The Computational Structural Mechanics Testbed Data Library Description

Compiled by Caroline B. Stewart

May 1990

(NASA-TM-100645-Rev-1) THE COMPUTATIONAL STRUCTURAL MECHANICS TESTBED DATA LIBRARY DESCRIPTION (NASA) 158 0 CSCL 20K

Unclas

G3/39 0280427
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.

The contents of this manual were compiled by Caroline B. Stewart of Analytical Services and Materials, Inc. NASA TM-83181 entitled SPAR Data Set Contents by Sally Cunningham, October 1981, was the starting point for this manual. Contributors include:

NASA Langley
Sue Bostic
Ronnie E. Gillian
William H. Greene
Norman F. Knight, Jr.
Jonathan Ransom
Olaf O. Storaasli

Lockheed Engineering and Sciences Company
Christine G. Lotts
Steven C. Macy
Susan L. McCleary
Sharon S. Paulson

Analytical Services and Materials, Inc.
Mohammad A. Aminpour
T. Krishnamurthy

Awesome Computing, Inc.
Andrea L. Overman
Eugene L. Poole

Lockheed Palo Alto Research Laboratory
William Loden
Shahram Nour-Omid
Charles R. Rankin
Marc E. Regelbrugge
Gary M. Stanley
Phillip Underwood
Mary A. Wright

Revised 5/17/90 CSM Testbed Data Library Description
<table>
<thead>
<tr>
<th>Update Log</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>TM-100645 initial release</td>
<td>October, 1988</td>
</tr>
<tr>
<td>TM-100645 revision 1</td>
<td>May, 1990</td>
</tr>
</tbody>
</table>
Table of Contents

CSM Testbed Data Library Description

Table of Contents

Chapter 1  Description of CSM Testbed Datasets

Chapter 2  Dataset Contents
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.
THIS PAGE LEFT BLANK INTENTIONALLY.
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.
THIS PAGE LEFT BLANK INTENTIONALLY.
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. \(a_{33}\)
10. \(X_o\)
11. \(Y_o\)
12. \(Z_o\)

Components of a coordinate transformation matrix

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

\textbf{ic2} = Parameter reflecting the cost of equation solution given a factored system matrix. Computed in processor TOPO.

\textbf{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.

\textbf{NJ} = total number of joints in the model
\textbf{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:

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

Repeated JOINTS times:

\textbf{JNT} - The number of the current joint.

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

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

\textbf{SUBMAP (CONRNG \times (CONRNG + 1)/2)} - Contains a pointer into the work array, S, for each submatrix in the active upper triangle.
Dataset Contents

APPL.FORC

**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 Dataset Contents

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. $\alpha_1$
6. $I_2$
7. $\alpha_2$
8. $a$
9. $f$
10. $f_1$
11. $z_1$
12. $z_2$
13. $\theta$
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. \} Not used.
5.
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

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.

Dataset Contents

CEM.SPAR.jdf2

\( jdf^2 = \text{square of the number of active degrees of freedom per joint} \)

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\textsubscript{...ncon}

\textit{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\textsubscript{2}) would have the integer 28949\textsubscript{10} stored according to the following binary bit pattern:

<table>
<thead>
<tr>
<th>JREF number</th>
<th>Joint Motion Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>0...0111</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>00</td>
</tr>
</tbody>
</table>

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 = +28672
Integer stored for this joint = 28949
CSMP.FOCS.1.1

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

\[ NI = 33 \]
\[ NJ = 1 \]
\[ \text{Type} = \text{Integer} \]

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 \( z = 0 \) edge of the panel.
6. Rotational constraints along the \( z = 0 \) edge of the panel.
7. Translational constraints along the \( y = 2 \ast (B_E + B_S) \) edge of the panel.
8. Rotational constraints along the \( y = 2 \ast (B_E + B_S) \) edge of the panel.
9. Translational constraints along the \( x = A_t \) edge of the panel.
10. Rotational constraints along the \( x = A_t \) 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 \((0,2 \ast (B_E + B_S))\)
16. Rotational constraints at the corner \((0,2 \ast (B_E + B_S))\)
17. Translational constraints at the corner \((A_t,2 \ast (B_E + B_S))\)
18. Rotational constraints at the corner \((A_t,2 \ast (B_E + B_S))\)
19. Translational constraints at the corner \((A_t,0)\)
20. Rotational constraints at the corner \((A_t,0)\)
21. Translational constraints on stiffeners at \( z = 0 \)
22. Rotational constraints on stiffeners at \( z = 0 \)
23. Translational constraints on stiffness at \( z = A_t \)
CSMP.FOCS.1.1 (concluded)

24. Rotational constraints on stiffeners at $z = A_i$
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 $0 < x < \frac{(A_1 - A)}{2}$
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 Dataset Contents

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 $z$ 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. $A_t$, 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 $z = 0$ edge of the panel.
6. Rotational constraints along the $z = 0$ 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 (NSEC 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 \( z \) 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
Dataset Contents

**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.
Dataset Contents

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

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

For 2-node elements:
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.

For E31 elements:
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

For E32 elements:
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.xxxxiset.icaJe (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

Revised 5/17/90
CSM Testbed Data Library Description 2.0 - 23
DISL.xxxx (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
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
Dataset Contents

**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, ESi.

- **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.

\[
\text{nmt} = \text{ndof}^2 \times \text{nen} \times (\text{nen} + 1)/2
\]

- **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.

\[
\text{nsrt} = \text{nen} \times \text{ndof} \times \text{nb}
\]

Revised 5/17/90
For elements implemented using a Structural Element processor (e.g., ES1, ES5), the structure of the dataset is as follows:

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

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

<table>
<thead>
<tr>
<th>Segment</th>
<th>Item</th>
<th>Length</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Definition</td>
<td>Integ</td>
<td></td>
<td>Same as dataset DEF.xxxx. itype.nnod</td>
</tr>
<tr>
<td>2</td>
<td>Material</td>
<td>Real</td>
<td></td>
<td>(currently unused)</td>
</tr>
<tr>
<td>3</td>
<td>Geometry</td>
<td>Real</td>
<td></td>
<td>Element dependent geometric parameters.</td>
</tr>
</tbody>
</table>

**Structural 1-D elements:**
- \( z \) 1: element length
- \( D_{ij} \) (3):
- \( R \) (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
### Dataset Contents

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

<table>
<thead>
<tr>
<th>Segment</th>
<th>Item</th>
<th>Length</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Vol.</td>
<td>1</td>
<td></td>
<td>3-d Solid elements:</td>
</tr>
<tr>
<td></td>
<td>x</td>
<td>(3,nen)</td>
<td></td>
<td>Element volume</td>
</tr>
<tr>
<td></td>
<td>TEG</td>
<td>(3,3)</td>
<td></td>
<td>Element nodal coordinates in element basis.</td>
</tr>
<tr>
<td></td>
<td>TEC</td>
<td>(3,3,nen)</td>
<td>Transf. from computational to element basis at element nodes.</td>
<td></td>
</tr>
</tbody>
</table>

#### Property

<table>
<thead>
<tr>
<th>4</th>
<th>Real</th>
<th>Structural 1-D elements:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Same as appropriate section properties dataset (e.g., BA.BTAB.<em>.</em>)</td>
</tr>
</tbody>
</table>

#### Structural 2-D elements:

<table>
<thead>
<tr>
<th>5 Intrinsic Stiffness</th>
<th>Km nmt</th>
<th>Real</th>
<th>Element intrinsic stiffness matrix; only upper triangle of nodal blocks.</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 Stress</td>
<td>R nser</td>
<td>Real</td>
<td>Full element stress recovery matrix</td>
</tr>
<tr>
<td>7 Stress</td>
<td>S nb</td>
<td>Real</td>
<td>Coefficients of stress terms</td>
</tr>
<tr>
<td>8 Thermal force</td>
<td></td>
<td></td>
<td>(currently unused)</td>
</tr>
<tr>
<td>9 Thermal Stress</td>
<td></td>
<td></td>
<td>(currently unused)</td>
</tr>
<tr>
<td>Recovery</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**ELTS.ISCT**

Created in processor ELD.

\[
\text{NJ} = \text{Number of element types in the model}
\]

\[
\text{NI} = 1
\]

Type = integer

Contents:

N4 of \(xx.BTAB.N3.N4\) where \(xx = BA, BC, SA, \ldots\) 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.

\[ NJ = \text{Number of element types in the model} \]
\[ NI = 1 \]
\[ \text{Type} = \text{integer} \]

Contents:

The number of nodes in each element type.
ES.SUMMARY

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)

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

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.xxx.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 **linear** static analysis:
   i = load step
   j = constraint case (ncon)

For **nonlinear** 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 *ietl* 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
iotype = 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 triangular 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:

<table>
<thead>
<tr>
<th>Record Name</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>INFO</td>
<td>Contains the following 10 values which are necessary to determine the lengths of the remaining records.</td>
</tr>
<tr>
<td></td>
<td>numjnt - number of joints</td>
</tr>
<tr>
<td></td>
<td>dof - maximum degrees of freedom per node</td>
</tr>
<tr>
<td></td>
<td>j dof - numjnt × dof</td>
</tr>
<tr>
<td></td>
<td>n - number of equations</td>
</tr>
<tr>
<td></td>
<td>n2 - n × 2 if double precision, n else</td>
</tr>
<tr>
<td></td>
<td>lk11 - number of non-zeros in strictly upper triangular part of $K_{1,1}$ matrix.</td>
</tr>
<tr>
<td></td>
<td>lk12 - non-zeros in rectangular matrix $K_{1,2}$</td>
</tr>
<tr>
<td></td>
<td>lk22 - number of non-zeros in strictly upper triangular part of $K_{2,2}$ matrix.</td>
</tr>
<tr>
<td></td>
<td>nk22 - number of rows in matrix $K_{2,2}$</td>
</tr>
<tr>
<td></td>
<td>nappl - number of non-zero fixed displacements</td>
</tr>
<tr>
<td>K11</td>
<td>Non-zero coefficients of strictly upper triangular symmetric $K_{1,1}$ matrix (by rows).</td>
</tr>
<tr>
<td></td>
<td>Record length is $lk_{11}$.</td>
</tr>
<tr>
<td>IK11</td>
<td>Column indices for each non-zero coefficient of strictly upper triangular symmetric $K_{1,1}$ matrix.</td>
</tr>
<tr>
<td></td>
<td>Record length is $lk_{11}$.</td>
</tr>
<tr>
<td>K22</td>
<td>Non-zero coefficients of strictly upper triangular symmetric $K_{2,2}$ matrix (by rows).</td>
</tr>
<tr>
<td></td>
<td>Record length is $lk_{22}$.</td>
</tr>
<tr>
<td>IK22</td>
<td>Joint-dof index for each non-zero coefficient of strictly upper triangular symmetric $K_{2,2}$ matrix.</td>
</tr>
<tr>
<td></td>
<td>Record length is $lk_{22}$.</td>
</tr>
<tr>
<td>KDIAG</td>
<td>Main diagonal coefficients for $K_{1,1}$ and $K_{2,2}$ matrices</td>
</tr>
<tr>
<td></td>
<td>Record length is $j dof$.</td>
</tr>
<tr>
<td>K12</td>
<td>Non-zero coefficients of rectangular $K_{1,2}$ matrix (by columns)</td>
</tr>
<tr>
<td></td>
<td>Record length is $lk_{12}$.</td>
</tr>
<tr>
<td>IK11</td>
<td>Joint-dof indices for each non-zero coefficient of rectangular $K_{1,2}$ matrix</td>
</tr>
<tr>
<td></td>
<td>Record length is $lk_{11}$.</td>
</tr>
<tr>
<td>PTR1</td>
<td>row length and row pointer arrays for $K_{1,1}$ and $K_{1,2}$ matrices.</td>
</tr>
<tr>
<td></td>
<td>Record length is $j dof × 2$.</td>
</tr>
<tr>
<td>PTR2</td>
<td>column length and column pointer arrays for $K_{2,2}$ matrix.</td>
</tr>
</tbody>
</table>
Record length is \( nk22 \times 2 \).

**JTOR** Ordering vector. \( JTOR(i) < 0 \) indicates joint-dof \( i \) corresponds to 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 \( j dof \).

**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 \( j dof \).

**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 \( K_{1,1} u = f - K_{1,2} x_{con} \).
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 z-direction, \( N_z \)
10. Tractive force in y-direction, \( N_y \)
11. Shearing force, \( N_{zy} \)

Formulas:

\[
S_z = \frac{N_z}{\text{thickness}}
\]
\[
S_y = \frac{N_y}{\text{thickness}}
\]
\[
T_{zy} = \frac{N_{zy}}{\text{thickness}}
\]
GSTR.E32 i_set.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. $M_z$ Bending moment about $y$-axis at joint 1
10. $M_y$ Bending moment about $z$-axis at joint 1
11. $M_{zy}$ Twisting moment at joint 1
12. $Q_z$ Transverse shear in $x$-direction at joint 1
13. $Q_y$ Transverse shear in $y$-direction at joint 1
14. $M_z$ Bending moment about $y$-axis at joint 2
15. $M_y$ Bending moment about $z$-axis at joint 2
16. $M_{zy}$ Twisting moment at joint 2
17. $Q_z$ Transverse shear in $x$-direction at joint 2
18. $Q_y$ Transverse shear in $y$-direction at joint 2
19. $M_z$ Bending moment about $y$-axis at joint 3
20. $M_y$ Bending moment about $z$-axis at joint 3
21. $M_{zy}$ Twisting moment at joint 3
22. $Q_z$ 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. $M_z$ 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:

\[
S_z = f_{4j} M_z \quad f_{ij} = 1/\text{thickness for } i \text{ and } j = 1, 2, 3
\]
\[
S_y = f_{5j} M_y \quad f_{42} = f_{52} = -f_{62} = 6/(\text{thickness})^2
\]
\[
T_{xy} = f_{6j} M_{xy} \quad f_{43} = f_{53} = -f_{63} = -6/(\text{thickness})^2
\]
GSTR.E33  

Dataset Contents

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. \( N_z \) Tractive force in z-direction
10. \( N_y \) Tractive force in y-direction
11. \( N_{xy} \) Shearing force
12. \( M_z \) 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. \( Q_z \) Transverse shear in z-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. \( Q_z \) Transverse shear in z-direction at joint 2
21. \( Q_y \) Transverse shear in y-direction at joint 2
22. \( M_z \) 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. $M_z$ Bending moment about $y$-axis at the center
28. $M_y$ Bending moment about $z$-axis at the center
29. $M_{xy}$ Twisting moment at the center
30. $Q_z$ Transverse shear in $z$-direction at the center
31. $Q_y$ Transverse shear in $y$-direction at the center

Formulas:

\[
S_x = f_{1j}N_x + f_{4j}M_z \\
S_y = f_{2j}N_y + f_{5j}M_y \\
T_{xy} = f_{3j}N_{xy} + f_{6j}M_{xy}
\]

\[
f_{ij} = 1/\text{thickness} \quad \text{for } i \text{ and } j = 1, 2, 3
\]

\[
f_{42} = f_{52} = -f_{62} = 6/(\text{thickness})^2
\]

\[
f_{43} = f_{53} = -f_{63} = -6/(\text{thickness})^2
\]
GSTR.E41

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.ise1.icase (concluded)

Formulas:

\[ S_x = N_x / \text{thickness} \]
\[ S_y = N_y / \text{thickness} \]
\[ T_{xy} = N_{xy} / \text{thickness} \]
GSTR.E42 Dataset Contents

GSTR.E42.i.et.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 z-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. $M_z$ Bending moment about y-axis at joint 2
15. $M_y$ Bending moment about z-axis at joint 2
16. $M_{yz}$ 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. $M_z$ Bending moment about y-axis at joint 3
20. $M_y$ Bending moment about z-axis at joint 3
21. $M_{zy}$ 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 z-axis at joint 4
26. $M_{zy}$ 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 z-axis at the center
31. $M_{zy}$ 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:

$$S_x = f_{4j}M_x \quad f_{42} = f_{52} = -f_{62} = -6/(\text{thickness})^2$$
$$S_y = f_{5j}M_y \quad f_{43} = f_{53} = -f_{63} = -6/(\text{thickness})^2$$
$$T_{zy} = f_{6j}M_{zy}$$
GSTR.E43

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. $N_z$ Tractive force in z-direction at joint 1
10. $N_y$ Tractive force in y-direction at joint 1
11. $N_{xy}$ Shearing force at joint 1
12. $N_z$ Tractive force in z-direction at joint 2
13. $N_y$ Tractive force in y-direction at joint 2
14. $N_{xy}$ Shearing force at joint 2
15. $N_z$ Tractive force in z-direction at joint 3
16. $N_y$ Tractive force in y-direction at joint 3
17. $N_{xy}$ Shearing force at joint 3
18. $N_z$ Tractive force in z-direction at joint 4
19. $N_y$ Tractive force in y-direction at joint 4
20. $N_{xy}$ Shearing force at joint 4
21. $N_z$ Tractive force in z-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.icas (concluded)

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

Formulas:

\[
S_x = f_{1j}N_z + f_{4j}M_z \quad f_{ij} = 1/\text{thickness for } i \text{ and } j = 1, 2, 3
\]
\[
S_y = f_{2j}N_y + f_{5j}M_y \quad f_{42} = f_{52} = -f_{62} = 6/(\text{thickness})^2
\]
\[
T_{xy} = f_{3j}N_{xy} + f_{6j}M_{xy} \quad f_{43} = f_{53} = -f_{63} = 6/(\text{thickness})^2
\]
GTIT.xxxx

GTIT.xxxx.iotype.nnod

xxxx = Element name
iotype = 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.
Dataset Contents

**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 \( L D L^T \), 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.
5. A list of unconstrained joint degrees of freedom, filled in
   consecutively from position number 4; unused values are zero.
6. Example of d.o.f. 1, 2, and 6 unconstrained:
7. 1,2,6,0,0,0
8.
9.
10.
11. A list specifying the order of each unconstrained degree of
    freedom; zero if not active.
12. Example for d.o.f. 1, 2, and 6 unconstrained:
13. 1,2,0,0,0,3
14.
15.
16.
17. Not used.
18.
JLOC.BTAB.2.5

Created in subprocessor JLOC of processor TAB.

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

Contents:

<table>
<thead>
<tr>
<th>I</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>x₁</td>
<td>x₂</td>
<td>... Rectangular coordinates of each joint in the global reference frame</td>
</tr>
</tbody>
</table>
**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

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

\[ jdf^2 = \text{square of the number of degrees of freedom in the model, JDF.} \]

Created in processor K.

\(NJ = \text{total number of joints in the model}\)

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

\( \text{nsubs} = \) the total number of submatrices in a sparse format system matrix for this model
\( \text{ksize} = \) 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.

\( \text{NJ} = \) total number of joints in the model
\( \text{Type} = \) 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 \( S(JDF, JDF, \text{KSIZE}) \) 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..\text{nsubs.ksize} shows which joint pair \( i, j \) is associated with each submatrix in \( S \).
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

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

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 **linear** dynamic analysis:

\[ i = \text{Load set (iset)} \]
\[ j = \text{Constraint case (ncon)} \]

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

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

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. $\nu$ = Poisson's Ratio
3. $G$ = shear modulus; default is $E/(2(1 + \nu))$
4. $\rho$ = Weight per unit volume
5. $\alpha_1$ = Thermal expansion coefficient, direction $x$
6. $\alpha_2$ = Thermal expansion coefficient, direction $y$
7. $\theta$ = Angle between element reference frame and the frame used for input of $\alpha_1$ and $\alpha_2$.

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. 11 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.

\[
\begin{align*}
iset & = \text{ Load set} \\
 icase & = \text{ Load case within set}
\end{align*}
\]

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. \(M_z\) Bending moment about y-axis at joint 1
10. \(M_y\) Bending moment about z-axis at joint 1
11. \(M_{xy}\) Twisting moment at joint 1
12. \(Q_z\) Transverse shear in z-direction at joint 1
13. \(Q_y\) Transverse shear in y-direction at joint 1
14. \(M_z\) Bending moment about y-axis at joint 2
15. \(M_y\) Bending moment about z-axis at joint 2
16. \(M_{xy}\) Twisting moment at joint 2
17. \(Q_z\) Transverse shear in z-direction at joint 2
18. \(Q_y\) Transverse shear in y-direction at joint 2
19. \(M_z\) Bending moment about y-axis at joint 3
20. \(M_y\) Bending moment about z-axis at joint 3
21. \(M_{xy}\) Twisting moment at joint 3
22. \(Q_z\) Transverse shear in z-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:

\[ S_x = f_{4j} M_x \]
\[ S_y = f_{5j} M_y \]
\[ T_{xy} = f_{6j} M_{xy} \]
\[ f_{ij} = 1 / \text{thickness for } i \text{ and } j = 1, 2, 3 \]
\[ f_{42} = f_{52} = -f_{62} = 6 / (\text{thickness})^2 \]
\[ f_{43} = f_{53} = -f_{63} = -6 / (\text{thickness})^2 \]
MSTR.E33.iset.icase

Contains stress resultants transformed to the material reference frame.

\[ iset = \text{Load set} \]
\[ icase = \text{Load case within set} \]

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. \( M_z \) Bending moment about y-axis at joint 2
18. \( M_y \) Bending moment about x-axis at joint 2
19. \( M_{zy} \) Twisting moment at joint 2
20. \( Q_z \) Transverse shear in x-direction at joint 2
21. \( Q_y \) Transverse shear in y-direction at joint 2
22. \( M_z \) Bending moment about y-axis at joint 3
23. \( M_y \) Bending moment about x-axis at joint 3
MSTR.E33 Dataset Contents

MSTR.E33 iset.icase (concluded)

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

Formulas:

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

---

2.0-74 CSM Testbed Data Library Description Revised 5/17/90
Dataset Contents

**MSTR.E41.iset.icase**

Contains stress resultants transformed to the material reference frame.

\[ i\text{set} = \text{Load set} \]
\[ i\text{c}\text{ase} = \text{Load case within set} \]

Created in processor GSF.

\[ NJ = \text{Number of E41 elements} \]
\[ NI = 23 \]
\[ \text{Type} = \text{single precision real} \]

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. \( N_z \) Tractive force in \( z \)-direction at joint 1
10. \( N_y \) Tractive force in \( y \)-direction at joint 1
11. \( N_{zy} \) Shearing force at joint 1
12. \( N_z \) Tractive force in \( z \)-direction at joint 2
13. \( N_y \) Tractive force in \( y \)-direction at joint 2
14. \( N_{zy} \) Shearing force at joint 2
15. \( N_z \) Tractive force in \( z \)-direction at joint 3
16. \( N_y \) Tractive force in \( y \)-direction at joint 3
17. \( N_{zy} \) Shearing force at joint 3
18. \( N_z \) Tractive force in \( z \)-direction at joint 4
19. \( N_y \) Tractive force in \( y \)-direction at joint 4
20. \( N_{zy} \) Shearing force at joint 4
21. \( N_z \) Tractive force in \( z \)-direction at the center
22. \( N_y \) Tractive force in \( y \)-direction at the center
23. \( N_{zy} \) Shearing force at the center

Revised 5/17/90 CSM Testbed Data Library Description 2.0 - 75
MSTR.E41 Dataset Contents

MSTR.E41.iset.icase (concluded)

Formulas:

\[ S_x = \frac{N_x}{\text{thickness}} \]
\[ S_y = \frac{N_y}{\text{thickness}} \]
\[ T_{xy} = \frac{N_{xy}}{\text{thickness}} \]
**MSTR.E42.iset.icase**

Contains stress resultants transformed to the material reference frame.

- \textit{iset} = Load set
- \textit{icase} = Load case within set

Created in processor GSF.

- \textit{NJ} = Number of E42 elements
- \textit{NI} = 33
- Type = single precision real

The dataset contains \textit{NJ} nominal records, \textit{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 $z$-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. $M_z$ Bending moment about $y$-axis at joint 2
15. $M_y$ Bending moment about $z$-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. $M_z$ Bending moment about $y$-axis at joint 3
20. $M_y$ Bending moment about $z$-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 Dataset Contents

MSTR.E42.i et. icase (concluded)

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

Formulas:

$$S_x = f_{4j}M_x \quad f_{42} = f_{52} = -f_{62} = -6/(\text{thickness})^2$$
$$S_y = f_{5j}M_y \quad f_{43} = f_{53} = -f_{63} = -6/(\text{thickness})^2$$
$$T_{xy} = f_{\theta j}M_{xy}$$
MSTR.E43.iJet.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. $N_z$ Tractive force in $z$-direction at joint 1
10. $N_y$ Tractive force in $y$-direction at joint 1
11. $N_{xy}$ Shearing force at joint 1
12. $N_z$ Tractive force in $z$-direction at joint 2
13. $N_y$ Tractive force in $y$-direction at joint 2
14. $N_{xy}$ Shearing force at joint 2
15. $N_z$ Tractive force in $z$-direction at joint 3
16. $N_y$ Tractive force in $y$-direction at joint 3
17. $N_{xy}$ Shearing force at joint 3
18. $N_z$ Tractive force in $z$-direction at joint 4
19. $N_y$ Tractive force in $y$-direction at joint 4
20. $N_{xy}$ Shearing force at joint 4
21. $N_z$ Tractive force in $z$-direction at the center
22. $N_y$ Tractive force in $y$-direction at the center
23. $N_{xy}$ Shearing force at the center

Revised 5/17/90

CSM Testbed Data Library Description 2.0 - 79
MSTR.E43 Dataset Contents

MSTR.E43.i set.icase (concluded)

24. $M_z$ 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. $Q_z$ Transverse shear in $x$-direction at joint 1
28. $Q_y$ Transverse shear in $y$-direction at joint 1
29. $M_z$ 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. $Q_z$ Transverse shear in $x$-direction at joint 2
33. $Q_y$ Transverse shear in $y$-direction at joint 2
34. $M_z$ 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. $Q_z$ Transverse shear in $x$-direction at joint 3
38. $Q_y$ Transverse shear in $y$-direction at joint 3
39. $M_z$ 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. $Q_z$ Transverse shear in $x$-direction at joint 4
43. $Q_y$ Transverse shear in $y$-direction at joint 4
44. $M_z$ 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. $Q_z$ Transverse shear in $x$-direction at the center
48. $Q_y$ Transverse shear in $y$-direction at the center

Formulas:

\[
S_x = f_{1j} N_z + f_{4j} M_z \quad f_{ij} = 1/\text{thickness for } i \text{ and } j = 1,2,3
\]
\[
S_y = f_{2j} N_y + f_{5j} M_y \quad f_{42} = f_{52} = -f_{62} = 6/(\text{thickness})^2
\]
\[
T_{xy} = f_{3j} N_{xy} + f_{6j} M_{xy} \quad f_{43} = f_{53} = -f_{63} = 6/(\text{thickness})^2
\]
NDAL

Created by the TITLE command in processor TAB.

NJ = 1
Type = alphanumeric

Contents:
Library title
NMVE.DISP.i.j

For linear dynamic analysis:

\[ i = \text{Load set (iset)} \]
\[ j = \text{Constraint case (ncon)} \]

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.
Dataset Contents

**NODA.PRES.iset.1**

\[iset = \text{Load set}\]

Created using subprocessor TABLE in processor AUS.

\[NJ = \text{Number of joints}\]
\[NI = 1\]

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

NODA.TEMP.iJet.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.
xxx.NODE.i.j

Contains nodal values interpolated from element centroidal values.

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

Created in processor NVAL.

- \texttt{NJ} = Number of joints
- \texttt{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

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, $\nu_{12}$
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, $\alpha_1$
8. Linear Thermal Expansion Coefficient, $\alpha_2$
9. Weight Density (weight per unit volume)
10. Longitudinal Compression Strain Allowable $(\epsilon_1)^C_{all}$
11. Transverse Compression Strain Allowable $(\epsilon_2)^C_{all}$
12. Inplane Shear Compression Strain Allowable $(\gamma_{12})^C_{all}$
13. Longitudinal Tension Strain Allowable $(\epsilon_1)^T_{all}$
14. Transverse Tension Strain Allowable $(\epsilon_2)^T_{all}$
15. Inplane Shear Tension Strain Allowable $(\gamma_{12})^T_{all}$
16. Zero-degree Lamina Compressive Strength , $\sigma_0$

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, $\nu_{12}$
8. Poisson's Ratio, $\nu_{23}$
9. Poisson's Ratio, $\nu_{13}$
10. Weight Density (weight per unit volume)
11. Linear Thermal Expansion Coefficient, $\alpha_1$
12. Linear Thermal Expansion Coefficient, $\alpha_2$
13. Linear Thermal Expansion Coefficient, $\alpha_3$

Repeated NJ times.
Dataset Contents

PRES.xxxx

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

Revised 5/17/90

CSM Testbed Data Library Description
PROP.BTAB Dataset Contents

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

\[
C(6,6) = \begin{pmatrix}
\bar{\varepsilon}_z & \kappa_y & \kappa_z & \alpha & \gamma_y & \gamma_z \\
N_z & C_{11} & C_{12} & C_{13} & 0 & 0 & 0 \\
M_y & C_{21} & C_{22} & C_{23} & 0 & 0 & 0 \\
M_z & C_{31} & C_{32} & C_{33} & 0 & 0 & 0 \\
T & 0 & 0 & 0 & C_{44} & C_{45} & C_{46} \\
Q_y & 0 & 0 & 0 & C_{54} & C_{55} & 0 \\
Q_z & 0 & 0 & 0 & C_{64} & 0 & C_{66}
\end{pmatrix}
\]

where \( C_{ij} \) are the coefficients of the integrated constitutive matrix relating stress resultants and strains. where \( N_z \), 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 \( \bar{\varepsilon}_z \) is the axial strain, \( \kappa_y \) and \( \kappa_z \) are the bending strains, \( \alpha \) is the torsional strain, and \( \gamma_y \) and \( \gamma_z \) are some "average" measures of the transverse-shear strains in the \( z - y \) and \( x - z \) planes, respectively.
Dataset Contents

PROP.BTAB

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, $\alpha_x$
24. linear thermal expansion coefficient, $\alpha_y$
25. linear thermal expansion coefficient, $\alpha_z$
27. $Y_{yy}$, reference stress for use in stress display
29. $Y_{yz}$, reference stress for use in stress display
30. $Y_{yz}$, reference stress for use in stress display
31. $Y_{xx}$, 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

\[
\begin{pmatrix}
\epsilon_z \\
\epsilon_y \\
\epsilon_z \\
\gamma_{xy} \\
\gamma_{yz} \\
\gamma_{zz}
\end{pmatrix}
=
\begin{bmatrix}
\frac{1}{E_1} & -\frac{\nu_{12}}{E_2} & -\frac{\nu_{13}}{E_3} & 0 & 0 & 0 \\
-\frac{\nu_{12}}{E_1} & \frac{1}{E_2} & -\frac{\nu_{23}}{E_3} & 0 & 0 & 0 \\
-\frac{\nu_{13}}{E_1} & -\frac{\nu_{23}}{E_2} & \frac{1}{E_3} & 0 & 0 & 0 \\
0 & 0 & 0 & \frac{1}{G_{12}} & 0 & 0 \\
0 & 0 & 0 & 0 & \frac{1}{G_{23}} & 0 \\
0 & 0 & 0 & 0 & 0 & \frac{1}{G_{13}}
\end{bmatrix}
\begin{pmatrix}
\sigma_z \\
\sigma_y \\
\sigma_z \\
\tau_{xy} \\
\tau_{yz} \\
\tau_{zz}
\end{pmatrix}
\]
or

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

where

\[E_1, E_2, E_3 = \text{Young's moduli in 1, 2, and 3 directions, respectively.}\]
\[\nu_{ij} = \text{Poisson's ratio for transverse strain in the } j \text{-direction when stressed in the } i \text{-direction.}\]

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

\[\frac{\nu_{ij}}{E_i} = \frac{\nu_{ji}}{E_j} \quad i, j = 1, 2, 3\]

Thus, there are three reciprocal relations that must be satisfied for an orthotropic material. Moreover, only \(\nu_{12}, \nu_{13}, \text{ and } \nu_{23}\) need be further considered since \(\nu_{21}, \nu_{31}, \text{ and } \nu_{32}\) 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

\[ NI = 40 \]
\[ NJ = \text{Number of shell sections} \]
\[ \text{Type} = \text{single precision real} \]

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,

\[
\begin{bmatrix}
N_x \\
N_y \\
N_{xy}
\end{bmatrix} =
\begin{bmatrix}
A_{11} & A_{12} & A_{16} \\
A_{12} & A_{22} & A_{26} \\
A_{16} & A_{26} & A_{66}
\end{bmatrix}
\begin{bmatrix}
B_{11} & B_{12} & B_{16} \\
B_{12} & B_{22} & B_{26} \\
B_{16} & B_{26} & B_{66}
\end{bmatrix}
\begin{bmatrix}
\epsilon_x^o \\
\epsilon_y^o \\
\gamma_{xy}^o
\end{bmatrix}
\]

\[
\begin{bmatrix}
M_x \\
M_y \\
M_{xy}
\end{bmatrix} =
\begin{bmatrix}
B_{11} & B_{12} & B_{16} \\
B_{12} & B_{22} & B_{26} \\
B_{16} & B_{26} & B_{66}
\end{bmatrix}
\begin{bmatrix}
D_{11} & D_{12} & D_{16} \\
D_{12} & D_{22} & D_{26} \\
D_{16} & D_{26} & D_{66}
\end{bmatrix}
\begin{bmatrix}
\kappa_x \\
\kappa_y \\
\gamma_{xy}
\end{bmatrix}
\]

and

\[
\begin{bmatrix}
Q_z \\
Q_y
\end{bmatrix} =
\begin{bmatrix}
C_{S55} & C_{S45} \\
C_{S45} & C_{S44}
\end{bmatrix}
\begin{bmatrix}
\gamma_{zz}^o \\
\gamma_{yz}^o
\end{bmatrix}
\]
Dataset Contents

PROP.BTAB

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  
9. $A_{22}$  
10. $A_{26}$  
11. $B_{12}$  
12. $B_{22}$  
13. $B_{26}$  
14. 0  
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. $CS_{44}$

Revised 5/17/90  
CSM Testbed Data Library Description 2.0 - 95
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 \( C S_{ij} \) are the transverse shear stiffness coefficients.

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

\[
\begin{bmatrix}
N_x \\
N_y \\
N_{xy}
\end{bmatrix} = 
\begin{bmatrix}
A_{11} & A_{12} & A_{16} & B_{11} & B_{12} & B_{16} & 0 & 0 \\
A_{12} & A_{22} & A_{26} & B_{12} & B_{22} & B_{26} & 0 & 0 \\
A_{16} & A_{26} & A_{66} & B_{16} & B_{26} & B_{66} & 0 & 0
\end{bmatrix}
\begin{bmatrix}
\epsilon_x^0 \\
\epsilon_y^0 \\
\gamma_{xy}^0 \\
\kappa_x^0 \\
\kappa_y^0 \\
\gamma_{xy}^0 \end{bmatrix}
\]

\[
\begin{bmatrix}
M_x \\
M_y \\
M_{xy}
\end{bmatrix} = 
\begin{bmatrix}
B_{11} & B_{12} & B_{16} & D_{11} & D_{12} & D_{16} & 0 & 0 \\
B_{12} & B_{22} & B_{26} & D_{12} & D_{22} & D_{26} & 0 & 0 \\
B_{16} & B_{26} & B_{66} & D_{16} & D_{26} & D_{66} & 0 & 0
\end{bmatrix}
\begin{bmatrix}
\kappa_x \\
\kappa_y \\
\gamma_{xy} \end{bmatrix}
\]

\[
\begin{bmatrix}
Q_x \\
Q_y
\end{bmatrix} = 
\begin{bmatrix}
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & C S_{55} & C S_{45} \\
0 & 0 & 0 & 0 & 0 & 0 & C S_{45} & C S_{44}
\end{bmatrix}
\]
**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 constitutive 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

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:

\[
\begin{bmatrix}
\sigma_x \\
\sigma_y \\
\tau_{xy}
\end{bmatrix} = \begin{bmatrix}
C_{11} & C_{12} & C_{13} \\
C_{12} & C_{22} & C_{23} \\
C_{13} & C_{23} & C_{33}
\end{bmatrix} \begin{bmatrix}
\epsilon_z \\
\epsilon_y \\
\gamma_{xy}
\end{bmatrix}
\]

**PLANE STRESS**

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

**PLANE STRAIN**

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

where \( E \) = Young's Modulus
\( \nu \) = Poisson's Ratio
Dataset Contents

PROP.MASS

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. $M_{66}$

$I(6,6) =$

$$
\begin{pmatrix}
M_{11} & 0 & 0 & 0 & M_{15} & M_{16} \\
0 & M_{22} & 0 & M_{24} & 0 & 0 \\
0 & 0 & M_{33} & M_{34} & 0 & 0 \\
0 & M_{42} & M_{43} & M_{44} & 0 & 0 \\
M_{51} & 0 & 0 & 0 & M_{55} & M_{56} \\
M_{61} & 0 & 0 & 0 & M_{65} & M_{66}
\end{pmatrix}
$$

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. $\bar{m}_0$
2. $\bar{m}_1$
3. $\bar{m}_2$

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

PROP.MASS.2.103

Created from solid section properties by processor LAU.

\[ NI = 1 \]
\[ NJ = \text{Number of solid sections} \]
\[ \text{Type = single precision real} \]

Contents include the average mass densities.

Contents of each entry:

1. \( \rho \)

where \( \rho \) is the average mass density for the solid sections.
QGEN.APPF Dataset Contents

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

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.

\[ NI = 12 \]
\[ NJ = \text{Number of superlements} \]
\[ \text{Type} = \text{Integer} \]

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 Dataset Contents

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.
Dataset Contents

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 $3 \times 3$ matrix to convert global reference frame to alternate reference frame for that joint.

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

coordinates in alternate reference frame 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.

<table>
<thead>
<tr>
<th>Record</th>
<th>Type</th>
<th>Length</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>COEF_DET.1:nstep</td>
<td>D</td>
<td>(1)</td>
<td>Coefficient of ten(10) in the stiffness determinant (i.e., det = coef_det * 10^{exp10_det})</td>
</tr>
<tr>
<td>DISP_dofi.i:1:nstep</td>
<td>D</td>
<td>(1)</td>
<td>Displacement dofi for node i</td>
</tr>
<tr>
<td>DISP_dofj.j:1:nstep</td>
<td>D</td>
<td>(1)</td>
<td>Displacement dofj for node j</td>
</tr>
<tr>
<td>ERROR.1:nstep</td>
<td>D</td>
<td>(1)</td>
<td>Relative energy error</td>
</tr>
<tr>
<td>EXP10_DET.1:nstep</td>
<td>I</td>
<td>(1)</td>
<td>Exponent of ten (10) in the stiffness determinant</td>
</tr>
<tr>
<td>FORCE_dofi.i:1:nstep</td>
<td>D</td>
<td>(1)</td>
<td>Reaction force in dofi direction for node i</td>
</tr>
<tr>
<td>FORCE_dofj.j:1:nstep</td>
<td>D</td>
<td>(1)</td>
<td>Reaction force in dofj direction for node j</td>
</tr>
<tr>
<td>LOAD.1:nstep</td>
<td>D</td>
<td>(1)</td>
<td>Load factor</td>
</tr>
<tr>
<td>LOAD_DIR.1:nstep</td>
<td>I</td>
<td>(1)</td>
<td>Direction of load</td>
</tr>
<tr>
<td>NEG_ROOTS.1:nstep</td>
<td>D</td>
<td>(1)</td>
<td>Number of negative diagonal terms in stiffness matrix</td>
</tr>
<tr>
<td>NUM_CUTS.1:nstep</td>
<td>I</td>
<td>(1)</td>
<td>Number of cuts in step size</td>
</tr>
<tr>
<td>NUM_ITERS.1:nstep</td>
<td>I</td>
<td>(1)</td>
<td>Number of iterations for current step size</td>
</tr>
<tr>
<td>PATH_INC.1:nstep</td>
<td>D</td>
<td>(1)</td>
<td>Path length increment</td>
</tr>
<tr>
<td>REF_ERR.1:nstep</td>
<td>D</td>
<td>(1)</td>
<td>Reference value of error</td>
</tr>
<tr>
<td>SIGN_DET.1:nstep</td>
<td>I</td>
<td>(1)</td>
<td>Sign of determinant</td>
</tr>
<tr>
<td>TOT_ITERS.1:nstep</td>
<td>I</td>
<td>(1)</td>
<td>Total number of iterations for current step. Will equal NUM_ITERS.i if NUM_CUTS.i = 0</td>
</tr>
</tbody>
</table>
RESPONSE.HISTORY (concluded)

where

\[ n_{step} \] is the number of steps in the nonlinear analysis

\[ dof_i, dof_j \] 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

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. \( d_{33} \) flexibility coefficients
10. \( d_{44} \)
11. \( d_{45} \)
12. \( d_{55} \)
13. \( d_{46} \)
14. \( d_{56} \)
15. \( d_{66} \)
16. thru Not used.
25. }

\( f_{11} \)  
26. \( f_{21} \)  
27. \( f_{31} \)  
28. \( f_{41} \)  
29. \( f_{51} \)  
30. \( f_{61} \)  
31. \( f_{12} \)  
32. \( f_{22} \)  
33. \( f_{32} \)  
34. \( f_{42} \)  
35. \( f_{52} \)  
36. \( f_{62} \)  
37. \( f_{13} \)  
38. \( f_{23} \)  
39. \( f_{33} \)  
40. \( f_{43} \)  
41. \( f_{53} \)  
42. \( f_{63} \)  
43. } stress coefficients
SA.BTAB.2.13 (continued)

For COUPLED section types:  \( NI = 43 \)

Contents of each entry:

1. Number indicating section type
   \( 4 = \text{COUPLED} \)
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. \( d_{66} \)

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

- \( 44.\) flexibility coefficients

Revised 5/17/90  CSM Testbed Data Library Description 2.0-113
**SA.BTAB.2.13 (concluded)**

For LAMINATE section types: $NI = 25 + (18 \text{ times number of layers})$

Contents of each entry:

1. Number indicating section type
   - $5 = \text{LAMINATE}$
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. $d_{15}$ flexibility coefficients
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. $d_{66}$
25. Number of layers
26. $g_{11}^1$
   - stress recovery coefficients for first layer
43. $g_{33}^1$
44. $g_{11}^2$
   - stress recovery coefficients for second layer
61. $g_{56}^2$
62. through $(25 + 18 \times \text{number of layers})$. Eighteen additional values of $g_{ij}^{\text{layer}}$ 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

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_Sdir.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_Sdir.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_Sdir.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 \( z \) direction is coincident with the global \( z \) direction. For \( dir = 2 \), the strain \( z \) direction is coincident with the global \( y \) direction. For \( dir = 3 \) the strain \( z \) 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

\text{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

**SPLI.GEOM.*isurf.nsymb**

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

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

Contains minimum and maximum z 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 z coordinate
2. Maximum z coordinate
3. Minimum y coordinate
4. Maximum y coordinate
Dataset Contents

SPLI.INPU

**SPLI.INPU.isurf.nsym**

\[ isurf = \text{surface number} \]

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

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:

\[
\begin{array}{c}
    I = 1, 2, \ldots \\
    J = 1, 2, \ldots \\
\end{array}
\]

Number of joints

\[
\begin{array}{c}
    1 \quad x_1 \quad x_2 \ldots \\
    2 \quad y_1 \quad y_2 \ldots 
\end{array}
\]

Rectangular coordinates of joints in global reference frame

Revised 5/17/90
SPLI.NODI

SPLI.NODI.isurf.nsym

isurf = surface number
n_sym = \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:

\begin{array}{l}
  J = 1, 2, \ldots \text{Number of joints} \\
  I = 1 \quad \mid J_1, J_2, \ldots \text{ Node numbers}
\end{array}
**Dataset Contents**

**SPLI.MATR**

**SPLI.MATR.isurf.nsym**

isurf = surface number

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

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

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:

1. \( a_{11} \)
2. \( a_{21} \)
3. \( a_{31} \)
   
\ldots

\( n_j \cdot a_{nj,1} \)

\( n_j + 1 \cdot a_{12} \)
\( n_j + 2 \cdot a_{22} \)
\( n_j + 3 \cdot a_{32} \)
   
\ldots

\( 2 \cdot n_j \cdot a_{nj,2} \)
   
\ldots

\( n_j \cdot n_i \cdot a_{ni,nj} \)

Components of a spline coefficient matrix or its inverse

\[
A_{ni,nj} = \begin{bmatrix}
    a_{11} & a_{12} & \ldots & a_{1,nj} \\
    a_{21} & a_{22} & \ldots & a_{2,nj} \\
    \vdots & \vdots & \ddots & \vdots \\
    a_{ni,1} & a_{ni,2} & \ldots & a_{ni,nj}
\end{bmatrix}
\]
STAT.DISP

Dataset Contents

STAT.DISP.\text{i}.j

For \textit{linear} static analysis:
\begin{align*}
i & = \text{Load set (iset)} \\
j & = \text{Constraint case (ncon)}
\end{align*}

For \textit{nonlinear} static analysis:
\begin{align*}
i & = \text{Load step (istep)} \\
j & = 0
\end{align*}

Created in processor SSOL.

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

Contents:

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

STAT.REAC.i.j

For **linear** static analysis:
- $i$ = Load set ($iset$)
- $j$ = Constraint case ($ncon$)

For **nonlinear** 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

Dataset Contents

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).
**Dataset Contents**

**STRN.xxxx**

**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 **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 strain components. The record names, contents, and sizes are defined as follows:

- **CENTROIDS.Sdir.ielt**  STRAIN components at the centroid of element \( ielt \) in reference frame \( dir \). Record length is the number of STRAIN components.
- **INTEG_PTS.Sdir.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.Sdir.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 \( z \) direction is coincident with the global \( z \) direction. For \( dir = 2 \), the strain \( z \) direction is coincident with the global \( y \) direction. For \( dir = 3 \) the strain \( z \) 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**

Revised 5/17/90  CSM Testbed Data Library Description  2.0 - 125
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: $\varepsilon_{zz}$, $\varepsilon_{yy}$, $\varepsilon_{xy}$, $\kappa_{zz}$, $\kappa_{yy}$, $\kappa_{zy}$, $\gamma_z$, $\gamma_y$. Users should consult the specific element processor documentation for the strain components calculated by the specific element processor.
STRS.E21iset.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. $\alpha_1$
26. $I_2$
27. $\alpha_2$
28. Cross-sectional Area
29. $f_1$
30. $f_2$
31. $z_1$
32. $z_2$
33. $\theta$
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  Dataset Contents

**STRS.E22.iJet.ica_e**

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.

\textit{iset.icase}

\texttt{iset} = Load set
\texttt{icase} = Load case within set

Created in processor GSF.

\texttt{NJ} = Number of E23 elements
\texttt{NI} = 6
\texttt{Type} = single precision real

The dataset contains \texttt{NJ} nominal records, \texttt{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

Dataset Contents

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

2.0- 130 CSM Testbed Data Library Description Revised 5/17/90
**Dataset Contents**

**STRS.E25**

**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 Dataset Contents

**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:

\[
S_z = \frac{N_z}{\text{thickness}} \\
S_y = \frac{N_y}{\text{thickness}} \\
T_{xy} = \frac{N_{xy}}{\text{thickness}}
\]
Dataset Contents

**STRS.E32**

**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. $M_y$ Bending moment about y-axis at joint 1
10. $M_y$ Bending moment about z-axis at joint 1
11. $M_y$ 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. $M_y$ Bending moment about y-axis at joint 2
15. $M_y$ Bending moment about z-axis at joint 2
16. $M_y$ 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. $M_y$ Bending moment about y-axis at joint 3
20. $M_y$ Bending moment about z-axis at joint 3
21. $M_y$ 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.E32Dataset Contents

STRS.E32.iset.icase (concluded)

24. $M_z$ Bending moment about $y$-axis at the center
25. $M_y$ Bending moment about $z$-axis at the center
26. $M_{zy}$ Twisting moment at the center
27. $Q_z$ Transverse shear in $x$-direction at the center
28. $Q_y$ Transverse shear in $y$-direction at the center

Formulas:

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

**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. $M_z$ Bending moment about z-axis at the center
28. $M_y$ Bending moment about y-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:

\[ S_x = f_{ij} N_z + f_{4j} M_z \quad f_{ij} = 1/\text{thickness for } i \text{ and } j = 1, 2, 3 \]
\[ S_y = f_{ij} N_y + f_{5j} M_y \quad f_{42} = f_{52} = -f_{62} = 6/(\text{thickness})^2 \]
\[ T_{xy} = f_{3j} N_{xy} + f_{6j} M_{xy} \quad f_{43} = f_{53} = -f_{63} = -6/(\text{thickness})^2 \]
**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. $N_z$ Tractive force in z-direction at joint 1
10. $N_y$ Tractive force in y-direction at joint 1
11. $N_{xy}$ Shearing force at joint 1
12. $N_z$ Tractive force in z-direction at joint 2
13. $N_y$ Tractive force in y-direction at joint 2
14. $N_{xy}$ Shearing force at joint 2
15. $N_z$ Tractive force in z-direction at joint 3
16. $N_y$ Tractive force in y-direction at joint 3
17. $N_{xy}$ Shearing force at joint 3
18. $N_z$ Tractive force in z-direction at joint 4
19. $N_y$ Tractive force in y-direction at joint 4
20. $N_{xy}$ Shearing force at joint 4
21. $N_z$ Tractive force in z-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.

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

Formulas:

\[ S_z = \frac{N_z}{\text{thickness}} \]
\[ S_y = \frac{N_y}{\text{thickness}} \]
\[ T_{xy} = \frac{N_{xy}}{\text{thickness}} \]
**Dataset Contents**

**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. $M_z$ Bending moment about $y$-axis at joint 1
10. $M_y$ Bending moment about $z$-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. $M_z$ Bending moment about $y$-axis at joint 2
15. $M_y$ Bending moment about $z$-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. $M_z$ Bending moment about $y$-axis at joint 3
20. $M_y$ Bending moment about $z$-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

Revised 5/17/90  
CSM Testbed Data Library Description 2.0 - 139
STRS.E42 Dataset Contents

STRS.E42.iset.icase (concluded)

24. $M_x$ Bending moment about y-axis at joint 4
25. $M_y$ Bending moment about z-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. $M_z$ Bending moment about y-axis at the center
30. $M_y$ Bending moment about z-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:

\[
\begin{align*}
S_x &= f_{4j}M_x \\
S_y &= f_{5j}M_y \\
T_{xy} &= f_{6j}M_{xy}
\end{align*}
\]

\[
\begin{align*}
f_{42} &= f_{52} = -f_{62} = -\frac{6}{(\text{thickness})^2} \\
f_{43} &= f_{53} = -f_{63} = -\frac{6}{(\text{thickness})^2}
\end{align*}
\]
STRS.E43

**Contents**

**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.

- \( N_J \) = Number of E43 elements
- \( N_I = 48 \)
- Type = single precision real

The dataset contains \( N_J \) nominal records, \( N_I \) 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. \( N_z \) Tractive force in \( z \)-direction at joint 1
10. \( N_y \) Tractive force in \( y \)-direction at joint 1
11. \( N_{zy} \) Shearing force at joint 1
12. \( N_z \) Tractive force in \( z \)-direction at joint 2
13. \( N_y \) Tractive force in \( y \)-direction at joint 2
14. \( N_{zy} \) Shearing force at joint 2
15. \( N_z \) Tractive force in \( z \)-direction at joint 3
16. \( N_y \) Tractive force in \( y \)-direction at joint 3
17. \( N_{zy} \) Shearing force at joint 3
18. \( N_z \) Tractive force in \( z \)-direction at joint 4
19. \( N_y \) Tractive force in \( y \)-direction at joint 4
20. \( N_{zy} \) Shearing force at joint 4
21. \( N_z \) Tractive force in \( z \)-direction at the center
22. \( N_y \) Tractive force in \( y \)-direction at the center
23. \( N_{zy} \) Shearing force at the center

Revised 5/17/90
24. $M_x$ Bending moment about $y$-axis at joint 1
25. $M_y$ Bending moment about $z$-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 $z$-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 $z$-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 $z$-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 $z$-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:

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

**STRS.E44.i set. 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

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:

\[ i = \text{Load set (iset)} \]
\[ j = \text{Constraint case (ncon)} \]

For nonlinear static analysis:

\[ i = \text{Load step (istep)} \]
\[ j = 0 \]

Created by processor ESi (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_Sdir.ielt** Stress components at the centroid of element ielt in reference frame dir. Record length is the number of stress components.
- **INTEG_PTS_Sdir.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_Sdir.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 z direction is coincident with the global z direction. For dir = 2, the stress z direction is coincident with the global y direction. For dir = 3 the stress z 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**

2.0 - 144 CSM Testbed Data Library Description Revised 5/17/90
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: \( N_x, N_y, N_{z_y}, M_z, M_y, M_{z_y}, Q_x, Q_y \). Users should consult the specific element processor documentation for the stress components calculated by the specific element processor.
TEMP.xxxx Dataset Contents

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.
**Dataset Contents**

**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 pseudo-vectors.

Revised 5/17/90 CSM Testbed Data Library Description 2.0 - 149
VIBR.EVAL

VIBR.EVAL.nset.ncon

\[ nset = \text{Set identifier} \]
\[ ncon = \text{Constraint case} \]

Created in processor EIG.

\[ NJ = 1 \]
\[ NI = \text{Number of eigenvalues} \]
\[ \text{Type} = \text{single precision real} \]

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

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

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.
THIS PAGE LEFT BLANK INTENTIONALLY.
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 organisation is presented.