U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

PB80-108152

Description and User's Manual of the Inelastic Dynamic Analysis Program. Optimum Seismic Protection for New Building Construction in Eastern Metropolitan Areas

Massachusetts Inst of Tech, Cambridge

Prepared for

National Science Foundation, Washington, DC

Sep 72

REPORT DOCUMENTATION PAGE

1. REPORT NO.
NSF-RA-E-72-294

2.

3. Recipient's Accession No.
PB 80 108152

4. Title and Subtitle
Inelastic Dynamic Analysis Program, Description and User's Manual (Optimum Seismic Protection for New Building Construction in Eastern Metropolitan Areas, Internal Study Report 16)

5. Report Date
September 1972

6.

7. Author(s)
S. Anagnostopoulos, J. M. Roesset

8. Performing Organization Rept. No.
No. 16

9. Performing Organization Name and Address
Massachusetts Institute of Technology
Department of Civil Engineering
Cambridge, Massachusetts 02139

10. Project/Task/Work Unit No.

11. Contract(C) or Grant(G) No.
(C)
(G) GK27955

12. Sponsoring Organization Name and Address
Engineering and Applied Science (EAS)
National Science Foundation
1800 G Street, N.W.
Washington, D.C. 20550

13. Type of Report & Period Covered

14.

15. Supplementary Notes

16. Abstract (Limit: 200 words)

A computer program, developed for the non-linear dynamic analysis of buildings, written in FORTRAN IV and using 350k of primary memory on an IBM 370/165 computer, is described. No secondary storage is required. The program is designed for buildings having a maximum of 30 stories, 30 different structural components, and 3000 points of ground acceleration in each of the two principal directions. The geometry of the building is specified through the number of stories, the heights, the number of structural components, and a plan. The information given for a plan forms the coordinates of some point along the centerline of each component and the orientation of this centerline with respect to the x axis. The masses are given for each floor level separately, together with the coordinates of the centroid and the corresponding moments of inertia. The required properties are given floor by floor for bending springs. For shear springs the user has the option of either specifying the spring characteristics floor by floor directly or in the case of frames to specify its geometry and the member properties at each level. The program will then compute the spring properties. The user has also the option to specify the number of modes for the elastic part of the analysis, together with the coordinates of a geometrical center with respect to which the modal shapes will be computed.

17. Document Analysis a. Descriptors

Computer programs
Earthquake resistant structures
Dynamic response
Elastic properties
Dynamic structural analysis

b. Identifiers/Open-Ended Terms

FORTRAN IV

c. COSATI Field/Group

18. Availability Statement
NTIS

19. Security Class (This Report)

20. Security Class (This Page)

21. No. of Pages
24

22. Price
A02 - A01

(See ANSI-Z39.18)

See Instructions on Reverse

OPTIONAL FORM 272 (4-77)
(Formerly NTIS-35)
Department of Commerce

DESCRIPTION AND USER'S MANUAL OF THE
INELASTIC DYNAMIC ANALYSIS PROGRAM

1. General Considerations

A computer program has been developed for the non-linear dynamic analysis of buildings, written in FORTRAN IV and using 350k of primary memory on an I.B.M. 370/165 computer. No secondary storage is required. The program is designed for buildings having a maximum of 30 stories, 30 different structural components (in plan) and 3000 points of ground acceleration in each of the two principal directions. Detailed information about the mathematical model and the underlying assumptions can be found in the Sc.D. thesis of S. Anagnostopoulos.

Since it was intended primarily for research, no special effort was put into adding special features, desirable in a program for commercial use (such as free input, problem-oriented language, unit conversion, etc.). The geometry of the building is specified through the number of stories, the heights, the number of structural components, and a plan. The information given for a plan is the coordinates of some point along the centerline of each component and the orientation of this centerline with respect to the x axis. The masses are given for each floor level separately, together with the coordinates of the centroid and the corresponding moments of inertia. For bending springs (shear walls) the required properties are given floor by floor. For shear springs there is the option of either specifying the spring characteristics (and spring type) floor by floor directly or in the case of frames to specify its geometry and the member properties at each level, and then the program will compute the spring properties by using the approximate formulas presented in the thesis by Anagnostopoulos. Information for identical elements or floors need not be repeated. A single number is required for the viscous damping, the percentage of critical to be used in each mode. The user has the option to specify the number of modes he wants for the elastic part of the analysis, together with the coordinates of a "geometrical center" with respect to which the modal shapes will be computed. The next set of information needed by the program is about the earthquake ground motions. It can read and store two different earthquake records (up to 3000 points each), one for the x and the other for the y direction, and it can combine them with appropriate direction cosines, so that directions of the motion other than x and y can be considered. The user can also specify a number of scales by which the originally read accelerograms will be multiplied and new analyses will be performed. The information given with each earthquake record is a scale factor, a time interval Δt and the values of the acceleration. Finally, the last piece of information required concerns plotting of various time-histories for relative displacements, absolute accelerations, interstory displacements and force versus deformation, at any level and for any direction. If the required number of plots exceeds the capacity of the program, the analysis will automatically be repeated until all the requested plots have been produced. This particular feature was a product of trade-off between increasing core requirements, possibility of using secondary storage and computational costs, arising from the fact that at each step of the numerical analysis previous information is lost, unless stored.

2. Program Description

MAIN

The main program is the spine of the computer module and most of the operations and tasks needed for the analysis are performed in there. It starts with initialization of various variables and arrays and proceeds with the reading of the input. There are only two other routines, SMART and READR that read input information. SMART is called only in the cases of frames to read data for geometry and member properties and then to compute the equivalent springs with the formulas described in Chapter 2 of the earlier mentioned thesis. The user, however, has the option to input directly the properties of the equivalent springs when he chooses not to use the approximate formulas employed in SMART. READR reads the earthquake record from punched cards. The stiffness and mass matrices are assembled in the main program and then subroutine EIGEN determines the natural frequencies and modal shapes. The damping matrix is subsequently formed and READR is called to read the earthquake record. Information about the required plots is then read in the MAIN and the necessary initializations are performed for the numerical analysis. Subroutine RUNGE that uses a 4th order Runge-Kutta numerical procedure is called to perform the first step of the numerical analysis while for all the subsequent steps subroutine BIGGS is used. The forces in the various springs are computed by calling appropriate routines, depending on the type of non-linearities that each spring represents. Maximum, cumulative and root-mean-square effects are calculated in the MAIN, to be printed after the analysis has been completed. After all the output has been printed, the MAIN will set-up the headers to be printed on the plots requested earlier and will call subroutine GRFIVC which will plot, using the SC4020 plotter, the time histories that were requested by input codes and stored permanently during the analysis. At the end it will check whether the number of scales (which are used to multiply the accelerogram) has been exhausted and if not, it will read the next scale and it will branch to the point at which it reads the information about the plots and the analysis will be repeated for the new record. The program will stop when all the earthquake scales have been exhausted.

READR (TITLE, SCALE, DT, ACCG, NACCG, VO)

It reads the digitized record in the following format:

1st card: Title of the record in FORMAT 20A4

2nd card: Scale, Dt in FORMAT 2F10.5

Set of cards: Ground accelerations in FORMAT 8F9.6

Last card: Any real number greater than 900. in F9.6 to indicate the end of the record.

READR will also print the title, the scale by which the values of the ground accelerations are multiplied inside READR, the time step Dt and the number of acceleration values it has read.

Input arguments: none

Return arguments:

TITLE: Array containing the title of the record.

SCALE: Factor by which all the values of the ground acceleration read have been multiplied

DT : Time step

ACCG : Array containing the ground accelerations (multiplied already by SCALE)

NACCG: Number of acceleration points

VO : Is not used here

SMART (I)

It reads the required information and computes the properties of the non-linear springs in the case of unbraced, braced, infilled and partially infilled frames. Depending on the particular type of spring, it will assign values for the initial stiffness and strength as well as values for the degradation factors. Partially infilled frames must be read as type 6 springs and will remain as such in case their shear capacity is inadequate, otherwise SMART will make them of type 2.

Input arguments:

I : Integer identifier of the frame

Output arguments: none

The rest of the information is transmitted through the COMMON.

DEFLT (JCOD, DLIM, AA, BB, CC)

It assigns default values to the degrading factors and maximum ductility factors in the case that they are not specified by the user.

Input arguments:

JCOD : Code indicating the spring type

Return arguments:

DLIM : Maximum ductility factor which if exceeded, failure is assumed

AA, BB, CC: Degrading factors for the various models

EIGEN (A, R, N, NT, MV)

I.B.M. routine that computes eigenvalues and eigenvectors of a real symmetric matrix

Input arguments:

A : Original matrix (symmetric) destroyed in computation. Resultant eigenvalues are developed in diagonal of matrix A in descending order.

N : Order of matrices A and R

NT : Value of first dimension of R in calling program

MV : Input code

0 computes eigenvalues and eigenvectors

1 computes eigenvalues only

Return arguments:

A : Contains the eigenvalues in its diagonal in descending order

R : Resultant matrix of eigenvectors (stored column-wise in same sequence as eigenvalues)

RUNGE (STK, AMASS, DAMP, RI, R, F, U1, UP1, U, UP, NDIM, N, DT, A1, A2, A3, A4, B1, B2, B3, B4)

Routine that performs a 4th order Runge-Kutta numerical analysis. In this particular program it is used only once, at the beginning of the numerical integration in order to provide the necessary starting points for the Constant Velocity method.

Input arguments:

STK : Stiffness matrix (dimension NDIM × NDIM, Size N × N)

AMASS: Mass vector

DAMP : Damping matrix (dimension NDIM × NDIM, Size N × N)

R1 : Excitation vector at time step 1

R : Excitation vector at time step 2

F : Force vector at time step 1

U1 : Displacement vector at time step 1

UP1 : Velocity vector at time step 1

NDIM : Dimension of matrices STK and DAMP in MAIN

N : Size of matrices STK and DAMP in MAIN

A1, A2, A3, A4
B1, B2, B3, B4 } Auxiliary vectors for intermediate computations

<u>Return arguments</u>:

U : Displacement vector at time step 2

UP : Velocity vector at time step 2

<u>BIGGS</u> (AMASS, STF, DAMP, R, F, A, U1, U2, U, NDIM, N, DT)

Routine that uses the Constant Velocity (or Impulse Acceleration) method for the numerical integration of the equations of motion.

<u>Input arguments</u>:

AMASS: Mass vector

STF : Contains pseudo-inverse of: $\frac{1}{Dt^2} M + \frac{1}{2Dt} C$
(derived from CROUT in MAIN)

DAMP : Contains damping matrix C

R : Excitation vector at time step n

F : Force vector at time step n (= $-KU_n$)

U1 : Displacement vector at step n (= U_n)

U2 : Displacement vector at step n-1 (= U_{n-1})

NDIM : Dimension of matrices STF, DAMP in MAIN

N : Size of matrices STF, DAMP in MAIN

DT : Time step of integration

Return arguments:

A : Acceleration vector at time step n (= $\ddot{U}_n$)

U : Displacement vector at time step n+1 (= U_{n+1})

CROUT (A, N, NDIM)

It performs the forward pass of the Gauss elimination procedure on a general matrix A.

Input arguments:

A : Original square matrix

N : Size of matrix A

NDIM : Dimension of A in MAIN

Return arguments:

A : Contains the pseudo-inverse of the original matrix

MATMP (A, N, B, NDIM, M)

Routine that performs the forward pass of the Gauss elimination on the right hand side vectors and the backsweep.

Input arguments:

A : Pseudo-inverse of a matrix as obtained by CROUT

N : Size of matrix A

B : Right hand side vector (or vectors, then B is a matrix with M columns)

NDIM : Dimension of A in MAIN

M : Number of right hand side vectors

Return arguments:

B : Contains for each vector (or column) $A^{-1}B$ if A was the original matrix entering CROUT

MAX (A, NA, ALOW, ATOP, ISK, IAO, DA, IGG)

Routine that determines the maximum and minimum values to be placed on a scale, on which the elements of an array A will be plotted.

Input arguments:

A : Vector whose elements are to be plotted

NA : Number of elements in array A

ALOW, ATOP: Minimum and maximum limits in the case that IGG > 0

ISK : Number of elements to be skipped when searching in A

IAO : Location of starting element in A

IGG $\leq$ 0 MAX will search to determine ALOW and ATOP

IGG > 0 ALOW, ATOP are input arguments

Return arguments:

ALOW, ATOP: Minimum and maximum limits of the scale on which A will be plotted. (It is ALOW $\leq$ Amin , ATOP $\geq$ Amax)

DA : Step that is used for the grid on the plot

GRFIVC (KO, LT, MRIGHT, MBOT, MTOP, NIVC, MIVC, IIVC, JIVC, NX, NY, NSPEC, NDASH, NPTS, IPOIN, ISXO, ISKX, ISYO, ISKY, LINE, IAVX, IAVY, NT, NTX, NTY, TIT, TITX, TITY, X, Y, SETXL, SETXR, SETYB, SETYT)

Routine that plots a set of values Y versus a set of values X using the SC4020 plotter.

Input arguments:

KO : Determines the nature of scale
= 1 x, y both linear
= 2 x linear, y logarithmic
= 3 x logarithmic, y linear
= 4 x, y both logarithmic

LT, MRIGHT, MBOT, MTOP: Left, right, bottom and top margins in raster units

NIVC, MIVC: Every nth vertical and every mth horizontal line to be re-emphasized. If NIVC and/or MIVC = 0 no lines are printed.

IIVC, JIVC: Every ith vertical and every jth horizontal line to be labeled. If IIVC and/or JIVC = 0 no lines labeled.

NX, NY: Indicate number of characters to be displayed in labels including decimal point and must be $|NX \text{ or } NY| \leq 7$ If NX and/or NY are negative, labels are in scientific notation.

NSPEC: = 1 Film will not be advanced, for multiple plots
≠ 1 Standard procedure

NDASH: = 1 Dashed lines
≠ 1 Solid

NPTS : Number of points to be plotted

IPOIN: = 0 Points will not be plotted
≠ 0 Points will be plotted
The value of IPOIN will be the code of the plotted character

ISXO : Location of the first element of vector X to be plotted

ISYO : Location of the first element of vector Y to be plotted

ISKX : Number of elements to be skipped in vector X

ISKY : Number of elements to be skipped in vector Y

LINE : = 1 Graph wanted

= 0 Graph not wanted (only points)

IAVX : = 0 Subroutine MAX will search for ALOW, ATOP

= 1 Subroutine MAX will not search for ALOW, ATOP but it will use earlier values

= 2 It will ·nput as limits to MAX SETXL, SETXR and MAX will only determine DA.

IAVY : Same as IAVX but for the Y vector

NT : Number of header characters

NTX : Number of characters of the X title

NTY : Number of characters of the Y title

TIT : Header

TITX : X title

TITY : Y title

SETXL, SETXR, SETYB, SETYT: arguments to be transmitted to subroutine MAX in the case that IAVX and/or IAVY = 2, to be used as ALOW and ATOP

Return arguments: none

BILIN (FY, RK1, RK2, FO, YO, FN, YN, JFLAG, JNDEX)

Routine that computes forces for a bilinear spring.

Input arguments:

FY : Force at yield

RK1 : Initial stiffness (slope of the first branch)

RK2 : Slope of the second branch

FO : Force at the last step (step n)

YO : Displacement at the last step (step n)

YN : New value of the displacement (step n+1)

JFLAG: Code to identify load reversal

JNDEX: Code to identify the loading or unloading branch

Return arguments:

FN : New value of the force (step n)

JNDEX: Code to identify the loading or unloading branch

STDG1 (. . . .)

Old version of STDG2. Less accurate and less efficient. It should be eliminated.

STDG2 (FY, RK, FO, YO, FN, YN, IDUM1, IDUM2, DUM1, CYP1, CYP2, DUM3, DUM4)

Routine that computes the force in a stiffness degrading spring, whose unloading is parallel to the initial branch.

Input arguments:

FY : Force at yield

RK : Initial stiffness

FO : Force at the last step (step n)

YO : Displacement at the last step (step n)

YN : New value of the displacement (step n+1)

IDUM1, IDUM2, DUM1, DUM3, DUM4: Dummy arguments

CYP1 : Maximum positive displacement attained up to step n

CYP2 : Minimum negative displacement attained up to step n

Return arguments:

FN : New value of the force (step n+1)

CYP1, CYP2: as above

STRDG1 (FY, RK, FO, YO, FN, YN, JFLAG, JNDEX, A, B, C, DMAX, MCYCL, JPOS, JNEG)

Routine that computes the force in a stiffness and strength degrading spring that corresponds to an infilled concrete frame.

Input arguments:

FY, RK, FO, YO, YN: as in STDG2

JFLAG, JNDEX : as in BILIN

A, B, C : Degrading factors

DMAX : Absolute value of the maximum attained displacement

MCYCL : Number of complete cycles

JPOS : Number of yieldings that occurred on the positive side

JNEG : Number of yieldings that occurred on the negative side

Return arguments:

FN : New value of the force (at step n+1)

JNDEX, DMAX, MCYCL, JPOS, JNEG: as above

STRDG2 (FY, RK, FO, YO, FN, YN, JFLAG, JNDEX, A, B, C, DMAX, MCYCL, JPOS,
JNEG, RMI, FMI)

Routine that computes the force in a stiffness and strength degrading spring that corresponds to an infilled concrete frame.

Input arguments:

All but RMI, FMI: as in STRDG1

RMI : Minimum value of stiffness corresponding to that of the frame alone

FMI : Minimum value of strength corresponding to that of the frame alone

Return arguments:

Same as in STRDG1

TRILIN (FY1, FY2, R1, R2, FO, YO, FN, YN, FA1, FA2)

Routine that computes the force in a trilinear spring

Input arguments:

FY1 : Value of the force at the end of the first branch

FY2 : Ultimate value of the yield force

R1 : Initial stiffness (slope of the first branch)

R2 : Stiffness after formation of plastic hinges (slope of the second branch)

FO : Force at the last step (step n)

YO : Displacement at the last step (step n)

YN : New value of displacement (step n+1)

FA1, FA2: Auxiliary variables

Return arguments:

FN : New value of the force (step n+1)

3. Output

The program prints the data about the building, the characteristics of the earthquake motion and the data about the plots requested right after it reads the appropriate information, so that the user can check his input. In the case of shear walls it prints the stiffness coefficients rather than the wall dimensions but it may be desirable to change that part and print the information as it is read.

Results of the analysis will then be printed in the following order:

1. Natural periods and modal shapes (two for x and y and one for torsion).
2. For each shear spring (frame) and for each floor it will print maximum interstory displacements, maximum ductility factors and permanent sets. In the case of shear walls it will print maximum interstory displacements, maximum ductility factors, maximum shears and maximum overturning moments.
3. For each floor level:
   a) Maximum floor acceleration, direction and time of occurrence.
   b) Maximum floor displacement (with respect to the ground) direction and time of occurrence.
   c) Maximum interstory displacement (of the centroids), direction and time of occurrence.
   d) Maximum x acceleration, displacement and interstory displacement, corresponding y and rotational values and times of occurrence.
   e) Maximum y acceleration, displacement and interstory displacement, corresponding x and rotational values and times of occurrence.
   f) Maximum torsional acceleration, rotation and interstory rotation, corresponding x and y values and times of occurrence.

4. For each floor level:

   Root mean square of the maximum accelerations and interstory displacements of all the elements for the x and y directions.

5. For each floor level:

   Root mean square of the time histories of the global accelerations and interstory displacements for the x and y directions and for the torsion.

6. For each floor level:

   Average root mean square of accelerations and interstory displacements for the x and y directions computed from time histories of each of the elements.

7. Maximum base shears and overturning moments in the x and y directions.

Output 4, 5, 6 is intended for later use of the program to estimate economic damage to the building due to earthquakes of different intensities. The program has also the capability of producing plots on an SC4020 plotter. The user can request and obtain any number of plots for the following:

1. For any floor level and for any of the three directions:
   a) Time histories of absolute accelerations.
   b) Time histories of displacements (and rotation) relative to ground.
   c) Time histories of interstory displacements (and rotations).
   d) Plot of total floor shear (torsional moment) vs. corresponding displacement (rotation) for all the duration of the earthquake.
2. For any element and for any floor:
   a) Time histories of accelerations.
   b) Time histories of displacements relative to ground.
   c) Time histories of interstory displacements.

d) Plot of spring force vs. deformation for all the duration of the earthquake.

The user can specify the starting and finishing time for the time history plots.

The maximum number of points that can be plotted in one analysis is 4500. If the user specifies plots that need N points in total where N > 4500, the program will repeat the analysis $(\frac{N}{4500} + 1)$ times until it produces all the requested plots. For each earthquake scale that the user requests, he must specify what plots he wants. These plots can be different from one scale to another.

4. User's Manual

			FORMAT
<u>One Card</u>	:	Title	20A4
<u>One Card</u>	:	NST = Number of stories	I10
<u>Set of Cards</u>	:	Heights (NST numbers)	8F10.3
<u>One Card</u>	:	NEL = Number of elements	I10
<u>One Card</u>	:	ICOD, NSIM	2I10

FOR EACH STRUCTURAL ELEMENT

ICOD = 1 Read springs directly

ICOD = 2 Read through SHART

NSIM = Additional number of elements for which following information applies

a) <u>ICOD = 1</u>

FOR EACH STRUCTURAL ELEMENT

For Each Different Floor

<u>One Card</u> : N1, N2, JCOD 3I10

N1, N2 = Identifiers of floor numbers with
same properties (N2-N1+1 floors);
N2 = 0 if information refers to a
single floor.

JCOD = 1 ÷ 8 = Spring type

<u>One Card</u> : AR1, AR2, AF1, AF2, AA, BB, CC, DLIM 8F10.3

If JCOD = 4 read a card in 2F10.3
with RKMIN, FYMIN

AR1 = Initial stiffness, AR2 = second stiffness

AF1 = Force at 1st yield, AF2 = Ultimate force

AA, BB, CC = Degradation factors

DLIM = Maximum ductility factor

<u>For Shear Walls</u>: (JCOD = 7)

AR1 = Modulus of elasticity

AR2 = Moment of inertia

AF1 = Shear area

AF2 = Plastic moment capacity

AA = Ultimate shear capacity

BB = Torsional rigidity

b) <u>ICOD = 2</u>

<u>One Card</u> : NSP, E, σy I10, 2F10.3

NSP = Number of spans

E = Modulus of elasticity

σy = Yield stress for bracing

<u>Set of Cards</u>: Spans (NSP numbers) 8F10.3

<u>One Card</u> : N1, N2, JCOD, SCOL, UL, A, B, C (3I10, 5F10.3)

N1, N2, JCOD as before

FOR EACH STRUCTURAL ELEMENT

For Each Different Floor

SCOL = Maximum shear capacity

UL = Maximum ductility factor

A, B, C = Degradation factors

If JCOD = 6 read a card with average
clear height in F10.3

<u>Set of Cards</u>: IC_1, MPC_1, IC_2, MPC_2, . . . 8F10.3

IC = Column moment of inertia

MPC = Plastic moment of a column

<u>Set of Cards</u>: IG_1, MPG_1, IG_2, MPG_2, . . . 8F10.3

IG = Girder moment of inertia

MPG = Plastic moment of a girder

<u>Columns and girders are numbered sequentially from left to right</u>

If <u>JCOD = 3</u> : <u>One Card</u>: Number of struts I10

<u>Set of Cards</u>: IDSPAN, ABR (I10, F10.3)

ABR = Area of bracing

If <u>JCOD = 4,5</u>: <u>One Card</u>: Number of infilled spans I10

<u>Set of Cards</u>: E, G, h, t, ℓ, τ (6F10.3, 1)

E = Modulus of elasticity

G = Shear modulus

h, t, ℓ = Infill dimensions

τ = Shear strength of infill

<u>Set of Cards</u>: N1, x, y, ALF (one card per element) (I10, 3F10.3)

N1 = Element ID

x,y = Coordinates of a point on the element

ALF = Angle (in degrees) of the element's
centerline with the x axis

Set of Cards: AMX, AMY, AIN, XCM, YCM (one card per floor) 5F10.3

AMX,AMY = Masses x, y

AIN = Slab moment of inertia about centroid

XCM,YCM = Coordinates of centroid

One Card : Damping ratio β F10.3

One Card : NMOD, XCR, YCR (I10, 2F10.3)

NMOD = Number of modes to be printed

XCR,YCR = Coordinates of geometrical center
(modal shapes are computed with
respect to that point)

One Card : NSCAL I10

NSCAL = Total number of motions for which
the analysis will be performed

One Card : NEAR I10

NEAR = Number of earthquake records to be read

One Card : Direction cosines for the motions 2F10.3

STANDARD RECORD

One Card : Earthquake title 20A4

One Card : SCALE, DT 2F10.5

Set of Cards: Ground accelerations 8F9.6

One Card : 999. F9.6

One Card : NPLOT, NPTSM 2I10

NPLOT = Number of plots

NPTSM = Average number of points per plot

Set of Cards: IPFL, IPCOD, IPDIR, NPL1, NPTS, IPEL 6I10
(NPLOT # of cards)

IPFL = Floor ID

IPCOD = Plotting code

IPDIR = Direction code

NPL1 = Starting point for plots

NPTS = Total number of points in plot

IPEL = Element ID

REPEAT NSCAL-1 TIMES

<u>One Card</u> : SCALF F10.3

SCALF = New scale factor by which the
accelerogram will be multiplied
and the analysis will be repeated

<u>One Card</u> : NPLOT, NPTSM (as before) 2I10

<u>Set of Cards</u>: IPFL, IPCOD, IPDIR, NPL1, NPTS, IPEL 6I10
(as before)

- -

/*

<u>CODES</u>

ICOD = 1 → Read spring properties directly

2 → Read properties of frames through SMART

JCOD = 1 → Bilinear spring

2 → Stiffness degradation (Concrete frame)

3 → Stiffness degradation (Braced frame)

4 → Stiffness and strength degradation (Infilled steel frame)

5 → Stiffness and strength degradation (Infilled concrete frame)

6 → Limited shear capacity

7 → Shear wall

8 → Trilinear spring

IPCOD = 1 → Absolute accelerations vs. time

2 → Displacements relative to ground vs. time

3 → Interstory displacement vs. time

4 → Force vs. distortion

IPDIR = 1 → x direction

2 → y direction

3 → Rotation