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AN UNUSUAL APPLICATION OF NASTRAN CONTOUR PLOTTING CAPABILITY

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SUMMARY

A simple procedure to obtain contour plots of any physical quantity defined on a number of points of the surface of a structure is presented. Rigid Format 1 of HEAT approach in Cosmic NASTRAN is ALTERED to enable use of contour plotting capability for scalar quantities. ALTERED DMAP sequence and examples are included.

INTRODUCTION

In many engineering situations either a user has the need for visual verification of the input data for structural analysis, e.g., temperature distribution for thermal stress analysis in heat exchangers or might wish to obtain contour plots of a nonstructural engineering quantity like flux or angles of incidence, etc. Most often, a detailed structural analysis of the same piece of the hardware is also required, for which a NASTRAN finite element model is already available. In such situations, the contour plotting capability in NASTRAN can be very conveniently used to generate desired plots. In NASTRAN contour plots can only be obtained for surfaces that have 2-dimensional elements. However, for models with solid elements only, dummy layers of very thin plate elements have been used to successfully draw contour plots even in the interior of the structure.

Heat approach, solution 1 in COSMIC NASTRAN is preferred for this application because it permits defining a scalar quantity at a grid point and makes the data preparation easier. Procedure is inexpensive because almost all the solution steps in the Rigid Format are skipped and only the plotting capability is made use of.

The application of the presented technique requires, for large problems, some additional computer programming effort where grid point definition data is read from a NASTRAN deck, the physical quantity is computed on the coordinates of grid points and the results are written out on NASTRAN formatted SPC cards. Alternatively, for small problems, this data can be manually input on NASTRAN cards.

CONTOUR PLOTTING PROCEDURE

To obtain contour plots, a regular NASTRAN run with DMAP alters, presented in Appendix A as part of a sample executive deck, is required to be submitted. Normal input data processing for geometry definition in terms of GRID and element connection cards and plot set definitions is done as usual.

The phvsical quantity must be defined as enforce   placement SPC cards for each grid point. The entire solution sequence is skipp d and an equivalence is made between the single point constraint set(U_s) and the structural set (U_g) (Referernce 1). This step redefines the input as output s at the output vector can now be processed to generate plots. Once the user   nes the SPC cards the rest of the procedure is automatic.

The case control deck consists of the selection of SPC set and printing out, if desired, of the physical quantity as temperature. The plotting itself is requested via regular NASTRAN cards. A sample case control deck is shown in Appendix B.

Bulk data must include GRID cards, element connection cards to define two dimensional surfaces and dummy property and material cards. In addition the SPC cards contain the information required to generate the contour plots. Appendix C shows a sample Bulk Data deck.

EXAMPLES

The first need at Bell Aerospace Textron for this uncommon application arose during thermal stress analysis of cooled laser mirrors. The temperature distribution on the mirror surface and the interior was used as one of the loading conditions for the stress analysis. The temperature had been computed using a finite difference heat transfer program. An intermediate FORTRAN program generated NASTRAN input data cards. As a verification of input data it was decided to obtain contour plots of the input temperature distribution. Typical temperature contour plot obtained is shown in Figure 1. This represents the temperature distribution on the mirror face. This process helped detect and correct errors in the input data for subsequent structural analysis.

A second example of the successful application of this technique relates to the angle of incidence plots for airborne radar applications. Structural analysis of a typical radome housing was required and a NASTRAN finite element model was already available. The current technique helped obtain contour plots of the angle of incidence on the radome surface. This provided useful information at relatively little cost. A short FORTRAN program was written to compute angles of incidence at a given point by reading the coordinates of grid points and computing normals to the neighboring elements. Typical contour plot is shown in Figure 2.

CONCLUDING REMARKS

1. A simple and inexpensive method of obtaining contour plots of any nonstructural quantity has been presented.

2. This method is most efficient when a structural finite element model of the surface on which contour plots are desired, is already available.

3. The physical quantity is defined on SPC cards. Usually, an intermediate computer program is helpful in generating input data for large problems.

4. DMAP ALTERS to be used in HEAT approach, Rigid Format 1 are provided.

5. Applications at Bell Aerospace Textron have been varied and have provided useful quick-look information.

REFERENCE

1. The NASTRAN User's Manual, NASA SP-222(06), Section 1.4.5, September 1983.

APPENDIX A

SAMPLE EXECUTIVE CONTROL DECK

```
NASTRAN BANDIT=-1
ID      SECOND EXAMPLE
APP     HEAT
SOL     1
TIME    5
ALTER 33,80
PARAM //*NOP*/P1=-1 $
EQUIV YS,HUGV/P1 $
SDR2 CASECC,CSTM,MPT,DIT,HEQEXIN,HSIL,GPTT,EDT,BGPDP,,,HUGV,HEST,,/
     ,,HOUGV1,,,HPUGV1/*STATICS* $
OFP HOUGV1,,,,,//S,N,CARDNO $
ENDALTER
CEND
```

APPENDIX B

SAMPLE CASE CONTROL DECK

```
TITLE    = NASTRAN USER'S COLLOQUIM # 13
SUBTITLE = CONTOUR PLOTS OF INCIDENT ANGLES
LABEL    = RADOME SURFACE
SPC      = 1
THERMAL(PRINT) = ALL
OUTPUT(PLOT)
PLOTTER NASTPLT, MODEL D, 0
PAPER SIZE  10.5 BY  8.0
VIEW 0.0,0.0,0.0
AXES Z,X,Y
SET  1    = QUAD2,TRIA2
FIND SCALE,SET 1,ORIGIN 1
PTITLE = FRONT VIEW
CONTOUR MAGNITUD,LIST 0.0,10.0,20.0,30.0,40.0,50.0,52.5,55.0,
        57.5,60.0,62.5,65.0,67.5,70.0,72.5,75.0,77.5,80.0,90.0
PLOT CONTOUR, SET 1, ORIGIN 1, OUTLINE
BEGIN BULK
```

APPENDIX C

SAMPLE BULK DATA DECK

```
GRID    420             9.816   8.633   2.439
CQUAD2  420     101     420     520     521     421
CTRIA2  217     201     215     317     318
PQUAD2  101     1001    .001
PTRIA2  201     1001    .001
MAT4    1001    1.0
SPC     1       420     1       60.231
ENDDATA
```

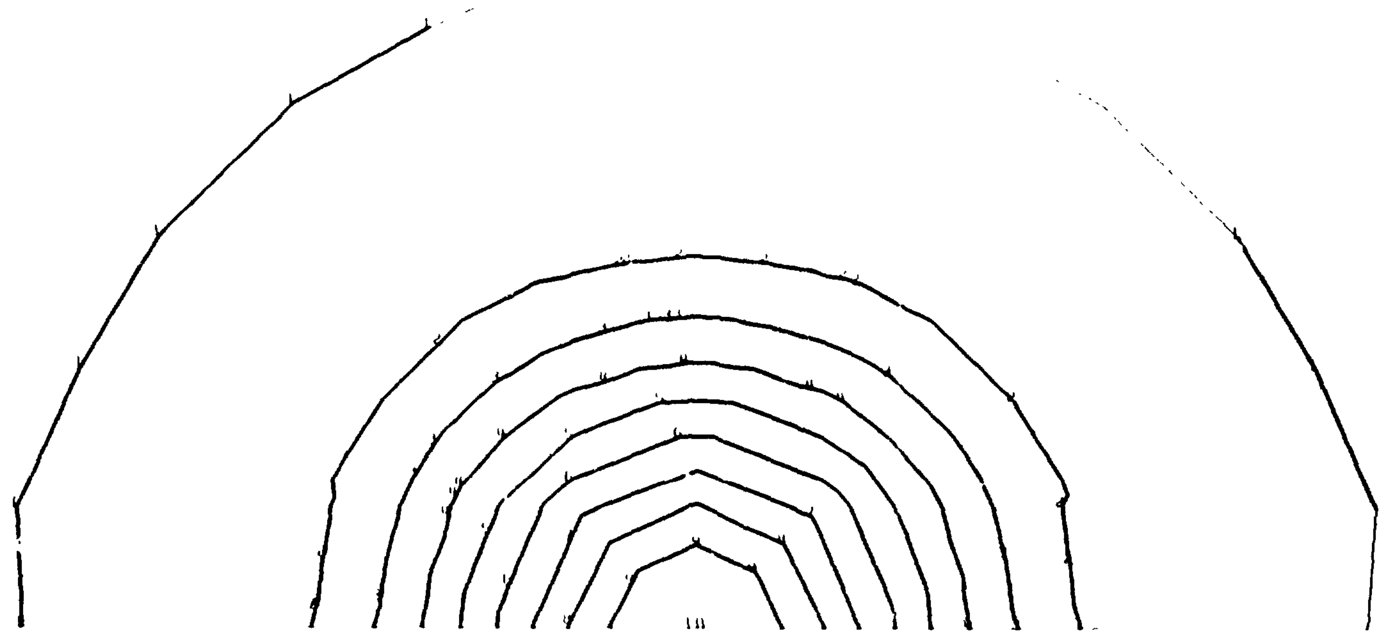

FIGURE 1. TEMPERATURE CONTOURS ON THE SURFACE OF LASER MIRROR

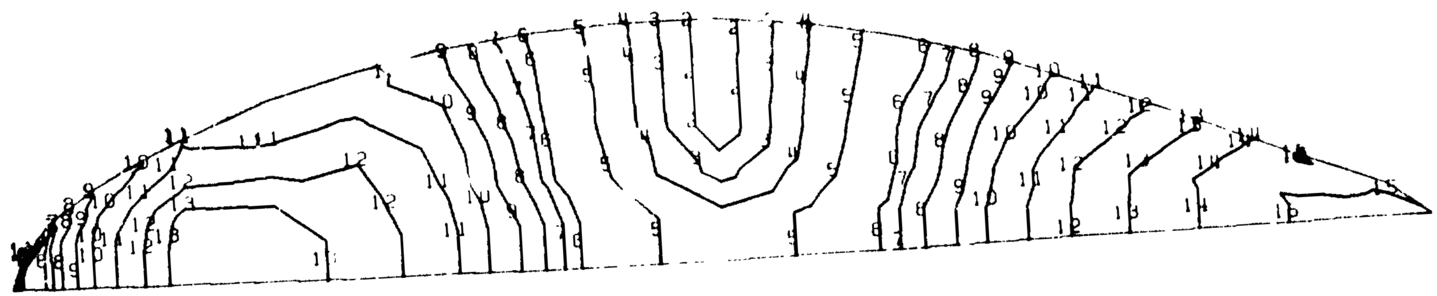

FIGURE 2. ANGLE OF INCIDENCE CONTOURS ON A RADOME SURFACE