COMPUTERS &
STRUCTURES
INC.

WALLER®

Design of Shear Wall Buildings

A Post Processor for ETABS®

Version 6.2
Revised May, 1997

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 WALLER. 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 PROGRAMS IS A VERY PRACTICAL TOOL FOR THE DESIGN OF CONCRETE AND MASONRY SHEAR WALL 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 AND MASONRY DESIGN THAT THE PROGRAM ALGORITHMS DO **NOT** ADDRESS.

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

Table of Contents

Chapter I

Introduction

WALLER is a concrete design post processor for the three-dimensional static and dynamic building analysis computer program ETABS.

The program is intended for the automated ACI code design [1] of shear wall structures that have been modeled for analysis using ETABS. Special seismic provisions in the ACI code and in the UBC94 [2] can be activated. An option for using the Canadian Concrete code [3] is also available.

The design is based upon user-specified loading combinations.

Most of the data required by WALLER 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 WALLER is very nominal and **if the program defaults are acceptable, no data input is required.**

The program options allow for the design of pier-spandrel systems, as well as isolated shear walls, including shear walls with special enlarged edge members. The program only designs planar portions of walls. It is important to utilize the ETABS option of separately obtaining the component forces on each planar portion of three-dimensional walls.

The walls (or piers) are designed for overturning moments and shear forces. The overturning effects may be processed in a check mode or a design mode. In the check mode the user specifics the distribution of the steel across the wall section and the program will check the adequacy of the wall section based upon the generation of a load-moment interaction diagram.

In the design mode the program will develop the trim steel required by the wall, based upon the axial forces and overturning moments, using an approximate conservative iterative technique.

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

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 over-stress. Backup design information, for convenient verification of the results produced by the program, is also provided.

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

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

Chapter II

Installation and Execution Procedure

This chapter deals with the installation and execution of WALLER on a Windows 95 or Windows NT 4.0 based computer system.

User familiarity with Windows is assumed.

WALLER is an add on concrete shearwall design postprocessor to the building analysis program ETABS. It is included in the ETABS Plus and ETABS Nonlinear packages.

A. Installing and Testing

The program provided must first be installed on the hard disk. Follow the instructions for installing the ETABS program 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 WALLER

WALLER is a post processor for the ETABS analysis program. Therefore, before running WALLER the user must generate an ETABS input data file and execute ETABS to create the ETABS post processing 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 EXWAL. A successful execution of ETABS with the data file EXWAL will create a post processing file EXWAL.PST.

The user may then also prepare a WALLER input data file using any text editor. This data file must conform to the specifications detailed in Chapter IV of this manual. This data file is not required if all program defaults are acceptable. Sample data is provided on the disk (filenames EXWAL for ETABS data and DESWAL for WALLER data) associated with the complete WALLER package.

C. Executing the WALLER Program

This section explains how to execute WALLER.

WALLER is a DOS program which can be run in a DOS window or can be launched from the Windows Icon.

Running WALLER in a DOS Window

To execute WALLER in a DOS window enter the following command at the DOS prompt:

WALLER ***etabsfile*** ***wallerfile***

Where ***etabsfile*** is the name of the ETABS input file which has already been run and for which the ETABS post processing file is available; and ***wallerfile*** is the name of the WALLER input file. If no WALLER input file is prepared because all program defaults were acceptable the ***wallerfile*** could be left blank. Both the ***etabsfile*** and the ***wallerfile*** can have paths included. Other command line options identical to options for executing ETABS (/M:nnnnn and /I) are also available. Refer to the ETABS manual for an explanation of these options.

As an example, say that ETABS has been run using an input data file named EXWAL, to create the post processing file EXWAL.PST; and that the data associated with the design of this structure for the WALLER postprocessor has been prepared and entered into a data file called DESWAL. In order to execute the WALLER program, enter the following command at the DOS prompt:

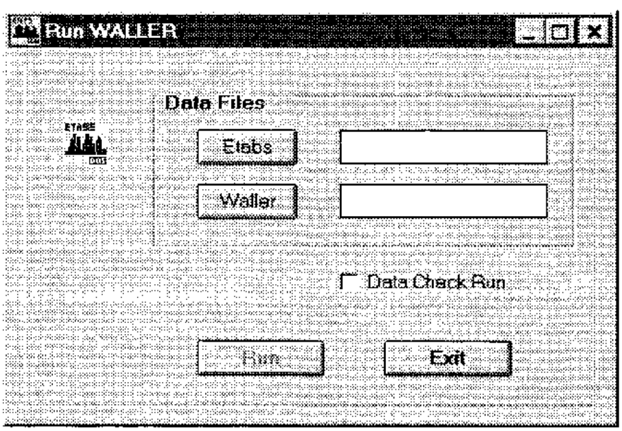
WALLER EXWAL DESWAL

Note: Since no paths have been specified with the input files the ETABS post processing file EXWAL.PST and the WALLER input data file DESWAL must reside in the current directory where the command is entered. Also the WALLER executable must also reside in the same directory unless a path to the WALLER executable has been activated using the MS-DOS **PATH** command.

After a few seconds a copyright notice will appear on the screen. The program will then go into execution mode and a series of progress messages will be flashed to the screen until the job has been completed. If the job completes successfully the last screen displays the names of the input files used and the output files created.

Running WALLER from Windows

To execute WALLER from Windows double click on the WALLER icon in the ETABS program group installed by the setup program. The following dialog box will appear:



Click the **Etabs** button which brings up the Open File Dialog box. Select the ETABS postprocessing file. Similarly select the WALLER input file by clicking on the **Waller** button. If all program defaults are acceptable then the WALLER input filename can be left blank. Clicking on **Run** launches the WALLER program. The program runs minimized in a DOS window.

The output files created by the program are explained in Chapter V. The files can be viewed and printed using any text editor. To print an output file from DOS the **PRINT** command may be used. Appropriate line counts and page ejects are built into the files.

Chapter III

Design Algorithms

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

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 or masonry design and user familiarity with References [1], [2] or [3] is assumed.

A description of the typical notations used throughout this chapter is presented in Figure III-1. References to pertinent sections and equations of the ACI Code [1] 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.

The details of the algorithms presented in Section B for concrete walls and Section C for concrete spandrel design are all based on ACI318-89 (Revised 1992) [1] and UBC94 [2] for concrete structures. The two codes are very similar. Where they differ, differences are identified. Section D identifies the differences between these algorithms and those used for the Canadian [3] code. Similarly, Section E identifies the differences between these algorithms and those used for masonry structures based on the UBC94 code.

A_{cv}	Area used to determine shear stress, sq-in
A_g	Gross section area, sq-in
A_h	Area of shear reinforcement parallel to flexural reinforcement, sq-in / in
A_n	Net cross-sectional area, sq-in
A_s	Total area of reinforcement, sq-in
A_{sc}	Area of compression reinforcement, sq-in
A_{st}	Area of tension reinforcement, sq-in
A_v	Area of shear reinforcement perpendicular to flexural reinforcement, sq-in / in
A_{vd}	Area of diagonal reinforcement, sq-in
a	Depth of compression block, in
b	Width of member, in
b_w	Width of web (T-beam section), in
b_f	Effective width of flange (T-beam section), in
c	Depth to neutral axis, in
c_b	Depth to neutral axis at balanced conditions, in
D	Total depth of member, in
d	Distance from compression face to tension reinforcement, in
d'	Concrete cover to center of reinforcing, in
d_s	Thickness of flange (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'_m	Specified compressive strength of masonry, psi
f_y	Specified yield strength of flexural reinforcement, psi
f_{ys}	Specified yield strength of shear reinforcement, psi
L	Length of member, in
M_b	Nominal moment capacity at balanced strain conditions, lb-in
M_o	Nominal moment capacity with no axial load, lb-in
M_u	Factored moment, lb-in
P_b	Nominal axial load capacity at balanced strain conditions, lbs
P_{max}	Maximum axial load strength allowed, lbs
P_n	Nominal axial load capacity, lbs
P_o	Nominal axial load capacity at zero eccentricity, lbs
P_u	Factored axial load , lbs

Notation
Figure III-1

t	Thickness of wall, in
$\mathbf{V_c}$	Nominal shear strength of concrete, lbs
$\mathbf{V_m}$	Nominal shear strength of masonry, lbs
$\mathbf{V_s}$	Nominal shear strength of shear reinforcement, lbs
$\mathbf{V_u}$	Factored shear force, lbs
β_1	Factor for obtaining depth of compression block
ε_c	Strain in concrete
ε_s	Strain in reinforcing steel
φ	Strength reduction factor

Notation
Figure III-1(continued)

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 specified in the WALLER input data is totally independent of the load case data specified in the ETABS manual.

The post processing file brings across forces and moments associated with the eight independent load conditions (I, II, III, A, B, C, D1, D2) 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 made to this procedure. In computing boundary member forces in walls designed for dynamic loads; the forces are first computed at the modal level and then the modal combination is made before any other load condition is added.

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:

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. $0.9\,DL - \sqrt{(1.4\,EQX)^2 + (1.4\,EQY)^2}$

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 [2] 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.

B. Wall Design (ACI318-89 and UBC94)

The shear wall design algorithms of WALLER allow for the design of symmetric shear wall sections of the types shown in Figure III-2. The design procedure considers only the wall in-plane moments and shears as shown in Figure III-3, and involves:

1. Check / design for overturning moments and axial loads.

2. Design for shear.

A shear wall may be modeled using column elements or "walls" (i.e. assemblages of panel elements). In each case the program assumes the major direction to be the in-plane direction.

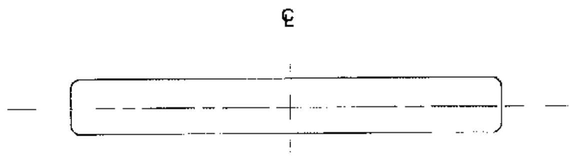
Walls modeled as panel elements or as column elements in ETABS will generally have both in-plane and out-of-plane stiffness, resulting in both in-plane and out-of-plane forces under loads. The WALLER program will only consider in-plane forces for design. The user must separately account for the out-of-plane forces in design. If these forces are not to be accounted for in design, it is recommended that modeling procedures given in ETABS be used to minimize or eliminate the out-of-plane stiffness of these walls. In all cases it is recommended that three dimensional walls be modeled as made up of several planar segments for WALLER design. This can easily be accomplished in ETABS by giving each planar segment (made up of a single or several panel elements) a different wall number.

1. Check / Design for Overturning Moments and Axial Loads

The WALLER program has options whereby the user can specify the section geometry and the explicit distribution of the vertical reinforcing across a shear wall section.

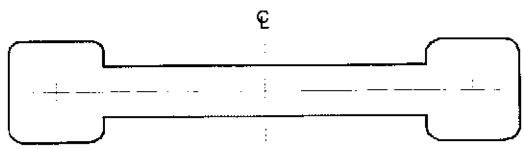
If the distribution of the reinforcing is specified (i.e. section types RW1 and RW2), the program will check the capacity of the specified wall section according to the procedure described in Section a below.

If only the section geometry is defined and the vertical reinforcing is not specified (i.e. section types W1 and W2) the program will calculate the vertical reinforcing (trim bars) required to resist the overturning moment and axial load effects, based upon an approximate design algorithm described in Section b below.



Rectangular Section

Type W1 : Rebar not specified
Type RW1 : Rebar specified



Flanged Section

Type W2 : Rebar not specified
Type RW2 : Rebar specified

Wall Section Types
Figure III-2

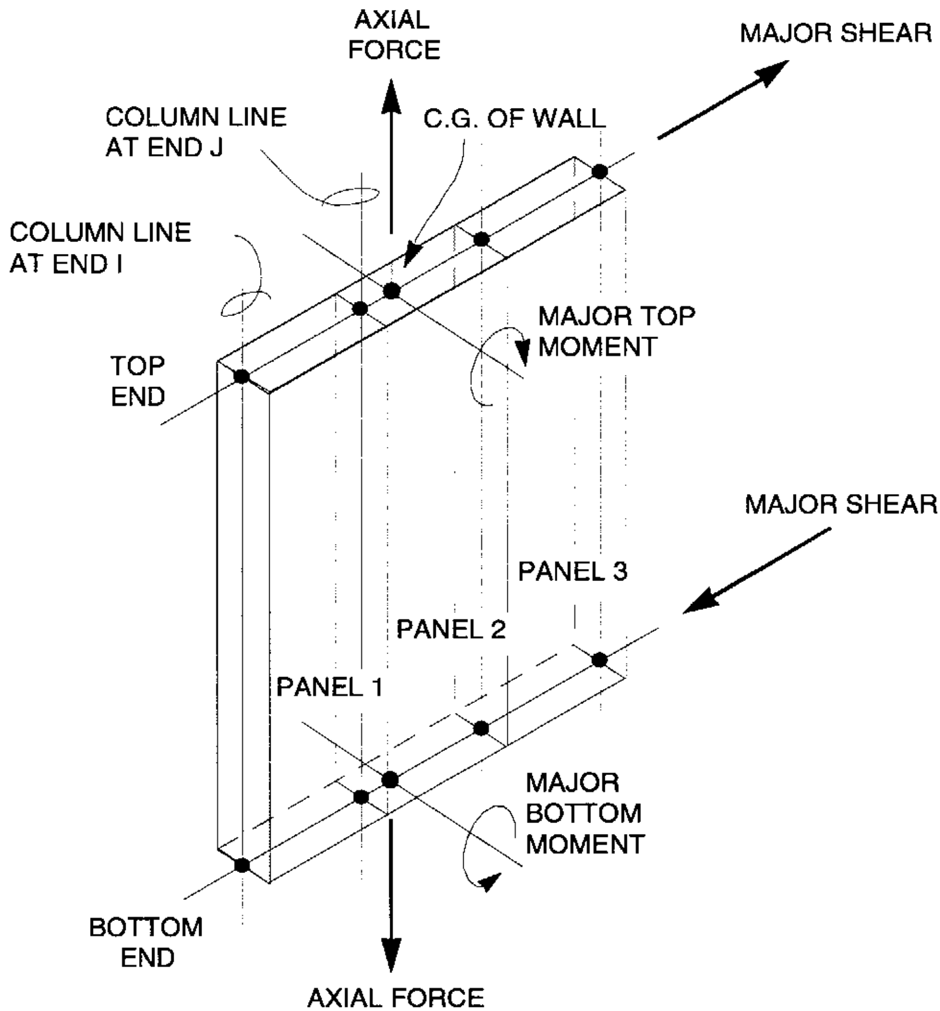
a. Checking Wall Section for Overturning Moment and Axial Load

When the geometry and the vertical reinforcing distribution for a particular wall section are specified, the capacity check of the section involves generating a load-moment interaction curve for the whole wall section. A typical interaction diagram is shown in Figure III-4.

The interaction diagram is numerically described by a series of discrete points. The coordinates of these points are determined by rotating a plane of linear strain on the section of the column. See Figure III-5. In addition to axial compression and bending, the formulation allows for considering axial tension and bending as shown in Figure III-3.

The formulation is based consistently upon the basic principles of ultimate strength design, (ACI 10.3).

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



In-plane Wall Design Forces
Figure III-3

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 plate).

The concrete compression stress block is assumed to be rectangular, with a stress value of $0.85\ f'_c$. See Figure III-6. 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 strength reduction factor, φ, for high axial compression, with or without moment is assumed to be 0.70. For low values of axial load, φ is increased linearly from 0.70 to 0.90 as the axial force capacity, φP_n, decreases from the smaller of $0.10\ f'_c\ A_g$ or φP_b to zero. See Figure III-7.

In cases involving axial tension, φ is always 0.90 (ACI 9.3.2.2).

The maximum factored compressive axial load (including φ-factor reduction) is limited to P_{max}, where

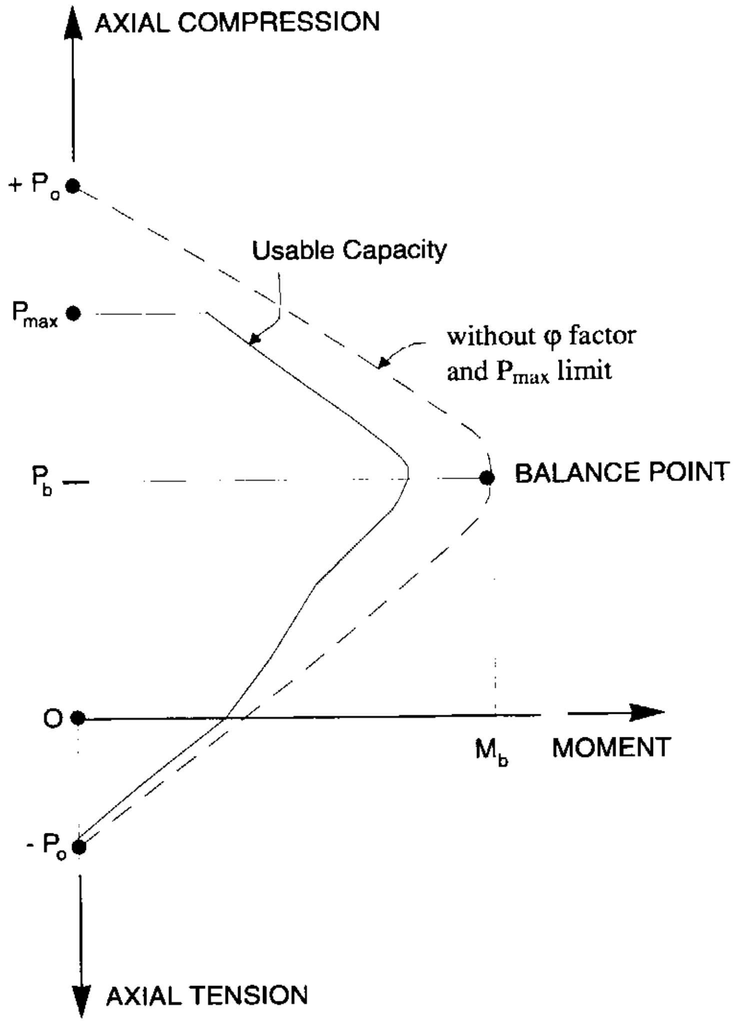
$$P_{max} = 0.80\ \varphi\ [0.85\ f'_c\ (A_g - A_s) + f_y\ A_s] \qquad \text{(ACI 10.3.5.2)}$$

After the moment interaction curve is generated, the wall capacity is checked for each loading combination at the top and bottom ends of each wall. In checking a particular wall for a particular loading combination at a particular location, the following steps are involved.

i. Determining the factored moments and axial forces from the analysis load conditions and the specified load combination factors to give P_u and M_u.

ii. Determining if the point, defined by the factored axial load and moment set, lies within the interaction curve.

The following two sections describe in detail the algorithms associated with the above mentioned Steps i and ii.



Typical Moment-Axial Load Interaction Diagram
Figure III-4

i. 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 post processing 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 and M_u, the factored axial load and moment applied to the whole wall section.

For dynamic loads, the relationship between the signs of the axial load and moments is lost during the modal combination. Additional loading combinations are automatically created by the program similar to those specified by the user, with the sign of the dynamic axial load reversed to conservatively account for this sign relationship.

ii. Capacity Check

The point L (P_u, M_u) is placed on the interaction diagram as shown in Figure III-8. If the point lies within the interaction curve, the wall capacity is adequate; however, if the point lies outside of the interaction curve, the wall is overstressed.

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

This ratio is achieved by plotting the point L, defined by P_u, M_u and determining the location of point C. The point C is defined as the point where the line OL (extended outward if needed) will intersect the interaction curve.

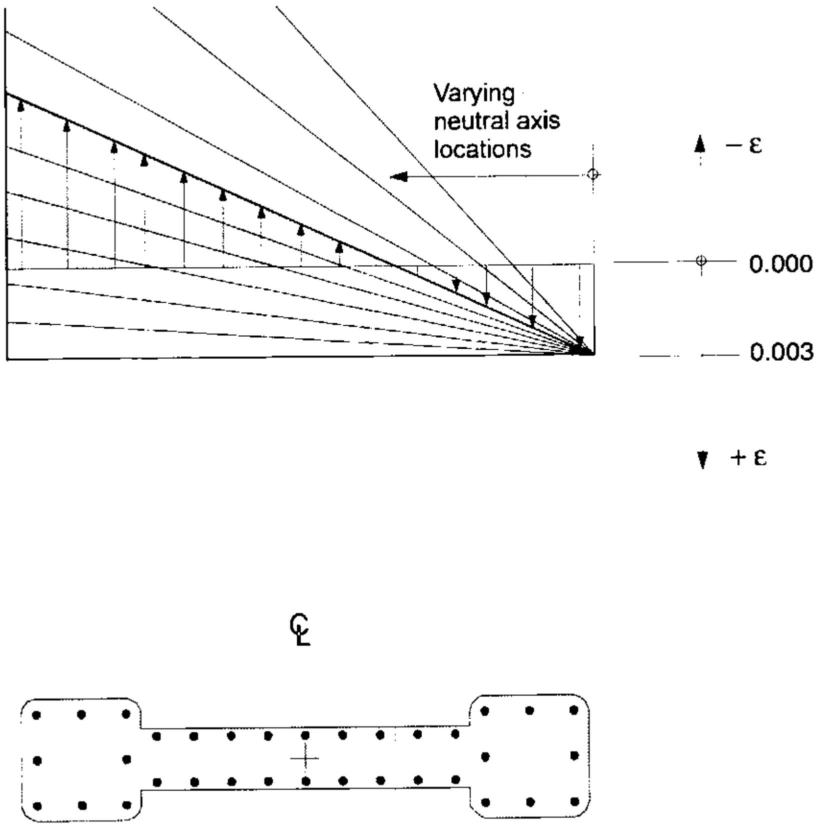
The capacity ratio, CR, is given by the ratio OL/OC.

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

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

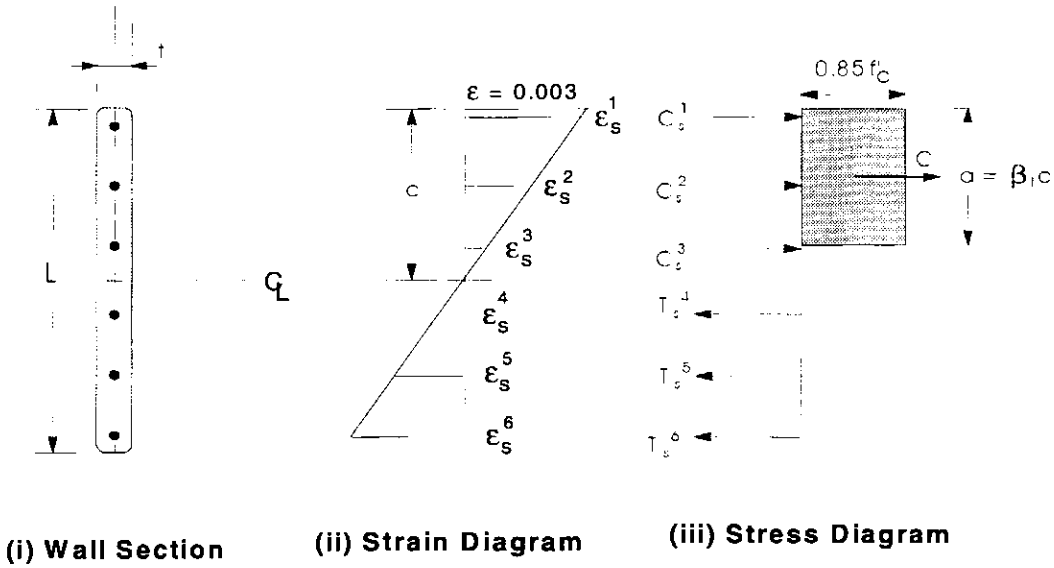
If OL > OC (or CR>1) the point lies outside the interaction curve and the wall is overstressed.

The maximum of all the values of CR calculated from each load combination is reported for the top and the bottom of the wall along with the controlling P_u and M_u set and associated load combination number.

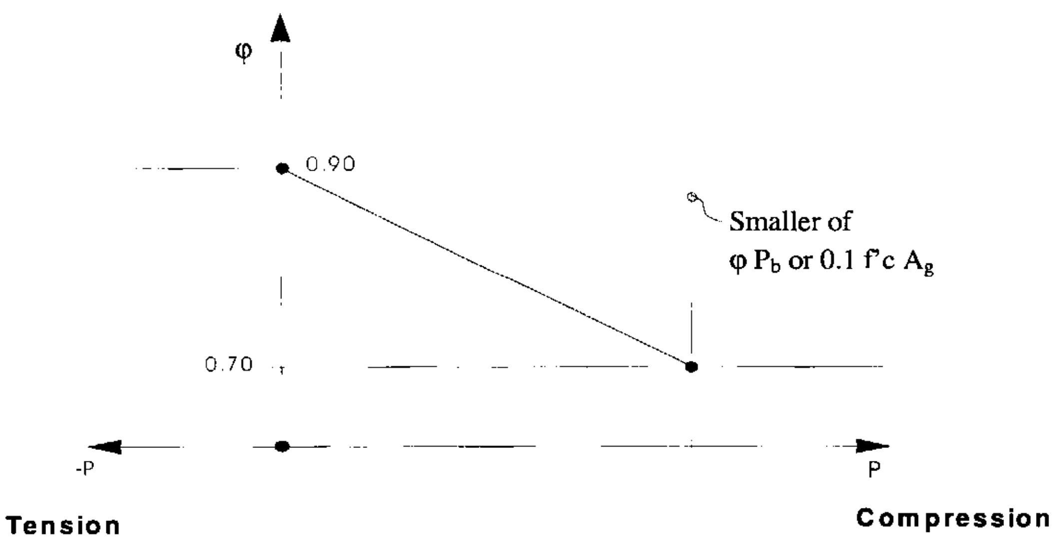


Varying Linear Strain Diagram

Generation of Interaction Diagram
Figure III-5



Concrete Stress-Strain Relationships
Figure III-6



Strength Reduction Factor, φ
Figure III-7

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

In other words, if the factored axial load and moment for which the wall is being checked is divided by the reported capacity ratio, the point defined by the resulting axial load and moment will lie on the interaction curve.

b. Designing Wall Section for Overturning Moment and Axial Load

When the wall vertical reinforcing is not specified, the program will calculate the required edge reinforcing to resist the axial forces and overturning moments. The algorithm focuses upon the development of edge members at the left and right ends of the wall while limiting the compression and tension reinforcing to the user-specified percentages.

The design procedure is as follows:

Consider the wall (type W1) shown in Figure III-9.

For a given location, say the top of the wall, for a given loading combination, the wall section is to be designed for a factored axial force F_T and a factored overturning moment M_T.

The program initiates the design procedure by assuming an edge member of thickness t and width B_1 (where $B_1 = t$) at each end of the wall.

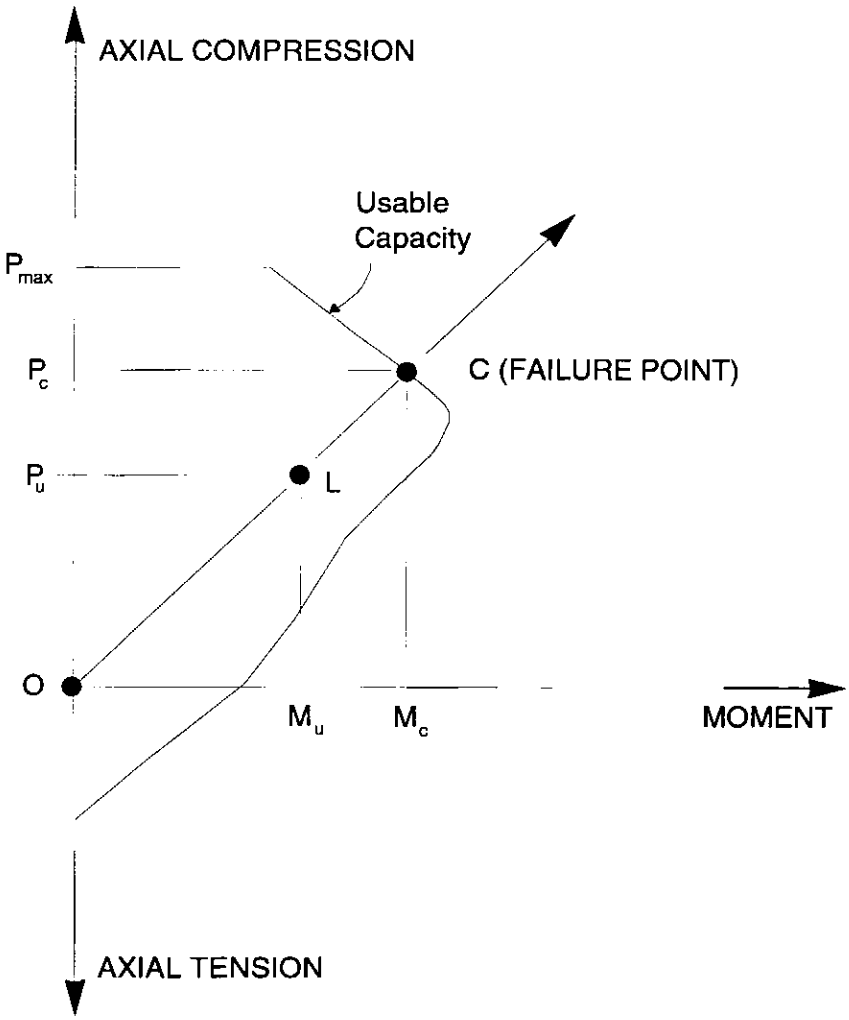
The overturning moment and axial force are converted to an equivalent force set P_L^T and P_R^T using the following relationships:

$$P_L^T = \frac{F_T}{2} + \frac{M_T}{ARM}$$

$$P_R^T = \frac{F_T}{2} - \frac{M_T}{ARM}$$

where $ARM = L - B_1$ the first time around. For any given loading combination, the net values for P_L^T or P_R^T could be tension or compression.

Note that , for dynamic loads, P_L^T and P_R^T are obtained at the modal level and the modal combinations made, before combining with other loads. Also for loading



Geometric Representation of the Wall Capacity Ratio
Figure III-8

combinations involving SRSS the P_L^T and P_R^T forces are obtained first for each load condition before combinations are made.

If any P value is tension, the area of steel required for tension is calculated as

$$A_{st} = \frac{P}{\varphi f_y} \qquad \text{where } \varphi = 0.90$$

If any P value is compression, for section adequacy, the compressive area of steel, A_{sc}, must satisfy the following relationship.

$$P = 0.80\,\varphi[0.85\,f'_c\,(A_g - A_{sc}) + f_y A_{sc}] \qquad \text{(ACI 10.3.5.2)}$$

where $A_g = t\,B_1$ and $\varphi = 0.70$

From which

$$A_{sc} = \frac{\left(\dfrac{P}{0.80\varphi} - 0.85\,f'_c\,A_g\right)}{(f_y - 0.85\,f'_c)}$$

If A_{sc} calculates negative, no compressive reinforcing is needed.

The maximum tensile reinforcing to be packed within the t times B_1 concrete edge member is limited by

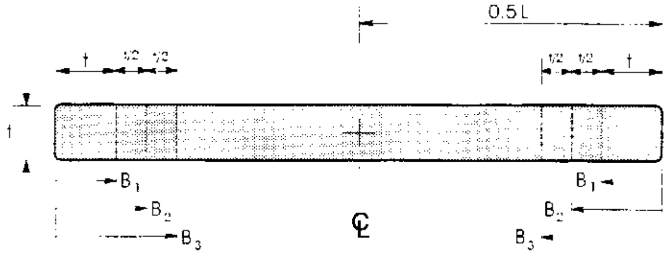
$$A_{st}^{max} = \textbf{PTMAX}\ t\ B_1$$

Similarly, the compressive reinforcing is limited by

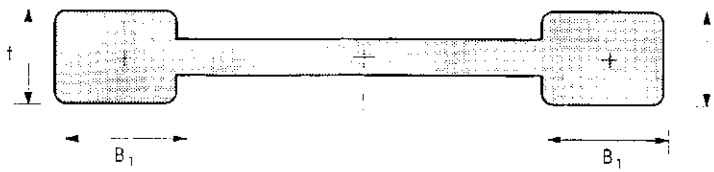
$$A_{sc}^{max} = \textbf{PCMAX}\ t\ B_1$$

where **PTMAX** and **PCMAX** are user-specified maximum tensile and compressive reinforcement ratios for the edge members of this section.

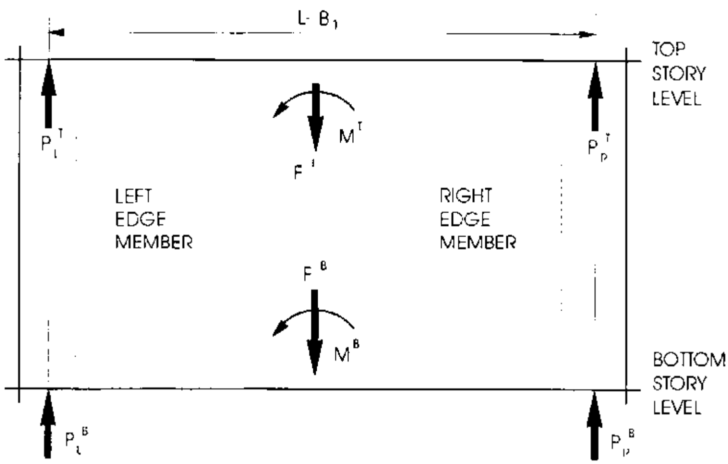
If A_{st} is less than A_{st}^{max} and A_{sc} is less than A_{sc}^{max} the program will proceed to check the next loading combination, otherwise the program will increment the B_1 dimension to B_2 (i.e. 1.5 t) and calculate new values for P_L^T, P_R^T, as the value of ARM changes to (L - B_2), resulting in new values of A_{st} and A_{sc}. This procedure continues until A_{st} and A_{sc} are within the allowed steel percentages.



Wall Section Type W1



Wall Section Type W2



Wall Elevation

Approximate Algorithm for Wall Overturning Design
Figure III-9

If the value of the width of the edge member B increments to where it reaches a value equal to L/2, the iteration is terminated and a failure condition is declared.

The tension design iteration is satisfied before the compression design iteration is initiated, in order to maintain the tensile reinforcing as close to the outer edge of the wall as possible.

For W2 type walls the program will only attempt one design iteration with the edge member growth being limited to the B1 times t area, as shown in Figure III-9(c).

This is an approximate but convenient design algorithm. Walls that are declared as overstressed using this algorithm could be found to be adequate if modeled using RW1 or RW2 wall types where the capacity of the wall is accurately evaluated using moment interaction diagrams. It should be noted, however, that some seismic codes require the use of edge members to resist the P_L^T and P_R^T values calculated.

2. Design for Shear

The shear reinforcing is designed for each of the loading combinations. In designing the shear reinforcing for a particular wall for a particular loading combination, the following steps are involved.

i. Determining the factored forces acting on the section, P_u, M_u and V_u. Note that P_u and M_u are needed for the calculation of V_c.

ii. Determining the shear force, V_c, that can be resisted by the concrete.

iii. Calculating the reinforcing steel required to carry the balance.

The following three sections describe in detail the algorithms associated with the above-mentioned Steps i, ii and iii.

i. Determine Section Forces

For a particular load combination, the wall axial force, P_u, the maximum moment along the member, M_u, and the wall shear force, V_u, are obtained by factoring the ETABS analysis load conditions with the corresponding load combination load factors.

ii. Determine the Concrete Shear Capacity

Given the design force set P_u, M_u and V_u, the shear force carried by the concrete, V_c, is calculated as follows (ACI 11.10.6):

$$V_c = 3.3\sqrt{f'_c}\,td + \frac{P_u d}{4L}$$

where V_c may not be greater than

$$V_c = \left[0.6\sqrt{f'_c} + \frac{L\left(1.25\sqrt{f'_c} + 0.2\dfrac{P_u}{Lt}\right)}{\dfrac{M_u}{V_u} - \dfrac{L}{2}}\right] td$$

where L is the length of the wall, t is the thickness of the wall, d is taken as 0.8L, and P_u is negative for tension. The second equation doesn't apply if $\frac{M_u}{V_u} - \frac{L}{2}$ is negative.

iii. 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

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

where

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

and

$$\frac{V_u}{\varphi} \text{ must not exceed } 10\sqrt{f'_c}\,td \qquad \text{(ACI 11.10.3)}$$

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 is reported for the wall.

Also reported is the maximum factored shear force V_u, a corresponding shear stress based on gross concrete area and the corresponding load combination number.

The wall shear reinforcing requirements reported by the program are based purely upon shear strength consideration. Any other minimum shear steel requirements must be investigated independently of the program by the user.

For shear design of walls subjected to seismic loads (Chapter 21 of ACI318-89) the following **additional** requirements are also checked:

The nominal shear strength of walls is limited to

$$V_n = \left(2\sqrt{f'_c} + \frac{A_v}{t} f_y \right) Lt \qquad \text{(ACI 21.6.4.2)}$$

where A_v is per unit length.

Since $V_u = \varphi V_n$, A_v can be calculated as

$$A_v = \frac{\dfrac{V_u}{\varphi} - 2\sqrt{f'_c}\, Lt}{L\, f_y}$$

where φ is 0.60 for shear (ACI 9.3.4.1.).

It is noted here that a lower value of A_v may be required based on ACI 21.6.4.3. Also in the satisfaction of ACI 21.6.4.6, the program makes the more conservative check that the individual pier nominal shear strength does not exceed $8\sqrt{f'_c}\,Lt$.

C. Spandrel Design (ACI318-89 and UBC94)

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

The spandrel design procedure involves the following steps:

1. Design for flexure.

2. Design for shear.

The following two sections describe in detail the algorithms associated with the above-mentioned Steps i and ii.

1. Design for Flexure

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:

i. Determine the maximum factored moments

ii. Determine the required flexural reinforcing

i. Determine the Maximum Factored Moments

In the design of the flexural reinforcing of the spandrels, the factored moments for each load combination at a particular beam station are obtained by factoring the ETABS analysis load condition results with the corresponding load factors.

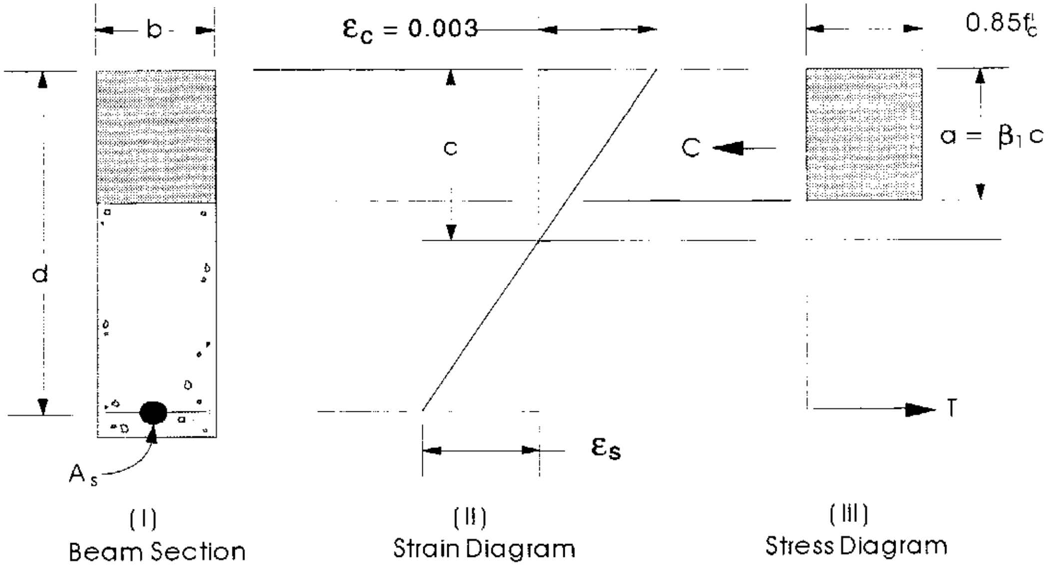
The beam section is then designed for the maximum positive M_u^+ and the maximum negative M_u^- factored moments obtained from all of the load combinations.

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.

ii. 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.



Rectangular Beam Spandrel Design
Figure III-10

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

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

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

where

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

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-10.

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 $a \leq 0.75\, \beta_1\, c_b$

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-11,

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

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

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

$$M_{u_f} = C_f\, (d - \frac{d_s}{2})\, \varphi$$

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

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

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.

2. Design for Shear

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.

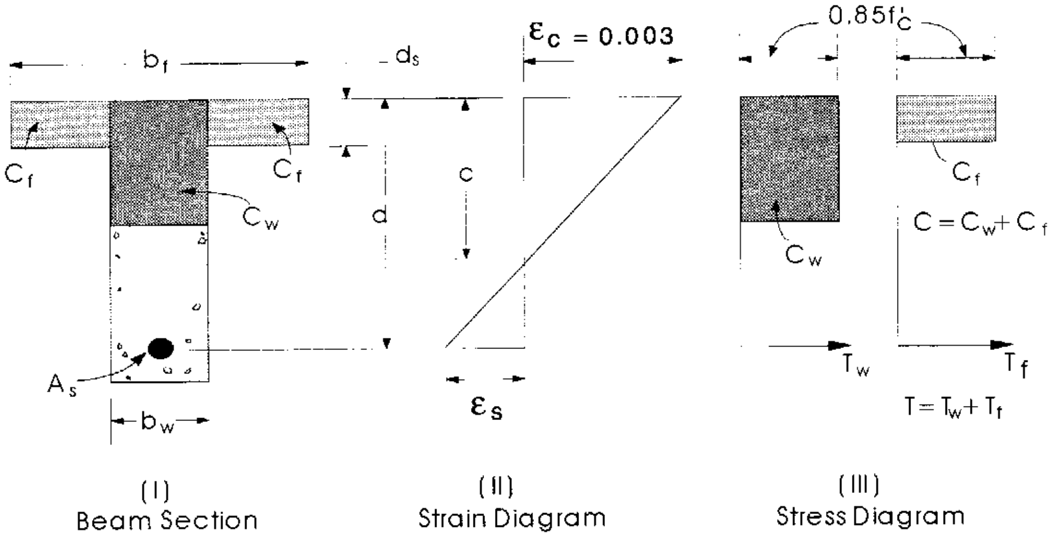
In designing the shear reinforcing for a particular beam for a particular loading combination at a particular station due to the beam major shear, the following steps are involved.

i. Determining the factored shear force, V_u.

ii. Determining the shear force, V_c, that can be resisted by the concrete.

iii. Determining the reinforcing steel required to carry the balance.

The following three sections describe in detail the algorithms associated with the above mentioned steps (i), (ii) and (iii).



T-Beam Spandrel Design
Figure III-11

i. Determine the Factored Shear Force

In the design of the beam shear reinforcing of a spandrel, the shear force, V_u, for a particular load combination at a particular beam station is obtained by factoring the ETABS analysis load conditions with the corresponding load combination factors.

ii. Determine the Concrete Shear Capacity

The allowable concrete shear capacity is given by

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

iii. Determine the Required Shear Reinforcing

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

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

The following additional checks are also performed.

When ${}^{L}/_{d} > 5$ and if $\dfrac{V_u}{\varphi} > 0.5\ V_c$

$$A_{v_{min}} = \frac{50\ b}{f_{ys}} \qquad \text{(ACI 11.5.5.3)}$$

$$A_{h_{min}} = 0$$

and $\left(\dfrac{V_u}{\varphi} - V_c\right)$ must not exceed $8\sqrt{f'_c}\ bd$

When ${}^{L}/_{d} > 5$ and if $\dfrac{V_u}{\varphi} \le 0.5\ V_c$ then

$$A_{v_{min}} = A_{h_{min}} = 0$$

For deep beams when ${}^{L}/_{d} \le 5$

$$A_{v_{min}} = 0.0015b \qquad \text{(ACI 11.8.9)}$$

$$A_{h_{min}} = 0.0025b \qquad \text{(ACI 11.8.10)}$$

and $\left(\dfrac{V_u}{\varphi}\right)$ must not exceed $(2/3)(10 + {}^{L}/_{d})\sqrt{f'_c}\ bd$

for $2 \le L/d \le 5$ (ACI 11.8.4)

However, when L/d is less than 2, $\dfrac{V_u}{\varphi}$ must not exceed $8\sqrt{f'_c}\ bd$.

Where φ, the strength reduction factor is 0.85 (ACI 9.3.2.3) for non-seismic design and is taken as 0.60 (ACI 9.3.4.1) for seismic design. L/d is the span to depth ratio. The maximum of all the calculated A_v values, obtained from each load combination for each location and A_{vmin} are reported.

Also reported are the L/d ratios and maximum shear stress at each location.

When UBC94 seismic design is requested and $^{L}/_{d} < 4$ and $V_u > 4\sqrt{f'_c}bd$ for coupling beams, the area of one leg of diagonal shear reinforcement is also reported as

$$A_{vd} = \frac{V_u}{2\, f_y \sin \alpha}$$

where $\sin \alpha = \dfrac{0.80D}{\sqrt{L^2+(0.80D)^2}}$

D. Canadian Code Differences

Design criteria / algorithms for the Canadian standards CAN3-A22.3-M84 are the same as ACI318-89 except for the following modified formulas (expressed in millimeter-Newton units).

1. φ factors

φ factors are material dependent and are defined as

$\varphi_c = 0.6$ for concrete (CAN 9.3.2)

$\varphi_s = 0.85$ for steel reinforcement (CAN 9.3.3)

Also for seismic design a member strength reduction factor of 0.70 is applied for shear only, to all members over and above the material strength reduction factors (CAN 21.2.3.2).

2. Wall Design

i. Maximum compressive load in wall,

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

ii. The area of steel required for tension edge members,

$$A_{st} = \frac{P}{\varphi_s\, f_y}$$

iii. The area of steel required for compression edge members,

$$A_{sc} = \frac{\left[\dfrac{P}{0.80} - 0.85\ \varphi_c\ f'_c\ A_g\right]}{(\varphi_s\ f_y - 0.85\ \varphi_c\ f'_c)}$$

iv. Concrete shear strength for walls,

$$V_c = 0.2\ \varphi_c \sqrt{f'_c}\left(1 + \frac{3P_u}{A_g\ f'_c}\right) t\ d \qquad \text{(CAN 11.3.4.3)}$$

when P_u is positive (compression), or

$$V_c = 0.2\ \varphi_c \sqrt{f'_c}\left(1 + \frac{P_u}{0.6\ \varphi_c \sqrt{f'_c}\ A_g}\right) t\ d \qquad \text{(CAN 11.3.4.2)}$$

when Pu is negative (tension).

v. Area of required shear reinforcing,

$$A_v = \frac{V_u - V_c}{\varphi_s\ f_{ys}\ d} \qquad \text{(CAN 11.3.6.1)}$$

where $V_u - V_c$ does not exceed $0.8\ \varphi_c \sqrt{f'_c}\ t\ d$ (CAN 11.3.6.6)

vi. No special requirements for ductile walls are checked.

3. Spandrel Design

i. Depth of compression block in beam design,

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

when $a > \beta_1 c$ a concrete compressive overstress condition occurs where

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

and

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

ii. Area of steel required in rectangular beams,

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

iii. For T-beam design,

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

$$A_{st1} = \frac{C_f}{\varphi_s f_y}$$

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

and

$$A_{st2} = \frac{M_{uw}}{\varphi_s f_y (d - \frac{a_1}{2})}$$

where

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

iv. Concrete shear strength for beams,

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

and

$$V_s \leq 0.8 \varphi_c \sqrt{f'_c}\, b\, d \qquad \text{(CAN 11.3.6.6)}$$

when $^L/_d > 4$ and if $V_u > 0.5 V_c$ (CAN 11.2.5.1)

$$A_{v_{min}} = 0.35 \frac{b}{fy} \qquad \text{(CAN 11.2.5.4)}$$

$$A_{h_{min}} = 0$$

when $^L/_d > 4$ and if $V_u \leq 0.5\ V_c$ then

$$A_{v_{min}} = A_{h_{min}} = 0$$

For deep beams when $^L/_d \leq 4$

$$A_{v_{min}} = 0.002b \qquad \text{(CAN 11.5.3.1)}$$

$$A_{h_{min}} = 0.002b \qquad \text{(CAN 11.5.3.2)}$$

E. UBC94 Masonry Code Differences

For the design of masonry shear walls and spandrel beams using the UBC94 code WALLER uses the same algorithms as listed in Sections B and C above for concrete shear walls and beams with the following **changes**:

i. The specified compressive strength of masonry, f'_m is used instead of f'_c.

ii. The strength reduction factors, φ, used in the algorithms are modified as follows (UBC 2108.1.4.3):

φ is 0.65 for compression,
φ varies from 0.65 to 0.85 as φP_n decreases
from $0.10\ f'_m\ A_n$ or $0.25\ P_b$ to zero,
φ is 0.85 for flexure,
φ is 0.60 for shear.

iii. The shear capacity of masonry, V_m (in lieu of V_c) is taken as

$$V_m = C_d \sqrt{f'_m}\ Lt$$

where

$$C_d = 2.4 - \left(\frac{M}{V\,d} - 0.25\right)1.6$$

but not less than 1.2 or greater than 2.4.

d is the effective depth, assumed as 0.8L for walls, and M and V are the moment and shear for the loading combinations being considered.

iv. The check on maximum nominal shear is made as follows:

$$\frac{V_u}{\varphi} = C_m\sqrt{f'_m}\,Lt$$

where

$$C_m = 6 - \left(\frac{M}{V\,d} - 0.25\right)2.67$$

but not less than 4 or greater than 6. M, V and d are as defined above for C_d.

It should be noted that the program assumes fully grouted masonry. That is, A_n, the net area and A_e, the effective area are both taken equal to A_g, the gross area.

Chapter IV

WALLER Input Data File

In order to execute the WALLER program, an ETABS post processing file and a WALLER input data file are required. However, if the program defaults are acceptable, the WALLER input data file is optional. The program defaults to the UBC94 code including the seismic requirements.

The ETABS post processing 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 WALLER post processor. Only those elements with material properties of type W (concrete walls) or M (masonry walls) will be processed by WALLER.

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 WALLER control variables described below, and with the main control variables of ETABS. Repeated references are made to these variables throughout this chapter.

The user is reminded of the following items which must be considered in preparing the ETABS input when it will be post processed by WALLER.

- For the built in loading combinations when using any code the WALLER program assumes that dead load is specified in ETABS Load Condition I, live load is specified in Load Condition II and the lateral loads are in Load Conditions A, B, C, D1 and D2. The user must account for this when preparing the ETABS data. All scaling of loads (for example, dynamic response spectrum loads) should be done in the ETABS eight basic load conditions.

- The design algorithm for shear walls in WALLER is only for the design of planar wall sections for axial load, in-plane moments and in-plane shears. The user must break up three dimensional walls into planar segments for design purposes by giving different wall numbers to each planar wall segment. For column elements to be designed as walls the user must suppress out-of-plane behavior by using the stiffness modifiers in the ETABS column section property data. **If out-of-plane forces are significant to the design they must be separately investigated.**

- All input data for ETABS and WALLER must be prepared using the same set of consistent units. Either English (Kip-inch) or MKS metric (Kilogramforce-meter) or SI metric (KiloNewton-meter) units are possible. The type of units is specified in the ETABS input data. 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.

All input data for WALLER is prepared in free format form similar to the ETABS input data. The formating rules described for the preparation of the ETABS input data (Chapter V of the ETABS User's Manual) also apply to the WALLER input data.

There are basically five data sections associated with the WALLER input. A summary of the data setup is shown in Figure IV-1. The sequence of data lines described herein will establish the data file required by WALLER.

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

First, the format giving 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 tabular description in the form:

Variable **Field** **Note** **Entry**

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

Data Block	When Needed
1. Main Control Data	Always
2. Load Combination Data	Only if **NLC** > 0
3. Material Property Redefinition Data	Only if **NRMP** > 0
4. Section Property Redefinition Data	
i. Column Properties	Only if **NRCP** > 0
ii. Beam Properties	Only if **NRBP** > 0
iii. Wall Properties	Only if **NRWP** > 0
5. Frame Design Activation Data	
i. Frame Control Data	Only if **NFR** > 0
ii. Element Reassignment Data	
a. Column	Only if **IRCP** > 0
b. Beam	Only if **IRBP** > 0
c. Wall	Only if **IRWP** > 0

Typical Data Setup For WALLER
Figure IV-1

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.

The **Note** number refers to the series of notes that exist at the end of the 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.

1. Main Control Data

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.

Format

a. Program Name and Version

Prepare one line of data to give the program name and version as follows:

WALLER 6.1

b. Heading Data

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

c. Execution Control Data

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

ICODE NFR NLC LLC NRMP NRCP NRBP NRWP NPTS IPRI IPHI

If no WALLER input file is provided, the **Heading Data** defaults to the **Heading Data** of ETABS; the **ICODE** parameter defaults to 1 (i.e. the UBC94 code for concrete); **NFR** defaults to designing all frames; **NLC** defaults to using the loading combination defaults given in the following Section 2; **LLC** defaults to 2;**NRMP**, **NRCP, NRBP** and **NRWP** all default to zero; **NPTS** defaults to 21; **IPRI** and **IPHI** default to zero.

Description

Variable	Field	Note	Entry
c. Execution Control Data			
ICODE	1	(1)	Code identifier: = 1 UBC94 concrete = 2 ACI 318-89 = 3 CAN3-A23.2-M84 = 11 UBC94 masonry
NFR	2	(2)	Number of frames to be designed.
NLC	3	(3)	Number of design loading combinations.
LLC	4	(4)	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	5	(5,6)	Number of redefined (or new) material property types.
NRCP	6	(5,7)	Number of redefined (or new) column section property types.
NRBP	7	(5,8)	Number of redefined (or new) beam section property types.
NRWP	8	(5,9)	Number of redefined (or new) panel / wall section property types.
NPTS	9	(10)	Number of points on each interaction curve.

Variable	Field	Note	Entry
IPRI	10	(11)	Interaction diagram print code: = 0 Suppress printing of curves = 1 Tabulate interaction curves
IPHI	11	(12)	Strength reduction factor, φ, overwrite code: = 0 use code values = 1 overwrite all φ's to 1.0

Notes

1. The WALLER program has options to check or design the shear wall structures with respect to several different codes. This options 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 WALLER program. Other significant aspects of shear wall design, for example, detailing, minimum thickness, minimum reinforcement, out-of-plane bending, etc., are not addressed by the program and should be separately addressed by the user.

2. This variable defines 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 design loading 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 the live load. The live load reduction factors are then applied to the member forces associated with this load condition, before they are summed into the combinations.

5. 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 material strengths or the dimensions of the walls or spandrels and make design iteration runs with WALLER 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 to final convergence.

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

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

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

9. The entry **NRWP** defines the number of panel / wall section property sets that are defined in Section 4.iii. below.

10. If the user specifies the steel reinforcing for a particular concrete wall section, the program will calculate a load-moment interaction diagram for the section. 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. A recommended value for **NPTS** is 21. The maximum allowed value is 51. The value for **NPTS** must be odd.

11. The tabulation of each interaction diagram requires one page of output.

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

2. Load Combination Data

Load combinations to convert the ETABS analysis load conditions to factored ultimate load levels with load factors are specified in this section as summations of the eight basic load conditions, namely:

- The vertical static load conditions, I, II and III.
- The lateral static load conditions, A B and C.
- The lateral dynamic load conditions, D1 and D2.

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

Format

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

L LTYP XI XII XIII XA XB XC XD1 XD2

Description

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 sign of multipliers = 2 SRSS A and B load conditions, combine linearly with others = 3 SRSS D1 and D2 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 static load condition A.
XB	7		Load factor for lateral static load condition B.
XC	8		Load factor for lateral static load condition C.
XD1	9		Load factor for dynamic load condition D1.
XD2	10		Load factor for dynamic load condition D2.

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 WALLER. 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 condition D1 and D2 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 excitation.

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

   Typically, structures 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 [1].

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 318-89 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.

When using UBC94 (Reference [2]) for concrete or masonry under seismic loads, the required loading combinations would be:

1. $1.4\ DL + 1.7\ LL$
2. $1.4\ DL + 1.4\ LL + 1.4\ (\sqrt{(EQX)^2 + (EQY)^2} + EQT)$
3. $1.4\ DL + 1.4\ LL + 1.4\ (\sqrt{(EQX)^2 + (EQY)^2} - EQT)$
4. $1.4\ DL + 1.4\ LL - 1.4\ (\sqrt{(EQX)^2 + (EQY)^2} + EQT)$
5. $1.4\ DL + 1.4\ LL - 1.4\ (\sqrt{(EQX)^2 + (EQY)^2} - EQT)$
6. $0.9\ DL + 1.4\ (\sqrt{(EQX)^2 + (EQY)^2} + EQT)$
7. $0.9\ DL + 1.4\ (\sqrt{(EQX)^2 + (EQY)^2} - EQT)$
8. $0.9\ DL - 1.4\ (\sqrt{(EQX)^2 + (EQY)^2} + EQT)$
9. $0.9\ DL - 1.4\ (\sqrt{(EQX)^2 + (EQY)^2} - EQT)$

These are the program defaults whenever the UBC94 code is requested, assuming DL is gravity load condition I , LL is gravity load condition II, EQX is static lateral load condition A, EQY is static lateral load condition B and EQT is static lateral load condition C due to accidental torsion.

When using the CAN3-A23.2-M84 (Reference [3])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 WALLER will retain the values that were assigned in the ETABS data. However, if for any W or M 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.

Format

Prepare the data in the following form:

MID MTYPE E U W M ALPHA FY FC FYS FCS

Description

Variable	Field	Note	Entry
MID	1	(1)	Material identification number.
MTYPE	2	(2)	Material type: = S Steel = C Concrete (frames) = W Concrete (walls) = M Masonry (walls) = O Other
E	3		Modulus of elasticity.
U	4		Poisson's ratio.
W	5	(3)	Weight density (weight/volume).
M	6	(3)	Mass density (mass/volume).
ALPHA	7	(3)	Coefficient of thermal expansion.
FY	8	(4)	Yield stress of reinforcing steel
FC	9	(5)	Ultimate strength of concrete or masonry.
FYS	10	(6)	Yield stress of shear reinforcing steel
FCS	11	(7)	Equivalent ultimate strength of concrete for shear strength evaluation.

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 post processors operating off the ETABS post processing data base are available. The material type designation is basically an indicator for the post processors. The shear wall design post processor, WALLER, for example, will only process those members that have a material type of W or M. Material types S,C, and O are ignored by the WALLER program.

3. These values are not used by the program WALLER. However, they are input here in the same order as in the ETABS input data for consistency with it.

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. If the masonry strength has not been specified, it is assumed to be 1.5 ksi or MKS or SI equivalent.

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 non zero 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 concrete where an equivalent value of $\sqrt{f'_c}$ must be used in the shear design (ACI 11.2.1).

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

4. Section Property Redefinition Data

This data section is only needed if the column, beam or panel / wall property tables that have been previously defined in ETABS are to be modified (or expanded) or reinforced concrete or masonry specific data is to be added to them.

Prepare one (or up to three) of the following data sections, 4.i. through 4.iii. below, to redefine the section property tables of the column, beam and panel / wall elements that make up the frames in the structure.

4.i. Column Property Redefinition Data

If **NRCP** is 0, skip this data section. Otherwise, provide **NRCP** data sets to redefine, add to or assign reinforced concrete or masonry specific wall design data to the ETABS column property table. Only column sections that have a wall or masonry material type (i.e. equal to W or M) will be included in the processing by WALLER.

Format

Each data set consists of two data lines, a section definition data line immediately followed by a reinforcement definition data line.

a. Section Definition Data Line

Prepare one data line in the following form:

ID ITYPE IMAT WD1 WD2 WD3 WD4

b. Reinforcement Definition Data Line

The format of this data line depends upon the section type, **ITYPE.**

If **ITYPE** is W1 or W2, namely, that explicit wall reinforcing is not being specified, prepare one data line in the following form to define the acceptable values of reinforcing percentages.

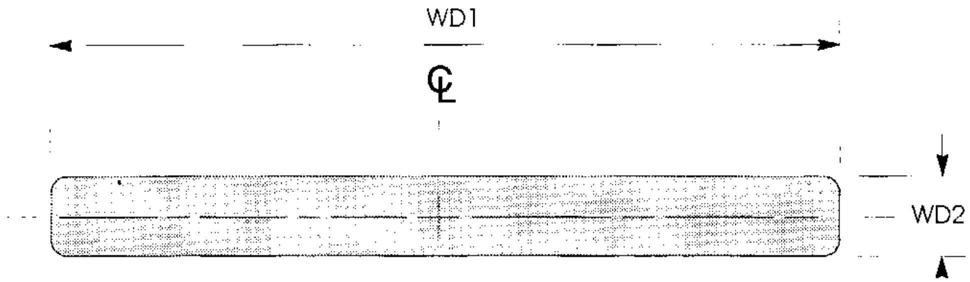
PTMAX PCMAX

If **ITYPE** is RW1 or RW2, namely, that wall reinforcement is explicitly being specified, prepare one data line to define the section reinforcement in the following form. See Figure IV-2.

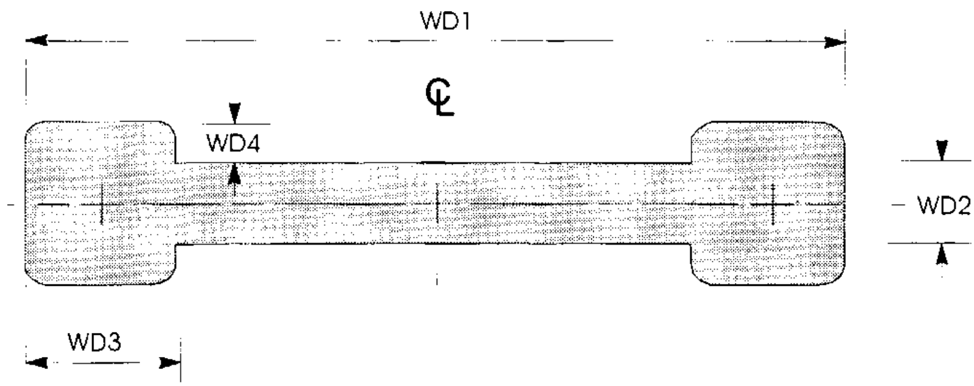
D1 A1 N1 S1 D2 A2 N2 S2 D3 A3 . . .

Description

Variable	Field	Note	Entry
a. Section Definition Data Line			
ID	1	(1)	Identification number of column section property set
ITYPE	2	(2)	Section type (See Figures IV-1 and IV-2): = W1 Rectangular section reinforcing not specified = W2 Flanged section reinforcing not specified = RW1 Rectangular section reinforcing specified = RW2 Flanged section reinforcing specified
IMAT	3	(3)	Material identification number for this section property.
WD1	4	(4)	Section dimension in major direction.
WD2	5		Section dimension in minor direction.
WD3	6		Flange dimension in major direction (for W2 and RW2 section types).
WD4	7		Flange dimension in minor direction (for W2 and RW2 section types).
b. Reinforcement Definition Data Line (ITYPE = W1 or W2)			
PTMAX	1	(5)	Maximum percentage of steel allowed for tension design.
PCMAX	2	(5)	Maximum percentage of steel allowed for compression design.



(a) Wall Section Type W1



(b) Wall Section Type W2

Wall Section Types W1 and W2 (Reinforcing Not Specified)
Figure IV-1

Variable	Field	Note	Entry

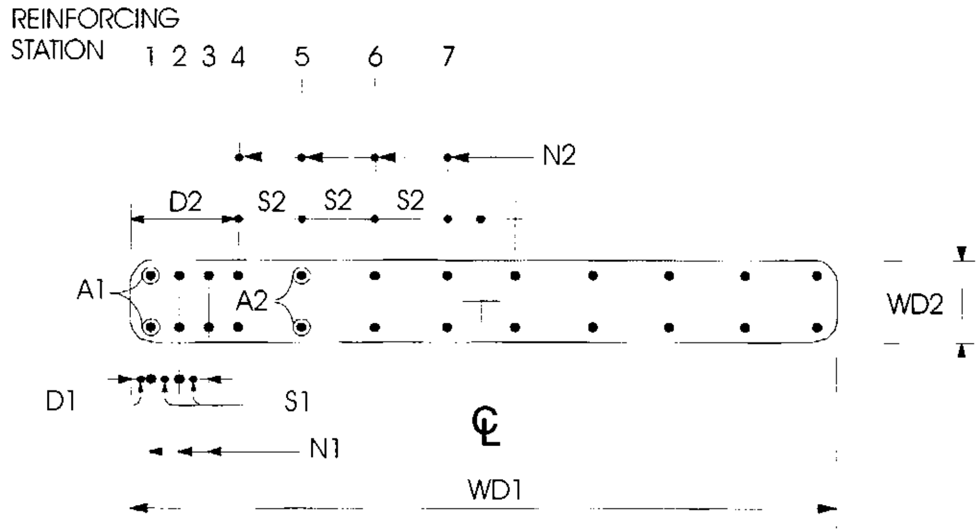
Reinforcement Definition Data Line (ITYPE = RW1 or RW2)

Defining Reinforcing Set #1:

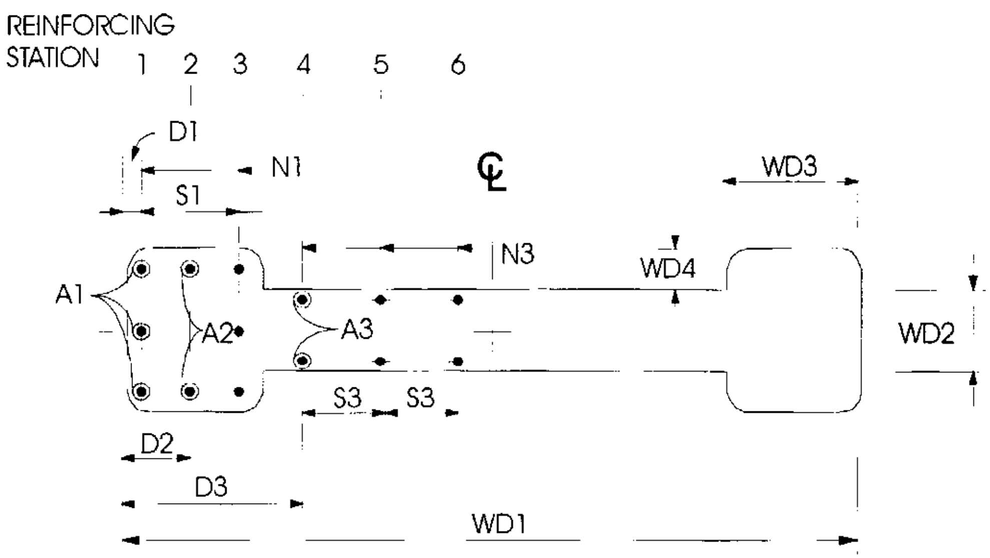
Variable	Field	Note	Entry
D1	1	(6)	Distance to center of first reinforcing station from face of section.
A1	2		Total area of reinforcing placed at the distance D1.
N1	3		Number of equally spaced reinforcing locations (including first station).
S1	4		Spacing between equally spaced reinforcing locations.

Defining Reinforcing Set #2:

Variable	Field	Note	Entry
D2	5		Distance to center of first reinforcing station from face of section.
A2	6		Total area of reinforcing placed at the distance D2.
N2	7		Number of equally spaced reinforcing locations (including first station).
S2	8		Spacing between equally spaced reinforcing locations.



(a) Wall Section Type RW1



(b) Wall Section Type RW2

Wall Section Types RW1 and RW2 (Reinforcing Specified)
Figure IV-2

Notes

1. The column property sets may be entered in any order; however, the identification numbers must lie 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. The WALLER program can only be used for the design of symmetric rectangular or flanged wall sections as shown in Figures IV-1 and IV-2.

   For wall section types W1 and W2, the wall trim reinforcing to satisfy overturning requirements and the wall horizontal and vertical reinforcing to satisfy shear requirements will be calculated by the program.

   For wall section types RW1 and RW2 the program will calculate load-moment interaction diagrams based upon the specified section dimension and reinforcing and report an overturning capacity ratio based upon the axial forces and overturning moments that exist in the walls. The shear design formulation for the RW1 and RW2 section types is identical to that of the W1 and W2 section types.

   See Chapter III for details of the design algorithms.

   For ETABS column properties not redefined in this section, the default section type is W1.

3. This entry references the material property types that were previously defined in the ETABS data or subsequently redefined or added 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.

4. The entries **WD1**, **WD2**, **WD3** and **WD4** define the geometry of the sections. The **WD3** and **WD4** entries are obviously not needed for section types W1 and RW1. For wall type W1, **WD1** must be greater than 2 times **WD2**. If the section property is not redefined, **WD1** and **WD2** default to the major and minor dimensions of the column property specified in the original ETABS data.

5. The wall design to accommodate the tension and compression effects of overturning is implemented using an iterative solution scheme which is based upon limiting

the tension and compression steel percentages in the edge members of the wall. Details of the algorithms are presented in Chapter III. These entries define the values of the steel percentages. Recommended values are

PTMAX = .060

PCMAX = .040

6. The wall reinforcing is defined by a series of **D**, **A**, **N** and **S** entries. To define the reinforcing of the section, the user may enter as many **D, A, N, S** sets as are possible on one data line.

   For example, the reinforcing in the wall section type RW1 shown in Figure IV-2a may be defined by a data line having two **D, A, N, S** sets as follows:

   D1 A1 N1 S1 D2 A2 N2 S2

   where **D1 A1 N1 S1** define the reinforcing at reinforcing stations 1, 2 and 3 as shown in the figure so that **N1** is 3 and the entries **D1**, **A1** and **S1** are as illustrated in Figure IV-2a.

   Similarly, **D2 A2 N2 S2** define the reinforcing at stations 4 through 7 so that **N2** is 4.

   The reinforcing in the wall section type RW2 as shown in Figure IV-2b is defined by three **D, A, N, S** sets, so that the data line is as follows:

   D1 A1 2 S1 D2 A2 1 0 D3 A3 3 S3

   The value of **N** in the **D, A, N, S** sequence must be at least 1. If **N** is 1, the S value is not used, however, a zero value must be entered to complete the sequence of the four **D, A, N, S** entries.

   Only the reinforcing that exists to the left of the center line of the wall should be specified. Reinforcing to the right of the center line will be generated by the program using symmetry. If reinforcing exists on the center line only one half of it should be specified.

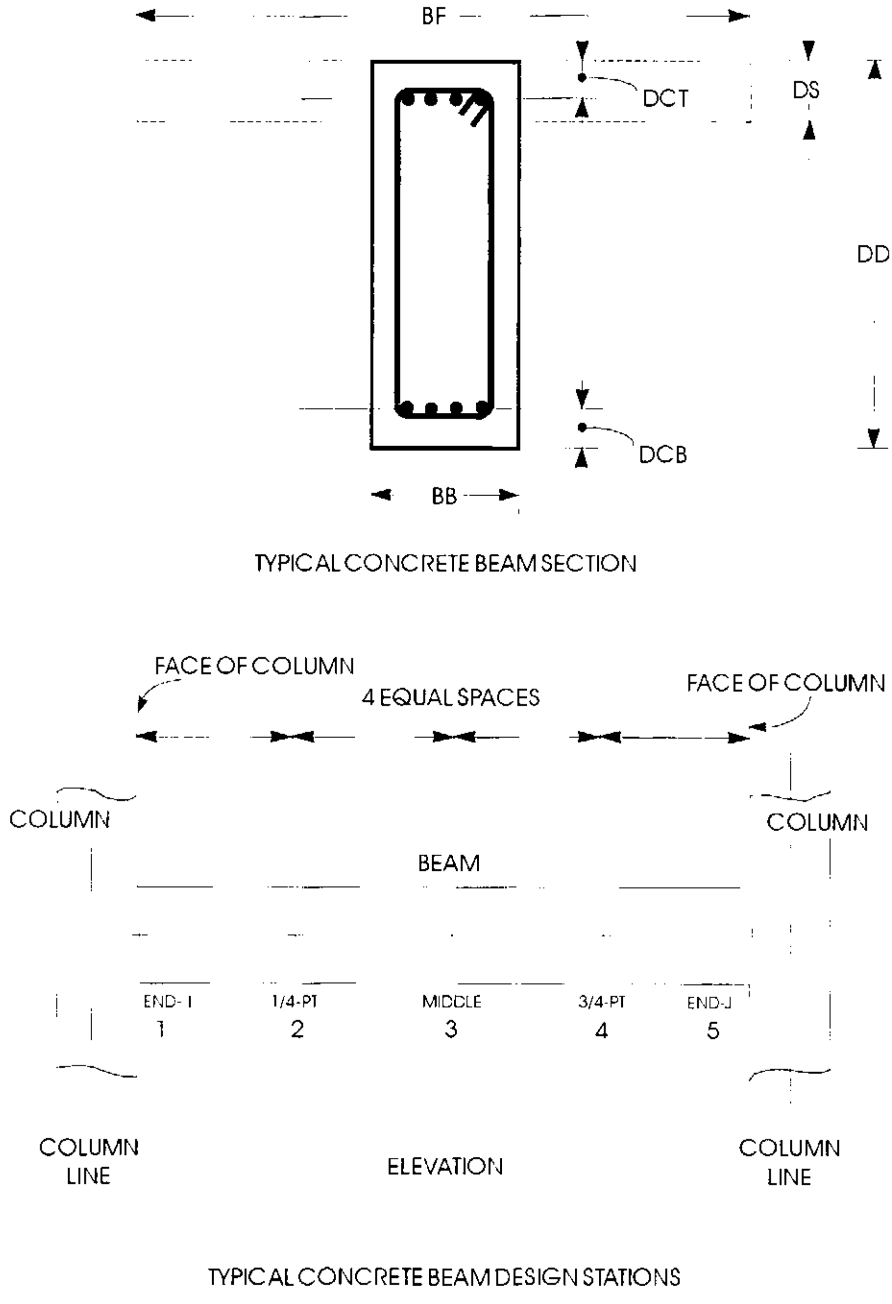
4.ii. Beam Property Redefinition Data

If **NRBP** is 0, skip this data section. Otherwise, provide **NRBP** data lines to redefine, add to or assign reinforced concrete or masonry specific beam design data to the ETABS beam property table. Only beam sections that have a wall or masonry material type (i.e. equal to W or M) will be included in the processing by WALLER.

Format

Prepare the data in the following form:

ID ITYPE IMAT DD BB DCT DCB DS BF



Spandrel Design
Figure IV-3

Description

Variable	Field	Note	Entry
ID	1	(1)	Identification number of the beam section property set.
ITYPE	2	(2)	Section type = SPANDREL
IMAT	3	(3)	Material identification number for this section property.
DD	4	(4)	Depth of beam.
BB	5		Width of beam.
DCT	6		Cover to center of top reinforcing steel.
DCB	7		Cover to center of bottom reinforcing steel.
DS	8	(4,5)	Thickness of slab for T-Beam sections (enter 0.0 for rectangular sections).
BF	9		Effective width of slab for T-Beam sections (enter 0.0 for rectangular sections).

Notes

1. The beam property sets may be entered in any order; however, the identification numbers must lie 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. The only valid reinforced concrete or masonry beam section type is SPANDREL. Enter the word SPANDREL for **ITYPE**.

3. 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.

4. See Figure IV-3 for an illustration of this variable. If the section property is not redefined, **DD** and **BB** default to the major and minor dimensions of the beam property specified in the original ETABS data. Also, **DCT** and **DCB** default to 10% of **DD**.

5. 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** is 0 or **BF** is 0 the section defaults to a rectangular section of dimensions **BB** times **DD**.

4.iii. Panel / Wall Property Redefinition Data

If **NRWP** is 0, skip this data section. Otherwise, provide **NRWP** data sets to redefine, add to or assign reinforced concrete or masonry specific wall design data to the ETABS panel property table. Only panel / wall sections that have a wall or masonry material type (i.e. equal to W or M) will be included in the processing by WALLER.

Format

Each data set consists of two data lines, a section definition data line immediately followed by a reinforcement definition data line.

a. Section Definition Data Line

Prepare one data line in the following form:

ID ITYPE IMAT WD1 WD2 WD3 WD4

b. Reinforcement Definition Data Line

The format of this data line depends upon the section type, **ITYPE.**

If **ITYPE** is W1 or W2, namely, that explicit wall reinforcing is not being specified, prepare one data line in the following form to define the acceptable values of reinforcing percentages.

PTMAX PCMAX

If ITYPE is RW1 or RW2, namely, that wall reinforcement is explicitly being specified, prepare one data line to define the section reinforcement in the following form. See Figure IV-2.

D1 A1 N1 S1 D2 A2 N2 S2 D3 A3...

Description

Variable	Field	Note	Entry
a. Section Definition Data Line			
ID	1	(1)	Identification number of panel /wall section property set.
ITYPE	2	(2)	Section type (See Figures IV-1 and IV-2): = W1 Rectangular section reinforcing not specified = W2 Flanged section reinforcing not specified = RW1 Rectangular section reinforcing specified = RW2 Flanged section reinforcing specified
IMAT	3	(3)	Material identification number for this section property.
WD1	4	(4)	Section dimension in major direction.
WD2	5		Section dimension in minor direction.
WD3	6		Flange dimension in major direction (for W2 and RW2 section types).
WD4	7		Flange dimension in minor direction (for W2 and RW2 section types).
b. Reinforcement Definition Data Line (ITYPE = W1 or W2)			
PTMAX	1	(5)	Maximum percentage of steel allowed for tension design.
PCMAX	2	(5)	Maximum percentage of steel allowed for compression design.

Variable	Field	Note	Entry

Reinforcement Definition Data Line (ITYPE = RW1 or RW2)

Defining Reinforcing Set #1:

D1	1	(6)	Distance to center of first reinforcing station from face of section.
A1	2		Total area of reinforcing placed at the distance D1.
N1	3		Number of equally spaced reinforcing locations (including first station).
S1	4		Spacing between equally spaced reinforcing locations.

Defining Reinforcing Set #2:

D2	5		Distance to center of first reinforcing station from face of section.
A2	6		Total area of reinforcing placed at the distance D2.
N2	7		Number of equally spaced reinforcing locations (including first station).
S2	8		Spacing between equally spaced reinforcing locations.

Notes

1. The wall property sets may be entered in any order, however, the identification numbers must be between 1 and (**NPP** + **NRWP**).

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

2. The WALLER program can only be used for the design of symmetric rectangular or flanged wall sections as shown in Figures IV-1 and IV-2.

   For wall section types W1 and W2, the wall trim reinforcing to satisfy overturning requirements and the wall horizontal and vertical reinforcing to satisfy shear requirements will be calculated by the program.

   For wall section types RW1 and RW2 the program will calculate load-moment interaction diagrams based upon the specified section dimension and reinforcing and report an overturning capacity ratio based upon the axial forces and overturning moments that exist in the walls. The shear design formulation for the RW1 and RW2 section types is identical to that of the W1 and W2 section types.

   See Chapter III for details of the design algorithms.

   For ETABS panel properties not redefined in this section, the default section type is W1.

3. This entry references the material property types that were previously defined in the ETABS data or subsequently redefined or added 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.

4. The entries **WD1**, **WD2**, **WD3** and **WD4** define the geometry of the sections. The **WD3** and **WD4** entries are obviously not needed for section types W1 and RW1. For wall type W1, **WD1** must be greater than 2 times **WD2**. Also, for wall type W1, if **WD1** is left as zero or if the section property is not redefined, it defaults to the sum of lengths of all panels making up the wall to which this section property is assigned. If the section property is not redefined **WD2** defaults to the thickness of the first panel that makes up the wall to which this section is assigned.

5. The wall design to accommodate the tension and compression effects of overturning is implemented using an iterative solution scheme which is based upon limiting the tension and compression steel percentages in the edge members of the wall. Details of the algorithms are presented in Chapter III. These entries define the values of the steel percentages. Recommended values are

   PTMAX = .060

   PCMAX = .040

6. The wall reinforcing is defined by a series of **D**, **A**, **N** and **S** entries. To define the reinforcing of the section, the user may enter as many **D, A, N, S** sets as are possible on one data line.

   For example, the reinforcing in the wall section type RW1 shown in Figure IV-2a may be defined by a data line having two **D, A, N, S** sets as follows:

   D1 A1 N1 S1 D2 A2 N2 S2

   where **D1 A1 N1 S1** define the reinforcing at reinforcing stations 1, 2 and 3 as shown in the figure so that **N1** is 3 and the entries **D1**, **A1** and **S1** are as illustrated in Figure IV-2a.

   Similarly, **D2 A2 N2 S2** define the reinforcing at stations 4 through 7 so that **N2** is 4.

   The reinforcing in the wall section type RW2 as shown in Figure IV-2b is defined by three **D, A, N, S** sets, so that the data line is as follows:

   D1 A1 2 S1 D2 A2 1 0 D3 A3 3 S3

   The value of **N** in the **D, A, N, S** sequence must be at least 1. If **N** is 1, the S value is not used, however, a zero value must be entered to complete the sequence of the four **D, A, N, S** entries.

   Only the reinforcing that exists to the left of the center line of the wall should be specified. Reinforcing to the right of the center line will be generated by the program using symmetry. If reinforcing exists on the center line only one half of it should be specified.

5. Frame Design Activation Data Sets

Provide **NFR** data sets, one for each of the ETABS frames that are to be designed/stress checked. Each set consists of one line of Frame Design Control Data and as many lines as needed of Element Reassignment Data as described in the following sections.

5.i. Frame Design Control Data

One line of control data is required.

Format

Prepare the data in the following form:

I ITYP IRCP IRBP IRWP

Description

Variable	Field	Note	Entry
I	1	(1)	Frame sequence number that uniquely identifies this frame among the **NTF** total frames.
ITYP	2	(2)	Frame design type: = 1 Seismic = 2 Non-Seismic
IRCP	3	(3)	Column reassignment flag: = 0 No column reassignments provided = 1 Column reassignments provided
IRBP	4		Beam reassignment flag: = 0 No beam reassignments provided = 1 Beam reassignments provided
IRWP	5		Wall reassignment flag: = 0 No wall reassignments provided = 1 Wall reassignments provided

Notes

1. This is a positive non zero number, not greater than **NTF**. This sequence number refers to the sequence in which the frames are entered in the ETABS Frame Location Data. In that 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 stress checked 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 are used. If **ITYP** is 2, the seismic requirements are not used. The default value for **ITYP** is 1.

3. Irrespective of any section (or material) property redefinition in the column section (or material) property data above, it is possible to reassign section properties and/or live load reduction 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 and **IRWP** applies to wall reassignment data.

5.ii. Element Reassignment Data

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

Prepare one (or up to three) of the following data Sections a, b and c below, as required.

5.ii.a. Column 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.**

Format

Prepare the data in the following form:

NT NC1 NC2 NSAME SD1 SD2 P

Description

Variable	Field	Note	Entry
NT	1	(1)	Data line type: = I Property type = R Live load factor
NC1	2	(2,6)	Column line number of first column line being reassigned.
NC2	3		Column line number of last column line being reassigned.
NSAME	4	(3)	Column line number, the properties of which are to be repeated at column lines **NC1** through **NC2**.
SD1	5	(4,5)	Identification of the first story level associated with the column being reassigned.
SD2	6		Identification of the last story level associated with the column being reassigned.
P	7	(6)	Parameter: = Column property ID (**NT** = I) = Live load factor (**NT** = R)

Notes

1. This entry identifies the type of data that is being defined by this data line. For example, if **NT** = R, the parameter **P** on this data line is the live load reduction factor for the element.

2. This entry is a column line number. The number must not be greater than **NC**.

3. If **NSAME** is non zero, 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 non zero 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 **NC1** through **NC2** are set identical to that of column line **NSAME** as it stands defined at the time of this entry.

   Subsequent reassignment of properties on column line **NSAME** in later data lines will not result in automatic corresponding reassignment of the properties on column lines **NC1** through **NC2**, or vice versa.

   In the duplication mode (i.e., when **NSAME** is non zero) the entries for **SD1, SD2** and **P** are meaningless and must not be entered. These entries are only needed if **NSAME** is 0.

4. This entry is an alphanumeric story identifier that must correspond to one of the story level identifiers previously defined in the ETABS data. The story level associated with a column element is the story level at the top of the column.

5. All column elements existing on column lines **NC1** through **NC2** associated with levels **SD1** through **SD2** will be assigned the properties identified by the entries **NT** and **P** on this data line.

6. 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 defining live load reduction factors. The entry **P** is the live load reduction factor for the element.

   Thus, for instance, if the axial force in a column at a particular level for load condition **LLC** is 50k, and the entry for **P** 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

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

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

5.ii.b. Beam 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.**

Format

Prepare the data in the following form:

NT NB1 NB2 NSAME SD1 SD2 P

Description

Variable	Field	Note	Entry
NT	1	(1)	Data line type: = I Property type = R Live load factor
NB1	2	(2,5)	Bay number of first bay being reassigned.
NB2	3		Bay number of last bay being reassigned.
NSAME	4	(3)	Bay number, the properties of which are to be repeated at bays **NB1** through **NB2**
SD1	5	(4,5)	Identification of the first story level associated with the beam being reassigned.
SD2	6		Identification of the last story level associated with the beam being reassigned.
P	7	(6)	Parameter: = Beam property ID (NT = I) = Live load factor (NT = R)

Notes

1. This entry identifies the type of data that is being defined by this data line. For example, if **NT** = R, the parameter **P** on this data line is the live load reduction factor for the element.

2. This entry is a bay number. The number must be positive and not greater than **NB**.

3. If **NSAME** is non zero, 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 non zero 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 **NB1** through **NB2** are set identical to that of bay **NSAME** as it stands defined at the time of this entry.

   Subsequent reassignment of properties to bay **NSAME** in later data lines will not result in automatic corresponding reassignment of the properties in bays **NB1** through **NB2**, or vice versa.

   In the duplication mode (i.e. when **NSAME** is non zero), the entries for **SD1**,**SD2** and **P** are meaningless and must not be entered. These entries are only used if **NSAME** is 0.

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

5. All beam elements existing in bays **NB1** through **NB2** between levels **SD1** through **SD2** will be assigned the properties identified by the entries **NT** and **P** on this data line.

6. 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 reassigning live load reduction factors. The entry **P** is the live load reduction factor for the beam.

   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.

5.ii.c. Wall Reassignment Data

If **IRWP** is 0, none of the wall element parameters are to be reassigned, therefore, skip this data section (including the blank termination line defined below). Also, if **MPAN** is 0, there are no wall elements 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 wall element at any level may be repeated. The last values read (or generated) will be used. **End this data section with a blank line.**

Format

Prepare the data in the following form:

NT NW1 NW2 SD1 SD2 P

Description

Variable	Field	Note	Entry
NT	1	(1)	Data line type: = I Property type = R Live load factor
NW1	2	(2,4)	Wall ID of first wall being reassigned.
NW2	3		Wall ID of last wall being reassigned.
SD1	4	(3,4)	Identification of the first story level associated with the wall being reassigned.
SD2	5		Identification of the last story level associated with the wall being reassigned.
P	6	(5)	Parameter: = Wall property ID (**NT** = I) = Live load factor (**NT** = R)

Notes

1. This entry identifies the type of data that is being defined by this data line. For example, if **NT** = R, the parameter **P** on this data line is the live load factor.

2. This entry is the ETABS wall identification number.

3. This entry is an alphanumeric story identifier that must correspond to one of the story level identifiers previously defined in the ETABS data.. The story level associated with a wall is the story level at the top of the wall.

4. All wall assemblages associated with levels **SD1** through **SD2** having identifications between **NW1** and **NW2** will be assigned the properties identified by the entries **NT** and **P** on this data line.

5. 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. For wall assemblages, since there is no corresponding wall property in ETABS, the wall property number in WALLER defaults to the panel property number of the first panel making up the wall assemblage.

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

   Thus, for instance, if the axial force in a wall at a particular level for load condition **LLC** is 50k, and the entry for **P** 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

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

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

Chapter V

Program Output

A. Description of Output Files

If the name of the ETABS analysis data file is EXWAL, the ETABS analysis will produce a post processing file called EXWAL.PST.

If the name of the WALLER input data file is DESWAL, there will be two output files produced by WALLER, namely DESWAL.WAL and DESWAL.WIN. However, if program defaults are acceptable, and WALLER input data file is not provided, the two output files produced by WALLER are EXWAL.WAL and EXWAL.WIN.

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 metric 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 metric 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 WALLER input data and control information recovered from the ETABS post processing file, the file DESWAL.WAL may contain the following:

1. For every wall (modeled as a column or an assemblage of panel elements) for which the explicit reinforcing has been specified by the user, namely, wall types RW1 and RW2, the file will contain the maximum moment interaction capacity ratios for the top and bottom ends of the wall with the associated load combination numbers and the controlling axial force and moment sets, namely, the coordinates of point L in Figure III-8.

   For every wall for which the explicit reinforcing has not been specified, namely, wall types W1 and W2, the file will contain the required tension and compression trim reinforcing for the top and bottom ends of the wall and the associated edge distance from the ends of the wall, within which the calculated reinforcing must be placed.

   Also, for every wall, the required shear reinforcing, the controlling shear force and shear stress, along with the controlling load combination number, are tabulated.

   See Figures V-2 and V-3 for details of the output formats.

2. For each concrete beam-spandrel, the file will contain the required top and bottom flexural reinforcing, shear reinforcing and shear stress at each of the five beam design stations. See Figure V-4 for details of the output format.

The file DESWAL.WIN contains additional back-up information associated with the design of each wall and beam. The purpose of this information is to aid the user in the manual verification of the results produced by the program. The file contains the following:

1. A numerical tabulation of the load-moment interaction diagrams generated by the program for the wall section types RW1 and RW2, namely, the wall sections for which explicit reinforcing has been specified by the user. See Figure III-4. The printing of these tables is optional.

   The interaction diagrams are tabulated both with the strength reduction factor and without it. The P_{max} limit is included in both tables.

2. For each wall of types RW1 or RW2, the file will contain the coordinates of the failure point, namely point C in Figure III-8, corresponding to the capacity ratios calculated for the top and bottom ends of the wall. See Figure V-5.

3. For each wall of types W1 or W2, the file will contain the controlling tension and compression edge forces (with the associated combination numbers) used for calculating the compression and tension reinforcing requirements for the top and bottom ends of the wall. See Figure V-6.

4. For each beam-spandrel, the file will contain the controlling positive and negative bending moments and shear forces at each of the five beam design stations, along with the controlling load combination numbers. See Figure V-7.

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

   The walls modeled as column elements are output first, followed by the design of the walls modeled as panel elements. The spandrel design is output last.

B. Design Overstresses and Failure Conditions

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 is presented in Figure V-1.

C. Details of 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, V-6 and V-7.

1. This is the level ID number of the column element being designed. The column line ID number is shown above.

   The output shown in Figure V-2 is for walls modeled with column elements. The output for walls modeled with wall elements will have the same information, except that the wall ID number is displayed instead of the column ID.

2. This is the station identification corresponding to the output line.

CHECK #	OVERSTRESS CONDITION
CHK#1	Concrete compression failure (depth of compression block exceeds maximum allowed). Increase section size, or try T-Beam if failure is due to positive moment.
CHK#2	Beam shear stress exceeds maximum allowed. No shear reinforcing calculated. Increase section size.
CHK#3	Wall shear stress exceeds maximum allowed. No shear reinforcing calculated. Increase section size.
CHK#4	P_u is greater than P_{max}. See Figure III-4. Increase section size.
CHK#5	P_u is less than $-P_o$. See Figure III-4. Increase reinforcing.
CHK#6	Tension failure in approximate design algorithm. Increase maximum steel percentage, **PTMAX,** or try using wall type with reinforcing specified, as this algorithm is conservative.
CHK#7	Compression failure in approximate design algorithm. Increase maximum steel percentage, **PCMAX,** or try using wall type with reinforcing specified, as this algorithm is conservative.
CHK#8	Design suppressed due to other compression or tension failure on section.

Design Overstress Checks
Figure V-1

3. This is the controlling axial force and moment set that produced the controlling stress ratio. A negative axial force indicates tension. This force, moment set represents the point L in Figure III-8; point C is defined in the DESWAL.WIN file. See Note 23 below.

4. This is the controlling load combination number that produced the controlling capacity ratio.

5. This is the controlling capacity ratio.

6. This is the value of the maximum factored shear force.

7. This is the value of the maximum factored shear stress, obtained by dividing the maximum factored shear force by the gross area of the section.

8. This is the controlling load combination number for the maximum factored shear force.

9. This is the required shear reinforcing in square inches/foot (or square centimeters/meter), namely, horizontal bars, averaging an area equal to this reported value for every foot along the height of the wall, to be provided. For example, if the reported steel is 0.60, #5 bars (area = 0.31 square inches) placed horizontally at 6 inches center to center along the height of the wall in a single layer at mid plane of the wall will be adequate, giving a total of 0.62 square inches/foot.

   The vertical reinforcing size and spacing is in general made to match that of the horizontal reinforcing.

   The shear reinforcing may be controlled by a different loading combination than the maximum factored shear force.

10. This is the edge member width, B, within which the calculated tension and compression steel must be located (see Figure III-9). As far as practical, the center of gravity of the steel must coincide with the center of this edge member.

    The reinforcing provided in the edge member distance must be the greater of the tension and compression steel areas that are reported. For the correct orientation of the left and right side of the wall, the element must be viewed with the positive axis (major) of the element pointing to the right.

11. This is the reinforcing that must be provided in the edge member to satisfy tension requirements.

12. This is the reinforcing that must be provided in the edge member to satisfy compression requirements.

13. This is the bay number of the spandrel.

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

15. This is the station identification where the design is being made.

16. This is the beam length to effective depth ratio.

17. This is the value of the maximum factored shear stress, obtained by dividing the maximum factored shear force by the gross area of the section.

18. This is the required top reinforcing at the station corresponding to the factored negative design moment.

19. This is the required bottom reinforcing at the station corresponding to the factored positive design moment.

20. This is the required vertical 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-3, 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.

21. This the required minimum horizontal shear reinforcing in square inches/foot (or square centimeters/meter), namely horizontal bars, averaging an area equal to this reported value for every foot of beam height are to be provided, when the beam falls under the category of a deep beam.

22. This is the required area of one leg of the diagonal (cross-bar) reinforcement in square inches (or square centimeters) for coupling beams which satisfy the UBC '94, Section 1921.6.9 requirements.

23. This axial force and moment set corresponds to the point C in Figure III-8. See Note 3 above. A negative axial force indicates tension.

24. This is the controlling P_u / P_o ratio. This is output to facilitate the determination of end pier widths required by some codes.

25. These are controlling factored design tension forces (and associated load combination numbers) that are used in the design of the edge member tension reinforcing.

26. These are the controlling design compression forces (and associated load combination numbers) that are used in the design of the edge member compression reinforcing.

27. 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.

28. 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.

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

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    8
                                          ETABS_FILE:EXWAL.PST/WALLER_FILE:DESWAL.WAL
 FILE : DESWAL   SAMPLE EXAMPLE FOR WALLER MANUAL
 CONCRETE SHEAR WALL BUILDING    UNITS ; KIP-INCH-SECOND

 WALL PROCESSING OF COLUMN ELEMENTS   (UBC 1994 CONCRETE)

 FRAME  ID .... /PIER-SPANDREL WALL
 COLUMN ID ....        1

 OUTPUT FOR WALL TYPES RW1 AND RW2

 LEVEL TYPE/-------WALL MOMENT INTERACTION-------/ /----WALL SHEAR DESIGN----/
 ID         STA      FORCE      MOMENT  COMBO  RATIO  FORCE  STRESS COMBO A(/ft)
            LOC       {K}       {K-in}                 {K}   {Ksi}        {sqin}
 ROOF
       RW1 (8.00in X 48.00in)                           19   0.050 < 3>   0.00
            TOP       -3          465   < 5>   0.11
            BOT       -3          674   < 5>   0.15
  |         |         |          |      |      |        |     |     |       |
 (1)       (2)       (3)        (3)    (4)    (5)      (6)   (7)   (8)     (9)
  |         |         |          |      |      |        |     |     |       |
  -----------------------Note Reference Number------------------------------
```

Typical Wall Output from File DESWAL.WAL
(Column and Panel Elements) Wall Section Types RW1 and RW2
Figure V-2

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE   20
                                   ETABS FILE:EXWAL.PST/WALLER_FILE:DESWAL.WAL
 FILE : DESWAL   SAMPLE EXAMPLE FOR WALLER MANUAL
 CONCRETE SHEAR WALL BUILDING    UNITS : KIP-INCH-SECOND

 WALL PROCESSING OF COLUMN ELEMENTS   (UBC 1994 CONCRETE)

 FRAME  ID .... /CANTILEVER WALL
 COLUMN ID ....        1

 OUTPUT FOR WALL TYPES W1 AND W2

 LEVEL TYPE/-------WALL OVERTURNING DESIGN--------//----WALL SHEAR DESIGN----/
 ID         STA    EDGE /-TENS STEEL-//-COMP STEEL-/ FORCE  STRESS COMBO A(/ft)
            LOC  MEMBER    LEFT  RIGHT   LEFT  RIGHT
                   (in)  (sqin) (sqin) (sqin) (sqin)   (K)    (Ksi)       (sqin)
 ROOF
       W1   (8.00in X 216.00in)                        100    0.058 < 2>   0.00
            TOP    8.00     0.0    0.0    0.0    0.0
            BOT    8.00     1.2    1.2    0.0    0.0
  |         |       |       |      |      |       |    |       |     |      |
 (1)       (2)    (10)    (11)   (11)   (12)    (12)  (6)     (7)   (8)    (9)
  |         |       |       |      |      |       |    |       |     |      |
  ---------------------------Note Reference Number-------------------------
```

Typical Wall Output from File DESWAL.WAL
(Column and Panel Elements) Wall Section Types W1 and W2
Figure V-3

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE   12
                                       ETABS_FILE:EXWAL.PST/WALLER_FILE:DESWAL.WAL
 FILE : DESWAL   SAMPLE EXAMPLE FOR WALLER MANUAL
 CONCRETE SHEAR WALL BUILDING    UNITS : KIP-INCH-SECOND

 SPANDREL DESIGN OF BEAM ELEMENTS   (UBC 1994 CONCRETE)

 FRAME ID .... /PIER-SPANDREL WALL
 LEVEL ID .... ROOF

  BAY     BEAM SIZE STRESS   L/d  SHEAR /-----------REQUIRED REBAR-----------/
   ID WIDTH X DEPTH  POINT RATIO STRESS  M(top) M(bot) Vv(/ft) Vh(/ft)     Avd
      (in)    (in)                (Ksi)  (sqin) (sqin)  (sqin) (sqin)  (sqin)
    1  8.00 X 36.00
                     END I   2.3   0.08    0.39   0.26    0.14    0.24    0.00
                    1/4-PT   2.3   0.07    0.15   0.18    0.14    0.24    0.00
                    MIDDLE   2.3   0.05    0.00   0.09    0.14    0.24    0.00
                    3/4-PT   2.3   0.05    0.08   0.18    0.14    0.24    0.00
                     END J   2.3   0.07    0.24   0.26    0.14    0.24    0.00
    |      |              |     |      |       |      |       |       |       |
  (13)   (14)           (15)  (16)   (17)    (18)   (19)    (20)    (21)    (22)
    |      |              |     |      |       |      |       |       |       |
    -----------------------Note Reference Number--------------------------
```

Typical Beam Design Output from File DESWAL.WAL
Figure V-4

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS   PAGE    2
                                   ETABS_FILE:EXWAL.PST/WALLER_FILE:DESWAL.WIN
 FILE : DESWAL   SAMPLE EXAMPLE FOR WALLER MANUAL
 CONCRETE SHEAR WALL BUILDING    UNITS : KIP-INCH-SECOND

 WALL PROCESSING OF COLUMN ELEMENTS   (UBC 1994 CONCRETE)

 FRAME  ID .... /PIER-SPANDREL WALL
 COLUMN ID ....        1

 BACKUP DESIGN INFORMATION FOR WALL TYPES RW1 AND RW2

 LEVEL TYPE/-------WALL INTERACTION INFORMATION--------/
 ID        STA          /---FAILURE  POINT---/
           LOC                 FORCE      MOMENT   PU/PO
                                 (K)      (K-in)
 ROOF
       RW1 (8.00in X 48.00in)
           TOP                   -25        4426    0.03
           BOT                   -18        4563    0.03
 |         |                     |           |       |
(1)       (2)                  (23)        (23)    (24)
 |         |                     |           |       |
 --------------Note Reference Number------------------
```

Typical Wall Design Backup Information from File DESWAL.WIN
(Column and Panel Elements) Wall Section Types RW1 and RW2
Figure V-5

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE   12
                                   ETABS FILE:EXWAL.PST/WALLER_FILE:DESWAL.WIN
 FILE : DESWAL   SAMPLE EXAMPLE FOR WALLER MANUAL
 CONCRETE SHEAR WALL BUILDING    UNITS : KIP-INCH-SECOND

 WALL PROCESSING OF COLUMN ELEMENTS   (UBC 1994 CONCRETE)

 FRAME  ID .... /CANTILEVER WALL
 COLUMN ID ....        1

 BACKUP DESIGN INFORMATION FOR WALL TYPES W1 AND W2

 LEVEL TYPE/---------------------WALL DESIGN INFORMATION---------------------/
 ID         STA/------TENSION FORCE-------/ /----COMPRESSION FORCE----/
            LOC     LEFT COMBO    RIGHT COMBO     LEFT COMBO   RIGHT COMBO   PU/PO
                      (K)           (K)            (K)           (K)
 ROOF
       W1  (8.00in X 216.00in)
            TOP        0  < 5>       0  < 5>        8  < 2>       8  < 2>    0.00
            BOT       64  < 5>      64  < 5>       77  < 2>      77  < 2>    0.00
  |          |          |             |              |             |          |
 (1)        (2)       (25)          (25)           (26)          (26)       (24)
  |          |          |             |              |             |          |
  ------------------------Note Reference Number---------------------------
```

Typical Wall Design Backup Information from File DESWAL.WIN (Column and Panel Elements) Wall Section Types W1 and W2
Figure V-6

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    6
                                 ETABS_FILE:EXWAL.PST/WALLER_FILE:DESWAL.WIN
 FILE : DESWAL   SAMPLE EXAMPLE FOR WALLER MANUAL
 CONCRETE SHEAR WALL BUILDING    UNITS : KIP-INCH-SECOND

 SPANDREL DESIGN OF BEAM ELEMENTS   (UBC 1994 CONCRETE)

 FRAME ID .... /PIER-SPANDREL WALL
 LEVEL ID .... ROOF

  BAY      BEAM SIZE STRESS /-FACTORED  LOADS  &  COMBOS-/
   ID WIDTH X DEPTH  POINT    -MOMENT   +MOMENT     SHEAR
      {in}    {in}             {K-in}    {K-in}       {K}
    1  8.00 X 36.00
                      END I   690 < 3>  462 < 4>   23 < 3>
                     1/4-PT   277 < 5>  320 < 2>   18 < 3>
                     MIDDLE     0 < 5>  166 < 2>   14 < 3>
                     3/4-PT   145 < 5>  323 < 2>   14 < 2>
                      END J   434 < 5>  475 < 2>   18 < 2>
    |      |            |        |         |          |
  (13)   (14)         (15)     (27)      (28)       (29)
    |      |            |        |         |          |
    -----------Note Reference Number-----------------
```

Typical Beam Design Backup Information from File DESWAL.WIN
Figure V-7

References

1. American Concrete Institute

Building Code Requirements for Reinforced Concrete (ACI 318-89) (Revised 1992) and Commentary - ACI 318R-89 (Revised 1992), Detroit, Michigan, 1992.

2. International Conference of Building Officials

Uniform Building Code, Whittier, California, 1994.

3. Canadian Standards Association

Design of Concrete Structures for Buildings, A National Standard of Canada, (CAN3-A23.3-M84), Rexdale, Ontario, 1989.

Sample Example

The following is an example to illustrate the typical input and output associated with a typical WALLER run.

The WALLER input data file, DESWAL, and the corresponding ETABS input data file EXWAL, along with ETABS post processing file EXWAL.PST, all exist on the WALLER disk, which comes with the complete WALLER package.

The three-story shear wall building consists of three frames, namely

- Pier-Spandrel Frame
- Shear Wall with an Opening
- Cantilever Shear Wall

Elevations of these three frames illustrating the structural geometry are shown in the figure.

In the pier-spandrel frame the piers are defined as walls of type RW1, whereas all the wall elements have been designated as type W1.

The superimposed load on the pier-spandrel frame and the shear wall with an opening for all levels is as follows.

Dead Load 1.0 K/ft

Live Load 0.5 K/ft

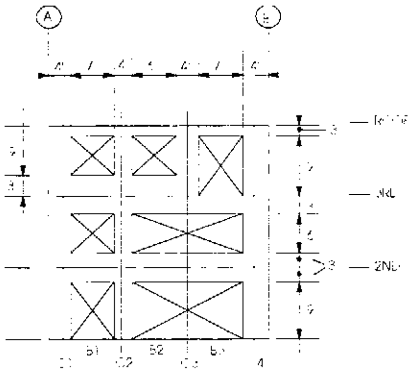
The design material properties are as follows:

f'_c = 4 ksi

f_y = 60.0 ksi

f_{ys} = 40.0 ksi

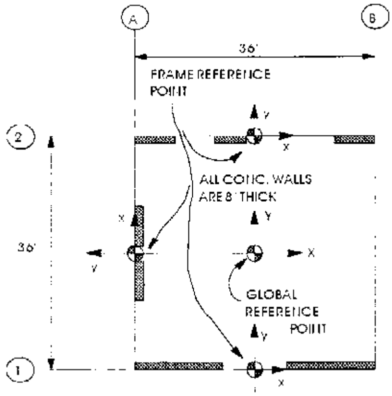
The UBC94 concrete code (including the seismic provisions) is used for design.



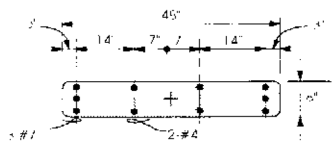
ELEVATION - LINE (2)

(PIER - SPANDREL)

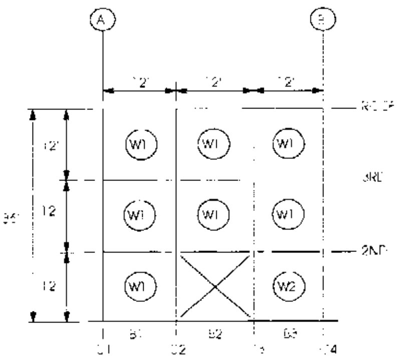
FRAME #1



PLAN



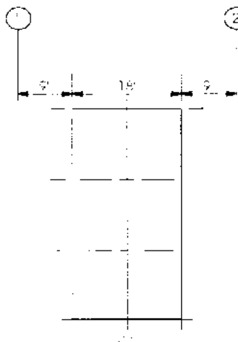
TYPICAL PIER



ELEVATION - LINE (1)

(WALL WITH OPENINGS)

FRAME #2



ELEVATION - LINE (A)

(CANTILEVER WALL)

FRAME #3

WALLER Example

```
$ -------------------------------------HEADING DATA
ETABS 6.1
EXAMPLE : EXWAL          SAMPLE EXAMPLE FOR WALLER MANUAL
CONCRETE SHEAR WALL BUILDING     UNITS : KIP-INCH-SECOND
$ -------------------------------------CONTROL DATA
 3 1 3 3 1 4 6 2 2 3 0 0 1 0 11 1 0 0 2 1 1
 386.4
$ -------------------------------------STORY MASS DATA
 1 1 1/386.4
 RECT .200/144 0 0 36*12 36*12
$ -------------------------------------STORY DATA
 ROOF 12*12 1
 1 1
 3RD 12*12 1
 1 1
 2ND 12*12 1
 1 1
$ -------------------------------------MATERIAL PROPERTY DATA
 1 W 3833 .15 .150/1728
 2 O
$ -------------------------------------COLUMN SECTION PROPERTY DATA
 1  RECT 1  4*12  8
 2  RECT 1 18*12  8
$ -------------------------------------BEAM SECTION PROPERTY DATA
 1  USER  2
 0 0 0 0 0 0
 2  RECT 1 3*12    0 8
 3  RECT 1 3*12 3*12 8
$ -------------------------------------PANEL SECTION PROPERTY DATA
 1 MEMB 1 8 8 8
$
/FRAME DATA FOR PIER-SPANDREL WALL
 1 4 3 0 0 2
$ -------------------------------------COLUMN LINE COORDINATES
 1 -16*12  0 0
 2  -5*12  0 0
 3   5*12  0 0
 4  16*12  0 0
$ -------------------------------------BAY CONNECTIVITY
 1 1 2
 2 2 3
 3 3 4
$ -------------------------------------BEAM SPAN VERTICAL LOAD PATTERNS
 1 0 1.0/12
 2 0 0.5/12
$ -------------------------------------COLUMN ASSIGNMENTS
 1 2 0 ROOF 2ND 1
 3 3 0 ROOF 3RD 1
 4 4 1

$ -------------------------------------BEAM ASSIGNMENTS
 1 1 0 ROOF ROOF 2
 1 1 0  3RD  2ND 3
 2 2 1
 3 3 0 ROOF  3RD 2
 3 3 0  2ND  2ND 3

$ -------------------------------------BEAM LOAD ASSIGNMENTS
 1 3 0 ROOF 2ND 1 2
```

*ETABS Input Data File : **EXWAL***

```
$
 /FRAME DATA FOR WALL WITH OPENING
 2 4 3 0 0 2 0 0 0 8
$ -------------------------------------COLUMN LINE COORDINATES
 1 -18*12 0 0
 2   -6*12 0 0
 3    6*12 0 0
 4  18*12 0 0
$ -------------------------------------BAY CONNECTIVITY
 1 1 2
 2 2 3
 3 3 4
$ -------------------------------------BEAM SPAN VERTICAL LOAD PATTERNS
 1 0 1.0/12
 2 0 0.5/12
$ -------------------------------------COLUMN ASSIGNMENTS

$ -------------------------------------BEAM ASSIGNMENTS
 1 3 0 ROOF 2ND 1

$ -------------------------------------PANEL ASSIGNMENTS
 1 ROOF 3RD 1 2 1
 1 ROOF 3RD 2 3 1
 1 ROOF 3RD 3 4 1
 2  2ND 2ND 1 2 1
 3  2ND 2ND 3 4 1

$ -------------------------------------BEAM LOAD ASSIGNMENTS
 1 3 0 ROOF 2ND 1 2

$
/FRAME DATA FOR CANTILEVER WALL
 3 1
$ -------------------------------------COLUMN LINE COORDINATES
 1 0 0 0
$ -------------------------------------COLUMN ASSIGNMENTS
 1 1 0 ROOF 2ND 2

$ -------------------------------------FRAME LOCATION DATA
 1       0  18*12  0 /PIER-SPANDREL WALL
 2       0 -18*12  0 /WALL WITH OPENINGS
 3 -18*12       0 90 /CANTILEVER WALL
$ -------------------------------------UBC94 STATIC SEISMIC LOADS
 .4 1 1.2
 0 .294 6 ROOF
 0 .294 6 ROOF
$ -------------------------------------ADDITIONAL STORY ECCENTRICITIES
 0 0 0 0
 0 0 0 0
 0 0 0 0
$ -------------------------------------LOAD CASE 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 : ***EXWAL*** *(continued)*

```
$ ----------------------------------------HEADING
 WALLER 6.1
 FILE : DESWAL    SAMPLE EXAMPLE FOR WALLER MANUAL
 CONCRETE SHEAR WALL BUILDING     UNITS : KIP-INCH-SECOND
$ ----------------------------------------CONTROL DATA
$ ICODE  NFR  NLC  LLC  NRMP  NRCP  NRBP  NRWP  NPTS  IPRI  IPHI
      1    3    5    2     1     2     2     2    21     1     0
$
$ ----------------------------------------LOAD COMBINATION DEFINITION DATA
$ L  LTYP    XI     XII     XIII    XA    XB    XC   XD1   XD2
  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     0.9   1.4   1.4
  5     2   0.9       0     0.9  -1.4   1.4
$
$                                         MATERIAL PROPERTY REDEFINITION DATA
$ MID MTYPE    E       U          W        M      ALPHA    FY  FC FYS  FCS
    1   W   3833    .15   .150/1728        0          0    60   4  40    4
$
$ ----------------------------------------COLUMN PROPERTY REDEFINITION DATA
$ ID ITYPE    IMAT    WD1   WD2  WD3   WD4
   1  RW1        1     48     8
 3  3*.60  1  0       17  2*.20  1  0    $  D-A-N-S REBAR SPECS
   2   W1        1  18*12     8
 .06   .04                              $  PTMAX AND PCMAX
$
$ ----------------------------------------BEAM PROPERTY REDEFINITION DATA
$ ID        ITYPE    IMAT    DD   BB   DCT  DCB   DS   BF
   2     SPANDREL       1    36    8   2.5  2.5    8   40
   3     SPANDREL       1    72    8   2.5  2.5
$
$ ----------------------------------------WALL PROPERTY REDEFINITION DATA
$ ID ITYPE   IMAT     WD1    WD2
   1    W1     1    36*12     8
 .06   .04                              $  PTMAX AND PCMAX
   2    W1     1    12*12     8
 .06   .04                              $  PTMAX AND PCMAX
$
$ ----------------------------------------FRAME DESIGN ACTIVATION DATA
$ I  ITYPE  IRCP  IRBP  IRWP    FRAME 1
  1      1     0     0     0
$ I  ITYPE  IRCP  IRBP  IRWP    FRAME 2
  2      1     0     0     1
$ ----------------------------------------WALL ELEMENT REASSIGNMENT DATA
$ NT MW1 MW2   SD1   SD2   P
   I   1   1  ROOF   3RD   1
   I   2   2   2ND   2ND   2
   I   3   3   2ND   2ND   2

$ I  ITYPE  IRCP  IRBP  IRWP    FRAME 3
  3      1     0     0     0
```

*WALLER Input Data File : **DESWAL***

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    1
                                  ETABS_FILE:EXWAL.PST/WALLER_FILE:DESWAL.WAL
 FILE : DESWAL   SAMPLE EXAMPLE FOR WALLER MANUAL
 CONCRETE SHEAR WALL BUILDING    UNITS : KIP-INCH-SECOND


 DESIGN CODE TYPE---------------------------      1  (UBC 1994 CONCRETE)

 NUMBER OF FRAMES TO BE DESIGNED/CHECKED----      3
 NUMBER OF LOAD COMBINATIONS----------------      5

 ETABS LIVE LOAD CONDITION NUMBER-----------      2

 NUMBER OF REPLACED MATERIAL PROPERTY SETS--      1
 NUMBER OF COLUMN-WALL DESIGN PROPERTY SETS-      2
 NUMBER OF SPANDREL DESIGN PROPERTY SETS----      2
 NUMBER OF PANEL-WALL DESIGN PROPERTY SETS--      2

 NUMBER OF POINTS PER INTERACTION CURVE-----     21
 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
```

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    2
                                  ETABS_FILE:EXWAL.PST/WALLER_FILE:DESWAL.WAL
 FILE : DESWAL   SAMPLE EXAMPLE FOR WALLER MANUAL
 CONCRETE SHEAR WALL BUILDING    UNITS : KIP-INCH-SECOND


 DESIGN LOADING COMBINATION DATA

 LOAD TYPE        I       II      III        A        B        C       D1      D2
    1    0    1.400    1.700    1.400    0.000    0.000    0.000    0.000   0.000
    2    2    1.400    1.400    1.400    1.400    1.400    0.000    0.000   0.000
    3    2    1.400    1.400    1.400   -1.400    1.400    0.000    0.000   0.000
    4    2    0.900    0.000    0.900    1.400    1.400    0.000    0.000   0.000
    5    2    0.900    0.000    0.900   -1.400    1.400    0.000    0.000   0.000
```

Sample Output from ***WALLER***

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    3
                                   ETABS FILE:EXWAL.PST/WALLER_FILE:DESWAL.WAL
 FILE : DESWAL   SAMPLE EXAMPLE FOR WALLER MANUAL
 CONCRETE SHEAR WALL BUILDING    UNITS : KIP-INCH-SECOND


 MATERIAL PROPERTIES

  ID TYPE      ELASTIC     POISSONS        UNIT         UNIT    COEFF OF
               MODULUS       RATIO        WEIGHT        MASS   EXPANSION
                {Ksi}                    {K/cuin}

   1    W  0.3833E+04      0.1500  0.8681E-04  0.0000E+00 0.0000E+00
   2    O  0.0000E+00      0.0000  0.0000E+00  0.0000E+00 0.0000E+00


 MATERIAL PROPERTIES FOR DESIGN

                  YIELD    STRENGTH        YIELD   STRENGTH        ALLOWABLES
  ID TYPE            FY       FC(FM)         FYS    FCS(FMS)       FBMAJ      FBMIN
                  {Ksi}        {Ksi}       {Ksi}       {Ksi}       {Ksi}      {Ksi}

   1    W  0.600E+02  0.400E+01  0.400E+02  0.400E+01



CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    4
                                   ETABS_FILE:EXWAL.PST/WALLER_FILE:DESWAL.WAL
 FILE : DESWAL   SAMPLE EXAMPLE FOR WALLER MANUAL
 CONCRETE SHEAR WALL BUILDING    UNITS : KIP-INCH-SECOND


 SECTION PROPERTIES FOR COLUMN ELEMENT WALLS

 SECTION DEFINITION DATA

        SECTION  MATERIAL       WALL       WALL     FLANGE    FLANGE
   ID   TYPE           ID     LENGTH      THICK     LENGTH     THICK
                                {in}       {in}       {in}      {in}

    1   RW1             1    48.0000     8.0000
    2   W1              1   216.0000     8.0000


 SECTION PROPERTIES FOR COLUMN ELEMENT WALLS

 REINFORCEMENT DEFINITION DATA

                 /---REBAR LIMITS---/ /--------REBAR SPECIFICATIONS--------/
       SECTION   (FOR W1 OR W2 TYPES)         (FOR RW1 OR RW2 TYPES)
   ID  TYPE            PTMAX      PCMAX   DISTANCE        AREA NUMBER  SPACING
                                              {in}      {sqin}            {in}
    1  RW1
                                             3.000     1.80000      1    0.000
                                            17.000     0.40000      1    0.000

    2  W1              0.060      0.040
```

*Sample Output from **WALLER** (continued)*

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    5
                                   ETABS_FILE:EXWAL.PST/WALLER_FILE:DESWAL.WAL
 FILE : DESWAL   SAMPLE EXAMPLE FOR WALLER MANUAL
 CONCRETE SHEAR WALL BUILDING    UNITS : KIP-INCH-SECOND


 SECTION PROPERTIES FOR BEAM SPANDRELS

       SECTION  MATERIAL      BEAM      BEAM       TOP       BOT  FLANGE   FLANGE
   ID  TYPE           ID     DEPTH     WIDTH     COVER     COVER   THICK    WIDTH
                              {in}      {in}      {in}      {in}    {in}     {in}

    1  USER            2
    2  SPANDREL        1   36.0000    8.0000    2.5000    2.5000  8.0000  40.0000
    3  SPANDREL        1   72.0000    8.0000    2.5000    2.5000  0.0000   0.0000


CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    6
                                   ETABS_FILE:EXWAL.PST/WALLER_FILE:DESWAL.WAL
 FILE : DESWAL   SAMPLE EXAMPLE FOR WALLER MANUAL
 CONCRETE SHEAR WALL BUILDING    UNITS : KIP-INCH-SECOND


 SECTION PROPERTIES FOR PANEL ELEMENT WALLS

 SECTION DEFINITION DATA

        SECTION  MATERIAL      WALL       WALL    FLANGE    FLANGE
   ID   TYPE           ID    LENGTH      THICK    LENGTH     THICK
                               {in}       {in}      {in}      {in}

    1   W1              1  432.0000     8.0000
    2   W1              1  144.0000     8.0000

 SECTION PROPERTIES FOR PANEL ELEMENT WALLS

 REINFORCEMENT DEFINITION DATA

                 /---REBAR LIMITS---/ /--------REBAR SPECIFICATIONS--------/
       SECTION   (FOR W1 OR W2 TYPES)         (FOR RW1 OR RW2 TYPES)
   ID  TYPE            PTMAX     PCMAX   DISTANCE       AREA NUMBER  SPACING
                                             {in}     {sqin}            {in}
    1  W1              0.060     0.040
    2  W1              0.060     0.040
```

Sample Output from ***WALLER*** *(continued)*

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    7
                                         ETABS_FILE:EXWAL.PST/WALLER_FILE:DESWAL.WAL
 FILE : DESWAL   SAMPLE EXAMPLE FOR WALLER MANUAL
 CONCRETE SHEAR WALL BUILDING    UNITS : KIP-INCH-SECOND


 FRAME DESIGN ACTIVATION CONTROL DATA . . .

 FRAME SEQUENCE NUMBER----------------------      1
 FRAME DESIGN TYPE--------------------------      1 (SEISMIC)

 COLUMN PROPERTY REASSIGNMENT FLAG----------      0
 BEAM PROPERTY REASSIGNMENT FLAG------------      0
 WALL PROPERTY ASSIGNMENT FLAG--------------      0


 FRAME CONTROL INFORMATION FROM ETABS DATA . . .

 FRAME TYPE NUMBER--------------------------      1
 NUMBER OF STORY LEVELS---------------------      3
 NUMBER OF COLUMN LINES---------------------      4
 NUMBER OF BAYS-----------------------------      3
 NUMBER OF BRACING ELEMENTS-----------------      0
 NUMBER OF PANEL ELEMENTS-------------------      0 (GIVING    0 WALL SECTIONS)
 NUMBER OF COLUMN LOAD TYPES----------------      0
 NUMBER OF BEAM SPAN LOAD TYPES-------------      2
 MAXIMUM POINT LOADS PER BEAM SPAN----------      4



CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    8
                                         ETABS FILE:EXWAL.PST/WALLER_FILE:DESWAL.WAL
 FILE : DESWAL   SAMPLE EXAMPLE FOR WALLER MANUAL
 CONCRETE SHEAR WALL BUILDING    UNITS : KIP-INCH-SECOND

 WALL PROCESSING OF COLUMN ELEMENTS   (UBC 1994 CONCRETE)

 FRAME  ID .... /PIER-SPANDREL WALL
 COLUMN ID ....        1

 OUTPUT FOR WALL TYPES RW1 AND RW2

 LEVEL TYPE/-------WALL MOMENT INTERACTION-------/ /----WALL SHEAR DESIGN----/
 ID        STA     FORCE      MOMENT  COMBO  RATIO  FORCE  STRESS COMBO A(/ft)
           LOC      (K)       (K-in)                 (K)    (Ksi)         (sqin)
 ROOF
       RW1 (8.00in X 48.00in)                           19   0.050 < 3>   0.00
           TOP       -3         465   < 5>   0.11
           BOT       -3         674   < 5>   0.15
 3RD
       RW1 (8.00in X 48.00in)                           26   0.068 < 3>   0.00
           TOP      -22         945   < 5>   0.28
           BOT      -22         741   < 5>   0.24
 2ND
       RW1 (8.00in X 48.00in)                           45   0.118 < 3>   0.38
           TOP      -68        1516   < 5>   0.58
           BOT      -68        3240   < 5>   0.93
```

Sample Output from ***WALLER*** *(continued)*

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    9
                                      ETABS_FILE:EXWAL.PST/WALLER_FILE:DESWAL.WAL
 FILE : DESWAL   SAMPLE EXAMPLE FOR WALLER MANUAL
 CONCRETE SHEAR WALL BUILDING    UNITS : KIP-INCH-SECOND

 WALL PROCESSING OF COLUMN ELEMENTS   (UBC 1994 CONCRETE)

 FRAME  ID .... /PIER-SPANDREL WALL
 COLUMN ID ....        2

 OUTPUT FOR WALL TYPES RW1 AND RW2

 LEVEL TYPE/-------WALL MOMENT INTERACTION-------/ /----WALL SHEAR DESIGN----/
 ID        STA      FORCE      MOMENT  COMBO  RATIO  FORCE  STRESS COMBO A(/ft)
           LOC       (K)       (K-in)                 (K)    (Ksi)        (sqin)
 ROOF
       RW1 (8.00in X 48.00in)                          27    0.071 < 3>   0.00
           TOP        12          776   < 5>   0.13
           BOT        12         1048   < 5>   0.18
 3RD
       RW1 (8.00in X 48.00in)                          43    0.112 < 3>   0.14
           TOP        17         1409   < 5>   0.24
           BOT        17         1386   < 5>   0.24
 2ND
       RW1 (8.00in X 48.00in)                          54    0.141 < 3>   0.30
           TOP        55         2040   < 5>   0.28
           BOT        55         3550   < 5>   0.59
```

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE   10
                                      ETABS_FILE:EXWAL.PST/WALLER_FILE:DESWAL.WAL
 FILE : DESWAL   SAMPLE EXAMPLE FOR WALLER MANUAL
 CONCRETE SHEAR WALL BUILDING    UNITS : KIP-INCH-SECOND

 WALL PROCESSING OF COLUMN ELEMENTS   (UBC 1994 CONCRETE)

 FRAME  ID .... /PIER-SPANDREL WALL
 COLUMN ID ....        3

 OUTPUT FOR WALL TYPES RW1 AND RW2

 LEVEL TYPE/-------WALL MOMENT INTERACTION-------/ /----WALL SHEAR DESIGN----/
 ID        STA      FORCE      MOMENT  COMBO  RATIO  FORCE  STRESS COMBO A(/ft)
           LOC       (K)       (K-in)                 (K)    (Ksi)        (sqin)
 ROOF
       RW1 (8.00in X 48.00in)                          26    0.067 < 2>   0.00
           TOP         7          955   < 4>   0.17
           BOT         7          825   < 4>   0.15
 3RD
       RW1 (8.00in X 48.00in)                          45    0.117 < 2>   0.16
           TOP        -8         1285   < 5>   0.29
           BOT        -8         1960   < 4>   0.43
```

Sample Output from ***WALLER*** *(continued)*

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE   11
                                       ETABS_FILE:EXWAL.PST/WALLER_FILE:DESWAL.WAL
 FILE : DESWAL   SAMPLE EXAMPLE FOR WALLER MANUAL
 CONCRETE SHEAR WALL BUILDING    UNITS : KIP-INCH-SECOND

 WALL PROCESSING OF COLUMN ELEMENTS   (UBC 1994 CONCRETE)

 FRAME  ID .... /PIER-SPANDREL WALL
 COLUMN ID ....         4

 OUTPUT FOR WALL TYPES RW1 AND RW2

 LEVEL TYPE/-------WALL MOMENT INTERACTION-------/ /----WALL SHEAR DESIGN----/
 ID        STA      FORCE       MOMENT  COMBO  RATIO  FORCE  STRESS COMBO A(/ft)
           LOC       (K)       (K-in)                  (K)   (Ksi)        (sqin)
 ROOF
       RW1 (8.00in X 48.00in)                            18    0.046 < 2>   0.00
           TOP         8        1090   < 2>   0.20
           BOT         8         816   < 2>   0.14
 3RD
       RW1 (8.00in X 48.00in)                            30    0.078 < 2>   0.01
           TOP       -10         567   < 4>   0.16
           BOT       -10        1146   < 4>   0.27
 2ND
       RW1 (8.00in X 48.00in)                            54    0.141 < 2>   0.34
           TOP       -40        1927   < 4>   0.55
           BOT       -40        3508   < 4>   0.87
```

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE   12
                                       ETABS_FILE:EXWAL.PST/WALLER_FILE:DESWAL.WAL
 FILE : DESWAL   SAMPLE EXAMPLE FOR WALLER MANUAL
 CONCRETE SHEAR WALL BUILDING    UNITS : KIP-INCH-SECOND

 SPANDREL DESIGN OF BEAM ELEMENTS   (UBC 1994 CONCRETE)

 FRAME ID .... /PIER-SPANDREL WALL
 LEVEL ID .... ROOF

  BAY     BEAM SIZE STRESS   L/d  SHEAR /-----------REQUIRED REBAR-----------/
   ID WIDTH X DEPTH  POINT RATIO STRESS  M(top) M(bot) Vv(/ft) Vh(/ft)     Avd
       (in)    (in)                (Ksi)  (sqin) (sqin)  (sqin) (sqin)  (sqin)
   1  8.00 X 36.00
                    END I    2.3   0.08    0.39   0.26    0.14   0.24    0.00
                    1/4-PT   2.3   0.07    0.15   0.18    0.14   0.24    0.00
                    MIDDLE   2.3   0.05    0.00   0.09    0.14   0.24    0.00
                    3/4-PT   2.3   0.05    0.08   0.18    0.14   0.24    0.00
                    END J    2.3   0.07    0.24   0.26    0.14   0.24    0.00
   2  8.00 X 36.00
                    END I    2.0   0.09    0.36   0.26    0.14   0.24    0.00
                    1/4-PT   2.0   0.08    0.15   0.17    0.14   0.24    0.00
                    MIDDLE   2.0   0.06    0.00   0.09    0.14   0.24    0.00
                    3/4-PT   2.0   0.05    0.08   0.19    0.14   0.24    0.00
                    END J    2.0   0.07    0.22   0.29    0.14   0.24    0.00
   3  8.00 X 36.00
                    END I    2.3   0.06    0.28   0.48    0.14   0.24    0.00
                    1/4-PT   2.3   0.06    0.11   0.30    0.14   0.24    0.00
                    MIDDLE   2.3   0.08    0.00   0.09    0.14   0.24    0.00
                    3/4-PT   2.3   0.10    0.20   0.17    0.14   0.24    0.00
                    END J    2.3   0.11    0.53   0.27    0.15   0.24    0.00
```

Sample Output from ***WALLER*** *(continued)*

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE   13
                                    ETABS_FILE:EXWAL.PST/WALLER FILE:DESWAL.WAL
 FILE : DESWAL   SAMPLE EXAMPLE FOR WALLER MANUAL
 CONCRETE SHEAR WALL BUILDING    UNITS : KIP-INCH-SECOND

 SPANDREL DESIGN OF BEAM ELEMENTS   (UBC 1994 CONCRETE)

 FRAME ID .... /PIER-SPANDREL WALL
 LEVEL ID .... 3RD

  BAY     BEAM SIZE STRESS   L/d  SHEAR /-----------REQUIRED REBAR-----------/
   ID WIDTH X DEPTH  POINT RATIO STRESS  M(top) M(bot) Vv(/ft) Vh(/ft)     Avd
       (in)    (in)               (Ksi)  (sqin) (sqin)  (sqin) (sqin)  (sqin)
    1  8.00 X 72.00
                      END I   1.2   0.09    0.59   0.44    0.14   0.24    0.00
                     1/4-PT   1.2   0.08    0.31   0.29    0.14   0.24    0.00
                     MIDDLE   1.2   0.07    0.09   0.14    0.14   0.24    0.00
                     3/4-PT   1.2   0.06    0.05   0.15    0.14   0.24    0.00
                      END J   1.2   0.07    0.25   0.33    0.14   0.24    0.00
    2  8.00 X 72.00
                      END I   1.0   0.12    0.44   0.34    0.16   0.24    0.00
                     1/4-PT   1.0   0.11    0.14   0.15    0.14   0.24    0.00
                     MIDDLE   1.0   0.10    0.05   0.14    0.14   0.24    0.00
                     3/4-PT   1.0   0.09    0.26   0.40    0.14   0.24    0.00
                      END J   1.0   0.09    0.49   0.65    0.14   0.24    0.00
    3  8.00 X 36.00
                      END I   2.3   0.09    0.36   0.69    0.14   0.24    0.00
                     1/4-PT   2.3   0.11    0.13   0.38    0.14   0.24    0.00
                     MIDDLE   2.3   0.12    0.02   0.12    0.19   0.24    0.00
                     3/4-PT   2.3   0.14    0.39   0.26    0.26   0.24    0.00
                      END J   2.3   0.16    0.87   0.42    0.32   0.24    0.00
```

Sample Output from ***WALLER*** *(continued)*

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE   14
                                      ETABS_FILE:EXWAL.PST/WALLER_FILE:DESWAL.WAL
 FILE : DESWAL   SAMPLE EXAMPLE FOR WALLER MANUAL
 CONCRETE SHEAR WALL BUILDING    UNITS : KIP-INCH-SECOND

 SPANDREL DESIGN OF BEAM ELEMENTS   (UBC 1994 CONCRETE)

 FRAME ID .... /PIER-SPANDREL WALL
 LEVEL ID .... 2ND

  BAY     BEAM SIZE STRESS   L/d  SHEAR /-----------REQUIRED REBAR-----------/
   ID WIDTH X DEPTH  POINT RATIO STRESS  M(top) M(bot) Vv(/ft) Vh(/ft)      Avd
       (in)    (in)                (Ksi)  (sqin) (sqin)  (sqin) (sqin)   (sqin)
    1  8.00 X 72.00
                     END I   1.2   0.12    0.90   0.77    0.19   0.24     0.00
                    1/4-PT   1.2   0.11    0.52   0.46    0.15   0.24     0.00
                    MIDDLE   1.2   0.10    0.18   0.15    0.14   0.24     0.00
                    3/4-PT   1.2   0.11    0.20   0.15    0.14   0.24     0.00
                     END J   1.2   0.12    0.56   0.45    0.18   0.24     0.00
    2  8.00 X 72.00
                     END I   1.0   0.13    0.76   0.50    0.22   0.24     0.00
                    1/4-PT   1.0   0.12    0.42   0.44    0.19   0.24     0.00
                    MIDDLE   1.0   0.11    0.19   0.45    0.16   0.24     0.00
                    3/4-PT   1.0   0.11    0.00   0.43    0.14   0.24     0.00
                     END J   1.0   0.10    0.00   0.47    0.14   0.24     0.00
    3  8.00 X 72.00
                     END I   1.2   0.14    0.09   0.82    0.25   0.24     0.00
                    1/4-PT   1.2   0.15    0.00   0.37    0.29   0.24     0.00
                    MIDDLE   1.2   0.16    0.21   0.50    0.32   0.24     0.00
                    3/4-PT   1.2   0.17    0.62   0.63    0.36   0.24     0.00
                     END J   1.2   0.18    1.17   0.84    0.40   0.24     0.00
```

Sample Output from ***WALLER*** *(continued)*

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE   15
                                 ETABS_FILE:EXWAL.PST/WALLER_FILE:DESWAL.WAL
 FILE : DESWAL    SAMPLE EXAMPLE FOR WALLER MANUAL
 CONCRETE SHEAR WALL BUILDING    UNITS : KIP-INCH-SECOND


 FRAME DESIGN ACTIVATION CONTROL DATA . . .

 FRAME SEQUENCE NUMBER----------------------      2
 FRAME DESIGN TYPE--------------------------      1 (SEISMIC)

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


 FRAME CONTROL INFORMATION FROM ETABS DATA . . .

 FRAME TYPE NUMBER--------------------------      2
 NUMBER OF STORY LEVELS---------------------      3
 NUMBER OF COLUMN LINES---------------------      4
 NUMBER OF BAYS-----------------------------      3
 NUMBER OF BRACING ELEMENTS-----------------      0
 NUMBER OF PANEL ELEMENTS-------------------      8 (GIVING    4 WALL SECTIONS)
 NUMBER OF COLUMN LOAD TYPES----------------      0
 NUMBER OF BEAM SPAN LOAD TYPES-------------      2
 MAXIMUM POINT LOADS PER BEAM SPAN----------      4


 ASSIGNED WALL PROPERTIES AND FACTORS

      WALL      LEVEL          PROP   LIVE LD
        ID      AT TOP           ID    FACTOR
         1      ROOF              1     1.000
         1      3RD               1     1.000
         2      2ND               2     1.000
         3      2ND               2     1.000
```

Sample Output from ***WALLER*** *(continued)*

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE   16
                                    ETABS_FILE:EXWAL.PST/WALLER_FILE:DESWAL.WAL
 FILE : DESWAL   SAMPLE EXAMPLE FOR WALLER MANUAL
 CONCRETE SHEAR WALL BUILDING    UNITS : KIP-INCH-SECOND

 WALL PROCESSING OF PANEL ELEMENTS   (UBC 1994 CONCRETE)

 FRAME  ID .... /WALL WITH OPENINGS
 WALL   ID ....        1

 OUTPUT FOR WALL TYPES W1 AND W2

 LEVEL TYPE/-------WALL OVERTURNING DESIGN--------//----WALL SHEAR DESIGN----/
 ID        STA    EDGE /-TENS STEEL-//-COMP STEEL-/ FORCE  STRESS COMBO A(/ft)
           LOC  MEMBER    LEFT  RIGHT   LEFT  RIGHT
                  (in)  (sqin) (sqin) (sqin) (sqin)   (K)   (Ksi)      (sqin)
 ROOF
       W1  (8.00in X 432.00in)                         70   0.020 < 2>   0.00
           TOP    8.00     0.0    0.0    0.0    0.0
           BOT    8.00     0.0    0.0    0.0    0.0
 3RD
       W1  (8.00in X 432.00in)                        118   0.034 < 2>   0.00
           TOP    8.00     0.0    0.0    0.7    0.7
           BOT    8.00     0.0    0.0    2.0    2.0
```

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE   17
                                    ETABS_FILE:EXWAL.PST/WALLER_FILE:DESWAL.WAL
 FILE : DESWAL   SAMPLE EXAMPLE FOR WALLER MANUAL
 CONCRETE SHEAR WALL BUILDING    UNITS : KIP-INCH-SECOND

 WALL PROCESSING OF PANEL ELEMENTS   (UBC 1994 CONCRETE)

 FRAME  ID .... /WALL WITH OPENINGS
 WALL   ID ....        2

 OUTPUT FOR WALL TYPES W1 AND W2

 LEVEL TYPE/-------WALL OVERTURNING DESIGN--------//----WALL SHEAR DESIGN----/
 ID        STA    EDGE /-TENS STEEL-//-COMP STEEL-/ FORCE  STRESS COMBO A(/ft)
           LOC  MEMBER    LEFT  RIGHT   LEFT  RIGHT
                  (in)  (sqin) (sqin) (sqin) (sqin)   (K)   (Ksi)      (sqin)
 2ND
       W1  (8.00in X 144.00in)                         80   0.069 < 3>   0.00
           TOP    8.00     0.0    0.5    0.0    1.9
           BOT    8.00     1.2    0.0    2.5    0.0
```

*Sample Output from **WALLER** (continued)*

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE   18
                                      ETABS_FILE:EXWAL.PST/WALLER FILE:DESWAL.WAL
 FILE : DESWAL   SAMPLE EXAMPLE FOR WALLER MANUAL
 CONCRETE SHEAR WALL BUILDING    UNITS : KIP-INCH-SECOND

 WALL PROCESSING OF PANEL ELEMENTS   (UBC 1994 CONCRETE)

 FRAME  ID .... /WALL WITH OPENINGS
 WALL   ID ....        3

 OUTPUT FOR WALL TYPES W1 AND W2

 LEVEL TYPE/-------WALL OVERTURNING DESIGN--------//----WALL SHEAR DESIGN----/
 ID        STA    EDGE /-TENS STEEL-//-COMP STEEL-/ FORCE  STRESS COMBO A(/ft)
           LOC  MEMBER    LEFT  RIGHT   LEFT  RIGHT
                  (in)  (sqin) (sqin) (sqin) (sqin)   (K)    (Ksi)       (sqin)
 2ND
       W1  (8.00in X 144.00in)                            80    0.069 < 2>    0.00
           TOP    8.00      0.5    0.0     1.9    0.0
           BOT    8.00      0.0    1.2     0.0    2.5
```

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE   19
                                      ETABS_FILE:EXWAL.PST/WALLER_FILE:DESWAL.WAL
 FILE : DESWAL   SAMPLE EXAMPLE FOR WALLER MANUAL
 CONCRETE SHEAR WALL BUILDING    UNITS : KIP-INCH-SECOND


 FRAME DESIGN ACTIVATION CONTROL DATA . . .

 FRAME SEQUENCE NUMBER----------------------     3
 FRAME DESIGN TYPE-------------------------     1 (SEISMIC)

 COLUMN PROPERTY REASSIGNMENT FLAG----------     0
 BEAM PROPERTY REASSIGNMENT FLAG------------     0
 WALL PROPERTY ASSIGNMENT FLAG--------------     0


 FRAME CONTROL INFORMATION FROM ETABS DATA . . .

 FRAME TYPE NUMBER-------------------------     3
 NUMBER OF STORY LEVELS---------------------     3
 NUMBER OF COLUMN LINES---------------------     1
 NUMBER OF BAYS-----------------------------     0
 NUMBER OF BRACING ELEMENTS-----------------     0
 NUMBER OF PANEL ELEMENTS-------------------     0 (GIVING    0 WALL SECTIONS)
 NUMBER OF COLUMN LOAD TYPES----------------     0
 NUMBER OF BEAM SPAN LOAD TYPES-------------     0
 MAXIMUM POINT LOADS PER BEAM SPAN----------     4
```

*Sample Output from **WALLER** (continued)*

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE   20
                                     ETABS_FILE:EXWAL.PST/WALLER_FILE:DESWAL.WAL
 FILE : DESWAL    SAMPLE EXAMPLE FOR WALLER MANUAL
 CONCRETE SHEAR WALL BUILDING    UNITS : KIP-INCH-SECOND

 WALL PROCESSING OF COLUMN ELEMENTS   (UBC 1994 CONCRETE)

 FRAME  ID .... /CANTILEVER WALL
 COLUMN ID ....         1

 OUTPUT FOR WALL TYPES W1 AND W2

 LEVEL TYPE/-------WALL OVERTURNING DESIGN--------//----WALL SHEAR DESIGN----/
 ID         STA    EDGE /-TENS STEEL-//-COMP STEEL-/ FORCE  STRESS COMBO A(/ft)
            LOC  MEMBER    LEFT  RIGHT   LEFT  RIGHT
                   (in)  (sqin) (sqin) (sqin) (sqin)   (K)    (Ksi)       (sqin)
 ROOF
       W1  (8.00in X 216.00in)                         100    0.058 < 2>   0.00
            TOP    8.00     0.0    0.0    0.0    0.0
            BOT    8.00     1.2    1.2    0.0    0.0
 3RD
       W1  (8.00in X 216.00in)                         167    0.096 < 2>   0.08
            TOP    8.00     1.0    1.0    0.0    0.0
            BOT   12.00     3.2    3.2    0.9    0.9
 2ND
       W1  (8.00in X 216.00in)                         198    0.115 < 3>   0.29
            TOP   12.00     3.0    3.0    1.4    1.4
            BOT   16.00     5.7    5.7    4.0    4.0
```

*Sample Output from **WALLER** (continued)*

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    1
                                 ETABS_FILE:EXWAL.PST/WALLER_FILE:DESWAL.WIN
 FILE : DESWAL   SAMPLE EXAMPLE FOR WALLER MANUAL
 CONCRETE SHEAR WALL BUILDING    UNITS : KIP-INCH-SECOND


 COLUMN-WALL LOAD/MOMENT INTERACTION DIAGRAM

 COLUMN-WALL PROPERTY ID------          1
 COLUMN-WALL SECTION TYPE-----         RW1
 WALL LENGTH------------------  48.000000 (in)
 WALL THICKNESS---------------   8.000000 (in)


         /-----PHI INCLUDED-----//-------PHI=1.00-------/
   POINT    ULTIMATE    ULTIMATE    ULTIMATE    ULTIMATE
  NUMBER        LOAD      MOMENT        LOAD      MOMENT
                 (K)      (K-in)         (K)      (K-in)

       1       870.6         0.0      1243.7         0.0
       2       870.6      2364.7      1243.7      3378.1
       3       870.6      3457.0      1243.7      4938.6
       4       864.1      4441.5      1234.4      6345.0
       5       811.5      5231.3      1159.3      7473.3
       6       753.4      6010.0      1076.2      8585.7
       7       693.7      6692.6       991.0      9560.9
       8       632.2      7285.9       903.1     10408.5
       9       568.2      7798.9       811.7     11141.3
      10       502.0      8237.7       717.1     11768.2
      11       430.6      8634.1       615.1     12334.4    BALANCE POINT
      12       382.6      8536.5       546.6     12195.0
      13       333.4      8343.9       476.3     11919.8
      14       282.5      8057.2       403.5     11510.4
      15       236.0      7642.3       337.1     10917.6
      16       187.7      7108.3       268.1     10154.7
      17       136.8      6458.5       195.4      9226.4
      18        89.5      5945.3       120.4      7999.4
      19        25.4      5387.8        29.4      6252.7
      20      -102.8      2934.3      -114.2      3260.3
      21      -237.6         0.0      -264.0         0.0
```

Sample Output from ***WALLER*** *(continued)*

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS   PAGE    2
                                      ETABS FILE:EXWAL.PST/WALLER_FILE:DESWAL.WIN
 FILE : DESWAL    SAMPLE EXAMPLE FOR WALLER MANUAL
 CONCRETE SHEAR WALL BUILDING    UNITS : KIP-INCH-SECOND

 WALL PROCESSING OF COLUMN ELEMENTS   (UBC 1994 CONCRETE)

 FRAME  ID .... /PIER-SPANDREL WALL
 COLUMN ID ....          1

 BACKUP DESIGN INFORMATION FOR WALL TYPES RW1 AND RW2

 LEVEL TYPE/-------WALL INTERACTION INFORMATION--------/
 ID         STA            /---FAILURE  POINT---/
            LOC                 FORCE       MOMENT    PU/P0
                                 (K)        (K-in)
 ROOF
      RW1 (8.00in X 48.00in)
            TOP                   -25         4426     0.03
            BOT                   -18         4563     0.03
 3RD
      RW1 (8.00in X 48.00in)
            TOP                   -79         3389     0.11
            BOT                   -93         3122     0.11
 2ND
      RW1 (8.00in X 48.00in)
            TOP                  -117         2615     0.20
            BOT                   -73         3496     0.20


CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS   PAGE    3
                                      ETABS_FILE:EXWAL.PST/WALLER_FILE:DESWAL.WIN
 FILE : DESWAL    SAMPLE EXAMPLE FOR WALLER MANUAL
 CONCRETE SHEAR WALL BUILDING    UNITS : KIP-INCH-SECOND

 WALL PROCESSING OF COLUMN ELEMENTS   (UBC 1994 CONCRETE)

 FRAME  ID .... /PIER-SPANDREL WALL
 COLUMN ID ....          2

 BACKUP DESIGN INFORMATION FOR WALL TYPES RW1 AND RW2

 LEVEL TYPE/-------WALL INTERACTION INFORMATION--------/
 ID         STA            /---FAILURE  POINT---/
            LOC                 FORCE       MOMENT    PU/P0
                                 (K)        (K-in)
 ROOF
      RW1 (8.00in X 48.00in)
            TOP                    93         5985     0.04
            BOT                    66         5743     0.04
 3RD
      RW1 (8.00in X 48.00in)
            TOP                    69         5769     0.09
            BOT                    70         5780     0.09
 2ND
      RW1 (8.00in X 48.00in)
            TOP                   193         7165     0.16
            BOT                    92         5977     0.16
```

Sample Output from ***WALLER*** *(continued)*

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS   PAGE     4
                                          ETABS_FILE:EXWAL.PST/WALLER_FILE:DESWAL.WIN
 FILE : DESWAL   SAMPLE EXAMPLE FOR WALLER MANUAL
 CONCRETE SHEAR WALL BUILDING    UNITS : KIP-INCH-SECOND

 WALL PROCESSING OF COLUMN ELEMENTS   (UBC 1994 CONCRETE)

 FRAME  ID .... /PIER-SPANDREL WALL
 COLUMN ID ....         3

 BACKUP DESIGN INFORMATION FOR WALL TYPES RW1 AND RW2

 LEVEL TYPE/-------WALL INTERACTION INFORMATION--------/
 ID          STA           /---FAILURE  POINT---/
             LOC                 FORCE      MOMENT    PU/P0
                                   (K)      (K-in)
 ROOF
       RW1 (8.00in X 48.00in)
             TOP                    42        5528     0.02
             BOT                    49        5590     0.02
 3RD
       RW1 (8.00in X 48.00in)
             TOP                   -28        4358     0.06
             BOT                   -19        4531     0.06
```

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS   PAGE     5
                                          ETABS_FILE:EXWAL.PST/WALLER_FILE:DESWAL.WIN
 FILE : DESWAL   SAMPLE EXAMPLE FOR WALLER MANUAL
 CONCRETE SHEAR WALL BUILDING    UNITS : KIP-INCH-SECOND

 WALL PROCESSING OF COLUMN ELEMENTS   (UBC 1994 CONCRETE)

 FRAME  ID .... /PIER-SPANDREL WALL
 COLUMN ID ....         4

 BACKUP DESIGN INFORMATION FOR WALL TYPES RW1 AND RW2

 LEVEL TYPE/-------WALL INTERACTION INFORMATION--------/
 ID          STA           /---FAILURE  POINT---/
             LOC                 FORCE      MOMENT    PU/P0
                                   (K)      (K-in)
 ROOF
       RW1 (8.00in X 48.00in)
             TOP                    40        5517     0.04
             BOT                    55        5646     0.04
 3RD
       RW1 (8.00in X 48.00in)
             TOP                   -66        3641     0.10
             BOT                   -37        4185     0.10
 2ND
       RW1 (8.00in X 48.00in)
             TOP                   -73        3504     0.23
             BOT                   -46        4021     0.23
```

*Sample Output from **WALLER** (continued)*

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    6
                                   ETABS_FILE:EXWAL.PST/WALLER_FILE:DESWAL.WIN
 FILE : DESWAL   SAMPLE EXAMPLE FOR WALLER MANUAL
 CONCRETE SHEAR WALL BUILDING    UNITS : KIP-INCH-SECOND

 SPANDREL DESIGN OF BEAM ELEMENTS   (UBC 1994 CONCRETE)

 FRAME ID .... /PIER-SPANDREL WALL
 LEVEL ID .... ROOF

  BAY     BEAM SIZE STRESS /-FACTORED  LOADS  &  COMBOS-/
   ID WIDTH X DEPTH  POINT    -MOMENT   +MOMENT     SHEAR
       (in)    (in)            (K-in)    (K-in)       (K)
    1  8.00 X 36.00
                      END I   690 < 3>  462 < 4>   23 < 3>
                     1/4-PT   277 < 5>  320 < 2>   18 < 3>
                     MIDDLE     0 < 5>  166 < 2>   14 < 3>
                     3/4-PT   145 < 5>  323 < 2>   14 < 2>
                      END J   434 < 5>  475 < 2>   18 < 2>
    2  8.00 X 36.00
                      END I   644 < 3>  463 < 4>   24 < 3>
                     1/4-PT   266 < 5>  313 < 2>   20 < 3>
                     MIDDLE     0 < 5>  159 < 2>   16 < 3>
                     3/4-PT   135 < 5>  340 < 2>   14 < 2>
                      END J   398 < 5>  531 < 2>   18 < 2>
    3  8.00 X 36.00
                      END I   504 < 5>  863 < 2>   17 < 3>
                     1/4-PT   191 < 5>  549 < 2>   17 < 2>
                     MIDDLE     0 < 5>  160 < 1>   22 < 2>
                     3/4-PT   355 < 3>  305 < 4>   26 < 2>
                      END J   946 < 3>  489 < 4>   30 < 2>
```

*Sample Output from **WALLER** (continued)*

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    7
                                     ETABS_FILE:EXWAL.PST/WALLER_FILE:DESWAL.WIN
 FILE : DESWAL   SAMPLE EXAMPLE FOR WALLER MANUAL
 CONCRETE SHEAR WALL BUILDING    UNITS : KIP-INCH-SECOND

 SPANDREL DESIGN OF BEAM ELEMENTS   (UBC 1994 CONCRETE)

 FRAME ID .... /PIER-SPANDREL WALL
 LEVEL ID .... 3RD

  BAY     BEAM SIZE STRESS /-FACTORED  LOADS  &  COMBOS-/
   ID WIDTH X DEPTH  POINT    -MOMENT   +MOMENT     SHEAR
       (in)    (in)            (K-in)    (K-in)       (K)
    1  8.00 X 72.00
                     END I  2191 < 3> 1647 < 4>   51 < 3>
                    1/4-PT  1171 < 3> 1083 < 4>   46 < 3>
                    MIDDLE   331 < 5>  538 < 2>   41 < 3>
                    3/4-PT   202 < 5>  544 < 2>   36 < 3>
                     END J   924 < 5> 1240 < 2>   37 < 2>
    2  8.00 X 72.00
                     END I  1649 < 3> 1278 < 4>   65 < 3>
                    1/4-PT   534 < 5>  578 < 2>   61 < 3>
                    MIDDLE   195 < 5>  535 < 2>   56 < 3>
                    3/4-PT   989 < 5> 1508 < 2>   52 < 3>
                     END J  1823 < 5> 2402 < 2>   47 < 5>
    3  8.00 X 36.00
                     END I   643 < 5> 1240 < 2>   24 < 2>
                    1/4-PT   228 < 5>  686 < 2>   29 < 2>
                    MIDDLE    28 < 5>  212 < 2>   33 < 2>
                    3/4-PT   701 < 3>  474 < 4>   37 < 2>
                     END J  1533 < 3>  760 < 4>   42 < 2>
```

*Sample Output from **WALLER** (continued)*

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    8
                                      ETABS_FILE:EXWAL.PST/WALLER_FILE:DESWAL.WIN
 FILE : DESWAL   SAMPLE EXAMPLE FOR WALLER MANUAL
 CONCRETE SHEAR WALL BUILDING    UNITS : KIP-INCH-SECOND

 SPANDREL DESIGN OF BEAM ELEMENTS   (UBC 1994 CONCRETE)

 FRAME ID .... /PIER-SPANDREL WALL
 LEVEL ID .... 2ND

  BAY      BEAM SIZE STRESS /-FACTORED  LOADS  &  COMBOS-/
   ID WIDTH X DEPTH  POINT     -MOMENT    +MOMENT      SHEAR
      (in)    (in)             (K-in)     (K-in)        (K)
    1  8.00 X 72.00
                     END I  3324 < 3> 2853 < 4>   68 < 3>
                    1/4-PT  1946 < 3> 1731 < 4>   63 < 3>
                    MIDDLE   677 < 3>  556 < 4>   58 < 3>
                    3/4-PT   733 < 3>  545 < 4>   62 < 2>
                     END J  2090 < 3> 1674 < 4>   67 < 2>
    2  8.00 X 72.00
                     END I  2829 < 3> 1861 < 4>   73 < 3>
                    1/4-PT  1583 < 5> 1636 < 2>   68 < 3>
                    MIDDLE   703 < 5> 1660 < 2>   64 < 3>
                    3/4-PT     0 < 5> 1604 < 2>   59 < 3>
                     END J     0 < 5> 1769 < 2>   55 < 3>
    3  8.00 X 72.00
                     END I   331 < 5> 3026 < 2>   77 < 2>
                    1/4-PT     0 < 5> 1390 < 1>   82 < 2>
                    MIDDLE   788 < 5> 1870 < 2>   87 < 2>
                    3/4-PT  2312 < 5> 2346 < 2>   92 < 2>
                     END J  4294 < 3> 3119 < 4>   97 < 2>
```

*Sample Output from **WALLER** (continued)*

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE     9
                                      ETABS_FILE:EXWAL.PST/WALLER_FILE:DESWAL.WIN
 FILE : DESWAL   SAMPLE EXAMPLE FOR WALLER MANUAL
 CONCRETE SHEAR WALL BUILDING    UNITS : KIP-INCH-SECOND

 WALL PROCESSING OF PANEL ELEMENTS   (UBC 1994 CONCRETE)

 FRAME  ID .... /WALL WITH OPENINGS
 WALL   ID ....        1

 BACKUP DESIGN INFORMATION FOR WALL TYPES W1 AND W2

 LEVEL TYPE/---------------------WALL DESIGN INFORMATION---------------------/
 ID         STA/------TENSION FORCE-------/ /----COMPRESSION FORCE----/
            LOC     LEFT COMBO   RIGHT COMBO     LEFT COMBO    RIGHT COMBO   PU/PO
                     (K)          (K)            (K)           (K)
 ROOF
       W1   (8.00in X 432.00in)
            TOP        0  < 5>       0  < 5>       56  < 1>      56  < 1>    0.01
            BOT        0  < 5>       0  < 5>       77  < 2>      77  < 2>    0.01
 3RD
       W1   (8.00in X 432.00in)
            TOP        0  < 5>       0  < 5>      145  < 2>     145  < 2>    0.02
            BOT        2  < 5>       2  < 5>      185  < 2>     185  < 2>    0.02
```

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    10
                                      ETABS_FILE:EXWAL.PST/WALLER_FILE:DESWAL.WIN
 FILE : DESWAL   SAMPLE EXAMPLE FOR WALLER MANUAL
 CONCRETE SHEAR WALL BUILDING    UNITS : KIP-INCH-SECOND

 WALL PROCESSING OF PANEL ELEMENTS   (UBC 1994 CONCRETE)

 FRAME  ID .... /WALL WITH OPENINGS
 WALL   ID ....        2

 BACKUP DESIGN INFORMATION FOR WALL TYPES W1 AND W2

 LEVEL TYPE/---------------------WALL DESIGN INFORMATION---------------------/
 ID         STA/------TENSION FORCE-------/ /----COMPRESSION FORCE----/
            LOC     LEFT COMBO   RIGHT COMBO     LEFT COMBO    RIGHT COMBO   PU/PO
                     (K)          (K)            (K)           (K)
 2ND
       W1   (8.00in X 144.00in)
            TOP        0  < 5>      28  < 5>      117  < 2>     182  < 2>    0.06
            BOT       63  < 5>       0  < 5>      202  < 2>      98  < 2>    0.06
```

Sample Output from ***WALLER*** *(continued)*

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE   11
                                     ETABS_FILE:EXWAL.PST/WALLER_FILE:DESWAL.WIN
 FILE : DESWAL   SAMPLE EXAMPLE FOR WALLER MANUAL
 CONCRETE SHEAR WALL BUILDING    UNITS : KIP-INCH-SECOND

 WALL PROCESSING OF PANEL ELEMENTS   (UBC 1994 CONCRETE)

 FRAME  ID .... /WALL WITH OPENINGS
 WALL   ID ....         3

 BACKUP DESIGN INFORMATION FOR WALL TYPES W1 AND W2

 LEVEL TYPE/---------------------WALL DESIGN INFORMATION----------------------/
 ID         STA/------TENSION FORCE-------/ /----COMPRESSION FORCE----/
            LOC     LEFT COMBO   RIGHT COMBO      LEFT COMBO   RIGHT COMBO    PU/PO
                     (K)          (K)              (K)          (K)
 2ND
       W1   (8.00in X 144.00in)
            TOP       28   < 5>       0   < 5>       182   < 2>     117   < 2>    0.06
            BOT        0   < 5>      63   < 5>        98   < 2>     202   < 2>    0.06
```

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE   12
                                     ETABS_FILE:EXWAL.PST/WALLER_FILE:DESWAL.WIN
 FILE : DESWAL   SAMPLE EXAMPLE FOR WALLER MANUAL
 CONCRETE SHEAR WALL BUILDING    UNITS : KIP-INCH-SECOND

 WALL PROCESSING OF COLUMN ELEMENTS   (UBC 1994 CONCRETE)

 FRAME  ID .... /CANTILEVER WALL
 COLUMN ID ....         1

 BACKUP DESIGN INFORMATION FOR WALL TYPES W1 AND W2

 LEVEL TYPE/---------------------WALL DESIGN INFORMATION----------------------/
 ID         STA/------TENSION FORCE-------/ /----COMPRESSION FORCE----/
            LOC     LEFT COMBO   RIGHT COMBO      LEFT COMBO   RIGHT COMBO    PU/PO
                     (K)          (K)              (K)          (K)
 ROOF
       W1   (8.00in X 216.00in)
            TOP        0   < 5>       0   < 5>         8   < 2>       8   < 2>    0.00
            BOT       64   < 5>      64   < 5>        77   < 2>      77   < 2>    0.00
 3RD
       W1   (8.00in X 216.00in)
            TOP       54   < 5>      54   < 5>        92   < 2>      92   < 2>    0.01
            BOT      173   < 5>     173   < 5>       211   < 2>     211   < 2>    0.01
 2ND
       W1   (8.00in X 216.00in)
            TOP      164   < 5>     164   < 5>       226   < 2>     226   < 2>    0.01
            BOT      310   < 5>     310   < 5>       372   < 2>     372   < 2>    0.01
```

*Sample Output from **WALLER** (continued)*

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