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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

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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.)

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.

* First two syllables of the word Elasticity.

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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 ith row and the jth column, and likewise the jth row and the ith 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 IPBG, 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 IPBG, 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.

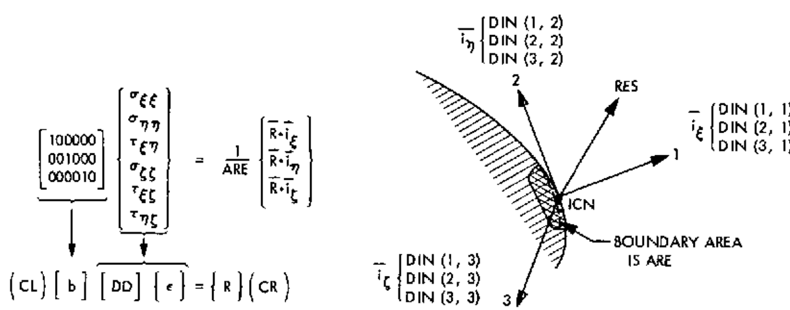
In Table V-1, the parameters used by the subroutine are defined. The meanings of these parameters are as follows: IEQ is the number of the stress boundary equations (note that the number of stress boundary conditions is the product of IEQ*IRIG); IRIG is the number of right-hand sides in the strain deflection 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	{1, 2}		{1., 1.}		3	$\frac{ARE}{TE*DD_{1,1}}$	$\frac{ARE^2}{DD_{1,1}}$	0
2	2	1	3		2	3	1	{2, 1}		{1., −1.}		3	$\frac{-TE^2*ARE}{12*DD_{1,1}}$	$\frac{ARE^2}{DD_{1,1}}$	1
3	2	1	3		1	2	1	{1, 2}		{1., 1.}		3	$\frac{ARE}{XX*DD_{1,1}}$	$\frac{ARE^2}{DD_{1,1}}$	0
4	3	1	3	5	1	3	1	{1, 2, 3}		{1., 1., 1.}		6	$\frac{1}{DD_{1,1}}$	$\frac{ARE}{DD_{1,1}}$	0
5	1	1			1	2	1	{1, 2}		{1., 1.}		1	$\frac{ARE^2}{XX*DD_{1,1}}$	$\frac{ARE^2}{DD_{1,1}}$	0
6	1	1			1	2	2	{1, 2}	{2}	{1., 1.}	{1.}	3	$\frac{ARE^2}{XX*DD_{1,1}}$	$\frac{ARE^2}{DD_{1,1}}$	0
7	2	1	3		1	3	1	{1, 2}		{1., 1.}		3	$\frac{ARE}{DD_{1,1}}$	$\frac{ARE^2}{DD_{1,1}}$	0
8	2	1	3		1	3	2	{1, 2}	{2, 1}	{1., 1.}	{1., −1.}	3	$\frac{ARE}{DD_{1,1}}$	$\frac{ARE^2}{DD_{1,1}}$	0



If IRIG = 2 { IREB = IREN$_{previous}$ + 1 ; IREN = IDEG }

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.

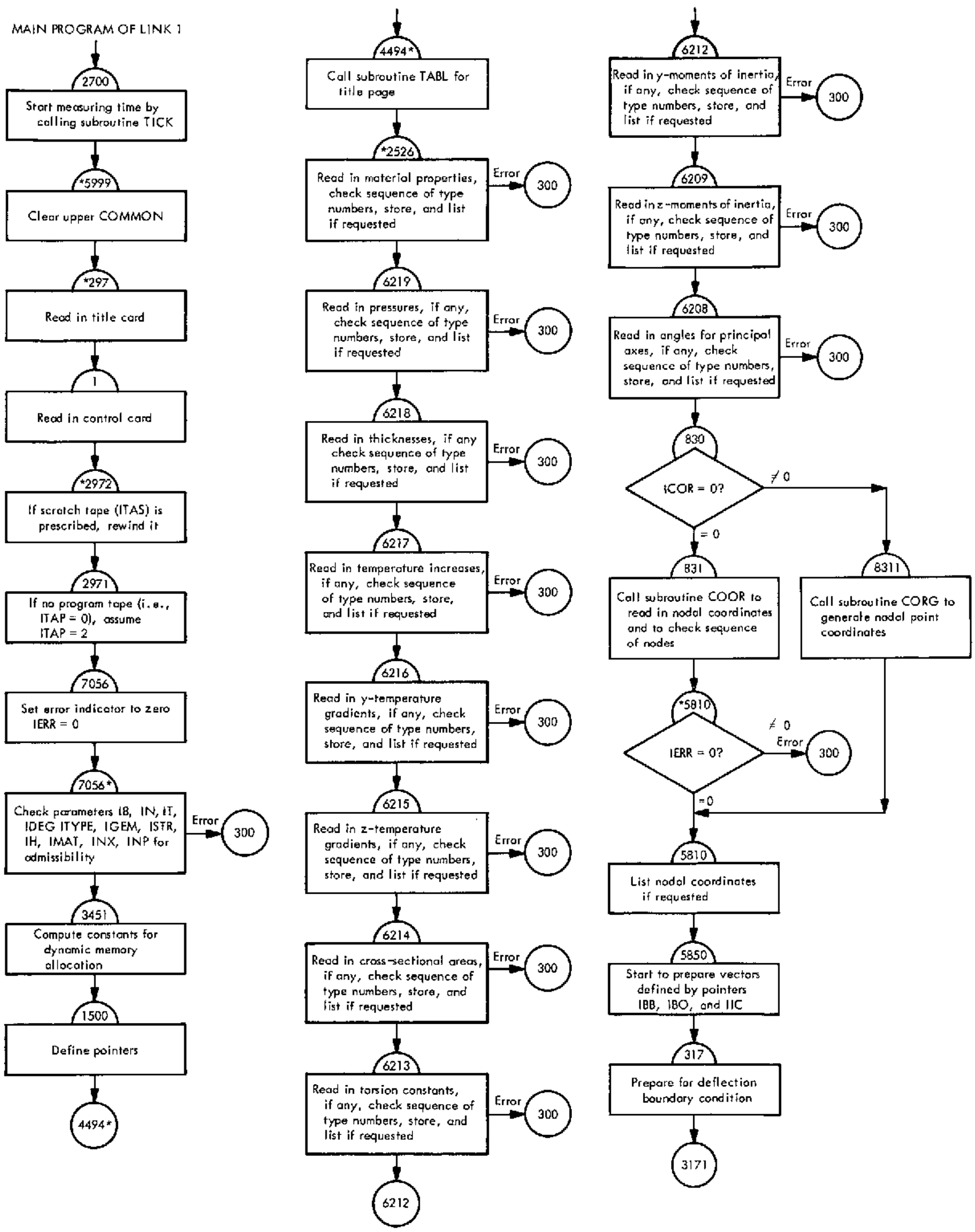


Fig. VI-1. Flowchart of main program of Link 1 (input link)

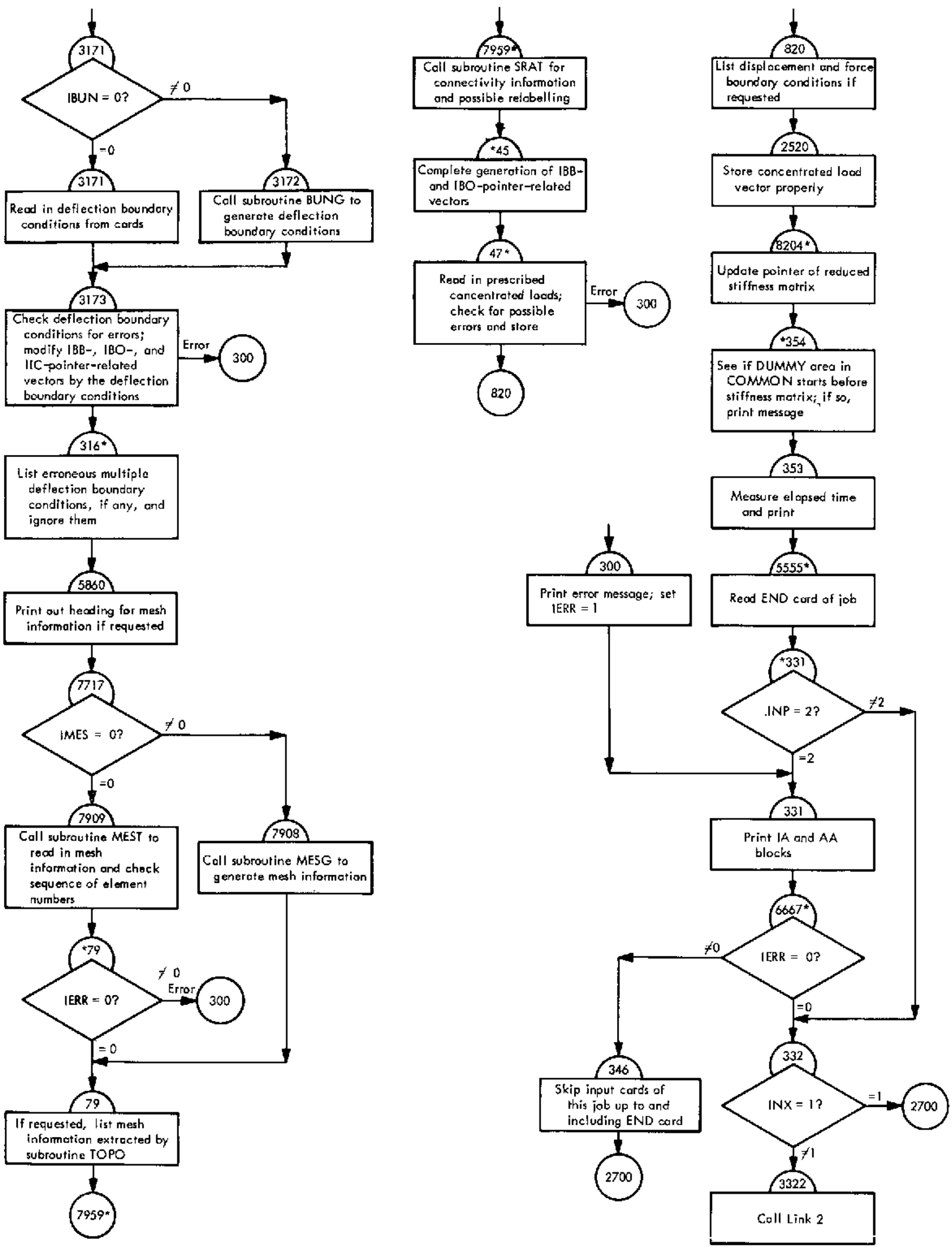


Fig. VI-1 (contd)

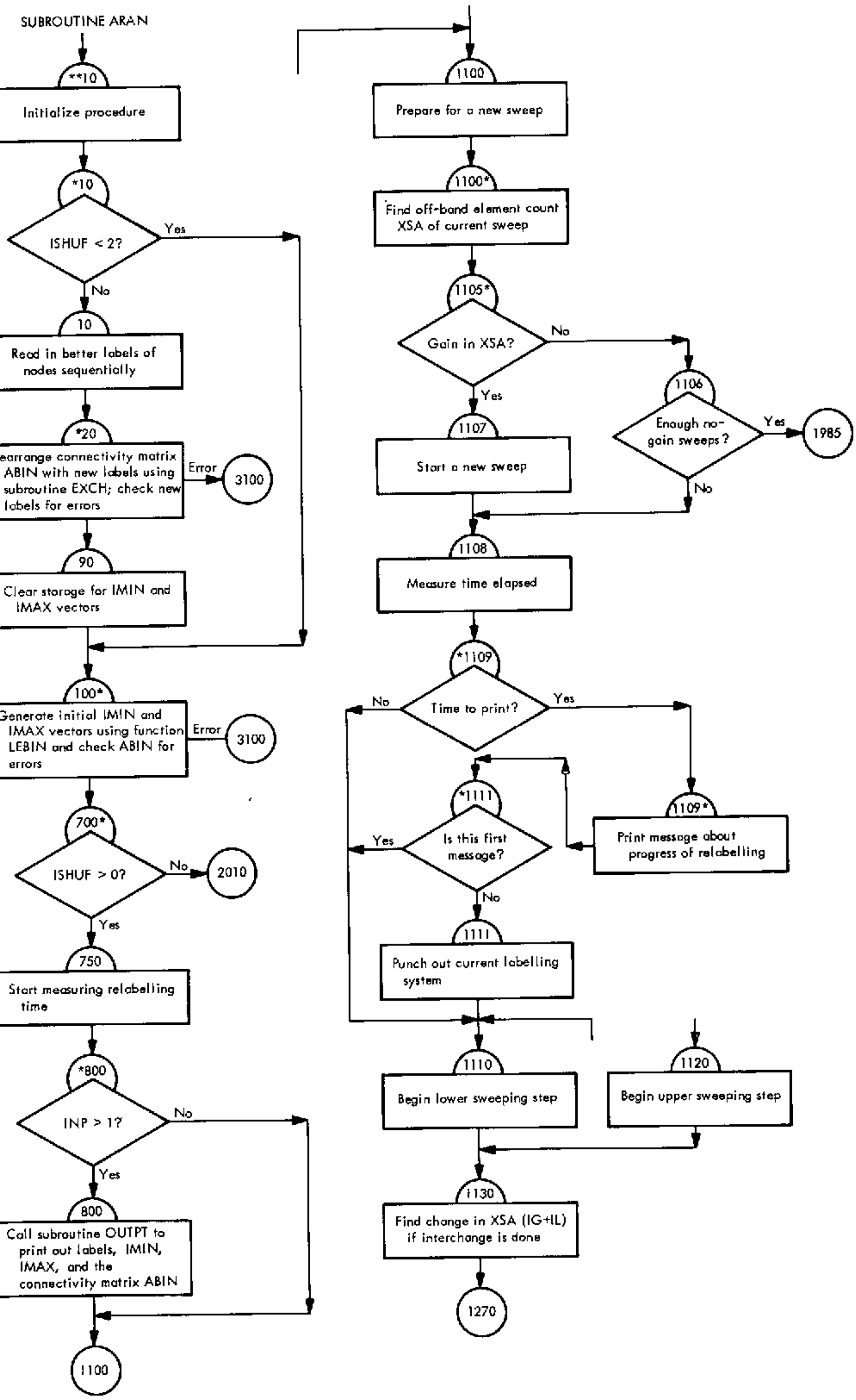


Fig. VI-2. Flowchart of subroutine ARAN (Link 1)

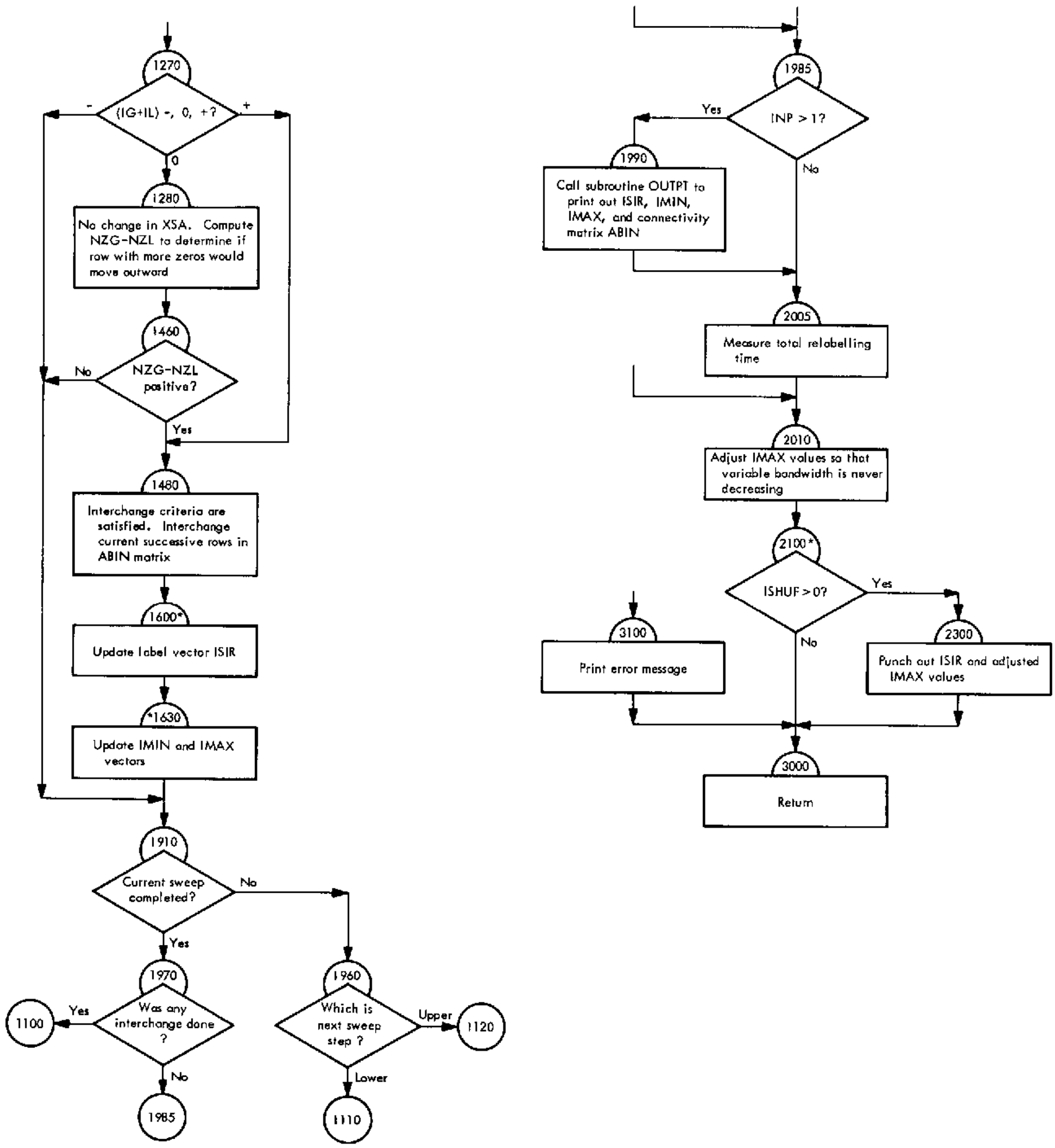


Fig. VI-2 (contd)

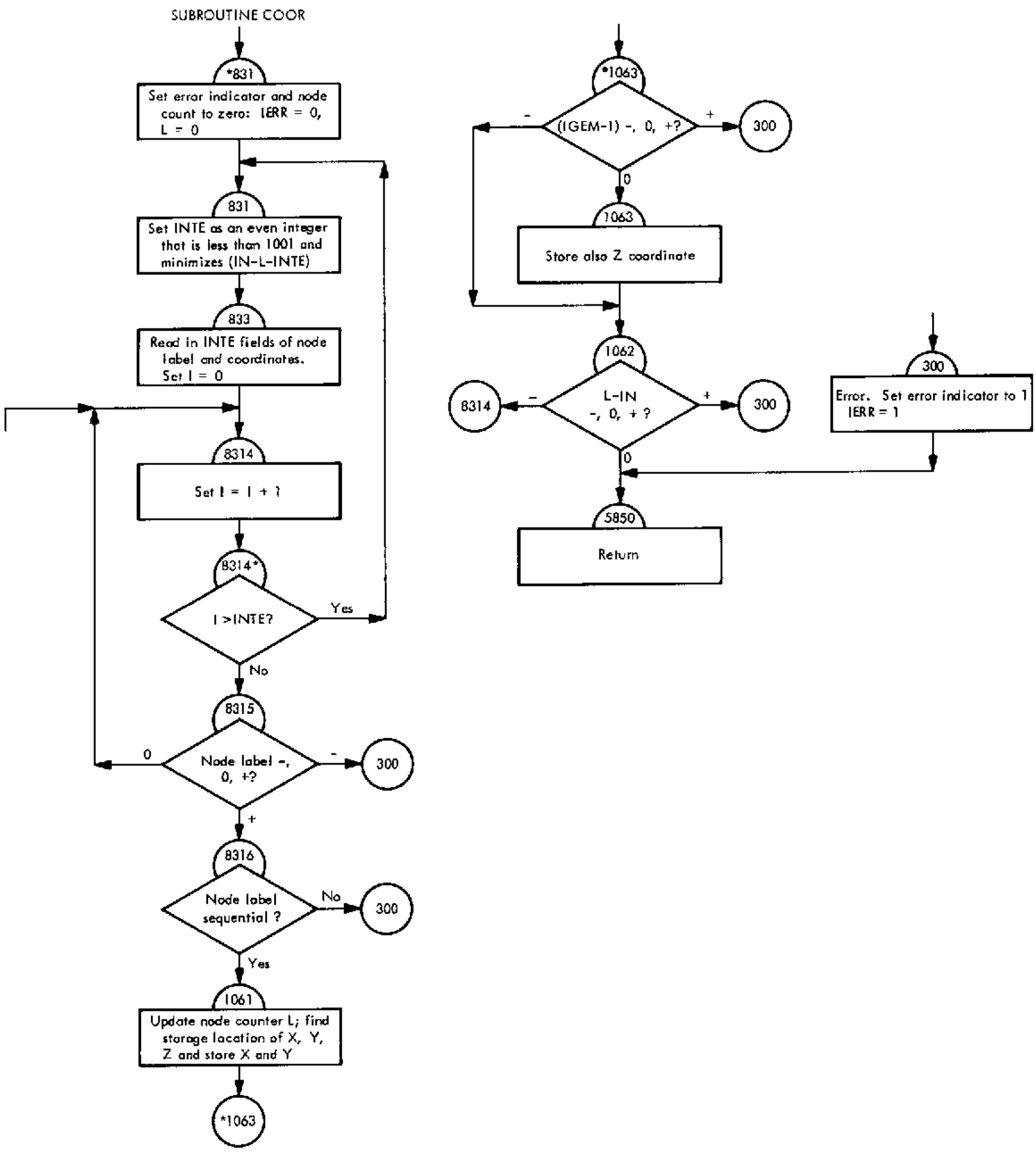


Fig. VI-3. Flowchart of subroutine COOR (Link 1)

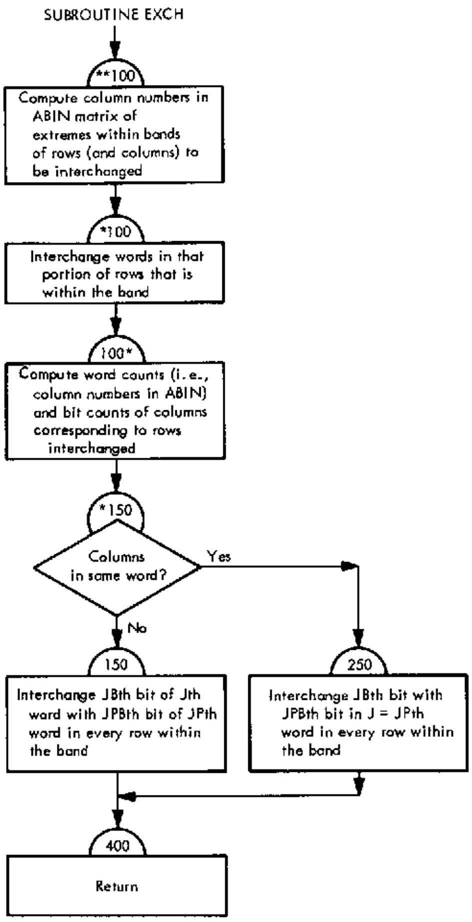


Fig. VI-4. Flowchart of subroutine EXCH (Link 1)

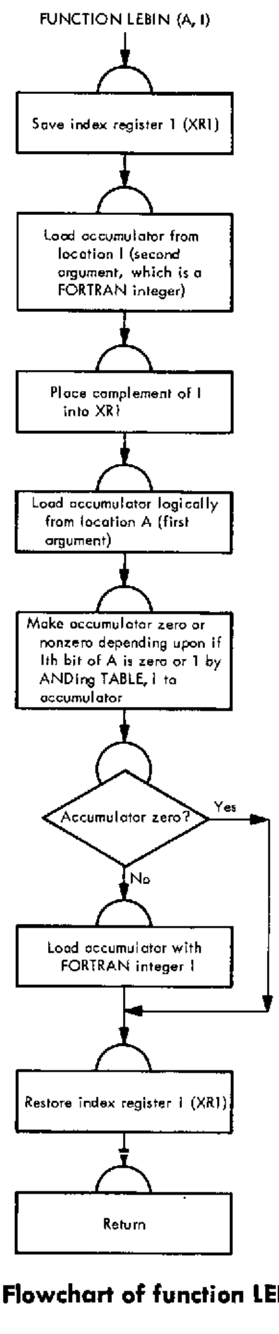


Fig. VI-5. Flowchart of function LEBIN (Link 1)

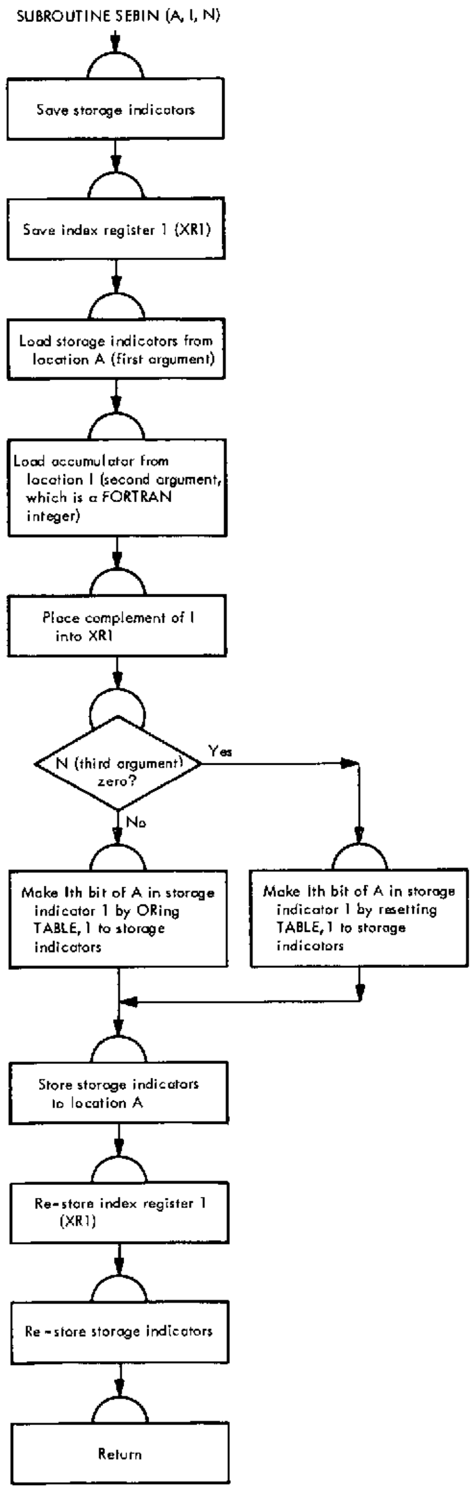


Fig. VI-6. Flowchart of subroutine SEBIN (Link 1)

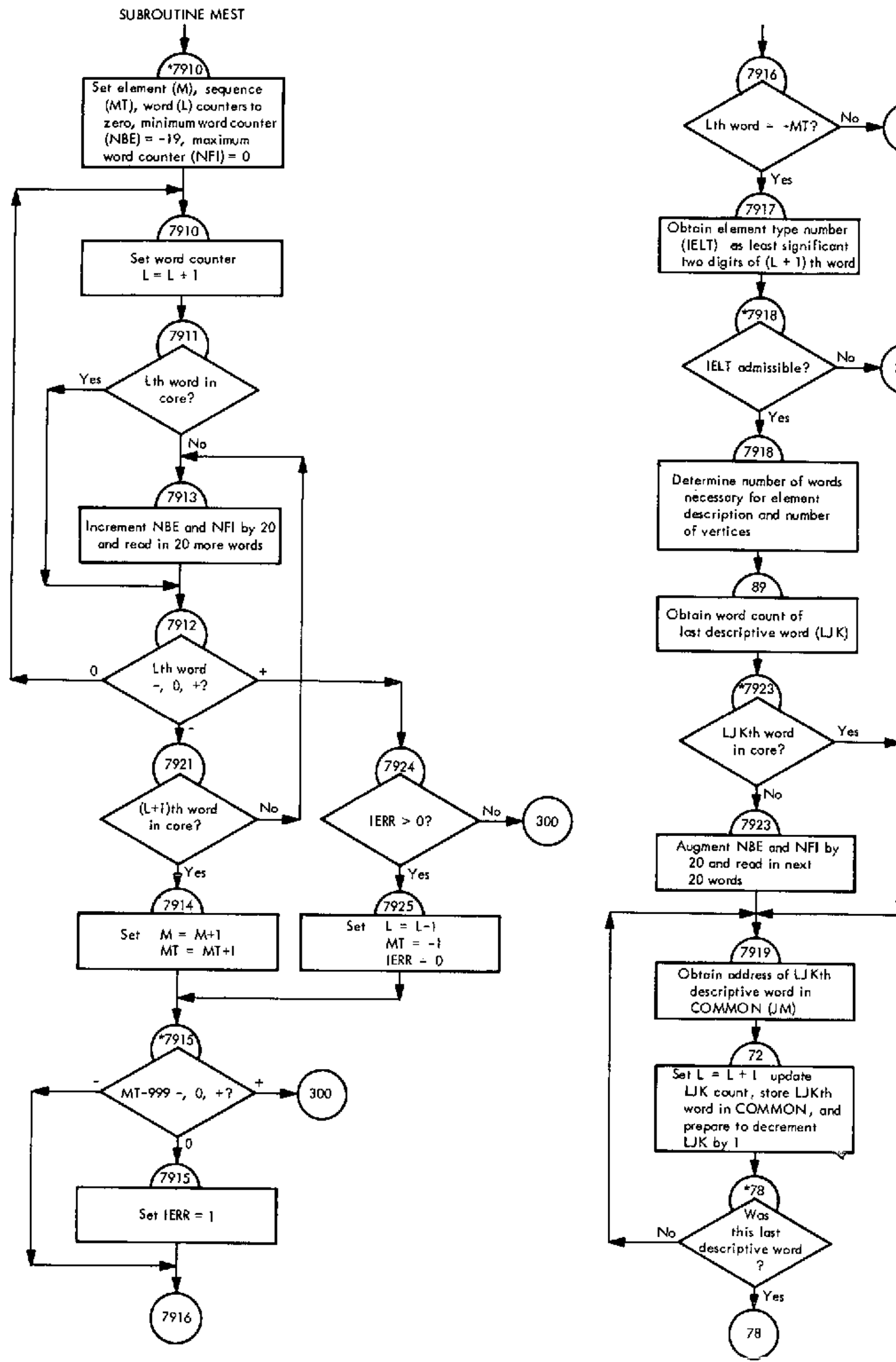


Fig. VI-7. Flowchart of subroutine MEST (Link 1)

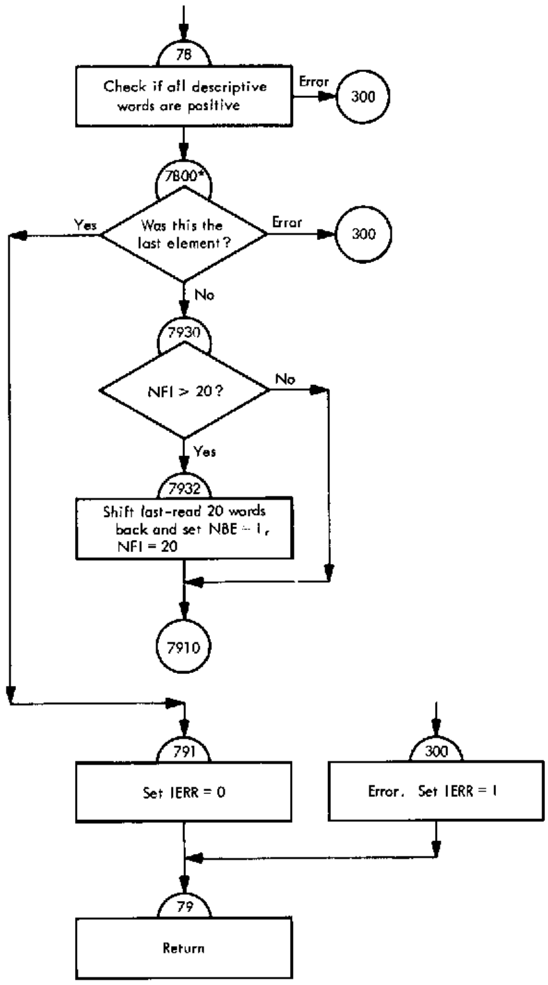


Fig. VI-7 (contd)

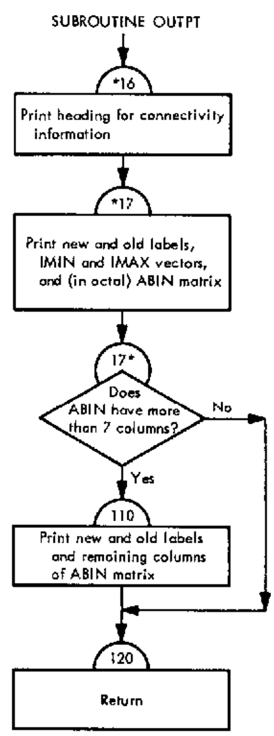


Fig. VI-8. Flowchart of subroutine OUTPT (Link 1)

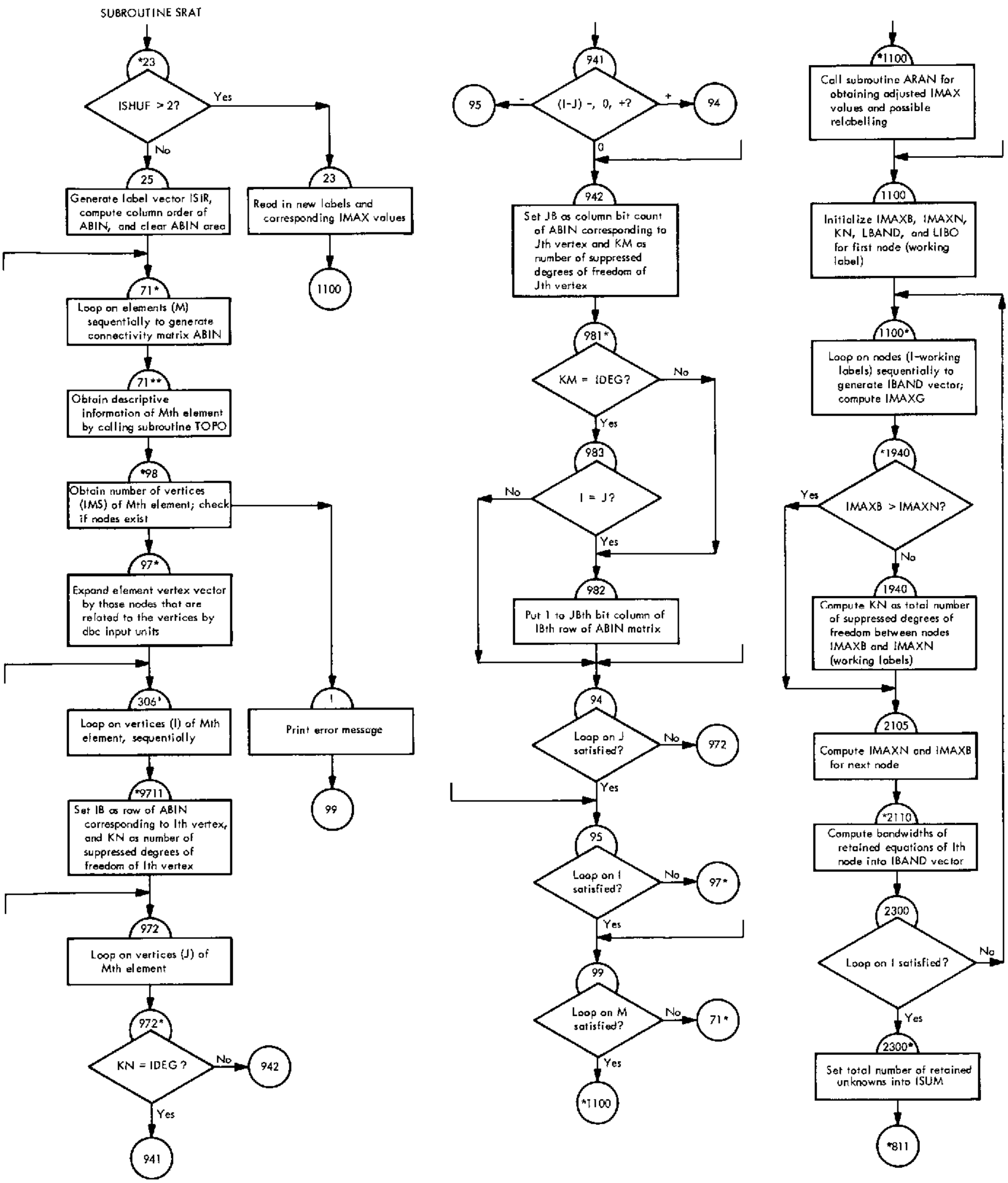


Fig. VI-9. Flowchart of subroutine SRAT (Link 1)

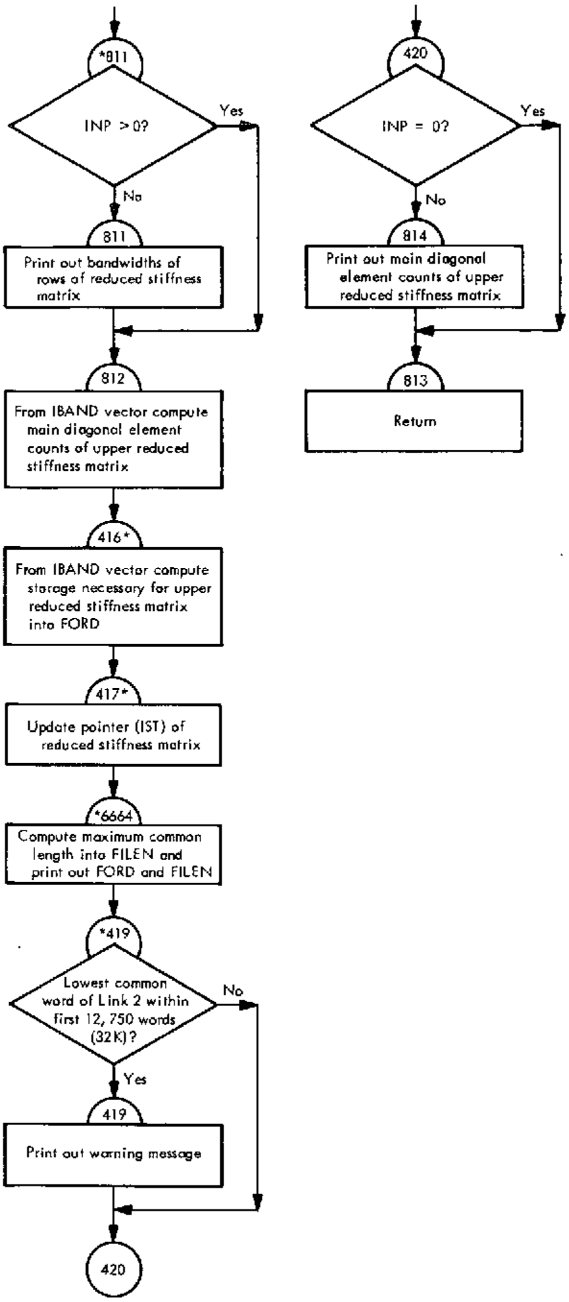


Fig. VI-9 (contd)

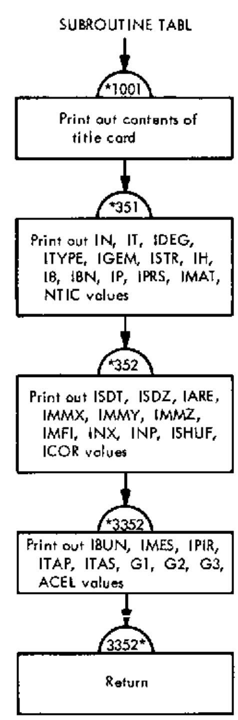


Fig. VI-10. Flowchart of subroutine TABL (Link 1)

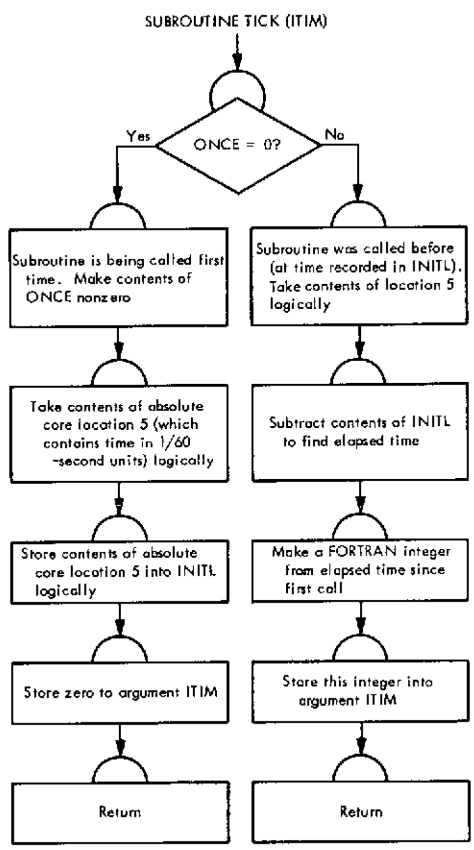


Fig. VI-11. Flowchart of subroutine TICK (Link 1)

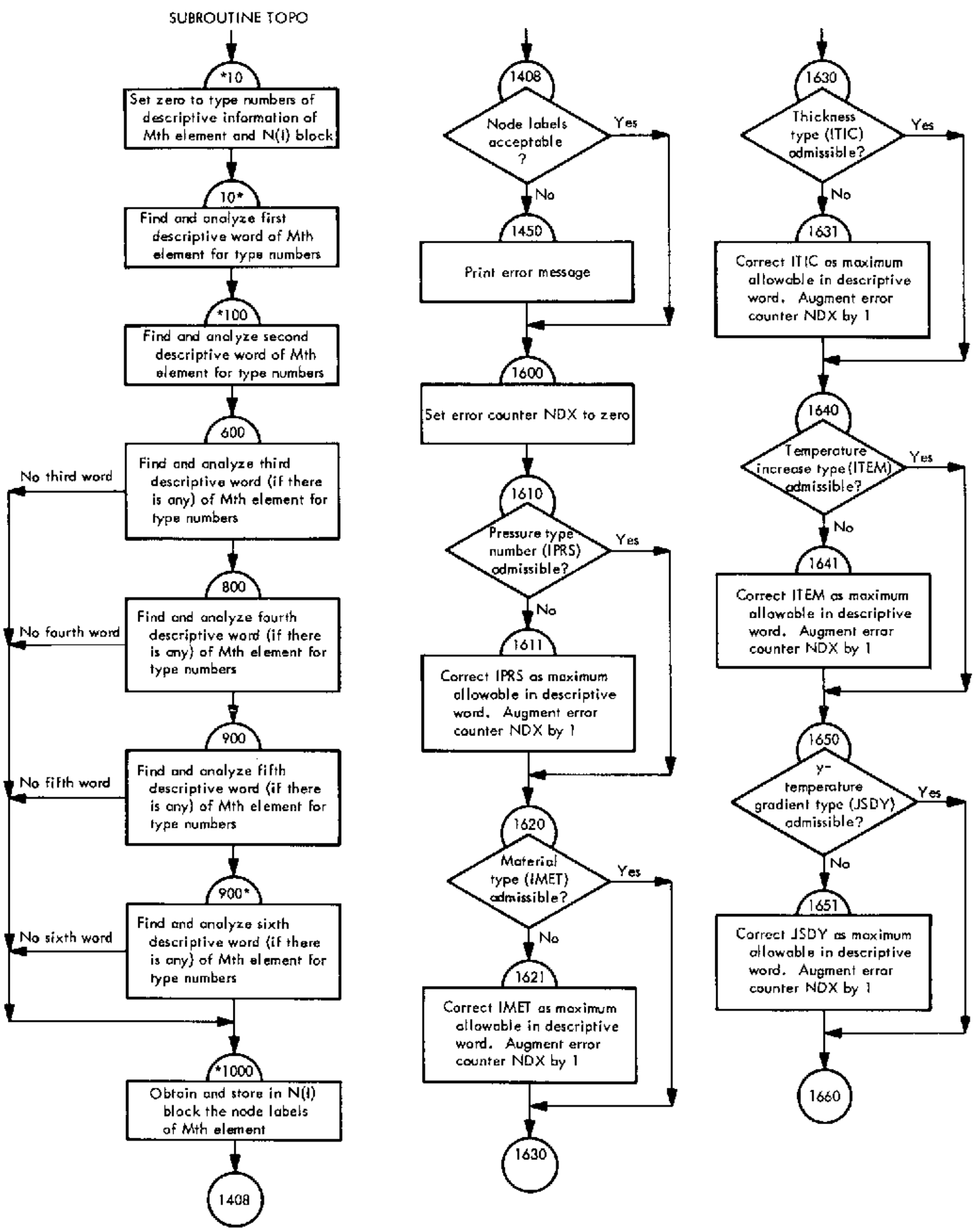


Fig. VI-12. Flowchart of subroutine TOPO (Link 1)

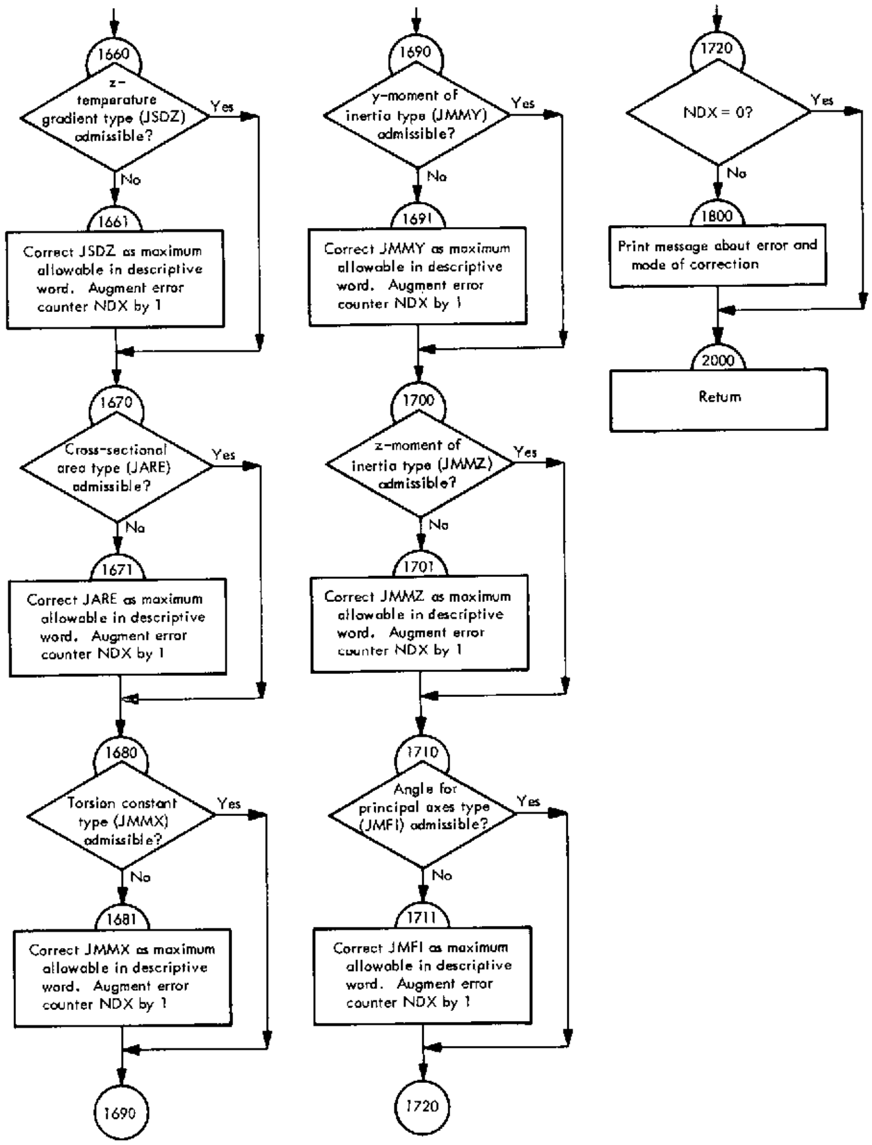


Fig. VI-12 (contd)

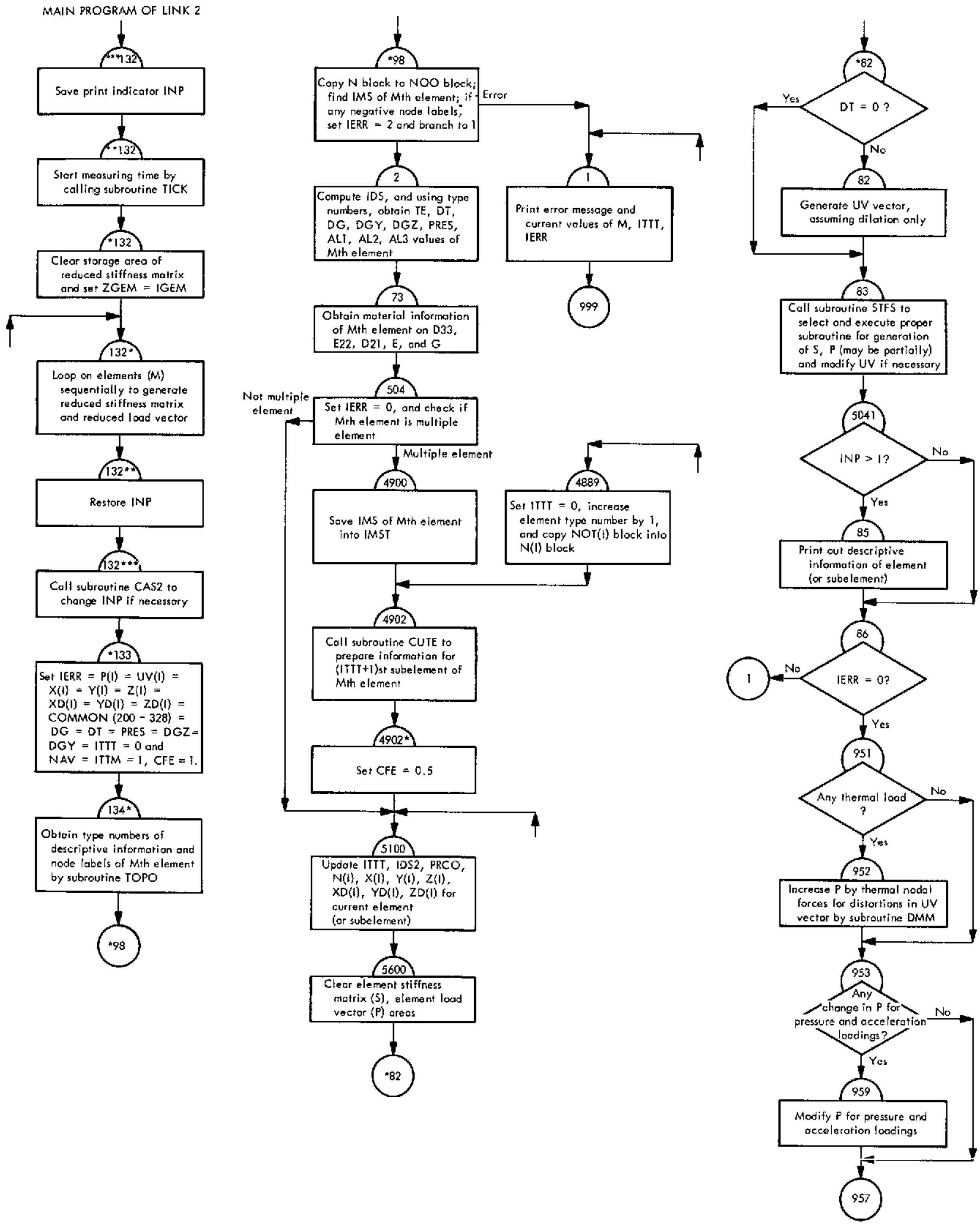


Fig. VI-13. Flowchart of main program of Link 2 (generation link)

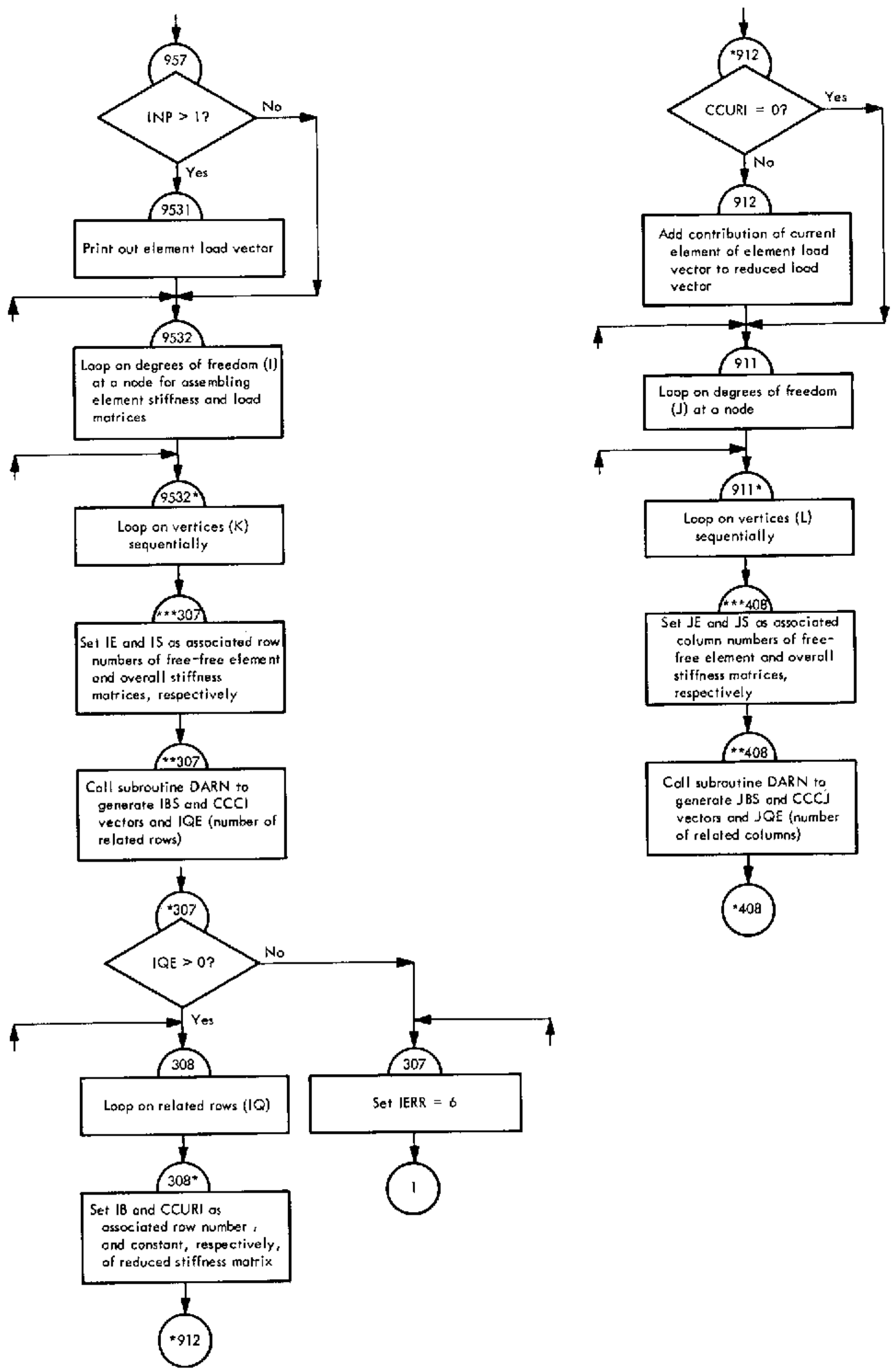


Fig. VI-13 (contd)

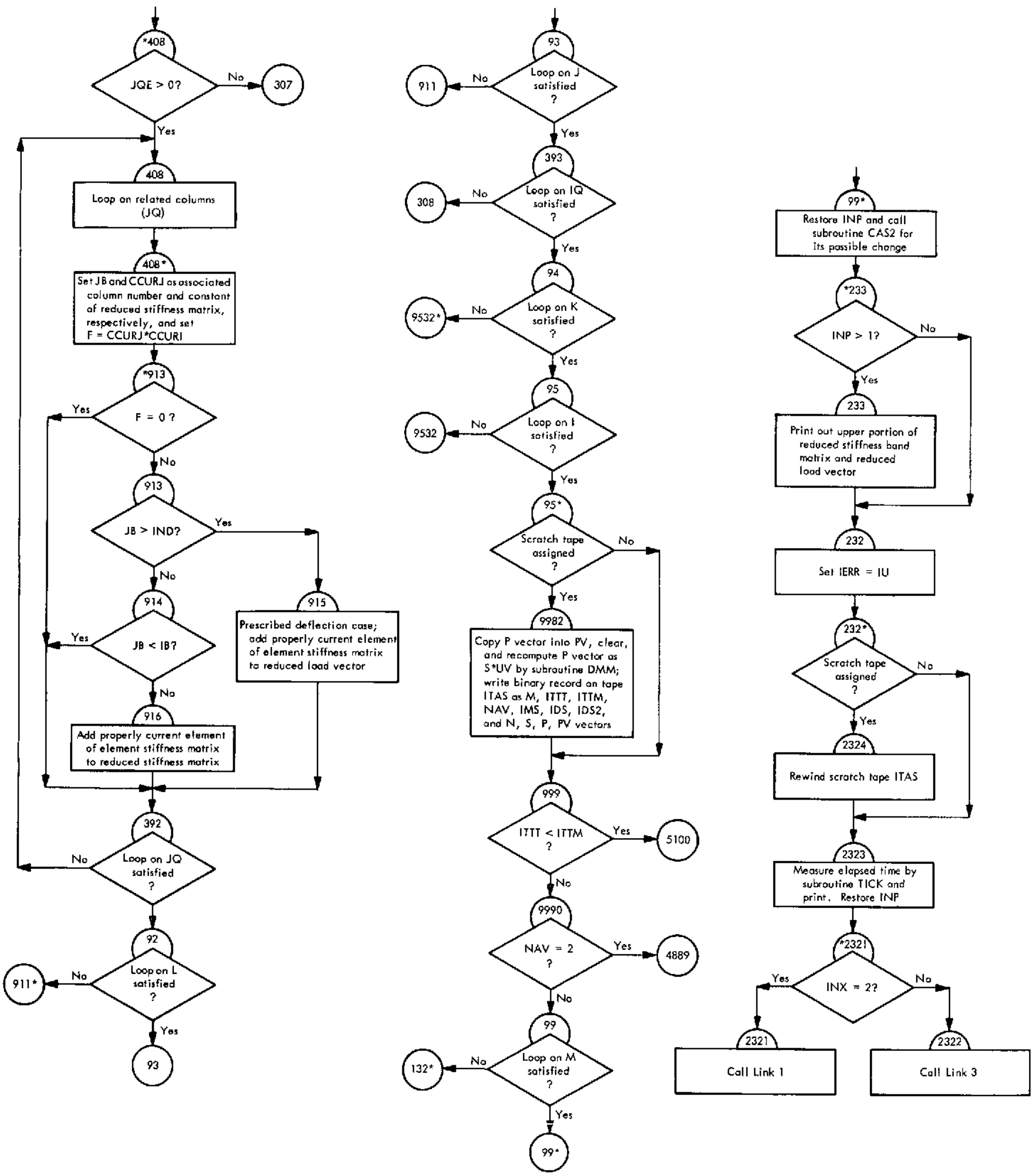


Fig. VI-13 (contd)

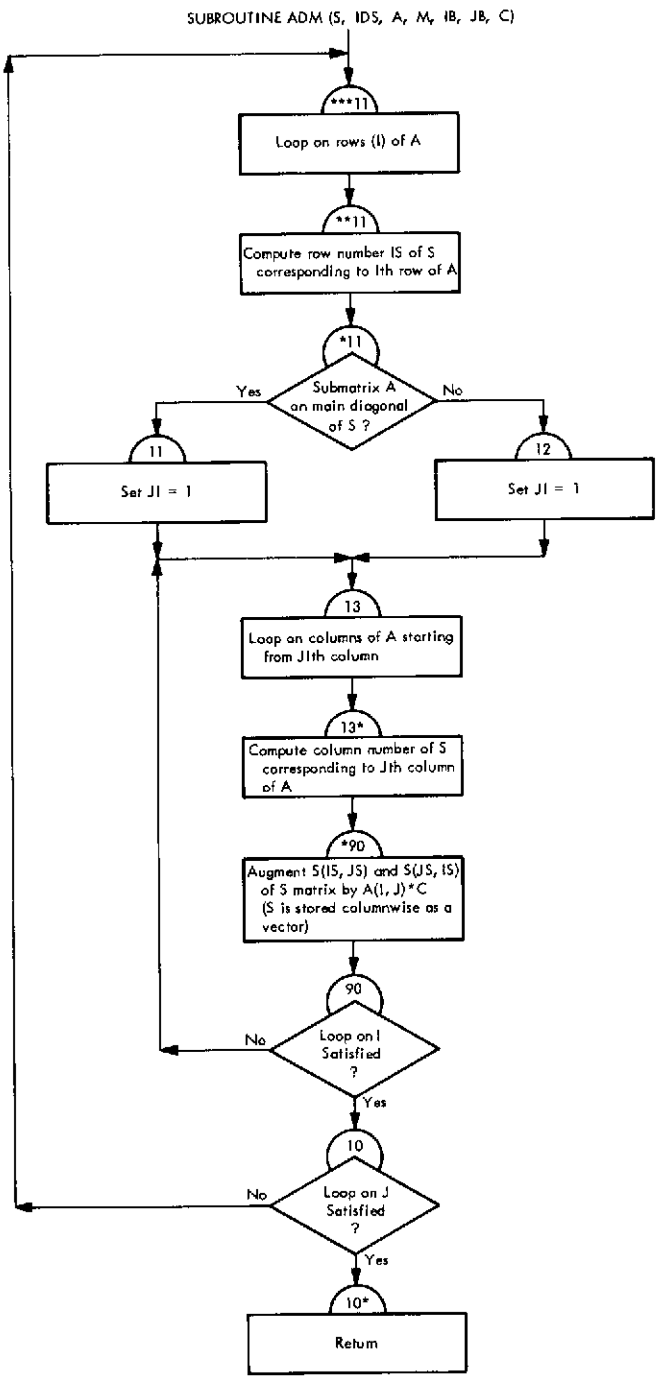


Fig. VI-14. Flowchart of subroutine ADM (Link 2)

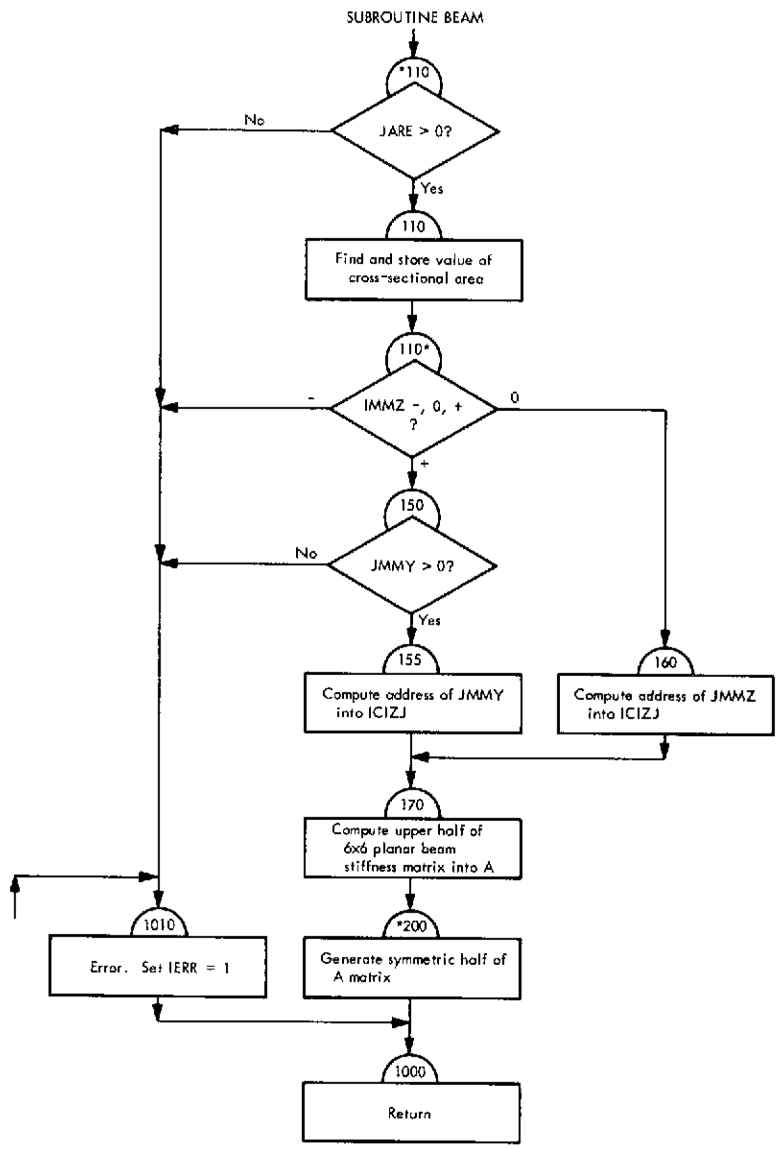


Fig. VI-15. Flowchart of subroutine BEAM (Link 2)

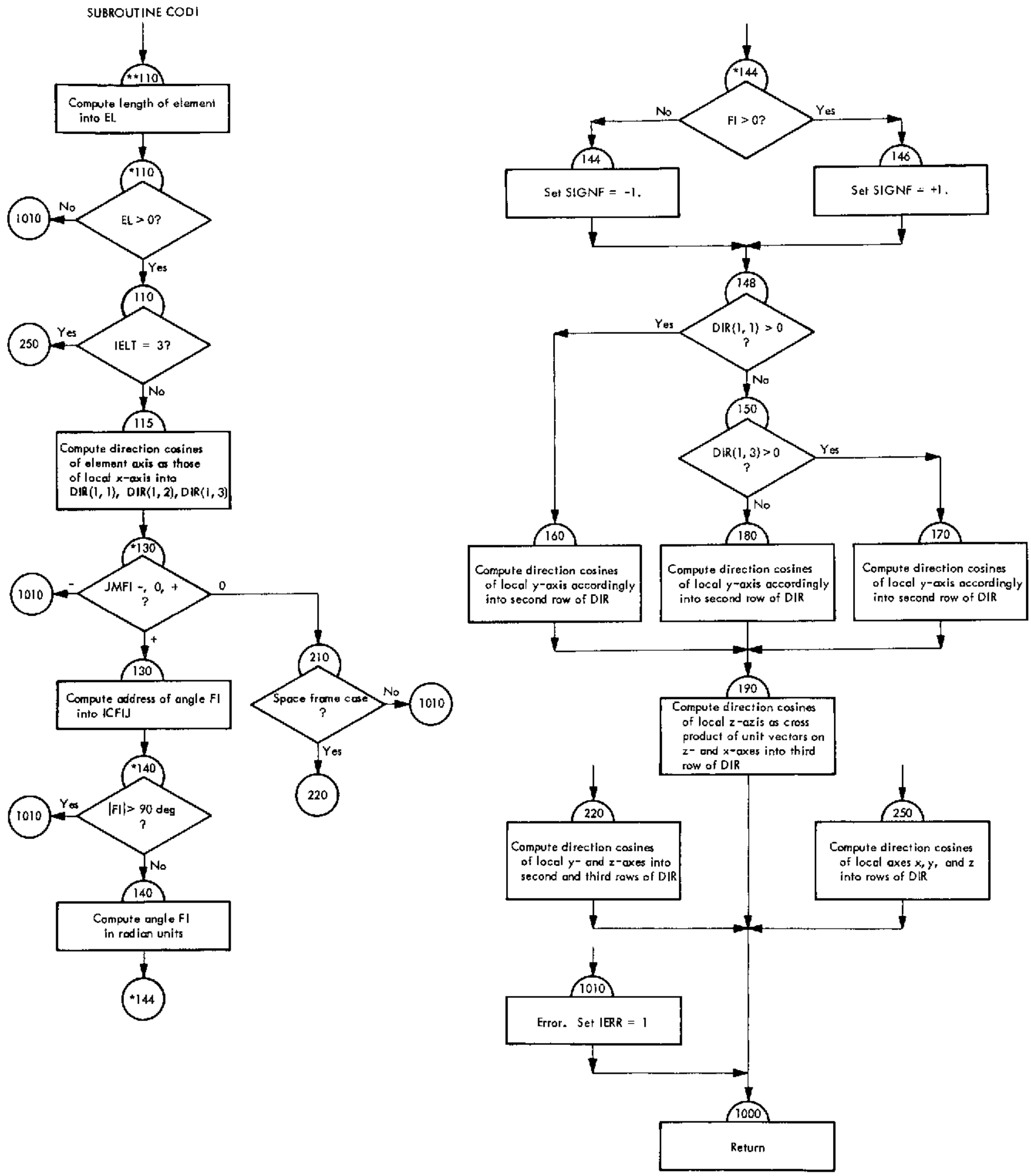


Fig. VI-16. Flowchart of subroutine CODI (Link 2)

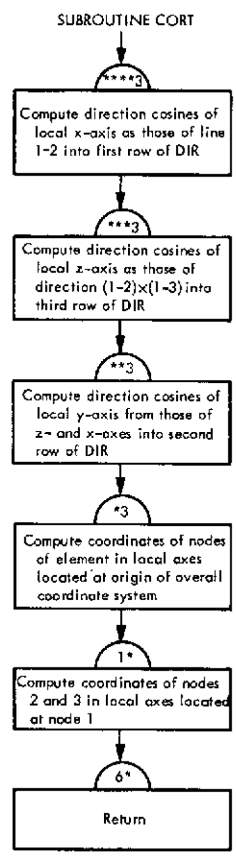


Fig. VI-17. Flowchart of subroutine CORT (Link 2)

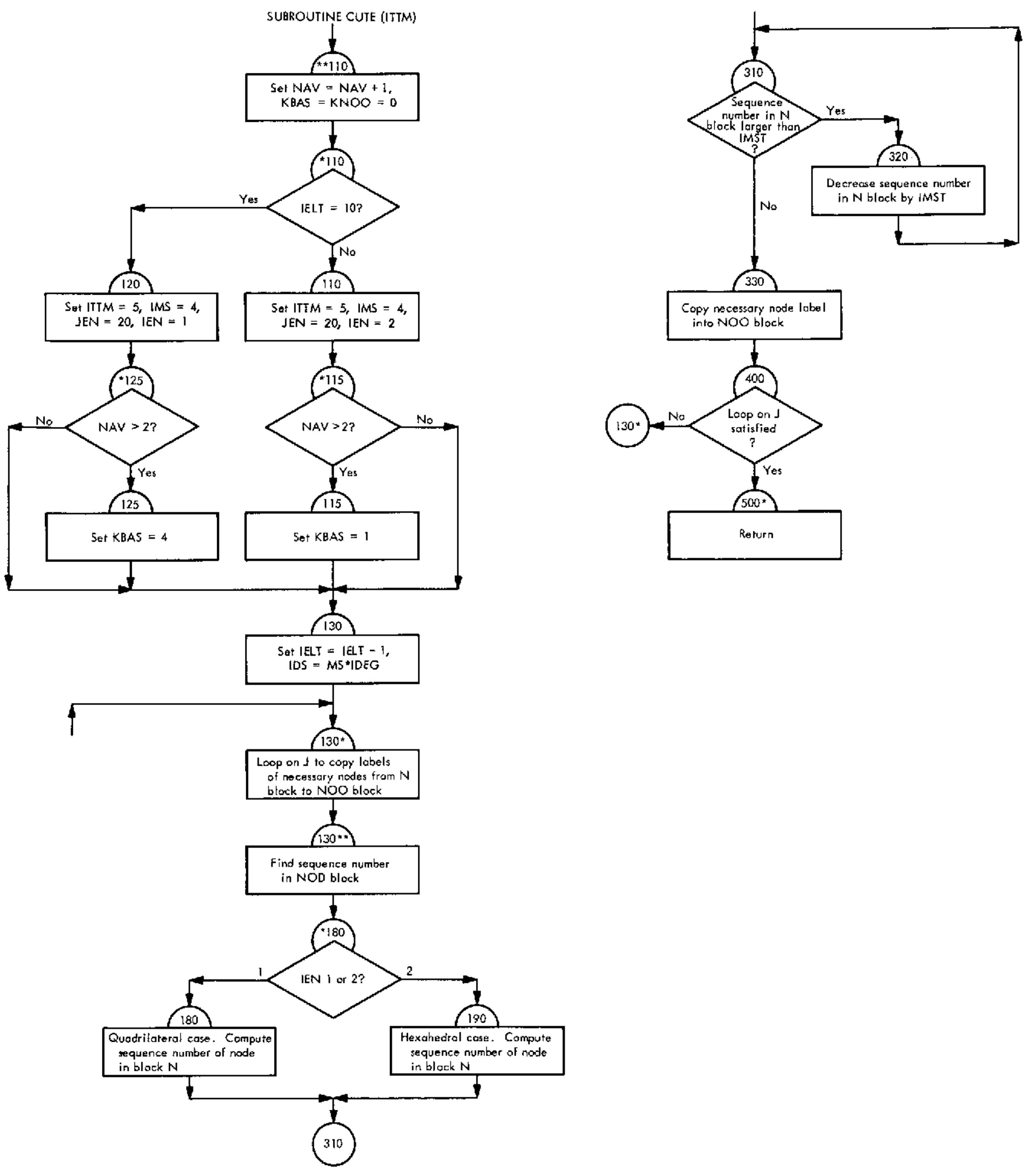


Fig. VI-18. Flowchart of subroutine CUTE (Link 2)

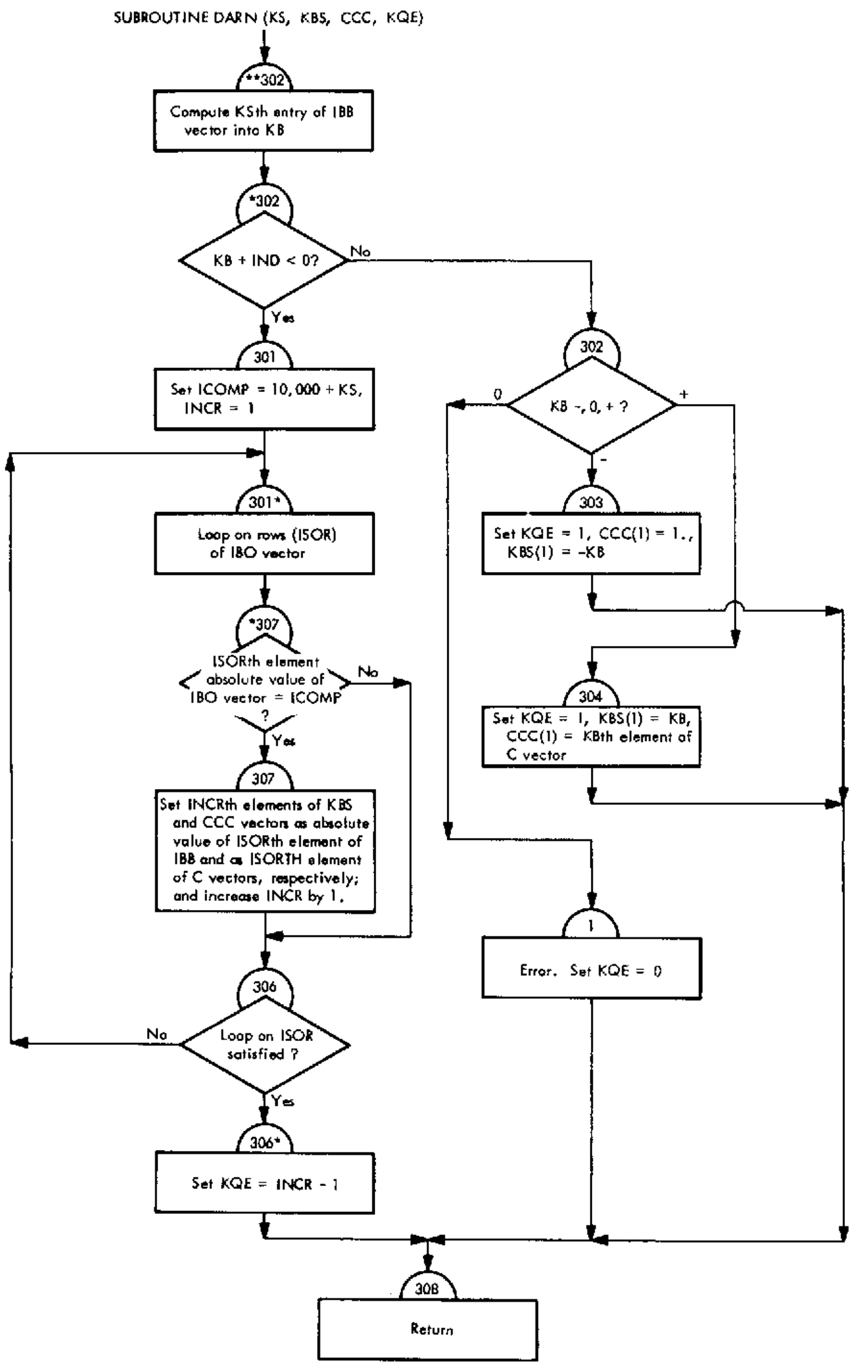


Fig. VI-19. Flowchart of subroutine DARN (Link 2)

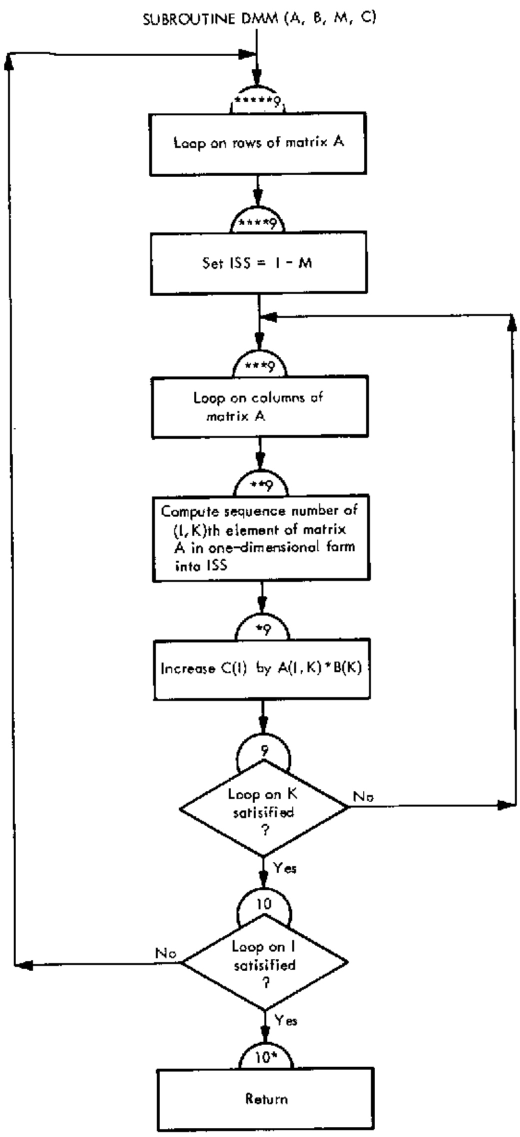


Fig. VI-20. Flowchart of subroutine DMM (Link 2)

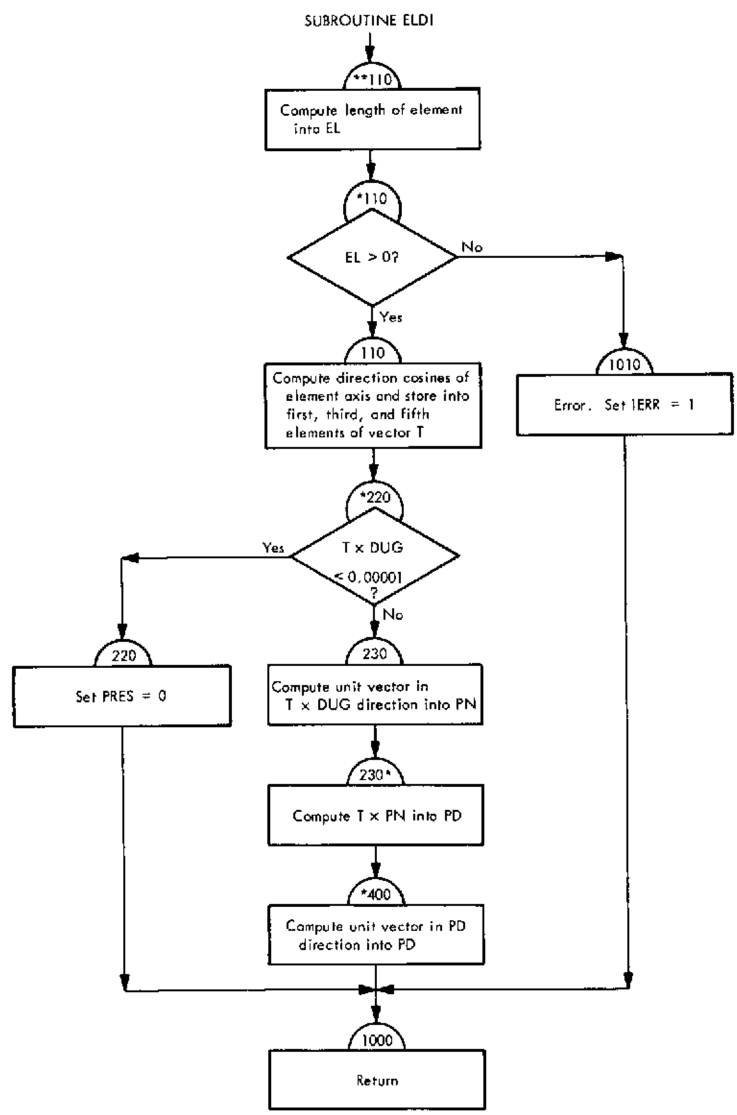


Fig. VI-21. Flowchart of subroutine ELDI (Link 2)

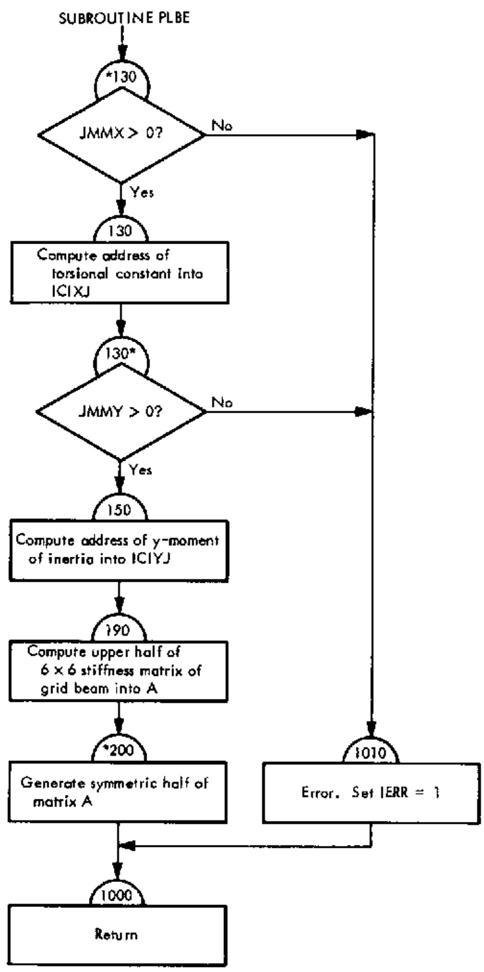


Fig. VI-22. Flowchart of subroutine PLBE (Link 2)

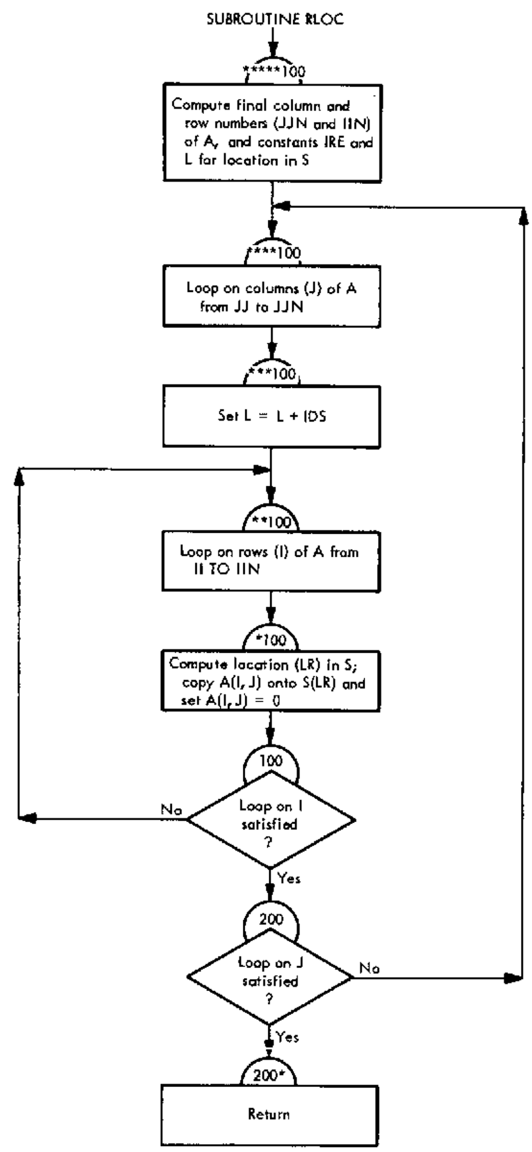


Fig. VI-23. Flowchart of subroutine RLOC (Link 2)

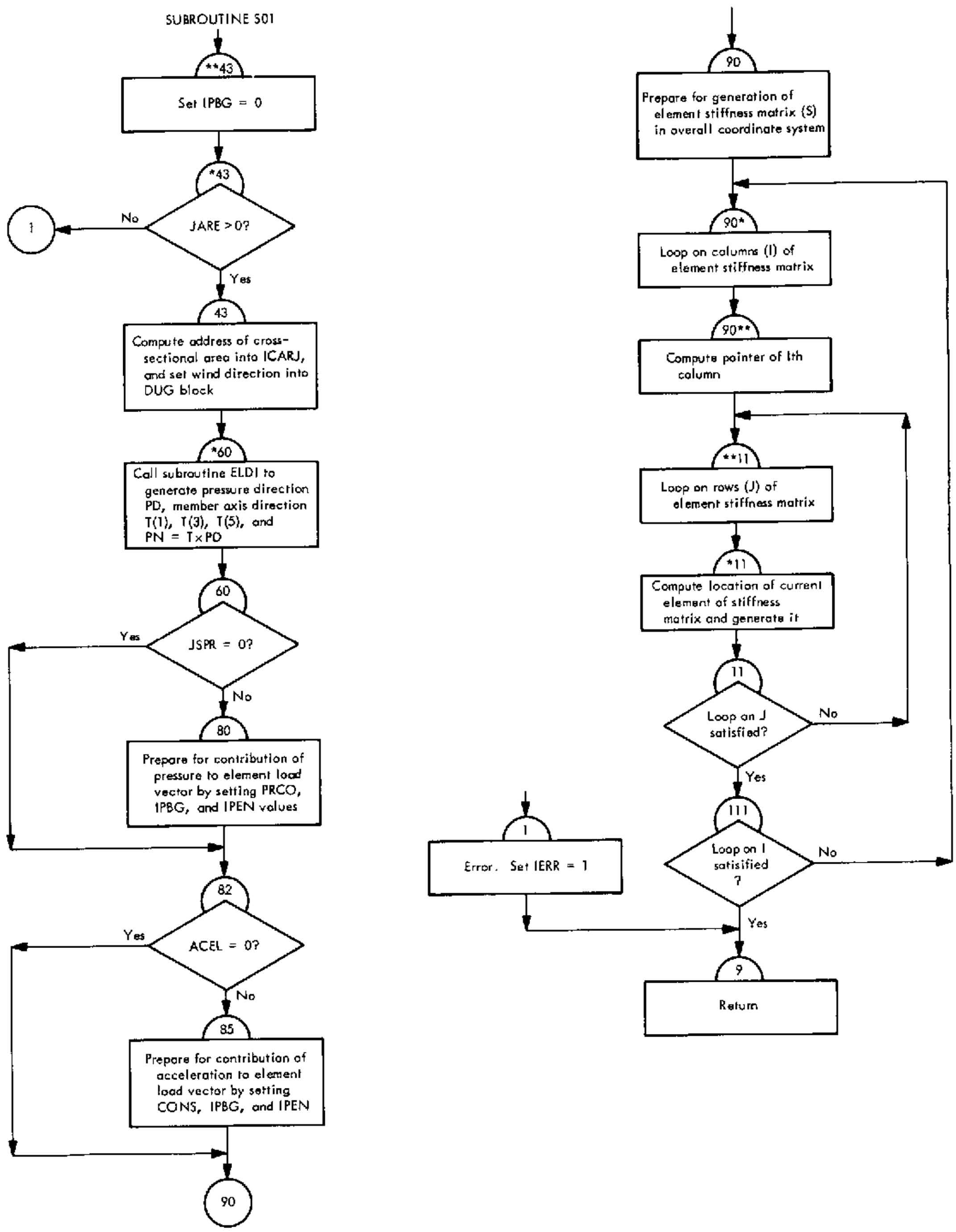


Fig. VI-24. Flowchart of subroutine S01 (Link 2)

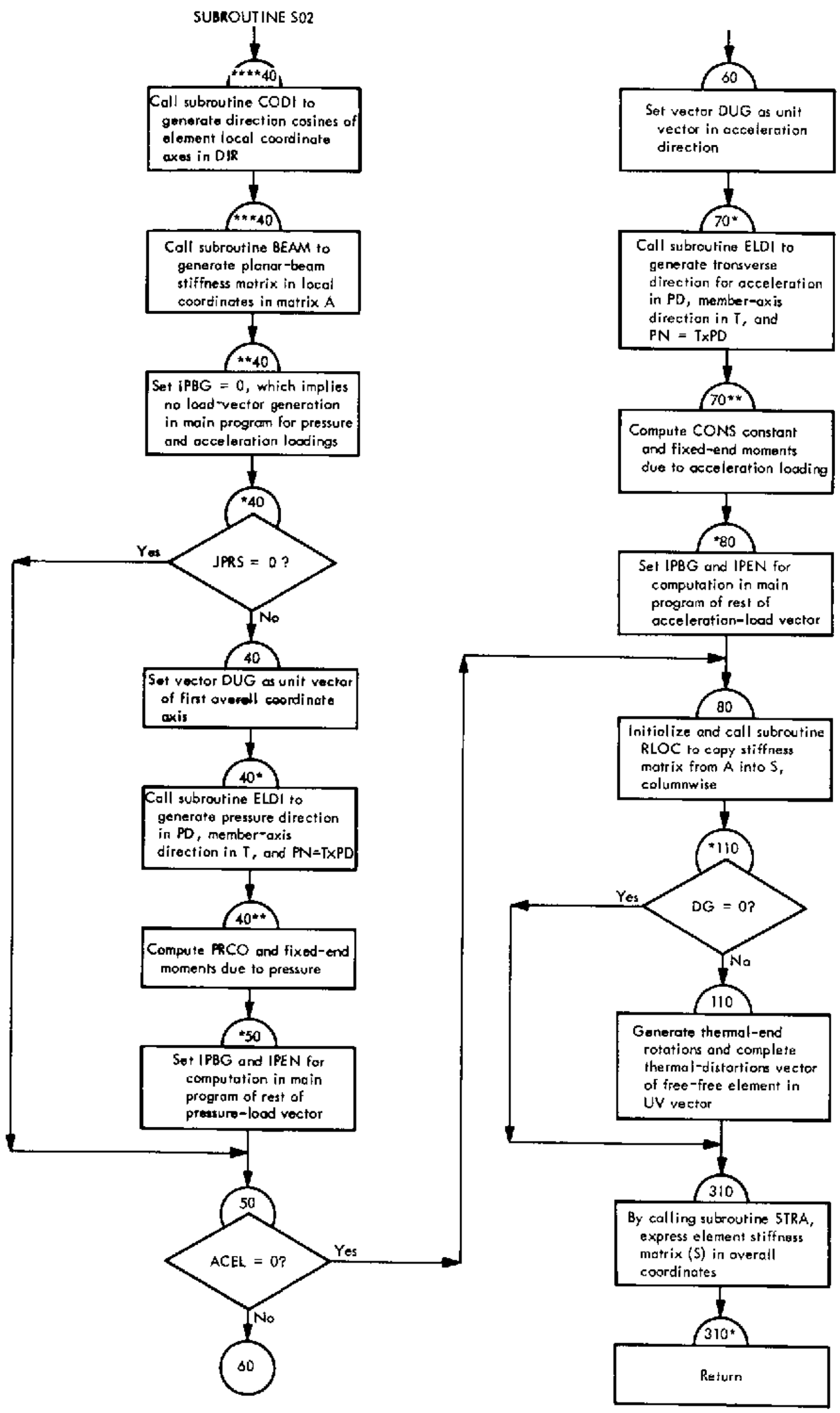


Fig. VI-25. Flowchart of subroutine S02 (Link 2)

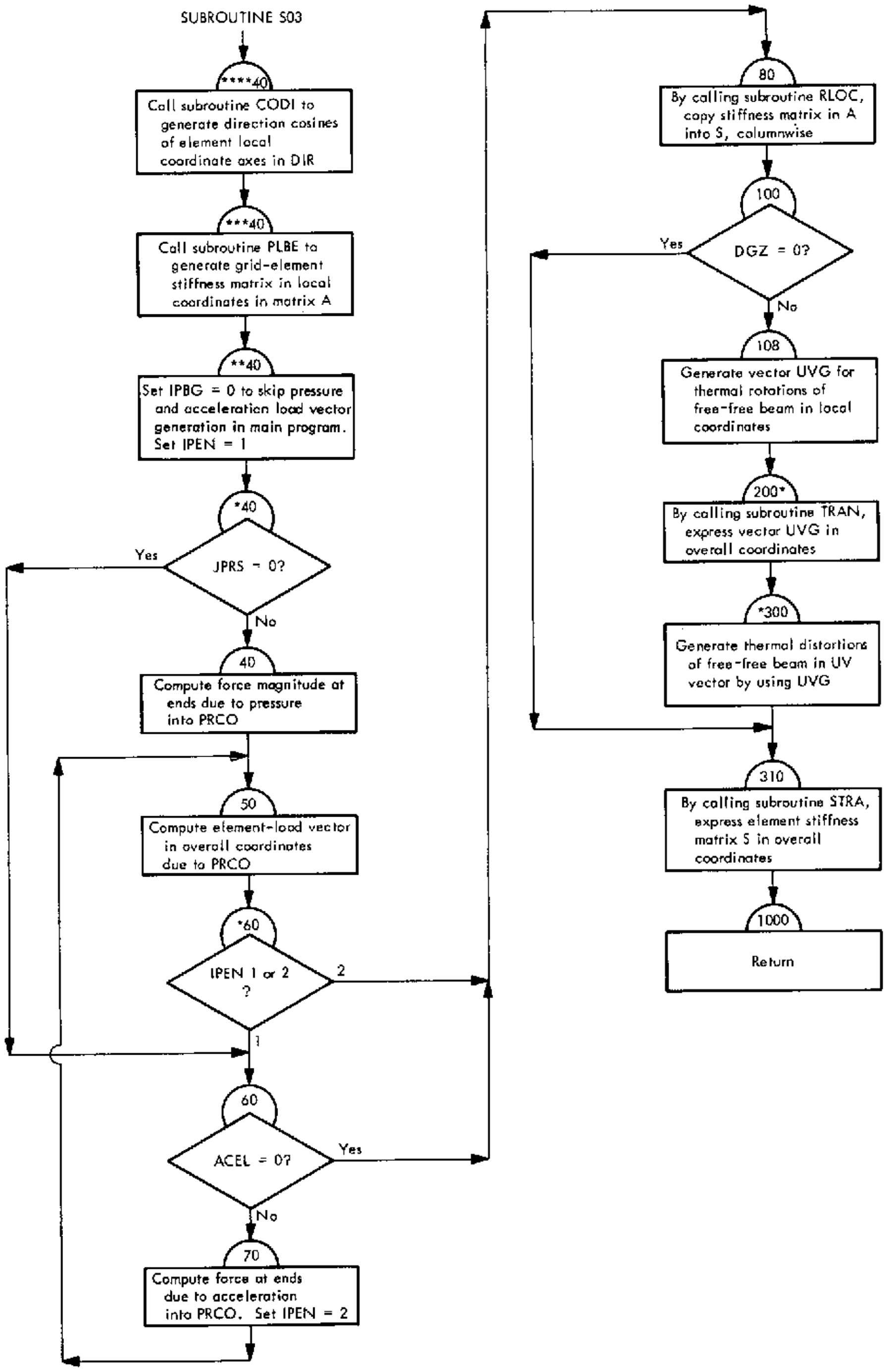


Fig. VI-26. Flowchart of subroutine S03 (Link 2)

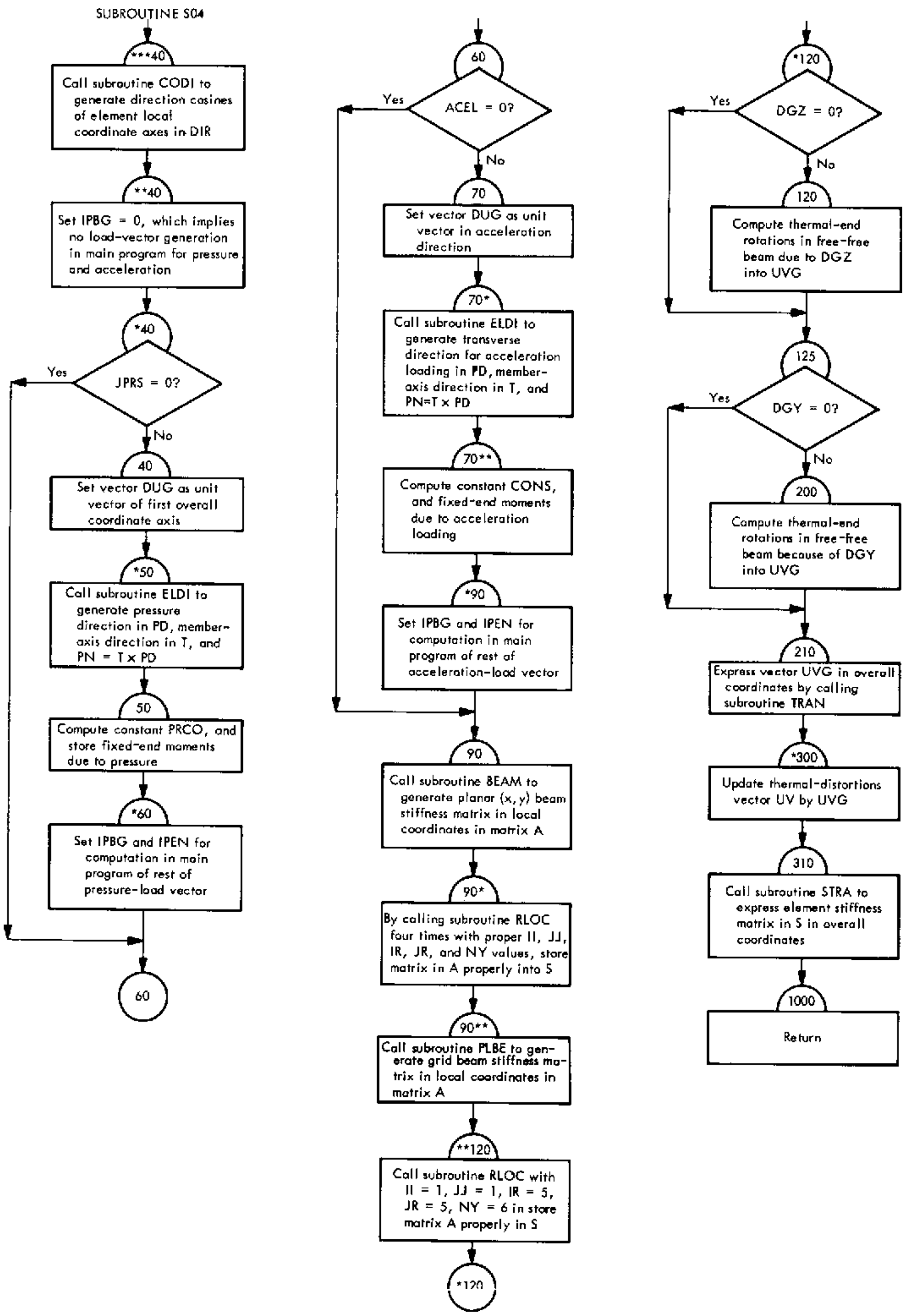


Fig. VI-27. Flowchart of subroutine S04 (Link 2)

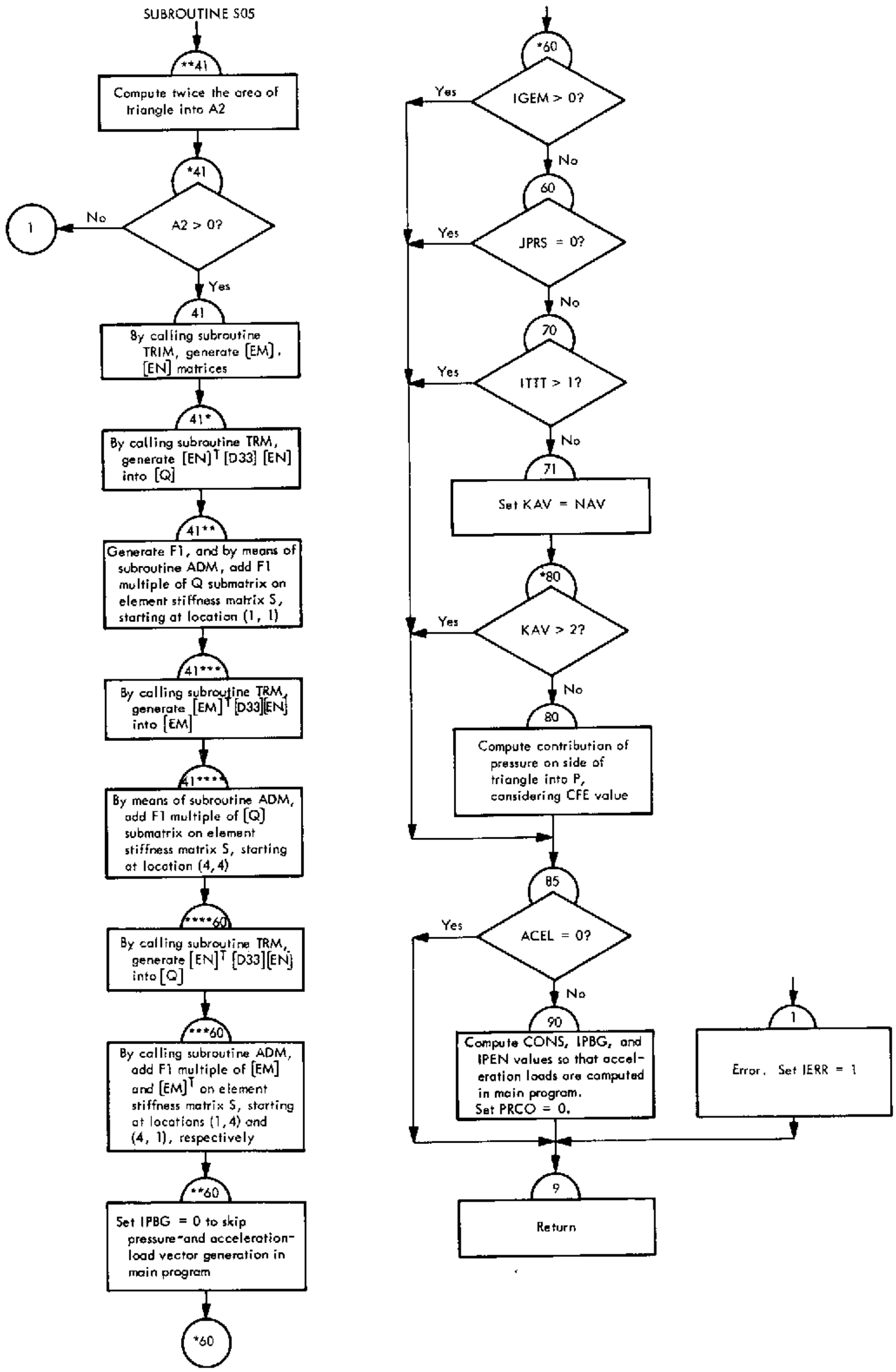


Fig. VI-28. Flowchart of subroutine S05 (Link 2)

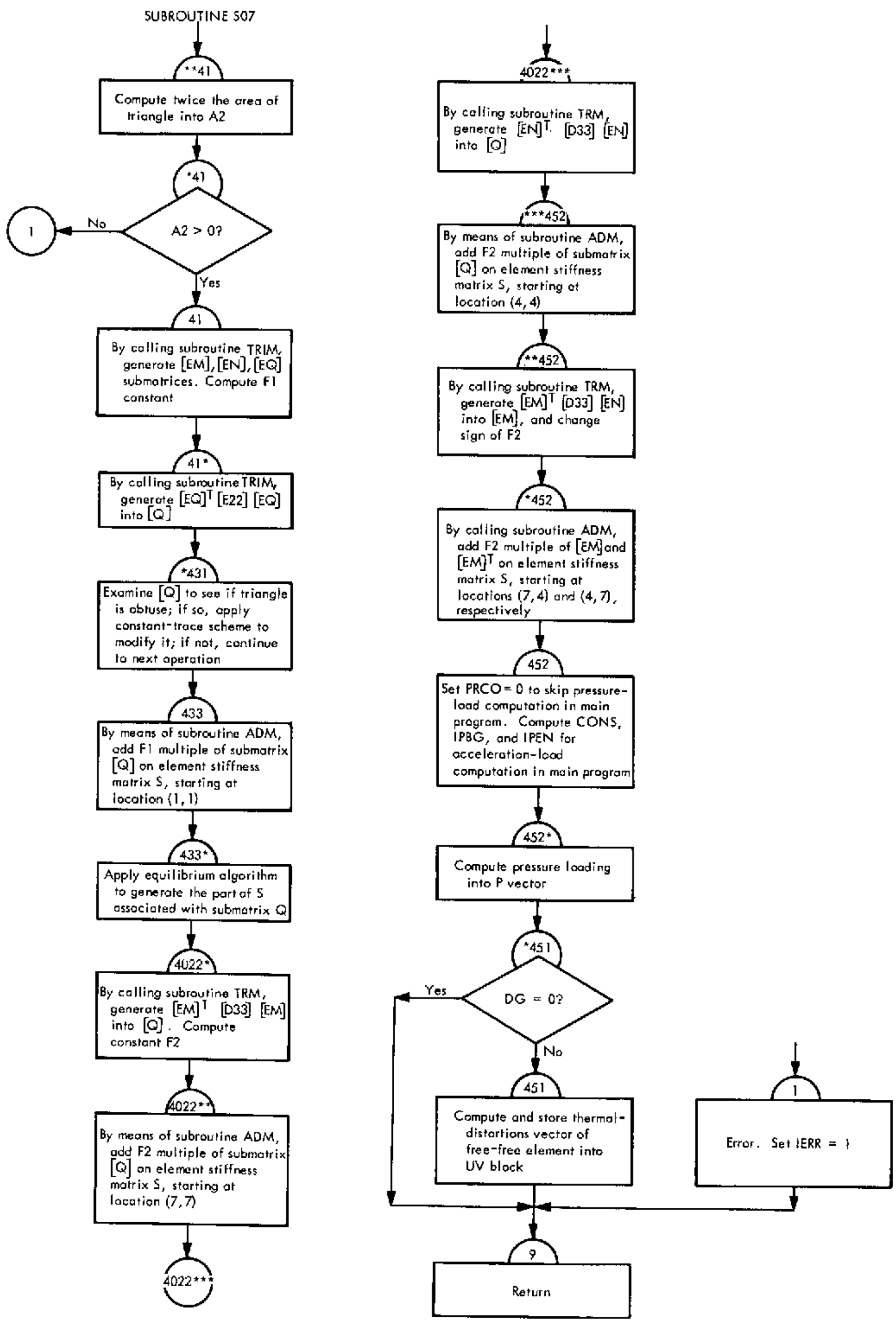


Fig. VI-29. Flowchart of subroutine S07 (Link 2)

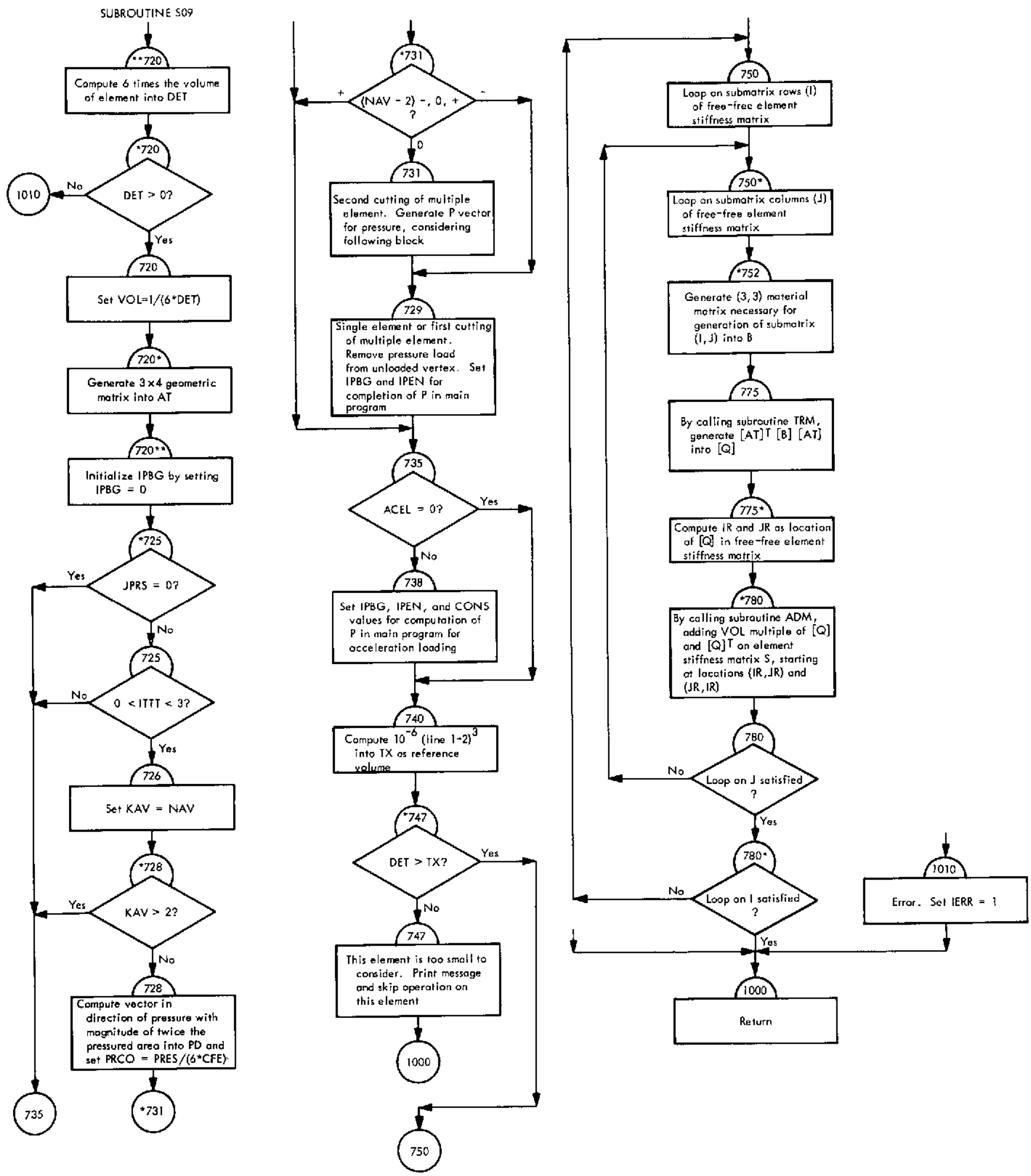


Fig. VI-30. Flowchart of subroutine S09 (Link 2)

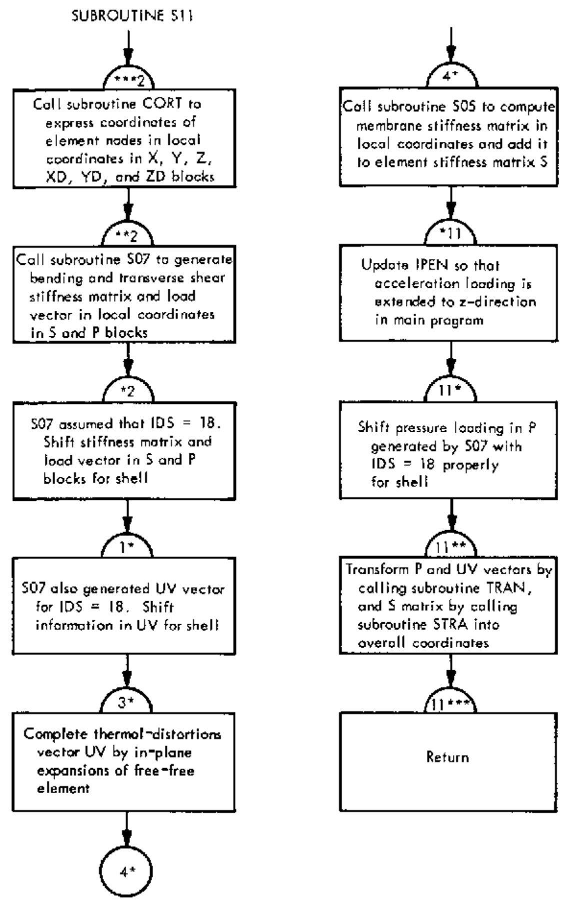


Fig. VI-31. Flowchart of subroutine S11 (Link 2)

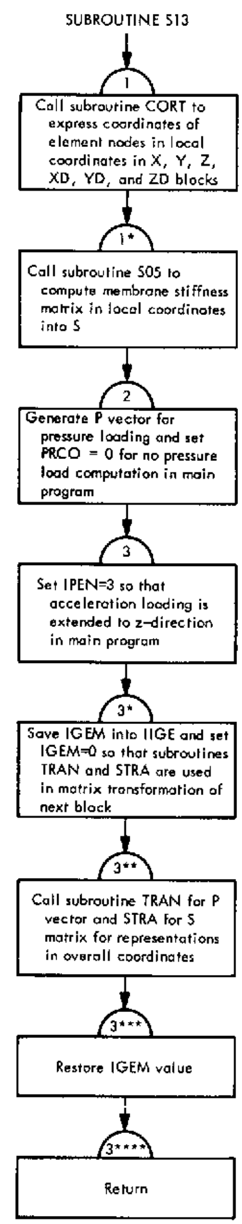


Fig. VI-32. Flowchart of subroutine S13 (Link 2)

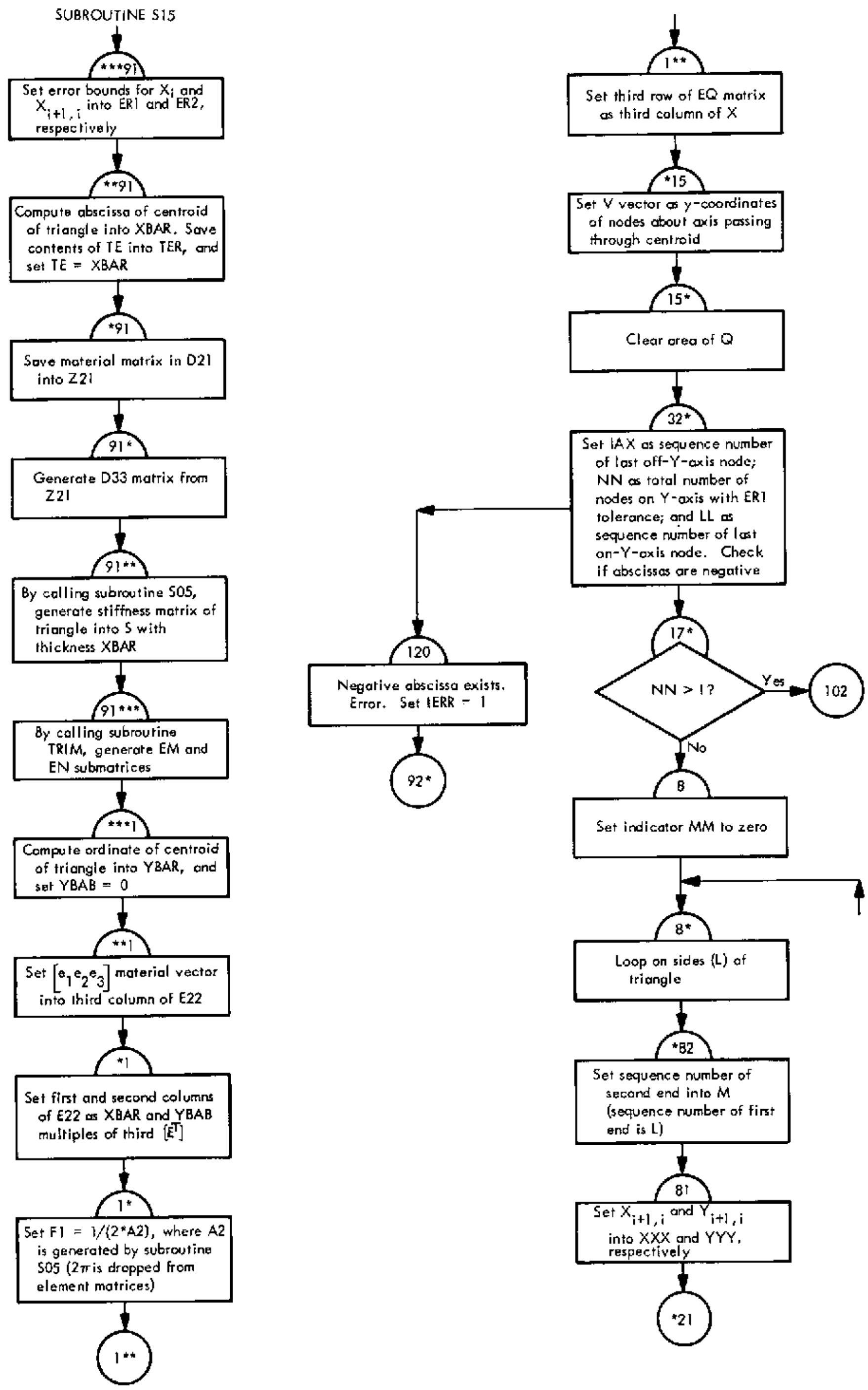


Fig. VI-33. Flowchart of subroutine S15 (Link 2)

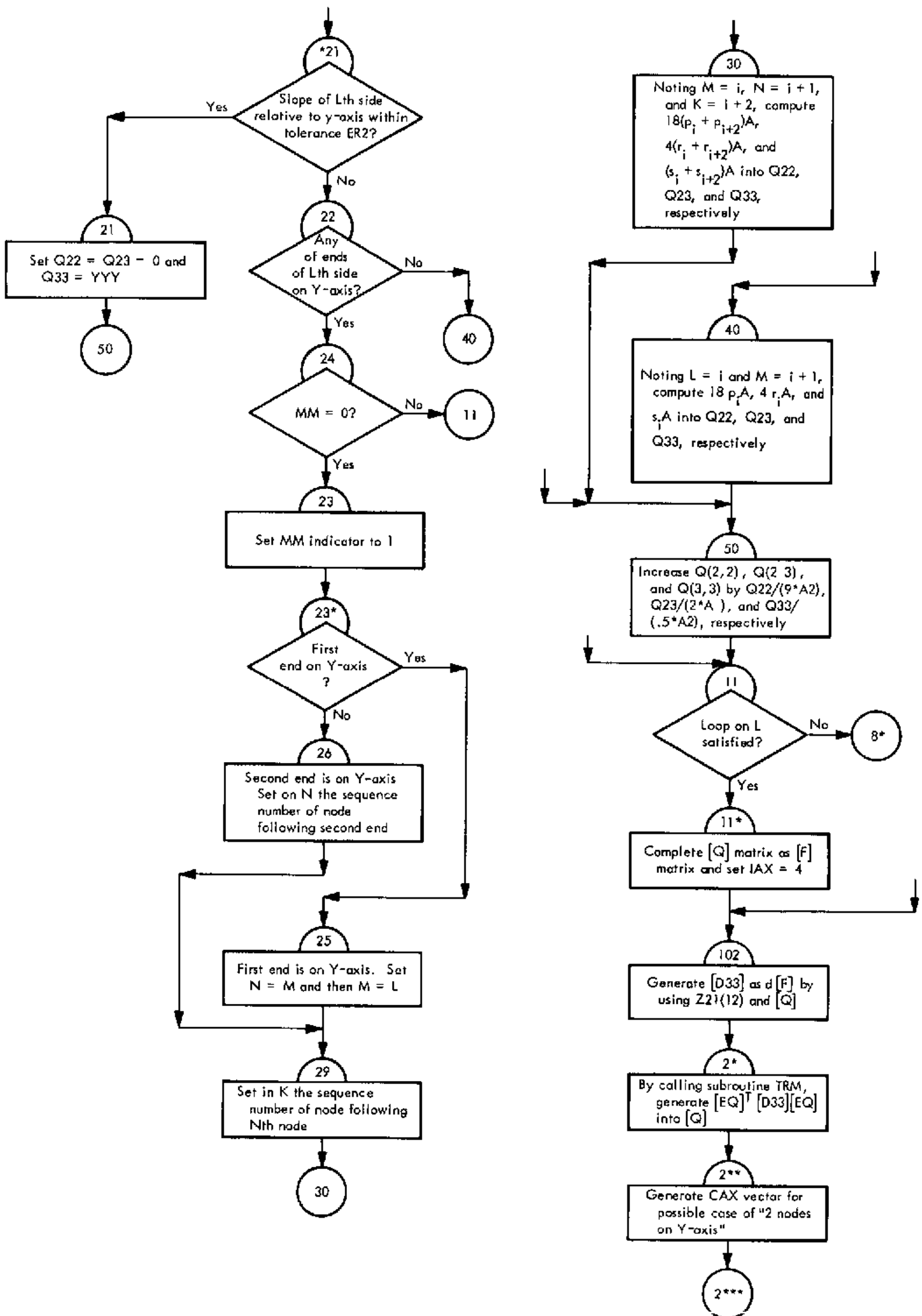


Fig. VI-33 (contd)

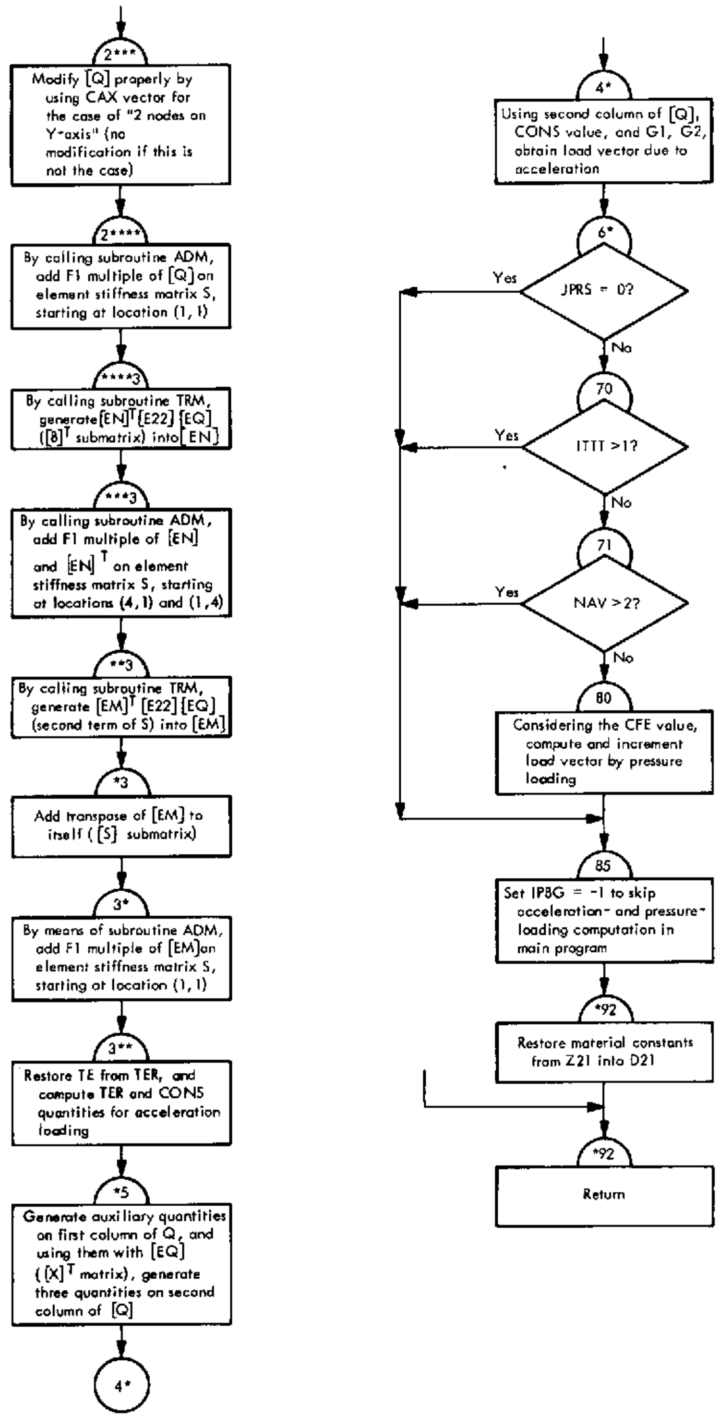


Fig. VI-33 (contd)

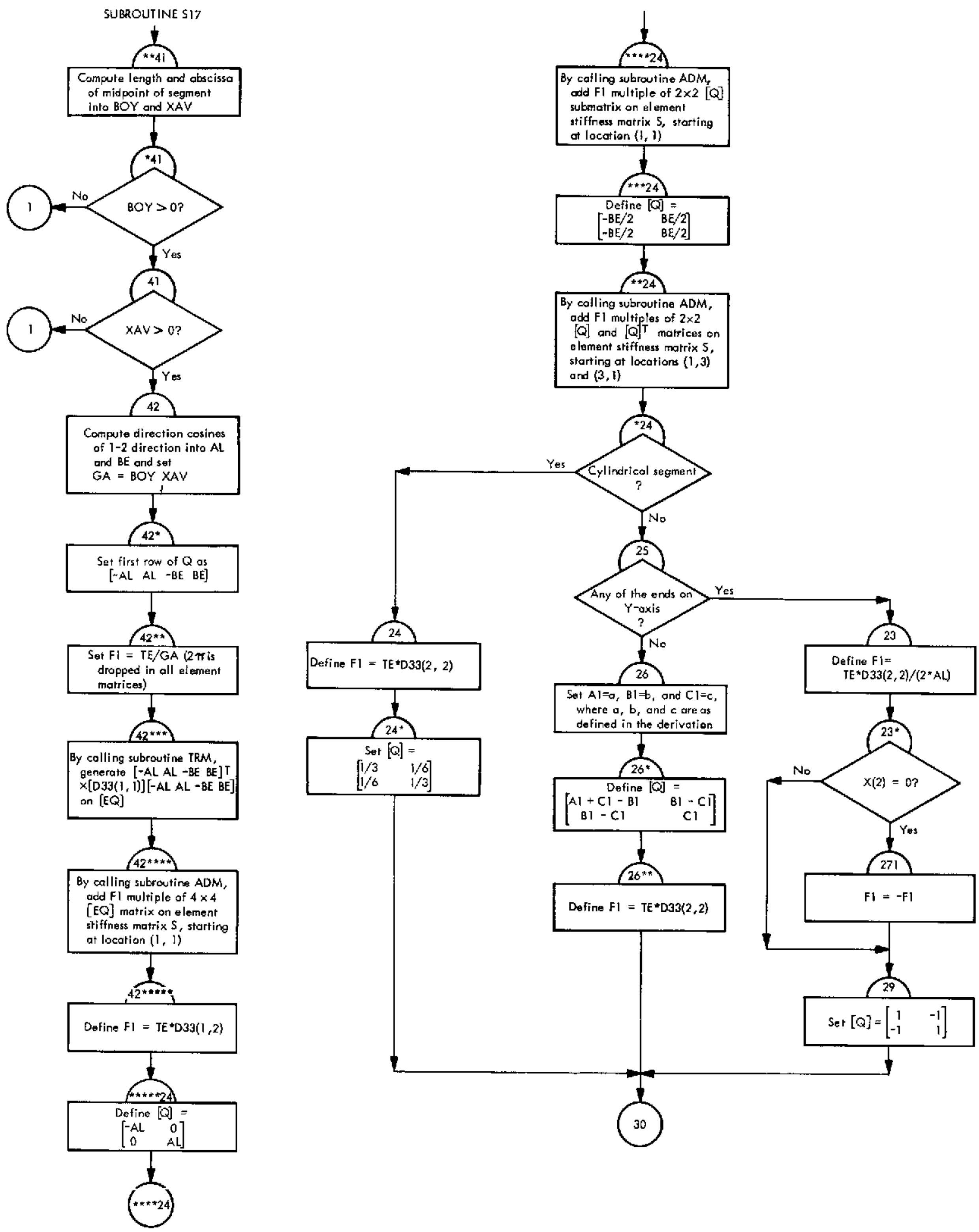


Fig. VI-34. Flowchart of subroutine S17 (Link 2)

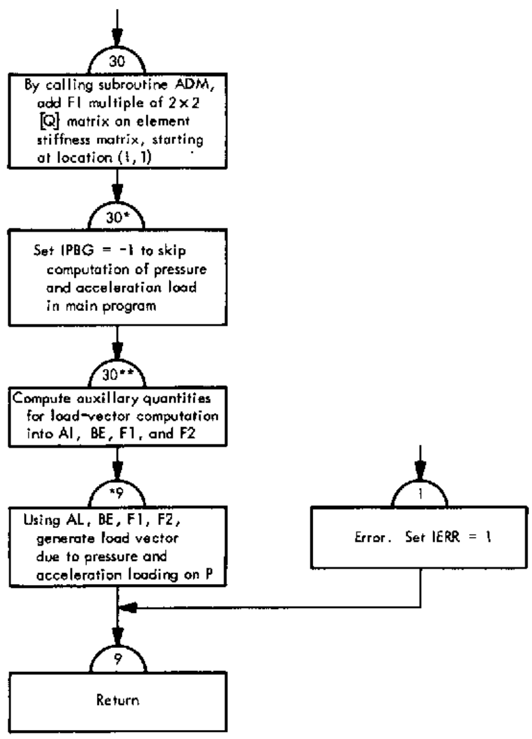


Fig. VI-34 (contd)

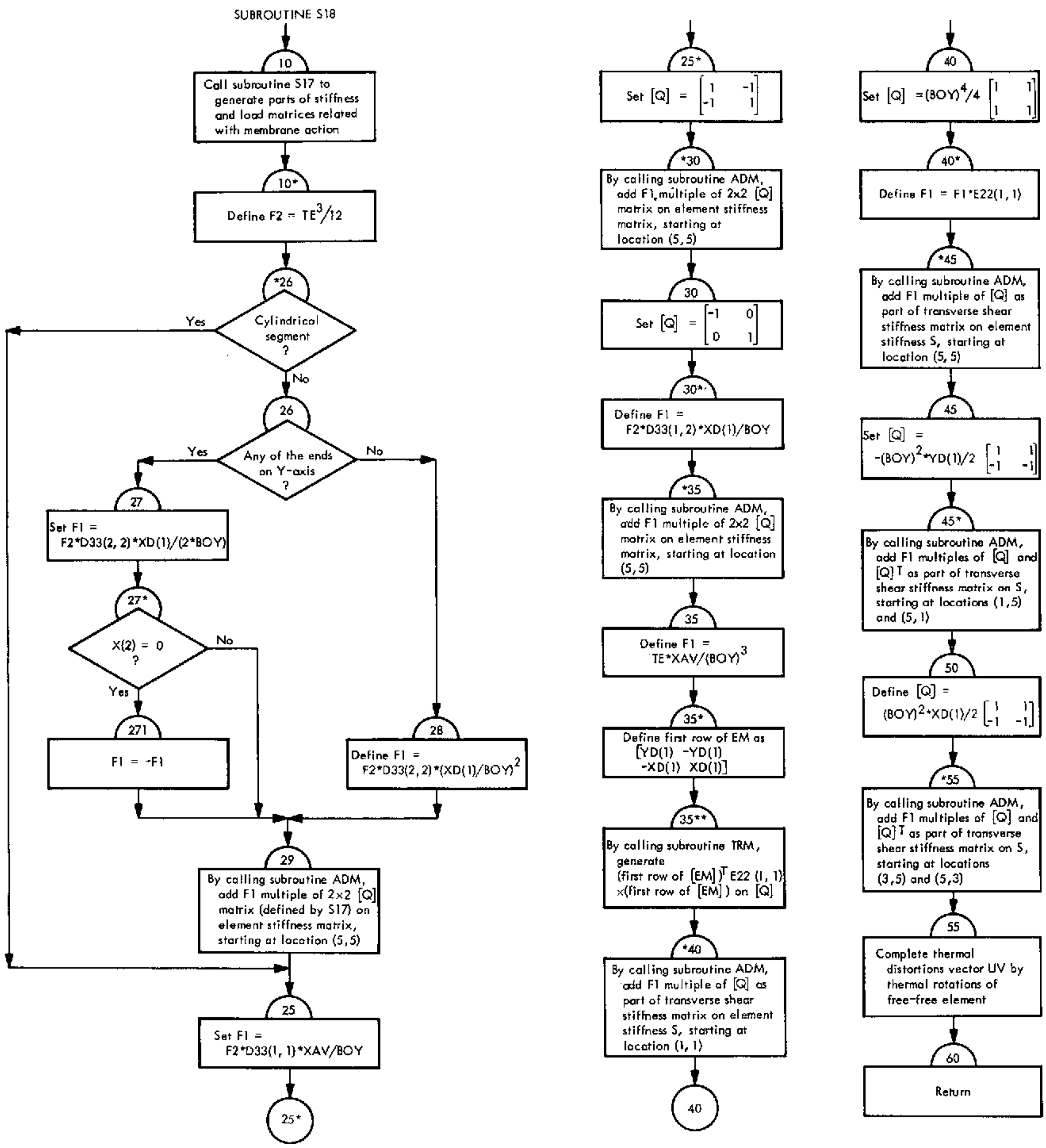


Fig. VI-35. Flowchart of subroutine S18 (Link 2)

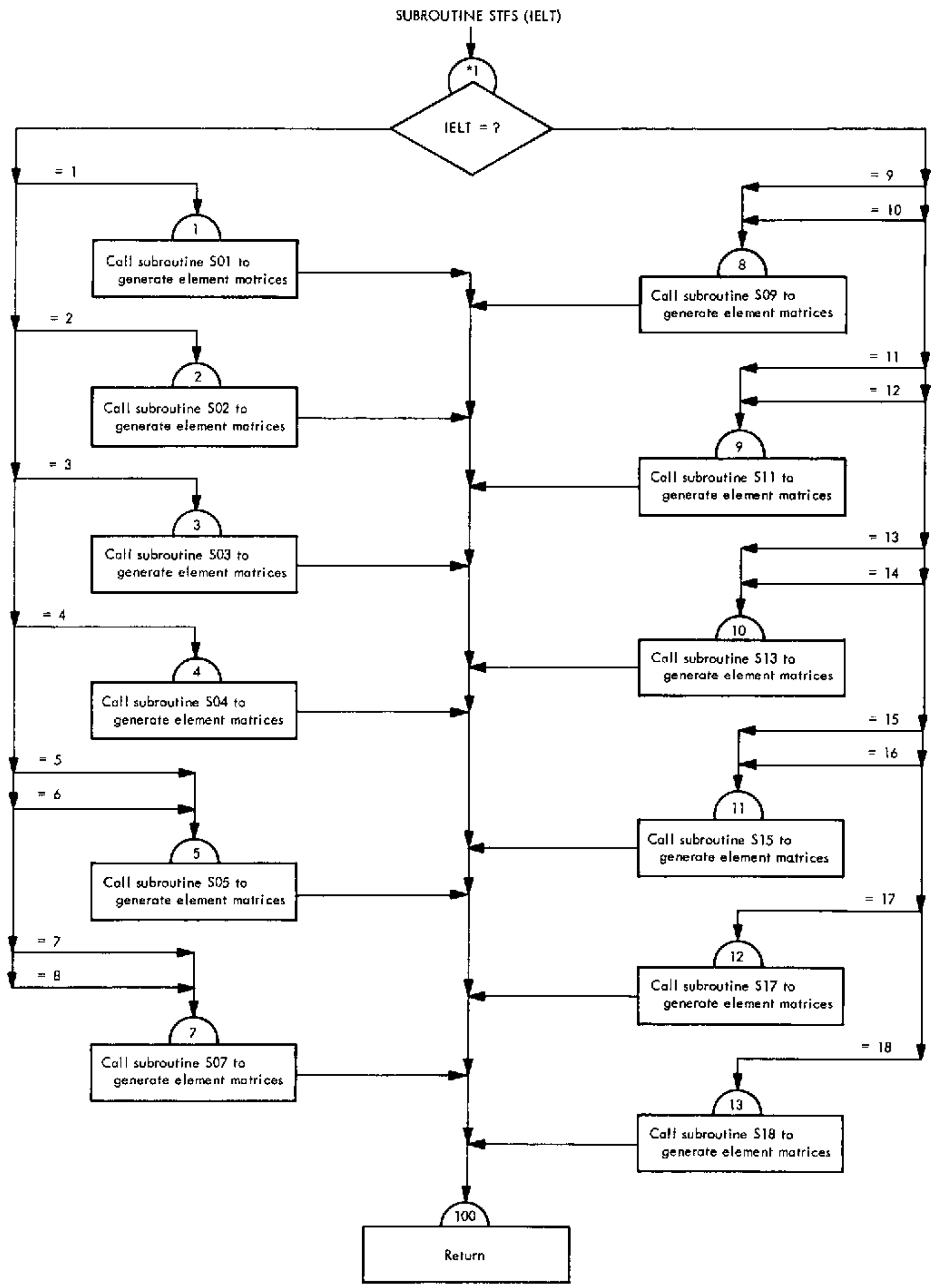


Fig. VI-36. Flowchart of subroutine STFS (Link 2)

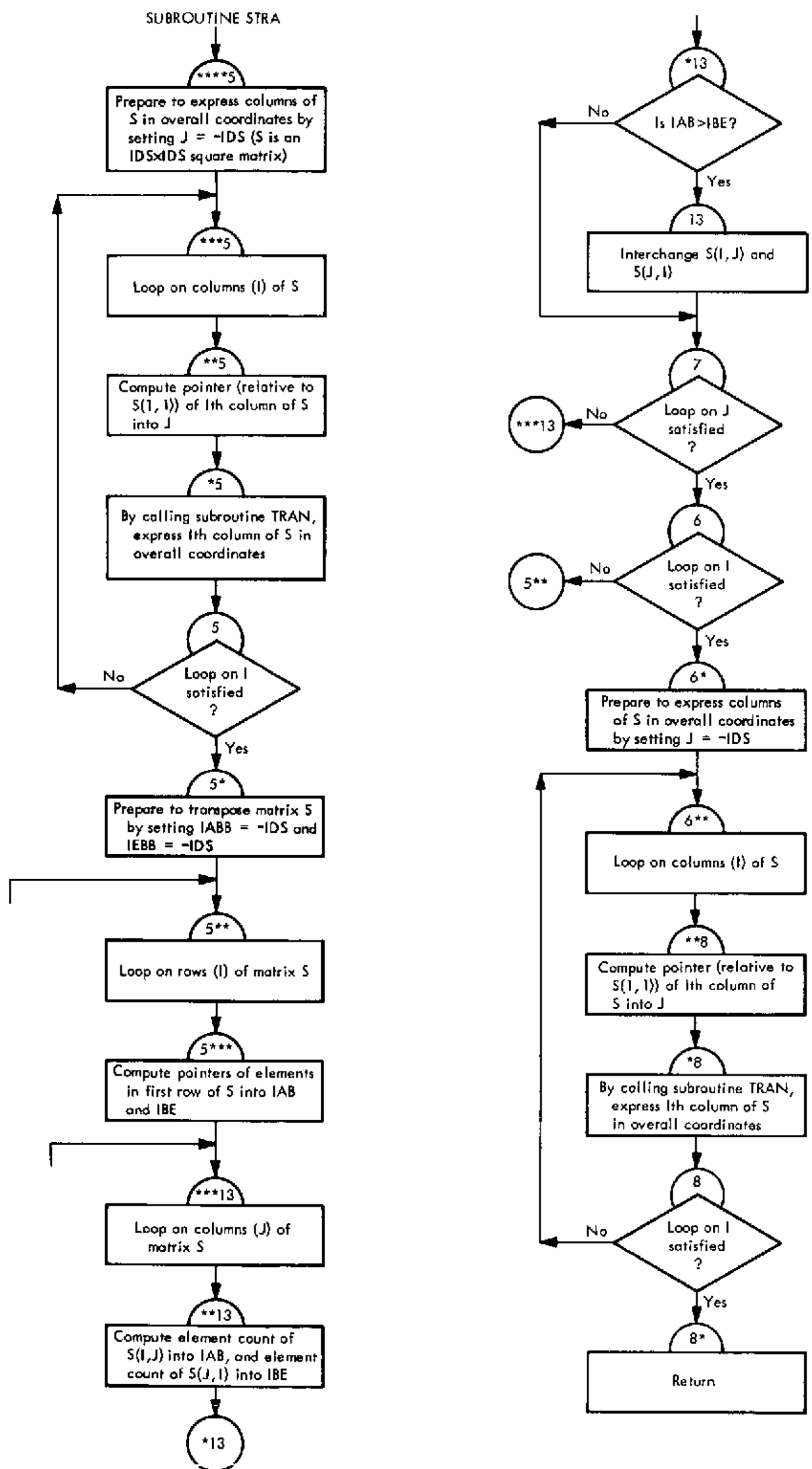


Fig. VI-37. Flowchart of subroutine STRA (Link 2)

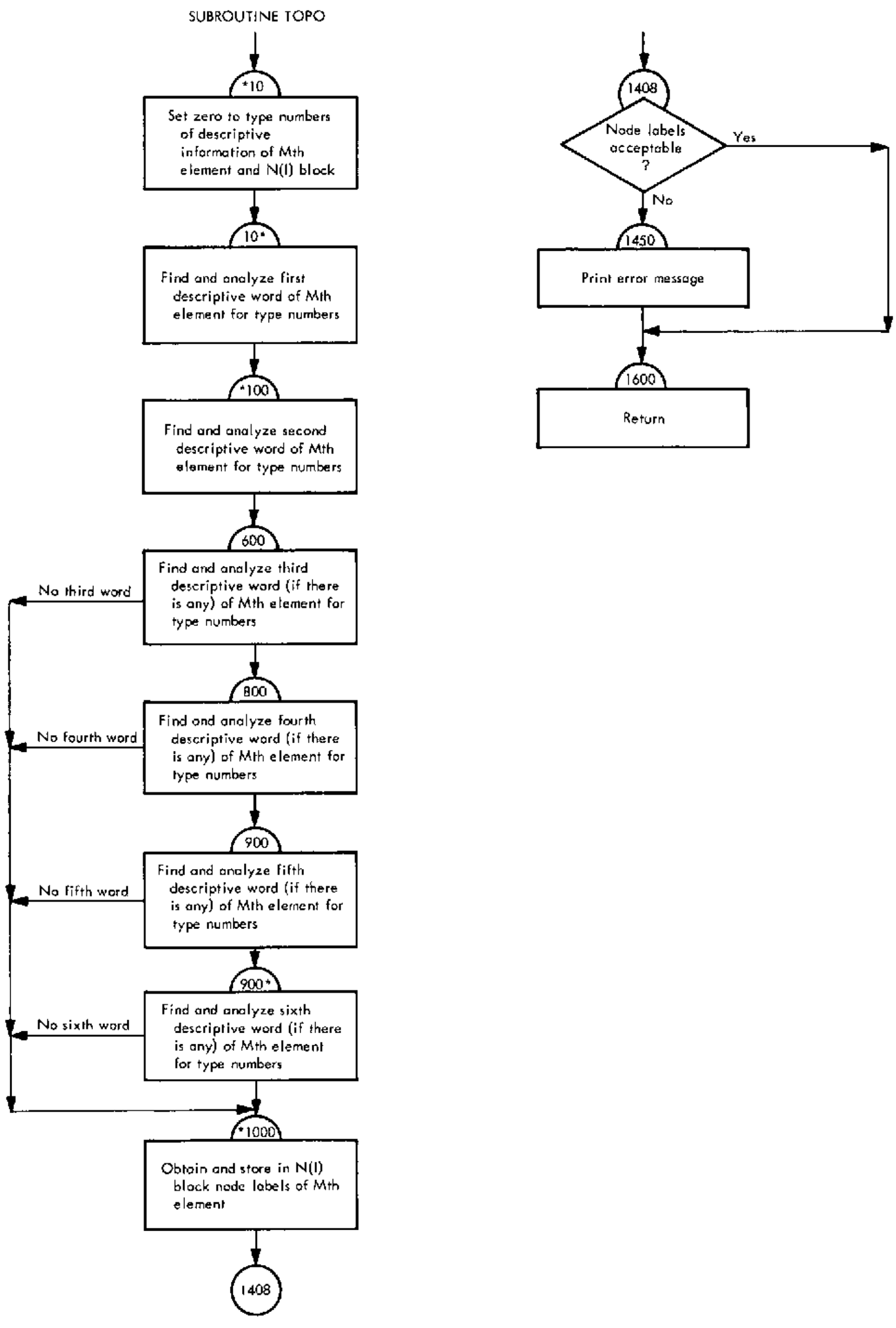


Fig. VI-38. Flowchart of subroutine TOPO (Link 2)

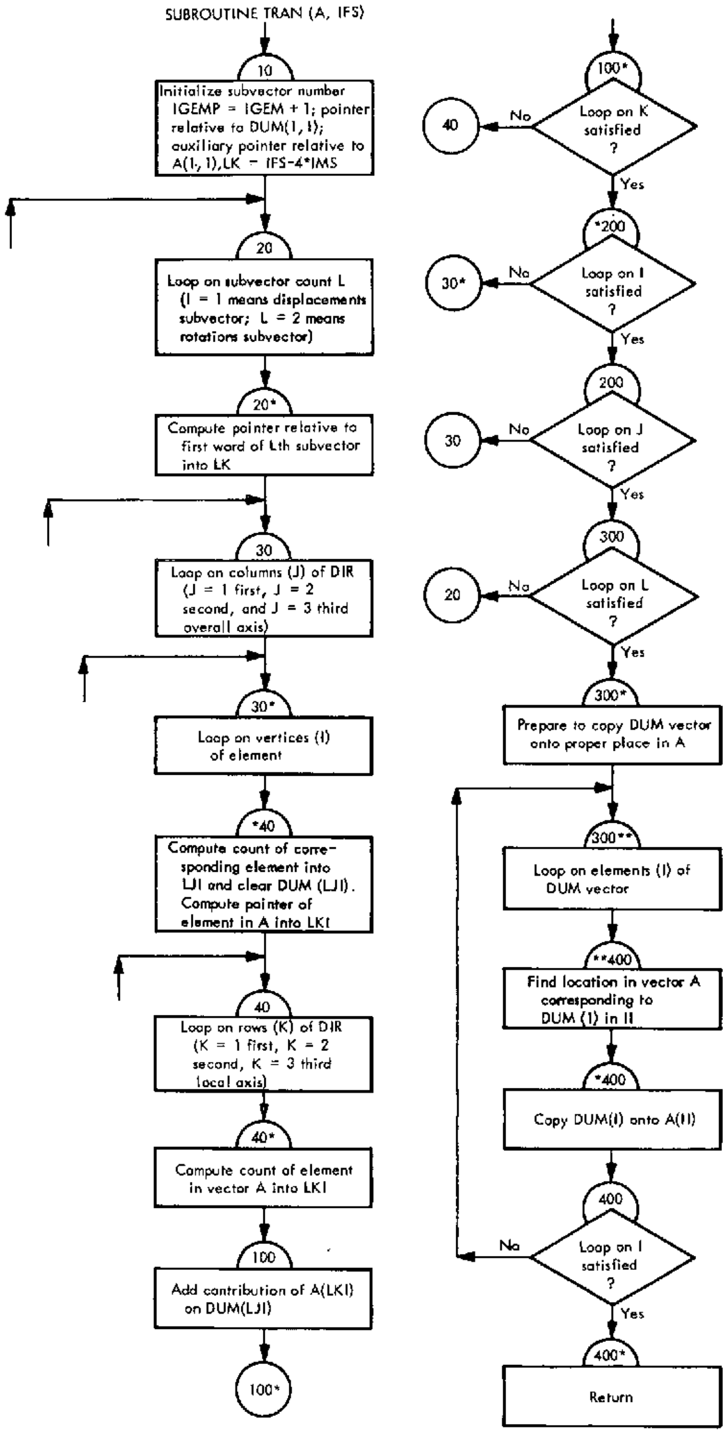


Fig. VI-39. Flowchart of subroutine TRAN (Link 2)

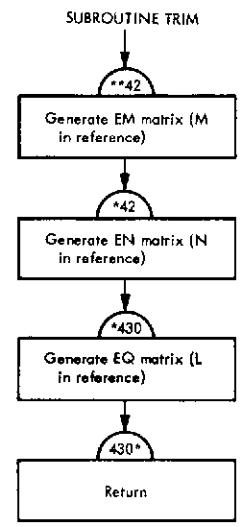


Fig. VI-40. Flowchart of subroutine TRIM (Link 2)

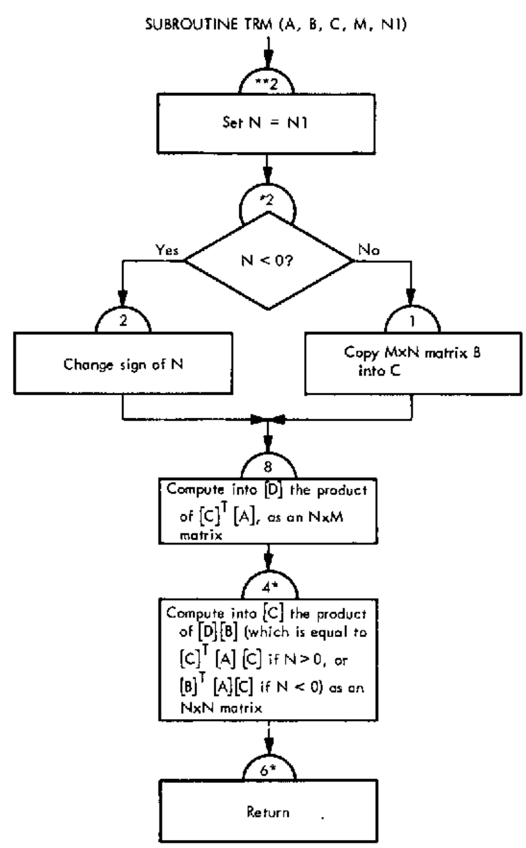


Fig. VI-41. Flowchart of subroutine TRM (Link 2)

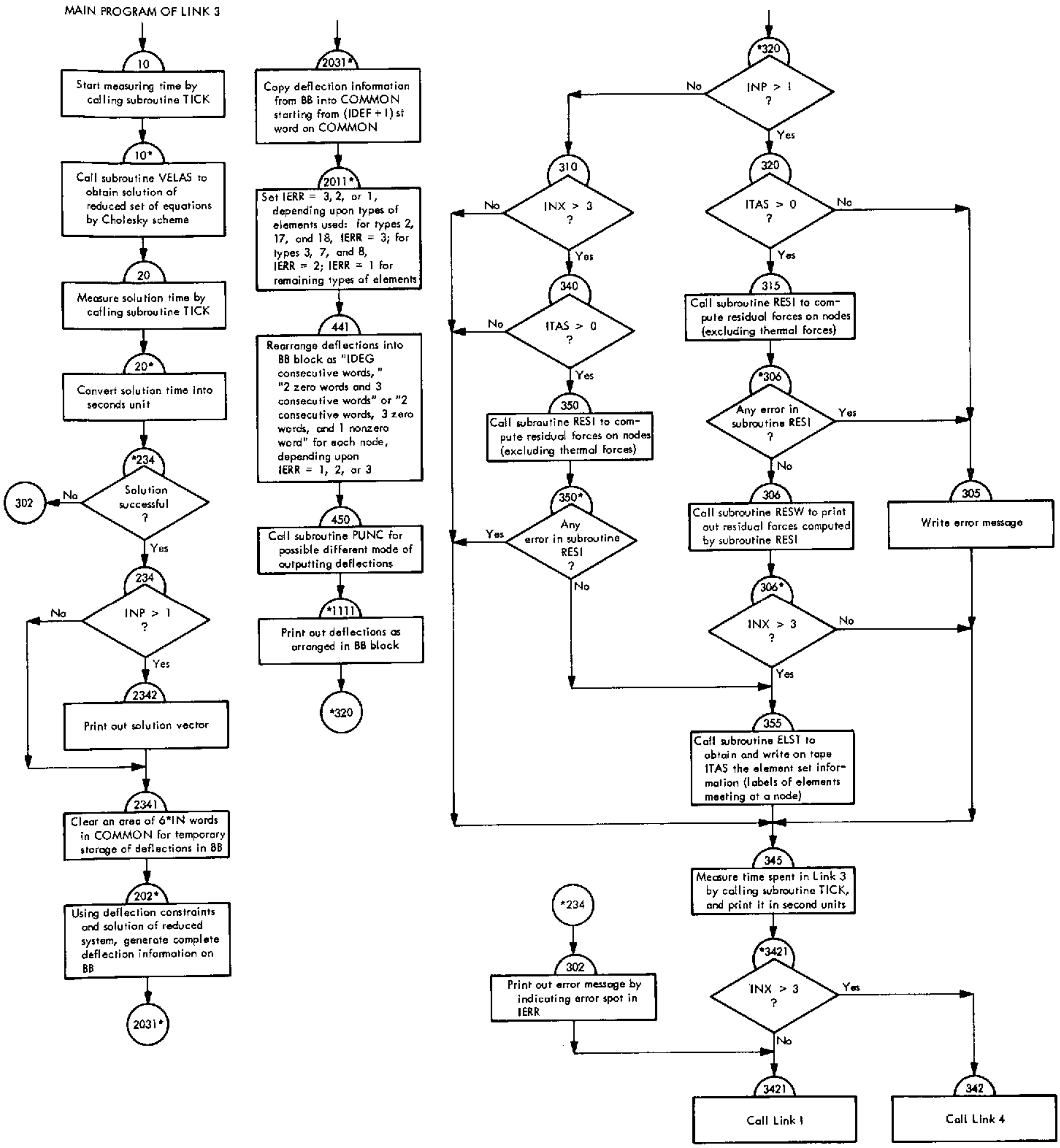


Fig. VI-42. Flowchart of main program of Link 3 (deflection link)

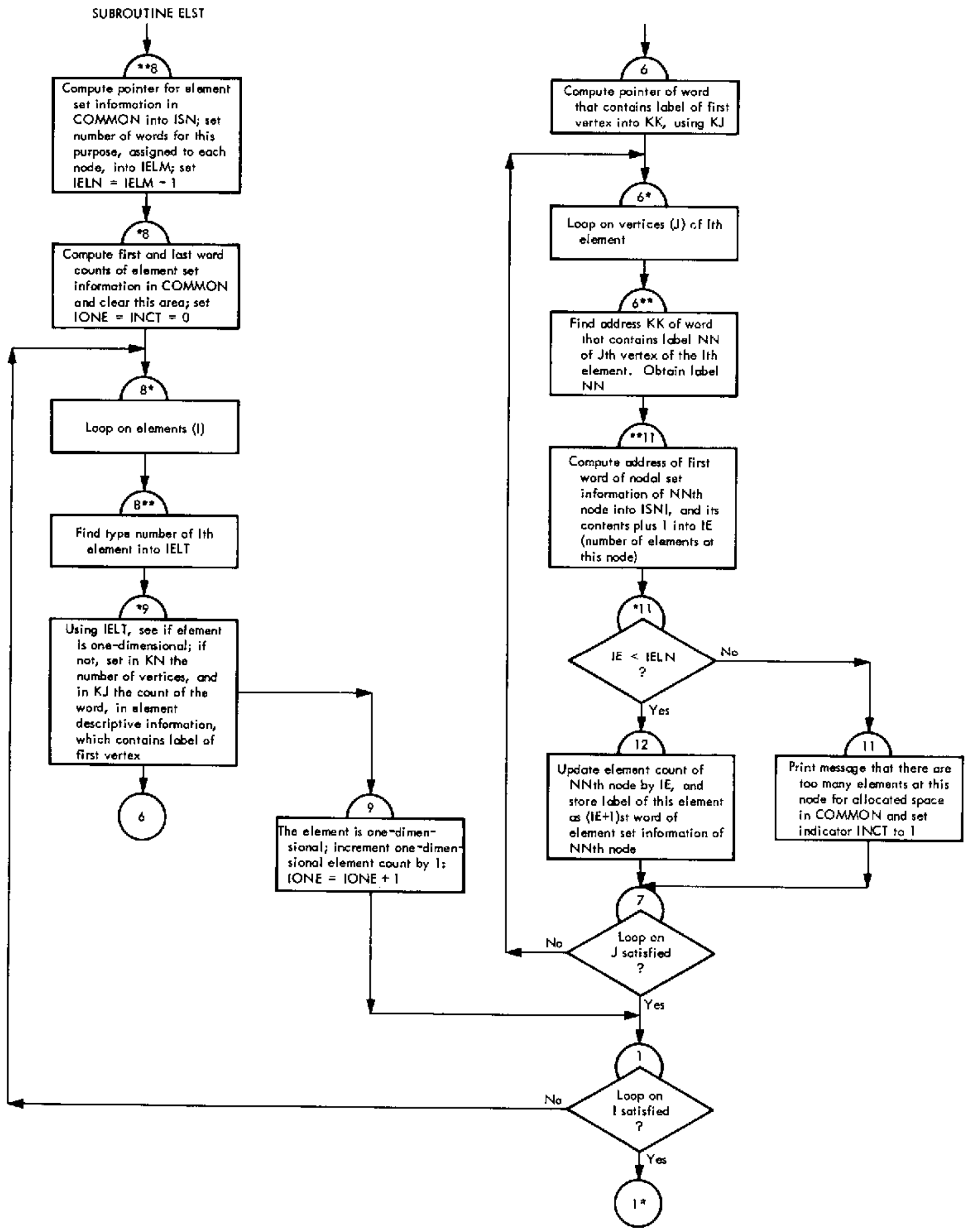


Fig. VI-43. Flowchart of subroutine ELST (Link 3)

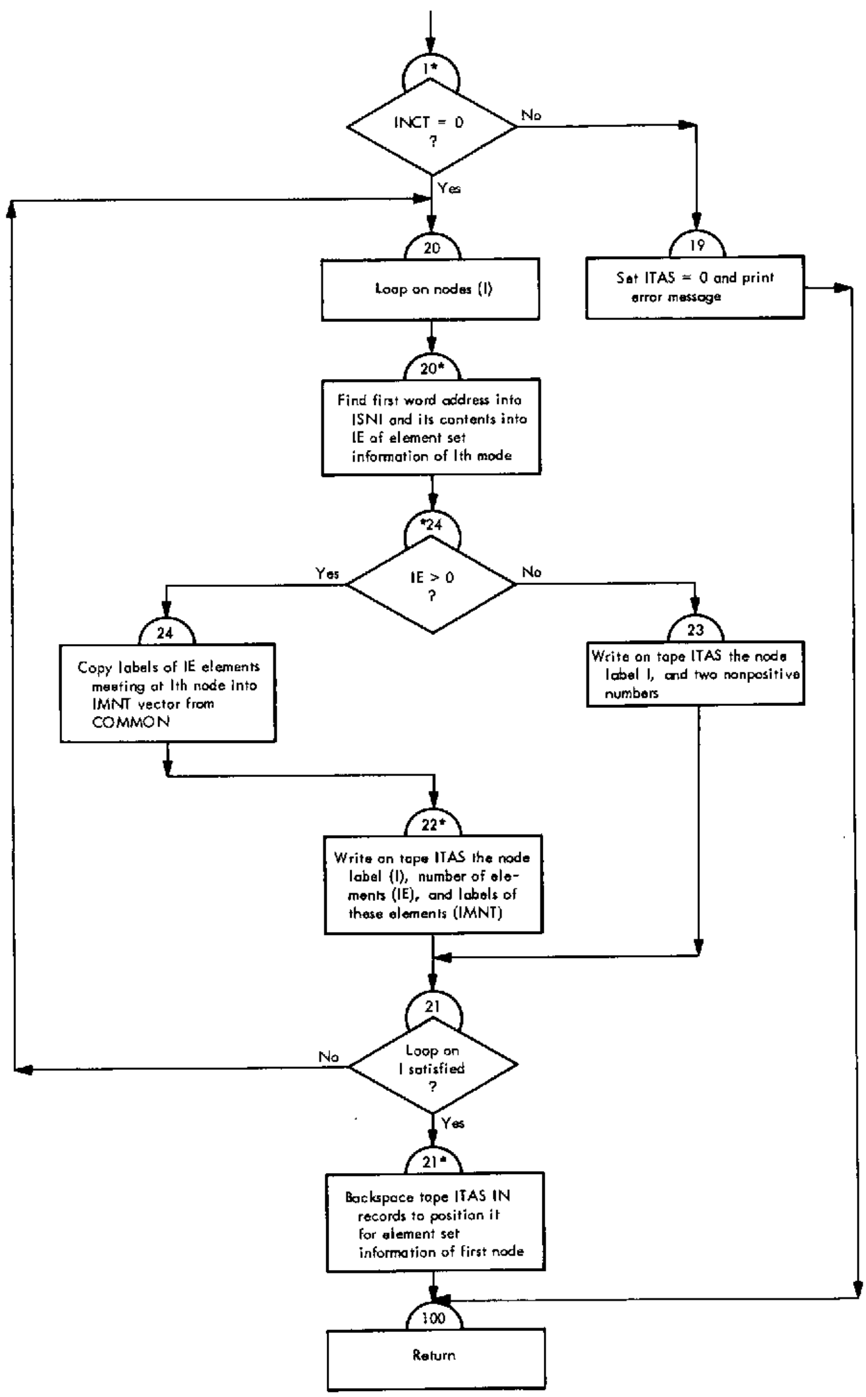


Fig. VI-43 (contd)

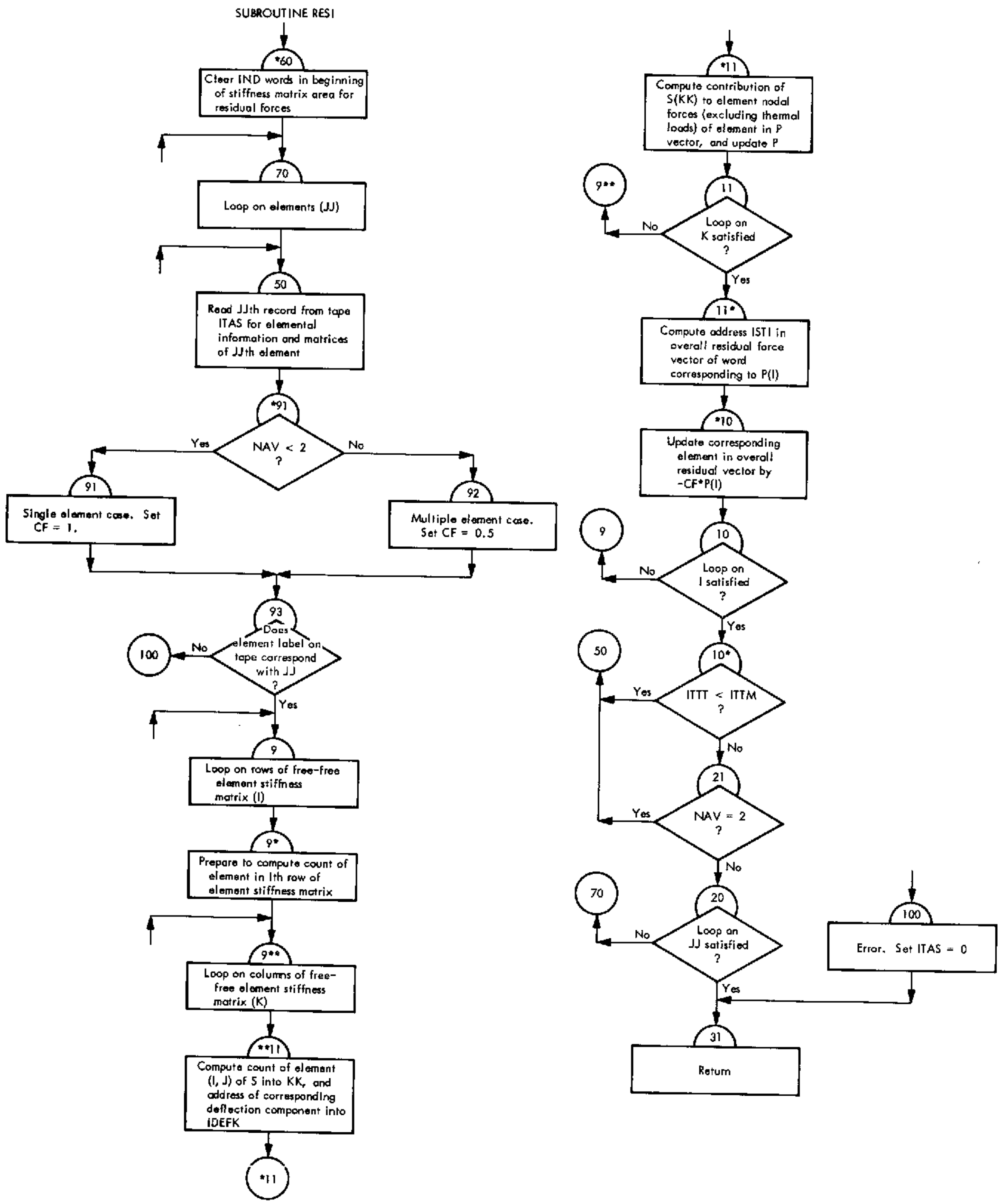


Fig. VI-44. Flowchart of subroutine RESI (Link 3)

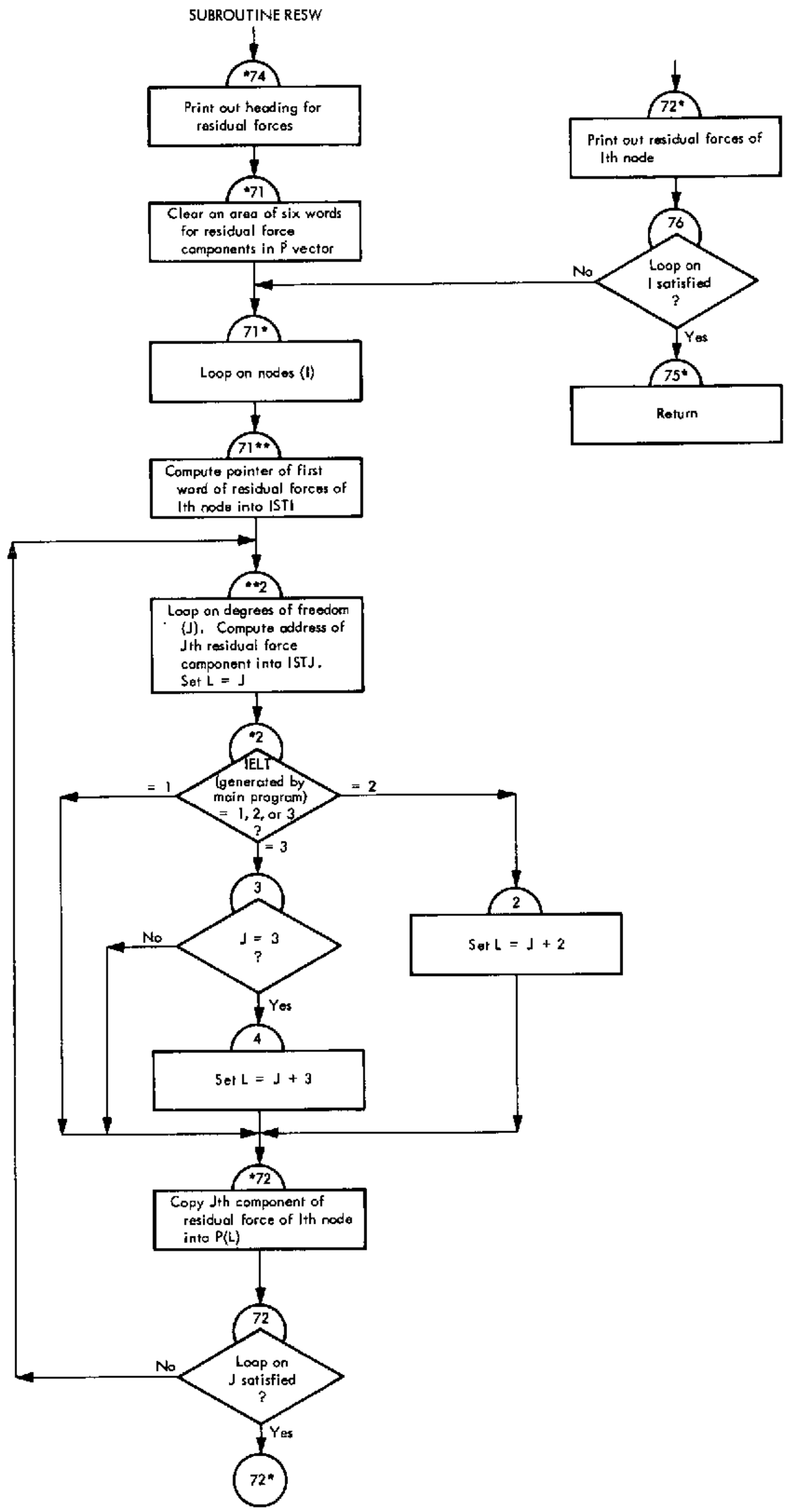


Fig. VI-45. Flowchart of subroutine RESW (Link 3)

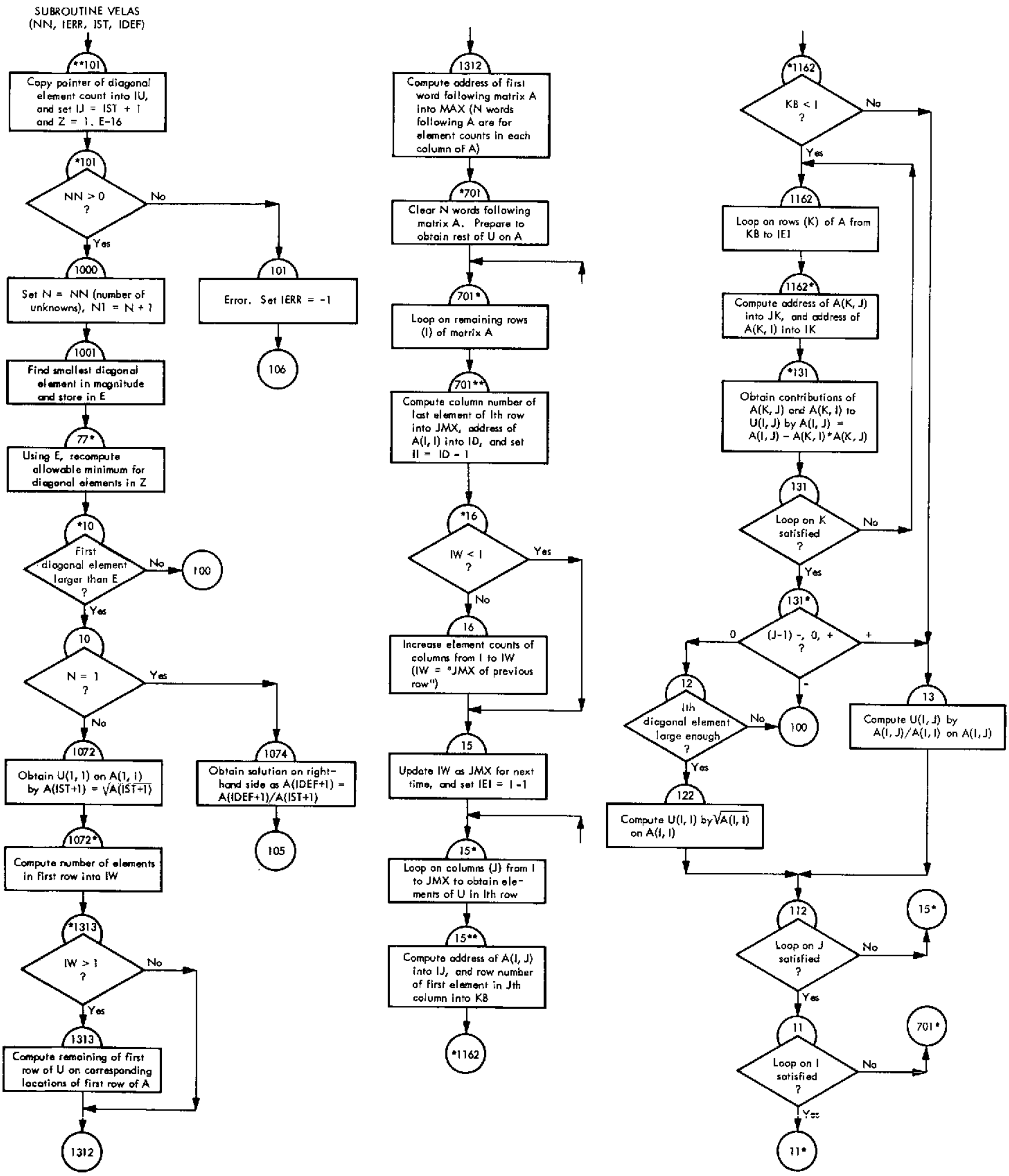


Fig. VI-46. Flowchart of subroutine VELAS (Link 3)

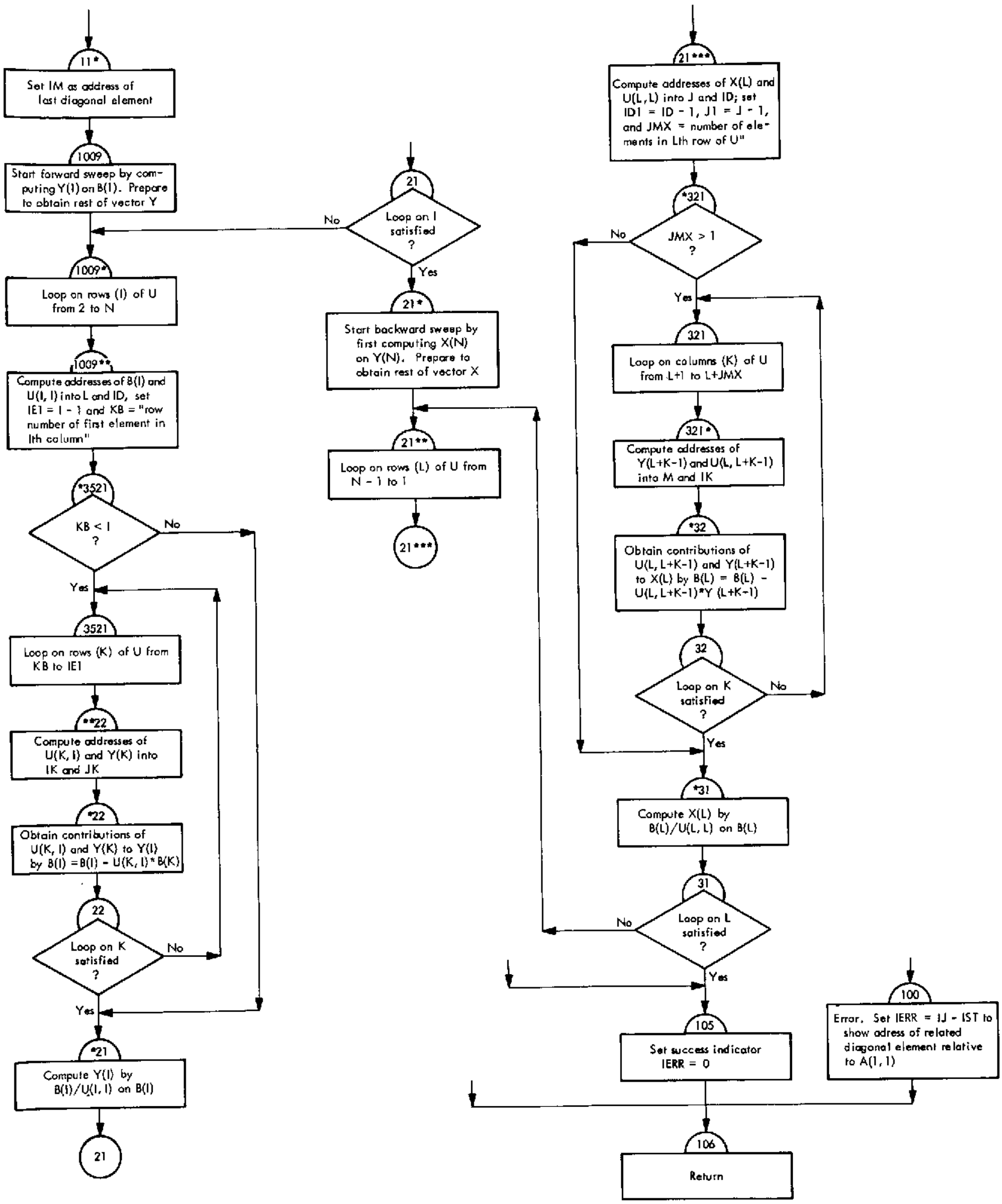


Fig. VI-46 (contd)

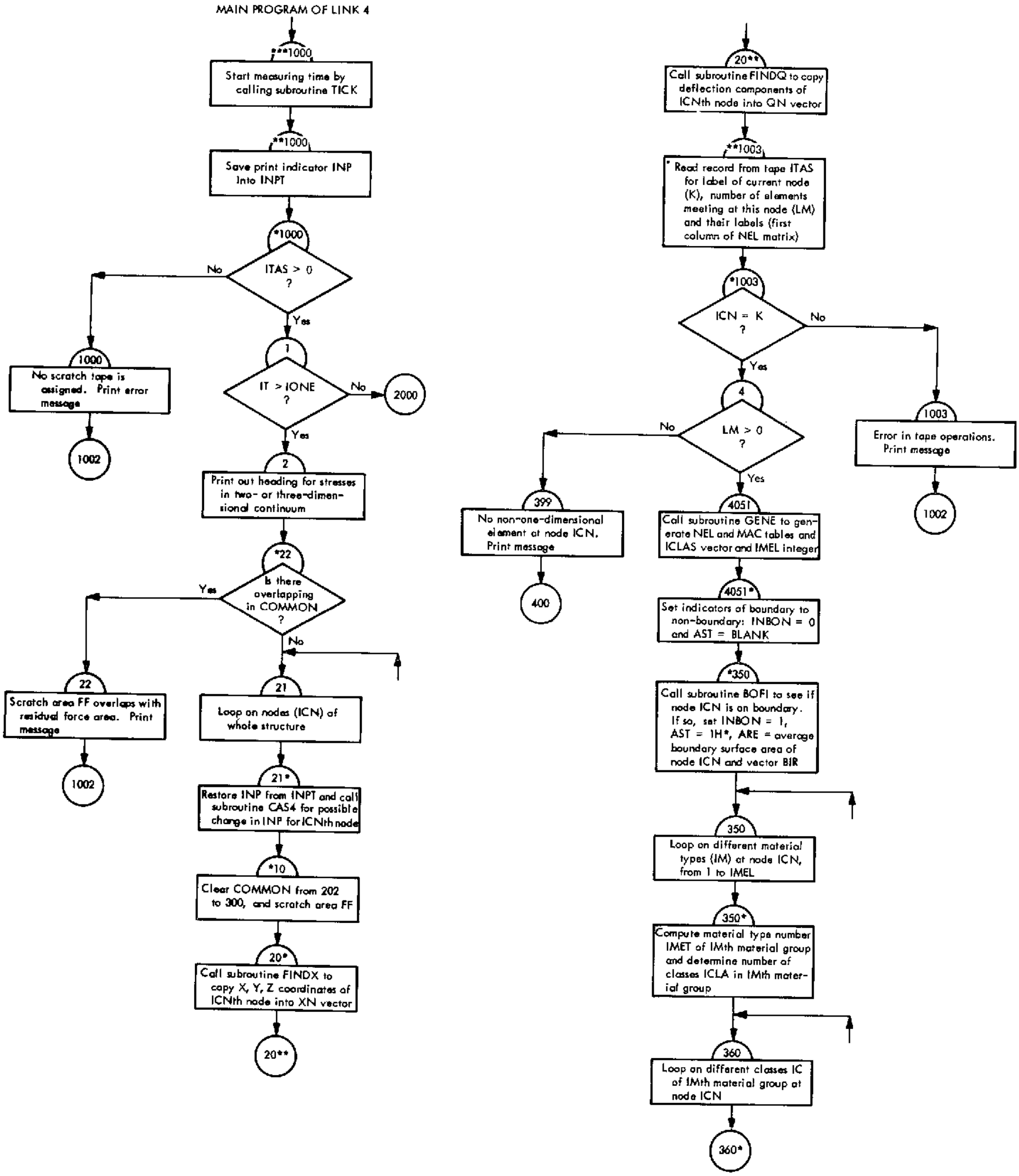


Fig. VI-47. Flowchart of main program of Link 4 (stress link)

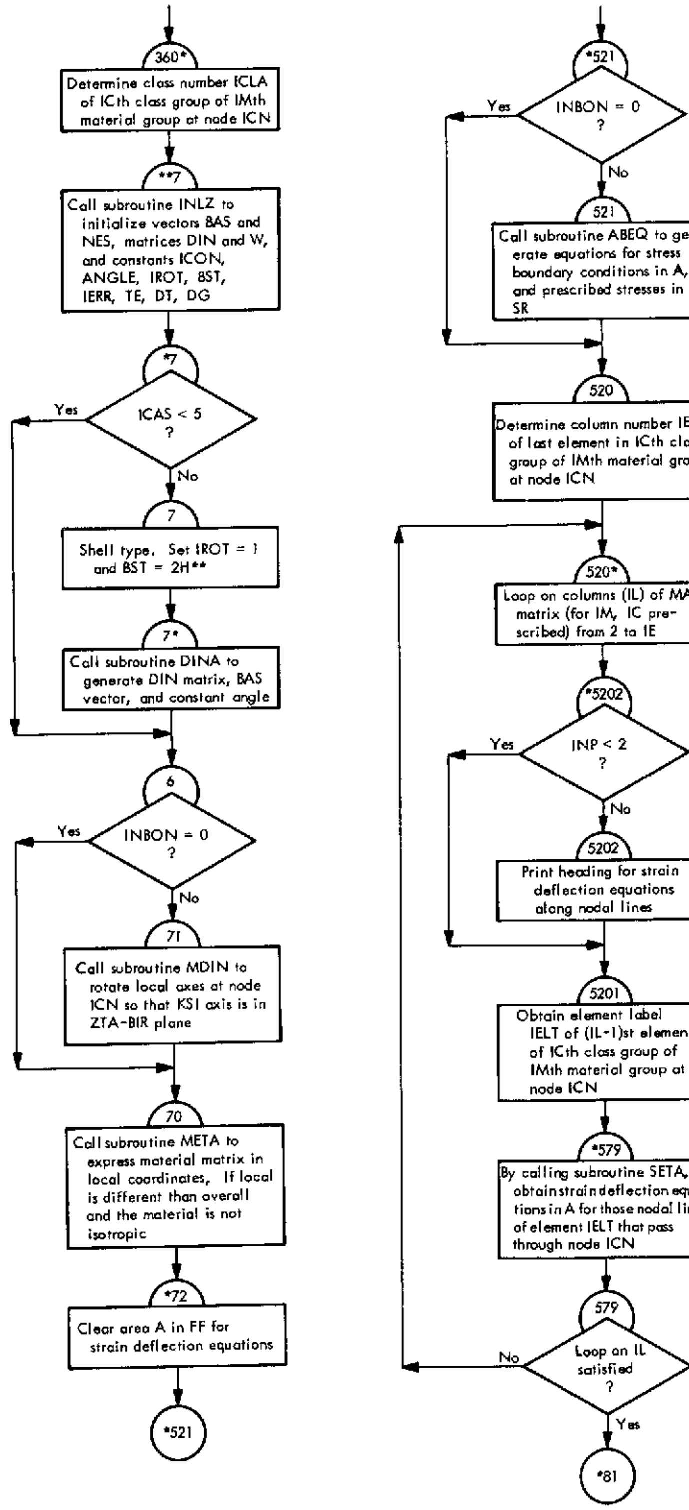


Fig. VI-47 (contd)

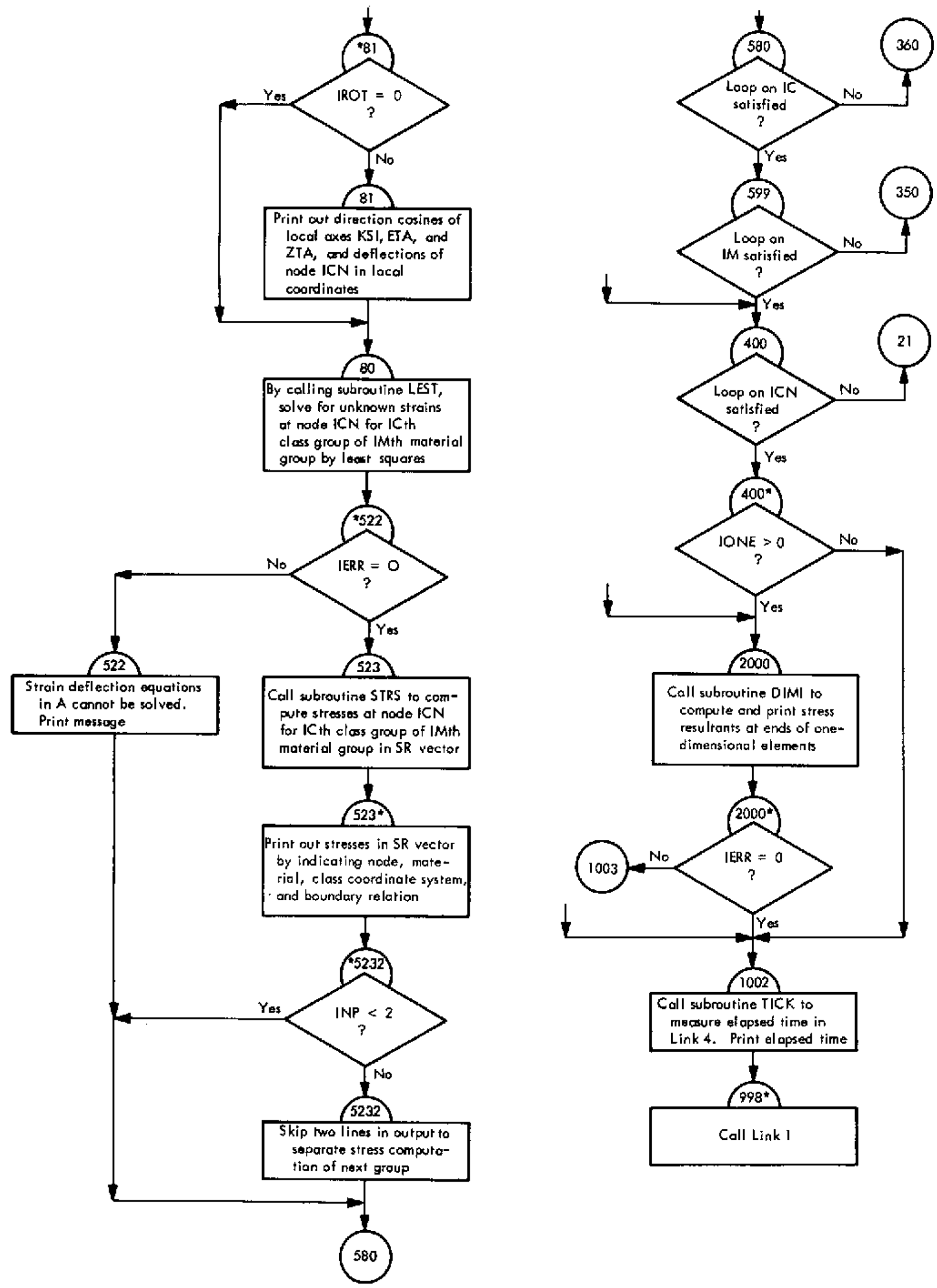


Fig. VI-47 (contd)

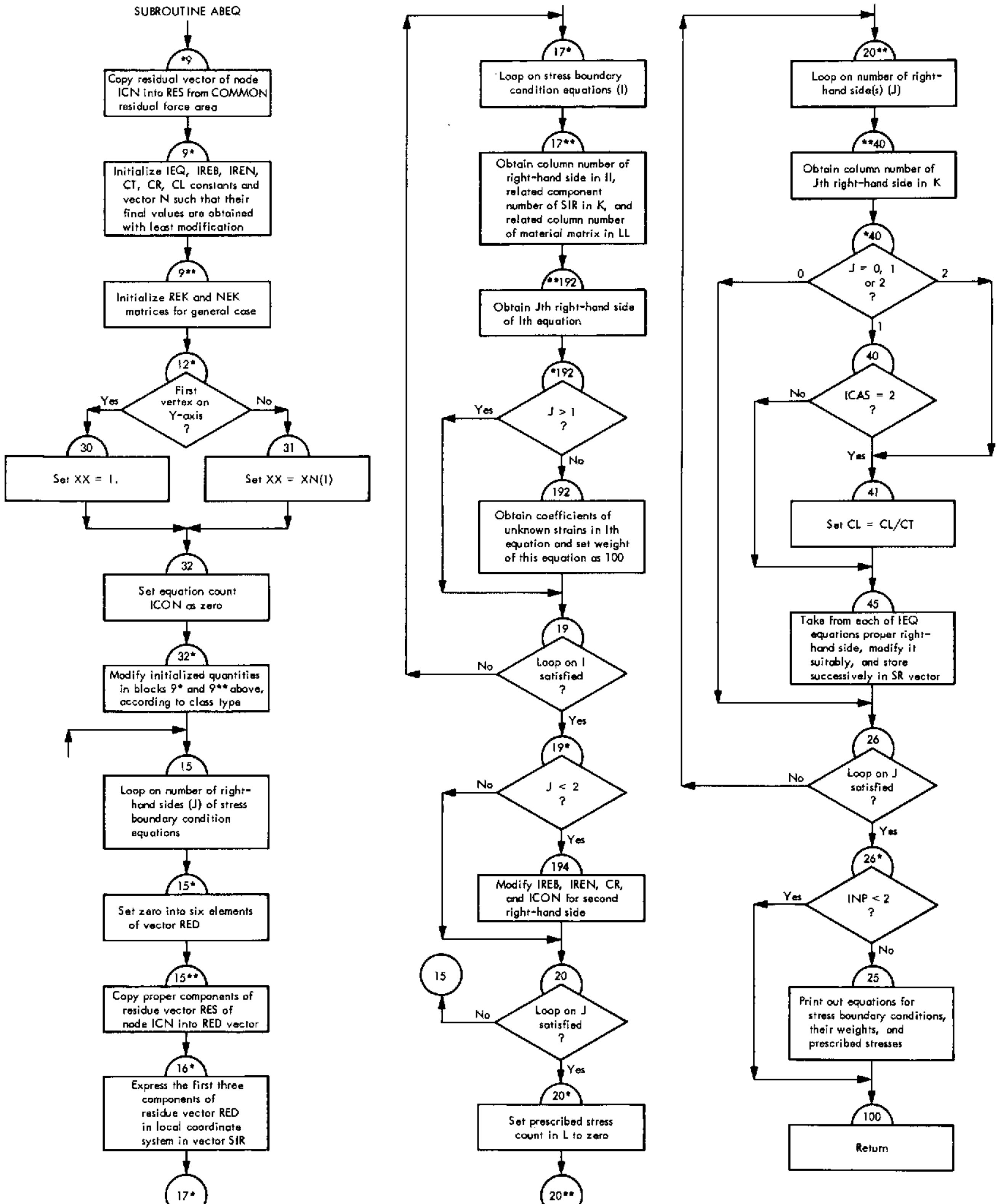


Fig. VI-48. Flowchart of subroutine ABEQ (Link 4)

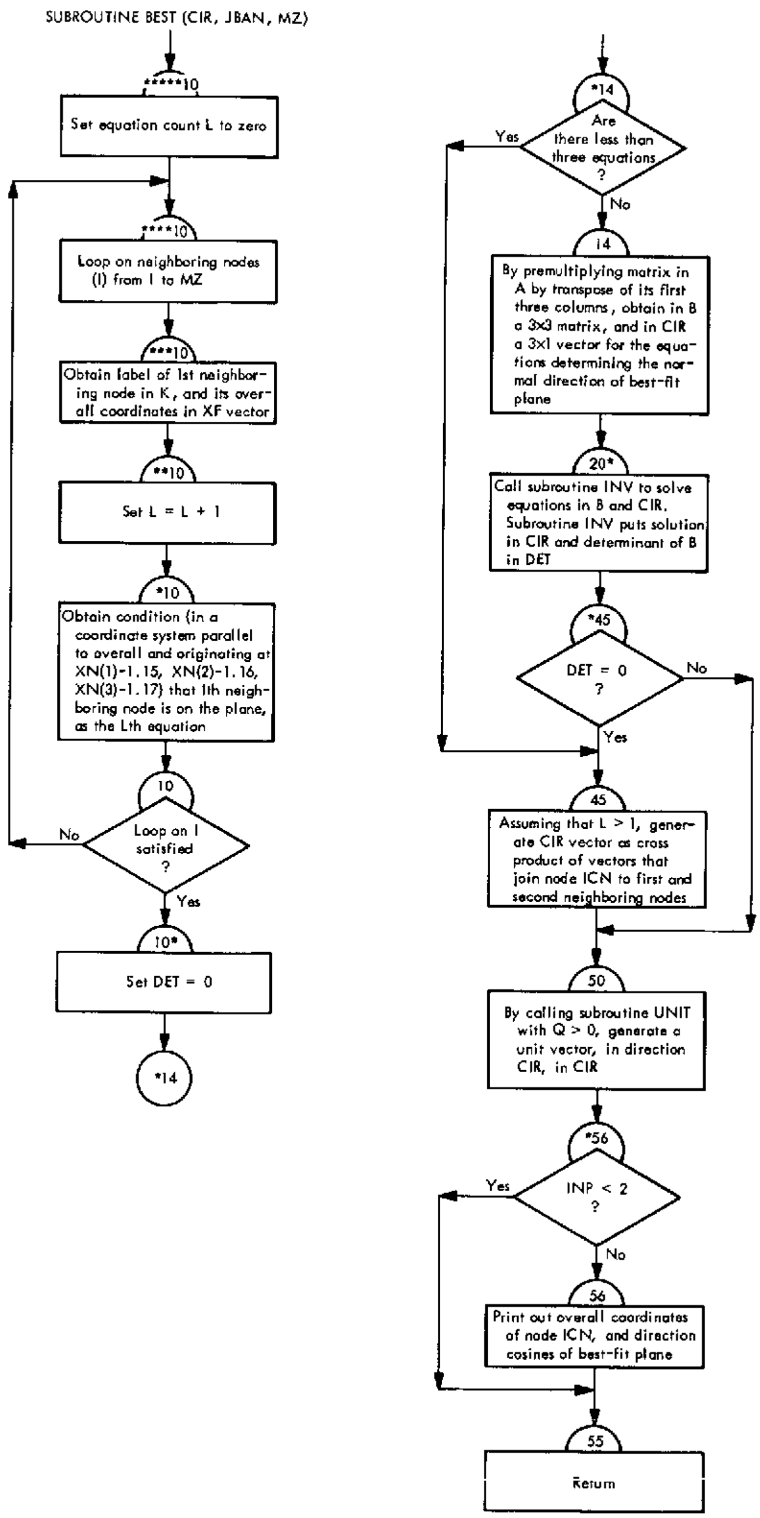


Fig. VI-49. Flowchart of subroutine BEST (Link 4)

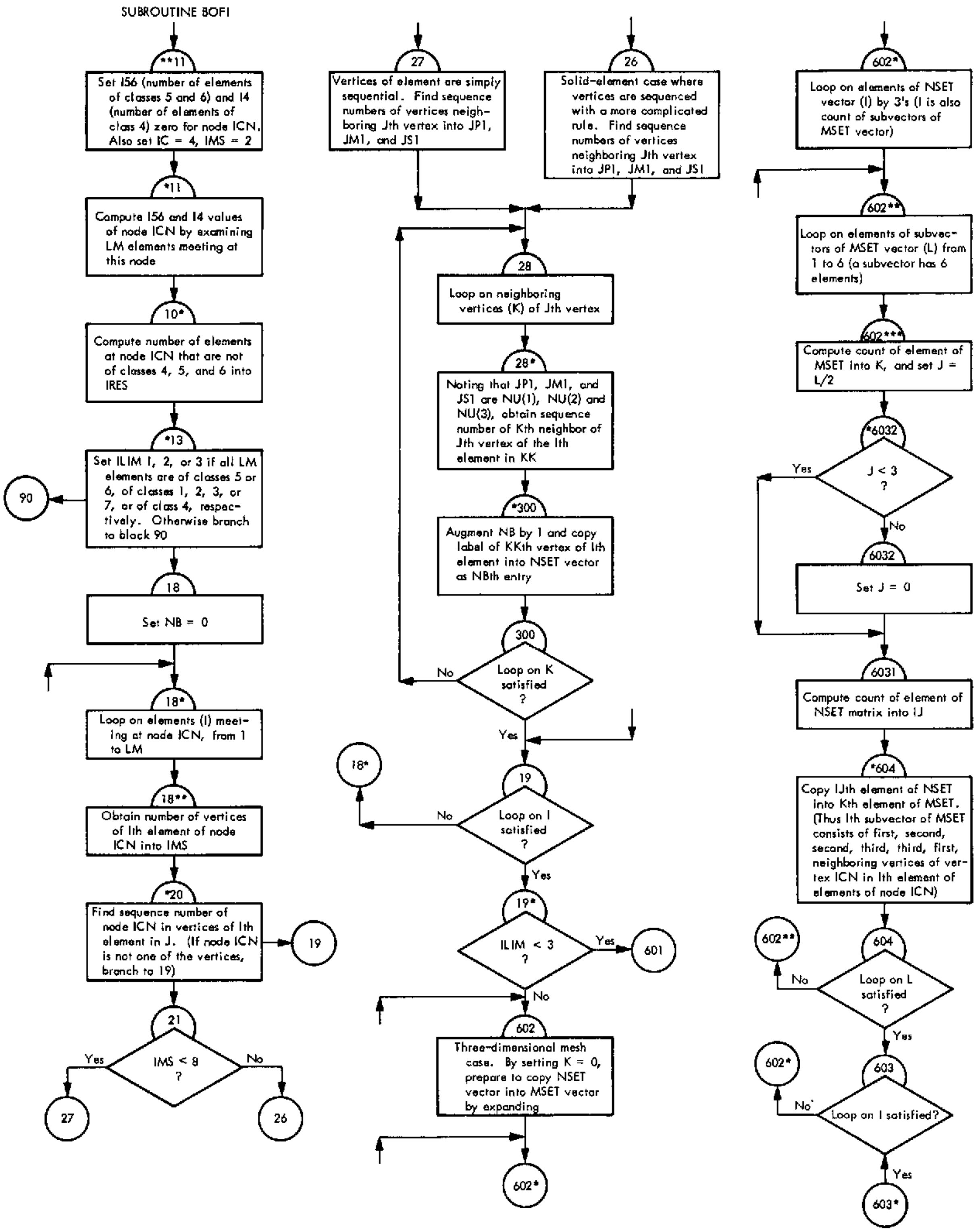


Fig. VI-50. Flowchart of subroutine BOFI (Link 4)

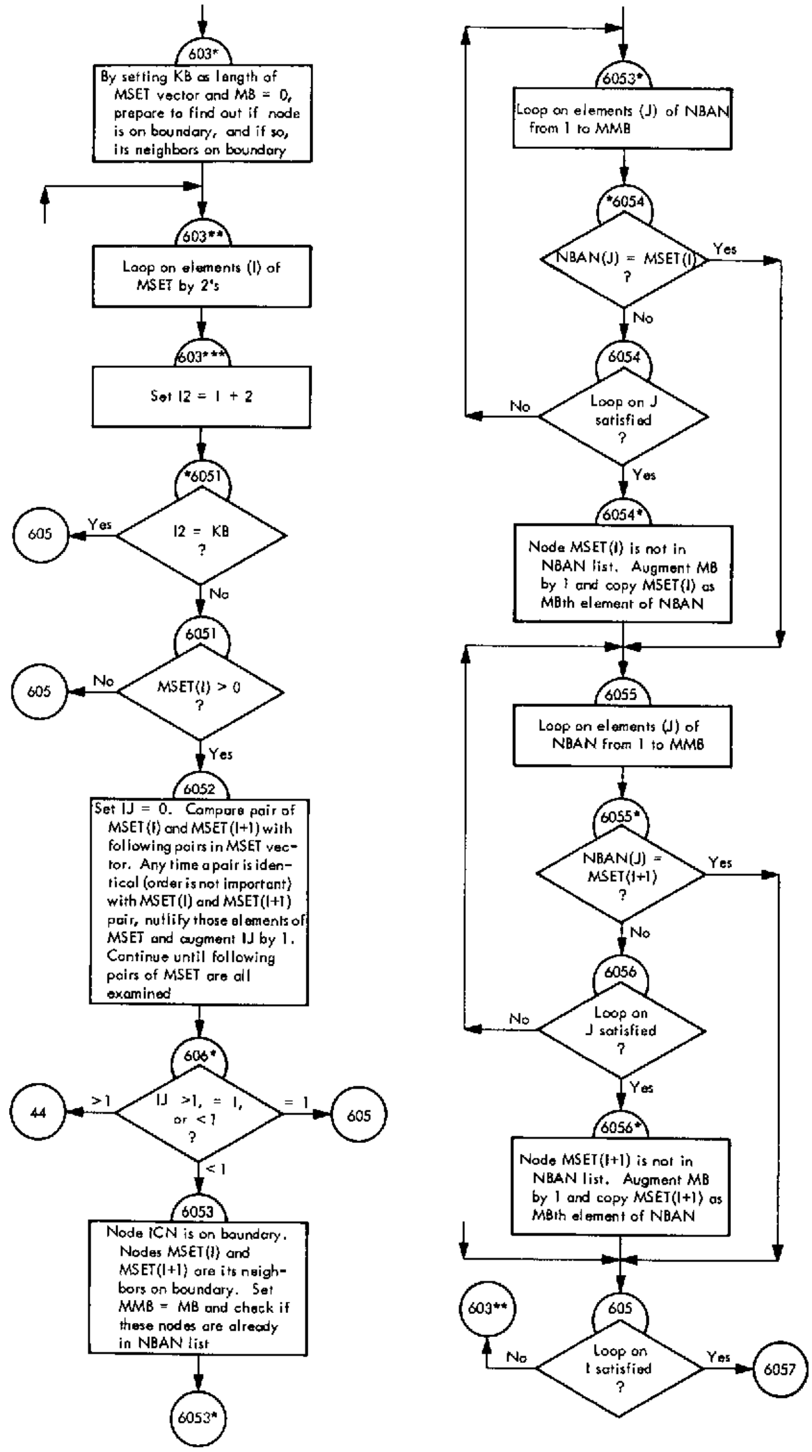


Fig. VI-50 (contd)

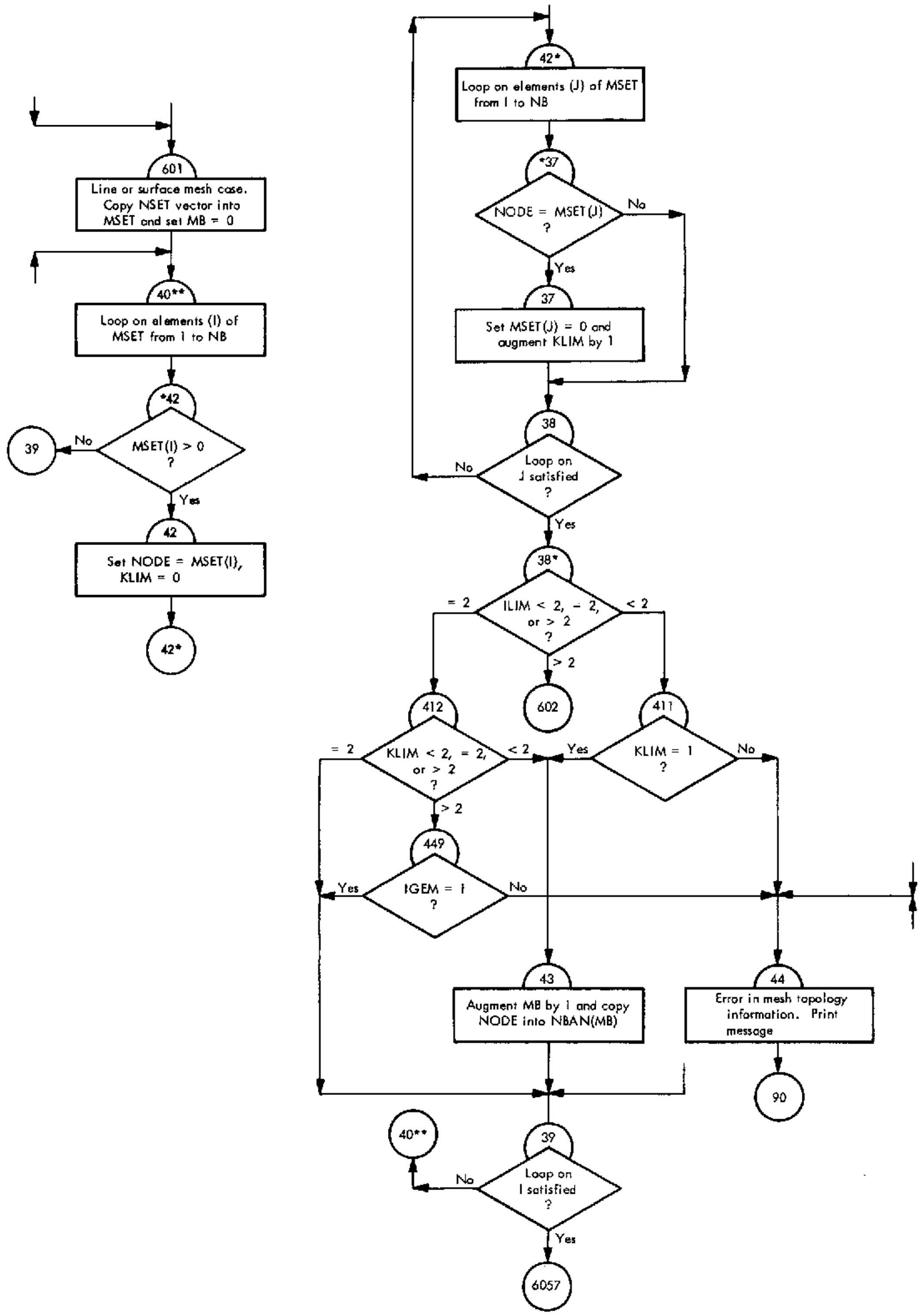


Fig. VI-50 (contd)

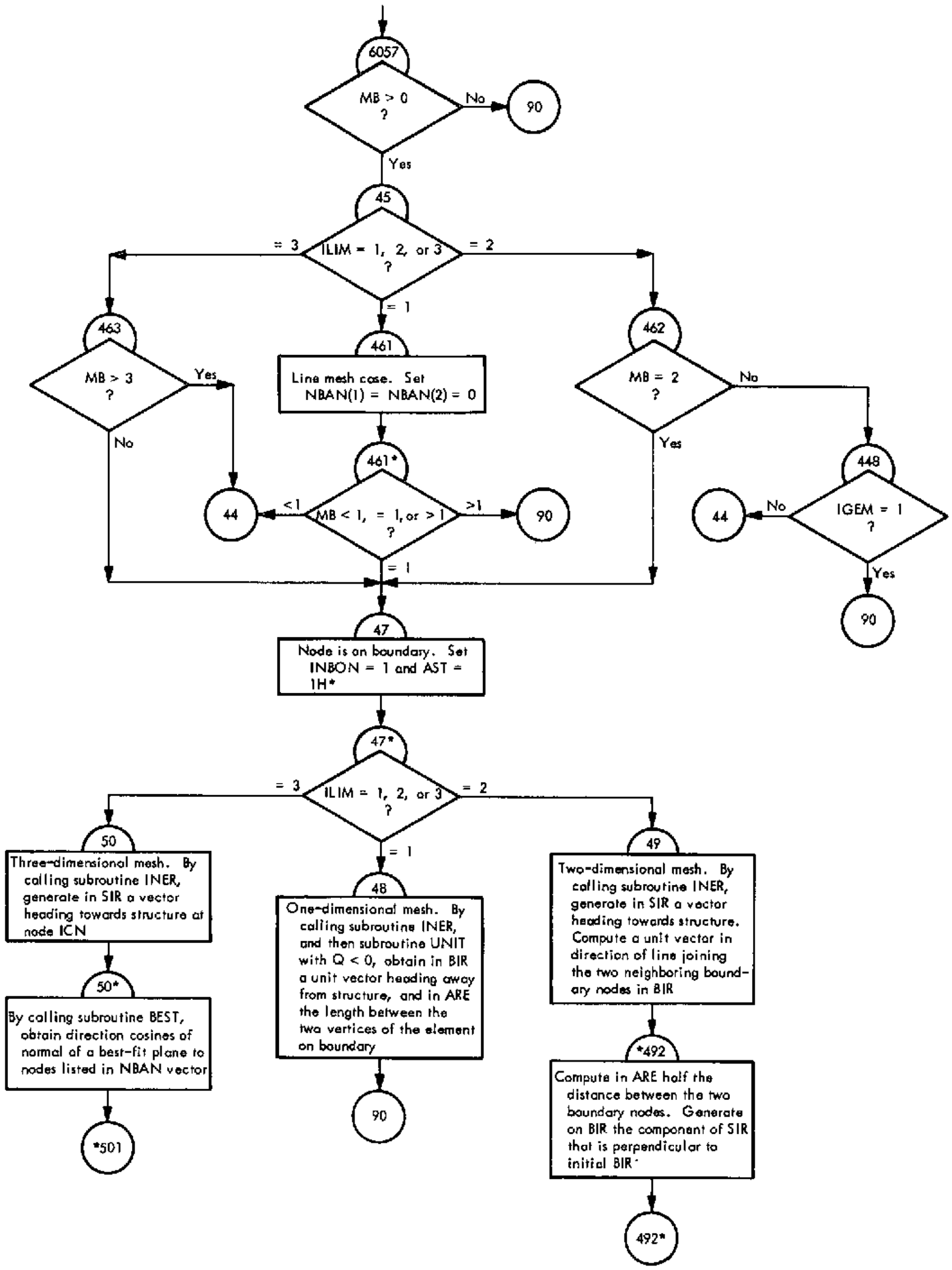


Fig. VI-50 (contd)

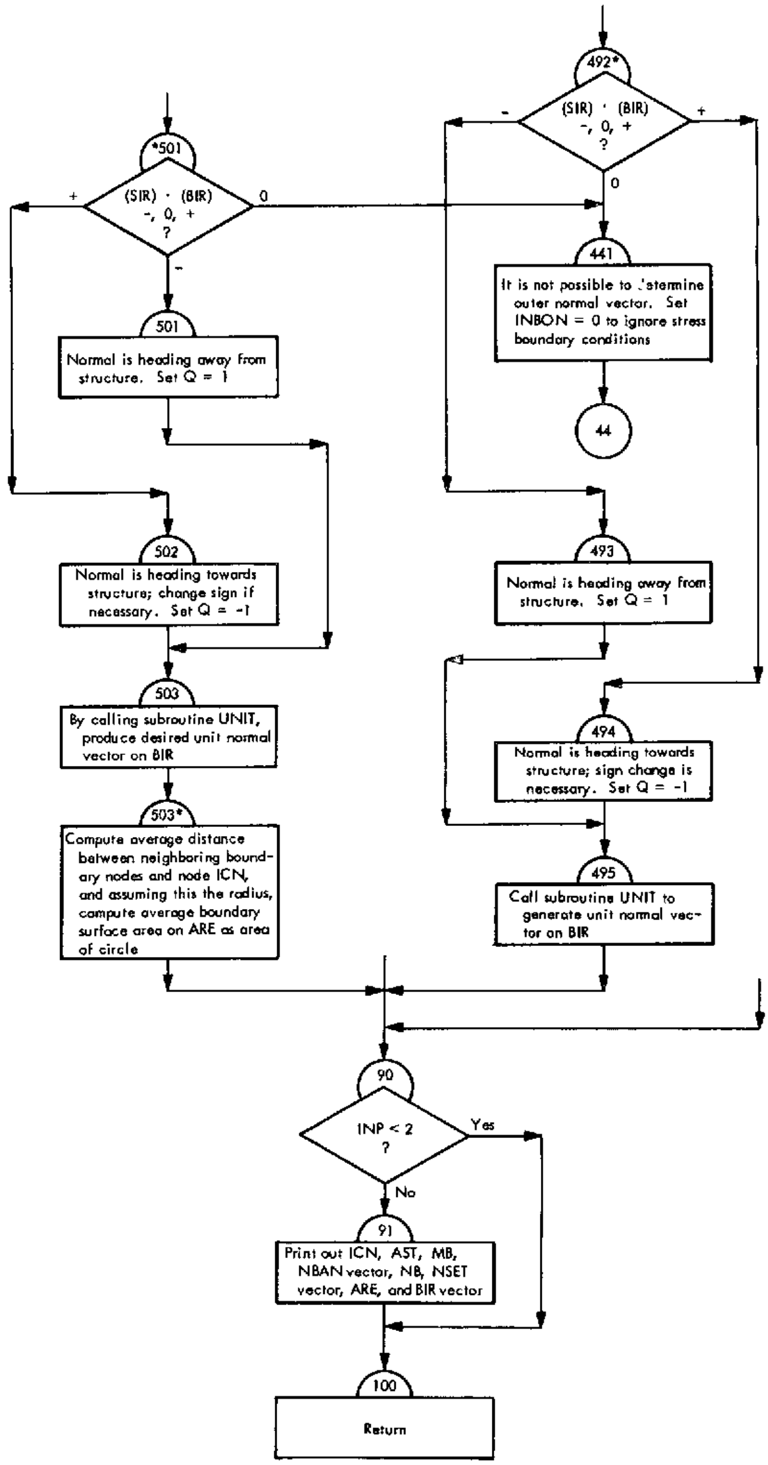


Fig. VI-50 (contd)

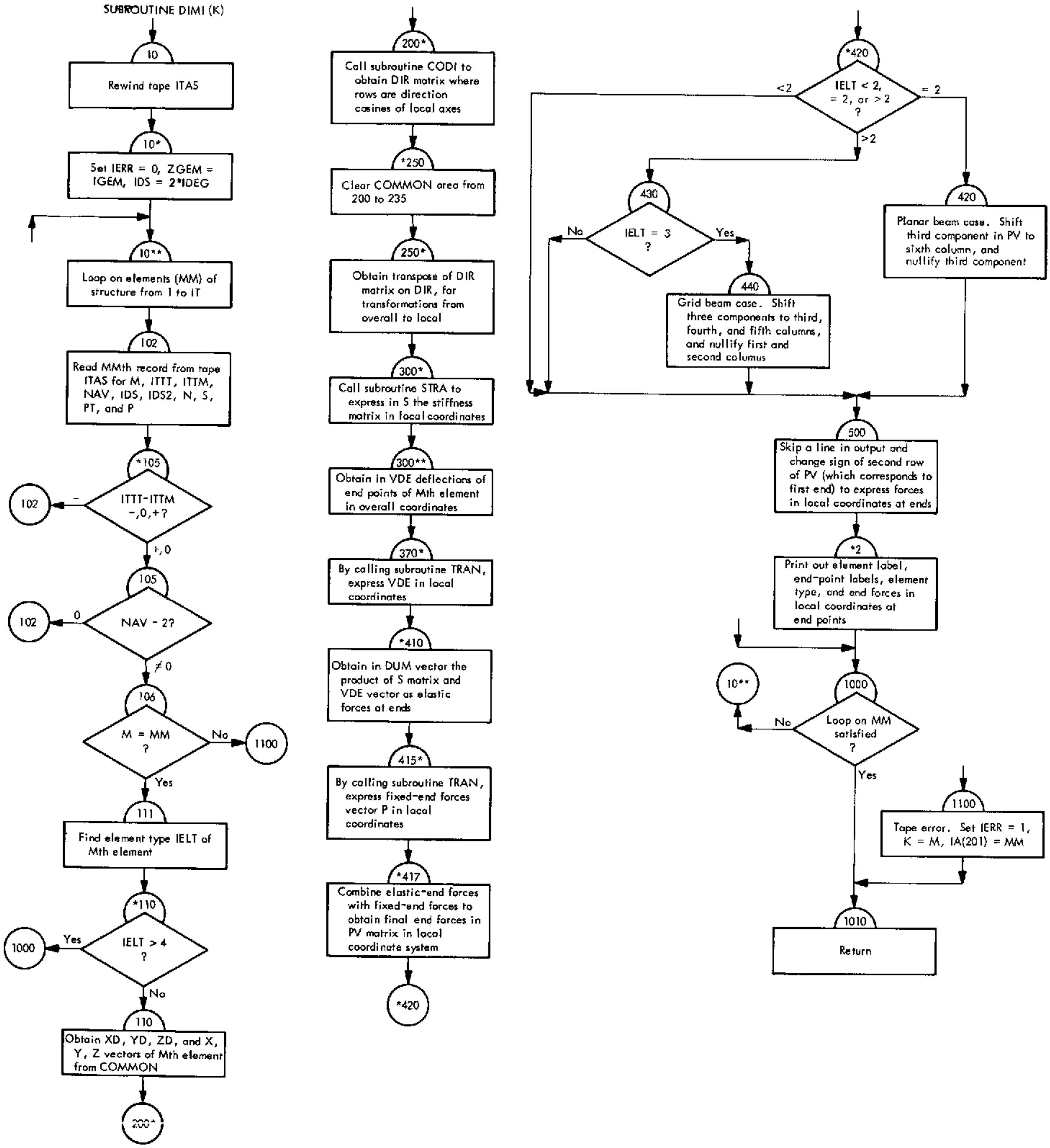


Fig. VI-51. Flowchart of subroutine DIMI (Link 4)

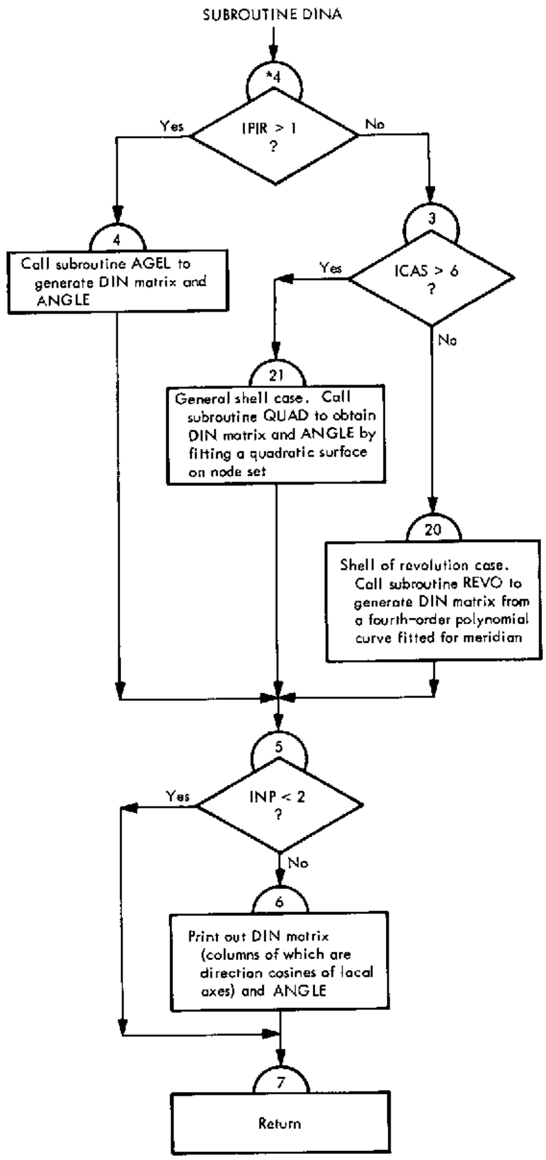


Fig. VI-52. Flowchart of subroutine DINA (Link 4)

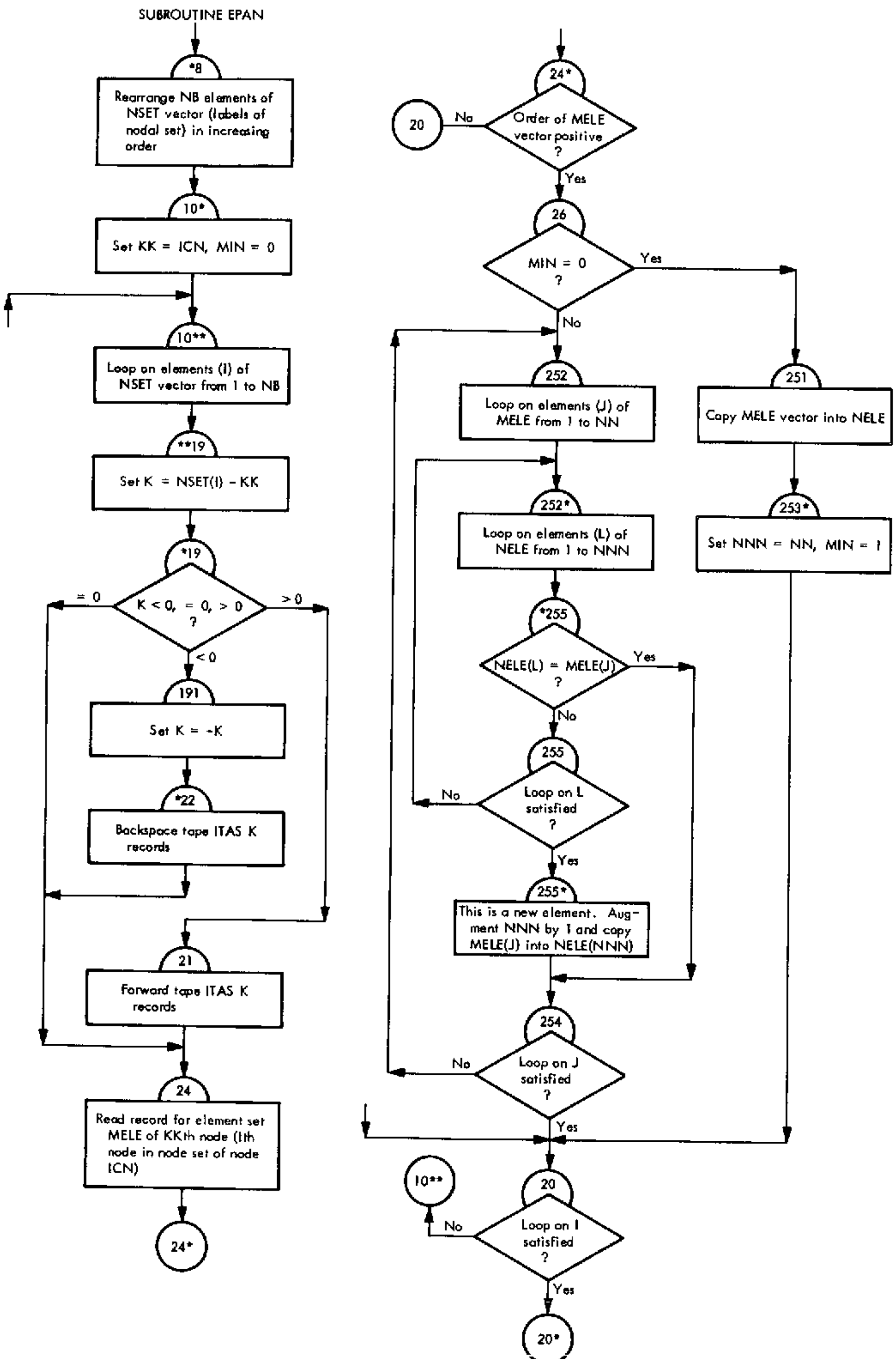


Fig. VI-53. Flowchart of subroutine EPAN (Link 4)

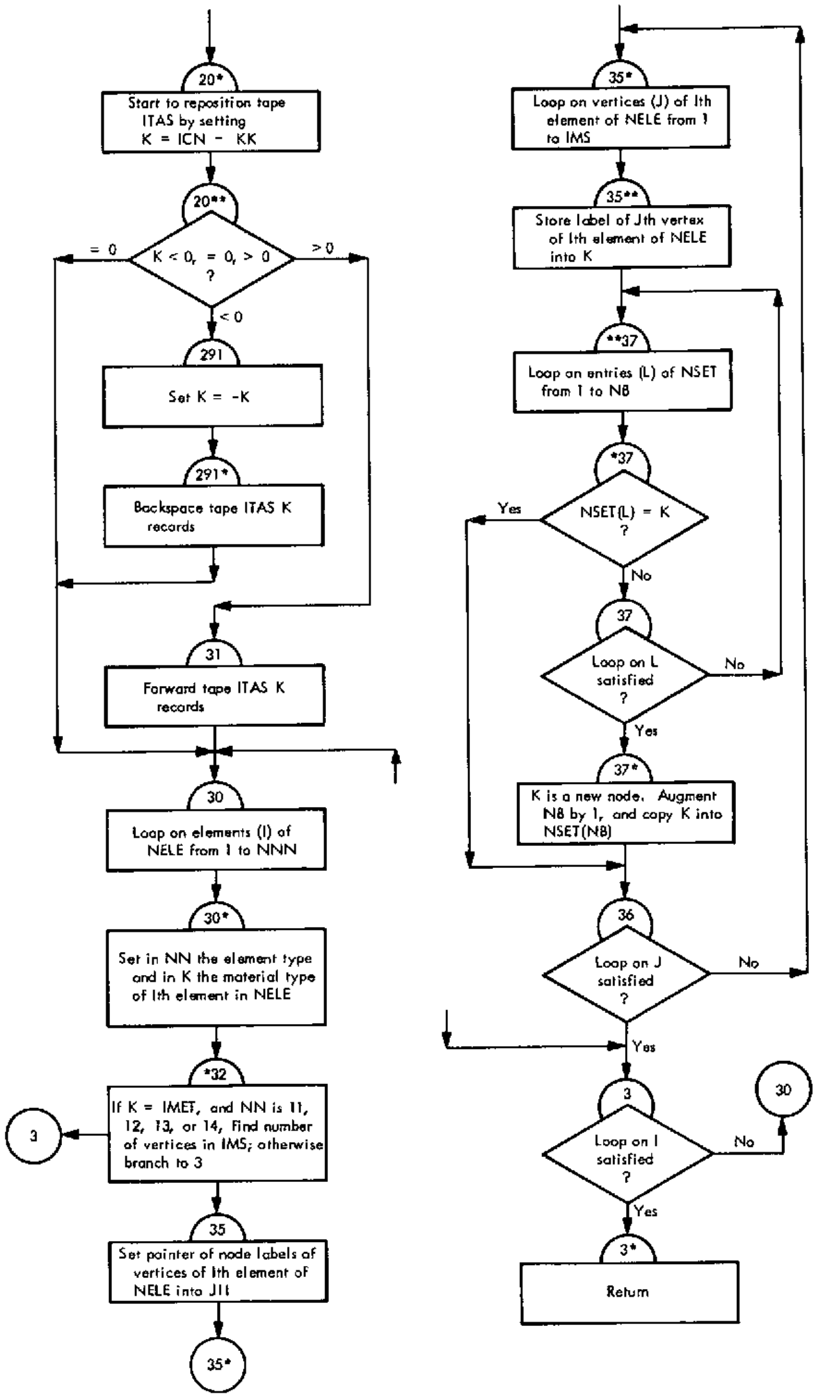


Fig. VI-53 (contd)

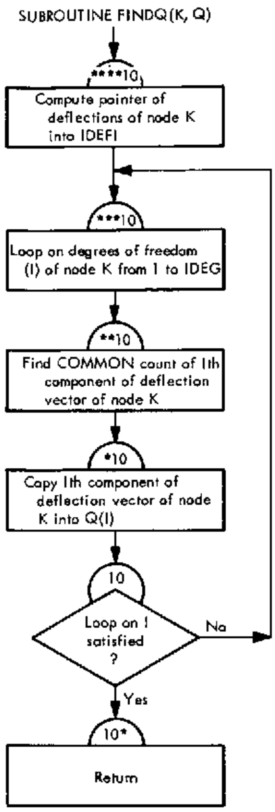


Fig. VI-54. Flowchart of subroutine FINDQ (Link 4)

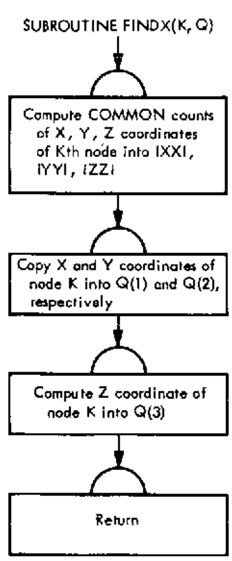


Fig. VI-55. Flowchart of subroutine FINDX (Link 4)

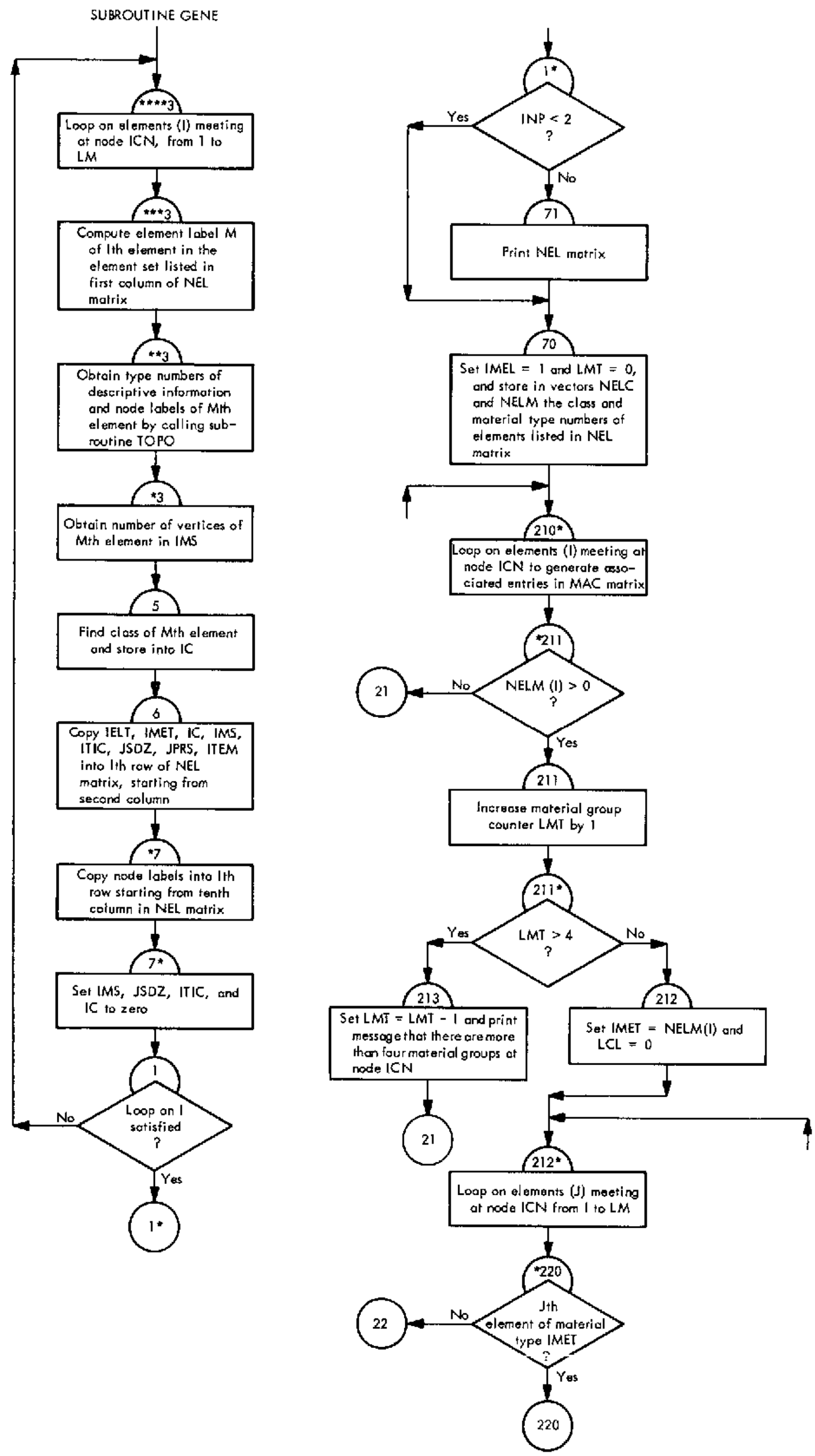


Fig. VI-56. Flowchart of subroutine GENE (Link 4)

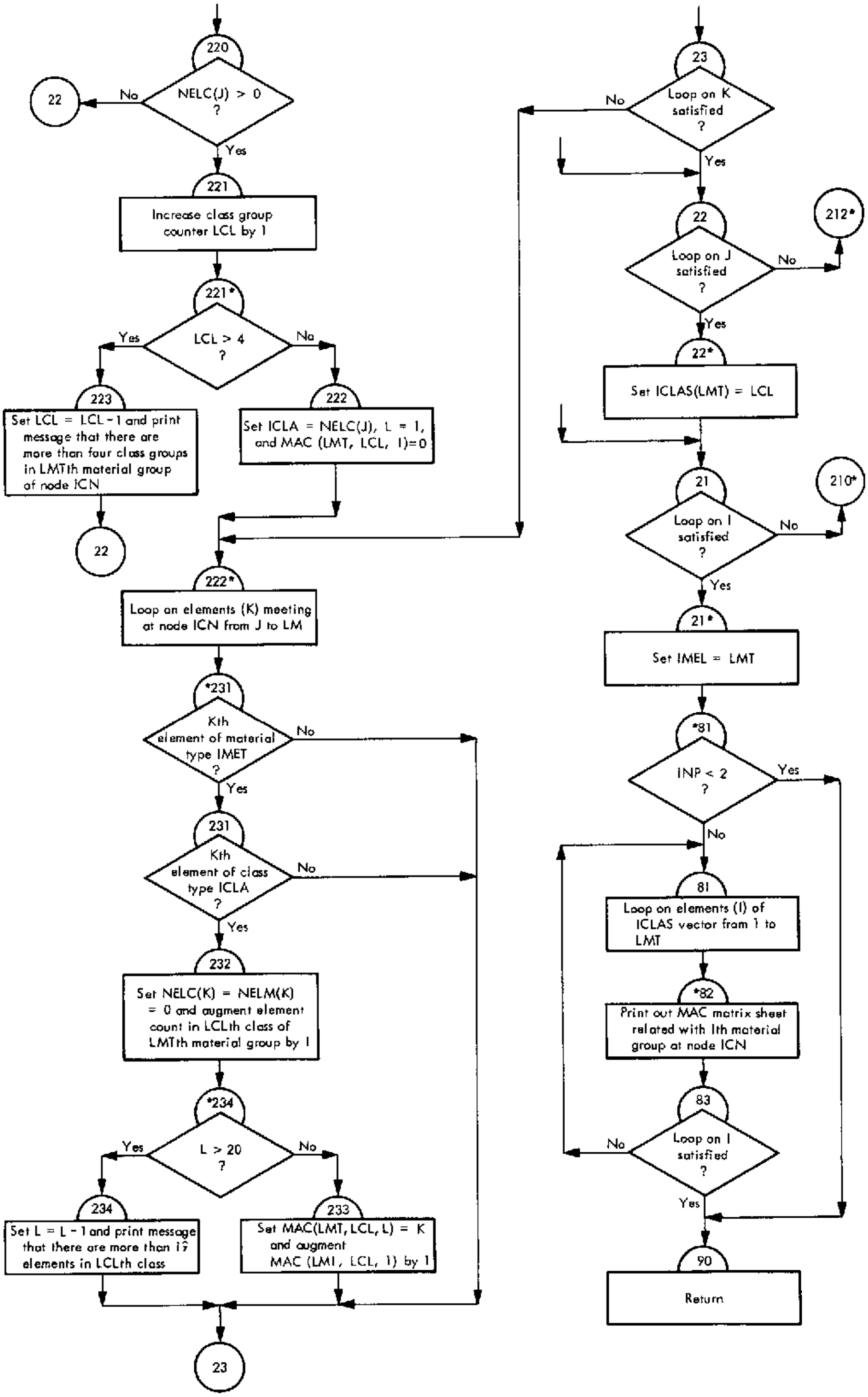


Fig. VI-56 (contd)

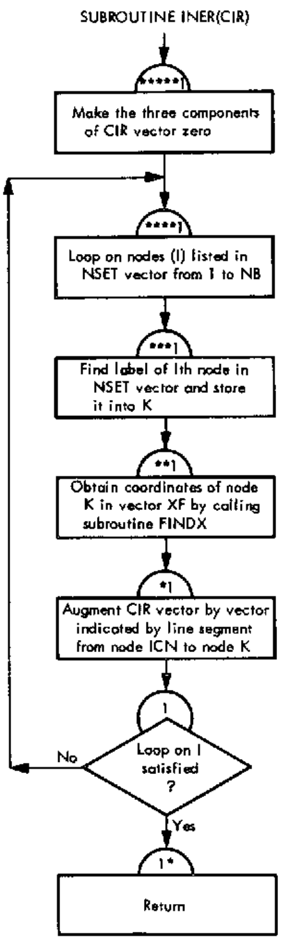


Fig. VI-57. Flowchart of subroutine INER (Link 4)

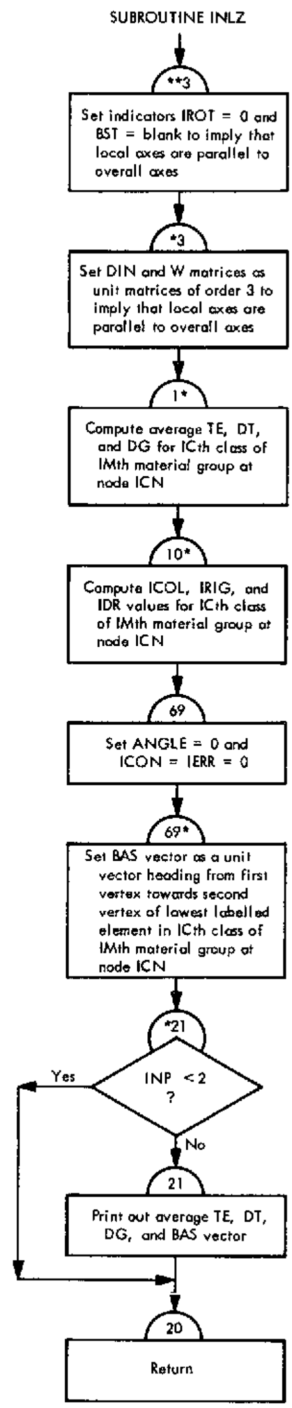


Fig. VI-58. Flowchart of subroutine INLZ (Link 4)

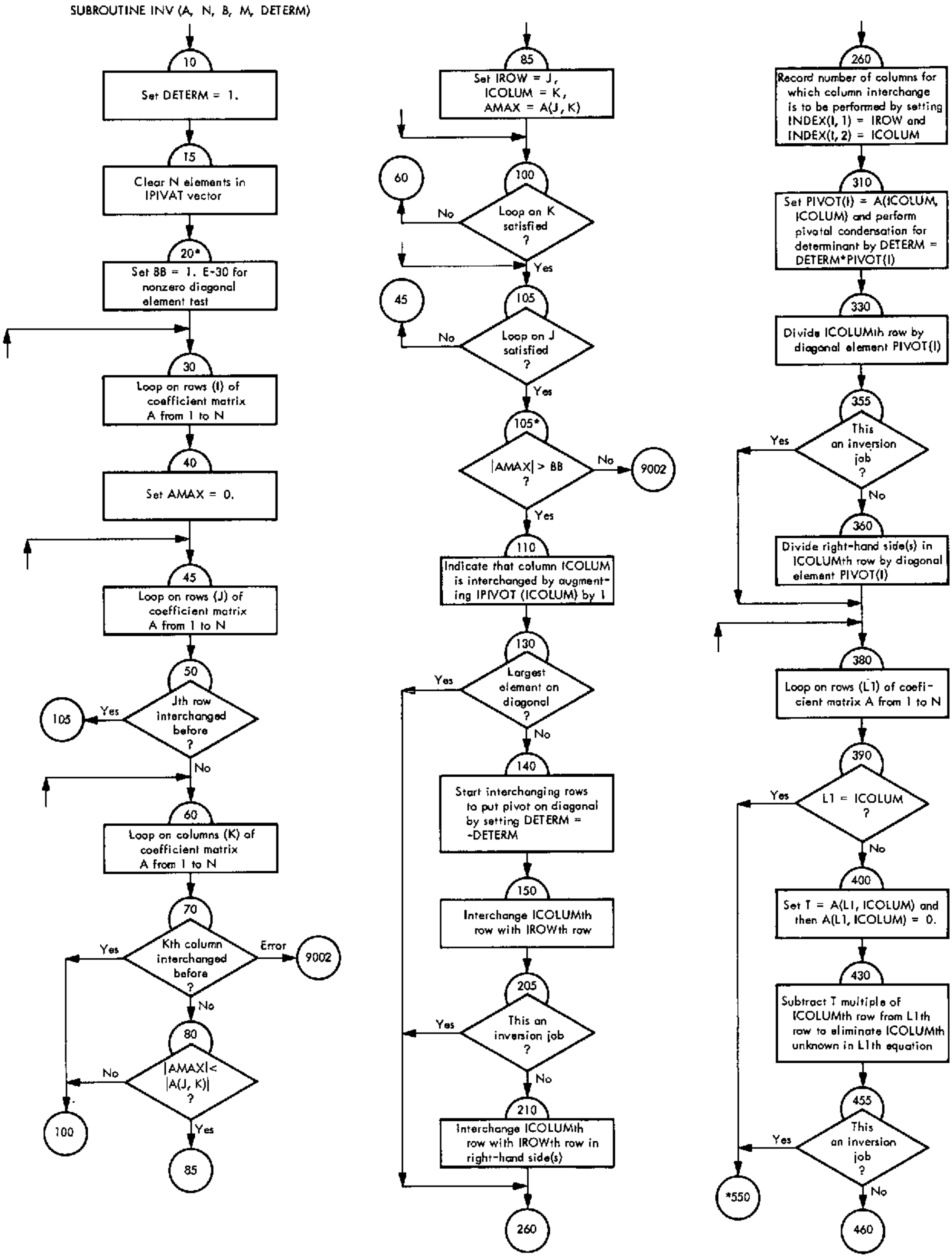


Fig. VI-59. Flowchart of subroutine INV (Link 4)

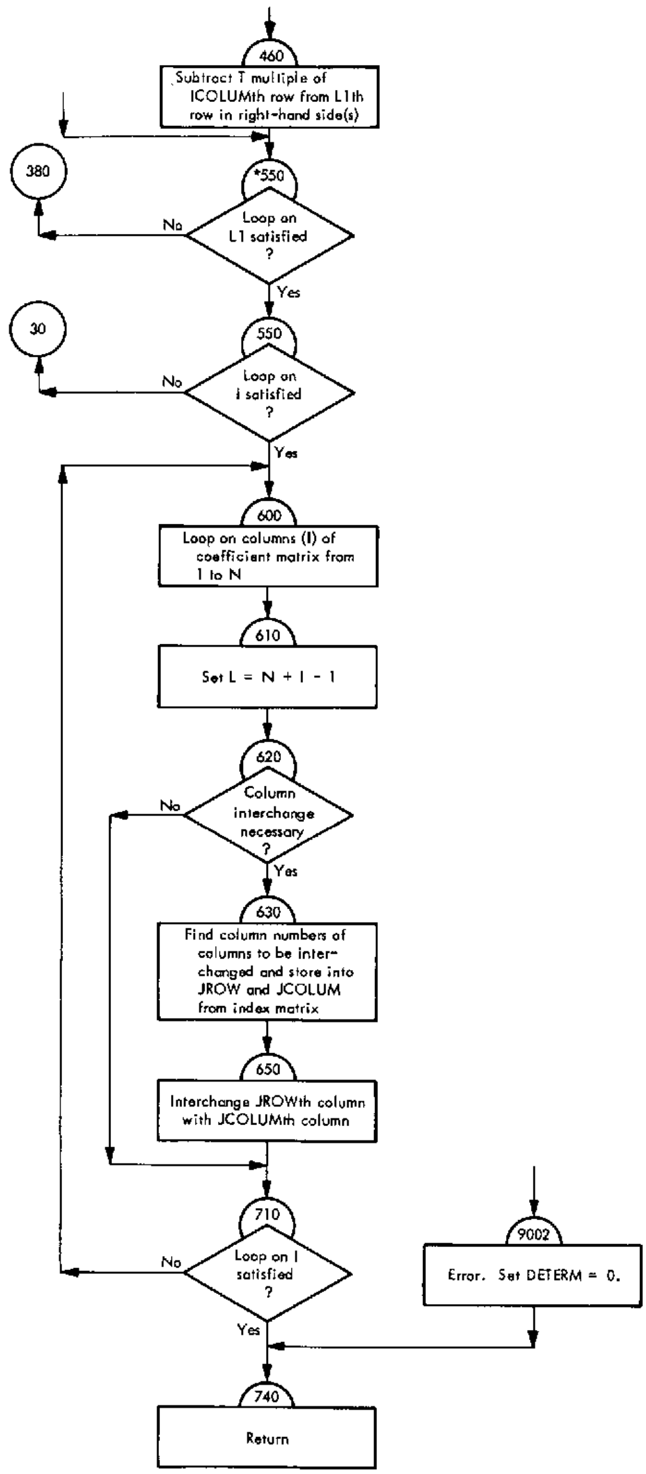


Fig. VI-59 (contd)

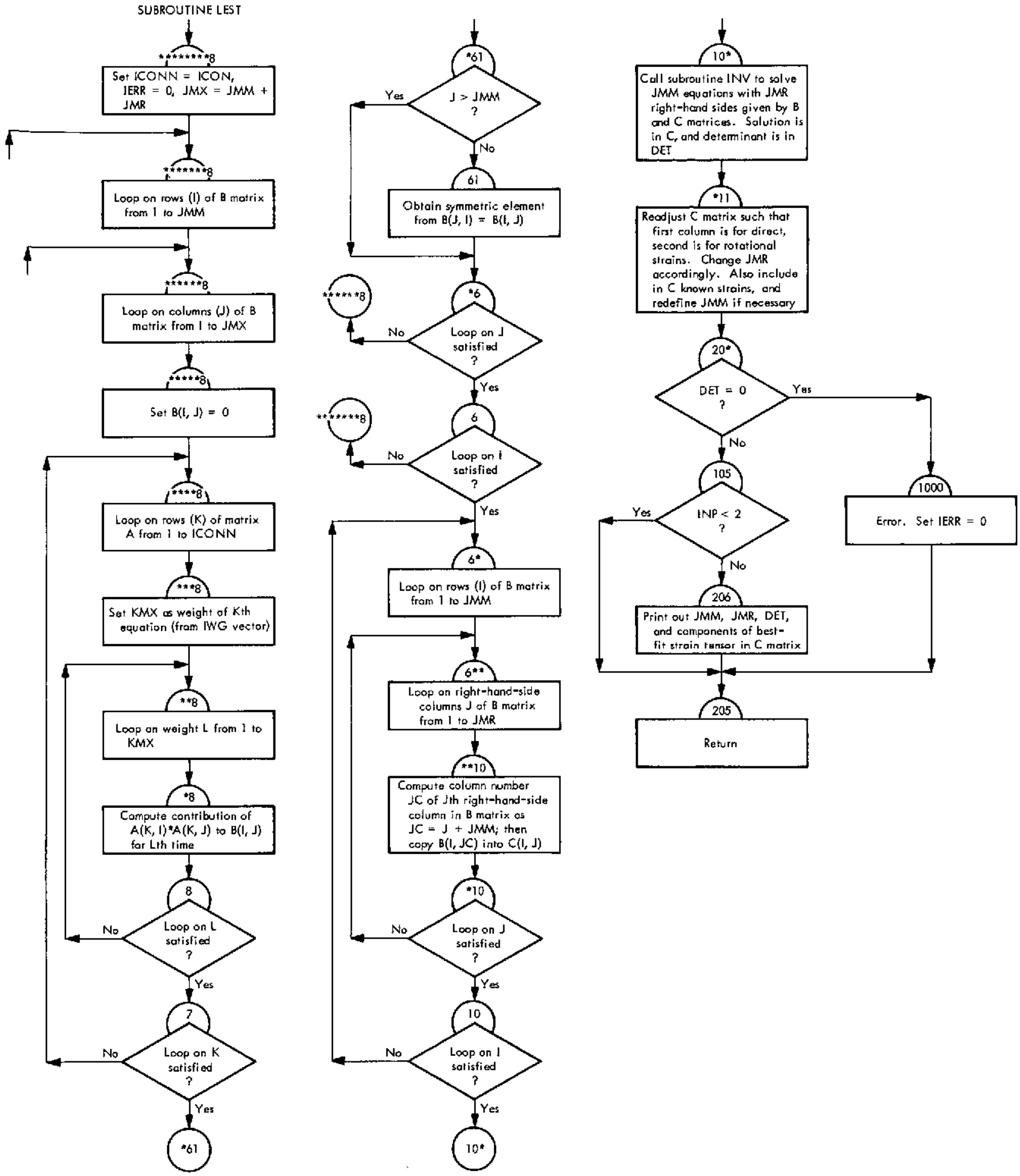


Fig. VI-60. Flowchart of subroutine LEST (Link 4)

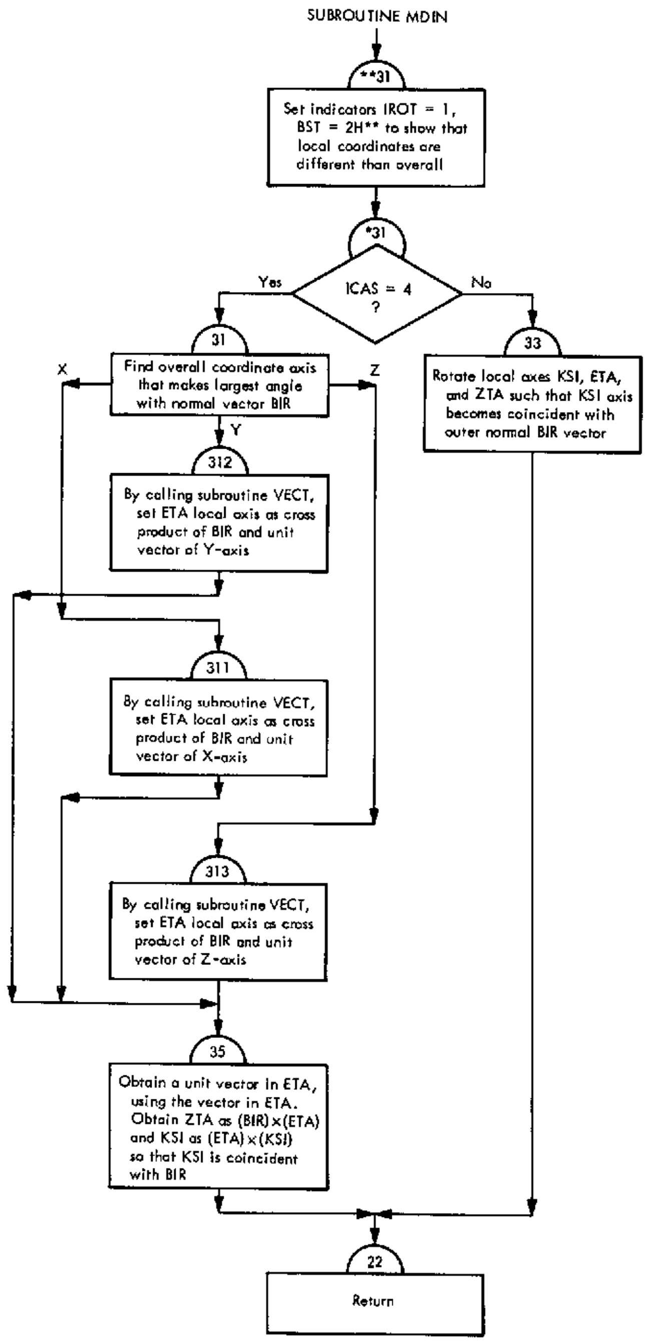


Fig. VI-61. Flowchart of subroutine MDIN (Link 4)

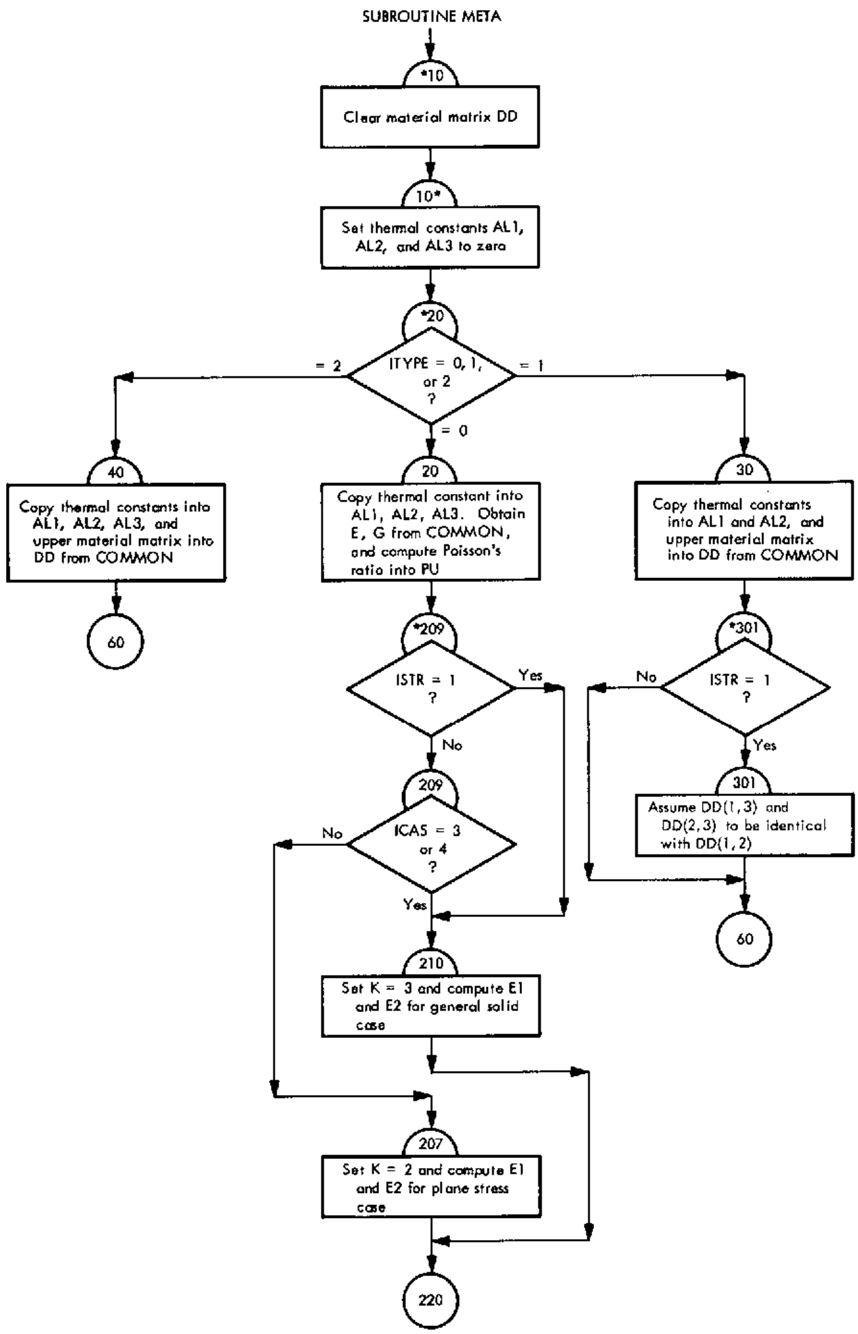


Fig. VI-62. Flowchart of subroutine META (Link 4)

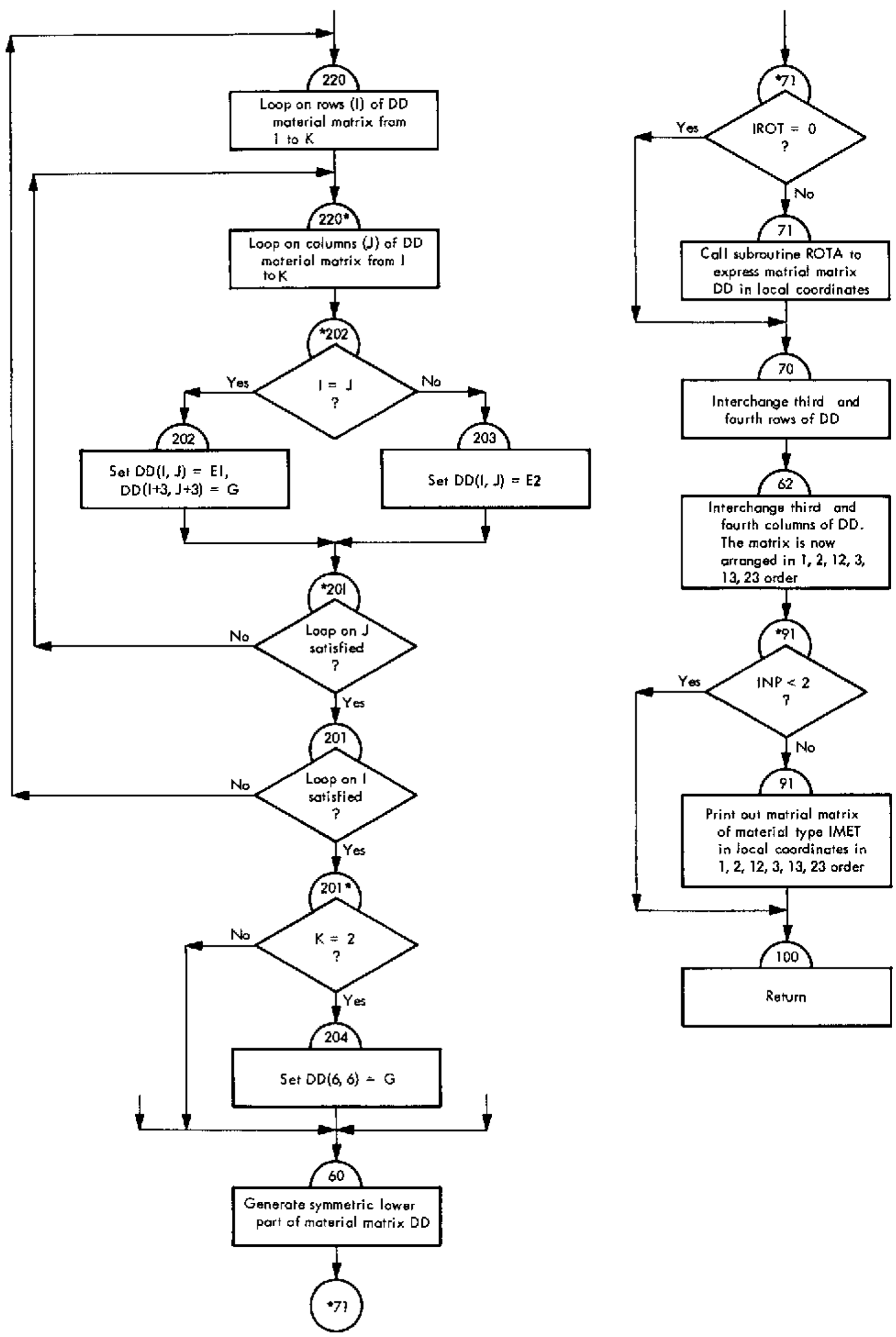


Fig. VI-62 (contd)

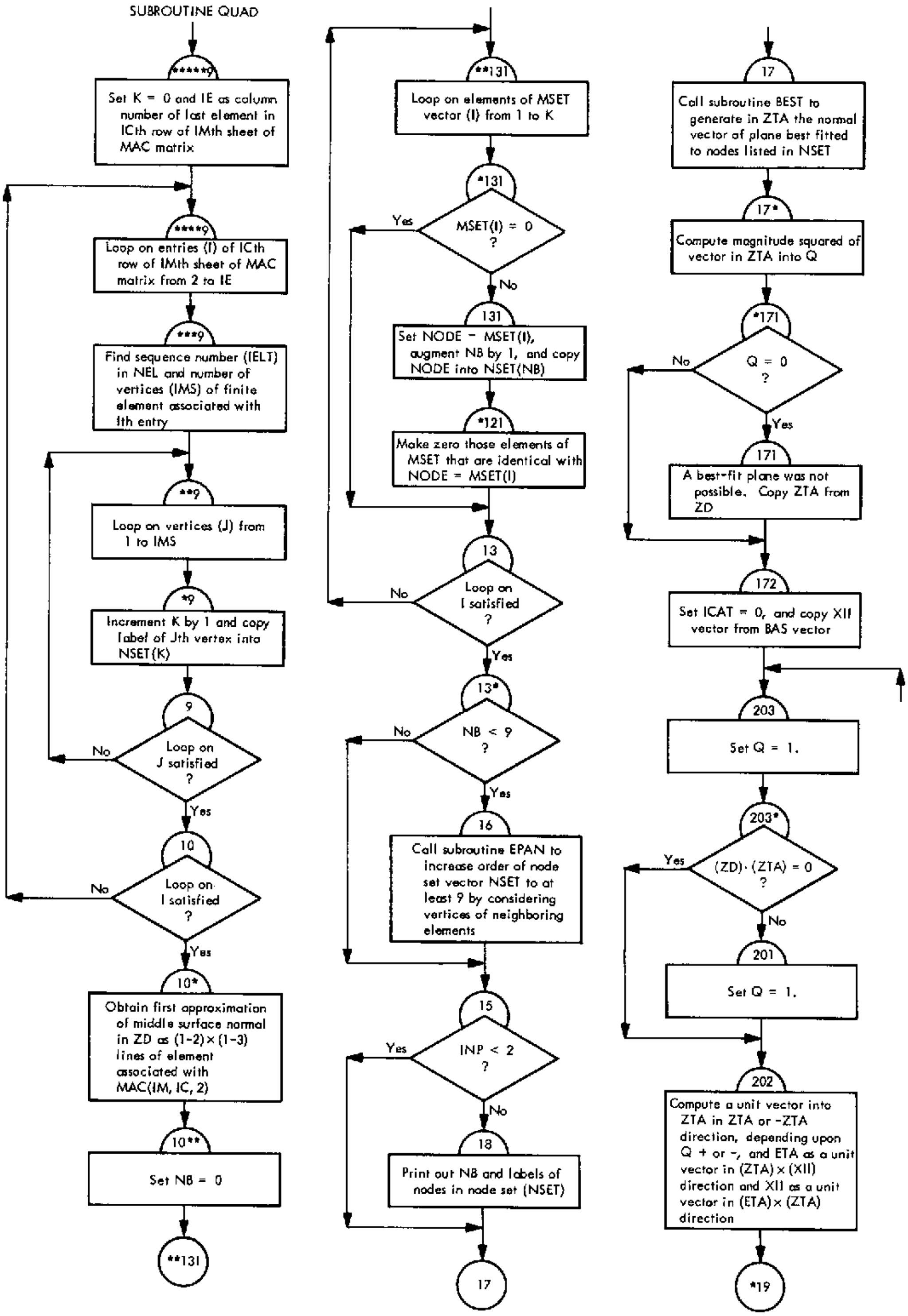


Fig. VI-63. Flowchart of subroutine QUAD (Link 4)

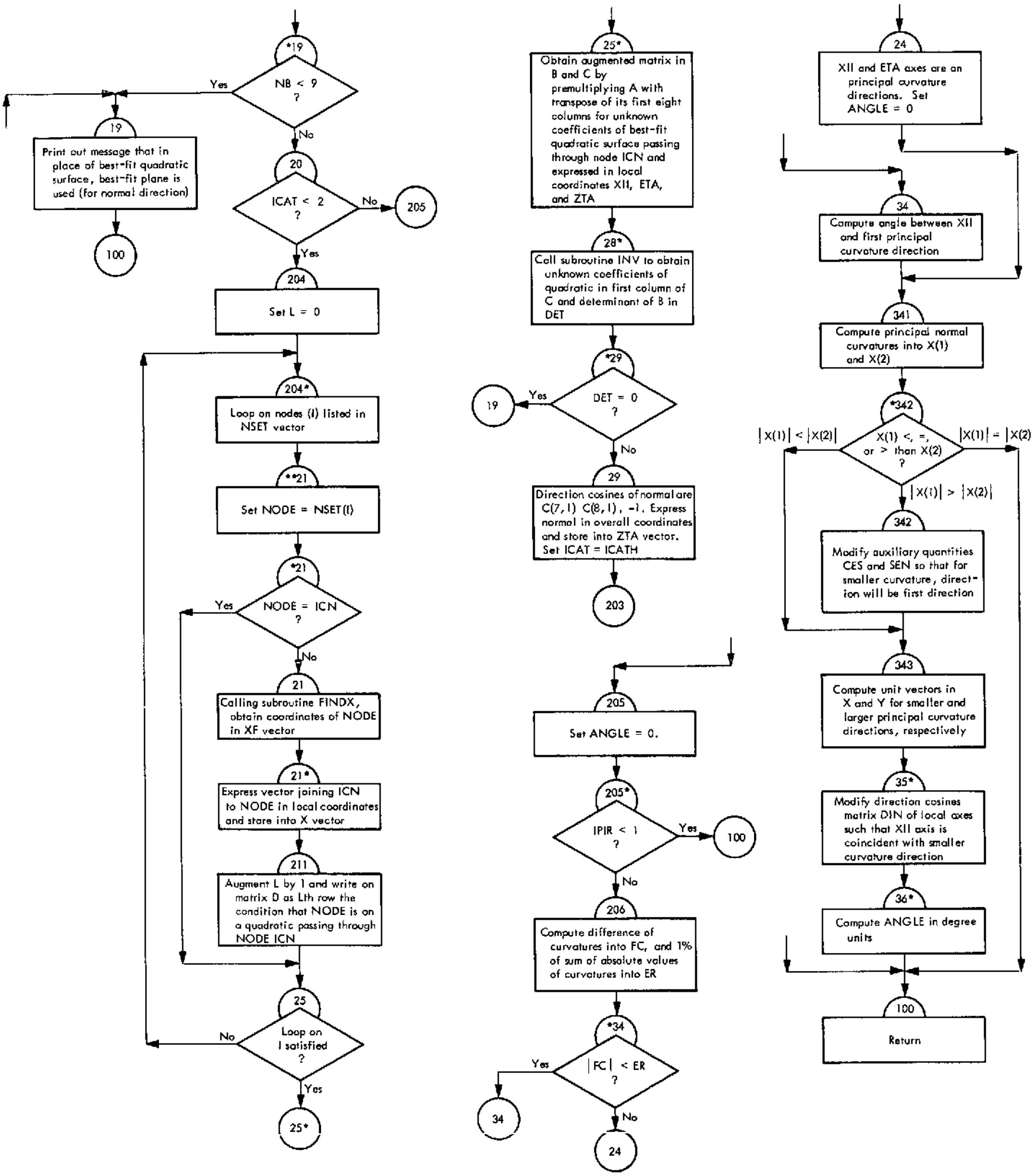


Fig. VI-63 (contd)

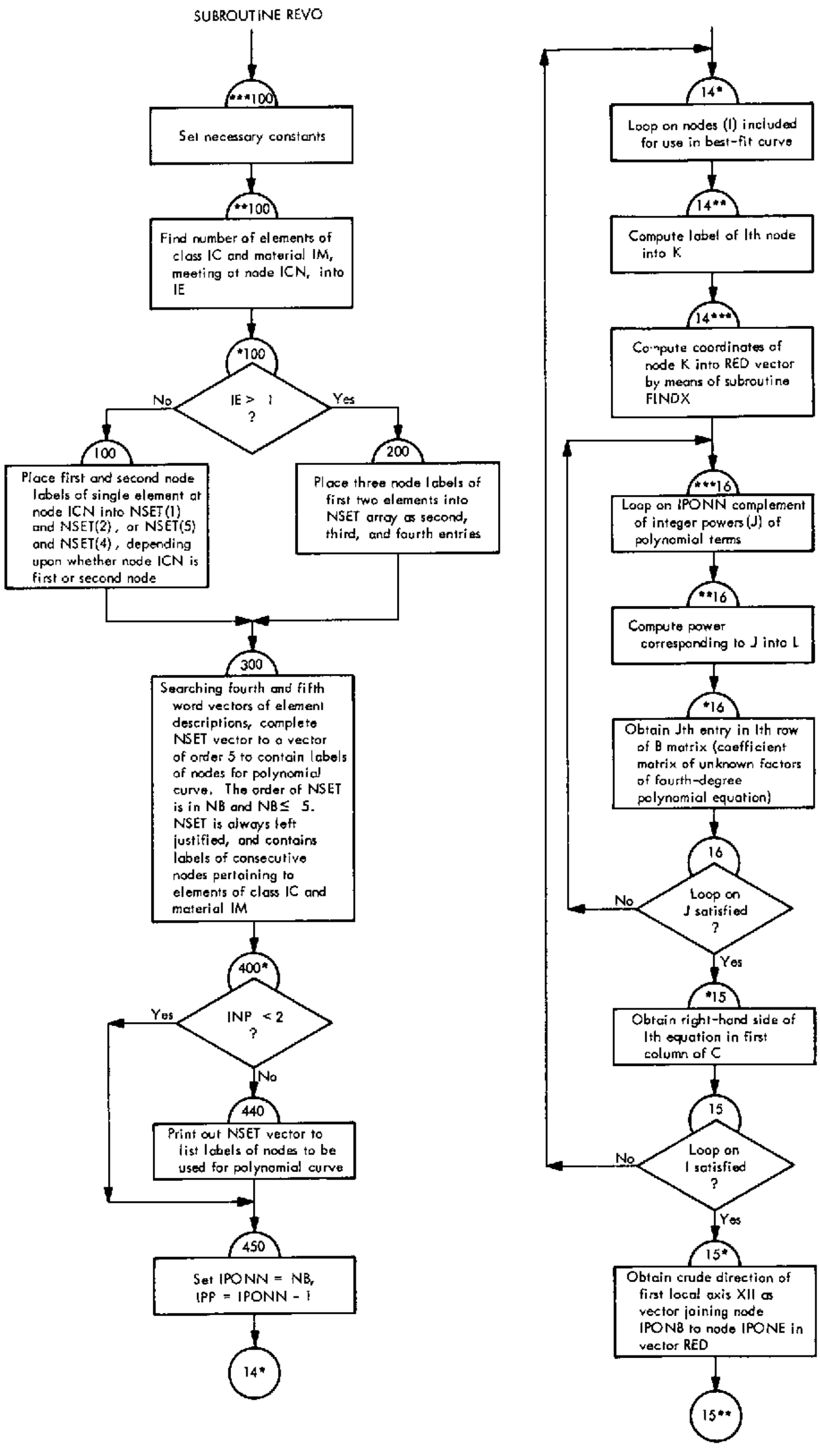


Fig. VI-64. Flowchart of subroutine REVO (Link 4)

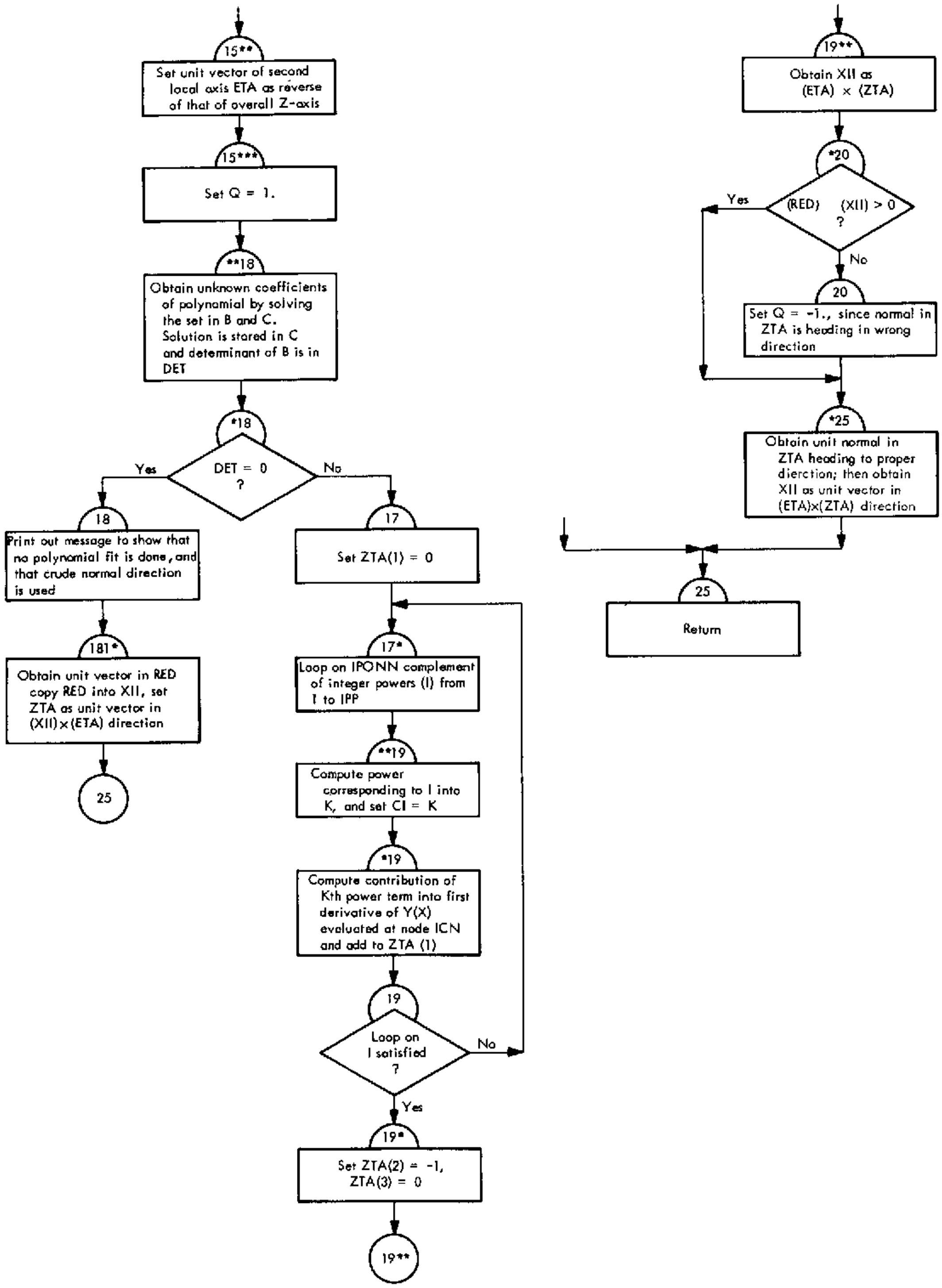


Fig. VI-64 (contd)

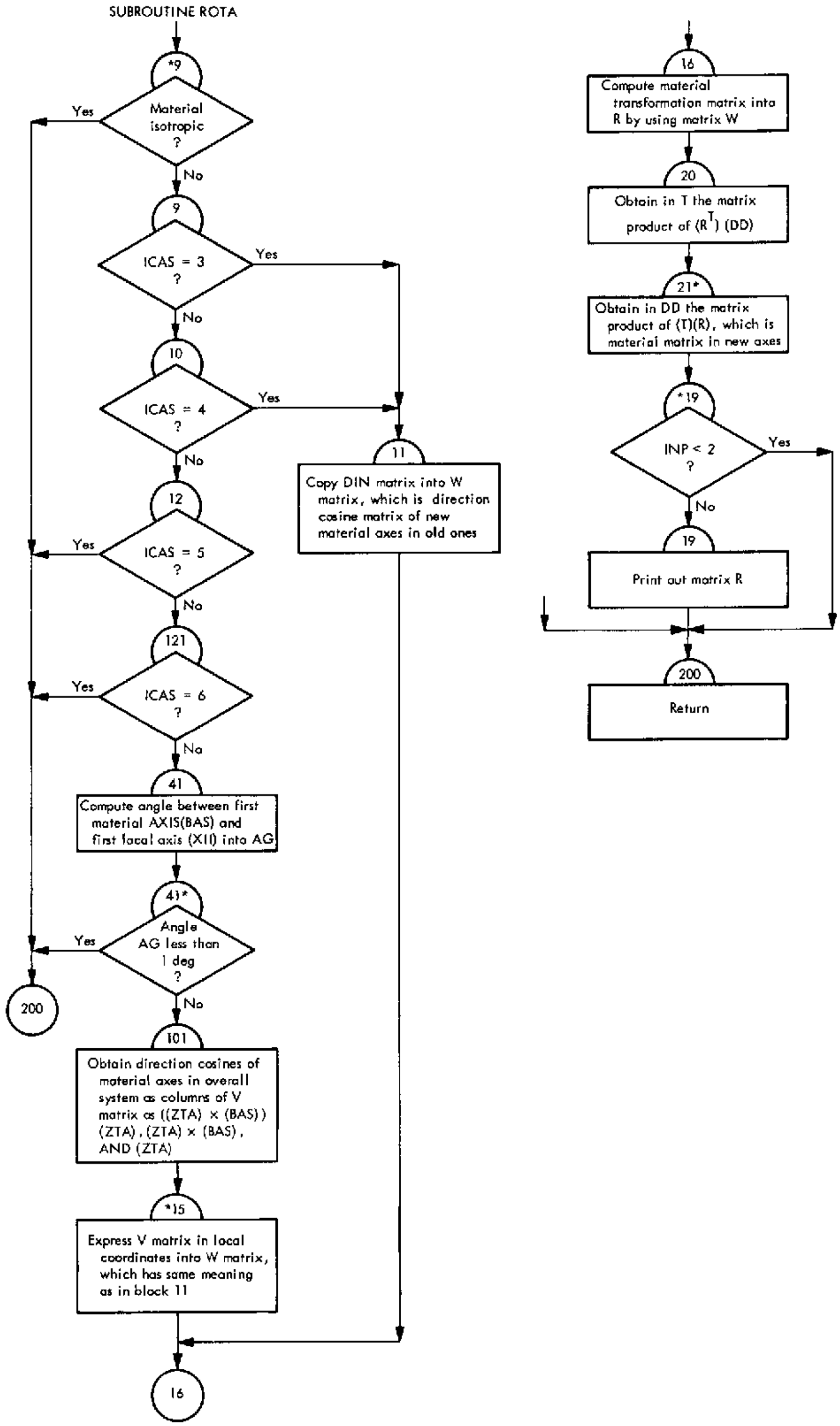


Fig. VI-65. Flowchart of subroutine ROTA (Link 4)

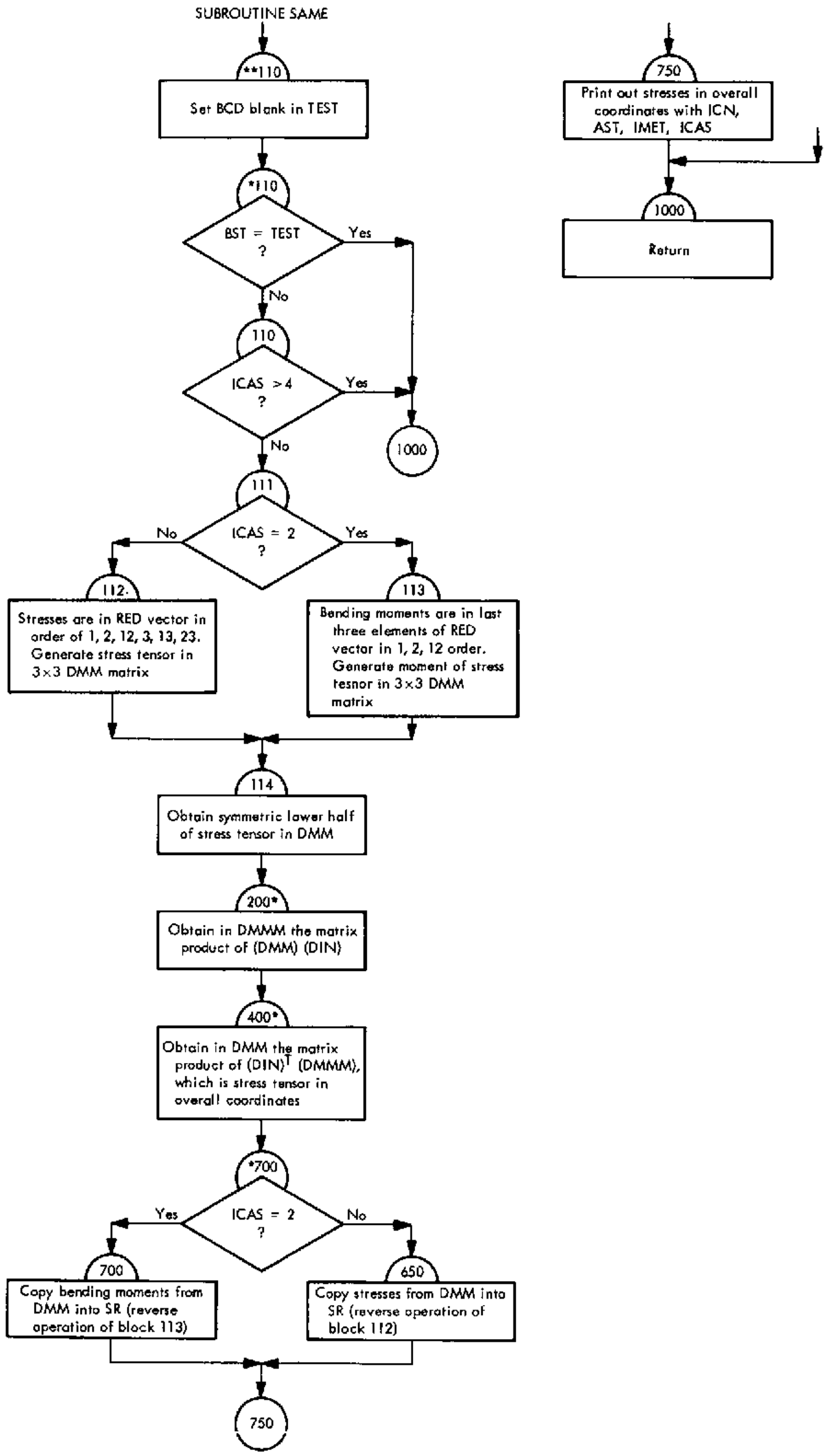


Fig. VI-66. Flowchart of subroutine SAME (Link 4)

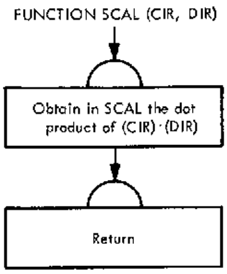


Fig. VI-67. Flowchart of function SCAL (Link 4)

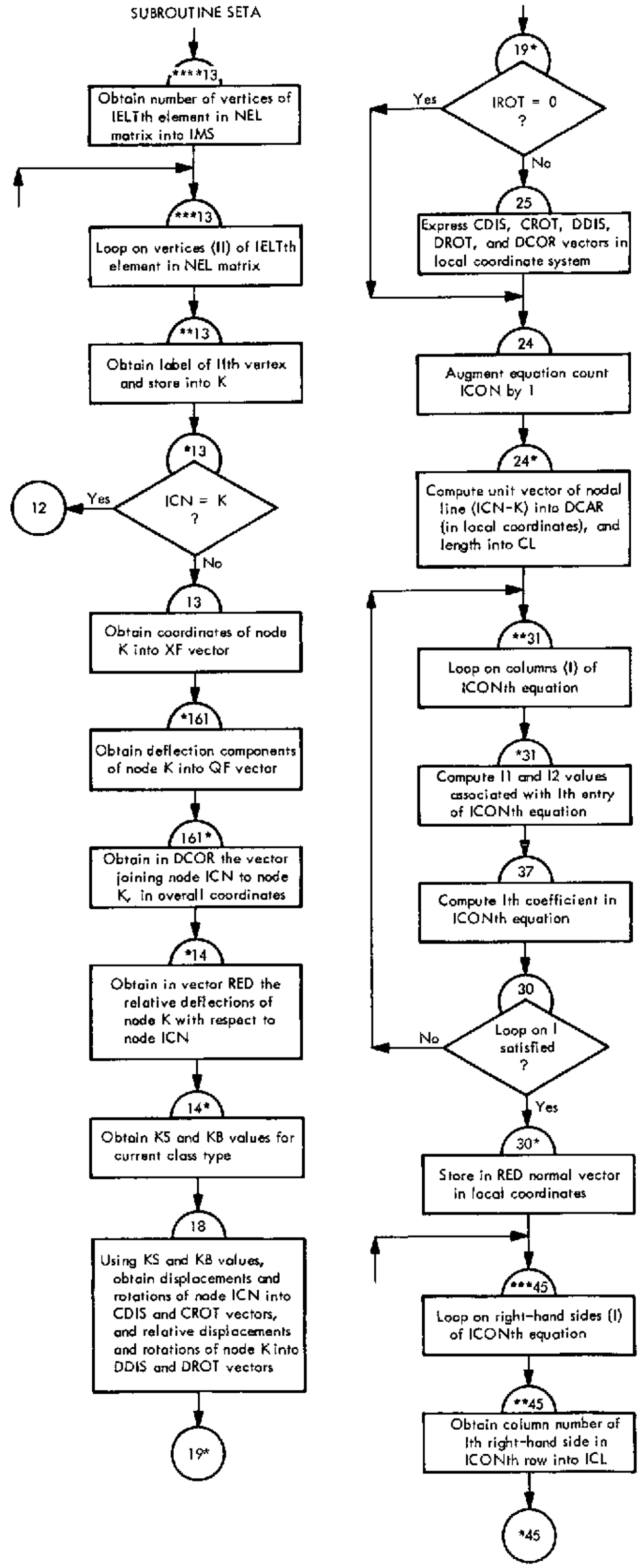


Fig. VI-68. Flowchart of subroutine SETA (Link 4)

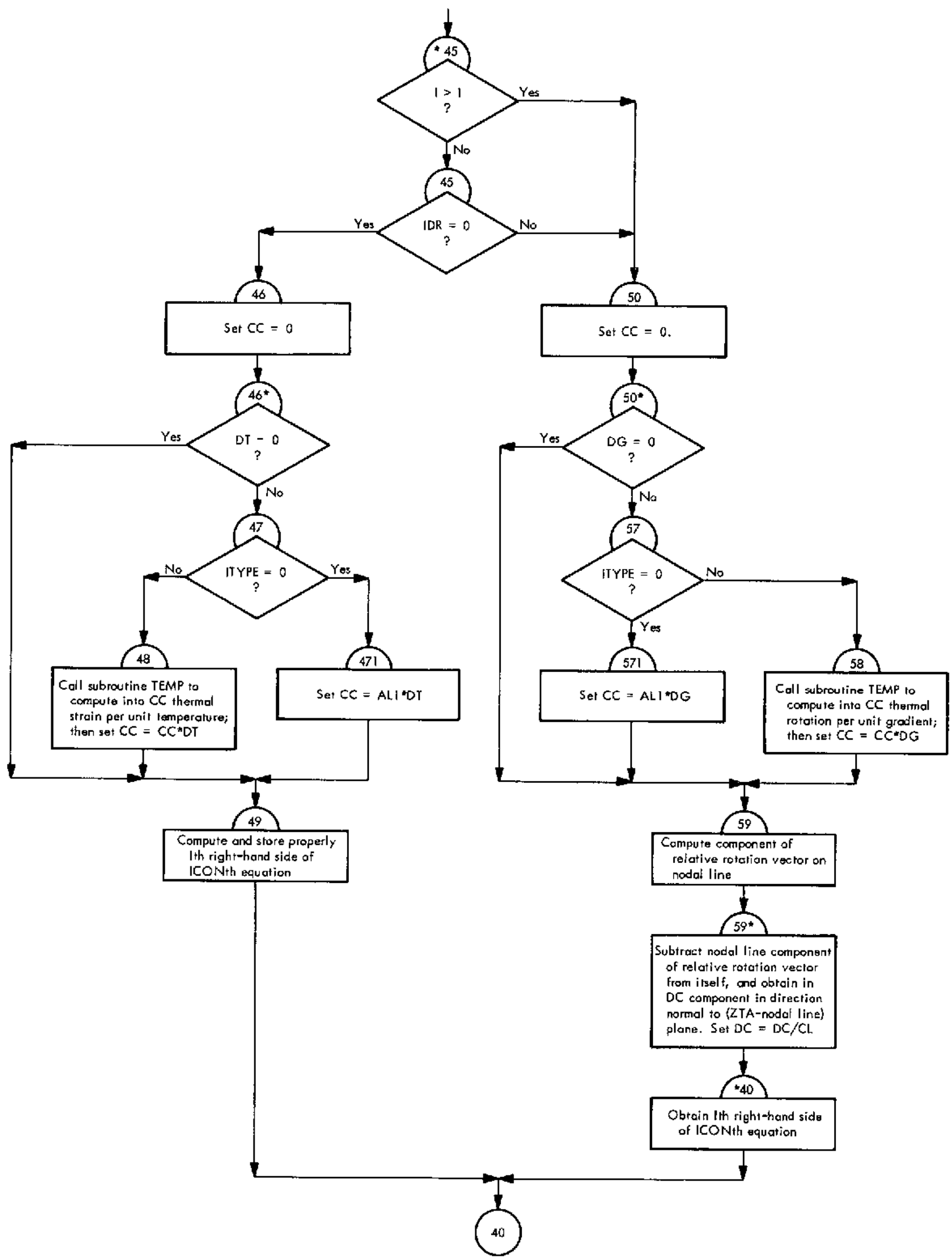


Fig. VI-68 (contd)

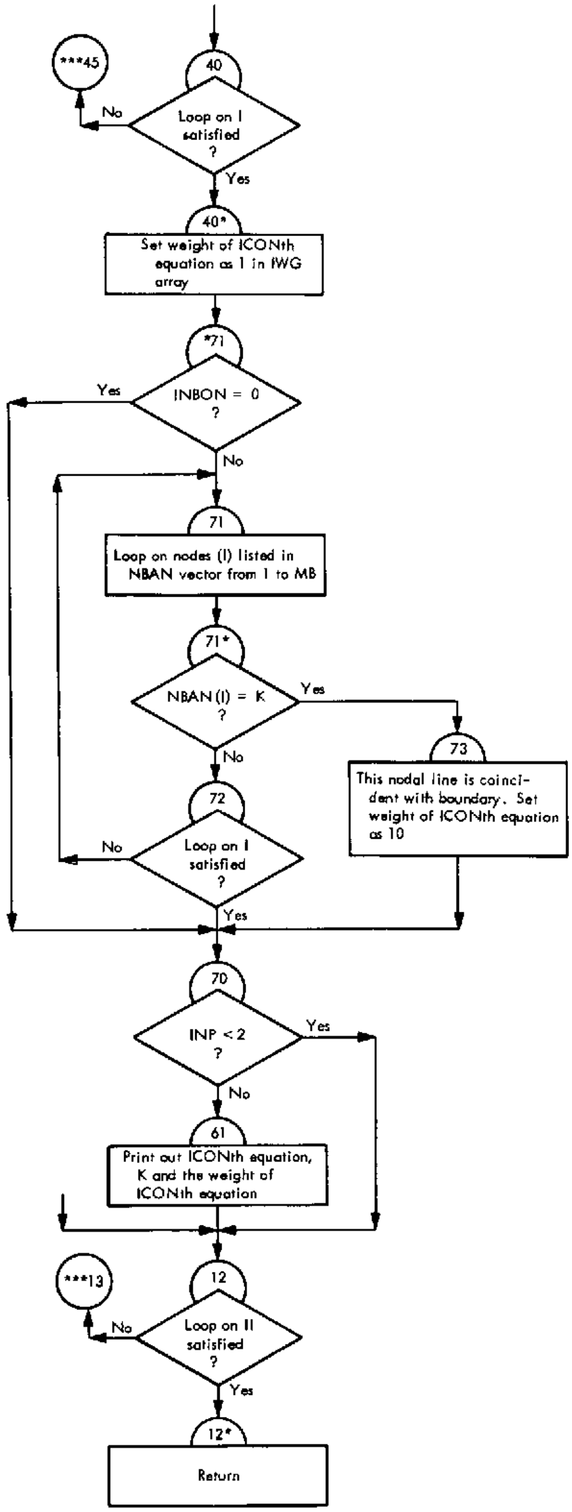


Fig. VI-68 (contd)

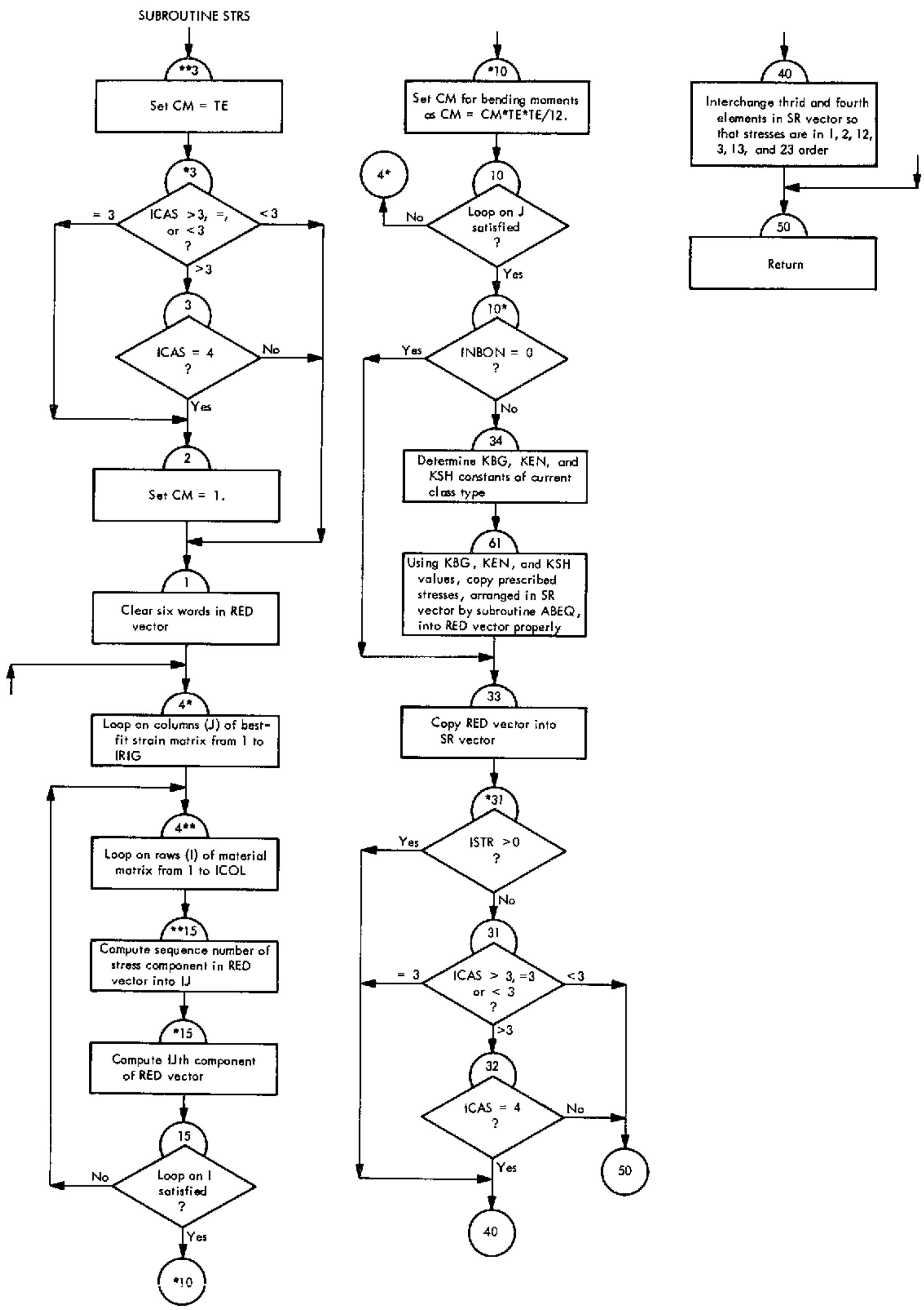


Fig. VI-69. Flowchart of subroutine STRS (Link 4)

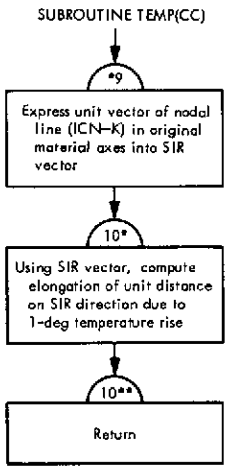


Fig. VI-70. Flowchart of subroutine TEMP (Link 4)

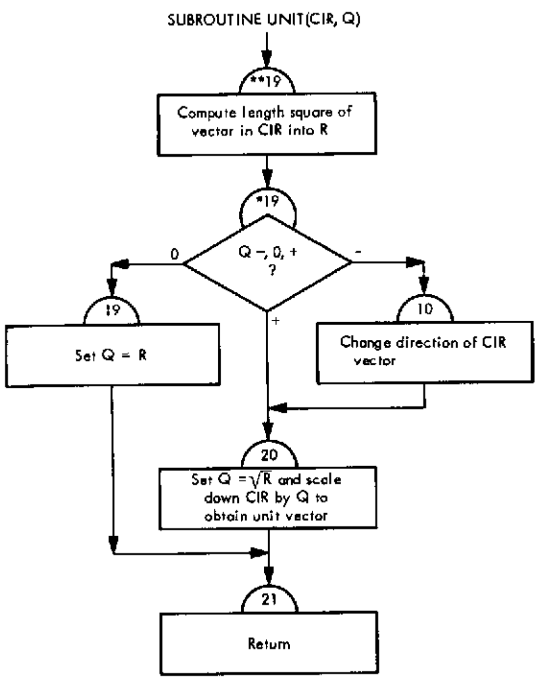


Fig. VI-71. Flowchart of subroutine UNIT (Link 4)

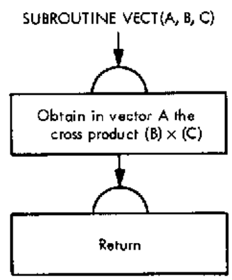


Fig. VI-72. Flowchart of subroutine VECT (Link 4)

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),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),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),IIAS),(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
        JOM=I+100*J
 5350   AA(JIDI)=DUMMY(JOM)
        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
        JOM=I+100*J
 5400   AA(JIDI)=DUMMY(JOM)
        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,E15.5)
 1800   FORMAT (5X,6E15.5,5X,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,E15.5,4X)))
 6218   IF (NTIC)  300,6217,2400
```

```
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 IOTI=IDT+I
     AA(IOTI)=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),I
    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
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Table VII-1 (contd)

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      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 MESG                                                            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,ITFM    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-CTES) 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),IB),(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),ICF1),(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),ISIR)                           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
```

```
1110 NEP=2                                                                F1ARN114
     NBO=NBO+1                                                            F1ARN115
     I=NBO                                                                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
```

```
      XSAP=0.
      XN=IN
      NCYCL=0
      NCYCN=IN/10+3
      ISURP=ISUR+1
      ICYCL=-1
      IF (ISHUF-1) 90,90,10
   10 READ INPUT TAPE 5,1,(ISIR(I),I=1,IN)
    1 FORMAT (20I4)
      DO 20 I=1,IN
   20 ISIRT(I)=I
      MI=1
      MX=IN
      DO 80 I=1,IN
      DO 23 IP=I,IN
      IF (ISIR(I)-ISIRT(IP)) 23,24,23
   23 CONTINUE
      GO TO 3100
   24 IF (I-IP) 25,80,25
   25 ISIRT(IP)=ISIRT(I)
      CALL EXCH
   80 CONTINUE
   90 DO 100 I=1,IN
      IMIN(I)=0
  100 IMAX(I)=0
      DO 700 I=1,IN
      DO 400 J=1,ISUR
      ACH=ABIN(I,J)
      DO 300 JB=1,36
      IF (LEBIN(ACH,JB)) 420,300,420
  300 CONTINUE
  400 CONTINUE
      GO TO 3100
  420 IMIN(I)=36*(J-1)+JB
      JC=ISURP-J
      DO 600 J=1,JC
      JBI=ISURP-J
      ACH=ABIN(I,JBI)
      DO 500 JB=1,36
      JBC=36-JB+1
      IF (LEBIN(ACH,JBC)) 620,500,620
  500 CONTINUE
  600 CONTINUE
      GO TO 3100
  620 IMAX(I)=36*JBI-JB+1
  700 CONTINUE
      IF (ISHUF-1) 2010,750,750
  750 CALL TICK (ITIM)
      CBT=ITIM
      IF (INP-1) 1100,1100,800
  800 CALL OUTPT
 1100 NBQ=0
      NEQ=IN
      NCH=0
      ICYCL=ICYCL+1
      XSA=IN-IMAX(1)
      IMAXP=IMAX(1)
      XMAXP=IMAXP
      DO 1105 I=2,IN
      IF (IMAX(I)-IMAXP)  1105,1105,1102
 1102 IMAXP=IMAX(I)
      XMAXP=IMAXP
 1105 XSA=XSA+XN-XMAXP
      IF (XSA-XSAP) 1106,1106,1107
 1106 NCYCL=NCYCL+1
      IF (NCYCL-NCYCN) 1108,1108,1985
 1107 XSAP=XSA
      NCYCL=0
 1108 CALL TICK (ITIM)
      CNT=ITIM
      CNT=(CNT-CBT)/60.
      IF (CNT-CLT) 1110,1109,1109
 1109 CLT=CLT+100.
      WRITE OUTPUT TAPE 6,3,CNT,ICYCL,XSA
      IF (CNT-100.) 1110,1110,1111
 1111 PUNCH 1,(ISIR(I),I=1,IN)
    3 FORMAT (3H AT,F7.2,19H SEC. OF RELABELING,I6,75H INTERCHANGES DONE
     1, UPPER OFF-BAND ELEMENT COUNT OF MESH TOPOLOGY MATRIX I5,F9.0)
      IJ=IP+J
      IF (IJ-IN) 1290,1290,1310
 1290 IF (IMIN(IJ)-MIM) 1300,1300,1320
 1300 CONTINUE
 1310 MNN=IN
      GO TO 1330
 1320 MNN=IMIN(IJ)-1
 1330 DO 1350 J=1,IN
      JI=I-J
      IF (JI-1) 1360,1340,1340
 1340 IF (IMAX(JI)-MXM) 1365,1350,1350
 1350 CONTINUE
 1360 MXB=1
      GO TO 1370
 1365 MXB=IMAX(JI)+1
 1370 IF (MNN-MIM) 1410,1375,1375
 1375 IF (MNN-I) 1390,1380,1380
 1380 MNN=I-1
      GO TO 1370
 1390 DO 1400 J=MIM,MNN
      JJ=(J-1)/36
      JJP=JJ+1
      ACH=ABIN(I,JJP)
      JBIT=J-36*JJ
      IF (LEBIN(ACH,JBIT)) 1395,1393,1395
 1393 NZG=NZG+1
 1395 ACH=ABIN(IP,JJP)
      JBIT=J-36*JJ
      IF (LEBIN(ACH,JBIT)) 1400,1397,1400
 1397 NZL=NZL+1
 1400 CONTINUE
 1410 IF (MXB-MXM) 1415,1415,1460
 1415 IF (MXB-IP) 1420,1420,1430
 1420 MXB=IP+1
      GO TO 1410
 1430 DO 1450 J=MXB,MXM
      JJ=(J-1)/36+1
      ACH=ABIN(I,JJ)
      BCH=ABIN(IP,JJ)
      JBIT=J-36*(JJ-1)
      IF (LEBIN(ACH,JBIT)) 1440,1435,1440
 1435 NZL=NZL+1
 1440 IF (LEBIN(BCH,JBIT)) 1450,1445,1450
 1445 NZG=NZG+1
 1450 CONTINUE
 1460 IF (NZG-NZL) 1910,1910,1480
 1480 ICYCL=ICYCL+1
      CALL EXCH
      NCH=ISIR(I)
      ISIR(I)=ISIR(IP)
      ISIR(IP)=NCH
      IF (IIP) 1720,1630,1720
 1630 IF (IMAX(IP)-IP) 1650,1640,1650
 1640 IMAX(IP)=IMAX(IP)-1
 1650 IF (IMAX(I)-I) 1670,1660,1670
 1660 IMAX(I)=IMAX(I)+1
 1670 IF (IMIN(I)-I) 1690,1680,1690
 1680 IMIN(I)=IMIN(I)+1
 1690 IF (IMIN(IP)-IP) 1720,1710,1720
 1710 IMIN(IP)=IMIN(IP)-1
 1720 NCH=IMAX(I)
      IMAX(I)=IMAX(IP)
      IMAX(IP)=NCH
      NCH=IMIN(I)
      IMIN(I)=IMIN(IP)
      IMIN(IP)=NCH
      DO 1900 J=MI,MX
      IF ((I-J)*(IP-J)) 1740,1900,1740
 1740 IF (J-I) 1810,1900,1750
 1750 IF (IMIN(J)-I) 1780,1760,1780
 1760 JJ=(J-1)/36+1
      ACH=ABIN(I,JJ)
      JBIT=J-36*(JJ-1)
      IF (LEBIN(ACH,JBIT)) 1900,1770,1900
 1770 IMIN(J)=IMIN(J)+1
      GO TO 1900
 1780 IF (IMIN(J)-IP) 1900,1790,1900
 1790 IMIN(J)=IMIN(J)-1
      GO TO 1900
 1810 IF (IMAX(J)-I) 1830,1820,1830
 1820 IMAX(J)=IMAX(J)+1
      GO TO 1900
 1830 IF (IMAX(J)-IP) 1900,1840,1900
 1840 JJ=(J-1)/36+1
      ACH=ABIN(IP,JJ)
      JBIT=J-36*(JJ-1)
      IF (LEBIN(ACH,JBIT)) 1900,1850,1900
 1850 IMAX(J)=IMAX(J)-1
 1900 CONTINUE
 1910 IF (NBQ-NEQ) 1960,1970,1970
 1960 GO TO (1110,1120),NEP
 1970 IF (NCH) 1100,1980,1100
 1980 CONTINUE
 1985 IF (INP-1) 2005,2005,1990
 1990 CALL OUTPT
 2005 CALL TICK(ITIM)
      CNT=ITIM
      CNT=(CNT-CBT)/60.
      WRITE OUTPUT TAPE 6,3,CNT,ICYCL,XSA
 2010 NEQ=IN-1
      DO 2100 I=1,NEQ
      IP=I+1
      IF (IMAX(IP )-IMAX(I)) 2030,2100,2100
 2030 IMAX(IP )=IMAX(I)
 2100 CONTINUE
      IF (ISHUF-1) 3000,2300,2300
 2300 PUNCH 1,(ISIR(I),IMAX(I),I=1,IN)
 3000 RETURN
 3100 WRITE OUTPUT TAPE 6,4,I
    4 FORMAT (10H THE POINT,I5,33H DOES NOT APPEAR IN MESH TOPOLOGY)
      GO TO 3000
      END
```

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

```
*     LABEL
CE1BUNG
      SUBROUTINE BUNG
C     DUMMY SUBROUTINE FOR BOUNDARY CONDITION GENERATOR
      RETURN
      END
```

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(1),REM)                 E1COR008
      EQUIVALENCE (IA(1),IN),(IA(2),IHN),(IA(3),IT),(IA(4),IP),(IA(5), E1COR009
     1IPRS),(IA(6),ITYPE),(IA(7),IMAF),(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),IIIC),(IA(31),IMET),   E1COR013
     5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),    E1COR014
     6IORD),(IA(38),IORD1),(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),IBO),(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),DG), E1COR022
     4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(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),ISDI),(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),IPRI,(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 CONSEQUETIVE 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                                                                  F1MESG00
       SUBROUTINE MESG                                                   F1MESG01
C      DUMMY SUBROUTINE FOR MESH GENERATOR                               F1MESG02
       RETURN                                                            F1MESG03
       END                                                               F1MESG04
```

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

```
*      LABEL
CE1MES                                                                  F1MES000
       SUBROUTINE MEST                                                  F1MES001
C      READS AND STORES MESH TOPOLOGY DATA                              F1MES002
       DIMENSION IA(1),AA(1),REM(13),NT(10),DUMMY(5000),IDUM(5000),N(8) F1MES003
      1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),RUMMY(27,9)       F1MES004
      2,D21(21),S(1),G1(1)                                              F1MES005
       COMMON IA,AA                                                     F1MES006
       EQUIVALENCE (IA,AA),(AA( 9000),DUMMY)                            F1MES007
       EQUIVALENCE (DUMMY,IDUM,NT,RUMMY),(DUMMY(11),REM)                F1MES008
       EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5), F1MES009
      1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),F1MES010
      2IH),(IA(11),IB),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),F1MES011
      3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),F1MES012
      4ISTR),(IA(28),IELT),(IA(29),ITFM),(IA(30),ITIC),(IA(31),IMST),   F1MES013
      5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),    F1MES014
      6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),     F1MES015
      7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57F1MES016
      8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBO),(IA(61),IID),(IA(62),F1MES017
      9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITE),(IA(41),ITAP)        F1MES018
       EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),   F1MES019
      1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),      F1MES020
      2(IA(74),IIC),(IA(75),IDCF),(IA(76),IST),(IA(77),IIS)             F1MES021
      3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),OT),(AA(82),DG), F1MES022
      4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P), F1MES023
      5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),   F1MES024
      6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)              F1MES025
      7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IUF1MES026
      8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                            F1MES027
       EQUIVALENCE (IA(349),NTIC),(IA(348),ISOT),(IA(347),ISDY),(IA(346) F1MES028
      1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)  F1MES029
      2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)     F1MES030
      3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)      E1MES031
      4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)        F1MES032
      5,(IA(329),IPIR)                                                  F1MES033
       IERR=0                                                           F1MES034
       M=0                                                              F1MES035
       MT=0                                                             F1MES036
       L=0                                                              F1MES037
       NBE=-19                                                          F1MES038
       NFI=0                                                            F1MES039
 7910  L=L+1                                                            F1MES040
 7911  IF (L-NFI)7912,7912,7913                                         F1MES041
 7913  NBE=NBE+20                                                       E1MES042
       NFI=NFI+20                                                       F1MES043
       READ INPUT TAPE 5,791,(IDUM(I),I=NBE,NFI)                        F1MES044
  791  FORMAT (20I4)                                                    F1MES045
 7912  IF (IDUM(L)) 7921,7910,7924                                      E1MES046
 7921  IF (L-NFI) 7914,7913,7913                                        F1MES047
 7924  IF (IERR) 300,300,7925                                           F1MES048
 7925  L=L-1                                                            E1MES049
       MT=-1                                                            F1MES050
       IERR=0                                                           F1MES051
 7914  M=M+1                                                            F1MES052
       MT=MT+L                                                          F1MES053
       IF (MT-999) 7916,7915,300                                        F1MES054
 7915  IERR=1                                                           F1MES055
 7916  IF (MT+IDUM(L)) 300,7917,300                                     F1MES056
 7917  IELT=IDUM(L+1)/100                                               F1MES057
       IF (IELT*(IELT-19)) 7918,300,300                                 F1MES058
 7918  GO TO (81,82,81,83,84,85,84,85,86,87,84,85,84,85,84,85,81,81),IELTF1MES059
   81  JK=5                                                             F1MES060
       JN=2                                                             F1MES061
       GO TO 89                                                         F1MES062
   82  JK=6                                                             F1MES063
       JN=2                                                             F1MES064
       GO TO 89                                                         F1MES065
   83  JK=8                                                             F1MES066
       JN=2                                                             F1MES067
       GO TO 89                                                         F1MES068
   84  JK=6                                                             F1MES069
       JN=3                                                             F1MES070
       GO TO 89                                                         F1MES071
   85  JK=7                                                             F1MES072
       JN=4                                                             F1MES073
       GO TO 89                                                         F1MES074
   86  JK=6                                                             E1MES075
       JN=4                                                             F1MES076
       GO TO 89                                                         F1MES077
   87  JK=10                                                            F1MES078
       JN=8                                                             F1MES079
   89  LC=L                                                             F1MES080
       LJK=LC+JK                                                        F1MES081
       LJKP=LJK+1                                                       F1MES082
       IF (LJK-NFI) 7919,7919,7923                                      F1MES083
 7923  NBE=NBE+20                                                       F1MES084
       NFI=NFI+20                                                       F1MES085
       READ INPUT TAPE 5,791,(IDUM(I),I=NBE,NFI)                        F1MES086
 7919  GO TO (70,69,68,67,66,65,64,63,62,61),JK                         F1MES087
 61    JM=J10+M                                                         F1MES088
       GO TO 72                                                         F1MES089
   62  JM=J9+M                                                          F1MES090
       GO TO 72                                                         F1MES091
 63    JM=J8+M                                                          F1MES092
       GO TO 72                                                         F1MES093
 64    JM=J7+M                                                          E1MES094
       GO TO 72                                                         F1MES095
 65    JM=J6+M                                                          F1MES096
       GO TO 72                                                         F1MES097
 66    JM=J5+M                                                          F1MES098
       GO TO 72                                                         F1MES099
 67    JM=J4+M                                                          F1MES100
       GO TO 72                                                         F1MES101
 68    JM=J3+M                                                          F1MES102
       GO TO 72                                                         F1MES103
 69    JM=J2+M                                                          F1MES104
       GO TO 72                                                         F1MES105
 70    JM=J1+M                                                          F1MES106
 72    L=L+1                                                            F1MES107
       LJK=LC+JK                                                        F1MES108
       IA(JM)=IDUM(LJK)                                                 F1MES109
       JK=JK-1                                                          F1MES110
       IF (JK) 78,78,7919                                               F1MES111
   78  DO 7800 J=1,JN                                                   F1MES112
       JL=LJKP-J                                                        F1MES113
       IF (IDUM(JL)) 300,300,7800                                       F1MES114
 7800  CONTINUE                                                         F1MES115
       IF (M-IT) 7930,799,300                                           F1MES116
 7930  IF (NFI-20) 7910,7910,7932                                       F1MES117
 7932  NIE=NFI-20                                                       F1MES118
       DO 7940 I=1,20                                                   F1MES119
       I1=I+NIE                                                         F1MES120
 7940  IDUM(I)=IDUM(I1)                                                 F1MES121
       L=L-NIE                                                          F1MES122
       NBE=1                                                            F1MES123
       NFI=20                                                           F1MES124
       GO TO 7910                                                       F1MES125
 799   IERR=0                                                           F1MES126
   79  RETURN                                                           F1MES127
  300  IERR=1                                                           F1MES128
       GO TO 79                                                         F1MES129
       END                                                              F1MES130
```

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

```
*      LABEL
CE1OPT                                                                  F1OPT000
       SUBROUTINE OUTPT                                                 F1OPT001
C      WRITES INFORMATION RELATED WITH RELABELLING                      F1OPT002
       DIMENSION IA(1),AA(1),REM(13),NT(10),DUMMY(5000),IDUM(5000),N(8) F1OPT003
      1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),RUMMY(27,9)       F1OPT004
      2,D21(21),S(1),G1(1)                                              F1OPT005
       COMMON IA,AA                                                     F1OPT006
       EQUIVALENCE (IA,AA),(AA( 9000),DUMMY)                            F1OPT007
       EQUIVALENCE (DUMMY,IDUM,NT,RUMMY),(DUMMY(11),REM)                F1OPT008
       EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5), F1OPT009
      1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),F1OPT010
      2IH),(IA(11),IB),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),F1OPT011
      3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),F1OPT012
      4ISTR),(IA(28),IELT),(IA(29),ITFM),(IA(30),ITIC),(IA(31),IMST),   F1OPT013
      5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),    F1OPT014
      6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),     E1OPT015
      7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57F1OPT016
      8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBO),(IA(61),IID),(IA(62),F1OPT017
      9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITE),(IA(41),ITAP)        F1OPT018
       EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),   F1OPT019
      1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),      F1OPT020
      2(IA(74),IIC),(IA(75),IDCF),(IA(76),IST),(IA(77),IIS)             E1OPT021
      3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),OT),(AA(82),DG), F1OPT022
      4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P), F1OPT023
      5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),   F1OPT024
      6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)              F1OPT025
      7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IUF1OPT026
      8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                            F1OPT027
       EQUIVALENCE (IA(349),NTIC),(IA(348),ISOT),(IA(347),ISDY),(IA(346) F1OPT028
      1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)  F1OPT029
      2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)     F1OPT030
      3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)      E1OPT031
      4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)        F1OPT032
       EQUIVALENCE (IA(35),ISHUF),(IA(301),ISUR)                        F1OPT033
       EQUIVALENCE (ABIN,IBBC),(ABIN,IBAND)                             F1OPT034
       DIMENSION IBBC(8000),IBAND(8000),ISIR(540),IMAX(540),IMIN(540),  E1OPT035
      1ABIN(540,15)                                                     F1OPT036
       EQUIVALENCE (DUMMY,ABIN),(DUMMY(8100),ISIR),(DUMMY(8640),IMAX),  F1OPT037
      1(DUMMY(9180),IMIN)                                               F1OPT038
       WRITE OUTPUT TAPE 6,16                                           F1OPT039
   16  FORMAT (1H1,5H  NO.,6H   ISIR,6H   IMIN,6H   IMAX,40X,21HLABEL MATRIXF1OPT040
      1 IN OCTAL//)                                                     F1OPT041
       WRITE OUTPUT TAPE 6,17,(I,ISIR(I),IMIN(I),IMAX(I),(ABIN(I,J),J=1,7F1OPT042
      1),I=1,IN)                                                        F1OPT043
   17  FORMAT (4I6,5X,7O13)                                             F1OPT044
       IF (ISUR-7) 120,120,110                                          F1OPT045
  110  WRITE OUTPUT TAPE 6,18,(I,ISIR(I),(ABIN(I,J),J=8,15),I=1,IN)     F1OPT046
   18  FORMAT (1H0/(2I6,4X,8O13))                                       F1OPT047
  120  RETURN                                                           F1OPT048
       END                                                              F1OPT049
```

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
     3IMET),(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),IS),(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),ITC),(IA(62),E1SRT017
     9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),IIF),(IA(A),IAP)           E1SRT018
      EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),    E1SRT019
     1ICIZ),(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),JMET),(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(301),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 DBC 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
      IBOL=KN+J                                                         E1SR61A8
      IF (IA(IBOL)-10000) 301,302,302                                   E1SR61A9
 302  KM=10000+IBOL-IBO                                                 E1SR61B0
      IBOL=IBO                                                          E1SR61B1
      DO 303 K=1,IND                                                    E1SR61B2
      IBOL=IBOL+1                                                       E1SR61B3
      IF (IA(IBOL)+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 E1SRT62.          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
      IBOL=LIBO+J                                                       E1SRT067
      IF (IA(IBOL)) 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
      LIBO=(JB-1)*IDEG+IBO                                              E1SRT076
      DO 981 L=1,IDEG                                                   E1SRT077
      IBOL=LIBO+L                                                       E1SRT078
      IF (IA(IBOL)) 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
      LIBO=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
      IBOJ=IBO+IDEG*(ISIR(J)-1)                                         E1SRT102
      DO 2000 K=1,IDEG                                                  E1SRT103
      IBOK=IBOJ+K                                                       E1SRT104
      IF (IA(IBOK)) 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+IBO                                         E1SRT111
      DO 2200 J=1,IDEG                                                  E1SRT112
      IBOL=LIBO+J                                                       E1SRT113
      IF (IA(IBOL))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////1XE1SRT122
     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
      FILEN=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./6X,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),G1(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
     3IMEI),(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),INS),(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
     9ITA),(IA(63),IOT),(IA(64),IOY),(IA(65),ITE),(IA(41),ITAP)         E1TBL018
      EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),    E1TBL019
     1ICIZ),(IA(70),ICEI),(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),TE),(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(35)),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),JMEI),(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,58H0 FOR ISOTROPIC, 1 FOR ORTHOTROPIC, 2 FOR GE1TBL045
     3ENERAL MATERIAL/11H IGEM VALUE,29X,I5,10X,40H0 FOR 2-, 1 FOR 3-DIME1TBL046
     4ENSIONAL STRUCTURES/11H ISTR VALUE,29X,I5,10X,36H1 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,IMEI   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,50H0 MINIMUM PRINT, 1 PARTIAL PRINT, 2 COE1TBL061
     7MPLETE PRINT/12H ISHUF VALUE,28X,I5,10X,63H0 NO RELABELLING, 1 RELE1TBL062
     8ABEL, 2 OR 3 READ CARDS FOR RELABELLING /11H ICOR VALUE,29X,I5,10XE1TBL063
     9,52H0 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,60H0 READ CARDS, 1 CALL SUBROUTE1TBL066
     1NE BUNG FOR BOUNDARY CONDITIONS/11H IMES VALUE,29X,I5,10X,54H0 REAE1TBL067
     2D CARDS, 1 CALL SUBROUTINE MESG FOR MESH TOPOLOGY/38H IPIR VALUE FE1TBL068
     3OR SHELL LOCAL NODAL AXES,I7,10X,54H0 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,50H0 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                                                                  E1TOPO00
      SUBROUTINE TOPO                                                   E1TOPO01
C     PREPARES ELEMENT PROPERTIES AND CHECKS                            E1TOPO02
      DIMENSION IA(1),AA(1),REM(13),NT(10),DUMMY(5000),IDUM(5000),N(8)  E1TOPO03
     1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),RUMMY(27,9)        E1TOPO04
     2,D21(21),S(1),G1(1)                                               E1TOPO05
      COMMON IA,AA                                                      E1TOPO06
      EQUIVALENCE (IA,AA),(AA( 9000),DUMMY)                             E1TOPO07
      EQUIVALENCE (DUMMY,IDUM,NT,RUMMY),(DUMMY(11),REM)                 E1TOPO08
      EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),  E1TOPO09
     1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),E1TOPO10
     2IH),(IA(11),IB),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),E1TOPO11
     3IMEI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),E1TOPO12
     4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),    E1TOPO13
     5(IA(32),ISUM),(IA(33),IND),(IA(34),INS),(IA(36),IDS),(IA(37),     E1TOPO14
     6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),      E1TOPO15
     7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57E1TOPO16
     8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBO),(IA(61),IID),(IA(62),E1TOPO17
     9ITA),(IA(63),IOT),(IA(64),IOY),(IA(65),ITE),(IA(41),ITAP)         E1TOPO18
      EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),    E1TOPO19
     1ICIZ),(IA(70),ICEI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),       E1TOPO20
     2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)              E1TOPO21
     3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG), E1TOPO22
     4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),  E1TOPO23
     5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),    E1TOPO24
     6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)               E1TOPO25
     7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IUE1TOPO26
     8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                             E1TOPO27
      EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346) E1TOPO28
     1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)   E1TOPO29
     2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)      E1TOPO30
     3,(IA(337),JMMZ),(IA(336),JMEI),(IA(335),ITAS),(IA(334),IDZ)       E1TOPO31
     4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)         E1TOPO32
      IELT=0                                                            E1TOPO33
      ITEM=0                                                            E1TOPO34
      ITIC=0                                                            E1TOPO35
      IMET=0                                                            E1TOPO36
      DO 10 I=1,8                                                       E1TOPO37
      N(I)=0                                                            E1TOPO38
      K=I+335                                                           E1TOPO39
   10 IA(K)=0                                                           E1TOPO40
      JM=J1+M                                                           E1TOPO41
      IELT=IA(JM)/100                                                   E1TOPO42
      IMET=IA(JM)-100*IELT                                              E1TOPO43
      JM=J2+M                                                           E1TOPO44
      IF (IELT-4) 100,100,450                                           E1TOPO45
  100 IF (IELT-3) 200,300,200                                           E1TOPO46
  200 JARE=IA(JM)/100                                                   E1TOPO47
      ITEM=IA(JM)-100*JARE                                              E1TOPO48
      GO TO 400                                                         E1TOPO49
  300 JPRS=IA(JM)/100                                                   E1TOPO50
      JSDZ=IA(JM)-100*JPRS                                              E1TOPO51
  400 IF (IELT-3) 600,800,800                                           E1TOPO52
  450 IF (IELT-10) 470,470,500                                          E1TOPO53
  470 IF (IELT-8) 500,500,480                                           E1TOPO54
  480 JPRS=IA(JM)/100                                                   E1TOPO55
      ITEM=IA(JM)-100*JPRS                                              E1TOPO56
      L=1                                                               E1TOPO57
      GO TO 1000                                                        E1TOPO58
  500 ITIC=IA(JM)/100                                                   E1TOPO59
      ITEM=IA(JM)-100*ITIC                                              E1TOPO60
      JM=J3+M                                                           E1TOPO61
      JSDZ=IA(JM)/100                                                   E1TOPO62
      JPRS=IA(JM)-100*JSDZ                                              E1TOPO63
      L=2                                                               E1TOPO64
      GO TO 1000                                                        E1TOPO65
  600 JM=J3+M                                                           E1TOPO66
      JPRS=IA(JM)                                                       E1TOPO67
      L=2                                                               E1TOPO68
      IF (IELT-2) 1000,700,700                                          E1TOPO69
  700 JM=J4+M                                                           E1TOPO70
      JMMZ=IA(JM)/100                                                   E1TOPO71
      JSDY=IA(JM)-100*JMMZ                                              E1TOPO72
      L=3                                                               E1TOPO73
      IF (IELT-4) 1000,900,1000                                         E1TOPO74
  800 JM=J3+M                                                           E1TOPO75
      JMMX=IA(JM)/100                                                   E1TOPO76
      JMMY=IA(JM)-100*JMMX                                              E1TOPO77
      L=2                                                               E1TOPO78
      IF (IELT-4) 1000,700,1000                                         E1TOPO79
  900 JM=J5+M                                                           E1TOPO80
      JSDZ=IA(JM)/100                                                   E1TOPO81
      JMEI=IA(JM)-100*JSDZ                                              E1TOPO82
      JM=J6+M                                                           E1TOPO83
      JPRS=IA(JM)                                                       E1TOPO84
      L=4                                                               E1TOPO85
 1000 I=1                                                               E1TOPO86
      GO TO (1100,1200,1300,1400),L                                     E1TOPO87
 1100 JM=J3+M                                                           E1TOPO88
      N(I)=IA(JM)                                                       E1TOPO89
      I=I+1                                                             E1TOPO90
 1200 JM=J4+M                                                           E1TOPO91
      N(I)=IA(JM)                                                       E1TOPO92
      I=I+1                                                             E1TOPO93
 1300 JM=J5+M                                                           E1TOPO94
      N(I)=IA(JM)                                                       E1TOPO95
      I=I+1                                                             E1TOPO96
      JM=J6+M                                                           E1TOPO97
      N(I)=IA(JM)                                                       E1TOPO98
      I=I+1                                                             E1TOPO99
 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),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),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
```

```
 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                                                               FLS2206A
     CX=0.                                                                  FLS2206B
     CY=0.                                                                  FLS2206C
     CZ=0.                                                                  FLS2206D
     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)                                                             FLS2217A
     CY=CY+Y(I)                                                             FLS2217B
     CZ=CZ+Z(I)                                                             FLS2217C
     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                                                             FLS2222B
     CZ=CZ/CIMS                                                             FLS2222C
     DO 5501 I=1,IMS                                                        FLS2222D
     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.                                                               FLS2224A
     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                                                       FLAS2230
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)                                                        FLAS2237
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,JPPS,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                                                      FLAS2242
951  IF (DT) 952,954,952                                                    FLAS2243
954  IF (DG) 952,9551,952                                                   FLAS2244
9551 IF (DGZ) 952,953,952                                                   FLAS2245
952  CALL DMM (S,UV,IDS,P)                                                  FLAS2246
953  IF (IPBG) 957,957,958                                                  FLAS2247
958  IF (IPBG-IPEN) 959,959,957                                             FLAS2248
959  DO 955 I=IPBG,IPEN                                                     FLAS2249
     DELP=CONS*GL(I)                                                        FLAS2250
     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                                                  FLAS2255
955  CONTINUE                                                               FLAS2256
957  IF (INP-1) 9532,9532,9531                                              FLAS2257
9531 WRITE OUTPUT TAPE 6,9533,(I,P(I),I=1,IDS)                              FLAS2258
9533 FORMAT (//(5(I6,E13.4,5X)))                                            FLAS2259
9532 DO 95 I=1,IDEG                                                         FLAS2260
     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,IOE)                                            FLAS2265
     IF (IOE) 307,307,308                                                   FLAS2266
307  IERR=6                                                                 FLAS2267
     GO TO 1                                                                FLAS2268
308  DO 393 IO=1,IOE                                                        FLAS2269
     ISS=ISE                                                                FLAS2270
     CCURI=CCCI(IO)*CFE                                                     FLAS2271
     IB=IBS(IO)                                                             FLAS2272
     IF (CCURI) 912,911,912                                                 FLAS2273
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                                                            FLAS2278
     JE=IMS*(J-1)+L                                                         FLAS2279
     JS=IDEG*(N(L)-1)+J                                                     FLAS2280
     CALL DARN (JS,JBS,CCCJ,JOE)                                            FLAS2281
     IF (JOE) 307,307,408                                                   FLAS2282
408  DO 392 JO=1,JOE                                                        FLAS2283
     CCURJ=CCCJ(JO)                                                         FLAS2284
     JB=JBS(JO)                                                             FLAS2285
     F=CCURI*CCURJ                                                          FLAS2286
     IF (F) 913,392,913                                                     FLAS2287
913  IF (JB-IND) 914,914,915                                                FLAS2288
915  AA(IDEFI)=AA(IDEFI)-F*S(ISS)                                           FLAS2289
     GO TO 392                                                              FLAS2290
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)                                             FLAS2294
392  CONTINUE                                                               FLAS2295
92   CONTINUE                                                               FLAS2296
93   CONTINUE                                                               FLAS2297
393  CONTINUE                                                               FLAS2298
94   CONTINUE                                                               FLAS2299
95   CONTINUE                                                               FLAS2300
     IF (ITAS) 9981,9981,9982                                               FLAS2301
9982 DO 9983 I=1,IDS                                                        FLAS2302
     PV(I)=P(I)                                                             FLAS2303
9983 P(I)=0.                                                                FLAS2304
     CALL DMM(S,UV,IDS,P)                                                   FLAS2305
     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                                          FLAS2309
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+IDRD                                                          FLAS2315
     IST1=IST+1                                                             FLAS2316
     WRITE OUTPUT TAPE 6,871,(I,AA(I),I=IST1,IEND)                          FLAS2317
871  FORMAT (1H1,62HUPPER HALF OF THE STIFFNESS MATRIX AFTER B.C. IMPOSFLAS2318
    1ED FOLLOWS./89H ROW LISTING. FOR BANDWIDTHS SEE THE TABLE FOR MESHFLAS2319
    2 TOPOLOGY OF REDUCED STIFFNESS MATRIX.///(5(I6,E14.5,4X)))             FLAS2320
     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)))FLAS2324
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.                                                            FLAS2331
     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
CE2BFA
        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),ACFL ),(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),OT),(AA(82),OG),
       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),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),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),ACFL ),(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),IOFF),(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 (EL) 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                                                                  E2CRT000
      SUBROUTINE CORT                                                   E2CRT001
C     OBTAINS COORDINATES OF TRIANGULAR SHELL ELEMENT IN LOCAL COORDNTS.E2CRT002
      DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)         E2CRT003
     1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)              E2CRT004
      COMMON IA,AA                                                      E2CRT005
      EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),E),(D21(20),G)E2CRT006
      EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),  E2CRT007
     1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),E2CRT008
     2IH),(IA(11),IR),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),E2CRT009
     3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),E2CRT010
     4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),    E2CRT011
     5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),     E2CRT012
     6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),      E2CRT013
     7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57E2CRT014
     8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBD),(IA(61),IID),(IA(62),E2CRT015
     9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITF),(IA(41),ITAP)         E2CRT016
      EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),    E2CRT017
     1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),       E2CRT018
     2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)              E2CRT019
     3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG), E2CRT020
     4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),  E2CRT021
     5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),    E2CRT022
     6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)               E2CRT023
     7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IOE2CRT024
     8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                             E2CRT025
      EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346) E2CRT026
     1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)   E2CRT027
     2,(IA(341),JSDZ),(IA(340),JARF),(IA(339),JMMX),(IA(338),JMMY)      E2CRT028
     3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)       E2CRT029
     4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)         E2CRT030
     5,(IA(329),IP(R)                                                   E2CRT031
      DIMENSION    DUMX(3),DUNX(3)                                      E2CRT032
      EQUIVALENCE  (AA(200),DUMX),(AA(203),DUNX)                        E2CRT033
      DIMENSION EM(4,4),EN(4,4),Q(4,4),DIR(3,3),DUM(18)                 E2CRT034
      EQUIVALENCE (AA(200),EM),(AA(216),EN),(AA(232),EQ),(AA(248),Q),   E2CRT035
     1(AA(264),DIR),(AA(273),DUM)                                       E2CRT036
      EL=SQRTF (XD(1)*XD(1)+YD(1)*YD(1)+ZD(1)*ZD(1))                    E2CRT037
      DIR(1,1)=XD(1)/EL                                                 E2CRT038
      DIR(1,2)=YD(1)/EL                                                 E2CRT039
      DIR(1,3)=ZD(1)/EL                                                 E2CRT040
      DIR(3,1)=DIR(1,2)*ZD(2)-DIR(1,3)*YD(2)                            E2CRT041
      DIR(3,2)=DIR(1,3)*XD(2)-DIR(1,1)*ZD(2)                            E2CRT042
      DIR(3,3)=DIR(1,1)*YD(2)-DIR(1,2)*XD(2)                            E2CRT043
      EL=SQRTF(DIR(3,1)*DIR(3,1)+DIR(3,2)*DIR(3,2)+DIR(3,3)*DIR(3,3))   E2CRT044
      DIR(3,1)=DIR(3,1)/EL                                              E2CRT045
      DIR(3,2)=DIR(3,2)/EL                                              E2CRT046
      DIR(3,3)=DIR(3,3)/EL                                              E2CRT047
      DIR(2,1)=DIR(3,2)*DIR(1,3)-DIR(3,3)*DIR(1,2)                      E2CRT048
      DIR(2,2)=DIR(3,3)*DIR(1,1)-DIR(3,1)*DIR(1,3)                      E2CRT049
      DIR(2,3)=DIR(3,1)*DIR(1,2)-DIR(3,2)*DIR(1,1)                      E2CRT050
      DO 1 I=1,3                                                        E2CRT051
      DUMX(1)=X(I)                                                      E2CRT052
      DUMX(2)=Y(I)                                                      E2CRT053
      DUMX(3)=Z(I)                                                      E2CRT054
      DO 2 J=1,3                                                        E2CRT055
      DUNX(J)=0.                                                        E2CRT056
      DO 3 K=1,3                                                        E2CRT057
    3 DUNX(J)=DUNX(J)+DIR(J,K)*DUMX(K)                                  E2CRT058
    2 CONTINUE                                                          E2CRT059
      X(I)=DUNX(1)                                                      E2CRT060
      Y(I)=DUNX(2)                                                      E2CRT061
    1 Z(I)=DUNX(3)                                                      E2CRT062
      DO 6 I=2,3                                                        E2CRT063
      XD(I-1)=X(I)-X(1)                                                 E2CRT064
      YD(I-1)=Y(I)-Y(1)                                                 E2CRT065
    6 ZD(I-1)=Z(I)-Z(1)                                                 E2CRT066
      RETURN                                                            E2CRT067
      END                                                               E2CRT068
```

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

```
*      LABEL
CE2CUT                                                                  E2CUT000
      SUBROUTINE CUTE (ITTM)                                            E2CUT001
C     CUTS QUADRILATERALS AND HEXAHEDRONS INTO TRIANGLES AND TETRAHEDRNSE2CUT002
      DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)         E2CUT003
     1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)              E2CUT004
      COMMON IA,AA                                                      E2CUT005
      EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),E),(D21(20),G)E2CUT006
      EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),  E2CUT007
     1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),E2CUT008
     2IH),(IA(11),IR),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),E2CUT009
     3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),E2CUT010
     4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),    E2CUT011
     5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),     E2CUT012
     6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),      E2CUT013
     7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57E2CUT014
     8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBD),(IA(61),IID),(IA(62),E2CUT015
     9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITF),(IA(41),ITAP)         E2CUT016
      EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),    E2CUT017
     1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),       E2CUT018
     2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)              E2CUT019
     3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG), E2CUT020
     4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),  E2CUT021
     5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),    E2CUT022
     6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)               E2CUT023
     7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IOE2CUT024
     8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                             E2CUT025
      EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346) E2CUT026
     1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)   E2CUT027
     2,(IA(341),JSDZ),(IA(340),JARF),(IA(339),JMMX),(IA(338),JMMY)      E2CUT028
     3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)       E2CUT029
     4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)         E2CUT030
     5,(IA(329),IP(R),(IA(328),NAV)                                     E2CUT031
      DIMENSION NOD(20)                                                 E2CUT032
      EQUIVALENCE (AA(300),NOD),(IA(326),IMST)                          E2CUT033
      NAV=NAV+1                                                         E2CUT034
      KBAS=0                                                            E2CUT035
      KNOD=0                                                            E2CUT036
      IF (IELT-10) 110,120,110                                          E2CUT037
  110 ITTM=2                                                            E2CUT038
      IMS=3                                                             E2CUT039
      JEN=6                                                             E2CUT040
      IEN=1                                                             E2CUT041
      GO TO (130,130,115),NAV                                           E2CUT042
  115 KBAS=1                                                            E2CUT043
      GO TO 130                                                         E2CUT044
  120 ITTM=5                                                            E2CUT045
      IMS=4                                                             E2CUT046
      JEN=20                                                            E2CUT047
      IEN=2                                                             E2CUT048
      GO TO (130,130,125),NAV                                           E2CUT049
  125 KBAS=4                                                            E2CUT050
  130 IELT=IELT-1                                                       E2CUT051
      IDS=IMS*IDEG                                                      E2CUT052
      DO 400 J=1,JEN                                                    E2CUT053
      KNODJ=KNOD+J                                                      E2CUT054
      GO TO (180,190),IEN                                               E2CUT055
  180 GO TO (210,220,230,230,240,210),J                                 E2CUT056
  190 GO TO (210,240,220,270,230,270,240,250,240,280,250,270,220,250,260E2CUT057
     1,270,220,240,250,270),J                                           E2CUT058
  210 KBASJ=KBAS+1                                                      E2CUT059
      GO TO 310                                                         E2CUT060
  220 KBASJ=KBAS+2                                                      E2CUT061
      GO TO 310                                                         E2CUT062
  230 KBASJ=KBAS+3                                                      E2CUT063
      GO TO 310                                                         E2CUT064
  240 KBASJ=KBAS+4                                                      E2CUT065
      GO TO 310                                                         E2CUT066
  250 KBASJ=KBAS+5                                                      E2CUT067
      GO TO 310                                                         E2CUT068
  260 KBASJ=KBAS+6                                                      E2CUT069
      GO TO 310                                                         E2CUT070
  270 KBASJ=KBAS+7                                                      E2CUT071
      GO TO 310                                                         E2CUT072
  280 KBASJ=KBAS+8                                                      E2CUT073
  310 IF (KBASJ-IMST) 330,330,320                                       E2CUT074
  320 KBASJ=KBASJ-IMST                                                  E2CUT075
      GO TO 310                                                         E2CUT076
  330 NOD(KNODJ)=N(KBASJ)                                               E2CUT077
  400 CONTINUE                                                          E2CUT078
  500 CONTINUE                                                          E2CUT079
      RETURN                                                            E2CUT080
      END                                                               E2CUT081
```

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),GIF2DRN006
      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
     2IHI,(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),IDS),(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),ITE),(IA(41),ITAP)         F2DRN016
      EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),    F2DRN017
     1ICIZ),(IA(70),ICEI),(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),GIF2ELD006
      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
     2IHI,(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),IDS),(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),ITE),(IA(41),ITAP)         F2ELD016
      EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),    F2ELD017
     1ICIZ),(IA(70),ICEI),(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
       SUBROUTINE PLBE
C      GENERATES SUBMATRICES FOR ELEMENT TYPES 3 AND 4
       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),
      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),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),EL),(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 (JMMX) 1010,1010,130
  130 ICIXJ=ICIX+JMMX
       IF (JMMY) 1010,1010,150
  150 ICIYJ=ICIY+JMMY
  190 A(1,1)=12.*E*AA(ICIYJ)/(EL**3)
       A(1,2)=-A(1,1)
       A(2,2)=A(1,1)
       A(2,5)=6.*E*AA(ICIYJ)/(EL**2)
       A(2,6)=A(2,5)
       A(1,5)=-A(2,5)
       A(1,6)=A(1,5)
       A(3,3)=G*AA(ICIXJ)/EL
       A(3,4)=-A(3,3)
       A(4,4)=A(3,3)
       A(5,5)=4.*E*AA(ICIYJ)/EL
       A(5,6)=.5*A(5,5)
       A(6,6)=A(5,5)
       DO 200 I=1,6
       DO 200 J=1,6
  200 A(J,I)=A(I,J)
 1000 RETURN
 1010 IERR=1
       GO TO 1000
       END
```

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

```
*      LABEL
CE2RLC
       SUBROUTINE RLOC
C      ADDS SUBMATRICES TO FORM ELEMENT STIFFNESS MATRICES OF LINE ELEMNT
       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),
      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),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)
       EQUIVALENCE (AA(200),A),(AA(236),EL),(AA(237),AREA ),(AA(238),II)
      1,(AA(239),JJ),(AA(240),IR),(AA(241),JR),(AA(242),NY),(AA(306),UVG)
      2,(AA(264),DIR)
       IIN=II+NY-1
       JJN=JJ+NY-1
       IRE=(JR-JJ)*IDS+IR-II
       L=(JJ-2)*IDS
       DO 200 J=JJ,JJN
       L=L+IDS
       DO 100 I=II,IIN
       LR=L+I+IRE
       S(LR)=A(I,J)
  100 A(I,J)=0.
  200 CONTINUE
       RETURN
       END
```

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

```
*      LABEL
CE2S01
       SUBROUTINE S01
C      GENERATES FOR ELEMENT TYPE 1 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),
      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),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),EL),(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)
       EQUIVALENCE (AA(324),PRCO)
C      PLANE OR SPACE TRUSS ELEMENT
       IPBG=0
       IF (JARE) 1,1,43
   43 ICARJ=ICAR+JARE
       DUG(1)=1.
       DUG(2)=0.
       DUG(3)=0.
       CALL ELDI
   60 IF (JPRS) 80,82,80
   80 PRCO=.5*EL*PRES*PD(1)
       IPBG=1
       IPEN=3
   82 IF (ACEL) 85,90,85
   85 CONS=.5*EL*ACEL*AA(ICARJ)
       IPBG=1
       IPEN=3
   90 SS=E*AA(ICARJ)/EL
       T(2)=-T(1)
       T(4)=-T(3)
       T(6)=-T(5)
       IK=-IDS
       DO 111 I=1,IDS
       IK=IK+IDS
       DO 11 J=1,IDS
       ISS=IK+J
   11 S(ISS)=SS*T(I)*T(J)
  111 CONTINUE
    9 RETURN
    1 IERR=1
       GO TO 9
       END
```

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),F),(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),IFLT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMFT),    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 ELDI                                                         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 ELDI                                                         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),IBD),(IA(61),IID),(IA(62),E2S04015
      9IIA),(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),IBD),(IA(61),IID),(IA(62),E2S05015
      9IIA),(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),O(4,4),EO(4,4)                          E2S05032
       EQUIVALENCE (AA(200),EM),(AA(216),EN),(AA(232),EO),(AA(248),O)    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,O,3,3)                                           E2S05039
       F1=TE/(2.*A2)                                                     E2S05040
       CALL ADM (S,IDS,O,3,1,1,F1)                                       E2S05041
       CALL TRM (D33,EN,O,3,3)                                           E2S05042
       CALL ADM (S,IDS,O,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),
      6IDRD),(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),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),(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,EO,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),IBM),(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),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),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 AT(4,4),B(3,3),Q(4,4),MOD(20),PD(3)
       EQUIVALENCE (AA(200),AT),(AA(216),B),(AA(225),Q),(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)
      B(2,2)= D21(17)
      B(2,3)= D21(13)
      B(3,1)= D21(21)
      B(3,2)= D21(20)
      B(3,3)= D21(15)
      GO TO 775
 756  GO TO (1000,757,758),J
 757  B(1,1)= D21(16)
      B(1,2)= D21(9)
      B(1,3)= D21(17)
      B(2,2)= D21(7)
      B(2,3)= D21(10)
      B(3,3)= D21(19)
      GO TO 739
 758  B(1,1)= D21(18)
      B(1,2)= D21(17)
      B(1,3)= D21(13)
      B(2,1)= D21(11)
      B(2,2)= D21(10)
      B(2,3)= D21(8)
      B(3,1)= D21(20)
      B(3,2)= D21(19)
      B(3,3)= D21(14)
      GO TO 775
 759  B(1,1)= D21(21)
      B(1,2)= D21(20)
      B(1,3)= D21(15)
      B(2,2)= D21(19)
      B(2,3)= D21(14)
      B(3,3)= D21(12)
 739  B(2,1)=B(1,2)
      B(3,1)=B(1,3)
      B(3,2)=B(2,3)
 775  CALL TRM (B,AT,Q,3,4)
      IR=4*I-3
      JC=4*J-3
      CALL ADM(S,IDS,Q,4,IR,JC,VOL)
 760  CONTINUE
 1000 RETURN
 1010 IERR=1
      GO TO 1000
      END
```

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

```
*     LABEL
CE2S11
      SUBROUTINE  S11
C     GENERATES FOR ELEMENT TYPE 11 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),II),(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),
     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),ISUM),(IA(33),INO),(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(279),DUM),(AA(297),A2)
C     TRIANGULAR SHELL ELEMENT
      CALL CORT
      CALL S07
      ISHF=6*(IDS+1)
      IESS=9*IDS
      DO 1 I=1,9
      IESS=IESS-IDS
      IES=IESS
      DO 2 J=1,9
      IES=IES+1
      IYE=IES+ISHF
      S(IYE)=S(IES)
 2    S(IES)=0.
 1    CONTINUE
      DO 3 I=4,9
 3    UV(I+6)=UV(I)
      DO 4 I=1,IMS
      I1=IMS+I
      I2=IMS+I1
      UV(I)=X(I)*DT*AL1
      UV(I1)=Y(I)*DT*AL2
 4    UV(I2)=0.
      CALL S05
      IPEN=3
      DO 11 I=1,3
      P(I+6)=P(I)
 11   P(I)=0.
C     TRANSFORM  S,P,UV INTO OVERALL SYSTEM
      CALL  TRAN (P,0)
      CALL  TRAN (UV,0)
      CALL STRA
      RETURN
      END
```

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

```
*     LABEL
CE2S13
      SUBROUTINE S13
C     GENERATES FOR ELEMENT TYPE 13 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),II),(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),INO),(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)
      EQUIVALENCE (AA(291),A2),(AA(324),PRCO)
 1    CALL CORT
      CALL S05
 2    CCNT=PRES*A2/6.
      P(7)=CCNT
      P(8)=CCNT
      P(9)=CCNT
      PRCO=0.
 3    IPEN=3
      IIGE=IGEM
      IGEM=0
      CALL TRAN (P,0)
      CALL STRA
      IGEM=IIGE
      RETURN
      END
```

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),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),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(351),S),(AA(40),ZGEM)
       7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),1U
       81),(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),GL(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),IB),(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),IOY),(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                                                                  E2TOP000
      SUBROUTINE TOPO                                                   E2TOP001
C     PREPARES ELEMENT PROPERTIES                                       E2TOP002
      DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)         E2TOP003
     1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)              E2TOP004
      COMMON IA,AA                                                      E2TOP005
      EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),E),(D21(20),G)E2TOP006
      EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),  E2TOP007
     1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),E2TOP008
     2IH),(IA(11),I8),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),E2TOP009
     3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),E2TOP010
     4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),    E2TOP011
     5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),     E2TOP012
     6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),      E2TOP013
     7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57E2TOP014
     8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),I80),(IA(61),IID),(IA(62),E2TOP015
     9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITE),(IA(41),ITAP)         E2TOP016
      EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),    E2TOP017
     1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),       E2TOP018
     2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)              E2TOP019
     3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG), E2TOP020
     4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),  E2TOP021
     5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),    E2TOP022
     6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)               E2TOP023
     7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IUE2TOP024
     8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                             E2TOP025
      EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346) E2TOP026
     1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)   E2TOP027
     2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)      E2TOP028
     3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),ID2)       E2TOP029
     4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)         E2TOP030
     5,(IA(329),IPIR)                                                   E2TOP031
      IELT=0                                                            E2TOP032
      ITEM=0                                                            E2TOP033
      ITIC=0                                                            E2TOP034
      IMET=0                                                            E2TOP035
      DO 10 I=1,8                                                       E2TOP036
      N(I)=0                                                            E2TOP037
      K=I+335                                                           E2TOP038
10    IA(K)=0                                                           E2TOP039
      JM=J1+M                                                           E2TOP040
      IELT=IA(JM)/100                                                   E2TOP041
      IMET=IA(JM)-100*IELT                                              E2TOP042
      JM=J2+M                                                           E2TOP043
      IF (IELT-4) 100,100,450                                           E2TOP044
100   IF (IELT-3) 200,300,200                                           E2TOP045
200   JARE=IA(JM)/100                                                   E2TOP046
      ITEM=IA(JM)-100*JARE                                              E2TOP047
      GO TO 400                                                         E2TOP048
  300 JPRS=IA(JM)/100                                                   E2TOP049
      JSDZ=IA(JM)-100*JPRS                                              E2TOP050
  400 IF (IELT-3) 600,800,800                                           E2TOP051
  450 IF (IELT-10) 470,470,500                                          E2TOP052
  470 IF (IELT-8) 500,500,480                                           E2TOP053
  480 JPRS=IA(JM)/100                                                   E2TOP054
      ITEM=IA(JM)-100*JPRS                                              E2TOP055
      L=1                                                               E2TOP056
      GO TO 1000                                                        E2TOP057
500   ITIC=IA(JM)/100                                                   E2TOP058
      ITEM=IA(JM)-100*ITIC                                              E2TOP059
      JM=J3+M                                                           E2TOP060
      JSDZ=IA(JM)/100                                                   E2TOP061
      JPRS=IA(JM)-100*JSDZ                                              E2TOP062
      L=2                                                               E2TOP063
      GO TO 1000                                                        E2TOP064
600   JM=J3+M                                                           E2TOP065
      JPRS=IA(JM)                                                       E2TOP066
      L=2                                                               E2TOP067
      IF (IELT-2) 1000,700,700                                          E2TOP068
700   JM=J4+M                                                           E2TOP069
      JMMZ=IA(JM)/100                                                   E2TOP070
      JSDY=IA(JM)-100*JMMZ                                              E2TOP071
      L=3                                                               E2TOP072
      IF (IELT-4) 1000,900,1000                                         E2TOP073
800   JM=J3+M                                                           E2TOP074
      JMMX=IA(JM)/100                                                   E2TOP075
      JMMY=IA(JM)-100*JMMX                                              E2TOP076
      L=2                                                               E2TOP077
      IF (IELT-4) 1000,700,1000                                         E2TOP078
900   JM=J5+M                                                           E2TOP079
      JSDZ=IA(JM)/100                                                   E2TOP080
      JMFI=IA(JM)-100*JSDZ                                              E2TOP081
      JM=J6+M                                                           E2TOP082
      JPRS=IA(JM)                                                       E2TOP083
      L=4                                                               E2TOP084
1000  I=1                                                               E2TOP085
      GO TO (1100,1200,1300,1400),L                                     E2TOP086
1100  JM=J3+M                                                           E2TOP087
      N(I)=IA(JM)                                                       E2TOP088
      I=I+L                                                             E2TOP089
1200  JM=J4+M                                                           E2TOP090
      N(I)=IA(JM)                                                       E2TOP091
      I=I+1                                                             E2TOP092
1300  JM=J5+M                                                           E2TOP093
      N(I)=IA(JM)                                                       E2TOP094
      I=I+1                                                             E2TOP095
      JM=J6+M                                                           E2TOP096
      N(I)=IA(JM)                                                       E2TOP097
      I=I+1                                                             E2TOP098
1400  JM=J7+M                                                           E2TOP099
      N(I)=IA(JM)                                                       E2TOP100
      I=I+1                                                             E2TOP101
      JM=J8+M                                                           E2TOP102
      N(I)=IA(JM)                                                       E2TOP103
      I=I+1                                                             E2TOP104
      JM=J9+M                                                           E2TOP105
      N(I)=IA(JM)                                                       E2TOP106
      I=I+1                                                             E2TOP107
      JM=J10+M                                                          E2TOP108
      N(I)=IA(JM)                                                       E2TOP109
      IF (I-IH) 1600,1600,1450                                          E2TOP110
1450  IHP=IH+1                                                          E2TOP111
      DO 1500 I=IHP,8                                                   E2TOP112
1500  N(I)=0.                                                           E2TOP113
1600  RETURN                                                            E2TOP114
      END                                                               E2TOP115
```

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

```
*     LABEL
CE2TRN                                                                  E2TRN000
      SUBROUTINE TRAN (A,IFS)                                           E2TRN001
C     TRANSFORMS THE DESCRIPTION OF A VECTOR FROM LOCAL TO OVERALL      E2TRN002
      DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)         E2TRN003
     1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)              E2TRN004
      COMMON IA,AA                                                      E2TRN005
      EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),E),(D21(20),G)E2TRN006
      EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),  E2TRN007
     1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),E2TRN008
     2IH),(IA(11),I8),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),E2TRN009
     3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),E2TRN010
     4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),    E2TRN011
     5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),     E2TRN012
     6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),      E2TRN013
     7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57E2TRN014
     8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),I80),(IA(61),IID),(IA(62),E2TRN015
     9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITE),(IA(41),ITAP)         E2TRN016
      EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),    E2TRN017
     1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),       E2TRN018
     2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)              E2TRN019
     3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG), E2TRN020
     4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),  E2TRN021
     5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),    E2TRN022
     6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)               E2TRN023
     7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IUE2TRN024
     8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                             E2TRN025
      EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346) E2TRN026
     1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)   E2TRN027
     2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)      E2TRN028
     3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),ID7)       E2TRN029
     4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)         E2TRN030
     5,(IA(329),IPIR)                                                   E2TRN031
      DIMENSION EM(4,4),EN(4,4),Q(4,4),DIR(3,3),DUM(18)                 E2TRN032
      EQUIVALENCE (AA(200),EM),(AA(216),EN),(AA(232),EQ),(AA(248),Q),   E2TRN033
     1(AA(264),DIR),(AA(273),DUM)                                       E2TRN034
      DIMENSION A(1)                                                    E2TRN035
10    IGEMP=IGEM+1                                                      E2TRN036
      LJI=0                                                             E2TRN037
      LK=IFS-4*IMS                                                      E2TRN038
20    DO 300 L=1,IGEMP                                                  E2TRN039
      LK=LK+3*IMS                                                       E2TRN040
30    DO 200 J=1,3                                                      E2TRN041
      DO 200 I=1,IMS                                                    E2TRN042
      LJI=LJI+1                                                         E2TRN043
      DUM(LJI)=0.                                                       E2TRN044
      LKI=LK+I                                                          E2TRN045
40    DO 100 K=1,3                                                      E2TRN046
      LKI=LKI+IMS                                                       E2TRN047
  100 DUM(LJI)=DUM(LJI)+DIR(K,J)*A(LKI)                                 E2TRN048
  200 CONTINUE                                                          E2TRN049
  300 CONTINUE                                                          E2TRN050
      INI=3*IGEMP*IMS                                                   E2TRN051
      DO 400 I=1,INI                                                    E2TRN052
      II=IFS+I                                                          E2TRN053
  400 A(II)=DUM(I)                                                      E2TRN054
      RETURN                                                            E2TRN055
      END                                                               E2TRN056
```

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),E),(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(4)),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),JARF),(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
       SUBROUTINE ELST
C      WRITES ON TAPE ITAS ELEMENT SET INFORMATION
       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)
       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),
      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 IMNT(24)
       EQUIVALENCE (UV,IMNT),(IA(200),IONE)
       ISN=IST+IND
       IELM=13
       IELN=IELM-1
       ISN1=ISN+1
       ISNN=ISN+IN*IELM
       INCT=0
       IONE=0
       DO 8 I=ISN1,ISNN
 8     IA(I)=0
       DO 1 I=1,IT
       J1I=J1+I
       IELT=IA(J1I)/100
       GO TO (9,9,9,9,2,3,2,3,4,5,2,3,2,3,2,3,14,14),IELT
 9     IONE=IONE+1
       GO TO 1
 2     KJ=4
       KN=3
       GO TO 6
 3     KJ=4
       KN=4
       GO TO 6
 4     KJ=3
       KN=4
       GO TO 6
 5     KJ=3
       KN=8
       GO TO 6
 14    KJ=4
       KN=2
 6     KK=J1+I+(KJ-2)*IT
       DO 7 J=1,KN
       KK=KK+IT
       NN=IA(KK)
       ISNI=ISN+(NN-1)*IELM+1
       IE=IA(ISNI)+1
       IF (IE-IELN)  12,11,11
 11    WRITE OUTPUT TAPE 6,13,IELN,NN
 13    FORMAT (10H MORE THAN,I4,2X,31HNON-ONE-DIMENSNL ELMNTS AT NODE,I5)
       INCT=1
       GO TO 7
 12    ISNN=ISNI+IE
       IA(ISNI)=IE
       IA(ISNN)=I
 7     CONTINUE
 1     CONTINUE
       IF (INCT) 19,20,19
 19    ITAS=0
       WRITE OUTPUT TAPE 6,191
 191   FORMAT(53H NODAL STRESS COMPUTATION IS DELETED DUE TO PRECEDING)
       GO TO 100
 20    DO 21 I=1,IN
       ISNI=ISN+(I-1)*IELM+1
       IE=IA(ISNI)
       IF(IE) 23,23,24
 24    DO 22 J=1,IE
       ISNN=ISNI+J
 22    IMNT(J)=IA(ISNN)
       WRITE TAPE ITAS,I,IE,(IMNT(J),J=1,IE)
       GO TO 21
 23    WRITE TAPE ITAS,I,IE,IE
 21    CONTINUE
       DO 25 I=1,IN
 25    BACKSPACE ITAS
 100   RETURN
       END
```

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

```
*      LABEL
CE3PUNC
       SUBROUTINE PUNC
C      DUMMY SUBROUTINE
       RETURN
       END
```

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

```
*      LABEL
CE3RES
       SUBROUTINE RESI
C      COMPUTES RESIDUAL FORCES AT THE NODES
       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)
       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),
      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)
C      FIND ELEMENTAL NODAL FORCES AND ASSEMBLE FOR OBTAINING RESIDUALS
       DO 60 I=1,IND
       ISTI=IST+I
 60    AA(ISTI)=0.
 70    DO 20  JJ=1,IT
C      READ THE QUANTITIES FOR ELEMENT JJ
 50    READ  TAPE ITAS,M,ITTT,ITTM,NAV,IMS,IDS,IDS2,(N(I),I=1,IMS),(S(I),
      1I=1,IDS2),(P(I),CF,I=1,IDS)
C      COMPUTE AND ASSEMBLE THE NODAL FORCES OF ELEMENT JJ
       IF (NAV-2) 91,92,92
 91    CF=1.
       GO TO 93
 92    CF=0.5
 93    IF (M-JJ) 100,9,100
 9     DO 10 I=1,IDS
       KK=-IDS+I
       DO 11 K=1,IDS
       KK=KK+IDS
       KDEG=((K-1)/IMS)+1
       KNOD=K-(KDEG-1)*IMS
       KNOD=N(KNOD)
       IDEFK=IDEF+(KNOD-1)*IDEG+KDEG
 11    P(I)=P(I)-S(KK)*AA(IDEFK)
       KDEG=((I-1)/IMS)+1
       KNOD=I-(KDEG-1)*IMS
       KNOD=N(KNOD)
       ND=(KNOD-1)*IDEG+KDEG
       ISTI=IST+ND
       AA(ISTI)=AA(ISTI)-P(I)*CF
 10    CONTINUE
       IF (ITTT-ITTM) 50,21,21
 21    IF (NAV-2) 20,50,20
 20    CONTINUE
 31    RETURN
 100   ITAS=0
       GO TO 31
       END
```

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

```
*     LABEL
CF3REW
      SUBROUTINE RESW
C     WRITES RESIDUAL FORCES AT THE NODES
      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)
      COMMON IA,AA
      EQUIVALENCE(IA,AA),(D2),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),IMFT),
     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),IHB),(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),ICF1),(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),JMFI),(IA(335),ITAS),(IA(334),ID7)
     4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRFS)
     5,(IA(329),IPIR)
      IELT=IELT
      WRITE OUTPUT TAPE 6,74
74    FORMAT (1H1,40X,26HFORCES ACTING AT THE NODES//5H NODE,5X,13HFORCE
     1 ALONG X,5X,13HFORCE ALONG Y,5X,13HFORCE ALONG Z,4X,14HMOMENT ABOU
     2T X,4X,14HMOMENT ABOUT Y,4X,14HMOMENT ABOUT Z//)
      DO 71 I=1,6
71    P(I)=0.
      DO 75 I=1,IN
      ND=(I-1)*IDEG
      ISTI=IST+ND
      DO 72 J=1,IDEG
      L=J
      ISTJ=ISTI+J
      GO TO (72,2,3),IELT
2     L=J+2
      GO TO 72
3     IF (J-3) 72,4,72
4     L=J+3
72    P(L)=AA(ISTJ)
      WRITE OUTPUT TAPE 6,76,I,(P(J),J=1,6)
76    FORMAT (I5,6E18.7)
75    CONTINUE
      RETURN
      END
```

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

```
*       FAP
        COUNT   25
        LBL     TICK
        ENTRY   TICK
TICK    NZT     ONCE
        TRA     FIRST
        CAL     5
        SUB     INITL
        ALS     18
        SLW*    1,4
        TRA     2,4
FIRST   STL     ONCE
        CAL     5
        SLW     INITL
        STZ*    1,4
        TRA     2,4
ONCE    PZE
INITL   PZE
        END
```

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=I-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-1
       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                                                                  ELAS4000
C      MAIN PROGRAM FOR STRESS LINK                                     ELAS4001
C      OBTAINS STRESSES AT MESH POINTS                                  ELAS4002
       DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)        ELAS4003
      1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)             ELAS4004
       COMMON IA,AA                                                     ELAS4005
       EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),F),(D21(20),G)ELAS4006
       EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5), ELAS4007
      1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),ELAS4008
      2IH),(IA(11),IB),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),ELAS4009
      3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),ELAS4010
      4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),   ELAS4011
      5(IA(32),ISDM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),    ELAS4012
      6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),     ELAS4013
      7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57ELAS4014
      8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBO),(IA(61),IID),(IA(62),ELAS4015
      9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITE),(IA(41),ITAP)        ELAS4016
       EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),   ELAS4017
      1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),      ELAS4018
      2(IA(74),IIC),(IA(75),IDEF),(IA(76),ISI),(IA(77),IIS)             ELAS4019
      3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG), ELAS4020
      4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),  ELAS4021
      5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),   ELAS4022
      6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)              ELAS4023
      7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IUELAS4024
      8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                            ELAS4025
       EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346) ELAS4026
      1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)  ELAS4027
      2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)     ELAS4028
      3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)      ELAS4029
      4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)        ELAS4030
      5,(IA(329),IPIR)                                                  ELAS4031
       DIMENSION BIR(3),SIR(3),DIN(3,3),SR(6),XN(3),XF(3),ON(6),OF(6),  ELAS4032
      1RES(6),RED(6),BAS(3),ICLAS(4),NBAN(10),NU(3),NES(3)              ELAS4033
       EQUIVALENCE (AA(200),IONE),(AA(201),ICN),(AA(202),LM),(AA(203),ASTELAS4034
      1),(AA(204),INBON),(AA(205),ARE),(AA(206),ICLA),(AA(207),IMEL),   ELAS4035
      2(AA(208),IM),(AA(209),IC),(AA(210),ICON),(AA(211),ANGLE),(AA(212),ELAS4036
      3ICAS),(AA(213),IE),(AA(214),NB),(AA(215),NR)                     ELAS4037
      4,(AA(216),IROT),(AA(217),BST)                                    ELAS4038
       EQUIVALENCE (AA(220),BIR),(AA(223),SIR),(AA(226),DIN),(AA(235),SR)ELAS4039
      1,(AA(241),XN),(AA(244),XF),(AA(247),ON),(AA(253),OF),(AA(259),RES)ELAS4040
      2,(AA(265),RED),(AA(271),BAS),(AA(274),ICLAS),(AA(278),NBAN)      ELAS4041
      3,(AA(292),NU),(AA(295),NES)                                      ELAS4042
       DIMENSION NEL(20,17),MAC(4,4,20),IWG(90),DD(6,6),A(90,7),B(8,8), ELAS4043
      1C(8,2),FF(1),NSET(100),MSET(100),W(3,3)                          ELAS4044
       EQUIVALENCE (AA(14000),FF),(NU(1),JP1),(NU(2),JM1),(NU(3),JS1)   ELAS4045
       EQUIVALENCE (FF(1),NEL),(FF(341),MAC),(FF(661),IWG),(FF(751),DD), ELAS4046
      1(FF(787),A),(FF(1417),B),(FF(1481),C),(FF(1497),NSET),(FF(1597), ELAS4047
      2MSET),(FF(1697),W)                                               ELAS4048
       EQUIVALENCE (NES(1),ICOL),(NES(2),IRIG),(NES(3),IDR)             ELAS4049
C      START THE CLOCK                                                  ELAS4050
       CALL TICK(ITIM)                                                  ELAS4051
       INPT=INP                                                         ELAS4052
C      SCRATCH TAPE ITAS NECESSARY. SEE IF IT IS GIVEN                  ELAS4053
       IF (ITAS) 1000,1000,1                                            ELAS4054
 1000  WRITE OUTPUT TAPE 6,1001                                         ELAS4055
 1001  FORMAT (46H NO SCRATCH TAPE, STRESS LINK IS NOT EXECUTED.)       ELAS4056
       GO TO 1002                                                       ELAS4057
C      SEE IF THERE IS ANY NON-ONE-DIMENSIONAL ELEMENT                  ELAS4058
 1     IF (IT-IONE) 2000,2000,2                                         ELAS4059
C      NON-ONE-DIMENSIONAL ELEMENTS EXIST. PRINT THE TABLE HEADING      ELAS4060
 2     WRITE OUTPUT TAPE 6,3                                            ELAS4061
 3     FORMAT (1H1,15X,87HSTRESSES AT THE NODES OF TWO- OR THREE-DIMENSIOELAS4062
      1NAL CONTINUUM BY BEST FIT STRAIN TENSORS/8X,104HALL QUANTITIES AREELAS4063
      2 IN OVERALL SYSTEM, UNLESS ** APPEARS INDICATING DATA IN KSI, ETA ELAS4064
      3AND ZTA LOCAL SYSTEM/45X,28H* INDICATES NODE ON BOUNDARY         ELAS4065
      4          //5H NODE,2X,3HMAT,5H CLAS,7X,11HFIRST  COMP,4X,11HSECELAS4066
      5OND COMP,4X,11HTHIRD  COMP,4X,11HFOURTH COMP,4X,11HFIFTH  COMP,4X,ELAS4067
      611HSIXTH  COMP//)                                                ELAS4068
       IF (14000-IST-IND) 22,22,21                                      ELAS4069
 22    WRITE OUTPUT TAPE 6,221                                          ELAS4070
 221   FORMAT (87H SCRATCH AREA FF OVERLAPS WITH RESIDUAL AREA. PUSH FF FELAS4071
      1URTHER DOWN BY RECOMPILING LINK4)                                ELAS4072
       GO TO 1002                                                       ELAS4073
C      START STRESS COMPUTATION AT NODES                                ELAS4074
 21    DO 400 ICN=1,IN                                                  ELAS4075
       ICN=ICN                                                          ELAS4076
       INP=INPT                                                         ELAS4077
       CALL CAS4                                                        ELAS4078
C      INITIALIZE AA AND FF AREAS                                       ELAS4079
       DO 10 I=202,300                                                  ELAS4080
 10    AA(I)=0.                                                         ELAS4081
       DO 20 I=1,1705                                                   ELAS4082
 20    FF(I)=0.                                                         ELAS4083
C      GENERATE THE COORDINATES AND THE DEFLECTIONS OF NODE ICN         ELAS4084
       CALL FINDX(ICN,XN)                                               ELAS4085
       CALL FINDO(ICN,ON)                                               ELAS4086
C      READ IN THE  ELEMENT SET                                         ELAS4087
       READ TAPE ITAS,K,LM,(NEL(J,I),J=1,LM)                            ELAS4088
       IF (ICN-K) 1003,4,1003                                           ELAS4089
 1003  WRITE OUTPUT TAPE 6,1004,ICN,K                                   ELAS4090
 1004  FORMAT (80H ERROR IN READING ELEMENT SETS FROM TAPE ITAS. STRESS LELAS4091
      1INK EXECUTION IS DELETED.,2I6)                                   ELAS4092
       GO TO 1002                                                       ELAS4093
C      SEE IF ANY NON-ONE-DIMENSIONAL ELEMENT AT THE CURRENT NODE       ELAS4094
 4     IF (LM) 399,399,4051                                             ELAS4095
 399   WRITE OUTPUT TAPE 6,3991,ICN                                     ELAS4096
 3991  FORMAT (I5,13X,43HNO NON-ONE-DIMENSIONAL ELEMENT AT THIS NODE)   ELAS4097
       GO TO 400                                                        ELAS4098
C      THERE IS AT LEAST ONE NON-ONE-DIMENSIONAL ELEMENT.               ELAS4099
C      PREPARE NEL(I,J),MAC(I,J,K) TABLES AND COMPUTE IMEL,ICLAS        ELAS4100
 4051  CALL GENE                                                        ELAS4101
C      SET INDICATORS TO NON-BOUNDARY NODE                              ELAS4102
       INBON=0                                                          ELAS4103
       AST=7H      A                                                    ELAS4104
C      SEE IF THE NODE IS ON BOUNDARY                                   ELAS4105
C      IF SO MAKE INBON=1, AST=1H* AND COMPUTE BIR(1) AND ARE           ELAS4106
       CALL BOFI                                                        ELAS4107
C      COMPUTE STRESSES FOR EACH  MATERIAL GROUP                        ELAS4108
       DO 599 IM=1,IMEL                                                 ELAS4109
       IM=IM                                                            ELAS4110
       IMET=MAC(IM,1,2)                                                 ELAS4111
       IMET=NEL(IMET,3)                                                 ELAS4112
C      COMPUTE STRESSES FOR EACH  CLASS                                 ELAS4113
       ICLA=ICLAS(IM)                                                   ELAS4114
       DO 580 IC=1,ICLA                                                 ELAS4115
       IC=IC                                                            ELAS4116
C      FIND THE CLASS TYPE                                              ELAS4117
       ICAS=MAC(IM,IC,2)                                                ELAS4118
       ICAS=NEL(ICAS,4)                                                 ELAS4119
C      INITIALIZE ICON,ANGLE,BAS,DIN,IROT,BST,IERR,TE,DT,DG,NES AND W   ELAS4120
       CALL  INLZ                                                       ELAS4121
C      SEE IF THE GROUP IS OF SHELL TYPE                                ELAS4122
       IF (ICAS-5) 6,7,7                                                ELAS4123
C      YES, IT IS OF SHELL TYPE, RE-DETERMINE LOCAL AXES (DIN)          ELAS4124
 7     IROT=1                                                           ELAS4125
       BST=2H**                                                         ELAS4126
       CALL DINA                                                        ELAS4127
C      IS LOCAL AXES (DIN) TO BE ROTATED                                ELAS4128
 6     IF (INBON) 71,70,71                                              ELAS4129
C      IF NECESSARY ROTATE DIN SO THAT KSI IS IN ZTA-BIR PLANE          ELAS4130
 71    CALL MDIN                                                        ELAS4131
C      GENERATE MATERIAL MATRIX DD IN LOCAL SYSTEM (DIN)                ELAS4132
 70    CALL META                                                        ELAS4133
C      CLEAR THE A AREA ON WHICH ABEQ AND SETA WILL OPERATE             ELAS4134
       DO 72 I=1,90                                                     ELAS4135
       DO 72 J=1,7                                                      ELAS4136
 72    A(I,J)=0.                                                        ELAS4137
C      CHECK IF THE NODE IS ON BOUNDARY                                 ELAS4138
       IF (INBON) 521,520,521                                           ELAS4139
C      YES IT IS ON BOUNDARY. GENERATE EQS FOR STRESS B.C.              ELAS4140
 521   CALL ABEQ                                                        ELAS4141
C      GENERATE STRAIN EQS FOR NODAL LINES OF ELEMENTS OF CLAS IC       ELAS4142
 520   IE=MAC(IM,IC,1)+1                                                ELAS4143
       DO 579 IL=2,IE                                                   ELAS4144
       IF (INP-2) 5201,5202,5202                                        ELAS4145
 5202  WRITE OUTPUT TAPE 6,5203,BST,NES(1),NES(2)                       ELAS4146
 5203  FORMAT (15X,A2,3X,41HSTRAIN EQUATIONS ALONG NODAL LINES FOLLOW,I4,ELAS4147
      13H X ,I1)                                                        ELAS4148
 5201  CONTINUE                                                         ELAS4149
       IL=IL                                                            ELAS4150
       IELT=MAC(IM,IC,IL)                                               ELAS4151
       CALL SETA                                                        ELAS4152
 579   CONTINUE                                                         ELAS4153
C      PRINT OUT DIN MATRIX AND DEFLNS. IN LOCAL IF NECESSARY           ELAS4154
       IF (IROT) 81,80,81                                               ELAS4155
 81    WRITE OUTPUT TAPE 6,83,ICN,((DIN(I,J),I=1,3),J=1,3),ICN,BST,(X(I),ELAS4156
      1I=4,9)                                                           ELAS4157
 83    FORMAT (I5,10H DR.COSINS,5X    ,3HKSI,2X,3F7.4,5X,3HETA,2X,3F7.4,5XELAS4158
      1,3HZTA,2X,3F7.4/I5,10H DEFLECTNS,A2,1X,6E15.5)                   ELAS4159
C      EQUATIONS ARE AVAILABLE, SOLVE WITH LEAST SQUARES                ELAS4160
 80    CALL LEST                                                        ELAS4161
C      SEE IF ENOUGH INDEPENDENT EQUATIONS EXIST                        ELAS4162
       IF (IERR)  522,523,522                                           ELAS4163
 522   WRITE OUTPUT TAPE 6,5221,ICN,AST,IMET,ICAS                       ELAS4164
 5221  FORMAT (I5,A1,I4,I5,3X,44HNOT ENOUGH INDEPENDENT INFORMATION AVAILELAS4165
      1ABLE)                                                            ELAS4166
       GO TO 580                                                        ELAS4167
C      COMPUTE STRESSES                                                 ELAS4168
 523   CALL STRS                                                        ELAS4169
C      PRINT OUT STRESSES                                               ELAS4170
       WRITE OUTPUT TAPE 6,5231,ICN,AST,IMET,ICAS,BST,(SR(I),I=1,6)     ELAS4171
 5231  FORMAT (I5,A1,I4,I5,A2,1X,6E15.5)                                ELAS4172
C      PRINT STRESSES IN THE OVERALL SYSTEM IF NECESSARY                ELAS4173
       CALL SAME                                                        ELAS4174
       IF (INP-2) 580,5232,5232                                         ELAS4175
 5232  WRITE OUTPUT TAPE 6,5233                                         ELAS4176
 5233  FORMAT (1H ,//)                                                  ELAS4177
 580   CONTINUE                                                         ELAS4178
 599   CONTINUE                                                         ELAS4179
 400   CONTINUE                                                         ELAS4180
       IF (IONE)  1002,1002,2000                                        ELAS4181
C      READ THE CLOCK  AND PRINT THE ELAPSED TIME                       ELAS4182
 1002  CALL TICK (ITIM)                                                 ELAS4183
       CIT=ITIM                                                         ELAS4184
       CIT=CIT/60.                                                      ELAS4185
       WRITE OUTPUT TAPE 6,998,CIT                                      ELAS4186
 998   FORMAT (1X,16HSTRESS LINK TOOK,F7.2,10H  SECONDS.)               ELAS4187
C      GO TO THE FIRST LINK                                             ELAS4188
       CALL CHAIN (1,ITAP)                                              ELAS4189
 2000  CALL DIMI(K)                                                     ELAS4190
       IF (IERR) 1003,1002,1003                                         ELAS4191
       END                                                              ELAS4192
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Table VII-54. Source program listing of subroutine ABEQ (Link 4)

```
*       LABEL
CF4ABQ                                                                  F4ABQ0000
        SUBROUTINE ABEQ                                                 F4ABQ0001
C       GENERATES EQUATIONS FOR STRESS BOUNDARY CONDITIONS AT A NODE    F4ABQ0002
        DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)      F4ABQ0003
       1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G(1)            F4ABQ0004
        COMMON IA,AA                                                    F4ABQ0005
        EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),E),(D21(20),G)F4ABQ0006
        EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5), F4ABQ0007
       1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),F4ABQ0008
       2IH),(IA(11),IB),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),F4ABQ0009
       3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),F4ABQ0010
       4ISTR),(IA(28),IFLT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),  F4ABQ0011
       5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),   F4ABQ0012
       6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),    F4ABQ0013
       7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57F4ABQ0014
       8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBO),(IA(61),IID),(IA(62),F4ABQ0015
       9IIA),(IA(63),IOT),(IA(64),IDY),(IA(65),ITE),(IA(41),ITAP)       F4ABQ0016
        EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),  F4ABQ0017
       1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),     F4ABQ0018
       2(IA(74),IIC),(IA(75),IDFF),(IA(76),IST),(IA(77),IIS)            F4ABQ0019
       3,(IA(78),IGEM),(IA(79),IFRR),(AA(80),TE),(AA(81),DT),(AA(82),DG), F4ABQ0020
       4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P), F4ABQ0021
       5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),  F4ABQ0022
       6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)             F4ABQ0023
       7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IUF4ABQ0024
       8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                           F4ABQ0025
        EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346) F4ABQ0026
       1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY) F4ABQ0027
       2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)    F4ABQ0028
       3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IOZ)     F4ABQ0029
       4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)       F4ABQ0030
       5,(IA(329),IPIR)                                                 F4ABQ0031
        DIMENSION BIR(3),SIR(3),DIN(3,3),SR(6),XN(3),XF(3),ON(6),OF(6), F4ABQ0032
       1RES(6),REO(6),BAS(3),ICLAS(4),NBAN(10),NU(3),NES(3)             F4ABQ0033
        EQUIVALENCE (AA(200),IONE),(AA(201),ICN),(AA(202),LM),(AA(203),ASTF4ABQ0034
       1),(AA(204),INBDN),(AA(205),ARE),(AA(206),ICLA),(AA(207),IMFL),  F4ABQ0035
       2(AA(208),IM),(AA(209),IC),(AA(210),ICDN),(AA(211),ANGLE),(AA(212),F4ABQ0036
       3ICAS),(AA(213),IE),(AA(214),NB),(AA(215),MB)                    F4ABQ0037
       4,(AA(216),IROT),(AA(217),BST)                                   F4ABQ0038
        EQUIVALENCE (AA(220),BIR),(AA(223),SIR),(AA(226),DIN),(AA(235),SR)F4ABQ0039
       1,(AA(241),XN),(AA(244),XF),(AA(247),ON),(AA(253),OF),(AA(259),RES)F4ABQ0040
       2,(AA(265),REO),(AA(271),BAS),(AA(274),ICLAS),(AA(278),NBAN)     F4ABQ0041
       3,(AA(292),NU),(AA(295),NES)                                     F4ABQ0042
        DIMENSION NEL(20,17),MAC(4,4,20),ING(90),DD(6,6),A(90,7),B(8,8), F4ABQ0043
       1C(8,2),FF(1),NSET(100),MSET(100),W(3,3)                         F4ABQ0044
        EQUIVALENCE (AA(14000),FF),(NU(1),JP1),(NU(2),JM1),(NU(3),JS1)  F4ABQ0045
        EQUIVALENCE (FF(1),NEL),(FF(341),MAC),(FF(661),ING),(FF(751),DD), F4ABQ0046
       1(FF(787),A),(FF(1417),B),(FF(1481),C),(FF(1497),NSET),(FF(1597), F4ABQ0047
       2MSET),(FF(1697),W)                                              F4ABQ0048
        EQUIVALENCE (NES(1),ICOL),(NES(2),IRIG),(NES(3),IDR)            F4ABQ0049
        DIMENSION REK(3,2),NEK(3,2)                                     F4ABQ0050
        EQUIVALENCE (X(1),REK),(Y(1),NEK)                               F4ABQ0051
        ICOL=ICOL                                                       F4ABQ0052
        IRIG=IRIG                                                       F4ABQ0053
C       GENERATE THE RESIDUE VECTOR                                     F4ABQ0054
        ISTI=151+(ICN-1)*IDEG                                           F4ABQ0055
        DO 9 I=1,IDEG                                                   F4ABQ0056
        ISTI=ISTI+1                                                     F4ABQ0057
  9     RES(I)=AA(ISTI)                                                 F4ABQ0058
C       INITIALIZE                                                      F4ABQ0059
        IEQ=2                                                           F4ABQ0060
        N(1)=1                                                          F4ABQ0061
        N(2)=3                                                          F4ABQ0062
        N(3)=5                                                          F4ABQ0063
        IREB=1                                                          F4ABQ0064
        IREN=2                                                          F4ABQ0065
        CT=-TE**3/12.                                                   F4ABQ0066
        CR=ARE/DD(1,1)                                                  F4ABQ0067
        CL=CR*ARE                                                       F4ABQ0068
        DO 12 J=1,2                                                     F4ABQ0069
        DO 12 I=1,3                                                     F4ABQ0070
        REK(I,J)=1.                                                     F4ABQ0071
 12     NEK(I,J)=I                                                      F4ABQ0072
        IF (XN(1)) 31,30,31                                             F4ABQ0073
 30     XX=1.                                                           F4ABQ0074
        GO TO 32                                                        F4ABQ0075
 31     XX=XN(1)                                                        F4ABQ0076
 32     ICON=0                                                          F4ABQ0077
C       GENERATE EQUATIONS ACCORDING TO CLASS                           F4ABQ0078
        ICAS=ICAS                                                       F4ABQ0079
        GO TO (1,2,3,4,5,6,7,8),ICAS                                    F4ABQ0080
C       PLANE STRESS AND PLANE STRAIN                                   F4ABQ0081
  1     CR=CR/TE                                                        F4ABQ0082
        GO TO 15                                                        F4ABQ0083
C       PLATE BENDING                                                   F4ABQ0084
  2     IREB=2                                                          F4ABQ0085
        IREN=3                                                          F4ABQ0086
        NEK(1,1)=2                                                      F4ABQ0087
        NEK(2,1)=1                                                      F4ABQ0088
        CR=CR/CT                                                        F4ABQ0089
        REK(2,1)=-1.                                                    F4ABQ0090
        GO TO 15                                                        F4ABQ0091
C       SOLID OF REVOLUTION                                             F4ABQ0092
  3     CR=ARE/(XX*DD(1,1))                                             F4ABQ0093
        GO TO 15                                                        F4ABQ0094
C       SOLID                                                           F4ABQ0095
  4     IEQ=3                                                           F4ABQ0096
        IREN=3                                                          F4ABQ0097
        CR=1./DD(1,1)                                                   F4ABQ0098
        CL=ARE/DD(1,1)                                                  F4ABQ0099
        GO TO 15                                                        F4ABQ0100
C       SHELL OF REVOLUTION, MEMBRANE CASE                              F4ABQ0101
  5     IEQ=1                                                           F4ABQ0102
        CR=CR*ARE/XX                                                    F4ABQ0103
        GO TO 15                                                        F4ABQ0104
C       SHELL OF REVOLUTION, MEMBRANE AND BENDING CASE                  F4ABQ0105
  6     IEQ=1                                                           F4ABQ0106
        NEK(1,2)=3                                                      F4ABQ0107
        CR=CR*ARE/XX                                                    F4ABQ0108
        GO TO 15                                                        F4ABQ0109
C       GENERAL SHELL MEMBRANE CASE                                     F4ABQ0110
  7     IREN=3                                                          F4ABQ0111
        GO TO 15                                                        F4ABQ0112
C       GENERAL SHELL MEMBRANE AND BENDING CASE                         F4ABQ0113
  8     IREN=3                                                          F4ABQ0114
        NEK(1,2)=2                                                      F4ABQ0115
        NEK(2,2)=1                                                      F4ABQ0116
        REK(2,2)=-1.                                                    F4ABQ0117
C       ESTABLISH THE EQUATIONS                                         F4ABQ0118
 15     DO 20 J=1,IRIG                                                  F4ABQ0119
        DO 151 I=1,6                                                    F4ABQ0120
 151    REO(I)=0.                                                       F4ABQ0121
        K=0                                                             F4ABQ0122
        DO 16 I=IREB,IREN                                               F4ABQ0123
        K=K+1                                                           F4ABQ0124
 16     REO(K)=RES(I)                                                   F4ABQ0125
        DO 17 I=1,3                                                     F4ABQ0126
        SIR(I)=0.                                                       F4ABQ0127
        DO 18 K=1,3                                                     F4ABQ0128
 18     SIR(I)=SIR(I)+REO(K)*DIN(K,I)                                   F4ABQ0129
 17     CONTINUE                                                        F4ABQ0130
        DO 19 I=1,IEQ                                                   F4ABQ0131
        ICON=ICON+1                                                     F4ABQ0132
        K=NEK(I,J)                                                      F4ABQ0133
        LL=N(I)                                                         F4ABQ0134
        II=ICOL+J                                                       F4ABQ0135
        A(ICON,II)=REK(I,J)*CR*SIR(K)                                   F4ABQ0136
        IF (J-1)  192,192,19                                            F4ABQ0137
 192    DO 191 L=1,ICOL                                                 F4ABQ0138
 191    A(ICON,L)=CL*DD(LL,L)                                           F4ABQ0139
        IWG(I)=100                                                      F4ABQ0140
 19     CONTINUE                                                        F4ABQ0141
        IF (J-IRIG) 194,20,20                                           F4ABQ0142
 194    IREB=IREN+1                                                     F4ABQ0143
        IREN=IDEG                                                       F4ABQ0144
        CR=CR/CT                                                        F4ABQ0145
        ICON=0                                                          F4ABQ0146
 20     CONTINUE                                                        F4ABQ0147
C       PLACE THE PRESCRIBED STRESSES INTO SR IN SUCCESSIVE ORDER       F4ABQ0148
        L=0                                                             F4ABQ0149
        DO 26 J=1,IRIG                                                  F4ABQ0150
        K=ICOL+J                                                        F4ABQ0151
        IF (J-1) 26,40,41                                               F4ABQ0152
 40     IF (ICAS-2) 45,41,45                                            F4ABQ0153
 41     CL=CL/CT                                                        F4ABQ0154
 45     DO 24 I=1,IEQ                                                   F4ABQ0155
        L=L+1                                                           F4ABQ0156
 24     SR(L)=A(I,K)/CL                                                 F4ABQ0157
 26     CONTINUE                                                        F4ABQ0158
        IF (INP-2) 100,25,25                                            F4ABQ0159
 25     IREN=ICOL+IRIG                                                  F4ABQ0160
        WRITE OUTPUT TAPE 6,251,BST,ICOL,IRIG,((A(I,J),J=1,7),IWG(I),I=1, F4ABQ0161
       1IEQ)                                                            F4ABQ0162
 251    FORMAT (15X,A2,3X,32HEQUATIONS FOR STRESS B.C. FOLLOW,I4,3H X ,I1/F4ABQ0163
       1(20X,7E13.5,I5))                                                F4ABQ0164
        WRITE OUTPUT TAPE 6,252         ,BST,(SR(I),I=1,6),CL           F4ABQ0165
 252    FORMAT (15X      ,A2,3X,13HPRSCRBD.STRS.,3X,7E12.4)             F4ABQ0166
 100    RETURN                                                          F4ABQ0167
        END                                                             F4ABQ0168
```

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

```
*       LABEL
CE4AGEL
        SUBROUTINE AGEL
C       DUMMY SUBROUTINE
        RETURN
        END
```

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

```
*       LABEL
CE4BST
        SUBROUTINE BEST(CIR,JBAN,MZ)
C       OBTAINS BEST FIT PLANE AT A NODE
C       TO OBTAIN UNIT NORMAL OF BEST FIT PLANE PASSING THROUGH MZ NODES
C       OF JBAN SET ON VECTOR CIR
        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),IBD),(IA(61),IID),(IA(62),
       9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),IIE),(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 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),MBAN(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),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 CIR(3),JBAN(10),VE1(3),VF2(3)
        EQUIVALENCE (B(1),VE1),(B(4),VE2)
        L=0
        DO 10 I=1,MZ
        K=JBAN(I)
        CALL FINDX (K,XF)
        L=L+1
        A(L,1)=XF(1)-XN(1)+1.15
        A(L,2)=XF(2)-XN(2)+1.16
        A(L,3)=XF(3)-XN(3)+1.17
        A(L,4)=1.
10      CONTINUE
        DET=0.
        IF (L-3) 45,14,14
14      DO 20 I=1,3
        DO 20 J=I,4
        B(I,J)=0.
        DO 30 K=1,L
30      B(I,J)=B(I,J)+A(K,I)*A(K,J)
        IF (J-3) 40,40,41
40      B(J,I)=B(I,J)
        GO TO 20
41      CIR(I)=B(I,4)
20      CONTINUE
        CALL INV(B,3,CIR,1,DET)
        IF (DET) 50,45,50
C       POINTS ARE ON ONE PLANE. COMPUTE NORMAL AS VECTOR PRODUCT
45      DO 46 I=1,3
        VE1(I)=A(1,I)
46      VE2(I)=A(2,I)
        CALL VECT (CIR,VE1,VE2)
50      O=1.
        CALL UNIT (CIR,O)
        IF (INP-2) 55,56,56
56      WRITE OUTPUT TAPE 6,57,XN(1),XN(2),XN(3),CIR(1),CIR(2),CIR(3)
57      FORMAT(20X,12HCOORDINATES ,3F12.4,4X,7HNORMAL ,3F8.5)
55      RETURN
        END
```

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

```
*       LABEL
CE4BOF
        SUBROUTINE BOFI
C       TO FIND IF THE NODE IS ON BOUNDARY
        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),IBD),(IA(61),IID),(IA(62),
       9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),IIE),(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 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),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       FIND MINIMUM CONNECTIVITY OF INTERNAL NODES (ILIM)
        IC=4
        I56=0
        I4=0
        IMS=2
        LM=LM
        DO 10 I=1,LM
        IF (IC-NEL(I,4)) 15,11,15
11      I4=I4+1
        GO TO 10
15      IF (IMS-NEL(I,5)) 10, 9,10
9       I56=I56+1
10      CONTINUE
        IRES=LM-I4-I56
        IF (LM-I4) 13,12,13
13      IF (LM-I56) 16,14,16
16      IF (LM-IRES) 90,17,90
C       THREE-DIMENSIONAL CONTINUUM
12      ILIM=3
        GO TO 18
C       SHELL OF REVOLUTION
14      ILIM=1
        GO TO 18
C       TWO-DIMENSIONAL CONTINUUM
17      ILIM=2
C       GENERATE LIST OF NODAL LINE SET VIA NODES (NSET)
18      NB=0
        DO 19 I=1,LM
C       FIND SEQUENCE NUMBER OF NODE ICN IN I TH ELEMENT
        IMS=NEL(I,5)
        DO 20 J=1,IMS
        IF (ICN-NEL(I,J+9)) 20,21,20
20      CONTINUE
        GO TO 19
C       FIND SEQUENCE NOS OF NODES AFTER(JP1),BEFORE(JM1),AND ABOVE(JS1)
21      IF (IMS-8) 27,26,26
27      JP1=J+1
        IF (JP1-IMS) 23,23,22
22      JP1=1
23      JM1=J-1
        IF (JM1) 24,24,25
24      JM1=IMS
25      JS1=JP1+1
        IF (JS1-IMS) 28,28,281
281     JS1=1
        GO TO 28
26      KK=((J-1)/4)*4
        JP1=J+1
        IF (JP1-4-KK) 29,29,30
30      JP1=1+KK
29      JM1=J-1
        IF (JM1-KK) 31,31,32
31      JM1=4+KK
32      JS1=9-JP1
C       GENERATE NODAL LINE SET NSET
28      DO 300 K=1,ILIM
        KK=NU(K)
        NB=NB+1
        NSET(NB)=NEL(I,KK+9)
300     CONTINUE
19      CONTINUE
C       GENERATE LIST OF NODES ON BOUNDARY. NBAN ARRAY
        GO TO (601,601,602),ILIM
C       THREE DIMENSIONAL MESH CASE
602     K=0
```

Table VII-57 (contd)

```
      DO 603 I=1,NB,3
      DO 604 L=1,6
      K=K+1
      J=L/2
      IF (J-3) 6031,6032,6032
6032  J=0
6031  IJ=I+J
604   MSET(K)=NSET(IJ)
603   CONTINUE
      KB=K
      MB=0
      DO 605 I=1,KB,2
      I2=I+2
      IF (I2-KB) 6051,6051,605
6051  IF (MSET(I)) 605,605,6052
6052  IJ=0
      DO 606 J=I2,KB,2
      IF (MSET(I)-MSET(J)) 6061,6062,6061
6061  IF (MSET(I)-MSET(J+1)) 606,6063,606
6063  IF (MSET(I+1)-MSET(J)) 606,6064,606
6062  IF (MSET(I+1)-MSET(J+1)) 606,6064,606
6064  MSET(J)=0
      MSET(J+1)=0
      IJ=IJ+1
606   CONTINUE
      IF (IJ-1) 6053,605,44
6053  MMB=MB
      DO 6054 J=1,MMB
      IF (NBAN(J)-MSET(I)) 6054,6055,6054
6054  CONTINUE
      MB=MB+1
      NBAN(MB)=MSET(I)
6055  DO 6056 J=1,MMB
      IF (NBAN(J)-MSET(I+1)) 6056,605,6056
6056  CONTINUE
      MB=MB+1
      NBAN(MB)=MSET(I+1)
605   CONTINUE
      GO TO 6057
601   DO 40 I=1,NB
40    MSET(I)=NSET(I)
      MB=0
      DO 39 I=1,NB
      IF (MSET(I)) 39,39,42
42    NODE=MSET(I)
      KLIM=0
      DO 38 J=1,NB
      IF (NODE-MSET(J)) 38,37,38
37    MSET(J)=0
      KLIM=KLIM+1
38    CONTINUE
      IF (ILIM-2) 411,412,602
411   IF (KLIM-1) 44,43,44
412   IF (KLIM-2) 43,39,449
C     MORE THAN 2 REPETITION IS POSSIBLE IF IGEM=1
449   IF (IGEM-1) 44,39,44
43    MB=MB+1
      NBAN(MB)=NODE
      GO TO 39
44    WRITE OUTPUT TAPE 6,961,ICN
961   FORMAT (I5,15X,44HERROR IN MESH TOPOLOGY.NODE ASSUMED INTERNAL)
      GO TO 90
39    CONTINUE
6057  IF (MB) 90,90,45
45    GO TO (461,462,463),ILIM
461   NBAN(1)=0
      NBAN(2)=0
      IF (MB-1) 44,47,90
462   IF (MB-2) 448,47,448
C     OTHER THAN 2 NEIGHBORING BOUNDARY NODES POSSIBLE IF IGEM=1
448   IF (IGEM-1) 44,90,44
463   IF (MB-3) 44,47,47
C     THE NODE IS ON BOUNDARY
47    INBON=1
      AST=1H*
C     ESTABLISH OUTER NORMAL ON BIR AND AREA ON ARE
      GO TO (48,49,50),ILIM
C     ONE-DIMENSIONAL CONTINUUM, SHELL OF REVOLUTION
48    CALL INER(BIR)
      Q=-1.
      CALL UNIT(BIR,Q)
      ARE=0
      GO TO 90
C     TWO-DIMENSIONAL CONTINUUM
49    CALL INER(SIR)
      K=NBAN(1)
      CALL FINDX(K,X)
      K=NBAN(2)
      CALL FINDX(K,Y)
      DO 491 I=1,3
491   BIR(I)=X(I)-Y(I)
      ARE=1.
      CALL UNIT(BIR,ARE)
      ARE=ARE/2.
      Q=SCAL(BIR,SIR)
      DO 492 I=1,3
492   BIR(I)=SIR(I)-Q*BIR(I)
      IF (SCAL(BIR,SIR)) 493,441,494
441   INBON=0
      GO TO 44
493   Q=1.
      GO TO 495
494   Q=-1.
495   CALL UNIT(BIR,Q)
      GO TO 90
C     THREE-DIMENSIONAL CONTINUUM
50    CALL INER(SIR)
      CALL BEST(BIR,NBAN,MB)
      IF (SCAL(BIR,SIR)) 501,441,502
501   Q=1.
      GO TO 503
502   Q=-1.
503   CALL UNIT(BIR,Q)
      Q=0.
      DO 504 I=1,MB
      K=NBAN(I)
      CALL FINDX(K,XF)
504   Q=Q+SQRTF((XF(1)-XN(1))**2+(XF(2)-XN(2))**2+(XF(3)-XN(3))**2)
      ARE=MB
      ARE=3.14159*(Q/(2.*ARE))**2
90    IF (INP-2) 100,91,91
91    WRITE OUTPUT TAPE 6,92,ICN,AST,MB,(NBAN(I),I=1,MB)
92    FORMAT (I5,A1,14X,21HBOUNDARY NODES FOLLOW,I20/(20X,20I5))
      WRITE OUTPUT TAPE 6,93,NB,(NSET(I),I=1,NB)
93    FORMAT (20X,18HNSET ARRAY FOLLOWS,I20/(20X,20I5))
      WRITE OUTPUT TAPE 6,94,ARE,(BIR(I),I=1,3)
94    FORMAT (20X,5HAREA=,E15.5,5X,12HOUTER NORMAL,2X,3E15.6)
100   RETURN
      END
```

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

```
*     LABEL
CE4CAS4
      SUBROUTINE CAS4
C     DUMMY SUBROUTINE
      RETURN
      END
```

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

```
*       LABEL
CE4COD
      SUBROUTINE CODI
C     TO GENERATE LOCAL-OVERALL COORDINATE TRANSFORMATION 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),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),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),IORDI),(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),IDFF),(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),EL),(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)
      EL=SQRTF(XD(1)*XD(1)+YD(1)*YD(1)+ZD(1)*ZD(1))
      IF (EL) 1010,1010,110
  110 IF (IELT-3) 115,250,115
  115 DIR(1,1)=XD(1)/EL
      DIR(1,2)=YD(1)/EL
      DIR(1,3)=ZD(1)/EL
      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)*3.1415926/180.
      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(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)/EL
      DIR(2,3)=YD(1)/EL
      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-60. Source program listing of subroutine DIMI (Link 4)

```
*       LABEL
CE4DIM
      SUBROUTINE DIMI(K)
C     TO GENERATE AND OUTPUT STRESSES OF ONE-DIMENSIONAL ELEMENTS
      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),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),IORDI),(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),IDFF),(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 VDE(12),PV(6,2),DIR(3,3),DUM(12),PT(24)
      EQUIVALENCE (AA(200),VDE),(AA(212),PV),(AA(224),DUM),(AA(236),EL)
     1,(AA(264),DIR),(AA(273),PT)
C     COMPUTE STRESSES AT THE NODES OF ONE DIMENSIONAL ELEMENTS
      WRITE OUTPUT TAPE 6,1
    1 FORMAT (1H1,29X,70HSTRESS AND MOMENT RESULTANTS  AT THE NODES OF O
     1NE DIMENSIONAL ELEMENTS/30X,70HQUANTITIES ARE IN THE LOCAL COORDIN
     2ATE SYSTEMS AT THE ENDS OF ELEMENTS//18H EL NO. NODE  TYPE,9X,3HN-
     3X,12X,3HQ-Y,12X,3HQ-Z,12X,3HM-X,12X,3HM-Y,12X,3HM-Z)
   10 REWIND ITAS
      IERR=0
      IDS=2*IDEG
      ZGEM=IGEM
      DO 1000 MM=1,IT
  102 READ TAPE ITAS,M,ITTT,ITTM,NAV,IMS,IDS,IDSZ,(N(I),I=1,IMS),(S(I),
     1I=1,IDSZ),(PT(I),P(I),I=1,IDS)
      IF (ITTT-ITTM) 102,105,105
  105 IF (NAV-2) 106,102,106
  106 IF (MM-M) 1100,111,1100
  111 J1M=J1+M
      IELT=IA(J1M)/100
      IF (IELT-4) 110,110,1000
  110 DO 200 I=1,IMS
      J=N(I)
      IXXJ=IXX+J
      IYYJ=IYY+J
      IZZJ=IZZ+J
      X(I)=AA(IXXJ)
      Y(I)=AA(IYYJ)
      Z(I)=AA(IZZJ)*ZGEM
      IF (I-1) 200,200,120
  120 XD(I-1)=X(I)-X(1)
      YD(I-1)=Y(I)-Y(1)
      ZD(I-1)=Z(I)-Z(1)
  200 CONTINUE
      CALL CODI
      DO 250 I=200,235
  250 AA(I)=0.
      DO 300 I=1,3
      DO 300 J=1,3
      DIRT=DIR(I,J)
      DIR(I,J)=DIR(J,I)
      DIR(J,I)=DIRT
  300 CONTINUE
      CALL STRA
      IDEFM=IDEF-IDEG
      LV=0
      DO 370 I=1,IDEG
      IDEFI=IDEFM+I
      DO 360 J=1,IMS
      IDEFJ=IDEFI+IDEG*N(J)
      LV=LV+1
      VDE(LV)=AA(IDEFJ)
  360 CONTINUE
  370 CONTINUE
      CALL TRAN(VDE,0)
      II=-IDS
      DO 415 I=1,IDS
      II=II+IDS
      DO 410 J=1,IDS
      IJ=II+J
      DUM(I)=DUM(I)+S(IJ)*VDE(J)
  410 CONTINUE
  415 CONTINUE
      CALL TRAN (P,0)
      L=0
      DO 418 I=1,6
      DO 417 J=1,2
      L=L+1
      PV(I,J)=DUM(L)-P(L)
  417 CONTINUE
  418 CONTINUE
      IF (IELT-2) 500,420,430
  420 PV(6,1)=PV(3,1)
      PV(6,2)=PV(3,2)
      PV(3,1)=0.
      PV(3,2)=0.
      GO TO 500
  430 IF (IELT-3) 500,440,500
  440 DO 450 J=1,2
      DO 450 I=1,3
      IM=6-I
```

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),IFLT,(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),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),MI),(IA(26),ITY),(IA(27),
     4ISTR),(IA(28),IELT),(IA(29),ITEN),(IA(30),ITIC),(IA(31),IMST),
     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),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),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),IIAS),(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),DN(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),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),DN),(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(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),DIN(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),IMFL),    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),DIN),(AA(235),SR)E4EPN039
      1,(AA(241),XN),(AA(244),XF),(AA(247),ON),(AA(253),OF),(AA(259),RES)E4EPN040
      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 (IMEF-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),ITE),(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
C      GENERATES NEL AND MAC MATRICES OF A NODE
C      TO GENERATE NEL(I,J),MAC(I,J,K),IMEL AND ICLAS(I)
       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),NI(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 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),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)
       DIMENSION NELM(20),NELC(20)
       EQUIVALENCE (MSET,NELM),(MSET(21),NELC)
       LM=LM
       DO 1 I=1,LM
       M=NEL(I,1)
       CALL TOPO
       KELT=IELT
       GO TO (1,1,1,1,3,4,3,4,4,8,3,4,3,4,3,4,2,2),KELT
3      IMS=3
       GO TO 5
4      IMS=4
       GO TO 5
8      IMS=8
       GO TO 5
2      IMS=2
5      GO TO (1,1,1,1,11,11,12,12,14,14,18,18,17,17,13,13,15,16),KELT
11     IC=1
       GO TO 6
12     IC=2
       GO TO 6
14     IC=4
       GO TO 6
18     IC=8
       GO TO 6
17     IC=7
       GO TO 6
13     IC=3
       GO TO 6
15     IC=5
       GO TO 6
16     IC=6
6      NEL(I,2)=IELT
       NEL(I,3)=IMET
       NEL(I,4)=IC
       NEL(I,5)=IMS
       NEL(I,6)=ITIC
       NEL(I,7)=JSDZ
       NEL(I,8)=JPRS
       NEL(I,9)=ITEM
       DO 7 J=1,IMS
7      NEL(I,J+9)=N(J)
       IMS=0
       JSDZ=0
       ITIC=0
       IC=0
1      CONTINUE
       IF (INP-2) 70,71,71
71     WRITE OUTPUT TAPE 6,72,ICN,LM,((NEL(I,J),J=1,17),I=1,LM)
72     FORMAT (I5,15X,18HNEL MATRIX FOLLOWS,I20/(20X,17I5))
70     IMEL=1
       DO 210 I=1,LM
       NELC(I)=NEL(I,4)
210    NELM(I)=NEL(I,3)
       LMT=0
       DO 21 I=1,LM
       IF (NELM(I)) 21,21,211
211    LMT=LMT+1
       IF (LMT-4) 212,212,213
213    WRITE OUTPUT TAPE 6,214,ICN
214    FORMAT (I5,15X,41HMORE THAN 4 MATERIALS, FIRST 4 CONSIDERED)
       LMT=LMT-1
       GO TO 21
212    IMET=NELM(I)
       LCL=0
       DO 22 J=I,LM
       IF (IMET-NELM(J)) 22,220,22
220    IF (NELC(J)) 22,22,221
221    LCL=LCL+1
       IF (LCL-4) 222,222,223
223    WRITE OUTPUT TAPE 6,224,ICN,IMET
224    FORMAT (2I5,10X,39HMORE THAN 4 CLASSES. FIRST 4 CONSIDERED)
       LCL=LCL-1
       GO TO 22
222    ICLA=NELC(J)
       L=1
       MAC(LMT,LCL,1)=0
       DO 23 K=J,LM
       IF (IMET-NELM(K)) 23,231,23
231    IF (ICLA-NELC(K)) 23,232,23
232    NELM(K)=0
       NELC(K)=0
       L=L+1
       IF (L-20) 233,233,234
234    WRITE OUTPUT TAPE 6,235,ICN,IMET,ICLA
235    FORMAT (3I5,5X,42HMORE THAN 19 ELEMENTS. FIRST 19 CONSIDERED)
       L=L-1
       GO TO 23
233    MAC(LMT,LCL,L)=K
       MAC(LMT,LCL,1)=MAC(LMT,LCL,1)+1
23     CONTINUE
22     CONTINUE
       ICLAS(LMT)=LCL
21     CONTINUE
       IMEL=LMT
       IF (INP-2) 90,81,81
81     DO 83 I=1,LMT
       ICLA=ICLAS(I)
       WRITE OUTPUT TAPE 6,82,ICN,I,(J,(MAC(I,J,K),K=1,20),J=1,ICLA)
82     FORMAT(I5,15X,36HMAC MATRICE(S) FOLLOW(S).  MAT.SEQ.=I3/
      1(17X,I3,20I5))
83     CONTINUE
90     RETURN
       END
```

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

```
*      LABEL
CE4INR
       SUBROUTINE INER(CIR)
C      OBTAINS A VECTOR HEADING TOWARDS THE STRUCTURE AT A BOUNDARY NODE
C      TO GENERATE A VECTOR HEADING INTO THE STRUCTURE ON CIR(I)
       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),NI(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 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),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)
       DIMENSION CIR(3)
       CIR(1)=0.
       CIR(2)=0.
       CIR(3)=0.
       DO 1 I=1,NB
       K=NSET(I)
       CALL FINDX(K,XF)
       CIR(1)=CIR(1)+XF(1)-XN(1)
       CIR(2)=CIR(2)+XF(2)-XN(2)
1      CIR(3)=CIR(3)+XF(3)-XN(3)
       RETURN
       END
```

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
      2IHI,(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),IBO),(IA(61),IID),(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),ICFI),(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),IOE4INZ025
      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),QN(6),QF(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),QN),(AA(253),QF),(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),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),
     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),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),
     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),ISI),(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),D2L),(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),IPHG),(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(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)
      DIMENSION U(3,5),CDIS(3),CROT(3),DDIS(3),DROT(3),DCOR(3)
      EQUIVALENCE (X(1),U,DCOR),(X(4),CDIS),(X(7),CROT),(X(10),DDIS),
     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)-DDIS(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                                                                  E4MDN000
      SUBROUTINE MDIN                                                   E4MDN001
C     ORIENTS LOCAL AXES PROPERLY AT A BOUNDARY NODE IN SHELLS          E4MDN002
C     TO ROTATE LOCAL AXES (DIN) SO THAT KSI IS IN ZTA-BIR PLANE        E4MDN003
      DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)         E4MDN004
     1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)              E4MDN005
      COMMON IA,AA                                                      E4MDN006
      EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),E),(D21(20),G)E4MDN007
      EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),II),(IA(4),IP),(IA(5),  E4MDN008
     1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),E4MDN009
     2IH),(IA(11),IB),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),E4MDN010
     3IMFI),(IA(16),IARE),(IA(17),NI1)),(IA(25),MI),(IA(26),ITY),(IA(27),E4MDN011
     4ISTR),(IA(28),IFLT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMFT),    E4MDN012
     5(IA(32),ISUM),(IA(33),INO),(IA(34),IMS),(IA(36),IDS),(IA(37),     E4MDN013
     6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),      E4MDN014
     7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57E4MDN015
     8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBO),(IA(61),IID),(IA(62),E4MDN016
     9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITE),(IA(41),ITAP)         E4MDN017
      EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),    E4MDN018
     1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),       E4MDN019
     2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)              E4MDN020
     3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG), E4MDN021
     4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D2)),(AA(107),P),  E4MDN022
     5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),    E4MDN023
     6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)               E4MDN024
     7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IHE4MDN025
     8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                             E4MDN026
      EQUIVALENCE (IA(349),NIIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346) E4MDN027
     1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)   E4MDN028
     2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)      E4MDN029
     3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)       E4MDN030
     4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)         E4MDN031
     5,(IA(329),IPIR)                                                   E4MDN032
      DIMENSION BIR(3),SIR(3),DIN(3,3),SR(6),XN(3),XF(3),QN(6),QF(6),   E4MDN033
     1RES(6),RED(6),BAS(3),ICLAS(4),NBAN(10),NU(3),NES(3)               E4MDN034
      EQUIVALENCE (AA(200),IONE),(AA(201),ICN),(AA(202),LM),(AA(203),ASTE4MDN035
     1),(AA(204),INBON),(AA(205),ARE),(AA(206),ICLA),(AA(207),IMEL),    E4MDN036
     2(AA(208),IM),(AA(209),IC),(AA(210),ICON),(AA(211),ANGLE),(AA(212),E4MDN037
     3ICAS),(AA(213),IE),(AA(214),NH),(AA(215),MB)                      E4MDN038
     4,(AA(216),IROT),(AA(217),BST)                                     E4MDN039
      EQUIVALENCE (AA(220),BIR),(AA(223),SIR),(AA(226),DIN),(AA(235),SR)E4MDN040
     1,(AA(241),XN),(AA(244),XF),(AA(247),QN),(AA(253),QF),(AA(259),RES)E4MDN041
     2,(AA(265),RED),(AA(271),BAS),(AA(274),ICLAS),(AA(278),NBAN)       E4MDN042
     3,(AA(292),NU),(AA(295),NES)                                       E4MDN043
      DIMENSION NEL(20,17),MAC(4,4,20),IWG(90),DD(6,6),A(90,7),B(8,8),  E4MDN044
     1C(8,2),FF(1),NSET(100),MSET(100),W(3,3)                           E4MDN045
      EQUIVALENCE (AA(14000),FF),(NU(1),JP1),(NU(2),JM1),(NU(3),JS1)    E4MDN046
      EQUIVALENCE (FF(1),NEL),(FF(341),MAC),(FF(661),IWG),(FF(751),DD), E4MDN047
     1(FF(787),A),(FF(1417),B),(FF(1481),C),(FF(1497),NSET),(FF(1597),  E4MDN048
     2MSET),(FF(1697),W)                                                E4MDN049
      DIMENSION XII(3),ETA(3),ZTA(3)                                    E4MDN050
      EQUIVALENCE (DIN(1),XII),(DIN(4),ETA),(DIN(7),ZTA)                E4MDN051
C     SET INDICATORS TO (LOCAL IS DIFFERENT THAN OVERALL)               E4MDN052
      IROT=1                                                            E4MDN053
      BST=2H**                                                          E4MDN054
C     SEE IF A SOLID                                                    E4MDN055
      IF (ICAS-4) 33,31,33                                              E4MDN056
C     SOLID CASE. FIND THE AXIS WHICH MAKES LARGEST ANGLE WITH BIR      E4MDN057
 31   IF (ABSF(BIR(1))-ABSF(BIR(2))) 315,315,316                        E4MDN058
 315  IF (ABSF(BIR(1))-ABSF(BIR(3))) 311,311,313                        E4MDN059
 316  IF (ABSF(BIR(2))-ABSF(BIR(3))) 312,312,313                        E4MDN060
 311  CALL VECT(ETA,BIR,XII)                                            E4MDN061
      GO TO 35                                                          E4MDN062
 312  CALL VECT(SIR,BIR,ETA)                                            E4MDN063
      ETA(1)=SIR(1)                                                     E4MDN064
      ETA(2)=SIR(2)                                                     E4MDN065
      ETA(3)=SIR(3)                                                     E4MDN066
      GO TO 35                                                          E4MDN067
 313  CALL VECT(ETA,BIR,ZTA)                                            E4MDN068
 35   CC=1.                                                             E4MDN069
      CALL UNIT(ETA,CC)                                                 E4MDN070
      CALL VECT(ZTA,BIR,ETA)                                            E4MDN071
      CALL UNIT(ZTA,CC)                                                 E4MDN072
      CALL VECT(XII,ETA,ZTA)                                            E4MDN073
      CALL UNIT(XII,CC)                                                 E4MDN074
      GO TO 22                                                          E4MDN075
C     NON-SOLID CASE                                                    E4MDN076
 33   CC=1.                                                             E4MDN077
      CALL VECT (ETA,ZTA,BIR)                                           E4MDN078
      CALL UNIT (ETA,CC)                                                E4MDN079
      CALL VECT (XII,ETA,ZTA)                                           E4MDN080
      CALL UNIT (XII,CC)                                                E4MDN081
 22   RETURN                                                            E4MDN082
      END                                                               E4MDN083
```

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

```
CE4MET                                                                  E4MET000
      SUBROUTINE META                                                   E4MET001
C     TO GENERATE MATERIAL MATRIX DD IN THE ORDER OF 1,2,12,3,13,23     E4MET002
C     IN LOCAL COORDINATE SYSTEM                                        E4MET003
      DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),E22(3,3)         E4MET004
     1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),GL(1)              E4MET005
      COMMON IA,AA                                                      E4MET006
      EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),E),(D21(20),G)E4MET007
      EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),  E4MET008
     1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),E4MET009
     2IH),(IA(11),I8),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),E4MET010
     3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),E4MET011
     4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),    E4MET012
     5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),     E4MET013
     6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),      E4MET014
     7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57E4MET015
     8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBO),(IA(61),IID),(IA(62),E4MET016
     9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITF),(IA(41),ITAP)         E4MET017
      EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),    E4MET018
     1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),       E4MET019
     2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)              E4MET020
     3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG), E4MET021
     4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),  E4MET022
     5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),    E4MET023
     6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)               E4MET024
     7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IDE4MET025
     8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                             E4MET026
      EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346) E4MET027
     1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)   E4MET028
     2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)      E4MET029
     3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)       E4MET030
     4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)         E4MET031
     5,(IA(329),IPIR)                                                   E4MET032
      DIMENSION BIR(3),SIR(3),DIN(3,3),SR(6),XN(3),XF(3),QN(6),QF(6),   E4MET033
     1RES(6),RED(6),BAS(3),ICLAS(4),NBAN(10),NU(3),NES(3)               E4MET034
      EQUIVALENCE (AA(200),IONE),(AA(201),ICN),(AA(202),LM),(AA(203),ASTE4MET035
     1),(AA(204),INBON),(AA(205),ARE),(AA(206),ICLA),(AA(207),IMEL),    E4MET036
     2(AA(208),IM),(AA(209),IC),(AA(210),ICON),(AA(211),ANGLE),(AA(212),E4MET037
     3ICAS),(AA(213),IE),(AA(214),NB),(AA(215),MB)                      E4MET038
     4,(AA(216),IROT),(AA(217),BST)                                     E4MET039
      EQUIVALENCE (AA(220),BIR),(AA(223),SIR),(AA(226),DIN),(AA(235),SR)E4MET040
     1,(AA(241),XN),(AA(244),XF),(AA(247),QN),(AA(253),QF),(AA(259),RES)E4MET041
     2,(AA(265),RED),(AA(271),BAS),(AA(274),ICLAS),(AA(278),NBAN)       E4MET042
     3,(AA(292),NU),(AA(295),NES)                                       E4MET043
      DIMENSION NEL(20,17),MAC(4,4,20),IWG(90),DD(6,6),A(90,7),B(8,8),  E4MET044
     1C(8,2),FF(1),NSET(100),MSET(100),W(3,3)                           E4MET045
      EQUIVALENCE (AA(4000),FF),(NU(1),JP1),(NU(2),JM1),(NU(3),JS1)     E4MET046
      EQUIVALENCE (FF(1),NEL),(FF(341),MAC),(FF(661),IWG),(FF(751),DD), E4MET047
     1(FF(787),A),(FF(1417),B),(FF(1481),C),(FF(1497),NSET),(FF(1597),  E4MET048
     2MSET),(FF(1697),W)                                                E4MET049
C     INITIALIZE DD ALPHA CONSTANTS                                     E4MET050
      DO 10 I=1,6                                                       E4MET051
      DO 10 J=1,6                                                       E4MET052
   10 DD(I,J)=0.                                                        E4MET053
      AL1=0.                                                            E4MET054
      AL2=0.                                                            E4MET055
      AL3=0.                                                            E4MET056
C     INQUIRE THE TYPE AND GENERATE DD IN THE ORDER OF 1,2,3,12,13,23   E4MET057
      IF (ITYPE-1) 20,30,40                                             E4MET058
C     ISOTROPIC MATERIAL                                                E4MET059
   20 IIDI=IID+(IMET-1)*2                                               E4MET060
      E=AA(IIDI+1)                                                      E4MET061
      G=AA(IIDI+2)                                                      E4MET062
      IIAI=IIA+IMET                                                     E4MET063
      AL1=AA(IIAI)                                                      E4MET064
      AL2=AL1                                                           E4MET065
      AL3=AL1                                                           E4MET066
      PU=E/(2.*G)-1.                                                    E4MET067
      IF (ISTR-1) 209,210,209                                           E4MET068
  209 IF (ICAS-3) 208,210,208                                           E4MET069
  208 IF (ICAS-4) 207,210,207                                           E4MET070
  207 E1=E/(1.-PU*PU)                                                   E4MET071
      E2=E1*PU                                                          E4MET072
      K=2                                                               E4MET073
      GO TO 220                                                         E4MET074
  210 K=3                                                               E4MET075
      E1=E*(1.-PU)/((1.-2.*PU)*(1.+PU))                                 E4MET076
      E2=E*PU/((1.-2.*PU)*(1.+PU))                                      E4MET077
  220 DO 201 I=1,K                                                      E4MET078
      DO 201 J=I,K                                                      E4MET079
      IF (I-J) 203,202,203                                              E4MET080
  202 DD(I,J)=E1                                                        E4MET081
      DD(I+3,J+3)=G                                                     E4MET082
      GO TO 201                                                         E4MET083
  203 DD(I,J)=E2                                                        E4MET084
  201 CONTINUE                                                          E4MET085
      IF (K-2) 60,204,60                                                E4MET086
  204 DD(6,6)=G                                                         E4MET087
      GO TO 60                                                          E4MET088
C     ORTHOTROPIC MATERIAL                                              E4MET089
   30 IIAI=IIA+(IMET-1)*2                                               E4MET090
      AL1=AA(IIAI+1)                                                    E4MET091
      AL2=AA(IIAI+2)                                                    E4MET092
      IIDI=IID+(IMET-1)*9                                               E4MET093
      DD(1,1)=AA(IIDI+1)                                                E4MET094
      DD(1,2)=AA(IIDI+2)                                                E4MET095
      DD(1,4)=AA(IIDI+3)                                                E4MET096
      DD(2,2)=AA(IIDI+4)                                                E4MET097
      DD(2,4)=AA(IIDI+5)                                                E4MET098
      DD(4,4)=AA(IIDI+6)                                                E4MET099
      DD(5,5)=AA(IIDI+7)                                                E4MET100
      DD(5,6)=AA(IIDI+8)                                                E4MET101
      DD(6,6)=AA(IIDI+9)                                                E4MET102
      IF (ISTR-1) 60,301,60                                             E4MET103
  301 DD(1,3)=DD(1,2)                                                   E4MET104
      DD(2,3)=DD(1,2)                                                   E4MET105
      GO TO 60                                                          E4MET106
C     GENERAL HOOKIAN MATERIAL                                          E4MET107
   40 IIAI=IIA+(IMET-1)*3                                               E4MET108
      AL1=AA(IIAI+1)                                                    E4MET109
      AL2=AA(IIAI+2)                                                    E4MET110
      AL3=AA(IIAI+3)                                                    E4MET111
      IIDI=IID+(IMET-1)*21                                              E4MET112
      DO 401 I=1,6                                                      E4MET113
      DO 401 J=I,6                                                      E4MET114
      IIDI=IIDI+1                                                       E4MET115
  401 DD(I,J)=AA(IIDI)                                                  E4MET116
C     OBTAIN THE SYMMETRIC HALF                                         E4MET117
   60 DO 61 I=1,6                                                       E4MET118
      DO 61 J=I,6                                                       E4MET119
   61 DD(J,I)=DD(I,J)                                                   E4MET120
C     ROTATE MATERIAL AXES IF NECESSARY SO THAT THEY COINCIDE WITH DIN  E4MET121
      IF (IROT) 71,70,71                                                E4MET122
   71 CALL ROTA                                                         E4MET123
C     SWITCH COLUMNS AND ROWS 3 AND 4 TO GET THE ORDER 1,2,12,3,13,23   E4MET124
   70 DO 62 I=1,6                                                       E4MET125
      E1=DD(4,I)                                                        E4MET126
      DD(4,I)=DD(3,I)                                                   E4MET127
   62 DD(3,I)=E1                                                        E4MET128
      DO 63 I=1,6                                                       E4MET129
      E1=DD(I,4)                                                        E4MET130
      DD(I,4)=DD(I,3)                                                   E4MET131
   63 DD(I,3)=E1                                                        E4MET132
      IF (INP-2) 100,91,91                                              E4MET133
   91 WRITE OUTPUT TAPE 6,92,ICN,BST,IMET,((DD(I,J),J=1,6),I=1,6)       E4MET134
   92 FORMAT (I5,10X,A2,3X,57HMATERIAL MATRIX (IN 1,2,12,3,13,23 ORDER) E4MET135
     1FOLLOWS,  MAT.=,I3/(20X,6E14.5))                                  E4MET136
  100 RETURN                                                            E4MET137
      END                                                               E4MET138
```

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

```
*      LABEL
CE4UAD
       SUBROUTINE QUAD
C      FINDS LOCAL COORINATE AXES BY BEST FIT QUADRATIC IN SHELLS
C      TO ESTABLISH DIN(3,3) AND ANGLE BY BEST FIT QUADRATIC SURFACE (9P)
       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),IIY),(IA(27),
      4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMETI,
      5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),
      6IORO),(IA(38),IORDI),(IA(39),ACEL ),(IA(50),JI),(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),II9),(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),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),ID/)
      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),ASTE
      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),E
      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),AI90,7),B(8,8),
      1C(8,2),FF(1),NSET(100),MSET(100),W(3,3)
       EQUIVALENCE (AA(14000),FF),(NU(1),JPL),(NU(2),JML),(NU(3),JSL)
       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),D(50,9)
       EQUIVALENCE (DIN(1),XII),(DIN(4),ETA),(DIN(7),ZTA),(A,D)
C      FIND THE SET OF NODES TO BE USED AND LIST THEM IN NSET ARRAY
       IC=IC
       IM=IM
       IE=MAC(IM,IC,1)+1
       K=0
       DO 10 I=2,IE
       IELT=MAC(IM,IC,I)
       IMS=NEL(IELT,5)
       DO 9 J=1,IMS
       K=K+1
 9     MSET(K)=NEL(IELT,J+9)
 10    CONTINUE
C      OBTAIN GENERAL DIRECTION OF MIDDLE SURFACE NORMAL ON ZD
       I=MSET(1)
       CALL FINDX(I,X)
       I=MSET(2)
       CALL FINDX(I,Y)
       XD(1)=Y(1)-X(1)
       XD(2)=Y(2)-X(2)
       XD(3)=Y(3)-X(3)
       I=MSET(3)
       CALL FINDX(I,X)
       YD(1)=X(1)-Y(1)
       YD(2)=X(2)-Y(2)
       YD(3)=X(3)-Y(3)
       CALL VECT (ZD,XD,YD)
       NB=0
       DO 13 I=1,K
       IF (MSET(I)) 13,13,131
 131   NODE=MSET(I)
       NB=NB+1
       NSET(NB)=NODE
       DO 12 J=I,K
       IF (NODE-MSET(J)) 12,121,12
 121   MSET(J)=0
 12    CONTINUE
 13    CONTINUE
C      SEE IF THERE ARE ENOUGH NODES
       IF (NB-9) 16,15,15
C      NOT ENOUGH. EXPAND THE POPULATION
 16    CALL EPAN
 15    IF (INP-2) 17,18,18
 18    WRITE OUTPUT TAPE 6,181,NB,(NSET(I),I=1,NB)
 181   FORMAT (20X,47HNODE SET FOR BEST FIT QUADRATIC SURFACE FOLLOWS,I10
      1/(20X,20I5))
C      FIND CRUDE DIRECTION FOR MIDDLE SURFACE NORMAL
 17    CALL BEST(ZTA,NSET,NB)
       Q=ZTA(1)**2+ZTA(2)**2+ZTA(3)**2
       IF (Q) 172,171,172
 171   ZTA(1)=ZD(1)
       ZTA(2)=ZD(2)
       ZTA(3)=ZD(3)
C      GENERATE FIRST APPROXIMATION FOR DIN
 172   ICAT=0
       XII(1)=BAS(1)
       XII(2)=BAS(2)
       XII(3)=BAS(3)
 203   Q=1.
       IF (SCAL(ZD,ZTA)) 201,201,202
 201   Q=-1.
 202   CALL UNIT (ZTA,Q)
       CALL VECT (ETA,ZTA,XII)
       CALL UNIT (ETA,Q)
       CALL VECT (XII,ETA,ZTA)
       CALL UNIT (XII,Q)
       IF (NB-9) 19,20,20
 19    WRITE OUTPUT TAPE 6,191,ICN
 191   FORMAT (I5,13X,71HNOT ENOUGH INFORMATION FOR BEST FIT QUADRATIC. B
      1EST FIT PLANE IS USED. )
       GO TO 100
C      SEE IF THIS DIN IS ACCEPTABLE
 20    IF (ICAT-2) 204,205,205
C      NOT ACCEPTABLE, CONTINUE ITERATION
 204   L=0
C      GENERATE EQUATIONS FOR THE COEFFICIENTS OF BEST FIT QUADRATIC
       DO 25 I=1,NB
       NODE=NSET(I)
       IF (ICN-NODE) 21,25,21
 21    CALL FINDX(NODE,XF)
       DO 211 J=1,3
       X(J)=0.
       DO 212 K=1,3
 212   X(J)=X(J)+(XF(K)-XN(K))*DIN(K,J)
 211   CONTINUE
       L=L+1
       D(L,1)=X(1)**2
       D(L,2)=X(2)**2
       D(L,3)=X(3)**2
       D(L,4)=X(1)*X(2)
       D(L,5)=X(1)*X(3)
       D(L,6)=X(2)*X(3)
       D(L,7)=X(1)
       D(L,8)=X(2)
       D(L,9)=X(3)
 25    CONTINUE
C      OBTAIN THE LEAST SQUARE EQUATIONS
       DO 28 I=1,8
       DO 27 J=I,8
       B(I,J)=0.
       DO 291 K=1,L
 291   B(I,J)=B(I,J)+D(K,I)*D(K,J)
 27    B(J,I)=B(I,J)
       C(I,1)=0.
       DO 26 K=1,L
 26    C(I,1)=C(I,1)+D(K,I)*D(K,9)
 28    CONTINUE
C      SOLVE FOR THE COEFFICIENTS
       CALL INV(B,8,C,1,DET)
       IF (DET) 29,19,29
 29    ZTA(1)=XII(1)*C(7,1)+ETA(1)*C(8,1)-ZTA(1)
       ZTA(2)=XII(2)*C(7,1)+ETA(2)*C(8,1)-ZTA(2)
       ZTA(3)=XII(3)*C(7,1)+ETA(3)*C(8,1)-ZTA(3)
       ICAT=ICAT+1
       GO TO 203
C      DIN ACCEPTABLE. SEE IF PRINCIPAL CURVATURE DIRECTIONS ARE REQUIRED
 205   ANGLE=0.
       IF (IPIR-1) 100,206,206
C      YES, ROTATE DIN AROUND ZTA UNTILL XII,ETA PRINCIPAL
 206   FC=C(1,1)-C(2,1)
       ER=ABSF(C(1,1))+ABSF(C(2,1))
       ER=ER*1.E-2
       IF(ABSF(FC)-ER) 24,24,34
 34    ANGLE=ATANF (C(4,1)/FC)/2.
       GO TO 341
 24    ANGLE=0.
 341   CES=COSF(ANGLE)
       SEN=SINF(ANGLE)
C      COMPUTE CURVATURES
       X(1)=CES*CES*C(1,1)+SEN*SEN*C(2,1)+2.*CES*SEN*C(4,1)
       X(2)=SEN*SEN*C(1,1)+CES*CES*C(2,1)-2.*CES*SEN*C(4,1)
C      FIND SMALLER CURVATURE DIRECTION
       IF (ABSF(X(1))-ABSF(X(2))) 343,100,342
 342   FC=CES
       CES=-SEN
       SEN=FC
C      BRING XII ON SMALLER CURVATURE DIRECTION
 343   DO 35 I=1,3
       X(I)=CES*DIN(I,1)+SEN*DIN(I,2)
       Y(I)=CES*DIN(I,2)-SEN*DIN(I,1)
 35    CONTINUE
       DO 36 I=1,3
       DIN (I,1)=X(I)
 36    DIN (I,2)=Y(I)
       ANGLE=ANGLE*180./3.14159
 100   RETURN
       END
```

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),G1(1)
      COMMON IA,AA
      EQUIVALENCE(IA,AA),(D21,D33),(D21(10),F22),(D21(19),F1),(D21(20),G)
      EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),
     1IPRS),(IA(6),ITYPE),(IA(7),IPAT),(IA(8),IDFG),(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),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),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),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),JMFI),(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),INBDN),(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),ZO(7),G1(1)              E4ROT005
      COMMON IA,AA                                                      E4ROT006
      EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),E),(D21(20),G1E4ROT007
      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),ZO),(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),JARF),(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),INRDN),(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(2,1)*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),IMET),   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),IBO),(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),TF),(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),ISDI),(IA(347),ISDY),(IA(346) F4SAM026
      1,ISD7),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)   F4SAM027
      2,(IA(341),JSD7),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)      F4SAM028
      3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),ID7)       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),INBDN),(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),IF),(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(4000),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
      SUBROUTINE SETA
C     GENERATES STRAIN-DEFLECTION RELATIONSHIP AT A NODAL LINE
      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),IR),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),
     3IMFI),(IA(16),IARE),(IA(17),NI1),(IA(25),M),(IA(26),ITY),(IA(27),
     4ISTR),(IA(28),IELT),(IA(29),IEMI),(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),IBD),(IA(60),IBO),(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),IDFF),(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),JIO),(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),IE),(AA(214),NU),(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),DCAR(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),DDIS(3),DROT(3),DCOR(3),ZTA(3)
      EQUIVALENCE (X(1),U,DCOR),(X(4),CDIS),(X(7),CROT),(X(10),DDIS),
     1(X(13),DROT),(DCAR,XF)
      EQUIVALENCE (NES(1),ICOL),(NES(2),IRIG),(NES(3),IDR),(DIN(7),ZTA)
C     INITIALIZE
      IELT=IELT
      IMS=NEL(IELT,5)
C     GENERATE STRAIN-DEFLECTION EQUATIONS FOR EVERY NODAL LINE
      DO 12 II=1,IMS
      K=NEL(IELT,II+9)
      IF (K-ICN) 13,12,13
C     FIND RELATIVE COORDNTS.AND DEFLNS.OF NODE K IN OVERALL SYSTEM
 13   CALL FINDX(K,XF)
      CALL FINDQ(K,QF)
      DO 161 I=1,15
 161  X(I)=0.
      DCOR(1)=XF(1)-XN(1)
      DCOR(2)=XF(2)-XN(2)
      DCOR(3)=XF(3)-XN(3)
      IDEG=IDEG
      DO 14 I=1,IDEG
 14   RED(I)=QF(I)-ON(I)
C     SEPARATE DEFLECTIONS INTO DISPLACEMENTS AND ROTATIONS
      KS=0
      KB=1
      IF (ICAS-2) 16,15,16
 16   IF (ICAS-6) 18,17,18
 15   KS=2
      GO TO 18
 17   KB=3
      KS=3
 18   DO 19 I=1,IDEG
      IK=I
      IF (I-KB)21,20,20
 20   IK=I+KS
 21   IF(IK-3) 22,22,23
 22   CDIS(IK)=ON(I)
      DDIS(IK)=RED(I)
      GO TO 19
 23   IK=IK-3
      CROT(IK)=ON(I)
      DROT(IK)=RED(I)
 19   CONTINUE
C     TRANSFORM COORDNTS.AND DEFLNS.INTO LOCAL IF NECESSARY
      IF (IROT) 25,24,25
 25   DO 26 J=1,5
      DO 27 I=1,3
      SIR(I)=0.
      DO 28 L=1,3
 28   SIR(I)=SIR(I)+DIN(L,I)*U(L,J)
 27   CONTINUE
      DO 29 I=1,3
 29   U(I,J)=SIR(I)
 26   CONTINUE
 24   ICON=ICON+1
      ICOL=ICOL
C     COMPUTE THE LENGTH AND THE UNIT VECTOR OF THE NODAL LINE
      DCAR(1)=DCOR(1)
      DCAR(2)=DCOR(2)
      DCAR(3)=DCOR(3)
      CL=1.
      CALL UNIT(DCAR,CL)
C     GENERATE LEFTHAND SIDE
      DO 30 I=1,ICOL
      I1=I
      I2=I
      IS=I
      GO TO (37,37,31,32,33,34),IS
 31   I1=1
      I2=2
      GO TO 37
 32   I1=3
      I2=3
      GO TO 37
 33   I1=1
      I2=3
      GO TO 37
 34   I1=2
      I2=3
 37   A(ICON,I)=DCAR(I1)*DCAR(I2)
 30   CONTINUE
C     SET THE UNIT VECTOR,IN ZTA DIRECTION IN THE SYSTEM OF DCOR
      RED(1)=0.
      RED(2)=0.
      RED(3)=1.
C     GENERATE RIGHTHAND SIDE(S)
      IRIG=IRIG
      DO 40 I=1,IRIG
      ICL=ICOL+I
      IF (I-1) 45,45,50
 45   IF (IDR) 50,46,50
C     LINEAL STRAIN CASE
 46   CC=0.
      IF (DT) 47,49,47
 47   IF (ITYPE) 48,471,48
 471  CC=AL1*DT
      GO TO 49
 48   CALL TEMP(CC)
      CC=CC*DT
 49   A(ICON,ICL)=SCAL(DDIS,DCAR)/CL-CC
      GO TO 40
C     CHANGE OF CURVATURE CASE
 50   CC=0.
      IF (DG) 57,59,57
 57   IF (ITYPE) 58,571,58
 571  CC=AL1*DG
      GO TO 59
 58   CALL TEMP(CC)
      CC=CC*DG
 59   DC=SCAL(DROT,DCAR)
      DO 592 J=1,3
 592  DROT(J)=DROT(J)-DC*DCAR(J)
      CALL VECT (SIR,RED,DCAR)
      DC=1.
      CALL UNIT(SIR,DC)
      DC=SCAL(SIR,DROT)/CL
      A(ICON,ICL)=DC-CC
 40   CONTINUE
      IWG(ICON)=1
      MB=MB
      IF (INBON) 71,70,71
 71   DO 72 I=1,MB
      IF (NBAN(I)-K) 72,73,72
 72   CONTINUE
      GO TO 70
 73   IWG(ICON)=10
 70   IF (INP-2) 12,61,61
 61   WRITE OUTPUT TAPE 6,62,ICN,K,(A(ICON,J),J=1,7),IWG(ICON)
 62   FORMAT (I5,3X,2HTO,I5,5X,7F13.5,I5)
 12   CONTINUE
      RETURN
      END
```

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

```
*      LABEL
CE4STA
       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),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),IDRO),(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),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),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),IDRO),(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),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),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)
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                                                                   E4TMP000
        SUBROUTINE TEMP(CC)                                              E4TMP001
C       COMPUTES NODAL LINE VECTOR IN ORIGINAL MATERIAL AXES             E4TMP002
C       TO COMPUTE LENGTH CHANGE PER UNIT TEMPERATURE PER UNIT DISTANCE  E4TMP003
        DIMENSION IA(1),AA(1),S(1),N(8),D21(21),D33(3,3),F22(3,3)        E4TMP004
       1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)             E4TMP005
        COMMON IA,AA                                                     E4TMP006
        EQUIVALENCE(IA,AA),(D21,D33),(D21(10),E22),(D21(19),E),(D21(20),GIE4TMP007
        EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),  E4TMP008
       1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),E4TMP009
       2IH),(IA(11),IB),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),E4TMP010
       3IMFI),(IA(16),IARE),(IA(17),N(1)),(IA(25),M),(IA(26),ITY),(IA(27),E4TMP011
       4ISTR),(IA(28),IELT),(IA(29),ITEM),(IA(30),ITIC),(IA(31),IMET),    E4TMP012
       5(IA(32),ISUM),(IA(33),IND),(IA(34),IMS),(IA(36),IDS),(IA(37),     E4TMP013
       6IORD),(IA(38),IORD1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),      E4TMP014
       7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57E4TMP015
       8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBO),(IA(61),IID),(IA(62),E4TMP016
       9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITE),(IA(41),ITAP)         E4TMP017
        EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),    E4TMP018
       1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),       E4TMP019
       2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)              E4TMP020
       3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG), E4TMP021
       4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),D21),(AA(107),P),  E4TMP022
       5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),    E4TMP023
       6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)               E4TMP024
       7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IUE4TMP025
       8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                             E4TMP026
        EQUIVALENCE (IA(349),NTIC),(IA(348),ISOT),(IA(347),ISOY),(IA(346) E4TMP027
       1,ISOZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)   E4TMP028
       2,(IA(341),JSOZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)      E4TMP029
       3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)       E4TMP030
       4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)         E4TMP031
       5,(IA(329),IPIR)                                                   E4TMP032
        DIMENSION BIR(3),SIR(3),DIN(3,3),SR(6),XN(3),XF(3),ON(6),OF(6),   E4TMP033
       1RES(6),RED(6),BAS(3),ICLAS(4),MBAN(10),NU(3),NFS(3)               E4TMP034
        EQUIVALENCE (AA(200),IDMF),(AA(201),ICN),(AA(202),LM),(AA(203),ASTE4TMP035
       1),(AA(204),INBON),(AA(205),ARE),(AA(206),ICLA),(AA(207),IMFL),    E4TMP036
       2(AA(208),IM),(AA(209),IC),(AA(210),ICON),(AA(211),ANGLE),(AA(212),E4TMP037
       3ICAS),(AA(213),IE),(AA(214),NB),(AA(215),MB)                      E4TMP038
       4,(AA(216),IROT),(AA(217),BS1)                                     E4TMP039
        EQUIVALENCE (AA(220),BIR),(AA(223),SIR),(AA(226),DIN),(AA(235),SR)E4TMP040
       1,(AA(241),XN),(AA(244),XF),(AA(247),ON),(AA(253),OF),(AA(259),RES)E4TMP041
       2,(AA(265),RED),(AA(271),BAS),(AA(274),ICLAS),(AA(278),NBAN)       E4TMP042
       3,(AA(292),NU),(AA(295),NFS)                                       E4TMP043
        DIMENSION NEL(20,17),MAC(4,4,20),IWG(90),DD(6,6),A(90,7),B(8,8),  E4TMP044
       1C(8,2),FF(1),NSET(100),MSET(100),W(3,3)                           E4TMP045
        EQUIVALENCE (AA(14000),FF),(NU(1),JP1),(NU(2),JM1),(NU(3),JS1)    E4TMP046
        EQUIVALENCE (FF(1),NEL),(FF(341),MAC),(FF(661),IWG),(FF(751),DD), E4TMP047
       1(FF(787),A),(FF(1417),B),(FF(1481),C),(FF(1497),NSET),(FF(1597),  E4TMP048
       2MSET),(FF(1697),W)                                                E4TMP049
C       COMPUTE THE NODAL LINE VECTOR IN THE ORIGINAL MATERIAL AXES       E4TMP050
C       XF,DCAR EQUIVALENCED IN SETA, CONTAIN UNIT VECTOR OF NODAL LINE   E4TMP051
        DO 10 I=1,3                                                       E4TMP052
        SIR(I)=0.                                                         E4TMP053
        DO 9 K=1,3                                                        E4TMP054
 9      SIR(I)=SIR(I)+W(I,K)*XF(K)                                        E4TMP055
 10     CONTINUE                                                          E4TMP056
C       COMPUTE THE REQUIRED QUANTITY                                     E4TMP057
        CC=AL1*SIR(1)**2+AL2*SIR(2)**2+AL3*SIR(3)**2                      E4TMP058
        RETURN                                                            E4TMP059
        END                                                               E4TMP060
```

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

```
*       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-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),GIE4TOP006
        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
       9IIA),(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),ISOT),(IA(347),ISOY),(IA(346) E4TOP026
       1,ISOZ),(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
        JSOZ=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
        JSOZ=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                                                                  E4TRN000
       SUBROUTINE TRAN (A,IFS)                                          E4TRN001
C      FOR LOCAL-OVERALL COORDINATE TRANSFORMATION FOR VECTORS          E4TRN002
       DIMENSION IA(1),AA(1),S(1),N(8),O21(21),O33(3,3),E22(3,3)        E4TRN003
      1,P(24),UV(24),X(8),Y(8),Z(8),XD(7),YD(7),ZD(7),G1(1)             E4TRN004
       COMMON IA,AA                                                     E4TRN005
       EQUIVALENCE(IA,AA),(O21,O33),(O21(10),E22),(O21(19),E),(O21(20),GE4TRN006
       EQUIVALENCE (IA(1),IN),(IA(2),IBN),(IA(3),IT),(IA(4),IP),(IA(5),  E4TRN007
      1IPRS),(IA(6),ITYPE),(IA(7),IMAT),(IA(8),IDEG),(IA(9),INX),(IA(10),E4TRN008
      2IH),(IA(11),I8),(IA(12),IMMX),(IA(13),IMMY),(IA(14),IMMZ),(IA(15),E4TRN009
      3IMFI),(IA(16),IARE),(IA(17),M(1)),(IA(25),M),(IA(26),ITY),(IA(27),E4TRN010
      4ISTR),(IA(28),IFLT),(IA(29),ITEM),(IA(30),ITTC),(IA(31),IMET),    E4TRN011
      5(IA(32),ISUM),(IA(33),INO),(IA(34),IMS),(IA(36),IOS),(IA(37),     E4TRN012
      6IORD),(IA(38),IORO1),(IA(39),ACEL ),(IA(50),J1),(IA(51),J2),      E4TRN013
      7(IA(52),J3),(IA(53),J4),(IA(54),J5),(IA(55),J6),(IA(56),J7),(IA(57E4TRN014
      8),J8),(IA(58),JTY),(IA(59),IBB),(IA(60),IBD),(IA(61),IID),(IA(62),E4TRN015
      9IIA),(IA(63),IDT),(IA(64),IDY),(IA(65),ITE),(IA(41),ITAP)         E4TRN016
       EQUIVALENCE (IA(66),ICAR),(IA(67),ICIX),(IA(68),ICIY),(IA(69),    E4TRN017
      1ICIZ),(IA(70),ICFI),(IA(71),IXX),(IA(72),IYY),(IA(73),IZZ),       E4TRN018
      2(IA(74),IIC),(IA(75),IDEF),(IA(76),IST),(IA(77),IIS)              E4TRN019
      3,(IA(78),IGEM),(IA(79),IERR),(AA(80),TE),(AA(81),DT),(AA(82),DG), E4TRN020
      4(AA(83),AL1),(AA(84),AL2),(AA(85),AL3),(AA(86),O21),(AA(107),P),  E4TRN021
      5(AA(131),UV),(AA(155),X),(AA(163),Y),(AA(171),Z),(AA(179),XD),    E4TRN022
      6(AA(186),YD),(AA(193),ZD),(AA(351),S),(AA(40),ZGEM)               E4TRN023
      7,(AA(42),INP),(AA(43),IPBG),(AA(44),IPEN),(AA(45),CONS),(AA(46),IUE4TRN024
      8),(AA(47),G1),(AA(48),G2),(AA(49),G3)                            E4TRN025
       EQUIVALENCE (IA(349),NTIC),(IA(348),ISDT),(IA(347),ISDY),(IA(346) E4TRN026
      1,ISDZ),(IA(345),J9),(IA(344),J10),(IA(343),JPRS),(IA(342),JSDY)   E4TRN027
      2,(IA(341),JSDZ),(IA(340),JARE),(IA(339),JMMX),(IA(338),JMMY)      E4TRN028
      3,(IA(337),JMMZ),(IA(336),JMFI),(IA(335),ITAS),(IA(334),IDZ)       E4TRN029
      4,(IA(333),IPR),(AA(332),DGY),(AA(331),DGZ),(AA(330),PRES)         E4TRN030
      5,(IA(329),IPTR)                                                  E4TRN031
       DIMENSION EM(4,4),EN(4,4),Q(4,4),DIR(3,3),DUM(18)                E4TRN032
       EQUIVALENCE (AA(200),EM),(AA(216),EN),(AA(232),EQ),(AA(248),Q),  E4TRN033
      1(AA(264),DIR),(AA(273),DUM)                                      E4TRN034
       DIMENSION A(1)                                                   E4TRN035
 10    IGEMP=IGEM+1                                                     E4TRN036
       LJI=0                                                            E4TRN037
       LK=IFS-4*IMS                                                     E4TRN038
 20    DO 300 L=1,IGEMP                                                 E4TRN039
       LK=LK+3*IMS                                                      E4TRN040
 30    DO 200 J=1,3                                                     E4TRN041
       DO 200 I=1,IMS                                                   E4TRN042
       LJI=LJI+1                                                        E4TRN043
       DUM(LJI)=0.                                                      E4TRN044
       LKI=LK+I                                                         E4TRN045
 40    DO 100 K=1,3                                                     E4TRN046
       LKI=LKI+IMS                                                      E4TRN047
  100  DUM(LJI)=DUM(LJI)+DIR(K,J)*A(LKI)                                E4TRN048
  200  CONTINUE                                                         E4TRN049
  300  CONTINUE                                                         E4TRN050
       INI=3*IGEMP*IMS                                                  E4TRN051
       DO 400 I=1,INI                                                   E4TRN052
       II=IFS+I                                                         E4TRN053
  400  A(II)=DUM(I)                                                     E4TRN054
       RETURN                                                           E4TRN055
       END                                                              E4TRN056
```

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

```
*      LABEL
CE4UNT                                                                  E4UNT000
       SUBROUTINE UNIT(CIR,Q)                                           E4UNT001
C      OBTAINS A UNIT VECTOR ALONG A LINE SEGMENT                       E4UNT002
C      IF Q=NEGATIVE, CHANGE DIRECTION AND REPLACE WITH UNITY, Q=LENGTH E4UNT003
C      IF Q=0, MAKE Q=LENGTH*LENGTH AND RETURN                          E4UNT004
C      IF Q=POSITIVE, REPLACE WITH UNITY,  Q=LENGTH                     E4UNT005
       DIMENSION CIR(3)                                                 E4UNT006
       R=CIR(1)**2+CIR(2)**2+CIR(3)**2                                  E4UNT007
       IF (Q) 10,19,20                                                  E4UNT008
 19    Q=R                                                              E4UNT009
       GO TO 21                                                         E4UNT010
 10    CIR(1)=-CIR(1)                                                   E4UNT011
       CIR(2)=-CIR(2)                                                   E4UNT012
       CIR(3)=-CIR(3)                                                   E4UNT013
 20    Q=SQRTF(R)                                                       E4UNT014
       CIR(1)=CIR(1)/Q                                                  E4UNT015
       CIR(2)=CIR(2)/Q                                                  E4UNT016
       CIR(3)=CIR(3)/Q                                                  E4UNT017
 21    RETURN                                                           E4UNT018
       END                                                              E4UNT019
```

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

```
*      LABEL
CE4VCT                                                                  E4VCT000
       SUBROUTINE VECT(A,B,C)                                           E4VCT001
C      PERFORMS VECTORIAL VECTOR PRODUCT                                E4VCT002
C      TO OBTAIN A AS BXC                                               E4VCT003
       DIMENSION A(3),B(3),C(3)                                         E4VCT004
       A(1)=B(2)*C(3)-B(3)*C(2)                                         E4VCT005
       A(2)=B(3)*C(1)-B(1)*C(3)                                         E4VCT006
       A(3)=B(1)*C(2)-B(2)*C(1)                                         E4VCT007
       RETURN                                                           E4VCT008
       END                                                              E4VCT009
```

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