GRAFAX is an interactive graphics system developed by A.O. SMITH Corporation. It is a proprietary computer program designed for use with MSC/NASTRAN. Pre and post-processing of FEM (Finite Element Model) data can be done at any location through the use of a graphics or RJE terminal connected to a time sharing system. GRAFAX is also available to run on some mini-computers.

GRAFAX is a user oriented system designed to create,verify, and update FEM data and study the FEA output. It can produce a new model file or restart an existing model file with input and/or output data. There are eight main functions of GRAFAX. These and their roles are as follows, in alphabetical order:

DIGIT - Creates FEM data by digitizing the geometry of a model from scaled drawings on a graphics tablet.

EDIT - Generates new FEM data. Modifies and/or adds FEM data.

GRAPH - Produces line graphs of displacements,constraint forces, element forces, element stresses, and applied loads generated by the FEA.

PRINT - Produces listings of displacements, constraint forces, element forces, element stresses, and applied loads generated by the FEA.

REPORT - Produces one page summary reports of maximum/minimum displacements, constraint forces,element forces, element stresses, and applied loads generated by the FEA.

RUN - Creates, updates, and submits a FEA batch run deck.

SECTION - Calculates beam cross section properties and adds FEM property cards to the file. After the FEA SECTION can calculate local collapse coefficients, or beam stresses at other than originally specified recovery points.

VIEW - Draws pictures of the undeformed and/or deformed FEM. Produces CALCOMP plots.

When GRAFAX is executed at a graphics terminal the GRAFAX major functions menu will be displayed when the system is ready for a function to be entered. This major functions menu is shown in Figure 1.

```
          AOS GRAFAX MAJOR FUNCTIONS MENU

PRE-PROCESSOR FUNCTIONS
     DIGIT  ---- DIGITIZE DATA FROM DRAWING
     EDIT   ---- EDIT OR GENERATE DATA
     SECTION---- CALCULATE BEAM PROPERTIES
     VIEW   ---- VIEW UNDEFORMED MODEL

POST-PROCESSOR FUNCTIONS
     SECTION---- CALCULATE BEAM COLLAPSE COEFFICIENT
     GRAPH  ---- GRAPH FEA
     PRINT  ---- DISPLAY FEA
     REPORT ---- SUMMARIZE FEA
     VIEW   ---- VIEW DEFORMED MODEL

SPECIAL FUNCTIONS
     END    ---- END SESSION
     HELP   ---- DISPLAY MAJOR FUNCTIONS MENU
     RUN    ---- CREATE, EDIT & SUBMIT A BATCH RUN DECK
```

Figure 1. GRAFAX Major Functions Menu.

This major functions menu shows each of the main functions and gives a brief description. It also shows which ones are used for pre and post-processing. There are also three special functions.

The special functions are normally used at any time before or after a FEA run has been made. The END function is used to end a GRAFAX work session. The HELP function is used to create a display of the major functions menu on the screen. The RUN function is used to prepare and submit a batch FEA run deck. It might also be used to modify an existing batch run deck and resubmit it.

The pre-processing functions are used before a FEA run is made. DIGIT is used to generate grid point and element connection data for a model by digitizing the geometry and connectivities from a drawing. The EDIT function is used to modify data generated using the DIGIT function, modify data that was already in the file, and add new data by entering the data via the terminal keyboard. The EDIT function also has data generating capabilities. The SECTION function is

used to calculate structural properties of thin-walled beam cross-sections and automatically fill out and add the FEM property data to the file. Data for this can be either digitized and/or entered via the terminal keyboard. The VIEW function is used to verify the geometry, element connections, and element properties of the model. Errors are often very obvious and once spotted, can be corrected by using the EDIT function. The VIEW function should always be used to verify the geometry of a model before a FEA run is made.

The post-processing functions are used after a FEA run is made. They should be used to study and evaluate the significance of a run, and eliminate the need for a standard printout.

The GRAPH function is used to prepare line graphs of the output that show range and magnitude of a parameter on the output for each grid point or element connection. From these line graphs the ranges and magnitudes can be seen at once and this can be used to determine the significance of the run and then to find critical areas of the model. The PRINT function is used to selectively generate the printout. The REPORT function is used to summarize the results of a type of output. It gives the magnitude of the minimum/maximum of each parameter in the output and the user grid point or element IDs at which they occurred. This can be used with the GRAPH function to pinpoint critical areas. The VIEW function is used to draw deformed or modal pictures of a model. This is very useful in understanding the behavior and significance of a model. The SECTION function is used to calculate local collapse coefficients and stress recovery data for thin-walled beam cross sections that have been created using this function.

A function is called by typing the function name at a terminal keyboard and pressing the RETURN key. Then, any one of the function's commands can be executed by typing in the command and again pressing the RETURN key. The RETURN key forwards the information to the computer and so should always be pressed after typing anything at the keyboard. A command that requires an end signal can be ended by pressing the RETURN key, thus entering a blank line. To end a digitizing command a R must be entered before pressing the return key. This also ends a function. After a command or function has ended,a prompt to enter a new command or function will always appear on the screen.

Figure 2 illustrates the process of using GRAFAX to generate a model,submit model to a FEA program, and examine the FEA output. The model can then be modified and rerun as needed.

GRAFAX INPUT FILES

The GRAFAX system uses the FEA input and output files. Each file has a unique name assigned by the user. When a GRAFAX work session begins, the system will prompt for a filename (if none was entered). The user must then enter a new or existing filename. The GRAFAX system then searches the user work library for files with the specified name and prints one of following four messages:

1. AN INPUT FILE CALLED XXXXXX IS BEING CREATED.

   This message is printed when the entered filename was not found in the user work library. The filename will be created on the user work library with a data format, and used to store GRAFAX output for later use.

2. AN INPUT FILE CALLED XXXXXX IS BEING RESTARTED.

   This message appears when the entered filename is found in the user work library with an output format. The data in this file is read into the GRAFAX system. The filename will also be used to create a data format file under that name on the user work library to store GRAFAX output for later use.

3. AN OUTPUT FILE CALLED XXXXXX IS BEING RESTARTED.

   This message appears when the entered filename is found in the user work library with an output format. The data in this file is read into the GRAFAX system. The filename will also be used to create a data format file under that name on the user work library to store GRAFAX output for later use.

4. INPUT AND OUTPUT FILES CALLED XXXXXX ARE BEING RESTARTED.

   This message is printed when the entered filename is found in the user work library with both data and output formats. The data in both files is read into the GRAFAX system. If FEM data exists on both files, the data from the output file is used. The data format file will then be reused to store GRAFAX output for later use.

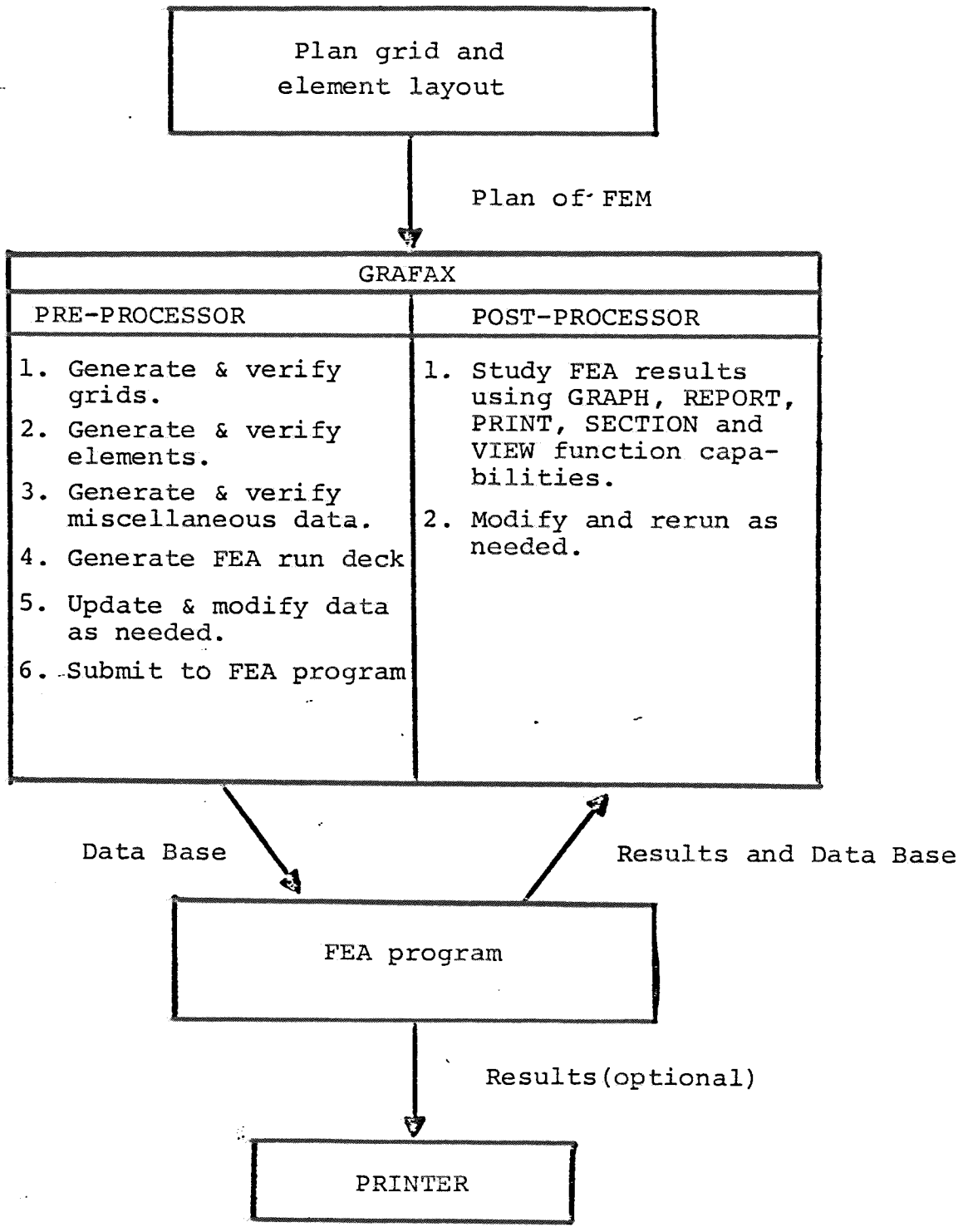


Figure 2. Using the GRAFAX system for Finite Element Modeling.

The XXXXXX in the above messages represents the entered filename.

A GRAFAX input file may contain the complete, or part of a FEA run deck. This file always has a data format. Figure 3. shows the card image order of a typical run deck stored in the input file.

```
JOB CONTROL LANGUAGE CARD IMAGES
:
:
FEA CONTROL CARD IMAGES
:
:
FEM DATA CARD IMAGES
:
:
JOB CONTROL LANGUAGE CARD IMAGES
:
:
```

Figure 3. Order of Typical FEA Run Deck.

It is not necessary to have the Job Control and FEA control cards in the input file. But, when they are present, the following rules must be adhered to:

1. The first card must be a job card.

2. The following cards must be arranged as they would be given to the FEA program.

A GRAFAX post-processor input file may contain FEA output of FEM data, displacements, applied loads, constraint forces, element forces, and element stresses. This file always has an output format and is created during the FEA run if requested. TABLE 1 lists the GRAFAX identification number that is assigned to each type of FEA output. These identification numbers will appear in user messages if the type of FEA output requested is not in the user output file.

When each GRAFAX session ends, any FEM data and run deck cards are stored in a data format file of the filename given at the beginning of the session. This data file should be moved to the user's permanent library.

TABLE 1. GRAFAX IDENTIFICATION NUMBERS FOR FEA OUTPUT.

TYPE	DESCRIPTION
0	GRAFAX GENERAL PURPOSE PLOT DATA
1	GRID DISPLACEMENT DATA
2	GRID CONSTRAINT FORCE DATA
3	GRID APPLIED LOAD DATA
4	BAR ELEMENT FORCE DATA
5	TRIA ELEMENT FORCE DATA
6	QUAD ELEMENT FORCE DATA
7	BEAM ELEMENT FORCE DATA
8	BAR ELEMENT STRESS DATA
9	TRIA ELEMENT STRESS DATA
10	QUAD ELEMENT STRESS DATA
11	BEAM ELEMENT STRESS DATA
12	TRIAX6 ELEMENT CENTER STRESS DATA
13	TRIAX6 ELEMENT GRID STRESS DATA
14	PENTA ELEMENT CENTER STRESS DATA
15	PENTA ELEMENT GRID STRESS DATA
16	HEXA ELEMENT CENTER STRESS DATA
17	HEXA ELEMENT GRID STRESS DATA

The DIGIT function is used to create data card images by digitizing on a graphics tablet the geometry of a model from a scaled drawing(s). The drawing(s) must have two parallel views with X, Y, and Z axes that correspond to one of the orientation coordinate systems shown for the DIGIT ORIENT command.

The DIGIT function is useful as a pre-processing tool. It can be used to quickly calculate grid locations and generate grid data. Beam, tria and quad element connection data can also be generated. This data is generated using the generating parameter values specified in the KEYBOARD command. For each work session the generating parameters are reset to their default values. These generating parameters can be changed as often as needed by using the KEYBOARD command. They should be changed when the user desires to have a specific value for a parameter on the next generated data. These parameters might be the grid or element ID, property ID, beam orientation vector, and input/output coordinate systems. The generating parameters are changed by entering its identifying name and the new value. The grid and element ID's that are entered will always be incremented by their respective increments before the next one is generated.

The EDIT function is used to modify, add, and generate new FEM data card images. FEM card images are divided into three classes when a GRAFAX work session begins. The three classes are element connections, grid points, and miscellaneous. The element connection class consists of all element connection data. The grid point class consists of all grid data, and the miscellaneous class consists of everything else.

The basic editing commands available in the EDIT function are add, change, delete, insert and list. These basic commands can be used for all three classes of data. The first letter of an EDIT command refers to the basic command and the second letter refers to the class of data.

Line numbers are assigned to all card images. These line numbers are used with the EDIT commands to specify which card images are to be updated. EDIT commands and line number(s) can be entered at the same time.

EDIT also has a series of commands that are used to create and modify generating card images. These generating card images are then used as input for another EDIT command that generates new data card images. One, two, and three dimensional fields of grid, element connection and miscellaneous data card images can be automatically generated. Geometric progression can also be applied to these fields. Continuation card images can be automatically generated if more than one data card image is required. A card image may have two continuation card images.

EDIT is useful as a pre-processing tool in helping to quickly make changes to FEM data card images. It is an alternative to keypunching and traditional methods of changing a library data file. Edit can be used at any time to modify data card images. It is normally used after errors have been found or new data card images are to be added. FEM geometry, element connection, and element property errors are often very obvious when using the VIEW function. They can be corrected by using the EDIT function and then the VIEW function can be used to verify corrections. DIGIT errors can also be corrected by using the EDIT function.

EDIT also has a powerful data generation capability. One, two, and three dimensional fields of grid, connection, or miscellaneous data card images can be generated with only a few input data card images. These input data card images can then be modified and used again and again. Geometric progression can be applied to groups of data. This feature will be very useful when regular or semi-regular data patterns exist.

The GRAPH function is used to produce line graphs of FEA output. Graphs of applied loads, displacements, constraint forces, element forces, and element stresses can be made for any of the FEA subcases.

The horizontal axis of each graph represents internal grid point or element connection location identification numbers. Internal identification numbers are assigned to all grid point and element connections. Each grid point and element connection is numbered starting with one and increases in increments of one for each of their occurences in the FEA output. These internal identification numbers will differ from the user assigned identification numbers if the user assigned identification numbers are not consecutive starting with one.

Internal identification numbers are used to make a one to one correspondence to the user assigned identification numbers and zoom-in on any area of a graph for more detailed results. They also can be used to examine the same output in the PRINT and REPORT functions.

Each of the GRAPH commands has an all feature. If all is entered on the prompt for subcase number then each subcase in the output file with the specified output will be automatically graphed and hard copied.

One, two or three different lines are used on the graphs. These different lines have specific meanings for each command. See the specific command for the meaning of the line(s).

After each graph is made a prompt for range to be graphed will appear. To zoom-in on the graph, enter the desired range. To end a command, enter a blank line by pressing the RETURN key.

REMARKS:

GRAPH is useful as a post-processing tool in helping quickly present an overall view of the output. The line graphs that can be generated will show the range and magnitude of parameters in the output. This step of finding the range and magnitude is very time consuming when only using the computer printout, and considering different loadings, and constraint conditions for a FEM.

With the available line graphs, ranges and magnitudes can be seen at once. This is very useful in determining the significance of the FEA or in finding critical areas. For elememt output, areas of tension, compression, and bending can be identified. This is useful in understanding the behavior of a FEM. These line graphs may be even more meaningful if the user considers the grid point and element numbering scheme at the time the model is being constructed.

The PRINT function is used to look at output generated by the FEA. Listings of applied loads, displacements, constraint forces, element forces, and element stresses can be produced for any of the FEA subcases. The listing format is similar to the FEA printout.

Internal identification numbers are assigned to all grid point and element connections. Each grid point and element connection is numbered starting with one and increases in increments of one for each of their occurences in the FEA output. These internal identification numbers will differ from the user assigned identification numbers if the user assigned identification numbers are not consecutive starting with one.

Internal identification numbers are used to make a one to one correspondence to the user assigned identification numbert. They are also used to examine the same output in GRAPH and REPORT functions.

Each of the PRINT commands has an all feature. If all is entered on the prompt for internal range to be listed then all output for the specified subcase will be listed and hard copied automatically.

After each listing is made, a prompt for range to be listed will appear. Any one or range of internal identification numbers can be entered. To end a command enter a blank line by pressing the RETURN key.

PRINT is useful as a post-processing tool. It can selectively list all or any part of the FEA output for a subcase. This can be helpful for spot checking areas of the FEA output before or after an actual FEA printout is made. Hopefully, it can eliminate the printout if PRINT is used along with the GRAPH and REPORT functions to determine the significance of the FEA run.

The REPORT function is used to produce one page summary reports of output generated by the FEA. Reports of applied loads, displacements, constraint forces, element stresses can be made for any of the FEA subcases.

Internal identification numbers are assigned to all grid points and element connections. Each grid point and element connection is numbered starting with one and increases in increments of one for each of their occurrences in the FEA output. These internal identification numbers will differ from the user assigned identification numbers of the user assigned identification numbers are not consecutive starting with one.

Internal identification numbers are used to make a one to one correspondence to the user assigned identification numbers. They are also used to examine the same output in GRAPH and PRINT functions.

Each of the REPORT commands has an all feature. If all is entered on the prompt for subcase number then each subcase in the output file with the specified output will be automatically reported and hard copied.

Each report gives the maximum and minimum of important parameters in the specified output. The user assigned element or grid IDs where these extremes occur is also given.

After each report is made, a prompt for range to be reported will appear. Any range of internal identification numbers or all can be entered. A minimum range of two is required for a report. To end a command enter a blank line by pressing the RETURN key.

REPORT is useful as a post-processing tool in helping quickly present a summary of the FEA output. The reports that can be generated will show the range and magnitude of the minimum/maximum of important parameters in the output. They also will give the user element a grid location identification numbers where these extremes occur. These summary reports can be used effectively with the GRAPH and PRINT functions to identify precisely the extreme magnitudes and user location identification numbers on graphs and listings.

The RUN function is used to create and modify a FEA batch run deck. It is also used to submit the complete file for a batch run. The batch run deck contains all card images required for the FEA program except the basic FEM data. This deck should also contain all required JCL (Job Control Language) card images. Figure 4 show the card image order of a general FEA run deck. Figure 3 shows the card image order order of a complete FEA run deck.

```
JOB CONTROL LANGUAGE CARD IMAGES
:
FEA CONTROL CARD IMAGES
:
JOB CONTROL LANGUAGE CARD IMAGES
```

Figure 4. Order of general FEA Run Deck.

It should be noted that any FEM data is automatically inserted after the FEA control card images each time the message data saved appears and when a FEA batch run is submitted. When a file is restarted all FEM data is located in the EDIT function and all JCL and FEA control card images are located in the RUN function.

The basic editing commands available in the RUN function are add, change, delete, insert and list. Line numbers are assigned to all card images. These line numbers are used with the above commands to specify which card images are to be updated. Editing commands and line number(s) can be entered at the same time.

A default FEA run deck can be automatically added by using the ADD DEFAULT DECK command. These card images can then be modified to meet the users specific needs. The card images that are generated will vary depending on the FEA program name specified at the beginning of the GRAFAX work session and on the host computer system being used.

The SUBMIT command is used to submit the complete file for a batch FEA run. Another command called BATCH is used for typical library maintenance and data transfer (to and from mini-computer work stations) jobs.

RUN is useful as a pre-processing tool in helping quickly prepare, modify, and submit a FEA batch run. It is an alternative to keypunching and traditional methods of preparing and submitting a batch run. RUN can be used at any time to modify or create a batch run deck. This function is very unique because all necessary data for a FEM can be stored in one place(a library data file), and recalled at any time to be used again.

The SECTION function is used to create beam cross section data. Then, structural properties, local collapse coefficients and stress data can then be calculated from cross section data and FEA output.

There are two methods of preparing beam cross section data. The first is by using the DIGITIZE DATA command and its subcommands. With this method, section data is entered by digitizing on a graphics tablet the geometry of a cross section from a scaled drawing. The second method is to use the terminal keyboard to input the cross section data. The ADD, CHANGE, DELETE, and LIST commands can be used to input and modify section data card images. The RETRIEVE SECTION DATA command can also be used to reuse old section data.

There are four section input data cards. These input data cards. These input data cards define the geometry and identification of a cross section. The PLOT command is used to draw and label the section data for verifying cross section geometry.

After entering and verifying the section data, the SOLVE CENTROIDAL or SOLVE PRINCIPAL commands can be used to calculate and display cross section properties, fill out the FEM property cards, and add section and FEM property data card images to the data file.

After the FEA run, the SOLVE STRESS RECOVERY and SOLVE LOCAL COLLAPSE commands can be used for calculating stress data or section collapse coefficients.

The DIGITIZE DATA command should be used when a scaled drawing of the cross section and graphics tablet are available. This method can be used to quickly prepare the necessary section data card images. The ADD command should be used if a scaled drawing and graphics tablet are not available. The user must then enter section data at the keyboard.

The FEA element stresses and forces are required to use the SOLVE STRESS RECOVERY or SOLVE LOCAL COLLAPSE commands.

The VIEW function is used to selectively display a FEM. Model Geometry can be easily evaluated using a variety of VIEW commands. Some of the VIEW capabilities are:

- grid & element data checking
- nested rectangular, cylindrical, and spherical coordinate systems
- grid sorting
- one, two, and three dimensional element commands
- rotating
- zooming
- plotting by element types
- plotting by element property types
- plotting grids
- labeling current plot set
- labeling grids and elements
- adding element types to picture
- adding element property types to picture
- adding grids to picutre
- adding grid and element labels to picture
- specifying character size
- showing individual grids or elements
- shrinking or expanding elements
- specifying maximum deformation
- overlaying undeformed and deformed pictures
- plotting by x, y, and z locations
- large or small color paper plots
- sorting of plot data
- specifying line size and pattern
- specifying different colors for paper plots

Many of the VIEW commands are turned on and off by entering the command and a y or n (y for yes, n for no). When the command to draw the picture is given, only the commands that are turned on are executed.

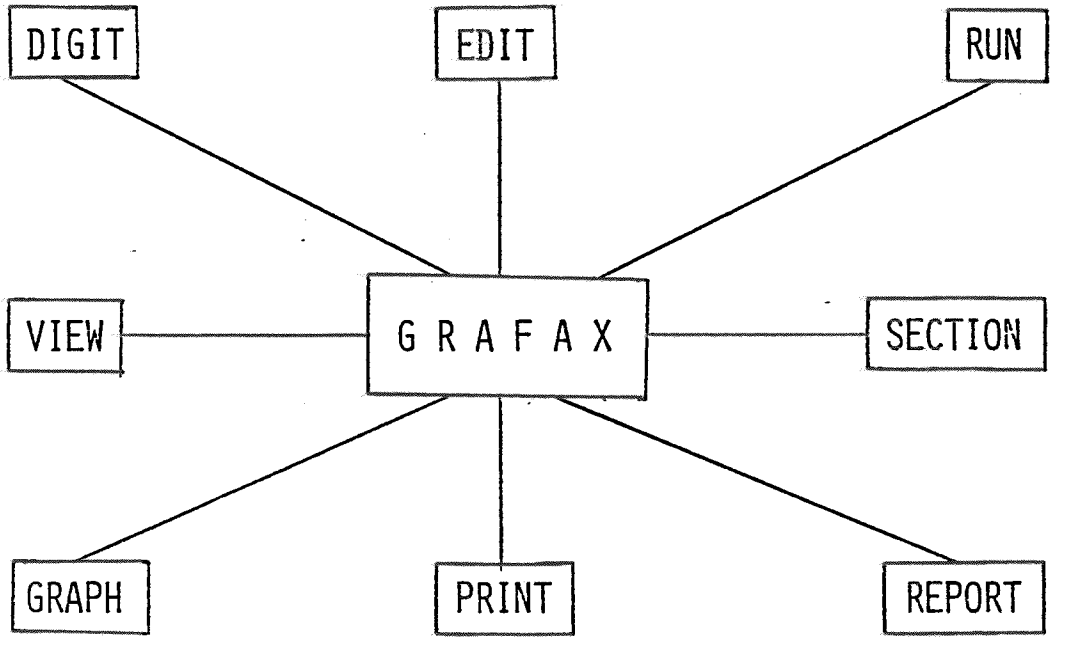
When the VIEW function is entered, a message saying checking and transforming XXX grid card images will appear. The XXX is the number of grid card images in the FEM file. All of these grids are transformed to the basic rectangular coordinate system if they are not already located in it. Then, a message saying checking and transforming XXX element card images will appear. Again the XXX is the number of element card images in the FEM file. Each element is then checked to see if all of the specified grids are in the FEM file. If a specified grid is not found for a element, a message will appear giving the grid and element identification. A hard copy will be made of any errors that are found. Any elements that have an error will not be drawn.

VIEW is useful as a pre and/or post-processing tool in helping quickly identify errors in FEM geometry, element connectivities, and element properties. It is also useful in evaluating and presenting the results of a FEA run. It should always be used before and after a FEA run to help verify the FEM.

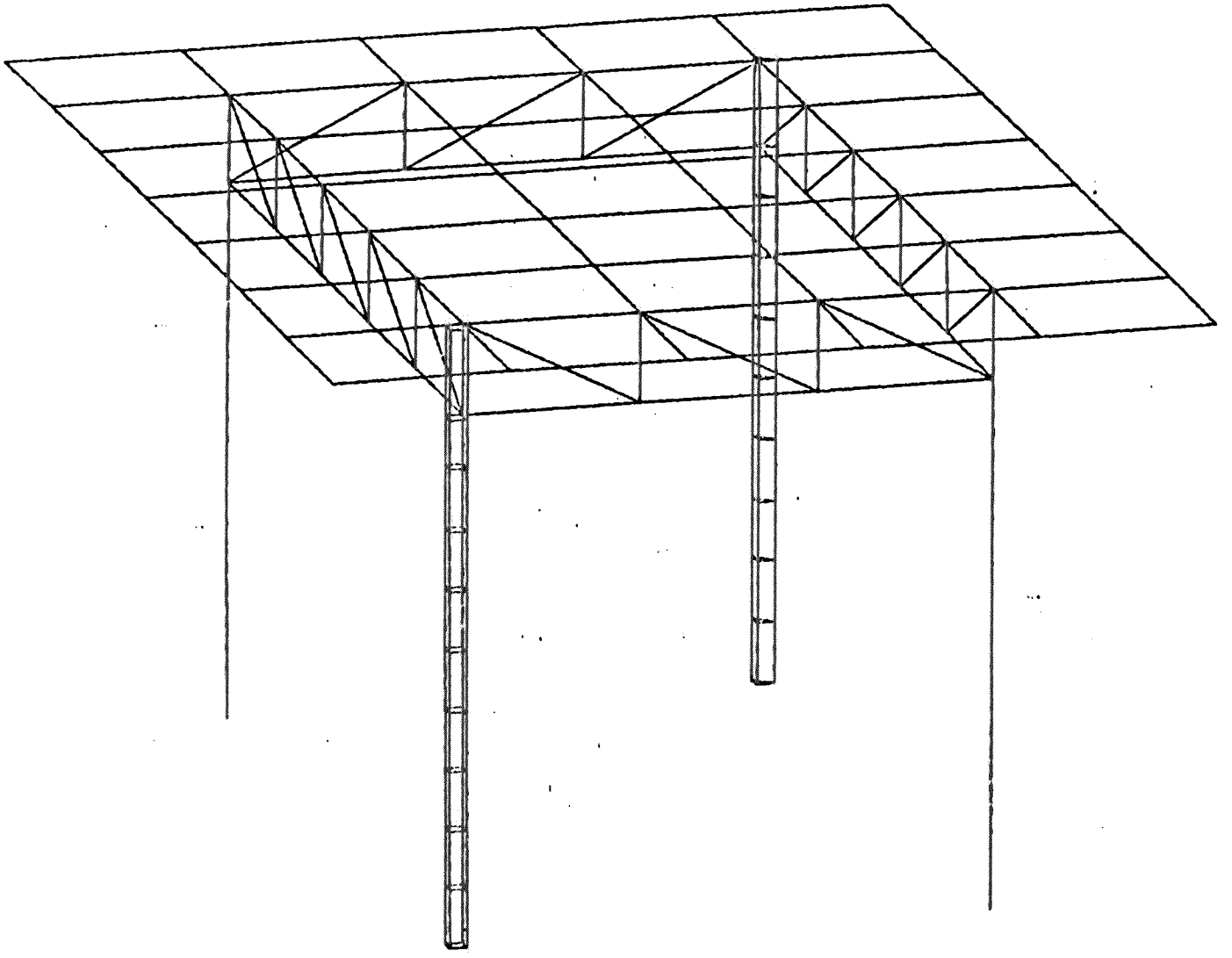
APPENDIX A

SELECTED EXAMPLES OF

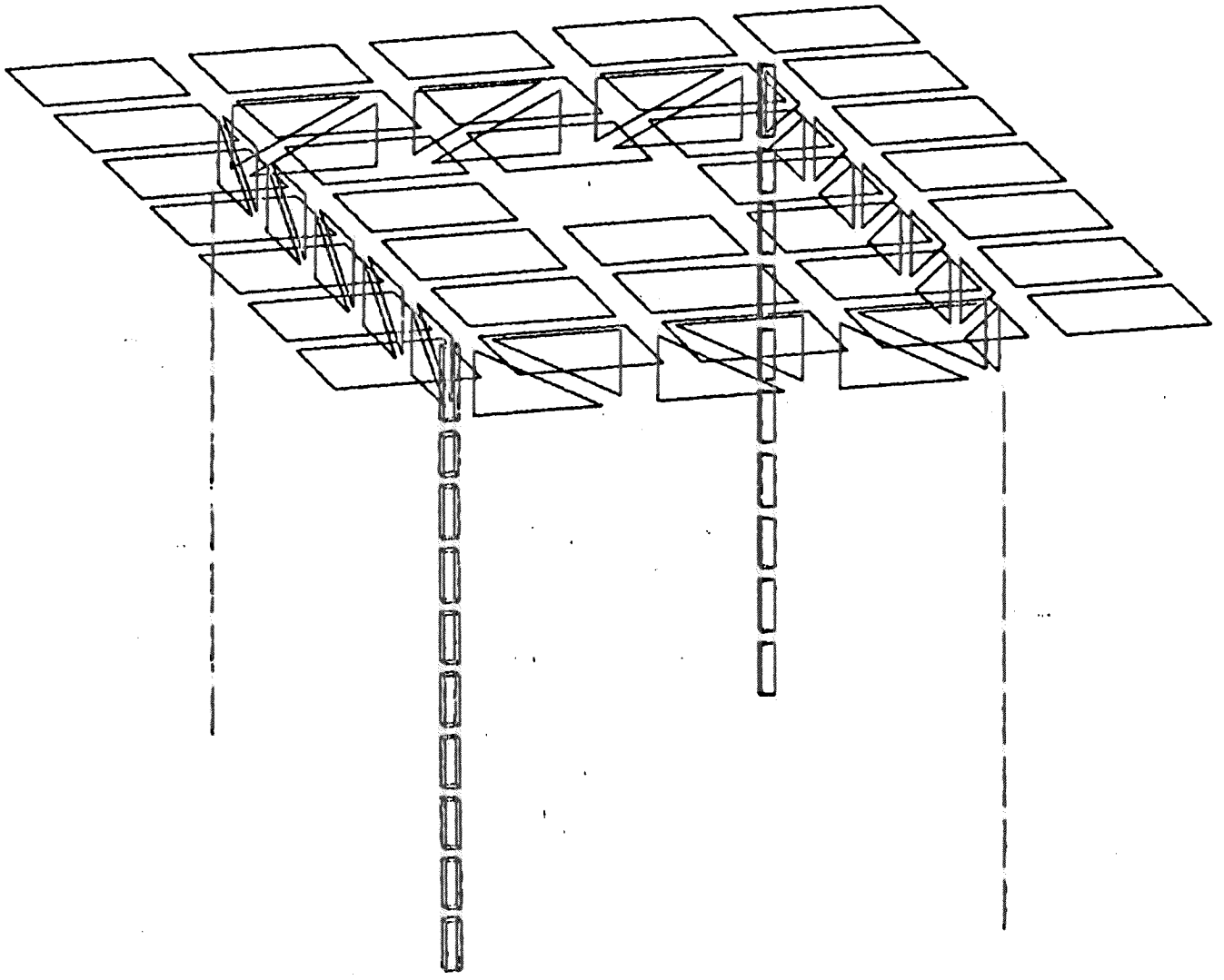
GRAFAX DISPLAYS



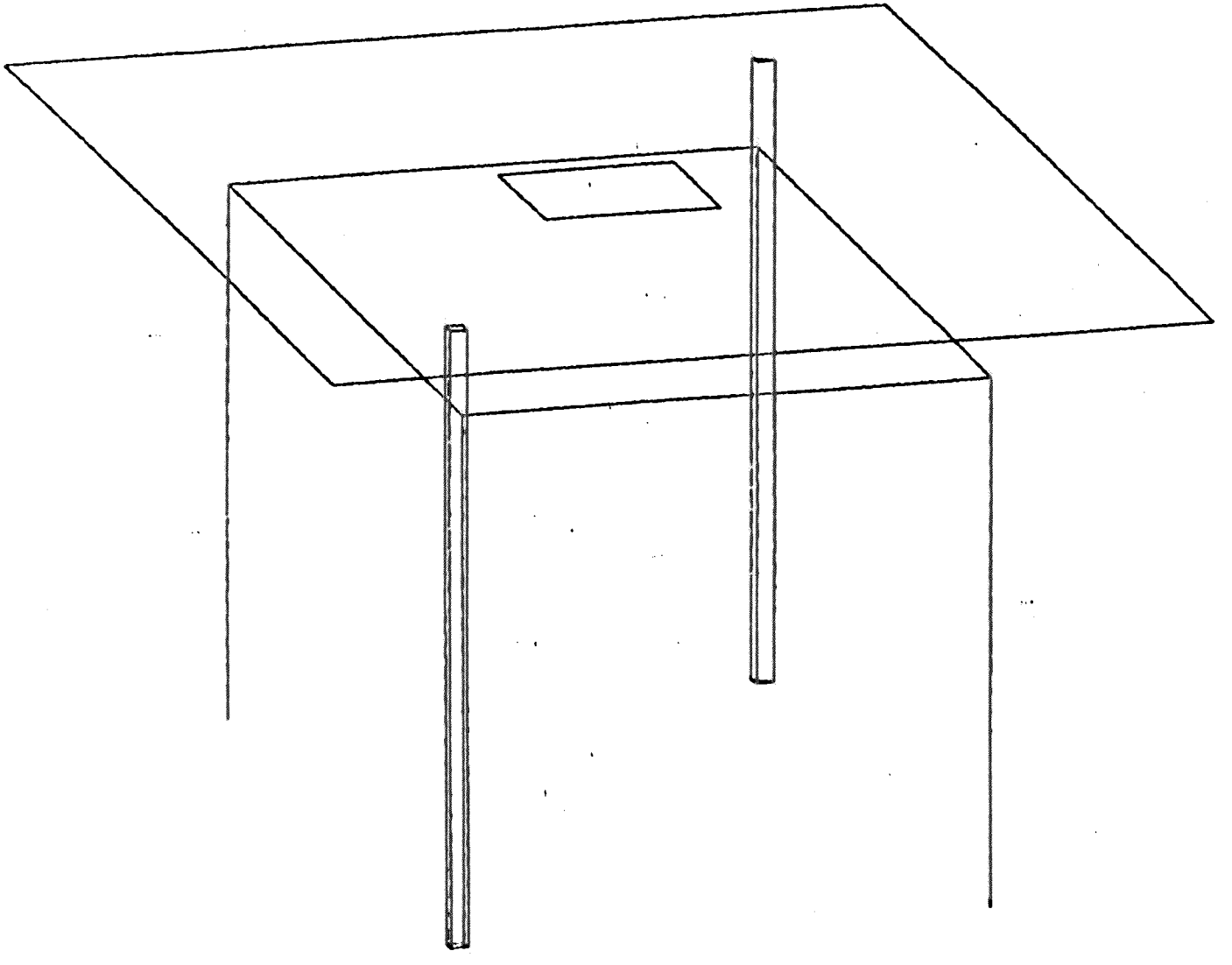
RX= -75. RY= 0. RZ= -75. GRAFAX 06-MAR-79
ENTER A VIEW COMMAND:



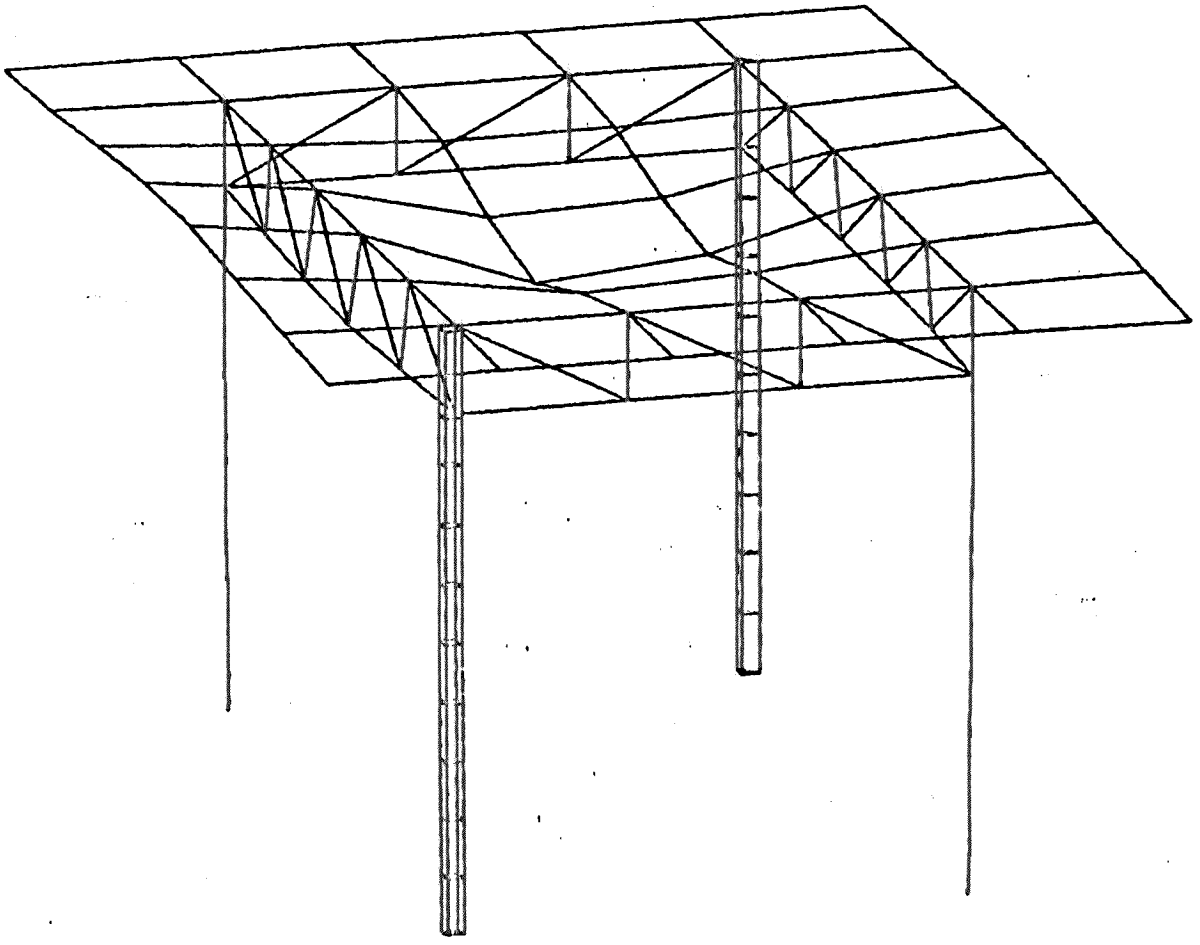
RX= -75. RY= 0 RZ= -75. CRAFAX 06-MAR-79
ENTER A VIEW COMMAND:



RX= -75. RY= 0. RZ= -75. GRAFAX 06-MAR-79
ENTER A VIEW COMMAND:

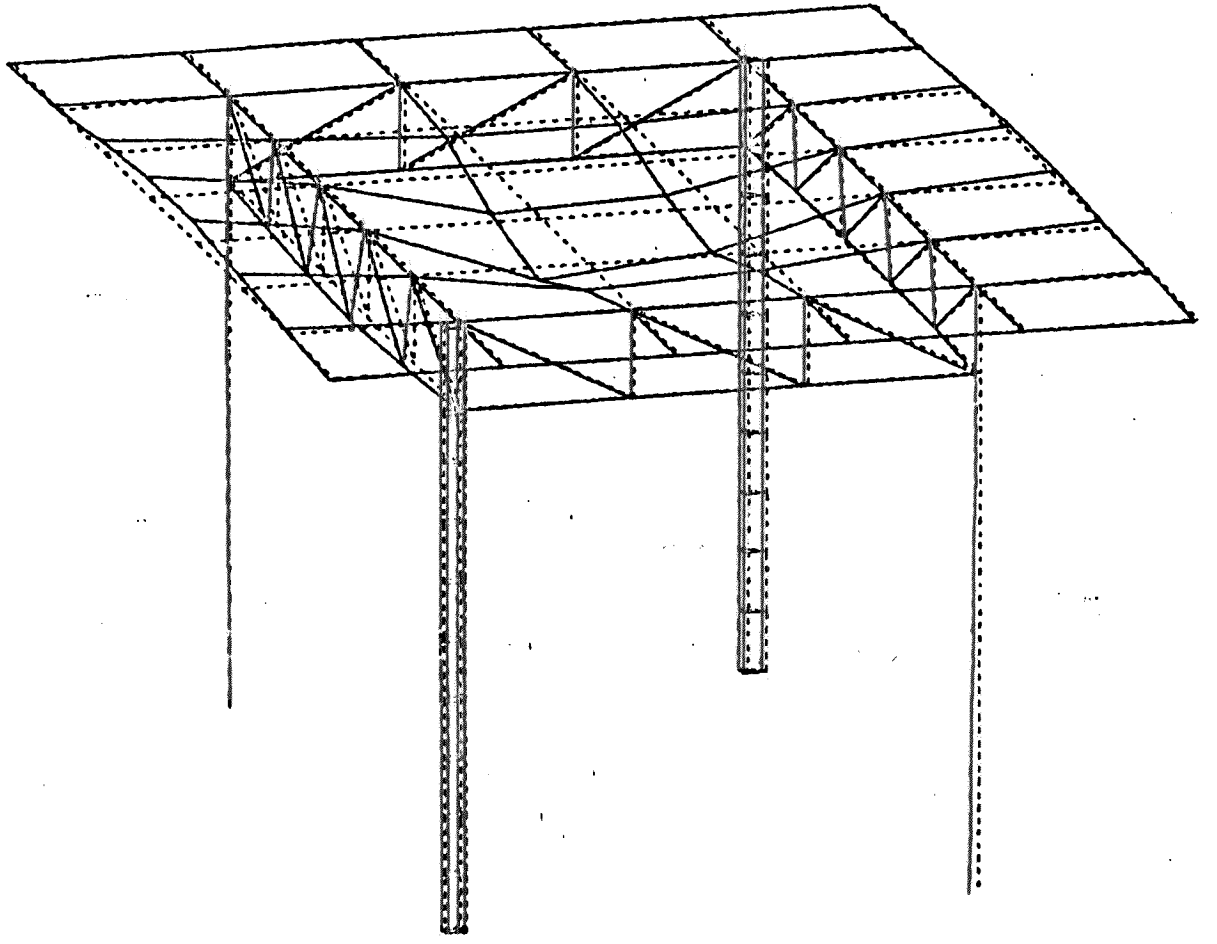


RX= -75. RY= 0. RZ= -75. GRAFAX 08-MAR-79
SUBCASE 1 MAXD -1.213109
ENTER A VIEW COMMAND

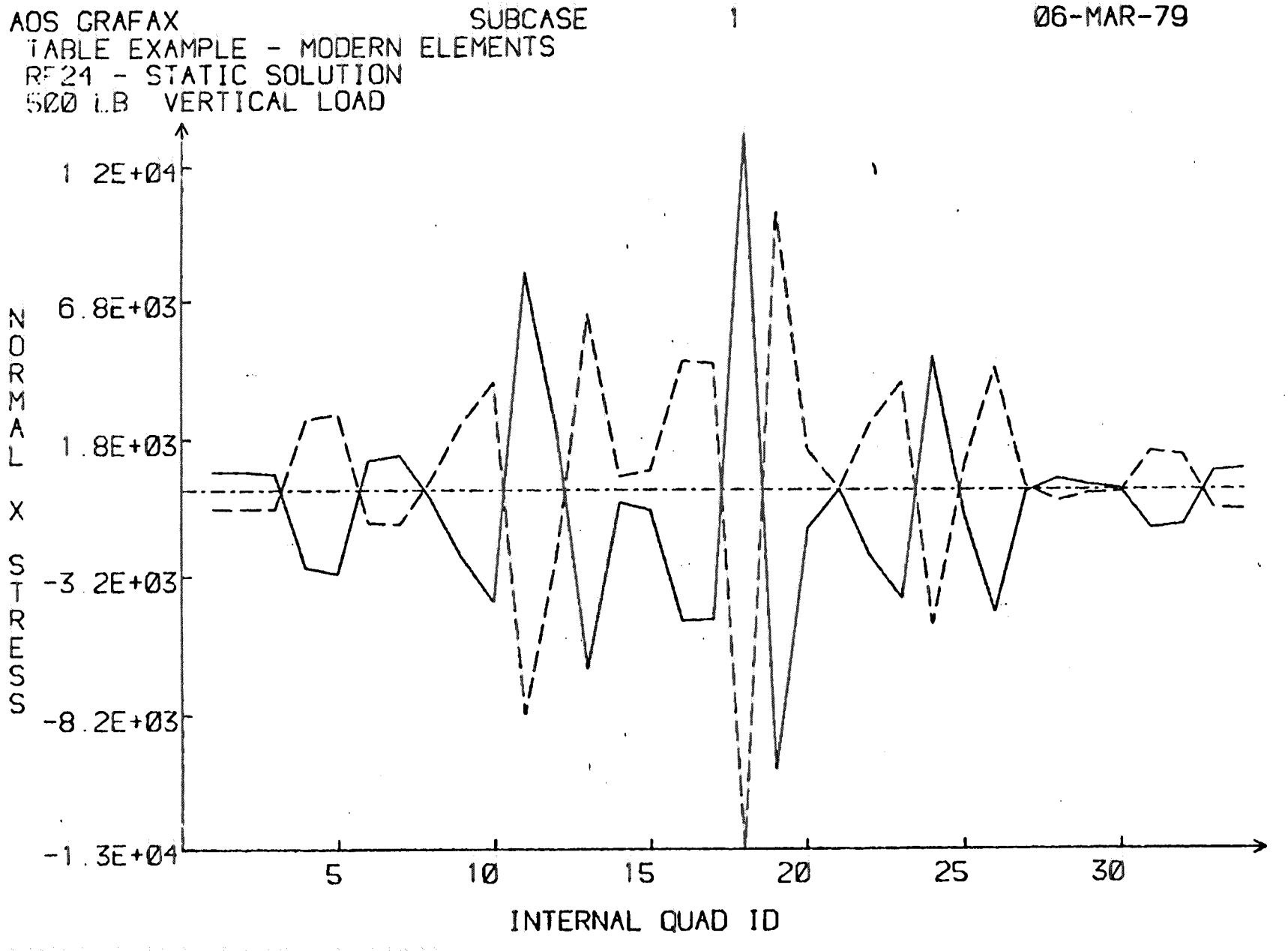


RX= -75. RY= 0 RZ= -75. GRAFAX 06-MAR-79
SUBCASE 1 MAXD -1.213109
ENTER A VIEW COMMAND
DP 1
ENTER A VIEW COMMAND
AUS

ENTER A VIEW COMMAND

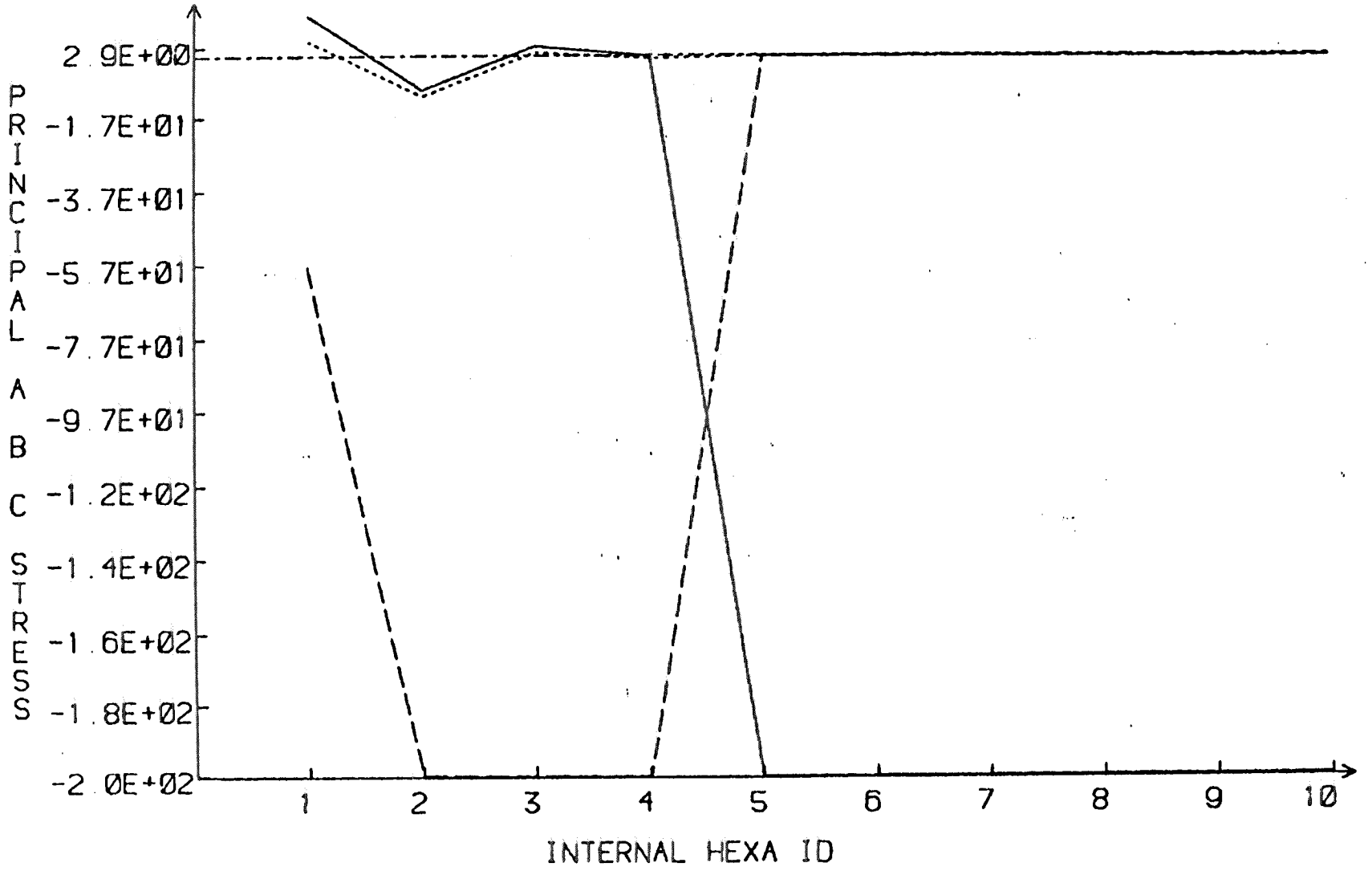


```
es
ENTER SUBCASE NUMBER:
i
ENTER ELEMENT TYPE (BAR, BEAM, TRIA, QUAD, TRI6, PENT, OR HEXA):
quad
*** CHOICES OF STRESS OUTPUT FOR QUAD ELEMENT

  NX        NORMAL X STRESS
. NY        NORMAL Y STRESS
  SH        XY SHEAR STRESS
  PA        PRINCIPAL STRESS ANGLE
  MJ        MAJOR PRINCIPAL STRESS
  MN        MINOR PRINCIPAL STRESS
  MX        MAXIMUM SHEAR STRESS

 ENTER DESIRED STRESS OUTPUT:
nx
ENTER RANGE TO BE GRAPHED:
all
```


AOS GRAFAX
SUBCASE 1
06-MAR-79
TABLE EXAMPLE - MODERN ELEMENTS
R524 - STATIC SOLUTION
500 LB VERTICAL LOAD
1.2E+04
6.8E+03
1.8E+03
-3.2E+03
-8.2E+03
-1.3E+04
NORMAL X STRESS
5
10
15
20
25
30
INTERNAL QUAD ID
ENTER RANGE TO BE GRAPHED:

AOS GRAFAX SUBCASE 1 06-MAR-79

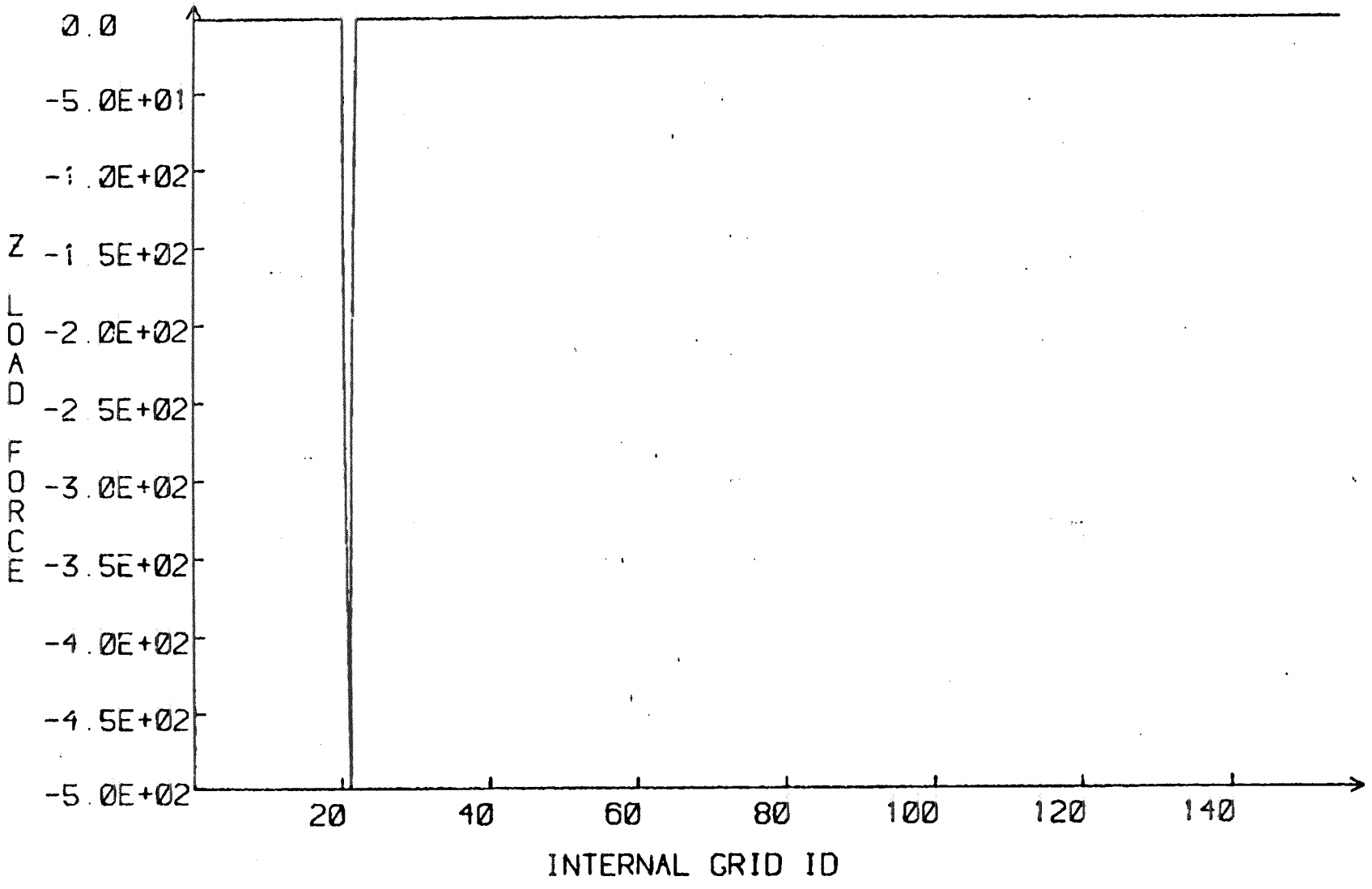
TABLE EXAMPLE - MODERN ELEMENTS
RF24 - STATIC SOLUTION
500 LB VERTICAL LOAD



ENTER RANGE TO BE GRAPHED:

AOS GRAFAX SUBCASE 1 06-MAR-79

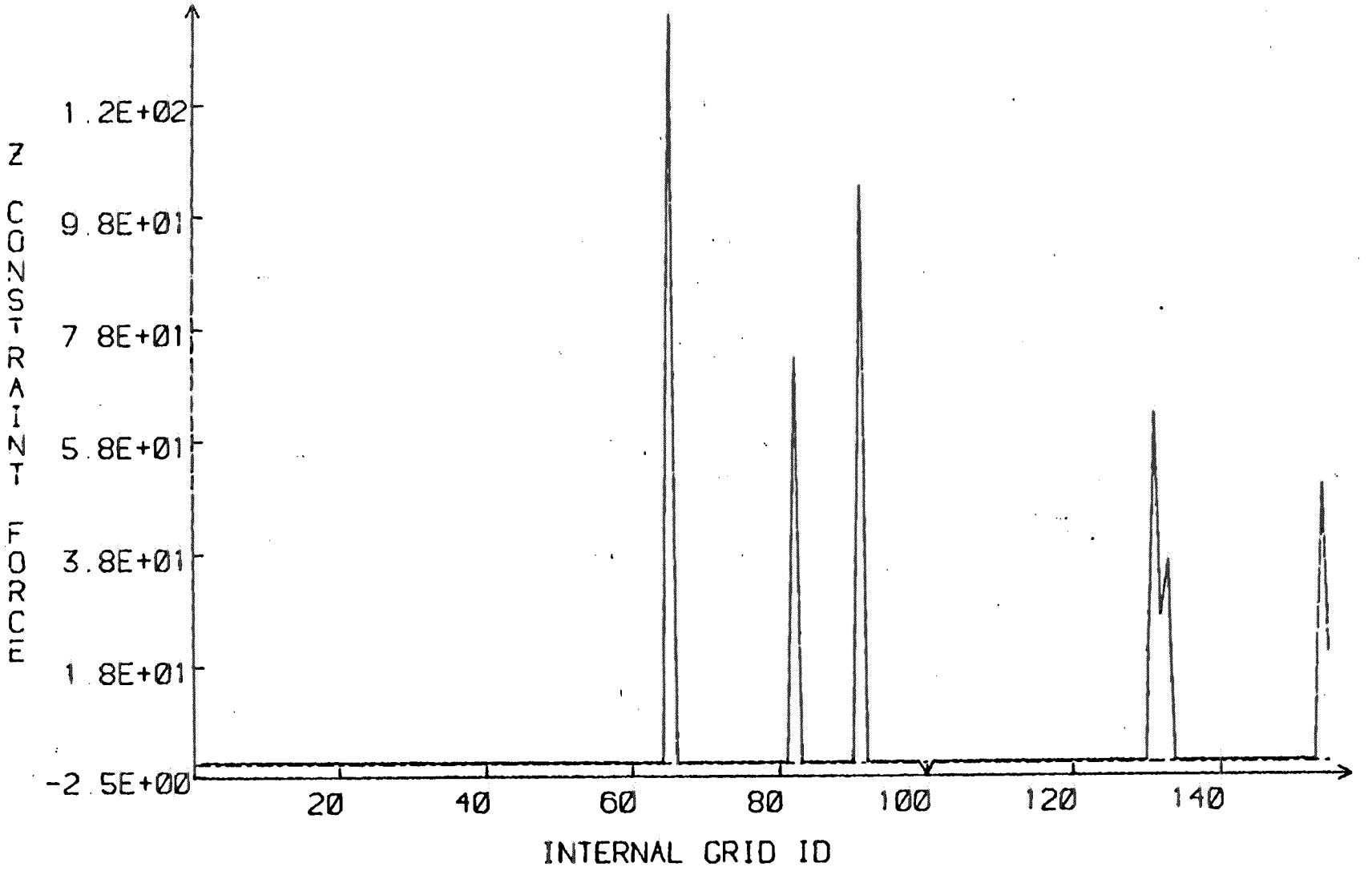
TABLE EXAMPLE - MODERN ELEMENTS
RF24 - STATIC SOLUTION
500 LB. VERTICAL LOAD



ENTER RANGE TO BE GRAPHED:

AOS GRAFAX SUBCASE 1 06-MAR-79

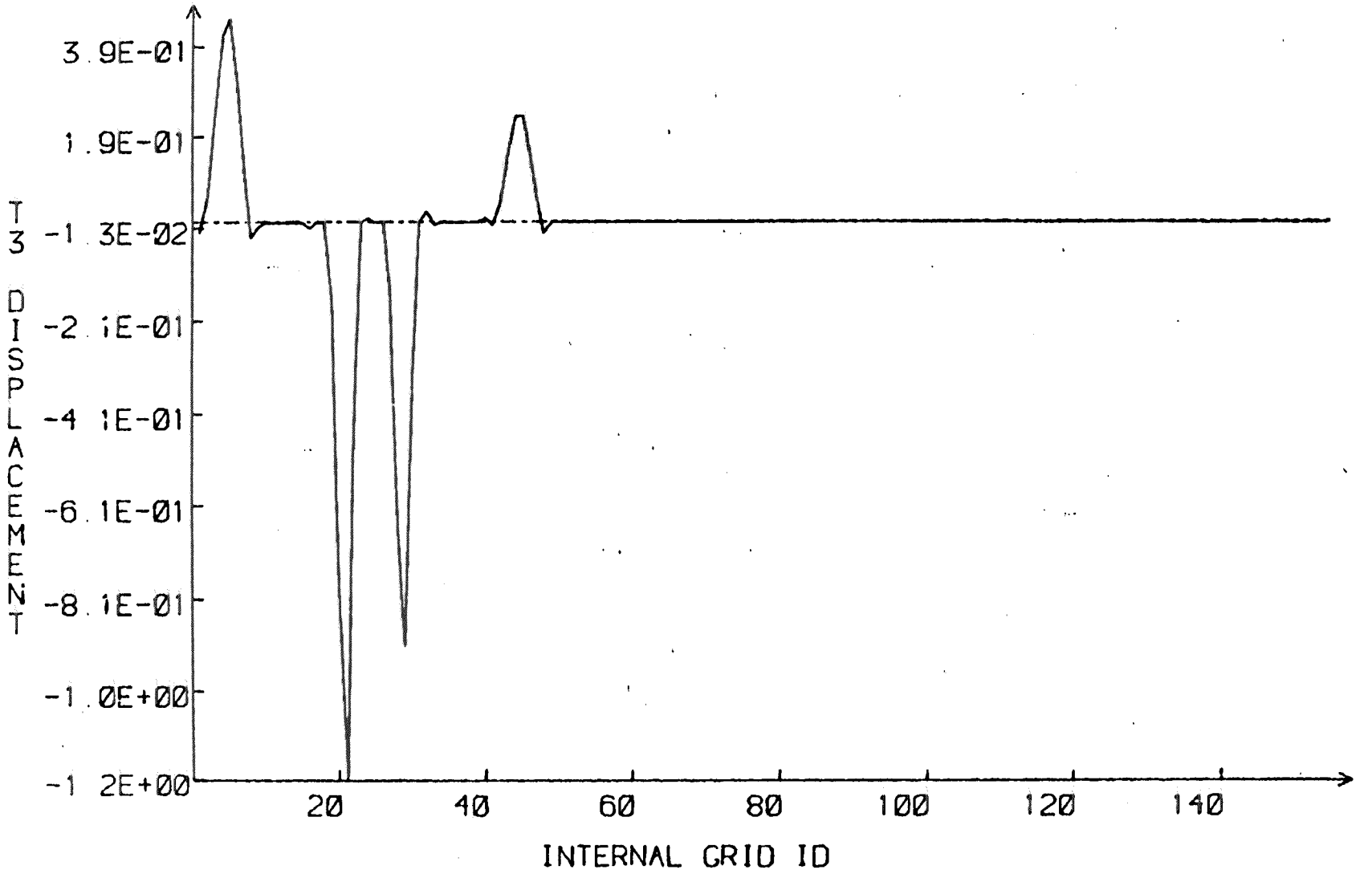
TABLE EXAMPLE - MODERN ELEMENTS
RF24 - STATIC SOLUTION
500 LB. VERTICAL LOAD



ENTER RANGE TO BE GRAPHED:

AOS GRAFAX SUBCASE 1 06-MAR-79

TABLE EXAMPLE - MODERN ELEMENTS
RF24 - STATIC SOLUTION
500 LB VERTICAL LOAD



ENTER RANGE TO BE GRAPHED:

```
report
ENTER A REPORT COMMAND:
es
ENTER SUBCASE NUMBER:
1
ENTER ELEMENT TYPE (BAR, BEAM, TRIA, QUAD, TRI6, PENT, OR, HEXA):
quad
ENTER RANGE TO BE REPORTED:
all
```

AOS GRAFAX ** SUMMARY REPORT ** 06-MAR-79

TABLE EXAMPLE - MODERN ELEMENTS
RF24 - STATIC SOLUTION
500 LB VERTICAL LOAD

SUBCASE 1 STRESSES IN QUADRILATERAL ELEMENTS
RANGE = 1 - 34(ALL)

		MAXIMUM	AT	MINIMUM	AT
STRESSES IN ELEM COORD					
NORMAL-X	-FIBRE	1.308E+04	119	-1.016E+04	120
	+FIBRE	1.007E+04	120	-1.316E+04	119
NORMAL-Y	-FIBRE	2.858E+04	119	-1.182E+04	125
	+FIBRE	1.177E+04	125	-2.871E+04	119
SHEAR-XY	-FIBRE	7.298E+03	112	-6.646E+03	110
	+FIBRE	6.625E+03	110	-7.300E+03	112
PRINCIPAL STRESSES					
MAJOR	-FIBRE	2.866E+04	119	-2.593E+03	104
	+FIBRE	1.335E+04	126	-1.308E+04	119
MINOR	-FIBRE	1.300E+04	119	-1.342E+04	126
	+FIBRE	2.349E+03	104	-2.879E+04	119
MAX SHEAR	-FIBRE	8.736E+03	125	4.919E+01	132
	+FIBRE	8.764E+03	125	8.253E+01	132

CONSTANT NEGATIVE FIBRE DISTANCE OF -5.000E-02
CONSTANT POSITIVE FIBRE DISTANCE OF 5.000E-02

ENTER RANGE TO BE REPORTED:

AOS GRAFAX ** SUMMARY REPORT ** 06-MAR-79

TABLE EXAMPLE - MODERN ELEMENTS
RF24 - STATIC SOLUTION
500 LB. VERTICAL LOAD

SUBCASE 1 STRESSES IN HEXAHEDRON SOLID ELEMENTS (CENTER)
RANGE = 1 - 10(ALL)

		MAXIMUM	AT	MINIMUM	AT
NORMAL	- X	4.739E+00	161	-1.065E+01	162
	- Y	4.432E+00	161	-9.942E+00	162
	- Z	-5.008E+01	161	-1.971E+02	162
SHEAR	- XY	8.911E-01	163	-8.322E-01	162
	- YZ	4.421E-09	162	-1.773E+01	161
	- ZX	1.253E+01	161	-8.223E-09	162
PRINCIPAL	- A	1.209E+01	161	-1.971E+02	167
	- B	9.658E-02	165	-1.971E+02	162
	- C	4.659E+00	161	-1.120E+01	162
MEAN PRESSURE		7.257E+01	162	1.364E+01	161
OCTAHEDRAL SHEAR		9.384E+01	163	3.128E+01	161

ENTER RANGE TO BE REPORTED:

AOS GRAFAX ** SUMMARY REPORT ** 06-MAR-79

TABLE EXAMPLE - MODERN ELEMENTS
RF24 - STATIC SOLUTION
500 LB VERTICAL LOAD

SUBCASE 1
RANGE = 1 - 155(ALL)

LOAD VECTOR

	MAXIMUM	AT	MINIMUM	AT
TRANSLATION - X	0.0	101	0.0	101
TRANSLATION - Y	0.0	101	0.0	101
TRANSLATION - Z	0.0	101	-5.000E+02	121
ROTATION - X	0.0	101	0.0	101
ROTATION - Y	0.0	101	0.0	101
ROTATION - Z	0.0	101	0.0	101

ENTER RANGE TO BE REPORTED:

AOS GRAFAX ** SUMMARY REPORT ** 06-MAR-79

TABLE EXAMPLE - MODERN ELEMENTS
RF24 - STATIC SOLUTION
500 LB VERTICAL LOAD

SUBCASE 1 FORCES OF SINGLE POINT CONSTRAINT
RANGE = 1 - 155(ALL)

	MAXIMUM	AT	MINIMUM	AT
TRANSLATION - X	2.055E+00	200	-2.055E+00	165
TRANSLATION - Y	0.0	101	-3.233E-07	165
TRANSLATION - Z	1.339E+02	165	-2.490E+00	200
ROTATION - X	0.0	101	0.0	101
ROTATION - Y	0.0	101	0.0	101
ROTATION - Z	5.558E+02	112	-6.118E+02	114

ENTER RANGE TO BE REPORTED:

AOS GRAFAX ** SUMMARY REPORT ** 06-MAR-79

TABLE EXAMPLE - MODERN ELEMENTS
RF24 - STATIC SOLUTION
500 LB. VERTICAL LOAD

SUBCASE 1
RANGE = 1 - 155(ALL)

GRID POINT DISPLACEMENTS

	MAXIMUM	AT	MINIMUM	AT
TRANSLATION - X	5.897E-02	284	-3.131E-02	291
TRANSLATION - Y	4.625E-02	159	-3.565E-01	152
TRANSLATION - Z	4.515E-01	105	-1.213E+00	121
ROTATION - X	1.386E-01	129	-1.253E-01	121
ROTATION - Y	9.028E-02	120	-8.905E-02	122
ROTATION - Z	1.087E-02	153	-8.386E-03	150

ENTER RANGE TO BE REPORTED:

```
ENTER A PRINT COMMAND:
es
ENTER SUBCASE NUMBER:
1
ENTER ELEMENT TYPE (BAR, BEAM, TRIA, QUAD, TRI6, PENT, OR HEXA):
quad
ENTER INTERNAL ID OR RANGE TO BE LISTED:
10 20
```

AOS GRAFAX SUBCASE 1 06-MAR-79
TABLE EXAMPLE - MODERN ELEMENTS
RF24 - STATIC SOLUTION
500 LB. VERTICAL LOAD

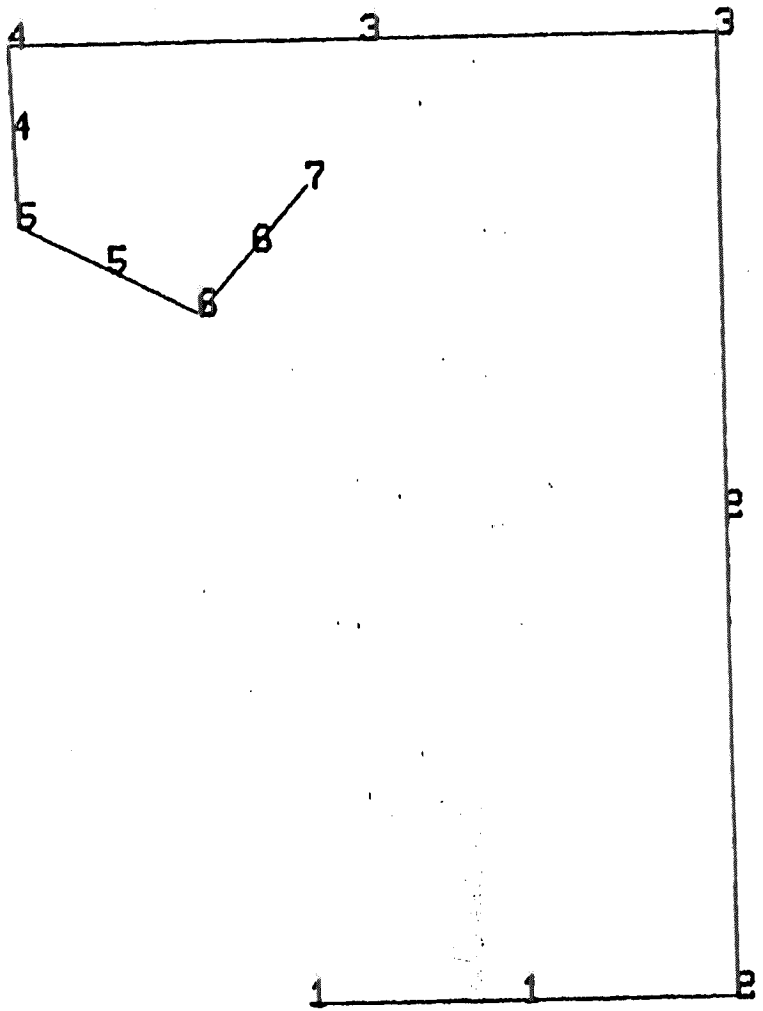
STRESSES IN QUADRILATERAL ELEMENTS

ELEMENT ID.	FIBRE DISTANCE	STRESSES IN ELEMENT COORD SYSTEM NORMAL-X	NORMAL-Y	SHEAR-XY	PRINCIPAL STRESSES (ZERO SHEAR) ANGLE	MAJOR	MINOR	MAX SHEAR
110	-4.999998E-02	-4.018831E+03	-1.583027E+03	-6.646309E+03	-50.1904	3.955554E+03	-9.558262E+03	6.756906E+03
	4.999998E-02	3.876186E+03	1.528605E+03	6.625457E+03	40.1026	9.455855E+03	-3.991067E+03	6.723461E+03
111	-4.999998E-02	7.836625E+03	-4.987211E+03	-3.880414E+03	-15.5909	8.919395E+03	-6.069977E+03	7.494684E+03
	4.999998E-02	-8.097367E+03	4.928758E+03	3.929240E+03	74.4432	6.016629E+03	-9.191230E+03	7.603934E+03
112	-4.999998E-02	2.195930E+03	-4.559160E+03	7.297848E+03	32.5823	6.859926E+03	-9.223150E+03	8.041543E+03
	4.999998E-02	-2.383827E+03	4.441004E+03	-7.300453E+03	-57.5263	9.087203E+03	-7.030823E+03	8.058613E+03
113	-4.999998E-02	-6.454422E+03	-1.410896E+03	5.213320E+03	67.8069	1.858548E+03	-9.723959E+03	5.791199E+03
	4.999998E-02	6.370203E+03	1.334805E+03	-5.230039E+03	-32.0603	9.627160E+03	-1.932152E+03	5.779656E+03
114	-4.999998E-02	-4.495266E+02	2.070857E+02	1.982442E+02	74.5656	2.612671E+02	-5.037080E+02	3.824876E+02
	4.999998E-02	4.615256E+02	-2.416620E+02	-1.807846E+02	-13.6157	5.053147E+02	-2.848508E+02	3.950828E+02
115	-4.999998E-02	-7.370735E+02	-1.122494E+03	-1.602687E+01	-2.3771	-7.364082E+02	-1.123159E+03	1.933755E+02
	4.999998E-02	7.293440E+02	1.110140E+03	-2.601710E-01	-89.9608	1.110140E+03	7.293440E+02	1.933982E+02
116	-4.999998E-02	-4.736027E+03	-1.158708E+03	2.512023E+02	86.0027	-1.141234E+03	-4.753582E+03	1.806174E+03
	4.999998E-02	4.663789E+03	1.134603E+03	-2.604717E+02	-4.1984	4.682910E+03	1.115482E+03	1.783715E+03
117	-4.999998E-02	-4.664715E+03	1.155458E+04	9.790474E+02	86.5560	1.161342E+04	-4.713633E+03	8.163527E+03
	4.999998E-02	4.564899E+03	-1.161839E+04	-9.519954E+02	-3.3551	4.620508E+03	-1.167420E+04	8.147355E+03
119	-4.999998E-02	1.307996E+04	2.858260E+04	-1.690306E+03	-85.9966	2.885890E+04	1.300366E+04	7.827621E+03
	4.999998E-02	-1.315567E+04	-2.871468E+04	1.100637E+03	4.0264	-1.307820E+04	-2.879216E+04	7.856977E+03
120	-4.999998E-02	-1.016316E+04	1.740465E+03	-1.142583E+03	-84.5665	1.849145E+03	-1.027184E+04	6.060492E+03
	4.999998E-02	1.007212E+04	-1.826179E+03	1.113549E+03	5.3809	1.017543E+04	-1.929498E+03	6.052465E+03
121	-4.999998E-02	-1.431110E+03	-2.358651E+03	1.845737E+02	10.9364	-1.395445E+03	-2.386316E+03	4.954355E+02
	4.999998E-02	1.422545E+03	2.318992E+03	-1.851226E+02	-78.7793	2.355716E+03	1.385820E+03	4.849480E+02

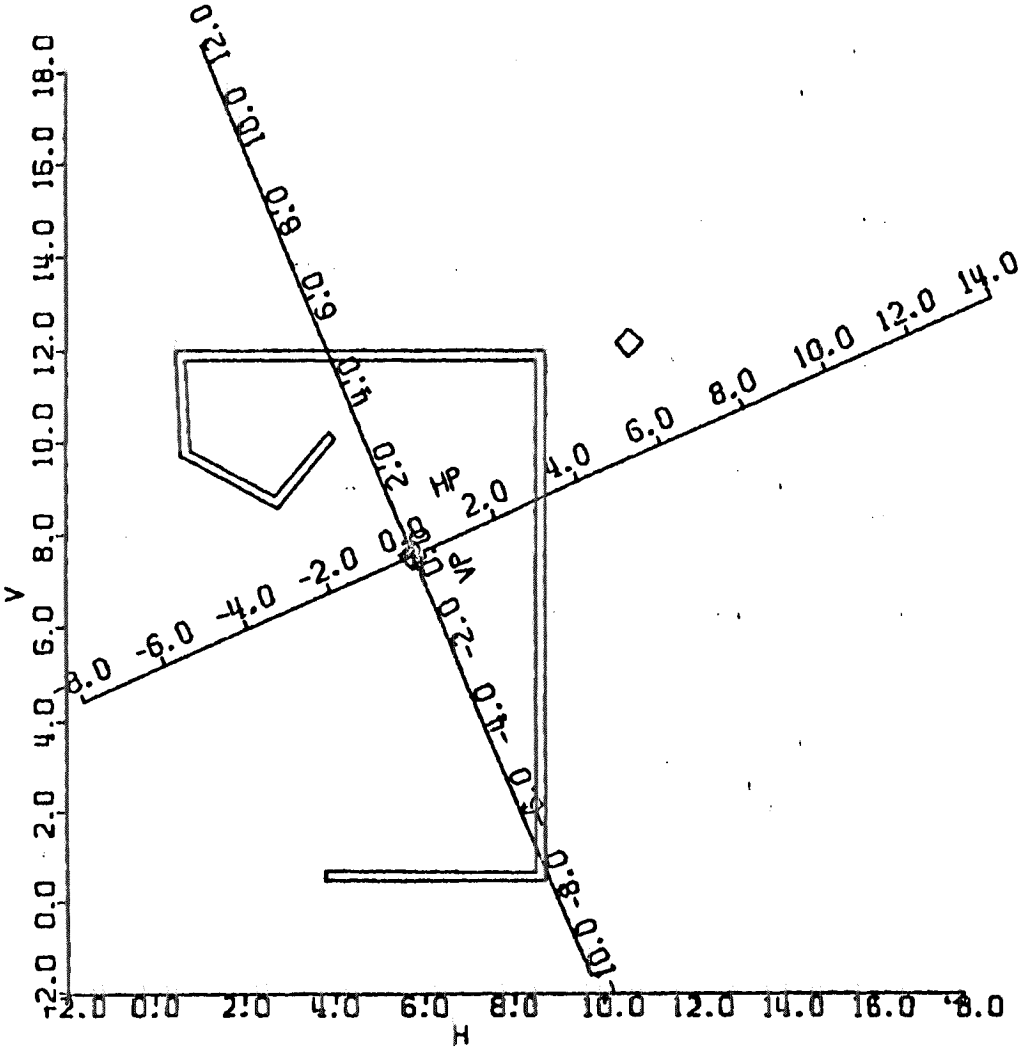
INTERNAL ID RANGE: 10 - 20
ENTER INTERNAL ID OR RANGE TO BE LISTED:

ENTER A SECTION COMMAND:
SP

06-MAR-79



```
GRAFAX                                                          06-MAR-79
PBAR          98      101    6.088 125.562  38.540    0.081
+PA0098   -5.641   -4.574   -7.544  -0.156   2.813    4.313    6.017   -3.040
+PB0098    0.335    0.225    0.0
ENTER A SECTION COMMAND:
```

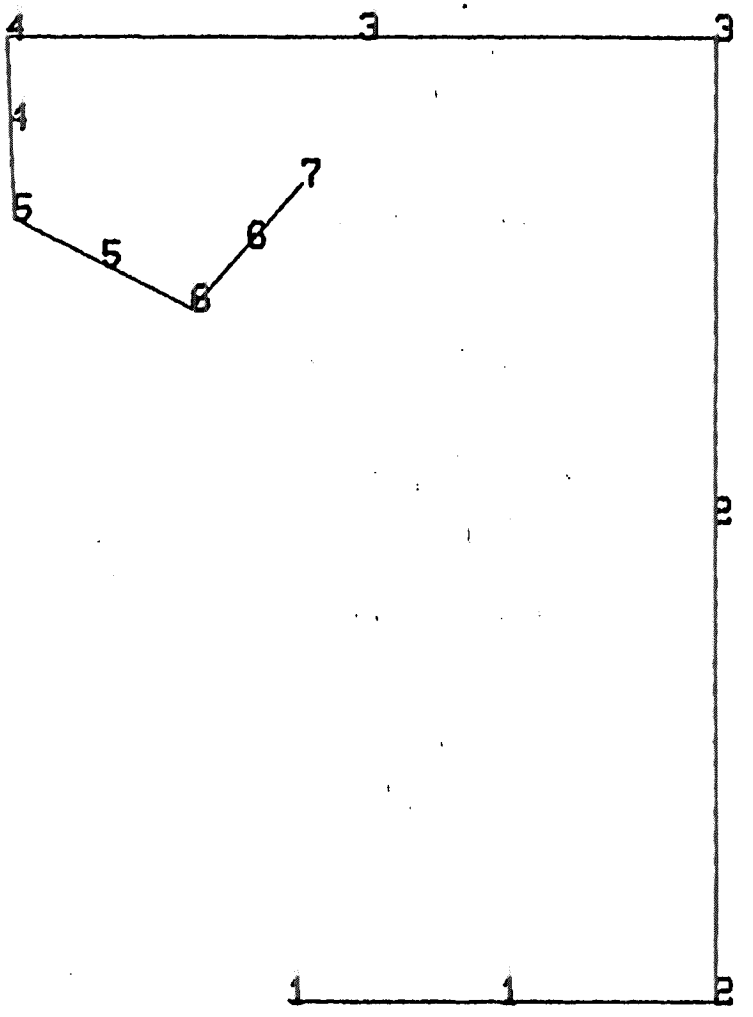


SECTION 98

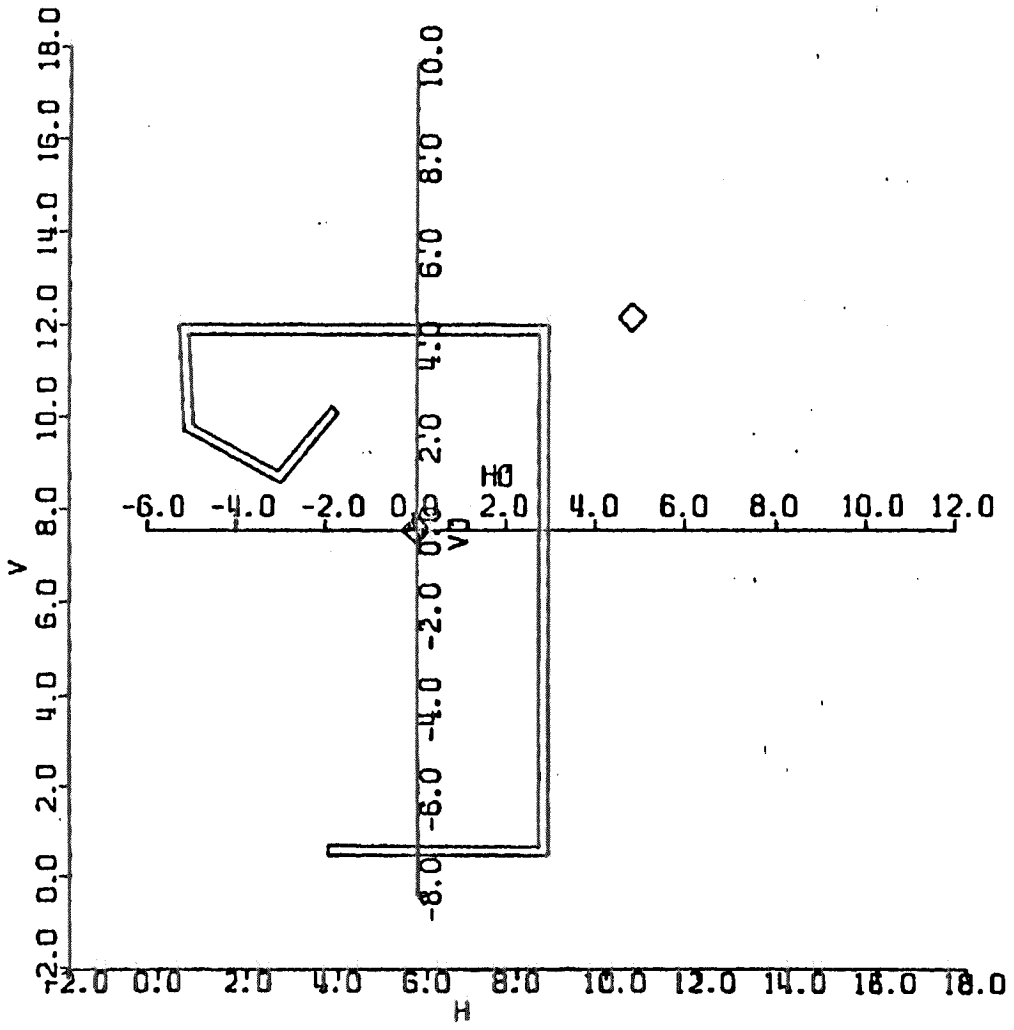
CENTROID	
5.743	7.556
SHEAR CENTER	
10.570	12.125
BETA	
-23.188	
IH	IV
125.562	38.540
TORSION CONSTANT	
.0812	
PERIMETER AREA	
6.0880	
KVV	KHV KHH
3.1591	-.9056 4.6954
WARPING CONSTANT	
1055.15	
PLASTIC MOMENT FACTORS	
VP	HP
13.8571	25.0615

ENTER A SECTION COMMAND:
SC

06-MAR-79



```
GRAFAX                                                          06-MAR-79
PBAR          98      101    6.088 112.071  52.032   0.081
+PA0098   -6.986   -1.983   -6.996   2.827   4.284   2.857   4.334  -5.163
+PB0098    0.335    0.225  -31.497
ENTER A SECTION COMMAND:
```

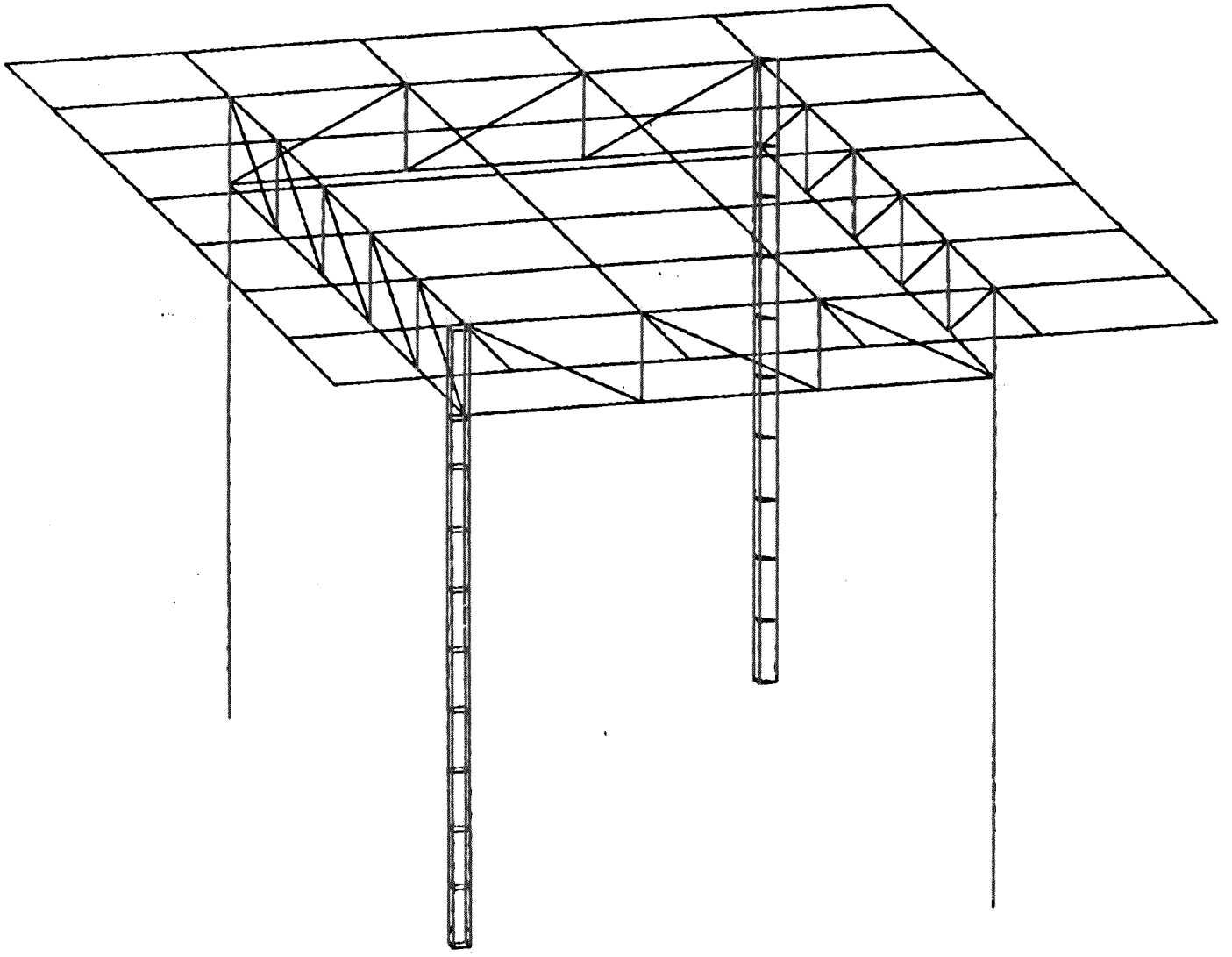


SECTION 98

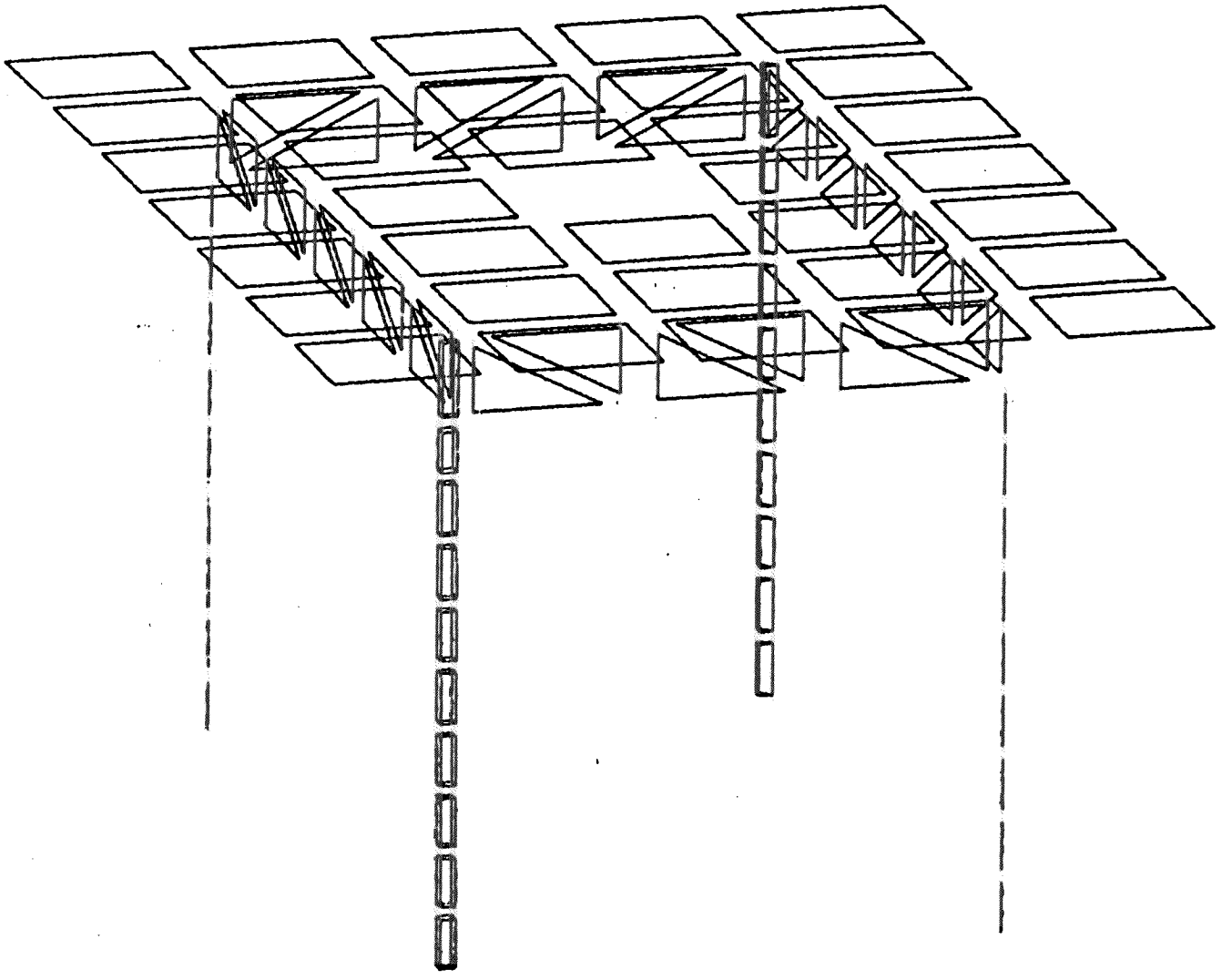
CENTROID		
5.743 , 7.556		
SHEAR CENTER		
10.570 , 12.125		
IVH		
-31.497		
IH	IV	
112.071	52.032	
TORSION CONSTANT		
.0812		
PERIMETER AREA		
6.0880		
KVV	KHV	KHH
3.1591	-.9056	4.6954
WARPING CONSTANT		
1055.15		
PLASTIC MOMENT FACTORS		
VP	HP	
18.2263	24.7316	

```
V I E W   H E L P   M E N U

COMMAND
  AB  ---- ADD BEAM
  ABL ---- ADD BEAM LABEL
  ABP ---- ADD BEAM PROPERTY ------------ (PID)
  AG  ---- ADD GRID
  AGL ---- ADD GRID LABEL
  AH  ---- ADD HEXA
  AHL ---- ADD HEXA LABEL
  AHP ---- ADD HEXA PROPERTY ------------ (PID)
  AP  ---- ADD PENT
  APL ---- ADD PENT LABEL
  APP ---- ADD PENT PROPERTY ------------ (PID)
  AQ  ---- ADD QUAD
  AQL ---- ADD QUAD LABEL
  AQP ---- ADD QUAD PROPERTY ------------ (PID)
  AT  ---- ADD TRIA
  ATL ---- ADD TRIA LABEL
  ATP ---- ADD TRIA PROPERTY ------------ (PID)
  AUS ---- ADD UNDEFORMED SHAPE
  CN  ---- CHARGE NUMBER
  CP  ---- CALCOMP PLOT ------------------ (Y) (N)
  CPC ---- CALCOMP PEN COLOR ------------- (VALUE)
  CPCS---- CALCOMP PLOT CHARACTER SIZE --- (VALUE)
  CPL ---- CALCOMP PLOT LENGTH ----------- (VALUE)
  CPW ---- CALCOMP PLOT WIDTH ------------ (VALUE)
  CS  ---- CHARACTER SIZE ---------------- (VALUE)
  CTCS---- CALCOMP TITLE CHARACTER SIZE -- (VALUE)
  DP  ---- DASH PATTERN ------------------ (VALUE)
  GS  ---- GRID SIZE -------------------- (VALUE)
  H   ---- CREATES THIS DISPLAY
  HC  ---- HARD COPY
  LCV ---- LIST COMMAND VALUES
  LB  ---- LABEL BEAM -------------------- (Y) (N)
  LG  ---- LABEL GRID -------------------- (Y) (N)
  LH  ---- LABEL HEXA -------------------- (Y) (N)
  LO  ---- LIST OUTPUT
  LP  ---- LABEL PENT -------------------- (Y) (N)
  LQ  ---- LABEL QUAD -------------------- (Y) (N)
  LS  ---- LINE SIZE --------------------- (VALUE)
  LT  ---- LABEL TRIA -------------------- (Y) (N)
  MCT ---- MOVIE COMMAND TIMING ---------- (VALUE)
  MD  ---- MAXIMUM DEFORMATION ----------- (VALUE)
  MM  ---- MODAL MOVIE
  MP  ---- MAGNETICS PLOT ---------------- (SID)
  NP  ---- NEW PAGE
  P   ---- PLOT MODEL USING CURRENT INFORMATION
  PB  ---- PLOT BEAM --------------------- (Y) (N)
  PBP ---- PLOT BEAM PROPERTY ------------ (Y,PID) (N)
  PDS ---- PLOT DEFORMED SHAPE ----------- (Y,SID) (N)
  PG  ---- PLOT GRID --------------------- (Y) (N)
  PH  ---- PLOT HEXA --------------------- (Y) (N)
  PHP ---- PLOT HEXA PROPERTY ------------ (Y,PID) (N)
  PL  ---- PLOT LOCATION ----------------- (Y) (N)
  PO  ---- PLOT OUTLINE ------------------ (Y) (N)
  PP  ---- PLOT PENT --------------------- (Y) (N)
  PPP ---- PLOT PENT PROPERTY ------------ (Y,PID) (N)
  PQ  ---- PLOT QUAD --------------------- (Y) (N)
  PQP ---- PLOT QUAD PROPERTY ------------ (Y,PID) (N)
  PT  ---- PLOT TRIA --------------------- (Y) (N)
  PTP ---- PLOT TRIA PROPERTY ------------ (Y,PID) (N)
  R   ---- RETURN
  RB  ---- RING BELL
  RN  ---- REMOTE NUMBER ----------------- (VALUE)
  RLS ---- REPLOT LAST SET
  RX  ---- ROTATE X ---------------------- (VALUE)
  RY  ---- ROTATE Y ---------------------- (VALUE)
  RZ  ---- ROTATE Z ---------------------- (VALUE)
  S   ---- SORT ------------------------- (Y) (N)
  SCT ---- SHOW COMMAND TIMING ----------- (VALUE)
  SE  ---- SHOW ELEMENT ------------------ (ID)
  SF  ---- SHRINK FACTOR ----------------- (VALUE)
  SG  ---- SHOW GRID --------------------- (ID)
  SM  ---- STATIC MOVIE
  SP  ---- SHRINK PLOT ------------------- (Y) (N)
  T   ---- TITLE ------------------------ (Y) (N)
  U   ---- USERID
  Z   ---- ZOOM -------------------------- (Y) (N)

ENTER LETTER(S) AT LEFT & PARAMETER(S) TO PERFORM COMMAND DESCRIBED
.

ENTER A VIEW COMMAND:
```

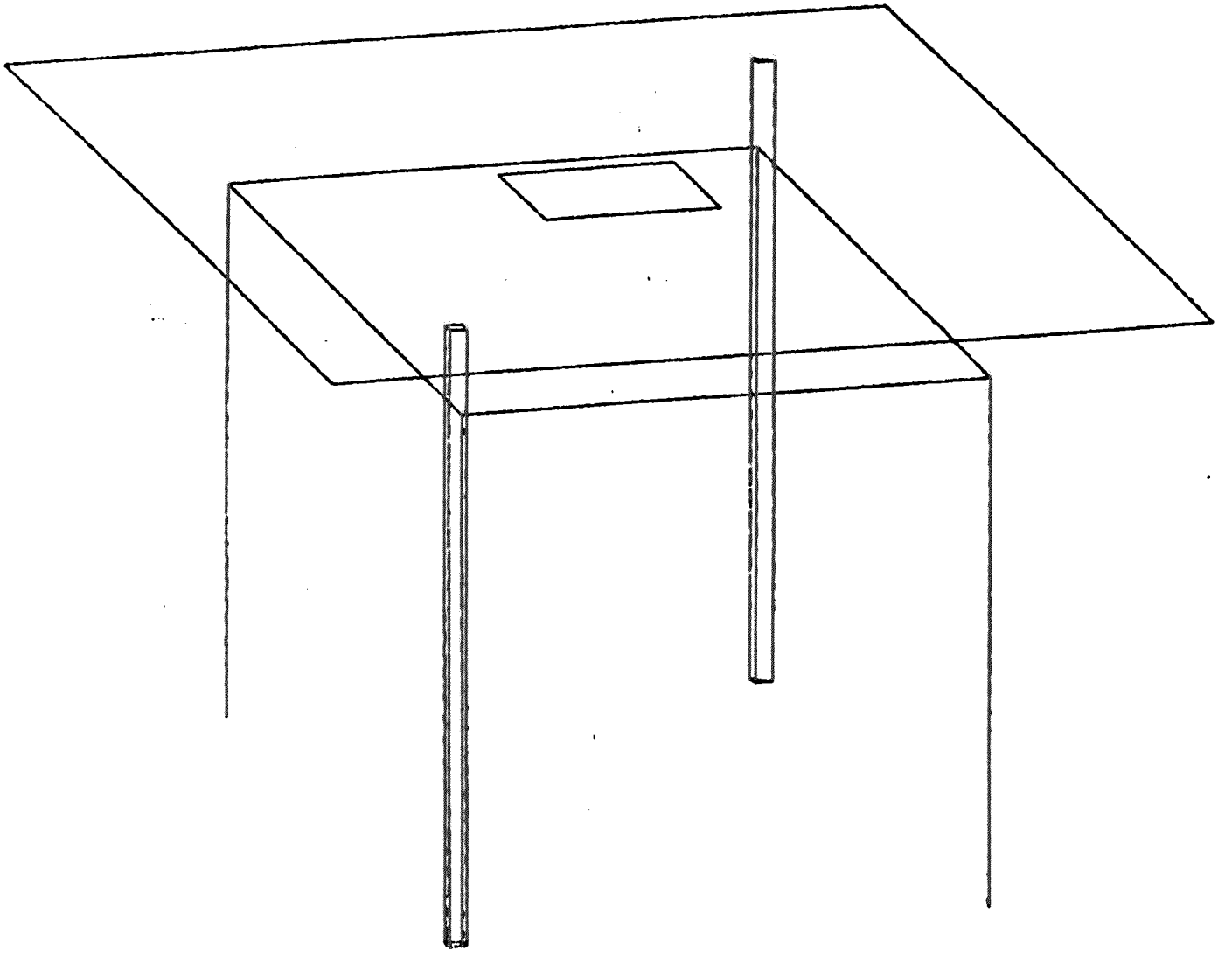
RX= -75 RY= 0. RZ= -75. GRAFAX 06-MAR-79
ENTER A VIEW COMMAND:



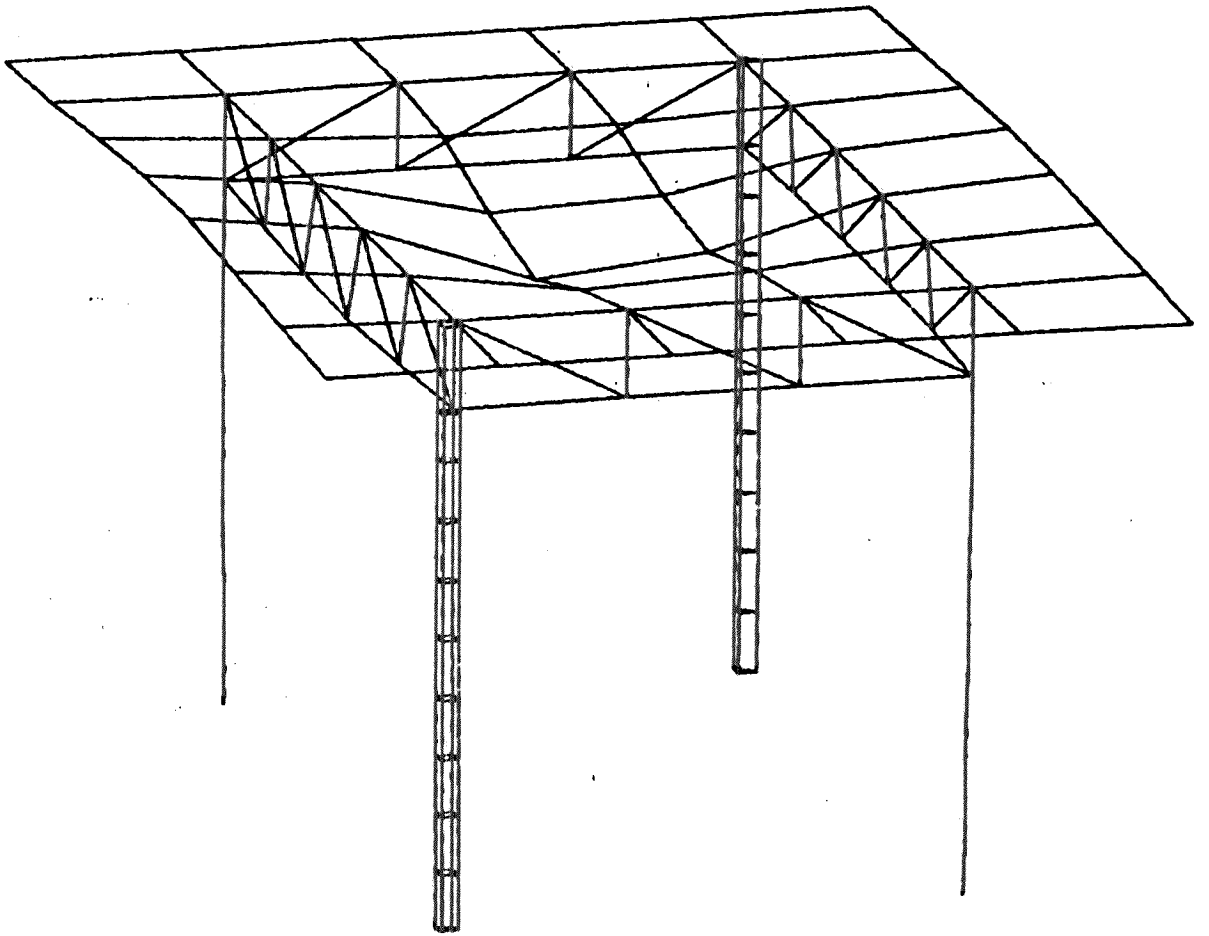
RX= -75. RY= 0 RZ= -75. GRAFAX 06-MAR-79
ENTER A VIEW COMMAND:



RX= -75. RY= 0. RZ= -75. GRAFAX 06-MAR-79
ENTER A VIEW COMMAND:

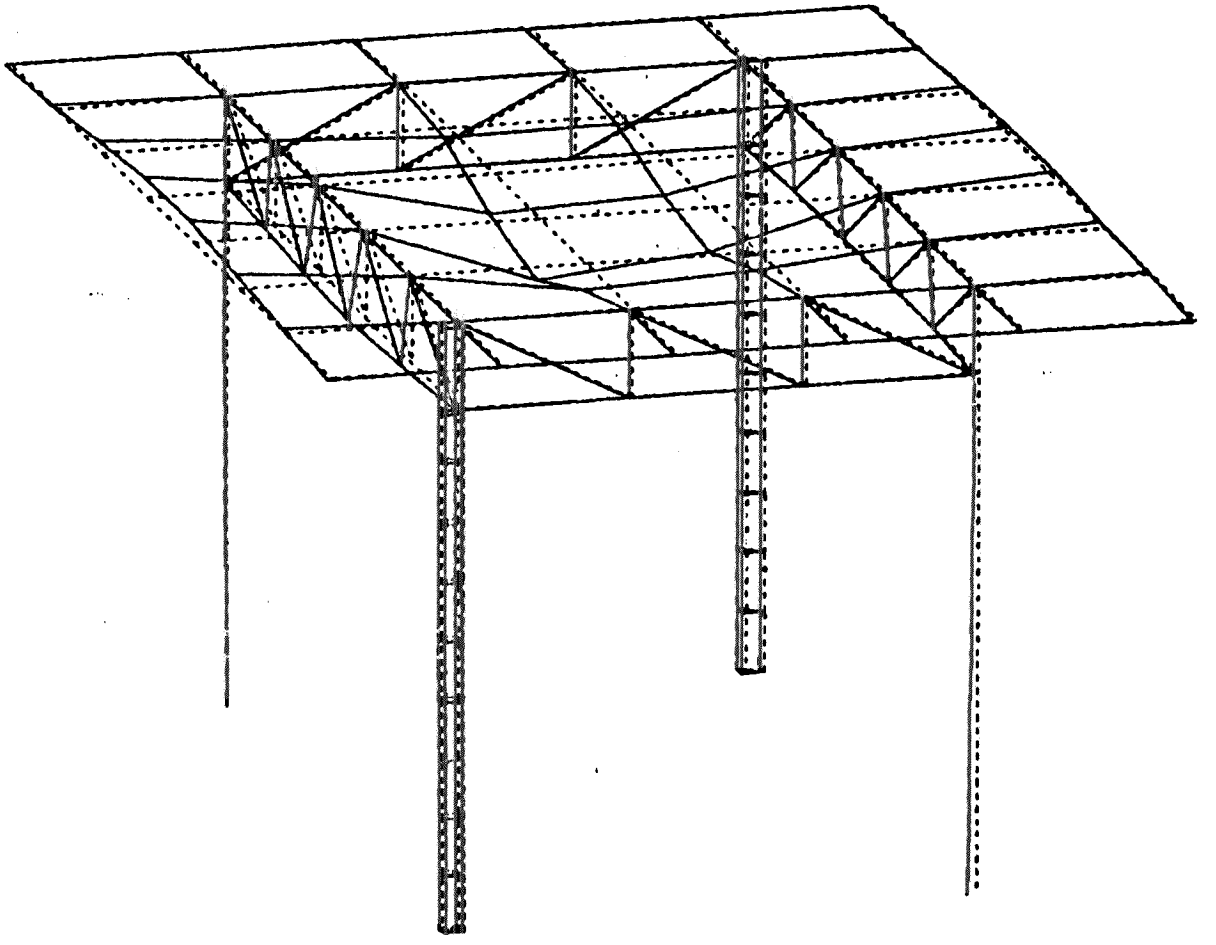


RX= -75. RY= 0. RZ= -75. CRAFAX 06-MAR-79
SUBCASE 1 MAXD -1.213109
ENTER A VIEW COMMAND



RX= -75 RY= 0 RZ= -75 GRAFAX 08-MAR-79
SUBCASE 1 MAXD -1.213109
ENTER A VIEW COMMAND
OP 1
ENTER A VIEW COMMAND
AUS

ENTER A VIEW COMMAND



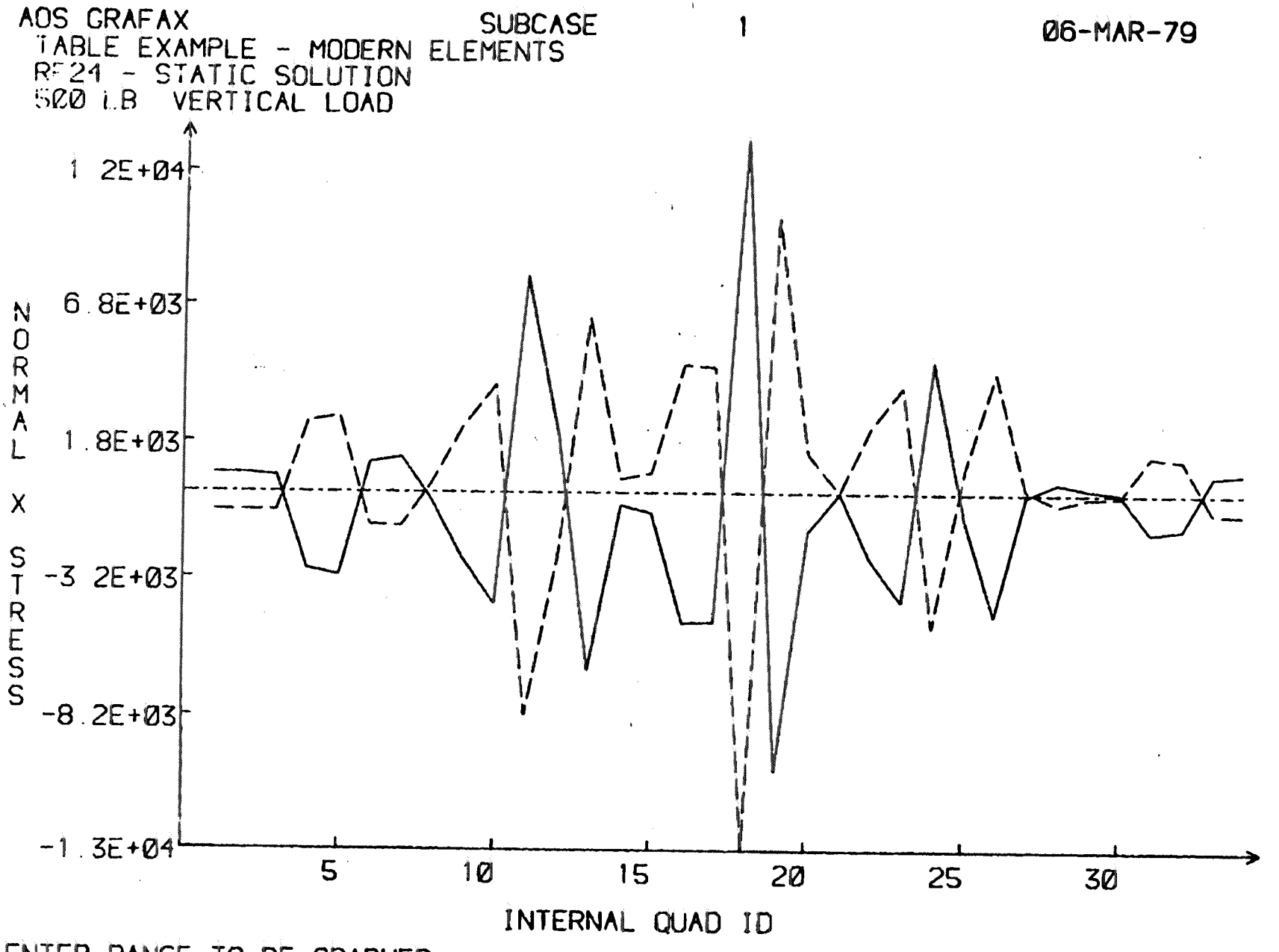
G R A P H H E L P M E N U

COMMAND

AL	APPLIED LOAD	
CF	CONSTRAINT FORCE	
CS	CHARACTER SIZE	(VALUE)
D	DISPLACEMENT	
EF	ELEMENT FORCE	
ES	ELEMENT STRESS	
H	CREATES THIS DISPLAY	
HC	HARD COPY	
LO	LIST OUTPUT	
LS	LINE SIZE	(VALUE)
NP	NEW PAGE	
R	RETURN	
RB	RING BELL	

ENTER A GRAPH COMMAND:

```
es
ENTER SUBCASE NUMBER:
1
ENTER ELEMENT TYPE (BAR, BEAM, TRIA, QUAD, TRI6, PENT, OR HEXA):
quad
*** CHOICES OF STRESS OUTPUT FOR QUAD ELEMENT

  NX        NORMAL X STRESS
  NY        NORMAL Y STRESS
  SH        XY SHEAR STRESS
  PA        PRINCIPAL STRESS ANGLE
  MJ        MAJOR PRINCIPAL STRESS
  MN        MINOR PRINCIPAL STRESS
  MX        MAXIMUM SHEAR STRESS

 ENTER DESIRED STRESS OUTPUT:
nx
ENTER RANGE TO BE GRAPHED:
all
```


AOS GRAFAX
SUBCASE 1
06-MAR-79
TABLE EXAMPLE - MODERN ELEMENTS
R521 - STATIC SOLUTION
500 LB VERTICAL LOAD
1.2E+04
6.8E+03
1.8E+03
-3.2E+03
-8.2E+03
-1.3E+04
NORMAL X STRESS
5
10
15
20
25
30
INTERNAL QUAD ID
ENTER RANGE TO BE GRAPHED:

R E P O R T H E L P M E N U

COMMAND

AL	APPLIED LOAD	
CF	CONSTRAINT FORCE	
CS	CHARACTER SIZE	(VALUE)
D	DISPLACEMENT	
EF	ELEMENT FORCE	
ES	ELEMENT STRESS	
H	CREATES THIS DISPLAY	
HC	HARD COPY	
LO	LIST OUTPUT	
LS	LINE SIZE	(VALUE)
NP	NEW PAGE	
R	RETURN	
RB	RING BELL	

ENTER A REPORT COMMAND:

```
report
ENTER A REPORT COMMAND:
es
ENTER SUBCASE NUMBER:
1
ENTER ELEMENT TYPE (BAR, BEAM, TRIA, QUAD, TRI6, PENT, OR, HEXA):
quad
ENTER RANGE TO BE REPORTED:
all
```

AOS GRAFAX ** SUMMARY REPORT ** 06-MAR-79

TABLE EXAMPLE - MODERN ELEMENTS
RF24 - STATIC SOLUTION
500 LB VERTICAL LOAD

SUBCASE 1 STRESSES IN QUADRILATERAL ELEMENTS
RANGE = 1 - 34 (ALL)

		MAXIMUM	AT	MINIMUM	AT
STRESSES IN ELEM COORD					
NORMAL-X	-FIBRE	1.308E+04	119	-1.016E+04	120
	+FIBRE	1.007E+04	120	-1.316E+04	119
NORMAL-Y	-FIBRE	2.858E+04	119	-1.182E+04	125
	+FIBRE	1.177E+04	125	-2.871E+04	119
SHEAR-XY	-FIBRE	7.298E+03	112	-6.646E+03	110
	+FIBRE	6.625E+03	110	-7.300E+03	112
PRINCIPAL STRESSES					
MAJOR	-FIBRE	2.866E+04	119	-2.593E+03	104
	+FIBRE	1.335E+04	126	-1.308E+04	119
MINOR	-FIBRE	1.300E+04	119	-1.342E+04	126
	+FIBRE	2.349E+03	104	-2.879E+04	119
MAX SHEAR	-FIBRE	8.736E+03	125	4.919E+01	132
	+FIBRE	8.764E+03	125	8.253E+01	132

CONSTANT NEGATIVE FIBRE DISTANCE OF -5.000E-02
CONSTANT POSITIVE FIBRE DISTANCE OF 5.000E-02

ENTER RANGE TO BE REPORTED:

P R I N T H E L P M E N U

COMMAND

AL	APPLIED LOAD	
CF	CONSTRAINT FORCE	
CS	CHARACTER SIZE	(VALUE)
D	DISPLACEMENT	
EF	ELEMENT FORCE	
ES	ELEMENT STRESS	
H	CREATES THIS DISPLAY	
HC	HARD COPY	
LO	LIST OUTPUT	
LS	LINE SIZE	(VALUE)
NP	NEW PAGE	
R	RETURN	
RB	RING BELL	

ENTER A PRINT COMMAND:

```
ENTER A PRINT COMMAND:
os
ENTER SUBCASE NUMBER:
1
ENTER ELEMENT TYPE (BAR, BEAM, TRIA, QUAD, TRI6, PENT, OR HEXA):
quad
ENTER INTERNAL ID OR RANGE TO BE LISTED:
10 20
```

AOS GRAFAX SUBCASE 1 06-MAR-79
TABLE EXAMPLE - MODERN ELEMENTS
RF24 - STATIC SOLUTION
500 LB. VERTICAL LOAD

S T R E S S E S I N Q U A D R I L A T E R A L E L E M E N T S

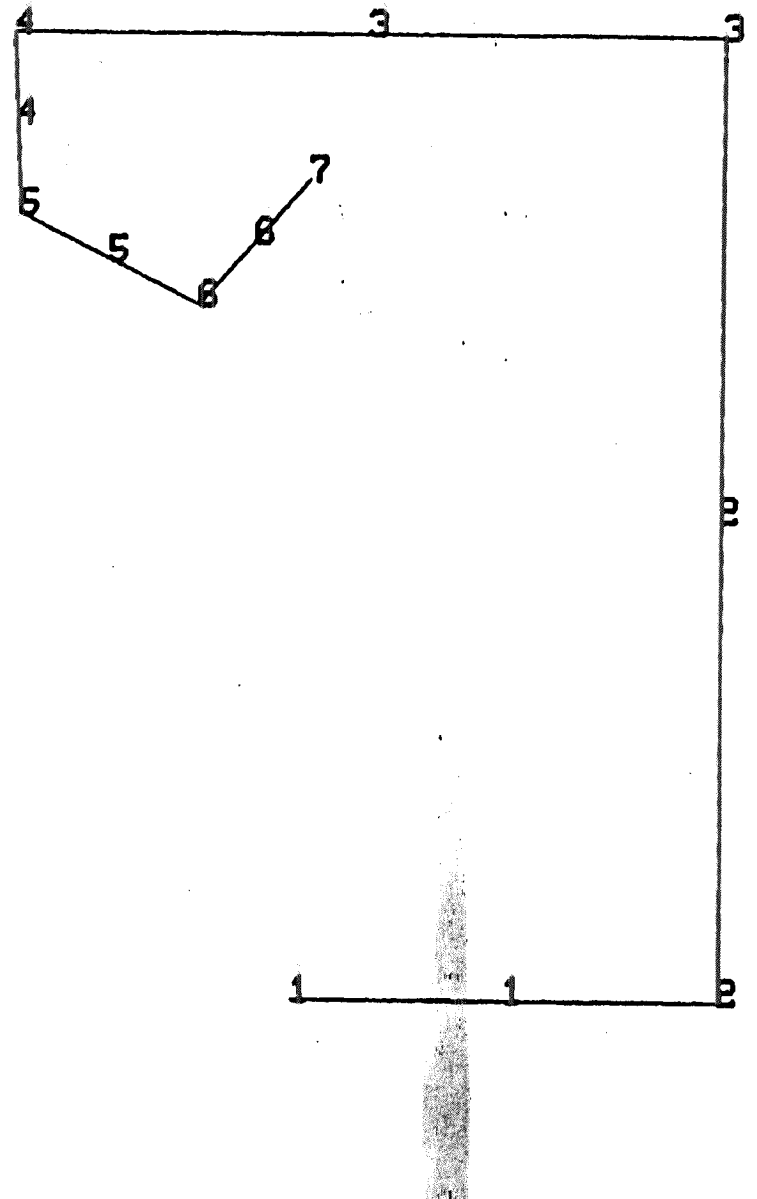
ELEMENT ID.	FIBRE DISTANCE	STRESSES IN ELEMENT COORD SYSTEM NORMAL-X	NORMAL-Y	SHEAR-XY	PRINCIPAL STRESSES (ZERO SHEAR) ANGLE	MAJOR	MINOR	MAX SHEAR
110	-4.999998E-02	-4.018881E+03	-1.583827E+03	-8.646309E+03	-50.1984	3.955554E+03	-9.558262E+03	6.756906E+03
	4.999998E-02	3.876186E+03	1.588605E+03	6.625457E+03	40.1026	9.455855E+03	-3.991067E+03	6.723461E+03
111	-4.999998E-02	7.836625E+03	-4.987211E+03	-3.880414E+03	-15.5909	8.919395E+03	-6.069977E+03	7.494684E+03
	4.999998E-02	-8.097367E+03	4.922758E+03	3.929240E+03	74.4432	6.016889E+03	-9.191238E+03	7.603934E+03
112	-4.999998E-02	2.195930E+03	-4.559160E+03	7.297848E+03	38.5823	6.859926E+03	-9.223156E+03	8.041543E+03
	4.999998E-02	-2.383827E+03	4.441004E+03	-7.300453E+03	-57.5263	9.087203E+03	-7.030023E+03	8.058613E+03
113	-4.999998E-02	-6.454422E+03	-1.410896E+03	5.213320E+03	67.9069	1.858642E+03	-9.723859E+03	5.791199E+03
	4.999998E-02	6.370203E+03	1.384885E+03	-5.200039E+03	-32.0603	9.627160E+03	-1.932152E+03	5.779656E+03
114	-4.999998E-02	-4.495266E+02	2.070857E+02	1.962442E+02	74.5656	2.612671E+02	-5.037028E+02	3.824875E+02
	4.999998E-02	4.615256E+02	-8.410680E+02	-1.807846E+02	-13.6157	6.053147E+02	-8.848508E+02	3.950828E+02
115	-4.999998E-02	-7.370735E+02	-1.122494E+03	-1.602687E+01	-2.3771	-7.364082E+02	-1.123159E+03	1.933755E+02
	4.999998E-02	7.293440E+02	1.110140E+03	-2.601710E-01	-89.9608	1.110140E+03	7.293440E+02	1.903982E+02
116	-4.999998E-02	-4.736027E+03	-1.158788E+03	2.512023E+02	86.0827	-1.141234E+03	-4.753582E+03	1.806174E+03
	4.999998E-02	4.663789E+03	1.134603E+03	-2.604717E+02	-4.1984	4.682916E+03	1.115482E+03	1.783715E+03
117	-4.999998E-02	-4.654715E+03	1.155450E+04	9.790474E+02	86.5560	1.161342E+04	-4.713633E+03	8.163587E+03
	4.999998E-02	4.564899E+03	-1.161839E+04	-9.519954E+02	-3.3551	4.620508E+03	-1.167420E+04	8.147356E+03
119	-4.999998E-02	1.307996E+04	2.858260E+04	-1.090306E+03	-85.9966	2.865890E+04	1.300368E+04	7.827621E+03
	4.999998E-02	-1.315567E+04	-2.871468E+04	1.100637E+03	4.0264	-1.307820E+04	-2.879216E+04	7.856977E+03
120	-4.999998E-02	-1.016316E+04	1.740465E+03	-1.142583E+03	-84.5665	1.849145E+03	-1.027184E+04	6.060492E+03
	4.999998E-02	1.007212E+04	-1.826179E+03	1.113549E+03	5.3009	1.017543E+04	-1.929498E+03	6.052465E+03
121	-4.999998E-02	-1.431110E+03	-2.360651E+03	1.845737E+02	10.9364	-1.396445E+03	-2.386316E+03	4.954355E+02
	4.999998E-02	1.422545E+03	2.318992E+03	-1.851226E+02	-78.7793	2.355716E+03	1.385820E+03	4.849488E+02

INTERNAL ID RANGE= 10 - 20
ENTER INTERNAL ID OR RANGE TO BE LISTED:

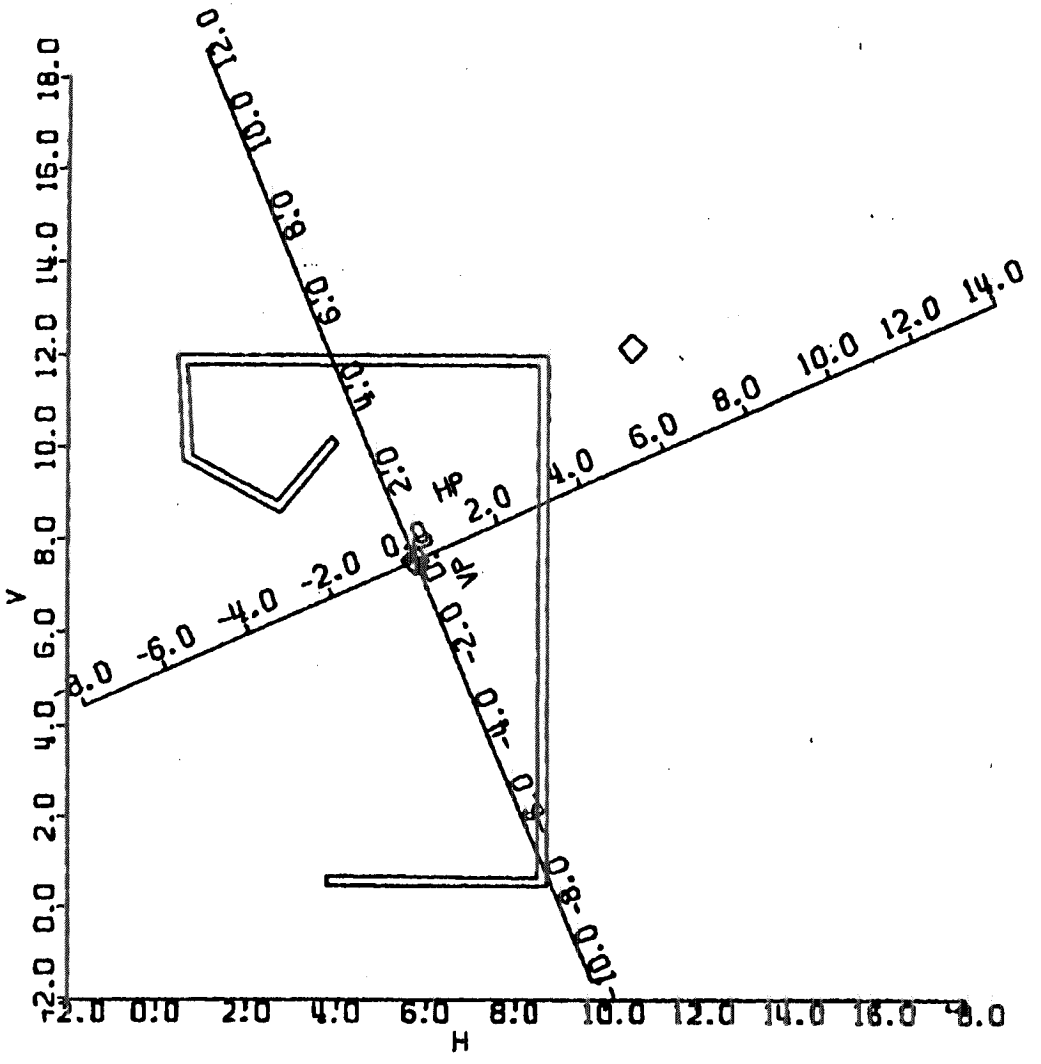
```
    S E C T I O N   H E L P   M E N U

COMMAND
    A    ---- ADD
    C    ---- CHANGE
    CS   ---- CHARACTER SIZE ------------------------- (VALUE)
    DD   ---- DIGITIZE DATA
    D    ---- DELETE
    H    ---- CREATES THIS DISPLAY
    HC   ---- HARD COPY
    L    ---- LIST
    LO   ---- LIST OUTPUT
    LS   ---- LINE SIZE ------------------------------- (VALUE)
    NP   ---- NEW PAGE
    P    ---- PLOT
    R    ---- RETURN
    RB   ---- RING BELL
    RSD  ---- RETRIEVE SECTION DATA ------------------ (PID)
    SC   ---- SOLVE CENTROIDAL
    SLC  ---- SOLVE LOCAL COLLAPSE
    SP   ---- SOLVE PRINCIPAL
    SSR  ---- SOLVE STRESS RECOVERY


          D I G I T I Z I N G   S U B C O M M A N D S

      C ---- CONNECT TO EXISTING NODE WITH A LINE
      J ---- START FROM EXISTING NODE WITH A LINE
      O ---- RE-ORIENT DRAWING ON TABLET
      T ---- CHANGE THICNESS
      P ---- DIGITIZE A STRESS RECOVERY POINT


ENTER A SECTION COMMAND:
```

ENTER A SECTION COMMAND:
SP

06-MAR-79



```
GRAFAX                                                          06-MAR-79
PBAR          98      101    6.088 125.562  38.540   0.081
+PA0098   -5.641   -4.574   -7.544  -0.156   2.813   4.313   6.017  -3.040
+PB0098    0.335    0.225    0.0
ENTER A SECTION COMMAND:
```



SECTION 98

CENTROID
5.743 , 7.556

SHEAR CENTER
10.570 , 12.125

BETA
-23.188

IH	IV
125.562	38.540

TORSION CONSTANT
.0812

PERIMETER AREA
6.0880

KVV	KHV	KHH
3.1591	-.9056	4.6954

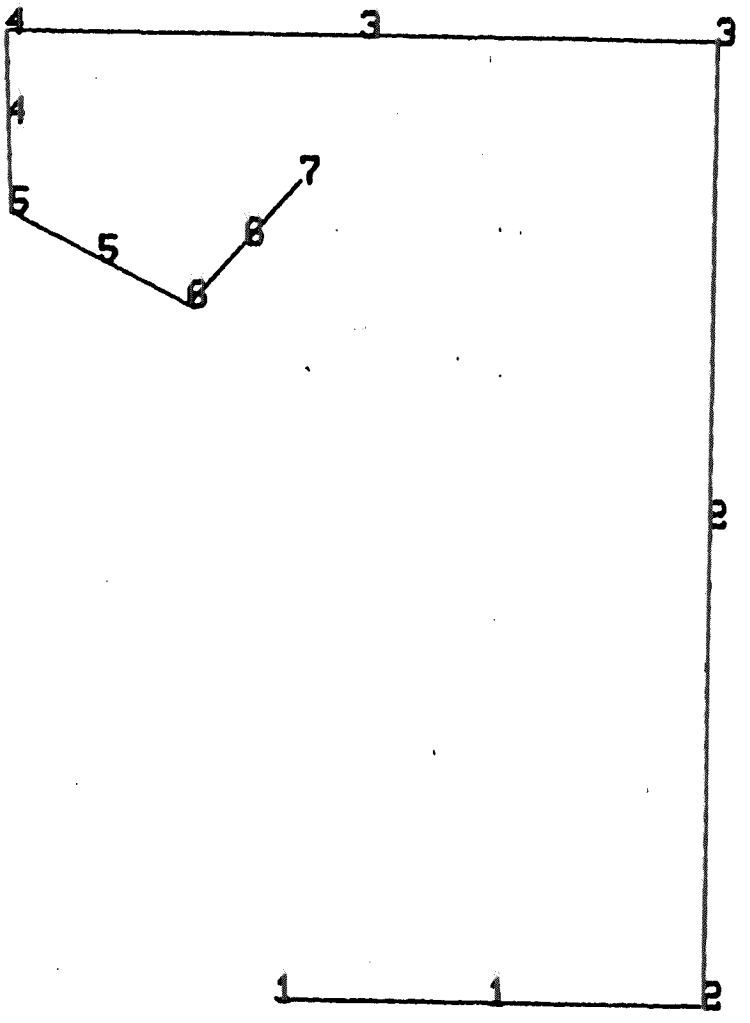
WARPING CONSTANT
1055.15

PLASTIC MOMENT FACTORS

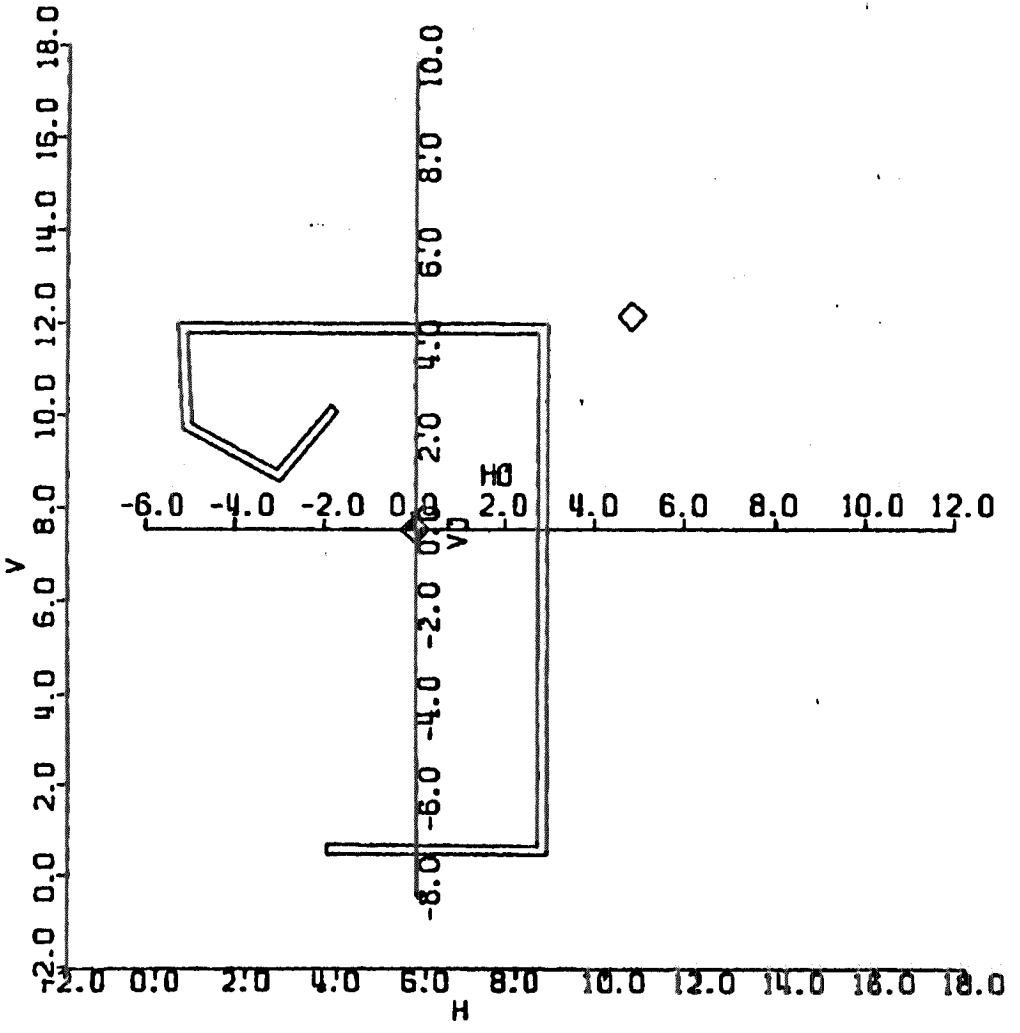
VP	HP
13.8571	25.0615

ENTER A SECTION COMMAND:
SC

06-MAR-79



```
GRAFAX                                                          06-MAR-79
PBAR          98      101    6.088 112.071   52.032    0.081
+PA0098   -6.986   -1.983   -6.996   2.827    4.284    2.857    4.334   -5.163
+PB0098    0.335    0.225  -31.497
ENTER A SECTION COMMAND:
```



SECTION 98

CENTROID
5.743 , 7.556

SHEAR CENTER
10.570 , 12.125

IVH
-31.497

IH	IV
112.071	52.032

TORSION CONSTANT
.0812

PERIMETER AREA
6.0880

KVV	KHV	KHH
3.1591	-.9056	4.6954

WARPING CONSTANT
1055.15

PLASTIC MOMENT FACTORS

VP	HP
18.2263	24.7316

R U N H E L P M E N U

COMMAND

A	----	ADD CARD
ADD	----	ADD DEFAULT DECK
B	----	SUBMIT A SELECTED BATCH RUN
C	----	CHANGE CARD
CS	----	CHARACTER SIZE ---------- (VALUE)
D	----	DELETE CARD
H	----	CREATES THIS DISPLAY
HC	----	HARD COPY
I	----	INSERT BLANK LINE
L	----	LIST CARD
LS	----	LINE SIZE ---------- (VALUE)
NP	----	NEW PAGE
R	----	RETURN
RB	----	RING BELL
S	----	SUBMIT FILE FOR BATCH RUN & END

ENTER LETTER(S) AT LEFT TO PERFORM COMMAND DESCRIBED.

E N T E R A R U N C O M M A N D :

E D I T H E L P M E N U

COMMAND

AC	----	ADD CONNECTION
AG	----	ADD GRID
AGD	----	ADD GENERATING DATA
AM	----	ADD MISCELLANEOUS
CC	----	CHANGE CONNECTION
CG	----	CHANGE GRID
CGD	----	CHANGE GENERATING DATA
CM	----	CHANGE MISCELLANEOUS
CS	----	CHARACTER SIZE ---------- (VALUE)
DC	----	DELETE CONNECTION
DG	----	DELETE GRID
DGD	----	DELETE GENERATING DATA
DM	----	DELETE MISCELLANEOUS
GND	----	GENERATE NEW DATA
H	----	CREATES THIS DISPLAY
HC	----	HARD COPY
IC	----	INSERT CONNECTION
IG	----	INSERT GRID
IGD	----	INSERT GENERATING DATA
IM	----	INSERT MISCELLANOUS
LC	----	LIST CONNECTION
LG	----	LIST GRID
LGD	----	LIST GENERATING DATA
LM	----	LIST MISCELLANOUS
LS	----	LINE SIZE ---------- (VALUE)
NP	----	NEW PAGE
R	----	RETURN
RB	----	RING BELL

E N T E R A N E D I T C O M M A N D :

```
LG 1 3
LINE I......II......II......II......II......II......II......II......II......I
   1 GRID    101     0       .00     .0      35.00   0       6
   2 GRID    102     0       10.00   .00     35.00   0       6
   3 GRID    103     0       20.00   .00     35.00   0       6
L I S T E D
ENTER LINENO OR RANGE TO BE LISTED:

E N T E R   A N   E D I T   C O M M A N D :
LC 1 3
LINE I......II......II......II......II......II......II......II......II......I
   1 CBAR    152     44      165     166     0.000   1.000   0.000   1
   2 CBAR    153     44      166     167     0.000   1.000   0.000   1
   3 CBAR    154     44      167     168     0.000   1.000   0.000   1
L I S T E D
ENTER LINENO OR RANGE TO BE LISTED:

E N T E R   A N   E D I T   C O M M A N D :
LM 1 3
LINE I......II......II......II......II......II......II......II......II......I
   1 EIGB    1       INV     .1      1000.   3       3       3               +E
   2 +E      MAX
   3 FORCE   1       121             500.    0.0     0.0     -1.0
L I S T E D
ENTER LINENO OR RANGE TO BE LISTED:

E N T E R   A N   E D I T   C O M M A N D :
```

```
 CHAN.CMD
EDIT
NP
CS 4
AGD
GRID,1,,1.0,0.0,0.0
GRID,2,,0.5,0.0,0.0
GRID,3,,0.0,0.0,0.0
GRID,4,,0.0,0.5,0.0
GRID,5,,0.0,1.0,0.0
GRID,6,,0.0,1.5,0.0
GRID,7,,0.0,2.0,0.0
GRID,8,,0.5,2.0,0.0
GRID,9,,1.0,2.0,0.0
=,10,=,=,=,0.5,==,9
=,100,=,=,6.0,=,==,1
=,1000,=,4.0,==,1

GND
HC
NP
DGD 1 999
AGD
CQUAD4,1,1,1,2,12,11
=,1,=,1,1,1,1,==,7
=,10,=,10,10,10,10,==,8
=,100,1,100,100,100,100,==,1
=,1000,10,1000,1000,1000,1000,==,1

GND
HC
R
END
READY
```

```
E N T E R   A N   E D I T   C O M M A N D :
E N T E R   A N   E D I T   C O M M A N D :
ENTER DATA FOR CARD:
   1 GRID,1,,1.0,0.0,0.0
A D D E D
ENTER DATA FOR CARD:
   2 GRID,2,,0.5,0.0,0.0
A D D E D
ENTER DATA FOR CARD:
   3 GRID,3,,0.0,0.0,0.0
A D D E D
ENTER DATA FOR CARD:
   4 GRID,4,,0.0,0.5,0.0
A D D E D
ENTER DATA FOR CARD:
   5 GRID,5,,0.0,1.0,0.0
A D D E D
ENTER DATA FOR CARD:
   6 GRID,6,,0.0,1.5,0.0
A D D E D
ENTER DATA FOR CARD:
   7 GRID,7,,0.0,2.0,0.0
A D D E D
ENTER DATA FOR CARD:
   8 GRID,8,,0.5,2.0,0.0
A D D E D
ENTER DATA FOR CARD:
   9 GRID,9,,1.0,2.0,0.0
A D D E D
ENTER DATA FOR CARD:
  10 *,10,*,*,*,0.5,**,9
A D D E D
ENTER DATA FOR CARD:
  11 *,100,*,*,6.0,*,**,1
A D D E D
ENTER DATA FOR CARD:
  12 *,1000,*,4.0,**,1
A D D E D
ENTER DATA FOR CARD:
E N T E R   A N   E D I T   C O M M A N D :
THE FOLLOWING HAS BEEN GENERATED & ADDED

    360 GRID CARD IMAGES.
E N T E R   A N   E D I T   C O M M A N D :
```

```
ENTER AN EDIT COMMAND:
DELETED
ENTER AN EDIT COMMAND:
ENTER DATA FOR CARD:
   1 CQUAD4,1,1,1,8,12,11
ADDED
ENTER DATA FOR CARD:
   2 -,1,-,1,1,1,1,--,7
ADDED
ENTER DATA FOR CARD:
   3 -,10,-,10,10,10,10,--,8
ADDED
ENTER DATA FOR CARD:
   4 -,100,1,100,100,100,100,--,1
ADDED
ENTER DATA FOR CARD:
   5 -,1000,10,1000,1000,1000,1000,--,1
ADDED
ENTER DATA FOR CARD:
ENTER AN EDIT COMMAND:
THE FOLLOWING HAS BEEN GENERATED & ADDED

     288 ELEMENT CARD IMAGES.
ENTER AN EDIT COMMAND:
```

```
CHECKING AND TRANSFORMING      360 GRID CARD IMAGES.
UNSORTED GRIDS APPEARED.
THEY HAVE BEEN SORTED.
D A T A    S A V E D
CHECKING AND TRANSFORMING      288 ELEMENT CARD IMAGES.
ENTER A VIEW COMMAND:
RX 20
ENTER A VIEW COMMAND:
RY 030
ENTER A VIEW COMMAND:
P
```

RX= 20. RY= 30. RZ= 0. GRAFAX 06-MAR-79
ENTER A VIEW COMMAND: