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NASTRAN: USER EXPERIENCE WITH FOUR EXAMPLE PROBLEMS

by R. M. RIVELLO

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13. ABSTRACT

The NASTRAN computer program is used to solve four simple structural problems. The problems are: (1) a simply-supported beam subjected to lateral loads, (2) a filamentary composite bar under the action of centrifugal forces, (3) a free beam subjected to lateral loads, and (4) the thermal buckling of a simply-supported plate. Input and output data are given for each problem to assist the new NASTRAN user in preparing program input data. The results are compared with solutions obtained by other methods. The example problems disclosed errors in the plotting and thermal-buckling routines of the computer. These have subsequently been corrected. The program was found to have broad capabilities and to offer many user conveniences.

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ABSTRACT

Four different structural problems are solved to gain familiarity with the NASTRAN computer program. The problems are: (1) a simply-supported beam subjected to lateral loads, (2) a rotating filamentary composite bar under the action of centrifugal forces, (3) a missile body with aerodynamic, gravitational, and inertial forces, and (4) a square simply-supported plate with in-plane temperature changes capable of buckling the plate. Input and output data are given for each problem. These should be of assistance to those who are using the program for the first time.

The results are compared with those obtained by other methods. However, except for the examples employing beam elements in which the agreement is excellent, the element breakup chosen for convenience in obtaining program familiarity is too coarse to draw conclusions regarding the program accuracy. The example problems disclosed errors in the plotting and thermal-buckling routines of the program.

The program was found to offer many user conveniences. Data preparation was straightforward once familiarity with the format appropriate to the problem was gained. The program documentation is complete for reference purposes, but is lacking in that it does not rapidly orient the new user. The capabilities and conveniences of the program greatly outweigh its inadequacies, and it is recommended that APL/JHU continue to update the program with each new release from NASA.

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1. INTRODUCTION

The advent of high-speed digital computers has had a revolutionary effect upon the analysis of stress and deflection of structures. Prior to the availability of these computers, it was necessary to use simplifying approximations to analyze structural components. Although approximate theories such as those for beams, plates, and shells frequently give satisfactory results for simple structural components, they are generally unsuitable for the accurate analysis of complex structures.

Matrix methods of structural analysis in which the complex structure is considered to be an assemblage of simple finite-sized elements were introduced in the late 1950's (Refs. 1 and 2). Most of the matrix methods that have been developed since then have used either forces or displacements as the unknowns. Of the methods that have been proposed, the so called "direct-stiffness" displacement method introduced in Ref. 2 has proven to be relatively simple to program and has given well-conditioned solutions. As a result, it has been widely used and undergone extensive development. Today many programs are available that use the direct-stiffness method and it does not appear economical for organizations contemplating the need for such a program to develop their own unless they require small special-purpose programs that will be sufficiently used to merit the costs of program development. However, in some cases it may be justifiable to write simple, efficient programs for special types of problems instead of using a large, complex, and inefficient all-purpose program.

Of the general-purpose programs, the NASA STRuctural ANalysis (NASTRAN) program is capable of handling the largest number of different types of structural problems. Several million dollars have been invested in the development of this program and an annual expenditure of approximately one-half million dollars has been budgeted by NASA for its upkeep and improvement.

The diversity and complexity of structural problems encountered by the Johns Hopkins University Applied Physics Laboratory (APL) are such that the availability of a general-purpose program is a necessity. The capabilities of the nonproprietary NASTRAN program make it a natural choice. Furthermore, the Naval Ship Research and Development Center (NSRDC) had already installed Level 12.0 of the program on the IBM 360 computer at APL and, when the program was released by NASA to nongovernmental agencies, the use of it was offered to APL.

Although the NASTRAN program had been installed on the APL computer, APL personnel had not been involved and were, therefore, untrained in the use of the program. Self instruction in the use of the program is not a small undertaking. The program has a total of twelve rigid formats to provide a general-purpose capability as follows:

1. Static Analysis
2. Static Analysis with Inertia Relief
3. Normal Modes Analysis
4. Differential Stiffness Analysis
5. Buckling Analysis
6. Piecewise Linear Analysis
7. Direct Complex Eigenvalue Analysis
8. Direct Frequency and Random Response
9. Direct Transient Response
10. Modal Complex Eigenvalue Analysis

11. Modal Frequency and Random Response

12. Modal Transient Response

The program documentation that is available from the NASA COSMIC Office consists of a Theoretical Manual (Ref. 3), a User's Manual (Ref. 4), a Programmer's Manual (Ref. 5), and a Demonstration Problem Manual (Ref. 6). The total number of pages in these documents is roughly 3300. Unfortunately for the new user, the manuals are for reference rather than tutorial purposes and do not include indices.

The Demonstration Problem Manual gives a comparison of NASTRAN results with solutions to the same problems obtained by other methods; however, this manual does not contain the input or output data for the NASTRAN solutions. As a result, it alone is of little value as a learning aid. The NASTRAN tapes available from COSMIC contain a file of the bulk data card images for the demonstration problems, but to obtain the full set of input and output data it is necessary to prepare executive and case control decks and run the problems. The NSRDC was never successful in getting this portion of the tape to run on the APL computer. Furthermore, considerable computer expense would be entailed in running the 25 demonstration problems.

After the four NASTRAN manuals were reviewed, it was concluded that the only sensible way to become familiar with the program would be to prepare the data for several example problems and run them. The purpose of this report is to document the input and output data for the example problems, in the hope that the examples will be helpful to those who are learning to use the program.

Subsequent to running some of the example problems, a set of the printouts of the demonstration problems of Ref. 6 was obtained. These printouts (which were run with NASTRAN Level 8. 1. 0) proved to be of considerable help, because there are several places where the User's Manual is unclear and some places where it is misleading.

After the work documented in this report was completed, a copy of a beginner's guide (Ref. 7) that is used in the NASTRAN training courses taught by the MacNeal-Schwendler Corporation was obtained. The printouts for the demonstration problems, the beginner's guide, and Refs. 8 through 12 should prove helpful to the new NASTRAN user. The BBE Project Office of APL has these references on file.

The job cards that are required to run NASTRAN on the APL computer are described in Ref. 12. The new user should also be aware of two newsletters that are periodically published for NASTRAN users. One of these, the NASTRAN Newsletter, is published by NASA. Users may be placed on the distribution list for this newsletter by writing or phoning:

NASTRAN Systems Management Office
Mail Stop 188c
NASA Langley Research Center
Hampton, Va. 23365
Telephone: (703) 827-2388

The other is the Navy Structures Computer Program NEWSLETTER that is published by NSRDC and is available from:

NASTRAN Evaluation Project, Code 823
Department of Applied Mathematics, NSRDC
Washington, D. C. 20034

2. EXAMPLE PROBLEMS

Example problems were chosen to exercise different rigid-format, structure-definition, loading, and output options of the program. The example problems are as follows:

1. Static Deformations of a Simply-Supported Beam

2. Static Deformation of a Composite Rectangular-Planform Flywheel

3. Static Deformation of a Missile Body Under the Action of Aerodynamic and Inertial Loads

4. Thermal Buckling of a Square Simply-Supported Plate

The program features that are demonstrated by these problems are:

1. Rigid Formats

   a. Static Analysis
   b. Static Analysis, Inertia Relief
   c. Buckling Analysis

2. Structure Definition Options

   a. Single-Point Constraints
   b. Free-Body Supports
   c. Bar Elements
   d. Quadrilateral Membrane Elements
   e. Quadrilateral Plate Elements
   f. Thermally-Dependent Materials
   g. Isotropic Materials
   h. Anistropic Materials

3. Static Loading

   a. Concentrated Loads
   b. Gravity Loads
   c. Inertial Loads
   d. Centrifugal Field Load
   e. Thermal Loads
   f. Combined Loads

4. Output Options

   a. Shape Plot of Undeformed Structure
   b. Shape Plot of Deformed Structure
   c. Vector Plot of Structural Displacements
   d. Point Output Selections
   e. Element Output Selections
   f. Subcase Level Request Changes
   g. Modal Plot

The program options that are used for each of the example problems are shown in Table 1.

The primary purpose of the example problems is to gain familiarity with the NASTRAN data format rather than to obtain high accuracy in the computed results. Because of this, crude structural modeling with few grid points and elements is used to reduce the data preparation and computing times. Improved accuracy could be obtained by using smaller elements, especially in the regions of large stress gradients.

In initial runs of the example problems, it was found that the program would not write a tape for the CALCOMP plotter. This difficulty was reported to NSRDC who made the necessary programming corrections to obtain CALCOMP Model 565 plots. It is still not possible to obtain plots with the CALCOMP Model 765, the default model for the program. It was also found that there was an error in the thermal-buckling portion of the program (this type of problem was not included in the demonstration problems of Ref. 6). The difficulty was reported to the NASTRAN Systems Management Office and to NSRDC. Corrections were made by NSRDC to the APL copy of the program.

Table 1

Program Options Used in Example Problems

Problem No.	Program Option																							
	1a	1b	1c	2a	2b	2c	2d	2e	2f	2g	2h	3a	3b	3c	3d	3e	3f	4a	4b	4c	4d	4e	4f	4g
1	X			X		X				X		X	X				X	X	X		X	X	X	
2	X			X			X				X				X			X	X	X	X	X		
3		X			X	X			X	X		X	X	X			X	X	X		X	X		
4			X				X	X		X						X		X	X					X

Detailed descriptions of the example problems are given in the following subsections in which the computed results are compared with the results obtained by other methods. The computer and plotter outputs for each of the example problems is given in the appendixes at the end of the report. The output contains an echo of the executive, case, and bulk data decks that constitute the input to the program. This input should serve as a useful guide to the new user in preparing program data.

EXAMPLE PROBLEM 1

The first example problem is for a uniform, simply-supported beam. The computer and CALCOMP outputs for the problem are given in Appendix A. The geometry, method of support, and material properties of the beam are shown in Fig. 1. The finite-element idealization consisting of four BAR (beam) elements and 5 grid points is also shown in this figure. The origin of the basic coordinate system is taken at grid point 1.

Three static-load subcases are used: Subcase 1 consists of a concentrated 100-lb load applied upward at grid point 3, Subcase 2 consists of a 100 lb/in uniformly distributed upward loading, and Subcase 3 is the sum of the loadings from subcases 1 and 2. The NASTRAN program does not have a distributed load bulk data card for BAR elements. In this example problem, the gravity-loading card GRAV is used to provide the distributed loading. A gravitional acceleration (gravity vector scale factor) of 3.86×10^4 in/s^2 is used to produce a loading of 10 lb/in with a cross sectional area of 1.0 in^2 and a material specific weight of 0.1 lb/in^3.

Vertical displacements and rotations (slopes) are computed at all grid points. Reactions are determined at all single-point constraints. Bending stresses are found at both ends of each element at the four cross-sectional points shown in Fig. 1. CALCOMP plot requests are made both for the undeformed structure and for the deformed

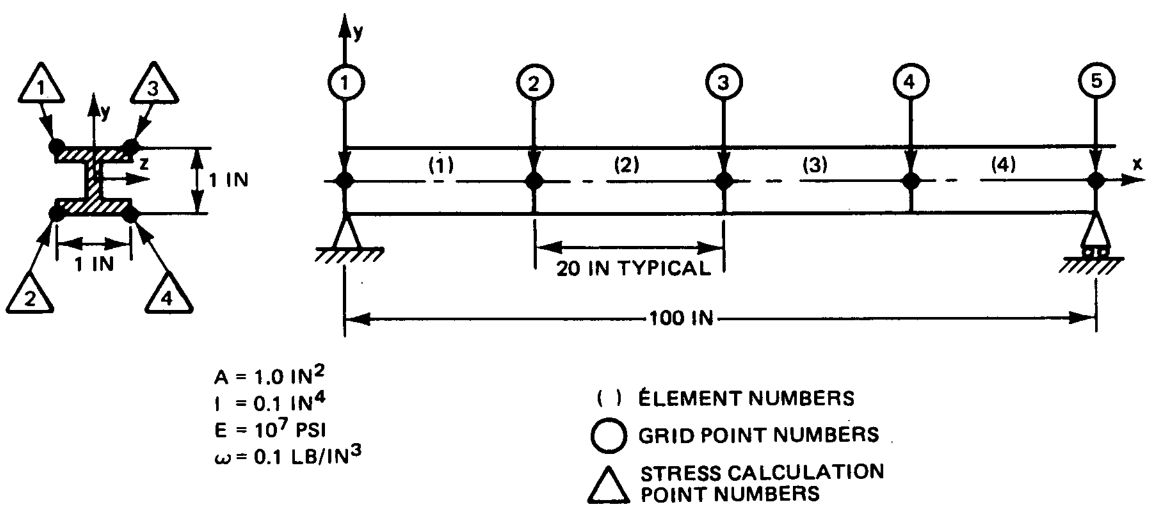


FIG. 1 SIMPLY-SUPPORTED BEAM, EXAMPLE PROBLEM 1

structure for each of the three subcase loads. The resulting CALCOMP plots are given at the end of Appendix A.

Bending deflection at the center of the beam and end slopes for subcases 1 and 2 were also computed. Stresses were calculated using bending-moment formulas from Ref. 13. The NASTRAN and beam-equation results are compared in Table 2. It is seen that the NASTRAN results are in perfect agreement with those from beam theory for Subcase 1. This would be expected, since the BAR-element deflection function used in the program is a cubic, as is the actual deflection shape for a beam with concentrated loads. As a result, element size in this case does not affect accuracy. For Subcase 2 the stresses are in good agreement, but the center deflection computed by NASTRAN is 5% less than the exact solution given by beam theory. The deflection result is not surprising since, for a distributed loading, the exact deflection curve for each element is a quartic rather than a cubic as assumed in NASTRAN and, in addition, the NASTRAN program uses lumped force rather than consistent force matrices for distributed loads. Of course, accuracy could be improved by using smaller elements than those in the crude four-element idealization used in the example.

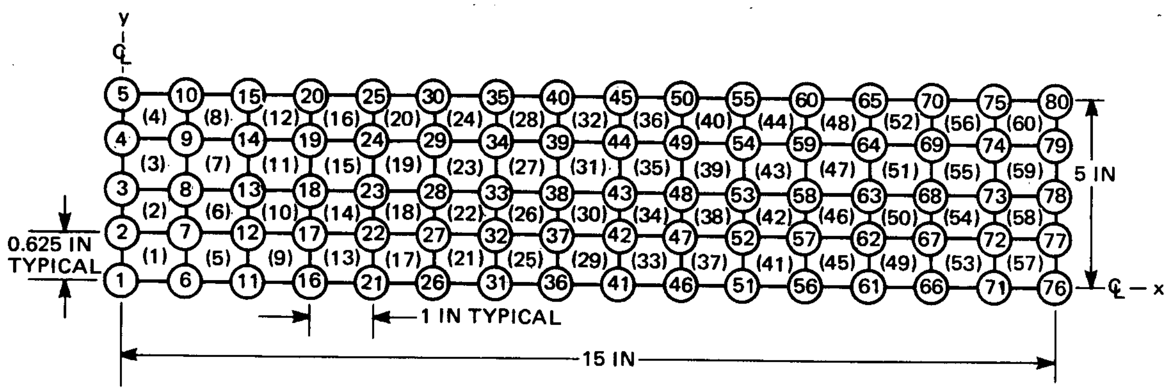
EXAMPLE PROBLEM 2

In this second example problem the NASTRAN program is applied to a unidirectional graphite-epoxy composite bar rotating at a constant angular velocity about its center of gravity. Since the geometry, elastic properties, and loading are symmetric about both the longitudinal and lateral axes of the body, it is only necessary to model one quadrant of the bar. The finite-element idealization consists of 60 identical nonisotropic, quadrilateral, membrane (QDMEM) elements with 80 grid points as shown in Fig. 2a. The origin of the basic x-y coordinate system is taken at grid point 1, the center of rotation. The angular velocity is 1.264 rad/s.

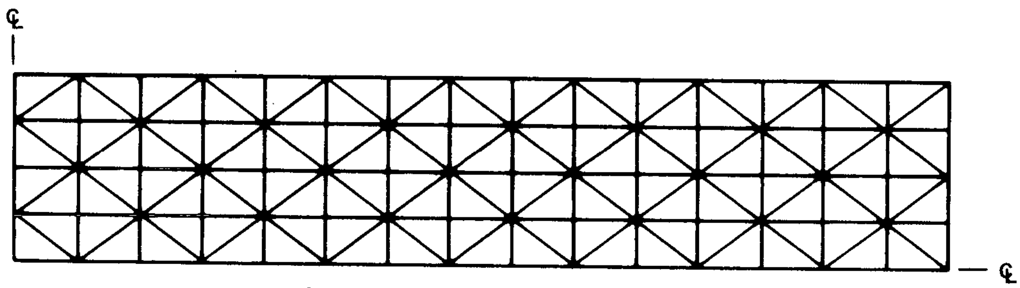
Table 2

**Example Problem 1:
Comparison of NASTRAN and Beam-Theory Results**

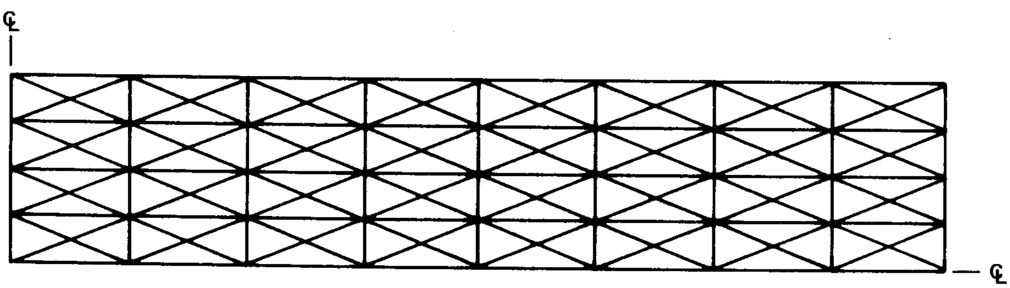
Loading	Center Deflection (inches)		End Slope (10^{-2} radians)		Center Bending Stress (psi)	
	NASTRAN	Beam Theory	NASTRAN	Beam Theory	NASTRAN	Beam Theory
Subcase 1	0.1333	0.1333	0.9999	1.0000	± 4 999	± 5 000
Subcase 2	0.3167	0.3333	2.5003	2.6667	±10 001	±10 000



(a) 80-GRID POINT – 60 ELEMENT NASTRAN IDEALIZATION



(b) 80-GRID POINT – 120 ELEMENT (80/120) IDEALIZATION USED IN REF. 15



(c) 77-GRID POINT – 128 ELEMENT (77/128) IDEALIZATION USED IN REF. 15

FIG. 2 FINITE-ELEMENT IDEALIZATIONS, EXAMPLE PROBLEM 2

The symmetry conditions are imposed by applying single-point constraints that prevent y-direction motion at grid points on the x-axis and x-direction motion at grid points on the y-axis.

The computer printout and CALCOMP plots for the problem are given in Appendix B. The centrifugal inertial forces are generated by using an RFORCE bulk-data card. Nondimensionalized values of the normal stresses σ_{xx} and σ_{yy}, and the shear stress σ_{xy} computed by the NASTRAN program are given in Fig. 3 by the solid curves.

An exact solution to this problem does not exist. Weiss has obtained approximate solutions to the problem by the collocation method (Ref. 14) and the finite-element method (Ref. 15). These results are also shown in Fig. 3. Two different finite-element breakups were used in Ref. 15. In one of these (Fig. 2b) 80 grid points and 120 triangular membrane elements (80/120) were used. In this case, the grid points were chosen to coincide with those used in the NASTRAN solution. In the other idealization shown in Fig. 2c, 77 grid points and 128 elements were used (77/128).

It is seen that the NASTRAN normal stresses are in excellent agreement with the finite-element solutions of Ref. 15, but the agreement in the shearing stresses is not as good. There is considerable scatter in the shearing stresses computed by both the 80/120 and 77/128 idealizations of Ref. 15. This scatter was not present in the NASTRAN results. Although they are not shown in Fig. 3, some of the values of the shear stress computed in Ref. 15 were negative for x/a = 0.6, and although the distribution shapes are similar, the collocation results do not agree well with either the NASTRAN results or those of Ref. 15. This is especially true of the shear stress. The reasons for the lack of agreement are not apparent and the correct solution is an open question. It appears, however, that the shear-stress calculations are very sensitive to the idealization.

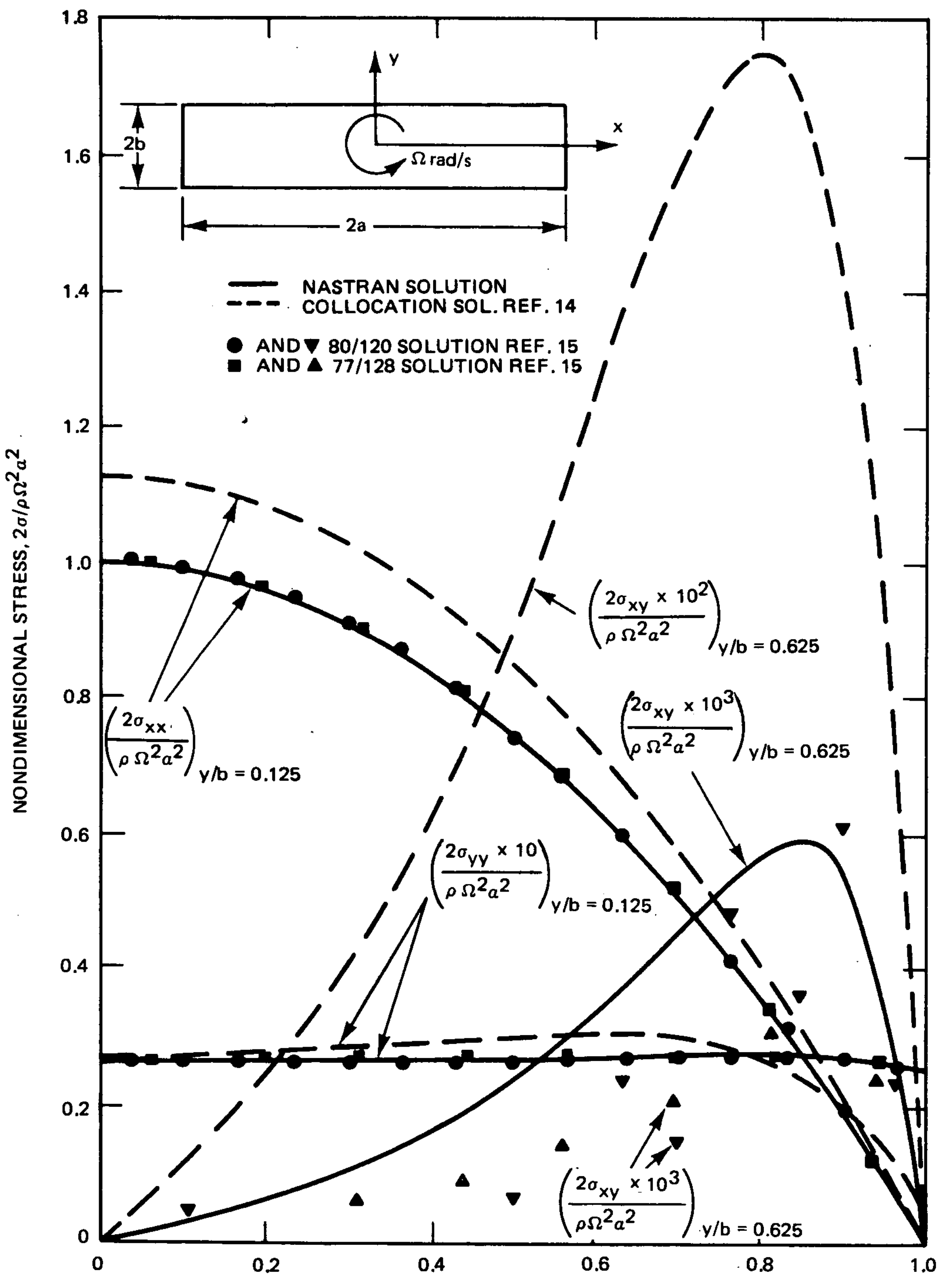


FIG. 3 COMPARISON OF EXAMPLE PROBLEM 2 RESULTS WITH RESULTS GIVEN IN REFS. 14 AND 15

EXAMPLE PROBLEM 3

The third example problem illustrates the applicability of NASTRAN to the calculation of shear-force, bending-moment, bending-stress, and deflection distributions of a missile body under the combined action of aerodynamic, gravitational, and inertial loads. To reduce data preparation, the simplified model (Fig. 4), which has constant cross-sectional properties and a uniform weight per unit length, was used to represent the missile. The NASTRAN program, of course, can handle the cross-sectional and weight distributions of an actual missile with no difficulty.

The finite-element idealization of the body by beam (BAR) elements is shown in Fig. 5. The computer printout and CALCOMP plots for the problems are given in Appendix C. Since the missile is a free body, it is necessary to use a SUPORT card in the bulk-data deck. Displacements are computed for a free-body support at grid point 6. The modulus of elasticity is made temperature dependent by the use of MAT 1, MATT 1, TABLEM 1, and TEMPD cards. The aerodynamic forces, gravitational forces, and inertial forces are applied by using FORCE, GRAV, and SUPORT cards, respectively.

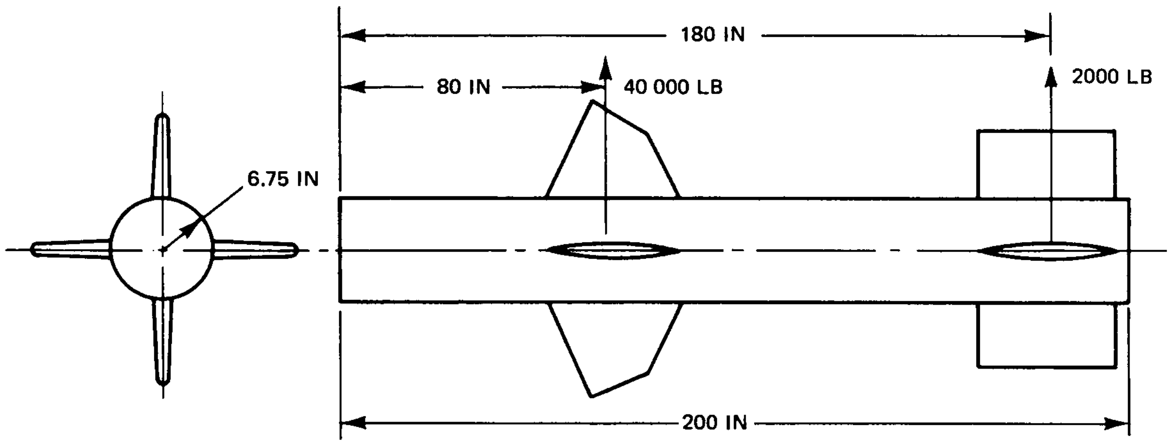
The NASTRAN results for shear, bending moment, and total deflection are given in Figs. 6 through 8. To check these results the shear, bending moment, and bending deformations were computed by numerical integration of the beam equations

$$p = \frac{dV}{dx} , \qquad (1)$$

$$V = \frac{dM}{dx} , \qquad (2)$$

and

$$\frac{d^2 w_b}{dx^2} = \frac{M}{EI} , \qquad (3)$$



CROSS–SECTIONAL PROPERTIES: I = 100 IN^4, A = 4.4 IN^2
MATERIAL: STEEL, ω = 0.3 LB/IN^3
NONSTRUCTURAL WEIGHT 8.68 LB/IN

FIG. 4 EXAMPLE PROBLEM 3

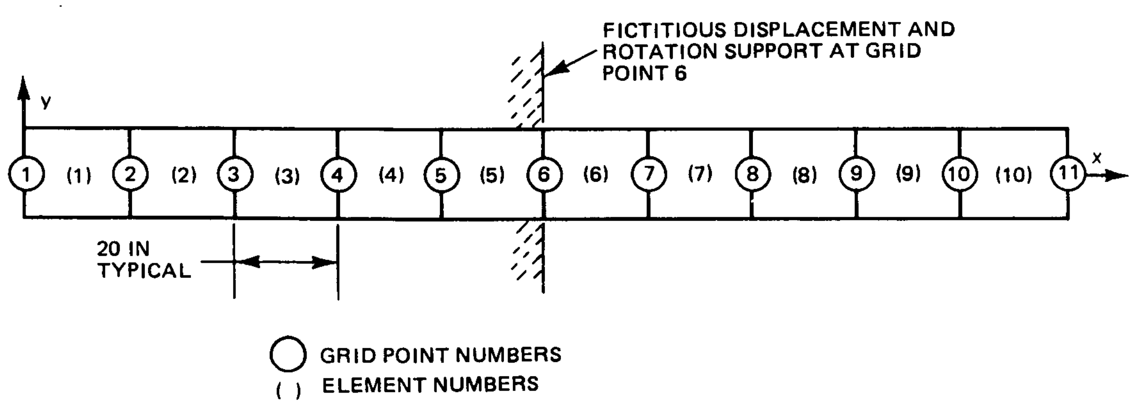


FIG. 5 FINITE-ELEMENT BREAKUP, EXAMPLE PROBLEM 3

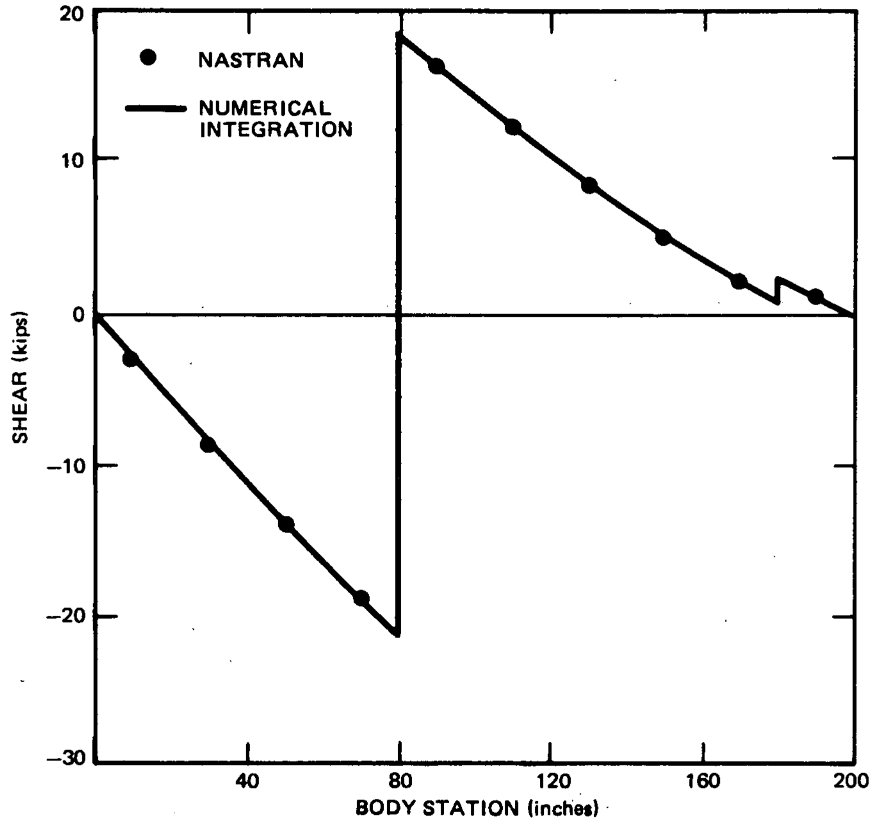


FIG. 6 SHEAR vs. BODY STATION, EXAMPLE PROBLEM 3

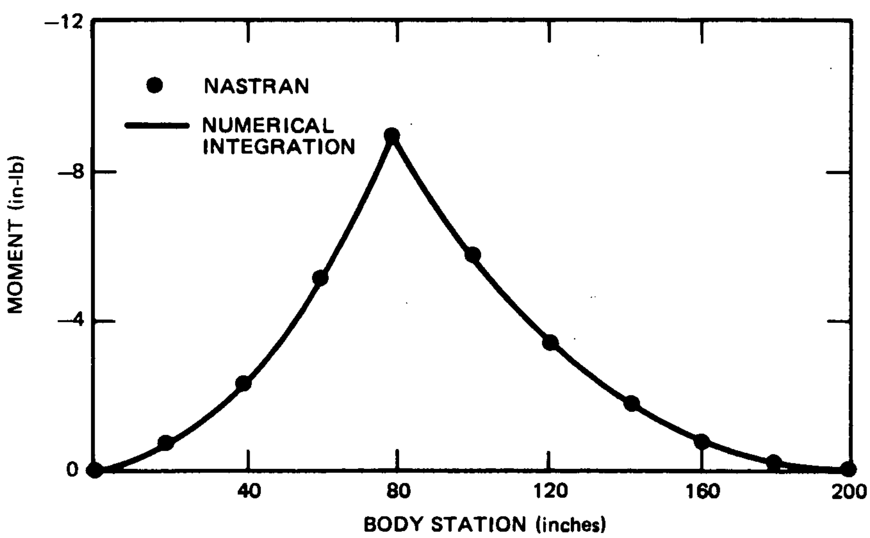


FIG. 7 BENDING MOMENT vs. BODY STATION, EXAMPLE PROBLEM 3

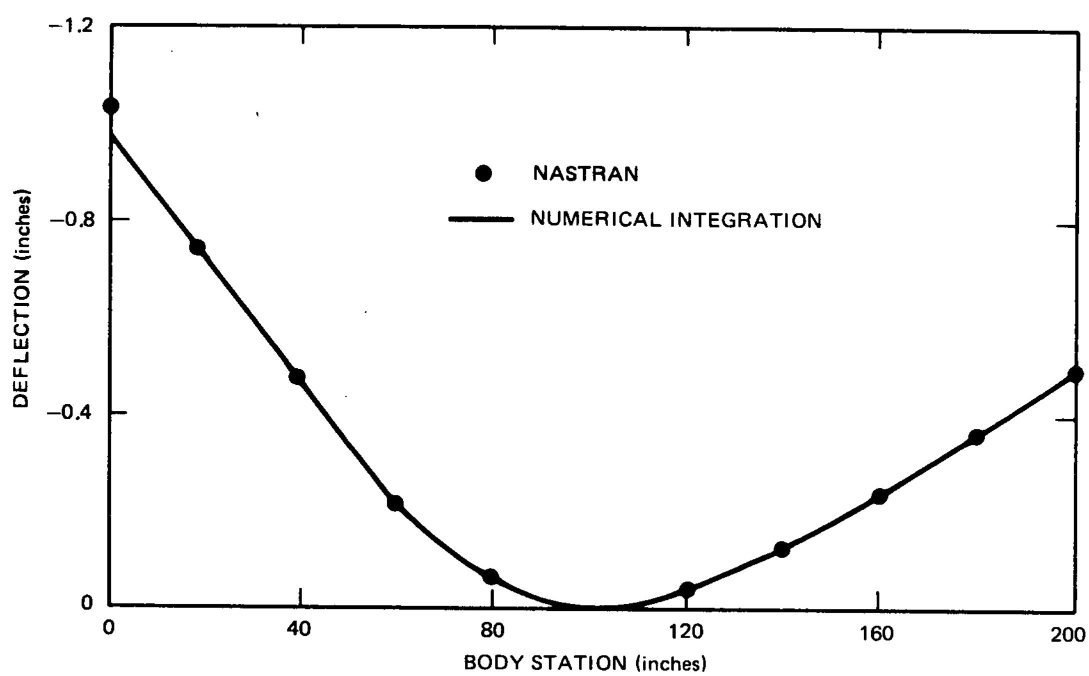


FIG. 8 DEFLECTION vs. BODY STATION, EXAMPLE PROBLEM 3

where

V = shear force (lb),

p = distributed load (lb/in),

M = bending moment (in-lb),

EI = bending rigidity (lb-in^2),

and

w_b = bending deformation (in),

Shear deformations w_s were determined from a numerical integration of the equation

$$\frac{dw_s}{dx} = \frac{V}{GKA} \,, \tag{4}$$

where

G = shear modulus of elasticity (psi),

K = cross-sectional area factor for shear, (nondimensional),

and

A = cross-sectional area (in^2).

The total deformation w was then computed from

$$w = w_b + w_s. \tag{5}$$

Deformations were computed relative to a fictitious support at grid point 6 as assumed in the NASTRAN computation. The results of the laborious hand calculations using Eqs. 1 through 5 are also plotted in Figs. 6 through 8. It is seen that the agreement in the two methods is very good.

EXAMPLE PROBLEM 4

Example problem 4 was chosen to illustrate the application of NASTRAN to thermal stress problems and, further, to demonstrate the method for computing thermal buckling. The structure is a square, simply-supported plate having uniform thickness. The geometry of the plate and the coordinate system are shown in Fig. 9. The plate is subjected to a temperature change T(x, y) that is symmetric about both the x and y axes.

If the magnitude of the temperature change is great enough, the thermal stresses induced in the plane of the plate will cause the plate to buckle. The mode shape of the buckle will be symmetric about the x and y axes. As a result of the above-noted symmetries, it is only necessary to model one quadrant of the plate if single-point constraints are used to prevent unsymmetrical deformations along the x and y axes.

The idealization using quadrilateral plate (QUAD2) elements is shown in Fig. 10. This figure also shows the temperature change at each of the grid points in terms of T_1, the temperature change at grid point 1. As shown, there is no temperature change at points on the simply-supported edges of the plate.

Difficulty was encountered in running the example problem. The NASTRAN Demonstration Problem 5-1 printout, run with NASTRAN Level 8. 1. 0, was used as a guide for preparation of the case control deck. In the Level 8. 1. 0 printout the load card appears before Subcase 1 (the statics solution). However, when the problem was run in this manner, there was a fatal-error message which indicated that Subcase 2 (the buckling solution) contained both a static load and a real eigenvalue method selection, and that one or the other must be removed. A check of the Level 12. 0 User's Manual (Ref. 4) indicated that the load (in this case TEMPERATURE(LOAD)) card must appear in Subcase 1 rather than above the subcase level.

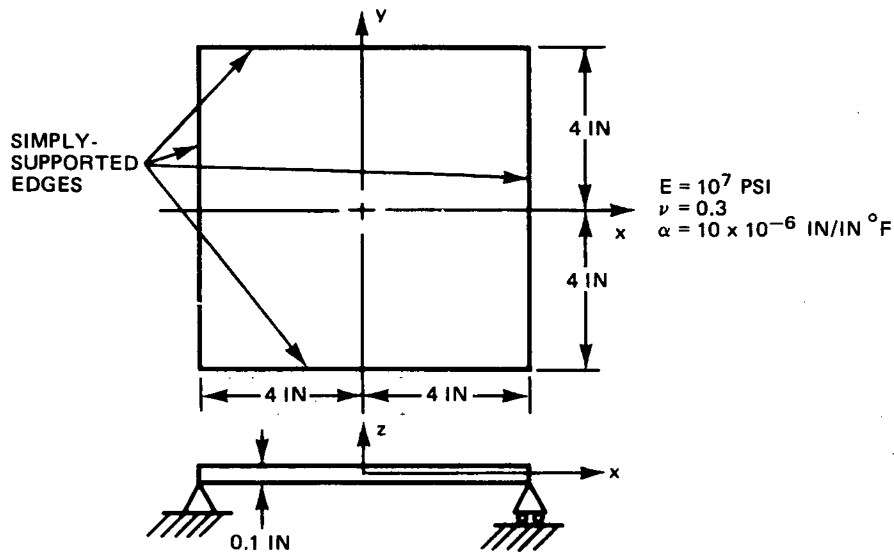


FIG. 9 EXAMPLE PROBLEM 4

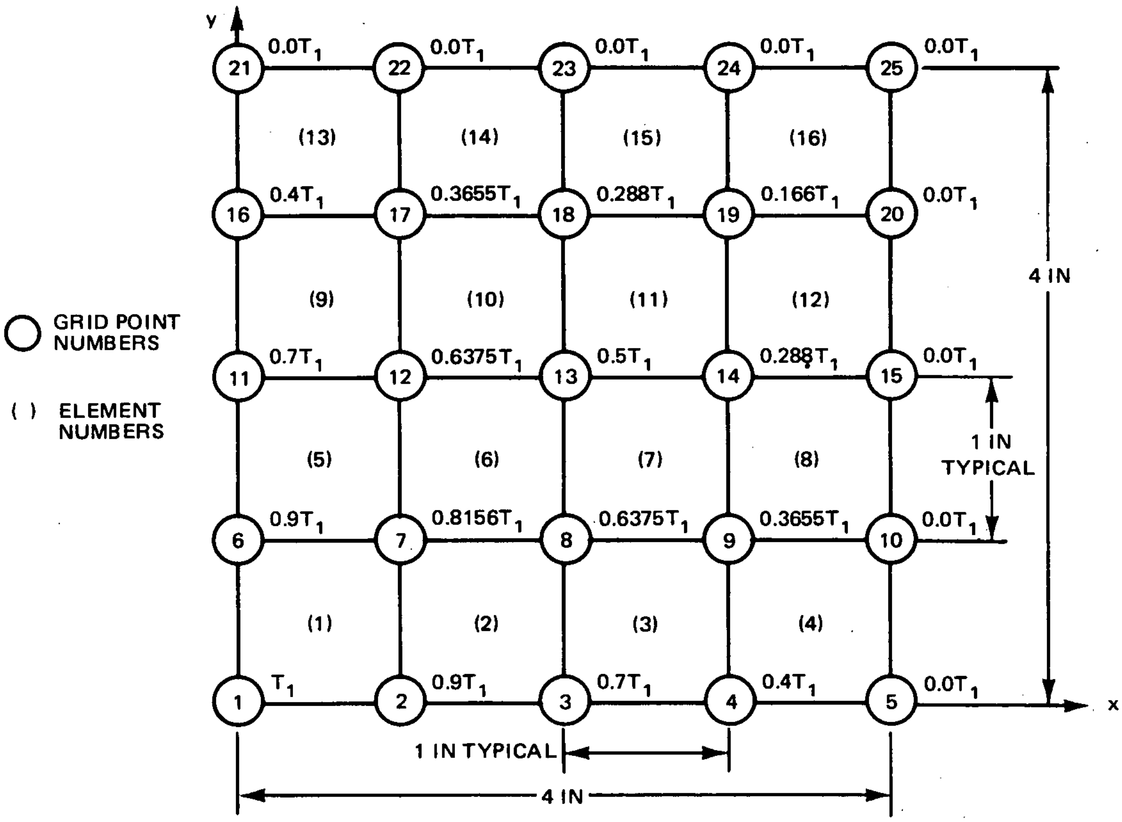


FIG. 10 NASTRAN IDEALIZATION AND TEMPERATURE DISTRIBUTION, EXAMPLE PROBLEM 4

This change was made and the example problem was rerun. The results contained only a static solution followed by "SYSTEM FATAL MESSAGE, 3001 ATTEMPT TO OPEN DATA SET **** IN SUBROUTINE DS1A, WHICH WAS NOT DEFINED IN FIST." Since the cause appeared to be a NASTRAN program error, the difficulty was reported to the NASTRAN System Management Office and NSRDC. Program corrections were made by NSRDC personnel who reran the problem, using both the inverse and determinant methods of eigenvalue extraction. The results of the two methods did not agree. The NASA Goddard Space Flight Center had experienced difficulty with the determinant eigenvalue method and had made corrections in their program for the IBM 360-95 computer. The problem was run at Goddard Space Flight Center and identical results were obtained by both the inverse and determinant methods. NSRDC then made the necessary corrections to the program on the APL computer.

The NASTRAN results given in Figs. 11 to 13 and Appendix D were obtained after the corrections noted above were made. The problem was also solved by the finite-differences method. This method was first used to determine the in-plane thermal stresses by obtaining an approximate solution to the differential equation

$$\nabla^4 F = -\alpha E t \nabla^2 T, \tag{6}$$

subject to the boundary conditions $F = \partial F/\partial n = 0$ along the boundary of the plate (Ref. 16), where F is the stress function defined by the equations

$$\sigma_{xx} = \frac{1}{t}\frac{\partial^2 F}{\partial y^2},\quad \sigma_{yy} = \frac{1}{t}\frac{\partial^2 F}{\partial x^2},\ \text{and}\ \sigma_{xy} = -\frac{1}{t}\frac{\partial^2 F}{\partial x \partial y}. \tag{7}$$

The finite-difference mesh that was used in the solution is shown in Fig. 14. The normal stress σ_{xx} and σ_{yy} determined by the NASTRAN program and the finite-difference

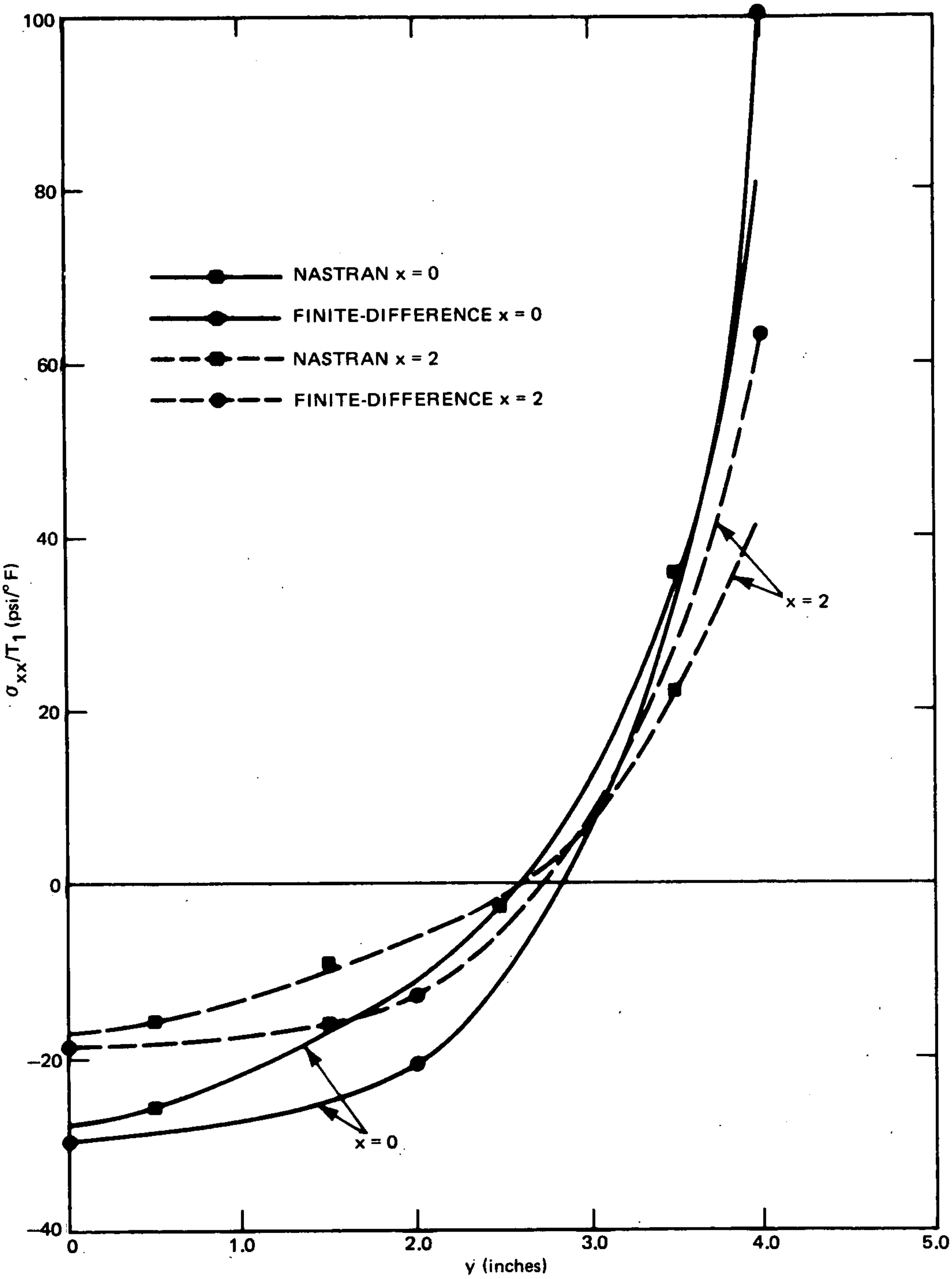


FIG. 11 DISTRIBUTION OF PREBUCKLING THERMAL STRESSES σ_{xx}, EXAMPLE PROBLEM 4

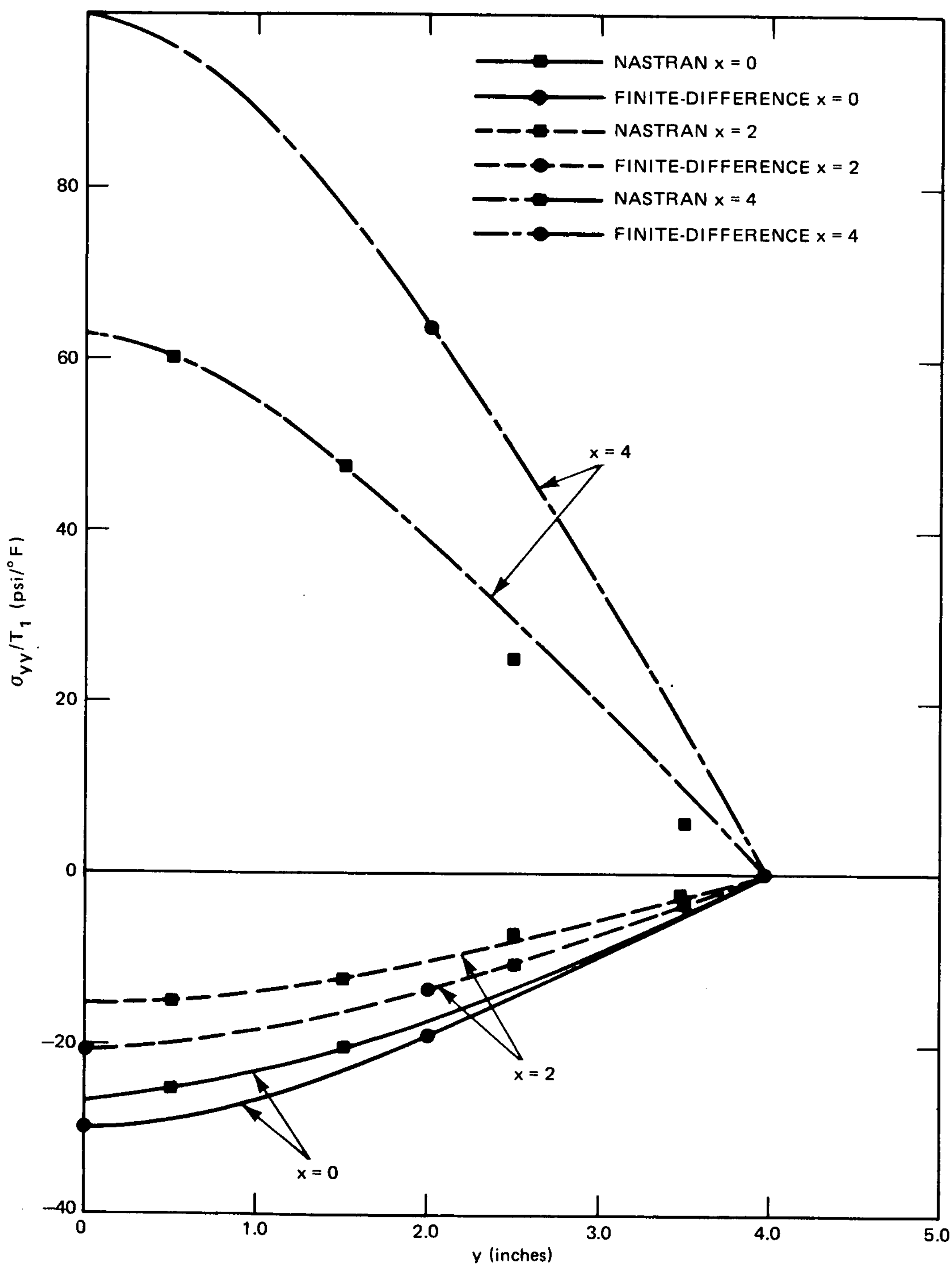


FIG. 12 DISTRIBUTION OF PREBUCKLING THERMAL STRESS σ_{yy}, EXAMPLE PROBLEM 4

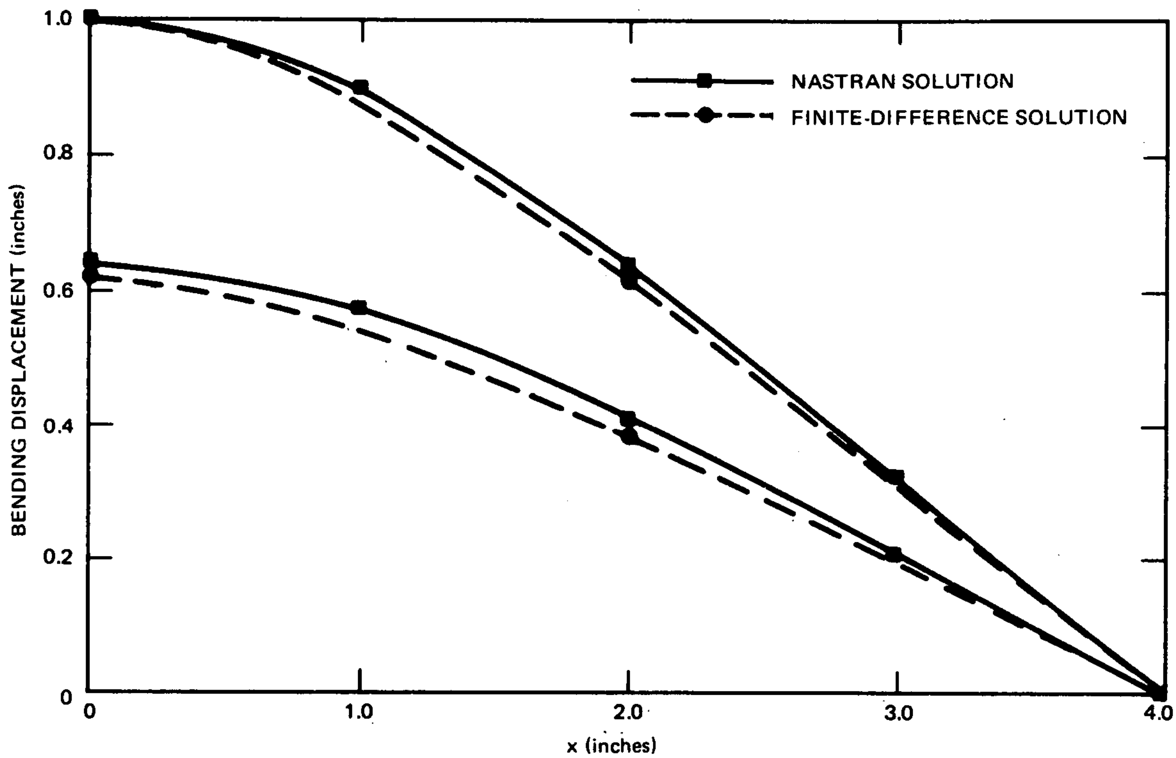


FIG. 13 THERMAL BUCKLING MODE SHAPE, EXAMPLE PROBLEM 4

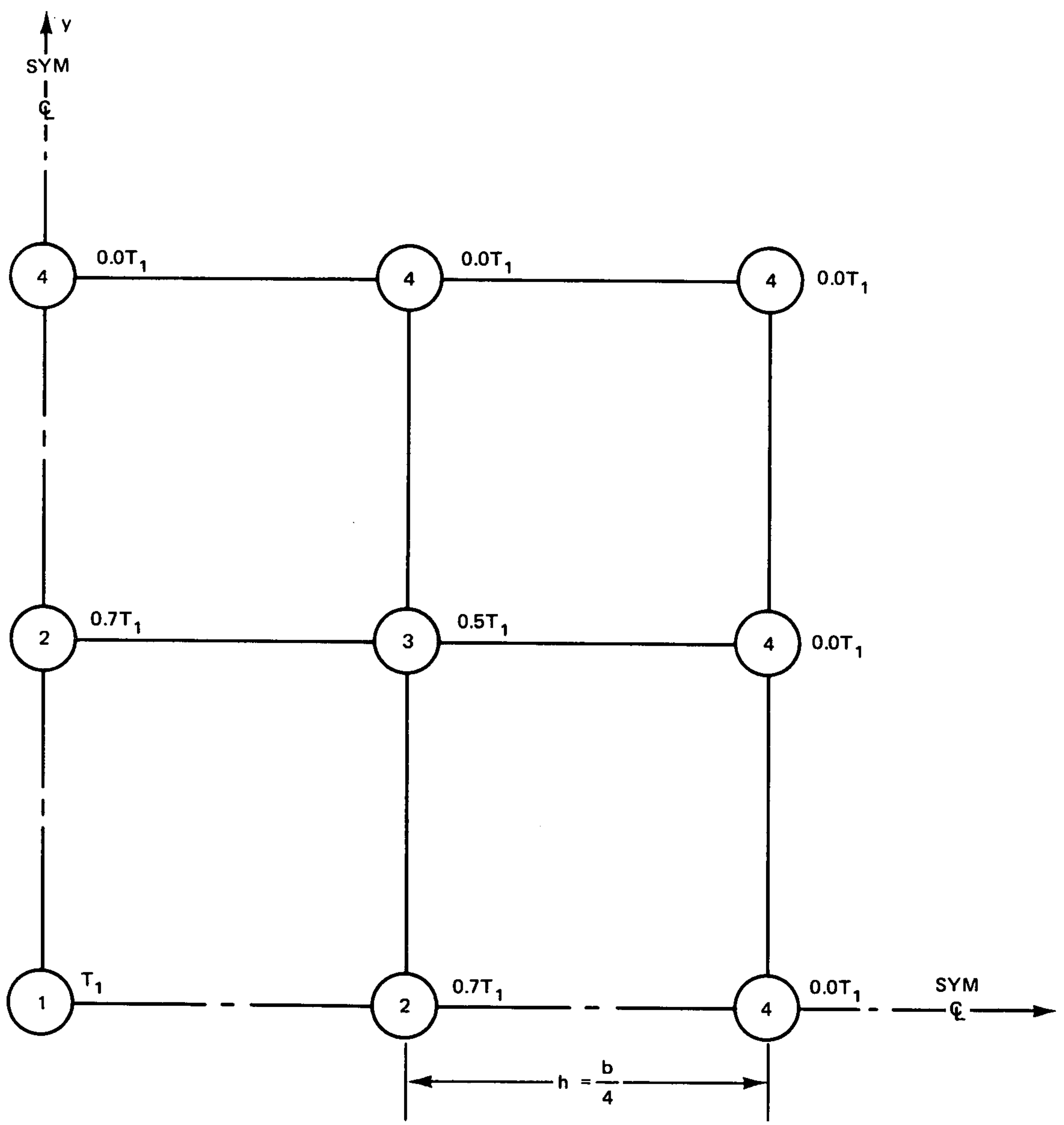


FIG. 14 FINITE DIFFERENCE MESH AND TEMPERATURE DISTRIBUTION, EXAMPLE PROBLEM 4

method are compared in Figs. 11 and 12. It is seen that, while the stress distributions computed by these two methods are similar, the stresses computed by the finite-difference method are larger than those calculated by NASTRAN. It is not possible to say which method is more accurate as the grids that were used in both methods are too coarse to expect accurate solutions. While the grid that was used for the NASTRAN results is twice as fine as that used in the finite-difference solution, the NASTRAN program assumes that the temperature within each quadrilateral element is constant and equal to the average of the temperatures at the grid points of the element. As a result, a zero temperature change on the boundary is not attained. It is expected that this would reduce the stresses computed by NASTRAN.

The finite-difference method was also used to solve for the eigenvalue λ and the mode shape $w(x, y)$ of the differential equation

$$\nabla^4 w = \frac{\lambda}{D}\left(\frac{\partial^2 F_o}{\partial y^2}\frac{\partial^2 w}{\partial x^2} - 2\frac{\partial^2 F_o}{\partial x \partial y}\frac{\partial^2 w}{\partial x \partial y} + \frac{\partial^2 F_o}{\partial x^2}\frac{\partial^2 w}{\partial y^2}\right), \quad (8)$$

subject to the boundary conditions $w = \partial^2 w/\partial n^2 = 0$ on the boundary (Ref. 16). In this equation λ is a constant which specifies the magnitude of the temperature change according to the equation

$$T(x, y) = \lambda T_o(x, y), \quad (9)$$

where $T_o(x, y)$ gives the spacial variation of the temperature change normalized so that $T_o(0, 0) = 1$. The function F_o is related to F by

$$F(x, y) = \lambda F_o(x, y). \quad (10)$$

Physically, λ is the temperature at the point (0, 0) at which thermal buckling of the plate occurs when it is subjected to the temperature change $T(x, y) = \lambda T_0(x, y)$.

The NASTRAN solution predicts that buckling will occur when the temperature change at the point (0, 0) reaches 314.7°F, while the finite-difference solution indicates that buckling will occur when the temperature change reaches 168.8°F. As expected, the finite-difference method predicts a lower buckling temperature because it predicts greater thermal stresses per degree of temperature change. The buckling mode shapes predicted by the two methods are shown in Fig. 13. It is seen that the agreement in the mode shapes is excellent.

3. DISCUSSION

The example problems demonstate only a few of the many capabilities of the NASTRAN program. Considerable effort has gone into providing user convenience in the program. Once familiarity with a rigid format is gained, data preparation is relatively simple and no programming skills are required. The price of these user convenience features is, of course, increased computer run times. In large problems with many elements, bulk data preparation is laborious as there are no provisions for the automated generation of grid point or element data.

Only the structural plot capabilities of the program were used in the example problems. The case control cards for these plots were found to be simple to prepare, since the program determines the appropriate scale, origin, and vantage point to be used for the plot. The x-y plot capability extends the usefulness of the program; however, there is no provision for stress-contour plots in two-dimensional bodies such as those described in Ref. 17.

While the documentation is complete in the sense that it provides a useful reference for those familiar with the program, it leaves something to be desired in aiding the new user. A tutorial manual would be very helpful. The situation for the new user is further aggravated by the lack of an index for the NASTRAN manuals.

While the NASTRAN element library is extensive, there are programs with more and improved types of elements. Fully compatible plate elements, consistent mass and force matrices for all elements, and elements with variable section properties and temperatures would allow adequate modeling with fewer elements.

The inadequacies of the program that have been pointed out have been noted by others and are well known to NASA. While these inadequacies are more than compensated for by the capability and convenience of the program, many of them are expected to be removed in later levels of the program. All indications are that the program will become more general, convenient, and accurate, while requiring less computer time. Use of the program is expected to become widespread both in government and industry. Under these circumstances it appears advisable for APL/JHU to constantly maintain its NASTRAN capability at the latest current level of release.

ACKNOWLEDGMENT

The author is indebted to Messrs. James McKee and Myles Hurwitz of NSRDC and to Mr. William Case and Dr. James Mason of the NASA Goddard Space Flight Center for their assistance when troubles were encountered in running the example problems described in this report.

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APPENDIX A

Example 1 — Simply-Supported Beam

THE JOHNS HOPKINS UNIVERSITY
APPLIED PHYSICS LABORATORY
SILVER SPRING, MARYLAND

PRECEDING PAGE BLANK NOT FILMED

```
N A S T R A N   E X E C U T I V E   C O N T R O L   D E C K   SEPTEMBER  29, 1971      PAGE      1

ID RIVELLO, NASPROB1
APP DISPLACEMENT
SOL 1,1
TIME 2
CEND


NASTRAN CHECK PROBLEM 1                                       SEPTEMBER  29, 1971      PAGE      2
STATIC LOADING OF SIMPLY SUPPORTED BEAM

                           C A S E   C O N T R O L   D E C K   E C H O
 CARD
 COUNT
  1      TITLE # NASTRAN CHECK PROBLEM 1
  2      SUBTITLE # STATIC LOADING OF SIMPLY SUPPORTED BEAM
  3      SPC # 1
  4      OUTPUT
  5      $ SET 1 IS ELEMENT NUMBERS
  6          SET 1 # 1 THRU 4
  7          DISPLACEMENT # ALL
  8          SPCFORCES # ALL
  9          STRESS # 1
 10      SUBCASE 1
 11          LABEL # CONCENTRATED LOAD AT CENTER
 12          LOAD # 1
 13          OLOAD # ALL
 14      SUBCASE 2
 15          LABEL # DISTRIBUTED LOAD
 16          LOAD # 2
 17          OLOAD # ALL
 18      SUBCASE 3
 19          LABEL # CONCENTRATED PLUS DISTRIBUTED LOAD
 20          LOAD # 3
 21      PLOTID # STATIC DEFORMATION OF BEAM
 22      OUTPUT%PLOT<
 23      SET 1 # ALL
 24      PLOTTER CALCOMP, MODEL 565,310
 25      ORTHOGRAPHIC PROJECTION
 26      MAXIMUM DEFORMATION 10.0
 27      FIND SCALE, ORIGIN 1, SET 1
 28      PLOT LABEL BOTH
 29      PLOT STATIC DEFORMATION 1, LABEL BOTH, SHAPE
 30      PLOT STATIC DEFORMATION 2, LABEL BOTH, SHAPE
 31      PLOT STATIC DEFORMATION 3, LABEL BOTH, SHAPE
 32      BEGIN BULK
```

S O R T E D   B U L K   D A T A   E C H O

CARD COUNT	. 1 ..	2 ..	3 ..	4 ..	5 ..	6 ..	7 ..	8 ..	9 ..	10 .
1*	BAROR		1			.0	1.0	.0	1	
2*	CBAR	1		1	2					
3*	CBAR	2		2	3					
4*	CBAR	3		3	4					
5*	CBAR	4		4	5					
6*	FORCE	1	3	0	1.0	.0	100.0	.0		
7*	GRAV	2	0	3.86&4	.0	1.0	.0			
8*	GRDSET							345		
9*	GRID	1		.0	.0	.0				
10*	GRID	2		10.0	.0	.0				
11*	GRID	3		20.0	.0	.0				
12*	GRID	4		30.0	.0	.0				
13*	GRID	5		40.0	.0	.0				
14*	LOAD	3	1.0	1.0	1	1.0	2			
15*	MAT1	1	10.0&6	4.0&6		2.591-4				
16*	PBAR	1	1	1.0	.1	.1				123
17*	&23	0.5	0.5	-0.5	0.5	0.5	-0.5	-0.5	-0.5	
18*	SPC	1	1	12	.0	5	2	.0		
	ENDDATA									

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

```
DMAP-DMAP INSTRUCTION
 NO.

  1  BEGIN    NO.1 STATICS ANALYSIS - SERIES L $

  2  FILE     LLL#TAPE $

  4  GP1      GEOM1,GEOM2,/GPL,EQEXIN,GPDT,CSTM,BGPDT,SIL/V,N,LUSET/ C,N,123/
              V,N,NOGPDT $

  5  SAVE     LUSET$

  6  CHKPNT   GPL,EQEXIN,GPDT,CSTM,BGPDT,SIL $

  7  GP2      GEOM2,EQEXIN/ECT $

  8  CHKPNT   ECT $

  9  PLTSET   PCDB,EQEXIN,ECT/PLTSETX,PLTPAR,GPSETS,ELSETS/V,N,NSIL/ V,N,
              JUMPPLOT $

 10  SAVE     NSIL,JUMPPLOT $

 11  PRTMSG   PLTSETX//$

 12  CHKPNT   PLTPAR,GPSETS,ELSETS $

 13  SETVAL   //V,N,PLTFLG/C,N,1/V,N,PFILE/C,N,0 $

 14  SAVE     PLTFLG,PFILE $

 15  COND     P1,JUMPPLOT $

 16  PLOT     PLTPAR,GPSETS,ELSETS,CASECC,BGPDT,EQEXIN,SIL,,/PLOTX1/ V,N,
              NSIL/V,N,LUSET/V,N,JUMPPLOT/V,N,PLTFLG/V,N,PFILE $

 17  SAVE     JUMPPLOT,PLTFLG,PFILE $

 18  PRTMSG   PLOTX1//$

 19  LABEL    P1$

 20  GP3      GEOM3,EQEXIN,GEOM2/SLT,GPTT/C,N,123/V,N,NOGRAV/C,N,123 $

 21  SAVE     NOGRAV$

 22  PARAM    //C,N,AND/V,N,SKPMGG/V,N,NOGRAV/V,Y,GRDPNT$

 23  PURGE    MGG/SKPMGG$

 24  CHKPNT   SLT,GPTT,MGG $
```

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

```
DMAP-DMAP INSTRUCTION
 NO.

 25  TA1,     ,ECT,EPT,BGPDT,SIL,GPTT,CSTM/EST,,GEI,ECPT,GPCT/V,N,LUSET/ C,N,
              123/V,N,NOSIMP/C,N,0/V,N,NOGENL/V,N,GENEL $

 26  SAVE     NOSIMP,NOGENL,GENEL $

 27  PARAM    //C,N,AND/V,N,NOELMT/V,N,NOGENL/V,N,NOSIMP $

 28  COND     ERROR4,NOELMT $

 29  PURGE    GPST/NOSIMP/OGPST/GENEL $

 30  CHKPNT   EST,ECPT,GPCT,GEI,GPST,OGPST $

 31  COND     LBL1,NOSIMP$

 32  SMA1     CSTM,MPT,ECPT,GPCT, DIT/KGGX,,GPST/V,N,NOGENL/V,N,NOK4GG $

 33  CHKPNT   GPST,KGGX $

 34  COND     LBL1,SKPMGG$

 35  SMA2     CSTM,MPT,ECPT,GPCT,DIT/MGG,/V,Y,WTMASS#1.0/V,N,NOMGG/V,N,NOBGG/
              V,Y,COUPMASS#-1 $

 36  SAVE     NOMGG$

 37  CHKPNT   MGG $

 38  COND     LBL1,GRDPNT$

 39  COND     ERROR2,NOMGG$

 40  GPWG     BGPDT,CSTM,EQEXIN,MGG/OGPWG/V,Y,GRDPNT#-1/V,Y,WTMASS$

 41  OFP      OGPWG,,,,,//V,N,CARDNO $

 42  SAVE     CARDNO $

 43  LABEL    LBL1 $

 44  EQUIV    KGGX,KGG/NOGENL $

 45  CHKPNT   KGG $

 46  COND     LBL11A,NOGENL $

 47  SMA3     GEI,KGGX/KGG/V,N,LUSET/V,N,NOGENL/V,N,NOSIMP $

 48  CHKPNT   KGG $
```

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

```
DMAP-DMAP INSTRUCTION
 NO.

 49  LABEL    LBL11A $

 50  PARAM    //C,N,MPY/V,N,NSKIP/C,N,0/C,N,0 $

 52  LABEL    LBL11 $

 53  GP4      CASECC,GEOM4,EQEXIN,SIL,GPDT/RG,YS,USET/V,N,LUSET/V,N,MPCF1/ V,
              N,MPCF2/V,N,SINGLE/V,N,OMIT/V,N,REACT/V,N,NSKIP/V,N,REPEAT/ V,
              N,NOSET/V,N,NOL/V,N,NOA $

 54  SAVE     MPCF1,MPCF2,SINGLE,OMIT,REACT,NSKIP,REPEAT,NOSET,NOL,NOA $

 55  COND     ERROR3,NOL $

 56  PARAM    //C,N,AND/V,N,NOSR/V,N,SINGLE/V,N,REACT $

 57  PURGE    KRR,KLR,QR,DM/REACT/ GM/MPCF1/ GO,KOOB,LOO,UOO,PO,UOOV,RUOV/
              OMIT/PS,KFS,KSS/SINGLE/QG/NOSR $

 58  EQUIV    KGG,KNN/MPCF1 $

 59  CHKPNT   KRR,KLR,QR,DM,GM,GO,KOOB,LOO,UOO,PO,UOOV,QG,PS,KFS,KSS,USET,
              RG,YS,RUOV,KNN $

 60  COND     LBL4,GENEL $

 61  GPSP     GPL,GPST,USET,SIL/OGPST $

 62  OFP      OGPST,,,,,//V,N,CARDNO $

 63  SAVE     CARDNO $

 64  LABEL    LBL4 $

 65  COND     LBL2,MPCF2 $

 66  MCE1     USET,RG/GM $

 67  CHKPNT   GM $

 68  MCE2     USET,GM,KGG,,,/KNN,,, $

 69  CHKPNT   KNN$

 70  LABEL    LBL2 $

 71  EQUIV    KNN,KFF/SINGLE $

 72  CHKPNT   KFF $
```

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

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DMAP-DMAP INSTRUCTION
 NO.

 73  COND      LBL3,SINGLE $

 74  SCE1      USET,KNN,,,/KFF,KFS,KSS,,, $

 75  CHKPNT    KFS,KSS,KFF$

 76  LABEL     LBL3 $

 77  EQUIV     KFF,KAA/OMIT $

 78  CHKPNT    KAA $

 79  COND      LBL5,OMIT $

 80  SMP1      USET,KFF,,,/GO,KAA,KOOB,LOO,UOO,,,,, $

 81  CHKPNT    GO,KAA,KOOB,LOO,UOO$

 82  LABEL     LBL5 $

 83  EQUIV     KAA,KLL/REACT $

 84  CHKPNT    KLL$

 85  COND      LBL6,REACT $

 86  RBMG1     USET,KAA,/KLL,KLR,KRR,,, $

 87  CHKPNT    KLL,KLR,KRR$

 88  LABEL     LBL6 $

 89  RBMG2     KLL/LLL,ULL $

 90  CHKPNT    ULL,LLL$

 91  COND      LBL7,REACT $

 92  RBMG3     LLL,ULL,KLR,KRR/DM $

 93  CHKPNT    DM$

 94  LABEL     LBL7 $

 95  SSG1      SLT,BGPDT,CSTM,SIL,EST,MPT,GPTT,EDT,MGG,CASECC,DIT/PG/V,N,
               LUSET/V,N,NSKIP $

 96  CHKPNT    PG $

 97  EQUIV     PG,PL/NOSET $
```

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

```
DMAP-DMAP INSTRUCTION
 NO.

 98  CHKPNT   PL $

 99  COND     LBL10,NOSET $

100  SSG2     USET,GM,YS,KFS,GO,DM,PG/QR,PO,PS,PL $

101  CHKPNT   QR,PO,PS,PL $

102  LABEL    LBL10 $

103  SSG3     LLL,ULL,KLL,PL,LOO,UOO,KOOB,PO/ULV,UOOV,RULV,RUOV/ V,N,OMIT/V,
              Y,IRES#-1 $

104  CHKPNT   ULV,UOOV,RULV,RUOV$

105  COND     LBL9,IRES$

106  MATGPR   GPL,USET,SIL,RULV//C,N,L $

107  MATGPR   GPL,USET,SIL,RUOV//C,N,O $

108  LABEL    LBL9$

109  SDR1     USET,PG,ULV,UOOV,YS,GO,GM,PS,KFS,KSS,QR/UGV,PGG,QG/V,N,NSKIP/
              C,N,STATICS$

110  CHKPNT   UGV,PGG$

115  CHKPNT   QG $

116  SDR2     CASECC,CSTM,MPT,DIT,EQEXIN,SIL,GPTT,EDT,BGPDT,PGG,QG,UGV,EST,/
              OPG1,OQG1,OUGV1,OES1,OEF1,PUGV1/C,N,STATICS $

117  OFP      OUGV1,OPG1,OQG1,OEF1,OES1,//V,N,CARDNO $

118  SAVE     CARDNO $

119  COND     P2,JUMPPLOT $

120  PLOT     PLTPAR,GPSETS,ELSETS,CASECC,BGPDT,EQEXIN,SIL,PUGV1, / PLOTX2/V,
              N,NSIL/V,N,LUSET/V,N,JUMPPLOT/V,N,PLTFLG/V,N,PFILE $

121  PRTMSG   PLOTX2// $

122  LABEL    P2 $

123  JUMP     FINIS$

126  LABEL    ERROR2$
```

```
   N A S T R A N   S O U R C E   P R O G R A M   C O M P I L A T I O N
DMAP-DMAP INSTRUCTION
 NO.

127  PRTPARM  //C,N,-2/C,N,STATICS$

128  LABEL    ERROR3 $

129  PRTPARM  //C,N,-3/C,N,STATICS $

130  LABEL    ERROR4 $

131  PRTPARM  //C,N,-4/C,N,STATICS $

132  LABEL    FINIS$

133  END      $

*** USER WARNING MESSAGE 27,
 LABEL NAMED LBL11    NOT REFERENCED

      **NO ERRORS FOUND - EXECUTE NASTRAN PROGRAM**
```

MESSAGES FROM THE PLOT MODULE

P L O T T E R   D A T A

THE FOLLOWING PLOTS ARE FOR A CALCOMP 565 INCREMENTAL PLOTTER %3 CHARACTERS/COMMAND - .010 STEP SIZE<

AN END-OF-FILE MARK FOLLOWS THE LAST PLOT

THE FIRST COMMAND FOR EACH PLOT CONTAINS THE PLOT NUMBER

PEN 1 - SIZE 1, BLACK

E N G I N E E R I N G   D A T A

ORTHOGRAPHIC PROJECTION
ROTATIONS %DEGREES< - GAMMA # 34.27, BETA # 23.17, ALPHA # 0.0 , AXES # &X,&Y,&Z, SYMMETRIC
SCALE %OBJECT-TO-PLOT SIZE< # 1.973244E-01

ORIGIN 1 - XO # -3.417761E 00, YO # -6.943212E 00 %INCHES<

MESSAGES FROM THE PLOT MODULE

PLOT 1 UNDEFORMED STRUCTURE

```
***USER INFORMATION MESSAGE 3023
B #     5 C #     0 R #     4
***USER INFORMATION MESSAGE 3027
DECOMPOSITION TIME ESTIMATE IS      0

*** USER INFORMATION MESSAGE 2073, MPYAD METHOD       1,NO. PASSES #       1
*** USER INFORMATION MESSAGE 2073, MPYAD METHOD       1,NO. PASSES #       1
*** USER INFORMATION MESSAGE 2073, MPYAD METHOD       1,NO. PASSES #       1
***USER INFORMATION MESSAGE 3035
FOR LOAD     1 EPSILON SUB E # -3.8548402E-15
***USER INFORMATION MESSAGE 3035
FOR LOAD     2 EPSILON SUB E # -8.0861966E-15
***USER INFORMATION MESSAGE 3035
FOR LOAD     3 EPSILON SUB E # -6.0295227E-15

*** USER INFORMATION MESSAGE 2073, MPYAD METHOD       1,NO. PASSES #       1
*** USER INFORMATION MESSAGE 2073, MPYAD METHOD       1,NO. PASSES #       1
```

NASTRAN CHECK PROBLEM 1
STATIC LOADING OF SIMPLY SUPPORTED BEAM

SEPTEMBER 29, 1971 PAGE 12

CONCENTRATED LOAD AT CENTER

SUBCASE 1

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

POINT ID.	TYPE	T1	T2	T3	R1	R2	R3
1	G	0.0	0.0	0.0	0.0	0.0	9.999990E-03
2	G	0.0	9.166658E-02	0.0	0.0	0.0	7.499993E-03
3	G	0.0	1.333331E-01	0.0	0.0	0.0	5.086260E-09
4	G	0.0	9.166658E-02	0.0	0.0	0.0	-7.499989E-03
5	G	0.0	0.0	0.0	0.0	0.0	-9.999990E-03

NASTRAN CHECK PROBLEM 1
STATIC LOADING OF SIMPLY SUPPORTED BEAM

SEPTEMBER 29, 1971 PAGE 13

DISTRIBUTED LOAD

SUBCASE 2

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

POINT ID.	TYPE	T1	T2	T3	R1	R2	R3
1	G	0.0	0.0	0.0	0.0	0.0	2.500310E-02
2	G	0.0	2.250279E-01	0.0	0.0	0.0	1.750217E-02
3	G	0.0	3.167058E-01	0.0	0.0	0.0	1.371065E-08
4	G	0.0	2.250279E-01	0.0	0.0	0.0	-1.750216E-02
5	G	0.0	0.0	0.0	0.0	0.0	-2.500310E-02

NASTRAN CHECK PROBLEM 1
STATIC LOADING OF SIMPLY SUPPORTED BEAM

SEPTEMBER 29, 1971 PAGE 14

CONCENTRATED PLUS DISTRIBUTED LOAD

SUBCASE 3

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

POINT ID.	TYPE	T1	T2	T3	R1	R2	R3
1	G	0.0	0.0	0.0	0.0	0.0	3.500309E-02
2	G	0.0	3.166944E-01	0.0	0.0	0.0	2.500216E-02
3	G	0.0	4.500389E-01	0.0	0.0	0.0	1.879691E-08
4	G	0.0	3.166944E-01	0.0	0.0	0.0	-2.500215E-02
5	G	0.0	0.0	0.0	0.0	0.0	-3.500308E-02

NASTRAN CHECK PROBLEM 1 SEPTEMBER 29, 1971 PAGE 15
STATIC LOADING OF SIMPLY SUPPORTED BEAM

CONCENTRATED LOAD AT CENTER SUBCASE 1

L O A D   V E C T O R

POINT ID.	TYPE	T1	T2	T3	R1	R2	R3
3	G	0.0	9.999997E 01	0.0	0.0	0.0	0.0

NASTRAN CHECK PROBLEM 1 SEPTEMBER 29, 1971 PAGE 16
STATIC LOADING OF SIMPLY SUPPORTED BEAM

DISTRIBUTED LOAD SUBCASE 2

L O A D   V E C T O R

POINT ID.	TYPE	T1	T2	T3	R1	R2	R3
1	G	0.0	5.000623E 01	0.0	0.0	0.0	0.0
2	G	0.0	1.000124E 02	0.0	0.0	0.0	0.0
3	G	0.0	1.000124E 02	0.0	0.0	0.0	0.0
4	G	0.0	1.000125E 02	0.0	0.0	0.0	0.0
5	G	0.0	5.000623E 01	0.0	0.0	0.0	0.0

NASTRAN CHECK PROBLEM 1 SEPTEMBER 29, 1971 PAGE 17
STATIC LOADING OF SIMPLY SUPPORTED BEAM

CONCENTRATED LOAD AT CENTER SUBCASE 1

F O R C E S   O F   S I N G L E - P O I N T   C O N S T R A I N T

POINT ID.	TYPE	T1	T2	T3	R1	R2	R3
1	G	0.0	-5.000000E 01	0.0	0.0	0.0	0.0
5	G	0.0	-5.000000E 01	0.0	0.0	0.0	0.0

NASTRAN CHECK PROBLEM 1 SEPTEMBER 29, 1971 PAGE 18
STATIC LOADING OF SIMPLY SUPPORTED BEAM

DISTRIBUTED LOAD SUBCASE 2

F O R C E S   O F   S I N G L E - P O I N T   C O N S T R A I N T

POINT ID.	TYPE	T1	T2	T3	R1	R2	R3
1	G	0.0	-2.000244E 02	0.0	0.0	0.0	0.0
5	G	0.0	-2.000244E 02	0.0	0.0	0.0	0.0

CONCENTRATED PLUS DISTRIBUTED LOAD SUBCASE 3

F O R C E S O F S I N G L E - P O I N T C O N S T R A I N T

POINT ID.	TYPE	T1	T2	T3	R1	R2	R3
1	G	0.0	-2.500239E 02	0.0	0.0	0.0	0.0
5	G	0.0	-2.500234E 02	0.0	0.0	0.0	0.0

CONCENTRATED LOAD AT CENTER SUBCASE 1

S T R E S S E S I N B A R E L E M E N T S %CBAR<

ELEMENT ID.	SA1 / SB1	SA2 / SB2	SA3 / SB3	SA4 / SB4	AXIAL STRESS	SA-MAX / SB-MAX	SA-MIN / SB-MIN	M.S.-T / M.S.-C
1	1.464844E-02	-1.464844E-02	1.464844E-02	-1.464844E-02	0.0	1.464844E-02	-1.464844E-02	
	2.500037E 03	-2.500037E 03	2.500037E 03	-2.500037E 03		2.500037E 03	-2.500037E 03	
2	2.500000E 03	-2.500000E 03	2.500000E 03	-2.500000E 03	0.0	2.500000E 03	-2.500000E 03	
	4.999980E 03	-4.999980E 03	4.999980E 03	-4.999980E 03		4.999980E 03	-4.999980E 03	
3	4.999957E 03	-4.999957E 03	4.999957E 03	-4.999957E 03	0.0	4.999957E 03	-4.999957E 03	
	2.499960E 03	-2.499960E 03	2.499960E 03	-2.499960E 03		2.499960E 03	-2.499960E 03	
4	2.499994E 03	-2.499994E 03	2.499994E 03	-2.499994E 03	0.0	2.499994E 03	-2.499994E 03	
	-2.929688E-02	2.929688E-02	-2.929688E-02	2.929688E-02		2.929688E-02	-2.929688E-02	

DISTRIBUTED LOAD SUBCASE 2

S T R E S S E S I N B A R E L E M E N T S %CBAR<

ELEMENT ID.	SA1 / SB1	SA2 / SB2	SA3 / SB3	SA4 / SB4	AXIAL STRESS	SA-MAX / SB-MAX	SA-MIN / SB-MIN	M.S.-T / M.S.-C
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	7.500984E 03	-7.500984E 03	7.500984E 03	-7.500984E 03		7.500984E 03	-7.500984E 03	
2	7.500957E 03	-7.500957E 03	7.500957E 03	-7.500957E 03	0.0	7.500957E 03	-7.500957E 03	
	1.000126E 04	-1.000126E 04	1.000126E 04	-1.000126E 04		1.000126E 04	-1.000126E 04	
3	1.000123E 04	-1.000123E 04	1.000123E 04	-1.000123E 04	0.0	1.000123E 04	-1.000123E 04	
	7.500926E 03	-7.500926E 03	7.500926E 03	-7.500926E 03		7.500926E 03	-7.500926E 03	
4	7.500918E 03	-7.500918E 03	7.500918E 03	-7.500918E 03	0.0	7.500918E 03	-7.500918E 03	
	-7.080072E-02	7.080072E-02	-7.080072E-02	7.080072E-02		7.080072E-02	-7.080072E-02	

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CONCENTRATED PLUS DISTRIBUTED LOAD SUBCASE 3

S T R E S S E S I N B A R E L E M E N T S %C B A R<

ELEMENT ID.	SA1 / SB1	SA2 / SB2	SA3 / SB3	SA4 / SB4	AXIAL STRESS	SA-MAX / SB-MAX	SA-MIN / SB-MIN	M.S.-T / M.S.-C
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	1.000100E 04	-1.000100E 04	1.000100E 04	-1.000100E 04		1.000100E 04	-1.000100E 04	
2	1.000090E 04	-1.000090E 04	1.000090E 04	-1.000090E 04	0.0	1.000090E 04	-1.000090E 04	
	1.500109E 04	-1.500109E 04	1.500109E 04	-1.500109E 04		1.500109E 04	-1.500109E 04	
3	1.500123E 04	-1.500123E 04	1.500123E 04	-1.500123E 04	0.0	1.500123E 04	-1.500123E 04	
	1.000104E 04	-1.000104E 04	1.000104E 04	-1.000104E 04		1.000104E 04	-1.000104E 04	
4	1.000090E 04	-1.000090E 04	1.000090E 04	-1.000090E 04	0.0	1.000090E 04	-1.000090E 04	
	-7.812494E-02	7.812494E-02	-7.812494E-02	7.812494E-02		7.812494E-02	-7.812494E-02	

MESSAGES FROM THE PLOT MODULE

P L O T T E R D A T A

THE FOLLOWING PLOTS ARE FOR A CALCOMP 565 INCREMENTAL PLOTTER %3 CHARACTERS/COMMAND - .010 STEP SIZE<

AN END-OF-FILE MARK FOLLOWS THE LAST PLOT

THE FIRST COMMAND FOR EACH PLOT CONTAINS THE PLOT NUMBER

PEN 1 - SIZE 1, BLACK

E N G I N E E R I N G D A T A

ORTHOGRAPHIC PROJECTION
ROTATIONS %DEGREES< - GAMMA # 34.27, BETA # 23.17, ALPHA # 0.0 , AXES # &X,&Y,&Z, SYMMETRIC
SCALE %OBJECT-TO-PLOT SIZE< # 1.973244E-01

ORIGIN 1 - X0 # -3.417761E 00, Y0 # -6.943212E 00 %INCHES<

MESSAGES FROM THE PLOT MODULE

PLOT 2 STATIC DEFORMATION - SUBCASE 1, LOAD SET 1

MESSAGES FROM THE PLOT MODULE

P L O T T E R   D A T A

THE FOLLOWING PLOTS ARE FOR A CALCOMP 565 INCREMENTAL PLOTTER %3 CHARACTERS/COMMAND - .010 STEP SIZE<

AN END-OF-FILE MARK FOLLOWS THE LAST PLOT

THE FIRST COMMAND FOR EACH PLOT CONTAINS THE PLOT NUMBER

PEN 1 - SIZE 1, BLACK

E N G I N E E R I N G   D A T A

ORTHOGRAPHIC PROJECTION
ROTATIONS %DEGREES< - GAMMA # 34.27, BETA # 23.17, ALPHA # 0.0 , AXES # &X,&Y,&Z, SYMMETRIC
SCALE %OBJECT-TO-PLOT SIZE< # 1.973244E-01

ORIGIN 1 - X0 # -3.417761E 00, Y0 # -6.943212E 00 %INCHES<

MESSAGES FROM THE PLOT MODULE

PLOT 3 STATIC DEFORMATION - SUBCASE 2, LOAD SET 2

MESSAGES FROM THE PLOT MODULE

P L O T T E R   D A T A

THE FOLLOWING PLOTS ARE FOR A CALCOMP 565 INCREMENTAL PLOTTER %3 CHARACTERS/COMMAND - .010 STEP SIZE<

AN END-OF-FILE MARK FOLLOWS THE LAST PLOT

THE FIRST COMMAND FOR EACH PLOT CONTAINS THE PLOT NUMBER

PEN 1 - SIZE 1, BLACK

E N G I N E E R I N G   D A T A

ORTHOGRAPHIC PROJECTION
ROTATIONS %DEGREES< - GAMMA # 34.27, BETA # 23.17, ALPHA #   0.0 , AXES # &X,&Y,&Z, SYMMETRIC
SCALE %OBJECT-TO-PLOT SIZE< # 1.973244E-01

ORIGIN   1   -   XO # -3.417761E 00, YO # -6.943212E 00   %INCHES<

MESSAGES FROM THE PLOT MODULE

PLOT   4   STATIC DEFORMATION - SUBCASE   3, LOAD SET   3

* * * END OF JOB * * *

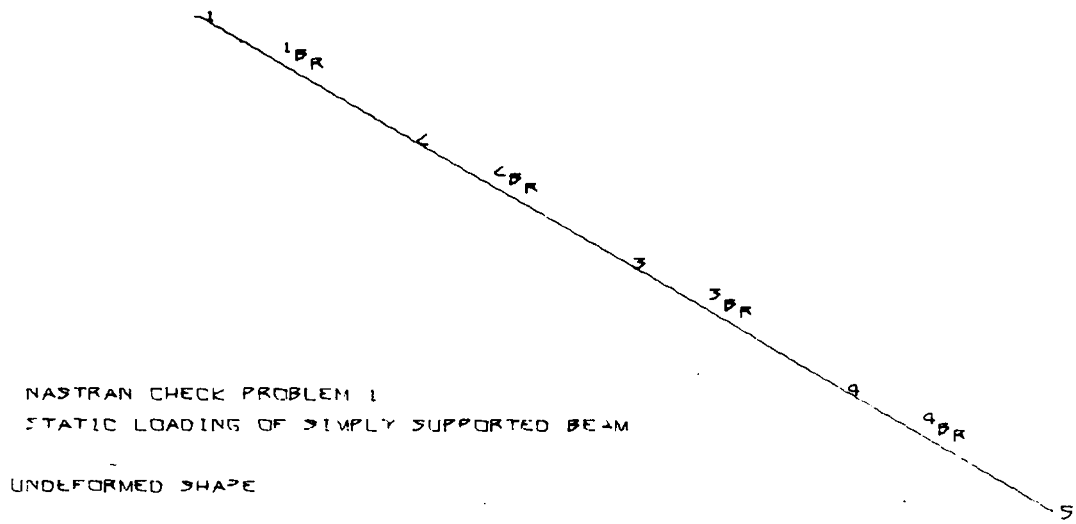

Fig. A-1 STATIC LOADING OF SIMPLY-SUPPORTED BEAM; NASTRAN EXAMPLE PROBLEM 1: UNDEFORMED SHAPE

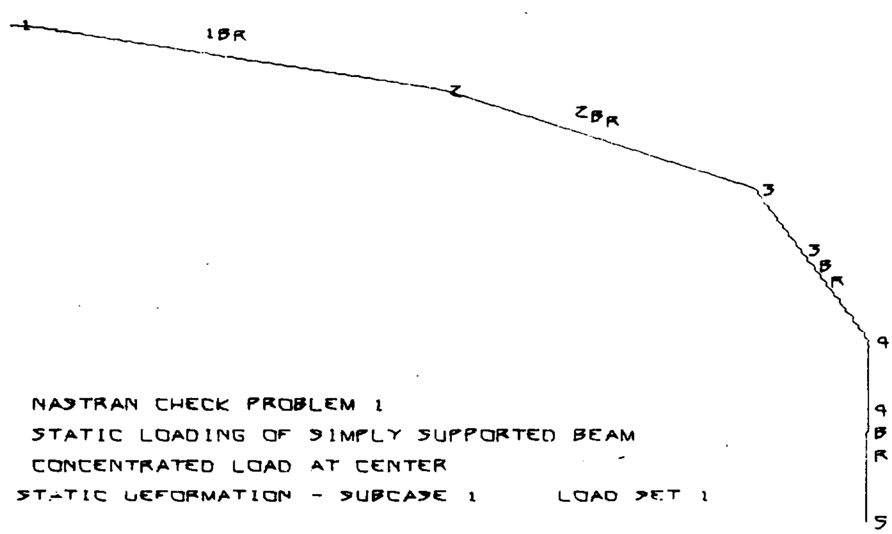

Fig. A-2 STATIC LOADING OF SIMPLY-SUPPORTED BEAM, CONCENTRATED LOAD AT CENTER; NASTRAN EXAMPLE PROBLEM 1: STATIC DEFORMATION—SUBCASE 1, LOAD SET 1

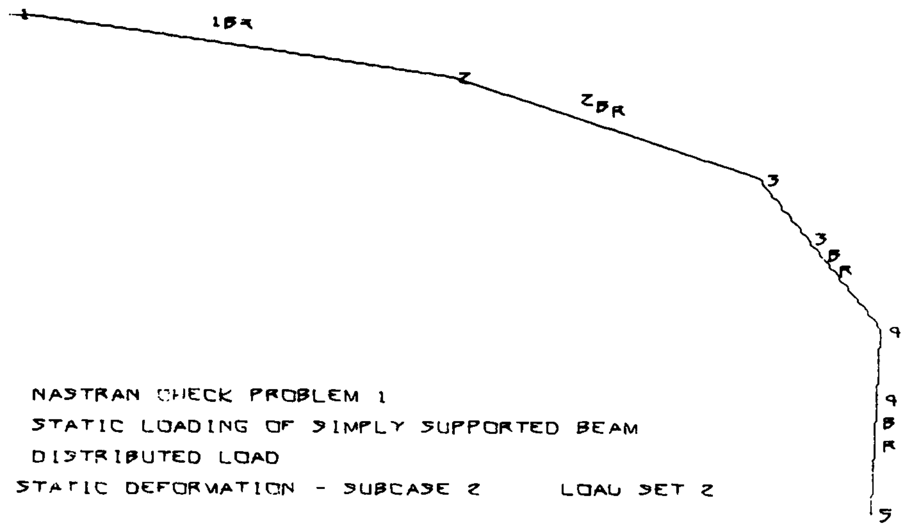

Fig. A-3 STATIC LOADING OF SIMPLY-SUPPORTED BEAM, DISTRIBUTED LOAD; NASTRAN EXAMPLE PROBLEM 1:STATIC DEFORMATION—SUBCASE 2, LOAD SET 2

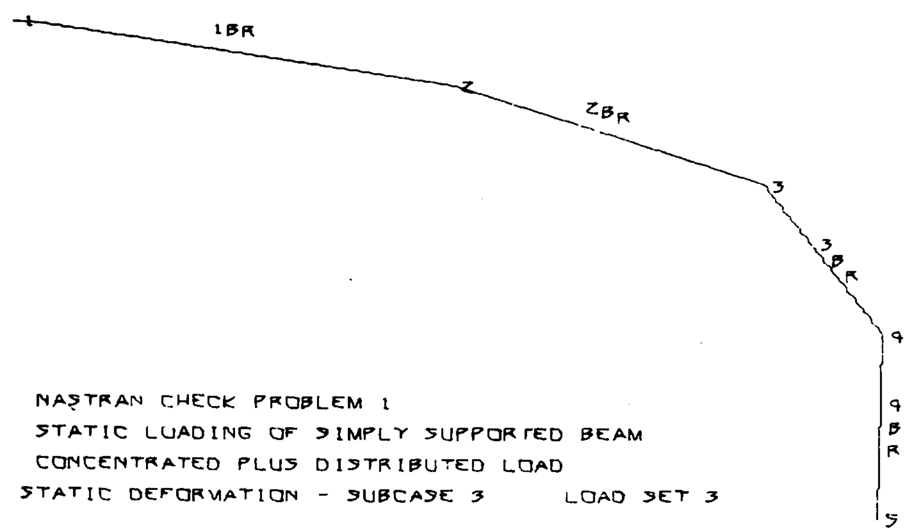

Fig. A-4 STATIC LOADING AT SIMPLY-SUPPORTED BEAM, CONCENTRATED PLUS DISTRIBUTED LOAD; NASTRAN EXAMPLE PROBLEM 1: STATIC DEFORMATION—SUBCASE 3, LOAD SET 3

C-2

APPENDIX B

Example 2 - Composite Flywheel

```
        N A S T R A N   E X E C U T I V E   C O N T R O L   D E C K   SEPTEMBER  25, 1971       PAGE      1

ID      RIVELLO, FLYWHEEL
APP     DISPLACEMENT
SOL     1,1
TIME    5
CEND
```

```
SUPER FLYWHEEL STRESS ANALYSIS 1.264 CPS                                SEPTEMBER  25, 1971       PAGE      2

NASTRAN CHECK PROBLEM 2
                                   C A S E   C O N T R O L   D E C K   E C H O
          CARD
          COUNT
            1      TITLE # SUPER FLYWHEEL STRESS ANALYSIS 1.264 CPS
            2      LABEL # NASTRAN CHECK PROBLEM 2
            3      LOAD # 1
            4      SPC # 1
            5      OUTPUT
            6         DISPLACEMENT # ALL
            7      OLOAD # ALL
            8         STRESS # ALL
            9      PLOTID # SUPER FLYWHEEL 1.264 CPS
           10      OUTPUT%PLOT<
           11      SET 1 # ALL
           12      PLOTTER CALCOMP, MODEL 565,310
           13      ORTHOGRAPHIC PROJECTION
           14      MAXIMUM DEFORMATION 1.0
           15      FIND SCALE, ORIGIN 1, SET 1
           16      PLOT LABEL BOTH
           17      PLOT STATIC DEFORMATION 1 LABEL BOTH
           18      PLOT STATIC DEFORMATION 0, 1, LABEL BOTH, SHAPE
           19      PLOT STATIC DEFORMATION 1, VECTOR RXY
           20      BEGIN BULK
```

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NASTRAN CHECK PROBLEM 2

SORTED BULK DATA ECHO

CARD COUNT	. 1 ..	2 ..	3 ..	4 ..	5 ..	6 ..	7 ..	8 ..	9 ..	10 .
1*	CQDMEM	1	1	1	6	7	2	.0		
2*	CQDMEM	2	1	2	7	8	3	.0		
3*	CQDMEM	3	1	3	8	9	4	.0		
4*	CQDMEM	4	1	4	9	10	5	.0		
5*	CQDMEM	5	1	6	11	12	7	.0		
6*	CQDMEM	6	1	7	12	13	8	.0		
7*	CQDMEM	7	1	8	13	14	9	.0		
8*	CQDMEM	8	1	9	14	15	10	.0		
9*	CQDMEM	9	1	11	16	17	12	.0		
10*	CQDMEM	10	1	12	17	18	13	.0		
11*	CQDMEM	11	1	13	18	19	14	.0		
12*	CQDMEM	12	1	14	19	20	15	.0		
13*	CQDMEM	13	1	16	21	22	17	.0		
14*	CQDMEM	14	1	17	22	23	18	.0		
15*	CQDMEM	15	1	18	23	24	19	.0		
16*	CQDMEM	16	1	19	24	25	20	.0		
17*	CQDMEM	17	1	21	26	27	22	.0		
18*	CQDMEM	18	1	22	27	28	23	.0		
19*	CQDMEM	19	1	23	28	29	24	.0		
20*	CQDMEM	20	1	24	29	30	25	.0		
21*	CQDMEM	21	1	26	31	32	27	.0		
22*	CQDMEM	22	1	27	32	33	28	.0		
23*	CQDMEM	23	1	28	33	34	29	.0		
24*	CQDMEM	24	1	29	34	35	30	.0		
25*	CQDMEM	25	1	31	36	37	32	.0		
26*	CQDMEM	26	1	32	37	38	33	.0		
27*	CQDMEM	27	1	33	38	39	34	.0		
28*	CQDMEM	28	1	34	39	40	35	.0		
29*	CQDMEM	29	1	36	41	42	37	.0		
30*	CQDMEM	30	1	37	42	43	38	.0		
31*	CQDMEM	31	1	38	43	44	39	.0		
32*	CQDMEM	32	1	39	44	45	40	.0		
33*	CQDMEM	33	1	41	46	47	42	.0		
34*	CQDMEM	34	1	42	47	48	43	.0		
35*	CQDMEM	35	1	43	48	49	44	.0		
36*	CQDMEM	36	1	44	49	50	45	.0		
37*	CQDMEM	37	1	46	51	52	47	.0		
38*	CQDMEM	38	1	47	52	53	48	.0		
39*	CQDMEM	39	1	48	53	54	49	.0		
40*	CQDMEM	40	1	49	54	55	50	.0		
41*	CQDMEM	41	1	51	56	57	52	.0		
42*	CQDMEM	42	1	52	57	58	53	.0		
43*	CQDMEM	43	1	53	58	59	54	.0		
44*	CQDMEM	44	1	54	59	60	55	.0		
45*	CQDMEM	45	1	56	61	62	57	.0		
46*	CQDMEM	46	1	57	62	63	58	.0		
47*	CQDMEM	47	1	58	63	64	59	.0		
48*	CQDMEM	48	1	59	64	65	60	.0		
49*	CQDMEM	49	1	61	66	67	62	.0		
50*	CQDMEM	50	1	62	67	68	63	.0		

NASTRAN CHECK PROBLEM 2

S O R T E D B U L K D A T A E C H O

CARD COUNT	. 1 ..	2 ..	3 ..	4 ..	5 ..	6 ..	7 ..	8 ..	9 ..	10 .
51*	CQDMEM	51	1	63	68	69	64	.0		
52*	CQDMEM	52	1	64	69	70	65	.0		
53*	CQDMEM	53	1	66	71	72	67	.0		
54*	CQDMEM	54	1	67	72	73	68	.0		
55*	CQDMEM	55	1	68	73	74	69	.0		
56*	CQDMEM	56	1	69	74	75	70	.0		
57*	CQDMEM	57	1	71	76	77	72	.0		
58*	CQDMEM	58	1	72	77	78	73	.0		
59*	CQDMEM	59	1	73	78	79	74	.0		
60*	CQDMEM	60	1	74	79	80	75	.0		
61*	GRDSET							3456		
62*	GRID	1		.0	.0	.0				
63*	GRID	2		.0	.625	.0				
64*	GRID	3		.0	1.25	.0				
65*	GRID	4		.0	1.875	.0				
66*	GRID	5		.0	2.5	.0				
67*	GRID	6		1.0	.0	.0				
68*	GRID	7		1.0	.625	.0				
69*	GRID	8		1.0	1.25	.0				
70*	GRID	9		1.0	1.875	.0				
71*	GRID	10		1.0	2.5	.0				
72*	GRID	11		2.0	.0	.0				
73*	GRID	12		2.0	.625	.0				
74*	GRID	13		2.0	1.25	.0				
75*	GRID	14		2.0	1.875	.0				
76*	GRID	15		2.0	2.5	.0				
77*	GRID	16		3.0	.0	.0				
78*	GRID	17		3.0	.625	.0				
79*	GRID	18		3.0	1.25	.0				
80*	GRID	19		3.0	1.875	.0				
81*	GRID	20		3.0	2.5	.0				
82*	GRID	21		4.0	.0	.0				
83*	GRID	22		4.0	.625	.0				
84*	GRID	23		4.0	1.25	.0				
85*	GRID	24		4.0	1.875	.0				
86*	GRID	25		4.0	2.5	.0				
87*	GRID	26		5.0	.0	.0				
88*	GRID	27		5.0	.625	.0				
89*	GRID	28		5.0	1.25	.0				
90*	GRID	29		5.0	1.875	.0				
91*	GRID	30		5.0	2.5	.0				
92*	GRID	31		6.0	.0	.0				
93*	GRID	32		6.0	.625	.0				
94*	GRID	33		6.0	1.25	.0				
95*	GRID	34		6.0	1.875	.0				
96*	GRID	35		6.0	2.5	.0				
97*	GRID	36		7.0	.0	.0				
98*	GRID	37		7.0	.625	.0				
99*	GRID	38		7.0	1.25	.0				
100*	GRID	39		7.0	1.875	.0				

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S O R T E D   B U L K   D A T A   E C H O

CARD COUNT	. 1 ..	2 ..	3 ..	4 ..	5 ..	6 ..	7 ..	8 ..	9 ..	10 .
101*	GRID	40		7.0	2.5	.0				
102*	GRID	41		8.0	.0	.0				
103*	GRID	42		8.0	.625	.0				
104*	GRID	43		8.0	1.25	.0				
105*	GRID	44		8.0	1.875	.0				
106*	GRID	45		8.0	2.5	.0				
107*	GRID	46		9.0	.0	.0				
108*	GRID	47		9.0	.625	.0				
109*	GRID	48		9.0	1.25	.0				
110*	GRID	49		9.0	1.875	.0				
111*	GRID	50		9.0	2.5	.0				
112*	GRID	51		10.0	.0	.0				
113*	GRID	52		10.0	.625	.0				
114*	GRID	53		10.0	1.25	.0				
115*	GRID	54		10.0	1.875	.0				
116*	GRID	55		10.0	2.5	.0				
117*	GRID	56		11.0	.0	.0				
118*	GRID	57		11.0	.625	.0				
119*	GRID	58		11.0	1.25	.0				
120*	GRID	59		11.0	1.875	.0				
121*	GRID	60		11.0	2.5	.0				
122*	GRID	61		12.0	.0	.0				
123*	GRID	62		12.0	.625	.0				
124*	GRID	63		12.0	1.25	.0				
125*	GRID	64		12.0	1.875	.0				
126*	GRID	65		12.0	2.5	.0				
127*	GRID	66		13.0	.0	.0				
128*	GRID	67		13.0	.625	.0				
129*	GRID	68		13.0	1.25	.0				
130*	GRID	69		13.0	1.875	.0				
131*	GRID	70		13.0	2.5	.0				
132*	GRID	71		14.0	.0	.0				
133*	GRID	72		14.0	.625	.0				
134*	GRID	73		14.0	1.25	.0				
135*	GRID	74		14.0	1.875	.0				
136*	GRID	75		14.0	2.5	.0				
137*	GRID	76		15.0	.0	.0				
138*	GRID	77		15.0	.625	.0				
139*	GRID	78		15.0	1.25	.0				
140*	GRID	79		15.0	1.875	.0				
141*	GRID	80		15.0	2.5	.0				
142*	MAT2	1	21.59&6	.3614&6	.0	1.446&6	.0	.616&6	1.398-4	
143*	PQDMEM	1	1	1.0						
144*	RFORCE	1	0	0	1.264	.0	.0	1.0		
145*	SPC1	1	1	1	2	3	4	5		
146*	SPC1	1	2	1	6	11	16	21	26	XSPC1A
147*	&SPC1A	31	36	41	46	51	56	61	66	XSPC1B
148*	&SPC1B	71	76							
	ENDDATA									

NASTRAN CHECK PROBLEM 2

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

```
DMAP-DMAP INSTRUCTION
 NO.

  1  BEGIN     NO.1 STATICS ANALYSIS - SERIES L $

  2  FILE      LLL#TAPE $

  4  GP1       GEOM1,GEOM2,/GPL,EQEXIN,GPDT,CSTM,BGPDT,SIL/V,N,LUSET/ C,N,123/
               V,N,NOGPDT $

  5  SAVE      LUSET$

  6  CHKPNT    GPL,EQEXIN,GPDT,CSTM,BGPDT,SIL $

  7  GP2       GEOM2,EQEXIN/ECT $

  8  CHKPNT    ECT $

  9  PLTSET    PCDB,EQEXIN,ECT/PLTSETX,PLTPAR,GPSETS,ELSETS/V,N,NSIL/ V,N,
               JUMPPLOT $

 10  SAVE      NSIL,JUMPPLOT $

 11  PRTMSG    PLTSETX//$

 12  CHKPNT    PLTPAR,GPSETS,ELSETS $

 13  SETVAL    //V,N,PLTFLG/C,N,1/V,N,PFILE/C,N,0 $

 14  SAVE      PLTFLG,PFILE $

 15  COND      P1,JUMPPLOT $

 16  PLOT      PLTPAR,GPSETS,ELSETS,CASECC,BGPDT,EQEXIN,SIL,,/PLOTX1/ V,N,
               NSIL/V,N,LUSET/V,N,JUMPPLOT/V,N,PLTFLG/V,N,PFILE $

 17  SAVE      JUMPPLOT,PLTFLG,PFILE $

 18  PRTMSG    PLOTX1//$

 19  LABEL     P1$

 20  GP3       GEOM3,EQEXIN,GEOM2/SLT,GPTT/C,N,123/V,N,NOGRAV/C,N,123 $

 21  SAVE      NOGRAV$

 22  PARAM     //C,N,AND/V,N,SKPMGG/V,N,NOGRAV/V,Y,GRDPNT$

 23  PURGE     MGG/SKPMGG$

 24  CHKPNT    SLT,GPTT,MGG $
```

NASTRAN CHECK PROBLEM 2

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

```
DMAP-DMAP INSTRUCTION
 NO.

 25  TA1,     ,ECT,EPT,BGPDT,SIL,GPTT,CSTM/EST,,GEI,ECPT,GPCT/V,N,LUSET/ C,N,
              123/V,N,NOSIMP/C,N,0/V,N,NOGENL/V,N,GENEL $

 26  SAVE     NOSIMP,NOGENL,GENEL $

 27  PARAM    //C,N,AND/V,N,NOELMT/V,N,NOGENL/V,N,NOSIMP $

 28  COND     ERROR4,NOELMT $

 29  PURGE    GPST/NOSIMP/OGPST/GENEL $

 30  CHKPNT   EST,ECPT,GPCT,GEI,GPST,OGPST $

 31  COND     LBL1,NOSIMP$

 32  SMA1     CSTM,MPT,ECPT,GPCT, DIT/KGGX,,GPST/V,N,NOGENL/V,N,NOK4GG $

 33  CHKPNT   GPST,KGGX $

 34  COND     LBL1,SKPMGG$

 35  SMA2     CSTM,MPT,ECPT,GPCT,DIT/MGG,/V,Y,WTMASS#1.0/V,N,NOMGG/V,N,NOBGG/
              V,Y,COUPMASS#-1 $

 36  SAVE     NOMGG$

 37  CHKPNT   MGG $

 38  COND     LBL1,GRDPNT$

 39  COND     ERROR2,NOMGG$

 40  GPWG     BGPDT,CSTM,EQEXIN,MGG/OGPWG/V,Y,GRDPNT#-1/V,Y,WTMASS$

 41  OFP      OGPWG,,,,,//V,N,CARDNO $

 42  SAVE     CARDNO $

 43  LABEL    LBL1 $

 44  EQUIV    KGGX,KGG/NOGENL $

 45  CHKPNT   KGG $

 46  COND     LBL11A,NOGENL $

 47  SMA3     GEI,KGGX/KGG/V,N,LUSET/V,N,NOGENL/V,N,NOSIMP $

 48  CHKPNT   KGG $
```

NASTRAN CHECK PROBLEM 2

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

```
DMAP-DMAP INSTRUCTION
NO.

 49  LABEL    LBL11A $

 50  PARAM    //C,N,MPY/V,N,NSKIP/C,N,0/C,N,0 $

 52  LABEL    LBL11 $

 53  GP4      CASECC,GEOM4,EQEXIN,SIL,GPDT/RG,YS,USET/V,N,LUSET/V,N,MPCF1/ V,
              N,MPCF2/V,N,SINGLE/V,N,OMIT/V,N,REACT/V,N,NSKIP/V,N,REPEAT/ V,
              N,NOSET/V,N,NOL/V,N,NOA $

 54  SAVE     MPCF1,MPCF2,SINGLE,OMIT,REACT,NSKIP,REPEAT,NOSET,NOL,NOA $

 55  COND     ERROR3,NOL $

 56  PARAM    //C,N,AND/V,N,NOSR/V,N,SINGLE/V,N,REACT $

 57  PURGE    KRR,KLR,QR,DM/REACT/ GM/MPCF1/ GO,KOOB,LOO,UOO,PO,UOOV,RUOV/
              OMIT/PS,KFS,KSS/SINGLE/QG/NOSR $

 58  EQUIV    KGG,KNN/MPCF1 $

 59  CHKPNT   KRR,KLR,QR,DM,GM,GO,KOOB,LOO,UOO,PO,UOOV,QG,PS,KFS,KSS,USET,
              RG,YS,RUOV,KNN $

 60  COND     LBL4,GENEL $

 61  GPSP     GPL,GPST,USET,SIL/OGPST $

 62  OFP      OGPST,,,,,//V,N,CARDNO $

 63  SAVE     CARDNO $

 64  LABEL    LBL4 $

 65  COND     LBL2,MPCF2 $

 66  MCE1     USET,RG/GM $

 67  CHKPNT   GM $

 68  MCE2     USET,GM,KGG,,,/KNN,,, $

 69  CHKPNT   KNN$

 70  LABEL    LBL2 $

 71  EQUIV    KNN,KFF/SINGLE $

 72  CHKPNT   KFF $
```

NASTRAN CHECK PROBLEM 2

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

```
DMAP-DMAP INSTRUCTION
 NO.

 73  COND      LBL3,SINGLE $
 74  SCE1      USET,KNN,,,/KFF,KFS,KSS,,, $
 75  CHKPNT    KFS,KSS,KFF$
 76  LABEL     LBL3 $
 77  EQUIV     KFF,KAA/OMIT $
 78  CHKPNT    KAA $
 79  COND      LBL5,OMIT $
 80  SMP1      USET,KFF,,,/GO,KAA,KOOB,LOO,UOO,,,,, $
 81  CHKPNT    GO,KAA,KOOB,LOO,UOO$
 82  LABEL     LBL5 $
 83  EQUIV     KAA,KLL/REACT $
 84  CHKPNT    KLL$
 85  COND      LBL6,REACT $
 86  RBMG1     USET,KAA,/KLL,KLR,KRR,,, $
 87  CHKPNT    KLL,KLR,KRR$
 88  LABEL     LBL6 $
 89  RBMG2     KLL/LLL,ULL $
 90  CHKPNT    ULL,LLL$
 91  COND      LBL7,REACT $
 92  RBMG3     LLL,ULL,KLR,KRR/DM $
 93  CHKPNT    DM$
 94  LABEL     LBL7 $
 95  SSG1      SLT,BGPDT,CSTM,SIL,EST,MPT,GPTT,EDT,MGG,CASECC,DIT/PG/V,N,
               LUSET/V,N,NSKIP $
 96  CHKPNT    PG $
 97  EQUIV     PG,PL/NOSET $
```

NASTRAN CHECK PROBLEM 2

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

```
DMAP-DMAP INSTRUCTION
 NO.

 98  CHKPNT   PL $

 99  COND     LBL10,NOSET $

100  SSG2     USET,GM,YS,KFS,GO,DM,PG/QR,PO,PS,PL $

101  CHKPNT   QR,PO,PS,PL $

102  LABEL    LBL10 $

103  SSG3     LLL,ULL,KLL,PL,LOO,UOO,KOOB,PO/ULV,UOOV,RULV,RUOV/ V,N,OMIT/V,
              Y,IRES#-1 $

104  CHKPNT   ULV,UOOV,RULV,RUOV$

105  COND     LBL9,IRES$

106  MATGPR   GPL,USET,SIL,RULV//C,N,L $

107  MATGPR   GPL,USET,SIL,RUOV//C,N,O $

108  LABEL    LBL9$

109  SDR1     USET,PG,ULV,UOOV,YS,GO,GM,PS,KFS,KSS,QR/UGV,PGG,QG/V,N,NSKIP/
              C,N,STATICS$

110  CHKPNT   UGV,PGG$

115  CHKPNT   QG $

116  SDR2     CASECC,CSTM,MPT,DIT,EQEXIN,SIL,GPTT,EDT,BGPDT,PGG,QG,UGV,EST,/
              OPG1,OQG1,OUGV1,OES1,OEF1,PUGV1/C,N,STATICS $

117  OFP      OUGV1,OPG1,OQG1,OEF1,OES1,//V,N,CARDNO $

118  SAVE     CARDNO $

119  COND     P2,JUMPPLOT $

120  PLOT     PLTPAR,GPSETS,ELSETS,CASECC,BGPDT,EQEXIN,SIL,PUGV1, / PLOTX2/V,
              N,NSIL/V,N,LUSET/V,N,JUMPPLOT/V,N,PLTFLG/V,N,PFILE $

121  PRTMSG   PLOTX2// $

122  LABEL    P2 $

123  JUMP     FINIS$

126  LABEL    ERROR2$
```

```
 NASTRAN CHECK PROBLEM 2

    N A S T R A N   S O U R C E   P R O G R A M   C O M P I L A T I O N
DMAP-DMAP INSTRUCTION
 NO.

127  PRTPARM  //C,N,-2/C,N,STATICS$

128  LABEL    ERROR3 $

129  PRTPARM  //C,N,-3/C,N,STATICS $

130  LABEL    ERROR4 $

131  PRTPARM  //C,N,-4/C,N,STATICS $

132  LABEL    FINIS$

133  END      $

*** USER WARNING MESSAGE 27,
     LABEL NAMED LBL11    NOT REFERENCED

          **NO ERRORS FOUND - EXECUTE NASTRAN PROGRAM**
```

NASTRAN CHECK PROBLEM 2

MESSAGES FROM THE PLOT MODULE

P L O T T E R   D A T A

THE FOLLOWING PLOTS ARE FOR A CALCOMP 565 INCREMENTAL PLOTTER %3 CHARACTERS/COMMAND - .010 STEP SIZE<

AN END-OF-FILE MARK FOLLOWS THE LAST PLOT

THE FIRST COMMAND FOR EACH PLOT CONTAINS THE PLOT NUMBER

PEN 1 - SIZE 1, BLACK

E N G I N E E R I N G   D A T A

ORTHOGRAPHIC PROJECTION
ROTATIONS %DEGREES< - GAMMA # 34.27, BETA # 23.17, ALPHA # 0.0 , AXES # &X,&Y,&Z, SYMMETRIC
SCALE %OBJECT-TO-PLOT SIZE< # 8.070700E-01

ORIGIN 1 - X0 # -1.397886E 00, Y0 # -7.404646E 00 %INCHES<

MESSAGES FROM THE PLOT MODULE

PLOT   1   UNDEFORMED STRUCTURE

```
***USER INFORMATION MESSAGE 3023
B #    11 C #     1 R #    10
***USER INFORMATION MESSAGE 3027
DECOMPOSITION TIME ESTIMATE IS      0

*** USER INFORMATION MESSAGE 2073, MPYAD METHOD       1,NO. PASSES #       1
*** USER INFORMATION MESSAGE 2073, MPYAD METHOD       1,NO. PASSES #       1
***USER INFORMATION MESSAGE 3035
FOR LOAD     1 EPSILON SUB E #  4.6903186E-14

*** USER INFORMATION MESSAGE 2073, MPYAD METHOD       1,NO. PASSES #       1
*** USER INFORMATION MESSAGE 2073, MPYAD METHOD       1,NO. PASSES #       1
```

THE JOHNS HOPKINS UNIVERSITY
APPLIED PHYSICS LABORATORY
SILVER SPRING, MARYLAND

NASTRAN CHECK PROBLEM 2

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

POINT ID.	TYPE	T1	T2	T3	R1	R2	R3
1	G	0.0	0.0	0.0	0.0	0.0	0.0
2	G	0.0	4.742830E-09	0.0	0.0	0.0	0.0
3	G	0.0	7.997297E-09	0.0	0.0	0.0	0.0
4	G	0.0	8.278043E-09	0.0	0.0	0.0	0.0
5	G	0.0	4.104741E-09	0.0	0.0	0.0	0.0
6	G	4.600195E-08	0.0	0.0	0.0	0.0	0.0
7	G	4.598960E-08	4.775298E-09	0.0	0.0	0.0	0.0
8	G	4.594881E-08	8.062120E-09	0.0	0.0	0.0	0.0
9	G	4.586927E-08	8.375022E-09	0.0	0.0	0.0	0.0
10	G	4.573777E-08	4.233705E-09	0.0	0.0	0.0	0.0
11	G	9.159254E-08	0.0	0.0	0.0	0.0	0.0
12	G	9.156810E-08	4.872721E-09	0.0	0.0	0.0	0.0
13	G	9.148727E-08	8.256617E-09	0.0	0.0	0.0	0.0
14	G	9.132918E-08	8.666007E-09	0.0	0.0	0.0	0.0
15	G	9.106679E-08	4.620649E-09	0.0	0.0	0.0	0.0
16	G	1.363605E-07	0.0	0.0	0.0	0.0	0.0
17	G	1.363246E-07	5.035165E-09	0.0	0.0	0.0	0.0
18	G	1.362053E-07	8.580919E-09	0.0	0.0	0.0	0.0
19	G	1.359707E-07	9.151158E-09	0.0	0.0	0.0	0.0
20	G	1.355785E-07	5.265722E-09	0.0	0.0	0.0	0.0
21	G	1.798943E-07	0.0	0.0	0.0	0.0	0.0
22	G	1.798477E-07	5.262745E-09	0.0	0.0	0.0	0.0
23	G	1.796924E-07	9.035229E-09	0.0	0.0	0.0	0.0
24	G	1.793845E-07	9.830742E-09	0.0	0.0	0.0	0.0
25	G	1.788645E-07	6.169195E-09	0.0	0.0	0.0	0.0
26	G	2.217824E-07	0.0	0.0	0.0	0.0	0.0
27	G	2.217263E-07	5.555613E-09	0.0	0.0	0.0	0.0
28	G	2.215383E-07	9.619853E-09	0.0	0.0	0.0	0.0
29	G	2.211615E-07	1.070516E-08	0.0	0.0	0.0	0.0
30	G	2.205165E-07	7.331465E-09	0.0	0.0	0.0	0.0
31	G	2.616130E-07	0.0	0.0	0.0	0.0	0.0
32	G	2.615490E-07	5.913957E-09	0.0	0.0	0.0	0.0
33	G	2.613324E-07	1.033515E-08	0.0	0.0	0.0	0.0
34	G	2.608928E-07	1.177489E-08	0.0	0.0	0.0	0.0
35	G	2.601271E-07	8.753020E-09	0.0	0.0	0.0	0.0
36	G	2.989741E-07	0.0	0.0	0.0	0.0	0.0
37	G	2.989039E-07	6.337952E-09	0.0	0.0	0.0	0.0
38	G	2.986642E-07	1.118147E-08	0.0	0.0	0.0	0.0
39	G	2.981694E-07	1.304043E-08	0.0	0.0	0.0	0.0
40	G	2.972891E-07	1.043433E-08	0.0	0.0	0.0	0.0
41	G	3.334534E-07	0.0	0.0	0.0	0.0	0.0
42	G	3.333793E-07	6.827616E-09	0.0	0.0	0.0	0.0
43	G	3.331229E-07	1.215889E-08	0.0	0.0	0.0	0.0
44	G	3.325827E-07	1.450195E-08	0.0	0.0	0.0	0.0
45	G	3.315965E-07	1.237554E-08	0.0	0.0	0.0	0.0
46	G	3.646384E-07	0.0	0.0	0.0	0.0	0.0
47	G	3.645628E-07	7.382450E-09	0.0	0.0	0.0	0.0
48	G	3.642974E-07	1.326657E-08	0.0	0.0	0.0	0.0
49	G	3.637240E-07	1.615846E-08	0.0	0.0	0.0	0.0
50	G	3.626445E-07	1.457552E-08	0.0	0.0	0.0	0.0

NASTRAN CHECK PROBLEM 2

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

POINT ID.	TYPE	T1	T2	T3	R1	R2	R3
51	G	3.921161E-07	0.0	0.0	0.0	0.0	0.0
52	G	3.920420E-07	8.000530E-09	0.0	0.0	0.0	0.0
53	G	3.917764E-07	1.450103E-08	0.0	0.0	0.0	0.0
54	G	3.911845E-07	1.800560E-08	0.0	0.0	0.0	0.0
55	G	3.900299E-07	1.702955E-08	0.0	0.0	0.0	0.0
56	G	4.154736E-07	0.0	0.0	0.0	0.0	0.0
57	G	4.154042E-07	8.676245E-09	0.0	0.0	0.0	0.0
58	G	4.151483E-07	1.585200E-08	0.0	0.0	0.0	0.0
59	G	4.145556E-07	2.003016E-08	0.0	0.0	0.0	0.0
60	G	4.133511E-07	1.972332E-08	0.0	0.0	0.0	0.0
61	G	4.342980E-07	0.0	0.0	0.0	0.0	0.0
62	G	4.342369E-07	9.394928E-09	0.0	0.0	0.0	0.0
63	G	4.340015E-07	1.729230E-08	0.0	0.0	0.0	0.0
64	G	4.334281E-07	2.219662E-08	0.0	0.0	0.0	0.0
65	G	4.322082E-07	2.261837E-08	0.0	0.0	0.0	0.0
66	G	4.481781E-07	0.0	0.0	0.0	0.0	0.0
67	G	4.481286E-07	1.012046E-08	0.0	0.0	0.0	0.0
68	G	4.479252E-07	1.875418E-08	0.0	0.0	0.0	0.0
69	G	4.473926E-07	2.441455E-08	0.0	0.0	0.0	0.0
70	G	4.462004E-07	2.561581E-08	0.0	0.0	0.0	0.0
71	G	4.567062E-07	0.0	0.0	0.0	0.0	0.0
72	G	4.566717E-07	1.076939E-08	0.0	0.0	0.0	0.0
73	G	4.565110E-07	2.007801E-08	0.0	0.0	0.0	0.0
74	G	4.560405E-07	2.646145E-08	0.0	0.0	0.0	0.0
75	G	4.549186E-07	2.845827E-08	0.0	0.0	0.0	0.0
76	G	4.594835E-07	0.0	0.0	0.0	0.0	0.0
77	G	4.594667E-07	1.116882E-08	0.0	0.0	0.0	0.0
78	G	4.593585E-07	2.093368E-08	0.0	0.0	0.0	0.0
79	G	4.589721E-07	2.784518E-08	0.0	0.0	0.0	0.0
80	G	4.579233E-07	3.033556E-08	0.0	0.0	0.0	0.0

NASTRAN CHECK PROBLEM 2

LOAD VECTOR

POINT ID.	TYPE	T1	T2	T3	R1	R2	R3
2	G	0.0	1.722226E-03	0.0	0.0	0.0	0.0
3	G	0.0	3.444448E-03	0.0	0.0	0.0	0.0
4	G	0.0	5.166668E-03	0.0	0.0	0.0	0.0
5	G	0.0	3.444446E-03	0.0	0.0	0.0	0.0
6	G	2.755559E-03	0.0	0.0	0.0	0.0	0.0
7	G	5.511120E-03	3.444450E-03	0.0	0.0	0.0	0.0
8	G	5.511116E-03	6.888895E-03	0.0	0.0	0.0	0.0
9	G	5.511113E-03	1.033334E-02	0.0	0.0	0.0	0.0
10	G	2.755559E-03	6.888893E-03	0.0	0.0	0.0	0.0
11	G	5.511116E-03	0.0	0.0	0.0	0.0	0.0
12	G	1.102224E-02	3.444450E-03	0.0	0.0	0.0	0.0
13	G	1.102223E-02	6.888896E-03	0.0	0.0	0.0	0.0
14	G	1.102223E-02	1.033334E-02	0.0	0.0	0.0	0.0
15	G	5.511116E-03	6.888896E-03	0.0	0.0	0.0	0.0
16	G	8.266680E-03	0.0	0.0	0.0	0.0	0.0
17	G	1.653337E-02	3.444452E-03	0.0	0.0	0.0	0.0
18	G	1.653336E-02	6.888904E-03	0.0	0.0	0.0	0.0
19	G	1.653336E-02	1.033335E-02	0.0	0.0	0.0	0.0
20	G	8.266684E-03	6.888900E-03	0.0	0.0	0.0	0.0
21	G	1.102224E-02	0.0	0.0	0.0	0.0	0.0
22	G	2.204449E-02	3.444452E-03	0.0	0.0	0.0	0.0
23	G	2.204448E-02	6.888904E-03	0.0	0.0	0.0	0.0
24	G	2.204448E-02	1.033335E-02	0.0	0.0	0.0	0.0
25	G	1.102224E-02	6.888900E-03	0.0	0.0	0.0	0.0
26	G	1.377780E-02	0.0	0.0	0.0	0.0	0.0
27	G	2.755561E-02	3.444452E-03	0.0	0.0	0.0	0.0
28	G	2.755560E-02	6.888904E-03	0.0	0.0	0.0	0.0
29	G	2.755560E-02	1.033335E-02	0.0	0.0	0.0	0.0
30	G	1.377781E-02	6.888900E-03	0.0	0.0	0.0	0.0
31	G	1.653336E-02	0.0	0.0	0.0	0.0	0.0
32	G	3.306673E-02	3.444452E-03	0.0	0.0	0.0	0.0
33	G	3.306673E-02	6.888904E-03	0.0	0.0	0.0	0.0
34	G	3.306673E-02	1.033335E-02	0.0	0.0	0.0	0.0
35	G	1.653337E-02	6.888900E-03	0.0	0.0	0.0	0.0
36	G	1.928892E-02	0.0	0.0	0.0	0.0	0.0
37	G	3.857787E-02	3.444452E-03	0.0	0.0	0.0	0.0
38	G	3.857784E-02	6.888904E-03	0.0	0.0	0.0	0.0
39	G	3.857784E-02	1.033335E-02	0.0	0.0	0.0	0.0
40	G	1.928893E-02	6.888900E-03	0.0	0.0	0.0	0.0
41	G	2.204448E-02	0.0	0.0	0.0	0.0	0.0
42	G	4.408898E-02	3.444452E-03	0.0	0.0	0.0	0.0
43	G	4.408898E-02	6.888904E-03	0.0	0.0	0.0	0.0
44	G	4.408898E-02	1.033335E-02	0.0	0.0	0.0	0.0
45	G	2.204450E-02	6.888900E-03	0.0	0.0	0.0	0.0
46	G	2.480004E-02	0.0	0.0	0.0	0.0	0.0
47	G	4.960009E-02	3.444452E-03	0.0	0.0	0.0	0.0
48	G	4.960009E-02	6.888904E-03	0.0	0.0	0.0	0.0
49	G	4.960009E-02	1.033335E-02	0.0	0.0	0.0	0.0
50	G	2.480006E-02	6.888900E-03	0.0	0.0	0.0	0.0
51	G	2.755561E-02	0.0	0.0	0.0	0.0	0.0

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NASTRAN CHECK PROBLEM 2

LOAD VECTOR

POINT ID.	TYPE	T1	T2	T3	R1	R2	R3
52	G	5.511123E-02	3.444452E-03	0.0	0.0	0.0	0.0
53	G	5.511123E-02	6.888904E-03	0.0	0.0	0.0	0.0
54	G	5.511123E-02	1.033335E-02	0.0	0.0	0.0	0.0
55	G	2.755563E-02	6.888900E-03	0.0	0.0	0.0	0.0
56	G	3.031117E-02	0.0	0.0	0.0	0.0	0.0
57	G	6.062237E-02	3.444452E-03	0.0	0.0	0.0	0.0
58	G	6.062234E-02	6.888904E-03	0.0	0.0	0.0	0.0
59	G	6.062234E-02	1.033335E-02	0.0	0.0	0.0	0.0
60	G	3.031119E-02	6.888900E-03	0.0	0.0	0.0	0.0
61	G	3.306673E-02	0.0	0.0	0.0	0.0	0.0
62	G	6.613344E-02	3.444452E-03	0.0	0.0	0.0	0.0
63	G	6.613344E-02	6.888904E-03	0.0	0.0	0.0	0.0
64	G	6.613344E-02	1.033335E-02	0.0	0.0	0.0	0.0
65	G	3.306673E-02	6.888900E-03	0.0	0.0	0.0	0.0
66	G	3.582228E-02	0.0	0.0	0.0	0.0	0.0
67	G	7.164454E-02	3.444452E-03	0.0	0.0	0.0	0.0
68	G	7.164454E-02	6.888904E-03	0.0	0.0	0.0	0.0
69	G	7.164454E-02	1.033335E-02	0.0	0.0	0.0	0.0
70	G	3.582231E-02	6.888900E-03	0.0	0.0	0.0	0.0
71	G	3.857784E-02	0.0	0.0	0.0	0.0	0.0
72	G	7.715571E-02	3.444452E-03	0.0	0.0	0.0	0.0
73	G	7.715565E-02	6.888904E-03	0.0	0.0	0.0	0.0
74	G	7.715565E-02	1.033335E-02	0.0	0.0	0.0	0.0
75	G	3.857787E-02	6.888900E-03	0.0	0.0	0.0	0.0
76	G	2.066670E-02	0.0	0.0	0.0	0.0	0.0
77	G	4.133342E-02	1.722226E-03	0.0	0.0	0.0	0.0
78	G	4.133339E-02	3.444450E-03	0.0	0.0	0.0	0.0
79	G	4.133339E-02	5.166672E-03	0.0	0.0	0.0	0.0
80	G	2.066671E-02	3.444448E-03	0.0	0.0	0.0	0.0

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NASTRAN CHECK PROBLEM 2

S T R E S S E S I N Q U A D R I L A T E R A L M E M B R A N E S %CQDMEM<

ELEMENT ID.	STRESSES IN ELEMENT COORD SYSTEM NORMAL-X	NORMAL-Y	SHEAR-XY	PRINCIPAL STRESS ANGLE	PRINCIPAL STRESSES MAJOR	MINOR	MAX SHEAR
1	9.958006E-01	2.763342E-02	3.910623E-06	0.0002	9.958003E-01	2.763337E-02	4.840835E-01
2	9.943661E-01	2.418022E-02	9.862939E-06	0.0006	9.943559E-01	2.418017E-02	4.850929E-01
3	9.913476E-01	1.727825E-02	1.064315E-05	0.0006	9.913471E-01	1.727790E-02	4.870346E-01
4	9.864939E-01	6.935049E-03	4.782341E-06	0.0003	9.864938E-01	6.935060E-03	4.897794E-01
5	9.869596E-01	2.763507E-02	1.191348E-05	0.0007	9.869592E-01	2.763496E-02	4.796622E-01
6	9.855359E-01	2.418152E-02	2.998114E-05	0.0018	9.855356E-01	2.418137E-02	4.806771E-01
7	9.825358E-01	1.727895E-02	3.246963E-05	0.0019	9.825357E-01	1.727903E-02	4.826283E-01
8	9.776988E-01	6.935220E-03	1.473725E-05	0.0009	9.776987E-01	6.935239E-03	4.853817E-01
9	9.692787E-01	2.763849E-02	2.027303E-05	0.0012	9.692786E-01	2.763855E-02	4.708200E-01
10	9.678786E-01	2.418426E-02	5.131960E-05	0.0031	9.678785E-01	2.418435E-02	4.718471E-01
11	9.649179E-01	1.728051E-02	5.582720E-05	0.0034	9.649178E-01	1.728058E-02	4.738186E-01
12	9.601139E-01	6.935649E-03	2.557412E-05	0.0015	9.601138E-01	6.935716E-03	4.765890E-01
13	9.427567E-01	2.764380E-02	2.938509E-05	0.0018	9.427565E-01	2.764386E-02	4.575564E-01
14	9.413910E-01	2.418847E-02	7.474422E-05	0.0047	9.413909E-01	2.418852E-02	4.586012E-01
15	9.384909E-01	1.728290E-02	8.201599E-05	0.0051	9.384907E-01	1.728296E-02	4.606039E-01
16	9.337425E-01	6.936308E-03	3.808737E-05	0.0024	9.337424E-01	6.936312E-03	4.634030E-01
17	9.073906E-01	2.765131E-02	3.951788E-05	0.0026	9.073905E-01	2.765143E-02	4.398695E-01
18	9.060725E-01	2.419455E-02	1.010895E-04	0.0066	9.060725E-01	2.419450E-02	4.409389E-01
19	9.032526E-01	1.728640E-02	1.119971E-04	0.0072	9.032525E-01	1.728642E-02	4.429830E-01
20	8.985834E-01	6.937277E-03	5.316734E-05	0.0034	8.985833E-01	6.937385E-03	4.458230E-01
21	8.631725E-01	2.766131E-02	5.114079E-05	0.0035	8.631724E-01	2.766132E-02	4.177555E-01
22	8.619165E-01	2.420269E-02	1.313686E-04	0.0090	8.619164E-01	2.420270E-02	4.188569E-01
23	8.592052E-01	1.729121E-02	1.474619E-04	0.0100	8.592051E-01	1.729131E-02	4.209569E-01
24	8.546438E-01	6.938674E-03	7.212162E-05	0.0049	8.546437E-01	6.938696E-03	4.238525E-01
25	8.101015E-01	2.767415E-02	6.443262E-05	0.0047	8.101014E-01	2.767420E-02	3.912136E-01
26	8.089228E-01	2.421326E-02	1.664162E-04	0.0122	8.089227E-01	2.421325E-02	3.923547E-01
27	8.063526E-01	1.729766E-02	1.899004E-04	0.0138	8.063525E-01	1.729774E-02	3.945274E-01
28	8.019400E-01	6.940614E-03	9.644032E-05	0.0070	8.019398E-01	6.940722E-03	3.974996E-01
29	7.481709E-01	2.768995E-02	7.963181E-05	0.0063	7.481708E-01	2.768999E-02	3.602404E-01
30	7.470837E-01	2.422649E-02	2.074242E-04	0.0164	7.470835E-01	2.422655E-02	3.614285E-01
31	7.446871E-01	1.730604E-02	2.412200E-04	0.0190	7.446870E-01	1.730609E-02	3.636904E-01
32	7.404709E-01	6.943267E-03	1.283288E-04	0.0100	7.404708E-01	6.943345E-03	3.667637E-01
33	6.773777E-01	2.770809E-02	9.709597E-05	0.0086	6.773775E-01	2.770823E-02	3.248346E-01
34	6.763983E-01	2.424195E-02	2.549291E-04	0.0224	6.763983E-01	2.424192E-02	3.260782E-01
35	6.742125E-01	1.731617E-02	3.025532E-04	0.0264	6.742125E-01	1.731610E-02	3.284482E-01
36	6.702504E-01	6.946586E-03	1.698136E-04	0.0147	6.702503E-01	6.946633E-03	3.316568E-01
37	5.977077E-01	2.772567E-02	1.166463E-04	0.0117	5.977076E-01	2.772570E-02	2.849910E-01
38	5.968533E-01	2.425747E-02	3.088117E-04	0.0309	5.968533E-01	2.425742E-02	2.862979E-01
39	5.949211E-01	1.732693E-02	3.749132E-04	0.0372	5.949212E-01	1.732677E-02	2.887972E-01
40	5.913210E-01	6.950408E-03	2.238154E-04	0.0219	5.913209E-01	6.950498E-03	2.921852E-01
41	5.091610E-01	2.773393E-02	1.374483E-04	0.0164	5.091609E-01	2.773398E-02	2.407135E-01
42	5.084496E-01	2.426547E-02	3.671646E-04	0.0434	5.084497E-01	2.426523E-02	2.420923E-01
43	5.068121E-01	1.733386E-02	4.559755E-04	0.0534	5.068124E-01	1.733345E-02	2.447395E-01
44	5.036726E-01	6.953210E-03	2.906919E-04	0.0335	5.036727E-01	6.953061E-03	2.483598E-01
45	4.117336E-01	2.770936E-02	1.570582E-04	0.0234	4.117336E-01	2.770935E-02	1.920121E-01
46	4.111767E-01	2.424636E-02	4.228354E-04	0.0626	4.111770E-01	2.424598E-02	1.934655E-01
47	4.098749E-01	1.732358E-02	5.362034E-04	0.0783	4.098755E-01	1.732284E-02	1.962764E-01
48	4.073229E-01	6.950717E-03	3.643036E-04	0.0521	4.073231E-01	6.950378E-03	2.001864E-01
49	3.054399E-01	2.759373E-02	1.689196E-04	0.0348	3.054400E-01	2.759367E-02	1.389232E-01
50	3.050461E-01	2.414934E-02	4.575253E-04	0.0933	3.050467E-01	2.414854E-02	1.404490E-01

NASTRAN CHECK PROBLEM 2

S T R E S S E S   I N   Q U A D R I L A T E R A L   M E M B R A N E S   %C Q D M E M<

ELEMENT	STRESSES IN ELEMENT COORD SYSTEM			PRINCIPAL	PRINCIPAL STRESSES		MAX
ID.	NORMAL-X	NORMAL-Y	SHEAR-XY	STRESS ANGLE	MAJOR	MINOR	SHEAR
51	3.041077E-01	1.726059E-02	5.883574E-04	0.1175	3.041087E-01	1.725948E-02	1.434246E-01
52	3.022633E-01	6.929334E-03	4.177690E-04	0.0810	3.022537E-01	6.928802E-03	1.476675E-01
53	1.903229E-01	2.725011E-02	1.584291E-04	0.0557	1.903229E-01	2.724999E-02	8.153647E-02
54	1.900930E-01	2.385089E-02	4.281402E-04	0.1476	1.900941E-01	2.384979E-02	8.312213E-02
55	1.895208E-01	1.704640E-02	5.437732E-04	0.1806	1.895224E-01	1.704472E-02	8.623886E-02
56	1.883907E-01	6.837551E-03	3.655553E-04	0.1154	1.883913E-01	6.836891E-03	9.077722E-02
57	6.649494E-02	2.638495E-02	9.769201E-05	0.1395	6.649512E-02	2.638472E-02	2.005523E-02
58	6.642528E-02	2.308388E-02	2.540946E-04	0.3359	6.642771E-02	2.308239E-02	2.167268E-02
59	6.622982E-02	1.642394E-02	2.673864E-04	0.3076	6.623119E-02	1.642251E-02	2.490437E-02
60	6.538486E-02	6.263599E-03	-6.502867E-05	-0.0630	6.538486E-02	6.263509E-03	2.956070E-02

NASTRAN CHECK PROBLEM 2

MESSAGES FROM THE PLOT MODULE

P L O T T E R   D A T A

THE FOLLOWING PLOTS ARE FOR A CALCOMP 565 INCREMENTAL PLOTTER %3 CHARACTERS/COMMAND - .010 STEP SIZE<

AN END-OF-FILE MARK FOLLOWS THE LAST PLOT

THE FIRST COMMAND FOR EACH PLOT CONTAINS THE PLOT NUMBER

PEN 1 - SIZE 1, BLACK

E N G I N E E R I N G   D A T A

ORTHOGRAPHIC PROJECTION
ROTATIONS %DEGREES< - GAMMA # 34.27, BETA # 23.17, ALPHA # 0.0 , AXES # &X,&Y,&Z, SYMMETRIC
SCALE %OBJECT-TO-PLOT SIZE< # 8.070700E-01

ORIGIN 1 - X0 # -1.397886E 00, Y0 # -7.404646E 00 %INCHES<

```
SUPER FLYWHEEL STRESS ANALYSIS 1.264 CPS                        SEPTEMBER  25, 1971      PAGE     21

NASTRAN CHECK PROBLEM 2
                                            MESSAGES FROM THE PLOT MODULE

                PLOT     2     STATIC DEFORMATION - SUBCASE    1,  LOAD SET       1



SUPER FLYWHEEL STRESS ANALYSIS 1.264 CPS                        SEPTEMBER  25, 1971      PAGE     22

NASTRAN CHECK PROBLEM 2
                                            MESSAGES FROM THE PLOT MODULE


P L O T T E R   D A T A

     THE FOLLOWING PLOTS ARE FOR A CALCOMP 565 INCREMENTAL PLOTTER %3 CHARACTERS/COMMAND - .010 STEP SIZE<

     AN END-OF-FILE MARK FOLLOWS THE LAST PLOT

     THE FIRST COMMAND FOR EACH PLOT CONTAINS THE PLOT NUMBER

     PEN 1 - SIZE 1, BLACK

E N G I N E E R I N G   D A T A

     ORTHOGRAPHIC PROJECTION
     ROTATIONS %DEGREES< - GAMMA #  34.27, BETA #  23.17, ALPHA #   0.0 ,  AXES # &X,&Y,&Z, SYMMETRIC
     SCALE %OBJECT-TO-PLOT SIZE< # 8.070700E-01

     ORIGIN       1   -   X0 # -1.397886E 00, Y0 # -7.404646E 00     %INCHES<
```

NASTRAN CHECK PROBLEM 2

MESSAGES FROM THE PLOT MODULE

PLOT 3 STATIC DEFORMATION - SUBCASE 1, LOAD SET 1

NASTRAN CHECK PROBLEM 2

MESSAGES FROM THE PLOT MODULE

P L O T T E R   D A T A

THE FOLLOWING PLOTS ARE FOR A CALCOMP 565 INCREMENTAL PLOTTER %3 CHARACTERS/COMMAND - .010 STEP SIZE<

AN END-OF-FILE MARK FOLLOWS THE LAST PLOT

THE FIRST COMMAND FOR EACH PLOT CONTAINS THE PLOT NUMBER

PEN 1 - SIZE 1, BLACK

E N G I N E E R I N G   D A T A

ORTHOGRAPHIC PROJECTION
ROTATIONS %DEGREES< - GAMMA # 34.27, BETA # 23.17, ALPHA # 0.0 , AXES # &X,&Y,&Z, SYMMETRIC
SCALE %OBJECT-TO-PLOT SIZE< # 8.070700E-01

ORIGIN 1 - XO # -1.397886E 00, YO # -7.404646E 00 %INCHES<

NASTRAN CHECK PROBLEM 2

MESSAGES FROM THE PLOT MODULE

PLOT 4 STATIC DEFORMATION - SUBCASE 1, LOAD SET 1

* * * END OF JOB * * *

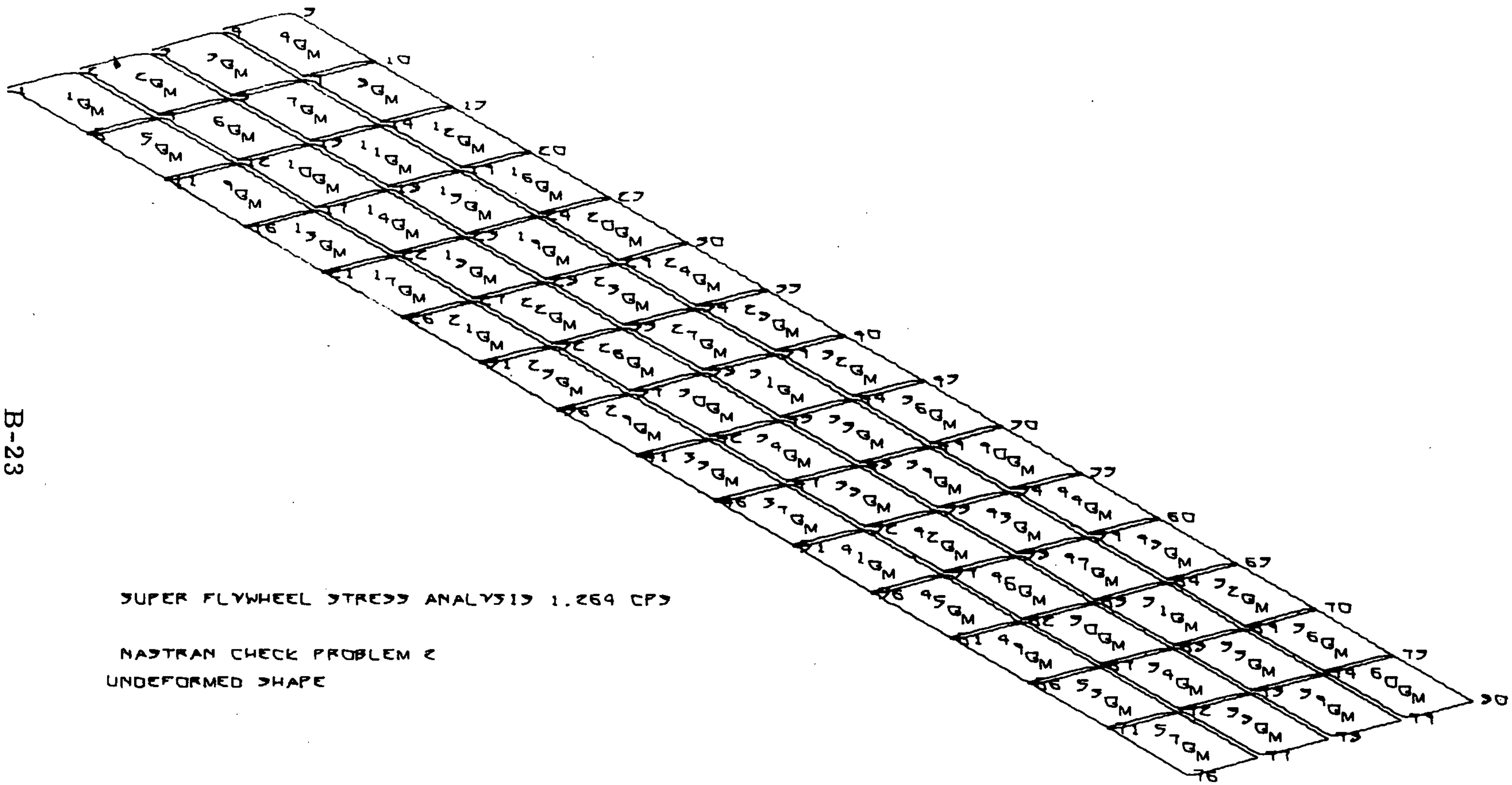

Fig. B-1 SUPER FLYWHEEL STRESS ANALYSIS, 1.254 cps; NASTRAN EXAMPLE PROBLEM 2: UNDEFORMED SHAPE

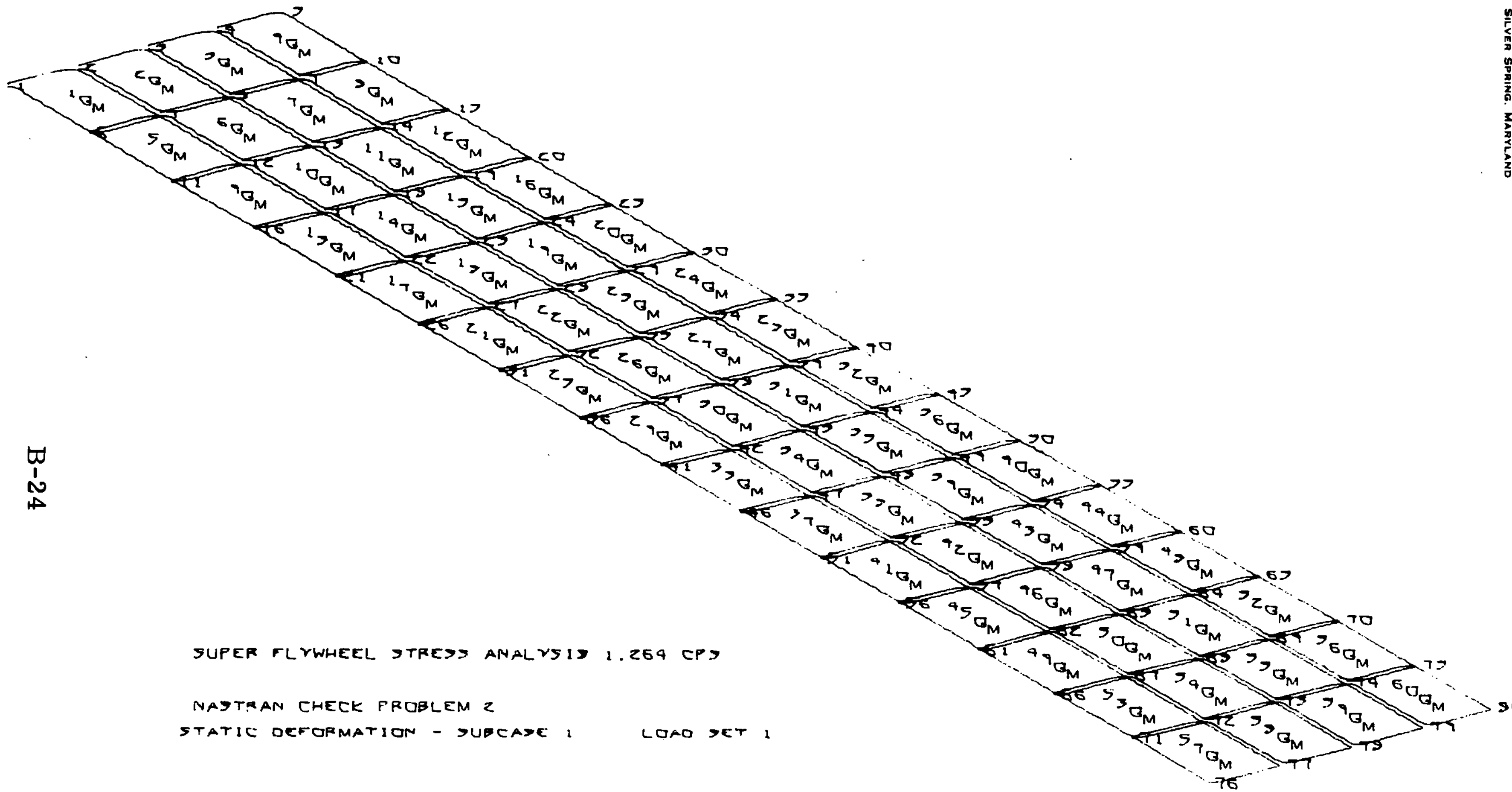

Fig. B-2 SUPER FLYWHEEL STRESS ANALYSIS, 1.254 cps; NASTRAN EXAMPLE PROBLEM 2: STATIC DEFORMATION–SUBCASE 1, LOAD SET 1

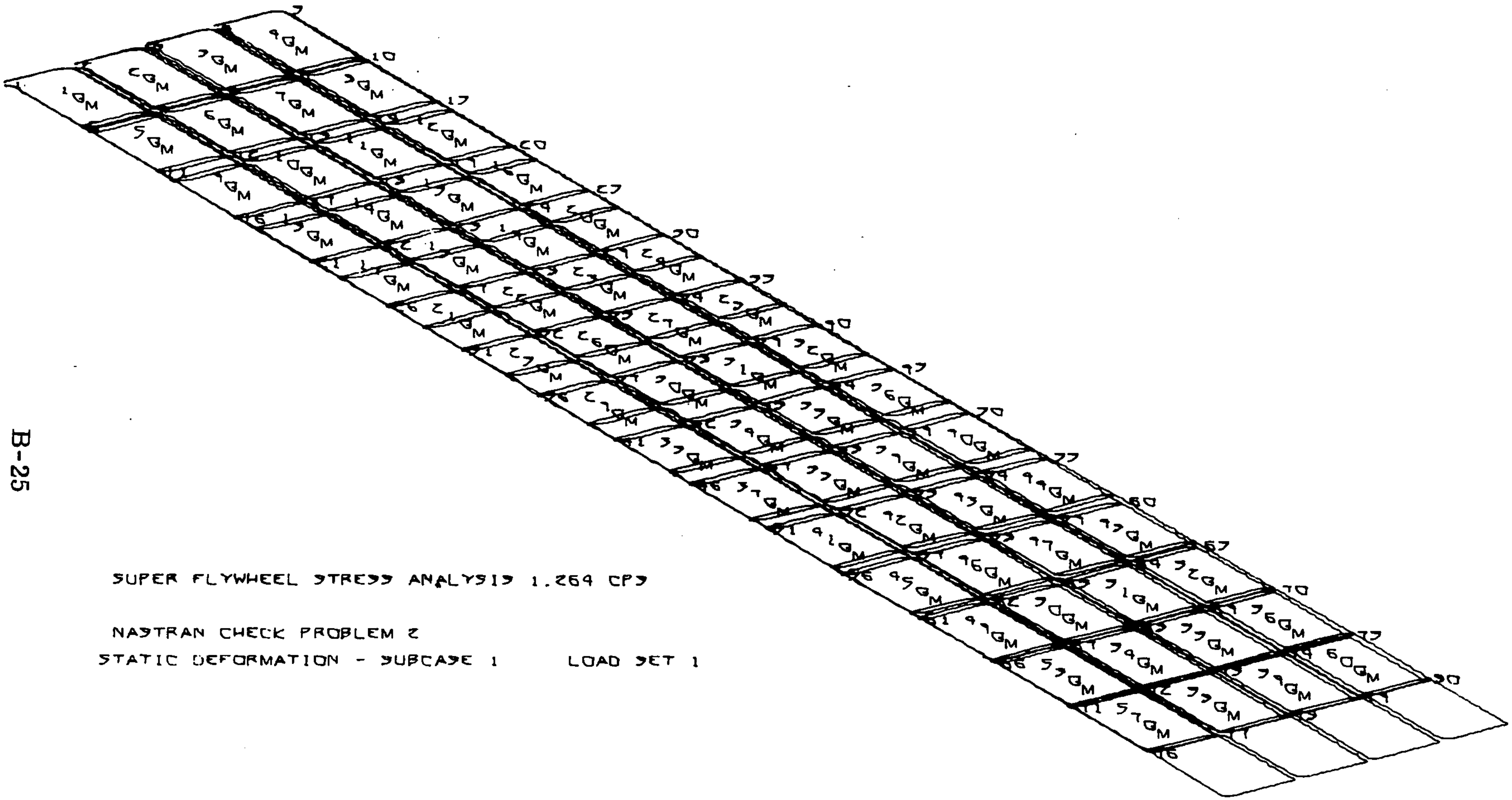

Fig. B-3 SUPER FLYWHEEL STRESS ANALYSIS, 1.254 cps; NASTRAN EXAMPLE PROBLEM 2: STATIC DEFORMATION—SUBCASE 1, LOAD SET 1, STATIC DEFORMATION SUPERIMPOSED ON UNDEFORMED SHAPE

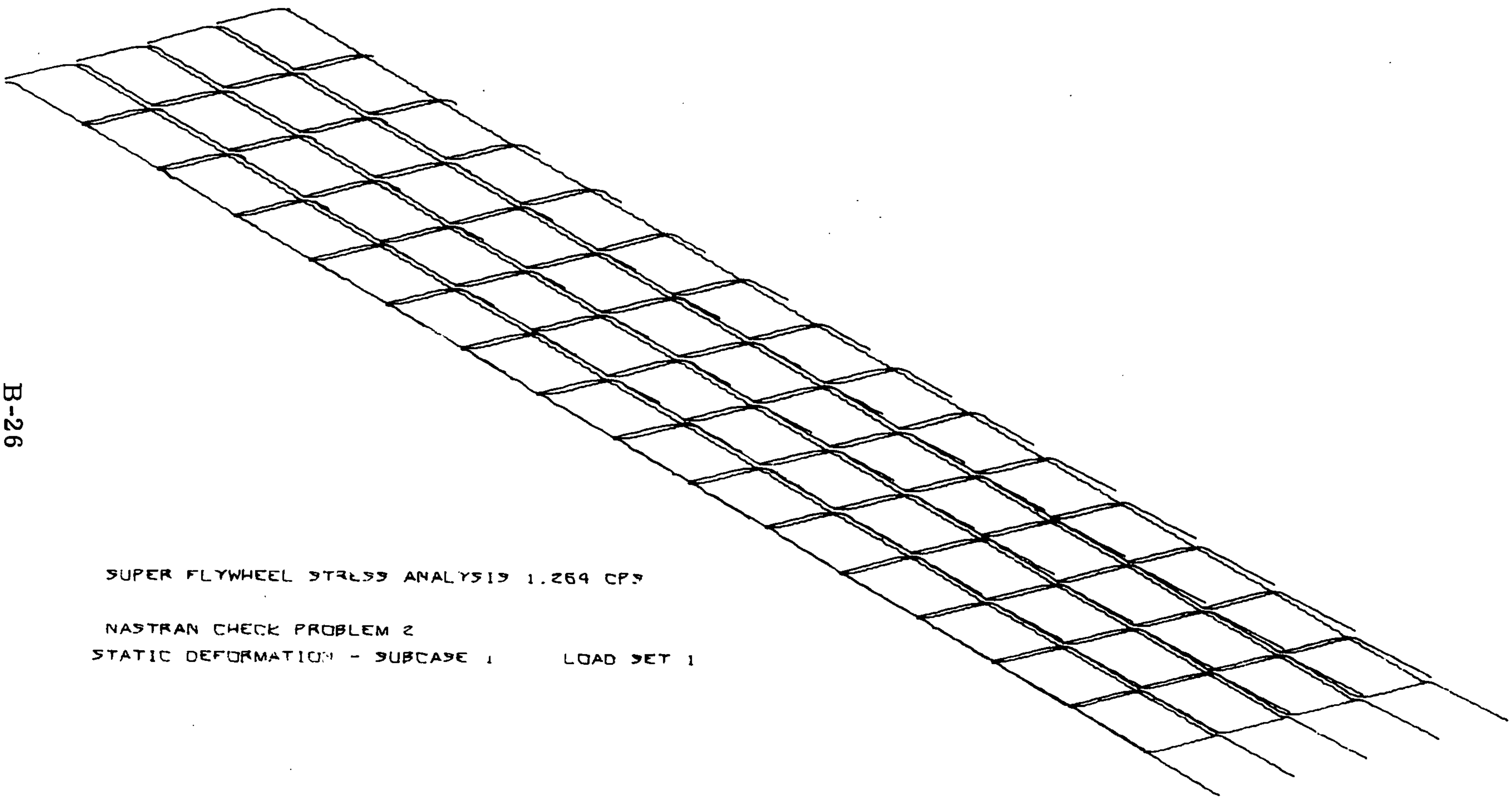

Fig. B-4 SUPER FLYWHEEL STRESS ANALYSIS, 1.254 cps; NASTRAN EXAMPLE PROBLEM 2: STATIC DEFORMATION—SUBCASE 1, LOAD SET 1, VECTOR PLOT

APPENDIX C

Example 3 - Missile Flight Loads

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        N A S T R A N   E X E C U T I V E   C O N T R O L   D E C K   SEPTEMBER  14, 1971     PAGE     1

ID      RIVELLO, FLIGHTLOADS
APP     DISPLACEMENT
SOL     2,1
TIME    5
CEND


FLIGHT LOAD PROBLEM                                                SEPTEMBER  14, 1971     PAGE     2

NASTRAN CHECK PROBLEM 4
                             C A S E   C O N T R O L   D E C K   E C H O
           CARD
           COUNT
             1       TITLE # FLIGHT LOAD PROBLEM
             2       LABEL # NASTRAN CHECK PROBLEM 4
             3       LOAD # 1
             4       TEMPERATURE%MATERIAL< # 5
             5       OUTPUT
             6          DISPLACEMENT # ALL
             7          OLOAD # ALL
             8          ELSTRESS # ALL
             9          ELFORCE # ALL
            10       PLOTID # FLIGHT LOAD PROBLEM
            11       OUTPUT%PLOT<
            12       SET 1 # ALL
            13       PLOTTER CALCOMP, MODEL 565,310
            14       ORTHOGRAPHIC PROJECTION
            15          MAXIMUM DEFORMATION 20.0
            16       FIND SCALE, ORIGIN 1, SET 1
            17       PLOT LABEL BOTH
            18       PLOT STATIC DEFORMATION 1 LABEL BOTH
            19       PLOT STATIC DEFORMATION 0, 1 LABEL BOTH
            20       BEGIN BULK
```

NASTRAN CHECK PROBLEM 4

```
                                  S O R T E D   B U L K   D A T A   E C H O
        CARD
        COUNT        .   1  ..   2  ..   3  ..   4  ..   5  ..   6  ..   7  ..   8  ..   9  ..  10  .
           1*        BAROR           1                       .0      1.0     .0      1
           2*        CBAR    1               1       2
           3*        CBAR    2               2       3
           4*        CBAR    3               3       4
           5*        CBAR    4               4       5
           6*        CBAR    5               5       6
           7*        CBAR    6               6       7
           8*        CBAR    7               7       8
           9*        CBAR    8               8       9
          10*        CBAR    9               9       10
          11*        CBAR    10              10      11
          12*        FORCE   2       5       0       1.0     .0      40000.  .0
          13*        FORCE   3       10      0       1.0     .0      2000.   .0
          14*        GRAV    4       0       386.    .0      -1.0    .0
          15*        GRDSET                                                  345
          16*        GRID    1               .0      .0      .0
          17*        GRID    2               20.     .0      .0
          18*        GRID    3               40.     .0      .0
          19*        GRID    4               60.     .0      .0
          20*        GRID    5               80.     .0      .0
          21*        GRID    6               100.0   .0      .0
          22*        GRID    7               120.    .0      .0
          23*        GRID    8               140.    .0      .0
          24*        GRID    9               160.    .0      .0
          25*        GRID    10              180.    .0      .0
          26*        GRID    11              200.    .0      .0
          27*        LOAD    1       1.0     1.0     2       1.0     3       1.0     4
          28*        MAT1    1       30.E6   12.E6           7.772-4         70.
          29*        MATT1   1       2
          30*        PBAR    1       1       4.4     100.    100.            2.25-2          &PBAR1
          31*        &PBAR1  6.75    0.0                                                     &PBAR2
          32*        &PBAR2  .9      .9
          33*        SUPORT  6       126
          34*        TABLEM1 2                                                               &TABLEM1
          35*        &TABLEM172.     30.0E6  200.    29.7E6  400.    28.2E6  600.    27.0E6  &TABLEM2
          36*        &TABLEM2800.    24.6E6  ENDT
          37*        TEMPD   5       560.
                     ENDDATA
```

NASTRAN CHECK PROBLEM 4

```
   N A S T R A N   S O U R C E   P R O G R A M   C O M P I L A T I O N
DMAP-DMAP INSTRUCTION
 NO.

  1  BEGIN    NO.2 INTERTIA RELIEF ANALYSIS - SERIES L $

  2  FILE     LLL=TAPE $

  4  GP1      GEOM1,GEOM2,/GPL,EQEXIN,GPDT,CSTM,BGPDT,SIL/V,N,LUSET/ C,N,123/
              V,N,NOGPDT $

  5  SAVE     LUSET$

  6  CHKPNT   GPL,EQEXIN,GPDT,CSTM,BGPDT,SIL $

  7  GP2      GEOM2,EQEXIN/ECT $

  8  CHKPNT   ECT $

  9  PLTSET   PCDB,EQEXIN,ECT/PLTSETX,PLTPAR,GPSETS,ELSETS/V,N,NSIL/ V,N,
              JUMPPLOT $

 10  SAVE     NSIL,JUMPPLOT $

 11  PRTMSG   PLTSETX//$

 12  CHKPNT   PLTPAR,GPSETS,ELSETS $

 13  SETVAL   //V,N,PLTFLG/C,N,1/V,N,PFILE/C,N,0 $

 14  SAVE     PLTFLG,PFILE $

 15  COND     P1,JUMPPLOT $

 16  PLOT     PLTPAR,GPSETS,ELSETS,CASECC,BGPDT,EQEXIN,SIL,,/PLOTX1/ V,N,
              NSIL/V,N,LUSET/V,N,JUMPPLOT/V,N,PLTFLG/V,N,PFILE $

 17  SAVE     JUMPPLOT,PLTFLG,PFILE $

 18  PRTMSG   PLOTX1//$

 19  LABEL    P1 $

 20  GP3      GEOM3,EQEXIN,GEOM2/SLT,GPTT/C,N,123/V,N,NOGRAV/C,N,123 $

 21  CHKPNT   SLT,GPTT $

 22  TA1,     ,ECT,EPT,BGPDT,SIL,GPTT,CSTM/EST,,GEI,ECPT,GPCT/V,N,LUSET/ C,N,
              123/V,N,NOSIMP/C,N,0/V,N,NOGENL/V,N,GENEL $

 23  SAVE     NOSIMP,NOGENL,GENEL $
```

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NASTRAN CHECK PROBLEM 4

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

```
DMAP-DMAP INSTRUCTION
 NO.

 24  COND      ERROR1,NOSIMP$

 25  PURGE     OGPST/GENEL $

 26  CHKPNT    EST,ECPT,GPCT,GEI,OGPST $

 27  SMA1      CSTM,MPT,ECPT,GPCT, DIT/KGGX,,GPST/V,N,NOGENL/V,N,NOK4GG$

 28  CHKPNT    GPST,KGGX $

 29  SMA2      CSTM,MPT,ECPT,GPCT,DIT/MGG,/V,Y,WTMASS=1.0/V,N,NOMGG/V,N,NOBGG/
               V,Y,COUPMASS=-1 $

 30  SAVE      NOMGG$

 31  COND      ERROR1,NOMGG$

 32  CHKPNT    MGG $

 33  COND      LGPWG,GRDPNT$

 34  GPWG      BGPDT,CSTM,EQEXIN,MGG/OGPWG/V,Y,GRDPNT=-1/V,Y,WTMASS$

 35  OFP       OGPWG,,,,,//V,N,CARDNO $

 36  SAVE      CARDNO $

 37  LABEL     LGPWG$

 38  EQUIV     KGGX,KGG/NOGENL $

 39  CHKPNT    KGG $

 40  COND      LBL11A,NOGENL $

 41  SMA3      GEI,KGGX/KGG/V,N,LUSET/V,N,NOGENL/V,N,NOSIMP $

 42  CHKPNT    KGG $

 43  LABEL     LBL11A $

 44  PARAM     //C,N,MPY/V,N,NSKIP/C,N,0/C,N,0 $

 46  LABEL     LBL11 $

 47  GP4       CASECC,GEOM4,EQEXIN,SIL,GPDT/RG,YS,USET/V,N,LUSET/V,N,MPCF1/ V,
               N,MPCF2/V,N,SINGLE/V,N,OMIT/V,N,REACT/V,N,NSKIP/V,N,REPEAT/ V,
               N,NOSET/V,N,NOL/V,N,NOA $

 48  SAVE      MPCF1,MPCF2,SINGLE,OMIT,REACT,NSKIP,REPEAT,NOSET,NOL,NOA $
```

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NASTRAN CHECK PROBLEM 4

```
   N A S T R A N   S O U R C E   P R O G R A M   C O M P I L A T I O N
DMAP-DMAP INSTRUCTION
NO.

49  COND      ERROR3,NOL $

50  COND      ERROR4,REACT $

51  PURGE     GM/MPCF1/GO,KOOB,LOO,UOO,MOOB,MOAB,PO,UOOV,RUOV/OMIT/ KSS,KFS,
              PS/SINGLE$

52  EQUIV     KGG,KNN/MPCF1/MGG,MNN/MPCF1$

53  CHKPNT    GM,RG,GO,KOOB,LOO,UOO,MOOB,MOAB,PO,KSS,KFS,YS,PS,USET,RUOV,
              KNN,MNN $

54  COND      LBL4,GENEL $

55  GPSP      GPL,GPST,USET,SIL/OGPST $

56  OFP       OGPST,,,,,//V,N,CARDNO $

57  SAVE      CARDNO $

58  LABEL     LBL4 $

59  COND      LBL2,MPCF2 $

60  MCE1      USET,RG/GM $

61  CHKPNT    GM$

62  MCE2      USET,GM,KGG,MGG,,/KNN,MNN,,$

63  CHKPNT    KNN,MNN$

64  LABEL     LBL2 $

65  EQUIV     KNN,KFF/SINGLE/MNN,MFF/SINGLE$

66  CHKPNT    KFF,MFF $

67  COND      LBL3,SINGLE $

68  SCE1      USET,KNN,MNN,,/KFF,KFS,KSS,MFF,, $

69  CHKPNT    KFS,KSS,KFF,MFF $

70  LABEL     LBL3 $

71  EQUIV     KFF,KAA/OMIT/ MFF,MAA/OMIT$

72  CHKPNT    KAA,MAA $
```

NASTRAN CHECK PROBLEM 4

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

```
DMAP-DMAP INSTRUCTION
 NO.

 73  COND      LBL5,OMIT $

 74  SMP1      USET,KFF,MFF,,/GO,KAA,KOOB,LOO,UOO,MAA,MOOB,MOAB,, $

 75  CHKPNT    GO,KAA,KOOB,LOO,UOO,MAA,MOOB,MOAB$

 76  LABEL     LBL5 $

 77  RBMG1     USET,KAA,MAA/KLL,KLR,KRR,MLL,MLR,MRR$

 78  CHKPNT    KLL,KLR,KRR,MLL,MLR,MRR$

 79  RBMG2     KLL/LLL,ULL $

 80  CHKPNT    ULL,LLL$

 81  RBMG3     LLL,ULL,KLR,KRR/DM $

 82  CHKPNT    DM$

 83  RBMG4     DM,MLL,MLR,MRR/MR$

 84  CHKPNT    MR$

 85  SSG1      SLT,BGPDT,CSTM,SIL,EST ,MPT,GPTT,EDT,MGG,CASECC,DIT/PG/V,N,
               LUSET/V,N,NSKIP $

 86  CHKPNT    PG $

 87  SSG2      USET,GM,YS,KFS,GO,DM,PG/QR,PO,PS,PL $

 88  CHKPNT    QR,PO,PS,PL $

 89  SSG4      PL,QR,PO,MR,MLR,DM,MLL,MOOB,MOAB,GO,USET/PLI,POI/V,N,OMIT $

 90  CHKPNT    PLI,POI$

 91  SSG3      LLL,ULL,KLL,PLI,LOO,UOO,KOOB,POI/ULV,UOOV,RULV,RUOV/ V,N,OMIT/
               V,Y,IRES=-1 $

 92  CHKPNT    ULV,UOOV,RULV,RUOV$

 93  COND      LBL9,IRES $

 94  MATGPR    GPL,USET,SIL,RULV//C,N,L $

 95  MATGPR    GPL,USET,SIL,RUOV//C,N,O $

 96  LABEL     LBL9 $
```

NASTRAN CHECK PROBLEM 4

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

```
DMAP-DMAP INSTRUCTION
 NO.

 97  SDR1      USET,PG,ULV,UOOV,YS,GO,GM,PS,KFS,KSS,QR/UGV,PGG,QG/V,N,NSKIP/
               C,N,STATICS$

 98  CHKPNT    UGV,QG,PGG $

103  CHKPNT    CSTM $

104  SDR2      CASECC,CSTM,MPT,DIT,EQEXIN,SIL,GPTT,EDT,BGPDT,PGG,QG,UGV,EST,/
               OPG1,OQG1,OUGV1,OES1,OEF1,PUGV1/C,N,STATICS $

105  OFP       OUGV1,OPG1,OQG1,OEF1,OES1,//V,N,CARDNO $

106  SAVE      CARDNO $

107  COND      P2,JUMPPLOT $

108  PLOT      PLTPAR,GPSETS,ELSETS,CASECC,BGPDT,EQEXIN,SIL,PUGV1, / PLOTX2/V,
               N,NSIL/V,N,LUSET/V,N,JUMPPLOT/V,N,PLTFLG/V,N,PFILE $

109  PRTMSG    PLOTX2// $

110  LABEL     P2 $

111  JUMP      FINIS$

112  LABEL     ERROR1$

113  PRTPARM   //C,N,-1/C,N,INERTIA$

116  LABEL     ERROR3 $

117  PRTPARM   //C,N,-3/C,N,INERTIA $

118  LABEL     ERROR4 $

119  PRTPARM   //C,N,-4/C,N,INERTIA $

120  LABEL     FINIS$

121  END       $

*** USER WARNING MESSAGE 27,
     LABEL NAMED LBL11     NOT REFERENCED

        **NO ERRORS FOUND - EXECUTE NASTRAN PROGRAM**
```

NASTRAN CHECK PROBLEM 4

MESSAGES FROM THE PLOT MODULE

P L O T T E R   D A T A

THE FOLLOWING PLOTS ARE FOR A CALCOMP 565 INCREMENTAL PLOTTER %3 CHARACTERS/COMMAND - .010 STEP SIZE<

AN END-OF-FILE MARK FOLLOWS THE LAST PLOT

THE FIRST COMMAND FOR EACH PLOT CONTAINS THE PLOT NUMBER

PEN 1 - SIZE 1, BLACK

E N G I N E E R I N G   D A T A

ORTHOGRAPHIC PROJECTION
ROTATIONS %DEGREES< - GAMMA # 34.27, BETA # 23.17, ALPHA # 0.0 , AXES # &X,&Y,&Z, SYMMETRIC
SCALE %OBJECT-TO-PLOT SIZE< # 6.201188E-02

ORIGIN 1 - X0 # -2.148154E 00, Y0 # -7.676333E 00 %INCHES<

NASTRAN CHECK PROBLEM 4

MESSAGES FROM THE PLOT MODULE

PLOT 1 UNDEFORMED STRUCTURE

```
***USER INFORMATION MESSAGE 3023
B =    5 C =    0 R =    4
***USER INFORMATION MESSAGE 3027
DECOMPOSITION TIME ESTIMATE IS      0
*** USER INFORMATION MESSAGE 2073, MPYAD METHOD       1,NO. PASSES =       1
***USER INFORMATION MESSAGE 3035
FOR LOAD    0 EPSILON SUB E =  7.2831620E-15
*** USER INFORMATION MESSAGE 2073, MPYAD METHOD       1,NO. PASSES =       1
*** USER INFORMATION MESSAGE 2073, MPYAD METHOD       1,NO. PASSES =       1
*** USER INFORMATION MESSAGE 2073, MPYAD METHOD       1,NO. PASSES =       1

*** USER INFORMATION MESSAGE 2073, MPYAD METHOD       1,NO. PASSES =       1
*** USER INFORMATION MESSAGE 2073, MPYAD METHOD       1,NO. PASSES =       1
*** USER INFORMATION MESSAGE 2073, MPYAD METHOD       1,NO. PASSES =       1
***USER INFORMATION MESSAGE 3023
B =    3 C =    0 R =    2
***USER INFORMATION MESSAGE 3027
DECOMPOSITION TIME ESTIMATE IS      0
```

*** USER INFORMATION MESSAGE 2073, MPYAD METHOD 1,NO. PASSES # 1

*** USER INFORMATION MESSAGE 2073, MPYAD METHOD 1,NO. PASSES # 1

*** USER INFORMATION MESSAGE 2073, MPYAD METHOD 1,NO. PASSES # 1

***USER INFORMATION MESSAGE 3035

FOR LOAD 1 EPSILON SUB E # -4.3105209E-14

*** USER INFORMATION MESSAGE 2073, MPYAD METHOD 1,NO. PASSES # 1

*** USER INFORMATION MESSAGE 2073, MPYAD METHOD 1,NO. PASSES # 1

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

POINT ID.	TYPE	T1	T2	T3	R1	R2	R3
1	G	0.0	-1.040740E 00	0.0	0.0	0.0	1.466051E-02
2	G	0.0	-7.477385E-01	0.0	0.0	0.0	1.443723E-02
3	G	0.0	-4.640597E-01	0.0	0.0	0.0	1.334843E-02
4	G	0.0	-2.153669E-01	0.0	0.0	0.0	1.058390E-02
5	G	0.0	-4.297474E-02	0.0	0.0	0.0	5.388692E-03
6	G	0.0	0.0	0.0	0.0	0.0	0.0
7	G	0.0	-4.101375E-02	0.0	0.0	0.0	-3.289715E-03
8	G	0.0	-1.301779E-01	0.0	0.0	0.0	-5.069535E-03
9	G	0.0	-2.428832E-01	0.0	0.0	0.0	-5.873285E-03
10	G	0.0	-3.646444E-01	0.0	0.0	0.0	-6.179497E-03
11	G	0.0	-4.898565E-01	0.0	0.0	0.0	-6.264579E-03

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NASTRAN CHECK PROBLEM 4

L O A D   V E C T O R

POINT ID.	TYPE	T1	T2	T3	R1	R2	R3
1	G	0.0	-1.000498E 02	0.0	0.0	0.0	0.0
2	G	0.0	-2.000997E 02	0.0	0.0	0.0	0.0
3	G	0.0	-2.000997E 02	0.0	0.0	0.0	0.0
4	G	0.0	-2.000997E 02	0.0	0.0	0.0	0.0
5	G	0.0	3.979989E 04	0.0	0.0	0.0	0.0
6	G	0.0	-2.000997E 02	0.0	0.0	0.0	0.0
7	G	0.0	-2.000998E 02	0.0	0.0	0.0	0.0
8	G	0.0	-2.000997E 02	0.0	0.0	0.0	0.0
9	G	0.0	-2.000997E 02	0.0	0.0	0.0	0.0
10	G	0.0	1.799900E 03	0.0	0.0	0.0	0.0
11	G	0.0	-1.000498E 02	0.0	0.0	0.0	0.0

NASTRAN CHECK PROBLEM 4

F O R C E S   I N   B A R   E L E M E N T S   % C B A R <

ELEMENT	BEND-MOMENT END-A		BEND-MOMENT END-B		- SHEAR -		AXIAL	
ID.	PLANE 1	PLANE 2	PLANE 1	PLANE 2	PLANE 1	PLANE 2	FORCE	TORQUE
1	-0.0	0.0	-6.082000E 04	0.0	3.041000E 03	-0.0	-0.0	-0.0
2	-6.082200E 04	0.0	-2.357570E 05	0.0	8.746750E 03	-0.0	-0.0	-0.0
3	-2.357620E 05	0.0	-5.172932E 05	0.0	1.407656E 04	-0.0	-0.0	-0.0
4	-5.172916E 05	0.0	-8.978816E 05	0.0	1.902950E 04	-0.0	-0.0	-0.0
5	-8.978799E 05	0.0	-5.699997E 05	0.0	-1.639404E 04	-0.0	-0.0	-0.0
6	-5.700007E 05	0.0	-3.261176E 05	0.0	-1.219416E 04	-0.0	-0.0	-0.0
7	-3.261170E 05	0.0	-1.587032E 05	0.0	-8.370687E 03	-0.0	-0.0	-0.0
8	-1.587060E 05	0.0	-6.023600E 04	0.0	-4.923500E 03	-0.0	-0.0	-0.0
9	-6.023700E 04	0.0	-2.317575E 04	0.0	-1.853062E 03	-0.0	-0.0	-0.0
10	-2.317600E 04	0.0	1.500000E 00	0.0	-1.158875E 03	-0.0	-0.0	-0.0

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NASTRAN CHECK PROBLEM 4

S T R E S S E S   I N   B A R   E L E M E N T S   (C B A R)

ELEMENT ID.	SA1 SB1	SA2 SB2	SA3 SB3	SA4 SB4	AXIAL STRESS	SA-MAX SB-MAX	SA-MIN SB-MIN	M.S.-T M.S.-C
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	4.105348E 03	0.0	0.0	0.0		4.105348E 03	0.0	
2	4.105484E 03	0.0	0.0	0.0	0.0	4.105484E 03	0.0	
	1.591359E 04	0.0	0.0	0.0		1.591359E 04	0.0	
3	1.591393E 04	0.0	0.0	0.0	0.0	1.591393E 04	0.0	
	3.491727E 04	0.0	0.0	0.0		3.491727E 04	0.0	
4	3.491717E 04	0.0	0.0	0.0	0.0	3.491717E 04	0.0	
	6.060698E 04	0.0	0.0	0.0		6.060698E 04	0.0	
5	6.060688E 04	0.0	0.0	0.0	0.0	6.060688E 04	0.0	
	3.847497E 04	0.0	0.0	0.0		3.847497E 04	0.0	
6	3.847502E 04	0.0	0.0	0.0	0.0	3.847502E 04	0.0	
	2.201293E 04	0.0	0.0	0.0		2.201293E 04	0.0	
7	2.201289E 04	0.0	0.0	0.0	0.0	2.201289E 04	0.0	
	1.071247E 04	0.0	0.0	0.0		1.071247E 04	0.0	
8	1.071265E 04	0.0	0.0	0.0	0.0	1.071265E 04	0.0	
	4.065929E 03	0.0	0.0	0.0		4.065929E 03	0.0	
9	4.065997E 03	0.0	0.0	0.0	0.0	4.065997E 03	0.0	
	1.564363E 03	0.0	0.0	0.0		1.564363E 03	0.0	
10	1.564380E 03	0.0	0.0	0.0	0.0	1.564380E 03	0.0	
	-1.012499E-01	0.0	0.0	0.0		0.0	-1.012499E-01	

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NASTRAN CHECK PROBLEM 4

MESSAGES FROM THE PLOT MODULE

P L O T T E R   D A T A

THE FOLLOWING PLOTS ARE FOR A CALCOMP 565 INCREMENTAL PLOTTER %3 CHARACTERS/COMMAND - .010 STEP SIZE<

AN END-OF-FILE MARK FOLLOWS THE LAST PLOT

THE FIRST COMMAND FOR EACH PLOT CONTAINS THE PLOT NUMBER

PEN 1 - SIZE 1, BLACK

E N G I N E E R I N G   D A T A

ORTHOGRAPHIC PROJECTION
ROTATIONS %DEGREES< - GAMMA # 34.27, BETA # 23.17, ALPHA # 0.0 , AXES # &X,&Y,&Z, SYMMETRIC
SCALE %OBJECT-TO-PLOT SIZE< # 6.201188E-02

ORIGIN 1 - X0 # -2.148154E 00, Y0 # -7.575333E 00 %INCHES<

```
FLIGHT LOAD PROBLEM                                              SEPTEMBER  14, 1971      PAGE     17

NASTRAN CHECK PROBLEM 4
                                          MESSAGES FROM THE PLOT MODULE

                   PLOT     2     STATIC DEFORMATION - SUBCASE     1,  LOAD SET        1


FLIGHT LOAD PROBLEM                                              SEPTEMBER  14, 1971      PAGE     18

NASTRAN CHECK PROBLEM 4
                                          MESSAGES FROM THE PLOT MODULE


P L O T T E R    D A T A

     THE FOLLOWING PLOTS ARE FOR A CALCOMP 565 INCREMENTAL PLOTTER %3 CHARACTERS/COMMAND - .010 STEP SIZE<

     AN END-OF-FILE MARK FOLLOWS THE LAST PLOT

     THE FIRST COMMAND FOR EACH PLOT CONTAINS THE PLOT NUMBER

     PEN 1 - SIZE 1, BLACK

E N G I N E E R I N G    D A T A

     ORTHOGRAPHIC PROJECTION
     ROTATIONS %DEGREES< - GAMMA #  34.27, BETA #  23.17, ALPHA #   0.0 ,  AXES # &X,&Y,&Z, SYMMETRIC
     SCALE %OBJECT-TO-PLOT SIZE< # 6.201188E-02

     ORIGIN       1   -   X0 # -2.148154E 00, Y0 # -7.675333E 00     %INCHES<


FLIGHT LOAD PROBLEM                                              SEPTEMBER  14, 1971      PAGE     19

NASTRAN CHECK PROBLEM 4
                                          MESSAGES FROM THE PLOT MODULE
                   PLOT     3     STATIC DEFORMATION - SUBCASE     1,  LOAD SET        1

                              * * * END OF JOB * * *
```

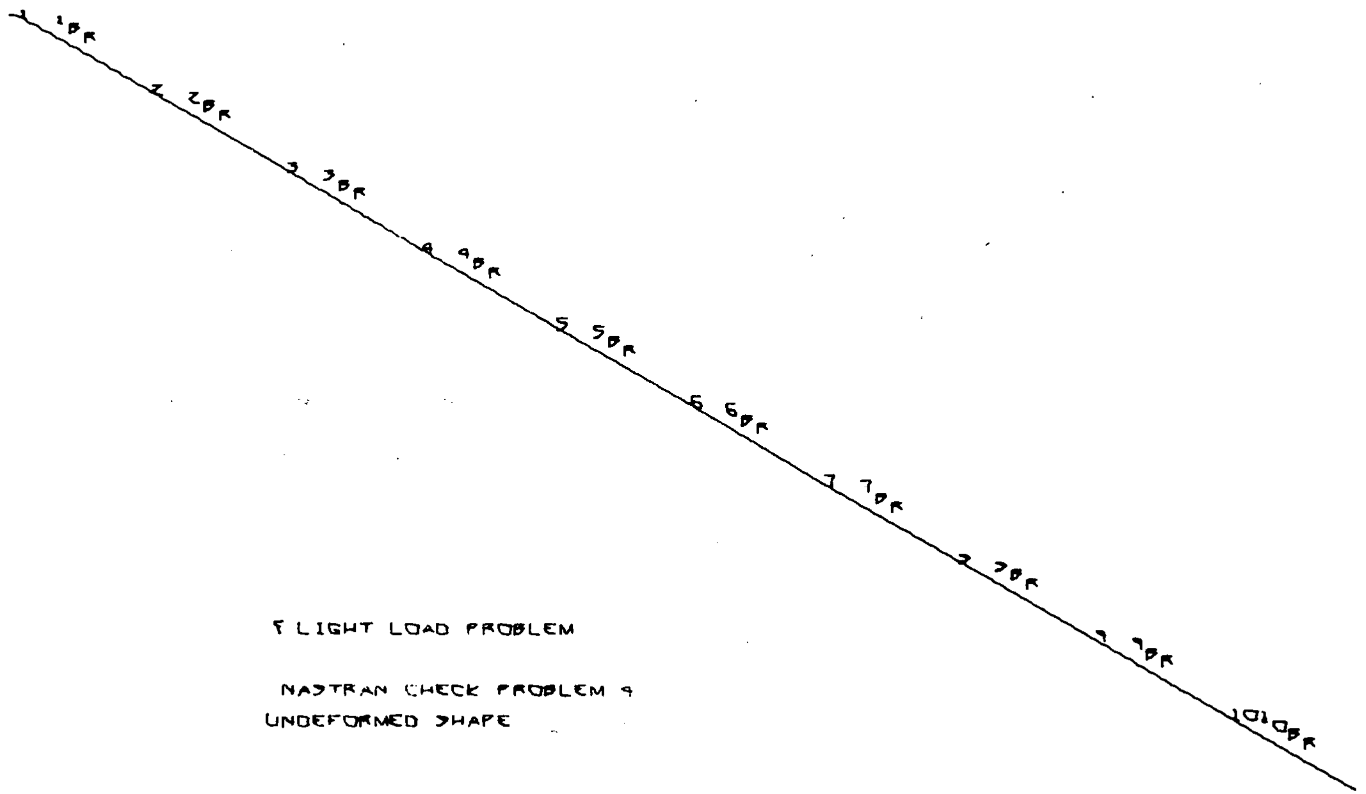

Fig. C-1 FLIGHT LOAD PROBLEM; NASTRAN EXAMPLE PROBLEM 3: UNDEFORMED SHAPE

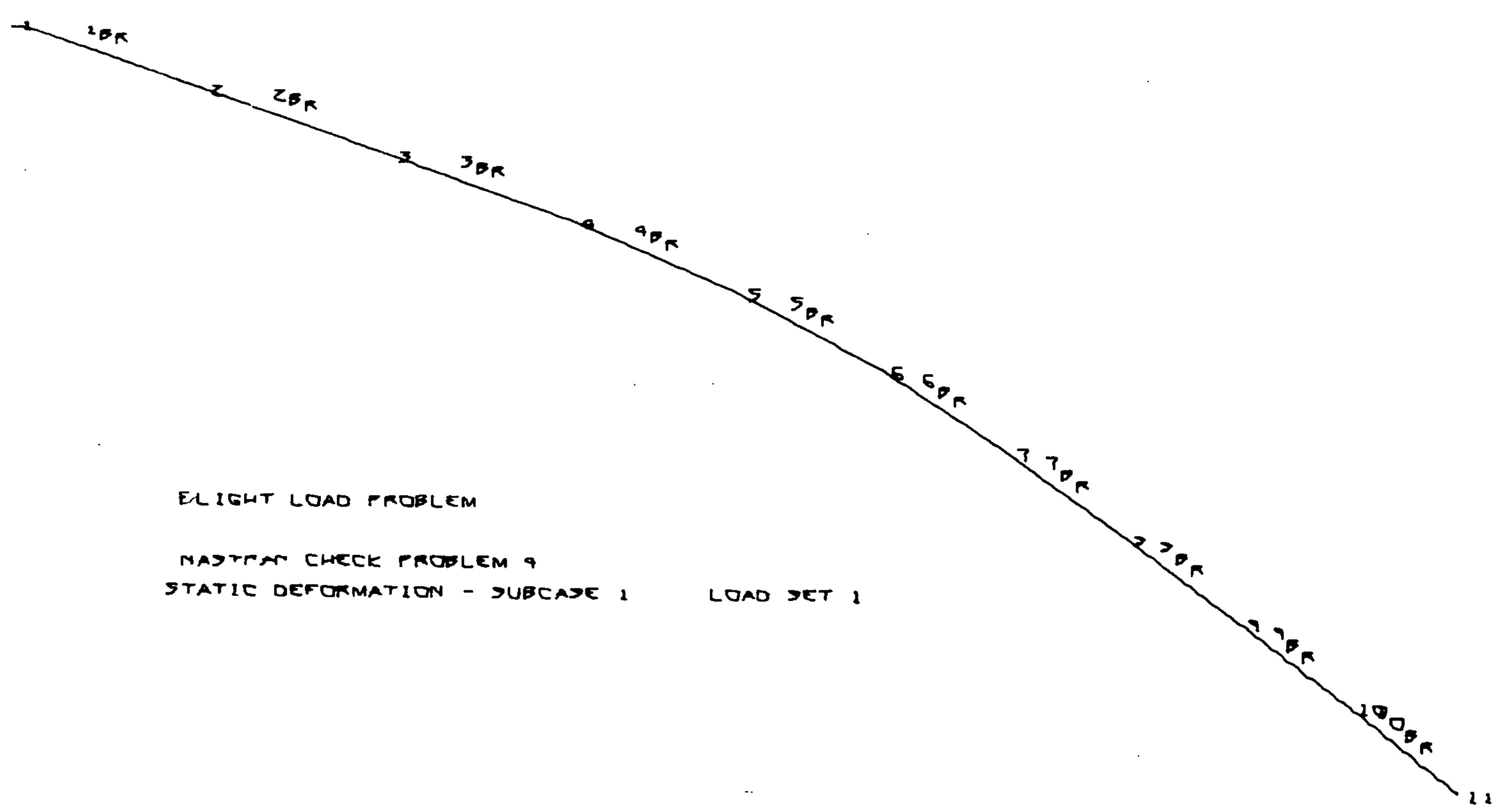

Fig. C-2 FLIGHT LOAD PROBLEM; NASTRAN EXAMPLE PROBLEM 3: STATIC DEFORMATION—SUBCASE 1, LOAD SET 1

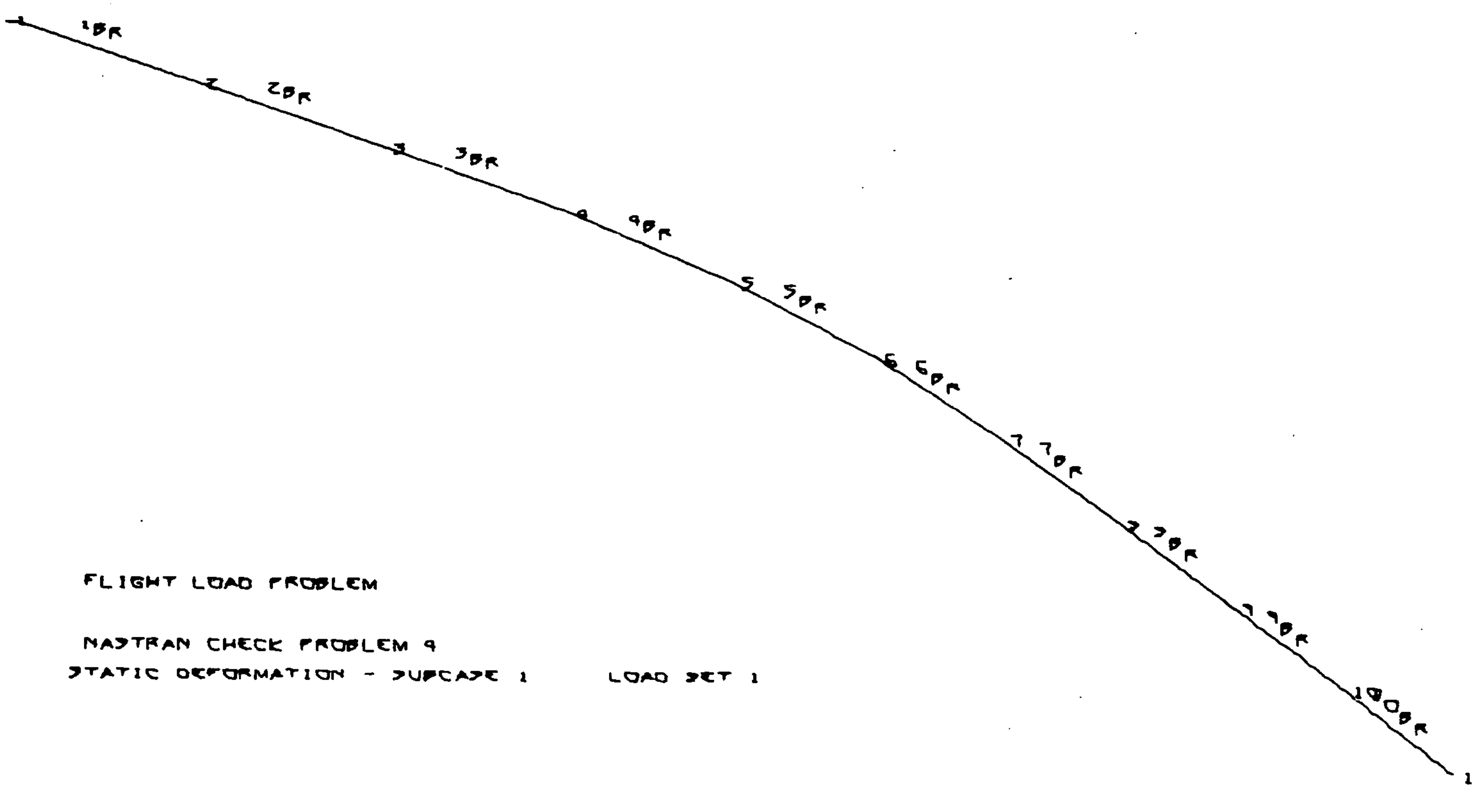

Fig. C-3 FLIGHT LOAD PROBLEM; NASTRAN EXAMPLE PROBLEM 3: STATIC DEFORMATION—SUBCASE 1, LOAD SET 1

APPENDIX D

Example 4 - Thermal Buckling

```
N A S T R A N   E X E C U T I V E   C O N T R O L   D E C K          MARCH   9, 1972        PAGE      1


IC       RIVELLO,THERMALBUCKLING
APP      DISPLACEMENT
SOL      5,0
TIME     5
CEND



THERMAL BUCKLING OF SQUARE PLATE                                      MARCH   9, 1972        PAGE      2
NASTRAN CHECK PROBLEM 3


                          C A S E   C O N T R O L   D E C K   E C H O
         CARD
         COUNT
           1       TITLE # THERMAL BUCKLING OF SQUARE PLATE
           2       SUBTITLE # NASTRAN CHECK PROBLEM 3
           3       OUTPUT
           4         DISPLACEMENT # ALL
           5         SPCFORCE # ALL
           6         ELFORCE # ALL
           7       SUBCASE 1
           8         LABEL # STATICS SOLUTION
           9       TEMPERATURE%LOAD< # 1
          10         OUTPUT
          11         ELSTRESS #ALL
          12       SUBCASE 2
          13         LABEL # BUCKLING SOLUTION
          14         METHOD # 1
          15       PLOTID # THERMAL BUCKLING OF SQUARE PLATE
          16         OUTPUT%PLOT<
          17       PLOTTER CALCOMP, MODEL 565,310
          18         SET 1 # ALL
          19         ORTHOGRAPHIC PROJECTION
          20       MAXIMUM DEFORMATION 1.0
          21         FIND SCALE, ORIGIN 1, SET 1
          22           PLOT LABEL BOTH
          23             PLOT STATIC DEFORMATION 1 LABEL SYMBOLS 6 SHAPE
          24             PLOT MODAL DEFORMATION 2, RANGE 1.0, 500.0 LABELS SYMBOLS 6 SHAPE
          25       BEGIN BULK
```

PRECEDING PAGE BLANK NOT FILMED

S O R T E D   B U L K   D A T A   E C H O

CARD COUNT	. 1 ..	2 ..	3 ..	4 ..	5 ..	6 ..	7 ..	8 ..	9 ..	10 .
1*	CQUAD2	1	1	1	2	7	6	.0		
2*	CQUAD2	2	1	2	3	8	7	.0		
3*	CQUAD2	3	1	3	4	9	8	.0		
4*	CQUAD2	4	1	4	5	10	9	.0		
5*	CQUAD2	5	1	6	7	12	11	.0		
6*	CQUAD2	6	1	7	8	13	12	.0		
7*	CQUAD2	7	1	8	9	14	13	.0		
8*	CQUAD2	8	1	9	10	15	14	.0		
9*	CQUAD2	9	1	11	12	17	16	.0		
10*	CQUAD2	10	1	12	13	18	17	.0		
11*	CQUAD2	11	1	13	14	19	18	.0		
12*	CQUAD2	12	1	14	15	20	19	.0		
13*	CQUAD2	13	1	16	17	22	21	.0		
14*	CQUAD2	14	1	17	18	23	22	.0		
15*	CQUAD2	15	1	18	19	24	23	.0		
16*	CQUAD2	16	1	19	20	25	24	.0		
17*	EIGB	1	INV	1.0	500.0	3	1	0	1.5E-5	&EIGB1
18*	&EIGB1	MAX								
19*	GRID	1		.0	.0	.0		12456		
20*	GRID	2		1.0	.0	.0		246		
21*	GRID	3		2.0	.0	.0		246		
22*	GRID	4		3.0	.0	.0		246		
23*	GRID	5		4.0	.0	.0		2346		
24*	GRID	6		.0	1.0	.0		156		
25*	GRID	7		1.0	1.0	.0		6		
26*	GRID	8		2.0	1.0	.0		6		
27*	GRID	9		3.0	1.0	.0		6		
28*	GRID	10		4.0	1.0	.0		346		
29*	GRID	11		.0	2.0	.0		156		
30*	GRID	12		1.0	2.0	.0		6		
31*	GRID	13		2.0	2.0	.0		6		
32*	GRID	14		3.0	2.0	.0		6		
33*	GRID	15		4.0	2.0	.0		346		
34*	GRID	16		.0	3.0	.0		156		
35*	GRID	17		1.0	3.0	.0		6		
36*	GRID	18		2.0	3.0	.0		6		
37*	GRID	19		3.0	3.0	.0		6		
38*	GRID	20		4.0	3.0	.0		346		
39*	GRID	21		.0	4.0	.0		1356		
40*	GRID	22		1.0	4.0	.0		356		
41*	GRID	23		2.0	4.0	.0		356		
42*	GRID	24		3.0	4.0	.0		356		
43*	GRID	25		4.0	4.0	.0		3456		
44*	MAT1	1	10.0E6		.3	.0	10.0-6	.0		
45*	PQUAD2	1	1	.1						
46*	TEMP	1	1	1.0	2	.9	3	.7		
47*	TEMP	1	4	.4	5	.0	6	.9		
48*	TEMP	1	7	.8156	8	.6375	9	.3655		
49*	TEMP	1	10	.0	11	.7	12	.6375		
50*	TEMP	1	13	.5	14	.288	15	.0		

```
                                S O R T E D   B U L K   D A T A   E C H O
CARD
COUNT      .  1  ..  2  ..  3  ..  4  ..  5  ..  6  ..  7  ..  8  ..  9  ..  10  .
  51*      TEMP    1       16       .4       17       .3655    18       .288
  52*      TEMP    1       19       .166     20       .0       21       .0
  53*      TEMP    1       22       .0       23       .0       24       .0
  54*      TEMP    1       25       .0
           ENDDATA
```

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

```
DMAP-DMAP INSTRUCTION
NO.

  1  BEGIN    NO.5 BUCKLING ANALYSIS - SERIES L $

  2  FILE     LLL#TAPE $

  3  GP1      GEOM1,GEOM2,/GPL,EQEXIN,GPDT,CSTM,BGPDT,SIL/V,N,LUSET/ C,N,123/
              V,N,NOGPDT $

  4  SAVE     LUSET$

  5  CHKPNT   GPL,EQEXIN,GPDT,CSTM,BGPDT,SIL $

  6  GP2      GEOM2,EQEXIN/ECT $

  7  CHKPNT   ECT $

  8  PLTSET   PCDB,EQEXIN,ECT/PLTSETX,PLTPAR,GPSETS,ELSETS/V,N,NSIL/ V,N,
              JUMPPLOT $

  9  SAVE     NSIL,JUMPPLOT $

 10  PRTMSG   PLTSETX//$

 11  CHKPNT   PLTPAR,GPSETS,ELSETS $

 12  SETVAL   //V,N,PLTFLG/C,N,1/V,N,PFILE/C,N,0 $

 13  SAVE     PLTFLG,PFILE $

 14  COND     P1,JUMPPLOT $

 15  PLOT     PLTPAR,GPSETS,ELSETS,CASECC,BGPDT,EQEXIN,SIL,,/PLOTX1/ V,N,
              NSIL/V,N,LUSET/V,N,JUMPPLOT/V,N,PLTFLG/V,N,PFILE $

 16  SAVE     JUMPPLOT,PLTFLG,PFILE $

 17  PRTMSG   PLOTX1//$

 18  LABEL    P1 $

 19  GP3      GEOM3,EQEXIN,GEOM2/SLT,GPTT/C,N,123/V,N,NOGRAV/C,N,123 $

 20  SAVE     NOGRAV$

 21  PARAM    //C,N,AND/V,N,SKPMGG/V,N,NOGRAV/V,Y,GRDPNT$

 22  PURGE    MGG/SKPMGG$

 23  CHKPNT   SLT,GPTT,MGG $
```

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

```
DMAP-DMAP INSTRUCTION
NO.

24  TA1,     ,ECT,EPT,BGPDT,SIL,GPTT,CSTM/EST,,GEI,ECPT,GPCT/V,N,LUSET/ C,N,
             123/V,N,NOSIMP/C,N,0/V,N,NOGENL/V,N,GENEL $

25  SAVE     NOSIMP,NOGENL,GENEL $

26  COND     ERROR1,NOSIMP$

27  PURGE    OGPST/GENEL$

28  CHKPNT   EST,ECPT,GPCT,GEI,OGPST $

29  SMA1     CSTM,MPT,ECPT,GPCT,DIT/KGGX,,GPST/V,N,NOGENL/V,N,NOK4GG $

30  CHKPNT   GPST,KGGX $

31  COND     LBL1,SKPMGG$

32  SMA2     CSTM,MPT,ECPT,GPCT,DIT/MGG,/V,Y,WTMASS#1.0/V,N,NOMGG/V,N,NOBGG/
             V,Y,COUPMASS#-1 $

33  SAVE     NOMGG$

34  CHKPNT   MGG $

35  COND     ERROR5,NOMGG$

36  COND     LBL1,GRDPNT$

37  GPWG     BGPDT,CSTM,EQEXIN,MGG/OGPWG/V,Y,GRDPNT#-1/V,Y,WTMASS$

38  OFP      OGPWG,,,,,//V,N,CARDNO $

39  SAVE     CARDNO $

40  LABEL    LBL1 $

41  EQUIV    KGGX,KGG/NOGENL $

42  CHKPNT   KGG $

43  COND     LBL11,NOGENL $

44  SMA3     GEI,KGGX/KGG/V,N,LUSET/V,N,NOGENL/C,N,-1 $

45  CHKPNT   KGG $

46  LABEL    LBL11 $

47  PARAM    //C,N,MPY/V,N,NSKIP/C,N,0/C,N,0 $
```

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

```
DMAP-DMAP INSTRUCTION
NO.

48  GP4       CASECC,GEOM4,EQEXIN,SIL,GPDT/RG,YS,USET/V,N,LUSET/V,N,MPCF1/ V,
              N,MPCF2/V,N,SINGLE/V,N,OMIT/V,N,REACT/V,N,NSKIP/V,N,REPEAT/ V,
              N,NOSET/V,N,NOL/V,N,NOA $

49  SAVE      MPCF1,MPCF2,SINGLE,OMIT,REACT,NSKIP,REPEAT,NOSET,NOL,NOA $

50  COND      ERROR6,NOA $

51  PARAM     //C,N,AND/V,N,NOSR/V,N,SINGLE/V,N,REACT$

52  PURGE     GM/MPCF1/GO,KOOB,LOO,UOO,PO,UOOV,RUOV/OMIT/PS,KFS,KSS/SINGLE/
              QG/NOSR$

53  EQUIV     KGG,KNN/MPCF1 $

54  CHKPNT    GM,RG,GO,KOOB,LOO,UOO,PO,UOOV,RUOV,YS,PS,KFS,KSS,USET,QG,KNN $

55  COND      LBL4D,REACT $

56  JUMP      ERROR2$

57  LABEL     LBL4D $

58  COND      LBL4,GENEL$

59  GPSP      GPL,GPST,USET,SIL/OGPST $

60  OFP       OGPST,,,,,//V,N,CARDNO $

61  SAVE      CARDNO $

62  LABEL     LBL4 $

63  COND      LBL2,MPCF2 $

64  MCE1      USET,RG/GM $

65  CHKPNT    GM$

66  MCE2      USET,GM,KGG,,,/KNN,,, $

67  CHKPNT    KNN$

68  LABEL     LBL2 $

69  EQUIV     KNN,KFF/SINGLE $

70  CHKPNT    KFF$

71  COND      LBL3,SINGLE $
```

```
   N A S T R A N   S O U R C E   P R O G R A M   C O M P I L A T I O N
DMAP-DMAP INSTRUCTION
 NO.

 72  SCE1      USET,KNN,,,/KFF,KFS,KSS,,, $

 73  CHKPNT    KFS,KSS,KFF$

 74  LABEL     LBL3 $

 75  EQUIV     KFF,KAA/OMIT $

 76  CHKPNT    KAA$

 77  COND      LBL5,OMIT $

 78  SMP1      USET,KFF,,,/GO,KAA,KOCB,LCC,LCC,,,,, $

 79  CHKPNT    GO,KAA,KOCB,LCC,UCC$

 80  LABEL     LBL5 $

 81  RBMG2     KAA/LLL,ULL $

 82  CHKPNT    ULL,LLL$

 83  SSG1      SLT,BGPDT,CSTM,SIL,EST,MPT,GPTT,EDT,MGG,CASECC,DIT/PG/ V,N,
               LUSET/C,N,1 $

 84  CHKPNT    PG $

 85  EQUIV     PG,PL/NOSET$

 86  CHKPNT    PL $

 87  COND      LBL10,NOSET$

 88  SSG2      USET,GM,YS,KFS,GO,,PG/,PO,PS,PL$

 89  CHKPNT    PO,PS,PL $

 90  LABEL     LBL10$

 91  SSG3      LLL,ULL,KAA,PL,LOC,UCC,KCCB,PC/ULV,UCCV,RULV,RUCV/ V,N,OMIT/V,
               Y,IRES#-1 $

 92  CHKPNT    ULV,UCOV,RULV,RUCV$

 93  COND      LBL9,IRES$

 94  MATGPR    GPL,USET,SIL,RULV//C,N,L $

 95  MATGPR    GPL,USET,SIL,RUCV//C,N,C $
```

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

```
DMAP-DMAP INSTRUCTION
NO.

 96  LABEL     LBL9$

 97  SDR1      USET,PG,ULV,UOOV,YS,GO,GM,PS,KFS,KSS,/UGV,PGG,QG/C,N,1/ C,N,
               BKL0$

 98  CHKPNT    UGV,QG,PGG $

 99  SDR2      CASECC,CSTM,MPT,DIT,EQEXIN,SIL,GPTT,EDT,BGPDT,PGG,QG,UGV,EST,/
               OPG1,OQG1,OUGV1,OES1,OEF1,PUGV1/C,N,BKL0 $

100  CHKPNT    PUGV1 $

101  OFP       OUGV1,OPG1,OQG1,OEF1,OES1,//V,N,CARDNO $

102  SAVE      CARDNO $

103  DSMG1     CASECC,GPTT,SIL,EDT,UGV,CSTM,MPT,ECPT,GPCT,DIT/KDGG/ V,N,
               DSCOSET$

104  CHKPNT    KDGG $

105  EQUIV     KDGG,KDNN/MPCF2$

106  CHKPNT    KDNN $

107  COND      LBL2D,MPCF2 $

108  MCE2      USET,GM,KDGG,,,/KDNN,,, $

109  CHKPNT    KDNN $

110  LABEL     LBL2D $

111  EQUIV     KDNN,KDFF/SINGLE$

112  CHKPNT    KDFF $

113  COND      LBL3D,SINGLE $

114  SCE1      USET,KDNN,,,/KDFF,KDFS,KDSS,,, $

115  CHKPNT    KDFF,KDFS,KDSS $

116  LABEL     LBL3D $

117  EQUIV     KDFF,KDAA/OMIT $

118  CHKPNT    KDAA $

119  COND      LBL5C,OMIT $
```

```
   N A S T R A N   S O U R C E   P R O G R A M   C O M P I L A T I O N
DMAP-DMAP INSTRUCTION
 NO.

120  SMP2     USET,GO,KOFF/KDAA$

121  CHKPNT   KDAA $

122  LABEL    LBL5D $

123  ADD      KDAA,/KDAAM/C,N,%-1.0,0.0</C,N,%0.0,0.0< $

124  CHKPNT   KDAAM $

125  DPD      DYNAMICS,GPL,SIL,USET/GPLD,SILD,USETD,,,,,,,EED,EQDYN/V,N,
              LUSET/V,N,LUSETD/V,N,NOTFL/V,N,NODLT/V,N,NOPSDL/V,N,NOFRL/ V,N,
              NONLFT/V,N,NOTRL/V,N,NOEED/C,N,123/V,N,NOUE $

126  SAVE     NOEED $

127  COND     ERROR3,NOEED$

128  CHKPNT   EED $

129  READ     KAA,KDAAM,,,EED,USET,CASECC/LAMA,PHIA,,OEIGS/C,N,BUCKLING/ V,N,
              NEIGV/C,N,2$

130  SAVE     NEIGV $

131  CHKPNT   LAMA,PHIA,OEIGS $

132  OFP      OEIGS,LAMA,,,,//V,N,CARDNO $

133  SAVE     CARDNO $

134  COND     ERROR4,NEIGV $

135  SDR1     USET,,PHIA,,,GO,GM,,KFS,,/PHIG,,BQG/C,N,1/C,N,BKL1 $

136  CHKPNT   PHIG,BQG $

137  SDR2     CASECC,CSTM,MPT,DIT,EQEXIN,SIL,,,BGPDT,LAMA,BQG,PHIG,EST,/ ,
              OBQG1,OPHIG,OBES1,OBEF1,PPHIG/C,N,BKL1 $

138  OFP      OPHIG,OBQG1,OBEF1,OBES1,,//V,N,CARDNO $

139  SAVE     CARDNO $

140  COND     P2,JUMPPLOT $

141  PLOT     PLTPAR,GPSETS,ELSETS,CASECC,BGPDT,EQEXIN,SIL,PUGV1,PPHIG /
              PLOTX2/V,N,NSIL/V,N,LUSET/V,N,JUMPPLOT/V,N,PLTFLG/V,N,PFILE $

142  PRTMSG   PLOTX2// $
```

```
   N A S T R A N   S O U R C E   P R O G R A M   C O M P I L A T I O N
DMAP-DMAP INSTRUCTION
 NO.

143  LABEL    P2 $

144  JUMP     FINIS$

145  LABEL    ERROR1$

146  PRTPARM  //C,N,-1/C,N,BUCKLING$

147  LABEL    ERROR2$

148  PRTPARM  //C,N,-2/C,N,BUCKLING$

149  LABEL    ERROR3$

150  PRTPARM  //C,N,-3/C,N,BUCKLING$

151  LABEL    ERROR4$

152  PRTPARM  //C,N,-4/C,N,BUCKLING$

153  LABEL    ERROR5$

154  PRTPARM  //C,N,-5/C,N,BUCKLING$

155  LABEL    ERROR6 $

156  PRTPARM  //C,N,-6/C,N,BUCKLING $

157  LABEL    FINIS$

158  END      $

      **NO ERRORS FOUND - EXECUTE NASTRAN PROGRAM**
```

MESSAGES FROM THE PLOT MODULE

P L C T T E R   C A T A

THE FCLLCWING PLOTS ARE FOR A CALCOMP 565 INCREMENTAL PLCTTER %3 CHARACTERS/COMMAND - .010 STEP SIZE<

AN ENC-OF-FILE MARK FOLLCWS THE LAST PLOT

THE FIRST COMMAND FOR EACH PLCT CCNTAINS THE PLCT NUMBER

PEN 1 - SIZE 1, BLACK

E N G I N E E R I N G   D A T A

CRTHOGRAPHIC PROJECTION
ROTATICNS %DEGREES< - GAMMA # 34.27, BETA # 23.17, ALPHA # 0.0 , AXES # &X,&Y,&Z, SYMMETRIC
SCALE %OBJECT-TC-PLOT SIZE< # 1.250271E 00

ORIGIN 1 - XO # -2.165533E 0C, YO # -5.919050E 00 %INCHES<

MESSAGES FROM THE PLOT MODULE

PLOT 1 UNDEFORMED STRUCTURE


```
***SYSTEM WARNING MESSAGE 3022
DATA SET MGG      IS REQUIRED AS INPUT AND IS NOT OUTPUT BY A PREVIOUS MODULE IN THE CURRENT DMAP ROUTE.
***SYSTEM WARNING MESSAGE 3022
DATA SET MGG      IS REQUIRED AS INPUT AND IS NOT OUTPUT BY A PREVIOUS MODULE IN THE CURRENT DMAP ROUTE.
***USER INFORMATION MESSAGE 3023
B #   29 C #    0 R #   28
***USER INFORMATION MESSAGE 3027
DECOMPOSITION TIME ESTIMATE IS      0

*** USER INFORMATION MESSAGE 2073, MPYAD METHOD       1,NO. PASSES #       1
*** USER INFORMATION MESSAGE 2073, MPYAD METHOD       1,NO. PASSES #       1
***USER INFORMATION MESSAGE 3035
FOR LOAD     1 EPSILON SUB E # -7.5504644E-16

*** USER INFORMATION MESSAGE 2073, MPYAD METHOD       1,NO. PASSES #       1
*** USER INFORMATION MESSAGE 2073, MPYAD METHOD       1,NO. PASSES #       1
```

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THERMAL BUCKLING OF SQUARE PLATE MARCH 9, 1972 PAGE 15
NASTRAN CHECK PROBLEM 3

STATICS SOLUTION SUBCASE 1

DISPLACEMENT VECTOR

POINT ID.	TYPE	T1	T2	T3	R1	R2	R3
1	G	0.0	0.0	0.0	0.0	0.0	0.0
2	G	7.533925E-06	0.0	0.0	0.0	0.0	0.0
3	G	1.385077E-05	0.0	0.0	0.0	0.0	0.0
4	G	1.803206E-05	0.0	0.0	0.0	0.0	0.0
5	G	1.862585E-05	0.0	0.0	0.0	0.0	0.0
6	G	0.0	7.533925E-06	0.0	0.0	0.0	0.0
7	G	7.169692E-06	7.169692E-06	0.0	0.0	0.0	0.0
8	G	1.319514E-05	6.313271E-06	0.0	0.0	0.0	0.0
9	G	1.718506E-05	5.485420E-06	0.0	0.0	0.0	0.0
10	G	1.780156E-05	5.592759E-06	0.0	0.0	0.0	0.0
11	G	0.0	1.385077E-05	0.0	0.0	0.0	0.0
12	G	6.313271E-06	1.319514E-05	0.0	0.0	0.0	0.0
13	G	1.161895E-05	1.161895E-05	0.0	0.0	0.0	0.0
14	G	1.512038E-05	1.003841E-05	0.0	0.0	0.0	0.0
15	G	1.579778E-05	1.000099E-05	0.0	0.0	0.0	0.0
16	G	0.0	1.803206E-05	0.0	0.0	0.0	0.0
17	G	5.485420E-06	1.718506E-05	0.0	0.0	0.0	0.0
18	G	1.003841E-05	1.512038E-05	0.0	0.0	0.0	0.0
19	G	1.296261E-05	1.296261E-05	0.0	0.0	0.0	0.0
20	G	1.369463E-05	1.247580E-05	0.0	0.0	0.0	0.0
21	G	0.0	1.862585E-05	0.0	0.0	0.0	0.0
22	G	5.592759E-06	1.780156E-05	0.0	0.0	0.0	0.0
23	G	1.000099E-05	1.579778E-05	0.0	0.0	0.0	0.0
24	G	1.247580E-05	1.369463E-05	0.0	0.0	0.0	0.0
25	G	1.305786E-05	1.305786E-05	0.0	0.0	0.0	0.0

THERMAL BUCKLING OF SQUARE PLATE MARCH 9, 1972 PAGE 16
NASTRAN CHECK PROBLEM 3

STATICS SOLUTION SUBCASE 1

FORCES OF SINGLE-POINT CONSTRAINT

POINT ID.	TYPE	T1	T2	T3	R1	R2	R3
1	G	1.249848E 00	1.249848E 00	0.0	0.0	0.0	0.0
2	G	0.0	1.978873E 00	0.0	0.0	0.0	0.0
3	G	0.0	7.408113E-01	0.0	0.0	0.0	0.0
4	G	0.0	-1.547422E 00	0.0	0.0	0.0	0.0
5	G	0.0	-2.422086E 00	0.0	0.0	0.0	0.0
6	G	1.978873E 00	0.0	0.0	0.0	0.0	0.0
11	G	7.408113E-01	0.0	0.0	0.0	0.0	0.0
16	G	-1.547422E 00	0.0	0.0	0.0	0.0	0.0
21	G	-2.422087E 00	0.0	0.0	0.0	0.0	0.0

STATICS SOLUTION SUBCASE 1

F O R C E S   I N   G E N E R A L   Q U A D R I L A T E R A L   E L E M E N T S   (C Q U A D 2)

ELEMENT ID.	BEND-MOMENT X	BEND-MOMENT Y	TWIST-MOMENT	SHEAR X	SHEAR Y
1	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0

THE JOHNS HOPKINS UNIVERSITY
APPLIED PHYSICS LABORATORY
SILVER SPRING, MARYLAND

STATICS SOLUTION   SUBCASE 1

S T R E S S E S   I N   G E N E R A L   Q U A D R I L A T E R A L   E L E M E N T S   %C Q U A D 2<

ELEMENT ID.	FIBRE DISTANCE	STRESSES IN ELEMENT COORD SYSTEM NORMAL-X	NORMAL-Y	SHEAR-XY	PRINCIPAL STRESSES %ZERO SHEAR< ANGLE	MAJOR	MINOR	MAX SHEAR
1	4.999998E-02	-2.410262E 01	-2.410262E 01	-1.400906E 00	-45.0000	-2.270171E 01	-2.550351E 01	1.400905E 00
	-4.999998E-02	-2.410262E 01	-2.410262E 01	-1.400906E 00	-45.0000	-2.270171E 01	-2.550351E 01	1.400905E 00
2	4.999998E-02	-1.899968E 01	-1.461256E 01	-3.608215E 00	-60.6484	-1.258346E 01	-2.102878E 01	4.222665E 00
	-4.999998E-02	-1.899968E 01	-1.461256E 01	-3.608215E 00	-60.6484	-1.258346E 01	-2.102878E 01	4.222665E 00
3	4.999998E-02	-1.076190E 01	3.189941E 00	-4.481702E 00	-73.6406	4.505527E 00	-1.207749E 01	8.291508E 00
	-4.999998E-02	-1.076190E 01	3.189941E 00	-4.481702E 00	-73.6406	4.505527E 00	-1.207749E 01	8.291508E 00
4	4.999998E-02	-2.428528E 00	3.552483E 01	-3.007660E 00	-85.4970	3.576166E 01	-2.665375E 00	1.921352E 01
	-4.999998E-02	-2.428528E 00	3.552483E 01	-3.007660E 00	-85.4970	3.576166E 01	-2.665375E 00	1.921352E 01
5	4.999998E-02	-1.461256E 01	-1.899968E 01	-3.608231E 00	-29.3516	-1.258344E 01	-2.102879E 01	4.222677E 00
	-4.999998E-02	-1.461256E 01	-1.899968E 01	-3.608231E 00	-29.3516	-1.258344E 01	-2.102879E 01	4.222677E 00
6	4.999998E-02	-1.158463E 01	-1.158463E 01	-9.356204E 00	-45.0000	-2.228422E 00	-2.094083E 01	9.356203E 00
	-4.999998E-02	-1.158463E 01	-1.158463E 01	-9.356204E 00	-45.0000	-2.228422E 00	-2.094083E 01	9.356203E 00
7	4.999998E-02	-6.552383E 00	2.552795E 00	-1.163316E 01	-55.6864	1.049247E 01	-1.449205E 01	1.249226E 01
	-4.999998E-02	-6.552383E 00	2.552795E 00	-1.163316E 01	-55.6864	1.049247E 01	-1.449205E 01	1.249226E 01
8	4.999998E-02	-1.458694E 00	2.803102E 01	-7.689484E 00	-76.2289	2.991562E 01	-3.343292E 00	1.662946E 01
	-4.999998E-02	-1.458694E 00	2.803102E 01	-7.689484E 00	-76.2289	2.991562E 01	-3.343292E 00	1.662946E 01
9	4.999998E-02	3.189941E 00	-1.076190E 01	-4.481705E 00	-16.3594	4.505528E 00	-1.207749E 01	8.291509E 00
	-4.999998E-02	3.189941E 00	-1.076190E 01	-4.481705E 00	-16.3594	4.505528E 00	-1.207749E 01	8.291509E 00
10	4.999998E-02	2.552765E 00	-6.552414E 00	-1.163316E 01	-34.3136	1.049243E 01	-1.449208E 01	1.249226E 01
	-4.999998E-02	2.552765E 00	-6.552414E 00	-1.163316E 01	-34.3136	1.049243E 01	-1.449208E 01	1.249226E 01
11	4.999998E-02	1.540283E 00	1.540283E 00	-1.437814E 01	-45.0000	1.591843E 01	-1.283786E 01	1.437814E 01
	-4.999998E-02	1.540283E 00	1.540283E 00	-1.437814E 01	-45.0000	1.591843E 01	-1.283786E 01	1.437814E 01
12	4.999998E-02	4.292755E-01	1.577385E 01	-9.202225E 00	-64.9097	2.008258E 01	-3.879461E 00	1.198102E 01
	-4.999998E-02	4.292755E-01	1.577385E 01	-9.202225E 00	-64.9097	2.008258E 01	-3.879461E 00	1.198102E 01
13	4.999998E-02	3.552483E 01	-2.428528E 00	-3.007660E 00	-4.5030	3.576166E 01	-2.665375E 00	1.921352E 01
	-4.999998E-02	3.552483E 01	-2.428528E 00	-3.007660E 00	-4.5030	3.576166E 01	-2.665375E 00	1.921352E 01
14	4.999998E-02	2.803102E 01	-1.458694E 00	-7.689484E 00	-13.7711	2.991562E 01	-3.343292E 00	1.662946E 01
	-4.999998E-02	2.803102E 01	-1.458694E 00	-7.689484E 00	-13.7711	2.991562E 01	-3.343292E 00	1.662946E 01
15	4.999998E-02	1.577385E 01	4.292755E-01	-9.202225E 00	-25.0903	2.008258E 01	-3.879461E 00	1.198102E 01
	-4.999998E-02	1.577385E 01	4.292755E-01	-9.202225E 00	-25.0903	2.008258E 01	-3.879461E 00	1.198102E 01
16	4.999998E-02	3.457728E 00	3.457728E 00	-4.321503E 00	-45.0000	7.779230E 00	-8.637733E-01	4.321502E 00
	-4.999998E-02	3.457728E 00	3.457728E 00	-4.321503E 00	-45.0000	7.779230E 00	-8.637733E-01	4.321502E 00

***USER INFORMATION MESSAGE 3023

B # 29 C # 0 R # 56

***USER INFORMATION MESSAGE 3028

BBAR # 28 CBAR # 0 R # 56

***USER INFORMATION MESSAGE 3027

DECCMPCSITION TIME ESTIMATE IS 1

E I G E N V A L U E A N A L Y S I S S U M M A R Y %INVERSE POWER<

NUMBER OF EIGENVALUES EXTRACTED	3
NUMBER CF STARTING POINTS USED	1
NUMBER OF STARTING POINT MOVES	0
NUMBER OF TRIANGULAR DECOMPOSITIONS	4
TOTAL NUMBER OF VECTOR ITERATIONS	24
REASON FOR TERMINATION	6
LARGEST OFF-DIAGONAL MODAL MASS TERM	0.0
MODE PAIR	0
	0
NUMBER OF OFF-DIAGONAL MODAL MASS TERMS FAILING CRITERION	0

THERMAL BUCKLING OF SQUARE PLATE
NASTRAN CHECK PROBLEM 3

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R E A L   E I G E N V A L U E S

MODE NO.	EXTRACTION ORDER	EIGENVALUE	RADIANS	CYCLES	GENERALIZED MASS	GENERALIZED STIFFNESS
1	1	3.146694E 02	1.773892E 01	2.823237E 00	0.0	0.0
2	2	1.589959E 03	3.987428E 01	6.346190E 00	0.0	0.0
3	3	2.990684E 03	5.468713E 01	8.703729E 00	0.0	0.0

THERMAL BUCKLING OF SQUARE PLATE
NASTRAN CHECK PROBLEM 3

MARCH 9, 1972 PAGE 22

*** USER INFORMATION MESSAGE 2073, MPYAD METHOD 1,NO. PASSES # 1

BUCKLING SOLUTION SUBCASE 2
EIGENVALUE # 3.146694E 02

R E A L E I G E N V E C T O R N O . 1

POINT ID.	TYPE	T1	T2	T3	R1	R2	R3
1	G	0.0	0.0	1.000000E 00	0.0	0.0	0.0
2	G	-8.073854E-41	0.0	8.979413E-01	0.0	1.947136E-01	0.0
3	G	-1.239482E-40	0.0	6.394876E-01	0.0	3.025950E-01	0.0
4	G	-1.782218E-40	0.0	3.201509E-01	0.0	3.206882E-01	0.0
5	G	-1.969819E-40	0.0	0.0	0.0	3.134115E-01	0.0
6	G	0.0	8.464029E-41	8.979413E-01	-1.947135E-01	0.0	0.0
7	G	-4.584885E-41	4.232602E-41	8.061378E-01	-1.753539E-01	1.753539E-01	0.0
8	G	-8.866463E-41	2.496533E-41	5.737916E-01	-1.259189E-01	2.723019E-01	0.0
9	G	-1.233400E-40	3.436199E-42	2.870202E-01	-6.375372E-02	2.881311E-01	0.0
10	G	-1.211282E-40	-1.306623E-40	0.0	0.0	2.812582E-01	0.0
11	G	0.0	1.296555E-40	6.394877E-01	-3.025950E-01	0.0	0.0
12	G	-2.496072E-41	8.769083E-41	5.737916E-01	-2.723019E-01	1.259189E-01	0.0
13	G	-4.271350E-41	4.067618E-41	4.077063E-01	-1.951684E-01	1.951684E-01	0.0
14	G	-3.541022E-41	-2.309077E-41	2.034069E-01	-9.850711E-02	2.055063E-01	0.0
15	G	-1.309605E-41	-2.045074E-40	0.0	0.0	1.998732E-01	0.0
16	G	0.0	1.822550E-40	3.201509E-01	-3.206882E-01	0.0	0.0
17	G	-4.622035E-42	1.268716E-40	2.870202E-01	-2.881311E-01	6.375372E-02	0.0
18	G	1.909698E-41	3.348785E-41	2.034069E-01	-2.055063E-01	9.850711E-02	0.0
19	G	6.416865E-41	-6.888689E-41	1.010855E-01	-1.029519E-01	1.029519E-01	0.0
20	G	9.426696E-41	-2.538508E-40	0.0	0.0	9.958249E-02	0.0
21	G	0.0	1.994978E-40	0.0	-3.134115E-01	0.0	0.0
22	G	1.335123E-40	1.274667E-40	0.0	-2.812582E-01	0.0	0.0
23	G	2.088597E-40	1.107028E-41	0.0	-1.998732E-01	0.0	0.0
24	G	2.540817E-40	-9.889527E-41	0.0	-9.958249E-02	0.0	0.0
25	G	2.768962E-40	-2.787811E-40	0.0	0.0	0.0	0.0

THERMAL BUCKLING OF SQUARE PLATE MARCH 9, 1972 PAGE 24
NASTRAN CHECK PROBLEM 3

BUCKLING SOLUTION SUBCASE 2
EIGENVALUE # 1.589959E 03

R E A L E I G E N V E C T O R N O . 2

POINT ID.	TYPE	T1	T2	T3	R1	R2	R3
1	G	0.0	0.0	2.163732E-01	0.0	0.0	0.0
2	G	-9.056496E-36	0.0	-3.373190E-01	0.0	8.633407E-01	0.0
3	G	-1.816332E-35	0.0	-9.838199E-01	0.0	2.373542E-01	0.0
4	G	-2.818997E-35	0.0	-7.497891E-01	0.0	-6.085179E-01	0.0
5	G	-3.089677E-35	0.0	0.0	0.0	-8.263519E-01	0.0
6	G	0.0	9.083137E-36	-3.373191E-01	-8.633409E-01	0.0	0.0
7	G	-7.817258E-36	7.801765E-36	-6.734542E-01	-5.130330E-01	5.130329E-01	0.0
8	G	-1.518637E-35	5.385060E-36	-9.999999E-01	-1.161985E-02	1.764669E-02	0.0
9	G	-2.156022E-35	7.372588E-37	-6.791480E-01	1.169165E-01	-5.835013E-01	0.0
10	G	-2.168351E-35	-2.115720E-35	0.0	0.0	-7.273762E-01	0.0
11	G	0.0	1.823589E-35	-9.838201E-01	-2.373541E-01	0.0	0.0
12	G	-5.419113E-36	1.519851E-35	-1.000000E 00	-1.764669E-02	1.161973E-02	0.0
13	G	-8.309581E-36	8.256256E-36	-8.729516E-01	2.590799E-01	-2.590801E-01	0.0
14	G	-7.491457E-36	-3.164942E-36	-4.847941E-01	2.259318E-01	-4.663031E-01	0.0
15	G	-3.816139E-36	-3.539153E-35	0.0	0.0	-4.897515E-01	0.0
16	G	0.0	2.834764E-35	-7.497891E-01	6.085181E-01	0.0	0.0
17	G	-8.065273E-37	2.162961E-35	-6.791480E-01	5.835014E-01	-1.169166E-01	0.0
18	G	3.073237E-36	7.423570E-36	-4.847941E-01	4.663031E-01	-2.259318E-01	0.0
19	G	1.074757E-35	-1.084720E-35	-2.335157E-01	2.461105E-01	-2.461104E-01	0.0
20	G	1.615811E-35	-4.503821E-35	0.0	0.0	-2.241344E-01	0.0
21	G	0.0	3.110387E-35	0.0	8.263519E-01	0.0	0.0
22	G	2.127706E-35	2.178027E-35	0.0	7.273762E-01	0.0	0.0
23	G	3.548813E-35	3.737577E-36	0.0	4.897513E-01	0.0	0.0
24	G	4.503345E-35	-1.625721E-35	0.0	2.241344E-01	0.0	0.0
25	G	4.957980E-35	-4.962510E-35	0.0	0.0	0.0	0.0

THERMAL BUCKLING OF SQUARE PLATE   MARCH 9, 1972   PAGE 25
NASTRAN CHECK PROBLEM 3

BUCKLING SOLUTION   SUBCASE 2
EIGENVALUE # 2.990684E 03

R E A L   E I G E N V E C T O R   N O .   3

POINT ID.	TYPE	T1	T2	T3	R1	R2	R3
1	G	0.0	0.0	5.013302E-07	0.0	0.0	0.0
2	G	2.096165E-34	0.0	6.481529E-01	0.0	-8.404900E-01	0.0
3	G	4.306896E-34	0.0	1.000000E 00	0.0	1.914781E-01	0.0
4	G	6.754435E-34	0.0	4.883242E-01	0.0	6.055129E-01	0.0
5	G	7.421930E-34	0.0	0.0	0.0	3.985773E-01	0.0
6	G	0.0	-2.086752E-34	-6.481519E-01	-8.404900E-01	0.0	0.0
7	G	1.861798E-34	-1.863695E-34	4.875777E-07	-9.553484E-01	-9.553484E-01	0.0
8	G	3.626716E-34	-1.317079E-34	5.799711E-01	-6.913307E-01	-1.281361E-01	0.0
9	G	5.169629E-34	-2.097540E-35	3.502488E-01	-2.543892E-01	3.979369E-01	0.0
10	G	5.212094E-34	5.077594E-34	0.0	0.0	3.145867E-01	0.0
11	G	0.0	-4.266203E-34	-9.999991E-01	1.914781E-01	0.0	0.0
12	G	1.290194E-34	-3.615097E-34	-5.799702E-01	-1.281361E-01	-6.913310E-01	0.0
13	G	1.974085E-34	-2.009504E-34	6.268465E-07	-3.428363E-01	-3.428361E-01	0.0
14	G	1.773375E-34	7.071005E-35	1.085266E-01	-1.779982E-01	7.736593E-02	0.0
15	G	8.997029E-35	8.477456E-34	0.0	0.0	1.330035E-01	0.0
16	G	0.0	-6.639027E-34	-4.883236E-01	6.055124E-01	0.0	0.0
17	G	1.582013E-35	-5.129154E-34	-3.502482E-01	3.979365E-01	-2.543893E-01	0.0
18	G	-7.649998E-35	-1.826182E-34	-1.085259E-01	7.736516E-02	-1.779980E-01	0.0
19	G	-2.594755E-34	2.533304E-34	1.881830E-07	-2.145950E-02	-2.145910E-02	0.0
20	G	-3.888262E-34	1.075591E-33	0.0	0.0	2.193170E-02	0.0
21	G	0.0	-7.258768E-34	0.0	3.985764E-01	0.0	0.0
22	G	-4.990378E-34	-5.161801E-34	0.0	3.145859E-01	0.0	0.0
23	G	-8.417105E-34	-9.556116E-35	0.0	1.330028E-01	0.0	0.0
24	G	-1.076091E-33	3.826859E-34	0.0	2.193136E-02	0.0	0.0
25	G	-1.186899E-33	1.183987E-33	0.0	0.0	0.0	0.0

BUCKLING SOLUTION   SUBCASE 2
EIGENVALUE # 3.146694E 02

F O R C E S   O F   S I N G L E - P O I N T   C O N S T R A I N T

POINT ID.	TYPE	T1	T2	T3	R1	R2	R3
1	G	3.796622E-35	-3.942738E-35	0.0	1.280936E 02	-1.280940E 02	0.0
2	G	0.0	-3.238169E-35	0.0	2.261982E 02	0.0	0.0
3	G	0.0	-1.493575E-35	0.0	1.532282E 02	0.0	0.0
4	G	0.0	1.017824E-36	0.0	7.245901E 01	0.0	0.0
5	G	0.0	8.572702E-35	-4.240826E 01	-4.300323E 00	0.0	0.0
6	G	3.650522E-35	0.0	0.0	0.0	-2.262038E 02	0.0
10	G	0.0	0.0	-6.277686E 01	3.885406E 00	0.0	0.0
11	G	1.367278E-35	0.0	0.0	0.0	-1.532396E 02	0.0
15	G	0.0	0.0	-1.818677E 01	5.660797E 00	0.0	0.0
16	G	-1.064327E-36	0.0	0.0	0.0	-7.245918E 01	0.0
20	G	0.0	0.0	7.032349E 00	5.396072E 00	0.0	0.0
21	G	-8.707993E-35	0.0	-4.240813E 01	0.0	4.300125E 00	0.0
22	G	0.0	0.0	-6.277760E 01	0.0	-3.885406E 00	0.0
23	G	0.0	0.0	-1.818616E 01	0.0	-5.660812E 00	0.0
24	G	0.0	0.0	7.032715E 00	0.0	-5.396072E 00	0.0
25	G	0.0	0.0	1.198838E 02	2.419378E 00	-2.419388E 00	0.0

BUCKLING SOLUTION   SUBCASE 2
EIGENVALUE # 1.589959E 03

F O R C E S   O F   S I N G L E - P O I N T   C O N S T R A I N T

POINT ID.	TYPE	T1	T2	T3	R1	R2	R3
1	G	3.707690E-30	-3.719196E-30	0.0	8.749749E 02	-8.749746E 02	0.0
2	G	0.0	-6.111007E-30	0.0	1.087192E 03	0.0	0.0
3	G	0.0	-3.726366E-30	0.0	2.832690E 01	0.0	0.0
4	G	0.0	1.751197E-31	0.0	-2.861228E 02	0.0	0.0
5	G	0.0	1.338143E-29	3.381875E 02	-2.056311E 01	0.0	0.0
6	G	6.126861E-30	0.0	0.0	0.0	-1.087190E 03	0.0
10	G	0.0	0.0	4.699058E 02	5.849231E 01	0.0	0.0
11	G	3.750436E-30	0.0	0.0	0.0	-2.832697E 01	0.0
15	G	0.0	0.0	9.004532E 01	3.935367E 01	0.0	0.0
16	G	-1.122629E-31	0.0	0.0	0.0	2.861301E 02	0.0
20	G	0.0	0.0	-8.849585E 01	-3.987335E 00	0.0	0.0
21	G	-1.347272E-29	0.0	3.381877E 02	0.0	2.056334E 01	0.0
22	G	0.0	0.0	4.698933E 02	0.0	-5.849210E 01	0.0
23	G	0.0	0.0	9.004100E 01	0.0	-3.935379E 01	0.0
24	G	0.0	0.0	-8.849780E 01	0.0	3.987213E 00	0.0
25	G	0.0	0.0	-2.649832E 02	-8.702866E 00	8.702988E 00	0.0

THE JOHNS HOPKINS UNIVERSITY
APPLIED PHYSICS LABORATORY
SILVER SPRING, MARYLAND

BUCKLING SOLUTION SUBCASE 2
EIGENVALUE # 2.990684E 03

F O R C E S O F S I N G L E - P O I N T C O N S T R A I N T

POINT ID.	TYPE	T1	T2	T3	R1	R2	R3
1	G	-8.476004E-29	8.428964E-29	0.0	1.212002E 03	1.212002E 03	0.0
2	G	0.0	1.459546E-28	0.0	2.105127E 03	0.0	0.0
3	G	0.0	9.206415E-29	0.0	1.324992E 03	0.0	0.0
4	G	0.0	-9.815502E-31	0.0	4.758584E 02	0.0	0.0
5	G	0.0	-3.213266E-28	7.689867E 01	-1.630159E 01	0.0	0.0
6	G	-1.458976E-28	0.0	0.0	0.0	2.105133E 03	0.0
10	G	0.0	0.0	3.124623E 01	1.342027E 02	0.0	0.0
11	G	-8.972076E-29	0.0	0.0	0.0	1.325000E 03	0.0
15	G	0.0	0.0	-2.930289E 01	6.365793E 01	0.0	0.0
16	G	6.124289E-30	0.0	0.0	0.0	4.758608E 02	0.0
20	G	0.0	0.0	5.880621E 01	-2.290895E 01	0.0	0.0
21	G	3.142542E-28	0.0	-7.689937E 01	0.0	-1.630144E 01	0.0
22	G	0.0	0.0	-3.124170E 01	0.0	1.342031E 02	0.0
23	G	0.0	0.0	2.930334E 01	0.0	6.365785E 01	0.0
24	G	0.0	0.0	-5.880646E 01	0.0	-2.290907E 01	0.0
25	G	0.0	0.0	2.123117E-04	-1.458500E 01	-1.458502E 01	0.0

BUCKLING SOLUTION SUBCASE 2
EIGENVALUE # 3.146694E 02

F O R C E S I N G E N E R A L Q U A D R I L A T E R A L E L E M E N T S % C Q U A D 2 <

ELEMENT ID.	BEND-MOMENT X	BEND-MOMENT Y	TWIST-MOMENT	SHEAR X	SHEAR Y
1	-2.202729E 02	-2.202729E 02	7.252441E 00	-7.808594E 01	-7.808984E 01
2	-1.351645E 02	-1.660766E 02	1.830981E 01	-1.661445E 02	-5.887500E 01
3	-4.158368E 01	-9.150357E 01	2.242041E 01	-1.397905E 02	-3.240625E 01
4	-2.278030E 00	-2.724693E 01	2.243286E 01	-7.107666E 01	-9.684082E 00
5	-1.660771E 02	-1.351652E 02	1.830835E 01	-5.886719E 01	-1.661484E 02
6	-9.892351E 01	-9.892351E 01	4.598193E 01	-1.229614E 02	-1.229609E 02
7	-2.626468E 01	-5.121181E 01	5.619556E 01	-9.810498E 01	-6.558081E 01
8	9.531860E-01	-1.419395E 01	5.600781E 01	-3.941089E 01	-1.898242E 01
9	-9.150363E 01	-4.158376E 01	2.242041E 01	-3.240991E 01	-1.397915E 02
10	-5.121172E 01	-2.626477E 01	5.619580E 01	-6.558643E 01	-9.810425E 01
11	-8.797867E 00	-8.797867E 00	6.816333E 01	-4.632544E 01	-4.632251E 01
12	3.511917E 00	-7.981415E-01	6.705721E 01	-6.191650E 00	-1.151587E 01
13	-2.724684E 01	-2.278107E 00	2.243307E 01	-9.686996E 00	-7.107642E 01
14	-1.419389E 01	9.531097E-01	5.600793E 01	-1.898784E 01	-3.941138E 01
15	-7.981262E-01	3.511871E 00	6.705711E 01	-1.151945E 01	-6.190674E 00
16	2.005751E 00	2.005753E 00	6.458414E 01	2.929367E 00	2.930664E 00

BUCKLING SOLUTION SUBCASE 2
EIGENVALUE # 1.589959E 03

FORCES IN GENERAL QUADRILATERAL ELEMENTS %CQUAD2<

ELEMENT ID.	BEND-MOMENT X	BEND-MOMENT Y	TWIST-MOMENT	SHEAR X	SHEAR Y
1	-8.192683E 02	-8.192683E 02	1.894141E 02	-1.742531E 03	-1.742526E 03
2	4.413760E 02	-8.619574E 01	2.664741E 02	-1.461379E 03	-6.499236E 02
3	6.770115E 02	2.469732E 02	6.273926E 01	6.223984E 02	1.232031E 02
4	1.816754E 02	1.032165E 02	-5.755151E 01	4.931619E 02	1.287773E 02
5	-8.619566E 01	4.413757E 02	2.664768E 02	-6.499258E 02	-1.461379E 03
6	4.559978E 02	4.559978E 02	3.667803E 02	-3.554688E 02	-3.554609E 02
7	4.222852E 02	2.848955E 02	4.735791E 01	5.707500E 02	3.818906E 02
8	9.158563E 01	7.289705E 01	-1.480720E 02	2.883218E 02	2.340273E 02
9	2.469739E 02	6.770122E 02	6.273999E 01	1.231992E 02	6.224023E 02
10	2.848955E 02	4.222859E 02	4.735791E 01	3.818867E 02	5.707656E 02
11	1.353549E 02	1.353550E 02	-9.976978E 01	4.036855E 02	4.036836E 02
12	3.444931E 00	9.440536E 00	-1.749949E 02	4.958496E 01	1.402671E 02
13	1.032163E 02	1.816755E 02	-5.755078E 01	1.287842E 02	4.931638E 02
14	7.289679E 01	9.158583E 01	-1.480717E 02	2.340331E 02	2.883210E 02
15	9.440460E 00	3.445023E 00	-1.749949E 02	1.402750E 02	4.958252E 01
16	-1.308125E 01	-1.308127E 01	-1.477960E 02	-2.242380E 01	-2.242676E 01

BUCKLING SOLUTION SUBCASE 2
EIGENVALUE # 2.990684E 03

FORCES IN GENERAL QUADRILATERAL ELEMENTS %CQUAD2<

ELEMENT ID.	BEND-MOMENT X	BEND-MOMENT Y	TWIST-MOMENT	SHEAR X	SHEAR Y
1	5.755879E 02	-5.755879E 02	-9.765625E-04	3.185776E 03	-3.185790E 03
2	-1.077459E 03	-1.009349E 03	2.092625E 02	3.983906E 02	-2.017672E 03
3	-5.603535E 02	-5.621523E 02	2.289473E 02	-1.831152E 03	-6.208594E 02
4	9.797162E 01	-7.660335E 01	9.037817E 01	4.203418E 01	-3.059814E 01
5	1.009350E 03	1.077459E 03	-2.092615E 02	2.017656E 03	-3.984063E 02
6	-3.768276E 02	3.768271E 02	4.882812E-04	1.008729E 03	-1.008723E 03
7	-3.749104E 02	6.456375E 01	2.804260E 02	-8.154565E 02	-7.428208E 02
8	2.318292E 01	3.878506E 01	1.644765E 02	5.502344E 01	-1.389956E 02
9	5.621523E 02	5.603530E 02	-2.289470E 02	6.208638E 02	1.831148E 03
10	-6.456514E 01	3.749097E 02	-2.804258E 02	7.428218E 02	8.154492E 02
11	-1.848528E 02	1.848523E 02	3.051758E-04	-3.894424E 00	3.891846E 00
12	-2.383992E 01	5.807253E 01	7.685799E 01	4.524605E 01	-7.467358E 01
13	7.660300E 01	-9.797202E 01	-9.037892E 01	3.060112E 01	-4.203467E 01
14	-3.878558E 01	-2.318314E 01	-1.644763E 02	1.390018E 02	-5.502441E 01
15	-5.807259E 01	2.383994E 01	-7.685765E 01	7.467520E 01	-4.524683E 01
16	-1.390727E 01	1.390732E 01	1.449585E-04	2.117361E 01	-2.117345E 01

MESSAGES FROM THE PLOT MODULE

P L O T T E R   D A T A

THE FOLLOWING PLOTS ARE FOR A CALCOMP 565 INCREMENTAL PLOTTER %3 CHARACTERS/COMMAND - .010 STEP SIZE<

AN END-OF-FILE MARK FOLLOWS THE LAST PLOT

THE FIRST COMMAND FOR EACH PLOT CONTAINS THE PLOT NUMBER

PEN 1 - SIZE 1, BLACK

E N G I N E E R I N G   D A T A

ORTHOGRAPHIC PROJECTION
ROTATIONS %DEGREES< - GAMMA # 34.27, BETA # 23.17, ALPHA # 0.0 , AXES # &X,&Y,&Z, SYMMETRIC
SCALE %OBJECT-TO-PLOT SIZE< # 1.250271E 00

ORIGIN 1 - XO # -2.165533E 00, YO # -5.919050E 00 %INCHES<

MESSAGES FROM THE PLOT MODULE

PLOT 2 STATIC DEFORMATION - SUBCASE 1, LOAD SET 0

MESSAGES FROM THE PLOT MODULE

P L O T T E R   D A T A

THE FOLLOWING PLOTS ARE FOR A CALCOMP 565 INCREMENTAL PLOTTER %3 CHARACTERS/COMMAND - .010 STEP SIZE<

AN END-OF-FILE MARK FOLLOWS THE LAST PLOT

THE FIRST COMMAND FOR EACH PLOT CONTAINS THE PLOT NUMBER

PEN 1 - SIZE 1, BLACK

E N G I N E E R I N G   D A T A

ORTHOGRAPHIC PROJECTION
ROTATIONS %DEGREES< - GAMMA # 34.27, BETA # 23.17, ALPHA #   0.0 , AXES # &X,&Y,&Z, SYMMETRIC
SCALE %OBJECT-TO-PLOT SIZE< # 1.250271E 00

ORIGIN   1 -   XO # -2.165533E 00, YO # -5.919050E 00   %INCHES<

MESSAGES FROM THE PLOT MODULE

PLOT   3   MODAL DEFORMATION - SUBCASE   2, MODE   1, EIGENVALUE # 3.146694E 02

* * * END OF JOB * * *

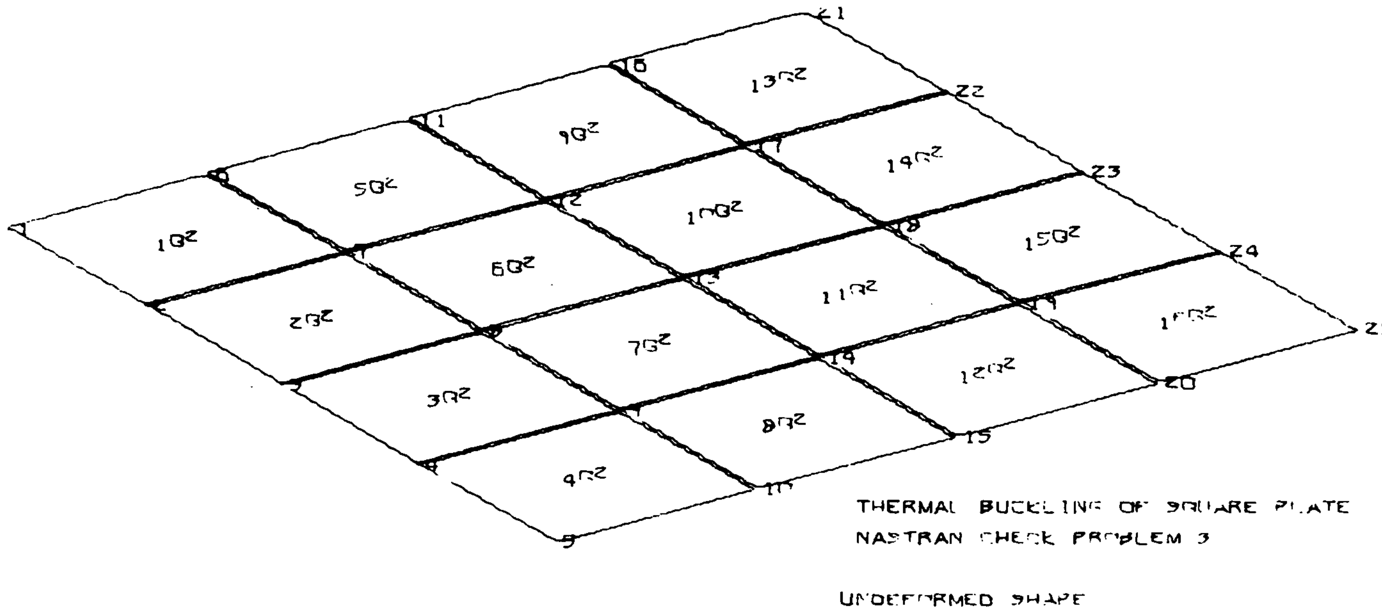

Fig. D-1 THERMAL BUCKLING OF SQUARE PLATE; NASTRAN EXAMPLE PROBLEM 4: UNDEFORMED SHAPE

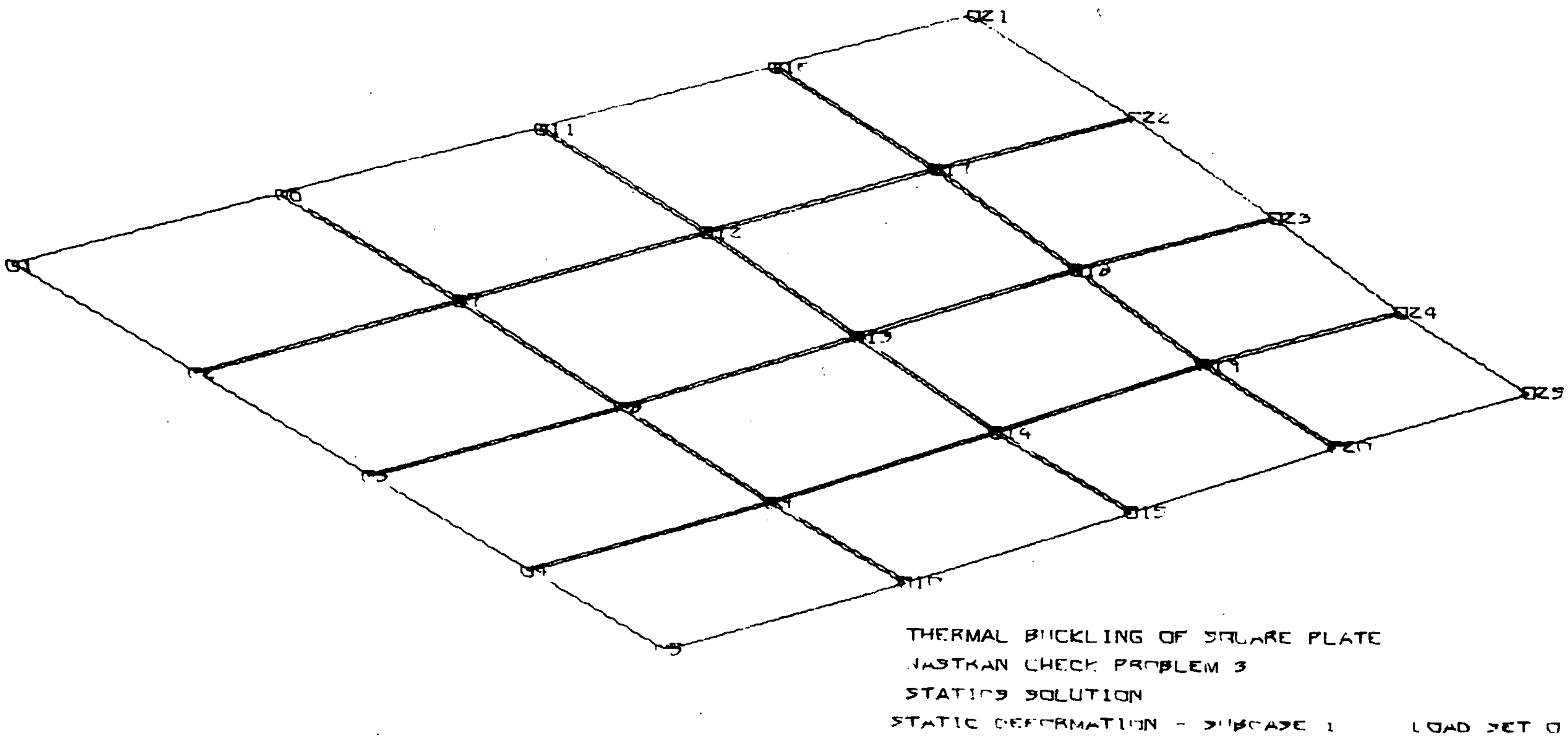

Fig. D-2 THERMAL BUCKLING OF SQUARE PLATE; NASTRAN EXAMPLE PROBLEM 4: STATIC SOLUTION, STATIC DEFORMATION—SUBCASE 1, LOAD SET 0

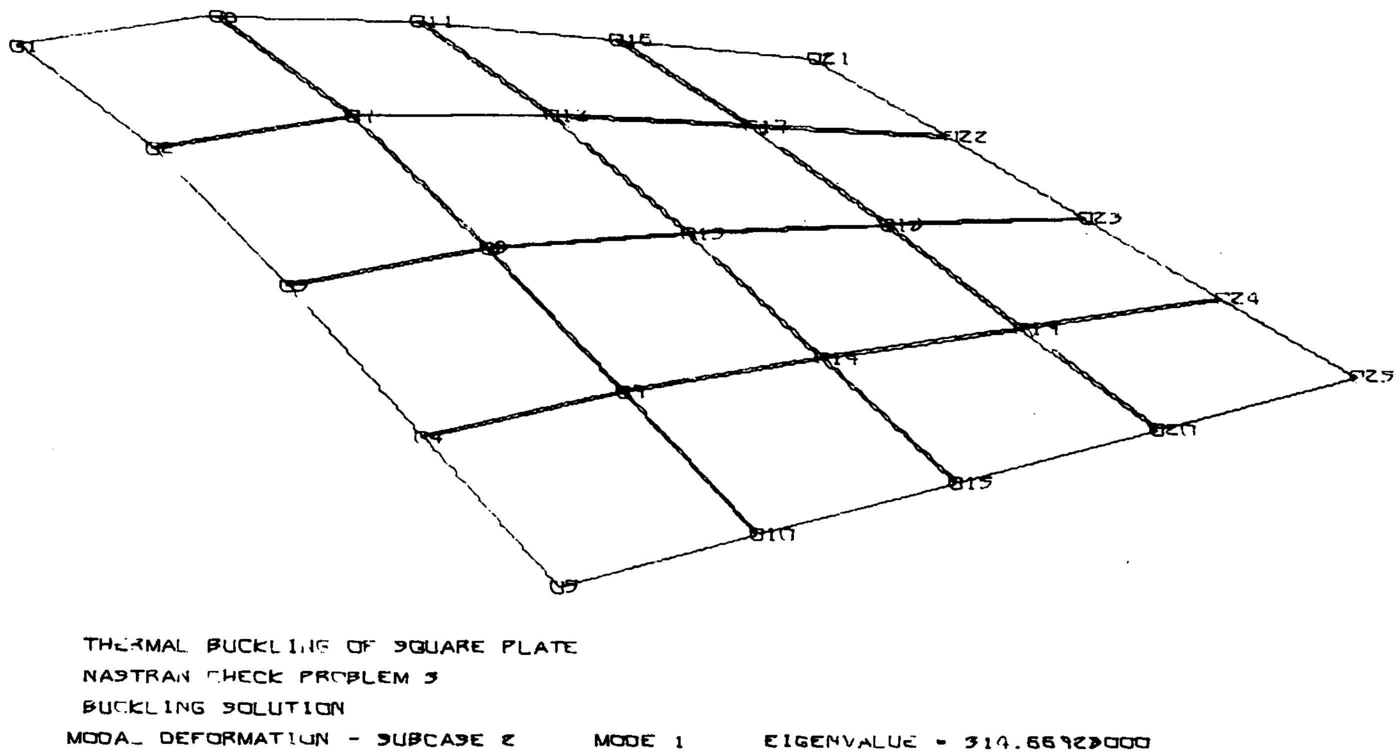

Fig. D-3 THERMAL BUCKLING OF SQUARE PLATE; NASTRAN EXAMPLE PROBLEM 4: BUCKLING SOLUTION–SUBCASE 2, MODE 1, EIGENVALUE = 314.55923000