FORMAT—FORTRAN MATRIX ABSTRACTION TECHNIQUE

VOLUME VI—SUPPLEMENT I. DESCRIPTION OF DIGITAL COMPUTER PROGRAM—PHASE I—EXTENDED

R. C. MORRIS

FOREWORD

This report was prepared by the Douglas Aircraft Company, Long Beach, California, under USAF Contract No. F33615-68-C-1633. The work was initiated under Project No. 1467 "Structural Analysis Methods", and Task No. 146705 "Automatic Computer Methods of Analysis for Flight Vehicle Structures". The work was administered under the Air Force Flight Dynamics Laboratory, by Mr. J. R. Johnson, FDTR, Project Engineer.

The work reported herein was conducted during the period July 1968 through April 1970. This report was submitted by the author for publication in April 1970.

Within the Douglas Aircraft Company, Mr. P. H. Denke, Director, Scientific Computing was responsible for administration and technical progress. Mr. D. S. Warren, Manager, Advanced Design and Research, Structural Mechanics Section was principal investigator. Many other Douglas personnel contributed singificantly to the project.

The general objective of the project was to update the FORMAT System documented in Volumes I through VII, as supplemented, by incorporation of additional basic capability and refinement of existing capability. The work is reported in Volume II - Supplement III, Volume V - Supplement I, Volume VI - Supplement I and Volume VII -Supplement I. A complete description of the current FORMAT System is contained in Volumes II, V, VI and VII, as supplemented (References 1 through 10). The supplements are the final reports of the investigation and conclude the work on Contract No. F33615-68-C-1633. The contractors report number is DAC-33569.

The report has been reviewed and is approved.

FRANCIS J. JANIK, JR.
Chief, Solid Mechanics Branch
Structures Division

ABSTRACT

The FORMAT System has been updated by the incorporation of additional basic capability and the refinement of existing capability. A simpler mode of updating case data and extended force method matrix generation capability has been incorporated in Phase I of the system. A refined "Structure Cutter" module, capabilities for matrix partitioning and instruction looping, and an additional eigenvalue/eigenvector extraction module have been incorporated in Phase II. Finally the limitations which existed in the matrix plotting capability in Phase III have been eliminated. Programming documentation for the extended capability of Phase I of the FORMAT System is presented in this report.

CONTENTS

Section		Page
I	INTRODUCTION	1
II	IMPLEMENTATION	3
APPENDIX I	- PHASE I ROUTINES - EXTENDED	5
REFERENCES		61

SECTION I

INTRODUCTION

The FORMAT System has been updated to provide additional basic capability and refinements to the existing capability.

Additions and modifications to Phase I (the case and matrix generation phase) of the system are as follows.

- Simplification of the input data required when case data is to be updated.
- Improved structural idealization capability in force method analyses by provision for multiple bars along a shear panel edge in the Basic Force Method Module (BFMM) and, in addition, the use of a revised algorithm for generation of the matrix of weighting factors in order to represent element relative stiffnesses more effectively.
- Extended program capability to accommodate unique structural idealizations where a majority of all unknown internal element forces contribute to a single degree of freedom.
- Automatic generation of an additional matrix by the Force Method Joining Module (FMJM) which enables force and moment summations of the applied loading to be obtained matrically.

These capabilities are an optional addition to the base capabilities of Phase I as described in Reference 7. User-oriented documentation is presented in Reference 6.

Section II of this report summarizes the steps required to implement these modifications. Routine descriptions are contained in Appendix I.

The overlay structure of Phase I and the error messages generated in Phase I are unchanged.

SECTION II

IMPLEMENTATION

Implementation of the program changes necessary for including the extended program capabilities described in Section I, requires only the replacement of the following 12 existing subroutines with the revised versions.

1. TGEN1 (Deck G031)
2. MGEN1 (Deck G120)
3. MGEN11 (Deck G121)
4. BFMM (Deck G200)
5. PANRD (Deck G205)
6. DWET (Deck G208)
7. PFO (Deck G215)
8. EXT (Deck G216)
9. FMJM (Deck G300)
10. JRD (Deck G301)
11. JDFA (Deck G302)
12. JOUT (Deck G307)

APPENDIX I

PHASE I ROUTINES - EXTENDED

This appendix contains a detailed description of all subroutines that were significantly modified in Phase I in the FORMAT System. Each subroutine is divided into sections which are the following.

(a) Algorithm

(b) Input/Output

(c) Error

(d) Subroutines Required

(e) Argument List

(f) Subroutine Length

(g) Symbol List

The symbol list is divided into five fields which are described as follows.

i. The first field contains the symbol.

ii. The second field contains the letters I, L, or R denoting integer, logical, or real variable, respectively.

iii. The third field contains the letters A, C, D, or U denoting argument list, common, dimensioned, or undimensioned variable respectively. The hierarchy of the above letters is A, C, D, U.

iv. The fourth field contains the definition of the symbol.

v. The fifth field contains the name of the subroutine in which the symbol occurs.

TABLE I. APPENDIX I - TABLE OF CONTENTS

			Page
1.	SUBROUTINE TGEN1	(Deck G031)	7
2.	SUBROUTINE BFMM	(Deck G200)	13
3.	SUBROUTINE PANRD	(Deck G205)	23
4.	SUBROUTINE DWET	(Deck G208)	29
5.	SUBROUTINE PFO	(Deck G215)	35
6.	SUBROUTINE EXT	(Deck G216)	41
7.	SUBROUTINE JRD	(Deck G301)	47
8.	SUBROUTINE JDFA	(Deck G302)	55

1. SUBROUTINE TGEN1 (DECK G031)

This routine analyzes the following Table Generator Control data cards:

(i)	CREATE	case name (data set name, modifier)
(ii)	REF	case name (data set name, modifier)
(iii)	TABLE	table number, case name (data set name, modifier)
(iv)	DATA	

a. Algorithm

Upon entry many variables are initialized. Blanks are compressed from the first data card starting in column seven. The card is then matched against valid control cards. If a match is not found, an error message is written and the card in error is ignored. If a match is found, control is transferred to that section of code which analyzes the appropriate type of card.

If the card is a CREATE or REF card the following analysis takes place.

(i) The card is scanned beginning in the card column following the CREATE or REF. When a left parenthesis is encountered, the field thus defined is checked for validity as a case name. If it is a valid case name, the name is stored and the scan continues until a comma is encountered.

(ii) The field delimited by the left parenthesis and the comma is checked for validity as a data set name. If it is a valid data set name, the name is stored and the scan continues until a right parenthesis is encountered.

(iii) The field delimited by the comma and the right parenthesis is checked for validity as a data set modifier (i.e., an integer). If it is a valid data set modifier, the modifier is stored.

(iv) If the card is a CREATE card and there exists more non-blank characters the search is continued the same as for the REF card.

(v) Finally, control is transferred to a section of code which depends on the option specified on the $EDITOR card.

If the card is a TABLE card, the following analysis takes place.

(i) The card is scanned beginning in the card column following TABLE. When a comma is encountered, the field thus defined is checked for validity as an integer between 1 and 99. If the field is a valid integer of the correct magnitude, it is stored and the scan continues until a left parenthesis is encountered.

(ii) The case name, data set name, and modifier are checked in the manner set forth in (i), (ii), and (iii) under the CREATE card.

(iii) The data set name and modifier are written on a scratch data set for future use.

(iv) Finally, control is transferred to a section of code specified on the $EDITOR card.

If the card is a DATA card, a flag is set and control is passed to a section of code which depends on the option specified on the $EDITOR card.

The wrap-up procedure for the NEW option consists of:

(i) Insuring that the create card has been correctly analyzed.

(ii) Insuring that the DATA card was the last card read.

(iii) Verifying that the specified data set exists.

The wrap-up procedure for the UPDATE option consists of the following:

(i) Verifying that all specified data sets exist.

(ii) Sorting the table cards and verifying the uniqueness of the table numbers.

(iii) Verifying that a CREATE-REF card has been analyzed correctly if no TABLE cards exist.

The wrap-up procedure for the MERGE and print options consists of:

(i) Insuring that all cards read are REF cards.

(ii) Writing the REF cards on a scratch data set.

The wrap-up for the SYMX, SYMY, SYMZ options consists of insuring that the one data card read is a REF card.

Control is returned to the Table Generator Control routine after the wrap-up procedure which follows the recognition of $ - control card on a DATA card.

b. Input/Output

(i) Data cards are read from the system input unit (NPIT) and listed on the system output unit (NPOT).

(ii) An intermediate utility data set is used for scratch.

c. Error

The following conditions cause an error:

(i) An unexpected $ card is encountered

(ii) An invalid data card is encountered

(iii) A table card is less than one or greater than 98

(iv) A data card is read which is inconsistent with the specified option

(v) Both the TABLE cards and the CREATE-REF card and the special data are missing when UPDATE is specified as an option

(vi) Duplicate table numbers appear on TABLE cards.

(vii) A specified data set does not exist.

d. Subroutines Required

PUTL1
PUTL2
PUTL3
PUTL4

e. Argument List

TGEN1 (ICARD, ISETNM, ITABLE, MAXTAB, ICASE, NUMTAB, IACT, NUMSET, IPRINT, LINE, DATA, ERR)

ICARD - array into which the data cards are read

ISETNM - array containing data set information

ITABLE - array containing table information

MAXTAB	-	largest table number specified
ICASE	-	array of case information
NUMTAB	-	number of valid TABLE cards read
IACT	-	integer denoting the option on the $EDITOR card
NUMSET	-	the number of available data sets
LINE	-	printed line counter
IPRINT	-	print flag
DATA	-	logical flag indicating whether a DATA card was read or not
ERR	-	logical error flag

f. Length

3506 words (approximate)

g. Symbol List

SYMBOLS USED IN SUBROUTINE TGEN1

DATA	L	A	FLAG INDICATING WHETHER DATA CARD WAS READ	TGEN1
EQUAL	L	U	FLAG INDICATING EQUALITY OF TWO ARRAYS	TGEN1
ERR	L	A	ERROR FLAG	TGEN1
ERROR	L	U	ERROR FLAG	TGEN1
FIRST	L	U	FLAG INDICATING WHEN FIRST $ CARD IS READ	TGEN1
I	I	U	INDEX INDICATING CURRENT CONTROL CARD	TGEN1
IACT	I	A	OPTION ON $EDITOR CARD	TGEN1
IACTX	I	U	TEMPORARY STORAGE FOR OPTION ON $EDITOR CARD	TGEN1
IBLK	I	C	BLOCK SIZE OF MASTER CASE DATA SETS	TGEN1
ICARD	I	A	STORAGE FOR CONTROL CARD	TGEN1
ICASE	I	A	STORAGE FOR CASE INFORMATION	TGEN1
ICNTRL	I	D	STORAGE FOR CONTROL CARD CHARACTERS	TGEN1
ICOM	I	U	CHARACTER (C)	TGEN1
IDOL	I	U	CHARACTER ($)	TGEN1
IEND	I	U	DO END	TGEN1
IPNCTC	I	D	PUNCTUATION FOR CREATE AND REF CARDS	TGEN1
IPNCTT	I	D	PUNCTUATION FOR TABLE CARD	TGEN1
IPRINT	I	A	PRINT FLAGS	TGEN1
IPT	I	U	DELIMETER COUNTER	TGEN1
ISETNM	I	A	TABLE OF MASTER DATA SET INFORMATION	TGEN1
ISETNX	I	D	TEMPORARY STORAGE FOR DATA SET NAME	TGEN1
ISETNY	I	D	TEMPORARY STORAGE FOR DATA SET NAMES	TGEN1
ISTART	I	U	DO BEGINNING	TGEN1
ITABLE	I	A	STORAGE FOR TABLE INFORMATION	TGEN1
ITEMP	I	U	INTERMEDIATE VARIABLE	TGEN1
ITIME	I	U	CONTROL CARD COUNTER	TGEN1
ITRAIL	I	U	CODE FOR DATA SET TRAILER (-20)	TGEN1
IZERO	I	U	INTEGER ZERO (0)	TGEN1
J	I	U	DO INDEX	TGEN1
K	I	U	INTERMEDIATE VARIABLE	TGEN1
KONFIG	I	C	TABLE OF AVAILABLE DATA SET INFORMATION	TGEN1
KONST	I	C	ORDER OF LARGEST MATRIX SYSTEM WILL PROCESS	TGEN1

SYMBOLS USED IN SUBROUTINE TGEN1

L	I	U	DO INDEX	TGEN1
LEFT	I	U	BEGINNING OF A FIELD ON A CONTROL CARD	TGEN1
LENGTH	I	U	LENGTH OF A FIELD	TGEN1
LINE	I	A	LINE COUNTER	TGEN1
LNCRL	I	D	NUMBER OF CHARACTERS IN EACH CONTROL CARD	TGEN1
MXLINE	I	U	MAXIMUM NUMBER OF LINES ON A PAGE	TGEN1
NCSE	I	U	NUMBER OF CREATE AND REF CARDS READ	TGEN1
NINET	I	U	NINE (9)	TGEN1
NINTY	I	U	DATA TRAILER (99)	TGEN1
NONBLK	I	U	THE NUMBER OF NON BLANK CHARACTERS IN A CONTROL CARD	TGEN1
NPIT	I	C	REFERENCE NUMBER OF SYSTEM INPUT UNIT	TGEN1
NPOT	I	C	REFERENCE NUMBER OF SYSTEM OUTPUT UNIT	TGEN1
NSET	I	U	TEMPORARY STORAGE FOR A DATA SET REFERENCE NUMBER	TGEN1
NSETI	I	U	REFERENCE NUMBER OF DATA SET CONTAINING TABLE CARDS	TGEN1
NUM	I	U	INTERMEDIATE VARIABLE	TGEN1
NUMBER	I	U	TABLE NUMBER EXTRACTED FROM TABLE CARD	TGEN1
NUMR	I	C	NUMBER OF AVAILABLE DATA SETS	TGEN1
NUMSET	I	A	NUMBER OF AVAILABLE MASTER DATA SETS	TGEN1
NUMTAB	I	A	NUMBER OF TABLE CARDS READ	TGEN1
NWORK	I	C	LENGTH OF WORKING STORAGE	TGEN1

2. SUBROUTINE BFMM (DECK G200)

This is the Analyzer Routine for the Basic Force Method Module which initiates and monitors the execution of ten computational routines.

a. Algorithm

The Analyzer Routine first locates the input case data on the master case data set using subroutine TUTL3 and then tests the control data passed from Matrix Generation Control Module. The routine determines if the available working storage and scratch data sets are sufficient to permit processing of the maximum size problem as defined by KONST. If so, working storage, scratch data sets and control flags are initialized and the locations within working storage for each array required by the first computational routine, JVRD, are set and routine JVRD called.

After each computational routine has been executed, error flags are tested and, if appropriate, the locations within working storage for each array required by the next routine are set, and the next routine is called. If any error is detected which prohibits further processing, the main error flag, ERROR, is set to TRUE and control is returned to the Matrix Generation Control Module.

All control data is stored in a column array IK which is 100 words long and occupies the first 100 locations of working storage. Permanent control data is stored in the first 50 locations of array IK while intermediate control data is stored in the remaining 50 locations. The permanent control data is defined in Table I.

Table II is a map of available working storage showing the allocation of memory for the arrays used by each of the computational routines. Array lengths are shown in parentheses.

Table III shows the utilization of the scratch data sets by each of the computational routines. The data groups symbolically represented are

PF	—	Unknown element force coefficients which constitute the elements of matrix PFT
PO	—	Applied load coefficients which constitute the elements of matrix POT
N	—	Indexing data and coefficients relative to matrices TF, TO, GR, GBT, GPF, and GPS
NPF	—	Indexing data and direction cosines of bar external reaction vectors

TABLE I. BASIC FORCE METHOD MODULE CONTROL ARRAY

ROW		ROW	
1	FORTRAN logical number of scratch data set 1	17	Number of bar external reaction vectors
2	FORTRAN logical number of scratch data set 2	18	Number of bar applied load vectors
3	FORTRAN logical number of scratch data set 3	19	Number of joint equilibrium equations
4	FORTRAN logical number of scratch data set 4	20	FORTRAN logical number of data set containing PFT after sort
5	Number of joints	21	FORTRAN logical number of data set containing POT after sort
6	Number of external reactions	22	FORTRAN logical number of scratch data set after sort
7	Number of applied load conditions	23	Number of distributed loading conditions
8	Number of bar elements	24	Number of matrices output
9	Number of shear panel elements	25	Number of resultant bar loads
10	Number of triangular membrane elements	26	Flag, set to 0 if ETT is null
11	Number of parallelogram membrane elements	27	Not used
12	Number of existing type 2 to 7 bar element forces	28	Flag, set to 1 if option 1 or 4 is specified
13	Number of force vectors in PFT	29	Flag, set to 1 if option 2 or 4 is specified
14	Number of moment vectors in PFT	30	Flag, set to 1 if option 3 or 4 is specified
15	Number of force vectors in POT	31	Error flag for joint coordinate data
16	Number of moment vectors in POT	32	Error flag for external reaction data
		33	Error flag for applied load vector data
		34	Error flag for applied distributed load data

TABLE I. BASIC FORCE METHOD MODULE CONTROL ARRAY (Continued)

ROW	
35	Error flag for bar element data
36	Error flag for shear panel element data
37	Error flag for triangular membrane element data
38	Error flag for parallelogram membrane element data
39	Error flag for bar applied load vectors
40	Error flag for elimination of extraneous equations
41	Data code number for joint coordinate data (1)
42	Data code number for external reaction data (3)
43	Data code number for applied load vector data (4)

ROW	
44	Data code number for first distributed load condition (11)
45	Data code number for last distributed load condition (18)
46	Data code number for bar element data (20)
47	Data code number for shear panel element data (30)
48	Data code number for triangular membrane element data (40)
49	Data code number for parallelogram membrane element data (50)
50	Not used

TABLE II. BASIC FORCE METHOD MODULE STORAGE ALLOCATION

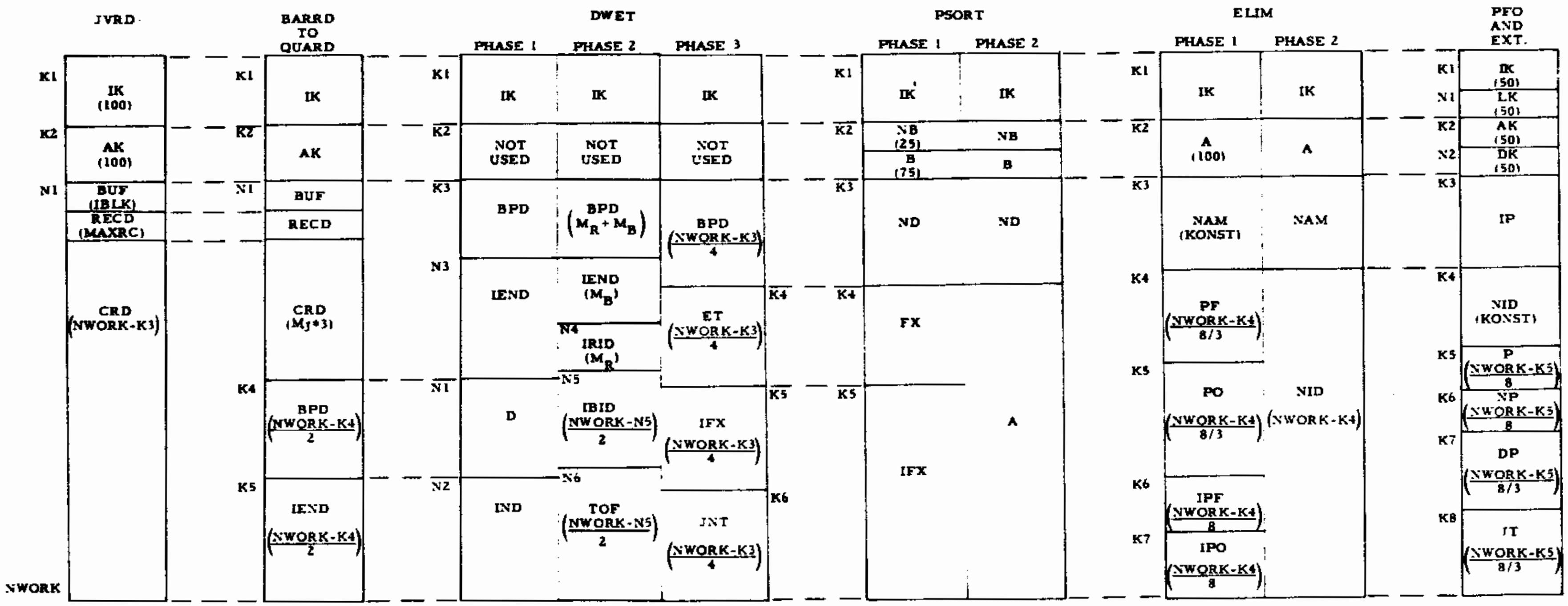


TABLE III. BASIC FORCE METHOD MODULE DATA SET UTILIZATION

SCRATCH DATA SET	ROUTINE							
	JVRD	BARRD	PANRD	TRIRD	QUARD	DWET	PSORT AND ELIM	PFO
1	PF(r)	PF(r) PF(b)	PF(r) PF(b) PF(p)	PF(r) PF(b) PF(p) PF(t)	PF(r) PF(b) PF(p) PF(t) PF(q)	PF(r) PF(b) PF(p) PF(t) PF(q) PF(rb)	PFT	Blank
2	PO(i) PO(d)	Unchanged	Unchanged	Unchanged	Unchanged	PO(i) PO(d) PO(ib) PO(db)	POT	GBT GPF GPS
3	Blank	N(b)	N(b) N(p)	N(b) N(p) N(t)	N(b) N(p) N(t) N(q)	N(b) N(p) N(t) N(q) N(ib) N(db) N(rb)	Unchanged	Unchanged
4	NPR(rb) NPO(ib) NPO(db)	NPF(rb) NPO(ib) NPO(db) D(b)	NPF(rb) NPO(ib) NPO(db) D(b) D(p)	NPF(rb) NPO(ib) NPO(db) D(b) D(p) D(t)	NPF(rb) NPO(ib) NPO(db) D(b) D(t) D(q)	Blank	Blank	Blank

NPO	—	Indexing data and direction cosines of bar applied load vectors
D	—	Structural element flexibilities which constitute elements of matrix D

and the subgroups denoted by symbols in parentheses are

(r)	contributions from	Joint external reactions
(b)		Bar elements
(p)		Shear panel elements
(t)		Triangular membrane elements
(q)		Parallelogram membrane elements
(i)	contributions from	Joint applied load vectors
(d)		Distributed load condition joint loads
(rb)	contributions from bar vectors which are	External reactions
(ib)		Applied load vectors
(db)		Distributed load condition bar loads

b. Input/Output

None

c. Error Messages

Error messages are printed when the master case header cannot be found on the master case data set and when the number of storage locations, scratch data sets, or output matrix names is insufficient. Whenever execution of this routine ends with an error condition, the control data and error flags in the first 50 locations of array IK are also printed.

d. Subroutines Required

TUTL3
LLINK
JVRD
BARRD
PANRD
TRIRD
QUARD

DWET
PSORT
ELIM
PFO
EXT

e. Argument List

BFMM (NUMOT, OUTPUT, IOSPEC, NUMSR, ISSPEC, LALAR, ERROR, NWORK, IWORK, KASIN, IPRINT)

NUMOT	—	Is a variable defining the number of output matrices to be generated (always 13).
OUTPUT	—	Is an array (7 x NUMOT) containing the six alphameric characters representing the names of each of the output matrices. Row 7 is set equal to one.
IOSPEC	—	Is an array (1 x NUMOT) containing the FORTRAN logical number of the data sets onto which each of the output matrices are to be written.
NUMSR	—	Is a variable defining the number of scratch data sets available.
ISSPEC	—	Is an array (1 x NUMSR) containing the FORTRAN logical number of each of the scratch data sets.
LALAR	—	Is a variable defining the output matrix group option.
ERROR	—	Is a logical variable which is the main error flag and is set to TRUE if an error occurs.
NWORK	—	Is a variable defining the number of words of working storage available.
IWORK	—	Is the working array (1 x NWORK).
KASIN	—	Is an array (7 x 1) containing the six alphameric characters representing the name of the input case and row 7 is the FORTRAN logical number of the data set where the case is stored.

IPRINT — Is a variable defining the output page size option (not used).

f. Subroutine Length

3064 words (approximate)

g. Symbol List

```
SYMBOLS USED IN SUBROUTINE BFMM

ERR      L  U  ERROR FLAG FOR TUTL3                                        BFMM
ERROR    L  A  MAIN ERROR FLAG                                             BFMM
I        I  U  INTERMEDIATE INDEX                                          BFMM
IBLK     I  C  REQUIRED BUFFER SIZE FOR TUTL7                              BFMM
IOSPEC   I  A  ARRAY OF OUTPUT MATRIX DATA SET NUMBERS                     BFMM
IPRINT   I  A  PRINT OPTION FLAG (NOT USED)                                BFMM
ISSPEC   I  A  ARRAY OF SCRATCH DATA SET NUMBERS                           BFMM
IST1     I  U  NUMBER OF SCRATCH DATA SET 1                                BFMM
IST2     I  U  NUMBER OF SCRATCH DATA SET 2                                BFMM
IST3     I  U  NUMBER OF SCRATCH DATA SET 3                                BFMM
IST4     I  U  NUMBER OF SCRATCH DATA SET 4                                BFMM
IWORK    I  A  WORKING ARRAY                                               BFMM
J        I  U  INTERMEDIATE INDEX                                          BFMM
K        I  U  SIZE OF AN INTERMEDIATE BLOCK OF THE WORK ARRAY             BFMM
KASIN    I  A  ARRAY OF INPUT CASE NAME AND DATA SET NUMBER                BFMM
KONST    I  C  MAXIMUM MATRIX SIZE                                         BFMM
K1       I  U  FIRST LOCATION OF CONTROL ARRAY                             BFMM
K2       I  U  FIRST LOCATION OF AN INTERMEDIATE TABLE                     BFMM
K3       I  U  FIRST LOCATION OF AN INTERMEDIATE TABLE                     BFMM
K4       I  U  FIRST LOCATION OF AN INTERMEDIATE TABLE                     BFMM
K5       I  U  FIRST LOCATION OF AN INTERMEDIATE TABLE                     BFMM
K6       I  U  FIRST LOCATION OF AN INTERMEDIATE TABLE                     BFMM
K7       I  U  FIRST LOCATION OF AN INTERMEDIATE TABLE                     BFMM
K8       I  U  FIRST LOCATION OF AN INTERMEDIATE TABLE                     BFMM
LALAR    I  A  OUTPUT MATRIX GROUP OPTION FLAG                             BFMM
MAXRC    I  U  MAXIMUM NUMBER OF DATA FIELDS IN AN ENTRY FOR THIS STRUCTURALBFMM
MAXRC    I  U  CASE                                                        BFMM
NNNN     I  C  (NOT USED)                                                  BFMM
NPIT     I  C  NUMBER OF SYSTEM INPUT DATA SET                             BFMM
NPOT     I  C  NUMBER OF SYSTEM OUTPUT DATA SET                            BFMM
NTAB     I  U  NUMBER OF TABLES IN DATA FOR THIS STRUCTURAL CASE           BFMM
NTEST    I  U  NUMBER OF REQUIRED STORAGE LOCATIONS                        BFMM
```

SYMBOLS USED IN SUBROUTINE BFMM

NUMOT	I	A	NUMBER OF OUTPUT MATRIX NAMES (ALWAYS 13)	BFMM
NUMSR	I	A	NUMBER OF SCRATCH DATA SETS	BFMM
NWORK	I	A	NUMBER OF AVAILABLE WORKING STORAGE LOCATIONS	BFMM
N1	I	U	FIRST LOCATION OF AN INTERMEDIATE TABLE	BFMM
N2	I	U	FIRST LOCATION OF AN INTERMEDIATE TABLE	BFMM
N3	I	U	FIRST LOCATION OF AN INTERMEDIATE TABLE	BFMM
N4	I	U	FIRST LOCATION OF AN INTERMEDIATE TABLE	BFMM
N5	I	U	FIRST LOCATION OF AN INTERMEDIATE TABLE	BFMM
N6	I	U	FIRST LOCATION OF AN INTERMEDIATE TABLE	BFMM
OUTPUT	R	A	ARRAY OF OUTPUT MATRIX NAMES	BFMM

3. SUBROUTINE PANRD (DECK G205)

This is the Shear Panel Element Data Processor Routine for the Basic Force Method Module which reads and processes all shear panel element data (Table 30).

a. Algorithm

After initializing all control data and counters, the shear panel element data is read, one element at a time, using subroutine TUTL7. All data associated with the bar including physical, material and mass properties is read before processing begins. The data required for static analysis is stored temporarily in arrays IK and AK.

Processing begins with the printing of the shear panel physical property page headings as appropriate. Tests are then made to verify sequence, table size compatibility, and p, q, r, and s joint numbers. Array IEND is then searched to find the bar elements along each edge of the panel.

Using the joint coordinates stored in array CRD and subroutine VECT, the panel edge lengths are computed and stored in locations 21 through 24 of array AK. Similarly, unit vectors in the positive direction of the panel K factors, K1, K2, K3, K4, K5, and the unit panel force, f, are computed and stored in columns 1 through 6 of array D. Vectors equal in magnitude to the edge lengths, gr, ps, rs, gp, and sp, are computed and stored in array D in columns 7 through 11.

The panel K factors, which are the reacting forces due to a unit force, f, on edge pq, are solved for by statics and stored in array AK in location 11 through 15. The components of the K factor vectors are stored in array DK. The shear panel element flexibility is then computed and stored in AK (17).

Array NID is then initialized with data defining the four panel edges in terms of the corner joint numbers and other control data. A search is then made of array IEND, the joint numbers at the ends of each bar, to find those bars which bound each panel. When a bar is found which is attached at one end to one of the panel corners and lies on one of the two edges associated with that corner, tests are made to determine if the other end of the bar is attached to the second joint defining that panel edge. If so, this indicates that all bars along the edge in question have been found and this condition is noted by a flag in array NID. If not, this indicates the bar in question extends only part way along the panel edge and this condition is noted by updating the panel edge definition in array NID. In either case, the contributions to matrices PFT and TF due to a unit panel force, f, are assembled in arrays D and AK, respectively. Indexing data for these conditions are stored in array ND.

The search continues until the bars along all four panel edges have been found or three passes have been made over array IEND. In the event all bars are not found after three passes, an error condition exists and is noted. This coding allows for six bars (seven joints) per panel edge.

Material properties and data associated with matrices D and W are written onto scratch data set IST4 and data associated with matrices TF, GPF, and GPS are written onto IST3. Vector contributions to matrix PFT are written onto scratch data set IST1.

Processing ends with printing of the shear panel element physical properties. Control is transferred to the beginning of the processing loop and the next element is read from the master case data set.

b. Input/Output

Table 30 is read from the master case data set and the shear panel element physical properties printed. Material properties and data for matrices D and W are written onto scratch data set IST4. Data for matrices TF, GPF, and GPS are written onto IST3. Vector contributions to matrix PFT are written onto IST1.

c. Error Messages

Error messages are printed for any entry out of sort. In addition, messages are printed for inconsistencies detected in shear panel definition such as omission of thickness or Shear Modulus, or no bar for a panel edge, or joint numbers referenced which are not in joint table (1).

d. Subroutines Required

TUTL7
VECT
SRT

e. Argument List

PANRD (IK, AK, BUF, IRECD, RECD, CRD, IEND, KASIN)

IK	—	Array of control and error flags
AK	—	Array for intermediate storage
BUF	—	Buffer array for utility routine TUTL7
IRECD	—	Array for intermediate storage of table entry integer data
RECD	—	Array for intermediate storage of table entry real data
CRD	—	Array of joint coordinates

IEND	—	Array of bar p and q joint numbers
KASIN	—	Array of input case name and data set number

f. Subroutine Length

3627 words (approximate)

g. Symbol List

SYMBOLS USED IN SUBROUTINE PANRD

AK	R	A	ARRAY FOR INTERMEDIATE STORAGE	PANRD
BUF	R	A	BUFFER ARRAY FOR UTILITY ROUTINE TUTL7	PANRD
CRD	R	A	ARRAY OF JOINT COORDINATES	PANRD
D	R	D	ARRAY OF DIRECTION COSINES OF SHEAR PANEL ELEMENT UNIT VECTOR	PANRD
DK	R	D	ARRAY OF PANEL K FACTOR COMPONENTS	PANRD
END	L	U	CONTROL FLAG FOR TUTL7	PANRD
ERR	L	U	ERROR FLAG FOR TUTL7	PANRD
I	I	U	INTERMEDIATE INDEX	PANRD
IBAR	I	U	NUMBER OF BARS	PANRD
ICARD	I	U	CONTINUATION NUMBER OF TABLE ENTRY	PANRD
ID	I	U	NUMBER OF JOINT P	PANRD
IE	I	U	NUMBER OF JOINT Q	PANRD
IEND	I	A	ARRAY OF BAR P AND Q JOINT NUMBERS	PANRD
IF	I	U	NUMBER OF JOINT R	PANRD
IG	I	U	NUMBER OF JOINT S	PANRD
IK	I	A	ARRAY OF CONTROL AND ERROR FLAGS	PANRD
INB	I	U	NUMBER OF CONTRIBUTIONS TO MATRIX PFT FOR ONE PANEL	PANRD
INODE	I	U	NUMBER OF JOINTS	PANRD
INUM	I	U	COMPOSITE ENTRY IDENTIFICATION NUMBER	PANRD
IPAN	I	U	COUNT OF NUMBER OF SHEAR PANELS	PANRD
IPASS	I	U	INTERMEDIATE INDEX	PANRD
IREAC	I	U	NUMBER OF REACTIONS	PANRD
IRECD	I	A	ARRAY FOR INTERMEDIATE STORAGE OF TABLE ENTRY INTEGER DATA	PANRD
IRBAR	I	U	ROW NUMBER OF PFT REPRESENTING LAST BAR ELEMENT FORCE	PANRD
ISORT	I	U	CHECK NUMBER FOR ENTRY SEQUENCE NUMBER	PANRD
IST1	I	U	NUMBER OF SCRATCH DATA SET 1	PANRD
IST3	I	U	NUMBER OF SCRATCH DATA SET 3	PANRD
IST4	I	U	NUMBER OF SCRATCH DATA SET 4	PANRD
J	I	U	INTERMEDIATE INDEX	PANRD
K	I	U	CONTROL FLAG FOR VECT	PANRD
KASIN	I	A	ARRAY OF INPUT CASE NAME AND DATA SET NUMBER	PANRD
KNODE	I	U	NUMBER OF JOINTS IN TABLE DEFINING PANEL EDGES	PANRD

SYMBOLS USED IN SUBROUTINE PANRD

KONST	I	C	MAXIMUM MATRIX SIZE	PANRD
KODE	I	U	PROCESSING ERROR TYPE CODE	PANRD
K1	I	U	INTERMEDIATE INDEX	PANRD
K2	I	U	INTERMEDIATE INDEX	PANRD
K3	I	U	INTERMEDIATE INDEX	PANRD
K4	I	U	INTERMEDIATE INDEX	PANRD
L	I	U	INTERMEDIATE INDEX	PANRD
LINE	I	U	PRINTED LINE COUNTER	PANRD
LREC	I	U	NUMBER OF LEADING NON ZERO VALUES IN A TABLE ENTRY	PANRD
MAXRC	I	U	MAXIMUM NUMBER OF DATA FIELDS ON A TABLE ENTRY	PANRD
MRPAN	I	U	COUNT OF FORCE VECTOR CONTRIBUTIONS TO MATRIX PFT	PANRD
N	I	U	CONTROL FLAG FOR VECT	PANRD
NB	I	U	NUMBER OF CONTRIBUTIONS TO MATRIX TF FOR ONE PANEL	PANRD
ND	I	D	ARRAY OF VECTOR IDENTIFICATION NUMBERS	PANRD
NID	I	D	ARRAY DEFINING PANEL EDGES AND CONTROL DATA	PANRD
NPIT	I	C	NUMBER OF SYSTEM INPUT DATA SET	PANRD
NPOT	I	C	NUMBER OF SYSTEM OUTPUT DATA SET	PANRD
NREAD	I	U	TABLE ENTRY READ CONTROL FLAG	PANRD
NSET	I	U	NUMBER OF MASTER CASE DATA SET	PANRD
NTAB	I	U	TABLE NUMBER FOR TUTL7	PANRD
N1	I	U	INTERMEDIATE INDEX	PANRD
N2	I	U	INTERMEDIATE INDEX	PANRD
N3	I	U	INTERMEDIATE INDEX	PANRD
N4	I	U	INTERMEDIATE INDEX	PANRD
N5	I	U	INTERMEDIATE INDEX	PANRD
PROP	R	U	MINIMUM VALUE FOR SECTION PROPERTIES	PANRD
RECD	R	A	ARRAY FOR INTERMEDIATE STORAGE OF TABLE ENTRY REAL DATA	PANRD
T	R	U	INTERMEDIATE STORAGE	PANRD
TT	R	U	INTERMEDIATE STORAGE	PANRD
TTT	R	U	INTERMEDIATE STORAGE	PANRD

4. SUBROUTINE DWET (DECK G208)

This is the Matrix Assembler A Routine for the Basic Force Method Module which assembles and outputs matrices D, W, and ETT, and prints the material properties for all elements.

a. Algorithm

Control data is initialized and the bar element p end axial flexibilities are transferred from array D to array BPD. Bar element joints p and q are transferred from array IND to array IEND.

If bar external reaction vectors or bar external load vectors are present, these vectors are processed by the same set of code by presetting control data appropriate to each type vector. The data for each vector is read from scratch data set IST4 where it was previously stored by subroutine JVRD. The array of bar p and q end joints, IEND, is searched to locate the bar associated with the bar vector. The vector identification number is assembled and is of the form.

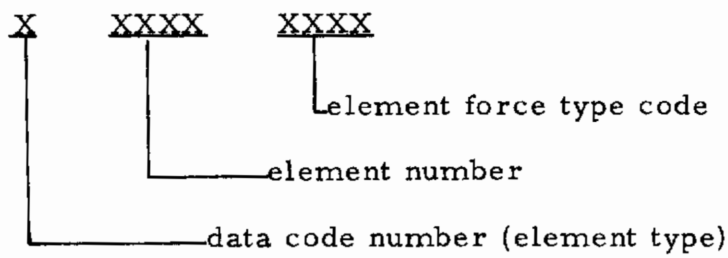
```
X    XXXX    XXXX
|     |       |
|     |       |_____________PFT or POT row number
|     |
|     |_____________________PFT or POT column number
|
|___________________________vector type code, 1 = force, 2 = moment
```

where the column number is the joint number where the vector acts, the row number of PFT is the element force row index number (reactions), and the row of POT is the condition number (applied loads). Vector contributions to matrix PFT are written onto scratch data set IST1 and contributions to POT on IST2. Data associated with matrix TF is assembled in array IRID and data for matrix TF is assembled in arrays IBID and TOF. When all bar vector data has been processed, these arrays are written onto scratch data set IST3.

The code from statement 120 to 600 reads the material properties and data associated with matrices D, W, and ETT for each element and performs the following functions:

(i) Assembles the element flexibility matrix D, column by column, and outputs the matrix onto the appropriate data set.

(ii) Assembles the element force row index code numbers in array IFX where the code number is of the form



(iii) Assembles all main diagonal elements of the flexibility matrix D in array BPD for subsequent generation of matrix W.

(iv) Assembles in array ETT, the thermal deformations at joints arising from applicable element deformations due to unit changes in temperature at the joints.

(v) Assembles the joint numbers in array JNT of the joints affected by each applicable element deformation.

The coding from statement 600 to 660 assembles and outputs the weighting factor matrix W, column by column, onto the appropriate data set using the element flexibilities stored in array BPD.

Matrix ETT, joint thermal deformations, is assembled from the deformations stored in array ET and associated joint numbers stored in array JNT, and is output onto the appropriate data set.

Subroutine EUTL5 and EUTL6 are used to write the matrix header and trailer, respectively, for all output matrices.

b. Input/Output

All intermediate data previously stored on scratch data set IST4 is read and used to assemble and output matrices D, W, and ETT and to print all element material properties. Bar external reaction vector contributions to matrices PFT and TF are assembled and written onto scratch data sets IST1 and IST3, respectively. Bar external load contributions to matrices POT and TO are assembled and written onto IST2 and IST3, respectively.

c. Error Messages

Error messages are printed for inconsistencies between bar vector and bar element definitions, and when the number of bar vectors exceeds the table size.

d. Subroutines Required

EUTL5
EUTL6

e. Argument List

DWET (IK, D, BPD, IND, IEND, IFX, JNT, ET, IOSPEC, OUTPUT, KASIN, IRID, IBID, TOF)

IK	—	Array of control and error flags
D	—	Array of intermediate storage of bar flexibility terms
BPD	—	Array of flexibility matrix main diagonal terms
IND	—	Array for intermediate storage of bar p and q joint numbers
IEND	—	Array of bar p and q joint numbers
IFX	—	Array of element force identification numbers
JNT	—	Array of row/column locations of contributions to matrix ETT
ET	—	Array of contributions to matrix ETT
IOSPEC	—	Array of output matrix data set numbers
OUTPUT	—	Array of output matrix names
KASIN	—	Array of input case name and data set number
IRID	—	Array of row and column locations in matrix TF for bar external reaction contributions.
IBID	—	Array of row and column locations in matrix TO for bar external load contributions.
TOF	—	Array of coefficients for matrix TO for bar external loads.

f. Subroutine Length

4444 words (approximate)

g. Symbol List

SYMBOLS USED IN SUBROUTINE DWET

A	R	D	ARRAY OF ELEMENT DATA	DWET
B	R	D	ARRAY OF ELEMENT FLEXIBILITIES	DWET
BPD	R	A	ARRAY OF FLEXIBILITY MATRIX MAIN DIAGONAL TERMS	DWET
D	R	A	ARRAY FOR INTERMEDIATE STORAGE OF BAR FLEXIBILITY TERMS	DWET
DMAX	R	U	MAXIMUM ELEMENT STIFFNESS	DWET
DMEAN	R	U	MEAN ELEMENT STIFFNESS	DWET
DMM	R	U	INTERMEDIATE STORAGE	DWET
ET	R	A	ARRAY OF CONTRIBUTIONS TO MATRIX ETT	DWET
I	I	U	INTERMEDIATE INDEX	DWET
IBAR	I	U	NUMBER OF BARS	DWET
IBID	I	A	ARRAY OF TO MATRIX ELEMENT LOCATIONS	DWET
ICND	I	U	COMPOSITE INDEX NUMBER	DWET
ICOND	I	U	ROW NUMBER IN MATRIX POT	DWET
IEND	I	A	ARRAY OF BAR P AND Q JOINT NUMBERS	DWET
IFX	I	A	ARRAY OF ELEMENT FORCE IDENTIFICATION NUMBERS	DWET
IK	I	A	ARRAY OF CONTROL AND ERROR FLAGS	DWET
IMAX	I	U	MATRIX ROW DIMENSION	DWET
IND	I	A	ARRAY FOR INTERMEDIATE STORAGE OF BAR P AND Q JOINT NUMBERS	DWET
INODE	I	U	NUMBER OF JOINTS	DWET
IOSPEC	I	A	ARRAY OF OUTPUT MATRIX DATA SET NUMBERS	DWET
IOUT	I	U	COUNT OF MATRICES OUTPUT	DWET
IPQ	I	U	COMPOSITE NUMBER OF JOINTS P AND Q	DWET
IP	I	U	NUMBER OF JOINT P	DWET
IPAN	I	U	NUMBER OF SHEAR PANELS	DWET
IQUAD	I	U	NUMBER OF PARALLELOGRAM MEMBRANES	DWET
IQ	I	U	NUMBER OF JOINT Q	DWET
IQP	I	U	COMPOSITE NUMBER OF JOINTS Q AND P	DWET
IREAC	I	U	NUMBER OF REACTIONS	DWET
IRID	I	A	ARRAY OF TF MATRIX ELEMENT LOCATIONS	DWET
IST1	I	U	NUMBER OF SCRATCH DATA SET 1	DWET
IST2	I	U	NUMBER OF SCRATCH DATA SET 2	DWET
IST3	I	U	NUMBER OF SCRATCH DATA SET 3	DWET

SYMBOLS USED IN SUBROUTINE DWET

IST4	I	U	NUMBER OF SCRATCH DATA SET 4	DWET
ISTEP	I	U	PROGRAM CONTROL FLAG	DWET
ISORT	I	U	VECTOR ENTRY NUMBER	DWET
ITRI	I	U	NUMBER OF TRIANGULAR MEMBRANES	DWET
ITAPE	I	U	NUMBER OF A DATA SET	DWET
ITEST	I	U	INTERMEDIATE INDEX	DWET
IXCOL	I	U	COLUMN NUMBER IN MATRIX TF	DWET
IXC	I	U	INTERMEDIATE INDEX	DWET
J	I	U	INTERMEDIATE INDEX	DWET
JMAX	I	U	MATRIX COLUMN DIMENSION	DWET
JNT	I	A	ARRAY OF ROW/COLUMN LOCATIONS OF CONTRIBUTIONS TO MATRIX ETT	DWET
K	I	U	INTERMEDIATE INDEX	DWET
KASIN	I	A	ARRAY OF INPUT CASE NAME AND DATA SET NUMBER	DWET
KODE	I	U	MATRIX COLUMN COMPRESSION CODE NUMBER	DWET
KONST	I	C	MAXIMUM MATRIX SIZE	DWET
L	I	U	INTERMEDIATE INDEX	DWET
LCOL	I	U	ROW NUMBER IN MATRIX TF	DWET
LD	I	U	BAR VECTOR ORIENTATION CODE NUMBER	DWET
LINE	I	U	PRINTED LINE COUNT	DWET
M	I	U	INTERMEDIATE INDEX	DWET
MAX	I	U	MAXIMUM NUMBER OF BAR LOAD VECTORS	DWET
MD	I	U	NUMBER OF ELEMENT FORCES FOR A BAR	DWET
N	I	U	INTERMEDIATE INDEX	DWET
NA	I	U	NUMBER OF BAR REACTION OR LOAD VECTORS	DWET
NAM	I	D	ARRAY OF ELEMENT INDEXING DATA	DWET
NAME	I	U	COMPOSITE VECTOR IDENTIFICATION NUMBER	DWET
NM	I	D	ARRAY OF MATRIX ELEMENT INDEXING DATA	DWET
NPIT	I	C	NUMBER OF SYSTEM INPUT DATA SET	DWET
NPOT	I	C	NUMBER OF SYSTEM OUTPUT DATA SET	DWET
NSET	I	U	OUTPUT MATRIX DATA SET NUMBER	DWET
NVEC	I	U	NUMBER OF BAR VECTORS IN A RECORD	DWET
OUTPUT	R	A	ARRAY OF OUTPUT MATRIX NAMES	DWET

SYMBOLS USED IN SUBROUTINE DWET

TEST	R	U	INTERMEDIATE STORAGE	DWET

5. SUBROUTINE PFO (DECK G215)

This is the Matrix Assembler B Routine for the Basic Force Method Module which assembles and outputs matrices PFT, POT, and TF.

a. Algorithm

After initializing all control data, matrices PFT and POT are assembled and output from the data stored on scratch data sets IST1 and IST2 respectively. The same code is used to output both matrices by pre-setting appropriate control data. Blocks of vector data are read from the scratch data set into arrays NP and DP. The valid equations (columns) of PFT or POT are identified using the code numbers sorted in array IP. The columns to be output are assembled in arrays DP and JT. Compressed columns are written directly onto the appropriate data set. Expanded columns are assembled into array ANID and written onto the appropriate data set. Subroutine SRT is used to sort blocks of vector data if required Subroutines EUTL5 and EUTL6 are used to write the matrix headers and trailers, respectively.

Matrix TF is then assembled from the bar external reaction vector data stored in array NID and the data stored on scratch data set IST3 by previous routines. First, the columns of matrix TF are assembled and output using the data in array NID. The columns corresponding to all p end bar forces, all remaining bar forces, all shear panel forces, all triangular membrane element forces, and all parallelogram membrane element forces are assembled and output in that order from the data stored on scratch data set IST3. Simultaneously, the data for extractor matrices GBT, GPF, and GPS are partially assembled and stored on scratch data set IST2.

After completing the output of matrix TF on the appropriate data set, the data associated with matrix TO for any bar external load vectors which are present, is read from scratch data set IST3 into array NID.

b. Input/Output

Sorted vector contributions to matrices PFT and POT are input on scratch data sets IST1 and IST2. All data associated with matrices TF, TO, GBT, GPF, and GPS are input on scratch data set IST3. Matrices PFT, POT, and TF are output onto the appropriate data sets and the partially assembled matrices GBT, GPF, and GPS are stored on scratch data set IST3.

c. Error Messages

None

d. Subroutines Required

EUTL5
EUTL6
SRT

e. Argument List

PFO (IK, LK, AK, DK, IP, NID, P, NP, DP, JT, IOSPEC, OUTPUT, ANID, TIP)

IK	—	Array of control and error flags
LK	—	Array of row locations of data in an output matrix column
AK	—	Array for intermediate storage
DK	—	Array for intermediate storage
IP	—	Array of code numbers identifying valid joint equations
NID	—	Array of bar vector data for matrix TO
P	—	Array of standard matrix coefficients
NP	—	Array of vector identification numbers
DP	—	Array of vector components
JT	—	Array of row locations of data in an output matrix column
IOSPEC	—	Array of output matrix data set numbers
OUTPUT	—	Array of output matrix names
ANID	—	Array used to assemble expanded columns of PFT and POT.
TIP	—	Not used

f. Subroutine Length

4021 words (approximate)

g. Symbol List

SYMBOLS USED IN SUBROUTINE PFO

TOF	R	A	ARRAY OF TO MATRIX ELEMENT COEFFICIENTS	PFO
AK	R	A	ARRAY FOR INTERMEDIATE STORAGE	PFO
ANID	R	A	ARRAY USED TO ASSEMBLE COLUMNS OF OUTPUT MATRICES	PFO
DK	R	A	ARRAY FOR INTERMEDIATE STORAGE	PFO
DP	R	A	ARRAY OF VECTOR COMPONENTS	PFO
I	I	U	INTERMEDIATE INDEX	PFO
IBAR	I	U	NUMBER OF BARS	PFO
IBR	I	U	NUMBER OF BAR REACTION VECTORS	PFO
IBCOL	I	U	ROW LOCATION IN MATRIX TF OF TYPE 1 BAR FORCE	PFO
ICOL	I	U	COLUMN LOCATION IN MATRIX TF	PFO
ID	R	U	COMPOSITE BAR RESULTANT LOAD IDENTIFICATION NUMBER	PFO
IFLAG	I	U	DIRECTION CODE WORD	PFO
IGBR	I	U	COUNT OF BAR LOADS TO BE EXTRACTED	PFO
IGP	R	U	COUNT OF PANEL AND MEMBRANE RESULTANT LOADS	PFO
IK	I	A	ARRAY OF CONTROL AND ERROR FLAGS	PFO
ILOC	I	U	INTERMEDIATE INDEX	PFO
IMAX	I	U	ROW DIMENSION OF OUTPUT MATRIX	PFO
IND	I	U	VECTOR TYPE AND JOINT NUMBER CODE	PFO
INODE	I	U	VECTOR TYPE AND JOINT NUMBER CODE	PFO
IOSPEC	I	A	ARRAY OF OUTPUT MATRIX DATA SET NUMBERS	PFO
IOUT	I	U	COUNT OF MATRICES OUTPUT	PFO
IPAN	I	U	NUMBER OF SHEAR PANELS	PFO
IPFB	I	U	NUMBER OF EXISTING TYPE 2-7 BAR FORCES	PFO
IP	I	A	ARRAY OF CODE NUMBERS IDENTIFYING VALID JOINT EQUATIONS	PFO
IQUAD	I	U	NUMBER OF PARALLELOGRAM MEMBRANES	PFO
IREAC	I	U	NUMBER OF REACTIONS	PFO
IROW	I	U	COUNT OF EQUATIONS OUTPUT	PFO
IST1	I	U	NUMBER OF SCRATCH DATA SET 1	PFO
IST2	I	U	NUMBER OF SCRATCH DATA SET 2	PFO
IST3	I	U	NUMBER OF SCRATCH DATA SET 3	PFO
IST4	I	U	NUMBER OF SCRATCH DATA SET 4	PFO
ISTEP	I	U	PROGRAM CONTROL FLAG	PFO

SYMBOLS USED IN SUBROUTINE PFO

ITRI	I	U	NUMBER OF TRIANGULAR MEMBRANES	PFO
IT	I	U	INTERMEDIATE DATA SET NUMBER	PFO
IXL	R	U	INTERMEDIATE INDEX	PFO
IXCOL	I	U	ROW LOCATION IN MATRIX TF OF TYPE 2-7 BAR FORCE	PFO
J	I	U	INTERMEDIATE INDEX	PFO
JMAX	I	U	COLUMN DIMENSION OF OUTPUT MATRIX	PFO
JT	I	A	ARRAY OF ROW LOCATIONS OF DATA IN AN OUTPUT MATRIX COLUMNS	PFO
K	I	U	INTERMEDIATE INDEX	PFO
KCOL	R	U	INTERMEDIATE INDEX	PFO
KONST	I	C	MAXIMUM MATRIX SIZE	PFO
KODE	I	U	OUTPUT MATRIX COLUMN COMPRESSION CODE	PFO
KR	I	U	NUMBER OF VECTORS IN THIS RECORD	PFO
KROW	R	U	INTERMEDIATE INDEX	PFO
K1	I	U	INTERMEDIATE INDEX	PFO
K2	I	U	INTERMEDIATE INDEX	PFO
L	I	U	INTERMEDIATE INDEX	PFO
LCOL	I	U	COLUMN LOCATION IN MATRIX TF	PFO
LK	I	A	ARRAY OF ROW LOCATIONS OF DATA IN AN OUTPUT MATRIX COLUMN	PFO
LNM	R	U	INTERMEDIATE INDEX	PFO
LROW	I	U	ROW LOCATION IN MATRIX TF	PFO
M	I	U	INTERMEDIATE INDEX	PFO
MD	I	U	SIZE OF ELEMENT FLEXIBILITY MATRIX	PFO
MKNT	I	U	NUMBER OF VECTORS IN PFT OR POT	PFO
MMAX	I	U	COUNT OF VECTORS READ	PFO
MREC	I	U	NUMBER OF VECTORS AT THIS JOINT	PFO
MR	I	U	INTERMEDIATE INDEX	PFO
MS	I	U	INTERMEDIATE INDEX	PFO
M1	I	U	INTERMEDIATE INDEX	PFO
M2	I	U	INTERMEDIATE INDEX	PFO
N	I	U	INTERMEDIATE INDEX	PFO
NAM	R	U	INTERMEDIATE INDEX	PFO
NB	I	U	NUMBER OF ELEMENTS IN TF DUE TO EACH SHEAR PANELS	PFO

SYMBOLS USED IN SUBROUTINE PFO

NID	I	A	ARRAY OF BAR VECTOR DATA FOR MATRIX TO	PFO
NM	R	U	INTERMEDIATE INDEX	PFO
NP	I	A	ARRAY OF VECTOR IDENTIFICATION NUMBERS	PFO
NPIT	I	C	NUMBER OF SYSTEM INPUT DATA SET	PFO
NPOT	I	C	NUMBER OF SYSTEM OUTPUT DATA SET	PFO
NR	I	U	COUNT OF VECTORS READ AT A JOINT	PFO
NRN	I	U	INTERMEDIATE COUNTER	PFO
NSET	I	U	MATRIX OUTPUT DATA SET NUMBER	PFO
NXC	R	U	INTERMEDIATE INDEX	PFO
NY	I	U	INTERMEDIATE COUNTER	PFO
OUTPUT	R	A	ARRAY OF OUTPUT MATRIX NAMES	PFO
P	R	A	ARRAY OF STANDARD MATRIX COEFFICIENTS	PFO
PQ	R	U	BAR LENGTH	PFO
TIP	R	A	NOT USED	PFO

6. SUBROUTINE EXT (DECK G216)

This is the Matrix Assembler C Routine for the Basic Force Method Module which assembles and outputs matrices TO, GR, GBT, GPF, and GPS and prints a summary description of all matrices generated.

a. Algorithm

After initializing all control data, matrix TO is assembled and output using the data stored in array NID which describes each bar load vector. Array TIP is used to assemble and output expanded columns of matrix TO, if necessary. Subroutines EUTL5 and EUTL6 are used to write the matrix header and trailer respectively.

Matrix GR is then assembled and output based on the number of external reactions and total number of internal element forces.

The data for matrix GBT is read from scratch data set IST2 and the columns are assembled and output onto the appropriate data set. Simultaneously code numbers defining the format of the resultant bar loads are formed in array IP. After completing the output of matrix GBT, the format of the resultant bar loads is printed.

The same code is used to output matrices GPF and GPS by presetting appropriate control data. Also, both the format of resultant panel forces and the format of resultant panel shear slows and stresses are printed by this code.

On the first pass matrix GPF is assembled and output. Data for shear panel elements is read from scratch data set IST2 and appropriate columns of matrix GPF output. Data for matrix GPS for shear panels is stored in array P. The same code is used to process triangular and parallelogram membrane elements by presetting appropriate control data. The columns of matrix GPF are assembled and output based on accumulated indexing information. As matrix GPF is generated and output, code numbers are assembled in array IP describing the format of resultant panel forces. After completion of assembly and output of matrix GPF, the format code numbers are printed.

On the second pass through this code, matrix GPS is assembled and output. The sequence of operations is the same as on the first pass except data for shear panels is extracted from array P and data for triangular and parallelogram membrane elements is read from scratch data set IST2.

After completion of matrix generation, a summary description of the structural case and the matrices created.

b. Input/Output

Data associated with matrices GBT, GPF, and GPS is input on scratch data set IST2. Matrices TO, GR, GBT, GPF, and GPS are output on the appropriate data sets and a summary description of the generated matrices is printed.

c. Error Messages

None

d. Subroutines Required

EUTL5
EUTL6

e. Argument List

EXT (IK, LK, AK, DK, IP, NID, P, NP, DP, JT, IOSPEC, OUTPUT, KASIN, ANID, TIP)

IK	—	Array of control and error flags
LK	—	Array of row locations of data in an matrix column
AK	—	Array for intermediate storage
DK	—	Array for intermediate storage
IP	—	Array of code numbers defining the format of resultant panel forces and panel stresses
NID	—	Array of bar vector data for matrix TO
P	—	Array of standard matrix coefficients
NP	—	Not used
DP	—	Not used
JT	—	Not used
IOSPEC	—	Array of output matrix data set numbers

OUTPUT	—	Array of output matrix names
KASIN	—	Is an array (7 x 1) containing the six alphameric characters representing the name of the input case and row 7 is the FORTRAN logical number of the data set where the case data is stored.
ANID	—	Array used to assemble compressed columns of matrix
TIP	—	Array used to assemble expanded columns of matrix TO

f. Subroutine Length

5244 words (approximate)

g. Symbol List

SYMBOLS USED IN SUBROUTINE EXT

AK	R	A	ARRAY FOR INTERMEDIATE STORAGE	EXT
ANID	R	A	ARRAY USED TO ASSEMBLE COMPRESSED COLUMS OF TO	EXT
DK	R	A	ARRAY FOR INTERMEDIATE STORAGE	EXT
DP	R	A	NOT USED	EXT
I	I	U	INTERMEDIATE INDEX	EXT
IBAR	I	U	NUMBER OF BARS	EXT
IBR	I	U	NUMBER OF BAR LOAD VECTORS	EXT
ICOND	I	U	COLUMN NUMBER OF MATRIX TO OF A BAR VECTOR	EXT
ICOL	I	U	COLUMN NUMBER OF MATRIX GPF	EXT
ID	I	U	INTERMEDIATE INDEX	EXT
IFLAG	I	U	DIRECTION CODE WORD	EXT
IGBR	I	U	TOTAL NUMBER OF RESULTANT BAR LOADS	EXT
IGPF	I	U	TOTAL NUMBER OF RESULTANT PANEL AND MEMBRANE LOADS	EXT
IGPS	I	U	TOTAL NUMBER OF RESULTANT PANEL SHEAR FLOWS AND MEMBRANE STRE	EXT
IGP	I	U	INTERMEDIATE INDEX	EXT
IK	I	A	ARRAY OF CONTROL AND ERROR FLAGS	EXT
ILOAD	I	U	NUMBER OF APPLIED LOADING CONDITIONS	EXT
IMAX	I	U	ROW DIMENSION OF OUTPUT MATRIX	EXT
IM	I	U	INTERMEDIATE INDEX	EXT
IMIN	I	U	INTERMEDIATE INDEX	EXT
IOSPEC	I	A	ARRAY OF OUTPUT MATRIX DATA SET NUMBERS	EXT
IOUT	I	U	COUNT OF MATRICES OUTPUT	EXT
IP	I	A	ARRAY OF CODE NUMBERS DEFINING THE FORMAT OF RESULTANT PANEL	EXT
IP	I	A	FORCES AND PANEL STRESSES	EXT
IPAN	I	U	NUMBER OF SHEAR PANELS	EXT
IPFB	I	U	TOTAL NUMBER OF UNKNOWN ELEMENT FORCES	EXT
IPFBT	I	U	TOTAL NUMBER OF ELEMENT FORCES	EXT
IQUA	I	U	NUMBER OF PARALLELOGRAM MEMBRANES	EXT
IREAC	I	U	NUMBER OF REACTIONS	EXT
IROW	I	U	NUMBER OF INDEPENDANT EQUATIONS	EXT
IST1	I	U	NUMBER OF SCRATCH DATA SET 1	EXT
IST2	I	U	NUMBER OF SCRATCH DATA SET 2	EXT

SYMBOLS USED IN SUBROUTINE EXT

IST3	I	U	NUMBER OF SCRATCH DATA SET 3	EXT
IST4	I	U	NUMBER OF SCRATCH DATA SET 4	EXT
ITRI	I	U	NUMBER OF TRIANGULAR MEMBRANES	EXT
IUNK	I	U	NUMBER OF REDUNDANT FORCES	EXT
IUNIT	I	U	NUMBER OF APPLIED LOAD VECTORS	EXT
IXCOL	I	U	COLUMN NUMBER OF MATRIX GPS	EXT
J	I	U	INTERMEDIATE INDEX	EXT
JMAX	I	U	COLUMN DIMENSION OF OUTPUT MATRIX	EXT
JT	I	A	NOT USED	EXT
K	I	U	INTERMEDIATE INDEX	EXT
KASIN	I	A	ARRAY OF INPUT CASE NAME AND DATA SET NUMBER	EXT
KK	I	U	INTERMEDIATE INDEX	EXT
KMAX	I	U	CUTOFF VALUE FOR COLUMN COMPRESSION	EXT
KONST	I	C	MAXIMUM MATRIX SIZE	EXT
KODE	I	U	OUTPUT MATRIX COLUMN COMPRESSION CODE	EXT
K1	I	U	INTERMEDIATE INDEX	EXT
K2	I	U	INTERMEDIATE INDEX	EXT
K3	I	U	INTERMEDIATE INDEX	EXT
K4	I	U	INTERMEDIATE INDEX	EXT
L	I	U	INTERMEDIATE INDEX	EXT
LCOL	I	U	COLUMN NUMBER OF MATRIX TO	EXT
LK	I	A	ARRAY OF ROW LOCATIONS OF DATA IN AN OUTPUT COLUMNS	EXT
LL	I	U	INTERMEDIATE INDEX	EXT
L1	I	U	INTERMEDIATE INDEX	EXT
L2	I	U	INTERMEDIATE INDEX	EXT
M	I	U	INTERMEDIATE INDEX	EXT
MM	I	U	INTERMEDIATE INDEX	EXT
N	I	U	PROGRAM CONTROL FLAG	EXT
NAME	I	U	PROGRAM CONTROL FLAG	EXT
NAP	I	U	INTERMEDIATE INDEX	EXT
NID	I	A	ARRAY FOR BAR VECTOR DATA FOR MATRIX TO	EXT
NMN	I	U	INTERMEDIATE INDEX	EXT

SYMBOLS USED IN SUBROUTINE EXT

NMNON	I	U	INTERMEDIATE INDEX	EXT
NM	I	U	INTERMEDIATE INDEX	EXT
NP	I	A	NOT USED	EXT
NPIT	I	C	NUMBER OF SYSTEM INPUT DATA SET	EXT
NPOT	I	C	NUMBER OF SYSTEM OUTPUT DATA SET	EXT
NSET	I	U	NUMBER OF MATRIX OUTPUT DATA SET	EXT
OUTPUT	R	A	ARRAY OF OUTPUT MATRIX NAMES	EXT
P	R	A	ARRAY OF STANDARD MATRIX COEFFICIENTS	EXT
T	R	U	INTERMEDIATE STORAGE	EXT
TIP	R	A	ARRAY USED TO ASSEMBLE EXPANDED COLUMNS OF TO	EXT

7. SUBROUTINE JRD (DECK G301)

This is the Joining Vector Processor Routine for the Force Method Joining Module which reads and processes all joint and vector data tables for all substructures.

a. Algorithm

After initializing all basic control data, the first data card is read which contains the reference point for the SUM matrix. Next, the control data for the first substructure is set. Using this control data, the entire routine is looped through and all joint and vector data tables for this substructure, as well as special data, are processed.

The loop begins by printing appropriate titles for the transformation data for the substructure followed by the reading of this special data from the system input data set. The sort of this data is tested and verified. Subroutine TUTL3 is used to locate the structural case data on the master case data set. The coordinate transformation matrix, which is used to transform the joint and vector data for the substructure from a local to global system, is computed and stored in array ADC.

A secondary loop is entered which processes all table data. By presetting control data, the same program code is used to process, in sequence, the joint coordinates, reactions, applied load vectors, and distributed loading conditions. Data entries are read using subroutine TUTL7 and tested for sort and table size compatibility.

Joint coordinate data is simply transformed to the global system and stored in array CRD. The maximum and minimum global coordinates are tested for and stored in array DST. Vector data which is related to the joining problem is processed as follows. The coordinates of the joint where the vector acts are extracted from array CRD and stored in the first column of array DC. Bar forces are assumed to act at the midpoint between the two defining joints. The direction cosines are transformed to the global system and stored in the second column of array DC. A control flag is assembled from all joining and symmetry flags on the entry data. The control flag is tested to determine the type of joining vector or vectors, if any, and program control is transferred to the appropriate code.

For each type of joining vector, a ten word integer description is assembled in array ID. Only the first nine of these ten words are used at this point in processing and the values stored correspond to

(i) Joining vector type flag

1 - Joined structure external load

2 - Substructure reaction which is a joining force

3 - Joined structure permanent reaction

4 - Joining element forces other than joined structure permanent reactions

(ii) Substructure identification number

XX X

- X:
  - 0 - True full substructure
  - 1 - First half of a symmetric substructure
  - 2 - Second half of a symmetric substructure
  - 3, 4, 5 - Dummy substructures (permanent reaction)
- XX: substructure number

(iii) Symmetry flag - set to one if this vector acts at a joint on the plane of symmetry in a symmetric substructure.

(iv) Joining vector sequence number - begins with one and incremented by one for each vector encountered in each of the four groups defined under joining vector type.

(v) Matching vector flag

0 - One or more vectors should be found to join with this vector

1 - No vector should be found to join with this vector

2 - One and only one vector should be found to join with this vector

(vi) Data code number

3 - Reaction

4 - Applied load vector

11 to 18 - Distributed load condition

(vii) Vector type flag

1 - Joint force

2 - Joint moment

3 - Bar force

(viii) Entry number - entry number in table

(ix) Deflection vector number - joined structure deflection vector number which is assigned to flagged joined structure external load vectors in the sequence they are encountered.

The ten word integer description, the coordinates of the joint where the vector acts, and the vector direction cosines of all vectors which will enter into joining equations are written onto scratch data set IST2. These vectors will be the substructure reactions, and joining element forces. The ten word integer description for all joined structure external load vectors is written onto scratch data set IST1. Data for printing, which consists of the ten-word integer description of joined structure external load vectors, joined structure permanent reaction vectors, and other joining element force vectors, are written onto scratch data set IST3. The sequence number of joining element forces of symmetric substructures, which are not on the plane of symmetry, are stored in array KID.

The contribution to matrix SUM for each joined structure external load condition is assembled in array SUM and written onto scratch data set IST4.

After processing all data for this substructure, the next column of array ISUB is set which contains the substructure identification number, number of reactions, and number of applied loading conditions. Control is then transferred to the beginning of the substructure loop and the next substructure processed.

b. Input/Output

Tables 1, 3, 4, and 11 through 18 are read from the master case data set for each structural case referenced. Transformation data for each substructure is read from the system input data set and printed. Data describing each vector entering into the joining equations is written onto scratch data IST2. Data describing each joined structure external load is written onto scratch data set IST1 and data for printing is written onto IST3. The contributions to the SUM matrix from each joined structure external load vector are written onto scratch data set IST4. The maximum and minimum global coordinates of the joined structure, which are stored in array DST are also written onto scratch data set IST4.

c. Error Messages

Messages are printed when the transformation data is omitted or out of sequence, when the structural case data cannot be found on the master case data set, and when the available working storage locations are insufficient. Messages are also printed in substructure data when a table cannot be found, when an entry in a table exceeds the available storage locations, and when a vector definition or joining flag is inconsistently defined. In addition, a message is printed when the combined number of applied loading conditions in a substructure external load or element forces exceeds the maximum matrix size.

d. Subroutines Required

TUTL3
TUTL7

e. Argument List

JRD (CRD, BUF, IRECD, RECD, ISUB, KASIN, IK, KID)

CRD	—	Array of joint coordinates
BUF	—	Buffer array for utility routine TUTL7
IRECD	—	Array for intermediate storage of table entry integer data
RECD	—	Array for intermediate storage of table entry real data
ISUB	—	Array of structural case identification data and counters
KASIN	—	Array of input case names and data set numbers
IK	—	Array of control and error flags
KID	—	Array of symmetric substructure joining element force sequence numbers

f. Subroutine Length

4501 words (approximate)

g. Symbol List

SYMBOLS USED IN SUBROUTINE JRD

AC	R	D	TRANSFORMATION MATRIX	JRD
ADC	R	D	ARRAY OF COORDINATE TRANSFORMATION DATA	JRD
BUF	R	A	BUFFER ARRAY FOR UTILITY ROUTINE TUTL7	JRD
CRD	R	A	ARRAY OF JOINT COORDINATES	JRD
DAD	R	U	INTERMEDIATE STORAGE	JRD
DBA	R	U	INTERMEDIATE STORAGE	JRD
DC	R	D	COORDINATES OF JOINT WHERE VECTOR ACTS AND VECTOR DIRECTION	CJRD
DDC	R	U	INTERMEDIATE STORAGE	JRD
DST	R	D	ARRAY OF MAX/MIN GLOBAL COORDINATES	JRD
DX	R	U	MOMENT ARM ABOUT GLOBAL X AXIS	JRD
DY	R	U	MOMENT ARM ABOUT GLOBAL Y AXIS	JRD
DZ	R	U	MOMENT ARM ABOUT GLOBAL Z AXIS	JRD
END	L	U	CONTROL FLAG FOR TUTL7	JRD
ERR	L	U	ERROR FLAG FOR TUTL7	JRD
I	I	U	INTERMEDIATE INDEX	JRD
IBLK	I	C	REQUIRED BUFFER SIZE FOR TUTL7	JRD
ID	I	D	ARRAY OF VECTOR INDEXING DATA	JRD
IK	I	A	ARRAY OF CONTROL AND ERROR FLAGS	JRD
INM	I	U	COMPOSITE ENTRY IDENTIFICATION NUMBER	JRD
IRECD	I	A	ARRAY FOR INTERMEDIATE STORAGE OF TABLE ENTRY INTEGER DATA	JRD
ISUB	I	A	ARRAY OF STRUCTURAL CASE IDENTIFICATION DATA AND COUNTERS	JRD
IST1	I	U	NUMBER OF SCRATCH DATA SET 1	JRD
IST2	I	U	NUMBER OF SCRATCH DATA SET 2	JRD
IST3	I	U	NUMBER OF SCRATCH DATA SET 3	JRD
IST4	I	U	NUMBER OF SCRATCH DATA SET 4	JRD
ISTRUC	I	U	SYMMETRY CODE WORD	JRD
ISTEP	I	U	PROGRAM CONTROL FLAG	JRD
ISORT	I	U	CHECK NUMBER FOR SEQUENCE OF TABLE ENTRIES	JRD
ITAB	I	U	NUMBER OF TABLES IN THIS STRUCTURAL CASE	JRD
ITEST	I	U	INTERMEDIATE INDEX	JRD
ITET	I	U	INTERMEDIATE INDEX	JRD
J	I	U	INTERMEDIATE INDEX	JRD

SYMBOLS USED IN SUBROUTINE JRD

JDISTB	I	U	FLAG IDENTIFYING DISTRIBUTED LOAD CONDITIONS	JRD
JDV	I	U	NUMBER OF JOINED STRUCTURE DEFLECTION VECTORS	JRD
JE	I	U	COUNT OF JOINING ELEMENT FORCES IN THIS SUBSTRUCTURE	JRD
JEF	I	U	TOTAL NUMBER OF JOINING ELEMENT FORCES	JRD
JJ	I	U	INTERMEDIATE INDEX	JRD
JPR	I	U	NUMBER OF JOINED STRUCTURE PERMANENT REACTIONS	JRD
JSR	I	U	NUMBER OF SUBSTRUCTURE REACTIONS WHICH ARE JOINING FORCES	JRD
JXL	I	U	NUMBER OF JOINED STRUCTURE EXTERNAL LOADS	JRD
K	I	U	INTERMEDIATE INDEX	JRD
KASIN	I	A	ARRAY OF INPUT CASE NAMES AND DATA SET NUMBERS	JRD
KEF	I	U	NUMBER OF JOINING ELEMENT FORCES IN LAST SUBSTRUCTURE	JRD
KEF	I	U	PROCESSED	JRD
KID	I	A	ARRAY OF SYMMETRIC SUBSTRUCTURE JOINING ELEMENT FORCES	JRD
KONST	I	C	MAXIMUM MATRIX SIZE	JRD
KODE	I	U	PROCESSING ERROR CODE NUMBER	JRD
L	I	U	INTERMEDIATE INDEX	JRD
LINE	I	U	PRINTED LINE COUNT	JRD
LREC	I	U	NUMBER OF LEADING NON ZERO VALUES IN A TABLE ENTRY	JRD
MAXBLK	I	U	MAXIMUM SIZE OF COMBINED BUFFERS	JRD
MAXRC	I	U	MAXIMUM NUMBER OF DATA FIELDS IN A TABLE ENTRY	JRD
MJE	I	U	NUMBER OF JOINING ELEMENT FORCES EXCLUDING PERMANENT REACTION	JRD
NBUF	I	U	FIRST LOCATION OF BUFFER FOR TUTL7 IN ARRAY IRECD	JRD
NER	I	U	CONTROL ARRAY LOCATION FOR PROCESSING ERROR FLAG	JRD
NJF	I	U	NUMBER OF JOINING FORCES	JRD
NNNN	I	C	NOT USED	JRD
NPIT	I	C	NUMBER OF SYSTEM INPUT DATA SET	JRD
NPOT	I	C	NUMBER OF SYSTEM OUTPUT DATA SET	JRD
NST	I	U	COUNT OF SUBSTRUCTURES	JRD
NSET	I	U	NUMBER OF MASTER CASE DATA SET	JRD
NSTRUC	I	U	COUNT OF STRUCTURAL CASES	JRD
NSUB	I	U	NUMBER OF STRUCTURAL CASES	JRD
NTAB	I	U	TABLE NUMBER FOR TUTL7	JRD

SYMBOLS USED IN SUBROUTINE JRD

NXL	I	U	NUMBER OF LOADING VECTORS	JRD
N52	I	U	MAXIMUM NUMBERS OF ENTRIES IN A TABLE	JRD
N5	I	U	LOCATION IN ARRAY IK TO STORE COUNT OF ENTRIES	JRD
N51	I	U	DATA CODE NUMBER OF TABLE BEING READ	JRD
N53	I	U	DATA CODE NUMBER OF LAST DISTRIBUTED LOAD CONDITION	JRD
RECD	R	A	ARRAY FOR INTERMEDIATE STORAGE OF TABLE ENTRY REAL DATA	JRD
SUM	R	D	ARRAY OF LOAD CONDITION COMPONENTS ABOUT SUMMATION POINT	JRD
XSUM	R	U	X GLOBAL COORDINATE OF SUMMATION POINT	JRD
YSUM	R	U	Y GLOBAL COORDINATE OF SUMMATION POINT	JRD
ZSUM	R	U	Z GLOBAL COORDINATE OF SUMMATION POINT	JRD

8. SUBROUTINE JDFA (DECK G302)

This is the Joining Degree of Freedom Analyzer for the Force Method Joining Module which outputs the SUM matrix, establishes the joining degrees of freedom, and relates each vector to a joining degree of freedom.

a. Algorithm

After initializing basic control data, the contributions to the SUM matrix are read from scratch data get IST4 and output onto the appropriate data set. TJTMAX and TJTMIN are then computed from the max/min global coordinates stored on scratch data set IST4, and the previously assembled print data for each vector on scratch data set IST3 is read into array ID. A code word is assembled for each vector consisting of data code number, entry number, and substructure number, and is stored in array NDC. When all print data has been read and processed, a loop is entered for printing the code words in array NDC which define the formats of joined structure external loads, joined structure deflection vectors, joined structure permanent reactions, and joining element forces.

All vectors entering into joining equations are read from scratch data set IST2 and processed. Processing is accomplished in a loop which assembles a memory storable block of joining degrees of freedom per cycle. The vectors are processed as follows. The descriptive vector data is read, one vector at a time, from the input scratch data set into arrays ID and AD. A search is made of the joining degrees of freedom already stored in arrays IDC and ADC to determine if this vector contributes to any of these equations. If not, the vector establishes a new degree of freedom and appropriate entries added to arrays IDC and ADC. Subroutine JVECT is used to complete vector cross products and joint coordinate differences in order to test vector coincidence. Array ADC stores the coordinates of the point where the vector acts and the vector direction cosines. The code words assembled and stored in rows 1 and 2 of array IDC are

```
XXX  XX  XXXX          X  X  XX  X
```

- XXX — substructure identification
- XX — vector data code No.
- XXXX — vector entry No.
- X — 1-joint force; 2-joint moment; 3-bar force
- X — 0-1 or more additional vectors should be found in this degree of freedom; 1-no additional vectors should be found in this degree of freedom; 2-only 1 additional vector should be found in this degree of freedom
- XX — count of additional vectors found in this degree of freedom
- X — count of permanent reactions in this degree of freedom

If the vector contributes to a degree of freedom already in the table, this is noted in the counters of array IDC. In addition, the joining degree of freedom number is stored in the ninth location of the vector description data, array ID. The integer data in array ID is written onto scratch data set IST1 if this is a substructure reaction and onto IST3 if this is a joined structure permanent reaction or joining element force.

When the memory storage block is full, all remaining vectors on the input scratch data set are examined and, if they do not contribute to this set of degrees of freedom, are copied onto a scratch data set. When all vectors have been examined, the data stored in array IDC which describes each degree of freedom established in this cycle is tested for consistency and printed. The input and scratch data sets are interchanges and another cycle initiated. This loop continues until all joining degrees of freedom have been established.

b. Input/Output

Data for matrix SUM is read from scratch data set IST4 and output onto the appropriate data set. Data for TJTMAX and TJTMIN are also read from scratch data set IST4. The preassembled print data on scratch data set IST3 is read and printed. The descriptive vector data for each vector contribution to the joining equations is read from scratch data set IST2, and, after establishing the joining degrees of freedom, a list describing the joining degrees of freedom is printed. Integer data describing each vector including the joining degree of freedom to which it is related, is written onto scratch data set IST3 and substructure reactions onto IST1.

c. Error Messages

Messages are printed when vectors which are apparently in the same degree of freedom are not coincedent, and when the number of vectors in a degree of freedom is inconsistent with the joining flags on the data entries or exceeds the maximum number allowed. A message is also printed when the total number of joining degrees of freedom exceeds the maximum matrix size.

d. Subroutines Required

EUTL5
EUTL6
EUTL8
JVECT

e. Argument List

JDFA (IDC, ADC, IK, NDC, OUTPUT, IOSPEC)

IDC	—	Array of joining degree of freedom vector identification numbers
ADC	—	Array of joining degree of freedom joint coordinates and direction cosines
IK	—	Array of control and error flags
NDC	—	Array of vector identification numbers for printing
OUTPUT	—	Is an array (7 x 1) containing the six alphameric characters and one integer representing the name of the first output matrix
IOSPEC	—	Is an array (1 x 1) containing the FORTRAN logical number of the data set onto which the first output matrix is to be written

f. Subroutine Length

3262 words (approximate)

g. Symbol List

SYMBOLS USED IN SUBROUTINE JDFA

ADC	R	A	ARRAY OF JOINING DEGREE OF FREEDOM JOINT COORDINATES AND	JDFA
ADC	R	A	DIRECTION COSINES	JDFA
AD	R	D	ARRAY FOR COORDINATES AND DIRECTION COSINES OF A VECTOR	JDFA
B	R	D	INTERMEDIATE STORAGE	JDFA
I	I	U	INTERMEDIATE INDEX	JDFA
ICODE	I	U	COMPOSITE VECTOR IDENTIFICATION NUMBER	JDFA
ICOL	I	U	COLUMN NUMBER IN OUTPUT MATRIX	JDFA
ID	I	D	ARRAY FOR VECTOR INDEXING DATA	JDFA
IDC	I	A	ARRAY OF JOINING DEGREE OF FREEDOM VECTOR IDENTIFICATION NOS.	JDFA
IK	I	A	ARRAY OF CONTROL AND ERROR FLAGS	JDFA
IMATCH	I	U	COUNT OF VECTORS IN THIS DEGREE OF FREEDOM	JDFA
IMAX	I	U	OUTPUT MATRIX ROW DIMENSION	JDFA
IOSPEC	I	A	OUTPUT MATRIX DATA SET	JDFA
IST1	I	U	NUMBER OF SCRATCH DATA SET 1	JDFA
IST2	I	U	NUMBER OF SCRATCH DATA SET 2	JDFA
IST3	I	U	NUMBER OF SCRATCH DATA SET 3	JDFA
IST4	I	U	NUMBER OF SCRATCH DATA SET 4	JDFA
IT1	I	U	INTERMEDIATE DATA SET NUMBER	JDFA
ITAPE	I	U	INTERMEDIATE DATA SET NUMBER	JDFA
IT	I	U	INTERMEDIATE DATA SET NUMBER	JDFA
IT2	I	U	INTERMEDIATE DATA SET NUMBER	JDFA
IVMAX	I	U	MAXIMUM NUMBER OF JOINING FORCES IN A DEGREE OF FREEDOM	JDFA
IVECT	I	U	COMPOSITE VECTOR IDENTIFICATION NUMBER	JDFA
J	I	U	INTERMEDIATE INDEX	JDFA
JDFMAX	I	U	MAXIMUM NUMBER OF JOINING DEGREES OF FREEDOM STORABLE IN	JDFA
JDFMAX	I	U	MEMORY	JDFA
JDF	I	U	COUNT OF DEGREES OF FREEDOM ESTABLISHED DURING THIS CYCLE	JDFA
JF	I	U	COUNT OF JOINING FORCES PROCESSED DURING THIS CYCLE	JDFA
JMAX	I	U	INTERMEDIATE INDEX	JDFA
K	I	U	INTERMEDIATE INDEX	JDFA
KER	I	U	PROCESSING ERROR FLAG	JDFA
KN	I	U	INTERMEDIATE INDEX	JDFA

SYMBOLS USED IN SUBROUTINE JDFA

KODE	I	U	MATRIX COLUMN COMPRESSION CODE	JDFA
KONST	I	C	MAXIMUM MATRIX SIZE	JDFA
K1	I	U	INTERMEDIATE INDEX	JDFA
K2	I	U	INTERMEDIATE INDEX	JDFA
L	I	U	INTERMEDIATE INDEX	JDFA
LER	I	U	PROCESSING ERROR TYPE CODE	JDFA
LINE	I	U	PRINTED LINE COUNTER	JDFA
N	I	U	INTERMEDIATE INDEX	JDFA
NDC	I	A	ARRAY OF VECTOR IDENTIFICATION NUMBERS FOR PRINTING	JDFA
NJF	I	U	NUMBER OF JOINING FORCES	JDFA
NJ	I	U	NUMBER OF JOINING FORCES REMAINING TO BE PROCESSED	JDFA
NKNT	I	U	NUMBER OF JOINING FORCES PROCESSED IN PREVIOUS CYCLES	JDFA
NKT	I	U	COUNT OF VECTORS STORED FOR SUBSEQUENT PROCESSING	JDFA
NM1	I	U	INTERMEDIATE INDEX	JDFA
NM2	I	U	INTERMEDIATE INDEX	JDFA
NM3	I	U	INTERMEDIATE INDEX	JDFA
NPIT	I	C	NUMBER OF SYSTEM INPUT DATA SET	JDFA
NPOT	I	C	NUMBER OF SYSTEM OUTPUT DATA SET	JDFA
NSET	I	U	OUTPUT MATRIX DATA SET	JDFA
NV	I	U	NUMBER OF VECTOR DEFINITIONS TO BE PRINTED	JDFA
OUTPUT	A	A	OUTPUT MATRIX NAME	JDFA
SUM	R	D	ARRAY TO ASSEMBLE OUTPUT MATIX COLUMNS	JDFA
T	R	U	INTERMEDIATE STORAGE	JDFA
TDCMAX	R	U	MAXIMUM DIFFERENCE OF DIRECTION COSINES	JDFA
TDCMIN	R	U	MINIMUM DIFFERENCE OF DIRECTION COSINES	JDFA
TJTMAX	R	U	MAXIMUM DIFFERENCE OF JOINT COORDINATES	JDFA
TJTMIN	R	U	MINIMUM DIFFERENCE OF JOINT COORDINATES	JDFA
TT	R	U	INTERMEDIATE STORAGE	JDFA

REFERENCES

1. J. P. Cogan, Jr., FORMAT II - Second Version of Fortran Matrix Abstraction Technique; Volume II. Description of Digital Computer Program, AFFDL-TR-66-207, Volume II, Air Force Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio, March 1967.

2. W. J. Lackey, R. E. Wild, FORMAT II - Second Version of Fortran Matrix Abstraction Technique; Volume II, Supplement I. Description of Digital Computer Program, AFFDL-TR-66-207, Volume II, Supplement I, Air Force Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio, November 1968.

3. C. G. Hooks, FORMAT II - Second Version of Fortran Matrix Abstraction Technique; Volume II, Supplement II. Description of Digital Computer Program System/360. AFFDL-TR-66-207, Volume II, Supplement II, Air Force Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio, February 1969.

4. W. J. Lackey, S. H. Miyawaki, FORMAT - Fortran Matrix Abstraction Technique; Volume II, Supplement III. Description of Digital Computer Program - Extended. AFFDL-TR-66-207, Volume II, Supplement III, Air Force Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio, June 1970.

5. J. Pickard, FORMAT - Fortran Matrix Abstraction Technique; Volume V. Engineering User and Technical Report. AFFDL-TR-66-207, Volume V, Air Force Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio, October 1968.

6. J. Pickard, FORMAT - Fortran Matrix Abstraction Technique; Volume V, Supplement I. Engineering User and Technical Report - Extended. AFFDL-TR-66-207, Volume V, Supplement I, Air Force Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio, June 1970.

7. J. P. Cogan, Jr., R. C. Morris, and J. R. Wells, FORMAT - Fortran Matrix Abstraction Technique; Volume VI. Description of Digital Computer Program - Phase I. AFFDL-TR-66-207, Volume VI, Air Force Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio, September 1968.

8. R. C. Morris, FORMAT - Fortran Matrix Abstraction Technique; Volume VI, Supplement I. Description of Digital Computer Program - Phase I - Extended. AFFDL-TR-66-207, Volume VI, Supplement I, Air Force Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio, June 1970.

9. R. C. Morris, J. R. Wells, and P. S. Yoon, FORMAT - Fortran Matrix Abstraction Technique; Volume VII. Description of Digital Computer Program - Phase III. AFFDL-TR-66-207, Volume VII, Air Force Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio, September 1968.

10. J. A. Frank, FORMAT - Fortran Matrix Abstraction Technique; Volume VII, Supplement I. Description of Digital Computer Program - Phase III - Extended. AFFDL-TR-66-207. Volume VII, Supplement I, Air Force Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio, June 1970.

UNCLASSIFIED
Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY *(Corporate author)* Douglas Aircraft Company	2a. REPORT SECURITY CLASSIFICATION Unclassified 2b. GROUP N/A
3. REPORT TITLE FORMAT - FORTRAN MATRIX ABSTRACTION TECHNIQUE Volume VI-Supplement I. Description of Digital Computer Program-Phase I-Extend.	
4. DESCRIPTIVE NOTES *(Type of report and inclusive dates)* Final Report 7/1/68 - 6/30/70	
5. AUTHOR(S) *(First name, middle initial, last name)* R. C. Morris	

6. REPORT DATE August 1970	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS 10

8a. CONTRACT OR GRANT NO. F33615-68-C-1633 b. PROJECT NO. 1467 c. Task No. 146705 d.	9a. ORIGINATOR'S REPORT NUMBER(S) DAC 33569 9b. OTHER REPORT NO(S) *(Any other numbers that may be assigned this report)* AFFDL-TR-66-207 Vol. VI, Supplement I
10. DISTRIBUTION STATEMENT This document has been approved for public release and sale; its distribution is unlimited	
11. SUPPLEMENTARY NOTES None	12. SPONSORING MILITARY ACTIVITY Air Force Flight Dynamics Laboratory Wright-Patterson Air Force Base, Ohio

13. ABSTRACT

The FORMAT System has been updated by the incorporation of additional basic capability and the refinement of existing capability. A simpler mode of updating case data and extended force method matrix generation capability has been incorporated in Phase I of the system. A refined "Structure Cutter" module, capabilities for matrix partitioning and instruction looping, and an additional eigenvalue/eigenvector extraction module have been incorporated in Phase II. Finally the limitations which existed in the matrix plotting capability in Phase III have been eliminated. Programming documentation for the extended capability of Phase I of the FORMAT System is presented in this report.

DD FORM 1 NOV 65 1473

UNCLASSIFIED
Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
1. Structural Analysis						
2. Matrix methods						
3. Matrix abstraction						
4. Digital computer methods						