* * * MSC/CASE * * *

COMPUTER AIDED SOLUTIONS FOR ENGINEERS

Structural and Mechanical Applications

WALTER SCHMIDT
CONSULTANT
D.V. SCHIAVELLO ENTERPRISES INC.

DANIEL V. SCHIAVELLO
EXECUTIVE CONSULTANT
D.V. SCHIAVELLO ENTERPRISES INC.

Developed and Supported by DVSE INC.
in cooperation with MSC

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A B S T R A C T

Microcomputers have an essential impact on structural/mechanical engineering applications. Microcomputers have not replaced mainframes and cannot be reasonably used to solve large analytical problems. However, with appropriate software, micro-computers can serve as a powerful labor saving tool for engineers, architects, physicists, educators, students and researchers.

Using conventional methods such as hand calculations, desk calculators or mainframes, calculation of input parameters, preliminary and parametric studies, and verification and interpretation of analytical results are cumbersome, if not impossible, tasks. Calculation of input parameters often require repetitive number crunching, gross approximations and extensive error checking. Preliminary and parametric studies, sometimes performed using equations provided by well-known reference books, are time consuming and tedious. Verification and interpretation of results, an extremely important phase of any analysis, are sometimes ignored due to the complexity of the models and analyses. Instead, engineers may rely too heavily on large volumes of almost unmanageable computer output.

MSC/CASE has been developed by engineers using database and equation solving techniques. This program will not only simplify these tasks, but also provides more reliable analyses in comparison with previously available methods. By reducing the risk of error, minimizing time and costs associated with these tasks and optimizing analysis parameters, MSC/CASE solutions provide the engineer with more confidence in the analytical model and the results.

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1.0 INTRODUCTION

MSC/CASE, "Computer Aided Solutions for Engineers" has been developed by engineers using database and equation solving techniques. MSC/CASE is an interactive program which numerically solves a variety of equations required in many categories of structural/mechanical engineering applications. These equations, based on the theory of elasticity and strength of materials, have been rigorously researched in the literature and represent the results of theoretical efforts by recognized masters of the engineering profession including Euler, Rayleigh, Love, St. Venant, Flügge, Timoshenko and many others.

MSC/CASE has a modular format, operates interactively and is driven by self-explanatory menus. Therefore, it requires no background with operating systems or computer programming.

Although the MSC/CASE User's Manual and the optional theoretical manual are informative and clearly written, extensive help screens are provided within the program to allow a beginner to use MSC/CASE with little or no reference to these manuals.

MSC/CASE utilizes high resolution graphics to provide easy input of geometrical and physical parameters and to present graphically enhanced solutions in addition to selected printed output.

This combination of self explanatory menus, modular format design, high resolution graphics and extensive help screens results in a versatile engineering tool operating in a user friendly microcomputer environment.

2.0 MSC/CASE DESCRIPTION

2.1 MSC/CASE Operating Environment

MSC/CASE operates on most 16-bit microcomputers including the entire IBM family, the Zenith Z-100 and other compatibles that use the MS-DOS operating system. The program provides color high resolution graphics for the Z-100 and compatibles, and monochrome high resolution graphics for the IBM PC and compatibles.

2.2 MSC/CASE Analysis Categories

The MSC/CASE system, which consists of 34 solution modules, initially prompts the user to select an analysis category from the MAIN MENU. These analysis categories are:

A. Geometric and Material Properties
B. Beams and Columns
C. Rings, Cables, Arches and Frames
D. Plates, Shells and Pressure Vessels
E. Natural Frequencies
F. Miscellaneous (Combined Stress, Stress Concentration Factors, Conversion Factors)
G. User Defined Modules

A module menu appears on the screen following the selection of a particular analysis category.

2.3 MSC/CASE Solution Modules

The MSC/CASE system consists of thirty solution modules accessible from the appropriate MODULE MENU. Additionally, the program provides expansion capability by permitting the user to append as many as four user defined solution modules.

Individual MSC/CASE solution modules include:

A. GEOMETRIC AND MATERIAL PROPERTIES

A-1 PROPERTIES OF PLANE SECTIONS

To compute the area, centroid location, moments of inertia, radii of gyration, shear center, shear area reduction factor, and torsional properties of thirty typical cross-sectional shapes.

A-2 PROPERTIES OF THREE-DIMENSIONAL SOLIDS

To compute the volume, centroid and mass moments of inertia about various axes for sixteen typical three-dimensional solids.

A-3 NEUTRAL AXIS SHIFT DUE TO BEAM CURVATURE

To compute the shift in neutral axis location, the change in extreme fiber stress, as well as the stress distribution profile when a curved beam is subjected to pure bending. Stresses are normalized based on the application of a unit moment.

A-4 MATERIAL PROPERTIES

To tabulate and store different values of the material constants for a variety of commonly used structural materials. This database of material constants is automatically accessed by the program whenever the user requests the constants for a particular material.

B. BEAMS AND COLUMNS

B-1 SINGLE SPAN BEAMS UNDER TRANSVERSE AND AXIAL LOADS

To compute the deflection, shear, and moment along a single span beam subjected to various combinations of loading and boundary conditions.

B-2 SINGLE SPAN BEAMS UNDER TORSIONAL LOADING

To compute the angle of twist, the first derivative of the angle of twist, and the twisting moment along a single span beam subjected to various loading and boundary conditions.

B-3 MULTI-SPAN BEAMS UNDER TRANSVERSE LOADING

To compute the deflection, shear, and moment along each span of a multispan beam subjected to various loading and boundary conditions.

B-4 CURVED BEAMS

To compute the deflection, bending and roll slopes, transverse shear, as well as bending and torsional moments at a set of points along a single span curved beam subject to various loading and boundary conditions.

B-5 BEAMS ON ELASTIC FOUNDATIONS-FINITE LENGTH

To compute the deflection, shear and moment along a finite length beam supported on an elastic foundation subjected to various loading conditions under several combinations of boundary conditions.

B-6 BEAMS ON ELASTIC FOUNDATIONS-INFINITE LENGTH

To compute the deflection, shear, and moment along an infinite or semi-infinite length beam supported on an elastic foundation and subjected to various loading conditions.

B-7 LATERAL BUCKLING OF BEAMS

To compute the critical load for beams that are laterally unsupported. A variety of beam cross-sections, load types, and boundary conditions are available for analysis.

To compute the critical buckling load of various columns with various boundary conditions and subjected to compressive loading.

C. RINGS, CABLES, ARCHES, AND FRAMES

C-1 CIRCULAR RINGS

To compute the deflections, hoop forces, and bending moments along a circular ring subjected to various loading and boundary conditions.

C-2 CABLES

To compute the cable tension and cable sag for uniformly loaded cables, point loaded cables, and cables that function as guys for masts.

C-3 CIRCULAR ARCHES

To compute the deflections and reactions for circular arches of constant radius and cross section when subjected to various loading and supporting conditions.

C-4 SINGLE BAY FRAMES

To compute the indeterminate reactions, moment diagram and deflections for various single bay frames consisting of one horizontal or inclined member (girder) and two vertical members (columns). Each member may be defined by a unique length and moment of inertia.

C-5 MULTI-BAY FRAMES

To compute the joint deflections, member forces and moments for 2-dimensional general frames. Each member may be defined by its length, moment of inertia, and elastic modulus.

D. PLATES, SHELLS AND PRESSURE VESSELS

D-1 PLATES-CIRCULAR

To compute the deflections, shears, and moments for circular plates. Numerous transverse loading conditions may be applied in combination with fixed or simply supported boundaries.

D-2 PLATES-RECTANGULAR

To compute the deflections, boundary shears, and moments for rectangular plates of uniform thickness. Numerous transverse loading conditions are considered in combination with a variety of boundary conditions.

D-3 CYLINDRICAL SHELLS-THIN WALLED

To compute the deflection, shears, and moments along the length of thin walled cylindrical shells subjected to various axisymmetric loading conditions and boundary conditions.

D-4 PRESSURE VESSELS-THIN WALLED

To compute the shell displacements and membrane stresses for thin walled pressure vessels subjected to various loading and boundary conditions.

D-5 PRESSURE VESSELS-THICK WALLED

To compute the shell displacements, the bending and membrane stresses, as well as the radial stresses for thick walled pressure vessels subjected to various loading conditions.

D-6 BUCKLING OF PLATES AND SHELLS

To compute the critical buckling loads for several forms of plates and shells variously supported and loaded .

E. NATURAL FREQUENCIES

E-1 NATURAL FREQUENCIES OF DISCRETE SYSTEMS

To compute the natural frequencies and corresponding mode shapes for a variety of discrete systems. Various single and multiple degree-of-freedom undamped oscillators are included.

E-2 NATURAL FREQUENCIES OF BEAMS

To compute the first three natural frequencies and corresponding mode shapes for single span beams under various boundary conditions and idealized weight distributions.

E-3 NATURAL FREQUENCIES OF PLATES

To compute the natural frequencies and corresponding mode shapes for rectangular plates under various boundary conditions and idealized weight distributions.

F. MISCELLANEOUS

F-1 COMBINED STRESS

To compute the principal stresses, the principal angle, the maximum shear stress as well as the normal and shear stresses on any given plane for a body subjected to a general condition of uniaxial, biaxial and triaxial applied stress. A Mohr's circle diagram is also displayed.

F-2 STRESS DISTRIBUTION ON CROSS-SECTIONS WITH NO STRESS REVERSAL

To compute the neutral axis position, the maximum fiber stress, and the kern dimensions for an eccentrically loaded circular or rectangular section on which stress reversal cannot take place. The applied load may act anywhere inside the section.

F-3 STRESS CONCENTRATION FACTORS

To compute the stress concentration factors for various types of structural discontinuities.

F-4 CONVERSION FACTORS

To provide a reference guide of conversion factors between several sets of standard units of measure. Conversions from one system of units to another are considered.

G. USER DEFINED MODULES

G-1 through G-4

To provide the user with the capability of appending MSC/CASE with special purpose programs.

2.4 Special Features

MSC/CASE has special features that result in a particularly practical product designed so that the user can concentrate on the engineering problem rather than the details of program operation.

A. MSC/CASE utilizes high resolution graphics to display graphical output when applicable. Deflection diagrams, shear and bending moment diagrams, mode shapes and stress distributions are just a few examples of the graphical output presented. In addition, digitized output files are available in report form.

B. Extensive help screens are provided within MSC/CASE solution modules. The "help" information is menu specific and becomes more detailed as more explanation becomes necessary.

C. An "Install" utility prompts the user with a series of questions concerning the type of system in use (e.g. graphics capabilities, printing capabilities, and color capabilities). Based on the user's responses, the program automatically establishes a set of parameters that will direct input and output routines consistent with the local system configuration. These parameters are written to the MSC/CASE system disk for permanent record. Thus, "Install" need not be executed again (unless the system configuration is altered).

D. The user can select any one of ten function keys to activate special utilities. They are shown at the bottom of individual menus when they are active. These function keys perform the following operations:

F1	HELP	To request help if necessary
F2	PRINT	To print an output file to a printer
F3	DISP	To display an output file on the screen
F4	MATL	To select a specific material as the "active" material
F5	PREV	To scroll to the previous screen within a multi-screen menu
F6	NEXT	To scroll to the next screen within a multi-screen menu
F7	MENU	Move backward from a given menu to a preceding menu in the menu heirarchy
F8	REDO	To redo calculations using new in put variables
F9	SAVE	To save an output file to disk

F10	TOP	To return to the opening menu from within a solution module
F10	SYSTEM	To exit to the disk operating system from any Module Menu or from the Main Menu

2.5 MSC/CASE User and Theoretical Manuals

The MSC/CASE User's Manual covers the installation and execution of the program. All of the program's capabilities are fully described and examples of these capabilities are provided.

The User's Manual explains each solution module description according to the following format:

1. **BRIEF**
2. **PROCEDURE**
3. **APPLICATION**

The **BRIEF** section is a condensed technical synopsis of the capabilities of a specific solution module option.

The **PROCEDURE** section is a step-by-step set of instructions which guide the user through the MSC/CASE analysis module selected.

The **APPLICATION** section consists of typical sample problems supplied to clarify user responses to program prompts as defined within the PROCEDURE section. Illustrations of various menus and typical output displays for the particular module are provided.

In addition, an Input/Output Nomenclature section is included within each solution module description to define input and output variables.

A presentation of the solution techniques implemented within MSC/CASE along with the appropriate references is available in the optional MSC/CASE Theoretical Manual.

3.0 MSC/CASE APPLICATIONS

3.1 MSC/CASE and the Analyst

MSC/CASE serves as an invaluable computational aid to the analyst by providing an efficient means of performing the following time-consuming tasks:

Calculations of Input Parameters -

Such calculations are often unnecessarily labor intensive and are therefore prone to a high risk of error. MSC/CASE frees the user from such lengthy calculations and minimizes time and cost.

Design and Analysis -

Analytical Results Including: Stresses, deflections, forces, shears, moments and reactions are quickly calculated and can be compared to applicable design criteria and stress limits.

Preliminary and Parametric Studies -

Such studies are often repetitive in nature. MSC/CASE facilitates the compilation of parametric studies with easily implemented input parameter definition and modification.

Verification of Test and Analytical Results -

Test results can be quickly verified to ensure test procedure reliability. In addition, the results and trends from complex analytical models can be easily verified by comparing solutions provided by MSC/CASE to results obtained from large scale-general purpose engineering analysis.

Research and Development -

By providing solutions to a large collection of engineering equations, MSC/CASE frees the user from tedious derivations and time consuming literature searches.

MSC/CASE provides the analyst with increased confidence in the analytical model and the associated results. The analyst can now concentrate on the engineering rather than the bookkeeping aspects of the structural/mechanical calculations.

3.2 Typical Applications

MSC/CASE provides assistance in developing solutions for a wide range of applications including:

ANALYSIS AND DESIGN APPLICATIONS

- Civil/Structural
  - Bridges
  - Power Plants
  - Buildings
  - Foundations
  - Complex Structures
- Mechanical/Electrical
  - Aircraft
  - Satellites
  - Pressure Vessels
  - Automobiles
  - Pumps and Motors
  - Piping Systems and Supports
  - Equipment

OTHER APPLICATIONS

- Stress Analysis
- Feasibility Studies
- Investigation of Structural Failures
- Research & Development
- Engineering Education
- Verification of Test Program Results
- Verification of Complex Analytical Models

In all of these applications, MSC/CASE can serve as a powerful labor saving tool.

3.3 Sample Problem

A simply supported beam spans a distance of 10 feet (120 inches).

Material Property:	A36 Steel
Cross-sectional Shape:	Hollow Rectangular Tube 10" x 4" x 1/2"

A linearly varying distributed load, 60 lbs per linear foot (5 lbs per linear inch) at the left end and 120 lbs per linear foot (10 lbs per linear inch) at the right end, which includes the beam dead load, is applied along the beam length bending it about its strong axis.

1. Calculate the section properties for the hollow rectangular section,
2. Set the active material property to A36 steel,
3. Determine the maximum static deflection of this beam, and
4. Find the first three resonant frequencies and corresponding mode shapes for this beam under the prescribed weight distribution.

SOLUTION:

Part 1: Section Properties

With the MAIN MENU displayed (as shown in Figure 1), select "A" to access the MODULE MENU for the analysis category entitled "Geometric and Material Properties".

Then select "1" at the "MODULE MENU" level to access the "Properties of Plane Sections" module (refer to Figure 2).

Next, choose the appropriate cross-sectional shape from the SECTION MENU. There are three section menus for this module which display thirty available cross-sectional shapes. In this example, the section is a hollow rectangle which is displayed in SECTION MENU "1". Choose section "4" as shown in Figure 3.

This entry activates the input request display. The section dimensions are now defined by entering the appropriate dimensions (always in consistent units). The last input entry automatically activates the MSC/CASE equation solving routines.

The display is then supplemented with the appropriate section properties including the area, centroid location, moments of inertia, radii of gyration, the torsional constant, and the shear area reduction factor, (refer to Figure 4).

For this example, only the major axis moment of inertia, (151.0833 inches^4) is required for the static and eigenvalue analyses.

Part 2: Setting the "Active" Material Property

MSC/CASE provides the user with a database of 25 specific materials. Figure 5 presents the first of five MATERIAL MENUS from Module "A-4" entitled "Material Properties". The "active" material for this example is "A36 Steel" (Selection "2"). The default properties for any material can be specified for use during input entry. Default values can be selected from within Module "A-4" or by using the Material Function Key F4 from within other modules.

Part 3: Static Analysis

Return to the MAIN MENU in order to access the MODULE MENU B for analysis category entitled "Beams and Columns".

Then select "1" at the MODULE MENU level to access "Single Span Beams under Transverse and Axial Loads", (refer to Figure 6).

The loading condition menu next appears as shown in Figure 7. In this example, the loading condition is a linearly varying distributed load. Select loading condition type "2".

Figure 8 presents the boundary condition menu. This problem defines the boundary conditions as simply supported at both ends. Enter selection "1".

This entry activates the input request display. Enter the appropriate values to define the beam properties, the loading intensity, and loading location (in consistent units). The last input entry automatically activates the MSC/CASE equation solving routines.

The display is then supplemented with the appropriate deflection, shear, and bending moment diagrams, (refer to Figure 9). In addition, the digitized maximum values and boundary values of the output are provided.

In this example, the maximum deflection is 0.0046 inches.

A detailed report providing the digitized values at fifty points along the beam length can be routed to a printer using the F2 PRINT function key or can be displayed on the screen using the F3 DISPLAY function key, (see Table 1).

Part 4 - Eigenvalue Analysis

Return to the MAIN MENU and select "E" to access the MODULE MENU for the analysis category entitled, "Natural Frequencies".

Then select "2" at the MODULE MENU level to access "Natural Frequencies of Beams", (refer to Figure 10).

Next, choose the appropriate boundary condition from the boundary condition menu presented in Figure 11. This problem defines the boundary conditions as simply supported at both ends. Choose selection "1".

The concentrated weight distribution menu now appears. This menu, shown in Figure 12, offers four concentrated weight distribution options. For this example, enter concentrated weight type "1" since no concentrated weight is applied.

The uniform weight distribution menu appears next, (refer to Figure 13). This menu offers four uniform weight distribution options. This example, assumes a linearly varying weight distribution, therefore enter uniform weight type "3".

This entry activates the input request display. Define the beam properties and the weight intensities by entering the appropriate values as previously defined. The last input entry automatically activates the MSC/CASE equation solving routines.

The display is then supplemented with the first three natural frequencies and mode shapes as shown in Figure 14.

In this example, the fundamental bending frequency for the beam is 51.8 Hz.

A detailed report providing the digitized values of the mode shapes at forty points along the beam length can be routed to a printer using the F2 PRINT function key or can be displayed on the screen using the F3 DISPLAY function key, (see Table 2).

4.0 CONCLUSION

4.1 MSC/CASE: A Professional Review

Upon reviewing MSC/CASE, Mario G. Salvadori, Professor Emeritus of Civil Engineering and of Architecture, Columbia University and Chairman of the Board of Weidlinger Associates, Consulting Engineers states:

> "...MSC/CASE is a practical tool in the hands of the professional engineer, a teaching aid in the hands of the educator, an exciting means of learning in the hands of the student, a constructive time-saver for the researcher, and a comprehensive source of information for the architect."

4.2 Technical Support

Technical support is provided by DVSE Inc. through a special hotline. In addition, engineering consultation is available upon request to assist in solving complex problems and to develop customized user defined modules.

LIST OF FIGURES

FIGURE 1: The Main Menu

FIGURE 2: Module Menu A - Geometric and Material Properties

FIGURE 3: Module A-1 - Section Menu 1 of 3

FIGURE 4: Module A-1 - Output Display

FIGURE 5: Module A-4 - Material Menu 1 of 5

FIGURE 6: Module Menu B - Beams and Columns

FIGURE 7: Module B-1 - Loading Condition Menu

FIGURE 8: Module B-1 - Boundary Condition Menu

FIGURE 9: Module B-1 - Output Display

FIGURE 10: Module Menu E - Natural Frequencies

FIGURE 11: Module E-2 - Boundary Condition Menu

FIGURE 12: Module E-2 - Concentrated Weight Distribution Menu

FIGURE 13: Module E-2 - Uniform Weight Distribution Menu

FIGURE 14: Module E-2 - Output Display

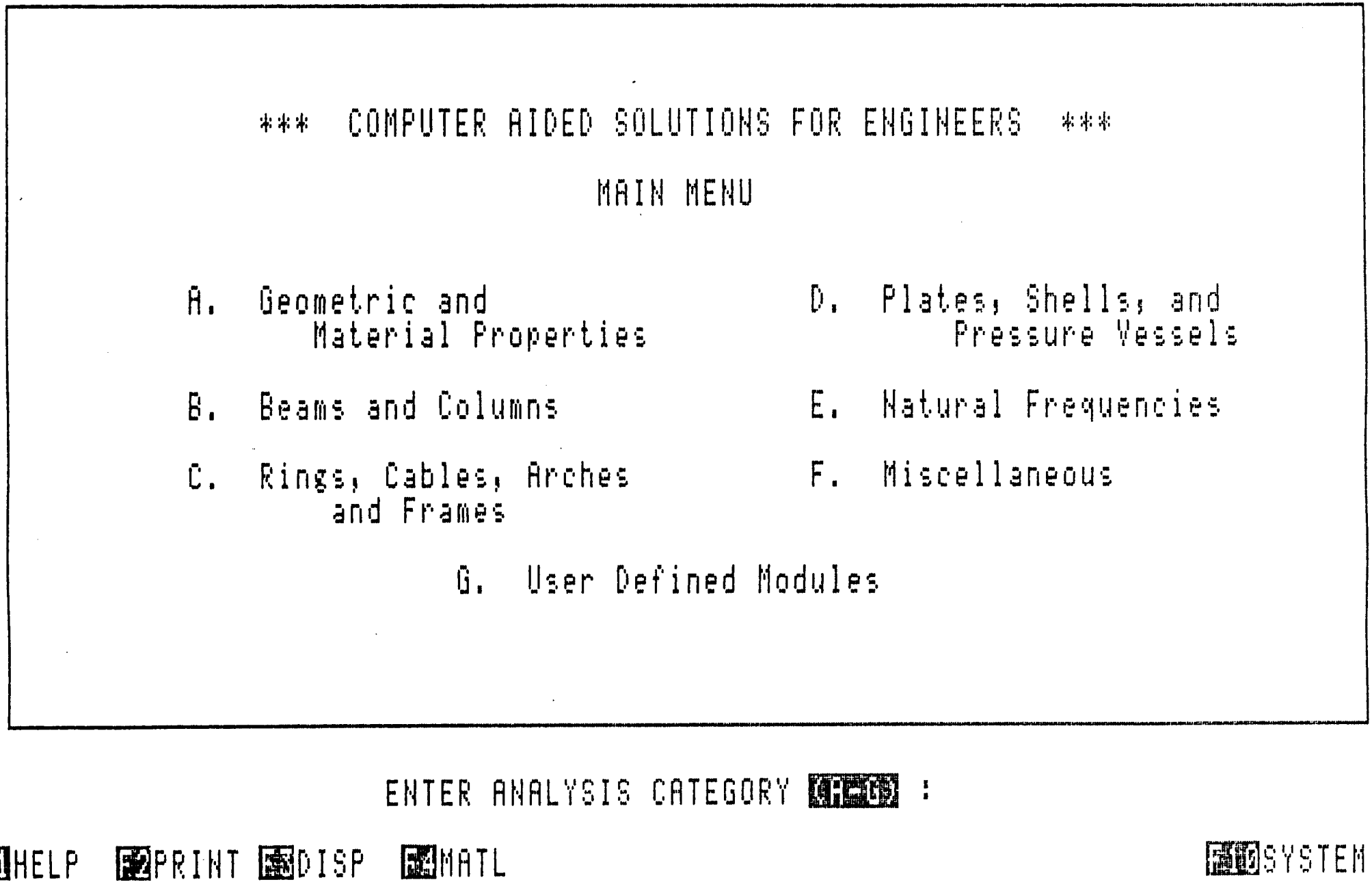


FIGURE 1: The Main Menu

* G E O M E T R I C A N D M A T E R I A L P R O P E R T I E S *

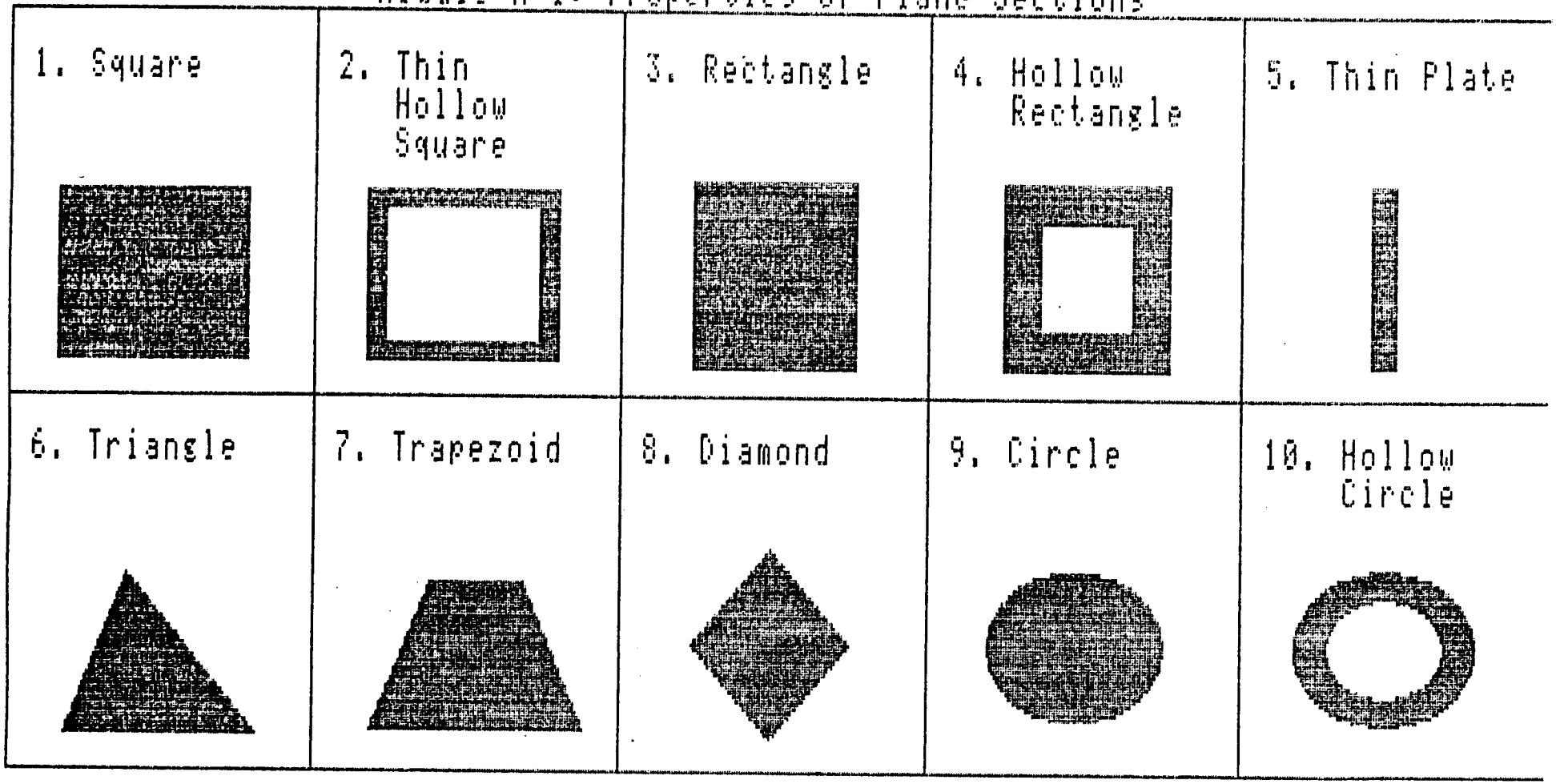
MODULE	DESCRIPTION
1	Properties of Plane Sections
2	Properties of Three-dimensional Solids
3	Neutral Axis Shift due to Beam Curvature
4	Material Properties

ENTER MODULE NUMBER OR F7 FOR MAIN MENU:

F1 HELP F2 PRINT F3 DISP F4 MATL F7 MENU

Module Menu A: Geometric and Material Properties

Module A-1: Properties of Plane Sections



SELECT SECTION NUMBER [1-10] OR [F7] FOR MODULE MENU:

[F1]HELP [F2]PRINT [F5]DISP [F6]MATL [F8]NEXT [F7]MENU

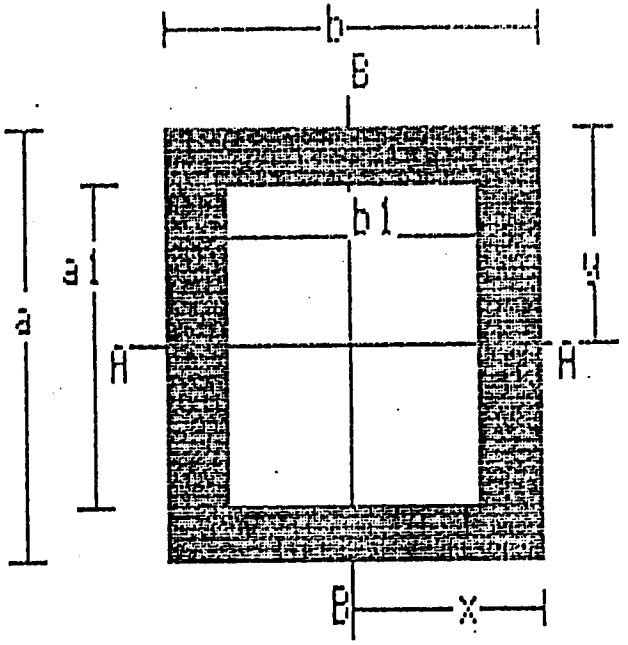
FIGURE 3: Module A-1: Section Menu 1 (of 3)

Module A-1: Properties of Plane Sections

```
DIMENSION a  = 10
DIMENSION a1 = 9
DIMENSION b  = 4
DIMENSION b1 = 3

Area    =  13
y       =  5
x       =  2
Iaa     =  151.0833
Ibb     =  33.08333
ra      =  3.409076
rb      =  1.595265
J       =  85.04327
K       =  .6407692
```

4. Hollow Rectangle



ENTER ▒▒ FOR SECTION MENU

▒▒PRINT ▒▒DISP ▒▒MENU ▒▒REDO ▒▒SAVE

FIGURE 4: Module A-1 - Output Display

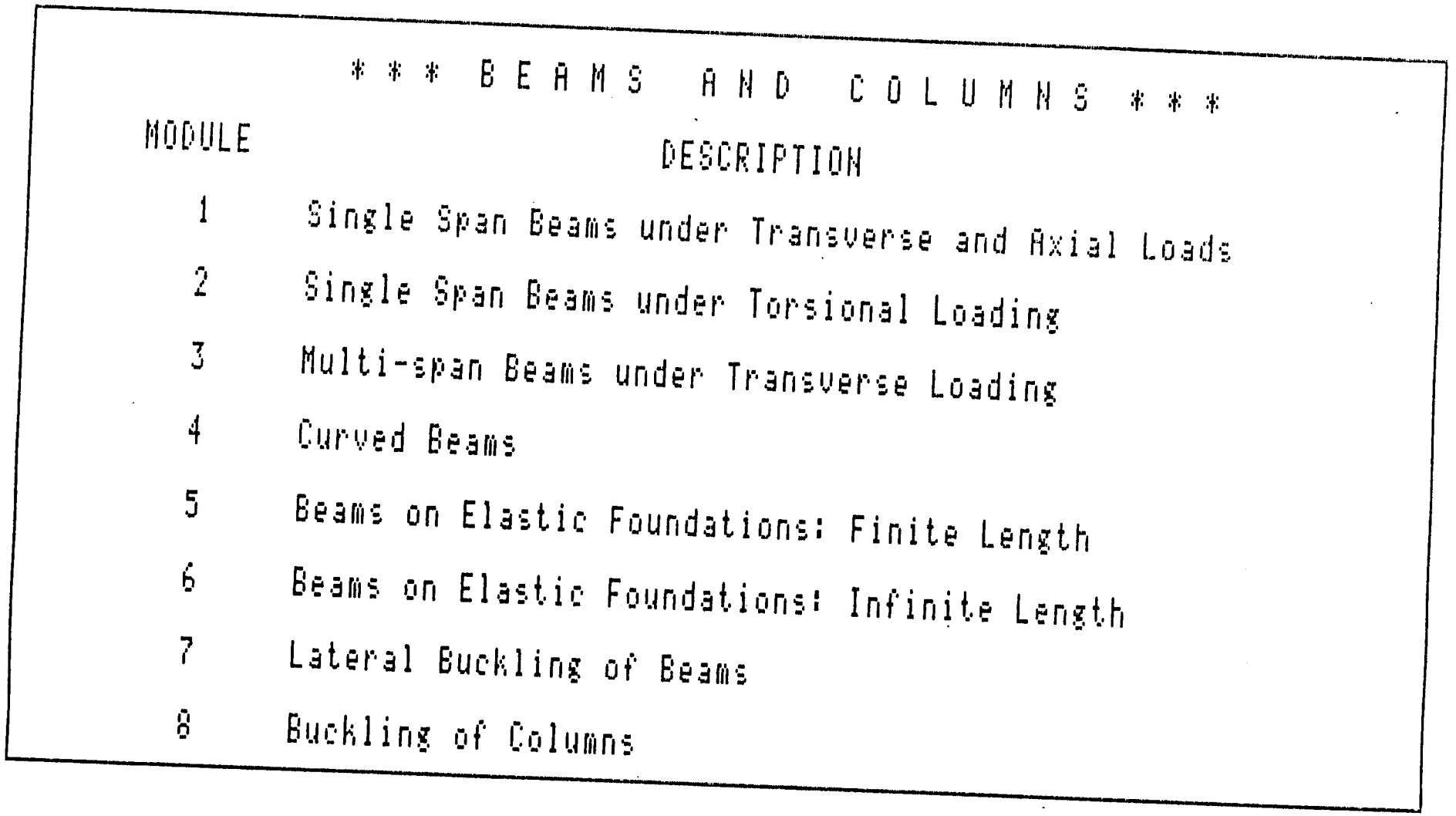


FIGURE 6: Module Menu B: Beams and Columns

Module A-4: Material Properties Screen 1 of 5

	Material Name	Young's Modulus (E)	Shear Modulus(G)	Poisson's Ratio (ν)	Wt Density (P)	Therm Exp Coeff (α)
1	AISI 1025 Steel	2.900D+07	1.100D+07	0.32	0.2840D+00	0.678D-05
2	Low Alloy Steel	2.900D+07	1.100D+07	0.32	0.2830D+00	0.630D-05
3	5CrMoV Steel	3.000D+07	1.100D+07	0.36	0.2810D+00	0.710D-05
4	Al 2014 sh/pl	1.070D+07	4.000D+06	0.33	0.1010D+00	0.125D-04
5	Al 2017 sh/pl	1.040D+07	4.000D+06	0.33	0.1010D+00	0.127D-04
6	Al 2024 sheet	1.050D+07	4.000D+06	0.33	0.1000D+00	0.129D-04
7	Al 2024 plate	1.070D+07	4.000D+06	0.33	0.1000D+00	0.129D-04
8	Al 2219 extrude	1.050D+07	4.000D+06	0.33	0.1020D+00	0.121D-04
9	Al 5052	1.010D+07	3.850D+06	0.33	0.9700D-01	0.126D-04
10	Al 5038	1.020D+07	3.850D+06	0.33	0.9600D-01	0.132D-04
11	Al 5086	1.020D+07	3.850D+06	0.33	0.9600D-01	0.132D-04
12	Al 6061	9.900D+06	3.800D+06	0.33	0.9800D-01	0.130D-04
13	Al 5454	1.020D+07	3.850D+06	0.33	0.9700D-01	0.131D-04
14	Al 7075	1.030D+07	3.900D+06	0.33	0.3300D+00	0.129D-04
15	AZ31B Magnesium	6.500D+06	2.400D+06	0.35	0.6390D-01	0.135D-04

The current active material is No. 1

ENTER MATERIAL PROPERTY ID [redacted] OR [redacted] FOR MODULE MENU:

[redacted]HELP [redacted]PRINT [redacted]DISP [redacted]PREV [redacted]NEXT [redacted]MENU

FIGURE 6: Module A-4 - Material Menu 1 (of 5)

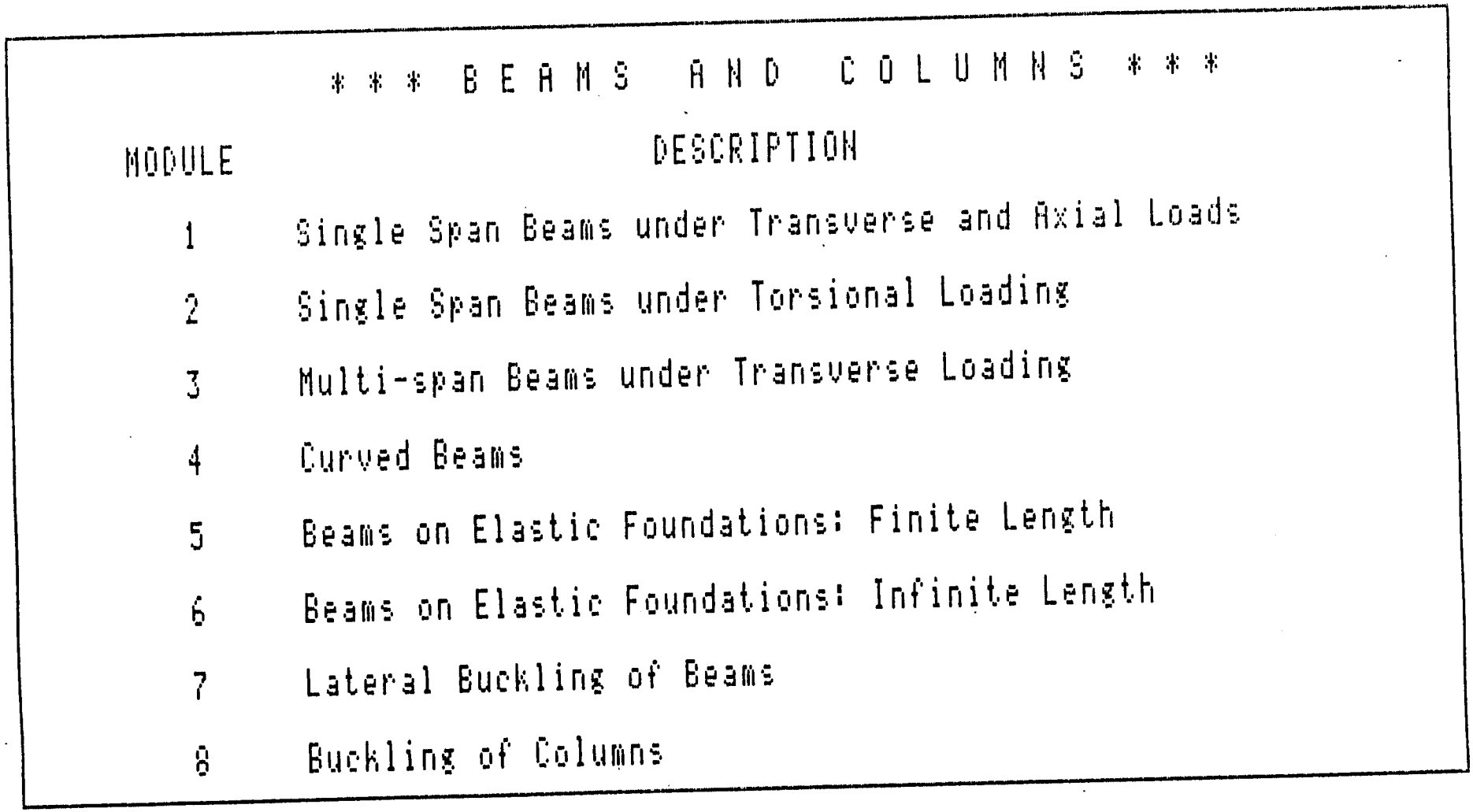


FIGURE 6: Module Menu B: Beams and Columns

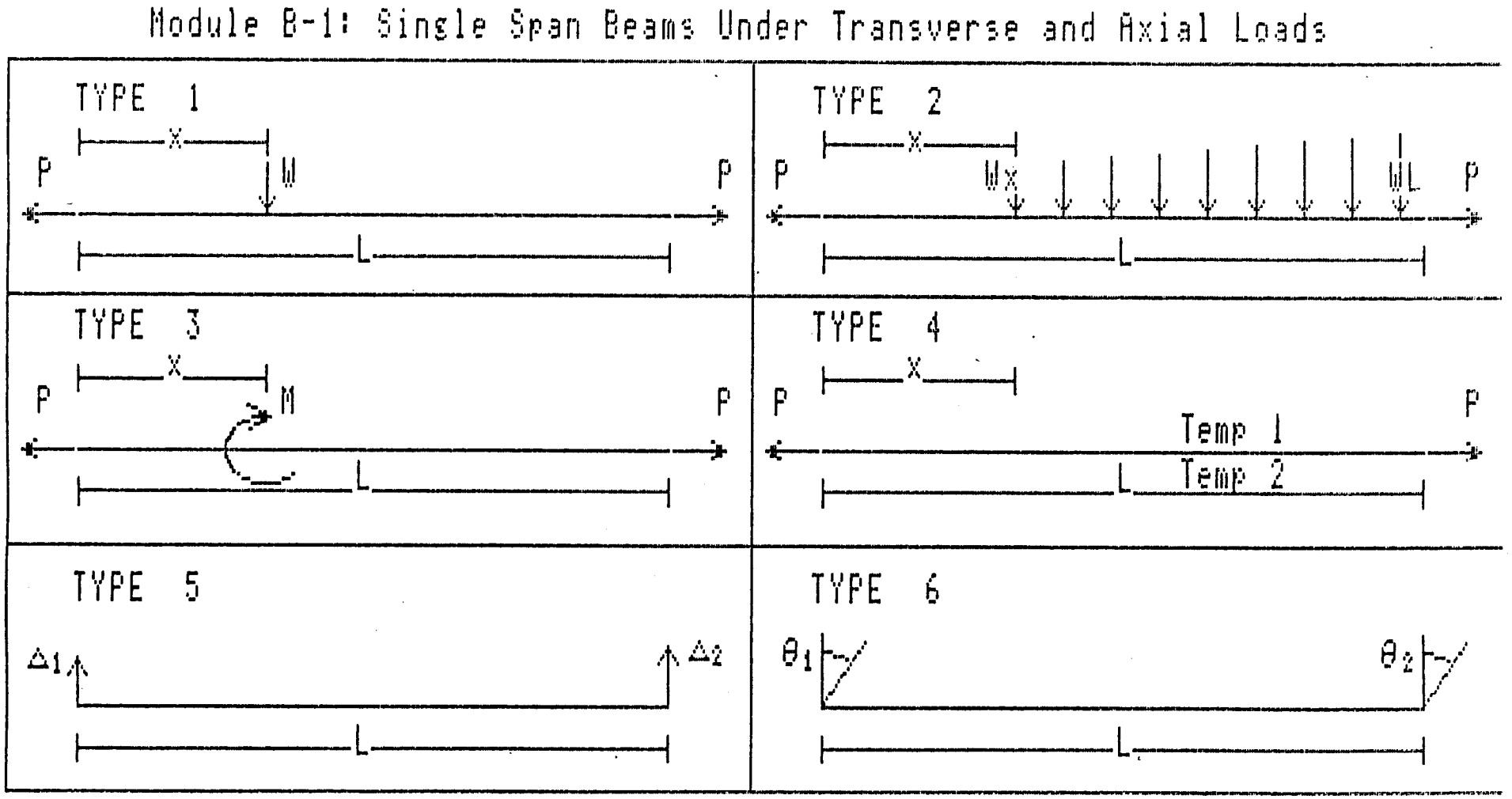


FIGURE 7: Module B-1: Loading Condition Menu

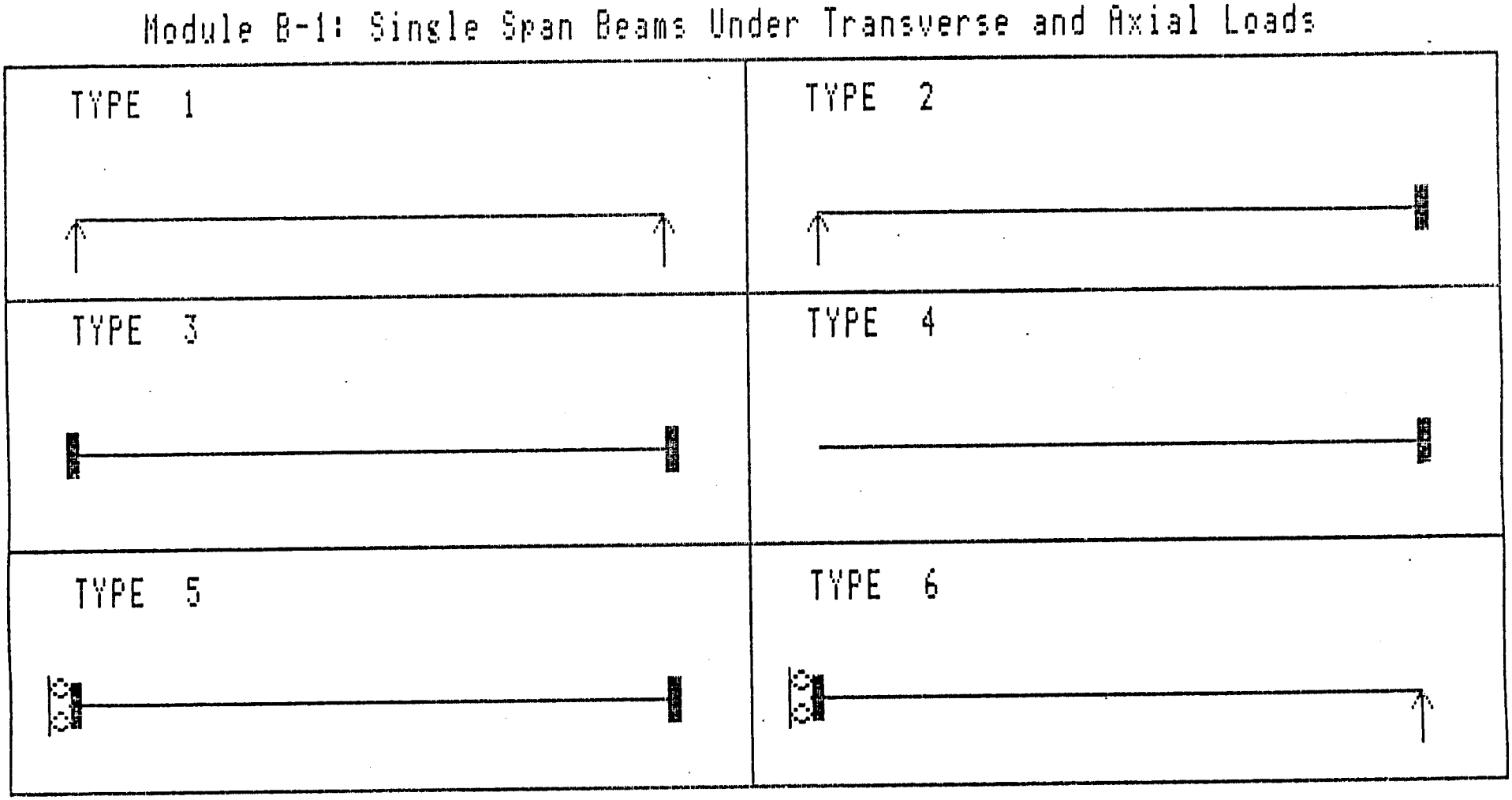


FIGURE 8: Module B-1: Boundary Condition Menu

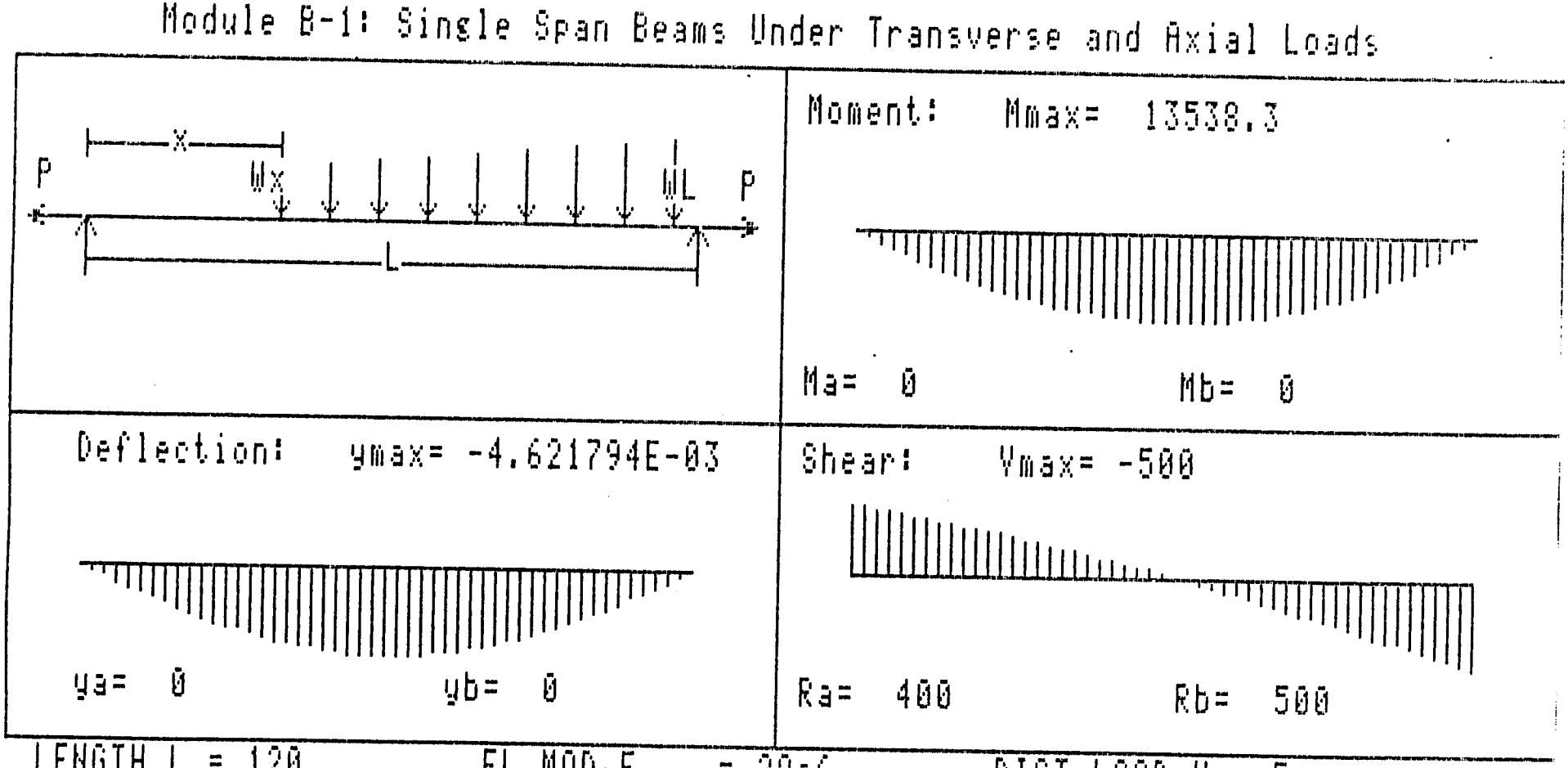


FIGURE 9: Module B-1: Output Display

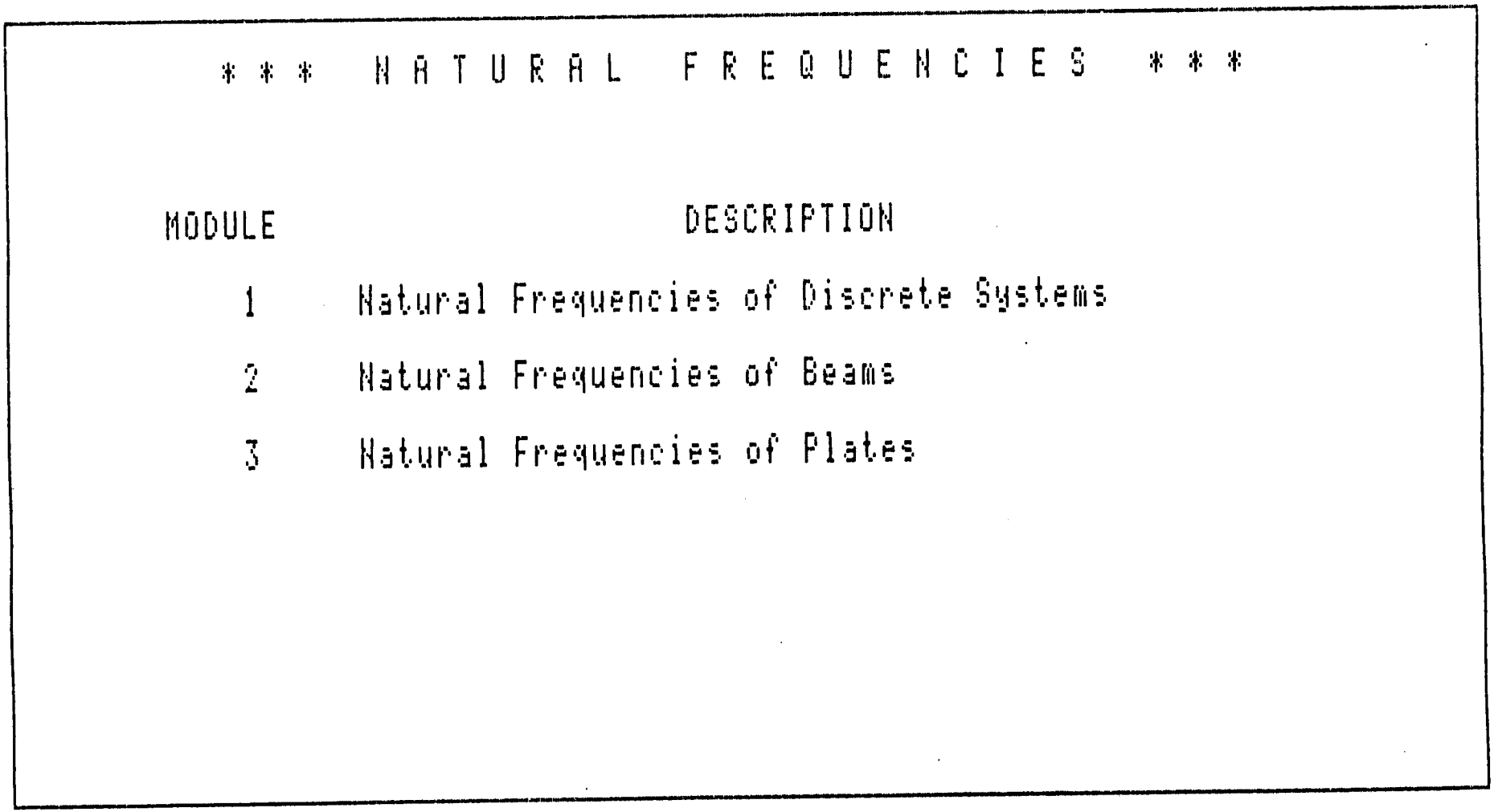
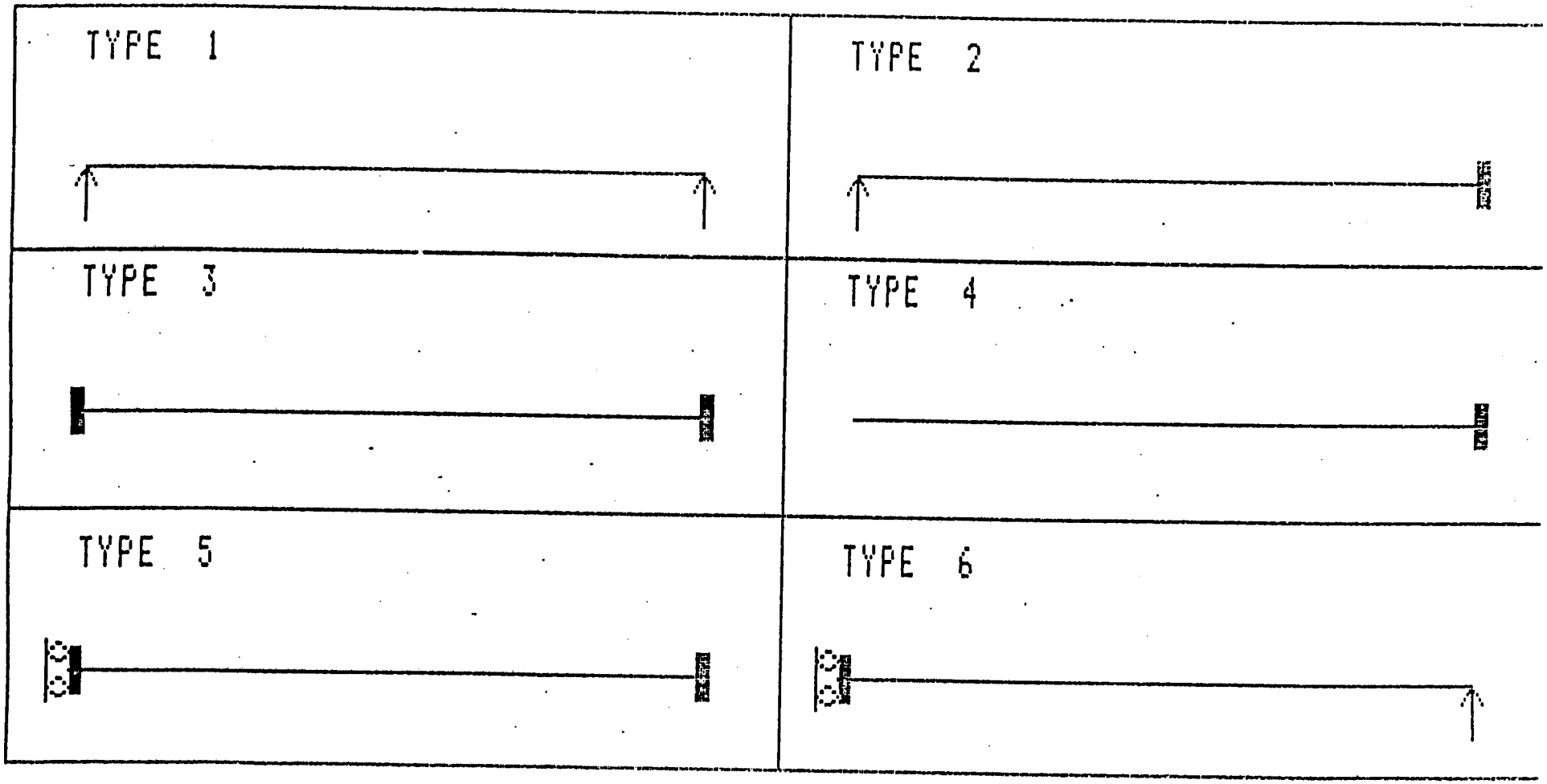


FIGURE 10: Module Menu E: Natural Frequencies

Module E-2: Natural Frequencies of Beams



SELECT BOUNDARY CONDITION TYPE [redacted] OR
[redacted] FOR MODULE MENU: 1

[redacted]HELP [redacted]PRINT [redacted]DISP [redacted]MATL [redacted]MENU

FIGURE 11: Module E-2 [illegible]

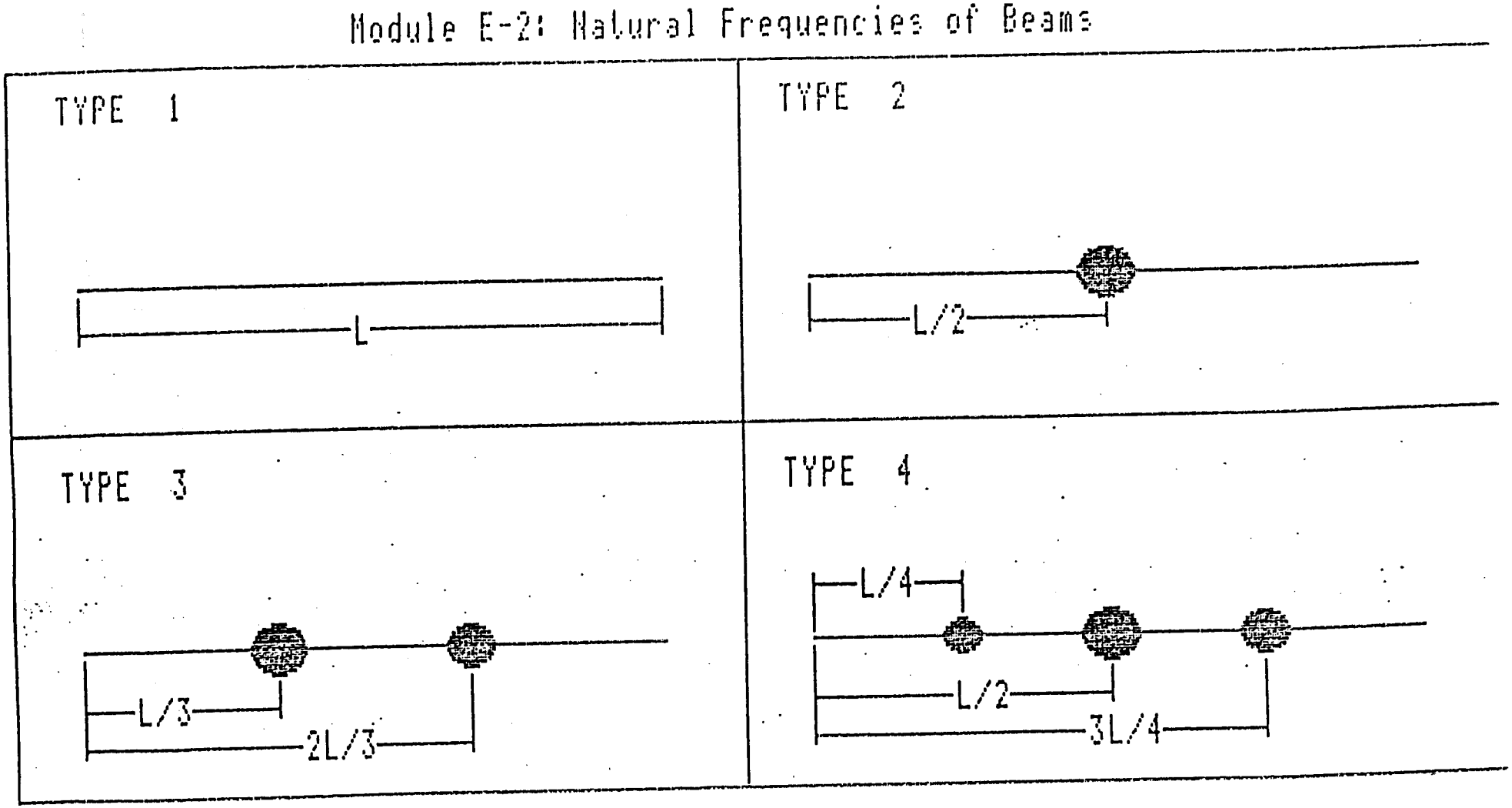


FIGURE 12: Module E-2 - Concentrated Weight Distribution

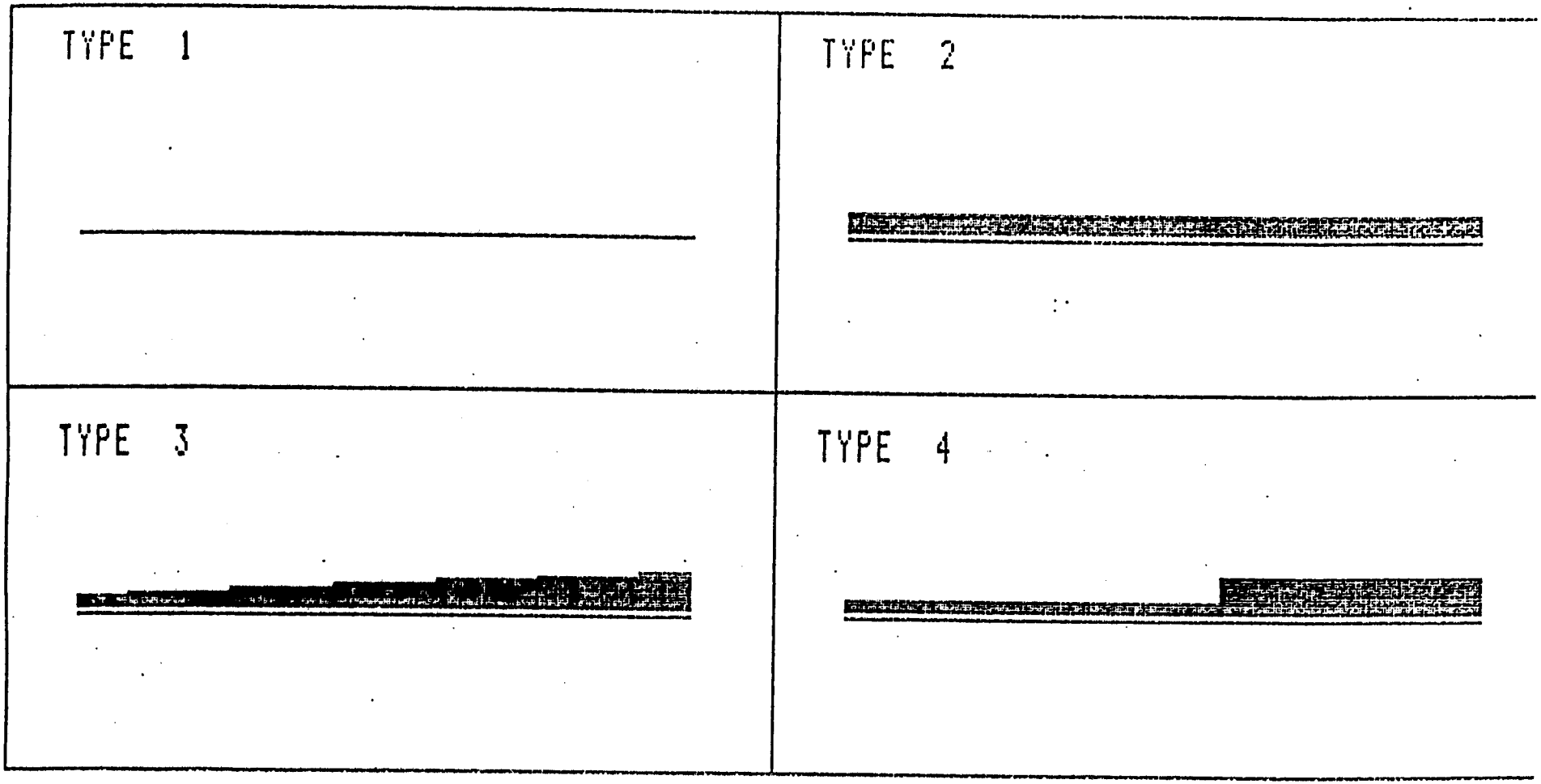


FIGURE 13: Module E-2 - Uniform Weight Distribution Menu

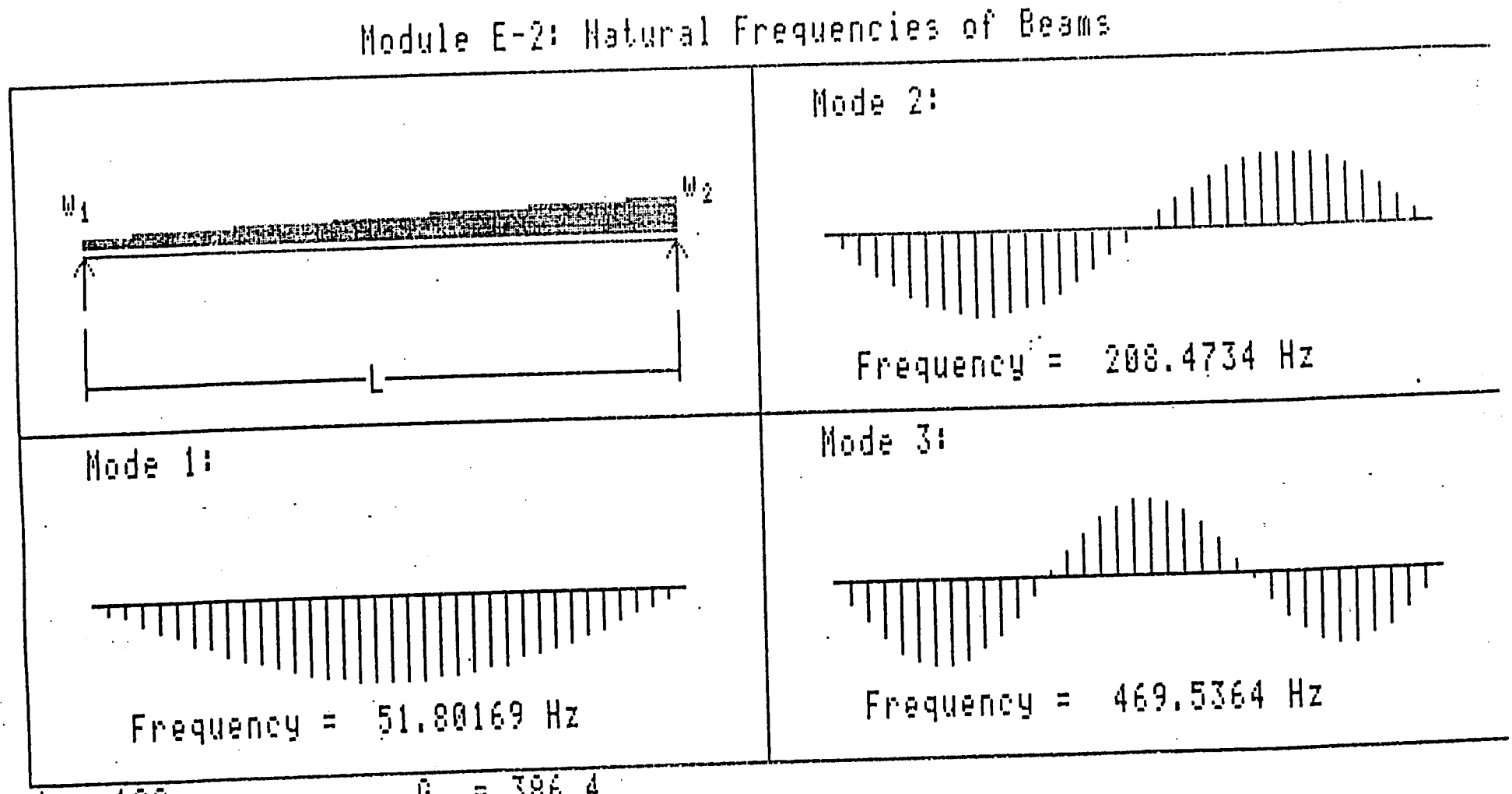


FIGURE 14: Module E-2 - Output Display

LIST OF TABLES

TABLE 1: Static Analysis Output

TABLE 2: Eigenvalue Analysis Output

TABLE 1: STATIC ANALYSIS OUTPUT

MSC/CASE Module B-1: Single Span Beams Under Transverse and Axial Loads

LOADING CONDITION : TYPE 2 - DISTRIBUTED LOAD
BOUNDARY CONDITIONS: TYPE 1 - PINNED / PINNED

INPUT VARIABLES:
L = 120.0
x = 0.0
E = 29000000
I = 151.0833
Wx = 5.0
WL = 10.0
P = 0.0

X	SHEAR	MOMENT	DEFLECTION
0.000000E+00	4.000000E+02	0.000000E+00	0.000000E+00
0.000000E+00	4.000000E+02	0.000000E+00	0.000000E+00
0.000000E+00	4.000000E+02	0.000000E+00	0.000000E+00
2.400000E+00	3.878800E+02	9.455040E+02	-2.890128E-04
4.800000E+00	3.755200E+02	1.861632E+03	-5.767859E-04
7.200000E+00	3.629200E+02	2.747808E+03	-8.621148E-04
9.600000E+00	3.500800E+02	3.603456E+03	-1.143835E-03
1.200000E+01	3.370000E+02	4.428000E+03	-1.420821E-03
1.440000E+01	3.236800E+02	5.220864E+03	-1.691989E-03
1.680000E+01	3.101200E+02	5.981472E+03	-1.956297E-03
1.920000E+01	2.963200E+02	6.709248E+03	-2.212746E-03
2.160000E+01	2.822800E+02	7.403616E+03	-2.460377E-03
2.400000E+01	2.680000E+02	8.064000E+03	-2.698280E-03
2.640000E+01	2.534800E+02	8.689824E+03	-2.925585E-03
2.880000E+01	2.387200E+02	9.280512E+03	-3.141469E-03
3.120000E+01	2.237200E+02	9.835488E+03	-3.345157E-03
3.360000E+01	2.084800E+02	1.035418E+04	-3.535919E-03
3.600000E+01	1.930000E+02	1.083600E+04	-3.713073E-03
3.840000E+01	1.772800E+02	1.128038E+04	-3.875985E-03
4.080000E+01	1.613200E+02	1.168675E+04	-4.024072E-03
4.320000E+01	1.451200E+02	1.205453E+04	-4.156800E-03
4.560000E+01	1.286800E+02	1.238314E+04	-4.273683E-03
4.800000E+01	1.120000E+02	1.267200E+04	-4.374292E-03
5.040000E+01	9.508000E+01	1.292054E+04	-4.458247E-03
5.280000E+01	7.792000E+01	1.312819E+04	-4.525220E-03
5.520000E+01	6.052000E+01	1.329437E+04	-4.574938E-03
5.760000E+01	4.288000E+01	1.341850E+04	-4.607184E-03
6.000000E+01	2.500000E+01	1.350000E+04	-4.621794E-03
6.240000E+01	6.880000E+00	1.353830E+04	-4.618661E-03

TABLE 1: STATIC ANALYSIS OUTPUT

X	SHEAR	MOMENT	DEFLECTION
6.480000E+01	-1.148000E+01	1.353283E+04	-4.597735E-03
6.720000E+01	-3.008000E+01	1.348301E+04	-4.559022E-03
6.960000E+01	-4.892000E+01	1.338826E+04	-4.502589E-03
7.200000E+01	-6.800000E+01	1.324800E+04	-4.428561E-03
7.440000E+01	-8.732000E+01	1.306166E+04	-4.337121E-03
7.680000E+01	-1.068800E+02	1.282867E+04	-4.228515E-03
7.920000E+01	-1.266800E+02	1.254845E+04	-4.103049E-03
8.160000E+01	-1.467200E+02	1.222042E+04	-3.961091E-03
8.400000E+01	-1.670000E+02	1.184400E+04	-3.803073E-03
8.640000E+01	-1.875200E+02	1.141862E+04	-3.629490E-03
8.880000E+01	-2.082800E+02	1.094371E+04	-3.440901E-03
9.120000E+01	-2.292800E+02	1.041869E+04	-3.237930E-03
9.360000E+01	-2.505200E+02	9.842976E+03	-3.021268E-03
9.600000E+01	-2.720000E+02	9.216000E+03	-2.791672E-03
9.840000E+01	-2.937200E+02	8.537184E+03	-2.549965E-03
1.008000E+02	-3.156800E+02	7.805952E+03	-2.297042E-03
1.032000E+02	-3.378800E+02	7.021728E+03	-2.033861E-03
1.056000E+02	-3.603200E+02	6.183936E+03	-1.761456E-03
1.080000E+02	-3.830000E+02	5.292000E+03	-1.480926E-03
1.104000E+02	-4.059200E+02	4.345344E+03	-1.193446E-0
1.128000E+02	-4.290800E+02	3.343392E+03	-9.002590E-0
1.152000E+02	-4.524800E+02	2.285568E+03	-6.026829E-0
1.176000E+02	-4.761200E+02	1.171296E+03	-3.021082E-0
1.200000E+02	-5.000000E+02	-9.094947E-13	4.336809E-1

MAXIMUMS:

MAX SHEAR = 500.0
MAX MOMENT = 13538.3
MAX DEFLECTION = 4.621794E-03

TABLE 2: EIGENVALUE ANALYSIS OUTPUT

MSC/CASE Module E-2: Natural Frequencies of Beams

OUNDARY CONDITIONS: TYPE 1 - PINNED / PINNED

ONCENTRATED WEIGHT DISTRIBUTION: TYPE 1 - NO CONCENTRATED WEIGHT
NIFORM WEIGHT DISTRIBUTION : TYPE 6 - TAPERED UNIFORM WEIGHT

NPUT VARIABLES:
= 120.0
= 29000000
= 151.0833
= 386.4
1 = 5.0
2 = 10.0

E I G E N V A L U E S

MODE 1: FREQUENCY = 51.80169 Hz
MODE 2: FREQUENCY = 208.4734 Hz
MODE 3: FREQUENCY = 469.5364 Hz

E I G E N V E C T O R S

X	MODE 1	MODE 2	MODE 3
0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
3.333333E+00	8.575741E-02	1.651300E-01	2.425831E-01
6.666667E+00	1.708954E-01	3.257984E-01	4.709526E-01
1.000000E+01	2.547981E-01	4.776504E-01	6.716552E-01
1.333333E+01	3.368563E-01	6.165460E-01	8.327479E-01
1.666667E+01	4.164719E-01	7.386681E-01	9.444999E-01
2.000000E+01	4.930610E-01	8.406271E-01	1.000000E+00
2.333333E+01	5.660582E-01	9.195576E-01	9.956279E-01
2.666667E+01	6.349199E-01	9.732052E-01	9.313506E-01
3.000000E+01	6.991293E-01	1.000000E+00	8.108167E-01
3.333333E+01	7.581990E-01	9.991128E-01	6.412292E-01
3.666667E+01	8.116754E-01	9.704929E-01	4.329927E-01
4.000000E+01	8.591427E-01	9.148845E-01	1.991418E-01
4.333333E+01	9.002255E-01	8.338208E-01	-4.542419E-02
4.666667E+01	9.345928E-01	7.295944E-01	-2.848624E-01
5.000000E+01	9.619610E-01	6.052041E-01	-5.034117E-01
5.333333E+01	9.820966E-01	4.642796E-01	-6.864583E-01
5.666667E+01	9.948183E-01	3.109839E-01	-8.215703E-01
6.000000E+01	1.000000E+00	1.498968E-01	-8.994250E-01
6.333333E+01	9.975719E-01	-1.411746E-02	-9.145537E-01

TABLE 2: EIGENVALUE ANALYSIS OUTPUT

E I G E N V E C T O R S

X	MODE 1	MODE 2	MODE 3
6.666666E+01	9.875220E-01	-1.760558E-01	-8.658379E-0
7.000000E+01	9.698972E-01	-3.309293E-01	-7.566999E-0
7.333334E+01	9.448035E-01	-4.739209E-01	-5.949548E-0
7.666666E+01	9.124066E-01	-6.005403E-01	-3.923140E-0
8.000000E+01	8.729302E-01	-7.067735E-01	-1.635613E-0
8.333334E+01	8.266561E-01	-7.892191E-01	7.454304E-0
8.666666E+01	7.739223E-01	-8.452092E-01	3.045442E-0
9.000000E+01	7.151206E-01	-8.729073E-01	5.096419E-0
9.333334E+01	6.506942E-01	-8.713821E-01	6.749725E-0
9.666666E+01	5.811346E-01	-8.406517E-01	7.886870E-0
1.000000E+02	5.069780E-01	-7.816980E-01	8.427106E-0
1.033333E+02	4.288009E-01	-6.964472E-01	8.331362E-0
1.066667E+02	3.472157E-01	-5.877184E-01	7.603146E-0
1.100000E+02	2.628655E-01	-4.591381E-01	6.288903E-0
1.133333E+02	1.764187E-01	-3.150225E-01	4.481890E-0
1.166667E+02	8.856322E-02	-1.602307E-01	2.326532E-0
1.200000E+02	0.000000E+00	0.000000E+00	0.000000E+0