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

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**NASA**

COBSTRAN User's Manual

COMPOSITE BLADE STRUCTURAL ANALYZER

# COBSTRAN

USER'S MANUAL

by

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STRUCTURES DIVISION

STRUCTURAL MECHANICS BRANCH

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COBSTRAN User's Manual

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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.

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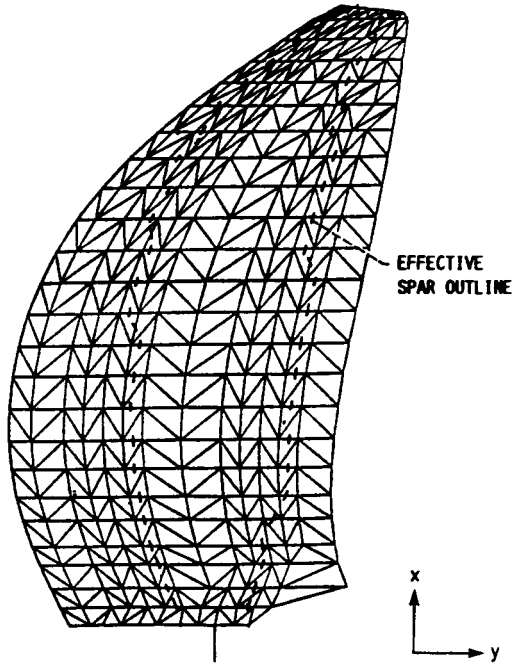


FIGURE 1. - COBSTRAN FINITE ELEMENT MODEL.  
328 NODES; 584 ELEMENTS.

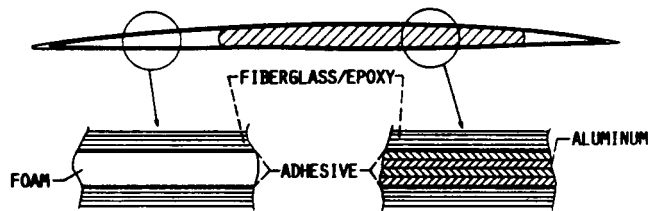


FIGURE 2. - TYPICAL BLADE CROSS-SECTION.

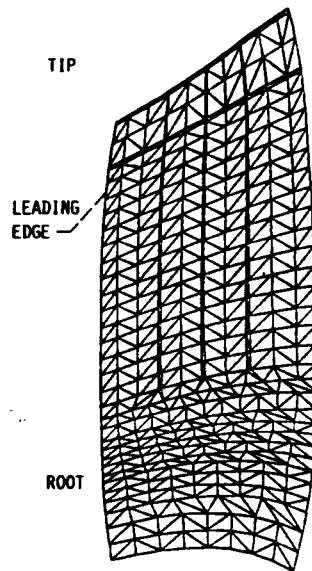


FIGURE 3. - COBSTRAN MODEL OF THE HOLLOW FAN BLADE (777 ELEMENTS).

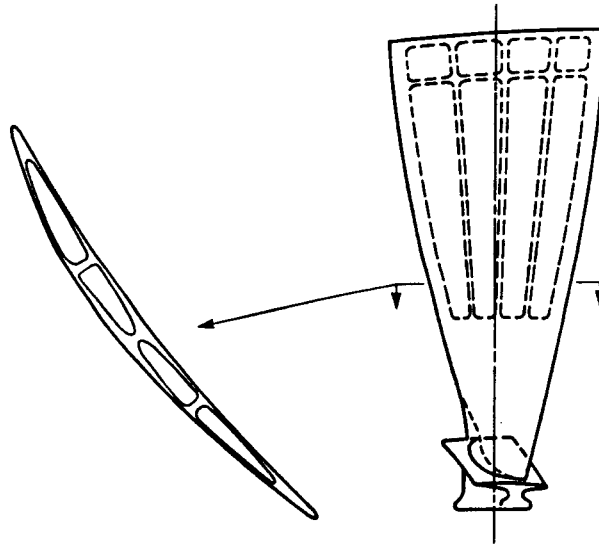


FIGURE 4. - TURBOFAN BLADE WITH HOLLOW CORE SECTIONS.

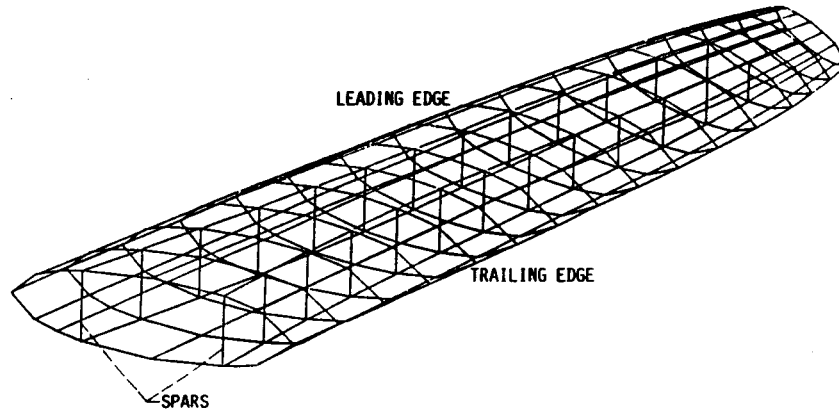


FIGURE 5. - TYPICAL MODEL GENERATED BY THE SHELL/SPAR OPTION.



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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.

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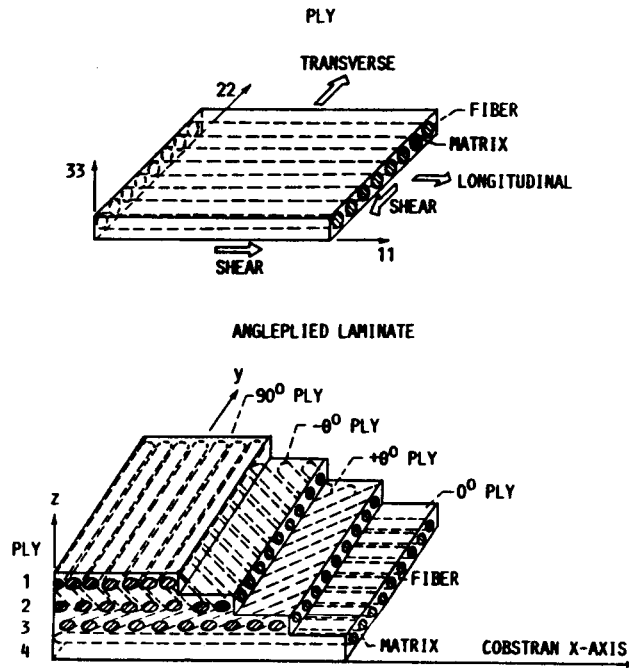


FIGURE 6. - FIBER COMPOSITE GEOMETRY RELATIVE TO COBSTRAN COORDINATE SYSTEM.

## 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.

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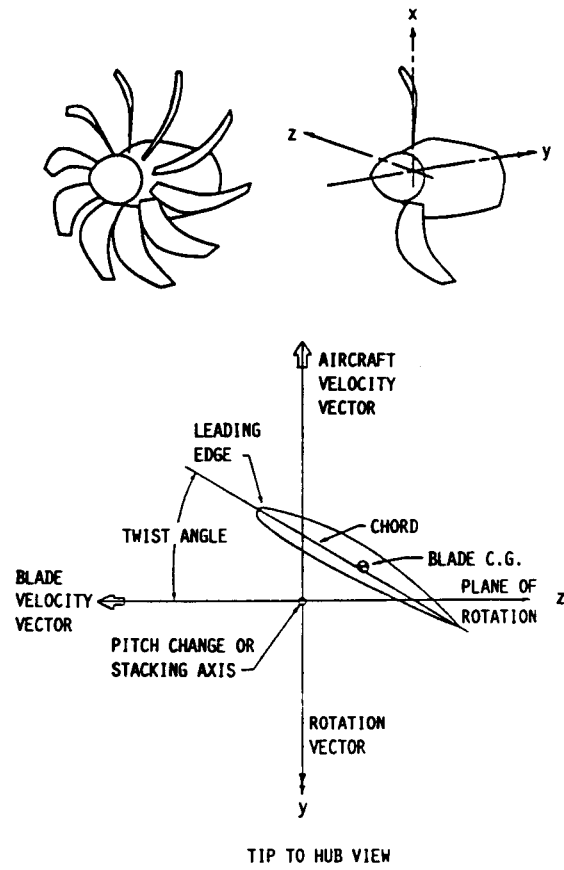
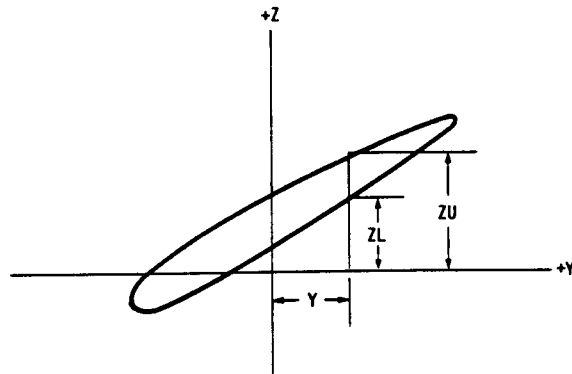


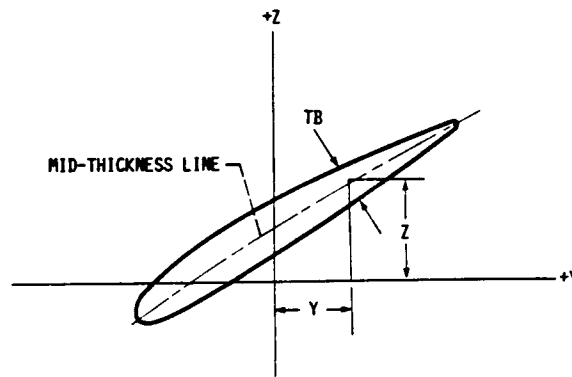
FIGURE 7. - COBSTRAN COORDINATE SYSTEM.

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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.

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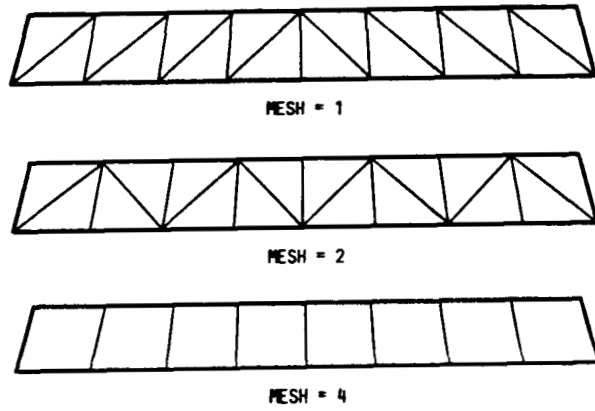


FIGURE 9. - COBSTRAN 2-D MESH PATTERNS.

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### 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 'PLOTTEL' 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



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

SOLID BLADE OPTION

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

END OF PREPROCESSOR DECK FOR SOLID OPTION

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

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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 LSECT(1) blocks each with MSECT(J,1) cards 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 LSECT(2) blocks each with MSECT(J,2) cards LSECT(2) MAX=10,      MSECT(J,2) MAX=30	8F10.2
15	Optional if ply properties are to be read in. Option activated if PROPERTY INPUT option selected NPM The next two(2) cards are repeated NPM times. NPD,KF,RHO,E1,E2,G12,NU12 S1t,S1c,S2t,S2c,S12,A1,A2	20I4 I4,6X,6E10.4 8E10.4
16	Optional if material properties are to be read in. Option activated if IMAT=3 (anisotropic material) A(I) I=1,6 RHO,AX,AY,AZ  Option activated if IMAT=4 (isotropic material) A(I) I=1,6 GE,ST,SC,SS	10E8.2 10E8.2

END OF PREPROCESSOR DECK FOR SHELL/SPAR OPTION

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POSTPROCESSOR OPTION

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

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)

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### 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



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### 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.

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### 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.

MLOTS

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

This option will cause the generation of a NASTRAN bulk data file containing 'PLOTTEL' 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.

## COBSTRAN User's Manual

### 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 layout.

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.

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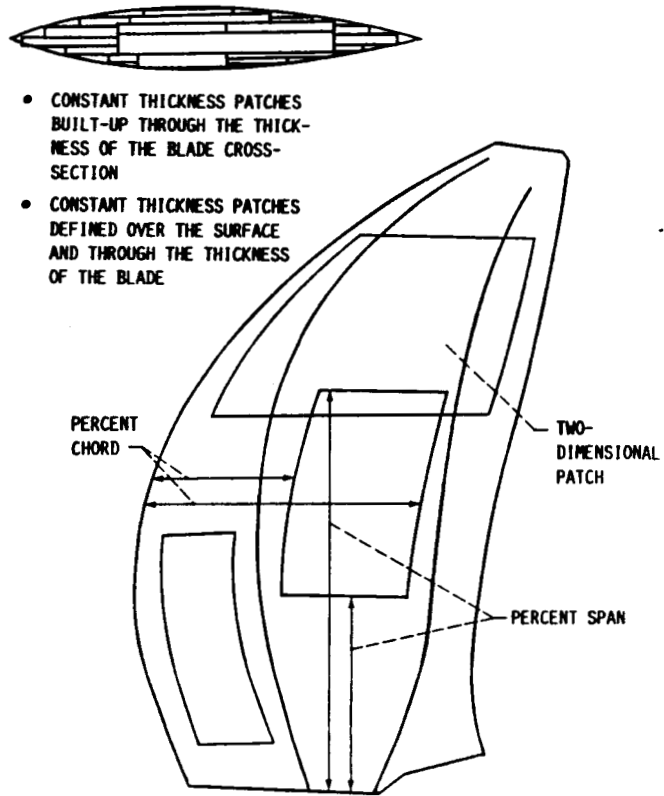


FIGURE 10. - COBSTRAN LAMINATED PLATE MODEL.

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.



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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

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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

## COBSTRAN User's Manual

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.



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## 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.

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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.

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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	

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## 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 <sup>3</sup>
E11	Modulus tension	lb/in <sup>2</sup>
E22	" transverse	"
NU12	Poisson's ratio	
NU23	" ratio	
G12	Shear modulus	lb/in <sup>2</sup>
G23	" "	"
ALPHA11	Thermal expansion coefficient	in/in/°F
ALPHA22	" " "	"
K11	" conductivity	BTU/hr ft <sup>2</sup> °F/in
K22	" "	"
HC	Heat capacity	BTU/lb °F
S11t	Strength-tension	lb/in <sup>2</sup>
S11c	" compression	"
S22t	" tension	"
S22c	" compression	"
S12s	" shear	"
S23s	" "	"

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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/in <sup>3</sup>
E	Modulus	lb/in <sup>2</sup>
NU	Poisson's ratio	
ALPHA	Thermal expansion coefficient	in/in/°F
Km	" conductivity	BTU/hr ft <sup>2</sup> °F/in
HC	Heat capacity	BTU/lb °F
Kv	Thermal conductivity (void)	BTU/hr ft <sup>2</sup> °F/in
St	Strength-tension	lb/in <sup>2</sup>
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  
 $S_{11cd} = a1 * (S_{112s}) + a2$   
 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

# COBSTRAN User's Manual

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

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## 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.

FORTRAN Code	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) 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 PLOTTEL 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.



# COBSTRAN User's Manual

## 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.*
```

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COBSTRAN DICTIONARY

If IMAT=3

A(1)	REAL	G11--	
A(2)	REAL	G12	Symmetric
A(3)	REAL	G13	stress/strain
A(4)	REAL	G22	relationships
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

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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 ----	- Ply thermal expansion coefficient
CTE22	REAL ----	
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 ----	- Ply elastic constants
EL22	REAL ----	
EL33	REAL ----	
EP	REAL	Elastic property matrix
EPS11	REAL ----	- Ply applied strains
EPS12	REAL ----	
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

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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 ----	- Ply elastic constants
GL13	REAL ----	
GL23	REAL ----	
HFC	REAL	Hoffman's failure criterion
HHCL	REAL	Ply heat capacity
HK11	REAL ----	- Ply heat conductivities
HK22	REAL ----	
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 In MIDWAL i=1 pressure surface 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 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 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

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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
KAD	INTEGER	index on NNSECT (number of sections of input per press/suct SHELL/SPAR) 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

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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	
LSC11C	REAL	
LSC11D	REAL	
LSC11T	REAL	
LSC22C	REAL	
LSC22T	REAL	
LSCC13	REAL	
LSCC23	REAL	
LSCDF	REAL	
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 from 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

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MPLT	BOOLEAN	True for NASTRAN PLOTTEL 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

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NMINT	BOOLEAN	TRUE for COSMIC NASTRAN deck input
NMODE(I)	INTEGER	Positive integer for each mode from NASTRAN
NNQ	INTEGER	NYSPEC + 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. $NPTOT1 = NPTOT + NP(\text{spars})$
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 ----	- Ply Poisson's ratio
NUL13	REAL	
NUL21	REAL	
NUL23	REAL	
NUL31	REAL	
NUL32	REAL ----	



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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

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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) PL(31,I) thru PL(33,I)	REAL REAL	Ply heat capacity HHCL 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) PL(50)	REAL REAL	Interply delamination factor ILMFC 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

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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 input 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. 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	- Ply stress-strain relationships
SC12	REAL	
SC13	REAL	
SC22	REAL	
SC23	REAL	
SC33	REAL	
SC44	REAL	
SC55	REAL	
SC66	REAL	
SHELL	BOOLEAN	

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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	----
S111cd	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

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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	REAL	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

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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

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### 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.

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### 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.



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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

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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)

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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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16. Abstract <p>This manual describes the installation and use of a computer code, COBSTRAN (COmposite Blade STRuctural 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.</p>					
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