University of Alberta
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Hybslab - A Finite Element Program For Stiffened Plate Analysis (Users' Manual)

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November, 1981

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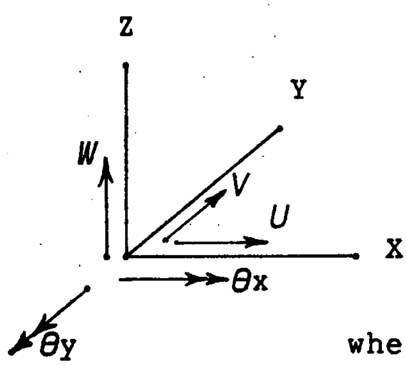
Chapter 1

INTRODUCTION to *HYBSLAB*

1.1 Coordinate Systems and Sign Conventions

This manual deals with the program *HYBSLAB* which was developed at the University of Alberta for the finite element analysis of plates with eccentric stiffeners. The program is based on the hybrid stress method. A detailed discussion of the theory is available in reference 2.

A right-hand Cartesian coordinate system (x,y,z), is used. The following degrees of freedom are defined at the midsurface of the finite element plates:



where,
W = transverse displacement,
θx= W,y= rotation about X axis,
θy= W,x= rotation about Y axis,
U = in-plane displacement (in the X direction),
V = in-plane displacement (in the Y direction).

Figure 1.1 Coordinate System and Degrees of Freedom.

The directions of moments and shears are defined according to the tensor sign convention shown below.

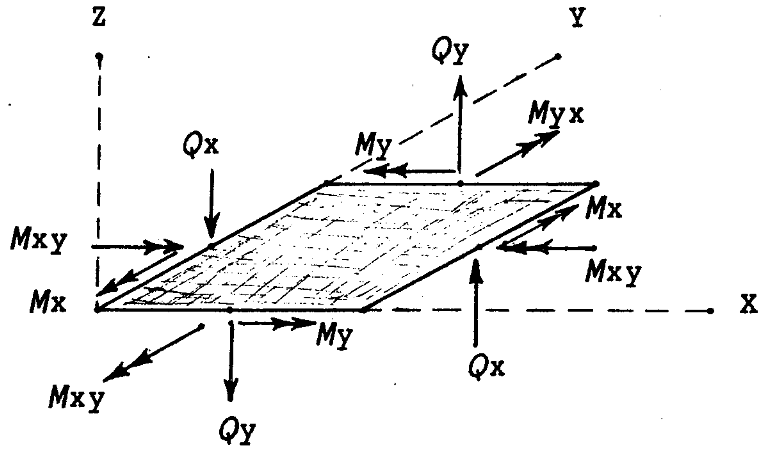


Figure 1.2 Moment and Shear Sign Convention.

1.2 Background Information

The program *HYBSLAB* was developed for the analysis of flat plates with integral eccentric stiffeners and either point or finite-sized columns. The program is intended primarily for use by consulting firms where at present the use of more approximate methods based on equivalent frames predominates.

The following characteristics of this program distinguish it from other existing programs:

(1) The program is based on the hybrid stress method. For reasons discussed elsewhere (Hrabok,1981), this formulation appears to be best suited for the analysis

of flat plate floor systems.

(2) In modelling the structure, any element shape ranging from a triangle to a six-sided polygon may be used. Floors of arbitrary planform can be analysed and the finite dimensions of column cross sections and the finite width of beams may be accounted for in the analysis. Translational in-plane degrees of freedom have been included to allow for displacements, such as those caused by eccentric stiffeners. The same subroutine which generates the flexural matrices for the various shaped elements is also used to obtain the in-plane matrices.

(3) In developing the program, much emphasis has been placed on reducing the user manpower demands. This has been done by automating the input of data and by using graphical displays to aid in the checking of input data and the interpreting of output data.

The variational basis for the hybrid stress method and proof of its convergence were established in the latter part of the 1960's by Pian and Tong (Pian,1969 and Tong,1969). The method is based on a modified complementary potential energy principle with Lagrangian multipliers being used to ensure overall equilibrium of the element. The Lagrangian multipliers for the modified complementary energy principle are the displacements and they are not eliminated at an element level.

The program *HYBSLAB* is based on Pian's method and has the capability of generating in-plane and plate bending stiffness matrices for a wide range of element shapes. The element shapes may vary from a 3-sided element (triangle) to a 6-sided irregular polygon. Some possible element configurations are shown in Figure 1.3.

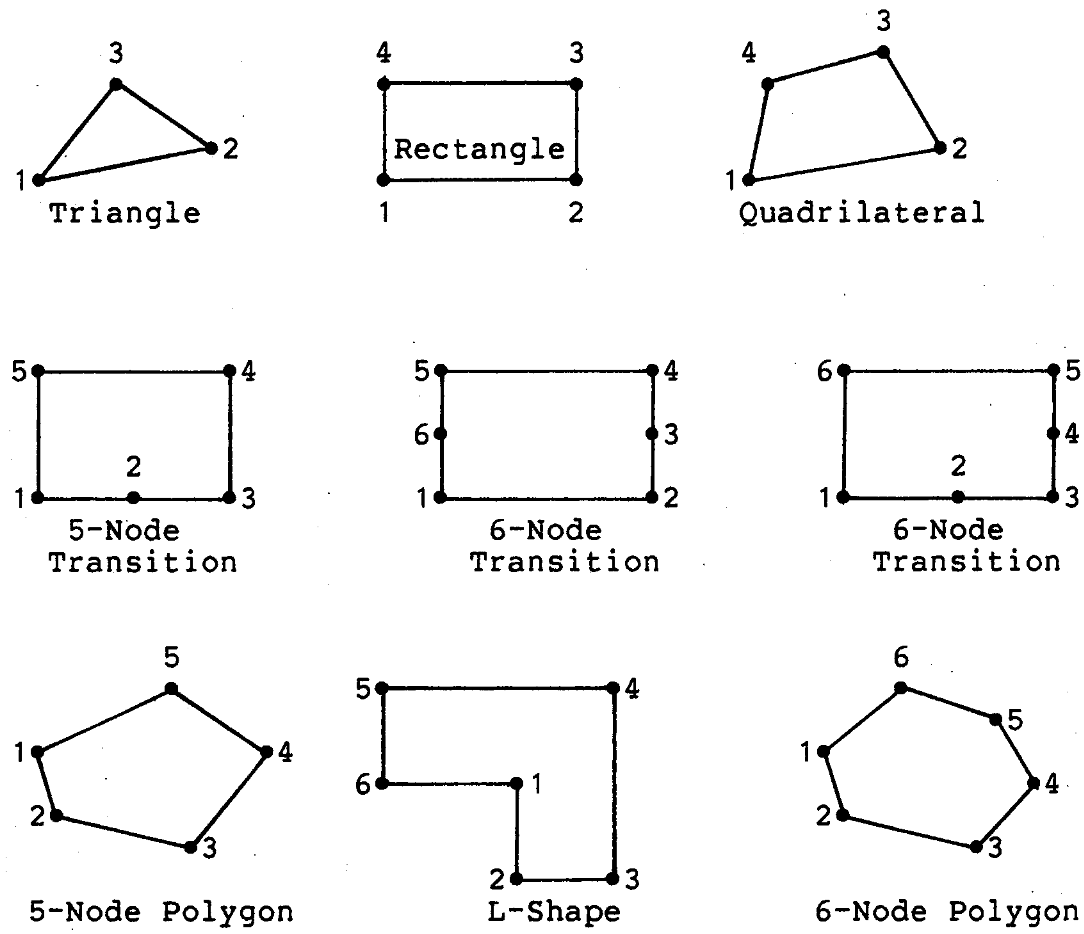


Figure 1.3 Some Possible Element Configurations

1.3 General Description of *HYBSLAB*

The following is a list of the subroutines in *HYBSLAB*. It is provided to give the user an overall view of the program.

```
*** GROUP 1 = STIFFNESS MATRIX SUBROUTINES   ***
 Subroutines :
STIFFS (Hybrid Stiffness Matrices for Elements:
            (i  ) Rectangles     ,
            (ii ) Triangles      ,
            (iii) Quadrilaterals ,
            (iv ) L-Shapes       ,
            (v  ) Transitions    ,
            (vi ) Polygons       .)
OFFSET (STIFFS Transformation for Eccentricities)
BMSTF  (Offset Beam Element Stiffness Matrices)
XSTIFF (Read-In Stiffness Matrices from Unit(11) )
COLCAP (Column Caps represented by Thick Plates)
SPRING (Additional Stiffness at Chosen DOF)
DISPRE (Prescribed Non-Zero Nodal Displacements)
```

```
***   GROUP 2 =  AUXILIARY SUBROUTINES    ***
 Subroutines :
ASSEMB (Element Stiffness Entry into Global Matrix
BANDWI (Semi-Band Width of Elements )
BANSOL (Gauss Equation Solver for Displacements)
INVERT (Inversion of H( , ) for  Hybrids)
CONECT (Joint & Member Input - Connectivity Data)
GRDATA (Read & Write Group Properties in GPROPS)
COORDS (Coordinate Generation from Group Data)
BMPROP (Beam Element Data)
```

```
***   GROUP 3 =  STRESS SUBROUTINES    ***
 Subroutines :
BFORCE (Beam Element Nodal Forces)
STRESS (Plate Element Stresses and Nodal Forces)
AVERAG (Averaged Stresses at Nodes)
```

```
Auxiliary Units :
          File(1) - Output of F.E. Mesh             ,
          File(2) - Output of 'W'  Displacements    ,
          File(3) - Output of Nodal Stresses        ,
          File(11)  - Read 'XSTIFF' matrices        .
```

The subroutine 'STIFFS' uses the hybrid stress method to calculate in-plane and flexural stiffness matrices for the various shaped elements shown in Figure 1.3.

The hybrid stress method as proposed by Pian and Tong requires that a set of stress functions be chosen to describe the stress field inside the element. A second set of independent functions is required to describe the displacement field along the element boundaries and to provide interelement displacement continuity. For the plane stress elements, the edge displacements between nodes are described by linear functions in *U* and *V* while the stresses are described by the partial quadratic polynomials:

$$\sigma x = \beta_1 + x\beta_2 + y\beta_3 + xy\beta_4$$
$$\sigma y = \beta_5 + x\beta_6 + y\beta_7 + xy\beta_8 \qquad (1.1)$$
$$\sigma xy = - y\beta_2 - 0.5y^2\beta_4 - x\beta_7 - 0.5x^2\beta_8 + \beta_9$$

For the plate bending elements, the element edge displacements for *W* and *W*,t (tangential slope) are described by first order Hermitian polynomials while *W*,n (normal slope) is assumed to vary linearly between nodes. In the interior of each element the following complete quadratic polynomials are used to describe the moment field:

$$Mx = \beta_1 + x\beta_2 + y\beta_3 + x^2\beta_4 + xy\beta_5 + y^2\beta_6$$
$$My = \beta_7 + x\beta_8 + y\beta_9 + x^2\beta_{10} + xy\beta_{11} + y^2\beta_{12} \qquad (1.2)$$
$$Mxy = - xy\beta_4 - xy\beta_{12} + \beta_{13} + x\beta_{14} + y\beta_{15} + x^2\beta_{16} + y^2\beta_{17}$$

When using the subroutine 'STIFFS' it is important to note that the local coordinate axes of an element may be placed at any location relative to the global axes but the local axes must remain parallel to the global axes.

Subroutine 'STIFFS' also generates the work-equivalent load vector for uniform normal loading of all the plate elements. For the in-plane loads, the program does not do this and the user is required to proportion the surface tractions, if any, to nodal loads.

The program has a number of other technical features which may be of interest. Provisions have been made in the program to accommodate singularity elements (Hrabok,1981) or any other user-provided element having the same nodal degrees of freedom as the *HYBSLAB* elements. For example, the stiffness matrix and load vector for the singularity elements are generated by a separate program and are stored in a file which is later accessed by *HYBSLAB*. This file is separate from the file which contains the data for the main problem and will be referred to as an auxiliary file.

To model eccentric stiffeners, the user can use either beam elements or other plate elements which have midsurfaces offset from the midsurface of the main plate. Details of this procedure are given in the next section.

The effects of columns may be lumped at a single node or the finite dimensions of the column cross section may be represented. A more detailed discussion of this topic is contained in the last section.

The program has a number of special features that may be required for certain problems. For example, the user may specify non-zero values for any degree of freedom or constrain two or more degrees of freedom to have the same value. As well, additional stiffness may be added to the diagonal term associated with any degree of freedom.

The solution for nodal displacements is obtained by using an in-core banded Gaussian elimination routine. The problem size that may be solved with the present version on the AMDAHL 470/V8 is 1500 unknowns with a semi-band of 80. These values may be varied subject to the condition that their product must be compatible with the in-core storage limits of the computer facility being used.

The following measures have been taken to assist the user with the practical aspects of time and cost, and error detection.

The input data may be specified in one of two ways, which will be referred to as 'automatic' and 'manual'. The automatic data generating subroutine, called 'CONECT', is specifically intended for 4-node element gridworks and requires very little input from the user. This subroutine operates from 2 two-dimensional integer matrices, one of which contains the joint numbers of the structure while the other contains the element numbers. The input required for this subroutine basically consists of specifying the rows of the matrices, but with provisions made to automatically generate subsequent rows from any given row and numbers within a row. This subroutine is specifically tailored for grids consisting of rectangles and/or quadrilaterals. An example illustrating the use of these matrices is given in Chapter 3.

The other method is to manually specify the input data, element by element. This is the most inefficient and time-consuming way to prepare the data and should only be used when necessary. To provide the user with added flexibility in data preparation, both methods may be used for a given problem.

To reduce computational costs, elements with identical stiffness matrices are placed in the same group so that only one element stiffness matrix needs to be calculated.

Another attractive feature of the program is that the user does not input the global coordinates of the joints. The subroutine 'COORDS' generates this data from the local coordinates used for calculating the stiffness matrix of each element group.

After the input data has been prepared, the user has the option of doing a check-run. The program is run without calculating any stiffness matrices and an auxiliary data file is created. This data file can then be used to produce a drawing of the structure complete with node and element numbers. This type of graphical display provides a quick and easy means of detecting errors in the connectivity data, the local coordinates of the element groups, and the grouping of the elements.

The program output for each load case consists of the nodal displacements and rotations, element nodal and centre point stress values, and internal nodal forces. As well, at each node, stresses averaged from the values associated with the adjoining elements are printed along with the principal flexural stresses.

The solution output may also be obtained in a graphical form. In the current version of the program, two auxiliary files are required to store output data for contour plots. The first of these files contains the nodal values of the transverse displacement W, while the second file contains the averaged nodal values of Mx, My, Mxy, Mp_1 and Mp_2, where Mp_1 and Mp_2 are the principal moments.

For example, if one were designing reinforced concrete slabs and if the reinforcing is to be placed in the X and Y coordinate directions, then contour plots of the orthogonal moments Mx and My would be most useful. If these plots are done to the same scale as the working drawings, then the designer can do the steel layout directly on the contour drawings. Examples of such moment plots are provided later.

1.4 Modelling of Eccentric Stiffeners

When a plate is stiffened by a beam which has its centroidal axis in a plane not coinciding with the plate's midsurface, then in-plane or membrane strains may be produced in the plate. The applied loads are carried jointly by flexural action and membrane action in proportion to the relative rigidities of the plate and the beam and the distance between their centroids. In order to analyse this type of structure it is necessary to consider not only the geometric degrees of freedom, $< W , \theta x , \theta y >$, but also, the in-plane displacements, $< U , V >$.

The method adopted in *HYBSLAB* for coupling an integral stiffener to a plate consists of calculating the stiffness matrix of the stiffener about its own centroid and then transferring it to the midsurface of the plate. This operation is accomplished by pre- and post- multiplying the beam stiffness matrix by a linear transformation matrix [Te]. In essence, the transformation matrix couples the nodal degrees of freedom in a manner equivalent to attaching the beam node to the plate node by a rigid bar. This is the same as specifying that plane sections remain plane. Although this method introduces additional unknowns in the form of in-plane degrees of freedom, it does not require estimating the location of the neutral axis in the composite section. This method was used in *HYBSLAB*; the details are given in reference 2.

The beam's local X axis is always along the longitudinal axis of the beam. The local Z axis always points in the same direction as the global Z axis. A local stiffness matrix [K] is calculated and then modified for eccentricities and rotation in-plan. To obtain the global matrix, [K] is first pre- and post-multiplied by the transformation matrix [Te]. Then, it is also pre- and post-multiplied by a rotational transformation matrix [Tr]. The [Tr] matrix consists of direction cosines between the local and global (X,Y) axes. The final form of the beam matrix in the global system (denoted by [Kb]) can be written as:

$$[Kb] = [Tr]^T[Te]^T[\underline{K}][Te][Tr] \tag{1.3}$$

The explicit form of the final global matrix [Kb] is given in reference 2.

The process described thus far has dealt with the representation of eccentric line beams. Provisions have also been made to allow the user to model the finite width of a rectangular beam. When this option is used the beam is referred to as a wide beam.

To model wide beams, thick plate elements are used and the stiffness matrix which is calculated at the midsurface of the thick plate is transferred to the global midsurface by pre- and post-multiplying it by a transformation matrix. Details of this operation are given in reference 2.

It is necessary to draw the user's attention to an error introduced by the method being used to model eccentric stiffeners. The nature of the error was identified in 1977 by Gupta and Ma (Gupta,1977). The error arises from a conflict in describing the axial displacement field of the beam element. If plane sections are assumed to remain plane, then a rotation at a node in the plate causes the axial displacements in the beam to vary according to the plate functions. The plate functions are usually quadratic or higher order and the conflict arises because a linear function was used to derive the beam's axial stiffness.

A typical beam and its cross section are shown in Figure 1.4. Also, as indicated in this figure, two choices exist for representing the flange and stem of the beam. The first choice, referred to here as the 'layered' approach, is to regard the plate as having the same width and thickness as the overall flange while the beam would consist of only the portion which protrudes above or below the slab. The second choice, referred to as the 'overall thickness' or 'overall height' approach, is to consider the plate as being only the overhanging portions of the T-beam flange. To illustrate the magnitude of the error, Gupta used the layered approach and replaced the plate element with a beam element. He then derived the following expression:

$$r = \frac{A_1 A_2 e^2}{4(A_1+A_2)(I_1+I_2)} \qquad (1.4)$$

where,
A_i = area of the cross section for beam 'i',(i=1,2),
I_i = moment of inertia for beam 'i',(i=1,2),
e = the distance between the beam centroids,
r = the error in the calculated *W* displacement.

Using the above equation for the T-beam shown in Figure 1.4, the error for the layered cross section can be calculated as 0.600. This means that if the entire length of the T-beam is represented by a single beam element, then the calculated displacement will be 1.600 times the correct value. However, for the overall cross section, also shown in the same figure, the same expression is valid and the error calculated for this cross section is only 0.136 . The above example illustrates that the user has some control over the magnitude of error depending on how the cross section is chosen.

Although the magnitude of the error is problem dependent, it is important to note that it can be estimated from Equation 1.4 and it decreases with an increase in the number of elements. Also, the overall model is expected to be the more accurate whether the stiffener is represented by a line beam or an offset plate.

More details on the magnitude of the error and the modelling of the cross section by line beams and plate elements are provided elsewhere (Hrabok,1981).

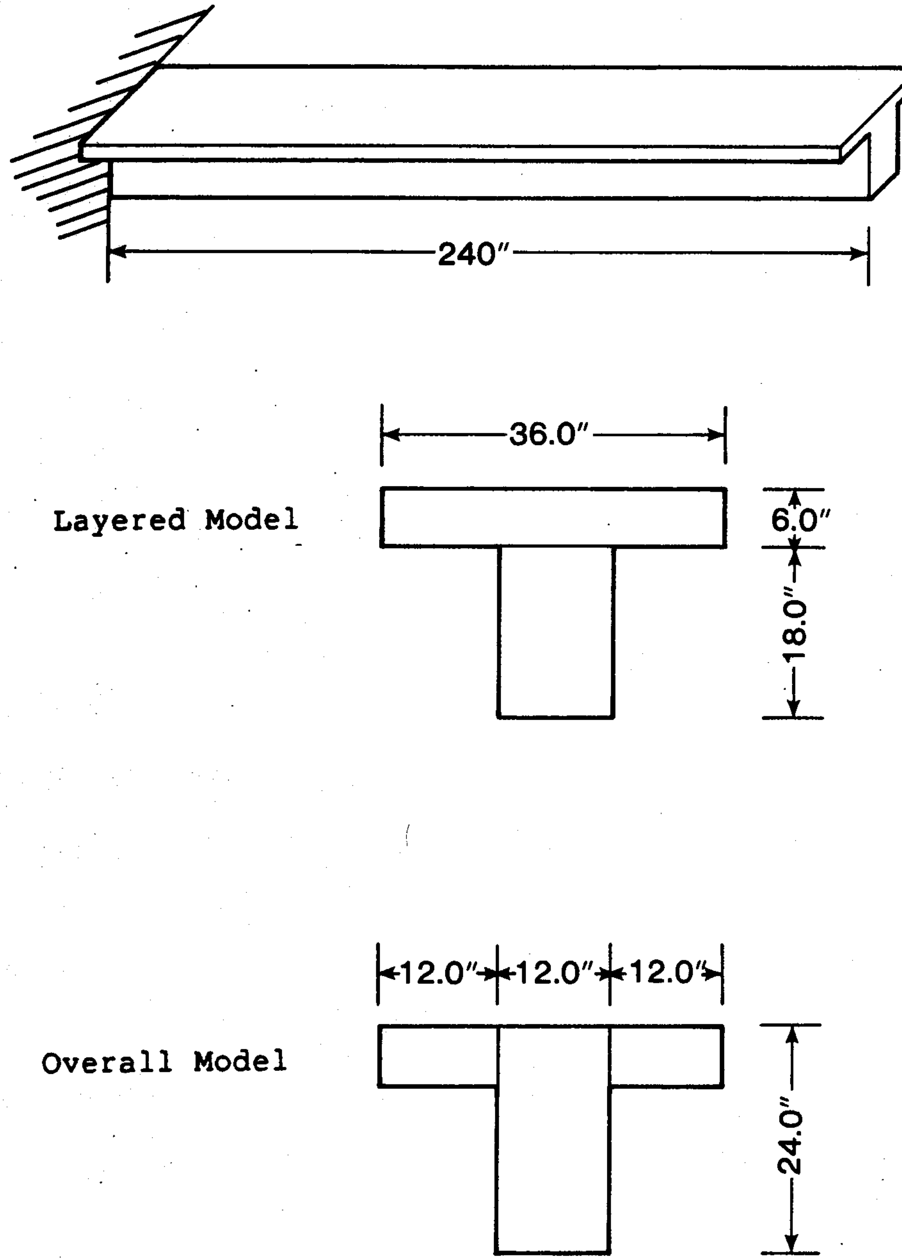


Figure 1.4 T-Beam and Representation of Cross Sections.

1.5 The Modelling of Columns

In the program *HYBSLAB*, provisions have been made to allow the designer to use either finite-sized or point columns. To use either type of column, the program requires as input the column's axial and flexural stiffnesses at the location where the column and the midsurface of the plate meet. Since these values are very much dependent on the far end conditions, the material properties of the column, and the joint connection detail, the selection of these values requires some engineering judgement on the part of the user. The remaining input consists of the X and Y coordinates for the column centroid and the joint numbers to which the centroidal stiffnesses are to be distributed.

For finite-sized columns, the joints to which the column stiffness is distributed are those on the perimeter of the column. The distribution is done so as to satisfy two conditions. The first is that the centroid of the column and the joints on the column's perimeter define an X-Y region which undergoes rigid body motions only. This region will be referred to as a 'column head' and the following constraint equations apply in this region:

$$\begin{aligned} W_i &= W_o + (y_i - y_o)\,\theta x_o + (x_i - x_o)\,\theta y_o \\ \theta x_i &= \theta x_o \\ \theta y_i &= \theta y_o \end{aligned} \qquad (1.5)$$

where, the subscript '$_o$' denotes the column centroid, and '$_i$' denotes a joint in the rigid-body region.

The second condition is that the substitute system of distributed stiffnesses at the perimeter joints contributes the same strain energy to the structure as the original system at the centroid. An alternate view of this method is that rigid bars have been used to attach each perimeter joint to the centroid of the column.

For point columns the same method is used but only one finite element joint is involved. The advantage of using this method for point supports is that the centroid of the column and a joint of the finite element model do not have to coincide. This permits the user to use more rectangles when doing the grid layout. However, the transfer distances between the two points must be kept small if the constraints in Equation 1.5 are to be realised.

To implement the constraint equations for finite-sized columns, artificially thick elements are used to represent the column head. The rigid body behavior described by Equation 1.5 is satisfied only approximately. The accuracy of such an approach can only be assessed by considering specific problems but results from a substructuring approach and comparisons done elsewhere (Hrabok,1981), indicate that the thick element approach can be made as accurate as desired for practical usage.

It is recommended that columns be represented by plate elements which have a specified thickness 100 times that of the surrounding plate. When using the program, the designer can always determine the extent of column head 'mushrooming' by looking at the displacement output for the column head.

Chapter 2

THE INPUT DATA

2.1 INPUT: The READ Statements

The program *HYBSLAB* is written in FORTRAN IV. All input data, both real and integer, are read using the following statement:

```
2      FORMAT(100G20.0 )
```

This is a free format type and the individual numerical fields in the input data must be separated by commas. A typical 'READ' statement using this format is:

```
READ(5,2) IGROUP,INPLAN,IPROP, XDIM,YDIM
```

In the above, '5' denotes the input unit or file number and '2' is the format statement described earlier. All headings and titles are read using:

```
1      FORMAT(15A4)
```

The following comments may be of interest to the user. The term 'degree of freedom' (dof) is used to denote a displacement coordinate of the finite element (FE) structure. These degrees of freedom are located only at the nodes of the model and are used to describe the displacements of the structure. There are 5 such displacement coordinates in *HYBSLAB*; the order of these dofs is $< W \ \theta x \ \theta y \ U \ V >$.

Most of the integer input required by the program is of a sequential form such as:

```
READ(5,2) J1,J2,JLAST
```

If the data to be input is: 2,5,8,11,14,17,20,23,26,29,32 then the required input is: 2,5,32, (that is: J1=2, J2=5 and JLAST=32). The program assumes that '2' is the first number of the series and '5' is the second number. From these two numbers an increment of '3' is calculated and is used to generate the remainder of the series. The number '32' is the last number of the series and generating of values ceases when this number is reached or exceeded.

The following is a scan of the 'READ' statements as they appear in the current version of the program. Explanations on the intended use of each variable are provided after each 'READ' statement. 'READ' statements preceded by a 'C' are comment cards for user convenience and are not executed by the program.

C READ-IN of DATA in *** MAIN ***

```
READ(5,1)   HEAD
        - Any title to identify the structure.


READ(5,1)   UNITS
        - Units of force and distance being used for
          the structure.
        - The program is unit independent and
          therefore only length (distance) and force
          can be specified; all else follows - the
          modulus of elasticity and all other data
          must be input in terms of these two units.
        - The units specified by this data line are
          simply to remind the user of the units which
          have been chosen, they have no influence on
          the running of the program.


READ(5,2) NRECTS,NBEAMS,NTRIAS,NQUADS,NLSHAP,
          NTRANI,NPOLYS,NEXTRA,NRCOLS,NSPRIG,NDIPRE
 where the total number of:
  1) Rectangular elements=      NRECTS
  2) Line beam elements=        NBEAMS
  3) Triangular elements=       NTRIAS
  4) Quadrilateral elements=    NQUADS
  5) L-shaped elements=         NLSHAP
  6) Rectangular transitions
       (either 5- or 6-node)=   NTRANI
  7) Polygonal shaped elements
       (either 5- or 6-sided)=  NPOLYS
   Note: The above classification is provided
         for user convenience; the stiffness
         matrices and uniform load vectors for
         each element shape are all generated
         by the subroutine 'STIFFS'. Elements
         in any of the above categories are
         numbered consecutively starting at '1'.
         See Figure 1.3 for sketches of some
         possible element configurations.
  8) Elements for which the
     stiffness matrices must
     be read from an
     auxiliary file(11)=       NEXTRA
```

```
 9) Columns supporting the plate
      (either point or finite-sized)=   NRCOLS
10) Springs added to chosen dofs for
      the purpose of stiffening or
      restraining a specific movement=  NSPRIG
11) Degrees of freedom with non-zero
      prescribed displacements=         NDIPRE
```

```
READ(5,2) NRTYPE,NBTYPE,NTTYPE,NQTYPE,NLTYPE,
          NATYPE,NPTYPE,NXTYPE
          (see note below)
where the number of:
 1) Rectangular element types=      NRTYPE
 2) Line beam element types=        NBTYPE
 3) Triangular element types=       NTTYPE
 4) Quadrilateral element types=    NQTYPE
 5) L-shaped element types=         NLTYPE
 6) Rectangular transition types=   NATYPE
 7) Polygonal shaped element types= NPTYPE
 8) External or extra element types=NXTYPE
  Note: This data is used to identify the
        various groups within each shape.
        The various element shapes are shown
        in Figure 1.3. Elements with identical
        stiffness matrices are classified as
        being of the same type and are assigned
        to one group.
```

```
READ(5,2) NJNTS,NMAST,NVECT,MPRINT,ISTOP,IPLOT
where,
 NJNTS= Number of joints in the finite element
        model of the real structure.

 NMAST= Number of master nodes; other degrees
        of freedom can be specified to have
        displacement values identical in
        magnitude to those of the master
        nodes.

 NVECT= Number of load vectors (not to exceed 3).
        In the present version of the program,
        the last column of the load matrix is
        occupied by the uniform unit load vector
        (this is reserved for future use in
         specifying checkerboard loading).
```

```
MPRINT= 0---> no element stresses will be printed.
        i---> stresses will be printed for 'i'
              number of elements; if stresses are
              to be printed for all elements then
              'i' is input as the total number of
              elements(beams+plate elements) and
              no other input is required.

ISTOP= 0---> the program does not stop; it forms
             and solves the entire set of equations.
       1---> the program stops after reading
             and echoing the input data (no
             stiffness matrices are calculated).

IPLOT= 0---> no data is stored to draw the finite
             element model (connectivity data and
             joint coordinates check in file(1)).
       1---> write connectivity data into file(1).
```

```
C     READ; Suppressed d.o.f. (zero disp.)

      READ(5,1) HEAD
          - a heading for clarity and user convenience.
            (e.g. 'Suppressed Degrees of Freedom').

      READ(5,2) J1,J2,JLAST,(LDOF(K),K=1,5)
              (repeat this data line as often as necessary)
       where,
        J1,J2,JLAST=      First, second and last joint
                          numbers of the joint sequence.
       (LDOF(K),K=1,5)=   An integer vector to describe
                          the freedom of the joint,
                           0 ---> no movement allowed,
                           1 ---> dof movement is permitted,
                   Note: see Fig. 1.1 for order of dofs.
          (End with a 0,0,0, terminator line.)
```

```
C     READ; Master & Slave Node d.o.f.

       - skip this data if NMAST=0.
       READ(5,1) HEAD
           - a heading for clarity and user convenience.
             (e.g. 'Master and Slave Nodes').

       READ(5,2) JMAST,J1,J2,JLAST,(LDOF(K),K=1,5)
               (repeat this data line as often as necessary)
        where,
         JMAST= The joint whose motion will be copied,
```

```
 J1,J2,JLAST=     First, second and last joint
                  numbers of the slave node sequence.
(LDOF(K),K=1,5)= An integer vector to describe the
                  dofs to be copied,
if               ┌0     ---> no change,             ┐
  LDOF(k)=       │+Jmast---> slave node will copy the│
                 └           'k' dof of JMAST exactly.┘
   (End with a 0,0,0, terminator line.)
```

```
.................................................................
C       (go to READ from Subroutine 'CONECT')---------------->
C       (back to READ from 'MAIN')                        <----/
         Note: The above pair of arrows denote that the
               description of the data to follow is contained
               in the explanation of the subroutine 'CONECT'.
               If NRECTS=0 and NQUADS=0 then skip this
               subroutine.
```

```
.................................................................
C     READ-in for Rectangles.

        - skip this data if NRECTS=0 (go to Beams).
        READ(5,1) HEAD
        |     - a heading for clarity and user convenience,
        |       (e.g. 'R E C T A N G L E S').
        |
        READ(5,2) NEL,MTYPE,(JTEMP(K),K=1,4)
        |        (repeat this data line as often as necessary)
        where,
        |      NEL= The member(rectangle) number.
        |    MTYPE= The rectangular group to which the
        |           member's stiffness matrix belongs.
        | JTEMP(K)= Global joint numbers of the rectangle,
        |           (start numbering at lower left corner
        |            and proceed counterclockwise,
        |            see Fig. 1.3 for assumed order).
        |   (Terminate prematurely with a 0,0,0, line.)

C       READ-in Group Data for Rectangles
        READ(5,1) HEAD
        |     - a heading for clarity and user convenience,
        |       (e.g. 'Rectangular Group Properties').
        |
        READ(5,2) EX1,EY1,POISX,GXY,THICK,ECC2
        where,
        |   EX1= Modulus of elasticity for uniaxial
        |        loading only in the X direction.
```

```
   EY1= Modulus of elasticity for uniaxial
        loading only in the Y direction.
 POISX= Poisson's ratio as measured when only
        the uniaxial Y load is present.
   GXY= Shear modulus of elasticity as
        measured from a pure shear condition.
     Note: The above elastic constants are
           independent of each other. It is
           assumed that:  EX1* POISY= EY1* POISX.
 THICK= The thickness of the plate element.
  ECC2= Eccentricity e2 of the offset plate
        element; non-zero only when a plate
        element is being used to represent
        an eccentric stiffener. e2 is the
        Z-distance between the midsurface of
        the plate representing the stiffener and
        the global X-Y plane of the structure.

READ(5,2) IGROUP,INPLAN,IPROP, XDIM,YDIM
        (repeat this data line 'NRTYPE' times)
where,
  IGROUP= The group number; these numbers
          must be consecutive integers
          starting from unity.
  INPLAN= 0 ---> in-plane dofs are zero,
          1 ---> midsurface displacements are
                 non-zero and the in-plane
                 stiffness matrix is calculated.
  IPROP=  0 ---> no change in the elastic constants,
                 thickness or eccentricity,
          1 ---> specify new values for the above;
                 these new values will be used until
                 re-specified.
  XDIM,YDIM= (X,Y) dimensions of the rectangle group.

   - skip the following data line if IPROP=0.
READ(5,2) EX1,EY1,POISX,GXY,THICK,ECC2
```

....

```
C    READ-in for Beams.

     - skip this data if NBEAMS=0 (go to Triangles).
C    READ-in for Beams in 'MAIN'.
      READ(5,1) HEAD
           - a heading for clarity and user convenience,
             (e.g.  -  'B E A M S  -  Connectivity Data').

      READ(5,2) M1,M2,MLAST,ITYPE,JOINTI,JOINTJ,
                JIINC,JJINC
      where,
       M1,M2,MLAST=  First, second and last beam
```

```
|                   numbers of the series for which
|                   the intermediate values will be
|                   generated automatically (as
|                   discussed in Section 2.1).
|            ITYPE= Group type to which the beam's
|                   stiffness matrix belongs.
| JOINTI,JOINTJ=Joints 'i' and 'j' of beam M1.
|   JIINC,JJINC=Integer increments to be added to
|                   joints 'i' and 'j' of beam M1
|                   to generate the 'i' and 'j' joint
|                   numbers for the other beams in
|                   the series.
L
```

```
C    READ <Emod,Pois, A,Ix,Iy,Cv, e1,e2 >
      READ(5,1) HEAD
      |      - a heading for clarity and user convenience,
      |        (e.g. 'Beam Group Properties').
      READ(5,2)  IGROUP,(RTEMP(K),K=1,8)
      |        (repeat this data line 'NBTYPE' times)
      |where,
      | RTEMP(1)= Modulus of elasticity in tension.
      |      (2)= Poisson's ratio.
      |      (3)= Cross sectional area of the beam.
      |      (4)= Moment of inertia for bending in a
      |           vertical plane,
      |      (5)= Moment of inertia for bending in
      |           the X-Y plane, caused by the two
      |           in-plane displacements.
      |      (6)= St. Venant's uniform torsion constant,
      |           (torsional stiffness due to restrained
      |            warping is not considered).
      |      (7)= eccentricity e1=Y(plate)-Y(stiffener).
      |      (8)= eccentricity e2=Z(plate)-Z(stiffener).
      |Note: e2 remains unchanged as the beam is rotated
      |      in plan, but e1 is calculated with the beam's
      |      local X axis along the longitudinal axis of
      |      the beam and the local and global Z axes
      |      pointing in the same direction (see Sec. 1.4).
      L
```

```
.......................................................................
C    READ-in for Triangles in 'MAIN'.

      - skip this data if NTRIAS=0 (go to Quads.).
      READ(5,1) HEAD
      |     - a heading for clarity and user convenience,
      |       (e.g. 'T R I A N G L E S').
      |
      READ(5,2) NEL,MTYPE,(JTEMP(K),K=1,3)
      |        (repeat this data line 'NTRIAS' times)
```

```
where,
      NEL= The member(triangle) number.
    MTYPE= The triangular group to which the
           member's stiffness matrix belongs.
 JTEMP(K)= Global joint numbers of the triangle,
           (start numbering at the left-most node
            and proceed counterclockwise,
            see Fig. 1.3 for assumed order).

C     go to READ from Subroutine 'GRDATA'(Triangles) ----->
                                                    <----/
```

Note: The above pair of arrows denote that the description of the data to follow is contained in the explanation of the subroutine 'GRDATA'.

....

```
C    READ-in for Quadrilaterals in 'MAIN'.

      - skip this data if NQUADS=0 (go to L-Shapes).
      READ(5,1) HEAD
           - a heading for clarity and user convenience,
             (e.g. 'Q U A D R I L A T E R A L S').

      READ(5,2) NEL,MTYPE,(JTEMP(K),K=1,4)
       where,
             NEL= The member(quadrilateral) number.
           MTYPE= The quadrilateral group to which the
                  member's stiffness matrix belongs.
        JTEMP(K)= Global joint numbers of the quadrilateral
                  (start numbering at the left-most node
                   and proceed counterclockwise,
                   see Fig. 1.3 for assumed order).
```

Note: When subroutine CONECT assigns joint numbers it automatically places local joint 1 at the lower left corner of the 4-node element. If this is not the left-most joint then the correction should be made here.

(Terminate prematurely with a 0,0,0, line.)

```
C     (go to READ from GRDATA for  Quadrilaterals -------->
                                                   <------/
```

Note: The above pair of arrows denote that the description of the data to follow is contained in the explanation of the subroutine 'GRDATA'.

....

```
C    READ-in for L-Shapes in 'MAIN'.

  - skip this data if NLSHAP=0 (go to Transitions).
```

```
READ(5,1) HEAD
|     - a heading for clarity and user convenience,
|       (e.g. 'L - S H A P E S').
|
READ(5,2) NEL,MTYPE,(JTEMP(K),K=1,6)
|        (repeat this data line 'NLSHAP' times)
|where,
|      NEL= The member(L-shape) number.
|    MTYPE= The L-shape group to which the
|           member's stiffness matrix belongs.
| JTEMP(K)= Global joint numbers of the L-shape,
|           (start numbering at the reentrant
|            corner and proceed counterclockwise,
|            see Fig. 1.3 for assumed order).
L

C    READ-in Group Data for L-Shapes
     READ(5,1) HEAD
     |     - a heading for clarity and user convenience,
     |       (e.g. 'L-Shaped Group Data').
     |
     READ(5,2) EX1,EY1,POISX,GXY,THICK,ECC2
     READ(5,2) IGROUP,INPLAN,IPROP, (XNODES(K),K=1,6)
     READ(5,2)                      (YNODES(K),K=1,6)
     |   (repeat above pair of data lines 'NLTYPE' times)
     |where,
     |      EX1,EY1,POISX,GXY,THICK,ECC2
     | and  IGROUP,INPLAN,IPROP,
     | are as defined earlier (see rectangles).
     |
     |  (XNODES(K),K=1,6)| Local (X,Y) coordinates
     |  (YNODES(K),K=1,6)| of the L-shaped element.
     |
     |   - skip the following data line if IPROP=0.
     READ(5,2) EX1,EY1,POISX,GXY,THICK,ECC2
     L


.............................................................
C    READ-in for Transition Rectangles in 'MAIN'.

     - skip this data if NTRANI=0 (go to Polygons).
     READ(5,1) HEAD
     |     - a heading for clarity and user convenience,
     |       (e.g. 'T R A N S I T I O N S').
     READ(5,2) NEL,MTYPE,NNODES,(JTEMP(K),K=1,NNODES)
     |        (repeat this data line 'NTRANI' times)
     |where,
     |      NEL= The member(transition) number.
     |    MTYPE= The transition group to which the
     |           member's stiffness matrix belongs.
     |   NNODES= The number of element nodes (≤6).
     | JTEMP(K)= Global joint numbers of the transition
```

```
|               element (rectangular shape),
|               (start numbering at lower left corner
|                and proceed counterclockwise,
|                see Fig. 1.3 for assumed order).
L

C    READ in Group Data for Transition Rectangles
     READ(5,1) HEAD
     |    - a heading for clarity and user convenience,
     |      (e.g. 'Transition Group Data').
     |
     READ(5,2) EX1,EY1,POISX,GXY,THICK,ECC2
     READ(5,2) IGROUP,INPLAN,IPROP, XDIM,YDIM
     |where,
     |      EX1,EY1,POISX,GXY,THICK,ECC2
     | and  IGROUP,INPLAN,IPROP,
     | have been defined earlier (see rectangles).
     | and,
     | XDIM= Overall X-dimension of the element,
     | YDIM= Overall Y-dimension of the element.
     |
     READ(5,2) (XNODES(K),K=1,NNODES)
     READ(5,2) (YNODES(K),K=1,NNODES)
     |where,
     | NNODES= Number of nodes (either 5 or 6).
     | (XNODES(K),K=1,NNODES)| Local (X,Y) coordinates
     | (YNODES(K),K=1,NNODES)| of the transition element.
     |      (repeat above 3 data lines 'NATYPE' times)
     |
     |  - skip the following data line if IPROP=0.
     READ(5,2) EX1,EY1,POISX,GXY,THICK,ECC2
     L


.............................................................
C    READ-in for Polygons in 'MAIN'.

     - skip this data if NPOLYS=0 (go to 'Externals').
     READ(5,1) HEAD
     |    - a heading for clarity and user convenience,
     |      (e.g. 'P O L Y G O N S').
     |
     READ(5,2) NEL,MTYPE,NNODES,(JTEMP(K),K=1,NNODES)
     |      (repeat this data line 'NPOLYS' times)
     |where,
     |     NEL= The member(polygon) number.
     |   MTYPE= The polygonal group to which the
     |          member's stiffness matrix belongs.
     |  NNODES= The number of element nodes (≤6).
     | JTEMP(K)= Global joint numbers of the polygon,
     |          (start numbering at left-most node
     |           and proceed counterclockwise,
     |           see Fig. 1.3 for assumed order).
     L
```

```
C     (go to READ from GRDATA for  Polygons)  ----------->
                                                    <----/
      Note: The above pair of arrows denote that the
            description of the data to follow is contained
            in the explanation of the subroutine 'GRDATA'.
```

....

```
C    READ-in for External(Singularity,...) in 'MAIN'.

      - skip this data if NEXTRA=0 (go to Coords.).
      READ(5,1) HEAD
      |     - a heading for clarity and user convenience,
      |       (e.g. 'Singularity L-Elements').
      |     - The stiffness data is read from auxiliary
      |       file(11) as indicated in subroutine 'XSTIFF'.
      |       The connectivity data must be user-specified
      |       as described below.
      |
      READ(5,2) NEL,MTYPE,NNODES,(JTEMP(K),K=1,NNODES)
      |        (repeat this data line 'NEXTRA' times)
      |where,
      |      NEL= The member(external) number.
      |    MTYPE= The external element group to which
      |           the member's stiffness matrix belongs.
      |   NNODES= The number of element nodes (≤30 dof).
      | JTEMP(K)= Global joint numbers of the external
      |           element, (order as defined by the
      |            stiffness matrix being supplied).
      L
```

....

```
C    READ; User Specified Global Coordinates .

      READ(5,1) HEAD
      |     - a heading for clarity and user convenience,
      |       (e.g. ' C O O R D I N A T E S').
      |
      READ(5,2) JNT,XORD(JNT),YORD(JNT)
      |     - the above joint and its coordinates
      |       are used in subroutine COORDS as
      |       the origin from which all the other
      |       global coordinates for the plate
      |       elements are generated.
      |
      READ(5,2) J1,J2,JLAST, X,Y,XINC,YINC
      |where,
      | J1,J2,JLAST= First, second and last joint
      |              numbers of the joint sequence.
      |         X,Y= X and Y coordinates of J1.
```

```
XINC,YINC= Increments to be added to the
           X and Y coordinates of J1 to
           generate the X and Y coordinates
           for the remaining joints in the
           sequence.
  (repeat as often as necessary, end
   with a 0,0,0, terminator line).
```

```
..........................................................
     - skip this data if NRCOLS=0 (go to Springs).
C    Column Head data is READ in 'COLCAP'  --------------->
                                                    <----/
      Note: The above pair of arrows denote that the
            description of the data to follow is contained
            in the explanation of the subroutine 'COLCAP'.
```

```
..........................................................
     - skip this data if NSPRIG=0 (go to Disps.).
C    Spring data is READ in 'SPRING' --------------------->
                                                    <----/
      Note: The above pair of arrows denote that the
            description of the data to follow is contained
            in the explanation of the subroutine 'SPRING'.
```

```
..........................................................
     - skip this data if NDIPRE=0 (go to Loads).
C    Prescribed Displacement data is READ in 'DISPRE'----->
                                                    <----/
      Note: The above pair of arrows denote that the
            description of the data to follow is contained
            in the explanation of the subroutine 'DISPRE'.
```

```
..........................................................
C    READ; Loads Manually Specified by User

      - repeat the following data 'NVECT' times.
     READ(5,1) (VHEAD(I,NV),I=1,15)
     |    - a heading for clarity and user convenience,
     |      (e.g. 'Point Load= 100 kips @ Joint 6').
     |
     READ(5,2) UDL
     |where,
     | UDL= The magnitude and sign of the
     |      uniform Z load.
     |
```

```
READ(5,2) J1,J2,JLAST,(TLOAD(K),K=1,5)
|where,
|     J1,J2,JLAST= First, second and last joint
|                  numbers of the joint sequence.
|(TLOAD(K),K=1,5)= The magnitude and sign of the
|                  nodal loads (order per Fig 1.1).
|     (repeat as often as necessary, end
|      with a 0,0,0, terminator line).
L
```

```
..............................................................
C    READ; Element Stress Printout Selection

      - skip this data if MPRINT=0 or if MPRINT=the
        total number of members (plate elements + beams).
      READ(5,1) HEAD
      |     - a heading for clarity and user convenience,
      |       (e.g. 'Selection of Printout').
      |
      READ(5,2) M1,M2,MLAST
      |where,
      | M1,M2,MLAST= First, second and last element
      |              numbers of the series for which
      |              the intermediate values will be
      |              generated automatically (as
      |              discussed in Section 2.1).
      |              For these members the stresses
      |              will be be printed.
      |    (End with a 0,0,0, terminator line.)
      L
..............................................................
```

The subroutines which follow have been identified in the discussion of the 'MAIN' part of the program. These subroutines are optional and are called only if the user specifies the appropriate parameters as discussed previously.

```
.==================*** SUBROUTINE XSTIFFS ******************.
C  READ-ins for  *** SUBROUTINE XSTIFFS ***

C   (READ-in Stiffness and Load from File(11) )
      READ(11,99) NNODES,MSIZE
       |where,
       | NNODES= The number of nodes for the extra element.
       |  MSIZE= The size of the stiffness matrix.
      READ(11)  (EKXTRA(I,J),J=1,MSIZE)
      READ(11)  (ELOAD(K),K=1,MSIZE)
       |where,
       | EKXTRA( , )= The stiffness matrix for the
       |              extra element.
       | ELOAD( )   = The uniform unit load vector
       |              for the above element.
       |_


.==================*** SUBROUTINE COLCAP ******************.
C  READ-ins for  *** SUBROUTINE COLCAP ***

      READ(5,1) HEAD
            - a heading for clarity and user convenience,
              (e.g. '*** Subroutine COLCAP***').

      - repeat the following data 'NRCOLS' times.
   ┌──READ(5,1) HEAD
   │   |      - a heading for clarity and user convenience,
   │   |        (e.g. 'Column A.1').
   │   |
   │  READ(5,2) NCOLJN
   │  READ(5,2) (JNTCOL(K,NR),K=2,NJP1)
   └─>READ(5,2) AXSTIF,OXSTIF,OYSTIF,XCENTR(NR),YCENTR(NR)
       |where,
       |       NCOLJN= The total number of finite element
       |               joints representing the column head,
       |               (the column head consists of the
       |                cross section of the column).
       |         Note: Point-sized columns usually
       |               have only one column head joint.
       |               Finite-sized column heads may
       |               have any number of joints. In the
       |               present version of the program the
       |               centroidal stiffnesses are
       |               distributed equally to all joints
       |               specified below in JNTCOL( , ).
       |               Because of this distribution a
       |               typical rectangular cross section
       |               should have only the 4 corner nodes
       |               in JNTCOL( , ), regardless of how
       |               many elements or joints are used
       |               to represent the column head.
       |
```

```
JNTCOL( , )= The joint numbers located on the
             perimeter of the column head.
             These are the joints to which the
             centroidal stiffnesses of the column
             will be distributed to (equally).

     AXSTIF= Axial stiffness of the column (AE/L).
     OXSTIF= Flexural stiffness of the column for
             rotation θx  (e.g.  4EI/L).
     OYSTIF= Flexural stiffness of the column for
             rotation θy  (e.g.  4EI/L).
 XCENTR(NR)= X coordinate of column centroid.
 YCENTR(NR)= Y coordinate of column centroid.
       Note: These centroidal coordinates
              are in the global system and are
              used to transfer the centroidal
              stiffnesses to the JNTCOL( ) nodes.
```

```
.=================*** SUBROUTINE SPRING ***==================.
C  READ-ins for  *** SUBROUTINE SPRING ***

      READ(5,1) HEAD
            - a heading for clarity and user convenience,
              (e.g. 'Subroutine Spring Stiffnesses').

      READ(5,2) NGRUPS
       where,
        NGRUPS= Number of spring groups. This grouping is
                provided for cases where the same spring
                stiffnesses is to be added to a number of
                different dofs.

       - repeat this data 'NGRUPS' times.
   ┌──READ(5,2) IGROUP,NJNTS
   │  READ(5,2) (JOINTS(K,NG),K=2,NJP1)
   │  READ(5,2) (SPRSTF(K,NG),K=1,5)
   └─>READ(5,2) (PFACT(K,NG),K=1,5)
       where,
        IGROUP= Identification number (consecutive
                integers) for spring groups which follow.
         NJNTS= The total number of joints in the group.

        JOINTS( , )= The joint numbers of the group.

        SPRSTF( , )= The spring stiffnesses to be added
                     to the 5 dofs of each joint.
         PFACT( , )= Load modification factors which
                     permit the user to manipulate the
```

```
                   load matrix. These 5 values are added
                   to the corresponding terms in the
                   current load vector(s).


.=================*** SUBROUTINE DISPRE ***==================.
C  READ-ins for  *** SUBROUTINE DISPRE ***

      READ(5,1) HEAD
          - a heading for clarity and user convenience,
            (e.g. 'Subroutine for Prescribed Displacements')

      READ(5,2) JOINT,JDOF,(RTEMP(K),K=1,NVECT)
              (repeat this data line 'NDIPRE' times)
       where,
           JOINT= The number of the joint with the
                  prescribed non-zero displacement.
            JDOF= The dof to which the prescribed
                  displacement applies (1,2,3,4, or 5).
        RTEMP( )= Values of the prescribed displacements
                  for the different load vectors.


.=================*** SUBROUTINE CONECT ***==================.
   The reason for this subroutine is to
   provide a somewhat automated means of
   inputting data for 4-node elements.
   The use of this subroutine can result in
   substantial time savings for the user.
   The approach in 'CONECT' is to form an element
   and joint matrix to represent the configuration
   of the structure; the input consists of lines of
   data to define the rows of these matrices.
   The subroutine operates from these two matrices.
   The first matrix is a joint matrix with 'NX+1'
   columns and 'MY+1' rows. The second is a
   member matrix with 'NX' columns and 'MY' rows.
   After the joint and member matrices are defined
   the subroutine assigns nodes to the members by
   'overlaying' the two matrices. For this reason
   the subroutine is specifically intended for
   4-node elements. Examples to clarify this
   procedure are given in Section 3.7 and in
   Chapter 4. The use of this matrix overlay
   method does not restrict the user from
   manually reassigning joint numbers to an
   element later in the program.
   Zero member numbers are permitted in the
   member matrix; the zero number indicates
   that no 4-node member is present and
```

the next number is considered.
A subroutine of this type is particularly useful for real structures such as the typical floors presented in Chapter 4.

```
C  READ-ins for  *** SUBROUTINE CONNECTIVITY DATA ***

     READ(5,1) HEAD
           - a heading for clarity and user convenience,
             (e.g. 'Subroutine for 4-Node Elements').
       -repeat this data 'NBLOCK' times.

     READ(5,3) ICODE,NBLOCK,NX,MY
      where,
       ICODE = A letter which identifies the data
               being entered; if the letter 'B' is absent
               then the subroutine assumes that block
               data input has terminated.
       NBLOCK= The number of the data block being entered.
               Usually the entire structure can be defined
               with only one'block' of data (i.e. one
               joint and one member matrix) as illustrated
               in Section 4.2. However, the designer is
               free to use any number of blocks.
           NX= Number of divisions in the X direction.
           MY= Number of divisions in the Y direction.
            Note: The size of the divisions in any
                  one direction need not be equal.

C   READ-in Joint Matrix
     READ(5,1) HEAD
          - a heading for clarity and user convenience,
            (e.g. 'Joint Matrix for Block 2').
     READ(5,2)  ICODE,JSTART,IROW,JCOL,JINCY,JYTOP
      where,
        ICODE= The letter 'J' to denote input of joint
               data. The letter 'E' ends the input.
       JSTART= The joint number at the lower left
               corner of the block.
         IROW= The row number of the joint matrix
               in which JSTART is to be placed.
               (Row 1 is the bottom row.)
         JCOL= The column number in which JSTART
               is to be placed.
               (Column 1 is at the extreme left.)
        JINCY= The increment to be added to JSTART from
               one row to the next.
        JYTOP= The top joint number of the matrix, i.e.
               the joint number at which the subroutine
               stops generating rows of joint numbers.
```

```
READ(5,2) (JTEMP(K),K=1,JLAST)
        (repeat this data line 'NY1' times,
         terminate prematurely with the letter 'E').
 where,
   JTEMP( )= The joint numbers of 'IROW'.


C  READ-in Element Matrix
     READ(5,1) HEAD
          - a heading for clarity and user convenience,
            (e.g. 'Element Matrix for Block 2').
     READ(5,2)  ICODE,MSTART,IROW,JCOL,MINCY,MYTOP
      where,
        ICODE= The letter 'R' to denote input of a row
               of rectangles only.
               The letter 'Q' to denote input of a row
               mixed with rectangles and quadrilaterals
               (or quadrilaterals only).
       MSTART= The member number at the lower left corner.
               in which MSTART is to be placed.
         IROW= The row number of the member matrix
               in which MSTART is to be placed.
               (Row 1 is the bottom row.)
         JCOL= The column number in which MSTART
               is to be placed.
               (Column 1 is at the extreme left.)
        MINCY= The increment to be added to MSTART from
               one row to the next.
        MYTOP= The top member number of the matrix, i.e.
               the member number at which the subroutine
               stops generating rows of member numbers.

     READ(5,2) (MTEMP(K),K=1,MLAST)
             (repeat this data line 'NY' times,
              terminate prematurely with the letter 'E').
      where,
       MTEMP( )= The element numbers, input row by row.
                 A large number of options exist in using
                 this portion of the program:
               (1) Specify all the numbers of the row.
               (2) If MTEMP(k) is zero then a zero
                   is entered in the member matrix; the
                   interpretation of this zero is
                   that a 4-node element does not appear
                   in this location.
               (3) If MTEMP(k)<0 then the entire row does
                   not have to specified and the program
                   generates a sequential series which
                   is determined by the three values of
                   MTEMP( ) which follow the negative
                   sign. This option can be used
                   repeatedly in a given row and
                   intermixed with numbers specified
```

```
|       |          manually. For example, the data line:
|       |          4,5,-2,6,22,75,76,-3,7,23,0,
|       |          should generate the following row:
|       |       4,5,2,6,10,14,18,22,75,76,3,7,11,15,19,23
|       |          In lieu of the above, the user can
|       |          choose to specify the connectivity
|       |          data manually, element by element,
|       |          later in this subroutine or in MAIN.
|       |    Note: Quadrilateral elements in the element
|       |          matrix are distinguished from rectangles
|       |          by adding the integer '4000' to the
|       |          quadrilateral element number.
|       |          For example, quadrilateral number 5
|       |          would be input as '4005' in MTEMP( )
|       |          while rectangle number 5 would be
|       |          input simply as '5'.
|       L
|
C └──>End of READ-in for Blocks


  READ(5,1) HEAD
     |     - a heading for clarity and user convenience,
     |       (e.g. 'Additional 4-Node Elements').
     |
     READ(5,2) ICODE,NEL,(JTEMP(K),K=1,4)
     |        (repeat the above data line as often as
     |         required, terminate with 'E'.)
     |where,
     |    ICODE= The letter 'R' to denote input for a
     |           group of rectangles.
     |           The letter 'Q' to denote input of a
     |           group of quadrilaterals.
     |      NEL= The member(rect. or quad.) number.
     | JTEMP(K)= The global joint numbers of the
     |           rectangular or quadrilateral element.
     |           (start numbering at extreme left corner
     |            and proceed counterclockwise,
     |            see Fig. 1.3 for assumed order).
     |   (Terminate with the letter 'E'.)
     L


C    READ-in of Rect. Element Grouping
     READ(5,1) HEAD
     |     - a heading for clarity and user convenience,
     |       (e.g. 'Grouping of All Rect. Elements').
     |
     READ(5,3) ICODE,IGROUP,(MTEMP(K),K=1,50)
     |        (repeat the above data line as often as
     |         required, terminate with 'E'.)
     |where,
     |  ICODE= The letter 'R' to denote input for a
     |         group of rectangles.
```

```
 IGROUP= The group number for the elements.
MTEMP(k)=The elements of the group. Where, as
         before, a negative sign denotes that
         the 3 integers which follow define
         a series.
         (Terminate with the letter 'E').
```

```
C    READ-in of Quad. Element Grouping
      READ(5,1) HEAD
           - a heading for clarity and user convenience,
             (e.g. 'Grouping of All Quad. Elements').

      READ(5,2) (MTEMP(K),K=1,NQUADS)
       where,
        MTEMP(k)= The group to which element 'k'
                  belongs.
```

```
.================*** SUBROUTINE GRDATA ***=================.
C  READ-ins for  *** SUBROUTINE GRDATA *** (Group Data).

      READ(5,1) HEAD
           - a heading for clarity and user convenience,
             (e.g. 'Group Data - Trias, Quads, Polygons')

      READ(5,2) EX1,EY1,POISX,GXY,THICK,ECC2
       where (as before),
          EX1= Modulus of elasticity for uniaxial
               loading only in the X direction.
          EY1= Modulus of elasticity for uniaxial
               loading only in the Y direction.
        POISX= Poisson's ratio as measured when only
               the uniaxial Y load is present.
          GXY= Shear modulus of elasticity as
               measured from a pure shear condition.
            Note: The above elastic constants are
                  independent of each other. It is
                  assumed that:  EX1* POISY= EY1* POISX.
        THICK= The thickness of the plate element.
         ECC2= Eccentricity e2 of the offset plate
               element; non-zero only when a plate
               element is being used to represent
               an eccentric stiffener.
```

```
READ(5,2) IGROUP,INPLAN,IPROP,(XNODES(K),K=1,NNODES)
|                              (YNODES(K),K=1,NNODES)
|        (repeat above 2 data lines 'NTTYPE',
|         'NQTYPE' or 'NPTYPE' times.)
|where,
| IGROUP= The group number; these numbers
|         must be consecutive integers
|         starting from unity.
| INPLAN= 0 ---> in-plane dofs are zero,
|         1 ---> midsurface displacements are
|                non-zero and the in-plane
|                stiffness matrix is calculated.
|  IPROP= 0 ---> no change in the elastic constants,
|                thickness or eccentricity,
|         1 ---> specify new values for the above;
|                these new values will be used until
|                re-specified.
| XNODES( )= X coordinates of the element group
|            (in a local coordinate system).
| XNODES( )= Y coordinates of the element group
|            (in a local coordinate system).
READ(5,2) EX1,EY1,POISX,GXY,THICK,ECC2
|  - This data line is only required
|    if IPROP=1 (or non-zero).
L
```

Chapter 3

SIMPLE EXAMPLE PROBLEMS

3.1 Introductory Comments

The examples problems presented in this chapter are of a simple nature and are intended to demonstrate how the input data is specified for the various element shapes. The use of the singularity elements is not included.

An example of the output is provided. The stress output for the most part is self-explanatory and consists first of nodal *stresses* for each element followed by a printout of the *nodal forces* which keep the element in equilibrium. Sample output data is examined in more detail in Chapter 5.

The default values for files 1,2 and 3 into which the graphical data is stored are:

1=-100   2=-200   and   3=-300

The user can over-ride these values by specifying alternate values in the 'RUN' command. Examples of graphical plots are given in Chapter 6.

3.2 Simply Supported Rectangular Plate

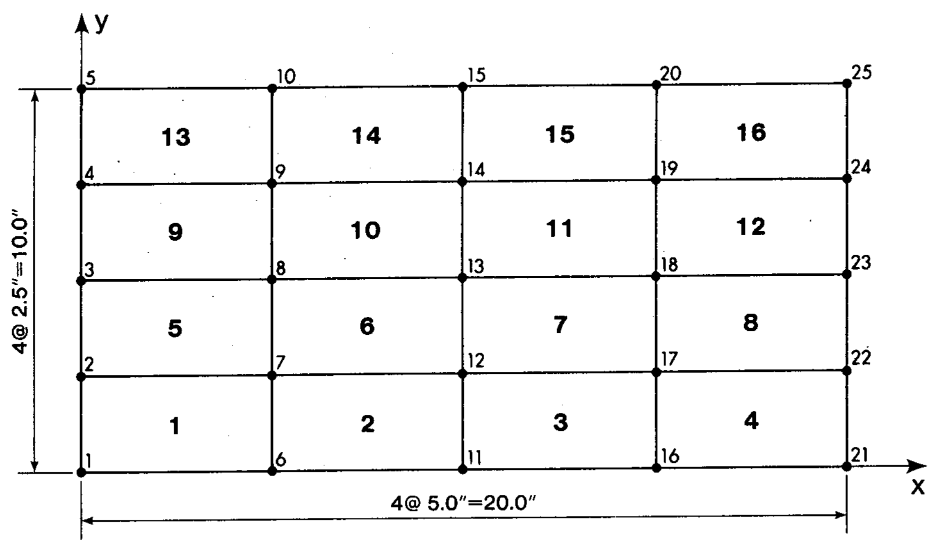


Figure 3.1 Simply Supported Rectangular Plate.

The above simply supported rectangular plate is chosen as the first example because it requires the least amount of input data. Only one load vector is considered and the loading is assumed to be a uniformly distributed gravity load.

The data file for this problem follows and is accessible to other users on the same system from CIVE:HYBSLAB.TD(1000,1099) .

To run the problem, type in the following:

$RUN CIVE:HYBSLAB 5=CIVE:HYBSLAB.TD(1000) 6=-1 t=3s

```
Rect. S.S. Plate, Uniform Load; MAN.egs(1000),
Units: Kips and Inches.      Rectangles only.
16,0,0,0,0, 0,0,0,0,0,0,
1,0,0,0,0,  0,0,0,
25,0,1,16,0,0,
SUPPRESSED DOF's
 1,2,25,  1,1,1,0,0,   <---This line eliminates in-plane dof's
 1,2,5,   0,0,1,0,0,
21,22,25, 0,0,1,0,0,
 6,11,16, 0,1,0,0,0,
10,15,20, 0,1,0,0,0,
 1,5,0,   0,0,0,0,0,
21,25,0,  0,0,0,0,0,
0,0,0,
     ***SUBROUTINE  C O N N E C T***
B1,4,4,
Joint Matrix 1
J1,1,1,1,5,
 -1,6,21,
E
Member Matrix 1
R1,1,1,4,13,
-1,2,4,
E
E
Additional Elements
E
Grouping of Elements
R1, -1,2,16,
E
R E C T A N G L E S
 0,0,0,
Group Data for Rectangles
27300.,27300.,0.3,10500., 0.1,0.0,
1,0,0, 5.0,2.5,
  C O O R D I N A T E S
1,0.,0.,
 0,0,0,
Gravity Load ( q= -0.2 ksi)
-0.20,
 0,0,0,
Stop
.
.
.
.
End of file
```

3.3 The Use of Master and Slave Nodes

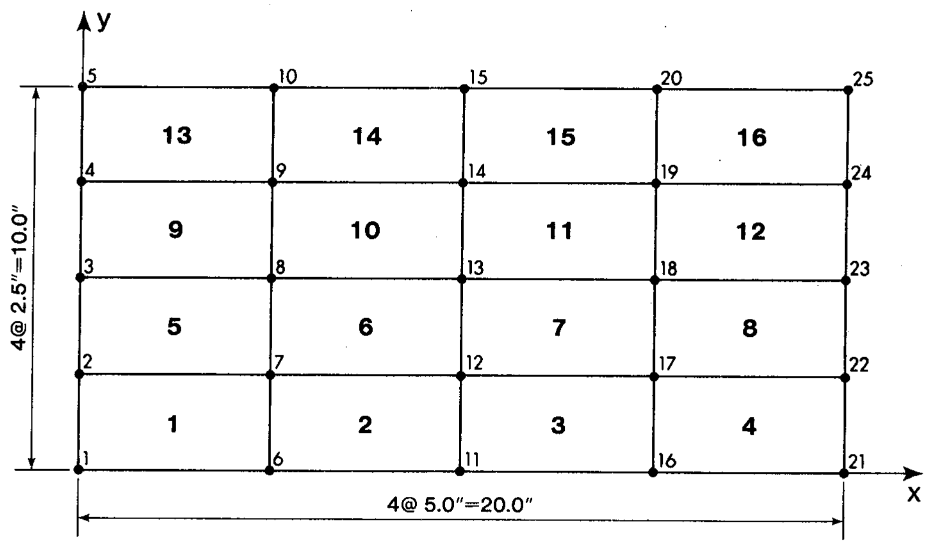


Figure 3.2 Plate with Master and Slave Nodes.

The same plate as in the previous example is used to demonstrate the use of master and slave nodes. Joint 4 is assigned the same θy value as joint 2. The W degrees of freedom for each of joints 9, 17 and 19 is set equal to that of joint 7. The data file is otherwise the same as the previous one in Section 3.2.

The data file for this problem follows and is accessible to other users from CIVE:HYBSLAB.TD(1200,1299) . To run the problem, use the following:

$RUN CIVE:HYBSLAB 5=CIVE:HYBSLAB.TD(1200) 6=-2 t=3s

```
   1200      Rect. S.S. Plate, Uniform Load; MAN.egs(1200),
   1202      Units: Kips and Inches.   (Rectangles & Master Nodes)
   1204      16,0,0,0,0, 0,0,0,0,0,0,
   1206      1,0,0,0,0,  0,0,0,
   1208      25,3,1,16,0,0,
   1210      SUPPRESSED DOF's
   1212       1,2,25,  1,1,1,0,0,    <---This line eliminates in-plane dof's
   1214       1,2,5,   0,0,1,0,0,
   1216      21,22,25, 0,0,1,0,0,
   1218       6,11,16, 0,1,0,0,0,
   1220      10,15,20, 0,1,0,0,0,
   1222       1,5,0,   0,0,0,0,0,
   1224      21,25,0,  0,0,0,0,0,
   1226      0,0,0,
   1228      COPYCAT NODES  (Master and Slave Nodes)
   1230      2, 4,4,0,   0,0,2,0,0,
   1232      7, 9,9,0,   7,0,0,0,0,
   1234      7, 17,19,19,7,0,0,0,0,
   1236           ***SUBROUTINE  C O N N E C T***
   1238      B1,4,4,
   1240      Joint Matrix 1
   1242      J1,1,1,1,5,
   1244       -1,6,21,
   1246      E
   1248      Member Matrix 1
   1250      R1,1,1,4,13,
   1252      -1,2,4,
   1254      E
   1256      E
   1258      Additional Elements
   1260      E
   1262      Grouping of Elements
   1264      R1, -1,2,16,
   1266      E
   1268      R E C T A N G L E S
   1270       0,0,0,
   1272      Group Data for Rectangles
   1274      27300.,27300.,0.3,10500., 0.1,0.0,
   1276      1,0,0, 5.0,2.5,
   1278        C O O R D I N A T E S
   1280      1,0.,0.,
   1282       0,0,0,
   1284      Gravity Load ( q= -0.2 ksi)
   1286      -0.20,
   1288       0,0,0,
   1290      Stop
   1292      .
   1294      .
   1296      .
   1298      .
End of file
```

3.4 Triangles and Polygons (Flexure Patch Test)

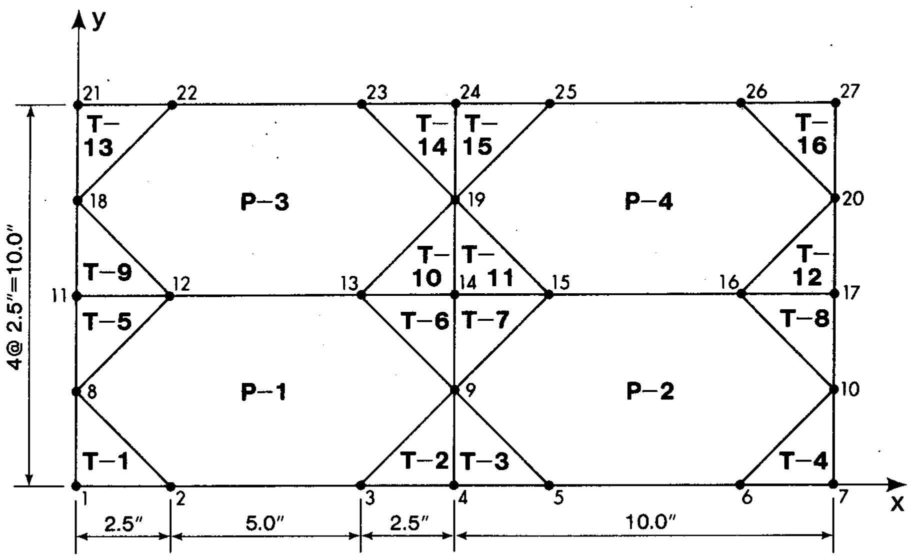


Figure 3.3   Plate Represented by Triangles and Polygons.

The plate shown above consists of triangular and polygonal elements. Loading is by prescribed displacements along the edges of the structure. The prescribed displacements are such that they should cause a condition of constant curvature in the structure (Hrabok,1981). The in-plane displacements are assumed to be zero.

The data file for this problem follows and is available to other users from CIVE:HYBSLAB.TD(2000,2299) . To run this problem, use the following:

$RUN CIVE:HYBSLAB 5=CIVE:HYBSLAB.TD(2000) 6=-3 t=3s

```
2000     S.S. Plate, Constant Curvatures; MAN.egs(2000),
2002     Units: Kips and Inches.        Triangles and Polygons.
2004     0,0,16,0,0, 0,4,0,0,0,60,
2006     0,0,4,0,0,  0,1,0,
2008     27,0,1,20,0,0,
2010     SUPPRESSED DOF's
2012      1,2,27,    1,1,1,0,0,
2014     0,0,0,
2016     TRIANGLES
2018      1,1,  1,2,8,
2020      2,2,  3,4,9,
2022      3,1,  4,5,9,
2024      4,2,  6,7,10,
2026      5,3,  11,8,12,
2028      6,4,  13,9,14,
2030      7,3,  14,9,15,
2032      8,4,  16,10,17,
2034      9,1,  11,12,18,
2036     10,2,  13,14,19,
2038     11,1,  14,15,19,
2040     12,2,  16,17,20,
2042     13,3,  21,18,22,
2044     14,4,  23,19,24,
2046     15,3,  24,19,25,
2048     16,4,  26,20,27,
2050     ** SUBROUTINE GRDATA **  (Triangles)
2052     27300.,27300.,0.3,10500., 0.1,0.0,
2054     1,0,0,   0.,   2.5,   0. ,
2056              0.,   0. ,   2.5,
2058     2,0,0,   0.,   2.5,   2.5,
2060              0.,   0. ,   2.5,
2062     3,0,0,   0.,   0. ,   2.5,
2064              0.,  -2.5,   0. ,
2066     4,0,0,   0.,   2.5,   2.5,
2068              0.,  -2.5,   0. ,
2070     POLYGONS
2072      1,1,6,   8,2,3,9,13,12,
2074      2,1,6,   9,5,6,10,16,15,
2076      3,1,6,   18,12,13,19,23,22,
2078      4,1,6,   19,15,16,20,26,25,
2080     ** SUBROUTINE GRDATA **  (Polygons)
2082     27300.,27300.,0.3,10500., 0.1,0.0,
2084     1,0,0,    0.,  2.5,  7.5, 10.0, 7.5, 2.5,
2086               0., -2.5, -2.5,  0.0, 2.5, 2.5,
2088       C O O R D I N A T E S
2090     1,0.,0.,
2092      0,0,0,
2094     *** SUBROUTINE DISPRE ***
2096      1,1,   1.0,
2098      1,2,   3.0,
2100      1,3,   2.0,
2102      4,1,   421.,
2104      4,2,   53.,
2106      4,3,   82.,
2108      7,1,   1641.,
2110      7,2,   103.,
2112      7,3,   162.,
2114     11,1,   166.,
2116     11,2,   63.,
```

```
 2118      11,3,  27.,
 2120      17,1,  2306.,
 2122      17,2,  163.,
 2124      17,3,  187.,
 2126      21,1,  631.,
 2128      21,2,  123.,
 2130      21,3,  52.,
 2132      24,1,  1551.,
 2134      24,2,  173.,
 2136      24,3,  132.,
 2138      27,1,  3271.,
 2140      27,2,  223.,
 2142      27,3,  212.,
 2144       2,1,  31.,
 2146       2,2,  15.5,
 2148       2,3,  22.,
 2150       3,1,  241.,
 2152       3,2,  40.5,
 2154       3,3,  62.,
 2156       5,1,  651.,
 2158       5,2,  65.5,
 2160       5,3,  102.,
 2162       6,1,  1261.,
 2164       6,2,  90.5,
 2166       6,3,  142.,
 2168       8,1,  46.,
 2170       8,2,  33.,
 2172       8,3,  14.5,
 2174      10,1,  1936.,
 2176      10,2,  133.,
 2178      10,3,  174.5,
 2180      18,1,  361.,
 2182      18,2,  93.,
 2184      18,3,  39.5,
 2186      20,1,  2751.,
 2188      20,2,  193.,
 2190      20,3,  199.5,
 2192      22,1,  786.,
 2194      22,2,  135.5,
 2196      22,3,  72.,
 2198      23,1,  1246.,
 2200      23,2,  160.5,
 2202      23,3,  112.,
 2204      25,1,  1906.,
 2206      25,2,  185.5,
 2208      25,3,  152.,
 2210      26,1,  2766.,
 2212      26,2,  210.5,
 2214      26,3,  192.,
 2216      No Loading
 2218      0.0,
 2220       0,0,0,
 2222      Stop
 2224       .
 2226       .
 2228       .
 2230       .
 2232       .
 2234       .
End of file
```

3.5 Quadrilaterals (Flexure and In-Plane Patch Tests)

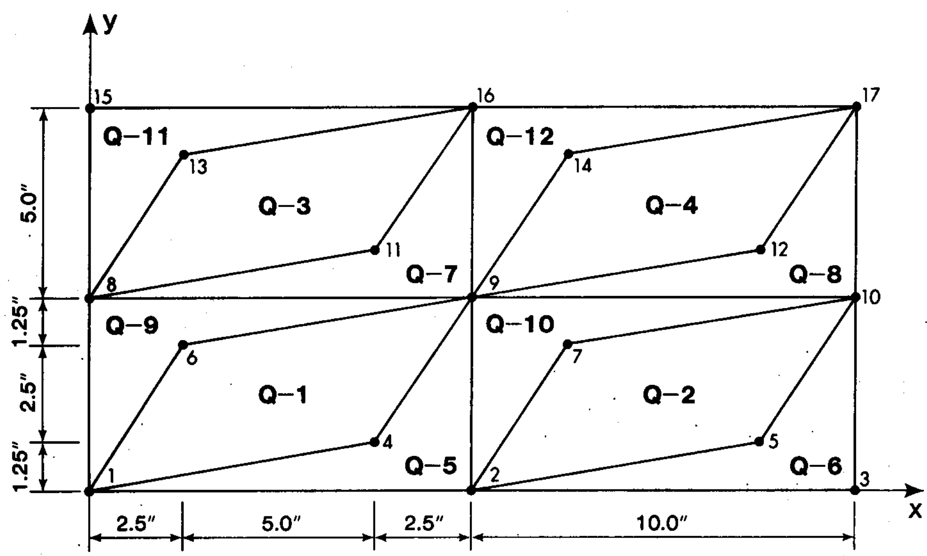


Figure 3.4 Plate Represented by Quadrilaterals.

The plate shown above consists of quadrilateral elements with and without reentrant corners. Two load vectors are considered, both are in the form of prescribed displacements along the edges of the structure. The first load case is a 'flexural' loading and should cause conditions of constant curvature throughout the structure. The second load case is an 'in-plane' loading and should cause conditions of constant strain at all points.

The data file follows and is available from CIVE:HYBSLAB.TD(2300,2599) . To run the problem:

$RUN CIVE:HYBSLAB 5=CIVE:HYBSLAB.TD(2300) 6=-4 t=3s

```
2300      Constant Strains and Curvatures; Quads.,'MAN.egs(2300)'
2302      Units: Kips and Inches.
2304      0,0,0,12,0, 0,0,0,0,0,40,
2306      0,0,0,3,0,  0,0,0,
2308      17,0,2,12,0,0,
2310      SUPPRESSED DOF's
2312      0,0,0,
2314           ***SUBROUTINE  C O N N E C T***
2316      E
2318      Q U A D R I L A T E R A L S
2320       1,1, 1,4,9,6,
2322       2,1, 2,5,10,7,
2324       3,1, 8,11,16,13,
2326       4,1, 9,12,17,14,
2328       5,2, 1,2,9,4,
2330       6,2, 2,3,10,5,
2332       7,2, 8,9,16,11,
2334       8,2, 9,10,17,12,
2336       9,3, 1,6,9,8,
2338      10,3, 2,7,10,9,
2340      11,3, 8,13,16,15,
2342      12,3, 9,14,17,16,
2344      Group Data for Quadrilaterals
2346      27300.,27300.,0.3,10500., 0.1,0.0,
2348      1,1,0,    0., 7.50, 10.,  2.50,
2350                0., 1.25,  5.,  3.75,
2352      2,1,0,    0., 10.0, 10.,  7.50,
2354                0.,  0.0,  5.,  1.25,
2356      3,1,0,    0., 2.50, 10.,   0.0,
2358                0., 3.75,  5.,   5.0,
2360        C O O R D I N A T E S
2362      1,0.,0.,
2364       0,0,0,
2366      *** SUBROUTINE DISPRE ***
2368       1,1,     1.,     0.,
2370       1,2,     3.,     0.,
2372       1,3,     2.,     0.,
2374       1,4,     0.,     1.,
2376       1,5,     0.,     4.,
2378       2,1,   421.,     0.,
2380       2,2,    53.,     0.,
2382       2,3,    82.,     0.,
2384       2,4,     0.,    21.,
2386       2,5,     0.,    54.,
2388       3,1,  1641.,     0.,
2390       3,2,   103.,     0.,
2392       3,3,   162.,     0.,
2394       3,4,     0.,    41.,
2396       3,5,     0.,   104.,
2398       8,1,   166.,     0.,
2400       8,2,    63.,     0.,
2402       8,3,    27.,     0.,
2404       8,4,     0.,    16.,
2406       8,5,     0.,    34.,
2408      10,1,  2306.,     0.,
2410      10,2,   163.,     0.,
2412      10,3,   187.,     0.,
2414      10,4,     0.,    56.,
2416      10,5,     0.,   134.,
```

```
15,1,  631.,     0.,
15,2,  123.,     0.,
15,3,   52.,     0.,
15,4,    0.,    31.,
15,5,    0.,    64.,
16,1, 1551.,     0.,
16,2,  173.,     0.,
16,3,  132.,    0.,
16,4,    0.,    51.,
16,5,    0.,   114.,
17,1, 3271.,     0.,
17,2,  223.,     0.,
17,3,  212.,     0.,
17,4,    0.,    71.,
17,5,    0.,   164.,
No Loading (Patch Test for Flexure)
0.0,
 0,0,0,
No Loading (In-Plane Patch Test)
0.0,
 0,0,0,
Stop
.
.
.
.
```
End of file

3.6 L-Shape and Transition (Pure Twist Test)

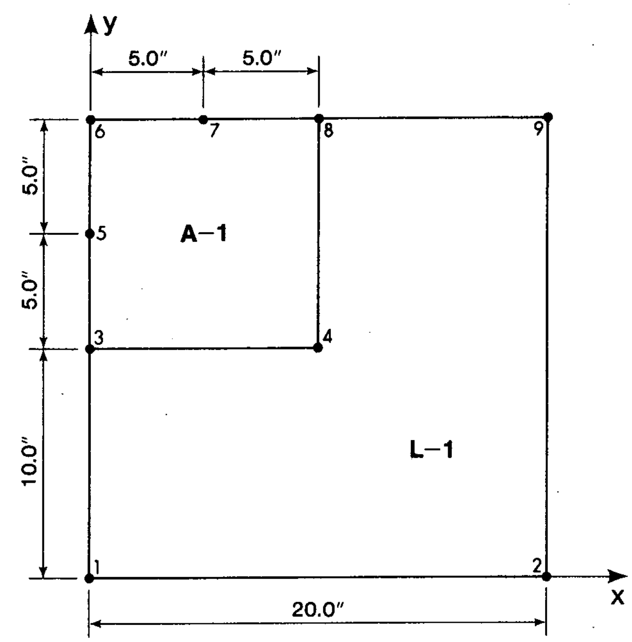


Figure 3.5 Plate with L-Shape and Transition Elements.

The square plate shown above is represented by an L-shaped element and a rectangular transition element. Three of the four corners are simply supported and the fourth corner is loaded in the Z direction. This is a test case for pure twist and is presented to demonstrate that these elements are capable of modelling this type of behavior exactly.

The data file for this problem follows and is accessible to other users from CIVE:HYBSLAB.TD(2600,2799) . To run the problem, use the following:

$RUN CIVE:HYBSLAB 5=CIVE:HYBSLAB.TD(2600) 6=-5 t=3s

```
Pure Twist; L-Shape & Transition Element,'MAN.egs(2600)'
Units: Kips and Inches.
0,0,0,0,1, 1,0,0,0,0,0,
0,0,0,0,1, 1,0,0,
9,0,1,2,0,0,
SUPPRESSED DOF's
1,2,9, 1,1,1,0,0,
1,2,2, 0,1,1,0,0,
6,6,0, 0,1,1,0,0,
0,0,0,
                    L-Shape
1,1,   4,3,1,2,9,8,
  L-Shape Group Properties
27300.,27300.,0.3,10500., 0.1,0.0,
1,0,0,  10.,    0.,    0., +20., +20., +10.,
        10., +10.,    0.,    0., +20., +20.,
                  Transition Element
1,1,6,  3,4,8,7,6,5,
  Transition Group Properties
27300.,27300.,0.3,10500., 0.1,0.0,
1,0,0,  10.,10.,
        0., +10., +10.,  +5.,    0.,   0.,
        0.,   0., +10., +10., +10., +5.,
  C O O R D I N A T E S
1,0.,0.,
 0,0,0,
Pure Twist Loading
0.0,
9,9,0, -1.0,0.,0., 0.,0.,
 0,0,0,
Coordinates
Stop
.
.
.
```

End of file

3.7 A Variety of Elements (Pure Twist Test)

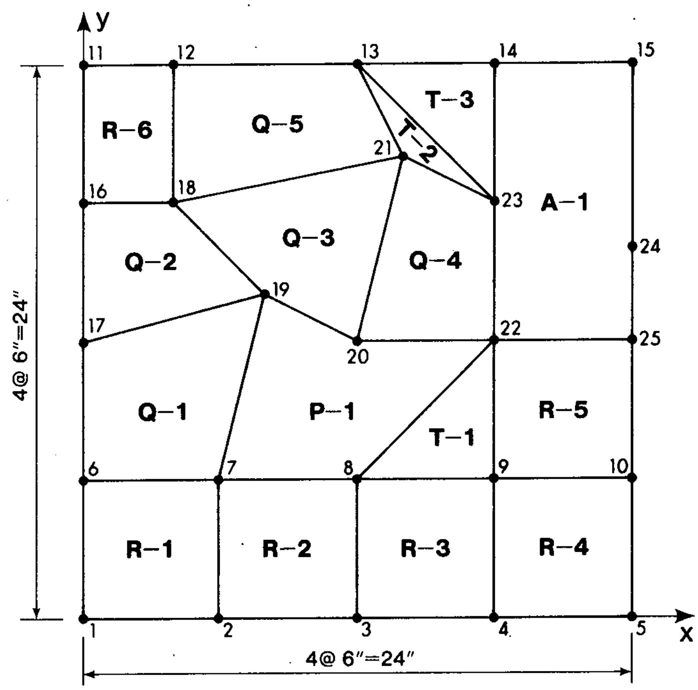


Figure 3.6 Plate with a Variety of Elements.

The square plate shown above is represented by a variety of element shapes. Three of the four corners are simply supported and the fourth corner is loaded with a point load in the Z direction. This is a pure twist test case similar to the previous example but with more shapes. It is presented to demonstrate that these elements are capable of modelling pure twist behavior exactly. Similar tests could be done for pure bending and constant in-plane strains.

The data file for this problem follows and can be copied by other users from CIVE:HYBSLAB.TD(2800,2999) . To run the problem, use the following:

```
$RUN CIVE:HYBSLAB 5=CIVE:HYBSLAB.TD(2800) 6=-6 t=3s
```

This problem will also be used to describe the matrix overlay technique used in the subroutine 'CONECT'. This subroutine is used to define the connectivity data of 4-node elements. The desired joint matrix for this plate is shown below and is generated from lines 2824-2842 of the data file.

11	12	13	14	15
16	18	21	23	24
17	19	20	22	25
6	7	8	9	10
1	2	3	4	5

The 4-noded element matrix which is overlaid on the above joint matrix is shown below. The rows with the bracketed quantities are not part of the input matrix.

6	4005	0	0
(R-6)	(Q-5)		
4002	4003	4004	0
(Q-2)	(Q-3)	(Q-4)	
4001	0	0	5
(Q-1)			(R-5)
1	2	3	4
(R-1)	(R-2)	(R-3)	(R-4)

Lines 2844-2862 of the data file generate the above element matrix. The connectivity of the remaining elements is input in 'MAIN'.

```
2800      Test Case with a variety of Elements,'MAN.egs(2800)'
2802      UNITS= feet, Kips .
2804      6,0,3,5,0, 1,1,0,0,0,0,
2806      2,0,3,5,0, 1,1,0,
2808      25,0,1,16,0,0,
2810      Suppressed D.O.F.s
2812      1,2,25,  1,1,1,0,0,
2814      1,11,11,  0,1,1,0,0,
2816      15,0,0,   0,1,1,0,0,
2818      0,0,0,
2820           ***SUBROUTINE  C O N N E C T***
2822      B1,4,4,
2824      Joint Matrix 1
2826      J1,1,1,5,6,
2828      -1,2,5,0,
2830      J17,3,1,0,0,
2832      17,19,20,22,25,
2834      J16,4,1,0,0,
2836      16,18,21,23,24,
2838      J11,5,1,0,0,
2840      -11,12,15,
2842      E
2844      Member Matrix 1
2846      R1,1,1,1,0,0,
2848      -1,2,4,
2850      Q1,2,1,0,0,
2852      4001,0,0,5,
2854      Q2,3,1,0,0,
2856      4002,4003,4004,0,
2858      R6,4,1,0,0,
2860      6,4005,0,0,
2862      E
2864      E
2866      Additional Elements
2868      E
2870      Grouping of Rectangles
2872      R1, -1,2,5,
2874      R2,  6,0,0,
2876      E
2878      Grouping of Quadrilaterals
2880      1,2,3,4,5,
2882                R E C T A N G L E S  (in MAIN)
2884       0,0,0,
2886      Group Data for Rectangles
2888      27300.,27300.,0.3,10500.,0.5,0.,
2890      1,0,0, 6.0,6.0,
2892      2,0,0, 4.0,6.0,
2894      T R I A N G L E S
2896      1,1, 8,9,22,
2898      2,2, 13,21,23,
2900      3,3, 13,23,14,
2902      Group Data for Triangles
2904      27300.,27300.,0.3,10500.,0.5,0.,
2906      1,0,0,  0., 6., 6.,
2908          0., 0., 6.,
2910      2,0,0,  0., 2., 6.,
2912          0.,-4.,-6.,
2914      3,0,0,  0., 6., 6.,
2916          0.,-6., 0.,
```

```
Q U A D R I L A T E R A L S
3,3, 18,19,20,21,
 0,0,0,
Group Data for Quadrilaterals
27300.,27300.,0.3,10500.,0.5,0.,
1,0,0,  0., 6., 8., 0.,
        0., 0., 8., 6.,
2,0,0,  0., 8., 4., 0.,
       -6., -4.,0., 0.,
3,0,0,  0., 4., 8.,10.,
       0.,-4.,-6.,+2.,
4,0,0,  0., 6., 6., 2.,
       0.,  0., 6., 8.,
5,0,0,  0.,10., 8., 0.,
        0., 2., 6., 6.,
T R A N S I T I O N S
1,1,6, 22,25,24,15,14,23,
Group Data for Transitions
27300.,27300.,0.3,10500.,0.5,0.,
1,0,0, 6.,12.,
   0., 6., 6., 6., 0., 0.,
   0., 0., 4.,12.,12., 6.,
P O L Y G O N S
1,1,5, 7,8,22,20,19,
Group Data for Polygons
27300.,27300.,0.3,10500.,0.5,0.,
1,0,0,  0., 6.,12., 6., 2.,
        0., 0., 6., 6., 8.,
  C O O R D I N A T E S
 1,0.,0.,
 0,0,0,
L O A D S
0.D0,
5,5,0, -10.,0.,0.,
 0,0,0,
End
```
End of file

3.8 Square Plate with Edge Beams

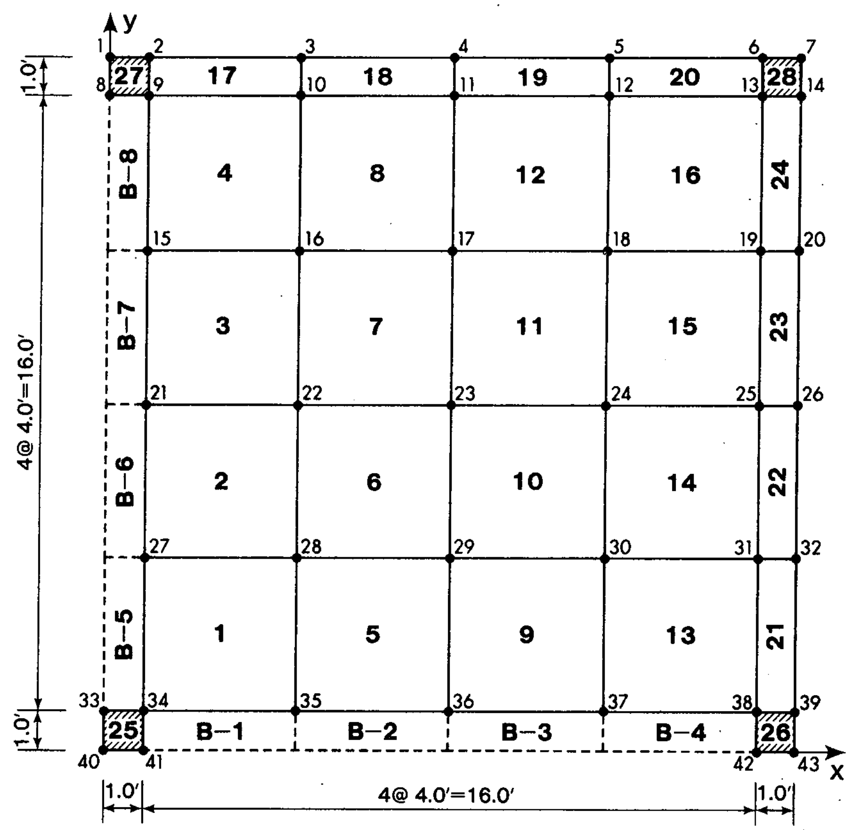


Figure 3.7 Plate with Edge Beams and Columns.

The above plate is 5.25 inches thick, supported by corner columns and has eccentric edge beams. The beams are 12.0 inches wide and have an overall depth of 8.25 inches. The columns are modelled as finite sized supports. The eccentric stiffeners are represented by line beams on two edges and as offset plates along the other two edges. A single point load is applied at the centre of the plate.

The data file follows and is available from CIVE:HYBSLAB.TD(3000,3199) . To run the problem:
$RUN CIVE:HYBSLAB 5=CIVE:HYBSLAB.TD(3000) 6=-7 t=3s .

```
3000   BEAM and COLUMN PLATE; 5=MAN.egs(3000)
3002   UNITS=FEET, KIPS.
3004   28,8,0,0,0,  0,0,0,4,0,0,
3006   4,2,0,0,0,   0,0,0,
3008   43,0,1,36,0,0,
3010   SUPPRESSED D.O.F.  .
3012    1,2,43,  1,1,1,0,0,
3014   0,0,0,
3016        ***SUBROUTINE  C O N N E C T***
3018   B1,5,5,
3020   Joint Matrix 1
3022   J34,1,1,0,0,
3024   -34,35,39,
3026   J27,2,1,-6,9,
3028   -27,28,32,
3030   J2,6,1,0,0,
3032   -2,3,7,
3034   E
3036   Member Matrix 1
3038   R1,1,1,1,4,
3040    -1,5,13,21,
3042   R17,5,1,0,0,
3044   17,18,19,20,28,
3046   E
3048   E
3050   Additional Elements
3052   R25, 40,41,34,33,
3054   R26, 42,43,39,38,
3056   R27, 8,9,2,1,
3058   E
3060   Grouping of Rectangular Elements
3062   R1, -1,2,16,
3064   R2, 21,22,23,24,
3066   R3, 17,18,19,20,
3068   R4, 25,26,27,28,
3070   E
3072   R E C T A N G L E S    (in MAIN)
3074   0,0,0,
3076   Rectangle Group Data
3078    528480.,528480.,0.15,229774., 0.4375,0.0,
3080    1,0,0,  4.00,4.00,
3082    2,0,0,  1.00,4.00,
3084    3,0,0,  4.00,1.00,
3086    4,0,1,  1.00,1.00,
3088    528480.,528480.,0.15,229774., 43.75,0.0,
3090    B E A M S    -  Connectivity Data
3092    1,2,4, 1,  34,35,1,1,
3094    5,0,0, 2,  34,27,-7,-7,
3096    6,7,8, 2,  27,21,-6,-6,
3098   0,0,0,
3100   Beam Group Properties
3102   1,528480.,0.15,0.68750,0.027080,0.057292,0.061400,+0.50,+0.1250,
3104   2,528480.,0.15,0.68750,0.027080,0.057292,0.061400,-0.50,+0.1250,
3106     C O O R D I N A T E S
3108   34,1.,1.,
3110    33,0,0,  0.00,1.00,
3112    40,0,0,  0.00,0.00,
3114    41,0,0,  1.00,0.00,
3116    42,0,0, 17.00,0.00,
```

```
 43,0,0, 18.00,0.00,
 0,0,0,
*****SUBROUTINE COLCAP*****
Column 1
4,
33,34,40,41,
15000., 4500., 4500.,0.50,0.50,
Column 2
4,
38,39,42,43,
15000., 4500., 4500.,17.5,0.50,
Column 3
4,
1,2,8,9,
15000., 4500., 4500.,0.50,17.5,
Column 4
4,
6,7,13,14,
15000., 4500., 4500.,17.5,17.5,
Central Point Load (P = 100. Kips)
 0.D0,
23,23,0, -100.,0.,0.,0.,0.,
 0,0,0,
.
.
.
.
stop
End of file
```

Chapter 4

FULL SCALE EXAMPLES

4.1 Introductory Comments

The examples presented in this chapter are taken from practise. They are used to give the user representative samples of data files required for various typical floors.

At present only one practical example is given. Additional examples will be added as they become available.

4.2 A Typical Flat Plate Floor System

To illustrate the use of the program *HYBSLAB* and to demonstrate the feasibility of using this program for the analysis of real floor systems, the floor plan shown in Figure 4.1 was chosen. It is a typical floor of a recently constructed 17 story condominium apartment building. This plan is characterized by an irregular layout of columns, large openings, cantilevered corners and load bearing walls. All of these features make it particularly difficult to choose a set of equivalent frames for analysis purposes. It is therefore the type of problem which is ideally suited for a finite element analysis.

The floor plan shown in Figure 4.1 has overall plan dimensions of 109.0 feet by 81.7 feet and a slab thickness of 7.0 inches. The concrete strength was assumed to be 3500 psi and only a uniform load of 0.225 ksf was considered.

The finite element gridwork is shown in Figure 4.2. A total of 504 joints and 430 elements were used. The data file for this problem follows the figures and is available to other users from CIVE:HYBSLAB.TD(5000,9999) .

To run the problem, use the following:

$RUN CIVE:HYBSLAB 5=CIVE:HYBSLAB.TD(5000) 6=-1 t=40s . Due to the time requirement for a complete analysis, this job should be submitted as a BATCH job at DEFERRED priority. To plot the grid alone (connectivity check) 3 seconds should be adequate. The stress output for this problem is not provided.

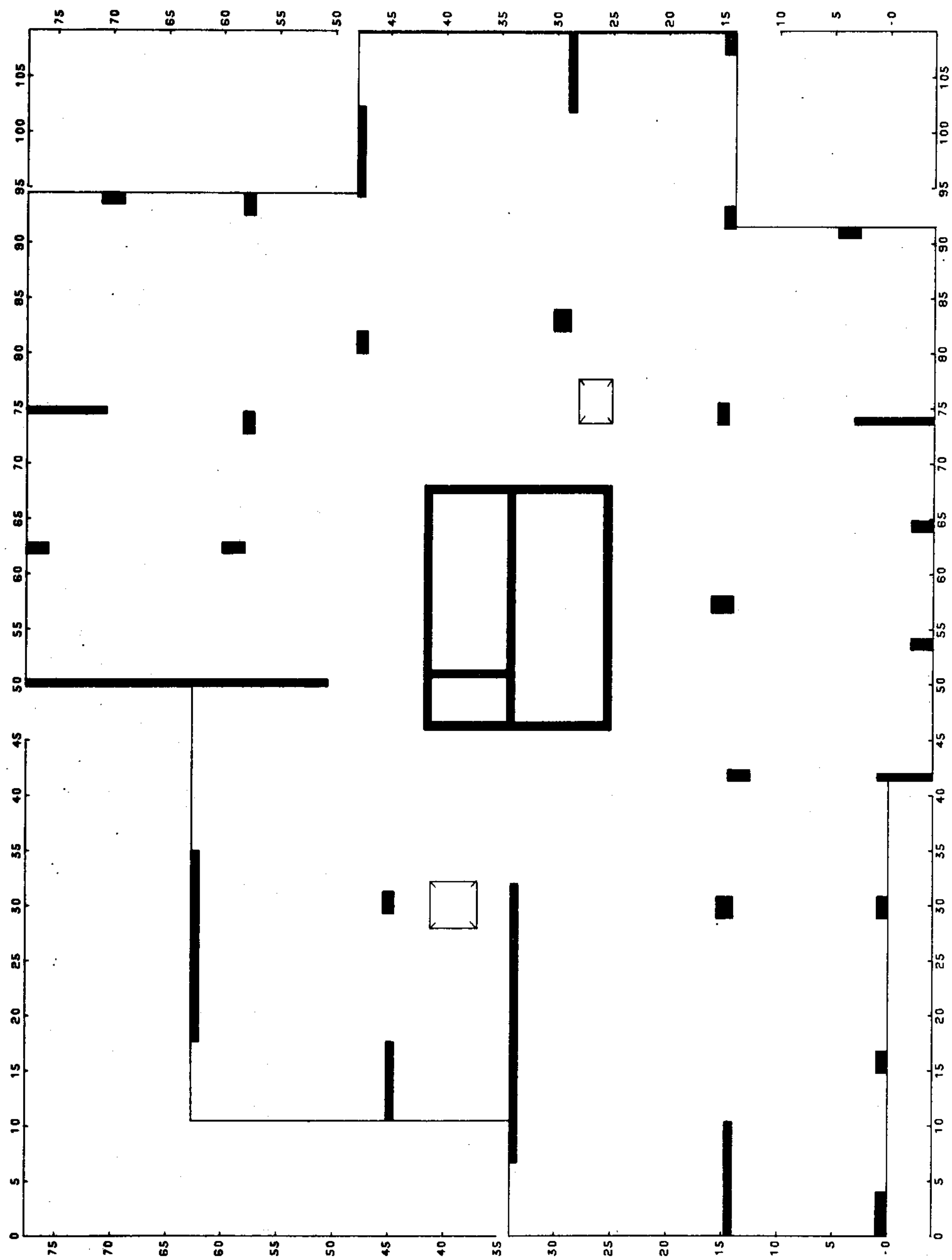


Figure 4.1 Plan of Floor 1.

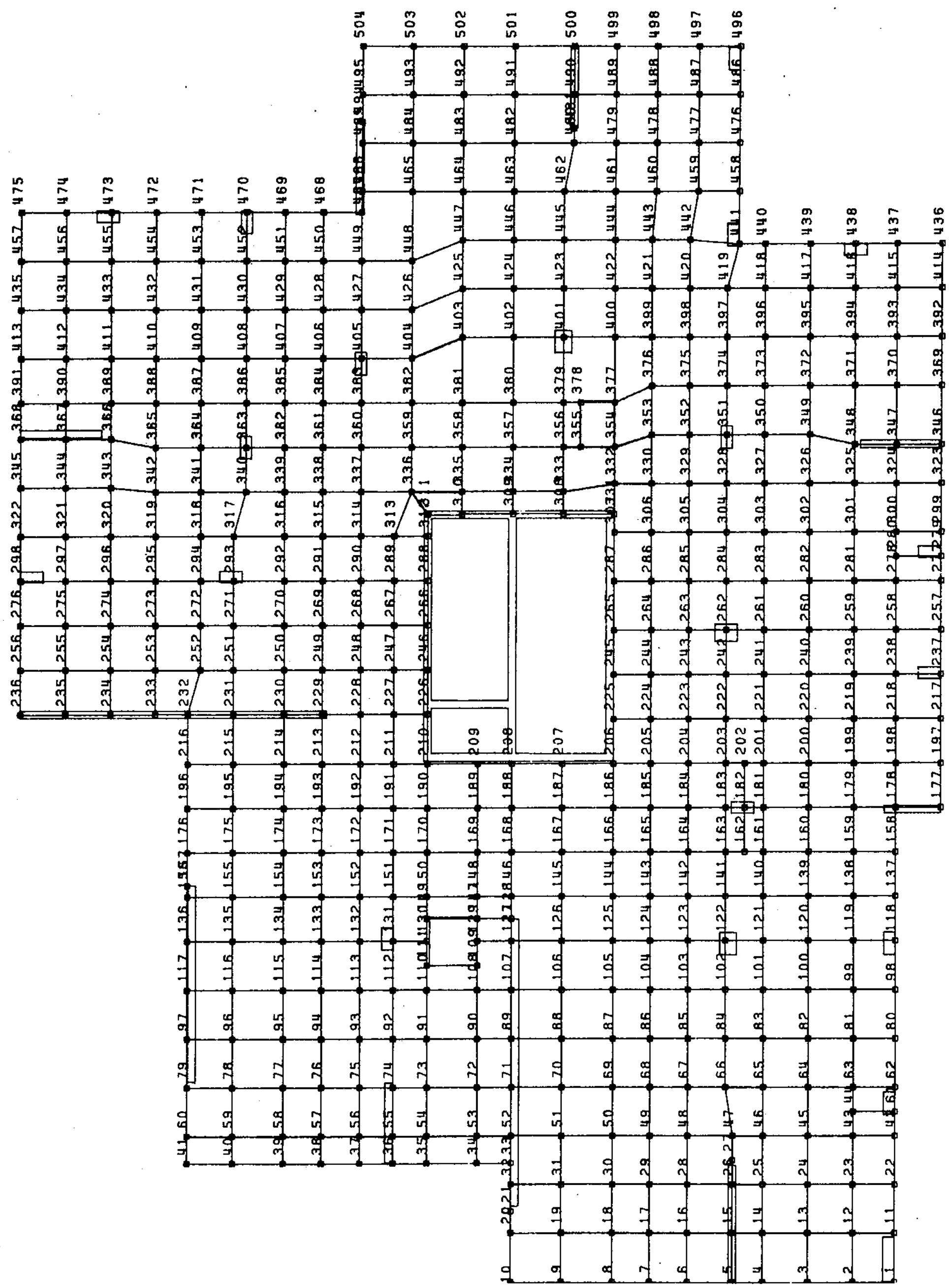


Figure 4.2 Designer's Layout of Finite Element Mesh.

```
FLOOR1(Manual): Typical Floor,HYBSLAB+MAN.Egs(5000),
UNITS= feet, Kips .
381,0,0,29,0, 19,1,0,20,0,0,
33,0,0,27,0,  16,1,0,
504,0,1,430,0,1,
          Suppressed D.O.F.s
1,2,504,    1,1,1,0,0,
177,178,0,  0,0,1,0,0,
346,347,348,0,0,1,0,0,
  5, 15, 0, 0,1,0,0,0,
 26, 27,0,  0,1,0,0,0,
481,481,0,  0,1,0,0,0,
490,500, 0, 0,1,0,0,0,
466,467,0,  0,1,0,0,0,
485,494,0,  0,1,0,0,0,
 21, 52, 0, 0,1,0,0,0,
 32, 33,0,  0,1,0,0,0,
 71,89,107, 0,1,0,0,0,
127,128,0,  0,1,0,0,0,
 36, 55,74, 0,1,0,0,0,
 79, 97, 0, 0,1,0,0,0,
117,136, 0, 0,1,0,0,0,
156,157,0,  0,1,0,0,0,
229,230,236,0,0,1,0,0,
366,367,368,0,0,1,0,0,
207,208,210,0,0,1,0,0,
308,309,311,0,0,1,0,0,
206,208,0,  0,0,0,0,0,
309,331, 0, 0,0,0,0,0,
225,245,265,0,1,0,0,0,
287,307, 0, 0,1,0,0,0,
226,246,266,0,1,0,0,0,
288,312, 0, 0,1,0,0,0,
0,0,0,
               ***SUBROUTINE  C O N N E C T***
B1,26,22,
Joint Matrix 1
J177,1,11,1,178,
177,197,217,237,257,277,299,323,346,369,392,414,436,
J1,2,1,1,2,
1,11,22,42,62,80,98,118,137,158,178,198,218,238,258,280,300,324,347,370,393,415,437,
J3,4,1,1,5,
3,13,24,45,64,82,100,120,139,160,180,200,220,240,260,282,302,326,349,372,395,417,439,
J5,6,1,1,10,
5,15,27,47,66,84,102,122,141,163,183,203,222,242,262,284,304,328,351,374,397,419,441,458,476,486,496,
J33,11,3,1,35,
33,52,71,89,107,127,147,168,188,208,0,0,0,0,309,334,357,380,402,424,446,463,482,491,501,
J35,13,3,0,0,
35,54,73,91,110,130,150,170,190,210,226,246,266,288,312,336,359,382,404,426,448,465,484,493,503,
J36,14,3,1,37,
36,55,74,92,112,131,151,171,191,211,227,247,267,289,313,336,359,382,404,426,448,465,484,493,503,
J38,16,3,1,41,
38,57,76,94,114,133,153,173,193,213,229,249,269,291,315,338,361,384,406,428,450,468,
J232,19,13,1,236,
232,252,272,294,318,341,364,387,409,431,453,471,
E
Member Matrix  1
R1,1,11,0,0,
-1,2,6, -8,9,13,
```

```
R14,2,1,0,0,
14,15,16,0,-19,20,29, 0,-30,31,35,
Q36,3,1,0,0,
36,37,38,0,-39,40,51, 4003, 4004,52,53,54,
R55,4,1,0,0,
-55,56,76,
Q77,5,1,0,0,
77,78,0, 4001,79,80,81,82,0,0,0,0,-87,88,95, 4005,
Q96,6,1,0,0,
96,97,0, 4002,-98,99,114, 4006, 4007,115,116,117,
R118,7,1,0,0,
-118,119,139, 4008,140,141,142,
Q143,8,1,0,0,
-143,144,158, 0, 4010, 4011, 4012,159,160, 4009,161,162,163,
Q164,9,1,0,0,
-164,165,174, 0,0,0,0,0, 4013,0,175,0,176,177,178, 4014,0,179,
Q180,10,1,0,0,
180,0,0,181,182,183,184,0,185,186,187,0,0,0,0,0,-188,189,194, 4015,0,195,
R196,11,3,0,0,
196,197,198,199,0,0,202,203,204,0,0,0,0,0,-205,206,214,
Q215,12,3,0,0,
-215,216,223,0,0,0,0,0, 4020,224,225, 4016, 4017, 4018, 4019,226,227,228,
Q229,13,3,0,0,
229,230,231,232,0,0,-233,234,240, 4021,0,
Q241,14,3,0,0,
-241,242,254, 4022,-255,256,259,0,260,0,261,
R262,15,3,21,283,
-262,263,282,
Q304,17,3,0,0,
-304,305,317, 4025,-318,319,323,
Q324,18,3,0,0,
-324,325,329,0,330,331,332, 4023,333,334,335, 4026,-336,337,341,
Q24,19,13,0,0,
4024,-342,343,351,
Q352,20,13,0,0,
352,353,354,355, 4027, 4028, 4029,356,357,358,359,
R360,21,13,11,371,
-360,361,370,
E
E
Additional Elements
R5,   257,277,278,258,
R6,   277,279,280,278,
R7,   279,299,300,280,
R17,   42, 61, 44, 43,
R18,   61, 62, 63, 44,
R29,  258,278,281,259,
R38,   23, 43, 45, 24,
R78,   14, 25, 26, 15,
R83,  162,182,183,163,
R84,  182,202,203,183,
R85,  161,181,182,162,
R86,  181,201,202,182,
R97,   15, 26, 28, 16,
R175, 355,378,379,356,
R185, 145,167,168,146,
R188, 308,333,334,309,
R189, 333,356,357,334,
R190, 356,379,380,357,
R191, 379,401,402,380,
```

```
R200, 127,128,147,129,
R201, 128,146,148,147,
R202, 146,168,169,148,
R219, 108,109,111,110,
R220, 147,148,150,149,
R260, 493,503,504,495,
R282, 449,467,468,450,
Q10,  330,353,354,332,
Q11,  354,353,376,377,
Q12,  377,376,399,400,
Q13,  331,332,333,308,
Q17,  404,403,425,426,
Q18,  426,425,447,448,
Q19,  448,447,464,465,
Q20,  310,335,336,311,
Q21,  312,311,336,313,
E
Grouping of Elements
R1, 1,2,3,4,13, -42,43,48, -62,63,68, 54,76,329,330,331,336,337,338, -342,343,348, -352,353,356, -360,361,363,367,374,378, -371,3
R2, 5,8,11,12, -36,37,41, -49,50,53, -55,56,61, -69,70,75, 96,97,325,326,327,328,332,339,340,341,349,350,351,357,358,359,364,365,
R2, 368,369,370, 375,376,379,380,381,
R3, 6,7,
R4, 9,
R5, 10,
R6, 14,15,16,19,20,21,29,30,33,34, 115,116,117, 140,141,142, 161,162,163,179,
R7, -22,23,28, 35,
R8, 17,18,
R9, 31,
R10, 32,
R11, 77,78,
R12, 83,84,85,86,
R13, 79,80,81, -89,90,95, 98,99,100,
R13, -108,109,114, -118,119,124, -132,133,139, -143,144,149, 157,158,159,160,
R14, 82,87,88,  -101,102,107, -125,126,131, -150,151,156,
R15, 171,172,173,174,185,186,187,189,190,206,207,221,222,223,224,225,
R15, 255,256,257,309,310,311,312, 314,315,316,317,
R16, -164,165,170, 176,177,178,180,181,182,183,184,192,193,194, -209,210,214,
R16, 216,217,218,226,227,228,258,259,260,261,313,305,306,307,308,
R17, 191,208,
R18, 188,205,
R19, 215,304,
R20, 202,203,204,233,234,235,237,238,239,240, -246,247,249, -251,252,254,
R21, 197,198,199,230,231,232,236,250, 242,243,244,245,
R22, 196,229,241,
R23, 200,201,
R24, 219,
R25, 220,
R26, 262,283,
R27, 267,268,269,270, -272,273,279,288,289,290,291, -293,294,300,318,319,320,
R28, 263,264,265,266,271,280,281,282, -284,285,286,287, 292,301,302,303,321,322,323,
R29, 324,
R30, 333,334,335,
R31, 366,377,
R32, 195,
R33, 175,
E
Quad. Grouping
1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,17,18,19,20,21,22,23,24,23,25,26,27,
R E C T A N G L E S                (back in MAIN)
 0,0,0,
```

```
Group Data for Rectangles
   485600.,485600.,0.15,211100., 0.58333,0.0,
 1,0,0,  3.917,4.000,
 2,0,0,  4.300,4.000,
 3,0,0,  2.150,4.000,
 4,0,0,  3.415,4.000,
 5,0,0,  5.185,4.000,
 6,0,0,  4.300,3.667,
 8,0,0,  2.150,3.667,
 7,0,0,  3.917,3.667,
 9,0,0,  3.415,3.667,
10,0,0,  5.185,3.667,
11,0,0,  4.300,2.667,
12,0,0,  3.917,1.667,
13,0,0,  4.300,3.333,
14,0,0,  3.917,3.333,
15,0,0,  3.917,4.500,
16,0,0,  4.300,4.500,
17,0,0,  5.750,4.500,
18,0,0,  2.000,4.500,
19,0,0,  2.400,4.500,
20,0,0,  3.917,3.000,
21,0,0,  4.300,3.000,
22,0,0,  2.400,3.000,
23,0,0,  1.959,3.000,
24,0,0,  2.150,4.500,
25,0,0,  1.959,4.500,
26,0,0,  2.400,3.400,
27,0,0,  3.917,3.400,
28,0,0,  4.300,3.400,
29,0,0,  2.400,4.000,
30,0,0,  3.917,2.900,
31,0,0,  3.151,4.000,
32,0,0,  4.300,5.300,
33,0,0,  3.917,1.500,
            Q U A D R I L A T E R A L S
 0,0,0,
Group Data for Quadrilaterals
     485600.,485600.,0.15,211100., 0.58333,0.0,
1,0,0,  0.000, 4.300, 4.300, 0.000,
        0.000, 0.000, 3.333, 2.667,
2,0,0,  0.000, 4.300, 4.300, 0.000,
        0.000, 0.667, 4.000, 4.000,
3,0,0,  0.000, 3.415, 4.300, 0.000,
        0.000, 0.000, 4.000, 4.000,
4,0,0,  0.000, 5.185, 5.185, 0.885,
        0.000, 0.000, 4.000, 4.000,
5,0,0,  0.000, 3.917, 3.917, 0.000,
        0.000, 0.000, 2.300, 3.333,
6,0,0,  0.000, 4.300, 4.300, 0.000,
        1.034, 0.000, 4.367, 4.367,
7,0,0,  0.000, 4.300, 4.300, 0.000,
        0.000, 0.000, 3.667, 4.367,
8,0,0,  0.000, 4.300, 4.300, 0.000,
        0.699, 0.000, 3.667, 4.033,
9,0,0,  0.000, 4.300, 4.300, 0.000,
        0.333, 0.000, 3.667, 3.667,
10,0,0, 0.000, 4.300, 3.233, 0.000,
        0.000, 0.000, 3.333, 3.333,
11,0,0, 0.000, 1.067, 5.367, 3.917,
```

```
           3.333, 0.000, 0.000, 3.333,
  12,0,0,  0.000, 1.450, 5.750, 5.750,
           3.333, 0.000, 0.000, 3.333,
  13,0,0,  0.000, 2.684, 2.000, 0.000,
           0.000, 0.000, 4.500, 4.500,
  14,0,0,  0.000, 4.300, 4.300, 0.000,
           0.000, 0.000, 3.667, 4.500,
  15,0,0,  0.000, 4.300, 4.300, 0.000,
           0.800, 0.000, 5.300, 5.300,
  16,0,0,  0.000, 5.750, 3.917, 0.000,
           0.000, 0.000, 4.500, 4.500,
  17,0,0,  0.000, 1.8333, 6.133, 4.300,
           4.500, 0.000, 0.000, 4.500,
  18,0,0,  0.000, 1.8333, 6.133, 6.133,
           4.500, 0.000, 0.000, 4.500,
  19,0,0,  0.000, 2.000, 2.000, 0.000,
           0.000, 0.000, 4.500, 3.000,
  20,0,0,  0.000, 1.917, 3.917, 0.000,
           0.000, 0.000, 1.500, 3.000,
  21,0,0,  0.000, 3.917, 3.917, 0.000,
           1.500, 0.000, 4.500, 4.500,
  23,0,0,  0.000, 3.917, 3.917, 0.000,
           1.100, 0.000, 4.000, 4.000,
  22,0,0,  0.000, 3.917, 3.917, 0.000,
           0.000, 0.000, 2.900, 4.000,
  24,0,0,  0.000, 3.917, 3.917, 0.000,
           0.000, 0.000, 3.400, 4.500,
  25,0,0,  0.000, 3.917, 4.300, 0.000,
           0.000, 0.000, 4.000, 4.000,
  26,0,0,  0.000, 3.917, 4.683, 0.383,
           0.000, 0.000, 4.000, 4.000,
  27,0,0,  0.000, 3.917, 3.917, 0.766,
           0.000, 0.000, 4.000, 4.000,
              T R A N S I T I O N S
   1,1,5,    43, 44, 63, 64, 45,
   2,2,5,   278,280,300,301,281,
   3,3,5,    25, 46, 47, 27, 26,
   4,1,5,    26, 27, 47, 48, 28,
   5,4,5,   140,161,162,163,141,
   6,5,5,   201,221,222,203,202,
   7,6,5,   306,330,332,331,307,
   8,7,5,    19, 31, 32, 21, 20,
   9,7,5,    31, 51, 52, 33, 32,
  10,8,5,   126,145,146,128,127,
  11, 9,5,  479,489,490,481,480,
  12,10,5,  480,481,490,491,482,
  13,11,5,  107,127,129,109,108,
  14,12,5,  110,111,130,131,112,
  15,13,5,  130,149,150,151,131,
  16,14,5,  448,465,466,467,449,
  17,7, 5,  484,493,495,494,485,
  18,15,5,  155,175,176,157,156,
  19,16,5,   377,400,401,379,378,
  Group Data for Transitions
     485600.,485600.,0.15,211100., 0.58333,0.0,
   1,0,0,     4.300,4.000,
      0.000, 2.150, 4.300, 4.300, 0.000,
      0.000, 0.000, 0.000, 4.000, 4.000,
   2,0,0,     4.300,3.667,
      0.000, 2.150, 4.300, 4.300, 0.000,
```

```
    0.000, 0.000, 0.000, 3.667, 3.667,
 3,0,0,    4.300,2.667,
    0.000, 4.300, 4.300, 2.150, 0.000,
    0.000, 0.000, 2.667, 2.667, 2.667,
 4,0,0,    3.917,3.333,
    0.000, 3.917, 3.917, 3.917, 0.000,
    0.000, 0.000, 1.667, 3.333, 3.333,
 5,0,0,    3.917,3.333,
    0.000, 3.917, 3.917, 0.000, 0.000,
    0.000, 0.000, 3.333, 3.333, 1.667,
 6,0,0,    4.300,3.333,
    0.000, 4.300, 4.300, 1.616, 0.000,
    0.000, 0.000, 3.333, 3.333, 3.333,
 7,0,0,    4.300,4.500,
    0.000, 4.300, 4.300, 1.900, 0.000,
    0.000, 0.000, 4.500, 4.500, 4.500,
 8,0,0,    3.917,4.500,
    0.000, 3.917, 3.917, 1.959, 0.000,
    0.000, 0.000, 4.500, 4.500, 4.500,
 9,0,0,    4.300,3.667,
    0.000, 4.300, 4.300, 1.314, 0.000,
    0.000, 0.000, 3.667, 3.667, 3.667,
10,0,0,    4.300,5.300,
    0.000, 1.314, 4.300, 4.300, 0.000,
    0.000, 0.000, 0.000, 5.300, 5.300,
11,0,0,    4.300,3.000,
    0.000, 4.300, 4.300, 2.150, 0.000,
    0.000, 0.000, 3.000, 3.000, 3.000,
12,0,0,    4.300,3.000,
    0.000, 2.150, 4.300, 4.300, 0.000,
    0.000, 0.000, 0.000, 3.000, 3.000,
13,0,0,    3.917,3.000,
    0.000, 1.959, 3.917, 3.917, 0.000,
    0.000, 0.000, 0.000, 3.000, 3.000,
14,0,0,    6.133,4.500,
    0.000, 6.133, 6.133, 4.300, 0.000,
    0.000, 0.000, 4.500, 4.500, 4.500,
15,0,0,    3.917,4.000,
    0.000, 3.917, 3.917, 0.983, 0.000,
    0.000, 0.000, 4.000, 4.000, 4.000,
16,0,0,    5.750,4.500,
    0.000, 5.750, 5.750, 0.000, 0.000,
    0.000, 0.000, 4.500, 4.500, 3.000,
           P O L Y G O N S
1,1,5,  333,332,354,355,356,
Group Data for Polygons
    485600.,485600.,0.15,211100., 0.58333,0.0,
1,0,0, 0.000, 0.684, 3.917, 3.917, 3.917,
       4.500, 0.000, 0.000, 3.000, 4.500,
C O O R D I N A T E S   in MAIN
 1,0.,0.,
 0,0,0,
            *** SUBROUTINE COLCAP ***
Column 1:   A.1;      (4.0 x 1.0)
2,
1,11,
242800., 80920., 1294900.,   2.000,0.500,
Column 2:   B.1;      (2.0 x 1.0)
1,
61,
```

```
121400.,  40460., 161860.,  15.750,0.500,
Column 3:   C.1;      (2.0 x 1.0)
1,
118,
121400.,  40460., 161860.,   29.833,0.500,
Column 4:   D.1;      (1.0 x 2.0)
1,
237,
121400.,  161860., 40460.,   53.667,-3.000,
Column 5:   E.1;      (1.0 x 2.0)
1,
279,
121400.,  161860., 40460.,   64.333,-3.000,
Column 6:   G.1;      (1.0 x 2.0)
1,
438,
121400.,  161860., 40460.,   91.000,3.667,
Column 7:  B-C.2;     (2.0 x 1.5)
1,
122,
182100.,  136570., 242800.,   29.833,14.750,
Column 8:   C.2;      (1.0 x 2.0)
1,
182,
121400.,  161860., 40460.,    41.833,13.500,
Column 9:   E.2;      (1.5 x 2.0)
1,
262,
182100.,  242800., 136570.,    57.250,15.000,
Column 10:   F.2;     (2.0 x 1.0)
1,
351,
121400.,  40460., 161860.,    74.500,15.250,
Column 11:   G.2;     (2.0 x 1.0)
1,
441,
121400.,  40460., 161860.,     92.333,14.500,
Column 12:   J.2;     (2.0 x 1.0)
1,
496,
121400.,  20230.,  80930.,   108.000,14.500,
Column 13:   F-G . 3;     (2.0 x 1.5)
1,
401,
182100.,  136570., 242800.,    83.000,29.500,
Column 14:   B-C . 4;     (2.0 x 1.0)
1,
131,
121400.,  40460., 161860.,     30.333,45.000,
Column 15:   F-G . 4;     (2.0 x 1.0)
1,
405,
121400.,  40460., 161860.,      81.000,47.500,
Column 16:   E . 4-5;     (1.0 x 2.0)
1,
293,
121400.,  161860., 40460.,      62.333,59.000,
Column 17:   F . 4-5;     (2.0 x 1.0)
1,
363,
```

```
121400.,  40460., 161860.,       73.650,57.667,
Column 18:   G. 4-5;      (2.0 x 1.0)
1,
470,
121400.,  40460., 161860.,       93.500,57.667,
Column 19:   E . 6;        (1.0 x 2.0)
1,
298,
121400.,  161860., 40460.,       62.333,76.667,
Column 20:   G . 5-6;      (1.0 x 2.0)
1,
473,
121400.,  161860., 40460.,       94.000,70.000,
UNIFORM LOAD ( Qo = - 0.225 Ksf )
-0.225,
 0,0,0,
stop
End of file
```

Chapter 5

THE OUTPUT DATA

5.1 Output Format

The output from the program *HYBSLAB* consists of two types. The first is an echoing of the input data; the second is the printing of output data.

In the first phase, the input data is used to calculate global coordinates, semi-band widths and the element limits of integration. If ISTOP=1 (ref. Chapter 2), then the program ceases execution after printing the above data.

If ISTOP=0 then the program continues on to calculate element stiffness matrices, assemble the global matrices, and solve for nodal displacements. These displacements are then used to obtain element stresses at the nodal points of each element and at one interior point. As well, the displacements for each element are used to calculate internal nodal forces. When checking the output, the user should always expect any free-body section of the structure to be in static equilibrium.

The complete output from the example in Section 3.7 is provided on the pages which follow. The program is unit independent; therefore, the units of force and length which applied to the input data also apply to the output data. Flexural stress resultants (moments per unit width) are printed using the tensor sign convention shown in

Figure 1.2. Internal nodal forces determined from the nodal displacements are printed with the positive sense being in the positive direction of the corresponding conjugate displacement degrees of freedom as shown in Figure 1.1. The last block of output data consists of the averaged values of flexural nodal stresses. This average is determined at a given joint by summing the values from the adjoining elements and dividing by the number of contributing elements. These values are used for plotting moment contours and the sign convention has been switched from the classical tensor sign convention to the more common engineers' sign convention.

```
Test Case with a variety of Elements,'MAN.egs(2800)'
UNITS= feet, Kips .
--------------------

Input checked by :____________________(Date:_______________)

Output checked by:____________________(Date:_______________)

Comments: __________________________________________________

____________________________________________________________

____________________________________________________________

POINTS TO REMEMBER  :
    (1)  UNITS;
         Only FORCE and DISTANCE can be specified,
         All else follows. (EMOD must be in these Units)
    (2)  NUMBER CONSECUTIVELY STARTING FROM UNITY
           (a)  All Joints ,
          and for a given shape ;
           (b)  All Members,
           (c)  All Groups  .
    (3)  SPECIFIED LOADS ARE ADDED TO GENERATED LOADS .
    (4)  ECCENTRICITES ARE MEASURED ALONG +ve AXES .
    (5)  PLATE ELEMENT LOCAL AXES MUST BE PARALLEL
         TO GLOBAL AXES OF THE STRUCTURE .
    (6)  JOINT ORDER FOR ELEMENT GROUPS :
           (a)  Joint 1 is the left-most Joint ,
           (b)  Numbering Sequence is consecutive C.C.W.
           (c)  Number of Joints must not exceed 6.
    (7)  ELEMENTS WITH DIMENSIONS X & Y EXCHANGED
         DO NOT HAVE THE SAME STIFFNESS MATRIX.
    (8) GRAPHICAL OUTPUT UNITS:
           File 1 = Finite Element Mesh,
           File 2 = Transverse Displacement , w ,
           File 3 = Coords and Mx, My, Mxy, Mp1, Mp2 .
    (*)  REGARDLESS OF ELEMENT SIZE ;
           ( i ) The Elements are always in Equilibrium
           ( ii) Nodal Displacements <w Ox Oy u v>
                        are always Compatible.

The Structure consists of ;
 STRESS HYBRID ELEMENTS ;
            ,RECTANGLES     =  6
            ,TRIANGLES      =  3
            ,QUADRILATERALS=  5
            ,L-SHAPES       =  0
            ,TRANSITIONS    =  1
            ,POLYGONS       =  1
    LINE BEAMS =  0
    EXTRA or EXTERNAL ELEMENTS =  0
    COLUMN HEADS =  0
    SPRING GROUPS =  0
    PRESCRIBED DISPLACEMENTS at,  0    DOFs.

NUMBER OF JOINTS= 25    ,NUMBER OF MASTER NODES=  0
```

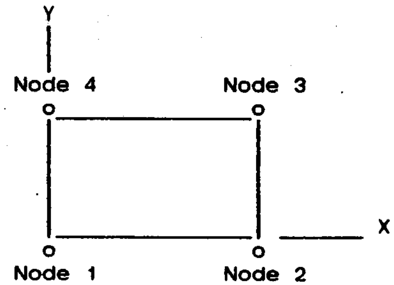
```
NUMBER OF LOAD VECTORS=  1


       STRUCTURE,S D.O.F.  (O--> zero movement)
     JOINT   W-DISP  X-ROT.  Y-ROT.  X-DISP. Y-DISP.
         1       0       1       2       0       0
         2       3       4       5       0       0
         3       6       7       8       0       0
         4       9      10      11       0       0
         5      12      13      14       0       0
         6      15      16      17       0       0
         7      18      19      20       0       0
         8      21      22      23       0       0
         9      24      25      26       0       0
        10      27      28      29       0       0
        11       0      30      31       0       0
        12      32      33      34       0       0
        13      35      36      37       0       0
        14      38      39      40       0       0
        15       0      41      42       0       0
        16      43      44      45       0       0
        17      46      47      48       0       0
        18      49      50      51       0       0
        19      52      53      54       0       0
        20      55      56      57       0       0
        21      58      59      60       0       0
        22      61      62      63       0       0
        23      64      65      66       0       0
        24      67      68      69       0       0
        25      70      71      72       0       0
   6     6     9    14    14    15    16
   2     2     5    10    10    11    12
   2     2     8    23    23    24    29
     ***SUBROUTINE  C O N N E C T***
BLOCK   1   has  4  XDIV. and  4  YDIV.
Joint Matrix 1
JOINT MATRIX for BLOCK;   1
     11   12   13   14   15
     16   18   21   23   24
     17   19   20   22   25
      6    7    8    9   10
      1    2    3    4    5
Member Matrix 1
  -1    2    4    0
  10    0    0    5
  11   12   13    0
   6   14    0    0
MEMBER MATRIX for BLOCK;   1
      6   14    0    0
     11   12   13    0
     10    0    0    5
      1    2    3    4
Additional Elements

ELEMENT     J O I N T S

Unspecified Rects=  0   ,Quads=  0
Grouping of Rectangles
Grouping of Quadrilaterals
```

** TYPICAL RECTANGULAR ELEMENT **



RECTANGULAR ELEMENT	(TYPE)	JOINTS (1)	(2)	(3)	(4)
1	(1) ;	1	2	7	6
2	(1) ;	2	3	8	7
3	(1) ;	3	4	9	8
4	(1) ;	4	5	10	9
5	(1) ;	9	10	25	22
6	(2) ;	16	18	12	11

RECTANGLE : 5 ,has NB= 49

GROUP	Ex1	Ey1	Poisx	Gxy	THICK.	Ecc2
1;	27300.	27300.	0.3000	10500.	0.5000	0.0
2;	27300.	27300.	0.3000	10500.	0.5000	0.0

N O D E S

GROUP	(1)	(2)	(3)	(4)	(5)	(6)
1;						
X = ;	0.0	6.000	6.000	0.0		
Y = ;	0.0	0.0	6.000	6.000		
GROUP 2;	(1)	(2)	(3)	(4)	(5)	(6)
X = ;	0.0	4.000	4.000	0.0		
Y = ;	0.0	0.0	6.000	6.000		

SIDE EQUATIONS of INTEGRATION AREAS

GROUP	Xi	Xf	Y - INTERCEPTS b1	b2	Slope 1	Slope 2
1;	0.0	6.000	0.0	6.000	0.0	0.0
2;	0.0	4.000	0.0	6.000	0.0	0.0

** TYPICAL TRIANGULAR ELEMENT **

```
Y
|
|            Node 3
|                o
|              *   *
|             *      *
|            *         *  Node
|           *            o  2
|          *           *
|         *         *
|   Node *     *
|    1   o
|_____________________________X
```

TRIANGULAR ELEMENT	(TYPE)	JOINTS (1)	(2)	(3)
1	(1) ;	8	9	22
2	(2) ;	13	21	23
3	(3) ;	13	23	14

TRIANGLE : 1 ,has NB= 43

GROUP	Ex1	Ey1	Poisx	Gxy	THICK.	Ecc2
1;	27300.	27300.	0.3000	10500.	0.5000	0.0
2;	27300.	27300.	0.3000	10500.	0.5000	0.0
3;	27300.	27300.	0.3000	10500.	0.5000	0.0

N O D E S

GROUP	(1)	(2)	(3)	(4)	(5)	(6)
1;						
X = ;	0.0	6.000	6.000			
Y = ;	0.0	0.0	6.000			
2;						
X = ;	0.0	2.000	6.000			
Y = ;	0.0	-4.000	-6.000			
3;						
X = ;	0.0	6.000	6.000			
Y = ;	0.0	-6.000	0.0			

SIDE EQUATIONS of INTEGRATION AREAS

GROUP	X1	Xf	Y - INTERCEPTS b1	b2	Slope 1	Slope 2
1;	0.0	6.000	0.0	0.0	0.0	1.000
1;	0.0	0.0	0.0	0.0	0.0	0.0
2;	0.0	2.000	0.0	0.0	-2.000	-1.000
2;	2.000	6.000	-3.000	0.0	-0.5000	-1.000
3;	0.0	6.000	0.0	0.0	-1.000	0.0
3;	0.0	0.0	0.0	0.0	0.0	0.0

** TYPICAL QUADRILATERAL ELEMENT **

```
Y
|            Node 4
|              o
|            *   *
|          *       *
|        *           *
|      *               *
| Node *                 *
|  1  o                    *  Node
|      *                  o 3
|________  *            *   __X
            *         *
              *     *
                 o
               Node 2
```

QUADRILATERAL ELEMENT	(TYPE)	JOINTS (1)	(2)	(3)	(4)
1	(1) ;	6	7	19	17
2	(2) ;	17	19	18	16
3	(3) ;	18	19	20	21
4	(4) ;	20	22	23	21
5	(5) ;	18	21	13	12

QUADRILATERAL : 1 ,has NB= 40

GROUP	Ex1	Ey1	Poisx	Gxy	THICK.	Ecc2
1;	27300.	27300.	0.3000	10500.	0.5000	0.0
2;	27300.	27300.	0.3000	10500.	0.5000	0.0
3;	27300.	27300.	0.3000	10500.	0.5000	0.0
4;	27300.	27300.	0.3000	10500.	0.5000	0.0
5;	27300.	27300.	0.3000	10500.	0.5000	0.0

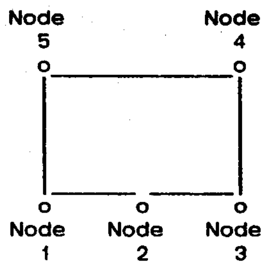
N O D E S

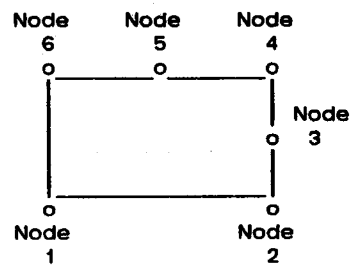
GROUP	(1)	(2)	(3)	(4)	(5)	(6)
1;						
X = ;	0.0	6.000	8.000	0.0		
Y = ;	0.0	0.0	8.000	6.000		
GROUP 2;						
X = ;	0.0	8.000	4.000	0.0		
Y = ;	-6.000	-4.000	0.0	0.0		
GROUP 3;						
X = ;	0.0	4.000	8.000	10.00		
Y = ;	0.0	-4.000	-6.000	2.000		
GROUP 4;						
X = ;	0.0	6.000	6.000	2.000		
Y = ;	0.0	0.0	6.000	8.000		
GROUP 5;						
X = ;	0.0	10.00	8.000	0.0		
Y = ;	0.0	2.000	6.000	6.000		

SIDE EQUATIONS of INTEGRATION AREAS

GROUP	Xi	Xf	Y - INTERCEPTS b1	b2	Slope 1	Slope 2
1;	0.0	0.0	0.0	0.0	0.0	0.0
1;	0.0	6.000	0.0	6.000	0.0	0.2500
1;	6.000	8.000	-24.00	6.000	4.000	0.2500
2;	0.0	0.0	0.0	0.0	0.0	0.0
2;	0.0	4.000	-6.000	0.0	0.2500	0.0
2;	4.000	8.000	-6.000	4.000	0.2500	-1.000
3;	0.0	4.000	0.0	0.1110E-15	-1.000	0.2000
3;	4.000	8.000	-2.000	0.1110E-15	-0.5000	0.2000
3;	8.000	10.00	-38.00	0.1110E-15	4.000	0.2000
4;	0.0	2.000	0.0	0.0	0.0	4.000
4;	2.000	6.000	0.0	9.000	0.0	-0.5000
4;	0.0	0.0	0.0	0.0	0.0	0.0
5;	0.0	0.0	0.0	0.0	0.0	0.0
5;	0.0	8.000	0.1110E-15	6.000	0.2000	0.0
5;	8.000	10.00	0.1110E-15	22.00	0.2000	-2.000

** TYPICAL TRANSITION ELEMENTS **





TRANSITION ELEMENTS ; J O I N T S

ELEMENT	(TYPE)	(1)	(2)	(3)	(4)	(5)	(6)
1	(1) ;	22	25	24	15	14	23

TRANSITION : 1 ,has NB= 35

GROUP	Ex1	Ey1	Poisx	Gxy	THICK.	Ecc2
1;	27300.	27300.	0.3000	10500.	0.5000	0.0

N O D E S

GROUP						
1;	(1)	(2)	(3)	(4)	(5)	(6)
X = ;	0.0	6.000	6.000	6.000	0.0	0.0
Y = ;	0.0	0.0	4.000	12.00	12.00	6.000

SIDE EQUATIONS of INTEGRATION AREAS

			Y - INTERCEPTS			
GROUP	Xi	Xf	b1	b2	Slope 1	Slope 2
1;	0.0	6.000	0.0	12.00	0.0	0.0

** TYPICAL POLYGONAL ELEMENT **

```
Y                       Node 5
|                          o
|                       *     *
|                    *           *
|     Node        *                 *   Node
|      6   o                          o  4
|           *                        *
|            *      Polygon         *
|             *                    *
|  Node o                         o Node
|   1       *                   *    3
|___________   *             * , ___________ X
                  *       *
                      o
                    Node 2
```

```
POLYGONAL                            J O I N T S
ELEMENT    (TYPE)     (1)    (2)   (3)   (4)   (5)    (6)
    1      ( 1) ;      7      8    22    20    19

POLYGON :  1          ,has NB=  46
```

GROUP	Ex1	Ey1	Poisx	Gxy	THICK.	Ecc2
1;	27300.	27300.	0.3000	10500.	0.5000	0.0

N O D E S

GROUP 1;	(1)	(2)	(3)	(4)	(5)	(6)
X = ;	0.0	6.000	12.00	6.000	2.000	
Y = ;	0.0	0.0	6.000	6.000	8.000	

SIDE EQUATIONS of INTEGRATION AREAS

			Y - INTERCEPTS			
GROUP	Xi	Xf	b1	b2	Slope 1	Slope 2
1;	0.0	2.000	0.0	0.0	0.0	4.000
1;	2.000	6.000	0.0	9.000	0.0	-0.5000
1;	6.000	6.000	-6.000	9.000	1.000	-0.5000
1;	6.000	12.00	-6.000	6.000	1.000	0.0

SEMI-BAND = 49   and TOTAL UNKNOWNS=   72

C O O R D I N A T E S

C O O R D S - Assigning of Joint Coordinates from GROUP data
After CYCLE 2   , 0   Elements still have unknown Coordinates.

LOADS SPECIFIED BY USER :

LOAD VECTOR NUMBER   1   ;L O A D S
(Uniform Load = 0.0   )

JOINT	Z-FORCE	X-MOMENT	Y-MOMENT	X-FORCE	Y-FORCE

```
  5    -10.000      0.0          0.0          0.0          0.0




P L A T E   G R O U P =   1
< Nodes > = , 1, 2, 3, 4,

  This ELEMENT has ;
      4   SIDES ,           4   NODES
    H.hh is integrated over  1   regions
    UDL(____)=  1.0000

JOINT   LOCAL-XCOORD   LOCAL-YCOORD
  1        0.0           0.0
  2         6.0000       0.0
  3         6.0000        6.0000
  4        0.0            6.0000

SIDE       OUTWARD NORMALS        SIDE LENGTH
        (Direction Cosines)
  1       0.0        -1.00000       6.0000
  2       1.00000    -0.0           6.0000
  3       0.0         1.00000       6.0000
  4      -1.00000    -0.0           6.0000

EX1(____)=        27300.0    ,EY1(____)=        27300.0
POISX=0.30000      ,POISY=0.30000
,GXY(____)=        10500.0

DRIGID-X=  312.5000          ,DRIGID-Y=  312.5000
(If Isotropic ; Emod=Ex1=Ey1 , Pois=Poisx=Poisy)
Thickness= 0.50000           ,Eccentricity(e2)= 0.0

INTEGRATION over  1   AREAS ;
                          * <-- Y= Slope2* X + b2
                         *
                       *..
                     *....
                   *......
                 *........
               *..........
               ........... *  <-- Y= Slope1* X + b1
               .........*
               ......*
               ...*
               *
               |         |
              Xi         Xf
            A R E A =  1;
               Xi= 0.0                   ,Xf=  6.000000
               b1= 0.0                   ,b2=  6.000000
               Slope1= 0.0               ,Slope2= 0.0


H.Inverse(17,17)  is accurate to 12  digits.
The largest OFF-DIAGONAL term =    0.1917276E-12
```

```
The worst DIAGONAL term =      1.000000
Summation of  EKB(z,1) =-0.1776357E-13

*** BENDING LOAD VECTOR ***          ( UDLOAD =   1.000)
  9.000000      9.000000      9.000000      9.000000      9.000000     -9.000000
  9.000000     -9.000000     -9.000000      9.000000     -9.000000      9.000000
Summation of  P.nodal(z)=  36.00000
Stiffness Matrix into  * ASSEMB *
Group  1      DIAGONAL TERMS
  101.6      529.2      529.2      101.6      529.2      529.2      101.6      529.2      529.2      101.6      529.2      529.2
ROW and COLUMN ENTRIES ;
   0   1   2   3   4   5  18  19  20  15  16  17
   3   4   5   6   7   8  21  22  23  18  19  20
   6   7   8   9  10  11  24  25  26  21  22  23
   9  10  11  12  13  14  27  28  29  24  25  26
  24  25  26  27  28  29  70  71  72  61  62  63



P L A T E   G R O U P =   2
< Nodes > = , 1, 2, 3, 4,

  This ELEMENT has ;
       4   SIDES ,            4   NODES
    H.hh is integrated over  1   regions
    UDL(____)=  1.0000

JOINT   LOCAL-XCOORD   LOCAL-YCOORD
  1        0.0            0.0
  2         4.0000        0.0
  3         4.0000         6.0000
  4        0.0             6.0000

SIDE      OUTWARD NORMALS       SIDE LENGTH
        (Direction Cosines)
  1       0.0        -1.00000       4.0000
  2       1.00000    -0.0           6.0000
  3       0.0         1.00000       4.0000
  4      -1.00000    -0.0           6.0000

EX1(____)=        27300.0     ,EY1(____)=        27300.0
POISX=0.30000       ,POISY=0.30000
,GXY(____)=         10500.0

DRIGID-X=  312.5000           ,DRIGID-Y=  312.5000
(If Isotropic ; Emod=Ex1=Ey1 , Pois=Poisx=Poisy)
Thickness= 0.50000            ,Eccentricity(e2)= 0.0

INTEGRATION over  1   AREAS ;
                            * <-- Y= Slope2* X + b2
                          *
                        *..
                      *....
                    *......
                  *........
                *..........
                ........... *  <-- Y= Slope1* X + b1
```

```
          .........*
          ......*
          ...*
          *
          |          |
         Xi          Xf
       A R E A =  1;
          Xi= 0.0                   ,Xf=  4.000000
          b1= 0.0                   ,b2=  6.000000
          Slope1= 0.0               ,Slope2= 0.0

H.Inverse(17,17)  is accurate to 12  digits.
The largest OFF-DIAGONAL term =    0.1497053E-12
The worst DIAGONAL term =     1.000000
Summation of  EKB(z,1) =-0.7105427E-13

*** BENDING LOAD VECTOR ***          ( UDLOAD =   1.000)
  6.000000     6.000000     4.000000     6.000000     6.000000    -4.000000
  6.000000    -6.000000    -4.000000     6.000000    -6.000000     4.000000
Summation of  P.nodal(z)=  24.00000
Stiffness Matrix into  * ASSEMB *
Group  2     DIAGONAL TERMS
  192.5     501.2     689.2     192.5     501.2     689.2     192.5     501.2     689.2     192.5     501.2     689.2
ROW and COLUMN ENTRIES ;
  43  44  45  49  50  51  32  33  34   0  30  31




P L A T E   G R O U P =   1
< Nodes > = , 1, 2, 3,

  This ELEMENT has ;
       3   SIDES ,            3   NODES
    H.hh is integrated over  2   regions
    UDL(____)=  1.0000

JOINT   LOCAL-XCOORD   LOCAL-YCOORD
  1        0.0            0.0
  2         6.0000        0.0
  3         6.0000         6.0000

SIDE       OUTWARD NORMALS       SIDE LENGTH
        (Direction Cosines)
  1      0.0        -1.00000      6.0000
  2      1.00000    -0.0          6.0000
  3     -0.70711     0.70711      8.4853

EX1(____)=      27300.0    ,EY1(____)=      27300.0
POISX=0.30000     ,POISY=0.30000
,GXY(____)=       10500.0
```

```
DRIGID-X=  312.5000          ,DRIGID-Y=  312.5000
(If Isotropic ; Emod=Ex1=Ey1 , Pois=Poisx=Poisy)
Thickness= 0.50000           ,Eccentricity(e2)= 0.0

INTEGRATION over  2   AREAS ;
                        * <-- Y= Slope2* X + b2
                       *
                     *..
                   *....
                 *......
               *........
             *..........
             ........... *  <-- Y= Slope1* X + b1
             .........*
             ......*
             ...*
             *
             |         |
            Xi         Xf
         A R E A =  1;
             Xi= 0.0                  ,Xf=  6.000000
             b1= 0.0                  ,b2= 0.0
             Slope1= 0.0              ,Slope2=  1.000000

H.Inverse(17,17)  is accurate to 12  digits.
The largest OFF-DIAGONAL term =    0.3517187E-12
The worst DIAGONAL term =     1.000000
Summation of  EKB(z,1) =-0.6394885E-12

*** BENDING LOAD VECTOR ***          ( UDLOAD =   1.000)
  6.062637     4.500000     9.187912     5.874725     4.312088     -4.312088
  6.062637    -9.187912    -4.500000
Summation of  P.nodal(z)=  18.00000
Stiffness Matrix into  * ASSEMB *
Group  1     DIAGONAL TERMS
  128.1      247.1      1200.      408.3      1135.      1135.      128.1      1200.      247.1
ROW and COLUMN ENTRIES ;
  21  22  23  24  25  26  61  62  63




P L A T E   G R O U P =   2
< Nodes > = , 1, 2, 3,

  This ELEMENT has ;
       3   SIDES ,            3   NODES
    H.hh is integrated over  2   regions
    UDL(____)=  1.0000

JOINT   LOCAL-XCOORD   LOCAL-YCOORD
  1        0.0            0.0
  2         2.0000        -4.0000
  3         6.0000        -6.0000

SIDE      OUTWARD NORMALS      SIDE LENGTH
        (Direction Cosines)
```

```
  1     -0.89443   -0.44721      4.4721
  2     -0.44721   -0.89443      4.4721
  3      0.70711    0.70711      8.4853

EX1(____)=        27300.0    ,EY1(____)=       27300.0
POISX=0.30000      ,POISY=0.30000
,GXY(____)=       10500.0

DRIGID-X=  312.5000          ,DRIGID-Y=  312.5000
(If Isotropic ; Emod=Ex1=Ey1 , Pois=Poisx=Poisy)
Thickness= 0.50000           ,Eccentricity(e2)= 0.0

INTEGRATION over  2   AREAS ;
                          * <-- Y= Slope2* X + b2
                        *
                      *..
                    *....
                  *......
                *........
              *..........
              ........... *  <-- Y= Slope1* X + b1
              ..........*
              .......*
              ...*
              *
              |          |
             Xi          Xf
          A R E A =  1;
              Xi= 0.0                   ,Xf=  2.000000
              b1= 0.0                   ,b2= 0.0
              Slope1= -2.000000         ,Slope2= -1.000000
          A R E A =  2;
              Xi=  2.000000             ,Xf=  6.000000
              b1= -3.000000             ,b2= 0.0
              Slope1=-0.5000000         ,Slope2= -1.000000

H.Inverse(17,17)  is accurate to 11  digits.
The largest OFF-DIAGONAL term =    0.5115908E-11
The worst DIAGONAL term =      1.000000
Summation of  EKB(z,1) = 0.7207746E-10

*** BENDING LOAD VECTOR ***          ( UDLOAD =   1.000)
  2.102306     -2.704613      2.102306      1.795387     0.3976935     0.3976935
  2.102306      2.102306     -2.704613
Summation of  P.nodal(z)=  6.000000
Stiffness Matrix into  * ASSEMB *
Group  2      DIAGONAL TERMS
  3002.     0.1193E+05  2922.     0.1118E+05  6846.      6846.      3002.      2922.     0.1193E+05
ROW and COLUMN ENTRIES ;
  35  36  37  58  59  60  64  65  66


P L A T E   G R O U P =   3
< Nodes > = , 1, 2, 3,
```

```
This ELEMENT has ;
      3   SIDES ,              3   NODES
   H.hh is integrated over  2   regions
    UDL(____)=  1.0000

JOINT   LOCAL-XCOORD   LOCAL-YCOORD
  1        0.0            0.0
  2         6.0000        -6.0000
  3         6.0000         0.0

SIDE      OUTWARD NORMALS        SIDE LENGTH
        (Direction Cosines)
  1     -0.70711   -0.70711       8.4853
  2      1.00000   -0.0           6.0000
  3      0.0        1.00000       6.0000

EX1(____)=         27300.0     ,EY1(____)=        27300.0
POISX=0.30000       ,POISY=0.30000
,GXY(____)=         10500.0

DRIGID-X=  312.5000          ,DRIGID-Y=  312.5000
(If Isotropic ; Emod=Ex1=Ey1 , Pois=Poisx=Poisy)
Thickness= 0.50000           ,Eccentricity(e2)= 0.0

INTEGRATION over  2   AREAS ;
                              * <-- Y= Slope2* X + b2
                            *
                          *..
                        *....
                      *......
                    *........
                  *..........
                  ........... *  <-- Y= Slope1* X + b1
                  ..........*
                  .......*
                  ....*
                  *
                  |         |
                 Xi         Xf
              A R E A =  1;
                 Xi= 0.0                 ,Xf=  6.000000
                 b1= 0.0                 ,b2= 0.0
                 Slope1= -1.000000       ,Slope2= 0.0

H.Inverse(17,17)  is accurate to 12  digits.
The largest OFF-DIAGONAL term =    0.3517187E-12
The worst DIAGONAL term =     1.000000
Summation of  EKB(z,1) =-0.5186962E-12

*** BENDING LOAD VECTOR ***            ( UDLOAD =    1.000)
  6.062637      -4.500000      9.187912       6.062637       9.187912      -4.500000
  5.874725      -4.312088     -4.312088
Summation of  P.nodal(z)=  18.00000
Stiffness Matrix into  * ASSEMB *
Group  3     DIAGONAL  TERMS
  128.1      247.1      1200.      128.1      1200.      247.1      408.3      1135.      1135.
ROW and COLUMN ENTRIES ;
  35  36  37  64  65  66  38 , 39  40
```

```
P L A T E   G R O U P =   1
< Nodes > = , 1, 2, 3, 4,

  This ELEMENT has ;
       4   SIDES ,              4   NODES
    H.hh is integrated over  3   regions
    UDL(____)=  1.0000

JOINT   LOCAL-XCOORD   LOCAL-YCOORD
  1        0.0            0.0
  2         6.0000        0.0
  3         8.0000         8.0000
  4        0.0             6.0000

SIDE       OUTWARD NORMALS        SIDE LENGTH
        (Direction Cosines)
  1      0.0        -1.00000        6.0000
  2      0.97014    -0.24254        8.2462
  3     -0.24254     0.97014        8.2462
  4     -1.00000    -0.0            6.0000

EX1(____)=        27300.0    ,EY1(____)=        27300.0
POISX=0.30000      ,POISY=0.30000
,GXY(____)=        10500.0

DRIGID-X=  312.5000          ,DRIGID-Y=  312.5000
(If Isotropic ; Emod=Ex1=Ey1 , Pois=Poisx=Poisy)
Thickness= 0.50000            ,Eccentricity(e2)= 0.0

INTEGRATION over  3   AREAS ;
                            * <-- Y= Slope2* X + b2
                          *
                        *..
                      *....
                    *......
                  *........
                *..........
                ........... *  <-- Y= Slope1* X + b1
                ..........*
                .......*
                ...*
                *
                |          |
               Xi          Xf
          A R E A =  2;
             Xi= 0.0                 ,Xf=  6.000000
             b1= 0.0                 ,b2=  6.000000
             Slope1= 0.0             ,Slope2= 0.2500000
          A R E A =  3;
             Xi=  6.000000           ,Xf=  8.000000
```

```
          b1= -24.00000              ,b2=  6.000000
          Slope1=  4.000000          ,Slope2= 0.2500000


H.Inverse(17,17)  is accurate to 12  digits.
The largest OFF-DIAGONAL term =    0.2451372E-12
The worst DIAGONAL term =     1.000000
Summation of  EKB(z,1) = 0.1101341E-12

*** BENDING LOAD VECTOR ***           ( UDLOAD =   1.000)
  9.081346      9.611702      9.611702      13.74516      18.75157      -10.48390
  11.42834     -15.77704     -15.77704      13.74516     -10.48390      18.75157
Summation of  P.nodal(z)=  48.00000
Stiffness Matrix into  * ASSEMB *
Group  1      DIAGONAL TERMS
  84.46      489.3      489.3      107.0      757.9      560.1      36.71      432.1      432.1      107.0      560.1      757.9
ROW and COLUMN ENTRIES ;
  15  16  17  18  19  20  52  53  54  46  47  48




P L A T E   G R O U P =   2
< Nodes > = , 1, 2, 3, 4,

  This ELEMENT has ;
       4   SIDES ,             4   NODES
    H.hh is integrated over  3   regions
    UDL(____)=  1.0000

JOINT   LOCAL-XCOORD   LOCAL-YCOORD
  1        0.0            -6.0000
  2         8.0000        -4.0000
  3         4.0000        0.0
  4        0.0            0.0

SIDE      OUTWARD NORMALS       SIDE LENGTH
        (Direction Cosines)
  1      0.24254   -0.97014       8.2462
  2      0.70711    0.70711       5.6569
  3      0.0        1.00000       4.0000
  4     -1.00000   -0.0           6.0000

EX1(____)=       27300.0    ,EY1(____)=       27300.0
POISX=0.30000      ,POISY=0.30000
,GXY(____)=        10500.0

DRIGID-X=  312.5000          ,DRIGID-Y=  312.5000
(If Isotropic ; Emod=Ex1=Ey1 , Pois=Poisx=Poisy)
Thickness= 0.50000           ,Eccentricity(e2)= 0.0

INTEGRATION over  3   AREAS ;
                        * <-- Y= Slope2* X + b2
                       *
                      *..
                     *....
                    *......
                   *........
```

```
          *..........
          ..........  *  <-- Y= Slope1* X + b1
          .........*
          ......*
          ...*
          *
          |          |
         Xi          Xf
       A R E A =  2;
           Xi= 0.0                   ,Xf=  4.000000
           b1= -6.000000             ,b2= 0.0
           Slope1= 0.2500000         ,Slope2= 0.0
       A R E A =  3;
           Xi=  4.000000             ,Xf=  8.000000
           b1= -6.000000             ,b2=  4.000000
           Slope1= 0.2500000         ,Slope2= -1.000000

H.Inverse(17,17)  is accurate to 12  digits.
The largest OFF-DIAGONAL term =    0.2480238E-12
The worst DIAGONAL term =     1.000000
Summation of  EKB(z,1) = 0.3552714E-13

*** BENDING LOAD VECTOR ***          ( UDLOAD =   1.000)
  9.699467      10.91437      10.99734      7.911042      2.431471     -13.37144
  8.100902     -7.783373     -2.080596      6.288589     -6.388159      4.762754
Summation of  P.nodal(z)=  32.00000
Stiffness Matrix into  * ASSEMB *
Group  2      DIAGONAL TERMS
  94.92       785.0      454.5      81.42      422.1      632.3      281.9      1116.      270.9      141.7      476.1      589.5
ROW and COLUMN ENTRIES ;
  46  47  48  52  53  54  49  50  51  43  44  45




P L A T E   G R O U P =   3
< Nodes > = , 1, 2, 3, 4,

  This ELEMENT has ;
       4   SIDES ,            4   NODES
    H.hh is integrated over  3   regions
    UDL(____)=  1.0000

JOINT   LOCAL-XCOORD   LOCAL-YCOORD
  1         0.0            0.0
  2         4.0000        -4.0000
  3         8.0000        -6.0000
  4        10.000          2.0000

SIDE       OUTWARD NORMALS       SIDE LENGTH
        (Direction Cosines)
  1     -0.70711   -0.70711       5.6569
  2     -0.44721   -0.89443       4.4721
  3      0.97014   -0.24254       8.2462
  4     -0.19612    0.98058       10.198

EX1(____)=        27300.0    ,EY1(____)=        27300.0
```

```
POISX=0.30000      ,POISY=0.30000
,GXY(____)=        10500.0

DRIGID-X=  312.5000          ,DRIGID-Y=  312.5000
(If Isotropic ; Emod=Ex1=Ey1 , Pois=Poisx=Poisy)
Thickness= 0.50000           ,Eccentricity(e2)= 0.0

INTEGRATION over  3   AREAS ;
                                 * <-- Y= Slope2* X + b2
                               *
                             *..
                           *....
                         *......
                       *........
                     *..........
                     ........... *  <-- Y= Slope1* X + b1
                     .........*
                     ......*
                     ...*
                     *
                     |         |
                    Xi         Xf
          A R E A =  1;
              Xi= 0.0                   ,Xf=  4.000000
              b1= 0.0                   ,b2= 0.1110223E-15
              Slope1= -1.000000         ,Slope2= 0.2000000
          A R E A =  2;
              Xi=  4.000000             ,Xf=  8.000000
              b1= -2.000000             ,b2= 0.1110223E-15
              Slope1=-0.5000000         ,Slope2= 0.2000000
          A R E A =  3;
              Xi=  8.000000             ,Xf=  10.00000
              b1= -38.00000             ,b2= 0.1110223E-15
              Slope1=  4.000000         ,Slope2= 0.2000000

H.Inverse(17,17)  is accurate to 12  digits.
The largest OFF-DIAGONAL term =    0.7212009E-12
The worst DIAGONAL term =     1.000000
Summation of  EKB(z,1) =-0.1101341E-12

*** BENDING LOAD VECTOR ***          ( UDLOAD =    1.000)
  10.32496     -3.864576      21.17339      9.310927      6.764164      4.576920
  8.934068      14.41012     -3.741259      13.43004     -17.32168     -21.02574
Summation of  P.nodal(z)=  42.00000
Stiffness Matrix into  * ASSEMB *
Group  3     DIAGONAL TERMS
  97.31     528.3     802.2     321.1     977.5     402.2     110.4     702.7     486.4     56.97     682.0     544.1
ROW and COLUMN ENTRIES ;
  49  50  51  52  53  54  55  56  57  58  59  60



P L A T E   G R O U P =   4
< Nodes > = , 1, 2, 3, 4,

  This ELEMENT has ;
```

```
      4   SIDES ,             4   NODES
    H.hh is integrated over  3   regions
    UDL(____)=  1.0000

JOINT   LOCAL-XCOORD   LOCAL-YCOORD
  1        0.0            0.0
  2         6.0000        0.0
  3         6.0000         6.0000
  4         2.0000         8.0000

SIDE       OUTWARD NORMALS        SIDE LENGTH
        (Direction Cosines)
  1      0.0       -1.00000         6.0000
  2      1.00000   -0.0             6.0000
  3      0.44721    0.89443         4.4721
  4     -0.97014    0.24254         8.2462

EX1(____)=        27300.0    ,EY1(____)=       27300.0
POISX=0.30000       ,POISY=0.30000
,GXY(____)=         10500.0

DRIGID-X=  312.5000          ,DRIGID-Y=  312.5000
(If Isotropic ; Emod=Ex1=Ey1 , Pois=Poisx=Poisy)
Thickness= 0.50000           ,Eccentricity(e2)= 0.0

INTEGRATION over  3   AREAS ;
                         * <-- Y= Slope2* X + b2
                       *
                     *..
                   *....
                 *......
               *........
             *..........
             ........... *  <-- Y= Slope1* X + b1
             .........*
             ......*
             ...*
             *
             |         |
            Xi         Xf
          A R E A =  1;
             Xi= 0.0                  ,Xf=  2.000000
             b1= 0.0                  ,b2= 0.0
             Slope1= 0.0              ,Slope2=  4.000000
          A R E A =  2;
             Xi=  2.000000            ,Xf=  6.000000
             b1= 0.0                  ,b2=  9.000000
             Slope1= 0.0              ,Slope2=-0.5000000

H.Inverse(17,17)  is accurate to 12  digits.
The largest OFF-DIAGONAL term =    0.2793321E-12
The worst DIAGONAL term =     1.000000
Summation of  EKB(z,1) = 0.5329071E-13

*** BENDING LOAD VECTOR ***          ( UDLOAD =    1.000)
  10.05429     11.81660     11.66669     8.743105     8.774556    -8.307466
  8.428373    -7.178020    -7.229289     8.774237   -14.17727      3.292732
Summation of  P.nodal(z)=  36.00000
Stiffness Matrix into  * ASSEMB *
```

```
Group  4      DIAGONAL  TERMS
  82.90      387.6      734.4      107.3      527.0      565.0      201.1      401.6      851.8      132.9      733.6      521.3
ROW and COLUMN ENTRIES ;
  55  56  57  61  62  63  64  65  66  58  59  60



P L A T E   G R O U P =   5
< Nodes > = , 1, 2, 3, 4,

  This ELEMENT has ;
        4   SIDES ,            4   NODES
    H.hh is integrated over  3   regions
    UDL(____)=   1.0000

JOINT   LOCAL-XCOORD   LOCAL-YCOORD
  1        0.0            0.0
  2         10.000          2.0000
  3         8.0000          6.0000
  4        0.0              6.0000

SIDE       OUTWARD NORMALS       SIDE LENGTH
        (Direction Cosines)
  1       0.19612   -0.98058       10.198
  2       0.89443    0.44721       4.4721
  3       0.0        1.00000       8.0000
  4      -1.00000   -0.0           6.0000

EX1(____)=        27300.0    ,EY1(____)=        27300.0
POISX=0.30000      ,POISY=0.30000
,GXY(____)=        10500.0

DRIGID-X=  312.5000         ,DRIGID-Y=  312.5000
(If Isotropic ; Emod=Ex1=Ey1 , Pois=Poisx=Poisy)
Thickness= 0.50000          ,Eccentricity(e2)= 0.0

INTEGRATION over  3   AREAS ;
                               * <-- Y= Slope2* X + b2
                             *
                           *..
                         *....
                       *......
                     *........
                   *..........
                   ........... *  <-- Y= Slope1* X + b1
                   .........*
                   ......*
                   ...*
                   *
                   |         |
                  Xi         Xf
            A R E A =  2;
                Xi= 0.0                   ,Xf=  8.000000
                b1= 0.1110223E-15         ,b2=  6.000000
                Slope1= 0.2000000         ,Slope2= 0.0
            A R E A =  3;
                Xi=  8.000000             ,Xf=  10.00000
```

```
            b1= 0.1110223E-15           ,b2=  22.00000
            Slope1= 0.2000000           ,Slope2= -2.000000


H.Inverse(17,17)  is accurate to 12  digits.
The largest OFF-DIAGONAL term =    0.2253753E-12
The worst DIAGONAL term =     1.000000
Summation of  EKB(z,1) = 0.1527667E-12

*** BENDING LOAD VECTOR ***          ( UDLOAD =    1.000)
  12.90810      15.20596      19.51610      10.95667      4.357522     -21.44172
  10.84789      -9.163981     -13.15195     11.28734     -10.45754      14.72772
Summation of  P.nodal(z)=  46.00000
Stiffness Matrix into  * ASSEMB *
Group  5      DIAGONAL TERMS
  92.63      904.3      448.2      148.7      651.2      892.0      203.7      1000.      458.4      98.05      677.3      517.6
ROW and COLUMN ENTRIES ;
  49  50  51  58  59  60  35  36  37  32  33  34




P L A T E   G R O U P =   1
< Nodes > = , 1, 2, 3, 4, 5, 6,

  This ELEMENT has ;
        6   SIDES ,              6   NODES
    H.hh is integrated over   1   regions
    UDL(____)=  1.0000

JOINT   LOCAL-XCOORD   LOCAL-YCOORD
  1        0.0            0.0
  2         6.0000        0.0
  3         6.0000         4.0000
  4         6.0000         12.000
  5        0.0             12.000
  6        0.0             6.0000

SIDE      OUTWARD NORMALS       SIDE LENGTH
        (Direction Cosines)
  1       0.0       -1.00000      6.0000
  2       1.00000   -0.0          4.0000
  3       1.00000   -0.0          8.0000
  4       0.0        1.00000      6.0000
  5      -1.00000   -0.0          6.0000
  6      -1.00000   -0.0          6.0000

EX1(____)=        27300.0    ,EY1(____)=        27300.0
POISX=0.30000       ,POISY=0.30000
,GXY(____)=         10500.0

DRIGID-X=  312.5000          ,DRIGID-Y=  312.5000
(If Isotropic ; Emod=Ex1=Ey1 , Pois=Poisx=Poisy)
```

```
Thickness= 0.50000          ,Eccentricity(e2)= 0.0

INTEGRATION over   1   AREAS ;
                         * <-- Y= Slope2* X + b2
                       *
                     *..
                   *....
                 *......
               *........
             *..........
             ........... *  <-- Y= Slope1* X + b1
             ..........*
             .......*
             ....*
             .*
             *
             |         |
            Xi         Xf
          A R E A =  1;
             Xi= 0.0                  ,Xf=  6.000000
             b1= 0.0                  ,b2=  12.00000
             Slope1= 0.0              ,Slope2= 0.0


H.Inverse(17,17)  is accurate to 12  digits.
The largest OFF-DIAGONAL term =    0.3979039E-12
The worst DIAGONAL term =     1.000000
Summation of  EKB(z,1) = 0.3974598E-13

*** BENDING LOAD VECTOR ***          ( UDLOAD =    1.000)
  9.496689      10.49007      10.20199      6.662252      5.766004     -7.580574
  17.00662      11.33775     -15.62914      12.33113     -17.10375     -12.79029
  9.496689     -10.49007      10.20199      17.00662     -0.1705303E-12  15.59603
Summation of  P.nodal(z)=  72.00000
Stiffness Matrix into  * ASSEMB *
Group  1      DIAGONAL TERMS
  63.72      390.3      451.4      61.33      380.1      305.9      124.1      93.34      800.9      72.37      428.1      598.7
  63.72      390.3      451.4      116.4      68.75      790.9
ROW and COLUMN ENTRIES ;
  61  62  63  70  71  72  67  68  69   0  41  42  38  39  40  64  65  66




P L A T E   G R O U P =   1
< Nodes > = , 1, 2, 3, 4, 5,

  This ELEMENT has ;
        5   SIDES ,             5   NODES
    H.hh is integrated over  5   regions
    UDL(____)=  1.0000

JOINT   LOCAL-XCOORD   LOCAL-YCOORD
  1        0.0            0.0
```

```
  2          6.0000         0.0
  3          12.000          6.0000
  4          6.0000          6.0000
  5          2.0000          8.0000

SIDE       OUTWARD NORMALS         SIDE LENGTH
        (Direction Cosines)
  1      0.0        -1.00000        6.0000
  2      0.70711    -0.70711        8.4853
  3      0.0         1.00000        6.0000
  4      0.44721     0.89443        4.4721
  5     -0.97014     0.24254        8.2462

EX1(____)=          27300.0    ,EY1(____)=          27300.0
POISX=0.30000        ,POISY=0.30000
,GXY(____)=          10500.0

DRIGID-X=  312.5000          ,DRIGID-Y=  312.5000
(If Isotropic ; Emod=Ex1=Ey1 , Pois=Poisx=Poisy)
Thickness= 0.50000           ,Eccentricity(e2)= 0.0

INTEGRATION over  5   AREAS ;
                         * <-- Y= Slope2* X + b2
                        *
                      *..
                    *....
                  *......
                *........
              *..........
              ........... *  <-- Y= Slope1* X + b1
              .........*
              ......*
              ...*
              *
              |         |
             Xi         Xf
          A R E A =  1;
              Xi= 0.0                     ,Xf=  2.000000
              b1= 0.0                     ,b2= 0.0
              Slope1= 0.0                 ,Slope2=  4.000000
          A R E A =  2;
              Xi=  2.000000               ,Xf=  6.000000
              b1= 0.0                     ,b2=  9.000000
              Slope1= 0.0                 ,Slope2=-0.5000000
          A R E A =  4;
              Xi=  6.000000               ,Xf=  12.00000
              b1= -6.000000               ,b2=  6.000000
              Slope1=  1.000000           ,Slope2= 0.0

H.Inverse(17,17)  is accurate to 12  digits.
The largest OFF-DIAGONAL term =    0.3999162E-12
The worst DIAGONAL term =     1.000000
Summation of  EKB(z,1) = 0.1172396E-12

*** BENDING LOAD VECTOR ***          ( UDLOAD =   1.000)
  10.35187      12.98907      13.04691      16.34303      21.59637      -4.734383
  7.540854     -5.650853     -13.94600      9.243989     -3.787551     -0.9878177
  10.52025     -18.01809      5.568412
Summation of  P.nodal(z)=  54.00000
```

```
Stiffness Matrix into  * ASSEMB *
Group  1     DIAGONAL  TERMS
  62.23      355.1      642.2      186.4      1402.      374.0      48.26      169.8      634.4      386.4      823.8      191.9
  82.35      561.4      450.8
ROW and COLUMN ENTRIES ;
  18  19  20  21  22  23  61  62  63  55  56  57  52  53  54
```

```
FINAL LOAD VECTORS  :

IF ALL JOINTS ARE LOADED WITH UDL = +1.0
THEN THE SUM OF Z-FORCES =  576.0000
```

```
ASSEMBLY COMPLETE
```

```
     ***  LOAD VECTOR NUMBER  ***  1    ;L O A D S
             ( Uniform Load = 0.0         )
                              DISPLACEMENTS
JOINT  W-DISP.(____)   X-ROT.(RAD)     Y-ROT.(RAD)     X-DISP.(____)   Y-DISP.(____)
    1  0.0            -0.1745964E-12  -0.5485714E+00   0.0             0.0
    2 -0.3291429E+01   0.1371429E+00  -0.5485714E+00   0.0             0.0
    3 -0.6582857E+01   0.2742857E+00  -0.5485714E+00   0.0             0.0
    4 -0.9874286E+01   0.4114286E+00  -0.5485714E+00   0.0             0.0
    5 -0.1316571E+02   0.5485714E+00  -0.5485714E+00   0.0             0.0
    6 -0.9299055E-12  -0.1097846E-12  -0.4114286E+00   0.0             0.0
    7 -0.2468571E+01   0.1371429E+00  -0.4114286E+00   0.0             0.0
    8 -0.4937143E+01   0.2742857E+00  -0.4114286E+00   0.0             0.0
    9 -0.7405714E+01   0.4114286E+00  -0.4114286E+00   0.0             0.0
   10 -0.9874286E+01   0.5485714E+00  -0.4114286E+00   0.0             0.0
   11  0.0             0.1749191E-12  -0.6669170E-12   0.0             0.0
   12 -0.2627676E-11   0.9142857E-01  -0.5920698E-12   0.0             0.0
   13 -0.5974901E-11   0.2742857E+00  -0.1120215E-12   0.0             0.0
   14 -0.4427366E-11   0.4114286E+00   0.5020281E-12   0.0             0.0
   15  0.0             0.5485714E+00   0.6602115E-12   0.0             0.0
   16 -0.9179991E-12   0.1164714E-12  -0.1371429E+00   0.0             0.0
   17 -0.1271668E-11   0.8874466E-14  -0.2742857E+00   0.0             0.0
   18 -0.5485714E+00   0.9142857E-01  -0.1371429E+00   0.0             0.0
   19 -0.1828571E+01   0.1828571E+00  -0.2285714E+00   0.0             0.0
   20 -0.3291429E+01   0.2742857E+00  -0.2742857E+00   0.0             0.0
   21 -0.1280000E+01   0.3200000E+00  -0.9142857E-01   0.0             0.0
   22 -0.4937143E+01   0.4114286E+00  -0.2742857E+00   0.0             0.0
   23 -0.2468571E+01   0.4114286E+00  -0.1371429E+00   0.0             0.0
   24 -0.4388571E+01   0.5485714E+00  -0.1828571E+00   0.0             0.0
   25 -0.6582857E+01   0.5485714E+00  -0.2742857E+00   0.0             0.0
```

```
*** PLATES ***
        (TENSOR Sign Convention for STRESSES)
        (Tension top fibres ---> + )
        (MOMENTS= Force*Dist/ Dist;     AXIAL & SHEAR= Force/ Area)
        (The Fixed-End Forces have been added to the Nodal Force Output.


 RECT.  =  1,(  1),    LOAD VECTOR=  1     (Stresses for UDL= 0.0          )
JOINT     XX-Moment     YY-Moment     XY-Moment     Sx.Axial     Sy.Axial   Shear.XY
  1     -0.5476E-12  -0.6506E-12   -5.000
  2     -0.6375E-11   0.2711E-12   -5.000
  7     -0.6762E-11  -0.3997E-11   -5.000
  6      0.4026E-12  -0.5749E-11   -5.000
  0     -0.3468E-11  -0.2466E-11   -5.000

                              (GLOBAL X-Y EQUILIBRIUM NODAL FORCES)
JOINT     PZ(NODAL)     M.OX(NODAL)  M.OY(NODAL)  PX.NODE      PY.NODE
  1        10.00       -0.2220E-15   0.1776E-13
  2       -10.00       -0.1155E-11   0.1910E-10
  7        10.00        0.1438E-10   0.2145E-10
  6       -10.00        0.1479E-10  -0.8100E-12


 RECT.  =  2,(  1),    LOAD VECTOR=  1     (Stresses for UDL= 0.0          )
JOINT     XX-Moment     YY-Moment     XY-Moment     Sx.Axial     Sy.Axial   Shear.XY
  2     -0.6250E-11   0.5964E-12   -5.000
  3     -0.1000E-10  -0.1187E-11   -5.000
  8     -0.7716E-11  -0.4012E-12   -5.000
  7     -0.6981E-11  -0.4068E-11   -5.000
  0     -0.7695E-11  -0.1384E-11   -5.000

                              (GLOBAL X-Y EQUILIBRIUM NODAL FORCES)
JOINT     PZ(NODAL)     M.OX(NODAL)  M.OY(NODAL)  PX.NODE      PY.NODE
  2        10.00        0.4774E-13  -0.1922E-10
  3       -10.00       -0.3087E-11   0.2875E-10
  8        10.00        0.4766E-11   0.2506E-10
  7       -10.00        0.9301E-11  -0.2017E-10


 RECT.  =  3,(  1),    LOAD VECTOR=  1     (Stresses for UDL= 0.0          )
JOINT     XX-Moment     YY-Moment     XY-Moment     Sx.Axial     Sy.Axial   Shear.XY
  3     -0.9138E-11  -0.3593E-12   -5.000
  4     -0.9638E-11  -0.4740E-12   -5.000
  9     -0.8701E-11  -0.5788E-11   -5.000
  8     -0.1136E-10  -0.2785E-11   -5.000
  0     -0.9962E-11  -0.2097E-11   -5.000

                              (GLOBAL X-Y EQUILIBRIUM NODAL FORCES)
JOINT     PZ(NODAL)     M.OX(NODAL)  M.OY(NODAL)  PX.NODE      PY.NODE
  3        10.00       -0.3402E-12  -0.2839E-10
  4       -10.00       -0.2100E-11   0.2773E-10
  9        10.00        0.1527E-10   0.2903E-10
  8       -10.00        0.9415E-11  -0.3381E-10


 RECT.  =  4,(  1),    LOAD VECTOR=  1     (Stresses for UDL= 0.0          )
```

```
JOINT     XX-Moment    YY-Moment    XY-Moment     Sx.Axial      Sy.Axial   Shear.XY
  4      -0.9355E-11  -0.5618E-12   -5.000
  5       0.7478E-12  -0.2410E-11   -5.000
 10      -0.1449E-11  -0.9381E-11   -5.000
  9      -0.8842E-11  -0.5856E-11   -5.000
  0      -0.5338E-11  -0.4311E-11   -5.000

                           (GLOBAL X-Y EQUILIBRIUM NODAL FORCES)
JOINT     PZ(NODAL)      M.OX(NODAL)  M.OY(NODAL)  PX.NODE       PY.NODE
  4        10.00        -0.3715E-11  -0.2717E-10
  5       -10.00        -0.5031E-11  -0.1066E-11
 10        10.00         0.2407E-10   0.6430E-11
  9       -10.00         0.2086E-10  -0.3008E-10


 RECT.  =  5,(  1),     LOAD VECTOR=  1      (Stresses for UDL= 0.0         )
JOINT     XX-Moment    YY-Moment    XY-Moment     Sx.Axial      Sy.Axial   Shear.XY
  9      -0.6058E-11  -0.3507E-11   -5.000
 10      -0.4728E-11  -0.1159E-10   -5.000
 25       0.1725E-10  -0.9391E-11   -5.000
 22      -0.2795E-10  -0.8909E-11   -5.000
  0      -0.5549E-11  -0.7933E-11   -5.000

                           (GLOBAL X-Y EQUILIBRIUM NODAL FORCES)
JOINT     PZ(NODAL)      M.OX(NODAL)  M.OY(NODAL)  PX.NODE       PY.NODE
  9        10.00        -0.2005E-10  -0.3641E-10
 10       -10.00        -0.2466E-10  -0.3357E-11
 25        10.00         0.2320E-10  -0.3242E-10
 22       -10.00         0.3013E-10  -0.6616E-10


 RECT.  =  6,(  2),     LOAD VECTOR=  1      (Stresses for UDL= 0.0         )
JOINT     XX-Moment    YY-Moment    XY-Moment     Sx.Axial      Sy.Axial   Shear.XY
 16      -0.1042E-11  -0.4433E-11   -5.000
 18      -0.2474E-11  -0.4065E-11   -5.000
 12      -0.1084E-10   0.2478E-11   -5.000
 11       0.5759E-12  -0.1392E-11   -5.000
  0      -0.3465E-11  -0.1797E-11   -5.000

                           (GLOBAL X-Y EQUILIBRIUM NODAL FORCES)
JOINT     PZ(NODAL)      M.OX(NODAL)  M.OY(NODAL)  PX.NODE       PY.NODE
 16        10.00        -0.8081E-11  -0.1366E-11
 18       -10.00        -0.8889E-11   0.1488E-10
 12        10.00        -0.2241E-11   0.2513E-10
 11       -10.00        -0.6582E-14   0.1670E-13


*** PLATES ***
          (TENSOR Sign Convention for STRESSES)
          (Tension top fibres ---> + )
          (MOMENTS= Force*Dist/ Dist;      AXIAL & SHEAR= Force/ Area)
          (The Fixed-End Forces have been added to the Nodal Force Output.


TRIANGLE =  1,(  1),     LOAD VECTOR=  1      (Stresses for UDL= 0.0         )
JOINT     XX-Moment    YY-Moment    XY-Moment     Sx.Axial      Sy.Axial   Shear.XY
  8      -0.1538E-10  -0.6900E-11   -5.000
```

```
  9     -0.1074E-10 -0.4875E-11  -5.000
 22     -0.7880E-11  0.1443E-11  -5.000
  0     -0.9486E-11 -0.4473E-11  -5.000

                           (GLOBAL X-Y EQUILIBRIUM NODAL FORCES)
JOINT    PZ(NODAL)      M.OX(NODAL)  M.OY(NODAL)  PX.NODE      PY.NODE
  8       5.000         -15.00        15.00
  9      -10.00        -0.1686E-10   0.2566E-10
 22       5.000         -15.00        15.00


TRIANGLE =   2,(  2),     LOAD VECTOR=  1     (Stresses for UDL= 0.0         )
JOINT      XX-Moment     YY-Moment    XY-Moment    Sx.Axial     Sy.Axial   Shear.XY
 13     -0.4174E-10 -0.1586E-10  -5.000
 21     -0.2366E-10 -0.7202E-10  -5.000
 23     -0.3901E-10 -0.1654E-10  -5.000
  0     -0.5113E-10 -0.1369E-10  -5.000

                           (GLOBAL X-Y EQUILIBRIUM NODAL FORCES)
JOINT    PZ(NODAL)      M.OX(NODAL)  M.OY(NODAL)  PX.NODE      PY.NODE
 13      -3.000          11.00        7.000
 21       6.000         -12.00       -12.00
 23      -3.000          7.000        11.00


TRIANGLE =   3,(  3),     LOAD VECTOR=  1     (Stresses for UDL= 0.0         )
JOINT      XX-Moment     YY-Moment    XY-Moment    Sx.Axial     Sy.Axial   Shear.XY
 13     -0.5804E-10 -0.1271E-10  -5.000
 23     -0.2208E-10  0.2344E-10  -5.000
 14     -0.1778E-10 -0.6302E-11  -5.000
  0     -0.2994E-10 -0.7093E-11  -5.000

                           (GLOBAL X-Y EQUILIBRIUM NODAL FORCES)
JOINT    PZ(NODAL)      M.OX(NODAL)  M.OY(NODAL)  PX.NODE      PY.NODE
 13      -5.000         -15.00       -15.00
 23      -5.000         -15.00       -15.00
 14       10.00         0.2146E-11   0.3138E-10

*** PLATES ***
         (TENSOR Sign Convention for STRESSES)
         (Tension top fibres ---> + )
         (MOMENTS= Force*Dist/ Dist;      AXIAL & SHEAR= Force/ Area)
         (The Fixed-End Forces have been added to the Nodal Force Output.


QUADRIL. =   1,(  1),     LOAD VECTOR=  1     (Stresses for UDL= 0.0         )
JOINT      XX-Moment     YY-Moment    XY-Moment    Sx.Axial     Sy.Axial   Shear.XY
  6     -0.5069E-12 -0.4689E-11  -5.000
  7     -0.6218E-11 -0.1883E-11  -5.000
 19     -0.1025E-10 -0.3510E-11  -5.000
 17     -0.1365E-11 -0.5772E-11  -5.000
  0     -0.3550E-11 -0.4345E-11  -5.000

                           (GLOBAL X-Y EQUILIBRIUM NODAL FORCES)
JOINT    PZ(NODAL)      M.OX(NODAL)  M.OY(NODAL)  PX.NODE      PY.NODE
  6       10.00        -0.1177E-10   0.1681E-12
```

7	-9.412	2.353	-9.412
19	8.824	-7.059	-7.059
17	-9.412	-9.412	2.353

QUADRIL. = 2,(2), LOAD VECTOR= 1 (Stresses for UDL= 0.0)

JOINT	XX-Moment	YY-Moment	XY-Moment	Sx.Axial	Sy.Axial	Shear.XY
17	-0.8131E-12	-0.5017E-11	-5.000			
19	-0.1219E-10	-0.3314E-11	-5.000			
18	-0.6349E-11	-0.3328E-11	-5.000			
16	0.2063E-11	-0.4348E-11	-5.000			
0	-0.4547E-11	-0.4576E-11	-5.000			

(GLOBAL X-Y EQUILIBRIUM NODAL FORCES)

JOINT	PZ(NODAL)	M.OX(NODAL)	M.OY(NODAL)	PX.NODE	PY.NODE
17	9.412	9.412	-2.353		
19	-4.412	19.41	7.647		
18	5.000	10.00	10.00		
16	-10.00	0.8221E-11	0.1425E-11		

QUADRIL. = 3,(3), LOAD VECTOR= 1 (Stresses for UDL= 0.0)

JOINT	XX-Moment	YY-Moment	XY-Moment	Sx.Axial	Sy.Axial	Shear.XY
18	-0.1124E-10	-0.5733E-11	-5.000			
19	-0.8048E-11	-0.3089E-11	-5.000			
20	-0.1264E-10	-0.1056E-10	-5.000			
21	-0.1454E-10	0.1036E-10	-5.000			
0	-0.1181E-10	-0.1864E-11	-5.000			

(GLOBAL X-Y EQUILIBRIUM NODAL FORCES)

JOINT	PZ(NODAL)	M.OX(NODAL)	M.OY(NODAL)	PX.NODE	PY.NODE
18	-4.615	-19.62	-8.077		
19	3.000	-18.00	-14.00		
20	-7.412	-5.647	-13.41		
21	9.027	-7.262	-7.489		

QUADRIL. = 4,(4), LOAD VECTOR= 1 (Stresses for UDL= 0.0)

JOINT	XX-Moment	YY-Moment	XY-Moment	Sx.Axial	Sy.Axial	Shear.XY
20	-0.2742E-10	-0.1134E-10	-5.000			
22	-0.3336E-11	-0.6814E-13	-5.000			
23	-0.7472E-10	-0.2411E-10	-5.000			
21	-0.2499E-10	0.6321E-11	-5.000			
0	-0.2762E-10	-0.7542E-11	-5.000			

(GLOBAL X-Y EQUILIBRIUM NODAL FORCES)

JOINT	PZ(NODAL)	M.OX(NODAL)	M.OY(NODAL)	PX.NODE	PY.NODE
20	9.412	-2.353	9.412		
22	-10.00	-0.1964E-10	0.5001E-10		
23	8.000	8.000	4.000		
21	-7.412	5.647	13.41		

QUADRIL. = 5,(5), LOAD VECTOR= 1 (Stresses for UDL= 0.0)

JOINT	XX-Moment	YY-Moment	XY-Moment	Sx.Axial	Sy.Axial	Shear.XY
18	-0.1129E-10	-0.9153E-11	-5.000			

21	-0.1185E-10	0.1848E-11	-5.000
13	-0.3192E-10	-0.1889E-10	-5.000
12	-0.5927E-12	0.3814E-11	-5.000
0	-0.1722E-10	-0.3360E-11	-5.000

(GLOBAL X-Y EQUILIBRIUM NODAL FORCES)

JOINT	PZ(NODAL)	M.OX(NODAL)	M.OY(NODAL)	PX.NODE	PY.NODE
18	9.615	9.615	-1.923		
21	-7.615	13.62	6.077		
13	8.000	4.000	8.000		
12	-10.00	0.2285E-11	-0.2499E-10		

*** PLATES ***
(TENSOR Sign Convention for STRESSES)
(Tension top fibres ---> +)
(MOMENTS= Force*Dist/ Dist;   AXIAL & SHEAR= Force/ Area)
(The Fixed-End Forces have been added to the Nodal Force Output.

TRANSI. = 1,(1),   LOAD VECTOR= 1   (Stresses for UDL= 0.0   )

JOINT	XX-Moment	YY-Moment	XY-Moment	Sx.Axial	Sy.Axial	Shear.XY
22	0.3510E-11	-0.4270E-11	-5.000			
25	-0.1336E-10	-0.7424E-11	-5.000			
24	-0.4705E-12	0.2759E-11	-5.000			
15	0.1309E-11	0.2368E-11	-5.000			
14	-0.1232E-10	-0.3204E-11	-5.000			
23	0.4598E-11	0.4047E-11	-5.000			
0	0.2650E-12	0.3419E-11	-5.000			

(GLOBAL X-Y EQUILIBRIUM NODAL FORCES)

JOINT	PZ(NODAL)	M.OX(NODAL)	M.OY(NODAL)	PX.NODE	PY.NODE
22	10.00	-0.1082E-10	0.4221E-11		
25	-10.00	-0.2080E-10	0.3216E-10		
24	0.8882E-12	0.2696E-12	-0.2231E-11		
15	10.00	-0.4263E-12	-0.6359E-12		
14	-10.00	-0.1869E-11	-0.3132E-10		
23	0.1441E-10	0.4021E-12	0.1855E-10		

*** PLATES ***
(TENSOR Sign Convention for STRESSES)
(Tension top fibres ---> +)
(MOMENTS= Force*Dist/ Dist;   AXIAL & SHEAR= Force/ Area)
(The Fixed-End Forces have been added to the Nodal Force Output.

POLYGON = 1,(1),   LOAD VECTOR= 1   (Stresses for UDL= 0.0   )

JOINT	XX-Moment	YY-Moment	XY-Moment	Sx.Axial	Sy.Axial	Shear.XY
7	-0.3636E-11	-0.4528E-11	-5.000			
8	-0.1023E-10	-0.4158E-11	-5.000			
22	-0.5941E-11	-0.3120E-12	-5.000			
20	-0.1225E-10	-0.3781E-11	-5.000			
19	-0.1072E-10	-0.6671E-11	-5.000			
0	-0.1154E-10	-0.2485E-11	-5.000			

(GLOBAL X-Y EQUILIBRIUM NODAL FORCES)

JOINT	PZ(NODAL)	M.OX(NODAL)	M.OY(NODAL)	PX.NODE	PY.NODE

7	9.412	-2.353	9.412
8	-5.000	15.00	-15.00
22	5.000	15.00	-15.00
20	-2.000	8.000	4.000
19	-7.412	5.647	13.41

*** PLATES *** ;
(ENGINEER,s Sign Convention for STRESSES)
(Tension top fibres ---> Negative)
(MOMENTS=Force*Dist/Dist ; AXIAL&SHEAR=Force/Dist)

*** LOAD VECTOR NUMBER *** 1 ;L O A D S
(Uniform Load = 0.0)

AVERAGED FLEXURAL STRESSES (Tension top fibres ---> Negative)

JOINT(ENTR.)	COORDINATES	M.SIGX	M.SIGY	M.SIGXY	M.SIG1	M.SIG2
1 (1)	(0.0 , 0.0)	0.5476E-12	0.6506E-12	5.000	-5.000	5.000
2 (2)	(6.00, 0.0)	0.6312E-11	-0.4338E-12	5.000	-5.000	5.000
3 (2)	(12.00, 0.0)	0.9570E-11	0.7732E-12	5.000	-5.000	5.000
4 (2)	(18.00, 0.0)	0.9496E-11	0.5179E-12	5.000	-5.000	5.000
5 (1)	(24.00, 0.0)	-0.7478E-12	0.2410E-11	5.000	-5.000	5.000
6 (2)	(0.0 , 6.00)	0.5214E-13	0.5219E-11	5.000	-5.000	5.000
7 (4)	(6.00, 6.00)	0.5899E-11	0.3619E-11	5.000	-5.000	5.000
8 (4)	(12.00, 6.00)	0.1117E-10	0.3561E-11	5.000	-5.000	5.000
9 (4)	(18.00, 6.00)	0.8585E-11	0.5007E-11	5.000	-5.000	5.000
10 (2)	(24.00, 6.00)	0.3089E-11	0.1049E-10	5.000	-5.000	5.000
11 (1)	(0.0 , 24.00)	-0.5759E-12	0.1392E-11	5.000	-5.000	5.000
12 (2)	(4.00, 24.00)	0.5716E-11	-0.3146E-11	5.000	-5.000	5.000
13 (3)	(12.00, 24.00)	0.4390E-10	0.1582E-10	5.000	-5.000	5.000
14 (2)	(18.00, 24.00)	0.1505E-10	0.4753E-11	5.000	-5.000	5.000
15 (1)	(24.00, 24.00)	-0.1309E-11	-0.2368E-11	5.000	-5.000	5.000
16 (2)	(0.0 , 18.00)	-0.5103E-12	0.4390E-11	5.000	-5.000	5.000
17 (2)	(0.0 , 12.00)	0.1089E-11	0.5395E-11	5.000	-5.000	5.000
18 (4)	(4.00, 18.00)	0.7840E-11	0.5570E-11	5.000	-5.000	5.000
19 (4)	(8.00, 14.00)	0.1030E-10	0.4146E-11	5.000	-5.000	5.000
20 (3)	(12.00, 12.00)	0.1744E-10	0.8562E-11	5.000	-5.000	5.000
21 (4)	(14.00, 20.00)	0.1876E-10	0.1337E-10	5.000	-5.000	5.000
22 (5)	(18.00, 12.00)	0.8318E-11	0.2423E-11	5.000	-5.000	5.000
23 (4)	(18.00, 18.00)	0.3280E-10	0.3291E-11	5.000	-5.000	5.000
24 (1)	(24.00, 16.00)	0.4705E-12	-0.2759E-11	5.000	-5.000	5.000
25 (2)	(24.00, 12.00)	-0.1943E-11	0.8407E-11	5.000	-5.000	5.000
	MAXIMUM VALUES =	0.1943E-11	0.3146E-11	-5.000		
	MINIMUM VALUES =	-0.4390E-10	-0.1582E-10	-5.000		

Chapter 6

GRAPHICAL DISPLAYS

6.1 Introduction

A large amount of numerical data may be generated from a finite element analysis of a real structure. To manually check this data may require a prohibitive number of man hours. Therefore, it is almost mandatory that visual displays and graphical plots become an integral part of the analysis package. The present version of *HYBSLAB* generates and stores plotting data in 3 separate files. The programs used to plot this data are very much dependent on the computer installation being used. The discussion of programs which follows pertains to the Calcomp plotter and related facilities at the University of Alberta.

Data from the first file (file(1)) is used to check much of the input data. A program called GRIDRAW is used to produce Calcomp plots of the finite element structure; this is a check on connectivity data, coordinates and element group data.

The second file (file(2)) contains the *W* displacements for the entire structure. A program called W.PLOT is used to draw the displacement contours. This program uses the SURFACE2 plotting package.

The third file (file(3)) contains averaged values of *M*x, *M*y, *M*xy, and their principal values. Moment contours for any one of these stresses can be plotted using the program M.PLOT . This program, like W.PLOT, uses the SURFACE2 plotting subroutines. Sample plots of *Mx* and *My* are provided on the next two pages.

Copies of the above programs are contained in the 'Plotter Supplement to *HYBSLAB*' which is available from the Civil Engineering Department at the University of Alberta.

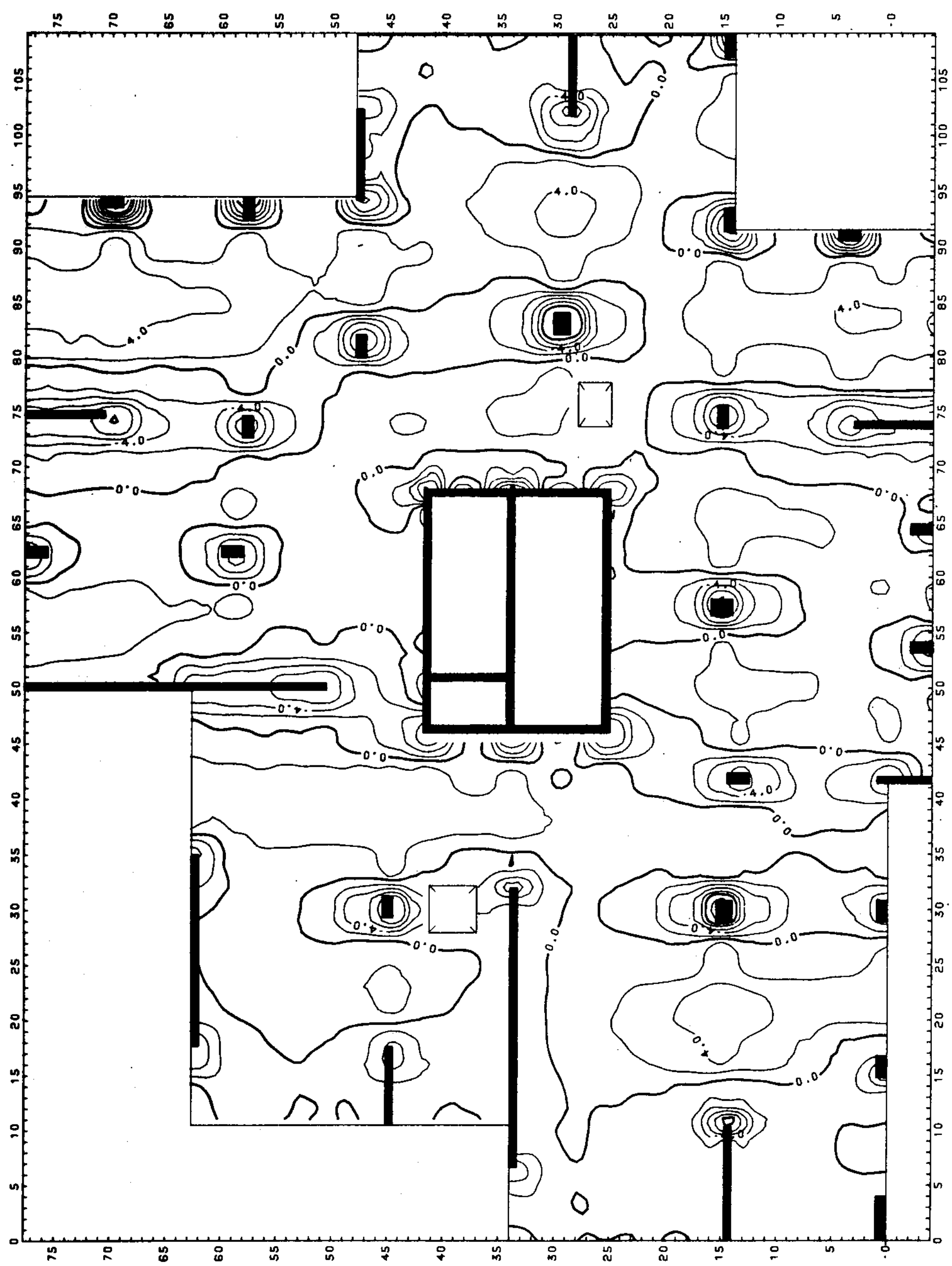


Figure 6.1 *Mx* Moment Contours for Floor 1.

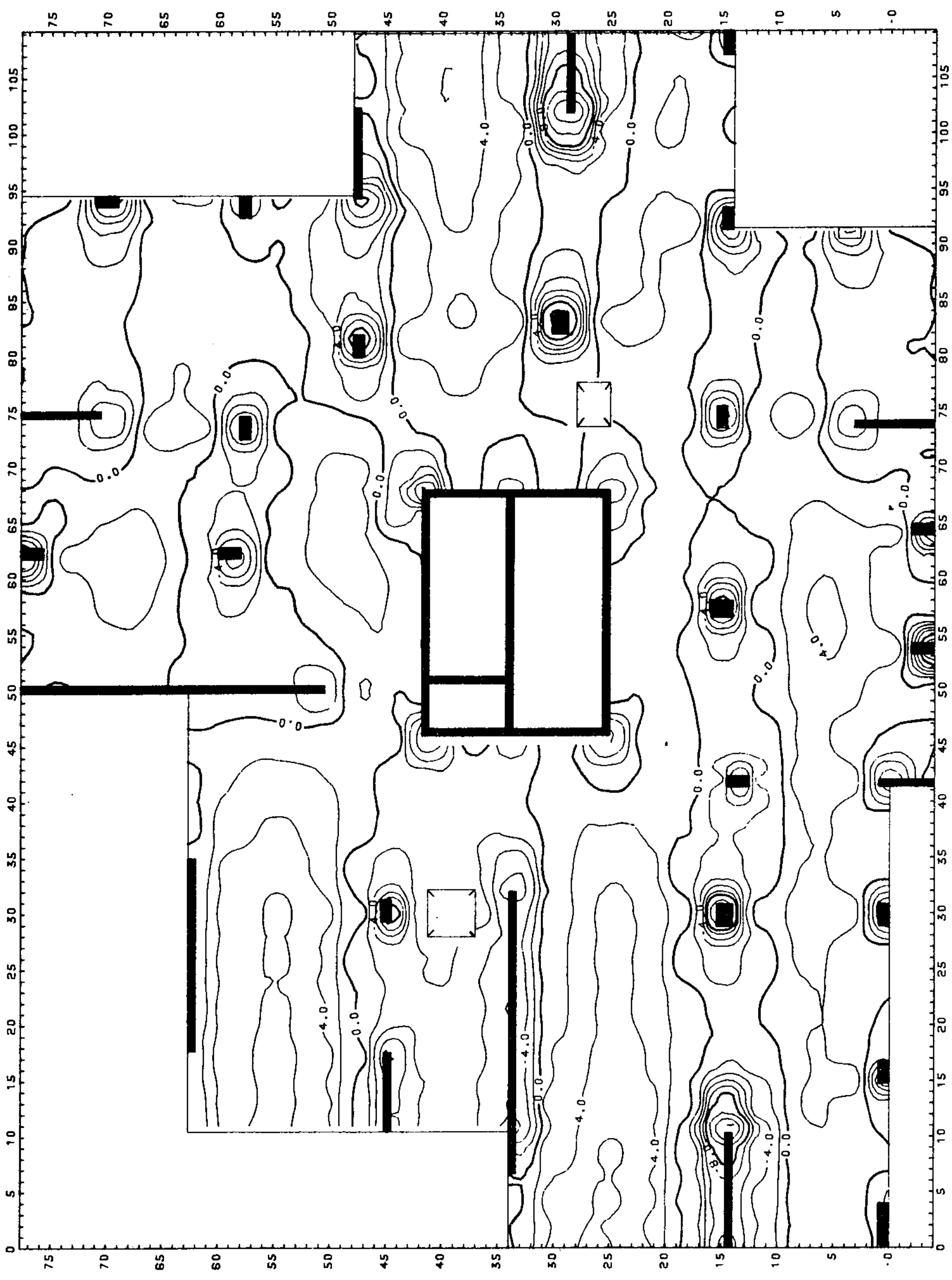


Figure 6.2 *My* Moment Contours for Floor 1.

Chapter 7

SUMMARY of *READ* STATEMENTS

```
C     P H A S E  I - READ-IN OF ALL DATA

      READ(5,1)   HEAD
      READ(5,1)   UNITS

      READ(5,2) NRECTS,NBEAMS,NTRIAS,NQUADS,NLSHAP,
                NTRANI,NPOLYS,NEXTRA,NRCOLS,NSPRIG,NDIPRE

      READ(5,2) NRTYPE,NBTYPE,NTTYPE,NQTYPE,NLTYPE,
                NATYPE,NPTYPE,NXTYPE

      READ(5,2) NJNTS,NMAST,NVECT,MPRINT,ISTOP,IPLOT

C     READ; Suppressed d.o.f. (zero disp.)
      READ(5,1) HEAD
      READ(5,2) J1,J2,JLAST,(LDOF(K),K=1,5)

C     READ; Master & Slave Node d.o.f.
      READ(5,1) HEAD
      READ(5,2) JMAST,J1,J2,JLAST,(LDOF(K),K=1,5)

C     Go to READ 4-Node Elements in 'CONECT'
C      (back to READ from 'MAIN')

C     READ-in for Rectangles.
      READ(5,1) HEAD
      READ(5,2) NEL,MTYPE,(JTEMP(K),K=1,4)
C     READ-in Group Data for Rectangles
      READ(5,1) HEAD
      READ(5,2) EX1,EY1,POISX,GXY,THICK,ECC2
      READ(5,2) IGROUP,INPLAN,IPROP, XDIM,YDIM
      READ(5,2) EX1,EY1,POISX,GXY,THICK,ECC2

C     READ-in for Beams.
      READ(5,1)   HEAD
      READ(5,2) M1,M2,MLAST,ITYPE,JOINTI,JOINTJ,JIINC,JJINC
C     READ <Emod,Pois, A,Ix,Iy,Cv, e1,e2 >
      READ(5,1) HEAD
      READ(5,2)  IGROUP,(RTEMP(K),K=1,8)

C     READ-in for Triangles in 'MAIN'.
      READ(5,1) HEAD
      READ(5,2) NEL,MTYPE,(JTEMP(K),K=1,3)
C      go to READ from 'GRDATA' (Triangles)

C     READ-in for Quadrilaterals in 'MAIN'.
      READ(5,1) HEAD
      READ(5,2) NEL,MTYPE,(JTEMP(K),K=1,4)
```

```
C       (go to READ from GRDATA for  Quads.)

C      READ-in for L-Shapes in 'MAIN'.
       READ(5,1) HEAD
       READ(5,2) NEL,MTYPE,(JTEMP(K),K=1,6)
C      READ-in Group Data for L-Shapes
       READ(5,1) HEAD
       READ(5,2) EX1,EY1,POISX,GXY,THICK,ECC2
       READ(5,2) IGROUP,INPLAN,IPROP, (XNODES(K),K=1,6)
       READ(5,2)                      (YNODES(K),K=1,6)
       READ(5,2) EX1,EY1,POISX,GXY,THICK,ECC2

C      READ-in for Transition Rectangles in 'MAIN'.
       READ(5,1) HEAD
       READ(5,2) NEL,MTYPE,NNODES,(JTEMP(K),K=1,NNODES)
C      READ in Group Data for Transition Rectangles
       READ(5,1) HEAD
       READ(5,2) EX1,EY1,POISX,GXY,THICK,ECC2
       READ(5,2) IGROUP,INPLAN,IPROP, XDIM,YDIM
       READ(5,2) (XNODES(K),K=1,NNODES)
       READ(5,2) (YNODES(K),K=1,NNODES)
       READ(5,2) EX1,EY1,POISX,GXY,THICK,ECC2

C      READ-in for Polygons in 'MAIN'.
       READ(5,1) HEAD
       READ(5,2) NEL,MTYPE,NNODES,(JTEMP(K),K=1,NNODES)
C       (go to READ from GRDATA for  Polygons)

C      READ-in for External(Singularity,...) in 'MAIN'.
       READ(5,1) HEAD
       READ(5,2) NEL,MTYPE,NNODES,(JTEMP(K),K=1,NNODES)

C      READ; User Specified Coordinates .
       READ(5,1) HEAD
       READ(5,2) JNT,XORD(JNT),YORD(JNT)
       READ(5,2) J1,J2,JLAST, X,Y,XINC,YINC

C      Column Head data is READ in 'COLCAP'

C      Spring data is READ in 'SPRING'

C      Prescribed Displacement data is READ in 'DISPRE'

C      READ; Manually Specified Loads by User
       READ(5,1) (VHEAD(I,NV),I=1,15)
       READ(5,2) UDL
       READ(5,2) J1,J2,JLAST,(TLOAD(K),K=1,5)

C      READ; Element Stress Printout Selection
       READ(5,1) HEAD
       READ(5,2) M1,M2,LAST


C  READ-ins for *** SUBROUTINE XSTIFFS ***
```

```
C      (READ-in Stiffness and Load from Unit(11) )
      READ(11,99) NNODES,MSIZE
      READ(11)  (EKXTRA(I,J),J=1,MSIZE)
      READ(11)  (ELOAD(K),K=1,MSIZE)


C  READ-ins for  *** SUBROUTINE COLCAP ***
      READ(5,1) HEAD
      READ(5,1) HEAD
      READ(5,2) NCOLJN
      READ(5,2) (JNTCOL(K,NR),K=2,NJP1)
      READ(5,2) AXSTIF,OXSTIF,OYSTIF,XCENTR(NR),YCENTR(NR)


C  READ-ins for  *** SUBROUTINE SPRING ***
      READ(5,1) HEAD
      READ(5,2)  NGRUPS
      READ(5,2) IGROUP,NJNTS
      READ(5,2) (JOINTS(K,NG),K=2,NJP1)
      READ(5,2) (SPRSTF(K,NG),K=1,5)
      READ(5,2) (PFACT(K,NG),K=1,5)


C  READ-ins for  *** SUBROUTINE DISPRE ***
      READ(5,1) HEAD
      READ(5,2) JOINT,JDOF,(RTEMP(K),K=1,NVECT)


C  READ-ins for  *** SUBROUTINE CONNECTIVITY DATA ***
      READ(5,1)   HEAD
      READ(5,3) ICODE,NBLOCK,NX,MY
      READ(5,1)   HEAD
      READ(5,3) ICODE,JSTART,IROW,JCOL,JINCY,JYTOP
      READ(5,2) (JTEMP(K),K=1,JLAST)
      READ(5,1)   HEAD
      READ(5,3) ICODE,MSTART,IROW,JCOL,MINCY,MYTOP
      READ(5,2) (MTEMP(K),K=1,MLAST)

      READ(5,1)   HEAD
      READ(5,3) ICODE,NEL,(JTEMP(K),K=1,4)

      READ(5,1)  HEAD
      READ(5,3) ICODE,IGROUP,(MTEMP(K),K=1,50)

      READ(5,1) HEAD
      READ(5,2) (MTEMP(K),K=1,NQUADS)


C  READ-ins for  *** SUBROUTINE GROUPDATA ***
      READ(5,1) HEAD
      READ(5,2) EX1,EY1,POISX,GXY,THICK,ECC2
      READ(5,2) IGROUP,INPLAN,IPROP,(XNODES(K),K=1,NNODES)
      READ(5,2)                     (YNODES(K),K=1,NNODES)
      READ(5,2) EX1,EY1,POISX,GXY,THICK,ECC2
```

Chapter 8

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