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# Composite Blade Structural Analyzer (COBSTRAN) User's Manual

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NASA

COMPOSITE BLADE STRUCTURAL ANALYZER

# COBSTRAN

## USER'S MANUAL

by

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STRUCTURAL MECHANICS BRANCH

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## INTRODUCTION

The COBSTRAN (COmposite Blade STRuctural ANalyzer) code was developed and used successfully at NASA Lewis Research Center for the design and analysis of composite turbofan and turboprop blades and also for composite wind turbine blades.

This code combines composite mechanics and laminate theory with a data base of fiber and matrix properties. As a preprocessor for NASTRAN, COBSTRAN generates a NASTRAN model with anisotropic homogeneous material properties. Stress output from NASTRAN is provided as input to the COBSTRAN postprocessor which uses the composite mechanics and laminate theory routines to calculate individual ply stresses, strains, interply stresses, thru-the-thickness stresses and failure margins.

Blades made from isotropic or anisotropic homogeneous materials can also be modeled as a special case of COBSTRAN. NASTRAN MAT1 or MAT2 material cards are generated according to user supplied properties.

COBSTRAN, written in FORTRAN 77, is currently configured for operation on the LeRC CRAY X-MP computer by use of the VM EXEC accessed thru the LeRC VM USERDISK.

## CONFIGURATION FORMATS

Two types of problem solution formats are available in this code. The first format is for a solid composite blade (Figures 1 & 2) or solid composite blade with hollow core sections (Figures 3 & 4) of the turboprop or turbofan types. Plate or shell type 2-D elements are created along the blade mid-thickness line and equivalent homogeneous material properties are calculated from the composite layup for each element. This format has dimension limits which restrict modeling to a maximum of 504 nodes and 910 elements.

The second format is for blades of the shell/spar type construction composed of membrane type quadrilateral shell elements on the airfoil surface separated by plate type spars at user selected chord positions. This format is most suitable for long wing-like structures used for wind power turbines (Figure 5). The limits to the number of nodes or elements when using this solution format are 5040 nodes and 9100 elements.

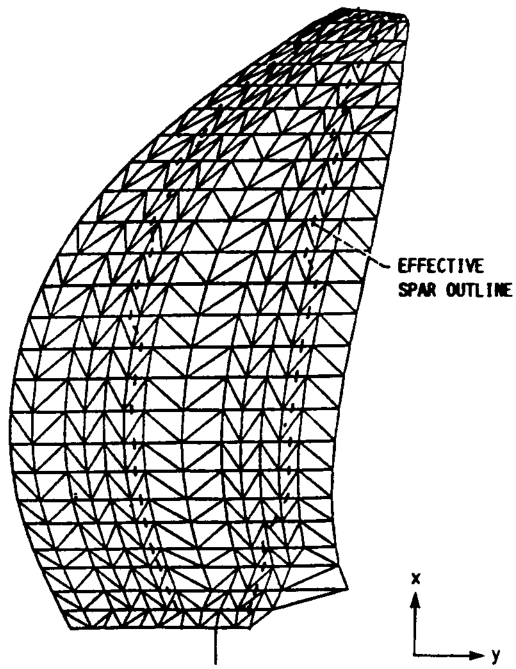



FIGURE 1. - COBSTRAN FINITE ELEMENT MODEL.
328 NODES; 584 ELEMENTS.

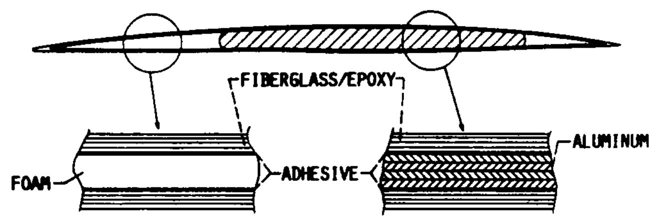



FIGURE 2. - TYPICAL BLADE CROSS-SECTION.

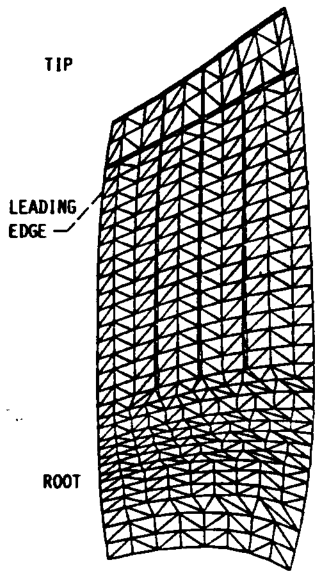



FIGURE 3. - COBSTRAN MODEL OF THE HOLLOW FAN BLADE (777 ELEMENTS).

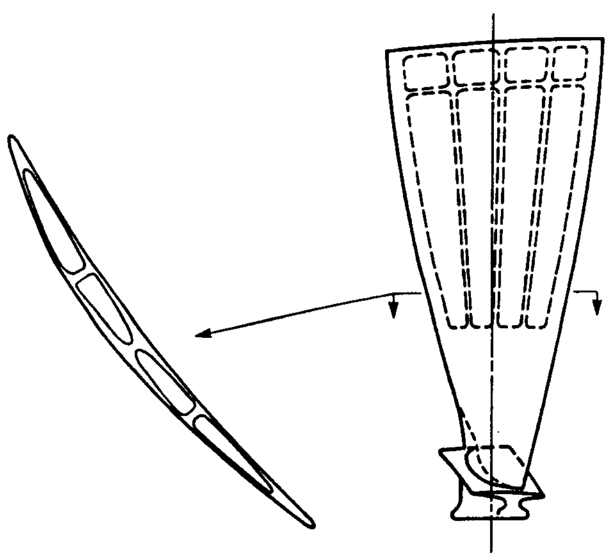


FIGURE 4. - TURBOFAN BLADE WITH HOLLOW CORE SECTIONS.

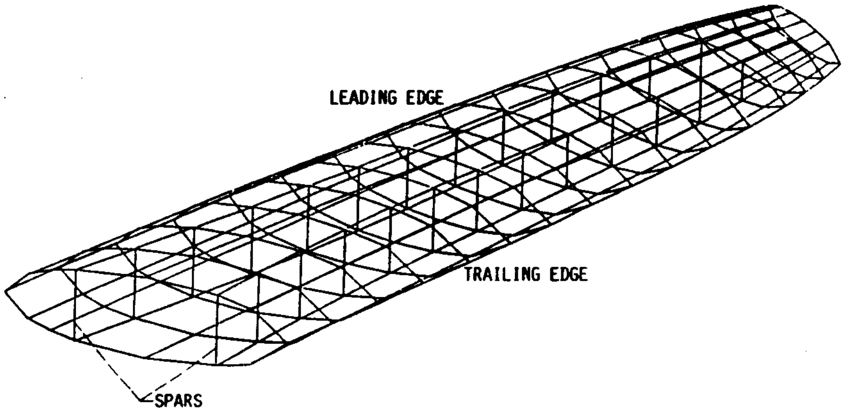



FIGURE 5. - TYPICAL MODEL GENERATED BY THE SHELL/SPAR OPTION.

This code would also be suitable for the analysis of any composite layups for which plate bending or membrane type NASTRAN elements are applicable. Curved panel structures may be modeled utilizing the SOLID option providing the curvature of a cross-section is defined by a single value function. The panel cannot have two coordinate values at any chordwise station.

As a preprocessor only, COBSTRAN can be used to generate NASTRAN grid, connectivity and material cards for component parts of a larger NASTRAN model. COBSTRAN writes these bulk data records to FORTRAN unit KBULK which can be assigned to a user designated file. These NASTRAN data sets can then be combined into a larger model.

## COMPOSITE ANALYSIS

COBSTRAN is designed to carry out the many linear analyses required to efficiently design and analyze structural components made of multilayered unidirectional fiber composites.

Inputs to the COBSTRAN composite analysis are constituent fiber and matrix material properties, factors reflecting the ply fabrication process and ply orientation and location geometry. COBSTRAN performs the micromechanics, macromechanics and laminate analyses of these fiber composites. See the COBSTRAN Theoretical/Programmers Manual.

The orientation angle of the 11-axis for each unidirectional ply designation is required input. This angle (measured in degrees) is defined from the COBSTRAN x-axis (0.0 degree ply orientation) to be positive in the positive x-y quadrant for the solid 2-D blade and for the airfoil surface of the shell/spar model (Figure 6). For the spars of the shell/spar model the angle is positive in the positive x-z quadrant.

Outputs are the various ply and composite properties, composite structural response (accounting for bending-stretching coupling) and composite stress analysis including the results of combined-stress strength failure criteria and Hoffman's failure criteria.

The output from COBSTRAN postprocessing is designed to make use of information generated in the preprocessor phase and stored in temporary files. Therefore the COBSTRAN-NASTRAN-COBSTRAN problem must be run in sequence.

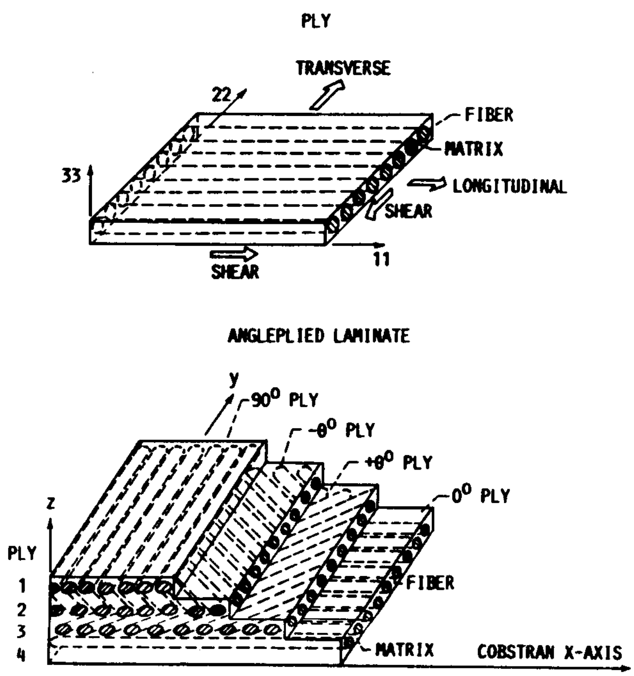



FIGURE 6. - FIBER COMPOSITE GEOMETRY RELATIVE TO COBSTRAN COORDINATE SYSTEM.

## COORDINATE SYSTEMS

COBSTRAN utilizes a right hand rectangular coordinate system in which the blade lies spanwise along the x-axis. The blade chord lies generally along the y-axis and the z-axis is through the thickness as shown in Figure 7.

For the shell/spar format the coordinates are assumed to be on the external surface of the model. These coordinates will automatically be transferred to the mid-wall position in accordance with the thickness specified. If this coordinate transformation is not desired a PROFILE option card should be included in the option deck.

## MESH GENERATION

The mesh generation capability in COBSTRAN is designed to create 2-D plate type meshes under the SOLID option and shell type blade meshes under the SHELL/SPAR option. In both cases meshes are created with 2-D elements.

When using the SOLID option blade format, the values of input for each radial station (x section) is defined as follows. For a given y point the maximum value of z is represented by ZU and the minimum value of z by ZL. From these input values the thickness normal to the mid-thickness line is calculated and the respective y and z values are determined on the mid-thickness line. Alternately the user may specify the final mid-thickness grid points to be used in COBSTRAN and the blade thickness at each of these points. These coordinate input formats are described in Figure 8.

Under the SOLID option four types of 2-D mesh patterns may be created from nodal points generated along the mid-thickness line. Three of these patterns are described in Figure 9. The pattern for MESH = 3 is currently not available.

Under the SHELL/SPAR option only quadrilateral elements are created. There is no user selection available.

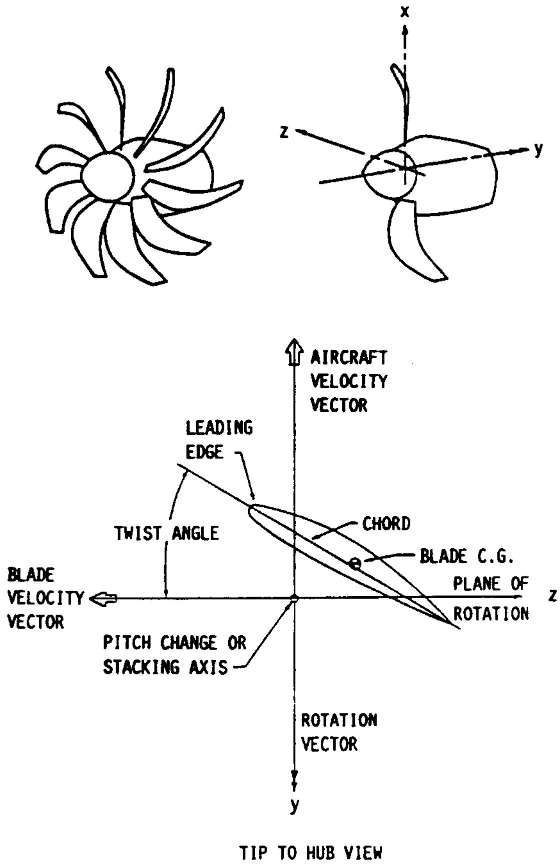
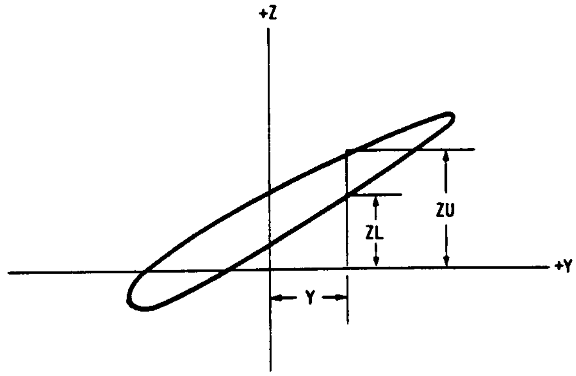
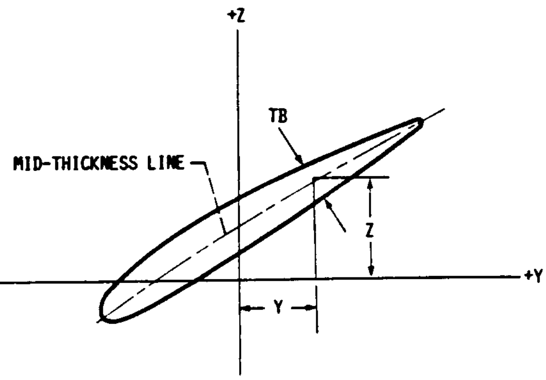



FIGURE 7. - COBSTRAN COORDINATE SYSTEM.




VIEW LOOKING TIP TO HUB (NEG X)
IGRD = 1 OR 2




VIEW LOOKING TIP TO HUB (NEG X)
IGRD = 3 OR 4

FIGURE 8. - COBSTRAN COORDINATE INPUT FORMATS.

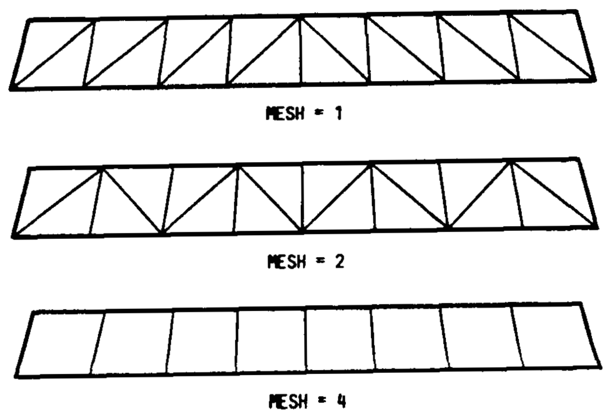



FIGURE 9. - COBSTRAN 2-D MESH PATTERNS.

# INPUT FORMAT

The COBSTRAN input format is described by card groups. The options activated and their respective card groups define the path which will be taken thru COBSTRAN. The use of each Program Option Card is described in Section 3.

Some of the card groups are dependant on either a Program Option Card being specified or a parameter defined in a previous card group. The optional card groups and their respective dependencies are explained within each card group listed under DECK SET-UP.

User controlled parameters are described in Section 3. Also, a dictionary of program variables is provided at the end of this manual in Section 6.

Although COBSTRAN retains most of the option requests in temporary files between pre- and postprocessing it is good practice to duplicate the preprocessor Program Option Cards for postprocessing. A separate input file is required for postprocessing.

Following, is the COBSTRAN DECK SET-UP by card groups.

If an optional card group is not activated by a previous Program Option Card or user selected parameter the optional card group must not be included in the dataset. The dataset should, however, be maintained in numerical order by card group number.

The following rule applies to card group 9 of the SOLID option and card groups 12 & 14 of the SHELL/SPAR option. Data input should be in ascending order (increasing values) for the x coordinates and for each x station the y values should be in ascending order.

## DECK SET-UP

CARD
GROUP

1 TITLE= Problem Identification
(Maximum of 5 TITLE cards)

2 Program Option Cards (order is optional)

PREPROCESSOR
POSTPROCESSOR
SOLID BLADE
SHELL/SPAR
BIDE -- interlaminar stiffness included
CONE ANGLE -- define wind turbine coning angle
COSMIC NASTRAN -- finite element format
DIAGNOSTIC= -- programmers utility
DUMP -- internal databank printout
ECHO -- reflection of user input dataset
EZREAD -- user-friendly input format
HOLLOW -- solid blade with hollow or filled cavities
MODAL STRESS OUTPUT -- eigenvector stress evaluation
MPLOTS -- generate NASTRAN 'PLOTEL' file
MSCMIN -- MSC NASTRAN interpreter
MSC NASTRAN -- finite element format
NASMIN -- COSMIC NASTRAN interpreter
PLYORDER -- symmetrical ply order specified by user
PRESSURE -- pressure input
PROFILE -- suppress mid-wall correction (SHELL/SPAR)
PROPERTY INPUT -- user supplied layer properties
PRTOUT -- extended data output
TEMPERATURE -- temperature input
UNSYMMETRICAL PLYORDER -- specified by user
ZIGZAG SPARS -- spars not normal to mid-chord line

3 ENDOPTION -- required at end of option selection

Note: All title and option cards require only
the first four characters in free-field format

IF PREPROCESSOR

and SOLID BLADE continue on page 2-3
or SHELL/SPAR continue on page 2-5

IF POSTPROCESSOR continue on page 2-7

SOLID BLADE OPTION

| CARD GROUP | | FORMAT |
|---|---|---|
| 4 | IMAT,NDES,NMODE(3) | 20I4 |
| 5 | NOPLY,NSECT,NCOREG,NGROUP | 20I4 |
| 6 | IGRD,IU,JU,MESH | 20I4 |
| 7 | MSECT(J) J=1,NSECT | 20I4 |
| 8 | Optional for root and tip designation<br>Option activated if IGRD = 1 or 4<br>XBEG,XEND | 10F8.4 |
| | NOTE: See EZREAD option for alternate input format | |
| 9 | GRID POINT INPUT<br>X,Y,ZU,ZL,TU,TL,PU,PL (IF IGRD = 1 or 2)<br>X,Y, Z,TB,TU,TL,PU,PL (IF IGRD = 3 or 4)<br>One block of data for each X-section (NSECT)<br>Each block contains MSECT(J) cards<br>See Section 3 for IGRD options | <br>10F8.4<br>10F8.4 |
| * 10 | Optional for material coordinate system designation.<br>Option activated if NCOREG is greater than zero.<br>NCOOR(1,I),NCOOR(2,I),NCOOR(3,I) I=1,NCOREG<br>NCOREG groups, Maximum of 8 groups | <br><br>8(2I4,I2) |
| | * Not recommended for VERSION 1.2 (Untested option) | |
| 11 | Optional if composite material is to be selected from DATABANK.<br>Option activated if IMAT=1,2,5,6,7 or 8<br>PLY DESCRIPTIONS<br>PERT(I) I=1,6<br>CODES(I) I=1,6<br>Two(2) cards are required for each ply description (NDES in Card Group 4, MAX=40)<br>Ply designation numbers are assigned in the order in which the ply descriptions are listed.<br>NOTE: For ply layers for which properties are input. Select PROPERTY INPUT option and set CODES(1)=T300 and CODES(2)=SPOX | <br><br><br>8F10.4<br>A4,1X,A4,1X,4F10.4 |

SOLID BLADE OPTION

| CARD GROUP | | FORMAT |
|---|---|---|
| 12 | Optional for hollow or filled cavities.<br>Option activated if HOLLOW option is selected<br>The last ply described in Card Group 11 will fill the cavity; PERT(1)=NGRD and PERT(2)=0.0 | |
| | KGRD(J),THWAL(J) J=1,NGRD | 6(I6,F6.3) |
| 13 | Optional if ply order to be specified (symmetrical or unsymmetrical)<br>Option activated if PLYORDER or UNSYMMETRICAL PLYORDER option selected and IMAT= 1,2,5,6,7 or 8 | |
| | MAXPLY (MAX=111) defines half max. thick. | 20I4 |
| | MPLY(I) I=1,MAXPLY | 20I4 |
| 14 | Optional if unsymmetrical ply order to be specified<br>Option activated if UNSYMMETRICAL PLYORDER option selected and IMAT= 1,2,5,6,7 or 8<br>(ply order for blade half opposite GROUP 13) | |
| | LMAX (MAX=111) defines half max. thick. | 20I4 |
| | NPLY(I) I=1,LMAX | 20I4 |
| 15 | Optional if ply properties are to be read in.<br>Option activated if PROPERTY INPUT option selected | |
| | NPM | 20I4 |
| | The next two(2) cards are repeated NPM times. | |
| | NPD,KF,RHO,E1,E2,G12,NU12 | I4,6X,6E10.3 |
| | S1t,S1c,S2t,S2c,S12,A1,A2 | 8E10.3 |
| 16 | Optional if material properties are to be read in.<br>Option activated if IMAT=3 (anisotropic material) | |
| | A(I) I=1,6 RHO,AX,AY,AZ | 10E8.2 |
| | Option activated if IMAT=4 (isotropic material) | |
| | A(I) I=1,6 GE,ST,SC,SS | 10E8.2 |

END OF PREPROCESSOR DECK FOR SOLID OPTION

## SHELL/SPAR OPTION

| CARD GROUP | | FORMAT |
|---|---|---|
| 4 | IMAT,NDES,NMODE(3) | 20I4 |
| 5 | NXSECT,NXSPAR,NSPAR,NYSPC,NOPLY,NSPDES(5) | 20I4 |
| 6a | NXSPC,X, (SY(1,I),SY(2,I), I=1,5) | I4,12F6.2 |
| 6b | Repeat 6a if ZIGZAG option selected<br>NXSECT + 1 cards | |
| 7 | Option activated if CONE ANGLE option selected<br>ALPHA(1,1),ALPHA(1,2),ALPHA(1,3),<br>ALPHA(2,1),ALPHA(2,2),ALPHA(2,3),<br>ALPHA(3,1),ALPHA(3,2),ALPHA(3,3) | 10F8.2 |
| 8 | Optional if composite material is to be selected from DATABANK.<br>Option activated if IMAT=1,2,5,6,7 or 8<br>PLY DESCRIPTIONS | |
| | PERT(I) I=1,6 | 8F10.4 |
| | CODES(I) I=1,6 | A4,1X,A4,1X,4F10.4 |
| | Two(2) cards are required for each ply description<br>(NDES in Card Group 4, MAX=40)<br>Ply designation numbers are assigned in the order in which the ply descriptions are listed.<br>NOTE: For ply layers for which properties are input. Select PROPERTY INPUT option and set CODES(1)=T300 and CODES(2)=SPOX | |
| 9 | Optional if ply order to be specified<br>Option activated if PLYORD option selected and IMAT= 1,2,5,6,7 or 8 | |
| | MAXPLY (MAX=111) defines half max. thick. | 20I4 |
| | MPLY(I) I=1,MAXPLY | 20I4 |
| 10 | LSECT(1),LSECT(2) | 20I4 |

## SHELL/SPAR OPTION

| CARD GROUP | | FORMAT |
|---|---|---|
| | **PRESSURE SURFACE DATA (11 & 12)** | |
| 11 | MSECT(J,1) J=1,LSECT(1) | 20I4 |
| 12 | X,Y,Z,THK,PRES,TEMP<br>LSECT(1) blocks each with MSECT(J,1) cards<br>LSECT(1) MAX=10, MSECT(J,1) MAX=30 | 8F10.2 |
| | **SUCTION SURFACE DATA (13 & 14)** | |
| 13 | MSECT(J,2) J=1,LSECT(2) | 20I4 |
| 14 | X,Y,Z,THK,PRES,TEMP<br>LSECT(2) blocks each with MSECT(J,2) cards<br>LSECT(2) MAX=10, MSECT(J,2) MAX=30 | 8F10.2 |
| 15 | Optional if ply properties are to be read in.<br>Option activated if PROPERTY INPUT option selected | |
| | NPM | 20I4 |
| | The next two(2) cards are repeated NPM times. | |
| | NPD,KF,RHO,E1,E2,G12,NU12 | I4,6X,6E10.4 |
| | S1t,S1c,S2t,S2c,S12,A1,A2 | 8E10.4 |
| 16 | Optional if material properties are to be read in.<br>Option activated if IMAT=3 (anisotropic material) | |
| | A(I) I=1,6 RHO,AX,AY,AZ | 10E8.2 |
| | Option activated if IMAT=4 (isotropic material) | |
| | A(I) I=1,6 GE,ST,SC,SS | 10E8.2 |

END OF PREPROCESSOR DECK FOR SHELL/SPAR OPTION

## POSTPROCESSOR OPTION

| CARD GROUP | | FORMAT |
|---|---|---|
| 4 | KSMF,NXSECT,NSPAR | 20I4 |
| * 5 | Optional for processing of NASTRAN dynamic output<br>Option activated if DYNAMIC OUTPUT option selected | |
| | NPTS,NELTS,NTIMES,NCYC | 20I4 |
| | TIMES(I), I=1,NTIMES | 12F6.2 |
| | MELTS(I), I=1,NELTS | 20I4 |
| | MPTS(I), I=1,NPTS | 20I4 |
| 6 | Optional for limiting nodal data output<br>Option activated if PRTOUT option is <u>not</u> selected<br>Ten sets of nodes may be specified. | |
| | NPRT(1,I),NPRT(2,I) I=1,10 | 20I4 |
| | If no output is desired a blank card is required | |
| 7 | Add NASTRAN element stress output in the format generated by a NASTRAN punch request.<br><br>A user designated temporary file is expected here. The NASTRAN punch file containing stress output is written to FORTRAN unit 7 for MSC/NASTRAN and FORTRAN unit 1 for RPK/NASTRAN. | |

END OF POSTPROCESSOR DECK

* Not recommended for VERSION 1.2 (Untested option)

# PROGRAM OPTION CARDS

There are five(5) primary option cards used in the input deck to control COBSTRAN.

PREPROCESSOR
POSTPROCESSOR
SOLID BLADE
SHELL/SPAR
ENDOPTION

PREPROCESSOR or POSTPROCESSOR determine if COBSTRAN is to generate a NASTRAN bulkdata deck or to process the stress output from NASTRAN.

SOLID BLADE or SHELL/SPAR determine the type of mesh and model to be generated by COBSTRAN.

ENDOPTION is required to designate the end of the option deck.

All other cards

| | |
|---|---|
| BIDE | MSC NASTRAN |
| CONE ANGLE | NASMIN |
| COSMIC NASTRAN | PLYORDER |
| DIAGNOSTIC= | PRESSURE |
| DUMP | PROFILE |
| ECHO | PROPERTY INPUT |
| EZREAD | PRTOUT |
| HOLLOW | TEMPERATURE |
| MODAL STRESS | TITLE= |
| MPLOTS | UNSYMMETRICAL PLYORDER |
| MSCMIN | ZIGZAG |

NOTE: Only the first four characters of the Option Cards are necessary. An equals sign is required when shown.

BIDE

USAGE ---- PREPROCESSOR and POSTPROCESSOR
SOLID BLADE and SHELL/SPAR options

This option indicates that the interply layer distortion energy coefficients $H_j$ will be calculated for each ply.

If BIDE is not present $H_j = 0.0$.

## CONE ANGLE

USAGE ---- PREPROCESSOR
SHELL/SPAR option only

This option is used to transform a blade defined in a local coordinate system into a structural or rotational coordinate system. A wind turbine blade is normally mounted at an angle out of the plane of rotation to compensate for aerodynamic forces.

Input values are in degrees and are defined as follows;

ALPHA(1,1) ---- angle between blade x-axis and system x-axis

ALPHA(1,2) ---- angle between blade x-axis and system y-axis

ALPHA(1,3) ---- angle between blade x-axis and system z-axis

ALPHA(2,1) ---- angle between blade y-axis and system x-axis

ALPHA(2,2) ---- angle between blade y-axis and system y-axis

ALPHA(2,3) ---- angle between blade y-axis and system z-axis

ALPHA(3,1) ---- angle between blade z-axis and system x-axis

ALPHA(3,2) ---- angle between blade z-axis and system y-axis

ALPHA(3,3) ---- angle between blade z-axis and system z-axis

COSMIC NASTRAN

USAGE ---- PREPROCESSOR
SOLID BLADE and SHELL/SPAR options

This option indicates that the finite element model generated by COBSTRAN will be written to the temporary file designated by the user as FORTRAN unit KBULK and the format will be in accordance with the following;

| | | | |
|---|---|---|---|
| GRID | CTRIA2 | PTRIA2 | MAT1 |
| TEMP | CQUAD2 | PQUAD2 | MAT2 |
| PLOAD | | | |

If IMAT = 5 or 6 the format of the following connectivity and property cards will be used.

| | |
|---|---|
| CTRIA1 | PTRIA1 |
| CQUAD1 | PQUAD1 |

Material property subroutine NASMAT will be used if this option is active.

DIAGNOSTIC=

. USAGE ---- SOLID BLADE and SHELL/SPAR options

NOTE: For debugging purposes only

The use of this option allows for evaluating selected subroutines according to the diagnostic numbers which follow the equal sign on the option DIAG line. This turns on the diagnostic print option in the corresponding subroutines. Presently the diagnostic output is designated to FORTRAN unit 6, the usual write unit. This output can be directed to other units by changing the value of KDIAG in subroutine CINIT.

This feature currently exists in the following subroutines which are listed with their corresponding diagnostic number.

| | |
|---|---|
| CSREAD | 3 |
| FFREAD | 18 |
| SPRSET | 45 |
| TBGRD | 47 |
| TBG01 | 48 |
| WREAD | 54 |
| WINPUT | 55 |
| WSPAR | 56 |
| WROTAT | 58 |

DUMP

USAGE ---- SOLID BLADE and SHELL/SPAR options

This option will print out the internal databank values for the fiber constituent properties, matrix constituent properties and correlation coefficients from the COBSTRAN internal databank. Values for the plies called in the preprocessor phase will be the only ones printed. This option is useful for preparation of an external databank when the user wants to tailor the properties for a particular application.

## ECHO

USAGE ---- SOLID BLADE and SHELL/SPAR options

This option provides a reflection of the input dataset to COBSTRAN prior to interpretation by COBSTRAN.

ENDOPTION

USAGE ---- ALL options

This option indicates the end of the option selection and must be present.

ENDPARAM

USAGE ---- ALL options

This card indicates the end of parameter selection and must be present if the EZREAD option is used. This does not represent an option selection itself but is used to indicate the end of parameter input when the EZREAD option is selected. Parameters follow the ENDOPTION card and are ended by this ENDPARAM card.

EZREAD

USAGE ---- SOLID BLADE and SHELL/SPAR options

This option enables a user-friendly input format for COBSTRAN parameters as indicated below.

Parameters read by this option are those designated in CARD GROUPS 4 thru 8 SOLID option only. Default for all parameters is zero. At least four characters must be used for each name.

Therefore;

IU --> IUXX or SPAN
JU --> JUYY or CHORD

Input Format Sample

```
ENDOPTION
          IMAT =  2
          SPAN =  15
          XBEG =  2.5
          MSECT = 4 4 4 6 7 8 8
ENDPARAM
```

MSECT = 3(4) 6 7 2(8)   produces   4 4 4 6 7 8 8

Parameter input must end with an ENDPARAM card.

CARD GROUPS 4 thru 8 must be removed from the input deck.

This option also activates a free-field input format for all remaining Card Groups. The user should follow the rules of FORTRAN 77 for this input.

HOLLOW

- USAGE ---- PREPROCESSOR
  SOLID BLADE option only

This option indicates that some node points have hollow cores and a "hollow" type material will fill that cavity.

In Card Group 11 the PERT and CODES arrays are used to designate the number of node points to be modified and the fill material to be used.

Card Group 12 contains the node points and their respective wall thicknesses.

The maximum number of plies for each material is based on a percentage of the wall thickness and plies needed to fill that thickness.

For other nodes the maximum number of plies of each material is used starting at the surface until the thickness is attained.

At selected grid points the wall thickness is used and the remaining thickness is composed of the last material specified.

NOTE: a) Not compatible if ply order is specified.

b) The blade layup is assumed symmetric.

c) The use of HOLO/HOLO plies generally precludes the use of this option.

MODAL STRESS OUTPUT

USAGE ---- PREPROCESSOR
SOLID BLADE and SHELL/SPAR options

This option indicates that the stress output for postprocessing will be stresses generated from the normalized eigenvectors in a NASTRAN modal analysis.

The subcases/modes to be evaluated by the COBSTRAN postprocessor are designated in the array NMODE in Card Group 4. A maximum of three modes may be evaluated.

This option is used to calculate relative ply stresses and strains in the surface layers resulting from the specified vibration mode shapes. These relative values are used to determine the placement of strain gages and the evaluation of gage readings during dynamic testing of the blades.

MPLOTS

USAGE ---- PREPROCESSOR
SOLID BLADE and SHELL/SPAR options

This option will cause the generation of a NASTRAN bulk data file containing 'PLOTEL' cards to generate an undeformed model plot. This file will be written to FORTRAN unit KPLOT.

This option is useful in utilizing NASTRAN plotting capability for generating undeformed plots of COBSTRAN generated models for other finite element codes when other plotting capability is not available.

MSCMIN

USAGE ---- PREPROCESSOR
SOLID BLADE option only

This option indicates that a MSC NASTRAN bulk data file is available and the user wants to reproduce the model using composites from the DATABANK. COBSTRAN interprets a MSC NASTRAN bulk data deck containing GRID and CTRIA3 or CQUAD4 cards and substitutes the corresponding values into COBSTRAN arrays GNP and KEI. The NASTRAN deck should not contain more than 504 grid points or 910 elements but the actual grid point and element numbers may exceed these values.

The same connectivity and mesh will be regenerated by COBSTRAN. The nodal thicknesses used to evaluate the nodal properties and number of plies at each node are generated by reading the node thicknesses on the CTRIA3 or CQUAD4 continuation card which must follow the corresponding CTRIA3 or CQUAD4 card.

New MAT2 cards will be generated for this model according to the user designated plies and layup.

Eliminate Card Groups 8-9-10 and put MSC NASTRAN bulk data deck ending with the ENDDATA card at the end of the preprocessing deck.

This option is useful for converting models from MSC NASTRAN to COSMIC NASTRAN by selecting the COSMIC NASTRAN option for output.

MSC/NASTRAN

USAGE ---- PREPROCESSOR
SOLID BLADE and SHELL/SPAR options

This option indicates that the finite element model generated by COBSTRAN will be written to the temporary file designated by the user as FORTRAN unit 54 and the format will be in accordance with the following;

| | | | |
|---|---|---|---|
| GRID | CTRIA3 | PSHELL | MAT1 |
| TEMP | CQUAD4 | | MAT2 |
| PLOAD | | | |

Material property subroutine NASMAT will be used if this option is active.

## NASMIN

USAGE ---- PREPROCESSOR
SOLID BLADE option only

This option indicates that a COSMIC NASTRAN bulk data file is available and the user wants to reproduce the model using composites from the DATABANK. COBSTRAN interprets a COSMIC NASTRAN bulk data deck containing GRID, CTRIA2, PTRIA2, CQUAD2 and PQUAD2 cards and substitutes the corresponding values into COBSTRAN arrays GNP and KEI. The NASTRAN deck should not contain more than 504 grid points or 910 elements but the actual grid point and element numbers may exceed these values.

The same connectivity and mesh will be regenerated by COBSTRAN. The nodal thicknesses used to evaluate the nodal properties and number of plies at each node are generated by averaging the element thicknesses for each node.

New MAT2 cards will be generated for this model according to the user designated plies and layup.

Eliminate Card Groups 8-9-10 and put COSMIC NASTRAN bulk data deck ending with the ENDDATA card at the end of the preprocessing deck.

This option is useful for converting models from COSMIC NASTRAN to MSC/NASTRAN by selecting the MSC/NASTRAN option for output.

PLYORDER

USAGE ---- PREPROCESSOR
SOLID BLADE and SHELL/SPAR options

COBSTRAN builds a composite blade model by defined patches over the surface of the blade and through the thickness producing an integrated lamination model of the entire blade (Figure 10). Each patch is referred to by a designation number determined by the order in which it is defined in Card Group 11 of the SOLID option and Card Group 8 of the SHELL/SPAR option.

Under the SOLID BLADE option this option indicates that the user will provide as input in Card Group 13 the order of the ply layup using the ply designation numbers (see Card Group 11) starting at the outer surface on the positive Z side and ending at the mid-thickness line.

Under the SHELL/SPAR option this option indicates that the user will provide as input in Card Group 9 the order of the ply layup using the ply designation numbers (see Card Group 8) starting at the outer surface of the blade shell and ending at the mid-thickness line. Layup applies only to the blade shell elements. Only one ply type may be designated for each spar. A sufficient number of these plies will be generated to fill the spar thickness and their orientation will be along the blade x-axis. The plies used for each spar are indicated in NSPDES of card group 5 by ply designation number.

For both options, sufficient layers should be designated to fill half of the thickest node. COBSTRAN will assume a symmetric ply layup and will fill all nodes starting at the outer surface to the half-thickness line and then apply symmetry.

NOTE: A zero ply designation number may be included within the ply layup order. This feature allows for the removal or addition of plies in the layup without regenerating the entire order.

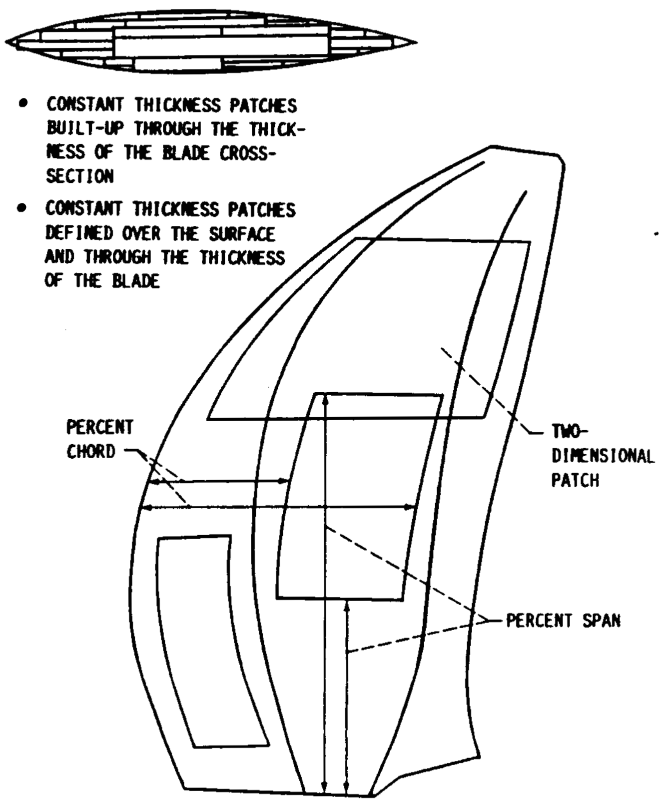



FIGURE 10. - COBSTRAN LAMINATED PLATE MODEL.

POSTPROCESSOR

USAGE ---- SOLID BLADE and SHELL/SPAR options

This option indicates that the card groups that follow are in the order required for postprocessing the data either in the SOLID BLADE or the SHELL/SPAR option format.

A minimum of postprocessing options are required because all necessary data is retained in the temporary files created in pre-processing.

If NASTRAN was the finite element analysis method used the stress output file must be in the NASTRAN punch format. COSMIC NASTRAN and MSC/NASTRAN generate the same format for the punch file.

PREPROCESSOR

USAGE ---- SOLID BLADE and SHELL/SPAR options

This option indicates that the card groups that follow are in the order required for preprocessing the data either in the SOLID BLADE or the SHELL/SPAR option format.

PRESSURE

USAGE ---- PREPROCESSOR
SOLID BLADE and SHELL/SPAR options

This option indicates that nodal pressure data are available on the grid point input data cards of Card Group 9 under the SOLID BLADE option and Card Groups 12 & 14 under the SHELL/SPAR option.

These pressures will be interpolated on both surfaces. The resultant on each element will be output on a NASTRAN "PLOAD" bulk data card with SID=4.

Note: A blank will indicate zero pressure for interpolation purposes.

PROFILE

USAGE ---- PREPROCESSOR
SHELL/SPAR option only

Without the presence of this option card the nodal input points are assumed to be on the outer surface of the shell. COBSTRAN will then correct the grid point position by moving them to the mid-wall position in a direction normal to the surface.

This option will suppress this mid-wall correction and will retain the grid points on the external profile of the shell.

PROPERTY INPUT

- USAGE ---- PREPROCESSOR
  SOLID BLADE and SHELL/SPAR options

This option indicates that the unidirectional layer properties are known and will be user-supplied input.

For the ply designation to be modified CODES(1) = T300 and CODES(2) = SPOX with the desired properties indicated by ply designation number in Card Group 15 of both the SOLID and SHELL/SPAR options. Internally COBSTRAN modifies the T300 fiber properties and the SPOX matrix properties to generate the specified layer properties.

The user should check these resultant layer properties as generated in preprocessing, comparing output with input, and make adjustments to the input as needed.

This procedure is based on modifying a graphite/epoxy ply and may not be suitable for other materials. A preferred method would be to create an external databank with properties of similar materials tailored to the specific problem.

PRTOUT

USAGE ---- PREPROCESSOR and POSTPROCESSOR
SOLID BLADE and SHELL/SPAR options

This option is used to control the printed output from the COBSTRAN program.

For preprocessing, the absence of this option card will eliminate the nodal property output but retain essential composite modeling information.

For postprocessing, the absence of this option card will require the user to specify node ranges at which output is desired. Ten separate node groups may be specified.

The presence of this option card in pre- and postprocessing will print all output from COBSTRAN.

SOLID BLADE

USAGE ---- PREPROCESSOR and POSTPROCESSOR options

This option indicates that the card groups that follow are in the order required for preprocessing the input data for a solid or hollow blade.

The maximum number of plies for each material is based on a percentage of the thickest node or, if the ply order is specified, is based on the node thickness and plies needed to fill that thickness.

For other nodes the maximum number of plies of each material is used starting at the surface until the thickness is attained.

SHELL/SPAR

USAGE ---- PREPROCESSOR and POSTPROCESSOR options

This option indicates that the card groups that follow are in the order required for preprocessing the data for a blade of thin shell construction separated by plate type spars at user selected nodes.

TEMPERATURE

USAGE ---- PREPROCESSOR
SOLID BLADE and SHELL/SPAR options

This option indicates that nodal temperature data are available on the grid point input data cards of Card Group 9 under the SOLID BLADE option and Card Groups 12 & 14 under the SHELL/SPAR option.

These temperatures will be interpolated on both surfaces. The resultant at each node will be output on a NASTRAN "TEMP" bulk data card with SID=3.

Note: A blank will indicate zero temperature for interpolation purposes.

TITLE=

USAGE ---- PREPROCESSOR and POSTPROCESSOR
SOLID BLADE and SHELL/SPAR options

A maximum of 5 title lines are allowed.

Each title line may have a maximum of 74 characters following the equal sign.

UNSYMMETRICAL PLYORDER

- USAGE ---- PREPROCESSOR
  SOLID BLADE option only

This option indicates that the ply order is not symmetric and that Card Group 14 will be provided by the user to designate the ply order of the opposite half of the blade starting at the outer surface on the negative Z side.

COBSTRAN will fill each node from the outer surface to the node half-thickness line.

When this option is activated the PLYORDER option is automatically activated.

ZIGZAG

USAGE ---- PREPROCESSOR
SHELL/SPAR option only

This option indicates that all of the spars will not be modeled normal to the mid-chord line. Therefore, spar locations relative to the leading edge will be required for both upper and lower surface of the shell structure.

User Controlled Parameters

Card Group 4 -- Preprocessing SOLID and SHELL/SPAR options

Purpose Select the format for the NASTRAN material cards.

IMAT=1 Anisotropic material properties are based on reduced axial stiffness. A separate MAT2 card is generated for each element.

IMAT=2 Anisotropic material properties are based on reduced bending stiffness. A separate MAT2 card is generated for each element.

IMAT=3 Anisotropic material properties are input in Card Group 16. An identical MAT2 card is generated for each element.

IMAT=4 Isotropic material properties are input in Card Group 16. An identical MAT1 card is generated for each element.

IMAT=5 Anisotropic material properties are based on reduced axial stiffness and reduced bending stiffness. Two separate MAT2 cards are generated for each element.

IMAT=6 Anisotropic material properties are based on reduced axial stiffness, reduced bending stiffness and transverse shear stiffness. Three separate MAT2 cards are generated for each element.

IMAT=7 Anisotropic material properties are based on axial stiffness, bending stiffness and coupling stiffness. Three separate MAT2 cards are generated for each element.

IMAT=8 Anisotropic material properties are based on axial stiffness, bending stiffness, transverse shear stiffness and coupling stiffness. Four separate MAT2 cards are generated for each element.

Card Group 6 -- Preprocessing SOLID option only

Purpose Select the format for blade coordinate input.

```
IGRD=1  Divide the X-axis into equal increments
        according to IU and the Y-axis into equal
        increments according to JU -- Interpolate
        other values using subroutine INTRPL
        IU = Number of desired X sections output
             Max = 36
        JU = Number of desired Y points per section
             output.  Max = 14
             (JU must be an odd value if MESH = 1)
        NSECT = Number of X sections input -- Max = 30
        MSECT(J) = Number of Y points input for each
                   X section -- Max = 20
        (X and Y values must be in ascending order)

IGRD=2  Use the input increments of X and Y as final values
        IU = Number of X sections of input -- Max = 36
        JU = 1    IF MESH = 2
        JU = MSECT(J)  IF MESH = 1 or 4
        NSECT = Number of X sections input -- Max = 36
        MSECT(J) = Number of Y points input for each
                   X section -- Max = 14
           (IF MESH=1  MSECT(J) must be odd and the same
                                value for each x-section)
           (IF MESH=2  MSECT(J) may vary by one per section
           (IF MESH=4  MSECT(J) same for each section
        (Y values must be in ascending order)

IGRD=3  Same as IGRD=2 except the input values are:
        X,Y,Z,TB,TU,TL,PU,PL
        Maximum number of grid points = 504
        Maximum number of elements = 910

IGRD=4  Same as IGRD=1 except the input values are:
        X,Y,Z,TB,TU,TL,PU,PL
```

See Figure 8

Card Group 6 -- Preprocessing SOLID option only

Purpose Select the mesh pattern for a solid blade.

MESH=1 Triangular elements are generated with diagonal sides symmetric about the blade center line

MESH=2 Triangular elements are generated with diagonal sides alternating across the blade

* MESH=3 Triangular elements are generated with three corner and three mid-side nodes

MESH=4 Quadrilateral elements are generated

* Not recommended for VERSION 1.2 (Untested option)

See Figure 9

Card Group 4 -- Postprocessing SOLID and SHELL/SPAR options

Purpose Select the method used to determine the strain magnification factor.

KSMF=0 Default *

KSMF=1 Parabolic strain distribution method

KSMF=2 Daniel's indirect method

KSMF=3 Kies's two-dimensional method

KSMF=4 Linear strain distribution method

* Default uses Kies's two-dimensional method unless its value is greater than 1.5 times the Linear strain distribution method. If this is so, then the Linear strain distribution method is used.

# DATABANK

An internal databank is provided with the COBSTRAN code which contains constitutive properties of 21 fiber types, 17 matrix types and correlation coefficients for 31 fiber/matrix combinations. This property databank is provided for user information and guidance only and no responsibility is assumed by the authors as to accuracy or currency of the values. All properties are in customary U.S. units. The internal databank is listed in this section.

For a user supplied databank, a format and definition of properties is provided in this section. This databank should be maintained in a separate file which is referenced to FORTRAN unit KDBANK (Section 5 Operational Procedures). The databank must be assembled with all fiber types first, then all matrix types followed by all correlation coefficient sets.

COBSTRAN provides a hierarchial approach to databank aquisition.

a) The user supplied databank is searched for the fiber and matrix properties requested.

b) The internal databank is searched for those properties not found in the user supplied databank.

The source of the properties is indicated in the output.

The DATABANK is required if the parameter IMAT is selected as 1,2,5,6,7 or 8 (see Section 3 for IMAT options)

If only the internal databank is to be used, the user supplied databank should contain three lines with zero on each line. COBSTRAN will search this databank first. An external databank of some form is always required.

Also, an option is available in which user specified unidirectional layer properties are supplied input. COBSTRAN will modify T300 fiber properties and SPOX matrix properties generating the specified layer properties. See PROPERTY INPUT option, Section 3.

# COBSTRAN Internal Databank

## Available Fiber Properties

| Code | Type | Date | Reference |
|---|---|---|---|
| ALT6 | ISO | 8-01-83 | NO REF |
| NIKL | ISO | 8-12-83 | NO REF |
| HGLA | ISO | 10-11-83 | CROSS WEAVE FOR SR7 PROP |
| FOAM | | 8-08-83 | CROSS WEAVE FOR SR7 PROP |
| T300 | ANIS | 10-26-79 | NO REF. |
| MOD2 | ANIS | 06-15-72 | NO REF. |
| MOD1 | ANIS | 06-15-72 | NO REF. |
| HM-S | ANIS | 06-15-72 | NO REF. |
| HT-S | ANIS | 06-15-72 | NO REF. |
| AS-- | ANIS | 06-15-72 | NO REF. |
| BOR4 | ISO | 11-07-73 | NO REF. |
| SGLA | ISO | 11-07-73 | NO REF. |
| KEVL | ANIS | 11-07-73 | NO REF. |
| HV-S | ANIS | 06-15-72 | NO REF. |
| BOR5 | ISO | 04-11-74 | NO REF. |
| BOR8 | ISO | 04-11-74 | NO REF. |
| EGLA | ISO | 04-11-74 | NO REF. |
| SW4M | ISO | 02-10-75 | NO REF. |
| TITF | ISO | 01-25-77 | NO REF. |
| ADHF | ISO | 01-25-77 | NO REF. |
| HOLO | | 03-20-79 | NO REF. |

COBSTRAN Internal Databank continued

Available Matrix Properties

| Code | Type | Date | Reference |
|---|---|---|---|
| SPOX | ISO | 9-26-80 | FOR COMPOSITE PROPERTY INPUT BY USER (ORIG MOD SR2C BLADE) |
| GK60 | | 11-27-72 | |
| FOAM | | 8-08-83 | FOR SR7 MODEL (SR7A 5-23-84) |
| NIKL | | 8-12-83 | |
| EPOX | ISO | 06-15-72 | NO REF. |
| ERLA | 4617 | 06-15-72 | NO REF. |
| POLY | | 06-15-72 | NO REF. |
| ALT6 | | 11-07-73 | |
| TIT6 | | 11-07-73 | MAT.ENG.1967 |
| EPOC | | 11-12-73 | NO REF. |
| SSAL | | 11-12-73 | MAT.ENG.1967 |
| GV60 | | 11-27-72 | |
| PMRP | | 06-20-74 | |
| BERY | | 07-10-74 | |
| NM40 | | 02-10-75 | |
| FMTH | | 01-25-77 | MFCA DATA |
| HOLO | | 03-20-79 | NO REF. |

COBSTRAN Internal Databank continued

Available Fiber/Matrix Combinations

| Fibe/Matr | Date | Reference |
|---|---|---|
| T300/SPOX | 9-26-80 | FOR COMPOSITE PROPERTY INPUT BY USER |
| T300/EPOX | 10-26-79 | |
| ALT6/ALT6 | 8-01-83 | |
| NIKL/NIKL | 8-12-83 | |
| HGLA/EPOX | 10-11-83 | CROSS WEAVE FOR SR7 PROP |
| FOAM/FOAM | 8-08-83 | |
| HT-S/GK60 | 11-27-72 | |
| MOD1/EPOX | 06-15-72 | |
| MOD2/EPOX | 06-15-72 | |
| MOD2/POLY | 06-15-72 | |
| HM-S/EPOX | 06-15-72 | |
| HT-S/EPOX | 06-15-72 | |
| MOD1/POLY | 06-15-72 | |
| HT-S/POLY | 06-15-72 | |
| BOR4/EPOX | 11-07-73 | |
| SGLA/EPOX | 11-07-73 | |
| KEVL/EPOC | 11-12-73 | |
| HV-S/GV60 | 11-27-72 | |
| HT-S/PMRP | 06-20-74 | |
| BOR4/ALT6 | 11-07-73 | |
| KEVL/TIT6 | 07-10-74 | |
| MOD2/BERY | 07-10-74 | |
| BOR5/EPOX | 02-04-75 | |
| KEVL/EPOX | 02-04-75 | |
| SW4M/NM40 | 02-10-75 | |
| HERC/SSAL | 02-04-75 | |
| BOR5/ALT6 | 01-25-77 | |
| TITF/TIT6 | 01-25-77 | |
| ADHF/FMTH | 01-25-77 | |
| HERC/EPOX | 01-25-77 | |
| HOLO/HOLO | 03-20-79 | |

## User Supplied Databank Format

### Fiber Properties

| | |
|---|---|
| NDUM1 (number of fiber data sets) | I2 |
| The following six lines are repeated NDUM1 times. | |
| DUN1 (name of fiber) | A4 |
| NDUN1,DUN2 (No. of fibers per bundle, fiber diameter) | I6,F10.3 |
| NDUM2 (No. of temp data sets per fiber) | I2 |
| TEMP,RHO,E11,E22,NU12,NU23,G12,G23, | 8F10.3 |
| ALPHA11,ALPHA22,K11,K22,HC,S11t,S11c,S22t, | 8F10.3 |
| S22c,S12s,S23s | 8F10.3 |

| | | |
|---|---|---|
| TEMP | Temperature at which data determined | °F |
| RHO | Weight density | $lb/in^3$ |
| E11 | Modulus tension | $lb/in^2$ |
| E22 | " transverse | " |
| NU12 | Poisson's ratio | |
| NU23 | " ratio | |
| G12 | Shear modulus | $lb/in^2$ |
| G23 | " " | " |
| ALPHA11 | Thermal expansion coefficient | in/in/°F |
| ALPHA22 | " " " | " |
| K11 | " conductivity | BTU/hr $ft^2$ °F/in |
| K22 | " " | " |
| HC | Heat capacity | BTU/lb °F |
| S11t | Strength-tension | $lb/in^2$ |
| S11c | " compression | " |
| S22t | " tension | " |
| S22c | " compression | " |
| S12s | " shear | " |
| S23s | " " | " |

## User Supplied Databank Format continued

### Matrix Properties

| | |
|---|---|
| NDUM1 (No. of matrix data sets) | I2 |
| The following four lines are repeated NDUM1 times | |
| DUN1 (Name of matrix) | A4 |
| NDUM2 (No. of temp data sets per matrix) | I2 |
| TEMP,RHO,E,NU,ALPHA,Km,HC,Kv, | 8F10.3 |
| St,Sc,Ss,SIGMAt,SIGMAc,SIGMAs,SIGMAtor | 8F10.3 |

| | | |
|---|---|---|
| TEMP | Temperature at which data determined | °F |
| RHO | Weight density | lb/in³ |
| E | Modulus | lb/in² |
| NU | Poisson's ratio | |
| ALPHA | Thermal expansion coefficient | in/in/°F |
| Km | " conductivity | BTU/hr ft² °F/in |
| HC | Heat capacity | BTU/lb °F |
| Kv | Thermal conductivity (void) | BTU/hr ft² °F/in |
| St | Strength-tension | lb/in² |
| Sc | " compression | " |
| Ss | " shear | " |
| SIGMAt | Strain-tension | " |
| SIGMAc | " compression | " |
| SIGMAs | " shear | " |
| SIGMAtor | " torsion | " |

User Supplied Databank Format continued

Correlation Coefficients

| | |
|---|---|
| NDUM1 (No. of C/C data sets) | I2 |

The following six lines are repeated NDUM1 times.

| | |
|---|---|
| DUN1,DUN2 (Fiber name/Matrix name) | A4,1X,A4 |
| Bf,Bm,B'f,B'm,B"f,B"m, | 8F10.3 |
| Bfb,Bmb,Bk1,Bk2,Bk3,Bkv, | 8F10.3 |
| Bft,Bfc,Bmt,Bmc,B22t,B22c, | 8F10.3 |
| B12s,B23s,a1,a2,Bdel,Bt, | 8F10.3 |
| K'112tt,K'112ct,K'112cc,K'112tc,Bh | 8F10.3 |

| | |
|---|---|
| a1,a2 | Coefficients for alternate method to compute ply longitudinal compressive strength S111cd = a1 * (S112s) + a2 |
| Bdel | Interply delamination limit strain |
| Bf-Bm | Extensional moduli and Poisson's ratio correlation with measured values |
| B'f-B'm | Ply shear moduli G112 & G113 correlation |
| B''f-B''m | Ply shear modulus G123 correlation |
| Bfb-Bmb | |
| Bfc-Bmc | Longitudinal compressive strength correlation |
| Bft-Bmt | Longitudinal tensile strength correlation |
| Bh | |
| Bt | Ratio of thickness-to-width of the rectangle formed by an in-situ end or tow of fibers |
| Bkv | Matrix void conductivity correlation |
| Bk1 | Ply K111 conductivity correlation |
| Bk2 | Ply K122 conductivity correlation |
| Bk3 | Ply K133 conductivity correlation |
| B22c | Transverse compressive strength correlation |
| B22t | Transverse tensile strength correlation |
| B12s | Intralaminar shear strength correlation |
| B23s | Transverse shear strength correlation |

## User Supplied Databank Format continued

### Correlation Coefficients continued

Combined-stress strength correlation

| | |
|---|---|
| K'112tt | Tension-tension |
| K'112ct | Compression-tension |
| K'112cc | Compression-compression |
| K'112tc | Tension-compression |

# OPERATIONAL PROCEDURES

## Allocation of COBSTRAN Data Files

The following FORTRAN I/O units are initially programmed in Subroutine CINIT. These may be reassigned according to site requirements by modifying this subroutine.

| Code | FORTRAN Unit No. | File contents |
|---|---|---|
| KREAD | 5 . . . | Input (read) unit |
| KOUT | 6 . . . | Output (write) unit |
| KDIAG | 6 . . . | Diagnostic output (write) unit |
| KDES1 | 52 . . . | THERMO, MDES, THHF, NLEP |
| KKEI | 53 . . . | KEI, CODES, FP, MP, CORC, DF, NF, NT, NP, NE, NPAST, NOPLY, NMODE, MESH, PRES, NYPTS, GNP, PROT, NPD |
| KBULK | 54 . . . | COBSTRAN generated finite element bulk data |
| KTTAB | 57 . . . | TTAB (Preprocessing SHELL/SPAR option)<br>SHL (Postprocessing SOLID BLADE option) |
| KDES2 | 58 . . . | THERMO, MDES, THHF, NLEP |
| KPROP1 | 59 . . . | EP, THP, THF, AS, CS, BS, RA, RB, DENS |
| KGNP | 60 . . . | GNP, IGRD, IU, JU, MSECT |
| KDBANK | 61 . . . | DATABANK (read) unit |
| KPROP2 | 62 . . . | EP, THP, THF, AS, CS, BS, RA, RB, DENS |
| KREFL | 63 . . . | For input dataset reflection |
| KPLOT | 64 . . . | NASTRAN PLOTEL bulk data |

Note: For the SHELL/SPAR option Unit KDES2 and Unit KPROP2 are overwritten during each cycle and Unit KDES1 contains the full version of Unit KDES2 and Unit KPROP1 contains the full version of Unit KPROP2. For postprocessing, files KDES1, KKEI and KGNP from preprocessing must be available to COBSTRAN in addition to NASTRAN stress output in the punched format.

CRAY X-MP Procedure

UNICOS 3.0 CFT77

File Assignments and Network Queuing System (NQS) Deck Set-up

A typical set-up for executing COBSTRAN on the CRAY X-MP UNICOS 3.0 is shown. COBSTRAN input files are fetched from the user's VM account by specifying file name, file type, and address by mini-disk number.

```
# USER=userid   PW=password
# QSUB -r           PLAT05          # job name
# QSUB -lM 1.0mw                    # central memory
# QSUB -eo                          # combine stderr and stdout
# QSUB -lT 00:01:00                 # set CPU time limit seconds
cd $HOME
set -xk
fetch fort.05 -mUX -t'fn=PREP1,ft=DEMO,addr=192'
touch fort.06
touch fort.54
fetch fort.61 -mUX -t'fn=DBANK0,ft=DEMO,addr=192'
/aerospace/smaiello/cob88x.abs < fort.05
touch fort.52
touch fort.53
touch fort.60
fetch nasdeck -mUX -t'fn=NAST1,ft=DEMO,addr=192'
dispose fort.06 -mUX -t'fn=PLAT05,ft=listing,addr=191'
cat fort.54 >> nasdeck
touch fort.01
touch fort.10
rpknast in=nasdeck out=nastout
dispose nastout -mUX -t'fn=nastran,ft=listing,addr=191'
dispose fort.10 -mUX -t'fn=nastran,ft=plotfil,addr=191'
fetch postdk -mUX -t'fn=NAST1,ft=DEMO,addr=192'
cat fort.01 >> postdk
ln postdk fort.05
dispose fort.10 -mUX -t'fn=PLAT05,ft=plotrpk,addr=191'
/aerospace/smaiello/cob88x.abs < fort.05
dispose fort.06 -mUX -t'fn=PLAT05,ft=listing,addr=191'
rm fort.*
```

# COBSTRAN DICTIONARY

If IMAT=3

| | | |
|---|---|---|
| A(1) | REAL | G11--\| Symmetric stress/strain relationships |
| A(2) | REAL | G12 |
| A(3) | REAL | G13 |
| A(4) | REAL | G22 |
| A(5) | REAL | G23 |
| A(6) | REAL | G33--\| |

If IMAT=4

| | | |
|---|---|---|
| A(1) | REAL | E-Youngs modulus |
| A(2) | REAL | G-Shear modulus |
| A(3) | REAL | NU-Poisson's ratio |
| A(4) | REAL | RHO-Mass density |
| A(5) | REAL | Thermal expansion coefficient |
| A(6) | REAL | Thermal expansion ref. temperature |
| | | |
| AB | REAL | Analysis stiffness matrix |
| ALPHA | REAL | Matrix of direction angles between blade coordinate and global coordinate systems (angles in degrees) |
| ALPP | REAL | Thermal expansion coefficients |
| ANG | REAL | Ply orientation angle |
| AS | REAL | Axial stiffness matrix |
| AX | REAL | Thermal expansion coeff. vector |
| AY | REAL | Thermal expansion coeff. vector |
| AZ | REAL | Thermal expansion coeff. vector |
| A1 | REAL | Longitudinal thermal expansion coeff. |
| A2 | REAL | Transverse thermal expansion coeff. |
| | | |
| BIDE | BOOLEAN | True for interply layer effects |
| BS | REAL | Bending stiffness matrix |
| | | |
| CC | REAL | Correlation coefficients |
| CH | CHARACTER | Character string to be evaluated |
| CHORD | CHARACTER | Alternate input name for JU |
| CODES(1) | CHARACTER | Type of ply fiber |
| CODES(2) | CHARACTER | Type of ply matrix |
| CODES(3) | REAL | Ply thickness |
| CODES(4) | REAL | Void volume ratio |
| CODES(5) | REAL | Fiber volume ratio |
| CODES(6) | REAL | Ply orientation angle (Degrees) |
| CONE | BOOLEAN | True if coning angle is specified |

| | | |
|---|---|---|
| COR | REAL | Fiber/matrix correlation coefficients read from the internal databank |
| CORC | REAL | Fiber/matrix correlation coefficients |
| COSD | BOOLEAN | True for COSMIC NASTRAN deck input |
| COSMIC | BOOLEAN | Generate COSMIC NASTRAN bulk data |
| CS | REAL | Coupling stiffness matrix |
| CSFC | REAL | Combined-stress strength criterion |
| CTE11 | REAL ----\| | |
| CTE22 | REAL \|- | Ply thermal expansion coefficient |
| CTE33 | REAL ----\| | |
| DELFC | REAL | Interply delamination criterion |
| DELTA | REAL | Ply and interply layer thickness |
| DEN | REAL | Array of nodal densities |
| DENS | REAL | Ply density |
| DF | REAL | Diameter of fiber bundle |
| DISV | REAL | Array of grid point displacements |
| DISV1 | REAL | Array of grid point displacements |
| DUM | REAL | Array of nodal shear forces |
| DUMM1 | REAL | Dummy array |
| DUMMY | REAL | Dummy array |
| DUMP | BOOLEAN | True for composite databank output |
| DYNA | BOOLEAN | True if dynamic stresses from NASTRAN output are to be read into post processing |
| E1 | REAL | Longitudinal modulus |
| E2 | REAL | Transverse modulus |
| ECHO | BOOLEAN | True for input dataset reflection |
| EL11 | REAL ----\| | |
| EL22 | REAL \|- | Ply elastic constants |
| EL33 | REAL ----\| | |
| EP | REAL | Elastic property matrix |
| EPS11 | REAL ----\| | |
| EPS12 | REAL \|- | Ply applied strains |
| EPS22 | REAL ----\| | |
| EX | REAL | Thermal expansion coefficients |
| EZREAD | BOOLEAN | True for user-friendly input format |
| FC | REAL | Array of minimum ply Failure Criteria at each grid point |
| FP | REAL | Array of fiber properties read from the internal databank |
| FPT | REAL | Ply fiber properties |
| F1 | REAL | Diameter of fiber bundle DN returned to subroutine BANKRD from subroutine BANKFB |

| | | |
|---|---|---|
| GA | REAL | Coordinates of point A |
| GB | REAL | Coordinates of point B |
| GE | REAL | Structural element damping coefficient |
| GNP | REAL | Nodal coordinates,thicknesses, temperatures and pressures |
| G12 | REAL | Shear modulus |
| GL12 | REAL ----\| | |
| GL13 | REAL \|- | Ply elastic constants |
| GL23 | REAL ----\| | |
| HFC | REAL | Hoffman's failure criterion |
| HHCL | REAL | Ply heat capacity |
| HK11 | REAL ----\| | |
| HK22 | REAL \|- | Ply heat conductivities |
| HK33 | REAL ----\| | |
| HOLD(I) | REAL | Array of user supplied material properties if IMAT = 3 or 4 |
| HOLLOW | BOOLEAN | True for hollow blade modeling |
| I | INTEGER | General do loop index<br>In MIDWAL i=1 pressure surface<br>In MIDWAL i=2 suction surface |
| ID | CHARACTER | Array of five TITLE lines |
| IF | INTEGER | Code indicating where the Fiber-Matrix-Correlation coeff. were obtained |
| IGRD | INTEGER | Grid point input options<br>See Section 3 Users Manual |
| III | INTEGER | Index of the number of the x-section NXSECT in SHELL/SPAR option |
| ILDC | REAL | Interply layer distortion energy coefficient |
| ILMFC | REAL | Interply delamination factor |
| IMAT | INTEGER | Material property generation options for NASTRAN see Section 3 Users Manual |
| IOPT | CHARACTER | Array of user selected options for summary output |
| IPAR | INTEGER | Parameter 0, 1 or 2 for free-field reading options in subroutine FFREAD |
| IT | INTEGER | Array of integer values |
| IU | INTEGER | Number of x-sections output<br>See Section 3 of the Users Manual |
| IUXX | INTEGER | Alternate for IU |
| IX | INTEGER | Ply designation number |
| I1 | REAL | Temperature of the fiber properties NT returned to subroutine BANKRD from subroutine BANKFB |

| | | |
|---|---|---|
| I2 | REAL | Number of fibers in a bundle NF returned to subroutine BANKRD from subroutine BANKFB |
| J | INTEGER | General do loop index |
| JU | INTEGER | Number of y points per x-section output See Section 3 Users Manual |
| JUYY | CHARACTER | Alternate for JU |
| K | INTEGER | General do loop index index on NNSECT (number of sections of input per press/suct SHELL/SPAR) |
| KAD | INTEGER | Equivalent to RAD and is also used to store shell grid point numbers corresponding to spar internal numbers |
| KBULK | INTEGER | COBSTRAN generated finite element bulk data FORTRAN unit |
| KDBANK | INTEGER | DATABANK (read) FORTRAN unit |
| KDES1 | INTEGER | Scratch FORTRAN unit for files; THERMO, MDES, THHF, NLEP |
| KDES2 | INTEGER | Scratch FORTRAN unit for files; THERMO, MDES, THHF, NLEP |
| KEI(I,J) | INTEGER | Element connectivities |
| KF | REAL | Apparent fiber volume ratio |
| KFB | REAL | Actual fiber volume ratio |
| KGNP | INTEGER | Scratch FORTRAN unit for files; GNP, IGRD, IU, JU, MSECT |
| KGRD | INTEGER | Grid point number at which wall thickness is defined |
| KKEI | INTEGER | Scratch FORTRAN unit for files; KEI, CODES, FP, MP, CORC, DF, NF, NT, NP, NE, NPAST, NOPLY, NMODE, MESH, PRES, NYPTS, GNP, PROT, NPD |
| KL12AB | REAL | Combined-stress strength criterion coefficient |
| KM | REAL | Apparent matrix volume ratio |
| KMB | REAL | Actual matrix volume ratio |
| KMHFOR | INTEGER | MHOST force input file |
| KOUT | INTEGER | Output (write) FORTRAN unit |
| KPLOT | INTEGER | NASTRAN PLOTEL bulk data FORTRAN unit |
| KPOST | INTEGER | Input (read) unit for postprocessing |
| KPROP1 | INTEGER | Scratch FORTRAN unit for files; EP, THP, THF, AS, CS, BS, RA, RB, DENS |
| KPROP2 | INTEGER | Scratch FORTRAN unit for files; EP, THP, THF, AS, CS, BS, RA, RB, DENS |
| KREAD | INTEGER | Input (read) unit |

| | | |
|---|---|---|
| KREFL | INTEGER | Scratch FORTRAN unit for files; For input data set echo |
| KSMF | INTEGER | Optional method for determining strain magnification factor See Section 3 Users Manual |
| KTTAB | INTEGER | Scratch FORTRAN unit for files; TTAB (Preprocessing SHELL/SPAR option) SHL (Postprocessing SOLID BLADE option) |
| KV | REAL | Void volume ratio |
| L | INTEGER | Number of points in interpolated function |
| LABEL | CHARACTER | Input line string in subroutine FFREAD |
| LDIAG | BOOLEAN | Array of logical values for diagnostics |
| LG | INTEGER | Length of character string |
| LMAX | INTEGER | Number of plies specified for opposite half of an unsymmetrical blade |
| LSC12 | REAL | Ply limiting stresses |
| LSC23 | REAL | Ply limiting stresses |
| LSC11C | REAL | Ply limiting stresses |
| LSC11D | REAL | Ply limiting stresses |
| LSC11T | REAL | Ply limiting stresses |
| LSC22C | REAL | Ply limiting stresses |
| LSC22T | REAL | Ply limiting stresses |
| LSCC13 | REAL | Ply limiting stresses |
| LSCC23 | REAL | Ply limiting stresses |
| LSCDF | REAL | Ply limiting stresses |
| LSECT(1) | INTEGER | Number of x sections of pressure surface coordinate input |
| LSECT(2) | INTEGER | Number of x sections of suction surface coordinate input |
| LSP | INTEGER | Location of the spar on the pressure and suction surfaces fron leading edge |
| LU | INTEGER | Length of arrays in subroutine FLIPIT |
| L1 | INTEGER | Input line string in subroutine FFREAD |
| MAXPLY | INTEGER | Number of plies specified for half-thickness at point of maximum blade thickness |
| MDES(I) | INTEGER | Ply order |
| MESH | INTEGER | Blade modeling technique options See Section 3 Users Manual |
| MHOST | BOOLEAN | True for MHOST structural analysis module |
| MINICH | BOOLEAN | True if MINICH element is used |
| MMM | INTEGER | Size of matrix to be inverted |
| MODES | BOOLEAN | True if NASTRAN stress output is from mode shapes |
| MP | REAL | Ply matrix properties |

| | | |
|---|---|---|
| MPLOT | BOOLEAN | True for NASTRAN PLOTEL generation |
| MPLY(I) | INTEGER | Ply order using ply designation numbers for one half blade thickness starting at the outer surface |
| MPT | REAL | Ply matrix properties |
| MSB | REAL | Applied moments at nodal points |
| MSCD | BOOLEAN | True for MSC/NASTRAN deck input |
| MSCNAS | BOOLEAN | Generate MSC/NASTRAN bulk data |
| MSECT(J) | INTEGER | Number of Y points input for each X section |
| MWSCT(J,1) | INTEGER | Number of grid points input on the pressure surface for each x section |
| MWSCT(J,2) | INTEGER | Number of grid points input on the suction surface for each x section |
| N | INTEGER | Number of points for interpolation |
| NAF | CHARACTER | Fiber name |
| NAM | CHARACTER | Matrix name |
| NAME | CHARACTER | Fiber or Matrix name |
| NA1 | CHARACTER | Fiber name |
| NA2 | CHARACTER | Matrix name |
| NCOOR(1,I) | INTEGER | Initial element number |
| NCOOR(2,I) | INTEGER | Final element number |
| NCOOR(3,I) | INTEGER | NCORDL for range of elements |
| NCORDL | INTEGER | Material coordinate system identification number |
| NCOREG | INTEGER | Number of groups of elements for which NCORDL is read as input currently NOT USED (blank or zero) |
| NCYC | INTEGER | Number of grid points to be evaluated in postprocessing |
| NDES | INTEGER | Number of ply designations (MAX=40) |
| NE | INTEGER | Number of elements |
| NELM | INTEGER | Number of elements |
| NELT | INTEGER | Number of elements in the input deck for the MSCMIN and NASMIN options |
| NELTS | INTEGER | Utilized in a discontinued option |
| NETOT | INTEGER | Total number of elements in a model using the SHELL/SPAR option |
| NF | INTEGER | Number of fibers per bundle |
| NGNP | INTEGER | Number of grid points |
| NGRD | REAL(Input) | Total number of grid points at which wall thickness will be input Maximum = 300 |
| NGRID | INTEGER | Number of grid points |
| NGROUP | INTEGER | currently NOT USED (blank or zero) |
| NLEP | INTEGER | Number of ply layers at a node |

| | | |
|---|---|---|
| NMINT | BOOLEAN | TRUE for COSMIC NASTRAN deck input |
| NMODE(I) | INTEGER | Positive integer for each mode from NASTRAN |
| NNQ | INTEGER | NYSPC + 2 |
| NNX | INTEGER | NXSECT + 1 |
| NNY | INTEGER | Number of sections to be evaluated in postprocessing |
| NODMAX | INTEGER | Grid point number of thickest point |
| NOPLY | INTEGER | Node at which ply properties are provided in output |
| NP | INTEGER | Number of grid points |
| NPAST | INTEGER | Last node of each SHELL/SPAR cycle |
| NPD | INTEGER | Ply designation number to which properties apply |
| NPLY(I) | INTEGER | Ply order using ply designation numbers for one half blade thickness starting at the outer surface except this order is for the opposite half of an unsymmetrical blade |
| NPM | INTEGER | Total number of ply types for which properties are input |
| NPRT(1,I) | INTEGER | Initial node for ply stress output |
| NPRT(2,I) | INTEGER | Final node for ply stress output |
| NPTOT | INTEGER | Total number of grid points in a model using the SHELL/SPAR option |
| NPTOT1 | INTEGER | The MHOST finite element code uses dual nodes at the intersection of the spars and outer shell in the SHELL/SPAR option. NPTOT1 = NPTOT + NP(spars) |
| NPTS | INTEGER | Number of nodal points of dynamic output |
| NSB | REAL | Applied membrane loads at nodal points |
| NSECT | INTEGER | Number of sections defining profile |
| NSPAR | INTEGER | Number of spars (SHELL=T) Max=5 |
| NSPDES | INTEGER | Spar composite designation (one for each spar) |
| NT | INTEGER | Number of temperature related fiber or matrix tables in the databank |
| NTIMES | INTEGER | Number of cycles of dynamic output |
| NU12 | REAL | Poisson's ratio |
| NUL12 | REAL ----\| | |
| NUL13 | REAL \| | |
| NUL21 | REAL \|- | Ply Poisson's ratio |
| NUL23 | REAL \| | |
| NUL31 | REAL \| | |
| NUL32 | REAL ----\| | |

| | | |
|---|---|---|
| NUML | INTEGER | Array containing element numbers of the input deck for options MSCMIN and NASMIN |
| NXSECT | INTEGER | Number of X-axis sections (SHELL=T) |
| NXSPAR | INTEGER | Number of NXSECT containing spars |
| NXSPC | INTEGER | Number of spaces to the next x section |
| NYPTS | INTEGER | Number of nodal points along the Y-axis |
| NYSPC | INTEGER | Number of spaces along the Y-axis (Must be divisible by NSPAR+1) Max=28 |
| PERT(1) | REAL | Initial thickness (percent of the thickness of each grid point) |
| PERT(2) | REAL | Final thickness (percent of the thickness of each grid point) |
| PERT(3) | REAL | Initial X-coordinate (percent span) |
| PERT(4) | REAL | Final X-coordinate (percent span) |
| PERT(5) | REAL | Initial Y-coordinate (percent chord) |
| PERT(6) | REAL | Final Y-coordinate (percent chord) |
| PIN | REAL | Geometry input (coord, press, temp) |
| PL | REAL | Grid point pressure lower surface |
| PL(1,I) | REAL | Ply void content KV |
| PL(2,I) | REAL | Ply apparent fiber content KF |
| PL(3,I) | REAL | Ply actual fiber content KFB |
| PL(4,I) | REAL | Ply apparent matrix content KM |
| PL(5,I) | REAL | Ply actual matrix content KMB |
| PL(6,I) | REAL | Ply weight density RHOL |
| PL(7,I) | REAL | Ply layer thickness TL |
| PL(8,I) | REAL | Ply and interply layer thickness DELTA |
| PL(9,I) | REAL | Interply layer distortion energy coefficient IDLC |
| PL(10,I) | REAL | Distance from bottom of composite to ply centroid ZB |
| PL(11,I) | REAL | Distance from reference plane to ply centroid ZGC |
| PL(12,I) | REAL | Angle from structural axis to composite material axis THCS (same for all plies) |
| PL(13,I) | REAL | Angle from ply material axis to composite material axis THLC |
| PL(14,I) | REAL | Angle from ply material axis to composite structural axis THLS |
| PL(15,I) thru PL(23,I) | REAL | Ply stress-strain relations SC11,SC12,SC13,SC22,SC23,SC33,SC44,SC55,SC66 |

| | | |
|---|---|---|
| PL(24,I) thru PL(26,I) | REAL | Ply thermal coeff. of expansion CTE11,CTE22,CTE33 |
| PL(27,I) thru PL(29,I) | REAL | Ply heat conductivities HK11,HK22,HK33 |
| PL(30) | REAL | Ply heat capacity HHCL |
| PL(31,I) thru PL(33,I) | REAL | Ply elastic constants EL11,EL22,EL33 |
| PL(34,I) thru PL(36,I) | REAL | Ply elastic constants GL23,GL13,GL12 |
| PL(37,I) thru PL(42,I) | REAL | Ply elastic constants NUL12,NUL21,NUL13,NUL31,NUL23,NUL32 |
| PL(43,I) thru PL(48,I) | REAL | Ply strain magnification factors SMFK22,SMFD22,SMFS22,SMFC22,SMFS12,SMFS23 |
| PL(49) | REAL | Interply delamination factor ILMFC |
| PL(50) | REAL | Ply temperature TEMPD |
| PL(51,I) thru PL(60,I) | REAL | Ply limiting stresses LSC11T,LSC11C,LSC11D,LSC22T,LSC22C, LSC12,LSC23,LSCC23,LSCC13,LSCDF |
| PL(61) | REAL | Coefficient in combined-stress-strength criterion KL12AB |
| PL(62) | REAL | Combined-stress-strength criterion CSFC |
| PL(63) | REAL | Interply delamination criterion DELFC |
| PL(64,I) thru PL(69,I) | REAL | Ply applied strains and stresses EPS11,EPS22,EPS12,SIG11,SIG22,SIG12 |
| PL(70) | REAL | Adjacent ply relative rotation RELROT |
| PL(71) | REAL | Hoffman's failure criterion HFC |
| PLYORD | BOOLEAN | True if ply order is specified |
| PM | REAL | Array of matrix properties read from the internal databank |

| | | |
|---|---|---|
| POST | BOOLEAN | True for post processing of NASTRAN output |
| PREP | BOOLEAN | True for preprocessing blade data |
| PRES | BOOLEAN | True if grid point pressure is input (SID=4 on NASTRAN PLOAD card) |
| PRES | REAL | External grid point pressure for SHELL/SPAR models |
| PROFIL | BOOLEAN | True to bypass mid-wall correction |
| PROT | BOOLEAN | True if ply properties are to be input for some ply designations |
| PRTOUT | BOOLEAN | True if extended output is desired; (EP,AS,CS,BS,THP,RA,RB) in preprocessing (Ply stresses and strains) in post processing |
| PU | REAL | Grid point pressure upper surface |
| RA | REAL | Reduced axial stiffness matrix |
| RANG | BOOLEAN | True for alternate material angle calculation algorithm |
| RAD | INTEGER | Array containing grid point numbers for the NASTRAN inpu deck for options MSCMIN and NASMIN |
| RB | REAL | Reduced bending stiffness matrix |
| RE | REAL | Array of real values |
| RELROT | REAL | Adjacent ply relative rotation |
| RHO | REAL | Mass density |
| RHOL | REAL | Ply weight density |
| RINDV | BOOLEAN | If TRUE for preprocessing, the material coordinate system designation will be set to 1 for all elements.<br>True if displacements are input to post-processing |
| RM | REAL | Reduced matrix |
| SC | REAL | Stress limit "compression" |
| SCXZ | REAL | Interply shear limiting stress x-face |
| SCYZ | REAL | Interply shear limiting stress y-face |
| SC11 | REAL | |
| SC12 | REAL | |
| SC13 | REAL | |
| SC22 | REAL | |
| SC23 | REAL | Ply stress-strain relationships (SC11 through SC66) |
| SC33 | REAL | |
| SC44 | REAL | |
| SC55 | REAL | |
| SC66 | REAL | |
| SHELL | BOOLEAN | True for shell/spar analysis |

| | | |
|---|---|---|
| SHL(1,J) | REAL | PL(7,J) Ply layer thickness |
| SHL(2,J) | REAL | PL(8,J) Ply + interply layer thickness |
| SHL(3,J) | REAL | PL(13,J) Angle from ply material axis to composite material axis |
| SHL(4,J) | REAL | PL(34,J) Ply elastic constant GL23 |
| SHL(5,J) | REAL | PL(35,J) Ply elastic constant GL13 |
| SHL(6,J) | REAL | MPT(3) Ply matrix modulus E |
| SHL(7,J) | REAL | MPT(4) Ply matrix poissons ratio NU |
| SHL(8,J) | REAL | MPT(14) Ply matrix shear strength SIGMAS |
| SIG11 | REAL ----\| | |
| SIG12 | REAL \| | \|- Ply applied stresses |
| SIG22 | REAL ----\| | |
| S11cd | REAL | Ply longitudinal compressive strength |
| S112s | REAL | Ply shear strength |
| SMF | REAL | Strain magnification factor |
| SMFC22 | REAL ----\| | |
| SMFD22 | REAL \| | |
| SMFK22 | REAL \| | \|- Ply strain magnification factors |
| SMFS12 | REAL \| | |
| SMFS22 | REAL \| | |
| SMFS23 | REAL ----\| | |
| SOLID | BOOLEAN | True for solid blade analysis |
| SPAN | CHARACTER | Alternate input name for IU |
| SPARS | BOOLEAN | True if spars are present |
| SS | REAL | Stress limit "shear" |
| ST | REAL | Stress limit "tension" |
| SY(1,I) | REAL | Spar y location from leading edge upper surface if ZIGZAG option, otherwise represents both surfaces |
| SY(2,I) | REAL | Spar thickness upper surface if ZIGZAG option, otherwise represents both surfaces |
| SY(3,I) | REAL | Spar y location from leading edge lower surface if ZIGZAG option, otherwise not used |
| SY(4,I) | REAL | Spar thickness lower surface if ZIGZAG option, otherwise not used |
| S1t | REAL | Longitudinal tensile strength |
| S1c | REAL | Longitudinal compressive strength |
| S2t | REAL | Transverse tensile strength |
| S2c | REAL | Transverse compressive strength |
| S12 | REAL | Intralaminar shear strength |

| | | |
|---|---|---|
| TB | REAL | Thickness of blade |
| TEM | BOOLEAN | True if temperatures are input (SID=3 on NASTRAN TEMP card) |
| TEMP | REAL | Temperature at grid point |
| TEMPD | REAL | Ply temperature |
| THCONN | REAL | Angle between element material and structural coordinate systems |
| THERMO(I) | REAL | Temperature of each ply layer at a given node |
| THCS | REAL | Angle from structural axes to composite material axes |
| THF | REAL | Thermal forces |
| THHF | INTEGER | Blade half-thickness at each node |
| THK | REAL | Thickness of shell |
| THLC | REAL | Angle from ply material axes to composite material axes |
| THLS | REAL | Angle from ply material axes to composite structural axes |
| THMAX | REAL | Half thickness of thickest grid point |
| THP | | Thermal property matrix |
| THWAL(I) | REAL | Wall thickness input for blade cavity analysis |
| TL | REAL | Temperature of the lower surface or thickness of ply layer |
| TTAB | REAL | Array of section coordinate data processed from PIN array (SHELL/SPAR) |
| TU | REAL | Temperature of the upper surface |
| U | REAL | Array of x-values for interpolation |
| V | REAL | Array of y-values from interpolation |
| VF | REAL | Shear forces in x and y direction |
| VFP | REAL | Derivative of shear forces VF |
| VDOT | REAL | First derivative of interpolation |
| WHAT | CHARACTER | Four character name |
| WINDML | BOOLEAN | True for shell/spar analysis |
| X | REAL | Blade station (spanwise) |
| X | REAL | X array for coordinate transformation |
| XA | REAL | X distance for coordinate translation |
| XBEG | REAL | Initial x-station for blade mesh |
| XEND | REAL | Final x-station for blade mesh |
| XINT | REAL | Dummy array for interpolation |
| XM | REAL | Array of bending moments spanwise |
| XOUT | REAL | Dummy array for interpolation |
| XX | REAL | Array for which order is reversed |

| | | |
|---|---|---|
| Y | REAL | Y coordinate |
| Y | REAL | Y array for coordinate transformation |
| YA | REAL | Y distance for coordinate translation |
| YINT | REAL | Dummy array for interpolation |
| YY | REAL | Array for which order is reversed |
| Z | REAL | Z mid-thickness coordinate |
| ZB | REAL | Distance from bottom of composite to ply centroid |
| ZGC | REAL | Distance from referance plane to ply centroid |
| ZIGZAG | BOOLEAN | True if spars not normal to mid-chord |
| ZL | REAL | Z lower coordinate |
| ZU | REAL | Z upper coordinate |

# COBSTRAN ACCESS
# on VM at
# Lewis Research Center

COBSTRAN is accessed on the VM system through the USERDISK. On VM typing USERDISK will present a list of programs and execs available to all VM IDs.

| | |
|---|---|
| COBSTRAN | accesses the COS version on the CRAY |
| COBUNIX | accesses the UNICOS version on the CRAY |

Both exec files allow the user access to the appropriate COBSTRAN program installed on the Lewis Research Center CRAY computer. CRAY control language commands are automatically generated for accessing COBSTRAN and finite element programs according to the operands selected.

OPERANDS

| | |
|---|---|
| PREP | preprocessor dataset name |
| DBANK | fiber/matrix databank dataset name |
| FEM | finite element method |
| FEDS | finite element dataset name |
| POST | postprocessing dataset name |
| OUTPUT | output dsname |
| UID | CRAY user ID |
| PSW | CRAY password |
| TOCRAY | y\|n |

PREP
: Specifies name of dataset which contains the COBSTRAN program preprocessor input excluding the databank.

DBANK
: Specifies name of dataset which contains the COBSTRAN program databank of fiber and matrix properties and correlation coefficients.

FEM
    specifies the finite element method to be used on the CRAY

| | | |
|---|---|---|
| MSC | --- for | MSC NASTRAN |
| RPK | --- for | RPK NASTRAN |
| MHOST | --- for | MHOST FE code |

FEDS
    Specifies name of the dataset which contains the input for the finite element method selected by fem.
    NOTE: For NASTRAN the dataset must end with an ENDDATA record.

POST
    Specifies name of the dataset which contains the COBSTRAN program postprocessor input.

OUTPUT
    Specifies name of the CRAY output dataset returned to the VM in the user's RDRLIST length must be less than seven characters.

UID
    specifies user's CRAY ID default UID specified in user GLOBALV LISTING file.

PSW
    specifies user's CRAY password default password specified in user GLOBALV LISTING file.

TOCRAY
    specifies submission of job to CRAY for processing Y or N. default N (job not submitted to CRAY).

## Functional Description

The COBSTRAN/COBUNIX exec will search your disks to locate a free disk number and filemode. This free disk will then be linked to a disk containing the COBSTRAN demonstration problems and EXEC files used to build the COBSTRAN deck for submission to the CRAY.

The user's disk will then be searched a second time to locate a free disk. This free disk will be set up as a temporary mini-disk and used for assembly and storage of the COBSTRAN deck with the appropriate CRAY JCL's. This file is titled CRAY RUN and the filemode will be that of the temporary mini-disk.

NOTE: This temporary mini-disk will be lost upon LOGOFF. Therefore, if the CRAY RUN file is to be saved it must be transferred elsewhere.

Prior to establishing the temporary mini-disk the user will be prompted as follows;

```
DASD xxx DEFINED 0010 CYL
DMSFOR603R FORMAT WILL ERASE ALL FILES ON DISK X(xxx)
           DO YOU WISH TO CONTINUE  ?(YES:NO)
 yes
 DMSFOR605R ENTER DISK LABEL:
 cobstr (or any label)
```

REMARKS

1) If the COBSTRAN preprocessor is used to generate a model in which isotropic material properties are given then the DBANK operand must be defaulted.

2) If only COBSTRAN preprocessing is desired for initial evaluation of a model then FEM, FEDS, and POST operands may be defaulted. For this case the finite element bulk data generated by COBSTRAN will be returned to the RDRLIST under the file name T4BULK.

3) POST must be defaulted unless FEM and FEDS are specified.

4) Suppression of submission to the CRAY is accomplished by setting TOCRAY=N. This is useful for modifying the dataset CRAY RUN prior to submission to the CRAY.

5) To set the global values for the CRAY userid and password enter:
GLOBALV SELECT COBVARS SETUP UID userid PSW password

EXAMPLE

Dataset PREP1 DEMO contains the preprocessing data setup as described in the COBSTRAN DEMONSTRATION MANUAL. Dataset DBANK1 DEMO contains the databank of fiber and matrix properties and correlation coefficients as described in the COBSTRAN DEMONSTRATION MANUAL

The COBSTRAN exec will prompt you for the appropriate filename - filetype - address as show below. If a demonstration problem on the link disk is selected filemode will be that of the free disk chosen for linking.

```
Ready; T=0.01/0.01 09:14:31
cobunix

    ENTERING THE WONDERFUL WORLD OF  C O B S T R A N
                  UNICOS VERSION

**********************************************************
*  I HAVE SELECTED YOUR UNUSED DISK -- 200  F -- FOR     *
*        LINKING TO R. AIELLO'S COBSTRAN DISK            *
*  DEMONSTRATION PROBLEMS ARE AVAILABLE ON THIS DISK     *
*    FILE TYPE = DEMO     FILE MODE = 200                *
**********************************************************

DASD 200 LINKED R/O; R/W BY SMAIELLO
F (200) R/O

**********************************************************
*   I HAVE SELECTED YOUR UNUSED DISK -- 202  H -- FOR    *
*   ASSEMBLY AND STORAGE OF THE CRAY RUN DATASET         *
*   THIS IS A TEMPORARY MINIDISK WHICH WILL BE           *
*   DELETED UPON LOGOFF                                  *
**********************************************************

DASD 202 DEFINED 0005 CYL
DMSFOR603R FORMAT will erase all files on disk H(202). Do you wish to continue?
Enter 1 (YES) or 0 (NO).
1
DMSFOR605R Enter disk label:
raa202
Formatting disk H
5 cylinders formatted on H(202)
202 replaces H (202)
```

```
                WELCOME TO COBSTRAN ...
PLEASE ENTER VARIABLES AS SHOWN IN ( ) WHEN PROMPTED:
OR ENTER QUIT TO CANCEL THIS TASK
OR RETURN IF NOT APPLICABLE

 *** NOTE: ADDR IS THE MINIDISK NUMBER ***

PREP DATASET? (FN FT ADDR)
prep1 demo 200
DATA BANK DATASET? (FN FT ADDR)
dbank0 demo 200
FINITE ELEMENT METHOD? (MSC/RPK/MHOST/'')
rpk
FINITE ELEMENT DATASET? (FN FT ADDR)
nast1 demo 200
POST PROCESS DATASET? (FN FT ADDR)
post1 demo 200
OUTPUT DATASET NAME? (CHOOSE <6 CHARS)
plat05
CRAY USERID?  DEFAULT IF GLOBALV
CRAY PASSWORD?  DEFAULT IF GLOBALV
SEND TO CRAY? (Y/N)
n
File CRAY RUN H not found
/////     CRAYRUN ERASED, CONTINUE                   /////

/////     RPK/NASTRAN JCL IS CREATED                 /////

/////     FIRST CRAY RUN EDITING COMPLETE            /////
/////     SECOND CRAY RUN EDITING COMPLETE           /////
/////     ASSEMBLY OF CRAY RUN FILE COMPLETE         /////

/////     CRAY RUN FILE NOT SENT TO CRAY             /////
/////     CRAY RUN IS ON YOUR -H- DISK               /////

DASD 200  DETACHED
Ready(00023); T=0.16/0.41 09:16:19
```

The final message is notifying the user that they have been detached from the semi-public disk.
The temporary mini-disk will remain active until LOGOFF.

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# Report Documentation Page

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15. Supplementary Notes

Version 1.2 dated August 31, 1988.
Composite Blade Structural Analyzer (COBSTRAN) Demonstration Manual NASA TM-101957.
Composite Blade Structural Analyzer (COBSTRAN) Theoretical/Programmer's Manual NASA TM-101958.

16. Abstract

This manual describes the installation and use of a computer code, COBSTRAN (COmposite Blade STRuctrual ANalyzer), developed for the design and analysis of composite turbofan and turboprop blades and also for composite wind turbine blades. This code combines composite mechanics and laminate theory with an internal data base of fiber and matrix properties. Inputs to the code are constituent fiber and matrix material properties, factors reflecting the fabrication process, composite geometry and blade geometry. COBSTRAN performs the micromechanics, macromechanics and laminate analyses of these fiber composites. COBSTRAN generates a NASTRAN model with equivalent anisotropic homogeneous material properties. Stress output from NASTRAN is used to calculate individual ply stresses, strains, interply stresses, thru-the-thickness stresses and failure margins. Curved panel structures may be modeled providing the curvature of a cross-section is defined by a single value function. COBSTRAN is written in FORTRAN 77.

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|---|---|
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