.65 \le \beta_1 \le 0.85)$$

and

$$c_b = \frac{600}{600 + f_y}\,d \qquad \text{(CAN 10.3.3)}$$

The area of steel is then given by

$$A_s = \frac{M_u}{\varphi_s f_y (d - \frac{a}{2})}$$

For a T-beam

$$a = d - \sqrt{d^2 - \frac{2M_u}{0.85 f'_c \varphi_c b_f}}$$

If $a < d_s$ (see Figure III-14) calculations for A_s are exactly as previously defined for the rectangular section design.

If $a > d_s$, then A_{s1} (area of steel to balance compressive force from flange) and A_{s2} (area of steel to balance compressive force from web) are defined as

$$A_{s1} = \frac{C_f}{\varphi_s f_y}$$

$$A_{s2} = \frac{M_{uw}}{\varphi_s f_y \left(d - \frac{a_1}{2}\right)}$$

where

$$A_s = A_{s1} + A_{s2}$$

$$C_f = 0.85 f'_c \varphi_c (b_f - b_w) d_s$$

$$M_{uf} = C_f (d - \frac{d_s}{2})$$

$$M_{uw} = M_u - M_{uf}$$

$$a_1 = d - \sqrt{d^2 - \frac{2\,M_{uw}}{0.85\,f'_c\,\varphi_c\,b_w}}$$

where

$$a_1 \leq \beta_1\,c_b$$

and

$$A_{s_{min}} = \frac{1.4\,b_w\,d}{f_y} \qquad \text{(CAN 10.5.1)}$$

(ii) Shear

$$V_c = 0.2\,\varphi_c\,\sqrt{f'_c}\,bd \qquad \text{(CAN 11.3.4.1)}$$

and

$$V_s < 0.8\,\varphi_c\,\sqrt{f'_c}\,bd \qquad \text{(CAN 11.3.6.6)}$$

4. Special Moment Resisting Frames
(ductile moment resisting frames)

For ductile moment resisting frames, the following conditions should be satisfied

(i) Columns

Column moments $\geq$ 1.1 Beam moments
$V_c = 0$ if $P_u \leq 0.10\,f'_c\,A_g$

(ii) Beams

$V_c = 0$ if $P_u \leq 0.10\,f'_c\,A_g$

(iii) Joints

The allowable panel zone shear stress is evaluated as follows

for confined joints

$$2.4\ \varphi_c \sqrt{f'_c} \qquad \text{(CAN 21.6.4.1a)}$$

for unconfined joints

$$1.8\ \varphi_c \sqrt{f'_c} \qquad \text{(CAN 21.6.4.1b)}$$

5. Intermediate Moment Resisting Frames
(frames requiring nominal ductility)

Same as ACI-318-89 except that special load combinations requiring factored shear forces with twice the earthquake loads are not checked.

Type of Check/Design	Ordinary Moment Resisting Space Frames (non-Seismic)	Intermediate Moment Resisting Space Frames (Seismic)	Special Moment Resisting Space Frames (Seismic)
Column Check (Interaction)	NLD Combinations Only	NLD Combinations Only	NLD Combinations Only
Column Design (Interaction)	NLD Combinations Only $1\% < \rho < 8\%$	NLD Combinations Only $1\% < \rho < 8\%$	NLD Combinations and 6/5‡ Beam Capacity $\alpha = 1.0$ $1\% < \rho < 6\%$
Column Shears	NLD Combinations	1. Modified NLD Combinations (earthquake loads doubled)‡ 2. Column Capacity $\varphi = 1.0$ and $\alpha = 1.0$	NLD Combinations and Beam Capacity $\varphi = 1.0$ and $\alpha = 1.25$
Beam Design Flexure	NLD Combinations	NLD Combinations	NLD Combinations $\rho_{max} \leq 0.025$
Beam Min. Moment Override Check	No Requirement	$M^+_{u_{END}} \geq \frac{1}{3} M^-_{u_{END}}$ $M^+_{u_{SPAN}} \geq \frac{1}{5} M^+_{u_{END}}$ $M^-_{u_{SPAN}} \geq \frac{1}{5} M^-_{u_{END}}$	$M^+_{u_{END}} \geq \frac{1}{2} M^-_{u_{END}}$ $M^+_{u_{SPAN}} \geq \frac{1}{4} M^+_{u_{END}}$ $M^-_{u_{SPAN}} \geq \frac{1}{4} M^-_{u_{END}}$

‡ The values are different for Canadian Code CAN-A23.3-M84. See Section F for differences.

Design Criteria Table
Figure III-17

Type of Check/Design	Ordinary Moment Resisting Space Frames (non-Seismic)	Intermediate Moment Resisting Space Frames (Seismic)	Special Moment Resisting Space Frames (Seismic)
Beam Design Shear	NLD Combinations	1. Modified NLD Combinations (Earthquake loads doubled)‡ 2. Beam Capacity Shear (Vp) with $\alpha = 1.0$ and $\varphi = 1.0$ plus VD+L	Beam Capacity Shear (V_p) with $\alpha = 1.25$ and $\varphi = 1.0$ plus V_{D+L}
Joint Design	No Requirement	No Requirement	Based on Beam Capacity with $\alpha = 1.25$ and $\varphi = 1.0$ No additional Reinf. allowed Joint Shear Stress compared to allowable
Beam/Column Ratios	No Requirement	No Requirement	Beam Capacity for $\alpha = 1.0$ Column Capacity based on Uniaxial Capacity under Axial Loads from NLD Combinations

‡ The values are different for Canadian Code CAN-A23.3-M84. See Section F for differences.

Design Criteria Table
Figure III-17 (continued)

IV.

INPUT DATA for PROGRAM CONKER

In order to execute the CONKER program, an ETABS postprocessing file and a CONKER input data file are required. However, if the program defaults are acceptable, the CONKER input data file is optional.

The ETABS postprocessing file contains information pertaining to the structural geometry and loading and the analytical results from the corresponding ETABS analysis. This file forms the interface between ETABS and the CONKER postprocessor. Only those elements with material properties of C (concrete frame) will be processed by CONKER.

The sequence of data lines described herein will establish the data file required by CONKER.

The user must read and understand the contents of Chapter III before proceeding with the data preparation described in this section.

The user should also be thoroughly familiar with the CONKER control variables described below, and with the main control variables of ETABS. Repeated references are made to these variables throughout this chapter.

A. FREE FORMAT

All input data for CONKER is prepared in free format. In other words, the data on a particular line does not have to correspond with prespecified column locations. The data is input as a string of numbers which are separated by one or more blanks. **It is important to enter all items even if they are zero; however, trailing zeros on any data line need not be input.** No data line may be more than eighty characters in length. Also, the data file should not contain spacing tab characters that are generated by some editors while preparing a data file.

B. COMMENT DATA

Any line having a $ (dollar) sign in Column 1 is treated as a comment line and ignored by the program.

The $ sign may also be used in any other column on any data line. In such cases entries to the right of the $ sign will be treated as comment data and ignored by the program. This option allows the user to effectively comment the data as it is being prepared.

C. ARITHMETIC OPERATIONS

Simple arithmetic statements are possible when entering floating point real numbers in the free format fields. The following type of operators can be used:

- \+ for addition
- – for subtraction
- / for division
- * for multiplication
- P for raising to the power of

The following are typical data entries that are possible:

```
11.92*12
7.63/386.4
3P.5
150P1.5*33
6.66-1.11*7.66/12.2
```

The operators are applied as they are encountered in the scan from left to right, so that

11.92*12 is evaluated as 11.92×12

7.63/386.4 is evaluated as $\frac{7.63}{386.4}$

3P.5 is evaluated as $3^{.5}$

150P1.5*33 is evaluated as $(150^{1.5}) \times 33$

6.66-1.11*7.66/12.2 is evaluated as $\frac{(6.66 - 1.11) \times 7.66}{12.2}$

Scientific exponential notation is also allowed. For example, the number 1.5E10 is read as 1.5×10^{10}.

D. UNITS

All input data for CONKER and the corresponding ETABS data must be prepared using either English or MKS metric or SI metric units.

If the English option is used, the input must be prepared using inch-kip-second units.

If the MKS metric option is used, the input must be prepared using meter-kilogram-second units.

If the SI metric option is used, the input must be prepared using meter-kiloNewton-second units.

This is irrespective of the fact that all the numerical techniques described in Chapter III are presented in inch-pound-second units or millimeter Newton-second units.

E. ETABS DATA PREPARATION HINTS

The design algorithms for column design in CONKER assume that a P-Delta analysis has been made in ETABS. That is, the bending moments causing sidesway do not have to be further amplified by moment magnification factors.

The ETABS program uses the **specified story masses** to calculate the P-Delta effects. A factor is also provided to increase this effect to account for factored loads and for inelastic displacements. The user should use this factor to account for factored dead and live loads due to which P-Delta effect should be accounted for in concrete design.

The CONKER program also assumes that the ETABS Load Conditions I, II and III are used for gravity loads which do not cause significant sidesway and the remaining load conditions are used for lateral loads.

If the above assumptions of the program are not correct for a particular problem, the user must provide over-riding moment magnification factors in the CONKER data.

F. DETAILED DESCRIPTION of the CONKER INPUT DATA

There are basically five data sections associated with the CONKER input. A summary of the data setup is shown in Figure IV-1. This chapter details each section and the associated data lines. A sample data file is listed in the last section of this manual.

The following is the convention used to define each data line:

First, the sequence of the entries of each data line is presented as a series of abbreviations of the options (or variables).

Each data section is then followed by a table in the form:

Variable Field Note Entry

The **Variable** is the abbreviation of the entry made on the data line.

The **Field** is a number that corresponds to the sequence in which the variable exists on the data line. Thus if a variable is the fourth entry on a data line, it will have a field number of 4.

Data Block	When Needed
1. Control Information	always
2. Load Combination Data	if **NLC** > 0
3. Material Property Redefinition Data	if **NRMP** > 0
4. Reinforced Concrete Section Property Data	
i) Column Properties	if **NRCP** > 0
ii) Beam Properties	if **NRBP** > 0
5. Frame Design Activation Data	
i) Frame Control Data	if **NFR** > 0
ii) Replaced Member Location Data	
a. Column	if **IRCP** > 0
b. Beam	if **IRBP** > 0

Typical Data Setup For CONKER
Figure IV-1

The **Note** number refers to the series of notes that exist after each corresponding data section. The notes describe the data options in more detail and give important information to aid the user in better understanding the options of the program.

The **Entry** is a brief description of the option (or entry).

1. CONTROL INFORMATION

Prepare the following data as defined in sections a, b and c below. This data is always needed. A total of 4 data lines are required.

a. Heading Data

Prepare **two** lines of data for output labeling, up to 70 characters per line. This information will appear on every page.

b. Execution Control Data

Prepare one line of data to define the program execution options in the following form:

ICODE NFR NLC LDC LLC NRMP NRCP NRBP NCRV NPTS IPRI IPHI IUNIT IEX

Note: The 14 entries shown above are to be entered on one data line in the input.

If no CONKER input file is provided, the **Heading Data** defaults to the **Heading Data** of ETABS; the **ICODE** parameter defaults to 1 (i.e. the UBC91 code for concrete);**NFR** defaults to designing all frames; **NLC** defaults to using the loading combination defaults given in Section 2 later; **LDC** defaults to 1; **LLC** defaults to 2; **NRMP**, **NRCP**, and **NRBP** all default to zero; **NCRV** defaults to 5; **NPTS** defaults to 11; **IPRI** and **IPHI** default to zero; **IUNIT** defaults to E; and **IEX** defaults to zero.

1. CONTROL INFORMATION (continued)

c. Output Control Data

Prepare one line of data to define the program map output options in the following form:

MBB MBV MCI MCV MJV MJR

1. CONTROL INFORMATION (continued)

Variable	Field	Note	Entry
ICODE	1	(1)	Code identifier = 1 UBC91 = 2 ACI 318-89 = 3 CAN3-A23.2-M84
NFR	2	(2)	Number of frames to be designed
NLC	3	(3)	Number of design loading combinations
LDC	4	(4)	ETABS load condition number that corresponds to dead load: = 1 Vertical load condition I = 2 Vertical load condition II = 3 Vertical load condition III
LLC	5	(5)	ETABS load condition number that corresponds to live load: = 1 Vertical load condition I = 2 Vertical load condition II = 3 Vertical load condition III
NRMP	6	(6,7)	Number of redefined (or new) material property types
NRCP	7	(6,8)	Number of redefined (or new) column section property types

1. CONTROL INFORMATION (continued)

Variable	Field	Note	Entry
NRBP	8	(6,9)	Number of redefined (or new) beam section property types
NCRV	9	(10)	Number of curves to be generated to define each column interaction volume diagram
NPTS	10	(11)	Number of points on each curve
IPRI	11	(12)	Interaction diagram print code: = 0 Suppress printing of interaction curves = 1 Tabulate interaction curves
IPHI	12	(13)	Strength reduction factor φ overwrite code = 0 use code values = 1 overwrite all φ's to 1.0
IUNIT	13	(14)	Type of units: = E English units = M MKS metric units = S SI metric units
IEX	14	(15)	Execution mode: = 0 Normal execution mode = 1 Data check mode

1. CONTROL INFORMATION (continued)

Variable	Field	Note	Entry
MBB	1	(16)	Flag for map of beam bending reinforcement
MBV	2	(16)	Flag for map of beam shear reinforcement
MCI	3	(16)	Flag for map of column longitudinal reinforcement and/or interaction stress ratios
MCV	4	(16)	Flag for map of column shear reinforcement
MJV	5	(16)	Flag for map of joint shear stress ratios
MJR	6	(16)	Flag for map of joint beam/column capacity ratios

1 - NOTES:

1. The CONKER program has options to check or design the concrete frame with respect to several different codes. This option allows the user to choose the code to be used. Refer to Chapter III for details of the checks used for the different codes.

   It is reiterated here that only the design checks listed in Chapter III are performed by the CONKER program. Other significant aspects of concrete frame design, for example detailing, minimum thickness, aspect ratios of sections, minimum reinforcement, confinement, development lengths, torsion design, etc., are not addressed by the program and should be separately addressed by the user.

2. This variable controls the number of frame design activation data sets to be provided in Section 5 below. If this number is zero, no data is expected or read in Section 5, but all frames are designed with default values.

3. This variable defines the number of load combinations and controls the number of data lines to be read in Section 2 below. If this number is zero, no data is expected or read in Section 2, but the default values of loading combinations given in Section 2 are used.

4. This entry defines the vertical load condition of ETABS that corresponds to dead load. This information is required in the calculation of β_d used in computing moment magnification factors.

1 - NOTES: (continued)

5. This entry defines the vertical load condition of ETABS that corresponds to the live load.

   The live load reduction factors for the members are applied to the member forces associated with this load condition, before the member forces are summed into the combinations.

6. It is possible to redefine or add new material properties or section properties in the material and section property tables that the user originally defined in the ETABS data.

   Via this option, the user can modify the concrete frame and make design iteration runs with CONKER without rerunning the analysis runs of ETABS.

   After the design is satisfactory, the user may incorporate the changes into the ETABS data and rerun the analysis and make the design runs for final convergence.

7. The entry **NRMP** defines the number of material property sets that are defined in Section 3 below.

8. The entry **NRCP** defines the number of column section property sets that are defined in Section 4(i) below.

9. The entry **NRBP** defines the number of beam section property sets that are defined in Section 4(ii) below.

1 - NOTES: (continued)

10. The column biaxial interaction volumes are defined by a series of three-dimensional interaction curves. The entry **NCRV** specifies the number of curves that will be used to define the volume. The larger the number of curves, the more accurate the definition of the failure surface. The default value for **NCRV** is 5. The maximum allowed value is 51. The value for **NCRV** must be odd. The first curve corresponds to major direction bending, with no minor direction bending and the **NCRV**-th curve corresponds to minor direction bending with no major direction bending.

11. Each interaction curve is defined by a series of points connected by straight lines. The entry **NPTS** specifies the number of points that will be generated on each curve. The default value for **NPTS** is 11. The maximum allowed value is 51. The value for **NPTS** must be odd.

12. The tabulation of each interaction volume diagram requires one page of output per curve. Therefore, if **NCRV** is set to 7, each concrete section tabulation will consume seven pages.

13. This option is useful if checks have to be made with respect to the ultimate capacities of the material.

14. If **IUNIT** is E all CONKER (and ETABS) input data must be prepared in inch-kip-second units and all output will be in the same units except required shear reinforcing area is given in in^2/ft.

1 - NOTES: (continued)

If **IUNIT** is M all CONKER (and ETABS) input data must be prepared in meter-kilogram-second units, however, all CONKER force and moment output will be in meter-ton-second units and required reinforcing is given in cm^2 and cm^2/meter.

If **IUNIT** is S all CONKER (and ETABS) input data must be prepared in meter-kiloNewton-seconds and all output will be in the same units except required reinforcing area is given in cm^2 and cm^2/meter.

If **IUNIT** is input as anything other than E or M or S it is assumed to be E.

15. If **IEX** is 1, the program will only read, print and check the data for consistency and will terminate execution after all the input has been read. All design operations will be bypassed. The normal execution mode will produce a complete echo of the input and results. If a data error is detected in a normal execution mode, the program will immediately switch to the data check mode and execution will be terminated after all the input has been read.

16. If this entry is 0, the program will not produce display maps associated with this parameter.

    If this entry is 1, display maps will be created and will exist in the .MAP output file as described in Chapter V.

    If no CONKER input file is provided, these entries default to 1.

2. LOAD COMBINATION DEFINITION DATA

Load combinations are defined as summations of the eight basic load conditions, namely:

a. The vertical static load conditions, I, II and III.

b. The lateral static load conditions, A and B.

c. The lateral dynamic load conditions, Dyn-1, Dyn-2 and Dyn-3.

The load combinations convert the ETABS analysis conditions to factored ultimate load levels with load factors that are specified in this section.

Provide one data line to define each of the **NLC** load combinations in the following form:

L LTYP XI XII XIII XA XB XD1 XD2 XD3

The data provided in this data section is completely independent of the load case data that is provided in the corresponding ETABS analysis run.

2. LOAD COMBINATION DEFINITION DATA (continued)

Variable	Field	Note	Entry
L	1	(1)	Load combination number
LTYP	2	(2)	Load Combination type: = 0 Linear combination, consider all signs = 1 Linear combination, use absolute value of responses, but consider signs of multipliers = 2 SRSS A and B Load Conditions, combine linearly with others = 3 SRSS Dyn-1 and Dyn-2 Load Conditions, combine linearly with others
XI	3	(3)	Load factor for vertical load condition I
XII	4		Load factor for vertical load condition II
XIII	5		Load factor for vertical load condition III
XA	6		Load factor for lateral load condition A

2. LOAD COMBINATION DEFINITION DATA (continued)

XB	7	Load factor for lateral load condition B
XD1	8	Load factor for dynamic load condition Dyn-1
XD2	9	Load factor for dynamic load condition Dyn-2
XD3	10	Load factor for dynamic load condition Dyn-3

2 - NOTES:

1. This number must be in ascending consecutive numerical sequence starting with the number 1.

2. If this entry is zero, linear combinations are produced and all signs are considered.

   If this entry is 1, linear combinations are produced, except that absolute values of responses are used, although signs of multipliers are considered. This type of combination is not recommended for CONKER. It has been kept here for consistency with ETABS.

   If this entry is 2, a square root of the sum of the squares (SRSS) combination of the Load Conditions A and B responses with the specified multipliers is first made, before combining linearly with the other load conditions. The SRSS value is assigned the sign of XA. This type of combination is required in some design codes for considering orthogonal effects of seismic excitations.

   If this entry is 3, a SRSS combination of the Load Conditions Dyn-1 and Dyn-2 responses with the specified multiplier is first made before combining linearly with the other load conditions. The SRSS value is assigned the sign of XD1. This type of combination is commonly used for dynamic analysis and is required by some design codes to consider orthogonal effects of seismic excitations.

3. Each member is designed (or checked) for each of the specified loading combinations. The design (or stress ratio) from the controlling loading combination is reported.

2 - NOTES: (continued)

Typically, building systems are subjected to vertical loads due to dead and live loads which usually act downwards. In addition to the vertical loads, the building is usually subjected to lateral loads, resulting from wind or seismic forces, which act along different directions (usually assumed to be in two mutually orthogonal directions), and the directions are reversible.

If the structure is subjected to dead load (DL) and live load (LL) only, the user need only specify one loading combination, namely, 1.4 DL + 1.7 LL as dead load and live load are not reversible.

However, if in addition to the dead load (DL) and the live load (LL) the structure is subjected to wind forces from two mutually perpendicular reversible directions (WX, WY), the user needs to specify the following loading combinations. See Reference [2].

1. 1.4 DL + 1.7 LL
2. 0.75 (1.4 DL + 1.7 LL + 1.7 WX)
3. 0.75 (1.4 DL + 1.7 LL + 1.7 WY)
4. 0.75 (1.4 DL + 1.7 LL - 1.7 WX)
5. 0.75 (1.4 DL + 1.7 LL - 1.7 WY)
6. (0.9 DL + 1.3 WX)
7. (0.9 DL + 1.3 WY)
8. (0.9 DL - 1.3 WX)
9. (0.9 DL - 1.3 WY)

These are the program defaults whenever the ACI code is requested, assuming DL is gravity load condition I , LL is gravity load condition II, WX is static lateral load condition A and WY is static lateral load condition B. The user should specify other combinations if seismic loads are present.

2 - NOTES: (continued)

When using UBC91 (Reference [4]) under seismic loads, the required loading combinations would be:

1. 1.4 DL + 1.7 LL
2. 1.4 DL + 1.4 LL + $\sqrt{(1.4\ EQX)^2 + (1.4\ EQY)^2}$
3. 1.4 DL + 1.4 LL - $\sqrt{(1.4\ EQX)^2 + (1.4\ EQY)^2}$
4. 0.9 DL + $\sqrt{(1.4\ EQX)^2 + (1.4\ EQY)^2}$
5. 0.9 DL - $\sqrt{(1.4\ EQX)^2 + (1.4\ EQY)^2}$

These are the program defaults whenever the UBC code is requested, assuming DL is gravity load condition I , LL is gravity load condition II, EQX is static lateral load condition A and EQY is static lateral load condition B.

When using the CAN3-A23.2-M84 the load combinations for wind loads would be and the program defaults are:

1. 1.25 DL
2. 1.25 DL + 1.5 LL
3. 1.25 DL + 1.05 LL + 1.05 WX
4. 1.25 DL + 1.05 LL - 1.05 WX
5. 1.25 DL + 1.05 LL + 1.05 WY
6. 1.25 DL + 1.05 LL - 1.05 WY
7. 1.25 DL + 1.5 WX
8. 1.25 DL - 1.5 WX
9. 1.25 DL + 1.5 WY
10. 1.25 DL - 1.5 WY
11. 0.85 DL + 1.5 WX
12. 0.85 DL - 1.5 WX
13. 0.85 DL + 1.5 WY
14. 0.85 DL - 1.5 WY

3. MATERIAL PROPERTY REDEFINITION DATA

This data section is only needed if the material property table that has been previously defined in the ETABS data is to be modified (or expanded).

If **NRMP** is 0, this data section is not needed and must be skipped. In this case, the values of the material properties used by CONKER will retain the values that were assigned in the ETABS data. However, if for any C material type the values for **FY, FC** or **FYS** have not been defined, they will be set to the default values defined herein (Notes 4, 5 and 6 below) irrespective of whether any material properties are being redefined.

If **NRMP** is not 0, provide **NRMP** data lines to redefine material property types that were previously defined in the ETABS data, or to define additional material property types.

Prepare the data in the following form:

MID MTYPE E U P FY FC FYS FCS

3. MATERIAL PROPERTY REDEFINITION DATA (continued)

Variable	Field	Note	Entry
MID	1	(1)	Identification number of material type that is being redefined or added
MTYPE	2	(2)	Material type: = S Steel = C Concrete (frames) = W Concrete (walls) = M Masonry (walls) = O Other
E	3	(3)	Modulus of elasticity
U	4		Unit weight
P	5		Poisson's ratio
FY	6	(4)	Yield stress of reinforcing steel
FC	7	(5)	Ultimate strength of concrete

3. MATERIAL PROPERTY REDEFINITION DATA (continued)

Variable	Field	Note	Entry
FYS	8	(6)	Yield stress of shear reinforcing steel
FCS	9	(7)	Equivalent ultimate strength of concrete for shear strength evaluation

3 - NOTES:

1. The material property sets may be entered in any order; however, the identification numbers must lie between 1 and **NMAT+ NRMP**.

   If the identification number is less than or equal to **NMAT**, this property set will replace the corresponding material property set that was previously defined in the ETABS data. If the identification number is greater than **NMAT**, the material property table is expanded, and a new material property set corresponding to this identification number is created.

2. A series of design/stress check postprocessors operating off the ETABS postprocessing data base are available. The material type designation is basically an indicator for the postprocessors.

   The concrete frame design postprocessor, CONKER, will only design those members that have a material type C. The shear wall design postprocessor, WALLER, for example, will only process those members that have a material type W or M. The structural steel checking postprocessor, STEELER, will only stress check members having a material designation of S. Materials having a designation type O will not be processed by any of the postprocessors.

3. Remember consistent units.

4. If the yield stress has not been specified, it is assumed to be 60 ksi or MKS or SI equivalent.

5. If the concrete strength has not been specified, it is assumed to be 4 ksi or MKS or SI equivalent.

3 - NOTES: (continued)

6. If the yield stress of the shear reinforcing has not been specified, it is assumed to be 40 ksi or MKS or SI equivalent.

7. A nonzero value for this parameter causes the program to use this equivalent value of f'_c in evaluating the value of $\sqrt{f'_c}$ for use in calculating the concrete shear strength, V_c. This option is useful for lightweight-aggregate concrete where an equivalent value of $\sqrt{f'_c}$ must be used in the shear design (ACI 11.2.1and 21.6.3.2).

   A zero value for this parameter defaults to the value for **FC**.

4. SECTION PROPERTY REDEFINITION DATA

The following data sections (i) and (ii) below redefine section properties for the column and beam elements previously defined in the ETABS analysis. Properties specific to reinforced concrete design are added in this section.

4(i). Column Property Redefinition Data

This data section is for assigning specific concrete column properties to the column section properties that have previously been defined in the ETABS data, or to define additional column property types.

Only column sections that have a concrete material type (i.e. equal to C) will be included in the processing by CONKER.

If **NRCP** is 0, skip this data section. Otherwise, provide **NRCP** data lines to assign column properties to the ETABS column property table in the following form:

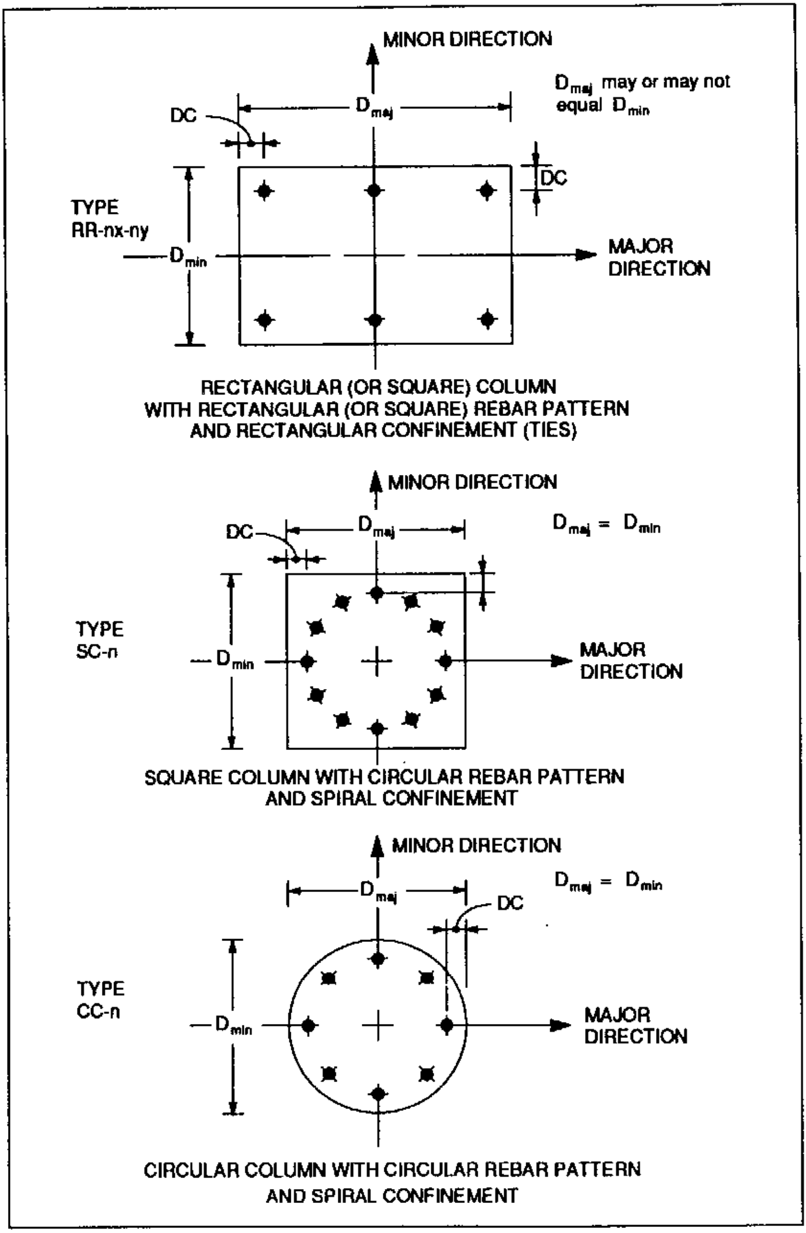
ID IMAT ITYPE DMAJ DMIN DC ABAR1 ABAR2

4(i). Column Property Redefinition Data (continued)

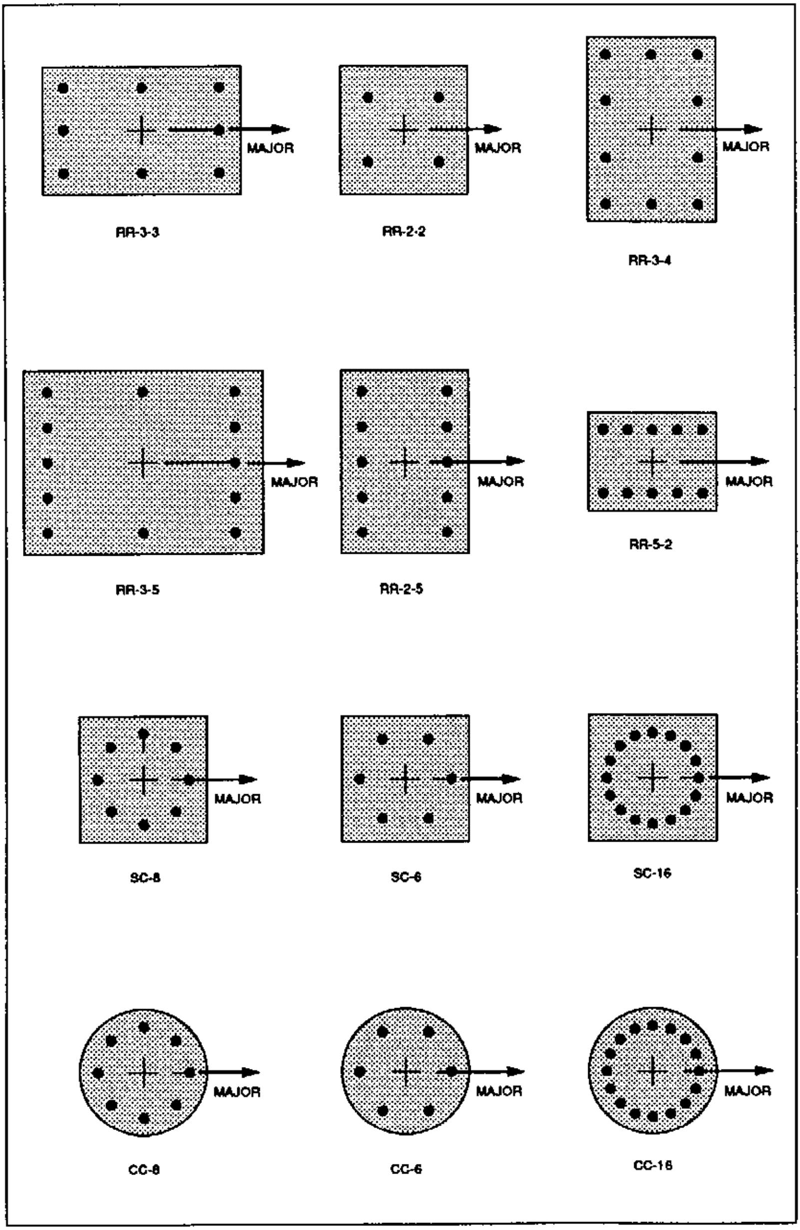
Variable	Field	Note	Entry
ID	1	(1)	Identification number of column section property that is being assigned concrete properties
IMAT	2	(2)	Material identification number for this section property
ITYPE	3	(3)	Section type: = RR-nx-ny = SC-n = CC-n
DMAJ	4	(4)	Section dimension in major direction, inches or meters
DMIN	5	(4)	Section dimension in minor direction, inches or meters
DC	6	(5)	Concrete cover to **center** of reinforcing bar, inches or meters

4(i). Column Property Redefinition Data (continued)

Variable	Field	Note	Entry
ABAR1	7	(6)	Area of reinforcing bar at each corner for section type RR. Area of one of the reinforcing bars for SC and CC section types, square inches or square meters
ABAR2	8	(7)	Area of one of the reinforcing bars except those at corners for section type RR, square inches or square meters



Valid Column Sections and Rebar Configurations
Figure IV-2



Examples of Valid Column Sections
Figure IV-3

4(i) - NOTES:

1. The column property sets may be entered in any order; however, the identification numbers must be between 1 and **NCP+ NRCP**.

   If the identification number is less than or equal to **NCP**, this property set will replace the corresponding column property set that was previously defined in the ETABS data. If the identification number is greater than **NCP**, the column property table is expanded and a new column property set corresponding to this identification number is created.

2. This entry references the material property types that were previously defined in the ETABS data or subsequently redefined in Section 3 above. This entry must not be less than 1 and must not be greater than the maximum number of material types which exist in the material property table.

3. See Figures IV-2 and IV-3. Section type RR is a rectangular (or square) section with a rectangular (or square) reinforcing arrangement, consisting of nx layers of bars in the major direction of the column and ny layers of bars in the minor direction of the column. Neither nx or ny may be less than 2. The section is assumed tied.

   Section type SC is a square section with a circular reinforcing arrangement, consisting of n bars. The value of n must be even and must not be less than 4. The section is assumed spirally confined.

   Section type CC is a circular section with a circular reinforcing arrangement consisting of n bars. The value of n must be even and must not be less than 4. The section is assumed spirally confined.

4(i) - NOTES: (continued)

Note that all sections are doubly symmetric.

If a column section is **not** redefined in this data section, the program assumes RR type reinforcement for rectangular (or square) sections and CC type reinforcement for circular sections. **The bar distribution is assumed uniform around the perimeter, with a cover to center of reinforcing as specified by DC.**

4. **DMAJ** and **DMIN** define the dimensions of the column. For SC and CC type columns, **DMAJ** must be equal to **DMIN**. If not defined, the program defaults them to values specified in the ETABS data.

5. The concrete cover is the same in the major or minor directions of the column. See Figure IV-2. If not defined, the program defaults it to the smaller of 10% of **DMAJ** and 10% of **DMIN**.

6. For SC or CC section types all bars in any one section must be of the same size. For RR section types the corner bars may be different in size from the other bars in the section.

7. A zero value for **ABAR2** defaults to the value for **ABAR1** If **ABAR1** and **ABAR2** are both zero, the program will design the column longitudinal reinforcement.

4(ii). Beam Property Redefinition Data

This data section is for assigning specific concrete spandrel properties to the beam section properties that have been previously defined in the ETABS data, or to define additional beam property types.

It should be reiterated that beams with concrete material type only (i.e. equal to C), will be included in the processing by CONKER.

If **NRBP** is 0, skip this data section. Otherwise, prepare **NRBP** data lines to assign reinforced concrete properties to the ETABS beam property table in the following form:

ID IMAT ITYPE DB DA BB DS BF DCT DCB ATI ABI ATJ ABJ

Note: The 14 entries shown above are to be entered on one data line in the input.

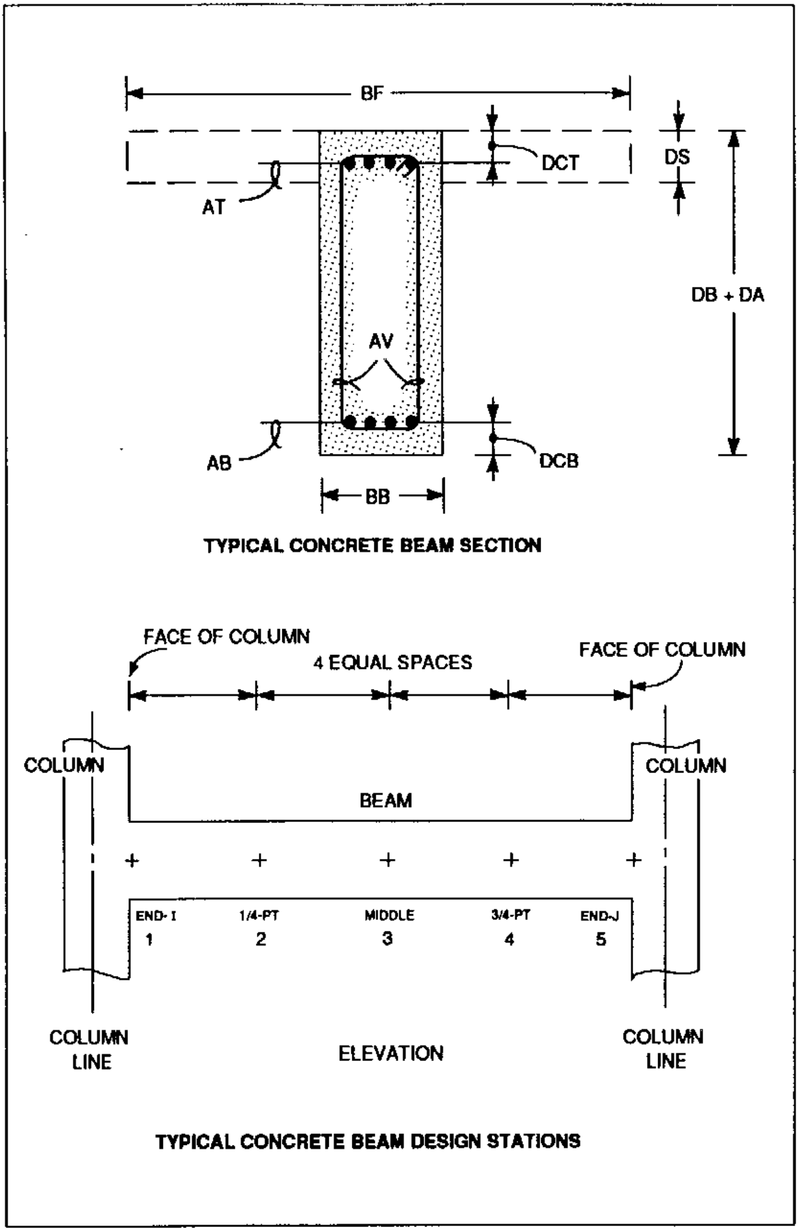

BF
DCT
DS
AT
DB + DA
AV
AB
DCB
BB
TYPICAL CONCRETE BEAM SECTION
FACE OF COLUMN
4 EQUAL SPACES
FACE OF COLUMN
COLUMN
COLUMN
BEAM
END- I
1/4-PT
MIDDLE
3/4-PT
END-J
1
2
3
4
5
COLUMN LINE
ELEVATION
COLUMN LINE
TYPICAL CONCRETE BEAM DESIGN STATIONS

Figure IV-4

4(ii). Beam Property Redefinition Data (continued)

Variable	Field	Note	Entry
ID	1	(1)	Identification number of beam section property that is being assigned concrete properties
IMAT	2	(2)	Material identification number for this section property
ITYPE	3	(3)	Section type = RCB
DB	4	(4,5)	Depth of beam below diaphragm, inches or meters
DA	5	(4,5)	Depth of beam above diaphragm, inches or meters
BB	6	(4)	Width of beam, inches or meters
DS	7	(4,6)	Thickness of slab, inches or meters (only for T-Beam sections, enter 0.0 for rectangular sections)
BF	8	(4,6)	Effective width of slab, inches or meters (only for T-Beam sections, enter 0.0 for rectangular sections)

4(ii). Beam Property Redefinition Data (continued)

Variable	Field	Note	Entry
DCT	9	(4)	Concrete cover to center of top reinforcing steel, inches or meters
DCB	10	(4)	Concrete cover to center of bottom reinforcing steel, inches or meters
ATI	11	(7)	Actual top flexural area of steel at END I, square inches or square meters
ABI	12	(7)	Actual bottom flexural area of steel at END I, square inches or square meters
ATJ	13	(7)	Actual top flexural area of steel at END J, square inches or square meters
ABJ	14	(7)	Actual bottom flexural area of steel at END J, square inches or square meters

4(ii) - NOTES:

1. The beam property sets may be defined in any order; however, the identification numbers must be between 1 and **NBP+ NRBP** .

   If the identification number is less than or equal to **NBP**, this property set will replace the corresponding beam property set that was previously defined in the ETABS data. If the identification number is greater than **NBP**, the beam property table is expanded and a new beam property set corresponding to this identification number is created.

2. This entry references the material property types that were previously defined in the ETABS data or subsequently redefined in Section 3 above. This entry must not be less than 1 and must not be greater than the maximum number of material types which exist in the material property table.

3. The only valid reinforced concrete beam section type is RCB. Enter the three letters RCB for **ITYPE**.

4. See Figure IV-4 for an illustration of this variable. If not defined, the program defaults **DCT** and **DCB** to 10% of **(DB+ DA)**.

5. For beam design the beam depth is assumed as **DB+ DA**. The split between beam depth below and above diaphragm is used only in calculating clear lengths of columns. If not defined, the program defaults them to values specified in the ETABS data.

4(ii) - NOTES: (continued)

6. The entries **DS** and **BF** are for introducing T-Beam effects into the beam design algorithm.

   The depth **DS** is always assumed to be at the top of the beam and the T-Beam effect is only introduced when the moment condition indicates compression at the top of the beam.

   If **DS** = 0 or **BF** = 0 the section defaults to a rectangular section of dimensions **BB (DB+ DA)**.

   The T-Beam section definition is purely for the design of the beam bottom steel. Any other section properties that are required in the design process are based upon the properties of the rectangular section **BB (DB+ DA)**.

7. The program calculates top and bottom flexural areas of steel for all beams in the design process, and reports the required areas of steel.

   The area of steel that is actually provided could end up being more than what is required due to the round off in converting the area of steel to numbers of reinforcing bars.

   For the design of special moment resisting frames, the beam flexural capacities required for the shear design of the beam, the column and the beam-column joint need to be based upon the area of steel that is actually provided.

   The four values **ATI**, **ABI**, **ATJ** and **ABJ** are the areas of steel that are actually provided in the beam. See Figure IV-4.

   These values are only required for the special moment resisting frame design option.

4(ii) - NOTES: (continued)

If these values are not input, the program will use the calculated areas of steel for implementing the design.

If these values are input, the program will use the maximum of the provided and the calculated steel values.

Obviously, these values are not known in the first design iteration runs, but as the design is finalized, these values are known and they must be introduced in the final runs to get the correct design.

Correct beam/column moment capacity ratios are also dependent upon the actual steel values being input.

5. FRAME DESIGN ACTIVATION DATA SETS

Provide **NFR** data sets, one for each of the ETABS frames that are to be designed/stress checked.

(i). Frame Design Control Data

Prepare one line of data in the following form:

IFRN ITYP IRCP IRBP ALPHA

5(i). Frame Design Control Data (Continued)

Variable	Field	Note	Entry
IFRN	1	(1)	Frame sequence number that uniquely identifies this frame among the **NTF** total frames
ITYP	2	(2)	Frame design type: = 1 Special moment resisting = 2 Intermediate moment resisting = 3 Ordinary moment resisting
IRCP	3	(3)	Column reassignment flag: = 0 No column reassignment provided = 1 Column reassignment provided
IRBP	4	(3)	Beam reassignment flag: = 0 No beam reassignment provided = 1 Beam reassignment provided
ALPHA	5	(4)	Reinforcing steel overstrength factor

5(i) - NOTES:

1. This is a positive nonzero number, not greater than **NTF**. This sequence number refers to the sequence in which the frames are entered in the ETABS data. See Chapter V, Section D-7 of the ETABS manual (Frame Location Data). In this data section the frame that is entered first has a sequence number of 1, and the frame that is entered last has a sequence number of **NTF**.

   The frames may be designed in any sequence.

2. This flag determines whether the special seismic requirements of the codes are to be used. If **ITYP** is 1, the seismic requirements for special moment resisting frames (high seismic risk areas) are used. If **ITYP** is 2, the seismic requirements for intermediate moment resisting frames (moderate seismic risk areas) is used. If **ITYP** is 3, the seismic requirements are not used. The default value of **ITYP** is 1.

3. Irrespective of any section (or material) property redefinitions in the column section (or material) property data above, it is possible to reassign section properties and/or live load reduction factors and/or moment magnification factors on a column-by-column basis by redefining the column assignment data. If **IRCP** is 1, the program will expect column reassignment data as defined in Section 5(ii)-a below.

   Similarly, **IRBP** applies to beam reassignment data.

5(i) - NOTES: (continued)

4. In special moment resisting frame design this overstrength factor is used to obtain the probable reinforcing steel yield stress in calculating beam ultimate moment capacities. These moment capacities are used in calculating required beam and joint shear strength and column flexural and shear strength. If a zero value for this entry is specified it defaults to a value of 1.25.

   This entry is used only if **ITYP** is 1, i.e. special moment resisting frames.

5(ii). Element Reassignment Data

This data section is only needed if the column or beam element section property identifications, live load reduction factors or column moment magnification factors are to be modified or overridden.

Prepare one (or both) of the following data Sections a and b below, as required.

a. Column Element Reassignment Data

If **IRCP** is 0, none of the column element parameters are to be reassigned, therefore, skip this data section (including the blank termination line defined below).

Otherwise, provide as many data lines as needed to define the required parameters. The order of input is immaterial, and parameter assignments for any column element at any level may be repeated. The last values read (or generated) will be used. **End this data section with a blank line.** Prepare the data in the following form:

NT NSAME MC1 MC2 SD1 SD2 P1 P2 P3 P4

5(ii)-a. Column Element Reassignment Data (continued)

Variable	Field	Note	Entry
NT	1	(1)	Data line type: = I Property type = R Live load factor = D Moment magnification factors
NSAME	2	(3)	Column line number, the properties of which are to be repeated at column lines **MC1** through **MC2**
MC1	3	(5,8)	Column line number of first column line being reassigned
MC2	4	(5,8)	Column line number of last column line being reassigned
SD1	5	(7,8)	Identification of the story level associated with topmost column being reassigned
SD2	6	(7,8)	Identification of the story level associated with bottommost column being reassigned

5(ii)-a. Column Element Reassignment Data (continued)

Variable	Field	Note	Entry
P1	7	(1)	Parameter 1: = Column property ID (NT = I) = Live load factor (NT = R) = Major moment magnification factor (sidesway moments) (NT = D)
P2	8	(1)	Parameter 2: = Minor moment magnification factor (sidesway moments) (NT = D)
P3	9	(1)	Parameter 3: = Major moment magnification factor (non-sidesway moment) (NT = D)
P4	10	(1)	Parameter 4: = Minor moment magnification factor (non-sidesway moment) (NT = D)

b. Beam Element Reassignment Data

If **IRBP** is 0, none of the beam element parameters are to be reassigned, therefore, skip this data section (including the blank termination line defined below). Also, if **NB** is 0 there are no bays defined in this frame. Therefore, skip this data section completely (including the blank termination line defined below).

Otherwise, provide as many data lines as needed to define the required parameters. The order of input is immaterial, and parameter assignments for any beam element at any level may be repeated. The last values read (or generated) will be used. **End this data section with a blank line.** Prepare the data in the following form:

NT NSAME MB1 MB2 SD1 SD2 P

5(ii)-b. Beam Element Reassignment Data (continued)

Variable	Field	Note	Entry
NT	1	(2)	Data line type: = I Property type = R Live load factor
NSAME	2	(4)	Bay number, the properties of which are to be repeated at bays **MB1** through **MB2**
MB1	3	(6,9)	Bay number of first bay being reassigned
MB2	4	(6,9)	Bay number of last bay being reassigned
SD1	5	(7,9)	Identification of the story level associated with topmost beam being reassigned
SD2	6	(7,9)	Identification of the story level associated with bottommost beam being reassigned
P	7	(2)	Parameter = Beam property ID (NT = I) = Live load factor (NT = R)

5(ii) - NOTES:

1. This entry identifies the type of data that is being defined by this data line.

   If **NT** = I, the data line is for reassigning member property identifications and the parameter **P1** is an integer entry referring to the section property tables originally defined in the ETABS data or redefined in Section 4 above.

   If **NT** = I, **P2**,**P3** and **P4** are not used. The default values for the section properties are as originally defined in the ETABS data.

   If **NT** = R, the data line is for defining live load reduction factors. The entry **P1** is the live load reduction factor for the column.

   Thus, for instance, if the axial force in a column at a particular level for load condition **LLC** is 50k, and the entry for **P1** is 0.7, then the axial force in load condition **LLC** (that will further be scaled by the design load combinations) will be taken as

   $$0.7 \times 50k = 35k$$

   The program does not have any algorithm based upon tributary area of the column to calculate a live load reduction factor.

   If **NT** = R, **P2**, **P3** and **P4** are not used. The default value for the live load reduction factor is 1.0.

5(ii) - NOTES: (continued)

If **NT** = D, the data line is for defining column element moment magnification factors. The entries **P1** and **P2** are the moment magnification factors for sidesway moments (from Load Condition A, B, Dyn-1, Dyn-2 and Dyn-3) in the major and minor directions, respectively. The default values for these is 1.0 as the program assumes a P-Delta analysis has been made. The entries **P3** and **P4** are moment magnification factors for non-sidesway moments (from Load Conditions I, II and III) in the major and minor directions respectively. The default values for these are as calculated in the algorithms defined in Chapter III.

2. This entry identifies the type of data that is being defined by this data line.

   If **NT** = I, the data line is for reassigning member property identifications and the parameter **P** is an integer entry referring to the section property tables originally defined in the ETABS data or redefined in Section 4 above.

   The default values for the section properties are as originally defined in the ETABS data.

   If **NT** = R, the data line is for redefining live load reduction factors. The entry **P** is the live load reduction factor for the beam.

5(ii) - NOTES: (continued)

Thus, for instance, if the shear force in a particular beam at a particular level for load condition **LLC** is 50k, and the entry for **P** is 0.7, then the shear force in load condition **LLC** (that will further be scaled by the design load combinations) will be taken as

$$0.7 \times 50^k = 35^k$$

The program does not have any algorithm based upon tributary area of the beam to calculate a live load reduction factor. The default value for the live load reduction factor is 1.0.

3. If **NSAME** is nonzero, it is a column line number, the properties of which are already defined by default or by user specifications in preceding data lines of this data section.

   The nonzero entry for **NSAME** puts the program into a duplication mode. In this mode, the member properties (as identified by the **NT** entry) for the column elements at all levels on column lines **MC1** through **MC2** are set identical to the properties of the column elements, at the corresponding levels, of column line **NSAME** as it stands defined at the time of this entry.

   Redefinitions of column properties on column line **NSAME** in subsequent data lines will not result in automatic corresponding redefinitions of the member properties on the duplicated column lines **MC1** through **MC2**.

   In the duplication mode, the entries for **SD1**,**SD2** and **P1**, **P2**, **P3**, **P4** are meaningless and must not be entered. These entries are only needed if **NSAME** is 0.

5(ii) - NOTES: (continued)

4. If **NSAME** is nonzero, it is a bay number, the properties of which are already defined by default or by user specification in preceding data lines of this data section.

   The nonzero entry for **NSAME** puts the program into a duplication mode. In this mode, the member properties (as identified by the **NT** entry) for the beam elements at all levels in bays **MB1** through **MB2** are set identical to the properties of the beam elements, at the corresponding levels, in bay **NSAME** as it stands defined at the time of this entry.

   Redefinitions of beam properties in bay **NSAME** in subsequent data lines will not result in automatic corresponding redefinitions of the member properties in the duplicated bays **MB1** through **MB2**.

   In the duplication mode, the entries for **SD1**,**SD2** and **P** are meaningless and must not be entered. These entries are only used if **NSAME** is 0.

5. This entry is a column line number. The number must not be greater than **NC**. Also, **MC2** may never be less than **MC1**.

6. This entry is a bay number. The number must not be greater than **NB**. Also, **MB2** may never be less than **MB1**.

7. This entry is an alphanumeric story identifier that must correspond to one of the story level identifiers previously defined in Section 3 of the ETABS data.

   The level associated with **SD2** may never be higher than the level associated with **SD1**.

5(ii) - NOTES: (continued)

8. All column elements existing on column lines **MC1** through **MC2** associated with levels **SD1** through **SD2** (inclusive) will be assigned the properties identified by the entries **NT**, **P1 P2**, **P3** and **P4** on this data line.

   As a reminder, column elements associated with a particular level exist below the level.

9. All beam elements existing in bays **MB1** through **MB2** between levels **SD1** through **SD2** (inclusive) will be assigned the properties identified by the entries **NT** and **P** on this data line.

V.

PROGRAM OUTPUT

A. DESCRIPTION OF OUTPUT FILES

If the name of the ETABS analysis data file is EXCON, the ETABS analysis will produce a postprocessing file called EXCON.PST.

If the name of the CONKER input data file is DESCON, there will be three output files produced by CONKER, namely DESCON.CNK, DESCON.COL and DESCON.MAP. However, if the program defaults are acceptable and the CONKER input data file is not provided, the three output files produced by CONKER are EXCON.CNK, EXCON.COL and EXCON.MAP.

Sample output is presented in the last section of this manual. For English units, all output is in kip-inch units except for the shear reinforcing steel, which is in square inches/foot. For MKS units, **all** tabulations associated with the **echoing of the input data** are in MKS units. However, **all calculated** forces and moments are in meter-ton-second units. **All calculated** reinforcing steel is output in square centimeters and all shear steel is tabulated in square centimeters/meter. For SI units, all output is in meter-kiloNewton units except calculated reinforcing steel is output in square centimeters and all shear reinforcing steel is tabulated in square centimeters/meter.

In addition to the echo of all of the CONKER input data and control information recovered from the ETABS postprocessing file, the file DESCON.CNK contains the following:

1. For each concrete beam, the file will contain the controlling positive and negative bending moments and shear forces at each of the five beam stations, along with the controlling load combination numbers and required top and bottom flexural reinforcing and shear reinforcing. See Figure V-2 for details of the output format.

2. In the design mode for each concrete column, the file will contain the required longitudinal reinforcement at the top and bottom of the column with associated controlling design load combination numbers and the critical axial force and biaxial moments. However, for columns in the check mode, the controlling moment interaction capacity ratios are reported instead of the longitudinal reinforcement. The required shear reinforcing in the major and minor direction of the column, along with the controlling load combination number of the critical shear force is also tabulated. See Figure V-3 and V-4 for details of the output format.

3. For each beam/column joint, the file will contain the controlling joint shear force in the major and minor direction of the column that corresponds to the joint, effective joint area, joint shear stress, allowable shear stress and shear stress ratio.

   Also, for special moment resisting concrete frames, the file will contain beam-column moment capacity ratios in the major and minor directions of the column that corresponds to the joint. See Figure V-5 for details of the output format.

The file DESCON.COL contains additional back-up information pertaining to the design or checking of each column. The file contains the following:

1. A tabulation of the concrete column moment interaction curves. Each concrete section property type will have a moment interaction volume generated that is defined by a series of **NCRV** curves. See Figure III-2. The first curve lies in the P-M_x plane with M_y being zero, the **NCRV**-th curve lies in the P-M_y plane with M_x being zero. All other curves are in a general three-dimensional space having P, M_x and M_y components. The interaction diagrams are tabulated both with the strength reduction factor and without it. The P_{max} limit is included in both tables. The printing of these tables is optional.

2. At top and bottom of each concrete column, the file will contain information on the moment magnification factors for non-sidesway moments, δ_b, in the major and minor direction and the coordinates of the failure surface point, namely point C in Figure III-10. The moment magnification factors for sidesway moments are assumed to be 1.0 (because of P-delta analysis), unless overridden by the user in which case the specified values are echoed in the .CNK file. See Figure V-6 for details of the output format.

The design output for a particular frame is in the following sequence:

1. Starting from the top of the frame, the design of all of the beams at a particular level, followed by the design of all of the beams at the next level below, and so on.

2. Starting from the top of the frame, the design of all of the columns at a particular level, followed by the design of all of the columns at the next level below, and so on. Also

columns to be designed are printed separately from and before columns to be checked.

3. Starting from the top of the frame, the design of all of the joints at a particular level, followed by the design of all of the joints at the next level below, and so on.

The file DESCON.MAP contains numerical maps of design parameters. Maps are printed for beam bending and shear reinforcement; column longitudinal reinforcement (or stress ratios) and shear reinforcement; and joint shear stress ratios and beam/column capacity ratios. These maps display the parameters in a spatial manner that corresponds to an elevation view of the frame being designed.

B. DESIGN OVERSTRESS AND FAILURE SITUATIONS

In the design or capacity check process, the program will produce diagnostic messages if overstress or failure conditions are encountered.

The diagnostics are in the form of check numbers, namely CHK#1, CHK#2, etc.

A description of the design diagnostic checks are presented in Figure V-1.

CHECK #	OVERSTRESS CONDITION
CHK #1	Concrete compression failure (depth of compression block exceeds maximum allowed)
CHK #2	Percentage of steel in beam design exceeds maximum allowed
CHK #3	Shear stress exceeds maximum allowed (or shear design cannot be implemented because the calculation of beam flexural capacities is not possible)
CHK #4	Column design moments cannot be calculated because calculation of beam flexural capacity is not possible.
CHK #5	Moment magnification factor cannot be calculated because $P_u \geq \varphi P_c$
CHK #6	Percentage of steel in column design exceeds the maximum allowable.
CHK #7	Beam-column capacity ratios cannot be calculated due to beam or column flexural overstresses

Design Overstress Checks
Figure V-1

C. DETAILS OF THE DESIGN OUTPUT INFORMATION

The following notes detail the information that is presented in the output files produced by the program. The notes correspond to the numbers shown in Figures V-2, V-3, V-4, V-5 and V-6.

(1) This is the bay number of the beam.

(2) This is the size of the beam being used. For a T-Beam section, these are the dimensions of the beam web.

(3) This is the station identification where the stress ratio is being evaluated.

(4) This is the maximum factored negative moment value (negative sign suppressed) at the station from all the loading combinations along with the number of the controlling load combination. In ductile concrete design, if minimum moment capacity requirements govern (ACI 21.3.2.2), the controlling load combination is given as zero.

(5) This is the maximum factored positive moment value at the station from all the loading combinations along with the number of the controlling load combination. In ductile concrete design, if minimum moment capacity requirements govern (ACI 21.3.2.2), the controlling load combination is given as zero.

(6) This is the maximum factored design shear force at the station from all the loading combinations along with number of the controlling load combination.

(7) This is the required top reinforcing at the station corresponding to the factored negative design moment. These values are subject to a minimum (ACI 10.5.1 and ACI 21.3.2.1).

(8) This is the required bottom reinforcing at the station corresponding to the factored positive design moment. These values are subject to a minimum (ACI 10.5.1 and ACI 21.3.2.1).

(9) This is the required shear reinforcing in square inches/foot (or square centimeters/ meter), namely vertical stirrups, averaging an area equal to this reported value for every foot of beam length are to be provided. For example, if the reported steel is 0.60, and the shear reinforcing is of the type shown in the beam section in Figure IV-4, a #5 stirrup (area = 0.31 square inches) placed at 12 inches center to center will be adequate, giving a total of 0.62 square inches/foot. (Note: minimum requirements should be checked separately by the user).

(10) This is the column line ID number of the column.

(11) This is the size and type of the column being used.

(12) This is the station identification where the stress ratio or longitudinal reinforcement is evaluated.

(13) This is the controlling axial force and biaxial moment set that produced the controlling stress ratio. A negative axial force indicates tension. The values include the effects of the load factors from the controlling load combination and the moment magnification factors.

(14) This is the controlling load combination number that produced the controlling capacity ratio.

(15) This is the required longitudinal reinforcement.

(16) This is the direction of the design shear force.

(17) This is the value of the factored design shear force.

(18) This is the controlling load combination number for the shear design.

(19) This is the required reinforcing in square inches/foot (or square centimeters/meter). Ties or spirals, averaging an area equal to this reported value for every foot along the length of the column are to be provided. For example, if the reported steel is 0.60 and the column ties are of the type shown in Figure III-12, a #5 tie (area = 0.31 square inches) placed at 12 inches center to center will be adequate, giving a total of 0.62 square inches per foot. (Note: minimum requirements should be checked separately by the user.)

(20) This is the controlling capacity ratio.

(21) The joint is located at the top end of the column defined by this column ID and this level ID.

(22) The joint analysis is done in the major and minor direction of the column line.

(23) This is the controlling joint shear force.

(24) This is the effective area of the joint.

(25) This is the joint shear stress (Shear Force / Effective Area).

(26) This is the allowable shear stress.

(27) This is the actual shear stress ratio.

(28) For ductile concrete frames, this number should be less than or equal to 0.83.

(29) These are the moment magnification factors used to amplify the moments in the column capacity check.

(30) This axial force and biaxial moment set corresponds to the point C in Figure III-10.

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    8
                                                 PROGRAM:CONKER/FILE:DESCON.CNK
/SAMPLE EXAMPLE FOR CONKER MANUAL
/SPECIAL MOMENT RESISTING CONCRETE FRAME

DESIGN OF BEAM ELEMENTS   (UBC 1991 CONCRETE)

FRAME ID .... /MAIN FRAME
LEVEL ID .... ROOF

 BAY      BEAM SIZE STRESS /-FACTORED  LOADS  &  COMBOS-//--REQUIRED  REBAR--/
  ID WIDTH X DEPTH  POINT    -MOMENT    +MOMENT      SHEAR M(top) M(bot) V(/ft)
       (in)    (in)           (K-in)     (K-in)        (K) (sqin) (sqin) (sqin)
   1 12.00 X 24.00
                    END I  1924 < 3>  962 < 0>   39 < 5>   1.72    .88    .62
                   1/4-PT   651 < 0>  761 < 2>   26 < 2>    .88    .88    .41
                   MIDDLE   651 < 0> 1225 < 1>   16 < 5>    .88   1.07    .26
                   3/4-PT   651 < 0>  365 < 2>   29 < 5>    .88    .88    .46
                    END J  2603 < 3> 1302 < 0>   42 < 5>   2.38   1.14    .67

NOTE:   (1)       (2)        (3)       (4)      (5)       (6)      (7)    (8)    (9)
```

Beam Output From File DESCON.CNK
Figure V-2

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE   11
                                               PROGRAM:CONKER/FILE:DESCON.CNK
/SAMPLE EXAMPLE FOR CONKER MANUAL
/SPECIAL MOMENT RESISTING CONCRETE FRAME

DESIGN OF COLUMN ELEMENTS   (UBC 1991 CONCRETE)

FRAME ID .... /MAIN FRAME
LEVEL ID .... ROOF

COL   COLUMN SIZE STR /------MOMENT INTERACTION------/ /----SHEAR DESIGN----/
 ID MAJOR X MINOR  PT      PU   MMAJ   MMIN COMBO REBAR  DIRN  VU COMBO A{/ft}
    {in}    {in}          {K} {K-in} {K-in}       {sqin}       {K}       {sqin}
  1 18.00 X 18.00                                        MAJOR  34  < 0>    .74
     RR-3-3                                              MINOR   7  < 0>    .15
                  TOP      17   2309      0  < 0>  5.94
                  BOT      38   1506    179  < 3>  3.38

NOTE: (10)    (11)     (12)    (13)  (13)   (13)  (14)  (15)  (16) (17)  (18)   (19)
```

Column Design Ouput from File DESCON.CNK
Figure V-3

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE   12
                                                 PROGRAM:CONKER/FILE:DESCON.CNK
/SAMPLE EXAMPLE FOR CONKER MANUAL
/SPECIAL MOMENT RESISTING CONCRETE FRAME

STRESS CHECK OF COLUMN ELEMENTS   (UBC 1991 CONCRETE)

FRAME ID .... /MAIN FRAME
LEVEL ID .... 1ST

COL   COLUMN SIZE STR /------MOMENT INTERACTION------/ /----SHEAR DESIGN----/
 ID MAJOR X MINOR  PT      PU    MMAJ    MMIN COMBO RATIO  DIRN  VU COMBO A(/ft)
     (in)    (in)         (K) (K-in) (K-in)                     (K)       (sqin)
  1 18.00 X 18.00                                          MAJOR  24  < 0>    .52
     RR-3-3                                                MINOR   4  < 0>    .09
                  TOP      76     737     264  < 3>   .26
                  BOT      76     958     658  < 3>   .42

NOTE:  (10)     (11)      (12)     (13)   (13)    (13)  (14)  (20)  (16) (17)  (18)    (19)
```

Column Check Output From File DESCON.CNK
Figure V-4

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE   13
                                                PROGRAM:CONKER/FILE:DESCON.CNK
/SAMPLE EXAMPLE FOR CONKER MANUAL
/SPECIAL MOMENT RESISTING CONCRETE FRAME

BEAM-COLUMN JOINT ANALYSIS   (UBC 1991 CONCRETE)

FRAME ID .... /MAIN FRAME
LEVEL ID .... ROOF

       COL    JOINT    SHEAR  EFFECTV    SHEAR    ALLOW   STRESS     BEAM/COLUMN
        ID     DIRN    FORCE     AREA   STRESS   STRESS    RATIO  STRENGTH RATIO
                         (K)   (sqin)    (Ksi)    (Ksi)

         1    MAJOR   128.85   324.00     .398     .645     .616            .834
              MINOR    42.00   324.00     .130     .645     .201            .178

NOTE:  (21)    (11)     (23)     (24)     (25)     (26)     (27)            (28)
```

Joint Output From File DESCON.CNK
Figure V-5

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE   46
                                                PROGRAM:CONKER/FILE:DESCON.COL
 /SAMPLE EXAMPLE FOR CONKER MANUAL
 /SPECIAL MOMENT RESISTING CONCRETE FRAME

 DESIGN OF COLUMN ELEMENTS   (UBC 1991 CONCRETE)

 FRAME ID .... /MAIN FRAME
 LEVEL ID .... ROOF

 COL STRESS       /DELTA(B)-FACTOR//----FAILURE SURFACE POINT---/
  ID  POINT            MAJOR  MINOR        PCA     MCMAJ     MCMIN
                                           (K)    (K-in)    (K-in)
   1
        TOP            1.00   1.00          17      2309         0
        BOT            1.00   1.00          38      1506       179

NOTE: (10)    (12)           (29)    (29)        (30)      (30)      (30)
```

Column Output From File DESCON.COL
Figure V-6

VI.

REFERENCES AND BIBLIOGRAPHY

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9. **American Concrete Institute, Journal of**

   "Capacity of Rectangular Columns," by Alfred L. Parme, Jose M. Nieves and Albert Gouwens, September 1966.

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13. White, D. W. and Hajjar, J. F.

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VII.

SAMPLE EXAMPLE

The following is an example to illustrate the typical input and output associated with a CONKER run. The CONKER input data file, DESCON, and the corresponding ETABS input data file EXCON, along with ETABS postprocessing file EXCON.PST, all exist on the CONKER disk, which comes with the complete CONKER package.

The two-story special moment resisting frame designed as per the UBC91 code has a partial floor diaphragm and a full roof diaphragm. There are a total of eight column lines and eight bays in the model.

Other structural data is as follows:

Typical Column @ Roof	18" x 18", rebar not specified 2" cover to center of steel
Typical Column @ 1st Floor	18" x 18" Fixed Base w/8-#9 bars (RR-3-3) and 2" cover to center of steel
Beams in Bays 1 through 4	12" x 24"
Beams in Bays 5 through 8	12" x 16"

Loading on Bays 1 through 4, Both Levels

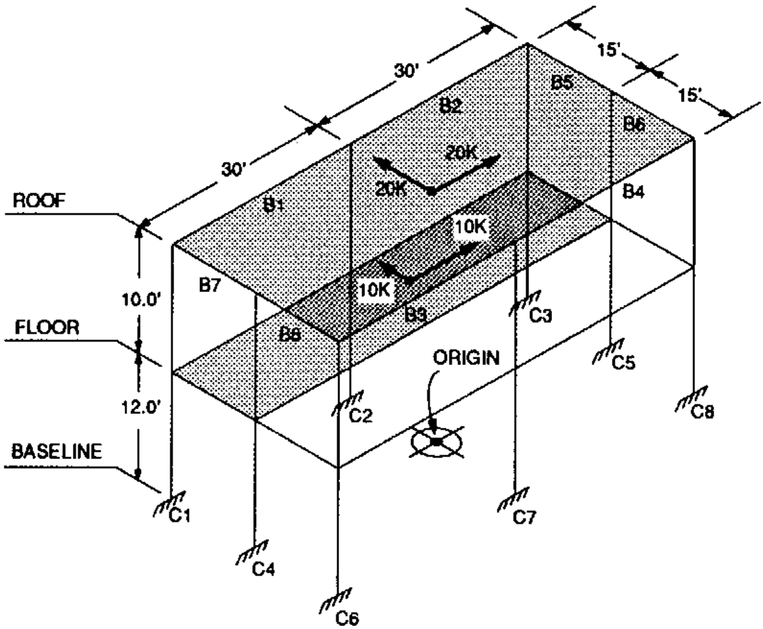
1.0 K/ft	DL
0.5 K/ft	LL

Material Properties	f'_c =	4.0 ksi
	f_y =	60.0 ksi
	f_{ys} =	40.0 ksi
	E_c =	3600 ksi

For analysis in ETABS the value of E_c was modified to account for cracking. A multiplier of 0.4 was used for columns assuming about 2% steel and a multiplier of 0.5 was used for the beams. See ACI 318-89, Section R.10.10.1.

For P-Delta analysis in ETABS

Story mass specified 100 psf	
Story dead load (asssumed)	100 psf
Story live load (assumed)	50 psf
P-Delta factor used in ETABS	3
(calculated as {1.4*100 + 1.4*50}/100/0.7)	



Special Moment Resisting Concrete Frame
Sample Example

```
$HEADING DATA
/SAMPLE EXAMPLE FOR CONKER MANUAL      UNITS:KIP-INCH-SECOND
/SPECIAL MOMENT RESISTING CONCRETE FRAME
$
$CONTROL DATA
2 1 1 2 4 0 2 1 2 0 0 1 0 0 1 2 0 1 0
386.4 0 0 3
$
$MASS DATA
1 1 1/386.4
.1/144  0  0  60*12 30*12
2 1 1/386.4
.1/144  0  7.5*12 60*12 15*12
$
$STORY DATA
ROOF 120 1
1ST 144  2
$
$MATERIAL PROPERTY DATA
1 C 3600*0.40 .150/1728 .15 60 4 40  $ for columns
2 C 3600*0.50 .150/1728 .15 60 4 40  $ for beams
$
$COLUMN SECTION PROPERTY DATA
1 1 RECT    18 18
$
$BEAM SECTION PROPERTY DATA
1 2 RECT    24 0 12
2 2 RECT    16 0 12
$
$FRAME HEADING
/MAIN FRAME
$
$FRAME CONTROL DATA
1 2 8 8 0 0 0 2
$
$COLUMN LINE COORDINATES AND ORIENTATION
1 -360 180
2 0 180
3 360 180
4 -360 0
5 360 0
6 -360 -180
7 0 -180
8 360 -180
1 1 2
2 2 3
3 6 7
4 7 8
5 3 5
6 5 8
7 1 4
8 4 6
$
$BEAM SPAN VERTICAL LOADING PATTERNS
1 0 1/12
2 0 0.5/12
```

ETABS Input Data File EXCON

```
$
$COLUMN ASSIGNMENT DATA
1 0 ROOF 1 1
2 1
3 1
4 1
5 1
6 0 ROOF 1 0 0 0
6 0 1ST 1 0 0 1
7 6
8 6

$BEAM ASSIGNMENT DATA
1 0 ROOF 1 1
2 1
3 0 ROOF 1
4 3
5 0 ROOF 2 1
6 5
7 5
8 5

$
$BEAM SPAN LOADING ASSIGNMENT DATA
1 0 ROOF 1 2 0 1
2 1
3 1
4 1

$
$FRAME LOCATION DATA
1 0 0 0 0 /MAIN FRAME
$
$STRUCTURAL STATIC LATERAL LOAD DATA
20 0 0 0 0 20
10 0 0 7.5*12 0 10
$
$LOAD CASE DEFINITION DATA
1  0  1
2  0  0  1
3  0  0  0  0  1
4  0  0  0  0  0  1
```

ETABS Input Data File EXCON (continued)

```
$HEADING DATA
/SAMPLE EXAMPLE FOR CONKER MANUAL
/SPECIAL MOMENT RESISTING CONCRETE FRAME
$
$CONTROL DATA
$ ICODE  NFR  NLC  LDC  LLC  NRMP  NRCP  NRBP  NCRV  NPTS  IPRI IPHI IUNIT IEX
      1    1    5    1    2     2     2     2     0     0    1    0    E    0
$ MBB  MBV  MCI  MCV  MJV  MJR
   1    1    1    1    1    1
$
$LOAD COMBINATION DEFINITION DATA
$L    LTYP     XI     XII   XIII     XA     XB    XD1    XD2    XD3
1        0    1.4     1.7    1.4
2        2    1.4     1.4    1.4    1.4    1.4
3        2    1.4     1.4    1.4   -1.4    1.4
4        2    0.9     0.0    0.9    1.4    1.4
5        2    0.9     0.0    0.9   -1.4    1.4
$
$MATERIAL PROPERTY REDEFINITION DATA
$MID  MTYPE    E              U     P   FY   FC   FYS   FCS
   1     C   3600  .150/1728  .15   60    4    40     4
   2     C   3600  .150/1728  .15   60    4    40     4
$
$COLUMN PROPERTY REDEFINITION DATA
$ID IMAT ITYPE   DMAJ  DMIN  DC   ABAR1   ABAR2
  1    1 RR-3-3   18     18   2        1       1
  2    1 RR-3-3   18     18   2
$
$BEAM PROPERTY REDEFINITION DATA
$ID IMAT ITYPE   DB  DA  BB  DS  BF  DCT  DCB  ATI  ABI  ATJ  ABJ
  1    2 RCB     24   0  12   0   0    2    2
  2    2 RCB     16   0  12   0   0    2    2
$
$FRAME DESIGN ACTIVATION DATA
$IFRN ITYP IRCP IRBP  ALPHA
    1    1    1    0   1.25
$COLUMN ELEMENT REASSIGNMENT DATA
$NT  NSAME  MC1  MC2    SD1    SD2    P1  P2  P3  P4
  I      0    1    8   ROOF   ROOF     2
```

CONKER Input Data File DESCON

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    1
                                  ETABS_FILE:EXCON.PST/CONKER_FILE:DESCON.CNK
/SAMPLE EXAMPLE FOR CONKER MANUAL
/SPECIAL MOMENT RESISTING CONCRETE FRAME

DESIGN CODE TYPE---------------------------      1 (UBC 1991 CONCRETE)

NUMBER OF FRAMES TO BE DESIGNED/CHECKED----      1
NUMBER OF LOAD COMBINATIONS----------------      5

ETABS DEAD LOAD CONDITION NUMBER-----------      1
ETABS LIVE LOAD CONDITION NUMBER-----------      2

NUMBER OF REDEFINED MATERIAL PROPERTIES----      2
NUMBER OF COLUMN DESIGN PROPERTY SETS------      2
NUMBER OF BEAM DESIGN PROPERTY SETS--------      2

NUMBER OF CURVES PER INTERACTION VOLUME----      5
NUMBER OF POINTS PER INTERACTION CURVE-----     11
CODE FOR PRINTING INTERACTION CURVES-------      1

CODE FOR UNITY PHI FACTOR OVER RIDE--------      0

TYPE OF UNITS (ENGLISH, MKS OR SI)---------      E

EXECUTION MODE-----------------------------      0
FLAG FOR MAP OF BEAM FLEXURAL STEEL--------      1
FLAG FOR MAP OF BEAM SHEAR STEEL-----------      1
FLAG FOR MAP OF COLUMN DESIGN/CHECK--------      1
FLAG FOR MAP OF COLUMN SHEAR STEEL---------      1
FLAG FOR MAP OF JOINT SHEAR STRESS RATIOS--      1
FLAG FOR MAP OF B/C MOMENT CAPACITY RATIOS-      1
```

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    2
                                       ETABS_FILE:EXCON.PST/CONKER_FILE:DESCON.CNK
/SAMPLE EXAMPLE FOR CONKER MANUAL
/SPECIAL MOMENT RESISTING CONCRETE FRAME


DESIGN LOADING COMBINATION DATA

LOAD TYPE        I       II      III        A        B    DYN-1    DYN-2  DYN-3
   1    0    1.400    1.700    1.400     .000     .000     .000     .000   .000
   2    2    1.400    1.400    1.400    1.400    1.400     .000     .000   .000
   3    2    1.400    1.400    1.400   -1.400    1.400     .000     .000   .000
   4    2     .900     .000     .900    1.400    1.400     .000     .000   .000
   5    2     .900     .000     .900   -1.400    1.400     .000     .000   .000
```

Sample Output from CONKER (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE     3
                              ETABS_FILE:EXCON.PST/CONKER_FILE:DESCON.CNK
/SAMPLE EXAMPLE FOR CONKER MANUAL
/SPECIAL MOMENT RESISTING CONCRETE FRAME


MATERIAL PROPERTIES

MAT  MAT    ELASTIC       UNIT  POISSONS     YIELD  STRENGTH     YIELD  STRENGTH
 ID TYPE    MODULUS     WEIGHT     RATIO        FY        FC       FYS       FCS
              (Ksi)   (K/cuin)               (Ksi)     (Ksi)     (Ksi)     (Ksi)

  1     C  .360E+04  .868E-04  .150E+00  .600E+02  .400E+01 .400E+02  .400E+01
  2     C  .360E+04  .868E-04  .150E+00  .600E+02  .400E+01 .400E+02  .400E+01
```

Sample Output from CONKER (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    4
                                   ETABS_FILE:EXCON.PST/CONKER_FILE:DESCON.CNK
/SAMPLE EXAMPLE FOR CONKER MANUAL
/SPECIAL MOMENT RESISTING CONCRETE FRAME


SECTION PROPERTIES FOR COLUMNS

SECT  MAT SECTION             MAJOR     MINOR CONCRETE  AREA OF  AREA OF
  ID   ID TYPE                  DIM       DIM    COVER  BARS  1  BARS 2
                               (in)      (in)     (in)   (sqin)  (sqin)

   1    1 RR-3-3            18.0000   18.0000  2.00000  1.00000 1.00000
   2    1 RR-3-3            18.0000   18.0000  2.00000   .00000  .00000
```

Sample Output from CONKER (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    5
                                 ETABS_FILE:EXCON.PST/CONKER_FILE:DESCON.CNK
/SAMPLE EXAMPLE FOR CONKER MANUAL
/SPECIAL MOMENT RESISTING CONCRETE FRAME


SECTION PROPERTIES FOR BEAMS

SECT  MAT SECT      DEPTH     DEPTH      BEAM      SLAB      SLAB      TOP   BOTTOM
  ID   ID TYPE      BELOW     ABOVE     WIDTH     THICK     WIDTH    COVER    COVER
                     (in)      (in)      (in)      (in)      (in)     (in)     (in)

   1    2 RCB     24.0000     .0000   12.0000     .0000     .0000 2.00000  2.00000
   2    2 RCB     16.0000     .0000   12.0000     .0000     .0000 2.00000  2.00000
```

Sample Output from CONKER (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    6
                                    ETABS_FILE:EXCON.PST/CONKER_FILE:DESCON.CNK
/SAMPLE EXAMPLE FOR CONKER MANUAL
/SPECIAL MOMENT RESISTING CONCRETE FRAME


SECTION PROPERTIES FOR BEAMS

SECT      TOP STEEL    BOT STEEL    TOP STEEL    BOT STEEL
 ID           END-I        END-I        END-J        END-J
             (sqin)       (sqin)       (sqin)       (sqin)

  1      .0000E+00    .0000E+00    .0000E+00    .0000E+00
  2      .0000E+00    .0000E+00    .0000E+00    .0000E+00
```

Sample Output from CONKER (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    7
                                     ETABS_FILE:EXCON.PST/CONKER_FILE:DESCON.CNK
/SAMPLE EXAMPLE FOR CONKER MANUAL
/SPECIAL MOMENT RESISTING CONCRETE FRAME

FRAME NUMBER-------------------------------        1

FRAMING TYPE-------------------------------        1 (SEISMIC)

COLUMN PROPERTY REASSIGNMENT FLAG----------        1
BEAM PROPERTY REASSIGNMENT FLAG------------        0

YIELD OVERSTRENGTH FACTOR------------------     1.25


FRAME ID NUMBER----------------------------        1
NUMBER OF STORY LEVELS---------------------        2
NUMBER OF COLUMN LINES---------------------        8
NUMBER OF BAYS-----------------------------        8
NUMBER OF BRACING ELEMENTS-----------------        0
NUMBER OF PANEL ELEMENTS-------------------        0
NUMBER OF COLUMN LATERAL LOAD PATTERNS-----        0
NUMBER OF BEAM SPAN LOAD PATTERNS----------        2
MAXIMUM NUMBER OF LOADS PER BEAM SPAN------        0

REASSIGNED COLUMN PROPERTY ID*S

LEVEL        1   2   3   4   5   6   7   8

ROOF         2   2   2   2   2   2   2   2
1ST          1   1   1   1   1   1   1   1

SPECIFIED COLUMN LIVE LOAD REDUCTION FACTORS

ALL ELEMENTS HAVE THIS OPTION SPECIFIED AS      1.000

SPECIFIED COLUMN MAJOR MM-FACTOR (SIDESWAY)

ALL ELEMENTS HAVE THIS OPTION SPECIFIED AS       .000

SPECIFIED COLUMN MINOR MM-FACTOR (SIDESWAY)

ALL ELEMENTS HAVE THIS OPTION SPECIFIED AS       .000

SPECIFIED COLUMN MAJOR MM-FACTOR (NO-SIDESWAY)

ALL ELEMENTS HAVE THIS OPTION SPECIFIED AS       .000

SPECIFIED COLUMN MINOR MM-FACTOR (NO-SIDESWAY)

ALL ELEMENTS HAVE THIS OPTION SPECIFIED AS       .000
```

Sample Output from CONKER (continued)

CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS PAGE 8
ETABS_FILE:EXCON.PST/CONKER_FILE:DESCON.CNK
/SAMPLE EXAMPLE FOR CONKER MANUAL
/SPECIAL MOMENT RESISTING CONCRETE FRAME

DESIGN OF BEAM ELEMENTS (UBC 1991 CONCRETE)

FRAME ID .... /MAIN FRAME
LEVEL ID .... ROOF

BAY ID	BEAM SIZE WIDTH X DEPTH (in) (in)	STRESS POINT	/-FACTORED -MOMENT (K-in)	LOADS & +MOMENT (K-in)	COMBOS-// SHEAR (K)	--REQUIRED M(top) (sqin)	REBAR M(bot) (sqin)	--/ V(/ft) (sqin)
1	12.00 X 24.00							
		END I	1861 < 3>	930 < 0>	39 < 5>	1.66	.88	.16
		1/4-PT	663 < 0>	828 < 2>	26 < 5>	.88	.88	.41
		MIDDLE	663 < 0>	1250 < 1>	16 < 5>	.88	1.09	.26
		3/4-PT	663 < 0>	362 < 2>	29 < 5>	.88	.88	.47
		END J	2653 < 3>	1326 < 0>	42 < 2>	2.43	1.16	.22
2	12.00 X 24.00							
		END I	2653 < 3>	1326 < 0>	42 < 2>	2.43	1.16	.22
		1/4-PT	663 < 0>	362 < 2>	29 < 5>	.88	.88	.47
		MIDDLE	663 < 0>	1250 < 1>	16 < 5>	.88	1.09	.26
		3/4-PT	663 < 0>	828 < 2>	26 < 5>	.88	.88	.41
		END J	1861 < 3>	930 < 0>	39 < 5>	1.66	.88	.16
3	12.00 X 24.00							
		END I	1219 < 3>	610 < 0>	37 < 5>	1.06	.88	.15
		1/4-PT	720 < 0>	1217 < 2>	25 < 5>	.88	1.06	.40
		MIDDLE	720 < 0>	1413 < 1>	19 < 5>	.88	1.24	.31
		3/4-PT	720 < 0>	360 < 0>	32 < 5>	.88	.88	.06
		END J	2878 < 3>	1439 < 0>	45 < 5>	2.66	1.26	.26
4	12.00 X 24.00							
		END I	2878 < 3>	1439 < 0>	45 < 5>	2.66	1.26	.26
		1/4-PT	720 < 0>	360 < 0>	32 < 5>	.88	.88	.06
		MIDDLE	720 < 0>	1413 < 1>	19 < 5>	.88	1.24	.31
		3/4-PT	720 < 0>	1217 < 2>	25 < 5>	.88	1.06	.40
		END J	1219 < 3>	610 < 0>	37 < 5>	1.06	.88	.15
5	12.00 X 16.00							
		END I	276 < 3>	249 < 4>	8 < 5>	.56	.56	.20
		1/4-PT	123 < 5>	163 < 2>	7 < 2>	.56	.56	.19
		MIDDLE	80 < 0>	62 < 0>	7 < 5>	.56	.56	.18
		3/4-PT	121 < 3>	108 < 4>	8 < 2>	.56	.56	.20
		END J	321 < 3>	186 < 4>	9 < 5>	.56	.56	.22
6	12.00 X 16.00							
		END I	323 < 3>	190 < 4>	9 < 2>	.56	.56	.22
		1/4-PT	122 < 3>	109 < 4>	8 < 5>	.56	.56	.20
		MIDDLE	81 < 0>	64 < 0>	7 < 2>	.56	.56	.18
		3/4-PT	127 < 5>	167 < 2>	7 < 2>	.56	.56	.19
		END J	283 < 3>	255 < 4>	8 < 5>	.56	.56	.20
7	12.00 X 16.00							
		END I	276 < 3>	249 < 4>	8 < 5>	.56	.56	.20
		1/4-PT	123 < 5>	163 < 2>	7 < 2>	.56	.56	.19
		MIDDLE	80 < 0>	62 < 0>	7 < 5>	.56	.56	.18
		3/4-PT	121 < 3>	108 < 4>	8 < 2>	.56	.56	.20
		END J	321 < 3>	186 < 4>	9 < 5>	.56	.56	.22

Sample Output from CONKER (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE     9
                                    ETABS_FILE:EXCON.PST/CONKER_FILE:DESCON.CNK
/SAMPLE EXAMPLE FOR CONKER MANUAL
/SPECIAL MOMENT RESISTING CONCRETE FRAME

DESIGN OF BEAM ELEMENTS    (UBC 1991 CONCRETE)

FRAME ID .... /MAIN FRAME
LEVEL ID .... ROOF

 BAY      BEAM SIZE STRESS /-FACTORED  LOADS  & COMBOS-//--REQUIRED  REBAR--/
  ID WIDTH X DEPTH  POINT    -MOMENT    +MOMENT       SHEAR M(top) M(bot) V(/ft)
     (in)    (in)            (K-in)     (K-in)          (K) (sqin) (sqin) (sqin)
   8 12.00 X 16.00
                     END I   323 < 3>  190 < 4>     9 < 2>    .56     .56    .22
                    1/4-PT   122 < 3>  109 < 4>     8 < 5>    .56     .56    .20
                    MIDDLE    81 < 0>   64 < 0>     7 < 2>    .56     .56    .18
                    3/4-PT   127 < 5>  167 < 2>     7 < 2>    .56     .56    .19
                     END J   283 < 3>  255 < 4>     8 < 5>    .56     .56    .20
```

Sample Output from CONKER (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE   10
                                     ETABS_FILE:EXCON.PST/CONKER_FILE:DESCON.CNK
/SAMPLE EXAMPLE FOR CONKER MANUAL
/SPECIAL MOMENT RESISTING CONCRETE FRAME

DESIGN OF BEAM ELEMENTS   (UBC 1991 CONCRETE)

FRAME ID .... /MAIN FRAME
LEVEL ID .... 1ST

 BAY     BEAM SIZE STRESS /-FACTORED  LOADS  & COMBOS-//--REQUIRED  REBAR--/
  ID WIDTH X DEPTH  POINT    -MOMENT    +MOMENT      SHEAR M(top) M(bot) V(/ft)
     (in)    (in)            (K-in)     (K-in)         (K) (sqin) (sqin) (sqin)
   1 12.00 X 24.00
                     END I  2274 < 3> 1137 < 0>   40 < 2>  2.06    .99    .19
                    1/4-PT   689 < 0>  813 < 2>   27 < 2>   .88    .88    .44
                    MIDDLE   689 < 0> 1193 < 1>   17 < 5>   .88   1.04    .27
                    3/4-PT   689 < 0>  474 < 2>   29 < 2>   .88    .88    .47
                     END J  2756 < 3> 1378 < 0>   42 < 2>  2.53   1.21    .22
   2 12.00 X 24.00
                     END I  2756 < 3> 1378 < 0>   42 < 2>  2.53   1.21    .22
                    1/4-PT   689 < 0>  474 < 2>   29 < 2>   .88    .88    .47
                    MIDDLE   689 < 0> 1193 < 1>   17 < 5>   .88   1.04    .27
                    3/4-PT   689 < 0>  813 < 2>   27 < 2>   .88    .88    .44
                     END J  2274 < 3> 1137 < 0>   40 < 2>  2.06    .99    .19
   5 12.00 X 16.00
                     END I   415 < 3>  372 < 4>    8 < 5>   .57    .56    .21
                    1/4-PT   192 < 5>  224 < 2>    8 < 2>   .56    .56    .19
                    MIDDLE   109 < 0>   93 < 0>    7 < 2>   .56    .56    .19
                    3/4-PT   177 < 3>  172 < 4>    8 < 5>   .56    .56    .20
                     END J   436 < 3>  316 < 4>    9 < 2>   .59    .56    .22
   6 12.00 X 16.00
                     END I   432 < 3>  317 < 4>    9 < 2>   .59    .56    .22
                    1/4-PT   176 < 3>  172 < 4>    8 < 5>   .56    .56    .20
                    MIDDLE   108 < 0>   92 < 0>    7 < 2>   .56    .56    .19
                    3/4-PT   191 < 5>  221 < 2>    8 < 2>   .56    .56    .19
                     END J   416 < 3>  369 < 4>    8 < 5>   .57    .56    .21
   7 12.00 X 16.00
                     END I   415 < 3>  372 < 4>    8 < 5>   .57    .56    .21
                    1/4-PT   192 < 5>  224 < 2>    8 < 2>   .56    .56    .19
                    MIDDLE   109 < 0>   93 < 0>    7 < 2>   .56    .56    .19
                    3/4-PT   177 < 3>  172 < 4>    8 < 5>   .56    .56    .20
                     END J   436 < 3>  316 < 4>    9 < 2>   .59    .56    .22
   8 12.00 X 16.00
                     END I   432 < 3>  317 < 4>    9 < 2>   .59    .56    .22
                    1/4-PT   176 < 3>  172 < 4>    8 < 5>   .56    .56    .20
                    MIDDLE   108 < 0>   92 < 0>    7 < 2>   .56    .56    .19
                    3/4-PT   191 < 5>  221 < 2>    8 < 2>   .56    .56    .19
                     END J   416 < 3>  369 < 4>    8 < 5>   .57    .56    .21
```

Sample Output from CONKER (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE   11
                                 ETABS_FILE:EXCON.PST/CONKER_FILE:DESCON.CNK
/SAMPLE EXAMPLE FOR CONKER MANUAL
/SPECIAL MOMENT RESISTING CONCRETE FRAME

DESIGN OF COLUMN ELEMENTS    (UBC 1991 CONCRETE)

FRAME ID .... /MAIN FRAME
LEVEL ID .... ROOF

COL   COLUMN SIZE  STR /------MOMENT INTERACTION------/ /----SHEAR DESIGN----/
 ID MAJOR X MINOR  PT      PU    MMAJ    MMIN COMBO REBAR  DIRN    VU COMBO A(/ft)
     (in)    (in)          (K) (K-in) (K-in)       (sqin)         (K)       (sqin)
  1 18.00 X 18.00                                          MAJOR   33 < 0>    .73
     RR-3-3                                                MINOR    7 < 0>    .15
                   TOP     16    2233       0  < 0>  5.75
                   BOT     37    1466     163  < 3>  3.26
  2 18.00 X 18.00                                          MAJOR   67 < 0>   1.47
     RR-3-3                                                MINOR    1 < 4>    .02
                   TOP     89    4775       0  < 0> 13.83
                   BOT     40    2255       0  < 0>  5.58
  3 18.00 X 18.00                                          MAJOR   33 < 0>    .73
     RR-3-3                                                MINOR    7 < 0>    .15
                   TOP     16    2233       0  < 0>  5.75
                   BOT     37    1466     163  < 3>  3.26
  4 18.00 X 18.00                                          MAJOR    2 < 3>    .05
     RR-3-3                                                MINOR   14 < 0>    .31
                   TOP      6      78     412  < 5>  3.24
                   BOT      6     140     365  < 5>  3.24
  5 18.00 X 18.00                                          MAJOR    2 < 2>    .05
     RR-3-3                                                MINOR   14 < 0>    .31
                   TOP      6      78     412  < 5>  3.24
                   BOT      6     140     365  < 5>  3.24
  6 18.00 X 18.00                                          MAJOR   13 < 0>    .28
     RR-3-3                                                MINOR    7 < 0>    .15
                   TOP     16    1463       0  < 0>  3.57
                   BOT     16     133     160  < 5>  3.24
  7 18.00 X 18.00                                          MAJOR   45 < 0>    .98
     RR-3-3                                                MINOR    1 < 5>    .02
                   TOP     95    5181       0  < 0> 15.26
                   BOT     43      56      93  < 5>  3.24
  8 18.00 X 18.00                                          MAJOR   13 < 0>    .28
     RR-3-3                                                MINOR    7 < 0>    .15
                   TOP     16    1463       0  < 0>  3.57
                   BOT     16     133     160  < 5>  3.24
```

Sample Output from CONKER (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE   12
                                        ETABS_FILE:EXCON.PST/CONKER_FILE:DESCON.CNK
/SAMPLE EXAMPLE FOR CONKER MANUAL
/SPECIAL MOMENT RESISTING CONCRETE FRAME

STRESS CHECK OF COLUMN ELEMENTS   (UBC 1991 CONCRETE)

FRAME ID .... /MAIN FRAME
LEVEL ID .... 1ST

COL   COLUMN SIZE STR /------MOMENT INTERACTION------/ /----SHEAR DESIGN----/
 ID MAJOR X MINOR  PT      PU   MMAJ   MMIN COMBO RATIO  DIRN    VU COMBO A(/ft)
     (in)    (in)         (K) (K-in) (K-in)                      (K)      (sqin)
  1 18.00 X 18.00                                        MAJOR   23 < 0>     .52
     RR-3-3                                              MINOR    6 < 4>     .13
                  TOP      94    758    206  < 2>   .26
                  BOT      74    958    564  < 3>   .39
  2 18.00 X 18.00                                        MAJOR   43 < 0>     .17
     RR-3-3                                              MINOR    4 < 2>     .00
                  TOP     168    404    192  < 2>   .22
                  BOT     168    734    472  < 2>   .33
  3 18.00 X 18.00                                        MAJOR   23 < 0>     .52
     RR-3-3                                              MINOR    6 < 4>     .13
                  TOP      94    758    206  < 2>   .26
                  BOT      74    958    564  < 3>   .39
  4 18.00 X 18.00                                        MAJOR    5 < 2>     .10
     RR-3-3                                              MINOR    9 < 0>     .19
                  TOP      19    153    324  < 3>   .13
                  BOT      20    527    629  < 2>   .30
  5 18.00 X 18.00                                        MAJOR    5 < 3>     .10
     RR-3-3                                              MINOR    9 < 0>     .19
                  TOP      19    153    324  < 3>   .13
                  BOT      20    527    629  < 2>   .30
  6 18.00 X 18.00                                        MAJOR   13 < 0>     .28
     RR-3-3                                              MINOR    6 < 3>     .13
                  TOP      54    323    212  < 2>   .14
                  BOT      54    951    558  < 2>   .39
  7 18.00 X 18.00                                        MAJOR   45 < 0>     .98
     RR-3-3                                              MINOR    1 < 5>     .02
                  TOP     101    130    133  < 1>   .12
                  BOT      96    535    257  < 2>   .21
  8 18.00 X 18.00                                        MAJOR   13 < 0>     .28
     RR-3-3                                              MINOR    6 < 3>     .13
                  TOP      54    323    212  < 2>   .14
                  BOT      54    951    558  < 2>   .39
```

Sample Output from CONKER (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE   13
                                   ETABS_FILE:EXCON.PST/CONKER_FILE:DESCON.CNK
/SAMPLE EXAMPLE FOR CONKER MANUAL
/SPECIAL MOMENT RESISTING CONCRETE FRAME

BEAM-COLUMN JOINT ANALYSIS    (UBC 1991 CONCRETE)

FRAME ID .... /MAIN FRAME
LEVEL ID .... ROOF
```

COL ID	JOINT DIRN	SHEAR FORCE (K)	EFFECTV AREA (sqin)	SHEAR STRESS (Ksi)	ALLOW STRESS (Ksi)	STRESS RATIO	BEAM/COLUMN STRENGTH RATIO
1	MAJOR	124.38	324.00	.384	.645	.595	.834
	MINOR	42.00	324.00	.130	.645	.201	.184
2	MAJOR	269.38	324.00	.831	.806	CHK#3	.832
	MINOR	.00	324.00	.000	.806	.000	.000
3	MAJOR	124.38	324.00	.384	.645	.595	.834
	MINOR	42.00	324.00	.130	.645	.201	.184
4	MAJOR	.00	324.00	.000	.806	.000	.000
	MINOR	84.00	324.00	.259	.806	.322	.629
5	MAJOR	.00	324.00	.000	.806	.000	.000
	MINOR	84.00	324.00	.259	.806	.322	.629
6	MAJOR	79.82	324.00	.246	.645	.382	.834
	MINOR	42.00	324.00	.130	.645	.201	.281
7	MAJOR	294.31	324.00	.908	.806	CHK#3	.832
	MINOR	.00	324.00	.000	.806	.000	.000
8	MAJOR	79.82	324.00	.246	.645	.382	.834
	MINOR	42.00	324.00	.130	.645	.201	.281

Sample Output from CONKER (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE   14
                                    ETABS_FILE:EXCON.PST/CONKER_FILE:DESCON.CNK
/SAMPLE EXAMPLE FOR CONKER MANUAL
/SPECIAL MOMENT RESISTING CONCRETE FRAME

BEAM-COLUMN JOINT ANALYSIS   (UBC 1991 CONCRETE)

FRAME ID .... /MAIN FRAME
LEVEL ID .... 1ST
```

COL ID	JOINT DIRN	SHEAR FORCE (K)	EFFECTV AREA (sqin)	SHEAR STRESS (Ksi)	ALLOW STRESS (Ksi)	STRESS RATIO	BEAM/COLUMN STRENGTH RATIO
1	MAJOR	130.67	324.00	.403	.645	.625	.509
	MINOR	38.11	324.00	.118	.645	.182	.093
2	MAJOR	238.04	324.00	.735	.806	.911	.772
	MINOR	.00	324.00	.000	.806	.000	.000
3	MAJOR	130.67	324.00	.403	.645	.625	.509
	MINOR	38.11	324.00	.118	.645	.182	.093
4	MAJOR	.00	324.00	.000	.806	.000	.000
	MINOR	77.78	324.00	.240	.806	.298	.192
5	MAJOR	.00	324.00	.000	.806	.000	.000
	MINOR	77.78	324.00	.240	.806	.298	.192
6	MAJOR	.00	324.00	.000	.645	.000	.000
	MINOR	38.18	324.00	.118	.645	.183	.093
7	MAJOR	.00	324.00	.000	.645	.000	.000
	MINOR	.00	324.00	.000	.645	.000	.000
8	MAJOR	.00	324.00	.000	.645	.000	.000
	MINOR	38.18	324.00	.118	.645	.183	.093

Sample Output from CONKER (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    1
                                ETABS_FILE:EXCON.PST/CONKER_FILE:DESCON.COL
/SAMPLE EXAMPLE FOR CONKER MANUAL
/SPECIAL MOMENT RESISTING CONCRETE FRAME


LOAD MOMENT INTERACTION DIAGRAM
NEUTRAL AXIS INCLINATION NUMBER  1

SECTION PROPERTY ID----------          1
SECTION PROPERTY TYPE--------     RR-3-3   ( 8 BARS)
MAJOR DIMENSION--------------  18.000000        (in)
MINOR DIMENSION--------------  18.000000        (in)
CONCRETE COVER---------------   2.000000        (in)
AREA OF BARS 1---------------   1.000000      (sqin)
AREA OF BARS 2---------------   1.000000      (sqin)
```

	/---------PHI INCLUDED	---------/		/-----------PHI=1.00	-----------/		
PT NO	AXIAL LOAD (K)	MAJOR MOMENT (K-in)	MINOR MOMENT (K-in)	AXIAL LOAD (K)	MAJOR MOMENT (K-in)	MINOR MOMENT (K-in)	
1	870.5	.0	.0	1243.5	.0	.0	
2	870.5	1372.0	.0	1243.5	1960.0	.0	
3	768.4	2039.0	.0	1097.7	2912.9	.0	
4	649.9	2537.4	.0	928.5	3624.9	.0	
5	508.4	2997.5	.0	726.2	4282.2	.0	
6	339.0	3429.7	.0	484.2	4899.5	.0	(PB,MB)
7	245.8	3308.6	.0	351.2	4726.5	.0	
8	122.8	3068.4	.0	172.9	4318.8	.0	
9	8.9	3108.3	.0	10.0	3507.1	.0	
10	-194.5	1768.5	.0	-216.1	1965.0	.0	
11	-432.0	.0	.0	-480.0	.0	.0	

Sample Output from CONKER (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE   46
                                    ETABS_FILE:EXCON.PST/CONKER_FILE:DESCON.COL
/SAMPLE EXAMPLE FOR CONKER MANUAL
/SPECIAL MOMENT RESISTING CONCRETE FRAME

DESIGN OF COLUMN ELEMENTS    (UBC 1991 CONCRETE)

FRAME ID .... /MAIN FRAME
LEVEL ID .... ROOF

COL STRESS        /DELTA(B)-FACTOR//----FAILURE SURFACE POINT---/
 ID  POINT            MAJOR  MINOR          PCA      MCMAJ      MCMIN
                                            (K)     (K-in)     (K-in)
  1
      TOP              1.00   1.00           16       2233          0
      BOT              1.00   1.00           37       1466        163
  2
      TOP              1.00   1.00           89       4775          0
      BOT              1.00   1.00           40       2255          0
  3
      TOP              1.00   1.00           16       2233          0
      BOT              1.00   1.00           37       1466        163
  4
      TOP              1.00   1.00            6         78        412
      BOT              1.00   1.00            6        140        365
  5
      TOP              1.00   1.00            6         78        412
      BOT              1.00   1.00            6        140        365
  6
      TOP              1.00   1.00           16       1463          0
      BOT              1.02   1.00           16        133        160
  7
      TOP              1.00   1.00           95       5181          0
      BOT              1.06   1.07           43         56         93
  8
      TOP              1.00   1.00           16       1463          0
      BOT              1.02   1.00           16        133        160
```

Sample Output from CONKER (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE   47
                         ETABS_FILE:EXCON.PST/CONKER_FILE:DESCON.COL
/SAMPLE EXAMPLE FOR CONKER MANUAL
/SPECIAL MOMENT RESISTING CONCRETE FRAME

STRESS CHECK OF COLUMN ELEMENTS    (UBC 1991 CONCRETE)

FRAME ID .... /MAIN FRAME
LEVEL ID .... 1ST

COL STRESS       /DELTA(B)-FACTOR//----FAILURE SURFACE POINT---/
 ID  POINT           MAJOR  MINOR         PCA      MCMAJ      MCMIN
                                          (K)     (K-in)     (K-in)
  1
       TOP            1.00   1.00         365       2933        798
       BOT            1.00   1.00         189       2434       1435
  2
       TOP            1.05   1.00         753       1806        859
       BOT            1.05   1.00         512       2234       1435
  3
       TOP            1.00   1.00         365       2933        798
       BOT            1.00   1.00         189       2434       1435
  4
       TOP            1.00   1.00         153       1210       2562
       BOT            1.00   1.00          65       1763       2103
  5
       TOP            1.00   1.00         153       1210       2562
       BOT            1.00   1.00          65       1763       2103
  6
       TOP            1.06   1.02         389       2351       1546
       BOT            1.06   1.02         136       2417       1418
  7
       TOP            1.13   1.16         833       1072       1102
       BOT            1.12   1.15         449       2514       1205
  8
       TOP            1.06   1.02         389       2351       1546
       BOT            1.06   1.02         136       2417       1418
```

Sample Output from CONKER (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    1
                                        ETABS_FILE:EXCON.PST/CONKER_FILE:DESCON.MAP
/SAMPLE EXAMPLE FOR CONKER MANUAL
/SPECIAL MOMENT RESISTING CONCRETE FRAME

FRAME ID .... /MAIN FRAME

MAP OF BEAM FLEXURAL TOP STEEL (sqin)  (UBC 1991 CONCRETE)

          BEAM      1      2      3      4      5      6      7     8
LEVEL

ROOF               2.4    2.4    2.7    2.7     .6     .6     .6    .6

1ST                2.5    2.5                   .6     .6     .6    .6

LEVEL
          BEAM      1      2      3      4      5      6      7     8
```

Sample Output from CONKER (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    2
                              ETABS_FILE:EXCON.PST/CONKER_FILE:DESCON.MAP
/SAMPLE EXAMPLE FOR CONKER MANUAL
/SPECIAL MOMENT RESISTING CONCRETE FRAME

FRAME ID .... /MAIN FRAME

MAP OF BEAM FLEXURAL BOTTOM STEEL (sqin)  (UBC 1991 CONCRETE)

            BEAM      1      2      3      4      5      6      7     8
LEVEL

ROOF                 1.2    1.2    1.3    1.3     .6     .6     .6    .6

1ST                  1.2    1.2                   .6     .6     .6    .6

LEVEL
            BEAM      1      2      3      4      5      6      7     8
```

Sample Output from CONKER (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    3
                              ETABS_FILE:EXCON.PST/CONKER_FILE:DESCON.MAP
/SAMPLE EXAMPLE FOR CONKER MANUAL
/SPECIAL MOMENT RESISTING CONCRETE FRAME

FRAME ID .... /MAIN FRAME

MAP OF BEAM SHEAR STEEL (sqin)(/ft)  (UBC 1991 CONCRETE)

          BEAM      1      2      3      4      5      6      7      8
LEVEL

ROOF               .47    .47    .40    .40    .22    .22    .22    .22

1ST                .47    .47                  .22    .22    .22    .22

LEVEL
          BEAM      1      2      3      4      5      6      7      8
```

Sample Output from CONKER (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    4
                                      ETABS_FILE:EXCON.PST/CONKER_FILE:DESCON.MAP
/SAMPLE EXAMPLE FOR CONKER MANUAL
/SPECIAL MOMENT RESISTING CONCRETE FRAME

FRAME ID .... /MAIN FRAME

MAP OF COLUMN LONGITUDINAL STEEL (sqin)  (UBC 1991 CONCRETE)

        COLUMN       1      2      3      4      5      6      7      8
LEVEL

ROOF                5.8   13.8    5.8    3.2    3.2    3.6   15.3    3.6

1ST                 N/C    N/C    N/C    N/C    N/C    N/C    N/C    N/C

LEVEL
        COLUMN       1      2      3      4      5      6      7      8
```

Sample Output from CONKER (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    5
                                   ETABS_FILE:EXCON.PST/CONKER_FILE:DESCON.MAP
/SAMPLE EXAMPLE FOR CONKER MANUAL
/SPECIAL MOMENT RESISTING CONCRETE FRAME

FRAME ID .... /MAIN FRAME

MAP OF COLUMN SHEAR STEEL  (MAJOR) (sqin)(/ft)  (UBC 1991 CONCRETE)

        COLUMN      1      2      3      4      5      6      7     8
LEVEL

ROOF              .73   1.47    .73    .05    .05    .28    .98   .28

1ST               N/C    N/C    N/C    N/C    N/C    N/C    N/C   N/C

LEVEL
        COLUMN      1      2      3      4      5      6      7     8
```

Sample Output from CONKER (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    6
                              ETABS_FILE:EXCON.PST/CONKER_FILE:DESCON.MAP
/SAMPLE EXAMPLE FOR CONKER MANUAL
/SPECIAL MOMENT RESISTING CONCRETE FRAME

FRAME ID .... /MAIN FRAME

MAP OF COLUMN SHEAR STEEL  (MINOR) (sqin)(/ft)  (UBC 1991 CONCRETE)

         COLUMN        1      2      3      4      5      6      7      8
LEVEL

ROOF                 .15    .02    .15    .31    .31    .15    .02    .15

1ST                  N/C    N/C    N/C    N/C    N/C    N/C    N/C    N/C

LEVEL
         COLUMN        1      2      3      4      5      6      7      8
```

Sample Output from CONKER (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    7
                                    ETABS_FILE:EXCON.PST/CONKER_FILE:DESCON.MAP
/SAMPLE EXAMPLE FOR CONKER MANUAL
/SPECIAL MOMENT RESISTING CONCRETE FRAME

FRAME ID .... /MAIN FRAME

MAP OF COLUMN INTERACTION CAPACITY RATIOS  (UBC 1991 CONCRETE)

         COLUMN       1      2      3      4      5      6      7      8
LEVEL

ROOF                N/C    N/C    N/C    N/C    N/C    N/C    N/C    N/C

1ST                .393   .329   .393   .299   .299   .393   .213   .393

LEVEL
         COLUMN       1      2      3      4      5      6      7      8
```

Sample Output from CONKER (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    8
                                      ETABS_FILE:EXCON.PST/CONKER_FILE:DESCON.MAP
/SAMPLE EXAMPLE FOR CONKER MANUAL
/SPECIAL MOMENT RESISTING CONCRETE FRAME

FRAME ID .... /MAIN FRAME

MAP OF COLUMN SHEAR STEEL  (MAJOR) (sqin)(/ft)  (UBC 1991 CONCRETE)

        COLUMN       1       2       3       4       5       6       7      8
LEVEL

ROOF                N/C     N/C     N/C     N/C     N/C     N/C     N/C    N/C

1ST                 .52     .17     .52     .10     .10     .28     .98    .28

LEVEL
        COLUMN       1       2       3       4       5       6       7      8
```

Sample Output from CONKER (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE     9
                         ETABS_FILE:EXCON.PST/CONKER_FILE:DESCON.MAP
/SAMPLE EXAMPLE FOR CONKER MANUAL
/SPECIAL MOMENT RESISTING CONCRETE FRAME

FRAME ID .... /MAIN FRAME

MAP OF COLUMN SHEAR STEEL  (MINOR) (sqin)(/ft)  (UBC 1991 CONCRETE)

        COLUMN       1      2      3      4      5      6      7     8
LEVEL

ROOF                N/C    N/C    N/C    N/C    N/C    N/C    N/C   N/C

1ST                 .13    .00    .13    .19    .19    .13    .02   .13

LEVEL
        COLUMN       1      2      3      4      5      6      7     8
```

Sample Output from CONKER (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE   10
                              ETABS_FILE:EXCON.PST/CONKER_FILE:DESCON.MAP
/SAMPLE EXAMPLE FOR CONKER MANUAL
/SPECIAL MOMENT RESISTING CONCRETE FRAME

FRAME ID .... /MAIN FRAME

MAP OF JOINT SHEAR STRESS RATIOS  (MAJOR)  (UBC 1991 CONCRETE)

         COLUMN      1      2      3      4      5      6      7      8
LEVEL

ROOF                .60    O/S    .60    .00    .00    .38    O/S    .38

1ST                 .63    .91    .63    .00    .00    .00    .00    .00

LEVEL
         COLUMN      1      2      3      4      5      6      7      8
```

Sample Output from CONKER (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE   11
                              ETABS_FILE:EXCON.PST/CONKER_FILE:DESCON.MAP
/SAMPLE EXAMPLE FOR CONKER MANUAL
/SPECIAL MOMENT RESISTING CONCRETE FRAME

FRAME ID .... /MAIN FRAME

MAP OF JOINT SHEAR STRESS RATIOS  (MINOR)  (UBC 1991 CONCRETE)

        COLUMN      1     2     3     4     5     6     7     8
LEVEL

ROOF               .20   .00   .20   .32   .32   .20   .00   .20

1ST                .18   .00   .18   .30   .30   .18   .00   .18

LEVEL
        COLUMN      1     2     3     4     5     6     7     8
```

Sample Output from CONKER (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE   12
                                    ETABS_FILE:EXCON.PST/CONKER_FILE:DESCON.MAP
/SAMPLE EXAMPLE FOR CONKER MANUAL
/SPECIAL MOMENT RESISTING CONCRETE FRAME

FRAME ID .... /MAIN FRAME

MAP OF B/C MOMENT CAPACITY RATIOS  (MAJOR)  (UBC 1991 CONCRETE)

         COLUMN       1      2      3      4      5      6      7      8
LEVEL

ROOF                .83    .83    .83    .00    .00    .83    .83    .83

1ST                 .51    .77    .51    .00    .00    .00    .00    .00

LEVEL
         COLUMN       1      2      3      4      5      6      7      8
```

Sample Output from CONKER (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE   13
                                      ETABS_FILE:EXCON.PST/CONKER_FILE:DESCON.MAP
/SAMPLE EXAMPLE FOR CONKER MANUAL
/SPECIAL MOMENT RESISTING CONCRETE FRAME

FRAME ID .... /MAIN FRAME

MAP OF B/C MOMENT CAPACITY RATIOS  (MINOR)  (UBC 1991 CONCRETE)

        COLUMN       1      2      3      4      5      6      7      8
LEVEL

ROOF                .18    .00    .18    .63    .63    .28    .00    .28

1ST                 .09    .00    .09    .19    .19    .09    .00    .09

LEVEL
        COLUMN       1      2      3      4      5      6      7      8
```

Sample Output from CONKER (continued)