COMPUTERS & STRUCTURES INC.

ETABS®

Three Dimensional Analysis of Building Systems

Verification Manual

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

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EXAMPLE 1

PLANE FRAME with BEAM SPAN LOADS
STATIC GRAVITY LOAD ANALYSIS

A. DESCRIPTION

This is a one-story two-dimensional frame, subjected to vertical static loading.

The frame geometry and loading patterns are shown in Figure 1-1.

B. SIGNIFICANT OPTIONS OF ETABS ACTIVATED

1. Two-dimensional frame analysis
2. Vertical beam span loading
3. No rigid joint offsets on beams and columns
4. Column pinned end connections

C. COMPUTER MODEL

The frame is a 3-column line, 2-bay system. Kip-inch-second units are used. The modulus of elasticity is 3000 ksi. All columns are 12" x 24", all beams are 12" x 30".

To be able to compare ETABS results with theoretical results using prismatic members and elementary beam theory, rigid joint offsets on columns and beams are not modeled, and axial and shear deformations are neglected. This is done by not using the automatic property generation feature of ETABS; instead, the axial area and moment of inertia for each member are explicitly input.

The input data file for this example is EX1. A listing of this input data is given in Figure 1-2.

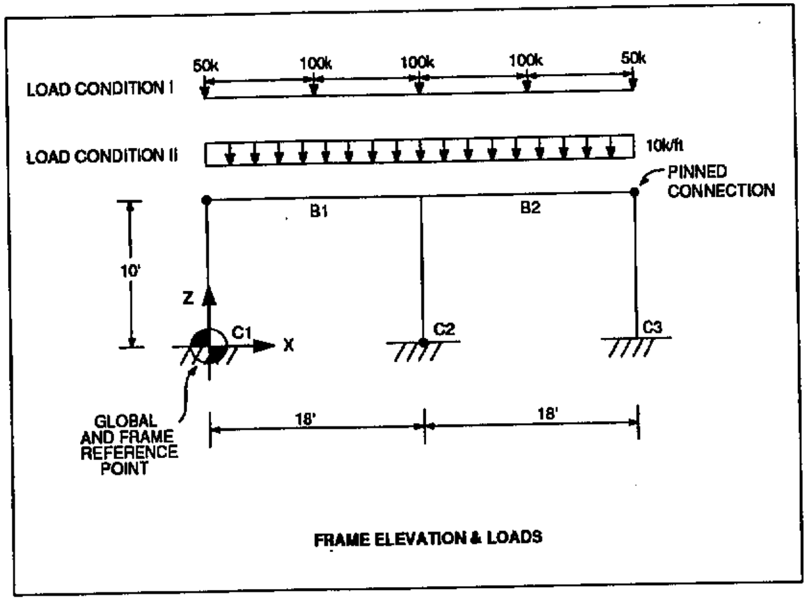
D. COMPARISON OF RESULTS

The theoretical results for bending moments and shear forces on beams B1 and B2 are easily obtained from tabulated values for propped cantilevers (see Reference [1]). These values for beam B1 are compared with ETABS results in Figure 1-3. As expected, the results are identical.

Selected output for frame member forces for this example is included in this manual.

E. REFERENCE

1. "Manual of Steel Construction-Allowable Stress Design," American Institute of Steel Construction, Chicago, Illinois, 1989.



Example 1
Plane Frame with Beam Span Loads
Figure 1-1

```
EXAMPLE 1 - PLANE FRAME WITH BEAM SPAN LOADS
STATIC GRAVITY LOAD ANALYSIS                    UNITS:KIP-INCH-SECOND
$                                               CONTROL DATA
 1  1  1  0  2  0  1  1  1  0  0  0  0  1  0  0  1  0  0
 386.4
$                                               STORY DATA
 1ST  10*12
$                                               MATERIAL DATA
 1  C  3000
$                                               COLUMN PROPERTIES
 1  1  USER
 1E7  0  0  0  24P3*12/12
$                                               BEAM PROPERTIES
 1  1  USER
 0  0  0  0  30P3*12/12
$                                               FRAME DATA
 TWO BAY PLANE FRAME
 1  1  3  2  0  0  0  2  1
$                                               COLUMN LINE LOCATION
 1  0
 2  18*12
 3  36*12
$                                               BAY CONNECTIVITY
 1  1  2
 2  2  3
$                                               BEAM SPAN LOADING PATTERNS
 1  1  0  50  50          $ CONCENTRATED LOAD
 9*12 100
 2  0  10/12              $ UNIFORM LOAD
$                                               COLUMN ASSIGNMENTS
 1  0  1ST  1  0  2
 2  0  1ST  1  0  1
 3  1

$                                               BEAM ASSIGNMENTS
 1  0  1ST  1
 2  1

$                                               BEAM SPAN LOAD ASSIGNMENTS
 1  0  1ST  1  2
 2  1

$                                               FRAME LOCATION DATA
 1  0  0  0  0  /TWO BAY FRAME
$                                               LOAD CASE DATA
 1  0  1
 2  0  0  1
$   END OF INPUT DATA
```

Example 1
Listing of Input Data
Figure 1-2

QUANTITY	LOCATION	LOAD CASE I (Concentrated Load)	
		ETABS	Theoretical
Bending Moments	End I	0.00	0.00
	1/4 Point	1687.50	1687.50
	1/2 Point	3375.00	3375.00
	3/4 Point	-337.50	-337.50
	End J	-4050.00	-4050.00
Shear Forces	End I	-31.25	-31.25
	1/4 Point	-31.25	-31.25
	1/2 Point	68.75	68.75
	3/4 Point	68.75	68.75
	End J	68.75	68.75

QUANTITY	LOCATION	LOAD CASE II (Uniform Load)	
		ETABS	Theoretical
Bending Moments	End I	0.00	0.00
	1/4 Point	2430.00	2430.00
	1/2 Point	2430.00	2430.00
	3/4 Point	0.00	0.00
	End J	-4860.00	-4860.00
Shear Forces	End I	-67.50	-67.50
	1/4 Point	-22.50	-22.50
	1/2 Point	22.50	22.50
	3/4 Point	67.50	67.50
	End J	112.50	112.50

Example 1
Comparison of Results for Beam B1
Figure 1-3

CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS PAGE 1
PROGRAM:ETABS/FILE:EX1.FRM
EXAMPLE 1 - PLANE FRAME WITH BEAM SPAN LOADS
STATIC GRAVITY LOAD ANALYSIS UNITS:KIP-INCH-SECOND

COLUMN FORCES AT LEVEL 1ST IN FRAME /TWO BAY FRAME

COL ID	OUTPUT ID	OUTPUT POINT	MAJOR MOMENT	MAJOR SHEAR	MINOR MOMENT	MINOR SHEAR	AXIAL FORCE	TORSIONAL MOMENT
1	CASE 1	TOP	.00	.00	.00	.00	-81.25	.00
		BOTTOM	.00		.00			
1	CASE 2	TOP	.00	.00	.00	.00	-67.50	.00
		BOTTOM	.00		.00			
2	CASE 1	TOP	.00	.00	.00	.00	-237.50	.00
		BOTTOM	.00		.00			
2	CASE 2	TOP	.00	.00	.00	.00	-225.00	.00
		BOTTOM	.00		.00			
3	CASE 1	TOP	.00	.00	.00	.00	-81.25	.00
		BOTTOM	.00		.00			
3	CASE 2	TOP	.00	.00	.00	.00	-67.50	.00
		BOTTOM	.00		.00			

BEAM FORCES AT LEVEL 1ST IN FRAME /TWO BAY FRAME

BAY ID	OUTPUT ID	OUTPUT POINT	MAJOR MOMENT	MAJOR SHEAR	MINOR MOMENT	MINOR SHEAR	AXIAL FORCE	TORSIONAL MOMENT
1	CASE 1	END-I	.00	-31.25	.00	.00	.00	.00
		1/4-PT	1687.50	-31.25	.00			
		1/2-PT	3375.00	68.75	.00			
		3/4-PT	-337.50	68.75	.00			
		END-J	-4050.00	68.75	.00			
1	CASE 2	END-I	.00	-67.50	.00	.00	.00	.00
		1/4-PT	2430.00	-22.50	.00			
		1/2-PT	2430.00	22.50	.00			
		3/4-PT	.00	67.50	.00			
		END-J	-4860.00	112.50	.00			
2	CASE 1	END-I	-4050.00	-68.75	.00	.00	.00	.00
		1/4-PT	-337.50	-68.75	.00			
		1/2-PT	3375.00	-68.75	.00			
		3/4-PT	1687.50	31.25	.00			
		END-J	.00	31.25	.00			
2	CASE 2	END-I	-4860.00	-112.50	.00	.00	.00	.00
		1/4-PT	.00	-67.50	.00			
		1/2-PT	2430.00	-22.50	.00			
		3/4-PT	2430.00	22.50	.00			
		END-J	.00	67.50	.00			

Example 1
Sample Output

EXAMPLE 2

THREE-STORY PLANE FRAME DYNAMIC RESPONSE SPECTRUM ANALYSIS

A. DESCRIPTION

This is a three-story plane frame subjected to the El Centro 1940 seismic response spectra, N-S component, 5 percent damping.

The frame geometry is shown in Figure 2-1.

B. SIGNIFICANT OPTIONS OF ETABS ACTIVATED

1. Two-dimensional frame analysis
2. Rigid joint offsets on beams and columns automatically calculated
3. Dynamic response spectrum analysis

C. COMPUTER MODEL

The frame is modeled as a 2-column line, single bay system. Kip-inch-second units are used. Other parameters associated with the structure are as follows:

All columns are W14X90
All beams are infinitely rigid and 24" deep
Modulus of elasticity = 29500 ksi
Typical story mass = 0.4 kip-sec^2/in

The column is modeled to have infinite axial area, so that axial deformation is neglected. Also, zero column shear area is input to trigger the ETABS option of neglecting shear deformations. These deformations are neglected to be consistent with the hand-calculated model with which the results are compared.

The input data file for this example is EX2. A listing of the input data is given in Figure 2-2.

D. COMPARISON OF RESULTS

Assuming the beams to be rigid and a rigid offset at the column top ends of 24 inches (i.e. equal to the depth of the beams), and neglecting both shear deformations and axial deformations, the story lateral stiffness for this example can be calculated (see Reference [1]).

The example then reduces to a three spring, three mass system with equal stiffnesses and masses. This can be analyzed using any exact method (see Reference [2]) to obtain the three natural periods and mass normalized mode shapes of the system.

The three theoretical natural periods and mass normalized mode shapes are compared in Figure 2-3 with ETABS results. As expected, the results are identical.

The spectral accelerations at the three natural periods can then be linearly interpolated from the response spectrum used.

The spectral accelerations can in turn be used with the mode shapes and story mass information to obtain the modal responses (see Reference [2]). The modal responses for story displacements and column moments can then be combined using the complete quadratic combination procedure (see Reference [3]).

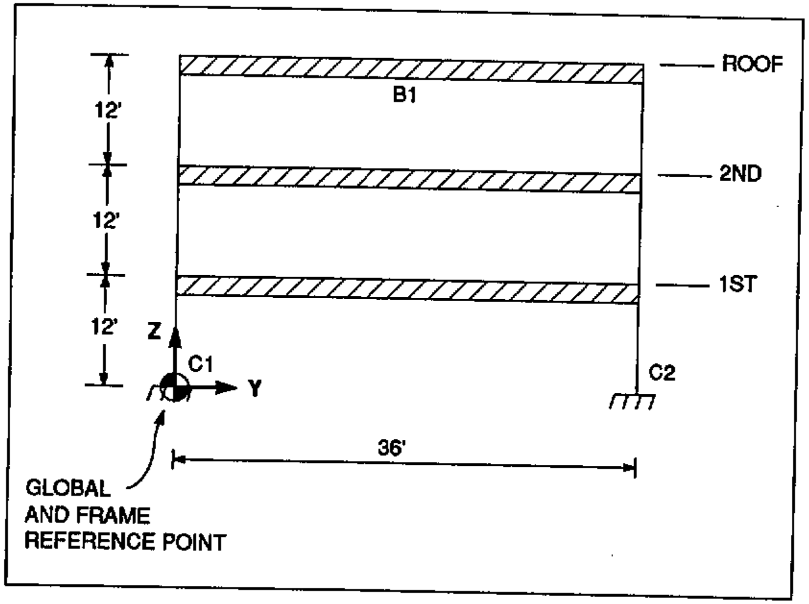
The story displacements and column moments thus obtained are compared in Figure 2-4 with ETABS results. As expected, the results are identical.

E. REFERENCES

1. Przemieniecki, J.S., "Theory of Matrix Structural Analysis," Mc-Graw-Hill, 1968.

2. Paz, M., "Structural Dynamics, Theory and Computations," Van Nostrand Reinhold, 1985.

3. Wilson, E.L., Kiureghian, A.D. and Bayo, E.P., "A Replacement for the SRSS Method in Seismic Analysis," Earthquake Engineering and Structural Dynamics, Vol. 9, 1981.



Example 2
Three-story Plane Frame
Figure 2-1

```
EXAMPLE  2  -  THREE STORY PLANE FRAME
DYNAMIC RESPONSE SPECTRUM ANALYSIS        UNITS:KIP-INCH-SECOND
$                                         CONTROL DATA
 3  1  1  0  1  3  1  1  1  0  0  0  2  2  0  0  0  0  0
 386.4                                    STORY DATA
$
 ROOF  12*12  0  0.4
  2ND  12*12  0  0.4
  1ST  12*12  0  0.4
$                                         MATERIAL DATA
 1  S  29500
$                                         COLUMN PROPERTIES
 1  1  USER
 1E7  0  0  0  999    $W14X90 NEGLECTING AXIAL & SHEAR DEFORMATION
$                                         BEAM PROPERTIES
 1  1  USER  24
 0  0  0  0  1E9
$                                         FRAME DATA
 THREE STORY PLANE FRAME
 1  3  2  1
$                                         COLUMN LINE LOCATION
 1  0  0  90
 2  0  36*12  90
$                                         BAY CONNECTIVITY
 1  1  2
$                                         COLUMN ASSIGNMENTS
 1  0  ROOF  1  2
 2  1

$                                         BEAM ASSIGNMENTS
 1  0  ROOF  1  2
$                                         FRAME LOCATION
 1  0  0  0  0  /PLANE FRAME
```

Example 2
Listing of Input Data
Figure 2-2

```
$                                                 RESPONSE SPECTRUM DATA
 ELCENTRO RESPONSE SPECTRUM
1 52 CQC 386.4 .05
 90
      .0    .3275
   .0263    .3299
   .0270    .3297
   .0278    .3429
   .0286    .3544
   .0294    .3626
   .0303    .3683
   .0313    .3676
   .0323    .3629
   .0333    .3604
   .0345    .3637
   .0357    .3632
   .0370    .3610
   .0385    .3585
   .0400    .3551
   .0417    .3458
   .0435    .3436
   .0455    .3465
   .0476    .3528
   .0500    .3542
   .0526    .3544
   .0556    .3546
   .0588    .3917
   .0625    .4305
   .0667    .4455
   .0714    .4784
   .0769    .5053
   .0833    .5181
   .0909    .4776
   .0966    .5526
   .1000    .5816
   .1015    .5846
   .1070    .5548
   .1130    .5292
   .1198    .5952
   .1274    .6373
   .1361    .6615
   .1460    .6885
   .1575    .8712
   .1709    .8167
   .1869    .9879
   .2062    .9697
   .2299    .7006
   .2597    .8576
   .2985    .7385
   .3509    .8705
   .4255    .9090
   .5405    .9824
   .7407    .4761
  1.1765    .2713
  2.8571    .1983
 1000.00   0.0
$                                                 LOAD CASE DATA
 1  0  0  0  0  0  0  1
$   END OF INPUT DATA
```

Example 2
Listing of Input Data
Figure 2-2 (continued)

ETABS

QUANTITY	MODE 1	MODE 2	MODE 3
Period, sec.	0.4414	0.1575	0.1090
Mode Shape: Level,			
Roof	1.165	0.934	0.519
2nd	0.934	-0.519	-1.165
1st	0.519	-1.165	0.934

THEORETICAL

QUANTITY	MODE 1	MODE 2	MODE 3
Period, sec.	0.4414	0.1575	0.1090
Mode Shape: Level,			
Roof	1.165	0.934	0.519
2nd	0.934	-0.519	-1.165
1st	0.519	-1.165	0.934

Example 2
Comparison of Results for Periods and Mode Shapes
Figure 2-3

QUANTITY	ETABS	THEORETICAL
Displacement at Level:		
Roof	2.139	2.139
2nd	1.716	1.716
1st	0.955	0.955
Base Moment Column C1	11730	11730

Example 2
Comparison of Results for Displacements and Column Moments
Figure 2-4

EXAMPLE 3

THREE-STORY PLANE FRAME
CODE SPECIFIED
STATIC LATERAL LOADS ANALYSIS

A. DESCRIPTION

This is a three-story plane frame which has been analyzed three times under the following code specified lateral load cases:

a. UBC 1991 specified seismic loads (Reference [1])

b. ATC 3-06 specified seismic loads (Reference [2])

c. UBC 1991 specified wind loads (Reference [1])

The frame geometry is shown in Figure 3-1.

B. SIGNIFICANT OPTIONS OF ETABS ACTIVATED

1. Two-dimensional frame analysis
2. Section properties automatically recovered from AISC data base
3. Automatic generation of UBC 1991 seismic loads
4. Automatic generation of ATC 3-06 seismic loads
5. Automatic generation of UBC 1991 wind loads

C. COMPUTER MODEL

The frame is modeled as a 2-column line, single bay system. Kip-inch-second units are used. Other parameters associated with the structure are as follows:

All columns are W14X90
All beams are infinitely rigid and 24" deep
Modulus of elasticity = 29500 ksi
Poisson's ratio = 0.3
Typical story mass = 0.4 kip-sec^2/in

For the UBC seismic load analysis, the input data file is EX3a. A listing of the input data is given in Figure 3-2. Code parameters associated with the analysis are as follows:

UBC zone factor, $Z = 0.40$
UBC Soil Profile Factor, $S = 1.2$
UBC Importance factor, $I = 1.25$
UBC Structural System coefficient, $R_w = 12$
UBC Method A time period, $T_a = 0.5144$ sec

For the ATC seismic load analysis, the input data file is EX3b. A listing of the input data is given in Figure 3-4. Code parameters associated with the analysis are as follows:

ATC coefficient, $A_v = 0.4$ g
ATC coefficient, $S = 1.2$
ATC coefficient, $R = 8$
ATC time period, $T_a = 0.5144$ sec

For the UBC 1991 wind load analysis, the input data file is EX3c. A listing of the input data is given in Figure 3-6. Exposure and code parameters associated with the analysis are as follows:

Width of structure supported by frame = 20 ft
UBC Basic wind speed = 100 mph
UBC Exposure type = C
UBC Importance factor, I = 1

D. COMPARISON OF RESULTS

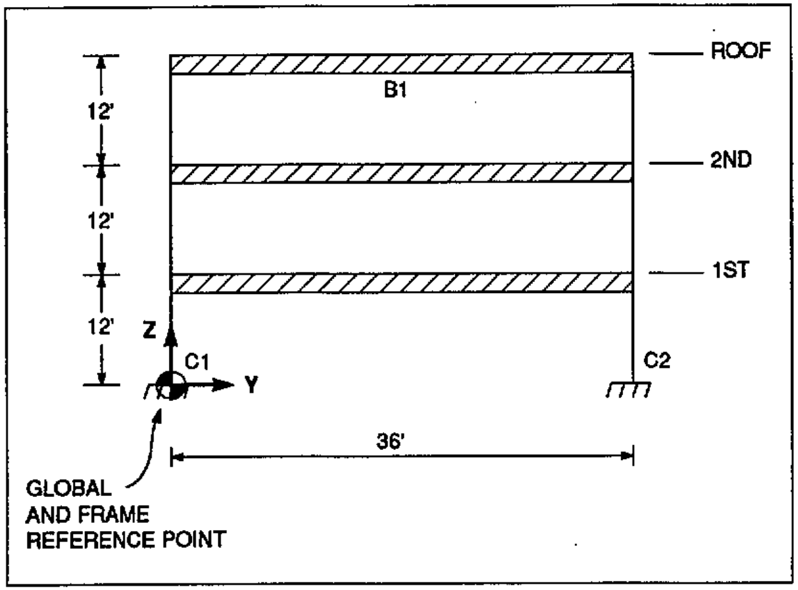
For each of the static lateral load analyses, the story shears can be computed using the formulae given in the applicable references. For the seismic loads, the fundamental period computed by ETABS can be used in the formulae. From ETABS results, this fundamental period is 0.5203 seconds. (Note the difference between the calculated fundamental period for this example and Example 2, which neglects shear and axial deformations.)

Hand-calculated story shears are compared with story shears produced by the ETABS program in Figure 3-3 for UBC seismic loads, Figure 3-5 for ATC seismic loads and Figure 3-7 for UBC wind loads. As expected, the values are identical.

Selected output for story displacements, drifts and shears for Example EX3c is included in this manual.

E. REFERENCES

1. International Conference of Building Officials, "Uniform Building Code," Whittier, California, 1991.
2. Applied Technology Council, ATC 3-06, "Tentative Provisions for the Development of Seismic Regulations for Buildings," June 1978.



Example 3
Three-story Plane Frame
Figure 3-1

```
EXAMPLE  3a  -  THREE STORY PLANE FRAME
UBC 1991, SEISMIC LOAD ANALYSIS           UNITS:KIP-INCH-SECOND
$                                         CONTROL DATA
 3  1  1  0  1  3  1  1  1  0  0  6  1  2  0  0  0  0  0
 386.4
$                                         STORY DATA
 ROOF  12*12  0  0.4
  2ND  12*12  0  0.4
  1ST  12*12  0  0.4
$                                         MATERIAL DATA
 1  S  29500 .49/1728  .3
$                                         COLUMN PROPERTIES
 1  1  W14X90
$                                         BEAM PROPERTIES
 1  1  USER  24
 0  0  0  0  1E9
$                                         FRAME DATA
 THREE STORY PLANE FRAME
 1  3  2  1
$                                         COLUMN LINE LOCATION
 1  0  0  90
 2  0  36*12  90
$                                         BAY CONNECTIVITY
 1  1  2
$                                         COLUMN ASSIGNMENTS
 1  0  ROOF  1  2
 2  1

$                                         BEAM ASSIGNMENTS
 1  0  ROOF  1  2

$                                         FRAME LOCATION
 1  0  0  0  0  /PLANE FRAME
$                                         UBC 1991, SEISMIC DATA
 .40  1.25  1.20
 0  0.5144 12  ROOF
 0  0.5144 12  ROOF


$                                         LOAD CASE DATA
 1  0  0  0  0  0  1
$   END OF INPUT DATA
```

Example 3a
Listing of Input Data
Figure 3-2

LEVEL	ETABS (Kips)	THEORETICAL (Kips)
Roof	22.40	22.40
2nd	37.33	37.33
1st	44.80	44.80

Example 3a
Comparison of Results for Story Shears
Figure 3-3

```
EXAMPLE  3b  -  THREE STORY PLANE FRAME
ATC 3-06, SEISMIC LOAD ANALYSIS              UNITS:KIP-INCH-SECOND
$                                            CONTROL DATA
 3  1  1  0  1  3  1  1  1  0  0  3  1  2  0  0  0  0  0
 386.4
$                                            STORY DATA
 ROOF  12*12  0  0.4
  2ND  12*12  0  0.4
  1ST  12*12  0  0.4
$                                            MATERIAL DATA
 1  S  29500 .49/1728  .3
$                                            COLUMN PROPERTIES
 1  1  W14X90
$                                            BEAM PROPERTIES
 1  1  USER  24
 0  0  0  0  1E9
$                                            FRAME DATA
 THREE STORY PLANE FRAME
 1  3  2  1
$                                            COLUMN LINE LOCATION
 1  0  0  90
 2  0  36*12  90
$                                            BAY CONNECTIVITY
 1  1  2
$                                            COLUMN ASSIGNMENTS
 1  0  ROOF  1  2
 2  1

$                                            BEAM ASSIGNMENTS
 1  0  ROOF  1  2

$                                            FRAME LOCATION
 1  0  0  0  0  /PLANE FRAME
$                                            ATC 3-06,SEISMIC DATA
 0.4  1.2  8
 0  0      ROOF
 0  0.5144 ROOF


$                                            LOAD CASE DATA
 1  0  0  0  0  0  1
$  END OF INPUT DATA
```

Example 3b
Listing of Input Data
Figure 3-4

LEVEL	ETABS (Kips)	THEORETICAL (Kips)
Roof	25.89	25.89
2nd	43.08	43.08
1st	51.61	51.61

Example 3b
Comparison of Results for Story Shears
Figure 3-5

```
EXAMPLE  3c  -  THREE STORY PLANE FRAME
UBC 1991, WIND LOAD ANALYSIS                    UNITS:KIP-INCH-SECOND
$                                               CONTROL DATA
 3  1  1  0  1  0  1  1  1  0  0  5  0  2  0  0  0  0  0
 386.4
$                                               STORY DATA
 ROOF  12*12
  2ND  12*12
  1ST  12*12
$                                               MATERIAL DATA
 1  S  29500  .49/1728  .3
$                                               COLUMN PROPERTIES
 1  1  W14X90
$                                               BEAM PROPERTIES
 1  1  USER  24
 0  0  0  0  1E9
$                                               FRAME DATA
 THREE STORY PLANE FRAME
 1  3  2  1
$                                               COLUMN LINE LOCATION
 1  0  0  90
 2  0  36*12  90
$                                               BAY CONNECTIVITY
 1  1  2
$                                               COLUMN ASSIGNMENTS
 1  0  ROOF  1  2
 2  1

$                                               BEAM ASSIGNMENTS
 1  0  ROOF  1  2

$                                               FRAME LOCATION
 1  0  0  0  0  /PLANE FRAME
$                                               UBC 1991, WIND DATA
 100  C  1  1/12  1/144000


 0  0  0  20*12
 0  0  0  20*12
 0  0  0  20*12
$                                               LOAD CASE DATA
 1  0  0  0  0  0  1
$  END OF INPUT DATA
```

Example 3c
Listing of Input Data
Figure 3-6

LEVEL	ETABS (Kips)	THEORETICAL (Kips)
Roof	5.15	5.15
2nd	14.75	14.75
1st	23.40	23.40

Example 3c
Comparison of Results for Story Shears
Figure 3-7

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    1
                                                      PROGRAM:ETABS/FILE:ex3c.STR
EXAMPLE  3C  -  THREE STORY PLANE FRAME
UBC 1991, WIND LOAD ANALYSIS           UNITS:KIP-INCH-SECOND

STATIC LOAD CONDITION LATERAL STORY DISPLACEMENTS

DISPLACEMENTS ARE AT THE CENTERS OF MASS OF THE RESPECTIVE STORY LEVELS

                  /-------------------LOAD CONDITIONS--------------------/
LEVEL     DIRN            I           II          III           A          B

ROOF         Y        .0000        .0000        .0000        .0000      .1474

2ND          Y        .0000        .0000        .0000        .0000      .1284

1ST          Y        .0000        .0000        .0000        .0000      .0780
```

Example 3c
Sample Output

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    2
                                                   PROGRAM:ETABS/FILE:ex3c.STR
EXAMPLE  3C  -  THREE STORY PLANE FRAME
UBC 1991, WIND LOAD ANALYSIS            UNITS:KIP-INCH-SECOND


STATIC LOAD CONDITION LATERAL FRAME DISPLACEMENTS

FRAME ID .... /PLANE FRAME

VALUES ARE AT THE FRAME ORIGIN IN THE FRAME LOCAL COORDINATES

                 /--------------------LOAD CONDITIONS--------------------/
LEVEL     DIRN             I           II          III            A          B

ROOF         X         .0000        .0000        .0000        .0000      .0000
ROOF         Y         .0000        .0000        .0000        .0000      .1474
ROOF      ROTZ         .0000        .0000        .0000        .0000      .0000

2ND          X         .0000        .0000        .0000        .0000      .0000
2ND          Y         .0000        .0000        .0000        .0000      .1284
2ND       ROTZ         .0000        .0000        .0000        .0000      .0000

1ST          X         .0000        .0000        .0000        .0000      .0000
1ST          Y         .0000        .0000        .0000        .0000      .0780
1ST       ROTZ         .0000        .0000        .0000        .0000      .0000
```

Example 3c
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    3
                                                     PROGRAM:ETABS/FILE:ex3c.STR
EXAMPLE  3C  -  THREE STORY PLANE FRAME
UBC 1991, WIND LOAD ANALYSIS          UNITS:KIP-INCH-SECOND


STATIC LOAD CONDITION LATERAL FRAME DRIFT RATIOS

FRAME ID .... /PLANE FRAME

VALUES ARE AT THE FRAME ORIGIN IN THE FRAME LOCAL COORDINATES

                 /--------------------LOAD CONDITIONS--------------------/
LEVEL     DIRN             I           II          III           A           B

ROOF         X        .00000       .00000       .00000      .00000      .00000
ROOF         Y        .00000       .00000       .00000      .00000      .00013
ROOF      ROTZ        .00000       .00000       .00000      .00000      .00000

2ND          X        .00000       .00000       .00000      .00000      .00000
2ND          Y        .00000       .00000       .00000      .00000      .00035
2ND       ROTZ        .00000       .00000       .00000      .00000      .00000

1ST          X        .00000       .00000       .00000      .00000      .00000
1ST          Y        .00000       .00000       .00000      .00000      .00054
1ST       ROTZ        .00000       .00000       .00000      .00000      .00000
```

Example 3c
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    4
                                                  PROGRAM:ETABS/FILE:ex3c.STR
EXAMPLE  3C  -  THREE STORY PLANE FRAME
UBC 1991, WIND LOAD ANALYSIS              UNITS:KIP-INCH-SECOND


STATIC LOAD CONDITION LATERAL FRAME STORY SHEARS & TORSIONS

FRAME ID .... /PLANE FRAME

VALUES ARE AT THE FRAME ORIGIN IN THE FRAME LOCAL COORDINATES

                /--------------------LOAD CONDITIONS---------------------/
LEVEL     DIRN            I          II          III           A          B

ROOF         X          .00         .00          .00         .00        .00
ROOF         Y          .00         .00          .00         .00       5.15
ROOF      ROTZ          .00         .00          .00         .00        .00

2ND          X          .00         .00          .00         .00        .00
2ND          Y          .00         .00          .00         .00      14.75
2ND       ROTZ          .00         .00          .00         .00        .00

1ST          X          .00         .00          .00         .00        .00
1ST          Y          .00         .00          .00         .00      23.40
1ST       ROTZ          .00         .00          .00         .00        .00
```

Example 3c
Sample Output (continued)

EXAMPLE 4

SINGLE STORY
THREE-DIMENSIONAL FRAME
DYNAMIC RESPONSE SPECTRUM ANALYSIS

A. DESCRIPTION

This is a one-story, four-bay, three-dimensional frame. The frame is subjected to the El Centro 1940 N-S component seismic response spectrum, for 5 percent damping, in two orthogonal directions.

The frame geometry is shown in Figure 4-1.

B. SIGNIFICANT OPTIONS OF ETABS ACTIVATED

1. Three-dimensional frame analysis
2. Automatic story mass calculation
3. Dynamic response spectrum analysis

C. COMPUTER MODEL

The structure is modeled as a single frame with four column lines and four bays. Kip-inch-second units are used. Other parameters associated with the structure are as follows:

Columns on lines C1 and C2 24" x 24"
Columns on lines C3 and C4 18" x 18"
All beams infinitely rigid and 36" deep

Modulus of elasticity = 3000 ksi
Story weight = 150 psf

The columns are modeled to neglect shear and axial deformations to be consistent with the assumptions of hand calculations with which the results are compared below.

The input data file for this example is EX4. A listing of the input data is given in Figure 4-2.

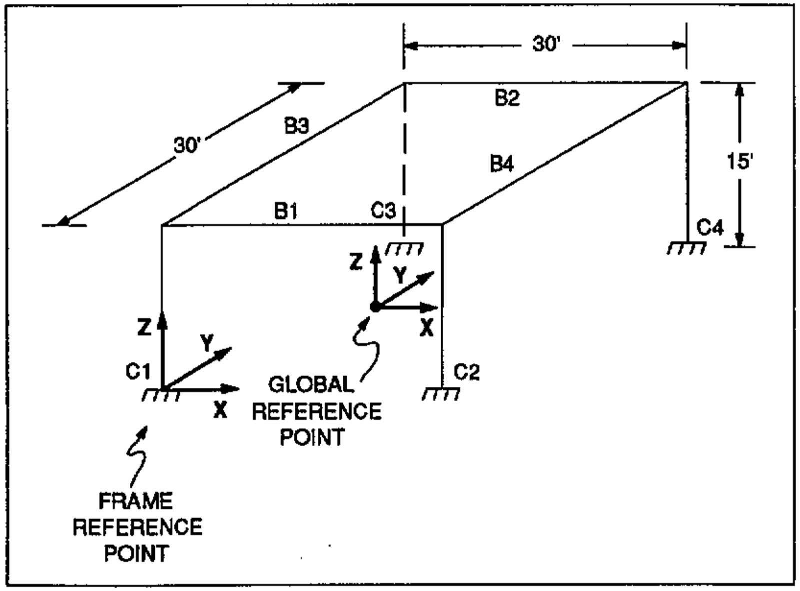
D. COMPARISON OF RESULTS

The example is a three degree of freedom system. From the individual column lateral stiffnesses assuming rigid beams and rigid offsets at column top ends equal to 36 inches (i.e. the depth of the beams), and neglecting both shear deformations and column axial deformations, the structural stiffness matrix can be assembled (see Reference [1]).

From the stiffness and mass matrices of the system, the three natural periods and mass normalized mode shapes of the system can be obtained (see Reference [2]). These are compared in Figure 4-3 with ETABS results. As expected, the results are identical.

E REFERENCES

1. Przemieniecki, J.S., "Theory of Matrix Structural Analysis," McGraw-Hill, 1968.
2. Paz, M., "Structural Dynamics, Theory and Computations," Van Nostrand Reinhold, 1985.



Example 4
Single Story Three-dimensional Frame
Figure 4-1

```
EXAMPLE  4  -  SINGLE STORY THREE-DIMENSIONAL FRAME
DYNAMIC RESPONSE SPECTRUM ANALYSIS      UNITS:KIP-INCH-SECOND
$                                       CONTROL DATA
 1  1  1  1  2  3  1  2  1  0  0  0  2  0  0  0  0  0  0
 386.4
$                                       MASS DATA
 1  1  1/386.4
 .15/144  0  0  30*12  30*12
$                                       STORY DATA
  1ST  15*12  1
$                                       MATERIAL DATA
 1  C  3000
$                                       COLUMN PROPERTIES
 1  1  USER
 1E7  0  0  0  24P4/12  24P4/12
 2  1  USER
 1E7  0  0  0  18P4/12  18P4/12
$                                       BEAM PROPERTIES
 1  1  USER  36
 0  0  0  0  1E9
$                                       FRAME DATA
 SINGLE STORY, THREE DIMENSIONAL FRAME
 1  1  4  4
$                                       COLUMN LINE LOCATION
 1  0
 2  30*12
 3  0       30*12
 4  30*12   30*12
$                                       BAY CONNECTIVITY
 1  1  2
 2  3  4
 3  1  3
 4  2  4
$                                       COLUMN ASSIGNMENTS
 1  0  1ST  1
 2  1
 3  0  1ST  2
 4  3

$                                       BEAM ASSIGNMENTS
 1  0  1ST  1
 2  1
 3  1
 4  1

$                                       FRAME LOCATION
 1  0 -15*12 -15*12  0  /SINGLE STORY 3-D FRAME
```

Example 4
Listing of Input Data
Figure 4-2

```
$                                          RESPONSE SPECTRUM DATA
 ELCENTRO RESPONSE SPECTRUM
2 52 CQC 386.4 .05
 0  90
       .0    .3275
    .0263    .3299
    .0270    .3297
    .0278    .3429
    .0286    .3544
    .0294    .3626
    .0303    .3683
    .0313    .3676
    .0323    .3629
    .0333    .3604
    .0345    .3637
    .0357    .3632
    .0370    .3610
    .0385    .3585
    .0400    .3551
    .0417    .3458
    .0435    .3436
    .0455    .3465
    .0476    .3528
    .0500    .3542
    .0526    .3544
    .0556    .3546
    .0588    .3917
    .0625    .4305
    .0667    .4455
    .0714    .4784
    .0769    .5053
    .0833    .5181
    .0909    .4776
    .0966    .5526
    .1000    .5816
    .1015    .5846
    .1070    .5548
    .1130    .5292
    .1198    .5952
    .1274    .6373
    .1361    .6615
    .1460    .6885
    .1575    .8712
    .1709    .8167
    .1869    .9879
    .2062    .9697
    .2299    .7006
    .2597    .8576
    .2985    .7385
    .3509    .8705
    .4255    .9090
    .5405    .9824
    .7407    .4761
   1.1765    .2713
   2.8571    .1983
 1000.00   0.0
$                                          LOAD CASE DATA
 1  0  0  0  0  0  0  1
 2  0  0  0  0  0  0  0  1
$   END OF INPUT DATA
```

Example 4
Listing of Input Data
Figure 4-2 (continued)

MODE	QUANTITY	ETABS	THEORETICAL
1	Period, sec	0.1389	0.1389
	Mode Shape		
	X-Translation	1.6244	1.6244
	Y-Translation	0.0000	0.0000
	Z-Rotation	-0.0032	-0.0032
2	Period, sec	0.1254	0.1254
	Mode Shape		
	X-Translation	0.0000	0.0000
	Y-Translation	-1.6918	-1.6918
	Z-Rotation	0.0000	0.0000
3	Period, sec	0.0703	0.0703
	Mode Shape		
	X-Translation	0.4728	0.4728
	Y-Translation	0.0000	0.0000
	Z-Rotation	0.0111	0.0111

Example 4
Comparison of results for Periods and Mode Shapes
Figure 4-3

EXAMPLE 5

THREE-STORY THREE-DIMENSIONAL BRACED FRAME BUILDING DYNAMIC RESPONSE SPECTRUM ANALYSIS

A. DESCRIPTION

This is an L-shaped building structure with four identical braced frames. All members (columns and braces) carry only axial loads.

The structure is subject to the El Centro 1940 N-S component seismic response spectrum in the X-direction. The structural damping is 5 percent.

The geometry of the structure and a typical frame are shown in Figure 5-1.

B. SIGNIFICANT OPTIONS OF ETABS ACTIVATED

1. Three-dimensional structure analysis using planar frames
2. Brace (diagonal) and column members with no bending stiffness
3. Dynamic response spectrum analysis

C. COMPUTER MODEL

The structure is modeled by appropriately placing four identical planar frames. Each frame is modeled by three column lines. Kip-inch-second units are used. The modulus of elasticity is taken as 29500 ksi and the typical member axial area as 6 in^2. A story mass of 1.242 kip-sec^2/in and a mass moment of inertia of 174907.4 kip-sec^2-in are used.

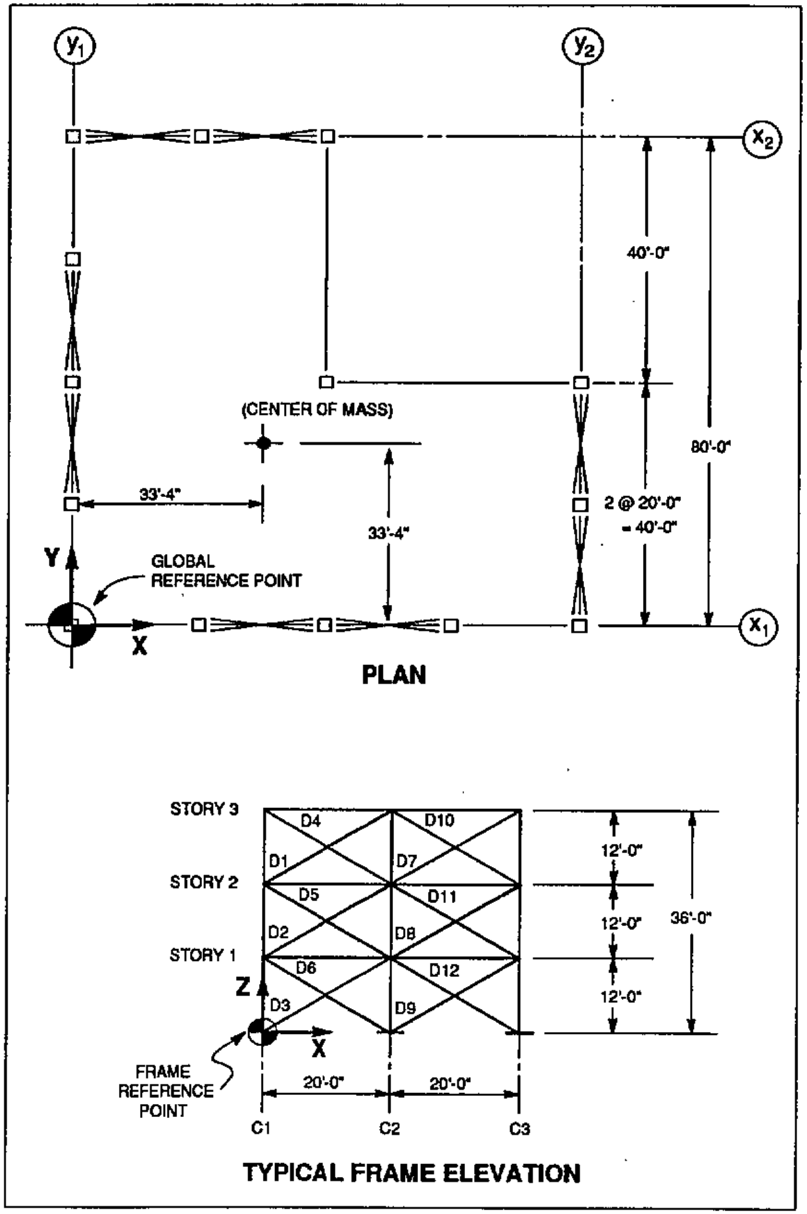
The input data file is EX5. The listing of the input data is given in Figure 5-2.

D. COMPARISON OF RESULTS

This example has been solved in References [1] and [2]. A comparison of ETABS results for natural periods and key member forces for frame X1 with References [1] and [2] is given in Figure 5-3. The comparison is excellent.

E. REFERENCES

1. Wilson, E.L. and Habibullah, A., "SAP90, Sample Example and Verification Manual," Computers and Structures, Inc., Berkeley, California, 1991.
2. Peterson, F.E., "EASE2, Elastic Analysis for Structural Engineering, Example Problem Manual," Engineering Analysis Corporation, Berkeley, California, 1981.



Example 5
Three-story, Three-dimensional Braced Frame Building
Figure 5-1

```
EXAMPLE  5  -  THREE STORY 3-D BRACED FRAME BUILDING
DYNAMIC RESPONSE SPECTRUM ANALYSIS    UNITS:KIP-INCH-SECOND
$                                       CONTROL DATA
3 1 4 0 1 2 1 1 0 1 0 0 2 0 0 0 0 0 0
386.4
$                                       STORY DATA
ST-3 144 0 1.242 174907.4 400 400
ST-2 144 0 1.242 174907.4 400 400
ST-1 144 0 1.242 174907.4 400 400
$                                       MATERIAL PROPERTIES
1 S 29500
$                                       COLUMN  PROPERTIES
1 1 USER
         6.0
$                                       BRACE PROPERTIES
1 1 USER
         6.0
$                                       FRAME DATA
 TYPICAL BRACED FRAME
1 3 3 0 12
$                                       COLUMN LINE LOCATION DATA
1 0
2 240
3 480
$                                       COLUMN ASSIGNMENT DATA
1 0 ST-3 1 2
2 1
3 1

$                                       BRACE LOCATION DATA
1 ST-3 1 2 1   2
4 ST-3 2 1 1   2
7 ST-3 2 3 1   2
10 ST-3 3 2 1   2
$                                       FRAME LOCATION DATA
1 0 240 0   0  X1
1 1 0   960 0  X2
1 0 0   240 90 Y1
1 1 960 0   90 Y2
$                                       RESPONSE SPECTRUM DATA
ELCENTRO EARTHQUAKE
1 4 CQC 386.4 .05 2
0
0 .7385
.2985 .7385
.3509 .8705
1000 .8705
$                                       LOAD CASE DATA
1 0 0 0 0 0 0 1
$   END OF INPUT DATA
```

Example 5
Listing of Input Data
Figure 5-2

QUANTITY	ETABS	Reference 1	Reference 2
Period, Mode 1	0.32686	0.32689	0.32689
Period, Mode 2	0.32061	0.32064	0.32064
Axial Force Column C1, Story 1	279.39	279.47	279.48
Axial Force Brace D3	194.44	194.51	194.50
Axial Force Brace D9	120.49	120.53	120.52

Example 5
Comparison of Results
Figure 5-3

EXAMPLE 6

NINE-STORY TEN-BAY PLANE FRAME EIGENVALUE ANALYSIS

A. DESCRIPTION

This is a nine-story ten-bay plane frame as shown in Figure 6-1.

An eigenvalue analysis is made.

B. SIGNIFICANT OPTIONS OF ETABS ACTIVATED

1. Two-dimensional frame analysis
2. Eigenvalue analysis

C. COMPUTER MODEL

The frame is modeled with eleven column lines and ten bays. Kip-ft-second units are used.

A modulus of elasticity of 432000 ksf is used. A typical member axial area of 3 ft^2 and moment of inertia of 1 ft^4 are used. A mass of 3 kip-sec^2/ft/ft of member length is converted to story mass using tributary lengths and used for the analysis.

The input data filename for this example is EX6. A listing of the input data is given in Figure 6-2.

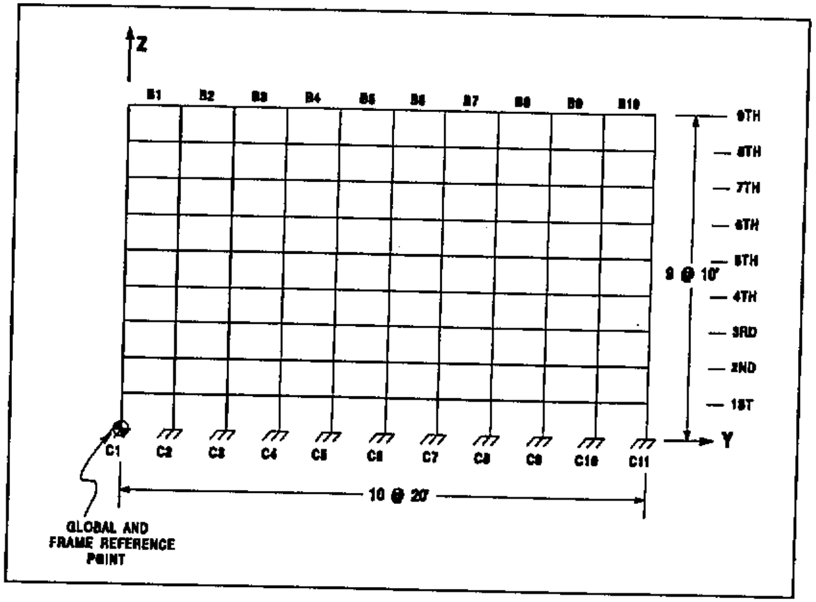
D. COMPARISON OF RESULTS

This example is also analyzed in References [1] and [2]. There are two differences between the ETABS analysis and the analyses of References [1] and [2]. The models of References [1] and [2] assign vertical and horizontal mass degrees of freedom to each joint in the structure. However, the ETABS model only assigns horizontal masses and additionally, only one horizontal mass is assigned for all the joints associated with any one floor level.

The eigenvalues obtained from ETABS are compared in Figure 6-3 with results from References [1] and [2]. Considering the differences in modeling enumerated above, the comparison is excellent.

E. REFERENCES

1. Wilson, E.L. and Habibullah, A., "SAP90, Sample Example and Verification Manual," Computers and Structures, Inc., Berkeley, California, 1991.
2. Bathe, K.J. and Wilson, E.L., "Large Eigenvalue Problems in Dynamic Analysis," Journal of the Eng. Mech. Div., ASCE, Vol. 98, No. EM6, Proc. Paper 9433, December 1972.



Example 6
Nine-story, Ten-bay Plane Frame
Figure 6-1

```
EXAMPLE 6  -  NINE STORY TEN BAY PLANE FRAME
EIGENVALUE ANALYSIS                        UNITS:KIP-FOOT-SECOND
$   CONTROL INFORMATION
 9  1  1  0  0  9  1  1  1  0  0  0  1  2  0  4  0  0  0
 32.2
$   STORY DATA
 9TH  10  0  765
 8TH  10  0  930
 7TH  10  0  930
 6TH  10  0  930
 5TH  10  0  930
 4TH  10  0  930
 3RD  10  0  930
 2ND  10  0  930
 1ST  10  0  930
$   FRAME MEMBER MATERIAL PROPERTY DATA
 1  C  4.32E5
$   COLUMN SECTION PROPERTY DATA
 1  1  USER
 3.0  0.0  0.0  0.0  1.0
$   BEAM SECTION PROPERTY DATA
 1  1  USER
 3.0  0.0  0.0  0.0  1.0
$   FRAME CONTROL DATA
 9-STORY,10-BAY PLANE FRAME
 1  9  11  10
$   COLUMN LINE COORDINATES
   1  0    0    90
   2  0   20    90
   3  0   40    90
   4  0   60    90
   5  0   80    90
   6  0  100    90
   7  0  120    90
   8  0  140    90
   9  0  160    90
  10  0  180    90
  11  0  200    90
```

Example 6
Listing of Input File
Figure 6-2

```
$    BAY CONNECTIVITY
  1   1   2
  2   2   3
  3   3   4
  4   4   5
  5   5   6
  6   6   7
  7   7   8
  8   8   9
  9   9  10
 10  10  11
$    COLUMN LOCATION DATA
  1   0    9TH  1  8
  2   1
  3   1
  4   1
  5   1
  6   1
  7   1
  8   1
  9   1
 10   1
 11   1

$    BEAM LOCATION DATA
  1   0    9TH  1  8
  2   1
  3   1
  4   1
  5   1
  6   1
  7   1
  8   1
  9   1
 10   1

$    FRAME LOCATION DATA
 1  0   0   0   0   2-D FRAME
$      END
```

Example 6
Listing of Input File
Figure 6-2 (continued)

MODE	ETABS	REFERENCE 1	REFERENCE 2
1	0.58964	0.58954	0.58954
2	5.53195	5.52696	5.52695
3	16.5962	16.5879	16.5878

Example 6
Comparison of Results for Eigenvalues
Figure 6-3

EXAMPLE 7

SEVEN-STORY PLANE FRAME GRAVITY and LATERAL LOADS ANALYSIS

A. DESCRIPTION

This is a seven-story plane frame. The gravity loads and the geometry of the frame are shown in Figure 7-1.

The frame is analyzed three times, subjected to the following lateral loads:

a. Static lateral loads, shown in Figure 7-1

b. Lateral loads resulting from the El Centro 1940 N-S component seismic response spectra, 5 percent damping

c. Lateral loads resulting from the El Centro 1940 N-S component acceleration time history.

B. SIGNIFICANT OPTIONS OF ETABS ACTIVATED

1. Two-dimensional frame analysis
2. User-specified section properties
3. User-specified lateral loads
4. Dynamic response spectrum analysis
5. Dynamic time history analysis

C. COMPUTER MODEL

The frame is modeled with three column lines and two bays. Kip-inch-second units are used. Since the wide flange members used in the frame are older sections, their properties are not available in the AISC section property data base included with the ETABS program, and the required properties therefore need to be explicitly provided in the input data.

The input data file for static lateral loads analysis is EX7a. A listing of this data file is given in Figure 7-2.

The input data file for dynamic response spectrum analysis is EX7b. A listing of this data file is given in Figure 7-4.

The input data file for dynamic time history analysis is EX7c. The input history is defined in file ELCENTRO. These files are listed in Figure 7-7. Time history results are obtained for the first eight seconds of the excitation. This is consistent with Reference [2], with which the results are compared.

D. COMPARISON OF RESULTS

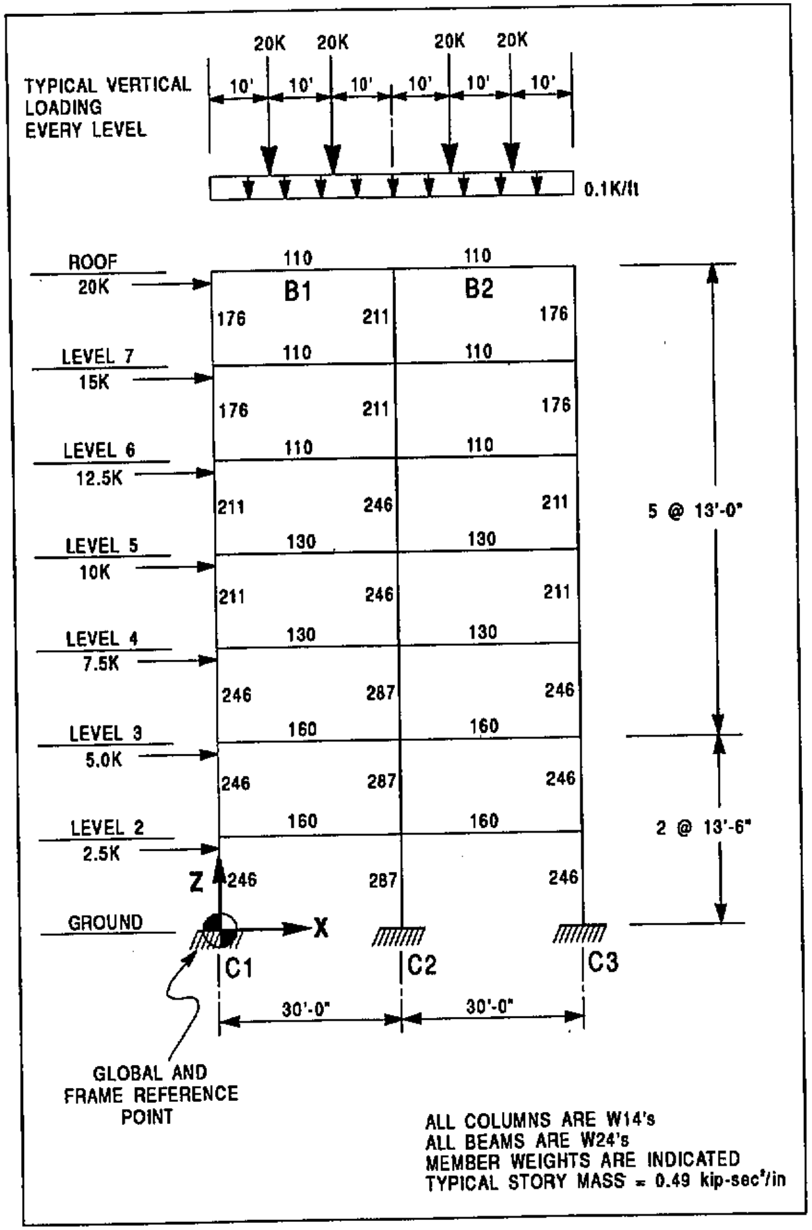
The example frame is analyzed in Reference [1] for gravity loads, static lateral loads and dynamic response spectrum loads. Reference [2] analyzes the example frame under static lateral loads and dynamic response spectrum and time history loads. A comparison of key ETABS results with Reference [1] and [2] results is presented in Figures 7-3, 7-5, 7-6 and 7-8. Note the difference in modal combination techniques between ETABS and Reference [1], which uses complete quadratic combination (CQC) and Reference [2], which uses square root of the sum of the squares combination (SRSS). The comparison of the results for all three analyses are excellent.

Selected output for story displacements, drifts and shears for Example EX7c is included in this manual.

E. REFERENCES

1. Wilson, E.L. and Habibullah, A., "SAP90, Sample Example and Verification Manual," Computers and Structures, Inc., Berkeley, California, 1991.

2. "Static and Dynamic Analysis of Multistory Frame Structures Using DYNAMIC/EASE2," Engineering Analysis Corporation and Computers and Structures, Inc. , Berkeley, California.



Example 7
Seven-story Plane Frame
Figure 7-1

```
EXAMPLE  7a  -  SEVEN STORY PLANE FRAME
GRAVITY AND STATIC LATERAL LOADS ANALYSIS  UNITS:KIP-INCH-SECOND
$                                           CONTROL DATA
7 1 1 0 2 0 1 4 3 0 0 1 0 1 0 4 1 0 0
386.4
ROOF 156
6TH 156
5TH 156
4TH 156
3RD 156
2ND 162
1ST 162
$                                           MATERIAL DATA
1 S 29500 0.49/1728 .30
$                                           COLUMN PROPERTIES
1 1 USER
 51.17  0   0   0   2150                      $W14X176
2 1 USER
 62.10  0   0   0   2670                      $W14X211
3 1 USER
 72.30  0   0   0   3230                      $W14X246
4 1 USER
 84.40  0   0   0   3910                      $W14X287
$                                           BEAM PROPERTIES
1 1 USER
  0.0    0   0   0   3330                     $W24X110
2 1 USER
  0.0    0   0   0   4020                     $W24X130
3 1 USER
  0.0    0   0   0   5120                     $W24X160
$                                           FRAME DATA
SEVEN STORY PLANE FRAME
1 7  3  2  0  0  0  1  2
$                                           COLUMN LINE LOCATION
1    0
2    360
3    720
$                                           BAY CONNECTIVITY
1    1  2
2    2  3
$                                           BEAM SPAN LOAD PATTERNS
1  2  0.1/12
10*12 20 20*12 20
```

Example 7a
Listing of Input Data
Figure 7-2

```
$                                       COLUMN ASSIGNMENTS
1   0 ROOF 1 1
1   0 5TH 2 1
1   0 3RD 3 2
2   0 ROOF 2 1
2   0 5TH  3 1
2   0 3RD  4 2
3   1
$                                       BEAM ASSIGNMENTS
1   0  ROOF 1 2
1   0  4TH  2 1
1   0  2ND  3 1
2   1
$                                       BEAM SPAN LOAD ASSIGNMENTS
1  0  ROOF  1  0  0  6
2  1
$                                       FRAME LOCATIONS
1 0 0 0 0 /7-STORY PLANE FRAME
$                                       LATERAL LOADS DATA
 20
 15
 12.5
 10
 7.5
 5
 2.5
$                                       LOAD CASE DATA
1 0 1
2 0 0 0 0 1
$   END OF INPUT DATA
```

Example 7a
Listing of Input Data
Figure 7-2 (Continued)

QUANTITY	ETABS	REFERENCE 1	REFERENCE 2
Lateral Displacement at Roof	1.4508	1.4508	1.4508
Axial Force Column C1 at Ground	69.99	69.99	69.99
Moment Column C1 at Ground	2324.68	2324.68	2324.68

Example 7a
Comparison of Results for Static Lateral Loads
Figure 7-3

```
EXAMPLE  7b  -  SEVEN STORY PLANE FRAME
DYNAMIC RESPONSE SPECTRUM ANALYSIS        UNITS:KIP-INCH-SECOND
                                           CONTROL DATA
$
7 1 1 0 1 7 1 4 3 0 0 0 2 1 0 4 0 0 0
386.4
$                                          STORY DATA
ROOF 156  0  0.49
 6TH 156  0  0.49
 5TH 156  0  0.49
 4TH 156  0  0.49
 3RD 156  0  0.49
 2ND 162  0  0.49
 1ST 162  0  0.49
$                                          MATERIAL DATA
1 S 29500 0.49/1728 .30
$                                          COLUMN PROPERTIES
1 1 USER
 51.17  0  0  0  2150                        $W14X176
2 1 USER
 62.10  0  0  0  2670                        $W14X211
3 1 USER
 72.30  0  0  0  3230                        $W14X246
4 1 USER
 84.40  0  0  0  3910                        $W14X287
$                                          BEAM PROPERTIES
1 1 USER
  0.0   0  0  0  3330                        $W24X110
2 1 USER
  0.0   0  0  0  4020                        $W24X130
3 1 USER
  0.0   0  0  0  5120                        $W24X160
$                                          FRAME DATA
SEVEN STORY PLANE FRAME
1 7  3  2
$                                          COLUMN LINE LOCATION
1   0
2   360
3   720
$                                          BAY CONNECTIVITY
1   1  2
2   2  3
```

Example7b
Listing of Input Data
Figure 7-4

```
$                                                    COLUMN ASSIGNMENTS
1    0 ROOF 1 1
1    0 5TH 2 1
1    0 3RD 3 2
2    0 ROOF 2 1
2    0 5TH  3 1
2    0 3RD  4 2
3    1

$                                                    BEAM ASSIGNMENTS
1    0  ROOF 1 2
1    0  4TH  2 1
1    0  2ND  3 1
2    1

$                                                    FRAME LOCATIONS
1 0 0 0 0 /7-STORY PLANE FRAME
$                                                    RESPONSE SPECTRUM DATA
 ELCENTRO RESPONSE SPECTRUM
1 35 CQC 386.4 .05
0
        .0        .3275
      .0769        .505311
      .0795        .519598
      .08          .520045
      .0833        .518093
      .0870        .493366
      .0909        .477599
      .0951        .527825
      .0952        .530631
      .1000        .581609
      .1053        .564412
      .1111        .523663
      .1176        .572438
      .1190        .588211
      .1250        .627807
      .1333        .665413
      .1429        .636531
      .1538        .905796
      .1602        .804605
      .1667        .787220
      .1818        .943909
      .2000       1.005620
      .2222        .746135
      .2420        .704753
      .2500        .798052
      .2857        .718264
      .3333        .880624
      .4000        .882996
      .4313        .921167
      .5000       1.046620
      .6667        .641750
     1.0000        .482251
     1.2730        .258617
     2.0000        .160189
1000 0
$                                                    LOAD CASE DATA
1 0 0 0 0 0 0 1
$    END OF INPUT DATA
```

Example 7b
Listing of Input Data
Figure 7-4 (continued)

MODE	ETABS	REFERENCE 1	REFERENCE 2
1	1.27321	1.27321	1.27321
2	0.43128	0.43128	0.43128
3	0.24204	0.24204	0.24204
4	0.16018	0.16018	0.16018
5	0.11899	0.11899	0.11899
6	0.09506	0.09506	0.09506
7	0.07951	0.07951	0.07951

Example 7b
Comparison of Results for Periods of Vibration
Figure 7-5

QUANTITY	ETABS CQC COMBINATION	REFERENCE 1 CQC COMBINATION	REFERENCE 2 SRSS COMBINATION
Lateral Displacement at Roof	5.4314	5.4314	5.4378
Axial Force Column C1, at Ground	261.52	261.52	261.52
Moment Column C1, at Ground	9916.12	9916.12	9868.25

Example 7b
Comparison of Results for Response Spectrum Analysis
Figure 7-6

```
EXAMPLE  7c  -  SEVEN STORY PLANE FRAME
DYNAMIC TIME HISTORY ANALYSIS                         UNITS:KIP-INCH-SEC
$                                                     CONTROL DATA
 7  1  1  0  1  7  1  4  3  0  0  0  3  1  0  4  0  0  0
 386.4
$                                                     STORY DATA
 ROOF 156  0  0.49
  6TH 156  0  0.49
  5TH 156  0  0.49
  4TH 156  0  0.49
  3RD 156  0  0.49
  2ND 162  0  0.49
  1ST 162  0  0.49
$                                                     MATERIAL PROPERTIES
 1  S  29500  0.49/1728  .30
$                                                     COLUMN PROPERTIES
 1  1  USER
 51.17  0  0  0  2150                                   $W14X176
 2  1  USER
 62.10  0  0  0  2670                                   $W14X211
 3  1  USER
 72.30  0  0  0  3230                                   $W14X246
 4  1  USER
 84.40  0  0  0  3910                                   $W14X287
$                                                     BEAM PROPERTIES
 1  1  USER
  0.0   0  0  0  3330                                   $W24X110
 2  1  USER
  0.0   0  0  0  4020                                   $W24X130
 3  1  USER
  0.0   0  0  0  5120                                   $W24X160
$                                                     FRAME DATA
 SEVEN STORY PLANE FRAME
 1  7  3  2
$                                                     COLUMN LINE COORDINATES
 1        0
 2        360
 3        720
$                                                     BAY CONNECTIVITY
 1        1    2
 2        2    3
$                                                     COLUMN ASSIGNMENTS
 1        0  ROOF  1  1
 1        0   5TH  2  1
 1        0   3RD  3  2
 2        0  ROOF  2  1
 2        0   5TH  3  1
 2        0   3RD  4  2
 3        1

$                                                     BEAM ASSIGNMENTS
 1        0  ROOF  1  2
 1        0   4TH  2  1
 1        0   2ND  3  1
 2        1

$                                                     FRAME LOCATION DATA
 1  0  0  0  0  /7-STORY  PLANE  FRAME
$                                                     SEISMIC TIME HISTORY DATA
  ELCENTRO TIME HISTORY
 0 400 0.02
 1 0.05
 2 0.05
 3 0.05
 4 0.05
 5 0.05
 6 0.05
 7 0.05
 ELCENTRO 386.4 0 0 6 0

$                                                     LOAD CASE DATA
 1  0  0  0  0  0  0  1
$   END OF INPUT DATA
```

Example 7c
Listing of Input Data (File: EX7c)
Figure 7-7

0.00000	.01080	.04200	.00100	.09700	.01590
.16100	-.00010	.22100	.01890	.26300	.00010
.29100	.00590	.33200	-.00120	.37400	.02000
.42900	-.02370	.47100	.00760	.58100	.04250
.62300	.00940	.66500	.01380	.72000	-.00880
.72010	-.02560	.78900	-.03870	.78910	-.05680
.87200	-.02320	.87210	-.03430	.94100	-.04020
.94110	-.06030	.99700	-.07890	1.06600	-.06660
1.06610	-.03810	1.09400	-.04290	1.16800	.08970
1.31500	-.16960	1.38400	-.08280	1.41200	-.08280
1.44000	-.09450	1.48100	-.08850	1.50900	-.10800
1.53700	-.12800	1.62800	.11440	1.70300	.23550
1.80000	.14280	1.85500	.17770	1.92400	-.26100
2.00700	-.31940	2.21500	.29520	2.27000	.26340
2.32000	-.29840	2.39500	.00540	2.45000	.28650
2.51900	-.04690	2.57500	.15160	2.65200	.20770
2.70800	.10870	2.76900	-.03250	2.89300	.10330
2.97600	-.08030	3.06800	.05200	3.12900	-.15470
3.21200	.00650	3.25300	-.20600	3.38600	.19270
3.41900	-.09370	3.53000	.17080	3.59900	-.03590
3.66800	.03650	3.73800	-.07360	3.83500	.03110
3.90400	-.18330	4.01400	.02270	4.05600	-.04350
4.10600	.02160	4.22200	-.19720	4.31400	-.17620
4.41600	.14600	4.47100	-.00470	4.61800	.25720
4.66500	-.20450	4.75600	.06080	4.83100	-.27330
4.97000	.17790	5.03900	.03010	5.10800	.21830
5.19900	.02670	5.23300	.12520	5.30200	.12900
5.33000	.10890	5.34300	-.02390	5.45400	.17230
5.51000	-.10210	5.60600	.01410	5.69000	-.19490
5.77300	-.02420	5.80000	-.00500	5.80900	-.02750
5.86900	-.05730	5.88300	-.03270	5.92500	.02160
5.98000	.01080	6.01300	.02350	6.08500	-.06650
6.13200	.00140	6.17400	.04930	6.18800	.01490
6.18810	-.02000	6.22900	-.03810	6.27900	.02070
6.32600	-.00580	6.36800	-.06030	6.38200	-.01620
6.40900	.02000	6.45900	-.01760	6.47800	-.00330
6.52000	.00430	6.53400	-.00400	6.56200	-.00990
6.57500	-.00170	6.60300	-.01700	6.64500	.03730
6.68600	.04570	6.71400	.03850	6.72800	.00090
6.76900	-.02880	6.76910	.00160	6.81100	.01130
6.85200	.00220	6.90800	.00920	6.99100	-.09960
7.07400	.03600	7.12100	.00780	7.14300	-.02770
7.14900	.00260	7.17100	.02720	7.22600	.05760
7.29500	-.04920	7.37000	.02970	7.40600	.01090
7.42500	.01860	7.46100	-.02530	7.52500	-.03470
7.57200	.00360	7.60000	-.06280	7.64100	-.02800
7.66900	-.01960	7.69100	.00680	7.75200	-.00540
7.79400	-.06030	7.83500	-.03570	7.87700	-.07160
7.96000	-.01400	7.98700	-.00560	8.00100	.02220
8.07000	.04680	8.12600	.02600	8.12610	-.03350
8.19500	-.01280	8.22300	.06610	8.27800	.03050
8.33400	.02460	8.40300	.03470	8.45800	-.03690
8.53300	-.03440	8.59600	-.01040	8.63800	-.02600
8.73500	.15340	8.81800	-.00280	8.86000	.02330
8.88200	-.02610	8.91500	-.00220	8.95600	-.18490
9.05300	.12600	9.09500	.03200	9.12300	.09550
9.15000	.12460	9.25300	-.03280	9.28900	-.04510
9.42700	.13010	9.44100	-.16570	9.51000	.04190
9.63500	-.09360	9.70400	.08160	9.81500	-.08810
9.89800	.00640	9.93900	-.00060	9.99500	.05860
10.02200	-.07130	10.05000	-.04480	10.05010	-.02210
10.10500	.00930	10.10510	.00240	10.18800	.05100

Example 7c
Listing of Input Time History Data (File: Elcentro)
Figure 7-7 (continued)

10.27200	-.12430	10.38200	.05870	10.42400	.01330
10.45200	.03860	10.46500	.11640	10.50700	-.03740
10.53400	-.05720	10.64500	.03080	10.70100	.02230
10.71400	.05150	10.77000	.09030	10.83900	-.01940
10.92200	.04710	10.92210	-.06770	10.96400	-.07940
10.99100	-.01200	11.07400	.06080	11.08800	-.02690
11.11600	-.04160	11.20700	.02930	11.20710	.05520
11.22700	.07560	11.26800	.04310	11.32400	.02080
11.43400	.11800	11.57300	-.09990	11.65600	-.12470
11.72500	-.20940	11.72510	-.14180	11.78000	-.11630
11.80800	0.00000	11.87700	.07620	11.91900	.05700
11.98800	.13540	12.04300	.06730	12.11300	.08650

Example 7c
Listing of Input Time History Data (File: Elcentro)
Figure 7-7 (continued)

	ETABS	REFERENCE 2
Maximum Roof Displacement	5.49	5.48
Maximum Base Shear	285	284
Maximum Axial Force Column C1, at Ground	263	258
Maximum Moment Column C1, at Ground	9104	8740

Example 7c
Comparison of Results for Time History Analysis
Figure 7-8

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    1
                                                 PROGRAM:ETABS/FILE:EX7C.STR
EXAMPLE  7C  -  SEVEN STORY PLANE FRAME
DYNAMIC TIME HISTORY ANALYSIS                   UNITS:KIP-INCH-SEC

TIME HISTORY LATERAL STORY DISPLACEMENTS

DISPLACEMENTS ARE AT THE CENTERS OF MASS OF THE RESPECTIVE STORY LEVELS

                  /------------LOAD CONDITION (DYN-1)------------/
                 /---------MAXIMUM--------//--------MINIMUM--------/
LEVEL    DIRN          VALUE        TIME        VALUE        TIME

ROOF       X          4.4613      6.7000      -5.4862      6.0400

6TH        X          4.1164      6.7200      -5.0618      6.0600

5TH        X          3.5456      6.7400      -4.3123      6.0800

4TH        X          2.8909      6.7600      -3.4779      6.1000

3RD        X          2.1482      6.7600      -2.5615      6.1400

2ND        X          1.3843      5.5000      -1.6345      6.1400

1ST        X           .5695      5.4800       -.6500      6.1400
```

Example 7c
Sample Output

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    2
                                                   PROGRAM:ETABS/FILE:EX7C.STR
EXAMPLE  7C  -  SEVEN STORY PLANE FRAME
DYNAMIC TIME HISTORY ANALYSIS           UNITS:KIP-INCH-SEC

TIME HISTORY LATERAL FRAME DISPLACEMENTS

FRAME ID .... /7-STORY  PLANE  FRAME

VALUES ARE AT THE FRAME ORIGIN IN THE FRAME LOCAL COORDINATES

                      /------------LOAD CONDITION (DYN-1)------------/
                     /--------MAXIMUM-------//-------MINIMUM--------/
LEVEL     DIRN            VALUE        TIME        VALUE        TIME

ROOF         X           4.4613      6.7000      -5.4862      6.0400
ROOF         Y            .0000      8.0000        .0000      8.0000
ROOF      ROTZ            .0000      8.0000        .0000      8.0000

6TH          X           4.1164      6.7200      -5.0618      6.0600
6TH          Y            .0000      8.0000        .0000      8.0000
6TH       ROTZ            .0000      8.0000        .0000      8.0000

5TH          X           3.5456      6.7400      -4.3123      6.0800
5TH          Y            .0000      8.0000        .0000      8.0000
5TH       ROTZ            .0000      8.0000        .0000      8.0000

4TH          X           2.8909      6.7600      -3.4779      6.1000
4TH          Y            .0000      8.0000        .0000      8.0000
4TH       ROTZ            .0000      8.0000        .0000      8.0000

3RD          X           2.1482      6.7600      -2.5615      6.1400
3RD          Y            .0000      8.0000        .0000      8.0000
3RD       ROTZ            .0000      8.0000        .0000      8.0000

2ND          X           1.3843      5.5000      -1.6345      6.1400
2ND          Y            .0000      8.0000        .0000      8.0000
2ND       ROTZ            .0000      8.0000        .0000      8.0000

1ST          X            .5695      5.4800       -.6500      6.1400
1ST          Y            .0000      8.0000        .0000      8.0000
1ST       ROTZ            .0000      8.0000        .0000      8.0000
```

Example 7c
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    3
                                                PROGRAM:ETABS/FILE:EX7C.STR
EXAMPLE  7C  -  SEVEN STORY PLANE FRAME
DYNAMIC TIME HISTORY ANALYSIS                  UNITS:KIP-INCH-SEC

TIME HISTORY LATERAL FRAME DRIFT RATIOS

FRAME ID .... /7-STORY  PLANE  FRAME

VALUES ARE AT THE FRAME ORIGIN IN THE FRAME LOCAL COORDINATES
```

LEVEL	DIRN	LOAD CONDITION (DYN-1) MAXIMUM VALUE	TIME	MINIMUM VALUE	TIME
ROOF	X	.00400	2.96000	-.00422	3.56000
ROOF	Y	.00000	8.00000	.00000	8.00000
ROOF	ROTZ	.00000	8.00000	.00000	8.00000
6TH	X	.00575	2.94000	-.00570	3.56000
6TH	Y	.00000	8.00000	.00000	8.00000
6TH	ROTZ	.00000	8.00000	.00000	8.00000
5TH	X	.00580	2.04000	-.00602	6.04000
5TH	Y	.00000	8.00000	.00000	8.00000
5TH	ROTZ	.00000	8.00000	.00000	8.00000
4TH	X	.00550	2.02000	-.00628	6.04000
4TH	Y	.00000	8.00000	.00000	8.00000
4TH	ROTZ	.00000	8.00000	.00000	8.00000
3RD	X	.00496	6.74000	-.00607	6.10000
3RD	Y	.00000	8.00000	.00000	8.00000
3RD	ROTZ	.00000	8.00000	.00000	8.00000
2ND	X	.00510	5.52000	-.00608	6.14000
2ND	Y	.00000	8.00000	.00000	8.00000
2ND	ROTZ	.00000	8.00000	.00000	8.00000
1ST	X	.00352	5.48000	-.00401	6.14000
1ST	Y	.00000	8.00000	.00000	8.00000
1ST	ROTZ	.00000	8.00000	.00000	8.00000

Example 7c
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    4
                                                        PROGRAM:ETABS/FILE:EX7C.STR
EXAMPLE  7C  -  SEVEN STORY PLANE FRAME
DYNAMIC TIME HISTORY ANALYSIS             UNITS:KIP-INCH-SEC

TIME HISTORY LATERAL FRAME STORY SHEARS

FRAME ID .... /7-STORY  PLANE  FRAME

VALUES ARE AT THE FRAME ORIGIN IN THE FRAME LOCAL COORDINATES

                    /------------LOAD CONDITION (DYN-1)------------/
                   /---------MAXIMUM--------//-------MINIMUM---------/
LEVEL       DIRN         VALUE          TIME          VALUE        TIME

ROOF           X        119.91          2.96        -131.07        3.56
ROOF           Y           .00          8.00            .00        8.00
ROOF        ROTZ           .00          8.00            .00        8.00

6TH            X        184.45          2.94        -179.08        3.56
6TH            Y           .00          8.00            .00        8.00
6TH         ROTZ           .00          8.00            .00        8.00

5TH            X        204.25          2.04        -206.36        6.04
5TH            Y           .00          8.00            .00        8.00
5TH         ROTZ           .00          8.00            .00        8.00

4TH            X        204.06          2.02        -223.20        6.04
4TH            Y           .00          8.00            .00        8.00
4TH         ROTZ           .00          8.00            .00        8.00

3RD            X        202.44          5.54        -249.04        6.12
3RD            Y           .00          8.00            .00        8.00
3RD         ROTZ           .00          8.00            .00        8.00

2ND            X        235.66          5.52        -274.64        6.14
2ND            Y           .00          8.00            .00        8.00
2ND         ROTZ           .00          8.00            .00        8.00

1ST            X        258.53          5.48        -284.70        6.16
1ST            Y           .00          8.00            .00        8.00
1ST         ROTZ           .00          8.00            .00        8.00
```

Example 7c
Sample Output (continued)

EXAMPLE 8

TWO-STORY THREE-DIMENSIONAL FRAME DYNAMIC RESPONSE SPECTRUM ANALYSIS

A. DESCRIPTION

This is a two-story three-dimensional building frame subjected to a response spectrum of constant amplitude.

The geometry of the structure is shown in Figure 8-1.

B. SIGNIFICANT OPTIONS OF ETABS ACTIVATED

1. Three-dimensional frame analysis
2. User-specified section properties
3. Dynamic response spectrum analysis

C. COMPUTER MODEL

The three-dimensional structure is modeled as a single frame with nine column lines and twelve bays. Kip-foot-second units are used.

For consistency with models documented in other computer programs with which the ETABS results are to be compared below, no story mass moments of inertia are assigned in the ETABS model. A response spectrum with a constant value of 0.4 g is used. Other parameters associated with the structure are as follows:

	Columns	Beams
Axial area	4 ft^2	5 ft^2
Minor moment of inertia	1.25 ft^4	1.67 ft^4
Major moment of inertia	1.25 ft^4	2.61 ft^4
Modulus of elasticity	350000 ksf	500000 ksf

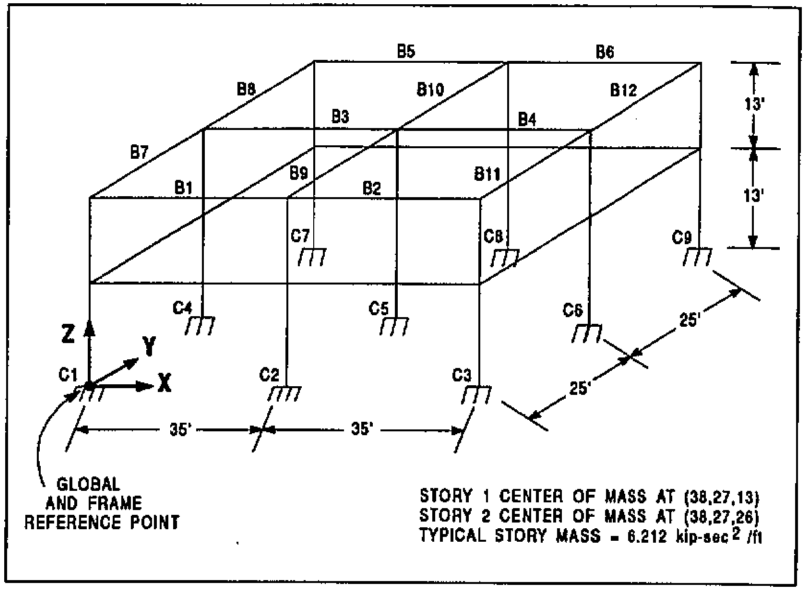
The input data file is EX8. A listing of the input data is given in Figure 8-2.

D. COMPARISON OF RESULTS

This example is also analyzed in References [1] and [2]. A comparison of the key ETABS results with References [1] and [2] is shown in Figure 8-3. The comparison is excellent.

E. REFERENCES

1. Wilson, E.L. and Habibullah, A., "SAP90, Sample Example and Verification Manual," Computers and Structures, Inc., Berkeley, California, 1991.
2. Peterson, F.E., "EASE2, Elastic Analysis for Structural Engineering, Example Problem Manual," Engineering Analysis Corporation, Berkeley, California, 1981.



Example 8
Two-story Three-dimensional Frame
Figure 8-1

```
EXAMPLE 8  -   TWO STORY THREE DIMENSIONAL BUILDING FRAME
DYNAMIC RESPONSE SPECTRUM ANALYSIS   UNITS:KIP-FOOT-SECOND
$   CONTROL DATA
 2  1  1  0  1  4  2  1  1  0  0  0  2  0  0  4  0  0  0
32.2
$   STORY DATA
 2ND  13  0  6.212  0.0   38 27  0.0  0.0  0.0
 1ST  13  0  6.212  0.0   38 27  0.0  0.0  0.0
$   FRAME MEMBER MATERIAL PROPERTY DATA
 1  C  3.5E5
 2  C  5.0E5
$   COLUMN SECTION PROPERTY DATA
 1  1  USER
 4.0  0.0  0.0  0.0  1.25  1.25
$   BEAM SECTION PROPERTY DATA
 1  2  USER
 5.0  0.0  0.0  0.0  2.61  1.67
$   FRAME CONTROL DATA
 THREE DIMENSIONAL BUILDING FRAME
 1  2  9  12  0  0  0  0  0
$   COLUMN LINE COORDINATES
 1  0  0
 2 35  0
 3 70  0
 4  0 25
 5 35 25
 6 70 25
 7  0 50
 8 35 50
 9 70 50
$   BAY CONNECTIVITY
 1  1  2
 2  2  3
 3  4  5
 4  5  6
 5  7  8
 6  8  9
 7  1  4
 8  4  7
 9  2  5
10  5  8
11  3  6
12  6  9
```

Example 8
Listing of Input Data
Figure 8-2

```
$   COLUMN LOCATION DATA
 1  0  2ND  1  1
 2  1
 3  1
 4  1
 5  1
 6  1
 7  1
 8  1
 9  1

$   BEAM LOCATION DATA
 1  0  2ND  1  1
 2  1
 3  1
 4  1
 5  1
 6  1
 7  1
 8  1
 9  1
10  1
11  1
12  1

$   FRAME LOCATION DATA
 1  0  0.0  0.0  0.0  3-D FRAME
$   RESPONSE SPECTRUM DATA
 CONSTANT 0.4G SPECTRUM
 1  2  CQC  32.2  0.04
 0.0
 0   0.4
100  0.4
$   LOAD CASE DATA
 1  0  0  0  0  0  0  1
$   END
```

Example 8
Listing of Input Data
Figure 8-2 (continued)

QUANTITY	ETABS	REFERENCE 1	REFERENCE 2
Period, Mode 1	0.22708	0.22706	0.22706
Period, Mode 2	0.21565	0.21563	0.21563
Period, Mode 3	0.07335	0.07335	0.07335
Period, Mode 4	0.07201	0.07201	0.07201
X-Displacement, Center of Mass, at Roof	0.0201	0.0201	0.0201

Example 8
Comparison of Results
Figure 8-3

EXAMPLE 9

TWO-STORY THREE-DIMENSIONAL UNSYMMETRICAL BUILDING FRAME DYNAMIC RESPONSE SPECTRUM ANALYSIS

A. DESCRIPTION

This is a two-story three-dimensional unsymmetrical building frame. The structure is subjected to a seismic response spectrum along two horizontal axes which are at a 30 degree angle to the building axes.

The geometry of the structure is shown in Figure 9-1.

B. SIGNIFICANT OPTIONS OF ETABS ACTIVATED

1. Three-dimensional frame analysis
2. Dynamic response spectrum analysis

C. COMPUTER MODEL

The three-dimensional structure is modeled as a single frame with six column lines and five bays. Kip-foot-second units are used. The seismic excitation is identical to the one used in

Reference [1]. Typical columns are 18" x 18" and beams are 12" x 24". The modulus of elasticity is taken as 432000 ksf.

The input data file is EX9. A listing of the input data is given in Figure 9-2.

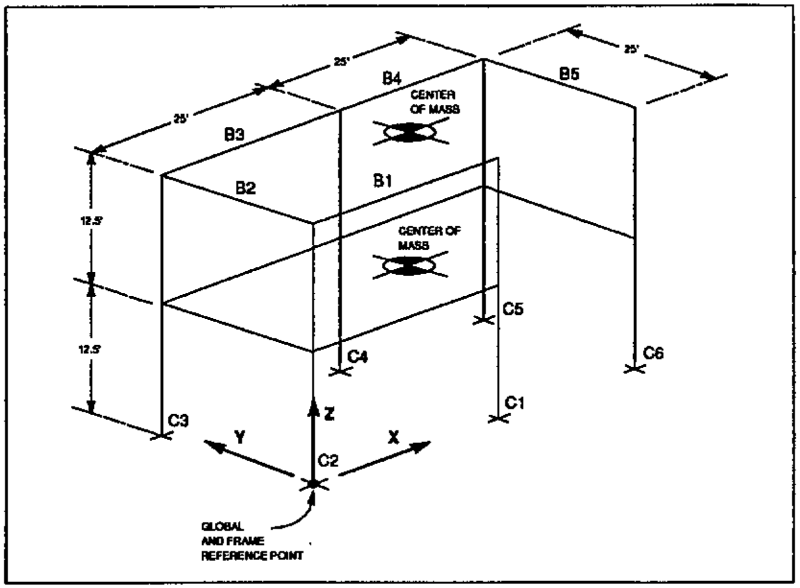
D. COMPARISON OF RESULTS

The structure is also analyzed in Reference [1]. Key ETABS results are compared in Figure 9-3. The comparison is excellent.

The complete ETABS output for this example, including the input echo, is included in this manual.

E. REFERENCE

1. Wilson, E.L. and Habibullah, A., "SAP90, Sample Example and Verification Manual," Computers and Structures, Inc., Berkeley, California, 1991.



Example 9
Two-story Three-dimensional Unsymmetrical Building Frame
Figure 9-1

```
EXAMPLE 9  -  TWO STORY 3-D UNSYMMETRICAL BUILDING FRAME
DYNAMIC RESPONSE SPECTRUM ANALYSIS        UNITS:KIP-FOOT-SECOND
$                                         CONTROL DATA
 2  1  1  0  2  6  1  1  1  0  0  0  2  0  0  4  1  0  0
 32.2
$                                         STORY DATA
 2ND  12.5 0 3.88  1011  25 12.5 0.0  0.0  0.0
 1ST  12.5 0 3.88  1011  25 12.5 0.0  0.0  0.0
$                                         MATERIAL PROPERTIES
 1  C  432000  0.15   0.2
$                                         COLUMN SECTION PROPERTY DATA
 1  1  USER
 2.25 0.0  0.0  0.0  .4219 .4219
$                                         BEAM SECTION PROPERTY DATA
 1  1  USER
 2.0  0.0  0.0  0.0  .6667 .1667
$                                         FRAME DATA
 THREE DIMENSIONAL BUILDING FRAME
 1  2  6  5   0  0  0  0  0
$                                         COLUMN LINE COORDINATES
 1  25 0
 2  0  0
 3  0 25
 4 25 25
 5 50 25
 6 50  0
$                                         BAY CONNECTIVITY
 1  1  2
 2  2  3
 3  3  4
 4  4  5
 5  5  6
```

Example 9
Listing of Input Data
Figure 9-2

```
$                                            COLUMN LOCATION DATA
 1  0  2ND  1  1
 2  1
 3  1
 4  1
 5  1
 6  1

$                                            BEAM LOCATION DATA
 1  0  2ND  1  1
 2  1
 3  1
 4  1
 5  1

$                                            FRAME LOCATION DATA
 1  0  0.0  0.0  0.0  3-D FRAME
$                                            RESPONSE SPECTRUM DATA
EL CENTRO 1940 SPECTRA
 2  16  CQC  32.2  0.05
 30  120
 0        .400
 0.100    .581
 0.125    .628
 0.167    .787
 0.182    .9439
 0.200    1.0056
 0.250    0.7980
 0.333    0.8806
 0.431    0.9212
 0.500    1.0466
 0.667    .6418
 1.000    .4822
 1.273    .2586
 2.000    .1602
 10.00    .0102
 100.0    .0
$                                            LOAD COMBINATION DATA
 1  0  0  0  0  0  0  1
 2  0  0  0  0  0  0  0  1
$   END OF INPUT DATA
```

Example 9
Listing of Input Data
Figure 9-2 (continued)

QUANTITY	ETABS	REFERENCE 1
Period, Mode 1	0.4146	0.4146
Period, Mode 2	0.3753	0.3753
Period, Mode 3	0.2436	0.2436
Period, Mode 4	0.1148	0.1148
Period, Mode 5	0.1103	0.1103
Period, Mode 6	0.0729	0.0729
X-Displacement, Center of Mass, at Roof, for:		
Seismic at 30° to X	0.1062	0.1062
Seismic at 120° to X	0.0617	0.0617

Example 9
Comparison Of Results
Figure 9-3

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    1
                                                PROGRAM:ETABS/FILE:EX9.EKO
EXAMPLE 9  -  TWO STORY 3-D UNSYMMETRICAL BUILDING FRAME
DYNAMIC RESPONSE SPECTRUM ANALYSIS       UNITS:KIP-FOOT-SECOND


NUMBER OF STORIES------------------------------------   2
NUMBER OF DIFFERENT FRAMES---------------------------   1
NUMBER OF TOTAL FRAMES-------------------------------   1
NUMBER OF MASS TYPES---------------------------------   0
NUMBER OF LOAD CASES---------------------------------   2
NUMBER OF STRUCTURAL PERIODS-------------------------   6
NUMBER OF MATERIAL PROPERTIES------------------------   1
NUMBER OF SECTION PROPERTIES FOR COLUMNS-------------   1
NUMBER OF SECTION PROPERTIES FOR BEAMS---------------   1
NUMBER OF SECTION PROPERTIES FOR DIAGONALS-----------   0
NUMBER OF SECTION PROPERTIES FOR PANELS--------------   0
CODE FOR STATIC LATERAL ANALYSIS---------------------   0
CODE FOR DYNAMIC LATERAL ANALYSIS--------------------   2
CODE FOR STRUCTURE TYPE------------------------------   0
CODE FOR P-DELTA ANALYSIS ---------------------------   0
CODE FOR FRAME JOINT STIFFNESS MODIFICATION----------   4
CODE FOR FRAME JOINT DISPLACEMENT--------------------   1
CODE FOR FRAME SELF WEIGHT LOAD CONDITION------------   0
CODE FOR POST PROCESSING MODE SHAPES-----------------   1


GRAVITATIONAL ACCELERATION-----------------------   .3220E+02
EIGEN CONVERGENCE TOLERANCE----------------------   .1000E-03
EIGEN CUTOFF TIME PERIOD-------------------------   .0000E+00
P-DELTA FACTOR-----------------------------------   .1000E+01
```

Example 9
Sample Output

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    2
                                                   PROGRAM:ETABS/FILE:EX9.EKO
EXAMPLE 9  -  TWO STORY 3-D UNSYMMETRICAL BUILDING FRAME
DYNAMIC RESPONSE SPECTRUM ANALYSIS        UNITS:KIP-FOOT-SECOND


STRUCTURAL STORY HEIGHTS AND MASS DATA  . . .

LEVEL          HEIGHT  MASS TYPE        MASS        MMI          XM         YM
2ND             12.50          0       3.880     1011.0       25.00      12.50
1ST             12.50          0       3.880     1011.0       25.00      12.50
```

Example 9
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    3
                                                   PROGRAM:ETABS/FILE:EX9.EKO
EXAMPLE 9  -  TWO STORY 3-D UNSYMMETRICAL BUILDING FRAME
DYNAMIC RESPONSE SPECTRUM ANALYSIS       UNITS:KIP-FOOT-SECOND


STRUCTURAL EXTERNAL STORY STIFFNESS DATA . . .

LEVEL            K-X          K-Y        K-ROTN
2ND        0.0000E+00   0.0000E+00   0.0000E+00
1ST        0.0000E+00   0.0000E+00   0.0000E+00
```

Example 9
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    4
                                                  PROGRAM:ETABS/FILE:EX9.EKO
EXAMPLE 9  -  TWO STORY 3-D UNSYMMETRICAL BUILDING FRAME
DYNAMIC RESPONSE SPECTRUM ANALYSIS        UNITS:KIP-FOOT-SECOND

MATERIAL PROPERTIES

 ID TYPE      ELASTIC        UNIT    POISSONS
              MODULUS      WEIGHT       RATIO
  1    C    .432E+06    .150E+00        .200

MATERIAL PROPERTIES FOR DESIGN

 ID TYPE           FY          FC          FYS         FBMAJ       FBMIN
  1    C    .000E+00    .000E+00    .000E+00
```

Example 9
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    5
                                              PROGRAM:ETABS/FILE:EX9.EKO
EXAMPLE 9  -  TWO STORY 3-D UNSYMMETRICAL BUILDING FRAME
DYNAMIC RESPONSE SPECTRUM ANALYSIS       UNITS:KIP-FOOT-SECOND

SECTION PROPERTIES FOR COLUMNS

     MAT  SECTION                    MAJOR     MINOR    FLANGE      WEB
ID   ID   TYPE                        DIM       DIM     THICK     THICK
 1    1   USER                       .000      .000      .000      .000

ANALYSIS SECTION PROPERTIES FOR  COLUMNS

            AXIAL       MAJOR       MINOR      TORSION       MAJOR       MINOR
ID              A          AV          AV            J           I           I
 1          2.250        .000        .000   .0000E+00   .4219E+00   .4219E+00
```

Example 9
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    6
                                                  PROGRAM:ETABS/FILE:EX9.EKO
EXAMPLE 9  -  TWO STORY 3-D UNSYMMETRICAL BUILDING FRAME
DYNAMIC RESPONSE SPECTRUM ANALYSIS       UNITS:KIP-FOOT-SECOND

SECTION PROPERTIES FOR BEAMS

      MAT  SECTION                DEPTH     DEPTH      BEAM   FLANGE       WEB
  ID   ID  TYPE                   BELOW     ABOVE     WIDTH    THICK     THICK
   1    1  USER                    .000      .000      .000     .000      .000

ANALYSIS SECTION PROPERTIES FOR   BEAMS

           AXIAL      MAJOR      MINOR    TORSION       MAJOR      MINOR
  ID           A         AV         AV          J           I          I
   1       2.000       .000       .000  .0000E+00   .6667E+00  .1667E+00
```

Example 9
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    7
                                                PROGRAM:ETABS/FILE:EX9.EKO
EXAMPLE 9  -  TWO STORY 3-D UNSYMMETRICAL BUILDING FRAME
DYNAMIC RESPONSE SPECTRUM ANALYSIS       UNITS:KIP-FOOT-SECOND


THREE DIMENSIONAL BUILDING FRAME

FRAME ID NUMBER----------------------------------   1
NUMBER OF STORY LEVELS---------------------------   2
NUMBER OF COLUMN LINES---------------------------   6
NUMBER OF BAYS-----------------------------------   5
NUMBER OF BRACING ELEMENTS-----------------------   0
NUMBER OF PANEL ELEMENTS-------------------------   0
NUMBER OF COLUMN LATERAL LOAD PATTERNS-----------   0
NUMBER OF BEAM SPAN LOAD PATTERNS----------------   0
MAXIMUM NUMBER OF LOADS PER BEAM SPAN------------   0


COLUMN LINE COORDINATES AND ORIENTATIONS

    COLUMN          X-ORD          Y-ORD          ANGLE
         1         25.000           .000         .00000
         2           .000           .000         .00000
         3           .000         25.000         .00000
         4         25.000         25.000         .00000
         5         50.000         25.000         .00000
         6         50.000           .000         .00000


BAY CONNECTIVITY DATA

      BAY       I-COLUMN       J-COLUMN     BAY LENGTH
        1              1              2         25.000
        2              2              3         25.000
        3              3              4         25.000
        4              4              5         25.000
        5              5              6         25.000


INPUT AND/OR GENERATED COLUMN PROPERTY ID*S

LEVEL        1    2    3    4    5    6

2ND          1    1    1    1    1    1
1ST          1    1    1    1    1    1


INPUT AND/OR GENERATED COLUMN PIN ENDS

DATA SPECIFIED FOR THIS OPTION IS ALL ZERO


INPUT AND/OR GENERATED COLUMN STORY DISCONNECTIONS

DATA SPECIFIED FOR THIS OPTION IS ALL ZERO
```

Example 9
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    8
                                                    PROGRAM:ETABS/FILE:EX9.EKO
EXAMPLE 9  -  TWO STORY 3-D UNSYMMETRICAL BUILDING FRAME
DYNAMIC RESPONSE SPECTRUM ANALYSIS       UNITS:KIP-FOOT-SECOND

INPUT AND/OR GENERATED BAY PROPERTY ID*S

LEVEL         1   2   3   4   5

2ND           1   1   1   1   1
1ST           1   1   1   1   1

INPUT AND/OR GENERATED BAY PIN ENDS

DATA SPECIFIED FOR THIS OPTION IS ALL ZERO
```

Example 9
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE     9
                                                 PROGRAM:ETABS/FILE:EX9.EKO
EXAMPLE 9  -  TWO STORY 3-D UNSYMMETRICAL BUILDING FRAME
DYNAMIC RESPONSE SPECTRUM ANALYSIS       UNITS:KIP-FOOT-SECOND


FRAME VERTICAL LOADING AND SELF WEIGHTS

LEVEL    /--VERTICAL LOAD CONDITION--/ /---------ELEMENT SELF WEIGHTS--------/
ID              I         II        III    COLUMN      BEAM     BRACE     PANEL
2ND            .0         .0         .0     25.3       37.5       .0        .0
1ST            .0         .0         .0     25.3       37.5       .0        .0

TOTALS         .0         .0         .0     50.6       75.0       .0        .0
```

Example 9
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE   10
                                                   PROGRAM:ETABS/FILE:EX9.EKO
EXAMPLE 9  -  TWO STORY 3-D UNSYMMETRICAL BUILDING FRAME
DYNAMIC RESPONSE SPECTRUM ANALYSIS        UNITS:KIP-FOOT-SECOND


FRAME POSITION DATA

FRAME FRAME OUTPT /----FRAME ORIENTATION----/ /--------FRAME HEADING--------/
COUNT    ID  CODE       X-ORD      Y-ORD   ANGLE
    1     1     0         .00        .00    .000 3-D FRAME
```

Example 9
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE   11
                                                     PROGRAM:ETABS/FILE:EX9.EKO
EXAMPLE 9  -  TWO STORY 3-D UNSYMMETRICAL BUILDING FRAME
DYNAMIC RESPONSE SPECTRUM ANALYSIS        UNITS:KIP-FOOT-SECOND


DYNAMIC RESPONSE SPECTRUM ANALYSIS

EL CENTRO 1940 SPECTRA

NUMBER OF EXCITATION DIRECTIONS-------------         2

NUMBER OF POINTS ON SPECTRUM CURVE----------        16

MODAL COMBINATION TECHNIQUE-----------------       CQC

SCALE FACTOR FOR SPECTRUM CURVE-------------    32.200

DAMPING ASSOCIATED WITH SPECTRUM CURVE------      .050
```

Example 9
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE   12
                                              PROGRAM:ETABS/FILE:EX9.EKO
EXAMPLE 9  -  TWO STORY 3-D UNSYMMETRICAL BUILDING FRAME
DYNAMIC RESPONSE SPECTRUM ANALYSIS       UNITS:KIP-FOOT-SECOND

DYNAMIC EXCITATION DIRECTIONS

DIRECTION FOR DYNAMIC LOAD CONDITION 1------     30.000

DIRECTION FOR DYNAMIC LOAD CONDITION 2------    120.000

RESPONSE SPECTRUM CURVE DATA

POINT          TIME        SPECTRAL
  NO         PERIOD    ACCELERATION
   1           .000           .400
   2           .100           .581
   3           .125           .628
   4           .167           .787
   5           .182           .944
   6           .200          1.006
   7           .250           .798
   8           .333           .881
   9           .431           .921
  10           .500          1.047
  11           .667           .642
  12          1.000           .482
  13          1.273           .259
  14          2.000           .160
  15         10.000           .010
  16        100.000           .000
```

Example 9
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE   13
                                                  PROGRAM:ETABS/FILE:EX9.EKO
EXAMPLE 9  -  TWO STORY 3-D UNSYMMETRICAL BUILDING FRAME
DYNAMIC RESPONSE SPECTRUM ANALYSIS       UNITS:KIP-FOOT-SECOND


LOAD CASE DEFINITION DATA

LOAD LABS      I      II     III      A      B   DYN-1  DYN-2  DYN-3
   1    0   .000    .000    .000   .000   .000  1.000   .000   .000
   2    0   .000    .000    .000   .000   .000   .000  1.000   .000



FOR DYNAMICS BY THE RESPONSE SPECTRUM METHOD

DYNAMIC 1 . . . SPECTRAL DIRECTION 1
DYNAMIC 2 . . . SPECTRAL DIRECTION 2
DYNAMIC 3 . . . SPECTRAL DIRECTION 3

FOR DYNAMICS BY THE TIME HISTORY METHOD

DYNAMIC 1 . . . TIME HISTORY MODAL ANALYSIS
DYNAMIC 2 . . . NOT USED
DYNAMIC 3 . . . NOT USED
```

Example 9
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    1
                                                   PROGRAM:ETABS/FILE:EX9.EIG
EXAMPLE 9  -  TWO STORY 3-D UNSYMMETRICAL BUILDING FRAME
DYNAMIC RESPONSE SPECTRUM ANALYSIS      UNITS:KIP-FOOT-SECOND


STRUCTURAL TIME PERIODS AND FREQUENCIES

  MODE                        PERIOD           FREQUENCY      CIRCULAR/FREQ
NUMBER                        (TIME)  (CYCLES/UNIT TIME)  (RADIANS/UNIT TIME)
     1                        .41460             2.41196           15.15478
     2                        .37530             2.66455           16.74184
     3                        .24357             4.10556           25.79599
     4                        .11480             8.71043           54.72924
     5                        .11030             9.06625           56.96491
     6                        .07287            13.72324           86.22565
```

Example 9
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    2
                                                PROGRAM:ETABS/FILE:EX9.EIG
EXAMPLE 9  -  TWO STORY 3-D UNSYMMETRICAL BUILDING FRAME
DYNAMIC RESPONSE SPECTRUM ANALYSIS        UNITS:KIP-FOOT-SECOND


MODAL PARTICIPATION FACTORS

  MODE               X-TRANS          Y-TRANS          Z-ROTN
 NUMBER             DIRECTION        DIRECTION        DIRECTION
     1                .01688          2.59189           .04917
     2               2.59785          -.01739          4.50301
     3                .30376           .00142        -42.08750
     4                .00478          1.02068           .01715
     5               -.95805           .00408         -1.56221
     6                .02723           .00004        -15.09709
```

Example 9
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    3
                                                 PROGRAM:ETABS/FILE:EX9.EIG
EXAMPLE 9  -  TWO STORY 3-D UNSYMMETRICAL BUILDING FRAME
DYNAMIC RESPONSE SPECTRUM ANALYSIS      UNITS:KIP-FOOT-SECOND
```

MODAL DIRECTION FACTORS

MODE NUMBER	X-TRANS DIRECTION	Y-TRANS DIRECTION	Z-ROTN DIRECTION
1	.00427	99.99558	.00015
2	98.80245	.00439	1.19316
3	1.22612	.00003	98.77385
4	.00199	99.99799	.00002
5	99.72459	.00201	.27341
6	.24058	.00000	99.75941

Example 9
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    4
                                                  PROGRAM:ETABS/FILE:EX9.EIG
EXAMPLE 9  -  TWO STORY 3-D UNSYMMETRICAL BUILDING FRAME
DYNAMIC RESPONSE SPECTRUM ANALYSIS        UNITS:KIP-FOOT-SECOND


EFFECTIVE MASS FACTORS

 MODE      /--X  TRANSLATION--//--Y  TRANSLATION--//-----Z ROTATION----/
NUMBER         %-MASS  <%-SUM>      %-MASS  <%-SUM>       %-MASS <%-SUM>
     1            .00  <    .0>      86.57  < 86.6>          .00 <   .0>
     2          86.97  < 87.0>         .00  < 86.6>         1.00 < 1.0>
     3           1.19  < 88.2>         .00  < 86.6>        87.60 < 88.6>
     4            .00  < 88.2>       13.43  <100.0>          .00 < 88.6>
     5          11.83  <100.0>         .00  <100.0>          .12 < 88.7>
     6            .01  <100.0>         .00  <100.0>        11.27 <100.0>
```

Example 9
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    5
                                                   PROGRAM:ETABS/FILE:EX9.EIG
EXAMPLE 9  -  TWO STORY 3-D UNSYMMETRICAL BUILDING FRAME
DYNAMIC RESPONSE SPECTRUM ANALYSIS      UNITS:KIP-FOOT-SECOND


STRUCTURAL MODE SHAPES

VALUES ARE AT THE CENTERS OF MASS OF THE
CORRESPONDING LEVELS IN GLOBAL COORDINATES

LEVEL       DIRN      MODE  1     MODE  2     MODE  3     MODE  4     MODE  5
ID            ID

2ND            X       .00305      .45826      .04605     -.00086      .21309
2ND            Y       .46554     -.00304      .00020     -.20248     -.00099
2ND         ROTZ       .00004      .00320     -.02825      .00000      .00010

1ST            X       .00130      .21129      .03224      .00209     -.46001
1ST            Y       .20248     -.00144      .00017      .46554      .00205
1ST         ROTZ       .00001      .00126     -.01338      .00001     -.00164

LEVEL       DIRN      MODE  6
ID            ID

2ND            X      -.01375
2ND            Y      -.00006
2ND         ROTZ       .01345

1ST            X       .02076
1ST            Y       .00007
1ST         ROTZ      -.02839
```

Example 9
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    1
                                                 PROGRAM:ETABS/FILE:EX9.STR
EXAMPLE 9  -  TWO STORY 3-D UNSYMMETRICAL BUILDING FRAME
DYNAMIC RESPONSE SPECTRUM ANALYSIS      UNITS:KIP-FOOT-SECOND


RESPONSE SPECTRUM LATERAL STORY DISPLACEMENTS

DISPLACEMENTS ARE AT THE CENTERS OF MASS OF THE RESPECTIVE STORY LEVELS

                       /---------LOAD  CONDITIONS---------/
LEVEL       DIRN            DYN-1        DYN-2        DYN-3

2ND            X            .1062        .0617        .0000
2ND            Y            .0779        .1337        .0000
2ND         ROTZ            .0008        .0005        .0000

1ST            X            .0490        .0285        .0000
1ST            Y            .0339        .0582        .0000
1ST         ROTZ            .0003        .0002        .0000
```

Example 9
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    2
                                                  PROGRAM:ETABS/FILE:EX9.STR
EXAMPLE 9  -  TWO STORY 3-D UNSYMMETRICAL BUILDING FRAME
DYNAMIC RESPONSE SPECTRUM ANALYSIS       UNITS:KIP-FOOT-SECOND


DYNAMIC STORY INERTIA LOADS/TORSIONS

LOADS ARE AT THE CENTERS OF MASS OF THE RESPECTIVE STORY LEVELS

                    /----------LOAD  CONDITIONS----------/
LEVEL      DIRN           DYN-1        DYN-2        DYN-3

2ND           X          116.23        67.61          .00
2ND           Y           69.73       119.87          .00
2ND        ROTZ          283.04       162.81          .00

1ST           X           60.62        35.22          .00
1ST           Y           35.22        60.66          .00
1ST        ROTZ          125.74        72.25          .00
```

Example 9
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    3
                                                   PROGRAM:ETABS/FILE:EX9.STR
EXAMPLE 9  -  TWO STORY 3-D UNSYMMETRICAL BUILDING FRAME
DYNAMIC RESPONSE SPECTRUM ANALYSIS        UNITS:KIP-FOOT-SECOND

DYNAMIC STORY SHEARS

                      /----------LOAD  CONDITIONS----------/
LEVEL      DIRN            DYN-1       DYN-2       DYN-3

2ND          X            116.23       67.61         .00
2ND          Y             69.73      119.87         .00

1ST          X            169.59       98.68         .00
1ST          Y            100.03      171.98         .00
```

Example 9
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE     4
                                                   PROGRAM:ETABS/FILE:EX9.STR
EXAMPLE 9   -  TWO STORY 3-D UNSYMMETRICAL BUILDING FRAME
DYNAMIC RESPONSE SPECTRUM ANALYSIS       UNITS:KIP-FOOT-SECOND


RESPONSE SPECTRUM LATERAL FRAME DISPLACEMENTS

FRAME ID .... 3-D FRAME

VALUES ARE AT THE FRAME ORIGIN IN THE FRAME LOCAL COORDINATES

                /---------LOAD  CONDITIONS---------/
LEVEL     DIRN          DYN-1        DYN-2        DYN-3

2ND          X          .1154        .0670        .0000
2ND          Y          .0710        .1391        .0000
2ND       ROTZ          .0008        .0005        .0000

1ST          X          .0526        .0306        .0000
1ST          Y          .0312        .0604        .0000
1ST       ROTZ          .0003        .0002        .0000
```

Example 9
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    5
                                              PROGRAM:ETABS/FILE:EX9.STR
EXAMPLE 9  -  TWO STORY 3-D UNSYMMETRICAL BUILDING FRAME
DYNAMIC RESPONSE SPECTRUM ANALYSIS       UNITS:KIP-FOOT-SECOND


RESPONSE SPECTRUM LATERAL FRAME DRIFT RATIOS

FRAME ID .... 3-D FRAME

VALUES ARE AT THE FRAME ORIGIN IN THE FRAME LOCAL COORDINATES

                 /---------LOAD  CONDITIONS---------/
LEVEL     DIRN          DYN-1        DYN-2        DYN-3

2ND          X         .00503       .00292       .00000
2ND          Y         .00319       .00631       .00000
2ND       ROTZ         .00004       .00002       .00000

1ST          X         .00421       .00245       .00000
1ST          Y         .00249       .00483       .00000
1ST       ROTZ         .00003       .00001       .00000
```

Example 9
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    6
                                                PROGRAM:ETABS/FILE:EX9.STR
EXAMPLE 9  -  TWO STORY 3-D UNSYMMETRICAL BUILDING FRAME
DYNAMIC RESPONSE SPECTRUM ANALYSIS       UNITS:KIP-FOOT-SECOND

RESPONSE SPECTRUM LATERAL FRAME STORY SHEARS

FRAME ID .... 3-D FRAME

VALUES ARE AT THE FRAME ORIGIN IN THE FRAME LOCAL COORDINATES

                  /----------LOAD  CONDITIONS---------/
LEVEL      DIRN          DYN-1        DYN-2        DYN-3

2ND           X         116.23        67.61          .00
2ND           Y          69.73       119.87          .00
2ND        ROTZ        1570.04      3424.11          .00

1ST           X         169.59        98.68          .00
1ST           Y         100.03       171.98          .00
1ST        ROTZ        2266.19      4928.61          .00
```

Example 9
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    1
                                                         PROGRAM:ETABS/FILE:EX9.DSP
EXAMPLE 9  -  TWO STORY 3-D UNSYMMETRICAL BUILDING FRAME
DYNAMIC RESPONSE SPECTRUM ANALYSIS      UNITS:KIP-FOOT-SECOND


FRAME LATERAL STORY DISPLACEMENTS

VALUES ARE AT THE FRAME ORIGIN IN THE FRAME LOCAL COORDINATES

FRAME ID  .... 3-D FRAME

LEVEL      DIRN       CASE 1       CASE 2
ID           ID
2ND           X       .11539       .06698
2ND           Y       .07099       .13910
2ND        ROTZ       .00079       .00045

1ST           X       .05263       .03058
1ST           Y       .03119       .06035
1ST        ROTZ       .00032       .00018
```

Example 9
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    2
                                                     PROGRAM:ETABS/FILE:EX9.DSP
EXAMPLE 9  -  TWO STORY 3-D UNSYMMETRICAL BUILDING FRAME
DYNAMIC RESPONSE SPECTRUM ANALYSIS       UNITS:KIP-FOOT-SECOND

VERTICAL DISPLACEMENTS AND ROTATIONS OF COLUMNS (TOP ENDS)

FRAME ID .... 3-D FRAME                               LEVEL ID .... 2ND

OUTPUT     DIRN      COLUMN      COLUMN      COLUMN      COLUMN      COLUMN
ID           ID           1           2           3           4           5
CASE 1     ROTX      .00338      .00166      .00166      .00338      .00212
CASE 1     ROTY      .00258      .00258      .00224      .00130      .00225
CASE 1     VERT      .00064      .00084      .00051      .00000      .00087

CASE 2     ROTX      .00579      .00328      .00328      .00579      .00302
CASE 2     ROTY      .00149      .00149      .00131      .00075      .00129
CASE 2     VERT      .00037      .00066      .00096      .00001      .00066

OUTPUT     DIRN      COLUMN
ID           ID           6
CASE 1     ROTX      .00212
CASE 1     ROTY      .00468
CASE 1     VERT      .00051

CASE 2     ROTX      .00302
CASE 2     ROTY      .00271
CASE 2     VERT      .00073
```

Example 9
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    3
                                                         PROGRAM:ETABS/FILE:EX9.DSP
EXAMPLE 9  -  TWO STORY 3-D UNSYMMETRICAL BUILDING FRAME
DYNAMIC RESPONSE SPECTRUM ANALYSIS      UNITS:KIP-FOOT-SECOND


VERTICAL DISPLACEMENTS AND ROTATIONS OF COLUMNS (TOP ENDS)

FRAME ID .... 3-D FRAME                                 LEVEL ID .... 1ST

OUTPUT      DIRN       COLUMN       COLUMN       COLUMN       COLUMN       COLUMN
ID            ID            1            2            3            4            5
CASE 1      ROTX       .00383       .00242       .00242       .00383       .00302
CASE 1      ROTY       .00396       .00396       .00346       .00233       .00346
CASE 1      VERT       .00046       .00060       .00037       .00000       .00062

CASE 2      ROTX       .00658       .00474       .00474       .00658       .00440
CASE 2      ROTY       .00229       .00229       .00201       .00135       .00201
CASE 2      VERT       .00027       .00047       .00068       .00001       .00047

OUTPUT      DIRN       COLUMN
ID            ID            6
CASE 1      ROTX       .00302
CASE 1      ROTY       .00576
CASE 1      VERT       .00036

CASE 2      ROTX       .00440
CASE 2      ROTY       .00334
CASE 2      VERT       .00052
```

Example 9
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    4
                                                  PROGRAM:ETABS/FILE:EX9.DSP
EXAMPLE 9  -  TWO STORY 3-D UNSYMMETRICAL BUILDING FRAME
DYNAMIC RESPONSE SPECTRUM ANALYSIS      UNITS:KIP-FOOT-SECOND

FRAME REACTION FORCES AT BASELINE (AT EACH COLUMN LINE)

VALUES ARE IN THE LOCAL COORDINATE SYSTEM OF THE FRAME

FRAME ID .... 3-D FRAME
```

COL ID	OUTPUT ID	FORCE ALONG-X	FORCE ALONG-Y	FORCE ALONG-Z	MOMENT ABOUT-XX	MOMENT ABOUT-YY	MOMENT ABOUT-ZZ
1	CASE 1	31.29	11.21	35.61	125.68	253.10	.00
1	CASE 2	18.22	19.28	20.78	215.94	147.20	.00
2	CASE 1	31.29	18.00	46.88	147.72	253.10	.00
2	CASE 2	18.22	34.47	36.54	284.33	147.20	.00
3	CASE 1	26.85	18.00	28.66	147.72	218.04	.00
3	CASE 2	15.59	34.47	53.20	284.33	126.69	.00
4	CASE 1	34.75	11.21	.25	125.68	251.01	.00
4	CASE 2	20.21	19.28	.43	215.94	145.97	.00
5	CASE 1	26.82	21.57	48.35	178.71	217.94	.00
5	CASE 2	15.63	32.41	36.47	266.48	126.86	.00
6	CASE 1	18.72	21.57	27.92	178.71	200.61	.00
6	CASE 2	10.89	32.41	40.51	266.48	116.60	.00

Example 9
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    5
                                                   PROGRAM:ETABS/FILE:EX9.DSP
EXAMPLE 9  -  TWO STORY 3-D UNSYMMETRICAL BUILDING FRAME
DYNAMIC RESPONSE SPECTRUM ANALYSIS      UNITS:KIP-FOOT-SECOND


SUMMATION OF FRAME REACTION FORCES AT BASELINE

VALUES ARE IN THE LOCAL COORDINATE SYSTEM OF THE FRAME

FRAME ID .... 3-D FRAME

     OUTPUT     FORCE      FORCE      FORCE
         ID   ALONG-X    ALONG-Y    ALONG-Z
     CASE 1    169.59     100.03        .00
     CASE 2     98.68     171.98        .00
```

Example 9
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    1
                                                 PROGRAM:ETABS/FILE:EX9.FRM
EXAMPLE 9  -  TWO STORY 3-D UNSYMMETRICAL BUILDING FRAME
DYNAMIC RESPONSE SPECTRUM ANALYSIS       UNITS:KIP-FOOT-SECOND


COLUMN FORCES AT LEVEL 2ND       IN FRAME 3-D FRAME

 COL OUTPUT OUTPUT      MAJOR      MAJOR      MINOR      MINOR      AXIAL TORSIONAL
  ID     ID  POINT     MOMENT      SHEAR     MOMENT      SHEAR      FORCE    MOMENT
   1 CASE 1    TOP     174.55      24.75        .00       1.31      13.96       .00
            BOTTOM     134.91                 16.37
   1 CASE 2    TOP     101.91      14.44        .00       2.26       8.15       .00
            BOTTOM      78.67                 28.27

   2 CASE 1    TOP     174.55      24.75     112.15      16.17      18.46       .00
            BOTTOM     134.91                 90.07
   2 CASE 2    TOP     101.91      14.44     222.74      32.27      14.85       .00
            BOTTOM      78.67                180.70

   3 CASE 1    TOP     131.93      18.30     112.15      16.17      11.24       .00
            BOTTOM      96.99                 90.07
   3 CASE 2    TOP      75.80      10.51     222.74      32.27      21.33       .00
            BOTTOM      55.70                180.70

   4 CASE 1    TOP     219.61      32.75        .00       1.31        .13       .00
            BOTTOM     189.78                 16.37
   4 CASE 2    TOP     127.53      19.02        .00       2.26        .23       .00
            BOTTOM     110.18                 28.27

   5 CASE 1    TOP     131.22      18.20     142.93      20.78      19.12       .00
            BOTTOM      96.49                116.95
   5 CASE 2    TOP      77.02      10.68     205.07      29.62      14.80       .00
            BOTTOM      56.55                165.30

   6 CASE 1    TOP        .00       2.80     142.93      20.78      11.43       .00
            BOTTOM      35.01                116.95
   6 CASE 2    TOP        .00       1.63     205.07      29.62      16.41       .00
            BOTTOM      20.42                165.30


BEAM FORCES AT LEVEL 2ND       IN FRAME 3-D FRAME

 BAY OUTPUT OUTPUT      MAJOR      MAJOR      MINOR      MINOR      AXIAL TORSIONAL
  ID     ID  POINT     MOMENT      SHEAR     MOMENT      SHEAR      FORCE    MOMENT
   1 CASE 1  END-I     174.55      13.96        .00        .00        .00       .00
             END-J     174.55                   .00
   1 CASE 2  END-I     101.91       8.15        .00        .00        .00       .00
             END-J     101.91                   .00

   2 CASE 1  END-I     112.15       8.97        .00        .00        .00       .00
             END-J     112.15                   .00
   2 CASE 2  END-I     222.74      17.82        .00        .00        .00       .00
             END-J     222.74                   .00

   3 CASE 1  END-I     131.93       9.69        .00        .00        .00       .00
             END-J     110.28                   .00
   3 CASE 2  END-I      75.80       5.55        .00        .00        .00       .00
             END-J      62.97                   .00
```

Example 9
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    2
                                                  PROGRAM:ETABS/FILE:EX9.FRM
EXAMPLE 9  -  TWO STORY 3-D UNSYMMETRICAL BUILDING FRAME
DYNAMIC RESPONSE SPECTRUM ANALYSIS         UNITS:KIP-FOOT-SECOND
```

BEAM FORCES AT LEVEL 2ND   IN FRAME 3-D FRAME

BAY ID	OUTPUT ID	OUTPUT POINT	MAJOR MOMENT	MAJOR SHEAR	MINOR MOMENT	MINOR SHEAR	AXIAL FORCE	TORSIONAL MOMENT
4	CASE 1	END-I	109.33	9.62	.00	.00	.00	.00
		END-J	131.22		.00			
4	CASE 2	END-I	64.59	5.66	.00	.00	.00	.00
		END-J	77.02		.00			
5	CASE 1	END-I	142.93	11.43	.00	.00	.00	.00
		END-J	142.93		.00			
5	CASE 2	END-I	205.07	16.41	.00	.00	.00	.00
		END-J	205.07		.00			

Example 9
Sample Output (continued)

CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS PAGE 3
PROGRAM:ETABS/FILE:EX9.FRM
EXAMPLE 9 - TWO STORY 3-D UNSYMMETRICAL BUILDING FRAME
DYNAMIC RESPONSE SPECTRUM ANALYSIS UNITS:KIP-FOOT-SECOND

COLUMN FORCES AT LEVEL 1ST IN FRAME 3-D FRAME

COL ID	OUTPUT ID	OUTPUT POINT	MAJOR MOMENT	MAJOR SHEAR	MINOR MOMENT	MINOR SHEAR	AXIAL FORCE	TORSIONAL MOMENT
1	CASE 1	TOP	138.20	31.29	16.37	11.21	35.61	.00
		BOTTOM	253.10		125.68			
1	CASE 2	TOP	80.59	18.22	28.27	19.28	20.78	.00
		BOTTOM	147.20		215.94			
2	CASE 1	TOP	138.20	31.29	77.43	18.00	46.88	.00
		BOTTOM	253.10		147.72			
2	CASE 2	TOP	80.59	18.22	146.75	34.47	36.54	.00
		BOTTOM	147.20		284.33			
3	CASE 1	TOP	117.70	26.85	77.43	18.00	28.66	.00
		BOTTOM	218.04		147.72			
3	CASE 2	TOP	68.27	15.59	146.75	34.47	53.20	.00
		BOTTOM	126.69		284.33			
4	CASE 1	TOP	183.43	34.75	16.37	11.21	.25	.00
		BOTTOM	251.01		125.68			
4	CASE 2	TOP	106.69	20.21	28.27	19.28	.43	.00
		BOTTOM	145.97		215.94			
5	CASE 1	TOP	117.51	26.82	91.08	21.57	48.35	.00
		BOTTOM	217.94		178.71			
5	CASE 2	TOP	68.60	15.63	138.80	32.41	36.47	.00
		BOTTOM	126.86		266.48			
6	CASE 1	TOP	35.01	18.72	91.08	21.57	27.92	.00
		BOTTOM	200.61		178.71			
6	CASE 2	TOP	20.42	10.89	138.80	32.41	40.51	.00
		BOTTOM	116.60		266.48			

BEAM FORCES AT LEVEL 1ST IN FRAME 3-D FRAME

BAY ID	OUTPUT ID	OUTPUT POINT	MAJOR MOMENT	MAJOR SHEAR	MINOR MOMENT	MINOR SHEAR	AXIAL FORCE	TORSIONAL MOMENT
1	CASE 1	END-I	270.83	21.67	.00	.00	.00	.00
		END-J	270.83		.00			
1	CASE 2	END-I	157.96	12.64	.00	.00	.00	.00
		END-J	157.96		.00			
2	CASE 1	END-I	165.90	13.27	.00	.00	.00	.00
		END-J	165.90		.00			
2	CASE 2	END-I	324.82	25.99	.00	.00	.00	.00
		END-J	324.82		.00			
3	CASE 1	END-I	212.24	15.94	.00	.00	.00	.00
		END-J	186.16		.00			
3	CASE 2	END-I	122.55	9.19	.00	.00	.00	.00
		END-J	107.30		.00			

Example 9
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    4
                                                    PROGRAM:ETABS/FILE:EX9.FRM
EXAMPLE 9  -  TWO STORY 3-D UNSYMMETRICAL BUILDING FRAME
DYNAMIC RESPONSE SPECTRUM ANALYSIS       UNITS:KIP-FOOT-SECOND

BEAM FORCES AT LEVEL 1ST       IN FRAME 3-D FRAME

 BAY OUTPUT OUTPUT      MAJOR      MAJOR     MINOR      MINOR     AXIAL TORSIONAL
  ID     ID  POINT     MOMENT      SHEAR    MOMENT      SHEAR     FORCE    MOMENT
   4 CASE 1  END-I     185.39      15.88       .00        .00       .00       .00
             END-J     211.55                  .00
   4 CASE 2  END-I     108.63       9.29       .00        .00       .00       .00
             END-J     123.74                  .00

   5 CASE 1  END-I     206.30      16.50       .00        .00       .00       .00
             END-J     206.30                  .00
   5 CASE 2  END-I     301.58      24.13       .00        .00       .00       .00
             END-J     301.58                  .00
```

Example 9
Sample Output (continued)

EXAMPLE 10

PANEL ELEMENT BEHAVIOR
STATIC LATERAL LOADS ANALYSIS

A. DESCRIPTION

This example analyzes a series of wall configurations to evaluate the behavior of the ETABS panel element. All walls are subjected to a static lateral load applied at the top of the wall.

The following walls are included:

a. Planar shear wall, shown in Figure 10-1

b. Wall supported on columns, shown in Figure 10-5

c. Wall-spandrel system, shown in Figure 10-9

d. C-shaped wall section, shown in Figure 10-13

e. Wall with edges thickened, shown in Figure 10-17

f. E-shaped wall section, shown in Figure 10-21

B. SIGNIFICANT OPTIONS OF ETABS ACTIVATED

1. Use of panel elements
2. Two-dimensional and three-dimensional shear wall systems
3. Static lateral loads analysis

C. COMPUTER MODEL

A modulus of elasticity of 3000 ksi and a Poisson's ratio of 0.2 are used for all walls. Kip-inch-second units are used throughout.

The following sections describe the models for the different walls:

a. Planar Shear Wall

This shear wall is modeled with one panel per story. Three different wall lengths of 120", 360" and 720" are analyzed. Also, one-story and three-story walls are analyzed, together with the six-story wall shown in Figure 10-1. A wall thickness of 12" is used.

The input data for the six-story wall with a wall length of 360" is included as file EX10a. A listing of this input data is given in Figure 10-2.

b. Wall Supported on Columns

This wall is modeled with two column lines. Columns are used for the first story and one panel per story is used for the top two stories. A wall and column thickness of 12" is used.

The input data for this wall is EX10b. A listing of this input data is given in Figure 10-6.

c. Wall-Spandrel System

This wall is modeled with four column lines. The spandrels are modeled as beams. Two different spandrel lengths of 60" and 240" are analyzed. Each wall is modeled with one panel per story. Three-story walls are also analyzed together with the six-story wall shown in Figure 10-9. A wall and spandrel thickness of 12" is used.

The input data for the six-story wall with 240" long spandrel beam is included as file EX10c. A listing of this input data is given in Figure 10-10.

d. C-Shaped Wall Section

This wall is modeled with six column lines and five panels per story, to model the shape of the wall. All five panels at a particular story have the same wall ID number so the member forces that are produced will be for the whole wall, at a particular level corresponding to the centroid of the C-section. A three-story wall was also analyzed together with the six-story wall, as shown in Figure 10-13. A wall thickness of 6" is used.

The input data for the six-story wall is included as file EX10d. A listing of this input data is given in Figure 10-14.

e. Wall with Edges Thickened

This wall is modeled with four column lines and three panels per story, with the thicknesses shown in Figure 10-17. All three panels at each story have the same wall ID number. A three-story wall was also analyzed together with the six-story wall shown in Figure 10-17.

The input data for the six-story wall is included as file EX10e. A listing of this input data is given in Figure 10-18.

f. E-Shaped Wall Section

This wall is modeled with six column lines and five panels per story to model the shape of the wall. All five panels at a particular story have the same wall ID number so the member forces that are produced will be for the whole E-shaped wall, at a particular level, corresponding to the centroid of the E-section. A three-story wall was also analyzed together with the six-story wall, as shown in Figure 10-21. A wall thickness of 6" is used.

The input data for the six-story wall is included as file EX10f. A listing of this input data is given in Figure 10-22.

D. COMPARISON OF RESULTS

All walls analyzed in this example using ETABS were also analyzed using the general structural analysis program SAP90 (Reference [1]), using refined meshes of the membrane/shell element of that program. The SAP90 meshes utilized are shown in Figures 10-3, 10-7, 10-11, 10-15, 10-19 and 10-23. For the SAP90 analysis, the rigid diaphragms at the floor levels were modeled by either constraining all wall nodes at the floor to have the same lateral displacement for planar walls, or by adding rigid members in the plane of the floor for three-dimensional walls.

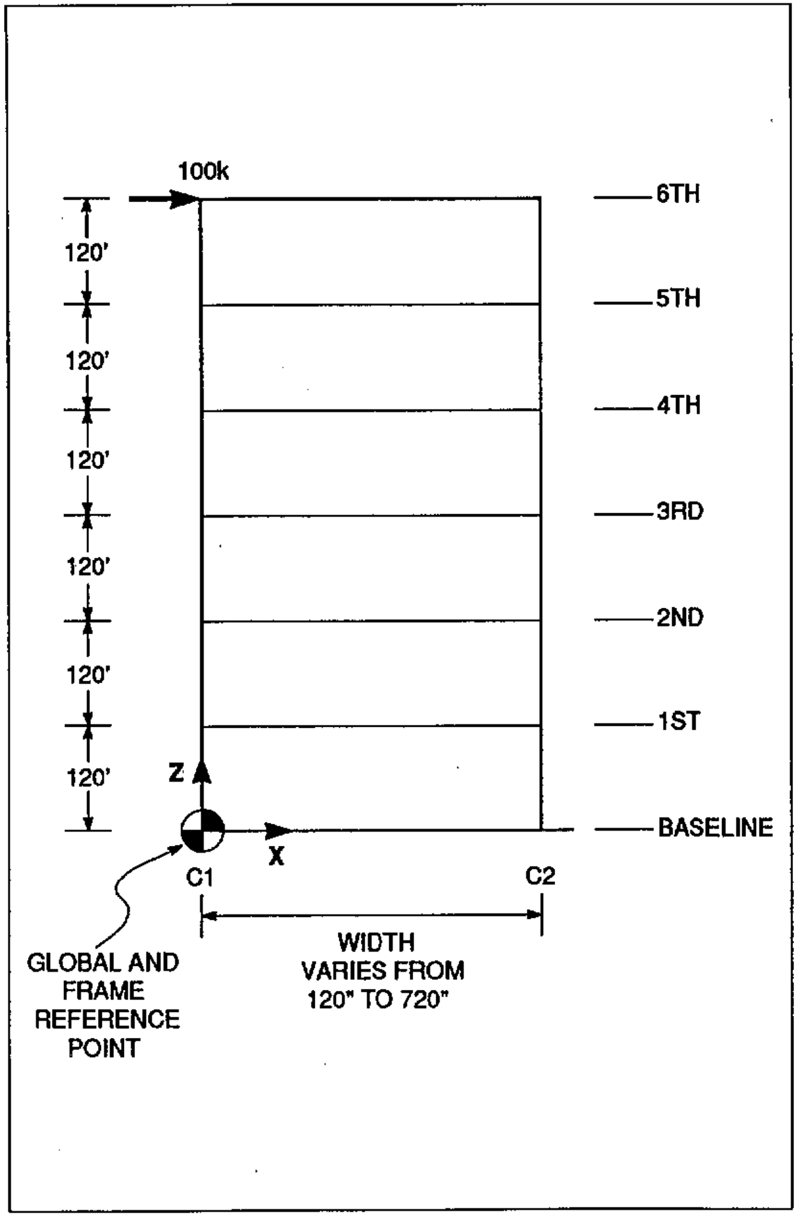
The lateral displacements from the ETABS and SAP90 analyses are compared in Figures 10-4, 10-8, 10-12, 10-16, 10-20 and 10-24 for the various walls. The comparison is good to excellent. In general, the comparisons become better as the number of stories is increased.

It should be noted here that most of the above walls were also analyzed with ETABS using additional column lines and panels (i.e. finer meshes of smaller panels). No significant differences in the displacements and member forces were discovered. Therefore, with the ETABS panel element the user need not be concerned with mesh refinement for more accurate results. Only the number of column lines and panel elements that are needed for the definition of the wall geometry need be defined.

The complete ETABS output for Example 10f, including the input echo, is included in this manual.

E. REFERENCE

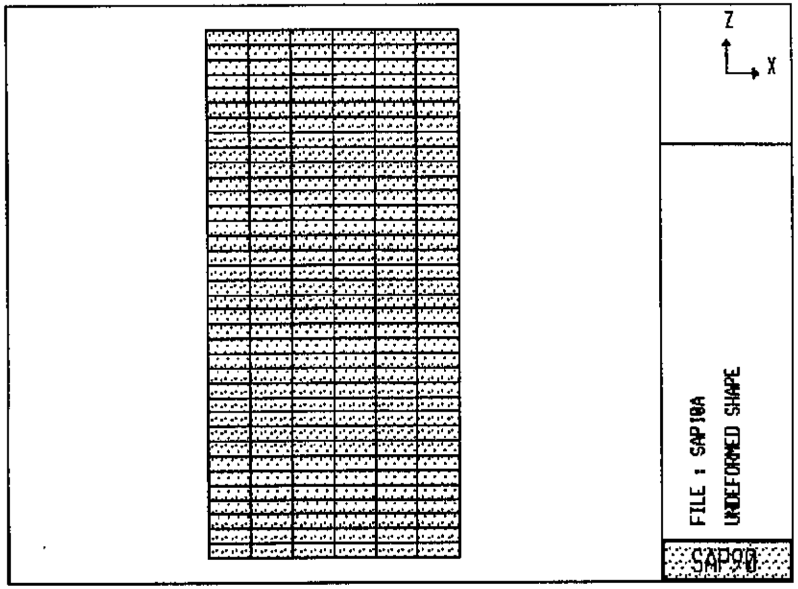
1. Wilson, E.L. and Habibullah, A., "SAP90, Users Manual," Computers and Structures, Inc., Berkeley, California, 1991.



Example 10a
Planar Shear Wall
Figure 10-1

```
EXAMPLE  10a  -  PANEL BEHAVIOR - 6 STORY PLANAR SHEAR-WALL
STATIC LATERAL LOADS ANALYSIS  UNITS:KIP-INCH-SECOND
$   CONTROL DATA
 6  1  1  0  2  0  1  0  0  0  1  1  0  1  0  0  1  1  0
 386.4
$   STORY DATA
 6TH  120
 5TH  120
 4TH  120
 3RD  120
 2ND  120
 1ST  120
$   MATERIAL PROPERTIES
 1  C  3000  0.15/1728  0.2
$   PANEL PROPERTIES
  1  1  12
$   FRAME DATA
 PLANAR SHEAR WALL
 1  6  2  0  0  6
$   COLUMN LINE LOCATIONS
 1  0
 2  360
$   COLUMN ASSIGNMENTS

$   PANEL LOCATIONS
 1  6TH  1  2  1  5
$   FRAME LOCATIONS
 1  0  0  0  0  /SHEAR WALL
$   LATERAL LOADS
 100


$   LOAD CASE DATA
 1  0  1
 2  0  0  0  0  1
$   END
```

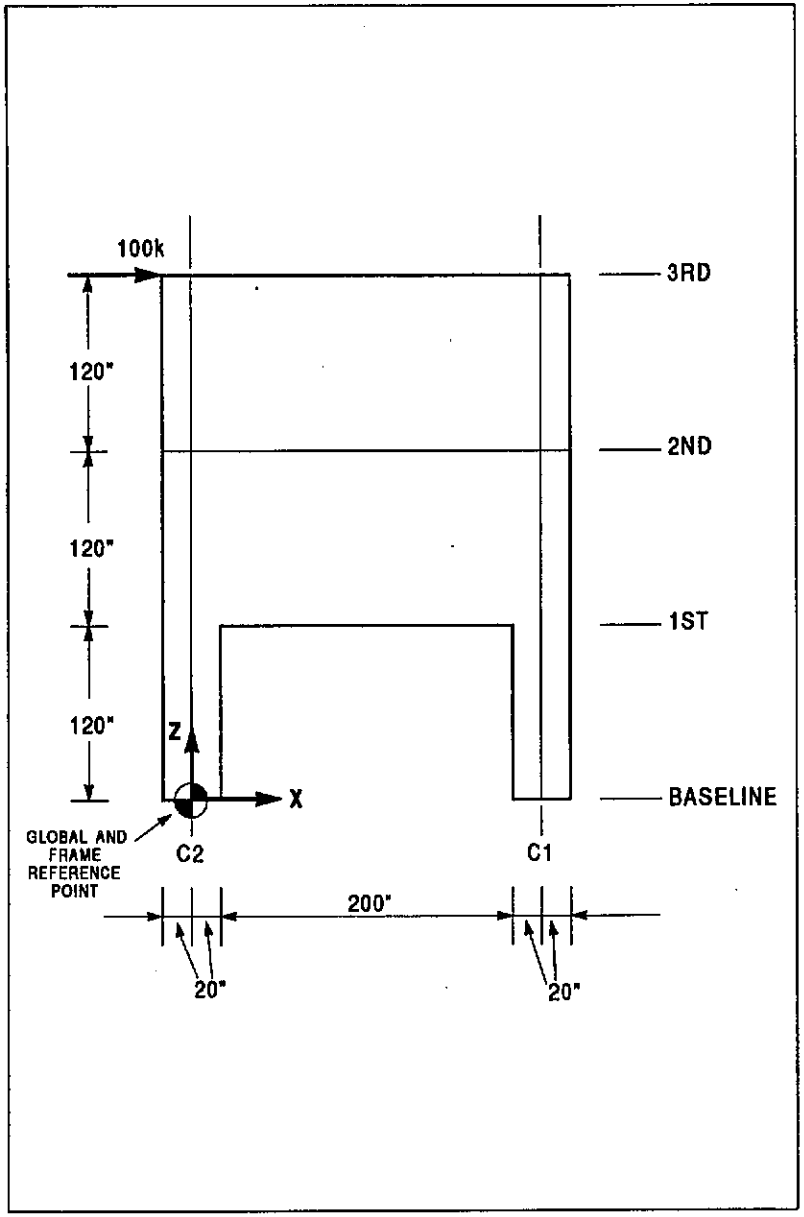
Example 10a
Listing of Input Data
Figure 10-2



Example 10a
SAP90 Mesh Used for Comparison
Figure 10-3

NUMBER OF STORIES	WALL HEIGHT (Inches)	LENGTH OF WALL (Inches)	ETABS (Inches)	SAP90 (Inches)
6	720	120	2.4233	2.4338
		360	0.1016	0.1033
		720	0.0177	0.0187
3	360	120	0.3177	0.3218
		360	0.0175	0.0187
		720	0.0047	0.0052
1	120	120	0.0150	0.0187
		360	0.0025	0.0029
		720	0.0012	0.0013

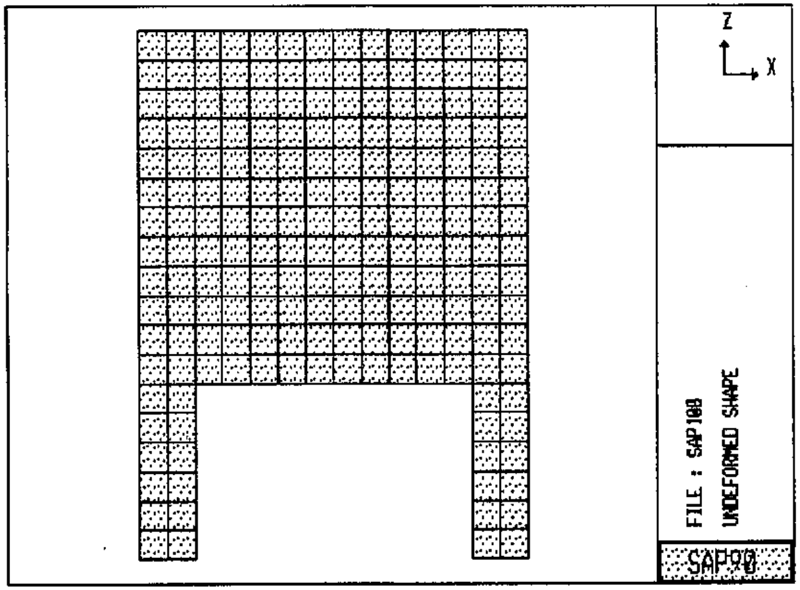
Example 10a
Comparison of Results for Top Displacements
Figure 10-4



Example 10b
Wall Supported on Columns
Figure 10-5

```
EXAMPLE 10b  -  PANEL BEHAVIOR - WALL SUPPORTED ON COLUMNS
STATIC LATERAL LOADS ANALYSIS      UNITS:KIP-INCH-SECOND
$   CONTROL DATA
 3  1  1  0  2  0  1  1  0  0  1  1  0  1  0  0  1  1  0
 386.4
$   STORY DATA
 3RD  120
 2ND  120
 1ST  120
$   MATERIAL PROPERTIES
 1  C  3000  0.15/1728  0.2
$   COLUMN PROPERTIES
 1  1  RECT  40  20
$   PANEL PROPERTIES
 1  1  12
$   FRAME DATA
 SHEAR WALL ON COLUMNS
 1  3  2  0  0  2
$   COLUMN LINE LOCATIONS
 1  240
 2  0
$   COLUMN ASSIGNMENTS
 1  0  1ST  1  0
 2  1

$   PANEL LOCATIONS
 1  3RD  2  1  1  1
$   FRAME LOCATIONS
 1  0  0  0  0  /WALL ON COLUMNS
$   LATERAL LOADS
 100

$   LOAD CASE DATA
 1  0  1
 2  0  0  0  0  1
$   END
```

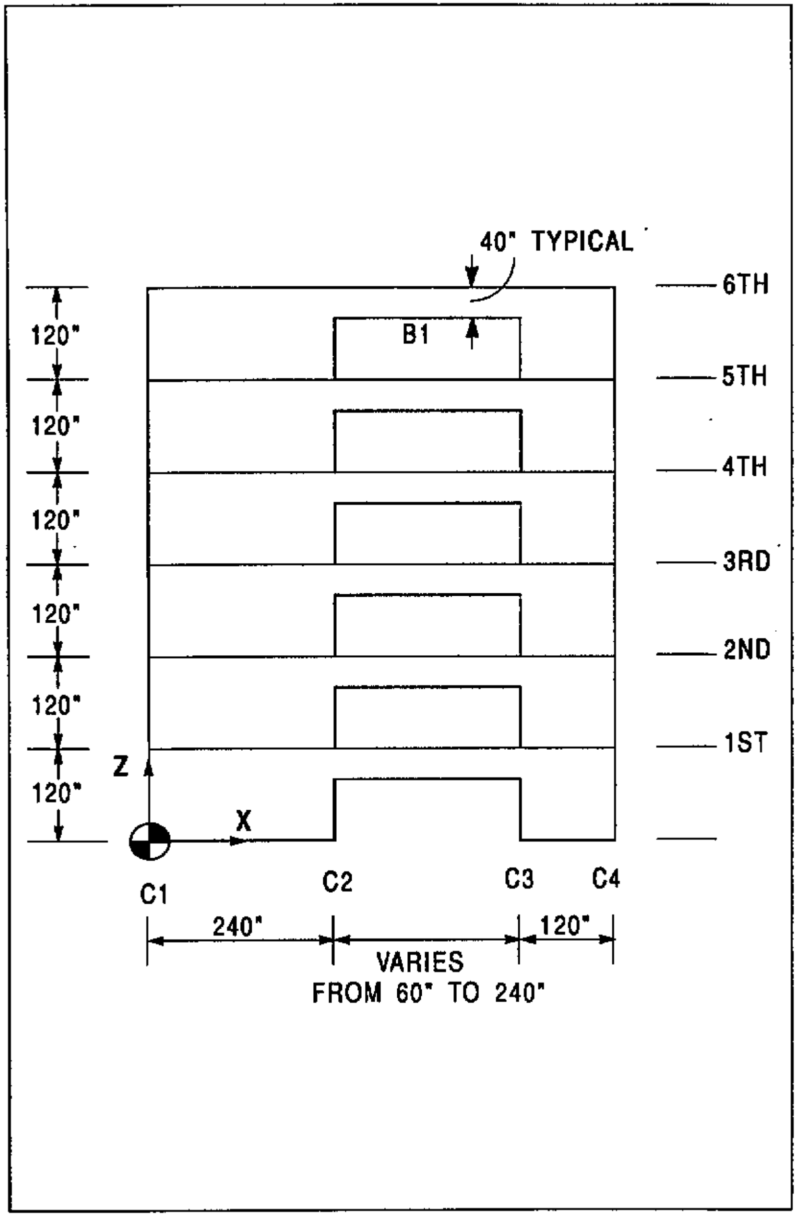
Example 10b
Listing of Input Data
Figure 10-6



Example 10b
SAP90 Mesh Used for Comparison
Figure 10-7

LOCATION	ETABS (Inches)	SAP90 (Inches)
Story 3	0.0651	0.0662
Story 2	0.0483	0.0521
Story 1	0.0358	0.0403

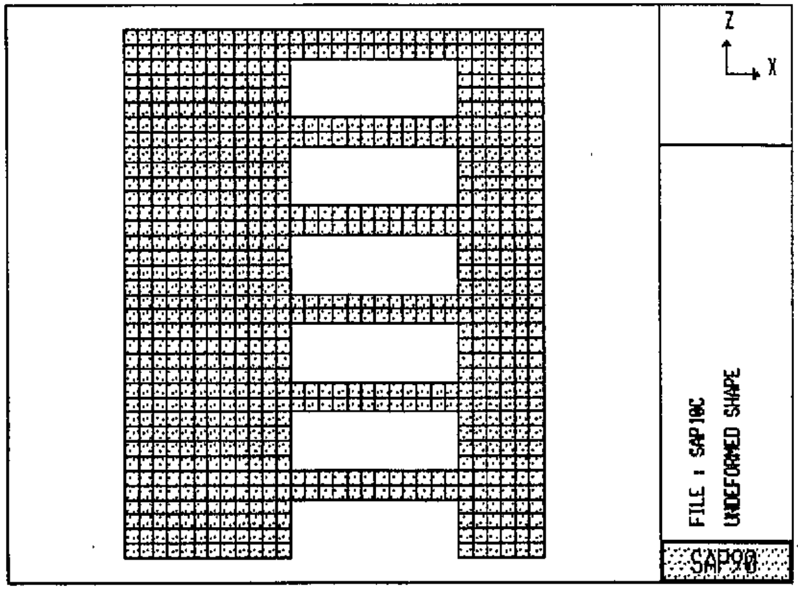
Example 10b
Comparison of Results for Displacements
Figure 10-8



Example 10c
Wall-spandrel System
Figure 10-9

```
EXAMPLE 10c  -  PANEL BEHAVIOR - WALL-SPANDREL SYSTEM
STATIC LATERAL LOAD ANALYSIS    UNITS:KIP-INCH-SECOND
$   CONTROL DATA
 6 1  1  0  2  0  1  0  1  0  1  1  0  1  0  0  1  1  0
 386.4
$   STORY DATA
 6TH  120
 5TH  120
 4TH  120
 3RD  120
 2ND  120
 1ST  120
$   MATERIAL PROPERTIES
 1  C  3000  0.15/1728  0.2
$   BEAM PROPERTIES
 1  1  RECT  40.0  0.0  12.0
$·  PANEL PROPERTIES
 1  1  12.0
$   FRAME DATA
 6 STORY WALL-SPANDREL PLANE FRAME
 1  6  4  1  0  12
$   COLUMN LINE LOCATIONS
 1  0
 2  240
 3  480
 4  600
$   BAY CONNECTIVITY DATA
 1  2  3

$   BEAM ASSIGNMENTS
 1  0  6TH  1  5

$   PANEL LOCATION DATA
 1  6TH  1  2  1  5
 2  6TH  3  4  1  5
$   FRAME LOCATION DATA
 1  0  0  0  0  /WALL-SPANDREL FRAME
$   USER SPECIFIED LATERAL LOADS
 100



$   LOAD CASE DATA
 1  0  1
 2  0  0  0  0  1
$   END OF INPUT DATA
```

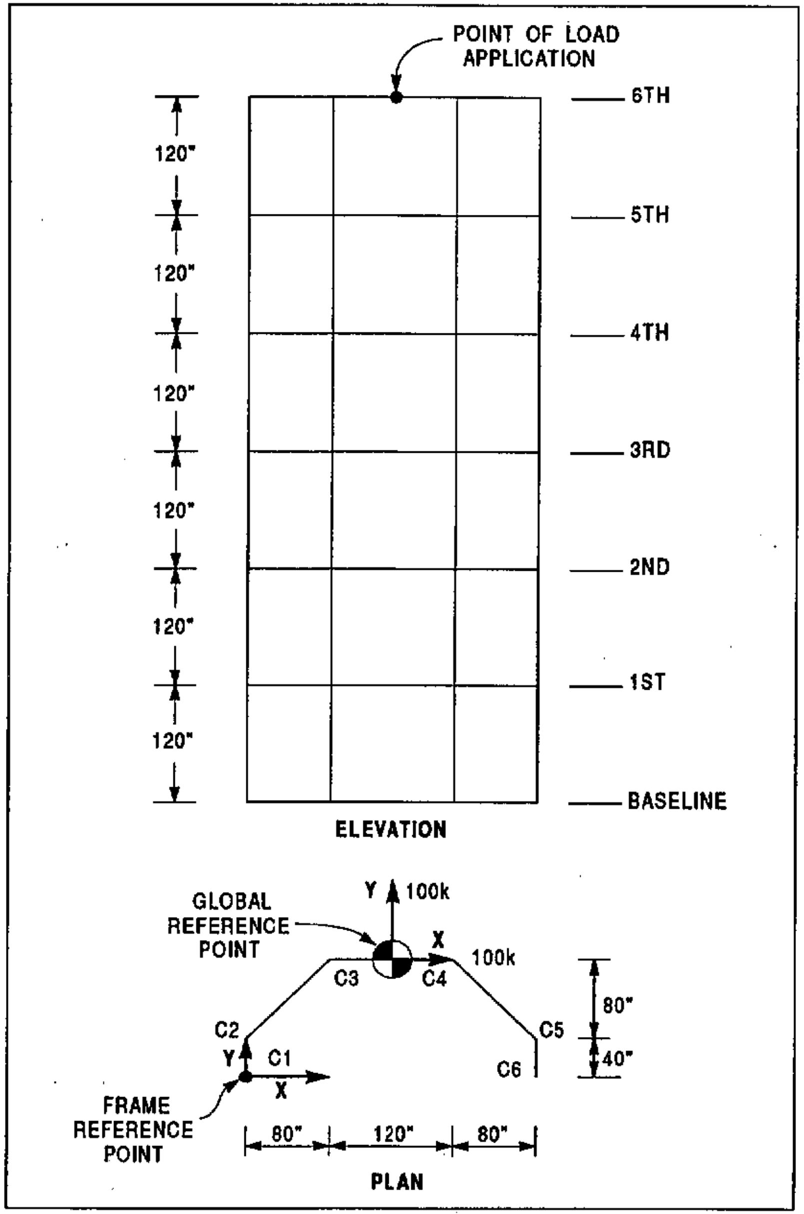
Example 10c
Listing of Input Data
Figure 10-10



Example 10c
SAP90 Mesh Used for Comparison
Figure 10-11

NUMBER OF STORIES	BEAM LENGTH (Inches)	ETABS (Inches)	SAP90 (Inches)
6	60	0.0856	0.0876
	240	0.1462	0.1539
3	60	0.0192	0.0205
	240	0.0320	0.0344

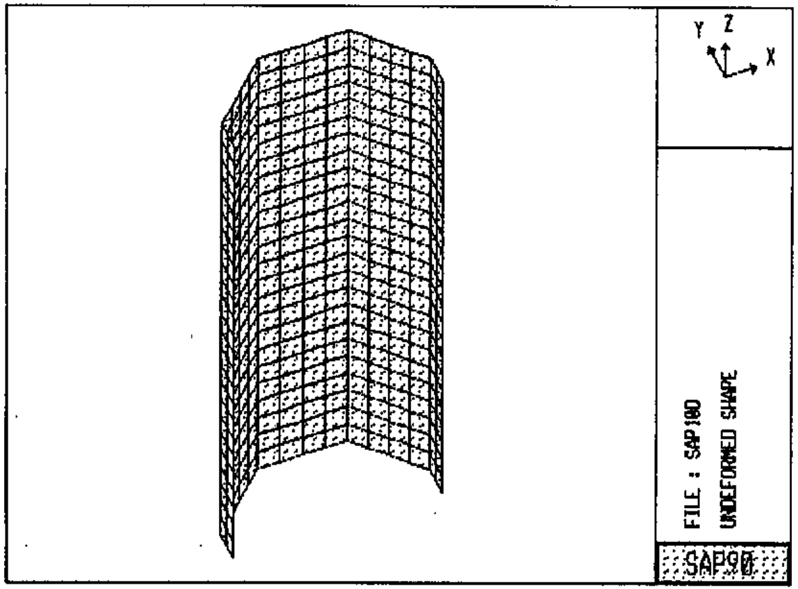
Example 10c
Comparison of Results for Top Displacements
Figure 10-12



Example 10d
C-Shaped Wall Section
Figure 10-13

```
EXAMPLE 10d  -  PANEL BEHAVIOR - 6 STORY C-SHAPED WALL SECTION
STATIC LATERAL LOADS ANALYSIS     UNITS:KIP-INCH-SECOND
$   CONTROL DATA
 6  1  1  0  3  0  1  0  0  0  1  1  0  0  0  0  1  1  0
 386.4
$   STORY DATA
 6TH  120
 5TH  120
 4TH  120
 3RD  120
 2ND  120
 1ST  120
$   MATERIAL PROPERTIES
 1  C  3000  0.15/1728  0.2
$   PANEL PROPERTIES
  1  1  6
$   FRAME DATA
 C-SECTION FRAME
 1  6  6  0  0  30
$   COLUMN LINE LOCATIONS
 1  0
 2  0    40
 3  80  120
 4  200 120
 5  280  40
 6  280  0
$   COLUMN LOCATIONS

$   PANEL LOCATIONS
 1  6TH  1  2  1  5
 1  6TH  2  3  1  5
 1  6TH  3  4  1  5
 1  6TH  4  5  1  5
 1  6TH  5  6  1  5
$   FRAME LOCATIONS
 1  0 -140 -120 0  C-SECTION
$   LATERAL LOADS
 100  0  0  0  0  100



$   LOAD COMBINATIONS
 1  0  1
 2  0  0  0  0  1
 3  0  0  0  0  0  1
$   END
```

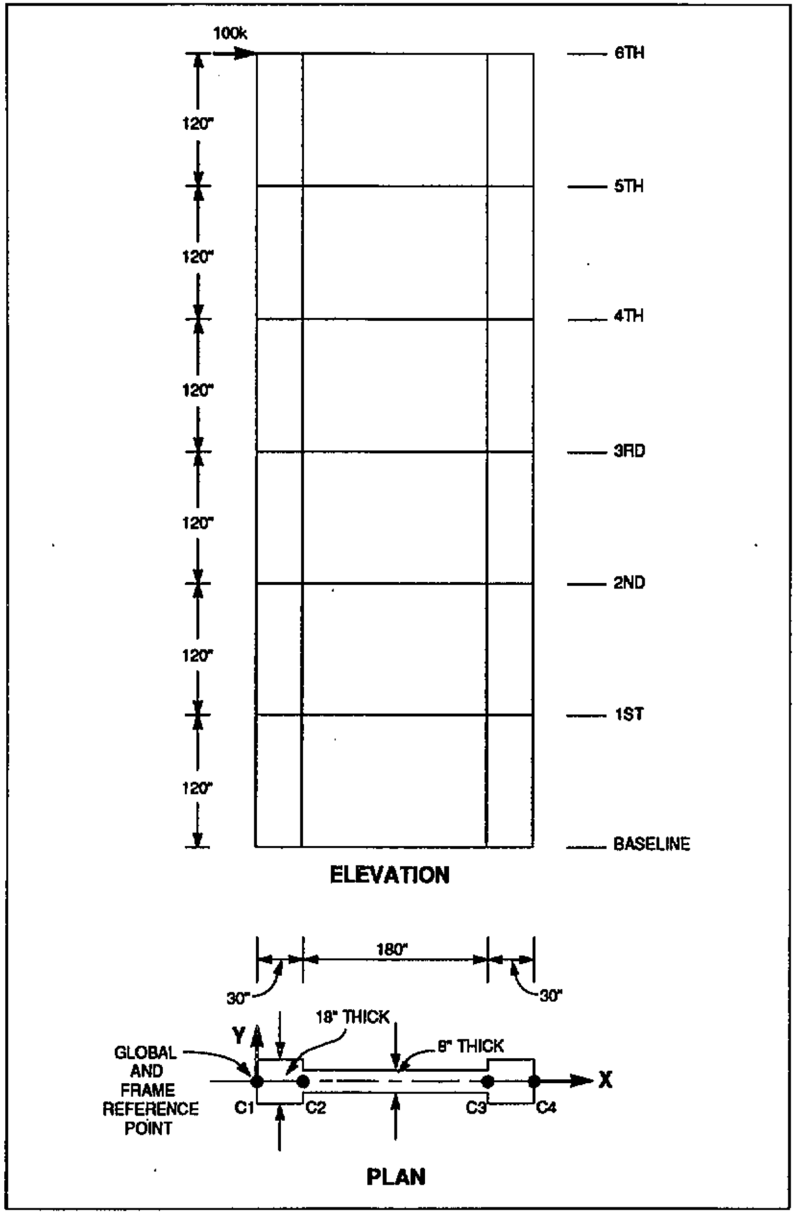
Example 10d
Listing of Input Data
Figure 10-14



Example 10d
SAP90 Mesh Used for Comparison
Figure 10-15

NUMBER OF STORIES	LOAD DIRECTION X	DISPLACE-MENT DIRECTION	ETABS	SAP90
6	X	X	0.8664"	0.8939"
	X	Rotation Z	0.0185	0.0191
	Y	Y	1.1481"	1.1884"
3	X	X	0.1257"	0.1338"
	X	Rotation Z	0.0024	0.0025
	Y	Y	0.1633"	0.1735"

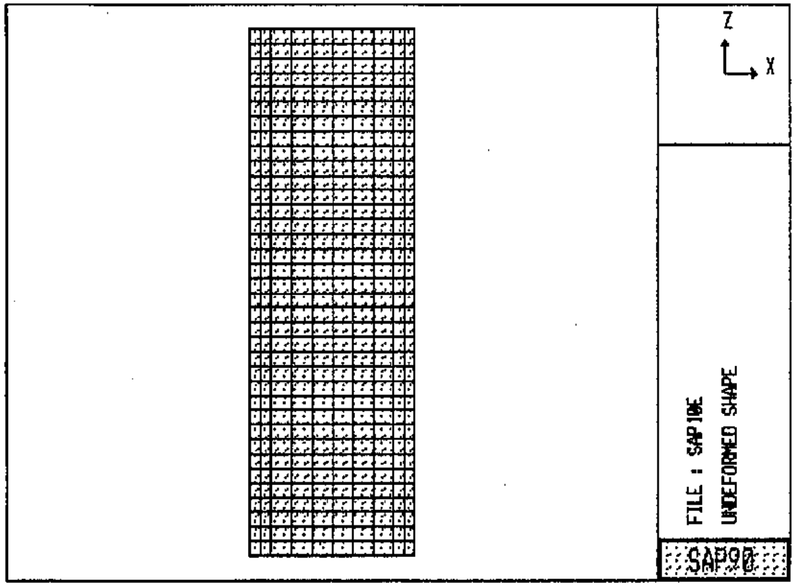
Example 10d
Comparison of Results for Displacements at Load Application Point
Figure 10-16



Example 10e
Wall with Edges Thickened
Figure 10-17

```
EXAMPLE 10e - PANEL BEHAVIOR - 6 STORY WALL WITH EDGES THICKENED
STATIC LATERAL LOADS ANALYSIS      UNITS:KIP-INCH-SECOND
$   CONTROL DATA
 6  1  1  0  2  0  1  0  0  0  2  1  0  1  0  0  1  1  0
 386.4
$   STORY DATA
 6TH  120
 5TH  120
 4TH  120
 3RD  120
 2ND  120
 1ST  120
$   MATERIAL PROPERTIES
 1  C  3000  0.15/1728  0.2
$   PANEL PROPERTIES
  1  1  8
 2  1  18
$   FRAME DATA
 PLANAR SHEAR WALL
 1  6  4  0  0  18
$   COLUMN LINE LOCATIONS
 1  0
 2  30
 3  210
 4  240
$   COLUMN ASSIGNMENTS

$   PANEL LOCATIONS
 1  6TH  1  2  2  5
 1  6TH  2  3  1  5
 1  6TH  3  4  2  5
$   FRAME LOCATIONS
 1  0  0  0  0  /SHEAR WALL
$   LATERAL LOADS
 100



$   LOAD CASE DATA
 1  0  1
 2  0  0  0  0  1
$   END
```

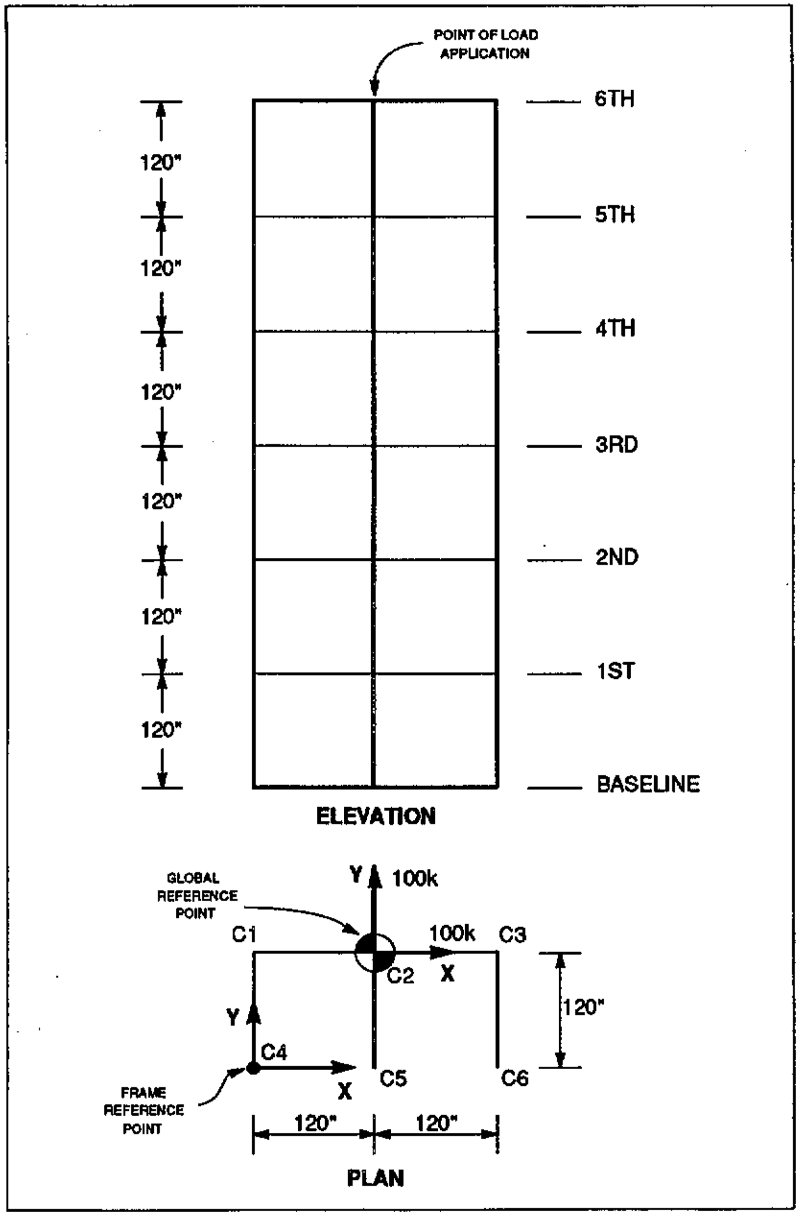
Example 10e
Listing of Input Data
Figure 10-18



Example 10e
SAP90 Mesh Used for Comparison
Figure 10-19

NUMBER OF STORIES	ETABS (Inches)	SAP90 (Inches)
6	0.2785	0.2909
3	0.0441	0.0483

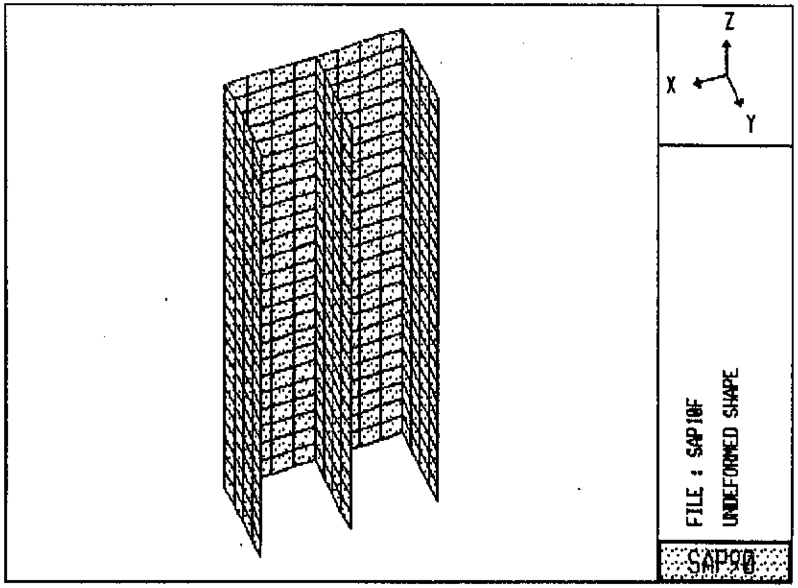
Example 10e
Comparison of Results for Top Displacements
Figure 10-20



Example 10f
E-Shaped Wall Section
Figure 10-21

```
EXAMPLE 10f  -  PANEL BEHAVIOR - 6 STORY E-SHAPED WALL SECTION
STATIC LATERAL LOAD ANALYSIS                   UNITS:KIP-INCH-SECOND
$                                              CONTROL DATA
 6  1  1  0  3  0  1  0  0  0  1  1  0  0  0  0  1  1  0
 386.4
$                                              STORY DATA
 6TH  120
 5TH  120
 4TH  120
 3RD  120
 2ND  120
 1ST  120
$                                              MATERIAL PROPERTIES
 1  C  3000  0.15/1728  0.2
$                                              PANEL PROPERTIES
  1  1  6
$                                              FRAME DATA
 E-SHAPED WALL SECTION
 1  6  6  0  0  30
$                                              COLUMN LINE LOCATIONS
 1  0   120
 2  120 120
 3  240 120
 4  0
 5  120
 6  240
$                                              COLUMN LOCATIONS
$                                              PANEL LOCATIONS
$
 1  6TH  1  2  1  5
 1  6TH  2  3  1  5
 1  6TH  1  4  1  5
 1  6TH  2  5  1  5
 1  6TH  3  6  1  5
$                                              FRAME LOCATIONS
 1  0  -120  -120  0   E-SHAPED WALL
$                                              LATERAL LOADS
 100  0  0  0  0  100



$                                              LOAD CASE DATA
 1  0  1
 2  0  0  0  0  1
 3  0  0  0  0  0  1
$   END OF INPUT DATA
```

Example 10f
Listing of Input Data
Figure 10-22



Example 10f
SAP90 Mesh Used for Comparison
Figure 10-23

NUMBER OF STORIES	LOAD DIRECTION X	DISPLACEMENT DIRECTION	ETABS	SAP90
6	X	X	0.3731"	0.3822"
	X	Rotation Z	0.0042	0.0043
	Y	Y	0.7335"	0.7512"
3	X	X	0.0608"	0.0639"
	X	Rotation Z	0.0005	0.0005
	Y	Y	0.1000"	0.1065"

Example 10f
Comparison of Results for Displacements at Load Application Point
Figure 10-24

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    1
                                                PROGRAM:ETABS/FILE:EX10F.EKO
EXAMPLE 10F  -  PANEL BEHAVIOR - 6 STORY E-SHAPED WALL SECTION
STATIC LATERAL LOAD ANALYSIS              UNITS:KIP-INCH-SECOND


NUMBER OF STORIES------------------------------   6
NUMBER OF DIFFERENT FRAMES---------------------   1
NUMBER OF TOTAL FRAMES-------------------------   1
NUMBER OF MASS TYPES---------------------------   0
NUMBER OF LOAD CASES---------------------------   3
NUMBER OF STRUCTURAL PERIODS-------------------   0
NUMBER OF MATERIAL PROPERTIES------------------   1
NUMBER OF SECTION PROPERTIES FOR COLUMNS-------   0
NUMBER OF SECTION PROPERTIES FOR BEAMS---------   0
NUMBER OF SECTION PROPERTIES FOR DIAGONALS-----   0
NUMBER OF SECTION PROPERTIES FOR PANELS--------   1
CODE FOR STATIC LATERAL ANALYSIS---------------   1
CODE FOR DYNAMIC LATERAL ANALYSIS--------------   0
CODE FOR STRUCTURE TYPE------------------------   0
CODE FOR P-DELTA ANALYSIS ---------------------   0
CODE FOR FRAME JOINT STIFFNESS MODIFICATION----   0
CODE FOR FRAME JOINT DISPLACEMENT--------------   1
CODE FOR FRAME SELF WEIGHT LOAD CONDITION------   1
CODE FOR POST PROCESSING MODE SHAPES-----------   0


GRAVITATIONAL ACCELERATION------------------   .3864E+03
EIGEN CONVERGENCE TOLERANCE-----------------   .1000E-03
EIGEN CUTOFF TIME PERIOD--------------------   .0000E+00
P-DELTA FACTOR------------------------------   .1000E+01
```

Example 10f
Sample Output

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    2
                                                     PROGRAM:ETABS/FILE:EX10F.EKO
EXAMPLE 10F  -  PANEL BEHAVIOR - 6 STORY E-SHAPED WALL SECTION
STATIC LATERAL LOAD ANALYSIS              UNITS:KIP-INCH-SECOND


STRUCTURAL STORY HEIGHTS AND MASS DATA  . . .

LEVEL         HEIGHT  MASS TYPE        MASS          MMI          XM          YM
6TH           120.00          0        .000           .0         .00         .00
5TH           120.00          0        .000           .0         .00         .00
4TH           120.00          0        .000           .0         .00         .00
3RD           120.00          0        .000           .0         .00         .00
2ND           120.00          0        .000           .0         .00         .00
1ST           120.00          0        .000           .0         .00         .00
```

Example 10f
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE     3
                                                  PROGRAM:ETABS/FILE:EX10F.EKO
EXAMPLE 10F  -  PANEL BEHAVIOR - 6 STORY E-SHAPED WALL SECTION
STATIC LATERAL LOAD ANALYSIS              UNITS:KIP-INCH-SECOND


STRUCTURAL EXTERNAL STORY STIFFNESS DATA . . .

LEVEL            K-X          K-Y         K-ROTN
6TH      0.0000E+00   0.0000E+00   0.0000E+00
5TH      0.0000E+00   0.0000E+00   0.0000E+00
4TH      0.0000E+00   0.0000E+00   0.0000E+00
3RD      0.0000E+00   0.0000E+00   0.0000E+00
2ND      0.0000E+00   0.0000E+00   0.0000E+00
1ST      0.0000E+00   0.0000E+00   0.0000E+00
```

Example 10f
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    4
                                              PROGRAM:ETABS/FILE:EX10F.EKO
EXAMPLE 10F  -  PANEL BEHAVIOR - 6 STORY E-SHAPED WALL SECTION
STATIC LATERAL LOAD ANALYSIS               UNITS:KIP-INCH-SECOND

MATERIAL PROPERTIES

 ID TYPE      ELASTIC         UNIT    POISSONS
              MODULUS       WEIGHT       RATIO
  1    C    .300E+04     .868E-04        .200

MATERIAL PROPERTIES FOR DESIGN

 ID TYPE           FY           FC          FYS        FBMAJ        FBMIN
  1    C    .000E+00     .000E+00     .000E+00
```

Example 10f
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    5
                                                  PROGRAM:ETABS/FILE:EX10F.EKO
EXAMPLE 10F  -  PANEL BEHAVIOR - 6 STORY E-SHAPED WALL SECTION
STATIC LATERAL LOAD ANALYSIS              UNITS:KIP-INCH-SECOND


SECTION PROPERTIES FOR   PANELS

      MAT       PANEL
  ID   ID       THICK
   1    1       6.000
```

Example 10f
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    6
                                              PROGRAM:ETABS/FILE:EX10F.EKO
EXAMPLE 10F  -  PANEL BEHAVIOR - 6 STORY E-SHAPED WALL SECTION
STATIC LATERAL LOAD ANALYSIS             UNITS:KIP-INCH-SECOND


E-SHAPED WALL SECTION

FRAME ID NUMBER-----------------------------------     1
NUMBER OF STORY LEVELS----------------------------     6
NUMBER OF COLUMN LINES----------------------------     6
NUMBER OF BAYS------------------------------------     0
NUMBER OF BRACING ELEMENTS------------------------     0
NUMBER OF PANEL ELEMENTS--------------------------    30
NUMBER OF COLUMN LATERAL LOAD PATTERNS------------     0
NUMBER OF BEAM SPAN LOAD PATTERNS-----------------     0
MAXIMUM NUMBER OF LOADS PER BEAM SPAN-------------     0


COLUMN LINE COORDINATES AND ORIENTATIONS

    COLUMN           X-ORD           Y-ORD          ANGLE
       1              .000         120.000          .00000
       2           120.000         120.000          .00000
       3           240.000         120.000          .00000
       4              .000            .000          .00000
       5           120.000            .000          .00000
       6           240.000            .000          .00000


INPUT AND/OR GENERATED COLUMN PROPERTY ID*S

DATA SPECIFIED FOR THIS OPTION IS ALL ZERO


INPUT AND/OR GENERATED COLUMN PIN ENDS

DATA SPECIFIED FOR THIS OPTION IS ALL ZERO


INPUT AND/OR GENERATED COLUMN STORY DISCONNECTIONS

DATA SPECIFIED FOR THIS OPTION IS ALL ZERO


INPUT AND/OR GENERATED PANEL DATA

      WALL     LEVEL      COLUMN    COLUMN     PROP         PANEL    PANEL
        ID    AT TOP        AT I      AT J       ID        LENGTH       ID
         1       6TH           1         2        1        120.00        1
         1       5TH           1         2        1        120.00        2
         1       4TH           1         2        1        120.00        3
         1       3RD           1         2        1        120.00        4
         1       2ND           1         2        1        120.00        5
         1       1ST           1         2        1        120.00        6
         1       6TH           2         3        1        120.00        7
         1       5TH           2         3        1        120.00        8
         1       4TH           2         3        1        120.00        9
         1       3RD           2         3        1        120.00       10
         1       2ND           2         3        1        120.00       11
```

Example 10f
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    7
                                                  PROGRAM:ETABS/FILE:EX10F.EKO
EXAMPLE 10F  -  PANEL BEHAVIOR - 6 STORY E-SHAPED WALL SECTION
STATIC LATERAL LOAD ANALYSIS            UNITS:KIP-INCH-SECOND
```

INPUT AND/OR GENERATED PANEL DATA

WALL ID	LEVEL AT TOP	COLUMN AT I	COLUMN AT J	PROP ID	PANEL LENGTH	PANEL ID
1	1ST	2	3	1	120.00	12
1	6TH	1	4	1	120.00	13
1	5TH	1	4	1	120.00	14
1	4TH	1	4	1	120.00	15
1	3RD	1	4	1	120.00	16
1	2ND	1	4	1	120.00	17
1	1ST	1	4	1	120.00	18
1	6TH	2	5	1	120.00	19
1	5TH	2	5	1	120.00	20
1	4TH	2	5	1	120.00	21
1	3RD	2	5	1	120.00	22
1	2ND	2	5	1	120.00	23
1	1ST	2	5	1	120.00	24
1	6TH	3	6	1	120.00	25
1	5TH	3	6	1	120.00	26
1	4TH	3	6	1	120.00	27
1	3RD	3	6	1	120.00	28
1	2ND	3	6	1	120.00	29
1	1ST	3	6	1	120.00	30

GENERATED WALL ASSEMBLAGE DATA

WALL ID	STORY LEVEL	NUMBER OF PANELS	PANEL ID FOR AXIS	WALL-CG X-ORD	WALL-CG Y-ORD	WALL AREA
1	6TH	5	1	120.000	84.000	3600.000
1	5TH	5	2	120.000	84.000	3600.000
1	4TH	5	3	120.000	84.000	3600.000
1	3RD	5	4	120.000	84.000	3600.000
1	2ND	5	5	120.000	84.000	3600.000
1	1ST	5	6	120.000	84.000	3600.000

Example 10f
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    8
                                             PROGRAM:ETABS/FILE:EX10F.EKO
EXAMPLE 10F  -  PANEL BEHAVIOR - 6 STORY E-SHAPED WALL SECTION
STATIC LATERAL LOAD ANALYSIS              UNITS:KIP-INCH-SECOND
```

FRAME VERTICAL LOADING AND SELF WEIGHTS

LEVEL ID	/--VERTICAL LOAD CONDITION--/ I	II	III	/----------ELEMENT SELF WEIGHTS--------/ COLUMN	BEAM	BRACE	PANEL
6TH	37.5	.0	.0	.0	.0	.0	37.5
5TH	37.5	.0	.0	.0	.0	.0	37.5
4TH	37.5	.0	.0	.0	.0	.0	37.5
3RD	37.5	.0	.0	.0	.0	.0	37.5
2ND	37.5	.0	.0	.0	.0	.0	37.5
1ST	37.5	.0	.0	.0	.0	.0	37.5
TOTALS	225.0	.0	.0	.0	.0	.0	225.0

Example 10f
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE     9
                                                   PROGRAM:ETABS/FILE:EX10F.EKO
EXAMPLE 10F  -  PANEL BEHAVIOR - 6 STORY E-SHAPED WALL SECTION
STATIC LATERAL LOAD ANALYSIS              UNITS:KIP-INCH-SECOND


FRAME POSITION DATA

FRAME FRAME OUTPT /----FRAME ORIENTATION----/ /--------FRAME HEADING--------/
COUNT    ID  CODE      X-ORD     Y-ORD   ANGLE
    1     1     0  -120.00   -120.00    .000 E-SHAPED WALL
```

Example 10f
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE   10
                                                PROGRAM:ETABS/FILE:EX10F.EKO
EXAMPLE 10F  -  PANEL BEHAVIOR - 6 STORY E-SHAPED WALL SECTION
STATIC LATERAL LOAD ANALYSIS            UNITS:KIP-INCH-SECOND


STRUCTURAL LATERAL LOAD CONDITION A . . .

LEVEL            FX         FY          X          Y
6TH          100.00        .00        .00        .00
5TH             .00        .00        .00        .00
4TH             .00        .00        .00        .00
3RD             .00        .00        .00        .00
2ND             .00        .00        .00        .00
1ST             .00        .00        .00        .00
```

Example 10f
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE   11
                                                    PROGRAM:ETABS/FILE:EX10F.EKO
EXAMPLE 10F  -  PANEL BEHAVIOR - 6 STORY E-SHAPED WALL SECTION
STATIC LATERAL LOAD ANALYSIS            UNITS:KIP-INCH-SECOND


STRUCTURAL LATERAL LOAD CONDITION B . . .

LEVEL              FX         FY          X          Y
6TH               .00     100.00        .00        .00
5TH               .00        .00        .00        .00
4TH               .00        .00        .00        .00
3RD               .00        .00        .00        .00
2ND               .00        .00        .00        .00
1ST               .00        .00        .00        .00
```

Example 10f
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE   12
                                             PROGRAM:ETABS/FILE:EX10F.EKO
EXAMPLE 10F  -  PANEL BEHAVIOR - 6 STORY E-SHAPED WALL SECTION
STATIC LATERAL LOAD ANALYSIS              UNITS:KIP-INCH-SECOND

LOAD CASE DEFINITION DATA

LOAD LABS       I       II      III       A        B    DYN-1    DYN-2  DYN-3
   1    0   1.000     .000     .000     .000     .000     .000     .000   .000
   2    0    .000     .000     .000    1.000     .000     .000     .000   .000
   3    0    .000     .000     .000     .000    1.000     .000     .000   .000


FOR DYNAMICS BY THE RESPONSE SPECTRUM METHOD

DYNAMIC 1 . . . SPECTRAL DIRECTION 1
DYNAMIC 2 . . . SPECTRAL DIRECTION 2
DYNAMIC 3 . . . SPECTRAL DIRECTION 3

FOR DYNAMICS BY THE TIME HISTORY METHOD

DYNAMIC 1 . . . TIME HISTORY MODAL ANALYSIS
DYNAMIC 2 . . . NOT USED
DYNAMIC 3 . . . NOT USED
```

Example 10f
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE     1
                                                   PROGRAM:ETABS/FILE:EX10F.STR
EXAMPLE 10F  -  PANEL BEHAVIOR - 6 STORY E-SHAPED WALL SECTION
STATIC LATERAL LOAD ANALYSIS                UNITS:KIP-INCH-SECOND

STATIC LOAD CONDITION LATERAL STORY DISPLACEMENTS

DISPLACEMENTS ARE AT THE CENTERS OF MASS OF THE RESPECTIVE STORY LEVELS
```

LEVEL	DIRN	I	II	III	A	B
6TH	X	.0000	.0000	.0000	.3731	.0000
6TH	Y	.0000	.0000	.0000	.0000	.7335
6TH	ROTZ	.0000	.0000	.0000	.0042	.0000
5TH	X	.0000	.0000	.0000	.2837	.0000
5TH	Y	.0000	.0000	.0000	.0000	.5537
5TH	ROTZ	.0000	.0000	.0000	.0032	.0000
4TH	X	.0000	.0000	.0000	.1990	.0000
4TH	Y	.0000	.0000	.0000	.0000	.3836
4TH	ROTZ	.0000	.0000	.0000	.0022	.0000
3RD	X	.0000	.0000	.0000	.1237	.0000
3RD	Y	.0000	.0000	.0000	.0000	.2334
3RD	ROTZ	.0000	.0000	.0000	.0013	.0000
2ND	X	.0000	.0000	.0000	.0622	.0000
2ND	Y	.0000	.0000	.0000	.0000	.1128
2ND	ROTZ	.0000	.0000	.0000	.0006	.0000
1ST	X	.0000	.0000	.0000	.0195	.0000
1ST	Y	.0000	.0000	.0000	.0000	.0317
1ST	ROTZ	.0000	.0000	.0000	.0002	.0000

Example 10f
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    2
                                                       PROGRAM:ETABS/FILE:EX10F.STR
EXAMPLE 10F  -  PANEL BEHAVIOR - 6 STORY E-SHAPED WALL SECTION
STATIC LATERAL LOAD ANALYSIS                 UNITS:KIP-INCH-SECOND


STATIC LOAD CONDITION LATERAL FRAME DISPLACEMENTS

FRAME ID .... E-SHAPED WALL

VALUES ARE AT THE FRAME ORIGIN IN THE FRAME LOCAL COORDINATES

                    /--------------------LOAD CONDITIONS--------------------/
LEVEL     DIRN            I           II          III           A           B

6TH          X        .0000        .0000        .0000       .8778       .0000
6TH          Y        .0000        .0000        .0000      -.5047       .7335
6TH       ROTZ        .0000        .0000        .0000       .0042       .0000

5TH          X        .0000        .0000        .0000       .6631       .0000
5TH          Y        .0000        .0000        .0000      -.3794       .5537
5TH       ROTZ        .0000        .0000        .0000       .0032       .0000

4TH          X        .0000        .0000        .0000       .4602       .0000
4TH          Y        .0000        .0000        .0000      -.2612       .3836
4TH       ROTZ        .0000        .0000        .0000       .0022       .0000

3RD          X        .0000        .0000        .0000       .2807       .0000
3RD          Y        .0000        .0000        .0000      -.1570       .2334
3RD       ROTZ        .0000        .0000        .0000       .0013       .0000

2ND          X        .0000        .0000        .0000       .1364       .0000
2ND          Y        .0000        .0000        .0000      -.0741       .1128
2ND       ROTZ        .0000        .0000        .0000       .0006       .0000

1ST          X        .0000        .0000        .0000       .0389       .0000
1ST          Y        .0000        .0000        .0000      -.0194       .0317
1ST       ROTZ        .0000        .0000        .0000       .0002       .0000
```

Example 10f
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    3
                                                  PROGRAM:ETABS/FILE:EX10F.STR
EXAMPLE 10F  -  PANEL BEHAVIOR - 6 STORY E-SHAPED WALL SECTION
STATIC LATERAL LOAD ANALYSIS               UNITS:KIP-INCH-SECOND


STATIC LOAD CONDITION LATERAL FRAME DRIFT RATIOS

FRAME ID .... E-SHAPED WALL

VALUES ARE AT THE FRAME ORIGIN IN THE FRAME LOCAL COORDINATES

                  /-------------------LOAD CONDITIONS--------------------/
LEVEL     DIRN              I           II          III            A          B

6TH          X         .00000       .00000       .00000       .00179     .00000
6TH          Y         .00000       .00000       .00000      -.00104     .00150
6TH       ROTZ         .00000       .00000       .00000       .00001     .00000

5TH          X         .00000       .00000       .00000       .00169     .00000
5TH          Y         .00000       .00000       .00000      -.00099     .00142
5TH       ROTZ         .00000       .00000       .00000       .00001     .00000

4TH          X         .00000       .00000       .00000       .00150     .00000
4TH          Y         .00000       .00000       .00000      -.00087     .00125
4TH       ROTZ         .00000       .00000       .00000       .00001     .00000

3RD          X         .00000       .00000       .00000       .00120     .00000
3RD          Y         .00000       .00000       .00000      -.00069     .00101
3RD       ROTZ         .00000       .00000       .00000       .00001     .00000

2ND          X         .00000       .00000       .00000       .00081     .00000
2ND          Y         .00000       .00000       .00000      -.00046     .00068
2ND       ROTZ         .00000       .00000       .00000       .00000     .00000

1ST          X         .00000       .00000       .00000       .00032     .00000
1ST          Y         .00000       .00000       .00000      -.00016     .00026
1ST       ROTZ         .00000       .00000       .00000       .00000     .00000
```

Example 10f
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    4
                                                   PROGRAM:ETABS/FILE:EX10F.STR
EXAMPLE 10F  -  PANEL BEHAVIOR - 6 STORY E-SHAPED WALL SECTION
STATIC LATERAL LOAD ANALYSIS              UNITS:KIP-INCH-SECOND


STATIC LOAD CONDITION LATERAL FRAME STORY SHEARS & TORSIONS

FRAME ID .... E-SHAPED WALL

VALUES ARE AT THE FRAME ORIGIN IN THE FRAME LOCAL COORDINATES

                 /---------------------LOAD CONDITIONS---------------------/
LEVEL    DIRN             I          II          III          A           B

6TH         X           .00         .00          .00      100.00         .00
6TH         Y           .00         .00          .00         .00      100.00
6TH      ROTZ           .00         .00          .00   -12000.00    12000.00

5TH         X           .00         .00          .00      100.00         .00
5TH         Y           .00         .00          .00         .00      100.00
5TH      ROTZ           .00         .00          .00   -12000.00    12000.00

4TH         X           .00         .00          .00      100.00         .00
4TH         Y           .00         .00          .00         .00      100.00
4TH      ROTZ           .00         .00          .00   -12000.00    12000.00

3RD         X           .00         .00          .00      100.00         .00
3RD         Y           .00         .00          .00         .00      100.00
3RD      ROTZ           .00         .00          .00   -12000.00    12000.00

2ND         X           .00         .00          .00      100.00         .00
2ND         Y           .00         .00          .00         .00      100.00
2ND      ROTZ           .00         .00          .00   -12000.00    12000.00

1ST         X           .00         .00          .00      100.00         .00
1ST         Y           .00         .00          .00         .00      100.00
1ST      ROTZ           .00         .00          .00   -12000.00    12000.00
```

Example 10f
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    1
                                                  PROGRAM:ETABS/FILE:EX10F.DSP
EXAMPLE 10F  -  PANEL BEHAVIOR - 6 STORY E-SHAPED WALL SECTION
STATIC LATERAL LOAD ANALYSIS            UNITS:KIP-INCH-SECOND


FRAME LATERAL STORY DISPLACEMENTS

VALUES ARE AT THE FRAME ORIGIN IN THE FRAME LOCAL COORDINATES

FRAME ID  .... E-SHAPED WALL

LEVEL      DIRN       CASE 1      CASE 2      CASE 3
ID           ID
6TH           X       .00000      .87776      .00000
6TH           Y       .00000     -.50468      .73354
6TH        ROTZ       .00000      .00421      .00000

5TH           X       .00000      .66312      .00000
5TH           Y       .00000     -.37939      .55366
5TH        ROTZ       .00000      .00316      .00000

4TH           X       .00000      .46019      .00000
4TH           Y       .00000     -.26116      .38365
4TH        ROTZ       .00000      .00218      .00000

3RD           X       .00000      .28070      .00000
3RD           Y       .00000     -.15705      .23339
3RD        ROTZ       .00000      .00131      .00000

2ND           X       .00000      .13636      .00000
2ND           Y       .00000     -.07411      .11277
2ND        ROTZ       .00000      .00062      .00000

1ST           X       .00000      .03889      .00000
1ST           Y       .00000     -.01941      .03166
1ST        ROTZ       .00000      .00016      .00000
```

Example 10f
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    2
                                                  PROGRAM:ETABS/FILE:EX10F.DSP
EXAMPLE 10F  -  PANEL BEHAVIOR - 6 STORY E-SHAPED WALL SECTION
STATIC LATERAL LOAD ANALYSIS                 UNITS:KIP-INCH-SECOND

VERTICAL DISPLACEMENTS AND ROTATIONS OF COLUMNS (TOP ENDS)

FRAME ID .... E-SHAPED WALL                             LEVEL ID .... 6TH

OUTPUT     DIRN       COLUMN       COLUMN       COLUMN       COLUMN       COLUMN
ID           ID            1            2            3            4            5
CASE 1     ROTX       .00000       .00000       .00000       .00000       .00000
CASE 1     ROTY       .00000       .00000       .00000       .00000       .00000
CASE 1     VERT      -.00840      -.00840      -.00840      -.00840      -.00840

CASE 2     ROTX       .00106       .00000      -.00106       .00106       .00000
CASE 2     ROTY       .00070       .00070       .00070       .00000       .00000
CASE 2     VERT       .08385       .00000      -.08385      -.04320       .00000

CASE 3     ROTX      -.00148      -.00148      -.00148      -.00148      -.00148
CASE 3     ROTY      -.00001       .00000       .00001       .00000       .00000
CASE 3     VERT      -.05366      -.05294      -.05366       .12425       .12497

OUTPUT     DIRN       COLUMN
ID           ID            6
CASE 1     ROTX       .00000
CASE 1     ROTY       .00000
CASE 1     VERT      -.00840

CASE 2     ROTX      -.00106
CASE 2     ROTY       .00000
CASE 2     VERT       .04320

CASE 3     ROTX      -.00148
CASE 3     ROTY       .00000
CASE 3     VERT       .12425
```

Example 10f
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE     3
                                                 PROGRAM:ETABS/FILE:EX10F.DSP
EXAMPLE 10F  -  PANEL BEHAVIOR - 6 STORY E-SHAPED WALL SECTION
STATIC LATERAL LOAD ANALYSIS              UNITS:KIP-INCH-SECOND

VERTICAL DISPLACEMENTS AND ROTATIONS OF COLUMNS (TOP ENDS)

FRAME ID .... E-SHAPED WALL                              LEVEL ID .... 5TH
```

OUTPUT ID	DIRN ID	COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5
CASE 1	ROTX	.00000	.00000	.00000	.00000	.00000
CASE 1	ROTY	.00000	.00000	.00000	.00000	.00000
CASE 1	VERT	-.00800	-.00800	-.00800	-.00800	-.00800
CASE 2	ROTX	.00103	.00000	-.00103	.00103	.00000
CASE 2	ROTY	.00068	.00068	.00068	.00000	.00000
CASE 2	VERT	.08152	.00000	-.08152	-.04200	.00000
CASE 3	ROTX	-.00144	-.00144	-.00144	-.00144	-.00144
CASE 3	ROTY	-.00001	.00000	.00001	.00000	.00000
CASE 3	VERT	-.05218	-.05146	-.05218	.12080	.12151

OUTPUT ID	DIRN ID	COLUMN 6
CASE 1	ROTX	.00000
CASE 1	ROTY	.00000
CASE 1	VERT	-.00800
CASE 2	ROTX	-.00103
CASE 2	ROTY	.00000
CASE 2	VERT	.04200
CASE 3	ROTX	-.00144
CASE 3	ROTY	.00000
CASE 3	VERT	.12080

Example 10f
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    4
                                                PROGRAM:ETABS/FILE:EX10F.DSP
EXAMPLE 10F  -  PANEL BEHAVIOR - 6 STORY E-SHAPED WALL SECTION
STATIC LATERAL LOAD ANALYSIS                 UNITS:KIP-INCH-SECOND

VERTICAL DISPLACEMENTS AND ROTATIONS OF COLUMNS (TOP ENDS)

FRAME ID .... E-SHAPED WALL                               LEVEL ID .... 4TH

OUTPUT     DIRN      COLUMN      COLUMN      COLUMN      COLUMN      COLUMN
ID           ID           1           2           3           4           5
CASE 1     ROTX       .00000      .00000      .00000      .00000      .00000
CASE 1     ROTY       .00000      .00000      .00000      .00000      .00000
CASE 1     VERT      -.00720     -.00720     -.00720     -.00720     -.00720

CASE 2     ROTX       .00094      .00000     -.00094      .00094      .00000
CASE 2     ROTY       .00062      .00062      .00062      .00000      .00000
CASE 2     VERT       .07454      .00000     -.07454     -.03840      .00000

CASE 3     ROTX      -.00132     -.00132     -.00132     -.00132     -.00132
CASE 3     ROTY      -.00001      .00000      .00001      .00000      .00000
CASE 3     VERT      -.04773     -.04702     -.04773      .11043      .11113

OUTPUT     DIRN      COLUMN
ID           ID           6
CASE 1     ROTX       .00000
CASE 1     ROTY       .00000
CASE 1     VERT      -.00720

CASE 2     ROTX      -.00094
CASE 2     ROTY       .00000
CASE 2     VERT       .03840

CASE 3     ROTX      -.00132
CASE 3     ROTY       .00000
CASE 3     VERT       .11043
```

Example 10f
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE     5
                                                    PROGRAM:ETABS/FILE:EX10F.DSP
EXAMPLE 10F  -  PANEL BEHAVIOR - 6 STORY E-SHAPED WALL SECTION
STATIC LATERAL LOAD ANALYSIS              UNITS:KIP-INCH-SECOND


VERTICAL DISPLACEMENTS AND ROTATIONS OF COLUMNS (TOP ENDS)

FRAME ID .... E-SHAPED WALL                              LEVEL ID .... 3RD

OUTPUT     DIRN        COLUMN        COLUMN        COLUMN        COLUMN      COLUMN
ID           ID             1             2             3             4           5
CASE 1     ROTX        .00000        .00000        .00000        .00000      .00000
CASE 1     ROTY        .00000        .00000        .00000        .00000      .00000
CASE 1     VERT       -.00600       -.00600       -.00600       -.00600     -.00600

CASE 2     ROTX        .00079        .00000       -.00079        .00079      .00000
CASE 2     ROTY        .00052        .00052        .00052        .00000      .00000
CASE 2     VERT        .06289        .00000       -.06289       -.03240      .00000

CASE 3     ROTX       -.00111       -.00111       -.00111       -.00111     -.00111
CASE 3     ROTY       -.00001        .00000        .00001        .00000      .00000
CASE 3     VERT       -.04032       -.03962       -.04032        .09316      .09382


OUTPUT     DIRN        COLUMN
ID           ID             6
CASE 1     ROTX        .00000
CASE 1     ROTY        .00000
CASE 1     VERT       -.00600

CASE 2     ROTX       -.00079
CASE 2     ROTY        .00000
CASE 2     VERT        .03240

CASE 3     ROTX       -.00111
CASE 3     ROTY        .00000
CASE 3     VERT        .09316
```

Example 10f
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    6
                                                PROGRAM:ETABS/FILE:EX10F.DSP
EXAMPLE 10F  -  PANEL BEHAVIOR - 6 STORY E-SHAPED WALL SECTION
STATIC LATERAL LOAD ANALYSIS                UNITS:KIP-INCH-SECOND

VERTICAL DISPLACEMENTS AND ROTATIONS OF COLUMNS (TOP ENDS)

FRAME ID .... E-SHAPED WALL                              LEVEL ID .... 2ND

OUTPUT    DIRN       COLUMN       COLUMN       COLUMN       COLUMN       COLUMN
ID          ID            1            2            3            4            5
CASE 1    ROTX       .00000       .00000       .00000       .00000       .00000
CASE 1    ROTY       .00000       .00000       .00000       .00000       .00000
CASE 1    VERT      -.00440      -.00440      -.00440      -.00440      -.00440

CASE 2    ROTX       .00059       .00000      -.00059       .00059       .00000
CASE 2    ROTY       .00039       .00039       .00039       .00000       .00000
CASE 2    VERT       .04659       .00000      -.04659      -.02400       .00000

CASE 3    ROTX      -.00082      -.00082      -.00082      -.00082      -.00082
CASE 3    ROTY      -.00001       .00000       .00001       .00000       .00000
CASE 3    VERT      -.02994      -.02926      -.02994       .06900       .06954

OUTPUT    DIRN       COLUMN
ID          ID            6
CASE 1    ROTX       .00000
CASE 1    ROTY       .00000
CASE 1    VERT      -.00440

CASE 2    ROTX      -.00059
CASE 2    ROTY       .00000
CASE 2    VERT       .02400

CASE 3    ROTX      -.00082
CASE 3    ROTY       .00000
CASE 3    VERT       .06900
```

Example 10f
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    7
                                                       PROGRAM:ETABS/FILE:EX10F.DSP
EXAMPLE 10F  -  PANEL BEHAVIOR - 6 STORY E-SHAPED WALL SECTION
STATIC LATERAL LOAD ANALYSIS               UNITS:KIP-INCH-SECOND


VERTICAL DISPLACEMENTS AND ROTATIONS OF COLUMNS (TOP ENDS)

FRAME ID .... E-SHAPED WALL                              LEVEL ID .... 1ST

OUTPUT     DIRN      COLUMN       COLUMN       COLUMN       COLUMN      COLUMN
ID           ID           1            2            3            4           5
CASE 1     ROTX      .00000       .00000       .00000       .00000      .00000
CASE 1     ROTY      .00000       .00000       .00000       .00000      .00000
CASE 1     VERT     -.00240      -.00240      -.00240      -.00240     -.00240

CASE 2     ROTX      .00032       .00000      -.00032       .00032      .00000
CASE 2     ROTY      .00021       .00021       .00021       .00000      .00000
CASE 2     VERT      .02562       .00000      -.02562      -.01320      .00000

CASE 3     ROTX     -.00045      -.00045      -.00045      -.00045     -.00045
CASE 3     ROTY     -.00001       .00000       .00001       .00000      .00000
CASE 3     VERT     -.01657      -.01596      -.01657       .03798      .03824


OUTPUT     DIRN      COLUMN
ID           ID           6
CASE 1     ROTX      .00000
CASE 1     ROTY      .00000
CASE 1     VERT     -.00240

CASE 2     ROTX     -.00032
CASE 2     ROTY      .00000
CASE 2     VERT      .01320

CASE 3     ROTX     -.00045
CASE 3     ROTY      .00000
CASE 3     VERT      .03798
```

Example 10f
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    8
                                                  PROGRAM:ETABS/FILE:EX10F.DSP
EXAMPLE 10F  -  PANEL BEHAVIOR - 6 STORY E-SHAPED WALL SECTION
STATIC LATERAL LOAD ANALYSIS                  UNITS:KIP-INCH-SECOND

FRAME REACTION FORCES AT BASELINE (AT EACH COLUMN LINE)

VALUES ARE IN THE LOCAL COORDINATE SYSTEM OF THE FRAME

FRAME ID .... E-SHAPED WALL

 COL OUTPUT    FORCE     FORCE     FORCE    MOMENT     MOMENT    MOMENT
  ID     ID  ALONG-X   ALONG-Y   ALONG-Z  ABOUT-XX   ABOUT-YY  ABOUT-ZZ
   1 CASE 1     4.50     -4.50     45.00       .00        .00       .00
   1 CASE 2   -49.02     11.65   -300.00       .00        .00       .00
   1 CASE 3    29.36      3.62    150.25       .00        .00       .00

   2 CASE 1      .00     -4.50     67.50       .00        .00       .00
   2 CASE 2    -1.96       .00       .00       .00        .00       .00
   2 CASE 3      .00      3.77    299.51       .00        .00       .00

   3 CASE 1    -4.50     -4.50     45.00       .00        .00       .00
   3 CASE 2   -49.02    -11.65    300.00       .00        .00       .00
   3 CASE 3   -29.36      3.62    150.25       .00        .00       .00

   4 CASE 1      .00      4.50     22.50       .00        .00       .00
   4 CASE 2      .00    -11.65       .00       .00        .00       .00
   4 CASE 3      .00    -36.51   -198.60       .00        .00       .00

   5 CASE 1      .00      4.50     22.50       .00        .00       .00
   5 CASE 2      .00       .00       .00       .00        .00       .00
   5 CASE 3      .00    -37.99   -202.81       .00        .00       .00

   6 CASE 1      .00      4.50     22.50       .00        .00       .00
   6 CASE 2      .00     11.65       .00       .00        .00       .00
   6 CASE 3      .00    -36.51   -198.60       .00        .00       .00
```

Example 10f
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    9
                                            PROGRAM:ETABS/FILE:EX10F.DSP
EXAMPLE 10F  -  PANEL BEHAVIOR - 6 STORY E-SHAPED WALL SECTION
STATIC LATERAL LOAD ANALYSIS            UNITS:KIP-INCH-SECOND


SUMMATION OF FRAME REACTION FORCES AT BASELINE

VALUES ARE IN THE LOCAL COORDINATE SYSTEM OF THE FRAME

FRAME ID .... E-SHAPED WALL

     OUTPUT     FORCE     FORCE     FORCE
         ID   ALONG-X   ALONG-Y   ALONG-Z
     CASE 1       .00       .00    225.00
     CASE 2   -100.00       .00       .00
     CASE 3       .00   -100.00       .00
```

Example 10f
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    1
                                               PROGRAM:ETABS/FILE:EX10F.FRM
EXAMPLE 10F  -  PANEL BEHAVIOR - 6 STORY E-SHAPED WALL SECTION
STATIC LATERAL LOAD ANALYSIS            UNITS:KIP-INCH-SECOND


WALL FORCES AT LEVEL 6TH        IN FRAME E-SHAPED WALL

WALL OUTPUT OUTPUT     MAJOR      MAJOR      MINOR      MINOR     AXIAL TORSIONAL
  ID     ID  POINT    MOMENT      SHEAR     MOMENT      SHEAR     FORCE    MOMENT
   1 CASE 1    TOP       .00        .00        .00        .00    -37.50       .00
            BOTTOM       .00                   .00
   1 CASE 2    TOP       .00     100.00        .00        .00       .00  -3600.00
            BOTTOM  12000.00                   .00
   1 CASE 3    TOP       .00        .00        .00     100.00       .00       .00
            BOTTOM       .00              12000.00
```

Example 10f
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    2
                                                    PROGRAM:ETABS/FILE:EX10F.FRM
EXAMPLE 10F  -  PANEL BEHAVIOR - 6 STORY E-SHAPED WALL SECTION
STATIC LATERAL LOAD ANALYSIS                UNITS:KIP-INCH-SECOND


WALL FORCES AT LEVEL 5TH      IN FRAME E-SHAPED WALL

WALL OUTPUT OUTPUT     MAJOR     MAJOR     MINOR     MINOR     AXIAL TORSIONAL
  ID     ID  POINT    MOMENT     SHEAR    MOMENT     SHEAR     FORCE    MOMENT
   1 CASE 1    TOP       .00       .00       .00       .00    -75.00       .00
            BOTTOM       .00                 .00
   1 CASE 2    TOP  12000.00    100.00       .00       .00       .00  -3600.00
            BOTTOM  24000.00                 .00
   1 CASE 3    TOP       .00       .00  12000.00    100.00       .00       .00
            BOTTOM       .00            24000.00
```

Example 10f
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    3
                                                   PROGRAM:ETABS/FILE:EX10F.FRM
EXAMPLE 10F  -  PANEL BEHAVIOR - 6 STORY E-SHAPED WALL SECTION
STATIC LATERAL LOAD ANALYSIS           UNITS:KIP-INCH-SECOND


WALL FORCES AT LEVEL 4TH      IN FRAME E-SHAPED WALL

WALL OUTPUT OUTPUT       MAJOR      MAJOR      MINOR      MINOR     AXIAL TORSIONAL
  ID     ID  POINT      MOMENT      SHEAR     MOMENT      SHEAR     FORCE    MOMENT
   1 CASE 1    TOP         .00        .00        .00        .00   -112.50       .00
            BOTTOM         .00                   .00
   1 CASE 2    TOP    24000.00     100.00        .00        .00       .00  -3600.00
            BOTTOM    36000.00                   .00
   1 CASE 3    TOP         .00        .00   24000.00     100.00       .00       .00
            BOTTOM         .00              36000.00
```

Example 10f
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    4
                                               PROGRAM:ETABS/FILE:EX10F.FRM
EXAMPLE 10F  -  PANEL BEHAVIOR - 6 STORY E-SHAPED WALL SECTION
STATIC LATERAL LOAD ANALYSIS                UNITS:KIP-INCH-SECOND

WALL FORCES AT LEVEL 3RD      IN FRAME E-SHAPED WALL

WALL OUTPUT OUTPUT     MAJOR     MAJOR     MINOR     MINOR     AXIAL TORSIONAL
  ID     ID  POINT    MOMENT     SHEAR    MOMENT     SHEAR     FORCE    MOMENT
   1 CASE 1    TOP       .00       .00       .00       .00   -150.00       .00
            BOTTOM       .00                 .00
   1 CASE 2    TOP  36000.00    100.00       .00       .00       .00  -3600.00
            BOTTOM  48000.00                 .00
   1 CASE 3    TOP       .00       .00  36000.00    100.00       .00       .00
            BOTTOM       .00            48000.00
```

Example 10f
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    5
                                              PROGRAM:ETABS/FILE:EX10F.FRM
EXAMPLE 10F  -  PANEL BEHAVIOR - 6 STORY E-SHAPED WALL SECTION
STATIC LATERAL LOAD ANALYSIS              UNITS:KIP-INCH-SECOND


WALL FORCES AT LEVEL 2ND        IN FRAME E-SHAPED WALL

WALL OUTPUT OUTPUT     MAJOR      MAJOR      MINOR      MINOR     AXIAL TORSIONAL
  ID     ID  POINT    MOMENT      SHEAR     MOMENT      SHEAR     FORCE    MOMENT
   1 CASE 1    TOP       .00        .00        .00        .00   -187.50       .00
            BOTTOM       .00                   .00
   1 CASE 2    TOP  48000.00     100.00        .00        .00       .00  -3600.00
            BOTTOM  60000.00                   .00
   1 CASE 3    TOP       .00        .00   48000.00     100.00       .00       .00
            BOTTOM       .00              60000.00
```

Example 10f
Sample Output (continued)

```
CSI/ETABS - EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS  PAGE    6
                                                 PROGRAM:ETABS/FILE:EX10F.FRM
EXAMPLE 10F  -  PANEL BEHAVIOR - 6 STORY E-SHAPED WALL SECTION
STATIC LATERAL LOAD ANALYSIS              UNITS:KIP-INCH-SECOND

WALL FORCES AT LEVEL 1ST      IN FRAME E-SHAPED WALL
```

WALL ID	OUTPUT ID	OUTPUT POINT	MAJOR MOMENT	MAJOR SHEAR	MINOR MOMENT	MINOR SHEAR	AXIAL FORCE	TORSIONAL MOMENT
1	CASE 1	TOP	.00	.00	.00	.00	-225.00	.00
		BOTTOM	.00		.00			
1	CASE 2	TOP	60000.00	100.00	.00	.00	.00	-3600.00
		BOTTOM	72000.00		.00			
1	CASE 3	TOP	.00	.00	60000.00	100.00	.00	.00
		BOTTOM	.00		72000.00			

Example 10f
Sample Output (continued)

EXAMPLE 11

SIX-STORY SHEAR WALL/FRAME BUILDING GRAVITY AND UBC 1991 SEISMIC LOAD ANALYSIS

A. DESCRIPTION

This is a six-story structure consisting of a ductile steel frame, concrete elevator core shear walls and basement shear walls.

The structure is analyzed for vertical dead and live loads and for lateral static seismic UBC 1991 loads acting in the longitudinal and transverse directions of the structure.

The geometry and the gravity loads are shown in Figures 11-1 and 11-2.

B. SIGNIFICANT OPTIONS OF ETABS ACTIVATED

1. Mass properties calculated automatically
2. AISC data base of section properties used
3. Vertical loading options activated
4. UBC 1991 seismic loads calculated automatically
5. Pin base conditions for steel frame

C. COMPUTER MODEL

This example is a typical shear wall/frame interaction problem. Vertical loading has only been applied to the steel frame. A typical story weight density of 100 psf is used to obtain mass properties. Kip-inch-second units are used.

The following UBC 91 factors are input to automatically generate seismic loads:

$Z = 0.4$
$I = 1.0$
$S = 1.0$
$R_W = 12$
$T_a = 0.44$ sec.

and the lateral load distribution is stopped above the basement walls.

This model consists of three total frames, as follows:

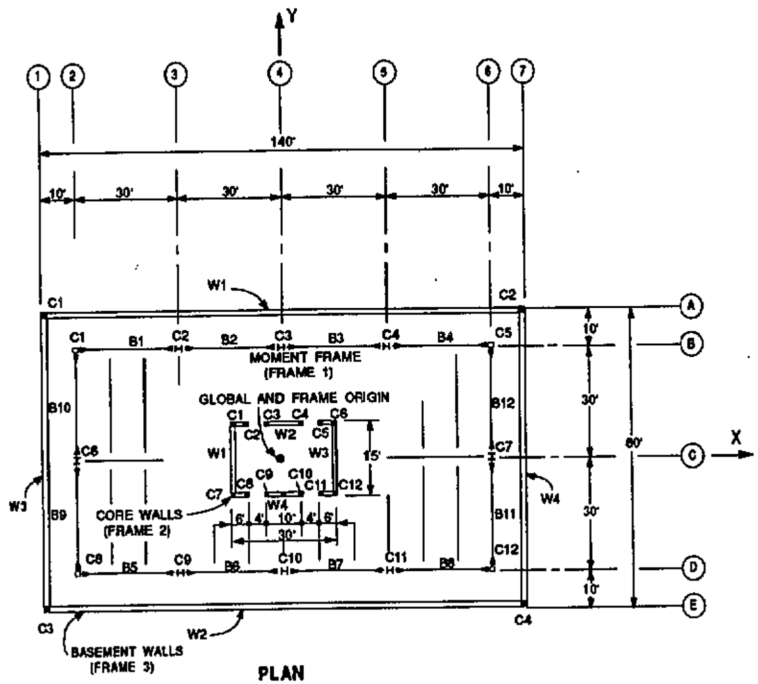
Frame 1: Ductile steel frame
Frame 2: Elevator core walls
Frame 3: Basement walls

The ductile steel frame is modeled with twelve column lines and eleven bays. A modulus of elasticity of 29500 ksi is used for steel. The box columns are assumed to be 16" x 16" with 1" thickness in the 1st and 2nd stories, 3/4" thickness in the 3rd and 4th stories, and 1/2" thickness in the 5th and 6th stories.

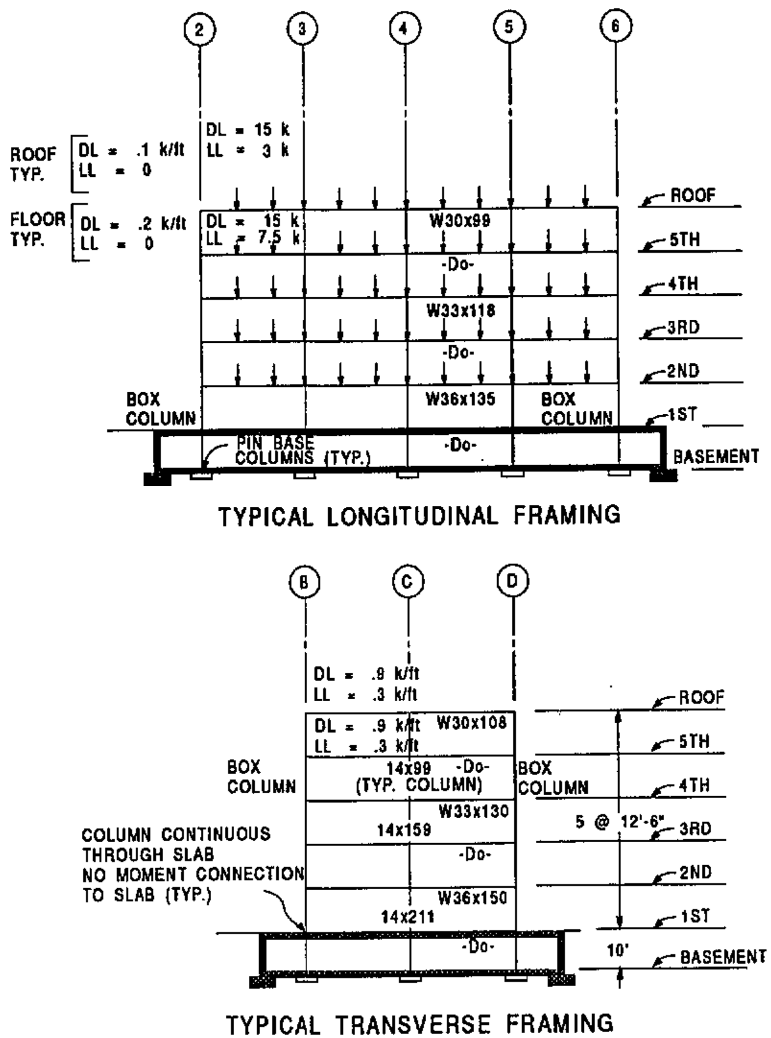
The elevator core walls are modeled with twelve column lines and eight panels per story. The eight panels are grouped into four walls, two planar and two C-sections. It should be noted that because of vertical isolation of the four walls, each could have been modeled as a separate frame. A modulus of elasticity of 3000 ksi is used for concrete. A wall thickness of 12" is used.

The basement walls are modeled with four column lines and four panels per story, each identified with a different wall ID number. A wall thickness of 12" is used.

The input data file for this example is EX11. A listing of the input data is given in Figure 11-3.



Example 11
Six-story Shear Wall / Frame Building
Figure 11-1



Example 11
Six-story Shear Wall / Frame Building
Figure 11-2

```
EXAMPLE 11  -  SIX STORY SHEAR-WALL/FRAME BUILDING
GRAVITY AND UBC 1988 SEISMIC ANALYSIS   UNITS:KIP-INCH-SECOND
$                       CONTROL DATA
6 3 3 1 4 9 2 6 6 0 1 6 1 0 0 2 0 0 0
386.4
$                       MASS DATA
1 1 1/386.4
.1/144 0 0 1440 720
$                       STORY DATA
ROOF 150 1
5TH  150 1
4TH  150 1
3RD  150 1
2ND  150 1
1ST  120 0
$                       MATERIAL DATA
1 S 29500 .490/1728 .30
2 C  3000 .150/1728 .15
$                       COLUMN SECTION DATA
1 1 W14X99
2 1 W14X159
3 1 W14X211
4 1 BOX  16  16  .5  .5
5 1 BOX  16  16  .75 .75
6 1 BOX  16  16 1.0 1.0
$                       BEAM SECTION DATA
1 1 W30X99
2 1 W33X118
3 1 W36X135
4 1 W30X108
5 1 W33X130
6 1 W36X150
$                       PANEL SECTION DATA
1 2 12
$                       FRAME DATA
$                       DATA FOR FRAME 1
/STEEL FRAME (3-DIMENSIONAL)
1 6 12 12 0 0 0 10 2
$                       COLUMN LINE DATA
1 -720 360
2 -360 360
3    0 360
4  360 360
5  720 360
6 -720 0    90
7  720 0    90
8 -720 -360
9 -360 -360
10   0 -360
11 360 -360
12 720 -360
```

Example 11
Listing of Input Data
Figure 11-3

```
$                                 BAY CONNECTIVITY DATA
1   1  2
2   2  3
3   3  4
4   4  5
5   8  9
6   9 10
7  10 11
8  11 12
9   8  6
10  6  1
11 12  7
12  7  5
$                                 SPAN LOADING DATA
1 2 .1/12 0 15
-.33 15 -.67 15
2 2  0    0 3
-.33 3.0 -.67 3.0
3 2 .2/12 0 15
-.33 15  -.67 15
4 2  0    0  7.5
-.33 7.5 -.67 7.5
5 2 .1/12
-.33 15  -.67 15
6 2  0
-.33 3.0 -.67 3.0
7 2 .2/12
-.33 15  -.67 15
8 2  0
-.33 7.5  -.67 7.5
9 0 .9/12
10 0 .3/12
$                                 COLUMN ASSIGNMENT DATA
1    0 ROOF 4 1
1    0 4TH  5 1
1    0 2ND  6 0
1    0 1ST  6 0 1
2    0 ROOF 1 1
2    0 4TH  2 1
2    0 2ND  3 0
2    0 1ST  3 0 1
3    2
4    2
5    1
6    2
7    2
8    1
9    2
10   2
11   2
12   1
```

Example 11
Listing of Input Data
Figure 11-3 (continued)

```
$                        BEAM ASSIGNMENT DATA
1   0  ROOF 1
1   0  5TH  1
1   0  4TH  2
1   0  3RD  2
1   0  2ND  3
2   1
3   1
4   1
5   1
6   1
7   1
8   1
9   0  ROOF 4
9   0  5TH  4
9   0  4TH  5
9   0  3RD  5
9   0  2ND  6
10  9
11  9
12  9
$                        BEAM LOADING ASSIGNMENT DATA
1   0 ROOF 1 2
1   0 5TH  3 4 0 3
2   1
3   1
4   0 ROOF 5 6
4   0 5TH  7 8 0 3
5   1
6   2
7   3
8   4
9   0 ROOF 9 10
9   0 5TH  9 10 0 3
10  9
11  9
12  9
```

Example 11
Listing of Input Data
Figure 11-3 (continued)

```
$                          DATA FOR FRAME 2
/CORE WALLS
2 6 12 0 0 48
1 -180  90
2 -108  90
3  -60  90
4   60  90
5  108  90
6  180  90
7 -180 -90
8 -108 -90
9  -60 -90
10  60 -90
11 108 -90
12 180 -90

1 ROOF  1  2  1  5
2 ROOF  3  4  1  5
3 ROOF  5  6  1  5
1 ROOF  1  7  1  5
3 ROOF  6 12  1  5
1 ROOF  7  8  1  5
4 ROOF  9 10  1  5
3 ROOF 11 12  1  5
$                          DATA FOR FRAME 3
/BASEMENT WALLS
3 1 4 0 0 4
1 -70*12  40*12
2  70*12  40*12
3 -70*12 -40*12
4  70*12 -40*12

1 1ST 1 2 1
2 1ST 3 4 1
3 1ST 3 1 1
4 1ST 4 2 1
$                          FRAME LOCATION DATA
1 0 0 0 0 /STEEL FRAME
2 0 0 0 0 /CORE WALLS
3 0 0 0 0 /BASEMENT WALLS
$                          UBC SEISMIC LOAD DATA
0.4 1.0 1.0
0.0  0.44  12  ROOF  1ST
0.0  0.44  12  ROOF  1ST
36 72
36 72
36 72
36 72
36 72

$                          LOAD CASE DATA
1 0 1
2 0 0 1
3 0 0 0 0 1
4 0 0 0 0 0 1
$   END OF INPUT DATA
```

Example 11
Listing of Input Data
Figure 11-3 (continued)

EXAMPLE 12

STEPPED DIAPHRAGM
PARKING STRUCTURE
ATC SEISMIC LOAD ANALYSIS

A. DESCRIPTION

This is a five-story split-level parking structure consisting of concrete beams and columns. Lateral loads are resisted by a three-dimensional moment frame. The structure is analyzed for lateral static seismic loads acting in the longitudinal and transverse directions of the structure.

The geometry of the structure is shown in Figure 12-1.

B. SIGNIFICANT OPTIONS OF ETABS ACTIVATED

1. Mass properties calculated automatically
2. Section properties calculated automatically
3. ATC lateral loads calculated automatically
4. Columns released from diaphragm at intermediate levels
5. External story restraint used to fix first level diaphragm laterally

C. COMPUTER MODEL

This example demonstrates the diaphragm disconnect feature of ETABS. This feature enables the user to model discontinuous diaphragms such that the column displacements at a particular level are independent of the diaphragm displacements for that level. Kip-inch-second units are used. A story weight density of 120 psf is assumed.

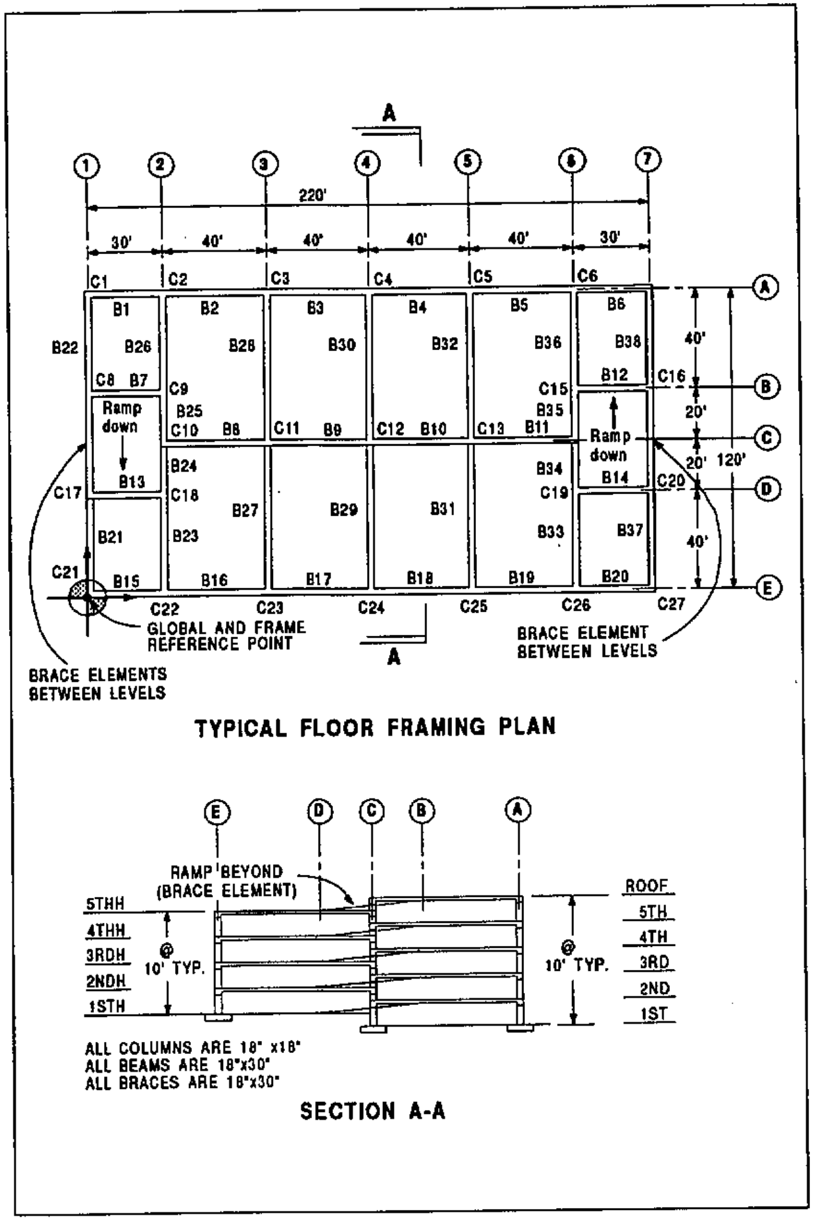
The following ATC factors are input to automatically generate ATC seismic loads:

$A_V = 0.4$ g
S $= 1.2$
R $= 7$
$T_a = 0.4344$ sec

The whole structure is modeled as a single frame with ten stories, to account for the stepped floor diaphragms, 27 column lines and 38 bays. Note that no columns exist on column lines C9, C15, C18 and C19. These column lines are included only to model the beams. All column lines on grid lines A and B in Figure 12-1 are disconnected from floor diaphragms of the stories bearing the story identification with the H suffix.

Similarly, all column lines on grid lines D and E are disconnected from floor diaphragms of the stories bearing story identifications without the H suffix. Rigid dummy columns are used under story 1ST H for columns on grid lines D and E, so that all columns have the same baseline.

The input data file for this example is EX12. A listing of the input data is given in Figure 12-2.



Example 12
Stepped Diaphragm Parking Structure
Figure 12-1

```
EXAMPLE 12  -  STEPPED DIAPHRAGM PARKING STRUCTURE
ATC 3-06, SEISMIC LOAD ANALYSIS    UNITS:KIP-INCH-SECOND
$                                       CONTROL DATA
10 1 1 2 2 9 2 2 1 1 0 3 1
386.4
$                                       MASS DATA
1 3 1/386.4
.12/144 1320 1080 1920 720
.12/144  180 1200  360 480
.12/144 2460 1200  360 480
2 3 1/386.4
.12/144 1320  360 1920 720
.12/144  180  240  360 480
.12/144 2460  240  360 480
$                                       STORY DATA
ROOF 60 1
5THH 60 2
5TH  60 1
4THH 60 2
4TH  60 1
3RDH 60 2
3RD  60 1
2NDH 60 2
2ND  60 1
1STH 60 0  0  0  0  0    9999999 9999999 9999999
$                                       MATERIAL DATA
1 C 3000 .150/1728 .2
2 O 999999
$                                       COLUMN PROPERTIES
1 1 RECT 18 18
2 2 USER
999999  0  0  0  999999  999999
$                                       BEAM PROPERTIES
1 1 RECT 30 0 18
$                                       BRACE PROPERTIES
1 1 RECT 30 18
$                                       FRAME DATA
/MAIN FRAME
1 10 27 38 9
$                                       COLUMN LINE LOCATION DATA
1      0 1440
2    360 1440
3    840 1440
4   1320 1440
5   1800 1440
6   2280 1440
7   2640 1440
8      0  960
```

Example 12
Listing of Input Data
Figure 12-2

```
9    360  960
10   360  720
11   840  720
12  1320  720
13  1800  720
14  2280  720
15  2280  960
16  2640  960
17     0  480
18   360  480
19  2280  480
20  2640  480
21     0    0
22   360    0
23   840    0
24  1320    0
25  1800    0
26  2280    0
27  2640    0
$                        BAY  CONNECTIVITY DATA
1    1  2
2    2  3
3    3  4
4    4  5
5    5  6
6    6  7
7    8  9
8   10 11
9   11 12
10  12 13
11  13 14
12  15 16
13  17 18
14  19 20
15  21 22
16  22 23
17  23 24
18  24 25
19  25 26
20  26 27
21  21 17
22   8  1
23  22 18
24  18 10
25  10  9
26   9  2
27  23 11
28  11  3
29  24 12
30  12  4
31  25 13
32  13  5
33  26 19
34  19 14
35  14 15
36  15  6
37  27 20
38  16  7
```

Example 12
Listing of Input Data
Figure 12-2 (continued)

```
$                                      COLUMN ASSIGNMENT DATA
1  0 ROOF 1 0 0 0
1  0 5THH 1 0 0 1
1  0 5TH  1 0 0 0
1  0 4THH 1 0 0 1
1  0 4TH  1 0 0 0
1  0 3RDH 1 0 0 1
1  0 3RD  1 0 0 0
1  0 2NDH 1 0 0 1
1  0 2ND  1 0 0 0
1  0 1STH 1 0 0 1
2  1
3  1
4  1
5  1
6  1
7  1
8  1
10 0 ROOF 1 9
11 10
12 10
13 10
14 10
16 1
17 0 5THH 1 0 0 0
17 0 5TH  1 0 0 1
17 0 4THH 1 0 0 0
17 0 4TH  1 0 0 1
17 0 3RDH 1 0 0 0
17 0 3RD  1 0 0 1
17 0 2NDH 1 0 0 0
17 0 2ND  1 0 0 1
17 0 1STH 2 0 0 0
20 17
21 17
22 17
23 17
24 17
25 17
26 17
27 17
```

Example 12
Listing of Input Data
Figure 12-2 (continued)

```
$                                          BEAM ASSIGNMENT DATA
1  0 ROOF 1
1  0 5TH  1
1  0 4TH  1
1  0 3RD  1
1  0 2ND  1
2  1
3  1
4  1
5  1
6  1
7  1
8  0  ROOF 1 8
9  8
10 8
11 8
12 1
13 0 5THH 1
13 0 4THH 1
13 0 3RDH 1
13 0 2NDH 1
14 13
15 13
16 13
17 13
18 13
19 13
20 13
21 13
22 1
23 13
24 13
25 1
26 1
27 13
28  1
29 13
30  1
31 13
32  1
33 13
34 13
35  1
36  1
37 13
38  1
$                                          BRACE LOCATION DATA
1 ROOF 17  8 1
2 5TH  17  8 1
3 4TH  17  8 1
4 3RD  17  8 1
5 2ND  17  8 1
6 5THH 16 20 1
7 4THH 16 20 1
8 3RDH 16 20 1
9 2NDH 16 20 1
```

Example 12
Listing of Input Data
Figure 12-2 (continued)

```
$                                       FRAME LOCATION DATA
1 0 0 0 0 /MAIN FRAME
$                                       ATC SEISMIC LOAD DATA
0.4 1.2 7.0
0.0 0.4344 ROOF 2ND
0.0 0.4344 ROOF 2ND
```

```
$                                        LOAD CASE DATA
1 0    0 0 0 1
2 0    0 0 0 0 1
$   END OF INPUT DATA
```

Example 12
Listing of Input Data
Figure 12-2 (continued)

EXAMPLE 13

PYRAMID BUILDING
STATIC LATERAL LOADS
AND EIGENVALUE ANALYSIS

A. DESCRIPTION

This is a five-level pyramid-type steel structure subjected to lateral static loads.

The lateral loads are applied in the global X-direction (Load Condition A) and in a direction inclined at 45 degrees to the global X-direction (Load Condition B).

The geometry and loads of the structure are shown in Figures 13-1 and 13-2.

B. SIGNIFICANT OPTIONS OF ETABS ACTIVATED

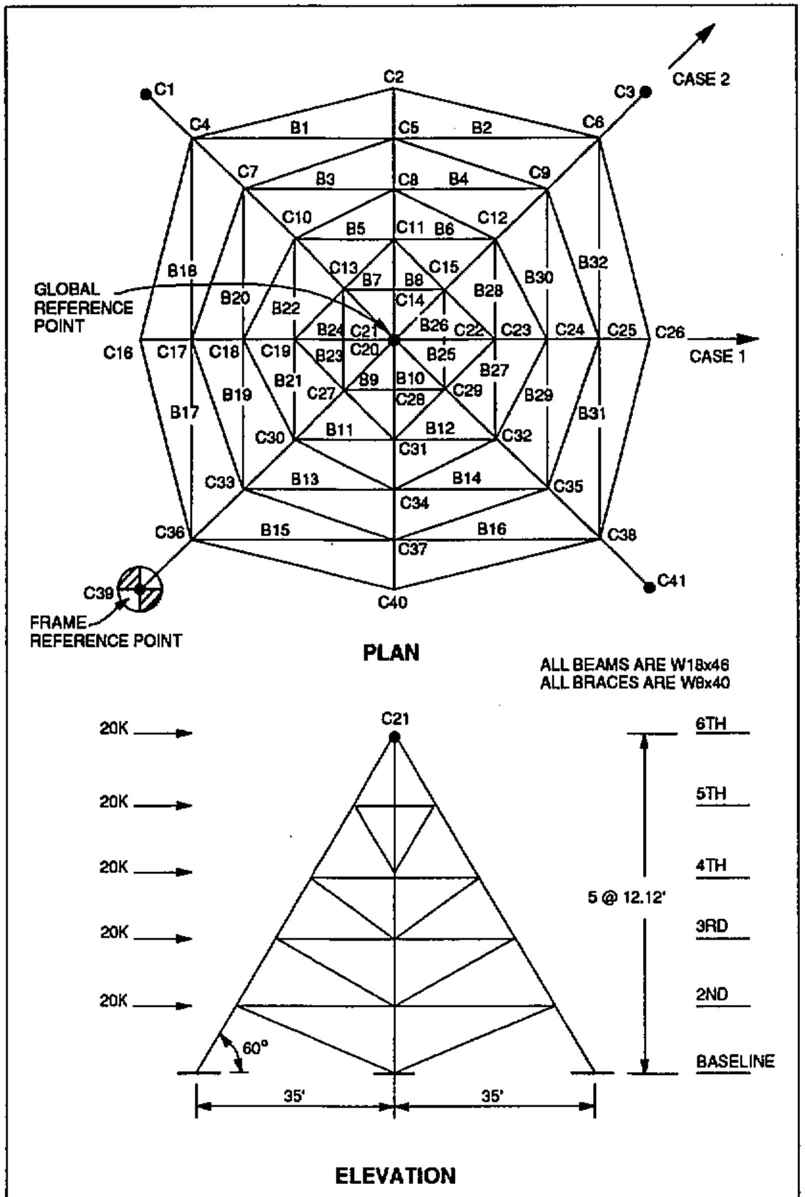
1. Use of bracing elements
2. Automatic AISC section property selection
3. User-specified static lateral loads
4. Calculation of structural time periods and mode shapes

C. COMPUTER MODEL

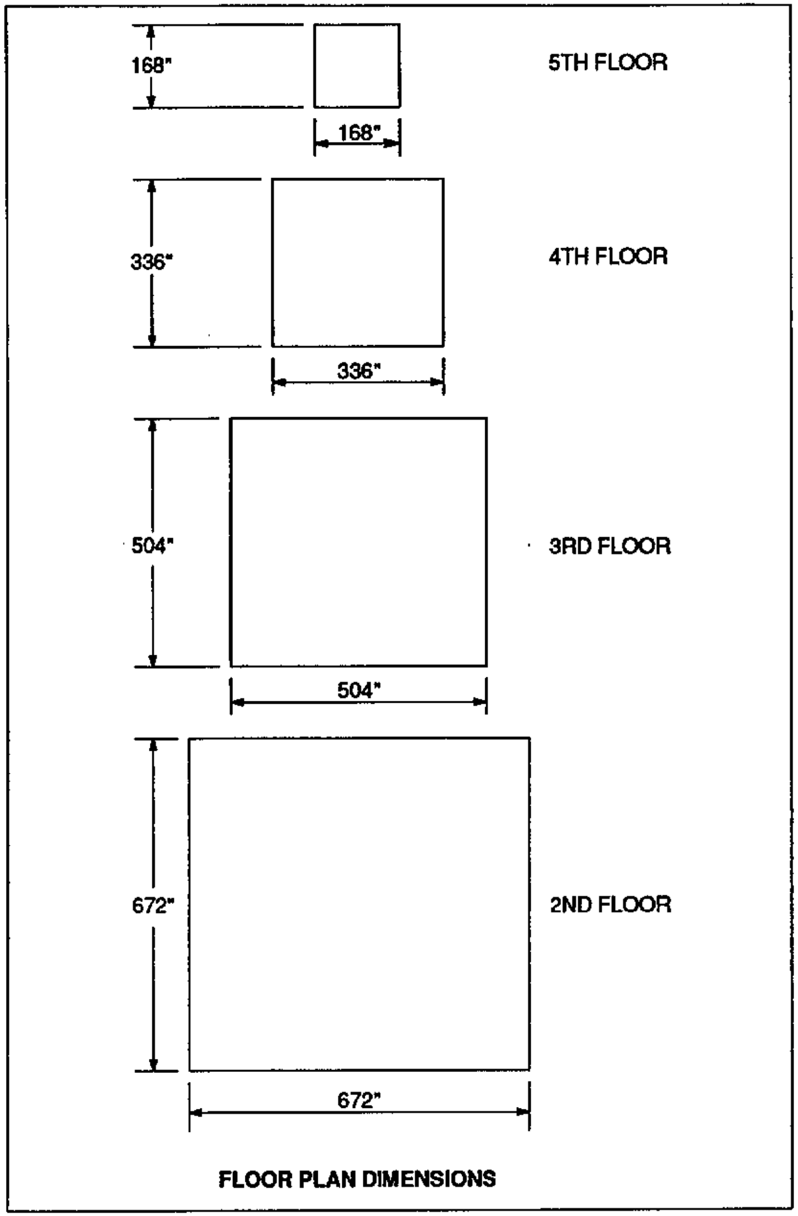
The structure is modeled as a single frame with 41 column lines and 32 bays. Note that this model has no vertical column elements. The column lines are used purely for the purpose of locating the beam and brace elements.

A modulus of elasticity of 29500 ksi is used. The story weight is taken as 100 psf. Kip-inch-second units are used.

The input data file for this example is EX13. A listing of the input data is given in Figure 13-3.



Example 13
Pyramid Building
Figure 13-1



Example 13
Pyramid Building
Figure 13-2

```
EXAMPLE 13  -  PYRAMID BUILDING
STATIC LATERAL LOADS AND EIGENVALUE ANALYSIS   UNITS:KIP-INCH
$                                                 CONTROL DATA
5 1 1 4 2 9 1 0 1 1 0 1 1
386.4
$                                                 MASS DATA
1 1 1/386.4
.1/144 0 0 168 168
2 1 1/386.4
.1/144 0 0 336 336
3 1 1/386.4
.1/144 0 0 504 504
4 1 1/386.4
.1/144 0 0 672 672
$                                                 STORY DATA
6TH  145.5 0
5TH  145.5 1
4TH  145.5 2
3RD  145.5 3
2ND  145.5 4
$                                                 MATERIAL PROPERTIES
1 S 29500 .490/1728 .3 36
$                                                 BEAM PROPERTIES
1 1 W18X46
$                                                 BRACE PROPERTIES
1 1 W8X40
$                                                 FRAME DATA
/MAIN FRAME
1 5 41 32 72
$                                                 COLUMN LINE LOCATION DATA
1     0 840
2   420 840
3   840 840
4    84 756
5   420 756
6   756 756
7   168 672
8   420 672
9   672 672
10  252 588
11  420 588
12  588 588
13  336 504
14  420 504
15  504 504
16    0 420
17   84 420
18  168 420
```

Example 13
Listing Of Input Data
Figure 13-3

```
19 252 420
20 336 420
21 420 420
22 504 420
23 588 420
24 672 420
25 756 420
26 840 420
27 336 336
28 420 336
29 504 336
30 252 252
31 420 252
32 588 252
33 168 168
34 420 168
35 672 168
36  84  84
37 420  84
38 756  84
39   0   0
40 420   0
41 840   0
$                        BAY CONNECTIVITY DATA
1    4  5
2    5  6
3    7  8
4    8  9
5   10 11
6   11 12
7   13 14
8   14 15
9   27 28
10  28 29
11  30 31
12  31 32
13  33 34
14  34 35
15  36 37
16  37 38
17  36 17
18  17  4
19  33 18
20  18  7
21  30 19
22  19 10
23  27 20
24  20 13
25  29 22
26  22 15
27  32 23
28  23 12
29  35 24
30  24  9
31  38 25
32  25  6
```

Example 13
Listing Of Input Data
Figure 13-3 (continued)

```
$                                       COLUMN ASSIGNMENT DATA
$                                       BEAM ASSIGNMENT DATA
1 0 2ND 1
2 1
3 0 3RD 1
4 3
5 0 4TH 1
6 5
7 0 5TH 1
8 7
9 7
10 7
11 5
12 5
13 3
14 3
15 1
16 1
17 1
18 1
19 3
20 3
21 5
22 5
23 7
24 7
25 7
26 7
27 5
28 5
29 3
30 3
31 1
32 1
$                                       BRACE LOCATION DATA
101 2ND  2  4  1
102 3RD  5  7  1
103 4TH  8 10  1
104 5TH 11 13  1
105 2ND  2  6  1
106 3RD  5  9  1
107 4TH  8 12  1
108 5TH 11 15  1
109 2ND  2  5  1
110 3RD  5  8  1
111 4TH  8 11  1
112 5TH 11 14  1
113 6TH 14 21  1
114 2ND  3  6  1
115 3RD  6  9  1
116 4TH  9 12  1
117 5TH 12 15  1
118 6TH 15 21  1
201 2ND 26  6  1
202 3RD 25  9  1
203 4TH 24 12  1
204 5TH 23 15  1
205 2ND 26 38  1
206 3RD 25 35  1
```

Example 13
Listing Of Input Data
Figure 13-3 (continued)

```
207 4TH 24 32  1
208 5TH 23 29  1
209 2ND 26 25  1
210 3RD 25 24  1
211 4TH 24 23  1
212 5TH 23 22  1
213 6TH 22 21  1
214 2ND 41 38  1
215 3RD 38 35  1
216 4TH 35 32  1
217 5TH 32 29  1
218 6TH 29 21  1
301 2ND 40 38  1
302 3RD 37 35  1
303 4TH 34 32  1
304 5TH 31 29  1
305 2ND 40 36  1
306 3RD 37 33  1
307 4TH 34 30  1
308 5TH 31 27  1
309 2ND 40 37  1
310 3RD 37 34  1
311 4TH 34 31  1
312 5TH 31 28  1
313 6TH 28 21  1
314 2ND 39 36  1
315 3RD 36 33  1
316 4TH 33 30  1
317 5TH 30 27  1
318 6TH 27 21  1
401 2ND 16 36  1
402 3RD 17 33  1
403 4TH 18 30  1
404 5TH 19 27  1
405 2ND 16  4  1
406 3RD 17  7  1
407 4TH 18 10  1
408 5TH 19 13  1
409 2ND 16 17  1
410 3RD 17 18  1
411 4TH 18 19  1
412 5TH 19 20  1
413 6TH 20 21  1
414 2ND  1  4  1
415 3RD  4  7  1
416 4TH  7 10  1
417 5TH 10 13  1
418 6TH 13 21  1
$                                             FRAME LOCATION DATA
1 0 -420 -420 0 /MAIN FRAME
$                                             USER SPECIFIED LATERAL LOADS
20  0  0  0    2P.5*20/2  2P.5*20/2
20  0  0  0    2P.5*20/2  2P.5*20/2
20  0  0  0    2P.5*20/2  2P.5*20/2
20  0  0  0    2P.5*20/2  2P.5*20/2
20  0  0  0    2P.5*20/2  2P.5*20/2
$                                             LOAD CASE DATA
1 0 0 0 0 1
2 0 0 0 0 0 1
$   END OF INPUT DATA
```

Example 13
Listing Of Input Data
Figure 13-3 (continued)

EXAMPLE 14

TWENTY-FIVE STORY TRIPLE TOWER BUILDING DYNAMIC RESPONSE SPECTRUM ANALYSIS

A. DESCRIPTION

This is a 25-story structure consisting of three identical three-dimensional circular towers connected by horizontal floor diaphragms. The geometry of the structure is shown in Figures 14-1 and 14-2.

A dynamic response spectrum analysis is performed. The dynamic excitation corresponds to the El Centro earthquake of 1940, N-S component, 5 percent damping, response spectra in two orthogonal horizontal directions.

B. SIGNIFICANT OPTIONS OF ETABS ACTIVATED

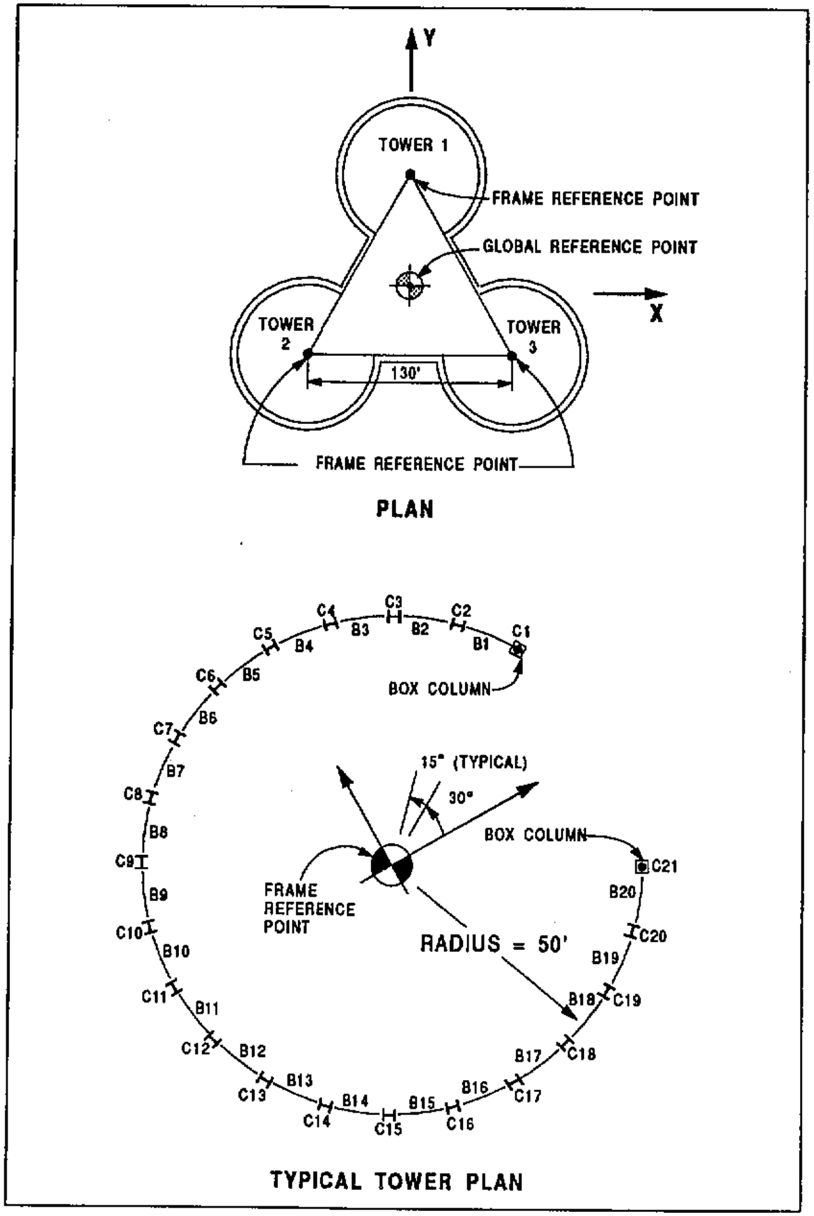
1. Large capacity dynamic response spectrum analysis
2. Arithmetic operations for coordinate calculation
3. Automatic AISC section property selection
4. Automatic section property calculation

C. COMPUTER MODEL

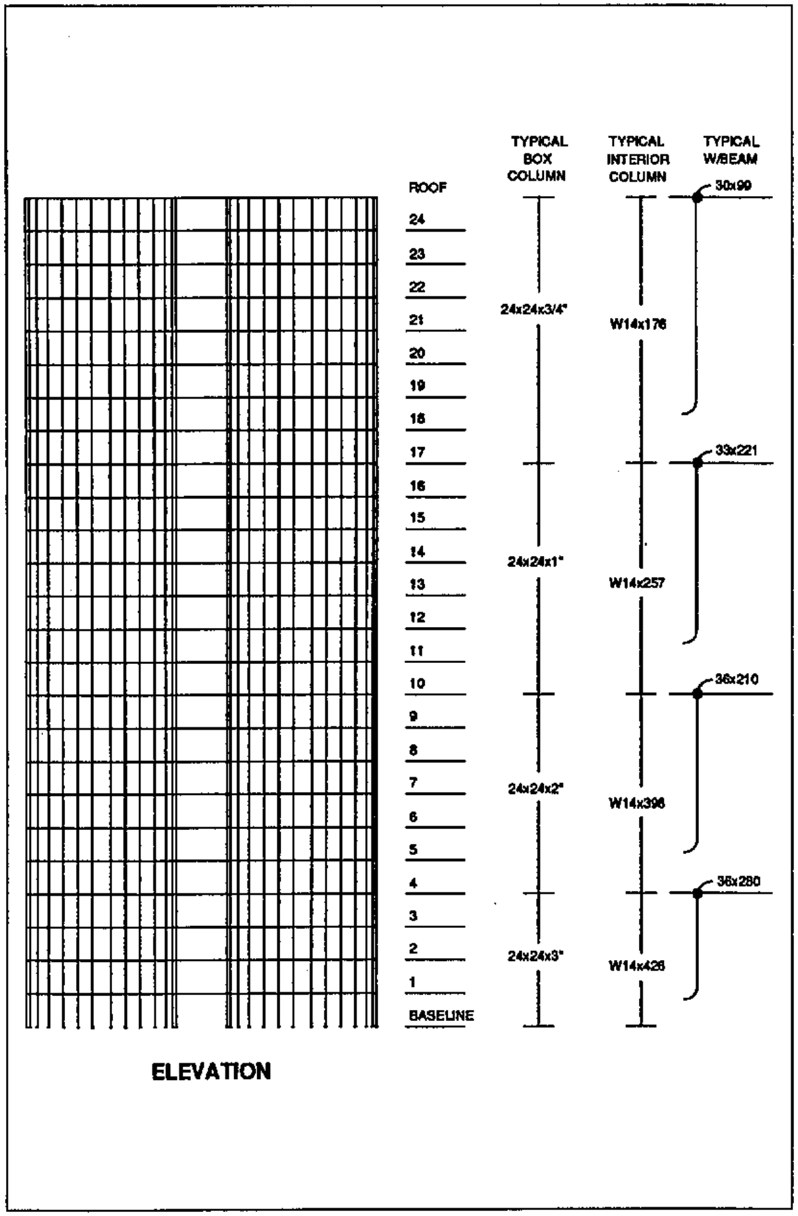
This structure is modeled with three identical frames. Each frame is modeled with 21 column lines and 20 bays. Kip-inch-second units are used. A modulus of elasticity of 29500 ksi is used. The story weight is taken as 1087 kips. The story mass moment of inertia is taken as 6254000 kip-sec^2-in.

Fifteen modes are used in the dynamic analysis.

The input data file for this example is EX14. A listing of the input data is given in Figure 14-3.



Example 14
Twenty-five Story Triple Tower Building
Figure 14-1



Example 14
Twenty-five Story Triple Tower Building
Figure 14-2

```
EXAMPLE 14  -  TWENTY FIVE STORY TRIPLE TOWER BUILDING
DYNAMIC RESPONSE SPECTRUM ANALYSIS  UNITS:KIP-INCH-SECOND
$   CONTROL DATA
 25 1 3 0 2 15 1 8 4 0 0 0 2 0 0 2 0 0 0
386.4
$   STORY DATA
ROOF   12.5*12   0  1087/386.4     6254000
24TH   12.5*12   0  1087/386.4     6254000
23RD   12.5*12   0  1087/386.4     6254000
22ND   12.5*12   0  1087/386.4     6254000
21ST   12.5*12   0  1087/386.4     6254000
20TH   12.5*12   0  1087/386.4     6254000
19TH   12.5*12   0  1087/386.4     6254000
18TH   12.5*12   0  1087/386.4     6254000
17TH   12.5*12   0  1087/386.4     6254000
16TH   12.5*12   0  1087/386.4     6254000
15TH   12.5*12   0  1087/386.4     6254000
14TH   12.5*12   0  1087/386.4     6254000
13TH   12.5*12   0  1087/386.4     6254000
12TH   12.5*12   0  1087/386.4     6254000
11TH   12.5*12   0  1087/386.4     6254000
10TH   12.5*12   0  1087/386.4     6254000
 9TH   12.5*12   0  1087/386.4     6254000
 8TH   12.5*12   0  1087/386.4     6254000
 7TH   12.5*12   0  1087/386.4     6254000
 6TH   12.5*12   0  1087/386.4     6254000
 5TH   12.5*12   0  1087/386.4     6254000
 4TH   12.5*12   0  1087/386.4     6254000
 3RD   12.5*12   0  1087/386.4     6254000
 2ND   12.5*12   0  1087/386.4     6254000
 1ST   20.0*12   0  1087/386.4     6254000
$   MATERIAL DATA
1 S 29500 .490/1728 .25 .36
$   COLUMN PROPERTIES
1 1 BOX   24 24   3    3
2 1 BOX   24 24   2    2
3 1 BOX   24 24   1    1
4 1 BOX   24 24   .75  .75
5 1 W14X426
6 1 W14X398
7 1 W14X257
8 1 W14X176
$   BEAM PROPERTIES
1 1 W36X280
2 1 W36X210
3 1 W33X221
4 1 W30X99
```

Example 14
Listing of Input Data
Figure 14-3

```
$   TYPICAL FRAME DATA
/TYPICAL ROUND TOWER
1 25 21 20
$   COLUMN LINE COORDINATES
1    3P.5/2*50*12            50*12/2                 120
2    2P-.5*50*12             2P-.5*50*12             135
3    50*12/2                 3P.5/2*50*12            150
4    3P.5-2*-1P.5/2*50*12  3P.5+2P.5/2*50*12       165
5    0                     50*12                  180
6    3P.5-2*-1P.5/2*-50*12 3P.5+2P.5/2*50*12       195
7    -50*12/2                3P.5/2*50*12            210
8    2P-.5*-50*12            2P-.5*50*12             225
9    3P.5/2*-50*12           50*12/2                 240
10   3P.5+2P.5/2*-50*12    3P.5-2*-1P.5/2*50*12    255
11   -50*12                  0                      270
12   3P.5+2P.5/2*-50*12    3P.5-2*-1P.5/2*-50*12   285
13   3P.5/2*-50*12           -50*12/2                300
14   2P-.5*-50*12            2P-.5*-50*12            315
15   -50*12/2                3P.5/2*-50*12           330
16   3P.5-2*-1P.5/2*-50*12 3P.5+2P.5/2*-50*12      345
17   0                     -50*12                 360
18   3P.5-2*-1P.5/2*50*12  3P.5+2P.5/2*-50*12       15
19   50*12/2                 3P.5/2*-50*12            30
20   2P-.5*50*12             2P-.5*-50*12             45
21   3P.5/2*50*12            -50*12/2                 60
$   BAY CONNECTIVITY
1  1  2
2  2  3
3  3  4
4  4  5
5  5  6
6  6  7
7  7  8
8  8  9
9  9  10
10  10  11
11  11  12
12  12  13
13  13  14
14  14  15
15  15  16
16  16  17
17  17  18
18  18  19
19  19  20
20  20  21
$   COLUMN ASSIGNMENTS
1 0 ROOF 4 7
1 0 17TH 3 6
1 0 10TH 2 5
1 0  4TH 1 3
2 0 ROOF 8 7
2 0 17TH 7 6
2 0 10TH 6 5
2 0  4TH 5 3
3 2
4 2
```

Example 14
Listing of Input Data
Figure 14-3 (continued)

```
5 2
6 2
7 2
8 2
9 2
10 2
11 2
12 2
13 2
14 2
15 2
16 2
17 2
18 2
19 2
20 2
21 1

$   BEAM ASSIGNMENTS
1 0 ROOF 4 7
1 0 17TH 3 6
1 0 10TH 2 5
1 0  4TH 1 3
2 1
3 1
4 1
5 1
6 1
7 1
8 1
9 1
10 1
11 1
12 1
13 1
14 1
15 1
16 1
17 1
18 1
19 1
20 1

$   FRAME LOCATIONS
1 0 0  3P.5*2/3*65*12 270    /TOWER 1
1 1 -65*12  3P.5*-65*12/3 30  /TOWER 2
1 1 65*12  3P.5*-65*12/3 150  /TOWER 3
$   RESPONSE SPECTRUM DATA
/ELCENTRO RESPONSE SPECTRUM
2 52 CQC 386.4 .05
0 90
      .0   .3275
   .0263   .3299
   .0270   .3297
   .0278   .3429
```

Example 14
Listing of Input Data
Figure 14-3 (continued)

```
    .0286   .3544
    .0294   .3626
    .0303   .3683
    .0313   .3676
    .0323   .3629
    .0333   .3604
    .0345   .3637
    .0357   .3632
    .0370   .3610
    .0385   .3585
    .0400   .3551
    .0417   .3458
    .0435   .3436
    .0455   .3465
    .0476   .3528
    .0500   .3542
    .0526   .3544
    .0556   .3546
    .0588   .3917
    .0625   .4305
    .0667   .4455
    .0714   .4784
    .0769   .5053
    .0833   .5181
    .0909   .4776
    .0966   .5526
    .1000   .5816
    .1015   .5846
    .1070   .5548
    .1130   .5292
    .1198   .5952
    .1274   .6373
    .1361   .6615
    .1460   .6885
    .1575   .8712
    .1709   .8167
    .1869   .9879
    .2062   .9697
    .2299   .7006
    .2597   .8576
    .2985   .7385
    .3509   .8705
    .4255   .9090
    .5405   .9824
    .7407   .4761
   1.1765   .2713
   2.8571   .1983
1000 0
$   LOAD CASE DATA
1 0     0 0 0   0 0   1
2 0     0 0 0   0 0   0 1
$   END OF INPUT DATA
```

Example 14
Listing of Input Data
Figure 14-3 (continued)

EXAMPLE 15

FOURTEEN-STORY SHEAR WALL/FRAME TOWER BOCA 1990 WIND LOAD ANALYSIS

A. DESCRIPTION

This is a 14-story shear wall/frame tower as shown in Figures 15-1 and 15-2.

The structure is analyzed for BOCA 1990 wind loading.

B. SIGNIFICANT OPTIONS OF ETABS ACTIVATED

1. Pierced shear wall modeling
2. Automated BOCA 1990 wind loading
3. Three-dimensional curved frame modeling

C. COMPUTER MODEL

The structure is modeled with a total of six frames. Three identical curved steel frames and three identical checkerboard shear wall frames are used. Kip-inch-second units are used.

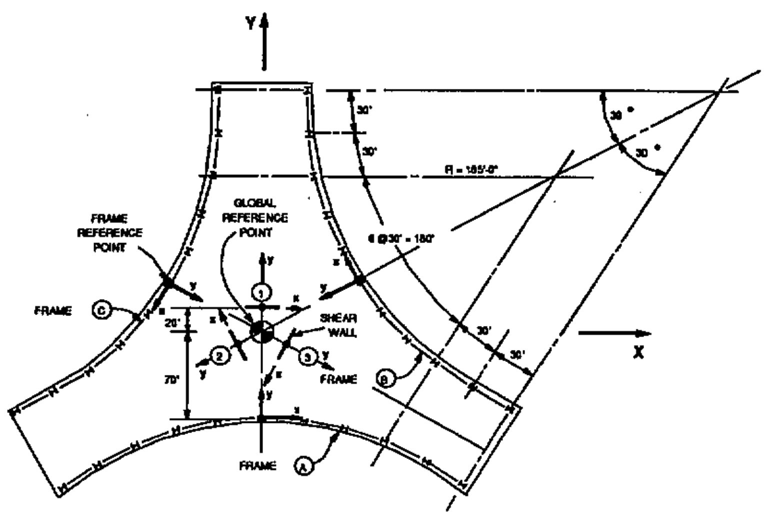
The following parameters are used to generate the wind loading:

Basic Wind Speed = 90 MPH
Exposure Type = C
Importance Factor = 1.0
Building Aspect Ratio = 1.0 (conservative)
Exposure Width = 400 ft (assumed)

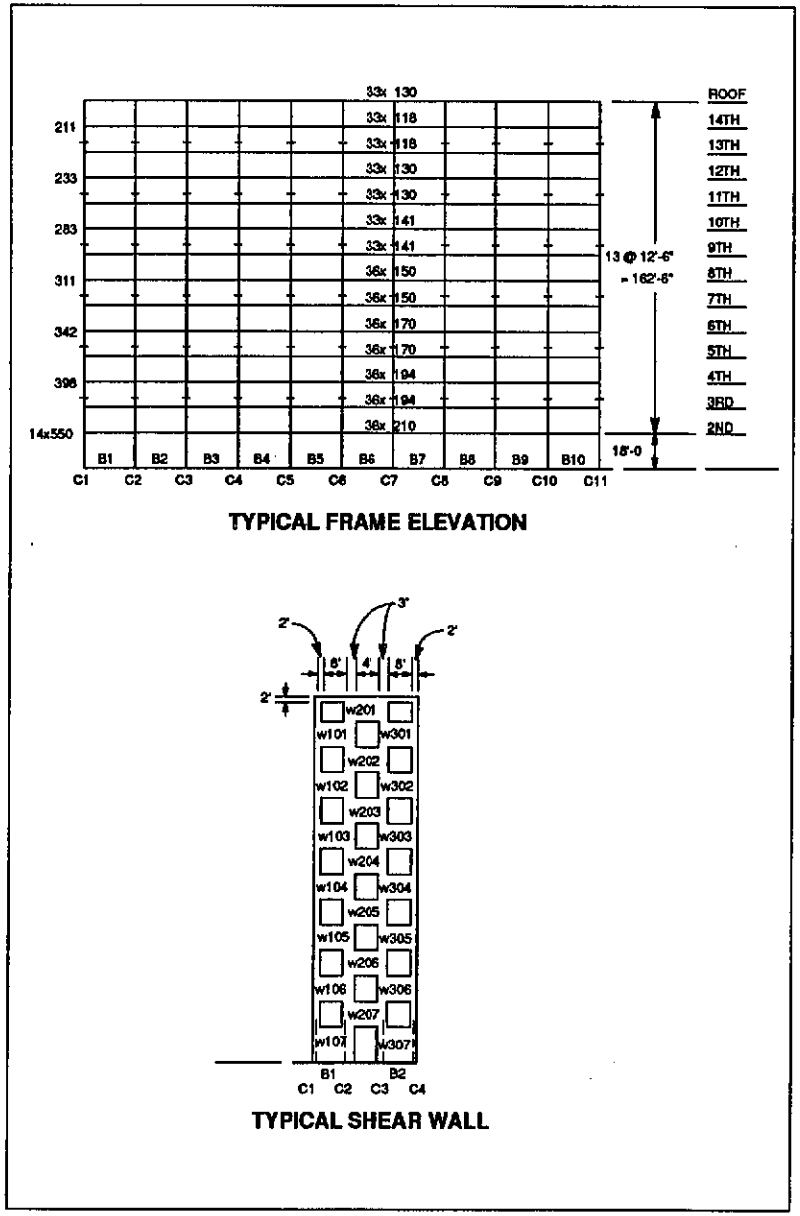
The steel frames are modeled with eleven column lines and ten bays. The modulus of elasticity of steel is taken as 29500 ksi.

The shear wall frame is modeled with four column lines, two bays and 21 panel elements. Two beam elements are used at the top story. A finer mesh can also be used to better define the geometry, but is not considered necessary.

The input data file for this example is EX15. A listing of the input data is given in Figure 15-3.



Example 15
Fourteen-story Shear Wall/frame Tower
Figure 15-1



Example 15
Fourteen-story Shear Wall/frame Tower
Figure 15-2

```
EXAMPLE  15  -  FOURTEEN STORY SHEAR-WALL/FRAME TOWER
BOCA 1990 WIND LOAD ANALYSIS                UNITS:KIP-INCH-SECOND
$                                           CONTROL DATA
 14  2  6  0  2  15  2  8  8  0  1  7  0  0  0  2  0  0  0
 386.4
$                                           STORY DATA
 ROOF  150
 14TH  150
 13TH  150
 12TH  150
 11TH  150
 10TH  150
  9TH  150
  8TH  150
  7TH  150
  6TH  150
  5TH  150
  4TH  150
  3RD  150
  2ND  216
$                                           MATERIAL DATA
 1  S  29500  .49/1728  .3
 2  C   3000  .15/1728  .15
$                                           COLUMN PROPERTIES
 1  1  W14X550
 2  1  W14X398
 3  1  W14X342
 4  1  W14X311
 5  1  W14X283
 6  1  W14X233
 7  1  W14X211
 8  2  RECT  24  18
$                                           BEAM PROPERTIES
 1  1  W33X130
 2  1  W33X118
 3  1  W33X141
 4  1  W36X150
 5  1  W36X170
 6  1  W36X194
 7  1  W36X210
 8  2  RECT  24  0  18
$                                           PANEL PROPERTIES
 1  2  18
$                                           FRAME DATA
$                                           DATA FOR TYPICAL STEEL FRAME
TYPICAL STEEL FRAME
 1  14  11  10
$                                           COLUMN LINE LOCATION
 1    -1661.42  -617.56   30.00
 2    -1349.65  -437.56   30.00
 3    -1037.90  -257.56   27.87
 4     -707.44  -115.74   18.58
 5     -358.42   -29.13    9.29
 6        0.00     0.00    0.00
 7     358.42  -29.13   -9.29
 8     707.44  -115.74  -18.58
 9     1037.90  -257.56  -27.87
 10    1349.65  -437.56  -30.00
 11    1661.42  -617.56  -30.00
```

Example 15
Listing Of Input Data
Figure 15-3

```
$                                          BAY CONNECTIVITY
 1  1  2
 2  2  3
 3  3  4
 4  4  5
 5  5  6
 6  6  7
 7  7  8
 8  8  9
 9  9  10
 10 10 11
$                                          COLUMN ASSIGNMENTS
 1    0  ROOF  7  1
 1    0  13TH  6  1
 1    0  11TH  5  1
 1    0    9TH  4  1
 1    0    7TH  3  1
 1    0    5TH  2  1
 1    0    3RD  1  1
 2    1
 3    1
 4    1
 5    1
 6    1
 7    1
 8    1
 9    1
 10  1
 11  1
$                                          BEAM ASSIGNMENTS
 1    0  ROOF  1
 1    0  14TH  2
 1    0  13TH  2
 1    0  12TH  1
 1    0  11TH  1
 1    0  10TH  3
 1    0    9TH  3
 1    0    8TH  4
 1    0    7TH  4
 1    0    6TH  5
 1    0    5TH  5
 1    0    4TH  6
 1    0    3RD  6
 1    0    2ND  7
 2    1
 3    1
 4    1
 5    1
 6    1
 7    1
 8    1
 9    1
 10  1
```

Example 15
Listing of Input Data
Figure 15-3 (continued)

```
$                                          DATA FOR TYPICAL SHEAR-WALL FRAME
TYPICAL SHEAR-WALL FRAME
 2  14  4  2  0  21
$                                          COLUMN LINE LOCATION
 1  -168
 2    -42
 3     42
 4     168
$                                          BAY CONNECTIVITY
 1  1  2
 2  3  4
$                                          COLUMN ASSIGNMENTS
 1  0  ROOF  8
 1  0  13TH  8
 1  0  11TH  8
 1  0    9TH  8
 1  0    7TH  8
 1  0    5TH  8
 1  0    3RD  8
 4  1

$                                          BEAM ASSIGNMENTS
 1  0  ROOF  8
 2  1

$                                          PANEL LOCATIONS
 101  14TH  1  2  1
 102  12TH  1  2  1
 103  10TH  1  2  1
 104    8TH  1  2  1
 105    6TH  1  2  1
 106    4TH  1  2  1
 107    2ND  1  2  1
 201  ROOF  2  3  1
 202  13TH  2  3  1
 203  11TH  2  3  1
 204    9TH  2  3  1
 205    7TH  2  3  1
 206    5TH  2  3  1
 207    3RD  2  3  1
 301  14TH  3  4  1
 302  12TH  3  4  1
 303  10TH  3  4  1
 304    8TH  3  4  1
 305    6TH  3  4  1
 306    4TH  3  4  1
 307    2ND  3  4  1
```

Example 15
Listing of Input Data
Figure 15-3 (continued)

```
$                                      FRAME LOCATIONS
 1  0        0.0      -840      0.0  /FRAME  A
 1  1    3P.5/2*70*12  420.0  120.0  /FRAME  B
 1  1    3P.5/2*-70*12  420.0  240.0  /FRAME  C
 2  0          0.00    240.00         0.0  /SHEAR  WALL  1
 2  1      3P.5/2*-20*12  -120.00      120.0  /SHEAR  WALL  2
 2  1      3P.5/2*20*12  -120.00    240.0  /SHEAR  WALL  3 .
$                                      BOCA 1990 WIND LOAD DATA
 90  C  1.0  1  1/12  1/144000


 4800  0    0    4800  0  0
 4800  0    0    4800  0  0
 4800  0    0    4800  0  0
 4800  0    0    4800  0  0
 4800  0    0    4800  0  0
 4800  0    0    4800  0  0
 4800  0    0    4800  0  0
 4800  0    0    4800  0  0
 4800  0    0    4800  0  0
 4800  0    0    4800  0  0
 4800  0    0    4800  0  0
 4800  0    0    4800  0  0
 4800  0    0    4800  0  0
 4800  0    0    4800  0  0
$                                      LOAD CASE DATA
 1  0  0  0  0  1
 2  0  0  0  0  0  1
$   END OF INPUT DATA
```

Example 15
Listing of Input Data
Figure 15-3 (continued)

EXAMPLE 16

SEVENTY-STORY TOWER ASCE 7-88 WIND AND EIGENVALUE ANALYSIS

A. DESCRIPTION

This is a 70-story tower structure, shown in plan in Figure 16-1. The lateral load resisting system consists of four steel frames at the periphery and four identical elevator walls. The steel frames are identical except that the north and south frames are longer than the east and west frames. The sizes of the members and the typical story weights are given in Figure 16-2.

The mode shapes and frequencies of the structure are evaluated.

B. SIGNIFICANT OPTIONS OF ETABS ACTIVATED

1. Three-dimensional analysis
2. Modeling of nonplanar walls
3. Shear wall/frame interaction
4. Automatic AISC wide flange property selection
5. Automated P-delta effect inclusion
6. Automatic calculation of story masses

7. Automated ASCE 7-88 Wind Loading
8. Large capacity analysis
9. Eigenvalue analysis

C. COMPUTER MODEL

The building is modeled by using a total of eight frames of three different types. The long steel frame is modeled with 12 column lines and 11 bays, and is used as the north and south frames. The short steel frame is modeled with eight column lines and seven bays, and is used as the east and west frames. The elevator shear wall unit is modeled with 10 column lines and 9 panels per floor and is used as each of the four identical elevator walls. Kip-inch-second units are used.

The following parameters are specified to automatically generate the ASCE 7-88 wind loading:

Basic Wind Speed = 90 MPH
Exposure Type = B
Importance Factor = 1.0
Aspect Ratio = 156/108 = 1.44
Gust Factor = 1.29 (calculated
for this flexible building as per
code appendix)

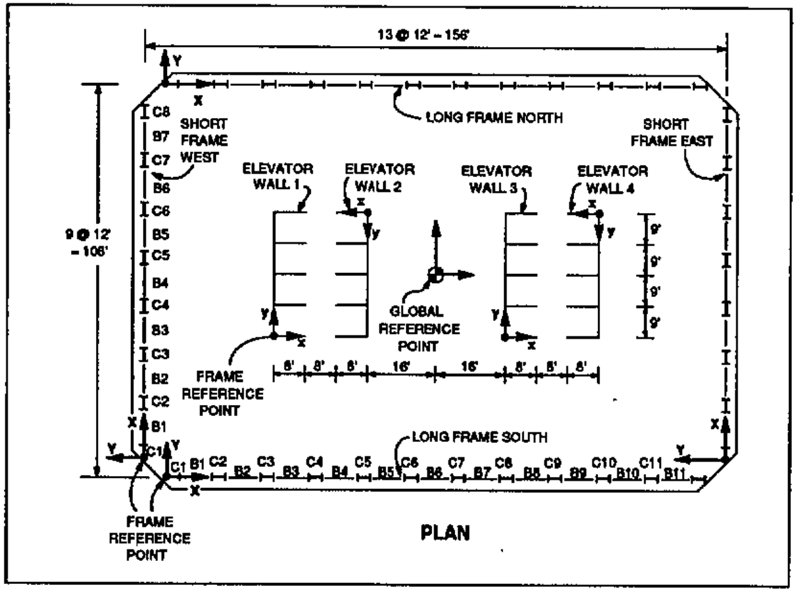
The first 30 eigenvalues are calculated. P-delta effects are included and the rigid offset lengths at the joints for beams and columns are reduced by 50% to account for deformations within the joints.

The input data file is EX16. A listing of the input data is given in Figure 16-3.

D. COMPARISON OF RESULTS

This example is included to test the large capacity options of the program.

This structure was also reanalyzed with the P-delta effect excluded. The natural periods from the two runs are compared in Figure 16-4. For this example, the maximum difference in the periods is about 7%.



Example 16
Seventy-story Tower
Figure 16-1

STORY	TYPICAL COLUMN SIZE	TYPICAL BEAM SIZE	TYPICAL WALL Thickness* (Inches)	TYPICAL STORY WEIGHTS (Ksf)
1st - 10th	W14X730	W36X300	42	0.19
11th - 20th	W14X730	W36X300	36	0.18
21st - 30th	W14X730	W36X300	32	0.17
31st - 40th	W14X605	W36X260	28	0.16
41st - 50th	W14X605	W36X260	24	0.15
51st - 60th	W14X426	W36X194	18	0.14
61st - 70th	W14X311	W36X160	12	0.13

*Inner cross walls are 18" thick for full height

Modulus of elasticity of steel = 29000 ksi
Modulus of elasticity of concrete = 4000 ksi

Example 16
Schedule of Sizes and Weights
Figure 16-2

```
EXAMPLE 16  -  SEVENTY STORY TOWER
ASCE 7-88 WIND AND EIGENVALUE ANALYSIS   UNITS:KIP-INCH-SECOND
$                                        CONTROL DATA
 70  3  8  7  2  30  2  4  4  0  7  8  1  0  1  2  0  0  0
 386.4
$                                        MASS DATA
 1  1  1/386.4
 .19/144 0  0  156*12  108*12
 2  1  1/386.4
 .18/144 0  0  156*12  108*12
 3  1  1/386.4
 .17/144 0  0  156*12  108*12
 4  1  1/386.4
 .16/144 0  0  156*12  108*12
 5  1  1/386.4
 .15/144 0  0  156*12  108*12
 6  1  1/386.4
 .14/144 0  0  156*12  108*12
 7  1  1/386.4
 .13/144 0  0  156*12  108*12
$                                        STORY DATA
 70TH  144  7
 69TH  144  7
 68TH  144  7
 67TH  144  7
 66TH  144  7
 65TH  144  7
 64TH  144  7
 63RD  144  7
 62ND  144  7
 61ST  144  7
 60TH  144  6
 59TH  144  6
 58TH  144  6
 57TH  144  6
 56TH  144  6
 55TH  144  6
 54TH  144  6
 53RD  144  6
 52ND  144  6
 51ST  144  6
 50TH  144  5
 49TH  144  5
 48TH  144  5
 47TH  144  5
 46TH  144  5
 45TH  144  5
 44TH  144  5
 43RD  144  5
 42ND  144  5
 41ST  144  5
 40TH  144  4
 39TH  144  4
 38TH  144  4
```

Example 16
Listing of Input Data
Figure 16-3

```
  37TH  144  4
  36TH  144  4
  35TH  144  4
  34TH  144  4
  33RD  144  4
  32ND  144  4
  31ST  144  4
  30TH  144  3
  29TH  144  3
  28TH  144  3
  27TH  144  3
  26TH  144  3
  25TH  144  3
  24TH  144  3
  23RD  144  3
  22ND  144  3
  21ST  144  3
  20TH  144  2
  19TH  144  2
  18TH  144  2
  17TH  144  2
  16TH  144  2
  15TH  144  2
  14TH  144  2
  13TH  144  2
  12TH  144  2
  11TH  144  2
  10TH  144  1
   9TH  144  1
   8TH  144  1
   7TH  144  1
   6TH  144  1
   5TH  144  1
   4TH  144  1
   3RD  144  1
   2ND  144  1
   1ST  216  1
$                                             MATERIAL PROPERTIES
 1  S  29000  .490/1728  0.3
 2  C   4000  .150/1728  0.2
$                                             COLUMN PROPERTIES
 1  1  W14X311
 2  1  W14X426
 3  1  W14X605
 4  1  W14X730
$                                             BEAM PROPERTIES
 1  1  W36X160
 2  1  W36X194
 3  1  W36X260
 4  1  W36X300
$                                             PANEL PROPERTIES
 1  2  12
 2  2  18
 3  2  24
 4  2  28
 5  2  32
 6  2  36
 7  2  42
```

Example 16
Listing of Input Data
Figure 16-3 (continued)

```
$                                             FRAME DATA
$                                             DATA FOR FRAME TYPE 1
LONG DIRECTION TYPICAL STEEL FRAME
 1  70  12  11
$                                             COLUMN LINE LOCATION DATA
 1   0
 2  12*12
 3  24*12
 4  36*12
 5  48*12
 6  60*12
 7  72*12
 8  84*12
 9  96*12
10 108*12
11 120*12
12 132*12
$                                             BAY CONNECTIVITY DATA
 1  1  2
 2  2  3
 3  3  4
 4  4  5
 5  5  6
 6  6  7
 7  7  8
 8  8  9
 9  9 10
10 10 11
11 11 12
$                                             COLUMN ASSIGNMENT DATA
 1  0  70TH  1   9
 1  0  60TH  2   9
 1  0  50TH  3  19
 1  0  30TH  4  29
 2  1
 3  1
 4  1
 5  1
 6  1
 7  1
 8  1
 9  1
10  1
11  1
12  1
$                                             BEAM ASSIGNMENT DATA
 1  0  70TH  1   9
 1  0  60TH  2   9
 1  0  50TH  3  19
 1  0  30TH  4  29
 2  1
 3  1
 4  1
 5  1
 6  1
 7  1
 8  1
 9  1
10  1
11  1
```

Example 16
Listing of Input Data
Figure 16-3 (continued)

```
$                                                   DATA FOR FRAME TYPE 2
SHORT DIRECTION TYPICAL STEEL FRAME
 2  70   8   7
$                                                   COLUMN LINE LOCATION DATA
 1   0
 2  12*12
 3  24*12
 4  36*12
 5  48*12
 6  60*12
 7  72*12
 8  84*12
$                                                   BAY CONNECTIVITY DATA
 1  1  2
 2  2  3
 3  3  4
 4  4  5
 5  5  6
 6  6  7
 7  7  8
$                                                   COLUMN ASSIGNMENT DATA
 1  0  70TH  1   9
 1  0  60TH  2   9
 1  0  50TH  3  19
 1  0  30TH  4  29
 2  1
 3  1
 4  1
 5  1
 6  1
 7  1
 8  1

$                                                   BEAM ASSIGNMENT DATA
 1  0  70TH  1   9
 1  0  60TH  2   9
 1  0  50TH  3  19
 1  0  30TH  4  29
 2  1
 3  1
 4  1
 5  1
 6  1
 7  1
```

Example 16
Listing of Input Data
Figure 16-3 (continued)

```
$                                       DATA FOR FRAME TYPE 3
TYPICAL ELEVATOR WALL
 3  70  10  0  0  630
$                                       COLUMN LINE LOCATION DATA
 1  0
 2  0      9*12
 3  0     18*12
 4  0     27*12
 5  0     36*12
 6  8*12   0
 7  8*12   9*12
 8  8*12  18*12
 9  8*12  27*12
10  8*12  36*12
$                                       COLUMN ASSIGNMENTS

$                                       PANEL ASSIGNMENTS
 1  70TH  1  6  1   9
 1  60TH  1  6  2   9
 1  50TH  1  6  3   9
 1  40TH  1  6  4   9
 1  30TH  1  6  5   9
 1  20TH  1  6  6   9
 1  10TH  1  6  7   9
 1  70TH  1  2  1   9
 1  60TH  1  2  2   9
 1  50TH  1  2  3   9
 1  40TH  1  2  4   9
 1  30TH  1  2  5   9
 1  20TH  1  2  6   9
 1  10TH  1  2  7   9
 1  70TH  2  3  1   9
 1  60TH  2  3  2   9
 1  50TH  2  3  3   9
 1  40TH  2  3  4   9
 1  30TH  2  3  5   9
 1  20TH  2  3  6   9
 1  10TH  2  3  7   9
 1  70TH  3  4  1   9
 1  60TH  3  4  2   9
 1  50TH  3  4  3   9
 1  40TH  3  4  4   9
 1  30TH  3  4  5   9
 1  20TH  3  4  6   9
 1  10TH  3  4  7   9
 1  70TH  4  5  1   9
 1  60TH  4  5  2   9
 1  50TH  4  5  3   9
 1  40TH  4  5  4   9
 1  30TH  4  5  5   9
 1  20TH  4  5  6   9
 1  10TH  4  5  7   9
 1  70TH  5 10  1   9
 1  60TH  5 10  2   9
 1  50TH  5 10  3   9
 1  40TH  5 10  4   9
 1  30TH  5 10  5   9
 1  20TH  5 10  6   9
 1  10TH  5 10  7   9
 1  70TH  2  7  2  69
 1  70TH  3  8  2  69
 1  70TH  4  9  2  69
```

Example 16
Listing of Input Data
Figure 16-3 (continued)

```
$                                                    FRAME LOCATION DATA
 1  1  -66*12  54*12   0  /LONG FRAME NORTHE
 1  1  -66*12 -54*12   0  /LONG FRAME SOUTH
 2  1  -78*12 -42*12  90  /SHORT FRAME WEST
 2  1   78*12 -42*12  90  /SHORT FRAME EAST
 3  1  -42*12 -18*12   0  /ELEVATOR WALL NO.1
 3  1  -18*12  18*12 180  /ELEVATOR WALL NO.2
 3  1   18*12 -18*12   0  /ELEVATOR WALL NO.3
 3  1   42*12  18*12 180  /ELEVATOR WALL NO.4
$                                                    ASCE 7-88 WIND LOAD DATA
 90  B  1.0  1.44  1.29  1/12  1/144000

 108*12  0  0  156*12  0  0
 108*12  0  0  156*12  0  0
 108*12  0  0  156*12  0  0
 108*12  0  0  156*12  0  0
 108*12  0  0  156*12  0  0
 108*12  0  0  156*12  0  0
 108*12  0  0  156*12  0  0
 108*12  0  0  156*12  0  0
 108*12  0  0  156*12  0  0
 108*12  0  0  156*12  0  0
 108*12  0  0  156*12  0  0
 108*12  0  0  156*12  0  0
 108*12  0  0  156*12  0  0
 108*12  0  0  156*12  0  0
 108*12  0  0  156*12  0  0
 108*12  0  0  156*12  0  0
 108*12  0  0  156*12  0  0
 108*12  0  0  156*12  0  0
 108*12  0  0  156*12  0  0
 108*12  0  0  156*12  0  0
 108*12  0  0  156*12  0  0
 108*12  0  0  156*12  0  0
 108*12  0  0  156*12  0  0
 108*12  0  0  156*12  0  0
 108*12  0  0  156*12  0  0
 108*12  0  0  156*12  0  0
 108*12  0  0  156*12  0  0
 108*12  0  0  156*12  0  0
 108*12  0  0  156*12  0  0
 108*12  0  0  156*12  0  0
 108*12  0  0  156*12  0  0
 108*12  0  0  156*12  0  0
 108*12  0  0  156*12  0  0
 108*12  0  0  156*12  0  0
 108*12  0  0  156*12  0  0
 108*12  0  0  156*12  0  0
 108*12  0  0  156*12  0  0
 108*12  0  0  156*12  0  0
 108*12  0  0  156*12  0  0
 108*12  0  0  156*12  0  0
```

Example 16
Listing of Input Data
Figure 16-3 (continued)

```
108*12  0  0  156*12  0  0
108*12  0  0  156*12  0  0
108*12  0  0  156*12  0  0
108*12  0  0  156*12  0  0
108*12  0  0  156*12  0  0
108*12  0  0  156*12  0  0
108*12  0  0  156*12  0  0
108*12  0  0  156*12  0  0
108*12  0  0  156*12  0  0
108*12  0  0  156*12  0  0
108*12  0  0  156*12  0  0
108*12  0  0  156*12  0  0
108*12  0  0  156*12  0  0
108*12  0  0  156*12  0  0
108*12  0  0  156*12  0  0
108*12  0  0  156*12  0  0
108*12  0  0  156*12  0  0
108*12  0  0  156*12  0  0
108*12  0  0  156*12  0  0
108*12  0  0  156*12  0  0
108*12  0  0  156*12  0  0
108*12  0  0  156*12  0  0
108*12  0  0  156*12  0  0
108*12  0  0  156*12  0  0
108*12  0  0  156*12  0  0
108*12  0  0  156*12  0  0
108*12  0  0  156*12  0  0
108*12  0  0  156*12  0  0
108*12  0  0  156*12  0  0
108*12  0  0  156*12  0  0
$                                 LOAD CASE DATA
1 0  0 0 0  1
2 0  0 0 0  0 1
$   END OF INPUT DATA
```

Example 16
Listing of Input Data
Figure 16-3 (continued)

MODE NUMBER	ANALYSIS WITH P-DELTA	ANALYSIS WITHOUT P-DELTA
1	9.480	8.885
2	8.803	8.339
3	5.987	5.987
4	2.552	2.487
5	1.902	1.877
6	1.597	1.597
7	1.322	1.298
8	0.866	0.852
9	0.784	0.780
10	0.780	0.779
11	0.635	0.627
12	0.486	0.486
13	0.486	0.480
14	0.435	0.433
15	0.384	0.380
16	0.342	0.342
17	0.312	0.309
18	0.280	0.279
19	0.259	0.257
20	0.256	0.256
21	0.218	0.217
22	0.200	0.200
23	0.198	0.198
24	0.186	0.185
25	0.163	0.163
26	0.161	0.160
27	0.150	0.149
28	0.140	0.138
29	0.136	0.136
30	0.123	0.122

Example 16
Comparisons of Natural Periods
Figure 16-4

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PLOTTER™

An Interactive Input and Output Display Postprocessor for ETABS®

by
Ashraf Habibullah

Version 5.4
Revised July, 1992

Developed and written in U.S.A.

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DISCLAIMER

CONSIDERABLE TIME, EFFORT AND EXPENSE HAVE GONE INTO THE DEVELOPMENT AND DOCUMENTATION OF PLOTTER. 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 USER MUST EXPLICITLY UNDERSTAND THE ASSUMPTIONS OF THE PROGRAM AND MUST INDEPENDENTLY VERIFY THE RESULTS.

TABLE OF CONTENTS

I.

INTRODUCTION

PLOTTER is an interactive input and output plotting post-processor for the building analysis computer program ETABS [1].

The program has options for plotting two-dimensional and three-dimensional views displaying any of the following:

1. Undeformed Structural Geometry
2. Frame Loading Plots
3. Static Analysis Deformed Shapes
4. Mode Shapes
5. Instantaneous Time History Deformed Shapes
6. Element Force Diagrams
7. STEELER [2] Calculated Stress Ratios

The model can be viewed from any arbitrary direction. The user locates an arbitrary point with respect to the ETABS Global X,Y,Z Coordinate System. This point is called the view control point. The view is set in the direction pointing from the view control point towards the ETABS Global origin. This convention only sets the view direction. The actual location of the viewer's eye is assumed to be at infinity; in other words, the view is an infinite projection onto the plot plane, and the vector from the view control point to the ETABS Global origin is the normal to the plot plane.

Once the view direction has been set, the user can rotate the view by specifying which of the ETABS global axes (X, Y, Z, -X, -Y or -Z) is to appear vertically up on the screen.

The ETABS positive Global X,Y,Z axes are plotted to show the orientation of the plot.

All scaling of the views is automatic and the program has options to display "blowups" of localized regions of the structure.

While displaying the deformed shape of a structure, the user may also plot the undeformed shape (as a "reference structure") allowing convenient comparison with the deformed shape. The user can set translational and rotational maxima to accentuate the structural deformation patterns.

The deformed shapes of elements may be plotted with displaced straight lines or with bent cubic curves that preserve joint rotational compatibility at the ends of the members.

Deformed shapes and mode shapes may be displayed with or without animation.

The program has an option whereby all elements may be shrunk about their centroids, thereby clearly displaying element connectivities and uncovering overlapped element boundaries. Also available is an option to remove hidden lines. All joints (or none) may be highlighted or only those disconnected from the diaphragm.

Labeling options for identifying the column lines, the bays and the brace and panel elements are available. Section property ID's of elements can be displayed. Also pin ended connections can be highlighted.

II.

SYSTEM PREPARATION, EXECUTION PROCEDURES, DETAILS

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

User familiarity with MS-DOS is assumed.

The complete PLOTTER package includes:

a. This manual

b. Floppy disk, containing the following:

   1. Program Executable, PLOTTER.EXE
   2. Sample ETABS Postprocessing Files
      (of the form ????.PST)
   3. Sample STEELER Plot Files
      (of the form ????.PLO)

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

A. INSTALLING, CONFIGURING AND TESTING

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

Before putting the system into a production mode, the user should test the system by running the sample postprocessing files provided on the disk.

B. EXECUTING THE PLOTTER PROGRAM

This section explains how to execute the PLOTTER program.

Say that the ETABS data, associated with the structure the user wishes to analyze, has been prepared and entered into a data file called EXAMPLE. A successful execution of ETABS with the data file EXAMPLE will then create a postprocessing file EXAMPLE.PST. This file will exist at the end of a data check run as well as at the end of a complete execution run. Deformed shapes, mode shapes and force/moment diagrams may only be plotted from a postprocessing file that is created by an execution run, whereas undeformed geometry plots and frame loading plots may be plotted from postprocessing files created by data check runs or execution runs.

A typical ETABS postprocessing file is the only file needed to execute PLOTTER if STEELER stress check results are not to be displayed. If stress check results are to be displayed the STEELER plot file of the form ???.PLO produced by a successful STEELER run is also required.

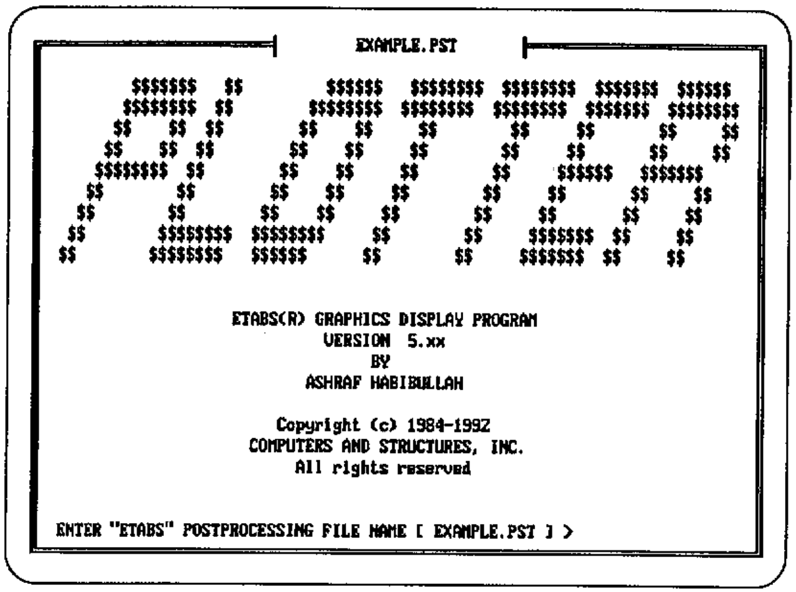
To execute PLOTTER proceed as follows:

From the directory where the postprocessing file resides, enter the command:

PLOTTER <CR>

Note: the PLOTTER executable must reside in the same directory unless a path to the PLOTTER executable has been activated using the MS-DOS PATH command.

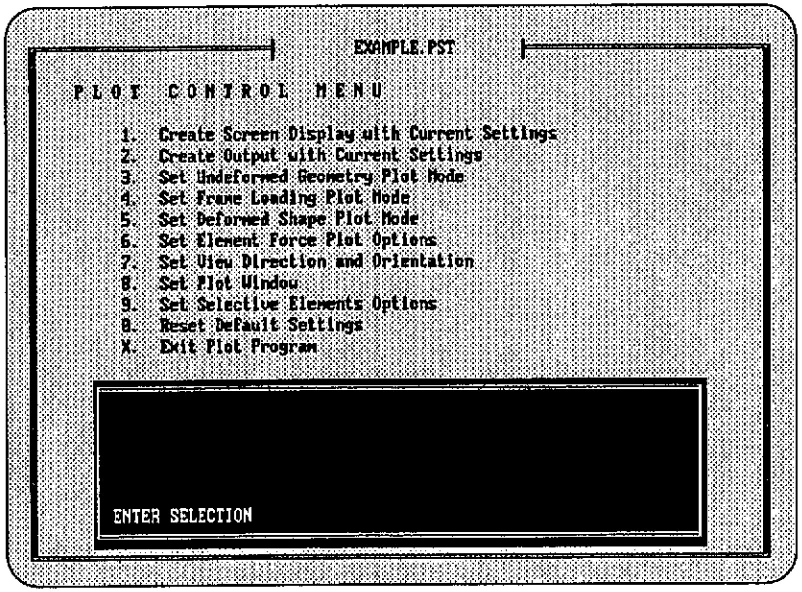
After a few seconds the following banner will appear on the screen:



Enter **EXAMPLE.PST <CR>**

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

After a few seconds of initialization, the program will flash the following menu:



This is the Plot Control Menu. Selection 1 will trigger the generation of a plot to the screen; selections 2 through 9 will display a lower level menu for setting other options; and selection 0 will activate a resetting process.

In each case, control is subsequently returned to this level and the Plot Control Menu is redisplayed.

Entering an X will exit the program and return control to the operating system.

A selection is made from the Plot Control Menu or any of the sub-menus by entering the selection number from the keyboard or by selecting the line through a mouse and clicking on either the mouse left or right button. A selection can also be made by using the up and down arrow keys on the keyboard to highlight the selection and then entering a <CR> or a mouse click. A carriage return or a mouse click is also required when any entry is made by the user in response to a menu prompt. (Any numerical entry may not be longer than ten characters).

If a menu option selected has several choices the left and right arrow keys should be used to cycle through them until they are set to the desired selection. Alternatively, repeated selection of a menu option will also cycle through the choices.

A display of N/A following a particular menu option indicates that the option was Not Activated in the particular ETABS data case.

An unacceptable entry is prompted by an error message and a beep. An unacceptable menu selection is prompted by a beep.

The following ten sections of this chapter correspond to the ten options of the Plot Control Menu. Each section defines in detail the response of the program associated with the corresponding user selection.

User familiarity with the ETABS control parameters is assumed.

1. CREATE SCREEN DISPLAY WITH CURRENT SETTINGS

This is Selection 1 on the Plot Control Menu.

This selection triggers the generation of the plot on the screen and the program will respond with the following message:

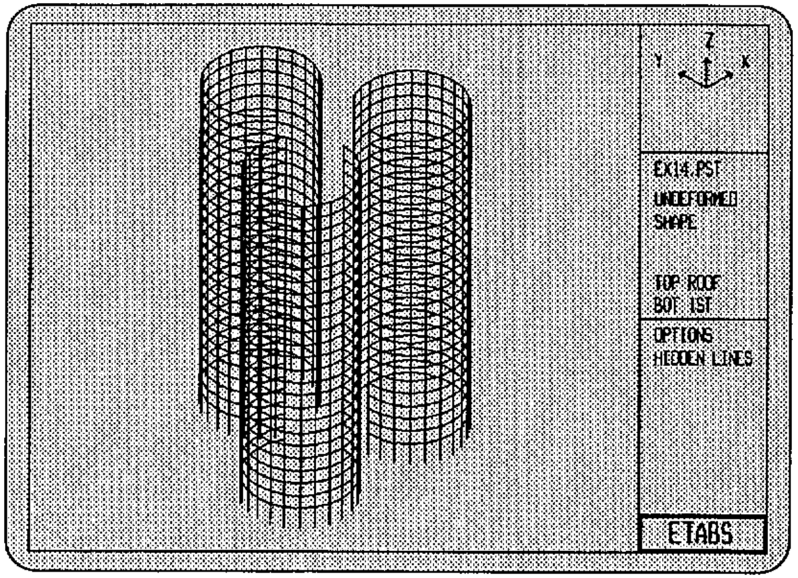
```
PLOT CREATION IN PROGRESS - PLEASE WAIT
```

A few seconds later, the plot will start appearing on the screen.

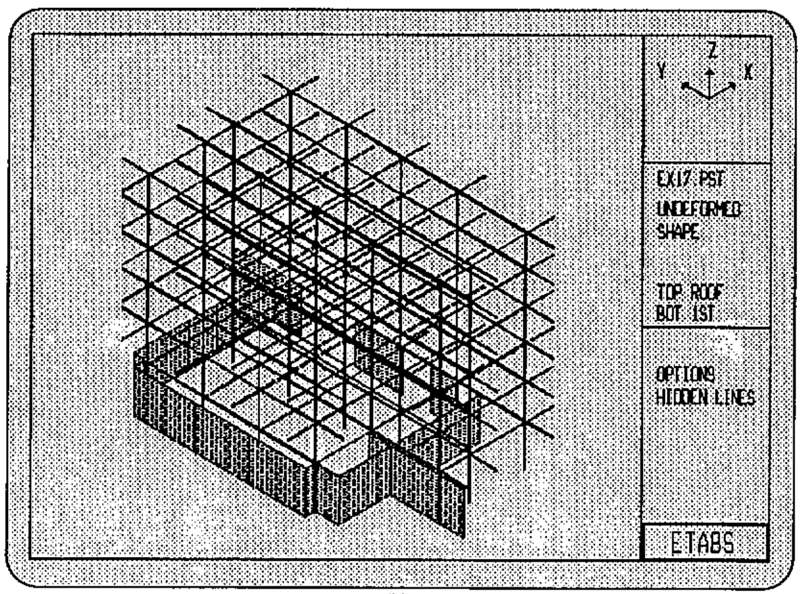
Options 3 through 9 on the Plot Control Menu have lower level menus that are used to set various program options. Once the options are set, the user must return to the Plot Control Menu and select this option to initiate the screen display.

At start-up the program is initialized with a set of default options and the Plot Control Menu is flashed. At this stage the user can, without setting any other parameters, choose Selection 1 on the Plot Control Menu and the program will produce a screen plot with the default options, namely, an isometric view of undeformed geometry of the whole structure, with no labeling. See Figure 1.

After the plot is complete, a <CR> or click of the mouse button will return the user to the Plot Control Menu.



(1a)



(1b)

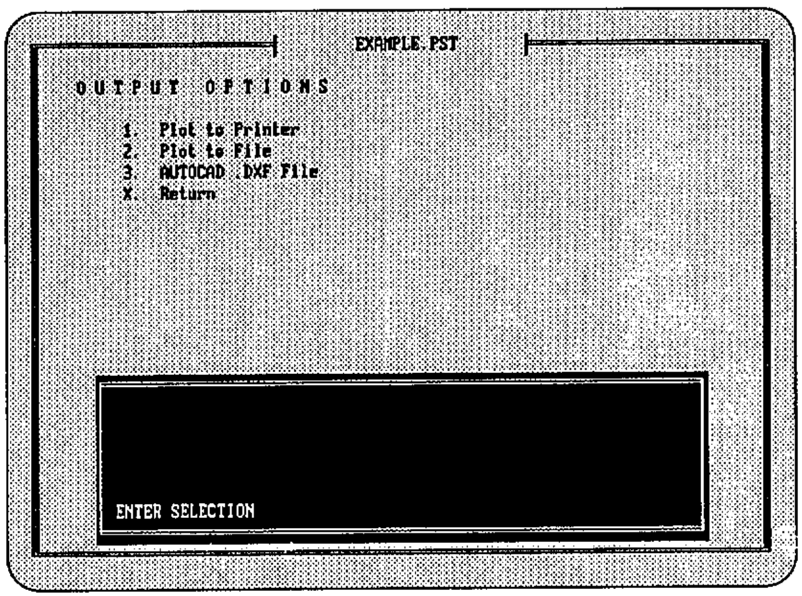
Undeformed Geometry Plots with Start-up Default Options
Figure 1

2. CREATE OUTPUT WITH CURRENT SETTINGS

This is Selection 2 on the Plot Control Menu.

This selection is for creating high resolution hard copies using a graphics-compatible dot matrix printer or for creating an AUTOCAD compatible ".DXF" file.

This selection responds with the following menu:



The following is a description of each of the output options listed in the menu above and the associated responses of the program.

1. Plot to Printer

This selection is for obtaining hard copies of the plot.

On selecting this option, the program will respond with the following question on the screen:

```
IS PRINTER ON LINE AND SET TO TOP OF FORM?
ENTER ([Y], N)  >
```

At this point, check the printer and paper and enter **<CR>** to accept the default of **Y**. If an **N** is entered the program will return to the output options menu.

The program will then begin the creation of a plot buffer and will respond with the following message on the screen:

```
PLOT CREATION IN PROGRESS - PLEASE WAIT
```

After the plot buffer is created, the hard copy will start appearing on the printer while the following message is displayed on the screen:

```
PLOT PRINTING IN PROGRESS - PLEASE WAIT
```

Upon completion of the hard copy, the program will return the user to the Plot Control Menu.

2. Plot to File

This option is for writing the plot to a file for later printing on a printer.

On selecting this option, the program will respond with the following message on the screen:

```
ENTER FILE NAME [EXAMPLE.PLT]  >
```

The default name shown is the name of the current file with a .PLT extension. If this name is acceptable, enter **<CR>**. If a new filename is desired enter a new filename with a .PLT extension. If no extension is provided or if another extension is entered, the program will use a .PLT extension.

If the file already exists, the program will respond as follows:

```
FILE ALREADY EXISTS.
O.K. TO APPEND  ??  ENTER ([Y], N)  >
```

If it is O.K. to append enter **<CR>** to accept the **Y** default. If an **N** is entered the program will return to the output options menu.

When the file selection is complete the program responds by displaying:

```
PLOT CREATION IN PROGRESS - PLEASE WAIT
```

A file is created (or appended to) in the current directory. This file can later be printed on the printer after exiting the PLOTTER program by using the DOS COPY command with a binary copy option activated as follows:

COPY ***filename*****.PLT LPT1: /b**

where *filename* is the name of the file to be printed. Substitute other device names if printer is not connected to LPT1.

Upon completion of the plot file creation, the program will return the user to the Plot Control Menu.

3. AUTOCAD .DXF File

This option is for creating an AUTOCAD compatible .DXF file. This file can be used to transfer the plot to AUTOCAD by use of the DXFIN command. The plot can then be manipulated within AUTOCAD and can be displayed/plotted on the various devices supported by AUTOCAD.

On selecting this option, the program will request the name of the .DXF file to be created as follows:

```
ENTER FILE NAME  >
```

Any eight character name can be provided. The program will automatically attach the .DXF extension to it. If a .DXF file by this name already exists, the program responds as follows:

```
FILE ALREADY EXISTS
```

The program will then return to the output options menu.

When the file selection is complete the program responds by displaying:

```
PLOT CREATION IN PROGRESS - PLEASE WAIT
```

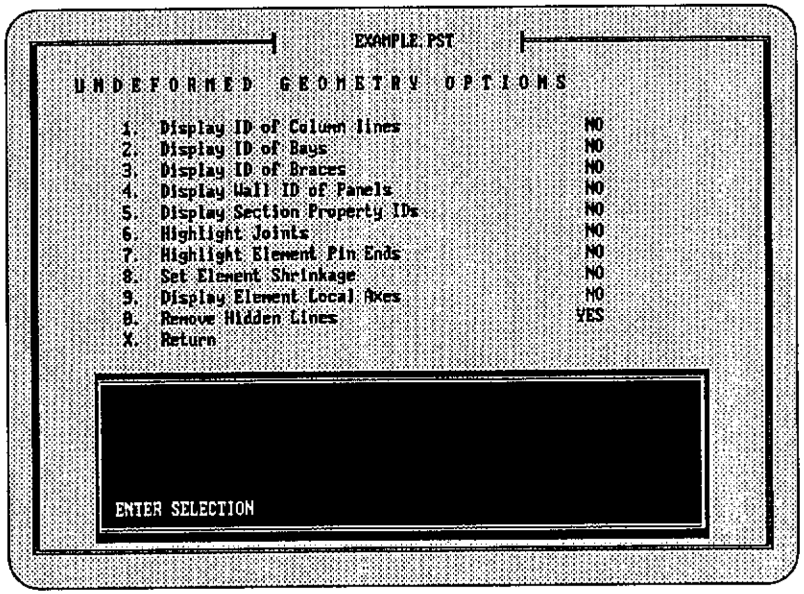
A .DXF file is created in the current directory.

Upon completion of the .DXF file creation, the program will return the user to the Plot Control Menu.

3. SET UNDEFORMED GEOMETRY PLOT MODE

This is Selection 3 on the Plot Control Menu.

This selection sets the program into an undeformed geometry plotting mode and responds with the following menu:



The current status of the options are displayed, with a YES or NO setting.

On selecting an option, the status of the selected option is immediately reversed, and the menu is redisplayed with the change.

Any of the options in this menu may be reset as many times as necessary. The last entry associated with the option is used and stays unchanged until it is reset.

When all entries are set as desired, enter an X to return to the Plot Control Menu.

The following is a description of each of the options listed in the above menu, and the associated responses of the program.

1. **Display ID of Column Lines**

   With this selection, column line numbers will be shown on the plot if this option is set to YES. See Figure 2a.

2. **Display ID of Bays**

   With this selection, bay numbers will be shown on the plot if this option is set to YES. See Figure 10b.

3. **Display ID of Braces**

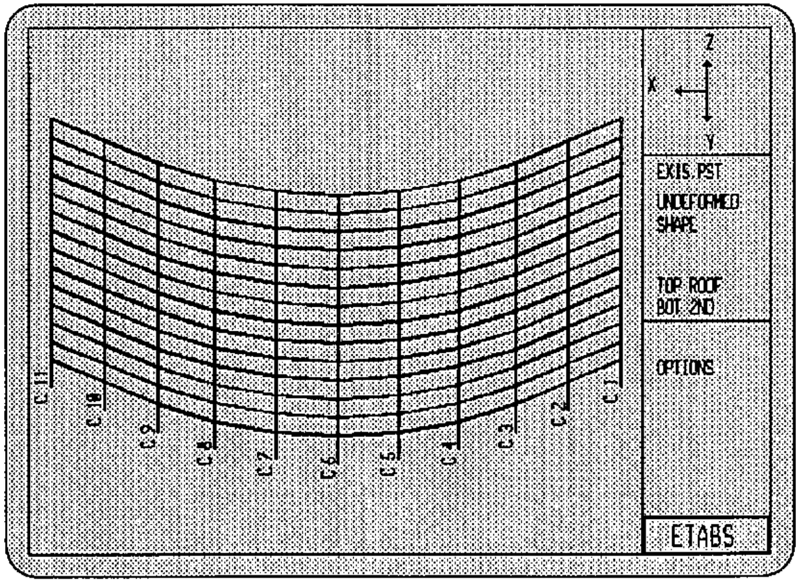
   With this selection, brace ID numbers will be shown on the plot if this option is set to YES.

4. **Display Wall ID of Panels**

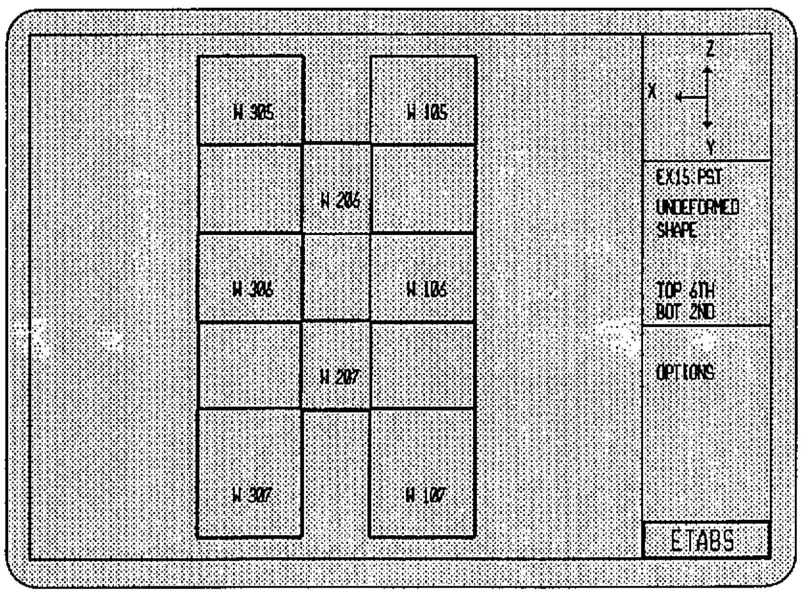
   With this selection, the wall ID numbers associated with each panel will be shown on the plot if this option is set to YES. See Figure 2b.

5. **Display Section Property ID's**

   With this selection, the section property ID's of the elements are shown on the plot if this option is set to YES.



(2a)



(2b)
Element Identifications
Figure 2

6. **Highlight Joints**

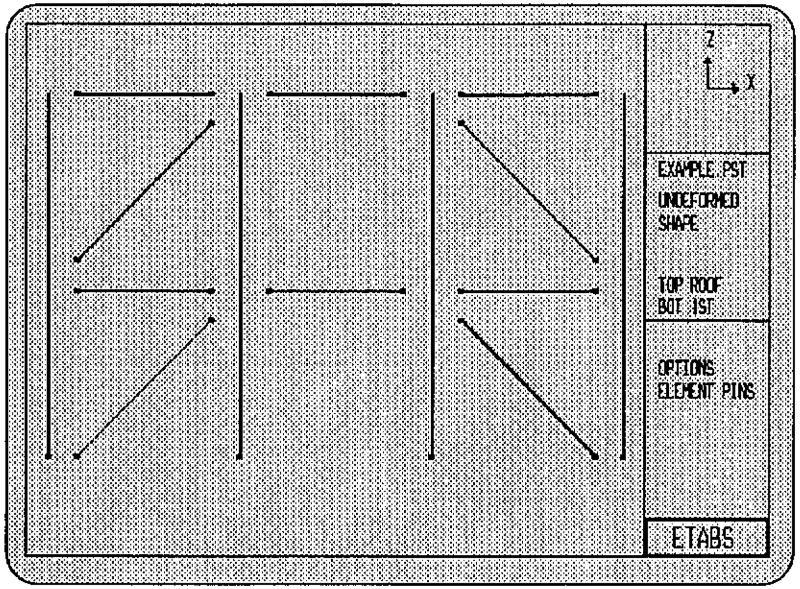
With this selection, the user is prompted to choose the joints to be highlighted. The choices are NO, ALL and DISC. If ALL is selected all joints in the structure will be highlighted with an asterisk. See Figure 3b. If DISC is selected all the joints that are disconnected from the corresponding diaphragms will be highlighted with an asterisk.

7. **Highlight Element Pin Ends**

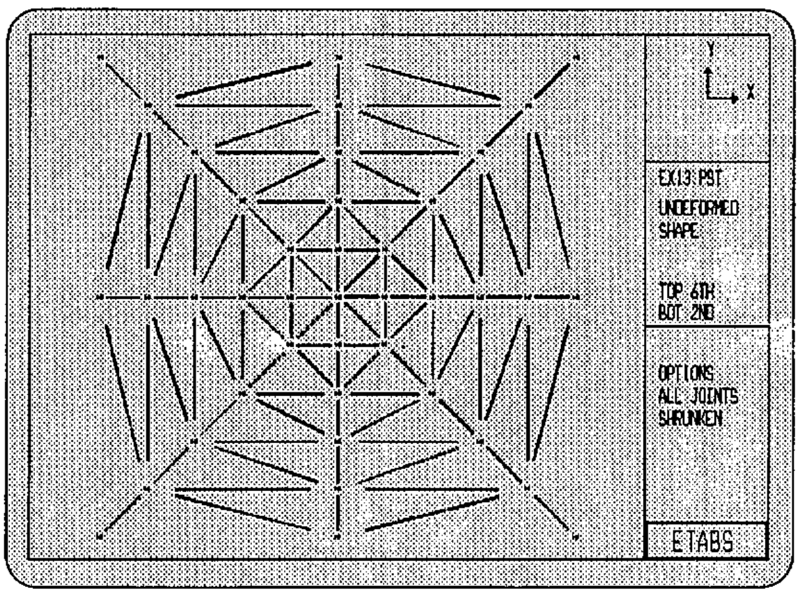
With this selection, pin end specifications for the column, beam and brace elements are highlighted if this option is set to YES. The pins are shown as dots close to the element end where pin conditions are specified and the element is shrunken at that end. See Figure 3a.

8. **Set Element Shrinkage**

If this option is set to YES, all elements will be shrunk about their corresponding centroids and displayed as shown in Figure 3b. With this option, any overlapping boundaries of the panel elements become clearly visible. In the case of column, beam and brace elements, elements that actually connect to each other at a joint are clearly distinguished from elements that merely overlap in space, or appear to intersect in a particular view.



(3a)



(3b)

Undeformed Geometry Plot Options

Figure 3

9. Display Element Local Axes

If this option is set to YES, the local axes of the elements are shown. For beams, columns and braces the positive local 1 and 2 (major) axes are shown. For clarity, a small I-shape is also shown to indicate major direction. For wall elements the positive local 1, 2 (major) and 3 (minor) axes are shown. The local 1 axes for walls will always be vertical. Also, for walls the axes are plotted at the location of the centroid of the panel elements that make up the wall.

0. Remove Hidden Lines

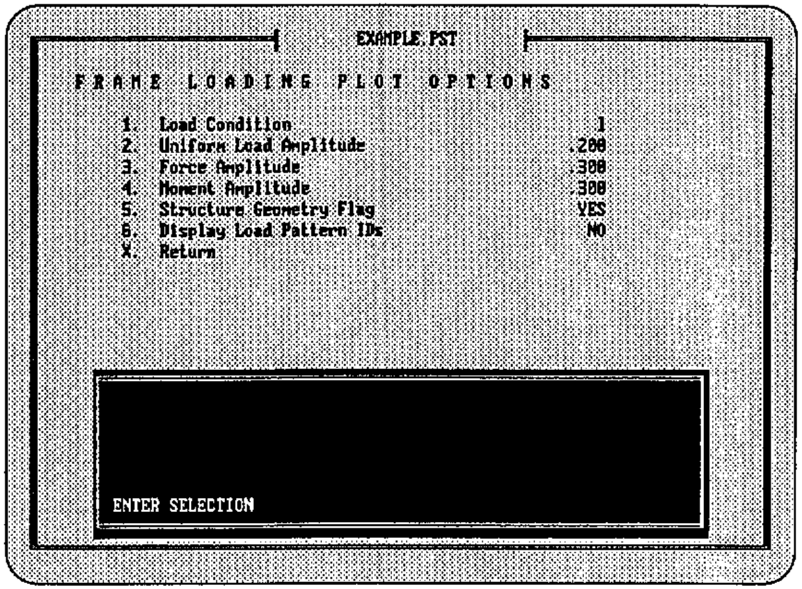
If this option is set to YES the panel elements will be filled and hidden lines removed. See Figure 1b. This allows for a much clearer view of the structure. In rare instances this option may not work correctly. This usually happens if very wide panel elements are used. Viewing the structure from a different view point or using narrower panel elements removes this problem.

Switching this option to YES will cause all other options on this menu to switch to NO. Similarly switching any other option on this menu to YES will cause this option to switch to NO.

4. SET FRAME LOADING PLOT MODE

This is Selection 4 on the Plot Control Menu.

This selection initiates the frame loading plot sequence and responds with the following menu:



This menu establishes the parameters needed for frame loading plots. The current settings of these options are displayed on the menu.

Any option may be reset as many times as necessary. The last entry associated with the option is used and stays unchanged until it is reset or respecified. All entries are initially set with default values.

When all entries are set as desired, enter an X to return to the Plot Control Menu.

The following is a description of each of the loading plot options listed in the menu above, and the associated responses of the program.

1. **Load Condition**

   This selection prompts for the ETABS static load conditions I, II, III, A or B for which the loads have to be plotted. The current setting of this option is displayed.

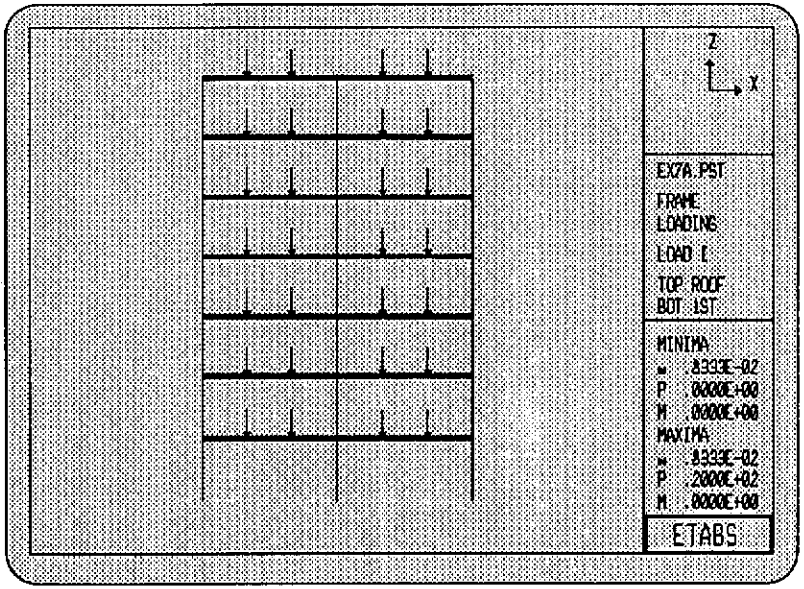
   Selection of load condition I, II, or III will put the program into the beam vertical loading plot mode. See Figure 4a. Selection of load condition A or B will put the program into the disconnected column lateral load plot mode. See Figure 4b. It must be noted that only loading applied at the ETABS frame level is displayed. Lateral loading applied at the ETABS building level is not displayed.

2. **Uniform Load Amplitude**

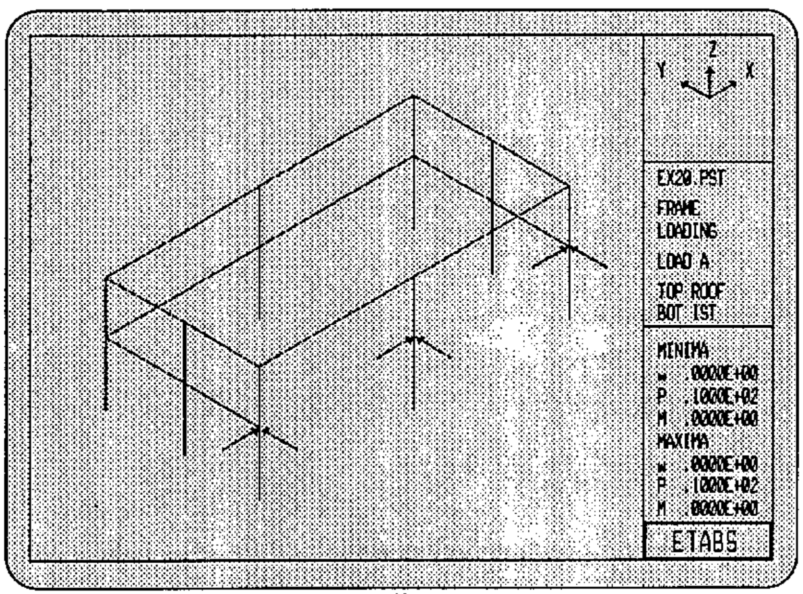
   The uniform vertical loads are plotted as Z-direction offsets from the beams on which they act. Positive loads (acting downwards) are plotted as offsets from the beam in the positive Z-direction.

   With this selection, the user is prompted for the maximum plotted uniform load offset (in inches). A typical value is between 0.2 to 0.5 inches. The maximum allowed is one inch.

   This value is assigned to the maximum visible uniform load (load offset projection on the plot plane) when viewed from the specified view direction. All other uniform loads are then scaled with the same ratio.



(4a)



(4b)
Frame Loading Plots
Figure 4

3. Force Amplitude

The point loads on beams, including loads at beam ends, and lateral loads are plotted as arrows in the directions they are acting.

The lengths of the arrows indicate their relative values.

With this selection, the user is prompted for the maximum plotted force amplitude (in inches). A typical value is between 0.3 to 0.7 inches. The maximum allowed is one inch.

This value is assigned to the maximum visible force (arrow length projection on the plot plane) when viewed from the specified view direction. All other forces are then scaled with the same ratio.

4. Moment Amplitude

The moment loads on beam ends and the torsional loads on disconnected columns are plotted as double arrows using the vector convention for moments (right-hand rule). The length of the arrows indicate their relative values.

With this selection the user is prompted for the maximum plotted moment amplitude (in inches). A typical value is between 0.3 to 0.7 inches. The maximum allowed is one inch.

This value is assigned to the maximum visible moment (arrow length projection on the plot plane) when viewed from the specified view direction. All other moments are then scaled with the same ratio.

5. Structure Geometry Flag

The current setting of this option is displayed on the screen with a YES or NO setting.

On selecting this option, the status is immediately reversed and the menu is redisplayed showing the change.

If this option is YES, the undeformed structural geometry is plotted over the load offsets and arrows for easy reference. If this option is NO, the plot of the reference structure is suppressed.

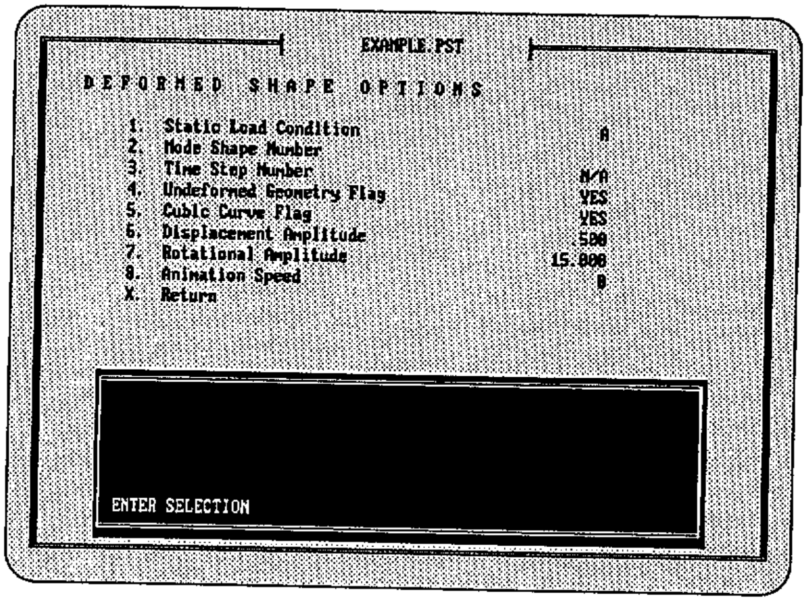
6. Display Load Pattern IDs

With this selection, beam span loading pattern numbers and disconnected column lateral load pattern numbers are shown on the respective beams and columns to which they are applied for the load condition specified in option 1 above.

5. SET DEFORMED SHAPE PLOT MODE

This is Selection 5 on the Plot Control Menu.

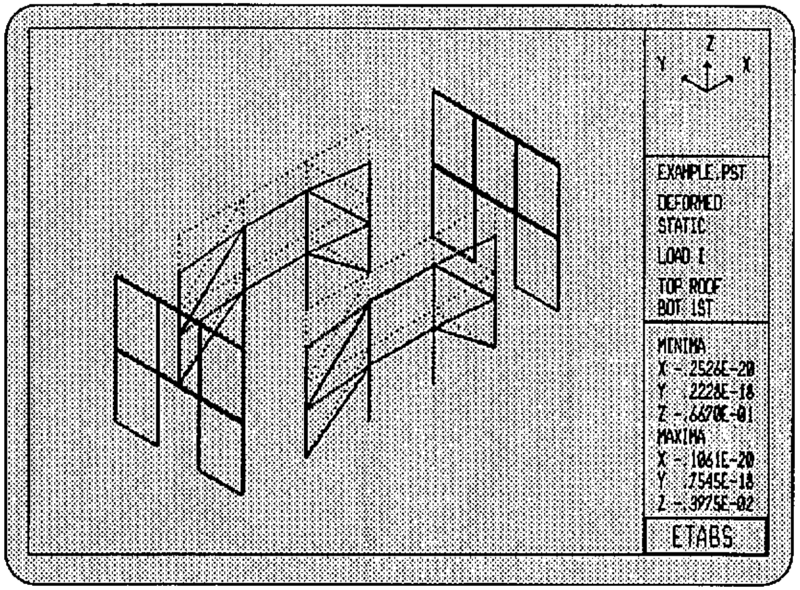
This selection initiates the deformed shape plotting sequence and responds with the following menu:



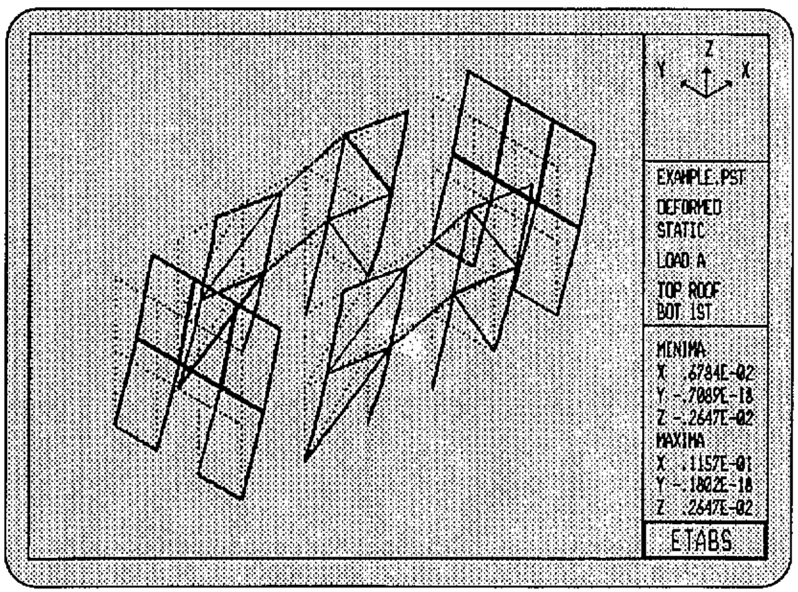
This menu establishes the parameters needed for deformed geometry plots. The current settings of these options are displayed on the menu.

Any option may be reset as many times as necessary. The last entry associated with the option is used and stays unchanged until it is reset or respecified. All entries are initially set with default values.

When all entries are set as desired, enter an X to return to the Plot Control Menu.



(5a)



(5b)

Static Deformed Shape Plots with Dashed Reference Structure
Figure 5

The following is a description of each of the deformed geometry options listed in the menu above, and the associated responses of the program.

1. **Static Load Condition**

   This selection sets the program into a static deformed shape plotting mode and the user is immediately prompted for the ETABS static load condition, I, II, III, A or B that is to be plotted. See Figure 5.

2. **Mode Shape Number**

   This selection sets the program into a mode shape plotting mode and the user is immediately prompted for the ETABS mode number, between 1 and NPER, that is to be plotted. This option is only valid if NDYN equals 1 or 2 and NMD equals 1 in the ETABS input data. See Figure 6.

3. **Time Step Number**

   This selection sets the program into a mode that will plot the instantaneous displacements at a specified time step of a time history analysis. The user is immediately prompted for a time step number, between 1 and NTIME. The instantaneous displacements of the structure at this time step will be plotted. This option is only valid if NDYN equals 3 in the ETABS input data.

4. **Undeformed Geometry Flag**

   The current setting of this option is displayed on the screen with a YES or NO setting.

On selecting this option, the status is immediately reversed and the menu is redisplayed showing the change.

If this option is YES, in addition to the deformed geometry, the program plots the undeformed shape of the structure with dashed lines (as a reference structure) for convenient comparison with the deformed shape. If this option is NO, the plot of the reference structure is suppressed. See Figure 5.

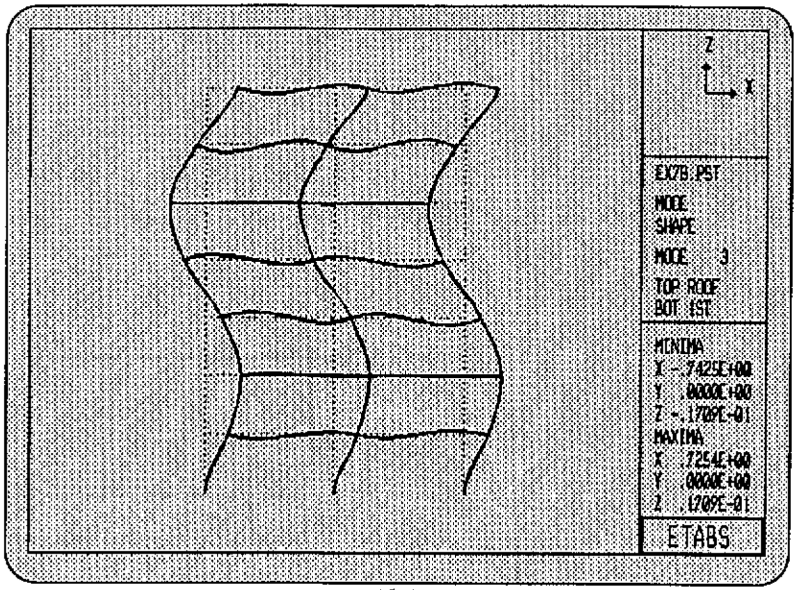
5. Cubic Curve Flag

The current setting of this option is displayed on the screen with a YES or NO setting.

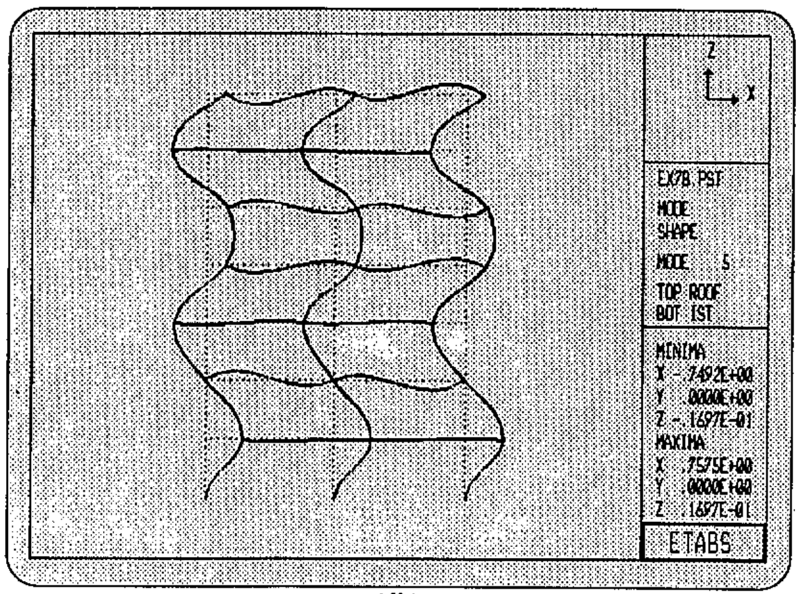
On selecting this option, the status is immediately reversed and the menu is redisplayed showing the change.

If this option is YES, all the deformed elements are plotted with cubic curves that preserve joint rotational compatibility. See Figure 6. If this option is NO, all the deformed elements are plotted with straight lines.

Deformed shapes may not be accurate for beams loaded with span loadings, if the deformed shapes are of a higher order.



(6a)



(6b)

Mode Shape Plots - Elements Plotted with Cubic Curves
Figure 6

6. Displacement Amplitude

With this selection, the user is immediately prompted for the maximum plotted joint displacement value (in inches). A typical value is between 0.25 and 0.75 inches. The maximum allowed is one inch.

This value is assigned to the maximum visible joint displacement (displacement projection on the plot plane) when viewed from the specified view direction. All other displacements are then scaled with the same ratio.

7. Rotational Amplitude

With this selection, the user is immediately prompted for the maximum plotted joint rotation value (in degrees). A typical value is between 10 and 30 degrees. The maximum allowed is 45 degrees.

The rotational scale is calculated in a manner consistent with the displacement and geometry scales unless the joint displacement amplitude is specified as zero or if there is no visible joint displacement. In which case this value is assigned to the maximum visible joint rotation (rotational projection on the plot plane) when viewed from the specified view direction. All other rotations are then scaled with the same ratio.

8. Animation Speed

The current setting of this option is displayed on the screen as a number between 0 and 100.

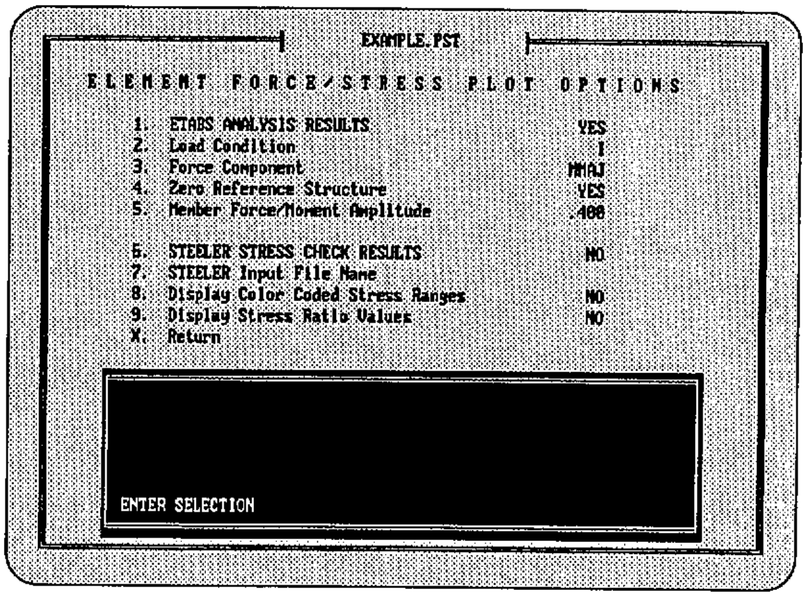
If this option is selected the user is prompted for a new value for the speed of oscillation. A value of zero represents static display. A non-zero value sets the program into the deformed shape or mode shape animation mode. A value of 100 represents the highest speed of oscillation possible with the particular hardware.

The generation of an animated plot takes approximately five times longer than an unanimated plot.

6. SET ELEMENT FORCE PLOT OPTIONS

This is Selection 6 on the Plot Control Menu.

This selection initiates the element force/stress ratio plotting sequence and responds with the following menu:



This menu establishes the parameters needed for element force/stress ratio plots. The current settings of these options are displayed on the menu.

Any option may be reset as many times as necessary. The last entry associated with the options is used and stays unchanged until it is reset or respecified. All entries are initially set with default values.

When all entries are set as desired, enter an X to return to the Plot Control Menu.

The following is a description of each of the element force/stress plot options listed in the menu above, and the associated responses of the program.

1. **ETABS Analysis Results**

   This selection sets the program into the element force/moment plot mode. Selections 2 to 5 below set the various parameters for these plots.

   With this selection, option 6 is set to NO.

2. **Load Condition**

   Selection of this option prompts for the ETABS load condition number I, II, III, A, B, D1, D2 or D3 for which the element forces have to be plotted. The current setting of this option is displayed on the screen.

3. **Force Component**

   With this selection the user is prompted for the element force/moment component that is to be displayed, namely MMAJ, MMIN, VMAJ, VMIN, P or T, which correspond to element bending moments around the major and minor axes; the element shear forces along the major and minor directions; and the element axial forces and torques respectively.

   The major moment, major shear, axial force and torque are plotted as offsets along the major direction of the member and minor moment and minor shear are plotted as offset along the minor direction of the member. See Figure 7a.

4. Zero Reference Structure

All force/moment diagrams are displayed as offsets with respect to the element line as the zero reference line, except for wall assemblages these offsets are with respect to the wall centroidal line as the zero reference line.

This option gives the user control over the display of the reference structure.

If the status of this option is set to YES, the zero reference structure is displayed over the force diagrams. If the status is set to NO, the plotting of the reference structure is suppressed.

5. Member Force/Moment Amplitude

This selection prompts the user for the maximum plotted member force/moment offset (in inches). A typical value is 0.2 to 0.7 inches. The maximum allowed is one inch. A negative value will flip the side on which the component is plotted. Therefore, moments can be plotted on tension or compression side.

This value is assigned to the maximum visible force/moment (offset projection on the plot plane) when viewed from the specified view location. All other force/moments are then scaled with the same ratio.

6. STEELER Stress Check Results

This selection sets the program into the STEELER stress check ratio plot mode. Selections 7 to 9 below set the various parameters for these plots.

With this selection, option 1 is set to NO.

7. **STEELER Input File Name**

This selection prompts the user for the filename of the STEELER run from which the stress ratios are to be displayed. The filename must have a .PLO extension; if not, the program will append this extension to it.

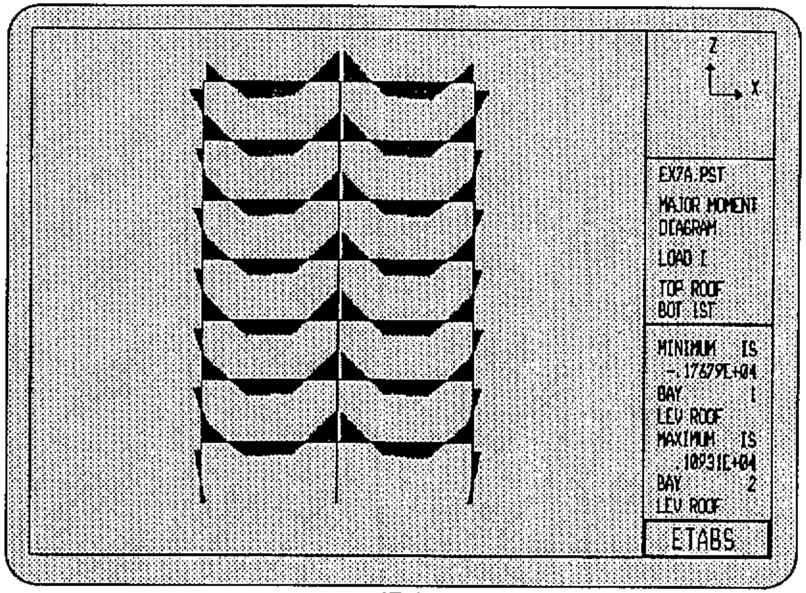
8. **Display Color Coded Stress Ranges**

With this selection the program is set to display the STEELER stress ratios from the filename named in option 7 above. The stress ratios are color coded based on their values.

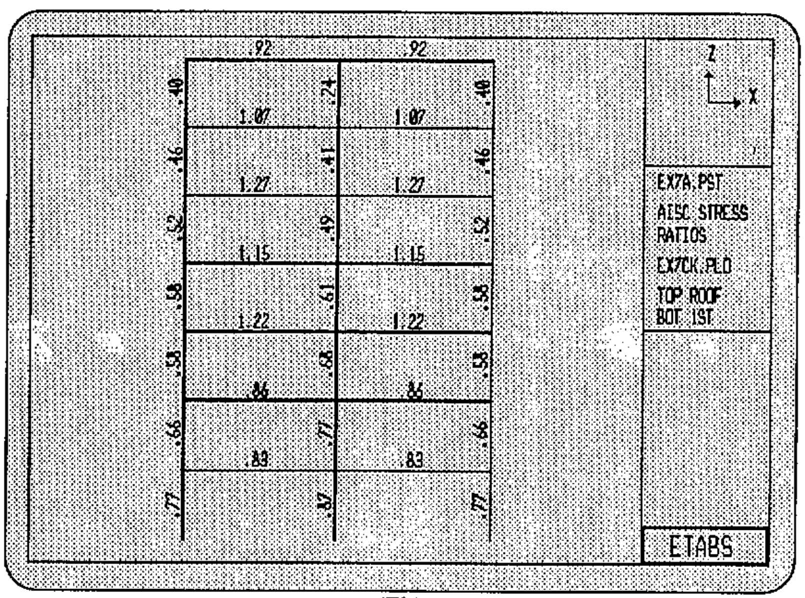
9. **Display Stress Ratio Values**

With this selection the program is set to display numerical values of STEELER stress ratios from the filename named in option 7 above.

This option is useful when a monochrome display is being used or hard copy plots are required. See Figure 7b.



(7a)

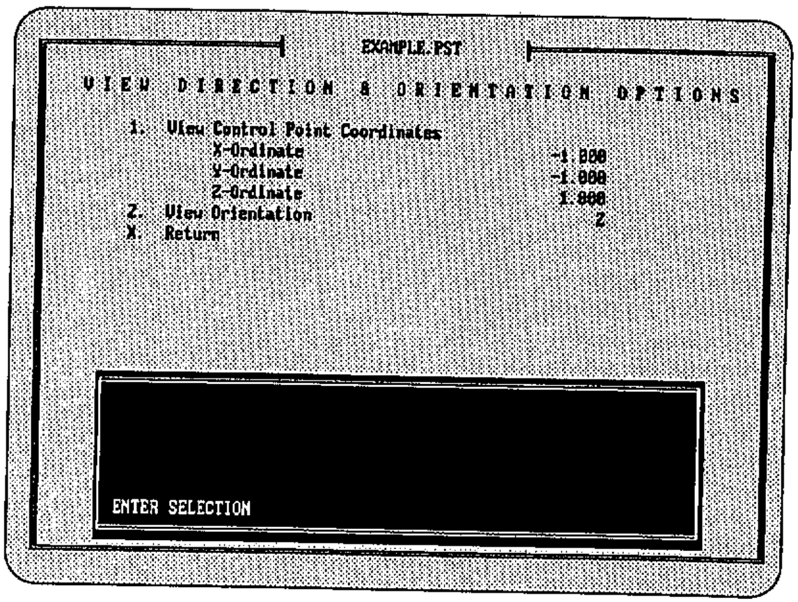


(7b)
Element Force-Stress Plots
Figure 7

7. SET VIEW DIRECTION AND ORIENTATION

This is Selection 7 on the Plot Control Menu.

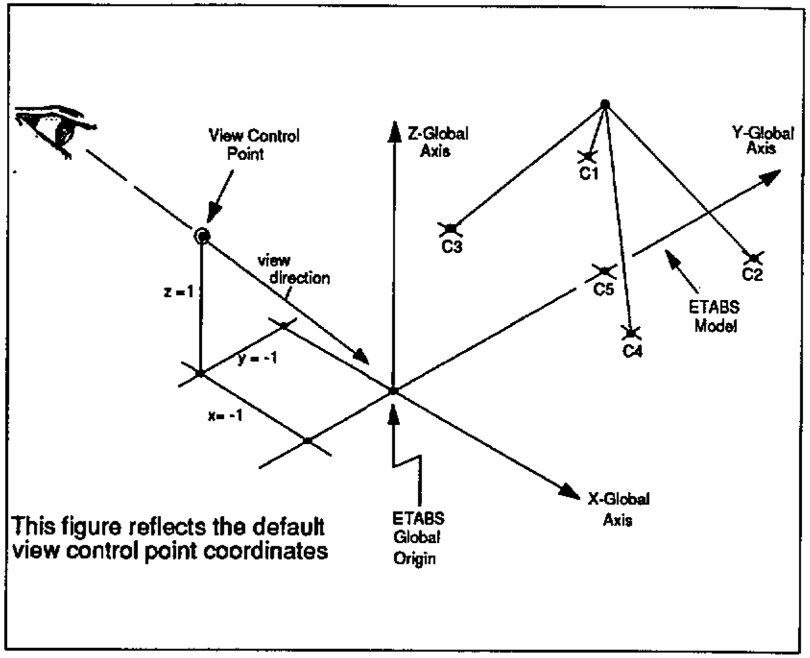
This selection is for resetting the view direction and plot orientation. The selection responds with the following menu:



The current settings of these options are displayed on the menu.

Any option may be reset as many times as necessary. The last entry associated with the option is used and stays unchanged until it is reset or respecified. All entries are initially set with default values.

When all entries are set as desired, enter an X to return to the Plot Control Menu.



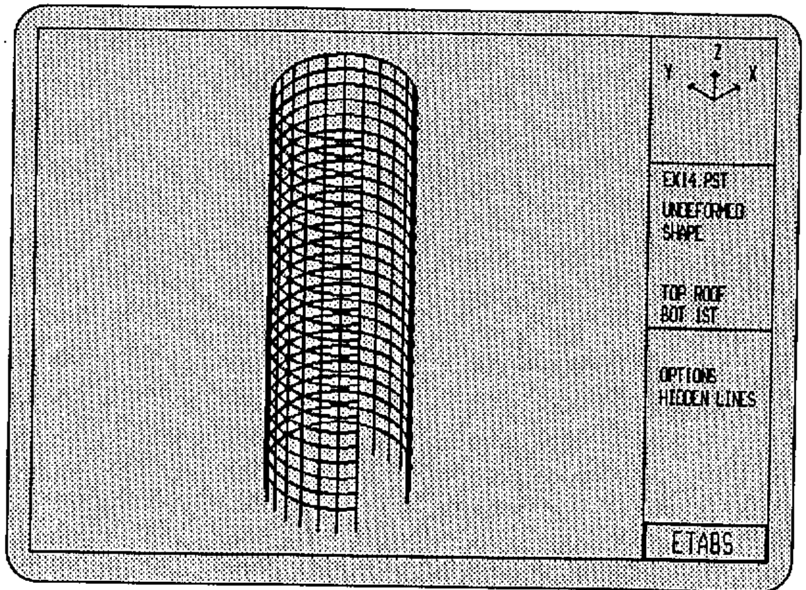
View Convention
Figure 8

The following is a description of each of the view direction options listed in the menu above, and the associated responses of the program.

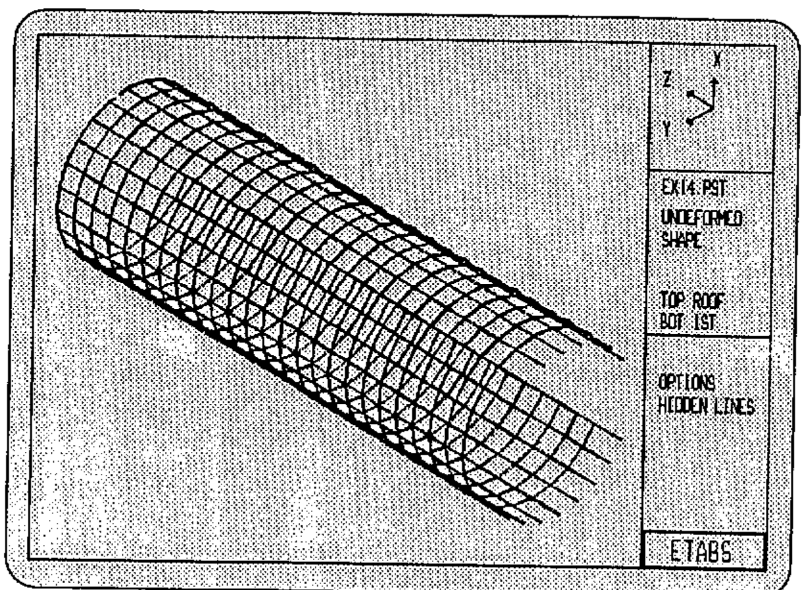
1. View Control Point Coordinates

With this selection, the user is immediately prompted for the X, Y and Z coordinates of the view control point.

The view is set in a direction pointing from the view control point towards the ETABS global origin. That is, the vector from the view control point towards the origin is normal to the plane of projection (i.e. the plot plane). See Figure 8.



(9a)



(9b)
View Orientation
Figure 9

If the absolute values of the three ordinates are equal, an isometric view will result. See Figure 10a.

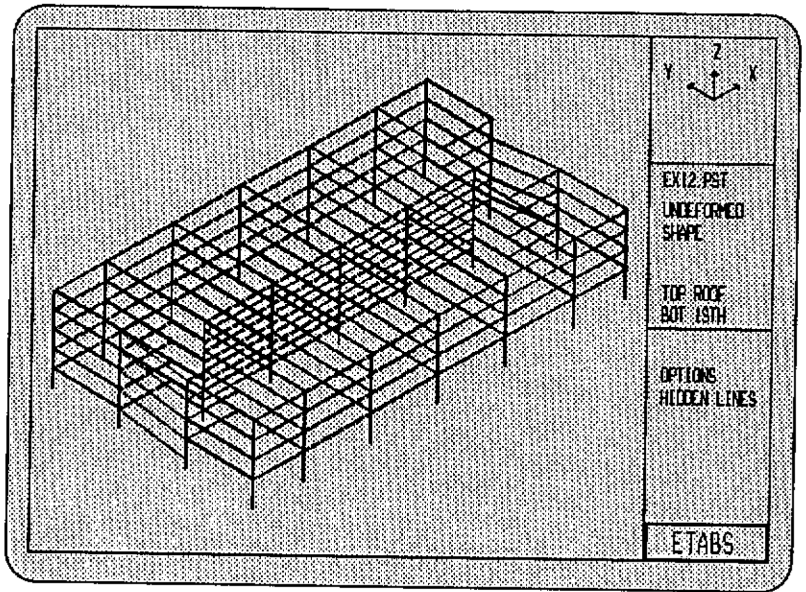
For an orthographic projection onto the X-Y plane, for example, the X and Y ordinates must be zero and the Z ordinate must be nonzero. See Figure 10b.

2. View Orientation

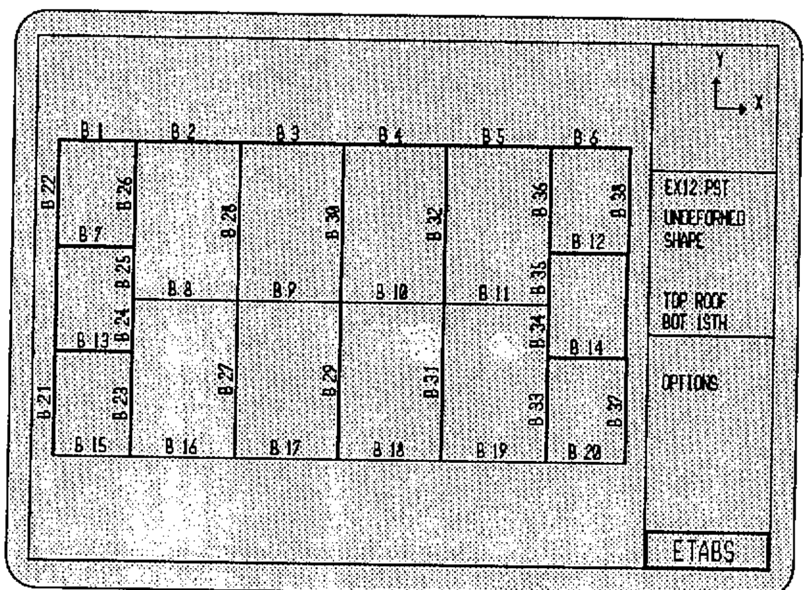
With this selection, the user is immediately prompted for the ETABS Global axis that is to be shown vertically up on the screen. The choices are X, Y, Z, -X, -Y and -Z.

In Figure 9a, the Z-axis points vertically up, whereas in Figure 9b, the X-axis points vertically up. In Figure 9b, the model is rotated on the screen, however, note that the view is exactly the same in both plots. Depending upon the dimensions of the model and the view direction, it may be possible to achieve a better scale by changing the plot orientation as demonstrated by Figure 9.

The view orientation axis cannot be parallel to the view direction. For example, if the view direction is directed along the Global Z axis (i.e. plan view), the user will not have the +Z or -Z axes as a view orientation option.



(10a)



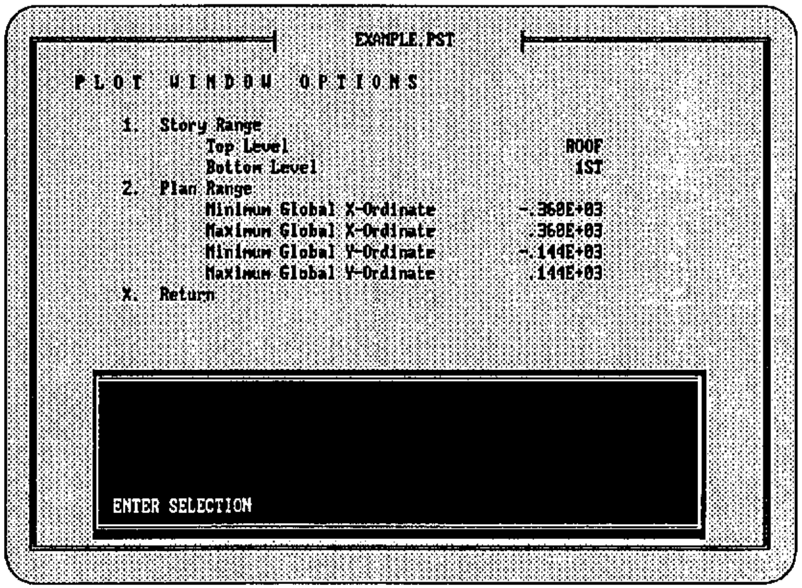
(10b)
Isometric and Plan Views
Figure 10

8. SET PLOT WINDOW

This is Selection 8 on the Plot Control Menu.

This selection is for resetting variables to enable the plotting of a localized region of the model at an enlarged scale.

The selection responds with the following menu:



The current settings of these options are displayed on the menu. Any option may be reset as many times as necessary. The last entry associated with the option is used and stays unchanged until it is reset or respecified.

All entries are initially set with default values.

When all entries are set as desired, enter an X to return to the Plot Control Menu.

The following is a description of each of the plot window options listed in the menu above, and the associated responses of the program.

1. **Story Range**

   With this selection, the user is prompted for top and bottom story level identifications, corresponding to the ETABS story data.

   Subsequent plots will include only the portion of the structure that is associated with the levels between the top level and bottom level that are specified by this selection.

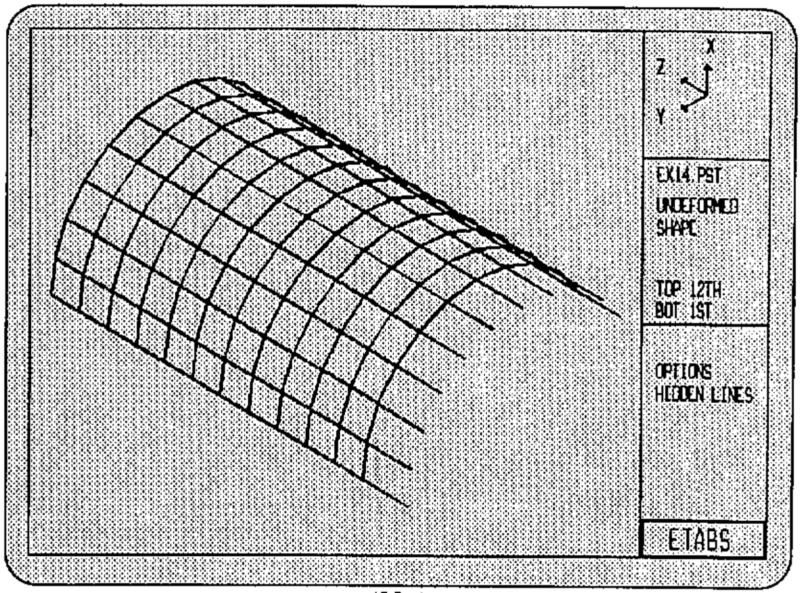
2. **Plan Range**

   With this selection, the user is prompted for X and Y, min/max plan ordinate values.

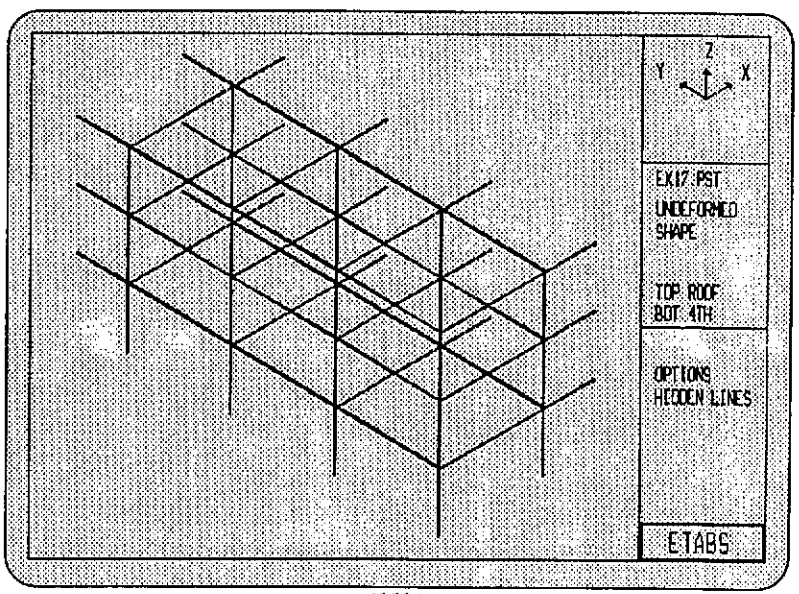
   These X, Y, min/max ordinates are with respect to the ETABS Global Coordinate System (i.e. plan coordinates). Only the portion of the structure that lies within this min/max range will be plotted.

   For any member to be included in the plot, it must lie completely within the max/min range of the plot.

   Figures 11a and 11b show magnified portions of Figures 1a and 1b, respectively.



(11a)



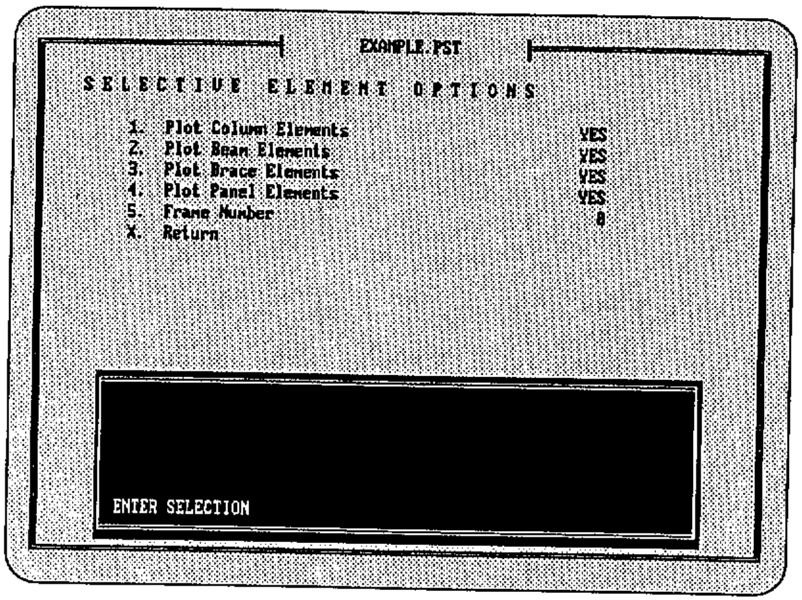
(11b)
Plot Window "Blowups"
Figure 11

9. SET SELECTIVE ELEMENT OPTIONS

This is Selection 9 on the Plot Control Menu.

This selection is for selectively plotting the various elements or frames of the structure.

This selection responds with the following menu:



The current settings of these options are displayed.

On selecting any one of the first four options, the status of the selected option is immediately reversed and the menu is redisplayed with the change.

Any of the options in this menu may be reset as many times as necessary. The last entry associated with the option is used and stays unchanged until it is reset.

When all entries are set as desired, enter an X to return to the Plot Control Menu.

The following is a description of each of the options listed in the above menu, and the associated responses of the program.

1. **Plot Column Elements**

   With this selection, plotting of all column elements will be suppressed if this option is set to NO.

2. **Plot Beam Elements**

   With this selection, plotting of all beam elements will be suppressed if this option is set to NO.

3. **Plot Brace Elements**

   With this selection, plotting of all brace elements will be suppressed if this option is set to NO.

4. **Plot Panel Elements**

   With this selection, plotting of all panel elements will be suppressed if this option is set to NO.

5. **Frame Number**

   With this selection, the user is immediately prompted for a frame number.

   This is a frame sequence number between 1 and NTF. Only the frame having the corresponding sequence number among the NTF frames will be considered for plotting, subject to the story range and plan range selections described in the "Set Plot Window" section above.

The sequence number refers to the sequence in which the frames are entered in the ETABS data. See Chapter V, Section D7, of the ETABS manual (Frame Location Data). In this data, 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.

If the user enters 0 in response to this prompt, all of the NTF frames are considered for plotting, subject to the story range and plan range selections described in the "Set Plot Window" section above.

Figure 1a is a plot of a complete structure having three circular frames. Figure 9 shows how only one of the three frames is plotted using this option.

10. RESET DEFAULT SETTINGS

This is Selection 0 on the Plot Control Menu.

This selection will reset all the current settings of the various plot parameters/options to what they were at program start-up and immediately redisplay the Plot Control Menu.

The program is put into an undeformed geometry plot mode with the settings shown in Figure 12.

UNDEFORMED GEOMETRY

Display ID of Column Lines	NO	Top Level	ROOF
Display ID of Bays	NO	Bottom Level	1ST
Display ID of Braces	NO		
Display Wall ID of Panels	NO	Min Global X-Ordinate	-.100E+11
Display Section Property IDs	NO	Max Global X-Ordinate	.100E+11
Highlight Joints	NO	Min Global Y-Ordinate	-.100E+11
Highlight Element Pin Ends	NO	Max Global Y-Ordinate	.100E+11
Set Element Shrinkage	NO		
Display Element Local Axes	NO		
Remove Hidden Lines	YES		
X-Ordinate of Viewpoint	-1.000	Plot Column Elements	YES
Y-Ordinate of Viewpoint	-1.000	Plot Beam Elements	YES
Z-Ordinate of Viewpoint	1.000	Plot Brace Elements	YES
View Orientation	Z	Plot Panel Elements	YES
		Frame Number	0

Default Settings
Figure 12

III.

REFERENCES

1. Habibullah, A.

   "ETABS - Three-Dimensional Analysis of Building Systems, Users Manual," Computers and Structures, Inc., Berkeley, California, 1991

2. Habibullah, A.

   "STEELER - Stress Check of Steel Frames, A Postprocessor for ETABS," Computers and Structures, Inc., Berkeley, California, 1992

COMPUTERS &
STRUCTURES
INC.

READER™

An Interactive Output Display PostProcessor for ETABS®

by
Ashraf Habibullah

Version 5.4
Revised July, 1992

Developed and written in U.S.A.

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Further information and copies of this documentation may be obtained from:

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DISCLAIMER

CONSIDERABLE TIME, EFFORT AND EXPENSE HAVE GONE INTO THE DEVELOPMENT AND DOCUMENTATION OF READER. 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 USER MUST EXPLICITLY UNDERSTAND THE ASSUMPTIONS OF THE PROGRAM AND MUST INDEPENDENTLY VERIFY THE RESULTS.

TABLE OF CONTENTS

I.

INTRODUCTION

READER is an interactive display and selective output postprocessor for ETABS [1].

The ETABS frame member force (.FRM) file and the ETABS frame displacement (.DSP) file are usually the largest output files generated by the ETABS program. Reviewing these output files with an editor is generally inconvenient, and printing the files to study the results can be time-consuming. The postprocessor, READER, has been developed to give the user convenient access to the information that is resident on the .FRM and .DSP files.

The program allows the user to instantaneously review the critical analysis results and gives the option to selectively print desired portions of the output. The user may redefine load cases different from the ETABS run. Maxima and minima of each output parameter, along with the controlling load case numbers, are also output.

The program has options for:

1. Instantaneously displaying frame joint displacements, frame base reactions and frame member forces of joints and members that are selected by the user in an interactive environment.

2. Printing frame displacements, frame base reactions and frame member forces associated with regions of interest that are selectively specified by the user. Segments of the results may be directed to different user-specified output files. The formatting of the frame member force output may be on a level-by-level basis or on an element-by-element basis.

3. Redefining load cases different from those specified in the ETABS data.

II.

SYSTEM PREPARATION, EXECUTION PROCEDURES, DETAILS

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

User familiarity with MS-DOS is assumed.

The complete READER package includes:

a. This manual

b. Floppy disk, containing the following:

   1. Program Executable; READER.EXE

   2. Sample ETABS postprocessing File, EXAMPLE.PST, for the sample structure described in the appendix of the ETABS Users Manual.

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

1. INSTALLING, CONFIGURING AND TESTING

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

Before putting the system into a production mode, the user should test the system by running the sample postprocessing file provided on the disk.

2. EXECUTING THE READER PROGRAM

This section explains how to execute the READER program.

Say that the ETABS data, associated with the structure the user wishes to analyze, has been prepared and entered into a data file called EXAMPLE. A successful execution of ETABS with the data file EXAMPLE will create a postprocessing file EXAMPLE.PST. This file will exist at the end of a data check run as well as at the end of a normal execution run. **READER may only be used with a postprocessing file that is created by an execution run.**

A typical ETABS postprocessing file is the only file needed to execute READER.

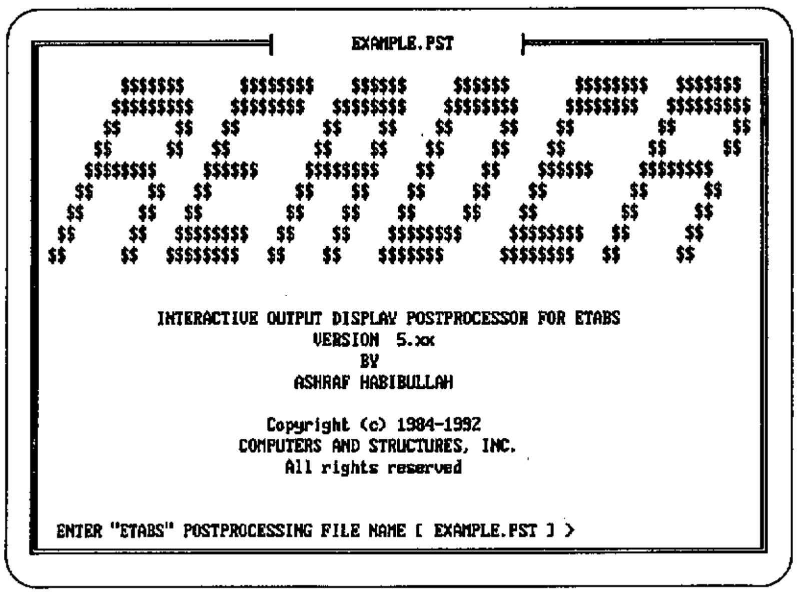
To execute READER proceed as follows:

From the directory where the postprocessing file resides, enter the command:

READER <CR>

Note: the READER executable must reside in the same directory unless a path to the READER executable has been activated using the MS-DOS **PATH** command.

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



Enter **EXAMPLE.PST <CR>**

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

After a few seconds of initialization, the program will flash the following menu:

```
                    EXAMPLE.PST

R E A D E R   C O N T R O L   M E N U

     A.  Display Frame Output
     B.  Print   Frame Output (With    Element Selection)
     C.  Print   Frame Output (Without Element Selection)
     D.  Display / Redefine Load Case Data
     X.  Exit


ENTER SELECTION  (A,B,C,D,X)  >
```

This is the READER Control Menu. Selections A, B, C or D will display corresponding lower level menus for activating display or printing options, or for changing the load case data.

Entering an X will exit the program and return control to the operating system.

The following four sections of this chapter, A, B, C and D correspond to the A, B, C and D options of the above Control Menu.

Each section defines in detail the response of the program associated with the corresponding user selection.

User familiarity with the ETABS control parameters is assumed.

A. DISPLAY FRAME OUTPUT

This is Selection A on the READER Control Menu.

This selection puts the program into an output display mode and flashes the following menu:

```
                         EXAMPLE.PST

F R A M E   O U T P U T   D I S P L A Y   M E N U

SET PARAMETERS
     A.  Frame Sequence Number                        1
     B.  Level  ID                                 ROOF
     C.  Column ID Number                             1
     D.  Bay    ID Number                             1
     E.  Brace  ID Number                             1
     F.  Wall   ID Number                           N/A
     G.  Column ID Number for Displacements           1
     H.  Column ID Number for Reactions               1

DISPLAY  DISPLACEMENTS    REACTIONS      FORCES
          1.  Global       3.  Global     5.  Columns
          2.  Local        4.  Local      6.  Beams
                                          7.  Braces
                                          8.  Walls

    <cr> To Return

ENTER SELECTION  <A,B,C,D,E,F,G,H,1,2,3,4,5,6,7,8>  >
```

The output display mode is only for viewing the output on the screen. No printing or file creation operation can be performed in this mode.

Selections A, B, C, D, E, F, G and H are for setting parameters that identify the members and joints that are to be processed when the display options are activated. The current settings of these parameters are displayed on the menu.

Any parameter may be reset as many times as necessary. The last setting stays unchanged until it is reset or respecified. All entries are set with default values when control is transferred to this menu by selecting option A on the READER Control Menu. A display of N/A indicates that the parameter is nonexistent in the current frame, identified by the frame sequence number.

Selections 1, 2, 3, 4, 5, 6, 7 and 8 are the options that trigger the display of the joint displacements, joint reactions or member forces.

A <CR> will return the user to the READER Control Menu.

The following is a description of the parameters associated with the options A through H of the above menu that the user may need to set before activating the display options.

A. FRAME SEQUENCE NUMBER

With this selection, the user is prompted for a frame sequence number between 1 and **NTF**. The sequence number refers to the sequence in which the frames are entered in the ETABS data. See Chapter V, Section D7, of the ETABS manual (Frame Location Data). In this data, 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**.

B. LEVEL ID

With this selection, the user is prompted for a valid story level identifier that has been previously defined as part of the ETABS data. See Chapter V, Section D3, of the ETABS manual (Story Data).

C. COLUMN ID NUMBER

With this selection, the user is prompted for a column ID number between 1 and NC, where NC is the number of column lines in the frame identified by the frame sequence number.

D. BAY ID NUMBER

With this selection, the user is prompted for a bay ID number between 1 and NB, where NB is the number of bays in the frame identified by the frame sequence number.

This option is inactive if the frame has no bays, i.e. NB = 0.

E. BRACE ID NUMBER

With this selection, the user is prompted for a valid brace ID number that has been previously defined as part of the ETABS data of the frame identified by the frame sequence number. See Chapter V, Section D6(vi), of the ETABS manual (Frame Data).

This option is inactive if there are no brace elements in the frame, i.e. NTRU = 0.

F. WALL ID NUMBER

With this selection, the user is prompted for a valid wall ID number that has been previously defined as part of the ETABS data of the frame identified by the frame sequence number. See Chapter V, Section D6(vi), of the ETABS manual (Frame Data).

This option is inactive if there are no panel elements in the frame, i.e. NPAN = 0.

G. COLUMN ID NUMBER FOR DISPLACEMENTS

With this selection, the user is prompted for a column ID number between 1 and NC, where NC is the number of column lines in the frame identified by the frame sequence number.

H. COLUMN ID NUMBER FOR REACTIONS

With this selection, the user is prompted for a column ID number between 1 and NC, where NC is the number of column lines in the frame identified by the frame sequence number.

The following is a description of the response of the program associated with each of the display options, 1 through 8, of the above menu.

1. GLOBAL DISPLACEMENTS

With this selection, the program will display the six displacement components of the joint that is uniquely identified by the parameters displayed in the menu, namely, the column ID number for displacements, the level ID and the frame sequence number. The displacements will be recovered at the story level (i.e. the top of the column). The displacements associated with all of the currently defined load cases will be displayed. The displacements will be with reference to the ETABS global coordinate system.

2. LOCAL DISPLACEMENTS

This selection is identical to selection 1, except that the displacements are with reference to the local coordinate system of the frame identified by the frame sequence number.

3. GLOBAL REACTIONS

With this selection, the program will display the six reaction components at the baseline level for the joint that is uniquely identified by the parameters displayed in the menu, namely, the column ID number for reactions and the frame sequence number. The reactions associated with all of the currently defined cases will be displayed. The reactions will be with reference to the ETABS global coordinate system.

4. LOCAL REACTIONS

This selection is identical to selection 3, except that the reactions are with reference to the local coordinate system of the frame identified by the frame sequence number.

5. COLUMN FORCES

With this selection, the program will display the column forces of the column that is uniquely identified by the parameters displayed in the menu, namely, the column ID number, the level ID and the frame sequence number. The forces associated with all of the currently defined load cases will be displayed.

6. BEAM FORCES

With this selection, the program will display the beam forces of the beam that is uniquely identified by the parameters displayed in the menu, namely, the bay ID number, the level ID and the frame sequence number. The forces associated with all of the currently defined load cases will be displayed.

7. BRACE FORCES

With this selection, the program will display the brace forces of the brace that is uniquely identified by the parameters displayed in the menu, namely, the brace ID number and the frame sequence number. The forces associated with all of the currently defined load cases will be displayed.

8. WALL FORCES

With this selection, the program will display the wall forces of the wall assemblage that is uniquely identified by the parameters displayed in the menu, namely, the wall ID number, the level ID number and the frame sequence number. The forces associated with all of the currently defined load cases will be displayed.

If the results associated with any of the display options are more than a screenful, the display will be segmented into screens, and the user will be prompted at the end of each screenful as follows:

```
ENTER <CR> FOR MORE
```

At the end of the display associated with any of the display options, the user will be prompted as follows:

```
ENTER <CR> FOR MENU OR N <CR> FOR NEXT
```

If the user enters **<CR>**, control will return to the "DISPLAY FRAME OUTPUT" level, the menu will be flashed, and the user can continue with the processing.

However, if the user enters **N** followed by **<CR>**, the results corresponding to the next joint or element will be displayed.

In other words, say that the user triggers display option 5 and the program has just displayed the column forces for Column 1 at a particular level of a particular frame. The user is now prompted as follows:

```
ENTER <CR> FOR MENU OR N <CR> FOR NEXT
```

If the user enters **N <CR>**, the program will immediately display the member forces of Column 2 at the same level of the same frame. Repeated **N <CR>** will display forces for Columns 3, 4, 5, . . .**NC**, 1, 2, 3, . . . **NC**, 1. . . entries.

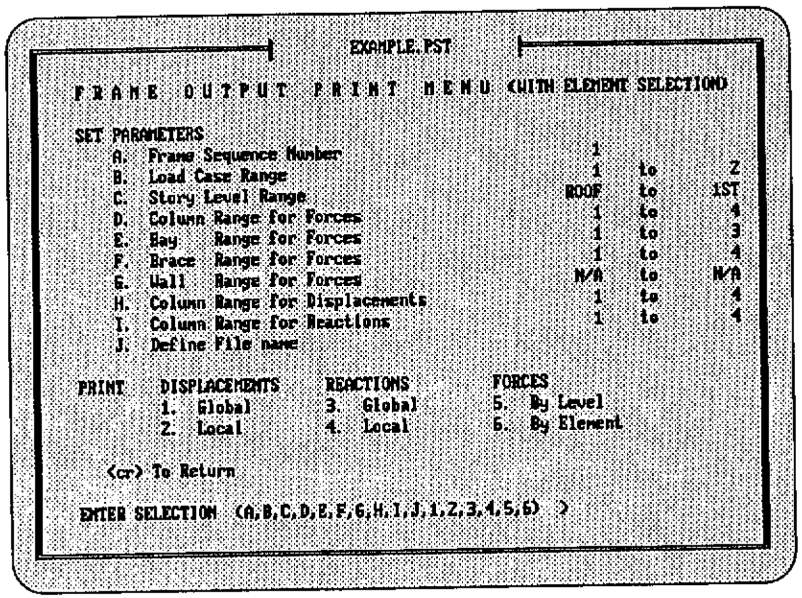
The use of the **N <CR>** option is similar with display options 2 through 8, as it relates to the other corresponding parameters on the menu.

This option allows the user to conveniently display the output of a series of joints or elements without having to reset any control parameters.

B. PRINT FRAME OUTPUT (With Element Selection)

This is Selection B on the READER Control Menu.

This selection puts the program into an output print mode and flashes the following menu:



This print mode is for selectively printing the output associated with any one frame at a time. This mode allows the user to assign ranges to elements and joints that are to be included in the processing of the print options.

Selections A, B, C, D, E, F, G, H, I and J are for setting parameters (and ranges) that identify the load cases and the region of the frame that will be processed when the print options are activated.

The current settings of these parameters (and ranges) are displayed on the menu.

Any parameter may be set as many times as necessary. The last setting stays unchanged until it is reset or respecified.

All entries are set with default values when control is transferred into this menu by selecting option B on the READER Control Menu.

A display of N/A indicates that the parameter is nonexistent in the current frame, identified by the frame sequence number.

Selections 1, 2, 3, 4, 5 and 6 are the options that generate the output files containing the selected analysis results.

A **<CR>** will return the user to the READER Control Menu.

The following is a description of the parameters associated with the options A through J of the above menu that the user may need to set before activating the print options.

A. FRAME SEQUENCE NUMBER

With this selection, the user is prompted for a frame sequence number between 1 and **NTF**. The sequence number refers to the sequence in which the frames are entered in the ETABS data. See Chapter V, Section D7, of the ETABS manual (Frame Location Data). In this data, 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.**

B. LOAD CASE RANGE

With this selection, the user is prompted for a pair of load case numbers between 1 and the number of load cases currently defined.

C. STORY LEVEL RANGE

With this selection, the user is prompted for a pair of valid story level identifiers that have been previously defined as part of the ETABS data. See Chapter V, Section D3, of the ETABS manual (Story Data).

D. COLUMN RANGE FOR FORCES

With this selection, the user is prompted for a pair of column ID numbers between 1 and **NC**, where **NC** is the number of column lines in the frame identified by the frame sequence number.

E. BAY RANGE FOR FORCES

With this selection, the user is prompted for a pair of bay ID numbers between 1 and **NB**, where **NB** is the number of bays in the frame identified by the frame sequence number.

This option is inactive if the frame has no bays, i.e. **NB** = 0.

F. BRACE RANGE FOR FORCES

With this selection, the user is prompted for a pair of valid brace ID numbers that have been previously defined as part of the ETABS data of the frame identified by the frame sequence number. See Chapter V, Section D6(vi), of the ETABS manual (Frame Data).

This option is inactive if there are no brace elements, i.e. **NTRU** = 0.

G. WALL RANGE FOR FORCES

With this selection, the user is prompted for a pair of valid wall ID numbers that have been previously defined as part of the ETABS data of the frame identified by the frame sequence number. See Chapter V, Section D6(vi), of the ETABS manual (Frame Data).

This option is inactive if there are no panel elements in the frame, i.e. **NPAN** = 0.

H. COLUMN RANGE FOR DISPLACEMENTS

With this selection, the user is prompted for a pair of column ID numbers between 1 and **NC**, where **NC** is the number of column lines in the frame identified by the frame sequence number.

I. COLUMN RANGE FOR REACTIONS

With this selection, the user is prompted for a pair of column ID numbers between 1 and **NC**, where **NC** is the number of column lines in the frame identified by the frame sequence number.

J. DEFINE FILENAME

With this selection, the user is prompted for a filename of up to eight characters long and no extension. The program will append an extension .OUT to this filename to obtain the name of the file containing the output for each of the load cases as selected in the range of load cases (selection B). Also, the program will append an .ENV to this filename to obtain the name of the file containing the maxima and minima and the controlling load case numbers of each output parameter within the range of load cases currently selected. All output produced by subsequent triggering of options 1 through 6 is written to these files. Each time the user activates this selection, new files are opened and the previous files are closed. Thus multiple files that contain different information may be created by a single READER session.

If the user selects any of the options 1 through 6 before defining a filename, the program will open files with the default filename corresponding to the postprocessor filename that is being processed by READER. For example, if the name of the postprocessing file is EXAMPLE.PST, the default filenames will be EXAMPLE.OUT and EXAMPLE.ENV.

If the user-specified filename conflicts with an existing filename, the existing file will be overwritten.

The following is a description of the response of the program associated with each of the print options, 1 through 6, of the above menu.

1. PRINT GLOBAL DISPLACEMENTS

With this selection, the program will print joint displacements in the ETABS global coordinate system for the joints of the frame (identified by the frame sequence number, selection A), that lie within the story level range (selection C) and column number range (selection H) as displayed in the menu.

Only the displacements associated with the load cases that lie within the load case range (selection B) will be printed.

Displacements are printed for all joints level by level, starting from the top level of the frame and progressing downward.

2. PRINT LOCAL DISPLACEMENTS

This selection is identical to selection 1, except that the displacements are with reference to the local coordinate system of the frame identified by the frame sequence number.

3. PRINT GLOBAL REACTIONS

With this selection, the program will print joint reactions in the ETABS global coordinate system for the joints at the baseline of the frame (identified by the frame sequence number, selection A) that lie within the column number range (selection I) as displayed in the menu.

Only the reactions associated with the load cases that lie within the load case range (selection B) will be printed.

4. PRINT LOCAL REACTIONS

This selection is identical to selection 3, except that the reactions are with reference to the local coordinate system of the frame identified by the frame sequence number.

5. PRINT FORCES BY LEVEL

With this selection, the program will print the element (column, beam, brace and wall) forces of the frame (identified by the frame sequence number, selection A) for all the elements that lie within the story level range and the element ranges (selections C through G) as displayed in the menu.

Only the member forces associated with the load cases that lie within the load case range (selection B) will be printed.

The member forces will be printed on a level-by-level basis. In other words, the member forces of all the elements that exist at the top level are printed first, followed by member forces of all the elements that exist at the next level below, and so on.

6. PRINT FORCES BY ELEMENT

This selection is identical to selection 5 except that the member forces will be printed on an element-by-element basis. In other words, the member forces for each element type are grouped together.

Therefore, the output for column members will be on a column line basis. Thus, output for all the column elements at all levels of column line 1 will be printed together starting from the top level of the frame and progressing downward, followed by elements of column line 2, and so on.

The column output will be followed by the output for beam elements on a bay-by-bay basis. Thus, output for all the beam elements at all levels of bay 1 will be printed together starting from the top level of the frame and progressing downward, followed by elements of bay 2, and so on.

The beam output will be followed by the output of all the brace elements of the frame printed together in the order in which the brace elements were input.

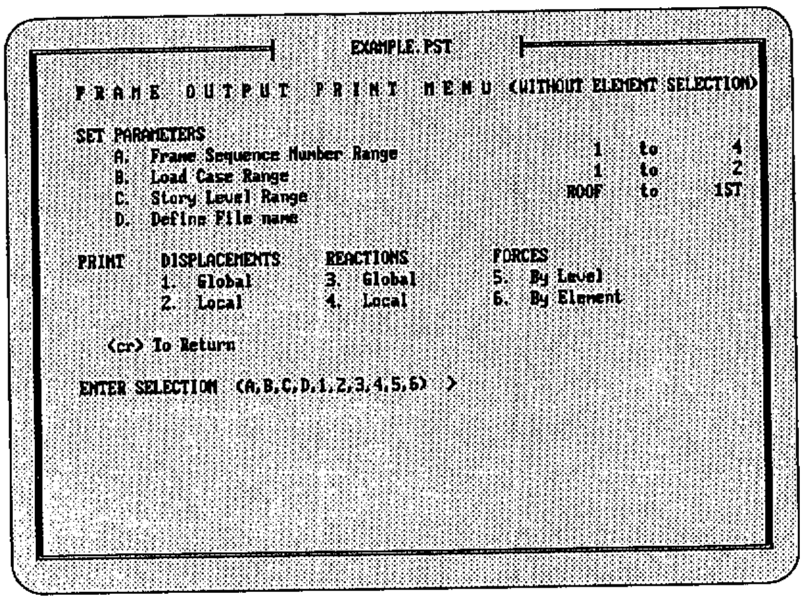
The brace member forces will be followed by the output of all the wall assemblages of the frame printed together starting from the top level of the frame and progressing downward.

In order to retain an 80-character per line output format, only the first four characters of each level ID are displayed in the beam and column output produced by this option.

C. PRINT FRAME OUTPUT (Without Element Selection)

This is Selection C on the READER Control Menu.

This selection puts the program into an output print mode and flashes the following menu:



This print mode is for conveniently printing the output associated with a series of frames. This mode does not allow the user to assign ranges to elements and joints that are to be included in the processing of the print options.

Selections A, B, C and D are for setting parameters (and ranges) that identify the load cases and levels of the structure that are to be included in the processing when the print options are activated.

The current settings of these parameters (and ranges) are displayed on the menu.

Any parameter may be set as many times as necessary. The last setting stays unchanged until it is reset or respecified.

All entries are set with default values when control is transferred into this menu by selecting option C on the READER Control Menu.

Selections 1, 2, 3, 4, 5 and 6 are the options that generate the output files containing the selected analysis results.

A <CR> will return the user to the READER Control Menu.

The following is a description of the parameters associated with the options A through D of the above menu that the user may need to set before activating the print options.

A. FRAME SEQUENCE NUMBER RANGE

With this selection, the user is prompted for a pair of frame sequence numbers between 1 and **NTF**. The sequence number refers to the sequence in which the frames are entered in the ETABS data. See Chapter V, Section D7, of the ETABS manual (Frame Location Data). In this data, 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.**

B. LOAD CASE RANGE

With this selection, the user is prompted for a pair of load case numbers between 1 and the number of load cases currently defined.

C. STORY LEVEL RANGE

With this selection, the user is prompted for a pair of valid story level identifiers that have been previously defined as part of the ETABS data. See Chapter V, Section D3, of the ETABS manual (Story Data).

D. DEFINE FILENAME

With this selection, the user is prompted for a filename of up to eight characters long and no extension. The program will append an extension .OUT to this filename to obtain the name of the file containing the output for each of the load cases as selected in the range of load cases (selection B). Also, the program will append an .ENV to this filename to obtain the name of the file containing the maxima and minima and the controlling load case numbers of each output parameter within the range of load cases currently selected. All output produced by subsequent triggering of options 1 through 6 is written to these files. Each time the user activates this selection, new files are opened and the previous files are closed. Thus multiple files that contain different information may be created by a single READER session.

If the user selects any of the options 1 through 6 before defining a filename, the program will open files with the default filename corresponding to the postprocessor filename that is being processed by READER. For example, if the name of the postprocessing file is EXAMPLE.PST, the default filenames will be EXAMPLE.OUT and EXAMPLE.ENV.

If the user-specified filename conflicts with an existing filename, the existing file will be overwritten.

The following is a description of the response of the program associated with each of the print options, 1 through 6, of the above menu.

1. PRINT GLOBAL DISPLACEMENTS

With this selection, the program will print joint displacements in the ETABS global coordinate system for the joints that lie within the story level range (selection C) for each of the frames identified by the range of frame sequence numbers (selection A).

Only the displacements associated with the load cases that lie within the load case range (selection B) will be printed. Displacements will be printed for all joints level by level, starting from the top level of the frame and progressing downward. All the displacements for the first frame will be followed by all the displacements for the next frame, and so on.

2. PRINT LOCAL DISPLACEMENTS

This selection is identical to selection 1, except that the displacements are with reference to the local coordinate system of the frame being processed.

3. PRINT GLOBAL REACTIONS

With this selection, the program will print joint reactions in the ETABS global coordinate system for the joints at the baseline of each of the frames identified by the range of frame sequence numbers (selection A).

Only the reactions associated with the load cases that lie within the load case range (selection B) will be printed. All the reactions for the first frame will be followed by all the reactions for the next frame, and so on.

4. **PRINT LOCAL REACTIONS**

This selection is identical to selection 3, except that the reactions are with reference to the local coordinate system of the frame being processed.

5. **PRINT FORCES BY LEVEL**

With this selection, the program will print the element (column, beam, brace and wall) forces for all the elements that lie within the story level range (selection C) for each of the frames identified by the range of the frame sequence numbers (selection A) as displayed in the menu.

Only the member forces associated with the load cases that lie within the load case range (selection B) will be printed.

The member forces will be printed on a level-by-level basis. In other words, the member forces of all the elements that exist at the top level are printed first, followed by member forces of all the elements that exist at the next level below, and so on.

All the member forces for the first frame will be followed by all the member forces for the next frame, and so on.

6. **PRINT FORCES BY ELEMENT**

This selection is identical to selection 5 except that the member forces will be printed on an element-by-element basis. In other words, the member forces for each element type of a particular frame will be grouped together.

Therefore, the output for column members will be on a column line basis. Thus, output for all the column elements at all levels of column line 1 will be printed together starting from the top level of the frame and progressing downward, followed by elements of column line 2, and so on.

The column output will be followed by the output for beam elements on a bay-by-bay basis. Thus, output for all the beam elements at all levels of bay 1 will be printed together starting from the top level of the frame and progressing downward, followed by elements of bay 2, and so on.

The beam output will be followed by the output of all the brace elements of the frame printed together in the order in which the brace elements were input.

The brace member forces will be followed by the output of all the wall assemblages of the frame printed together starting from the top level of the frame and progressing downward.

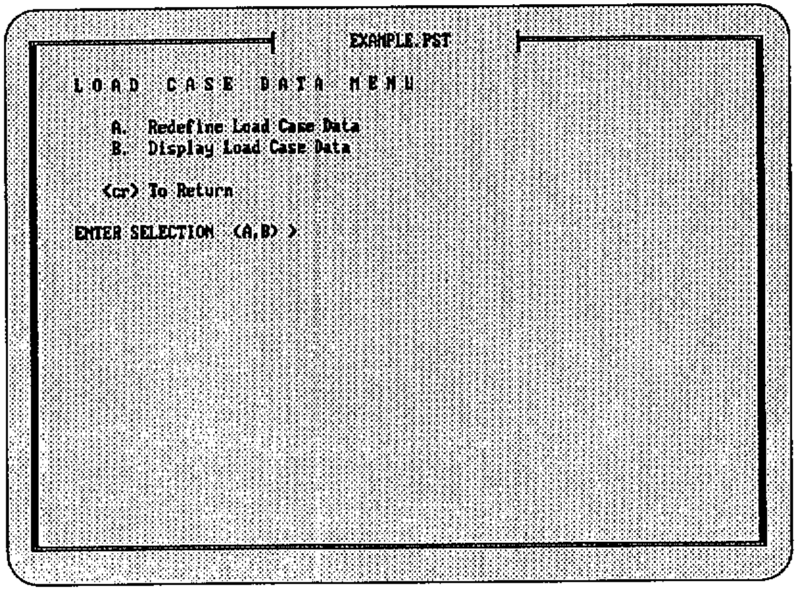
All the member forces for the first frame will be followed by all the member forces for the next frame, and so on.

In order to retain an 80-character per line output format, only the first four characters of each level ID are displayed in the beam and column output produced by this option.

D. DISPLAY/REDEFINE LOAD CASE DATA

This is Selection D on the READER Control Menu.

This selection puts the program into a load case display/redefine mode and flashes the following menu:



The following is a description of the response of the program associated with the options A and B of the above menu.

A. REDEFINE LOAD CASE DATA

With this selection, the user is prompted for a filename of the file containing load case redefinition data. The format of the load case redefinition must be the same as specified for the ETABS load case data. See Chapter V, Section D11 of the ETABS Users Manual. The load cases must be defined in ascending, consecutive order starting from 1. The total number of load cases so defined may be more or less than NLD, as defined in the ETABS run. The number of data lines in this file will set the number of load cases.

The new set of load cases defined in this file replaces the set defined in the ETABS data. These load cases will be active for this READER session until this option is reactivated and another set of load cases is defined.

B. DISPLAY LOAD CASE DATA

With this selection, the program displays the load cases that are currently active.

III.

REFERENCES

1. **Habibullah, A.**

"ETABS - Three-Dimensional Analysis of Building Systems, Users Manual," Computers and Structures, Inc., Berkeley, California, 1991.

COMPUTERS & STRUCTURES INC.

SAP90™ ETABS® SAFE™

Computer Software for Structural & Earthquake Engineering

Installation Guide

Developed and written in U.S.A.

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Further information and copies of this documentation may be obtained from:

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Revised June, 1991

DISCLAIMER

CONSIDERABLE TIME, EFFORT AND EXPENSE HAVE GONE INTO THE DEVELOPMENT AND DOCUMENTATION OF SAP90, ETABS AND SAFE. THE PROGRAMS HAVE BEEN THOROUGHLY TESTED AND USED. IN USING THE PROGRAMS, 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 PROGRAMS.

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

TABLE OF CONTENTS

I.

INTRODUCTION

This guide provides information on customizing and installing the Computers and Structures, Inc. programs SAP90, ETABS and SAFE and their pre- and post-processors on MS-DOS/PC-DOS personal computers such as the IBM AT, PS/2 or compatibles.

The regular versions of the programs require the computer to have at least 640K bytes of RAM, a math coprocessor and a hard disk drive. The PLUS versions of the programs require a 80386 based computer with at least 2M bytes of RAM, a 80387 math-coproccesor and a hard disk drive. The graphics programs require a graphics adapter and a printer for hard copies.

Chapter II provides information for installing the programs; Chapter III provides additional requirements for use of the Windows-based interactive model building programs; and Chapter IV provides information on configuring the computer to enhance program performance.

II.

INSTALLING THE PROGRAMS

This section provides information on installing the programs SAP90, ETABS and SAFE and their pre- and postprocessors.

User familiarity with MS-DOS is assumed.

Note:

> **The characters <CR> appear repeatedly in the text of this guide. These characters mean "press the carriage return key". DO NOT type the characters <, C, R and >.**

A complete program package includes:

1. This installation guide.

2. Program manuals.

3. Program disks containing program executables, sample files and in the case of SAP90 and ETABS programs, a database of steel section properties.

4. A hardware copy protection device.

The following steps will install the program:

A. Backing up the Master Disks

Before installing the programs on the computer, make backup copies of the master disks and store the originals in a safe place. The DOS **DISKCOPY** command can be used for this purpose. Consult the DOS manual for the use of this command.

B. Copying Programs to the Hard Disk

Copy all disks to the hard disk, one disk at a time, as follows:

Place disk #1 in drive A. From the DOS C prompt and from within the subdirectory to which the program is to be copied, enter the command:

C> **COPY A: *.* C:** <CR>

This will copy all of the files from the floppy disk to the hard disk. After copying is complete, remove the original disk.

Repeat the same procedure for all other disks.

It is recommended that executables associated with each system (i.e. SAP90, ETABS, or SAFE) be copied to a different subdirectory and the DOS **PATH** command be used to access them.

For the SAP90 and ETABS programs, the database of AISC steel section properties is supplied in two different units. File AISC.INC contains the database in inch units and file AISC.MET contains the database in meter units. The user should copy the file with the appropriate units to a file called

AISC.DAT which the programs access. This should be done from the subdirectory in which the files reside by entering:

C> COPY AISC.INC AISC.DAT <CR>

for the inch units database, or by entering:

C> COPY AISC.MET AISC.DAT <CR>

for the meter units database.

The AISC.DAT file should reside in the same directory as the SAP90/ETABS programs.

C. Using the SETUP Program

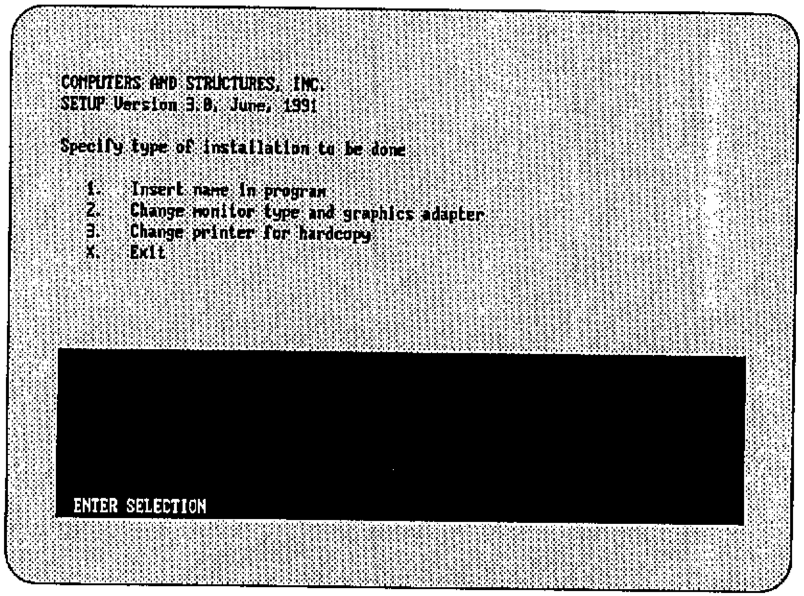
The SETUP program and associated files provided on the SETUP disk allow users to customize the company name on the program output and to configure the graphics programs for a particular graphics adapter/monitor and for a particular printer. All programs come with default settings and may be used without using the SETUP program.

To use the SETUP program, copy the contents of the SETUP disk to the hard disk as per section II-B above. The SETUP disk should be copied into the directory where the executable to be modified exists.

To begin SETUP, enter the following command from the directory to which the SETUP disk was copied.

C > **SETUP** <CR>

The program will respond with the following screen:



This is the SETUP control menu. The selections 1, 2 and 3 will display lower level menus for setting other options; entering a X will exit the program.

The following three sub-sections correspond to the three options of the SETUP control menu and describe the program actions corresponding to other options.

1. Insert Name in Program

This is selection 1 on the SETUP control menu. This selection responds with the following menu:

```
Specify Program for name insertion

    1.  SAP90.EXE
    2.  ETABS.EXE
    3.  SAFE.EXE

    <cr> To Return



  ENTER SELECTION
```

Selecting 1, 2 or 3 will prompt with the following message:

```
Enter name to be inserted in program (maximum of 68
characters)
```

Specifying the company name and pressing <CR> will then insert the specified name in the corresponding program and a message to that effect will be given.

Entering <CR> at the selection prompt will return user to the SETUP control menu.

The company name in the programs may be changed any number of times. However, before changing the name, the program SAP90.EXE, ETABS.EXE or SAFE.EXE, as required, must be copied from the **original disk** or its backup to the hard disk.

2. Change monitor type and graphics adapter

This is selection 2 on the SETUP control menu. This selection responds with the following menu:

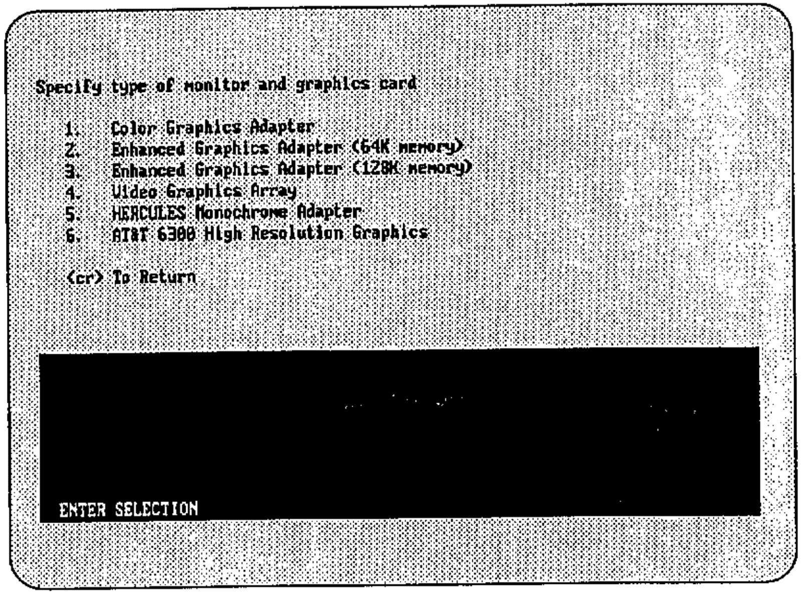
```
Specify Graphics Program for device installation

    1.  SAPLOT.EXE
    2.  PLOTTER.EXE
    3.  SAFEPL.EXE
    4.  SAPTIME.EXE
    5.  SAPSPEC.EXE
    6.  SAPHTA.EXE

    <cr> To Return


ENTER SELECTION
```

Selection 1, 2, 3, 4, 5 or 6 will prompt with the following choices:



Entering a selection will then configure the graphics program for the particular adapter and a message to that effect will be given. A <CR> without a selection will return to the SETUP control menu.

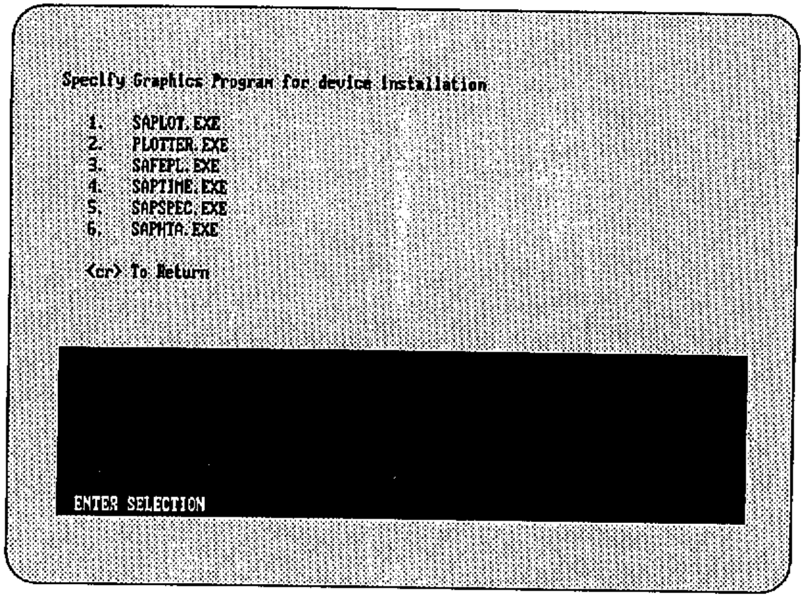
The default is the "Enhanced Graphics Adapter (128K memory)".

The graphics program adapter configuration may be changed as many times as required.

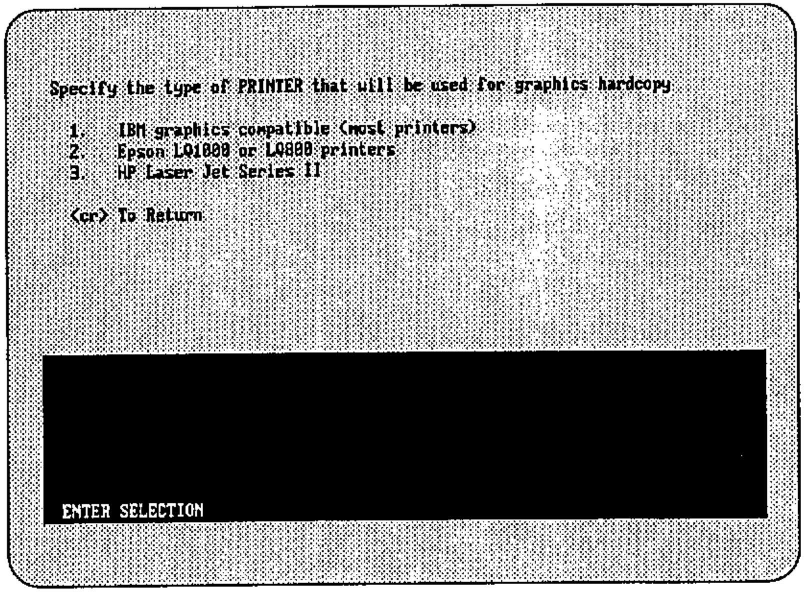
The choices shown above may vary with different versions of the program.

3. Change Printer for the Graphics Hard Copy

This is selection 3 on the SETUP control menu. This selection responds with the following menu:



Selecting 1, 2, 3, 4, 5 or 6 will prompt with the following choices:



Entering a selection will then configure the graphics program for the particular printer and a message to that effect will be given. A <CR> without a selection will return to the SETUP control menu.

The default printer is the "IBM graphics compatible printer".

The graphics program printer configuration may be changed as many times as required.

The choices shown above may vary with different versions of the program.

D. Modifying the CONFIG.SYS file

The SAP90 and ETABS programs require that FILES=15 or more be present in the CONFIG.SYS file in the root directory of the computer before it is booted.

If the CONFIG.SYS file exists and contains FILES=15 or more it need not be modified.

If the CONFIG.SYS file exists but does not contain the Files=... line or has a number less than 15, it should be modified to contain FILES=15 by use of a text editor.

If the CONFIG.SYS file does not exist, the file CONFIG.CSI provided on the SETUP disk should be copied into the root directory of the hard disk. From the DOS C prompt, enter the command:

C> COPY A: CONFIG.CSI C:\ CONFIG.SYS <CR>

E. Using the Copy Protection Device

The SAP90, ETABS and SAFE software are copy protected with a hardware copy protection device that is provided with the software.

The hardware copy protection device should be attached to the parallel printer port of the computer. The port to which the device is attached should be designated as LPT1. The device goes between the computer and the printer (or any data transfer switches.)

If other programs use similar devices, all of these devices can be attached in series. Also an extension cable may be used between the computer and the device.

The copy protection device does not require the printer to be connected or, if connected, to be powered.

III.

USING THE WINDOWS-BASED MODEL BUILDERS

Programs SAPIN/ETABSIN/SAFEIN are interactive, graphical, mouse driven model builders for programs SAP90/ETABS/SAFE, respectively. These programs create input files for the respective analysis programs. The use of these model generators is not mandatory, as input files can also be created with a text editor. However, these programs provide a convenient means of generating structural models and provide options for graphically editing any existing input files.

The model building programs work under the Microsoft Windows environment. The additional requirements for the use of these programs are:

a. Microsoft Windows, version 3.0 or later, running in either the standard or the enhanced mode;

b. A mouse or other pointing device supported by Windows;

c. An EGA or VGA color display and graphics adapter supported by Windows.

To use these programs the following steps must be followed:

a. Install Windows on the computer using the Windows installation instructions.

b. Copy all files from the SAPIN/ETABSIN/SAFEIN program disk to a directory on your hard disk as per Section II-B of this guide.

c. Start Windows and the SAPIN program (or ETABSIN or SAFEIN) by entering:

   WIN SAPIN <CR>

   This must be done from the directory where SAPIN.EXE resides. The path must include the Windows directory using the DOS **PATH** command. Substitute the appropriate program name in the above command.

   There are several different ways to start a program under Windows. The method described above is the fastest if Windows is not running. If Windows is already running, please refer to the Windows Users Guide for other options.

d. After the program has started and the menu appears, click on HELP for assistance. Tutorials and detailed explanations of the commands are available in the program manuals for SAPIN, ETABSIN and SAFEIN.

IV.

ENHANCING PROGRAM PERFORMANCE

The regular versions of programs SAP90/ETABS/SAFE and their pre- and post-processors are designed to work in any available memory between 480K and 640K bytes. The PLUS versions of the programs must have at least 1.0M bytes of extended memory available. The larger the available memory, the faster the programs will work. Additionally, the problem capacity will be increased as memory increases. If required, available memory may be increased by removing memory resident programs and, if necessary, by modifying the CONFIG.SYS and AUTOEXEC.BAT files and then rebooting.

The performance of some portions of the programs for large problems is heavily I/O dependent. This performance can be significantly improved by using a disk caching program. The RAM used for this disk caching, however, should be above the 640K boundary (i.e. in extended memory). Please note that some disk caching programs may be incompatible with the PLUS versions of SAP90, ETABS and SAFE.