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The Computational Structural Mechanics Testbed Data Library Description

Compiled by Caroline B. Stewart

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Preface

The purpose of this manual is to document the datasets created and used by the Computational Structural Mechanics (CSM) Testbed software system. A description of each dataset including its form, contents, and organization is presented.

Periodically, updates to this manual will be released which describe new datasets that are created by new Testbed processors or changes to existing datasets.

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CSM Testbed Data Library Description

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1.0 Description of CSM Testbed Datasets

Descriptions of the datasets created and used by the Testbed processors are given, ordered alphabetically by dataset name. Each nominal dataset name involves four components referred to as NAME1, NAME2, NAME3, and NAME4. NAME1 and NAME2 are alphanumeric names with a maximum of four characters each. NAME3 and NAME4 are integers.

Several standard dataset forms are used by nearly all of the Testbed processors. Four such dataset forms are designated TABLE, SYSVEC, ELDATA, and ALPHA. TABLE is a generalized dataset form for the storage of any type of data. Data such as node-point position coordinates and nodal temperatures are stored in TABLE format. SYSVEC is a special case of the TABLE form. SYSVEC is used primarily to represent the displacements and rotations at all points in a structure, and the forces and moments acting on all joints. This form is also used for diagonal mass matrices. ELDATA is a dataset form used to represent certain categories of data bearing a one-to-one relationship with structural elements of a given type, such as element pressure or temperature loads. The ALPHA dataset form is used to store lines of alphanumeric text, such as static load case titles.

The contents of most of the datasets may be viewed logically as two-dimensional tables, where NI is the first dimension, or column-size, and NJ is the second dimension, or row-size. Data are written to the Testbed global database as named records in nominal datasets, with a record length of NI*NJ data items. If the dataset is blocked, each block is written as one nominal record. The NJ parameter (row-size) is stored in a Testbed record as the matrix dimension parameter. The default record name used by the currently installed Testbed processors is "DATA".

Most datasets contain data of only a single type: integer, single precision real, double precision real, or alphanumeric. These are indicated by type codes 0, -1 or 1, -2 or 2, and 4, respectively. Alphanumeric data are packed four characters to a machine word.

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2.0 Dataset Contents

The content of each Testbed dataset is described in this chapter. The dataset description includes dataset name, content, size, and format. The processor which creates each dataset is also identified.

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ALTR.BTAB.2.4

Created by the ALTREF subprocessor of processor TAB

NJ = Number of alternate reference frames
NI = 12
Type = single precision real

Contents of each entry:

1. a_{11}
2. a_{21}
3. a_{31}
4. a_{12}
5. a_{22}
6. a_{32}
7. a_{13}
8. a_{23}
9. a_{33}

(items 1–9: Components of a coordinate transformation matrix)

10. X_o
11. Y_o
12. Z_o

(items 10–12: Location of origin of alternate reference frame given in global coordinates)

Formula:

$$\begin{Bmatrix} X_a \\ Y_a \\ Z_a \end{Bmatrix} = \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix} \begin{Bmatrix} X_g \\ Y_g \\ Z_g \end{Bmatrix} + \begin{Bmatrix} X_o \\ Y_o \\ Z_o \end{Bmatrix}$$

coordinates in alternate reference frame — coordinates in global reference frame

AMAP..*ic2.isize*

ic2 = Parameter reflecting the cost of equation solution given a factored system matrix. Computed in processor TOPO.
isize = The maximum number of submatrices involved during the factorization process.

Created in processor TOPO and used by INV to guide factorization of system matrices.

NJ = total number of joints in the model
Type = integer

The purpose of this dataset is to furnish compact information describing the location of each submatrix in the "active" upper triangle of the system matrix as each joint is eliminated. During factorization, the active upper triangle is held in the work array S(JDF, JDF, *isize*). The pointers in AMAP..*ic2.isize* point to JDF by JDF submatrices in this array. The dataset consists of one or more records with the default record size of 1792 words. A joint group is included for each joint in the model. Each record contains the following:

JOINTS - The number of joint groups contained in this record. A joint group is not allowed to span a record boundary.

Repeated JOINTS times:

JNT - The number of the current joint.

CONRNG - The number of submatrices including the diagonal in the upper triangle for the current joint as it is being eliminated.

CONECT(CONRNG-1) - A list of column positions for each of the submatrices in the JNT row.

SUBMAP (CONRNG * (CONRNG + 1)/2) - Contains a pointer into the work array, S, for each submatrix in the active upper triangle.

APPL.FORC.*iset*.1

iset = Load set

Created in processor AUS.

NI = maximum number of active degrees of freedom per joint
NJ = total number of joints in the model
Type = single precision real

SYSVEC-format dataset. A SYSVEC dataset has NJ equal to the number of joints in the model and NI equal to the number of active (unconstrained) degrees of freedom per joint. When these datasets are manipulated by a processor, they are expanded to six degrees of freedom per joint by subroutine PUP. SYSVEC-format datasets frequently have multiple blocks. The meaning of the block number varies depending on the particular dataset. In static analyses the block number indicates the load case. In eigenvalue problems, the block number indicates the eigenvector.

Contents:

Each entry contains applied forces and moments on that joint in each active direction.

APPL.MOTI.*iset*.1

iset = Load set

Created in processor AUS.

SYSVEC format. See APPL.FORC.*iset*.1.

Contents:

Each entry contains applied motions on that joint in each active direction.

BA.BTAB.2.9

Created from E21 section properties in processor TAB

NJ = Number of entries
NI = 31
Type = single precision real

Contents of each entry:

For a description of the section property input for the E21 element, see Section 4.1.3.15 of the CSM Testbed User's Manual.

1. Element type indicator
2. Not used
3. Not used
4. I_1
5. α_1
6. I_2
7. α_2
8. a
9. f
10. f_1
11. z_1
12. z_2
13. θ
14. q_1
15. q_2
16. q_3
17. Number of points at which stresses are to be calculated
18. y_{11}
19. y_{12}
20. y_{21}
21. y_{22}
22. y_{31}
23. y_{32}
24. y_{41}
25. y_{42}
26. b_1
27. t_1
28. b_2
29. t_2
30. b_3
31. t_3

BC.BTAB.2.11

Created from E23 section properties in processor TAB

NJ = Number of entries
NI = 6
Type = single precision real

Contents of each entry:

1. Cross-sectional area of axial element
2. Cross-sectional area of axial element
3. }
4. }
5. } Not used.
6. }

BUCK.EVAL.*nset.ncon*

nset = Set identifier
ncon = Constraint case

Created in processor EIG

NJ = 1
NI = Number of eigenvalues
Type = single precision real

Contents:

Buckling eigenvalues corresponding to each eigenvector in BUCK.MODE.*nset.ncon*.

BUCK.MODE.*nset.ncon*

nset = Set identifier
ncon = Constraint case

Created in processor EIG.

SYSVEC format. See APPL.FORC.*iset*.1.

Contents:

Each block of data contains an eigenvector (buckling mode shape) corresponding to an eigenvalue stored in BUCK.EVAL.*nset.ncon*.

CASE.TITL.*iset*.1

iset = Load set

Created in processor AUS.

Number of blocks = Number of load cases in this load set
Type = alphanumeric

Contents:

Each block contains the title for the corresponding load case.

CEM.SPAR.*jdf2*

jdf2 = square of the number of active degrees of freedom per joint

Created in processor M.

A Testbed sparse matrix format system matrix. See K.SPAR.*jdf2*.

Contents:

The unconstrained system consistent mass matrix considering only the structural and nonstructural distributed mass associated with the elements.

CON..*ncon*

ncon = Constraint case

Created by CON subprocessor in processor TAB

NJ = Number of joints
NI = 1
Type = integer

Contents:

Each entry contains an integer representing the joint reference frame number and constrained components for that joint. This integer is interpreted as a bit pattern with two bits allocated for each joint degree of freedom and the joint reference frame number stored in the leading bits. For each joint degree of freedom the bit pattern 00 indicates that component is free, the pattern 01 indicates that component is constrained to be zero, and the pattern 10 indicates that a non-zero value of this component will be applied using the APPL.MOTI.*iset*.1 dataset.

For example:

A joint with components 1, 2, 3 and 5 constrained to zero and JREF = 7 (0111_2) would have the integer 28949_{10} stored according to the following binary bit pattern:

JREF number	Joint Motion Components					
	6	5	4	3	2	1
0...0111	00	01	00	01	01	01

Component 1 (constrained)	=	1 × 1	=	1
Component 2 (constrained)	=	1 × 4	=	4
Component 3 (constrained)	=	1 × 16	=	16
Component 4 (unconstrained)	=	0 × 64	=	0
Component 5 (constrained)	=	1 × 256	=	256
Component 6 (unconstrained)	=	0 × 1024	=	0
JREF number = 7	=	7 × 4096	=	+ 28 672
Integer stored for this joint			=	28 949

CSMP.FOCS.1.1

Contains integer input for processor CSM1 (see CSM Testbed User's Manual Section 14.1 for a definition of terms).

NI = 33
NJ = 1
Type = Integer

Contents of each record:

1. NNPE, Number of nodes per element (3, 4, or 9)
2. IOPT, Element option: 0 for E33 or E43 elements; 1 for experimental (GEP-implemented) elements
3. NRINGS, Number of rings *of elements* (4 or 9 node) around hole
4. NSPOKES, Number of radial spokes *of nodes* normal to hole boundary (must be a multiple of 8)
5. Translational constraints along the $x = 0$ edge of the panel.
6. Rotational constraints along the $x = 0$ edge of the panel.
7. Translational constraints along the $y = 2 * (B_E + B_S)$ edge of the panel.
8. Rotational constraints along the $y = 2 * (B_E + B_S)$ edge of the panel.
9. Translational constraints along the $x = A_l$ edge of the panel.
10. Rotational constraints along the $x = A_l$ edge of the panel.
11. Translational constraints along the $y = 0$ edge of the panel.
12. Rotational constraints along the $y = 0$ edge of the panel.
13. Translational constraints at the corner $(0, 0)$
14. Rotational constraints at the corner $(0, 0)$
15. Translational constraints at the corner $(0, 2 * (B_E + B_S))$
16. Rotational constraints at the corner $(0, 2 * (B_E + B_S))$
17. Translational constraints at the corner $(A_l, 2 * (B_E + B_S))$
18. Rotational constraints at the corner $(A_l, 2 * (B_E + B_S))$
19. Translational constraints at the corner $(A_l, 0)$
20. Rotational constraints at the corner $(A_l, 0)$
21. Translational constraints on stiffeners at $x = 0$
22. Rotational constraints on stiffeners at $x = 0$
23. Translational constraints on stiffness at $x = A_l$

CSMP.FOCS.1.1 (concluded)

24. Rotational constraints on stiffeners at $x = A_l$
25. IWALL, Panel section property flag (NSECT for panel skin)
26. JWALL, Stiffener section property flag (NSECT for stiffeners)
27. IREF, Material reference frame for panel skin
28. JREF, Material reference frame for stiffeners
29. NELX, Number of elements (4 or 9 node) between $0 < x < \frac{(A_l - A)}{2}$
30. NELE, Number of elements (4 or 9 node) from panel edge to outside stiffener; between $0 < y < B_E$
31. NELBS, Number of elements (4 or 9 node) between interior stiffeners; between $B_S < y < [B_E + B_S - \frac{A}{2}]$
32. NELS, Number of elements (4 or 9 node) across height of stiffener; if NELS = 0, there are no stiffeners
33. IFILL, Flag to fill in hole: 0=No fill-in, 1=Fill-in

CSMP.FOCS.1.2

Contains floating point input for processor CSM1 (see CSM Testbed User's Manual Section 14.1 for a definition of terms).

NI = 10
NJ = 1
Type = single precision real

1. A, Length of a side of the central square region; $A < 2B_S$
2. D_{HOLE}, Diameter of hole. $D_{HOLE} < A$
3. Local x coordinate of the center of the hole relative to the Point O
4. Local y coordinate of the center of the hole relative to the Point O
5. Local z coordinate of the center of the hole relative to the Point O
6. RAT, Mesh grading factor. For RAT = 0, element rings will be of nearly equal size. As RAT is increased to a value of one (1), the mesh becomes finer close to the hole and coarser away from the hole. RAT is only effective within the A by A square region around the hole.
7. A_l, Overall length of the panel.
8. B_E, Distance between the panel edge and an outside stiffener.
9. B_S, Distance between an outside stiffener and the inside stiffener.
10. H_S, Height of each stiffener.

CSMP.FOCS.2.1

Contains integer input for processor CSM2 (see CSM Testbed User's Manual, Section 14.6 for a definition of terms).

NI = 23
NJ = 1
Type = Integer

Contents of each record:

1. NNPE, Number of nodes per element (3, 4, or 9)
2. IOPT, Element option: 0 for E33 or E43 elements; 1 for experimental (GEP-implemented) elements
3. NRINGS, Number of rings *of elements* (4 or 9 node) around hole
4. NSPOKES, Number of radial spokes *of nodes* normal to hole boundary (must be a multiple of 8)
5. Translational constraints along the $x = 0$ edge of the panel.
6. Rotational constraints along the $x = 0$ edge of the panel.
7. Translational constraints along the $y = A$ edge of the panel.
8. Rotational constraints along the $y = A$ edge of the panel.
9. Translational constraints along the $x = A$ edge of the panel.
10. Rotational constraints along the $x = A$ edge of the panel.
11. Translational constraints along the $y = 0$ edge of the panel.
12. Rotational constraints along the $y = 0$ edge of the panel.
13. Translational constraints at the corner $(0, 0)$
14. Rotational constraints at the corner $(0, 0)$
15. Translational constraints at the corner $(0, A)$
16. Rotational constraints at the corner $(0, A)$
17. Translational constraints at the corner (A, A)
18. Rotational constraints at the corner (A, A)
19. Translational constraints at the corner $(A, 0)$
20. Rotational constraints at the corner $(A, 0)$
21. IWALL, Panel section property flag (NSECT for panel)
22. IREF, Material reference frame for panel
23. IFILL, Flag to fill in hole: 0=No fill-in, 1=Fill-in

CSMP.FOCS.2.2

Contains floating point input for processor CSM2 (see CSM Testbed User's Manual, Section 14.6 for a definition of terms).

NI = 7
NJ = 1
Type = single precision real

1. A, Length of a side of the panel
2. D_{HOLE}, Diameter of hole. $D_{HOLE} < A$
3. Local x coordinate of the center of the hole relative to the Point O
4. Local y coordinate of the center of the hole relative to the Point O
5. Local z coordinate of the center of the hole relative to the Point O
6. RAT, Mesh grading factor. For RAT = 0, element rings will be of nearly equal size. As RAT is increased to a value of one (1), the mesh becomes finer close to the hole and coarser away from the hole.
7. RCURV, Radius of curvature of panel

DEF.xxxx.*itype.nnod*

xxxx = element name (*e.g.*, E43, S81, EX97)
itype = element type number
(E21=1 thru E44=12, S41=16, S61=17, S81=18, element implemented using an independent element processor = 0)
nnod= number of joints per element

Created in processor ELD.

NJ = Number of elements type xxxx
NI varies depending on the number of nodes in the element
Type = integer

The dataset contains NJ nominal records, NI items per record.

Contents:

1. Element number
2. Group number
3. Element number within group
4. Stress reference frame number
5. N3 of corresponding dataset xx.BTAB.N3.N4
6. N4 where xx = BA, BB, SA, . . .
7. Index of MATC entry for element material constants
8. Index of section property dataset entry for element section properties
9. Index of non-structural weight dataset entry (NSW)
10. Index of rigid link offset dataset entry (BRL)
11. Index of beam orientation dataset entry (MREF)
12. Section type code
13. Node #1
14. Node #2
15. Node #3
16. Node #4

⋮

Node *n*

DEM.DIAG

Created in processor E.

SYSVEC format. See APPL.FORC.*iset*.1

Contents:

System mass matrix in diagonal form.

DIR.xxxx.*itype.nnod*

xxxx = element name (*e.g.*, E43, S81, EX97)
itype = element type number
(E21=1 thru E44=12, S41=16, S61=17, S81=18, element implemented using an independent element processor = 0)
nnod = number of joints per element

Created in processor ELD.

NJ = 1
NI = 20
Type = integer

Contents:

1. Number of nodes
2. Element type number
3. Number of elements of this type
4. N4 in name of dataset xx.BTAB.N3.N4 where xx is BA, BB, SA, ...
5. Length of E-file† entry for this element
6. Offset of the end of segment 1 from the beginning of E-file entry
7. Offset of the end of segment 2 from the beginning of E-file entry
8. Offset of the end of segment 3 from the beginning of E-file entry
9. Offset of the end of segment 4 from the beginning of E-file entry
10. Offset of the end of segment 5 from the beginning of E-file entry
11. Offset of the end of segment 6 from the beginning of E-file entry
12. Offset of the end of segment 7 from the beginning of E-file entry
13. Offset of the end of segment 8 from the beginning of E-file entry
14. Offset of the end of segment 9 from the beginning of E-file entry
15. Precision of element stiffness in segment 5 of the E-file entry;
    1 = single precision, 2 = double precision
16. Number of stresses
17. Number of thermal loads
18. Number of degrees of freedom per node
19. MAJOR (=1 for beams, =2 for plates/shells, =3 for solids)
20. MINOR

† The term "E-file" refers to the xxxx.EFIL.*itype.nnod* dataset.

DISL.xxxx.*iset.icase*

xxxx = element name
iset = load set
icase= load case within load set

Created in processor AUS.

NJ = number of elements of this type
Type = single precision real

<u>For 2-node elements:</u>
NI = 6
Contents of each entry:

1. Displacement in direction 1
2. Displacement in direction 2
3. Displacement in direction 3
4. Rotation about axis 1
5. Rotation about axis 2
6. Rotation about axis 3

These displacements and rotations are relative to a reference frame, parallel to the element's reference frame, and embedded in node 2.

<u>For E31 elements:</u>
NI = 3
Contents of each entry:

1. Displacement of joint 2 in direction 1
2. Displacement of joint 3 in direction 1
3. Displacement of joint 3 in direction 2

<u>For E32 elements:</u>
NI = 6
Contents of each entry:

1. Displacement of joint 2 in direction 3
2. Rotation of joint 2 about axis 1
3. Rotation of joint 2 about axis 2
4. Displacement of joint 3 in direction 3
5. Rotation of joint 3 about axis 1
6. Rotation of joint 3 about axis 2

DISL.xxxx.*iset.icase* (continued)

For E33 elements

NI = 9

Contents of each entry:

1. Displacement of joint 2 in direction 1
2. Displacement of joint 3 in direction 1
3. Displacement of joint 3 in direction 2
4. Displacement of joint 2 in direction 3
5. Rotation of joint 2 about axis 1
6. Rotation of joint 2 about axis 2
7. Displacement of joint 3 in direction 3
8. Rotation of joint 3 about axis 1
9. Rotation of joint 3 about axis 2

For E41 elements:

NI = 6

Contents of each entry:

1. Displacement of joint 2 in direction 1
2. Displacement of joint 3 in direction 1
3. Displacement of joint 3 in direction 2
4. Displacement of joint 4 in direction 1
5. Displacement of joint 4 in direction 2
6. Displacement of joint 4 in direction 3

For E42 elements:

NI = 9

Contents of each entry:

1. Displacement of joint 2 in direction 3
2. Rotation of joint 2 about axis 1
3. Rotation of joint 2 about axis 2
4. Displacement of joint 3 in direction 3
5. Rotation of joint 3 about axis 1
6. Rotation of joint 3 about axis 2
7. Displacement of joint 4 in direction 3
8. Rotation of joint 4 about axis 1
9. Rotation of joint 4 about axis 2

DISL.xxxx.*iset.icase* (concluded)

For E43 elements:

NI = 14

Contents of each entry:

1. Displacement of joint 2 in direction 1
2. Displacement of joint 3 in direction 1
3. Displacement of joint 3 in direction 2
4. Displacement of joint 4 in direction 1
5. Displacement of joint 4 in direction 2
6. Displacement of joint 2 in direction 3
7. Rotation of joint 2 about axis 1
8. Rotation of joint 2 about axis 2
9. Displacement of joint 3 in direction 3
10. Rotation of joint 3 about axis 1
11. Rotation of joint 3 about axis 2
12. Displacement of joint 4 in direction 3.
13. Rotation of joint 4 about axis 1
14. Rotation of joint 4 about axis 2

For E44 elements:

NI = 6

Contents of each entry:

1. Displacement of joint 2 in direction 1
2. Displacement of joint 3 in direction 1
3. Displacement of joint 3 in direction 2
4. Displacement of joint 4 in direction 1
5. Displacement of joint 4 in direction 2
6. Displacement of joint 4 in direction 3

xxxx.EFIL.*itype.nnod*

xxxx = element name (*e.g.*, E43, S81, EX97)
itype = element type number
(E21=1 thru E44=12, S41=16, S61=17, S81=18, element implemented using an independent element processor = 0)
nnod = number of joints per element

Created by processor E, modified by processors EKS and GSF and by independent element processors, ES*i*.

NJ = Number of elements of this type
Type = mixed integer and real

Contents:

This dataset contains NJ entries, written as one entry per nominal record of mixed type data; each entry is made up of segments whose offsets from the beginning of the entry may be determined from the DIR.xxxx.*itype.nnod* dataset for the corresponding element type. There are two possible structures for records in this dataset: one structure is used for elements implemented in a structural element processor and a different dataset record structure is used for original SPAR elements. The two structures are described on the following pages.

For the remaining discussion of this dataset, the following definitions apply:

nen = the number of nodes

ndof = the number of degrees of freedom per element node

nee = the number of element degrees of freedom (typically $nen * ndof$)

nmt = the number of matrix terms in the upper triangle of the element matrices.

$$nmt = ndof^2 * nen * (nen + 1)/2$$

nb = the number of stress terms; used for SPAR elements only.

nsrt = the number of matrix terms in the full stress recovery matrix for original SPAR elements.

$$nsrt = nen * ndof * nb$$

xxxx.EFIL.*itype.nnod* (continued)

For elements implemented using a Structural Element processor (*e.g.*, ES1, ES5), the structure of the dataset is as follows:

Segment		Item	Length	Type	Description
1	Definition			Integ	Same as dataset DEF.<ES_NAME>.
2	Material			Real	(currently unused)
3	Geometry			Real	Element geometric parameters.
		XE0	(3,*nen*)		Initial element nodal coordinates in element basis.
		TEG	(3,3)		Transf. from global to current element basis.
		TEC	(3,3,*nen*)		Transf. from computational to element basis at element nodes.
		XG0	(3,*nen*)		Initial elt. nodal coords in global basis.
		TEG0	(3,3)		Transf. from global to initial element basis.
		DE	(*nee*)		Deformational displacements ($\mathbf{d}_e^{def}$).
4	Property			Real	(currently unused)
5	Matrix	KM	*nmt*	Real*	Element matrix (stiffness/mass); only upper triangle of nodal blocks.
6	Aux. Storage			Real	Auxiliary storage for element developer.
7	Stress			Real	(currently unused)
8	Therm. Force			Real	(currently unused)
9	Therm. Stress			Real	(currently unused)

*The element stiffness/mass matrix, item KM in Segment 5, may be stored in either single or double precision, as specified in dataset DIR.xxxx.*itype.nnod* (entry 15). However, all of the other REAL data in the xxxx.EFIL.*itype.nnod* dataset are stored exclusively in single precision.

xxxx.EFIL.*itype.nnod* (continued)

For the original SPAR elements the structure of the record is as follows:

Segment		Item	Length	Type	Description
1	Definition			Integ	Same as dataset DEF.xxxx. *itype.nnod*
2	Material			Real	(currently unused)
3	Geometry			Real	Element dependent geometric parameters.
					Structural 1-D elements:
		z	1		element length
		Dij	3		coordinates of node 2 in element basis
		R	(3,3)		Transf. from global to element basis
		Q	(3,3,2)		Transf. from global to nodal basis
		X_{off}	(3,2)		Rigid link offsets
					Structural 3-node elements:
		Area	1		Element area
		x	(2,3)		Element nodal coordinates in element basis
		TEG	(3,3)		Transf. from global to element basis
		TEC	(3,3,3)		Transf. from computational to element basis at element nodes
					Structural 4-node elements:
		Area	1		Element area
		A_{123}	1		Area of triangle connecting element nodes 1, 2 and 3
		A_{124}	1		Area of triangle connecting element nodes 1, 2 and 4
		X_{34}	1		Amount of warping
		X	(2,4)		Element nodal coordinates in element basis
		TEG	(3,3)		Transf. from global to element basis
		TEC	(3,3,4)		Transf. from computational to element basis at element nodes

xxxx.EFIL.*itype.nnod* **(concluded)**

	Segment	Item	Length	Type	Description
					3-d Solid elements:
		Vol.	1		Element volume
		x	(3,*nen*)		Element nodal coordinates in element basis.
		TEG	(3,3)		Transf. from global to element basis
		TEC	(3,3,*nen*)		Transf. from computational to element basis at element nodes.
4	Property			Real	**Structural 1-D elements:** Same as appropriate section properties dataset (*e.g.*, BA.BTAB.*.*)
					Structural 2-D elements:
					Section type (as used in SA.BTAB.2.13 dataset), material i.d., flexibility coefficients in upper triangular form. The flexibility matrix is transformed and rewritten as requested by processor EKS.
					3-D solid elements:
					Same as PROP.BTAB.2.21 dataset
5	Intrinsic Stiffness	Km	nmt	Real	Element intrinsic stiffness matrix; only upper triangle of nodal blocks.
6	Stress	R	*nsrt*	Real	Full element stress recovery matrix
7	Stress	S	*nb*	Real	Coefficients of stress terms
8	Thermal force				(currently unused)
9	Thermal Stress Recovery				(currently unused)

ELTS.ISCT

Created in processor ELD.

NJ = Number of element types in the model
NI = 1
Type = integer

Contents:

N4 of xx.BTAB.N3.N4 where xx = BA, BC, SA, ... which contains section property information for an element type.

ELTS.NAME

Created in processor ELD.

NI = 1
NJ = Number of element types in the model
Type = alphanumeric

Contents:

Alphanumeric element name of each element used in the model.

ELTS.NNOD

Created in processor ELD.

NJ = Number of element types in the model
NI = 1
Type = integer

Contents:

The number of nodes in each element type.

ES.SUMMARY

Created by structural element processors, ESi.
Type = mixed integer, real, and character

Contents:

This dataset contains a comprehensive set of parameters which collectively describe each element type/processor involved in the current model definition. The dataset is useful for both user query during pre/post-processing, as well as for driving the standard ES procedure which cycles through all pertinent element processors/types to perform analysis functions.

The following table describes the various record groups stored in dataset ES.SUMMARY.

ES.SUMMARY (concluded)

Record	Type	Length	Description
ES_C.1:*nesp*	Integ	(1)	Element displacement continuity (*e.g.*, 1⇒ C^1).
ES_CLAS.1:*nesp*	Char	(4)	Element class, *e.g.*, BEAM | SHELL | SOLID.
ES_CNS.1:*nesp*	Integ	(1)	Constitutive option.
ES_DIM.1:*nesp*	Integ	(1)	Number of element intrinsic dimensions (1,2,3).
ES_NAME.1:*nesp*	Char	(4)	Element type name within Processor. (*e.g.*, EX97).
ES_NDOF.1:*nesp*	Integ	(1)	Number of freedoms per element node (1:6).
ES_NEE.1:*nesp*	Integ	(1)	Number of element equations (NDOF*NEN).
ES_NEN.1:*nesp*	Integ	(1)	Number of element nodes.
ES_NIP.1:*nesp*	Integ	(1)	Number of element integration (stress) points.
ES_NORO.1:*nesp*	Integ	(1)	Nodal drilling-rotation parameter.
ES_NSTR.1:*nesp*	Integ	(1)	Number of stress components per integ. point.
ES_OPT.1:*nesp*	Integ	(1)	Element developer's option number (internal).
ES_NPAR.1:*nesp*	Integ	(1)	Number of meaningful research parameters in ES_PARS.
ES_PARS.1:*nesp*	Real	(NPAR)	Element research parameters.
ES_PROC.1:*nesp*	Char	(4)	Element Processor name (*e.g.*, ES1, ES2, ...).
ES_PROJ.1:*nesp*	Integ	(1)	Corotational projection option.
ES_SHAP.1:*nesp*	Char	(4)	Element planform shape: TRIA | QUAD.
ES_STOR.1:*nesp*	Integ	(1)	Number of entries in Segment 6 of EFIL dataset.

where *nesp* is the number of structural-element (ES) processors active in the current model. The sequence of element processors/types represented in this dataset corresponds to the sequence in which the elements were defined, using the DEFINE ELEMENTS command. Note that the *i*th element-processor and element-type defined in the model would be stored in records ES_PROC.*i* and ES_NAME.*i*, respectively.

EXT.FORC

Created by procedure NL_STATIC_1.
SYSVEC format. See APPL.FORC.*iset*.1

Contents:

This dataset contains the external forces at any load step. If no, APPL.FORC.*iset*.1 dataset is defined, EXT.FORC is initialized to zero by procedure NL_STATIC_1.

FAIL.xxxx.*i.j*

Contains failure criteria evaluated at the lower and upper surfaces of each layer in a laminate at one or more of the following locations: element centroid, element integration points, and element nodes.

xxxx = element name (*e.g.*, E41, EX97)

For <u>linear</u> static analysis:

i = load step
j = constraint case (ncon)

For <u>nonlinear</u> static analysis.

i = load step
$j = 0$

Created by processor FPF.

Type = single precision real

The dataset may contain as many as 21 record groups, one record in each record group per element. The record name is determined by the location at which a given criterion is evaluated as well as the specific criterion being evaluated. Record names may in general be defined as

rname_savid.ielt

where *rname* corresponds to the failure criterion evaluated, *savid* corresponds to the location, and *ielt* designates the element number.

Currently, permissible values for *rname* are:

MAX_STRESS	AZZI_TSAI
MAX_STRAIN	HOFFMAN
TSAI_HILL	TSAI_WU
M_TSAI_WU	

Permissible values for *savid* are: 'N' (nodes), 'I' (integration points), 'C' (centroids).

Each record contains n items of data where

$$n = nsave * max\_layer\_model * icrit$$

nsave = 1 if location = CENTROIDS,
element nodes if location = NODES, or
element integration points if location = INTEG_PTS

max_layer_model = maximum number of layers in the model; records for elements with fewer layers are zero-filled

icrit = number of values saved at each point for each layer (*e.g.*, icrit = 6 for

MAX_STRESS (three margins at lower and upper surfaces); icrit = 2 for TSAI_WU (one value at lower and upper surface))

The data is stored by layers for each evaluation location. For example, when location = NODES, the record MAX_STRESS_N.1 will contain:

3 margins at lower surface of laminate at node 1
3 margins at upper surface of bottom layer at node 1
⋮
3 margins at lower surface of top layer at node 1
3 margins at upper surface of laminate at node 1
3 margins at lower surface of laminate at node 2
⋮
⋮
3 margins at upper surface of laminate at node 4

GD.xxxx.*itype.nnod*

xxxx = Element name
itype = Type number
(E21=1 thru E44=12, S41=16, S61=17, S81=18, element implemented using an independent element processor = 0)
nnod = number of joints per element

Created from element definitions in processor ELD.

NJ = Number of groups
NI = 2
Type = integer

Contents of each entry:

1. Total number of elements within group
2. Cumulative total of elements in all previous groups

xxxx.GSP.*iset.ncon*

Created by processor GETK.
xxxx = first part of SPAR sparse formatted matrix dataset (*e.g.*, K, CEM, K+KG, etc.)
iset = Load set
ncon = Constraint case

Contains matrix coefficients and various associated integer pointer arrays. The coefficients are obtained by processor GETK from SPAR sparse formatted matrices stored in xxxx.SPAR datasets. SPAR sparse matrix format is the nodal block sparse storage used by processor K and matrix factorization processor INV. The sparse matrix format created by processor GETK, hereafter referred to as *dof* sparse format, is designed for more general degree-of-freedom oriented equation solvers. The *dof* sparse storage scheme is storage of the coefficients of the lower triangular part of symmetric matrices. The lower triangular coefficients are stored in a named record in the dataset xxxx.GSP.*iset.ncon*, arranged by columns. For each coefficient stored, an integer row index is also stored in a separate integer named record. Two additional integer named records are stored giving the starting position of each column of the lower trianglar matrix and the number of non-zeros in each column. Section 6.8 in the Testbed User's Manual describes the purpose and use of processor GETK and provides examples showing how to access the named records within the xxxx.GSP.*iset.ncon* dataset from a FORTRAN program.

The matrices stored in this dataset are stored with row or column pointer indices which reference the coefficients in one of two numbering schemes. The first scheme is used for the coefficients of matrix $K_{1,1}$ (see 6.8.1 in the Testbed Users Manual). The $K_{1,1}$ matrix is an $n \times n$ symmetric matrix where the integer stored for each coefficient indicates the row in which each coefficient is located. This symmetric non-singular matrix is usually factored or used as the input matrix for an iterative equation solver. The term *equation ordering* is used to describe this numbering scheme. The second scheme is used to minimize the need for indirect addressing associated with the multiplication of the $K_{1,2}$ and $K_{2,2}$ matrices stored in the xxxx.GSP.*iset.ncon* dataset by SYSVEC format vectors (see 6.8.1 in the Testbed Users Manual). The dimensions of these matrices are determined by the number of constraint conditions specified for a given problem. If m different constraints are specified (either fixed zero or non-zero displacements), then matrix $K_{1,2}$ has dimension $n \times m$ while $K_{2,2}$ is symmetric and has dimension $m \times m$. For both of these matrices the integer stored for each coefficient indicates the *joint-dof* corresponding to that coefficient. The term *joint-dof* identifies both the joint and degree-of-freedom associated with a particular equation in the global stiffness matrix. (*e.g.*, the third degree-of-freedom for node j would have a *joint-dof* of $(j-1) \times ndof + 3$ where *ndof* is the number of degrees of freedom at each node). This scheme is used because matrices $K_{1,2}$ and $K_{2,2}$ are used only to multiply SYSVEC format vectors which are stored in the *joint-dof* ordering. Since the coefficients of $K_{1,2}$ and $K_{2,2}$ are also stored in the *joint-dof* ordering no transformation from a local numbering for the coefficients of the matrices to the *joint-dof* numbering is required. The $K_{1,2}$ matrix is not symmetric and is stored by columns with only the coefficients of $K_{1,2}$ and $K_{2,2}$ are also stored in the *joint-dof* ordering no transformation from a local numbering for the coefficients of the matrices to the *joint-dof* numbering is required. The $K_{1,2}$ matrix is not symmetric and is stored by columns with only the non-zero coefficients in each column stored. Example 2 in Section 6.8.7 of the Testbed Users Manual illustrates the differences between the *equation ordering* numbering scheme and the *joint-dof* numbering scheme.

The dataset may contain as many as 14 named records. The record names, contents, and sizes are defined as follows:

Record Name	Contents
INFO	Contains the following 10 values which are necessary to determine the lengths of the remaining records. *numjnt* - number of joints *dof* - maximum degrees of freedom per node *jdof* - numjnt × dof *n* - number of equations *n2* - n × 2 if double precision, n else *lk11* - number of non-zeros in strictly upper triangular part of $K_{1,1}$ matrix. *lk12* - non-zeros in rectangular matrix $K_{1,2}$ *lk22* - number of non-zeros in strictly upper triangular part of $K_{2,2}$ matrix. *nk22* - number of rows in matrix $K_{2,2}$ *nappl* - number of non-zero fixed displacements
K11	Non-zero coefficients of strictly upper triangular symmetric $K_{1,1}$ matrix (by rows). Record length is *lk11*.
IK11	Column indices for each non-zero coefficient of strictly upper triangular symmetric $K_{1,1}$ matrix. Record length is *lk11*.
K22	Non-zero coefficients of strictly upper triangular symmetric $K_{2,2}$ matrix (by rows). Record length is *lk22*.
IK22	Joint-dof index for each non-zero coefficient of strictly upper triangular symmetric $K_{2,2}$ matrix. Record length is *lk22*.
KDIAG	Main diagonal coefficients for $K_{1,1}$ and $K_{2,2}$ matrices Record length is *jdof*.
K12	Non-zero coefficients of rectangular $K_{1,2}$ matrix (by columns) Record length is *lk12*.
IK11	Joint-dof indices for each non-zero coefficient of rectangular $K_{1,2}$ matrix Record length is *lk11*.
PTR1	row length and row pointer arrays for $K_{1,1}$ and $K_{1,2}$ matrices. Record length is *jdof* × 2.
PTR2	column length and column pointer arrays for $K_{2,2}$ matrix.

	Record length is $nk22 \times 2$.
JTOR	Ordering vector. JTOR(i) <0 indicates joint-dof i corresponds a row JTOR(i) >0 indicates that joint-dof i corresponds to row JTOR(i) in $K_{1,1}$. JTOR(i) $=0$ if joint-dof i is not active. Record length is $jdof$.
RTOJ	Ordering vector. RTOJ(i) indicates the joint-dof corresponding to row i in $K_{2,2}$ for i=1,n. For i=n+1,n+nk22 RTOJ(i) gives a list of joints corresponding to each row in $K_{2,2}$. Record length is $jdof$.
FORC	The total applied force stored in joint-dof ordering. Represents the sum of APPL.FORC.*.* and EQNF.FORC.*.* datasets. Does not include the effects of the applied displacements (APPL.MOTI.*.*).
RHS	The right hand side for the constrained linear system $K_{1,1}\mathbf{u} = \mathbf{f} - K_{1,2}\mathbf{x}_{con}$. Equation ordering for $K_{1,1}$ is used for RHS. Record length is n.

GSTR.E31.*iset.icase*

Contains stress resultants transformed to the global reference frame.

iset = Load set
icase = Load case within set

Created in processor GSF.

NJ = Number of E31 elements
NI = 11
Type = single precision real

The dataset contains NJ nominal records, NI items per record.

Contents of each record: (Note – x, y, z are in global reference frame.)

1. Group number
2. Element number within group
3. Joint #1
4. Joint #2
5. Joint #3
6. not used
7. Index of section property dataset entry for element section properties
8. Section type code
9. Tractive force in x-direction, N_x
10. Tractive force in y-direction, N_y
11. Shearing force, N_{xy}

Formulas:

$$S_x = N_x/\text{thickness}$$
$$S_y = N_y/\text{thickness}$$
$$T_{xy} = N_{xy}/\text{thickness}$$

GSTR.E32.*iset.icase*

Contains stress resultants transformed to the global reference frame.

iset = Load set
icase = Load case within set

Created in processor GSF.

NJ = Number of E32 elements
NI = 28
Type = single precision real

The dataset contains NJ nominal records, NI items per record.

Contents of each record:

1. Group number
2. Element number within group
3. Joint #1
4. Joint #2
5. Joint #3
6. Not used
7. Index of section property dataset entry for element section properties
8. Section type code
9. M_x Bending moment about y-axis at joint 1
10. M_y Bending moment about x-axis at joint 1
11. M_{xy} Twisting moment at joint 1
12. Q_x Transverse shear in x-direction at joint 1
13. Q_y Transverse shear in y-direction at joint 1
14. M_x Bending moment about y-axis at joint 2
15. M_y Bending moment about x-axis at joint 2
16. M_{xy} Twisting moment at joint 2
17. Q_x Transverse shear in x-direction at joint 2
18. Q_y Transverse shear in y-direction at joint 2
19. M_x Bending moment about y-axis at joint 3
20. M_y Bending moment about x-axis at joint 3
21. M_{xy} Twisting moment at joint 3
22. Q_x Transverse shear in x-direction at joint 3
23. Q_y Transverse shear in y-direction at joint 3

GSTR.E32.*iset.icase* (concluded)

24. M_x Bending moment about y-axis at the center
25. M_y Bending moment about x-axis at the center
26. M_{xy} Twisting moment at the center
27. Q_x Transverse shear in x-direction at the center
28. Q_y Transverse shear in y-direction at the center

Formulas:

$$S_x = f_{4j} M_x \qquad f_{ij} = 1/\text{thickness for } i \text{ and } j = 1,2,3$$
$$S_y = f_{5j} M_y \qquad f_{42} = f_{52} = -f_{62} = 6/(\text{thickness})^2$$
$$T_{xy} = f_{6j} M_{xy} \qquad f_{43} = f_{53} = -f_{63} = -6/(\text{thickness})^2$$

GSTR.E33.*iset.icase*

Contains stress resultants transformed to the global reference frame.

iset = Load set
icase = Load case within set

Created in processor GSF.

NJ = Number of E33 elements
NI = 31
Type = single precision real

The dataset contains NJ nominal records, NI items per record.

Contents of each record:

1. Group number
2. Element number within group
3. Joint #1
4. Joint #2
5. Joint #3
6. Not used
7. Index of section property dataset entry for element section properties
8. Section type code
9. N_x Tractive force in x-direction
10. N_y Tractive force in y-direction
11. N_{xy} Shearing force
12. M_x Bending moment about y-axis at joint 1
13. M_y Bending moment about x-axis at joint 1
14. M_{xy} Twisting moment at joint 1
15. Q_x Transverse shear in x-direction at joint 1
16. Q_y Transverse shear in y-direction at joint 1
17. M_x Bending moment about y-axis at joint 2
18. M_y Bending moment about x-axis at joint 2
19. M_{xy} Twisting moment at joint 2
20. Q_x Transverse shear in x-direction at joint 2
21. Q_y Transverse shear in y-direction at joint 2
22. M_x Bending moment about y-axis at joint 3
23. M_y Bending moment about x-axis at joint 3

GSTR.E33.*iset.icase* (concluded)

24. M_{xy} Twisting moment at joint 3
25. Q_x Transverse shear in x-direction at joint 3
26. Q_y Transverse shear in y-direction at joint 3
27. M_x Bending moment about y-axis at the center
28. M_y Bending moment about x-axis at the center
29. M_{xy} Twisting moment at the center
30. Q_x Transverse shear in x-direction at the center
31. Q_y Transverse shear in y-direction at the center

Formulas:

$$S_x = f_{1j}N_x + f_{4j}M_x \qquad f_{ij} = 1/\text{thickness for } i \text{ and } j = 1,2,3$$
$$S_y = f_{2j}N_y + f_{5j}M_y \qquad f_{42} = f_{52} = -f_{62} = 6/(\text{thickness})^2$$
$$T_{xy} = f_{3j}N_{xy} + f_{6j}M_{xy} \qquad f_{43} = f_{53} = -f_{63} = -6/(\text{thickness})^2$$

GSTR.E41.*iset.icase*

Contains stress resultants transformed to the global reference frame.

iset = Load set
icase = Load case within set

Created in processor GSF.

NJ = Number of E41 elements
NI = 23
Type = single precision real

The dataset contains NJ nominal records, NI items per record.

Contents of each record:

1. Group number
2. Element number within group
3. Joint #1
4. Joint #2
5. Joint #3
6. Joint #4
7. Index of section property dataset entry for element section properties
8. Section type code
9. N_x Tractive force in x-direction at joint 1
10. N_y Tractive force in y-direction at joint 1
11. N_{xy} Shearing force at joint 1
12. N_x Tractive force in x-direction at joint 2
13. N_y Tractive force in y-direction at joint 2
14. N_{xy} Shearing force at joint 2
15. N_x Tractive force in x-direction at joint 3
16. N_y Tractive force in y-direction at joint 3
17. N_{xy} Shearing force at joint 3
18. N_x Tractive force in x-direction at joint 4
19. N_y Tractive force in y-direction at joint 4
20. N_{xy} Shearing force at joint 4
21. N_x Tractive force in x-direction at the center
22. N_y Tractive force in y-direction at the center
23. N_{xy} Shearing force at the center

GSTR.E41.*iset.icase* (concluded)

Formulas:

$$S_x = N_x/\text{thickness}$$
$$S_y = N_y/\text{thickness}$$
$$T_{xy} = N_{xy}/\text{thickness}$$

GSTR.E42.*iset.icase*

Contains stress resultants transformed to the global reference frame.

iset = Load set
icase = Load case within set

Created in processor GSF.

NJ = Number of E42 elements
NI = 33
Type = single precision real

The dataset contains NJ nominal records, NI items per record.

Contents of each record:

1. Group number
2. Element number within group
3. Joint #1
4. Joint #2
5. Joint #3
6. Joint #4
7. Index of section property dataset entry for element section properties
8. Section type code
9. M_x Bending moment about y-axis at joint 1
10. M_y Bending moment about x-axis at joint 1
11. M_{xy} Twisting moment at joint 1
12. Q_x Transverse shear in x-direction at joint 1
13. Q_y Transverse shear in y-direction at joint 1
14. M_x Bending moment about y-axis at joint 2
15. M_y Bending moment about x-axis at joint 2
16. M_{xy} Twisting moment at joint 2
17. Q_x Transverse shear in x-direction at joint 2
18. Q_y Transverse shear in y-direction at joint 2
19. M_x Bending moment about y-axis at joint 3
20. M_y Bending moment about x-axis at joint 3
21. M_{xy} Twisting moment at joint 3
22. Q_x Transverse shear in x-direction at joint 3
23. Q_y Transverse shear in y-direction at joint 3

GSTR.E42.*iset.icase* (concluded)

24. M_x Bending moment about y-axis at joint 4
25. M_y Bending moment about x-axis at joint 4
26. M_{xy} Twisting moment at joint 4
27. Q_x Transverse shear in x-direction at joint 4
28. Q_y Transverse shear in y-direction at joint 4
29. M_x Bending moment about y-axis at the center
30. M_y Bending moment about x-axis at the center
31. M_{xy} Twisting moment at the center
32. Q_x Transverse shear in x-direction at the center
33. Q_y Transverse shear in y-direction at the center

Formulas:

$$S_x = f_{4j} M_x \qquad f_{42} = f_{52} = -f_{62} = -6/(\text{thickness})^2$$
$$S_y = f_{5j} M_y \qquad f_{43} = f_{53} = -f_{63} = -6/(\text{thickness})^2$$
$$T_{xy} = f_{6j} M_{xy}$$

GSTR.E43.*iset.icase*

Contains stress resultants transformed to the global reference frame.

iset = Load set
icase = Load case within set

Created in processor GSF.

NJ = Number of E43 elements
NI = 48
Type = single precision real

The dataset contains NJ nominal records, NI items per record.

Contents of each record:

1. Group number
2. Element number within group
3. Joint #1
4. Joint #2
5. Joint #3
6. Joint #4
7. Index of section property dataset entry for element section properties
8. Section type code
9. N_x Tractive force in x-direction at joint 1
10. N_y Tractive force in y-direction at joint 1
11. N_{xy} Shearing force at joint 1
12. N_x Tractive force in x-direction at joint 2
13. N_y Tractive force in y-direction at joint 2
14. N_{xy} Shearing force at joint 2
15. N_x Tractive force in x-direction at joint 3
16. N_y Tractive force in y-direction at joint 3
17. N_{xy} Shearing force at joint 3
18. N_x Tractive force in x-direction at joint 4
19. N_y Tractive force in y-direction at joint 4
20. N_{xy} Shearing force at joint 4
21. N_x Tractive force in x-direction at the center
22. N_y Tractive force in y-direction at the center
23. N_{xy} Shearing force at the center

GSTR.E43.*iset.icase* (concluded)

24. M_x Bending moment about y-axis at joint 1
25. M_y Bending moment about x-axis at joint 1
26. M_{xy} Twisting moment at joint 1
27. Q_x Transverse shear in x-direction at joint 1
28. Q_y Transverse shear in y-direction at joint 1
29. M_x Bending moment about y-axis at joint 2
30. M_y Bending moment about x-axis at joint 2
31. M_{xy} Twisting moment at joint 2
32. Q_x Transverse shear in x-direction at joint 2
33. Q_y Transverse shear in y-direction at joint 2
34. M_x Bending moment about y-axis at joint 3
35. M_y Bending moment about x-axis at joint 3
36. M_{xy} Twisting moment at joint 3
37. Q_x Transverse shear in x-direction at joint 3
38. Q_y Transverse shear in y-direction at joint 3
39. M_x Bending moment about y-axis at joint 4
40. M_y Bending moment about x-axis at joint 4
41. M_{xy} Twisting moment at joint 4
42. Q_x Transverse shear in x-direction at joint 4
43. Q_y Transverse shear in y-direction at joint 4
44. M_x Bending moment about y-axis at the center
45. M_y Bending moment about x-axis at the center
46. M_{xy} Twisting moment at the center
47. Q_x Transverse shear in x-direction at the center
48. Q_y Transverse shear in y-direction at the center

Formulas:

$$\begin{aligned} S_x &= f_{1j}N_x + f_{4j}M_x & f_{ij} &= 1/\text{thickness for } i \text{ and } j = 1,2,3 \\ S_y &= f_{2j}N_y + f_{5j}M_y & f_{42} &= f_{52} = -f_{62} = 6/(\text{thickness})^2 \\ T_{xy} &= f_{3j}N_{xy} + f_{6j}M_{xy} & f_{43} &= f_{53} = -f_{63} = 6/(\text{thickness})^2 \end{aligned}$$

GTIT.xxxx.*itype.nnod*

xxxx = Element name
itype = Type number
(E21=1 thru E44=12, S41=16, S61=17, S81=18, element implemented using an independent element processor = 0)
nnod = Number of joints/element

Created from element definitions in processor ELD.

NJ = Number of groups
NI = 15
Type = alphanumeric

Contents of each entry:

15 words of title for each group; default is blanks.

ICA.IN2.1.1

Created using AUS/TABLE for processors LDR and TRAN.

Contains the discrete force data for a variable forcing function.

NI = 1
NJ = Number of points
Type = Single-precision real

Contents:

1. f_1
2. f_2
3. f_3
4. etc.

INT.FORC

Created by procedure NL_STATIC_1.
SYSVEC format. See APPL.FORC.*iset*.1

Contents:

This dataset contains the internal forces at the current load step. At each load step, *istep*, internal forces are computed and saved in this dataset (overwriting the data from the previous load step) which is then copied into the REAC.FORC.*istep* dataset.

INV.*name.ncon*

name = name of the unfactored sparse format system matrix
ncon = constraint case applied during factorization

Created in processor INV.

NJ = total number of joints in the model
Type = mixed real and integer

Contains the upper triangle of the factored system matrix. For a matrix, **A**, factored into the product LDL^T, INV.A.2 dataset contains the inverse of the diagonal matrix D and the triangular matrix L^T stored by row for the system matrix **A** subject to constraint set 2. The dataset consists of one or more records with the default record size of 3584 words. A joint group is included for every joint in the model. Each record contains the following:

JOINTS - The number of joint groups contained in this record. A joint group is not allowed to span a record boundary.

INDEX(JMAX) - An array of integers pointing to the beginning of each joint group in the record. JMAX is defaulted to 50 and JOINTS must be $\leq$ JMAX.

Repeated JOINTS times:

JNT - The number of the current joint.

NZERO - the number of active degrees of freedom at the current joint. If NZERO equals zero, the next joint group follows.

MAP(NZERO) - a list of the unconstrained degrees of freedom at the current joint.

CONRNG - the number of joints connected to the current joint at the time of its elimination.

CONECT(CONRNG-1) - a list of all connected joints in the upper triangle of the factored matrix.

A(JDF, CONRNG, NZERO) - contains the $1/D_{ii}$ and L^T_{ij} components of the factored matrix for this joint. For each active degree of freedom (1 to NZERO), there is a vector JDF $\times$ CONRNG in length which represents a row of the factored matrix.

ITIM.IN2.1.1

Created using AUS/TABLE for processors LDR and TRAN.

Contains the time data for a variable forcing function.

NI = 1
NJ = Number of points
Type = Single-precision real

Contents:

1. t_1
2. t_2
3. t_3
4. etc.

JDF1.BTAB.1.8

Created by the TAB processor START command.

NJ = 1
NI = 18
Type = integer

Contents:

1. Total number of joints.
2. Number of active (unconstrained) degrees of freedom per joint.
3. Number of joint translational degrees of freedom not constrained.

4.–9. A list of unconstrained joint degrees of freedom, filled in consecutively from position number 4; unused values are zero. Example of d.o.f. 1, 2, and 6 unconstrained: 1,2,6,0,0,0

10.–15. A list specifying the order of each unconstrained degree of freedom; zero if not active. Example for d.o.f. 1, 2, and 6 unconstrained: 1,2,0,0,0,3

16.–18. Not used.

JLOC.BTAB.2.5

Created in subprocessor JLOC of processor TAB.

NJ = Number of joints
NI = 3
Type = single precision real

Contents:

	J = 1, 2, . . . Number of joints	
I = 1	x_1 x_2 ...	Rectangular coordinates
2	y_1 y_2 ...	of each joint in the
3	z_1 z_2 ...	global reference frame

JREF.BTAB.2.6

Created by subprocessor JREF of processor TAB.

NJ = Total number of joints
NI = 1
Type = integer

Contents:

Contains the joint reference frame number for each joint, corresponding to the entry in dataset ALTR.BTAB.2.4 containing the definition of each joint reference frame.

JSEQ.BTAB.2.17

Created by subprocessor JSEQ in processor TAB or by automatic joint ordering processors.

NJ = number of joints in the model
NI = 1
Type = integer

Contents:

The j^{th} entry contains the elimination order number for joint j.

K.SPAR.*jdf2*

jdf2 = square of the number of degrees of freedom in the model, JDF.

Created in processor K.

NJ = total number of joints in the model
Type = single or double precision real

Contents:

Contains the assembled global stiffness matrix in the Testbed sparse matrix format. The Testbed sparse matrix format stores only the nonzero JDF by JDF submatrices in the upper triangle of the symmetric system matrix. Submatrix i, j is nonzero if an element connects joints i and j. A Testbed sparse matrix format dataset consists of one or more fixed length records with a default record size of 2240 words. A joint group is included for every joint in the model starting in record 1 with the first joint to be eliminated in factorization. Integer information is converted to the numeric type of the dataset before being stored in the record. Each record contains the following:

JOINTS - The number of joint groups contained in this record. A joint group is not allowed to span a record boundary.

Repeated JOINTS times:

CONRNG - The number of submatrices including the diagonal in the upper triangle for the current joint.

SUBMAP(CONRNG) - A list of joints connected to the current joint (listed first).

S(JDF, JDF, CONRNG) - The submatrices in the upper triangle of the system matrix connected to the current joint. These correspond to the joints listed in SUBMAP.

KMAP..*nsubs.ksize*

nsubs = the total number of submatrices in a sparse format system matrix for this model
ksize = the maximum number of joints active at any time during the assembly of the system matrix

Created in processor TOPO and used by various processors to guide the assembly of system matrices.

NJ = total number of joints in the model
Type = integer

Contents:

The purpose of this dataset is to furnish compact information about elements connected to each joint in the model. It also defines which upper triangle submatrices will be nonzero for each joint. During assembly of a Testbed system matrix, a work area S(JDF, JDF, KSIZE) is used to hold the active submatrices. Information in the dataset shows where each piece of an elemental matrix fits in the array S. Other information in KMAP..*nsubs.ksize* shows which joint pair i, j is associated with each submatrix in S.

KMAP..*nsubs.ksize* (concluded)

The KMAP..*nsubs.ksize* dataset consists of one or more fixed length records with a default record size of 1792. A joint group is included for each joint in the model. Each joint group contains element groups for elements connected to the joint. Each record contains the following:

JOINTS - Number of joint groups contained in this record. A joint group is not allowed to span a record boundary.

Repeated JOINTS times:

- JNT - The number of the current joint
- LRNG - Number of elements which connect to JNT and any higher numbered joints. These are elements which will contribute to the upper triangle of the system matrix.

  Repeated LRNG times:

  - NODES - Number of nodes in the current element type
  - LTYPE - Integer number for this element type
  - NSE - Element number. For each element type, this number begins at one and increments for each element of the particular type.
  - ITYPE - Pointer into dataset NS for this element type
  - NSCT - N4 of the section property dataset name for this element type. See the ELTS.ISCT dataset.
  - ISCT - Index of section property dataset entry for element section properties.
  - MAP (NODES $*$ (NODES + 1)/2) - Location in the work area, S, where each submatrix in the elemental submatrix is to be summed. If MAP(I) ≤ 0, then the transpose of the elemental submatrix should be summed into S.

- CONRNG - The number of submatrices, including the diagonal, in the upper triangle for the current joint.
- CONECT(CONRNG-1) - A list of joints connected to the current joint.
- SUBMAP(CONRNG) - A pointer into the work array, S, for each submatrix associated with the current joint.

LAM.OMB.*nsect*.1

Contains the laminate data for shell section number "*nsect*".

Created using AUS/TABLE

NI = 3
NJ = Number of layers
Type = single precision real

Contents of each entry:

1. Material number
2. Layer thickness
3. Layer orientation

Repeated NJ times.

LAM.O3D.*nsect*.1

Contains the laminate data for solid section number "*nsect*".

Created using AUS/TABLE

NI = 3
NJ = Number of layers
Type = single precision real

Contents of each entry:

1. Material number
2. Layer thickness
3. Layer orientation

Repeated NJ times.

LANC.DISP.*i.j*

For <u>linear</u> dynamic analysis:

$i =$ Load set (*iset*)
$j =$ Constraint case (*ncon*)

Created in processor TRAN.

SYSVEC format. See APPL.FORC.*iset*.1.

Contents:

Each entry contains displacements for that joint in each active direction found using the Lanczos-vectors as basis vectors.

LANC.VECT.*nset.ncon*

nset = Set identifier

ncon = Constraint case

Created in processor LAN.

SYSVEC format. See APPL.FORC.*iset*.1.

Contents of each record:

Each block of data contains one Lanczos vector corresponding to an eigenvalue stored in VIBR.EVAL.*nset.ncon* created by processor LAN. Data are stored for each joint in each active direction.

MATC.BTAB.2.2

Created by MATC subprocessor of processor TAB.

NJ = Number of material types
NI = 10
Type = single precision real

Contents of each entry:

1. E = Modulus of elasticity
2. ν = Poisson's Ratio
3. G = shear modulus; default is $E/(2(1+\nu))$
4. ρ = Weight per unit volume
5. α_1 = Thermal expansion coefficient, direction x
6. α_2 = Thermal expansion coefficient, direction y
7. θ = Angle between element reference frame and the frame used for input of α_1 and α_2.
8. }
9. } Not used.
10. }

MREF.BTAB.2.7

Created by subprocessor MREF in processor TAB.

NJ = Number of beam orientation entries
NI = 5
Type = single precision real

Contents of each entry:

Format 1 (Default)

1. Beam axis NB
2. Global axis NG
3. 1. (floating point one) if cosine between NB and NG is positive, −1. (floating point negative one) if negative
4. Cosine of angle between NB and NG
5. 1. (floating point one; indicates format = 1)

Format 2

1. X1
2. X2
3. X3
4. I1 axis orientation
5. −1. (floating point negative one; indicating format = 2)

MSTR.E31.*iset.icase*

Contains stress resultants transformed to the material reference frame.

iset = Load set
icase = Load case within set

Created in processor GSF.

NJ = Number of E31 elements
NI = 11
Type = single precision real

The dataset contains NJ nominal records, NI items per record.

Contents of each record: (Note – x, y, z are in material reference frame.)

1. Group number
2. Element number within group
3. Joint #1
4. Joint #2
5. Joint #3
6. Not used
7. Index of section property dataset entry for element section properties
8. Section type code
9. Tractive force in x-direction N_x
10. Tractive force in y-direction N_y
11. Shearing force N_{xy}

Formulas:

$$S_x = N_x/\text{thickness}$$
$$S_y = N_y/\text{thickness}$$
$$T_{xy} = N_{xy}/\text{thickness}$$

MSTR.E32.*iset.icase*

Contains stress resultants transformed to the material reference frame.

iset = Load set
icase = Load case within set

Created in processor GSF.

NJ = Number of E32 elements
NI = 28
Type = single precision real

The dataset contains NJ nominal records, NI items per record.

Contents of each record:

1. Group number
2. Element number within group
3. Joint #1
4. Joint #2
5. Joint #3
6. Not used
7. Index of section property dataset entry for element section properties
8. Section type code
9. M_x Bending moment about y-axis at joint 1
10. M_y Bending moment about x-axis at joint 1
11. M_{xy} Twisting moment at joint 1
12. Q_x Transverse shear in x-direction at joint 1
13. Q_y Transverse shear in y-direction at joint 1
14. M_x Bending moment about y-axis at joint 2
15. M_y Bending moment about x-axis at joint 2
16. M_{xy} Twisting moment at joint 2
17. Q_x Transverse shear in x-direction at joint 2
18. Q_y Transverse shear in y-direction at joint 2
19. M_x Bending moment about y-axis at joint 3
20. M_y Bending moment about x-axis at joint 3
21. M_{xy} Twisting moment at joint 3
22. Q_x Transverse shear in x-direction at joint 3
23. Q_y Transverse shear in y-direction at joint 3

MSTR.E32.*iset.icase* (concluded)

24. M_x Bending moment about y-axis at the center
25. M_y Bending moment about x-axis at the center
26. M_{xy} Twisting moment at the center
27. Q_x Transverse shear in x-direction at the center
28. Q_y Transverse shear in y-direction at the center

Formulas:

$$S_x = f_{4j} M_x \qquad f_{ij} = 1/\text{thickness for } i \text{ and } j = 1,2,3$$
$$S_y = f_{5j} M_y \qquad f_{42} = f_{52} = -f_{62} = 6/(\text{thickness})^2$$
$$T_{xy} = f_{6j} M_{xy} \qquad f_{43} = f_{53} = -f_{63} = -6/(\text{thickness})^2$$

MSTR.E33.*iset.icase*

Contains stress resultants transformed to the material reference frame.

iset = Load set
icase = Load case within set

Created in processor GSF.

NJ = Number of E33 elements
NI = 31
Type = single precision real

The dataset contains NJ nominal records, NI items per record.

Contents of each record:

1. Group number
2. Element number within group
3. Joint #1
4. Joint #2
5. Joint #3
6. Not used
7. Index of section property dataset entry for element section properties
8. Section type code
9. N_x Tractive force in x-direction
10. N_y Tractive force in y-direction
11. N_{xy} Shearing force
12. M_x Bending moment about y-axis at joint 1
13. M_y Bending moment about x-axis at joint 1
14. M_{xy} Twisting moment at joint 1
15. Q_x Transverse shear in x-direction at joint 1
16. Q_y Transverse shear in y-direction at joint 1
17. M_x Bending moment about y-axis at joint 2
18. M_y Bending moment about x-axis at joint 2
19. M_{xy} Twisting moment at joint 2
20. Q_x Transverse shear in x-direction at joint 2
21. Q_y Transverse shear in y-direction at joint 2
22. M_x Bending moment about y-axis at joint 3
23. M_y Bending moment about x-axis at joint 3

MSTR.E33.*iset.icase* (concluded)

24. M_{xy} Twisting moment at joint 3
25. Q_x Transverse shear in x-direction at joint 3
26. Q_y Transverse shear in y-direction at joint 3
27. M_x Bending moment about y-axis at the center
28. M_y Bending moment about x-axis at the center
29. M_{xy} Twisting moment at the center
30. Q_x Transverse shear in x-direction at the center
31. Q_y Transverse shear in y-direction at the center

Formulas:

$$S_x = f_{1j}N_x + f_{4j}M_x \qquad f_{ij} = 1/\text{thickness for } i \text{ and } j = 1,2,3$$
$$S_y = f_{2j}N_y + f_{5j}M_y \qquad f_{42} = f_{52} = -f_{62} = 6/(\text{thickness})^2$$
$$T_{xy} = f_{3j}N_{xy} + f_{6j}M_{xy} \qquad f_{43} = f_{53} = -f_{63} = -6/(\text{thickness})^2$$

MSTR.E41.*iset.icase*

Contains stress resultants transformed to the material reference frame.

iset = Load set
icase = Load case within set

Created in processor GSF.

NJ = Number of E41 elements
NI = 23
Type = single precision real

The dataset contains NJ nominal records, NI items per record.

Contents of each record:

1. Group number
2. Element number within group
3. Joint #1
4. Joint #2
5. Joint #3
6. Joint #4
7. Index of section property dataset entry for element section properties
8. Section type code
9. N_x Tractive force in x-direction at joint 1
10. N_y Tractive force in y-direction at joint 1
11. N_{xy} Shearing force at joint 1
12. N_x Tractive force in x-direction at joint 2
13. N_y Tractive force in y-direction at joint 2
14. N_{xy} Shearing force at joint 2
15. N_x Tractive force in x-direction at joint 3
16. N_y Tractive force in y-direction at joint 3
17. N_{xy} Shearing force at joint 3
18. N_x Tractive force in x-direction at joint 4
19. N_y Tractive force in y-direction at joint 4
20. N_{xy} Shearing force at joint 4
21. N_x Tractive force in x-direction at the center
22. N_y Tractive force in y-direction at the center
23. N_{xy} Shearing force at the center

MSTR.E41.*iset.icase* (concluded)

Formulas:

$$S_x = N_x/\text{thickness}$$
$$S_y = N_y/\text{thickness}$$
$$T_{xy} = N_{xy}/\text{thickness}$$

MSTR.E42.*iset.icase*

Contains stress resultants transformed to the material reference frame.

iset = Load set
icase = Load case within set

Created in processor GSF.

NJ = Number of E42 elements
NI = 33
Type = single precision real

The dataset contains NJ nominal records, NI items per record.

Contents of each record:

1. Group number
2. Element number within group
3. Joint #1
4. Joint #2
5. Joint #3
6. Joint #4
7. Index of section property dataset entry for element section properties
8. Section type code
9. M_x Bending moment about y-axis at joint 1
10. M_y Bending moment about x-axis at joint 1
11. M_{xy} Twisting moment at joint 1
12. Q_x Transverse shear in x-direction at joint 1
13. Q_y Transverse shear in y-direction at joint 1
14. M_x Bending moment about y-axis at joint 2
15. M_y Bending moment about x-axis at joint 2
16. M_{xy} Twisting moment at joint 2
17. Q_x Transverse shear in x-direction at joint 2
18. Q_y Transverse shear in y-direction at joint 2
19. M_x Bending moment about y-axis at joint 3
20. M_y Bending moment about x-axis at joint 3
21. M_{xy} Twisting moment at joint 3
22. Q_x Transverse shear in x-direction at joint 3
23. Q_y Transverse shear in y-direction at joint 3

MSTR.E42.*iset.icase* (concluded)

24. M_x Bending moment about y-axis at joint 4
25. M_y Bending moment about x-axis at joint 4
26. M_{xy} Twisting moment at joint 4
27. Q_x Transverse shear in x-direction at joint 4
28. Q_y Transverse shear in y-direction at joint 4
29. M_x Bending moment about y-axis at the center
30. M_y Bending moment about x-axis at the center
31. M_{xy} Twisting moment at the center
32. Q_x Transverse shear in x-direction at the center
33. Q_y Transverse shear in y-direction at the center

Formulas:

$$S_x = f_{4j} M_x \qquad f_{42} = f_{52} = -f_{62} = -6/(\text{thickness})^2$$
$$S_y = f_{5j} M_y \qquad f_{43} = f_{53} = -f_{63} = -6/(\text{thickness})^2$$
$$T_{xy} = f_{6j} M_{xy}$$

MSTR.E43.*iset.icase*

Contains stress resultants transformed to the material reference frame.

iset = Load set
icase = Load case within set

Created in processor GSF.

NJ = Number of E43 elements
NI = 48
Type = single precision real

The dataset contains NJ nominal records, NI items per record.

Contents of each record:

1. Group number
2. Element number within group
3. Joint #1
4. Joint #2
5. Joint #3
6. Joint #4
7. Index of section property dataset entry for element section properties
8. Section type code
9. N_x Tractive force in x-direction at joint 1
10. N_y Tractive force in y-direction at joint 1
11. N_{xy} Shearing force at joint 1
12. N_x Tractive force in x-direction at joint 2
13. N_y Tractive force in y-direction at joint 2
14. N_{xy} Shearing force at joint 2
15. N_x Tractive force in x-direction at joint 3
16. N_y Tractive force in y-direction at joint 3
17. N_{xy} Shearing force at joint 3
18. N_x Tractive force in x-direction at joint 4
19. N_y Tractive force in y-direction at joint 4
20. N_{xy} Shearing force at joint 4
21. N_x Tractive force in x-direction at the center
22. N_y Tractive force in y-direction at the center
23. N_{xy} Shearing force at the center

MSTR.E43.*iset.icase* (concluded)

24. M_x Bending moment about y-axis at joint 1
25. M_y Bending moment about x-axis at joint 1
26. M_{xy} Twisting moment at joint 1
27. Q_x Transverse shear in x-direction at joint 1
28. Q_y Transverse shear in y-direction at joint 1
29. M_x Bending moment about y-axis at joint 2
30. M_y Bending moment about x-axis at joint 2
31. M_{xy} Twisting moment at joint 2
32. Q_x Transverse shear in x-direction at joint 2
33. Q_y Transverse shear in y-direction at joint 2
34. M_x Bending moment about y-axis at joint 3
35. M_y Bending moment about x-axis at joint 3
36. M_{xy} Twisting moment at joint 3
37. Q_x Transverse shear in x-direction at joint 3
38. Q_y Transverse shear in y-direction at joint 3
39. M_x Bending moment about y-axis at joint 4
40. M_y Bending moment about x-axis at joint 4
41. M_{xy} Twisting moment at joint 4
42. Q_x Transverse shear in x-direction at joint 4
43. Q_y Transverse shear in y-direction at joint 4
44. M_x Bending moment about y-axis at the center
45. M_y Bending moment about x-axis at the center
46. M_{xy} Twisting moment at the center
47. Q_x Transverse shear in x-direction at the center
48. Q_y Transverse shear in y-direction at the center

Formulas:

$$
\begin{aligned}
S_x &= f_{1j}N_x + f_{4j}M_x & \qquad f_{ij} &= 1/\text{thickness for } i \text{ and } j = 1,2,3 \\
S_y &= f_{2j}N_y + f_{5j}M_y & \qquad f_{42} &= f_{52} = -f_{62} = 6/(\text{thickness})^2 \\
T_{xy} &= f_{3j}N_{xy} + f_{6j}M_{xy} & \qquad f_{43} &= f_{53} = -f_{63} = 6/(\text{thickness})^2
\end{aligned}
$$

NDAL

Created by the TITLE command in processor TAB.

NJ = 1
Type = alphanumeric

Contents:

Library title

NMBE.DISP.*i.j*

For <u>linear</u> dynamic analysis:

$i =$ Load set (*iset*)
$j =$ Constraint case (*ncon*)

Created in processor TRAN.

SYSVEC format. See APPL.FORC.*iset*.1.

Contents:

Each entry contains displacements for that joint in each active direction found using the Newmark Beta method.

NODA.PRES.*iset*.1

iset = Load set

Created using subprocessor TABLE in processor AUS.

NJ = Number of joints
NI = 1
Number of blocks = Number of load cases in this load set.
Type = single precision real

Contents:

Each block of data contains nodal pressures for every joint in the structure. One block corresponds to one load case.

NODA.TEMP.*iset*.1

iset = Load set

Created using subprocessor TABLE in processor AUS.

NJ = Number of joints
NI = 1
Number of blocks = Number of load cases in this load set.
Type = single precision real

Contents:

Each block of data contains nodal temperatures for every joint in the structure. One block corresponds to one load case.

xxxx.NODE.*i.j*

Contains nodal values interpolated from element centroidal values.

xxxx = first word of the element value dataset name from which interpolation occurred (*e.g.*, ESR, ESC)
i.j = the same as used in the element value dataset name

Created in processor NVAL.

NJ = Number of joints
NI is a variable determined by resets used in Processor NVAL. Default = 8
Type = single precision real

Contents:

The dataset contains one nominal record. This record contains "smoothed" nodal values interpolated from 2-D structural element centroidal values (*i.e.*, stress resultants, strain energy, etc.).

NS

Created in processor ELD.

NJ = Number of element types present
NI = 1
Type = integer

Contents of each entry:

1. Offset of the end of segment 1 from the beginning of E-file† entry
2. Offset of the end of segment 2 from the beginning of E-file entry
3. Offset of the end of segment 3 from the beginning of E-file entry
4. Offset of the end of segment 4 from the beginning of E-file entry
5. Offset of the end of segment 5 from the beginning of E-file entry
6. Offset of the end of segment 6 from the beginning of E-file entry
7. Offset of the end of segment 7 from the beginning of E-file entry
8. Offset of the end of segment 8 from the beginning of E-file entry
9. Offset of the end of segment 9 from the beginning of E-file entry
10. Precision of element stiffness in segment 5 of the E-file entry
    1 = single precision, 2 = double precision
11. Number of stress resultants per element for elements implemented using an independent structural element processor. For original SPAR elements, this position is used to indicate the number of terms used in the stress approximation. For example, for E31 elements, a three (3) is stored here; for E41 elements a five (5) is stored here. See the CSM Testbed Theory Manual for further information.
12. Number of thermal loads
13. Number of degrees of freedom per node
14. MAJOR
15. MINOR

(The contents of each entry are the same as words 6-20 of the DIR.xxxx.*itype.nnod* dataset for the element type.)

† The term "E-file" refers to the xxxx.EFIL.*itype.nnod* dataset.

OMB.DATA.1.1

Created by AUS/TABLE

Contains the material properties for the 2-D section types.
NI = 16
NJ = Number of materials
Type = Real

Contents of each entry:

1. Young's Modulus, E_1
2. Poisson's Ratio, ν_{12}
3. Young's Modulus, E_2
4. Shear Modulus, G_{12}
5. Shear Modulus, G_{13}
6. Shear Modulus, G_{23}
7. Linear Thermal Expansion Coefficient, α_1
8. Linear Thermal Expansion Coefficient, α_2
9. Weight Density (weight per unit volume)
10. Longitudinal Compression Strain Allowable $(\epsilon_1)_{all}^C$
11. Transverse Compression Strain Allowable $(\epsilon_2)_{all}^C$
12. Inplane Shear Compression Strain Allowable $(\gamma_{12})_{all}^C$
13. Longitudinal Tension Strain Allowable $(\epsilon_1)_{all}^T$
14. Transverse Tension Strain Allowable $(\epsilon_2)_{all}^T$
15. Inplane Shear Tension Strain Allowable $(\gamma_{12})_{all}^T$
16. Zero-degree Lamina Compressive Strength , σ_0

Repeated NJ times.

O3D.DATA.1.1

Created using AUS/TABLE

Contains the material properties for the 3-D section types.
NI = 13
NJ = Number of materials
Type = Real

Contents of each entry:

1. Young's Modulus, E_1
2. Young's Modulus, E_2
3. Young's Modulus, E_3
4. Shear Modulus, G_{12}
5. Shear Modulus, G_{23}
6. Shear Modulus, G_{13}
7. Poisson's Ratio, ν_{12}
8. Poisson's Ratio, ν_{23}
9. Poisson's Ratio, ν_{13}
10. Weight Density (weight per unit volume)
11. Linear Thermal Expansion Coefficient, α_1
12. Linear Thermal Expansion Coefficient, α_2
13. Linear Thermal Expansion Coefficient, α_3

Repeated NJ times.

PRES.xxxx.*iset.icase*

xxxx = Element name
iset = Load set
icase = Load case within Load set

Created in processor AUS.

NJ = Number of elements of this type
Type = single precision real

For 2-node elements:
Not Applicable.

For 3-node structural elements:
NI = 3
Contents of each entry:

1. Pressure at joint 1
2. Pressure at joint 2
3. Pressure at joint 3

For 4-node structural elements:
NI = 4
Contents of each entry:

1. Pressure at joint 1
2. Pressure at joint 2
3. Pressure at joint 3
4. Pressure at joint 4

PROP.BTAB.1.101

Created from beam section properties in processor LAUB

NI = 36
NJ = Number of beam fabrications
Type = double precision real

Contents of each entry:

1. C_{11}	13. C_{13}	25. 0
2. C_{21}	14. C_{23}	26. 0
3. C_{31}	15. C_{33}	27. 0
4. 0	16. 0	28. C_{45}
5. 0	17. 0	29. C_{55}
6. 0	18. 0	30. 0
7. C_{12}	19. 0	31. 0
8. C_{22}	20. 0	32. 0
9. C_{32}	21. 0	33. 0
10. 0	22. C_{44}	34. C_{46}
11. 0	23. C_{54}	35. 0
12. 0	24. C_{64}	36. C_{66}

$$C(6,6) = \begin{array}{c} \\ N_x \\ M_y \\ M_z \\ T \\ Q_y \\ Q_z \end{array} \begin{array}{c} \begin{array}{cccccc} \bar{\epsilon}_x & \kappa_y & \kappa_z & \alpha & \gamma_y & \gamma_z \end{array} \\ \begin{pmatrix} C_{11} & C_{12} & C_{13} & 0 & 0 & 0 \\ C_{21} & C_{22} & C_{23} & 0 & 0 & 0 \\ C_{31} & C_{32} & C_{33} & 0 & 0 & 0 \\ 0 & 0 & 0 & C_{44} & C_{45} & C_{46} \\ 0 & 0 & 0 & C_{54} & C_{55} & 0 \\ 0 & 0 & 0 & C_{64} & 0 & C_{66} \end{pmatrix} \end{array}$$

where C_{ij} are the coefficients of the integrated constitutive matrix relating stress resultants and strains. where N_x, is the axial force, M_z and M_y are the two bending moments, T is the torsional moment, and Q_y, and Q_z, are the two transverse shear forces, and $\bar{\epsilon}_x$ is the *axial* strain, κ_y and κ_z are the *bending* strains, α is the *torsional strain*, and γ_y and γ_z are some "average" measures of the *transverse-shear* strains in the $x-y$ and $x-z$ planes, respectively.

PROP.BTAB.2.21

Created from solid section properties in processor LAU if reset SPAR = −1

NI = 31
NJ = Number of solid sections
Type = single precision real

Contents of each entry:

1. weight/unit volume
2. a_{11}
3. a_{21}
4. a_{22}
5. a_{31}
6. a_{32}
7. a_{33}
8. a_{41}
9. a_{42}
10. a_{43}
11. a_{44}
12. a_{51}
13. a_{52}
14. a_{53}
15. a_{54}
16. a_{55}
17. a_{61}
18. a_{62}
19. a_{63}
20. a_{64}
21. a_{65}
22. a_{66}
23. linear thermal expansion coefficient, α_x
24. linear thermal expansion coefficient, α_y
25. linear thermal expansion coefficient, α_z
26. Y_{xx}, reference stress for use in stress display
27. Y_{yy}, reference stress for use in stress display
28. Y_{zz}, reference stress for use in stress display
29. Y_{xy}, reference stress for use in stress display
30. Y_{yz}, reference stress for use in stress display
31. Y_{xz}, reference stress for use in stress display

The default values of each reference stress is 1.0.

For an orthotropic material with the 1-, 2-, and 3-directions aligned with the x-, y-, and z-directions respectively, the flexibility matrix components in terms of the engineering constants are

$$\begin{Bmatrix} \epsilon_x \\ \epsilon_y \\ \epsilon_z \\ \gamma_{xy} \\ \gamma_{yz} \\ \gamma_{zx} \end{Bmatrix} = \begin{bmatrix} \frac{1}{E_1} & -\frac{\nu_{21}}{E_2} & -\frac{\nu_{31}}{E_3} & 0 & 0 & 0 \\ -\frac{\nu_{12}}{E_1} & \frac{1}{E_2} & -\frac{\nu_{32}}{E_3} & 0 & 0 & 0 \\ -\frac{\nu_{13}}{E_1} & -\frac{\nu_{23}}{E_2} & \frac{1}{E_3} & 0 & 0 & 0 \\ 0 & 0 & 0 & \frac{1}{G_{12}} & 0 & 0 \\ 0 & 0 & 0 & 0 & \frac{1}{G_{23}} & 0 \\ 0 & 0 & 0 & 0 & 0 & \frac{1}{G_{13}} \end{bmatrix} \begin{Bmatrix} \sigma_x \\ \sigma_y \\ \sigma_z \\ \tau_{xy} \\ \tau_{yz} \\ \tau_{zx} \end{Bmatrix}$$

PROP.BTAB.2.21 (concluded)

or

$$\begin{Bmatrix} \epsilon_x \\ \epsilon_y \\ \epsilon_z \\ \gamma_{xy} \\ \gamma_{yz} \\ \gamma_{zx} \end{Bmatrix} = \begin{bmatrix} a_{11} & & & & & \\ a_{21} & a_{22} & & \text{symmetric} & & \\ a_{31} & a_{32} & a_{33} & & & \\ a_{41} & a_{42} & a_{43} & a_{44} & & \\ a_{51} & a_{52} & a_{53} & a_{54} & a_{55} & \\ a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & a_{66} \end{bmatrix} \begin{Bmatrix} \sigma_x \\ \sigma_y \\ \sigma_z \\ \tau_{xy} \\ \tau_{yz} \\ \tau_{zx} \end{Bmatrix}$$

where

E_1, E_2, E_3 = Young's moduli in 1, 2, and 3 directions, respectively.

ν_{ij} = Poisson's ratio for transverse strain in the j-direction when stressed in the i-direction.

G_{23}, G_{13}, G_{12} = shear moduli in the 2-3, 1-3, and 1-2 planes, respectively.

$$\frac{\nu_{ij}}{E_i} = \frac{\nu_{ji}}{E_j} \qquad i,j = 1,2,3$$

Thus, there are three reciprocal relations that must be satisfied for an orthotropic material. Moreover, only ν_{12}, ν_{13}, and ν_{23} need be further considered since ν_{21}, ν_{31}, and ν_{32} can be expressed in terms of the first-mentioned Poisson's ratios and the Young's moduli.

PROP.BTAB.2.101

Created from shell section properties in processor LAU

NI = 40
NJ = Number of shell sections
Type = single precision real

Contents include the stiffness coefficients for a first-order transverse shear deformation theory.

Contents of each entry:

1. A_{11}
2. A_{21}
3. A_{16}
4. B_{11}
5. B_{12}
6. B_{16}
7. A_{12}
8. A_{22}
9. A_{26}
10. B_{12}
11. B_{22}
12. B_{26}
13. A_{16}
14. A_{26}
15. A_{66}
16. B_{16}
17. B_{26}
18. B_{66}
19. B_{11}
20. B_{12}
21. B_{16}
22. D_{11}
23. D_{12}
24. D_{16}
25. B_{12}
26. B_{22}
27. B_{26}
28. D_{12}
29. D_{22}
30. D_{26}
31. B_{16}
32. B_{26}
33. B_{66}
34. D_{16}
35. D_{26}
36. D_{66}
37. CS_{55}
38. CS_{45}
39. CS_{45}
40. CS_{44}

where A_{ij} are the extensional stiffness coefficients, B_{ij} are the bending-extensional coupling stiffness coefficients, D_{ij} are the bending stiffness coefficients, and CS_{ij} are the transverse shear stiffness coefficients.

PROP.BTAB.2.101 (concluded)

These stiffness coefficients relate the force and moment resultants to the middle surface strains and curvatures. That is,

$$\begin{Bmatrix} N_x \\ N_y \\ N_{xy} \\ \text{—} \\ M_x \\ M_y \\ M_{xy} \end{Bmatrix} = \left[\begin{array}{ccc|ccc} A_{11} & A_{12} & A_{16} & B_{11} & B_{12} & B_{16} \\ A_{12} & A_{22} & A_{26} & B_{12} & B_{22} & B_{26} \\ A_{16} & A_{26} & A_{66} & B_{16} & B_{26} & B_{66} \\ \hline B_{11} & B_{12} & B_{16} & D_{11} & D_{12} & D_{16} \\ B_{12} & B_{22} & B_{26} & D_{12} & D_{22} & D_{26} \\ B_{16} & B_{26} & B_{66} & D_{16} & D_{26} & D_{66} \end{array}\right] \begin{Bmatrix} \epsilon_x^o \\ \epsilon_y^o \\ \gamma_{xy}^o \\ \text{—} \\ \kappa_x \\ \kappa_y \\ \kappa_{xy} \end{Bmatrix}$$

and

$$\begin{Bmatrix} Q_x \\ Q_y \end{Bmatrix} = \begin{bmatrix} CS_{55} & CS_{45} \\ CS_{45} & CS_{44} \end{bmatrix} \begin{Bmatrix} \gamma_{xz}^o \\ \gamma_{yz}^o \end{Bmatrix}$$

PROP.BTAB.2.102

Created from shell section properties in processor LAU

NI = 64
NJ = Number of shell sections
Type = single precision real

Contents include the stiffness coefficients for a first-order transverse shear deformation theory.

Contents of each entry:

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

PROP.BTAB.2.102 (concluded)

where A_{ij} are the extensional stiffness coefficients, B_{ij} are the bending-extensional coupling stiffness coefficients, D_{ij} are the bending stiffness coefficients, and CS_{ij} are the transverse shear stiffness coefficients.

These stiffness coefficients relate the force and moment resultants to the middle surface strains and curvatures. That is,

$$\left\{\begin{array}{c} N_x \\ N_y \\ N_{xy} \\ - \\ M_x \\ M_y \\ M_{xy} \\ - \\ Q_x \\ Q_y \end{array}\right\} = \left[\begin{array}{ccc|ccc|cc} A_{11} & A_{12} & A_{16} & B_{11} & B_{12} & B_{16} & 0 & 0 \\ A_{12} & A_{22} & A_{26} & B_{12} & B_{22} & B_{26} & 0 & 0 \\ A_{16} & A_{26} & A_{66} & B_{16} & B_{26} & B_{66} & 0 & 0 \\ \hline B_{11} & B_{12} & B_{16} & D_{11} & D_{12} & D_{16} & 0 & 0 \\ B_{12} & B_{22} & B_{26} & D_{12} & D_{22} & D_{26} & 0 & 0 \\ B_{16} & B_{26} & B_{66} & D_{16} & D_{26} & D_{66} & 0 & 0 \\ \hline 0 & 0 & 0 & 0 & 0 & 0 & CS_{55} & CS_{45} \\ 0 & 0 & 0 & 0 & 0 & 0 & CS_{45} & CS_{44} \end{array}\right] \left\{\begin{array}{c} \epsilon_x^o \\ \epsilon_y^o \\ \gamma_{xy}^o \\ - \\ \kappa_x \\ \kappa_y \\ \kappa_{xy} \\ - \\ \gamma_{xz}^o \\ \gamma_{yz}^o \end{array}\right\}$$

PROP.BTAB.2.103

Created from solid section properties in processor LAU
NI = 36
NJ = Number of solid sections
Type = single precision real

Contents include the constitute matrix for 3-D elasticity.

Contents of each entry:

1. C_{11}
2. C_{12}
3. C_{13}
4. C_{14}
5. C_{15}
6. C_{16}
7. C_{12}
8. C_{22}
9. C_{23}
10. C_{24}
11. C_{25}
12. C_{26}
13. C_{13}
14. C_{23}
15. C_{33}
16. C_{34}
17. C_{16}
18. C_{35}
19. C_{14}
20. C_{24}
21. C_{34}
22. C_{44}
23. C_{45}
24. C_{46}
25. C_{15}
26. C_{25}
27. C_{35}
28. C_{45}
29. C_{55}
30. C_{56}
31. C_{16}
32. C_{26}
33. C_{36}
34. C_{46}
35. C_{56}
36. C_{66}

For an orthotropic material with the 1-, 2-, and 3-directions aligned with the $x-$, $y-$, and $z-$directions, respectively, the stress-strain relations are:

$$\begin{Bmatrix} \sigma_x \\ \sigma_y \\ \sigma_z \\ \tau_{yz} \\ \tau_{xz} \\ \tau_{xy} \end{Bmatrix} = \begin{bmatrix} C_{11} & C_{12} & C_{13} & 0 & 0 & 0 \\ C_{12} & C_{22} & C_{23} & 0 & 0 & 0 \\ C_{13} & C_{23} & C_{33} & 0 & 0 & 0 \\ 0 & 0 & 0 & C_{44} & 0 & 0 \\ 0 & 0 & 0 & 0 & C_{55} & 0 \\ 0 & 0 & 0 & 0 & 0 & C_{66} \end{bmatrix} \begin{Bmatrix} \epsilon_x \\ \epsilon_y \\ \epsilon_z \\ \gamma_{yz} \\ \gamma_{xz} \\ \gamma_{xy} \end{Bmatrix}$$

PROP.BTAB.2.104

Created from 2-D section properties in processor LAU
NI = 13
NJ = Number of 2-D sections
Type = single precision real

Contents include the stiffness coefficients for 2-D plane elasticity.

Contents of each entry:

1. C_{11}
2. C_{12}
3. C_{13}
4. C_{12}
5. C_{22}
6. C_{23}
7. C_{13}
8. C_{23}
9. C_{33}
10. Thermal expansion coefficient, $x-$direction
11. Thermal expansion coefficient, $y-$direction
12. Weight density
13. Thickness

For isotropic materials only, the stress-strain relations are:

$$\begin{Bmatrix} \sigma_x \\ \sigma_y \\ \tau_{xy} \end{Bmatrix} = \begin{bmatrix} C_{11} & C_{12} & C_{13} \\ C_{12} & C_{22} & C_{23} \\ C_{13} & C_{23} & C_{33} \end{bmatrix} \begin{Bmatrix} \epsilon_x \\ \epsilon_y \\ \gamma_{xy} \end{Bmatrix}$$

PLANE STRESS

$$\begin{Bmatrix} \sigma_x \\ \sigma_y \\ \tau_{xy} \end{Bmatrix} = \frac{E}{(1-\nu^2)} \begin{bmatrix} 1 & \nu & 0 \\ \nu & 1 & 0 \\ 0 & 0 & \frac{1-\nu}{2} \end{bmatrix} \begin{Bmatrix} \epsilon_x \\ \epsilon_y \\ \gamma_{xy} \end{Bmatrix}$$

PLANE STRAIN

$$\begin{Bmatrix} \sigma_x \\ \sigma_y \\ \tau_{xy} \end{Bmatrix} = \frac{E}{(1+\nu)(1-2\nu)} \begin{bmatrix} 1-\nu & \nu & 0 \\ \nu & 1-\nu & 0 \\ 0 & 0 & \frac{1-2\nu}{2} \end{bmatrix} \begin{Bmatrix} \epsilon_x \\ \epsilon_y \\ \gamma_{xy} \end{Bmatrix}$$

where E = Young's Modulus
ν = Poisson's Ratio

PROP.MASS.1.101

Created from beam section properties in processor LAUB

NI = 36
NJ = Number of beam fabrications
Type = double precision real

Contents of each entry:

1. M_{11}
2. 0
3. 0
4. 0
5. M_{51}
6. M_{61}
7. 0
8. M_{22}
9. 0
10. M_{42}
11. 0
12. 0
13. 0
14. 0
15. M_{33}
16. M_{43}
17. 0
18. 0
19. 0
20. M_{24}
21. M_{34}
22. M_{44}
23. 0
24. 0
25. M_{15}
26. 0
27. 0
28. 0
29. M_{55}
30. M_{65}
31. M_{16}
32. 0
33. 0
34. 0
35. M_{56}
36. M_{66}

$$\mathcal{I}(6,6) = \begin{pmatrix} M_{11} & 0 & 0 & 0 & M_{15} & M_{16} \\ 0 & M_{22} & 0 & M_{24} & 0 & 0 \\ 0 & 0 & M_{33} & M_{34} & 0 & 0 \\ 0 & M_{42} & M_{43} & M_{44} & 0 & 0 \\ M_{51} & 0 & 0 & 0 & M_{55} & M_{56} \\ M_{61} & 0 & 0 & 0 & M_{65} & M_{66} \end{pmatrix}$$

where M_{ij} are the coefficients of the integrated inertia matrix.

PROP.MASS.2.102

Created from shell section properties by processor LAU.

NI = 3
NJ = Number of shell sections
Type = single precision real

Contents include the mass coefficients.

Contents of each entry:

1. $\overline{m}_0$
2. $\overline{m}_1$
3. $\overline{m}_2$

where $\overline{m}_0$ is the translational inertia coefficient, $\overline{m}_1$ is the translational-rotary inertia coupling coefficient, and $\overline{m}_2$ is the rotary inertia coefficient. The effect of an eccentric middle surface of the shell is included in these coefficients.

PROP.MASS.2.103

Created from solid section properties by processor LAU.

NI = 1
NJ = Number of solid sections
Type = single precision real

Contents include the average mass densities.

Contents of each entry:

1. ρ

where ρ is the average mass density for the solid sections.

QGEN.APPF.*iset*.1

Created using AUS/TABLE for processor QGEN.

Contains input for uniform line loads along any arbitrary edge or line (defined by the two points P and Q) for 2-D problems where *iset* is the load set number.

NI = 6
NJ = Number of edges
Type = Mixed

Contents of each record:

1. x- coordinate of point P
2. y- coordinate of point P
3. x- coordinate of point Q
4. y- coordinate of point Q
5. Direction of the constant force
6. = 1, if the force acts normal to PQ
7. = 2, if the force acts tangential to PQ
6. Numerical value of the constant force

Repeated NJ times.

QGEN.APPM.*con*.1

Created using AUS/TABLE for processor QGEN.

Contains the nonzero displacement boundary conditions in any arbitrary plane line, or point (defined by the coordinates of the three points P, Q, and R) for constraint set number *con*.

NI = 11
NJ = Number of planes
Type = Mixed

Contents of each record:

1. x- coordinate of point P
2. y- coordinate of point P
3. z- coordinate of point P
4. x- coordinate of point Q
5. y- coordinate of point Q
6. z- coordinate of point Q
7. x- coordinate of point R
8. y- coordinate of point R
9. z- coordinate of point R
10. Degree of freedom which is nonzero
11. Numerical value of the nonzero degree of freedom

Repeated NJ times.

QGEN.BCS.*con*.1

Created using AUS/TABLE for processor QGEN.

Contains the constrained (zero-displacement) boundary conditions in any arbitrary plane, line, or point (defined by the coordinates of the three points P, Q, and R) for constraint set number *con*.

NI = 15
NJ = Number of planes
Type = Mixed

Contents of each record:

1. x- coordinate of point P
2. y- coordinate of point P
3. z- coordinate of point P
4. x- coordinate of point Q
5. y- coordinate of point Q
6. z- coordinate of point Q
7. x- coordinate of point R
8. y- coordinate of point R
9. z- coordinate of point R
10. First degrees of freedom to be suppressed
11. Second degrees of freedom to be suppressed
12. Third degrees of freedom to be suppressed
13. Fourth degrees of freedom to be suppressed
14. Fifth degrees of freedom to be suppressed
15. Sixth degrees of freedom to be suppressed

Repeated NJ times.

QGEN.DEF.1.1

Created using AUS/TABLE for processor QGEN

Contains the element connectivity for the superelements.

NI = 12
NJ = Number of superlements
Type = Integer

Contents of each record:

1. Node number 1 of superelement 1
2. Node number 2 of superelement 1
3. Node number 3 of superelement 1
4. Node number 4 of superelement 1
5. Node number 5 of superelement 1
6. Node number 6 of superelement 1
7. Node number 7 of superelement 1
8. Node number 8 of superelement 1
9. Material identification for the element (= 1 if left blank)
10. Sectional property identification for the element (= 1 if left blank)
11. Group identification for the element (= 1 if left blank)
12. Stress reference frame (= 0 if left blank)

Repeated NJ times.

Note: All elements generated within a superelement will have the same values for NMAT, NSECT, GROUP and SREF as specified in entries (9) to (12).

QGEN.DVID.1.1

Created using AUS/TABLE for processor QGEN.

Contains the element division (discretization) in each superelement along with mesh grading factors.

NI = 5
NJ = Number of superelements in model.
Type = Mixed

Contents of each record:

1. Element number
2. Number of divisions needed in $\xi-$ direction
3. Number of divisions needed in $\eta-$ direction
4. Grading factor BETA1, in $\xi-$ direction
5. Grading factor BETA2, in $\eta-$ direction

Repeated NJ times.

QGEN.JLOC.1.1

Created using AUS/TABLE for processor QGEN.

Contains the coordinates of the user-defined points in the superelement model (midside points on straight sides are generated automatically by processor QGEN).

NI = 4
NJ = Number of joints for which coordinates are input
Type = Mixed

Contents of each record:

1. Joint number
2. x- coordinates or the joint
3. y- coordinates of the joint
4. z- coordinates of the joint

Repeated NJ times.

QJJT.BTAB.2.19

Created in processor TAB.

NJ = Number of Joints
NI = 9
Type = single precision real

Contents of each entry:

1. a_{11}
2. a_{21}
3. a_{31}
4. a_{12}
5. a_{22}
6. a_{32}
7. a_{13}
8. a_{23}
9. a_{33}

Formula:

Each entry contains a 3 × 3 matrix to convert global reference frame to alternate reference frame for that joint.

$$\underbrace{\begin{Bmatrix} X_a \\ Y_a \\ Z_a \end{Bmatrix}}_{\text{coordinates in alternate reference frame}} = \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix} \underbrace{\begin{Bmatrix} X_g \\ Y_g \\ Z_g \end{Bmatrix}}_{\text{coordinates in global reference frame}}$$

REAC.FORC.*istep*

istep = Load step for nonlinear static analysis

Created by procedure NL_STATIC_1.
SYSVEC format. See APPL.FORC.*iset*.1

Contents:

This dataset contains the nodal reaction forces at load step *istep*.

RESPONSE.HISTORY

Created by procedure NL_STATIC_1.
Type = mixed integer and double precision real

Contents:

This dataset contains a nonlinear response history. The user may select the nodes and degrees-of-freedom to be saved. The following table describes the various record groups stored in RESPONSE.HISTORY dataset.

Record	Type	Length	Description
COEF.DET.1:*nesp*	D	(1)	Coefficient of ten(10) in the stiffness determinant (*i.e.*, det=coef_det * $10^{(exp10\_det)}$)
DISP_*dofi*_*i*.1:*nstep*	D	(1)	Displacement *dofi* for node *i*
DISP_*dofj*_*j*.1:*nstep*	D	(1)	Displacement *dofj* for node *j*
ERROR.1:*nstep*	D	(1)	Relative energy error
EXP10_DET.1:*nstep*	I	(1)	Exponent of ten (10) in the stiffness determinant
FORCE_*dof*_*i*.1:*nstep*	D	(1)	Reaction force in *dofi* direction for node *i*
FORCE_*dof*_*j*.1:*nstep*	D	(1)	Reaction force in *dofj* direction for node *j*
LOAD.1:*nstep*	D	(1)	Load factor
LOAD_DIR.1:*nstep*	I	(1)	Direction of load
NEG_ROOTS.1:*nstep*	D	(1)	Number of negative diagonal terms in stiffness matrix
NUM_CUTS.1:*nstep*	I	(1)	Number of cuts in step size
NUM_ITERS.1:*nstep*	I	(1)	Number of iterations for current step size
PATH_INC.1:*nstep*	D	(1)	Path length increment
REF_ERR.1:*nstep*	D	(1)	Reference value of error
SIGN_DET.1:*nstep*	I	(1)	Sign of determinant
TOT.ITERS.1:*nstep*	I	(1)	Total number of iterations for current step. Will equal NUM_ITERS.*i* if NUM_CUTS.*i* = 0

RESPONSE.HISTORY (concluded)

where

nstep is the number of steps in the nonlinear analysis

dofi, dofj are degrees-of-freedom specified in NL_STATIC_1 argument list (SEL_DOFS)

i, j are nodes specified in NL_STATIC_1 argument list (SEL_NODES)

Note that the name of this dataset is an argument to the NL_STATIC_1 procedure. The name, RESPONSE.HISTORY, is the default name.

SA.BTAB.2.13

Created from shell section properties in processor TAB.

NJ = Number of entries
Type = single precision real

Contents vary according to section type:

For MEMBRANE, PLATE, ISOTROPIC or UNCOUPLED section types: NI = 43

Contents of each entry:

1. Number indicating section type
   1 MEMBRANE
   2 PLATE
   3 ISOTROPIC or UNCOUPLED
2. Pointer to entry IN MATC.BTAB.2.2 containing material constants
3. Structural weight/area
4. d_{11}
5. d_{12}
6. d_{22}
7. d_{13}
8. d_{23}
9. d_{33}
10. d_{44}
11. d_{45}
12. d_{55}
13. d_{46}
14. d_{56}
15. d_{66}

(4–15: flexibility coefficients)

16. thru 25. Not used.

26. f_{11}
27. f_{21}
28. f_{31}
29. f_{41}
30. f_{51}
31. f_{61}
32. f_{12}
33. f_{22}
34. f_{32}
35. f_{42}
36. f_{52}
37. f_{62}
38. f_{13}
39. f_{23}
40. f_{33}
41. f_{43}
42. f_{53}
43. f_{63}

(26–43: stress coefficients)

SA.BTAB.2.13 (continued)

For COUPLED section types: NI = 43

Contents of each entry:

1. Number indicating section type
   4 = COUPLED
2. Pointer to entry in MATC.BTAB.2.2 containing material constants
3. Structural weight/area
4. d_{11}
5. d_{12}
6. d_{22}
7. d_{13}
8. d_{23}
9. d_{33}
10. d_{14}
11. d_{24}
12. d_{34}
13. d_{44}
14. d_{15}
15. d_{25}
16. d_{35}
17. d_{45}
18. d_{55}
19. d_{16}
20. d_{26}
21. d_{36}
22. d_{46}
23. d_{56}
24. d_{66}

(items 4–24: flexibility coefficients)

25. Number of layers
26. f_{11}
27. f_{21}
28. f_{31}
29. f_{41}
30. f_{51}
31. f_{61}
32. f_{12}
33. f_{22}
34. f_{32}
35. f_{42}
36. f_{52}
37. f_{62}
38. f_{13}
39. f_{23}
40. f_{33}
41. f_{43}
42. f_{53}
43. f_{63}

(items 26–43: stress coefficients)

SA.BTAB.2.13 (concluded)

For LAMINATE section types: NI = 25 + (18 times number of layers)

Contents of each entry:

1. Number indicating section type
   5 = LAMINATE
2. Pointer to entry in MATC.BTAB.2.2 containing material constants
3. Structural weight/area
4. d_{11}
5. d_{12}
6. d_{22}
7. d_{13}
8. d_{23}
9. d_{33}
10. d_{14}
11. d_{24}
12. d_{34}
13. d_{44}
14. d_{15}
15. d_{25}
16. d_{35}
17. d_{45}
18. d_{55}
19. d_{16}
20. d_{26}
21. d_{36}
22. d_{46}
23. d_{56}
24. d_{66}

(items 4–24: flexibility coefficients)

25. Number of layers
26. g^1_{11}
   .
   .
   .
43. g^1_{36}

(items 26–43: stress recovery coefficients for first layer)

44. g^2_{11}
   .
   .
   .
61. g^2_{36}

(items 44–61: stress recovery coefficients for second layer)

62. through (25 + 18 * number of layers). Eighteen additional values of g_{ij}^{nlayer} for each successive layer.

SB.BTAB.2.14

Created by subprocessor SB in processor TAB.

NJ = Number of entries
NI = 4
Type = single precision real

Contents of each entry:

1. Thickness of E44 element
2. }
3. } Not used.
4. }

SED.xxxx.*i*.*j*

Contains element strain energy density (SED) components for 2-D elements at one or more of the following locations: element centroid, each integration point, and each node.

xxxx = element name (*e.g.*, EX41, EX97)

For **linear** static analysis:

i = Load set (*iset*)
j = Constraint case (*ncon*)

For **nonlinear** static analysis:

i = Load step (*istep*)
j = 0

Created by processor SED

Type = single precision real

The dataset may contain as many as 12 record groups, one record in each record group per structural element. The record name is determined by the location and the reference frame used in calculating the strain energy density. The record names, contents, and sizes are defined as follows:

CENTROIDS_S*dir*.*ielt*	SED components at the centroid of element *ielt* based on stress resultants in reference frame *dir*. Record length is the number of strain energy density components.
INTEG_PTS_S*dir*.*ielt*	SED components at each integration point of element *ielt* based on stress resultants in reference frame *dir*. The record is ordered such that all SED components at the first integration point are followed by all SED components at the second integration point, etc. Record length is equal to the number of SED components times the number of integration points.
NODES_S*dir*.*ielt*	SED components at each node of element *ielt* in reference frame *dir*. The record is ordered such that all SED components at the first node are followed by all SED components at the second node, etc. Record length is equal to the number of SED components times the number of nodes.

where *dir* indicates the stress/strain reference frame. Strain components may be computed in the element stress/strain reference frame ($dir = 0$) or in one of three alternate reference frames. For $dir = 1$, the strain x direction is coincident with the global x direction. For $dir = 2$, the strain x direction is coincident with the global y direction. For $dir = 3$ the strain x direction is coincident with the global z direction. Note that the chosen reference frame need not be coincident with the material reference frame. For example, a record named

CENTROIDS_S1.15

will contain SED components, at the centroids, computed in the global reference frame for element number 15.

Strain energy density components are ordered: SED due to membrane stress resultants, SED due to out-of-plane bending resultants, SED due to membrane-bending coupling, SED due to transverse shear, and the total SED (the sum of the first four components).

SPLI.GEOM.*isurf.nsym*

$isurf$ = surface number

$$nsym = \begin{cases} isym & \text{if } isym \geq 0; \\ |isym| + 2 & \text{otherwise.} \end{cases}$$

where *isurf* and *isym* are defined in processor SPLN (see Section 14.2 of the CSM Testbed User's Manual).

Contains minimum and maximum x and y values for the spline interpolation region within the global model.

Created in processor SPLN.

NJ = 1
NI = 4
Type = single precision real

The dataset contains NJ nominal records, NI items per record.

Contents of each record:

1. Minimum x coordinate
2. Maximum x coordinate
3. Minimum y coordinate
4. Maximum y coordinate

SPLI.INPU.*isurf.nsym*

$isurf$ = surface number

$$nsym = \begin{cases} isym & \text{if } isym \geq 0; \\ |isym| + 2 & \text{otherwise.} \end{cases}$$

where *isurf* and *isym* are defined in processor SPLN (see Section 14.2 of the CSM Testbed User's Manual).

Contains the nodal x and y coordinates for the spline interpolation region within the global model.

Created in processor SPLN.

NJ = number of joints in interpolation region
NI = 2
Type = single precision real

The dataset contains NJ nominal records, NI items per record.

Contents:

	J = 1, 2, . . . Number of joints
I = 1	x_1 x_2 ... Rectangular coordinates of
2	y_1 y_2 ... joints in global reference frame

SPLI.NODI.*isurf.nsym*

$isurf$ = surface number

$$nsym = \begin{cases} isym & \text{if } isym \geq 0; \\ |isym| + 2 & \text{otherwise.} \end{cases}$$

where $isurf$ and $isym$ are defined in processor SPLN (See Section 14.2 of the CSM Testbed User's Manual).

Contains the node numbers of the corresponding x and y coordinates for the spline interpolation region within the global model.

Created in processor SPLN.

NJ = number of joints in interpolation region
NI = 1
Type = integer

The dataset contains NJ nominal records, NI items per record.

Contents:

	J = 1, 2, . . . Number of joints
I = 1	J_1 J_2 ... Node numbers

SPLI.MATR.*isurf.nsym*

$isurf$ = surface number

$$nsym = \begin{cases} isym & \text{if } isym \geq 0; \\ |isym| + 2 & \text{otherwise.} \end{cases}$$

where $isurf$ and $isym$ are defined in processor SPLN (see Section 14.2 of the CSM Testbed User's Manual).

Contains the spline coefficient matrix or its inverse to be used for interpolating the specified field. If the reset parameter INV is equal to one, the dataset contains the inverse of the coefficient matrix. If INV is not equal to one, then the dataset contains the coefficient matrix.

Created in processor SPLN.

NJ = number of joints in interpolation region + n
NI = number of joints in interpolation region + n
Type = single precision real

$$\text{where } n = \begin{cases} 3 & \text{if } isym = 0; \\ 2 & \text{otherwise.} \end{cases}$$

The dataset contains NJ nominal records, NI items per record.

Contents:

$$\left.\begin{array}{rl} 1. & a_{11} \\ 2. & a_{21} \\ 3. & a_{31} \\ \vdots & \\ nj. & a_{nj,1} \\ nj+1. & a_{12} \\ nj+2. & a_{22} \\ nj+3. & a_{32} \\ \vdots & \\ 2*nj. & a_{nj,2} \\ \vdots & \\ nj*ni. & a_{ni,nj} \end{array}\right\} \begin{array}{c} \text{Components of a} \\ \text{spline coefficient matrix} \\ \text{or its inverse} \end{array}$$

$$A_{ni,nj} = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1,nj} \\ a_{21} & a_{22} & \cdots & a_{2,nj} \\ \vdots & \vdots & \ddots & \vdots \\ a_{ni,1} & a_{ni,2} & \cdots & a_{ni,nj} \end{bmatrix}$$

STAT.DISP.*i.j*

For <u>linear</u> static analysis:

i = Load set (*iset*)
j = Constraint case (*ncon*)

For **<u>nonlinear</u>** static analysis:

i = Load step (*istep*)
j = 0

Created in processor SSOL.

SYSVEC format. See APPL.FORC.*iset*.1.

Contents:

Each entry contains static displacements for that joint in each active direction.

STAT.REAC.*i.j*

For <u>linear</u> static analysis:

i = Load set (*iset*)
j = Constraint case (*ncon*)

For <u>nonlinear</u> static analysis:

i = Load step (*istep*)
j = 0

Created in processor SSOL.

SYSVEC format. See APPL.FORC.*iset*.1.

Contents:

Each entry contains static reactions for the joint constrained degrees of freedom and residual errors for the joint unconstrained degrees of freedom. There are no entries for globally constrained degrees of freedom (*i.e.*, those declared inactive using TAB/START).

STAT.RES.*iset.ncon*

iset = Load set
ncon = Constraint set

Created in processor ITER.

SYSVEC format

Each entry represents the residual for the associated equation in the linear system $Ku = f$. The residual is computed using the constrained system K which is derived by applying constraint conditions to the unconstrained stiffness matrix (usually K.SPAR). This dataset is useful whenever one wants to examine the error in the computed solution u, particularly when there are fixed displacements in the problem (APPL.MOTI.). See documentation for processor ITER in the User's Manual (Section 7.5).

STRN.xxxx.*i.j*

Contains element strain components at **one or more** of the following locations: element centroid, each integration point, and each node.

xxxx = element name (*e.g.*, EX41, EX97)

For <u>linear</u> static analysis:

i = Load set (*iset*)
j = Constraint case (*ncon*)

For <u>nonlinear</u> static analysis:

i = Load step (*istep*)
j = 0

Created by processor ES*i* (*e.g.*, ES1, ES2, ES5)

Type = single precision real

The dataset may contain as many as 12 record groups, one record in each record group per structural element. The record name is determined by the location and the reference frame used in calculating the strain components. The record names, contents, and sizes are defined as follows:

CENTROIDS_S*dir.ielt*	STRAIN components at the centroid of element *ielt* in reference frame *dir*. Record length is the number of STRAIN components.
INTEG_PTS_S*dir.ielt*	STRAIN components at each integration point of element *ielt* in reference frame *dir*. The record is ordered such that all STRAIN components at the first integration point are followed by all STRAIN components at the second integration point, etc. Record length is equal to the number of STRAIN components times the number of integration points.
NODES_S*dir.ielt*	STRAIN components at each node of element *ielt* in reference frame *dir*. The record is ordered such that all STRAIN components at first node are followed by all STRAIN components at the second node, etc. Record length is equal to the number of STRAIN components times the number of nodes.

where *dir* indicates the stress/strain reference frame. Strain components may be computed in the element stress/strain reference frame ($dir = 0$) or in one of three alternate reference frames. For $dir = 1$, the strain x direction is coincident with the global x direction. For $dir = 2$, the strain x direction is coincident with the global y direction. For $dir = 3$ the strain x direction is coincident with the global z direction. Note that the chosen reference frame need not be coincident with the material reference frame. For example, a record named

CENTROIDS_S1.15

will contain strain components, at the centroids, computed in the global reference frame for element number 15.

For 2-D structural elements, strain components are typically ordered: ϵ^o_{xx}, ϵ^o_{yy}, ϵ^o_{xy}, κ_{xx}, κ_{yy}, κ_{xy}, γ_x, γ_y. Users should consult the specific element processor documentation for the strain components calculated by the specific element processor.

STRS.E21*iset.icase*

iset = Load set
icase = Load case within set

Created in processor GSF.

NJ = Number of E21 elements
NI = 52
Type = single precision real

The dataset contains NJ nominal records, NI items per record.

Contents of each record:

1. Group number
2. Element number within group
3. Joint #1
4. Joint #2
5. Max. combined P/A + bending (tension)
6. Max. combined P/A + bending (compression)
7. P/A
8. Transverse shear stress, S
9. Transverse shear stress, S
10. Twist shear
11. Shear force, end 1, direction 1
12. Shear force, end 1, direction 2
13. Axial force, end 1, direction 3
14. Moment, end 1, direction 4
15. Moment, end 1, direction 5
16. Moment, end 1, direction 6
17. Shear force, end 2, direction 1
18. Shear force, end 2, direction 2
19. Axial force, end 2, direction 4
20. Moment, end 2, direction 4
21. Moment, end 2, direction 5
22. Moment, end 2, direction 6
23. Not used
24. I_1
25. α_1
26. I_2
27. α_2
28. Cross-sectional Area
29. f_1
30. f_2
31. z_1
32. z_2
33. θ
34. q_1
35. q_2
36. q_3
37. NY = number of points for stress
38. y_{11}
39. y_{12}
40. y_{21}
41. y_{22}
42. y_{31}
43. y_{32}
44. y_{41}
45. y_{42}
46. b_1
47. t_1
48. b_2
49. t_2
50. b_3
51. t_3

STRS.E22.*iset.icase*

iset = Load set
icase = Load case within set

Created in processor GSF.

NJ = Number of E22 elements
NI = 16
Type = single precision real

The dataset contains NJ nominal records, NI items per record.

Contents of each record:

1. Group number
2. Element number within group
3. Joint #1
4. Joint #2
5. Force in direction 1 at joint 1
6. Force in direction 2 at joint 1
7. Force in direction 3 at joint 1
8. Moment about axis 1 at joint 1
9. Moment about axis 2 at joint 1
10. Moment about axis 3 at joint 1
11. Force in direction 1 at joint 2
12. Force in direction 2 at joint 2
13. Force in direction 3 at joint 2
14. Moment about axis 1 at joint 2
15. Moment about axis 2 at joint 2
16. Moment about axis 3 at joint 2

STRS.E23.*iset.icase*

iset = Load set
icase = Load case within set

Created in processor GSF.

NJ = Number of E23 elements
NI = 6
Type = single precision real

The dataset contains NJ nominal records, NI items per record.

Contents of each record:

1. Group number
2. Element number within group
3. Joint #1
4. Joint #2
5. Force in element
6. Stress in element

STRS.E24.*iset.icase*

iset = Load set
icase = Load case within set

Created in processor GSF.

NJ = Number of E24 elements
NI = 18
Type = single precision real

The dataset contains NJ nominal records, NI items per record.

Contents of each record:

1. Group number
2. Element number within group
3. Joint #1
4. Joint #2
5. Axial force at joint 1
6. Transverse shear at joint 1
7. Moment at joint 1
8. Axial force at joint 2
9. Transverse shear at joint 2
10. Moment at joint 2
11. Axial stress at joint 1
12. Shear stress at joint 1
13. Bending stress on upper surface at joint 1
14. Bending stress on lower surface at joint 1
15. Axial stress at joint 2
16. Shear stress at joint 2
17. Bending stress on upper surface at joint 2
18. Bending stress on lower surface at joint 2

STRS.E25.*iset.icase*

iset= Load set
icase = Load case within set

Created in processor GSF.

NJ = Number of E25 elements
NI = 16
Type = single precision real

The dataset contains NJ nominal records, NI items per record.

Contents of each record:

1. Group number
2. Element number within group
3. Joint #1
4. Joint #2
5. Force in direction 1 at joint 1
6. Force in direction 2 at joint 1
7. Force in direction 3 at joint 1
8. Moment about axis 1 at joint 1
9. Moment about axis 2 at joint 1
10. Moment about axis 3 at joint 1
11. Force in direction 1 at joint 2
12. Force in direction 2 at joint 2
13. Force in direction 3 at joint 2
14. Moment about axis 1 at joint 2
15. Moment about axis 2 at joint 2
16. Moment about axis 3 at joint 2

STRS.E31.*iset.icase*

Contains stress resultants calculated in the element reference frame.

iset = Load set
icase = Load case within set

Created in processor GSF.

NJ = Number of E31 elements
NI = 11
Type = single precision real

The dataset contains NJ nominal records, NI items per record.

Contents of each record:

1. Group number
2. Element number within group
3. Joint #1
4. Joint #2
5. Joint #3
6. Not used
7. Index of section property dataset entry for element section properties
8. Section type code
9. Tractive force in x-direction N_x
10. Tractive force in y-direction N_y
11. Shearing force N_{xy}

Formulas:

$$S_x = N_x/\text{thickness}$$
$$S_y = N_y/\text{thickness}$$
$$T_{xy} = N_{xy}/\text{thickness}$$

STRS.E32.*iset.icase*

Contains stress resultants calculated in the element reference frame.

iset = Load set
icase = Load case within set

Created in processor GSF.

NJ = Number of E32 elements
NI = 28
Type = single precision real

The dataset contains NJ nominal records, NI items per record.

Contents of each record:

1. Group number
2. Element number within group
3. Joint #1
4. Joint #2
5. Joint #3
6. Not used
7. Index of section property dataset entry for element section properties
8. Section type code
9. M_x Bending moment about y-axis at joint 1
10. M_y Bending moment about x-axis at joint 1
11. M_{xy} Twisting moment at joint 1
12. Q_x Transverse shear in x-direction at joint 1
13. Q_y Transverse shear in y-direction at joint 1
14. M_x Bending moment about y-axis at joint 2
15. M_y Bending moment about x-axis at joint 2
16. M_{xy} Twisting moment at joint 2
17. Q_x Transverse shear in x-direction at joint 2
18. Q_y Transverse shear in y-direction at joint 2
19. M_x Bending moment about y-axis at joint 3
20. M_y Bending moment about x-axis at joint 3
21. M_{xy} Twisting moment at joint 3
22. Q_x Transverse shear in x-direction at joint 3
23. Q_y Transverse shear in y-direction at joint 3

STRS.E32.*iset.icase* (concluded)

24. M_x Bending moment about y-axis at the center
25. M_y Bending moment about x-axis at the center
26. M_{xy} Twisting moment at the center
27. Q_x Transverse shear in x-direction at the center
28. Q_y Transverse shear in y-direction at the center

Formulas:

$$S_x = f_{4j} M_x \qquad f_{ij} = 1/\text{thickness for } i \text{ and } j = 1,2,3$$
$$S_y = f_{5j} M_y \qquad f_{42} = f_{52} = -f_{62} = 6/(\text{thickness})^2$$
$$T_{xy} = f_{6j} M_{xy} \qquad f_{43} = f_{53} = -f_{63} = -6/(\text{thickness})^2$$

STRS.E33.*iset.icase*

Contains stress resultants calculated in the element reference frame.

iset = Load set
icase = Load case within set

Created in processor GSF.

NJ = Number of E33 elements
NI = 31
Type = single precision real

The dataset contains NJ nominal records, NI items per record.

Contents of each record:

1. Group number
2. Element number within group
3. Joint #1
4. Joint #2
5. Joint #3
6. Not used
7. Index of section property dataset entry for element section properties
8. Section type code
9. N_x Tractive force in x-direction
10. N_y Tractive force in y-direction
11. N_{xy} Shearing force
12. M_x Bending moment about y-axis at joint 1
13. M_y Bending moment about x-axis at joint 1
14. M_{xy} Twisting moment at joint 1
15. Q_x Transverse shear in x-direction at joint 1
16. Q_y Transverse shear in y-direction at joint 1
17. M_x Bending moment about y-axis at joint 2
18. M_y Bending moment about x-axis at joint 2
19. M_{xy} Twisting moment at joint 2
20. Q_x Transverse shear in x-direction at joint 2
21. Q_y Transverse shear in y-direction at joint 2
22. M_x Bending moment about y-axis at joint 3
23. M_y Bending moment about x-axis at joint 3

STRS.E33.*iset.icase* (concluded)

24. M_{xy} Twisting moment at joint 3
25. Q_x Transverse shear in x-direction at joint 3
26. Q_y Transverse shear in y-direction at joint 3
27. M_x Bending moment about y-axis at the center
28. M_y Bending moment about x-axis at the center
29. M_{xy} Twisting moment at the center
30. Q_x Transverse shear in x-direction at the center
31. Q_y Transverse shear in y-direction at the center

Formulas:

$$S_x = f_{1j}N_x + f_{4j}M_x \qquad f_{ij} = 1/\text{thickness for } i \text{ and } j = 1,2,3$$
$$S_y = f_{2j}N_y + f_{5j}M_y \qquad f_{42} = f_{52} = -f_{62} = 6/(\text{thickness})^2$$
$$T_{xy} = f_{3j}N_{xy} + f_{6j}M_{xy} \qquad f_{43} = f_{53} = -f_{63} = -6/(\text{thickness})^2$$

STRS.E41.*iset.icase*

Contains stress resultants calculated in the element reference frame.

iset = Load set
icase = Load case within set

Created in processor GSF.

NJ = Number of E41 elements
NI = 23
Type = single precision real

The dataset contains NJ nominal records, NI items per record.

Contents of each record:

1. Group number
2. Element number within group
3. Joint #1
4. Joint #2
5. Joint #3
6. Joint #4
7. Index of section property dataset entry for element section properties
8. Section type code
9. N_x Tractive force in x-direction at joint 1
10. N_y Tractive force in y-direction at joint 1
11. N_{xy} Shearing force at joint 1
12. N_x Tractive force in x-direction at joint 2
13. N_y Tractive force in y-direction at joint 2
14. N_{xy} Shearing force at joint 2
15. N_x Tractive force in x-direction at joint 3
16. N_y Tractive force in y-direction at joint 3
17. N_{xy} Shearing force at joint 3
18. N_x Tractive force in x-direction at joint 4
19. N_y Tractive force in y-direction at joint 4
20. N_{xy} Shearing force at joint 4
21. N_x Tractive force in x-direction at the center
22. N_y Tractive force in y-direction at the center
23. N_{xy} Shearing force at the center

STRS.E41.*iset.icase* (concluded)

Formulas:

$$S_x = N_x/\text{thickness}$$
$$S_y = N_y/\text{thickness}$$
$$T_{xy} = N_{xy}/\text{thickness}$$

STRS.E42.*iset.icase*

Contains stress resultants calculated in the element reference frame.

iset = Load set
icase = Load case within set

Created in processor GSF.

NJ = Number of E42 elements
NI = 33
Type = single precision real

The dataset contains NJ nominal records, NI items per record.

Contents of each record:

1. Group number
2. Element number within group
3. Joint #1
4. Joint #2
5. Joint #3
6. Joint #4
7. Index of section property dataset entry for element section properties
8. Section type code
9. M_x Bending moment about y-axis at joint 1
10. M_y Bending moment about x-axis at joint 1
11. M_{xy} Twisting moment at joint 1
12. Q_x Transverse shear in x-direction at joint 1
13. Q_y Transverse shear in y-direction at joint 1
14. M_x Bending moment about y-axis at joint 2
15. M_y Bending moment about x-axis at joint 2
16. M_{xy} Twisting moment at joint 2
17. Q_x Transverse shear in x-direction at joint 2
18. Q_y Transverse shear in y-direction at joint 2
19. M_x Bending moment about y-axis at joint 3
20. M_y Bending moment about x-axis at joint 3
21. M_{xy} Twisting moment at joint 3
22. Q_x Transverse shear in x-direction at joint 3
23. Q_y Transverse shear in y-direction at joint 3

STRS.E42.*iset.icase* (concluded)

24. M_x Bending moment about y-axis at joint 4
25. M_y Bending moment about x-axis at joint 4
26. M_{xy} Twisting moment at joint 4
27. Q_x Transverse shear in x-direction at joint 4
28. Q_y Transverse shear in y-direction at joint 4
29. M_x Bending moment about y-axis at the center
30. M_y Bending moment about x-axis at the center
31. M_{xy} Twisting moment at the center
32. Q_x Transverse shear in x-direction at the center
33. Q_y Transverse shear in y-direction at the center

Formulas:

$$S_x = f_{4j} M_x \qquad f_{42} = f_{52} = -f_{62} = -6/(\text{thickness})^2$$
$$S_y = f_{5j} M_y \qquad f_{43} = f_{53} = -f_{63} = -6/(\text{thickness})^2$$
$$T_{xy} = f_{6j} M_{xy}$$

STRS.E43.*iset.icase*

Contains stress resultants calculated in the element reference frame.

iset = Load set
icase = Load case within set

Created in processor GSF.

NJ = Number of E43 elements
NI = 48
Type = single precision real

The dataset contains NJ nominal records, NI items per record.

Contents of each record:

1. Group number
2. Element number within group
3. Joint #1
4. Joint #2
5. Joint #3
6. Joint #4
7. Index of section property dataset entry for element section properties
8. Section type code
9. N_x Tractive force in x-direction at joint 1
10. N_y Tractive force in y-direction at joint 1
11. N_{xy} Shearing force at joint 1
12. N_x Tractive force in x-direction at joint 2
13. N_y Tractive force in y-direction at joint 2
14. N_{xy} Shearing force at joint 2
15. N_x Tractive force in x-direction at joint 3
16. N_y Tractive force in y-direction at joint 3
17. N_{xy} Shearing force at joint 3
18. N_x Tractive force in x-direction at joint 4
19. N_y Tractive force in y-direction at joint 4
20. N_{xy} Shearing force at joint 4
21. N_x Tractive force in x-direction at the center
22. N_y Tractive force in y-direction at the center
23. N_{xy} Shearing force at the center

STRS.E43.*iset.icase* (concluded)

24. M_x Bending moment about y-axis at joint 1
25. M_y Bending moment about x-axis at joint 1
26. M_{xy} Twisting moment at joint 1
27. Q_x Transverse shear in x-direction at joint 1
28. Q_y Transverse shear in y-direction at joint 1
29. M_x Bending moment about y-axis at joint 2
30. M_y Bending moment about x-axis at joint 2
31. M_{xy} Twisting moment at joint 2
32. Q_x Transverse shear in x-direction at joint 2
33. Q_y Transverse shear in y-direction at joint 2
34. M_x Bending moment about y-axis at joint 3
35. M_y Bending moment about x-axis at joint 3
36. M_{xy} Twisting moment at joint 3
37. Q_x Transverse shear in x-direction at joint 3
38. Q_y Transverse shear in y-direction at joint 3
39. M_x Bending moment about y-axis at joint 4
40. M_y Bending moment about x-axis at joint 4
41. M_{xy} Twisting moment at joint 4
42. Q_x Transverse shear in x-direction at joint 4
43. Q_y Transverse shear in y-direction at joint 4
44. M_x Bending moment about y-axis at the center
45. M_y Bending moment about x-axis at the center
46. M_{xy} Twisting moment at the center
47. Q_x Transverse shear in x-direction at the center
48. Q_y Transverse shear in y-direction at the center

Formulas:

$$S_x = f_{1j}N_x + f_{4j}M_x \qquad f_{ij} = 1/\text{thickness for } i \text{ and } j = 1,2,3$$
$$S_y = f_{2j}N_y + f_{5j}M_y \qquad f_{42} = f_{52} = -f_{62} = 6/(\text{thickness})^2$$
$$T_{xy} = f_{3j}N_{xy} + f_{6j}M_{xy} \qquad f_{43} = f_{53} = -f_{63} = 6/(\text{thickness})^2$$

STRS.E44.*iset.icase*

iset = Load set
icase = Load case within set

Created in processor GSF.

NJ = Number of E44 elements
NI = 8
Type = single precision real

The dataset contains NJ nominal records, NI items per record.

Contents of each record:

1. Group number
2. Element number within group
3. Joint #1
4. Joint #2
5. Joint #3
6. Joint #4
7. Element thickness
8. Shear stress

STRS.xxxx.*i.j*

Contains element stress components at **one or more** of the following locations: element centroid, each integration point, and each node.

xxxx = element name (*e.g.*, EX41, EX97)

For **linear** static analysis:

i = Load set (*iset*)
j = Constraint case (*ncon*)

For **nonlinear** static analysis:

i = Load step (*istep*)
j = 0

Created by processor ES*i* (*e.g.*, ES1, ES2, ES5)

Type = single precision real

The dataset may contain as many as 12 record groups, one record in each record group per structural element. The record name is determined by the location and the reference frame used in calculating the stress components. The record names, contents, and sizes are defined as follows:

CENTROIDS_S*dir.ielt*	Stress components at the centroid of element *ielt* in reference frame *dir*. Record length is the number of stress components.
INTEG_PTS_S*dir.ielt*	Stress components at each integration point of element *ielt* in reference frame *dir*. The record is ordered such that all stress components at the first integration point are followed by all stress components at the second integration point, etc. Record length is equal to the number of stress components times the number of integration points.
NODES_S*dir.ielt*	Stress components at each node of element *ielt* in reference *dir*. The record is ordered such that all stress components at the first node are followed by all stress components at the second node, etc. Record length is equal to the number of stress components times the number of nodes.

where *dir* indicates the stress/strain reference frame. Stress resultants may be computed in the element stress/strain reference frame ($dir = 0$) or in one of three alternate reference frames. For $dir = 1$, the stress x direction is coincident with the global x direction. For $dir = 2$, the stress x direction is coincident with the global y direction. For $dir = 3$ the stress x direction is coincident with the global z direction. Note that the chosen reference frame need not be coincident with the material reference frame. For example, a record named

CENTROIDS_S1.15

will contain stress components, at the centroids, computed in the global reference frame for element number 15.

For 2-D structural elements, the stress components are stress resultants which are typically ordered: N_x, N_y, N_{xy}, M_x, M_y, M_{xy}, Q_x, Q_y. Users should consult the specific element processor documentation for the stress components calculated by the specific element processor.

TEMP.xxxx.*iset.icase*

xxxx = Element name
iset = Load set
icase = Load case within Load set

Created using processor AUS.

NJ = Number of elements of this type.
Type = single precision real

For 2-node elements (Not defined for E25 elements):
NI = 3
Contents of each entry:

1. Average temperature of the element
2. Transverse gradient in direction 1
3. Transverse gradient in direction 2

For 3-node structural elements (Not defined for E32 elements):
NI = 3
Contents of each entry:

1. Temperature at joint 1 of element
2. Temperature at joint 2 of element
3. Temperature at joint 3 of element

For 4-node structural elements (Not defined for E42 elements):
NI = 4
Contents of each entry:

1. Temperature at joint 1 of element
2. Temperature at joint 2 of element
3. Temperature at joint 3 of element
4. Temperature at joint 4 of element

Formula:

Total effective temperature at node n = Element temperature at node n + Nodal temperature from block *icase* of dataset NODA.TEMP. *iset.1*

TEXT.BTAB.2.1

Created by TEXT subprocessor in processor TAB.
Type = alphanumeric

Contains data in text.

TOT.DISP.*istep*

istep = Load step for nonlinear static analysis

Created by procedure NL_STATIC_1.
SYSVEC format. See APPL.FORC.*iset*.1

Contents:

This dataset contains the total displacement solution at load step *istep*. Procedure NL_STATIC_1 uses processor SSOL to generate a STAT.DISP.1.1 dataset at each load step. This dataset is immediately renamed to TOT.DISP.*istep* by the procedure.

Note that for geometrically (large-rotation) nonlinear analysis, the rotational components of TOT.DISP.*istep* may not be physically meaningful. In that case, the current orientation of the nodal (surface) triads is used to represent the rotational part of the motion. These triads are stored in TOT.ROTN.*istep*.

TOT.ROTN.*istep*

istep = Load step for nonlinear static analysis

Created by procedure NL_STATIC_1.
NI = 3
NJ = total number of joints in model
Type = single precision real

Contents:

This dataset contains nodal pseudo-vectors representing the rotation of the nodal freedom triad, from the initial configuration to the current configuration. These pseudo-vectors are relevant only for large-rotation geometrically nonlinear analysis in which rotational freedoms are used at some nodes. Otherwise, this dataset should not even appear in the database (note that the rotational components of the TOT.DISP.*istep* datasets are meaningful for small or moderate rotation analysis).

The pseudo-vector at each node points in the direction of the axis of rotation, and the magnitude is simply the angle of rotation (in radians) – where the rotation is measured from the initial configuration to the current configuration, and the components are expressed in the global coordinate system. Note that there is a unique correspondence between pseudo-vectors and rotation (orthogonal) matrices, so that a full 3×3 triad can be obtained at each node from the 3-component psuedo-vectors.

VIBR.EVAL.*nset.ncon*

nset = Set identifier
ncon = Constraint case

Created in processor EIG.

NJ = 1
NI = Number of eigenvalues
Type = single precision real

Contains eigenvalues corresponding to each eigenvector in VIBR.MODE.*nset.ncon*.

VIBR.MODE.*nset.ncon*

nset = Set identifier
ncon = Constraint case

Created in processor EIG.

SYSVEC format. See APPL.FORC.*iset*.1.

Contents:

Each block of data contains one eigenvector (vibration mode shape) corresponding to an eigenvalue stored in VIBR.EVAL.*nset.ncon*. Data is stored for each joint in each active direction.

VISC.DAMP.*nset.ncon*

Created using AUS/TABLE for processors LDR and TRAN.

Contains the damping coefficients for a discrete damper at each active degree of freedom.

NI = 1
NJ = Number of active degrees of freedom
Type = Single-precision real

Contents:

1. Damping coefficient for discrete damper at joint one in the direction of degree of freedom one.
2. etc.

WALL.PROP.1.1

Created using AUS/TABLE.

Contains shell wall properties for the 2-D section types.
NI = 5
NJ = Number of sections
Type = single precision real

Content of each entry:

1. Shell wall eccentricity, ecz
2. (Reserved for future use.)
3. (Reserved for future use.)
4. (Reserved for future use.)
5. (Reserved for future use.)

Repeated NJ times.

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16. Abstract
The purpose of this manual is to document the datasets created and used by the Computational Structural Mechanics (CSM) Testbed software system. A description of each dataset including its form, contents, and organization is presented.

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