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FINLIN USER'S MANUAL

M. B. Roy

PURDUE UNIVERSITY
INDIANA STATE HIGHWAY COMMISSION

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User's Manual
FINLIN USER'S MANUAL

TO: J. F. McLaughlin, Director
Joint Highway Research Project
May 5, 1976

FROM: H. L. Michael, Associate Director
Joint Highway Research Project
Project: C-36-62F
File: 9-8-6

The attached "FINLIN User's Manual" is provided for the computer program FINLIN developed in the HPR Part II Research Study "Performance of Pipe Culverts Buried in Soil". Its development and formulation is reported in the Interim Report "Predicting Performance of Pipe Culverts Buried in Soil", M. B. Roy, JHRP-76-15, May 1976.

This Report and its companion volume, JHRP-76-15, were presented to the JHRP Board at its meeting on May 5, 1976, and accepted as fulfillment of the objectives of Phase I of the Study. It is now forwarded for review, comment and similar acceptance by ISHC and FHWA.

Respectfully submitted,

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16. Abstract This is a User's Manual for the Computer Program FINLIN (Finite element, Isoparametric, Non-Linear with Interaction and No-tension). It is a finite element computer program for analysis of flexible pipe culverts buried in soil. Details of mathematical formulations, developments of different element properties, and related information can be found in the Interim Report "Predicting Performance of Pipe Culverts Buried in Soil", M. B. Roy, JHRP-76-15, May 1976.			
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User's Manual
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The contents of this report reflect the views of the author who is responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

This User's Manual is for the computer program for analysis of flexible pipe culverts buried in soils and reported in Interim Report "Predicting Performance of Pipe Culverts Buried in Soil", M. B. Roy, JHRP No. 15, May 1976.

Purdue University
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CHAPTER I. INTRODUCTION

FINLIN (Finite element, Isoparametric, Non-Linear with Interaction and No-tension) is a finite element computer program for analysis of flexible pipe culverts buried in soil. Curved bar segments have been used to simulate flexible pipes. A zero thickness special type of frictional element is used to simulate the occurrence of slip between pipe and soil. Isoparametric, linear-strain triangular elements are used to represent the soil. Non-linear, anisotropic, state of stress-dependent soil properties expressed in terms of octahedral stresses are used. Several option commands permit realistic analysis of a culvert problem in two dimensions. Incremental stages of construction, controlled slip between soil and pipe and no-tension analysis can be performed. The program has been written in FORTRAN IV source language using hard and soft wire facilities available in the CDC computer system. In this report, the procedure for preparation of input data for a problem will be discussed; a complete listing of the source program is included. Details of mathematical formulations, developments of different element properties, and related information can be found in the Interim Report - "Predicting Performance of Pipe Culverts Buried in Soil", by M. B. Roy, Purdue University, May, 1976, JHRP-76-15.

In any finite element analysis the first step is to bound the problem by a set of finite boundaries with appropriate boundary conditions. Then each region of different materials has to be distinguished. In the next step, each zone is subdivided into a number of characteristic finite elements maintaining continuity at the boundary between two elements. Then nodes and elements are numbered in sequence. Required material properties for every element need to be defined. In the case of nonlinear analysis, where material properties change depending upon the state of stress, parameters which govern the variation of properties need to be defined. Also, construction in layers, load application in increments, limited shear or slip in the pipe-soil inter-

action, and no-tension in soil must be accommodated.

Preparation of data for a real problem should take advantage of the fact that:

1. The boundaries need only define the areas of primary interest, and obvious features, like symmetry, should be recognized.
2. Smaller sized elements are needed in zones of maximum interest and/or high stress gradients; larger elements may be used elsewhere.
3. Each region is divided into an appropriate number and type of elements whose node points are numbered sequentially. The cost of a solution depends heavily on the numbering sequence of nodes even if the total number of nodes and elements remain the same. A useful general rule is to minimize the maximum difference between the highest and lowest node numbers in an element.

The next step is selection of the type of analysis, such as number of construction layers, number of increments of load in a given layer, interaction properties, no-tension in soil and other similar decisions. All information has to be digitized and checked for correctness.

CHAPTER II. COMPUTER PROGRAM

1. Types of Finite Elements

Several types of finite elements have been used in the program FINLIN. Description of each type follows.

Type I, Curved Bar Element

Segments of a ring have been used to represent flexible pipe, which has small thickness compared to the radius. Figure 1 shows a typical Type I element with two nodes, each node having three degrees of freedom - radial, tangential and rotational. The radius of the pipe, its stiffness EI (young's modulus times moment of inertia), and the nodal coordinates need to be defined. The position of the center of curvature is also necessary.

Type II, Interaction Element

This is a zero thickness, rectangular element with four nodes, each node having two degrees of freedom in the normal and tangential directions. Figure 2 shows a typical interaction element where the coordinates of nodes 1 and 4 (and 2 and 3) are initially the same. Coordinates of all four nodes, stiffness values in normal and tangential directions, E_n and E_s respectively, need to be defined. The program will modify the values of E_n and E_s according to the state of stress in these elements.

For both Type I and Type II elements, the program will perform the necessary coordinate transformation depending upon their position and orientation.

Type III, Isoparametric Triangular Element

This type of triangular element has three corner nodes and three intermediate (midpoint) nodes, each node having two degrees of freedom (Figure 3). The face 1-4-2 can be a

Figure 1. Type - I, Curved Bar Element

Figure 2. Type - II, Interaction Element

Figure 3. Type -III , Isoparametric Triangular Element

curved boundary. Nodes of the Type III element must be defined in the order shown in Figure 3. Coordinates of only corner nodes need to be defined. This element is used to simulate the soil medium and for thick pipes where rotation at pipe nodes are not significant. Required material properties for this type of element are modulus and poisson's ratio. Depending upon the nature of the material, linear or nonlinear properties can be used.

In case of analysis with no interaction element between pipe and soil, placing Type III element adjacent to Type I elements causes a difficulty in numerical procedure because nodes of 2 and 3 degrees of freedom lie at one point. To eliminate this problem Type IV and Type V elements are used. Type IV element (Figure 4) has the face 1-4-2 adjacent to the pipe. For Type V element (Figure 5) node 3 touches the pipe. Improper representation of elements will cause abnormal termination of the program.

Material Properties for Type III Elements

The program is capable of using linear, nonlinear and anisotropic material properties. Also different types of soils with distinct properties can be used. For linear materials only values of Young's modulus E and Poisson's ratio ν need to be defined. For anisotropic material, the ratio of moduli in vertical to horizontal direction has to be defined. For nonlinear properties, experimental data are directly used. It is to be noted that, in this program tangent modulus and tangent Poisson's ratio values are used for incremental analysis. Also octahedral normal and shear stresses have been used in the formulation. Nonlinear soil properties for any value of stress level and stress ratio are interpolated using cubic spline functions.

It is necessary to convert conventional test data (e.g. Figure 6) to a form which is acceptable to this program, as follows:

Figure 4. Type - IV, Triangular Element

Figure 5. Type - V , Triangular Element

Figure 6, Plane Strain Test on Loose Monterey No.0 Sand (after Lade, 1972)

1. Select successive values of $(\sigma_1 - \sigma_3)$, ϵ_v and ϵ_1 from the test data, at a given σ_3 starting from zero.
2. Cubic splines are fitted to the data.
3. Small increments of ϵ_1 are chosen, and values of σ_2 , E_t and ν_t are computed from the generalized Hooke's Law. With σ_1 , σ_2 , and σ_3 known, values of σ_{oct} and τ_{oct} and $\tau_{oct}/\tau_{oct \text{ failure}}$ are calculated.
4. Step (3) is repeated for each increment of ϵ_1 up to failure.
5. Steps (1) through (4) are repeated for all curves with different σ_3 .
6. All values of E_t are plotted against corresponding σ_{oct} , and values of stress ratio

$$\left(\frac{\tau_{oct}}{\tau_{oct \text{ failure}}} \right)$$

are noted for all points.

7. Contour lines are drawn for selected values of stress ratio. For convenience, values of stress-ratio are made to range from zero to unity with increments of 0.1. This will generate 11 curves of E_t vs σ_{oct} for stress ratio from 0 to 1 (see Figure 7).
8. Procedures similar to steps (6) and (7) are employed for tangent Poisson's ratio, ν_t , (see Figure 8).

To aid this procedure of data reduction, a small computer program called "PROPRTY" can be helpful which will cover steps (1) through (5) and prints out data required for steps (6) and (8).

Description of the Computer Program

The program FINLIN has been divided into several primary sections which are called OVERLAYS. Each OVERLAY performs specific computations and stores the results for future use. Figure 9 shows the principal organization of the program and several OVERLAYS. Each OVERLAY consists of one main program

Figure 7 , Tangent Modulus vs. Octahedral Normal Stress and Failure Ratio for Loose Sand.

Figure 8 , Tangent Poisson's Ratio vs. Octahedral Normal Stress and Failure Ratio for Loose Sand.

and several subroutines. OVERLAY 1 and 3 are the two most important sections of the program. Names of subroutines associated with OVERLAY 1 and 3 are shown in Figure 10. A general flow-chart of the program FINLIN is shown in Figure 11. Brief descriptions of the computations performed in OVERLAY (1.0) and (3.0) are given below.

INPUT1 -	Reads nodal and element data for all elements, material properties, pipe geometry and properties.
INPUT2 -	Reads modulus and Poisson's ratio value for linear elastic materials.
PLSTRS -	Computes elasticity matrix for plane stress condition.
PARAMTR -	Computes elasticity matrix for plane strain condition.
AREAS -	Area of triangular elements, and semi-band width for global stiffness matrix are evaluated in this routine.
SPLINE -	If nonlinear properties are specified, this routine reads data for non-linear analysis and stores them in a convenient form for future use.
SPLFIT -	Cubic spline fitting for nonlinear material properties is the primary function of this routine.
COFRIT -	Generates coefficients for cubic spline function.
TRIDGNL -	Solution of tridiagonal equation for spline fit.
FD and BD -	Foreward and backward interpolation formulae to determine slope.
ORDINET -	Spline-function interpolation formula.
FAILURE -	Function defining stress ratio at failure.

Fig. 10 SUBROUTINES IN OVERLAY (1.0) AND (3.0)

Figure 11 General Flow Chart of Program FINLIN

- BLOCK - This is the most important routine in FINLIN. Primary functions are (1) selection of elements in a given layer, (2) evaluation of nodal loads due to a given layer and number of increments of load, (3) generation of element stiffness matrix for all three basic types of elements, (4) modification of appropriate material properties for given state of stress condition, (5) formation of global stiffness matrix and load vector, (6) storing the matrix on tape for future use.
- TRANGLE - Evaluates element stiffness matrix for linear-strain-triangular elements (Type III, IV, V).
- RING - Creates stiffness matrix for curved-bar or ring elements (Type I).
- JOINT - Evaluates stiffness matrix for interaction elements (Type II).

In this program several means have been used to make efficient use of memory spaces. For this purpose the same locations have been used several times for entirely different purposes. If a user wants to modify or change any portion of the program, he should make sure that the intended changes do not wipe out or overwrite a portion of memory.

3. Limitations of the Program

In its present form the program takes about 112,000 (octal) core memory spaces to load and execute. FINLIN uses nine disc tape units, out of which two units are used for INPUT, OUTPUT, five for random access mass storage and two for intermediate storage purposes. Limitations of the program are listed below (they can be modified easily by changing a few cards):

- (1) Total number of nodes: (NNODES) = 550
- (2) Total number of elements: (NELEMNT) = 250
- (3) Different types of materials: (MATRIAL) = 25
- (4) Increments of stress ratio in Figure 7 and 8 = 0.1
- (5) Maximum number of points for nonlinear material properties = 7
- (6) Maximum semi-bandwidth for global stiffness matrix (including diagonal) = 103

However, semi-bandwidth capacity can be modified easily by making changes as follows:

- (a) Estimate the maximum semi-bandwidth (including the diagonal term). If it is even, add one and make it odd numbered, which is the final semi-bandwidth (N) of the system. Numerals in the indicated places should at least be N.
- (b) OVERLAY (0.0), Line: FLN-36, NSIZE = N
- (c) OVERLAY (3.0), Line: BLK-15
DIMENSION A(N,N), ARRAY (N)
- (d) OVERLAY (6.0), Line: SOL-10
DIMENSION A(N,2N), B(2N), ARRAY(N)
- (e) SUBROUTINE MODIFY, Line: 3
DIMENSION A(N,2N), B(2N).

CHAPTER III. INPUT DATA CARDS FOR PROGRAM "FINLIN"

- 1st Card Type: TITLE, MESH
 FORMAT (13A 6, I2)
 One card identifying the problem.
- Col. 2-78: alphanumeric description of the problem to be printed in the output.
- Col. 79-80: if greater than 0, a plot of finite element mesh is generated by CALCOMP plotter. If zero or blank, no plot is generated.
- 2nd Card Type: NNODES, NELEMNT, MATERIAL, NPRSR, LAYERS, ISTOP
 FORMAT (2I5, 2I3, 2X, I2, 2X, I2)
 One card defining problem.
- Col. 1-5: NNODES - Total number of node points.
- Col. 6-10: NELEMNT - Total number of elements (all types included).
- Col. 11-13: MATERIAL - Total number of different soil types.
- Col. 14-16: NPRSR - 0
- Col. 19-20: LAYERS - Number of construction layers.
- Col. 23-24: ISTOP - If zero, linear elastic soil properties, if greater than zero, nonlinear soil properties.
- 3rd Card Type: NTYPE, GAMA, TYPE
 FORMAT (I5, F10.0, 10A6)
 Soil type cards, one card for each soil type, total number = MATERIAL
- Col. 1-5: NTYPE - Soil-type identification number.
- Col. 6-15: GAMA - Unit weight of soil.
- Col. 16-75: TYPE - Alphanumeric description of this soil type.

4th Card Type: ANLSIS, DELTA

FORMAT (A6, F5.0)

One card specifying type of analysis and angle of friction between soil and pipe.

Col. 1-6: PLSTRS - For plane-stress analysis.

PLSTRN - For plane-strain analysis.

Col. 7-11: DELTA - Angle of friction between pipe material and soil adjacent to pipe, in degrees.

5th Card Type: Two cards per soil material type, total number = 2X MATERIAL, specifying initial modulus and Poisson's ratio for each soil type.

(a) 1st Card - E

FORMAT (E10.0)

Col. 1-8: E - Initial modulus.

(b) 2nd Card - NUE

FORMAT (F5.0)

Col. 1-5: NUE - Initial Poisson's ratio.

6th Card Type: These cards are required only for nonlinear materials i.e. if ISTOP is greater than zero (in 2nd Card Type). This set of cards is repeated for each nonlinear soil type. If ISTOP = 0 or blank, these cards are not required.

(a) NP, PSI, PHI, ANISO, DELTA, FACTOR

FORMAT (I5, 5F10.0)

One card identifying soil properties.

Col. 1-5: NP - Number of points on each tangent modulus and tangent Poisson's ratio vs. σ_{oct} curve.

Col. 6-15: PSI - Factor defined as

$$\Psi = \frac{\sigma_2}{(\sigma_1 + \sigma_3)}$$

Col. 16-25: PHI - Friction angle for soil, in degrees.

Col. 26-35: ANISO - Anisotropy ratio,

$$\frac{E_x}{E_y}$$

If isotropic, ANISO = 1.0

- Col. 36-45: DELTA - Angle of friction, in degrees between pipe and soil.
- Col. 46-55: FACTOR - Conversion factor for σ_{oct} and tangent modulus, e.g. $\sigma_{oct} = \text{FACTOR} * \sigma_{oct}$ and $E_t = \text{FACTOR} * E_t$.
If no conversion is required, FACTOR = 1.0

(b) XP(1)

FORMAT (8F10.0)

σ_{oct} values of nonlinear property cards, total number values = NP, up to 8 values per card.

- Col. 1-10: NP(1) - 1st value of σ_{oct} .
- Col. 11-20: NP(2) - 2nd value of σ_{oct} .
and so on.

(c) EP, PSNR

FORMAT (2F10.0)

These set of cards define the nonlinear material properties. Two sets of curves are required (1) for tangent modulus, E_t vs σ_{oct} for stress-ratio ranging from 0.0 to 1.0 and (2) same type of curves for tangent Poisson's ratio ν_t , each curve of E_t and ν_t is defined by NP number of points, so total number of cards = NP x 11.

- Col. 1-10: EP - Tangent modulus value.

- Col. 11-20: PSNR - Tangent Poisson's ratio value

Note: (1) First NP cards should read the values of E_t and ν_t for increasing values of σ_{oct} starting from $\sigma_{oct} = 0$.
(2) The first set of NP cards are for curve of stress ratio = 1. The second set of NP cards will stand for stress ratio = 0.9 and so on. The last set of NP cards will read values of E_t and ν_t for stress-ratio = 0.0.

(3) A set of cards which includes cards from (a) to (c), define a complete set of Type 6 cards. As no material number has been attached to it, the sequence in which the set of cards are placed, will define the soil type. For example, the first complete set of type 6 cards (which includes (a), (b) and (c) type cards) will automatically be defined for Type 1 (NTYPE in 3rd Card Type) soil and the second set of type 2 and so on.

7th Card Type: NREAD, FACTOR
FORMAT (I5, F10.0)

Col. 1-5: NREAD - Total number of node point data cards. The triangular finite elements have six nodes i.e. three corner nodes and three mid-side nodes. Co-ordinates of mid-side nodes are calculated by the program. Except for defining boundary conditions, these nodes need not be defined.

Col. 6-15: FACTOR - Conversion factor for node point coordinates such as Ft. to Meter. If no conversion is required, FACTOR = 1.0.

8th Card Type: NN, NCODE, X, Y
FORMAT (I5, 5X, I2, F10.0, 20X, F10.0)
Nodal cards, one card per nodal point, total number = NREAD.

Col. 1-5: NN - Node point number.

Col. 11-12: NCODE - Node point boundary condition. The following table describes values of NCODE to represent desired boundary condition.

NCODE	Node Type	Boundary Condition
0	2 degrees of freedom in X and Y directions	Free X and Y directions.
1		Fixed in X and free in Y directions.
2		Free in X and fixed in Y directions.
3		Fixed in both X and Y directions.
4	3 degrees of freedom in X, Y direction and in rotation (θ)	Free in X, Y and θ directions.
5		Fixed in X, free in Y and θ directions.
6		Fixed in Y, free in X and θ directions.
7		Fixed in θ , free in X and Y directions.
8		Fixed in X and θ , free in Y directions.
9		Fixed in Y and θ , free in X directions.

Col. 13-22: X - X co-ordinate of node point.

Y - Y co-ordinate of node point.

Nodal data cards may be placed in any order.

9th Card Type: IEL, IX

FORMAT (I3, 2X, 2(3I5, 5X), 4X, I1, 3X, I2)

Element cards, one card per element total
number = NELEMNT Cards.

Col. 1-3: IEL - Element number.

Col. 6-10: IX(1) - Node number 1 of element no. IEL.

Col. 11-15: IX(2) - Node number 2 of element no. IEL.

Col. 16-20: IX(3) - Node number 3 of element no. IEL.

Col. 26-30: IX(4) - Node number 4 of element no. IEL.

Col. 31-35: IX(5) - Node number 5 of element no. IEL.

Col. 36-40: IX(6) - Node number 6 of element no. IEL.

Col. 50: IX(7) - Element type identification number.

Col. 54-55: IX(8) - Material type identification number.

Element types 1, 2, 3 and corresponding node numbers are shown in Figure 1 to Figure 3.

This numbering scheme has been used in the program. For type 4 and type 5 elements see Figures 4 and 5.

The element data cards can be placed in any order.

10th Card Type: ZAI(1), ZAI(2), ZAI(3)

FORMAT (3F10.0)

One card defining the point where stress of triangular element is required. (See Figure 12 for definition of ZAI).

Col. 1-10: ZAI(1) -

Col. 11-20: ZAI(2) - Area coordinates.

Col. 21-30: ZAI(3) -

11th Card Type: XCEN, YCEN, RADIUS, EI

FORMAT (3F10.0, E10.0)

One card defines center of circular pipe, radius and stiffness.

Col. 1-10: XCEN - X-coordinate of center of pipe.

YCEN - Y-coordinate of center of pipe.

RADIUS - Radius of pipe.

EI - Stiffness of pipe, Young's modulus times moment of inertia of pipe cross section per unit length.

12th Card Type: This card is required only when a plot of finite element mesh of the problem is required, which is specified in 1st Card Type. If Col. 79-80 is zero or blank no plot is generated. If any number is punched in Col. 79-80, a plot will be generated and in that case only this card is required.

XMAX, YMAX, YCEN

FORMAT (3F10.0)

Col. 1-10: XMAX - Maximum size of mesh in X-direction.

YMAX - Maximum size of mesh in Y-direction.

YCEN - Y-coordinate of center of pipe.

Figure 12. Definition of Area Co-ordinates

13th Card Type: NOTENSN, INTER, NSTEP, H1, H2, KN, KS, NITER
 FORMAT (3I2, 4X, 2F10.0, 2E10.0, 15)

This card contains very important information regarding type of analysis required. Total number of cards = LAYERS (as specified in Col. 19-20 of 2nd Card Type).

- Col. 1-2: NOTENSN = 0, if soil is allowed to take tension.
 = 1, if 'no-tension' in soil analysis is required.
- Col. 3-4: INTER = 0, if 'no-interaction' between soil and pipe is required in type II elements. In this case, pipe and soil are rigidly connected.
 = 1, if interaction between soil and pipe is desired which will permit slip depending upon the state of stresses in type II elements.
- Col. 5-6: NSTEP - Number of equal increments of application of gravity load in a particular layer.
- Col. 11-20: H1 - Starting height of a construction layer being analyzed.
- Col. 21-30: H2 - Finish height of a construction layer being analyzed.
- Col. 31-40: KN - Normal stiffness of pipe-soil interaction element (type II) before failure in tension. In case tension develop in an interaction element, the program will modify value of this stiffness.
- Col. 41-50: KS - Shear-stiffness of pipe-soil interaction element (type II) before failure. If INTER = 0, value of KN and KS are kept unchanged in all interaction elements throughout the analysis, which simulates rigid connection if values of KN and KS are considerably high. If INTER > 0 values of KN and KS are modified based on failure conditions specified for an interaction element.

Col. 51-55: NITER - Maximum number of iterations specified for 'no-tension' analysis. If the solution does not converge after specified number (= NITER) of iterations, farther execution will be stopped and a message will be printed.

Input Data Cards for Program 'PROPRTY'

In program FINLIN, an octahedral stress-strain system and tangent modulus and tangent Poisson's ratio values have been used for representing nonlinear soil properties. Required data for nonlinear properties in FINLIN (data card type 6), is difficult to get from conventional triaxial or plane strain tests.

In program FINLIN, some routine calculations and interpolations have to be performed to prepare data for card type 6. The program PROPRTY has been written to aid in generation of the data required for interpolation. This program accepts actual test data and interpolates using spline function, prints values of octahedral stress, strain, stress-ratio, tangent modulus, tangent Poisson's ratio and similar informations.

1st Card Type: TITL

FORMAT (10A8)

Col. 2-80: TITL - Alphanumeric identification of soil and test; one card.

2nd Card Type: TEST, NOCURVS, RF

FORMAT (A6, I3, F10.0)

One card defines type of test performed and other information.

Col. 1-6: TEST = PLSTRS for plane-stress test and
= PLSTRN for plane-strain test performed
on the sample.

Col. 7-9: NOCURVS - Number of confining pressures used in the test; should at least be three.

Col. 10-19: RF - Ratio of τ_{oct}/σ_{oct} at failure.

3rd Card Type: SIGMA3, NP

FORMAT (5X, F10.0, 15)

One card specifies value of confining pressure and number of points for this test with given confining pressure.

Col. 6-15: SIGMA3 - Confining pressure.

Col. 16-20: NP - Number of points on a curve of given σ_3 .

4th Card Type: XP, YP, VP

FORMAT (3F5.0)

One card per point, total number = NP; containing information about stress-strain and volume change data for a given σ_3 .

Col. 1-5: XP - Axial strain in percent (ϵ_1 %).

Col. 6-10: YP - Deviator stress ($\sigma_1 - \sigma_3$) corresponding to axial strain, XP.

Col. 11-15: VP - Volume strain in percent (ϵ_v %).

Note: 3rd and 4th card types are repeated NOCURVS times.

APPENDIX - I

FINLIN
PROGRAM LISTING

```

OVERLAY(RDY,0,0)                                FLN 1
C          OVERLAY(RDY,0,0)                        FLN 2
PROGRAM FINISH (INPUT,OUTPUT,TAPE2,TAPE3,TAPE5=INPUT,TAPE6=OUTPUT,FLN 3
1TAPE1,TAPE3,TAPE4,TAPE7,TAPE10,PL0T)           FLN 4
C                                                  FLN 5
C      THIS FINITE ELEMENT PROGRAM HAS BEEN WRITTEN FOR PH.D. THESIS FLN 6
C      PREDICTING PERFORMANCE OF PIPE CULVERTS IN SOIL FLN 7
C      BY H. B. ROY, GRADUATE RESEARCH ASSISTANT FLN 8
C      SCHOOL OF CIVIL ENGINEERING, GEOTECHNICAL ENGINEERING, FLN 9
C      PURDUE UNIVERSITY, WEST LAFAYETTE, INDIANA - 47907 FLN 10
C      DATE DECEMBER, 1975. FLN 11
C                                                  FLN 12
COMMON NNODES,NLEMMT,NDOF,NBAND,NB,NL3,ISTOP,NCYCLE,LAYERS,ISTEP,FLN 13
1NSTEP,NT12,EY(N1,NT1,NT2,NITENON,IFLAG,NSIZE,NODE(550),X(550),FLN 14
2),JNDX(51),ANLST5,IX(8,2),0),AREA(250),INDX(250),INDEX(250),GAMA(2FLN 15
35),ZAI(3) FLN 16
COMMON /1/ E,MUE,RADIUS,ACEN,YOEN,EI,KH,KS,H1,H2,INTER FLN 17
COMMON /2/ B FLN 18
COMMON /3/ P FLN 19
COMMON /4/ NDOU(26),DELTA FLN 20
COMMON /5/ R(1100),LIST(101) FLN 21
DIMENSION TITLE(13), R(1100), TEMP(17) FLN 22
DIMENSION E(10), MUE(10), B(10,10) FLN 23
REAL MUE FLN 24
REAL KH,KS FLN 25
C                                                  FLN 26
C      THIS IS AN OVERLAY, WHICH DIRECTS EXECUTION OF OTHER OVERLAYS FLN 27
C      DEPENDING UPON TYPE OF ANALYSIS AND OTHER COMMANDS FLN 28
C      FOLLOWING TWO STATEMENTS ARE LIBRARY ROUTINES FOR FOR BLOCK AND STFLN 29
C      FLN 30
CALL FTHBIN (1,0) FLN 31
CALL SETSTAK (0) FLN 32
C                                                  FLN 33
C      MAX. SIZE OF SEMI-BAND WIDTHOF TOTAL STIFFNESS MATRIX INCLUDING DIFLN 34
C      FLN 35
NSIZE=103 FLN 36
NSTEP=1 FLN 37
IFLAG=0 FLN 38
REHIND 2 FLN 39
READ (5,55) TITLE,MESH FLN 40
IF (EOF,5) 5,10 FLN 41
5 GO TO 40 FLN 42
10 CONTINUE FLN 43
CALL ZERO (R,1100) FLN 44
WRITE (2) (R(I),I=1,1100) FLN 45
ISTEP=1 FLN 46
WRITE (6,60) TITLE FLN 47
C                                                  FLN 48
C      CREATE MASS STORAGE FILES FLN 49
C      INITIALISE MASS STORAGE UNITS FLN 50
C                                                  FLN 51
CALL OPENMS (1,INDX,250,0) FLN 52
CALL OPENMS (3,INDEX,250,0) FLN 53
CALL OPENMS (4,NDOU,26,0) FLN 54
CALL OPENMS (7,JNDX,51,0) FLN 55
CALL OPENMS (10,LIST,1100,0) FLN 56
ND=NSIZE FLN 57
C                                                  FLN 58
C      OVERLAY(1,0) READS PROBLEM GEOMETRY AND MATERIAL PROPERTIES FLN 59

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C	CALL OVERLAY (3HRDY,1,0,6HRECALL)	FLN	60
C	IF (MESH.GT.0) CALL OVERLAY (3HRDY,2,0,6HRECALL)	FLN	61
C	CALL ZERO (TEMP,17)	FLN	62
C	DO 15 I=1,NELNNT	FLN	63
C	CALL WRITH (1,TEMP,17,1)	FLN	64
C	15 CONTINUE	FLN	65
C		FLN	66
C	FOLLOWING PARAMETERS DESCRIBE TYPE OF ANALYSIS DESIRED	FLN	67
C	NOTENSH .GT. 0 = NO-TENSION ANALYSIS; . = 0 = NO CHECK FOR TENSION	FLN	68
C	INTER .GT. ZERO = INTERACTION; INTER=0 = NO INTERACTION	FLN	69
C	NSTEP = NO. OF INCREMENTS PER LAYER	FLN	70
C	H1 = STARTING HEIGHT OF THIS LAYER	FLN	71
C	H2 = ENDING HEIGHT OF THIS LAYER	FLN	72
C	KN = NORMAL STIFFNESS FOR INTERACTION	FLN	73
C	KS = SHEAR STIFFNESS FOR INTERACTION	FLN	74
C	NITER = NO. OF ITERATION SPECIFIED FOR NO-TENSION ANALYSIS	FLN	75
C		FLN	76
C	20 READ (5,65) NOTENSH,INTER,NSTEP,H1,H2,KN,KS,NITER	FLN	77
C	HCYCLE=1	FLN	78
C	WRITE (6,70) INTER,NSTEP,H1,H2,NOTENSH	FLN	79
C	25 HD=HSIZE	FLN	80
C	HCOUNT=0	FLN	81
C		FLN	82
C	FORM STRUCTURAL STIFFNESS MATRIX AND LOAD VECTOR	FLN	83
C		FLN	84
C	CALL OVERLAY (3HRDY,3,0,6HRECALL)	FLN	85
C	WRITE (6,75)	FLN	86
C		FLN	87
C	MODIFY FOR BOUNDARY CONDITIONS	FLN	88
C	SOLVE FOR DISPLACEMENT	FLN	89
C		FLN	90
C	CALL OVERLAY (3HRDY,6,0,6HRECALL)	FLN	91
C		FLN	92
C	FIND STRESSES AND STRAINS, AND PRINT RESULTS	FLN	93
C		FLN	94
C	30 CALL OVERLAY (3HRDY,4,0,6HRECALL)	FLN	95
C	CALL OVERLAY (3HRDY,5,0,6HRECALL)	FLN	96
C	IF (IFLAG.LE.0) GO TO 35	FLN	97
C		FLN	98
C	RECYCLE FOR NO-TENSION	FLN	99
C		FLN	100
C	HCOUNT=HCOUNT+1	FLN	101
C	IF (HCOUNT.GT.NITER) GO TO 50	FLN	102
C	CALL OVERLAY (3HRDY,6,0,6HRECALL)	FLN	103
C	GO TO 30	FLN	104
C		FLN	105
C	RECYCLE PROGRAM FOR INCREMENTAL OR NON-LINEAR ANALYSIS	FLN	106
C		FLN	107
C	35 HCYCLE=HCYCLE+1	FLN	108
C	IFLAG=0	FLN	109
C	IF (HCYCLE.GT.NSTEP) GO TO 40	FLN	110
C	GO TO 25	FLN	111
C	40 ISTEP=ISTEP+1	FLN	112
C	IF (ISTEP.GT.LAYERS) GO TO 45	FLN	113
C	GO TO 20	FLN	114
C	45 WRITE (6,80)	FLN	115
C		FLN	116
C		FLN	117
C	CLOSE ALL MASS STORAGE UNITS	FLN	118
C		FLN	119

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      CALL CLOSEMS (1)      FLN 120
      CALL CLOSEMS (3)      FLN 121
      CALL CLOSEMS (4)      FLN 122
      CALL CLOSEMS (7)      FLN 123
      CALL CLOSEMS (10)     FLN 124
C
      STOP                  FLN 125
50 WRITE (6,85) HCOUNT    FLN 126
      STOP                  FLN 128
C
55 FORMAT (12A6,12)        FLN 129
60 FORMAT (20X,15A6)        FLN 130
65 FORMAT (3I2,4X,2F10.0,2E19.0,15) FLN 132
70 FORMAT (<10X, 12H LAYER INFORMATION</10X, 14H INTERACTION = +15/10X, FLN 133
      1 35ND, OF INCREMENTS FOR THIS LAYER = +15/10X, 32H STARTING HEIGHT<FLN 134
      2 OF THIS LAYER = +10.2/10X, 32H FINISHING HEIGHT OF THIS LAYER = +FLN 135
      3F10.2/10X, 14H NO-TENSION = +15/10X, 30HND, OF ITERATIONS SPECIFIED<FLN 136
      40 = +15/10X)          FLN 137
75 FORMAT (10X, 23H OVERLAY (3+0) COMPLETED) FLN 138
80 FORMAT (<10X, 5X, 15H END OF PROBLEM)      FLN 139
85 FORMAT (<10X, 45HND-TENSION ITERATION DOES NOT CONVERGE AFTER +1FLN 140
      15, 13H ITERATIONS,</10X, 20H EXECUTION TERMINATED) FLN 141
C
      END                  FLN 142
      SUBROUTINE ZERO (A,N)      ZRO 2
C
C *****
C THIS SUBROUTINE GENERATES A NULL VECTOR.
C *****
C
      DIMENSION A(N)           ZRO 8
      DO 5 I=1,N               ZRO 9
        A(I)=0.0              ZRO 10
5 CONTINUE                    ZRO 11
      RETURN                  ZRO 12
C
      END                  ZRO 14
      SUBROUTINE NULLMAT (A,M,N)  NUL 2
C
C THIS ROUTINE GENERATES A NULL MATRIX A OF SIZE (M X N)
C
      DIMENSION A(M,N)        NUL 6
      DO 5 I=1,M              NUL 7
        DO 5 J=1,N            NUL 8
          A(I,J)=0.0          NUL 9
5 CONTINUE                    NUL 10
      RETURN                  NUL 11
C
      END                  NUL 13
      OVERLAY(ROY,1,0)        IN1 1
C
      OVERLAY(ROY,1,0)        IN1 2
      PROGRAM INPUT          IN1 3
      COMMON NNODES,NELEMENT,NDOF,NBAND,ND,MT3,ISTOP,NCYCLE,LAYERS,ISTEP,IN1 4
      1HSTEP,HT12,ETA,HT1,HT2,NOTENCH,IFLAG,NSIZE,NCOOE(550),X(550),Y(550)IN1 5
      2),JNDX(51),ANLSIS,IX(8,250),AREAA(250),INDX(250),INDEX(250),GANA(2)IN1 6
      35),ZAT(3)              IN1 7
      COMMON /1/ E,NUE,RADIUS,XCEN,YCEN,E1,KN,KS,H1,H2,INTER IN1 8
      COMMON /2/ D            IN1 9
      COMMON /4/ MODU(26),DELTA IN1 10
      DIMENSION E(10), NUE(10), D(10,10) IN1 11

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DIMENSION TYPE(10)	INH	12
DIMENSION HL(4)	INH	13
DATA HNDP,HMODEL,HNDNT(50,25,25)	INH	14
DATA PLSTR,PLSTRH,GMPLSTR,SHPLSTR	INH	15
REAL KZERO	INH	16
REAL KTHK	INH	17
REAL HRE	INH	18
HT3=0	INH	19
HQOF=0	INH	20
HNDP=0	INH	21
HT1=0	INH	22
HT2=0	INH	23
HT12=0	INH	24
C	INH	25
C	INH	26
C	INH	27
READ (5,75) HNDP,HNDNT,MATERIAL,NPRSR,LAYERS,ISTOP	INH	28
IF (HNDP.LE.HQOF) GO TO 5	INH	29
WRITE (6,80) HNDP	INH	30
5 IF (HNDNT(1,1).LE.HMODEL) GO TO 10	INH	31
WRITE (6,85) HNDNT	INH	32
C	INH	33
C	INH	34
C	INH	35
C	INH	36
C	INH	37
10 WRITE (6,90) HNDP,HNDNT,MATERIAL,NPRSR,LAYERS	INH	38
IF (MATERIAL.LE.HNDNT) GO TO 15	INH	39
WRITE (6,95) MATERIAL	INH	40
15 CONTINUE	INH	41
C	INH	42
C	INH	43
C	INH	44
C	INH	45
C	INH	46
WRITE (6,105)	INH	47
CALL ZERO (GMNDP,25)	INH	48
DO 20 I=1,MATERIAL	INH	49
READ (5,100) HTYPE,GMND(HTYPE),TYPE	INH	50
WRITE (6,110) HTYPE,GMND(HTYPE),TYPE	INH	51
20 CONTINUE	INH	52
READ (5,115) HMLSD,DELTA	INH	53
DO 25 I=1,MATERIAL	INH	54
CALL HPM12 (I)	INH	55
IF (HMLSD(10,PLSTR)) CALL F-PLSTR (I)	INH	56
IF (HMLSD(10,PLSTRH)) CALL F-PLSTRH (I)	INH	57
C	INH	58
C	INH	59
C	INH	60
IF (ISTOP.GT.0) CALL PLINE (1)	INH	61
25 CONTINUE	INH	62
C	INH	63
C	INH	64
C	INH	65
CALL ZERO (G,HNDP)	INH	66
CALL ZERO (G,HNDNT)	INH	67
CALL ZERO (HCODE,950)	INH	68
C	INH	69
C	INH	70
C	INH	71
READ NODAL POINT DATA, CODE, COORDINATES, LOADS, ETC.	INH	
HNDP = TOTAL NO. OF NODAL DATA CARDS SUPPLIED	INH	

C	FACTOR = UNIT CONVERSION FACTOR FOR NODAL COORDINATE DATA	IN1	72
C		IN1	73
	READ (5,126) HRCAD,FACTOR	IN1	74
	DO 30 I=1,NREAD	IN1	75
	READ (5,125) HX,NODE(NH)*X(ND)+Y(ND)	IN1	76
	IF (NCODE(NH).GT.3) HX=HX+1	IN1	77
	X(ND)=X(NH)*FACTOR	IN1	78
	Y(ND)=Y(NH)*FACTOR	IN1	79
	30 CONTINUE	IN1	80
C		IN1	81
C	*****	IN1	82
C	READ ELEMENT DATA, TYPE, MATERIAL	IN1	83
C		IN1	84
	CALL HELMAT (IX,8,NELEMT)	IN1	85
	CALL ZORD (AREA,NELEMT)	IN1	86
	DO 35 I=1,NELEMT	IN1	87
	READ (5,130) IEL,(IX(I,IEL)*J=1-2)	IN1	88
	HT=IX(7,IEL)	IN1	89
	IF (HT.EQ.1) HT1=HT1+1	IN1	90
	IF (HT.EQ.2) HT2=HT2+1	IN1	91
	35 CONTINUE	IN1	92
	HT12=HT1+HT2	IN1	93
C		IN1	94
C	WRITE NODAL POINT INFORMATION	IN1	95
C		IN1	96
	WRITE (6,125)	IN1	97
	DO 40 I=1,NNODES	IN1	98
	WRITE (6,140) I,NCODE(I)*X(I)+Y(I)	IN1	99
	40 CONTINUE	IN1	100
C		IN1	101
C	WRITE ELEMENT INFORMATION	IN1	102
C		IN1	103
	WRITE (6,145)	IN1	104
	DO 45 I=1,NELEMT	IN1	105
	WRITE (6,150) I,(IX(I,I)*J=1-8)	IN1	106
	45 CONTINUE	IN1	107
	READ (5,150) ZAI(1),ZAI(2),ZAI(3)	IN1	108
	WRITE (6,155) ZAI(1),ZAI(2),ZAI(3)	IN1	109
C		IN1	110
C	DETERMINE BAND WIDTH	IN1	111
C		IN1	112
C	DETERMINE NODAL FORCES DUE TO SELF WEIGHT, FOR THIS PURPOSE	IN1	113
C		IN1	114
	WRITE (6,165)	IN1	115
	DO 65 II=1,NELEMT	IN1	116
	HT=IX(7,II)	IN1	117
	GO TO (50,55,60,60,60), HT	IN1	118
50	I1=IX(1,II)	IN1	119
	I2=IX(2,II)	IN1	120
	I3=I1-I2	IN1	121
	HRCAD=(1485*IBC)*1)*3	IN1	122
	IF (HRCAD.GT.HCRAD) HRCAD=HCRAD	IN1	123
	GO TO 65	IN1	124
55	I1=IX(1,II)	IN1	125
	I2=IX(2,II)	IN1	126
	I3=IX(3,II)	IN1	127
	I4=IX(4,II)	IN1	128
	NL(1)=3*I1-2	IN1	129
	NL(2)=3*I2-2	IN1	130
	NL(3)=2*I3-1+HT3	IN1	131

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      NL(4)=2*I4-1+NT3                                IN1 132
      MAX=MAX0(NL(1),NL(2),NL(3),NL(4))                IN1 133
      MIN=MIN0(NL(1),NL(2),NL(3),NL(4))                IN1 134
      MBAND=MAX-MIN+2                                    IN1 135
      IF (MBAND.GT.MBAND) MBAND=MBAND                  IN1 136
      GO TO 65                                           IN1 137
60  CALL WREAS (I1,NT)                                  IN1 138
65  CONTINUE                                           IN1 139
      NDOF=2*NNODES+NT3                                IN1 140
C                                           IN1 141
C                                           IN1 142
C               PRINT SIZE OF THE PROBLEM              IN1 143
C                                           IN1 144
      WRITE (6,170) NDOF,MBAND                          IN1 145
C                                           IN1 146
      IF (NT3.LE.0) GO TO 70                            IN1 147
C                                           IN1 148
C               READ CENTER, RADIUS, AND EI OF PIPE    IN1 149
C                                           IN1 150
      READ (5,175) XCEN,YCEN,R,RADIUS,EI              IN1 151
      WRITE (6,180) XCEN,YCEN,RADIUS,EI                IN1 152
C                                           IN1 153
C               DETERMINE ETA FOR TRIANGULAR ELEMENTS  IN1 154
C                                           IN1 155
      NT12P1=NT12+1                                    IN1 156
      IF (NT12P1.GT.NELEMNT) GO TO 70                  IN1 157
      I1=IX(1,NT12P1)                                  IN1 158
      I2=IX(2,NT12P1)                                  IN1 159
      X1=X(I1)                                          IN1 160
      Y1=Y(I1)                                          IN1 161
      X2=X(I2)                                          IN1 162
      Y2=Y(I2)                                          IN1 163
      SPAN=CONJ(X1-X2)**2+(Y1-Y2)**2                  IN1 164
      CN=0.5*SPAN/RADIUS                               IN1 165
      TH=ASIN(CN)                                       IN1 166
      THETA=2.*TH                                       IN1 167
      R2=RADIUS**2                                      IN1 168
      A1=0.5*THETA*R2                                  IN1 169
      A2=0.5*R2*SIN(THETA)                             IN1 170
      A4=A1-A2                                          IN1 171
      ETA=A4/AREAR(NT12P1)                             IN1 172
      ETA=0.0                                           IN1 173
C                                           IN1 174
70  CONTINUE                                           IN1 175
      WRITE (6,185)                                     IN1 176
      RETURN                                           IN1 177
C                                           IN1 178
75  FORMAT (2I5,2I3,2X,I2,2X,I2,1X,I1,1X,I2)          IN1 179
80  FORMAT (5X, 40HND. OF NODES EXCEEDS LIMIT(<=900), NNODES=,I5) IN1 180
85  FORMAT (5X, 40HND. OF ELEMENTS EXCEEDS LIMIT(<=500), NELEMNT=,I5) IN1 181
90  FORMAT (10X, 19HPROBLEM DESCRIPTION,/,5X, 19HND. OF NODE POINTS=,I10) IN1 182
      15/5X, 16HND. OF ELEMENTS=,I5/5X, 17HND. OF MATERIALS=,I5/5X, 26HND. OF BOUNDARY PRESSURES=,I5/5X, 29HND. OF CONSTRUCTION LAYERS =,I10) IN1 183
      25/5X)                                           IN1 184
95  FORMAT (5X, 40HND. OF MATERIALS EXCEEDS LIMIT (<= 25), MATERIAL=,I5) IN1 185
100 FORMAT (15,F10.0,/,10X)                             IN1 186
115 FORMAT (/,/,10X, 21H MATERIAL DESCRIPTIONS,/,5X, 30HND.,5X, 11HUNIT IN1 187
      11HUNIT=10X, 11HDESCRIPTION,/,)                IN1 188
110 FORMAT (5X,I2,3X,F8.4,10X,10X)                     IN1 189
115 FORMAT (A6,F5.0)                                     IN1 190
120 FORMAT (15,F10.0)                                   IN1 191

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	HUEK=HUE(K)	PLS	11
	C=E(10)*(1.-HUEK*HUEK)	PLS	12
	D(K,8)=0.0	PLS	13
	D(K,7)=D(K,8)	PLS	14
	D(K,6)=D(K,7)	PLS	15
	D(K,3)=D(K,6)	PLS	16
	D(K,5)=C	PLS	17
	D(K,1)=D(K,5)	PLS	18
	D(K,4)=C*HUEK	PLS	19
	D(K,2)=D(K,4)	PLS	20
	D(K,9)=0.5*C*(1.-HUEK)	PLS	21
	D(K,10)=HUEK	PLS	22
	RETURN	PLS	23
C	END	PLS	24
	SUBROUTINE PYRANTR (K)	PLS	25
	COMMON /1/ E,HUE,RADIUS,ICEN,YCEN,ET,KH,KS,H1,H2,INTER	PLN	3
	COMMON /2/ D	PLN	4
	REAL KH,KS	PLN	5
C		PLN	6
C	THIS ROUTINE IS FOR PLANE STEWIN	PLN	7
C		PLN	8
	REAL HUE,HUEK	PLN	9
	DIMENSION D(10,10), E(10), HUE(10)	PLN	10
	HUEK=HUE(K)	PLN	11
	C=(E(K)*(1.-HUEK))/(E(1)+HUEK*(1.-2.*HUEK))	PLN	12
	D(K,5)=C	PLN	13
	D(K,1)=D(K,5)	PLN	14
	D(K,4)=C*HUEK/(1.-HUEK)	PLN	15
	D(K,2)=D(K,4)	PLN	16
	D(K,9)=C*(1.-2.*HUEK)/(2.*(1.-HUEK))	PLN	17
	D(K,8)=0.0	PLN	18
	D(K,7)=D(K,8)	PLN	19
	D(K,6)=D(K,7)	PLN	20
	D(K,3)=D(K,6)	PLN	21
	D(K,10)=HUEK	PLN	22
	RETURN	PLN	23
C	END	PLN	24
	SUBROUTINE AREAS (NH,NT)	ARE	25
	COMMON /INDEX/NELEMT,NDRIF,MBAND,ND,NT3,ISTOP,NCYCLE,LAYERS,ISTEP,ARE	ARE	3
	1/STEP,NT12,ETA,NT1,NT2,MTECHN,(FLAG+HSIZE,NCODE(550),X(550),Y(550)ARE	ARE	4
	2),JNDX(51),ANLSIS,IX(8,250),AREAR(250),INDX(250),INDEX(250),GAMA(2ARE	ARE	5
	35),ZAI(3)	ARE	6
	DIMENSION LM(6)	ARE	7
C		ARE	8
C	*****	ARE	9
C	THIS ROUTINE CALCULATES ELEMENT AREA, AND SEMI BAND WIDTH	ARE	10
C		ARE	11
	AREAR=0.0	ARE	12
	I=IX(1,NH)	ARE	13
	J=IX(2,NH)	ARE	14
	K=IX(3,NH)	ARE	15
	NH=NT-2	ARE	16
	GO TO (5,15,20), NK	ARE	17
5	DO 10 N=1,6	ARE	18
10	LM(N)=2*IX(N,NH)+NT3-1	ARE	19
	GO TO 30	ARE	20
15	LM(1)=3*IX(1,NH)-2	ARE	21
	LM(2)=3*IX(2,NH)-2	ARE	22

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LN(3)=2*IN(3,ND)-1+NT3
LN(4)=3*IN(4,ND)-2
LN(5)=2*IN(5,ND)-1+NT3
LN(6)=2*IN(6,ND)-1+NT3
GO TO 30
20 DO 25 I=1,6
25 LN(I)=2*IN(I,ND)-1+NT3
LN(3)=3*IN(3,ND)-2
30 AREA=ABS(.5*(X(J)*Y(G)-X(J)*X(I)*Y(I)+X(I)*Y(J)-X(K)*Y(I)*X(G)-X(J)*Y(I)
1)
N0=N0+(LN(1)+LN(2)+LN(3)+LN(4)+LN(5)+LN(6))
NIN=NIN+(LN(1)+LN(2)+LN(3)+LN(4)+LN(5)+LN(6))
NWIDTH=N0-NIN*2
IF (NWIDTH.GT.NBAND) NBAND=NWIDTH
IF (NWIDTH.GT.NB) WRITE (5,40) NWIDTH-NB
IF (AREA.GT.0) GO TO 35
WRITE (5,45) NB
RETURN
40
35 ZAI(1)=X(I)+ZAI(2)*X(J)+ZAI(3)*X(G)
ZY=ZAI(1)*Y(I)+ZAI(2)*Y(J)+ZAI(3)*Y(G)
AREA=ZAI(3)*AREA
WRITE (5,50) NB, ZAI(1), I=1,3, AREA, ZY
RETURN
45
40 FORMAT (2X, 30B#NWIDTH EXCEEDS LIMIT, NBAND=, 15, 5X, 17HIN ELEMARE
INT NO. =, 15)
45 FORMAT (5X, 30B#NEGATIVE OR ZERO AREA, ELEMENT NO.,=, 15)
50 FORMAT (26, 15, 50 4E14, 3, 3F12, 2)
52
END
SUBROUTINE SPLINE (INAT)
COMMON /4/ NDDU(26), DELTA
DIMENSION NP(7), EP(11,7), POP(11,7), PSNR(11,7), SPNR(11,7)
DIMENSION POP(319), SRD(11)
6
7
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30
SPLINE FITTING FOR TAN, MOD, TAN, POISSON RATIO VS. SIGMOCTA
NF= NO. OF DATA POINTS FOR STRESS
PHI= FRICTION ANGLE FOR SOIL (DEGREES)
PSI= RATIO OF (SIG-VA2)/(SIGMA1+SIGMA3) FOR PLANE STRAIN
ANISO= DEGREE OF ANISOTROPY OF SOIL STRENGTH
FOR ISOTROPIC MATERIAL ANISO=1.
DELTA= ANGLE OF FRICTION ( DEGREES ) BETWEEN SOIL AND PIPE
FACTOR= STRENGTH PROPERTY CONVERSION FACTOR
READ (5,55) NF, PSI, PHI, ANISO, DELTA, FACTOR
IF (ANISO.LE.0.0) ANISO=.0
FRATIO=FAILURE(PSI, PHI)
SR= OCTAHedral NORMAL STRESS VECTOR
TP= TANGENT MODULUS
PSNR= TANGENT POISSONS RATIO
READ (5,65) OPCI, I=1, NF)
DO 5 I=1, NF
5 OPCI=FACTOR*OPCI
DO 15 I=1, 11
READ (5,70) (EP(I, J), PSNR(I, J), J=1, NF)
SRD(I)=(1.-FLRAT(I))/10.
DO 16 J=1, NF

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10   EP(HD,J)=FACTOR*EP(HD,J)                                SPL 31
C                                         SPL 32
C       CUBIC SPLINE FITTING FOR TANGENT MODULUS AND POISSONS RATIO SPL 33
C                                         SPL 34
C       CALL SPLFIT (HP,HD,XP,EP,SEP)                        SPL 35
C       CALL SPLFIT (HP,HD,XP,PSNR,SPSR)                     SPL 36
15  CONTINUE                                                  SPL 37
    WRITE (6,75) 'MAT'                                         SPL 38
    WRITE (6,60) PHI,PSI,FRATIO,DELTA,ANISO                   SPL 39
    WRITE (6,80) (GP(I),I=1,11)                               SPL 40
    WRITE (6,85) (GRO(I),I=1,11)                               SPL 41
    DO 20 I=1,11                                               SPL 42
20  WRITE (6,90) (EP(J,I),J=1,11)                             SPL 43
    WRITE (6,95) (GRO(I),I=1,11)                               SPL 44
    DO 25 I=1,11                                               SPL 45
25  WRITE (6,90) (PSHR(J,I),J=1,11)                           SPL 46
C                                         SPL 47
C       STORE MATERIAL PROPERTIES ON MASS STORAGE UNIT      SPL 48
C                                         SPL 49
C                                         SPL 50
    PROP(1)=ANISO                                              SPL 51
    PROP(2)=DELTA                                              SPL 52
    PROP(3)=FRATIO                                             SPL 53
    MD=3                                                       SPL 54
    DO 30 I=1,7                                                SPL 55
    MD=MD+1                                                    SPL 56
30  PROP(MD)=WP(1)                                             SPL 57
    DO 35 I=1,11                                               SPL 58
    DO 35 J=1,7                                                SPL 59
    MD=MD+1                                                    SPL 60
35  PROP(MD)=EP(I,J)                                           SPL 61
    DO 40 I=1,11                                               SPL 62
    DO 40 J=1,7                                                SPL 63
    MD=MD+1                                                    SPL 64
40  PROP(MD)=SEP(I,J)                                           SPL 65
    DO 45 I=1,11                                               SPL 66
    DO 45 J=1,7                                                SPL 67
    MD=MD+1                                                    SPL 68
45  PROP(MD)=PSHR(I,J)                                           SPL 69
    DO 50 I=1,11                                               SPL 70
    DO 50 J=1,7                                                SPL 71
    MD=MD+1                                                    SPL 72
50  PROP(MD)=SPSR(I,J)                                           SPL 73
    PROP(319)=FLOAT(HP)                                         SPL 74
    CALL WRITING (4,PROP,319,'MAT')                             SPL 75
    RETURN                                                       SPL 76
C                                         SPL 77
55  FORMAT (15,5F10.0)                                          SPL 78
60  FORMAT (1X, 24HFAILURE RATIO FOR PHI = ,F6.2, 12H AND PSI = ,F5.2,SPL 79
1, 8H IS = ,F6.3/10X, 8HDELTA = ,F6.2, 22H ANISOTROPY FACTOR =SPL 80
2, F6.2/)                                                       SPL 81
65  FORMAT (2F10.0)                                             SPL 82
70  FORMAT (2F10.0)                                             SPL 83
75  FORMAT (/10X) 45HNON-LINEAR SOIL PROPERTIES FOR MATERIAL MD = ,15)SPL 84
80  FORMAT (1X, 11HSIGMA(DCT)=,12E9.1)                         SPL 85
85  FORMAT (10X, 22HTANGENT MODULUS VALUES,/2X, 15HSTRESS RATIO = ,F3,SPL 86
11,10X,F3.1)/)                                                 SPL 87
90  FORMAT (15X, 11E9.2)                                         SPL 88
95  FORMAT (/10X) 28HTANGENT POISSON RATIO VALUES,/2X, 15HSTRESS RATISPL 89
10 = ,F3.1,10X,F3.1)/)                                         SPL 90
C                                         SPL 91

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	END	SPL	91
	SUBROUTINE SHFIT (NPN,ND,XP,YC,YDP)	SPE	2
	DIMENSION XP(7), YP(11,7), YDF(11,7), HC(7), YC(7), AI(7), BI(7), CI,SPE		3
	1(7), DI(7), SDP(7)	SPE	4
C		SPE	5
C	CUBIC SPLINE FITTING	SPE	6
C		SPE	7
	NP1=NPN-1	SPE	8
	DO 5 N=1,NP1	SPE	9
	5 HC(N)=XP(N+1)-XP(N)	SPE	10
	SLOP1=FD(HC(1),HC(2),YP(ND,1),YP(ND,2),YP(ND,3))	SPE	11
	SLOPN=BD(HC(NPN-2),HC(NPN-1),YP(ND,NPN-2),YP(ND,NPN-1),YP(ND,NPN))	SPE	12
	DO 10 M=1,NPN	SPE	13
	10 Y(M)=YP(ND,M)	SPE	14
	CALL COFIT (NPN,XP,Y,SLOP1,SLOPN,AI,BI,CI,DI)	SPE	15
	CALL TRIDGNL (NPN,AI,BI,CI,DI,SDP)	SPE	16
	DO 15 I=1,NPN	SPE	17
	15 YDP(ND,I)=SDP(I)	SPE	18
	RETURN	SPE	19
C		SPE	20
	END	SPE	21
	SUBROUTINE CURFIT (NPN,XP,YP,SLOP1,SLOPN,AI,BI,CI,DI)	COF	2
	DIMENSION XP(7), YP(7), AI(7), BI(7), CI(7), DI(7)	COF	3
C		COF	4
C	GENERATE SPLINE COEFFICIENTS	COF	5
C		COF	6
	AI(1)=0.0	COF	7
	BI(1)=(XP(2)-XP(1))/3.	COF	8
	CI(1)=BI(1)/2.	COF	9
	DI(1)=(YP(2)-YP(1))/(XP(2)-XP(1))-SLOP1	COF	10
	AI(NPN)=(XP(NPN)-XP(NPN-1))/6.	COF	11
	BI(NPN)=AI(NPN)*2.	COF	12
	CI(NPN)=0.0	COF	13
	DI(NPN)=-(YP(NPN)-YP(NPN-1))/(XP(NPN)-XP(NPN-1))+SLOPN	COF	14
	N1=NPN-1	COF	15
	DO 5 I=2,N1	COF	16
	AI(I)=(XP(I)-XP(I-1))/6.	COF	17
	BI(I)=(XP(I+1)-XP(I-1))/3.	COF	18
	CI(I)=(XP(I+1)-XP(I))/6.	COF	19
	DI(I)=(YP(I+1)-YP(I))/(XP(I+1)-XP(I))-(YP(I)-YP(I-1))/(XP(I)-XP(I-1))	COF	20
	1 CI(I)	COF	21
	5 CONTINUE	COF	22
	RETURN	COF	23
C		COF	24
	END	COF	25
	SUBROUTINE TRIDGNL (NPN,AI,BI,CI,DI,YDP)	TRI	2
	DIMENSION AI(7), BI(7), CI(7), DI(7), YDP(7), O(10), U(10)	TRI	3
C		TRI	4
C	SOLVE TRI-DIAGONAL MATRIX	TRI	5
C		TRI	6
	P=BI(1)	TRI	7
	Q(1)=-CI(1)/P	TRI	8
	U(1)=DI(1)/P	TRI	9
	DO 5 K=2,NPN	TRI	10
	P=AI(K)*Q(K-1)+BI(K)	TRI	11
	Q(K)=-CI(K)/P	TRI	12
	U(K)=(DI(K)-AI(K)*U(K-1))/P	TRI	13
	5 CONTINUE	TRI	14
	YDP(NPN)=U(NPN)	TRI	15
	N1=NPN-1	TRI	16

DO 10 L=1,N1	TR1	17
K=N1+1-L	TR1	18
YDF(K)=0.0(K)*YDF(K+1)+1.0	TR1	19
10 CONTINUE	TR1	20
RETURN	TR1	21
C	TR1	22
END	TR1	23
FUNCTION FD(S1,S2,R1,R2,R3)	FD	2
C	FD	3
C	FD	4
C	FD	5
IF (S1-S2) 5,10,5	FD	6
5 FD=(R2-R1)/S1	FD	7
RETURN	FD	8
10 FD=(-3.*R1+4.*R2-R3)/(2.*S1)	FD	9
RETURN	FD	10
C	FD	11
END	FD	12
FUNCTION BD(S1,S2,R1,R2,R3)	BD	2
C	BD	3
C	BD	4
C	BD	5
IF (S1-S2) 5,10,5	BD	6
5 BD=(R3-R2)/S2	BD	7
RETURN	BD	8
10 BD=(-3.*R3+4.*R2-R1)/(2.*S1)	BD	9
RETURN	BD	10
C	BD	11
END	BD	12
FUNCTION ORDINET(A,B,C,D,E,F,P)	ORD	2
HJ=B-C	ORD	3
B1=D-P	ORD	4
B2=P-C	ORD	5
A1=B1**3	ORD	6
A2=B2**3	ORD	7
T1=A1*A/(6.*HJ)	ORD	8
T2=A2*B/(6.*HJ)	ORD	9
T3=(E-A*HJ**2/6.)*(D-P)/HJ	ORD	10
T4=(F-B*HJ**2/6.)*(P-C)/HJ	ORD	11
ORDINET=T1+T2+T3+T4	ORD	12
RETURN	ORD	13
C	ORD	14
END	ORD	15
FUNCTION FAILURE(PSI,PHI)	FR	2
C	FR	3
C	FR	4
C	FR	5
REAL NPHI	FR	6
PI=22./7.	FR	7
PHI=PHI*PI/180.	FR	8
SINPHI=SIN(PHI)	FR	9
NPHI=(1.+SINPHI)/(1.-SINPHI)	FR	10
T1=6.*NPHI/((NPHI+1.）**2)	FR	11
T2=2.*(PSI**2-PSI+1.)	FR	12
T3=SQRT(T2-T1)	FR	13
T4=T3/(1.+PSI)	FR	14
FAILURE=T4	FR	15
RETURN	FR	16
C	FR	17
END	FR	18

	OVERLAY(PDY+2,0)	PLT	1
	OVERLAY(PDY+2,0)	PLT	2
C	PROGRAM LAY/OUT	PLT	3
	COMMON /NODES,NELEMT,NEEF,HEF,ND,NT3,ISTOP,NCYCLE,LAYERS,ISTEP,PLT	PLT	4
	ISTEP,NT12,ETA,NT1,NT2,NTENSH,IFLAG,NC12,NCODE(SS0),X(SS0),Y(SS0),PLT	PLT	5
	2),JND(X5),APR(S10),IX(8,250),APR(A(250),INDE(250),INDE(250),GAMA(2PLT	PLT	6
	35),ZAI(3)	PLT	7
	DIRECTION(XPOLY(6),YPOLY(6))	PLT	8
	CALL PLOT	PLT	9
	READ (5,25) /ZAI,VMAC,VCEN	PLT	10
	IF=10./VMAC	PLT	11
	CALL FACTOR (IF)	PLT	12
	CALL PLOT (0.0,0.0,-3)	PLT	13
	XPOLY(4)=0.0	PLT	14
	XPOLY(4)=XPOLY(4)	PLT	15
	YPOLY(5)=1.0	PLT	16
	YPOLY(5)=YPOLY(5)	PLT	17
	CALL AC10 (0.0,0.0,200,-2,200,0.0,XPOLY(4),YPOLY(5),0)	PLT	18
	CALL AC12 (0.0,0.0,200,-2,200,30.0,XPOLY(4),YPOLY(5),-1)	PLT	19
	CALL PLOT (0.0,VMAC,3)	PLT	20
	CALL PLOT (200,VMAC,2)	PLT	21
	CALL PLOT (200,0.0,2)	PLT	22
	DO 20 I=1,NELEMT	PLT	23
	NT=I(7,1)	PLT	24
	GO TO (5,10,15), NT	PLT	25
5	11=I(2,1)	PLT	26
	12=I(3,1)	PLT	27
	XPOLY(1)=X(11)	PLT	28
	YPOLY(1)=Y(11)	PLT	29
	XPOLY(2)=X(12)	PLT	30
	YPOLY(2)=Y(12)	PLT	31
	XPOLY(3)=0.0	PLT	32
	XPOLY(3)=XPOLY(3)	PLT	33
	YPOLY(4)=1.0	PLT	34
	YPOLY(4)=YPOLY(4)	PLT	35
	CALL LINE (XPOLY,YPOLY+2,1,0,0)	PLT	36
	GO TO 20	PLT	37
10	CONTINUE	PLT	38
15	11=I(1,1)	PLT	39
	12=I(2,1)	PLT	40
	13=I(3,1)	PLT	41
	XPOLY(4)=X(11)	PLT	42
	XPOLY(1)=XPOLY(4)	PLT	43
	YPOLY(4)=Y(11)	PLT	44
	YPOLY(1)=YPOLY(4)	PLT	45
	XPOLY(2)=X(12)	PLT	46
	YPOLY(2)=Y(12)	PLT	47
	XPOLY(3)=X(13)	PLT	48
	YPOLY(3)=Y(13)	PLT	49
	XPOLY(5)=0.0	PLT	50
	XPOLY(5)=XPOLY(5)	PLT	51
	YPOLY(6)=1.0	PLT	52
	YPOLY(6)=YPOLY(6)	PLT	53
	CALL LINE (XPOLY,YPOLY+4,1,0,0)	PLT	54
	XC=(X(11)+X(12)+X(13))/3.-0.2	PLT	55
	YC=(Y(11)+Y(12)+Y(13))/3.	PLT	56
	CALL NUMBER CAC,YC,0.4,1,0.0,2H13)	PLT	57
20	CONTINUE	PLT	58
	XC=ZAI/2.-2.	PLT	59
	YC=VMAC+2.	PLT	60

	CALL SYMBOL (A,0,YCEN,0,3*11,0,0,-1)	PLT	61
	CALL SYMBOL (XC,YC,0,6,1*4*FINITE ELEMENT MESH,6,0,19)	PLT	62
	CALL PLOT (6,6,6,0,999)	PLT	63
	RETURN	PLT	64
C		PLT	65
	25 FORMAT (3F10.0)	PLT	66
C		PLT	67
	END	PLT	68
	OVERLAY(CDY,3,0)	BLK	1
C	OVERLAY(CDY,3,0)	BLK	2
	PROGRAM BLOCK	BLK	3
	COMMON /NODES/ NELEMENT,NDXIF,NBRAND,ND,NT3,ISTOP,NCYCLE,LAYERS,ISTEP,BLK	BLK	4
	INSTEP,NT12,ETA,NT1,NT2,INTENSH, (FLAG,NSIZE,NODEC(550),X(550),Y(550),BLK	BLK	5
	2),JNDX(51),ANLSTS,IX(8,2*6),AREA(250),INDX(250),INDEX(250),GAMA(2,BLK	BLK	6
	35),ZAI(3)	BLK	7
	COMMON /1/ E,HUE,RADIUS,YCEN,YLEN,EI,KH,KS,H1,H2,INTER	BLK	8
	COMMON /3/ R	BLK	9
	COMMON /4/ NDOX(26),DELTA	BLK	10
	COMMON /5/ Q(1100),LIST(1101)	BLK	11
	DIMENSION R(1100), TEMP(17), LK(6), SK(12,12)	BLK	12
	DIMENSION WP(7), EP(11,7), DEP(11,7), PSNR(11,7), CPSNR(11,7)	BLK	13
	DIMENSION E(10), HUE(10), PPDP(319)	BLK	14
	DIMENSION A(103,103), ARRAY(103)	BLK	15
	DIMENSION SR(6,6), SKJT(8,8)	BLK	16
	DIMENSION TEMP(17)	BLK	17
	REAL HUEX,HUEY	BLK	18
	REAL KH,KS	BLK	19
	REAL HUE	BLK	20
	PI=22./7.	BLK	21
	ANISO=1.0	BLK	22
	NDINC=1	BLK	23
	IF (NT3.LE.0) NDINC=0	BLK	24
	IF (NT3.LE.0) ND=ND-1	BLK	25
	NEND=3*NT3	BLK	26
	ND2=2*ND	BLK	27
	NDOF=2*NNODES-NT3	BLK	28
	CALL HULLMAT (A,NSIZE,NSIZE)	BLK	29
	CALL HULLMAT (SK,12,12)	BLK	30
	CALL ZERO (0,NDOF)	BLK	31
C		BLK	32
C	FIND NODAL LOADS FOR ELEMENTS IN THIS PARTICULAR LAYER	BLK	33
C		BLK	34
	DO 40 11=1,NELEMENT	BLK	35
	NT=IX(7,11)	BLK	36
	GO TO (40,40,5,5,5), NT	BLK	37
5	11=IX(1,11)	BLK	38
	12=IX(2,11)	BLK	39
	13=IX(3,11)	BLK	40
	YC=(Y(11)+Y(12)+Y(13))/3.	BLK	41
	IF (YC.GT.R2.OR.YC.LE.H1) GO TO 40	BLK	42
	NT=IX(8,11)	BLK	43
	NT=GAMA(NT)*AREA(11)	BLK	44
	MK=NT-2	BLK	45
	GO TO (10,20,25), MK	BLK	46
10	DO 15 1=1,6	BLK	47
15	LN(1)=2*IX(1,11)+NT3	BLK	48
	GO TO 35	BLK	49
20	LN(1)=3*IX(1,11)-1	BLK	50
	LN(2)=3*IX(2,11)-1	BLK	51
	LN(3)=2*IX(3,11)+NT3	BLK	52

	LH(4)=2*IX(4,11)-1	BLK	53
	LH(5)=2*IX(5,11)+NT3	BLK	54
	LH(6)=2*IX(6,11)+NT3	BLK	55
	GO TO 35	BLK	56
25	DO 30 I=1,6	BLK	57
30	LH(I)=2*IX(I,11)+NT3	BLK	58
	LH(3)=3*IX(3,11)-1	BLK	59
35	I1=LH(1)	BLK	60
	I2=LH(2)	BLK	61
	I3=LH(3)	BLK	62
	I4=LH(4)	BLK	63
	I5=LH(5)	BLK	64
	I6=LH(6)	BLK	65
	O(I1)=O(I1)-WT/12.	BLK	66
	O(I2)=O(I2)-WT/12.	BLK	67
	O(I3)=O(I3)-WT/12.	BLK	68
	O(I4)=O(I4)-WT/4.	BLK	69
	O(I5)=O(I5)-WT/4.	BLK	70
	O(I6)=O(I6)-WT/4.	BLK	71
40	CONTINUE	BLK	72
	DO 45 I=1,NHOF	BLK	73
45	O(I)=O(I)+FLW*HT*CTEP	BLK	74
C		BLK	75
	READP 9	BLK	76
C		BLK	77
C		BLK	78
C	FORM STIFFNESS MATRIX IN BLOCKS	BLK	79
		BLK	80
	INAT=0	BLK	81
	KSHIFT=0	BLK	82
	HUNBLK=1	BLK	83
	NN=ND	BLK	84
	NL=1	BLK	85
	THETA=DELTA*PI/180.	BLK	86
	SLIP=TAN(THETA)	BLK	87
	SLIP=1.1*SLIP	BLK	88
50	WRITE (6,319) KSHIFT,HUNBLK,NN,NL,ND	BLK	89
	DO 290 KI=1,NELEMIT	BLK	90
	HT=IX(7,KI)	BLK	91
	HT=IX(8,KI)	BLK	92
	ENORHL=HN	BLK	93
	ES=KS	BLK	94
	IF (HT,LE,2) GO TO 85	BLK	95
	IF (1STOP,LE,0) GO TO 35	BLK	96
	IF (HT,NE,INAT) GO TO 55	BLK	97
	GO TO 85	BLK	98
55	INAT=HT	BLK	99
	CALL READMC (4,PROP,319,HT)	BLK	100
	AMTID=PROP(1)	BLK	101
	FRMTID=PROP(3)	BLK	102
	NQ=3	BLK	103
	DO 60 I=1,7	BLK	104
	NQ=NQ+1	BLK	105
60	XP(I)=PROP(NQ)	BLK	106
	DO 65 I=1,11	BLK	107
	DO 65 J=1,7	BLK	108
	NQ=NQ+1	BLK	109
65	EP(I,J)=PROP(NQ)	BLK	110
	DO 70 I=1,11	BLK	111
	DO 70 J=1,7	BLK	112
	NQ=NQ+1		

70	SEP(I,J)=PROP(MD)	BLK	113
	DO 75 I=1,11	BLK	114
	DO 75 J=1,7	BLK	115
	MD=MD+1	BLK	116
75	PCNR(I,J)=PROP(MD)	BLK	117
	DO 80 I=1,11	BLK	118
	DO 80 J=1,7	BLK	119
	MD=MD+1	BLK	120
80	SPSHR(I,J)=PROP(MD)	BLK	121
	NP=INT(PROP(319))	BLK	122
85	CONTINUE	BLK	123
C		BLK	124
C	SEARCH FOR ELEMENTS BELONG TO THIS LAYER	BLK	125
C		BLK	126
	GO TO (90,120,200,200,200), NT	BLK	127
C		BLK	128
C	TYPE I ELEMENTS	BLK	129
C		BLK	130
90	DO 95 I=1,2	BLK	131
95	LM(I)=3*IX(I,KI)-3	BLK	132
	DO 100 I=1,2	BLK	133
	IF (LM(I)+1,LT,NL) GO TO 100	BLK	134
	IF (LM(I)+1,LE,NM) GO TO 105	BLK	135
100	CONTINUE	BLK	136
	GO TO 290	BLK	137
105	I1=IX(1,KI)	BLK	138
	I2=IX(2,KI)	BLK	139
	CALL RING (KI,RADIUS,EI,VCEN,X(I1),X(I2),Y(I1),Y(I2),SR)	BLK	140
C		BLK	141
C	JOIN TYPE I ELEMENTS	BLK	142
C		BLK	143
	DO 115 I=1,2	BLK	144
	DO 115 K=1,3	BLK	145
	II=LM(I)+K-KSHIFT	BLK	146
	IF (II,LE,0,OR,II,GE,NM) GO TO 115	BLK	147
	KK=3*I-3+K	BLK	148
	DO 110 J=1,2	BLK	149
	DO 110 L=1,3	BLK	150
	JJ=LM(J)+L-KSHIFT-II+1	BLK	151
	IF (JJ,LE,0) GO TO 110	BLK	152
	LL=3*J-3+L	BLK	153
	A(JJ,II)=A(JJ,II)+SR(K,LL)	BLK	154
110	CONTINUE	BLK	155
115	CONTINUE	BLK	156
	GO TO 290	BLK	157
C		BLK	158
C	TYPE II ELEMENTS	BLK	159
C		BLK	160
120	DO 125 I=1,2	BLK	161
	LM(I)=3*IX(I,KI)-3	BLK	162
125	CONTINUE	BLK	163
	DO 130 I=3,4	BLK	164
130	LM(I)=2*IX(I,KI)-2+NT3	BLK	165
	DO 135 I=1,4	BLK	166
	IF (LM(I)+1,LT,NL) GO TO 135	BLK	167
	IF (LM(I)+1,LE,NM) GO TO 140	BLK	168
135	CONTINUE	BLK	169
	GO TO 290	BLK	170
140	I1=IX(1,KI)	BLK	171
	I2=IX(2,KI)	BLK	172

	EN=ENDRHL	BLK	173
	YC=0.5*(Y(11)+Y(12))	BLK	174
	CALL READR (1,TEMP,17,KI)	BLK	175
	CALL READR (1,TEMP,1,-KI+1)	BLK	176
	IF (INTER.LE.0) GO TO 160	BLK	177
	IF (YC.GT.H2) GO TO 140	BLK	178
	IF (YC.GT.H1.AND.HCYCLE.EQ.1) GO TO 160	BLK	179
	SIGNA=(TEMP(1)+TEMP(1))/2.	BLK	180
	TANA=(TEMP(2)+TEMP(2))/2.	BLK	181
	IF (ABS(SIGNA).LT.GMIN(H1)) GO TO 160	BLK	182
	IF (SIGNA+GMIN(H1)) 175,145,145	BLK	183
145	RO=TAN/CI(25)	BLK	184
	RATIO=ABS(RO)	BLK	185
	IF (RATIO.GT.SLIP) GO TO 150	BLK	186
	GO TO 160	BLK	187
150	ES=1000.0	BLK	188
	WRITE (6,320) KI	BLK	189
	GO TO 165	BLK	190
155	ES=1000.0	BLK	191
	EN=ES	BLK	192
	WRITE (6,315) KI	BLK	193
	GO TO 165	BLK	194
	ES=100.0	BLK	195
	EN=ES	BLK	196
	GO TO 165	BLK	197
160	EN=ENDRHL	BLK	198
165	CALL JOINT (KI+YCEN+EN+ES*(Y(11)+X(12)+Y(11)+Y(12)+TH1+TH2+SKJT)	BLK	199
	IX(5+KI)=INT(TH1)	BLK	200
	IX(6+KI)=INT(TH2)	BLK	201
	TEMP(3)=EN	BLK	202
	TEMP(4)=ES	BLK	203
	CALL WRITR (1,TEMP,17,KI)	BLK	204
C		BLK	205
C		BLK	206
C	JOINT TYPE II ELEMENT	BLK	207
	DO 175 I=1,4	BLK	208
	DO 175 J=1,2	BLK	209
	II=LN(I)+K-KSHIFT	BLK	210
	IF (II.LE.0.OR.II.GT.ND) GO TO 175	BLK	211
	IO=2*I-2+K	BLK	212
	DO 170 J=1,4	BLK	213
	DO 170 L=1,2	BLK	214
	JJ=LN(J)+L-KSHIFT-II+1	BLK	215
	LL=2*J-2+L	BLK	216
	IF (JJ.LE.0) GO TO 170	BLK	217
	AC(J+II)=AC(J+II)+SKJT*(KK*LL)	BLK	218
170	CONTINUE	BLK	219
175	CONTINUE	BLK	220
C		BLK	221
	DO 180 I=1,2	BLK	222
180	LN(I)=2*I/(I+KI+1)-3	BLK	223
	DO 185 I=3,4	BLK	224
185	LN(I)=2*(X(I,KI+1)-2*H1)	BLK	225
	I1=I/(I+KI+1)	BLK	226
	I2=I/(I+KI+1)	BLK	227
	CALL JOINT (KI+1+YCEN+EN+ES*(X(11)+X(12)+Y(11)+Y(12)+TH1+TH2+SKJ	BLK	228
1	T)	BLK	229
	IX(5+KI+1)=INT(TH1)	BLK	230
	IX(6+KI+1)=INT(TH2)	BLK	231
	TEMP(3)=EN	BLK	232

	TEMP(4)=ES	BLK 233
	CALL UPRTMS (1,TEMP,17,KI+1)	BLK 234
	DO 195 I=1,4	BLK 235
	DO 195 K=1,2	BLK 236
	II=LN(I)+K-KSHIFT	BLK 237
	IF (II.LE.0.OR.II.GT.NB) GO TO 195	BLK 238
	KK=2*I-2+K	BLK 239
	DO 196 J=1,4	BLK 240
	DO 196 L=1,2	BLK 241
	JJ=LN(J)+L-KSHIFT-II+1	BLK 242
	LL=2*J-2+L	BLK 243
	IF (JJ.LE.0) GO TO 196	BLK 244
	KKJJ=KK*JJ+II*JJ*OF(JT*KK*LL)	BLK 245
190	CONTINUE	BLK 246
195	CONTINUE	BLK 247
	KI=KI+1	BLK 248
C		BLK 249
	GO TO 250	BLK 250
C		BLK 251
C		BLK 252
C	TRIANGULAR ELEMENT TYPE III	BLK 253
C		BLK 254
200	NO=NT-2	BLK 255
	GO TO (205,215,225,235) NO	BLK 256
205	DO 210 I=1,6	BLK 257
210	LN(I)=2*LN(1+KI)-2*NT2	BLK 258
	GO TO 230	BLK 259
215	LN(1)=3*LN(1+KI)-3	BLK 260
	LN(2)=3*LN(2+KI)-3	BLK 261
	LN(3)=2*LN(3+KI)-2*NT3	BLK 262
	LN(4)=3*LN(4+KI)-3	BLK 263
	LN(5)=2*LN(5+KI)-2*NT2	BLK 264
	LN(6)=2*LN(6+KI)-2*NT3	BLK 265
	GO TO 230	BLK 266
220	DO 225 I=1,6	BLK 267
225	LN(1)=2*LN(1+KI)-2*NT2	BLK 268
	LN(3)=3*LN(3+KI)-3	BLK 269
230	DO 235 I=1,6	BLK 270
	IF (LN(I)+1.LT.NL) GO TO 235	BLK 271
	IF (LN(I)+1.LE.NB) GO TO 240	BLK 272
235	CONTINUE	BLK 273
	GO TO 290	BLK 274
240	I1=LN(1+KI)	BLK 275
	I2=LN(2+KI)	BLK 276
	I3=LN(3+KI)	BLK 277
	VC=(YC(I1)+YC(I2)+YC(I3))/3.	BLK 278
C		BLK 279
C	TYPE III ELEMENT	BLK 280
C		BLK 281
	IF (ISTOP.LE.0) GO TO 270	BLK 282
	IF (VC.GT.H2) GO TO 265	BLK 283
	IF (VC.GT.H1.AND.NVCLE.E0.1) GO TO 270	BLK 284
	CALL READMS (1,TEMP,17,KI)	BLK 285
	STRESS=ABS(TEMP(7))	BLK 286
	THUDCT=ABS(TEMP(8))	BLK 287
	THUF=STRESS/THUDCT	BLK 288
	RNTID=THUDCT/THUF	BLK 289
	IF (PATID.GT.1.0) WRITE (6,325) PATID,KI	BLK 290
DO 245 LI=1,10		BLK 291
	R1=FLDWT(LI-1)/10.	BLK 292
	R2=FLDWT(LI)/10.	BLK 293

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      LJ=LI-LI+1                                BLK 293
      IF (RAT(D,GT,R1,AND,RATIO,LE,R2) GO TO 250 BLK 294
245  CONTINUE                                    BLK 295
      LJ=2                                        BLK 296
C      * LJ * IS THE ET VS. SIGMA3 CURVE NO. SELECTED BASED ON STRESS RATE BLK 297
C      NOW SELECT INTERVAL OF COFFILING/PRESSURE BLK 298
C      IF (STRESSX,LT,XP(1),OR,STRESSX,GT,XP(NP)) WRITE (6,330) STRESS BLK 299
250  IF (STRESSX,LT,XP(1),OR,STRESSX,GT,XP(NP)) WRITE (6,330) STRESS BLK 300
      X=K1                                        BLK 301
      DO 255 LK=2,NP                             BLK 302
      LI=LK                                        BLK 303
      IF (STRESSX,GE,XP(LK-1),AND,STRESSX,LE,XP(LK)) GO TO 260 BLK 304
255  CONTINUE                                    BLK 305
      LI=NP                                        BLK 306
260  YDP1=SEP(LJ,LI-1)                           BLK 307
      YDPN1=SPSHR(LJ,LI-1)                       BLK 308
      YDP2=SEP(LJ,LI)                             BLK 309
      YDPN2=SPSHR(LJ,LI)                         BLK 310
      X1=XP(LI-1)                                BLK 311
      X2=XP(LI)                                  BLK 312
      Y1=EP(LJ,LI-1)                             BLK 313
      YN1=PSHR(LJ,LI-1)                         BLK 314
      Y2=EP(LJ,LI)                               BLK 315
      YN2=PSHR(LJ,LI)                           BLK 316
      PP=STRESSX                                  BLK 317
      ET1=ORDINET(YDP1,YDP2,X1,X2,Y1,Y2,PP)      BLK 318
      PSN1=ORDINET(YDPN1,YDPN2,X1,X2,YN1,YN2,PP) BLK 319
      YDP1=SEP(LJ-1,LI-1)                       BLK 320
      YDPN1=SPSHR(LJ-1,LI-1)                   BLK 321
      YDP2=SEP(LJ-1,LI)                         BLK 322
      YDPN2=SPSHR(LJ-1,LI)                     BLK 323
      Y1=EP(LJ-1,LI-1)                         BLK 324
      YN1=PSHR(LJ-1,LI-1)                     BLK 325
      Y2=EP(LJ-1,LI)                           BLK 326
      YN2=PSHR(LJ-1,LI)                       BLK 327
      ET2=ORDINET(YDP1,YDP2,X1,X2,Y1,Y2,PP)      BLK 328
      PSN2=ORDINET(YDPN1,YDPN2,X1,X2,YN1,YN2,PP) BLK 329
      EY=ET2+(ET1-ET2)*(RATIO-R1)              BLK 330
      NUEY=PSN2+(PSN1-PSN2)*(RATIO-R1)          BLK 331
      EX=ANISO*EY                                BLK 332
      NUEX=NUEY*EX/EY                            BLK 333
      GO TO 275                                  BLK 334
265  EY=E(MT)/1000.0                            BLK 335
      EX=ANISO*EY                                BLK 336
      NUEY=NUE(MT)                              BLK 337
      NUEX=NUEY*EX/EY                            BLK 338
      GO TO 275                                  BLK 339
270  EY=E(MT)                                    BLK 340
      EX=ANISO*EY                                BLK 341
      NUEY=NUE(MT)                              BLK 342
      NUEX=NUEY*EX/EY                            BLK 343
275  CALL TRANGLE (KI,MT,EX,EY,NUEX,NUEY,SK)     BLK 344
      DO 285 I=1,6                               BLK 345
      DO 285 K=1,2                               BLK 346
      II=LK(I)+K-KSHIFT                         BLK 347
      IF (II,LE,0,OR,II,GT,ND) GO TO 285         BLK 348
      KK=I+(K-1)*6                             BLK 349
      DO 280 J=1,6                               BLK 350
      DO 280 L=1,2                               BLK 351

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      JJ=J(JU)+L-KSHIFT+1-11      BLK 353
      IF (J(JL),0) GO TO 280      BLK 354
      LL=J(LL-1)*6                BLK 355
      A(JJ,LL)=A(JJ,LL)+SK(KL*LL) BLK 356
284      CONTINUE                  BLK 357
285      CONTINUE                  BLK 358
290      CONTINUE                  BLK 359
C                                  BLK 360
C                                  BLK 361
C      WRITE STIFFNESS EQUATIONS ON TAPE 10      BLK 362
C                                  BLK 363
C      WRITE(10) ((A(JJ,LL),N=1,NBAND),N=1,NB) BLK 364
C                                  BLK 365
C      CALL ZERO (ARRAY,NSIZE)      BLK 366
      NB=NL-1                      BLK 367
      DO 300 N=1,NBICE              BLK 368
        DO 295 M=1,NSIZE            BLK 369
295      ARRAY(M)=A(JJ,M)          BLK 370
        CALL WRITE (10,ARRAY,NSIZE,NX,NB) BLK 371
300      CONTINUE                  BLK 372
      IF (NB,GE,NBIC) GO TO 305     BLK 373
      CALL HULLMAT (A,NSIZE,NSIZE)  BLK 374
      KSHIFT=KSHIFT+NB             BLK 375
      IF (HUMBLK,EQ,1) ND=ND+NBIC   BLK 376
      HUMBLK=HUMBLK+1              BLK 377
      NB=NB+NB                     BLK 378
      NL=NL+NB+1                   BLK 379
      GO TO 50                      BLK 380
305      IF (NT3,GT,0) ND=ND+NBIC   BLK 381
      RETURN                        BLK 382
C                                  BLK 383
310      FORMAT (5X, 9H KSHIFT = ,I8,5X, 9H HUMBLK = ,I5, 8H  NB = ,I5, BLK 384
      18H  NL = ,I5, 7H  ND = ,I5) BLK 385
315      FORMAT (5X, 24H INTERACTION ELEMENT NO. ,I5,3X, 21HAS FAILED IN TRBLK 386
      1NSIDE)                       BLK 387
320      FORMAT (5X, 26H INTERACTION ELEMENT NO. = ,I5,3X, 31H HAS FAILED INBLK 388
      1 EXCESSIVE SHEAR)            BLK 389
325      FORMAT (10X, 41H STRESS RATIO IS GREATER THAN 1 + RATIO = ,F6.2,5X, BLK 390
      1 17HIN ELEMENT NO. = ,I5)   BLK 391
330      FORMAT (10X, 56H CONFINING PRESSURE IS OUT OF RANGE OF SIGMAS, STREBLK 392
      1SSK = ,E12.2,5X, 17HIN ELEMENT NO. = ,I5) BLK 393
C                                  BLK 394
      END                          BLK 395
      SUBROUTINE TRIANGLE (K,NT,X,Y,XU,XUEN,XUEN,SK) TRG 2
      COMMON INDECS,NELEMT,NBDF,ABAND,ND,NT3,ISTOP,NCYCLE,LAYERS,ISTEP,TRG 3
      INSTEP,NT12,ETA,NT1,NT2,ND/ENH,IFLAG,NSIZE,NDOUE(550),X(550),Y(550)TRG 4
      2),JNDX(51),ANLSSIS,IX(8,250),ARENA(250),INDX(250),INDEX(250),GAMA(2)TRG 5
      35),ZAI(3)                      TRG 6
      COMMON /1/ E,XUE,RADIUS,XLEN,YLEN,EI,KN,KS,H1,H2,INTER TRG 7
      COMMON /2/ D                   TRG 8
      DATA PLSTRS,PLSTRM/6HPLSTRS,6HPLSTRM/ TRG 9
      REAL XUEN,XUEN,XUENS           TRG 10
      DIMENSION SK(12,12), E(10), XUE(10), D(10,10) TRG 11
      DIMENSION DD(3,3), DMAT(90)   TRG 12
      REAL KN,KS                     TRG 13
C                                  TRG 14
C      ***** TRG 15
C      GENERATE STIFFNESS MATRIX FOR TRIANGULAR ELEMENTS TRG 16
C                                  TRG 17
C      AA=ARENA(K)                   TRG 18
      HT=IX(8,K)                     TRG 19

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	TA=1./AA	TRG	20
C		TRG	21
C		TRG	22
C		TRG	23
	L=D(1,1)	TRG	24
	M=D(2,1)	TRG	25
	N=D(3,1)	TRG	26
	X21=X(10)-X(L)	TRG	27
	X13=X(L)-X(10)	TRG	28
	X32=X(10)-X(L)	TRG	29
	Y12=Y(L)-Y(10)	TRG	30
	Y23=Y(10)-Y(L)	TRG	31
	Y31=Y(10)-Y(L)	TRG	32
	IF (.NOT.(LE.N)) GO TO 5	TRG	33
	GO TO 10	TRG	34
5	D11=D(1,1)	TRG	35
	D12=D(1,2)	TRG	36
	D13=D(1,3)	TRG	37
	D21=D(2,1)	TRG	38
	D22=D(2,2)	TRG	39
	D23=D(2,3)	TRG	40
	D31=D(3,1)	TRG	41
	D32=D(3,2)	TRG	42
	D33=D(3,3)	TRG	43
	GO TO 15	TRG	44
C		TRG	45
10	IF (NLS10.E0.PLSTR) CALL PLSTRS (EX+EY,NUEX+NUCY,DD)	TRG	46
	IF (NLS10.E0.PLSTRD) CALL VALUES (EX+EY,NUEX+NUCY,DD)	TRG	47
	D11=DD(1,1)	TRG	48
	D12=DD(1,2)	TRG	49
	D13=DD(1,3)	TRG	50
	D21=DD(2,1)	TRG	51
	D22=DD(2,2)	TRG	52
	D23=DD(2,3)	TRG	53
	D31=DD(3,1)	TRG	54
	D32=DD(3,2)	TRG	55
	D33=DD(3,3)	TRG	56
15	A1=D11*Y23+D13*X32	TRG	57
	A2=D31*Y23+D33*X32	TRG	58
	A3=D11*Y31+D13*X13	TRG	59
	A4=D31*Y31+D33*X13	TRG	60
	A5=D11*Y12+D13*X21	TRG	61
	A6=D31*Y12+D33*X21	TRG	62
	A7=D12*X32+D13*Y23	TRG	63
	A8=D32*X32+D33*Y23	TRG	64
	A9=D12*X13+D13*Y31	TRG	65
	A10=D32*X13+D33*Y31	TRG	66
	A11=D12*Y21+D13*Y12	TRG	67
	A12=D32*Y21+D33*Y12	TRG	68
C		TRG	69
	B1=D21*Y23+D23*X32	TRG	70
	B2=D21*Y31+D23*X13	TRG	71
	B3=D21*Y12+D23*X21	TRG	72
	B4=D22*X32+D23*Y23	TRG	73
	B5=D22*X13+D23*Y31	TRG	74
	B6=D22*X21+D23*Y12	TRG	75
C		TRG	76
	C11=Y23*A1+X32*A2	TRG	77
	C12=Y23*A3+X32*A4	TRG	78
	C13=Y23*A5+X32*A6	TRG	79

	C14=Y23*A7+X32*A8	TRG	80
	C15=Y23*A9+X32*A10	TRG	81
	C16=Y23*A11+X32*A12	TRG	82
C		TRG	83
	C21=Y31*A1+X13*A2	TRG	84
	C22=Y31*A3+X13*A4	TRG	85
	C23=Y31*A5+X13*A6	TRG	86
	C24=Y31*A7+X13*A8	TRG	87
	C25=Y31*A9+X13*A10	TRG	88
	C26=Y31*A11+X13*A12	TRG	89
C		TRG	90
	C31=Y12*A1+X21*A2	TRG	91
	C32=Y12*A3+X21*A4	TRG	92
	C33=Y12*A5+X21*A6	TRG	93
	C34=Y12*A7+X21*A8	TRG	94
	C35=Y12*A9+X21*A10	TRG	95
	C36=Y12*A11+X21*A12	TRG	96
C		TRG	97
	C41=X32*B1+Y23*A2	TRG	98
	C42=X32*B2+Y23*A4	TRG	99
	C43=X32*B3+Y23*A6	TRG	100
	C44=X32*B4+Y23*A8	TRG	101
	C45=X32*B5+Y23*A10	TRG	102
	C46=X32*B6+Y23*A12	TRG	103
C		TRG	104
	C51=X13*B1+Y31*A2	TRG	105
	C52=X13*B2+Y31*A4	TRG	106
	C53=X13*B3+Y31*A6	TRG	107
	C54=X13*B4+Y31*A8	TRG	108
	C55=X13*B5+Y31*A10	TRG	109
	C56=X13*B6+Y31*A12	TRG	110
C		TRG	111
	C63=X21*B3+Y12*A6	TRG	112
	C61=X21*B1+Y12*A2	TRG	113
	C62=X21*B2+Y12*A4	TRG	114
	C64=X21*B4+Y12*A8	TRG	115
	C65=X21*B5+Y12*A10	TRG	116
	C66=X21*B6+Y12*A12	TRG	117
C		TRG	118
	IF GK.GT.NT12.AND.K.LE.(NT12*NT1/2)>> GO TO 20	TRG	119
	GO TO 25	TRG	120
20	ETTA=ETA/2.	TRG	121
	ETATHO=1.-2.*ETTA	TRG	122
	ETAFDUR=1.-4.*ETTA	TRG	123
	ETA2=ETATHO*ETATHO	TRG	124
	ETA4=ETAFDUR*ETAFDUR	TRG	125
	GO TO 30	TRG	126
25	ETTA=0.0	TRG	127
	ETAFDUR=1.0	TRG	128
	ETATHO=ETAFDUR	TRG	129
	ETA4=1.0	TRG	130
	ETA2=ETA4	TRG	131
C		TRG	132
C		TRG	133
30	SK(1,1)=C11*TA*(1.+4.*ETTA/3.+4.*ETTA*ETTA)/(ETATHO*ETATHO*4.)	TRG	134
	SK(2,1)=-C12*TA/(12.*ETAFDUR)	TRG	135
	SK(1,2)=SK(2,1)	TRG	136
C		TRG	137
	SK(1,3)=C13*TA*(-0.333+2.*ETTA/3.+ETTA*ETTA)/(4.*ETATHO)	TRG	138
	SK(3,1)=SK(1,3)	TRG	139

	$SK(2,3)=-C23*TA/12,$	TRG	140
	$SK(3,2)=SK(2,3)$	TRG	141
	$SK(2,2)=C22*TA/(4.*ETA4)$	TRG	142
	$SK(3,3)=C33*TA*(1.+0.*ETIA/3.+16.*ETIA*ETIA)/4,$	TRG	143
C	$SK(1,4)=TA*(C11*C2.*ETIA+C12*(4./3.+8.*ETIA/3.))/4.*ETA2*ETATND)$	TRG	144
	$SK(4,1)=SK(1,4)$	TRG	145
	$SK(2,4)=C21*TA*(3.*ETA2*ETAFDUR)$	TRG	146
	$SK(4,2)=SK(2,4)$	TRG	147
	$SK(3,4)=4.*C31+C32)*TA*(1+TA/3.*ETA2)$	TRG	148
	$SK(4,3)=SK(3,4)$	TRG	149
	$SK(4,4)=2.*C31+C12+C21+C1.*C22*TA*(3.*ETA2*ETA2)$	TRG	150
C	$SK(1,5)=2.*ETIA*(C11+C13)*TA*(3.*ETATND*ETAFDUR)$	TRG	151
	$SK(5,1)=SK(1,5)$	TRG	152
	$SK(2,5)=C23*TA*(3.*ETA4)$	TRG	153
	$SK(5,2)=SK(2,5)$	TRG	154
	$SK(3,5)=(C32*(1.+4.*ETIA)+C33*4.*ETIA)*TA*(3.*ETAFDUR)$	TRG	155
	$SK(5,3)=SK(3,5)$	TRG	156
	$SK(4,5)=TA*(C12+2.*C13+C22+C23)/(3.*ETAFDUR*ETA2)$	TRG	157
	$SK(5,4)=SK(4,5)$	TRG	158
	$SK(5,5)=TA*(2.*C22+C23+C12+2.*C13)/(3.*ETIA)$	TRG	159
C	$SK(1,6)=TA*(C13+2.*ETIA*(C11+C13))/(3.*ETATND*ETAFDUR)$	TRG	160
	$SK(6,1)=SK(1,6)$	TRG	161
	$SK(2,6)=0,0$	TRG	162
	$SK(6,2)=SK(2,6)$	TRG	163
	$SK(3,6)=TA*(C31+4.*ETIA*(C31+C33))/(3.*ETAFDUR)$	TRG	164
	$SK(6,3)=SK(3,6)$	TRG	165
	$SK(4,6)=TA*(C11+C13+C21+2.*C23)/(3.*ETAFDUR*ETA2)$	TRG	166
	$SK(6,4)=SK(4,6)$	TRG	167
	$SK(5,6)=TA*(2.*C21+C23+C11+C33)/(3.*ETA4)$	TRG	168
	$SK(6,5)=SK(5,6)$	TRG	169
	$SK(6,6)=TA*(2.*C11+C13+C11+2.*C33)/(3.*ETIA)$	TRG	170
C	$SK(1,7)=C14*TA*(1.+4.*ETIA/3.+4.*ETIA*ETIA)/(4.*ETA2)$	TRG	171
	$SK(7,1)=SK(1,7)$	TRG	172
	$SK(2,7)=-C24*TA*(12.*ETAFDUR)$	TRG	173
	$SK(7,2)=SK(2,7)$	TRG	174
	$SK(3,7)=-C34*TA*(1.+6.*ETIA+24.*ETIA*ETIA)/(12.*ETATND)$	TRG	175
	$SK(7,3)=SK(3,7)$	TRG	176
	$SK(4,7)=TA*(2.*C14*ETIA*(24*(1.+2.*ETIA))/(3.*ETA2*ETATND)$	TRG	177
	$SK(7,4)=SK(4,7)$	TRG	178
	$SK(5,7)=2.*ETIA*TA*(C24+C34)/(3.*ETATND*(1.+2.*ETIA))$	TRG	179
	$SK(7,5)=SK(5,7)$	TRG	180
	$SK(6,7)=TA*(2.*C14*ETIA+C34*(1.+2.*ETIA))/(3.*ETATND*ETAFDUR)$	TRG	181
	$SK(7,6)=SK(6,7)$	TRG	182
	$SK(7,7)=TA*(C44*(1.+4.*ETIA/3.+4.*ETIA*ETIA)/(4.*ETA2)$	TRG	183
C	$SK(1,8)=TA*(C15*(-1.+2.*ETIA)/(12.*ETAFDUR*ETATND)$	TRG	184
	$SK(8,1)=SK(1,8)$	TRG	185
	$SK(2,8)=TA*(C25/(4.*ETA4)$	TRG	186
	$SK(8,2)=SK(2,8)$	TRG	187
	$SK(3,8)=-C35*TA/12,$	TRG	188
	$SK(8,3)=SK(3,8)$	TRG	189
	$SK(4,8)=C15*TA/(3.*ETAFDUR*ETA2)$	TRG	190
	$SK(8,4)=SK(4,8)$	TRG	191
	$SK(5,8)=C35*TA/(3.*ETA4)$	TRG	192
	$SK(8,5)=SK(5,8)$	TRG	193
	$SK(6,8)=0,0$	TRG	194
		TRG	195
		TRG	196
		TRG	197
		TRG	198
		TRG	199

	$SK(8,6)=SK(6,8)$	TRG	200
	$SK(7,8)=-C45*TA/(12.*ETAFDUR)$	TRG	201
	$SK(8,7)=SK(7,8)$	TRG	202
	$SK(8,8)=C55*TA/(4.*ETA4)$	TRG	203
C		TRG	204
	$SK(1,9)=-C16*TA*(1.-2.*ETTA-8.*ITTA*ETTA)/(12.*ETATWD)$	TRG	205
	$SK(9,1)=SK(1,9)$	TRG	206
	$SK(2,9)=-C26*TA/12.$	TRG	207
	$SK(9,2)=SK(2,9)$	TRG	208
	$SK(3,9)=C36*TA*(1.+6.*ETTA/3.+16.*ETTA*ETTA)/4.$	TRG	209
	$SK(9,3)=SK(3,9)$	TRG	210
	$SK(4,9)=4.*ETTA*TA*(C16+C26)/(3.*ETA2)$	TRG	211
	$SK(9,4)=SK(4,9)$	TRG	212
	$SK(5,9)=TA*(C26*(1.+4.*ETTA)+C36*4.*ETTA)/(3.*ETAFDUR)$	TRG	213
	$SK(9,5)=SK(5,9)$	TRG	214
	$SK(6,9)=TA*(C16*(1.+4.*ETTA)+C36*4.*ETTA)/(3.*ETAFDUR)$	TRG	215
	$SK(9,6)=SK(6,9)$	TRG	216
	$SK(7,9)=-TA*C46*(1.-6.*ETTA-24.*ETTA*ETTA)/(12.*ETATWD)$	TRG	217
	$SK(9,7)=SK(7,9)$	TRG	218
	$SK(8,9)=-C56*TA/12.$	TRG	219
	$SK(9,8)=SK(8,9)$	TRG	220
	$SK(9,9)=C66*TA*(1.+6.*ETTA/3.+16.*ETTA*ETTA)/4.$	TRG	221
C		TRG	222
	$SK(1,10)=TA*(C14*2.*ETTA+C15*(1.+2.*ETTA))/(3.*ETATWD*ETA2)$	TRG	223
	$SK(10,1)=SK(1,10)$	TRG	224
	$SK(2,10)=C24*TA/(3.*ETAFDUR*ETA2)$	TRG	225
	$SK(10,2)=SK(2,10)$	TRG	226
	$SK(3,10)=4.*TA*ETTA*(C34+C35)/(3.*ETA2)$	TRG	227
	$SK(10,3)=SK(3,10)$	TRG	228
	$SK(4,10)=TA*(2.*C14+C15+C24+2.*C25)/(3.*ETA2*ETA2)$	TRG	229
	$SK(10,4)=SK(4,10)$	TRG	230
	$SK(5,10)=TA*(C24+C25+2.*C34+C35)/(3.*ETAFDUR*ETA2)$	TRG	231
	$SK(10,5)=SK(5,10)$	TRG	232
	$SK(6,10)=TA*(C14+C15+C34+2.*C35)/(3.*ETA2*ETAFDUR)$	TRG	233
	$SK(10,6)=SK(6,10)$	TRG	234
	$SK(7,10)=TA*(2.*ETTA*C44+C45*(1.+2.*ETTA))/(3.*ETA2*ETATWD)$	TRG	235
	$SK(10,7)=SK(7,10)$	TRG	236
	$SK(8,10)=C54*TA/(3.*ETAFDUR*ETA2)$	TRG	237
	$SK(10,8)=SK(8,10)$	TRG	238
	$SK(9,10)=4.*ETTA*TA*(C64+C65)/(3.*ETA2)$	TRG	239
	$SK(10,9)=SK(9,10)$	TRG	240
	$SK(10,10)=TA*(2.*C44+C45+C54+2.*C55)/(3.*ETA4*ETA4)$	TRG	241
C		TRG	242
	$SK(1,11)=2.*ETTA*TA*(C15+C16)/(3.*ETATWD*ETAFDUR)$	TRG	243
	$SK(11,1)=SK(1,11)$	TRG	244
	$SK(2,11)=C26*TA/(3.*ETA4)$	TRG	245
	$SK(11,2)=SK(2,11)$	TRG	246
	$SK(3,11)=TA*(C35*(1.+4.*ETTA)+4.*ETTA*C36)/(3.*ETAFDUR)$	TRG	247
	$SK(11,3)=SK(3,11)$	TRG	248
	$SK(4,11)=TA*(C15+2.*C16+C25+C26)/(3.*ETAFDUR*ETA2)$	TRG	249
	$SK(11,4)=SK(4,11)$	TRG	250
	$SK(5,11)=TA*(2.*C25+C26+C35+2.*C36)/(3.*ETA4)$	TRG	251
	$SK(11,5)=SK(5,11)$	TRG	252
	$SK(6,11)=TA*(2.*C15+C16+C35+C36)/(3.*ETA4)$	TRG	253
	$SK(11,6)=SK(6,11)$	TRG	254
	$SK(7,11)=TA*2.*ETTA*(C45+C46)/(3.*ETATWD*ETAFDUR)$	TRG	255
	$SK(11,7)=SK(7,11)$	TRG	256
	$SK(8,11)=TA*C56/(3.*ETA4)$	TRG	257
	$SK(11,8)=SK(8,11)$	TRG	258
	$SK(9,11)=TA*(C65*(1.+4.*ETTA)+4.*ETTA*C66)/(3.*ETAFDUR)$	TRG	259

	SK(11,9)=SK(9,11)	TRG	260
	SK(10,11)=TA*(C45+2.*C46+C55+C56)/(3.*ETA*FOUR*ETA2)	TRG	261
	SK(11,10)=SK(10,11)	TRG	262
	SK(11,11)=TA*(2.*C55+C56+C65+2.*C66)/(3.*ETA4)	TRG	263
C		TRG	264
	SK(1,12)=TA*(C14*2.*ETTA+C16*(1.+2.*ETTA))/(3.*ETATWO)	TRG	265
	SK(12,1)=SK(1,12)	TRG	266
	SK(2,12)=0.0	TRG	267
	SK(12,2)=SK(2,12)	TRG	268
	SK(3,12)=TA*(C34*(1.+4.*ETTA)+C36*4.*ETTA)/(3.*ETA*FOUR)	TRG	269
	SK(12,3)=SK(3,12)	TRG	270
	SK(4,12)=TA*(C14+C16+C24+2.*C26)/(3.*ETA*FOUR*ETA2)	TRG	271
	SK(12,4)=SK(4,12)	TRG	272
	SK(5,12)=TA*(2.*C24+C26+C34+C36)/(3.*ETA4)	TRG	273
	SK(12,5)=SK(5,12)	TRG	274
	SK(6,12)=TA*(2.*C14+C16+C34+2.*C36)/(3.*ETA4)	TRG	275
	SK(12,6)=SK(6,12)	TRG	276
	SK(7,12)=TA*(2.*ETTA*C44+(1.+2.*ETTA)*C46)/(3.*ETATWO*ETA*FOUR)	TRG	277
	SK(12,7)=SK(7,12)	TRG	278
	SK(8,12)=0.0	TRG	279
	SK(12,8)=SK(8,12)	TRG	280
	SK(9,12)=TA*(C64*(1.+4.*ETTA)+C66*4.*ETTA)/(3.*ETA*FOUR)	TRG	281
	SK(12,9)=SK(9,12)	TRG	282
	SK(10,12)=TA*(C44+C46+C54+2.*C56)/(3.*ETA*FOUR*ETA2)	TRG	283
	SK(12,10)=SK(10,12)	TRG	284
	SK(11,12)=TA*(2.*C54+C56+C64+C66)/(3.*ETA4)	TRG	285
	SK(12,11)=SK(11,12)	TRG	286
	SK(12,12)=TA*(2.*C44+C46+C64+2.*C66)/(3.*ETA4)	TRG	287
C		TRG	288
C		TRG	289
	ND=0	TRG	290
	DO 45 I=1,3	TRG	291
	DO 45 J=1,3	TRG	292
	ND=ND+1	TRG	293
	IF (.NOT.) 35,35,40	TRG	294
35	DNAT(ND)=DNAT+ND	TRG	295
	GO TO 45	TRG	296
40	DNAT(ND)=DB(I,J)	TRG	297
45	CONTINUE	TRG	298
	DNAT(10)=NUEC	TRG	299
	DNAT(11)=NUEV	TRG	300
	ND=11	TRG	301
	DO 55 I=1,12	TRG	302
	DO 50 J=1,12	TRG	303
	ND=ND+1	TRG	304
50	DNAT(ND)=SK(I,J)	TRG	305
55	CONTINUE	TRG	306
	CALL WRITNG (3, DNAT, 89, K)	TRG	307
	RETURN	TRG	308
C		TRG	309
	END	TRG	310
	SUBROUTINE NATMULT (A,B,C,M,N)	MAT	2
	DIMENSION A(M,N), B(N,N), C(M,N)	MAT	3
C		MAT	4
C	MATRIX * A * IS MULTIPLIED WITH * B * AND STORED IN * C *	MAT	5
C		MAT	6
	DO 10 I=1,M	MAT	7
	DO 10 J=1,N	MAT	8
	SUM=0.0	MAT	9
	DO 5 K=1,N	MAT	10

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5      SUM=SUM+A(I,K)*B(K,J)                                MAT 11
10 C(I,J)=SUM                                                MAT 12
    RETURN                                                    MAT 13
C                                                    MAT 14
    ENTRY MATPRN                                              MAT 15
C                                                    MAT 16
C      TRANSPOSE OF * A * IS MULTIPLIED WITH * B * AND STORED INTO * C * MAT 17
C                                                    MAT 18
    DO 20 I=1-IT                                              MAT 19
    DO 20 J=1-IT                                              MAT 20
        SUM=0.0                                              MAT 21
        DO 15 K=1-IT                                        MAT 22
15      SUM=SUM+A(K,I)*B(K,J)                                MAT 23
20 C(I,J)=SUM                                                MAT 24
    RETURN                                                    MAT 25
C                                                    MAT 26
    END                                                        MAT 27
SUBROUTINE VALUES (EX,EY,HUEX,HUEY,DD)                    VLU 2
C                                                    VLU 3
C      CALCULATE = DD = MATRIX FOR PLANE STRAIN SITUATION VLU 4
C                                                    VLU 5
    DIMENSION DD(3,3)                                        VLU 6
    REAL HUEX,HUEY                                          VLU 7
    RH=EY/EY                                                VLU 8
    RH=0.5/(1.+HUEY)                                        VLU 9
    C=EY/(1.+HUEX*(1.-HUEX-2.*RH*HUEY*HUEY))              VLU 10
    DD(1,1)=C*RH*(1.-RH*HUEY*HUEY)                        VLU 11
    DD(2,1)=C*RH*(1.-RH*HUEY*HUEY)                        VLU 12
    DD(1,2)=C*RH*(1.+HUEX*HUEY)                            VLU 13
    DD(2,2)=C*(1.-HUEX*HUEX)                                VLU 14
    DD(3,3)=C*RH*(1.+HUEX*(1.-HUEX-2.*RH*HUEY*HUEY))      VLU 15
    DD(3,2)=0.0                                              VLU 16
    DD(2,1)=DD(3,2)                                          VLU 17
    DD(2,3)=DD(3,1)                                          VLU 18
    DD(1,3)=DD(2,3)                                          VLU 19
    RETURN                                                    VLU 20
C                                                    VLU 21
    END                                                        VLU 22
SUBROUTINE PLUSTRS (EX,EY,HUEX,HUEY,DD)                    PLS 2
C                                                    PLS 3
C      CALCULATE = DD = MATRIX FOR PLANE STRESS SITUATION PLS 4
C                                                    PLS 5
    DIMENSION DD(3,3)                                        PLS 6
    REAL HUEX,HUEY                                          PLS 7
    RH=EY/EY                                                PLS 8
    RH=0.5/(1.+HUEY)                                        PLS 9
    C=EY/(1.-RH*HUEY*HUEY)                                  PLS 10
    DD(1,1)=C*RH                                            PLS 11
    DD(2,1)=C*RH*HUEY                                       PLS 12
    DD(1,2)=DD(2,1)                                          PLS 13
    DD(2,2)=C                                              PLS 14
    DD(3,3)=C*RH*(1.-RH*HUEY*HUEY)                         PLS 15
    DD(3,2)=0.0                                              PLS 16
    DD(3,1)=DD(3,2)                                          PLS 17
    DD(2,3)=DD(3,1)                                          PLS 18
    DD(1,3)=DD(2,3)                                          PLS 19
    RETURN                                                    PLS 20
C                                                    PLS 21
    END                                                        PLS 22
FUNCTION ORDINET(M,B,C,D,E,F,P)                            ORF 2

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C		ORD	3
C		ORD	4
C		ORD	5
	HJ=D-C	ORD	6
	B1=B-F	ORD	7
	B2=P-C	ORD	8
	A1=B1*B1*B1	ORD	9
	A2=B2*B2*B2	ORD	10
	T1=A1*A/(G.*HJ)	ORD	11
	T2=A2*B/(G.*HJ)	ORD	12
	T3=(E-4*HJ*HJ/G.)*(C-B)*HJ	ORD	13
	T4=(F-2*HJ*HJ/G.)*(P-C)*HJ	ORD	14
	ORDINET=T1+T2+T3+T4	ORD	15
	RETURN	ORD	16
C	END	ORD	17
		ORD	18
	SUBROUTINE RING (K1,R,E1,VCEN,K1,X2,Y1,Y2,SK)	RNG	2
	DIMENSION SR(6,6), SI(6,6)	RNG	3
	DIMENSION TL(6,6), TC(6,6)	RNG	4
	DIMENSION TRP(66)	RNG	5
	REAL HUE	RNG	6
C		RNG	7
C		RNG	8
C		RNG	9
	SPAN=SQRT((X1-X2)**2+(Y1-Y2)**2)	RNG	10
	BETA=SPAN/R	RNG	11
	BETA2=2.*BETA	RNG	12
	SH=SIN(BETA)	RNG	13
	CS=COS(BETA)	RNG	14
	SH2=SIN(BETA2)	RNG	15
	H=BETA-SH	RNG	16
	B=CS*SH*SH/2.-1.	RNG	17
	C=1.5*BETA-2.*SH*SH2/4.	RNG	18
	D=0.5*BETA-SH2/4.	RNG	19
	E=CS-1.	RNG	20
	HA=C*E/BETA-B	RNG	21
	BB=B-H*E/BETH	RNG	22
	CC=A*B-B*E	RNG	23
	DB=A*A/BETA-C	RNG	24
	EE=C*E-A*B	RNG	25
	FF=B*B-C*D	RNG	26
	G=B*(B-2.*H*E/BE)+(C*E-C/BETA-B)+H*A*B/BETA	RNG	27
	FT=EI/(R**3)*G	RNG	28
	SR(1,1)=FT*AA	RNG	29
	SR(1,2)=FT*BB	RNG	30
	SR(2,1)=SR(1,2)	RNG	31
	SR(1,3)=FT*CC*B/BETA	RNG	32
	SR(3,1)=SR(1,3)	RNG	33
	SR(2,2)=FT*DB	RNG	34
	SR(2,3)=FT*EE*B/BETA	RNG	35
	SR(3,2)=SR(2,3)	RNG	36
	SR(3,3)=FT*FF*B*B/BETA	RNG	37
	SR(4,1)=-FT*(HA*CS+BB*SH)	RNG	38
	SR(1,4)=SR(4,1)	RNG	39
	SR(4,2)=-FT*(HB*CS+DB*SH)	RNG	40
	SR(2,4)=SR(4,2)	RNG	41
	SR(4,3)=-FT*(CC*CS+EE*SH)*R/BETA	RNG	42
	SR(3,4)=SR(4,3)	RNG	43
	SR(1,5)=FT*(HA*SH-BB*CS)	RNG	44
	SR(5,1)=SR(1,5)	RNG	45

	SR(5,2)=FT*(BB*SH-DD*CS)	RNG	44
	SR(2,5)=SR(5,2)	RNG	45
	SR(5,3)=FT*(CC*SH-EE*CS)*R/BETA	RNG	46
	SR(3,5)=SR(5,3)	RNG	47
	SR(6,1)=FT*(BB*(CS-1.)*BH*SH-CC/BETA)*R	RNG	48
	SR(1,6)=SR(6,1)	RNG	49
	SR(6,2)=FT*(BB*(CS-1.)*BH*SH-EE/BETA)*R	RNG	50
	SR(2,6)=SR(6,2)	RNG	51
	SR(6,3)=FT*(CC*(CS-1.)*BH*SH-FF)*R*B/BETA	RNG	52
	SR(3,6)=SR(6,3)	RNG	53
	SR(4,4)=SR(1,1)	RNG	54
	SR(4,5)=-SR(1,2)	RNG	55
	SR(5,4)=SR(4,5)	RNG	56
	SR(4,6)=SR(1,3)	RNG	57
	SR(6,4)=SR(4,6)	RNG	58
	SR(5,5)=SR(2,2)	RNG	59
	SR(5,6)=-SR(2,3)	RNG	60
	SR(6,5)=SR(5,6)	RNG	61
	SR(6,6)=SR(3,3)	RNG	62
C		RNG	63
C		RNG	64
C		RNG	65
	TRANSFORMATION OF COORDINATE SYSTEM	RNG	66
	CALL NULLMAT (TL,6,6)	RNG	67
	CALL NULLMAT (TC,6,6)	RNG	68
	T1=Y1-YCEH	RNG	69
	T2=Y2-YCEH	RNG	70
	IF (X1.EQ.0.0) X1=0.00001	RNG	71
	IF (X2.EQ.0.0) X2=0.00001	RNG	72
	TH1=T1/X1	RNG	73
	TH2=T2/X2	RNG	74
	PHI1=ATAN(TH1)	RNG	75
	PHI2=ATAN(TH2)	RNG	76
	CS1=COS(PHI1)	RNG	77
	SH1=SIN(PHI1)	RNG	78
	CS2=COS(PHI2)	RNG	79
	SH2=SIN(PHI2)	RNG	80
	TL(1,1)=-SH1	RNG	81
	TL(1,2)=+CS1	RNG	82
	TL(2,1)=-CS1	RNG	83
	TL(2,2)=-SH1	RNG	84
	TL(4,4)=-SH2	RNG	85
	TL(4,5)=+CS2	RNG	86
	TL(5,4)=-CS2	RNG	87
	TL(5,5)=-SH2	RNG	88
	TL(6,6)=1.0	RNG	89
	TL(3,3)=TL(6,6)	RNG	90
	CALL MATMULT (SR,TL,TC,6,6)	RNG	91
	CALL MATMULT (TL,TC,SK,6,6)	RNG	92
	ND=0	RNG	93
	DO 5 I=1,6	RNG	94
	DO 5 J=1,6	RNG	95
	ND=ND+1	RNG	96
	TMP(ND)=SK(I,J)	RNG	97
5	CONTINUE	RNG	98
	CALL WRITING (7,TMP,ND,K1)	RNG	99
	RETURN	RNG	100
C		RNG	101
	END	RNG	102
	SUBROUTINE JOINT (K1,YCEH,EN,ES,X1,X2,Y1,Y2,TH1,TH2,SKJT)	RNG	103
	DIMENSION SKJT(8,8), TL(6,8), TC(8,8), TMP(64)	JRT	2
		JRT	3

	EQUIVALENCE (TC*(1+1)*THP*1))	JNT	4
C		JNT	5
C	STIFFNESS MATRIX FOR INTERACTION ELEMEN	JNT	6
C		JNT	7
	P1=22./7.	JNT	8
	SPWH=SQRT((X1-22)**2+(Y1-Y2)**2)	JNT	9
	T1=Y1-YCEN	JNT	10
	T2=Y2-YCEN	JNT	11
	T1=-T1	JNT	12
	T2=-T2	JNT	13
	IF (T1.EQ.0.0) T1=0.00001	JNT	14
	IF (T2.EQ.0.0) T1=0.00001	JNT	15
	TH1=ABS(X1/T1)	JNT	16
	TH2=ABS(X2/T2)	JNT	17
	THETA1=ATAN(TH1)	JNT	18
	THETA2=ATAN(TH2)	JNT	19
	IF (T1.LT.0.0) THETA1=22./7.-THETA1	JNT	20
	IF (T2.LT.0.0) THETA2=22./7.-THETA2	JNT	21
	TH1=10.*(THETA1*180./PI)	JNT	22
	TH2=10.*(THETA2*180./PI)	JNT	23
	CALL HULLMAT (SKJT*8*8)	JNT	24
	CS=SPWH*ES/6.	JNT	25
	CH=SPWH*CH/6.	JNT	26
	SKJT(1,1)=2.*CS	JNT	27
	SKJT(1,3)=CS	JNT	28
	SKJT(1,5)=-CS	JNT	29
	SKJT(1,7)=-2.*CS	JNT	30
	SKJT(2,2)=2.*CH	JNT	31
	SKJT(2,4)=CH	JNT	32
	SKJT(2,6)=-CH	JNT	33
	SKJT(2,8)=-2.*CH	JNT	34
	SKJT(3,1)=CS	JNT	35
	SKJT(3,3)=2.*CS	JNT	36
	SKJT(3,5)=-2.*CS	JNT	37
	SKJT(3,7)=-CS	JNT	38
	SKJT(4,2)=CH	JNT	39
	SKJT(4,4)=2.*CH	JNT	40
	SKJT(4,6)=-2.*CH	JNT	41
	SKJT(4,8)=-CH	JNT	42
	SKJT(5,1)=-CS	JNT	43
	SKJT(5,3)=-2.*CS	JNT	44
	SKJT(5,5)=2.*CS	JNT	45
	SKJT(5,7)=CS	JNT	46
	SKJT(6,2)=-CH	JNT	47
	SKJT(6,4)=-2.*CH	JNT	48
	SKJT(6,6)=2.*CH	JNT	49
	SKJT(6,8)=CH	JNT	50
	SKJT(7,1)=-2.*CS	JNT	51
	SKJT(7,3)=-CS	JNT	52
	SKJT(7,5)=CS	JNT	53
	SKJT(7,7)=2.*CS	JNT	54
	SKJT(8,2)=-2.*CH	JNT	55
	SKJT(8,4)=-CH	JNT	56
	SKJT(8,6)=CH	JNT	57
	SKJT(8,8)=2.*CH	JNT	58
	CALL HULLMAT (TL*8*8)	JNT	59
	CALL HULLMAT (TC*8*8)	JNT	60
	CS1=COS(THETA1)	JNT	61
	SH1=SIN(THETA1)	JNT	62
	CS2=COS(THETA2)	JNT	63

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      SN2=SIN(THETA2)                                JNT 64
      TL(7,7)=CS1                                     JNT 65
      TL(1,1)=TL(7,7)                                JNT 66
      TL(7,8)=SN1                                     JNT 67
      TL(1,2)=TL(7,8)                                JNT 68
      TL(8,7)=-SN1                                    JNT 69
      TL(2,1)=TL(8,7)                                JNT 70
      TL(8,8)=CS1                                     JNT 71
      TL(2,2)=TL(8,8)                                JNT 72
      TL(5,5)=CS2                                     JNT 73
      TL(3,3)=TL(5,5)                                JNT 74
      TL(5,6)=SN2                                     JNT 75
      TL(3,4)=TL(5,6)                                JNT 76
      TL(6,5)=-SN2                                    JNT 77
      TL(4,3)=TL(6,5)                                JNT 78
      TL(6,6)=CS2                                     JNT 79
      TL(4,4)=TL(6,6)                                JNT 80
      CALL NATRNL (SKJT,TL,TC,9,8)                    JNT 81
      CALL NATRNL (TL,TC,SKJT,8,8)                    JNT 82
      MD=0                                             JNT 83
      DO 5 I=1,8                                       JNT 84
      DO 5 J=1,8                                       JNT 85
        MD=MD+1                                       JNT 86
        TRP(MD)=SKJT(I,J)                            JNT 87
5     CONTINUE                                       JNT 88
      CALL WRITE (7,TRP,MD,K1)                        JNT 89
      RETURN                                          JNT 90
C                                                    JNT 91
      END                                           JNT 92
OVERLAY(RDY,4,0)                                     STR 1
C                                                    STR 2
      OVERLAY(RDY,4,0)                               STR 3
      PROGRAM STRESS                                STR 4
      COMMON /NODE/,NELEMT,NDOF,HQ=40,HD,HT3,ISTOP,NCYCLE,LAYERS,ISTEP,STR 5
      1HTEP,HT12,ETG(HT1,HT2),HDTEN,IFLAG,NS12E,NCODE(550),X(550),Y(550),STR 6
      2JNDX(51),ANL111,IX(8,250),APE(4,250),INDX(250),INDEX(250),GAMA(250),STR 7
      3ZG(3)                                           STR 8
      COMMON /1/ E,HUE,RADIUS,X,CEN,Y,CEN,EI,HM,KD,HT,H2,INTER STR 9
      COMMON /2/ D                                     STR 10
      COMMON /3/ R                                     STR 11
      COMMON /4/ HEM(26),DELTA                         STR 12
      COMMON /5/ G(1100),LIST(1101)                   STR 13
      REAL HUE1,HUE2,HUE,HUDE,K1,FR                               STR 14
      DIMENSION TENP(17), R(1102), E(10), HUE(10), D(10,10) STR 15
      DIMENSION INAT(90), UK(12), SKJT(12,12), PP(12), TENP(17) STR 16
      DIMENSION Ia(50,4), FR(2)                         STR 17
C                                                    STR 18
C ***** STR 19
C   THIS ROUTINE COMPUTES STRESS, STRAIN, OCTAHEDRAL STRESSES AND STR 20
C   STRAINS FROM COMPUTED NODAL DISPLACEMENTS STORED AS R(1) ON TAPE STR 21
C ***** STR 22
C ***** STR 23
C   PI=22./7, STR 24
C   CALL ZERO (0,NDOF) STR 25
C   IFLAG=0 STR 26
C   THETA=DELTA*PI/180, STR 27
C   CLIP=TAN(THETA) STR 28
C   SLIP=1.1*CLIP STR 29
C ***** STR 30
      DO 100 KEL=1,NELEMT STR 31

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	ITYP=IX(7+KEL)	STR	32
	MT=IX(8+KEL)	STR	33
	GO TO (100,5,35,35,35), ITYP	STR	34
C		STR	35
C	TYPE II INTERACTION ELEMENT	STR	36
C		STR	37
5	CALL ZERO (U,12)	STR	38
	DO 10 I=1,2	STR	39
	DO 10 J=1,2	STR	40
	K=(I-1)*2+J	STR	41
	H=3*IX(1+KEL)-3+J	STR	42
	IA(KEL,1)=H	STR	43
	U(K)=R/H	STR	44
10	CONTINUE	STR	45
	DO 15 I=3,4	STR	46
	DO 15 J=1,2	STR	47
	K=(I-1)*2+J	STR	48
	H=3*IX(1+KEL)-2+H(I)+J	STR	49
	IA(KEL,1)=H	STR	50
	U(K)=R/H	STR	51
15	CONTINUE	STR	52
	I=IX(1+KEL)	STR	53
	J=IX(2+KEL)	STR	54
	SPIN=DEFT*(XX(I)-X(J))**2*(Y(I)-Y(J))**2)	STR	55
	TH1=FLDAT(IX(5+KEL))	STR	56
	TH2=FLDAT(IX(6+KEL))	STR	57
	THETA1=TH1*PI/180.	STR	58
	THETA2=TH2*PI/180.	STR	59
	CS1=COS(THETA1)	STR	60
	SH1=SIN(THETA1)	STR	61
	CS2=COS(THETA2)	STR	62
	SH2=SIN(THETA2)	STR	63
	CALL ZERO (PP,12)	STR	64
	CALL NULHAT (SKUT,12,12)	STR	65
	SKUT(7,7)=CS1	STR	66
	SKUT(1,1)=SKUT(7,7)	STR	67
	SKUT(7,8)=SH1	STR	68
	SKUT(1,2)=SKUT(7,8)	STR	69
	SKUT(8,7)=-SH1	STR	70
	SKUT(2,1)=SKUT(8,7)	STR	71
	SKUT(8,8)=CS1	STR	72
	SKUT(2,2)=SKUT(8,8)	STR	73
	SKUT(5,5)=CS2	STR	74
	SKUT(3,3)=SKUT(5,5)	STR	75
	SKUT(5,6)=SH2	STR	76
	SKUT(3,4)=SKUT(5,6)	STR	77
	SKUT(6,5)=-SH2	STR	78
	SKUT(4,3)=SKUT(6,5)	STR	79
	SKUT(6,6)=CS2	STR	80
	SKUT(4,4)=SKUT(6,6)	STR	81
	DO 25 I=1,8	STR	82
	SUM=0.0	STR	83
	DO 20 K=1,8	STR	84
20	SUM=SUM+SKUT(1,K)*U(K)	STR	85
	PP(1)=SUM	STR	86
25	CONTINUE	STR	87
	T1=-PP(1)-PP(3)+PP(5)+PP(7)	STR	88
	T2=-PP(2)-PP(4)+PP(6)+PP(8)	STR	89
	CALL READHS (1+TEMP,17+KEL)	STR	90
	FINH=TEMP(1)	STR	91

	FIXS=TEMP(2)	STR	92
	EH=TEMP(3)	STR	93
	ES=TEMP(4)	STR	94
	PH=0.5*(2*EH/SPAH)	STR	95
	PS=0.5*(2*ES/SPAH)	STR	96
	TEMP(1)=TEMP(1)+PH	STR	97
	TEMP(2)=TEMP(2)+PS	STR	98
	DO 30 K=5,12	STR	99
30	TEMP(K)=U(K-4)	STR	100
	TEMP(13)=PS	STR	101
	TEMP(14)=PH	STR	102
	TEMP(15)=FIXS	STR	103
	TEMP(16)=FIXDI	STR	104
	CALL WRITMS (1,TEMP,17,KEL)	STR	105
	GO TO 109	STR	106
C		STR	107
C		STR	108
C	TYPE III ELEMENT	STR	109
C		STR	110
35	I=IX(1,KEL)	STR	111
	J=IX(2,KEL)	STR	112
	K=IX(3,KEL)	STR	113
	L=IX(4,KEL)	STR	114
	M=IX(5,KEL)	STR	115
	N=IX(6,KEL)	STR	116
	M=ITYP-2	STR	117
	GO TO (40,45,50), M	STR	118
40	I1=2*I-1+HT3	STR	119
	I2=2*J-1+HT3	STR	120
	I3=2*K-1+HT3	STR	121
	I4=2*L-1+HT3	STR	122
	I5=2*M-1+HT3	STR	123
	I6=2*N-1+HT3	STR	124
	GO TO 55	STR	125
45	I1=3*I-2	STR	126
	I2=3*J-2	STR	127
	I3=2*K-1+HT3	STR	128
	I4=3*L-2	STR	129
	I5=2*M-1+HT3	STR	130
	I6=2*N-1+HT3	STR	131
	GO TO 55	STR	132
50	I1=2*I-1+HT3	STR	133
	I2=2*J-1+HT3	STR	134
	I3=3*K-2	STR	135
	I4=2*L-1+HT3	STR	136
	I5=2*M-1+HT3	STR	137
	I6=2*N-1+HT3	STR	138
55	CONTINUE	STR	139
	MM=REAR(KEL)	STR	140
	YC=(Y(I)+Y(J)+Y(K))/3.	STR	141
	IF (YC.GT.H2) GO TO 140	STR	142
	CALL READMS (3,DMAT,8,KEL)	STR	143
	D11=DMAT(1)	STR	144
	D12=DMAT(2)	STR	145
	D13=DMAT(3)	STR	146
	D21=DMAT(4)	STR	147
	D22=DMAT(5)	STR	148
	D23=DMAT(6)	STR	149
	D31=DMAT(7)	STR	150
	D32=DMAT(8)	STR	151

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D33=DMAT(9) STR 152
HUE1=DMAT(10) STR 153
HUE2=DMAT(11) STR 154
X21=(XJ)-X(I) STR 155
X13=(XI)-X(00) STR 156
X32=(X(00)-X(J) STR 157
Y23=(YJ)-Y(00) STR 158
Y31=(Y(00)-Y(I) STR 159
Y12=(Y(I)-Y(J) STR 160
U1=R(I1) STR 161
U2=R(I2) STR 162
U3=R(I3) STR 163
U4=R(I4) STR 164
U5=R(I5) STR 165
U6=R(I6) STR 166
V1=R(I1*1) STR 167
V2=R(I2*1) STR 168
V3=R(I3*1) STR 169
V4=R(I4*1) STR 170
V5=R(I5*1) STR 171
V6=R(I6*1) STR 172
C STR 173
HODE=0 STR 174
IF (GEL.GT.HT12.AND.REL.LE.(HT12+HT1/2)) GO TO 60 STR 175
GO TO 65 STR 176
60 ETATHD=1./ETA STR 177
ETAFDUR=1./2.*ETA STR 178
ETA2=ETATHD*ETATHD STR 179
ETH4=ETAFDUR*ETAFDUR STR 180
KODE=1 STR 181
GO TO 70 STR 182
65 HT=10.0*HT1) STR 183
ETAFDUR=1./0 STR 184
ETATHD=ETAFDUR STR 185
ETH4=1./0 STR 186
ETA2=ETH4 STR 187
C STR 188
C STR 189
C GENERATE AND STORE STRESS AND STRAINS ELEMENT BY ELEMENTC STR 189
C STR 190
70 K=REL STR 191
F1=4.*ZAI(1)-ETATHD/ETATHD STR 192
F2=4.*ZAI(2)-1./ETAFDUR STR 193
F3=4.*ZAI(3)-ETAFDUR STR 194
C STR 195
C STR 196
C STRAINS AT CENTROID STR 196
C STR 197
1 STRAINX=(Z2)*F1*U1+Y31*F2*U2+Y12*F3*U3+(Y23*4.*ZAI(2)+Y31*4.*ZAI STR 198
1 (1))*U4/ETA2+(Y31*4.*ZAI(3)+Y12*4.*ZAI(2))*U5/ETAFDUR+(Y23*4.*Z STR 199
2 AI(3)+Y12*4.*ZAI(1))*U6/ETAFDUR STR 200
STRAINX=0.5*STRAINX/AF STR 201
STRAINX=(X32*F1*V1+X13*F2*V2+X21*F3*V3+4.*X32*ZAI(2)+X13*ZAI(1) STR 202
1 )*V4/ETA2+4.*X13*ZAI(3)+X21*ZAI(2))*V5/ETAFDUR+4.*X32*ZAI(3)+ STR 203
2 X21*ZAI(1))*V6/ETAFDUR STR 204
STRAINX=0.5*STRAINX/AF STR 205
C STR 206
R1=X32*F1*U1 STR 207
R2=X13*F2*U2 STR 208
R3=X21*F3*U3 STR 209
R4=4.*(X32*ZAI(2)+X13*ZAI(1))*U4/ETA2 STR 210
R5=4.*(X13*ZAI(3)+X21*ZAI(2))*U5/ETAFDUR STR 211

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A6=4.*V23*Z41(3)+V21*Z41(1)+*V6/ETAFOUR      STR 212
B1=V23*F1*V1                                     STR 213
B2=V31*F2*V2                                     STR 214
B3=V12*F3*V3                                     STR 215
B4=4.*V23*Z41(2)+V31*Z41(1)+*V4/ETA2           STR 216
B5=4.*V31*Z41(3)+V12*Z41(2)+*V5/ETAFOUR        STR 217
B6=4.*V23*Z41(3)+V12*Z41(1)+*V6/ETAFOUR        STR 218
STR40CY=A1+A2+A3+A4+A5+A6+B1+B2+B3+B4+B5+B6     STR 219
STR40CY=0.5*STR40CY/W                             STR 220
C                                                    STR 221
C                                                    STR 222
C      ELEMENT STRESSES AT CENTROID IN X Y AND XY DIRECTIONS STR 223
C                                                    STR 224
C      STRESSX=D11*STRAINX+D12*STRAINY+D13*STR40CY STR 225
C      STRESSY=D21*STRAINX+D22*STRAINY+D23*STR40CY STR 226
C      STRESSXY=D31*STRAINX+D32*STRAINY+D33*STR40CY STR 227
C                                                    STR 228
C      DETERMINE PRINCIPLE STRESSES SIGMA1, SIGMA2,SIGMA3 ... .. STR 229
C                                                    STR 230
C      STRESS1=(STRESSX+STRESSY)/2.                STR 231
C      STRESS2=SQRT((STRESSX-STRESSY)/2.)**2+STRESSXY**2) STR 232
C      SIGMA1=STRESS1+STRESS2                       STR 233
C      SIGMA3=(STRESS1-STRESS2)                     STR 234
C      SIGMA2=(SIGMA1+SIGMA3)*(TRUE1+TRUE2)/2.      STR 235
C                                                    STR 236
C      DETERMINE OCTAHEDRAL STRESSES SGMDOCT, TAUOCT ... .. STR 237
C                                                    STR 238
C      SGMDOCT=(SIGMA1+SIGMA2+SIGMA3)/3.            STR 239
C      TAUOCT=(SQRT((SIGMA1-SIGMA2)**2+(SIGMA2-SIGMA3)**2+(SIGMA3-SIGMA1)**2))/3. STR 240
C      A1**2)/3.                                     STR 241
C                                                    STR 242
C      DETERMINE PRINCIPLE STRAINS EPL1SH1, EPL1SH2, EPL1SH3 ... .. STR 243
C                                                    STR 244
C      E1=(STRAINX+STRAINY)/2.                      STR 245
C      E2=SQRT((STRAINX-STRAINY)/2.)**2+STR40CY**2) STR 246
C      EPL1SH1=E1+E2                                 STR 247
C      EPL1SH3=E1-E2                                 STR 248
C      EPL1SH2=(EPL1SH1+EPL1SH3)*(ONE+E1+TRUE2)/2. STR 249
C                                                    STR 250
C      DETERMINE OCTAHEDRAL STRAINS - EPSDOCT, GAMDOCT ... .. STR 251
C                                                    STR 252
C      EPSDOCT=(EPL1SH1+EPL1SH2+EPL1SH3)/3.         STR 253
C      GAMDOCT=2.*SQRT((EPL1SH1-EPL1SH2)**2+(EPL1SH2-EPL1SH3)**2+(EPL1SH3-EPL1SH1)**2))/3. STR 254
C      I1SH3-EPL1SH1)**2))/3.                       STR 255
C                                                    STR 256
C      STORE STRESSES AND STRAINS ON TAPE 1          STR 257
C                                                    STR 258
C      CALL READMS (1,TEMP,17,IEL)                  STR 259
C      IELSIG1=SIGMA1                                STR 260
C      SIG1=TEMP(4)                                   STR 261
C      STRESSX=STRESSX+TEMP(1)                        STR 262
C      STRESSY=STRESSY+TEMP(2)                        STR 263
C      STRESSXY=STRESSXY+TEMP(3)                     STR 264
C      SIGMA1=SIGMA1+TEMP(4)                          STR 265
C      SIGMA2=SIGMA2+TEMP(5)                          STR 266
C      SIGMA3=SIGMA3+TEMP(6)                          STR 267
C      SGMDOCT=SGMDOCT+TEMP(7)                       STR 268
C      TAUOCT=TAUOCT+TEMP(8)                         STR 269
C      STRAINX=STRAINX+TEMP(9)                       STR 270
C      STRAINY=STRAINY+TEMP(10)                      STR 271

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	STRAINX=STRAINX+TEMP(11)	STR	272
	EPLISH1=EPLISH2+TEMP(12)	STR	273
	EPLISH2=EPLISH2+TEMP(13)	STR	274
	EPLISH3=EPLISH3+TEMP(14)	STR	275
	EPSHOCT=EPSHOCT+TEMP(15)	STR	276
	GAMDOCT=GAMDOCT+TEMP(16)	STR	277
C		STR	278
	TEMP(1)=STRESSX	STR	279
	TEMP(2)=STRESSY	STR	280
	TEMP(3)=STRESSZ	STR	281
	TEMP(4)=SIGMA1	STR	282
	TEMP(5)=SIGMA2	STR	283
	TEMP(6)=SIGMA3	STR	284
	TEMP(7)=GAMDOCT	STR	285
	TEMP(8)=EPSHOCT	STR	286
	TEMP(9)=STRAINX	STR	287
	TEMP(10)=STRAINX	STR	288
	TEMP(11)=STRAINX	STR	289
	TEMP(12)=EPLISH1	STR	290
	TEMP(13)=EPLISH2	STR	291
	TEMP(14)=EPLISH3	STR	292
	TEMP(15)=EPSHOCT	STR	293
	TEMP(16)=GAMDOCT	STR	294
C		STR	295
	CALL WRITING (1,TEMP,17,KEL)	STR	296
C		STR	297
	IF (NOTENFILE,0) GO TO 100	STR	298
C		STR	299
C		STR	300
C	HO-TENSION ANALYSIS	STR	301
		STR	302
	SIGHOLD=SIG1+DELSIG1	STR	303
75	IF (SIGHOLD+GAMDOCT) 75,100,100	STR	304
	WRITE (6,165) KEL,SIG1,DELSIG1	STR	305
	CALL ZORO (PP,12)	STR	306
	CALL HULLMAT (ZKJT,12,12)	STR	307
	PATID=1.-ABS(SIG1)/ABS(DELSIG1)	STR	308
	HO=11	STR	309
	DO 05 JH=1,12	STR	310
	DO 00 JH=JH,12	STR	311
	HO=HO+1	STR	312
80	ZKJT(JH,JH)=ZKJT(JH,JH)+DELSIG1	STR	313
85	CONTINUE	STR	314
	U(1)=U1	STR	315
	U(2)=U2	STR	316
	U(3)=U3	STR	317
	U(4)=U4	STR	318
	U(5)=U5	STR	319
	U(6)=U6	STR	320
	U(7)=V1	STR	321
	U(8)=V2	STR	322
	U(9)=V3	STR	323
	U(10)=V4	STR	324
	U(11)=V5	STR	325
	U(12)=V6	STR	326
	DO 95 JI=1,12	STR	327
	SUM=0.0	STR	328
	DO 90 KI=1,12	STR	329
90	SUM=SUM+ZKJT(JI,KI)*U(KI)	STR	330
	PPC(JI)=-SUM*PATID	STR	331
95	CONTINUE	STR	332

C	Q(I1)=Q(I1)+PP(1)	STR	332
	Q(I2)=Q(I2)+PP(2)	STR	333
	Q(I3)=Q(I3)+PP(3)	STR	334
	Q(I4)=Q(I4)+PP(4)	STR	335
	Q(I5)=Q(I5)+PP(5)	STR	336
	Q(I6)=Q(I6)+PP(6)	STR	337
	Q(I1+1)=Q(I1+1)+PP(7)	STR	338
	Q(I2+1)=Q(I2+1)+PP(8)	STR	339
	Q(I3+1)=Q(I3+1)+PP(9)	STR	340
	Q(I4+1)=Q(I4+1)+PP(10)	STR	341
	Q(I5+1)=Q(I5+1)+PP(11)	STR	342
	Q(I6+1)=Q(I6+1)+PP(12)	STR	343
	IFLAG=1	STR	344
C		STR	345
100	CONTINUE	STR	346
	IF (NT3.LE.0) GO TO 160	STR	347
	IF (INTER.LE.0) GO TO 160	STR	348
C		STR	349
C	HO-TENSION ANALYSIS FOR INTERACTION ELEMENT	STR	350
C		STR	351
	NTSTART=NT1+1	STR	352
	DO 155 KEL=NTSTART,NT12+2	STR	353
	NT=IN(S,KEL)	STR	354
	FR(2)=0.0	STR	355
	FR(1)=FR(2)	STR	356
	CALL READMS (1,TEMP,1)+KEL)	STR	357
	CALL READMS (1,TEMP,17)+KEL+1)	STR	358
	PNORHL=(TEMP(1)+TEMP(17))*0.5	STR	359
	PSHEAR=(TEMP(2)+TEMP(17))*0.5	STR	360
	IF (ABS(PNORHL)<.1*G0NA(NT)) GO TO 155	STR	361
	IF (PNORHL+G0NA(NT)) 110,105,105	STR	362
105	IF (NCYCLE.EQ.1) GO TO 155	STR	363
	RATIO=ABS(PSHEAR/PNORHL)	STR	364
	IF (RATIO.LE.SLIP) GO TO 155	STR	365
	R1=ABS(TEMP(15)/TEMP(16))	STR	366
	Q0=TEMP(13)/TEMP(14)	STR	367
	F10H=TEMP(16)	STR	368
	PH=TEMP(14)	STR	369
	DR=SLIP-R1	STR	370
	T3=Q0-R1-DR	STR	371
	DSR=DR*F10H/T3	STR	372
	T4=(PH-DSR)/PH	STR	373
	FR(1)=T4+FR(1)	STR	374
	FR(1)=-FR(1)	STR	375
	WRITE (6,170) KEL,RATIO,SLIP,R1,Q0,DR,DSR,F10H,PH,FR(1)	STR	376
	R1=ABS(TEMP(15)/TEMP(16))	STR	377
	Q0=TEMP(13)/TEMP(14)	STR	378
	F10H=TEMP(16)	STR	379
	PH=TEMP(14)	STR	380
	DR=SLIP-R1	STR	381
	T3=Q0-R1-DR	STR	382
	DSR=DR*F10H/T3	STR	383
	T4=(PH-DSR)/PH	STR	384
	FR(2)=T4+FR(2)	STR	385
	FR(2)=-FR(2)	STR	386
	KEL1=KEL+1	STR	387
	WRITE (6,170) KEL1,RATIO,SLIP,R1,Q0,DR,DSR,F10H,PH,FR(2)	STR	388
	GO TO 115	STR	389
C		STR	390
		STR	391

110	T1=(TEMP(16)+TEMP(16))/2.	STR	392
	T2=(TEMP(14)+TEMP(14))/2.	STR	393
C		STR	394
C	FR(1)=FR(2)*1.-ABSCT1)/ABSCT2)	STR	395
C		STR	396
	T3=1.-T1/2	STR	397
	FR(2)=T3/2.	STR	398
	FR(1)=FR(2)	STR	399
	KEL1=KEL+1	STR	400
	WRITE (6,175) KEL,KEL1,FR(1),FR(2)	STR	401
115	NUM=KEL	STR	402
	ND=1	STR	403
120	CALL PDSBHS (7,DNAT,6,(NUM)	STR	404
	ND=0	STR	405
	DO 125 IN=1,8	STR	406
	DO 125 JN=1,8	STR	407
	ND=ND+1	STR	408
	SKJTC(IN,JN)=DNAT(ND)	STR	409
125	CONTINUE	STR	410
	DO 140 IN=1,8	STR	411
	GO TO (130,135), ND	STR	412
130	U(IN)=TEMP(IN+4)	STR	413
	GO TO 140	STR	414
135	U(IN)=TEMP(IN+4)	STR	415
140	CONTINUE	STR	416
	DO 150 JI=1,8	STR	417
	SUM=0.0	STR	418
	DO 145 KI=1,8	STR	419
145	SUM=SUM+SKJTC(JI,KI)*U(KI)	STR	420
C		STR	421
C	PP(JI)=SUM * FR(ND)	STR	422
C		STR	423
	PP(JI)=SUM*FR(ND)	STR	424
150	CONTINUE	STR	425
	WRITE (6,180) (PP(JI),JI=1,8)	STR	426
	I1=IA(NUM,1)	STR	427
	I2=IA(NUM,2)	STR	428
	I3=IA(NUM,3)	STR	429
	I4=IA(NUM,4)	STR	430
C		STR	431
	Q(11)=Q(11)+PP(1)	STR	432
	Q(11+1)=Q(11+1)+PP(2)	STR	433
	Q(12)=Q(12)+PP(3)	STR	434
	Q(12+1)=Q(12+1)+PP(4)	STR	435
	Q(13)=Q(13)+PP(5)	STR	436
	Q(13+1)=Q(13+1)+PP(6)	STR	437
	Q(14)=Q(14)+PP(7)	STR	438
	Q(14+1)=Q(14+1)+PP(8)	STR	439
	IFLAG=1	STR	440
	ND=ND+1	STR	441
	IF (ND,GT,2) GO TO 155	STR	442
	NUM=KEL+1	STR	443
	GO TO 120	STR	444
155	CONTINUE	STR	445
160	WRITE (6,185)	STR	446
	RETURN	STR	447
C		STR	448
165	FORMAT (10X, 24HTENSION IN ELEMENT ND = ,15, 8H SIGNAL=,E12.3, 13STR		449
	1H DELSIGNAL = ,E12.3)	STR	450
170	FORMAT (1X, 8HINT SLIP,15,9E12.3)	STR	451

175	FORMAT (1X, 20H)INTERACTION TE(SION,215,2E12,3)	STR	452
180	FORMAT (1X, 9H)HT.FORCE 0E12,3)	STR	453
185	FORMAT (1X, 23H)OVERLAY (1,0) COMPLETED)	STR	454
C		STR	455
	END	STR	456
	OVERLAY(RDY,5,0)	RES	1
C		RES	2
	OVERLAY(RDY,5,0)	RES	3
	PROGRAM RESULTS	RES	4
	COMMON NNODES,NELEMT,NDMF,MBAND,ND,NT3,ISTEP,NCYCLE,LAYERS,ISTEP,RES	RES	5
	1HSTEP,NT12,ETA,NT1,NT2,NTTENS,IFLAG,NSIZE,NODE(550),X(550),Y(550)RES	RES	6
	2),JNDX(51),ANLSIS,IX(8,250),ARFAA(250),INDX(250),INDEX(250),GAMA(2RES	RES	7
	35),ZAI(3)	RES	8
	COMMON /1/ E=NUE,RADIUS,DCEN,YCEN,EI,KH,KS,H1,H2,INTER	RES	9
	COMMON /3/ R	RES	10
	DIMENSION TEMP(17), R(1100), RP(1100)	RES	11
	DIMENSION E(10), NUE(10)	RES	12
	DIMENSION THP(36), UC(6), SRG(6,6), PKY(30), QMY(30), MDM(30), P(30)RES	RES	13
	1), Q(30), PP(6)	RES	14
	DIMENSION SG(30), S1(90)	RES	15
	REAL NUE	RES	16
	REAL HN,KS	RES	17
	REAL MDM	RES	18
	INTEGER U1,U2,U3,U4,U5,U6,U7,U8,U9	RES	19
C		RES	20
C	THIS ROUTINE RECORDS RESULTS FROM DIFFERENT ROUTINES AND TAPES ANDRES	RES	21
C	STORES, ADDS, FOR SUCCESSIVE TERMS IF INCREMENTAL ANALYSIS AND	RES	22
C	FINALLY OUTPUTTED	RES	23
C		RES	24
C	WRITTING NODAL FORCES, DISPLACEMENTS, ELEMENT STRESSES, STRAINS ..	RES	25
C		RES	26
	REWIND 2	RES	27
	NDRING=3*NT3	RES	28
	DO 5 I=1,NDRING	RES	29
5	S1(I)=R(I)	RES	30
	READ (2) (RP(I),I=1,NDOF)	RES	31
	DO 10 I=1,NDOF	RES	32
	R(I)=R(I)+RP(I)	RES	33
10	CONTINUE	RES	34
	REWIND 2	RES	35
	WRITE (2) (R(I),I=1,NDOF)	RES	36
C		RES	37
	WRITE (6,90) ISTEP,NCYCLE	RES	38
	IF (NT3.LE.0) GO TO 20	RES	39
	WRITE (6,95)	RES	40
	DO 15 I=1,NT3	RES	41
	K1=3*I-2	RES	42
	WRITE (6,100) I,R(K1),R(K1+1),R(K1+2)	RES	43
15	CONTINUE	RES	44
20	IF (NCYCLE.NE.NSTEP) GO TO 35	RES	45
	IF (IFLAG.GT.0) GO TO 35	RES	46
	WRITE (6,105)	RES	47
	NT3P1=NT3+1	RES	48
	DO 25 I=NT3P1/NNODES+3	RES	49
	K1=2*I-1+NT3	RES	50
	K2=K1+1	RES	51
	K3=2*(I+1)-1+NT3	RES	52
	K4=K3+1	RES	53
	K5=2*(I+2)-1+NT3	RES	54
	K6=K5+1	RES	55
	I2=I+2	RES	56

	WRITE (6+110) 1,R(1),R(2), (1,R(3),R(4),12,R(5),R(6))	RES	57
25	CONTINUE	RES	58
C		RES	59
C	PRINT ELEMENT STRESSED	RES	60
C		RES	61
	WRITE (6+115)	RES	62
	NT12P1=NT12+1	RES	63
	DO 30 I=NT12P1,NELEMT	RES	64
	CALL READNG (1,TEMP,17+1)	RES	65
	WRITE (6+120) (1,(TEMP(J),J=1,8))	RES	66
30	CONTINUE	RES	67
C		RES	68
C	CALCULATION OF NORMAL- SHEAR FORCE AND MOMENTS FOR PIPE NODES	RES	69
C		RES	70
35	IF (HTS.LE.0) GO TO 85	RES	71
	WRITE (6+125)	RES	72
	HEL=NT3-1	RES	73
	DO 55 I=1,HEL	RES	74
	IF (IX(7+I),HE,1) GO TO 55	RES	75
	I1=IX(1+I)	RES	76
	I2=IX(2+I)	RES	77
	U1=3*(I1-1)+1	RES	78
	U2=U1+1	RES	79
	U3=U1+2	RES	80
	U4=3*(I2-1)+1	RES	81
	U5=U4+1	RES	82
	U6=U4+2	RES	83
	U(1)=S1(U1)	RES	84
	U(2)=S1(U2)	RES	85
	U(3)=S1(U3)	RES	86
	U(4)=S1(U4)	RES	87
	U(5)=S1(U5)	RES	88
	U(6)=S1(U6)	RES	89
	CALL READNG (7,TRP,36+1)	RES	90
C		RES	91
	MD=0	RES	92
	CALL READNG (1,TEMP,17+1)	RES	93
	DO 40 K=1,6	RES	94
	DO 40 L=1,6	RES	95
	MD=MD+1	RES	96
	SRG(MD)=TRP(MD)	RES	97
40	CONTINUE	RES	98
	DO 50 K=1,6	RES	99
	SUM=0.0	RES	100
	DO 45 L=1,6	RES	101
45	SUM=SUM+SRG(K+L)*U(L)	RES	102
	PP(K)=SUM	RES	103
50	CONTINUE	RES	104
	PXY(11)=PP(4)+TEMP(3)	RES	105
	QXY(11)=PP(5)+TEMP(4)	RES	106
	MDM(11)=PP(6)+TEMP(5)	RES	107
	PXY(12)=PP(1)+TEMP(6)	RES	108
	QXY(12)=PP(2)+TEMP(7)	RES	109
	MDM(12)=PP(3)+TEMP(8)	RES	110
	TEMP(3)=PXY(11)	RES	111
	TEMP(4)=QXY(11)	RES	112
	TEMP(5)=MDM(11)	RES	113
	TEMP(6)=PXY(12)	RES	114
	TEMP(7)=QXY(12)	RES	115
	TEMP(8)=MDM(12)	RES	116

CALL WRITING (1,TEMP,17,1)	RES 117
55 CONTINUE	RES 118
DO 70 I=1,NT12	RES 119
IF (1,EQUAL(2)) GO TO 60	RES 120
GO TO 65	RES 121
60 PXY(1)=PXY(1)	RES 122
QXY(1)=QXY(1)	RES 123
MDM(1)=MDM(1)	RES 124
65 YC=Y(1)-YCDN	RES 125
XC=X(1)-XCDN	RES 126
IF (XC.EQ. 0.0) XC=0.0001	RES 127
TH=YC/XC	RES 128
THETA=ATAN(TH)	RES 129
SH=SIN(THC70)	RES 130
CS=COS(THC70)	RES 131
P(1)=PXY(1)*SH+QXY(1)*CS	RES 132
Q(1)=PXY(1)*CS+QXY(1)*SH	RES 133
WRITE (6,130) 1,P(1),Q(1),MDM(1)	RES 134
70 CONTINUE	RES 135
WRITE (6,140)	RES 136
NTSTART=NT1+1	RES 137
DO 75 I=NTSTART,NT12,2	RES 138
CALL READIN (1,TEMP,17,1)	RES 139
T1=TEMP(1)	RES 140
T2=TEMP(2)	RES 141
CALL READIN (1,TEMP,17,1+1)	RES 142
TEMP(1)=0.5*(T1+TEMP(1))	RES 143
TEMP(2)=0.5*(T2+TEMP(2))	RES 144
RATIO=ABS(TEMP(2)/TEMP(1))	RES 145
IP1=I+1	RES 146
WRITE (6,135) 1,IP1,TEMP(1),TEMP(2),RATIO	RES 147
75 CONTINUE	RES 148
C	RES 149
C	RES 150
C	RES 151
WRITE (6,145)	RES 152
DO 80 I=NT12F1,NLELENT	RES 153
CALL READIN (1,TEMP,17,1)	RES 154
WRITE (6,120) (1,TEMP(J),J=9,16)	RES 155
80 CONTINUE	RES 156
85 WRITE (6,150)	RES 157
RETURN	RES 158
C	RES 159
90 FORMAT (10X,10X, 14RESULTS AFTER 15, 17H LAYERS OF FILL,5X, 15RES 160	
1INCREMENT NO = 15//)	RES 161
95 FORMAT (10X, 20H3 - D.O.F. NODAL DEFLECTIONS,/,10X, 8HNODE NO.,5XRES 162	
1, 14H1 - DEFLECTION,5X, 14H2 - DEFLECTION,5X, 8HROTATION,/,)	RES 163
100 FORMAT (7X,15,7X,3X,E14.4,/,3X)	RES 164
105 FORMAT (/,10X, 21HNODE POINT DEFLECTION,/,3X,3X, 8HNODE NO.,3X, 12PRES 165	
10H1-DEFLECTION,5X, 10H2-DEFLECTION,/,)	RES 166
110 FORMAT (3X,14,5X,E12.4, 5X,E12.4)	RES 167
115 FORMAT (1H1/10X, 16HELEMENT STRESSES,/,5X, 11HELEMENT NO.,3X, 7HMORE 168	
1STRESS,7X, 7H2STRESS,7X, 7H3STRESS,7X, 6HSIGMA1,8X, 6HSIGMA2,8RES 169	
2X, 6HSIGMA3,7X, 8HSIGMAOCT,6X, 7HTAUOCT,/,)	RES 170
120 FORMAT (5X,15,2X,E14.2)	RES 171
125 FORMAT (/,10X, 47HNORMAL AND SHEAR FORCES, MOMENTS AT PIPE NODES,RES 172	
1/10X, 8HNODE NO.,10X, 12HNORMAL FORCE,5X, 11HSHEAR FORCE,5X, 12HRES 173	
20DAL MOMENT,/,)	RES 174
130 FORMAT (13X,13,12X,E12.2,2(4X,E12.2))	RES 175
135 FORMAT (3X,12, 3H + 12,12X,E10.2,12X,E10.2,12X,F10.4)	RES 176

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140 FORMAT (///10X, 52HNORMAL AND SHEAR STRESS ON SOIL IN INTERACTION RES 177
1LAYER,///5X, 7HELE.ND.,14X, 12HNORMAL STRS.,10X, 12HSHEAR STRESS,1RES 178
20X, 12H RATIO T/N ,//) RES 179
145 FORMAT (1H1//10X, 15HELEMENT STRAINS,///5X, 11HELEMENT NO.,3X, 7HSTRES 180
1RAINX,7X, 7HSTRAINX,7X, 7HSTRAINXY,7X, 7HEPSILN1,7X, 7HEPSILN2,RES 181
27X, 7HEPSILN3,7X, 7HEP-HOCT,7X, 7HGAMHCT,7X) RES 182
150 FORMAT (1X, 23HOVERLAY (1,0) COMPLETED) RES 183
C RES 184
END RES 185
OVERLAY(RDY,6,0) SOL 1
C OVERLAY(RDY,6,0) SOL 2
PROGRAM RESOLV SOL 3
COMMON NNODES,NELEMENT,NDINC,NBAND,ND,NT3,ISTOP,NCYCLE,LAYERS,ISTEP,SOL 4
1NSTEP,NT12,ETA,NT1,NT2,NUTENSH,FLAG,NSIZE,NCODE(550),X(550),Y(550)SOL 5
2),INDX(51),ARX,SIZE,IX(8,250),ARY,AY(250),INDX(250),INDEX(250),GAMA(250)SOL 6
35),ZAI(3) SOL 7
COMMON /3/ R SOL 8
COMMON /5/ Q(1100),LIST(101) SOL 9
DIMENSION A(100,206), B(106), ARRAY(103) SOL 10
DIMENSION R(1100) SOL 11
REIND 9 SOL 12
C SOL 13
C SOLUTION OF STIFFNESS EQUATIONS FOR GIVEN BOUNDARY CONDITIONS AND SOL 14
C SOL 15
NUNBLK=1 SOL 16
NL=1 SOL 17
NM=ND SOL 18
KSHIFT=0 SOL 19
ND2=2*ND SOL 20
NEND=3*NT3 SOL 21
NDINC=1 SOL 22
IF (NT3.LE.0) NDINC=0 SOL 23
IF (NT3.LE.0) ND=ND-1 SOL 24
CALL NULLMAT (A,ND,ND2) SOL 25
CALL ZERO (B,ND2) SOL 26
NX=NL-1 SOL 27
CALL ZERO (ARRAY,NSIZE) SOL 28
DO 10 N=1,NSIZE SOL 29
CALL READN3 (10,ARRAY,NSIZE,NX+N) SOL 30
DO 5 M=1,NSIZE SOL 31
5 A(N,M)=ARRAY(M) SOL 32
10 CONTINUE SOL 33
GO TO 30 SOL 34
15 NX=NL-1 SOL 35
CALL ZERO (ARRAY,NSIZE) SOL 36
DO 25 N=1,NSIZE SOL 37
CALL READN3 (10,ARRAY,NSIZE,NX+N) SOL 38
DO 20 M=1,NSIZE SOL 39
20 A(N,M)=A(N,M)+ARRAY(M) SOL 40
25 CONTINUE SOL 41
C SOL 42
C MODIFICATION FOR LOAD AND BOUNDARY CONDITIONS SOL 43
C SOL 44
30 I=NL SOL 45
35 IF (I.GT.NEND) GO TO 70 SOL 46
FIND=FLOAT(I+2)/3. SOL 47
II=INT(FIND) SOL 48
PX=0(I) SOL 49
PY=0(I+1) SOL 50
ICODE=NCODE(II)-3 SOL 51

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	GO TO (40,45,50,55,60,65), ICODE	SOL	52
40	J=I-KSHIFT	SOL	53
	B(J)=B(J)+PX	SOL	54
	B(J+1)=B(J+1)+PY	SOL	55
	I=I+3	SOL	56
	GO TO 35	SOL	57
45	J=I-KSHIFT	SOL	58
	P=0.0	SOL	59
	CALL MODIFY (J,ND,P,A,B)	SOL	60
	B(J+1)=B(J+1)+PY	SOL	61
	I=I+3	SOL	62
	GO TO 35	SOL	63
50	J=I-KSHIFT	SOL	64
	B(J)=B(J)+PX	SOL	65
	P=0.0	SOL	66
	CALL MODIFY (J+1,ND,P,A,B)	SOL	67
	I=I+3	SOL	68
	GO TO 35	SOL	69
55	J=I-KSHIFT	SOL	70
	B(J)=B(J)+PX	SOL	71
	B(J+1)=B(J+1)+PY	SOL	72
	P=0.0	SOL	73
	CALL MODIFY (J+2,ND,P,A,B)	SOL	74
	I=I+3	SOL	75
	GO TO 35	SOL	76
60	J=I-KSHIFT	SOL	77
	P=0.0	SOL	78
	CALL MODIFY (J,ND,P,A,B)	SOL	79
	B(J+1)=B(J+1)+PY	SOL	80
	CALL MODIFY (J+2,ND,P,A,B)	SOL	81
	I=I+3	SOL	82
	GO TO 35	SOL	83
65	J=I-KSHIFT	SOL	84
	B(J)=B(J)+PX	SOL	85
	P=0.0	SOL	86
	CALL MODIFY (J+1,ND,P,A,B)	SOL	87
	CALL MODIFY (J+2,ND,P,A,B)	SOL	88
	I=I+3	SOL	89
	GO TO 35	SOL	90
70	IF (1,GT,ND,OR,1,GT,NDP) GO TO 95	SOL	91
	FIND=FLOAT(1-INT3+1)/2.	SOL	92
	II=INT(FIND)	SOL	93
	PX=0(1)	SOL	94
	PY=0(1+1)	SOL	95
	ICODE=NCODE(II)+1	SOL	96
	GO TO (75,80,85,90), ICODE	SOL	97
75	J=I-KSHIFT	SOL	98
	B(J)=B(J)+PX	SOL	99
	B(J+1)=B(J+1)+PY	SOL	100
	I=I+2	SOL	101
	GO TO 70	SOL	102
80	J=I-KSHIFT	SOL	103
	P=0.0	SOL	104
	CALL MODIFY (J,ND,P,A,B)	SOL	105
	B(J+1)=B(J+1)+PY	SOL	106
	I=I+2	SOL	107
	GO TO 70	SOL	108
85	J=I-KSHIFT	SOL	109
	B(J)=B(J)+PX	SOL	110
	P=0.0	SOL	111

CALL MODIFY (J+1,ND,P,A,I)	SOL	112
I=I+2	SOL	113
GO TO 70	SOL	114
90 J=I-KSHIFT	SOL	115
P=0.0	SOL	116
CALL MODIFY (J,ND,P,A,B)	SOL	117
CALL MODIFY (J+1,ND,P,A,I)	SOL	118
I=I+2	SOL	119
GO TO 70	SOL	120
95 CONTINUE	SOL	121
C	SOL	122
C	SOL	123
C	SOL	124
DO 110 N=1,ND	SOL	125
IF (A(1,N),EQ,0.0) GO TO 117	SOL	126
B(N)=B(N)/A(1,N)	SOL	127
DO 105 L=2,ND	SOL	128
IF (A(L,N),EQ,0.0) GO TO 105	SOL	129
C=A(L,N)/A(1,N)	SOL	130
I=HL-1	SOL	131
J=0	SOL	132
DO 100 I=I,ND	SOL	133
J=J+1	SOL	134
100 A(I,J)=A(I,J)-C*B(J)	SOL	135
B(I)=B(I)-A(L,N)*B(N)	SOL	136
A(L,N)=C	SOL	137
105 CONTINUE	SOL	138
110 CONTINUE	SOL	139
IF (CHLGE.NDEF) GO TO 124	SOL	140
C	SOL	141
C	SOL	142
C	SOL	143
WRITE (9) (B(N), (A(N,N)+1)/B(N), N=1,ND)	SOL	144
C	SOL	145
C	SOL	146
C	SOL	147
DO 115 N=1,ND	SOL	148
NN=ND+N	SOL	149
B(N)=B(NN)	SOL	150
B(NN)=0.0	SOL	151
DO 115 N=1,NN	SOL	152
A(N,N)=A(N,NN)	SOL	153
A(N,NN)=0.0	SOL	154
115 CONTINUE	SOL	155
KSHIFT=KSHIFT+ND	SOL	156
IF (NUMBLK.EQ,1) ND=ND-NDINC	SOL	157
NUMBLK=NUMBLK+1	SOL	158
NN=NN+ND	SOL	159
HL=NN-ND+1	SOL	160
GO TO 15	SOL	161
C	SOL	162
C	SOL	163
C	SOL	164
120 CALL ZERO (R,NDIF)	SOL	165
IF (NUMBLK.EQ,1) NDINC=0	SOL	166
C	SOL	167
NU=ND*NUMBLK+1+NDINC	SOL	168
ND=NUMBLK	SOL	169
125 DO 135 N=1,ND	SOL	170
N=ND+1-N	SOL	171

	DO 130 K=2,NBAND	SOL	172
	L=N+K-1	SOL	173
130	B(N)=B(N)-A(K,N)*B(L)	SOL	174
	NN=N+ND	SOL	175
	IF (NB.EQ.2) NN=NN+ND(NC	SOL	176
	B(NN)=B(N)	SOL	177
	NU=NU-1	SOL	178
135	R(NU)=B(N)	SOL	179
	NB=NB-1	SOL	180
	IF (NB.EQ.1) ND=ND+NDINC	SOL	181
	IF (NB.LE.0) GO TO 140	SOL	182
	BACKSPACE 9	SOL	183
	READ (9) (B(N), (A(M,N),M=1,NBAND),N=1,ND)	SOL	184
	BACKSPACE 9	SOL	185
	GO TO 125	SOL	186
140	CONTINUE	SOL	187
	RETURN	SOL	188
C		SOL	189
C		SOL	190
	END	SOL	191
	SUBROUTINE MODIFY (N,ND,P,A,B)		2
	DIMENSION A(103,206), B(206)		3
C			4
C	MODIFICATION FOR BOUNDARY CONDITIONS		5
C			6
	ND2=2*ND		7
	DO 10 M=2,ND		8
	K=N-M+1		9
	IF (K.LE.0) GO TO 5		10
	B(K)=B(K)-A(N,K)*P		11
	A(N,K)=0.0		12
5	K=N+M-1		13
	IF (K.GT.ND2) GO TO 10		14
	B(K)=B(K)-A(N,K)*P		15
	A(N,K)=0.0		16
10	CONTINUE		17
	A(1,N)=0.0		18
	B(N)=0.0		19
	RETURN		20
C			21
	END		22

APPENDIX - II

PROPRY
PROGRAM LISTING

	PROGRAM PROPERTY (INPUT,OUTPUT)	PRO	2
	DIMENSION IP(20), YP(20), VP(20), YDP1(20), YDPV(20), TITL(10)	PRO	3
	REAL NUE,NUEIN	PRO	4
	DATA PLSTRS,PLSTRH,SHPLSTRS,SHPLSTRH	PRO	5
C		PRO	6
C	THIS PROGRAM GENERATES DATA REQUIRED FOR EVALUATION OF TANGENT	PRO	7
C	MODULUS AND POISSONS RATIO VS. SIGMA(DCT) FOR VARIOUS STRESS RATIO	PRO	8
C		PRO	9
	READ 70, (TITL(I),I=1,10)	PRO	10
	READ 75, TEST,NOCURVS,RF	PRO	11
	IF (TEST.EQ.PLSTRS) NGD=1	PRO	12
	IF (TEST.EQ.PLSTRH) NGD=2	PRO	13
	DO 65 I=1,NOCURVS	PRO	14
	READ 80, SIGMA3,NP	PRO	15
	READ 85, (XP(I),YP(I),VP(I),I=1,NP)	PRO	16
	PRINT 70, (TITL(I),I=1,10)	PRO	17
	PRINT 90, I,SIGMA3,NP,RF	PRO	18
	PRINT 95, (I,XP(I),YP(I),VP(I),I=1,NP)	PRO	19
	DO 5 I=1,NP	PRO	20
5	VP(I)=VP(I)-XP(I)	PRO	21
	SINH=SIGMA3	PRO	22
	XIH=0.0	PRO	23
	E3IH=0.0	PRO	24
	CALL SPLINE (NP,XP,YP,YDP1)	PRO	25
	CALL SPLINE (NP,XP,VP,YDPV)	PRO	26
	PRINT 100	PRO	27
	X=0.00001	PRO	28
	DX=0.000001	PRO	29
	NUE=0.5	PRO	30
10	DO 15 L=2,NP	PRO	31
	IF (X.LT.XP(L),AND,X.GE.XP(L-1)) GO TO 20	PRO	32
15	CONTINUE	PRO	33
	GO TO 65	PRO	34
20	A=YDP1(L-1)	PRO	35
	B=YDP1(L)	PRO	36
	C=XP(L-1)	PRO	37
	D=XP(L)	PRO	38
	E=YP(L-1)	PRO	39
	F=YP(L)	PRO	40
	PP=X	PRO	41
	S1=ORDINET(A,B,C,D,E,F,PP)	PRO	42
C		PRO	43
	DO 25 L=2,NP	PRO	44
	IF (X.LT.XP(L),AND,X.GE.XP(L-1)) GO TO 30	PRO	45
25	CONTINUE	PRO	46
	GO TO 65	PRO	47
30	A=YDPV(L-1)	PRO	48
	B=YDPV(L)	PRO	49
	C=XP(L-1)	PRO	50
	D=XP(L)	PRO	51
	E=VP(L-1)	PRO	52
	F=VP(L)	PRO	53
	PP=X	PRO	54
	E3=ORDINET(A,B,C,D,E,F,PP)	PRO	55
	B1=S1+SIGMA3	PRO	56
	B3=SIGMA3	PRO	57
	GO TO (35+40), NGD	PRO	58
35	B2=B3	PRO	59
	GO TO 45	PRO	60

END	PPD	121
SUBROUTINE SPLINE (NPN,XP,YP,YDP)	SPL	2
DIMENSION XP(20), YP(20), YDP(20), H(20), AI(20), BI(20), CI(20),	SPL	3
DI(20)	SPL	4
NP1=NPN-1	SPL	5
DO 5 M=1, NP1	SPL	6
5 H(M)=XP(M+1)-XP(M)	SPL	7
SLOP1=FD(H(1),H(2),YP(1),YP(2),YP(3))	SPL	8
SLOPN=BD(H(NPN-2),H(NPN-1),YP(NPN-2),YP(NPN-1),YP(NPN))	SPL	9
CALL COFRIT (NPN,XP,YP,SLOP1,SLOPN,AI,BI,CI,DI)	SPL	10
CALL TRIDGNL (NPN,AI,BI,CI,DI,YDP)	SPL	11
RETURN	SPL	12
C	SPL	13
END	SPL	14
SUBROUTINE COFRIT (NPN,XP,YP,SLOP1,SLOPN,AI,BI,CI,DI)	COF	2
DIMENSION XP(20), YP(20), AI(20), BI(20), CI(20), DI(20)	COF	3
AI(1)=0.0	COF	4
BI(1)=(XP(2)-XP(1))/3.	COF	5
CI(1)=BI(1)/2.	COF	6
DI(1)=(YP(2)-YP(1))/(XP(2)-XP(1))-SLOP1	COF	7
AI(NPN)=(XP(NPN)-XP(NPN-1))/6.	COF	8
BI(NPN)=AI(NPN)*2.	COF	9
CI(NPN)=0.0	COF	10
DI(NPN)=(YP(NPN)-YP(NPN-1))/(XP(NPN)-XP(NPN-1))+SLOPN	COF	11
N1=NPN-1	COF	12
DO 5 I=2,N1	COF	13
AI(I)=(XP(I)-XP(I-1))/6.	COF	14
BI(I)=(XP(I+1)-XP(I-1))/3.	COF	15
CI(I)=(XP(I+1)-XP(I))/6.	COF	16
DI(I)=(YP(I+1)-YP(I))/(XP(I+1)-XP(I))-(YP(I)-YP(I-1))/(XP(I)-XP(I-1))	COF	17
1 (I-1)	COF	18
5 CONTINUE	COF	19
RETURN	COF	20
C	COF	21
END	COF	22
SUBROUTINE TRIDGNL (NPN,AI,BI,CI,DI,YDP)	TRI	2
DIMENSION AI(20), BI(20), CI(20), DI(20), YDP(20), Q(30), U(30)	TRI	3
P=BI(1)	TRI	4
Q(1)=-CI(1)/P	TRI	5
U(1)=DI(1)/P	TRI	6
DO 5 K=2,NPN	TRI	7
P=AI(K)*Q(K-1)+BI(K)	TRI	8
Q(K)=-CI(K)/P	TRI	9
U(K)=(DI(K)-AI(K)*U(K-1))/P	TRI	10
5 CONTINUE	TRI	11
YDP(NPN)=U(NPN)	TRI	12
N1=NPN-1	TRI	13
DO 10 L=1,N1	TRI	14
K=N1+1-L	TRI	15
YDP(K)=Q(K)*YDP(K+1)+U(K)	TRI	16
10 CONTINUE	TRI	17
RETURN	TRI	18
C	TRI	19
END	TRI	20
FUNCTION ET(R1,R2,Z1,Z2,Z3,S1,S2)	ET	2
HJ=Z2-Z1	ET	3
T1=-0.5*(S1*(Z2-Z3)**2)/HJ	ET	4
T2=0.5*(S2*(Z3-Z1)**2)/HJ	ET	5
T3=(R2-R1)/HJ	ET	6
T4=-(S2-S1)*HJ/6.	ET	7

	ET=T1+T2+T3+T4	ET	8
	RETURN	ET	9
C	END	ET	10
	FUNCTION FD(S1,S2,R1,R2,R3)	ET	11
	IF (S1-S2) 5,10,5	FD	2
	5 FD=(R2-R1)/S1	FD	3
	RETURN	FD	4
10	FD=(-3.*R1+4.*R2-R3)/(2.*S1)	FD	5
	RETURN	FD	6
C	END	FD	7
	FUNCTION BD(S1,S2,R1,R2,R3)	FD	8
	IF (S1-S2) 5,10,5	FD	9
	5 BD=(R3-R2)/S2	BD	2
	RETURN	BD	3
10	BD=(3.*R3-4.*R2+R1)/(2.*S1)	BD	4
	RETURN	BD	5
C	END	BD	6
	FUNCTION ORDINET(A,B,C,D,E,F,P)	BD	7
	HJ=D-C	BD	8
	B1=D-P	BD	9
	B2=P-C	ORD	2
	A1=B1**3	ORD	3
	A2=B2**3	ORD	4
	T1=A1*A/(6.*HJ)	ORD	5
	T2=A2*B/(6.*HJ)	ORD	6
	T3=(E-A*HJ**2/6.)*(D-P)/HJ	ORD	7
	T4=(F-B*HJ**2/6.)*(P-C)/HJ	ORD	8
	ORDINET=T1+T2+T3+T4	ORD	9
	RETURN	ORD	10
C	END	ORD	11
		ORD	12
		ORD	13
		ORD	14
		ORD	15