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Addendum

ELAS—A General-Purpose Computer Program for the Equilibrium Problems of Linear Structures

Volume II. Documentation of the Program

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N O T I C E

Preface

The work described in this report was performed by the Engineering Mechanics Division of the Jet Propulsion Laboratory.

The program was developed by Dr. Senol Utku and Dr. Fevzican A. Akyuz, and is dedicated to the memory of Professor M. Inan of the Technical University of Istanbul.

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Abstract

A general-purpose digital computer program (named ELAS) for the in-core solution of linear equilibrium problems of structural mechanics is described for potential and actual users in Volume I of this report, and is documented in Volume II. The program requires minimum input for the description of the problem. The solution is obtained by means of the displacement method and the finite element technique. Almost any geometry and structure may be handled because of the availability of lineal, triangular, quadrilateral, tetrahedral, hexahedral, conical, triangular torus, and quadrilateral torus elements. The assumption of piecewise linear deflection distribution insures monotonic convergence of the deflections from the stiffer side with decreasing mesh size. The stresses are provided by the best-fit strain tensors in the least-squares sense at the mesh points where the deflections are given. The selection of local coordinate systems whenever necessary is automatic. The core memory is efficiently used by means of dynamic memory allocation, an optional mesh-point relabelling scheme, imposition of the boundary conditions during the assembly time, and the straight-line storage of the rows of the stiffness matrix within variable bandwidth and the main diagonal. The number of unsuppressed degrees of freedom that can be handled in a given problem is 500 to 600 for a typical structure, but might far exceed these average values for special types of problems; the execution time of such problems is about four minutes in 32K IBM 7094 Model I machines. The program is written in FORTRAN II language. The source deck consists of about 8000 cards and the object deck contains about 1400 binary cards. The physical program (standard ELAS) is available from COSMIC, the agency for the distribution of NASA computer programs.

I. Introduction

Volume I, *User's Manual*, of this report gives a general description of ELAS,* a general-purpose digital computer program for the in-core solution of linear equilibrium problems of structural mechanics, and contains the information necessary for input preparation, arrangement of the physical program, and interpretation of output and error messages. Volume II, *Documentation of the Program*, is published in two parts: the basic Volume II, which gives the theoretical background of the program and contains tables and figures describing the COMMON variables, their meanings, and their arrangement in COMMON; and this report—Addendum to Volume II—which contains program descriptions, flowcharts, and source program listings for all program elements of ELAS/Level 3. (The original version of the ELAS program made available from COSMIC** in April 1968 is designated ELAS/Level 0. Subsequent program corrections made in January 1969, March 1969, and May 1969 updated the program to ELAS/Level 1, ELAS/Level 2, and ELAS/Level 3, respectively.)

* First two syllables of the word Elasticity.

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Sections II, III, IV, and V of the Addendum briefly describe the main programs and the subroutines of Links 1, 2, 3, and 4, respectively, of the ELAS program with reference to the flowcharts illustrated in Section VI, and the source program listings given in Section VII. Program descriptions include all subroutines that are not in the FORTRAN library. The standard ELAS is coded in FORTRAN II, with the exception of subroutines LEBIN, SEBIN, and TICK, which are in FAP. The subroutines are described in alphabetical order under each main program. The flowcharts, which are also in alphabetical order, present semidetailed diagrams of the sequential logic and decision points in the program. The source program listings are a straight listing of the first file in the program tape that contains the physical program.

The user of this Addendum will need both Volume I and the basic Volume II for reference because of numerous cross-references to figures and tables contained therein. The information in the referenced figures and tables is essential to interpretation of the content of the Addendum. Reference is also made herein to program input and output items and error messages, which are described and identified by number in Volume I.

II. Main Program and Subroutines of Link 1

A. Main Program of Link 1

The flowchart and the source program listing of the main program of Link 1 are given in Fig. VI-1 and Table VII-1, respectively. The logical function of the program may be summarized as follows:

(1) It defines IN, IT, IDEG, ITYPE, IGEM, ISTR, IH, I8, IBN, IP, IPRS, IMAT, NTIC, ISDT, ISDY, ISDZ, IARE, IMMX, IMMY, IMMZ, IMFI, INX, INP, ISHUF, ICOR, IBUN, IMES, IPIR, ITAP, ITAS, G1, G2, G3, ACEL directly from Input Item 2.

(2) It computes constants ISUM, IND, IORD, IORD1, and ZGEM, and pointers J1, J2, J3, J4, J5, J6, J7, J8, J9, J10, IBB, IBO, IID, IIA, IDT, IDY, ITE, ICAR, ICIX, ICIY, ICIZ, ICFI, IXX, IYY, IZZ, IIC, IDEF, IST, IIS, IU, and IDZ from the information given by Input Item 2.

(3) It generates the vectors related with pointers J1, J2, J3, J4, J5, J6, J7, J8, J9, J10, IBB, IBO, IIC, IXX, IYY, IZZ, and IDEF (partially) directly or indirectly from the input information of the job.

(4) Depending upon the value of INX, it transfers control either to statement 2700 or to the main program of Link 3.

Before using any input information, the main program checks it against the input specifications (see Sect. III and IV, Vol. I). If the program encounters an irrecoverable error in the input information, it always branches to statement 300, which prints out COMMON both in fixed- and floating-point modes and skips the related job. In transferring information from input cards into the proper locations in COMMON, the program uses DUMMY (also called IDUM) area in COMMON for temporary storage. The main program calls subroutine TABL to print out Output Item 1; subroutine TICK to measure time; subroutine BUNG to generate deflection boundary conditions (dbc) input units automatically, if IBUN = 1; subroutine CORG to generate coordinates of the nodes automatically, if ICOR = 1; subroutine MESG to generate mesh topology and element properties automatically, if IMES = 1; subroutine COOR to read in, examine, and store nodal coordinates; subroutine MEST to read in and store element data; subroutine TOPO to examine and separate the element data in storage; and finally, subroutine SRAT to obtain internal node labels in vector ISIR, and the highest internal label in the node set of each node in vector IMAX (refer to Input Item 17, Sect. IV, Vol. I). Among these subroutines, subroutine SRAT has its own subroutine. The contribution of the prescribed concentrated loads to the right-hand-side vector of the equilibrium equations before the displacement boundary conditions are imposed is stored in the

IDEF-pointer-related vector, first as in item (1) of the IDEF entry of Table III-3, Vol. II (basic), and then as in item (2) in the same entry. Probably the most important function of the main program is the generation of vectors defined by pointers IBB, IBO, and IIC. The meanings of the entries of these vectors are given in Table III-3, Vol. II (basic), and Table VI-2, Vol. I. These vectors are first generated as if all deflections were independent and with IBB numbers always equal to IND + 1. Then the numbers are modified with the dbc input units to recognize linear dependence. Finally, when vectors ISIR and IMAX are provided by subroutine SRAT, they are finalized. Vectors defined by pointers IBB, IBO, and IIC are first used in the main program to compute the contribution of the prescribed concentrated loads to the reduced right-hand-side vector in the IDEF-pointer-related vector. Later in Link 2, they are used in computing the contributions of the element stiffness matrices to the reduced stiffness matrix in the IST-pointer-related vector and the reduced load vector in the IDEF-pointer-related vector, and the contributions of the element load vectors to the reduced load vector in the IDEF-pointer-related vector. In Link 3, these three vectors are used in obtaining the deflections of all nodes from the reduced deflection vector in the IDEF-pointer-related vector. The standard ELAS Link 1 main program assumes that IN $\leq$ 540 and ISUM $<$ 10000. (See Appendix, Vol. I, for instructions on how to change these limits.)

B. Subroutines of Link 1

1. Subroutine ARAN. Subroutine ARAN is called by subroutine SRAT. The flowchart and the source program listing of ARAN are given in Fig. VI-2 and Table VII-2, respectively. The logical function of the subroutine may be summarized as follows:

(1) Subroutine ARAN generates vector IMAX for subroutine SRAT.

(2) If 0 $<$ ISHUF $<$ 3, the subroutine modifies vector ISIR and computes vector IMAX accordingly, to minimize the shaded area of the coefficient matrix shown in Fig. II-1 (Vol. I).

(3) If ISHUF = 2, the subroutine reads cards for vector ISIR, modifies matrix ABIN accordingly, and performs the function given in (2).

(4) The subroutine produces relabelling output items (Output Item 5) according to Sect. VI-F, Vol. I.

In performing these tasks, subroutine ARAN expects that connectivity matrix ABIN, ISIR vector of labels, row order IN, and column order ISUR of matrix ABIN are available in COMMON. In performing logical function (2), the subroutine also generates vector IMIN. Subroutine ARAN calls subroutine OUTPT to print out mesh topology (P) of Output Item 5 (see Sect. VI-F, Vol. I), subroutine EXCH to interchange to successive rows and their respective columns in the connectivity matrix ABIN, function LEBIN to find out if a node is connected with another node, and subroutine TICK to measure relabelling time. The algorithm for logical function (2) is given in Ref. 1. The standard ELAS assumes that a word consists of 36 binary bits, and this is assumed in subroutine ARAN. (See Appendix, Vol. I, for instructions on how to change this constraint.)

2. Subroutine BUNG. Subroutine BUNG is called by the main program of Link 1, if IBUN = 1. The standard ELAS contains only the dummy version of this subroutine, as shown in Table VII-3. If IBUN = 1, the subroutine should be rewritten by the user, as explained in Sect. V-D, Vol. I. The logical function of the subroutine is to place IBN number of dbc input units into DUMMY or IDUM area.

3. Subroutine COOR. Subroutine COOR is called by the main program of Link 1, if ICOR = 0. The flowchart and the source program listing of COOR are given in Fig. VI-3 and Table VII-4, respectively. The function of this subroutine is to read the cards of Input Item 14 in blocks of not greater than 1000 nodes, to examine whether the node labels are sequential, and to generate IXX-, IYY-, and IZZ-pointer-related vectors. If IGEM = 0, the IZZ-pointer-related vector will not be generated. In case of error, the subroutine returns control to the calling program with IERR = 1, without completing its function.

4. Subroutine CORG. Subroutine CORG is called by the main program of Link 1, if ICOR = 1. The standard ELAS contains only the dummy version of this subroutine, as shown in Table VII-5. If ICOR = 1, the subroutine should be rewritten by the user, as explained in Sect. V-B, Vol. I. The logical function of this subroutine, when ICOR = 1, is to generate vectors related with pointers IXX, IYY, and IZZ.

5. Subroutine EXCH. Subroutine EXCH is called by subroutine ARAN. The flowchart and the source program listing of EXCH are given in Fig. VI-4 and Table VII-6, respectively. The function of this subroutine is to interchange the I*th* row with the IP*th* row of the ABIN matrix, and I*th* binary column with the IP*th* binary column of the same matrix; MI is the smallest binary column number of the first nonzero binary entry either in row I or in row IP; MX is the largest binary column number of the last nonzero binary entry either in row I or in row IP. Since ABIN is a symmetric binary matrix, MI and MX also define the limits of the I*th* and IP*th* columns. Interchange operation is carried out only within these limits. The subroutine expects ABIN, I, IP, MI, and MX to be available in COMMON, and it assumes that a word consists of 36 binary bits. (See Appendix, Vol. I for instructions on how to change this limit.) Subroutine EXCH calls function LEBIN to obtain the value of a certain bit of a word, and subroutine SEBIN to store 1 or 0 in a certain bit of a word.

6. Function LEBIN. The subprogram LEBIN is called by subroutines ARAN and EXCH. The flowchart and the source program listing of LEBIN are given in Fig. VI-5 and Table VII-7, respectively. The coding is in FAP for the IBM 7094. The logical function of LEBIN is to return as a FORTRAN integer the value of the bit, shown in the second argument, of the word shown in the first argument. It assumes that the word length is 36 binary bits. For any other machine, this function should be rewritten.

7. Subroutine SEBIN. Subroutine SEBIN is called by subroutines EXCH and SRAT. The flowchart and the source program listing of SEBIN are given in Fig. VI-6 and Table VII-7, respectively. The coding is in FAP for the IBM 7094. The logical function of SEBIN is to store 1 or 0 (as shown in the third argument) in to the bit (shown in the second argument) of the word (shown in the first argument). The subroutine assumes that a word consists of 36 binary bits. For any other machine, this subroutine should be rewritten.

8. Subroutine MESG. Subroutine MESG is called by the main program of Link 1, if IMES = 1. The standard ELAS contains only the dummy version of this subroutine, as shown in Table VII-8. If IMES = 1, the subroutine should be rewritten by the user, as explained in Sect. V-C, Vol. I. The logical function of this subroutine, when IMES = 1, is to generate vectors related with pointers J1, J2, J3, J4, J5, J6, J7, J8, J9, and J10.

9. Subroutine MEST. Subroutine MEST is called by the main program of Link 1, if IMES = 0. The flowchart and the source program listing of MEST are given in Fig. VI-7 and Table VII-9, respectively. The function of this subroutine is first to read the cards of Input Item 16, one or more at a time, into DUMMY area, and to check the validity of M number of the element descriptors (see Table IV-3, Vol. I), then to store words J1W, J2W, J3W, J4W, J5W, and if they exist, J6W, J7W, J8W, J9W, J10W of the element descriptors into the proper locations in the respective vectors related with pointers J1, J2, J3, J4, J5, J6, J7, J8, J9, and J10, and to check the positiveness of the vertex labels. In case of error, the subroutine returns control to the calling program with IERR = 1, without completing its function. If no error is encountered, the subroutine performs its operations on the input cards of every element, sequentially, until all element data are processed.

10. Subroutine OUTPT. Subroutine OUTPUT is called by subroutine ARAN, if INP = 2. The flowchart and the source program listing of OUTPT are given in Fig. VI-8 and Table VII-10, respectively. The function of this subroutine is to print out Output Item 5(P) (see Sect. VI-F, Vol. I). This subroutine assumes that a word is 36 binary bits and IN $\leq$ 540. (See Appendix, Vol. I for instructions on how to change these limits.) Subroutine OUTPT expects ISIR, IMIN, IMAX vectors, ABIN matrix, IN, and ISUR to be available in COMMON.

11. Subroutine SRAT. Subroutine SRAT is called by the main program of Link 1. The flowchart and the source program listing of SRAT are given in Fig. VI-9 and Table VII-11, respectively. The functions of this program may be summarized as follows:

(1) If ISHUF = 3, subroutine SRAT reads the cards of Input Item 17 for the generation of internal node labels in vector ISIR, and the highest internal label in the node set of each node in vector IMAX (refer to Input Item 17, Sect. IV, Vol. I). If ISHUF $\neq$ 3, subroutine SRAT generates vector ISIR by assuming that internal and external labels of the nodes are the same; computes ISUR, which is the number of words whose binary bits are enough to provide one bit for each of the IN nodes; generates connectivity matrix ABIN from the mesh-topology information of Input Item 16 and from the deflection boundary condition input units already in the IBO-pointer-related vector; and calls subroutine ARAN to obtain the finalized values of vectors ISIR and IMAX. (In generating the binary connectivity matrix ABIN, subroutine SRAT first clears matrix ABIN; then it processes elements one at time by first listing the labels of the vertices of the element and the labels of the nodes connected with these vertices through the dbc

input items; and then indicates, by means of a binary 1 in the proper places in matrix ABIN, the fact that all these nodes are connected with each other. In matrix ABIN, one row and one column are assigned to every node so that ABIN is a symmetric matrix. If a node *i* is connected with a node *j*, the *i*th row and the *j*th column, and likewise the *j*th row and the *i*th column, of the binary matrix ABIN contain a binary bit 1. All diagonal elements of the binary matrix ABIN are binary bit 1. If a node is constrained completely by means of dbc input items the only nonzero bit in the row and the column of this node is on the diagonal. The ordering of rows and columns of the binary matrix ABIN is done by the order that is available in vector ISIR.)

(2) If INP $\neq 0$, subroutine SRAT generates and prints out Output Item 6.

(3) It generates the vector related with pointer IU, and if INP $\neq 0$, prints it as Output Item 9.

(4) It computes the number of words between points D and F, and between the beginning of COMMON and point G, designated in Fig. III-1, Vol. II (basic), and prints out Output Items 7 and 8.

(5) It prints Error Message 5 (see Table VII-1, Vol. I) if the number of words to the left of point G is less than 12,750, which is based on the assumption that the core memory is 32,768 words. (See Appendix, Vol. I for instructions on how to modify the program for other core memory sizes.)

Subroutine SRAT calls subroutine TOPO in obtaining the vertex labels of the elements, subroutine SEBIN in generating binary matrix ABIN, and subroutine ARAN to obtain vector IMAX and the corresponding vector ISIR.

12. Subroutine TABL. Subroutine TABL is called by the main program of Link 1. The flowchart and the source program listing of TABL are given in Fig. VI-10 and Table VII-12, respectively. The function of this subroutine is to print out Output Item 1. It expects the contents of Input Items 1 and 2 to be available in COMMON.

13. Subroutine TICK. Subroutine TICK is called by the main program of Link 1. It is also called by subroutine ARAN and by the main programs of Links 2, 3, and 4. The flowchart and the source program listing of subroutine TICK are given in Fig. VI-11 and Table VII-13, respectively. The coding is in FAP for the IBM 7094. The subroutine expects the time in units of 1/60 second in the absolute memory location 5 as a binary integer. Its function is to return, as a FORTRAN integer in the argument, the time, in 1/60-second units, elapsed since the first call. (See Appendix, Vol. I, for instructions on how to change this subroutine for other machines.)

14. Subroutine TOPO. Subroutine TOPO is called by the main program of Link 1. It is also called by subroutine SRAT. The flowchart and the source program listing of TOPO are given in Fig. VI-12 and Table VII-14, respectively. The function of this subroutine may be summarized as follows:

(1) It extracts from J1-, J2-, J3-, J4-, J5-, J6-, J7-, J8-, J9-, and J10-pointer-related vectors for the M*th* element the vertex labels in N_i vector, the pressure type number in JPRS, the material type number in IMET, the thickness type number in ITIC, the temperature increase type number in ITEM, the temperature gradient in *y*-direction type number in JSDY, the temperature gradient in *z*-direction type number in JSDZ, the cross-sectional area type number in JARE, the torsional constant type number in JMMX, the *y*-moment of inertia type number in JMMY, the *z*-moment of inertia type number in JMMZ, and the angle for principal axes type number in JMFI, as described in Table III-2 (Vol. II, basic).

(2) It checks whether the vertex labels and the property type numbers are within the bounds prescribed in Input Item 2. In case of error, the subroutine continues scanning the properties of the M*th* element and prints out Error Message 3 (see Table VII-1, Vol. I) after executing the implementation of the message.

III. Main Program and Subroutines of Link 2

A. Main Program of Link 2

The flowchart and the source program listing of the main program of Link 2 are given in Fig. VI-13 and Table VII-15, respectively. The logical function of the program may be summarized as follows:

(1) It clears the reduced stiffness matrix area (the IST-pointer-related vector of Table III-3, Vol. II, basic).

(2) It generates the elemental matrices in S and P areas, and assembles these into IST- and IDEF-pointer-related vectors, sequentially.

(3) It stores on tape ITAS (if available) the elemental matrices, sequentially.

(4) Depending upon the value of INX, it transfers control either to the main program of Link 1 or to the main program of Link 3.

In carrying out function (2) listed above, the program executes a DO-loop on element labels M. In this loop, for any element M, it first clears a certain work area (see block *133 in Fig. VI-13) and sets the variables ITTT = 0, ITTM = NAV = 1, and CFE = 1. Variable ITTM is not in COMMON. For element types 1, 2, 3, 4, 5, 7, 9, 11, 13, 15, 17, and 18, ITTM = NAV = 1 and CFE = 1., and ITTT is made 1 at block 5100 of Fig. VI-13. For the remaining element types, that is, element types 6, 8, 10, 12, 14, and 16, the program establishes subelements as described in Table VI-5 (Vol. I). For element types 6, 8, 12, 14, and 16, the program obtains two triangles for every quadrilateral in two ways, as shown in Table VI-5 (Vol. I). Since such a procedure is equivalent to doubling the material volume of the structure, the elemental matrices are weighted with constant CFE = 1/2 (See block 4902 of Fig. VI-13); ITTM is the number of the subelements and ITTT is the subelement count in each way of subdivision, and NAV − 1 is the count of subdivisions. For example, NAV = 2, ITTT = 2 means the second triangle of the first way of subdivision, and NAV = 3, ITTT = 1 means the first triangle of the second way of subdivision. The same symbolism applies for element type 10, where ITTM = 5, which indicates that there are five tetrahedrons for every way of subdividing an hexahedron. The subdivision procedure is achieved as indicated in block 504 of Fig. VI-13, with the help of subroutine CUTE.

In the DO-loop on elements, after the initialization of block *133 (Fig. IV-13), by means of subroutine TOPO, the descriptive words of the element (the quantities listed in J1- through J10-pointer-related vectors) are extracted and analyzed to obtain the vertex labels in N block and the property type numbers. Next, the vertex labels are copied to NOO block in preparation for the subdivision operation and IMS is established. Following this, the order of the element stiffness matrix IDS is determined, actual values of load and geometry constraints are obtained, and the material constants are prepared. Even if an element is subdivided, the same load, geometry, and material constants are used for the subelements. The following constants are prepared, as explained in Sect. III-C, Vol. I: E and G for element types 1, 2, 3, and 4; D21 for element types 9, 10, 15, and 16; D33 for element types 5, 6, 7, 8, 11, 12, 13, and 14; and E22 for element types 7, 8, 11, 12, and 18. The constant E is the Young's modulus, G is the shear modulus, D21 is the upper half of the 6×6 material matrix, D33 is the material constants matrix for in-plane deformations, and E22 is the material constants matrix for out-of-plane deformations. Finally, arrays related with subelement vertex coordinates and labels are prepared (see block 5100, Fig. VI-13), the subelement count ITTT is set, and the number of entries in the free-free stiffness matrix, IDS2, is obtained; and S and P areas are cleared for elemental matrices of the subelement/element (see block 5600, Fig. VI-13).

In the DO-loop on elements, for every subelement/element, a free-free stiffness matrix and a load vector are generated in S and P, respectively. For this purpose the program calls subroutine STFS, which, in turn, calls the proper subroutine determined by the type number of the current element. These subroutines are S01, S02, S03, S04, S05, S07, S09, S11, S13, S15, S17, and S18. The numeral in these names corresponds to the type number of the element for which the subroutine is directly applicable. In all these subroutines, the input information is in X, Y, Z, XD, YD, ZD, DT, DG, DGY, DGZ, TE, AL1, AL2, AL3, E, G, D21, D33, E22, PRES, ACEL, N, CONS, UV, and COMMON 200–328 locations. The output consists of S, P, and sometimes IPBG and IPEN constants. The latter two constants indicate whether the element load vector in P is complete, or whether some additional operation is necessary in the main program. If IPBG is nonpositive and IPBG$<$IPEN, no additional operation is expected from the main program to modify load vector P. The thermal portion of load vector P is always completed by the main program. Before the subroutines are called, the main program sets in vector UV the list of vertex deflections due to DT of the free-free element. The subroutines called by subroutine STFS modify this vector properly so that the portion of the element load vector due to temperature changes can be added to P as the product of the free-free stiffness matrix of the element (the quantities in S) times the deflections in UV by means of subroutine DMM. This is shown in block 951 of Fig. VI-13. In this figure, Block 953 corresponds to the inquiries on constants IPEN and IPBG. The modification to vector P in the main program consists of adding certain constant values derived from CONS, PRCO, and PD values to certain subvectors of P as indicated by IPEN and IPBG. The values of IPEN, IPBG, CONS, PRCO, and PD are determined by the subroutine that generates S and P.

After the generation of S and P in the DO-loop on elements, the main program scans each entry of S and P one at a time and assembles it to the governing equations of the system. This is the operation in block 9532 of Fig. VI-13, which ends just before block 95*. The assembly procedure is described in Sect. II, Vol. II (basic). With the notation given there, $\underline{a}$, $\tilde{e}_a'$, i_a', and $\underline{b}$, $\tilde{e}_b'$, j_b' are generated in IQE, CCCI, IBS and JQE, CCCJ, JBS locations of COMMON, respectively, by means of subroutine DARN. After the assembly of the subelement/element matrices S and P, if a scratch tape is available, the operations shown in block 9982 (Fig. IV-13) are for future reference. Next, ITTT is compared with ITTM, and the value of NAV (which is updated by subroutine CUTE) is inquired. When the last subelement of the last subdivision is completed, the process is repeated for the next element until all the elements are handled. Then, scratch tape ITAS (if prescribed) is rewound, the total time elapsed since the first entry to the main program is obtained by means of subroutine TICK and recorded, and the transfer of control is made.

The main program of Link 2 is also responsible for the production of Output Items 14, 15, 16, and 17, as prescribed by INP and subroutine CAS2 (see Table VI-1, Vol. I). At the end of Link 2, the coefficients in the shaded areas of Fig. II-1, Vol. I, are generated and stored in IST- and IDEF-pointer-related arrays of COMMON.

B. Subroutines of Link 2

1. Subroutine ADM. Subroutine ADM is called by subroutines S05, S07, S09, S15, S17, and S18. The flowchart and the source program listing of ADM are given in Fig. VI-14 and Table VII-16, respectively. The subroutine has seven arguments. The function of the subroutine is to add a constant times a square matrix to another one which is symmetric. The constant is given by the seventh argument, the matrix to be added is given by the third argument, and the matrix to be increased is given by the first argument. The order of the latter matrix is given in the second argument, the order of the former by the fourth argument. Since the orders are different, the row and column numbers of the entry in the matrix of the first argument corresponding to the first entry of the matrix of the third argument are given with the fifth and sixth arguments. The addition operation is carried out such that the matrix of the first argument always remains symmetrical. Both matrices are assumed to be listed columnwise, with the column orders as prescribed by the second and fourth arguments. The order of the matrix in the third argument cannot be larger than 4. There is no error return of the subroutine. In all cases, the matrix in the first argument is the free-free stiffness matrix of various types of elements, and the matrix in the third argument is usually a submatrix related with given degree-of-freedom directions.

2. ***Subroutine BEAM.*** Subroutine BEAM is called by subroutines S02 and S04. The flowchart and the source program listing of BEAM are given in Fig. VI-15 and Table VII-17, respectively. This subroutine generates, in local coordinates, the free-free stiffness matrix of a planar beam element and stores it in A(6,6), which is located in COMMON (200). The matrix may be partitioned with respect to degrees of freedom (nine submatrices, 2 × 2 each). In generation of the stiffness matrix, the shear deformations are ignored.

3. ***Subroutine CAS2.*** Subroutine CAS2 is called by the main program of Link 2. The standard ELAS contains only the dummy version of this subroutine, as shown in Table VII-18. If Output Items 14, 15, and 16 are to be produced selectively, the subroutine should be rewritten by the user, as explained in Sect. V-G, Vol. I. The logical function of this subroutine is to change the value of INP as desired in the DO-loop on elements of the main program of Link 2.

4. ***Subroutine CODI.*** Subroutine CODI is called by subroutines S02, S03, and S04. The flowchart and the source program listing of CODI are given in Fig. VI-16 and Table VII-19, respectively. The subroutine generates the direction cosines of the local axes for element types 2, 3, and 4 in DIR(3,3) array, which is located in COMMON(264). The first row of DIR corresponds to local x-axis, the second row corresponds to local y-axis, and the third row corresponds to local z-axis. (See Table III-3, Vol. I, and the description of Input Item 13, Sect. IV-B, Vol. I, for the rules covering the local coordinate systems of these elements.) The subroutine sets IERR = 1 and returns control to the calling program as soon as an error is detected.

5. ***Subroutine CORT.*** Subroutine CORT is called by subroutines S11 and S13. The flowchart and the source program listing of CORT are given in Fig. VI-17 and Table VII-20, respectively. The subroutine generates the direction cosines of the local coordinate axes for elements 11 and 13 in DIR(3,3) array, which is located in COMMON(264). The first, second, and third rows of DIR correspond to the first, second, and third local axis, respectively. (See Table III-3, Vol. I, for the rules in selecting the local coordinate system for elements 11 and 13.) After computation of direction cosines, the subroutine replaces X, Y, and Z values with the coordinates of the vertices in a coordinate system located usually at the centroid of the element and yet parallel to the local coordinate system of the element. Next, the subroutine computes in XD, YD, and ZD the coordinates of the second and third vertex in a coordinate system that is located at the first vertex, yet is parallel to the local coordinate system of the element. There is no error return in the subroutine.

6. ***Subroutine CUTE.*** Subroutine CUTE is called by the main program of Link 2. The flowchart and the source program listing of the subroutine are given in Fig. VI-18 and Table VII-21, respectively. This subroutine has the ITTM value as an argument (see Sect. III-A). The subroutine is called twice for element types 6, 8, 10, 12, 14, and 16 and is not called for other types of elements. Each time it is called for an element, the subroutine increments NAV (see Sect. III-A) by 1; determines ITTM, IMS, IELT, IDS values for the subelements; and generates in NOO array the list of mesh-point labels that conform to the (NAV − 1)st row in part A or B of Table VI-5, Vol. I, depending upon whether the value of ITTM is 2 or 5, respectively. For example, for a quadrilateral element with mesh-point labels 13, 8, 51, 16, the value of ITTM is 2, and if NAV = 2, according to the first line of Table VI-5A, Vol. I, the NOO array contains the following list: 13, 8, 51, 51, 16, 13. There is no error return in the subroutine.

7. ***Subroutine DARN.*** Subroutine DARN is called by the main program of Link 2. The flowchart and the

source program listing of the subroutine are given in Fig. VI-19 and Table VII-22, respectively. The subroutine has four arguments. The last three arguments, KBS, CCC, and KQE, correspond to i'_a, $\tilde{e}'_a$, and $\underline{a}$ (or j'_b, $\tilde{e}'_b$, and $\underline{b}$), respectively, of Sect. II, Vol. II (basic). The first argument is the label of the degree-of-freedom direction under question (see Sect. III-A). To achieve this function, subroutine DARN interprets the entries of IBB-, IBO-, and IIC-pointer-related vectors, as described in Table VI-2, Vol. I. In case of error, the last argument is set to zero, and the subroutine returns control to the calling program.

8. Subroutine DMM. Subroutine DMM is called by the main program of Link 2. The flowchart and the source program listing of the subroutine are given in Fig. VI-20 and Table VII-23, respectively. The subroutine has four arguments. The first argument is a square matrix, and the second and fourth are vectors of order given by the third argument. The square matrix is assumed to be listed columnwise (the number and orders of the vectors being equal to the third argument). The subroutine adds on the vector in the fourth argument the product of the matrix in the first argument by the vector in the second argument. There is no error return in the subroutine.

9. Subroutine ELDI. Subroutine ELDI is called by subroutines S01, S02, and S04. The flowchart and the source program listing of ELDI are given in Fig. VI-21 and Table VII-24, respectively. The subroutine generates in vector PD the direction cosines of the pressure direction for element types 1, 2, and 4. (See description of Input Item 4, Sect. IV-B, Vol. I, and Table III-3, Vol. I, for the rule for determining the pressure direction.) If the element is in the general wind direction, the pressure is set to zero. If an error is encountered, IERR is set to 1, and the subroutine returns control to the calling program.

10. Subroutine PLBE. Subroutine PLBE is called by subroutines S03, and S04. The flowchart and the source program listing of PLBE are given in Fig. VI-22 and Table VII-25, respectively. This subroutine generates, in local coordinates, the free-free stiffness matrix of a grid beam element in A(6,6), which is located in COMMON(200). The matrix may be partitioned with respect to degrees of freedom (nine submatrices, 2×2 each). In generation of the stiffness matrix, the shear deformations are ignored.

11. Subroutine RLOC. Subroutine RLOC is called by subroutines S02, S03, and S04. The flowchart and the source program listing of RLOC are given in Fig. VI-23 and Table VII-26, respectively. Its function is similar to that of subroutine ADM, described in Sect. III-B. The arguments in this subroutine are all implicit. They are S, A, IDS, II, JJ, IR, JR, NY. The subroutine assumes that S is an IDS × IDS matrix; A is a 6×6 matrix. The objective of the subroutine is to put NY × NY submatrix of matrix A on matrix S. The constants II and JJ are the row and column numbers of the first word of NY × NY submatrix of matrix A. The constants IR and JR are the row and column numbers of the corresponding word in matrix S. In contrast to subroutine ADM, subroutine RLOC does not add, but replaces the entries of matrix A on S. After the replacement, the processed portion of A is nullified. There is no error return in the subroutine.

12. Subroutine S01. Subroutine S01 is called by subroutine STFS. The flowchart and the source program listing of S01 are given in Fig. VI-24 and Table VII-27, respectively. The subroutine generates in S the free-free stiffness matrix of element type 1 in the overall coordinate system, and determines constants PRCO, CONS, IPBG, and IPEN for the generation of load vector P (also in overall coordinates) in the main program of Link 2, as described in Sect. III-A. The portion of the load vector related with the temperature change is also handled in the main program of Link 2. To obtain the direction cosines of the unit vector in the pressure direction, subroutine S01 calls subroutine ELDI. When an error condition is encountered, subroutine S01 sets IERR to 1 and returns control to the calling program.

13. Subroutine S02. Subroutine S02 is called by subroutine STFS. The flowchart and the source program listing of S02 are given in Fig. VI-25 and Table VII-28, respectively. The subroutine generates in S the free-free stiffness matrix of element type 2 in the overall coordinate system, determines constants PRCO, CONS, IPBG, IPEN, and modifies vector UV so that load vector P expressed in overall coordinates can be generated by the main program of Link 2 (see Sect. III-A). By calling subroutine CODI, subroutine S02 first generates the direction cosines of the local axes in DIR(3,3). Then subroutine BEAM is called to generate in A(6,6) the free-free stiffness matrix of the element in the local coordinate system. The direction cosines of the direction normal to the element are obtained and stored in PD(3) by means of subroutine ELDI. Then the free-free stiffness matrix, in local coordinates, is carried from A(6,6) into S by means of subroutine RLOC. Finally, by calling subroutine STRA, subroutine S02 obtains and stores in S the description of the free-free stiffness matrix in the overall coordinate system. The content of COMMON location IERR is transmitted intact to the calling program for error handling.

14. Subroutine S03. Subroutine S03 is called by subroutine STFS. The flowchart and the source program listing of S03 are given in Fig. VI-26 and Table VII-29, respectively. The subroutine generates in S the free-free stiffness matrix of element type 3 in the overall coordinate system, modifies vector UV so that the portion of element load vector P related with the thermal loads can be generated in the main program of Link 2, and generates the remaining portion of element load vector P in the overall coordinate system. By calling subroutine CODI, subroutine S03 generates the direction cosines of the local axes in DIR(3,3). Then, by means of subroutine PLBE, the free-free stiffness matrix of the element in the local coordinate system is obtained and stored in A(6,6). The free-free stiffness matrix in local coordinates is carried from A(6,6) into S by means of subroutine RLOC. By calling subroutine STRA, subroutine S04 obtains and stores in S the description of the free-free stiffness matrix in the overall coordinate system. The load vector due to pressure and acceleration is obtained in the overall coordinate system and stored in P. The distortions of the free-free element due to temperature gradient are first obtained in the local coordinate system, then, by means of subroutine TRAN, in the overall coordinate system, and both descriptions are placed in UVG. Vector UVG is then added to vector UV, so that the main program of Link 2 can handle the thermal portion of P (see Sect. III-A). The content of COMMON location IERR is transmitted intact to the calling program for error handling.

15. Subroutine S04. Subroutine S04 is called by subroutine STFS. The flowchart and the source program listing of S04 are given in Fig. VI-27 and Table VII-30, respectively. The program generates in S the free-free stiffness matrix of element type 4 in the overall coordinate system, and the description of the element load vector P in the overall coordinate system is partly obtained. The remaining portion of element load vector P is obtained in the main program of Link 2. By calling subroutine CODI, subroutine S04 first obtains and stores in DIR(3,3) the direction cosines of the local axes. Then the contributions of the pressure and the acceleration loadings to the description of element load vector P in the overall coordinate system are partly obtained. In obtaining the pressure direction, subroutine S04 calls subroutine ELDI. The stiffness matrix in the local coordinates is obtained in two steps. In the first step, subroutine BEAM is called to obtain the stiffness of the element in the local xy plane for storage in A(6,6). Then this matrix is carried into S by calling subroutine RLOC four times. In the second step, subroutine PLBE is called to obtain the stiffness of the element for deformations out of the local xy plane for storage in A(6,6), and the matrix is carried into S by calling subroutine RLOC once. The description of the free-free stiffness matrix is first obtained in local coordinates, then by means of subroutine STRA, in overall coordinates, for storage in S. So that the thermal load portion of P can be properly obtained in the main program of Link 2, subroutine S04 first computes into UVG the distortions of the free-free element due to temperature gradients, in the local coordinate system. Then, by means of subroutine TRAN, this vector is expressed in the overall coordinate system and added to vector UV. The content of COMMON location IERR is transmitted intact to the calling program for error handling.

16. Subroutine S05. Subroutine S05 is called by subroutines STFS, S11, S13, and S15. The flowchart and the source program listing of S05 are given in Fig. VI-28 and Table VII-31, respectively. When called by STFS (COMMON location IGEM is zero when called by STFS), subroutine S05 generates the free-free stiffness matrix S and partially generates load vector P of element type 5 in the overall coordinate system. When called by subroutines S11 and S13, it generates S and P (partially) in the local coordinates of the element, for element types 11 and 13, respectively, for membrane stretching. Actually, for the latter type of elements, X, Y, Z, XD, YD, and ZD contain local coordinates of the vertices. By calling subroutine TRIM, subroutine S05 first generates $[M]$ and $[N]$ matrices (defined in Ref. 2), in EM and EN locations in COMMON. The $[D]$ matrix (Ref. 2) corresponds to D33 in the subroutine. As far as the free-free stiffness matrix is concerned, the objective of this subroutine is to generate the $[K_M]$ matrix of Eq. (46) in Ref. 2 with $a = b = c = d = e = 0$. Submatrices $[P]$, $[Q]$, and $[R]$ (Ref. 2) are obtained by executing the triple matrix products by means of subroutine TRM, and then placed into S by means of subroutine ADM. For element types 11 and 13, pressure loading is not considered in this subroutine, but for element type 5, the pressure loading is handled in this routine. In the latter case, if the element is a subelement, the pressure is considered only for the first subelement of both ways of subdivisions (see Sect. III-A). Constants IPBG, IPEN, and CONS for the handling of the acceleration loading in the main program of Link 2 are generated in this subroutine for all cases. The temperature loading portion of element load vector P is also handled in the main program of Link 2. When an error condition is encountered, the subroutine sets IERR to 1 and returns control to the calling program. The explicit expression of the free-free stiffness matrix may be obtained from Ref. 2.

17. Subroutine S07. Subroutine S07 is called by subroutines STFS and S11. The flowchart and the source program listing of S07 are given in Fig. VI-29 and Table VII-32, respectively. If the calling program is S11, then X, Y, Z, XD, YD, and ZD contain the local coordinates of the vertices; therefore S and P represent the free-free stiffness matrix and the element load vector for bending of element type 11, in local coordinates. If the calling program is STFS, S and P represent the free-free stiffness matrix and the element load vector of element type 7, in the overall coordinate system. The portion of P related with pressure loading is generated by subroutine S07. The constants IPBC, IPEN, and CONS are generated by subroutine S07 so that the portion of the vector P related with acceleration loading can be handled in the main program of Link 2 (see Sect. III-A). The portion of P related with the thermal loads is also handled in the main program of Link 2. Subroutine S07 generates in vector UV the distortions of the free-free element due to temperature gradient (see Sect. III-A). By calling subroutine TRIM, subroutine S07 first obtains $[M]$, $[N]$, and $[L]$ matrices of Ref. 2 in locations EM, EN, and EL. The matrices $[D]$ and $[D']$ of this reference correspond to D33 and E22 in the subroutine. The triple matrix products indicated by Eqs. (45) and (51) of Ref. 2 are carried out by means of subroutine TRM, and are properly placed into S by means of subroutine ADM. The objective of subroutine S07 in generating S is to obtain the shaded portions of $[K_B]$ and $[K_S]$ matrices given by Eqs. (49) and (55) of Ref. 2. In generating the shaded portion of $[K_S]$ given by Eq. (55) of Ref. 2, the subroutine uses the "constant trace scheme" of Ref. 3. When an error condition is detected, the subroutine sets IERR to 1 and returns control to the calling program.

18. Subroutine S09. Subroutine S09 is called by subroutine STFS. The flowchart and the source program listing of S09 are given in Fig. VI-30 and Table VII-33, respectively. The objective of this subroutine is to compute the free-free stiffness matrix and the element load vector of element type 9, in the overall coordinate system, into locations S and P. The portion of P related with pressure loading is generated in subroutine S09. The subroutine generates the values of IPBC, IPEN, and CONS values for the handling of the acceleration loading portion of P in the main program of Link 2, which also handles the thermal load portion. The submatrices of the free-free stiffness matrix are obtained in the form of triple matrix products computed by means of subroutine TRM. These submatrices are properly placed in S by means of subroutine ADM. If the volume of the element is too small relative to a reference volume, an error message is printed out and the generation of S and P is skipped. If an error condition is encountered during the execution of the subroutine, IERR is set to 1, and control is returned to the calling program.

19. Subroutine S11. Subroutine S11 is called by subroutine STFS. The flowchart and the source program listing of S11 are given in Fig. VI-31 and Table VII-34, respectively. The objective of this subroutine is to generate the free-free stiffness matrix and partially generate the element load vector in S and P, respectively, of element type 11, in the overall coordinate system. The matrix in S is that of Eq. (61) of Ref. 2, with $a = b = c = d = e = 0$. Subroutine S11 first calls subroutine CORT to obtain and store in X, Y, Z, XD, YD, ZD, the coordinates of the vertices in the local coordinate system, and the direction cosines of the local axes in DIR(3,3). Next, by calling subroutine S07, subroutine S11 generates the bending portion of S and P by assuming the order as 9. Next, the quantities in S and P are properly relocated so that S and P are of order 18. The same relocation is applied to vector UV, which is generated by subroutine S07. After this, subroutine S11 calls subroutine S05 to generate the membrane portion of S and P. The P vector is partially generated in subroutine S11. The acceleration loading and the thermal loading portions of P are handled in the main program of Link 2 (see Sect. III-A). Subroutine S11 calls subroutine TRAN to express P and UV in overall coordinates, and subroutine STRA to express S in overall coordinates. The content of COMMON location IERR is transmitted intact to the calling program for error handling.

20. Subroutine S13. Subroutine S13 is called by subroutine STFS. The flowchart and the source program listing of S13 are given in Fig. VI-32 and Table VII-35, respectively. The objective of this subroutine is to generate the free-free stiffness matrix and partially generate the element load vector in S and P, respectively, of element type 13, in the overall coordinate system. Subroutine S13 first calls subroutine CORT to obtain and store in X, Y, Z, XD, YD, ZD the coordinates of the vertices in the local coordinate system, and the direction cosines of the local axes in DIR(3,3). Next, subroutine S13 calls subroutine S05 to generate the membrane rigidity and the corresponding load vector in S and P. The pressure load portion of P is generated in subroutine S13, and the acceleration loading portion and the thermal load portion of P are generated in the main program of Link 2 (see Sect. III-A). Having generated S and P in local coordinates, subroutine S13 calls subroutine TRAN to express P in the overall coordinate system, and subroutine STRA to express S in the overall coordinate system. The content of COMMON location IERR is transmitted intact to the calling program for error handling.

21. Subroutine S15. Subroutine S15 is called by subroutine STFS. The flowchart and the source program listing of S15 are given in Fig. VI-33 and Table VII-36, respectively. The objective of this subroutine is to generate the free-free stiffness matrix and the element load vector of element type 15, in locations S and P, expressed in the overall coordinate system. Only the thermal load portion of P is generated in the main program of Link 2 (see Sect. III-A). The generation of the free-free stiffness matrix is performed as described in Ref. 4. The terminology of Table VII-36 should be interpreted in the light of Ref. 4. Subroutine S15 calls subroutine TRIM to obtain the EM and EN arrays corresponding to M and N, respectively, of Ref. 4. The triple matrix products of Ref. 4 are performed by means of subroutine TRM, and properly placed in S by means of subroutine ADM. The first term in Eq. (9) of Ref. 4 is obtained in S by means of subroutine S05. In case of error, IERR location is set to 1 and control is returned to the calling program.

22. Subroutine S17. Subroutine S17 is called by subroutines STFS and S18. The flowchart and the source program listing of S17 are given in Fig. VI-34 and Table VII-37, respectively. The objective of this subroutine is to generate the free-free stiffness matrix and the element load vector of element type 17, in locations S and P, expressed in the overall coordinate system. Only the thermal load portion of P is generated in the main program of Link 2 (see Sect. III-A). The generation of the free-free stiffness matrix is performed as described in Ref. 5. The triple matrix products of this reference are performed by means of subroutine TRM, and properly placed in S by means of subroutine ADM. The terminology in Table VII-37 should be interpreted in the light of Ref. 5. In case of error, location IERR is set to 1 and control is returned to the calling program.

23. Subroutine S18. Subroutine S18 is called by subroutine STFS. The flowchart and the source program listing of S18 are given in Fig. VI-35 and Table VII-38, respectively. The objective of this subroutine is to generate the free-free stiffness matrix and the element load vector of element type 18, in locations S and P, expressed in the overall coordinate system. Only the thermal load portion of P is generated in the main program of Link 2 (see Sect. III-A). The generation of the free-free stiffness matrix is performed as described in Ref. 5. For this purpose, subroutine S18 first calls subroutine S17 to generate the membrane portion of S and P. The triple matrix products of Ref. 5 are performed by means of subroutine TRM, and properly placed in S by means of subroutine ADM. The terminology in Table VII-38 should be interpreted in the light of Ref. 5. Before returning control to the calling program, the subroutine modifies vector UV for the inclusion of thermal gradient effects. The content of COMMON location IERR is transmitted intact to the calling program for error handling.

24. Subroutine STFS. Subroutine STFS is called by the main program of Link 2. The flowchart and the source program listing of STFS are given in Fig. VI-36 and Table VII-39, respectively. The subroutine has one argument, which is the type number of the current element being processed by the calling program. The function of this subroutine is to call the proper subroutine from among S01, S02, S03, S04, S05, S07, S09, S11, S13, S15, S17, and S18 to suit the type number in the argument. The functions of these subroutines are to generate the free-free stiffness matrix, and partially generate the element load vector, in locations S and P, expressed in the overall coordinate system. There is no error return in the subroutine.

25. Subroutine STRA. Subroutine STRA is called by subroutines S02, S03, S04, S11, and S13. The flowchart and the source program listing of STRA are given in Fig. VI-37 and Table VII-40, respectively. The objective of this subroutine is to generate in S the description of the free-free stiffness matrix, in overall coordinates, from the description in local coordinates in S, and the directions cosines of local axes in DIR(3,3). The subroutine assumes that S is an IDS × IDS matrix. By calling subroutine TRAN, IDS times, subroutine STRA first obtains and places the description of each of the IDS vectors of S, in overall coordinates, in the same S locations. Then it generates in S the transpose of IDS × IDS free-free stiffness matrix. Finally, by calling subroutine TRAN, again IDS times, subroutine STRS obtains and places the description of each of the IDS vectors of the transposed matrix, in overall coordinates, in the same S locations. The final matrix is the description of the free-free stiffness matrix in the overall coordinate system. There is no error return in the subroutine, and all arguments are implicit.

26. Subroutine TICK. Subroutine TICK is called by the main program of Link 2. It is identical with subroutine TICK of Link 1. For further information, see Sect. II-B-13. The source program listing of this program is given in Table VII-41.

27. Subroutine TOPO. Subroutine TOPO is called by the main program of Link 2. The flowchart and the source program listing of TOPO are given in Fig. VI-38 and Table VII-42, respectively. The objective of this subroutine is to extract and analyze the descriptive words of the element being currently processed by the main program of Link 2. The subroutine is identical with subroutine TOPO of Link 1 up to the statement whose number is 1450 (see Fig. VI-38). As a result of the analysis of the descriptive words, the vertex labels and the property type numbers of the element are obtained in N block and in locations IELT, IMET, JPRS, ITIC, ITEM, JSDY, JSDZ, JMMX, JMMY, JMMZ, JMFI, JARE, respectively. In case of error, the subroutine returns control to the calling program.

28. Subroutine TRAN. Subroutine TRAN is called by subroutines S03, S04, S11, S13, and STRA. The flowchart and the source program listing of TRAN are given in Fig. VI-39 and Table VII-43, respectively. The subroutine has two explicit arguments. The objective of this subroutine is to generate the description of a vector of order (IGEM+1)*IMS*3 in the overall coordinates from the description of the vector in the local coordinates, and DIR(3,3) (the directions cosines of local axes). The description of the vector in the local coordinate system is in the array indicated by the first argument, just after the entry indicated by the second argument. The subroutine first computes the description of the vector in the overall system in DUM block, and then carries it on the local description. There is no error return in the subroutine.

29. Subroutine TRIM. Subroutine TRIM is called by subroutines S05, S07, and S15. The flowchart and the source program listing of TRIM are given in Fig. VI-40 and Table VII-44, respectively. The objective of this subroutine is to obtain in blocks EM, EN, and EQ the matrices $[M]$, $[N]$, and $[L]$ of Ref. 2 from the information in XD and YD. There is no error return in the subroutine.

30. Subroutine TRM. Subroutine TRM is called by subroutines S05, S07, S09, S15, S17, and S18. The flowchart and the source program listing of TRM are given in Fig. VI-41 and Table VII-45, respectively. The objective of the subroutine is to perform triple matrix products of the type $[B]^T[A][B]$ or $[C^T][A][B]$ where $[A]$ is always a symmetric matrix of order 3 or less, and $[B]$ and $[C]$ matrices of order (3×4) or less. The subroutine has five arguments. If the last argument is negative, $[C^T][A][B]$ is performed; if the last argument is positive, $[B]^T[A][B]$ is performed. The order of the symmetric matrix $[A]$ is given by the fourth argument. The absolute value of the last argument is the column order of $[C]$ or $[B]$. The matrices $[A]$, $[B]$, and $[C]$ are indicated by the first, second, and third arguments, respectively. The subroutine returns control to the calling program by placing the triple product into the array indicated by the third argument. There is no error return in the subroutine.

IV. Main Program and Subroutines of Link 3

A. Main Program of Link 3

The flowchart and the source program listing of the main program of Link 3 are given in Fig. VI-42 and Table VII-46, respectively. The logical function of the program may be summarized as follows:

(1) The program generates and stores the upper decomposed stiffness matrix in the IST-pointer-related vector, and the unknown deflections in the IDEF-pointer-related vector.

(2) Possibly destroying some portions of the decomposed stiffness matrix, the program generates in BB array the complete list of nodal deflections, and carries them onto the IDEF-pointer-related vector.

(3) If execution of the stress link is requested, i.e., if INX = 4, the program computes into the IST-pointer-related vector the forces acting on mesh points (see Output Item 20, Sect. VI-D, Vol. I).

(4) If INX = 4, the program generates in the IST-pointer-related vector the list of labels of the elements meeting at the mesh points, immediately after the residual forces computed in (3), and saves this list on tape ITAS for use in Link 4.

(5) Depending upon the values of INX and ITAS, the main program transfers the control either to Link 4 or to Link 1, as the logically last operation.

In carrying out function (1), the program calls subroutine VELAS, which requires as arguments the number of equations in the system, the pointer of the list of pointers of the diagonal elements of the coefficient matrix, the pointer of the coefficient matrix, and the pointer of the right-hand-side vector. The successful solution of linear equations is indicated by the zero content of the second argument. Function (2) is carried out with the help of the information in IBO-, IBB- and IIC-pointer-related arrays and within the framework of Table III-1, Vol. I. The program produces Output Item 19 from BB block, and calls subroutine PUNC for other modes of output (see Sect. V-F, Vol. I). Then, the information in BB block is carried out to the IDEF-pointer-related vector for use in Link 4. To carry out function (3), the program calls subroutine RESI, and to produce Output Item 20, it calls subroutine RESW. Function (4) is carried out by means of subroutine ELST. The main program, in measuring the elapsed time in executing Link 3, and solving the linear equations, calls subroutine TICK. Output Items 18, 19, and 21 are directly produced by the main program.

B. Subroutines of Link 3

1. Subroutine ELST. Subroutine ELST is called by the main program of Link 3. The flowchart and the source program listing of ELST are given in Fig. VI-43 and Table VII-47, respectively. The function of the subroutine is to generate, for each node, information listing the labels of the non-one-dimensional elements meeting at a node. This information is listed as a one-dimensional array starting immediately after the residual forces produced by subroutine RESI (between points E and E′ in Fig. III-1, Vol. II, basic). For this purpose, 13 words are assigned for every mesh point. The first word contains the number of non-one-dimensional elements meeting at the mesh point, and the remaining words the labels of these elements. Whenever there are more than 12 non-one-dimensional elements meeting at the mesh point, subroutine ELST returns control to the calling program by setting ITAS to zero, thus preventing the execution of Link 4 even if INX = 4. When the number of non-one-dimensional elements meeting at a mesh point and their labels are obtained successfully, the subroutine generates one logical record on tape ITAS for each mesh point to contain such information, and thus releases the corresponding core area. These records are listed after the elemental matrices, and are ordered with the labels of the mesh points. The subroutine also counts the one-dimensional elements and saves the total in COMMON location IONE. If a mesh point does not have any non-one-dimensional elements, the respective record in tape ITAS contains the label of this mesh point and two negative integers. The subroutine, before returning control to the calling program, positions the tape to the nodal set information of the first mesh point by means of IN number of BACKSPACE commands.

2. Subroutine PUNC. Subroutine PUNC is called by the main program of Link 3. The standard ELAS contains only the dummy version of this subroutine, as shown in Table VII-48. If the user wishes to produce Output Item 19 in different media and format, he may do so by writing his version of this subroutine, as explained in Sect. V-F, Vol. I. The logical function of this subroutine is to copy deflections from BB block to the desired output media with the desired format.

3. Subroutine RESI. Subroutine RESI is called by the main program of Link 3. The flowchart and the source program listing of RESI are given in Fig. VI-44 and Table VII-49, respectively. The function of this subroutine is to generate the forces acting at the mesh points, in the overall coordinate system, in the IST-pointer-related vector. Such forces consist of nonthermal element forces less the elastic forces (element stiffness matrix times the vertex deflections). In the absence of thermal loading, these forces represent the round-off errors at a nonboundary point, and the reaction force at a boundary point where the deflections are prescribed, or prescribed concentrated loads where the deflections are not prescribed. In this context, these forces are labelled as the residual forces. The residual forces are used in Link 4 to compute average stresses at the boundary points. To compute the residual forces, subroutine RESI clears the first IND words of the IST-pointer-related vector, and considers that the residual forces are to be listed as in Table III-3 with increasing mesh-point labels and conforming with Table III-1, Vol. I (i.e., the residual forces of the first mesh point are to be listed first, the residual forces of the second mesh point are to be listed second, etc.). Since tape ITAS is already positioned by the main program of Link 2 for this purpose, the subroutine reads in sequentially the element matrices (the stiffness matrix and the load vector without thermal load contribution) one at a time, and performs the operation of "element load vector less element stiffness matrix times vertex deflections," and assembles the resulting vector onto the vector of residual forces. In the case of subelements, the scaling factors discussed in Section III-A are properly considered. If an error is detected during the tape handling, the subroutine sets the contents of ITAS to zero and returns control to the calling program, thus preventing the execution of Link 4 even if INX = 4. The residual forces are kept intact in the core until the execution of Link 4 is completed.

4. Subroutine RESW. Subroutine RESW is called by the main program of Link 3, if INP $\neq$ 0. The flowchart and the source program listing of RESW are given in Fig. VI-45 and Table VII-50, respectively. The purpose of this subroutine is to produce Output Item 20. This is achieved by looping on mesh points. At every loop cycle, the subroutine first abstracts the residual force of the respective mesh point from the list of residual forces in the IST-pointer-related vector, and arranges the components to a complete six-component vector in accordance with Table III-1, Vol. I, and finally prints a line for these components. The ordering of the residual forces is explained in Table III-3, Vol. II (basic). In arranging the components of a mesh point, the subroutine uses the constant IELT, which is generated by the main program of Link 3 for Output Item 19 (the ordering of Output Items 19 and 20 is similar). There is no error return in the subroutine.

5. Subroutine TICK. Subroutine TICK is called by the main program of Link 3. It is identical with subroutine TICK of Link 1. For further information see Section II-B-13. The source program listing of this program is given in Table VII-51.

6. Subroutine VELAS. Subroutine VELAS is called by the main program of Link 3. The flowchart and the source program listing of VELAS are given in Fig. VI-46 and Table VII-52, respectively. The purpose of this subroutine is to solve linear equations with positive-definite, symmetric, and variable-banded coefficient matrices. The subroutine has four explicit and no implicit arguments. The first argument is the order of the linear system (i.e., the number of equations); at entry to the program, the second argument contains the pointer of the vector listing the pointers of the diagonal elements of the coefficient matrix; the third argument is the pointer of the coefficient matrix; the fourth argument is the pointer of the right-hand-side vector. Subroutine VELAS assumes that the arrays related with the last three arguments are all in COMMON. By applying the Cholesky scheme, the subroutine first obtains the decomposed matrix (referred to in Fig. VI-46 as U(I,J)) on the coefficient matrix (referred to in Fig. VI-46 as A(I,J)); then by a forward sweep it obtains the auxiliary solution (referred to in Fig. VI-46 as Y(I)) in the right-hand-side vector (referred to in Fig. VI-46 as B(I)); and finally, by a backward sweep, it obtains the solution vector (referred to in Fig. VI-46 as X(I)) in the right-hand-side vector (referred to in Fig. VI-46 as B(I)). During decomposition, if the quantity under the radical sign is nonpositive, the subroutine returns control to the calling program by setting the location of the associated diagonal element relative to the beginning of the coefficient matrix in the second argument. If the first argument is nonpositive, the return is made by setting the second argument to -1. The subroutine assumes that a quantity is positive if it is larger than the 10^{-16} multiple of the smallest diagonal element (in magnitude) of the coefficient matrix. During decomposition, the subroutine uses NN locations immediately after the array related with the third argument to store the number of matrix elements in the columns of coefficient matrix within the shaded area shown in Fig. II-1, Vol. I. Here NN is the order of the system. The subroutine assumes that the coefficient matrix is arranged as described in Table III-3 under IST-pointer-related vector.

V. Main Program and Subroutines of Link 4

A. Main Program of Link 4

The flowchart and the source program listing of the main program of Link 4 are given in Fig. VI-47 and Table VII-53, respectively. The logical functions of the program may be summarized as follows:

(1) For line elements, by means of subroutine DIMI, the program computes stress resultants at the end points of the elements and prints out Output Item 24.

(2) For non-one-dimensional elements, it computes, with the method described in Sect. II, Vol. II (basic), the stresses at the mesh points and prints out Output Item 22, by means of Link 4 programs other than DIMI.

(3) It transfers control to the main program of Link 1 as the logically last operation.

By checking the contents of IONE (see Sect. IV-B-1), the main program performs either function (1) or (2) or both.

If function (2) is to be performed, the program checks whether the starting point of vector FF (see Tables III-4 and III-5, Vol. II, basic) and point E (see Fig. III-1, Vol. II, basic) are overlapping. If overlapping occurs, Error Message 23 is produced and no stress computation is done. Otherwise the main program loops on mesh points with the objective of computing stresses at a mesh point for each material group and for each class group (see Output Item 22 in Sect. VI-E, Vol. I). When the loop on mesh points is satisfied, if there are line elements in the structure, the main program calls subroutine DIMI for function (1). During the performance of function (2), the program calls subroutines ABEQ, BOFI, CAS4, DINA, FINDQ, FINDX, GENE, INLZ, LEST, MDIN, META, SAME, SETA, and STRS. The program calls subroutine TICK to measure the time spent in Link 4. The main program is directly responsible for the production of Output Items 22 and 25.

B. Subroutines of Link 4

1. Subroutine ABEQ. Subroutine ABEQ is called by the main program of Link 4, if the current mesh point ICN is on the boundary of a two- or three-dimensional continuum. The flowchart and the source program listing of ABEQ are given in Fig. VI-48 and Table VII-54, respectively. The objective of this subroutine is to generate the first IEQ rows of the augmented matrix A (see Table III-5, Vol. II, basic), the corresponding weights in vector IWG, and the actual values of the prescribed stresses in vector SR. The first IEQ rows of the augmented matrix A correspond to the IEQ number of stress boundary conditions at the boundary point ICN. These equations are generated as discussed in Sect. II, Vol. II (basic). The subroutine first copies the residual vector (see Sect. IV-B-3) of mesh point ICN into RES vector. Then, depending upon the class type of current IC*th* group, it computes certain parameters listed in Table V-1. The program carries two right-hand-side vectors for class 6 and 8 structures in the strain deflection equations, because of the symmetry in strains and curvature changes (see Ref. 2). This is very useful in minimizing the column order of the strain deflection equations.

In Table V-1, the parameters used by the subroutine are defined. The meanings of these parameters are as follows: IEQ is the number of the stress boundary equations (note that the number of stress boundary conditions is the product of IEQ*IRIG); IRIG is the number of right-hand sides in the strain deflection equations; ICOL is the column order of the coefficient matrix of strain deflection equations; vector N lists the component number (see Table VI-6, Vol. I) of the prescribed stress (as stated in Sect. VI-E, Vol. I, the local coordinate axes on a boundary point are such that the first axis is the outer normal of the boundary surface, and the second and the third axes are tangential to the boundary surface; the stress boundary conditions are expressed in the local coordinate system); IREB and IREN are the entry numbers of the beginning and the end, respectively, of the portion of vector RES to be used in generating the prescribed stress values for the right-hand sides of the stress boundary condition equations. Because of the ordering of the residual forces (first, force components, and then moment components) for the second right-hand side, the program takes IREB and IREN as IREB + 1 and IDEG, respectively. The first and second columns of matrix NEK list the labels of the local axes to be used in projecting the portion of vector RES for obtaining the prescribed stress components, for the first and second right-hand sides, respectively. Matrix REK, like matrix NEK, indicates whether any sign change is to be performed for the correct sign of the prescribed stress. Scale factors CR and CL are used in scaling a stress boundary condition equation to achieve similar orders of magnitude in the whole set strain deflection equations; CR is for the right-hand side, CL for the left-hand side. The basic format of a stress boundary condition equation is shown in Table V-1. To obtain the components of the best-fit strain tensor from the strain deflection equations in a manner that satisfies the stress boundary conditions more correctly than the remaining equations, the subroutine assigns the stress boundary equations a weight of 100 in the corresponding entries of vector IWG. The subroutine also updates the equation count ICON, and saves the prescribed stress values in vector SR in the order shown in Table V-2. There is no error return in the subroutine.

2. ***Subroutine AGEL.*** Subroutine AGEL is called by subroutine DINA if the IPIR field of the control card (see Table IV-2, Vol. I) is 2. The standard ELAS contains only the dummy version of this subroutine, as shown in Table VII-55. If the user wishes to prescribe local coordinate systems at the mesh points of shell structures, he may do so by writing his version of this subroutine, as explained in Sect. V-E, Vol. I. The logical function of this subroutine is to define matrix DIN for the direction cosines of the local axes of mesh point ICN.

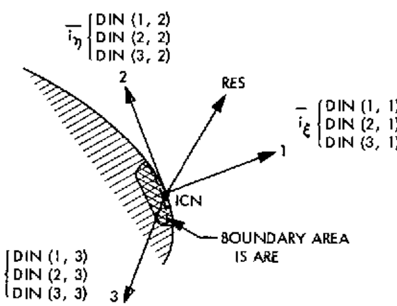
3. ***Subroutine BEST.*** Subroutine BEST is called by subroutines BOFI and QUAD. The flowchart and the source program listing of BEST are given in Fig. VI-49 and Table VII-56, respectively. The objective of this subroutine is to obtain the direction cosines of the normal of the best-fit plane (in the least squares sense) related with the mesh points listed in the array referenced by the second argument and mesh point ICN. The number of mesh points listed in the second argument is given by the third argument. The subroutine places the direction cosines of the normal into the array indicated by the first argument. One condition equation is generated for each mesh point listed in the array referenced by the second argument to express the situation for that point to be in the sought-for plane. The mesh-point coordinates are obtained by means of subroutine FINDX. The equation of the plane is arbitrarily expressed in a coordinate system that is parallel to the overall, but located at a point with coordinates 1.15, 1.16, and 1.17 less than those of mesh point ICN. Once the condition equations are established, the coefficients of variables (i.e., quantities proportional to the direction cosines of the normal) are solved by least squares, by first premultiplying both sides of the condition equations by the transpose of the coefficient matrix, and then solving the resulting equations by means of subroutine INV. If the inversion fails in subroutine INV, subroutine BEST attempts to approximate the direction cosines of the normal, as explained in block 45 of Fig. VI-49. This latter process necessitates a vector product, which is carried out by means of subroutine VECT.

Table V-1. Values of important parameters used in subroutine ABEQ for various classes (see Sect. V-B-1 for discussion)

Class No.	IEQ	N(1)	N(2)	N(3)	IREB	IREN	IRIG, (NES(2))	NEK(I,1)	NEK(I,2)	REK(I,1)	REK(I,2)	ICOL, (NES(1))	CR	CL	IDR, (NES(3))
1	2	1	3		1	2	1	$\begin{Bmatrix}1\\2\end{Bmatrix}$		$\begin{Bmatrix}1.\\1.\end{Bmatrix}$		3	$\frac{ARE}{TE*DD_{1,1}}$	$\frac{ARE^3}{DD_{1,1}}$	0
2	2	1	3		2	3	1	$\begin{Bmatrix}2\\1\end{Bmatrix}$		$\begin{Bmatrix}1.\\-1.\end{Bmatrix}$		3	$\frac{-TE^2*ARE}{12*DD_{1,1}}$	$\frac{ARE^2}{DD_{1,1}}$	1
3	2	1	3		1	2	1	$\begin{Bmatrix}1\\2\end{Bmatrix}$		$\begin{Bmatrix}1.\\1.\end{Bmatrix}$		3	$\frac{ARE}{XX*DD_{1,1}}$	$\frac{ARE^2}{DD_{1,1}}$	0
4	3	1	3	5	1	3	1	$\begin{Bmatrix}1\\2\\3\end{Bmatrix}$		$\begin{Bmatrix}1.\\1.\\1.\end{Bmatrix}$		6	$\frac{1}{DD_{1,1}}$	$\frac{ARE}{DD_{1,1}}$	0
5	1	1			1	2	1	$\begin{Bmatrix}1\\2\end{Bmatrix}$		$\begin{Bmatrix}1.\\1.\end{Bmatrix}$		1	$\frac{ARE^2}{XX*DD_{1,1}}$	$\frac{ARE^3}{DD_{1,1}}$	0
6	1	1			1	2	2	$\begin{Bmatrix}1\\2\end{Bmatrix}$	$\{2\}$	$\begin{Bmatrix}1.\\1.\end{Bmatrix}$	$\{1.\}$	3	$\frac{ARE^2}{XX*DD_{1,1}}$	$\frac{ARE^2}{DD_{1,1}}$	0
7	2	1	3		1	3	1	$\begin{Bmatrix}1\\2\end{Bmatrix}$		$\begin{Bmatrix}1.\\1.\end{Bmatrix}$		3	$\frac{ARE}{DD_{1,1}}$	$\frac{ARE^2}{DD_{1,1}}$	0
8	2	1	3		1	3	2	$\begin{Bmatrix}1\\2\end{Bmatrix}$	$\begin{Bmatrix}2\\1\end{Bmatrix}$	$\begin{Bmatrix}1.\\1.\end{Bmatrix}$	$\begin{Bmatrix}1.\\-1.\end{Bmatrix}$	3	$\frac{ARE}{DD_{1,1}}$	$\frac{ARE^2}{DD_{1,1}}$	0

$$\begin{bmatrix}100000\\001000\\000010\end{bmatrix}\begin{Bmatrix}\sigma_{\xi\xi}\\\sigma_{\eta\eta}\\\tau_{\xi\eta}\\\sigma_{\zeta\zeta}\\\tau_{\xi\zeta}\\\tau_{\eta\zeta}\end{Bmatrix} = \frac{1}{ARE}\begin{Bmatrix}\overline{R}\cdot\overline{i}_{\xi}\\\overline{R}\cdot\overline{i}_{\eta}\\\overline{R}\cdot\overline{i}_{\zeta}\end{Bmatrix}$$

$$(CL)\,[b]\,\overline{[DD]\,\{\epsilon\}} = \{R\}\,(CR)$$



If IRIG = 2 $\begin{cases} IREB = IREN_{previous} + 1 \\ IREN = IDEG \end{cases}$

In shells of revolution ARE = element length

XX = XN(1) (if XN(1) = 0, XX = 1.)

Table V-2. Arrangement of prescribed boundary forces by subroutine ABEQ in SR vector for the eight class[a] types

SR \ Class	1	2	3	4	5	6	7	8
SR(1)	σ_{ξ}	M_{ξ}	σ_{ξ}	σ_{ξ}	N_{ξ}	N_{ξ}	N_{ξ}	N_{ξ}
SR(2)	$\tau_{\xi\eta}$	$M_{\xi\eta}$	$\tau_{\xi\eta}$	$\tau_{\xi\eta}$		M_{ξ}	$N_{\xi\eta}$	$N_{\xi\eta}$
SR(3)				$\tau_{\xi\zeta}$				M_{ξ}
SR(4)								$M_{\xi\eta}$

[a]See Table VI-6, Vol. I.

Before returning control to the calling program, subroutine BEST calls subroutine UNIT to normalize the vector in the first argument. There is no error return in the subroutine.

4. Subroutine BOFI. Subroutine BOFI is called by the main program of Link 4. The flowchart and the source program of BOFI are given in Fig. VI-50 and Table VII-57, respectively. The objective of this subroutine is to determine from the element set information in NEL whether mesh point ICN is on the boundary. If mesh point ICN is not on the boundary, the subroutine returns control to the calling program without any action. However, if mesh point ICN is found to be on the boundary, the subroutine sets INBON = 1 and AST = 1H*, and computes the direction cosines of the outer normal of the boundary at mesh point ICN into vector BIR. To obtain the direction cosines, subroutine BOFI calls subroutine INER to obtain a general vector heading towards the structure, and calls subroutine BEST to obtain the direction cosines of the best-fit plane to boundary nodes neighboring mesh point ICN. After redirecting the normal of the plane with the general vector heading towards the structure, the normal of the best-fit plane is assumed to be the outer normal of the structure at the boundary node. If any trouble arises in finding the outer normal, subroutine BOFI will assume that mesh point ICN is an internal one. The subroutine also generates in ARE an average boundary surface area if mesh point ICN is on the boundary. The number of repeated interelement boundaries in the element set and the number of unrepeated element boundaries are used in determining whether mesh point ICN is on the boundary. In performing its function, BOFI also calls subroutines FINDX, SCAL, and UNIT. There is no error return in the subroutine.

5. Subroutine CAS4. Subroutine CAS4 is called by the main program of Link 4. The standard ELAS contains only the dummy version of this subroutine, as shown in Table VII-58. If Output Item 23 is to be produced selectively, this subroutine should be rewritten by the user, as explained in Sect. V-H, Vol. I. The logical function of this subroutine is to change the value of INP as desired in the DO loop on mesh points in the main program of Link 4.

6. Subroutine CODI. Subroutine CODI is called by subroutine DIMI. It is identical with subroutine CODI of Link 2. For further information, see Section III-B-4. The source program listing of this subroutine is given in Table VII-59.

7. Subroutine DIMI. Subroutine DIMI is called by the main program of Link 4, if IONE is positive. The flowchart and the source program listing of DIMI are given in Fig. VI-51 and Table VII-60, respectively. The objective of this subroutine is to obtain the end forces of the one-dimensional elements in the local coordinate system and to produce Output Item 24. For this purpose, the subroutine rewinds tape ITAS and processes the mesh elements one at a time. If a one-dimensional element is encountered, by means of subroutines CODI, STRA and TRAN, the element stiffness matrix, the element load vector, and the deflection vector of the vertices are first expressed in local coordinates of the element (see Fig. VI-1, Vol. I), and then the end forces are expressed as the product of the element stiffness matrix and the vector of vertex deflections less the element load vector. If an error is encountered during the tape handling, the subroutine sets IERR = 1, ICN = the element number, and the explicit argument of the subroutine with the record number as read from the tape, and returns control to the calling program.

8. Subroutine DINA. Subroutine DINA is called by the main program of Link 4, if the current class group is of shell type (i.e., ICAS is equal to or larger than 5). The flowchart and the source program listing of DINA are given in Fig. VI-52 and Table VII-61, respectively. The objective of this subroutine is to determine the direction cosines of the axes in which the stresses are to be expressed in DIN and find the value of ANGLE associated with these axes. If the IPIR value of the control card (see Table IV-2, Vol. I) is larger than 1, subroutine DINA calls subroutine AGEL to do the job. Otherwise, subroutine DINA calls either subroutine QUAD or subroutine REVO, depending upon whether the shell is general or axisymmetrical type, respectively, to perform its function. There is no error return in the subroutine.

9. Subroutine EPAN. Subroutine EPAN is called by subroutine QUAD, if there are less than eight neighboring mesh points in the element set of mesh point ICN (subroutine QUAD is called only for the general shell case). The flowchart and the source program listing of EPAN are given in Fig. VI-53 and Table VII-62, respectively. The objective of this subroutine is to expand the vector containing the labels of the mesh points in the immediate neighborhood of the current mesh point ICN by the element set information of the mesh points in the immediate neighborhood of mesh point ICN. When control is transferred to the subroutine, vector NSET contains the labels of the immediate neighbors of mesh point ICN, and NB contains the order of this vector. By minimum tape handling, the subroutine obtains the element set information of each of these immediate neighbors from tape ITAS and expands vector NSET with the mesh-point labels of the neighbors of neighbors of mesh point ICN and updates NB correspondingly. Before it returns control to the calling program, the subroutine repositions tape ITAS to the position at the time of entry. There is no error return in the subroutine.

10. Subroutine FINDQ. Subroutine FINDQ is called by the main program of Link 4 and by subroutine SETA. The flowchart and the source program listing of FINDQ are given in Fig. VI-54 and Table VII-63, respectively. The function of this subroutine is to compute, in overall coordinates, the deflection components of the mesh point indicated by the first argument into the vector indicated by the second argument. There is no error return in this subroutine.

11. Subroutine FINDX. Subroutine FINDX is called by the main program of Link 4 and subroutines BEST, BOFI, INER, INLZ, QUAD, REVO, and SETA. The flowchart and the source program listing of FINDX are given in Fig. VI-55 and Table VII-64, respectively. The function of this subroutine is to compute the overall coordinates of the mesh point indicated by the first argument into the vector indicated by the second argument. There is no error return in the subroutine.

12. Subroutine GENE. Subroutine GENE is called by the main program of Link 4. The flowchart and the source program listing of GENE are given in Fig. VI-56 and Table VII-65, respectively. The objective of this subroutine is to generate the columns of matrix NEL, other than the first (the first column of NEL is already generated by the main program of Link 4), the corresponding matrix MAC, vector ICLAS, and variable IMEL. The format of NEL and MAC matrices is given in Table VI-7, Vol. I. Since the rows of matrix NEL contain information about the elements meeting at mesh point ICN, subroutine GENE calls subroutine TOPO to extract such information from COMMON. Matrix MAC is generated by the information in completed matrix NEL. Vector ICLAS and variable IMEL are generated as a by-product of the generation of matrix MAC. Error conditions that may be encountered during the generation of matrix MAC may cause the production of Error Messages 18, 19, and 20. There is no error return in the subroutine.

13. Subroutine INER. Subroutine INER is called by subroutine BOFI, if mesh point ICN is on the boundary. The flowchart and the source program listing of INER are given in Fig. VI-57 and Table VII-66, respectively. The objective of this subroutine is to generate the components of a vector heading towards the structure at mesh point ICN, and store them in the vector indicated by the argument. At the time of entry to the subroutine, vector NSET contains the labels of the neighboring mesh point. The subroutine simply adds the vectors, joining mesh point ICN to its neighbors to obtain the required vector. The mesh-point coordinates are obtained by means of subroutine FINDX. There is no error return in the subroutine.

14. Subroutine INLZ. Subroutine INLZ is called by the main program of Link 4. The flowchart and the source program listing of INLZ are given in Fig. VI-58 and Table VII-67, respectively. The function of this subroutine is to initialize the values of IROT, BST, DIN, W, TE, DT, DG, ICOL, IRIG, IDR, ANGLE, ICON, IERR, and BAS quantities for the stress computation corresponding to the current values of ICN/IM/IC (see Table III-4). In initializing these values, the subroutine assumes that the mesh point is an internal one and the local coordinate system is parallel to the overall coordinate system. Values of TE, DT, and DG are obtained as the arithmetical average of those of the related mesh elements. Values of IRIG, ICOL, and IDR are obtained, depending upon the class type number of the current mesh-element group (see Tables III-4, Vol. II, basic, and V-1). To perform its functions, INLZ calls subroutines FINDX and UNIT. There is no error return in the subroutine.

15. Subroutine INV. Subroutine INV is called by subroutines BEST, LEST, QUAD, and REVO of Link 4. The flowchart and the source program listing of INV are given in Fig. VI-59 and Table VII-68, respectively. The purpose of the subroutine is to solve a set of linear equations by Gauss elimination. The coefficient matrix is referred by the first argument, and the right-hand-side vectors are referred by the third argument. The second argument is the order of the system, and the fourth argument is the number of right-hand-side vectors. When the subroutine returns control to the calling program, the fifth argument contains the value of the determinant of the coefficient matrix, the first argument contains the inverse of the coefficient matrix, and the third argument contains the solution vector if the fourth argument and the determinant are nonzero. This subroutine is borrowed from the IBM 1620 library of the Jet Propulsion Laboratory as of September 1966.

*16. **Subroutine LEST.*** Subroutine LEST is called by the main program of Link 4. The flowchart and the source program listing of LEST are given in Fig. VI-60 and Table VII-69, respectively. The objective of this subroutine is to obtain the components of the best-fit strains from the strain deflection equations. At the time of entry to the subroutine, matrix A contains the augmented matrix of the strain deflection equations, ICON contains the number of equations, JMM the number of columns in the coefficient matrix, JMR the number of right-hand sides (therefore JMX = JMM + JMR is the column order of the augmented matrix), and IWG the weight assigned to each of the strain deflection equations. Considering the multiplicity of the equations as given in vector IWG, the subroutine premultiplies both sides of the strain deflection equations by the transpose of the coefficient matrix, then calls subroutine INV to obtain the best-fit strain components, and reorders the components in matrix C and redefines JMM and JMR such that the first column contains the usual strain components and the second column contains the angular strain (curvature change) components. For axisymmetrical structures, cases in which mesh point ICN is on the axis of revolution are handled separately in the subroutine by considering the thermal strains, if there are any. For shells of revolution, if mesh point ICN is on the axis, vectors DDIS, DROT, and DCOR contain the relative displacement, relative rotation, and relative coordinate of the opposite end of the nodal line with respect to mesh point ICN. These vectors are expressed in the local coordinate system of mesh point ICN. If the inversion performed by subroutine INV is not successful (indicated by zero determinant), subroutine LEST sets IERR = 1 and returns control to the calling program. If INP is 2, the best-fit strain components are printed out as part of Output Item 23.

*17. **Subroutine MDIN.*** Subroutine MDIN is called by the main program of Link 4, if mesh point ICN is on the boundary. The flowchart and the source program listing of MDIN are given in Fig. VI-61 and Table VII-70, respectively. The objective of this subroutine is to obtain the direction cosines of the local coordinate axes at mesh point ICN with the specifications described in Sect. VI-E, Volume I; i.e., the first local axis is always normal to the boundary. At the time of entry to the subroutine, matrix DIN contains the direction cosines of the local axes of mesh point ICN, assuming that the mesh point is not on boundary, and vector BIR contains the direction cosines of the outer unit normal vector of the boundary surface at mesh point ICN. In reorienting the local axes, subroutine MDIN calls subroutines UNIT and VECT. There is no error return in the subroutine.

*18. **Subroutine META.*** Subroutine META is called by the main program of Link 4. The flowchart and the source program listing of META are given in Fig. VI-62 and Table VII-71, respectively. The objective of this subroutine is to obtain the material matrix (see Fig. III-2b, Vol. I) and thermal expansion coefficients of the current element group associated with ICN/IM/IC, in DD and AL1, AL2, AL3, respectively, in the local coordinate system of mesh point ICN. If the material axes of the current group are not parallel to the local axes of mesh point ICN, subroutine META calls subroutine ROTA to express the material matrix in the local coordinate system. Before returning control to the calling program, subroutine META rearranges the rows and the columns of DD such that the material matrix is arranged with the order of 11, 22, 12, 33, 13, 23. There is no error return in the subroutine.

*19. **Subroutine QUAD.*** Subroutine QUAD is called by subroutine DINA if a general shell structure is under question. The flowchart and the source program listing of QUAD are given in Fig. VI-63 and Table VII-72, respectively. The objective of the subroutine is to generate in DIN the direction cosines of the local axes of mesh point ICN of the shell structure, and find the value of ANGLE. The subroutine first obtains in vector MSET the labels of the nodes appearing in the mesh elements corresponding to the current values of ICN/IM/IC. Then it obtains in ZD a vector in the general direction of shell normal (block 10* of Fig. VI-63). After this, the subroutine extracts from vector MSET a list of unrepeated labels in vector NSET. The order of NSET is in NB. If NB is not smaller than 9, a best-fit quadratic surface passing through mesh point ICN and its immediate neighbors may be possible. If NB is smaller than 9, subroutine QUAD calls subroutine EPAN to enlarge vector NSET and NB to include in the list the labels of the immediate neighbors of the mesh points that are already included in vector NSET, without repetition.

Next, by calling subroutine BEST, subroutine QUAD attempts to generate in vector ZTA the direction cosines of the normal of a best-fit plane (in the least squares sense) to the family of mesh points listed in vector NSET. If this fails, vector ZD is taken as vector ZTA. Then, assuming that the first local axis is in the direction of vector BAS, the subroutine generates the first approximation of matrix DIN (the first, second, and third columns of matrix DIN are referred to as vectors XII, ETA, and ZTA). If NB is not smaller than 9, subroutine QUAD generates in matrix D the condition equations for a quadratic surface passing through the mesh points listed in vector NSET. The condition equations are obtained in the first approximation of the local axes. These equations are next solved by a least squares method with the help of subroutine INV. If the solution is successful, the local normal is taken as the normal direction of this quadratic surface, and matrix DIN is corrected accordingly. With the use of the new matrix DIN, the process of locating a best-fit quadratic surface is repeated to increase the accuracy. If the process of finding a best-fit quadratic surface fails, the subroutine prints out Error Message 21 and returns control to the calling program with the first approximation of matrix DIN. Otherwise, the subroutine examines the value of IPIR. If IPIR is larger than 1, the subroutine rotates the local axes about the normal until the first local axis is in the smaller principal curvature direction of the best-fit quadratic surface. Initially zero value of ANGLE is changed to the degrees value of the angle between vector BAS and the final orientation of the first local axis. In performing its functions, QUAD also calls subroutines FINDX, SCAL, UNIT, and VECT. There is no error return in the subroutine.

20. Subroutine REVO. Subroutine REVO is called by subroutine DINA if a shell of revolution is under question. The flowchart and the source program listing of REVO are given in Fig. VI-64 and Table VII-73, respectively. The objective of this subroutine is to generate in matrix DIN the direction cosines of the local axes by fitting, if possible, a fourth-order polynomial to the meridional curve. The normal of this curve is taken as the direction for the third local axis. For this purpose, the subroutine first finds the labels of the first four immediate neighbors of mesh point ICN and places them in vector NSET. Vector NSET also contains the label of ICN. The order of NSET is NB. If for some reason NB is less than 5, the subroutine fits a polynomial curve of degree NB-1 to the meridional curve. The conditions for the mesh points listed in vector NSET on the polynomial curve are generated on matrix B and vector C. The unknown coefficients of the polynomial are obtained from these conditions by means of subroutine INV. If the system is singular, and a polynomial curve fit is not possible, the program will use the line segment joining the mesh points confining mesh point ICN as the fitted curve and cause the production of Error Message 22. The normal direction of the fitted curve is taken as the third local axis. The overall Z axis is taken as the negative of the second local axis. The first local axis is tangent to the fitted curve and heads towards the increasing arc distance on the meridian (the meridian curve is assumed directed). The first, second, and third columns of matrix DIN are named as vectors XII, ETA, and ZTA, and contain the direction cosines of the first, second, and third local axes. In obtaining the direction cosines of the local axes, subroutine REVO calls subroutines FINDX, SCAL, UNIT, and VECT.

21. Subroutine ROTA. Subroutine ROTA is called by subroutine META if the local axes are not parallel to the material axes. The flowchart and the source program listing of ROTA are given in Fig. VI-65 and Table VII-74, respectively. The objective of this subroutine is to express the material matrix DD in the local coordinate system defined by matrix DIN (see Table III-5, Vol. II, basic). There is no error return in the subroutine. In obtaining various unit vectors, subroutine ROTA calls subroutines SCAL, UNIT, and VECT.

22. Subroutine SAME. Subroutine SAME is called by the main program of Link 4. The flowchart and the source program listing of SAME are given in Fig. VI-66 and Table VII-75, respectively. The objective of this subroutine is to output stresses for the current ICN/IC/IM group, in the local coordinate system if mesh point ICN is a boundary point, and the group is not of shell type. Therefore, this subroutine produces the last portion of Output Item 22. There is no error return in the subroutine.

23. Function SCAL. Function SCAL is called by subroutines BOFI, QUAD, REVO, ROTA, and SETA of Link 4. The flowchart and the source program listing of SCAL are given in Fig. VI-67 and Table VII-76, respectively. The objective of the program is to return to the calling program the scalar product of the vectors referred by the first and second arguments. There is no error return.

24. Subroutine SETA. Subroutine SETA is called by the main program of Link 4 once for every mesh element in the group of current ICN/IM/IC. The flowchart and the source program listing of SETA are given in Fig. VI-68 and Table VII-77, respectively. The objective of the program is to add one additional row to the augmented matrix of strain deflection equations for each direction joining mesh point ICN to the remaining vertices of the mesh element. The subroutine assigns a weight of 10 or 1 to the equation of a direction, depending upon whether the vertex is on the boundary or not. The weights are recorded in vector IWG. The subroutine generates the row of the augmented matrix as described in Sect. II, Vol. II (basic), by considering thermal strains. When a row is added to the augmented matrix, row count ICON is also updated. In obtaining the thermal strain per unit temperature in a given direction, subroutine SETA calls subroutine TEMP. In achieving various vector operations, it also calls function SCAL, and subroutines FINDQ, FINDX, UNIT, and VECT of Link 4. There is no error return in the program.

*25. **Subroutine STRA.*** Subroutine STRA is called by subroutine DIMI. It is identical with subroutine STRA of Link 2. For further information, see Sect. III-B-25. The source program listing of this subroutine is given in Table VII-78. In performing its function, STRA calls subroutine TRAN.

*26. **Subroutine STRS.*** Subroutine STRS is called by the main program of Link 4. The flowchart and the source program listing of STRS are given in Fig. VI-69 and Table VII-79, respectively. The objective of this subroutine is to obtain the components of the best-fit stress tensor for current ICN/IM/IC, and list them in vector SR to comply with Table VI-6, Vol. I. At the time of entry to the subroutine, matrix DD contains the material constants, matrix C contains the components of the best-fit usual and angular strains in the first and second columns, respectively, and SR contains the prescribed stresses in the order shown in Table V-2. The subroutine first generates in vector RED the best-fit stresses, then modifies them with the prescribed stresses in SR, and finally copies the final set into vector SR in the order shown in Table VI-6, Vol. I. There is no error return in the subroutine.

*27. **Subroutine TEMP.*** Subroutine TEMP is called by subroutine SETA if temperature loading of an anisotropic material is under question. The flowchart and the source program listing of TEMP are given in Fig. VI-70 and Table VII-80, respectively. The objective of this subroutine is to obtain the lineal strain in the direction given by the unit vector in XF (see the comment in Table VII-80) due to unit temperature increase, and to store this quantity in the explicit argument. To do this, the subroutine uses matrix W generated by subroutine ROTA and XF generated by subroutine SETA as DCAR. There is no error return in the subroutine.

*28. **Subroutine TICK.*** Subroutine TICK is called by the main program of Link 4. It is identical with subroutine TICK of Link 1. For further information, see Sect. II-B-13. The source program listing of this program is given in Table VII-81.

*29. **Subroutine TOPO.*** Subroutine TOPO is called by subroutine GENE. It is identical with subroutine TOPO of Link 2. For further information, see Sect. III-B-27. The source program listing of this program is given in Table VII-82.

*30. **Subroutine TRAN.*** Subroutine TRAN is called by subroutines DIMI and STRA of Link 4. It is identical with subroutine TRAN of Link 2. For further information, see Sect. III-B-28. The source program listing of the program is given in Table VII-83.

*31. **Subroutine UNIT.*** Subroutine UNIT is called by subroutines BEST, BOFI, INLZ, MDIN, QUAD, REVO, ROTA, and SETA of Link 4. The flowchart and the source program listing of UNIT are given in Fig. VI-71 and Table VII-84, respectively. The objective of the subroutine depends upon the contents of the second argument. If the second argument is zero, the subroutine computes the magnitude squared of the vector indicated by the first argument and returns control to the calling program. If the second argument is nonzero, the subroutine replaces the vector in the first argument with a unit vector and the second argument with the magnitude of the original vector. If the second argument, at the beginning, is a positive number, the unit vector is parallel and in the same direction as the original vector. If the second argument, at the beginning, is a negative number, the unit vector is parallel and in the opposite direction of the original vector. There is no error return in the subroutine.

*32. **Subroutine VECT.*** Subroutine VECT is called by subroutines BEST, MDIN, QUAD, REVO, ROTA, and SETA of Link 4. The flowchart and the source program listing of VECT are given in Fig. VI-72 and Table VII-85, respectively. The objective of this subroutine is to obtain in the vector indicated by the first argument the cross-product of the vector in the second argument times the vector in the third argument. There is no error return in the subroutine.

VI. Semidetailed Flowcharts

This section contains semidetailed flowcharts of ELAS/Level 3. The flowchart of each program element is treated separately, and given a figure number. The flowcharts are arranged alphabetically by the subroutine names, under the main program of each link. The meanings of the symbols used in the flowcharts may be obtained from the text description of the corresponding subroutine given in the preceding sections and/or Tables III-2 and III-4 of Vol. II (basic). Each flowchart should be considered together with the corresponding source program listing in Sect. VII, and the descriptive paragraph of the earlier sections. The number attached to a block in a flowchart is the number of the first statement in the source program listing corresponding to this block. If the first statement does not have a statement number, the nearest statement number is used with an asterisk in the block. An asterisk before the number in the block means that the first statement of the block is before the statement indicated by the block number. An asterisk after the number in the block means that the first statement of the block is after the statement indicated by the block number. Multiple asterisks indicate qualitatively the distance between the statement with the number and the first statement of the block in the source program listing.

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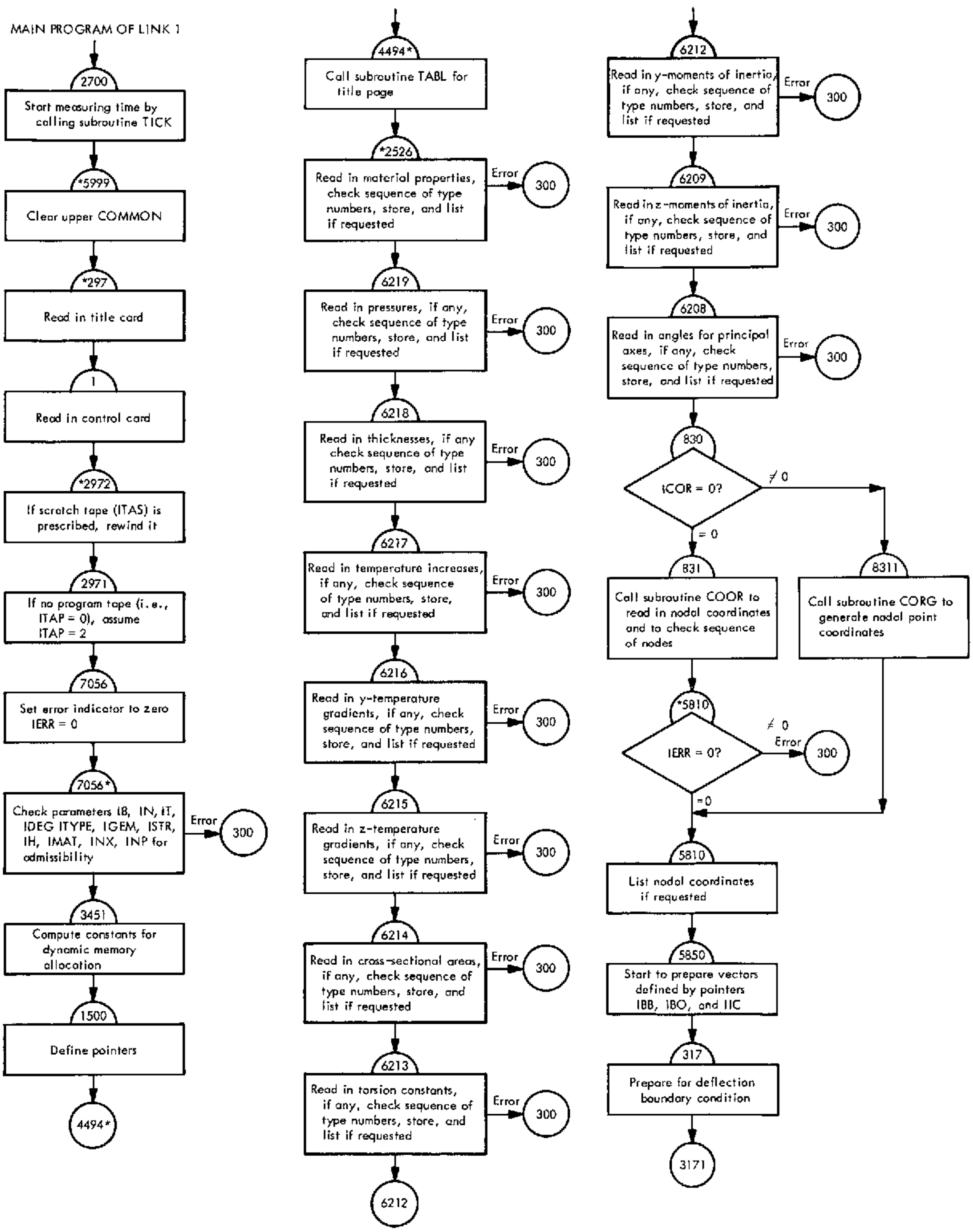

Fig. VI-1. Flowchart of main program of Link 1 (input link)

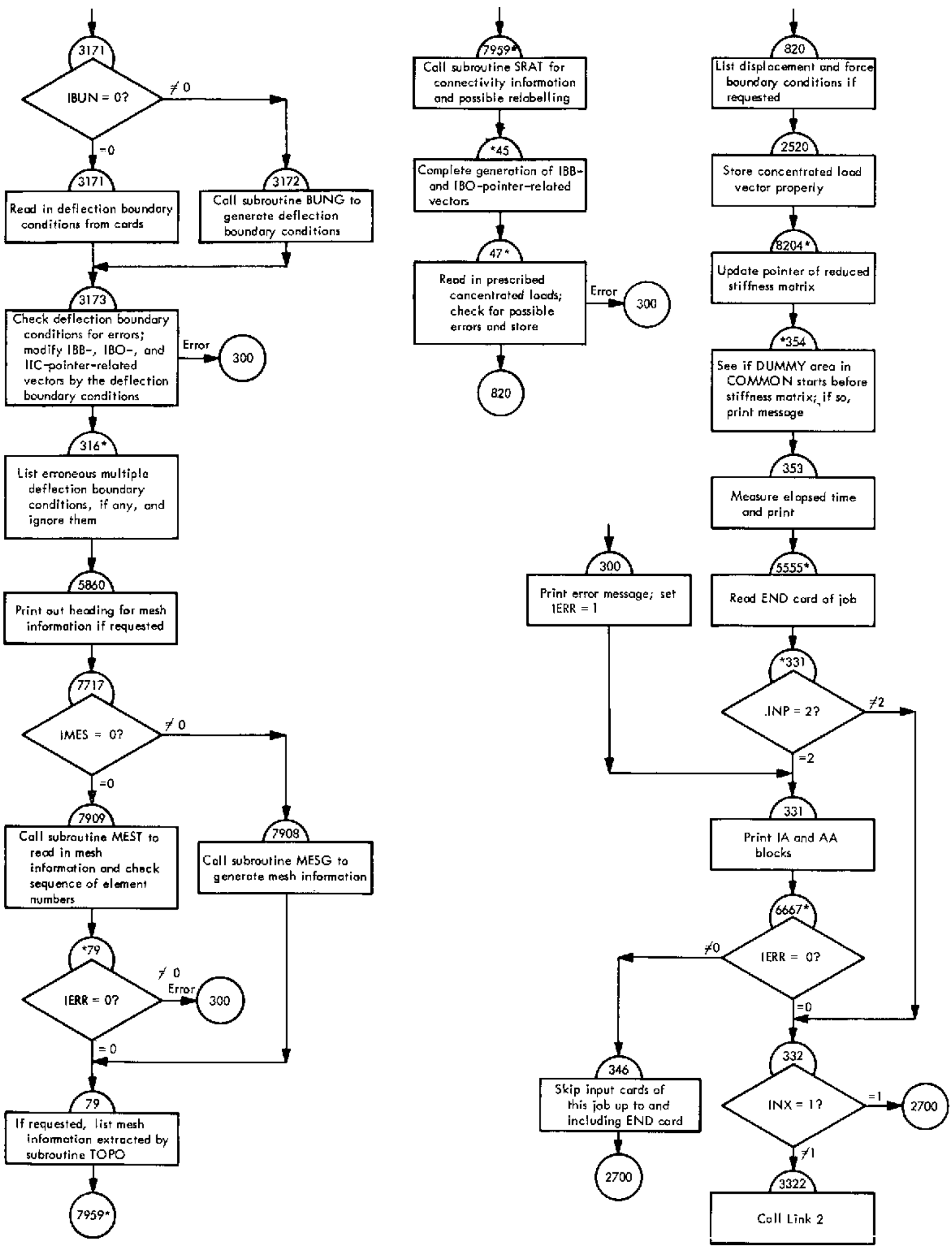

Fig. VI-1 (contd)

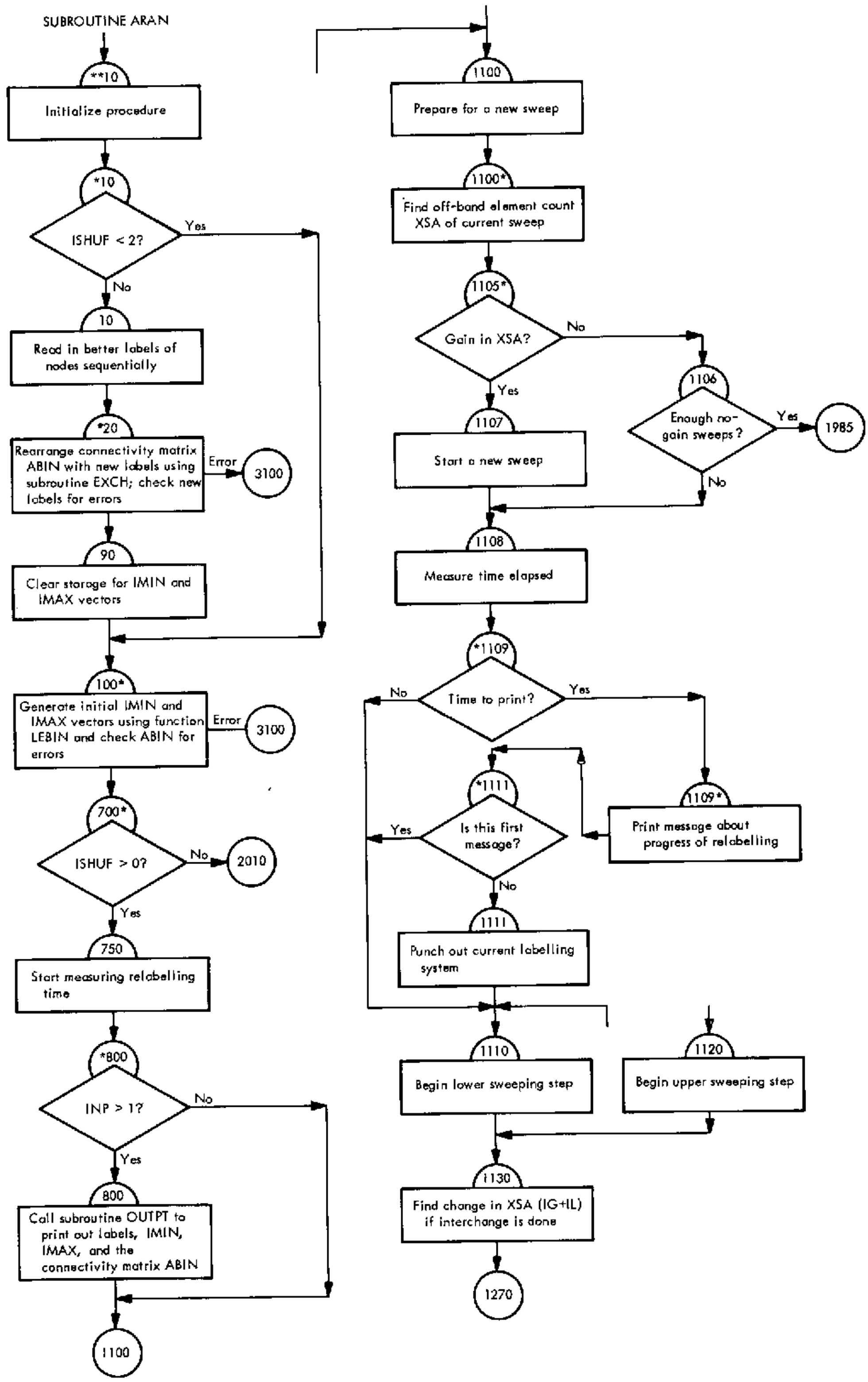

Fig. VI-2. Flowchart of subroutine ARAN (Link 1)

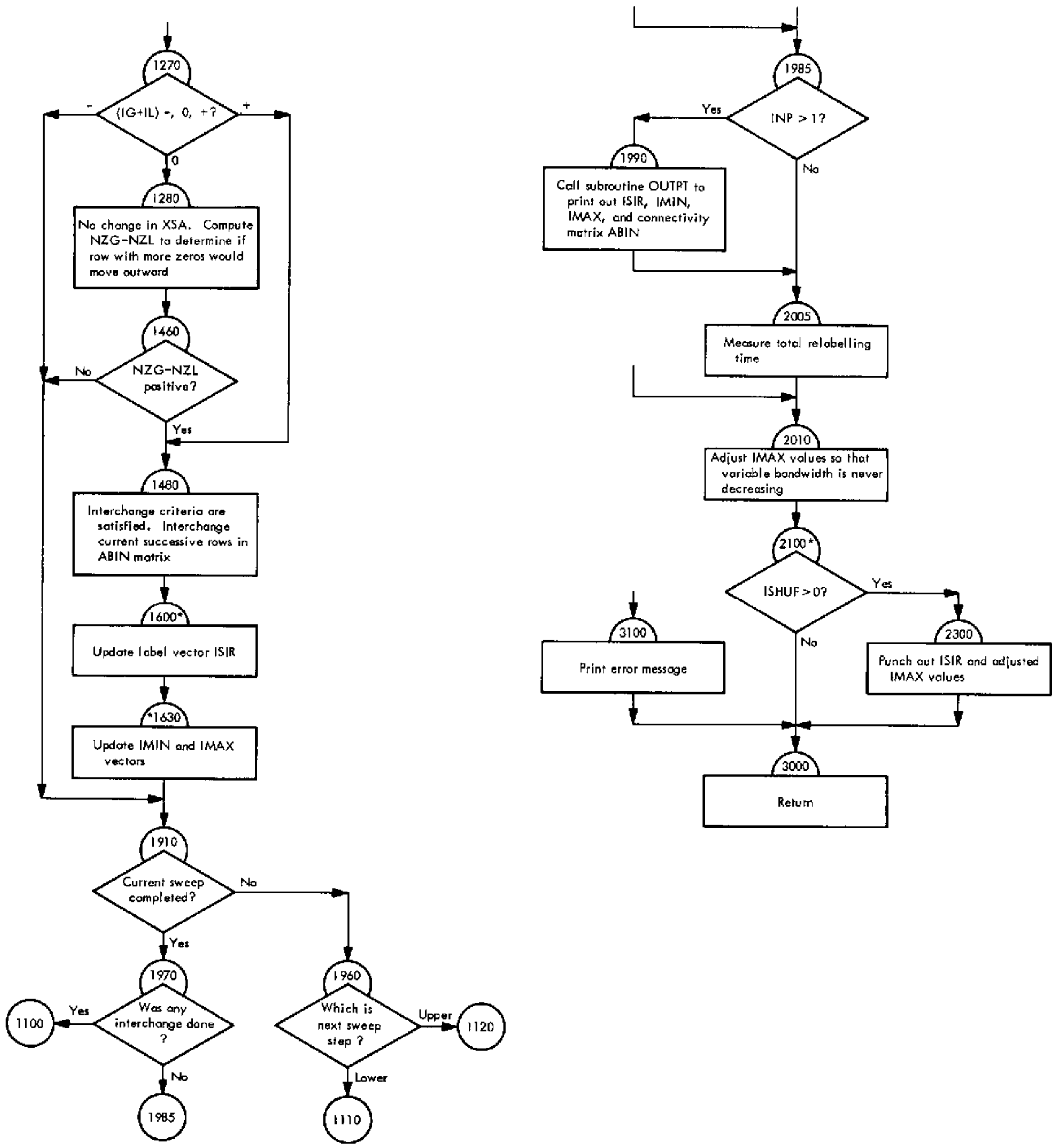

Fig. VI-2 (contd)

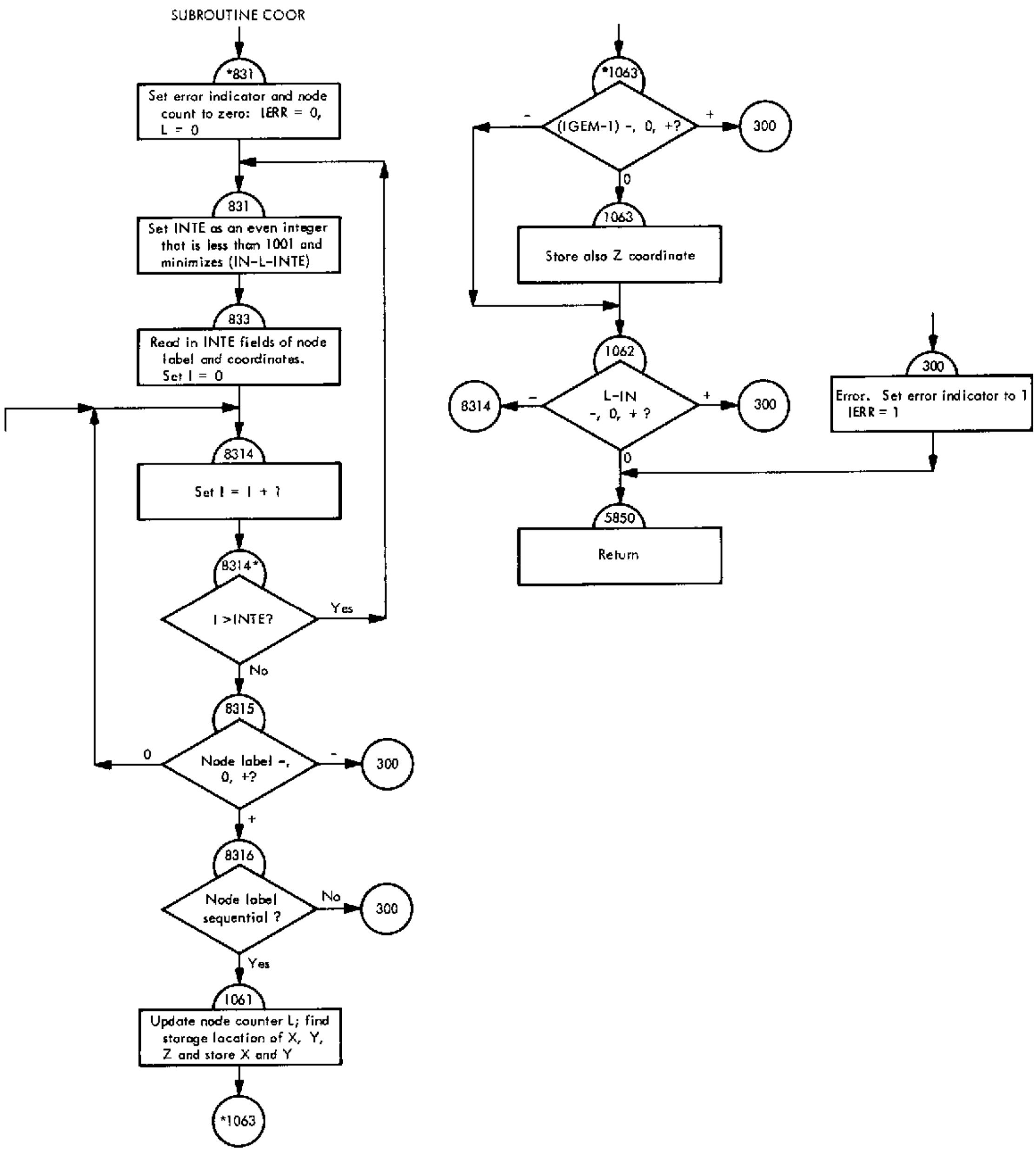

Fig. VI-3. Flowchart of subroutine COOR (Link 1)

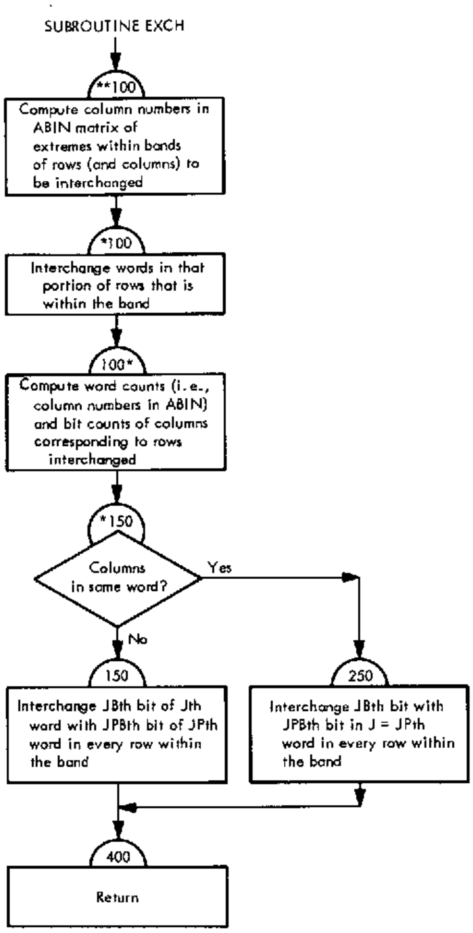

Fig. VI-4. Flowchart of subroutine EXCH (Link 1)

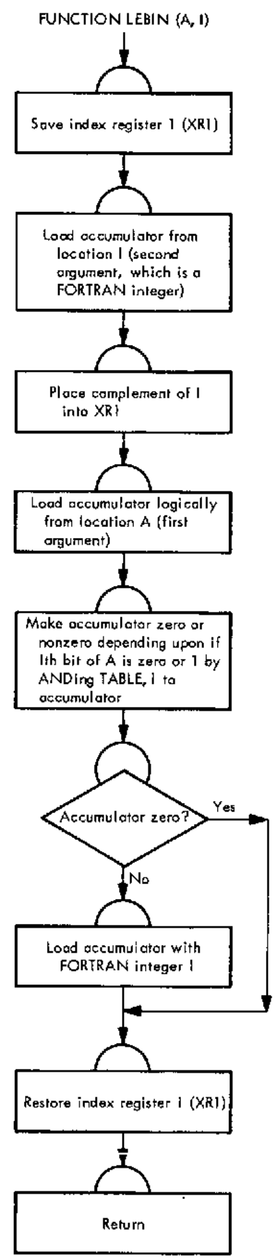

Fig. VI-5. Flowchart of function LEBIN (Link 1)

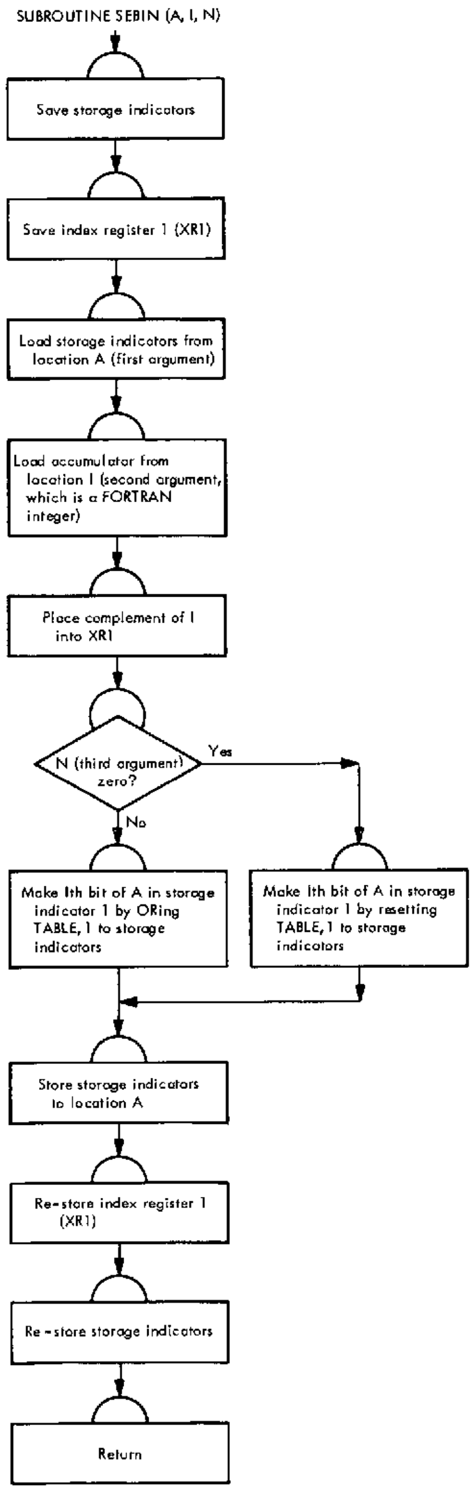

Fig. VI-6. Flowchart of subroutine SEBIN (Link 1)

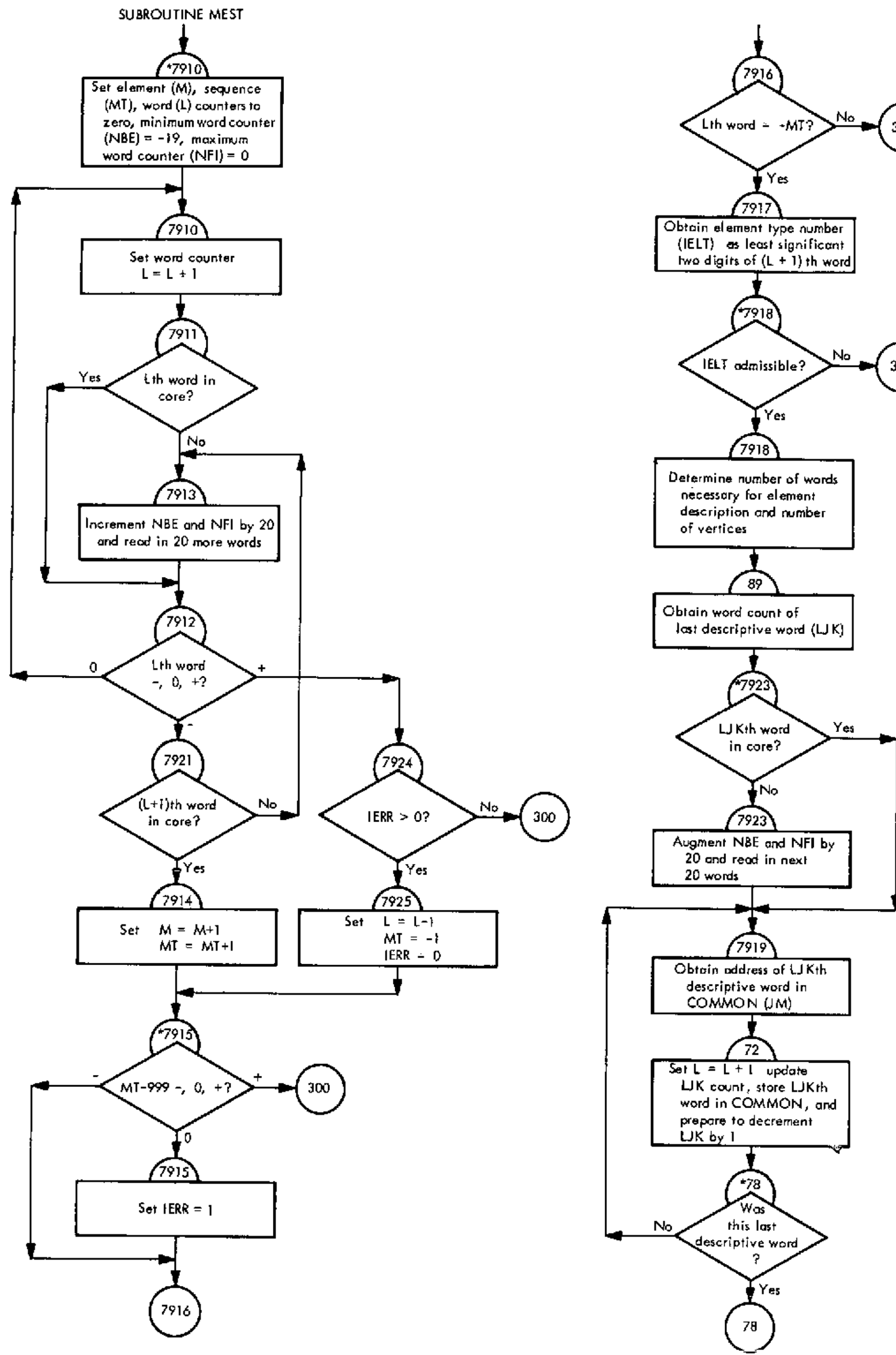

Fig. VI-7. Flowchart of subroutine MEST (Link 1)

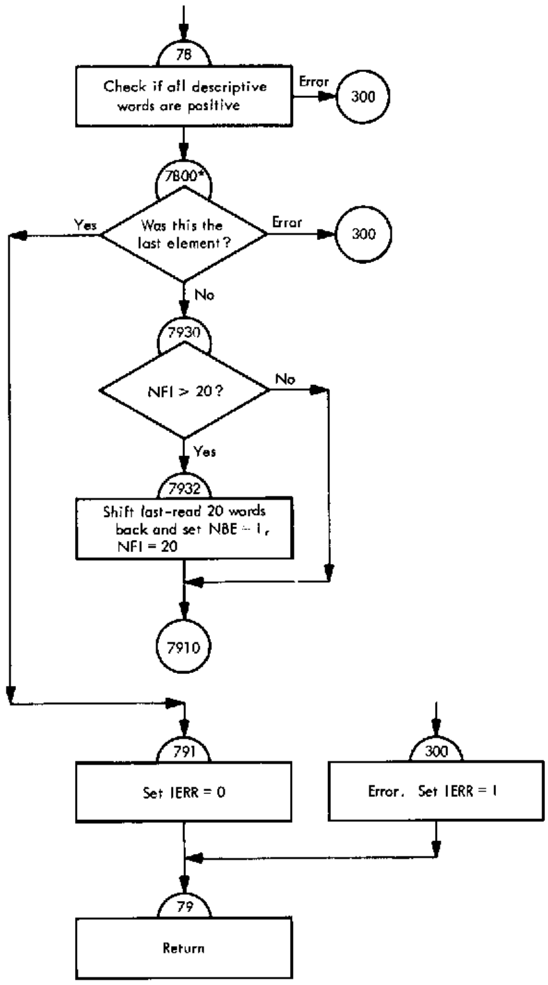

Fig. VI-7 (contd)

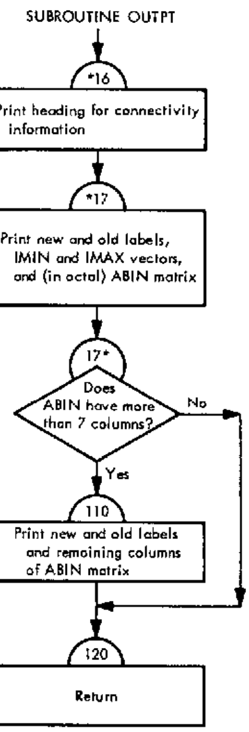

Fig. VI-8. Flowchart of subroutine OUTPT (Link 1)

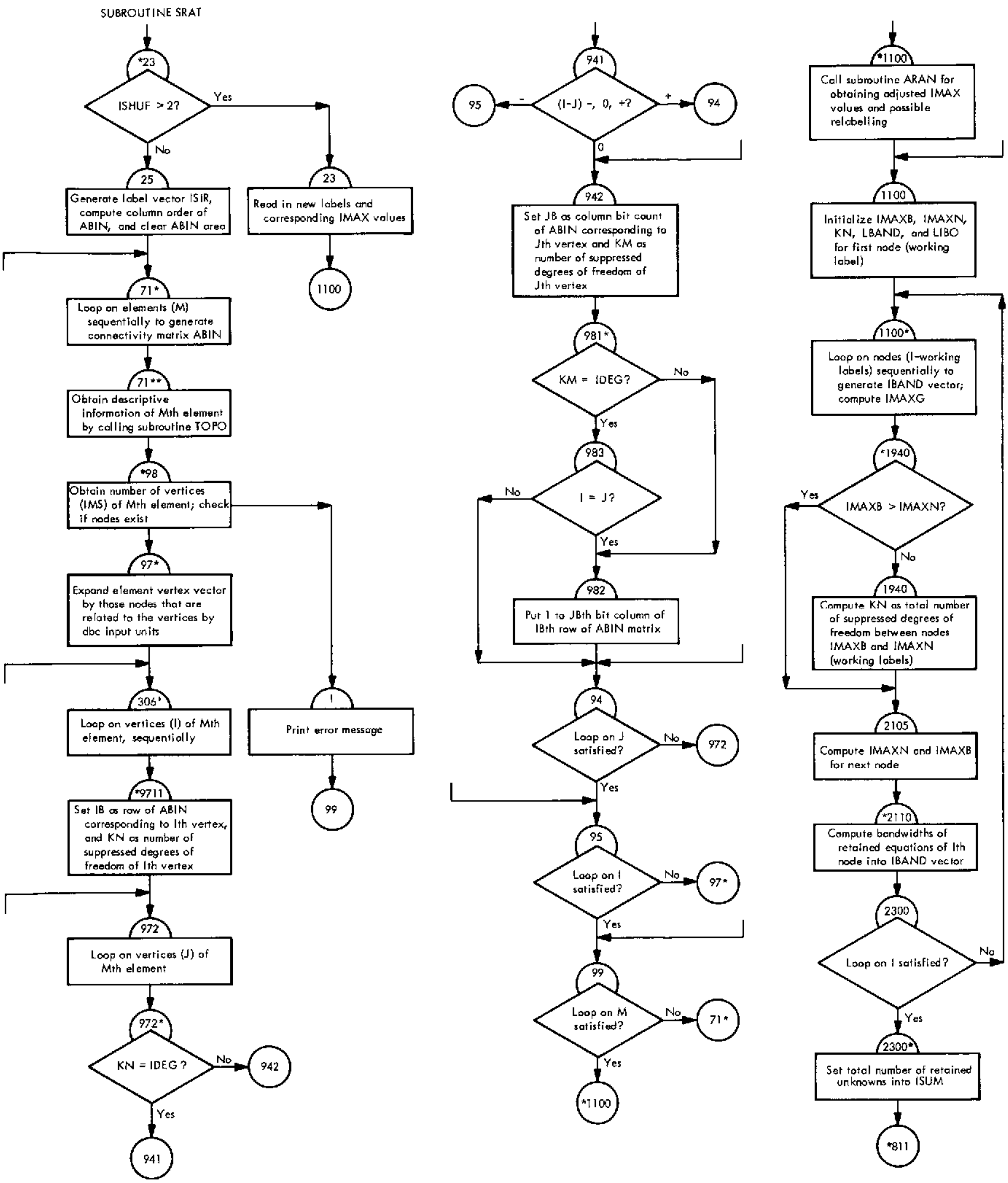

Fig. VI-9. Flowchart of subroutine SRAT (Link 1)

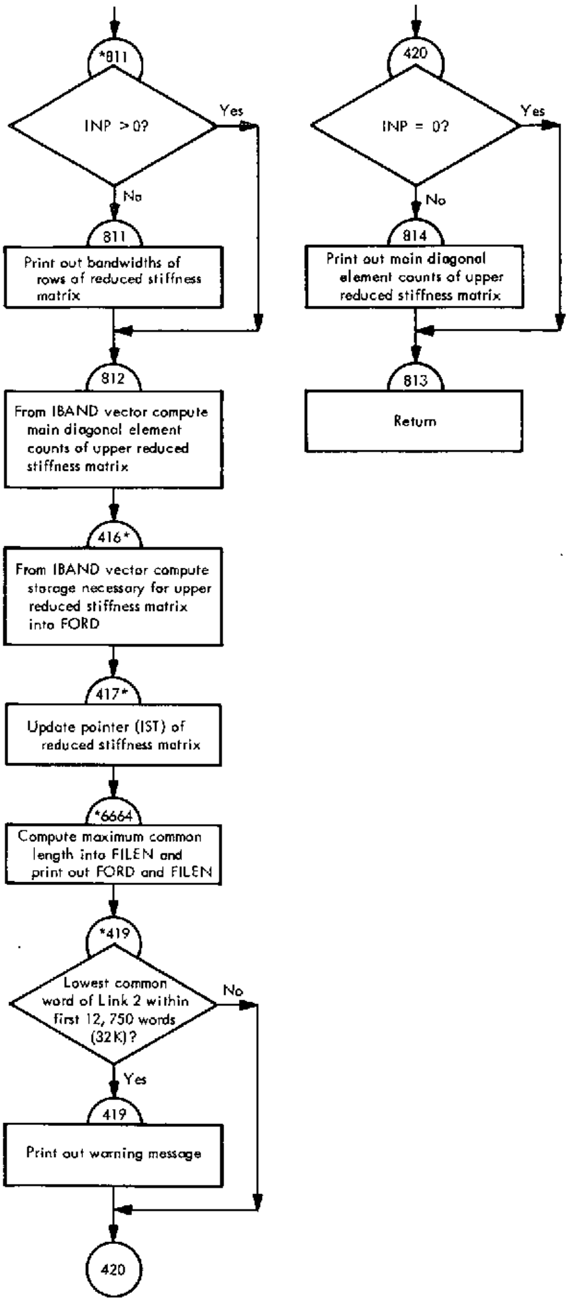

Fig. VI-9 (contd)

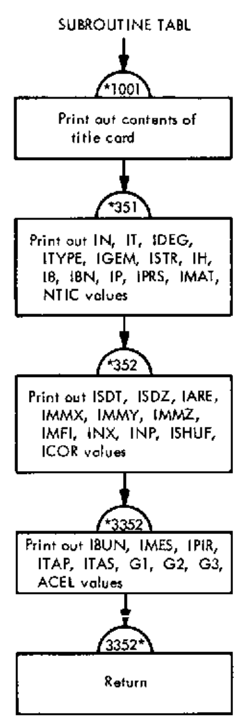

Fig. VI-10. Flowchart of subroutine TABL (Link 1)

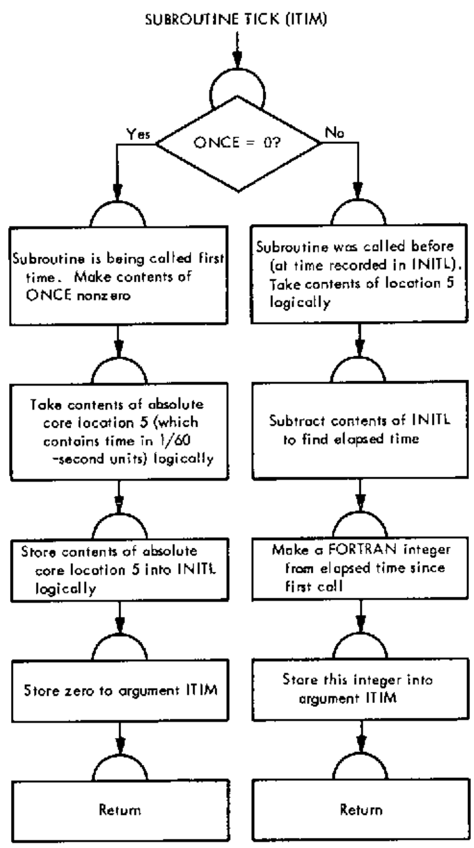

Fig. VI-11. Flowchart of subroutine TICK (Link 1)

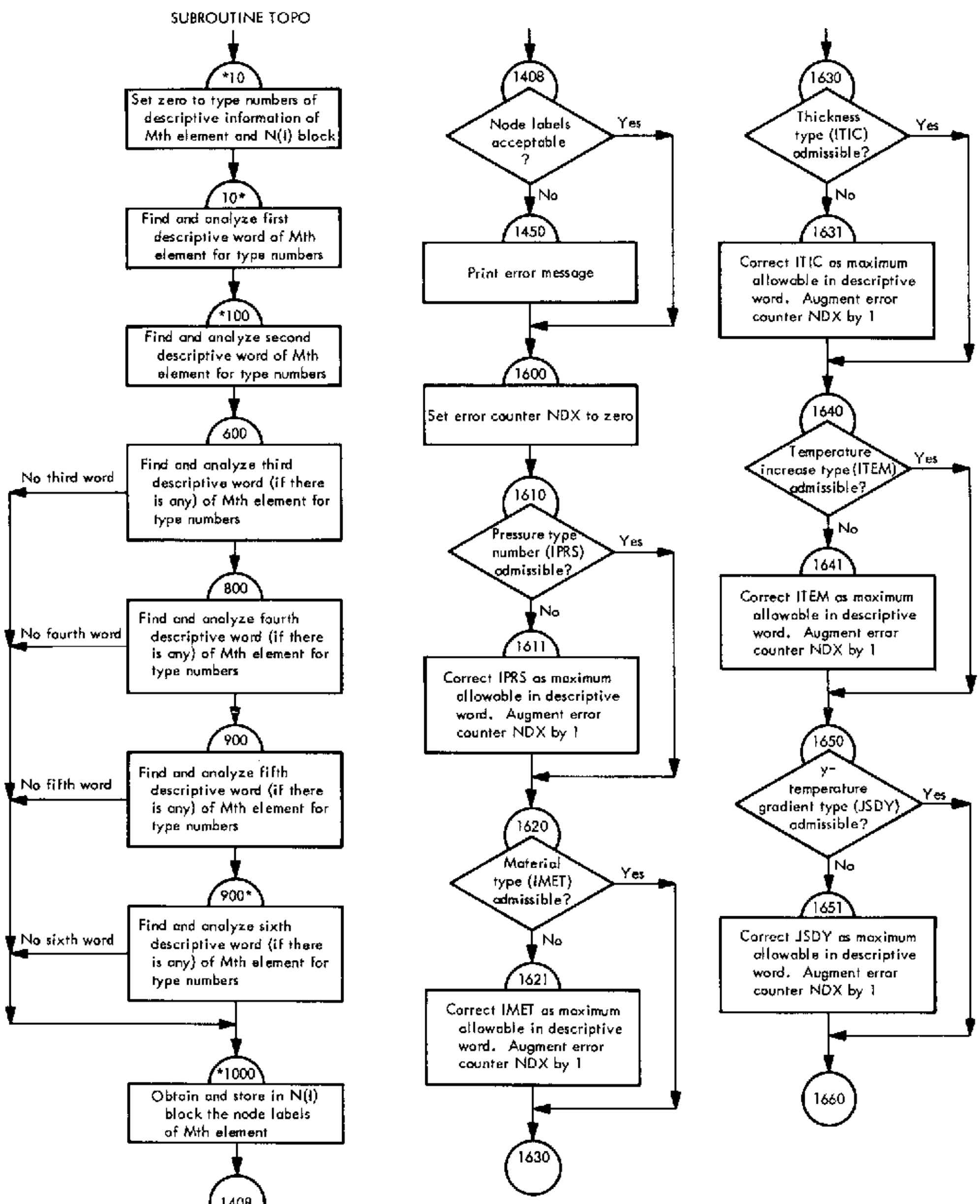

Fig. VI-12. Flowchart of subroutine TOPO (Link 1)

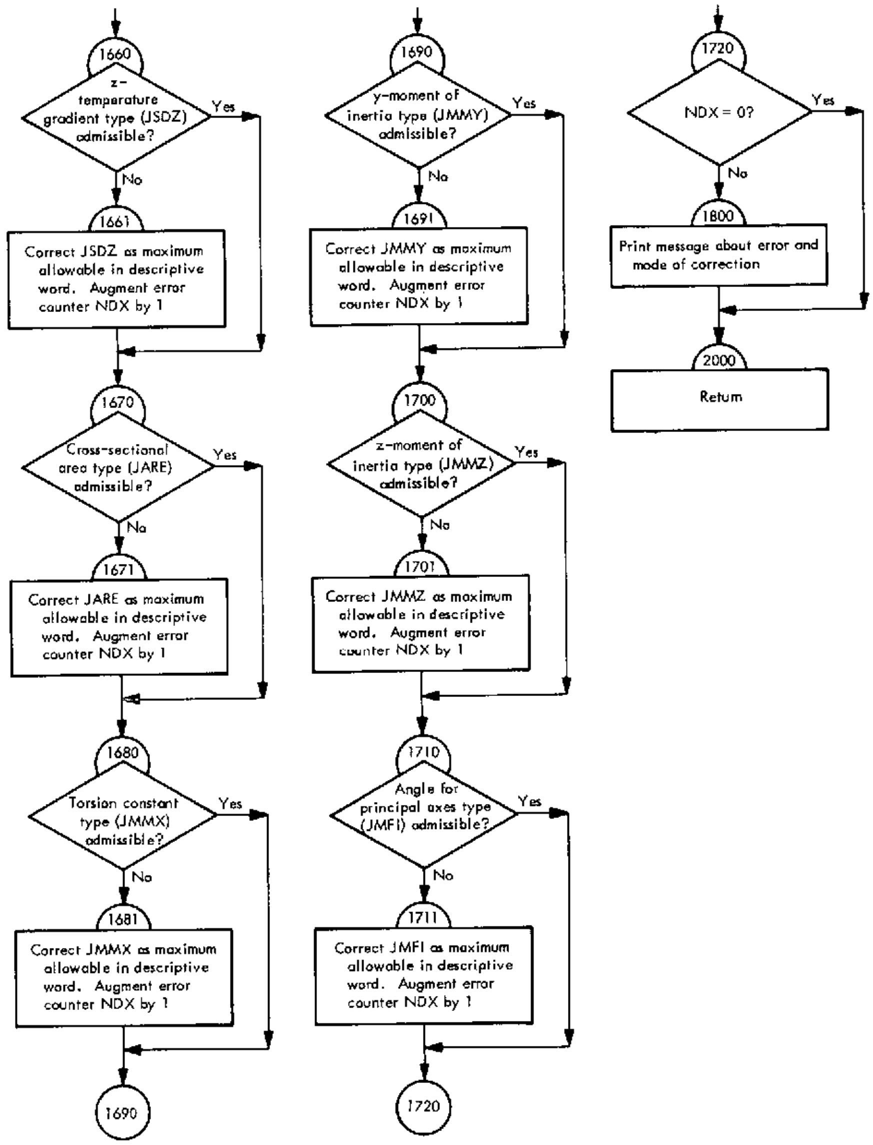

Fig. VI-12 (contd)

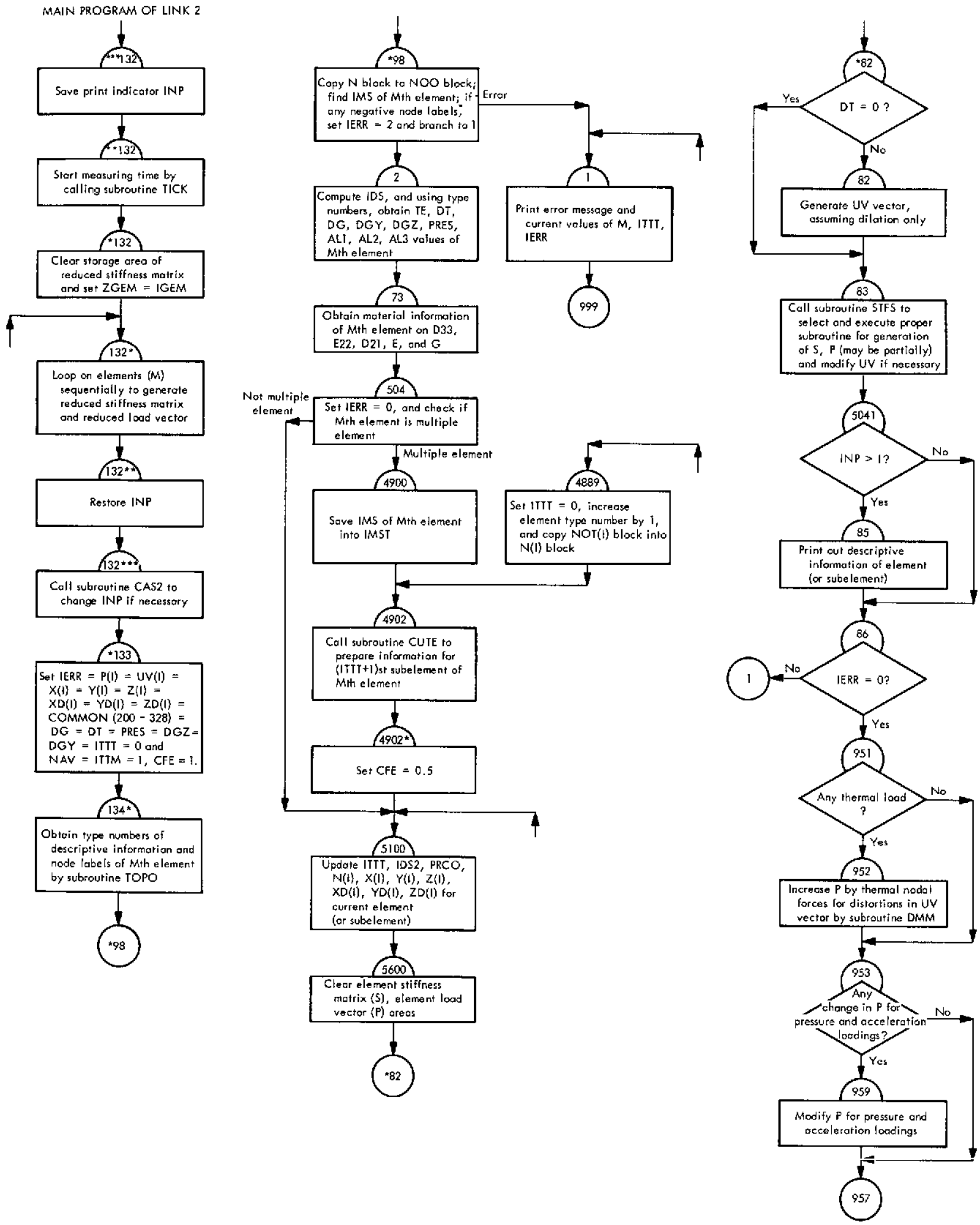

Fig. VI-13. Flowchart of main program of Link 2 (generation link)

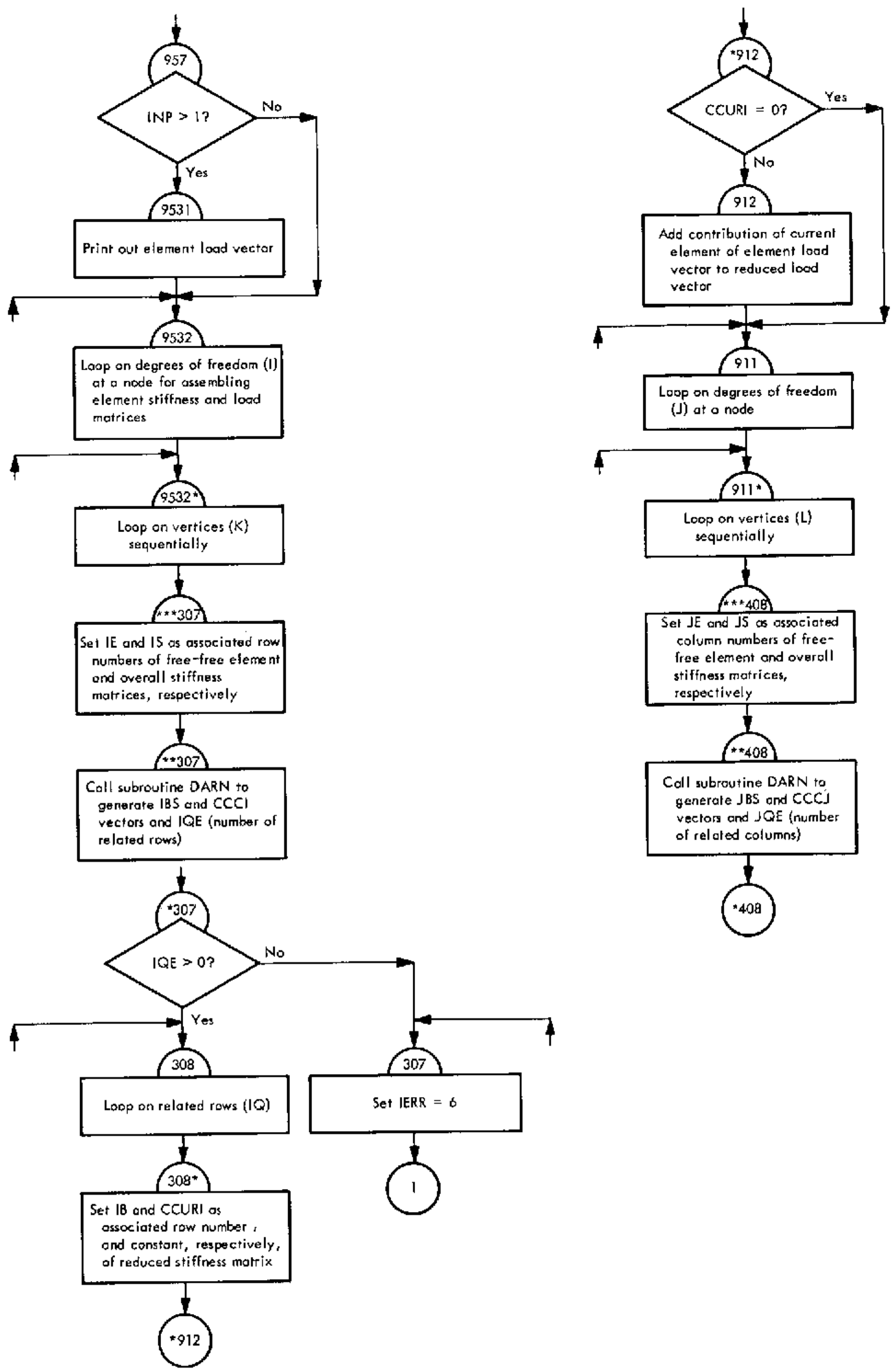

Fig. VI-13 (contd)

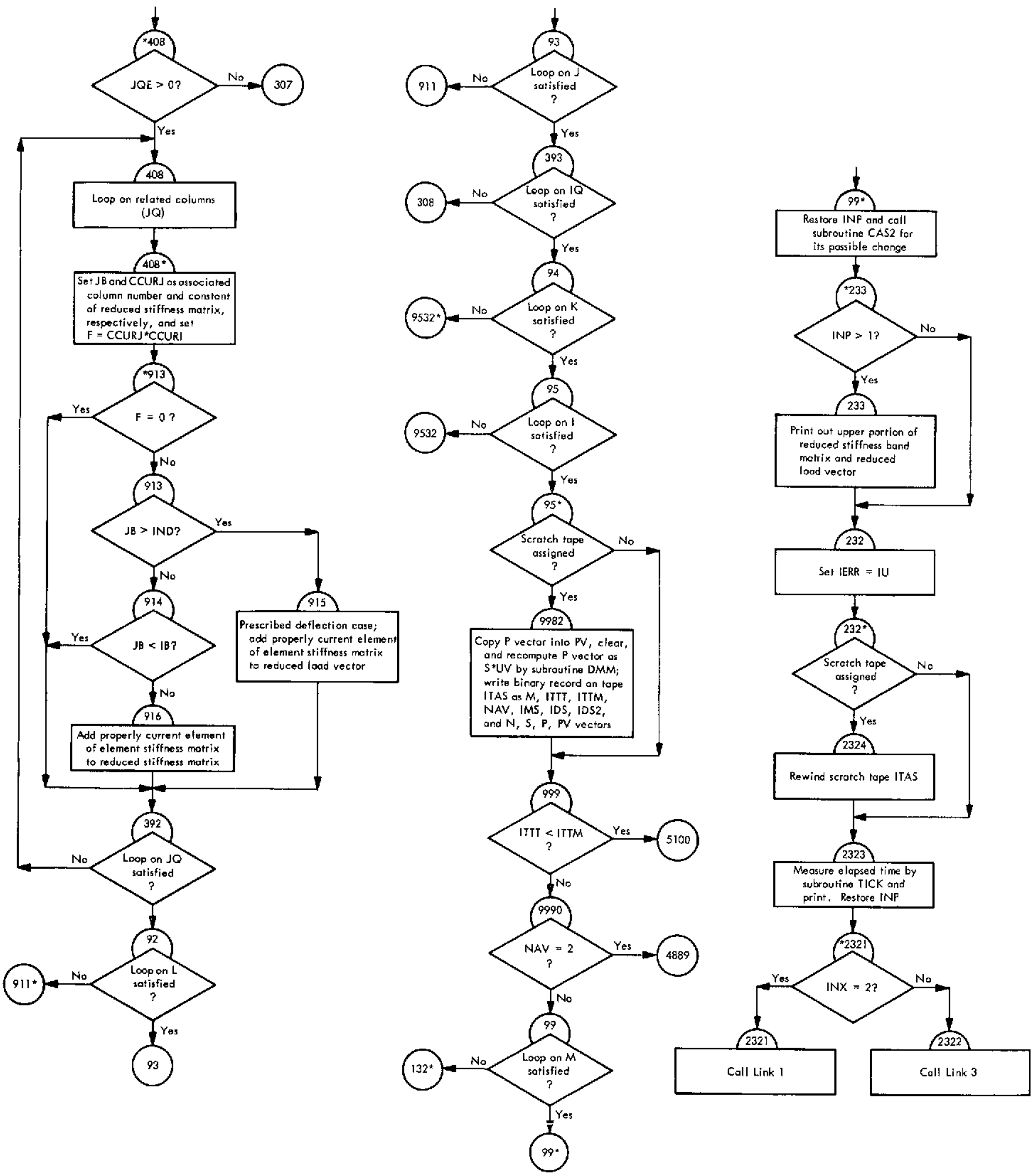

Fig. VI-13 (contd)

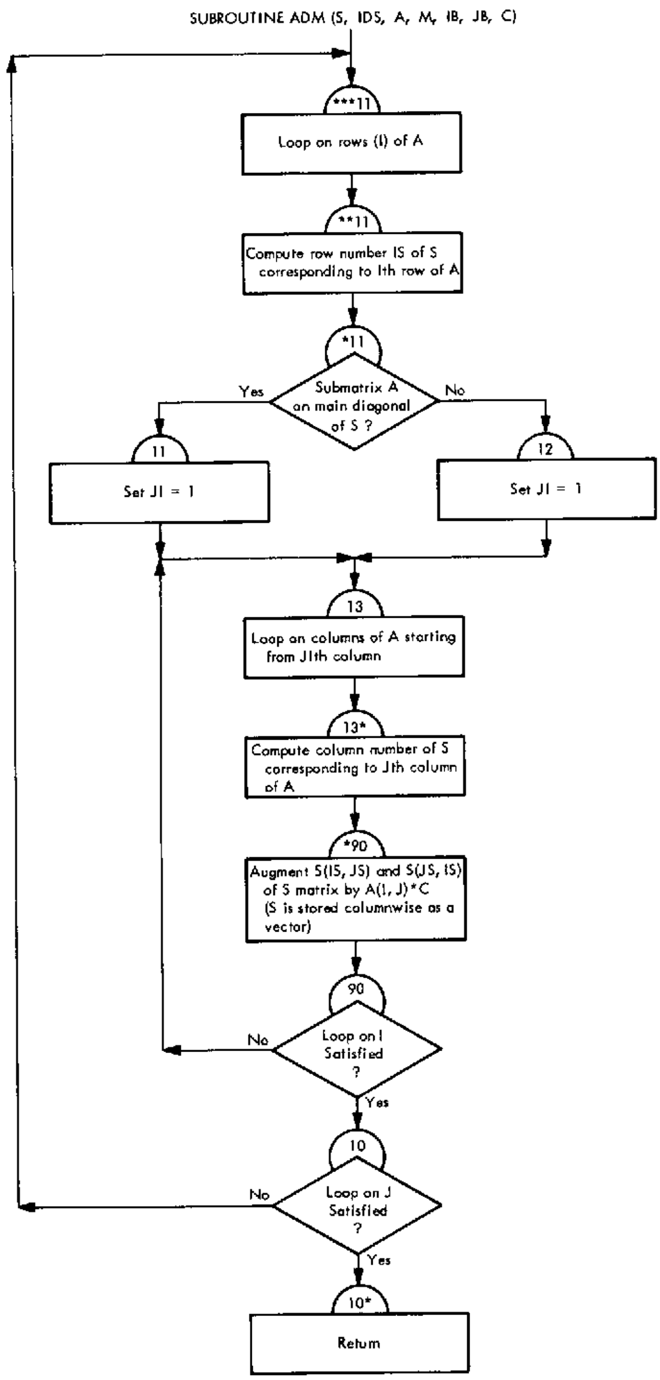

Fig. VI-14. Flowchart of subroutine ADM (Link 2)

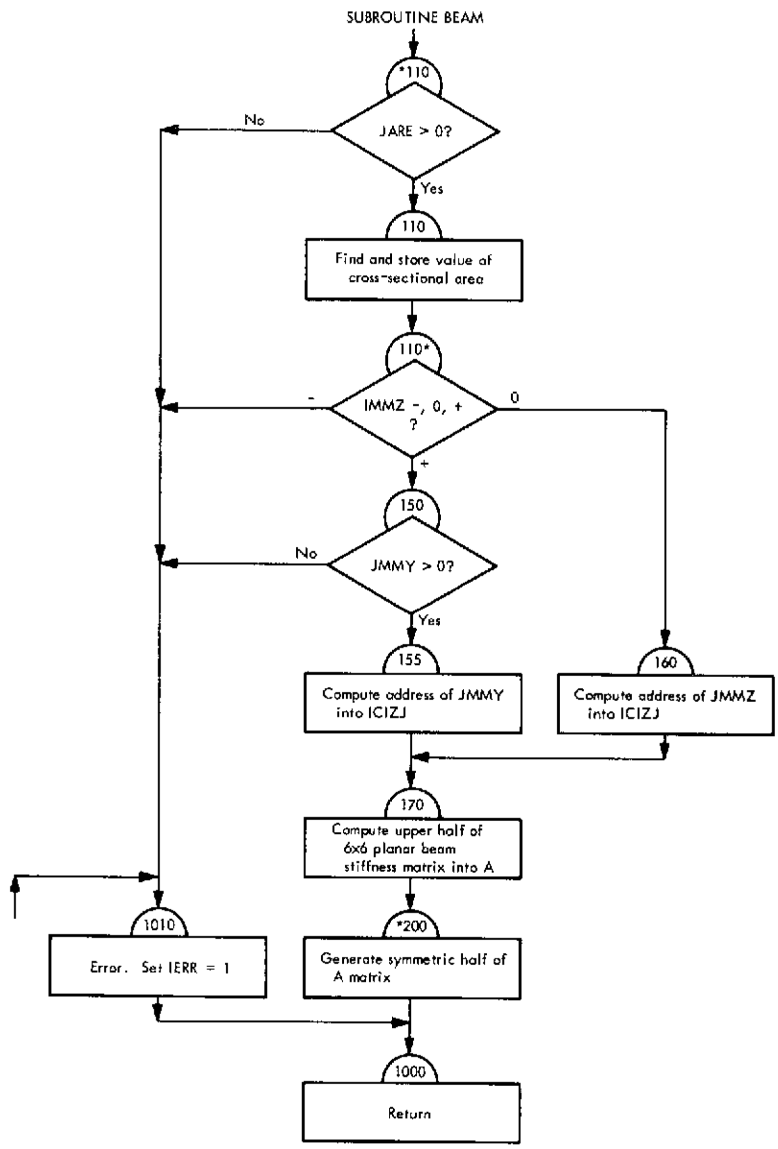

Fig. VI-15. Flowchart of subroutine BEAM (Link 2)

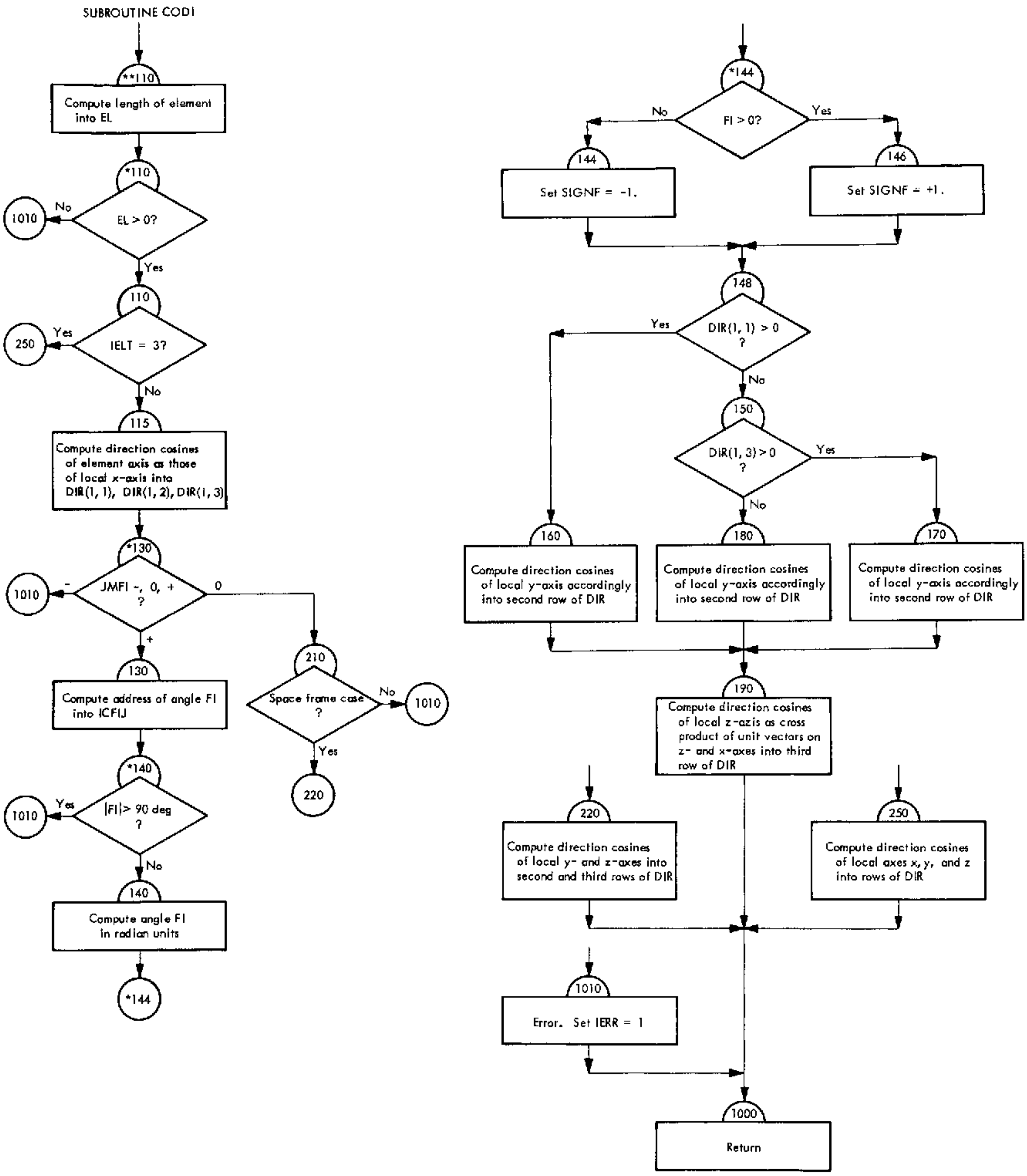

Fig. VI-16. Flowchart of subroutine CODI (Link 2)

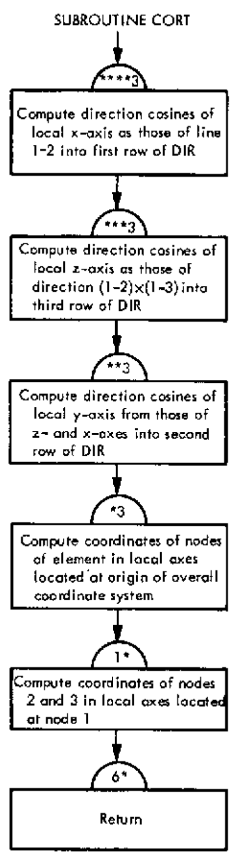

Fig. VI-17. Flowchart of subroutine CORT (Link 2)

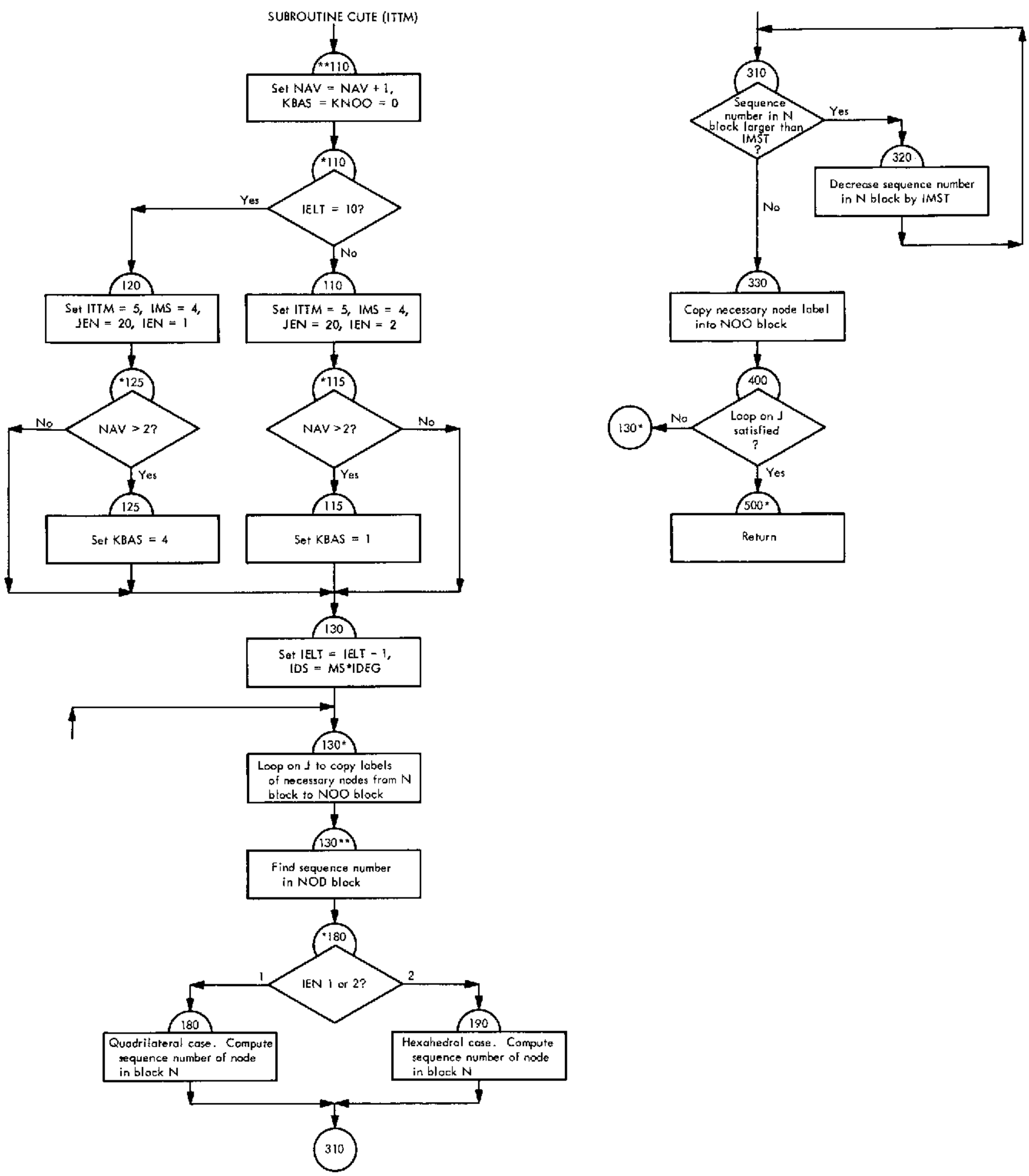

Fig. VI-18. Flowchart of subroutine CUTE (Link 2)

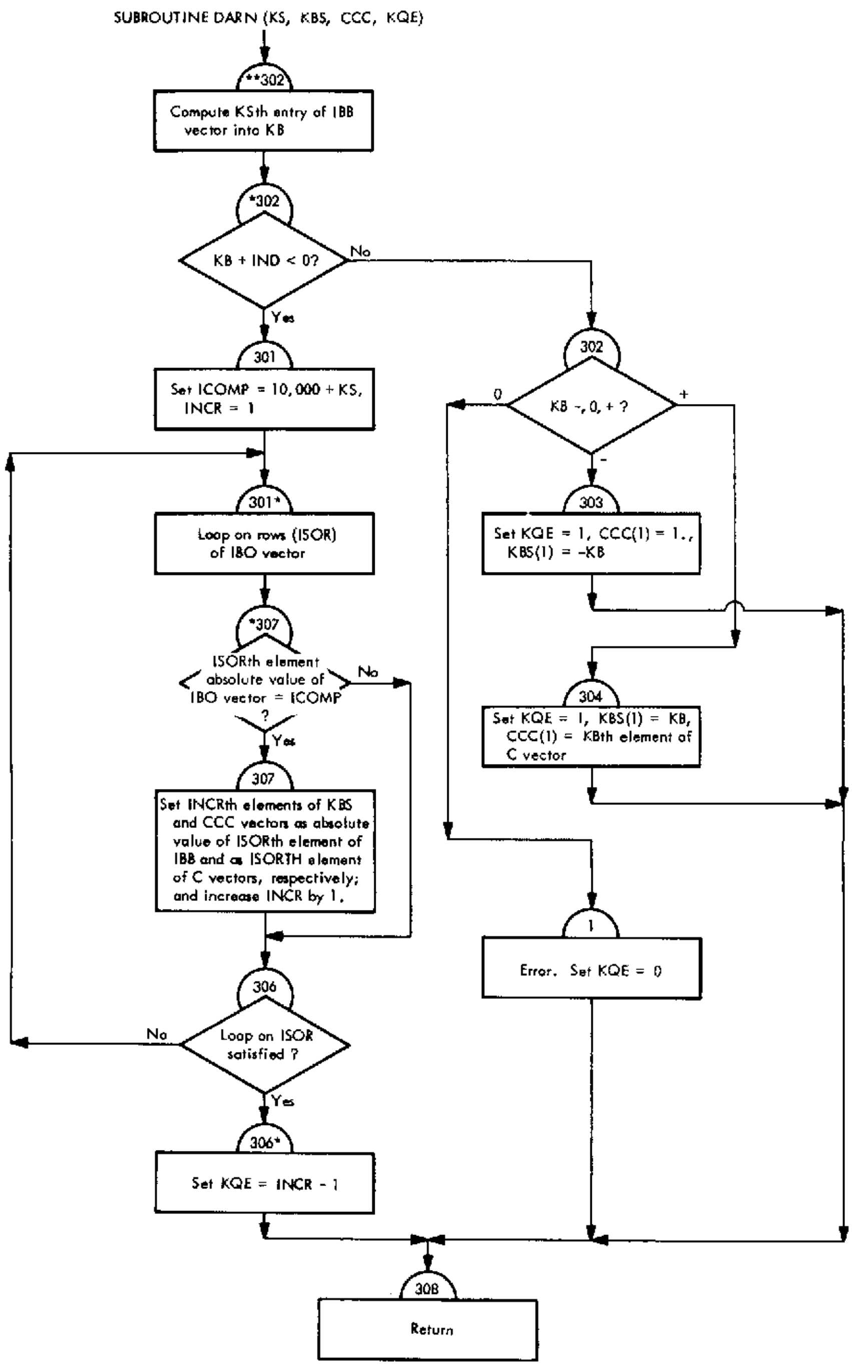

Fig. VI-19. Flowchart of subroutine DARN (Link 2)

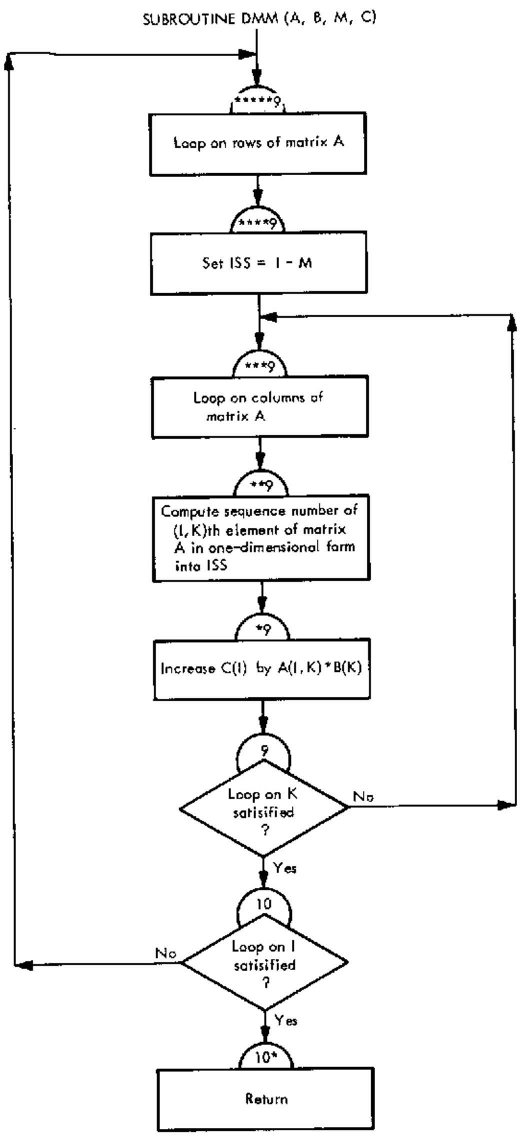

Fig. VI-20. Flowchart of subroutine DMM (Link 2)

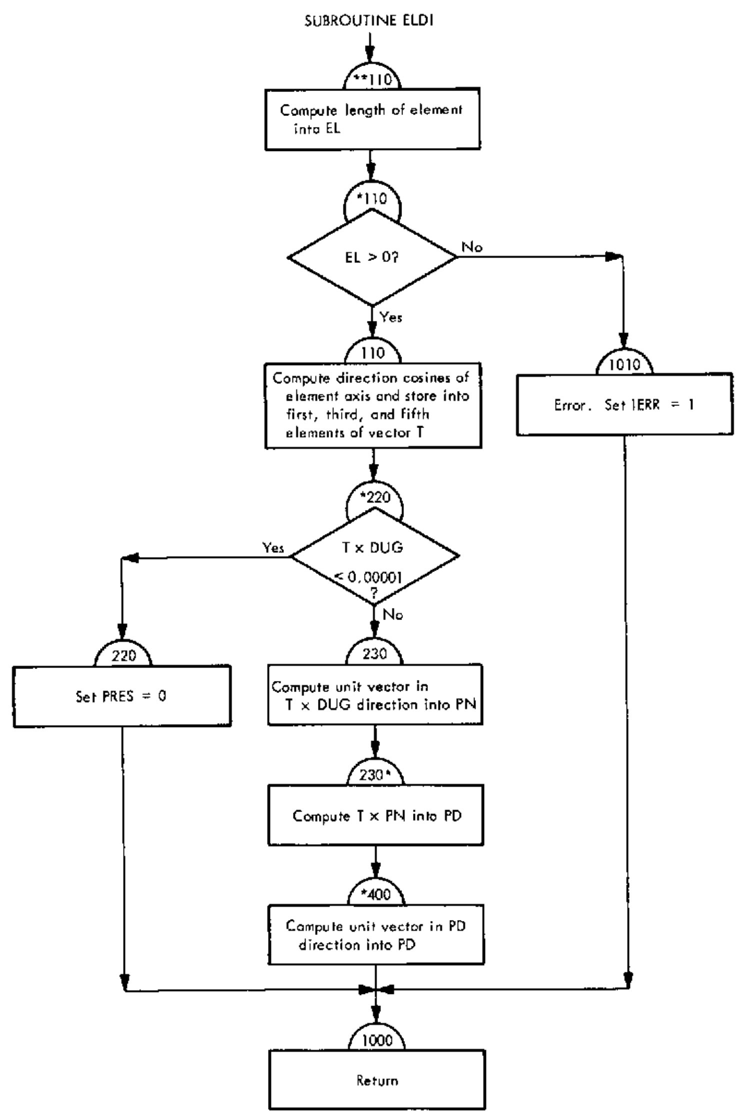

Fig. VI-21. Flowchart of subroutine ELDI (Link 2)

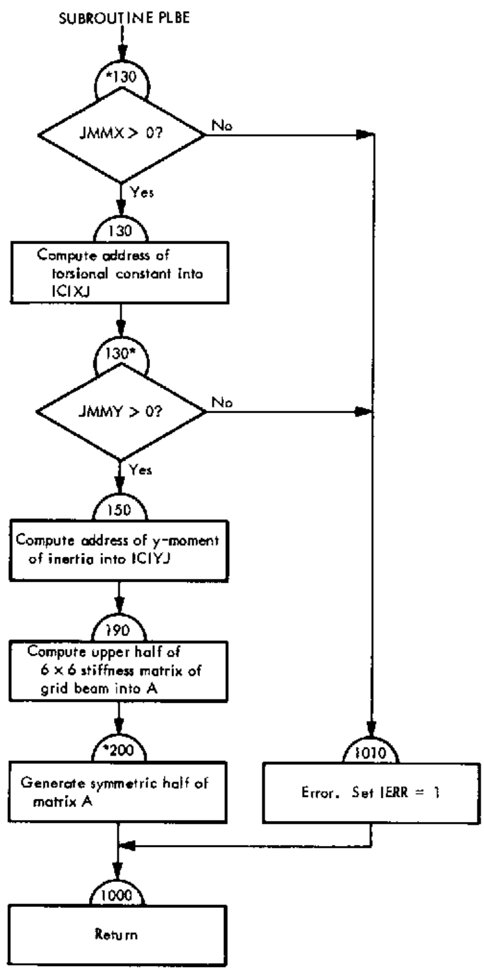

Fig. VI-22. Flowchart of subroutine PLBE (Link 2)

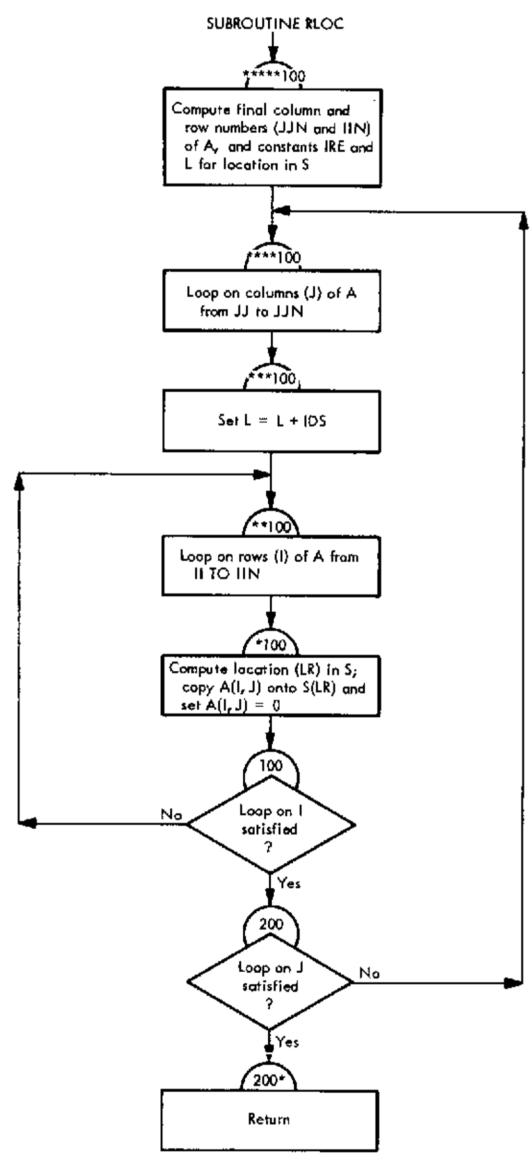

Fig. VI-23. Flowchart of subroutine RLOC (Link 2)

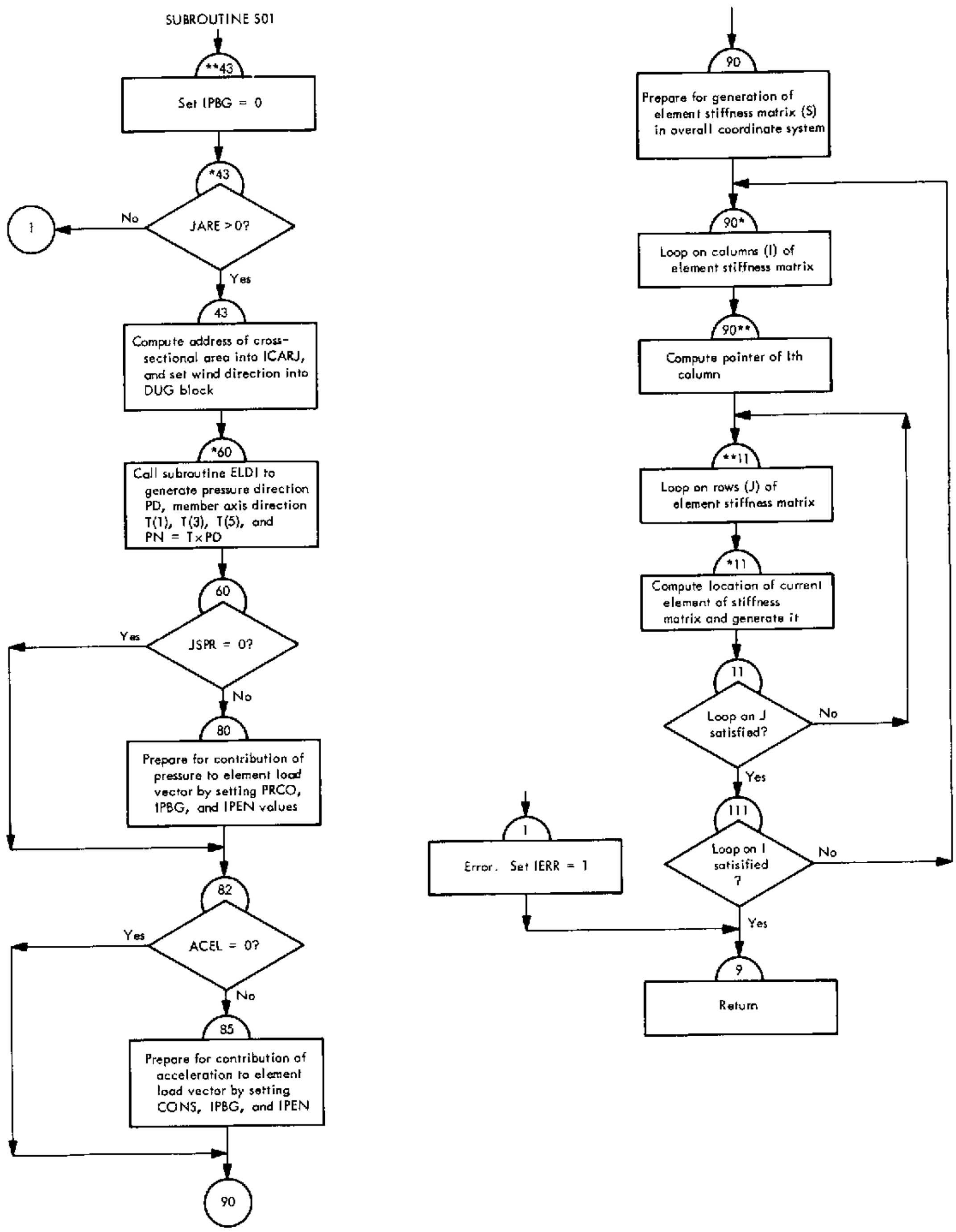

Fig. VI-24. Flowchart of subroutine S01 (Link 2)

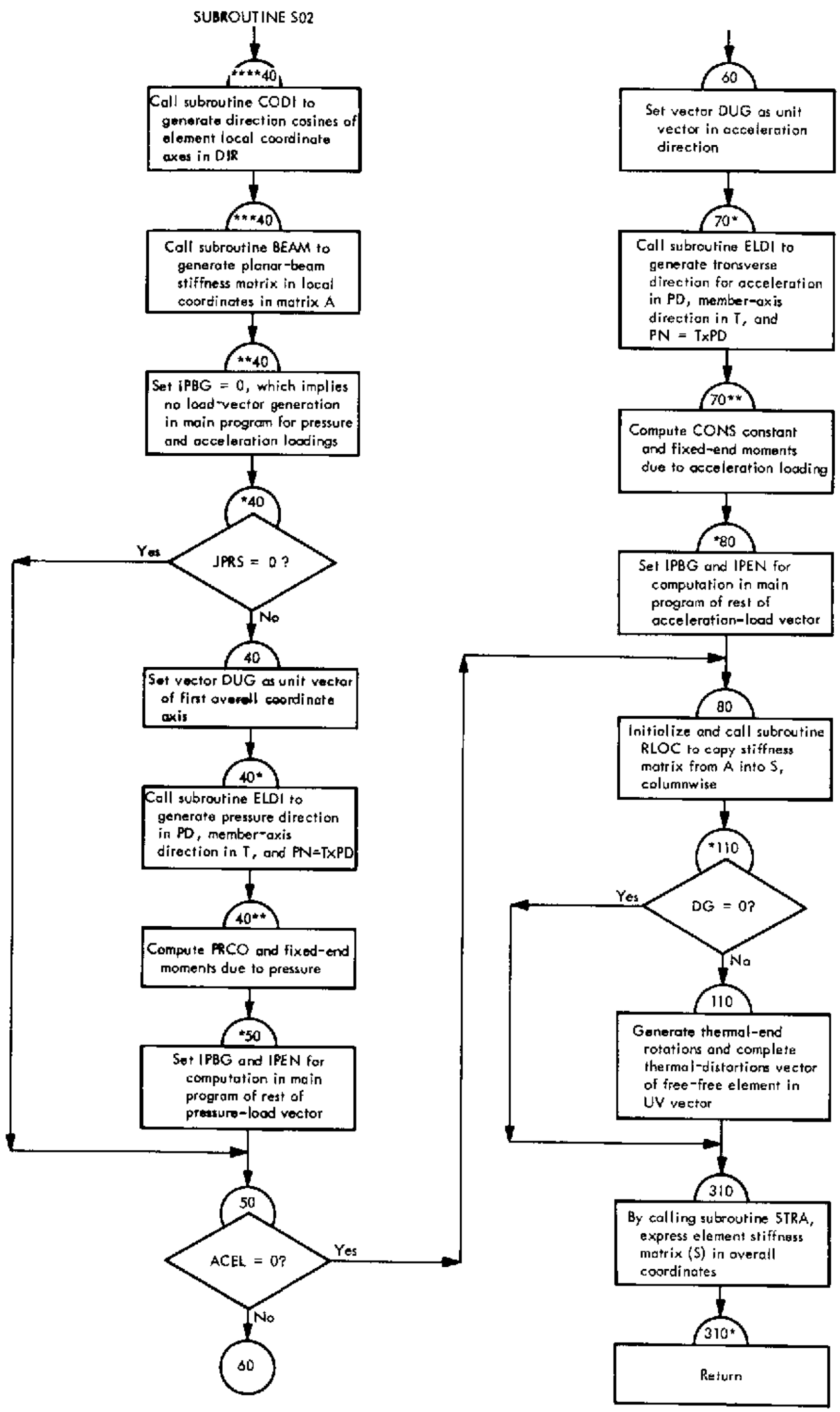

Fig. VI-25. Flowchart of subroutine S02 (Link 2)

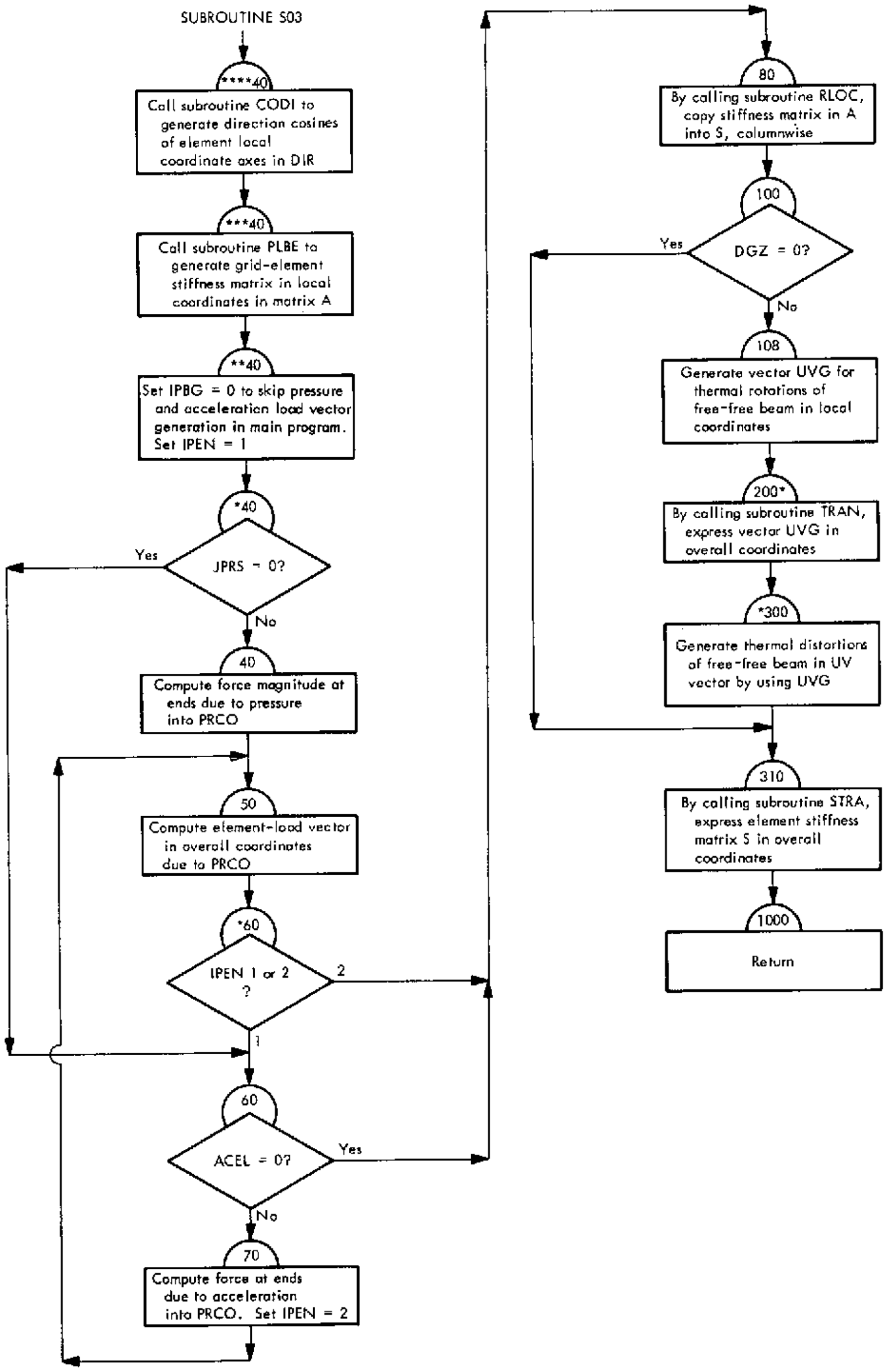

Fig. VI-26. Flowchart of subroutine S03 (Link 2)

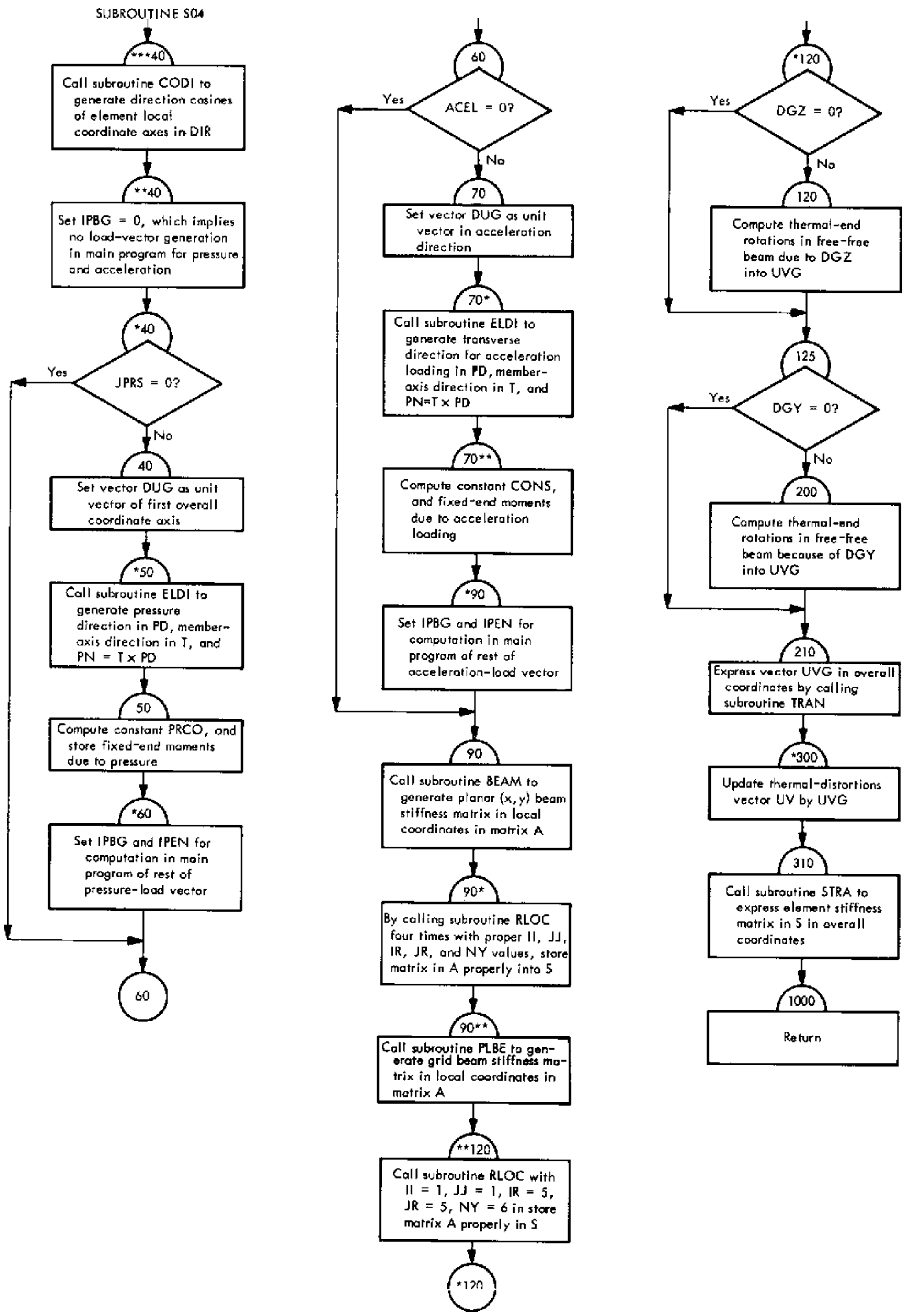

Fig. VI-27. Flowchart of subroutine S04 (Link 2)

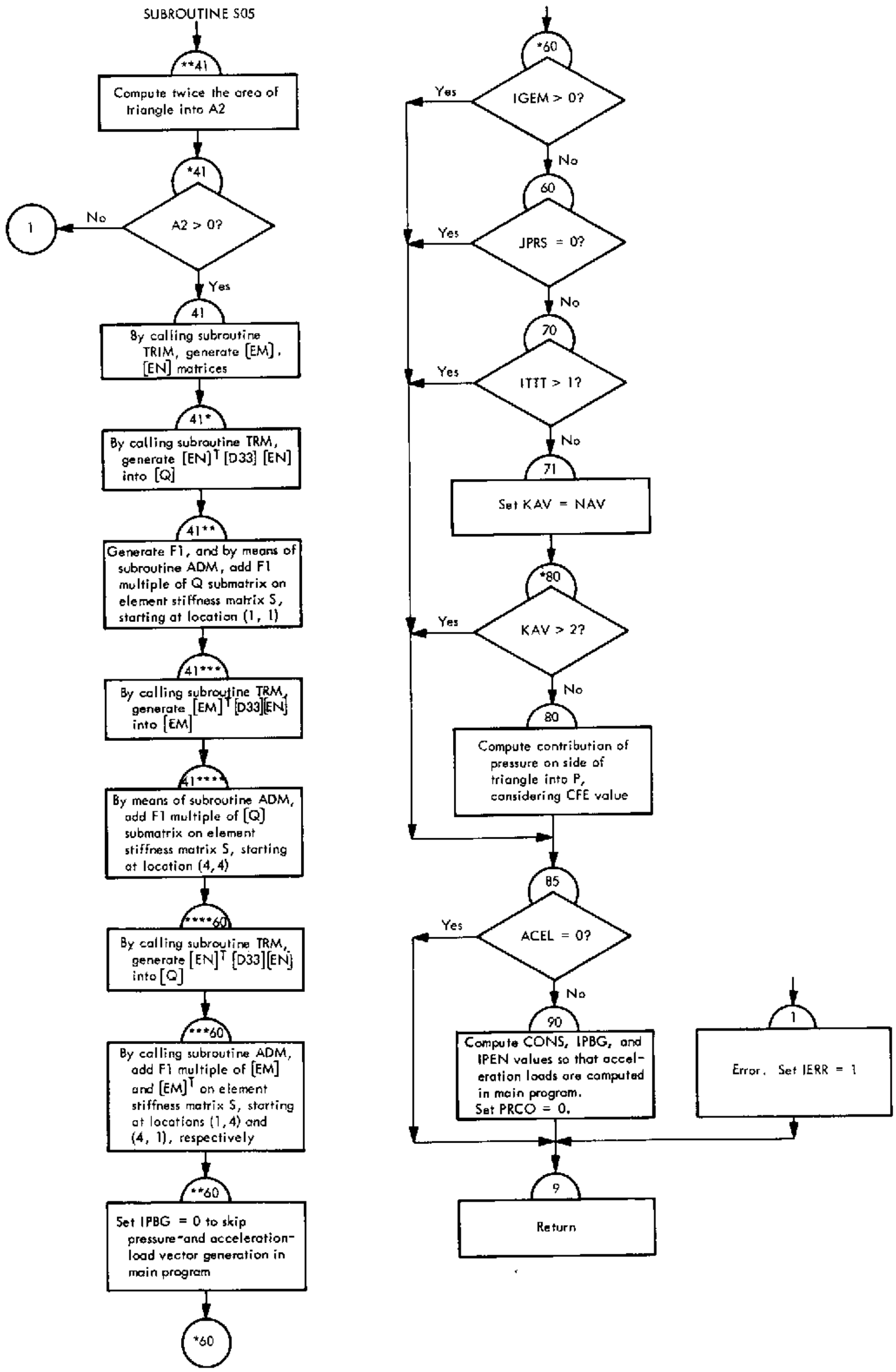

Fig. VI-28. Flowchart of subroutine S05 (Link 2)

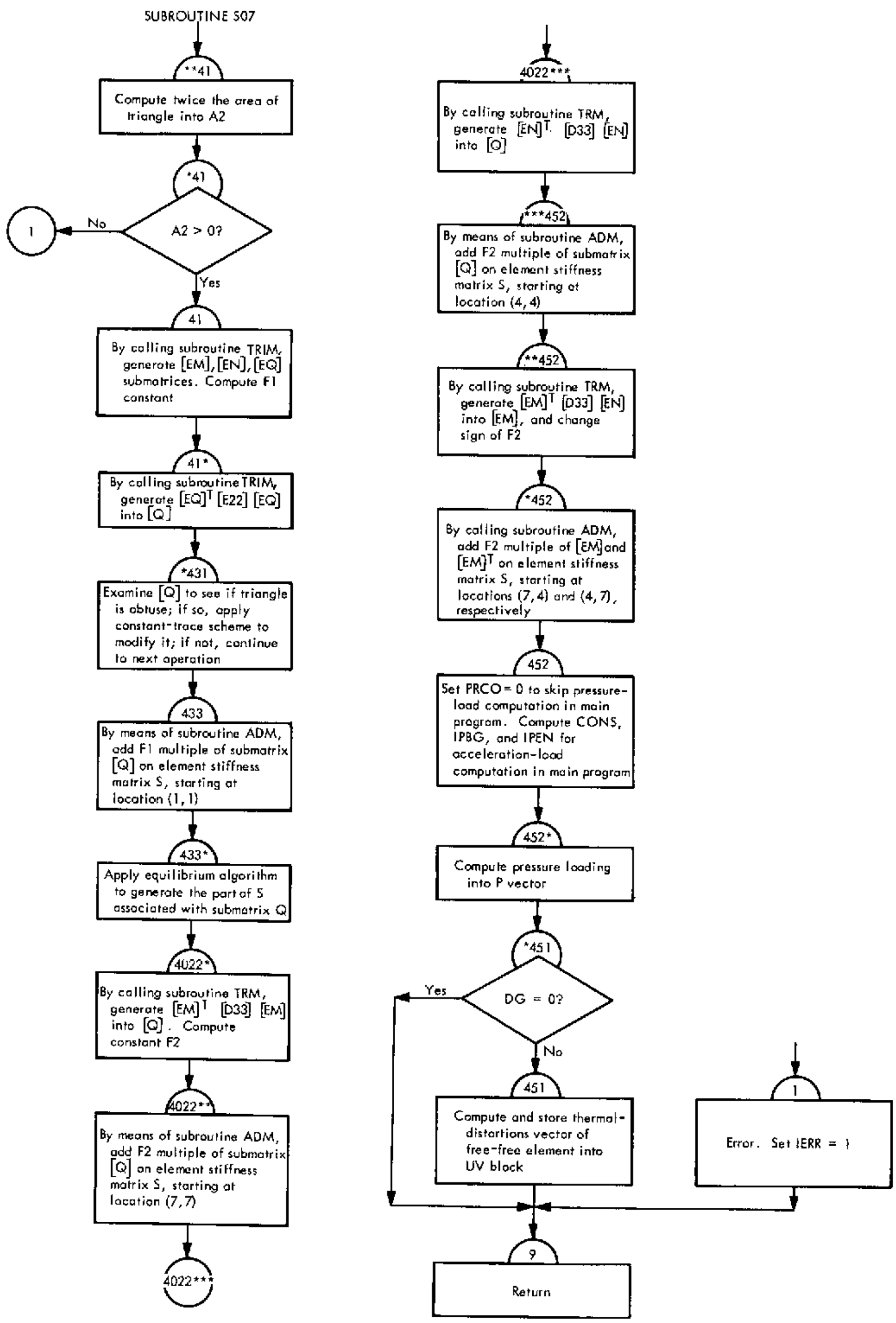

Fig. VI-29. Flowchart of subroutine S07 (Link 2)

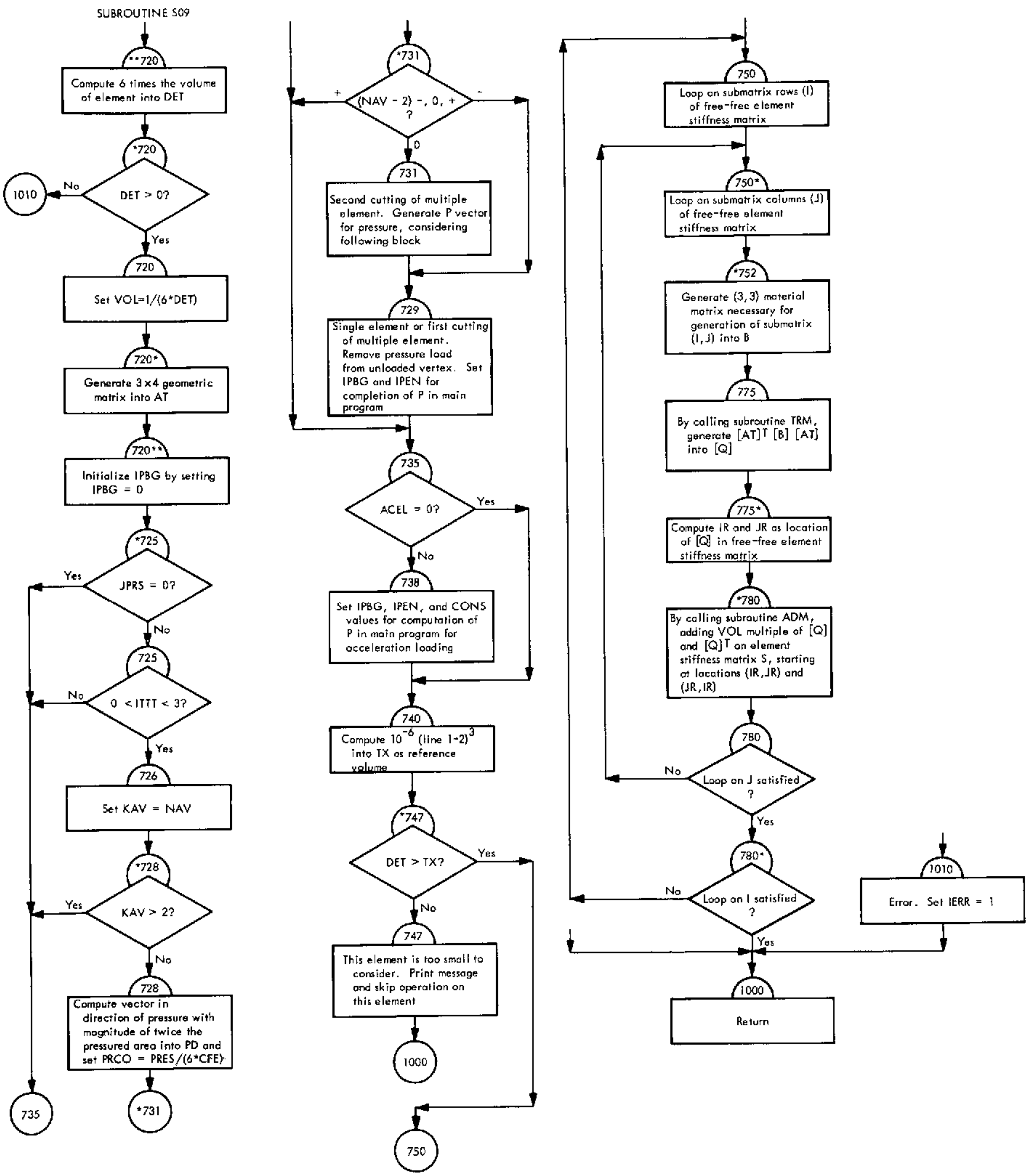

Fig. VI-30. Flowchart of subroutine S09 (Link 2)

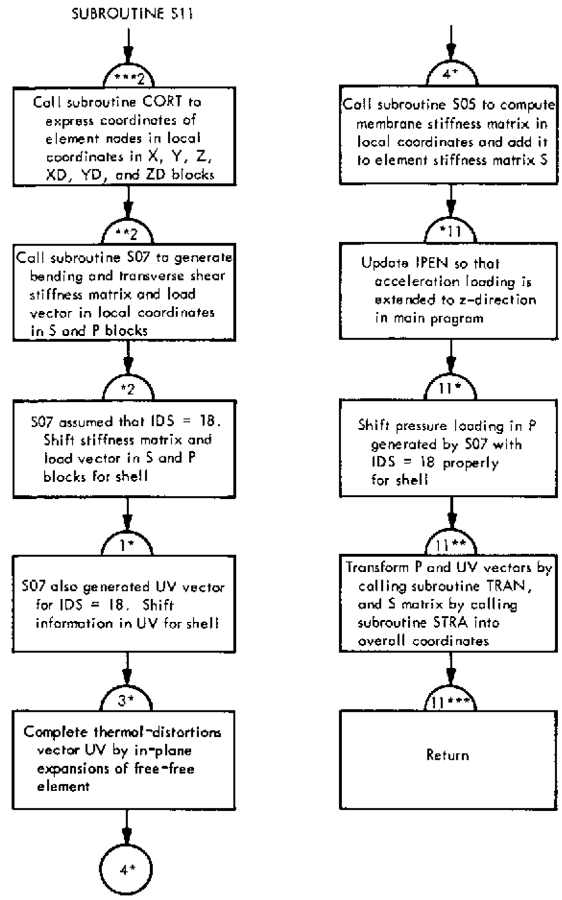

Fig. VI-31. Flowchart of subroutine S11 (Link 2)

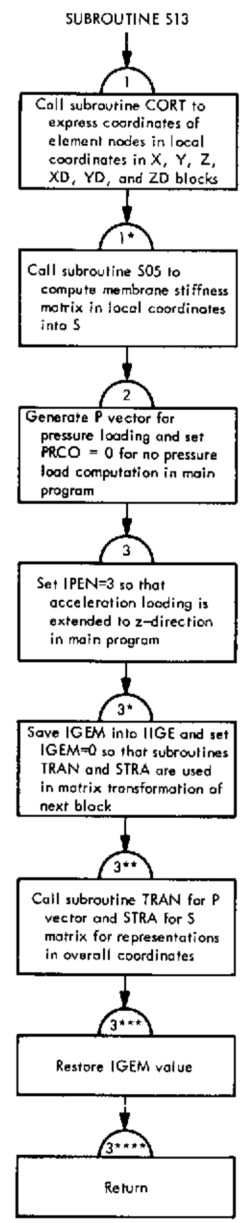

Fig. VI-32. Flowchart of subroutine S13 (Link 2)

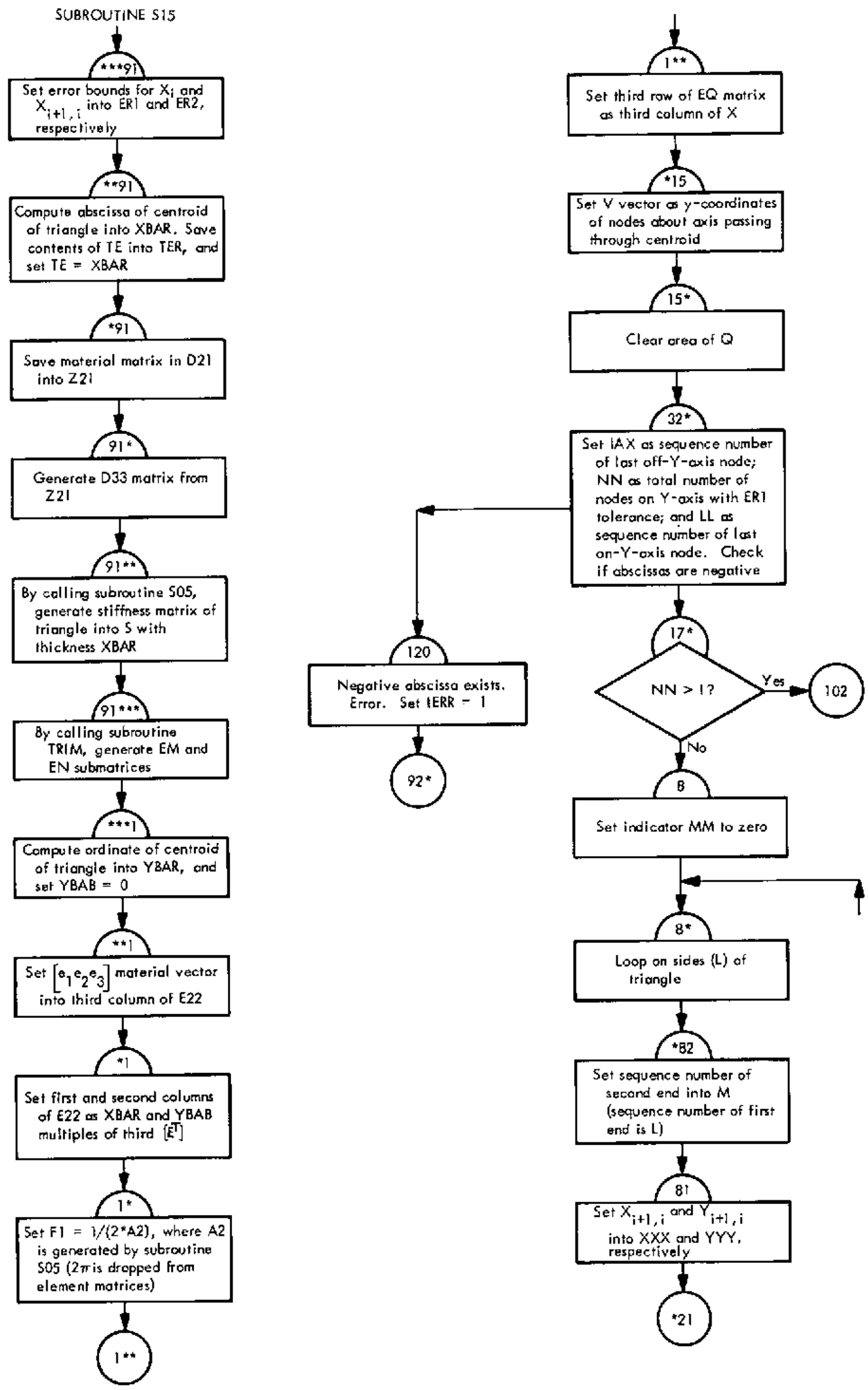

Fig. VI-33. Flowchart of subroutine S15 (Link 2)

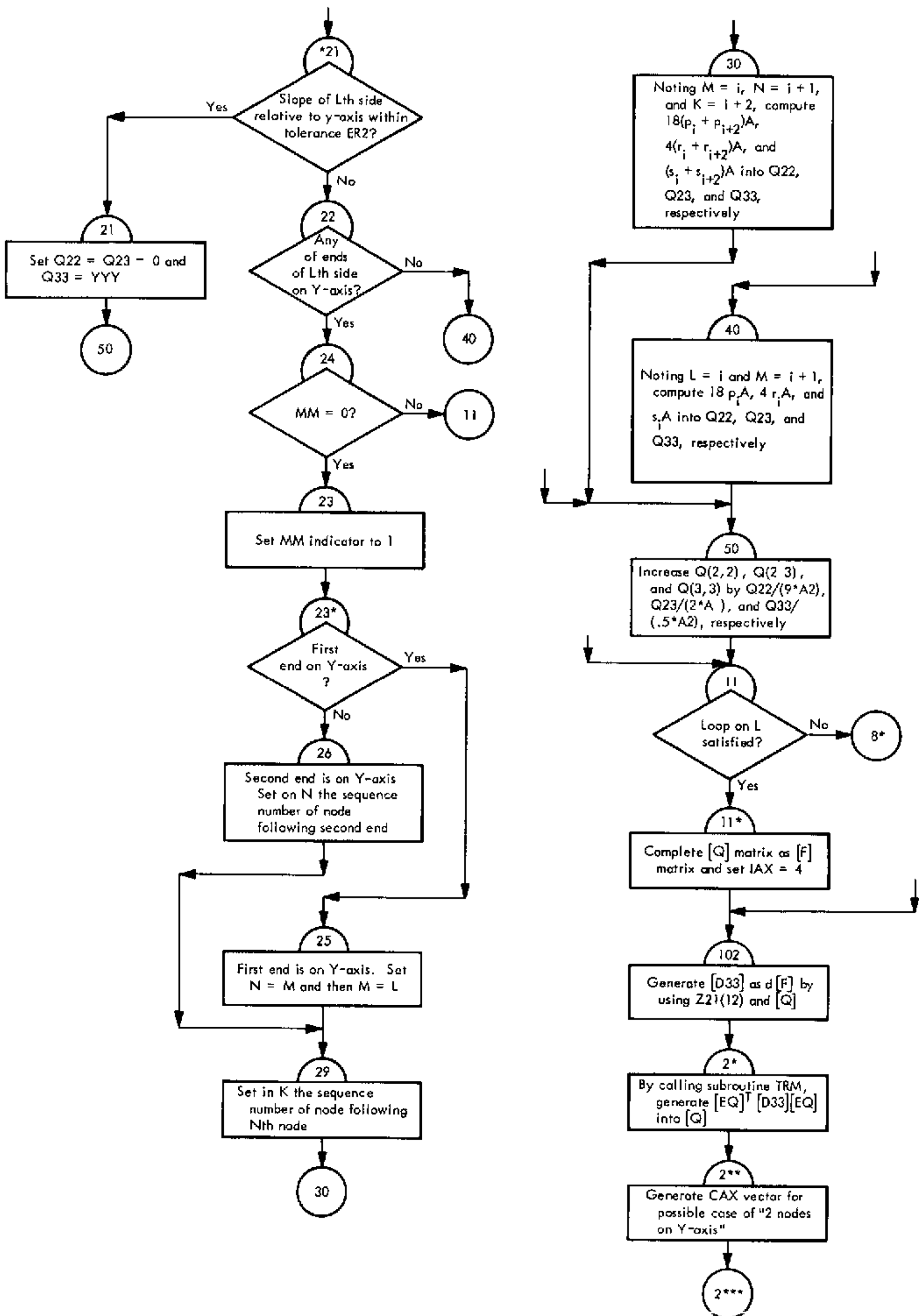

Fig. VI-33 (contd)

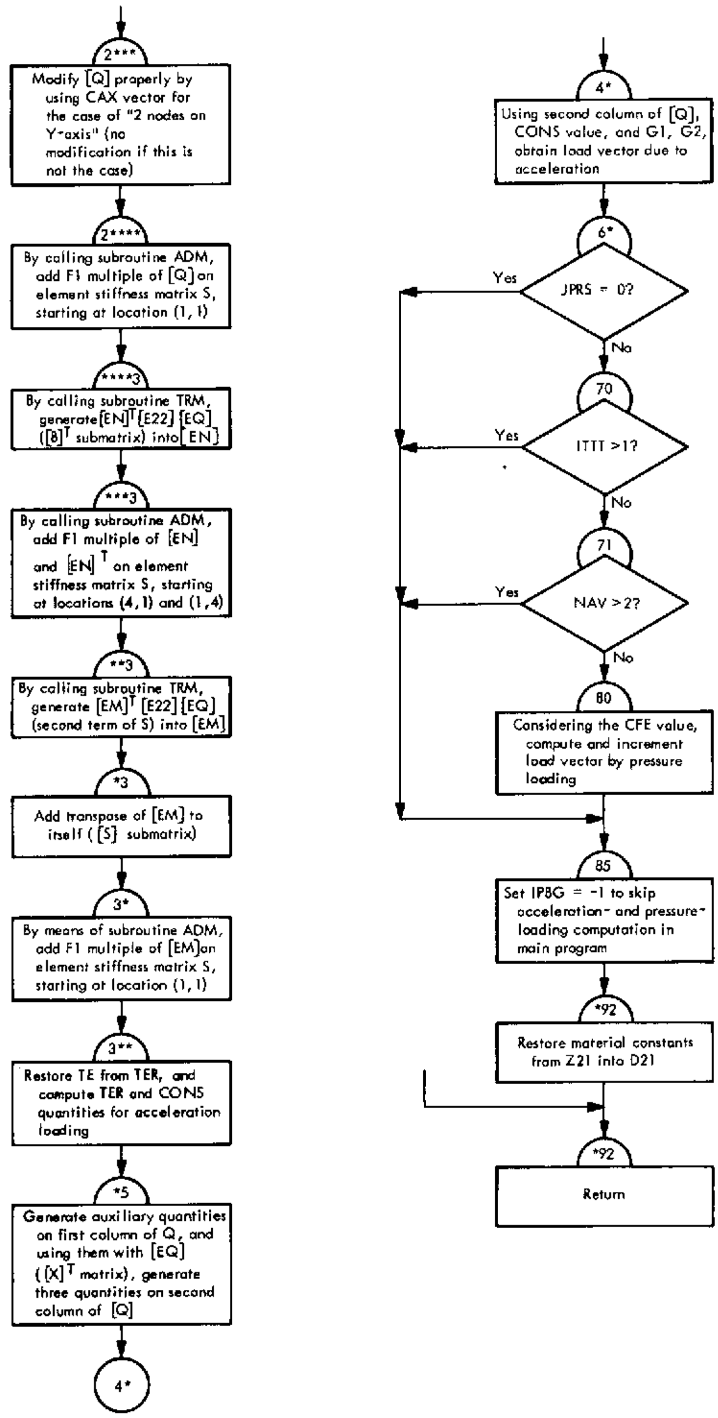

Fig. VI-33 (contd)

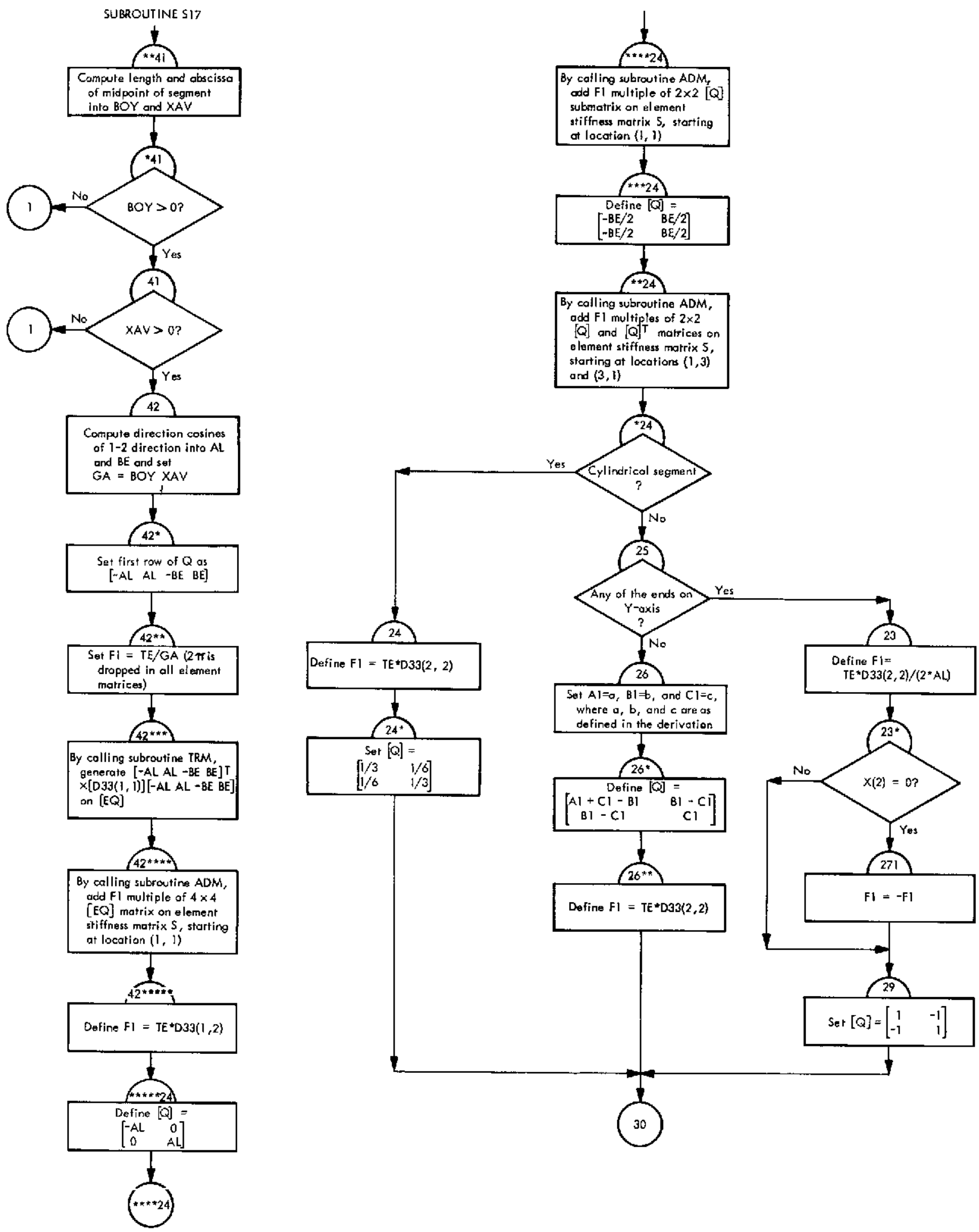

Fig. VI-34. Flowchart of subroutine S17 (Link 2)

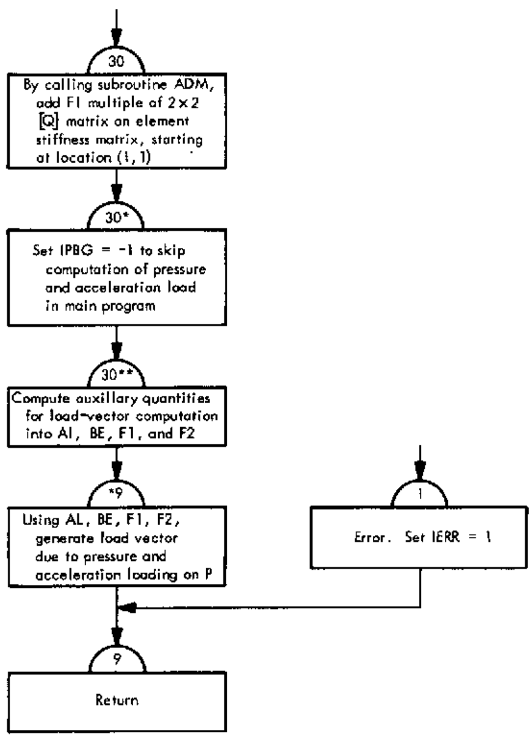

Fig. VI-34 (contd)

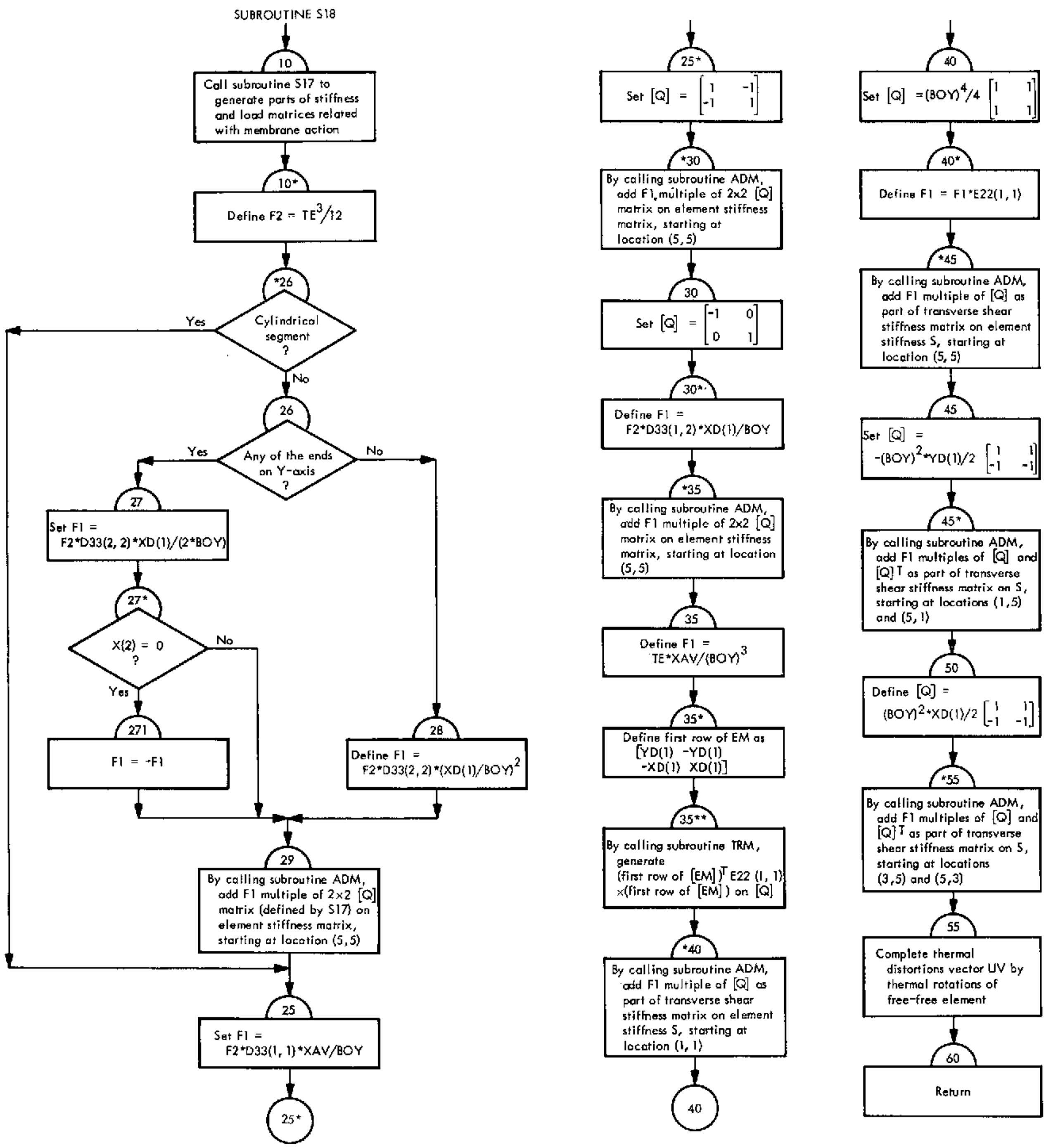

Fig. VI-35. Flowchart of subroutine S18 (Link 2)

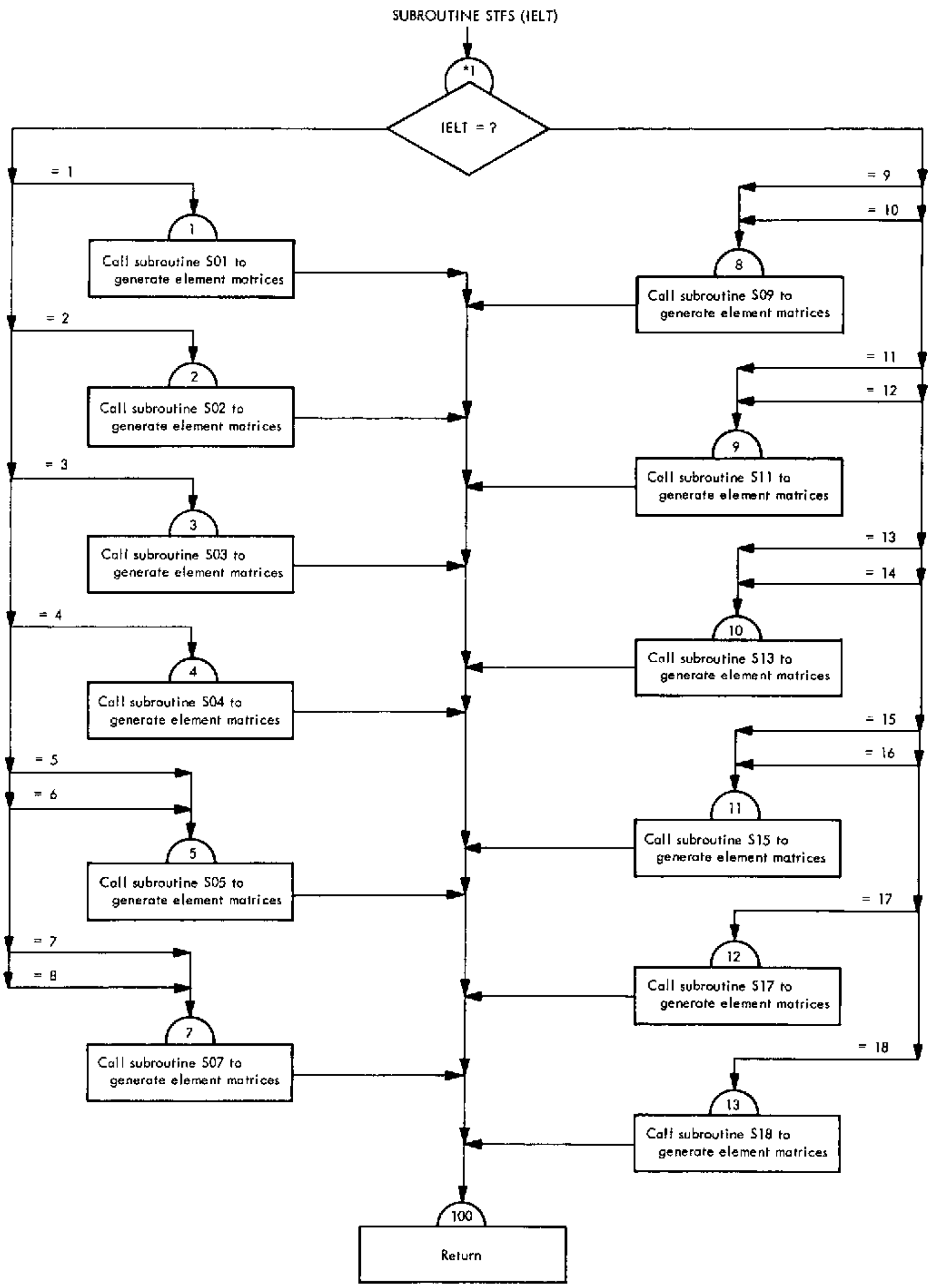

Fig. VI-36. Flowchart of subroutine STFS (Link 2)

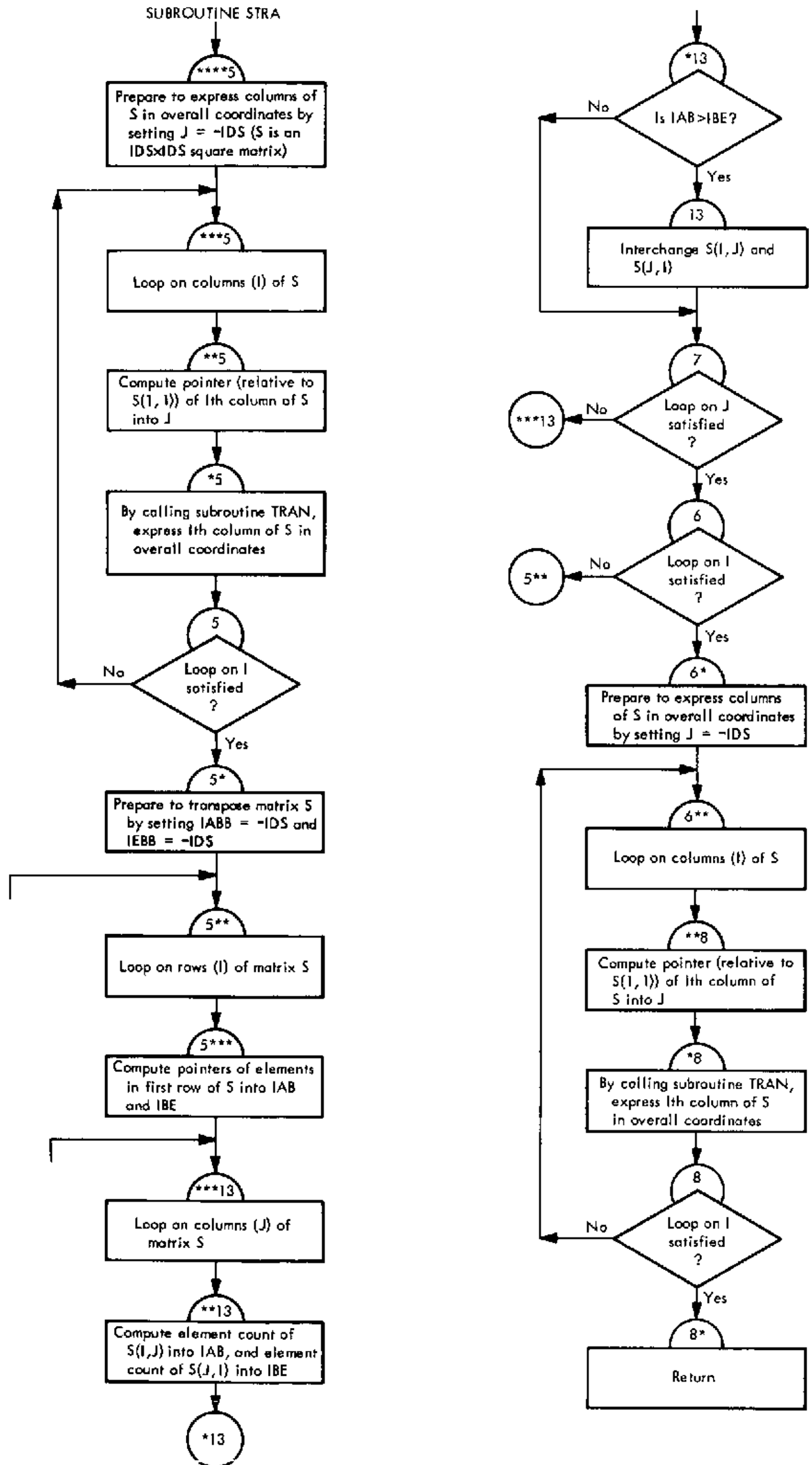

Fig. VI-37. Flowchart of subroutine STRA (Link 2)

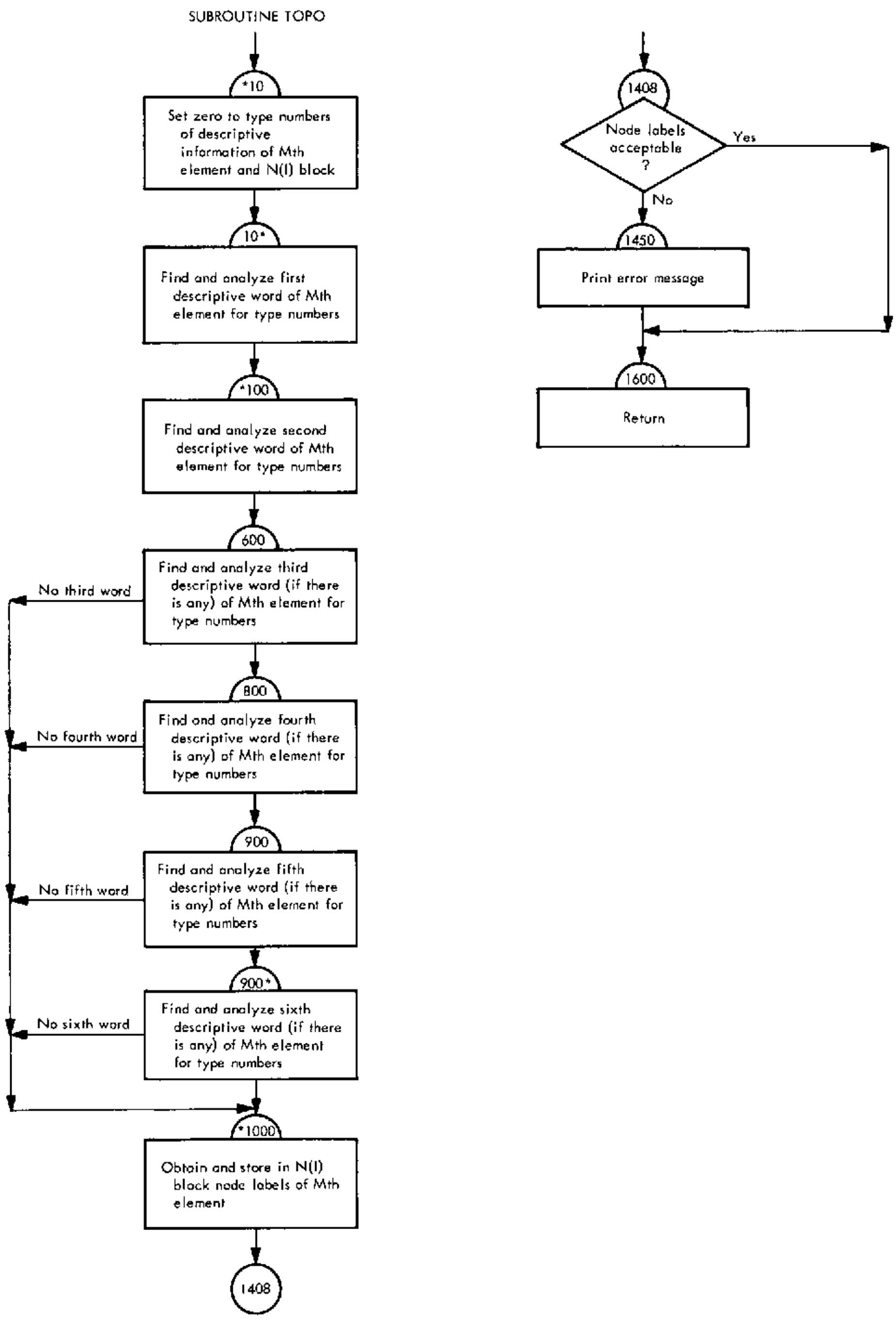

Fig. VI-38. Flowchart of subroutine TOPO (Link 2)

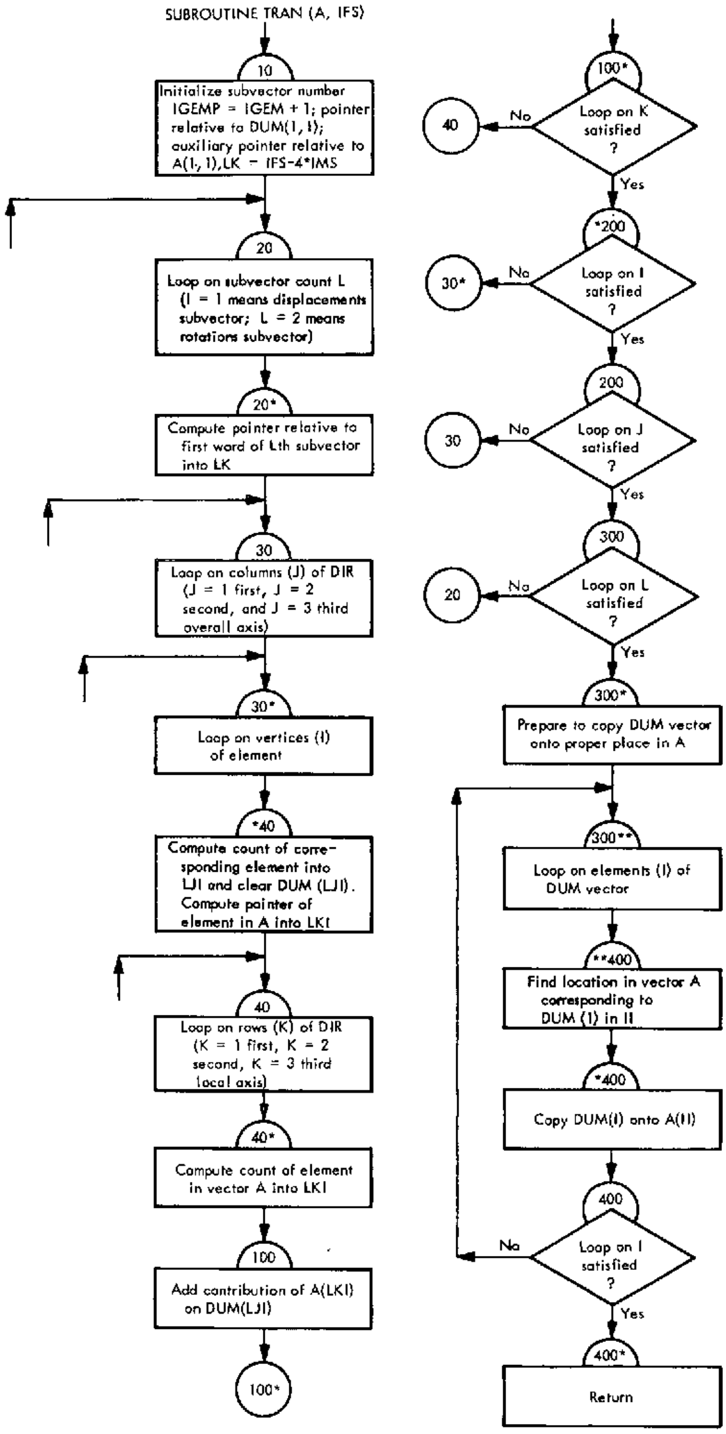

Fig. VI-39. Flowchart of subroutine TRAN (Link 2)

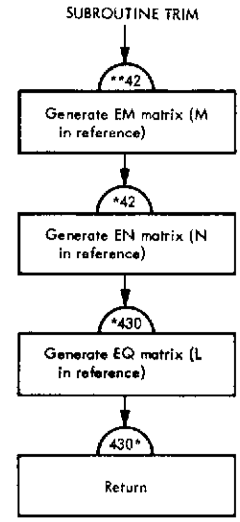

Fig. VI-40. Flowchart of subroutine TRIM (Link 2)

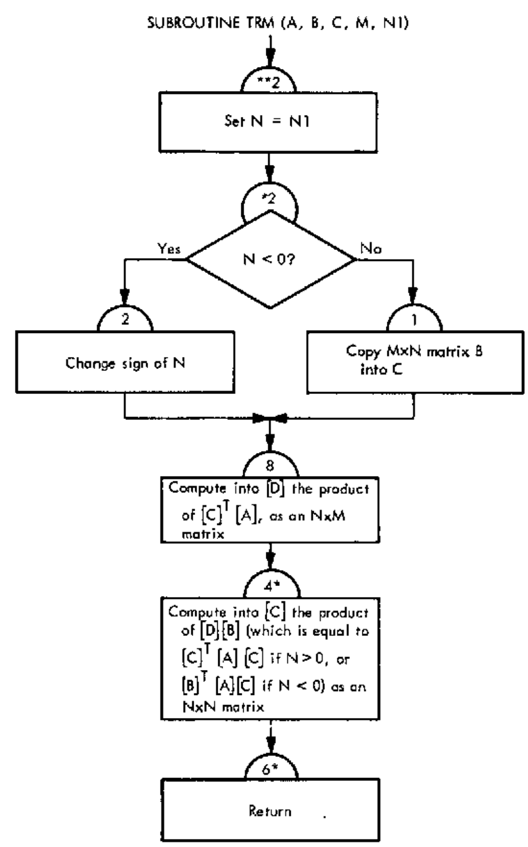

Fig. VI-41. Flowchart of subroutine TRM (Link 2)

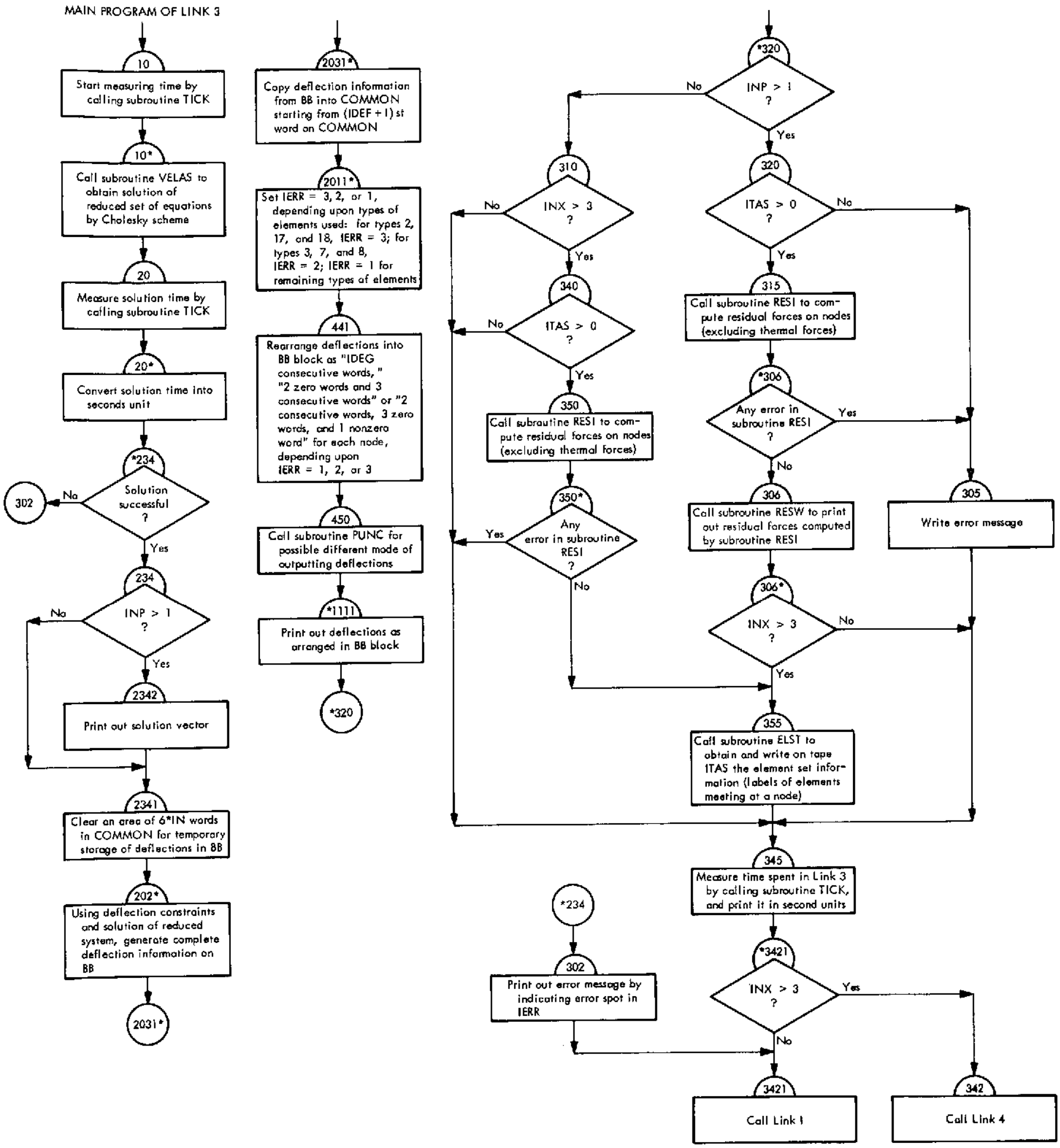

Fig. VI-42. Flowchart of main program of Link 3 (deflection link)

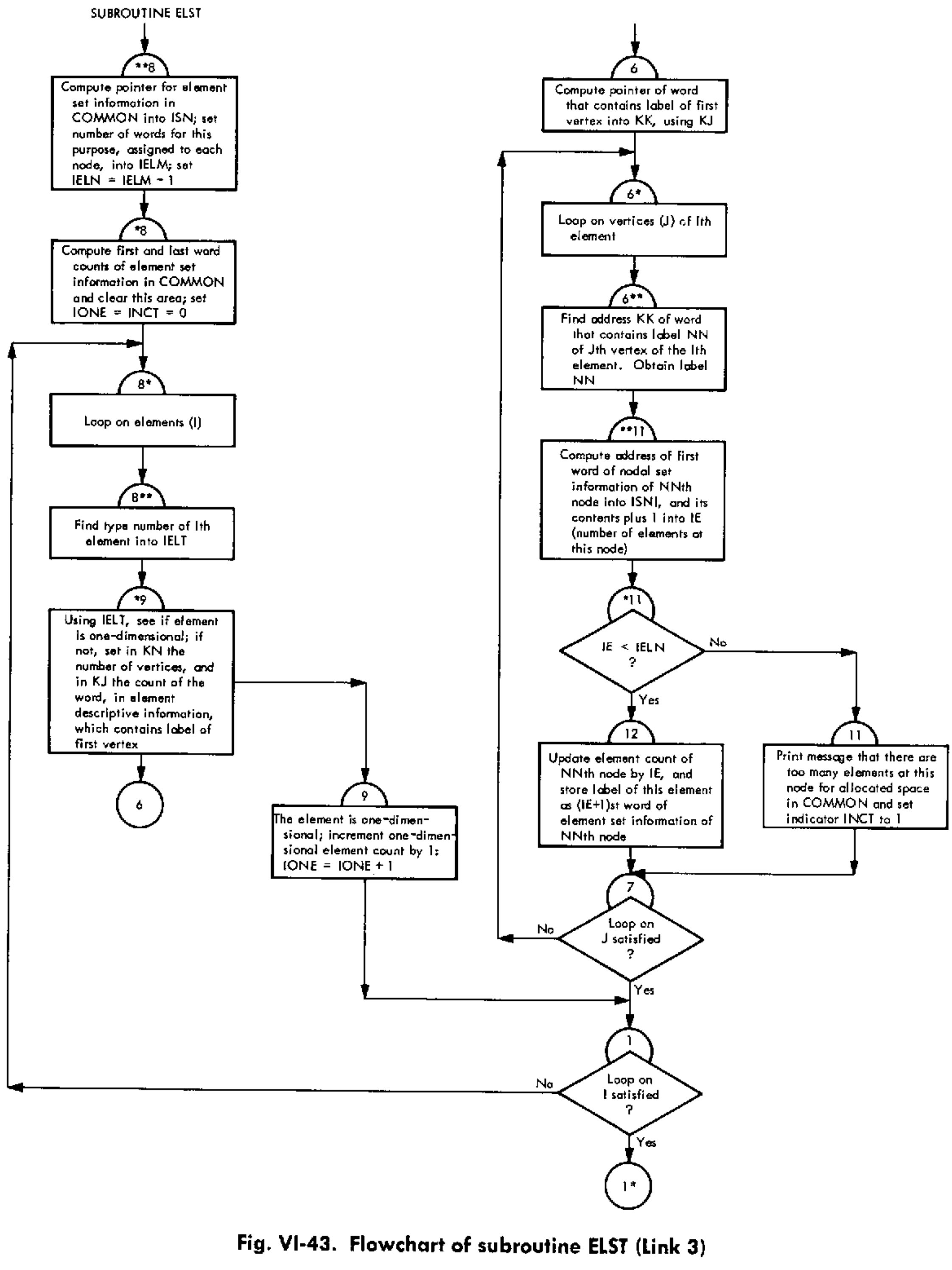

Fig. VI-43. Flowchart of subroutine ELST (Link 3)

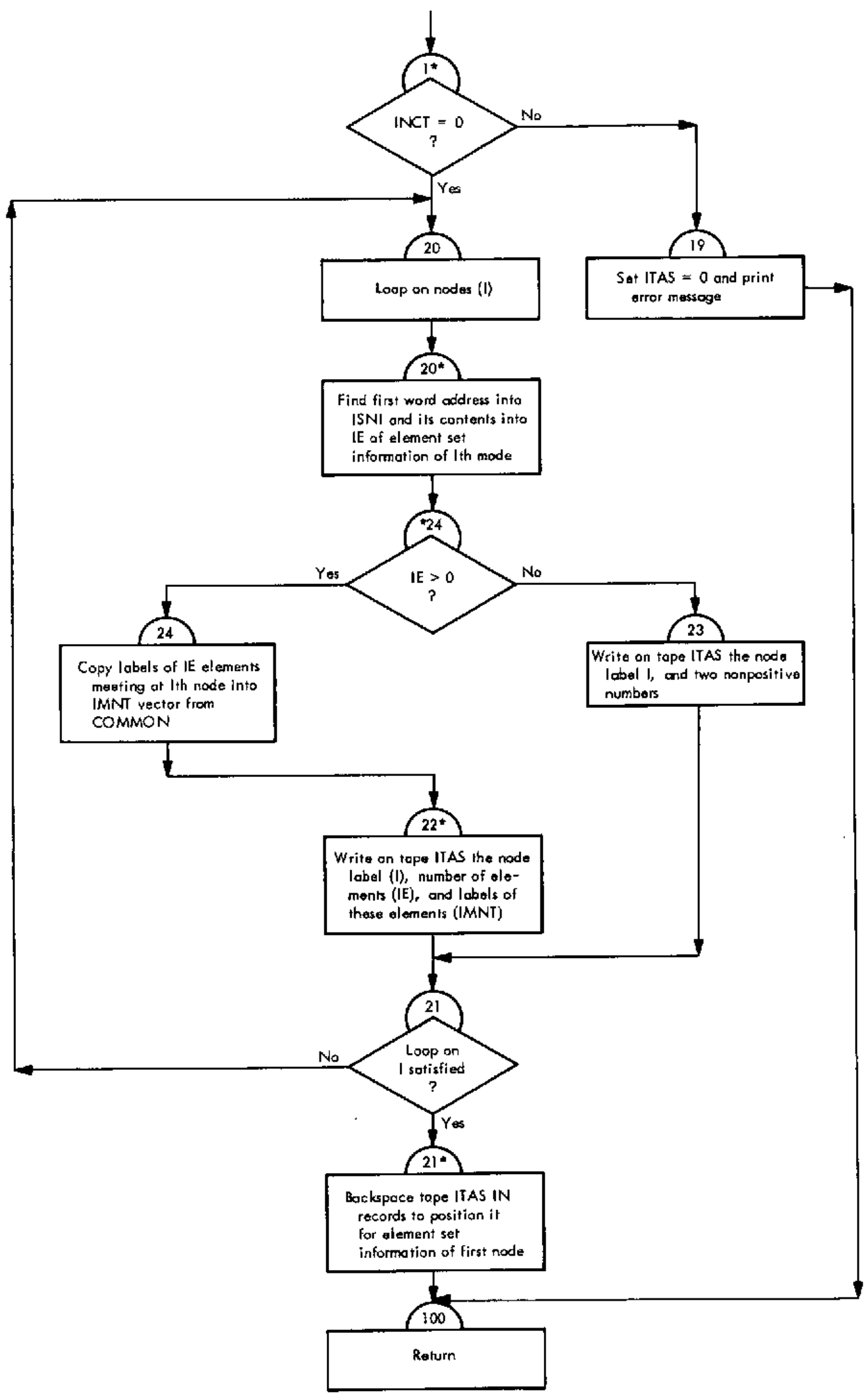

Fig. VI-43 (contd)

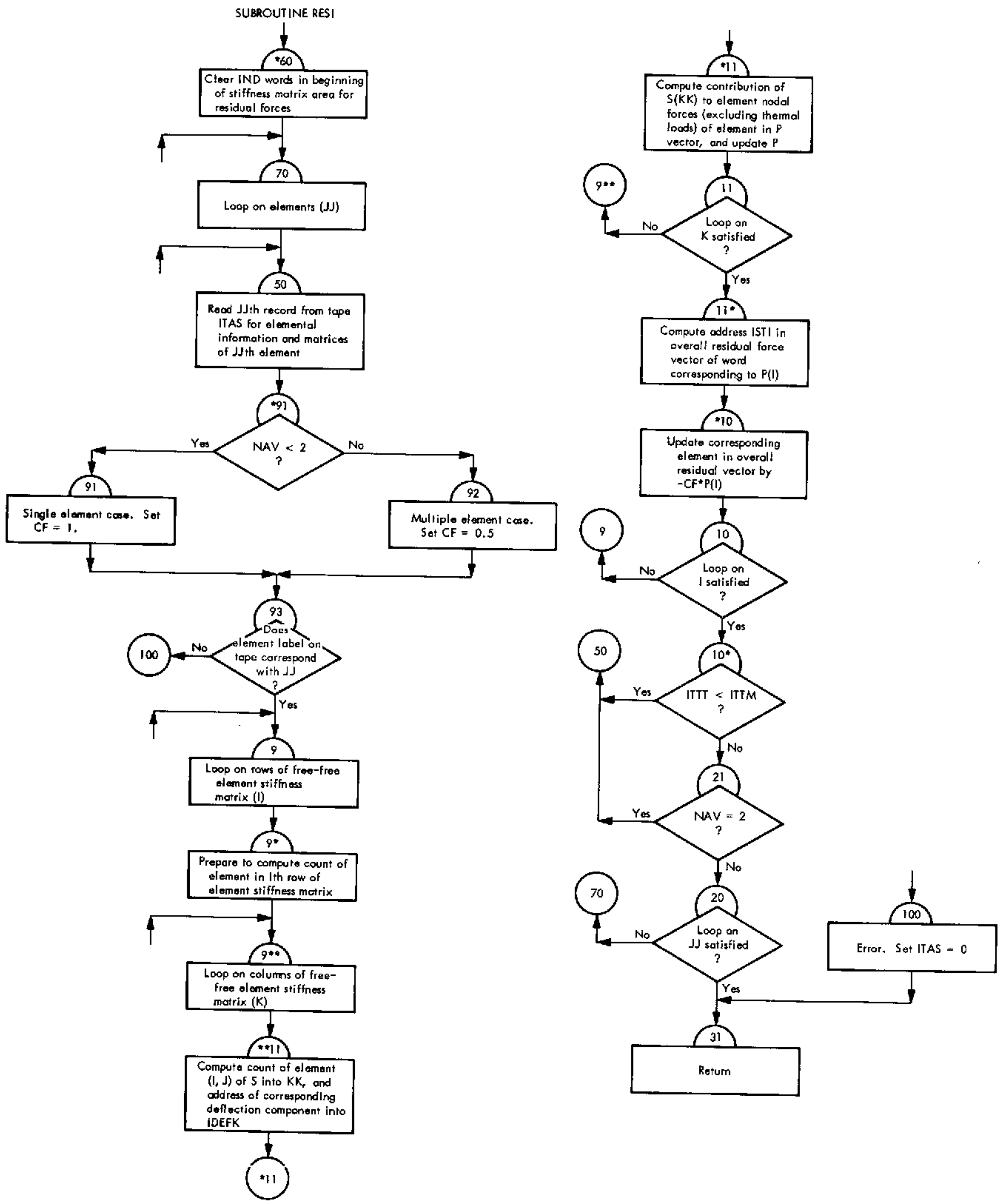

Fig. VI-44. Flowchart of subroutine RESI (Link 3)

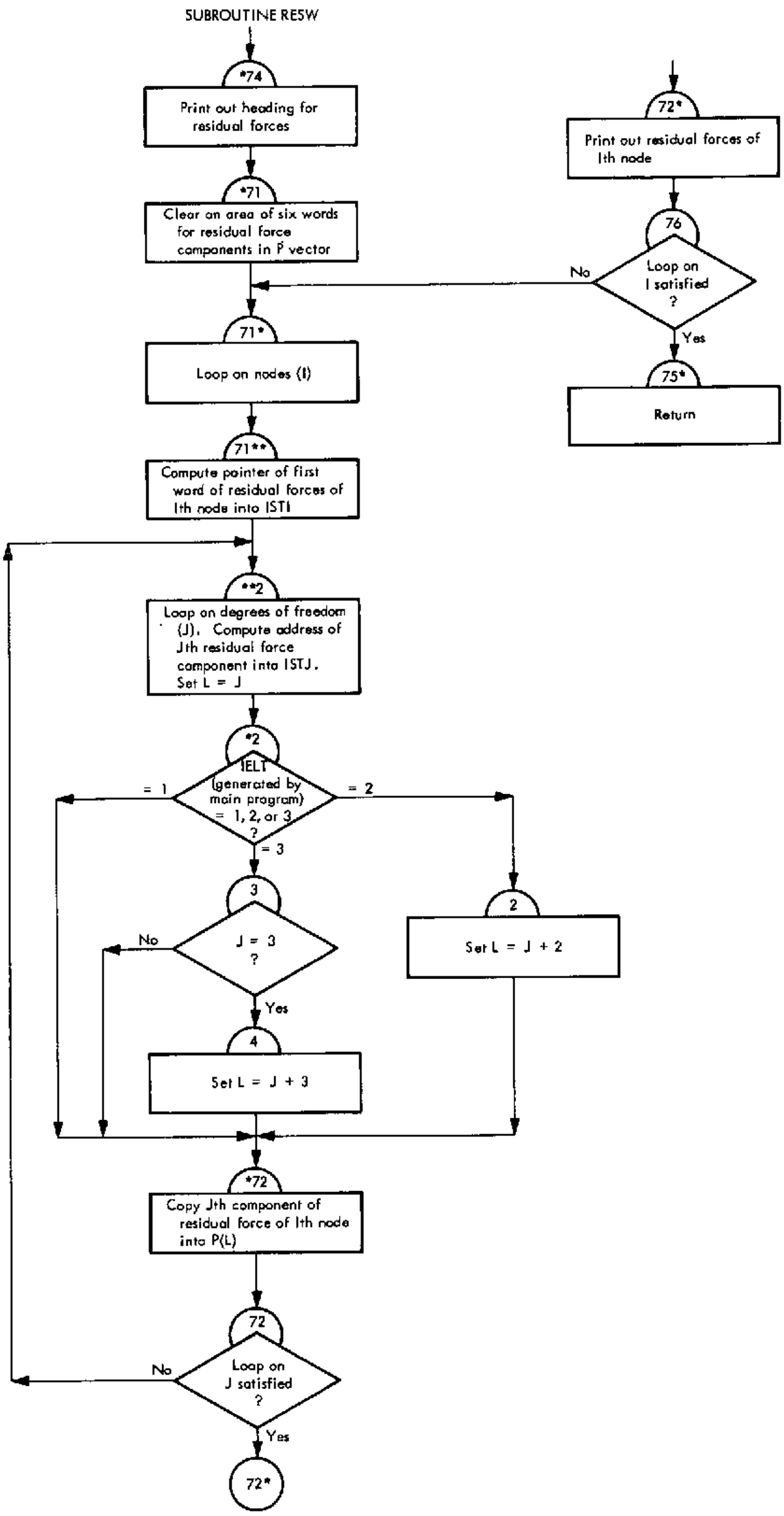

Fig. VI-45. Flowchart of subroutine RESW (Link 3)

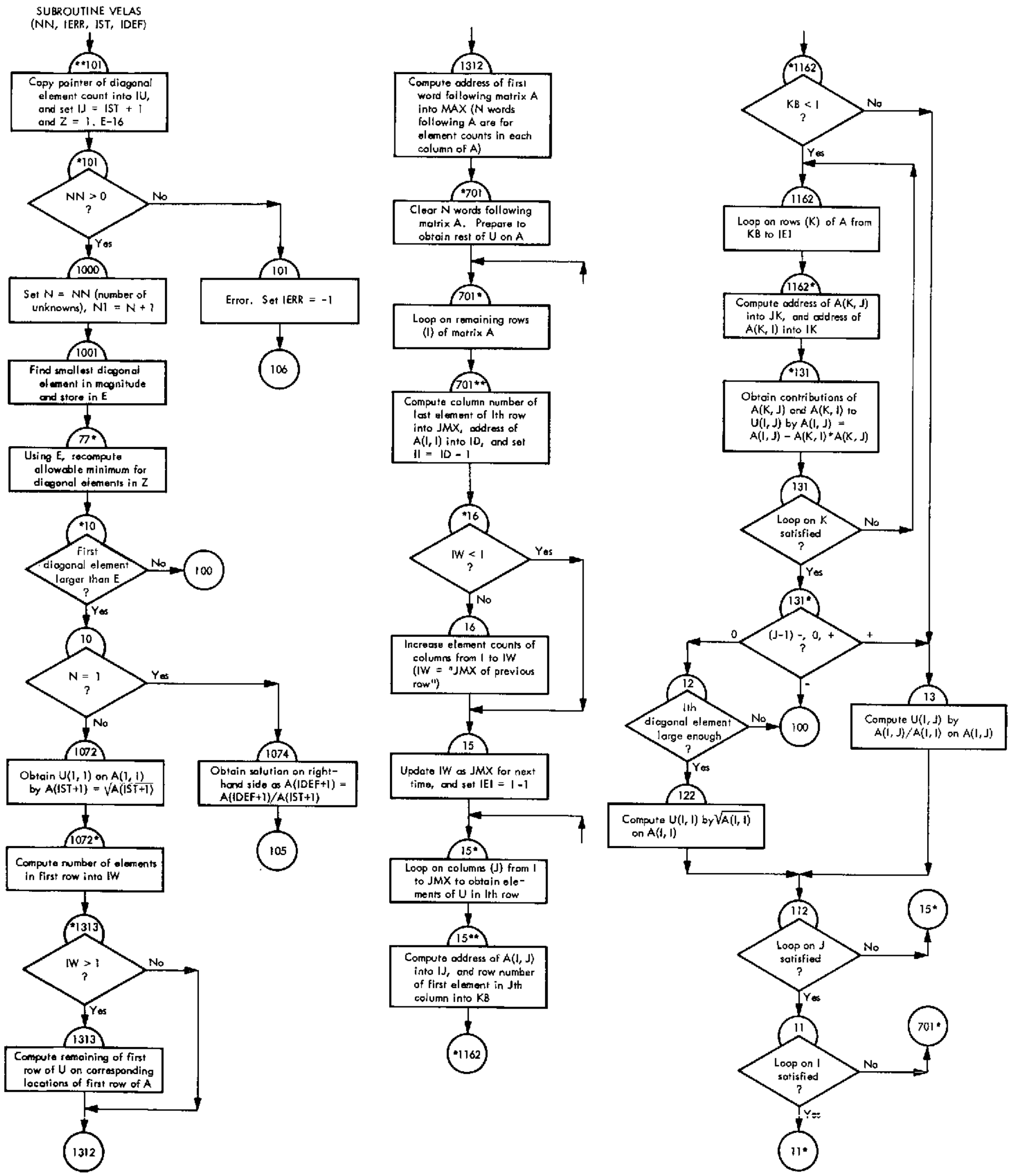

Fig. VI-46. Flowchart of subroutine VELAS (Link 3)

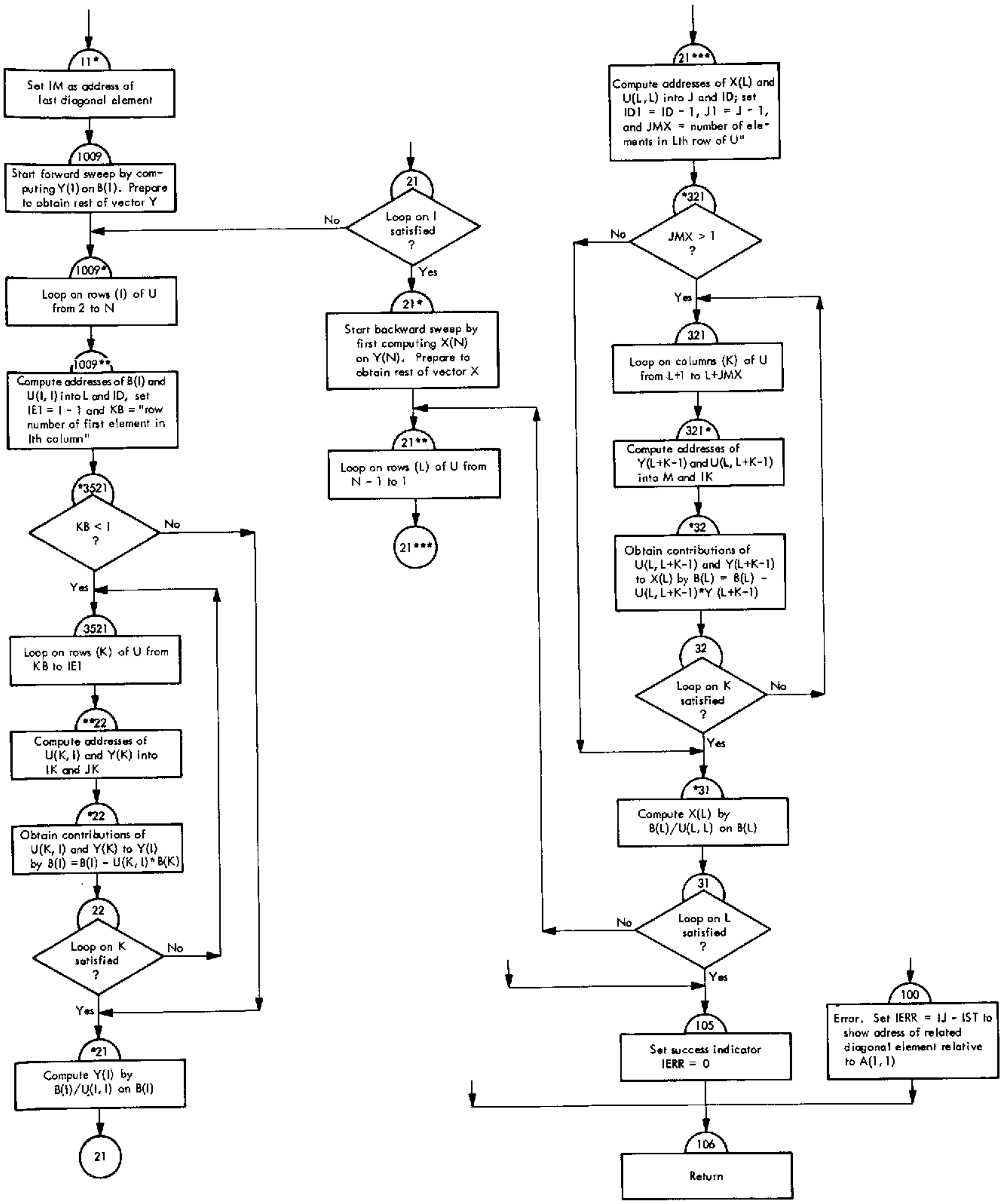

Fig. VI-46 (contd)

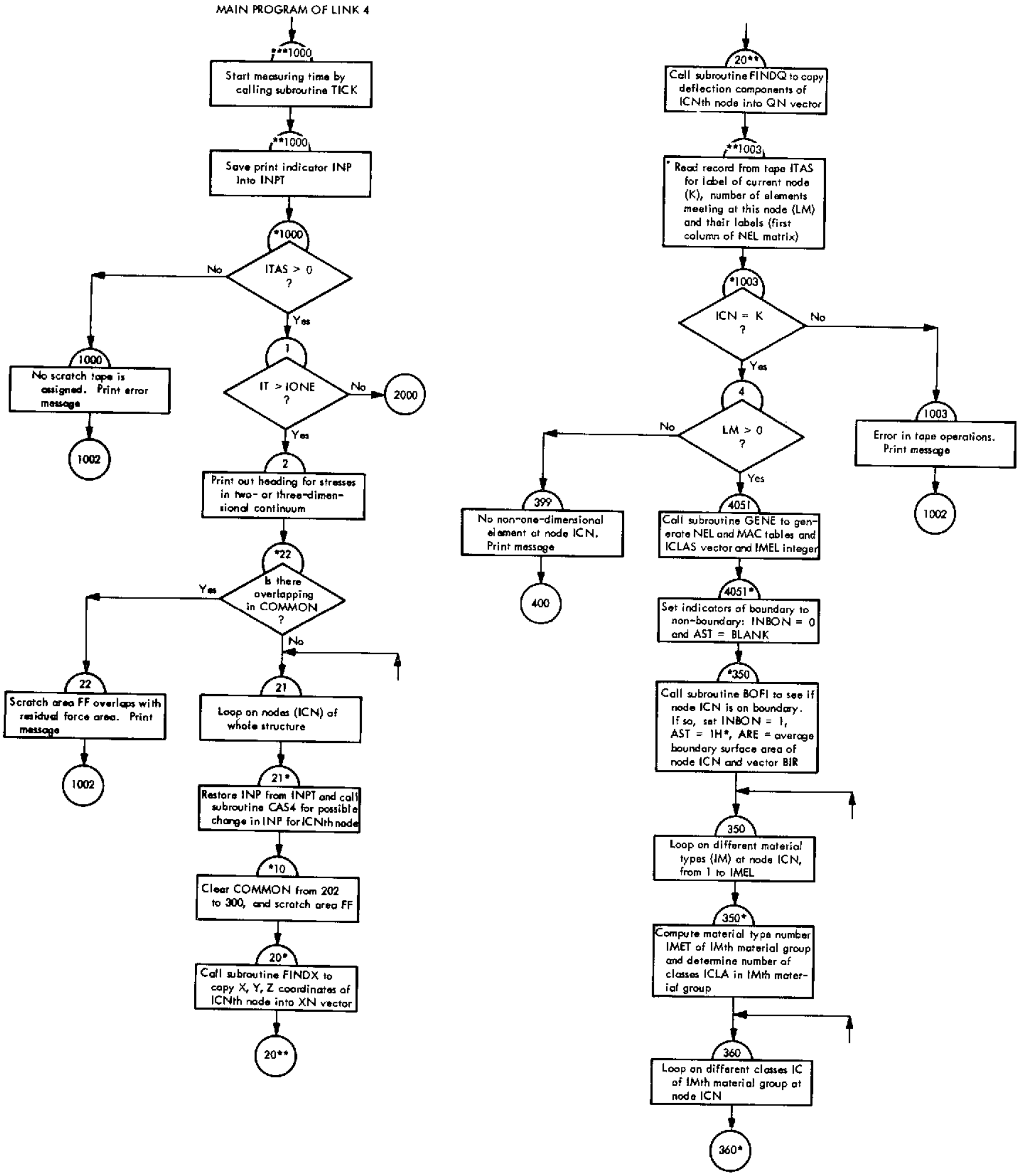

Fig. VI-47. Flowchart of main program of Link 4 (stress link)

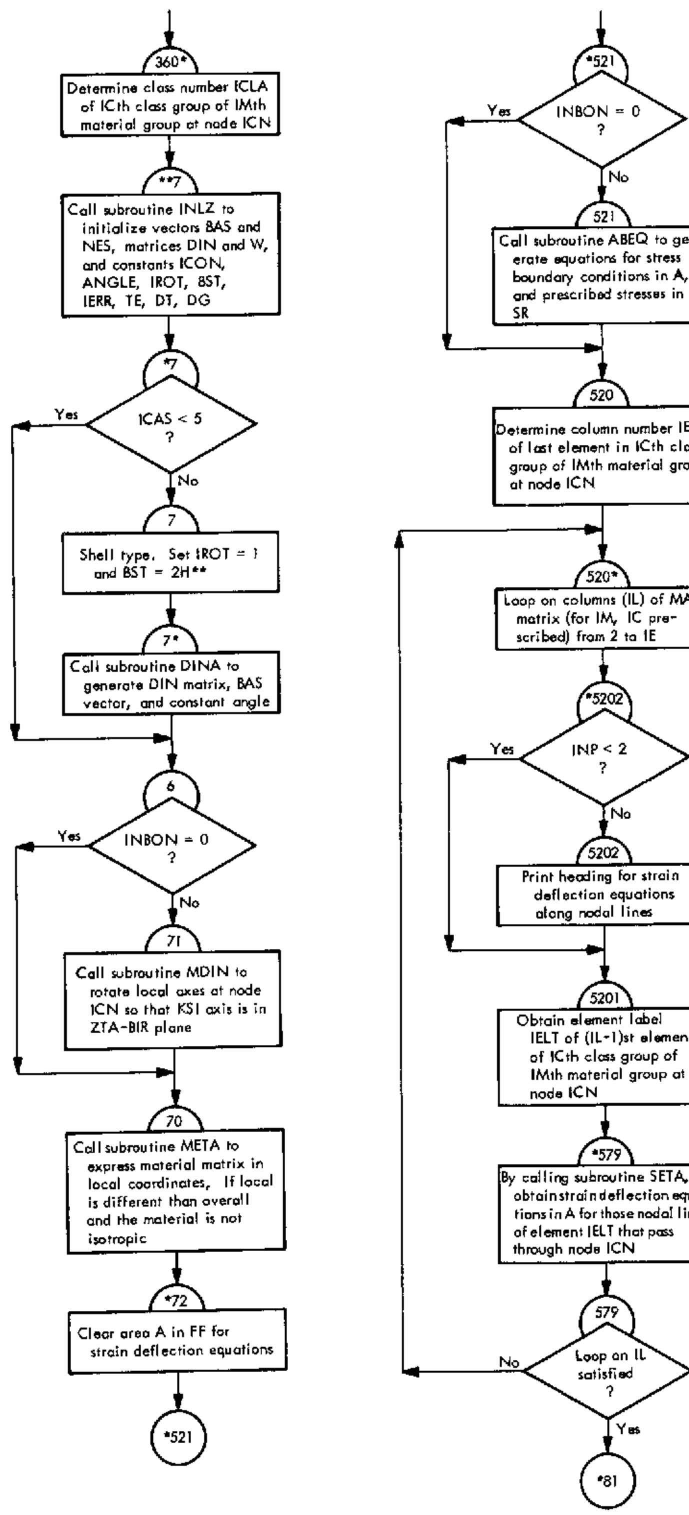

Fig. VI-47 (contd)

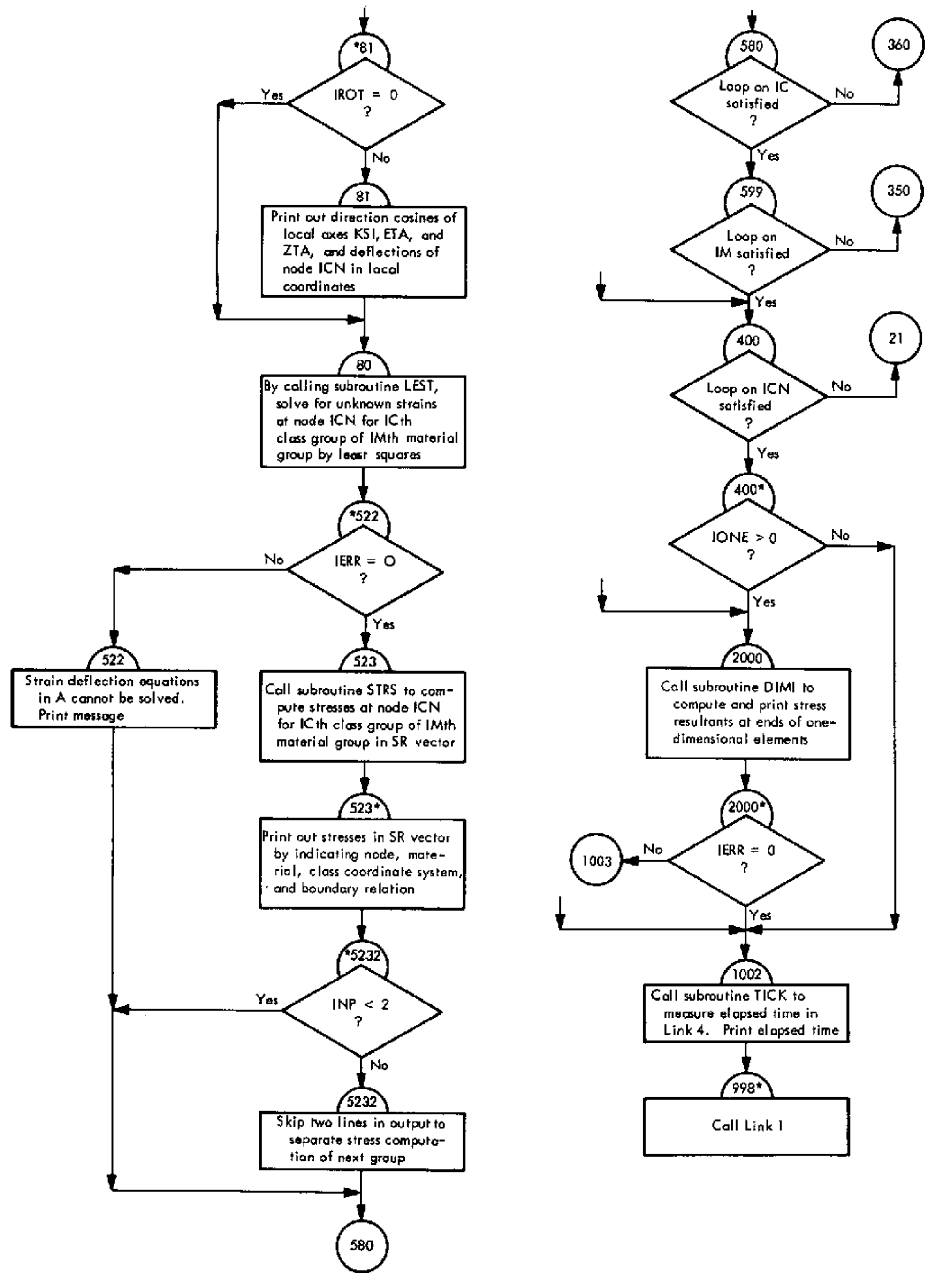

Fig. VI-47 (contd)

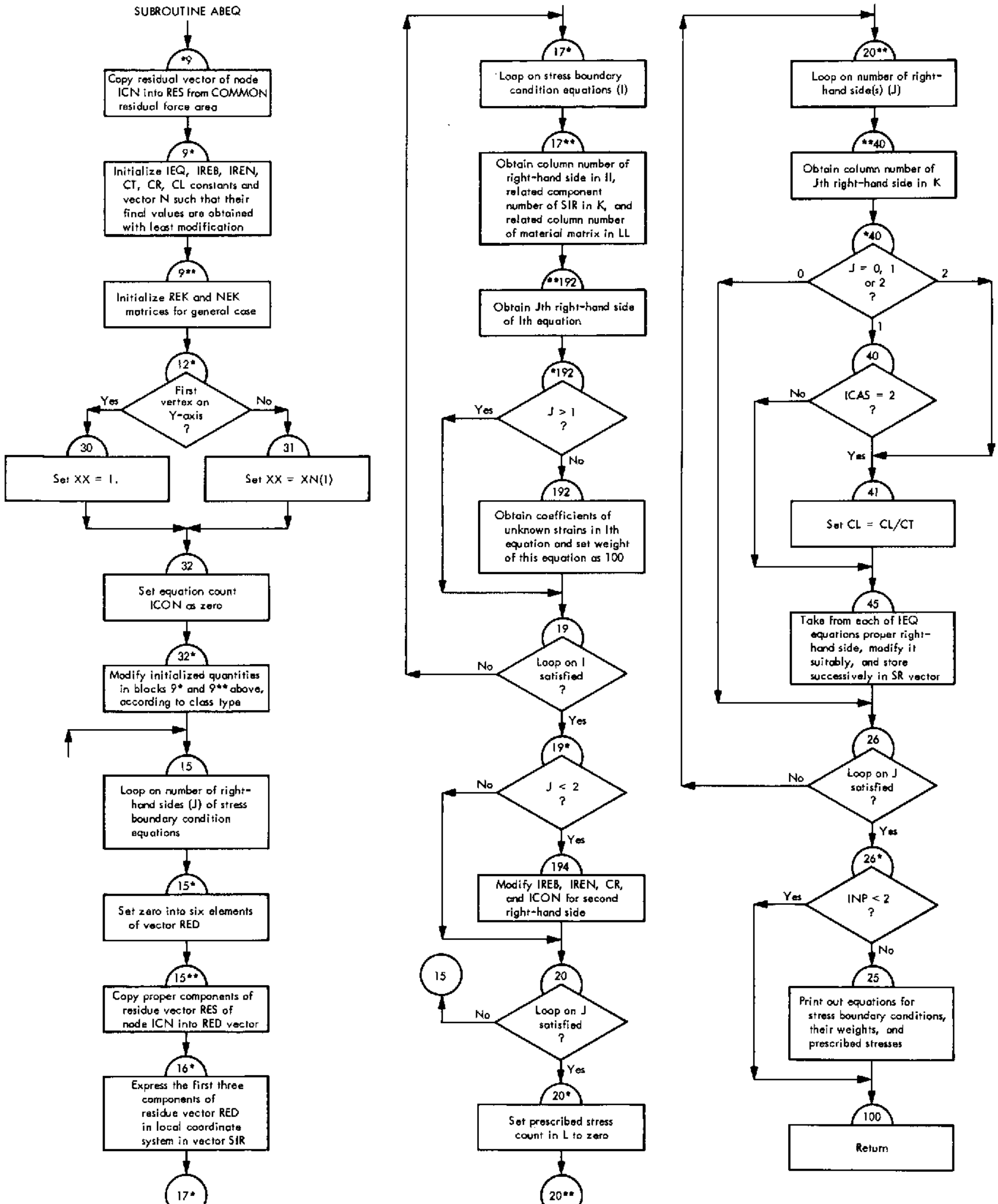

Fig. VI-48. Flowchart of subroutine ABEQ (Link 4)

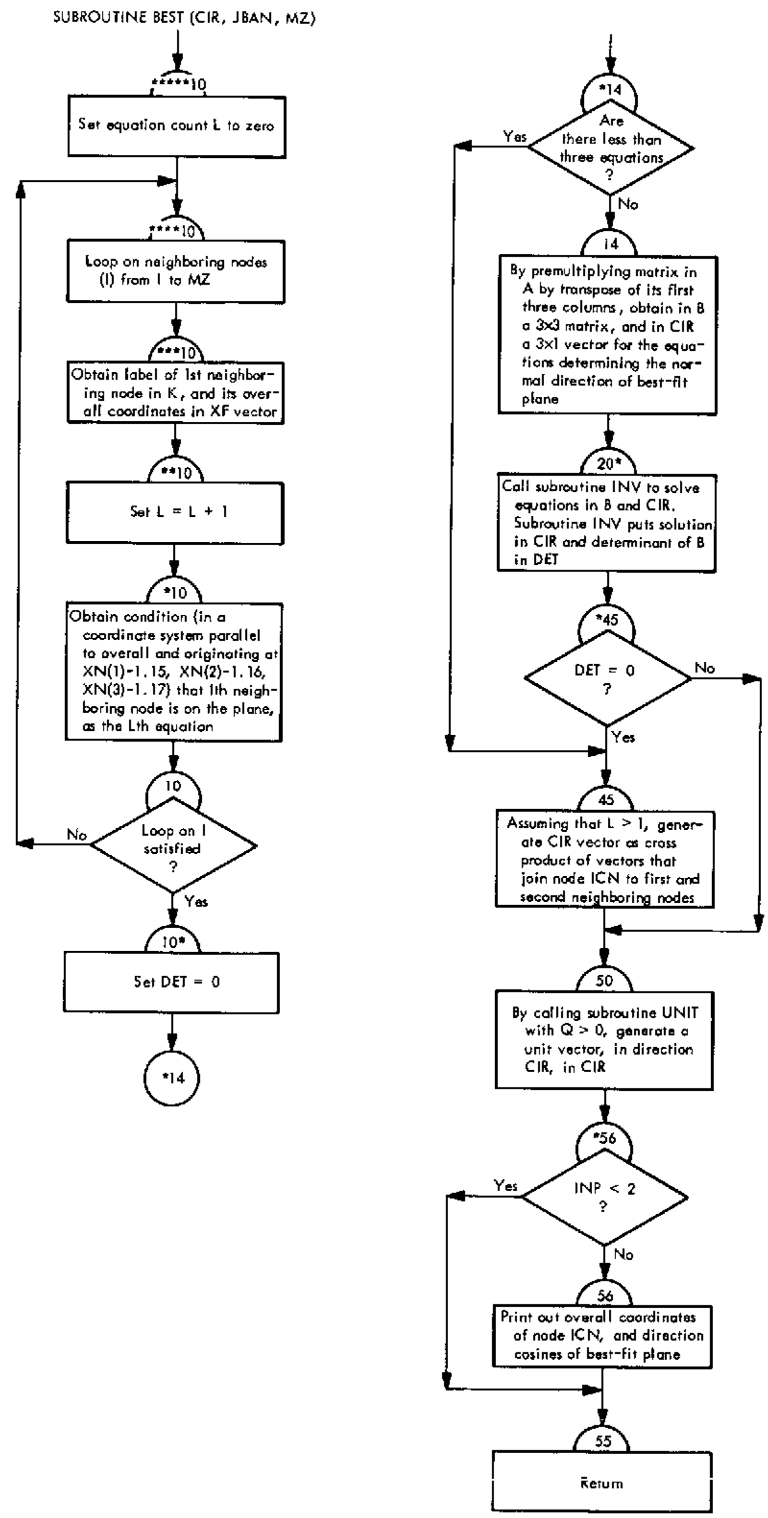

Fig. VI-49. Flowchart of subroutine BEST (Link 4)

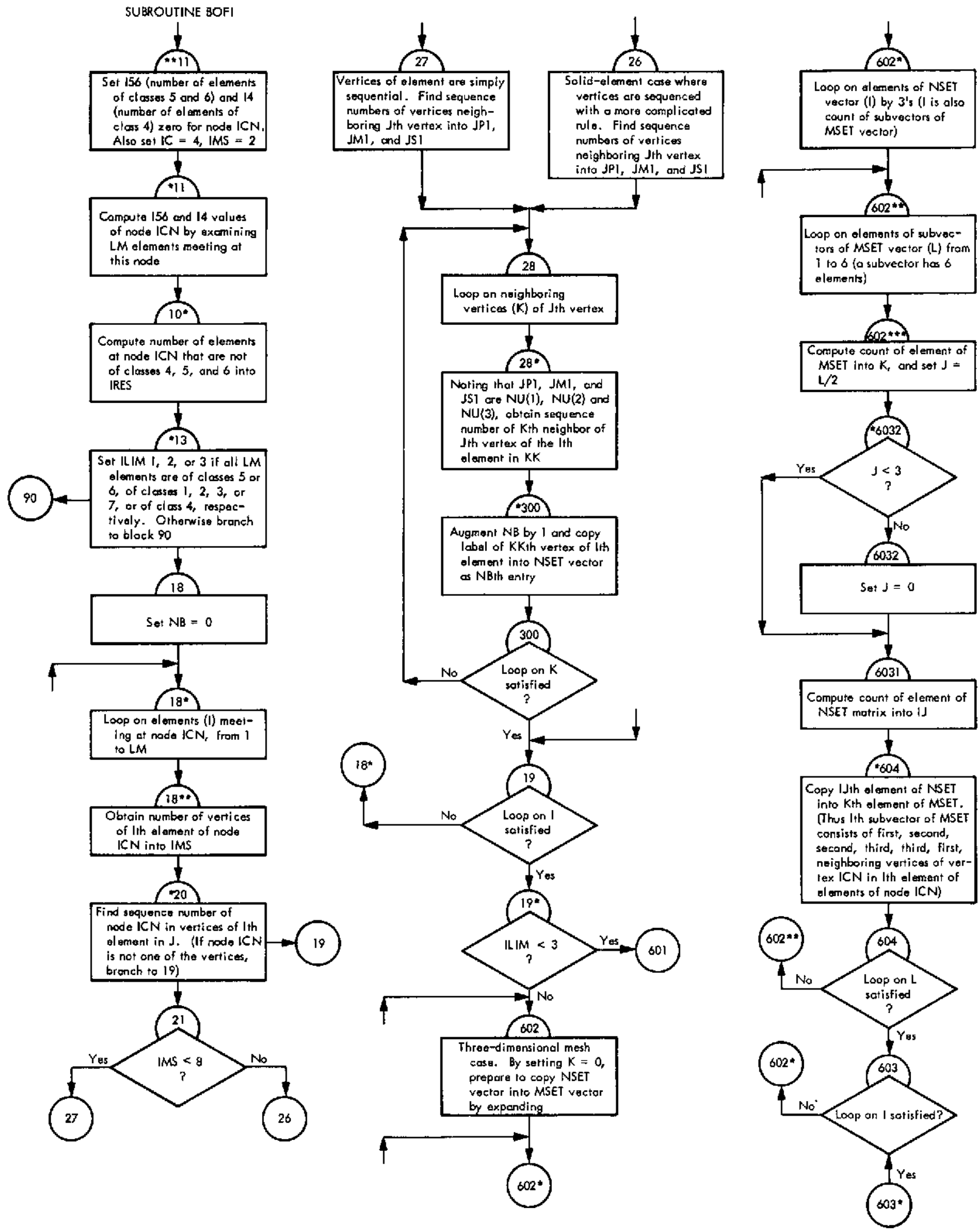

Fig. VI-50. Flowchart of subroutine BOFI (Link 4)

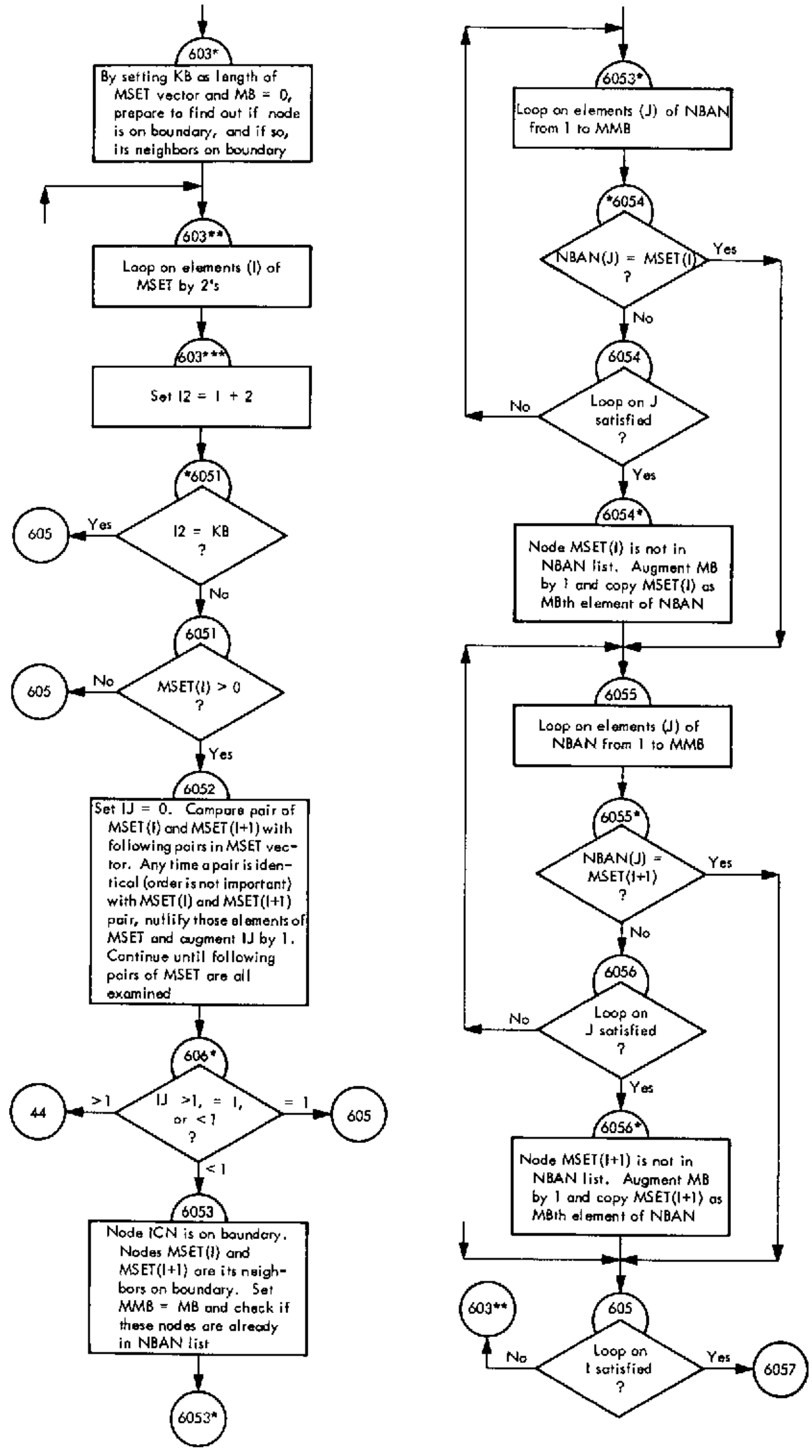

Fig. VI-50 (contd)

C-2

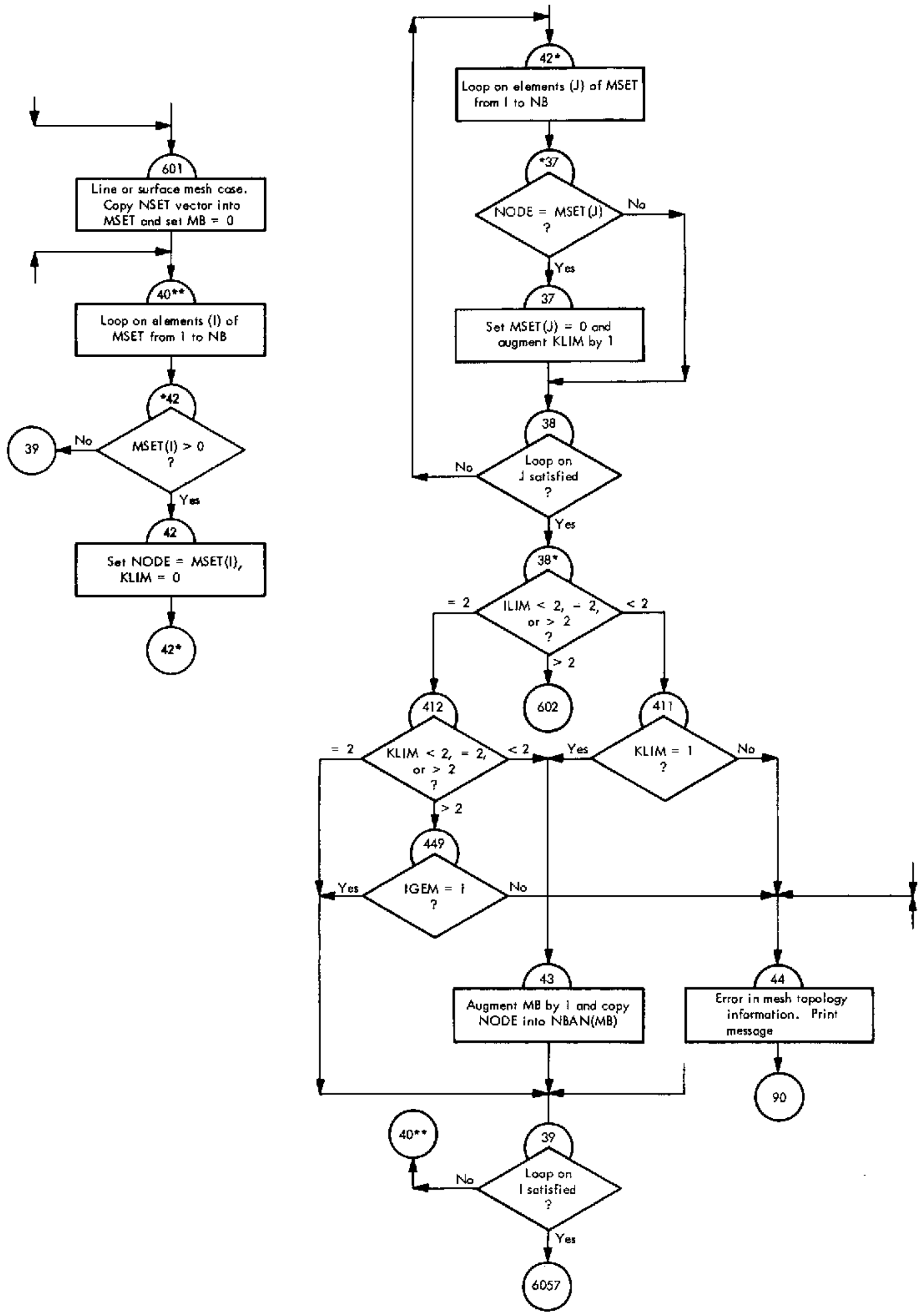

Fig. VI-50 (contd)

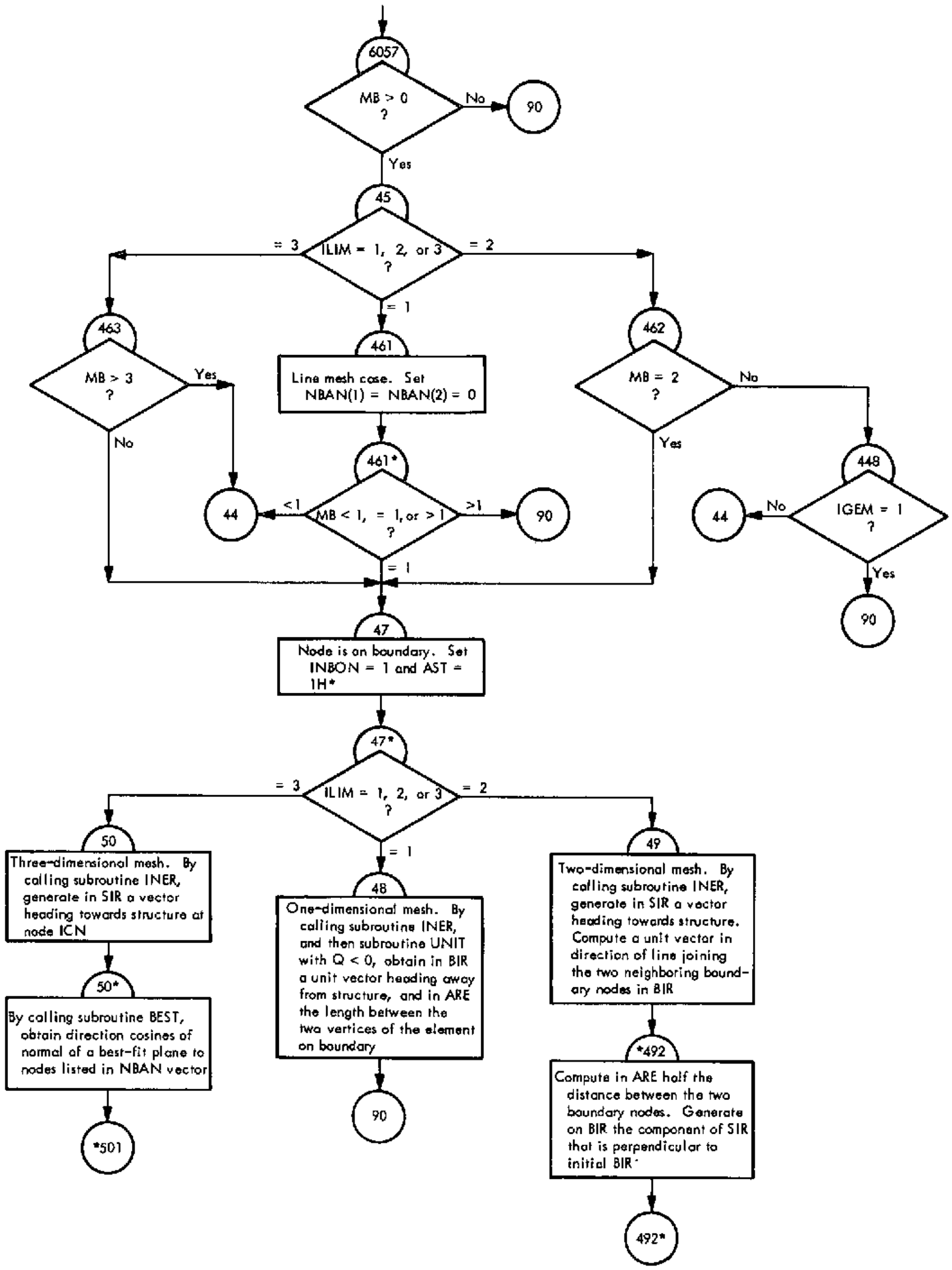

Fig. VI-50 (contd)

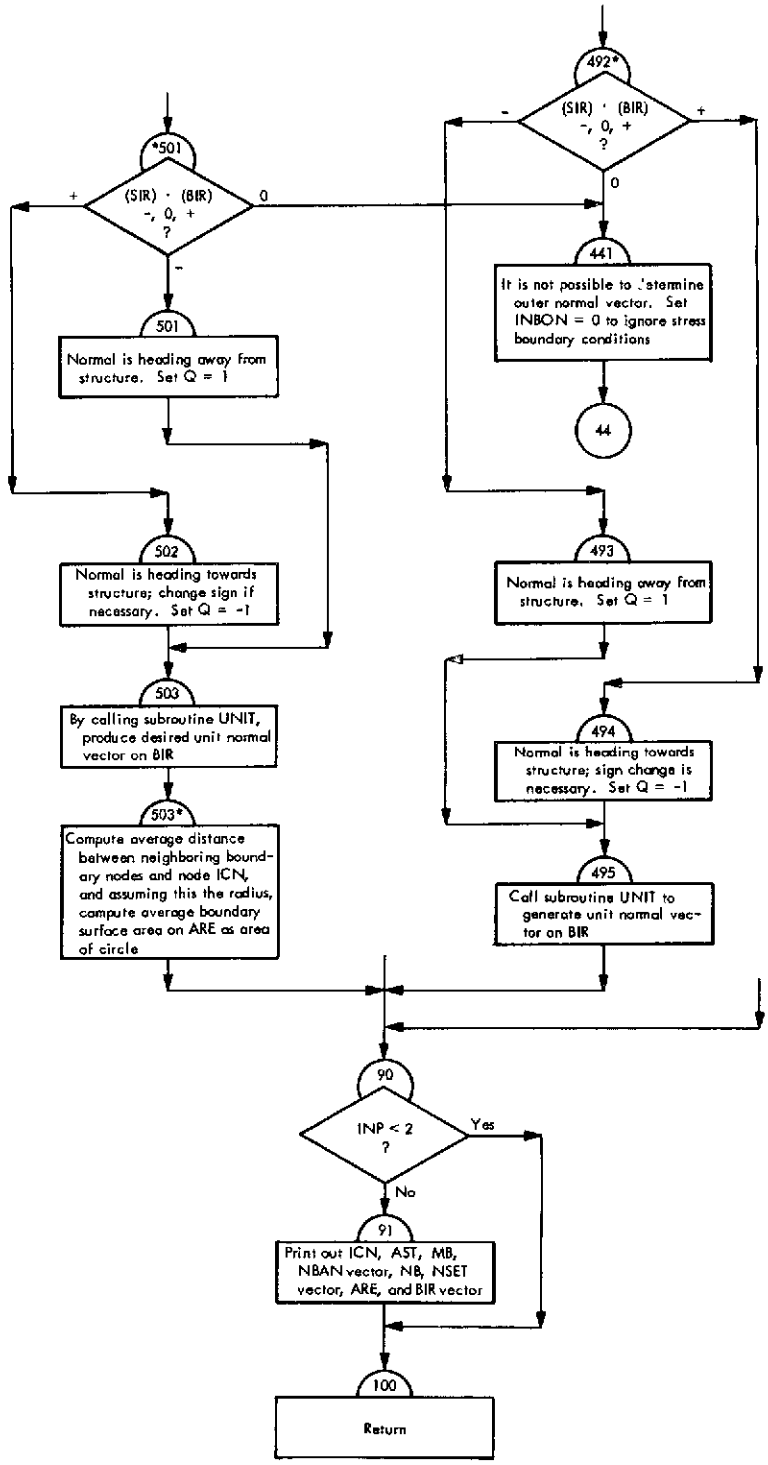

Fig. VI-50 (contd)

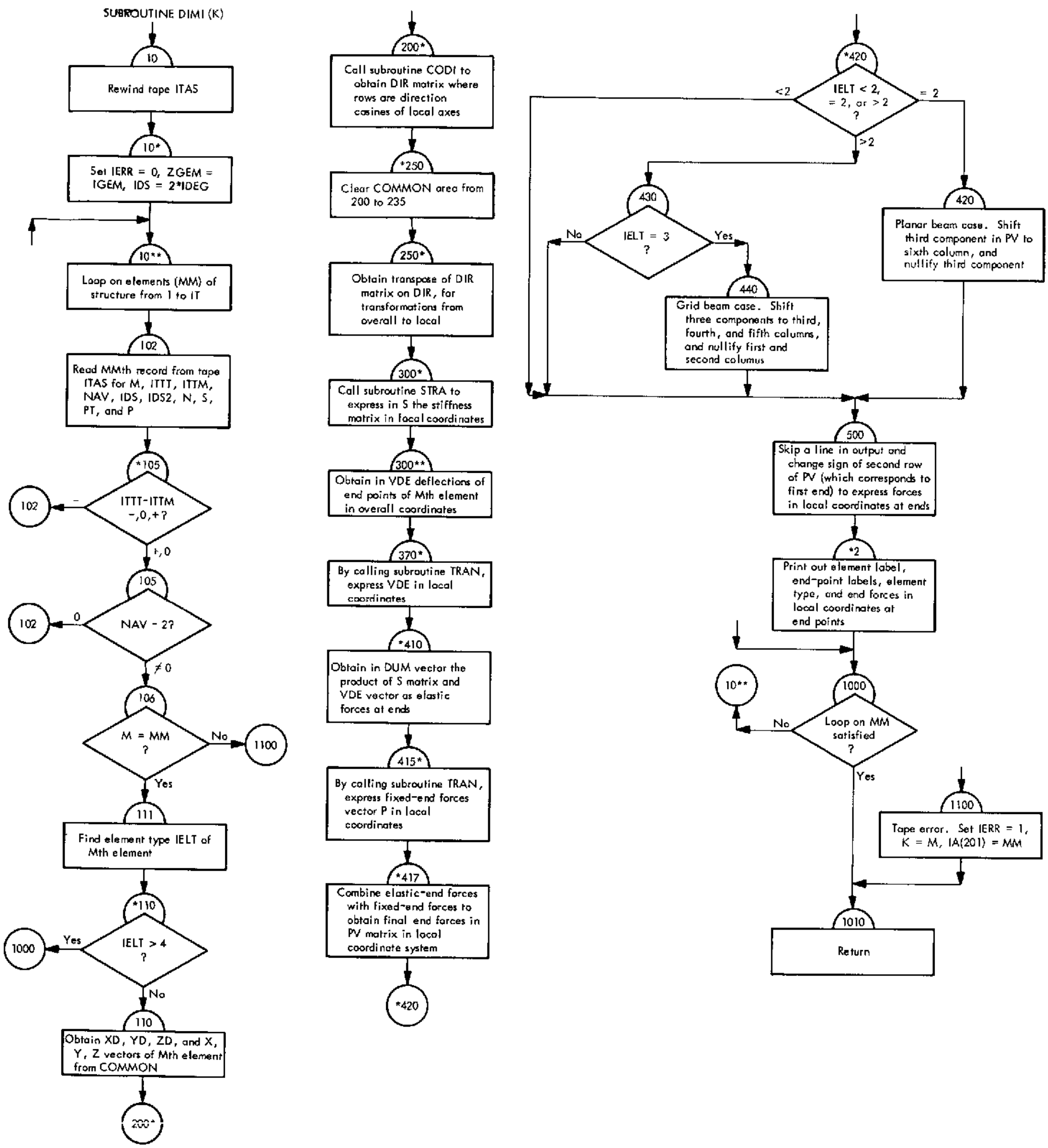

Fig. VI-51. Flowchart of subroutine DIMI (Link 4)

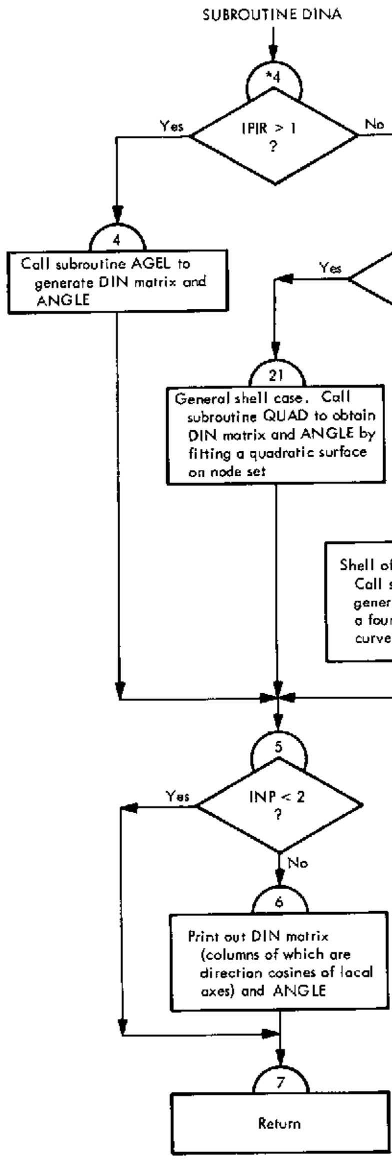

Fig. VI-52. Flowchart of subroutine DINA (Link 4)

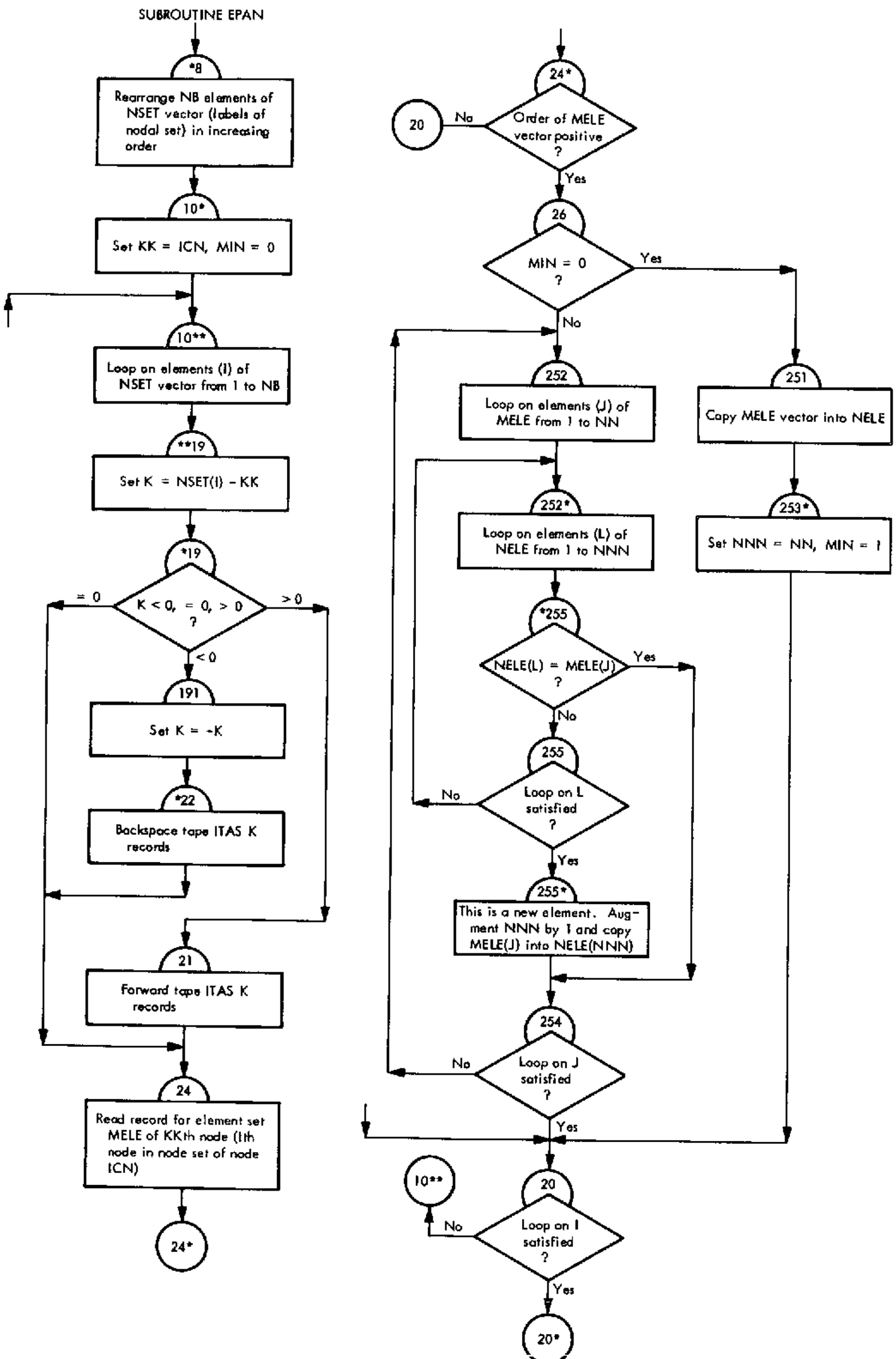

Fig. VI-53. Flowchart of subroutine EPAN (Link 4)

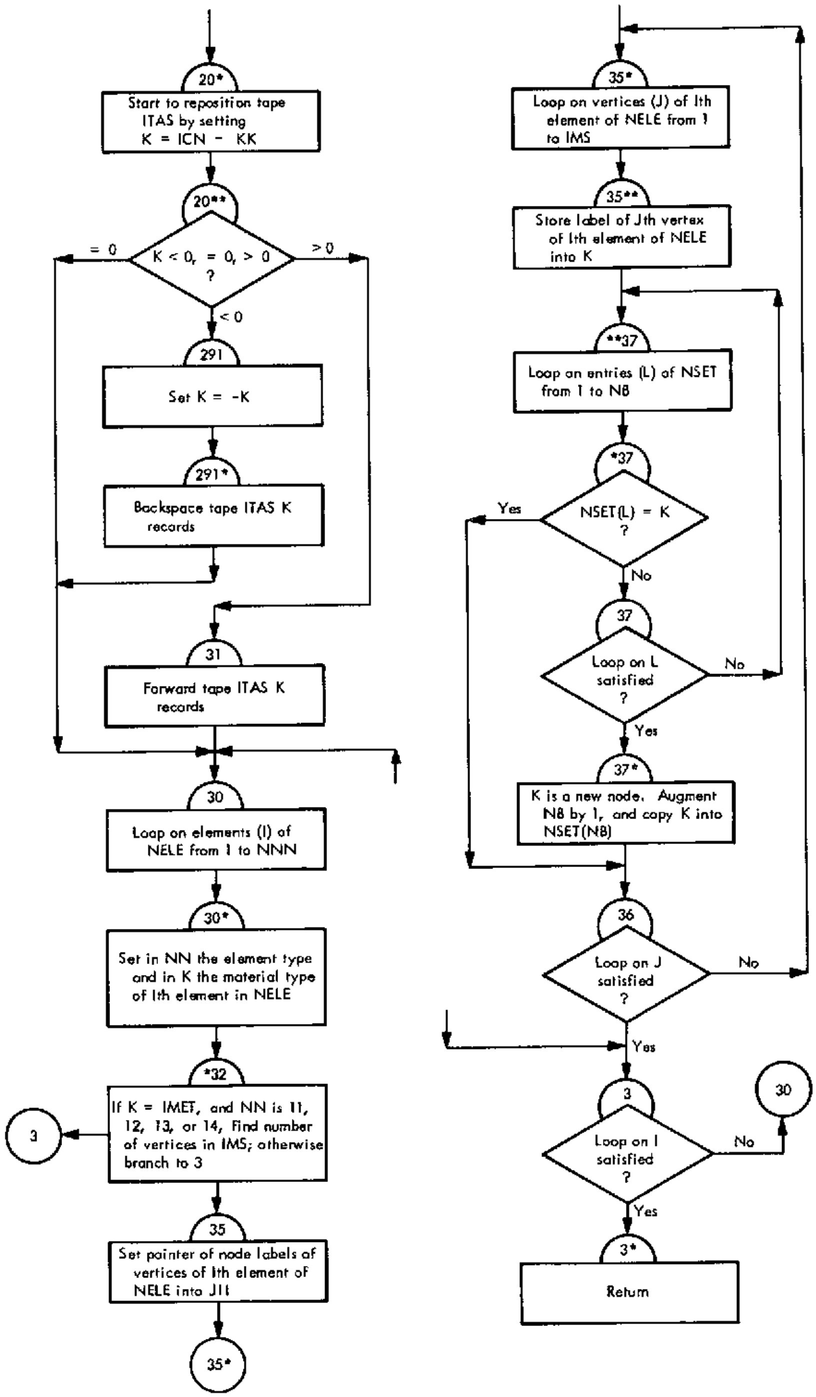

Fig. VI-53 (contd)

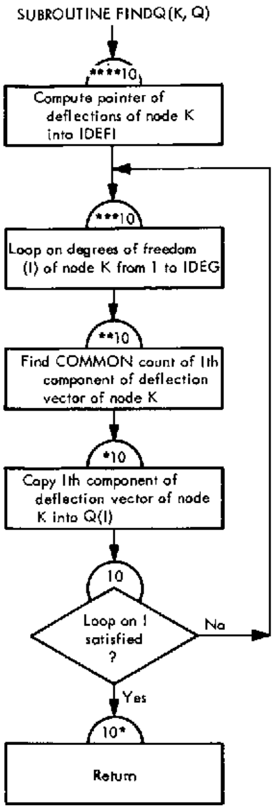

Fig. VI-54. Flowchart of subroutine FINDQ (Link 4)

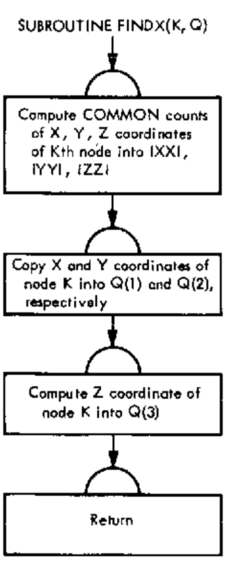

Fig. VI-55. Flowchart of subroutine FINDX (Link 4)

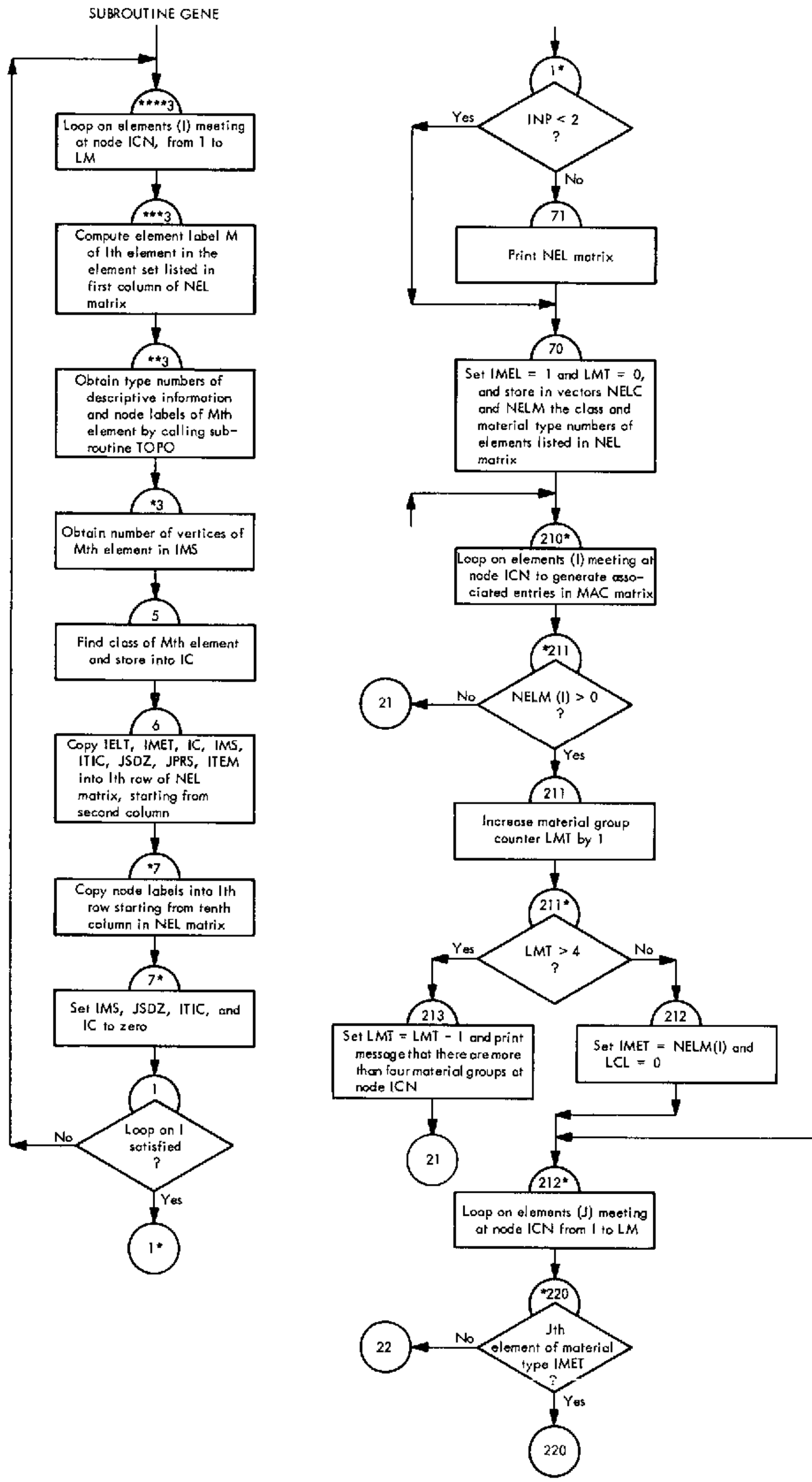

Fig. VI-56. Flowchart of subroutine GENE (Link 4)

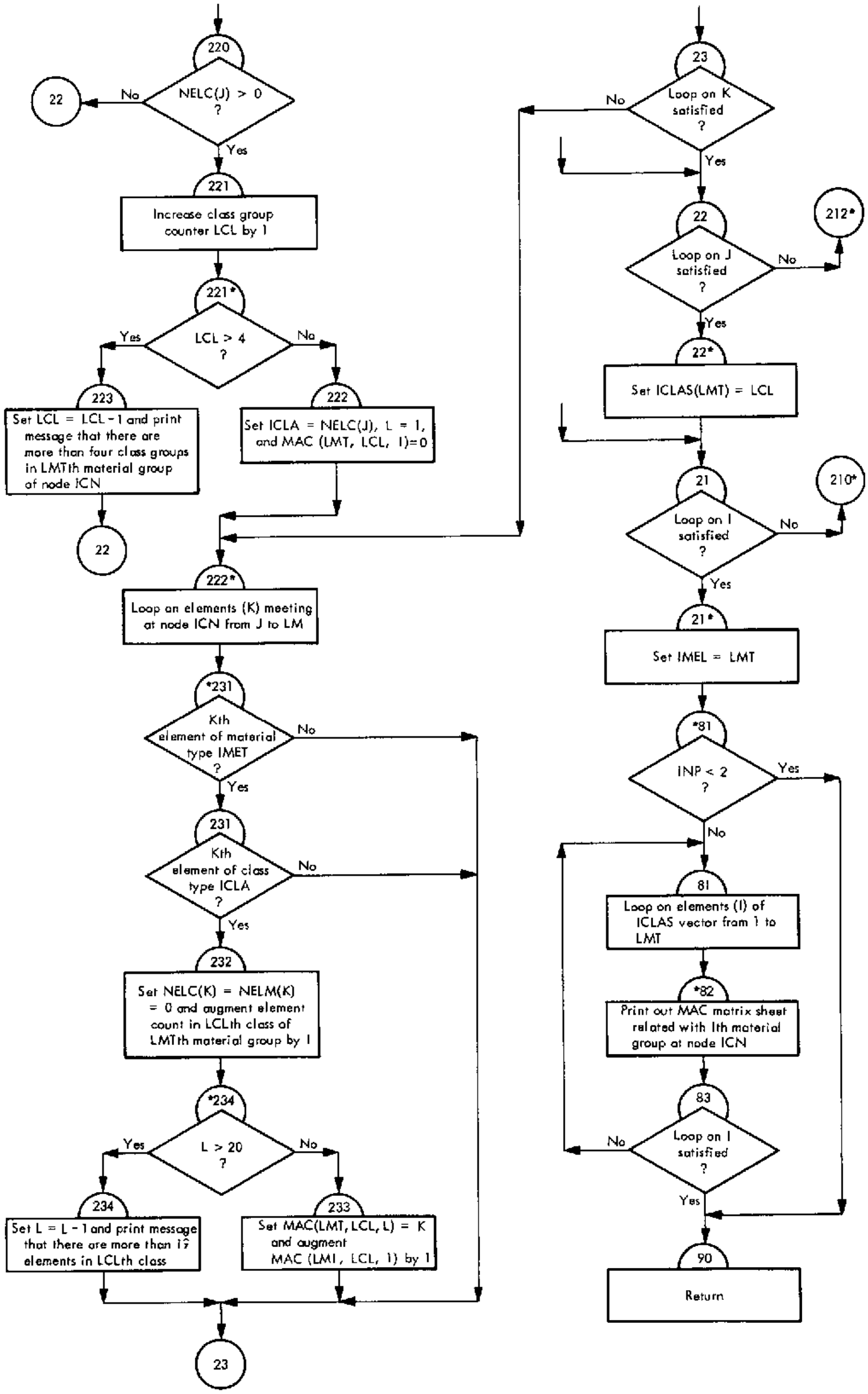

Fig. VI-56 (contd)

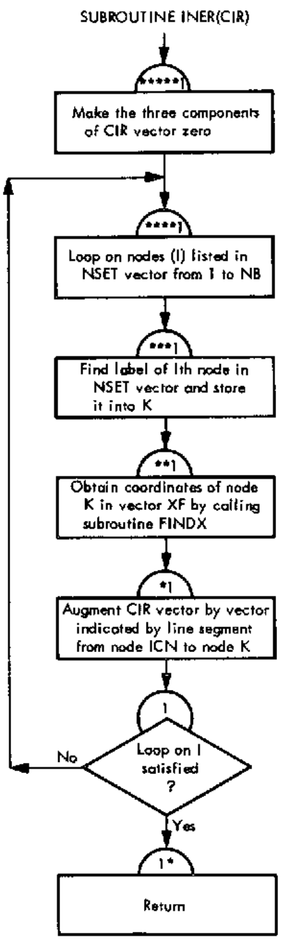

Fig. VI-57. Flowchart of subroutine INER (Link 4)

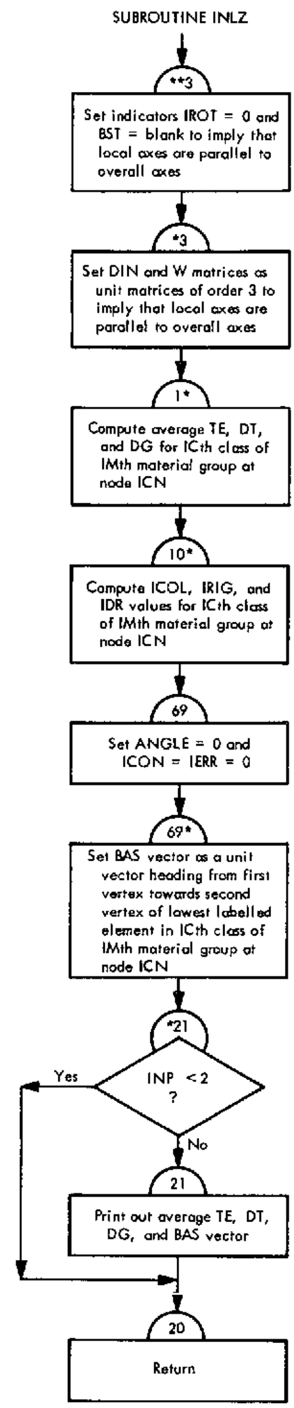

Fig. VI-58. Flowchart of subroutine INLZ (Link 4)

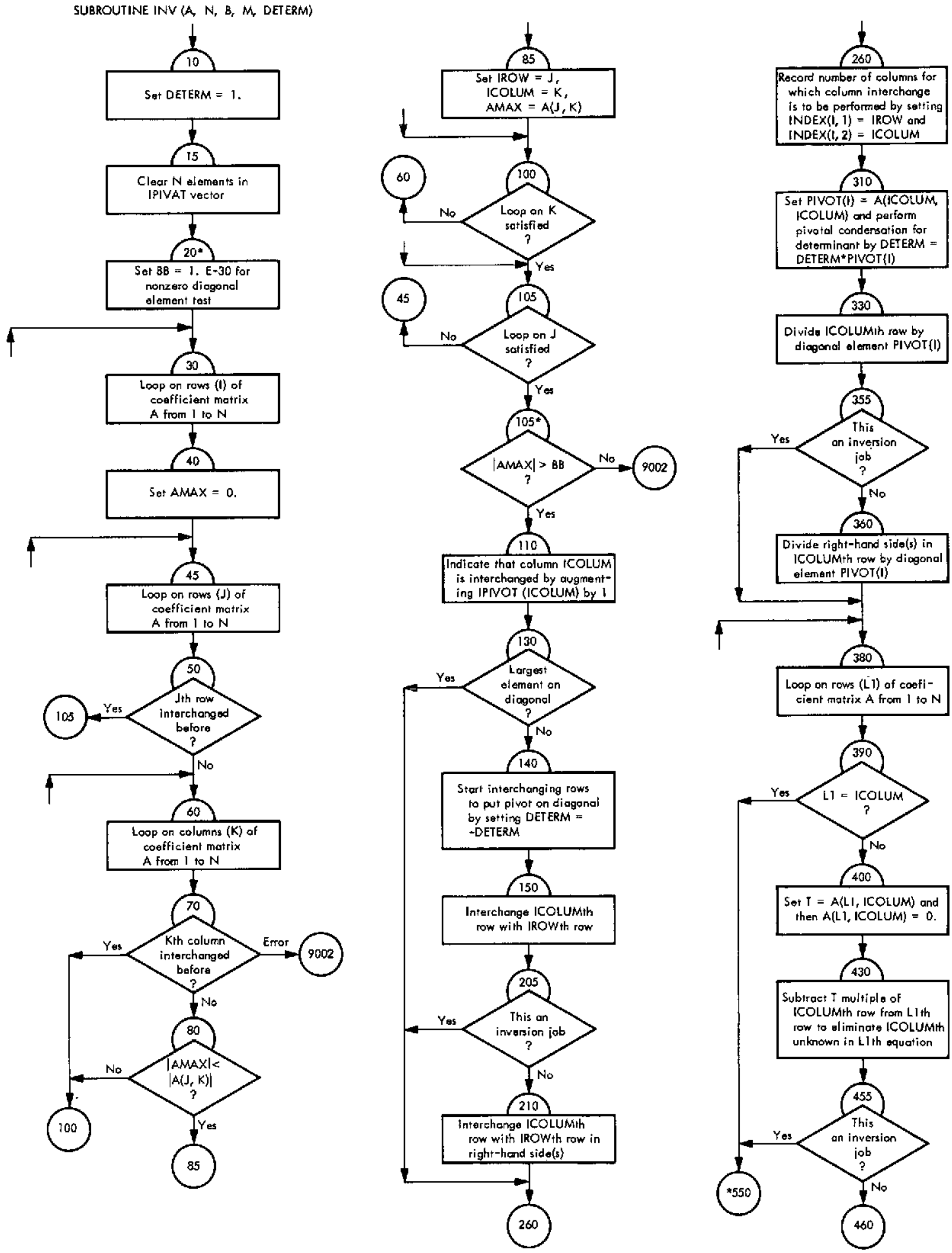

Fig. VI-59. Flowchart of subroutine INV (Link 4)

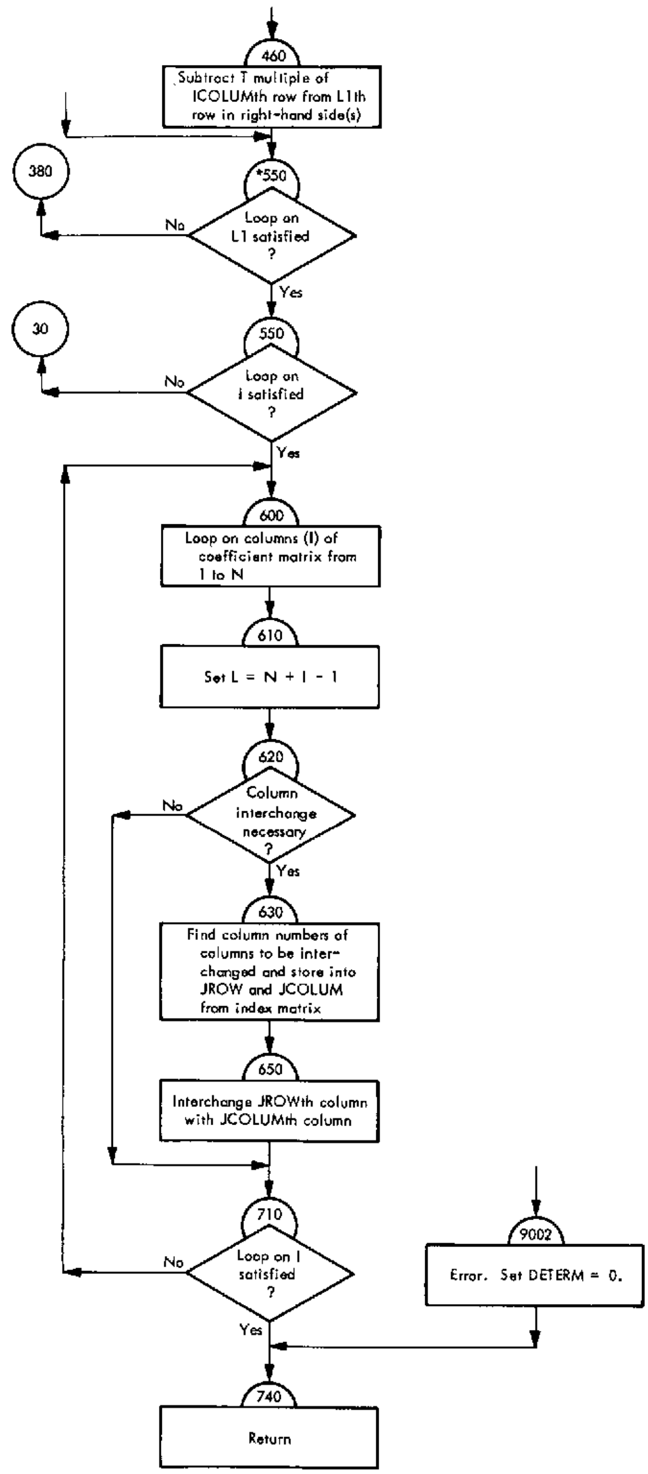

Fig. VI-59 (contd)

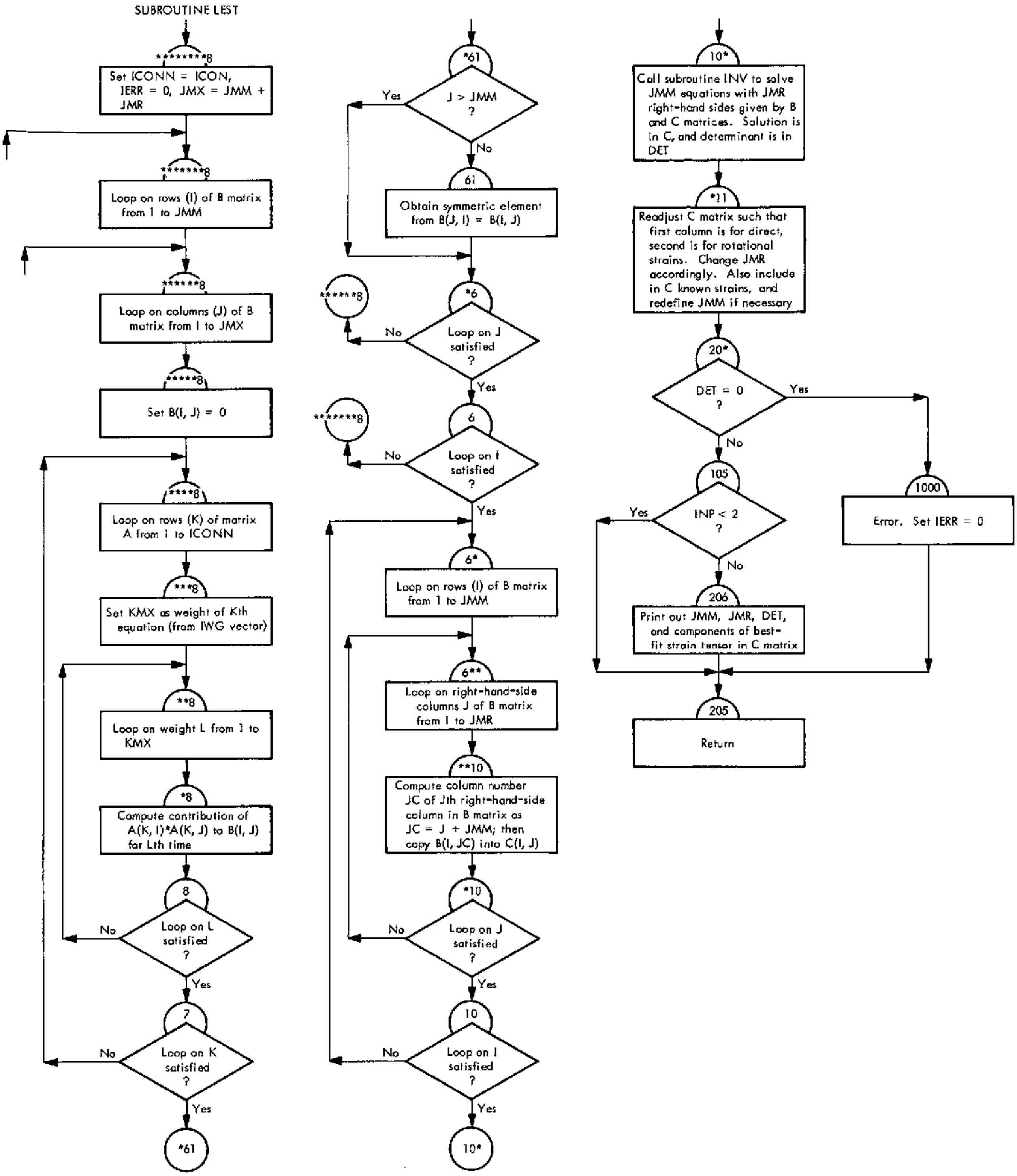

Fig. VI-60. Flowchart of subroutine LEST (Link 4)

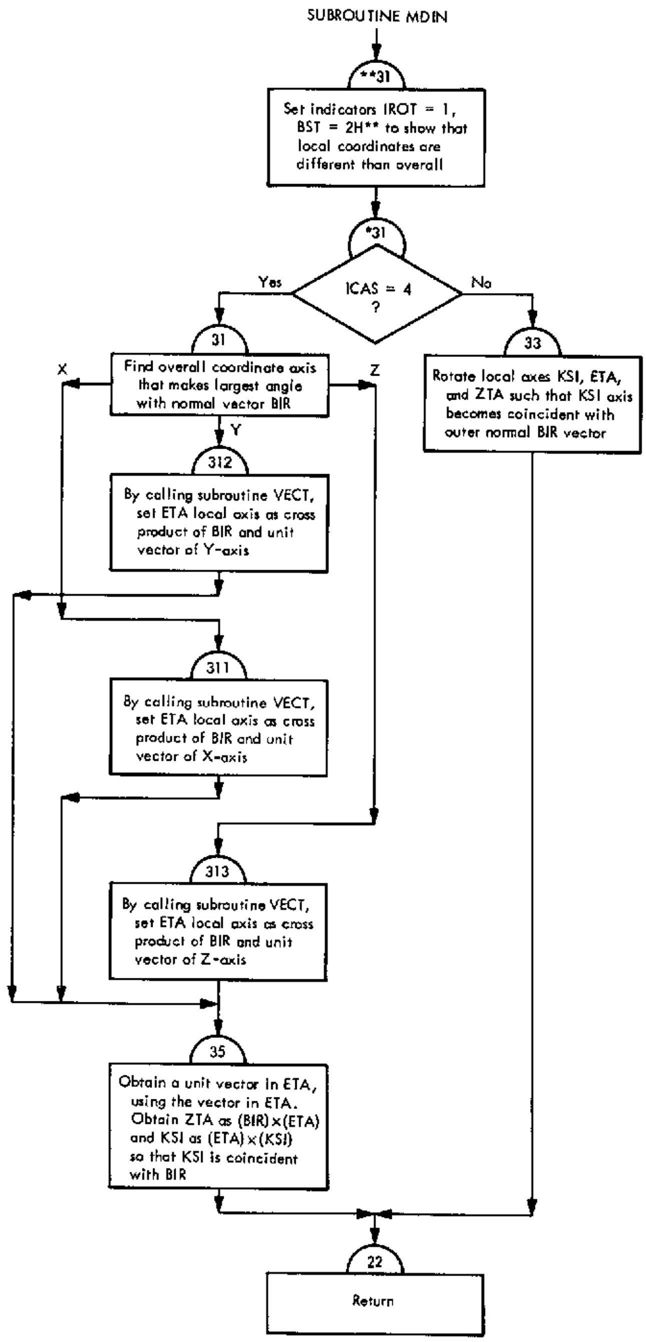

Fig. VI-61. Flowchart of subroutine MDIN (Link 4)

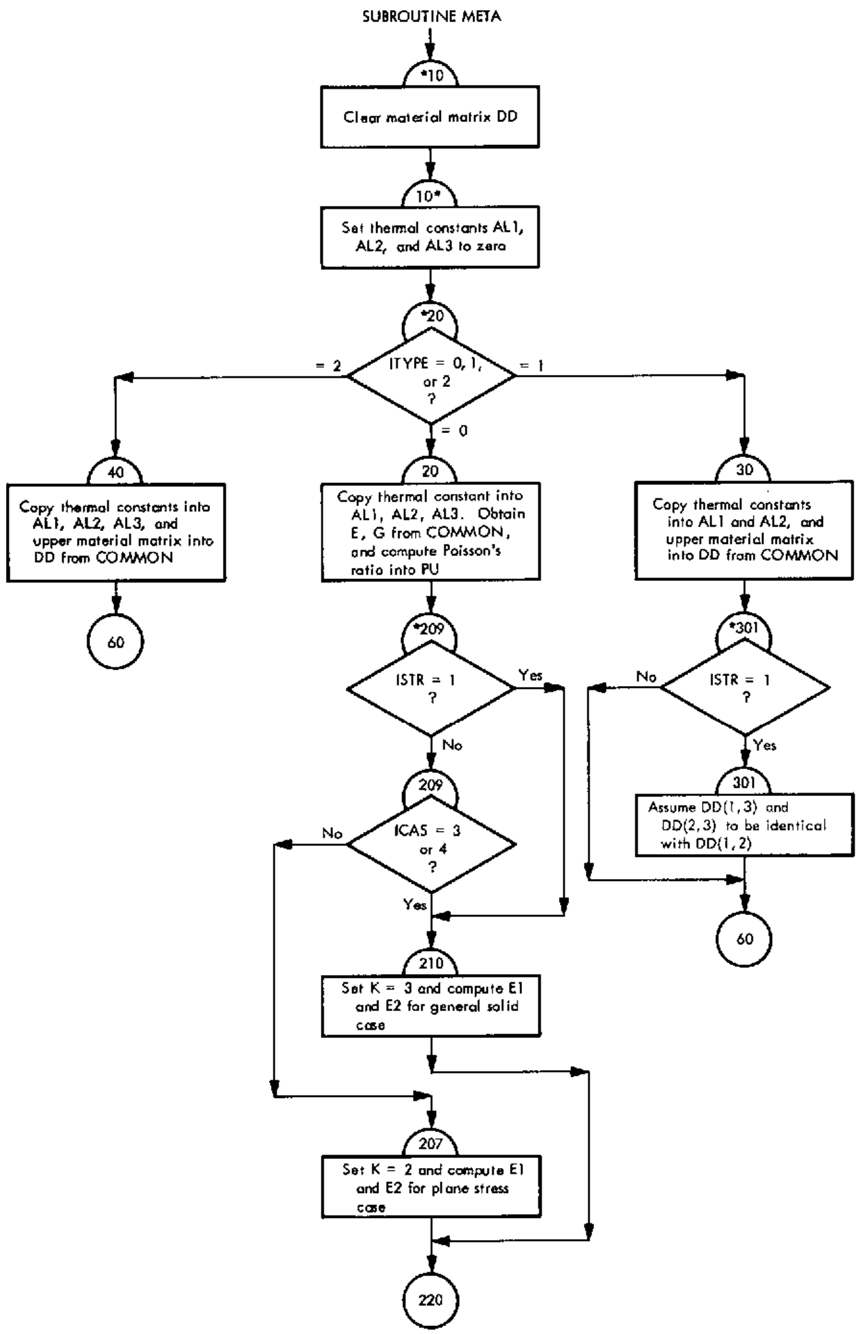

Fig. VI-62. Flowchart of subroutine META (Link 4)

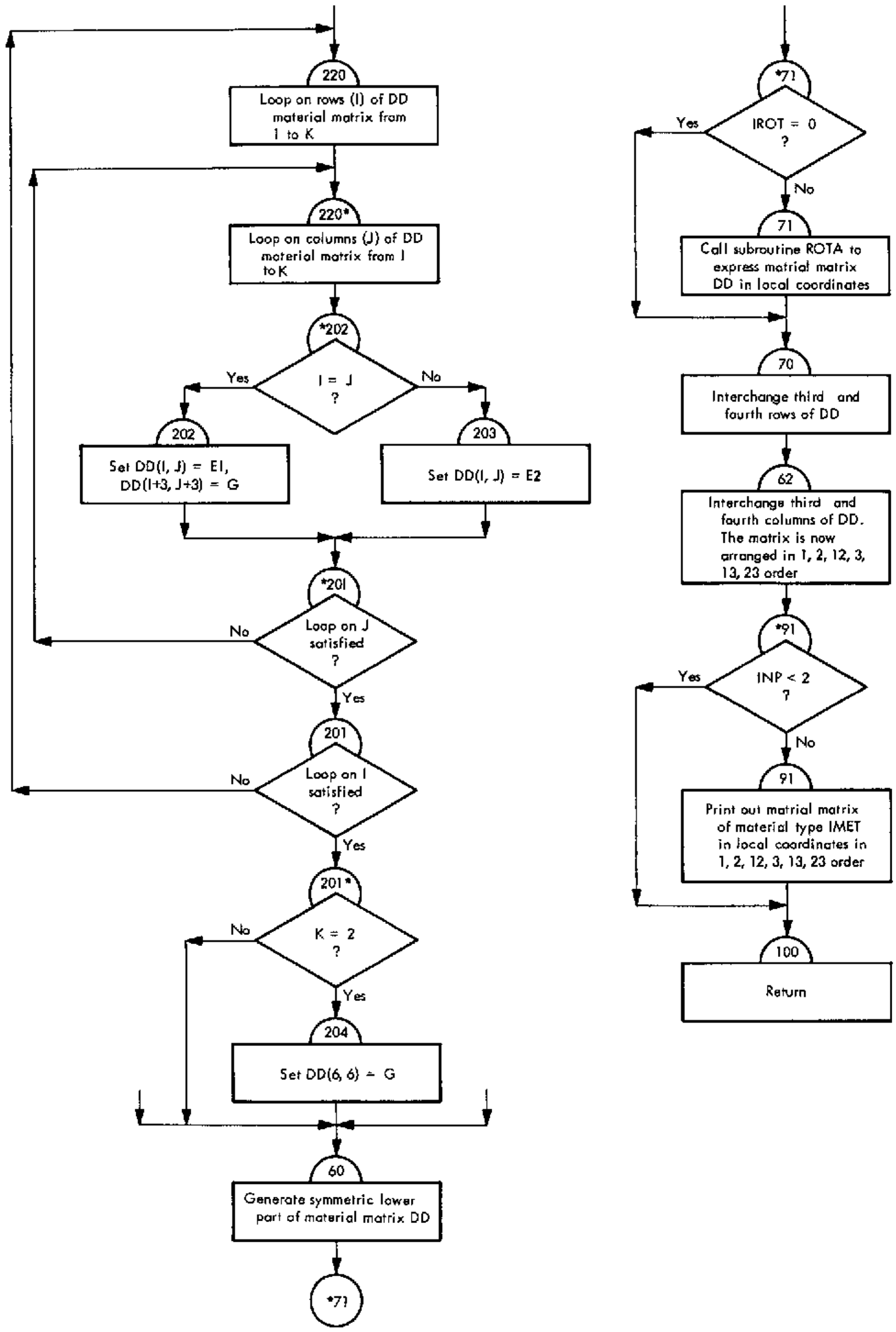

Fig. VI-62 (contd)

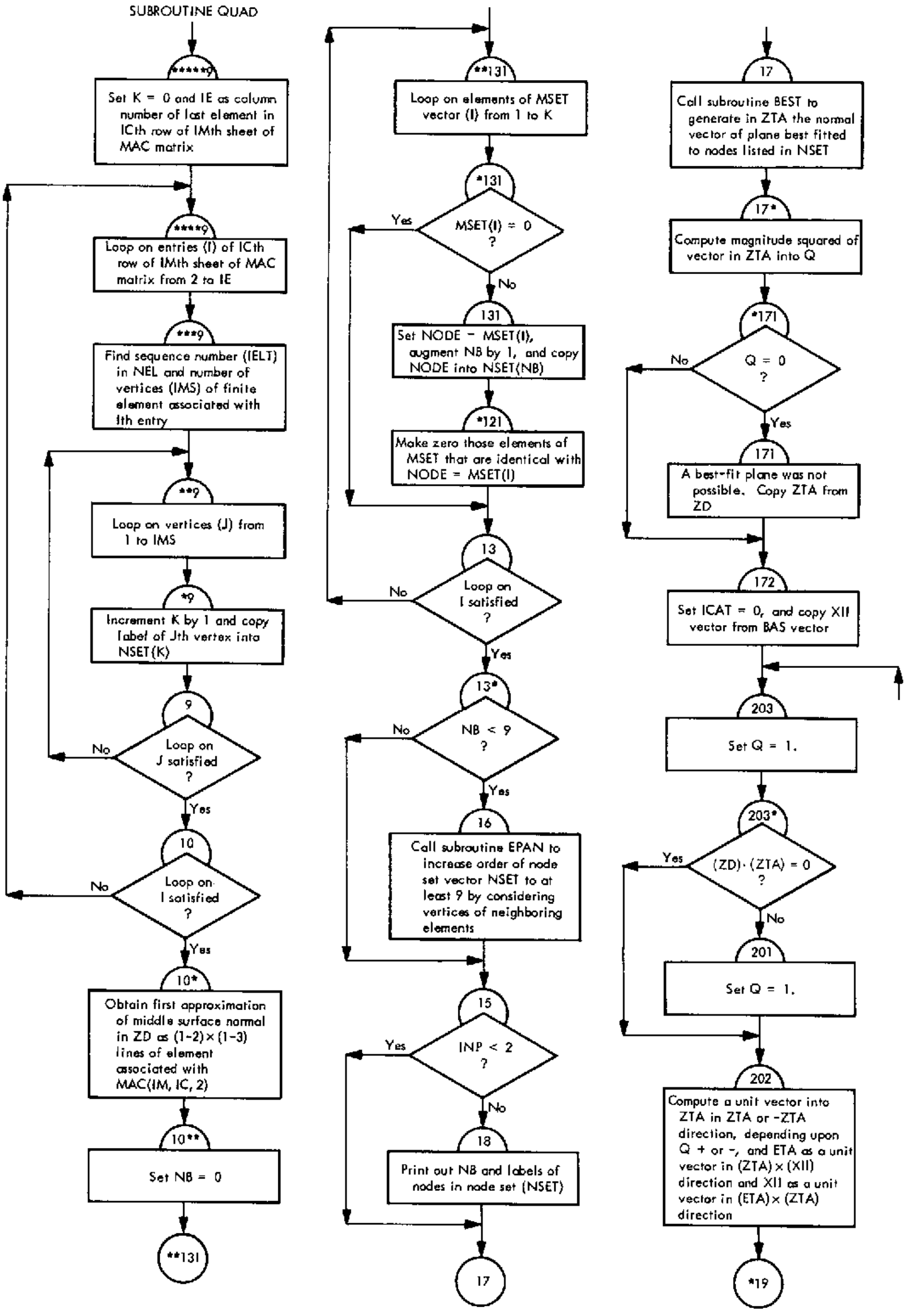

Fig. VI-63. Flowchart of subroutine QUAD (Link 4)

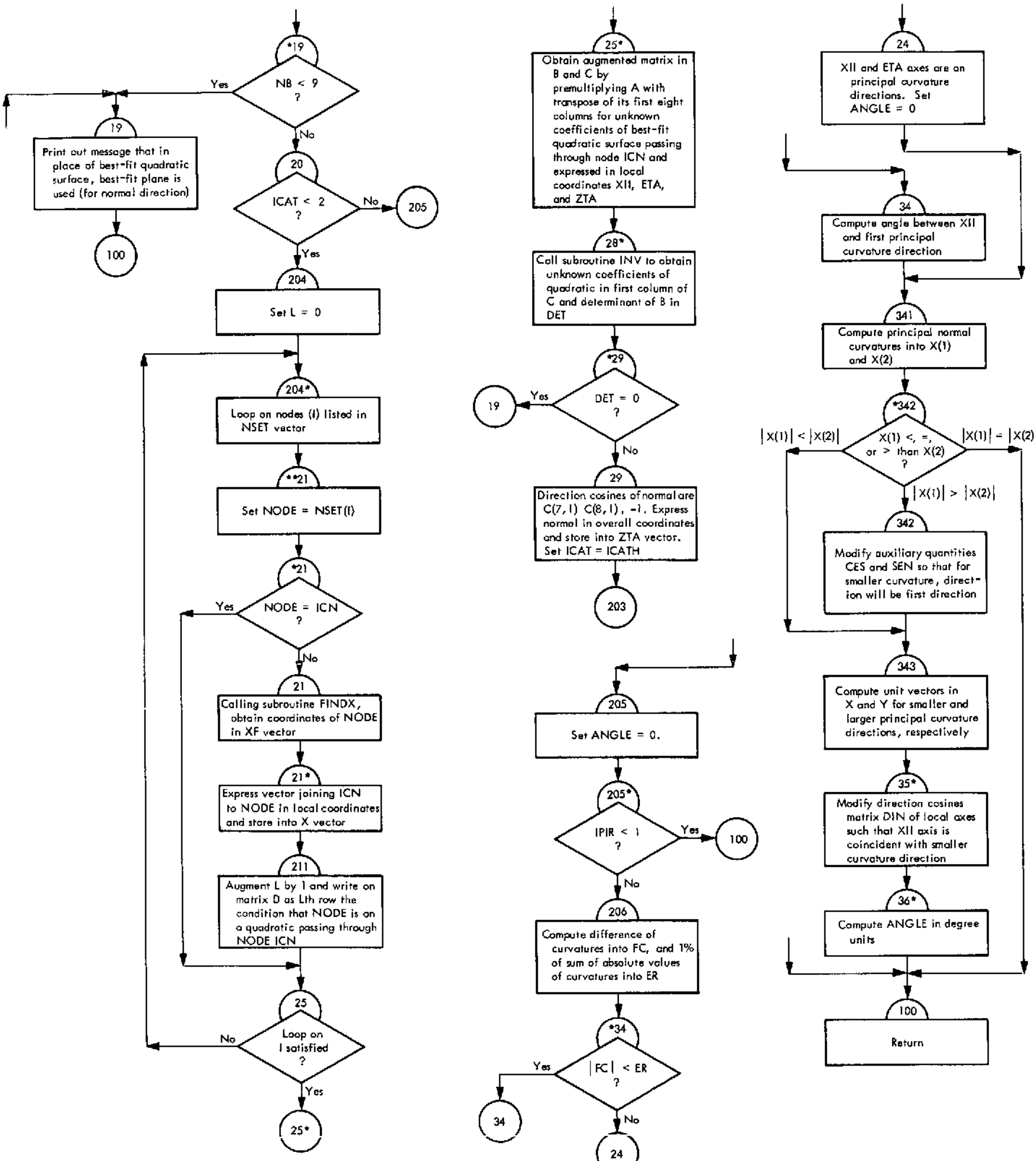

Fig. VI-63 (contd)

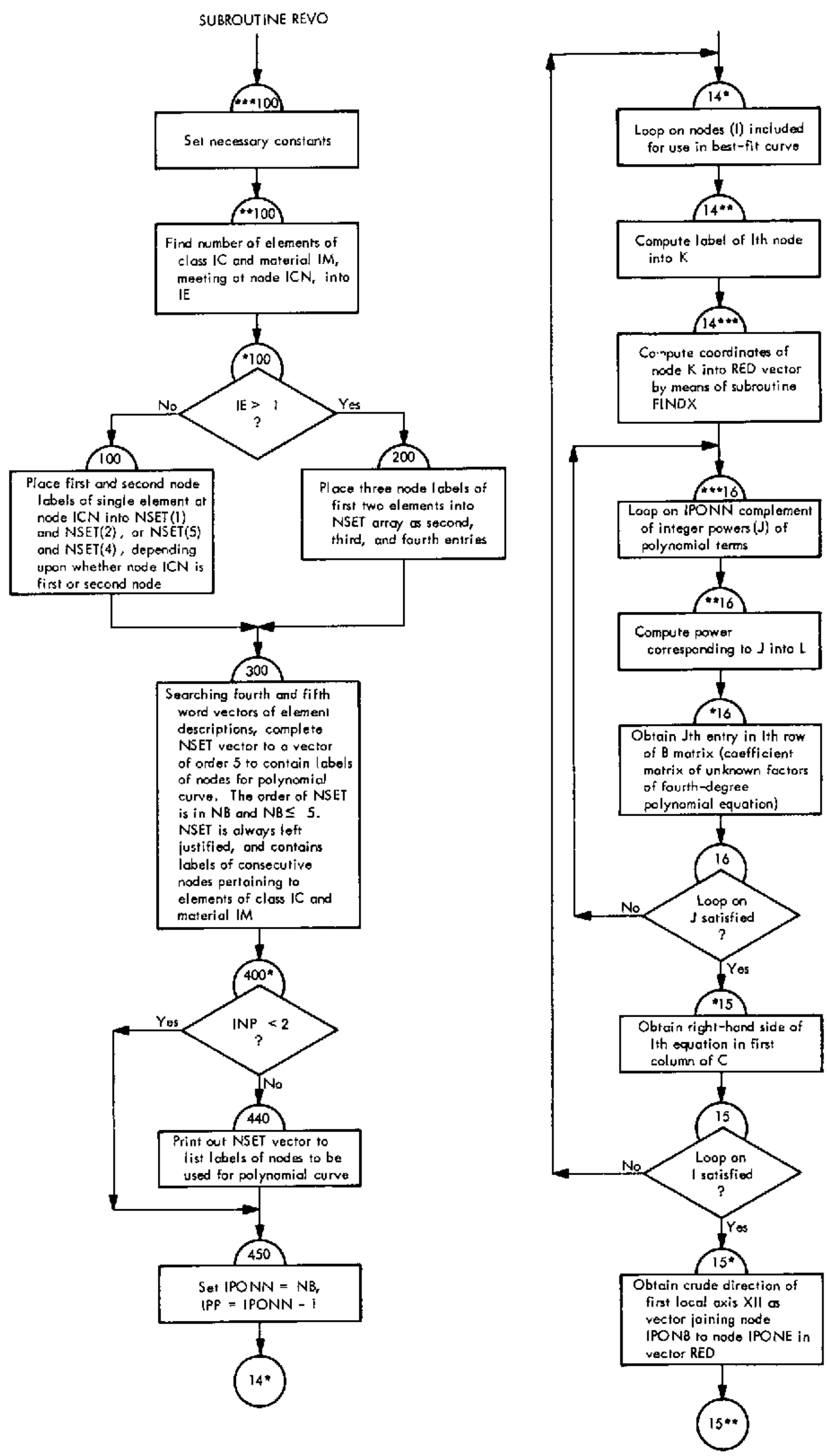

Fig. VI-64. Flowchart of subroutine REVO (Link 4)

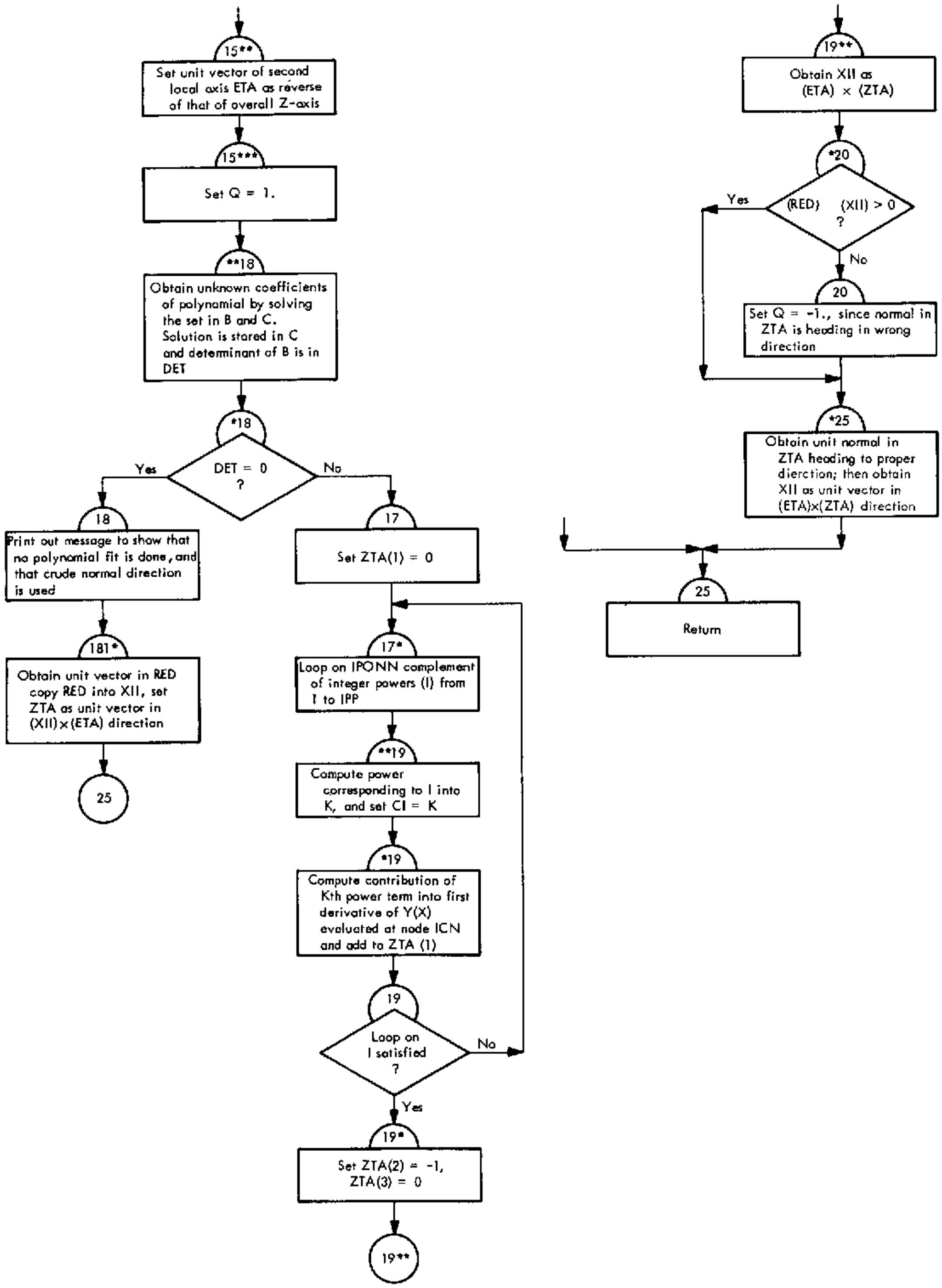

Fig. VI-64 (contd)

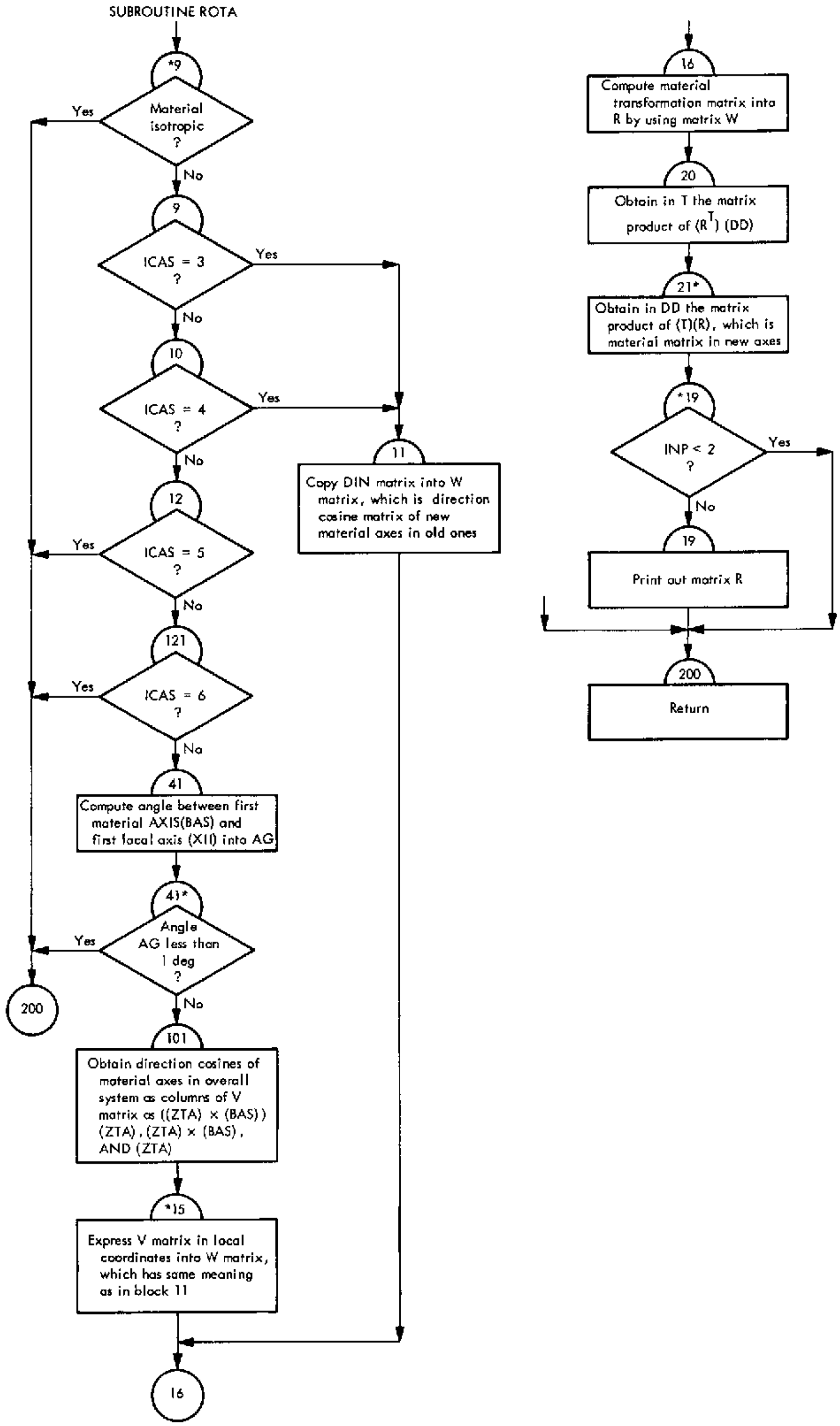

Fig. VI-65. Flowchart of subroutine ROTA (Link 4)

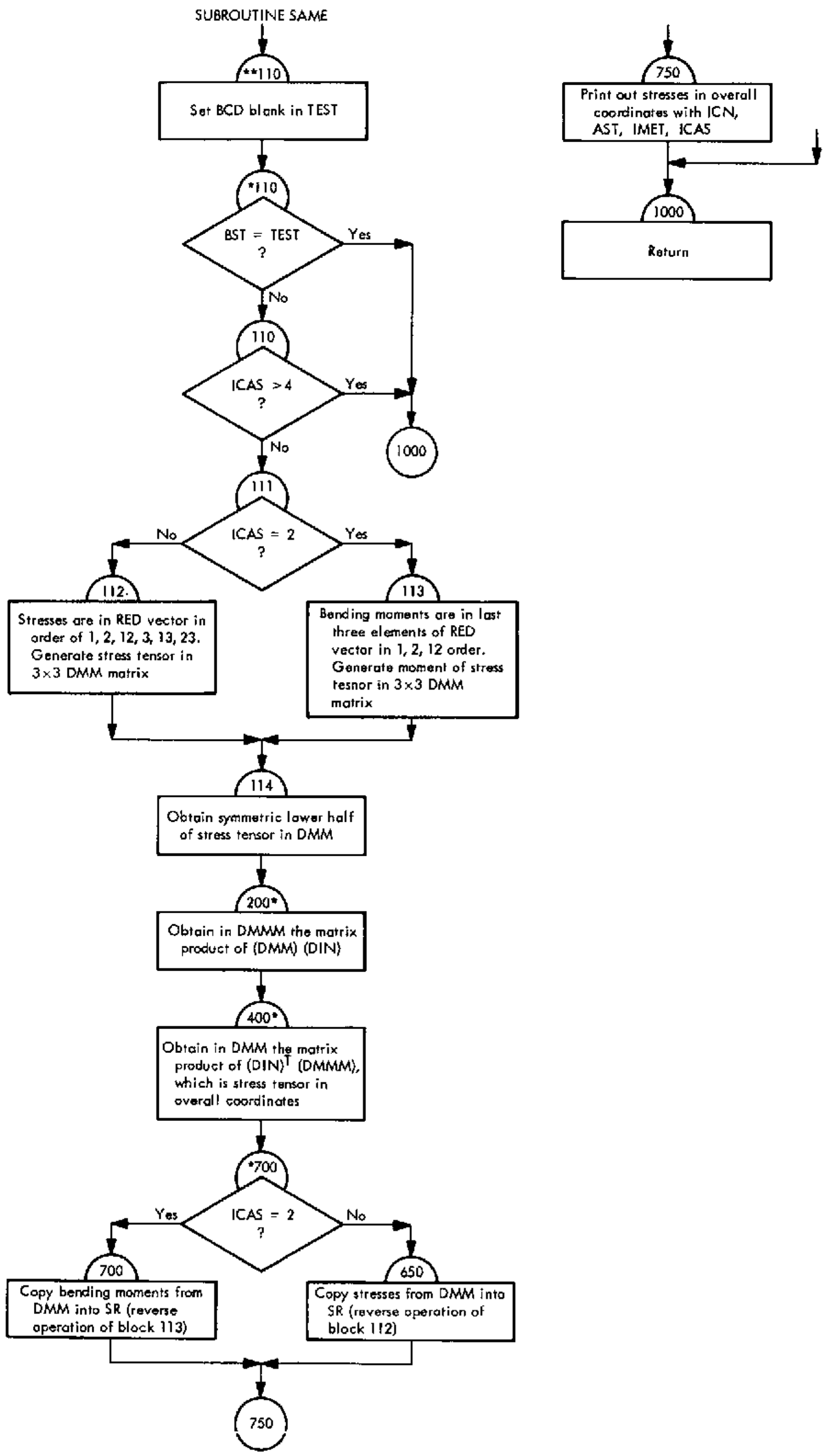

Fig. VI-66. Flowchart of subroutine SAME (Link 4)

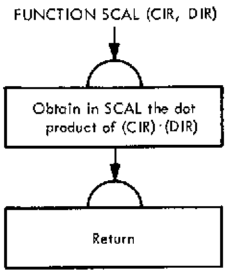

Fig. VI-67. Flowchart of function SCAL (Link 4)

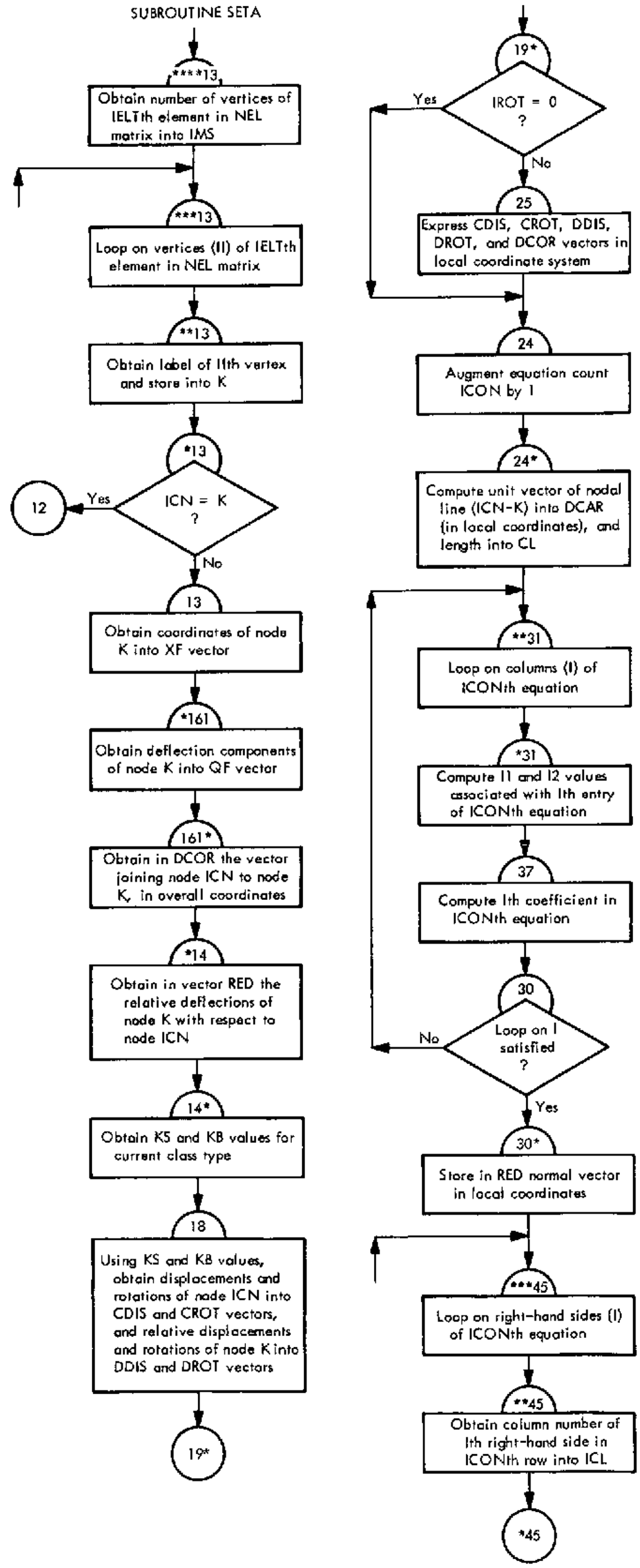

Fig. VI-68. Flowchart of subroutine SETA (Link 4)

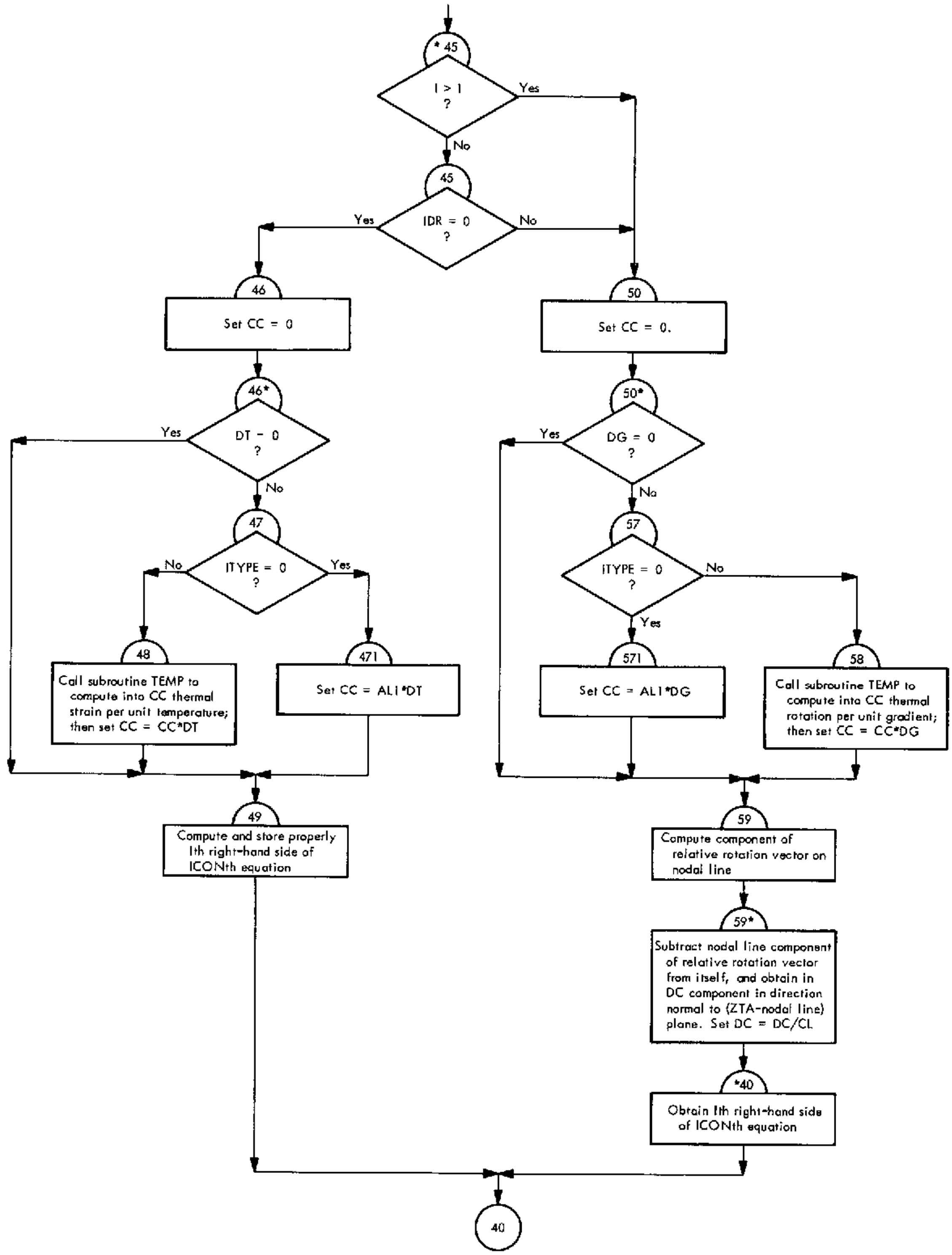

Fig. VI-68 (contd)

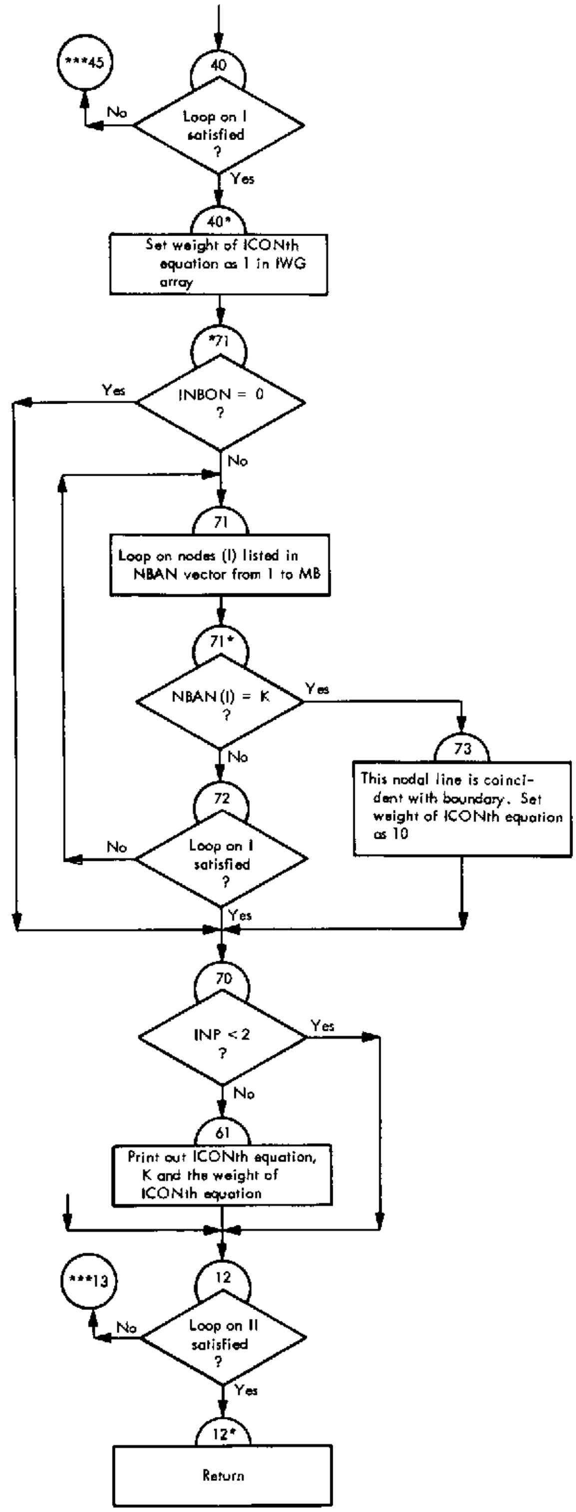

Fig. VI-68 (contd)

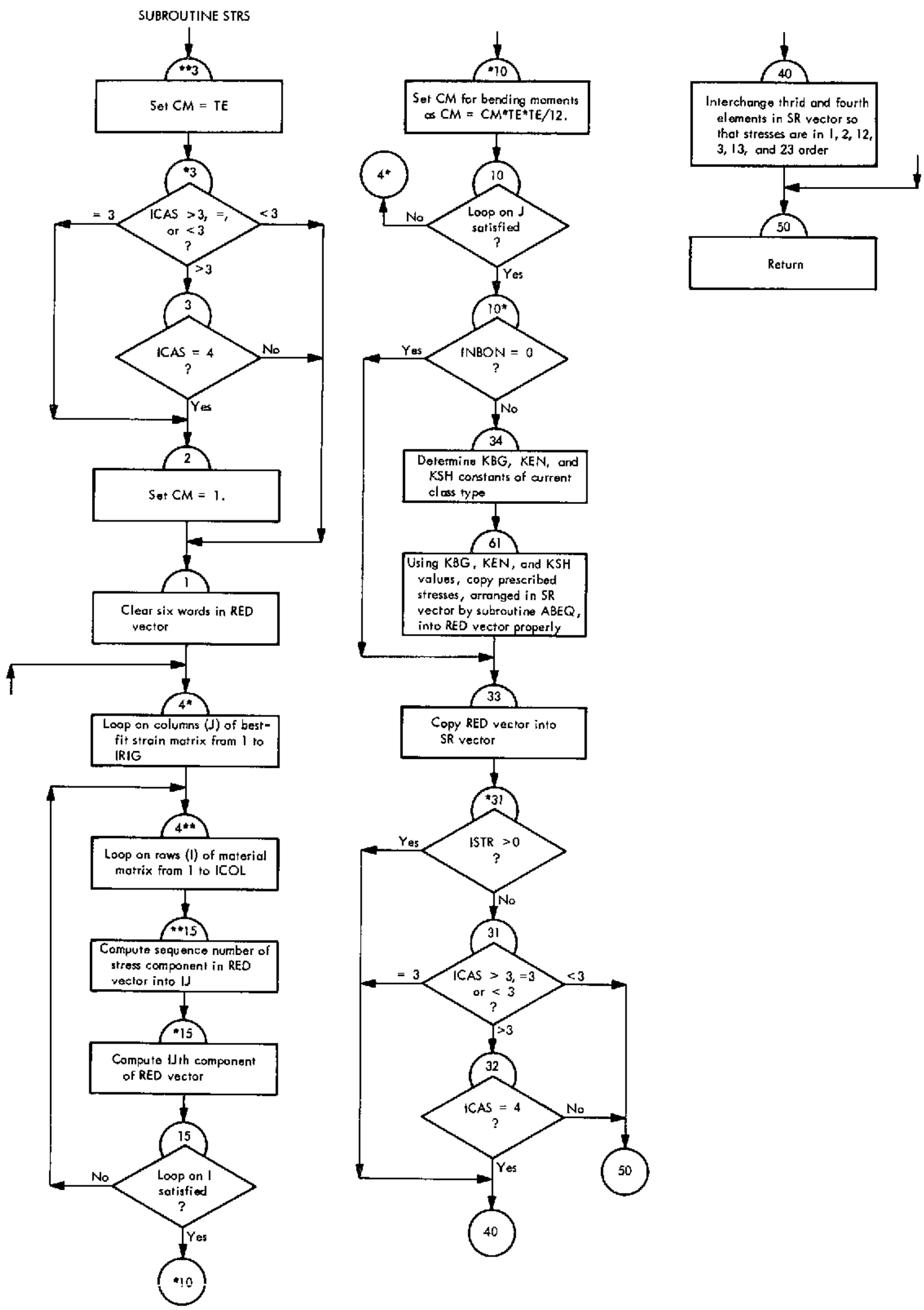

Fig. VI-69. Flowchart of subroutine STRS (Link 4)

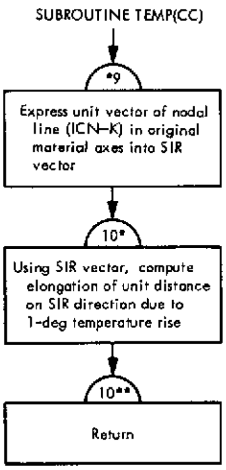

Fig. VI-70. Flowchart of subroutine TEMP (Link 4)

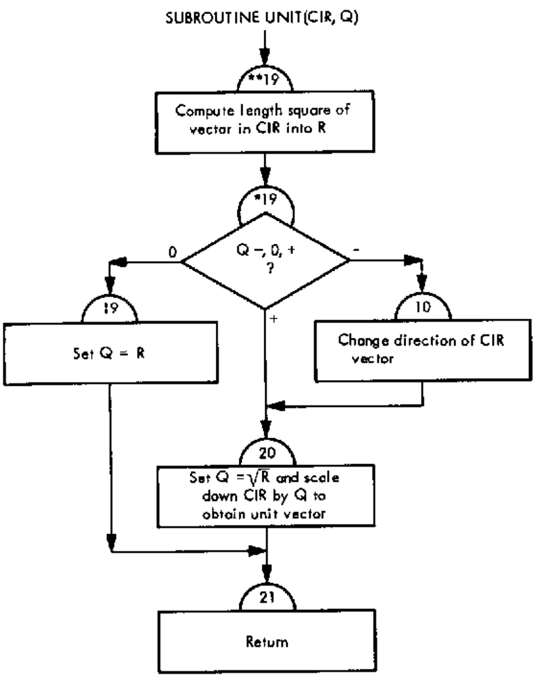

Fig. VI-71. Flowchart of subroutine UNIT (Link 4)

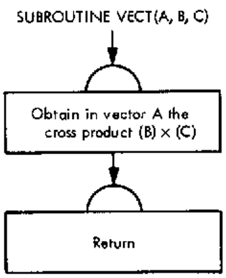

Fig. VI-72. Flowchart of subroutine VECT (Link 4)

VII. Source Program Listings

This section contains the source program listings of ELAS/Level 3. The listing of each program element is treated separately, and given a table number. The listings are arranged alphabetically by the subroutine names, under the main program of each link. The meanings of the variables used in the source program may be obtained from Tables III-2, III-3, and III-4 of Vol. II (basic). The organization of COMMON for each link is shown in Fig. III-1 of Vol. II (basic).

Table VII-1. Source program listing of main program of Link 1 (input link)

```
$EXECUTE        FORTRAN
$ID
*       XEQ
*       CHAIN (1,2)
*       LABEL
CELAS1
C       MAIN PROGRAM FOR INPUT LINK
C       READS, STORES AND CHECKS INPUT DATA
        DIMENSION IA(1),AA(1),REM(13),NT(10),DUMMY(5000),IDUM(5000),N(8)
       1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),RUMMY(27,9)
       2,D21(21),S(1),G1(1)
        COMMON IA,AA
        EQUIVALENCE (IA,AA),(AA( 9000),DUMMY)
        EQUIVALENCE (DUMMY,IDUM,NT,RUMMY),(DUMMY(11),REM)
        EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),
       1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),
       2IH),(IA(11),IB),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),
       3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),
       4ISTR),(IA(28),IFL1),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMETI,
       5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),
       6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),
       7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57
       8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBO),(IA(61),IID),(IA(62),
       9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITE),(IA(41),ITAP)
        EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),
       1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),
       2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)
       3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG),
       4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),
       5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),
       6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)
       7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IU
       8),(AA(47),G1),(AA(48),G2),(AA(49),G3)
        EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346)
       1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)
       2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)
       3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)
       4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)
       5,(IA(329),IPIR),(IA(328),ICOR),(IA(327),IBUN),(IA(326),IMES)
        DIMENSION IBERR(50)
        EQUIVALENCE (IA(200),IBERR)
        DIMENSION ISIR(540)
        EQUIVALENCE (DUMMY(8100),ISIR)
        EQUIVALENCE (IA(35),ISHUF)
 2700   CALL TICK (ITIM)
        CTES=3HEND
        DO 5999 I=1,9000
 5999   IA(I)=0
        READ INPUT TAPE 5,297,(REM(I),I=1,14)
 297    FORMAT (14A6)
C       COMPUTE DYNAMIC MEMORY ALLOCATION CONSTANTS
 1      READ INPUT TAPE 5,101,IN,IT,IDEG,ITYPE,IGEM,ISTR,IH,IB,IBN,IP,IPRS
       1,IMAT,NTIC,ISDT,ISDY,ISDZ,IARE,IMMX,IMMY,IMMZ,IMFI,INX,INP,ISHUF
       2,ICOR,IBUN,IMES,IPIR,ITAP,ITAS,G1,G2,G3,ACEL
 101    FORMAT (2I4,6I1,3I4,10I2,9I1,3F5.4,E10.5)
        IF (ITAS) 2971,2971,2972
 2972   REWIND ITAS
 2971   CONTINUE
        IF (ITAP) 7055,7055,7056
 7055   ITAP=2
 7056   IERR=0
        IF (IB) 300,3008,3009
 3008   IB=10
 3009   IF (IN) 300,300,3001
 3001   IF (IT) 300,300,3002
 3002   IF ((IDEG-1)*(IDEG-6)) 3003,3003,300
 3003   IF (ITYPE-2) 3004,3004,300
 3004   IF (IGEM-1) 3005,3005,300
 3005   IF (ISIR-1) 3006,3006,300
 3006   IF (IH-2) 300,3007,3007
 3007   IF (IB-IH) 300,3011,3011
 3011   IF (IMAT) 300,300,3021
 3021   IF (INX*(INX-5)) 3022,300,300
 3022   IF (INP-2) 3451,3451,300
 3451   IND=IDEG*IN
        ZGEM=IGEM
        IND1=IND+1
        IF (IH-4) 1400,1199,1300
 1199   IF (IDEG-2) 300,1400,1200
 1200   IDS=3*IDEG
        GO TO 1500
 1300   IDS=4*IDEG
        GO TO 1500
 1400   IDS=IH*IDEG
 1500   IIS=350
        DO 1025 I=1,10
 1025   NT(I)=0
        DO 103 I=1,IB
 103    NT(I)=IT
        J1=IIS+IDS*IDS
        J2=J1+NT(1)
        J3=J2+NT(2)
        J4=J3+NT(3)
        J5=J4+NT(4)
        J6=J5+NT(5)
        J7=J6+NT(6)
        J8=J7+NT(7)
        J9=J8+NT(8)
        J10=J9+NT(9)
        IBB=J10+NT(10)
        IBO=IBB+IND
        IID=IBO+IND
        IF (ITYPE-1) 4491,4492,4493
 4491   IIA=IID+2*IMAT
        IPR=IIA+IMAT
        GO TO 4494
 4492   IIA=IID+9*IMAT
        IPR=IIA+2*IMAT
        GO TO 4494
 4493   IIA=IID+21*IMAT
        IPR=IIA+3*IMAT
 4494   ITE=IPR+IPRS
        IDT=ITE+NTIC
        IDY=IDT+ISDT
        IDZ=IDY+ISDY
        ICAR=IDZ+ISDZ
        ICIX=ICAR+IARE
        ICIY=ICIX+IMMX
        ICIZ=ICIY+IMMY
        ICFI=ICIZ+IMMZ
        IXX=ICFI+IMFI
        IYY=IXX+IN
        IZZ=IYY+IN
        IIC=IZZ+IN*IGEM
        IDEF=IIC+IND
        IU=IDEF+IND1
        IST=IU
        CALL TABL
C       READ AND PRINT OUT THE PHYSICAL AND GEOMETRICAL PROPERTIES OF THE
C       ELEMENTS
        IF (INP-1) 2527,2526,2526
 2526   WRITE OUTPUT TAPE 6,356
 356    FORMAT (1H1, 3X,19HMATERIAL PROPERTIES)
 2527   IF (ITYPE-1) 4487,4388,4389
 4487   IF (INP-1) 2501,2502,2502
 2502   WRITE OUTPUT TAPE 6,4486
 4486   FORMAT (    /2(3X,2HTP,5X,1HE,14X,1HG,14X,5HALPHA,15X)//)
 2501   READ INPUT TAPE 5,100,(IDUM(I),DUMMY(I+100),DUMMY(I+200),DUMMY(I+3
       100),I=1,IMAT)
 100    FORMAT (3(I2,3E8.5))
        DO 4285 I=1,IMAT
        IF (IDUM(I)-I) 300,2500,300
 2500   IIDI=IID+2*(I-1)+1
        IIAI=IIA+I
        AA(IIDI)=DUMMY(I+100)
        AA(IIDI+1)=DUMMY(I+200)
        AA(IIAI)=DUMMY(I+300)
 4285   CONTINUE
        IF (INP-1) 6219,5550,5550
 5550   WRITE OUTPUT TAPE 6,4483,(I,DUMMY(I+100),DUMMY(I+200),DUMMY(I+300)
       1,I=1,IMAT)
 4483   FORMAT (2(I5,3E15.5,10X))
        GO TO 6219
 4388   IF (INP-1) 2504,2505,2505
 2505   WRITE OUTPUT TAPE 6,4386
 4386   FORMAT (    /7X,4HE OR,6X,4HG OR/3H TP,4X,3HD11,7X,3HD12,7X,3HD14,
       17X,3HD22,7X,3HD24,7X,3HD44,7X,3HD55,7X,3HD56,7X,3HD66,12X,6HALPHA1
       2,4X,6HALPHA2//)
 2504   READ INPUT TAPE 5,200,(IDUM(I),DUMMY(I+100),DUMMY(I+200),DUMMY(I+3
       100),DUMMY(I+400),DUMMY(I+500),DUMMY(I+600),DUMMY(I+700),DUMMY(I+80
       20),DUMMY(I+900),IDUM(I),DUMMY(I+1000),DUMMY(I+1100),I=1,IMAT)
 200    FORMAT (I2,9E8.5/I2,2E8.5)
        DO 4385 I=1,IMAT
        IF (IDUM(I)-I) 300,5560,300
 5560   IIDI=IID+9*(I-1)
        IIAI=IIA+2*(I-1)+1
        DO 5350 J=1,9
        JIDI=IIDI+J
        JDM=I+100*J
 5350   AA(JIDI)=DUMMY(JDM)
        AA(IIAI)=DUMMY(I+1000)
        AA(IIAI+1)=DUMMY(I+1100)
 4385   CONTINUE
        IF (INP-1) 6219,4400,4400
 4400   WRITE OUTPUT TAPE 6,4383,(I,DUMMY(I+100),DUMMY(I+200),DUMMY(I+300)
       1,DUMMY(I+400),DUMMY(I+500),DUMMY(I+600),DUMMY(I+700),DUMMY(I+800),
       2DUMMY(I+900),DUMMY(I+1000),DUMMY(I+1100),I=1,IMAT)
 4383   FORMAT (I3,2X,9E10.3,5X,2F10.3)
        GO TO 6219
 4389   IF (INP-1) 2506,2507,2507
 2507   WRITE OUTPUT TAPE 6,4351
 4351   FORMAT (    /9X,4HE OR,11X,4HG OR/3X,2HTP,4X,3HDXX,12X,3HDYY,12X,3H
       1DZZ,12X,3HDXY,12X,3HDYZ,12X,3HDZX,17X,6HALPHAS)
 2506   READ INPUT TAPE 5,4352,(IDUM(I),DUMMY(I+100),DUMMY(I+200),DUMMY(I+
       1300),DUMMY(I+400),DUMMY(I+500),DUMMY(I+600),DUMMY(I+700),DUMMY(I+8
       200),DUMMY(I+900),IDUM(I),DUMMY(I+1000),DUMMY(I+1100),DUMMY(I+1200)
       3,DUMMY(I+1300),DUMMY(I+1400),DUMMY(I+1500),DUMMY(I+1600),DUMMY(I+1
       4700),DUMMY(I+1800),IDUM(I),DUMMY(I+1900),DUMMY(I+2000),DUMMY(I+210
       50),DUMMY(I+2200),DUMMY(I+2300),DUMMY(I+2400),I=1,IMAT)
 4352   FORMAT (I2,9E8.5/I2,9E8.5/I2,6E8.5)
        DO 1041 I=1,IMAT
        IF (IDUM(I)-I) 300,1043,300
 1043   IIDI=IID+21*(I-1)
        IIAI=IIA+3*(I-1)+1
        DO 5400 J=1,21
        JIDI=IIDI+J
        JDM=I+100*J
 5400   AA(JIDI)=DUMMY(JDM)
        AA(IIAI)=DUMMY(I+2200)
        AA(IIAI+1)=DUMMY(I+2300)
        AA(IIAI+3)=DUMMY(I+2400)
 1041   CONTINUE
        IF (INP-1) 6219,5590,5590
 5590   DO 5600 I=1,IMAT
        WRITE OUTPUT TAPE 6,1700,(I,DUMMY(I+100),DUMMY(I+200),DUMMY(I+300)
       1,DUMMY(I+400),DUMMY(I+500),DUMMY(I+600),DUMMY(I+2200))
        WRITE OUTPUT TAPE 6,1800,(DUMMY(I+200),DUMMY(I+700),DUMMY(I+800),D
       1UMMY(I+900),DUMMY(I+1000),DUMMY(I+1100),DUMMY(I+2300))
        WRITE OUTPUT TAPE 6,1800,(DUMMY(I+300),DUMMY(I+800),DUMMY(I+1200),
       1DUMMY(I+1300),DUMMY(I+1400),DUMMY(I+1500),DUMMY(I+2400))
        WRITE OUTPUT TAPE 6,1900,(DUMMY(I+400),DUMMY(I+900),DUMMY(I+1300),
       1DUMMY(I+1600),DUMMY(I+1700),DUMMY(I+1800))
        WRITE OUTPUT TAPE 6,1900,(DUMMY(I+500),DUMMY(I+1000),DUMMY(I+1400)
       1,DUMMY(I+1700),DUMMY(I+1900),DUMMY(I+2000))
 5600   WRITE OUTPUT TAPE 6,1900,(DUMMY(I+600),DUMMY(I+1100),DUMMY(I+1500)
       1,DUMMY(I+1800),DUMMY(I+2000),DUMMY(I+2100))
 1700   FORMAT (//I5,6E15.5,5X,F15.5)
 1800   FORMAT (5X,6F15.5,5X,E15.5)
 1900   FORMAT (6E15.5)
 6219   IF (IPRS)  300,6218,2000
 2000   READ INPUT TAPE 5,2001,(IDUM(I),DUMMY(I+100),I=1,IPRS)
        DO 2200 I=1,IPRS
       .IF (IDUM(I)-I) 300,2100,300
 2100   IPRI=IPR+I
        AA(IPRI)=DUMMY(I+100)
 2200   CONTINUE
        IF (INP-1) 6218,2300,2300
 2300   WRITE OUTPUT TAPE 6,1301,(I,DUMMY(I+100),I=1,IPRS)
 1301   FORMAT (////4X,14HPRESSURE TYPES//(5(I5,F15.5,4X)))
 6218   IF (NTIC)  300,6217,2400
```

Table VII-1 (contd)

```
2400 READ INPUT TAPE 5,2001,(IDUM(I),DUMMY(I+100),I=1,NTIC)
     DO 2600 I=1,NTIC
     IF (IDUM(I)-1) 300,5500,300
5500 ITEI=ITE+I
     AA(ITEI)=DUMMY(I+100)
2600 CONTINUE
     IF (INP-1) 6217,2900,2900
2900 WRITE OUTPUT TAPE 6,1302,(I,DUMMY(I+100),I=1,NTIC)
1302 FORMAT (////4X,15HTHICKNESS TYPES//(5(I5,F15.5,4X)))
6217 IF (ISDT)  300,6216,5700
5700 READ INPUT TAPE 5,2001,(IDUM(I),DUMMY(I+100),I=1,ISDT)
     DO 5720 I=1,ISDT
     IF (IDUM(I)-1) 300,5710,300
5710 IDTI=IDT+I
     AA(IDTI)=DUMMY(I+100)
5720 CONTINUE
     IF (INP-1) 6216,5730,5730
5730 WRITE OUTPUT TAPE 6,1303,(I,DUMMY(I+100),I=1,ISDT)
1303 FORMAT (////4X,26HTEMPERATURE INCREASE TYPES//(5(I5,E15.5,4X)))
6216 IF (ISDY)  300,6215,3500
3500 READ INPUT TAPE 5,2001,(IDUM(I),DUMMY(I+100),I=1,ISDY)
     DO 3700 I=1,ISDY
     IF (IDUM(I)-1) 300,3600,300
3600 IDYI=IDY+I
     AA(IDYI)=DUMMY(I+100)
3700 CONTINUE
     IF (INP-1) 6215,3800,3800
3800 WRITE OUTPUT TAPE 6,1304,(I,DUMMY(I+100),I=1,ISDY)
1304 FORMAT (////4X,39HTEMPERATURE GRADIENT TYPES ALONG Y AXIS//
    1(5(I5,E15.5,4X)))
6215 IF (ISDZ)  300,6214,4000
4000 READ INPUT TAPE 5,2001,(IDUM(I),DUMMY(I+100),I=1,ISDZ)
     DO 4200 I=1,ISDZ
     IF (IDUM(I)-1) 300,4100,300
4100 IDZI=IDZ+I
     AA(IDZI)=DUMMY(I+100)
4200 CONTINUE
     IF (INP-1) 6214,4300,4300
4300 WRITE OUTPUT TAPE 6,1305,(I,DUMMY(I+100),I=1,ISDZ)
1305 FORMAT (////4X,39HTEMPERATURE GRADIENT TYPES ALONG Z AXIS//
    1(5(I5,E15.5,4X)))
6214 IF (IARE)  300,6213,4500
4500 READ INPUT TAPE 5,2001,(IDUM(I),DUMMY(I+100),I=1,IARE)
     DO 4700 I=1,IARE
     IF (IDUM(I)-1) 300,4600,300
4600 ICARI=ICAR+I
     AA(ICARI)=DUMMY(I+100)
4700 CONTINUE
     IF (INP-1) 6213,4800,4800
4800 WRITE OUTPUT TAPE 6,1306,(I,DUMMY(I+100),I=1,IARE)
1306 FORMAT (////4X,10HAREA TYPES//(5(I5,E15.5,4X)))
6213 IF (IMMX)  300,6212,5000
5000 READ INPUT TAPE 5,2001,(IDUM(I),DUMMY(I+100),I=1,IMMX)
     DO 5200 I=1,IMMX
     IF (IDUM(I)-1) 300,5100,300
5100 ICIXI=ICIX+I
     AA(ICIXI)=DUMMY(I+100)
5200 CONTINUE
     IF (INP-1) 6212,5300,5300
5300 WRITE OUTPUT TAPE 6,1307,(I,DUMMY(I+100),I=1,IMMX)
1307 FORMAT (////4X,22HTORSION CONSTANT TYPES//(5(I5,E15.5,4X)))
6212 IF (IMMY)  300,6209,6000
6000 READ INPUT TAPE 5,2001,(IDUM(I),DUMMY(I+100),I=1,IMMY)
     DO 6200 I=1,IMMY
     IF (IDUM(I)-1) 300,6100,300
6100 ICIYI=ICIY+I
     AA(ICIYI)=DUMMY(I+100)
6200 CONTINUE
     IF (INP-1) 6209,6300,6300
6300 WRITE OUTPUT TAPE 6,1308,(I,DUMMY(I+100),I=1,IMMY)
1308 FORMAT (////4X,50HMOMENT OF INERTIA TYPES ABOUT FIRST PRINCIPAL AX
    1IS//(5(I5,E15.5,4X)))
6209 IF (IMMZ)  300,6208,6500
6500 READ INPUT TAPE 5,2001,(IDUM(I),DUMMY(I+100),I=1,IMMZ)
     DO 6700 I=1,IMMZ
     IF (IDUM(I)-1) 300,6600,300
6600 ICIZI=ICIZ+I
     AA(ICIZI)=DUMMY(I+100)
6700 CONTINUE
     IF (INP-1) 6208,6800,6800
6800 WRITE OUTPUT TAPE 6,1309,(I,DUMMY(I+100),I=1,IMMZ)
1309 FORMAT (////4X,51HMOMENT OF INERTIA TYPES ABOUT SECOND PRINCIPAL A
    1XIS//(5(I5,E15.5,4X)))
6208 IF (IMFI) 300,830,7000
7000 READ INPUT TAPE 5,2001,(IDUM(I),DUMMY(I+100),I=1,IMFI)
     DO 7200 I=1,IMFI
     IF (IDUM(I)-1) 300,7100,300
7100 ICFII=ICFI+I
     AA(ICFII)=DUMMY(I+100)
7200 CONTINUE
     IF (INP-1) 830,7300,7300
7300 WRITE OUTPUT TAPE 6,1310,(I,DUMMY(I+100),I=1,IMFI)
1310 FORMAT (////4X,35HANGLE TYPES DEFINING PRINCIPAL AXES//(5(I5,E15.5
    1,4X)))
2001 FORMAT (8(I2,E8.5))
C     READ IN AND PRINT OUT NODAL COORDINATES
8302 FORMAT (1H1,50X,17HNODAL COORDINATES///2(5H NODE,5X,1HX,14X,1HY,
    114X,1HZ,19X)//2(I5,3E15.5,10X))
830  IF (ICOR) 8311,831,8311
8311 CALL CORG
     GO TO 5810
 831 CALL COOR
     IF (IERR) 300,5810,300
5810 IF (INP-1) 5850,2519,2519
2519 L=0
     NTP=IN
9010 IF (L+1000-NTP) 9015,9020,9020
9015 IN=1000
     GO TO 9025
9020 IN=NTP-L
9025 DO 5800 I=1,IN
     IXXI=IXX+I
     IYYI=IYY+I
     IZZI=IZZ+I
     DUMMY(I)=AA(IXXI)
     DUMMY(I+1000)=AA(IYYI)
     DUMMY(I+2000)=AA(IZZI)*ZGEM
5800 CONTINUE
     WRITE OUTPUT TAPE 6,8302,(I,DUMMY(I),DUMMY(I+1000),DUMMY(I+2000),
    1I=1,IN)
     L=L+1000
     IF (L-NTP) 9010,9030,9030
9030 IN=NTP
C     PREPARE VECTORS NECESSARY FOR IMPOSING BOUNDARY CONDITIONS
5850 DO 6 I=1,IND
     IBOI=IBO+I
     IBBI=IBB+I
     IICI=IIC+I
     IA(IBOI)=-1
     IA(IBBI)=INOI
6    AA(IICI)=1.
     IF (IBN) 300,5860,317
C     READ IN BOUNDARY CONDITIONS
317  L=0
     IBRR=1
     NTP=IBN
3000 IF (L+1000-NTP) 3100,3200,3200
3100 IBN=1000
     GO TO 3170
3200 IBN=NTP-L
3170 IF (IBUN) 3172,3171,3172
3172 CALL BUNG
     GO TO 3173
3171 READ INPUT TAPE 5,108,(IDUM(I),IDUM(I+1000),IDUM(I+2000),IDUM(I+30
    100),DUMMY(I+4000),I=1,IBN)
108  FORMAT (5(I4,I1,I4,I1,F6.5))
3173 DO 441 I=1,IBN
     KCO=IDUM(I+1000)
     KCR=IDUM(I+3000)
     IF (KCR-IDEG) 318,319,300
318  IF (KCR) 300,300,319
319  IF (KCO-IDEG) 320,321,300
320  IF (KCO) 300,300,321
321  NO=IDUM(I)
     NR=IDUM(I+2000)
     IF (NO-IN) 322,323,300
322  IF (NO) 300,300,323
323  IF (NR-IN) 324,325,300
324  IF (NR) 300,300,325
325  II=IDEG*(NO-1)+KCO
     JJ=IDEG*(NR-1)+KCR
     IBOI=IBO+II
     IICI=IIC+II
     N=IA(IBOI)
     GO TO 172
176  IF (N+1)  357,1757,1758
1757 IA(IBOI)=JJ
     GO TO 44
1758 IF (N-10000)1759,1760,1760
1760 IBOJ=IBO+JJ
     IF (IA(IBOJ)+1) 357,1763,357
1763 IA(IBOJ)=-10000-II
     IICJ=IIC+JJ
     AA(IICJ)=DUMMY(I+4000)
     GO TO 441
1759 IBOJ=IBO+JJ
     IF (IA(IBOJ)+1) 357,1761,357
1761 IBON=IBO+N
     IF (IA(IBON)+1) 357,1762,357
1762 IICN=IIC+N
     IA(IBON)=-10000-II
     AA(IICN)=AA(IICI)
     AA(IICI)=0.
     IA(IBOJ)=IA(IBON)
     IICJ=IIC+JJ
     AA(IICJ)=DUMMY(I+4000)
     IA(IBOI)=10000
     GO TO 441
172  IF (II-JJ) 176,175,176
175  IF (N) 1751,357,1753
1751 IF (N+1) 357,1750,175
1750 IA(IBOI)=0
     GO TO 44
1752 IA(IBOI)=10000+II
     GO TO 44
1753 IF (N-10000)1754,1752,357
1754 IBON=IBO+N
     IF (IA(IBON)+1) 357,1756,357
1756 IA(IBOI)=10000+II
     IICN=IIC+N
     AA(IICN)=AA(IICI)
     IA(IBON) =-10000-II
     GO TO 44
357  IBERR(IBRR)=I
     IBRR=IBRR+1
     GO TO 441
44   AA(IICI)=DUMMY(I+4000)
441  CONTINUE
3165 L=L+1000
     IF (L-NTP) 3000,316,316
 316 IBN=NTP
     IBRR=IBRR-1
     IF (IBRR) 3161,5860,3161
3161 WRITE OUTPUT TAPE 6,3162
3162 FORMAT(1H1,111HTHE FOLLOWING DISPLACEMENT BOUNDARY CONDITION(S) CA
    1USE(S) MORE THAN ONE MULTIPLE CONNECTION FOR THE UNKNOWN(S)./
    218H THEY ARE IGNORED.     )
     DO 3163 I=1,IBRR
     J=IBERR(I)
     WRITE OUTPUT TAPE 6,3164,IDUM(J),IDUM(J+1000),IDUM(J+2000),IDUM(J+
    13000),DUMMY(J+4000)
3164 FORMAT (4I6,E15.5)
3163 CONTINUE
C     READ IN AND PRINT OUT MESH TOPOLOGY AND ELEMENT TYPES
5860 IF (INP-1) 7717,2523,2523
2523 WRITE OUTPUT TAPE 6,795
C     PRINT OUT THE HEADLINE
795  FORMAT (1H1,23X,13HMESH TOPOLOGY,42X,22HELEMENT PROPERTY TYPES///6
    1H EL NO,5X,4HND-1,5H ND-2,5H ND-3,5H ND-4,5H ND-5,5H ND-6,5H ND-7,
    25H ND-8,11X,4HELMT,5H PRES,5H MTRL,5H THCK,5H DTMP,5H TGDY,5H TGDZ
```

Table VII-1 (contd)

```
      3,5H AREA,5H I-XX,5H I-YY,5H I-ZZ,5H FI-Y//)                      FLAS1455
7717 IF (IMES) 7908,7909,7908                                            FLAS1456
7908 CALL MESC                                                           FLAS1457
     GO TO 79                                                            FLAS1458
7909 CALL MEST                                                           FLAS1459
     IF (IERR) 300,79,300                                                FLAS1460
  79 DO 9000 M=1,IT                                                      FLAS1461
     CALL TOPO                                                           FLAS1462
     IF (INP-1) 9000,5895,5895                                           FLAS1463
5895 WRITE OUTPUT TAPE 6,7959,M,(N(I),I=1,8),IELT,JPRS,IMPT,ITIC,ITEM    FLAS1464
    1,JSDY,JSDZ,JARE,JMMX,JMMY,JMMZ,JMFI                                 FLAS1465
9000 CONTINUE                                                            FLAS1466
7959 FORMAT (I6,4X,8I5,10X,12I5)                                         FLAS1467
     CALL SRAT                                                           FLAS1468
     II=1                                                                FLAS1469
     DO 461 K=1,IN                                                       FLAS1470
     IK=ISIR(K)                                                          FLAS1471
     IKD=(IK-1)*IDEG                                                     FLAS1472
     DO 46 J=1,IDEG                                                      FLAS1473
     I=IKD+J                                                             FLAS1474
     IBBI=IBB+I                                                          FLAS1475
     IBOI=IBO+I                                                          FLAS1476
     N=IA(IBOI)                                                          FLAS1477
     IF (N) 45,46,46                                                     FLAS1478
45   IF (N+1) 451,452,46                                                 FLAS1479
451  IA(IBBI)=-II                                                        FLAS1480
     GO TO 453                                                           FLAS1481
452  IA(IBBI)=II                                                         FLAS1482
453  II=II+1                                                             FLAS1483
46   CONTINUE                                                            FLAS1484
461  CONTINUE                                                            FLAS1485
     ISUM=II-1                                                           FLAS1486
     DO 47 I=1,IND                                                       FLAS1487
     IBOI=IBO+I                                                          FLAS1488
     N=IA(IBOI)                                                          FLAS1489
     IF (N) 47,47,48                                                     FLAS1490
48   IF (N-10000)481,482,482                                             FLAS1491
482  IBBI=IBB+I                                                          FLAS1492
     IA(IBBI)=-IND1                                                      FLAS1493
     GO TO 47                                                            FLAS1494
481  IBBN=IBB+N                                                          FLAS1495
     IBBI=IBB+I                                                          FLAS1496
     IA(IBBI)=IA(IBBN)                                                   FLAS1497
47   CONTINUE                                                            FLAS1498
C    READ IN EXTERNAL CONCENTRATED LOADS                                 FLAS1499
     DO 2310 I=1,IND                                                     FLAS1500
     IDEFI=IDEF+I                                                        FLAS1501
     DUMMY (I+4000)=0.                                                   FLAS1502
2310 AA(IDEFI)=0.                                                        FLAS1503
     IF (IP)  300,820,5450                                               FLAS1504
5450 L=0                                                                 FLAS1505
     NTP=IP                                                              FLAS1506
8000 IF (L+1000-NTP) 8100,8200,8200                                      FLAS1507
8100 IP=1000                                                             FLAS1508
     GO TO 1211                                                          FLAS1509
8200 IP=NTP-L                                                            FLAS1510
1211 READ INPUT TAPE 5,121,(IDUM(I),IDUM(I+1000),DUMMY(I+2000),I=1,IP)   FLAS1511
     DO 2311 I=1,IP                                                      FLAS1512
     NO=IDUM(I)                                                          FLAS1513
     KCO=IDUM(I+1000)                                                    FLAS1514
     IF (KCO-IDEG) 326,327,300                                           FLAS1515
326  IF (KCO) 300,300,327                                                FLAS1516
327  IF (NO-IN) 328,329,300                                              FLAS1517
328  IF (NO) 300,300,329                                                 FLAS1518
329  J=IDEG*(NO-1)+KCO                                                   FLAS1519
     IDEFJ=IDEF+J                                                        FLAS1520
     AA(IDEFJ)=DUMMY(I+2000)                                             FLAS1521
     IBBJ=IBB+J                                                          FLAS1522
     IB=IA(IBBJ)                                                         FLAS1523
     IICJ=IIC+J                                                          FLAS1524
2311 DUMMY(IB+4000)=DUMMY(IB+4000)+AA(IICJ)*DUMMY(I+2000)                FLAS1525
121  FORMAT (5(I4,I1,E11.5))                                             FLAS1526
C    PRINT OUT DISPLACEMENT AND FORCE BOUNDARY CONDITIONS                FLAS1527
820  IF (INP-1) 2520,2521,2521                                           FLAS1528
2521 DO 8201 J=1,IDEG                                                    FLAS1529
     IBOJ=IBO+J-1                                                        FLAS1530
     IBBJ=IBB+J-1                                                        FLAS1531
     IICJ=IIC+J-1                                                        FLAS1532
     IDEFJ=IDEF+J-1                                                      FLAS1533
     WRITE OUTPUT TAPE 6,8202,J                                          FLAS1534
8202 FORMAT (1H1,30X,55HFORCE AND DISPLACEMENT BOUNDARY CONDITIONS IN DFLAS1535
    1IRECTION,I5///2(5H NODE,7X,1HP,12X,3HIBO,4X,3HIBB,6X,1HC,18X)//)    FLAS1536
     DO 8203 I=1,IND,IDEG                                                FLAS1537
     IBOI=IBOJ+I                                                         FLAS1538
     IBBI=IBBJ+I                                                         FLAS1539
     IICI=IICJ+I                                                         FLAS1540
     IDEFI=IDEFJ+I                                                       FLAS1541
     K=I/IDEG+1                                                          FLAS1542
     DUMMY(K)    =AA(IDEFI)                                              FLAS1543
     IDUM(K+1000)=IA(IBBI)                                               FLAS1544
     IDUM(K+2000)=IA(IBOI)                                               FLAS1545
8203 DUMMY(K+3000)=AA(IICI)                                              FLAS1546
     WRITE OUTPUT TAPE 6,8214,(K,DUMMY(K),IDUM(K+2000),IDUM(K+1000),     FLAS1547
    1DUMMY(K+3000),K=1,IN)                                               FLAS1548
8214 FORMAT ((2(I5,E16.4,2I7,F15.4,10X)))                                FLAS1549
8201 CONTINUE                                                            FLAS1550
     L=L+1000                                                            FLAS1551
     IF (L-NTP) 8000,2517,2517                                           FLAS1552
2517 IP=NTP                                                              FLAS1553
2520 DO 8204 I=1,IND                                                     FLAS1554
     IDEFI=IDEF+I                                                        FLAS1555
8204 AA(IDEFI)=DUMMY(I+4000)                                             FLAS1556
C    COMPUTE IMPORTANT CONSTANTS                                         FLAS1557
     IST=IU+ISUM+1                                                       FLAS1558
     LIST=IST-9000                                                       FLAS1559
     IF (LIST) 353,354,354                                               FLAS1560
354  WRITE OUTPUT TAPE 6,355,LIST                                        FLAS1561
355  FORMAT (6X ,34HDUMMY AREA OVERLAPS COMMON AREA BY,I6,19H DECIMAL LFLAS1562
    1OCATIONS,/5X,87H RECOMPILE BY CHANGING THE EQUIVALENCES OF DUMMY AFLAS1563
    2ND BB IN LINKS 1 AND 3, RESPECTIVELY.)                              FLAS1564
353  CALL TICK (ITIM)                                                    FLAS1565
     C1T=ITIM                                                            FLAS1566
     C1T=C1T/60.                                                         FLAS1567
     WRITE OUTPUT TAPE  6,5555,C1T                                       FLAS1568
5555 FORMAT(      16H INPUT LINK TOOK,F7.2,10H  SECONDS.)                FLAS1569
     READ INPUT TAPE 5,2800,TEST                                         FLAS1570
     IF (INP-1) 332,332,331                                              FLAS1571
331  NB1=XLOCF(AA(1))                                                    FLAS1572
     NB2=XLOCF(AA(IID+1))                                                FLAS1573
     NB3=XLOCF(AA(IST+1))                                                FLAS1574
     NC1=NB1-NB2                                                         FLAS1575
     NC3=NB1-NB3                                                         FLAS1576
     WRITE OUTPUT TAPE 6,6666,(I,IA(I),I=1,NC1)                          FLAS1577
6666 FORMAT (1H1,8HIA BLOCK//(20I6))                                     FLAS1578
     WRITE OUTPUT TAPE 6,6667,(I,AA(I),I=1,NC3)                          FLAS1579
6667 FORMAT (1H1,8HAA BLOCK//(5(I6,E15.7,3X)))                           FLAS1580
     IF (IERR) 346,332,346                                               FLAS1581
346  READ INPUT TAPE 5,2800,TEST                                         FLAS1582
     IF (TEST-CTEST) 346,2700,346                                        FLAS1583
2800 FORMAT (77X,A3)                                                     FLAS1584
332  IF (INX-1) 300,3321,3322                                            FLAS1585
3321 GO TO 2700                                                          FLAS1586
3322 CALL CHAIN (2,ITAP)                                                 FLAS1587
300  WRITE OUTPUT TAPE 6,6665                                            FLAS1588
6665 FORMAT (1H1,12H INPUT ERROR)                                        FLAS1589
     IERR=1                                                              FLAS1590
     GO TO 331                                                           FLAS1591
     END                                                                 FLAS1592
```

Table VII-2. Source program listing of subroutine ARAN (Link 1)

```
*    LABEL
CF1ARN                                                                   F1ARN000
     SUBROUTINE ARAN                                                     F1ARN001
C    RELABELS MESH POINTS                                                F1ARN002
     DIMENSION IA(1),AA(1),REM(13),NT(10),DUMMY(5000),IDUM(5000),N(8)    F1ARN003
    1,P(24),UV(24),X(8),Y(8),Z(8),XO(7),YO(7),ZO(7),RUMMY(27,9)          F1ARN004
    2,D21(21),S(1),G1(1)                                                 F1ARN005
     COMMON IA,AA                                                        F1ARN006
     EQUIVALENCE (IA,AA),(AA( 9000),DUMMY)                               F1ARN007
     EQUIVALENCE (DUMMY,IDUM,NT,RUMMY),(DUMMY(11),REM)                   F1ARN008
     EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),KK),(IA(5),    F1ARN009
    1IPRS),(IA(6),ITYPE),(IA(7),IMA),(IA(8),IDEG),(IA(9),INX),(IA(10),F1ARN010
    2IH),(IA(11),IR),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),F1ARN011
    3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),F1ARN012
    4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMFT),     F1ARN013
    5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),      F1ARN014
    6IORD),(IA(38),IORDI),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),       F1ARN015
    7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57F1ARN016
    8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBO),(IA(61),IID),(IA(62),F1ARN017
    9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITF),(IA(41),ITAP)           F1ARN018
     EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),      F1ARN019
    1IC17),(IA(70),ICF),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),          F1ARN020
    2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)                F1ARN021
    3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TF),(AA(81),DT),(AA(82),DG),   F1ARN022
    4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),    F1ARN023
    5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XO),      F1ARN024
    6(AA(186),YO),(AA(193),ZO),(AA(351),S),(AA(40),ZGEM)                 F1ARN025
    7,(AA(42),INP),(AA(43),IPDG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IUF1ARN026
    8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                               F1ARN027
     EQUIVALENCE (IA(35),ISHUF),(IA(301),ISUR)                           F1ARN028
     EQUIVALENCE (AA(302),MI),(AA(303),MX),(AA(304),I),(AA(305),IP)      F1ARN029
     EQUIVALENCE (ABIN,IBBC),(ABIN,IBAND)                                F1ARN030
     DIMENSION IBBC(8000),IBAND(8000),ISIR(540),IMAX(540),IMIN(540),     F1ARN031
    1ABIN(540,15),ISIRT(540)                                             F1ARN032
     EQUIVALENCE (DUMMY,ABIN),(DUMMY(8100),ISIR),(DUMMY(8640),IMAX),     F1ARN033
    1(DUMMY(9180),IMIN),(DUMMY(8640),ISIRT)                              F1ARN034
     CLT=0.                                                              F1ARN035
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```
1110 NEP=2                                                               F1ARN114
     NBQ=NBQ+1                                                           F1ARN115
     I=NBQ                                                               F1ARN116
     GO TO 1130                                                          F1ARN117
1120 NEP=1                                                               F1ARN118
     NEQ=NEQ-1                                                           F1ARN119
     I=NEQ                                                               F1ARN120
1130 IP=I+1                                                              F1ARN121
     IG=IMAX(I)-IMAX(IP)                                                 F1ARN122
     IL=IMIN(I)-IMIN(IP)                                                 F1ARN123
     IF (IG) 1140,1150,1150                                              F1ARN124
1140 MXM=IMAX(I)                                                         F1ARN125
     MX=IMAX(IP)                                                         F1ARN126
     GO TO 1160                                                          F1ARN127
1150 MXM=IMAX(IP)                                                        F1ARN128
     MX=IMAX(I)                                                          F1ARN129
1160 IF (IL) 1170,1180,1180                                              F1ARN130
1170 MIM=IMIN(IP)                                                        F1ARN131
     MI=IMIN(I)                                                          F1ARN132
     GO TO 1190                                                          F1ARN133
1180 MIM=IMIN(I)                                                         F1ARN134
     MI=IMIN(IP)                                                         F1ARN135
1190 JJ=(I-1)/36+1                                                       F1ARN136
     ACH=ABIN(IP,JJ)                                                     F1ARN137
     JBIT=I-36*(JJ-1)                                                    F1ARN138
     IIP=LFBIN(ACH,JBIT)                                                 F1ARN139
     IF (IIP) 1270,1210,1270                                             F1ARN140
1210 IF (IMIN(I)-I) 1220,1230,1220                                       F1ARN141
1220 IF (IMIN(IP)-IP) 1240,1230,1240                                     F1ARN142
1230 IL=IL+1                                                             F1ARN143
1240 IF (IMAX(I)-I) 1250,1260,1250                                       F1ARN144
1250 IF (IMAX(IP)-IP) 1270,1260,1270                                     F1ARN145
1260 IG=IG+1                                                             F1ARN146
1270 IF (IG+IL) 1910,1280,1480                                           F1ARN147
1280 NZL=0                                                               F1ARN148
     NZG=0                                                               F1ARN149
     DO 1300 J=1,IN                                                      F1ARN150
```

Table VII-2 (contd)

```
      XSAP=0.                                                           F1ARN036
      XN=IN                                                             F1ARN037
      NCYCL=0                                                           F1ARN038
      NCYCN=IN/10+3                                                     F1ARN039
      ISURP=ISUR+1                                                      F1ARN040
      ICYCL=-1                                                          F1ARN041
      IF (ISHUF-1) 90,90,10                                             F1ARN042
   10 READ INPUT TAPE 5,1,(ISIR(I),I=1,IN)                              F1ARN043
    1 FORMAT (20I4)                                                     F1ARN044
      DO 20 I=1,IN                                                      F1ARN045
   20 ISIRT(I)=I                                                        F1ARN046
      MI=1                                                              F1ARN047
      MX=IN                                                             F1ARN048
      DO 80 I=1,IN                                                      F1ARN049
      DO 23 IP=I,IN                                                     F1ARN050
      IF (ISIR(I)-ISIRT(IP)) 23,24,23                                   F1ARN051
   23 CONTINUE                                                          F1ARN052
      GO TO 3100                                                        F1ARN053
   24 IF (I-IP) 25,80,25                                                F1ARN054
   25 ISIRT(IP)=ISIRT(I)                                                F1ARN055
      CALL EXCH                                                         F1ARN056
   80 CONTINUE                                                          F1ARN057
   90 DO 100 I=1,IN                                                     F1ARN058
      IMIN(I)=0                                                         F1ARN059
  100 IMAX(I)=0                                                         F1ARN060
      DO 700 I=1,IN                                                     F1ARN061
      DO 400 J=1,ISUR                                                   F1ARN062
      ACH=ABIN(I,J)                                                     F1ARN063
      DO 300 JB=1,36                                                    F1ARN064
      IF (LEBIN(ACH,JB)) 420,300,420                                    F1ARN065
  300 CONTINUE                                                          F1ARN066
  400 CONTINUE                                                          F1ARN067
      GO TO 3100                                                        F1ARN068
  420 IMIN(I)=36*(J-1)+JB                                               F1ARN069
      JC=ISURP-J                                                        F1ARN070
      DO 600 J=1,JC                                                     F1ARN071
      JBI=ISURP-J                                                       F1ARN072
      ACH=ABIN(I,JBI)                                                   F1ARN073
      DO 500 JB=1,36                                                    F1ARN074
      JBC=36-JB+1                                                       F1ARN075
      IF (LEBIN(ACH,JBC)) 620,500,620                                   F1ARN076
  500 CONTINUE                                                          F1ARN077
  600 CONTINUE                                                          F1ARN078
      GO TO 3100                                                        F1ARN079
  620 IMAX(I)=36*JBI-JB+1                                               F1ARN080
  700 CONTINUE                                                          F1ARN081
      IF (ISHUF-1) 2010,750,750                                         F1ARN082
  750 CALL TICK (ITIM)                                                  F1ARN083
      CBT=ITIM                                                          F1ARN084
      IF (INP-1) 1100,1100,800                                          F1ARN085
  800 CALL OUTPT                                                        F1ARN086
 1100 NBQ=0                                                             F1ARN087
      NEQ=IN                                                            F1ARN088
      NCH=0                                                             F1ARN089
      ICYCL=ICYCL+1                                                     F1ARN090
      XSA=IN-IMAX(1)                                                    F1ARN091
      IMAXP=IMAX(1)                                                     F1ARN092
      XMAXP=IMAXP                                                       F1ARN093
      DO 1105 I=2,IN                                                    F1ARN094
      IF (IMAX(I)-IMAXP)  1105,1105,1102                                F1ARN095
 1102 IMAXP=IMAX(I)                                                     F1ARN096
      XMAXP=IMAXP                                                       F1ARN097
 1105 XSA=XSA+XN-XMAXP                                                  F1ARN098
      IF (XSA-XSAP) 1106,1106,1107                                      F1ARN099
 1106 NCYCL=NCYCL+1                                                     F1ARN100
      IF (NCYCL-NCYCN) 1108,1108,1985                                   F1ARN101
 1107 XSAP=XSA                                                          F1ARN102
      NCYCL=0                                                           F1ARN103
 1108 CALL TICK (ITIM)                                                  F1ARN104
      CNT=ITIM                                                          F1ARN105
      CNT=(CNT-CBT)/60.                                                 F1ARN106
      IF (CNT-CLT) 1110,1109,1109                                       F1ARN107
 1109 CLT=CLT+100.                                                      F1ARN108
      WRITE OUTPUT TAPE 6,3,CNT,ICYCL,XSA                               F1ARN109
      IF (CNT-100.) 1110,1110,1111                                      F1ARN110
 1111 PUNCH 1,(ISIR(I),I=1,IN)                                          F1ARN111
    3 FORMAT (3H AT,F7.2,19H SEC. OF RELABELING,I6,75H INTERCHANGES DONEF1ARN112
     1, UPPER OFF-BAND ELEMENT COUNT OF MESH TOPOLOGY MATRIX I5,F9.0)   F1ARN113
      IJ=IP+J                                                           F1ARN151
      IF (IJ-IN) 1290,1290,1310                                         F1ARN152
 1290 IF (IMIN(IJ)-MIM) 1300,1300,1320                                  F1ARN153
 1300 CONTINUE                                                          F1ARN154
 1310 MNN=IN                                                            F1ARN155
      GO TO 1330                                                        F1ARN156
 1320 MNN=IMIN(IJ)-1                                                    F1ARN157
 1330 DO 1350 J=1,IN                                                    F1ARN158
      JI=I-J                                                            F1ARN159
      IF (JI-1) 1360,1340,1340                                          F1ARN160
 1340 IF (IMAX(JI)-MXM) 1365,1350,1350                                  F1ARN161
 1350 CONTINUE                                                          F1ARN162
 1360 MXB=1                                                             F1ARN163
      GO TO 1370                                                        F1ARN164
 1365 MXB=IMAX(JI)+1                                                    F1ARN165
 1370 IF (MNN-MIM) 1410,1375,1375                                       F1ARN166
 1375 IF (MNN-I) 1390,1380,1380                                         F1ARN167
 1380 MNN=I-1                                                           F1ARN168
      GO TO 1370                                                        F1ARN169
 1390 DO 1400 J=MIM,MNN                                                 F1ARN170
      JJ=(J-1)/36                                                       F1ARN171
      JJP=JJ+1                                                          F1ARN172
      ACH=ABIN(I,JJP)                                                   F1ARN173
      JBIT=J-36*JJ                                                      F1ARN174
      IF (LEBIN(ACH,JBIT)) 1395,1393,1395                               F1ARN175
 1393 NZG=NZG+1                                                         F1ARN176
 1395 ACH=ABIN(IP,JJP)                                                  F1ARN177
      JBIT=J-36*JJ                                                      F1ARN178
      IF (LEBIN(ACH,JBIT)) 1400,1397,1400                               F1ARN179
 1397 NZL=NZL+1                                                         F1ARN180
 1400 CONTINUE                                                          F1ARN181
 1410 IF (MXB-MXM) 1415,1415,1460                                       F1ARN182
 1415 IF (MXB-IP) 1420,1420,1430                                        F1ARN183
 1420 MXB=IP+1                                                          F1ARN184
      GO TO 1410                                                        F1ARN185
 1430 DO 1450 J=MXB,MXM                                                 F1ARN186
      JJ=(J-1)/36+1                                                     F1ARN187
      ACH=ABIN(I,JJ)                                                    F1ARN188
      BCH=ABIN(IP,JJ)                                                   F1ARN189
      JBIT=J-36*(JJ-1)                                                  F1ARN190
      IF (LEBIN(ACH,JBIT)) 1440,1435,1440                               F1ARN191
 1435 NZL=NZL+1                                                         F1ARN192
 1440 IF (LEBIN(BCH,JBIT)) 1450,1445,1450                               F1ARN193
 1445 NZG=NZG+1                                                         F1ARN194
 1450 CONTINUE                                                          F1ARN195
 1460 IF (NZG-NZL) 1910,1910,1480                                       F1ARN196
 1480 ICYCL=ICYCL+1                                                     F1ARN197
      CALL EXCH                                                         F1ARN198
      NCH=ISIR(I)                                                       F1ARN199
      ISIR(I)=ISIR(IP)                                                  F1ARN200
      ISIR(IP)=NCH                                                      F1ARN201
      IF (IIP) 1720,1630,1720                                           F1ARN202
 1630 IF (IMAX(IP)-IP) 1650,1640,1650                                   F1ARN203
 1640 IMAX(IP)=IMAX(IP)-1                                               F1ARN204
 1650 IF (IMAX(I)-I) 1670,1660,1670                                     F1ARN205
 1660 IMAX(I)=IMAX(I)+1                                                 F1ARN206
 1670 IF (IMIN(I)-I) 1690,1680,1690                                     F1ARN207
 1680 IMIN(I)=IMIN(I)+1                                                 F1ARN208
 1690 IF (IMIN(IP)-IP) 1720,1710,1720                                   F1ARN209
 1710 IMIN(IP)=IMIN(IP)-1                                               F1ARN210
 1720 NCH=IMAX(I)                                                       F1ARN211
      IMAX(I)=IMAX(IP)                                                  F1ARN212
      IMAX(IP)=NCH                                                      F1ARN213
      NCH=IMIN(I)                                                       F1ARN214
      IMIN(I)=IMIN(IP)                                                  F1ARN215
      IMIN(IP)=NCH                                                      F1ARN216
      DO 1900 J=MI,MX                                                   F1ARN217
      IF ((I-J)*(IP-J)) 1740,1900,1740                                  F1ARN218
 1740 IF (J-I) 1810,1900,1750                                           F1ARN219
 1750 IF (IMIN(J)-I) 1780,1760,1780                                     F1ARN220
 1760 JJ=(J-1)/36+1                                                     F1ARN221
      ACH=ABIN(I,JJ)                                                    F1ARN222
      JBIT=J-36*(JJ-1)                                                  F1ARN223
      IF (LEBIN(ACH,JBIT)) 1900,1770,1900                               F1ARN224
 1770 IMIN(J)=IMIN(J)+1                                                 F1ARN225
      GO TO 1900                                                        F1ARN226
 1780 IF (IMIN(J)-IP) 1900,1790,1900                                    F1ARN227
 1790 IMIN(J)=IMIN(J)-1                                                 F1ARN228
      GO TO 1900                                                        F1ARN229
 1810 IF (IMAX(J)-I) 1830,1820,1830                                     F1ARN230
 1820 IMAX(J)=IMAX(J)+1                                                 F1ARN231
      GO TO 1900                                                        F1ARN232
 1830 IF (IMAX(J)-IP) 1900,1840,1900                                    F1ARN233
 1840 JJ=(J-1)/36+1                                                     F1ARN234
      ACH=ABIN(IP,JJ)                                                   F1ARN235
      JBIT=J-36*(JJ-1)                                                  F1ARN236
      IF (LEBIN(ACH,JBIT)) 1900,1850,1900                               F1ARN237
 1850 IMAX(J)=IMAX(J)-1                                                 F1ARN238
 1900 CONTINUE                                                          F1ARN239
 1910 IF (NBQ-NEQ) 1960,1970,1970                                       F1ARN240
 1960 GO TO (1110,1120),NEP                                             F1ARN241
 1970 IF (NCH) 1100,1980,1100                                           F1ARN242
 1980 CONTINUE                                                          F1ARN243
 1985 IF (INP-1) 2005,2005,1990                                         F1ARN244
 1990 CALL OUTPT                                                        F1ARN245
 2005 CALL TICK(ITIM)                                                   F1ARN246
      CNT=ITIM                                                          F1ARN247
      CNT=(CNT-CBT)/60.                                                 F1ARN248
      WRITE OUTPUT TAPE 6,3,CNT,ICYCL,XSA                               F1ARN249
 2010 NEQ=IN-1                                                          F1ARN250
      DO 2100 I=1,NEQ                                                   F1ARN251
      IP=I+1                                                            F1ARN252
      IF (IMAX(IP )-IMAX(I)) 2030,2100,2100                             F1ARN253
 2030 IMAX(IP )=IMAX(I)                                                 F1ARN254
 2100 CONTINUE                                                          F1ARN255
      IF (ISHUF-1) 3000,2300,2300                                       F1ARN256
 2300 PUNCH 1,(ISIR(I),IMAX(I),I=1,IN)                                  F1ARN257
 3000 RETURN                                                            F1ARN258
 3100 WRITE OUTPUT TAPE 6,4,I                                           F1ARN259
    4 FORMAT (10H THE POINT,I5,33H DOES NOT APPEAR IN MESH TOPOLOGY)    F1ARN260
      GO TO 3000                                                        F1ARN261
      END                                                               F1ARN262
```

Table VII-3. Source program listing of subroutine BUNG (Link 1)

```
*     LABEL
CE1BUNG
      SUBROUTINE BUNG                                                   F1BUNG00
C     DUMMY SUBROUTINE FOR BOUNDARY CONDITION GENERATOR                 F1BUNG01
      RETURN                                                            F1BUNG02
      END                                                               F1BUNG03
                                                                        F1BUNG04
```

Table VII-4. Source program listing of subroutine COOR (Link 1)

```
*       LABEL
CE1COR                                                                  E1COR000
      SUBROUTINE COOR                                                   E1COR001
C     READS AND STORES COORDINATES                                      E1COR002
      DIMENSION IA(1),AA(1),REM(13),NT(10),DUMMY(5000),IDUM(5000),N(8)  E1COR003
     1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),RUMMY(27,9)        E1COR004
     2,D21(21),S(1),G1(1)                                               E1COR005
      COMMON IA,AA                                                      E1COR006
      EQUIVALENCE (IA,AA),(AA( 9000),DUMMY)                             E1COR007
      EQUIVALENCE (DUMMY,IDUM,NT,RUMMY),(DUMMY(11),REM)                 E1COR008
      EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),  E1COR009
     1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),E1COR010
     2IH),(IA(11),IB),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),E1COR011
     3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),E1COR012
     4ISTR),(IA(28),IFLT),(IA(29),ITEM),(IA(30),IIC),(IA(31),IMET),     E1COR013
     5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),     E1COR014
     6IORD),(IA(38),IORDI),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),      E1COR015
     7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57E1COR016
     8),J8),(IA(58),JTY),(IA(59),IHB),(IA(60),IB0),(IA(61),IID),(IA(62),E1COR017
     9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),IIF),(IA(41),ITAP)         E1COR018
      EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),    E1COR019
     1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),       E1COR020
     2(IA(74),IIC),(IA(75),IDFF),(IA(76),IST),(IA(77),IIS)              E1COR021
     3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TF),(AA(81),DT),(AA(82),OG), E1COR022
     4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),O21),(AA(107),P),  E1COR023
     5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),    E1COR024
     6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)               E1COR025
     7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IUE1COR026
     8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                             E1COR027
      EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346) E1COR028
     1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)   E1COR029
     2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)      E1COR030
     3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),ID7)       E1COR031
     4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)         E1COR032
     5,(IA(329),IPIR)                                                   E1COR033
      IERR=0                                                            E1COR034
      L=0                                                               E1COR035
 831  INTE=(IN-L-1)/2                                                   E1COR036
      INTE=2*(INTE+1)                                                   E1COR037
      IF (INTE-1000) 833,833,832                                        E1COR038
  832 INTE=1000                                                         E1COR039
  833 READ INPUT TAPE 5,102,(IDUM(I),DUMMY(I+1000),DUMMY(I+2000),DUMMY  E1COR040
     1(I+3000),I=1,INTE)                                                E1COR041
  102 FORMAT (2(I4,3E12.7))                                             E1COR042
      I=0                                                               E1COR043
 8314 I=I+1                                                             E1COR044
      IF (I-INTE) 8315,8315,831                                         E1COR045
 8315 IF (IDUM(I)) 300,8314,8316                                        E1COR046
 8316 IF (IDUM(I)-L-1) 300,1061,300                                     E1COR047
 1061 L=L+1                                                             E1COR048
      IXXL=IXX+L                                                        E1COR049
      IYYL=IYY+L                                                        E1COR050
      IZZL=IZZ+L                                                        E1COR051
      AA(IXXL)=DUMMY(I+1000)                                            E1COR052
      AA(IYYL)=DUMMY(I+2000)                                            E1COR053
      IF (IGEM-1) 1062,1063,300                                         E1COR054
 1063 AA(IZZL)=DUMMY(I+3000)                                            E1COR055
 1062 IF (L-IN) 8314,5850,300                                           E1COR056
 5850 RETURN                                                            E1COR057
  300 IERR=1                                                            E1COR058
      GO TO 5850                                                        E1COR059
      END                                                               E1COR060
```

Table VII-5. Source program listing of subroutine CORG (Link 1)

```
*       LABEL
CE1CORG                                                                 E1CORG00
      SUBROUTINE CORG                                                   E1CORG01
C     DUMMY SUBROUTINE FOR COORDINATE GENERATOR                         E1CORG02
      RETURN                                                            E1CORG03
      END                                                               E1CORG04
```

Table VII-6. Source program listing of subroutine EXCH (Link 1)

```
*       LABEL
CE1EXC                                                                  E1EXC000
      SUBROUTINE EXCH                                                   E1EXC001
C     INTERCHANGES CONSECUTIVE ROWS AND COLUMNS OF CONNECTIVITY MATRIX  E1EXC002
      COMMON AA                                                         E1EXC003
      EQUIVALENCE (AA( 9000),ABIN)                                      E1EXC004
      EQUIVALENCE (AA(302),MI),(AA(303),MX),(AA(304),I),(AA(305),IP)    E1EXC005
      DIMENSION ABIN(540,15)                                            E1EXC006
      JMI=(MI-1)/36+1                                                   E1EXC007
      JMX=(MX-1)/36+1                                                   E1EXC008
      DO 100 K=JMI,JMX                                                  E1EXC009
      ACH=ABIN(I,K)                                                     E1EXC010
      ABIN(I,K)=ABIN(IP,K)                                              E1EXC011
  100 ABIN(IP,K)=ACH                                                    E1EXC012
      J=(I-1)/36+1                                                      E1EXC013
      JB=I-36*(J-1)                                                     E1EXC014
      JP=(IP-1)/36+1                                                    E1EXC015
      JPB=IP-36*(JP-1)                                                  E1EXC016
      IF (J-JP) 150,250,150                                             E1EXC017
  150 DO 200 K=MI,MX                                                    E1EXC018
      ACH=ABIN(K,J)                                                     E1EXC019
      BCH=ABIN(K,JP)                                                    E1EXC020
      NCH=LEBIN(ACH,JB)                                                 E1EXC021
      NCT=LEBIN(BCH,JPB)                                                E1EXC022
      CALL SEBIN (ACH,JB,NCT)                                           E1EXC023
      CALL SEBIN (BCH,JPB,NCH)                                          E1EXC024
      ABIN(K,J)=ACH                                                     E1EXC025
  200 ABIN(K,JP)=BCH                                                    E1EXC026
      GO TO 400                                                         E1EXC027
  250 DO 300 K=MI,MX                                                    E1EXC028
      ACH=ABIN(K,J)                                                     E1EXC029
      NCH=LEBIN(ACH,JB)                                                 E1EXC030
      NCT=LEBIN(ACH,JPB)                                                E1EXC031
      CALL SEBIN (ACH,JB,NCT)                                           E1EXC032
      CALL SEBIN (ACH,JPB,NCH)                                          E1EXC033
  300 ABIN(K,J)=ACH                                                     E1EXC034
  400 RETURN                                                            E1EXC035
      END                                                               E1EXC036
```

Table VII-7. Source program listing of function LEBIN and subroutine SEBIN (Link 1)

```
*       FAP                                                             E1LED000
        COUNT   100                                                     E1LED001
        LBL     E1LED                                                   E1LED002
        REM                                                             E1LED003
*       THIS SUBPROGRAM IS CALLED USING FORTRAN 'SUBROUTINE' CONVENTIONS.E1LED004
*       CALLING SEQUENCE IS...                                          E1LED005
*               CALL SEBIN(A,I,N)                                       E1LED006
*       WHERE   'A' IS THE NAME OF A WORD (VARIABLE).                   E1LED007
*               'I' IS FTN INTEGER SPECIFYING DESIRED BIT (1-36) IN 'A'. E1LED008
*               'N' IS A FORTRAN INTEGER ONE OR ZERO INDICATING THE NEW E1LED009
*                   VALUE OF THE I'TH BIT OF 'A'.                       E1LED010
        REM                                                             E1LED011
        ENTRY   SEBIN                                                   E1LED012
        ENTRY   LEBIN                                                   E1LED013
        REM                                                             E1LED014
        EVEN                                                            E1LED015
        NAC                                                             E1LED016
SEBIN   EQU     *                                                       E1LED017
        STI     INDKTR          SAVE INDICATORS                         E1LED018
        SXA     SAVX1,1         AND XR1                                 E1LED019
        LDI*    1,4             RESET                                   E1LED020
        CLA*    2,4                                                     E1LED021
        PDC     ,1                                                      E1LED022
        ZET*    3,4             DO WE SET OR RESET                      E1LED023
        TRA     SET             SET                                     E1LED024
        RIS     TABLE,1         RESET                                   E1LED025
        TRA     EXIT                                                    E1LED026
        EVEN                                                            E1LED027
SET     OSI     TABLE,1                                                 E1LED028
EXIT    STI*    1,4                                                     E1LED029
SAVX1   AXT     **,1                                                    E1LED030
        LDI     INDKTR                                                  E1LED031
        TRA     4,4                                                     E1LED032
        REM                                                             E1LED033
INDKTR  PZE     **                                                      E1LED034
TABLE   PZE     0                                                       E1LED035
        MZE                                                             E1LED036
        DEC     1B1,1B2,1B3,1B4,1B5,1B6,1B7,1B8,1B9,1B10,1B11,1B12      E1LED037
        DEC     1B13,1B14,1B15,1B16,1B17,1B18,1B19,1B20,1B21,1B22       E1LED038
        DEC     1B23,1B24,1B25,1B26,1B27,1B28,1B29,1B30,1B31,1B32       E1LED039
        DEC     1B33,1B34,1B35                                          E1LED040
        SPACE   4                                                       E1LED041
*       A FUNCTION SUBPROGRAM...                                        E1LED042
*       CALLING SEQUENCE 'X=LEBIN(A,I)'                                 E1LED043
*       WHERE   'A' IS THE NAME OF A VARIABLE                           E1LED044
*               'I' IS A FTN INTEGER SPECIFYING THE DESIRED BIT IN 'A'. E1LED045
*                   ON RETURN TO CALLER THE AC CONTAINS A FORTRAN INTEGER E1LED046
*                   ONE OR ZERO DEPENDING ON WHETHER I'TH BIT OF 'A' IS E1LED047
*                   ONE OR ZERO.                                        E1LED048
        REM                                                             E1LED049
LEBIN   EQU     *                                                       E1LED050
        SXA     LEBX1,1                                                 E1LED051
        CAL*    2,4             THIS BIT                                E1LED052
        PDC     ,1                                                      E1LED053
        CAL*    1,4                                                     E1LED054
        ANA     TABLE,1                                                 E1LED055
        TZE     LEBX1                                                   E1LED056
        CAL     ONE                                                     E1LED057
LEBX1   AXT     **,1                                                    E1LED058
        TRA     3,4                                                     E1LED059
        REM                                                             E1LED060
ONE     PZE     ,,1             A FORTRAN II 1                          E1LED061
        END                                                             E1LED062
```

Table VII-8. Source program listing of subroutine MESG (Link 1)

```
*       LABEL
CE1MESG
        SUBROUTINE MESG
C       DUMMY SUBROUTINE FOR MESH GENERATOR
        RETURN
        END
```

Table VII-9. Source program listing of subroutine MEST (Link 1)

```
*       LABEL
CEIMES
      SUBROUTINE MEST
C     READS AND STORES MESH TOPOLOGY DATA
      DIMENSION IA(1),AA(1),REM(13),NT(10),DUMMY(5000),IDUM(5000),N(8)
     1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),RUMMY(27,9)
     2,D21(21),S(1),G1(1)
      COMMON IA,AA
      EQUIVALENCE (IA,AA),(AA( 9000),DUMMY)
      EQUIVALENCE (DUMMY,IDUM,NT,RUMMY),(DUMMY(11),REM)
      EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),
     1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),
     2IH),(IA(11),IB),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),
     3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),
     4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),
     5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),
     6IDRD),(IA(38),IDRD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),
     7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57
     8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBD),(IA(61),IID),(IA(62),
     9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITE),(IA(41),ITAP)
      EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),
     1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),
     2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)
     3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),OT),(AA(82),DG),
     4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),
     5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),
     6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)
     7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IUF
     8),(AA(47),G1),(AA(48),G2),(AA(49),G3)
      EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346)
     1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)
     2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)
     3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)
     4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)
     5,(IA(329),IPIR)
      IERR=0
      M=0
      MT=0
      L=0
      NBE=-19
      NFI=0
 7910 L=L+1
 7911 IF (L-NFI)7912,7912,7913
 7913 NBE=NBE+20
      NFI=NFI+20
      READ INPUT TAPE 5,791,(IDUM(I),I=NBE,NFI)
  791 FORMAT (20I4)
 7912 IF (IDUM(L)) 7921,7910,7924
 7921 IF (L-NFI) 7914,7913,7913
 7924 IF (IERR) 300,300,7925
 7925 L=L-1
      MT=-1
      IERR=0
 7914 M=M+1
      MT=MT+1
      IF (MT-999) 7916,7915,300
 7915 IERR=1
 7916 IF (MT+IDUM(L)) 300,7917,300
 7917 IELT=IDUM(L+1)/100
      IF (IELT*(IELT-19)) 7918,300,300
 7918 GO TO (81,82,81,83,84,85,84,85,86,87,84,85,84,85,84,85,81,81),IFLT
   81 JK=5
      JN=2
      GO TO 89
   82 JK=6
      JN=2
      GO TO 89
   83 JK=8
      JN=2
      GO TO 89
   84 JK=6
      JN=3
      GO TO 89
   85 JK=7
      JN=4
      GO TO 89
   86 JK=6
      JN=4
      GO TO 89
   87 JK=10
      JN=8
   89 LC=L
      LJK=LC+JK
      LJKP=LJK+1
      IF (LJK-NFI) 7919,7919,7923
 7923 NBE=NBE+20
      NFI=NFI+20
      READ INPUT TAPE 5,791,(IDUM(I),I=NBE,NFI)
 7919 GO TO (70,69,68,67,66,65,64,63,62,61),JK
 61   JM=J10+M
      GO TO 72
   62 JM=J9+M
      GO TO 72
 63   JM=J8+M
      GO TO 72
 64   JM=J7+M
      GO TO 72
 65   JM=J6+M
      GO TO 72
 66   JM=J5+M
      GO TO 72
 67   JM=J4+M
      GO TO 72
 68   JM=J3+M
      GO TO 72
 69   JM=J2+M
      GO TO 72
 70   JM=J1+M
 72   L=L+1
      LJK=LC+JK
      IA(JM)=IDUM(LJK)
      JK=JK-1
      IF (JK) 78,78,7919
   78 DO 7800 J=1,JN
      JL=LJKP-J
      IF (IDUM(JL)) 300,300,7800
 7800 CONTINUE
      IF (M-IT) 7930,799,300
 7930 IF (NFI-20) 7910,7910,7932
 7932 NIE=NFI-20
      DO 7940 I=1,20
      II=I+NIE
 7940 IDUM(I)=IDUM(II)
      L=L-NIE
      NBE=1
      NFI=20
      GO TO 7910
 799  IERR=0
   79 RETURN
  300 IERR=1
      GO TO 79
      END
```

Table VII-10. Source program listing of subroutine OUTPT (Link 1)

```
*       LABEL
CEIUPT
      SUBROUTINE OUTPT
C     WRITES INFORMATION RELATED WITH RELABELLING
      DIMENSION IA(1),AA(1),REM(13),NT(10),DUMMY(5000),IDUM(5000),N(8)
     1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),RUMMY(27,9)
     2,D21(21),S(1),G1(1)
      COMMON IA,AA
      EQUIVALENCE (IA,AA),(AA( 9000),DUMMY)
      EQUIVALENCE (DUMMY,IDUM,NT,RUMMY),(DUMMY(11),REM)
      EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),
     1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),
     2IH),(IA(11),IB),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),
     3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),
     4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),
     5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),
     6IDRD),(IA(38),IDRD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),
     7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57
     8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBD),(IA(61),IID),(IA(62),
     9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITE),(IA(41),ITAP)
      EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),
     1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),
     2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)
     3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),OT),(AA(82),DG),
     4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),
     5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),
     6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)
     7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IUF
     8),(AA(47),G1),(AA(48),G2),(AA(49),G3)
      EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346)
     1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)
     2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)
     3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),JTAS),(IA(334),IDZ)
     4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)
      EQUIVALENCE (IA(35),ISHUF),(IA(301),ISUR)
      EQUIVALENCE (ABIN,IBBC),(ABIN,IBAND)
      DIMENSION IBBC(8000),IBAND(8000),ISIR(540),IMAX(540),IMIN(540),
     1ABIN(540,15)
      EQUIVALENCE (DUMMY,ABIN),(DUMMY(8100),ISIR),(DUMMY(8640),IMAX),
     1(DUMMY(9180),IMIN)
      WRITE OUTPUT TAPE 6,16
   16 FORMAT (1H1,5H NO.,6H ISIR,6H IMIN,6H IMAX,60X,21HLABEL MATRIX
     1 IN OCTAL//)
      WRITE OUTPUT TAPE 6,17,(I,ISIR(I),IMIN(I),IMAX(I),(ABIN(I,J),J=1,7
     1),I=1,IN)
   17 FORMAT (4I6,5X,7O13)
      IF (ISUR-7) 120,120,110
  110 WRITE OUTPUT TAPE 6,18,(I,ISIR(I),(ABIN(I,J),J=8,15),I=1,IN)
   18 FORMAT (1H0/(2I6,4X,8O13))
  120 RETURN
      END
```

Table VII-11. Source program listing of subroutine SRAT (Link 1)

```
*      LABEL
CE1SRT                                                                  E1SRT000
       SUBROUTINE SRAT                                                  E1SRT001
C      GENERATES CONNECTIVITY MATRIX AND DESCRIBES TOPOLOGY OF STIFF.MAT.E1SRT002
       DIMENSION IA(1),AA(1),REM(13),NT(10),DUMMY(5000),IDUM(5000),N(8) E1SRT003
      1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),RUMMY(27,9)       E1SRT004
      2,D21(21),S(1),G1(1)                                              E1SRT005
       COMMON IA,AA                                                     E1SRT006
       EQUIVALENCE (IA,AA),(AA( 9000),DUMMY)                            E1SRT007
       EQUIVALENCE (DUMMY,IDUM,NT,RUMMY),(DUMMY(11),REM)                E1SRT008
       EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5), E1SRT009
      1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),E1SRT010
      2IH),(IA(11),IB),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),E1SRT011
      3IMFI),(IA(16),IARS),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),E1SRT012
      4ISTR),(IA(28),IEL),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IVET),    E1SRT013
      5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),ISS),(IA(37),    E1SRT014
      6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),     E1SRT015
      7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57E1SRT016
      8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBO),(IA(61),ITI),(IA(62),E1SRT017
      9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),IIF),(IA(4),IIAP)         E1SRT018
       EQUIVALENCE (IA(66),ICAR),(IA(67),ICTX),(IA(68),ICTY),(IA(69),   E1SRT019
      1ICTZ),(IA(70),ICF),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),       E1SRT020
      2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)             E1SRT021
      3,(IA(78),IGEM),(IA(79),IERR),(AA(80),IF),(AA(81),CT),(AA(82),DG), E1SRT022
      4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P), E1SRT023
      5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),   E1SRT024
      6(AA(186),YD),(AA(193),ZD),(AA(35),S),(AA(40),ZGEM)               E1SRT025
      7,(AA(42),INP),(AA(43),IPPG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IOE1SRT026
      8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                            E1SRT027
       EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346) E1SRT028
      1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)  E1SRT029
      2,(IA(341),JSDZ),(IA(340),JARS),(IA(339),JMMX),(IA(338),JMMY)     E1SRT030
      3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),ID7)      E1SRT031
      4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)        E1SRT032
       DIMENSION IBS(25),CCCI(25),JBS(25),CCCJ(25)                      E1SRT033
       EQUIVALENCE (IA(200),IBS),(IA(225),JBS),(AA(250),CCCI),          E1SRT034
      1(AA(275),CCCJ)                                                   E1SRT035
       EQUIVALENCE (IA(35),ISHUF),(IA(30),ISUR)                         E1SRT036
       EQUIVALENCE (ABIN,IBBC),(ABIN,IBAND)                             E1SRT037
       DIMENSION IBBC(8000),IBAND(8000),ISIR(540),IMAX(540),IMIN(540),  E1SRT038
      1ABIN(540,15)                                                     E1SRT039
       EQUIVALENCE (DUMMY,ABIN),(DUMMY(8100),ISIR),(DUMMY(8640),IMAX),  E1SRT040
      1(DUMMY(9180),IMIN)                                               E1SRT041
       IF (ISHUF-2) 25,25,23                                            E1SRT042
   23 READ INPUT TAPE 5,100,(ISIR(I),IMAX(I),I=1,IN)                    E1SRT043
  100 FORMAT (20I4)                                                     E1SRT044
      GO TO 1100                                                        E1SRT045
   25 DO 22 I=1,IN                                                      E1SRT046
   22  ISIR(I)=I                                                        E1SRT047
       ISUR=(IN-1)/36+1                                                 E1SRT048
       DO 71 I=1,IN                                                     E1SRT049
       DO 71 J=1,ISUR                                                   E1SRT050
   71 ABIN(I,J)=0.                                                      E1SRT051
       DO 99 M=1,IT                                                     E1SRT052
       CALL TOPO                                                        E1SRT053
       DO 98 I=1,IH                                                     E1SRT054
       L=IH-I+1                                                         E1SRT055
       IF (N(L)) 98,98,97                                               E1SRT056
   98  CONTINUE                                                         E1SRT057
    1  WRITE OUTPUT TAPE 6,111,M                                        E1SRT058
  111  FORMAT (      8H ELEMENT,I4,2X,29HIS UNACCEPTABLE. DISREGARDED.) E1SRT059
       GO TO 99                                                         E1SRT060
   97  IMS=I                                                            E1SRT061
C      THIS CARD (E1SR61A0) IS IMMEDIATELY AFTER CARD E1SRT061.         E1SR61A0
C      EXPAND ELEMENT VERTEX VECTOR,BY MULTIPLE DRC INPUT UNITS,IN IMAX E1SR61A1
       L=0                                                              E1SR61A2
       DO 300 I=1,IMS                                                   E1SR61A3
       L=L+1                                                            E1SR61A4
       IMAX(L)=N(I)                                                     E1SR61A5
       KN=(N(I)-1)*IDEG+IBO                                             E1SR61A6
       DO 301 J=1,IDEG                                                  E1SR61A7
       IROL=KN+J                                                        E1SR61A8
       IF (IA(IROL)-10000) 301,302,302                                  E1SR61A9
  302  KM=10000+IROL-IBO                                                E1SR61B0
       IROL=IBO                                                         E1SR61B1
       DO 303 K=1,IND                                                   E1SR61B2
       IROL=IROL+1                                                      E1SR61B3
       IF (IA(IROL)+KM) 303,304,303                                     E1SR61B4
  304  L=L+1                                                            E1SR61B5
       IMAX(L)=(K-1)/IDEG+1                                             E1SR61B6
  303  CONTINUE                                                         E1SR61B7
  301  CONTINUE                                                         E1SR61B8
  300  CONTINUE                                                         E1SR61B9
       IMS=1                                                            E1SR61C0
       DO 306 I=2,L                                                     E1SR61C1
       KN=IMAX(I)                                                       E1SR61C2
       DO 307 J=1,IMS                                                   E1SR61C3
       IF (IMAX(J)-KN) 307,306,307                                      E1SR61C4
  307  CONTINUE                                                         E1SR61C5
       IMS=IMS+1                                                        E1SR61C6
       IMAX(IMS)=KN                                                     E1SR61C7
  306  CONTINUE                                                         E1SR61C8
C      THIS CARD (E1SR61C9) IS IMMEDIATELY BEFORE CARD E1SRT062.        E1SR61C9
       DO 95 I=1,IMS                                                    E1SRT062
       IB=IMAX(I)                                                       E1SRT063
       KN=0                                                             E1SRT064
       LIBO=(IB-1)*IDEG+IBO                                             E1SRT065
       DO 971 J=1,IDEG                                                  E1SRT066
       IROL=LIBO+J                                                      E1SRT067
       IF (IA(IROL)) 972,9711,9711                                      E1SRT068
 9711 KN=KN+1                                                           E1SRT069
  971 CONTINUE                                                          E1SRT070
  972 DO 94 J=1,IMS                                                     E1SRT071
       IF (KN-IDEG) 942,941,942                                         E1SRT072
  941 IF (I-J) 95,942,94                                                E1SRT073
  942 JB=IMAX(J)                                                        E1SRT074
       KM=0                                                             E1SRT075
       LIPO=(JB-1)*IDEG+IBO                                             E1SRT076
       DO 981 L=1,IDEG                                                  E1SRT077
       IROL=LIBO+L                                                      E1SRT078
       IF (IA(IPOL)) 982,9811,9811                                      E1SRT079
 9811 KM=KM+1                                                           E1SRT080
  981 CONTINUE                                                          E1SRT081
       IF (KM-IDEG) 982,983,982                                         E1SRT082
  983 IF (I-J) 94,982,94                                                E1SRT083
  982 JJ=(JB-1)/36+1                                                    E1SRT084
       ACH=ABIN(IB,JJ)                                                  E1SRT085
       JBIT=JB-36*(JJ-1)                                                E1SRT086
       CALL SEBIN (ACH,JBIT,1)                                          E1SRT087
       ABIN(IB,JJ)=ACH                                                  E1SRT088
   94 CONTINUE                                                          E1SRT089
   95 CONTINUE                                                          E1SRT090
   99 CONTINUE                                                          E1SRT091
       CALL ARAN                                                        E1SRT092
 1100 IMAXN=IMAX(1)                                                     E1SRT093
       IMAXB=1                                                          E1SRT094
       KN=0                                                             E1SRT095
       LBAND=0                                                          E1SRT096
       LIPO=0                                                           E1SRT097
       DO 2300 I=1,IN                                                   E1SRT098
       IMAXG=IMAX(I)*IDEG                                               E1SRT099
       IF (IMAXB-IMAXN) 1940,1940,2105                                  E1SRT100
 1940 DO 2100 J=IMAXB,IMAXN                                             E1SRT101
       IPOJ=IPO+IDEG*(ISIR(J)-1)                                        E1SRT102
       DO 2000 K=1,IDEG                                                 E1SRT103
       IROK=IPOJ+K                                                      E1SRT104
       IF (IA(IROK)) 2000,1950,1950                                     E1SRT105
 1950 KN=KN+1                                                           E1SRT106
 2000 CONTINUE                                                          E1SRT107
 2100 CONTINUE                                                          E1SRT108
 2105 IMAXN=IMAX(I+1)                                                   E1SRT109
       IMAXB=IMAX(I)+1                                                  E1SRT110
       LIBO=(ISIR(I)-1)*IDEG+IPO                                        E1SRT111
       DO 2200 J=1,IDEG                                                 E1SRT112
       IROL=LIBO+J                                                      E1SRT113
       IF (IA(IROL))2110,2200,2200                                      E1SRT114
 2110 LBAND=LBAND+1                                                     E1SRT115
       IBAND(LBAND)=IMAXG-LBAND-KN+1                                    E1SRT116
 2200 CONTINUE                                                          E1SRT117
 2300 CONTINUE                                                          E1SRT118
       ISUM=LBAND                                                       E1SRT119
       IF (INP-1) 812,811,811                                           E1SRT120
  811 WRITE OUTPUT TAPE 6,415     ,(I,IBAND(I),I=1,ISUM)                E1SRT121
  415 FORMAT (1H1,39X,40HTOPOLOGY OF THE REDUCED STIFFNESS MATRIX/////17E1SRT122
     1X,85HNUMBER OF ELEMENTS RETAINED AT EACH ROW OF UPPER STIFFNESS MAE1SRT123
     2TRIX (DIAGONAL INCLUDED)//(10(4X,I4,1X,I3)))                      E1SRT124
  812 IUI=IU+1                                                          E1SRT125
       IA(IUI)=1                                                        E1SRT126
       ISUM1=ISUM+1                                                     E1SRT127
       DO 416 I=2,ISUM1                                                 E1SRT128
       IUI=IU+I                                                         E1SRT129
  416  IA(IUI)=IA(IUI-1)+IBAND(I-1)                                     E1SRT130
       IORD=IA(IUI)-1                                                   E1SRT131
       FORD=0.                                                          E1SRT132
       DO 417 I=1,ISUM                                                  E1SRT133
       FXX=IBAND(I)                                                     E1SRT134
  417  FORD=FORD+FXX                                                    E1SRT135
       IST=IU+ISUM1                                                     E1SRT136
       FIST=IST                                                         E1SRT137
       FISUM=ISUM                                                       E1SRT138
       FILFN=FIST+FORD+FISUM+1.                                         E1SRT139
       IORD1=IORD+1                                                     E1SRT140
       WRITE OUTPUT TAPE 6,6664,FORD,FILEN                              E1SRT141
 6664 FORMAT (       1X,35HSTIFFNESS MATRIX REQUIRES (DECIMAL),F6.0,19H  E1SRT142
     1STORAGE LOCATIONS/1X,32HTOTAL COMMON LENGTH IS (DECIMAL),F9.0, 19HE1SRT143
     2  STORAGE LOCATIONS)                                              E1SRT144
       IF (19810.-FILEN+FISUM) 419,420,420                              E1SRT145
  419  WRITE OUTPUT TAPE 6,4211                                         E1SRT146
 4211 FORMAT (     6X,83HWARNING. LESS THAN 12750 DECIMAL LOCATION IS  AVE1SRT147
     1AILABLE FOR THE NEXT LINK PROGRAMS./5X,47HTHOUGH IT MAY BE SUICIDAE1SRT148
     2L, EXECUTION CONTINUES.)                                          E1SRT149
  420 IF (INP-1) 813,814,814                                            E1SRT150
  814 DO 421 I=1,ISUM1                                                  E1SRT151
       IUI=IU+I                                                         E1SRT152
  421  IBAND(I)=IA(IUI)                                                 E1SRT153
       WRITE OUTPUT TAPE 6,422, (I,IBAND(I),I=1,ISUM1)                  E1SRT154
  422  FORMAT (1H1,30X,62HCOUNT OF MAIN DIAGONAL ELEMENTS OF ROW LISTED SE1SRT155
     1TIFFNESS MATRIX//(10(2X,I4,1X,I5)))                               E1SRT156
  813 RETURN                                                            E1SRT157
       END                                                              E1SRT158
```

Table VII-12. Source program listing of subroutine TABL (Link 1)

```
*     LABEL
CE1TBL                                                                  E1TBL000
      SUBROUTINE TABL                                                   E1TBL001
C     PRINTS FIRST OUTPUT ITEM                                          E1TBL002
      DIMENSION IA(1),AA(1),REM(13),NT(10),DUMMY(5000),IDUM(5000),N(8)  E1TBL003
     1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),RUMMY(27,9)       E1TBL004
     2,D21(21),S(1),G(1)                                               E1TBL005
      COMMON IA,AA                                                      E1TBL006
      EQUIVALENCE (IA,AA),(AA( 9000),DUMMY)                             E1TBL007
      EQUIVALENCE (DUMMY,IDUM,NT,RUMMY),(DUMMY(11),REM)                 E1TBL008
      EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),  E1TBL009
     1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),E1TBL010
     2IH),(IA(11),IB),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),E1TBL011
     3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),E1TBL012
     4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),    E1TBL013
     5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),     E1TBL014
     6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),      E1TBL015
     7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57E1TBL016
     8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBO),(IA(61),IID),(IA(62),E1TBL017
     9IA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITE),(IA(41),ITAP)          E1TBL018
      EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),    E1TBL019
     1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),       E1TBL020
     2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)              E1TBL021
     3,(IA(78),IGEM),(IA(79),IERR),(AA(80),IE),(AA(81),DT),(AA(82),DG), E1TBL022
     4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),  E1TBL023
     5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),    E1TBL024
     6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)               E1TBL025
     7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IUE1TBL026
     8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                             E1TBL027
      EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346) E1TBL028
     1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)   E1TBL029
     2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)      E1TBL030
     3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)       E1TBL031
     4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)         E1TBL032
     5,(IA(329),IPIR),(IA(328),ICOR),(IA(327),IBUN),(IA(326),IMES)      E1TBL033
      DIMENSION IBERR(50)                                               E1TBL034
      EQUIVALENCE (IA(200),IBERR)                                       E1TBL035
      DIMENSION ISIR(540)                                               E1TBL036
      EQUIVALENCE (DUMMY(8100),ISIR)                                    E1TBL037
      EQUIVALENCE (IA(35),ISHUF)                                        E1TBL038
      WRITE OUTPUT TAPE 6,1001,(REM(I),I=1,14)                          E1TBL039
 1001 FORMAT (1H1,36X,25HLINEAR ELASTICITY PROBLEM/// 2X,14A6)          E1TBL040
      WRITE OUTPUT TAPE 6,351,IN,IT,IDEG,ITYPE,IGEM,ISTR,IH,IB,IBN,IP   E1TBL041
     1,IPRS,IMAT,NTIC                                                   E1TBL042
  351 FORMAT (//22H TOTAL NUMBER OF NODES,18X,I5/32H TOTAL NUMBER OF FINE1TBL043
     1ITE ELEMENTS,8X,I5/29H DEGREES OF FREEDOM AT A NODE,11X,I5/12H ITYE1TBL044
     2PE VALUE,28X,I5,10X,58HO FOR ISOTROPIC, 1 FOR ORTHOTROPIC, 2 FOR GE1TBL045
     3ENERAL MATERIAL/11H IGEM VALUE,29X,I5,10X,40HO FOR 2-, 1 FOR 3-DIME1TBL046
     4ENSIONAL STRUCTURES/11H ISTR VALUE,29X,I5,10X,36HO FOR PLANE STRAIE1TBL047
     5N CASE, 0 OTHERWISE/41H MAXIMUM NUMBER OF CONTACTS IN AN ELEMENT,IE1TBL048
     64/33H CONTACT NUMBER INCLUDING DUMMIES,I12/10H IBN VALUE,30X,I5,10E1TBL049
     7X,65HNUMBER OF SUPRESSED DEGREES OF FREEDOM IF NO MULTIPLE CONNECTE1TBL050
     8IONS/35H TOTAL NUMBER OF CONCENTRATED LOADS,5X,I5/15H PRESSURE TYPE1TBL051
     9ES,25X,I5/15H MATERIAL TYPES,25X,I5/16H THICKNESS TYPES,24X,I5)   E1TBL052
      WRITE OUTPUT TAPE 6,352,ISDT,ISDY,ISDZ,IARE,IMMX,IMMY,IMMZ,IMFI   E1TBL053
     1,INX,INP,ISHUF,ICOR                                               E1TBL054
  352 FORMAT (25H TEMPERATURE CHANGE TYPES,15X,I5/35H TEMPERATURE GRADIE1TBL055
     1NT TYPES ALONG Y,5X,I5/35H TEMPERATURE GRADIENT TYPES ALONG Z,5X,IE1TBL056
     25/11H AREA TYPES,29X,I5/23H TORSION CONSTANT TYPES,17X,I5/26H Y MOE1TBL057
     3MENT OF INERTIA TYPES,14X,I5/26H Z MOMENT OF INERTIA TYPES,14X,I5/E1TBL058
     439H NUMBER OF ANGLES FIXING PRINCIPAL AXES,I6/10H INX VALUE,30X,I5E1TBL059
     5,10X,57HNUMBER OF THE LINK FROM WHICH RETURN-TO-BEGINNING IS MADE/E1TBL060
     610H INP VALUE,30X,I5,10X,50HO MINIMUM PRINT, 1 PARTIAL PRINT, 2 COE1TBL061
     7MPLETE PRINT/12H ISHUF VALUE,28X,I5,10X,63HO NO RELABELLING, 1 RELE1TBL062
     8ABEL, 2 OR 3 READ CARDS FOR RELABELLING /11H ICOR VALUE,29X,I5,10XE1TBL063
     9,52HO READ CARDS, 1 CALL SUBROUTINE CORG FOR COORDINATES)         E1TBL064
      WRITE OUTPUT TAPE 6,3352,IBUN,IMES,IPIR,ITAP,ITAS,ACEL,G1,G2,G3   E1TBL065
 3352 FORMAT (11H IBUN VALUE,29X,I5,10X,60HO READ CARDS, 1 CALL SUBROUTIE1TBL066
     1NE BUNG FOR BOUNDARY CONDITIONS/11H IMES VALUE,29X,I5,10X,54HO REAE1TBL067
     2D CARDS, 1 CALL SUBROUTINE MESG FOR MESH TOPOLOGY/38H IPIR VALUE FE1TBL068
     3OR SHELL LOCAL NODAL AXES,I7,10X,54HO ASSUME ZERO, 1 COMPUTE AS PRE1TBL069
     4INCIPAL, 2 READ AS INPUT/26H CHAIN PROGRAM TAPE NUMBER,14X,I5/20H E1TBL070
     5SCRATCH TAPE NUMBER,20X,I5,10X,50HO OR - DO NOT COMPUTE RESIDUALS,E1TBL071
     6 OTHERWISE COMPUTE/ 23H ACCELERATION*UNIT MASS,17X,F10.5/34H DIRECE1TBL072
     7TION COSINES OF ACCELERATION,F16.5,3X,F10.5,3X,F10.5////)         E1TBL073
      RETURN                                                            E1TBL074
      END                                                               E1TBL075
```

Table VII-13. Source program listing of subroutine TICK (Link 1)

```
*       FAP                                                  TICK000
        COUNT   25                                           TICK001
        LBL     TICK                                         TICK002
        ENTRY   TICK                                         TICK003
TICK    NZT     ONCE                                         TICK004
        TRA     FIRST                                        TICK005
        CAL     5                                            TICK006
        SUB     INITL                                        TICK007
        ALS     18                                           TICK008
        SLW*    1,4                                          TICK009
        TRA     2,4                                          TICK010
FIRST   STL     ONCE                                         TICK011
        CAL     5                                            TICK012
        SLW     INITL                                        TICK013
        STZ*    1,4                                          TICK014
        TRA     2,4                                          TICK015
ONCE    PZE                                                  TICK016
INITL   PZE                                                  TICK017
        END                                                  TICK018
```

Table VII-14. Source program listing of subroutine TOPO (Link 1)

```
*     LABEL
CE1TOP                                                                  E1TOP000
      SUBROUTINE TOPO                                                   E1TOP001
C     PREPARES ELEMENT PROPERTIES AND CHECKS                            E1TOP002
      DIMENSION IA(1),AA(1),REM(13),NT(10),DUMMY(5000),IDUM(5000),N(8)  E1TOP003
     1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),RUMMY(27,9)       E1TOP004
     2,D21(21),S(1),G(1)                                               E1TOP005
      COMMON IA,AA                                                      E1TOP006
      EQUIVALENCE (IA,AA),(AA( 9000),DUMMY)                             E1TOP007
      EQUIVALENCE (DUMMY,IDUM,NT,RUMMY),(DUMMY(11),REM)                 E1TOP008
      EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),  E1TOP009
     1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),E1TOP010
     2IH),(IA(11),IB),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),E1TOP011
     3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),E1TOP012
     4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),    E1TOP013
     5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),     E1TOP014
     6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),      E1TOP015
     7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57E1TOP016
     8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBO),(IA(61),IID),(IA(62),E1TOP017
     9IA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITE),(IA(41),ITAP)          E1TOP018
      EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),    E1TOP019
     1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),       E1TOP020
     2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)              E1TOP021
     3,(IA(78),IGEM),(IA(79),IERR),(AA(80),IE),(AA(81),DT),(AA(82),DG), E1TOP022
     4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),  E1TOP023
     5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),    E1TOP024
     6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)               E1TOP025
     7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IUE1TOP026
     8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                             E1TOP027
      EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346) E1TOP028
     1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)   E1TOP029
     2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)      E1TOP030
     3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)       E1TOP031
     4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)         E1TOP032
      IELT=0                                                            E1TOP033
      ITEM=0                                                            E1TOP034
      ITIC=0                                                            E1TOP035
      IMET=0                                                            E1TOP036
      DO 10 I=1,8                                                       E1TOP037
      N(I)=0                                                            E1TOP038
      K=I+335                                                           E1TOP039
   10 IA(K)=0                                                           E1TOP040
      JM=J1+M                                                           E1TOP041
      IELT=IA(JM)/100                                                   E1TOP042
      IMET=IA(JM)-100*IELT                                              E1TOP043
      JM=J2+M                                                           E1TOP044
      IF (IELT-4) 100,100,450                                           E1TOP045
  100 IF (IELT-3) 200,300,200                                           E1TOP046
  200 JARE=IA(JM)/100                                                   E1TOP047
      ITEM=IA(JM)-100*JARE                                              E1TOP048
      GO TO 400                                                         E1TOP049
  300 JPRS=IA(JM)/100                                                   E1TOP050
      JSDZ=IA(JM)-100*JPRS                                              E1TOP051
  400 IF (IELT-3) 600,800,800                                           E1TOP052
  450 IF (IELT-10) 470,470,500                                          E1TOP053
  470 IF (IELT-8) 500,500,480                                           E1TOP054
  480 JPRS=IA(JM)/100                                                   E1TOP055
      ITEM=IA(JM)-100*JPRS                                              E1TOP056
      L=1                                                               E1TOP057
      GO TO 1000                                                        E1TOP058
  500 ITIC=IA(JM)/100                                                   E1TOP059
      ITEM=IA(JM)-100*ITIC                                              E1TOP060
      JM=J3+M                                                           E1TOP061
      JSDZ=IA(JM)/100                                                   E1TOP062
      JPRS=IA(JM)-100*JSDZ                                              E1TOP063
      L=2                                                               E1TOP064
      GO TO 1000                                                        E1TOP065
  600 JM=J3+M                                                           E1TOP066
      JPRS=IA(JM)                                                       E1TOP067
      L=2                                                               E1TOP068
      IF (IELT-2) 1000,700,700                                          E1TOP069
  700 JM=J4+M                                                           E1TOP070
      JMMZ=IA(JM)/100                                                   E1TOP071
      JSDY=IA(JM)-100*JMMZ                                              E1TOP072
      L=3                                                               E1TOP073
      IF (IELT-4) 1000,900,1000                                         E1TOP074
  800 JM=J3+M                                                           E1TOP075
      JMMX=IA(JM)/100                                                   E1TOP076
      JMMY=IA(JM)-100*JMMX                                              E1TOP077
      L=2                                                               E1TOP078
      IF (IELT-4) 1000,700,1000                                         E1TOP079
  900 JM=J5+M                                                           E1TOP080
      JSDZ=IA(JM)/100                                                   E1TOP081
      JMFI=IA(JM)-100*JSDZ                                              E1TOP082
      JM=J6+M                                                           E1TOP083
      JPRS=IA(JM)                                                       E1TOP084
      L=4                                                               E1TOP085
 1000 I=1                                                               E1TOP086
      GO TO (1100,1200,1300,1400),L                                     E1TOP087
 1100 JM=J3+M                                                           E1TOP088
      N(I)=IA(JM)                                                       E1TOP089
      I=I+1                                                             E1TOP090
 1200 JM=J4+M                                                           E1TOP091
      N(I)=IA(JM)                                                       E1TOP092
      I=I+1                                                             E1TOP093
 1300 JM=J5+M                                                           E1TOP094
      N(I)=IA(JM)                                                       E1TOP095
      I=I+1                                                             E1TOP096
      JM=J6+M                                                           E1TOP097
      N(I)=IA(JM)                                                       E1TOP098
      I=I+1                                                             E1TOP099
 1400 JM=J7+M                                                           E1TOP100
      N(I)=IA(JM)                                                       E1TOP101
      I=I+1                                                             E1TOP102
      JM=J8+M                                                           E1TOP103
      N(I)=IA(JM)                                                       E1TOP104
      I=I+1                                                             E1TOP105
      JM=J9+M                                                           E1TOP106
```

Table VII-14 (contd)

```
      N(I)=IA(JM)
      I=I+1
      JM=J10+M
      N(I)=IA(JM)
      IF (I-IH) 1408,1408,1402
 1402 IHP=IH+1
      DO 1405 J=IHP,8
 1405 N(J)=0
 1408 DO 1410 J=1,IH
      IF (N(J)-IN) 1410,1410,1450
 1410 CONTINUE
      GO TO 1600
 1450 WRITE OUTPUT TAPE 6,2,M
    2 FORMAT (11H IN ELEMENT,I5,59H  ERROR IN MESH TOPOLOGY INFORMATION,
     1 NO CORRECTION IS MADE)
 1600 NDX=0
 1610 IF ((JPRS+1)*(JPRS-IPRS-1)) 1620,1611,1611
 1611 JPRS=IPRS
      IF (IELT-4) 1612,1613,1614
 1612 IF (IELT-3) 1614,1616,1614
 1614 IF (IELT-9) 1618,1616,1617
 1617 IF (IELT-10) 1618,1616,1618
 1616 JM=J2+M
      L=IA(JM)-(IA(JM)/100)*100
      IA(JM)=100*JPRS+L
      GO TO 1615
 1613 JM=J6+M
      IA(JM)=JPRS
      GO TO 1615
 1618 JM=J3+M
      L=IA(JM)/100
      IA(JM)=100*L+JPRS
 1615 CONTINUE
      NDX=NDX+1
 1620 IF (IMET*(IMET-IMAT-1)) 1630,1621,1621
 1621 IMET=IMAT
      JM=J1+M
      IA(JM)=100*IELT+IMET
      NDX=NDX+1
 1630 IF ((ITIC+1)*(ITIC-NTIC-1)) 1640,1631,1631
 1631 ITIC=NTIC
      JM=J2+M
      L=IA(JM)-(IA(JM)/100)*100
      IA(JM)=100*ITIC+L
      NDX=NDX+1
 1640 IF ((ITEM+1)*(ITEM-ISDT-1)) 1650,1641,1641
 1641 ITEM=ISDT
      JM=J2+M
      L=IA(JM)/100
      IA(JM)=100*L+ITEM
      NDX=NDX+1
 1650 IF ((JSDY+1)*(JSDY-ISDY-1)) 1660,1651,1651
 1651 JSDY=ISDY
      JM=J4+M
      L=IA(JM)/100
      IA(JM)=100*L+JSDY
      NDX=NDX+1
 1660 IF ((JSDZ+1)*(JSDZ-ISDZ-1)) 1670,1661,1661
 1661 JSDZ=ISDZ
      IF (IELT-4) 1662,1663,1664
 1662 JM=J2+M
      L=IA(JM)/100
      IA(JM)=100*L+JSDZ
      GO TO 1665
 1663 JM=J5+M
      GO TO 1666
 1664 JM=J3+M
 1666 L=IA(JM)-(IA(JM)/100)*100
      IA(JM)=100*JSDZ+L
 1665 CONTINUE
      NDX=NDX+1
 1670 IF ((JARE+1)*(JARE-IARE-1)) 1680,1671,1671
 1671 JARE=IARE
      JM=J2+M
      L=IA(JM)-(IA(JM)/100)*100
      IA(JM)=100*JARE+L
      NDX=NDX+1
 1680 IF ((JMMX+1)*(JMMX-IMMX-1)) 1690,1681,1681
 1681 JMMX=IMMX
      JM=J3+M
      L=IA(JM)-(IA(JM)/100)*100
      IA(JM)=100*JMMX+L
      NDX=NDX+1
 1690 IF ((JMMY+1)*(JMMY-IMMY-1)) 1700,1691,1691
 1691 JMMY=IMMY
      JM=J3+M
      L=IA(JM)/100
      IA(JM)=100*L+JMMY
      NDX=NDX+1
 1700 IF ((JMMZ+1)*(JMMZ-IMMZ-1)) 1710,1701,1701
 1701 JMMZ=IMMZ
      JM=J4+M
      L=IA(JM)-(IA(JM)/100)*100
      IA(JM)=100*JMMZ+L
      NDX=NDX+1
 1710 IF ((JMFI+1)*(JMFI-IMFI-1)) 1720,1711,1711
 1711 JMFI=IMFI
      JM=J5+M
      L=IA(JM)/100
      IA(JM)=100*L+JMFI
      NDX=NDX+1
 1720 IF (NDX) 2000,2000,1800
 1800 WRITE OUTPUT TAPE 6,1,M,NDX
    1 FORMAT(11H IN ELEMENT,I5,2X,1H,,I5,2X, 95HPROPERTY TYPE NUMBER(S)
     1IS OUTSIDE THE PRESCRIBED RANGE. TYPE NO IS ASSUMED AS LARGEST POS
     2SIBLE)
 2000 RETURN
      END
```

Table VII-15. Source program listing of main program of Link 2 (generation link)

```
*     CHAIN (2,2)
*     LABEL
CFLAS2
C     MAIN PROGRAM FOR GENERATION LINK
C     GENERATES GOVERNING EQUATIONS
      DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),F22(3,3)
     1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)
      COMMON IA,AA
      EQUIVALENCE(IA,AA),(D21,D33),(D21(10),F22),(D21(19),E),(D21(20),G)
      EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),
     1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),IMX),(IA(10),
     2IH),(IA(11),IB),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),
     3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),
     4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),
     5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),
     6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),
     7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57
     8),J8),(IA(58),JIY),(IA(59),IB8),(IA(60),IB0),(IA(61),IID),(IA(62),
     9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITE),(IA(41),ITAP)
      EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),
     1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),
     2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)
     3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG),
     4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),
     5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),
     6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)
     7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IU
     8),(AA(47),G1),(AA(48),G2),(AA(49),G3)
      EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346)
     1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)
     2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)
     3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)
     4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)
     5,(IA(329),IPIR),(IA(328),NAV),(AA(327),CFE)
      DIMENSION IBS(25),CCCI(25),JBS(25),CCCJ(25),PV(24)
      EQUIVALENCE (IA(200),IBS),(IA(225),JBS),(AA(250),CCCI),
     1(AA(275),CCCJ,PV)
      DIMENSION NOD(20),PD(3),NOT(4)
      EQUIVALENCE (AA(300),NOD),(AA(324),PRCO),(AA(325),ITTT),(AA(291),P
     1D),(IA(326),IMS1)
      INPT=INP
      CALL TICK (ITIM)
C     CLEAR  ST  ARRAY
      DO 132 I=1,IORD1
      ISTI=IST+I
 132  AA(ISTI)=0.
C     GENERATE ELEMENTAL MATRICES AND ASSEMBLE
      ZGEM=IGEM
      DO 99 M=1,II
      INP=INPT
      CALL CAS2
      IERR=0
      DO 133 I=1,8
      N(I)=0
      X(I)=0.
      Y(I)=0.
  133 Z(I)=0.
      DO 134 I=107,328
  134 AA(I)=0.
      DG=0.
      DT=0.
      PRES=0.
      DGZ=0.
      DGY=0.
      CFE=1.
      NAV=1
      ITTT=0
      ITTM=1
      CALL TOPO
      DO 98 I=1,IH
      NOD(I)=N(I)
      IF (N(I)) 9800,97,98
 98   CONTINUE
      IMS=IH
      GO TO 2
 9800 IERR=2
    1 WRITE OUTPUT TAPE 6,111,M,ITTT,IERR
  111 FORMAT (8H ELEMENT,2I4,2X,29HIS UNACCEPTABLE. DISREGARDED.,I8)
      WRITE TAPE ITAS,M,ITTT,ITTM,NAV,IMS,IDS,IDS2,(N(I),I=1,IMS),(S(I),
     1I=1,IDS2),(P(I),PV(I),I=1,IDS)
      IERR=0
      GO TO 999
 97   IMS=I-1
    2 ITEI=ITE+ITIC
      IDS=IMS*IDEG
      TE=AA(ITEI)
      IF (ITEM) 972,972,971
  971 IDTI=IDT+ITEM
      DT=AA(IDTI)
  972 IF (JSDY) 974,974,973
  973 IDYI=IDY+JSDY
      DG=AA(IDYI)
      DGY=DG
  974 IF (JSDZ) 976,976,975
  975 IDZI=IDZ+JSDZ
      DGZ=AA(IDZI)
      DG=DGZ
  976 IF (JPRS) 978,978,977
  977 IPRI=IPR+JPRS
      PRES=AA(IPRI)
  978 IF (ITYPE-1) 70,71,72
 70   IIAI=IIA+IMET
      AL1=AA(IIAI)
      AL2=AL1
      AL3=AL1
      GO TO 73
 71   IIAI=IIA+(IMET-1)*2
      AL1=AA(IIAI+1)
      AL2=AA(IIAI+2)
      AL3=0
      GO TO 73
 72   IIAI=IIA+(IMET-1)*3
      AL1=AA(IIAI+1)
      AL2=AA(IIAI+2)
      AL3=AA(IIAI+3)
   73 IF (ITYPE-1) 601,602,603
```

Table VII-15 (contd)

```
  601 IIDI=IID+(IMET-1)*2                                                      FLAS2113
      GO TO 604                                                                FLAS2114
  602 IIDI=IID+(IMET-1)*9                                                      FLAS2115
      GO TO 604                                                                FLAS2116
  603 IIDI=IID+(IMET-1)*21                                                     FLAS2117
  604 E=AA(IIDI+1)                                                             FLAS2118
      G=AA(IIDI+2)                                                             FLAS2119
      PU=E/(2.*G)-1.                                                           FLAS2120
      KELT=IELT                                                                FLAS2121
      GO TO (504,504,504,504,502,502,502,502,503,503,502,502,502,502,          FLAS2122
     1503,503,502,502),KELT                                                    FLAS2123
  502 IF (ITYPE-1) 5021,5022,5023                                              FLAS2124
 5021 IF (ISTR) 6021,6021,6022                                                 FLAS2125
 6021 D33(1,1)=2.*G/(1.-PU)                                                    FLAS2126
      D33(2,2)=D33(1,1)                                                        FLAS2127
      D33(1,2)=D33(1,1)*PU                                                     FLAS2128
      GO TO 6023                                                               FLAS2129
 6022 D33(1,1)=2.*G*(1.-PU)/(1.-2.*PU)                                         FLAS2130
      D33(2,2)=D33(1,1)                                                        FLAS2131
      D33(1,2)=2.*G*PU/(1.-2.*PU)                                              FLAS2132
 6023 D33(1,3)=0.                                                              FLAS2133
      D33(2,3)=0.                                                              FLAS2134
      D33(3,3)=G                                                               FLAS2135
      IF (IELT-5) 5024,5024,6025                                               FLAS2136
 6025 IF (IELT-6) 5024,5024,6024                                               FLAS2137
 6024 E22(1,1)=G                                                               FLAS2138
      E22(1,2)=0.                                                              FLAS2139
      E22(2,2)=G                                                               FLAS2140
      GO TO 5024                                                               FLAS2141
 5022 D33(1,1)=AA(IIDI+1)                                                      FLAS2142
      D33(1,2)=AA(IIDI+2)                                                      FLAS2143
      D33(1,3)=AA(IIDI+3)                                                      FLAS2144
      D33(2,2)=AA(IIDI+4)                                                      FLAS2145
      D33(2,3)=AA(IIDI+5)                                                      FLAS2146
      D33(3,3)=AA(IIDI+6)                                                      FLAS2147
      E22(1,1)=AA(IIDI+7)                                                      FLAS2148
      E22(1,2)=AA(IIDI+8)                                                      FLAS2149
      E22(2,2)=AA(IIDI+9)                                                      FLAS2150
      GO TO 5024                                                               FLAS2151
 5023 D33(1,1)=AA(IIDI+1)                                                      FLAS2152
      D33(1,2)=AA(IIDI+2)                                                      FLAS2153
      D33(1,3)=AA(IIDI+4)                                                      FLAS2154
      D33(2,2)=AA(IIDI+7)                                                      FLAS2155
      D33(2,3)=AA(IIDI+9)                                                      FLAS2156
      D33(3,3)=AA(IIDI+16)                                                     FLAS2157
      E22(1,1)=AA(IIDI+19)                                                     FLAS2158
      E22(1,2)=AA(IIDI+20)                                                     FLAS2159
      E22(2,2)=AA(IIDI+21)                                                     FLAS2160
 5024 D33(2,1)=D33(1,2)                                                        FLAS2161
      D33(3,1)=D33(1,3)                                                        FLAS2162
      D33(3,2)=D33(2,3)                                                        FLAS2163
      E22(2,1)=E22(1,2)                                                        FLAS2164
      GO TO 504                                                                FLAS2165
  503 IF (ITYPE-1) 5031,5031,5033                                              FLAS2166
 5031 EE=E                                                                     FLAS2167
      GG=G                                                                     FLAS2168
      DO 5032 I=1,21                                                           FLAS2169
 5032 D21(I)=0.                                                                FLAS2170
      D21(1)=2.*GG*(1.-PU)/(1.-2.*PU)                                          FLAS2171
      D21(2)=D21(1)*PU/(1.-PU)                                                 FLAS2172
      D21(3)=D21(2)                                                            FLAS2173
      D21(7)=D21(1)                                                            FLAS2174
      D21(8)=D21(2)                                                            FLAS2175
      D21(12)=D21(1)                                                           FLAS2176
      D21(16)=GG                                                               FLAS2177
      D21(19)=GG                                                               FLAS2178
      D21(21)=GG                                                               FLAS2179
      GO TO 504                                                                FLAS2180
 5033 DO 5034 I=1,21                                                           FLAS2181
      IIDII=IIDI+I                                                             FLAS2182
 5034 D21(I)=AA(IIDII)                                                         FLAS2183
  504 IERR=0                                                                   FLAS2184
C     IS THERE  MULTIPLE ELEMENT                                               FLAS2185
      IF (IELT-6) 5100,4900,4699                                               FLAS2186
 4699 IF (IELT-8) 5100,4900,4700                                               FLAS2187
 4700 IF (IELT-10) 5100,4900,4800                                              FLAS2188
 4800 IF (IELT-12) 5100,4900,4850                                              FLAS2189
 4850 IF (IELT-14) 5100,4900,4880                                              FLAS2190
 4880 IF (IELT-16) 5100,4900,5100                                              FLAS2191
C     THERE IS MULTIPLE ELEMENT,CUT IT IN PIECES                               FLAS2192
 4889 ITTT=0                                                                   FLAS2193
      IELT=IELT+1                                                              FLAS2194
      DO 4890 I=1,4                                                            FLAS2195
 4890 N(I)=NOT(I)                                                              FLAS2196
      GO TO 4902                                                               FLAS2197
 4900 IMSI=IMS                                                                 FLAS2198
      DO 4901 I=1,4                                                            FLAS2199
 4901 NOT(I)=N(I)                                                              FLAS2200
 4902 CALL CUTE (ITTM)                                                         FLAS2201
      CFE=.5                                                                   FLAS2202
 5100 JI=ITTT*IMS                                                              FLAS2203
      PRCO=0.                                                                  FLAS2204
      ITTT=ITTT+1                                                              FLAS2205
      IDS2=IDS*IDS                                                             FLAS2206
      CIMS=IMS                                                                 ELS2206A
      CX=0.                                                                    FLS2206B
      CY=0.                                                                    ELS2206C
      CZ=0.                                                                    ELS2206D
      DO 5500 I=1,IMS                                                          FLAS2207
      JII=JI+I                                                                 FLAS2208
      J=NOD(JII)                                                               FLAS2209
      N(I)=J                                                                   FLAS2210
      IF (J) 1,1,5450                                                          FLAS2211
 5450 IXXJ=IXX+J                                                               FLAS2212
      IYYJ=IYY+J                                                               FLAS2213
      IZZJ=IZZ+J                                                               FLAS2214
      X(I)=AA(IXXJ)                                                            FLAS2215
      Y(I)=AA(IYYJ)                                                            FLAS2216
      Z(I)=AA(IZZJ)*ZGEM                                                       FLAS2217
      CX=CX+X(I)                                                               ELS2217A
      CY=CY+Y(I)                                                               FLS2217B
      CZ=CZ+Z(I)                                                               ELS2217C
      IF (I-1) 5500,5500,5460                                                  FLAS2218
 5460 XD(I-1)=X(I)-X(1)                                                        FLAS2219
      YD(I-1)=Y(I)-Y(1)                                                        FLAS2220
      ZD(I-1)=Z(I)-Z(1)                                                        FLAS2221
 5500 CONTINUE                                                                 FLAS2222
      CX=CX/CIMS                                                               FLS2222A
      CY=CY/CIMS                                                               ELS2222B
      CZ=CZ/CIMS                                                               ELS2222C
      DO 5501 I=1,IMS                                                          ELS2222D
      X(I)=X(I)-CX                                                             FLS2222E
      Y(I)=Y(I)-CY                                                             FLS2222F
 5501 Z(I)=Z(I)-CZ                                                             FLS2222G
 5600 DO 6 I=1,IDS                                                             FLAS2223
      P(I)=0.                                                                  FLAS2224
      UV(I)=0.                                                                 ELS2224A
      ISS=I-IDS                                                                FLAS2225
      DO 7 J=1,IDS                                                             FLAS2226
      ISS=ISS+IDS                                                              FLAS2227
 7    S(ISS)=0.                                                                FLAS2228
 6    CONTINUE                                                                 FLAS2229
      IF (DT) 82,83,82                                                         ELAS2230
 82   DO 84 I=1,IMS                                                            FLAS2231
      I1=IMS+I                                                                 FLAS2232
      I2=IMS+I1                                                                FLAS2233
      UV(I)=X(I)*DT*AL1                                                        FLAS2234
      UV(I1)=Y(I)*DT*AL2                                                       FLAS2235
 84   UV(I2)=Z(I)*DT*AL3                                                       FLAS2236
   83 CALL STFS(IELT)                                                          ELAS2237
 5041 IF (INP-1) 86,86,85                                                      FLAS2238
   87 FORMAT (////20I5/12F10.3/12F10.3//(5(I6,F13.4,5X)))                      FLAS2239
 85   WRITE OUTPUT TAPE 6,87,M,(N(J),J=1,8),IELT,IMET,ITIC,ITEM,JPRS,JARELAS2240
     1E,JSDY,JSDZ,JMMX,JMFI,IDS,(X(J),Y(J),Z(J),J=1,8),(I,S(I),I=1,IDS2)FLAS2241
   86 IF (IERR) 1,951,1                                                        ELAS2242
 951  IF (DT) 952,954,952                                                      FLAS2243
 954  IF (DG) 952,9551,952                                                     FLAS2244
 9551 IF (DGZ) 952,953,952                                                     ELAS2245
 952  CALL DMM (S,UV,IDS,P)                                                    FLAS2246
 953  IF (IPBG) 957,957,958                                                    ELAS2247
 958  IF (IPBG-IPEN) 959,959,957                                               FLAS2248
 959  DO 955 I=IPBG,IPEN                                                       FLAS2249
      DELP=CONS*GL(I)                                                          ELAS2250
      CPRS=PRCO*PO(I)                                                          FLAS2251
      IJ=(I-IPBG)*IMS                                                          FLAS2252
      DO 956 J=1,IMS                                                           FLAS2253
      IJ=IJ+1                                                                  FLAS2254
 956  P(IJ)=P(IJ)+DELP+CPRS                                                    ELAS2255
 955  CONTINUE                                                                 ELAS2256
 957  IF (INP-1) 9532,9532,9531                                                ELAS2257
 9531 WRITE OUTPUT TAPE 6,9533,(I,P(I),I=1,IDS)                                ELAS2258
 9533 FORMAT (//(5(I6,E13.4,5X)))                                              ELAS2259
 9532 DO 95 I=1,IDEG                                                           ELAS2260
      DO 94 K=1,IMS                                                            FLAS2261
      IE=IMS*(I-1)+K                                                           FLAS2262
      IS=IDEG*(N(K)-1)+I                                                       FLAS2263
      ISE=IE-IDS                                                               FLAS2264
      CALL DARN (IS,IBS,CCCI,IQE)                                              ELAS2265
      IF (IQE) 307,307,308                                                     FLAS2266
 307  IERR=6                                                                   FLAS2267
      GO TO 1                                                                  FLAS2268
 308  DO 393 IQ=1,IQE                                                          FLAS2269
      ISS=ISE                                                                  ELAS2270
      CCURI=CCCI(IQ)*CFE                                                       FLAS2271
      IB=IBS(IQ)                                                               FLAS2272
      IF (CCURI) 912,911,912                                                   ELAS2273
 912  IDEFI=IDEF+IB                                                            FLAS2274
      AA(IDEFI)=AA(IDEFI)+CCURI*P(IE)                                          FLAS2275
 911  DO 93 J=1,IDEG                                                           FLAS2276
      DO 92 L=1,IMS                                                            FLAS2277
      ISS=ISS+IDS                                                              ELAS2278
      JE=IMS*(J-1)+L                                                           ELAS2279
      JS=IDEG*(N(L)-1)+J                                                       FLAS2280
      CALL DARN (JS,JBS,CCCJ,JQE)                                              FLAS2281
      IF (JQE) 307,307,408                                                     ELAS2282
 408  DO 392 JQ=1,JQE                                                          FLAS2283
      CCURJ=CCCJ(JQ)                                                           ELAS2284
      JB=JBS(JQ)                                                               FLAS2285
      F=CCURI*CCURJ                                                            FLAS2286
      IF (F) 913,392,913                                                       FLAS2287
 913  IF (JB-IND) 914,914,915                                                  ELAS2288
 915  AA(IDEFI)=AA(IDEFI)-F*S(ISS)                                             ELAS2289
      GO TO 392                                                                ELAS2290
 914  IF (JB-IB) 392,916,916                                                   FLAS2291
 916  IUI=IU+IB                                                                FLAS2292
      ISTI=IST+IA(IUI)+JB-IB                                                   FLAS2293
      AA(ISTI)=AA(ISTI)+F*S(ISS)                                               ELAS2294
 392  CONTINUE                                                                 FLAS2295
 92   CONTINUE                                                                 ELAS2296
 93   CONTINUE                                                                 FLAS2297
 393  CONTINUE                                                                 ELAS2298
 94   CONTINUE                                                                 FLAS2299
 95   CONTINUE                                                                 ELAS2300
      IF (ITAS) 9981,9981,9982                                                 ELAS2301
 9982 DO 9983 I=1,IDS                                                          FLAS2302
      PV(I)=P(I)                                                               FLAS2303
 9983 P(I)=0.                                                                  FLAS2304
      CALL DMM(S,UV,IDS,P)                                                     ELAS2305
      WRITE TAPE ITAS,M,ITTT,ITTM,NAV,IMS,IDS,IDS2,(N(I),I=1,IMS),(S(I),FLAS2306
     1I=1,IDS2),(P(I),PV(I),I=1,IDS)                                           FLAS2307
 9981 CONTINUE                                                                 FLAS2308
  999 IF (ITTT-ITTM) 5100,9990,9990                                            ELAS2309
 9990 IF (NAV-2) 99,4889,99                                                    FLAS2310
 99   CONTINUE                                                                 FLAS2311
      INP=INPT                                                                 FLAS2312
      CALL CAS2                                                                FLAS2313
      IF (INP-1) 232,232,233                                                   FLAS2314
 233  IEND=IST+IORD                                                            FLAS2315
      IST1=IST+1                                                               FLAS2316
      WRITE OUTPUT TAPE 6,871,(I,AA(I),I=IST1,IEND)                            ELAS2317
 871  FORMAT (1H1,62HUPPER HALF OF THE STIFFNESS MATRIX AFTER B.C. IMPOSELAS2318
     1ED FOLLOWS./89H ROW LISTING. FOR BANDWIDTHS SEE THE TABLE FOR MESHELAS2319
     2 TOPOLOGY OF REDUCED STIFFNESS MATRIX.///(5(I6,E14.5,4X)))               ELAS2320
      IDEF1=IDEF+1                                                             FLAS2321
      IEND=IDEF+ISUM                                                           FLAS2322
      WRITE OUTPUT TAPE 6,8711,(I,AA(I),I=IDEF1,IEND)                          FLAS2323
 8711 FORMAT (1H1,31HREDUCED LOADING VECTOR FOLLOWS.///(5(I6,F14.5,4X)))ELAS2324
 232  IERR=10                                                                  FLAS2325
      IF (ITAS) 2323,2323,2324                                                 FLAS2326
 2324 REWIND ITAS                                                              FLAS2327
 2323 CONTINUE                                                                 FLAS2328
      CALL TICK (ITIM)                                                         FLAS2329
      C2T=ITIM                                                                 FLAS2330
      C2T=C2T/60.                                                              ELAS2331
      WRITE OUTPUT TAPE 6,5555,C2T                                             FLAS2332
 5555 FORMAT (     21H GENERATION LINK TOOK,F7.2,10H  SECONDS.)                FLAS2333
      INP=INPT                                                                 FLAS2334
      IF (INX-2) 2321,2321,2322                                                FLAS2335
 2321 CALL CHAIN (1,ITAP)                                                      FLAS2336
 2322 CALL CHAIN (3,ITAP)                                                      FLAS2337
      END                                                                      FLAS2338
```

Table VII-16. Source program listing of subroutine ADM (Link 2)

```
*       LABEL
CF2ADM
        SUBROUTINE ADM (S,IDS,A,M,IB,JB,C)
C       ADDS SUBMATRICES TO FORM STIFFNESS MATRIX
        DIMENSION A(4,4),S(1)
        DO 10 I=1,M
        IS=IB+I-1
        IF (IB-JB) 12,11,12
 11     JI=I
        GO TO 13
 12     JI=1
 13     DO 90 J=JI,M
        JS=JB+J-1
        ISS=(JS-1)*IDS+IS
        S(ISS)=S(ISS)+A(I,J)*C
        ISR=(IS-1)*IDS+JS
        S(ISR)=S(ISS)
 90     CONTINUE
 10     CONTINUE
        RETURN
        END
```

Table VII-17. Source program listing of subroutine BEAM (Link 2)

```
*       LABEL
CE2BEA
        SUBROUTINE BEAM
C       GENERATES SUBMATRICES FOR ELEMENT TYPES 2 AND 4
        DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),F22(3,3)
       1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)
        COMMON IA,AA
        EQUIVALENCE(IA,AA),(D21,D33),(D21(10),F22),(D21(19),E),(D21(20),G)
        EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),
       1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),
       2IH),(IA(11),IB),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),
       3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),
       4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),
       5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),
       6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),
       7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57
       8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBO),(IA(61),IID),(IA(62),
       9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITE),(IA(41),ITAP)
        EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),
       1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),
       2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)
       3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG),
       4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),
       5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),
       6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)
       7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IU
       8),(AA(47),G1),(AA(48),G2),(AA(49),G3)
        EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346)
       1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)
       2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)
       3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)
       4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)
       5,(IA(329),IPIR)
        DIMENSION A(6,6),DIR(3,3),UVG(12),T(6),PD(3),PN(3),DUG(3)
        EQUIVALENCE (AA(200),A),(AA(236),FL),(AA(237),AREA ),(AA(238),II)
       1,(AA(239),JJ),(AA(240),IR),(AA(241),JR),(AA(242),NY),(AA(264),DIR)
       2,(AA(306),UVG),(AA(291),PD),(AA(294),PN),(AA(297),DUG),(AA(300),T)
        IF (JARE) 1010,1010,110
  110   ICARJ=ICAR+JARE
        AREA=AA(ICARJ)
        IF (IMMZ) 1010,150,160
  150   IF (IMMY) 1010,1010,155
  155   ICIZJ=ICIY+JMMY
        GO TO 170
  160   ICIZJ=ICIZ+JMMZ
  170   A(1,1)=E*AREA/FL
        A(1,2)=-A(1,1)
        A(2,2)=A(1,1)
        A(3,3)=12.*E*AA(ICIZJ)/(FL**3)
        A(3,4)=-A(3,3)
        A(4,4)=A(3,3)
        A(3,5)=6.*E*AA(ICIZJ)/(FL**2)
        A(3,6)=A(3,5)
        A(4,5)=-A(3,5)
        A(4,6)=A(4,5)
        A(5,5)=4.*E*AA(ICIZJ)/FL
        A(5,6)=.5*A(5,5)
        A(6,6)=A(5,5)
        DO 200 I=1,6
        DO 200 J=I,6
  200   A(J,I)=A(I,J)
 1000   RETURN
 1010   IERR=1
        GO TO 1000
        END
```

Table VII-18. Source program listing of subroutine CAS2 (Link 2)

```
*       LABEL
CF2CAS2
        SUBROUTINE CAS2
C       DUMMY SUBROUTINE
        RETURN
        END
```

Table VII-19. Source program listing of subroutine CODI (Link 2)

```
*       LABEL
CF2COD
        SUBROUTINE CODI
C       OBTAINS TRANSFORMATION MATRIX OF LOCAL-OVERALL FOR LINE ELEMENT
        DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),F22(3,3)
       1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)
        COMMON IA,AA
        EQUIVALENCE(IA,AA),(D21,D33),(D21(10),F22),(D21(19),E),(D21(20),G)
        EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),
       1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),
       2IH),(IA(11),IB),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),
       3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),
       4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),
       5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),
       6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),
       7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57
       8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBO),(IA(61),IID),(IA(62),
       9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITE),(IA(41),ITAP)
        EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),
       1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),
       2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)
       3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG),
       4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),
       5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),
       6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)
       7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IU
       8),(AA(47),G1),(AA(48),G2),(AA(49),G3)
        EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346)
       1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)
       2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)
       3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)
       4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)
       5,(IA(329),IPIR)
        DIMENSION A(6,6),DIR(3,3),UVG(12),T(6),PD(3),PN(3),DUG(3)
        EQUIVALENCE (AA(200),A),(AA(236),FL),(AA(237),AREA ),(AA(238),II)
       1,(AA(239),JJ),(AA(240),IR),(AA(241),JR),(AA(242),NY),(AA(264),DIR)
       2,(AA(306),UVG),(AA(291),PD),(AA(294),PN),(AA(297),DUG),(AA(300),T)
        FL=SQRTF(XD(1)*XD(1)+YD(1)*YD(1)+ZD(1)*ZD(1))
        IF (FL) 1010,1010,110
  110   IF (IELT-3) 115,250,115
  115   DIR(1,1)=XD(1)/FL
        DIR(1,2)=YD(1)/FL
        DIR(1,3)=ZD(1)/FL
        IF (JMFI) 1010,210,130
  210   IF (IGEM) 1010,220,1010
  130   ICFIJ=ICFI+JMFI
        IF (ABSF(AA(ICFIJ))-90.) 140,140,1010
  140   FI=AA(ICFIJ)*3.14159267/180.
        IF (FI) 144,144,146
  144   SIGNFI=-1.
        GO TO 148
  146   SIGNFI=1.
  148   IF(ABSF(DIR(1,1))-.1E-3) 150,150,160
  150   IF(ABSF(DIR(1,3))-.1E-3) 180,180,170
  160   DIR(2,2)=COSF(FI)
        ASQ=DIR(1,1)*DIR(1,1)
        AX=1.+DIR(1,3)*DIR(1,3)/ASQ
        BX=DIR(1,2)*DIR(1,3)*DIR(2,2)/ASQ
        CX=DIR(2,2)*DIR(2,2)+DIR(1,2)*DIR(1,2)*DIR(2,2)*DIR(2,2)/ASQ-1.
        DIR(2,3)=(-BX+SIGNFI*SQRTF(BX*BX-AX*CX))/AX
  165   DIR(2,1)=(-DIR(1,2)*DIR(2,2)-DIR(1,3)*DIR(2,3))/DIR(1,1)
        GO TO 190
  170   DIR(2,2)=COSF(FI)
        DIR(2,3)=-DIR(1,2)*DIR(2,2)/DIR(1,3)
        DIR(2,1)=SIGNFI*SQRTF(1.-DIR(2,2)*DIR(2,2)-DIR(2,3)*DIR(2,3))
        GO TO 190
  180   DIR(2,3)=COSF(FI)
        DIR(2,2)=0.
        DIR(2,1)=SIGNFI*SQRTF(1.-DIR(2,3)*DIR(2,3))
  190   DIR(3,1)=DIR(1,2)*DIR(2,3)-DIR(1,3)*DIR(2,2)
        DIR(3,2)=-DIR(1,1)*DIR(2,3)+DIR(1,3)*DIR(2,1)
        DIR(3,3)=DIR(1,1)*DIR(2,2)-DIR(1,2)*DIR(2,1)
        GO TO 1000
  220   DIR(2,1)=-DIR(1,2)
        DIR(2,2)=DIR(1,1)
        DIR(2,3)=0.
        DIR(3,1)=0.
        DIR(3,2)=0.
        DIR(3,3)=1.
        GO TO 1000
  250   DIR(1,1)=1.
        DIR(1,2)=0.
        DIR(1,3)=0.
        DIR(2,1)=0.
        DIR(2,2)=XD(1)/FL
        DIR(2,3)=YD(1)/FL
        DIR(3,1)=0.
        DIR(3,2)=-DIR(2,3)
        DIR(3,3)=DIR(2,2)
 1000   RETURN
 1010   IERR=1
        GO TO 1000
        END
```

Table VII-20. Source program listing of subroutine CORT (Link 2)

```
*       LABEL
CE2CRT                                                                  F2CRT000
        SUBROUTINE  CORT                                                F2CRT001
C       OBTAINS COORDINATES OF TRIANGULAR SHELL ELEMENT IN LOCAL COORDNTS.F2CRT002
        DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)       F2CRT003
       1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)            F2CRT004
        COMMON IA,AA                                                    F2CRT005
        EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),E),(D21(20),G)F2CRT006
        EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),  F2CRT007
       1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),F2CRT008
       2IH),(IA(11),IR),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),F2CRT009
       3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),F2CRT010
       4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),    F2CRT011
       5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),     F2CRT012
       6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),      F2CRT013
       7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57F2CRT014
       8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBD),(IA(61),IID),(IA(62),F2CRT015
       9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITF),(IA(41),ITAP)         F2CRT016
        EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),    F2CRT017
       1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),       F2CRT018
       2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)              F2CRT019
       3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG), F2CRT020
       4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),  F2CRT021
       5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),    F2CRT022
       6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)               F2CRT023
       7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IOF2CRT024
       8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                             F2CRT025
        EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346) F2CRT026
       1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)   F2CRT027
       2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)      F2CRT028
       3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)       F2CRT029
       4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)         F2CRT030
       5,(IA(329),IPIR)                                                   F2CRT031
        DIMENSION    DUMX(3),DUNX(3)                                    F2CRT032
        EQUIVALENCE  (AA(200),DUMX),(AA(203),DUNX)                      F2CRT033
        DIMENSION EM(4,4),EN(4,4),Q(4,4),DIR(3,3),DUM(18)               F2CRT034
        EQUIVALENCE (AA(200),EM),(AA(216),EN),(AA(232),EQ),(AA(248),Q),  F2CRT035
       1(AA(264),DIR),(AA(273),DUM)                                      F2CRT036
        EL=SQRTF (XD(1)*XD(1)+YD(1)*YD(1)+ZD(1)*ZD(1))                  F2CRT037
        DIR(1,1)=XD(1)/EL                                               F2CRT038
        DIR(1,2)=YD(1)/EL                                               F2CRT039
        DIR(1,3)=ZD(1)/EL                                               F2CRT040
        DIR(3,1)=DIR(1,2)*ZD(2)-DIR(1,3)*YD(2)                          F2CRT041
        DIR(3,2)=DIR(1,3)*XD(2)-DIR(1,1)*ZD(2)                          F2CRT042
        DIR(3,3)=DIR(1,1)*YD(2)-DIR(1,2)*XD(2)                          F2CRT043
        EL=SQRTF(DIR(3,1)*DIR(3,1)+DIR(3,2)*DIR(3,2)+DIR(3,3)*DIR(3,3)) F2CRT044
        DIR(3,1)=DIR(3,1)/EL                                            F2CRT045
        DIR(3,2)=DIR(3,2)/EL                                            F2CRT046
        DIR(3,3)=DIR(3,3)/EL                                            F2CRT047
        DIR(2,1)=DIR(3,2)*DIR(1,3)-DIR(3,3)*DIR(1,2)                    F2CRT048
        DIR(2,2)=DIR(3,3)*DIR(1,1)-DIR(3,1)*DIR(1,3)                    F2CRT049
        DIR(2,3)=DIR(3,1)*DIR(1,2)-DIR(3,2)*DIR(1,1)                    F2CRT050
        DO 1 I=1,3                                                      F2CRT051
        DUMX(1)=X(I)                                                    F2CRT052
        DUMX(2)=Y(I)                                                    F2CRT053
        DUMX(3)=Z(I)                                                    F2CRT054
        DO 2 J=1,3                                                      F2CRT055
        DUNX(J)=0.                                                      F2CRT056
        DO 3 K=1,3                                                      F2CRT057
3       DUNX(J)=DUNX(J)+DIR(J,K)*DUMX(K)                                F2CRT058
2       CONTINUE                                                        F2CRT059
        X(I)=DUNX(1)                                                    F2CRT060
        Y(I)=DUNX(2)                                                    F2CRT061
1       Z(I)=DUNX(3)                                                    F2CRT062
        DO 6 I=2,3                                                      F2CRT063
        XD(I-1)=X(I)-X(1)                                               F2CRT064
        YD(I-1)=Y(I)-Y(1)                                               F2CRT065
6       ZD(I-1)=Z(I)-Z(1)                                               F2CRT066
        RETURN                                                          F2CRT067
        END                                                             F2CRT068
```

Table VII-21. Source program listing of subroutine CUTE (Link 2)

```
*       LABEL
CE2CUT                                                                  F2CUT000
        SUBROUTINE CUTE (ITTM)                                          F2CUT001
C       CUTS QUADRILATERALS AND HEXAHEDRONS INTO TRIANGLES AND TETRAHEDRNSF2CUT002
        DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)       F2CUT003
       1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)            F2CUT004
        COMMON IA,AA                                                    F2CUT005
        EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),E),(D21(20),G)F2CUT006
        EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),  F2CUT007
       1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),F2CUT008
       2IH),(IA(11),IR),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),F2CUT009
       3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),F2CUT010
       4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),    F2CUT011
       5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),     F2CUT012
       6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),      F2CUT013
       7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57F2CUT014
       8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBD),(IA(61),IID),(IA(62),F2CUT015
       9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITF),(IA(41),ITAP)         F2CUT016
        EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),    F2CUT017
       1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),       F2CUT018
       2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)              F2CUT019
       3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG), F2CUT020
       4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),  F2CUT021
       5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),    F2CUT022
       6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)               F2CUT023
       7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IOF2CUT024
       8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                             F2CUT025
        EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346) F2CUT026
       1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)   F2CUT027
       2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)      F2CUT028
       3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)       F2CUT029
       4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)         F2CUT030
       5,(IA(329),IPIR),(IA(328),NAV)                                     F2CUT031
        DIMENSION NOD(20)                                               F2CUT032
        EQUIVALENCE (AA(300),NOD),(IA(326),IMST)                        F2CUT033
        NAV=NAV+1                                                       F2CUT034
        KBAS=0                                                          F2CUT035
        KNOD=0                                                          F2CUT036
        IF (IELT-10) 110,120,110                                        F2CUT037
  110   ITTM=2                                                          F2CUT038
        IMS=3                                                           F2CUT039
        JEN=6                                                           F2CUT040
        IEN=1                                                           F2CUT041
        GO TO (130,130,115),NAV                                         F2CUT042
  115   KBAS=1                                                          F2CUT043
        GO TO 130                                                       F2CUT044
  120   ITTM=5                                                          F2CUT045
        IMS=4                                                           F2CUT046
        JEN=20                                                          F2CUT047
        IEN=2                                                           F2CUT048
        GO TO (130,130,125),NAV                                         F2CUT049
  125   KBAS=4                                                          F2CUT050
  130   IELT=IELT-1                                                     F2CUT051
        IDS=IMS*IDEG                                                    F2CUT052
        DO 400 J=1,JEN                                                  F2CUT053
        KNODJ=KNOD+J                                                    F2CUT054
        GO TO (180,190),IEN                                             F2CUT055
  180   GO TO (210,220,230,230,240,210),J                               F2CUT056
  190   GO TO (210,240,220,270,230,220,240,250,240,280,250,270,220,250,260F2CUT057
       1,270,220,240,250,270),J                                         F2CUT058
  210   KBASJ=KBAS+1                                                    F2CUT059
        GO TO 310                                                       F2CUT060
  220   KBASJ=KBAS+2                                                    F2CUT061
        GO TO 310                                                       F2CUT062
  230   KBASJ=KBAS+3                                                    F2CUT063
        GO TO 310                                                       F2CUT064
  240   KBASJ=KBAS+4                                                    F2CUT065
        GO TO 310                                                       F2CUT066
  250   KBASJ=KBAS+5                                                    F2CUT067
        GO TO 310                                                       F2CUT068
  260   KBASJ=KBAS+6                                                    F2CUT069
        GO TO 310                                                       F2CUT070
  270   KBASJ=KBAS+7                                                    F2CUT071
        GO TO 310                                                       F2CUT072
  280   KBASJ=KBAS+8                                                    F2CUT073
  310   IF (KBASJ-IMST) 330,330,320                                     F2CUT074
  320   KBASJ=KBASJ-IMST                                                F2CUT075
        GO TO 310                                                       F2CUT076
  330   NOD(KNODJ)=N(KBASJ)                                             F2CUT077
  400   CONTINUE                                                        F2CUT078
  500   CONTINUE                                                        F2CUT079
        RETURN                                                          F2CUT080
        END                                                             F2CUT081
```

Table VII-22. Source program listing of subroutine DARN (Link 2)

```
*       LABEL
CE2DRN                                                                  F2DRN000
      SUBROUTINE DARN (KS,KBS,CCC,KOE)                                  F2DRN001
C     PREPARES INFORMATION RELATED WITH CONSTRAINTS FOR ASSEMBLY        F2DRN002
      DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)         F2DRN003
     1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)              F2DRN004
      COMMON IA,AA                                                      F2DRN005
      EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),E),(D21(20),G1F2DRN006
      EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),  F2DRN007
     1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),F2DRN008
     2IH),(IA(11),I8),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),F2DRN009
     3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),F2DRN010
     4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),    F2DRN011
     5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IOS),(IA(37),     F2DRN012
     6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),      F2DRN013
     7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57F2DRN014
     8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBO),(IA(61),IID),(IA(62),F2DRN015
     9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITF),(IA(41),ITAP)         F2DRN016
      EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),    F2DRN017
     1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),       F2DRN018
     2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)              F2DRN019
     3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TF),(AA(81),DT),(AA(82),DG), F2DRN020
     4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),  F2DRN021
     5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),    F2DRN022
     6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)               F2DRN023
     7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IUF2DRN024
     8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                             F2DRN025
      EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346) F2DRN026
     1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)   F2DRN027
     2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)      F2DRN028
     3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)       F2DRN029
     4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)         F2DRN030
     5,(IA(329),IPIR)                                                   F2DRN031
      DIMENSION IBS(25),CCCI(25),JBS(25),CCCJ(25)                       F2DRN032
      EQUIVALENCE (IA(200),IBS),(IA(225),JBS),(AA(250),CCCI),           F2DRN033
     1(AA(275),CCCJ)                                                    F2DRN034
      DIMENSION KBS(1),CCC(1)                                           F2DRN035
      IBBI=IBB+KS                                                       F2DRN036
      KB=IA(IBBI)                                                       F2DRN037
      IF (KB+IND) 301,302,302                                           F2DRN038
  302 IF (KB) 303,1,304                                                 F2DRN039
  304 KOE=1                                                             F2DRN040
      IICI=IIC+KS                                                       F2DRN041
      CCC(1)=AA(IICI)                                                   F2DRN042
      KBS(1)=KB                                                         F2DRN043
      GO TO 308                                                         F2DRN044
  303 KOE=1                                                             F2DRN045
      CCC(1)=1.                                                         F2DRN046
      KBS(1)=-KB                                                        F2DRN047
      GO TO 308                                                         F2DRN048
  301 ICOMP=10000+KS                                                    F2DRN049
      INCR=1                                                            F2DRN050
      DO 306 ISOR=1,IND                                                 F2DRN051
      IBOI=IBO+ISOR                                                     F2DRN052
      IF (XABSF(IA(IBOI))-ICOMP) 306,307,306                            F2DRN053
  307 IBBI=IBB+ISOR                                                     F2DRN054
      IICI=IIC+ISOR                                                     F2DRN055
      KBS(INCR)=XABSF(IA(IBBI))                                         F2DRN056
      CCC(INCR)=AA(IICI)                                                F2DRN057
      INCR=INCR+1                                                       F2DRN058
  306 CONTINUE                                                          F2DRN059
      KOE=INCR-1                                                        F2DRN060
  308 RETURN                                                            F2DRN061
1     KOE=0                                                             F2DRN062
      GO TO 308                                                         F2DRN063
      END                                                               F2DRN064
```

Table VII-23. Source program listing of subroutine DMM (Link 2)

```
*       LABEL
CE2DMM                                                                  F2DMM000
      SUBROUTINE DMM (A,B,M,C)                                          F2DMM001
C     OBTAINS THE PRODUCT OF ELEMENT STIFFNESS MATRIX TIMES A VECTOR    F2DMM002
      DIMENSION A(1),B(1),C(1)                                          F2DMM003
      DO 10 I=1,M                                                       F2DMM004
      ISS=I-M                                                           F2DMM005
      DO 9 K=1,M                                                        F2DMM006
      ISS=ISS+M                                                         F2DMM007
    9 C(I)=C(I)+A(ISS)*B(K)                                             F2DMM008
   10 CONTINUE                                                          F2DMM009
      RETURN                                                            F2DMM010
      END                                                               F2DMM011
```

Table VII-24. Source program listing of subroutine ELDI (Link 2)

```
*       LABEL
CE2ELD                                                                  F2ELD000
      SUBROUTINE ELDI                                                   F2ELD001
C     OBTAINS UNIT VECTOR OF PRESSURE FOR LINE ELEMENT                  F2ELD002
      DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)         F2ELD003
     1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)              F2ELD004
      COMMON IA,AA                                                      F2ELD005
      EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),E),(D21(20),G1F2ELD006
      EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),  F2ELD007
     1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),F2ELD008
     2IH),(IA(11),I8),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),F2ELD009
     3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),F2ELD010
     4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),    F2ELD011
     5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IOS),(IA(37),     F2ELD012
     6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),      F2ELD013
     7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57F2ELD014
     8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBO),(IA(61),IID),(IA(62),F2ELD015
     9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITF),(IA(41),ITAP)         F2ELD016
      EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),    F2ELD017
     1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),       F2ELD018
     2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)              F2ELD019
     3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TF),(AA(81),DT),(AA(82),DG), F2ELD020
     4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),  F2ELD021
     5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),    F2ELD022
     6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)               F2ELD023
     7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IUF2ELD024
     8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                             F2ELD025
      EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346) F2ELD026
     1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)   F2ELD027
     2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)      F2ELD028
     3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)       F2ELD029
     4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)         F2ELD030
     5,(IA(329),IPIR)                                                   F2ELD031
      DIMENSION A(6,6),DIR(3,3),UVG(12),T(6),PD(3),PN(3),DUG(3)         F2ELD032
      EQUIVALENCE (AA(200),A),(AA(236),EL),(AA(237),AREA ),(AA(238),II) F2ELD033
     1,(AA(239),JJ),(AA(240),IR),(AA(241),JR),(AA(242),NY),(AA(264),DIR)F2ELD034
     2,(AA(306),UVG),(AA(291),PD),(AA(294),PN),(AA(297),DUG),(AA(300),T)F2ELD035
      EL=SQRTF(XD(1)*XD(1)+YD(1)*YD(1)+ZD(1)*ZD(1))                     F2ELD036
      IF (EL) 1010,1010,110                                             F2ELD037
  110 ELI=1./EL                                                         F2ELD038
      T(1)=XD(1)*ELI                                                    F2ELD039
      T(3)=YD(1)*ELI                                                    F2ELD040
      T(5)=ZD(1)*ELI                                                    F2ELD041
      PN(1)=DUG(2)*T(5)-DUG(3)*T(3)                                     F2ELD042
      PN(2)=DUG(3)*T(1)-DUG(1)*T(5)                                     F2ELD043
      PN(3)=DUG(1)*T(3)-DUG(2)*T(1)                                     F2ELD044
      VEL=SQRTF(PN(1)*PN(1)+PN(2)*PN(2)+PN(3)*PN(3))                    F2ELD045
      IF (VEL-.1E-4) 220,220,230                                        F2ELD046
  220 PRES=0.                                                           F2ELD047
      GO TO 1000                                                        F2ELD048
  230 VELI=1./VEL                                                       F2ELD049
      DO 300 I=1,3                                                      F2ELD050
  300 PN(I)=PN(I)*VELI                                                  F2ELD051
      PD(1)=T(3)*PN(3)-T(5)*PN(2)                                       F2ELD052
      PD(2)=T(5)*PN(1)-T(1)*PN(3)                                       F2ELD053
      PD(3)=T(1)*PN(2)-T(3)*PN(1)                                       F2ELD054
      VELI=1./SQRTF(PD(1)*PD(1)+PD(2)*PD(2)+PD(3)*PD(3))                F2ELD055
      DO 400 I=1,3                                                      F2ELD056
  400 PD(I)=PD(I)*VELI                                                  F2ELD057
 1000 RETURN                                                            F2ELD058
 1010 IERR=1                                                            F2ELD059
      GO TO 1000                                                        F2ELD060
      END                                                               F2ELD061
```

Table VII-25. Source program listing of subroutine PLBE (Link 2)

```
*       LABEL
CE2PLB                                                                  E2PLB000
      SUBROUTINE PLBE                                                   E2PLB001
C     GENERATES SUBMATRICES FOR ELEMENT TYPES 3 AND 4                   E2PLB002
      DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)         E2PLB003
     1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)              E2PLB004
      COMMON IA,AA                                                      E2PLB005
      EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),F),(D21(20),G)E2PLB006
      EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),  E2PLB007
     1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),E2PLB008
     2IH),(IA(11),IB),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),E2PLB009
     3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),E2PLB010
     4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),    E2PLB011
     5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),     E2PLB012
     6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),      E2PLB013
     7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57E2PLB014
     8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBD),(IA(61),IID),(IA(62),E2PLB015
     9IIA),(IA(63),IDI),(IA(64),IDY),(IA(65),ITF),(IA(41),ITAP)         E2PLB016
      EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),    E2PLB017
     1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),       E2PLB018
     2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)              E2PLB019
     3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG), E2PLB020
     4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),  E2PLB021
     5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),    E2PLB022
     6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)               E2PLB023
     7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IUE2PLB024
     8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                             E2PLB025
      EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346) E2PLB026
     1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)   E2PLB027
     2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)      E2PLB028
     3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)       E2PLB029
     4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)         E2PLB030
     5,(IA(329),IPIR)                                                   E2PLB031
      DIMENSION A(6,6),DIR(3,3),UVG(12),T(6),PD(3),PN(3),DUG(3)         E2PLB032
      EQUIVALENCE (AA(200),A),(AA(236),EL),(AA(237),AREA ),(AA(238),II) E2PLB033
     1,(AA(239),JJ),(AA(240),IR),(AA(241),JR),(AA(242),NY),(AA(264),DIR)E2PLB034
     2,(AA(306),UVG),(AA(291),PD),(AA(294),PN),(AA(297),DUG),(AA(300),T)E2PLB035
      IF (JMMX) 1010,1010,130                                           E2PLB036
  130 ICIXJ=ICIX+JMMX                                                   E2PLB037
      IF (JMMY) 1010,1010,150                                           E2PLB038
  150 ICIYJ=ICIY+JMMY                                                   E2PLB039
  190 A(1,1)=12.*E*AA(ICIYJ)/(EL**3)                                    E2PLB040
      A(1,2)=-A(1,1)                                                    E2PLB041
      A(2,2)=A(1,1)                                                     E2PLB042
      A(2,5)=6.*E*AA(ICIYJ)/(EL**2)                                     E2PLB043
      A(2,6)=A(2,5)                                                     E2PLB044
      A(1,5)=-A(2,5)                                                    E2PLB045
      A(1,6)=A(1,5)                                                     E2PLB046
      A(3,3)=G*AA(ICIXJ)/EL                                             E2PLB047
      A(3,4)=-A(3,3)                                                    E2PLB048
      A(4,4)=A(3,3)                                                     E2PLB049
      A(5,5)=4.*E*AA(ICIYJ)/EL                                          E2PLB050
      A(5,6)=.5*A(5,5)                                                  E2PLB051
      A(6,6)=A(5,5)                                                     E2PLB052
      DO 200 I=1,6                                                      E2PLB053
      DO 200 J=1,6                                                      E2PLB054
  200 A(J,I)=A(I,J)                                                     E2PLB055
 1000 RETURN                                                            E2PLB056
 1010 IERR=1                                                            E2PLB057
      GO TO 1000                                                        E2PLB058
      END                                                               E2PLB059
```

Table VII-26. Source program listing of subroutine RLOC (Link 2)

```
*       LABEL
CE2RLC                                                                  E2RLC000
      SUBROUTINE RLOC                                                   E2RLC001
C     ADDS SUBMATRICES TO FORM ELEMENT STIFFNESS MATRICES OF LINE ELEMNTE2RLC002
      DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)         E2RLC003
     1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)              E2RLC004
      COMMON IA,AA                                                      E2RLC005
      EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),F),(D21(20),G)E2RLC006
      EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),  E2RLC007
     1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),E2RLC008
     2IH),(IA(11),IB),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),E2RLC009
     3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),E2RLC010
     4ISTR),(IA(28),IFLT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMFI),    E2RLC011
     5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),     E2RLC012
     6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),      E2RLC013
     7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57E2RLC014
     8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBD),(IA(61),IID),(IA(62),E2RLC015
     9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITF),(IA(41),ITAP)         E2RLC016
      EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),    E2RLC017
     1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),       E2RLC018
     2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)              E2RLC019
     3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG), E2RLC020
     4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),  E2RLC021
     5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),    E2RLC022
     6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)               E2RLC023
     7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IUE2RLC024
     8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                             E2RLC025
      EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346) E2RLC026
     1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)   E2RLC027
     2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)      E2RLC028
     3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)       E2RLC029
     4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)         E2RLC030
     5,(IA(329),IPIR)                                                   E2RLC031
      DIMENSION A(6,6),DIR(3,3),UVG(12)                                 E2RLC032
      EQUIVALENCE (AA(200),A),(AA(236),EL),(AA(237),AREA ),(AA(238),II) E2RLC033
     1,(AA(239),JJ),(AA(240),IR),(AA(241),JR),(AA(242),NY),(AA(306),UVG)E2RLC034
     2,(AA(264),DIR)                                                    E2RLC035
      IIN=II+NY-1                                                       E2RLC036
      JJN=JJ+NY-1                                                       E2RLC037
      IRE=(JR-JJ)*IDS+IR-II                                             E2RLC038
      L=(JJ-2)*IDS                                                      E2RLC039
      DO 200 J=JJ,JJN                                                   E2RLC040
      L=L+IDS                                                           E2RLC041
      DO 100 I=II,IIN                                                   E2RLC042
      LR=L+I+IRE                                                        E2RLC043
      S(LR)=A(I,J)                                                      E2RLC044
  100 A(I,J)=0.                                                         E2RLC045
  200 CONTINUE                                                          E2RLC046
      RETURN                                                            E2RLC047
      END                                                               E2RLC048
```

Table VII-27. Source program listing of subroutine S01 (Link 2)

```
*       LABEL
CE2S01                                                                  E2S01000
      SUBROUTINE S01                                                    E2S01001
C     GENERATES FOR ELEMENT TYPE 1 STIFFNESS AND LOAD MATRICES          E2S01002
      DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)         E2S01003
     1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)              E2S01004
      COMMON IA,AA                                                      E2S01005
      EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),F),(D21(20),G)E2S01006
      EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),  E2S01007
     1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),E2S01008
     2IH),(IA(11),IB),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),E2S01009
     3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),E2S01010
     4ISTR),(IA(28),IFLT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),    E2S01011
     5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),     E2S01012
     6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),      E2S01013
     7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57E2S01014
     8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBD),(IA(61),IID),(IA(62),E2S01015
     9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITE),(IA(41),ITAP)         E2S01016
      EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),    E2S01017
     1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),       E2S01018
     2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)              E2S01019
     3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG), E2S01020
     4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),  E2S01021
     5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),    E2S01022
     6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)               E2S01023
     7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IUE2S01024
     8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                             E2S01025
      EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346) E2S01026
     1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)   E2S01027
     2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)      E2S01028
     3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)       E2S01029
     4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)         E2S01030
     5,(IA(329),IPIR)                                                   E2S01031
      DIMENSION A(6,6),DIR(3,3),UVG(12),T(6),PD(3),PN(3),DUG(3)         E2S01032
      EQUIVALENCE (AA(200),A),(AA(236),EL),(AA(237),AREA ),(AA(238),II) E2S01033
     1,(AA(239),JJ),(AA(240),IR),(AA(241),JR),(AA(242),NY),(AA(264),DIR)E2S01034
     2,(AA(306),UVG),(AA(291),PD),(AA(294),PN),(AA(297),DUG),(AA(300),T)E2S01035
      EQUIVALENCE (AA(324),PRCO)                                        E2S01036
C     PLANE OR SPACE TRUSS ELEMENT                                      E2S01037
      IPBG=0                                                            E2S01038
      IF (JARE) 1,1,43                                                  E2S01039
   43 ICARJ=ICAR+JARE                                                   E2S01040
      DUG(1)=1.                                                         E2S01041
      DUG(2)=0.                                                         E2S01042
      DUG(3)=0.                                                         E2S01043
      CALL ELDI                                                         E2S01044
   60 IF (JPRS) 80,82,80                                                E2S01045
   80 PRCO=.5*EL*PRES*PD(1)                                             E2S01046
      IPBG=1                                                            E2S01047
      IPEN=3                                                            E2S01048
   82 IF (ACEL) 85,90,85                                                E2S01049
   85 CONS=.5*EL*ACEL*AA(ICARJ)                                         E2S01050
      IPBG=1                                                            E2S01051
      IPEN=3                                                            E2S01052
   90 SS=E*AA(ICARJ)/EL                                                 E2S01053
      T(2)=-T(1)                                                        E2S01054
      T(4)=-T(3)                                                        E2S01055
      T(6)=-T(5)                                                        E2S01056
      IK=-IDS                                                           E2S01057
      DO 111 I=1,IDS                                                    E2S01058
      IK=IK+IDS                                                         E2S01059
      DO 11 J=1,IDS                                                     E2S01060
      ISS=IK+J                                                          E2S01061
   11 S(ISS)=SS*T(I)*T(J)                                               E2S01062
  111 CONTINUE                                                          E2S01063
    9 RETURN                                                            E2S01064
    1 IERR=1                                                            E2S01065
      GO TO 9                                                           E2S01066
      END                                                               E2S01067
```

Table VII-28. Source program listing of subroutine S02 (Link 2)

```
*      LABEL
CE2S02                                                                  E2S02000
      SUBROUTINE S02                                                    E2S02001
C     GENERATES FOR ELEMENT TYPE 2 STIFFNESS AND LOAD MATRICES          E2S02002
      DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)         E2S02003
     1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)              E2S02004
      COMMON IA,AA                                                      E2S02005
      EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),E),(D21(20),G)E2S02006
      EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),  E2S02007
     1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),E2S02008
     2IH),(IA(11),IB),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),E2S02009
     3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),E2S02010
     4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),    E2S02011
     5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),     E2S02012
     6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),      E2S02013
     7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57E2S02014
     8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBO),(IA(61),IID),(IA(62),E2S02015
     9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITF),(IA(41),ITAP)         E2S02016
      EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),    E2S02017
     1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),       E2S02018
     2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)              E2S02019
     3,(IA(78),IGEN),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG), E2S02020
     4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),  E2S02021
     5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),    E2S02022
     6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)               E2S02023
     7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IUE2S02024
     8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                             E2S02025
      EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346) E2S02026
     1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)   E2S02027
     2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)      E2S02028
     3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)       E2S02029
     4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)         E2S02030
     5,(IA(329),IPIR),(AA(324),PRCO)                                    E2S02031
      DIMENSION A(6,6),DIR(3,3),UVG(12),T(6),PD(3),PN(3),DUG(3)         E2S02032
      EQUIVALENCE (AA(200),A),(AA(236),EL),(AA(237),AREA ),(AA(238),II) E2S02033
     1,(AA(239),JJ),(AA(240),IR),(AA(241),JR),(AA(242),NY),(AA(264),DIR)E2S02034
     2,(AA(306),UVG),(AA(291),PD),(AA(294),PN),(AA(297),DUG),(AA(300),T)E2S02035
      CALL CODI                                                         E2S02036
      CALL BEAM                                                         E2S02037
      IPBG=0                                                            E2S02038
      IF (JPRS) 40,50,40                                                E2S02039
   40 DUG(1)=1.                                                         E2S02040
      DUG(2)=0.                                                         E2S02041
      DUG(3)=0.                                                         E2S02042
      CALL EL01                                                         E2S02043
      PRCO=.5*EL*PRES*PD(1)                                             E2S02044
      P(5)=-PRCO*EL/6.                                                  E2S02045
      P(6)=-P(5)                                                        E2S02046
      IPBG=1                                                            E2S02047
      IPEN=2                                                            E2S02048
   50 IF (ACEL) 60,80,60                                                E2S02049
   60 DO 70 I=1,2                                                       E2S02050
   70 DUG(I)=G1(I)                                                      E2S02051
      CALL ELD1                                                         E2S02052
      CONS=.5*EL*ACEL*AREA                                              E2S02053
      CACE=(DUG(1)*PD(1)+DUG(2)*PD(2))*CONS*EL/6.                       E2S02054
      P(5)=P(5)-CACE                                                    E2S02055
      P(6)=-P(5)                                                        E2S02056
      IPBG=1                                                            E2S02057
      IPEN=2                                                            E2S02058
   80 II=1                                                              E2S02059
      JJ=1                                                              E2S02060
      IR=1                                                              E2S02061
      JR=1                                                              E2S02062
      NY=6                                                              E2S02063
      CALL RLOC                                                         E2S02064
      IF (DG) 110,310,110                                               E2S02065
  110 UVG(5)=.5*DG*AL1*EL                                               E2S02066
      UVG(6)=-UVG(5)                                                    E2S02067
      DO 300 I=1,IDS                                                    E2S02068
  300 UV(I)=UV(I)+UVG(I)                                                E2S02069
  310 CALL STRA                                                         E2S02070
      RETURN                                                            E2S02071
      END                                                               E2S02072
```

Table VII-29. Source program listing of subroutine S03 (Link 2)

```
*      LABEL
CE2S03                                                                  E2S03000
      SUBROUTINE S03                                                    E2S03001
C     GENERATES FOR ELEMENT TYPE 3 STIFFNESS AND LOAD MATRICES          E2S03002
      DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)         E2S03003
     1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)              E2S03004
      COMMON IA,AA                                                      E2S03005
      EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),E),(D21(20),G)E2S03006
      EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),  E2S03007
     1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),E2S03008
     2IH),(IA(11),IB),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),E2S03009
     3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),E2S03010
     4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),    E2S03011
     5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),     E2S03012
     6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),      E2S03013
     7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57E2S03014
     8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBO),(IA(61),IID),(IA(62),E2S03015
     9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITF),(IA(41),ITAP)         E2S03016
      EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),    E2S03017
     1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),       E2S03018
     2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)              E2S03019
     3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG), E2S03020
     4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),  E2S03021
     5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),    E2S03022
     6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)               E2S03023
     7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IUE2S03024
     8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                             E2S03025
      EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346) E2S03026
     1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)   E2S03027
     2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)      E2S03028
     3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)       E2S03029
     4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)         E2S03030
     5,(IA(329),IPIR),(AA(324),PRCO)                                    E2S03031
      DIMENSION A(6,6),DIR(3,3),UVG(12),T(6),PD(3),PN(3),DUG(3)         E2S03032
      EQUIVALENCE (AA(200),A),(AA(236),EL),(AA(237),AREA ),(AA(238),II) E2S03033
     1,(AA(239),JJ),(AA(240),IR),(AA(241),JR),(AA(242),NY),(AA(264),DIR)E2S03034
     2,(AA(306),UVG),(AA(291),PD),(AA(294),PN),(AA(297),DUG),(AA(300),T)E2S03035
      CALL CODI                                                         E2S03036
      CALL PLBF                                                         E2S03037
      IPBG=0                                                            E2S03038
      IPEN=1                                                            E2S03039
      IF (JPRS) 40,60,40                                                E2S03040
   40 PRCO=.5*EL*PRES                                                   E2S03041
   50 P(1)=PRCO+P(1)                                                    E2S03042
      P(2)=PRCO+P(2)                                                    E2S03043
      P(3)=PRCO*EL*DIR(1,2)/6.+P(3)                                     E2S03044
      P(4)=-P(3)+P(4)                                                   E2S03045
      P(5)=PRCO*EL*DIR(1,1)/6.+P(5)                                     E2S03046
      P(6)=-P(5)+P(6)                                                   E2S03047
      GO TO (60,80),IPEN                                                E2S03048
   60 IF (ACEL) 70,80,70                                                E2S03049
   70 PRCO=.5*EL*ACEL*G3                                                E2S03050
      IPEN=2                                                            E2S03051
      GO TO 50                                                          E2S03052
   80 II=1                                                              E2S03053
      JJ=1                                                              E2S03054
      IR=1                                                              E2S03055
      JR=1                                                              E2S03056
      NY=6                                                              E2S03057
      CALL RLOC                                                         E2S03058
  100 IF (DGZ) 108,310,108                                              E2S03059
  108 DG=DGZ                                                            E2S03060
  110 CONTINUE                                                          E2S03061
      UVG(5)=-.5*DG*AL1*EL                                              E2S03062
      UVG(6)=-UVG(5)                                                    E2S03063
      CALL TRAN (UVG,0)                                                 E2S03064
      DO 300 I=1,IDS                                                    E2S03065
  300 UV(I)=UV(I)+UVG(I)                                                E2S03066
  310 CALL STRA                                                         E2S03067
 1000 RETURN                                                            E2S03068
      END                                                               E2S03069
```

Table VII-30. Source program listing of subroutine S04 (Link 2)

```
*      LABEL
CE2S04                                                                   E2S04000
       SUBROUTINE S04                                                    E2S04001
C      GENERATES FOR ELEMENT TYPE 4 STIFFNESS AND LOAD MATRICES          E2S04002
       DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)         E2S04003
      1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)              E2S04004
       COMMON IA,AA                                                      E2S04005
       EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),E),(D21(20),G)E2S04006
       EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),  E2S04007
      1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),E2S04008
      2IH),(IA(11),IB),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),E2S04009
      3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),E2S04010
      4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),    E2S04011
      5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),     E2S04012
      6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),      E2S04013
      7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57E2S04014
      8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBO),(IA(61),IIO),(IA(62),E2S04015
      9ITA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITE),(IA(41),ITAP)         E2S04016
       EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),    E2S04017
      1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),       E2S04018
      2(IA(74),ITC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)              E2S04019
      3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG), E2S04020
      4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),  E2S04021
      5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),    E2S04022
      6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)               E2S04023
      7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IUE2S04024
      8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                             E2S04025
       EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346) E2S04026
      1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)   E2S04027
      2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)      E2S04028
      3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)       E2S04029
      4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)         E2S04030
      5,(IA(329),IPIR),(AA(324),PRCO)                                    E2S04031
       DIMENSION A(6,6),DIR(3,3),UVG(12),T(6),PD(3),PN(3),DUG(3)         E2S04032
       EQUIVALENCE (AA(200),A),(AA(236),EL),(AA(237),AREA ),(AA(238),II) E2S04033
      1,(AA(239),JJ),(AA(240),IR),(AA(241),JR),(AA(242),NY),(AA(264),DIR)E2S04034
      2,(AA(306),UVG),(AA(291),PD),(AA(294),PN),(AA(297),DUG),(AA(300),T)E2S04035
       CALL CODI                                                         E2S04036
       IPBG=0                                                            E2S04037
       IF (JPRS) 40,60,40                                                E2S04038
    40 DUG(1)=1.                                                         E2S04039
       DUG(2)=0.                                                         E2S04040
       DUG(3)=0.                                                         E2S04041
       CALL ELDI                                                         E2S04042
    50 PRCO=.5*EL*PRES*PD(1)                                             E2S04043
       P(7)=-PRCO*EL*PN(1)/6.                                            E2S04044
       P(8)=-P(7)                                                        E2S04045
       P(9)=-PRCO*EL*PN(2)/6.                                            E2S04046
       P(10)=-P(9)                                                       E2S04047
       P(11)=-PRCO*EL*PN(3)/6.                                           E2S04048
       P(12)=-P(11)                                                      E2S04049
       IPBG=1                                                            E2S04050
       IPEN=3                                                            E2S04051
    60 IF (ACEL) 70,90,70                                                E2S04052
    70 DO 80 I=1,3                                                       E2S04053
    80 DUG(I)=G1(I)                                                      E2S04054
       CALL ELDI                                                         E2S04055
       CONS=.5*EL*ACEL*AREA                                              E2S04056
       CACE=(DUG(1)*PD(1)+DUG(2)*PD(2)+DUG(3)*PD(3))*CONS*EL/6.          E2S04057
       P(7)=P(7)-CACE*PN(1)                                              E2S04058
       P(8)=-P(7)                                                        E2S04059
       P(9)=P(9)-CACE*PN(2)                                              E2S04060
       P(10)=-P(9)                                                       E2S04061
       P(11)=P(11)-CACE*PN(3)                                            E2S04062
       P(12)=-P(11)                                                      E2S04063
       IPBG=1                                                            E2S04064
       IPEN=3                                                            E2S04065
    90 CALL BEAM                                                         E2S04066
       II=5                                                              E2S04067
       JJ=3                                                              E2S04068
       IR=11                                                             E2S04069
       JR=3                                                              E2S04070
       NY=2                                                              E2S04071
       CALL RLOC                                                         E2S04072
       JJ=5                                                              E2S04073
       JR=11                                                             E2S04074
       CALL RLOC                                                         E2S04075
       II=3                                                              E2S04076
       IR=3                                                              E2S04077
       CALL RLOC                                                         E2S04078
       II=1                                                              E2S04079
       JJ=1                                                              E2S04080
       IR=1                                                              E2S04081
       JR=1                                                              E2S04082
       NY=4                                                              E2S04083
       CALL RLOC                                                         E2S04084
       CALL PLBF                                                         E2S04085
       IR=5                                                              E2S04086
       JR=5                                                              E2S04087
       NY=6                                                              E2S04088
       CALL RLOC                                                         E2S04089
       IF (DGZ) 120,125,120                                              E2S04090
   120 UVG(9)=-.5*DGZ*AL1*EL                                             E2S04091
       UVG(10)=-UVG(9)                                                   E2S04092
   125 IF (DGY) 200,210,200                                              E2S04093
   200 UVG(11)=.5*DGY*AL1*EL                                             E2S04094
       UVG(12)=-UVG(11)                                                  E2S04095
   210 CALL TRAN (UVG,0)                                                 E2S04096
       DO 300 I=1,IDS                                                    E2S04097
   300 UV(I)=UV(I)+UVG(I)                                                E2S04098
   310 CALL STRA                                                         E2S04099
  1000 RETURN                                                            E2S04100
       END                                                               E2S04101
```

Table VII-31. Source program listing of subroutine S05 (Link 2)

```
*      LABEL
CE2S05                                                                   E2S05000
       SUBROUTINE S05                                                    E2S05001
C      GENERATES FOR ELEMENT TYPE 5 STIFFNESS AND LOAD MATRICES          E2S05002
       DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)         E2S05003
      1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)              E2S05004
       COMMON IA,AA                                                      E2S05005
       EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),E),(D21(20),G)E2S05006
       EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),  E2S05007
      1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),E2S05008
      2IH),(IA(11),IB),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),E2S05009
      3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),E2S05010
      4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),    E2S05011
      5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),     E2S05012
      6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),      E2S05013
      7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57E2S05014
      8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBO),(IA(61),IIO),(IA(62),E2S05015
      9ITA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITE),(IA(41),ITAP)         E2S05016
       EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),    E2S05017
      1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),       E2S05018
      2(IA(74),ITC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)              E2S05019
      3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG), E2S05020
      4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),  E2S05021
      5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),    E2S05022
      6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)               E2S05023
      7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IUE2S05024
      8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                             E2S05025
       EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346) E2S05026
      1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)   E2S05027
      2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)      E2S05028
      3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)       E2S05029
      4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)         E2S05030
      5,(IA(329),IPIR),(IA(328),NAV),(IA(327),CFE),(IA(325),ITTT)        E2S05031
       DIMENSION EM(4,4),EN(4,4),Q(4,4),EQ(4,4)                          E2S05032
       EQUIVALENCE (AA(200),EM),(AA(216),EN),(AA(232),EQ),(AA(248),Q)    E2S05033
      1,(AA(291),A2),(AA(324),PRCO)                                      E2S05034
C      TRIANGULAR PLANE ELEMENT                                          E2S05035
       A2=XD(1)*YD(2)-XD(2)*YD(1)                                        E2S05036
       IF (A2) 1,1,41                                                    E2S05037
 41    CALL TRIM                                                         E2S05038
       CALL TRM (D33,EM,Q,3,3)                                           E2S05039
       F1=TE/(2.*A2)                                                     E2S05040
       CALL ADM (S,IDS,Q,3,1,1,F1)                                       E2S05041
       CALL TRM (D33,EN,Q,3,3)                                           E2S05042
       CALL ADM (S,IDS,Q,3,4,4,F1)                                       E2S05043
       CALL TRM (D33,EN,EM,3,-3)                                         E2S05044
       CALL ADM (S,IDS,EM,3,1,4,F1)                                      E2S05045
       IPBG=0                                                            E2S05046
       IF (IGEM) 60,60,85                                                E2S05047
    60 IF (JPRS) 70,85,70                                                E2S05048
    70 IF (ITTT-1) 71,71,85                                              E2S05049
    71 KAV=NAV                                                           E2S05050
       GO TO (80,80,85),KAV                                              E2S05051
    80 P(1)=.5*PRES*YD(1)/CFE                                            E2S05052
       P(2)=P(1)                                                         E2S05053
       P(4)=-.5*PRES*XD(1)/CFE                                           E2S05054
       P(5)=P(4)                                                         E2S05055
    85 IF (ACEL) 90,9,90                                                 E2S05056
    90 CONS=TE*A2*ACEL/6.                                                E2S05057
       IPBG=1                                                            E2S05058
       IPEN=2                                                            E2S05059
       PRCO=0.                                                           E2S05060
 9     RETURN                                                            E2S05061
 1     IERR=1                                                            E2S05062
       GO TO 9                                                           E2S05063
       END                                                               E2S05064
```

Table VII-32. Source program listing of subroutine S07 (Link 2)

```
*       LABEL
CE2S07
        SUBROUTINE S07
C       GENERATES FOR ELEMENT TYPE 7 STIFFNESS AND LOAD MATRICES
        DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)
       1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)
        COMMON IA,AA
        EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),E),(D21(20),G)
        EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),
       1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),
       2IH),(IA(11),IB),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),
       3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),
       4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),
       5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),
       6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),
       7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57
       8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBO),(IA(61),IIO),(IA(62),
       9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITE),(IA(41),ITAP)
        EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),
       1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),
       2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)
       3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG),
       4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),
       5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),
       6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)
       7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IH
       8),(AA(47),G1),(AA(48),G2),(AA(49),G3)
        EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346)
       1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)
       2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)
       3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)
       4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)
       5,(IA(329),IPIR),(AA(324),PRCO)
        DIMENSION EM(4,4),EN(4,4),Q(4,4),EO(4,4)
        EQUIVALENCE (AA(200),EM),(AA(216),EN),(AA(232),EO),(AA(248),Q)
C       TRIANGULAR BENDING ELEMENT.  CONSTANT TRACE SCHEME
        A2=XD(1)*YD(2)-XD(2)*YD(1)
        IF (A2) 1,1,41
  41    CALL TRIM
        F1=TE/(2.*A2)
        CALL TRM (E22,EQ,Q,2,3)
        IF (Q(2,1)) 431,431,435
 431    IF (Q(3,1)) 432,432,436
 432    IF (Q(3,2)) 433,433,437
 435    Q(3,1)=Q(3,1)+Q(2,1)/2.
        Q(3,2)=Q(3,2)+Q(2,1)/2.
        Q(2,1)=0.
        GO TO 438
 436    Q(2,1)=Q(2,1)+Q(3,1)/2.
        Q(3,2)=Q(3,2)+Q(3,1)/2.
        Q(3,1)=0.
        GO TO 438
 437    Q(2,1)=Q(2,1)+Q(3,2)/2.
        Q(3,1)=Q(3,1)+Q(3,2)/2.
        Q(3,2)=0.
 438    Q(1,1)=-Q(2,1)-Q(3,1)
        Q(1,2)=Q(2,1)
        Q(1,3)=Q(3,1)
        Q(2,2)=-Q(1,2)-Q(3,2)
        Q(2,3)=Q(3,2)
        Q(3,3)=-Q(1,3)-Q(2,3)
 433    CALL ADM (S,IDS,Q,3,1,1,F1)
        DO 4022 L=1,3
        IF (L-2) 4019,4018,4019
 4018   DO 4021 II=4,9
        DO 4021 JJ=1,3
        ISS=(JJ-1)*IDS+II
        ISR=(II-1)*IDS+JJ
 4021   S(ISR)=S(ISS)
 4019   DO 4010 I=1,3
        I1=I-(I/3)*3+1
        I2=I1-(I1/3)*3+1
        K=3*(L-1)+I
        ISS=(K-1)*IDS
        ISS1=ISS+I
        ISS2=ISS+I1
        ISS3=ISS+I2
        CY=(X(I1)-X(I))*S(ISS2)
        DY=(X(I2)-X(I))*S(ISS3)
        CX=-(Y(I1)-Y(I))*S(ISS2)
        DX=-(Y(I2)-Y(I))*S(ISS3)
        S(ISS1+3)=(CX+DX)/2.
        S(ISS2+3)=CX/2.
        S(ISS3+3)=DX/2.
        S(ISS1+6)=(CY+DY)/2.
        S(ISS2+6)=CY/2.
 4010   S(ISS3+6)=DY/2.
 4022   CONTINUE
        CALL TRM (D33,EM,Q,3,3)
        F2=F1*TE*TE/12.
        CALL ADM (S,IDS,Q,3,7,7,F2)
        CALL TRM (D33,EN,Q,3,3)
        CALL ADM (S,IDS,Q,3,4,4,F2)
        CALL TRM (D33,EN,EM,3,-3)
        F2=-F2
        CALL ADM (S,IDS,EM,3,7,4,F2)
 452    PRCO=0.
        IPBG=3
        IPEN=3
        CONS=A2*ACEL*TE/6.
        CCNT=PRES*A2   /6.
        P(1)=CCNT
        P(2)=CCNT
        P(3)=CCNT
C       COMPUTE THERMAL DEFORMATION VECTOR
 451    F1=DG*AL1
        F2=DG*AL2
        DO 455 I=1,3
        I1=IMS +I
        I2=IMS +I1
        UV(I)=0.
        UV(I2)=F1*X(I)
 455    UV(I1)=-F2*Y(I)
 9      RETURN
 1      IERR=1
        GO TO 9
        END
```

Table VII-33. Source program listing of subroutine S09 (Link 2)

```
*       LABEL
CE2S09
        SUBROUTINE S09
C       GENERATES FOR ELEMENT TYPE 9 STIFFNESS AND LOAD MATRICES
        DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)
       1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)
        COMMON IA,AA
        EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),E),(D21(20),G)
        EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),
       1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),
       2IH),(IA(11),IB),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),
       3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),
       4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),
       5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),
       6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),
       7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57
       8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBO),(IA(61),IIO),(IA(62),
       9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITE),(IA(41),ITAP)
        EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),
       1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),
       2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)
       3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG),
       4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),
       5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),
       6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)
       7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IH
       8),(AA(47),G1),(AA(48),G2),(AA(49),G3)
        EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346)
       1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)
       2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)
       3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)
       4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)
       5,(IA(329),IPIR),(IA(328),NAV),(AA(327),CFE)
        DIMENSION AT(4,4),B(3,3),O(4,4),MOD(20),PD(3)
        EQUIVALENCE (AA(200),AT),(AA(216),B),(AA(225),O),(AA(241),DET),(AA
       1(300),MOD),(AA(324),PRCO),(AA(325),ITTT),(AA(291),PD)
        DET=-XD(1)*(YD(2)*ZD(3)-YD(3)*ZD(2))+YD(1)*(XD(2)*ZD(3)-XD(3)*ZD(2
       1))-ZD(1)*(XD(2)*YD(3)-XD(3)*YD(2))
        IF (DET) 1010,1010,720
 720    VOL=1./(6.*DET)
        AT(1,1)=((YD(2)-YD(1))*(ZD(3)-ZD(1))-(YD(3)-YD(1))*(ZD(2)-ZD(1)))
        AT(1,2)=(-YD(2)*ZD(3)+YD(3)*ZD(2))
        AT(1,3)=( YD(1)*ZD(3)-YD(3)*ZD(1))
        AT(1,4)=(-YD(1)*ZD(2)+YD(2)*ZD(1))
        AT(2,1)=(-(XD(2)-XD(1))*(ZD(3)-ZD(1))+(XD(3)-XD(1))*(ZD(2)-ZD(1)))
        AT(2,2)=( XD(2)*ZD(3)-XD(3)*ZD(2))
        AT(2,3)=(-XD(1)*ZD(3)+XD(3)*ZD(1))
        AT(2,4)=( XD(1)*ZD(2)-XD(2)*ZD(1))
        AT(3,1)=((XD(2)-XD(1))*(YD(3)-YD(1))-(XD(3)-XD(1))*(YD(2)-YD(1)))
        AT(3,2)=(-XD(2)*YD(3)+XD(3)*YD(2))
        AT(3,3)=( XD(1)*YD(3)-XD(3)*YD(1))
        AT(3,4)=(-XD(1)*YD(2)+XD(2)*YD(1))
        IPBG=0
        IF (JPRS) 725,735,725
 725    IF ((ITTT-1)*(ITTT-2)) 735,726,735
 726    KAV=NAV
        GO TO (728,728,735),KAV
 728    PD(1)=YD(1)*ZD(2)-YD(2)*ZD(1)
        PD(2)=-XD(1)*ZD(2)+XD(2)*ZD(1)
        PD(3)=XD(1)*YD(2)-XD(2)*YD(1)
        PRCO=PRES/(6.*CFE)
        IF (NAV-2) 729,731,735
 731    DO 737 I=1,3
        II=I-4
        DO 736 J=1,3
        II=II+4
        GO TO (732,733,733),I
 732    P(II)=PRCO*PD(J)/2.
        GO TO 736
 733    P(II)=-PRCO*PD(J)/4.
 736    CONTINUE
 737    CONTINUE
 729    DO 730 I=1,3
        I4=4*I
 730    P(I4)=-PRCO*PD(I)
        IPBG=1
        IPEN=3
 735    IF (ACEL) 738,740,738
 738    CONS=DET*ACEL/24.
        IPBG=1
        IPEN=3
 740    TX=0.
        DO 745 I=1,3
 745    TX=XD(I)*XD(I)+YD(I)*YD(I)+ZD(I)*ZD(I)
        TX=SQRTF(TX)
        TX=1.E-6*TX**3
        IF (DET-TX) 747,747,750
 747    WRITE OUTPUT TAPE 6,1,M,ITTT,DET
      1 FORMAT(22H0THE VOLUME OF ELEMENT,2I4,12HIS TOO SMALL,E12.4,13H DIS
      1REGARDED.)
        GO TO 1000
 750    DO 780 I=1,3
        DO 780 J=I,3
        GO TO (752,756,759),I
 752    GO TO (753,754,755),J
 753    B(1,1)= D21(1)
        B(1,2)= D21(4)
        B(1,3)= D21(6)
        B(2,2)= D21(16)
        B(2,3)= D21(18)
        B(3,3)= D21(21)
        GO TO 739
 754    B(1,1)= D21(4)
        B(1,2)= D21(2)
        B(1,3)= D21(5)
        B(2,1)= D21(16)
        B(2,2)= D21(9)
        B(2,3)= D21(10)
        B(3,1)= D21(18)
        B(3,2)= D21(11)
        B(3,3)= D21(20)
        GO TO 775
 755    B(1,1)= D21(6)
        B(1,2)= D21(5)
        B(1,3)= D21(3)
```

Table VII-33 (contd)

```
      B(2,1)= D21(18)                                                   E2S09114
      B(2,2)= D21(17)                                                   E2S09115
      B(2,3)= D21(13)                                                   E2S09116
      B(3,1)= D21(21)                                                   E2S09117
      B(3,2)= D21(20)                                                   E2S09118
      B(3,3)= D21(15)                                                   E2S09119
      GO TO 775                                                         E2S09120
 756  GO TO (1000,757,758),J                                            E2S09121
 757  B(1,1)= D21(16)                                                   E2S09122
      B(1,2)= D21(9)                                                    E2S09123
      B(1,3)= D21(17)                                                   E2S09124
      B(2,2)= D21(7)                                                    E2S09125
      B(2,3)= D21(10)                                                   E2S09126
      B(3,3)= D21(19)                                                   E2S09127
      GO TO 739                                                         E2S09128
 758  B(1,1)= D21(18)                                                   E2S09129
      B(1,2)= D21(17)                                                   E2S09130
      B(1,3)= D21(13)                                                   E2S09131
      B(2,1)= D21(11)                                                   E2S09132
      B(2,2)= D21(10)                                                   E2S09133
      B(2,3)= D21(8)                                                    E2S09134
      B(3,1)= D21(20)                                                   E2S09135
      B(3,2)= D21(19)                                                   E2S09136
      B(3,3)= D21(14)                                                   E2S09137
      GO TO 775                                                         E2S09138
 759  B(1,1)= D21(21)                                                   E2S09139
      B(1,2)= D21(20)                                                   E2S09140
      B(1,3)= D21(15)                                                   E2S09141
      B(2,2)= D21(19)                                                   E2S09142
      B(2,3)= D21(14)                                                   E2S09143
      B(3,3)= D21(12)                                                   E2S09144
 739  B(2,1)=B(1,2)                                                     E2S09145
      B(3,1)=B(1,3)                                                     E2S09146
      B(3,2)=B(2,3)                                                     E2S09147
 775  CALL TRM (B,AT,O,3,4)                                             E2S09148
      IR=4*I-3                                                          E2S09149
      JC=4*J-3                                                          E2S09150
      CALL ADMIS,IDS,O,4,IR,JC,VOL)                                     E2S09151
 760  CONTINUE                                                          E2S09152
1000  RETURN                                                            E2S09153
1010  IERR=1                                                            E2S09154
      GO TO 1000                                                        E2S09155
      END                                                               E2S09156
```

Table VII-34. Source program listing of subroutine S11 (Link 2)

```
*     LABEL
CE2S11                                                                  E2S11000
      SUBROUTINE  S11                                                   E2S11001
C     GENERATES FOR ELEMENT TYPE 11 STIFFNESS AND LOAD MATRICES         E2S11002
      DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)         E2S11003
     1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)              E2S11004
      COMMON IA,AA                                                      E2S11005
      EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),E),(D21(20),G)E2S11006
      EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),II),(IA(4),IP),(IA(5),  E2S11007
     1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),E2S11008
     2IH),(IA(11),IB),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),E2S11009
     3IMF1),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),E2S11010
     4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),    E2S11011
     5(IA(32),ISUM),(IA(33),INO),(IA(34),IMS),(IA(36),IDS),(IA(37),     E2S11012
     6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),      E2S11013
     7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57E2S11014
     8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBO),(IA(61),IID),(IA(62),E2S11015
     9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITE),(IA(41),ITAP)         E2S11016
      EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),    E2S11017
     1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),       E2S11018
     2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)              E2S11019
     3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG), E2S11020
     4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),  E2S11021
     5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),    E2S11022
     6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)               E2S11023
     7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IUE2S11024
     8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                             E2S11025
      EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346) E2S11026
     1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)   E2S11027
     2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)      E2S11028
     3,(IA(337),JMMZ),(IA(336),JMF1),(IA(335),ITAS),(IA(334),IDZ)       E2S11029
     4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)         E2S11030
     5,(IA(329),IPIR)                                                   E2S11031
      DIMENSION EM(4,4),EN(4,4),O(4,4),DIR(3,3),DUM(18)                 E2S11032
      EQUIVALENCE (AA(200),EM),(AA(216),EN),(AA(232),EQ),(AA(248),O),   E2S11033
     1(AA(264),DIR),(AA(279),DUM),(AA(297),A2)                          E2S11034
C     TRIANGULAR SHELL ELEMENT                                          E2S11035
      CALL CORT                                                         E2S11036
      CALL SO7                                                          E2S11037
      ISHF=6*(IDS+1)                                                    E2S11038
      IESS=9*IDS                                                        E2S11039
      DO 1 I=1,9                                                        E2S11040
      IESS=IESS-IDS                                                     E2S11041
      IES=IESS                                                          E2S11042
      DO 2 J=1,9                                                        E2S11043
      IES=IES+1                                                         E2S11044
      IYE=IES+ISHF                                                      E2S11045
      S(IYE)=S(IES)                                                     E2S11046
 2    S(IES)=0.                                                         E2S11047
 1    CONTINUE                                                          E2S11048
      DO 3 I=4,9                                                        E2S11049
 3    UV(I+6)=UV(I)                                                     E2S11050
      DO 4 I=1,IMS                                                      E2S11051
      I1=IMS+I                                                          E2S11052
      I2=IMS+I1                                                         E2S11053
      UV(I)=X(I)*DT*AL1                                                 E2S11054
      UV(I1)=Y(I)*DT*AL2                                                E2S11055
 4    UV(I2)=0.                                                         E2S11056
      CALL SO5                                                          E2S11057
      IPEN=3                                                            E2S11058
      DO 11 I=1,3                                                       E2S11059
      P(I+6)=P(I)                                                       E2S11060
 11   P(I)=0.                                                           E2S11061
C     TRANSFORM  S,P,UV INTO OVERALL SYSTEM                             E2S11062
      CALL  TRAN (P,0)                                                  E2S11063
      CALL  TRAN (UV,0)                                                 E2S11064
      CALL STRA                                                         E2S11065
      RETURN                                                            E2S11066
      END                                                               E2S11067
```

Table VII-35. Source program listing of subroutine S13 (Link 2)

```
*     LABEL
CE2S13                                                                  E2S13000
      SUBROUTINE S13                                                    E2S13001
C     GENERATES FOR ELEMENT TYPE 13 STIFFNESS AND LOAD MATRICES         E2S13002
      DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)         E2S13003
     1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)              E2S13004
      COMMON IA,AA                                                      E2S13005
      EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),E),(D21(20),G)E2S13006
      EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),II),(IA(4),IP),(IA(5),  E2S13007
     1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),E2S13008
     2IH),(IA(11),IB),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),E2S13009
     3IMF1),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),E2S13010
     4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),    E2S13011
     5(IA(32),ISUM),(IA(33),INO),(IA(34),IMS),(IA(36),IDS),(IA(37),     E2S13012
     6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),      E2S13013
     7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57E2S13014
     8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBO),(IA(61),IID),(IA(62),E2S13015
     9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITE),(IA(41),ITAP)         E2S13016
      EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),    E2S13017
     1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),       E2S13018
     2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)              E2S13019
     3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG), E2S13020
     4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),  E2S13021
     5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),    E2S13022
     6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)               E2S13023
     7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IUE2S13024
     8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                             E2S13025
      EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346) E2S13026
     1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)   E2S13027
     2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)      E2S13028
     3,(IA(337),JMMZ),(IA(336),JMF1),(IA(335),ITAS),(IA(334),IDZ)       E2S13029
     4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)         E2S13030
     5,(IA(329),IPIR)                                                   E2S13031
      EQUIVALENCE (AA(291),A2),(AA(324),PRCO)                           E2S13032
 1    CALL CORT                                                         E2S13033
      CALL SO5                                                          E2S13034
 2    CCNT=PRES*A2/6.                                                   E2S13035
      P(7)=CCNT                                                         E2S13036
      P(8)=CCNT                                                         E2S13037
      P(9)=CCNT                                                         E2S13038
      PRCO=0.                                                           E2S13039
 3    IPEN=3                                                            E2S13040
      IIGE=IGEM                                                         E2S13041
      IGEM=0                                                            E2S13042
      CALL TRAN (P,0)                                                   E2S13043
      CALL STRA                                                         E2S13044
      IGEM=IIGE                                                         E2S13045
      RETURN                                                            E2S13046
      END                                                               E2S13047
```

Table VII-36. Source program listing of subroutine S15 (Link 2)

```
*       LABEL
CE2S15
        SUBROUTINE S15
C       GENERATES FOR ELEMENT TYPE 15 STIFFNESS AND LOAD MATRICES
        DIMENSION IA(1),AA(1),S(1),T(8),D21(21),D33(3,3),E22(3,3)
       1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G(1)
        COMMON IA,AA
        EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),E),(D21(20),G)
        EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),
       1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),
       2IH),(IA(11),IB),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),
       3IMFI),(IA(16),IARE),(IA(17),T(1)),(IA(25),D),(IA(26),ITY),(IA(27),
       4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),
       5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),
       6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),
       7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57
       8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IB0),(IA(61),I10),(IA(62),
       9IA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITF),(IA(41),ITAP)
        EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),
       1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),
       2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)
       3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG),
       4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),
       5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),
       6(AA(186),YD),(AA(193),ZD),(AA(35)),S),(AA(40),ZGEM)
       7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),1U
       8),(AA(47),G1),(AA(48),G2),(AA(49),G3)
        EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346)
       1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)
       2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)
       3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)
       4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)
       5,(IA(329),IPIR),(IA(328),NAV),(IA(327),CFE),(IA(325),ITTT)
        DIMENSION EM(4,4),EN(4,4),Q(4,4),EQ(4,4),CAX(4),Z21(21),V(3)
        EQUIVALENCE (AA(200),EM),(AA(216),EN),(AA(232),EQ),(AA(248),Q)
       1,(AA(291),A2),(AA(292),IAX),(AA(293),CAX),(AA(264),Z21)
        EQUIVALENCE (AA(297),XBAR),(AA(298),YBAR),(CAX,V)
C        SET BOUNDS FOR X SUBI AND X SUBI,I+1
        ER2=0.1
        ER1=1.E-4
        XBAR=(X(1)+X(2)+X(3))/3.
        TER=TE
        TE=XBAR
        DO 91 I=1,21
 91     Z21(I)=D21(I)
        D33(1,1)= Z21(1)
        D33(1,2)= Z21(2)
        D33(1,3)= Z21(4)
        D33(2,2)= Z21(7)
        D33(2,3)= Z21(9)
        D33(3,3)= Z21(16)
        D33(2,1)= D33(1,2)
        D33(3,1)= D33(1,3)
        D33(3,2)= D33(2,3)
        CALL S05
        CALL TRIM
        YBAR=(Y(1)+Y(2)+Y(3))/3.
        YBAB=0.
        E22(1,3)=Z21(3)
        E22(2,3)=Z21(8)
        E22(3,3)=Z21(13)
        DO 1 I=1,3
        E22(I,1)=XBAR*E22(I,3)
 1      E22(I,2)=YBAB*E22(I,3)
        F1=1./(2.*A2)
        EQ(3,1)=X(2)*(Y(3)-YBAR)-X(3)*(Y(2)-YBAR)
        EQ(3,2)=X(3)*(Y(1)-YBAR)-X(1)*(Y(3)-YBAR)
        EQ(3,3)=X(1)*(Y(2)-YBAR)-X(2)*(Y(1)-YBAR)
C       COMPUTE THE INTEGRATION CONSTANT
        DO 15 I=1,3
 15     V(I)=Y(I)-YBAR
        DO 32 I=1,4
        DO 32 J=1,4
 32     Q(I,J)=0.
        LL=0
        NN=0
        DO 17 I=1,3
        IF (X(I)) 120,20,121
  121   IF (X(I)-ER1) 20,20,51
  120   IERR=1
        RETURN
 51     IAX=I
        GO TO 17
 20     NN=NN+1
        LL=I
 17     CONTINUE
        IF (NN-1) 8,8,102
 8      MM=0
        DO 11 L=1,3
        M=L+1
        IF (M-3) 81,81,82
 82     M=1
 81     XXX=X(M)-X(L)
        YYY=V(M)-V(L)
        IF (ABSF(XXX/SQRTF(XXX*XXX+YYY*YYY))-ER2) 21,21,22
 21     Q22=0.
        Q23=0.
        Q33=YYY
        GO TO 50
   22   IF (ABSF(X(M)*X(L))-ER1) 24,24,40
 24     IF (MM) 11,23,11
 23     MM=1
        IF (LL-L) 26,25,26
 26     N=M+1
        IF (N-3) 27,27,28
 28     N=1
 27     GO TO 29
 25     N=M
        M=L
 29     K=N+1
        IF (K-3) 30,30,31
 31     K=1
 30     GG=LOGF(X(K)/X(N))
        YKN=V(K)-V(N)
        Q33=V(M)*GG
        Q23=2.*V(M)**2*GG+YKN*(2.*V(M)+V(N)+V(K))
        Q22=-6.*V(M)**3*GG+YKN*(2.*(V(N)**2+V(N)*V(K)+V(K)**2)
       1  +6.*V(M)**2+3.*V(M)*(V(N)+V(K)))
        GO TO 50
 40     GG=LOGF(X(M)/X(L))
        F=(X(L)*V(M)-X(M)*V(L))/XXX
        Q33=F*GG
        Q23=YYY*(3.*F+(X(L)*V(L)-X(M)*V(M))/XXX)-2.*F**2*GG
        Q22=YYY*(-V(M)**2*(11.*X(L)**2-7.*X(L)*X(M)+2.*X(M)**2)
       1           -V(L)**2*(11.*X(M)**2-7.*X(L)*X(M)+2.*X(L)**2)
       2        -V(L)*V(M)*(5.*X(L)**2+5.*X(M)**2-22.*X(L)*X(M)))/XXX**2
       3           +6.*F**3*GG
 50     Q(2,2)=Q(2,2)+Q22/( 9.*A2)
        Q(2,3)=Q(2,3)+Q23/(2.*A2)
        Q(3,3)=Q(3,3)+Q33/(0.5*A2)
 11     CONTINUE
        Q(1,1)=XBAR
        Q(1,2)=YBAB
        Q(1,3)=1.
        Q(2,1)=Q(1,2)
        Q(3,1)=Q(1,3)
        Q(3,2)=Q(2,3)
        IAX=4
 102    CONTINUE
        DO 2 I=1,3
        DO 2 J=1,3
 2      D33(I,J)=Z21(12)*Q(I,J)
        CALL TRM (D33,EQ,Q,3,3)
        CAX(1)=0.
        CAX(2)=0.
        CAX(3)=0.
        CAX(IAX)=1.
        Q(IAX,IAX)=Z21(12)*XBAR*(CAX(1)*EN(3,1)+CAX(2)*EN(3,2)+CAX(3)*
       1  EN(3,3))**2
        CALL ADM (S,IDS,Q,3,1,1,F1)
        CALL TRM (E22,EQ,EN,3,-3)
        CALL ADM (S,IDS,EN,3,4,1,F1)
        CALL TRM (E22,EQ,EM,3,-3)
        DO 3 I=1,3
        DO 3 J=I,3
 3      EM(I,J)=EM(I,J)+EM(J,I)
        EM(2,1)=EM(1,2)
        EM(3,1)=EM(1,3)
        EM(3,2)=EM(2,3)
        CALL ADM (S,IDS,EM,3,1,1,F1)
        TE=TER
        TER=((X(1)-XBAR)*(Y(2)-YBAR)-(X(2)-XBAR)*(Y(1)-YBAR))/(2.*A2)
        CONS=TE*ACEL*A2/4.
        Q(1,1)=TER*((X(1)-XBAR)**2+(X(1)-XBAR)*(X(2)-XBAR)+(X(2)-XBAR)**2
       1   +XBAR**2
        Q(2,1)=TER*((Y(1)-YBAR)*(2.*(X(1)-XBAR)+(X(2)-XBAR))+(Y(2)-YBAR)*
       1                            ((X(1)-XBAR)+2.*(X(2)-XBAR)))/2.
        Q(3,1)=XBAR
        DO 4 I=1,3
        Q(I,2)=0.
        DO 5 K=1,3
 5      Q(I,2)=Q(I,2)+EQ(I,K)*Q(K,1)
 4      CONTINUE
        DO 6 I=1,3
        P(I)=CONS*G1*Q(I,2)
 6      P(I+3)=CONS*G2*Q(I,2)
        IF (JPRS) 70,85,70
 70     IF (ITTT-1) 71,71,85
 71     KAV=NAV
        GO TO (80,80,85),KAV
 80     CONS=(X(1)/3.+X(2)/6.)*PRES/CFE
        TER=(X(1)/6.+X(2)/3.)*PRES/CFE
        P(1)=P(1)+YD(1)*CONS
        P(2)=P(2)+YD(1)*TER
        P(4)=P(4)-XD(1)*CONS
        P(5)=P(5)-XD(1)*TER
 85     CONS=0.
        IPBG=-1
        DO 92 I=1,21
 92     D21(I)=Z21(I)
        RETURN
        END
```

Table VII-37. Source program listing of subroutine S17 (Link 2)

```
*       LABEL
CE2S17
        SUBROUTINE S17
C       GENERATES FOR ELEMENT TYPE 17 STIFFNESS AND LOAD MATRICES
        DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)
       1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)
        COMMON IA,AA
        EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),E),(D21(20),G)
        EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),
       1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),
       2IH),(IA(11),IB),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),
       3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),
       4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),
       5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),
       6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),
       7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57
       8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBO),(IA(61),IID),(IA(62),
       9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITE),(IA(41),ITAP)
        EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),
       1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),
       2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)
       3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG),
       4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),
       5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),
       6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)
       7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IU
       8),(AA(47),G1),(AA(48),G2),(AA(49),G3)
        EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346)
       1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)
       2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)
       3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)
       4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)
       5,(IA(329),IPIR)
        DIMENSION EM(4,4),EN(4,4),Q(4,4),EQ(4,4)
        EQUIVALENCE (AA(200),EM),(AA(216),EN),(AA(232),EQ),(AA(248),Q),
       1(AA(264),F1),(AA(265),F2),(AA(266),BOY),(AA(267),XAV)
        ERI=1.E-2
        BOY=SQRTF (XD(1)**2+YD(1)**2)
        XAV=(X(1)+X(2))/2.
        IF (BOY) 1,1,41
 41     IF (XAV) 1,1,42
 42     IF (X(1)) 1,43,43
 43     IF (X(2)) 1,44,44
 44     AL=XD(1)/BOY
        BE=YD(1)/BOY
        GA=BOY/XAV
        Q(1,1)=-AL
        Q(1,2)=AL
        Q(1,3)=-BE
        Q(1,4)=BE
        F1=TE/GA
        CALL TRM (D33,Q,EQ,1,4)
        CALL ADM (S,IDS,EQ,4,1,1,F1)
        F1=TE*D33(1,2)
        Q(1,1)=-AL
        Q(2,2)=AL
        Q(1,2)=0.
        Q(2,1)=0.
        CALL ADM (S,IDS,Q,2,1,1,F1)
        Q(1,1)=-BE/2.
        Q(2,1)=Q(1,1)
        Q(1,2)=-Q(1,1)
        Q(2,2)=Q(1,2)
        CALL ADM (S,IDS,Q,2,1,3,F1)
        IF (ABSF(AL)-ERI) 24,24,25
 24     F1=TE*D33(2,2)*GA
        Q(1,1)=0.33333333
        Q(1,2)=Q(1,1)/2.
        Q(2,1)=Q(1,2)
        Q(2,2)=Q(1,1)
        GO TO 30
 25     IF (X(1)*X(2)) 26,23,26
 23     F1=TE*D33(2,2)/(2.*AL)
        IF (X(2)) 271,271,29
 271    F1=-F1
 29     Q(1,1)=1.
        Q(1,2)=-1.
        Q(2,1)=-1.
        Q(2,2)=1.
        GO TO 30
 26     GOL=LOGF(X(2)/X(1))
        A1=BOY*GOL/XD(1)
        B1=(1.-X(1)*GOL/XD(1))*BOY/XD(1)
        C1=(XAV/XD(1)-2.*X(1)/XD(1)+(X(1)/XD(1))**2*GOL)*BOY/XD(1)
        F1=TE*D33(2,2)
        Q(1,1)=A1+C1-2.*B1
        Q(1,2)=B1-C1
        Q(2,1)=Q(1,2)
        Q(2,2)=C1
 30     CALL ADM (S,IDS,Q,2,1,1,F1)
        IPBG=-1
        F1=-PRES*YD(1)+BOY*ACEL*TE*G1
        F2= PRES*XD(1)+BOY*ACEL*TE*G2
        AL=X(1)/3.+X(2)/6.
        BE=X(1)/6.+X(2)/3.
        P(1)=F1*AL
        P(2)=F1*BE
        P(3)=F2*AL
        P(4)=F2*BE
 9      RETURN
 1      IERR=1
        GO TO 9
        END
```

Table VII-38. Source program listing of subroutine S18 (Link 2)

```
*       LABEL
CE2S18
        SUBROUTINE S18
C       GENERATES FOR ELEMENT TYPE 18 STIFFNESS AND LOAD MATRICES
        DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)
       1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)
        COMMON IA,AA
        EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),E),(D21(20),G)
        EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),
       1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),
       2IH),(IA(11),IB),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),
       3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),
       4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),
       5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),
       6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),
       7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57
       8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBO),(IA(61),IID),(IA(62),
       9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITE),(IA(41),ITAP)
        EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),
       1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),
       2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)
       3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG),
       4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),
       5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),
       6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)
       7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IU
       8),(AA(47),G1),(AA(48),G2),(AA(49),G3)
        EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346)
       1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)
       2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)
       3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)
       4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)
       5,(IA(329),IPIR)
        DIMENSION EM(4,4),EN(4,4),Q(4,4),EQ(4,4)
        EQUIVALENCE (AA(200),EM),(AA(216),EN),(AA(232),EQ),(AA(248),Q),
       1(AA(264),F1),(AA(265),F2),(AA(266),BOY),(AA(267),XAV)
 10     CALL S17
        F2=TE**3/12.
        IF (XD(1)) 26,25,26
 26     IF (X(1)*X(2)) 28,27,28
 27     F1=F2*D33(2,2)* XD(1)/(2.*BOY)
        IF (X(2)) 271,271,29
 271    F1=-F1
        GO TO 29
 28     F1=F2*D33(2,2)*(XD(1)/BOY)**2
 29     CALL ADM (S,IDS,Q,2,5,5,F1)
 25     F1=F2*D33(1,1)*XAV/BOY
        Q(1,1)=1.
        Q(1,2)=-1.
        Q(2,1)=-1.
        Q(2,2)=1.
        CALL ADM (S,IDS,Q,2,5,5,F1)
 30     Q(1,1)=-1.
        Q(1,2)=0.
        Q(2,1)=0.
        F1=F2*D33(1,2)*XD(1)/BOY
        CALL ADM (S,IDS,Q,2,5,5,F1)
 35     F1=TE*XAV/BOY**3
        EM(1,1)=YD(1)
        EM(1,2)=-YD(1)
        EM(1,3)=-XD(1)
        EM(1,4)= XD(1)
        CALL TRM (E22,EM,Q,1,4)
        CALL ADM (S,IDS,Q,4,1,1,F1)
 40     Q(1,1)=BOY**4/4.
        Q(1,2)=Q(1,1)
        Q(2,1)=Q(1,1)
        Q(2,2)=Q(1,1)
        F1=F1*E22(1,1)
        CALL ADM(S,IDS,Q,2,5,5,F1)
 45     Q(1,1)=-(BOY**2)*YD(1)/2.
        Q(1,2)= Q(1,1)
        Q(2,1)=-Q(1,1)
        Q(2,2)=-Q(1,1)
        CALL ADM (S,IDS,Q,2,1,5,F1)
 50     Q(1,1)=(BOY**2)*XD(1)/2.
        Q(1,2)=Q(1,1)
        Q(2,1)=-Q(1,1)
        Q(2,2)=-Q(1,1)
        CALL ADM (S,IDS,Q,2,3,5,F1)
 55     UV(5)=0.
        UV(6)=DG*BOY*AL1
 60     RETURN
        END
```

Table VII-39. Source program listing of subroutine STFS (Link 2)

```
*      LABEL
CE2STF                                                                   E2STF000
       SUBROUTINE STFS (IELT)                                            E2STF001
C      SELECTS PROPER SUBROUTINE FOR GENERATION OF ELEMENT MATRICES      E2STF002
       IELT=IELT                                                         E2STF003
       GO TO (1,2,3,4,5,5,7,7,8,8,9,9,10,10,11,11,12,13),IELT            E2STF004
 1     CALL S01                                                          E2STF005
       GO TO 100                                                         E2STF006
 2     CALL S02                                                          E2STF007
       GO TO 100                                                         E2STF008
 3     CALL S03                                                          E2STF009
       GO TO 100                                                         E2STF010
 4     CALL S04                                                          E2STF011
       GO TO 100                                                         E2STF012
 5     CALL S05                                                          E2STF013
       GO TO 100                                                         E2STF014
 7     CALL S07                                                          E2STF015
       GO TO 100                                                         E2STF016
     8 CALL S09                                                          E2STF017
       GO TO 100                                                         E2STF018
     9 CALL S11                                                          E2STF019
       GO TO 100                                                         E2STF020
    10 CALL S13                                                          E2STF021
       GO TO 100                                                         E2STF022
    11 CALL S15                                                          E2STF023
       GO TO 100                                                         E2STF024
    12 CALL S17                                                          E2STF025
       GO TO 100                                                         E2STF026
    13 CALL S18                                                          E2STF027
 100   RETURN                                                            E2STF028
       END                                                               E2STF029
```

Table VII-40. Source program listing of subroutine STRA (Link 2)

```
*      LABEL
CE2STR                                                                   E2STR000
       SUBROUTINE STRA                                                   E2STR001
C      TRANSFORMS DESCRIPTION OF ELEMENT MATRICES FROM LOCAL TO OVERALL  E2STR002
       DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)         E2STR003
      1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)              E2STR004
       COMMON IA,AA                                                      E2STR005
       EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),E),(D21(20),G)E2STR006
       EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),  E2STR007
      1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),E2STR008
      2IH),(IA(11),IR),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),E2STR009
      3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),E2STR010
      4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),    E2STR011
      5(IA(32),ISUM),(IA(33),INO),(IA(34),IMS),(IA(36),IDS),(IA(37),     E2STR012
      6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),      E2STR013
      7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57E2STR014
      8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBD),(IA(61),IID),(IA(62),E2STR015
      9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITF),(IA(41),ITAP)         E2STR016
       EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),    E2STR017
      1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),       E2STR018
      2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)              E2STR019
      3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG), E2STR020
      4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),  E2STR021
      5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),    E2STR022
      6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)               E2STR023
      7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IUE2STR024
      8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                             E2STR025
       EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346) E2STR026
      1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)   E2STR027
      2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)      E2STR028
      3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),ID7)       E2STR029
      4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)         E2STR030
      5,(IA(329),IPIR)                                                   E2STR031
       J=-IDS                                                            E2STR032
       DO 5 I=1,IDS                                                      E2STR033
       J=J+IDS                                                           E2STR034
       CALL TRAN (S,J)                                                   E2STR035
 5     CONTINUE                                                          E2STR036
       IABB=-IDS                                                         E2STR037
       IEBB=-IDS                                                         E2STR038
       DO 6 I=1,IDS                                                      E2STR039
       IABB=IABB+1                                                       E2STR040
       IAB=IABB                                                          E2STR041
       IEBB=IEBB+IDS                                                     E2STR042
       IBE=IEBB                                                          E2STR043
       DO 7 J=1,IDS                                                      E2STR044
       IAB=IAB+IDS                                                       E2STR045
       IBE=IBE+1                                                         E2STR046
       IF (IAB-IBE) 7,7,13                                               E2STR047
 13    TEMP=S(IBE)                                                       E2STR048
       S(IBE)=S(IAB)                                                     E2STR049
       S(IAB)=TEMP                                                       E2STR050
 7     CONTINUE                                                          E2STR051
 6     CONTINUE                                                          E2STR052
       J=-IDS                                                            E2STR053
       DO 8 I=1,IDS                                                      E2STR054
       J=J+IDS                                                           E2STR055
       CALL TRAN (S,J)                                                   E2STR056
 8     CONTINUE                                                          E2STR057
       RETURN                                                            E2STR058
       END                                                               E2STR059
```

Table VII-41. Source program listing of subroutine TICK (Link 2)

```
*       FAP                                                              TICK000
        COUNT   25                                                       TICK001
        LBL     TICK                                                     TICK002
        ENTRY   TICK                                                     TICK003
TICK    NZT     ONCE                                                     TICK004
        TRA     FIRST                                                    TICK005
        CAL     5                                                        TICK006
        SUB     INITL                                                    TICK007
        ALS     18                                                       TICK008
        SLW*    1,4                                                      TICK009
        TRA     2,4                                                      TICK010
FIRST   STL     ONCE                                                     TICK011
        CAL     5                                                        TICK012
        SLW     INITL                                                    TICK013
        STZ*    1,4                                                      TICK014
        TRA     2,4                                                      TICK015
ONCE    PZE                                                              TICK016
INITL   PZE                                                              TICK017
        END                                                              TICK018
```

Table VII-42. Source program listing of subroutine TOPO (Link 2)

```
*      LABEL
CE2TOP
       SUBROUTINE TOPO
C      PREPARES ELEMENT PROPERTIES
       DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)
      1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)
       COMMON IA,AA
       EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),E),(D21(20),G)
       EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),
      1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),
      2IH),(IA(11),I8),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),
      3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),
      4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),
      5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),
      6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),
      7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57
      8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBO),(IA(61),IID),(IA(62),
      9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITE),(IA(41),ITAP)
       EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),
      1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),
      2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)
      3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG),
      4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),
      5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),
      6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)
      7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IU
      8),(AA(47),G1),(AA(48),G2),(AA(49),G3)
       EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346)
      1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)
      2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)
      3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)
      4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)
      5,(IA(329),IPIR)
       IELT=0
       ITEM=0
       ITIC=0
       IMET=0
       DO 10 I=1,8
       N(I)=0
       K=I+335
10     IA(K)=0
       JM=J1+M
       IELT=IA(JM)/100
       IMET=IA(JM)-100*IELT
       JM=J2+M
       IF (IELT-4) 100,100,450
100    IF (IELT-3) 200,300,200
200    JARE=IA(JM)/100
       ITEM=IA(JM)-100*JARE
       GO TO 400
 300   JPRS=IA(JM)/100
       JSDZ=IA(JM)-100*JPRS
 400   IF (IELT-3) 600,800,800
 450   IF (IELT-10) 470,470,500
 470   IF (IELT-8) 500,500,480
 480   JPRS=IA(JM)/100
       ITEM=IA(JM)-100*JPRS
       L=1
       GO TO 1000
500    ITIC=IA(JM)/100
       ITEM=IA(JM)-100*ITIC
       JM=J3+M
       JSDZ=IA(JM)/100
       JPRS=IA(JM)-100*JSDZ
       L=2
       GO TO 1000
600    JM=J3+M
       JPRS=IA(JM)
       L=2
       IF (IELT-2) 1000,700,700
700    JM=J4+M
       JMMZ=IA(JM)/100
       JSDY=IA(JM)-100*JMMZ
       L=3
       IF (IELT-4) 1000,900,1000
800    JM=J3+M
       JMMX=IA(JM)/100
       JMMY=IA(JM)-100*JMMX
       L=2
       IF (IELT-4) 1000,700,1000
900    JM=J5+M
       JSDZ=IA(JM)/100
       JMFI=IA(JM)-100*JSDZ
       JM=J6+M
       JPRS=IA(JM)
       L=4
1000   I=1
       GO TO (1100,1200,1300,1400),L
1100   JM=J3+M
       N(I)=IA(JM)
       I=I+1
1200   JM=J4+M
       N(I)=IA(JM)
       I=I+1
1300   JM=J5+M
       N(I)=IA(JM)
       I=I+1
       JM=J6+M
       N(I)=IA(JM)
       I=I+1
1400   JM=J7+M
       N(I)=IA(JM)
       I=I+1
       JM=J8+M
       N(I)=IA(JM)
       I=I+1
       JM=J9+M
       N(I)=IA(JM)
       I=I+1
       JM=J10+M
       N(I)=IA(JM)
       IF (I-IH) 1600,1600,1450
1450   IHP=IH+1
       DO 1500 I=IHP,8
1500   N(I)=0.
1600   RETURN
       END
```

Table VII-43. Source program listing of subroutine TRAN (Link 2)

```
*      LABEL
CE2TRN
       SUBROUTINE TRAN (A,IFS)
C      TRANSFORMS THE DESCRIPTION OF A VECTOR FROM LOCAL TO OVERALL
       DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)
      1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)
       COMMON IA,AA
       EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),E),(D21(20),G)
       EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),
      1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),
      2IH),(IA(11),I8),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),
      3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),
      4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),
      5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),
      6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),
      7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57
      8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBO),(IA(61),IID),(IA(62),
      9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITE),(IA(41),ITAP)
       EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),
      1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),
      2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)
      3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG),
      4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),
      5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),
      6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)
      7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IU
      8),(AA(47),G1),(AA(48),G2),(AA(49),G3)
       EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346)
      1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)
      2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)
      3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)
      4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)
      5,(IA(329),IPIR)
       DIMENSION EM(4,4),EN(4,4),Q(4,4),DIR(3,3),DUM(18)
       EQUIVALENCE (AA(200),EM),(AA(216),EN),(AA(232),EQ),(AA(248),Q),
      1(AA(264),DIR),(AA(273),DUM)
       DIMENSION A(1)
10     IGEMP=IGEM+1
       LJI=0
       LK=IFS-4*IMS
20     DO 300 L=1,IGEMP
       LK=LK+3*IMS
30     DO 200 J=1,3
       DO 200 I=1,IMS
       LJI=LJI+1
       DUM(LJI)=0.
       LKI=LK+I
40     DO 100 K=1,3
       LKI=LKI+IMS
 100   DUM(LJI)=DUM(LJI)+DIR(K,J)*A(LKI)
 200   CONTINUE
 300   CONTINUE
       INI=3*IGEMP*IMS
       DO 400 I=1,INI
       II=IFS+I
 400   A(II)=DUM(I)
       RETURN
       END
```

Table VII-44. Source program listing of subroutine TRIM (Link 2)

```
*     LABEL
CE2TRI                                                                  E2TRI000
      SUBROUTINE TRIM                                                   E2TRI001
C     GENERATES M , N AND L MATRICES OF THIN TRIANGULAR ELEMENT         E2TRI002
      DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)         E2TRI003
     1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)              E2TRI004
      COMMON IA,AA                                                      E2TRI005
      EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),E),(D21(20),GIE2TRI006
      EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),  E2TRI007
     1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),E2TRI008
     2IH),(IA(11),I8),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),E2TRI009
     3IMFI),(IA(16),IARE),(IA(17),NI1)),(IA(25),M),(IA(26),ITY),(IA(27),E2TRI010
     4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),    E2TRI011
     5(IA(32),ISUM),(IA(33),INO),(IA(34),IMS),(IA(36),IDS),(IA(37),     E2TRI012
     6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),      E2TRI013
     7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57E2TRI014
     8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBD),(IA(61),IIO),(IA(62),E2TRI015
     9IIA),(IA(63),IOT),(IA(64),IDY),(IA(65),ITE),(IA(41),ITAP)         E2TRI016
      EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),    E2TRI017
     1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),       E2TRI018
     2(IA(74),IIC),(IA(75),IOEF),(IA(76),IST),(IA(77),IIS)              E2TRI019
     3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DGI, E2TRI020
     4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),  E2TRI021
     5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),    E2TRI022
     6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)               E2TRI023
     7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IUE2TRI024
     8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                             E2TRI025
      DIMENSION EM(4,4),EN(4,4),O(4,4),EQ(4,4)                          E2TRI026
      EQUIVALENCE (AA(200),EM),(AA(216),EN),(AA(232),EQ),(AA(248),O)    E2TRI027
      EM(1,2)=YD(2)                                                     E2TRI028
      EM(1,3)=-YD(1)                                                    E2TRI029
      EM(1,1)=YD(1)-YD(2)                                               E2TRI030
      EM(2,1)=0.                                                        E2TRI031
      EM(2,2)=0.                                                        E2TRI032
      EM(2,3)=0.                                                        E2TRI033
      EM(3,1)=XD(2)-XD(1)                                               E2TRI034
      EM(3,2)=-XD(2)                                                    E2TRI035
      EM(3,3)=XD(1)                                                     E2TRI036
      DO 42 J=1,3                                                       E2TRI037
      EN(1,J)=EM(2,J)                                                   E2TRI038
      EN(2,J)=EM(3,J)                                                   E2TRI039
      EN(3,J)=EM(1,J)                                                   E2TRI040
42    CONTINUE                                                          E2TRI041
      DO 430 J=1,3                                                      E2TRI042
      EQ(1,J)=EM(1,J)                                                   E2TRI043
430   EQ(2,J)=EM(3,J)                                                   E2TRI044
      RETURN                                                            E2TRI045
      END                                                               E2TRI046
```

Table VII-45. Source program listing of subroutine TRM (Link 2)

```
*     LABEL
CE2TRM                                                                  E2TRM000
      SUBROUTINE TRM (A,B,C,M,N1)                                       E2TRM001
      N=N1                                                              E2TRM002
      DIMENSION A(3,3),B(4,4),C(4,4),D(4,4)                             E2TRM003
      IF (N) 2,1,1                                                      E2TRM004
2     N=-N                                                              E2TRM005
      GO TO 8                                                           E2TRM006
1     DO 3 I=1,M                                                        E2TRM007
      DO 3 J=1,N                                                        E2TRM008
3     C(I,J)=B(I,J)                                                     E2TRM009
8     DO 4 I=1,N                                                        E2TRM010
      DO 4 J=1,M                                                        E2TRM011
      D(I,J)=0.                                                         E2TRM012
      DO 5 K=1,M                                                        E2TRM013
5     D(I,J)=D(I,J)+C(K,I)*A(K,J)                                       E2TRM014
4     CONTINUE                                                          E2TRM015
      DO 6 I=1,N                                                        E2TRM016
      DO 6 J=1,N                                                        E2TRM017
      C(I,J)=0.                                                         E2TRM018
      DO 7 K=1,M                                                        E2TRM019
7     C(I,J)=C(I,J)+D(I,K)*B(K,J)                                       E2TRM020
6     CONTINUE                                                          E2TRM021
      RETURN                                                            E2TRM022
      END                                                               E2TRM023
```

Table VII-46. Source program listing of main program of Link 3 (deflection link)

```
*       CHAIN (3,2)
*       LABEL
CELAS3                                                                  ELAS3000
C       MAIN PROGRAM FOR DEFLECTION LINK                                ELAS3001
C       OBTAINS THE DEFLECTION COMPONENTS IN OVERALL COORDINATES        ELAS3002
        DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)       ELAS3003
       1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7)                  ELAS3004
        COMMON IA,AA                                                    ELAS3005
        EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),E1),(D21(20),GIELAS3006
        EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),  ELAS3007
       1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),ELAS3008
       2IH),(IA(11),T8),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),ELAS3009
       3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),ELAS3010
       4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),    ELAS3011
       5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),    ELAS3012
       6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),     ELAS3013
       7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57ELAS3014
       8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBD),(IA(61),IID),(IA(62),ELAS3015
       9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITE),(IA(41),ITAP)         ELAS3016
        EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),    ELAS3017
       1ICIZ),(IA(70),ICF1),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),      ELAS3018
       2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)             ELAS3019
       3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TF),(AA(81),OT),(AA(82),DG), ELAS3020
       4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),  ELAS3021
       5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),    ELAS3022
       6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)              ELAS3023
       7,(AA(42),INP),(AA(43),IPRG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IUELAS3024
       8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                             ELAS3025
        EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346) ELAS3026
       1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)  ELAS3027
       2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)     ELAS3028
       3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)      ELAS3029
       4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRFS)        ELAS3030
       5,(IA(329),IPIR)                                                  ELAS3031
        DIMENSION BB(999,6)                                              ELAS3032
        EQUIVALENCE (AA( 9000),BB)                                       ELAS3033
C       SOLVE THE EQUILIBRIUM EQUATIONS FOR UNKNOWN DEFLECTIONS          ELAS3034
 10     CALL TICK (ITIM)                                                 ELAS3035
        CALL VELAS(ISUM,IERR,IST,IDEF)                                   ELAS3036
 20     CALL TICK(ITIM)                                                  ELAS3037
        TINV=ITIM                                                        ELAS3038
        TINV=TINV/60.                                                    ELAS3039
        IF (IERR) 302,234,302                                            ELAS3040
 234    IF (INP-1) 2341,2341,2342                                        ELAS3041
 2342   IDEF1=IDEF+1                                                     ELAS3042
        IEND=IDEF+ISUM                                                   ELAS3043
        WRITE OUTPUT TAPE 6,2343,(I,AA(I),I=IDEF1,IEND)                  ELAS3044
 2343   FORMAT (1H1,34HREDUCED DEFLECTION VECTOR FOLLOWS.///(5(I6,E14.5,  ELAS3045
       14X)))                                                            ELAS3046
C       COMPLETE THE DEFLECTION VECTOR AND PRINT.                        ELAS3047
 2341   DO 202 M=1,IN                                                    ELAS3048
        DO 202 K=1,6                                                     ELAS3049
 202    BB(M,K)=0.                                                       ELAS3050
        JJ=-IDEG                                                         ELAS3051
        DO 2031M=1,IN                                                    ELAS3052
        JJ=JJ+IDEG                                                       ELAS3053
        DO 203 K=1,IDEG                                                  ELAS3054
        J=JJ+K                                                           ELAS3055
        ISTJ=IST+J                                                       ELAS3056
        IBDJ=IBD+J                                                       ELAS3057
        L=IA(IBDJ)                                                       ELAS3058
        IICJ=IIC+J                                                       ELAS3059
        IF (L) 204,205,206                                               ELAS3060
 204    IF (L+1) 2042,2041,206                                           ELAS3061
 2042   L=-(L+10000)                                                     ELAS3062
        IBBJ=IBB+J                                                       ELAS3063
        I=IA(IBBJ)                                                       ELAS3064
        IDEFI=IDEF-I                                                     ELAS3065
        BB(M,K)=AA(IDEFI)                                                ELAS3066
        L1=(L-1)/IDEG+1                                                  ELAS3067
        L2=L-(L1-1)*IDEG                                                 ELAS3068
        BB(L1,L2)=BB(L1,L2)+AA(IICJ)*BB(M,K)                             ELAS3069
        GO TO 203                                                        ELAS3070
 2041   IBBJ=IBB+J                                                       ELAS3071
        I=IA(IBBJ)                                                       ELAS3072
        IDEFI=IDEF+I                                                     ELAS3073
        BB(M,K)=AA(IDEFI)                                                ELAS3074
        GO TO 203                                                        ELAS3075
 205    BB(M,K)=AA(IICJ)+BB(M,K)                                         ELAS3076
        GO TO 203                                                        ELAS3077
 206    IF (L-10000) 2061,205,205                                        ELAS3078
 2061   LL=IBD+L                                                         ELAS3079
        LL=IA(LL)                                                        ELAS3080
        IDEFL=IDEF+LL                                                    ELAS3081
        BB(M,K)=AA(IDEFL)*AA(IICJ)                                       ELAS3082
 203    CONTINUE                                                         ELAS3083
 2031   CONTINUE                                                         ELAS3084
        JJ=-IDEG                                                         ELAS3085
        DO 2011M=1,IN                                                    ELAS3086
        JJ=JJ+IDEG                                                       ELAS3087
        DO 201 K=1,IDEG                                                  ELAS3088
        IDEFI=IDEF+JJ+K                                                  ELAS3089
 201    AA(IDEFI)=BB(M,K)                                                ELAS3090
 2011   CONTINUE                                                         ELAS3091
C       REARRANGE DEFLECTIONS ACCORDING' TO TYPE                         ELAS3092
C       ASSUME NORMAL CASE                                               ELAS3093
        IELT=1                                                           ELAS3094
C       CHECK THE SPECIAL CASES                                          ELAS3095
        IF (IDEG-3)  450,449,450                                         ELAS3096
 449    IF (IGEM)    450,448,450                                         ELAS3097
 448    IF (IH-2)    450,447,443                                         ELAS3098
C       DISTINGUISH GRIDWORK CASE                                        ELAS3099
 447    IF (IMMY) 443,442,443                                            ELAS3100
C       PLATE AND/OR GRIDWORK CASE                                       ELAS3101
 443    IELT=2                                                           ELAS3102
        GO TO 441                                                        ELAS3103
C       SHELL OF REVOLUTION OR PLANAR FRAME CASE                         ELAS3104
 442    IELT=3                                                           ELAS3105
 441    DO 40 M=1,IN                                                     ELAS3106
        GO TO (40,42,43),IELT                                            ELAS3107
 42     X(1)=BB(M,1)                                                     ELAS3108
        X(2)=BB(M,2)                                                     ELAS3109
        X(3)=BB(M,3)                                                     ELAS3110
        BB(M,1)=0.                                                       ELAS3111
        BB(M,2)=0.                                                       ELAS3112
        BB(M,3)=X(1)                                                     ELAS3113
        BB(M,4)=X(2)                                                     ELAS3114
        BB(M,5)=X(3)                                                     ELAS3115
        GO TO 40                                                         ELAS3116
 43     X(1)=BB(M,3)                                                     ELAS3117
        BB(M,3)=0.                                                       ELAS3118
        BB(M,6)=X(1)                                                     ELAS3119
 40     CONTINUE                                                         ELAS3120
C       PUNCH OUT RESULTS IF NECESSARY                                   ELAS3121
 450    CALL PUNC                                                        ELAS3122
        WRITE OUTPUT TAPE 6,1111,(M,(BB(M,K),K=1,6),M=1,IN)              ELAS3123
 1111   FORMAT (1H1,39X,17HNODAL DEFLECTIONS//5H NODE,5X,13HDISP. ALONG X,ELAS3124
       15X,13HDISP. ALONG Y,5X,13HDISP. ALONG Z,5X,13HROTA. ABOUT X,     ELAS3125
       25X,13HROTA. ABOUT Y,5X,13HROTA. ABOUT Z//(I5,6E18.7))            ELAS3126
        IF (INP) 310,310,320                                             ELAS3127
 320    IF (ITAS) 305,305,315                                            ELAS3128
 315    CALL RESI                                                        ELAS3129
        IF(ITAS) 305,305,306                                             ELAS3130
 306    CALL RESW                                                        ELAS3131
        IF (INX-3) 345,345,355                                           ELAS3132
 305    WRITE OUTPUT TAPE 6,3051                                         ELAS3133
 3051   FORMAT (54H NO SCRATCH TAPE IS GIVEN OR ERROR IN THE SCRATCH TAPE)ELAS3134
        GO TO 345                                                        ELAS3135
 310    IF (INX-3) 345,345,340                                           ELAS3136
 340    IF (ITAS) 345,345,350                                            ELAS3137
 350    CALL RESI                                                        ELAS3138
        IF (ITAS) 345,345,355                                            ELAS3139
 355    CALL ELST                                                        ELAS3140
 345    CALL TICK (ITIM)                                                 ELAS3141
        C3T=ITIM                                                         ELAS3142
        C3T=C3T/60.                                                      ELAS3143
        WRITE OUTPUT TAPE 6,5555,C3T,TINV                                ELAS3144
 5555   FORMAT (21H DEFLECTION LINK TOOK,F7.2,2X,8HSECONDS.,75X,F7.2)    ELAS3145
        IF (INX-3) 3421,3421,342                                         ELAS3146
 3421   CALL CHAIN (1,ITAP)                                              ELAS3147
 342    CALL CHAIN (4,ITAP)                                              ELAS3148
 302    WRITE OUTPUT TAPE 6,3021,IERR                                    ELAS3149
 3021   FORMAT (42H STIFFNESS MATRIX IS NOT POSITIVE DEFINITE,I5)        ELAS3150
        GO TO 3421                                                       ELAS3151
        END                                                              ELAS3152
```

Table VII-47. Source program listing of subroutine ELST (Link 3)

```
*       LABEL
CE3ELT                                                                  F3ELT000
        SUBROUTINE ELST                                                 E3ELT001
C       WRITES ON TAPE ITAS ELEMENT SET INFORMATION                     E3ELT002
        DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)       E3ELT003
       1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7)                  E3ELT004
        COMMON IA,AA                                                    E3ELT005
        EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),F),(D21(20),G)F3ELT006
        EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5), E3ELT007
       1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),F3ELT008
       2IH),(IA(11),IB),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),E3ELT009
       3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),F3ELT010
       4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),   E3ELT011
       5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),    E3ELT012
       6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),     E3ELT013
       7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57E3ELT014
       8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBD),(IA(61),IID),(IA(62),E3ELT015
       9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITE),(IA(41),ITAP)        E3ELT016
        EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),    E3ELT017
       1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),      E3ELT018
       2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)             F3ELT019
       3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG), E3ELT020
       4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),  E3ELT021
       5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),    E3ELT022
       6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)              F3ELT023
       7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IUE3ELT024
       8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                            E3ELT025
        EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346) E3ELT026
       1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)  E3ELT027
       2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)     E3ELT028
       3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)      E3ELT029
       4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)        F3ELT030
       5,(IA(329),IPIR)                                                  F3ELT031
        DIMENSION IMNT(24)                                              E3ELT032
        EQUIVALENCE (UV,IMNT),(IA(200),IONE)                            E3ELT033
        ISN=IST+IND                                                     E3ELT034
        IELM=13                                                         F3ELT035
        IELN=IELM-1                                                     E3ELT036
        ISN1=ISN+1                                                      E3ELT037
        ISNN=ISN+IN*IELM                                                F3ELT038
        INCT=0                                                          F3ELT039
        IONE=0                                                          E3ELT040
        DO 8 I=ISN1,ISNN                                                F3ELT041
 8      IA(I)=0                                                         F3ELT042
        DO 1 I=1,IT                                                     E3ELT043
        J1I=J1+I                                                        E3ELT044
        IELT=IA(J1I)/100                                                F3ELT045
        GO TO (9,9,9,9,2,3,2,3,4,5,2,3,2,3,2,3,14,14),IELT              E3ELT046
 9      IONE=IONE+1                                                     F3ELT047
        GO TO 1                                                         E3ELT048
 2      KJ=4                                                            E3ELT049
        KN=3                                                            E3ELT050
        GO TO 6                                                         E3ELT051
 3      KJ=4                                                            E3ELT052
        KN=4                                                            E3ELT053
        GO TO 6                                                         E3ELT054
 4      KJ=3                                                            E3ELT055
        KN=4                                                            F3ELT056
        GO TO 6                                                         E3ELT057
 5      KJ=3                                                            E3ELT058
        KN=8                                                            E3ELT059
        GO TO 6                                                         F3ELT060
 14     KJ=4                                                            E3ELT061
        KN=2                                                            E3ELT062
 6      KK=J1+I+(KJ-2)*IT                                               E3ELT063
        DO 7 J=1,KN                                                     F3ELT064
        KK=KK+IT                                                        E3ELT065
        NN=IA(KK)                                                       F3ELT066
        ISNI=ISN+(NN-1)*IELM+1                                          E3ELT067
        IE=IA(ISNI)+1                                                   F3ELT068
        IF (IE-IELN)  12,11,11                                          E3ELT069
 11     WRITE OUTPUT TAPE 6,13,IELN,NN                                  F3ELT070
 13     FORMAT (10H MORE THAN,I4,2X,31HNON-ONE-DIMENSNL ELMNTS AT NODE,I5)F3ELT071
        INCT=1                                                          E3ELT072
        GO TO 7                                                         F3ELT073
 12     ISNN=ISNI+IE                                                    F3ELT074
        IA(ISNI)=IE                                                     E3ELT075
        IA(ISNN)=I                                                      E3ELT076
 7      CONTINUE                                                        F3ELT077
 1      CONTINUE                                                        F3ELT078
        IF (INCT) 19,20,19                                              F3ELT079
 19     ITAS=0                                                          E3ELT080
        WRITE OUTPUT TAPE 6,191                                         F3ELT081
 191    FORMAT(53H NODAL STRESS COMPUTATION IS DELETED DUE TO PRECEDING) F3ELT082
        GO TO 100                                                       F3ELT083
 20     DO 21 I=1,IN                                                    F3ELT084
        ISNI=ISN+(I-1)*IELM+1                                           F3ELT085
        IE=IA(ISNI)                                                     F3ELT086
        IF(IE) 23,23,24                                                 F3ELT087
 24     DO 22 J=1,IE                                                    F3ELT088
        ISNN=ISNI+J                                                     F3ELT089
 22     IMNT(J)=IA(ISNN)                                                F3ELT090
        WRITE TAPE ITAS,I,IE,(IMNT(J),J=1,IE)                           F3ELT091
        GO TO 21                                                        E3ELT092
 23     WRITE TAPE ITAS,I,IE,IE                                         E3ELT093
 21     CONTINUE                                                        F3ELT094
        DO 25 I=1,IN                                                    E3ELT095
 25     BACKSPACE ITAS                                                  F3ELT096
 100    RETURN                                                          F3ELT097
        END                                                             F3ELT098
```

Table VII-48. Source program listing of subroutine PUNC (Link 3)

```
*       LABEL
CE3PUNC                                                                 F3PUNC00
        SUBROUTINE PUNC                                                 F3PUNC01
C       DUMMY SUBROUTINE                                                F3PUNC02
        RETURN                                                          F3PUNC03
        END                                                             F3PUNC04
```

Table VII-49. Source program listing of subroutine RESI (Link 3)

```
*       LABEL
CE3RES                                                                  F3RES000
        SUBROUTINE RESI                                                 F3RES001
C       COMPUTES RESIDUAL FORCES AT THE NODES                           F3RES002
        DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)       F3RES003
       1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7)                  F3RES004
        COMMON IA,AA                                                    F3RES005
        EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),F),(D21(20),G)F3RES006
        EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5), F3RES007
       1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),E3RES008
       2IH),(IA(11),IB),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),F3RES009
       3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),F3RES010
       4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),   F3RES011
       5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),    F3RES012
       6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),     F3RES013
       7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57F3RES014
       8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBD),(IA(61),IID),(IA(62),F3RES015
       9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITE),(IA(41),ITAP)        F3RES016
        EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),    F3RES017
       1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),      F3RES018
       2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)             E3RES019
       3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG), E3RES020
       4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),  E3RES021
       5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),    E3RES022
       6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)              E3RES023
       7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IUE3RES024
       8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                            F3RES025
        EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346) F3RES026
       1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)  E3RES027
       2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)     F3RES028
       3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)      E3RES029
       4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)        F3RES030
       5,(IA(329),IPIR)                                                  E3RES031
C       FIND ELEMENTAL NODAL FORCES AND ASSEMBLE FOR OBTAINING RESIDUALS E3RES032
        DO 60 I=1,IND                                                   F3RES033
        ISTI=IST+I                                                      E3RES034
 60     AA(ISTI)=0.                                                     F3RES035
 70     DO 20  JJ=1,IT                                                  F3RES036
C       READ THE QUANTITIES FOR ELEMENT JJ                              F3RES037
 50     READ  TAPE ITAS,M,ITTT,ITTM,NAV,IMS,IDS,IDS2,(N(I),I=1,IMS),(S(I),E3RES038
       1I=1,IDS2),(P(I),CF,I=1,IDS)                                      F3RES039
C       COMPUTE AND ASSEMBLE THE NODAL FORCES OF ELEMENT JJ             E3RES040
        IF (NAV-2) 91,92,92                                             F3RES041
 91     CF=1.                                                           F3RES042
        GO TO 93                                                        E3RES043
 92     CF=0.5                                                          E3RES044
 93     IF (M-JJ) 100,9,100                                             F3RES045
 9      DO 10 I=1,IDS                                                   F3RES046
        KK=-IDS+I                                                       F3RES047
        DO 11 K=1,IDS                                                   E3RES048
        KK=KK+IDS                                                       F3RES049
        KDEG=((K-1)/IMS)+1                                              F3RES050
        KNOD=K-(KDEG-1)*IMS                                             E3RES051
        KNOD=N(KNOD)                                                    F3RES052
        IDEFK=IDEF+(KNOD-1)*IDEG+KDEG                                   F3RES053
 11     P(I)=P(I)-S(KK)*AA(IDEFK)                                       F3RES054
        KDEG=((I-1)/IMS)+1                                              F3RES055
        KNOD=I-(KDEG-1)*IMS                                             F3RES056
        KNOD=N(KNOD)                                                    F3RES057
        ND=(KNOD-1)*IDEG+KDEG                                           E3RES058
        ISTI=IST+ND                                                     E3RES059
        AA(ISTI)=AA(ISTI)-P(I)*CF                                       F3RES060
 10     CONTINUE                                                        E3RES061
        IF (ITTT-ITTM) 50,21,21                                         F3RES062
 21     IF (NAV-2) 20,50,20                                             E3RES063
 20     CONTINUE                                                        E3RES064
 31     RETURN                                                          F3RES065
 100    ITAS=0                                                          F3RES066
        GO TO 31                                                        F3RES067
        END                                                             F3RES068
```

Table VII-50. Source program listing of subroutine RESW (Link 3)

```
*       LABEL
CF3REW                                                                          F3REW000
        SUBROUTINE RESW                                                         F3REW001
C       WRITES RESIDUAL FORCES AT THE NODES                                     F3REW002
        DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)              F3REW003
       1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7)                         F3REW004
        COMMON IA,AA                                                            F3REW005
        EQUIVALENCE(IA,AA),(D2),D33),(D21(10),E22),(D21(19),E),(D21(20),G)F3REW006
        EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),    F3REW007
       1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),F3REW008
       2IH),(IA(11),I8),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),F3REW009
       3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),F3REW010
       4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMFT),     F3REW011
       5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),      F3REW012
       6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),       F3REW013
       7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57F3REW014
       8),J8),(IA(58),JTY),(IA(59),IHB),(IA(60),IBO),(IA(61),IID),(IA(62),F3REW015
       9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITF),(IA(41),ITAP)          F3REW016
        EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),     F3REW017
       1ICIZ),(IA(70),ICF1),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),         F3REW018
       2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)                F3REW019
       3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TF),(AA(81),DT),(AA(82),DG),  F3REW020
       4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),   F3REW021
       5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),     F3REW022
       6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)                F3REW023
       7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IUF3REW024
       8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                               F3REW025
        EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346) F3REW026
       1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)    F3REW027
       2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)       F3REW028
       3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)        F3REW029
       4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)          F3REW030
       5,(IA(329),IPIR)                                                       F3REW031
        IELT=IELT                                                             F3REW032
        WRITE OUTPUT TAPE 6,74                                                F3REW033
 74     FORMAT (1H1,40X,26HFORCES ACTING AT THE NODES//5H NODE,5X,13HFORCEF3REW034
       1 ALONG X,5X,13HFORCE ALONG Y,5X,13HFORCE ALONG Z,4X,14HMOMENT ABOUF3REW035
       2T X,4X,14HMOMENT ABOUT Y,4X,14HMOMENT ABOUT Z//)                    F3REW036
        DO 71 I=1,6                                                           F3REW037
 71     P(I)=0.                                                               F3REW038
        DO 75 I=1,IN                                                          F3REW039
        ND=(I-1)*IDEG                                                         F3REW040
        ISTI=IST+ND                                                           F3REW041
        DO 72 J=1,IDEG                                                        F3REW042
        L=J                                                                   F3REW043
        ISTJ=ISTI+J                                                           F3REW044
        GO TO (72,2,3),IELT                                                   F3REW045
 2      L=J+2                                                                 F3REW046
        GO TO 72                                                              F3REW047
 3      IF (J-3) 72,4,72                                                      F3REW048
 4      L=J+3                                                                 F3REW049
 72     P(L)=AA(ISTJ)                                                         F3REW050
        WRITE OUTPUT TAPE 6,76,I,(P(J),J=1,6)                                 F3REW051
 76     FORMAT (I5,6E18.7)                                                    F3REW052
 75     CONTINUE                                                              F3REW053
        RETURN                                                                F3REW054
        END                                                                   F3REW055
```

Table VII-51. Source program listing of subroutine TICK (Link 3)

```
*       FAP                                                                   TICK000
        COUNT   25                                                            TICK001
        LBL     TICK                                                          TICK002
        ENTRY   TICK                                                          TICK003
TICK    NZT     ONCE                                                          TICK004
        TRA     FIRST                                                         TICK005
        CAL     5                                                             TICK006
        SUB     INITL                                                         TICK007
        ALS     18                                                            TICK008
        SLW*    1,4                                                           TICK009
        TRA     2,4                                                           TICK010
FIRST   STL     ONCE                                                          TICK011
        CAL     5                                                             TICK012
        SLW     INITL                                                         TICK013
        STZ*    1,4                                                           TICK014
        TRA     2,4                                                           TICK015
ONCE    PZE                                                                   TICK016
INITL   PZE                                                                   TICK017
        END                                                                   TICK018
```

Table VII-52. Source program listing of subroutine VELAS (Link 3)

```
*      LABEL
CE3VEL
       SUBROUTINE VELAS (NN,IERR,IST,IDEF)
C      SOLVES THE GOVERNING EQUATIONS BY VARIABLE BAND-WIDTH CHOLESKI MTD
       DIMENSION A(1),IA(1)
       COMMON A
       EQUIVALENCE (A,IA)
       IU=IERR
       IJ=IST+1
       Z=1.E-16
       IF (NN) 101,101,1000
 101   IERR=-1
       GO TO 106
 1000  N=NN
       N1=N+1
C      FIND THE SMALLEST DIAGONAL ELEMENT.
 1001  E=ABSF(A(IST+1))
       DO 77 I=1,N
       IUI=IU+I
       ID=IA(IUI)+IST
 76    IF (ABSF(A(ID))-E) 771,77,77
 771   E=ABSF(A(ID))
 77    CONTINUE
C      SET ALLOWABLE MINIMUM ON DIAGONAL ELEMENTS.
       E=E*Z
C      OBTAIN U(1,1)
       IF (A(IST+1) -E) 100,100,10
 10    IF (N-1) 1072,1074,1072
 1074  A(IDEF+1)=A(IDEF+1)/A(IST+1)
       GO TO 105
 1072  A(IST+1)=SQRTF(A(IST+1))
C      OBTAIN THE REST OF FIRST ROW OF U.
       IUI=IU+2
       IW=IA(IUI)-1
       IF (IW-1) 1312,1312,1313
 1313  DO 1311 J=2,IW
       IJ=IST+J
 1311  A(IJ)=A(IJ)/A(IST+1)
C      OBTAIN THE OTHER ROWS OF U SEQUENTIALLY.
 1312  IUI=IU+N1
       MAX=IA(IUI)+IST
       DO 701 J=1,N
       JJ=MAX+J
 701   IA(JJ)=0
       DO 11 I=2,N
C      PREPARE FOR THE I TH ROW.
       IUI=IU+I
       ID=IA(IUI)
       IDE=IA(IUI+1)
       JMX=IDE-ID+1-1
       ID=ID+IST
       I1=ID-I
       IF (IW-I) 15,16,16
 16    DO 702 J=1,IW
       JJ=MAX+J
 702   IA(JJ)=IA(JJ)+1
 15    IW=JMX
       IE1=I-1
       DO 112 J=I,JMX
       IJ=I1+J
       JJ=MAX+J
       KB=1-IA(JJ)
       IF (KB-I) 1162,13,13
 1162  DO 131 K=KB,IE1
       IUK=IU+K
       KD=IA(IUK)+IST
       IK=KD+I-K
       JK=KD+J-K
 131   A(IJ) =A(IJ)-A(IK)*A(JK)
       IF (J-I) 100,12,13
 12    IF (A(IJ)-E) 100,100,122
 122   A(ID)=SQRTF (A(ID))
       GO TO 112
 13    A(IJ)=A(IJ)/A(ID)
 112   CONTINUE
 11    CONTINUE
       IM=ID
C      U IS NOW AVAILABLE COMPLETELY.
C      SOLUTION IS REQUESTED.  START FORWARD SWEEP. FIRST B(1)
 1009  A(IDEF+1)=A(IDEF+1)/A(IST+1)
C      THEN THE REST OF B.
       DO 21 I=2,N
       L=IDEF+I
       IUI=IU+I
       ID=IA(IUI)+IST
       IE1=I-1
       JJ=MAX+I
       KB=I-IA(JJ)
       IF (KB-I) 3521,21,21
 3521  DO 22 K=KB,IE1
       IUK=IU+K
       KD=IA(IUK)+IST
       IK=KD+I-K
       JK=IDEF+K
 22    A(L)=A(L)-A(IK)*A(JK)
 21    A(L)=A(L)/A(ID)
C      FORWARD SWEEP IS COMPLETED. START BACKWARD SWEEP. B(N) FIRST.
       L=IDEF+N
       A(L)=A(L)/A(IM)
C      THEN THE REST OF B IN BACKWARD DIRECTION.
       DO 31 L=2,N
       I=N1-L
       J=I+IDEF
       J1=J-1
       I1=I+1
       IUI=IU+I
       ID=IA(IUI)
       IDE=IA(IUI+1)
       JMX=IDE-ID
       ID=ID+IST
       ID1=ID-I
       IF (JMX-1)  31,31,321
 321   DO 32 K=2,JMX
       M=J1+K
       IK=ID1+K
 32    A(J)=A(J)-A(M)*A(IK)
 31    A(J)=A(J)/A(ID)
C      THE SOLUTION IS OBTAINED SUCCESSFULLY ON B.
 105   IERR=0
C      NOW GO HOME.
       GO TO 106
 100   IERR=IJ-IST
 106   RETURN
       END
```

Table VII-53. Source program listing of main program of Link 4 (stress link)

```
*     CHAIN (4,2)
*     LABEL
CELAS4
C     MAIN PROGRAM FOR STRESS LINK
C     OBTAINS STRESSES AT MESH POINTS
      DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)
     1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)
      COMMON IA,AA
      EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),F),(D21(20),G)
      EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),
     1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),
     2IH),(IA(11),I8),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),
     3IMF1),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),
     4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),
     5(IA(32),ISDM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),
     6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),
     7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57
     8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBD),(IA(61),IID),(IA(62),
     9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITE),(IA(41),ITAP)
      EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),
     1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),
     2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)
     3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG),
     4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),
     5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),
     6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)
     7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IUF
     8),(AA(47),G1),(AA(48),G2),(AA(49),G3)
      EQUIVALENCE (IA(349),NFIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346),
     1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)
     2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)
     3,(IA(337),JMMZ),(IA(336),JMF1),(IA(335),ITAS),(IA(334),IDZ)
     4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)
     5,(IA(329),IPIR)
      DIMENSION BIR(3),SIR(3),DIN(3,3),SR(6),XN(3),XE(3),DN(6),DE(6),
     1RES(6),RED(6),BAS(3),ICLAS(4),NBAN(10),NU(3),NES(3)
      EQUIVALENCE (AA(200),IONE),(AA(201),ICN),(AA(202),LM),(AA(203),AST
     1),(AA(204),INBON),(AA(205),ARE),(AA(206),ICLA),(AA(207),IMEL),
     2(AA(208),IM),(AA(209),IC),(AA(210),ICON),(AA(211),ANGLE),(AA(212),
     3ICAS),(AA(213),IE),(AA(214),NB),(AA(215),KB)
     4,(AA(216),IROT),(AA(217),BST)
      EQUIVALENCE (AA(220),BIR),(AA(223),SIR),(AA(226),DIN),(AA(235),SR)
     1,(AA(241),XN),(AA(244),XE),(AA(247),DN),(AA(253),DE),(AA(259),RES)
     2,(AA(265),RED),(AA(271),BAS),(AA(274),ICLAS),(AA(278),NBAN)
     3,(AA(292),NU),(AA(295),NES)
      DIMENSION NEL(20,17),MAC(4,4,20),IWG(90),DD(6,6),A(90,7),B(8,8),
     1C(8,2),FF(1),NSET(100),MSET(100),W(3,3)
      EQUIVALENCE (AA(14000),FF),(NU(1),JP1),(NU(2),JM1),(NU(3),JS1)
      EQUIVALENCE (FF(1),NEL),(FF(341),MAC),(FF(661),IWG),(FF(751),DD),
     1(FF(787),A),(FF(1417),B),(FF(1481),C),(FF(1497),NSET),(FF(1597),
     2MSET),(FF(1697),W)
      EQUIVALENCE (NES(1),ICOL),(NES(2),IRIG),(NES(3),IDR)
C     START THE CLOCK
      CALL TICK(ITIM)
      INPT=INP
C     SCRATCH TAPE ITAS NECESSARY. SEE IF IT IS GIVEN
      IF (ITAS) 1000,1000,1
 1000 WRITE OUTPUT TAPE 6,1001
 1001 FORMAT (46H NO SCRATCH TAPE. STRESS LINK IS NOT EXECUTED.)
      GO TO 1002
C     SEE IF THERE IS ANY NON-ONE-DIMENSIONAL ELEMENT
    1 IF (IT-IONE) 2000,2000,2
C     NON-ONE-DIMENSIONAL ELEMENTS EXIST. PRINT THE TABLE HEADING
    2 WRITE OUTPUT TAPE 6,3
    3 FORMAT (1H1,15X,87HSTRESSES AT THE NODES OF TWO- OR THREE-DIMENSIO
     1NAL CONTINUUM BY BEST FIT STRAIN TENSORS/9X,104HALL QUANTITIES ARE
     2 IN OVERALL SYSTEM, UNLESS ** APPEARS INDICATING DATA IN KSI, ETA
     3AND ZTA LOCAL SYSTEM/45X,28H* INDICATES NODE ON BOUNDARY
     4             //5H NODE,2X,3HMAT,5H CLAS,7X,11HFIRST  COMP,4X,11HSEC
     5OND COMP,4X,11HTHIRD  COMP,4X,11HFOURTH COMP,4X,11HFIFTH  COMP,4X,
     611HSIXTH  COMP//)
      IF (14000-IST-IND) 22,22,21
   22 WRITE OUTPUT TAPE 6,221
  221 FORMAT (87H SCRATCH AREA FF OVERLAPS WITH RESIDUAL AREA. PUSH FF F
     1URTHER DOWN BY RECOMPILING LINK4)
      GO TO 1002
C     START STRESS COMPUTATION AT NODES
   21 DO 400 ICN=1,IN
      ICN=ICN
      INP=INPT
      CALL CAS4
C     INITIALIZE AA AND FF AREAS
      DO 10 I=202,300
   10 AA(I)=0.
      DO 20 I=1,1705
   20 FF(I)=0.
C     GENERATE THE COORDINATES AND THE DEFLECTIONS OF NODE ICN
      CALL FINDX(ICN,XN)
      CALL FINDO(ICN,DN)
C     READ IN THE  ELEMENT SET
      READ TAPE ITAS,K,LM,(NEL(J,1),J=1,LM)
      IF (ICN-K) 1003,4,1003
 1003 WRITE OUTPUT TAPE 6,1004,ICN,K
 1004 FORMAT (80H ERROR IN READING ELEMENT SETS FROM TAPE ITAS. STRESS L
     1INK EXECUTION IS DELETED.,2I6)
      GO TO 1002
C     SEE IF ANY NON-ONE-DIMENSIONAL ELEMENT AT THE CURRENT NODE
    4 IF (LM) 399,399,4051
  399 WRITE OUTPUT TAPE 6,3991,ICN
 3991 FORMAT (I5,13X,43HNO NON-ONE-DIMENSIONAL ELEMENT AT THIS NODE)
      GO TO 400
C     THERE IS AT LEAST ONE NON-ONE-DIMENSIONAL ELEMENT.
C     PREPARE NEL(I,J),MAC(I,J,K) TABLES AND COMPUTE IMEL,ICLAS
 4051 CALL GENE
C     SET INDICATORS TO NON-BOUNDARY NODE
      INBON=0
      AST=7H      A
C     SEE IF THE NODE IS ON BOUNDARY
C     IF SO MAKE INBON=1, AST=1H* AND COMPUTE BIR(1) AND ARE
      CALL BOFI
C     COMPUTE STRESSES FOR EACH  MATERIAL GROUP
      DO 599 IM=1,IMEL
      IM=IM
      IMET=MAC(IM,1,2)
      IMET=NEL(IMET,3)
C     COMPUTE STRESSES FOR EACH  CLASS
      ICLA=ICLAS(IM)
      DO 580 IC=1,ICLA
      IC=IC
C     FIND THE CLASS TYPE
      ICAS=MAC(IM,IC,2)
      ICAS=NEL(ICAS,4)
C     INITIALIZE ICON,ANGLE,BAS,DIN,IROT,BST,IERR,TE,DT,DG,NES AND W
      CALL  INLZ
C     SEE IF THE GROUP IS OF SHELL TYPE
      IF (ICAS-5) 6,7,7
C     YES, IT IS OF SHELL TYPE, RE-DETERMINE LOCAL AXES (DIN)
    7 IROT=1
      BST=2H**
      CALL DINA
C     IS LOCAL AXES (DIN) TO BE ROTATED
    6 IF (INBON) 71,70,71
C     IF NECESSARY ROTATE DIN SO THAT KSI IS IN ZTA-BIR PLANE
   71 CALL MDIN
C     GENERATE MATERIAL MATRIX DD IN LOCAL SYSTEM (DIN)
   70 CALL META
C     CLEAR THE A AREA ON WHICH ABEQ AND SETA WILL OPERATE
      DO 72 I=1,90
      DO 72 J=1,7
   72 A(I,J)=0.
C     CHECK IF THE NODE IS ON BOUNDARY
      IF (INBON) 521,520,521
C     YES IT IS ON BOUNDARY. GENERATE EQS FOR STRESS B.C.
  521 CALL ABEQ
C     GENERATE STRAIN EQS FOR NODAL LINES OF ELEMENTS OF CLAS IC
  520 IE=MAC(IM,IC,1)+1
      DO 579 IL=2,IE
      IF (INP-2) 5201,5202,5202
 5202 WRITE OUTPUT TAPE 6,5203,BST,NES(1),NES(2)
 5203 FORMAT (15X,A2,3X,41HSTRAIN EQUATIONS ALONG NODAL LINES FOLLOW,I4,
     13H X ,I1)
 5201 CONTINUE
      IL=IL
      IELT=MAC(IM,IC,IL)
      CALL SETA
  579 CONTINUE
C     PRINT OUT DIN MATRIX AND DEFLNS. IN LOCAL IF NECESSARY
      IF (IROT) 81,80,81
   81 WRITE OUTPUT TAPE 6,83,ICN,((DIN(I,J),I=1,3),J=1,3),ICN,BST,(X(I),
     1I=4,9)
   83 FORMAT (I5,10H DR.COSINS,5X    ,3HKSI,2X,3F7.4,5X,3HETA,2X,3F7.4,5X
     1,3HZTA,2X,3F7.4/I5,10H DEFLECTNS,A2,1X,6E15.5)
C     EQUATIONS ARE AVAILABLE. SOLVE WITH LEAST SQUARES
   80 CALL LEST
C     SEE IF ENOUGH INDEPENDENT EQUATIONS EXIST
      IF (IERR)  522,523,522
  522 WRITE OUTPUT TAPE 6,5221,ICN,AST,IMET,ICAS
 5221 FORMAT (I5,A1,I4,I5,3X,44HNOT ENOUGH INDEPENDENT INFORMATION AVAIL
     1ABLE)
      GO TO 580
C     COMPUTE STRESSES
  523 CALL STRS
C     PRINT OUT STRESSES
      WRITE OUTPUT TAPE 6,5231,ICN,AST,IMET,ICAS,BST,(SR(I),I=1,6)
 5231 FORMAT (I5,A1,I4,I5,A2,1X,6E15.5)
C     PRINT STRESSES IN THE OVERALL SYSTEM IF NECESSARY
      CALL SAME
      IF (INP-2) 580,5232,5232
 5232 WRITE OUTPUT TAPE 6,5233
 5233 FORMAT (1H ,//)
  580 CONTINUE
  599 CONTINUE
  400 CONTINUE
      IF (IONE)  1002,1002,2000
C     READ THE CLOCK  AND PRINT THE ELAPSED TIME
 1002 CALL TICK (ITIM)
      CIT=ITIM
      CIT=CIT/60.
      WRITE OUTPUT TAPE 6,998,CIT
  998 FORMAT (1X,16HSTRESS LINK TOOK,F7.2,10H  SECONDS.)
C     GO TO THE FIRST LINK
      CALL CHAIN (1,ITAP)
 2000 CALL DIMI(K)
      IF (IERR) 1003,1002,1003
      END
```

Table VII-54. Source program listing of subroutine ABEQ (Link 4)

```
*      LABEL
CF4ABQ
       SUBROUTINE ABEQ
C      GENERATES EQUATIONS FOR STRESS BOUNDARY CONDITIONS AT A NODE
       DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)
      1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G(1)
       COMMON IA,AA
       EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),E),(D21(20),G)
       EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),
      1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),
      2IH),(IA(11),IB),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),
      3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),
      4ISTR),(IA(28),IFLT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),
      5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),
      6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),
      7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57
      8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBO),(IA(61),IID),(IA(62),
      9IIA),(IA(63),IOT),(IA(64),IDY),(IA(65),ITE),(IA(41),ITAP)
       EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),
      1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),
      2(IA(74),IIC),(IA(75),IDFF),(IA(76),IST),(IA(77),IIS)
      3,(IA(78),IGEM),(IA(79),IFRB),(AA(80),TE),(AA(81),DT),(AA(82),DG),
      4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),
      5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),
      6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)
      7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IU
      8),(AA(47),G1),(AA(48),G2),(AA(49),G3)
       EQUIVALENCE (IA(349),NTIC),(IA(348),ISOT),(IA(347),ISDY),(IA(346)
      1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)
      2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)
      3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IOZ)
      4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)
      5,(IA(329),IPIR)
       DIMENSION BIR(3),SIR(3),DIN(3,3),SR(6),XN(3),XF(3),ON(6),OF(6),
      1RES(6),REO(6),BAS(3),ICLAS(4),NBAN(10),NU(3),NES(3)
       EQUIVALENCE (AA(200),IONE),(AA(201),ICN),(AA(202),LM),(AA(203),AST
      1),(AA(204),INBDN),(AA(205),ARE),(AA(206),ICLA),(AA(207),IMFL),
      2(AA(208),IM),(AA(209),IC),(AA(210),ICON),(AA(211),ANGLE),(AA(212),
      3ICAS),(AA(213),IE),(AA(214),NB),(AA(215),MB)
      4,(AA(216),IROT),(AA(217),BST)
       EQUIVALENCE (AA(220),BIR),(AA(223),SIR),(AA(226),DIN),(AA(235),SR)
      1,(AA(241),XN),(AA(244),XF),(AA(247),ON),(AA(253),OF),(AA(259),RES)
      2,(AA(265),REO),(AA(271),BAS),(AA(274),ICLAS),(AA(278),NBAN)
      3,(AA(292),NU),(AA(295),NES)
       DIMENSION NEL(20,17),MAC(4,4,20),ING(90),DD(6,6),A(90,7),B(8,8),
      1C(8,2),FF(1),NSET(100),MSET(100),W(3,3)
       EQUIVALENCE (AA(14000),FF),(NU(1),JP1),(NU(2),JM1),(NU(3),JS1)
       EQUIVALENCE (FF(1),NEL),(FF(341),MAC),(FF(661),ING),(FF(751),DD),
      1(FF(787),A),(FF(1417),B),(FF(1481),C),(FF(1497),NSET),(FF(1597),
      2MSET),(FF(1697),W)
       EQUIVALENCE (NES(1),ICOL),(NES(2),IRIG),(NES(3),IDR)
       DIMENSION REK(3,2),NEK(3,2)
       EQUIVALENCE (X(1),REK),(Y(1),NEK)
       ICOL=ICOL
       IRIG=IRIG
C      GENERATE THE RESIDUE VECTOR
       ISTI=151+(ICN-1)*IDEG
       DO 9 I=1,IDEG
       ISTI=ISTI+1
 9     RES(I)=AA(ISTI)
C      INITIALIZE
       IEQ=2
       N(1)=1
       N(2)=3
       N(3)=5
       IREB=1
       IREN=2
       CT=-TE**3/12.
       CR=ARE/DD(1,1)
       CL=CR*ARE
       DO 12 J=1,2
       DO 12 I=1,3
       REK(I,J)=1.
 12    NEK(I,J)=I
       IF (XN(1)) 31,30,31
 30    XX=1.
       GO TO 32
 31    XX=XN(1)
 32    ICON=0
C      GENERATE EQUATIONS ACCORDING TO CLASS
       ICAS=ICAS
       GO TO (1,2,3,4,5,6,7,8),ICAS
C      PLANE STRESS AND PLANE STRAIN
 1     CR=CR/TE
       GO TO 15
C      PLATE BENDING
 2     IREB=2
       IREN=3
       NEK(1,1)=2
       NEK(2,1)=1
       CR=CR/CT
       REK(2,1)=-1.
       GO TO 15
C      SOLID OF REVOLUTION
 3     CR=ARE/(XX*DD(1,1))
       GO TO 15
C      SOLID
 4     IEQ=3
       IREN=3
       CR=1./DD(1,1)
       CL=ARE/DD(1,1)
       GO TO 15
C      SHELL OF REVOLUTION, MEMBRANE CASE
 5     IEQ=1
       CR=CR*ARE/XX
       GO TO 15
C      SHELL OF REVOLUTION, MEMBRANE AND BENDING CASE
 6     IEQ=1
       NEK(1,2)=3
       CR=CR*ARE/XX
       GO TO 15
C      GENERAL SHELL MEMBRANE CASE
 7     IREN=3
       GO TO 15
C      GENERAL SHELL MEMBRANE AND BENDING CASE
 8     IREN=3
       NEK(1,2)=2
       NEK(2,2)=1
       REK(2,2)=-1.
C      ESTABLISH THE EQUATIONS
 15    DO 20 J=1,IRIG
       DO 151 I=1,6
 151   REO(I)=0.
       K=0
       DO 16 I=IREB,IREN
       K=K+1
 16    REO(K)=RES(I)
       DO 17 I=1,3
       SIR(I)=0.
       DO 18 K=1,3
 18    SIR(I)=SIR(I)+REO(K)*DIN(K,I)
 17    CONTINUE
       DO 19 I=1,IEQ
       ICON=ICON+1
       K=NEK(I,J)
       LL=N(I)
       II=ICOL+J
       A(ICON,II)=REK(I,J)*CR*SIR(K)
       IF (J-1)  192,192,19
 192   DO 191 L=1,ICOL
 191   A(ICON,L)=CL*DD(LL,L)
       ING(I)=100
 19    CONTINUE
       IF (J-IRIG) 194,20,20
 194   IREB=IREN+1
       IREN=IDEG
       CR=CR/CT
       ICON=0
 20    CONTINUE
C      PLACE THE PRESCRIBED STRESSES INTO SR IN SUCCESSIVE ORDER
       L=0
       DO 26 J=1,IRIG
       K=ICOL+J
       IF (J-1) 26,40,41
 40    IF (ICAS-2) 45,41,45
 41    CL=CL/CT
 45    DO 24 I=1,IEQ
       L=L+1
 24    SR(L)=A(I,K)/CL
 26    CONTINUE
       IF (INP-2) 100,25,25
 25    IREN=ICOL+IRIG
       WRITE OUTPUT TAPE 6,251,BST,ICOL,IRIG,((A(I,J),J=1,7),ING(I),I=1,
      1IEQ)
 251   FORMAT (15X,A2,3X,32HEQUATIONS FOR STRESS B.C. FOLLOW,I4,3H X ,I1/
      1(20X,7E13.5,I5))
       WRITE OUTPUT TAPE 6,252        ,BST,(SR(I),I=1,6),CL
 252   FORMAT (15X     ,A2,3X,13HPRSCRBD.STRS.,3X,7E12.4)
 100   RETURN
       END
```

Table VII-55. Source program listing of subroutine AGEL (Link 4)

```
*       LABEL
CE4AGEL
        SUBROUTINE AGEL                                                 E4AGEL00
C       DUMMY SUBROUTINE                                                E4AGEL01
        RETURN                                                          E4AGEL02
        END                                                             E4AGEL03
                                                                        E4AGEL04
```

Table VII-56. Source program listing of subroutine BEST (Link 4)

```
*       LABEL
CE4BST                                                                  E4BST000
        SUBROUTINE BEST(CIR,JBAN,MZ)                                    E4BST001
C       OBTAINS BEST FIT PLANE AT A NODE                                E4BST002
C       TO OBTAIN UNIT NORMAL OF BEST FIT PLANE PASSING THROUGH MZ NODES E4BST003
C       OF JBAN SET ON VECTOR CIR                                       E4BST004
        DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)       E4BST005
       1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)            E4BST006
        COMMON IA,AA                                                    E4BST007
        EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),E),(D21(20),GIE4BST008
        EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5), E4BST009
       1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDFG),(IA(9),INX),(IA(10),E4BST010
       2IH),(IA(11),IB),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),E4BST011
       3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),E4BST012
       4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),  E4BST013
       5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),   E4BST014
       6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),    E4BST015
       7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57E4BST016
       8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBD),(IA(61),IID),(IA(62),E4BST017
       9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),IIE),(IA(41),ITAP)       E4BST018
        EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),  E4BST019
       1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),     E4BST020
       2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)            E4BST021
       3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TF),(AA(81),DT),(AA(82),DG), E4BST022
       4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P), E4BST023
       5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),  E4BST024
       6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)             E4BST025
       7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IUE4BST026
       8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                           E4BST027
        EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346) E4BST028
       1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY) E4BST029
       2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)    E4BST030
       3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)     E4BST031
       4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)       E4BST032
       5,(IA(329),IPIR)                                                 E4BST033
        DIMENSION BIR(3),SIR(3),DIN(3,3),SR(6),XN(3),XF(3),ON(6),OF(6), E4BST034
       1RES(6),RED(6),BAS(3),ICLAS(4),NBAN(10),NU(3),NES(3)             E4BST035
        EQUIVALENCE (AA(200),IONE),(AA(201),ICN),(AA(202),LM),(AA(203),ASTE4BST036
       1),(AA(204),INBON),(AA(205),ARE),(AA(206),ICLA),(AA(207),IMEL),  E4BST037
       2(AA(208),IM),(AA(209),IC),(AA(210),ICON),(AA(211),ANGLE),(AA(212),E4BST038
       3ICAS),(AA(213),IE),(AA(214),NB),(AA(215),MB)                    E4BST039
       4,(AA(216),IROT),(AA(217),BST)                                   E4BST040
        EQUIVALENCE (AA(220),BIR),(AA(223),SIR),(AA(226),DIN),(AA(235),SRIE4BST041
       1),(AA(241),XN),(AA(244),XF),(AA(247),ON),(AA(253),OF),(AA(259),RES)E4BST042
       2,(AA(265),RED),(AA(271),BAS),(AA(274),ICLAS),(AA(278),NBAN)     E4BST043
       3,(AA(292),NU),(AA(295),NES)                                     E4BST044
        DIMENSION NEL(20,17),MAC(4,4,20),IWG(90),DD(6,6),A(90,7),B(8,8), E4BST045
       1C(8,2),FF(1),NSET(100),MSET(100),W(3,3)                         E4BST046
        EQUIVALENCE (AA(14000),FF),(NU(1),JP1),(NU(2),JM1),(NU(3),JS1)  E4BST047
        EQUIVALENCE (FF(1),NEL),(FF(341),MAC),(FF(661),IWG),(FF(751),DD), E4BST048
       1(FF(787),A),(FF(1417),B),(FF(1481),C),(FF(1497),NSET),(FF(1597), E4BST049
       2MSET),(FF(1697),W)                                              E4BST050
        DIMENSION CIR(3),JBAN(10),VE1(3),VE2(3)                         E4BST051
        EQUIVALENCE (B(1),VE1),(B(4),VE2)                               E4BST052
        L=0                                                             E4BST053
        DO 10 I=1,MZ                                                    E4BST054
        K=JBAN(I)                                                       E4BST055
        CALL FINDX (K,XF)                                               E4BST056
        L=L+1                                                           E4BST057
        A(L,1)=XF(1)-XN(1)+1.15                                         E4BST058
        A(L,2)=XF(2)-XN(2)+1.16                                         E4BST059
        A(L,3)=XF(3)-XN(3)+1.17                                         E4BST060
        A(L,4)=1.                                                       E4BST061
 10     CONTINUE                                                        E4BST062
        DET=0.                                                          E4BST063
        IF (L-3) 45,14,14                                               E4BST064
 14     DO 20 I=1,3                                                     E4BST065
        DO 20 J=I,4                                                     E4BST066
        B(I,J)=0.                                                       E4BST067
        DO 30 K=1,L                                                     E4BST068
 30     B(I,J)=B(I,J)+A(K,I)*A(K,J)                                     E4BST069
        IF (J-3) 40,40,41                                               E4BST070
 40     B(J,I)=B(I,J)                                                   E4BST071
        GO TO 20                                                        E4BST072
 41     CIR(I)=B(I,4)                                                   E4BST073
 20     CONTINUE                                                        E4BST074
        CALL INV(B,3,CIR,1,DET)                                         E4BST075
        IF (DET) 50,45,50                                               E4BST076
C       POINTS ARE ON ONE PLANE. COMPUTE NORMAL AS VECTOR PRODUCT       E4BST077
 45     DO 46 I=1,3                                                     E4BST078
        VE1(I)=A(1,I)                                                   E4BST079
 46     VE2(I)=A(2,I)                                                   E4BST080
        CALL VECT (CIR,VE1,VE2)                                         E4BST081
 50     O=1.                                                            E4BST082
        CALL UNIT (CIR,O)                                               E4BST083
        IF (INP-2) 55,56,56                                             E4BST084
 56     WRITE OUTPUT TAPE 6,57,XN(1),XN(2),XN(3),CIR(1),CIR(2),CIR(3)   E4BST085
 57     FORMAT(20X,12HCOORDINATES ,3F12.4,4X,7HNORMAL ,3F8.5)           E4BST086
 55     RETURN                                                          E4BST087
        END                                                             E4BST088
```

Table VII-57. Source program listing of subroutine BOFI (Link 4)

```
*       LABEL
CE4BOF                                                                  E4BOF000
        SUBROUTINE BOFI                                                 E4BOF001
C       TO FIND IF THE NODE IS ON BOUNDARY                              E4BOF002
        DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)       E4BOF003
       1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)            E4BOF004
        COMMON IA,AA                                                    E4BOF005
        EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),E),(D21(20),G)E4BOF006
        EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5), E4BOF007
       1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDFG),(IA(9),INX),(IA(10),E4BOF008
       2IH),(IA(11),IB),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),E4BOF009
       3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),E4BOF010
       4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),  E4BOF011
       5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),   E4BOF012
       6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),    E4BOF013
       7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57E4BOF014
       8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBD),(IA(61),IID),(IA(62),E4BOF015
       9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),IIE),(IA(41),ITAP)       E4BOF016
        EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),  E4BOF017
       1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),     E4BOF018
       2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)            E4BOF019
       3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG), E4BOF020
       4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P), E4BOF021
       5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),  E4BOF022
       6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)             E4BOF023
       7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IUE4BOF024
       8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                           E4BOF025
        EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346) E4BOF026
       1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY) E4BOF027
       2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)    E4BOF028
       3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)     E4BOF029
       4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)       E4BOF030
       5,(IA(329),IPIR)                                                 E4BOF031
        DIMENSION BIR(3),SIR(3),DIN(3,3),SR(6),XN(3),XF(3),ON(6),OF(6), E4BOF032
       1RES(6),RED(6),BAS(3),ICLAS(4),NBAN(10),NU(3),NES(3)             E4BOF033
        EQUIVALENCE (AA(200),IONE),(AA(201),ICN),(AA(202),LM),(AA(203),ASTE4BOF034
       1),(AA(204),INBON),(AA(205),ARE),(AA(206),ICLA),(AA(207),IMEL),  E4BOF035
       2(AA(208),IM),(AA(209),IC),(AA(210),ICON),(AA(211),ANGLE),(AA(212),E4BOF036
       3ICAS),(AA(213),IE),(AA(214),NB),(AA(215),MB)                    E4BOF037
       4,(AA(216),IROT),(AA(217),BST)                                   E4BOF038
        EQUIVALENCE (AA(220),BIR),(AA(223),SIR),(AA(226),DIN),(AA(235),SR)E4BOF039
       1,(AA(241),XN),(AA(244),XF),(AA(247),ON),(AA(253),OF),(AA(259),RES)E4BOF040
       2,(AA(265),RED),(AA(271),BAS),(AA(274),ICLAS),(AA(278),NBAN)     E4BOF041
       3,(AA(292),NU),(AA(295),NES)                                     E4BOF042
        DIMENSION NEL(20,17),MAC(4,4,20),IWG(90),DD(6,6),A(90,7),B(8,8), E4BOF043
       1C(8,2),FF(1),NSET(100),MSET(100),W(3,3)                         E4BOF044
        EQUIVALENCE (AA(14000),FF),(NU(1),JP1),(NU(2),JM1),(NU(3),JS1)  E4BOF045
        EQUIVALENCE (FF(1),NEL),(FF(341),MAC),(FF(661),IWG),(FF(751),DD), E4BOF046
       1(FF(787),A),(FF(1417),B),(FF(1481),C),(FF(1497),NSET),(FF(1597), E4BOF047
       2MSET),(FF(1697),W)                                              E4BOF048
C       FIND MINIMUM CONNECTIVITY OF INTERNAL NODES (ILIM)              E4BOF049
        IC=4                                                            E4BOF050
        I56=0                                                           E4BOF051
        I4=0                                                            E4BOF052
        IMS=2                                                           E4BOF053
        LM=LM                                                           E4BOF054
        DO 10 I=1,LM                                                    E4BOF055
        IF (IC-NEL(I,4)) 15,11,15                                       E4BOF056
 11     I4=I4+1                                                         E4BOF057
        GO TO 10                                                        E4BOF058
 15     IF (IMS-NEL(I,5)) 10, 9,10                                      E4BOF059
 9      I56=I56+1                                                       E4BOF060
 10     CONTINUE                                                        E4BOF061
        IRES=LM-I4-I56                                                  E4BOF062
        IF (LM-I4) 13,12,13                                             E4BOF063
 13     IF (LM-I56) 16,14,16                                            E4BOF064
 16     IF (LM-IRES) 90,17,90                                           E4BOF065
C       THREE-DIMENSIONAL CONTINUUM                                     E4BOF066
 12     ILIM=3                                                          E4BOF067
        GO TO 18                                                        E4BOF068
C       SHELL OF REVOLUTION                                             E4BOF069
 14     ILIM=1                                                          E4BOF070
        GO TO 18                                                        E4BOF071
C       TWO-DIMENSIONAL CONTINUUM                                       E4BOF072
 17     ILIM=2                                                          E4BOF073
C       GENERATE LIST OF NODAL LINE SET VIA NODES (NSET)                E4BOF074
 18     NB=0                                                            E4BOF075
        DO 19 I=1,LM                                                    E4BOF076
C       FIND SEQUENCE NUMBER OF NODE ICN IN I TH ELEMENT                E4BOF077
        IMS=NEL(I,5)                                                    E4BOF078
        DO 20 J=1,IMS                                                   E4BOF079
        IF (ICN-NEL(I,J+9)) 20,21,20                                    E4BOF080
 20     CONTINUE                                                        E4BOF081
        GO TO 19                                                        E4BOF082
C       FIND SEQUENCE NOS OF NODES AFTER(JP1),BEFORE(JM1),AND ABOVE(JS1) E4BOF083
 21     IF (IMS-8) 27,26,26                                             E4BOF084
 27     JP1=J+1                                                         E4BOF085
        IF (JP1-IMS) 23,23,22                                           E4BOF086
 22     JP1=1                                                           E4BOF087
 23     JM1=J-1                                                         E4BOF088
        IF (JM1) 24,24,25                                               E4BOF089
 24     JM1=IMS                                                         E4BOF090
 25     JS1=JP1+1                                                       E4BOF091
        IF (JS1-IMS) 28,28,281                                          E4BOF092
 281    JS1=1                                                           E4BOF093
        GO TO 28                                                        E4BOF094
 26     KK=((J-1)/4)*4                                                  E4BOF095
        JP1=J+1                                                         E4BOF096
        IF (JP1-4-KK) 29,29,30                                          E4BOF097
 30     JP1=1+KK                                                        E4BOF098
 29     JM1=J-1                                                         E4BOF099
        IF (JM1-KK) 31,31,32                                            E4BOF100
 31     JM1=4+KK                                                        E4BOF101
 32     JS1=9-JP1                                                       E4BOF102
C       GENERATE NODAL LINE SET NSET                                    E4BOF103
 28     DO 300 K=1,ILIM                                                 E4BOF104
        KK=NU(K)                                                        E4BOF105
        NB=NB+1                                                         E4BOF106
        NSET(NB)=NEL(I,KK+9)                                            E4BOF107
 300    CONTINUE                                                        E4BOF108
 19     CONTINUE                                                        E4BOF109
C       GENERATE LIST OF NODES ON BOUNDARY. NBAN ARRAY                  E4BOF110
        GO TO (601,601,602),ILIM                                        E4BOF111
C       THREE DIMENSIONAL MESH CASE                                     E4BOF112
 602    K=0                                                             E4BOF113
```

Table VII-57 (contd)

```
      DO 603 I=1,NB,3                                                   E4BOF114
      DO 604 L=1,6                                                      E4BOF115
      K=K+1                                                             E4BOF116
      J=L/2                                                             E4BOF117
      IF (J-3) 6031,6032,6032                                           E4BOF118
 6032 J=0                                                               E4BOF119
 6031 IJ=I+J                                                            E4BOF120
 604  MSET(K)=NSET(IJ)                                                  E4BOF121
 603  CONTINUE                                                          E4BOF122
      KB=K                                                              E4BOF123
      MB=0                                                              E4BOF124
      DO 605 I=1,KB,2                                                   E4BOF125
      I2=I+2                                                            E4BOF126
      IF (I2-KB) 6051,6051,605                                          E4BOF127
 6051 IF (MSET(I)) 605,605,6052                                         E4BOF128
 6052 IJ=0                                                              E4BOF129
      DO 606 J=I2,KB,2                                                  E4BOF130
      IF (MSET(I)-MSET(J)) 6061,6062,6061                               E4BOF131
 6061 IF (MSET(I)-MSET(J+1)) 606,6063,606                               E4BOF132
 6063 IF (MSET(I+1)-MSET(J)) 606,6064,606                               E4BOF133
 6062 IF (MSET(I+1)-MSET(J+1)) 606,6064,606                             E4BOF134
 6064 MSET(J)=0                                                         E4BOF135
      MSET(J+1)=0                                                       E4BOF136
      IJ=IJ+1                                                           E4BOF137
 606  CONTINUE                                                          E4BOF138
      IF (IJ-1) 6053,605,44                                             E4BOF139
 6053 MMB=MB                                                            E4BOF140
      DO 6054 J=1,MMB                                                   E4BOF141
      IF (NBAN(J)-MSET(I)) 6054,6055,6054                               E4BOF142
 6054 CONTINUE                                                          E4BOF143
      MB=MB+1                                                           E4BOF144
      NBAN(MB)=MSET(I)                                                  E4BOF145
 6055 DO 6056 J=1,MMB                                                   E4BOF146
      IF (NBAN(J)-MSET(I+1)) 6056,605,6056                              E4BOF147
 6056 CONTINUE                                                          E4BOF148
      MB=MB+1                                                           E4BOF149
      NBAN(MB)=MSET(I+1)                                                E4BOF150
 605  CONTINUE                                                          E4BOF151
      GO TO 6057                                                        E4BOF152
 601  DO 40 I=1,NB                                                      E4BOF153
 40   MSET(I)=NSET(I)                                                   E4BOF154
      MB=0                                                              E4BOF155
      DO 39 I=1,NB                                                      E4BOF156
      IF (MSET(I)) 39,39,42                                             E4BOF157
 42   NODE=MSET(I)                                                      E4BOF158
      KLIM=0                                                            E4BOF159
      DO 38 J=1,NB                                                      E4BOF160
      IF (NODE-MSET(J)) 38,37,38                                        E4BOF161
 37   MSET(J)=0                                                         E4BOF162
      KLIM=KLIM+1                                                       E4BOF163
 38   CONTINUE                                                          E4BOF164
      IF (ILIM-2) 411,412,602                                           E4BOF165
 411  IF (KLIM-1) 44,43,44                                              E4BOF166
 412  IF (KLIM-2) 43,39,449                                             E4BOF167
C     MORE THAN 2 REPETITION IS POSSIBLE IF IGEM=1                      E4BOF168
 449  IF (IGEM-1) 44,39,44                                              E4BOF169
 43   MB=MB+1                                                           E4BOF170
      NBAN(MB)=NODE                                                     E4BOF171
      GO TO 39                                                          E4BOF172
 44   WRITE OUTPUT TAPE 6,961,ICN                                       E4BOF173
 961  FORMAT (I5,15X,44HERROR IN MESH TOPOLOGY.NODE ASSUMED INTERNAL)   E4BOF174
      GO TO 90                                                          E4BOF175
 39   CONTINUE                                                          E4BOF176
 6057 IF (MB) 90,90,45                                                  E4BOF177
 45   GO TO (461,462,463),ILIM                                          E4BOF178
 461  NBAN(1)=0                                                         E4BOF179
      NBAN(2)=0                                                         E4BOF180
      IF (MB-1) 44,47,90                                                E4BOF181
 462  IF (MB-2) 448,47,448                                              E4BOF182
C     OTHER THAN 2 NEIGHBORING BOUNDARY NODES POSSIBLE IF IGEM=1        E4BOF183
 448  IF (IGEM-1) 44,90,44                                              E4BOF184
 463  IF (MB-3) 44,47,47                                                E4BOF185
C     THE NODE IS ON BOUNDARY                                           E4BOF186
 47   INBON=1                                                           E4BOF187
      AST=1H*                                                           E4BOF188
C     ESTABLISH OUTER NORMAL ON BIR AND AREA ON ARE                     E4BOF189
      GO TO (48,49,50),ILIM                                             E4BOF190
C     ONE-DIMENSIONAL CONTINUUM, SHELL OF REVOLUTION                    E4BOF191
 48   CALL INER(BIR)                                                    E4BOF192
      Q=-1.                                                             E4BOF193
      CALL UNIT(BIR,Q)                                                  E4BOF194
      ARE=0                                                             E4BOF195
      GO TO 90                                                          E4BOF196
C     TWO-DIMENSIONAL CONTINUUM                                         E4BOF197
 49   CALL INER(SIR)                                                    E4BOF198
      K=NBAN(1)                                                         E4BOF199
      CALL FINDX(K,X)                                                   E4BOF200
      K=NBAN(2)                                                         E4BOF201
      CALL FINDX(K,Y)                                                   E4BOF202
      DO 491 I=1,3                                                      E4BOF203
 491  BIR(I)=X(I)-Y(I)                                                  E4BOF204
      ARE=1.                                                            E4BOF205
      CALL UNIT(BIR,ARE)                                                E4BOF206
      ARE=ARE/2.                                                        E4BOF207
      Q=SCAL(BIR,SIR)                                                   E4BOF208
      DO 492 I=1,3                                                      E4BOF209
 492  BIR(I)=SIR(I)-Q*BIR(I)                                            E4BOF210
      IF (SCAL(BIR,SIR)) 493,441,494                                    E4BOF211
 441  INBON=0                                                           E4BOF212
      GO TO 44                                                          E4BOF213
 493  Q=1.                                                              E4BOF214
      GO TO 495                                                         E4BOF215
 494  Q=-1.                                                             E4BOF216
 495  CALL UNIT(BIR,Q)                                                  E4BOF217
      GO TO 90                                                          E4BOF218
C     THREE-DIMENSIONAL CONTINUUM                                       E4BOF219
 50   CALL INER(SIR)                                                    E4BOF220
      CALL BEST(BIR,NBAN,MB)                                            E4BOF221
      IF (SCAL(BIR,SIR)) 501,441,502                                    E4BOF222
 501  Q=1.                                                              E4BOF223
      GO TO 503                                                         E4BOF224
 502  Q=-1.                                                             E4BOF225
 503  CALL UNIT(BIR,Q)                                                  E4BOF226
      Q=0.                                                              E4BOF227
      DO 504 I=1,MB                                                     E4BOF228
      K=NBAN(I)                                                         E4BOF229
      CALL FINDX(K,XF)                                                  E4BOF230
 504  Q=Q+SQRTF((XF(1)-XN(1))**2+(XF(2)-XN(2))**2+(XF(3)-XN(3))**2)     E4BOF231
      ARE=MB                                                            E4BOF232
      ARE=3.14159*(Q/(2.*ARE))**2                                       E4BOF233
 90   IF (INP-2) 100,91,91                                              E4BOF234
 91   WRITE OUTPUT TAPE 6,92,ICN,AST,MB,(NBAN(I),I=1,MB)                E4BOF235
 92   FORMAT (I5,A1,14X,21HBOUNDARY NODES FOLLOW,I20/(20X,20I5))        E4BOF236
      WRITE OUTPUT TAPE 6,93,NB,(NSET(I),I=1,NB)                        E4BOF237
 93   FORMAT (20X,18HNSET ARRAY FOLLOWS,I20/(20X,20I5))                 E4BOF238
      WRITE OUTPUT TAPE 6,94,ARE,(BIR(I),I=1,3)                         E4BOF239
 94   FORMAT (20X,5HAREA=,E15.5,5X,12HOUTER NORMAL,2X,3E15.6)           E4BOF240
 100  RETURN                                                            E4BOF241
      END                                                               E4BOF242
```

Table VII-58. Source program listing of subroutine CAS4 (Link 4)

```
*     LABEL                                                             E4CAS400
CE4CAS4                                                                 E4CAS401
      SUBROUTINE CAS4                                                   E4CAS402
C     DUMMY SUBROUTINE                                                  E4CAS403
      RETURN                                                            E4CAS404
      END
```

Table VII-59. Source program listing of subroutine CODI (Link 4)

```
*      LABEL
CE4COD                                                                  E4COD000
      SUBROUTINE CODI                                                   E4COD001
C     TO GENERATE LOCAL-OVERALL COORDINATE TRANSFORMATION MATRIX        E4COD002
      DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)         E4COD003
     1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)              E4COD004
      COMMON IA,AA                                                      E4COD005
      EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),E),(D21(20),G)E4COD006
      EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),  E4COD007
     1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),E4COD008
     2IH),(IA(11),I8),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),E4COD009
     3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),E4COD010
     4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),    E4COD011
     5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),     E4COD012
     6IORD),(IA(38),IORDI),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),      E4COD013
     7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57E4COD014
     8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBO),(IA(61),IIO),(IA(62),E4COD015
     9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITE),(IA(41),ITAP)         E4COD016
      EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),    E4COD017
     1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),       E4COD018
     2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)              E4COD019
     3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG), E4COD020
     4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),  E4COD021
     5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),    E4COD022
     6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)               E4COD023
     7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IUE4COD024
     8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                             E4COD025
      EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346) E4COD026
     1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)   E4COD027
     2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)      E4COD028
     3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)       E4COD029
     4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)         E4COD030
     5,(IA(329),IPIR)                                                   E4COD031
      DIMENSION A(6,6),DIR(3,3),UVG(12),T(6),PD(3),PN(3),DUG(3)         E4COD032
      EQUIVALENCE (AA(200),A),(AA(236),EL),(AA(237),AREA ),(AA(238),II) E4COD033
     1,(AA(239),JJ),(AA(240),IR),(AA(241),JR),(AA(242),NY),(AA(264),DIR)E4COD034
     2,(AA(306),UVG),(AA(291),PD),(AA(294),PN),(AA(297),DUG),(AA(300),T)E4COD035
      EL=SQRTF(XD(1)*XD(1)+YD(1)*YD(1)+ZD(1)*ZD(1))                     E4COD036
      IF (EL) 1010,1010,110                                             E4COD037
  110 IF (IELT-3) 115,250,115                                           E4COD038
  115 DIR(1,1)=XD(1)/EL                                                 E4COD039
      DIR(1,2)=YD(1)/EL                                                 E4COD040
      DIR(1,3)=ZD(1)/EL                                                 E4COD041
      IF (JMFI) 1010,210,130                                            E4COD042
  210 IF (IGEM) 1010,220,1010                                           E4COD043
  130 ICFIJ=ICFI+JMFI                                                   E4COD044
      IF (ABSF(AA(ICFIJ))-90.) 140,140,1010                             E4COD045
  140 FI=AA(ICFIJ)*3.1415926/180.                                       E4COD046
      IF (FI) 144,144,146                                               E4COD047
  144 SIGNFI=-1.                                                        E4COD048
      GO TO 148                                                         E4COD049
  146 SIGNFI=1.                                                         E4COD050
  148 IF(ABSF(DIR(1,1))-.1E-3) 150,150,160                              E4COD051
  150 IF(ABSF(DIR(1,3))-.1E-3) 180,180,170                              E4COD052
  160 DIR(2,2)=COSF(FI)                                                 E4COD053
      ASQ=DIR(1,1)*DIR(1,1)                                             E4COD054
      AX=1.+DIR(1,3)*DIR(1,3)/ASQ                                       E4COD055
      BX=DIR(1,2)*DIR(1,3)*DIR(2,2)/ASQ                                 E4COD056
      CX=DIR(2,2)*DIR(2,2)+DIR(1,2)*DIR(1,2)*DIR(2,2)*DIR(2,2)/ASQ-1.   E4COD057
      DIR(2,3)=(-BX+SIGNFI*SQRTF(BX*BX-AX*CX))/AX                       E4COD058
  165 DIR(2,1)=(-DIR(1,2)*DIR(2,2)-DIR(1,3)*DIR(2,3))/DIR(1,1)          E4COD059
      GO TO 190                                                         E4COD060
  170 DIR(2,2)=COSF(FI)                                                 E4COD061
      DIR(2,3)=-DIR(1,2)*DIR(2,2)/DIR(1,3)                              E4COD062
      DIR(2,1)=SIGNFI*SQRTF(1.-DIR(2,2)*DIR(2,2)-DIR(2,3)*DIR(2,3))     E4COD063
      GO TO 190                                                         E4COD064
  180 DIR(2,3)=COSF(FI)                                                 E4COD065
      DIR(2,2)=0.                                                       E4COD066
      DIR(2,1)=SIGNFI*SQRTF(1.-DIR(2,3)*DIR(2,3))                       E4COD067
  190 DIR(3,1)=DIR(1,2)*DIR(2,3)-DIR(1,3)*DIR(2,2)                      E4COD068
      DIR(3,2)=-DIR(1,1)*DIR(2,3)+DIR(1,3)*DIR(2,1)                     E4COD069
      DIR(3,3)=DIR(1,1)*DIR(2,2)-DIR(1,2)*DIR(2,1)                      E4COD070
      GO TO 1000                                                        E4COD071
  220 DIR(2,1)=-DIR(1,2)                                                E4COD072
      DIR(2,2)=DIR(1,1)                                                 E4COD073
      DIR(2,3)=0.                                                       E4COD074
      DIR(3,1)=0.                                                       E4COD075
      DIR(3,2)=0.                                                       E4COD076
      DIR(3,3)=1.                                                       E4COD077
      GO TO 1000                                                        E4COD078
  250 DIR(1,1)=1.                                                       E4COD079
      DIR(1,2)=0.                                                       E4COD080
      DIR(1,3)=0.                                                       E4COD081
      DIR(2,1)=0.                                                       E4COD082
      DIR(2,2)=XD(1)/EL                                                 E4COD083
      DIR(2,3)=YD(1)/EL                                                 E4COD084
      DIR(3,1)=0.                                                       E4COD085
      DIR(3,2)=-DIR(2,3)                                                E4COD086
      DIR(3,3)=DIR(2,2)                                                 E4COD087
 1000 RETURN                                                            E4COD088
 1010 IERR=1                                                            E4COD089
      GO TO 1000                                                        E4COD090
      END                                                               E4COD091
```

Table VII-60. Source program listing of subroutine DIMI (Link 4)

```
*      LABEL
CE4DIM                                                                  E4DIM000
      SUBROUTINE DIMI(K)                                                E4DIM001
C     TO GENERATE AND OUTPUT STRESSES OF ONE-DIMENSIONAL ELEMENTS       E4DIM002
      DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)         E4DIM003
     1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)              E4DIM004
      COMMON IA,AA                                                      E4DIM005
      EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),E),(D21(20),G)E4DIM006
      EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),  E4DIM007
     1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),E4DIM008
     2IH),(IA(11),I8),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),E4DIM009
     3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),E4DIM010
     4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),    E4DIM011
     5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),     E4DIM012
     6IORD),(IA(38),IORDI),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),      E4DIM013
     7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57E4DIM014
     8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBO),(IA(61),IID),(IA(62),E4DIM015
     9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITE),(IA(41),ITAP)         E4DIM016
      EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),    E4DIM017
     1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),       E4DIM018
     2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)              E4DIM019
     3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG), E4DIM020
     4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),  E4DIM021
     5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),    E4DIM022
     6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)               E4DIM023
     7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IUE4DIM024
     8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                             E4DIM025
      EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346) E4DIM026
     1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)   E4DIM027
     2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)      E4DIM028
     3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)       E4DIM029
     4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)         E4DIM030
     5,(IA(329),IPIR)                                                   E4DIM031
      DIMENSION VDE(12),PV(6,2),DIR(3,3),DUM(12),PT(24)                 E4DIM032
      EQUIVALENCE (AA(200),VDE),(AA(212),PV),(AA(224),DUM),(AA(236),EL) E4DIM033
     1,(AA(264),DIR),(AA(273),PT)                                       E4DIM034
C     COMPUTE STRESSES AT THE NODES OF ONE DIMENSIONAL ELEMENTS         E4DIM035
      WRITE OUTPUT TAPE 6,1                                             E4DIM036
    1 FORMAT (1H1,29X,70HSTRESS AND MOMENT RESULTANTS  AT THE NODES OF OE4DIM037
     1NE DIMENSIONAL ELEMENTS/30X,70HQUANTITIES ARE IN THE LOCAL COORDINE4DIM038
     2ATE SYSTEMS AT THE ENDS OF ELEMENTS//18H EL NO. NODE  TYPE,9X,3HN-E4DIM039
     3X,12X,3HQ-Y,12X,3HQ-Z,12X,3HM-X,12X,3HM-Y,12X,3HM-Z)              E4DIM040
   10 REWIND ITAS                                                       E4DIM041
      IERR=0                                                            E4DIM042
      IDS=2*IDEG                                                        E4DIM043
      ZGEM=IGEM                                                         E4DIM044
      DO 1000 MM=1,IT                                                   E4DIM045
  102 READ TAPE ITAS,M,ITTT,ITTM,NAV,IMS,IDS,IDS2,(N(I),I=1,IMS),(S(I), E4DIM046
     1I=1,IDS2),(PT(I),P(I),I=1,IDS)                                    E4DIM047
      IF (ITTT-ITTM) 102,105,105                                        E4DIM048
  105 IF (NAV-2) 106,102,106                                            E4DIM049
  106 IF (MM-M) 1100,111,1100                                           E4DIM050
  111 J1M=J1+M                                                          E4DIM051
      IELT=IA(J1M)/100                                                  E4DIM052
      IF (IELT-4) 110,110,1000                                          E4DIM053
  110 DO 200 I=1,IMS                                                    E4DIM054
      J=N(I)                                                            E4DIM055
      IXXJ=IXX+J                                                        E4DIM056
      IYYJ=IYY+J                                                        E4DIM057
      IZZJ=IZZ+J                                                        E4DIM058
      X(I)=AA(IXXJ)                                                     E4DIM059
      Y(I)=AA(IYYJ)                                                     E4DIM060
      Z(I)=AA(IZZJ)*ZGEM                                                E4DIM061
      IF (I-1) 200,200,120                                              E4DIM062
  120 XD(I-1)=X(I)-X(1)                                                 E4DIM063
      YD(I-1)=Y(I)-Y(1)                                                 E4DIM064
      ZD(I-1)=Z(I)-Z(1)                                                 E4DIM065
  200 CONTINUE                                                          E4DIM066
      CALL CODI                                                         E4DIM067
      DO 250 I=200,235                                                  E4DIM068
  250 AA(I)=0.                                                          E4DIM069
      DO 300 I=1,3                                                      E4DIM070
      DO 300 J=1,3                                                      E4DIM071
      DIRT=DIR(I,J)                                                     E4DIM072
      DIR(I,J)=DIR(J,I)                                                 E4DIM073
      DIR(J,I)=DIRT                                                     E4DIM074
  300 CONTINUE                                                          E4DIM075
      CALL STRA                                                         E4DIM076
      IDEFM=IDEF-IDEG                                                   E4DIM077
      LV=0                                                              E4DIM078
      DO 370 I=1,IDEG                                                   E4DIM079
      IDEFI=IDEFM+I                                                     E4DIM080
      DO 360 J=1,IMS                                                    E4DIM081
      IDEFJ=IDEFI+IDEG*N(J)                                             E4DIM082
      LV=LV+1                                                           E4DIM083
      VDE(LV)=AA(IDEFJ)                                                 E4DIM084
  360 CONTINUE                                                          E4DIM085
  370 CONTINUE                                                          E4DIM086
      CALL TRAN(VDE,2)                                                  E4DIM087
      II=-IDS                                                           E4DIM088
      DO 415 I=1,IDS                                                    E4DIM089
      II=II+IDS                                                         E4DIM090
      DO 410 J=1,IDS                                                    E4DIM091
      IJ=II+J                                                           E4DIM092
      DUM(I)=DUM(I)+S(IJ)*VDE(J)                                        E4DIM093
  410 CONTINUE                                                          E4DIM094
  415 CONTINUE                                                          E4DIM095
      CALL TRAN (P,0)                                                   E4DIM096
      L=0                                                               E4DIM097
      DO 418 I=1,6                                                      E4DIM098
      DO 417 J=1,2                                                      E4DIM099
      L=L+1                                                             E4DIM100
      PV(I,J)=DUM(L)-P(L)                                               E4DIM101
  417 CONTINUE                                                          E4DIM102
  418 CONTINUE                                                          E4DIM103
      IF (IELT-2) 500,420,430                                           E4DIM104
  420 PV(6,1)=PV(3,1)                                                   E4DIM105
      PV(6,2)=PV(3,2)                                                   E4DIM106
      PV(3,1)=0.                                                        E4DIM107
      PV(3,2)=0.                                                        E4DIM108
      GO TO 500                                                         E4DIM109
  430 IF (IELT-3) 500,440,500                                           E4DIM110
  440 DO 450 J=1,2                                                      E4DIM111
      DO 450 I=1,3                                                      E4DIM112
      IM=6-I                                                            E4DIM113
```

Table VII-60 (contd)

```
      IM4=IM-4
      PV(IM,J)=PV(IM4,J)
      PV(IM4,J)=0.
  450 CONTINUE
  500 WRITE OUTPUT TAPE 6,3
    3 FORMAT (1H )
      DO 510 I=1,6
  510 PV(I,1)=-PV(I,1)
      WRITE OUTPUT TAPE 6,2,(M,N(I),IFLI,(PV(J,I),J=1,6),I=1,2)
    2 FORMAT (1X,I4,2I6,3X,6E15.5)
 1000 CONTINUE
 1010 RETURN
 1100 IERR=1
      K=M
      IA(201)=MM
      GO TO 1010
      END
```

Table VII-61. Source program listing of subroutine DINA (Link 4)

```
*     LABEL
CE4DIN
      SUBROUTINE DINA
C     OBTAINS LOCAL COORDINATE AXES AT A NODE IN SHELLS
C     TO GENERATE BAS VECTOR, DIN MATRIX AND ANGLE
      DIMENSION IA(1),AA(1),S(1),N(8),O21(21),O33(3,3),E22(3,3)
     1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)
      COMMON IA,AA
      EQUIVALENCE(IA,AA),(O21,O33),(O21(10),E22),(O21(19),E),(O21(20),G)
      EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),
     1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),
     2IH),(IA(11),I8),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),
     3IMFI),(IA(16),IARF),(IA(17),M(1)),(IA(25),M),(IA(26),ITY),(IA(27),
     4ISTR),(IA(28),IELT),(IA(29),ITEN),(IA(30),ITIC),(IA(31),IMET),
     5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),
     6IORD),(IA(38),IORD1),(IA(39),AGEL ),(IA(50),J1),(IA(51),J2),
     7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57
     8),J8),(IA(58),JTY),(IA(59),IB0),(IA(60),IBO),(IA(61),IID),(IA(62),
     9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITF),(IA(41),ITAP)
      EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),
     1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),
     2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)
     3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TF),(AA(81),DT),(AA(82),DG),
     4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),O21),(AA(107),P),
     5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),
     6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)
     7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),I0
     8),(AA(47),G1),(AA(48),G2),(AA(49),G3)
      EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346)
     1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)
     2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)
     3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),IIAS),(IA(334),IDZ)
     4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRFS)
     5,(IA(329),IPIR)
      DIMENSION BIR(3),SIR(3),DIN(3,3),SR(6),XN(3),XF(3),DN(6),OF(6),
     1RES(6),RED(6),BAS(3),ICLAS(4),NBAN(10),NU(3),NES(3)
      EQUIVALENCE (AA(200),IONE),(AA(201),ICN),(AA(202),LM),(AA(203),AST
     1),(AA(204),INBON),(AA(205),ARE),(AA(206),ICLA),(AA(207),IMFL),
     2(AA(208),IM),(AA(209),IC),(AA(210),ICON),(AA(211),ANGLE),(AA(212),
     3ICAS),(AA(213),IE),(AA(214),NB),(AA(215),MB)
     4,(AA(216),IROT),(AA(217),BST)
      EQUIVALENCE (AA(220),BIR),(AA(223),SIR),(AA(226),DIN),(AA(235),SR)
     1,(AA(241),XN),(AA(244),XF),(AA(247),ON),(AA(253),OF),(AA(259),RES)
     2,(AA(265),RED),(AA(271),BAS),(AA(274),ICLAS),(AA(278),NBAN)
     3,(AA(292),NU),(AA(295),NES)
      DIMENSION NEL(20,17),MAC(4,4,20),IWG(90),DD(6,6),A(90,7),B(8,8),
     1C(8,2),FF(1),NSET(100),MSET(100),W(3,3)
      EQUIVALENCE (AA(14000),FF),(NU(1),JP1),(NU(2),JM1),(NU(3),JS1)
      EQUIVALENCE (FF(1),NEL),(FF(341),MAC),(FF(661),IWG),(FF(751),DD),
     1(FF(787),A),(FF(1417),B),(FF(1481),C),(FF(1497),NSET),(FF(1597),
     2MSET),(FF(1697),W)
C     SEE IF DIN AND ANGLE ARE TO BE OBTAINED VIA SUBROUTINE AGEL
      IF (IPIR-1) 3,3,4
C     CALL SUBROUTINE AGEL FOR DIN AND ANGLE
 4    CALL AGEL
      GO TO 5
C     IS IT SHELL OF REVOLUTION
 3    IF (ICAS-6) 20,20,21
C     SHELL OF REVOLUTION
 20   CALL REVU
      GO TO 5
C     GENERAL SHELL. DETERMINE DIN AND ANGLE BY BEST FIT QUADRATIC
 21   CALL QUAD
 5    IF (INP-2) 7,6,6
 6    WRITE OUTPUT TAPE 6,61,ANGLE,((DIN(I,J),I=1,3),J=1,3)
 61   FORMAT(20X                                ,5HANGLE,2X,F10.3/
     120X,3HDIN,5X,3HKSI,2X,3F7.4,5X,3HETA,2X,3F7.4,5X,4HZETA,1X,3F7.4)
 7    RETURN
      END
```

Table VII-62. Source program listing of subroutine EPAN (Link 4)

```
*     LABEL
CE4EPN
      SUBROUTINE EPAN                                                   E4EPN000
C     INCREASES NODE SET BEYOND 9 IN SHELLS AT A NODE                   E4EPN001
C     TO INCREASE NODE SET (NSET) POPULATION NB BEYOND 9 FOR QUAD       E4EPN002
      DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)         E4EPN003
     1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)              E4EPN004
      COMMON IA,AA                                                      E4EPN005
      EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),E),(D21(20),G)E4EPN006
      EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),  E4EPN007
     1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),E4EPN008
     2IH),(IA(11),IB),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),E4EPN009
     3IMFI),(IA(16),IARE),(IA(17),M(1)),(IA(25),MI),(IA(26),ITY),(IA(27),E4EPN010
     4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),    E4EPN011
     5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),     E4EPN012
     6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),      E4EPN013
     7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57E4EPN014
     8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBD),(IA(61),IID),(IA(62),E4EPN015
     9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITE),(IA(41),ITAP)         E4EPN016
      EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),    E4EPN017
     1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),       E4EPN018
     2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)              E4EPN019
     3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG), E4EPN020
     4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),  E4EPN021
     5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),    E4EPN022
     6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)               E4EPN023
     7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IOE4EPN024
     8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                             E4EPN025
      EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346) E4EPN026
     1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)   E4EPN027
     2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)      E4EPN028
     3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)       E4EPN029
     4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)         E4EPN030
     5,(IA(329),IPIR)                                                   E4EPN031
      DIMENSION BIR(3),SIR(3),BIN(3,3),SR(6),XN(3),XF(3),ON(6),OF(6),   E4EPN032
     1RES(6),RED(6),BAS(3),ICLAS(4),NBAN(10),NU(3),NES(3)               E4EPN033
      EQUIVALENCE (AA(200),IDNE),(AA(201),ICN),(AA(202),LM),(AA(203),ASTE4EPN034
     1),(AA(204),INBON),(AA(205),ARE),(AA(206),ICLA),(AA(207),IMEL),    E4EPN035
     2(AA(208),IM),(AA(209),IC),(AA(210),ICON),(AA(211),ANGLE),(AA(212),E4EPN036
     3ICAS),(AA(213),IE),(AA(214),NB),(AA(215),MB)                      E4EPN037
     4,(AA(216),IROT),(AA(217),BST)                                     E4EPN038
      EQUIVALENCE (AA(220),BIR),(AA(223),SIR),(AA(226),BIN),(AA(235),SR)E4EPN039
     1,(AA(241),XN),(AA(244),XF),(AA(247),ON),(AA(253),OF),(AA(259),RESE4EPN040
     2,(AA(265),RED),(AA(271),BAS),(AA(274),ICLAS),(AA(278),NBAN)       E4EPN041
     3,(AA(292),NU),(AA(295),NES)                                       E4EPN042
      DIMENSION NEL(20,17),MAC(4,4,20),ING(90),DD(6,6),A(90,7),B(8,8),  E4EPN043
     1C(8,2),FF(1),NSET(100),MSET(100),W(3,3)                           E4EPN044
      EQUIVALENCE (AA(14000),FF),(NU(1),JP1),(NU(2),JM1),(NU(3),JS1)    E4EPN045
      EQUIVALENCE (FF(1),NEL),(FF(341),MAC),(FF(661),ING),(FF(751),DD), E4EPN046
     1(FF(787),A),(FF(1417),B),(FF(1481),C),(FF(1497),NSET),(FF(1597),  E4EPN047
     2MSET),(FF(1697),W)                                                E4EPN048
      DIMENSION  MELE(25),NELE (200)                                    E4EPN049
      EQUIVALENCE (A,MELE),(A(26),NELE)                                 E4EPN050
C     ORDER THE NODES IN NSET AS INCREASING                             E4EPN051
      NB=NB                                                             E4EPN052
      DO 10 I=1,NB                                                      E4EPN053
      MIN=NSET(I)                                                       E4EPN054
      DO 9 J=I,NB                                                       E4EPN055
      IF (MIN-NSET(J)) 9,9,8                                            E4EPN056
    8 NSET(I)=NSET(J)                                                   E4EPN057
      NSET(J)=MIN                                                       E4EPN058
      MIN=NSET(I)                                                       E4EPN059
    9 CONTINUE                                                          E4EPN060
   10 CONTINUE                                                          E4EPN061
C     LIST ELEMENTS MEETING AT EACH NODE OF NSET IN NELE                E4EPN062
      KK=ICN                                                            E4EPN063
      MIN=0                                                             E4EPN064
                                                                        E4EPN065
      DO 20 I=1,NB                                                      E4EPN066
      K=NSET(I)-KK                                                      E4EPN067
      IF (K) 19,20,19                                                   E4EPN068
   19 K=K-1                                                             E4EPN069
      IF (K) 191,24,21                                                  E4EPN070
  191 K=-K                                                              E4EPN071
      DO 22 J=1,K                                                       E4EPN072
      BACKSPACE ITAS                                                    E4EPN073
   22 CONTINUE                                                          E4EPN074
      GO TO 24                                                          E4EPN075
   21 DO 23 J=1,K                                                       E4EPN076
      READ TAPE ITAS                                                    E4EPN077
   23 CONTINUE                                                          E4EPN078
   24 READ TAPE ITAS,KK,NN,(MELE(J),J=1,NN)                             E4EPN079
      IF (NN) 20,20,26                                                  E4EPN080
   26 IF (MIN) 252,251,252                                              E4EPN081
  251 DO 253 J=1,NN                                                     E4EPN082
  253 NELE(J)=MELE(J)                                                   E4EPN083
      NNN=NN                                                            E4EPN084
      MIN=1                                                             E4EPN085
      GO TO 20                                                          E4EPN086
  252 DO 254 J=1,NN                                                     E4EPN087
      DO 255 L=1,NNN                                                    E4EPN088
      IF (NELE(L)-MELE(J)) 255,254,255                                  E4EPN089
  255 CONTINUE                                                          E4EPN090
      NNN=NNN+1                                                         E4EPN091
      NELE(NNN)=MELE(J)                                                 E4EPN092
  254 CONTINUE                                                          E4EPN093
   20 CONTINUE                                                          E4EPN094
C     NEIGHBORING ELMTS ARE ON NELE, THE COUNT IS NNN. REPOSITION ITAS  E4EPN095
      K=ICN-KK                                                          E4EPN096
      IF (K) 291,30,31                                                  E4EPN097
  291 K=-K                                                              E4EPN098
      DO 42 J=1,K                                                       E4EPN099
      BACKSPACE ITAS                                                    E4EPN100
   42 CONTINUE                                                          E4EPN101
      GO TO 30                                                          E4EPN102
   31 DO 43 J=1,K                                                       E4EPN103
      READ TAPE ITAS                                                    E4EPN104
   43 CONTINUE                                                          E4EPN105
C     UPDATE NB AND NSET                                                E4EPN106
   30 DO 3 I=1,NNN                                                      E4EPN107
      KK=NELE(I)                                                        E4EPN108
      J1I=J1+KK                                                         E4EPN109
      NN=IA(J1I)/100                                                    E4EPN110
      K= IA(J1I)-100*NN                                                 E4EPN111
      IF (IMET-K) 3,32,3                                                E4EPN112
   32 GO TO (3,3,3,3,3,3,3,3,3,3,33,34,33,34,3,3,3,3),NN                E4EPN113
   33 IMS=3                                                             E4EPN114
      GO TO 35                                                          E4EPN115
   34 IMS=4                                                             E4EPN116
   35 J1I=J3+KK                                                         E4EPN117
      DO 36 J=1,IMS                                                     E4EPN118
      J1I=J1I+IT                                                        E4EPN119
      K=IA(J1I)                                                         E4EPN120
C     SEE IF NODE K IS ALREADY IN NSET                                  E4EPN121
      DO 37 L=1,NB                                                      E4EPN122
      IF (NSET(L)-K) 37,36,37                                           E4EPN123
   37 CONTINUE                                                          E4EPN124
C     THIS IS A NEW NODE, UPDATE NB AND NSET                            E4EPN125
      NB=NB+1                                                           E4EPN126
      NSET(NB)=K                                                        E4EPN127
   36 CONTINUE                                                          E4EPN128
    3 CONTINUE                                                          E4EPN129
C     NOW GO HOME                                                       E4EPN130
      RETURN                                                            E4EPN131
      END                                                               E4EPN132
```

Table VII-63. Source program listing of subroutine FINDQ (Link 4)

```
*       LABEL
CE4FNO                                                                    E4FNQ000
      SUBROUTINE FINDQ(K,Q)                                               E4FNQ001
C     OBTAINS DEFLECTIONS OF A NODE IN OVERALL COORDINATES                E4FNQ002
C     TO GENERATE THE DEFLECTIONS OF NODE K ON VECTOR Q                   E4FNQ003
      DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)           E4FNQ004
     1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)                E4FNQ005
      COMMON IA,AA                                                        E4FNQ006
      EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),E),(D21(20),GE4FNQ007
      EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),  E4FNQ008
     1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),E4FNQ009
     2IH),(IA(11),IB),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),E4FNQ010
     3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),E4FNQ011
     4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),    E4FNQ012
     5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),     E4FNQ013
     6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),      E4FNQ014
     7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57E4FNQ015
     8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBO),(IA(61),IID),(IA(62),E4FNQ016
     9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),IIE),(IA(41),ITAP)          E4FNQ017
      EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),    E4FNQ018
     1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),       E4FNQ019
     2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)              E4FNQ020
     3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG), E4FNQ021
     4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),  E4FNQ022
     5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),    E4FNQ023
     6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)               E4FNQ024
     7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IUE4FNQ025
     8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                             E4FNQ026
      EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346) E4FNQ027
     1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)   E4FNQ028
     2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)      E4FNQ029
     3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)       E4FNQ030
     4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)         E4FNQ031
     5,(IA(329),IPIR)                                                   E4FNQ032
      DIMENSION BIR(3),SIR(3),DIN(3,3),SR(6),XN(3),XF(3),ON(6),OF(6),   E4FNQ033
     1RES(6),RED(6),BAS(3),ICLAS(4),NBAN(10),NU(3),NES(3)               E4FNQ034
      EQUIVALENCE (AA(200),IONE),(AA(201),ICN),(AA(202),LM),(AA(203),ASTE4FNQ035
     1),(AA(204),INBON),(AA(205),ARE),(AA(206),ICLA),(AA(207),IMEL),    E4FNQ036
     2(AA(208),IM),(AA(209),IC),(AA(210),ICON),(AA(211),ANGLE),(AA(212),E4FNQ037
     3ICAS),(AA(213),IE),(AA(214),NB),(AA(215),MB)                      E4FNQ038
     4,(AA(216),IROT),(AA(217),BST)                                     E4FNQ039
      EQUIVALENCE (AA(220),BIR),(AA(223),SIR),(AA(226),DIN),(AA(235),SR)E4FNQ040
     1,(AA(241),XN),(AA(244),XF),(AA(247),ON),(AA(253),OF),(AA(259),RES)E4FNQ041
     2,(AA(265),RED),(AA(271),BAS),(AA(274),ICLAS),(AA(278),NBAN)       E4FNQ042
     3,(AA(292),NU),(AA(295),NES)                                       E4FNQ043
      DIMENSION NEL(20,17),MAC(4,4,20),IWG(90),DD(6,6),A(90,7),B(8,8),  E4FNQ044
     1C(8,2),FF(1),NSET(100),MSET(100),W(3,3)                           E4FNQ045
      EQUIVALENCE (AA(14000),FF),(NU(1),JP1),(NU(2),JM1),(NU(3),JS1)    E4FNQ046
      EQUIVALENCE (FF(1),NEL),(FF(341),MAC),(FF(661),IWG),(FF(751),DD), E4FNQ047
     1(FF(787),A),(FF(1417),B),(FF(1481),C),(FF(1497),NSET),(FF(1597),  E4FNQ048
     2MSET),(FF(1697),W)                                                E4FNQ049
      DIMENSION Q(6)                                                    E4FNQ050
      IDEF1=IDEF+(K-1)*IDEG                                             E4FNQ051
      DO 10 I=1,IDEG                                                    E4FNQ052
      IDEF1=IDEF1+1                                                     E4FNQ053
      Q(I)=AA(IDEF1)                                                    E4FNQ054
   10 CONTINUE                                                          E4FNQ055
      RETURN                                                            E4FNQ056
      END                                                               E4FNQ057
```

Table VII-64. Source program listing of subroutine FINDX (Link 4)

```
*       LABEL
CE4FNX                                                                    E4FNX000
      SUBROUTINE FINDX(K,Q)                                               E4FNX001
C     OBTAINS OVERALL COORDINATES OF A NODE                               E4FNX002
C     TO GENERATE THE COORDINATES OF NODE K ON VECTOR Q                   E4FNX003
      DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)           E4FNX004
     1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)                E4FNX005
      COMMON IA,AA                                                        E4FNX006
      EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),E),(D21(20),G)E4FNX007
      EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),  E4FNX008
     1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),E4FNX009
     2IH),(IA(11),IB),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),E4FNX010
     3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),E4FNX011
     4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),    E4FNX012
     5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),     E4FNX013
     6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),      E4FNX014
     7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57E4FNX015
     8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBO),(IA(61),IID),(IA(62),E4FNX016
     9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITE),(IA(41),ITAP)          E4FNX017
      EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),    E4FNX018
     1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),       E4FNX019
     2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)              E4FNX020
     3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG), E4FNX021
     4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),  E4FNX022
     5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),    E4FNX023
     6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)               E4FNX024
     7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IUE4FNX025
     8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                             E4FNX026
      EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346) E4FNX027
     1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)   E4FNX028
     2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)      E4FNX029
     3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)       E4FNX030
     4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)         E4FNX031
     5,(IA(329),IPIR)                                                   E4FNX032
      DIMENSION BIR(3),SIR(3),DIN(3,3),SR(6),XN(3),XF(3),ON(6),OF(6),   E4FNX033
     1RES(6),RED(6),BAS(3),ICLAS(4),NBAN(10),NU(3),NES(3)               E4FNX034
      EQUIVALENCE (AA(200),IONE),(AA(201),ICN),(AA(202),LM),(AA(203),ASTE4FNX035
     1),(AA(204),INBON),(AA(205),ARE),(AA(206),ICLA),(AA(207),IMEL),    E4FNX036
     2(AA(208),IM),(AA(209),IC),(AA(210),ICON),(AA(211),ANGLE),(AA(212),E4FNX037
     3ICAS),(AA(213),IE),(AA(214),NB),(AA(215),MB)                      E4FNX038
     4,(AA(216),IROT),(AA(217),BST)                                     E4FNX039
      EQUIVALENCE (AA(220),BIR),(AA(223),SIR),(AA(226),DIN),(AA(235),SR)E4FNX040
     1,(AA(241),XN),(AA(244),XF),(AA(247),ON),(AA(253),OF),(AA(259),RES)E4FNX041
     2,(AA(265),RED),(AA(271),BAS),(AA(274),ICLAS),(AA(278),NBAN)       E4FNX042
     3,(AA(292),NU),(AA(295),NES)                                       E4FNX043
      DIMENSION NEL(20,17),MAC(4,4,20),IWG(90),DD(6,6),A(90,7),B(8,8),  E4FNX044
     1C(8,2),FF(1),NSET(100),MSET(100),W(3,3)                           E4FNX045
      EQUIVALENCE (AA(14000),FF),(NU(1),JP1),(NU(2),JM1),(NU(3),JS1)    E4FNX046
      EQUIVALENCE (FF(1),NEL),(FF(341),MAC),(FF(661),IWG),(FF(751),DD), E4FNX047
     1(FF(787),A),(FF(1417),B),(FF(1481),C),(FF(1497),NSET),(FF(1597),  E4FNX048
     2MSET),(FF(1697),W)                                                E4FNX049
      DIMENSION Q(3)                                                    E4FNX050
      IXXI=IXX+K                                                        E4FNX051
      IYYI=IYY+K                                                        E4FNX052
      IZZI=IZZ+K                                                        E4FNX053
      Q(1)=AA(IXXI)                                                     E4FNX054
      Q(2)=AA(IYYI)                                                     E4FNX055
      Q(3)=AA(IZZI)*ZGEM                                                E4FNX056
      RETURN                                                            E4FNX057
      END                                                               E4FNX058
```

Table VII-65. Source program listing of subroutine GENE (Link 4)

```
*       LABEL
CE4GEN
        SUBROUTINE GENE                                                  E4GEN000
C       GENERATES NEL AND MAC MATRICES OF A NODE                         E4GEN001
C       TO GENERATE NEL(I,J),MAC(I,J,K),IMEL AND ICLAS(I)                E4GEN002
        DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)        E4GEN003
       1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)            E4GEN004
        COMMON IA,AA                                                     E4GEN005
        EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),E),(D21(20),GE4GEN006
        EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),  E4GEN007
       1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),E4GEN008
       2IH),(IA(11),I8),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),E4GEN009
       3IMFI),(IA(16),IARE),(IA(17),NI1),(IA(25),M),(IA(26),ITY),(IA(27),E4GEN010
       4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),    E4GEN011
       5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),     E4GEN012
       6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),      E4GEN013
       7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57E4GEN014
       8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBD),(IA(61),IID),(IA(62),E4GEN015
       9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITE),(IA(41),ITAP)         E4GEN016
        EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),    E4GEN017
       1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),       E4GEN018
       2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)              E4GEN019
       3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG), E4GEN020
       4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),  E4GEN021
       5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),    E4GEN022
       6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)               E4GEN023
       7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IUE4GEN024
       8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                             E4GEN025
        EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346) E4GEN026
       1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)   E4GEN027
       2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)      E4GEN028
       3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)       E4GEN029
       4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)         E4GEN030
       5,(IA(329),IPIR)                                                   E4GEN031
        DIMENSION BIR(3),SIR(3),DIN(3,3),SR(6),XN(3),XF(3),ON(6),OF(6),   E4GEN032
       1RES(6),RED(6),BAS(3),ICLAS(4),NBAN(10),NU(3),NES(3)               E4GEN033
        EQUIVALENCE (AA(200),IONE),(AA(201),ICN),(AA(202),LM),(AA(203),ASTE4GEN034
       1),(AA(204),INBON),(AA(205),ARE),(AA(206),ICLA),(AA(207),IMEL),    E4GEN035
       2(AA(208),IM),(AA(209),IC),(AA(210),ICON),(AA(211),ANGLE),(AA(212),E4GEN036
       3ICAS),(AA(213),IE),(AA(214),NB),(AA(215),MB)                      E4GEN037
       4,(AA(216),IROT),(AA(217),RST)                                     E4GEN038
        EQUIVALENCE (AA(220),BIR),(AA(223),SIR),(AA(226),DIN),(AA(235),SRE4GEN039
       1),(AA(241),XN),(AA(244),XF),(AA(247),ON),(AA(253),OF),(AA(259),RES)E4GEN040
       2,(AA(265),RED),(AA(271),BAS),(AA(274),ICLAS),(AA(278),NBAN)       E4GEN041
       3,(AA(292),NU),(AA(295),NES)                                       E4GEN042
        DIMENSION NEL(20,17),MAC(4,4,20),IWG(90),DD(6,6),A(90,7),B(8,8),  E4GEN043
       1C(8,2),FF(1),NSET(100),MSET(100),W(3,3)                           E4GEN044
        EQUIVALENCE (AA(14000),FF),(NU(1),JP1),(NU(2),JM1),(NU(3),JS1)    E4GEN045
        EQUIVALENCE (FF(1),NEL),(FF(341),MAC),(FF(661),IWG),(FF(751),DD), E4GEN046
       1(FF(787),A),(FF(1417),B),(FF(1481),C),(FF(1497),NSET),(FF(1597),  E4GEN047
       2MSET),(FF(1697),W)                                                E4GEN048
        DIMENSION NELM(20),NELC(20)                                       E4GEN049
        EQUIVALENCE (MSET,NELM),(MSET(21),NELC)                           E4GEN050
        LM=LM                                                             E4GEN051
        DO 1 I=1,LM                                                       E4GEN052
        M=NEL(I,1)                                                        E4GEN053
        CALL TOPO                                                         E4GEN054
        KELT=IELT                                                         E4GEN055
        GO TO (1,1,1,1,3,4,3,4,4,8,3,4,3,4,3,4,2,2),KELT                  E4GEN056
3       IMS=3                                                             E4GEN057
        GO TO 5                                                           E4GEN058
4       IMS=4                                                             E4GEN059
        GO TO 5                                                           E4GEN060
8       IMS=8                                                             E4GEN061
        GO TO 5                                                           E4GEN062
2       IMS=2                                                             E4GEN063
5       GO TO (1,1,1,1,11,11,12,12,14,14,18,18,17,17,13,13,15,16),KELT    E4GEN064
11      IC=1                                                              E4GEN065
        GO TO 6                                                           E4GEN066
12      IC=2                                                              E4GEN067
        GO TO 6                                                           E4GEN068
14      IC=4                                                              E4GEN069
        GO TO 6                                                           E4GEN070
18      IC=8                                                              E4GEN071
        GO TO 6                                                           E4GEN072
17      IC=7                                                              E4GEN073
        GO TO 6                                                           E4GEN074
13      IC=3                                                              E4GEN075
        GO TO 6                                                           E4GEN076
15      IC=5                                                              E4GEN077
        GO TO 6                                                           E4GEN078
16      IC=6                                                              E4GEN079
6       NEL(I,2)=IELT                                                     E4GEN080
        NEL(I,3)=IMET                                                     E4GEN081
        NEL(I,4)=IC                                                       E4GEN082
        NEL(I,5)=IMS                                                      E4GEN083
        NEL(I,6)=ITIC                                                     E4GEN084
        NEL(I,7)=JSDZ                                                     E4GEN085
        NEL(I,8)=JPRS                                                     E4GEN086
        NEL(I,9)=ITEM                                                     E4GEN087
        DO 7 J=1,IMS                                                      E4GEN088
7       NEL(I,J+9)=N(J)                                                   E4GEN089
        IMS=0                                                             E4GEN090
        JSDZ=0                                                            E4GEN091
        ITIC=0                                                            E4GEN092
        IC=0                                                              E4GEN093
1       CONTINUE                                                          E4GEN094
        IF (INP-2) 70,71,71                                               E4GEN095
71      WRITE OUTPUT TAPE 6,72,ICN,LM,((NEL(I,J),J=1,17),I=1,LM)          E4GEN096
72      FORMAT (I5,15X,18HNEL MATRIX FOLLOWS,I20/(20X,17I5))              E4GEN097
70      IMEL=1                                                            E4GEN098
        DO 210 I=1,LM                                                     E4GEN099
        NELC(I)=NEL(I,4)                                                  E4GEN100
210     NELM(I)=NEL(I,3)                                                  E4GEN101
        LMT=0                                                             E4GEN102
        DO 21 I=1,LM                                                      E4GEN103
        IF (NELM(I)) 21,21,211                                            E4GEN104
211     LMT=LMT+1                                                         E4GEN105
        IF (LMT-4) 212,212,213                                            E4GEN106
213     WRITE OUTPUT TAPE 6,214,ICN                                       E4GEN107
214     FORMAT (I5,15X,41HMORE THAN 4 MATERIALS, FIRST 4 CONSIDERED)      E4GEN108
        LMT=LMT-1                                                         E4GEN109
        GO TO 21                                                          E4GEN110
212     IMET=NELM(I)                                                      E4GEN111
        LCL=0                                                             E4GEN112
        DO 22 J=I,LM                                                      E4GEN113
        IF (IMET-NELM(J)) 22,220,22                                       E4GEN114
220     IF (NELC(J)) 22,22,221                                            E4GEN115
221     LCL=LCL+1                                                         E4GEN116
        IF (LCL-4) 222,222,223                                            E4GEN117
223     WRITE OUTPUT TAPE 6,224,ICN,IMET                                  E4GEN118
224     FORMAT (2I5,10X,39HMORE THAN 4 CLASSES, FIRST 4 CONSIDERED)       E4GEN119
        LCL=LCL-1                                                         E4GEN120
        GO TO 22                                                          E4GEN121
222     ICLA=NELC(J)                                                      E4GEN122
        L=1                                                               E4GEN123
        MAC(LMT,LCL,1)=0                                                  E4GEN124
        DO 23 K=J,LM                                                      E4GEN125
        IF (IMET-NELM(K)) 23,231,23                                       E4GEN126
231     IF (ICLA-NELC(K)) 23,232,23                                       E4GEN127
232     NELM(K)=0                                                         E4GEN128
        NELC(K)=0                                                         E4GEN129
        L=L+1                                                             E4GEN130
        IF (L-20) 233,233,234                                             E4GEN131
234     WRITE OUTPUT TAPE 6,235,ICN,IMET,ICLA                             E4GEN132
235     FORMAT (3I5,5X,42HMORE THAN 19 ELEMENTS, FIRST 19 CONSIDERED)     E4GEN133
        L=L-1                                                             E4GEN134
        GO TO 23                                                          E4GEN135
233     MAC(LMT,LCL,L)=K                                                  E4GEN136
        MAC(LMT,LCL,1)=MAC(LMT,LCL,1)+1                                   E4GEN137
23      CONTINUE                                                          E4GEN138
22      CONTINUE                                                          E4GEN139
        ICLAS(LMT)=LCL                                                    E4GEN140
21      CONTINUE                                                          E4GEN141
        IMEL=LMT                                                          E4GEN142
        IF (INP-2) 90,81,81                                               E4GEN143
81      DO 83 I=1,LMT                                                     E4GEN144
        ICLA=ICLAS(I)                                                     E4GEN145
        WRITE OUTPUT TAPE 6,82,ICN,I,(J,(MAC(I,J,K),K=1,20),J=1,ICLA)     E4GEN146
82      FORMAT(I5,15X,36HMAC MATRICE(S) FOLLOW(S).  MAT.SEQ.=I3/          E4GEN147
       1(17X,I3,20I5))                                                    E4GEN148
83      CONTINUE                                                          E4GEN149
90      RETURN                                                            E4GEN150
        END                                                               E4GEN151
                                                                          E4GEN152
```

Table VII-66. Source program listing of subroutine INER (Link 4)

```
*       LABEL
CE4INR
                                                                          E4INR000
        SUBROUTINE INER(CIR)                                              E4INR001
C       OBTAINS A VECTOR HEADING TOWARDS THE STRUCTURE AT A BOUNDARY NODE E4INR002
C       TO GENERATE A VECTOR HEADING INTO THE STRUCTURE ON CIR(I)         E4INR003
        DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)         E4INR004
       1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)             E4INR005
        COMMON IA,AA                                                      E4INR006
        EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),E),(D21(20),GE4INR007
        EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),  E4INR008
       1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),E4INR009
       2IH),(IA(11),I8),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),E4INR010
       3IMFI),(IA(16),IARE),(IA(17),NI1),(IA(25),M),(IA(26),ITY),(IA(27),E4INR011
       4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),    E4INR012
       5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),     E4INR013
       6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),      E4INR014
       7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57E4INR015
       8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBD),(IA(61),IID),(IA(62),E4INR016
       9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITE),(IA(41),ITAP)         E4INR017
        EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),    E4INR018
       1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),       E4INR019
       2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)              E4INR020
       3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG), E4INR021
       4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),  E4INR022
       5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),    E4INR023
       6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)               E4INR024
       7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IUE4INR025
       8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                             E4INR026
        EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346) E4INR027
       1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)   E4INR028
       2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)      E4INR029
       3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)       E4INR030
       4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)         E4INR031
       5,(IA(329),IPIR)                                                   E4INR032
        DIMENSION BIR(3),SIR(3),DIN(3,3),SR(6),XN(3),XF(3),ON(6),OF(6),   E4INR033
       1RES(6),RED(6),BAS(3),ICLAS(4),NBAN(10),NU(3),NES(3)               E4INR034
        EQUIVALENCE (AA(200),IONE),(AA(201),ICN),(AA(202),LM),(AA(203),ASTE4INR035
       1),(AA(204),INBON),(AA(205),ARE),(AA(206),ICLA),(AA(207),IMEL),    E4INR036
       2(AA(208),IM),(AA(209),IC),(AA(210),ICON),(AA(211),ANGLE),(AA(212),E4INR037
       3ICAS),(AA(213),IE),(AA(214),NB),(AA(215),MB)                      E4INR038
       4,(AA(216),IROT),(AA(217),RST)                                     E4INR039
        EQUIVALENCE (AA(220),BIR),(AA(223),SIR),(AA(226),DIN),(AA(235),SRE4INR040
       1),(AA(241),XN),(AA(244),XF),(AA(247),ON),(AA(253),OF),(AA(259),RES)E4INR041
       2,(AA(265),RED),(AA(271),BAS),(AA(274),ICLAS),(AA(278),NBAN)       E4INR042
       3,(AA(292),NU),(AA(295),NES)                                       E4INR043
        DIMENSION NEL(20,17),MAC(4,4,20),IWG(90),DD(6,6),A(90,7),B(8,8),  E4INR044
       1C(8,2),FF(1),NSET(100),MSET(100),W(3,3)                           E4INR045
        EQUIVALENCE (AA(14000),FF),(NU(1),JP1),(NU(2),JM1),(NU(3),JS1)    E4INR046
        EQUIVALENCE (FF(1),NEL),(FF(341),MAC),(FF(661),IWG),(FF(751),DD), E4INR047
       1(FF(787),A),(FF(1417),B),(FF(1481),C),(FF(1497),NSET),(FF(1597),  E4INR048
       2MSET),(FF(1697),W)                                                E4INR049
        DIMENSION CIR(3)                                                  E4INR050
        CIR(1)=0.                                                         E4INR051
        CIR(2)=0.                                                         E4INR052
        CIR(3)=0.                                                         E4INR053
        DO 1 I=1,NB                                                       E4INR054
        K=NSET(I)                                                         E4INR055
        CALL FINDX(K,XF)                                                  E4INR056
        CIR(1)=CIR(1)+XF(1)-XN(1)                                         E4INR057
        CIR(2)=CIR(2)+XF(2)-XN(2)                                         E4INR058
1       CIR(3)=CIR(3)+XF(3)-XN(3)                                         E4INR059
        RETURN                                                            E4INR060
        END                                                               E4INR061
```

Table VII-67. Source program listing of subroutine INLZ (Link 4)

```
*     LABEL
CE4INZ                                                                  E4INZ000
      SUBROUTINE INLZ                                                   E4INZ001
C     INITIALIZES SCALARS, VECTORS AND MATRICES AT A NODE               E4INZ002
C     TO INITIALIZE  ICON,ANGLE,BAS,DIN,W,IROT,BST,IERR,TE,DT,DG,AND NESE4INZ003
      DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)         E4INZ004
     1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)              E4INZ005
      COMMON IA,AA                                                      E4INZ006
      EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),F),(D21(20),G)E4INZ007
      EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),  E4INZ008
     1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),E4INZ009
     2IH),(IA(11),IB),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),E4INZ010
     3INF.),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),E4INZ011
     4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),    E4INZ012
     5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),     E4INZ013
     6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),      E4INZ014
     7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57E4INZ015
     8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBU),(IA(61),LID),(IA(62),E4INZ016
     9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITE),(IA(41),IIAP)         E4INZ017
      EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),    E4INZ018
     1ICIZ),(IA(70),ICF),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),        E4INZ019
     2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)              E4INZ020
     3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG), E4INZ021
     4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),  E4INZ022
     5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),    E4INZ023
     6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)               E4INZ024
     7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IUE4INZ025
     8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                             E4INZ026
      EQUIVALENCE (IA(349),NTIC),(IA(348),ISOT),(IA(347),ISDY),(IA(346) E4INZ027
     1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)   E4INZ028
     2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)      E4INZ029
     3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)       E4INZ030
     4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)         E4INZ031
     5,(IA(329),IPIR)                                                   E4INZ032
      DIMENSION BIR(3),SIR(3),DIN(3,3),SR(6),XN(3),XF(3),DN(6),DF(6),   E4INZ033
     1RES(6),RED(6),BAS(3),ICLAS(4),NBAN(10),NU(3),NES(3)               E4INZ034
      EQUIVALENCE (AA(200),IONE),(AA(201),ICN),(AA(202),LM),(AA(203),ASTE4INZ035
     1),(AA(204),INBON),(AA(205),AREI),(AA(206),ICLA),(AA(207),IMELI,   E4INZ036
     2(AA(208),IM),(AA(209),IC),(AA(210),ICON),(AA(211),ANGLE),(AA(212),E4INZ037
     3ICAS),(AA(213),IE),(AA(214),NB),(AA(215),MB)                      E4INZ038
     4,(AA(216),IROT),(AA(217),BST)                                     E4INZ039
      EQUIVALENCE (AA(220),BIR),(AA(223),SIR),(AA(226),DIN),(AA(235),SRIE4INZ040
     1),(AA(241),XN),(AA(244),XF),(AA(247),DN),(AA(253),DF),(AA(259),RES)E4INZ041
     2,(AA(265),RED),(AA(271),BAS),(AA(274),ICLAS),(AA(278),NBAN)       E4INZ042
     3,(AA(292),NU),(AA(295),NES)                                       E4INZ043
      DIMENSION NEL(20,17),MAC(4,4,20),ING(90),DD(6,6),A(90,7),B(8,8),  E4INZ044
     1C(8,2),FF(1),NSET(100),MSET(100),W(3,3)                           E4INZ045
      EQUIVALENCE (AA(14000),FF),(NU(1),JP1),(NU(2),JM1),(NU(3),JS1)    E4INZ046
      EQUIVALENCE (FF(1),NEL),(FF(341),MAC),(FF(661),ING),(FF(751),DD), E4INZ047
     1(FF(787),A),(FF(1417),B),(FF(1481),C),(FF(1497),NSET),(FF(1597),  E4INZ048
     2MSET),(FF(1697),W)                                                E4INZ049
      EQUIVALENCE (NES(1),ICOL),(NES(2),IRIG),(NES(3),IDR)              E4INZ050
C     SET INDICATORS TO LOCAL=OVERALL                                   E4INZ051
      IROT=0                                                            E4INZ052
      BST=7H      A                                                     E4INZ053
C     GENERATE DIN AND W TRANSFORMATION MATRICES FOR LOCAL=OVERALL      E4INZ054
      DO 1 I=1,3                                                        E4INZ055
      DO 1 J=1,3                                                        E4INZ056
      IF (I-J) 2,3,2                                                    E4INZ057
 3    DIN(I,J)=1.                                                       E4INZ058
      W(I,J)=1.                                                         E4INZ059
      GO TO 1                                                           E4INZ060
 2    DIN(I,J)=0.                                                       E4INZ061
      W(I,J)=0.                                                         E4INZ062
 1    CONTINUE                                                          E4INZ063
C     COMPUTE AVERAGE THICKNESS,TEMP.INCREASE,TEMP GRADIENT             E4INZ064
      TE=0.                                                             E4INZ065
      DT=0.                                                             E4INZ066
      DG=0.                                                             E4INZ067
      IM=IM                                                             E4INZ068
      IC=IC                                                             E4INZ069
      IE=MAC(IM,IC,1)+1                                                 E4INZ070
      DO 10 IL=2,IE                                                     E4INZ071
      K=MAC(IM,IC,IL)                                                   E4INZ072
      K1=NEL(K,6)                                                       E4INZ073
      IF (K1) 11,11,12                                                  E4INZ074
 12   K1=ITE+K1                                                         E4INZ075
      TE=TE+AA(K1)                                                      E4INZ076
 11   K1=NEL(K,9)                                                       E4INZ077
      IF (K1) 13,13,14                                                  E4INZ078
 14   K1=IDT+K1                                                         E4INZ079
      DT=DT+AA(K1)                                                      E4INZ080
 13   K1=NEL(K,7)                                                       E4INZ081
      IF (K1) 10,10,15                                                  E4INZ082
 15   K1=IDZ+K1                                                         E4INZ083
      DG=DG+AA(K1)                                                      E4INZ084
 10   CONTINUE                                                          E4INZ085
      CC=IE-1                                                           E4INZ086
      TE=TE/CC                                                          E4INZ087
      DG=DG/CC                                                          E4INZ088
      DT=DT/CC                                                          E4INZ089
C     DETERMINE NECESSARY PARAMETERS ACCORDING TO CLASS                 E4INZ090
      ICOL=3                                                            E4INZ091
      IRIG=1                                                            E4INZ092
      IDR=0                                                             E4INZ093
      ICAS=ICAS                                                         E4INZ094
      GO TO (69,62,69,64,65,66,69,68),ICAS                              E4INZ095
 62   IDR=1                                                             E4INZ096
      GO TO 69                                                          E4INZ097
 64   ICOL=6                                                            E4INZ098
      GO TO 69                                                          E4INZ099
 65   ICOL=1                                                            E4INZ100
      GO TO 69                                                          E4INZ101
 66   ICOL=1                                                            E4INZ102
      IRIG=2                                                            E4INZ103
      GO TO 69                                                          E4INZ104
 68   IRIG=2                                                            E4INZ105
C     INITIALIZE THE OTHER CONSTANTS                                    E4INZ106
 69   ANGLE=0.                                                          E4INZ107
      ICON=0                                                            E4INZ108
      IERR=0                                                            E4INZ109
C     GENERATE BAS VECTOR                                               E4INZ110
      IE=MAC(IM,IC,2)                                                   E4INZ111
      K=NEL(IE,10)                                                      E4INZ112
      CALL FINDX(K,X)                                                   E4INZ113
      K=NEL(IE,11)                                                      E4INZ114
      CALL FINDX(K,Y)                                                   E4INZ115
      BAS(1)=Y(1)-X(1)                                                  E4INZ116
      BAS(2)=Y(2)-X(2)                                                  E4INZ117
      BAS(3)=Y(3)-X(3)                                                  E4INZ118
      CC=1.                                                             E4INZ119
      CALL UNIT(BAS,CC)                                                 E4INZ120
      IF (INP-2) 20,21,21                                               E4INZ121
 21   WRITE OUTPUT TAPE 6,22,TE,DT,DG,BAS(1),BAS(2),BAS(3)              E4INZ122
 22   FORMAT (20X,5HTHICK,2X,E11.4,3X,11HTEMP.INCRSE,2X,E11.4,3X,10HTEMPE4INZ123
     1.GRAD.,2X,E11.4,3X,3HBAS,2X,3F7.3)                                E4INZ124
 20   RETURN                                                            E4INZ125
      END                                                               E4INZ126
```

Table VII-68. Source program listing of subroutine INV (Link 4)

```
*       LABEL
CF4INV
        SUBROUTINE    INV(A,N,B,M,DETERM)
C       INVERTS MATRICES UPTO ORDER 8 BY GAUSS ELIMINATION
        DIMENSION IPIVOT( 8),A( 8, 8),B( 8,2),INDEX( 8,2),PIVOT( 8)
        EQUIVALENCE (IROW,JROW), (ICOLUM,JCOLUM), (AMAX, T, SWAP)
C
C
C       INITIALIZATION
C
   10 DETERM=1.0
   15 DO 20 J=1,N
   20 IPIVOT(J)=0
      BB=1.E-30
      GO TO 9003
 9002 DETERM=0.
      GO TO 740
 9003 CONTINUE
   30 DO 550 I=1,N
C
C       SEARCH FOR PIVOT ELEMENT
C
   40 AMAX=0.0
   45 DO 105 J=1,N
   50 IF (IPIVOT(J)-1) 60, 105, 60
   60 DO 100 K=1,N
   70 IF (IPIVOT(K)-1) 80, 100, 9002
   80 IF (ABSF(AMAX)-ABSF(A(J,K))) 85, 100, 100
   85 IROW=J
   90 ICOLUM=K
   95 AMAX=A(J,K)
  100 CONTINUE
  105 CONTINUE
      IF (ABSF(AMAX)-BB) 9002,9002,110
  110 IPIVOT(ICOLUM)=IPIVOT(ICOLUM)+1
C
C       INTERCHANGE ROWS TO PUT PIVOT ELEMENT ON DIAGONAL
C
  130 IF (IROW-ICOLUM) 140, 260, 140
  140 DETERM=-DETERM
  150 DO 200 L=1,N
  160 SWAP=A(IROW,L)
  170 A(IROW,L)=A(ICOLUM,L)
  200 A(ICOLUM,L)=SWAP
  205 IF(M) 260, 260, 210
  210 DO 250 L=1, M
  220 SWAP=B(IROW,L)
  230 B(IROW,L)=B(ICOLUM,L)
  250 B(ICOLUM,L)=SWAP
  260 INDEX(I,1)=IROW
  270 INDEX(I,2)=ICOLUM
  310 PIVOT(I)=A(ICOLUM,ICOLUM)
  320 DETERM=DETERM*PIVOT(I)
C
C       DIVIDE PIVOT ROW BY PIVOT ELEMENT
C
  330 A(ICOLUM,ICOLUM)=1.0
  340 DO 350 L=1,N
  350 A(ICOLUM,L)=A(ICOLUM,L)/PIVOT(I)
  355 IF(M) 380, 380, 360
  360 DO 370 L=1,M
  370 B(ICOLUM,L)=B(ICOLUM,L)/PIVOT(I)
C
C       REDUCE NON-PIVOT ROWS
C
  380 DO 550 L1=1,N
  390 IF(L1-ICOLUM) 400, 550, 400
  400 T=A(L1,ICOLUM)
  420 A(L1,ICOLUM)=0.0
  430 DO 450 L=1,N
  450 A(L1,L)=A(L1,L)-A(ICOLUM,L)*T
  455 IF(M) 550, 550, 460
  460 DO 500 L=1,M
  500 B(L1,L)=B(L1,L)-B(ICOLUM,L)*T
  550 CONTINUE
C
C       INTERCHANGE COLUMNS
C
  600 DO 710 I=1,N
  610 L=N+1-I
  620 IF (INDEX(L,1)-INDEX(L,2)) 630, 710, 630
  630 JROW=INDEX(L,1)
  640 JCOLUM=INDEX(L,2)
  650 DO 705 K=1,N
  660 SWAP=A(K,JROW)
  670 A(K,JROW)=A(K,JCOLUM)
  700 A(K,JCOLUM)=SWAP
  705 CONTINUE
  710 CONTINUE
  740 RETURN
      END
```

Table VII-69. Source program listing of subroutine LEST (Link 4)

```
*       LABEL
CE4LST
      SUBROUTINE LEST
C     OBTAINS STRAIN COMPONENTS BY LEAST SQUARES AT A NODE
      DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)
     1,P(24),OV(24),X(8),Y(8),Z(8),XO(7),YO(7),ZO(7),G(11)
      COMMON IA,AA
      EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),F),(D21(20),G)
      EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),
     1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),
     2IH),(IA(11),IB),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),
     3IMF),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),
     4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),
     5(IA(32),ISUM),(IA(33),INO),(IA(34),IMS),(IA(36),IDS),(IA(37),
     6IORD),(IA(38),IROT),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),
     7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57
     8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBD),(IA(61),IID),(IA(62),
     9IA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITE),(IA(41),ITAP)
      EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),
     1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),
     2(IA(74),IIC),(IA(75),IDEF),(IA(76),ISI),(IA(77),IIS)
     3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TF),(AA(81),DT),(AA(82),DG),
     4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D2L),(AA(107),P),
     5(AA(131),OV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XO),
     6(AA(186),YO),(AA(193),ZO),(AA(351),S),(AA(40),ZGEM)
     7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IU
     8),(AA(47),G1),(AA(48),G2),(AA(49),G3)
      EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346)
     1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)
     2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)
     3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)
     4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)
     5,(IA(329),IPIR)
      DIMENSION BIR(3),SIR(3),DIN(3,3),SR(6),XN(3),XF(3),ON(6),OF(6),
     1RES(6),RED(6),BAS(3),ICLAS(4),NBAN(10),NU(3),NES(3)
      EQUIVALENCE (AA(200),IONE),(AA(201),ICN),(AA(202),LM),(AA(203),AST
     1),(AA(204),INBON),(AA(205),ARE),(AA(206),ICLA),(AA(207),IMEL),
     2(AA(208),IM),(AA(209),IC),(AA(210),ICON),(AA(211),ANGLE),(AA(212),
     3ICAS),(AA(213),IF),(AA(214),NB),(AA(215),MB)
     4,(AA(216),IROT),(AA(217),BST)
      EQUIVALENCE (AA(220),BIR),(AA(223),SIR),(AA(226),DIN),(AA(235),SR)
     1,(AA(241),XN),(AA(244),XF),(AA(247),ON),(AA(253),OF),(AA(259),RES)
     2,(AA(265),RED),(AA(271),BAS),(AA(274),ICLAS),(AA(278),NBAN)
     3,(AA(292),NU),(AA(295),NES)
      DIMENSION NEL(20,17),MAC(4,4,20),IWG(90),DD(6,6),A(90,7),B(8,8),
     1C(8,2),FF(1),NSET(100),MSET(100),W(3,3)
      EQUIVALENCE (AA(14000),FF),(NU(1),JP1),(NU(2),JM1),(NU(3),JS1)
      EQUIVALENCE (FF(1),NEL),(FF(341),MAC),(FF(661),IWG),(FF(751),DD),
     1(FF(787),A),(FF(1417),B),(FF(1481),C),(FF(1497),NSET),(FF(1597),
     2MSET),(FF(1697),W)
      DIMENSION U(3,5),CDIS(3),CROT(3),ODIS(3),DROT(3),DCOR(3)
      EQUIVALENCE (X(1),U,DCOR),(X(4),CDIS),(X(7),CROT),(X(10),ODIS),
     1(X(13),DROT)
      EQUIVALENCE (NES(1),JMM),(NES(2),JMR)
      JMX=JMM+JMR
      ICAS=ICAS
      ICONN=ICON
      IERR=0
      DO 6 I=1,JMM
      DO 6 J=I,JMX
      B(I,J)=0.
      DO 7 K=1,ICONN
      KMX=IWG(K)
      DO 8 L=1,KMX
 8    B(I,J)=B(I,J)+A(K,I)*A(K,J)
 7    CONTINUE
      IF (J-JMM) 61,61,6
 61   B(J,I)=B(I,J)
 6    CONTINUE
      DO 10 I=1,JMM
      DO 10 J=1,JMR
      JC=J+JMM
 10   C(I,J)=B(I,JC)
      CALL INV(B,JMM,C,JMR,DET)
C     REARRANGE STRAINS
      GO TO (11,12,13,20,15,16,20,20),ICAS
 11   C(4,1)=0.
      JMM=4
      GO TO 20
 12   DO 121 I=1,3
      C(I,2)=C(I,1)
 121  C(I,1)=0.
      JMR=2
      GO TO 20
 13   IF(XN(1)) 131,131,132
 131  C(4,1)=C(1,1)
      GO TO 133
 132  C(4,1)=ON(1)/XN(1)-DT*AL3
 133  JMM=4
      GO TO 20
 15   IF (XN(1)) 152,152,151
 151  C(2,1)=(CDIS(1)*DIN(1,1)-CDIS(3)*DIN(2,1))/XN(1)-DT*AL3
      GO TO 153
 152  C(2,1)=(DDIS(1)*DIN(1,1)-ODIS(3)*DIN(2,1))/DCOR(1)-DT*AL3
 153  JMM=2
      GO TO 20
 16   IF (XN(1)) 162,162,161
 161  C(2,2)=-ON(3)*DIN(1,1)/XN(1)+DG*AL3
      GO TO 163
 162  C(2,2)=-DROT(3)*DIN(1,1)/DCOR(1)+DG*AL3
 163  GO TO 15
 20   CONTINUE
      IF (DET)  105,1000,105
 105  IF (INP-2) 205,206,206
 206  WRITE OUTPUT TAPE 6,207,BST,JMM,JMR,DET,((C(I,J),I=1,JMM),J=1,JMR)
 207  FORMAT (15X,A2,3X,40HBEST FIT STRAIN TENSOR COMPONENTS FOLLOW,I4,
     13H X ,I1,5X,4HDET=,E15.7/18X,6F15.5)
 205  RETURN
 1000 IERR=1
      GO TO 105
      END
```

Table VII-70. Source program listing of subroutine MDIN (Link 4)

```
*      LABEL
CE4MDN                                                                  F4MDN000
      SUBROUTINE MDIN                                                   F4MDN001
C     ORIENTS LOCAL AXES PROPERLY AT A BOUNDARY NODE IN SHELLS          F4MDN002
C     TO ROTATE LOCAL AXES (DIN) SO THAT KSI IS IN ZTA-BIR PLANE        F4MDN003
      DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)         F4MDN004
     1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)              F4MDN005
      COMMON IA,AA                                                      F4MDN006
      EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),E),(D21(20),G)F4MDN007
      EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),II),(IA(4),IP),(IA(5),  F4MDN008
     1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),F4MDN009
     2IH),(IA(11),IB),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),F4MDN010
     3IMFI),(IA(16),IARE),(IA(17),NI1)),(IA(25),MI),(IA(26),ITY),(IA(27),F4MDN011
     4ISTR),(IA(28),IFLT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMFT),    F4MDN012
     5(IA(32),ISUM),(IA(33),INO),(IA(34),IMS),(IA(36),IDS),(IA(37),     F4MDN013
     6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),      F4MDN014
     7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57F4MDN015
     8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBD),(IA(61),IID),(IA(62),F4MDN016
     9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITE),(IA(41),ITAP)         F4MDN017
      EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),    F4MDN018
     1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),       F4MDN019
     2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)              F4MDN020
     3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TF),(AA(81),DT),(AA(82),DG), F4MDN021
     4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D2)),(AA(107),P),  F4MDN022
     5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),    F4MDN023
     6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)               F4MDN024
     7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),THF4MDN025
     8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                             F4MDN026
      EQUIVALENCE (IA(349),NIIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346) F4MDN027
     1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)   F4MDN028
     2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)      F4MDN029
     3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)       F4MDN030
     4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)         F4MDN031
     5,(IA(329),IPIR)                                                   F4MDN032
      DIMENSION BIR(3),SIR(3),DIN(3,3),SR(6),XN(3),XF(3),QN(6),QF(6),   F4MDN033
     1RES(6),RED(6),BAS(3),ICLAS(4),NBAN(10),NU(3),NES(3)               F4MDN034
      EQUIVALENCE (AA(200),IONE),(AA(201),ICN),(AA(202),LM),(AA(203),ASTF4MDN035
     1),(AA(204),INBON),(AA(205),ARE),(AA(206),ICLA),(AA(207),IMEL),    F4MDN036
     2(AA(208),IM),(AA(209),IC),(AA(210),ICON),(AA(211),ANGLE),(AA(212),F4MDN037
     3ICAS),(AA(213),IE),(AA(214),NB),(AA(215),MB)                      F4MDN038
     4,(AA(216),IROT),(AA(217),BST)                                     F4MDN039
      EQUIVALENCE (AA(220),BIR),(AA(223),SIR),(AA(226),DIN),(AA(235),SR)F4MDN040
     1,(AA(241),XN),(AA(244),XF),(AA(247),QN),(AA(253),QF),(AA(259),RES)F4MDN041
     2,(AA(265),RED),(AA(271),BAS),(AA(274),ICLAS),(AA(278),NBAN)       F4MDN042
     3,(AA(292),NU),(AA(295),NES)                                       F4MDN043
      DIMENSION NEL(20,17),MAC(4,4,20),IWG(90),DD(6,6),A(90,7),B(8,8),  F4MDN044
     1C(8,2),FF(1),NSET(100),MSET(100),W(3,3)                           F4MDN045
      EQUIVALENCE (AA(14000),FF),(NU(1),JP1),(NU(2),JM1),(NU(3),JS1)    F4MDN046
      EQUIVALENCE (FF(1),NEL),(FF(341),MAC),(FF(661),IWG),(FF(751),DD), F4MDN047
     1(FF(787),A),(FF(1417),B),(FF(1481),C),(FF(1497),NSET),(FF(1597),  F4MDN048
     2MSET),(FF(1697),W)                                                F4MDN049
      DIMENSION XII(3),ETA(3),ZTA(3)                                    F4MDN050
      EQUIVALENCE (DIN(1),XII),(DIN(4),ETA),(DIN(7),ZTA)                F4MDN051
C     SET INDICATORS TO (LOCAL IS DIFFERENT THAN OVERALL)               F4MDN052
      IROT=1                                                            F4MDN053
      BST=2H**                                                          F4MDN054
C     SEE IF A SOLID                                                    F4MDN055
      IF (ICAS-4) 33,31,33                                              F4MDN056
C     SOLID CASE. FIND THE AXIS WHICH MAKES LARGEST ANGLE WITH BIR      F4MDN057
 31   IF (ABSF(BIR(1))-ABSF(BIR(2))) 315,315,316                        F4MDN058
 315  IF (ABSF(BIR(1))-ABSF(BIR(3))) 311,311,313                        F4MDN059
 316  IF (ABSF(BIR(2))-ABSF(BIR(3))) 312,312,313                        F4MDN060
 311  CALL VECT(ETA,BIR,XII)                                            F4MDN061
      GO TO 35                                                          F4MDN062
 312  CALL VECT(SIR,BIR,ETA)                                            F4MDN063
      ETA(1)=SIR(1)                                                     F4MDN064
      ETA(2)=SIR(2)                                                     F4MDN065
      ETA(3)=SIR(3)                                                     F4MDN066
      GO TO 35                                                          F4MDN067
 313  CALL VECT(ETA,BIR,ZTA)                                            F4MDN068
 35   CC=1.                                                             F4MDN069
      CALL UNIT(ETA,CC)                                                 F4MDN070
      CALL VECT(ZTA,BIR,ETA)                                            F4MDN071
      CALL UNIT(ZTA,CC)                                                 F4MDN072
      CALL VECT(XII,ETA,ZTA)                                            F4MDN073
      CALL UNIT(XII,CC)                                                 F4MDN074
      GO TO 22                                                          F4MDN075
C     NON-SOLID CASE                                                    F4MDN076
 33   CC=1.                                                             F4MDN077
      CALL VECT (ETA,ZTA,BIR)                                           F4MDN078
      CALL UNIT (ETA,CC)                                                F4MDN079
      CALL VECT (XII,ETA,ZTA)                                           F4MDN080
      CALL UNIT (XII,CC)                                                F4MDN081
 22   RETURN                                                            F4MDN082
      END                                                               F4MDN083
```

Table VII-71. Source program listing of subroutine META (Link 4)

```
CE4MET
      SUBROUTINE META
C     TO GENERATE MATERIAL MATRIX DD IN THE ORDER OF 1,2,12,3,13,23
C     IN LOCAL COORDINATE SYSTEM
      DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)
     1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)
      COMMON IA,AA
      EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),E),(D21(20),G)
      EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),
     1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),
     2IH),(IA(11),I8),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),
     3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),
     4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),
     5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),
     6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),
     7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57
     8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBO),(IA(61),IID),(IA(62),
     9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITF),(IA(41),ITAP)
      EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),
     1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),
     2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)
     3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG),
     4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),
     5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),
     6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)
     7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IIE
     8),(AA(47),G1),(AA(48),G2),(AA(49),G3)
      EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346)
     1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)
     2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)
     3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)
     4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)
     5,(IA(329),IPIR)
      DIMENSION BIR(3),SIR(3),DIN(3,3),SR(6),XN(3),XF(3),QN(6),QF(6),
     1RES(6),RED(6),BAS(3),ICLAS(4),NBAN(10),NU(3),NES(3)
      EQUIVALENCE (AA(200),IONE),(AA(201),ICN),(AA(202),LM),(AA(203),AST
     1),(AA(204),INBUN),(AA(205),ARE),(AA(206),ICLA),(AA(207),IMEL),
     2(AA(208),IM),(AA(209),IC),(AA(210),ICON),(AA(211),ANGLE),(AA(212),
     3ICAS),(AA(213),IE),(AA(214),NB),(AA(215),MB)
     4,(AA(216),IROT),(AA(217),BST)
      EQUIVALENCE (AA(220),BIR),(AA(223),SIR),(AA(226),DIN),(AA(235),SR)
     1,(AA(241),XN),(AA(244),XF),(AA(247),QN),(AA(253),QF),(AA(259),RES)
     2,(AA(265),RED),(AA(271),BAS),(AA(274),ICLAS),(AA(278),NBAN)
     3,(AA(292),NU),(AA(295),NES)
      DIMENSION NEL(20,17),MAC(4,4,20),IWG(90),DD(6,6),A(90,7),B(8,8),
     1C(8,2),FF(1),NSET(100),MSET(100),W(3,3)
      EQUIVALENCE (AA(4000),FF),(NU(1),JP1),(NU(2),JM1),(NU(3),JS1)
      EQUIVALENCE (FF(1),NEL),(FF(341),MAC),(FF(661),IWG),(FF(751),DD),
     1(FF(787),A),(FF(1417),B),(FF(1481),C),(FF(1497),NSET),(FF(1597),
     2MSET),(FF(1697),W)
C     INITIALIZE DD ALPHA CONSTANTS
      DO 10 I=1,6
      DO 10 J=1,6
 10   DD(I,J)=0.
      AL1=0.
      AL2=0.
      AL3=0.
C     INQUIRE THE TYPE AND GENERATE DD IN THE ORDER OF 1,2,3,12,13,23
      IF (ITYPE-1) 20,30,40
C     ISOTROPIC MATERIAL
 20   IIDI=IID+(IMET-1)*2
      E=AA(IIDI+1)
      G=AA(IIDI+2)
      IIAI=IIA+IMET
      AL1=AA(IIAI)
      AL2=AL1
      AL3=AL1
      PU=E/(2.*G)-1.
      IF (ISTR-1) 209,210,209
 209  IF (ICAS-3) 208,210,208
 208  IF (ICAS-4) 207,210,207
 207  E1=E/(1.-PU*PU)
      E2=E1*PU
      K=2
      GO TO 220
 210  K=3
      E1=E*(1.-PU)/((1.-2.*PU)*(1.+PU))
      E2=E*PU/((1.-2.*PU)*(1.+PU))
 220  DO 201 I=1,K
      DO 201 J=I,K
      IF (I-J) 203,202,203
 202  DD(I,J)=E1
      DD(I+3,J+3)=G
      GO TO 201
 203  DD(I,J)=E2
 201  CONTINUE
      IF (K-2) 60,204,60
 204  DD(6,6)=G
      GO TO 60
C     ORTHOTROPIC MATERIAL
 30   IIAI=IIA+(IMET-1)*2
      AL1=AA(IIAI+1)
      AL2=AA(IIAI+2)
      IIDI=IID+(IMET-1)*9
      DD(1,1)=AA(IIDI+1)
      DD(1,2)=AA(IIDI+2)
      DD(1,4)=AA(IIDI+3)
      DD(2,2)=AA(IIDI+4)
      DD(2,4)=AA(IIDI+5)
      DD(4,4)=AA(IIDI+6)
      DD(5,5)=AA(IIDI+7)
      DD(5,6)=AA(IIDI+8)
      DD(6,6)=AA(IIDI+9)
      IF (ISTR-1) 60,301,60
 301  DD(1,3)=DD(1,2)
      DD(2,3)=DD(1,2)
      GO TO 60
C     GENERAL HOOKIAN MATERIAL
 40   IIAI=IIA+(IMET-1)*3
      AL1=AA(IIAI+1)
      AL2=AA(IIAI+2)
      AL3=AA(IIAI+3)
      IIDI=IID+(IMET-1)*21
      DO 401 I=1,6
      DO 401 J=I,6
      IIDI=IIDI+1
 401  DD(I,J)=AA(IIDI)
C     OBTAIN THE SYMMETRIC HALF
 60   DO 61 I=1,6
      DO 61 J=I,6
 61   DD(J,I)=DD(I,J)
C     ROTATE MATERIAL AXES IF NECESSARY SO THAT THEY COINCIDE WITH DIN
      IF (IROT) 71,70,71
 71   CALL ROTA
C     SWITCH COLUMNS AND ROWS 3 AND 4 TO GET THE ORDER 1,2,12,3,13,23
 70   DO 62 I=1,6
      E1=DD(4,I)
      DD(4,I)=DD(3,I)
 62   DD(3,I)=E1
      DO 63 I=1,6
      E1=DD(I,4)
      DD(I,4)=DD(I,3)
 63   DD(I,3)=E1
      IF (INP-2) 100,91,91
 91   WRITE OUTPUT TAPE 6,92,ICN,BST,IMET,((DD(I,J),J=1,6),I=1,6)
 92   FORMAT (I5,10X,A2,3X,57HMATERIAL MATRIX (IN 1,2,12,3,13,23 ORDER)
     1FOLLOWS,  MAT.=,I3/(20X,6E14.5))
 100  RETURN
      END
```

Table VII-72. Source program listing of subroutine QUAD (Link 4)

```
*       LABEL
CE4UAD                                                                  E40AD0000
      SUBROUTINE QUAD                                                   E40AD001
C     FINDS LOCAL COORINATE AXES BY BEST FIT QUADRATIC IN SHELLS        E40AD002
C     TO ESTABLISH DIN(3,3) AND ANGLE BY BEST FIT QUADRATIC SURFACE (9PE40AD003
      DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)        E40AD004
     1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)             E40AD005
      COMMON IA,AA                                                      E40AD006
      EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),E),(D21(20),G)E40AD007
      EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),  E40AD008
     1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),E40AD009
     2IH),(IA(11),IB),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),E40AD010
     3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),IIY),(IA(27),E40AD011
     4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),    E40AD012
     5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),     E40AD013
     6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),      E40AD014
     7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57E40AD015
     8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBD),(IA(61),IID),(IA(62),E40AD016
     9IA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITE),(IA(41),ITAP)          E40AD017
      EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),    E40AD018
     1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),       E40AD019
     2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)              E40AD020
     3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG), E40AD021
     4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),  E40AD022
     5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),    E40AD023
     6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)              E40AD024
     7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IUE40AD025
     B1,(AA(47),G1),(AA(48),G2),(AA(49),G3)                            E40AD026
      EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346) E40AD027
     1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)   E40AD028
     2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)      E40AD029
     3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),ID7)       E40AD030
     4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)         E40AD031
     5,(IA(329),IPIR)                                                   E40AD032
      DIMENSION BIR(3),SIR(3),DIN(3,3),SR(6),XN(3),XF(3),ON(6),OF(6),   E40AD033
     1RES(6),RED(6),BAS(3),ICLAS(4),NBAN(10),NU(3),NES(3)               E40AD034
      EQUIVALENCE (AA(200),IONE),(AA(201),ICN),(AA(202),LM),(AA(203),ASTE40AD035
     1),(AA(204),INBON),(AA(205),ARE),(AA(206),ICLA),(AA(207),IMEL),    E40AD036
     2(AA(208),IM),(AA(209),IC),(AA(210),ICON),(AA(211),ANGLE),(AA(212),E40AD037
     3ICAS),(AA(213),IE),(AA(214),NB),(AA(215),MB)                     E40AD038
     4,(AA(216),IROT),(AA(217),BST)                                     E40AD039
      EQUIVALENCE (AA(220),BIR),(AA(223),SIR),(AA(226),DIN),(AA(235),SR)E40AD040
     1,(AA(241),XN),(AA(244),XF),(AA(247),ON),(AA(253),OF),(AA(259),RES)E40AD041
     2,(AA(265),RED),(AA(271),BAS),(AA(274),ICLAS),(AA(278),NBAN)      E40AD042
     3,(AA(292),NU),(AA(295),NES)                                       E40AD043
      DIMENSION NEL(20,17),MAC(4,4,20),IWG(90),DD(6,6),A(90,7),B(8,8),  E40AD044
     1C(B,2),FF(1),NSET(100),MSET(100),W(3,3)                           E40AD045
      EQUIVALENCE (AA(14000),FF),(NU(1),JPL),(NU(2),JML),(NU(3),JSL)    E40AD046
      EQUIVALENCE (FF(1),NEL),(FF(341),MAC),(FF(661),IWG),(FF(751),DD), E40AD047
     1(FF(787),A),(FF(1417),B),(FF(1481),C),(FF(1497),NSET),(FF(1597),  E40AD048
     2MSET),(FF(1697),W)                                                E40AD049
      DIMENSION  XII(3),ETA(3),ZTA(3),D(50,9)                           E40AD050
      EQUIVALENCE (DIN(1),XII),(DIN(4),ETA),(DIN(7),ZTA),(A,D)          E40AD051
C     FIND THE SET OF NODES TO BE USED AND LIST THEM IN NSET ARRAY      E40AD052
      IC=IC                                                             E40AD053
      IM=IM                                                             E40AD054
      IE=MAC(IM,IC,1)+1                                                 E40AD055
      K=0                                                               E40AD056
      DO 10 I=2,IE                                                      E40AD057
      IELT=MAC(IM,IC,I)                                                 E40AD058
      IMS=NEL(IELT,5)                                                   E40AD059
      DO 9 J=1,IMS                                                      E40AD060
      K=K+1                                                             E40AD061
    9 MSET(K)=NEL(IELT,J+9)                                             E40AD062
   10 CONTINUE                                                          E40AD063
C     OBTAIN GENERAL DIRECTION OF MIDDLE SURFACE NORMAL ON ZD           E40AD064
      I=MSET(1)                                                         E40AD065
      CALL FINDX(I,X)                                                   E40AD066
      I=MSET(2)                                                         E40AD067
      CALL FINDX(I,Y)                                                   E40AD068
      XD(1)=Y(1)-X(1)                                                   E40AD069
      XD(2)=Y(2)-X(2)                                                   E40AD070
      XD(3)=Y(3)-X(3)                                                   E40AD071
      I=MSET(3)                                                         E40AD072
      CALL FINDX(I,X)                                                   E40AD073
      YD(1)=X(1)-Y(1)                                                   E40AD074
      YD(2)=X(2)-Y(2)                                                   E40AD075
      YD(3)=X(3)-Y(3)                                                   E40AD076
      CALL VECT (ZD,XD,YD)                                              E40AD077
      NB=0                                                              E40AD078
      DO 13 I=1,K                                                       E40AD079
      IF (MSET(I)) 13,13,131                                            E40AD080
  131 NODE=MSET(I)                                                      E40AD081
      NB=NB+1                                                           E40AD082
      NSET(NB)=NODE                                                     E40AD083
      DO 12 J=I,K                                                       E40AD084
      IF (NODE-MSET(J)) 12,121,12                                       E40AD085
  121 MSET(J)=0                                                         E40AD086
   12 CONTINUE                                                          E40AD087
   13 CONTINUE                                                          E40AD088
C     SEE IF THERE ARE ENOUGH NODES                                     E40AD089
      IF (NB-9) 16,15,15                                                E40AD090
C     NOT ENOUGH, EXPAND THE POPULATION                                 E40AD091
   16 CALL EPAN                                                         E40AD092
   15 IF (INP-2) 17,18,18                                               E40AD093
   18 WRITE OUTPUT TAPE 6,181,NB,(NSET(I),I=1,NB)                       E40AD094
  181 FORMAT (20X,47HNODE SET FOR BEST FIT QUADRATIC SURFACE FOLLOWS,I10E40AD095
     1/(20X,20I5))                                                      E40AD096
C     FIND CRUDE DIRECTION FOR MIDDLE SURFACE NORMAL                    E40AD097
   17 CALL BEST(ZTA,NSET,NB)                                            E40AD098
      Q=ZTA(1)**2+ZTA(2)**2+ZTA(3)**2                                   E40AD099
      IF (Q) 172,171,172                                                E40AD100
  171 ZTA(1)=ZD(1)                                                      E40AD101
      ZTA(2)=ZD(2)                                                      E40AD102
      ZTA(3)=ZD(3)                                                      E40AD103
C     GENERATE FIRST APPROXIMATION FOR DIN                              E40AD104
  172 ICAT=0                                                            E40AD105
      XII(1)=BAS(1)                                                     E40AD106
      XII(2)=BAS(2)                                                     E40AD107
      XII(3)=BAS(3)                                                     E40AD108
  203 Q=1.                                                              E40AD109
      IF (SCAL(ZD,ZTA)) 201,201,202                                     E40AD110
  201 Q=-1.                                                             E40AD111
  202 CALL UNIT (ZTA,Q)                                                 E40AD112
      CALL VECT (ETA,ZTA,XII)                                           E40AD113
      CALL UNIT (ETA,Q)                                                 E40AD114
      CALL VECT (XII,ETA,ZTA)                                           E40AD115
      CALL UNIT (XII,Q)                                                 E40AD116
      IF (NB-9) 19,20,20                                                E40AD117
   19 WRITE OUTPUT TAPE 6,191,ICN                                       E40AD118
  191 FORMAT (I5,13X,71HNOT ENOUGH INFORMATION FOR BEST FIT QUADRATIC. BE40AD119
     1EST FIT PLANE IS USED. )                                          E40AD120
      GO TO 100                                                         E40AD121
C     SEE IF THIS DIN IS ACCEPTABLE                                     E40AD122
   20 IF (ICAT-2) 204,205,205                                           E40AD123
C     NOT ACCEPTABLE, CONTINUE ITERATION                                E40AD124
  204 L=0                                                               E40AD125
C     GENERATE EQUATIONS FOR THE COEFFICIENTS OF BEST FIT QUADRATIC     E40AD126
      DO 25 I=1,NB                                                      E40AD127
      NODE=NSET(I)                                                      E40AD128
      IF (ICN-NODE) 21,25,21                                            E40AD129
   21 CALL FINDX(NODE,XF)                                               E40AD130
      DO 211 J=1,3                                                      E40AD131
      X(J)=0.                                                           E40AD132
      DO 212 K=1,3                                                      E40AD133
  212 X(J)=X(J)+(XF(K)-XN(K))*DIN(K,J)                                  E40AD134
  211 CONTINUE                                                          E40AD135
      L=L+1                                                             E40AD136
      D(L,1)=X(1)**2                                                    E40AD137
      D(L,2)=X(2)**2                                                    E40AD138
      D(L,3)=X(3)**2                                                    E40AD139
      D(L,4)=X(1)*X(2)                                                  E40AD140
      D(L,5)=X(1)*X(3)                                                  E40AD141
      D(L,6)=X(2)*X(3)                                                  E40AD142
      D(L,7)=X(1)                                                       E40AD143
      D(L,8)=X(2)                                                       E40AD144
      D(L,9)=X(3)                                                       E40AD145
   25 CONTINUE                                                          E40AD146
C     OBTAIN THE LEAST SQUARE EQUATIONS                                 E40AD147
      DO 28 I=1,8                                                       E40AD148
      DO 27 J=I,8                                                       E40AD149
      B(I,J)=0.                                                         E40AD150
      DO 291 K=1,L                                                      E40AD151
  291 B(I,J)=B(I,J)+D(K,I)*D(K,J)                                       E40AD152
   27 B(J,I)=B(I,J)                                                     E40AD153
      C(I,1)=0.                                                         E40AD154
      DO 26 K=1,L                                                       E40AD155
   26 C(I,1)=C(I,1)+D(K,I)*D(K,9)                                       E40AD156
   28 CONTINUE                                                          E40AD157
C     SOLVE FOR THE COEFFICIENTS                                        E40AD158
      CALL INV(B,8,C,1,DET)                                             E40AD159
      IF (DET) 29,19,29                                                 E40AD160
   29 ZTA(1)=XII(1)*C(7,1)+ETA(1)*C(8,1)-ZTA(1)                         E40AD161
      ZTA(2)=XII(2)*C(7,1)+ETA(2)*C(8,1)-ZTA(2)                         E40AD162
      ZTA(3)=XII(3)*C(7,1)+ETA(3)*C(8,1)-ZTA(3)                         E40AD163
      ICAT=ICAT+1                                                       E40AD164
      GO TO 203                                                         E40AD165
C     DIN ACCEPTABLE. SEE IF PRINCIPAL CURVATURE DIRECTIONS ARE REQUIREDE40AD166
  205 ANGLE=0.                                                          E40AD167
      IF (IPIR-1) 100,206,206                                           E40AD168
C     YES, ROTATE DIN AROUND ZTA UNTILL XII,ETA PRINCIPAL               E40AD169
  206 FC=C(1,1)-C(2,1)                                                  E40AD170
      ER=ABSF(C(1,1))+ABSF(C(2,1))                                      E40AD171
      ER=ER*1.E-2                                                       E40AD172
      IF(ABSF(FC)-ER) 24,24,34                                          E40AD173
   34 ANGLE=ATANF (C(4,1)/FC)/2.                                        E40AD174
      GO TO 341                                                         E40AD175
   24 ANGLE=0.                                                          E40AD176
  341 CES=COSF(ANGLE)                                                   E40AD177
      SEN=SINF(ANGLE)                                                   E40AD178
C     COMPUTE CURVATURES                                                E40AD179
      X(1)=CES*CES*C(1,1)+SEN*SEN*C(2,1)+2.*CES*SEN*C(4,1)              E40AD180
      X(2)=SEN*SEN*C(1,1)+CES*CES*C(2,1)-2.*CES*SEN*C(4,1)              E40AD181
C     FIND SMALLER CURVATURE DIRECTION                                  E40AD182
      IF (ABSF(X(1))-ABSF(X(2))) 343,100,342                            E40AD183
  342 FC=CES                                                            E40AD184
      CES=-SEN                                                          E40AD185
      SEN=FC                                                            E40AD186
C     BRING XII ON SMALLER CURVATURE DIRECTION                          E40AD187
  343 DO 35 I=1,3                                                       E40AD188
      X(I)=CES*DIN(I,1)+SEN*DIN(I,2)                                    E40AD189
      Y(I)=CES*DIN(I,2)-SEN*DIN(I,1)                                    E40AD190
   35 CONTINUE                                                          E40AD191
      DO 36 I=1,3                                                       E40AD192
      DIN (I,1)=X(I)                                                    E40AD193
   36 DIN (I,2)=Y(I)                                                    E40AD194
      ANGLE=ANGLE*180./3.14159                                          E40AD195
  100 RETURN                                                            E40AD196
      END                                                               E40AD197
```

Table VII-73. Source program listing of subroutine REVO (Link 4)

```
*       LABEL
CE4REV
      SUBROUTINE REVO
C     FINDS LOCAL AXES BY BEST FIT 4 TH ORDER POLYNOMIAL IN SHELLS OF RV
C     TO FIND DIN(3,3) FOR SHELLS OF REVOLUTION BY 4TH ORDER PLYNML FIT
      DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),F22(3,3)
     1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),GI(1)
      COMMON IA,AA
      EQUIVALENCE(IA,AA),(D21,D33),(D21(10),F22),(D21(19),F),(D21(20),G)
      EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),
     1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDFG),(IA(9),INX),(IA(10),
     2IH),(IA(11),IB),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),
     3IMF1),(IA(16),IARE),(IA(17),NI11),(IA(25),M),(IA(26),ITY),(IA(27),
     4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),
     5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),
     6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),
     7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57
     8),JB),(IA(58),JTY),(IA(59),IBB),(IA(60),IBO),(IA(61),IID),(IA(62),
     9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITF),(IA(41),IIAP)
      EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),
     1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),
     2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)
     3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TF),(AA(81),DT),(AA(82),DG),
     4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),
     5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),
     6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)
     7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IU
     8),(AA(47),G1),(AA(48),G2),(AA(49),G3)
      EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346)
     1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)
     2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)
     3,(IA(337),JMMZ),(IA(336),JMF1),(IA(335),IIA5),(IA(334),IDZ)
     4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)
     5,(IA(329),IPIR)
      DIMENSION BIR(3),SIR(3),DIN(3,3),SR(6),XN(3),XF(3),ON(6),OF(6),
     1RES(6),RED(6),BAS(3),ICLAS(4),NBAN(10),NU(3),NES(3)
      EQUIVALENCE (AA(200),IONE),(AA(201),ICN),(AA(202),LM),(AA(203),AST
     1),(AA(204),INBON),(AA(205),ARE),(AA(206),ICLA),(AA(207),IMEL),
     2(AA(208),IM),(AA(209),IC),(AA(210),ICOM),(AA(211),ANGLE),(AA(212),
     3ICAS),(AA(213),IF),(AA(214),NB),(AA(215),MB)
     4,(AA(216),IROT),(AA(217),BST)
      EQUIVALENCE (AA(220),BIR),(AA(223),SIR),(AA(226),DIN),(AA(235),SR)
     1,(AA(241),XN),(AA(244),XF),(AA(247),ON),(AA(253),OF),(AA(259),RES)
     2,(AA(265),RED),(AA(271),BAS),(AA(274),ICLAS),(AA(278),NBAN)
     3,(AA(292),NU),(AA(295),NES)
      DIMENSION NEL(20,17),MAC(4,4,20),IWG(90),DD(6,6),A(90,7),B(8,8),
     1C(8,2),FF(1),NSET(100),MSET(100),W(3,3)
      EQUIVALENCE (AA(14000),FF),(NU(1),JP1),(NU(2),JM1),(NU(3),JS1)
      EQUIVALENCE (FF(1),NEL),(FF(341),MAC),(FF(661),IWG),(FF(751),DD),
     1(FF(787),A),(FF(1417),B),(FF(1481),C),(FF(1497),NSET),(FF(1597),
     2MSET),(FF(1697),W)
      DIMENSION XII(3),ETA(3),ZTA(3)
      EQUIVALENCE (DIN(1),XII),(DIN(4),ETA),(DIN(7),ZTA)
C     FIND THE FIRST AND THE LAST NODE TO BE CONSIDERED FOR THE FIT
      IM=IM
      IC=IC
      I17M=IMET+1700
      I18M=IMET+1800
      LL=0
      IE=MAC(IM,IC,1)
      IF (IE-1) 100,100,200
100   IELT=MAC(IM,IC,2)
      IF(NEL(IELT,10)-ICN) 102,101,102
101   KL=1
      KR=2
      LL=1
      NSET(KL)=ICN
      NSET(KR)=NEL(IELT,11)
      GO TO 300
102   KL=4
      KR=5
      NSET(KL)=NEL(IELT,10)
      NSET(KR)=ICN
      GO TO 300
200   I=2
220   IELT=MAC(IM,IC,I)
      IF (NEL(IELT,10)-ICN) 202,201,202
201   NSET( 3)=ICN
      NSET( 4)=NEL(IELT,11)
      GO TO 210
202   NSET( 3)=ICN
      NSET( 2)=NEL(IELT,10)
210   IF (I-3) 215,216,216
215   I=3
      GO TO 220
216   KL=2
      KR=4
300   DO 390 J=1,3
      IF (KL-1) 301,301,302
302   J=2
      NOD1=NSET(KL)
      GO TO 350
301   IF (KR-5) 303,400,400
303   J=1
      NOD1=NSET(KR)
350   J4B=J4+(J-1)*IT
      J4C=J4+(2-J)*IT
      LODE=0
      DO 355 K=1,IT
      L1=J4B+K
      L2=J4C+K
      L3=J1+K
      IF (IA(L3)-I17M) 358,356,358
358   IF (IA(L3)-I18M) 355,356,355
356   IF (IA(L1)-NOD1) 355,357,355
357   LODE=IA(L2)
      GO TO 359
355   CONTINUE
359   IF (LODE) 360,360,370
360   IF (LL-1) 365,390,365
365   NB=KR-KL+1
      DO 366 L=1,NB
      IF (J-1) 362,362,361
361   L1=L
      L2=KL+L-1
      GO TO 366
362   L1=6-L
      L2=KR-L+1
366   NSET(L1)=NSET(L2)
      IF (J-1) 364,364,363
363   KL=1
      KR=NB
      LL=1
      GO TO 390
364   KR=5
      KL=6-NB
      GO TO 390
370   IF (J-1) 375,375,380
375   KR=KR+1
      NSET(KR)=LODE
      GO TO 390
380   KL=KL-1
      NSET(KL)=LODE
390   CONTINUE
400   NB=KR
      IF (INP-2) 450,440,440
440   WRITE OUTPUT TAPE 6,441,IE,NB,(NSET(I),I=1,NB)
441   FORMAT (20X,55HNODE SET FOR FOURTH (OR LESS) DEGREE POLYNOMIAL FOL
     1LOWS,2I10/(20X,20I5))
450   IPONN=NB
C     SET THE EQUATIONS FOR THE COEFFICIENTS
14    IPP=IPONN-1
      DO 15 I=1,IPONN
      K=NSET(I)
      CALL FINDX (K,RED)
      DO 16 J=1,IPP
      L=IPONN-J
16    B(I,J)=RED(1)**L
      B(I,IPONN)=1.
15    C(I,1)=RED(2)
C     OBTAIN THE CRUDE DIRECTION OF XII AND SET THE DIRECTION OF ETA
      RED(1)=B(IPONN,IPONN-1)-B(1,IPONN-1)
      RED(2)=C(IPONN,1)-C(1,1)
      RED(3)=0.
      ETA(1)=0.
      ETA(2)=0.
      ETA(3)=-1.
      O=1.
C     FIND THE COEFFICIENTS
      CALL INV (B,IPONN,C,1,DET)
      IF (DET) 17,18,17
18    WRITE OUTPUT TAPE 6,181,ICN
181   FORMAT (I5,13X,89HNOT ENOUGH INFORMATION FOR MIDDLE SURFACE NORMAL
     1, APPROXIMATE XII AND ZTA VALUES ARE USED)
      CALL UNIT (RED,O)
      XII(1)=RED(1)
      XII(2)=RED(2)
      XII(3)=RED(3)
      CALL VECT (ZTA,XII,ETA)
      CALL UNIT (ZTA,O)
      GO TO 25
C     COMPUTE DIRECTION COSINES
17    IF (IE-2) 171,171,172
172   WRITE OUTPUT TAPE 6,181,ICN
171   ZTA(1)=0.
      DO 19 I=1,IPP
      K=IPONN-I
      CI=K
19    ZTA(1)=ZTA(1)+CI*C(I,1)*XN(1)**(K-1)
      ZTA(2)=-1.
      ZTA(3)=0.
      CALL VECT (XII,ETA,ZTA)
      IF (SCAL(RED,XII)) 20,20,21
20    O=-1.
21    CALL UNIT (ZTA,O)
      CALL VECT (XII,ETA,ZTA)
      CALL UNIT (XII,O)
25    RETURN
      END
```

Table VII-74. Source program listing of subroutine ROTA (Link 4)

```
*      LABEL
CE4ROT                                                                    E4ROT000
       SUBROUTINE ROTA                                                    E4ROT001
C      EXPRESSES MATERIAL MATRIX IN LOCAL AXES                            E4ROT002
C      TO ROTATE MATERIAL AXES IF NECESSARY SO THAT THEY COINCIDE W. DIN  E4ROT003
       DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)          E4ROT004
      1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)               E4ROT005
       COMMON IA,AA                                                       E4ROT006
       EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),E),(D21(20),GIE4ROT007
       EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),   E4ROT008
      1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),E4ROT009
      2IH),(IA(11),I8),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),E4ROT010
      3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),E4ROT011
      4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),     E4ROT012
      5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),      E4ROT013
      6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),       E4ROT014
      7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57E4ROT015
      8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBO),(IA(61),IID),(IA(62),E4ROT016
      9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITE),(IA(41),ITAP)          E4ROT017
       EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),     E4ROT018
      1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),        E4ROT019
      2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)               E4ROT020
      3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DI),(AA(82),DG),  E4ROT021
      4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),   E4ROT022
      5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),     E4ROT023
      6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)                E4ROT024
      7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IUE4ROT025
      8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                              E4ROT026
       EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346)  E4ROT027
      1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)    E4ROT028
      2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)       E4ROT029
      3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)        E4ROT030
      4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)          E4ROT031
      5,(IA(329),IPIR)                                                    E4ROT032
       DIMENSION BIR(3),SIR(3),DIN(3,3),SR(6),XN(3),XF(3),QN(6),QF(6),    E4ROT033
      1RES(6),RED(6),BAS(3),ICLAS(4),NBAN(10),NU(3),NES(3)                E4ROT034
       EQUIVALENCE (AA(200),IDNE),(AA(201),ICN),(AA(202),LM),(AA(203),ASTE4ROT035
      1),(AA(204),INBON),(AA(205),ARE),(AA(206),ICLA),(AA(207),IMEL),     E4ROT036
      2(AA(208),IM),(AA(209),IC),(AA(210),ICON),(AA(211),ANGLE),(AA(212),E4ROT037
      3ICAS),(AA(213),IE),(AA(214),NB),(AA(215),MB)                       E4ROT038
      4,(AA(216),IROT),(AA(217),BST)                                      E4ROT039
       EQUIVALENCE (AA(220),BIR),(AA(223),SIR),(AA(226),DIN),(AA(235),SR)E4ROT040
      1,(AA(241),XN),(AA(244),XF),(AA(247),QN),(AA(253),QF),(AA(259),RES)E4ROT041
      2,(AA(265),RED),(AA(271),BAS),(AA(274),ICLAS),(AA(278),NBAN)        E4ROT042
      3,(AA(292),NU),(AA(295),NES)                                        E4ROT043
       DIMENSION NEL(20,17),MAC(4,4,20),IWG(90),DD(6,6),A(90,7),B(8,8),   E4ROT044
      1C(8,2),FF(1),NSET(100),MSET(100),W(3,3)                            E4ROT045
       EQUIVALENCE (AA(14000),FF),(NU(1),JP1),(NU(2),JM1),(NU(3),JS1)     E4ROT046
       EQUIVALENCE (FF(1),NEL),(FF(341),MAC),(FF(661),IWG),(FF(751),DD),  E4ROT047
      1(FF(787),A),(FF(1417),B),(FF(1481),C),(FF(1497),NSET),(FF(1597),   E4ROT048
      2MSET),(FF(1697),W)                                                 E4ROT049
       DIMENSION XI1(3),ETA(3),ZTA(3)                                     E4ROT050
       EQUIVALENCE (DIN(1),XI1),(DIN(4),ETA),(DIN(7),ZTA)                 E4ROT051
       DIMENSION R(6,6),T(6),V (3,3),SI(3),RI(3)                          E4ROT052
       EQUIVALENCE (A(1),R),(A(37),T),(V(1),SI),(V(4),T),(V(7),RI)        E4ROT053
C      NO ROTATION IF MATERIAL IS ISOTROPIC                               E4ROT054
       IF (ITYPE) 200,200,9                                               E4ROT055
C      SEE IF SOLID                                                       E4ROT056
  9    IF (ICAS-3) 10,11,10                                               E4ROT057
 10    IF (ICAS-4) 12,11,12                                               E4ROT058
C      IF SHELL OF REVOLUTION, DO NOT TRANSFORM                           E4ROT059
 12    IF (ICAS-5) 121,200,121                                            E4ROT060
 121   IF (ICAS-6)  41,200,41                                             E4ROT061
C      COMPUTE THE ANGLE BETWEEN BAS AND KSI                              E4ROT062
 41    AG=SCAL(BAS,XI1)                                                   E4ROT063
C      NO ROTATION IF THE ANGLE IS SMALL                                  E4ROT064
       IF (1.-ABSF(AG)-1.E-4) 200,200,101                                 E4ROT065
C      NON-SOLID. MATERIAL AXES ARE   (ZTAXBAS)XZTA,ZTAXBAS,ZTA           E4ROT066
 101   CC=1.                                                              E4ROT067
       CALL VECT (T,ZTA,BAS)                                              E4ROT068
       CALL UNIT (T,CC)                                                   E4ROT069
       CALL VECT (SI,T,ZTA)                                               E4ROT070
       CALL UNIT (SI,CC)                                                  E4ROT071
       CALL VECT (RI,SI,T)                                                E4ROT072
       DO 14 I=1,3                                                        E4ROT073
       DO 14 J=1,3                                                        E4ROT074
       W(J,I)=0.                                                          E4ROT075
       DO 15 K=1,3                                                        E4ROT076
 15    W(J,I)=W(J,I)+DIN(K,I)*V(K,J)                                      E4ROT077
 14    CONTINUE                                                           E4ROT078
       GO TO 16                                                           E4ROT079
C      SOLID MATERIAL AXES ARE PARALLEL TO OVERALL SYSTEM.                E4ROT080
 11    DO 13 I=1,3                                                        E4ROT081
       DO 13 J=1,3                                                        E4ROT082
 13    W(I,J)=DIN(I,J)                                                    E4ROT083
       GO TO 16                                                           E4ROT084
C      GENERATE   R  OF    (R)TRANS*(DD)*(R)                              E4ROT085
 16    DO 17 J=1,3                                                        E4ROT086
       DO 17 I=1,3                                                        E4ROT087
 17    R(I,J)=W(I,J)**2                                                   E4ROT088
       DO 18 I=1,3                                                        E4ROT089
       R(I,4)=W(I,1)*W(I,2)                                               E4ROT090
       R(I,5)=W(I,1)*W(I,3)                                               E4ROT091
       R(I,6)=W(I,2)*W(I,3)                                               E4ROT092
       R(4,I)=W(1,I)*W(2,I)*2.                                            E4ROT093
       R(5,I)=W(1,I)*W(3,I)*2.                                            E4ROT094
 18    R(6,I)=W(2,I)*W(3,I)*2.                                            E4ROT095
       R(4,4)=W(1,1)*W(2,2)+W(2,1)*W(1,2)                                 E4ROT096
       R(4,5)=W(1,1)*W(2,3)+W(2,1)*W(1,3)                                 E4ROT097
       R(4,6)=W(1,2)*W(2,3)+W(2,2)*W(1,3)                                 E4ROT098
       R(5,4)=W(1,1)*W(3,2)+W(3,1)*W(1,2)                                 E4ROT099
       R(5,5)=W(1,1)*W(3,3)+W(3,1)*W(1,3)                                 E4ROT100
       R(5,6)=W(1,2)*W(3,3)+W(3,2)*W(1,3)                                 E4ROT101
       R(6,4)=W(2,1)*W(3,2)+W(3,1)*W(2,2)                                 E4ROT102
       R(6,5)=W(2,1)*W(3,3)+W(3,1)*W(2,3)                                 E4ROT103
       R(6,6)=W(2,2)*W(3,3)+W(3,2)*W(2,3)                                 E4ROT104
 20    DO 21 I=1,6                                                        E4ROT105
       DO 22 J=1,6                                                        E4ROT106
       T(J)=0.                                                            E4ROT107
       DO 23 K=1,6                                                        E4ROT108
 23    T(J)=T(J)+DD(I,K)*R(K,J)                                           E4ROT109
 22    CONTINUE                                                           E4ROT110
       DO 24 J=1,6                                                        E4ROT111
 24    DD(I,J)=T(J)                                                       E4ROT112
 21    CONTINUE                                                           E4ROT113
       DO 31 J=1,6                                                        E4ROT114
       DO 32 I=1,6                                                        E4ROT115
       T(I)=0.                                                            E4ROT116
       DO 33 K=1,6                                                        E4ROT117
 33    T(I)=T(I)+R(K,I)*DD(K,J)                                           E4ROT118
 32    CONTINUE                                                           E4ROT119
       DO 34 I=1,6                                                        E4ROT120
 34    DD(I,J)=T(I)                                                       E4ROT121
 31    CONTINUE                                                           E4ROT122
C      DIRECTION COSINES OF NEW MATE.AXES IN THE OLD ARE IN W(3,3)        E4ROT123
       IF (INP-2) 200,19,19                                               E4ROT124
 19    WRITE OUTPUT TAPE 6,191,((R(I,J),J=1,6),I=1,6)                     E4ROT125
 191   FORMAT (20X,57HPOSTMULTIPLYING MATRIX IN MATERIAL TRANSFORMATION FE4ROT126
      1OLLOWS/(20X,6F12.5))                                               E4ROT127
 200   RETURN                                                             E4ROT128
       END                                                                E4ROT129
```

Table VII-75. Source program listing of subroutine SAME (Link 4)

```
*     LABEL
CE4SAM                                                                  F4SAM000
      SUBROUTINE SAME                                                   F4SAM001
C     EXPRESSES STRESS TENSOR IN OVERALL COORDINATE SYSTEM              F4SAM002
      DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)         F4SAM003
     1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)              F4SAM004
      COMMON IA,AA                                                      F4SAM005
      EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),F),(D21(20),GF4SAM006
      EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),  F4SAM007
     1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),F4SAM008
     2IH),(IA(11),IB),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),F4SAM009
     3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),F4SAM010
     4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMFT),    F4SAM011
     5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),     F4SAM012
     6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),      F4SAM013
     7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57F4SAM014
     8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBD),(IA(61),IID),(IA(62),F4SAM015
     9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITE),(IA(41),ITAP)         F4SAM016
      EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),    F4SAM017
     1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),       F4SAM018
     2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)              F4SAM019
     3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),OT),(AA(82),DG), F4SAM020
     4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),  F4SAM021
     5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),    F4SAM022
     6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)               F4SAM023
     7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),INF4SAM024
     8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                             F4SAM025
      EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346) F4SAM026
     1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)   F4SAM027
     2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)      F4SAM028
     3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)       F4SAM029
     4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)         F4SAM030
     5,(IA(329),IPIR)                                                   F4SAM031
      DIMENSION BIR(3),SIR(3),DIN(3,3),SR(6),XN(3),XF(3),ON(6),OF(6),   F4SAM032
     1RES(6),RED(6),BAS(3),ICLAS(4),NBAN(10),NU(3),NES(3)               F4SAM033
      EQUIVALENCE (AA(200),IONE),(AA(201),ICN),(AA(202),LM),(AA(203),ASTF4SAM034
     1),(AA(204),INBON),(AA(205),ARE),(AA(206),ICLA),(AA(207),IMEL),    F4SAM035
     2(AA(208),IM),(AA(209),IC),(AA(210),ICON),(AA(211),ANGLE),(AA(212),F4SAM036
     3ICAS),(AA(213),IE),(AA(214),NB),(AA(215),MB)                      F4SAM037
     4,(AA(216),IROT),(AA(217),BST)                                     F4SAM038
      EQUIVALENCE (AA(220),BIR),(AA(223),SIR),(AA(226),DIN),(AA(235),SR)F4SAM039
     1,(AA(241),XN),(AA(244),XF),(AA(247),ON),(AA(253),OF),(AA(259),RES)F4SAM040
     2,(AA(265),RED),(AA(271),BAS),(AA(274),ICLAS),(AA(278),NBAN)       F4SAM041
     3,(AA(292),NU),(AA(295),NES)                                       F4SAM042
      DIMENSION NEL(20,17),MAC(4,4,20),IWG(90),DD(6,6),A(90,7),B(8,8),  F4SAM043
     1C(8,2),FF(1),NSET(100),MSET(100),W(3,3)                           F4SAM044
      EQUIVALENCE (AA(14000),FF),(NU(1),JP1),(NU(2),JM1),(NU(3),JS1)    F4SAM045
      EQUIVALENCE (FF(1),NEL),(FF(341),MAC),(FF(661),IWG),(FF(751),DD), F4SAM046
     1(FF(787),A),(FF(1417),B),(FF(1481),C),(FF(1497),NSET),(FF(1597),  F4SAM047
     2MSET),(FF(1697),W)                                                F4SAM048
      EQUIVALENCE (NES(1),ICOL),(NES(2),IRIG),(NES(3),IDR)              F4SAM049
      DIMENSION DMM(3,3),DMMM(3,3)                                      F4SAM050
      EQUIVALENCE (A(1),DMM),(A(10),DMMM)                               F4SAM051
C     NO COMPUTATION IF OVERALL COORDINATES ARE IDENTICAL WITH LOCAL    F4SAM052
      TEST=7H      A                                                    F4SAM053
      IF (BST-TEST) 110,1000,110                                        F4SAM054
C     NO COMPUTATION  IF IT IS A SHELL POINT                            F4SAM055
  110 IF (ICAS-4) 111,111,1000                                          F4SAM056
C     IF IT IS A PLATE NOTE THE SHIFT IN RED VECTOR                     F4SAM057
  111 IF (ICAS-2) 112,113,112                                           F4SAM058
  112 DMM(1,1)=RED(1)                                                   F4SAM059
      DMM(1,2)=RED(3)                                                   F4SAM060
      DMM(1,3)=RED(5)                                                   F4SAM061
      DMM(2,2)=RED(2)                                                   F4SAM062
      DMM(2,3)=RED(6)                                                   F4SAM063
      DMM(3,3)=RED(4)                                                   F4SAM064
      GO TO 114                                                         F4SAM065
  113 DMM(1,1)=RED(4)                                                   F4SAM066
      DMM(1,2)=RED(6)                                                   F4SAM067
      DMM(2,2)=RED(5)                                                   F4SAM068
      DMM(1,3)=0.                                                       F4SAM069
      DMM(2,3)=0.                                                       F4SAM070
      DMM(3,3)=0.                                                       F4SAM071
C     OBTAIN THE SYMMETRIC PART                                         F4SAM072
  114 DO 200 I=1,3                                                      F4SAM073
      DO 200 J=I,3                                                      F4SAM074
  200 DMM(J,I)=DMM(I,J)                                                 F4SAM075
C     PERFORM THE TRANSFORMATION USING THE DIN MATRIX                   F4SAM076
      DO 400 I=1,3                                                      F4SAM077
      DO 400 J=1,3                                                      F4SAM078
      DMMM(I,J)=0.                                                      F4SAM079
      DO 300 K=1,3                                                      F4SAM080
  300 DMMM(I,J)=DMMM(I,J)+DIN(I,K)*DMM(K,J)                             F4SAM081
  400 CONTINUE                                                          F4SAM082
      DO 600 I=1,3                                                      F4SAM083
      DO 600 J=1,3                                                      F4SAM084
      DMM(I,J)=0.                                                       F4SAM085
      DO 500 K=1,3                                                      F4SAM086
  500 DMM(I,J)=DMM(I,J)+DMMM(I,K)*DIN(J,K)                              F4SAM087
  600 CONTINUE                                                          F4SAM088
C     REARRANGE SR NOTING THE SHIFT IN PLATE CASE                       F4SAM089
      IF (ICAS-2) 650,700,650                                           F4SAM090
  700 SR(1)=0.                                                          F4SAM091
      SR(2)=0.                                                          F4SAM092
      SR(3)=0.                                                          F4SAM093
      SR(4)=DMM(1,1)                                                    F4SAM094
      SR(5)=DMM(2,2)                                                    F4SAM095
      SR(6)=DMM(1,2)                                                    F4SAM096
      GO TO 750                                                         F4SAM097
  650 SR(1)=DMM(1,1)                                                    F4SAM098
      SR(2)=DMM(2,2)                                                    F4SAM099
      SR(3)=DMM(3,3)                                                    F4SAM100
      SR(4)=DMM(1,2)                                                    F4SAM101
      SR(5)=DMM(1,3)                                                    F4SAM102
      SR(6)=DMM(2,3)                                                    F4SAM103
C     PRINT THE RESULTS AND RETURN                                      F4SAM104
  750 WRITE OUTPUT TAPE 6,1,ICN,AST,IMET,ICAS,(SR(I),I=1,6)             F4SAM105
    1 FORMAT (I5,A1,I4,I5,3X,6E15.5)                                    F4SAM106
 1000 RETURN                                                            F4SAM107
      END                                                               F4SAM108
```

Table VII-76. Source program listing of function SCAL (Link 4)

```
*     LABEL
CE4SCL                                                                  F4SCL000
      FUNCTION SCAL(CIR,DIR)                                            F4SCL001
C     PERFORMS SCALAR VECTOR PRODUCT                                    F4SCL002
C     TO OBTAIN THE SCALAR PRODUCT OF VECTORS CIR AND DIR ON SCAL       F4SCL003
      DIMENSION CIR(3),DIR(3)                                           F4SCL004
      SCAL=CIR(1)*DIR(1)+CIR(2)*DIR(2)+CIR(3)*DIR(3)                    F4SCL005
      RETURN                                                            F4SCL006
      END                                                               F4SCL007
```

Table VII-77. Source program listing of subroutine SETA (Link 4)

```
*     LABEL
CE4SET                                                                  E4SET000
      SUBROUTINE SETA                                                   E4SET001
C     GENERATES STRAIN-DEFLECTION RELATIONSHIP AT A NODAL LINE          E4SET002
      DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),F22(3,3)         E4SET003
     1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)              E4SET004
      COMMON IA,AA                                                      E4SET005
      EQUIVALENCE(IA,AA),(D21,D33),(D21(10),F22),(D21(19),E),(D21(20),G)E4SET006
      EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),  E4SET007
     1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),E4SET008
     2IH),(IA(11),IR),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),E4SET009
     3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),E4SET010
     4ISTR),(IA(28),IELT),(IA(29),IIEM),(IA(30),ITIC),(IA(31),IMET),    E4SET011
     5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),     E4SET012
     6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),      E4SET013
     7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57E4SET014
     8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBO),(IA(61),IID),(IA(62),E4SET015
     9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),IIE),(IA(41),ITAP)         E4SET016
      EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),    E4SET017
     1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),       E4SET018
     2(IA(74),IIC),(IA(75),IDFF),(IA(76),IST),(IA(77),IIS)              E4SET019
     3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG), E4SET020
     4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),  E4SET021
     5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),    E4SET022
     6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)               E4SET023
     7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IUE4SET024
     8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                             E4SET025
      EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346) E4SET026
     1,ISDZ),(IA(345),J9),(IA(344),JIO),(IA(343),JPRS),(IA(342),JSOY)   E4SET027
     2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)      E4SET028
     3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),IIAS),(IA(334),IDZ)       E4SET029
     4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)         E4SET030
     5,(IA(329),IPIR)                                                   E4SET031
      DIMENSION BIR(3),SIR(3),DIN(3,3),SR(6),XN(3),XF(3),ON(6),OF(6),   E4SET032
     1RES(6),RED(6),BAS(3),ICLAS(4),NBAN(10),NU(3),NES(3)               E4SET033
      EQUIVALENCE (AA(200),IONE),(AA(201),ICN),(AA(202),LM),(AA(203),ASTE4SET034
     1),(AA(204),INBON),(AA(205),ARE),(AA(206),ICLA),(AA(207),IMEL),    E4SET035
     2(AA(208),IM),(AA(209),IC),(AA(210),ICON),(AA(211),ANGLE),(AA(212),E4SET036
     3ICAS),(AA(213),IE),(AA(214),NU),(AA(215),MB)                      E4SET037
     4,(AA(216),IROT),(AA(217),BST)                                     E4SET038
      EQUIVALENCE (AA(220),BIR),(AA(223),SIR),(AA(226),DIN),(AA(235),SR)E4SET039
     1,(AA(241),XN),(AA(244),XF),(AA(247),ON),(AA(253),OF),(AA(259),RES)E4SET040
     2,(AA(265),RED),(AA(271),BAS),(AA(274),ICLAS),(AA(278),NBAN)       E4SET041
     3,(AA(292),NU),(AA(295),NES)                                       E4SET042
      DIMENSION NEL(20,17),MAC(4,4,20),IWG(90),DD(6,6),A(90,7),B(8,8),  E4SET043
     1C(8,2),FF(1),NSET(100),MSET(100),W(3,3),DCAR(3)                   E4SET044
      EQUIVALENCE (AA(14000),FF),(NU(1),JP1),(NU(2),JM1),(NU(3),JS1)    E4SET045
      EQUIVALENCE (FF(1),NEL),(FF(341),MAC),(FF(661),IWG),(FF(751),DD), E4SET046
     1(FF(787),A),(FF(1417),B),(FF(1481),C),(FF(1497),NSET),(FF(1597),  E4SET047
     2MSET),(FF(1697),W)                                                E4SET048
      DIMENSION U(3,5),CDIS(3),CROT(3),DDIS(3),DROT(3),DCOR(3),ZTA(3)   E4SET049
      EQUIVALENCE (X(1),U,DCOR),(X(4),CDIS),(X(7),CROT),(X(10),DDIS),   E4SET050
     1(X(13),DROT),(DCAR,XF)                                            E4SET051
      EQUIVALENCE (NES(1),ICOL),(NES(2),IRIG),(NES(3),IDR),(DIN(7),ZTA) E4SET052
C     INITIALIZE                                                        E4SET053
      IELT=IELT                                                         E4SET054
      IMS=NEL(IELT,5)                                                   E4SET055
C     GENERATE STRAIN-DEFLECTION EQUATIONS FOR EVERY NODAL LINE         E4SET056
      DO 12 II=1,IMS                                                    E4SET057
      K=NEL(IELT,II+9)                                                  E4SET058
      IF (K-ICN) 13,12,13                                               E4SET059
C     FIND RELATIVE COORDNTS.AND DEFLNS.OF NODE K IN OVERALL SYSTEM     E4SET060
 13   CALL FINDX(K,XF)                                                  E4SET061
      CALL FINDQ(K,QF)                                                  E4SET062
      DO 161 I=1,15                                                     E4SET063
 161  X(I)=0.                                                           E4SET064
      DCOR(1)=XF(1)-XN(1)                                               E4SET065
      DCOR(2)=XF(2)-XN(2)                                               E4SET066
      DCOR(3)=XF(3)-XN(3)                                               E4SET067
      IDEG=IDEG                                                         E4SET068
      DO 14 I=1,IDEG                                                    E4SET069
 14   RED(I)=QF(I)-ON(I)                                                E4SET070
C     SEPARATE DEFLECTIONS INTO DISPLACEMENTS AND ROTATIONS             E4SET071
      KS=0                                                              E4SET072
      KB=1                                                              E4SET073
      IF (ICAS-2) 16,15,16                                              E4SET074
 16   IF (ICAS-6) 18,17,18                                              E4SET075
 15   KS=2                                                              E4SET076
      GO TO 18                                                          E4SET077
 17   KB=3                                                              E4SET078
      KS=3                                                              E4SET079
 18   DO 19 I=1,IDEG                                                    E4SET080
      IK=I                                                              E4SET081
      IF (I-KB)21,20,20                                                 E4SET082
 20   IK=I+KS                                                           E4SET083
 21   IF(IK-3) 22,22,23                                                 E4SET084
 22   CDIS(IK)=ON(I)                                                    E4SET085
      DDIS(IK)=RED(I)                                                   E4SET086
      GO TO 19                                                          E4SET087
 23   IK=IK-3                                                           E4SET088
      CROT(IK)=ON(I)                                                    E4SET089
      DROT(IK)=RED(I)                                                   E4SET090
 19   CONTINUE                                                          E4SET091
C     TRANSFORM COORDNTS.AND DEFLNS.INTO LOCAL IF NECESSARY             E4SET092
      IF (IROT) 25,24,25                                                E4SET093
 25   DO 26 J=1,5                                                       E4SET094
      DO 27 I=1,3                                                       E4SET095
      SIR(I)=0.                                                         E4SET096
      DO 28 L=1,3                                                       E4SET097
 28   SIR(I)=SIR(I)+DIN(L,I)*U(L,J)                                     E4SET098
 27   CONTINUE                                                          E4SET099
      DO 29 I=1,3                                                       E4SET100
 29   U(I,J)=SIR(I)                                                     E4SET101
 26   CONTINUE                                                          E4SET102
 24   ICON=ICON+1                                                       E4SET103
      ICOL=ICOL                                                         E4SET104
C     COMPUTE THE LENGTH AND THE UNIT VECTOR OF THE NODAL LINE          E4SET105
      DCAR(1)=DCOR(1)                                                   E4SET106
      DCAR(2)=DCOR(2)                                                   E4SET107
      DCAR(3)=DCOR(3)                                                   E4SET108
      CL=1.                                                             E4SET109
      CALL UNIT(DCAR,CL)                                                E4SET110
C     GENERATE LEFTHAND SIDE                                            E4SET111
      DO 30 I=1,ICOL                                                    E4SET112
      I1=I                                                              E4SET113
      I2=I                                                              E4SET114
      IS=I                                                              E4SET115
      GO TO (37,37,31,32,33,34),IS                                      E4SET116
 31   I1=1                                                              E4SET117
      I2=2                                                              E4SET118
      GO TO 37                                                          E4SET119
 32   I1=3                                                              E4SET120
      I2=3                                                              E4SET121
      GO TO 37                                                          E4SET122
 33   I1=1                                                              E4SET123
      I2=3                                                              E4SET124
      GO TO 37                                                          E4SET125
 34   I1=2                                                              E4SET126
      I2=3                                                              E4SET127
 37   A(ICON,I)=DCAR(I1)*DCAR(I2)                                       E4SET128
 30   CONTINUE                                                          E4SET129
C     SET THE UNIT VECTOR.IN ZTA DIRECTION IN THE SYSTEM OF DCOR        E4SET130
      RED(1)=0.                                                         E4SET131
      RED(2)=0.                                                         E4SET132
      RED(3)=1.                                                         E4SET133
C     GENERATE RIGHTHAND SIDE(S)                                        E4SET134
      IRIG=IRIG                                                         E4SET135
      DO 40 I=1,IRIG                                                    E4SET136
      ICL=ICOL+I                                                        E4SET137
      IF (I-1) 45,45,50                                                 E4SET138
 45   IF (IDR) 50,46,50                                                 E4SET139
C     LINEAL STRAIN CASE                                                E4SET140
 46   CC=0.                                                             E4SET141
      IF (DT) 47,49,47                                                  E4SET142
 47   IF (ITYPE) 48,471,48                                              E4SET143
 471  CC=ALL*DT                                                         E4SET144
      GO TO 49                                                          E4SET145
 48   CALL TEMP(CC)                                                     E4SET146
      CC=CC*DT                                                          E4SET147
 49   A(ICON,ICL)=SCAL(DDIS,DCAR)/CL-CC                                 E4SET148
      GO TO 40                                                          E4SET149
C     CHANGE OF CURVATURE CASE                                          E4SET150
 50   CC=0.                                                             E4SET151
      IF (DG) 57,59,57                                                  E4SET152
 57   IF (ITYPE) 58,571,58                                              E4SET153
 571  CC=ALL*DG                                                         E4SET154
      GO TO 59                                                          E4SET155
 58   CALL TEMP(CC)                                                     E4SET156
      CC=CC*DG                                                          E4SET157
 59   DC=SCAL(DROT,DCAR)                                                E4SET158
      DO 592 J=1,3                                                      E4SET159
 592  DROT(J)=DROT(J)-DC*DCAR(J)                                        E4SET160
      CALL VECT (SIR,RED,DCAR)                                          E4SET161
      DC=1.                                                             E4SET162
      CALL UNIT(SIR,DC)                                                 E4SET163
      DC=SCAL(SIR,DROT)/CL                                              E4SET164
      A(ICON,ICL)=DC-CC                                                 E4SET165
 40   CONTINUE                                                          E4SET166
      IWG(ICON)=1                                                       E4SET167
      MB=MB                                                             E4SET168
      IF (INBON) 71,70,71                                               E4SET169
 71   DO 72 I=1,MB                                                      E4SET170
      IF (NBAN(I)-K) 72,73,72                                           E4SET171
 72   CONTINUE                                                          E4SET172
      GO TO 70                                                          E4SET173
 73   IWG(ICON)=10                                                      E4SET174
 70   IF (INP-2) 12,61,61                                               E4SET175
 61   WRITE OUTPUT TAPE 6,62,ICN,K,(A(ICON,J),J=1,7),IWG(ICON)          E4SET176
 62   FORMAT (I5,3X,2HTO,I5,5X,7F13.5,I5)                               E4SET177
 12   CONTINUE                                                          E4SET178
      RETURN                                                            E4SET179
      END                                                               E4SET180
```

Table VII-78. Source program listing of subroutine STRA (Link 4)

```
*       LABEL
CF4STA
        SUBROUTINE STRA
C       COORDINATE TRANSFORMATION FOR STIFFNESS MATRIX
        DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)
       1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)
        COMMON IA,AA
        EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),E),(D21(20),G)
        EQUIVALENCE ((IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),
       1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDFG),(IA(9),INX),(IA(10),
       2IH),(IA(11),I8),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),
       3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),
       4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),
       5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),
       6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),
       7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57
       8),J8),(IA(58),JTY),(IA(59),I88),(IA(60),I80),(IA(61),II0),(IA(62),
       9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITE),(IA(41),ITAP)
        EQUIVALENCE ((IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),
       1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),
       2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)
       3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG),
       4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),
       5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),
       6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)
       7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IU
       8),(AA(47),G1),(AA(48),G2),(AA(49),G3)
        EQUIVALENCE ((IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346)
       1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)
       2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)
       3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),ID7)
       4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)
       5,(IA(329),IPIR)
        J=-IDS
        DO 5 I=1,IDS
        J=J+IDS
        CALL TRAN (S,J)
 5      CONTINUE
        IABB=-IDS
        IEBB=-IDS
        DO 6 I=1,IDS
        IABB=IABB+1
        IAB=IABB
        IEBB=IEBB+IDS
        IBE=IEBB
        DO 7 J=1,IDS
        IAB=IAB+IDS
        IBE=IBE+1
        IF (IAB-IBE) 7,7,13
 13     TEMP=S(IBE)
        S(IBE)=S(IAB)
        S(IAB)=TEMP
 7      CONTINUE
 6      CONTINUE
        J=-IDS
        DO 8 I=1,IDS
        J=J+IDS
        CALL TRAN (S,J)
 8      CONTINUE
        RETURN
        END
```

Table VII-79. Source program listing of subroutine STRS (Link 4)

```
*       LABEL
CF4STR
        SUBROUTINE STRS
C       COMPUTES STRESSES FROM STRAINS
        DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)
       1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)
        COMMON IA,AA
        EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),E),(D21(20),G)
        EQUIVALENCE ((IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),
       1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDFG),(IA(9),INX),(IA(10),
       2IH),(IA(11),I8),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),
       3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),
       4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),
       5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),
       6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),
       7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57
       8),J8),(IA(58),JTY),(IA(59),I88),(IA(60),I80),(IA(61),II0),(IA(62),
       9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITE),(IA(41),ITAP)
        EQUIVALENCE ((IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),
       1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),
       2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)
       3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG),
       4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),
       5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),
       6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)
       7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IU
       8),(AA(47),G1),(AA(48),G2),(AA(49),G3)
        EQUIVALENCE ((IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346)
       1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)
       2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)
       3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),ID7)
       4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)
       5,(IA(329),IPIR)
        DIMENSION BIR(3),SIR(3),DIN(3,3),SR(6),XN(3.,XF(3),ON(6),OF(6),
       1RES(6),RED(6),BAS(3),ICLAS(4),NBAN(10),NU(3),NES(3)
        EQUIVALENCE (AA(200),IONE),(AA(201),ICN),(AA(202),LM),(AA(203),AST
       1),(AA(204),INBON),(AA(205),ARE),(AA(206),ICLA),(AA(207),IMEL),
       2(AA(208),IM),(AA(209),IC),(AA(210),ICON),(AA(211),ANGLE),(AA(212),
       3ICAS),(AA(213),IF),(AA(214),NB),(AA(215),MB)
       4,(AA(216),IROT),(AA(217),BST)
        EQUIVALENCE (AA(220),BIR),(AA(223),SIR),(AA(226),DIN),(AA(235),SR)
       1,(AA(241),XN),(AA(244),XF),(AA(247),ON),(AA(253),OF),(AA(259),RES)
       2,(AA(265),RED),(AA(271),BAS),(AA(274),ICLAS),(AA(278),NBAN)
       3,(AA(292),NU),(AA(295),NES)
        DIMENSION NEL(20,17),MAC(4,4,20),IWG(90),DD(6,6),A(90,7),B(8,8),
       1C(8,2),FF(1),NSET(100),MSET(100),W(3,3)
        EQUIVALENCE (AA(14000),FF),(NU(1),JP1),(NU(2),JM1),(NU(3),JS1)
        EQUIVALENCE (FF(1),NEL),(FF(341),MAC),(FF(661),ING),(FF(751),DD),
       1(FF(787),A),(FF(1417),B),(FF(1481),C),(FF(1497),NSET),(FF(1597),
       2MSET),(FF(1697),W)
        EQUIVALENCE (NES(1),ICOL),(NES(2),TRIG),(NES(3),IDR)
C       COMPUTE GEOMETRIC CONSTANT
        ICOL=ICOL
        IRIG=IRIG
        CM=TE
        IF (ICAS-3) 1,2,3
 3      IF (ICAS-4) 1,2,1
 2      CM=1.
C       INITIALIZE STRESS AREA
 1      DO 4 I=1,6
 4      RED(I)=0.
C       COMPUTE STRESSES
        DO 10 J=1,IRIG
        DO 15 I=1,ICOL
        IJ=(J-1)*3+I
        DO 20 K=1,ICOL
 20     RED(IJ)=RED(IJ)+DD(I,K)*C(K,J)*CM
 15     CONTINUE
        CM= CM*TE*TE/12.
 10     CONTINUE
C       MODIFY THE COMPUTED STRESSES WITH THE PRESCRIBED ONES IF ANY
        IF (INBON) 34,33,34
 34     KBG=1
        KEN=3
        KSH=1
        ICAS=ICAS
        GO TO (61,62,61,64,65,66,61,68),ICAS
 62     KBG=4
        KEN=6
        GO TO 61
 64     KEN=5
        GO TO 61
 65     KEN=1
        GO TO 61
 66     KEN=1
        KSH=2
        GO TO 61
 68     KSH=2
 61     K=0
        DO 69 I=1,KSH
        DO 70 J=KBG,KEN,2
        K=K+1
 70     RED(J)=SR(K)
        KBG=KBG+3
        KEN=KEN+3
 69     CONTINUE
C       ARRANGE STRESSES IN ORDER OF 1,2,3,12,13,23 IN SR BLOCK
 33     DO 30 I=1,6
 30     SR(I)=RED(I)
        IF (ISTR) 31,31,40
 31     IF (ICAS-3) 50,40,32
 32     IF (ICAS-4) 50,40,50
 40     SR(3)=RED(4)
        SR(4)=RED(3)
 50     RETURN
        END
```

Table VII-80. Source program listing of subroutine TEMP (Link 4)

```
*     LABEL
CE4TMP                                                                  F4TMP000
      SUBROUTINE TEMP(CC)                                               F4TMP001
C     COMPUTES NODAL LINE VECTOR IN ORIGINAL MATERIAL AXES              F4TMP002
C     TO COMPUTE LENGTH CHANGE PER UNIT TEMPERATURE PER UNIT DISTANCE   F4TMP003
      DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),F22(3,3)         F4TMP004
     1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)              F4TMP005
      COMMON IA,AA                                                      F4TMP006
      EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),E),(D21(20),G)F4TMP007
      EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),  F4TMP008
     1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),F4TMP009
     2IH),(IA(11),IB),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),F4TMP010
     3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),F4TMP011
     4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),    F4TMP012
     5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),     F4TMP013
     6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),      F4TMP014
     7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57F4TMP015
     8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBO),(IA(61),IID),(IA(62),F4TMP016
     9ITA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITE),(IA(41),ITAP)         F4TMP017
      EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),    F4TMP018
     1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),       F4TMP019
     2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)              F4TMP020
     3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG), F4TMP021
     4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),  F4TMP022
     5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),    F4TMP023
     6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)               F4TMP024
     7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IUF4TMP025
     8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                             F4TMP026
      EQUIVALENCE (IA(349),NTIC),(IA(348),ISOT),(IA(347),ISOY),(IA(346) F4TMP027
     1,ISOZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)   F4TMP028
     2,(IA(341),JSOZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)      F4TMP029
     3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)       F4TMP030
     4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)         F4TMP031
     5,(IA(329),IPIR)                                                   F4TMP032
      DIMENSION BIR(3),SIR(3),DIN(3,3),SR(6),XN(3),XF(3),ON(6),OF(6),   F4TMP033
     1RES(6),RED(6),BAS(3),ICLAS(4),MBAN(10),NU(3),MES(3)               F4TMP034
      EQUIVALENCE (AA(200),IDME),(AA(201),ICN),(AA(202),LM),(AA(203),ASTF4TMP035
     1),(AA(204),INBON),(AA(205),ARE),(AA(206),ICLA),(AA(207),IMFL),    F4TMP036
     2(AA(208),IM),(AA(209),IC),(AA(210),ICON),(AA(211),ANGLE),(AA(212),F4TMP037
     3ICAS),(AA(213),IE),(AA(214),NB),(AA(215),MB)                      F4TMP038
     4,(AA(216),IROT),(AA(217),BS1)                                     F4TMP039
      EQUIVALENCE (AA(220),BIR),(AA(223),SIR),(AA(226),DIN),(AA(235),SR)F4TMP040
     1,(AA(241),XN),(AA(244),XF),(AA(247),ON),(AA(253),OF),(AA(259),RESF4TMP041
     2,(AA(265),RED),(AA(271),BAS),(AA(274),ICLAS),(AA(278),MBAN)       F4TMP042
     3,(AA(292),NU),(AA(295),MES)                                       F4TMP043
      DIMENSION NEL(20,17),MAC(4,4,20),IWG(90),DD(6,6),A(90,7),B(8,8),  F4TMP044
     1C(8,2),FF(1),NSET(100),MSET(100),W(3,3)                           F4TMP045
      EQUIVALENCE (AA(14000),FF),(NU(1),JP1),(NU(2),JM1),(NU(3),JS1)    F4TMP046
      EQUIVALENCE (FF(1),NEL),(FF(341),MAC),(FF(661),IWG),(FF(751),DD), F4TMP047
     1(FF(787),A),(FF(1417),B),(FF(1481),C),(FF(1497),NSET),(FF(1597),  F4TMP048
     2MSET),(FF(1697),W)                                                F4TMP049
C     COMPUTE THE NODAL LINE VECTOR IN THE ORIGINAL MATERIAL AXES       F4TMP050
C     XF,DCAR EQUIVALENCED IN SETA, CONTAIN UNIT VECTOR OF NODAL LINE   F4TMP051
      DO 10 I=1,3                                                       F4TMP052
      SIR(I)=0.                                                         F4TMP053
      DO 9 K=1,3                                                        F4TMP054
    9 SIR(I)=SIR(I)+W(I,K)*XF(K)                                        F4TMP055
   10 CONTINUE                                                          F4TMP056
C     COMPUTE THE REQUIRED QUANTITY                                     F4TMP057
      CC=AL1*SIR(1)**2+AL2*SIR(2)**2+AL3*SIR(3)**2                      F4TMP058
      RETURN                                                            F4TMP059
      END                                                               F4TMP060
```

Table VII-81. Source program listing of subroutine TICK (Link 4)

```
                                                                        TICK000
*       FAP                                                             TICK001
        COUNT   25                                                      TICK002
        LBL     TICK                                                    TICK003
        ENTRY   TICK                                                    TICK004
TICK    NZT     ONCE                                                    TICK005
        TRA     FIRST                                                   TICK006
        CAL     5                                                       TICK007
        SUB     INITL                                                   TICK008
        ALS     18                                                      TICK009
        SLW*    1,4                                                     TICK010
        TRA     2,4                                                     TICK011
FIRST   STL     ONCE                                                    TICK012
        CAL     5                                                       TICK013
        SLW     INITL                                                   TICK014
        STZ*    1,4                                                     TICK015
        TRA     2,4                                                     TICK016
ONCE    PZE                                                             TICK017
INITL   PZE                                                             TICK018
        END
```

Table VII-82. Source program listing of subroutine TOPO (Link 4)

```
*     LABEL
CE4TOP                                                                  E4TOP000
      SUBROUTINE TOPO                                                   E4TOP001
C     PREPARES ELEMENT PROPERTIES                                       E4TOP002
      DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),F22(3,3)         E4TOP003
     1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)              E4TOP004
      COMMON IA,AA                                                      E4TOP005
      EQUIVALENCE(IA,AA),(D21,D33),(D21(10),F22),(D21(19),E),(D21(20),G)E4TOP006
      EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),  E4TOP007
     1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),E4TOP008
     2IH),(IA(11),IB),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),E4TOP009
     3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),E4TOP010
     4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),    E4TOP011
     5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),     E4TOP012
     6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),      E4TOP013
     7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57E4TOP014
     8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBO),(IA(61),IID),(IA(62),E4TOP015
     9ITA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITE),(IA(41),ITAP)         E4TOP016
      EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),    E4TOP017
     1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),       E4TOP018
     2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)              E4TOP019
     3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG), E4TOP020
     4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),  E4TOP021
     5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),    E4TOP022
     6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)               E4TOP023
     7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IUE4TOP024
     8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                             E4TOP025
      EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346) E4TOP026
     1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)   E4TOP027
     2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)      E4TOP028
     3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)       E4TOP029
     4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)         E4TOP030
     5,(IA(329),IPIR)                                                   E4TOP031
      IELT=0                                                            E4TOP032
      ITEM=0                                                            E4TOP033
      ITIC=0                                                            E4TOP034
      IMET=0                                                            E4TOP035
      DO 10 I=1,8                                                       E4TOP036
      N(I)=0                                                            E4TOP037
      K=I+335                                                           E4TOP038
   10 IA(K)=0                                                           E4TOP039
      JM=J1+M                                                           E4TOP040
      IELT=IA(JM)/100                                                   E4TOP041
      IMET=IA(JM)-100*IELT                                              E4TOP042
      JM=J2+M                                                           E4TOP043
      IF (IELT-4) 100,100,450                                           E4TOP044
  100 IF (IELT-3) 200,300,200                                           E4TOP045
  200 JARE=IA(JM)/100                                                   E4TOP046
      ITEM=IA(JM)-100*JARE                                              E4TOP047
      GO TO 400                                                         E4TOP048
  300 JPRS=IA(JM)/100                                                   E4TOP049
      JSDZ=IA(JM)-100*JPRS                                              E4TOP050
  400 IF (IELT-3) 600,800,800                                           E4TOP051
  450 IF (IELT-10) 470,470,500                                          E4TOP052
  470 IF (IELT-8) 500,500,480                                           E4TOP053
  480 JPRS=IA(JM)/100                                                   E4TOP054
      ITEM=IA(JM)-100*JPRS                                              E4TOP055
      L=1                                                               E4TOP056
      GO TO 1000                                                        E4TOP057
  500 ITIC=IA(JM)/100                                                   E4TOP058
      ITEM=IA(JM)-100*ITIC                                              E4TOP059
      JM=J3+M                                                           E4TOP060
      JSDZ=IA(JM)/100                                                   E4TOP061
      JPRS=IA(JM)-100*JSDZ                                              E4TOP062
      L=2                                                               E4TOP063
      GO TO 1000                                                        E4TOP064
  600 JM=J3+M                                                           E4TOP065
      JPRS=IA(JM)                                                       E4TOP066
      L=2                                                               E4TOP067
      IF (IELT-2) 1000,700,700                                          E4TOP068
  700 JM=J4+M                                                           E4TOP069
      JMMZ=IA(JM)/100                                                   E4TOP070
      JSDY=IA(JM)-100*JMMZ                                              E4TOP071
      L=3                                                               E4TOP072
      IF (IELT-4) 1000,900,1000                                         E4TOP073
  800 JM=J3+M                                                           E4TOP074
      JMMX=IA(JM)/100                                                   E4TOP075
      JMMY=IA(JM)-100*JMMX                                              E4TOP076
      L=2                                                               E4TOP077
      IF (IELT-4) 1000,700,1000                                         E4TOP078
  900 JM=J5+M                                                           E4TOP079
      JSDZ=IA(JM)/100                                                   E4TOP080
      JMFI=IA(JM)-100*JSDZ                                              E4TOP081
      JM=J6+M                                                           E4TOP082
      JPRS=IA(JM)                                                       E4TOP083
      L=4                                                               E4TOP084
 1000 I=1                                                               E4TOP085
      GO TO (1100,1200,1300,1400),L                                     E4TOP086
 1100 JM=J3+M                                                           E4TOP087
      N(I)=IA(JM)                                                       E4TOP088
      I=I+1                                                             E4TOP089
 1200 JM=J4+M                                                           E4TOP090
      N(I)=IA(JM)                                                       E4TOP091
      I=I+1                                                             E4TOP092
 1300 JM=J5+M                                                           E4TOP093
      N(I)=IA(JM)                                                       E4TOP094
      I=I+1                                                             E4TOP095
      JM=J6+M                                                           E4TOP096
      N(I)=IA(JM)                                                       E4TOP097
      I=I+1                                                             E4TOP098
 1400 JM=J7+M                                                           E4TOP099
      N(I)=IA(JM)                                                       E4TOP100
      I=I+1                                                             E4TOP101
      JM=J8+M                                                           E4TOP102
      N(I)=IA(JM)                                                       E4TOP103
      I=I+1                                                             E4TOP104
      JM=J9+M                                                           E4TOP105
      N(I)=IA(JM)                                                       E4TOP106
      I=I+1                                                             E4TOP107
      JM=J10+M                                                          E4TOP108
      N(I)=IA(JM)                                                       E4TOP109
      IF (I-IH) 1600,1600,1450                                          E4TOP110
 1450 IHP=IH+1                                                          E4TOP111
      DO 1500 I=IHP,8                                                   E4TOP112
 1500 N(I)=0.                                                           E4TOP113
 1600 RETURN                                                            E4TOP114
      END                                                               E4TOP115
```

Table VII-83. Source program listing of subroutine TRAN (Link 4)

```
*       LABEL
CE4TRN
        SUBROUTINE TRAN (A,IFS)
C       FOR LOCAL-OVERALL COORDINATE TRANSFORMATION FOR VECTORS
        DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)
       1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)
        COMMON IA,AA
        EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),E),(D21(20),G)
        EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),
       1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),
       2IH),(IA(11),I8),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),
       3IMFI),(IA(16),IARE),(IA(17),M(1)),(IA(25),M),(IA(26),ITY),(IA(27),
       4ISTR),(IA(28),IFLT),(IA(29),ITEM),(IA(30),ITTC),(IA(31),IMET),
       5(IA(32),ISUM),(IA(33),INO),(IA(34),IMS),(IA(36),IOS),(IA(37),
       6IDRD),(IA(38),IORO1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),
       7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57
       8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBD),(IA(61),IID),(IA(62),
       9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITE),(IA(41),ITAP)
        EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),
       1IC12),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),
       2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)
       3,(IA(78),IGEM),(IA(79),IFRR),(AA(80),TE),(AA(81),DT),(AA(82),DG),
       4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),
       5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),
       6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)
       7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IU
       8),(AA(47),G1),(AA(48),G2),(AA(49),G3)
        EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346)
       1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)
       2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)
       3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)
       4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)
       5,(IA(329),IPTR)
        DIMENSION EM(4,4),EN(4,4),Q(4,4),DIR(3,3),DUM(18)
        EQUIVALENCE (AA(200),EM),(AA(216),EN),(AA(232),EQ),(AA(248),Q),
       1(AA(264),DIR),(AA(273),DUM)
        DIMENSION A(1)
 10     IGEMP=IGEM+1
        LJI=0
        LK=IFS-4*IMS
 20     DO 300 L=1,IGEMP
        LK=LK+3*IMS
 30     DO 200 J=1,3
        DO 200 I=1,IMS
        LJI=LJI+1
        DUM(LJI)=0.
        LKI=LK+I
 40     DO 100 K=1,3
        LKI=LKI+IMS
  100   DUM(LJI)=DUM(LJI)+DIR(K,J)*A(LKI)
  200   CONTINUE
  300   CONTINUE
        INI=3*IGEMP*IMS
        DO 400 I=1,INI
        II=IFS+I
  400   A(II)=DUM(I)
        RETURN
        END
```

Table VII-84. Source program listing of subroutine UNIT (Link 4)

```
*       LABEL
CE4UNT
        SUBROUTINE UNIT(CIR,Q)
C       OBTAINS A UNIT VECTOR ALONG A LINE SEGMENT
C       IF Q=NEGATIVE, CHANGE DIRECTION AND REPLACE WITH UNITY, Q=LENGTH
C       IF Q=0, MAKE Q=LENGTH*LENGTH AND RETURN
C       IF Q=POSITIVE, REPLACE WITH UNITY,  Q=LENGTH
        DIMENSION CIR(3)
        R=CIR(1)**2+CIR(2)**2+CIR(3)**2
        IF (Q) 10,19,20
 19     Q=R
        GO TO 21
 10     CIR(1)=-CIR(1)
        CIR(2)=-CIR(2)
        CIR(3)=-CIR(3)
 20     Q=SQRTF(R)
        CIR(1)=CIR(1)/Q
        CIR(2)=CIR(2)/Q
        CIR(3)=CIR(3)/Q
 21     RETURN
        END
```

Table VII-85. Source program listing of subroutine VECT (Link 4)

```
*       LABEL
CE4VCT
        SUBROUTINE VECT(A,B,C)
C       PERFORMS VECTORIAL VECTOR PRODUCT
C       TO OBTAIN A AS BXC
        DIMENSION A(3),B(3),C(3)
        A(1)=B(2)*C(3)-B(3)*C(2)
        A(2)=B(3)*C(1)-B(1)*C(3)
        A(3)=B(1)*C(2)-B(2)*C(1)
        RETURN
        END
```

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