6. PROPERTY Data Groups

6.1 MATERIAL DATA GROUP

This data group is used to define material properties.

6.1.1 IMAT - Isotropic material data group

IMAT	*ID*	*E1*	*NULT*	*RHO*	*ALPHA*	*P*

ID Identification number for the material (positive integer)

E1 YOUNG'S Modulus

NULT Poisson's Ratio

RHO Mass density

ALPHA Coefficient of thermal expansion

P Plastic strain Vs true stress

Eg:- IMAT, 1, 70000, 0.3, 2.8E-09, 0, 0

6.1.2 OMAT - Orthotropic Material data group

OMAT	*ID*	*EL*	*ET*	*EN*	*NULT*	*NULN*	*NUTN*	*RHO*

ALPL	*ALPT*	*ALPN*	*GLT*	*GLN*	*GTN*	*XT*	*XC*	*YT*	*YC*	*FS*	*FXYS*

ID Identification number for the material (positive integer)

EL Longitudinal Modulus

ET Transverse Modulus

EN Normal Modulus

NULT	Poisson's ratio in L-T plane
NULN	Poisson's ratio in L-N plane
NUTN	Poisson's ratio in T-N plane
RHO	Mass density
ALPL	Coefficient of thermal expansion in L-direction.
ALPT	Coefficient of thermal expansion in T-direction.
ALPN	Coefficient of thermal expansion in N-direction.
GLT	In-plane shear modulus in L-T plane
GLN	In-plane shear modulus in L-N plane
GTN	In-plane shear modulus in T-N plane
XT	Logitudinal tensile strength
XC	Logitudinal compressive strength
YT	Transverse tensile strength
YC	Transverse compressive strength
FS	In-plane shear strength (FS)
FXYS	Interaction coefficient in failure theory

Eg:- OMAT, 3, 10, 10, 0, 0.2, 0.2, 0, 65, 0, 0, 0, 355, 355, 0, 0, 0, 0, 0, 0, 0

6.1.3 AMAT - Anisotropic Material data group

AMAT	*ID*	*S11*	*S22*	*S33*	*S44*	*S55*	*S66*	*S12*
	S13	*S14*	*S15*	*S16*	*S23*	*S24*	*S25*	*S26*	*S34*	*S35*	*S36*
	S45	*S46*	*S56*	*RHO*	*C11*	*C22*	*C33*	*C12*	*C13*	*C23*

ID	Identification number for the material (positive integer)
S11	Stiffness in 11 location of the elasticity matrix
S22	Stiffness in 22 location of the elasticity matrix

S33	Stiffness in 33 location of the elasticity matrix
S44	Stiffness in 44 location of the elasticity matrix
S55	Stiffness in 55 location of the elasticity matrix
S66	Stiffness in 66 location of the elasticity matrix
S12	Stiffness in 12 location of the elasticity matrix
S13	Stiffness in 13 location of the elasticity matrix
S14	Stiffness in 14 location of the elasticity matrix
S15	Stiffness in 15 location of the elasticity matrix
S16	Stiffness in 16 location of the elasticity matrix
S23	Stiffness in 23 location of the elasticity matrix
S24	Stiffness in 24 location of the elasticity matrix
S25	Stiffness in 25 location of the elasticity matrix
S26	Stiffness in 26 location of the elasticity matrix
S34	Stiffness in 34 location of the elasticity matrix
S35	Stiffness in 35 location of the elasticity matrix
S36	Stiffness in 36 location of the elasticity matrix
S45	Stiffness in 45 location of the elasticity matrix
S46	Stiffness in 46 location of the elasticity matrix
S56	Stiffness in 56 location of the elasticity matrix
RHO	Mass density (RHO)
C11	Coefficient of thermal expansion in 11 location of the alpha matrix
C22	Coefficient of thermal expansion in 22 location of the alpha matrix
C33	Coefficient of thermal expansion in 33 location of the alpha matrix
C12	Coefficient of thermal expansion in 12 location of the alpha matrix
C13	Coefficient of thermal expansion in 13 location of the alpha matrix

C23 Coefficient of thermal expansion in 23 location of the alpha matrix

Eg:-

6.1.4 VISCOMAT – Visco Elastic Material.

VISCOMAT	*ID*	*ME*	*NULT*	*RHO*	*ALPHA*	*TVsM*	*PC*

ID Identification number

ME Modulus of elasticity

NULT Poisson's ratio

RHO Mass density

ALPHA Coefficient of thermal expansion

TVsM Time Vs Modulus

PC Prony coefficients

Eg: VISCOMAT, 1, 1594.11, 0.4954, 0.00178, 0, 0, F1

6.1.5 IMATHT – Material data for heat transfer.

IMATHT	*ID*	*CX*	*CY*	*CZ*	*SH*	*RHO*

ID Identification number

CX Conductivity-X

CY Conductivity-Y

CZ Conductivity-Z

SH Specific Heat

RHO Mass density

Eg: IMATHT, 1, 17.4, 17.4, 0, 0, 0

6.2 PHYSICAL PROPERTIES

6.2.1 THICK - THICKNESS

This data group is used for the thickness at nodes for shell elements

THICK	*ID*	*n*	*t1*	*t2*	*t3*	…

ID Identification number for thickness (positive integer)

n Number of thickness values

t1, t2,..tn Nodal thickness values

NOTE:- The thickness may be specified as t1,t2,..tn, where n is the number of nodes of an element . If a single value is specified, a uniform thickness is assumed. If the number of values specified is less than the number of nodes of an element, the last value in the sequence in assumed for the rest of nodes.

Eg:- **THICK, 1, 1, 3.1** A uniform thickness of 3.1

THICK, 2, 2, 1.2/3.1/1.2 A variable thickness of 1.2, 3.1, 1.2 is assigned for 3-node triangular elements and a thickness of 1.2, 3.1, 1.2, 1.2 is assigned to 4-node quadrilateral elements (the last value is repeated)

6.2.2 BPROP - BEAM PROPERTIES

BPROP	*ID*	*Area*	*Iyy*	*Izz*	*J*	*Sy*	*Sz*	*Ky*	*Kz*	*yoff*	*zoff*

ID	Unique identification number
Area	Area of cross-section
Iyy	Moment of inertia about local y-axis
Izz	Moment of inertia about local z-axis
J	Torsional constant
Sy	Shear centre offset – y axis
Sz	Shear centre offset – z axis
Ky	Shear factor -Ky – y axis
Kz	Shear factor - Kz – z axis
yoff	Node offset -yoff
zoff	Node offset -zoff

NOTE: If torsional constant J is not specified, it is taken as Iyy+Izz

Eg: **BPROP, 1, 20, 41.6667, 26.6667, 87.875, 0, 0, 0, 0, 0**

6.2.3 RP – PROPERTIES FOR ROD ELEMENTS

RP	*ID*	*A1*	*A2*	*J*

ID Unique identification number

A1, A2 Area of cross section at the ends. A2 = A1, if A2=0 or not specified

J Shear due to torsion factor

NOTE: If J is non-zero the rod also includes torsional degree of freedom

Eg: RP, 1, 1, 0, 0

6.2.4 MANGLE - Material Angle for Laminates

MANGLE	*ID*	*LCS ID*	*dir*	*n*	*t1*	*t2*	..	*tn*

ID Identification number for the data

LCS ID Local coordinate system ID

dir Reference direction

= 0 First element edge

= 1 Local X direction

= 2 Local Y direction

= 3 Local Z direction

n Total number of angles

t1,t2…,tn Angles in degrees

NOTES

1. If dir = 0 the angle is interpreted w.r.t the first edge of the element. If dir > 0 the angle is interpreted w.r.t the projection of the direction-vector on the element face

2. The angles may be specified as t1,t2,..tn, where n is the number of nodes of an element . If a single value is specified, a uniform value is assumed. If the number of values specified is less than the number of nodes of an element, the last value in the sequence is assumed for the rest of nodes.

Eg: MANGLE, 1, 0, 0, 4, 45, 30, 30, 45

6.2.5 SOFF – Shell Offset

Reference plane offset for shell elements

SOFF	*ID*	*Offset*	*Element IDs*

ID Identification number

Offset Shell offset in

- Middle
- Bottom
- Top
- Other

Element IDs List of element IDs.

Eg: SOFF, 2, 0, MIDDLE, 286T300

6.2.6 LAYUP - Laminate details for composite elements.

LAYUP	*ID*	*nLayer*	*m1*	*a1*	*t1*	*m2*	*a2*	*t2*	..	..	..

ID Identification number

nLayer Number of layers

m1,m2,.. Material Id for the ith layer

a1,a2,.. Material angle Id for the ith layer

t1,t2,… Thickness Id for each ith layer

Note: The triplets (m1, a1, t1) , (m2, a2, t2), .. are to be repeated *'nLayer'* times, where m1,a1,t1,… are the IDs of material properties (IMAT, OMAT), laminate angles (MANGLE) and thickness (THICK) respectively

Eg: LAYUP, 1, 2, 2, 1, 1, 1, 2, 1

6.3 FUNCTION

6.3.1 TAB - REAL TABLE

TAB	*ID*	*X*	*x1*	*y1*	*x2*	*y2*	..	..	*xn*	*yn*

Table Data is used to specify a variation of a quantity with reference to another independent variable, y = f(x). For a given **x** the value of **y** is evaluated as follows

$x_i <= x <= x_{i+1}$ $$y = y_i + \frac{(y_{i+1} - y_i)}{(x_{i+1} - x_i)}(x - x_i)$$

$x < x_i$ $y = y_1$

$x > x_n$ $y = y_n$

ID Identification number for Table Data

X X refers to

-Temperature

- X coordinate

- Y coordinate

- Z coordinate

- Time

- Frequency

x1,x2..xn Independent variable

y1,y2..yn Dependent variable

Eg: TAB, 1, TEMP, 1, 0.1, 2, 0.2, 3, 0.3, 4, 0.4

6.3.2 EXPR – Expression

EXPR	*ID*	*n*	*Exp*

ID Identification number for table data

n (default : 0)

Exp *Expression*

Eg: EXPR, 1, 0, -(.05*sin(3.14*X/200)*sin(3.14*Y/100))

6.4 NSMASS – Nonstructural mass

NSMASS	*ID*	*md*	*Obj*

ID Identification number for table data

md Mass per unit dimension

Obj *Object list*

Eg: NSMASS, 26, 7, 946T956(F1)/1043T1053(F1)/1140T1150(F1)

6.5 OPTSURF – Optical data

OPTSURF	*ID*	*LCS*	*AT*	*RA*	*AD*	*AR*	*CC*	*VC*	*faces*

ID Identification number for optical data

LCS Local coordinate system

AT Aperature type in

0 - Circular

1 - Rectangular

2 - Hexagonal

3 - Annular

RA Reflection Axis in

0 - Off Axis

1 - On Axis

AD Aperature Distance

AR Aperature Radius

CC Conic Constant

VC Vertex Curvature

faces Optical faces

6.6 GP – Gap Property

GP	*ID*	*IGap*	*NStiff*	*NRStiff*	*Tol*

ID Unique identification number.

IGap Initial Gap.

NStiff Normal stiffness.

NRStiff Normal rigid body stiffness.

Tol Tolerance

Eg:- GP, 1, 1, 2, 0, 0.0001