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ABSTRACT

This report describes a computer program for the sway increment method for the elastic-plastic analysis of unbraced multi-story frames. The program is designed to determine the lateral load versus drift behavior of an unbraced multi-story frame up to and beyond the stability limit load under nonproportional combined loads. Detailed explanations of the sway increment method can be found in Ref. 1 of the report.

The report gives a brief explanation of the program, instructions on the use of the program and interpretation of the output. Also, a full listing of the program, flow charts and portions of the output from an analysis of an example frame are provided.

1. INTRODUCTION

In the analysis and design of an unbraced multi-story frame it is necessary to be able to determine the complete lateral-load versus drift behavior of the frame or individual stories.[1] The loading conditions should be nonproportional where the gravity loads are held constant while the lateral loads vary. This loading condition is considered more realistic than the proportional loading condition.

Continuing research into the behavior of multi-story frames is presently investigating the redistribution of lateral loads to parallel frames which are dissimilar. This research also requires that the complete loading and unloading behavior of multi-story frames under the nonproportional loading conditions described above can be determined.

This report describes a computer program developed for use in conjunction with the sway increment method of analysis described in Ref. 6. The sway increment method of analysis is based on determining the magnitude of an assumed distribution of lateral loading when the frame is subjected to a known sway or drift, and the gravity loads are held constant. The method uses a second-order elastic-plastic analysis, an incremental procedure and a "next hinge" prediction technique to improve the program speed and efficiency. The method includes column shortening, hinge reversal and the effect of residual stresses in the columns. A unique aspect of the sway increment method of analysis is the technique of applying the constant gravity loads. Before considering the lateral loads, the gravity loads are applied incrementally to detect plastic hinges under gravity loads alone. In this way a frame with initial plastic hinges or real hinges can be analyzed under combined loads. Further details of the theoretical development of the method are contained in Ref. 1.

The computer program described herein was programmed in Fortran IV for use on a CDC 6400 computer located at Lehigh University.

2. COMPUTER PROGRAM

2.1 Computational Procedure

The computational procedure in the program is that given in Chapter 2 of Ref. 1, which is repeated as follows:

1. Assume that the frame is initially unloaded and unstrained.
2. Apply the working gravity loads first. After that, increments of the gravity load will be applied.
3. Calculate joint rotations and joint vertical deflections at non-swayed position and then all member end forces.
4. Check all moments. If there is any cross-section where the moment exceeds its plastic moment capacity, insert a plastic hinge.
5. Repeat steps 2 and 4 until the factored gravity loads are reached.
6. Set sway increment. Initially, an arbitrary small increment is chosen and from then on, the increment is determined in steps 13 and 18.
7. Determine stability factors and stability functions of incremental slope-deflection equations for all members with the known member end forces.
8. Apply the sway increment which is fixed in step 6, to the bottom story (to the failed story, after the

stability limit load is reached) and calculate the corresponding incremental load intensity.

9. Determine the sway increment which results in same incremental load intensity with that calculated in step 8 at each story except the story used in step 8, by iteration.

10. If the sway increment cannot be obtained at a particular story in step 9, this means that no more lateral load can be resisted by the story and the stability limit load is reached. Now on the sway deflection of the failed story is incremented.

11. Calculate incremental moments, axial forces and axial shortening of columns from the deformations determined in the calculations of steps 8 and 9.

12. Repeat steps 6 to 12 inclusive until the value of the incremental load intensity calculated in the bottom story (in the failed story, after the stability limit load is reached) converges for the given sway increment.

13. Predict the minimum sway increment required in the bottom story (in the failed story, after the stability limit load is reached) for next hinge. Repeat steps 6 to 12 until prediction converges within tolerance.

14. Calculate inelastic hinge angles and test if there are any hinge reversals. If there are any hinge reversals, lock the hinges that have been unloaded. Return

sway increment to the value at the start of the current increment and do again from step 6.

15. Calculate the total lateral load and the total sway deflection at each story by adding the current incremental values to the previous subtotals.
16. Test the ratio of the maximum lateral load (corresponding to the stability limit load) and the present lateral load. If the ratio reached the desired range on unloading part, stop the program and terminate the calculation.
17. Check all moments and insert a new hinge at the location where the moment reaches its plastic moment of the section.
18. Predict the minimum sway increment of the bottom story (of the failed story) required for the next hinge.
19. Repeat steps 6 to 18 until the condition in step 16 is satisfied.

2.2 Brief Description of Program

The whole program was divided into a main program and nine subroutines for ease in compiling. A listing of the computer program is presented in Appendix I. The flow charts of the main program and individual subroutines are given in Appendix III. The symbols used in the program and in the flow charts are explained in Appendix II. The subroutines called by the main program or other subroutine are briefly described below.

Subroutine BEGIN: - Reads the geometry of the frame, member sizes and working gravity loads and lateral load indices. The material properties such as yield stress, modulus of elasticity and residual stress level are read at the same time. All the input quantities are printed out for future reference.

The end moments on beams and columns, joint rotations and lateral deflection are initialized. The plastic hinge combination for beams and columns is initialized as combination which does not have any plastic hinges (the detailed description on various combinations is given in Section 4.1).

This subroutine also calls subroutine GRALD which performs the function described below.

Subroutine GRALD: - The gravity loads are applied to the frame in the non-swayed position. The working gravity loads are applied at first and after that, the gravtiy loads are incremented until the factored gravity loads are reached. The main function of this subroutine is to check the formation of any plastic hinges under gravity loads only and to take into account of the effect of the plastic hinges, if any.

Subroutine CSCOE: - Determines the incremental fixed-end moments for all beams and the slope-deflection coefficients for beams and columns according to the plastic hinge combination. It also computes the summation of incremental independent moments at the joints and in the stories. These moments do not depend upon the incremental joint rotations or sway deflections of stories. They are incremental fixed-end moments due to incremental gravity loads or vertical deflections of joints or the moment differences caused by the variation in reduced plastic moments at the column plastic hinge locations or carryover moments.

Subroutine HORF - Solves the joint equilibrium equations for the incremental joint rotations utilizing the Gauss-Seidel iteration method. These equations contain known quantities like slope-deflection coefficients, incremental independent moments and sway deflections of stories. From the values of calculated incremental joint rotations, the story shear force is computed. Then, the value of the applied lateral load consistent with the given sway deflection of a story is determined from the story shear force.

Subroutine ENMT: - Determines the incremental end moments acting on the beams and columns utilizing incremental joint rotations, sway deflections of stories, slope-deflection coefficients and incremental independent moments acting on each member. These incremental end moments acting on each joint will be in balance. Adding the incremental end moments to the previous subtotals, the total end moments acting on the beams and columns at a sway increment are determined.

In this subroutine the axial loads in columns are also computed from statical equilibrium for the given vertical loads and the end moments on the beams. From the calculated axial loads, the incremental axial shortening of the columns and then the incremental joint vertical deflections are computed.

Subroutine PRED: - Predicts the minimum sway increment required in the bottom story (in the failed story, after the stability limit load is reached) for the next plastic hinge. The increments of lateral load intensity at all the potential hinge locations are calculated for plastic hinges from the linear predictions and then the smallest increment is selected for the next hinge. The smallest increment of lateral load intensity is converted to the necessary sway increment of the bottom story (of the failed story, after the stability limit load is reached).

Subroutine HINRE: - Computes the incremental inelastic hinge rotation and examines for any reversal of the direction of the rotation at each plastic hinge. If there are any hinge reversals occurred, the plastic hinges are eliminated and plastic hinge combination numbers are adjusted accordingly.

Subroutine BEAM: - Checks all beams for new hinge formation. If a plastic hinge has formed, a proper plastic hinge combination number is allotted to that beam. The combination number, the end moments and the maximum positive moment of each beam are printed out at each sway deflection increment.

Subroutine COL: - Does the same functions for the columns, which subroutine BEAM does for the beams.

2.4 Limitations

The limitation imposed on the number of bays and the number of stories is that dictated only by the computer time and the storage capacity of the particular computer employed. The program listed in Appendix 1 can be used for a frame up to 30 stories high and 3 bays wide. For a larger frame, the dimensions for various variables should be adjusted accordingly.

In the program, the deformation history is specified at working gravity loads and at each increment of gravity loads in the non-swayed position and at each successive hinge. The information between hinge formations is not recorded. Also, the deformations are calculated only at the joints; that is, in-span deflections of the beams and columns are not calculated.

In the computer program, the test employed for convergence of a hinge prediction requires that the difference between the prediction in the previous cycle and in the current cycle should be within 5 percent of the predicted sway increment of the previous cycle. As the criteria for the formation of a plastic hinge, the difference between the calculated moment at a section and the plastic moment or the reduced plastic moment of the section should be within 1 percent for beams and 2 percent for columns. In some cases, the above criteria are satisfied simultaneously at more than one point in a frame. In such a case it is considered that more than one plastic hinge form at the same sway increment. Those criteria could be modified, if necessary.

In applying the gravity loads to the frame at non-swayed position, the working gravtiy loads are applied at first. After that, the gravity loads are increased with the increment of onetenth of the working gravity loads until the factored gravity loads are reached. If it is desired to use a different magnitude of the increment of the gravity loads or other initial gravity loads instead of the working gravity loads, those factors can be adjusted.

3. DATA CARD SET-UP

The first card of the data card requires the specification of number of stories, number of bays, modulus elasticity, yield stress level, residual stress level, load factor for combined loads and load factor for the initial gravity loads to be applied.

On the second card, bay lengths (center-to-center span lengths) are read from the left. On the third card, story heights and lateral load indices are read from the top. Following this card, moments of inertia and plastic moduli of beams are read from the top left to the bottom right. Next, working gravity loads for beams are read from the top left to the bottom right. Then, moments of inertia, plastic moduli, areas and working gravity loads for columns are read from the top left to the bottom right. Last, depths of columns are read.

The following descriptions show the set-up of the data cards and input formats used in the program.

Card No.	Data	Symbol	Format
1	Number of stories	MS	2I5
	Number of bays	NB	
	Modulus of elasticity (k/in^2)	E	5F10.3
	Yield stress level (k/in^2)	FY	
	Maximum compressive residual stress nondimensionalized with yield stress	FRC	
	Load factor for combined loads	FAC	
	Load factor for initial gravity loads to be applied	GLF	
2	Bay length (in)	S	4F10.5
3F*	Story height (in)	H	8F10.5
	Lateral load index	WH	
4F*	Moment of inertia--Beams (in^4)	BI	6F10.5
	Plastic modulus--Beams (in^3)	BZ	
5F*	Working gravity load--Beams (k/in)	FL	6F10.5
6F*	Moment of inertia--Columns (in^4)	CI	8F10.5
	Plastic modulus--Columns (in^3)	CZ	
	Area--Columns (in^2)	AR	
	Working gravity load - Columns (kip)	PC	
7F*	Depths of Columns (in)	D	8F10.5

Read "and following cards as required" for F*

As an illustration, for a frame with the geometry, member sizes, working gravity loads and lateral loads as shown in Fig. 1, the set-up of the data cards for input is given in Fig. 2. The frame shown in Fig. 1 is used for simplicity in this report. Otherwise, no restrictions on the frame size are implied other than those imposed by the capacity of the computer.

4. INTERPRETATION OF OUTPUT

4.1 Sign and Numbering Conventions

The sign convention adopted in the program is as follows:

1. Moments and rotations at the ends of members are positive when clockwise.
2. Moments acting at a joint are positive when counter-clockwise.
3. Moment in the interior of a beam is positive when it produces tension on the bottom.
4. Moment in the interior of a column is positive when it produces tension on the right.
5. Horizontal shear in a column is positive if it causes a clockwise moment about the end of the column.
6. Axial forces in beams and columns are positive when they produce compression.
7. Vertical deflection of joints are positive when downward.
8. Lateral deflections of joints are positive when towards the right.

The numbering system for a level (boundary between two stories) used in the program starts from the top of a frame with one and proceeds downward. Stories are numbered from the bottom and proceed upward. Bays are numbered from the left.

In order to specify the hinge combinations occurred in members, a numbering system shown in Fig. 3 was used. The same combination number was used for beams and columns. For beams, the end A in Fig. 3 is corresponding to the left end of a beam. For columns, the end A in Fig. 3 is corresponding to the bottom end of a column. Hence, from the combination number of a member, the locations of plastic hinges on the member can be readily located. At each sway increment, the combination number for each member is printed out along with its member moments.

For the designation of the location of the possible next hinge point for which the sway increment is adopted or the locations where hinge reversals occur, the potential plastic hinge locations of a member at the start of analysis were numbered. Those locations are both ends of a member and an interior point where the maximum bending moment occurs. For convenience, in the program the potential hinge locations of a beam and a column are numbered consecutively as shown in Fig. 4. Using this numbering system, a potential hinge location can be identified with the level number, the bay number and the "potential hinge number". As an example, the location marked with A in Fig. 4 is identified with the point with number 2 at the Mth level in the Nth bay of the frame. The quantities pertaining to that location can be conveniently designated with three dimensionally subscripted variables with level number as first subscript, bay number as second subscript and potential hinge number as third subscript. In output, the possible next hinge location for which a sway increment is adopted is described with the three subscripts. The locations where hinge reversals occur are also indicated with the subscripts.

4.2 Output

All the input quantities discussed in Chapter 3 are printed out at the beginning of output. Then, the total load factor and the incremental load factor for gravity loads, the locations of plastic hinges, member moments (k-in), axial forces in columns (kip) and joint vertical deflections (in) are printed out at each increment of gravity loads in the non-swayed position. Next, the following information is printed out at each sway increment: the required sway increment for next hinge (*E/H) (k/in^2) and the location where the increment is adopted, the process of iteration for lateral load intensity by specifying its value at each iteration, the process of hinge prediction by specifying the number of iteration, the total sway increment adopted at the current iteration and the correction for the next iteration, number of hinge reversals occurred, their locations, total inelastic hinge rotations (*E)(k/in^2) at the previous increment at the plastic hinges subjected to reversals and increment of rotation (*E)(k/in^2) at the locations at the current increment, if there are any hinge reversals, total lateral load intensity (kip), lateral deflections (in) and deflection indices of individual stories, deflection index of frame, locations of plastic hinges, member moments, axial forces in columns and joint vertical deflections.

As an example, portions of the output from the analysis of a two-bay three-story frame shown in Fig. 1 are presented in Appendix IV. Page 80 of Appendix IV includes the results of the analysis with factored gravity loads in the non-swayed position and the output from the first sway increment. Page 81 contains a portion of the output at a sway increment before the stability limit load is reached. At this increment a number of plastic hinges is seen to have formed. However, there are no hinge reversals at this stage. Page 82 presents a portion of the output at a sway increment after the stability limit load is reached. The negative increment of lateral load intensity indicates that the lateral load decreases and the frame is unloaded. At this increment, eight plastic hinges are subjected to hinge reversals. The stability limit load (the maximum lateral load) is recorded when it occurs. However, in this example the output at the maximum lateral load is omitted.

5. APPENDIX I - LISTING OF PROGRAM

```
      PROGRAM  KIMOI3(OUTPUT,TAPE 2=OUTPUT,INPUT,TAPE 1=INPUT)
C
C
C     PROGRAM FOR COMPLETE LOAD-DEFLECTION BEHAVIOR OF UNBRACED FRAME
C
C     LA=1  AXIAL SHORTENING IS NOT CONSIDERED
C     LA=2  AXIAL SHORTENING IS CONSIDERED
C     LR=1  HINGE REVERSAL IS NOT CONSIDERED
C     LR=2  HINGE REVERSAL IS CONSIDERED
C
C
      COMMON/BLOCKA/E,FY,BI(30,3),BZ(30,3),PB(30,3),CI(30,4),CZ(30,4),AR
     1(30,4),PC(30,4),ET(31,4),PZ(4),KB(30,3),BA(30,3),BB(30,3),BC(30,3)
     2,BAP(30,3),BBP(30,3),BCP(30,3),FBA(30,3),FBB(30,3),BAI(30,3),BBI(3
     30,3),BCI(30,3),CA(30,3),SA(30,3),CB(30,3),SB(30,3),KC(30,4),BU(30,
     44),BL(30,4),BM(30,4),BUP(30,4),BLP(30,4),BMP(30,4),BUI(30,4),BLI(3
     50,4),BMI(30,4),FBU(30,4),FBL(30,4),CP(30,4),CPP(30,4),CU(30,4),SU(
     630,4),CL(30,4),SL(30,4),CC(30,4),CS(30,4),CX(30,4),SX(30,4),CY(30,
     74),SY(30,4),SM(30,4),SH(30),X(30,3),Y(30,3),XC(30,4),YC(30,4),P(30
     8,4),PP(30,4),PI(30,4),ED(30,4),EDT(30,4),EDTP(30,4),HF(30),HFP(30)
     9,HFT,PHF,HMAX,ER(30),ERP(30),ERT(30),IM,KAA,KM,MAXP,MF,MS,MT,NB,NC
     1,M,N,DERN,LD,FRC,NHR,LA,LR,BP(30,3),D(30,4),H(30),WH(30),FL(30,3),
     2S(3),RY(30,4),HRO(30,4,6),PHRO(30,4,6),KHR(30,4,6),KPRD,GLF,TGLF,
     3FAC,SMA,KBP(30,3),KCP(30,4)
      DIMENSION HHF(4),HER(4)
      LA=2
      LR=2
      IM=1
      KAA=1
      NNN=1
      NDER=1
      KM=1
      II=1
      MAXP=1
      CALL BEGIN
      IF(IM.LE.0) GO TO 100
  120 MK=1
      ER(MF)=DERN
      PDERN=DERN
      TDER=0.0
    1 TDER=TDER+DERN
      NM=1
    2 DO 50 M=1,MS
      SH(M)=0.0
      DO 50 N=1,NC
      SM(M,N)=0.0
   50 CONTINUE
      CALL CSCOF
      IF(IM)100,100,3
    3 M=MF
      CALL HORF
      IF(IM.LE.0) GO TO 100
      WRITE(2,103)M,HF(M),ER(M)
      IF(MF.EQ.1) GO TO 14
      NS=1
      NSL=MF-1
      IN=1
```

```
      GO TO 13
   14 NS=MF+1
      NSL=MS
      IN=2
   13 DO 15 I=NS,NSL
      IF(IN .EQ. 1) GO TO 11
      M=I
      GO TO 12
   11 M=MF-I
   12 NN=1
      DO 5 L=1,4
      HHF(L)=0.0
    5 HER(L)=0.0
      IF(MK-1)60,60,61
   61 ER(M)=ER(M)*HF(MF)/HF(M)
      GO TO 18
   60 IF(KAA-2)16,16,17
   16 ER(M)=ER(MF)
      GO TO 18
   17 ER(M)=ERP(M)*HF(MF)/HFP(M)
   18 CALL HORF
      IF(IM.LE.0) GO TO 100
      IF(ABS(HF(MF)) .GT. 0.1) GO TO 79
      IF(ABS(HF(M)/HF(MF)-1.00)-0.15)9,9,19
   79 IF(ABS(HF(M)/HF(MF)-1.00)-0.07)9,9,19
   19 IF(NN.GT.10)GO TO 21
      HHF(4)=HHF(3)
      HHF(3)=HHF(2)
      HHF(2)=HHF(1)
      HHF(1)=HF(M)
      HER(4)=HER(3)
      HER(3)=HER(2)
      HER(2)=HER(1)
      HER(1)=ER(M)
      IF(NN.EQ.4.OR.NN.EQ.8)GO TO 90
   92 ER(M)=HER(1)+(HER(1)-HER(2))*(HF(MF)-HHF(1))/(HHF(1)-HHF(2))
   20 NN=NN+1
      GO TO 18
   90 IF(HHF(3).GT.HF(MF).AND.HHF(2).GT.HF(MF))GO TO 91
      IF(HHF(3).LT.HF(MF).AND.HHF(2).LT.HF(MF))GO TO 97
      ER(M)=(HER(2)+HER(1))/2.
      GO TO 20
   91 IF(HHF(3).GT.HHF(2).AND.HHF(2).GT.HHF(1))GO TO 92
      IF(HHF(3).LT.HHF(2).AND.HHF(2).LT.HHF(1))GO TO 92
      IF(HHF(3).LT.HHF(2).AND.HHF(2).GT.HHF(1))GO TO 93
   94 ER(M)=HER(2)+(HER(2)-HER(4))*(HF(MF)-HHF(2))/(HHF(2)-HHF(4))
      GO TO 20
   93 ER(M)=HER(1)+(HER(1)-HER(3))*(HF(MF)-HHF(1))/(HHF(1)-HHF(3))
      GO TO 20
   97 IF(HHF(3).LT.HHF(2).AND.HHF(2).LT.HHF(1))GO TO 92
      IF(HHF(3).GT.HHF(2).AND.HHF(2).GT.HHF(1))GO TO 92
      IF(HHF(3).GT.HHF(2).AND.HHF(2).LT.HHF(1))GO TO 93
      GO TO 94
   21 IF(MAXP .GE. 2) GO TO 25
   10 IF(NNN .GT. 3) GO TO 25
      DO 121 L=1,MS
      ER(L)=0.0
      DO 121 N=1,NC
```

```
      ET(L,N)=0.0
      ED(L,N)=0.0
      P(L,N)=PP(L,N)
  121 CONTINUE
      MPF=MF
      MF=M
      DERN=ERP(M)*PDERN/ERP(MPF)
      NNN=NNN+1
      WRITE(2,70)M
      IF(DERN.LT.ERT(MF)/10.) GO TO 120
      DERN=ERT/10.
      LD=2
      GO TO 120
    9 IF(HF(MF))15,15,8
    8 IF(ER(M))10,10,15
   15 CONTINUE
      IF(MF.EQ.MS.OR.MF.EQ.1)GO TO 30
      IF(IN .EQ. 2) GO TO 30
      GO TO 14
   30 DO 201 IET=1,5
      DO 201 M=1,MS
      IF(M-1)202,202,203
  203 ET(M,1)=(-SM(M,1)-SA(M,1)*ET(M,2)-SL(M-1,1)*ET(M-1,1)-SU(M,1)*ET(M
     1+1,1)+(CU(M,1)+SU(M,1))*ER(M)+(CL(M-1,1)+SL(M-1,1))*ER(M-1))/(CA(M
     3,1)+CL(M-1,1)+CU(M,1))
      ET(M,NC)=(-SM(M,NC)-SB(M,NB)*ET(M,NB)-SL(M-1,NC)*ET(M-1,NC)-SU(M,N
     1C)*ET(M+1,NC)+(CU(M,NC)+SU(M,NC))*ER(M)+(CL(M-1,NC)+SL(M-1,NC))*ER
     2(M-1))/(CB(M,NB)+CL(M-1,NC)+CU(M,NC))
      IF(NB-1) 201,201,207
  207 DO 208 N=2,NB
  208 ET(M,N)=(-SM(M,N)-SA(M,N)*ET(M,N+1)-SB(M,N-1)*ET(M,N-1)-SL(M-1,N)*
     1ET(M-1,N)-SU(M,N)*ET(M+1,N)+(CL(M-1,N)+SL(M-1,N))*ER(M-1)+(CU(M,N)
     2+SU(M,N))*ER(M))/(CA(M,N)+CB(M,N-1)+CL(M-1,N)+CU(M,N))
      GO TO 201
  202 ET(1,1)=(-SM(1,1)-SA(1,1)*ET(1,2)-SU(1,1)*ET(2,1)+(CU(1,1)+SU(1,1)
     1)*ER(1))/(CA(1,1)+CU(1,1))
      ET(1,NC)=(-SM(1,NC)-SB(1,NB)*ET(1,NB)-SU(1,NC)*ET(2,NC)+(CU(1,NC)+
     1SU(1,NC))*ER(1))/(CB(1,NB)+CU(1,NC))
      IF(NB-1) 201,201,204
  204 DO 205 N=2,NB
  205 ET(1,N)=(-SM(1,N)-SB(1,N-1)*ET(1,N-1)-SA(1,N)*ET(1,N+1)-SU(1,N)*ET
     1(2,N)+(CU(1,N)+SU(1,N))*ER(1))/(CB(1,N-1)+CA(1,N)+CU(1,N))
  201 CONTINUE
      CALL ENMT
      IF(ABS(PHF/HF(MF)-1.00)-0.05)58,58,62
   62 IF(ABS(HF(MF)).GT.HFT/200.) GO TO 162
      IF(ABS(HF(MF)).GT.HFT/1000.) GO TO 163
      GO TO 58
  163 IF(ABS(PHF/HF(MF)-1.00)-0.5)58,162,162
  162 IF(NM-11)69,25,25
   69 NM=NM+1
      PHF=HF(MF)
      MK=MK+1
      GO TO 2
   25 WRITE(2,26)
      WRITE(2,27)M,HF(M),ER(M)
      GO TO 100
   58 PHF=0.0
```

```
      IF(LD.EQ.2)GO TO 173
      IF(ABS(HF(MF)).LT.HFT/100.) GO TO 173
      IF(HF(MF))83,83,84
   83 MAXP=2
   84 KPRD=0
      CALL PRED
      IF(ABS(DERN/TDER) .LE. 0.05) GO TO 173
      IF(ABS(DERN/ERT(MF)).LE.0.005) GO TO 173
   39 IF(NDER-5)71,72,72
   71 NDER=NDER+1
      IF(LD.EQ.1) GO TO 76
      ER(MF)=DERN
      TDER=0.0
      PDERN=DERN
      GO TO 77
   76 ER(MF)=ER(MF)+DERN
   77 WRITE(2,56)NDER,TDER,DERN
      GO TO 1
   72 WRITE(2,35) NDER,TDER,DERN
      GO TO 80
  173 WRITE(2,73)NDER, TDER,DERN
   80 NDER=1
      IF(LR.EQ.1) GO TO 81
      CALL HINRE
      IF(NHR)81,81,141
  141 WRITE(2,43)II,NHR
      IF(KM.GT.1) GO TO 142
      MAXP=1
  142 II=II+1
      TDER=PDERN
      ER(MF)=PDERN
      NM=1
      GO TO 2
   81 HFT=HFT+HF(MF)
      DELT=0.0
      TOH=0.0
      DO 82 M=1,MS
      TOH=TOH+H(M)
      ERT(M)=ERT(M)+ER(M)
      DOH=ERT(M)/F
      DEL=DOH*H(M)
      DELT=DELT+DEL
      MI=MT-M
      WRITE(2,78)MI,HFT,ERT(M),DOH,DEL
   82 CONTINUE
      DELT=DELT/TOH
      WRITE(2,178)HFT,DELT
      IF(KM .GT. 1)GO TO 54
      IF(HF(MF))53,165,165
  165 MAXP=1
      GO TO 54
   53 HMAX=HFTP
      MAXP=2
      KM=2
      MI=MT-M
      WRITE(2,55)MI,HMAX
   54 IF(ABS(HMAX/HFT).GE.1.2) GO TO 100
      DO 46 M=1,MS
```

```
      CALL BEAM
      IF(IM)100,100,47
   47 CALL COL
      IF(IM)100,100,46
   46 CONTINUE
      IF(LR.EQ.1) GO TO 119
      DO 118 M=1,MS
      DO 118 N=1,NC
      DO 118 L=1,6
  118 KHR(M,N,L)=0
      IF(II.LE.1) GO TO 399
      DO 400 M=1,MS
      DO 401 N=1,NB
      L=KBP(M,N)-KB(M,N)
      IF(L)401,401,402
  402 K=KBP(M,N)
      GO TO (401,401,403,403,404,404,405),K
  403 PHRO(M,N,1)=0.0
      GO TO 401
  404 PHRO(M,N,2)=0.0
      GO TO 401
  405 GO TO (403,403,404,404,406,406),L
  406 PHRO(M,N,1)=0.0
      PHRO(M,N,2)=0.0
  401 CONTINUE
      DO 400 N=1,NC
      L=KCP(M,N)-KC(M,N)
      IF(L)400,400,408
  408 K=KCP(M,N)
      GO TO (400,400,409,400,410,400,411),K
  409 PHRO(M,N,4)=0.0
      GO TO 400
  410 PHRO(M,N,5)=0.0
      GO TO 400
  411 GO TO (400,409,400,410,412,412),L
  412 PHRO(M,N,4)=0.0
      PHRO(M,N,5)=0.0
  400 CONTINUE
  399 II=1
  119 KPRD=1
      CALL PRED
      DO 45 M=1,MS
      ERP(M)=ER(M)
      HFP(M)=HF(M)
      ER(M)=0.0
      DO 57 N=1,NB
      BAP(M,N)=BA(M,N)
      BBP(M,N)=BB(M,N)
      BCP(M,N)=BC(M,N)
      KBP(M,N)=KB(M,N)
   57 CONTINUE
      DO 45 N=1,NC
      BUP(M,N)=BU(M,N)
      BLP(M,N)=BL(M,N)
      BMP(M,N)=BM(M,N)
      CPP(M,N)=CP(M,N)
      KCP(M,N)=KC(M,N)
      ET(M,N)=0.0
```

```
      PP(M,N)=P(M,N)
      IF(LA .EQ. 1) GO TO 49
      EDT(M,N)=EDTP(M,N)+ED(M,N)/E
      EDTP(M,N)=EDT(M,N)
      ED(M,N)=0.0
   49 DO 45 L=1,6
      PHRO(M,N,L)=PHRO(M,N,L)+HRO(M,N,L)
   45 CONTINUE
      WRITE(2,37)((P(M,N),N=1,NC),M=1,MS)
      ER(MF)=DERN
      PDERN=DERN
      TDER=0.0
      HFTP=HFT
      KAA=KAA+1
      MK=1
      IF(LA .EQ. 1) GO TO 1
      WRITE(2,38)((EDT(M,N),N=1,NC),M=1,MS)
      GO TO 1
   26 FORMAT(*    PROBABLE DIVERENCE OF HF*)
   27 FORMAT(*    M=*,I4,*    HF(M)=*,F12.5,*    ER(M)=*,F12.5)
   35 FORMAT(*    PRED DOES NOT CONVERGE WITHIN 5 CYCLES. NDER,TDER,DERN
     1=*,I4,2F15.5)
   37 FORMAT(*    AXLD*,8(1X,F8.2))
   38 FORMAT(*    ENDF*,8(1X,F8.3))
   43 FORMAT(*    HINGE REVERSAL OCCURRED  II=*,I3,* NHR=*,I3)
   55 FORMAT(*    FAILURE AT STORY  *,I3,*    HMAX=*,F12.5)
   56 FORMAT(*    NDER,TDER,DERN=*,I4,2F10.4)
   70 FORMAT(*    PROBABLE FAILURE AT M=*,I4)
   73 FORMAT(*   PRED CONV  NDER, TDER,DERN=*,I4,2F15.5)
   78 FORMAT(*    STORY *,I3,*  HFT=*,F12.4,*  ERT=*,F12.4,*  DOH=*,F12.
     14,*  DEL=*,F12.4)
  103 FORMAT(*        M,HF,ER  *,I3,3X,2F11.4)
  178 FORMAT(*    FOR PLOTTING   LATERAL LOAD=*,F12.5,*  DEFLECTION INDE
     1X OF FRAME=*,F12.5)
  100 CALL EXIT
      END
```

```
      SUBROUTINE BEGIN
      COMMON/BLOCKA/E,FY,BI(30,3),BZ(30,3),PB(30,3),CI(30,4),CZ(30,4),AR
     1(30,4),PC(30,4),ET(31,4),PZ(4),KB(30,3),BA(30,3),BB(30,3),BC(30,3)
     2,BAP(30,3),BBP(30,3),BCP(30,3),FBA(30,3),FBB(30,3),BAI(30,3),BBI(3
     30,3),BCI(30,3),CA(30,3),SA(30,3),CB(30,3),SB(30,3),KC(30,4),BU(30,
     44),BL(30,4),BM(30,4),BUP(30,4),BLP(30,4),BMP(30,4),BUI(30,4),BLI(3
     50,4),BMI(30,4),FBU(30,4),FBL(30,4),CP(30,4),CPP(30,4),CU(30,4),SU(
     630,4),CL(30,4),SL(30,4),CC(30,4),CS(30,4),CX(30,4),SX(30,4),CY(30,
     74),SY(30,4),SM(30,4),SH(30),X(30,3),Y(30,3),XC(30,4),YC(30,4),P(30
     8,4),PP(30,4),PI(30,4),ED(30,4),EDT(30,4),EDTP(30,4),HF(30),HFP(30)
     9,HFT,PHF,HMAX,ER(30),ERP(30),ERT(30),IM,KAA,KM,MAXP,MF,MS,MT,NB,NC
     1,M,N,DERN,LD,FRC,NHR,LA,LR,BP(30,3),D(30,4),H(30),WH(30),FL(30,3),
     2S(3),RY(30,4),HRO(30,4,6),PHRO(30,4,6),KHR(30,4,6),KPRD,GLF,TGLF,
     3FAC,SMA,KBP(30,3),KCP(30,4)
      READ(1,1)MS,NB,E,FY,FRC,FAC,GLF
      WRITE(2,2)MS,NB,E,FY,FRC,FAC,GLF
      NC=NB+1
      MT=MS+1
      READ(1,3)(S(N),N=1,NB)
      WRITE(2,4)(S(N),N=1,NB)
      READ(1,6)  (H(M),WH(M),M=1,MS)
      READ(1,5)((BI(M,N),BZ(M,N),N=1,NB),M=1,MS)
      READ(1,5)((FL(M,N),N=1,NB),M=1,MS)
      READ(1,6)((CI(M,N),CZ(M,N),AR(M,N),PC(M,N),N=1,NC),M=1,MS)
      READ(1,6)  ((D(M,N),N=1,NC),M=1,MS)
      DO 7 M=1,MS
      WRITE(2,8)M,H(M),WH(M),FL(M)
      WRITE(2,9)(BI(M,N),N=1,NB)
      WRITE(2,9)(BZ(M,N),N=1,NB)
      WRITE(2,10)(CI(M,N),N=1,NC)
      WRITE(2,10)(CZ(M,N),N=1,NC)
      WRITE(2,10)(AR(M,N),N=1,NC)
      WRITE(2,10)(D(M,N),N=1,NC)
      WRITE(2,10)(PC(M,N),N=1,NC)
    7 CONTINUE
      DO 12 N=1,NC
      ET(MT,N)=0.0
   12 PZ(N)=0.0
      MF=MS
      PHF=0.0
      HFT=0.0
      HMAX=0.0
      DO 14 M=1,MS
      DO 15 N=1,NB
      BP(M,N)=FY*BZ(M,N)
      BAP(M,N)=0.0
      BBP(M,N)=0.0
      BCP(M,N)=0.0
      X(M,N)=0.0
      Y(M,N)=0.0
      KBP(M,N)=1
   15 KB(M,N)=1
      DO 16 N=1,NC
      CP(M,N)=FY*CZ(M,N)
      BUP(M,N)=0.0
      BLP(M,N)=0.0
      BMP(M,N)=0.0
```

```
      BM(M,N)=0.0
      KCP(M,N)=1
      KC(M,N)=1
      XC(M,N)=0.0
      YC(M,N)=0.0
      PP(M,N)=0.0
      ET(M,N)=0.0
      ED(M,N)=0.0
      EDT(M,N)=0.0
      EDTP(M,N)=0.0
      CPP(M,N)=0.0
      DO 16 L=1,6
      KHR(M,N,L)=0
      HRO(M,N,L)=0.0
      PHRO(M,N,L)=0.0
   16 CONTINUE
      ER(M)=0.0
      ERP(M)=0.0
      ERT(M)=0.0
      HFP(M)=0.0
      P(M,1)=PZ(1)+ GLF*PC(M,1)+ GLF*FL(M,1)*S(1)/2.0
      PZ(1)=P(M,1)
      P(M,NC)=PZ(NC)+ GLF*PC(M,NC)+ GLF*FL(M,NB)*S(NB)/2.0
      PZ(NC)=P(M,NC)
      IF(NB-1)14,14,18
   18 DO 17 N=2,NB
      P(M,N)=PZ(N)+ GLF*PC(M,N)+ GLF*(FL(M,N)*S(N)+FL(M,N-1)*S(N-1))/2.0
   17 PZ(N)=P(M,N)
   14 CONTINUE
      CALL GRALD
      IF(IM.LE.0) GO TO 100
      KAA=2
      GLF=0.0
      TGLF=FAC
    1 FORMAT(2I5,5F10.3)
    2 FORMAT(1H1,* NO OF STORY=*,I4,*  NO. OF BAY=*,I4,* E=*,F8.2,* FY=*
     1,F8.2,* FRC=*,F8.4,* FAC=*,F8.4,* GLF=*,F8.4)
    3 FORMAT(4F10.5)
    4 FORMAT(*     S(N)=*,4F10.4)
    5 FORMAT((6F10.5))
    6 FORMAT((8F10.5))
    8 FORMAT(*  M=*,I3,3X,5F10.5)
    9 FORMAT(10X,3(F10.5,2X))
   10 FORMAT(4X,4(F10.5,2X))
  100 RETURN
      END
```

```
      SUBROUTINE GRALD
      COMMON/BLOCKA/E,FY,BI(30,3),BZ(30,3),PB(30,3),CI(30,4),CZ(30,4),AR
     1(30,4),PC(30,4),ET(31,4),PZ(4),KB(30,3),BA(30,3),BB(30,3),BC(30,3)
     2,BAP(30,3),BBP(30,3),BCP(30,3),FBA(30,3),FBB(30,3),BAI(30,3),BBI(3
     30,3),BCI(30,3),CA(30,3),SA(30,3),CB(30,3),SB(30,3),KC(30,4),BU(30,
     44),BL(30,4),BM(30,4),BUP(30,4),BLP(30,4),BMP(30,4),BUI(30,4),BLI(3
     50,4),BMI(30,4),FBU(30,4),FBL(30,4),CP(30,4),CPP(30,4),CU(30,4),SU(
     630,4),CL(30,4),SL(30,4),CC(30,4),CS(30,4),CX(30,4),SX(30,4),CY(30,
     74),SY(30,4),SM(30,4),SH(30),X(30,3),Y(30,3),XC(30,4),YC(30,4),P(30
     8,4),PP(30,4),PI(30,4),ED(30,4),EDT(30,4),EDTP(30,4),HF(30),HFP(30)
     9,HFT,PHF,HMAX,ER(30),ERP(30),ERT(30),IM,KAA,KM,MAXP,MF,MS,MT,NB,NC
     1,M,N,DERN,LD,FRC,NHR,LA,LR,BP(30,3),D(30,4),H(30),WH(30),FL(30,3),
     2S(3),RY(30,4),HRO(30,4,6),PHRO(30,4,6),KHR(30,4,6),KPRD,GLF,TGLF,
     3FAC,SMA,KBP(30,3),KCP(30,4)
      TGLF=0.0
    1 TGLF=TGLF+GLF
      WRITE(2,30)TGLF,GLF
      DO 103 KSW=1,3
      DO 2 M=1,MS
      SH(M)=0.0
      DO 2 N=1,NC
      SM(M,N)=0.0
    2 CONTINUE
      CALL CSCOE
      IF(IM.LE.0) GO TO 101
      DO 3 IET=1,5
      DO 3 I=1,MS
      M=MS-I+1
      CALL HORF
      IF(IM.LE.0) GO TO 101
    3 CONTINUE
      CALL ENMT
  103 CONTINUE
      CALL HINRE
      DO 5 M=1,MS
      CALL BEAM
      IF(IM)100,100,26
   26 CALL COL
      IF(IM) 100,100,5
    5 CONTINUE
      IF(TGLF.LT.(FAC-0.05)) GO TO 15
      DO 39 M=1,MS
      DO 40 N=1,NB
      L=KB(M,N)-KBP(M,N)
      IF(L)40,40,41
   41 GO TO (40,42,40,43,40,44),L
   42 PHRO(M,N,1)=0.001*BA(M,N)/ABS(BA(M,N))
      GO TO 40
   43 PHRO(M,N,2)=0.001*BB(M,N)/ABS(BB(M,N))
      GO TO 40
   44 PHRO(M,N,1)=0.001*BA(M,N)/ABS(BA(M,N))
      PHRO(M,N,2)=0.001*BB(M,N)/ABS(BB(M,N))
   40 CONTINUE
      DO 39 N=1,NC
      L=KC(M,N)-KCP(M,N)
      IF(L)39,39,45
   45 GO TO (39,46,39,47,39,48),L
```

```
 46 PHRO(M,N,4)=0.001*BL(M,N)/ABS(BL(M,N))
    GO TO 39
 47 PHRO(M,N,5)=0.001*BU(M,N)/ABS(BU(M,N))
    GO TO 39
 48 PHRO(M,N,4)=0.001*BL(M,N)/ABS(BL(M,N))
    PHRO(M,N,5)=0.001*BU(M,N)/ABS(BU(M,N))
 39 CONTINUE
 15 DO 17 M=1,MS
    DO 16 N=1,NB
    BAP(M,N)=BA(M,N)
    BBP(M,N)=BB(M,N)
    BCP(M,N)=BC(M,N)
    KBP(M,N)=KB(M,N)
 16 CONTINUE
    DO 17 N=1,NC
    BUP(M,N)=BU(M,N)
    BLP(M,N)=BL(M,N)
    BMP(M,N)=BM(M,N)
    CPP(M,N)=CP(M,N)
    KCP(M,N)=KC(M,N)
    PP(M,N)=P(M,N)
    ET(M,N)=0.0
    ER(M)=0.0
    IF(LA .EQ. 1) GO TO 18
    EDT(M,N)=EDTP(M,N)+ED(M,N)/E
    EDTP(M,N)=EDT(M,N)
    ED(M,N)=0.0
 18 DO 17 L=1,6
    PHRO(M,N,L)=PHRO(M,N,L)+HRO(M,N,L)
 17 CONTINUE
    WRITE(2,20)((P(M,N),N=1,NC),M=1,MS)
    IF(LA .EQ. 1) GO TO 19
    WRITE(2,21)((EDT(M,N),N=1,NC),M=1,MS)
 19 IF(TGLF.GT.(FAC-0.05)) GO TO 100
    GLF=0.1
    GO TO 1
100 DERN=0.06*E/H(MF)
    LD=2
101 RETURN
 20 FORMAT(*     AXLD*,12(1X,F8.2))
 21 FORMAT(*     ENDF*,12(1X,F8.3))
 30 FORMAT(*     TOTAL GRAVITY LOAD FACTOR=*,F10.3,*  INCREMENTAL LOAD
   1FACTOR=*,F10.3)
    END
```

```
      SUBROUTINE CSCOE
      COMMON/BLOCKA/E,FY,BI(30,3),BZ(30,3),PB(30,3),CI(30,4),CZ(30,4),AR
     1(30,4),PC(30,4),ET(31,4),PZ(4),KB(30,3),BA(30,3),BB(30,3),BC(30,3)
     2,BAP(30,3),BBP(30,3),BCP(30,3),FBA(30,3),FBB(30,3),BAI(30,3),BBI(3
     30,3),BCI(30,3),CA(30,3),SA(30,3),CB(30,3),SB(30,3),KC(30,4),BU(30,
     44),BL(30,4),BM(30,4),BUP(30,4),BLP(30,4),BMP(30,4),BUI(30,4),BLI(3
     50,4),BMI(30,4),FBU(30,4),FBL(30,4),CP(30,4),CPP(30,4),CU(30,4),SU(
     630,4),CL(30,4),SL(30,4),CC(30,4),CS(30,4),CX(30,4),SX(30,4),CY(30,
     74),SY(30,4),SM(30,4),SH(30),X(30,3),Y(30,3),XC(30,4),YC(30,4),P(30
     8,4),PP(30,4),PI(30,4),ED(30,4),EDT(30,4),EDTP(30,4),HF(30),HFP(30)
     9,HFT,PHF,HMAX,ER(30),ERP(30),ERT(30),IM,KAA,KM,MAXP,MF,MS,MT,NB,NC
     1,M,N,DERN,LD,FRC,NHR,LA,LR,BP(30,3),D(30,4),H(30),WH(30),FL(30,3),
     2S(3),RY(30,4),HRO(30,4,6),PHRO(30,4,6),KHR(30,4,6),KPRD,GLF,TGLF,
     3FAC,SMA,KBP(30,3),KCP(30,4)
      DIMENSION Z(2)
      DO 1 M=1,MS
      DO 2 N=1,NB
      IF(LA.GT.1) GO TO 8
      FED=0.0
      TOE=0.0
      GO TO 9
    8 FED=-(ED(M,N+1)-ED(M,N))
      TOE=6.*FED*BI(M,N)/S(N)/S(N)
    9 CA(M,N)=0.0
      SA(M,N)=0.0
      CB(M,N)=0.0
      SB(M,N)=0.0
      FBA(M,N)=0.0
      FBB(M,N)=0.0
      FM=GLF*FL(M,N)*S(N)*S(N)/12.
      K=KB(M,N)
      GO TO (3,4,5,10,7,11,2,100),K
    3 CA(M,N)=4.0*BI(M,N)/S(N)
      SA(M,N)=CA(M,N)/2.
      CB(M,N)=CA(M,N)
      SB(M,N)=SA(M,N)
      FBA(M,N)=TOE-FM
      FBB(M,N)=TOE+FM
      SM(M,N)=SM(M,N)+FBA(M,N)
      SM(M,N+1)=SM(M,N+1)+FBB(M,N)
      GO TO 2
    4 XY=X(M,N)**3+Y(M,N)**3
      CA(M,N)=3.0*BI(M,N)*X(M,N)**2/XY
      SA(M,N)=3.0*BI(M,N)*X(M,N)*Y(M,N)/XY
      CB(M,N)=3.0*BI(M,N)*Y(M,N)**2/XY
      SB(M,N)=SA(M,N)
      TO=3.0*S(N)/XY
      TT=GLF*FL(M,N)*X(M,N)*(Y(M,N)**3*TO+X(M,N))/8.
      TTH=GLF*FL(M,N)*Y(M,N)*(X(M,N)**3*TO+Y(M,N))/8.
      FBA(M,N)=SA(M,N)*FED/Y(M,N)-TT
      FBB(M,N)=SA(M,N)*FED/X(M,N)+TTH
      SM(M,N)=SM(M,N)+FBA(M,N)
      SM(M,N+1)=SM(M,N+1)+FBB(M,N)
      GO TO 2
    5 CB(M,N)=3.0*BI(M,N)/S(N)
      FBB(M,N)=TOE/2.0+FM*1.5
      SM(M,N+1)=SM(M,N+1)+FBB(M,N)
```

```
      GO TO 2
   10 FBB(M,N)=GLF*FL(M)*S(N)*Y(M,N)/2.
      SM(M,N+1)=SM(M,N+1)+FBB(M,N)
      GO TO 2
    7 CA(M,N)=3.0*BI(M,N)/S(N)
      FBA(M,N)=TOE/2.0-FM*1.5
      SM(M,N)=SM(M,N)+FBA(M,N)
      GO TO 2
   11 FBA(M,N)=-GLF*FL(M)*S(N)*X(M,N)/2.
      SM(M,N)=SM(M,N)+FBA(M,N)
    2 CONTINUE
      DO 1 N=1,NC
      POPY=P(M,N)/FY/AR(M,N)
      IF(POPY-1.0+FRC)14,14,15
   14 RY(M,N)=1.0
      GO TO 16
   15 IF(1.0-POPY)116,116,117
  116 WRITF(2,118) M,N,P(M,N),POPY
      RY(M,N)=0.1
      GO TO 16
  117 RY(M,N)=SQRT((1.0-POPY)/FRC)
   16 IF(P(M,N))32,32,30
   30 TON=P(M,N)/(E*CI(M,N)*RY(M,N))
      PHI=H(M)*SQRT(TON)
      SMS=(PHI/SIN(PHI)-1.0)/PHI**2
      SMC=(1.0-PHI*COS(PHI)/SIN(PHI))/PHI**2
      DSQ=(SMC*SMC-SMS*SMS)*H(M)/CI(M,N)/RY(M,N)
      CC(M,N)=SMC/DSQ
      CS(M,N)=SMS/DSQ
      GO TO 132
   32 CC(M,N)=4.0
      CS(M,N)=2.0
  132 IF(POPY-0.15)12,12,13
   12 CP(M,N)=FY*CZ(M,N)
      GO TO 17
   13 IF(POPY-1.0)24,24,25
   24 CP(M,N)=1.18*(1.0-POPY)*FY*CZ(M,N)
      GO TO 17
   25 WRITE(2,26)M,N,POPY
      CP(M,N)=0.0
   17 RCP=CP(M,N)-CPP(M,N)
      CU(M,N)=0.0
      SU(M,N)=0.0
      CL(M,N)=0.0
      SL(M,N)=0.0
      FBU(M,N)=0.0
      FBL(M,N)=0.0
      RAT=CS(M,N)/CC(M,N)
      K=KC(M,N)
      GO TO  (18,22,19,100,20,100,21),K
   18 CU(M,N)=CC(M,N)
      CL(M,N)=CC(M,N)
      SU(M,N)=CS(M,N)
      SL(M,N)=CS(M,N)
      GO TO 1
   22 Z(1)=XC(M,N)
      Z(2)=YC(M,N)
      DO 23 L=1,2
      IF(P(M,N))23,23,33
```

```
 33 PHI=Z(L)*SQRT(P(M,N)/(E*CI(M,N)*RY(M,N)))
    SMC=(1.0-PHI*COS(PHI)/SIN(PHI))/PHI**2
    SMS=(PHI/SIN(PHI)-1.0)/PHI**2
    DSQ=(SMC*SMC-SMS*SMS)*Z(L)/CI(M,N)/RY(M,N)
    IF(L.LE.1) GO TO 27
    CY(M,N)=SMC/DSQ
    SY(M,N)=SMS/DSQ
    GO TO 23
 27 CX(M,N)=SMC/DSQ
    SX(M,N)=SMS/DSQ
 23 CONTINUE
    OK=(CX(M,N)*CX(M,N)-SX(M,N)*SX(M,N))/CX(M,N)
    TK=(CY(M,N)*CY(M,N)-SY(M,N)*SY(M,N))/CY(M,N)
    THK=OK*YC(M,N)/XC(M,N)+TK*XC(M,N)/YC(M,N)-PI(M,N)*H(M)/E
    CL(M,N)=OK-OK*OK*YC(M,N)/THK/XC(M,N)
    SL(M,N)=OK*TK/THK
    CC(M,N)=OK*H(M)*(PI(M,N)/E-TK/YC(M,N))/THK
    SK=SX(M,N)*YC(M,N)/CX(M,N)+SY(M,N)*XC(M,N)/CY(M,N)+H(M)
    AM=RCP*BM(M,N)/ABS(BM(M,N))
    FBL(M,N)=(OK*SK/THK/XC(M,N)-SX(M,N)/CX(M,N))*AM
    CU(M,N)=TK-TK*TK*XC(M,N)/THK/YC(M,N)
    SU(M,N)=OK*TK/THK
    CS(M,N)=TK*H(M)*(XC(M,N)*(TK/YC(M,N)-PI(M,N)/E)/THK-1.)/YC(M,N)
    FBU(M,N)=(SY(M,N)/CY(M,N)-TK*SK/THK/YC(M,N))*AM
    SH(M)=SH(M)+FBL(M,N)+FBU(M,N)
    SM(M,N)=SM(M,N)+FBU(M,N)
    SM(M+1,N)=SM(M+1,N)+FBL(M,N)
    BM(M,N)=CP(M,N)*BM(M,N)/ABS(BM(M,N))
    GO TO 1
 19 BL(M,N)=CP(M,N)*BL(M,N)/ABS(BL(M,N))
    CU(M,N)=(CC(M,N)**2-CS(M,N)**2)/CC(M,N)
    AL=RCP*BL(M,N)/ABS(BL(M,N))
    SH(M)=SH(M)+(1.0+RAT)*AL
    SM(M,N)=SM(M,N)+RAT*AL
    SM(M+1,N)=SM(M+1,N)+AL
    FBU(M,N)=AL*RAT
    GO TO 1
 20 BU(M,N)=CP(M,N)*BU(M,N)/ABS(BU(M,N))
    CL(M,N)=(CC(M,N)**2-CS(M,N)**2)/CC(M,N)
    AT=RCP*BU(M,N)/ABS(BU(M,N))
    SH(M)=SH(M)+(1.+RAT)*AT
    SM(M,N)=SM(M,N)+AT
    SM(M+1,N)=SM(M+1,N)+RAT*AT
    FBL(M,N)=AT*RAT
    GO TO 1
 21 BU(M,N)=CP(M,N)*BU(M,N)/ABS(BU(M,N))
    BL(M,N)=CP(M,N)*BL(M,N)/ABS(BL(M,N))
    SH(M)=SH(M)+RCP*BU(M,N)/ABS(BU(M,N))+RCP*BL(M,N)/ABS(BL(M,N))
    SM(M,N)=SM(M,N)+RCP*BU(M,N)/ABS(BU(M,N))
    SM(M+1,N)=SM(M+1,N)+RCP*BL(M,N)/ABS(BL(M,N))
  1 CONTINUE
    RETURN
100 IM=0
    WRITE(2,101)M,N,K
102 RETURN
 26 FORMAT(*  M,N,POPY*,2I5,F15.7)
101 FORMAT(*     IMP COMB OF KB OR KC   M,N,K*,3I4)
118 FORMAT(*     POPY GT 1   M=*,I4,*  N=*,I4,*  P(M,N)=*,F10.4,*  POPY
   1=*,F10.4)
    END
```

```
      SUBROUTINE HORF
      COMMON/BLOCKA/F,FY,BI(30,3),BZ(30,3),PB(30,3),CI(30,4),CZ(30,4),AR
     1(30,4),PC(30,4),ET(31,4),PZ(4),KB(30,3),BA(30,3),BB(30,3),BC(30,3)
     2,BAP(30,3),BBP(30,3),BCP(30,3),FBA(30,3),FBB(30,3),BAI(30,3),BBI(3
     30,3),BCI(30,3),CA(30,3),SA(30,3),CB(30,3),SB(30,3),KC(30,4),BU(30,
     44),BL(30,4),BM(30,4),BUP(30,4),BLP(30,4),BMP(30,4),BUI(30,4),BLI(3
     50,4),BMI(30,4),FBU(30,4),FBL(30,4),CP(30,4),CPP(30,4),CU(30,4),SU(
     630,4),CL(30,4),SL(30,4),CC(30,4),CS(30,4),CX(30,4),SX(30,4),CY(30,
     74),SY(30,4),SM(30,4),SH(30),X(30,3),Y(30,3),XC(30,4),YC(30,4),P(30
     8,4),PP(30,4),PI(30,4),ED(30,4),EDT(30,4),EDTP(30,4),HF(30),HFP(30)
     9,HFT,PHF,HMAX,ER(30),ERP(30),ERT(30),IM,KAA,KM,MAXP,MF,MS,MT,NB,NC
     1,M,N,DERN,LD,FRC,NHR,LA,LR,BP(30,3),D(30,4),H(30),WH(30),FL(30,3),
     2S(3),RY(30,4),HRO(30,4,6),PHRO(30,4,6),KHR(30,4,6),KPRD,GLF,TGLF,
     3FAC,SMA,KBP(30,3),KCP(30,4)
      DO 40 KET=1,5
      IF(M-1)1,1,9
    9 DN=CA(M,1)+CL(M-1,1)+CU(M,1)
      IF(DN .EQ. 0.00) GO TO 100
      ET(M,1)=(-SM(M,1)-SA(M,1)*ET(M,2)-SL(M-1,1)*ET(M-1,1)-SU(M,1)*ET(M
     1+1,1)+(CU(M,1)+SU(M,1))*ER(M)+(CL(M-1,1)+SL(M-1,1))*ER(M-1))/DN
   11 DN=CB(M,NB)+CL(M-1,NC)+CU(M,NC)
      IF(DN .EQ. 0.00) GO TO 100
      ET(M,NC)=(-SM(M,NC)-SB(M,NB)*ET(M,NB)-SL(M-1,NC)*ET(M-1,NC)-SU(M,N
     1C)*ET(M+1,NC)+(CU(M,NC)+SU(M,NC))*ER(M)+(CL(M-1,NC)+SL(M-1,NC))*ER
     2(M-1))/DN
   13 IF(NB-1)40,40,16
   16 DO 14 N=2,NB
      DN=CA(M,N)+CB(M,N-1)+CL(M-1,N)+CU(M,N)
      IF(DN .EQ. 0.00) GO TO 100
      ET(M,N)=(-SM(M,N)-SA(M,N)*ET(M,N+1)-SB(M,N-1)*ET(M,N-1)-SL(M-1,N)*
     1ET(M-1,N)-SU(M,N)*ET(M+1,N)+(CL(M-1,N)+SL(M-1,N))*ER(M-1)+(CU(M,N)
     2+SU(M,N))*ER(M))/DN
   14 CONTINUE
      GO TO 40
    1 DN=CA(1,1)+CU(1,1)
      IF(DN .EQ. 0.00) GO TO 100
      ET(1,1)=(-SM(1,1)-SA(1,1)*ET(1,2)-SU(1,1)*ET(2,1)+(CU(1,1)+SU(1,1)
     1)*ER(1))/DN
    3 DN=CB(1,NB)+CU(1,NC)
      IF(DN .EQ. 0.00) GO TO 100
      ET(1,NC)=(-SM(1,NC)-SB(1,NB)*ET(1,NB)-SU(1,NC)*ET(2,NC)+(CU(1,NC)+
     1SU(1,NC))*ER(1))/DN
    5 IF(NB-1)40,40,8
    8 DO 6 N=2,NB
      DN=CB(1,N-1)+CA(1,N)+CU(1,N)
      IF(DN .EQ. 0.00) GO TO 100
      ET(1,N)=(-SM(1,N)-SB(1,N-1)*ET(1,N-1)-SA(1,N)*ET(1,N+1)-SU(1,N)*ET
     1(2,N)+(CU(1,N)+SU(1,N))*ER(1))/DN
    6 CONTINUE
   40 CONTINUE
      IF(KAA.LE.1) GO TO 21
      FN=0.0
      DO 20 I=1,M
   20 FN=FN+WH(I)
      PT=0.0
      SSCT=SH(M)
      DO 17 N=1,NC
```

```
      PT=PT+P(M,N)
      SSCT=(CU(M,N)+SL(M,N))*ET(M,N)+(SU(M,N)+CL(M,N))*ET(M+1,N)-(CU(M,N
     1)+SU(M,N)+CL(M,N)+SL(M,N))*ER(M)+SSCT
   17 CONTINUE
      HF(M)=-(SSCT+PT*H(M)*ER(M)/E)/FN/H(M)
      RETURN
  100 WRITE(2,101)M,N
  101 FORMAT(*     IMPRO HINGE COMB (JOINT MECH)*,2I3)
      IM=0
   21 RETURN
      END
```

```
      SUBROUTINE ENMT
      COMMON/BLOCKA/E,FY,BI(30,3),BZ(30,3),PB(30,3),CI(30,4),CZ(30,4),AR
     1(30,4),PC(30,4),ET(31,4),PZ(4),KB(30,3),BA(30,3),BB(30,3),BC(30,3)
     2,BAP(30,3),BBP(30,3),BCP(30,3),FBA(30,3),FBB(30,3),BAI(30,3),BBI(3
     30,3),BCI(30,3),CA(30,3),SA(30,3),CB(30,3),SB(30,3),KC(30,4),BU(30,
     44),BL(30,4),BM(30,4),BUP(30,4),BLP(30,4),BMP(30,4),BUI(30,4),BLI(3
     50,4),BMI(30,4),FBU(30,4),FBL(30,4),CP(30,4),CPP(30,4),CU(30,4),SU(
     630,4),CL(30,4),SL(30,4),CC(30,4),CS(30,4),CX(30,4),SX(30,4),CY(30,
     74),SY(30,4),SM(30,4),SH(30),X(30,3),Y(30,3),XC(30,4),YC(30,4),P(30
     8,4),PP(30,4),PI(30,4),ED(30,4),EDT(30,4),EDTP(30,4),HF(30),HFP(30)
     9,HFT,PHF,HMAX,ER(30),ERP(30),ERT(30),IM,KAA,KM,MAXP,MF,MS,MT,NB,NC
     1,M,N,DERN,LD,FRC,NHR,LA,LR,BP(30,3),D(30,4),H(30),WH(30),FL(30,3),
     2S(3),RY(30,4),HRO(30,4,6),PHRO(30,4,6),KHR(30,4,6),KPRD,GLF,TGLF,
     3FAC,SMA,KBP(30,3),KCP(30,4)
      DO 4 M=1,MS
      DO 2 N=1,NB
      BAI(M,N)=FBA(M,N)+CA(M,N)*ET(M,N)+SA(M,N)*ET(M,N+1)
      BBI(M,N)=FBB(M,N)+CB(M,N)*ET(M,N+1)+SB(M,N)*ET(M,N)
      BCI(M,N)=0.0
      BA(M,N)=BAP(M,N)+BAI(M,N)
      BB(M,N)=BBP(M,N)+BBI(M,N)
      K=KB(M,N)
      GO TO (27,2,27,2,27,2,15,100),K
   27 SBM=-(BA(M,N)+BB(M,N))
      X(M,N)=S(N)/2.0+SBM/(TGLF*FL(M,N)*S(N))
      IF(X(M,N)-D(M,N)/2.)21,21,22
   21 X(M,N)=0.0
      BC(M,N)=0.0
      GO TO 25
   22 Y(M,N)=S(N)-X(M,N)
      IF(Y(M,N)-D(M,N+1)/2.)23,23,24
   23 X(M,N)=S(N)
      BC(M,N)=0.0
      GO TO 25
   24 BC(M,N)=FL(M,N)*TGLF*Y(M,N)*X(M,N)/2.0+BA(M,N)+SBM*X(M,N)/S(N)
   25 BCI(M,N)=BC(M,N)-BCP(M,N)
      GO TO 2
   15 IF(KAA .GT. 1) GO TO 2
      GO TO 27
    2 CONTINUE
      DO 4 N=1,NC
      BUI(M,N)=0.0
      BLI(M,N)=0.0
      BMI(M,N)=0.0
      K=KC(M,N)
      GO TO (5,40,5,4,5,4,4),K
    5 BUI(M,N)=CU(M,N)*ET(M,N)+SU(M,N)*ET(M+1,N)-(CU(M,N)+SU(M,N))*ER(M)
     1+FBU(M,N)
      BLI(M,N)=CL(M,N)*ET(M+1,N)+SL(M,N)*ET(M,N)-(CL(M,N)+SL(M,N))*ER(M)
     1+FBL(M,N)
      BU(M,N)=BUP(M,N)+BUI(M,N)
      BL(M,N)=BLP(M,N)+BLI(M,N)
      IF(K.GT.1) GO TO 4
      IF(KAA.EQ.1) GO TO 4
      RAT=ABS(BL(M,N))*BU(M,N)/ABS(BU(M,N))/BL(M,N)
      IF(RAT.GE.0.0) GO TO 4
      IF(ABS(BL(M,N))-ABS(BU(M,N)))41,41,42
```

```
 41 AM=ABS(BU(M,N))
    BN=ABS(BL(M,N))*RAT
    I=-1
    GO TO 43
 42 AM=ABS(BL(M,N))
    BN=ABS(BU(M,N))*RAT
    I=1
 43 PHI=H(M)*SQRT(P(M,N)/(E*CI(M,N)*RY(M,N)))
    ZK=ATAN(-(BN+AM*COS(PHI))/AM/SIN(PHI))
    IF(ZK)44,44,45
 44 XC(M,N)=0.0
    YC(M,N)=0.0
    BM(M,N)=0.0
    GO TO 49
 45 BMAX=SQRT(AM*AM+BN*BN+2.*AM*BN*COS(PHI))/SIN(PHI)
    XZ=ZK/SQRT(P(M,N)/(E*CI(M,N)*RY(M,N)))
    IF(I)46,45,47
 46 XC(M,N)=H(M)-XZ
    GO TO 48
 47 XC(M,N)=XZ
 48 BM(M,N)=BMAX*BL(M,N)/ABS(BL(M,N))
    YC(M,N)=H(M)-XC(M,N)
 49 BMI(M,N)=BM(M,N)-BMP(M,N)
    GO TO 4
 40 BUI(M,N)=CU(M,N)*ET(M,N)+SU(M,N)*ET(M+1,N)+CS(M,N)*ER(M)+FBU(M,N)
    BLI(M,N)=CL(M,N)*ET(M+1,N)+SL(M,N)*ET(M,N)+CC(M,N)*ER(M)+FBL(M,N)
    BU(M,N)=BUP(M,N)+BUI(M,N)
    BL(M,N)=BLP(M,N)+BLI(M,N)
  4 CONTINUE
    DO 6 N=1,NC
  6 PZ(N)=0.0
    DO 7 M=1,MS
    P(M,1)=PZ(1)+TGLF*PC(M,1)+TGLF*FL(M,1)*S(1)/2.-(BA(M,1)+BB(M,1))/S
   1(1)
    PZ(1)=P(M,1)
    P(M,NC)=PZ(NC)+TGLF*PC(M,NC)+TGLF*FL(M,NB)*S(NB)/2.+(BA(M,NB)+BB(M
   1,NB))/S(NB)
    PZ(NC)=P(M,NC)
    IF(NB-1)7,7,8
  8 DO 9 N=2,NB
    P(M,N)=PZ(N)+TGLF*PC(M,N)+TGLF*(FL(M,N)*S(N)+FL(M,N-1)*S(N-1))/2.-
   1(BA(M,N)+BB(M,N))/S(N)+(BA(M,N-1)+BB(M,N-1))/S(N-1)
  9 PZ(N)=P(M,N)
  7 CONTINUE
    DO 30 M=1,MS
    DO 30 N=1,NC
 30 PI(M,N)=P(M,N)-PP(M,N)
    IF(LA.EQ.1) GO TO 100
    DO 31 M=1,MS
    DO 31 N=1,NC
    MI=MS
    EDI=PI(MI,N)*H(MI)/AR(MI,N)
 32 MI=MI-1
    IF(MI-M)33,34,34
 34 EDI=EDI+PI(MI,N)*H(MI)/AR(MI,N)
    GO TO 32
 33 ED(M,N)=EDI
 31 CONTINUE
100 RETURN
    END
```

```
      SUBROUTINE PRED
      COMMON/BLOCKA/E,FY,BI(30,3),BZ(30,3),PB(30,3),CI(30,4),CZ(30,4),AR
     1(30,4),PC(30,4),ET(31,4),PZ(4),KB(30,3),BA(30,3),BB(30,3),BC(30,3)
     2,BAP(30,3),BBP(30,3),BCP(30,3),FBA(30,3),FBB(30,3),BAI(30,3),BBI(3
     30,3),BCI(30,3),CA(30,3),SA(30,3),CB(30,3),SB(30,3),KC(30,4),BU(30,
     44),BL(30,4),BM(30,4),BUP(30,4),BLP(30,4),BMP(30,4),BUI(30,4),BLI(3
     50,4),BMI(30,4),FBU(30,4),FBL(30,4),CP(30,4),CPP(30,4),CU(30,4),SU(
     630,4),CL(30,4),SL(30,4),CC(30,4),CS(30,4),CX(30,4),SX(30,4),CY(30,
     74),SY(30,4),SM(30,4),SH(30),X(30,3),Y(30,3),XC(30,4),YC(30,4),P(30
     8,4),PP(30,4),PI(30,4),ED(30,4),EDT(30,4),EDTP(30,4),HF(30),HFP(30)
     9,HFT,PHF,HMAX,ER(30),ERP(30),ERT(30),IM,KAA,KM,MAXP,MF,MS,MT,NB,NC
     1,M,N,DERN,LD,FRC,NHR,LA,LR,BP(30,3),D(30,4),H(30),WH(30),FL(30,3),
     2S(3),RY(30,4),HRO(30,4,6),PHRO(30,4,6),KHR(30,4,6),KPRD,GLF,TGLF,
     3FAC,SMA,KBP(30,3),KCP(30,4)
      DIMENSION PRE(30,4,6),SMAL(30),NS(30),LC(30,6)
      LD=1
      DO 4 M=1,MS
      IF(MAXP-2)6,5,5
    5 M=MF
    6 DO 1 N=1,NC
      DO 1 L=1,6
      IF(HF(MF))3,2,2
    2 TA=HFT*100.
      GO TO 57
    3 TA=-HFT*100.
   57 PRE(M,N,L)=TA
    1 CONTINUE
      DO 7 N=1,NB
      K=KB(M,N)
      GO TO (8,8,12,12,8,12,12,12),K
    8 IF(ABS(BAI(M,N)).LT.BP(M,N)/100.) GO TO 12
      IF(BAI(M,N))9,12,10
    9 CBP=-BP(M,N)
      GO TO 11
   10 CBP=BP(M,N)
   11 PRE(M,N,1)=HF(MF)*(CBP-BA(M,N))/BAI(M,N)
   12 GO TO(13,13,13,17,17,17,17,17),K
   13 IF(ABS(BBI(M,N)).LT.BP(M,N)/100.) GO TO 17
      IF(BBI(M,N))14,17,15
   14 CBP=-BP(M,N)
      GO TO 16
   15 CBP=BP(M,N)
   16 PRE(M,N,2)=HF(MF)*(CBP-BB(M,N))/BBI(M,N)
   17 GO TO (18,7,7,7,18,7,7,7),K
   18 IF(X(M,N).GT.D(M,N)/2. .AND. Y(M,N).GT.D(M,N+1)/2.) GO TO 41
      GO TO 7
   41 IF(ABS(BCI(M,N)).LT.BP(M,N)/100.) GO TO 7
      IF(BCI(M,N))19,7,20
   19 CBP=-BP(M,N)
      GO TO 21
   20 CBP=BP(M,N)
   21 PRE(M,N,3)=HF(MF)*(CBP-BC(M,N))/BCI(M,N)
    7 CONTINUE
      DO 22 N=1,NC
      K=KC(M,N)
      GO TO (23,27,27,27,23,27,27),K
   23 IF(ABS(BLI(M,N)).LT.CP(M,N)/100.) GO TO 27
```

```
      IF(BLI(M,N))24,27,25
   24 CCP=-CP(M,N)
      GO TO 26
   25 CCP=CP(M,N)
   26 PRE(M,N,4)=HF(MF)*(CCP-BL(M,N))/BLI(M,N)
   27 GO TO (28,50,28,50,50,50,50),K
   28 IF(ABS(BUI(M,N)).LT.CP(M,N)/100.) GO TO 50
      IF(BUI(M,N))29,50,30
   29 CCP=-CP(M,N)
      GO TO 31
   30 CCP=CP(M,N)
   31 PRE(M,N,5)=HF(MF)*(CCP-BU(M,N))/BUI(M,N)
   50 GO TO (51,22,22,22,22,22,22),K
   51 IF(ABS(BMI(M,N)).LT.CP(M,N)/100.) GO TO 22
      IF(BMI(M,N))53,22,54
   53 CCP=-CP(M,N)
      GO TO 52
   54 CCP=CP(M,N)
   52 PRE(M,N,6)=HF(MF)*(CCP-BM(M,N))/BMI(M,N)
   22 CONTINUE
      DO 80 N=1,NC
      DO 80 L=1,6
      IF(KHR(M,N,L).EQ.0) GO TO 80
      PRE(M,N,L)=TA
   80 CONTINUE
      IF(MAXP-2)32,33,33
   32 SMAL(M)=PRE(M,1,1)
      DO 34 N=1,NC
      DO 34 L=1,6
      IF(PRE(M,N,L) .GT. SMAL(M))GO TO 34
      SMAL(M)=PRE(M,N,L)
      NS(M)=N
      LC(M,N)=L
   34 CONTINUE
    4 CONTINUE
      SMA=SMAL(1)
      DO 35 M=1,MS
      IF(SMAL(M) .GT. SMA) GO TO 35
      SMA=SMAL(M)
      MC=M
   35 CONTINUE
      DERN=ER(MF)*SMA/HF(MF)
      NSS=NS(MC)
      WRITE(2,39)MC,NS(MC),LC(MC,NSS),DERN
   42 IF(KPRD.EQ.0) GO TO 36
      IF(DERN.GT.0.0025*E/H(MF)) GO TO 43
      DERN=0.0025*E/H(MF)
      GO TO 102
   43 IF(ABS(DERN/ERT(MF)).GT.0.02) GO TO 36
      DERN=ERT(MF)*0.02
      GO TO 102
   33 DERN=ER(MF)*PRE(MF,1,1)/HF(MF)
      DO 37 N=1,NC
      DO 37 L=1,6
      DD=ER(MF)*PRE(MF,N,L)/HF(MF)
      IF(DD .GT. DERN) GO TO 37
      DERN=DD
   37 CONTINUE
```

```
      CED=ER(MF)*TA/HF(MF)
      IF(DERN .GT. CED) GO TO 92
      IF(ABS(DERN).GT.ERT(MF)/10.) GO TO 92
      GO TO 42
   92 DERN=ERT(MF)/10.
  102 LD=2
      WRITE(2,38)MF,DERN
   38 FORMAT(*     SPECIAL PRED ADOPTED MF=*,I4,*  DERN=*,F15.5)
   39 FORMAT(*     PRED ADOPTED AT MC,NS,LC=*,3I4,* DERN=*,F15.5)
   36 RETURN
      END
```

```
      SUBROUTINE HINRE
      COMMON/BLOCKA/E,FY,BI(30,3),BZ(30,3),PB(30,3),CI(30,4),CZ(30,4),AR
     1(30,4),PC(30,4),ET(31,4),PZ(4),KB(30,3),BA(30,3),BB(30,3),BC(30,3)
     2,BAP(30,3),BBP(30,3),BCP(30,3),FBA(30,3),FBB(30,3),PAI(30,3),BBI(3
     30,3),BCI(30,3),CA(30,3),SA(30,3),CB(30,3),SB(30,3),KC(30,4),BU(30,
     44),BL(30,4),BM(30,4),BUP(30,4),BLP(30,4),BMP(30,4),BUI(30,4),BLI(3
     50,4),BMI(30,4),FBU(30,4),FBL(30,4),CP(30,4),CPP(30,4),CU(30,4),SU(
     630,4),CL(30,4),SL(30,4),CC(30,4),CS(30,4),CX(30,4),SX(30,4),CY(30,
     74),SY(30,4),SM(30,4),SH(30),X(30,3),Y(30,3),XC(30,4),YC(30,4),P(30
     8,4),PP(30,4),PI(30,4),ED(30,4),EDT(30,4),EDTP(30,4),HF(30),HFP(30)
     9,HFT,PHF,HMAX,ER(30),ERP(30),ERT(30),IM,KAA,KM,MAXP,MF,MS,MT,NB,NC
     1,M,N,DERN,LD,FRC,NHR,LA,LR,BP(30,3),D(30,4),H(30),WH(30),FL(30,3),
     2S(3),RY(30,4),HRO(30,4,6),PHRO(30,4,6),KHR(30,4,6),KPRD,GLF,TGLF,
     3FAC,SMA,KBP(30,3),KCP(30,4)
      NHR=0
      DO 1 M=1,MS
      DO 2 N=1,NB
      IF(LA.GT.1) GO TO 48
      FED=0.0
      GO TO 49
   48 FED=ED(M,N+1)-ED(M,N)
   49 DO 3 L=1,3
    3 HRO(M,N,L)=0.0
      FM=GLF*FL(M,N)*S(N)*S(N)*S(N)/12./BI(M,N)
      K=KB(M,N)
      GO TO (2,4,5,6,7,8,9,2),K
    4 XO=0.5/(X(M,N)**3+Y(M,N)**3)
      XT=2.*Y(M,N)**3+3.*X(M,N)*Y(M,N)**2-X(M,N)**3
      XF=Y(M,N)**3-3.*Y(M,N)*X(M,N)**2-2.*X(M,N)**3
      XS=3.*(X(M,N)*X(M,N)-Y(M,N)*Y(M,N))
      XE=6.*X(M,N)*X(M,N)*Y(M,N)*Y(M,N)*S(N)*S(N)*XO-1.0/XO/6.0
      HRO(M,N,3)=XO*(XT*ET(M,N)+XF*ET(M,N+1)+XS*FED)+GLF*FL(M)*XE/16./BI
     1(M,N)
      GO TO 10
    5 HRO(M,N,1)=ET(M,N)+ET(M,N+1)/2.-1.5*FED/S(N)-FM/4.0
      GO TO 10
    6 TO=(4.*X(M,N)+3.*Y(M,N))*Y(M,N)**3/X(M,N)+X(M,N)**3
      TT=Y(M,N)**3*(8.*X(M,N)+3.*Y(M,N))+X(M,N)*X(M,N)*(6.*Y(M,N)*Y(M,N)
     1-X(M,N)*X(M,N))
      HRO(M,N,1)=ET(M,N)+Y(M,N)*ET(M,N+1)/X(M,N)-FED/X(M,N)-GLF*FL(M,N)*
     1TO/24./BI(M,N)
      HRO(M,N,3)=-(Y(M,N)/X(M,N)+1.)*ET(M,N+1)+FED/X(M,N)+GLF*FL(M,N)*TT
     1/(24.*X(M,N)*BI(M,N))
      GO TO 10
    7 HRO(M,N,2)=ET(M,N+1)+ET(M,N)/2.-1.5*FED/S(N)+FM/4.0
      GO TO 10
    8 TO=(3.*X(M,N)+4.*Y(M,N))*X(M,N)**3/Y(M,N)+Y(M,N)**3
      TT=X(M,N)**3*(8.*Y(M,N)+3.*X(M,N))+Y(M,N)*Y(M,N)*(6.*X(M,N)*X(M,N)
     1-Y(M,N)*Y(M,N))
      HRO(M,N,2)=ET(M,N+1)+X(M,N)*ET(M,N)/Y(M,N)-FED/Y(M,N)+GLF*FL(M,N)*
     1TO/24./BI(M,N)
      HRO(M,N,3)=(X(M,N)/Y(M,N)+1.)*ET(M,N)+FED/Y(M,N)+GLF*FL(M,N)*TT/(
     124.*Y(M,N)*BI(M,N))
      GO TO 10
    9 HRO(M,N,1)=ET(M,N)-FED/S(N)-FM/2.0
      HRO(M,N,2)=ET(M,N+1)-FED/S(N)+FM/2.0
   10 DO 11 L=1,3
      IF( HRO(M,N,L)*PHRO(M,N,L)) 15,11,11
   15 NHR=NHR+1
      KHR(M,N,L)=1
```

```
      WRITE(2,40)M,N,L,PHRO(M,N,L),HRO(M,N,L)
   40 FORMAT(*    HINGE REV  M,N,L,PHRO,HRO *,3I4,2E11.3)
      GO TO (16,37,38),L
   16 KB(M,N)=KB(M,N)-2
      GO TO 11
   37 KB(M,N)=KB(M,N)-4
      GO TO 11
   38 KB(M,N)=KB(M,N)-1
   11 CONTINUE
    2 CONTINUE
      DO 17 N=1,NC
      DO 47 L=4,6
   47 HRO(M,N,L)=0.0
      K=KC(M,N)
      GO TO (17,61,18,17,19,17,20),K
   61 OK=(CX(M,N)*CX(M,N)-SX(M,N)*SX(M,N))/CX(M,N)
      TK=(CY(M,N)*CY(M,N)-SY(M,N)*SY(M,N))/CY(M,N)
      THK=OK*YC(M,N)/XC(M,N)+TK*XC(M,N)/YC(M,N)-PI(M,N)*H(M)/E
      FK=(CX(M,N)+SX(M,N))/CX(M,N)/XC(M,N)+(CY(M,N)+SY(M,N))/CY(M,N)/YC(
     1M,N)
      C1=FK*OK*YC(M,N)/THK-SX(M,N)/CX(M,N)
      C2=SY(M,N)/CY(M,N)-FK*TK*XC(M,N)/THK
      C3=(SX(M,N)*YC(M,N)/CX(M,N)+SY(M,N)*XC(M,N)/CY(M,N)+H(M))*FK/THK
      C4=1./CX(M,N)+1./CY(M,N)
      C5=(TK/YC(M,N)-PI(M,N)/E)*FK*XC(M,N)/THK
      C6=(CY(M,N)+SY(M,N))/YC(M,N)/CY(M,N)
      C7=(CP(M,N)-CPP(M,N))*BM(M,N)/ABS(BM(M,N))
      HRO(M,N,6)=C1*ET(M+1,N)+C2*ET(M,N)-(C3+C4)*C7+(C5-C6)*ER(M)*H(M)
      GO TO 21
   18 OK=CS(M,N)/CC(M,N)
      TK=(CP(M,N)-CPP(M,N))*BL(M,N)/ABS(BL(M,N))
      THK=TK/CC(M,N)
      HRO(M,N,4)=ET(M+1,N)+OK*ET(M,N)-(1.+OK)*ER(M)-THK
      GO TO 21
   19 OK=CS(M,N)/CC(M,N)
      TK=(CP(M,N)-CPP(M,N))*BU(M,N)/ABS(BU(M,N))
      THK=TK/CC(M,N)
      HRO(M,N,5)=ET(M,N)+OK*ET(M+1,N)-(1.+OK)*ER(M)-THK
      GO TO 21
   20 OK=(CP(M,N)-CPP(M,N))*BL(M,N)/ABS(BL(M,N))
      TK=(CP(M,N)-CPP(M,N))*BU(M,N)/ABS(BU(M,N))
      THK=1./(CC(M,N)+CS(M,N))
      HRO(M,N,4)=ET(M+1,N)-ER(M)-OK*THK
      HRO(M,N,5)=ET(M,N)-ER(M)-TK*THK
   21 DO 24 L=4,6
      IF( HRO(M,N,L)*PHRO(M,N,L)) 26,24,24
   26 NHR=NHR+1
      KHR(M,N,L)=1
      WRITE(2,40)M,N,L,PHRO(M,N,L),HRO(M,N,L)
      K=L-3
      GO TO (27,28,62),K
   27 KC(M,N)=KC(M,N)-2
      GO TO 24
   28 KC(M,N)=KC(M,N)-4
      GO TO 24
   62 KC(M,N)=KC(M,N)-1
   24 CONTINUE
   17 CONTINUE
    1 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE BEAM
      COMMON/BLOCKA/E,FY,BI(30,3),BZ(30,3),PB(30,3),CI(30,4),CZ(30,4),AR
     1(30,4),PC(30,4),ET(31,4),PZ(4),KB(30,3),BA(30,3),BB(30,3),BC(30,3)
     2,BAP(30,3),BBP(30,3),BCP(30,3),FBA(30,3),FBB(30,3),BAI(30,3),BBI(3
     30,3),BCI(30,3),CA(30,3),SA(30,3),CB(30,3),SB(30,3),KC(30,4),BU(30,
     44),BL(30,4),BM(30,4),BUP(30,4),BLP(30,4),BMP(30,4),BUI(30,4),BLI(3
     50,4),BMI(30,4),FBU(30,4),FBL(30,4),CP(30,4),CPP(30,4),CU(30,4),SU(
     630,4),CL(30,4),SL(30,4),CC(30,4),CS(30,4),CX(30,4),SX(30,4),CY(30,
     74),SY(30,4),SM(30,4),SH(30),X(30,3),Y(30,3),XC(30,4),YC(30,4),P(30
     8,4),PP(30,4),PI(30,4),ED(30,4),EDT(30,4),EDTP(30,4),HF(30),HFP(30)
     9,HFT,PHF,HMAX,ER(30),ERP(30),ERT(30),IM,KAA,KM,MAXP,MF,MS,MT,NB,NC
     1,M,N,DERN,LD,FRC,NHR,LA,LR,BP(30,3),D(30,4),H(30),WH(30),FL(30,3),
     2S(3),RY(30,4),HRO(30,4,6),PHRO(30,4,6),KHR(30,4,6),KPRD,GLF,TGLF,
     3FAC,SMA,KBP(30,3),KCP(30,4)
      DO 40 N=1,NB
    2 K=KB(M,N)
      GO TO (1,5,1,40,1,40,1,9),K
    1 IF(ABS(BC(M,N))-BP(M,N)*0.99)3,4,4
    3 GO TO (5,101,20,101,5,101,40,101),K
    4 BC(M,N)=BP(M,N)*BC(M,N)/ABS(BC(M,N))
      GO TO (6,101,7,101,8,101,9,101),K
    6 IF(ABS(BA(M,N))-BP(M,N)*0.99) 23,102,102
   23 KB(M,N)=2
      GO TO 15
    7 KB(M,N)=4
      GO TO 20
    8 IF(ABS(BA(M,N))-BP(M,N)*0.99) 24,102,102
  102 BC(M,N)=0.0
      WRITE(2,103)M,N,KB(M,N),X(M,N)
  103 FORMAT(*    BC MAX OCCURS NEAR CONN. M,N,KB,X=*,3I5,F10.3)
      GO TO 12
   24 KB(M,N)=6
      GO TO 40
    9 KB(M,N)=8
      WRITE(2,10)M,N
      GO TO 100
    5 IF(ABS(BA(M,N))-BP(M,N)*0.995)15,12,12
   15 K=KB(M,N)
      GO TO (20,20,101,101,40,40,101,101),K
   12 BA(M,N)=BP(M,N)*BA(M,N)/ABS(BA(M,N))
      K=KB(M,N)
      GO TO (13,13,20,20,14,9,40,9),K
   13 KB(M,N)=KB(M,N)+2
      GO TO 20
   14 KB(M,N)=7
      GO TO 40
   20 IF(ABS(BB(M,N))-BP(M,N)*0.99)40,21,21
   21 BB(M,N)=BP(M,N)*BB(M,N)/ABS(BB(M,N))
      K=KB(M,N)
      GO TO (22,22,22,9,101,101,101,101),K
   22 KB(M,N)=KB(M,N)+4
      GO TO 40
  101 WRITE(2,11)M,N,KB(M,N)
      GO TO 100
   40 CONTINUE
   30 WRITE(2,31)(M,N,KB(M,N),BA(M,N),BC(M,N),BB(M,N),N=1,NB)
      RETURN
```

```
100 IM=0
    RETURN
 10 FORMAT(*     BEAM MECHANISM  M,N=*,2I4)
 11 FORMAT(*     IMP COMB OF KB  M,N,KB=*,3I4)
 31 FORMAT((1X,3I3,1X,F9.2,F9.2,F9.2,2X,3I3,1X,F9.2,F9.2,F9.2,2X,3I3,1
   1X,F9.2,F9.2,F9.2))
    END
```

```
      SUBROUTINE COL
      COMMON/BLOCKA/F,FY,BI(30,3),BZ(30,3),PB(30,3),CI(30,4),CZ(30,4),AR
     1(30,4),PC(30,4),ET(31,4),PZ(4),KB(30,3),BA(30,3),BB(30,3),BC(30,3)
     2,BAP(30,3),BBP(30,3),BCP(30,3),FBA(30,3),FBB(30,3),BAI(30,3),BBI(3
     30,3),BCI(30,3),CA(30,3),SA(30,3),CB(30,3),SB(30,3),KC(30,4),BU(30,
     44),BL(30,4),BM(30,4),BUP(30,4),BLP(30,4),BMP(30,4),BUI(30,4),BLI(3
     50,4),BMI(30,4),FBU(30,4),FBL(30,4),CP(30,4),CPP(30,4),CU(30,4),SU(
     630,4),CL(30,4),SL(30,4),CC(30,4),CS(30,4),CX(30,4),SX(30,4),CY(30,
     74),SY(30,4),SM(30,4),SH(30),X(30,3),Y(30,3),XC(30,4),YC(30,4),P(30
     8,4),PP(30,4),PI(30,4),ED(30,4),EDT(30,4),EDTP(30,4),HF(30),HFP(30)
     9,HFT,PHF,HMAX,ER(30),ERP(30),ERT(30),IM,KAA,KM,MAXP,MF,MS,MT,NP,NC
     1,M,N,DERN,LO,FRC,NHR,LA,LR,BP(30,3),D(30,4),H(30),WH(30),FL(30,3),
     2S(3),RY(30,4),HRO(30,4,6),PHRO(30,4,6),KHR(30,4,6),KPRD,GLF,TGLF,
     3FAC,SMA,KBP(30,3),KCP(30,4)
      DO 1 N=1,NC
      K=KC(M,N)
      GO TO(2,21,3,100,4,100,7),K
    2 IF(ABS(BM(M,N))-CP(M,N)*0.98)20,21,21
   21 BM(M,N)=CP(M,N)*BM(M,N)/ABS(BM(M,N))
      KC(M,N)=2
      GO TO 1
   20 IF(ABS(BL(M,N))-CP(M,N)*0.98)14,3,3
    3 BL(M,N)=CP(M,N)*BL(M,N)/ABS(BL(M,N))
      KC(M,N)=3
   14 IF(ABS(BU(M,N))-CP(M,N)*0.98)1,6,6
    6 BU(M,N)=CP(M,N)*BU(M,N)/ABS(BU(M,N))
      KC(M,N)=KC(M,N)+4
      GO TO 1
    4 IF(ABS(BL(M,N))-CP(M,N)*0.98)9,7,7
    7 KC(M,N)=7
    8 BL(M,N)=CP(M,N)*BL(M,N)/ABS(BL(M,N))
    9 BU(M,N)=CP(M,N)*BU(M,N)/ABS(BU(M,N))
    1 CONTINUE
      WRITE(2,10)(M,N,KC(M,N),BU(M,N),BL(M,N),N=1,NC)
      RETURN
  100 WRITE(2,11)M,N,KC(M,N)
      IM=0
      RETURN
   10 FORMAT((1X,3I3,1X,F9.2,F9.2,1X,3I3,1X,F9.2,F9.2,1X,3I3,1X,F9.2,F9.
     12,1X,3I3,1X,F9.2,F9.2))
   11 FORMAT(*     IMP COMB OF KC  M,N,KC=*,3I4)
      END
```

6. APPENDIX II - SYMBOLS IN PROGRAM

AL Moment change at the bottom of a column due to the change of the reduced plastic moment at the plastic hinge at the top (kip-in)

AM Larger of the two end moments in a column (kip-in)

AR Area of a column (in^2)

AT Moment change at the top of a column due to the change of the reduced plastic moment at the plastic hinge at the bottom (kip-in)

BA Moment at the end A in beam (kip-in)

BAI Moment increment at the end A in beam (kip-in)

BAP Moment at the end A in beam at the previous sway increment (kip-in)

BB Moment at the end B in beam (kip-in)

BBI Moment increment at the end B in beam (kip-in)

BBP Moment at the end B in beam at the previous sway increment (kip-in)

BC Maximum moment between ends A and B in beam (kip-in)

BCI Moment increment at the location of the maximum moment between ends A and B in beam (kip-in)

BCP Maximum moment between ends A and B in beam at the previous sway increment (kip-in)

BEAM A subroutine subprogram

BEGIN A subroutine subprogram

BI Moment of inertia--Beams (in^4)

BL Moment at the end L in column (kip-in)

BLI Moment increment at the end L in column (kip-in)

BLP Moment at the end L in column at the previous sway increment (kip-in)

BM	Maximum moment between ends L and U in columns (kip-in)
BMAX	Maximum moment in column (kip-in)
BMI	Moment increment at the location of the maximum moment between ends L and U in column (kip-in)
BMP	Maximum moment between ends L and U in column at the previous sway increment (kip-in)
BN	Smaller of the two end moments in a column (kip-in)
BP	Plastic moment of a beam (kip-in)
BU	Moment at the end U in column (kip-in)
BUI	Moment increment at the end U in column (kip-in)
BUP	Moment at the end U in column at the previous sway increment (kip-in)
BZ	Plastic modulus of a section--Beams (in^3)
CA	Slope-deflection coefficient for the moment at A due to rotation at A in the beam AB (kip-in)
CB	Slope-deflection coefficient for the moment at B due to rotation at B in the beam AB (kip-in)
CBP	A variable used in subroutine PRED
CC	Stiffness coefficient for a column
CCP	A variable used in subroutine PRED
CED	A variable used in subroutine PRED
CI	Moment of inertia--Columns (in^4)
CL	Slope-deflection coefficient for the moment at L due to rotation at L in column LU (kip-in)
COL	A subroutine subprogram
CP	Reduced plastic moment of a column (kip-in)
CPP	Reduced plastic moment of a column at the previous sway increment (kip-in)
CS	Stiffness coefficient for a column

CSCOE	A subroutine subprogram
CSMA	A variable used in subroutine PRED
CU	Slope-deflection coefficient for the moment at U due to rotation at U in column LU (kip-in)
CX	Stiffness coefficient for a part of a column in plastic hinge combination (2)
CY	Stiffness coefficient for a part of a column in plastic hinge combination (2)
CZ	Plastic modulus of section--Columns (in^3)
C1,C2,C3, C4,C5,C6, C7	Variables used in subroutines HINRE
D	Depth of a column (in)
DD	A variable used in subroutine PRED
DEL	Relative lateral deflection of a story (in)
DELT	Lateral deflection at the top of a frame (in)
DERN	Predicted increment of lateral deflection (*E/H)(k/in^2)
DN	A variable used in subroutine HORD
DOH	Deflection index of a story
DSQ	A variable used in calculating stiffness coefficients for a column in subroutine CSCOE
E	Modulus of elasticity (k/in^2)
ED	Increment of vertical deflection of a joint due to column shortening (*E) (k/in^2)
EDT	Total vertical deflection of a joint due to column shortening (in)
EDTP	Total vertical deflection of a joint due to column shortening at the previous sway increment (in)
ENMT	A subroutine subprogram

ER	Increment of lateral deflection of a story (*E/H)(k/in^2)
ERP	Increment of lateral deflection of a story at the previous sway increment (*E/H)(k/in^2)
ERT	Total lateral deflection of a story (*E/H)(k/in^2)
ET	Increment of rotation of a joint (*E)(k/in^2)
FAC	Load factor for the combined loads
FBA	Fixed end moment at the end A in beam (kip-in)
FBB	Fixed end moment at the end B in beam (kip-in)
FBL	Moment correction at the end L in column due to the change of reduced plastic moment from the previous sway increment (kip-in)
FBU	Moment correction at the end U in column due to the change of reduced plastic moment from the previous sway increment (kip-in)
FED	A variable used to indicate the difference between the increments of vertical deflection of two adjacent joints in a story (*E) (k/in^2)
FK	A variable used in subroutine HINRE
FL	Uniformly distributed beam load (k/in)
FM	A variable used in subroutine CSCOE
FN	A variable used in subroutine HORF
FRC	Maximum compressive residual stress nondimensionalized with yield stress
FY	Yield stress (k/in^2)
GLF	Load factor for the initial gravity loads to be applied at the start of analysis. Increment of load factor for the gravity loads in the non-swayed position
GRALD	A subroutine subprogram
H	Height of a story (in)
HER	A variable used in main program

HF	Increment of lateral load (kip)
HFP	Increment of lateral load at the previous sway increment (kip)
HFT	Total lateral load (kip)
HFTP	Total lateral load at the previous sway increment (kip)
HHF	A variable used in main program
HINRE	A subroutine subprogram
HMAX	Maximum lateral load (kip)
HORF	A subroutine subprogram
HRO	Inelastic hinge rotation at a plastic hinge (*E) (k/in^2)
I	Fixed point variable I keeps track of which end of a column has the larger moment
IET	Number of an iteration to solve simultaneous equations
II	Number used to indicate how many times subroutine HINRE is called in a sway increment
IM	Fixed point variable used to stop the program if undesirable plastic hinge combination is detected
IN	Fixed point variable used to indicate the end of computation performed on individual stories
K	Fixed point variable K is equal to KB or KC when it is used in computed "GO TO"
KAA	Fixed point variable used to indicate the calculation to be performed in the non-swayed position
KB	Plastic hinge combination for a beam
KBP	Plastic hinge combination for a beam at the previous sway increment
KC	Plastic hinge combination for a column
KCP	Plastic hinge combination for a column at the previous sway increment

KET Number of an iteration to solve simultaneous equations in subroutine HORF

KHR Fixed point variable used to indicate the location of hinge reversals occurred in the current sway increment

KM Fixed point variable used to indicate whether or not the maximum lateral load is passed

KPRD Fixed point variable used to indicate whether subroutine PRED is called for the next sway increment or to check the convergence of the current sway increment

KSW Number of an iteration to calculate end moments in subroutine GRALD

L Number used to indicate the potential plastic hinge location or the plastic hinge location. The left end of a beam at a level is numbered 1, the right end of the beam 2 and an interior point of the beam 3. The bottom of the left column of the beam below that level is numbered 4, the top of the column 5 and an interior point of the column 6. Third subscript for the quantities pertaining to that potential plastic hinge location or that plastic hinge location.

LA Fixed point variable used to indicate whether the effect of axial shortening of columns is considered or not

LC An index used to indicate the potential plastic hinge location where the prediction is taken

LD Fixed point variable used to indicate whether the iteration of prediction is required or not

LR Fixed point variable used to indicate whether the effect of hinge reversals is considered or not

M Level number, numbered from the top. First subscript for the quantities pertaining to that level and story just below that level

MAXP Fixed point variable used to indicate whether the maximum lateral load is passed or not

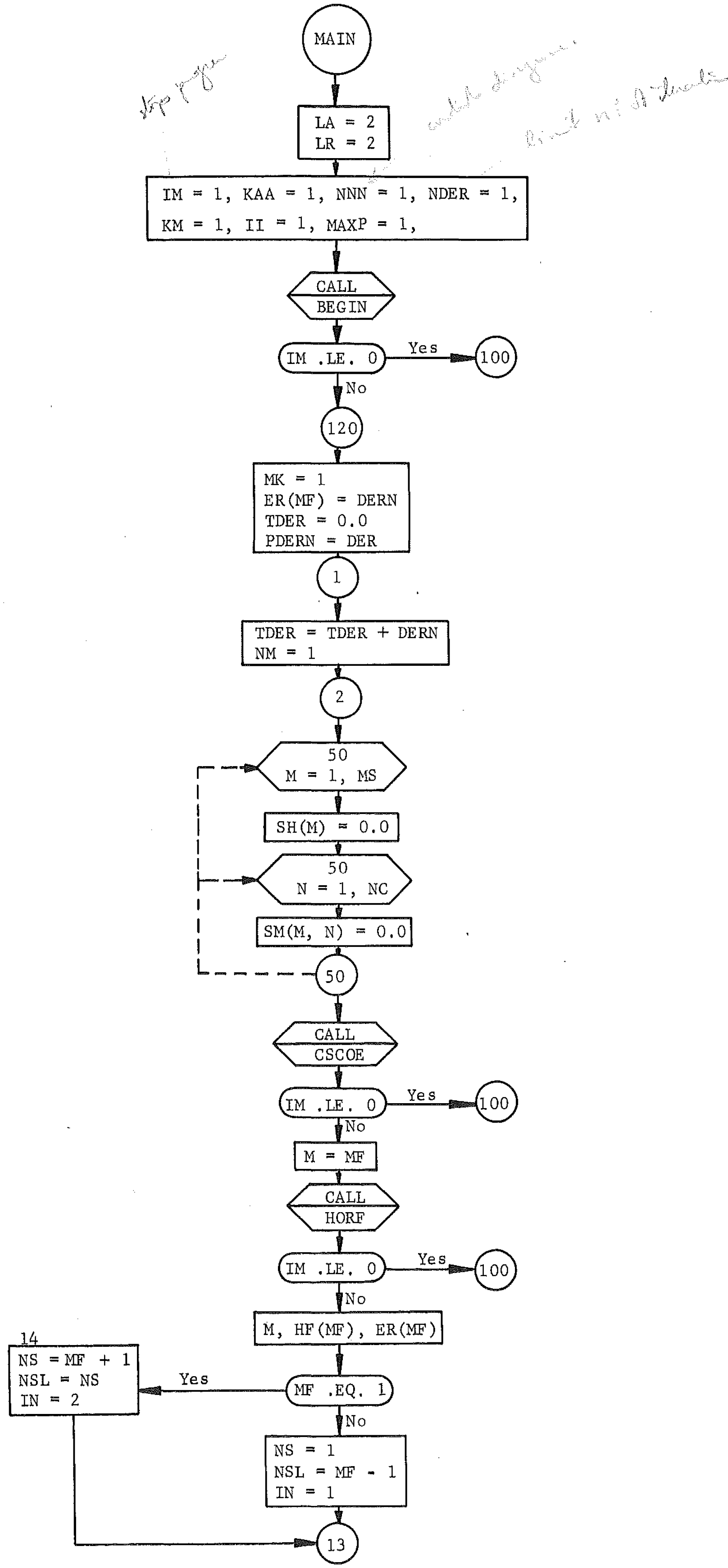
MC	An index used to indicate a level. In the story below that level, the prediction is taken
MF	Level number. At the story below that level, the sway deflection is incremented
MI	Fixed point variable number for a story
MK	Fixed point variable used to indicate the start of computation in a story
MPF	Level number. At the story below that level, the sway deflection was initially incremented
MS	Total number of stories
MT	Total number of levels
N	Bay number, numbered from the left. Second subscript for the quantities pertaining to that bay
NB	Total number of bays
NC	Total number of columns in a story
NDER	Fixed point variable used to limit the number of iterations for the convergence of prediction
NHR	Number of hinge reversals occurred in a sway increment
NM	Fixed point variable used to limit the number of iterations at the story whose sway deflection is incremented
NN	Fixed point variable used to limit the number of iterations at all stories except the story whose sway deflection is incremented
NNN	Fixed point variable used to stop the program if the solution diverges
NS	An index used to indicate the lower limit of an iteration in main program
NSL	An index used to indicate the upper limit of an iteration in main program
NSS	An index used to indicate the bay where the prediction is taken

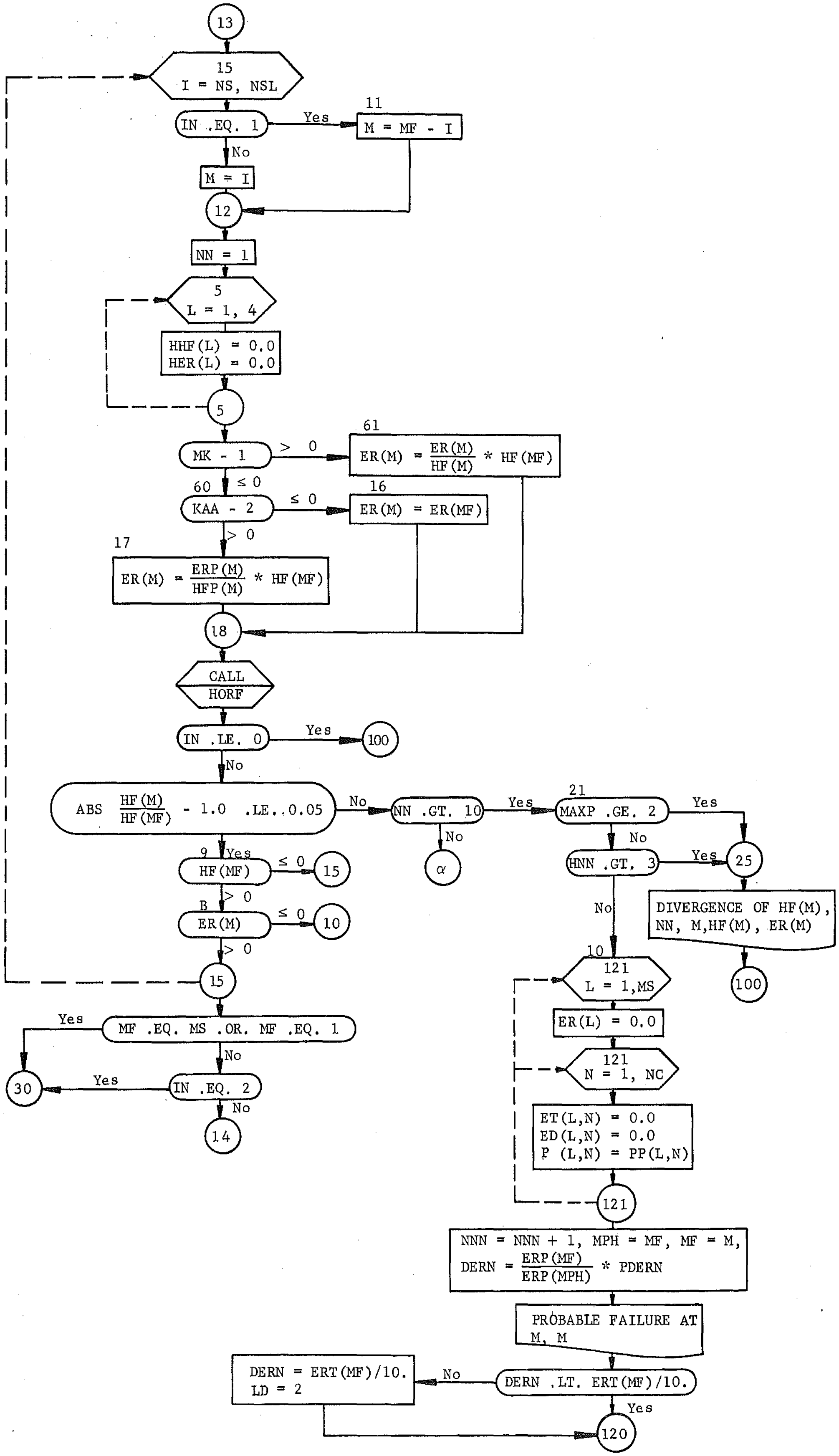
OK	Variables used in subroutine HINRE
P	Axial load in a column (kip)
PB	Concentrated gravity load applied on a beam (kip)
PC	Concentrated gravity load applied at a joint (kip)
PDERN	The initial sway increment adopted at the start of the current increment (*E/H) (k/in^2)
PHF	The lateral load increment at the previous sway increment (kip)
PHI	A variable used in calculating stiffness coefficients for a column
PHRO	Inelastic hinge rotation of a plastic hinge at the previous sway increment (*E) (k/in^2)
PI	Increment of axial load in a column (kip)
POPY	Axial load (P) nondimensionalized with axial yield load
PP	Axial load in a column at the previous sway increment (kip)
PRE	Lateral load increment required for a plastic hinge at a potential plastic hinge location (kip)
PRED	A subroutine subprogram
PT	Total axial load in columns in a story (kip)
PZ	A variable used in calculating axial loads
RAT	Ratio of stiffness coefficients in a column. Ratio of end moments.
RCP	Change of the reduced plastic moment from the value at the previous sway increment (kip-in)
RY	Effective moment of inertia factor
S	Width of a bay (in)
SA	Slope-deflection coefficient for moment at A due to rotation at B in a beam AB
SB	Slope-deflection coefficient for moment at B due to rotation at A in a beam AB

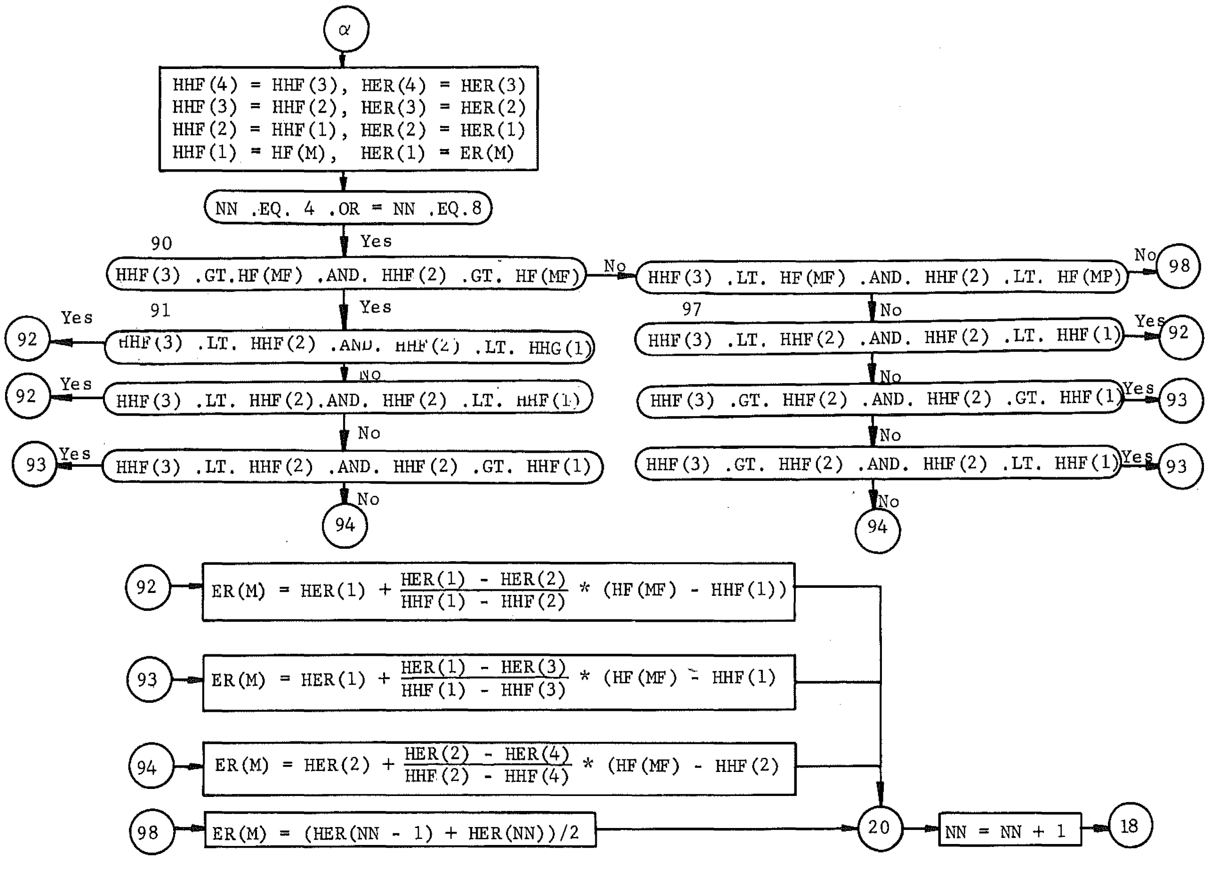
SBM	A variable used in calculating the maximum moment in a beam in subroutine ENMT
SH	Sum of the independent moments in all the columns of a story
SK	A variable used in subroutine CSCOE
SL	Slope-deflection coefficient for moment at L due to rotation at U in a column LU
SM	Sum of independent moments at the ends of the members framing into one joint
SMA	The smallest lateral load increment required for the next plastic hinge (kip)
SMAL	A variable used to select the smallest lateral load increment for the next hinge
SMC	A variable used in subroutine CSCOE
SMS	A variable used in subroutine CSCOE
SSCT	A variable used in subroutine HORF
SU	Slope-deflection coefficient for moment at U due to rotation at L in a column LU
SX	Stiffness coefficient for a part of a column in plastic hinge combination (2)
SY	Stiffness coefficient for a part of a column in plastic hinge combination (2)
TA	A variable used in subroutine PRED
TDER	Total lateral deflection taken at each iteration for convergence of prediction (*E/H)(k/in^2)
TGLF	Total load factor for the gravity loads at a gravity load increment
THK,TK, TO,TON, TT,TTH	Variables used in subroutines CSCOE and HINRE
TOE	Fixed end moment in a beam due to vertical deflection of joints (k/in^2)

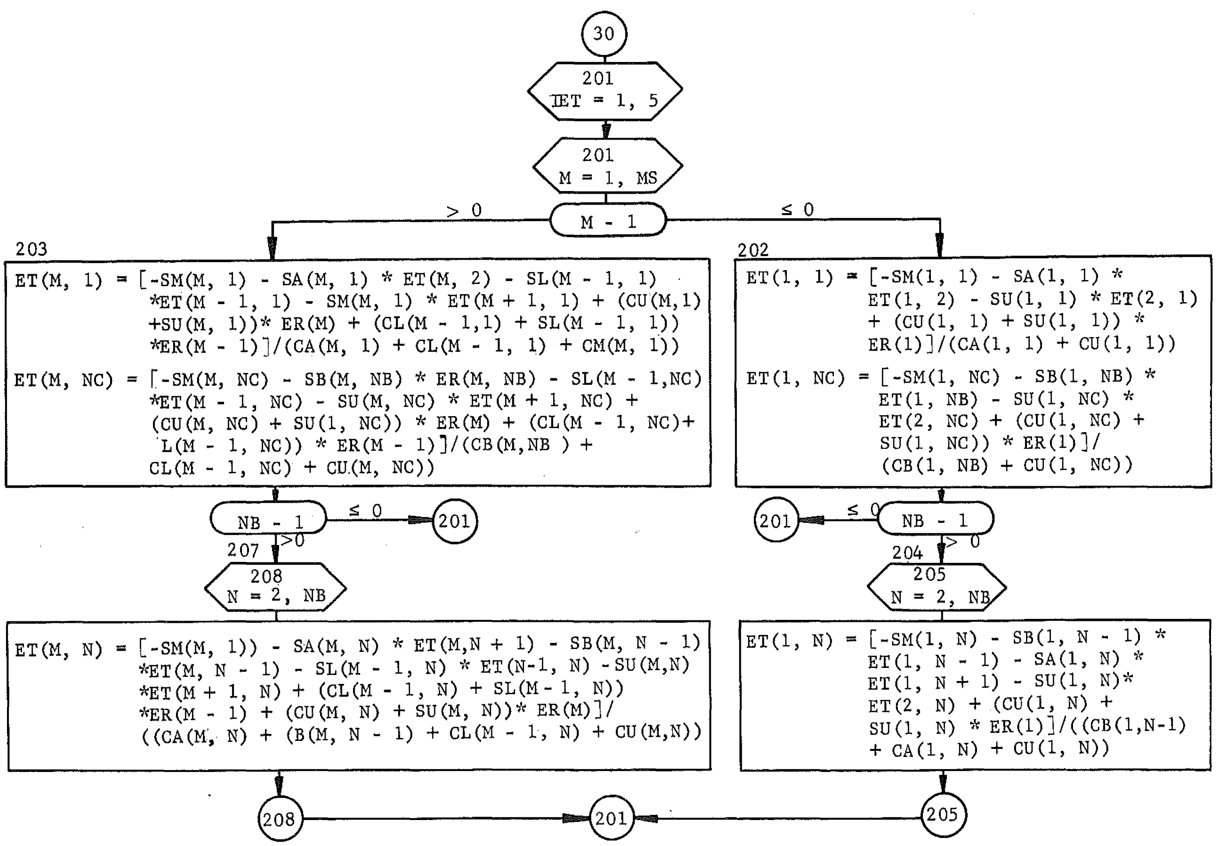
TOH	Total height of frame (in)
WH	Lateral load index
X	Distance from the end A to the maximum positive moment point in a beam (in)
XC	Distance from the end L to the maximum moment point in a column (in)
XE,XF,XO, XS,XT	Variables used in calculating inelastic hinge rotation in subroutine HINRE
XY	A variable used in calculating slope-deflection coefficient for a beam
XZ	A variable used in calculating the distance from the end L to the maximum moment point in a column
Y	Complement of X (in)
YC	Complement of XC (in)
Z	A variable used to indicate XC or YC in calculating stiffness coefficient for a part of a column
ZK	A variable used to indicate whether the maximum moment occurs at an end or an interior point in a column

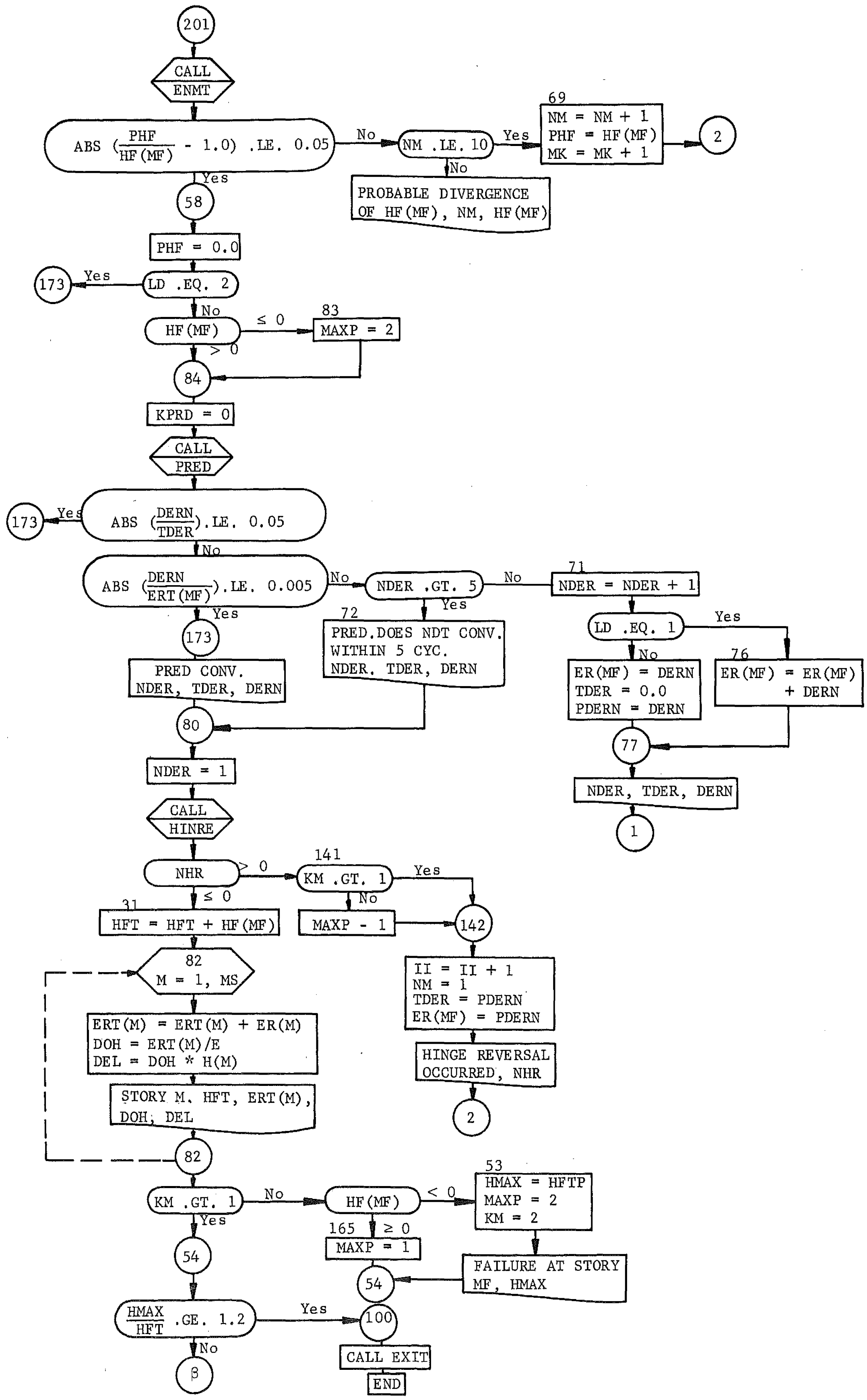
7. APPENDIX III - FLOW CHARTS

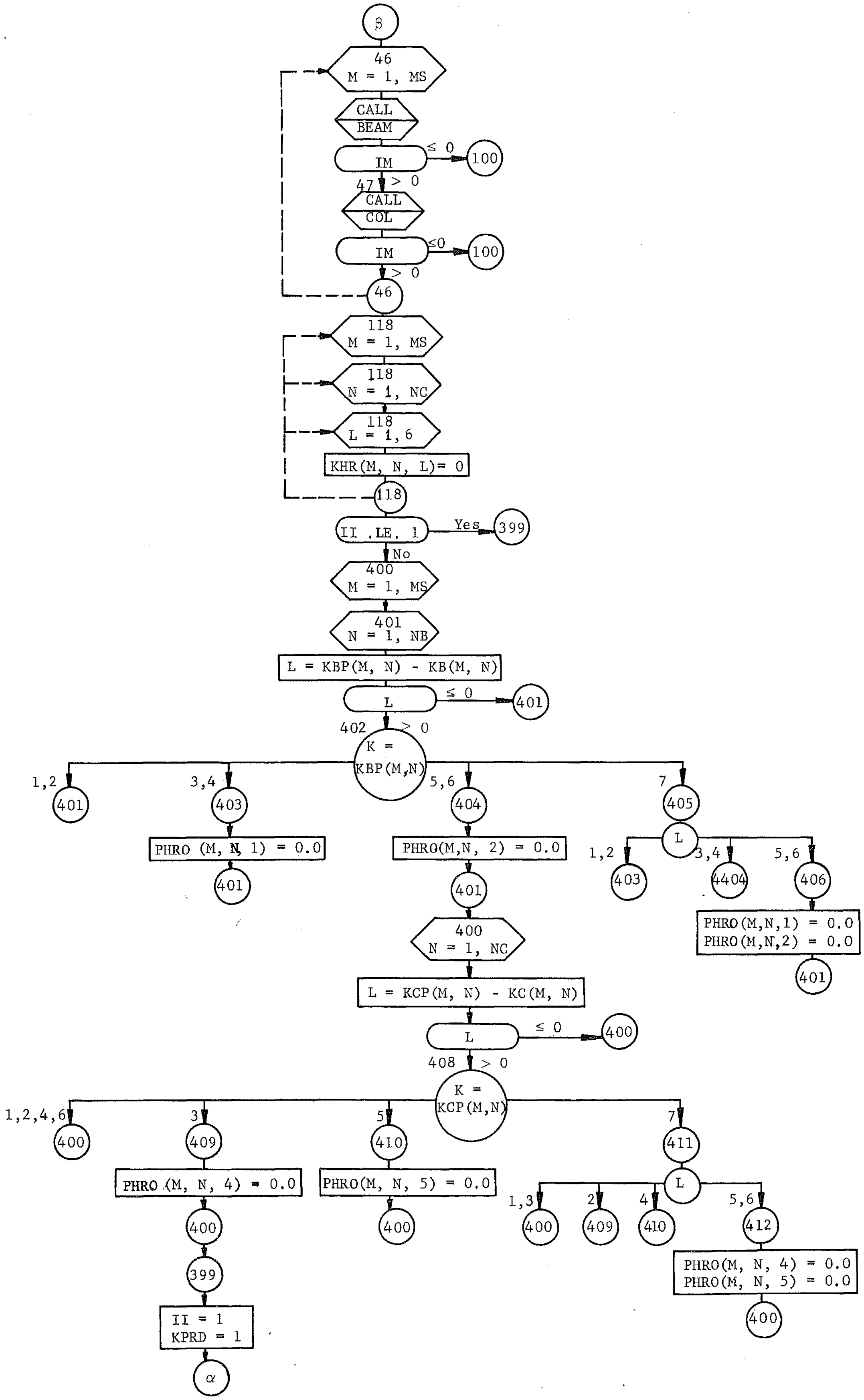

MAIN
LA = 2
LR = 2
IM = 1, KAA = 1, NNN = 1, NDER = 1,
KM = 1, II = 1, MAXP = 1,
CALL
BEGIN
IM .LE. 0
Yes
100
No
120
MK = 1
ER(MF) = DERN
TDER = 0.0
PDERN = DER
1
TDER = TDER + DERN
NM = 1
2
50
M = 1, MS
SH(M) = 0.0
50
N = 1, NC
SM(M, N) = 0.0
50
CALL
CSCOE
IM .LE. 0
Yes
100
No
M = MF
CALL
HORF
IM .LE. 0
Yes
100
No
M, HF(MF), ER(MF)
MF .EQ. 1
Yes
14
NS = MF + 1
NSL = NS
IN = 2
No
NS = 1
NSL = MF - 1
IN = 1
13

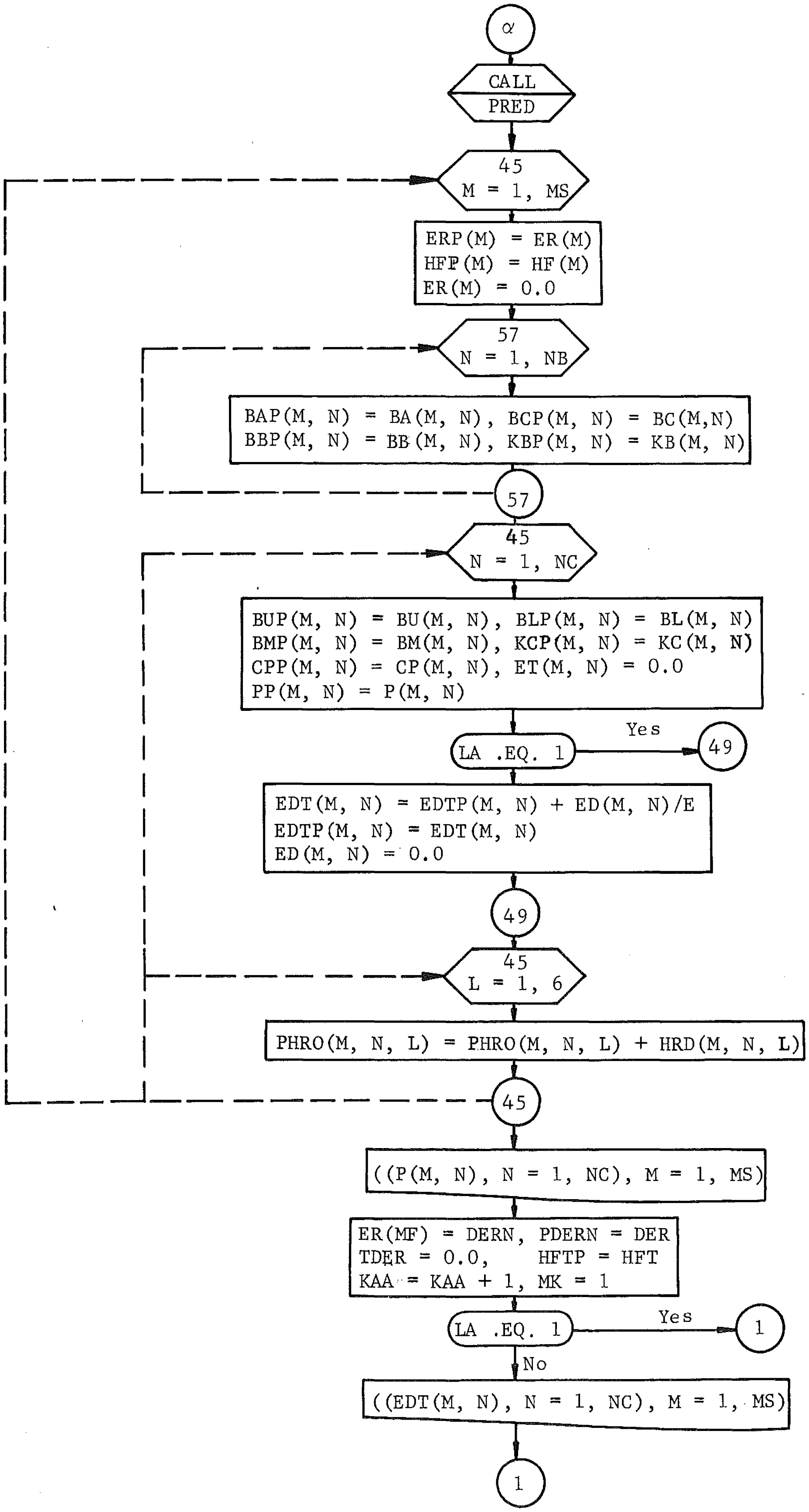

13
15
I = NS, NSL
IN .EQ. 1
Yes
11
M = MF - I
No
M = I
12
NN = 1
5
L = 1, 4
HHF(L) = 0.0
HER(L) = 0.0
5
61
MK - 1
> 0
ER(M) = ER(M)/HF(M) * HF(MF)
≤ 0
60
KAA - 2
≤ 0
16
ER(M) = ER(MF)
> 0
17
ER(M) = ERP(M)/HFP(M) * HF(MF)
18
CALL
HORF
IN .LE. 0
Yes
100
No
ABS HF(M)/HF(MF) - 1.0 .LE. 0.05
No
NN .GT. 10
Yes
21
MAXP .GE. 2
Yes
No
α
No
HNN .GT. 3
Yes
25
DIVERGENCE OF HF(M), NN, M,HF(M), ER(M)
100
9
Yes
HF(MF)
≤ 0
15
> 0
B
ER(M)
≤ 0
10
> 0
15
No
10
121
L = 1,MS
ER(L) = 0.0
121
N = 1, NC
ET(L,N) = 0.0
ED(L,N) = 0.0
P (L,N) = PP(L,N)
121
Yes
MF .EQ. MS .OR. MF .EQ. 1
No
30
Yes
IN .EQ. 2
No
14
NNN = NNN + 1, MPH = MF, MF = M,
DERN = ERP(MF)/ERP(MPH) * PDERN
PROBABLE FAILURE AT M, M
DERN = ERT(MF)/10.
LD = 2
No
DERN .LT. ERT(MF)/10.
Yes
120

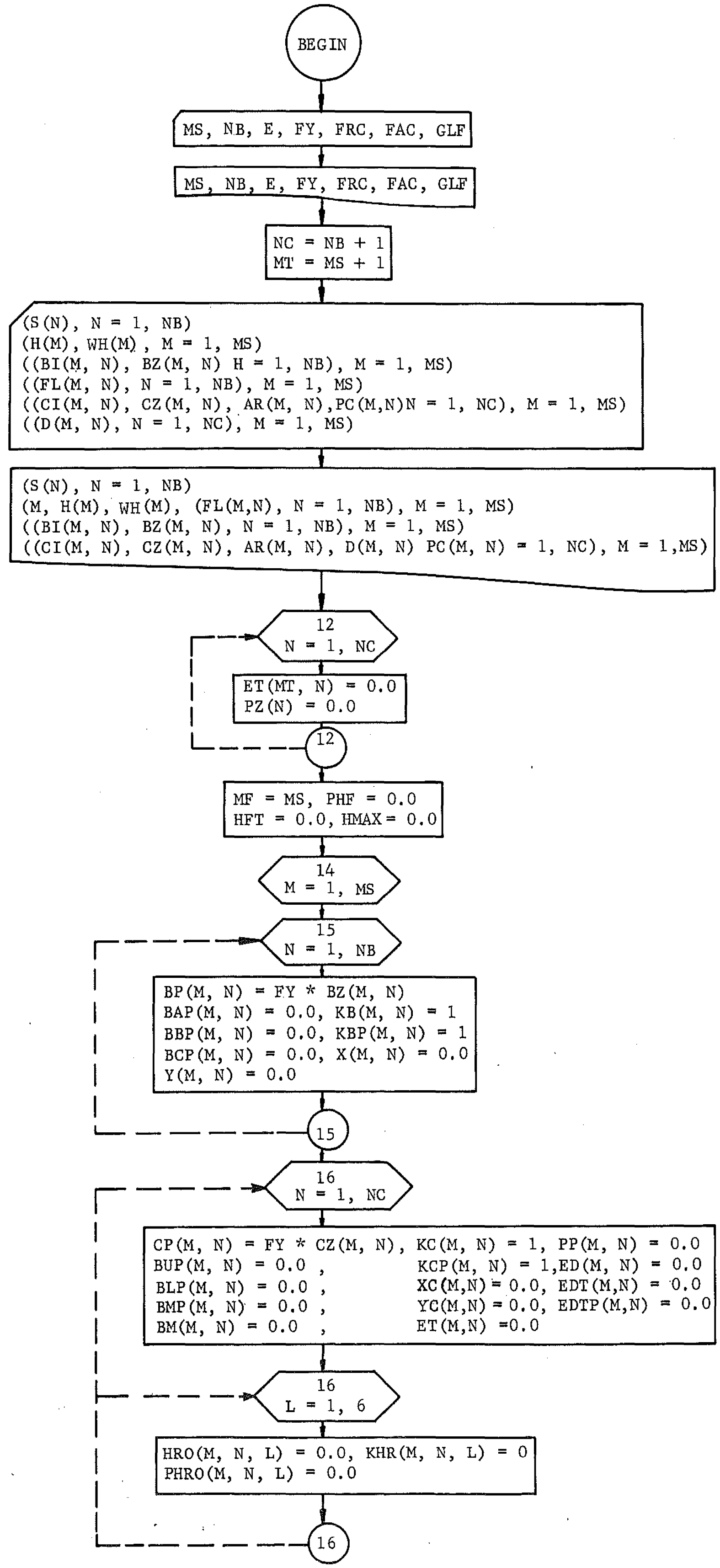

α
HHF(4) = HHF(3), HER(4) = HER(3)
HHF(3) = HHF(2), HER(3) = HER(2)
HHF(2) = HHF(1), HER(2) = HER(1)
HHF(1) = HF(M), HER(1) = ER(M)
NN .EQ. 4 .OR = NN .EQ.8
Yes
90
HHF(3) .GT.HF(MF) .AND. HHF(2) .GT. HF(MF)
No
HHF(3) .LT. HF(MF) .AND. HHF(2) .LT. HF(MP)
No
98
91
Yes
97
No
92
Yes
HHF(3) .LT. HHF(2) .AND. HHF(2) .LT. HHG(1)
HHF(3) .LT. HHF(2) .AND. HHF(2) .LT. HHF(1)
Yes
92
No
92
Yes
HHF(3) .LT. HHF(2).AND. HHF(2) .LT. HHF(1)
HHF(3) .GT. HHF(2) .AND. HHF(2) .GT. HHF(1)
Yes
93
No
No
93
Yes
HHF(3) .LT. HHF(2) .AND. HHF(2) .GT. HHF(1)
HHF(3) .GT. HHF(2) .AND. HHF(2) .LT. HHF(1)
Yes
93
No
94
No
94
92
ER(M) = HER(1) + (HER(1) - HER(2))/(HHF(1) - HHF(2)) * (HF(MF) - HHF(1))
93
ER(M) = HER(1) + (HER(1) - HER(3))/(HHF(1) - HHF(3)) * (HF(MF) - HHF(1)
94
ER(M) = HER(2) + (HER(2) - HER(4))/(HHF(2) - HHF(4)) * (HF(MF) - HHF(2)
98
ER(M) = (HER(NN - 1) + HER(NN))/2
20
NN = NN + 1
18

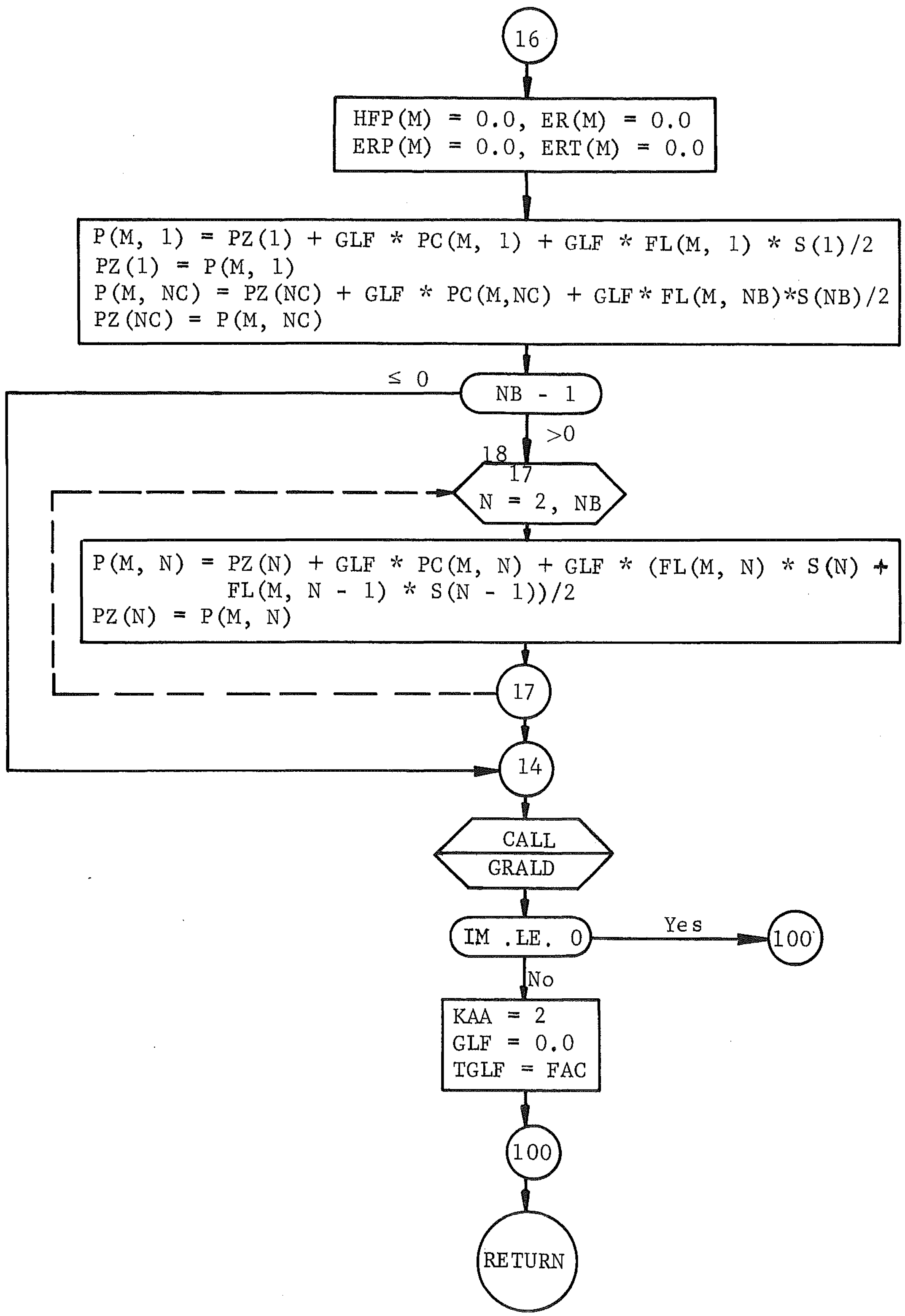

30
201
IET = 1, 5
201
M = 1, MS
> 0
M - 1
≤ 0
203
ET(M, 1) = [-SM(M, 1) - SA(M, 1) * ET(M, 2) - SL(M - 1, 1)
*ET(M - 1, 1) - SM(M, 1) * ET(M + 1, 1) + (CU(M,1)
+SU(M, 1))* ER(M) + (CL(M - 1,1) + SL(M - 1, 1))
*ER(M - 1)]/(CA(M, 1) + CL(M - 1, 1) + CM(M, 1))
ET(M, NC) = [-SM(M, NC) - SB(M, NB) * ER(M, NB) - SL(M - 1,NC)
*ET(M - 1, NC) - SU(M, NC) * ET(M + 1, NC) +
(CU(M, NC) + SU(1, NC)) * ER(M) + (CL(M - 1, NC)+
L(M - 1, NC)) * ER(M - 1)]/(CB(M,NB) +
CL(M - 1, NC) + CU(M, NC))
202
ET(1, 1) = [-SM(1, 1) - SA(1, 1) *
ET(1, 2) - SU(1, 1) * ET(2, 1)
+ (CU(1, 1) + SU(1, 1)) *
ER(1)]/(CA(1, 1) + CU(1, 1))
ET(1, NC) = [-SM(1, NC) - SB(1, NB) *
ET(1, NB) - SU(1, NC) *
ET(2, NC) + (CU(1, NC) +
SU(1, NC)) * ER(1)]/
(CB(1, NB) + CU(1, NC))
NB - 1
≤ 0
201
>0
207
208
N = 2, NB
201
≤ 0
NB - 1
> 0
204
205
N = 2, NB
ET(M, N) = [-SM(M, 1)) - SA(M, N) * ET(M,N + 1) - SB(M, N - 1)
*ET(M, N - 1) - SL(M - 1, N) * ET(N-1, N) -SU(M,N)
*ET(M + 1, N) + (CL(M - 1, N) + SL(M-1, N))
ER(M - 1) + (CU(M, N) + SU(M, N)) ER(M)]/
((CA(M, N) + (B(M, N - 1) + CL(M - 1, N) + CU(M,N))
ET(1, N) = [-SM(1, N) - SB(1, N - 1) *
ET(1, N - 1) - SA(1, N) *
ET(1, N + 1) - SU(1, N)*
ET(2, N) + (CU(1, N) +
SU(1, N) * ER(1)]/((CB(1,N-1)
+ CA(1, N) + CU(1, N))
208
201
205

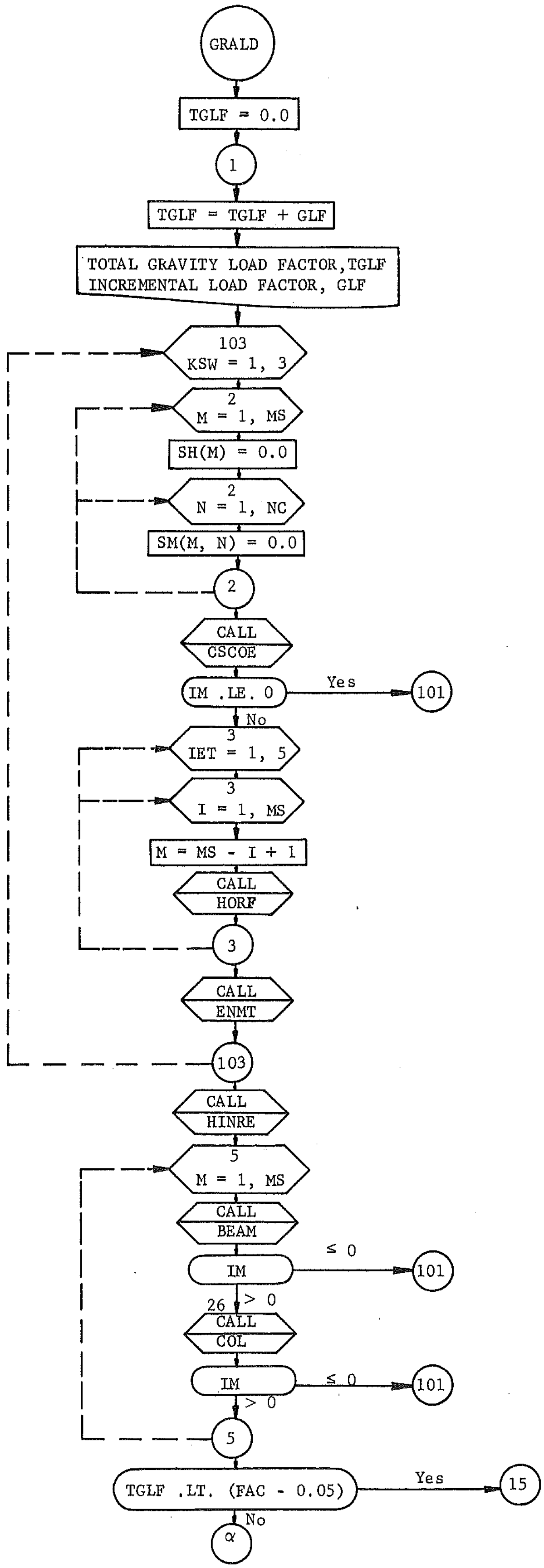

201
CALL ENMT
ABS (PHF / HF(MF) - 1.0) .LE. 0.05
No
NM .LE. 10
Yes
69
NM = NM + 1
PHF = HF(MF)
MK = MK + 1
2
No
PROBABLE DIVERGENCE OF HF(MF), NM, HF(MF)
Yes
58
PHF = 0.0
173
Yes
LD .EQ. 2
No
HF(MF)
≤ 0
83
MAXP = 2
> 0
84
KPRD = 0
CALL PRED
173
Yes
ABS (DERN / TDER) .LE. 0.05
No
ABS (DERN / ERT(MF)) .LE. 0.005
No
NDER .GT. 5
No
71
NDER = NDER + 1
Yes
72
PRED.DOES NOT CONV. WITHIN 5 CYC. NDER, TDER, DERN
LD .EQ. 1
Yes
No
ER(MF) = DERN
TDER = 0.0
PDERN = DERN
76
ER(MF) = ER(MF) + DERN
77
NDER, TDER, DERN
1
Yes
173
PRED CONV. NDER, TDER, DERN
80
NDER = 1
CALL HINRE
NHR
> 0
141
KM .GT. 1
Yes
No
MAXP - 1
142
II = II + 1
NM = 1
TDER = PDERN
ER(MF) = PDERN
HINGE REVERSAL OCCURRED, NHR
2
≤ 0
31
HFT = HFT + HF(MF)
82
M = 1, MS
ERT(M) = ERT(M) + ER(M)
DOH = ERT(M)/E
DEL = DOH * H(M)
STORY M, HFT, ERT(M), DOH, DEL
82
KM .GT. 1
No
HF(MF)
< 0
53
HMAX = HFTP
MAXP = 2
KM = 2
FAILURE AT STORY MF, HMAX
165
≥ 0
MAXP = 1
54
Yes
54
HMAX / HFT .GE. 1.2
Yes
100
CALL EXIT
END
No
β

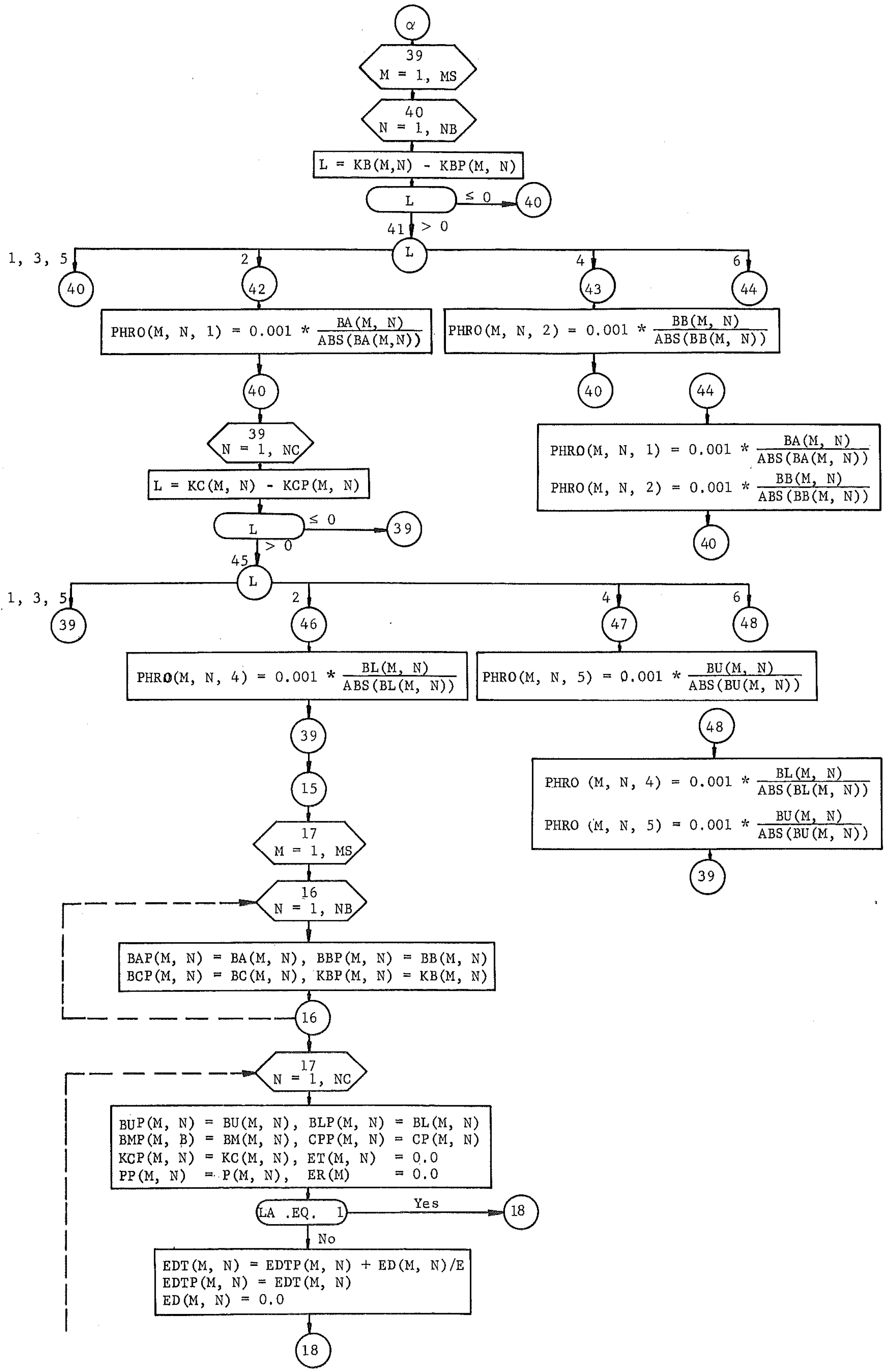

β
46
M = 1, MS
CALL
BEAM
IM
≤ 0
100
47
> 0
CALL
COL
IM
≤0
100
> 0
46
118
M = 1, MS
118
N = 1, NC
118
L = 1, 6
KHR(M, N, L)= 0
118
II .LE. 1
Yes
399
No
400
M = 1, MS
401
N = 1, NB
L = KBP(M, N) - KB(M, N)
L
≤ 0
401
402
> 0
K =
KBP(M,N)
1,2
401
3,4
403
PHRO (M, N, 1) = 0.0
401
5,6
404
PHRO(M,N, 2) = 0.0
401
400
N = 1, NC
L = KCP(M, N) - KC(M, N)
L
≤ 0
400
408
> 0
K =
KCP(M,N)
7
405
L
1,2
403
3,4
4404
5,6
406
PHRO(M,N,1) = 0.0
PHRO(M,N,2) = 0.0
401
1,2,4,6
400
3
409
PHRO (M, N, 4) = 0.0
400
399
II = 1
KPRD = 1
α
5
410
PHRO(M, N, 5) = 0.0
400
7
411
L
1,3
400
2
409
4
410
5,6
412
PHRO(M, N, 4) = 0.0
PHRO(M, N, 5) = 0.0
400

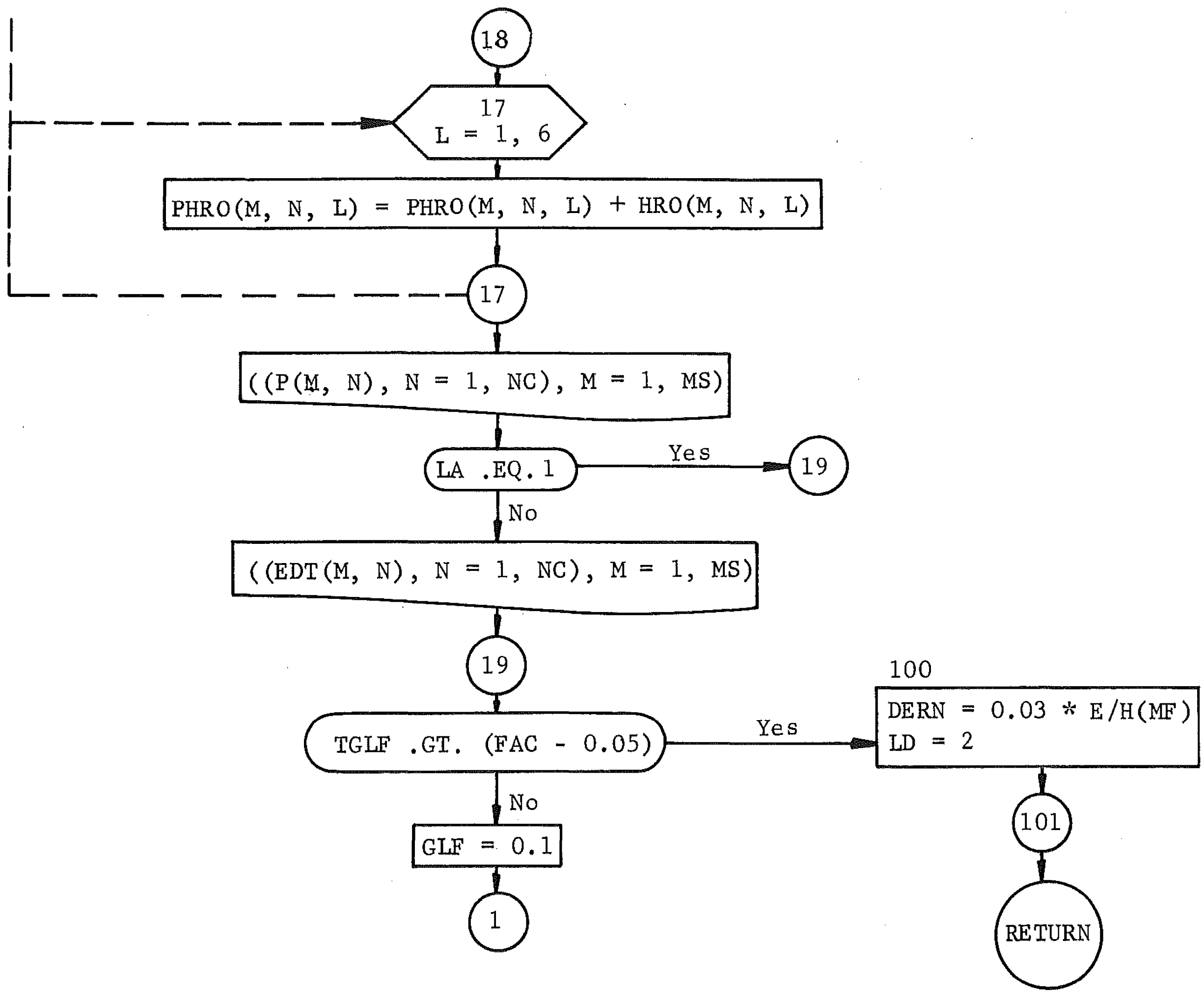

α
CALL
PRED
45
M = 1, MS
ERP(M) = ER(M)
HFP(M) = HF(M)
ER(M) = 0.0
57
N = 1, NB
BAP(M, N) = BA(M, N), BCP(M, N) = BC(M,N)
BBP(M, N) = BB(M, N), KBP(M, N) = KB(M, N)
57
45
N = 1, NC
BUP(M, N) = BU(M, N), BLP(M, N) = BL(M, N)
BMP(M, N) = BM(M, N), KCP(M, N) = KC(M, N)
CPP(M, N) = CP(M, N), ET(M, N) = 0.0
PP(M, N) = P(M, N)
LA .EQ. 1
Yes
49
EDT(M, N) = EDTP(M, N) + ED(M, N)/E
EDTP(M, N) = EDT(M, N)
ED(M, N) = 0.0
49
45
L = 1, 6
PHRO(M, N, L) = PHRO(M, N, L) + HRD(M, N, L)
45
((P(M, N), N = 1, NC), M = 1, MS)
ER(MF) = DERN, PDERN = DER
TDER = 0.0, HFTP = HFT
KAA = KAA + 1, MK = 1
LA .EQ. 1
Yes
1
No
((EDT(M, N), N = 1, NC), M = 1, MS)
1

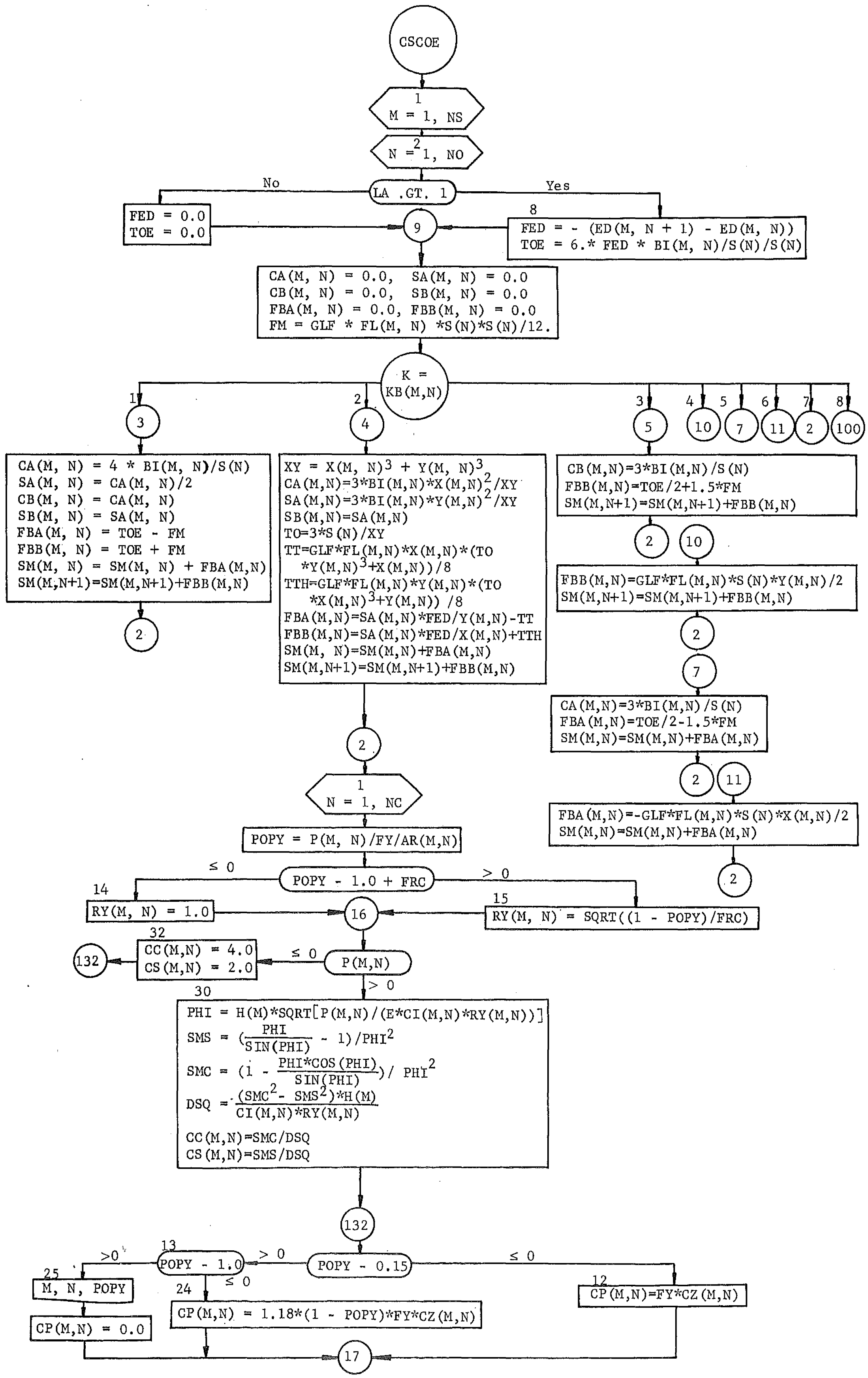

BEGIN
MS, NB, E, FY, FRC, FAC, GLF
MS, NB, E, FY, FRC, FAC, GLF
NC = NB + 1
MT = MS + 1
(S(N), N = 1, NB)
(H(M), WH(M), M = 1, MS)
((BI(M, N), BZ(M, N) H = 1, NB), M = 1, MS)
((FL(M, N), N = 1, NB), M = 1, MS)
((CI(M, N), CZ(M, N), AR(M, N),PC(M,N)N = 1, NC), M = 1, MS)
((D(M, N), N = 1, NC), M = 1, MS)
(S(N), N = 1, NB)
(M, H(M), WH(M), (FL(M,N), N = 1, NB), M = 1, MS)
((BI(M, N), BZ(M, N), N = 1, NB), M = 1, MS)
((CI(M, N), CZ(M, N), AR(M, N), D(M, N) PC(M, N) = 1, NC), M = 1,MS)
12
N = 1, NC
ET(MT, N) = 0.0
PZ(N) = 0.0
12
MF = MS, PHF = 0.0
HFT = 0.0, HMAX = 0.0
14
M = 1, MS
15
N = 1, NB
BP(M, N) = FY * BZ(M, N)
BAP(M, N) = 0.0, KB(M, N) = 1
BBP(M, N) = 0.0, KBP(M, N) = 1
BCP(M, N) = 0.0, X(M, N) = 0.0
Y(M, N) = 0.0
15
16
N = 1, NC
CP(M, N) = FY * CZ(M, N), KC(M, N) = 1, PP(M, N) = 0.0
BUP(M, N) = 0.0 , KCP(M, N) = 1,ED(M, N) = 0.0
BLP(M, N) = 0.0 , XC(M,N) = 0.0, EDT(M,N) = 0.0
BMP(M, N) = 0.0 , YC(M,N) = 0.0, EDTP(M,N) = 0.0
BM(M, N) = 0.0 , ET(M,N) =0.0
16
L = 1, 6
HRO(M, N, L) = 0.0, KHR(M, N, L) = 0
PHRO(M, N, L) = 0.0
16

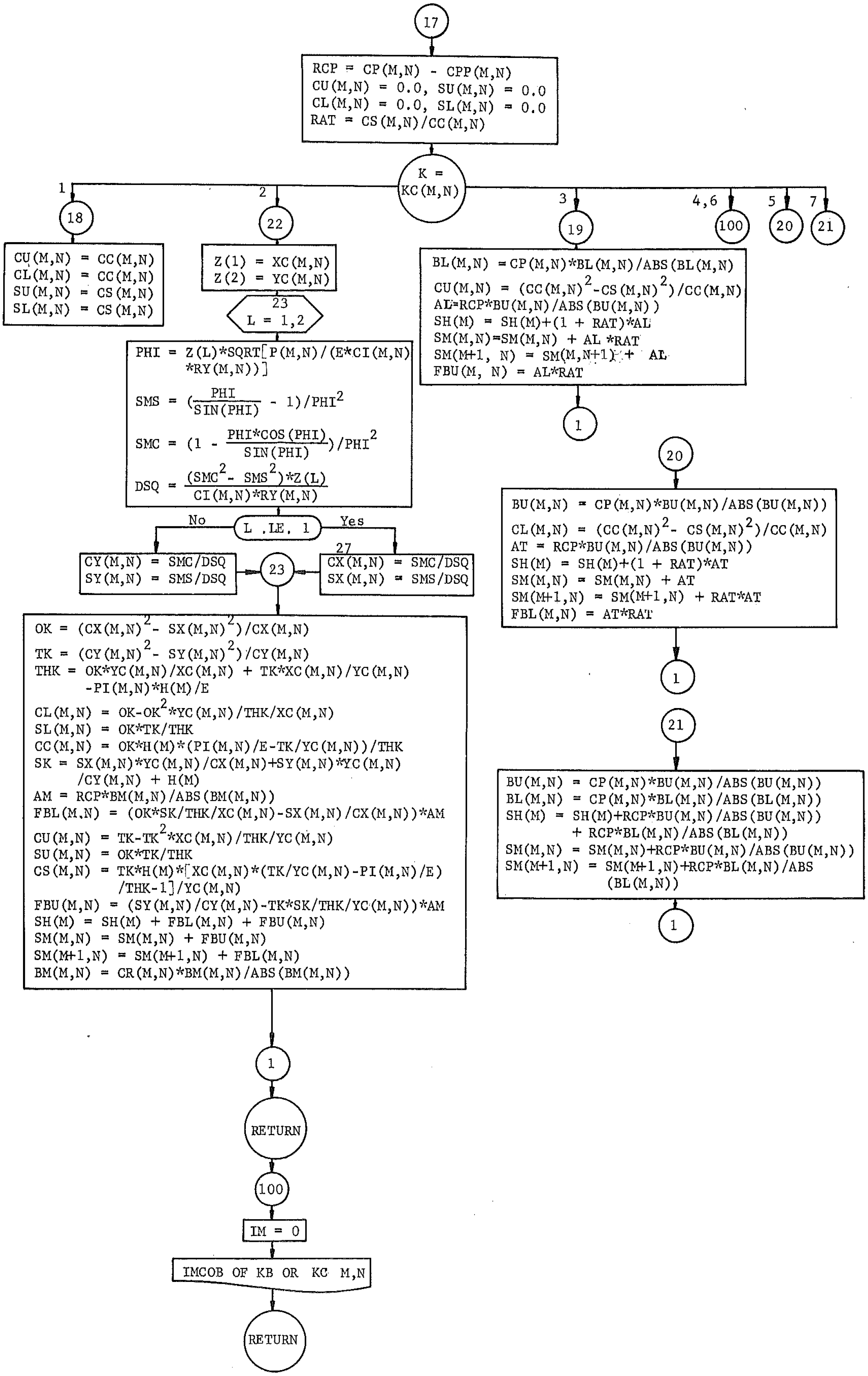

16
HFP(M) = 0.0, ER(M) = 0.0
ERP(M) = 0.0, ERT(M) = 0.0
P(M, 1) = PZ(1) + GLF * PC(M, 1) + GLF * FL(M, 1) * S(1)/2
PZ(1) = P(M, 1)
P(M, NC) = PZ(NC) + GLF * PC(M,NC) + GLF * FL(M, NB)*S(NB)/2
PZ(NC) = P(M, NC)
≤ 0
NB - 1
>0
18
17
N = 2, NB
P(M, N) = PZ(N) + GLF * PC(M, N) + GLF * (FL(M, N) * S(N) + FL(M, N - 1) * S(N - 1))/2
PZ(N) = P(M, N)
17
14
CALL
GRALD
IM .LE. 0
Yes
100
No
KAA = 2
GLF = 0.0
TGLF = FAC
100
RETURN

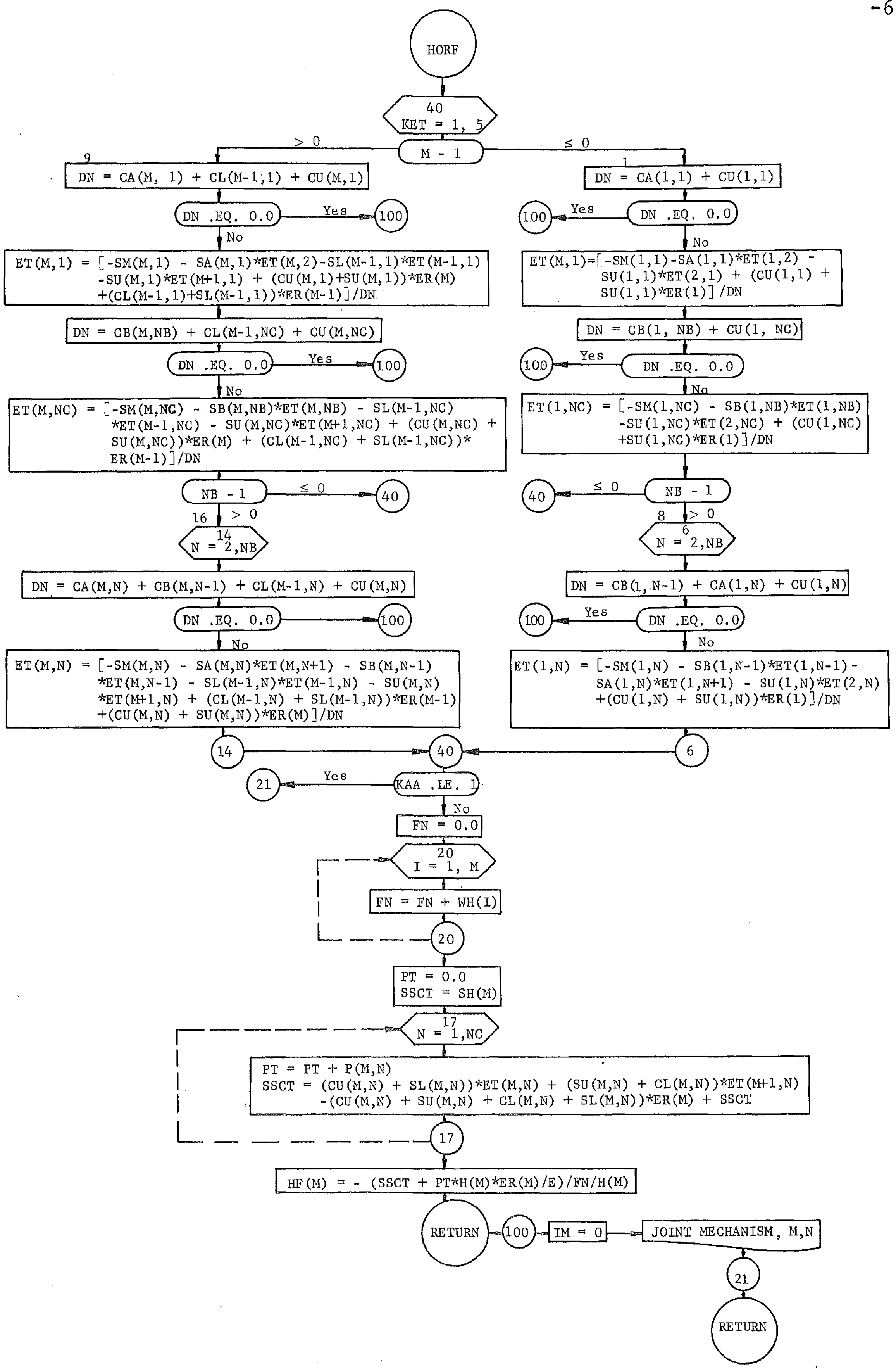

GRALD
TGLF = 0.0
1
TGLF = TGLF + GLF
TOTAL GRAVITY LOAD FACTOR, TGLF
INCREMENTAL LOAD FACTOR, GLF
103
KSW = 1, 3
2
M = 1, MS
SH(M) = 0.0
2
N = 1, NC
SM(M, N) = 0.0
2
CALL
CSCOE
IM .LE. 0
Yes
101
No
3
IET = 1, 5
3
I = 1, MS
M = MS - I + 1
CALL
HORF
3
CALL
ENMT
103
CALL
HINRE
5
M = 1, MS
CALL
BEAM
IM
≤ 0
101
> 0
26
CALL
COL
IM
≤ 0
101
> 0
5
TGLF .LT. (FAC - 0.05)
Yes
15
No
α


α
39
M = 1, MS
40
N = 1, NB
L = KB(M,N) - KBP(M, N)
L
≤ 0
40
41
> 0
L
1, 3, 5
2
4
6
40
42
43
44
PHRO(M, N, 1) = 0.001 * BA(M, N) / ABS(BA(M,N))
PHRO(M, N, 2) = 0.001 * BB(M, N) / ABS(BB(M, N))
40
40
44
PHRO(M, N, 1) = 0.001 * BA(M, N) / ABS(BA(M, N))
PHRO(M, N, 2) = 0.001 * BB(M, N) / ABS(BB(M, N))
40
39
N = 1, NC
L = KC(M, N) - KCP(M, N)
L
≤ 0
39
> 0
45
L
1, 3, 5
2
4
6
39
46
47
48
PHRO(M, N, 4) = 0.001 * BL(M, N) / ABS(BL(M, N))
PHRO(M, N, 5) = 0.001 * BU(M, N) / ABS(BU(M, N))
39
48
PHRO (M, N, 4) = 0.001 * BL(M, N) / ABS(BL(M, N))
PHRO (M, N, 5) = 0.001 * BU(M, N) / ABS(BU(M, N))
39
15
17
M = 1, MS
16
N = 1, NB
BAP(M, N) = BA(M, N), BBP(M, N) = BB(M, N)
BCP(M, N) = BC(M, N), KBP(M, N) = KB(M, N)
16
17
N = 1, NC
BUP(M, N) = BU(M, N), BLP(M, N) = BL(M, N)
BMP(M, B) = BM(M, N), CPP(M, N) = CP(M, N)
KCP(M, N) = KC(M, N), ET(M, N) = 0.0
PP(M, N) = P(M, N), ER(M) = 0.0
LA .EQ. 1
Yes
18
No
EDT(M, N) = EDTP(M, N) + ED(M, N)/E
EDTP(M, N) = EDT(M, N)
ED(M, N) = 0.0
18

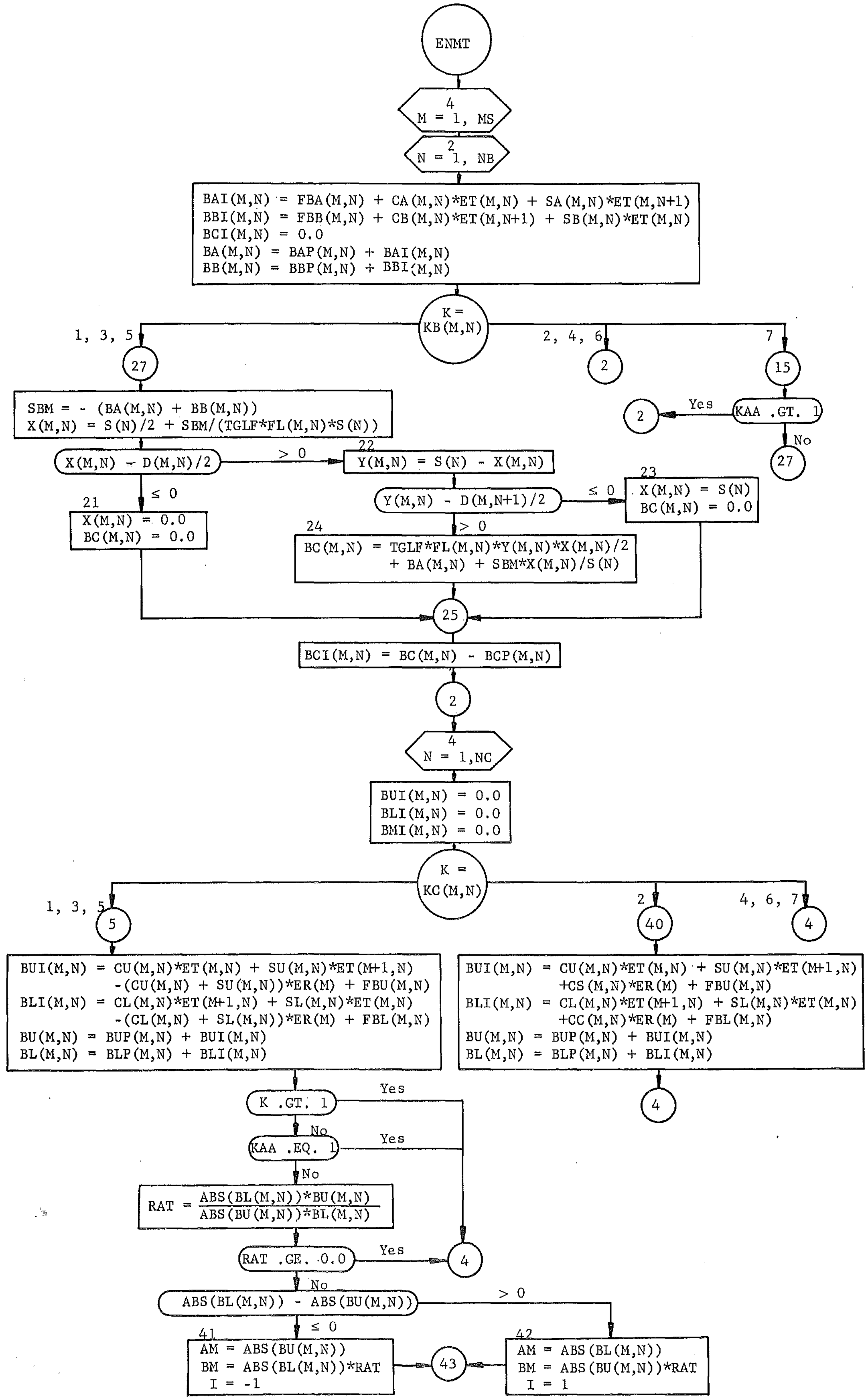

18
17
L = 1, 6
PHRO(M, N, L) = PHRO(M, N, L) + HRO(M, N, L)
17
((P(M, N), N = 1, NC), M = 1, MS)
LA .EQ. 1
Yes
19
No
((EDT(M, N), N = 1, NC), M = 1, MS)
19
TGLF .GT. (FAC - 0.05)
Yes
100
DERN = 0.03 * E/H(MF)
LD = 2
101
RETURN
No
GLF = 0.1
1

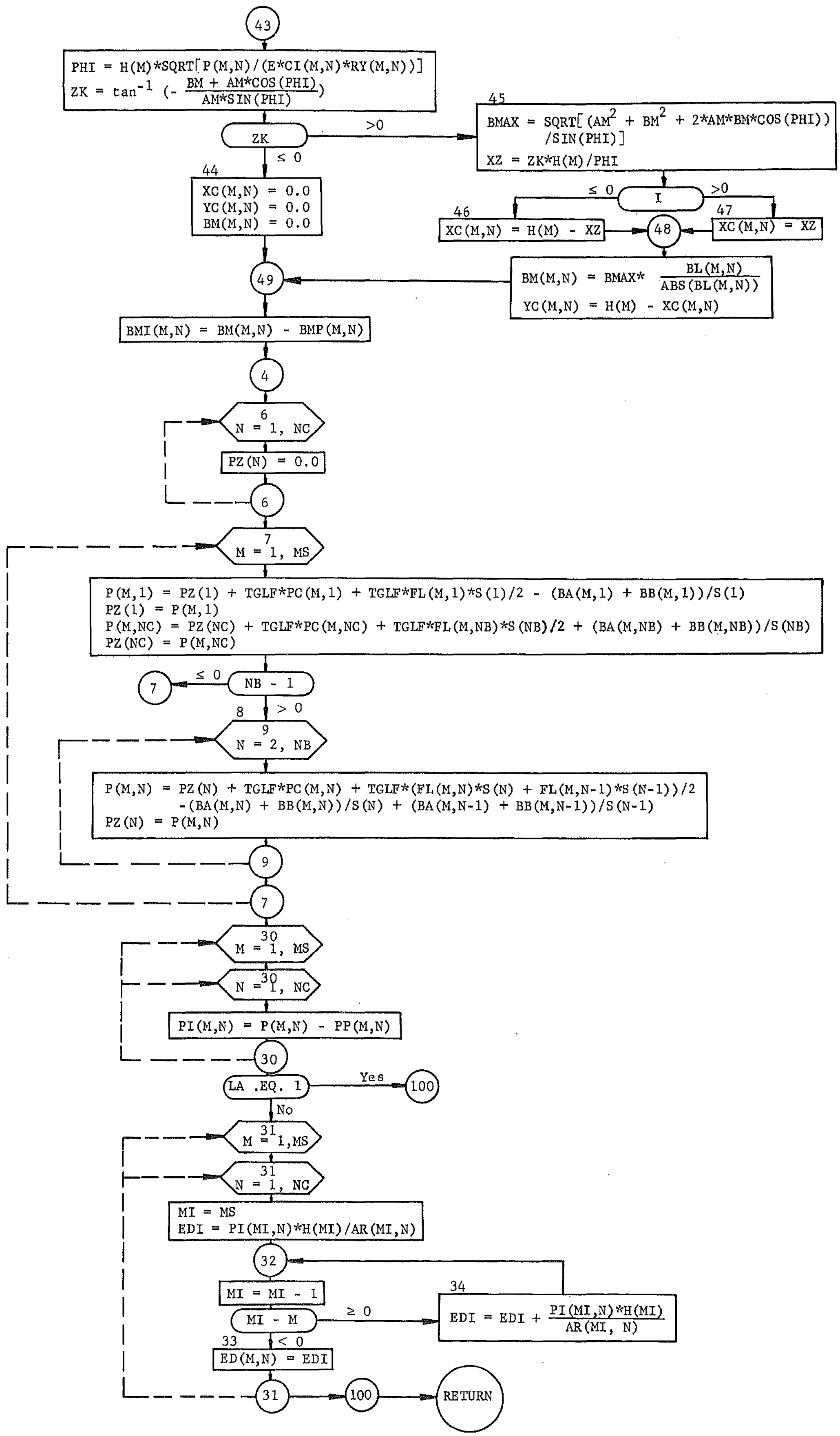

CSCOE
1
M = 1, NS
2
N = 1, NO
LA .GT. 1
No
Yes
FED = 0.0
TOE = 0.0
8
FED = - (ED(M, N + 1) - ED(M, N))
TOE = 6.* FED * BI(M, N)/S(N)/S(N)
9
CA(M, N) = 0.0, SA(M, N) = 0.0
CB(M, N) = 0.0, SB(M, N) = 0.0
FBA(M, N) = 0.0, FBB(M, N) = 0.0
FM = GLF * FL(M, N) *S(N)*S(N)/12.
K = KB(M,N)
1
2
3
4
5
6
7
8
3
4
5
10
7
11
2
100
CA(M, N) = 4 * BI(M, N)/S(N)
SA(M, N) = CA(M, N)/2
CB(M, N) = CA(M, N)
SB(M, N) = SA(M, N)
FBA(M, N) = TOE - FM
FBB(M, N) = TOE + FM
SM(M, N) = SM(M, N) + FBA(M,N)
SM(M,N+1)=SM(M,N+1)+FBB(M,N)
2
XY = X(M, N)3 + Y(M, N)3
CA(M,N)=3*BI(M,N)*X(M,N)2/XY
SA(M,N)=3*BI(M,N)*Y(M,N)2/XY
SB(M,N)=SA(M,N)
TO=3*S(N)/XY
TT=GLF*FL(M,N)*X(M,N)*(TO *Y(M,N)3+X(M,N))/8
TTH=GLF*FL(M,N)*Y(M,N)*(TO *X(M,N)3+Y(M,N)) /8
FBA(M,N)=SA(M,N)*FED/Y(M,N)-TT
FBB(M,N)=SA(M,N)*FED/X(M,N)+TTH
SM(M, N)=SM(M,N)+FBA(M,N)
SM(M,N+1)=SM(M,N+1)+FBB(M,N)
CB(M,N)=3*BI(M,N)/S(N)
FBB(M,N)=TOE/2+1.5*FM
SM(M,N+1)=SM(M,N+1)+FBB(M,N)
2
10
FBB(M,N)=GLF*FL(M,N)*S(N)*Y(M,N)/2
SM(M,N+1)=SM(M,N+1)+FBB(M,N)
2
7
CA(M,N)=3*BI(M,N)/S(N)
FBA(M,N)=TOE/2-1.5*FM
SM(M,N)=SM(M,N)+FBA(M,N)
2
11
FBA(M,N)=-GLF*FL(M,N)*S(N)*X(M,N)/2
SM(M,N)=SM(M,N)+FBA(M,N)
2
2
1
N = 1, NC
POPY = P(M, N)/FY/AR(M,N)
≤ 0
POPY - 1.0 + FRC
> 0
14
RY(M, N) = 1.0
16
15
RY(M, N) = SQRT((1 - POPY)/FRC)
32
CC(M,N) = 4.0
CS(M,N) = 2.0
132
≤ 0
P(M,N)
> 0
30
PHI = H(M)*SQRT[P(M,N)/(E*CI(M,N)*RY(M,N))]
SMS = (PHI/SIN(PHI) - 1)/PHI2
SMC = (1 - PHI*COS(PHI)/SIN(PHI))/ PHI2
DSQ = (SMC2- SMS2)*H(M) / CI(M,N)*RY(M,N)
CC(M,N)=SMC/DSQ
CS(M,N)=SMS/DSQ
132
13
POPY - 1.0
> 0
POPY - 0.15
≤ 0
>0
≤ 0
25
M, N, POPY
CP(M,N) = 0.0
24
CP(M,N) = 1.18*(1 - POPY)*FY*CZ(M,N)
12
CP(M,N)=FY*CZ(M,N)
17


17
RCP = CP(M,N) - CPP(M,N)
CU(M,N) = 0.0, SU(M,N) = 0.0
CL(M,N) = 0.0, SL(M,N) = 0.0
RAT = CS(M,N)/CC(M,N)
K = KC(M,N)
1
2
3
4,6
5
7
18
22
19
100
20
21
CU(M,N) = CC(M,N)
CL(M,N) = CC(M,N)
SU(M,N) = CS(M,N)
SL(M,N) = CS(M,N)
Z(1) = XC(M,N)
Z(2) = YC(M,N)
23
L = 1,2
PHI = Z(L)*SQRT[P(M,N)/(E*CI(M,N) *RY(M,N))]
SMS = (PHI/SIN(PHI) - 1)/PHI^2
SMC = (1 - PHI*COS(PHI)/SIN(PHI))/PHI^2
DSQ = (SMC^2 - SMS^2)*Z(L) / CI(M,N)*RY(M,N)
No
L .LE. 1
Yes
27
CY(M,N) = SMC/DSQ
SY(M,N) = SMS/DSQ
23
CX(M,N) = SMC/DSQ
SX(M,N) = SMS/DSQ
OK = (CX(M,N)^2 - SX(M,N)^2)/CX(M,N)
TK = (CY(M,N)^2 - SY(M,N)^2)/CY(M,N)
THK = OK*YC(M,N)/XC(M,N) + TK*XC(M,N)/YC(M,N)
-PI(M,N)*H(M)/E
CL(M,N) = OK-OK^2*YC(M,N)/THK/XC(M,N)
SL(M,N) = OK*TK/THK
CC(M,N) = OK*H(M)*(PI(M,N)/E-TK/YC(M,N))/THK
SK = SX(M,N)*YC(M,N)/CX(M,N)+SY(M,N)*YC(M,N)
/CY(M,N) + H(M)
AM = RCP*BM(M,N)/ABS(BM(M,N))
FBL(M,N) = (OK*SK/THK/XC(M,N)-SX(M,N)/CX(M,N))*AM
CU(M,N) = TK-TK^2*XC(M,N)/THK/YC(M,N)
SU(M,N) = OK*TK/THK
CS(M,N) = TK*H(M)*[XC(M,N)*(TK/YC(M,N)-PI(M,N)/E)
/THK-1]/YC(M,N)
FBU(M,N) = (SY(M,N)/CY(M,N)-TK*SK/THK/YC(M,N))*AM
SH(M) = SH(M) + FBL(M,N) + FBU(M,N)
SM(M,N) = SM(M,N) + FBU(M,N)
SM(M+1,N) = SM(M+1,N) + FBL(M,N)
BM(M,N) = CR(M,N)*BM(M,N)/ABS(BM(M,N))
1
RETURN
100
IM = 0
IMCOB OF KB OR KC M,N
RETURN
BL(M,N) = CP(M,N)*BL(M,N)/ABS(BL(M,N))
CU(M,N) = (CC(M,N)^2-CS(M,N)^2)/CC(M,N)
AL=RCP*BU(M,N)/ABS(BU(M,N))
SH(M) = SH(M)+(1 + RAT)*AL
SM(M,N)=SM(M,N) + AL *RAT
SM(M+1, N) = SM(M,N+1) + AL
FBU(M, N) = AL*RAT
1
20
BU(M,N) = CP(M,N)*BU(M,N)/ABS(BU(M,N))
CL(M,N) = (CC(M,N)^2- CS(M,N)^2)/CC(M,N)
AT = RCP*BU(M,N)/ABS(BU(M,N))
SH(M) = SH(M)+(1 + RAT)*AT
SM(M,N) = SM(M,N) + AT
SM(M+1,N) = SM(M+1,N) + RAT*AT
FBL(M,N) = AT*RAT
1
21
BU(M,N) = CP(M,N)*BU(M,N)/ABS(BU(M,N))
BL(M,N) = CP(M,N)*BL(M,N)/ABS(BL(M,N))
SH(M) = SH(M)+RCP*BU(M,N)/ABS(BU(M,N))
+ RCP*BL(M,N)/ABS(BL(M,N))
SM(M,N) = SM(M,N)+RCP*BU(M,N)/ABS(BU(M,N))
SM(M+1,N) = SM(M+1,N)+RCP*BL(M,N)/ABS
(BL(M,N))
1

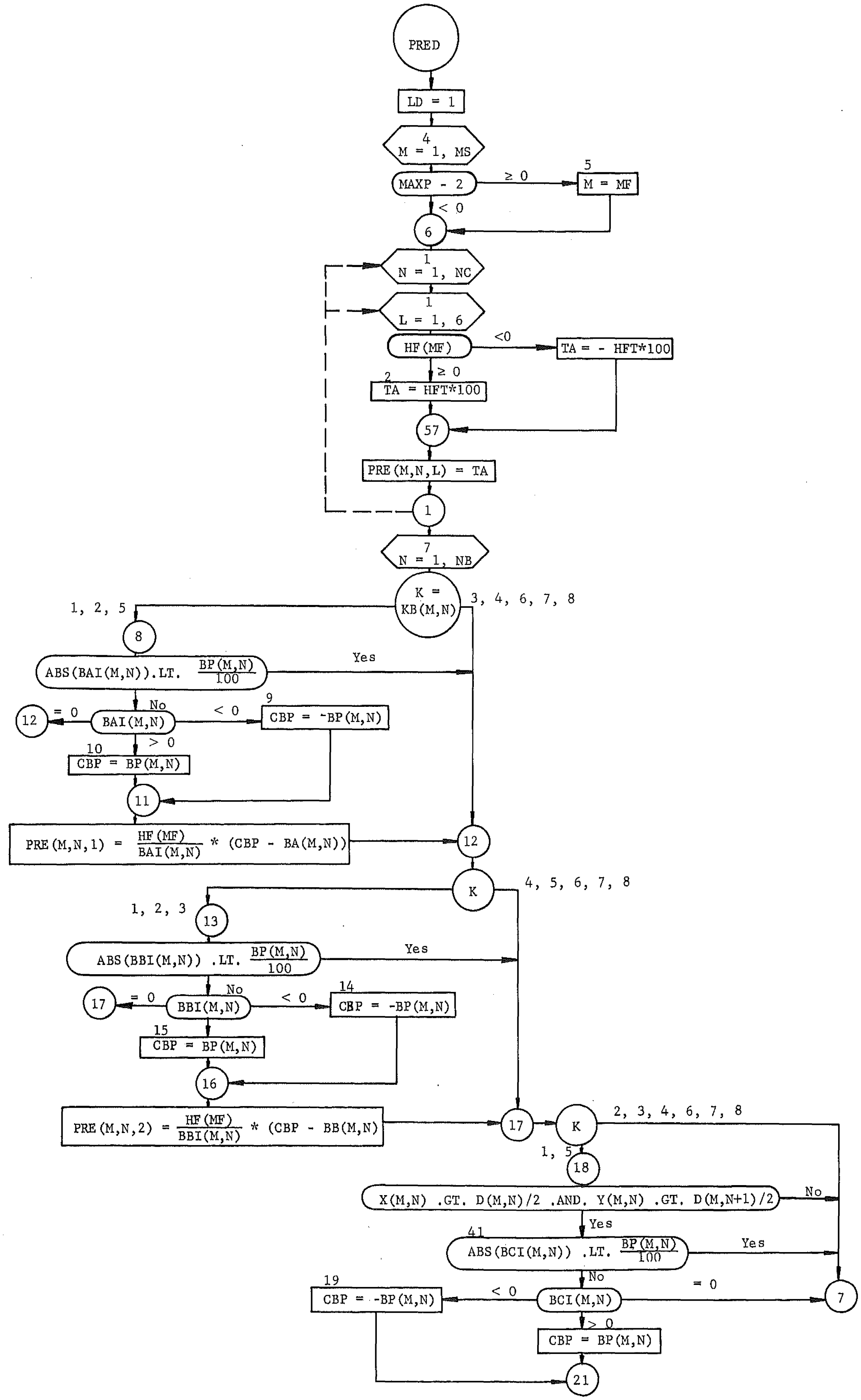


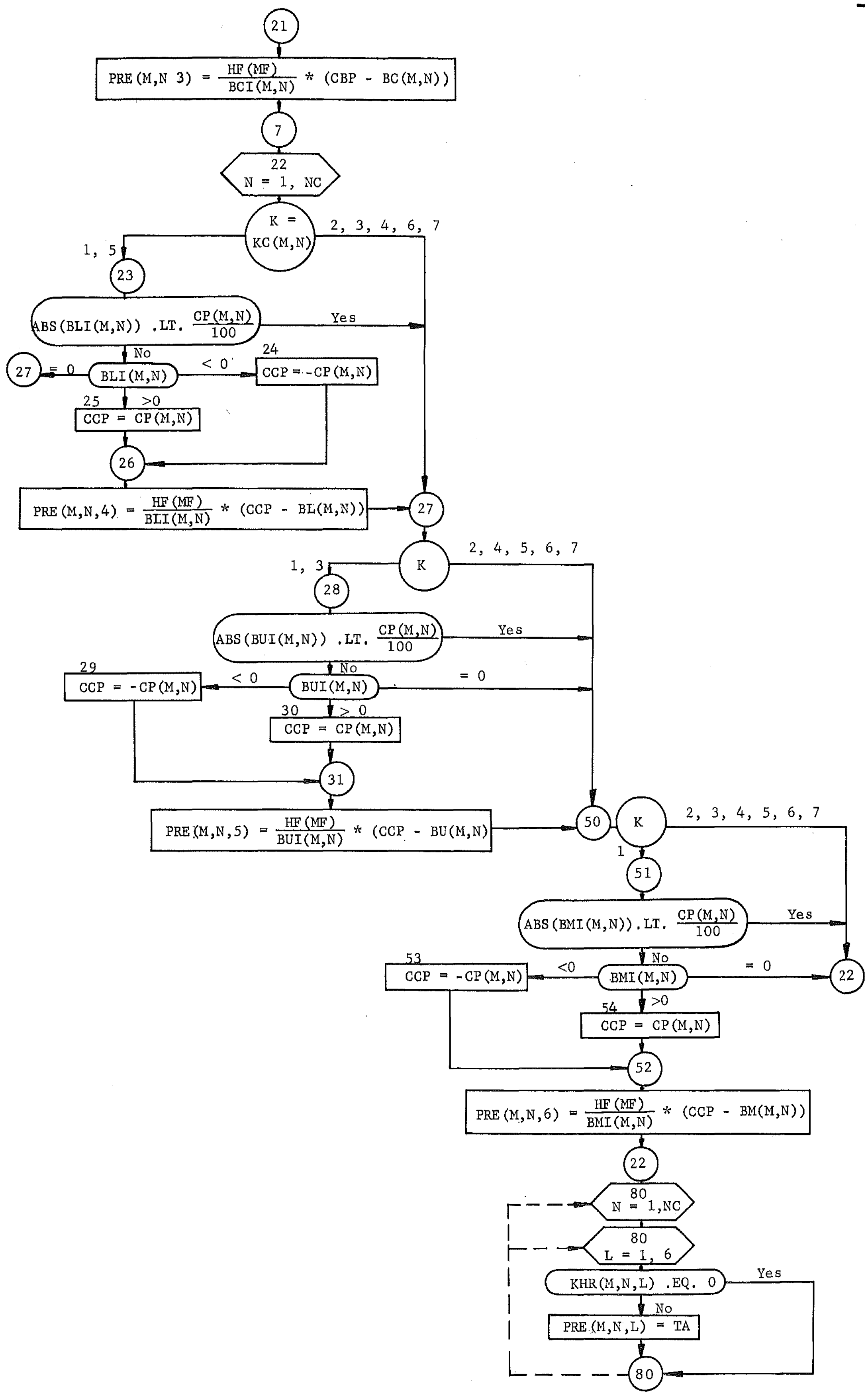
HORF
40
KET = 1, 5
M - 1
> 0
≤ 0
9
DN = CA(M, 1) + CL(M-1,1) + CU(M,1)
DN .EQ. 0.0
Yes
100
No
ET(M,1) = [-SM(M,1) - SA(M,1)*ET(M,2)-SL(M-1,1)*ET(M-1,1) -SU(M,1)*ET(M+1,1) + (CU(M,1)+SU(M,1))*ER(M) +(CL(M-1,1)+SL(M-1,1))*ER(M-1)]/DN
DN = CB(M,NB) + CL(M-1,NC) + CU(M,NC)
ET(M,NC) = [-SM(M,NC) - SB(M,NB)*ET(M,NB) - SL(M-1,NC) *ET(M-1,NC) - SU(M,NC)*ET(M+1,NC) + (CU(M,NC) + SU(M,NC))*ER(M) + (CL(M-1,NC) + SL(M-1,NC))* ER(M-1)]/DN
NB - 1
40
16
14
N = 2,NB
DN = CA(M,N) + CB(M,N-1) + CL(M-1,N) + CU(M,N)
ET(M,N) = [-SM(M,N) - SA(M,N)*ET(M,N+1) - SB(M,N-1) *ET(M,N-1) - SL(M-1,N)*ET(M-1,N) - SU(M,N) *ET(M+1,N) + (CL(M-1,N) + SL(M-1,N))*ER(M-1) +(CU(M,N) + SU(M,N))*ER(M)]/DN
1
DN = CA(1,1) + CU(1,1)
ET(M,1)=[-SM(1,1)-SA(1,1)*ET(1,2) - SU(1,1)*ET(2,1) + (CU(1,1) + SU(1,1)*ER(1)]/DN
DN = CB(1, NB) + CU(1, NC)
ET(1,NC) = [-SM(1,NC) - SB(1,NB)*ET(1,NB) -SU(1,NC)*ET(2,NC) + (CU(1,NC) +SU(1,NC)*ER(1)]/DN
8
6
N = 2,NB
DN = CB(1,N-1) + CA(1,N) + CU(1,N)
ET(1,N) = [-SM(1,N) - SB(1,N-1)*ET(1,N-1) - SA(1,N)*ET(1,N+1) - SU(1,N)*ET(2,N) +(CU(1,N) + SU(1,N))*ER(1)]/DN
14
40
6
21
KAA .LE. 1
FN = 0.0
20
I = 1, M
FN = FN + WH(I)
20
PT = 0.0
SSCT = SH(M)
17
N = 1,NC
PT = PT + P(M,N)
SSCT = (CU(M,N) + SL(M,N))*ET(M,N) + (SU(M,N) + CL(M,N))*ET(M+1,N) -(CU(M,N) + SU(M,N) + CL(M,N) + SL(M,N))*ER(M) + SSCT
17
HF(M) = - (SSCT + PT*H(M)*ER(M)/E)/FN/H(M)
RETURN
100
IM = 0
JOINT MECHANISM, M,N
21
RETURN

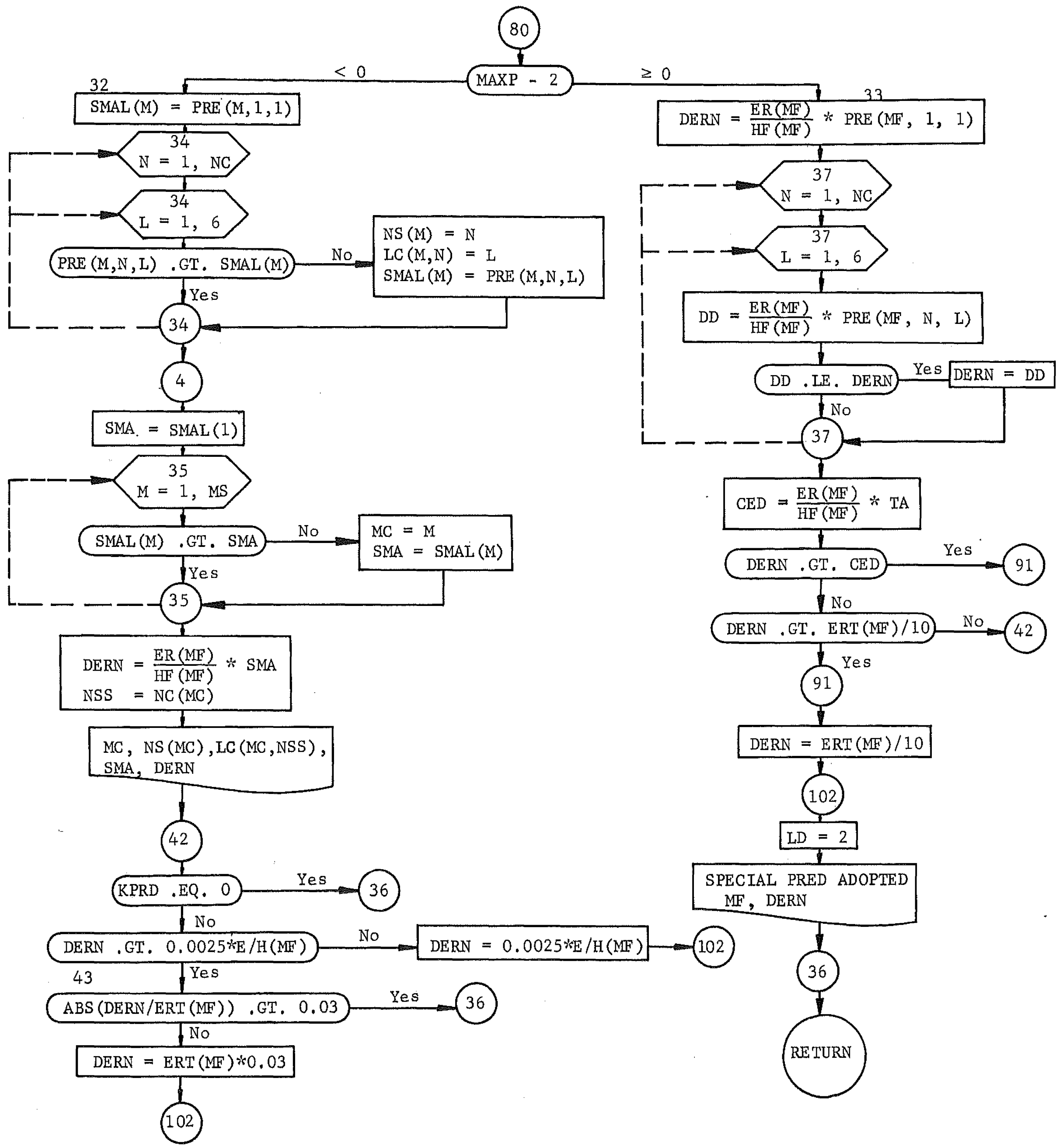

ENMT
4
M = 1, MS
2
N = 1, NB
BAI(M,N) = FBA(M,N) + CA(M,N)*ET(M,N) + SA(M,N)*ET(M,N+1)
BBI(M,N) = FBB(M,N) + CB(M,N)*ET(M,N+1) + SB(M,N)*ET(M,N)
BCI(M,N) = 0.0
BA(M,N) = BAP(M,N) + BAI(M,N)
BB(M,N) = BBP(M,N) + BBI(M,N)
K = KB(M,N)
1, 3, 5
2, 4, 6
7
27
2
15
SBM = - (BA(M,N) + BB(M,N))
X(M,N) = S(N)/2 + SBM/(TGLF*FL(M,N)*S(N))
KAA .GT. 1
Yes
No
2
27
X(M,N) - D(M,N)/2
> 0
22
Y(M,N) = S(N) - X(M,N)
≤ 0
21
X(M,N) = 0.0
BC(M,N) = 0.0
Y(M,N) - D(M,N+1)/2
≤ 0
23
X(M,N) = S(N)
BC(M,N) = 0.0
> 0
24
BC(M,N) = TGLF*FL(M,N)*Y(M,N)*X(M,N)/2
+ BA(M,N) + SBM*X(M,N)/S(N)
25
BCI(M,N) = BC(M,N) - BCP(M,N)
2
4
N = 1,NC
BUI(M,N) = 0.0
BLI(M,N) = 0.0
BMI(M,N) = 0.0
K = KC(M,N)
1, 3, 5
2
4, 6, 7
5
40
4
BUI(M,N) = CU(M,N)*ET(M,N) + SU(M,N)*ET(M+1,N)
-(CU(M,N) + SU(M,N))*ER(M) + FBU(M,N)
BLI(M,N) = CL(M,N)*ET(M+1,N) + SL(M,N)*ET(M,N)
-(CL(M,N) + SL(M,N))*ER(M) + FBL(M,N)
BU(M,N) = BUP(M,N) + BUI(M,N)
BL(M,N) = BLP(M,N) + BLI(M,N)
BUI(M,N) = CU(M,N)*ET(M,N) + SU(M,N)*ET(M+1,N)
+CS(M,N)*ER(M) + FBU(M,N)
BLI(M,N) = CL(M,N)*ET(M+1,N) + SL(M,N)*ET(M,N)
+CC(M,N)*ER(M) + FBL(M,N)
BU(M,N) = BUP(M,N) + BUI(M,N)
BL(M,N) = BLP(M,N) + BLI(M,N)
4
K .GT. 1
Yes
No
KAA .EQ. 1
Yes
No
RAT = ABS(BL(M,N))*BU(M,N) / ABS(BU(M,N))*BL(M,N)
RAT .GE. 0.0
Yes
4
No
ABS(BL(M,N)) - ABS(BU(M,N))
> 0
≤ 0
41
AM = ABS(BU(M,N))
BM = ABS(BL(M,N))*RAT
I = -1
43
42
AM = ABS(BL(M,N))
BM = ABS(BU(M,N))*RAT
I = 1

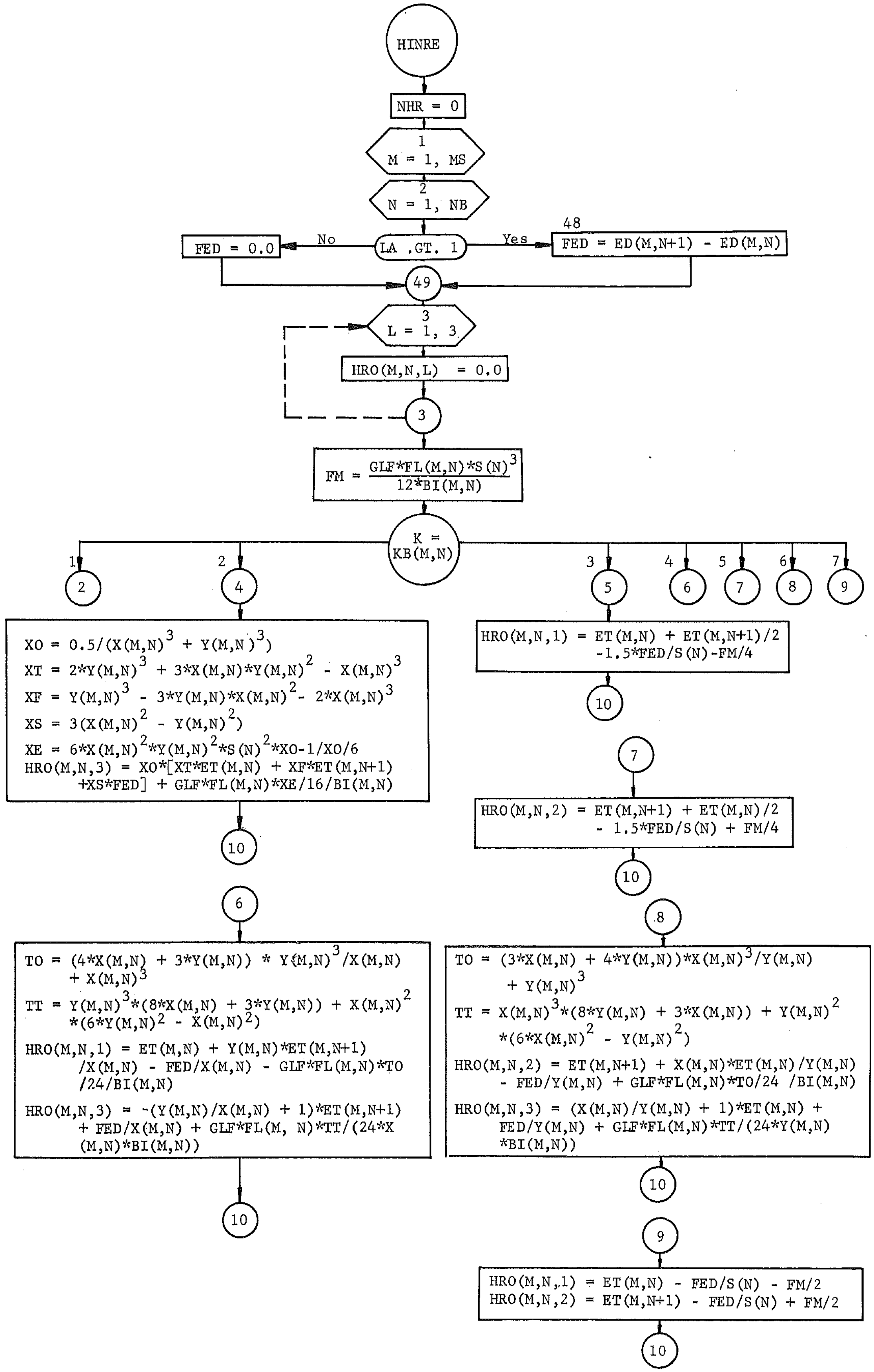


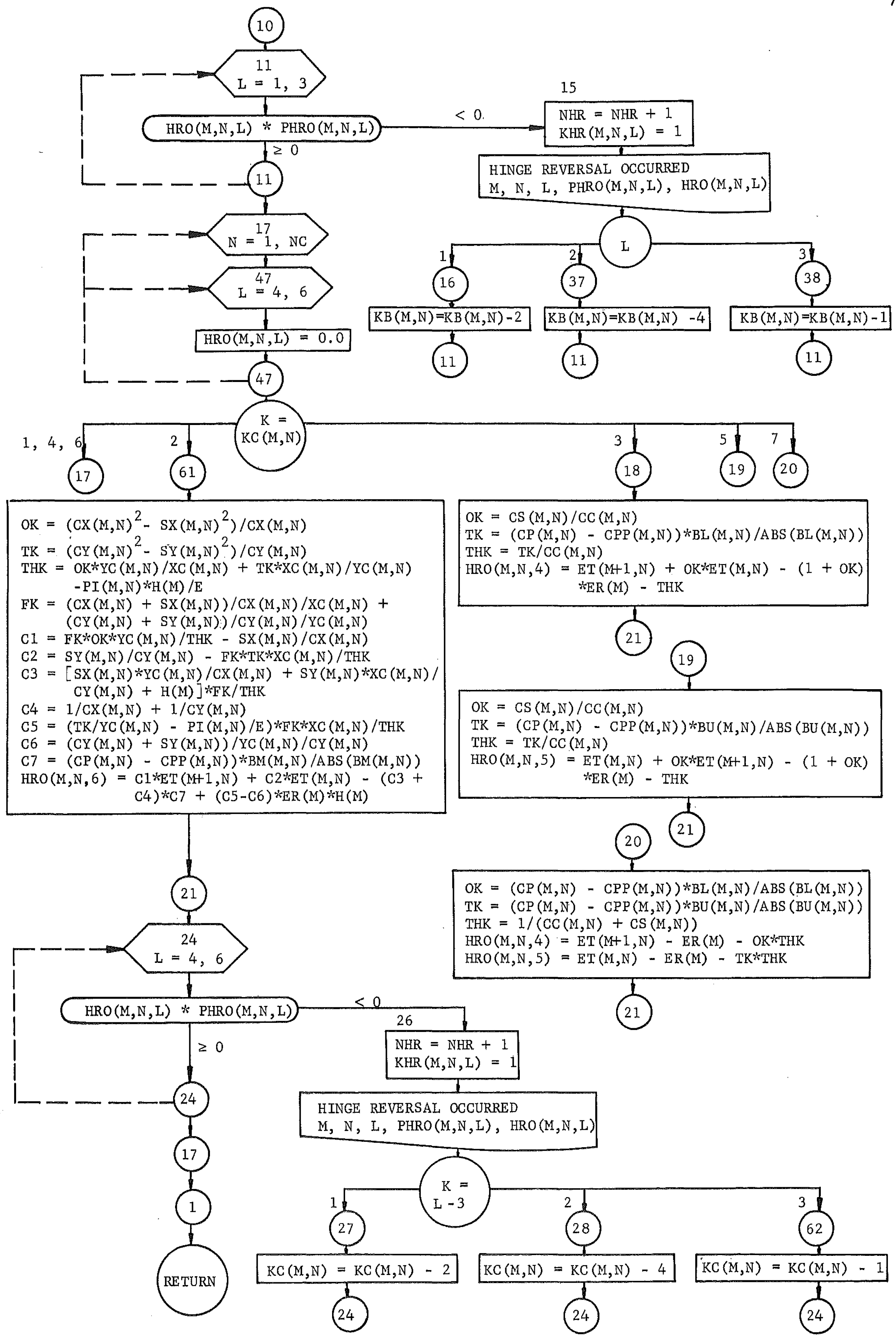
43
PHI = H(M)*SQRT[P(M,N)/(E*CI(M,N)*RY(M,N))]
ZK = tan^-1 (- BM + AM*COS(PHI) / AM*SIN(PHI))
ZK
>0
≤ 0
45
BMAX = SQRT[(AM^2 + BM^2 + 2*AM*BM*COS(PHI))/SIN(PHI)]
XZ = ZK*H(M)/PHI
44
XC(M,N) = 0.0
YC(M,N) = 0.0
BM(M,N) = 0.0
I
46
XC(M,N) = H(M) - XZ
48
47
XC(M,N) = XZ
49
BM(M,N) = BMAX* BL(M,N) / ABS(BL(M,N))
YC(M,N) = H(M) - XC(M,N)
BMI(M,N) = BM(M,N) - BMP(M,N)
4
6
N = 1, NC
PZ(N) = 0.0
7
M = 1, MS
P(M,1) = PZ(1) + TGLF*PC(M,1) + TGLF*FL(M,1)*S(1)/2 - (BA(M,1) + BB(M,1))/S(1)
PZ(1) = P(M,1)
P(M,NC) = PZ(NC) + TGLF*PC(M,NC) + TGLF*FL(M,NB)*S(NB)/2 + (BA(M,NB) + BB(M,NB))/S(NB)
PZ(NC) = P(M,NC)
NB - 1
> 0
8
9
N = 2, NB
P(M,N) = PZ(N) + TGLF*PC(M,N) + TGLF*(FL(M,N)*S(N) + FL(M,N-1)*S(N-1))/2
-(BA(M,N) + BB(M,N))/S(N) + (BA(M,N-1) + BB(M,N-1))/S(N-1)
PZ(N) = P(M,N)
30
M = 1, MS
N = 1, NC
PI(M,N) = P(M,N) - PP(M,N)
LA .EQ. 1
Yes
100
No
31
M = 1,MS
N = 1, NC
MI = MS
EDI = PI(MI,N)*H(MI)/AR(MI,N)
32
MI = MI - 1
MI - M
≥ 0
34
EDI = EDI + PI(MI,N)*H(MI) / AR(MI, N)
33
< 0
ED(M,N) = EDI
RETURN


PRED
LD = 1
4
M = 1, MS
MAXP - 2
≥ 0
5
M = MF
< 0
6
1
N = 1, NC
1
L = 1, 6
HF (MF)
<0
TA = - HFT*100
≥ 0
2
TA = HFT*100
57
PRE (M,N,L) = TA
1
7
N = 1, NB
K = KB(M,N)
1, 2, 5
3, 4, 6, 7, 8
8
ABS(BAI(M,N)).LT. BP(M,N)/100
Yes
No
= 0
12
BAI(M,N)
< 0
9
CBP = -BP(M,N)
> 0
10
CBP = BP(M,N)
11
PRE (M,N,1) = HF (MF)/BAI(M,N) * (CBP - BA(M,N))
12
K
4, 5, 6, 7, 8
1, 2, 3
13
ABS(BBI(M,N)) .LT. BP(M,N)/100
Yes
No
17
= 0
BBI(M,N)
< 0
14
CBP = -BP(M,N)
15
CBP = BP(M,N)
16
PRE (M,N,2) = HF (MF)/BBI(M,N) * (CBP - BB(M,N)
17
K
2, 3, 4, 6, 7, 8
1, 5
18
X(M,N) .GT. D(M,N)/2 .AND. Y(M,N) .GT. D(M,N+1)/2
No
Yes
41
ABS(BCI(M,N)) .LT. BP(M,N)/100
Yes
No
19
CBP = -BP(M,N)
< 0
BCI(M,N)
= 0
7
> 0
CBP = BP(M,N)
21

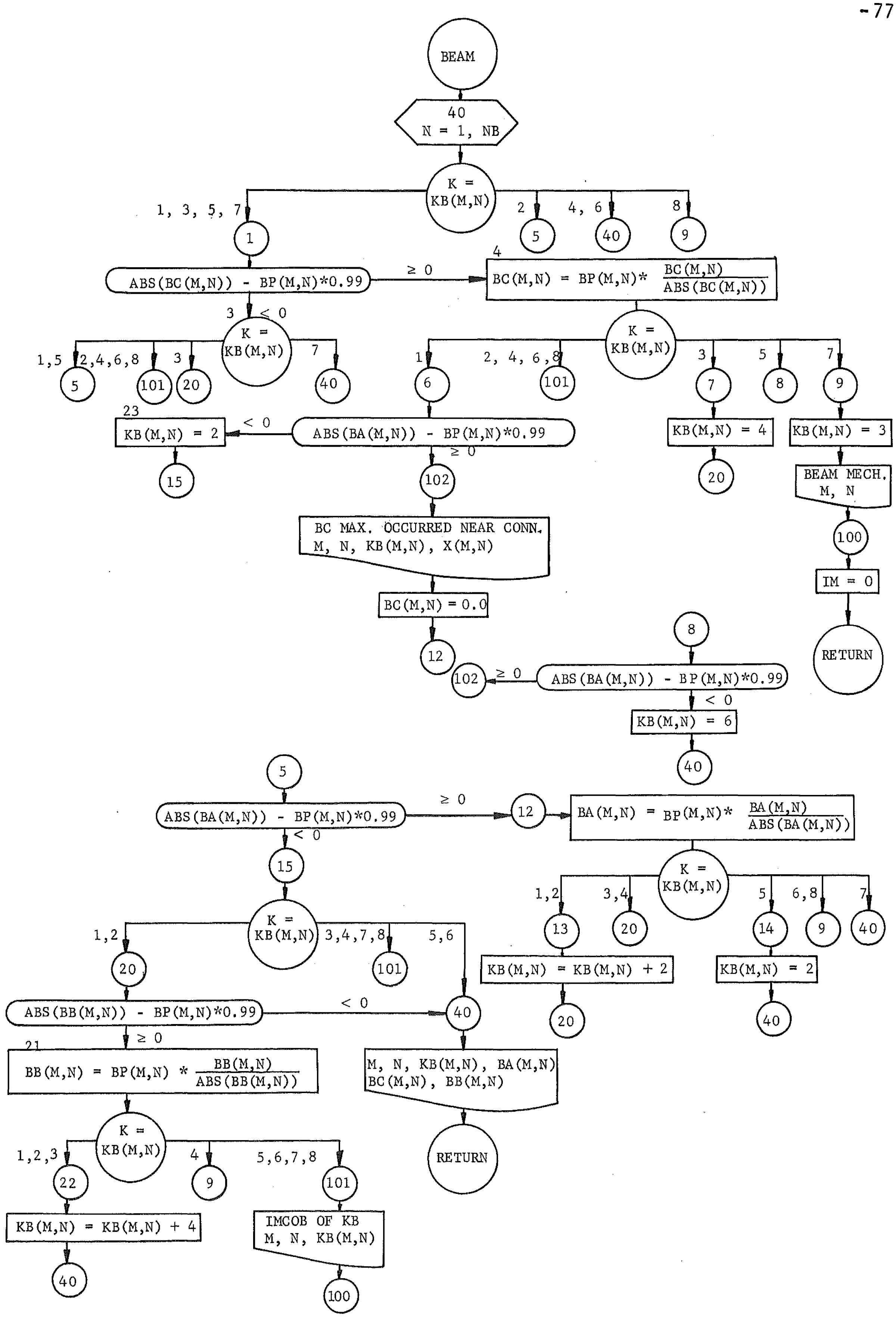

21
PRE (M,N 3) = HF (MF) / BCI (M,N) * (CBP - BC(M,N))
7
22
N = 1, NC
K = KC(M,N)
2, 3, 4, 6, 7
1, 5
23
ABS (BLI(M,N)) .LT. CP(M,N) / 100
Yes
No
24
27
= 0
BLI(M,N)
< 0
CCP = -CP(M,N)
25
>0
CCP = CP(M,N)
26
PRE (M,N,4) = HF (MF) / BLI(M,N) * (CCP - BL(M,N))
27
K
2, 4, 5, 6, 7
1, 3
28
ABS (BUI(M,N)) .LT. CP(M,N) / 100
Yes
29
No
CCP = -CP(M,N)
< 0
BUI(M,N)
= 0
30
> 0
CCP = CP(M,N)
31
PRE (M,N,5) = HF (MF) / BUI(M,N) * (CCP - BU(M,N)
50
K
2, 3, 4, 5, 6, 7
1
51
ABS (BMI(M,N)).LT. CP(M,N) / 100
Yes
53
No
CCP = -CP(M,N)
<0
BMI(M,N)
= 0
22
54
>0
CCP = CP(M,N)
52
PRE (M,N,6) = HF (MF) / BMI(M,N) * (CCP - BM(M,N))
22
80
N = 1,NC
80
L = 1, 6
KHR(M,N,L) .EQ. 0
Yes
No
PRE (M,N,L) = TA
80

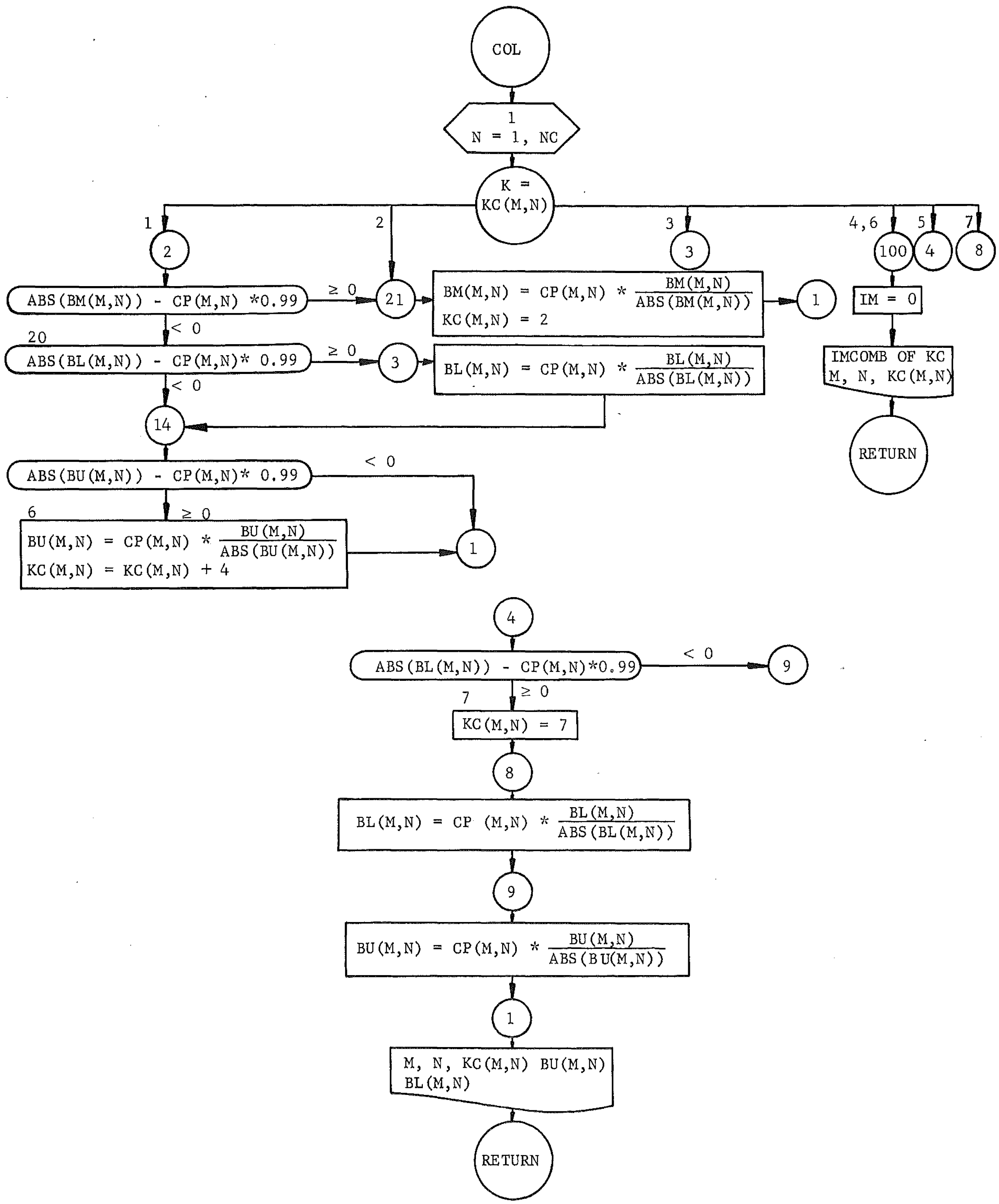

80
MAXP - 2
< 0
≥ 0
32
SMAL(M) = PRE(M,1,1)
34
N = 1, NC
34
L = 1, 6
PRE(M,N,L) .GT. SMAL(M)
No
NS(M) = N
LC(M,N) = L
SMAL(M) = PRE(M,N,L)
Yes
34
4
SMA = SMAL(1)
35
M = 1, MS
SMAL(M) .GT. SMA
No
MC = M
SMA = SMAL(M)
Yes
35
DERN = ER(MF)/HF(MF) * SMA
NSS = NC(MC)
MC, NS(MC),LC(MC,NSS),
SMA, DERN
42
KPRD .EQ. 0
Yes
36
No
DERN .GT. 0.0025*E/H(MF)
No
DERN = 0.0025*E/H(MF)
102
43
Yes
ABS(DERN/ERT(MF)) .GT. 0.03
Yes
36
No
DERN = ERT(MF)*0.03
102
33
DERN = ER(MF)/HF(MF) * PRE(MF, 1, 1)
37
N = 1, NC
37
L = 1, 6
DD = ER(MF)/HF(MF) * PRE(MF, N, L)
DD .LE. DERN
Yes
DERN = DD
No
37
CED = ER(MF)/HF(MF) * TA
DERN .GT. CED
Yes
91
No
DERN .GT. ERT(MF)/10
No
42
Yes
91
DERN = ERT(MF)/10
102
LD = 2
SPECIAL PRED ADOPTED
MF, DERN
36
RETURN


HINRE
NHR = 0
1
M = 1, MS
2
N = 1, NB
LA .GT. 1
No
FED = 0.0
Yes
48
FED = ED(M,N+1) - ED(M,N)
49
3
L = 1, 3
HRO(M,N,L) = 0.0
3
FM = GLF*FL(M,N)*S(N)^3 / 12*BI(M,N)
K = KB(M,N)
1
2
2
4
3
5
4
6
5
7
6
8
7
9
XO = 0.5/(X(M,N)^3 + Y(M,N)^3)
XT = 2*Y(M,N)^3 + 3*X(M,N)*Y(M,N)^2 - X(M,N)^3
XF = Y(M,N)^3 - 3*Y(M,N)*X(M,N)^2 - 2*X(M,N)^3
XS = 3(X(M,N)^2 - Y(M,N)^2)
XE = 6*X(M,N)^2*Y(M,N)^2*S(N)^2*XO-1/XO/6
HRO(M,N,3) = XO*[XT*ET(M,N) + XF*ET(M,N+1) +XS*FED] + GLF*FL(M,N)*XE/16/BI(M,N)
10
HRO(M,N,1) = ET(M,N) + ET(M,N+1)/2 -1.5*FED/S(N)-FM/4
10
7
HRO(M,N,2) = ET(M,N+1) + ET(M,N)/2 - 1.5*FED/S(N) + FM/4
10
6
TO = (4*X(M,N) + 3*Y(M,N)) * Y(M,N)^3/X(M,N) + X(M,N)^3
TT = Y(M,N)^3*(8*X(M,N) + 3*Y(M,N)) + X(M,N)^2 *(6*Y(M,N)^2 - X(M,N)^2)
HRO(M,N,1) = ET(M,N) + Y(M,N)*ET(M,N+1) /X(M,N) - FED/X(M,N) - GLF*FL(M,N)*TO /24/BI(M,N)
HRO(M,N,3) = -(Y(M,N)/X(M,N) + 1)*ET(M,N+1) + FED/X(M,N) + GLF*FL(M, N)*TT/(24*X (M,N)*BI(M,N))
10
8
TO = (3*X(M,N) + 4*Y(M,N))*X(M,N)^3/Y(M,N) + Y(M,N)^3
TT = X(M,N)^3*(8*Y(M,N) + 3*X(M,N)) + Y(M,N)^2 *(6*X(M,N)^2 - Y(M,N)^2)
HRO(M,N,2) = ET(M,N+1) + X(M,N)*ET(M,N)/Y(M,N) - FED/Y(M,N) + GLF*FL(M,N)*TO/24 /BI(M,N)
HRO(M,N,3) = (X(M,N)/Y(M,N) + 1)*ET(M,N) + FED/Y(M,N) + GLF*FL(M,N)*TT/(24*Y(M,N) *BI(M,N))
10
9
HRO(M,N,1) = ET(M,N) - FED/S(N) - FM/2
HRO(M,N,2) = ET(M,N+1) - FED/S(N) + FM/2
10



10
11
L = 1, 3
HRO(M,N,L) * PHRO(M,N,L)
< 0.
≥ 0
15
NHR = NHR + 1
KHR(M,N,L) = 1
HINGE REVERSAL OCCURRED
M, N, L, PHRO(M,N,L), HRO(M,N,L)
L
1
2
3
16
37
38
KB(M,N)=KB(M,N)-2
KB(M,N)=KB(M,N) -4
KB(M,N)=KB(M,N)-1
11
17
N = 1, NC
47
L = 4, 6
HRO(M,N,L) = 0.0
47
K = KC(M,N)
1, 4, 6
2
3
5
7
17
61
18
19
20
OK = (CX(M,N)^2 - SX(M,N)^2)/CX(M,N)
TK = (CY(M,N)^2 - SY(M,N)^2)/CY(M,N)
THK = OK*YC(M,N)/XC(M,N) + TK*XC(M,N)/YC(M,N) -PI(M,N)*H(M)/E
FK = (CX(M,N) + SX(M,N))/CX(M,N)/XC(M,N) + (CY(M,N) + SY(M,N))/CY(M,N)/YC(M,N)
C1 = FK*OK*YC(M,N)/THK - SX(M,N)/CX(M,N)
C2 = SY(M,N)/CY(M,N) - FK*TK*XC(M,N)/THK
C3 = [SX(M,N)*YC(M,N)/CX(M,N) + SY(M,N)*XC(M,N)/CY(M,N) + H(M)]*FK/THK
C4 = 1/CX(M,N) + 1/CY(M,N)
C5 = (TK/YC(M,N) - PI(M,N)/E)*FK*XC(M,N)/THK
C6 = (CY(M,N) + SY(M,N))/YC(M,N)/CY(M,N)
C7 = (CP(M,N) - CPP(M,N))*BM(M,N)/ABS(BM(M,N))
HRO(M,N,6) = C1*ET(M+1,N) + C2*ET(M,N) - (C3 + C4)*C7 + (C5-C6)*ER(M)*H(M)
OK = CS(M,N)/CC(M,N)
TK = (CP(M,N) - CPP(M,N))*BL(M,N)/ABS(BL(M,N))
THK = TK/CC(M,N)
HRO(M,N,4) = ET(M+1,N) + OK*ET(M,N) - (1 + OK) *ER(M) - THK
21
19
OK = CS(M,N)/CC(M,N)
TK = (CP(M,N) - CPP(M,N))*BU(M,N)/ABS(BU(M,N))
THK = TK/CC(M,N)
HRO(M,N,5) = ET(M,N) + OK*ET(M+1,N) - (1 + OK) *ER(M) - THK
21
20
OK = (CP(M,N) - CPP(M,N))*BL(M,N)/ABS(BL(M,N))
TK = (CP(M,N) - CPP(M,N))*BU(M,N)/ABS(BU(M,N))
THK = 1/(CC(M,N) + CS(M,N))
HRO(M,N,4) = ET(M+1,N) - ER(M) - OK*THK
HRO(M,N,5) = ET(M,N) - ER(M) - TK*THK
21
21
24
L = 4, 6
HRO(M,N,L) * PHRO(M,N,L)
< 0
≥ 0
26
NHR = NHR + 1
KHR(M,N,L) = 1
HINGE REVERSAL OCCURRED
M, N, L, PHRO(M,N,L), HRO(M,N,L)
24
17
1
RETURN
K = L-3
1
2
3
27
28
62
KC(M,N) = KC(M,N) - 2
KC(M,N) = KC(M,N) - 4
KC(M,N) = KC(M,N) - 1
24


BEAM
40
N = 1, NB
K = KB(M,N)
1, 3, 5, 7
2
4, 6
8
ABS(BC(M,N)) - BP(M,N)*0.99
≥ 0
4
BC(M,N) = BP(M,N)* BC(M,N) / ABS(BC(M,N))
3 ≤ 0
1,5
2,4,6,8
7
2, 4, 6, 8
23
KB(M,N) = 2
< 0
ABS(BA(M,N)) - BP(M,N)*0.99
KB(M,N) = 4
KB(M,N) = 3
BEAM MECH.
M, N
BC MAX. OCCURRED NEAR CONN.
M, N, KB(M,N), X(M,N)
BC(M,N) = 0.0
IM = 0
RETURN
KB(M,N) = 6
ABS(BB(M,N)) - BP(M,N)*0.99
21
BB(M,N) = BP(M,N) * BB(M,N) / ABS(BB(M,N))
BA(M,N) = BP(M,N)* BA(M,N) / ABS(BA(M,N))
1,2
3,4,7,8
5,6
3,4
6,8
KB(M,N) = KB(M,N) + 2
M, N, KB(M,N), BA(M,N)
BC(M,N), BB(M,N)
1,2,3
5,6,7,8
KB(M,N) = KB(M,N) + 4
IMCOB OF KB
M, N, KB(M,N)



COL
1
N = 1, NC
K = KC(M,N)
1
2
3
4,6
5
7
2
3
100
4
8
ABS(BM(M,N)) - CP(M,N) *0.99
≥ 0
< 0
21
BM(M,N) = CP(M,N) * BM(M,N) / ABS(BM(M,N))
KC(M,N) = 2
1
IM = 0
20
ABS(BL(M,N)) - CP(M,N)* 0.99
≥ 0
< 0
3
BL(M,N) = CP(M,N) * BL(M,N) / ABS(BL(M,N))
IMCOMB OF KC
M, N, KC(M,N)
14
RETURN
ABS(BU(M,N)) - CP(M,N)* 0.99
< 0
6
≥ 0
BU(M,N) = CP(M,N) * BU(M,N) / ABS(BU(M,N))
KC(M,N) = KC(M,N) + 4
1
4
ABS(BL(M,N)) - CP(M,N)*0.99
< 0
9
7
≥ 0
KC(M,N) = 7
8
BL(M,N) = CP (M,N) * BL(M,N) / ABS(BL(M,N))
9
BU(M,N) = CP(M,N) * BU(M,N) / ABS(BU(M,N))
1
M, N, KC(M,N) BU(M,N)
BL(M,N)
RETURN

8. APPENDIX IV - SAMPLE OUTPUT

```
 TOTAL GRAVITY LOAD FACTOR=      1.300  INCREMENTAL LOAD FACTOR=       .100
1  1  1    -290.23    284.11    531.52    1  2  1    -531.52    284.11    290.23
1  1  1     290.23    239.28    1  2  1      0.00      0.00   1  3  1    -290.23   -239.28
2  1  1    -444.99    331.27    624.02    2  2  1    -624.02    331.27    444.99
2  1  1     205.71    223.68    2  2  1      0.00      0.00   2  3  1    -205.71   -223.68
3  1  1    -383.57    346.60    661.31    3  2  1    -661.31    346.60    383.57
3  1  1     159.88     81.66    3  2  1      0.00      0.00   3  3  1    -159.88    -81.66
 AXLD    13.99     33.34     13.99     32.18     73.70     32.18     49.82    115.16     49.82
 ENDF      .053      .122      .053      .045      .104      .045      .027      .063      .027
     M,HF,ER    3          .5048     14.8000
     M,HF,ER    3          .4283     14.8000
     M,HF,ER    3          .4127     14.8000
PRED CONV  NDER, TDER,DERN=   1         14.80000         14.80000
 STORY   3  HFT=        .4127  ERT=      7.8681  DOH=         .0003  DEL=        .0319
 STORY   2  HFT=        .4127  ERT=     14.4646  DOH=         .0005  DEL=        .0586
 STORY   1  HFT=        .4127  ERT=     14.8000  DOH=         .0005  DEL=        .0600
 FOR PLOTTING  LATERAL LOAD=       .41265  DEFLECTION INDEX OF FRAME=       .00042
1  1  1    -282.55    285.37    537.95    1  2  1    -525.10    282.89    297.90
1  1  1     282.55    234.27    1  2  1    -12.85    -11.07   1  3  1    -297.90   -244.29
2  1  1    -423.76    333.93    642.21    2  2  1    -605.83    328.84    466.23
2  1  1     189.49    210.99    2  2  1    -25.31    -24.08   2  3  1    -221.94   -236.37
3  1  1    -351.02    352.27    687.77    3  2  1    -634.86    341.44    416.11
3  1  1     140.03     52.31    3  2  1    -28.82    -33.58   3  3  1    -179.74   -111.01
 PRED ADOPTED AT MC,NS,LC=   3   1   2 DERN=        30.12096
 AXLD    13.91     33.34     14.06     31.88     73.70     32.48     49.20    115.16
 AXLD    50.45
 ENDF      .052      .122      .053      .045      .104      .046      .027      .063
 ENDF      .028
```

```
     M,HF,ER     3         1.2524     94.5231
     M,HF,ER     3          .8910     94.5231
     M,HF,ER     3          .7729     94.5231
     M,HF,ER     3          .7365     94.5231
 PRED ADOPTED AT MC,NS,LC=    3    1    4 DERN=        -2.64777
PRED CONV  NDER, TDER,DERN=    1        94.52312        -2.64777
 STORY   3  HFT=       6.9294  ERT=     226.4160  DOH=        .0076  DEL=       .9179
 STORY   2  HFT=       6.9294  ERT=     424.4240  DOH=        .0143  DEL=      1.7206
 STORY   1  HFT=       6.9294  ERT=     416.7036  DOH=        .0141  DEL=      1.6893
 FOR PLOTTING   LATERAL LOAD=     6.92935  DEFLECTION INDEX OF FRAME=      .01202
1  1  5   -121.19   359.87   576.00    1  2  1   -326.11   283.02   492.28
1  1  1    121.19   160.24   1  2  1   -249.14  -148.04   1  3  1   -492.28  -279.73
2  1  5     18.60   543.79   741.60    2  2  5   -111.44   465.68   741.60
2  1  1   -178.84   -33.59   2  2  1   -483.30  -404.75   2  3  1   -461.70  -336.95
3  1  5    317.79   732.79   741.60    3  2  5     48.79   562.27   741.60
3  1  3   -284.20  -682.15   3  2  3   -386.61  -468.76   3  3  3   -407.81  -616.98
 PRED ADOPTED AT MC,NS,LC=    3    1    3 DERN=          9.41430
 AXLD     12.80     32.26     16.25     27.76     71.36     38.94     41.07    111.23
 AXLD     62.52
 ENDF      .045      .118      .065      .038      .100      .056      .023      .061
 ENDF      .034
```

```
     M,HF,ER     3          -.3604   148.9810
     M,HF,ER     3          -.3604   148.9810
PRED CONV   NDER, TDER,DERN=   1       148.98103       148.98103
HINGE REV   M,N,L,PHRO,HRO     1   1   2  1.806E+02 -1.103E+01
HINGE REV   M,N,L,PHRO,HRO     2   1   2  3.918E+02 -1.355E+01
HINGE REV   M,N,L,PHRO,HRO     2   2   2  4.748E+02 -2.431E+01
HINGE REV   M,N,L,PHRO,HRO     2   2   4 -1.427E+02  2.506E+01
HINGE REV   M,N,L,PHRO,HRO     2   2   5 -3.177E+02  1.771E+01
HINGE REV   M,N,L,PHRO,HRO     3   1   2  1.013E+03 -1.699E+01
HINGE REV   M,N,L,PHRO,HRO     3   1   3  1.165E+03 -4.888E+01
HINGE REV   M,N,L,PHRO,HRO     3   2   2  1.119E+03 -2.737E+01
 HINGE REVERSAL OCCURRED  II=  1 NHR=  8
     M,HF,ER     3          -.3604   148.9810
     M,HF,ER     3          -.3604   148.9810
PRED CONV   NDER, TDER,DERN=   1       148.98103       148.98103
 STORY   3  HFT=      5.9113  ERT=    285.6605  DOH=        .0097  DEL=       1.1581
 STORY   2  HFT=      5.9113  ERT=    806.9664  DOH=        .0273  DEL=       3.2715
 STORY   1  HFT=      5.9113  ERT=   1638.7913  DOH=        .0554  DEL=       6.6437
 FOR PLOTTING   LATERAL LOAD=     5.91126  DEFLECTION INDEX OF FRAME=      .03076
1  1  1     -92.65   379.02   570.04    1  2  1    -282.36   301.98   501.84
1  1  1      92.65   187.27   1  2  1    -286.93  -158.31   1  3  1   -501.85  -115.84
2  1  1     169.30   643.25   725.67    2  2  1      -5.75   536.53   722.47
2  1  1    -356.57   374.40   2  2  1    -568.28  -566.98   2  3  1   -606.46  -119.26
3  1  1     309.60   731.58   729.76    3  2  1     303.45   728.39   727.42
3  1  7    -684.25  -684.25   3  2  7    -472.85  -472.85   3  3  7   -610.79  -610.79
 SPECIAL PRED ADOPTED MF=   3  DERN=       163.87913
 AXLD    12.67    32.09    16.55    26.89    71.45    39.72    40.30   109.88
 AXLD    64.63
 ENDF     .044     .117     .067     .037     .100     .057     .022     .060
 ENDF     .036
```

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9. FIGURES

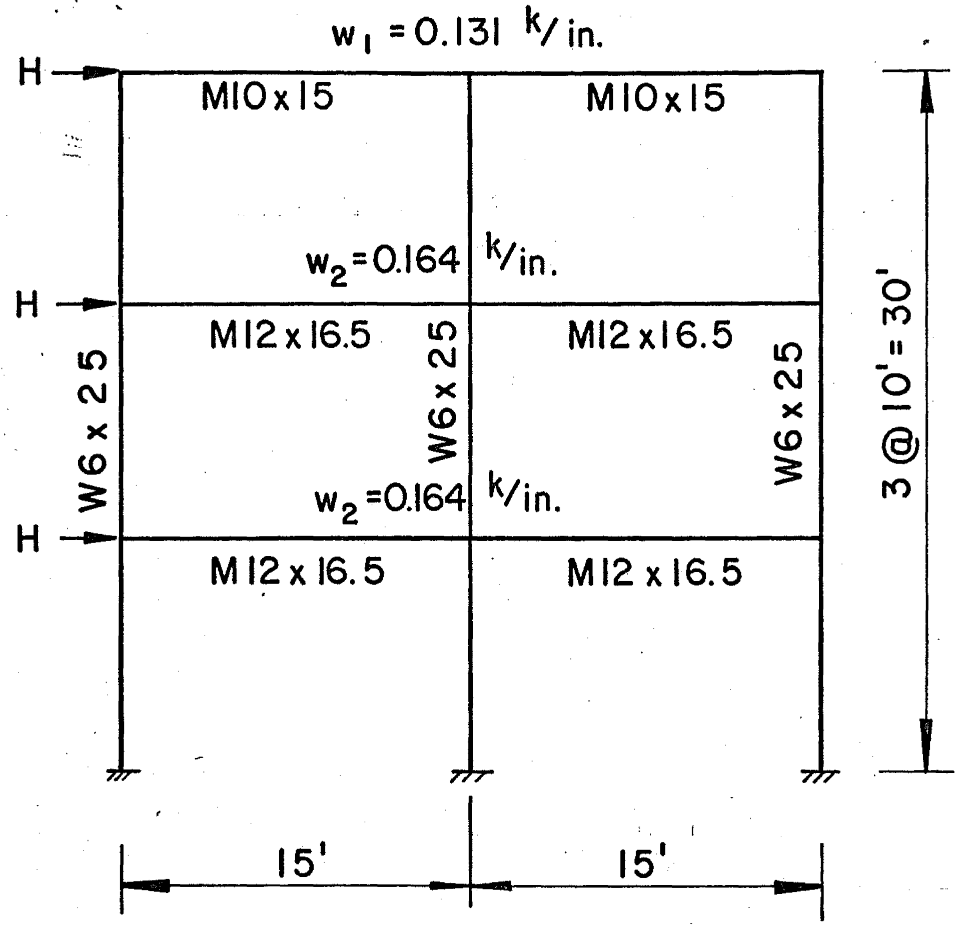
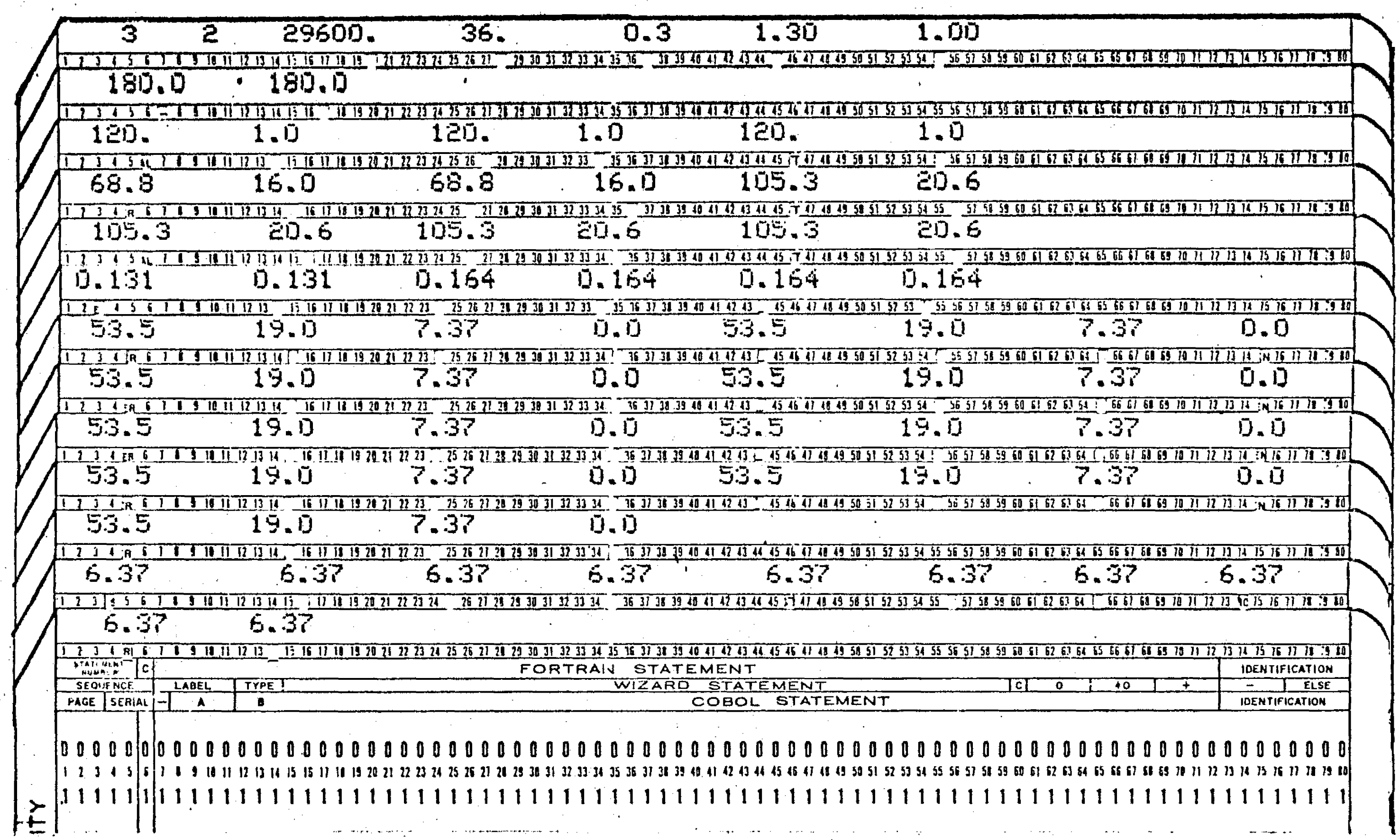


Fig. 1 EXAMPLE FRAME



Note: The data cards are read correctly from the top of the page downward but the cards themselves are stacked in the reverse order.

Fig. 2 SET-UP OF DATA CARDS FOR EXAMPLE FRAME

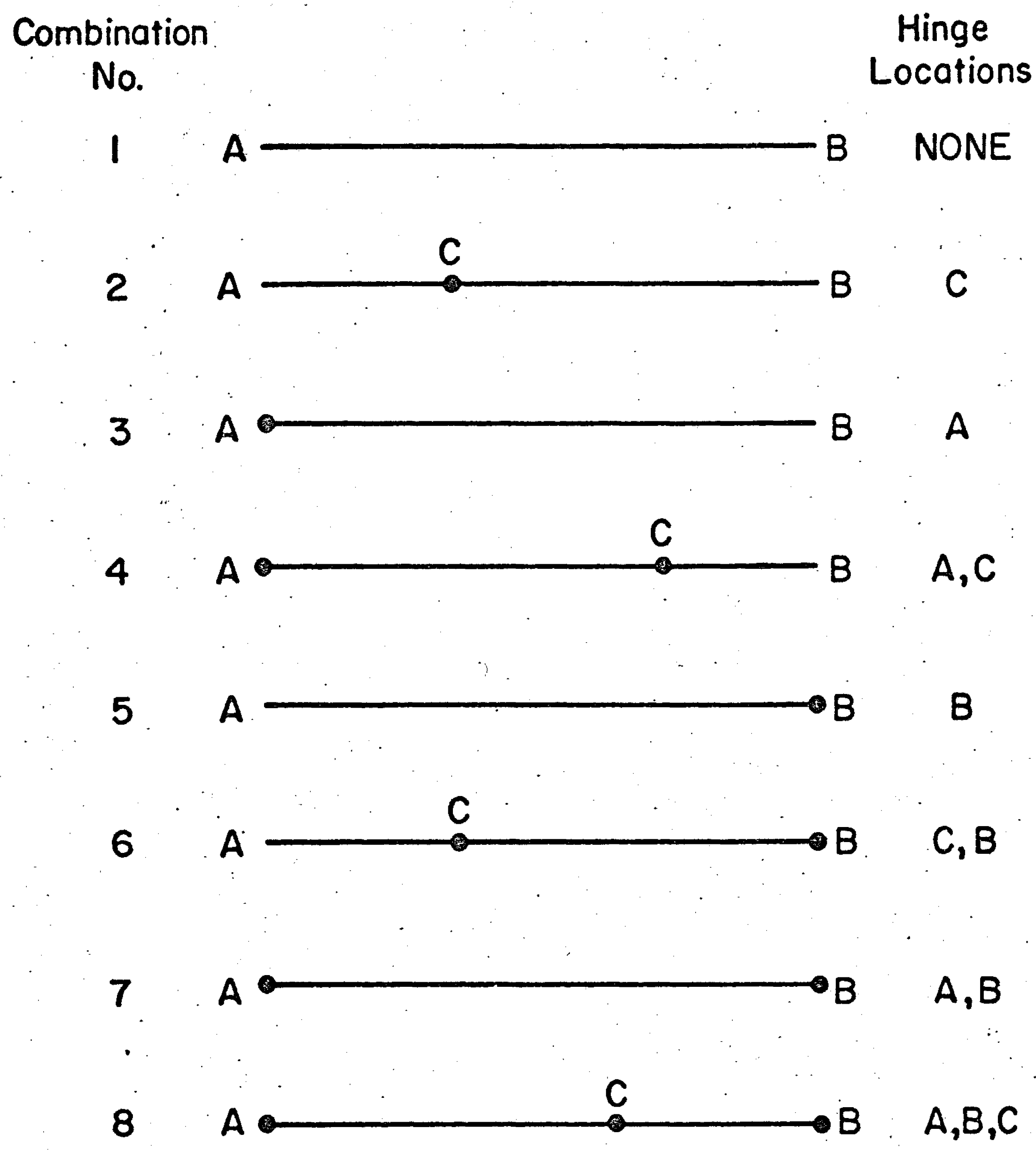


Fig. 3 HINGE COMBINATION NUMBER USED IN PROGRAM

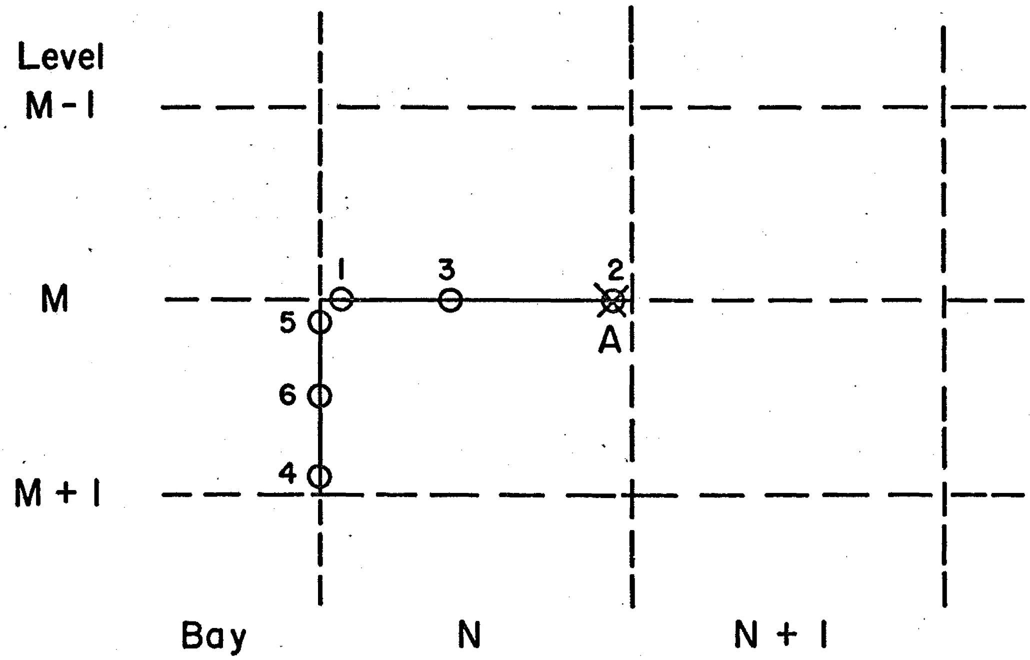


Fig. 4 NUMBERING FOR POTENTIAL
HINGE LOCATIONS

10. REFERENCES

1. Kim, S. W. and Daniels, J. H.
ELASTIC-PLASTIC ANALYSIS OF UNBRACED FRAMES, Fritz Engineering Laboratory Report No. 346.5, Lehigh University, March 1971.

11. ACKNOWLEDGMENTS

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