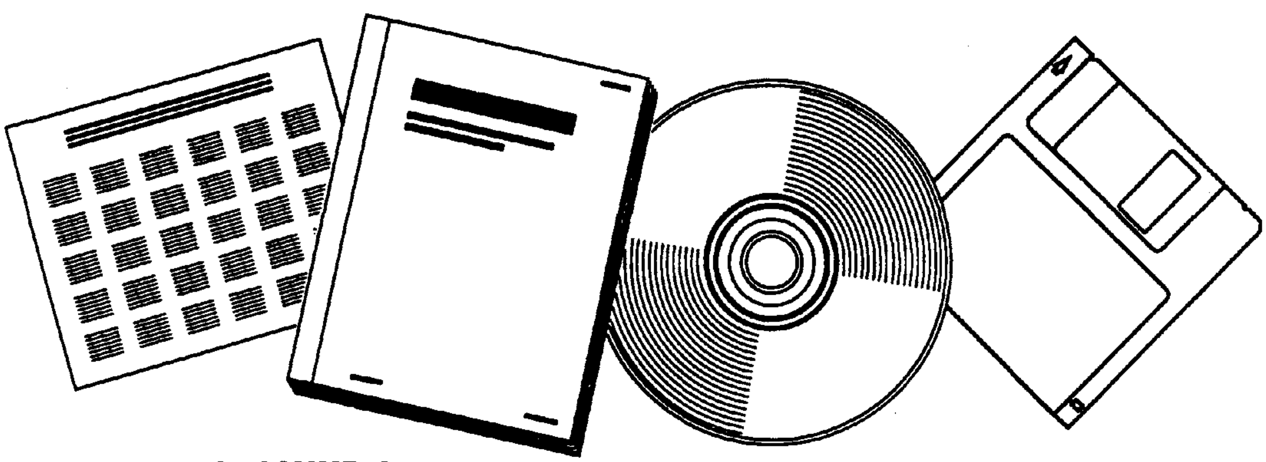
PB81-165318

Information is our business.

ASSESSMENT OF DAMAGEABILITY FOR EXISTING BUILDINGS IN A NATURAL HAZARDS ENVIRONMENT VOLUME II: DAMAGE COMPUTER PROGRAM USERS MANUAL

J.H. WIGGINS COMPANY
REDONDO BEACH, CA

SEP 80



U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

NSF/RA-800332

PB81-165318

ASSESSMENT OF DAMAGEABILITY FOR EXISTING BUILDINGS IN A NATURAL HAZARDS ENVIRONMENT

VOLUME II: 'DAMAGE' COMPUTER PROGRAM USERS MANUAL

TECHNICAL REPORT NO. 80-1332-2 • PREPARED FOR THE NATIONAL SCIENCE FOUNDATION, WASHINGTON, D.C.

j.h.wiggins company

THIS MATERIAL IS BASED UPON RESEARCH SUPPORTED BY THE NATIONAL SCIENCE FOUNDATION UNDER GRANT NUMBER ENV 77-19342. ANY OPINIONS, FINDINGS, AND CONCLUSIONS OR RECOMMENDATIONS EXPRESSED IN THIS PUBLICATION ARE THOSE OF THE AUTHOR(S) AND DO NOT NECESSARILY REFLECT THE VIEWS OF THE NATIONAL SCIENCE FOUNDATION.

50272-101

REPORT DOCUMENTATION PAGE	1. REPORT NO. NSF/RA-800332	2.	3. Recipient's Accession No. PB81 165318

4. Title and Subtitle
Assessment of Damageability for Existing Buildings in a Natural Hazards Environment, Vol. II: DAMAGE Computer Program Users Manual

5. Report Date
September 1980

6.

7. Author(s)
T. K. Hasselman, S. H. Chen, R. T. Eguchi, J. H. Wiggins

8. Performing Organization Rept. No.
80-1332-2

9. Performing Organization Name and Address
J. H. Wiggins Company
1650 South Pacific Coast Highway
Redondo Beach, CA 90277

10. Project/Task/Work Unit No.

11. Contract(C) or Grant(G) No.
(C)
(G) PFR7719342

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 new computer program for estimating the damage by floor for any type of building subjected to earthquake or wind loads is described. An original program provided a flexible tool for the analysis of these natural forces and their effect on specific buildings. Since this flexibility became a deterrent to practical use, the new program has incorporated several major changes. These are based on an investigation of the trade-offs between modeling detail and flexibility on one hand, and utility on the other, as they affect the primary output of the program--structural response and damageability. Changes incorporated in the new program include: (1) simplification of text; (2) internal setting of original input parameters; (3) elimination of several options present in the original program; and (4) use of a different damage estimation routine. This manual provides a general overview of the damageability assessment procedure and the input instructions for the DAMAGE computer program. The appendices include a sample input data form, an input/output example using the new program, and a FORTRAN computer listing of the DAMAGE program.

17. Document Analysis a. Descriptors

Earthquakes
Hazards
Damage control
Dynamic response
Computer programs
Wind pressure
Buildings
Structural analysis

b. Identifiers/Open-Ended Terms

Damageability assessment
DAMAGE

Earthquake Hazards Mitigation

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages
NTIS	20. Security Class (This Page)	22. Price

(See ANSI-Z39.18) See Instructions on Reverse OPTIONAL FORM 272 (4-77) (Formerly NTIS-35) Department of Commerce

ASSESSMENT OF DAMAGEABILITY FOR EXISTING BUILDINGS IN A NATURAL HAZARDS ENVIRONMENT

VOLUME II: 'DAMAGE' COMPUTER PROGRAM USERS MANUAL

Technical Report No. 80-1332-2

Prepared for

The National Science Foundation
1800 G Street, N. W.
Washington, D.C. 20550

by

T.K. Hasselman
Shwu-jen Hong Chen
Ronald T. Eguchi
John H. Wiggins

J.H. Wiggins Company
1650 South Pacific Coast Highway
Redondo Beach, California 90277

September 1980

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

1.1 Background

Reference [2] documents the development of a methodology and computer program for estimating the damage by floor for any type of building subjected to earthquake or wind loads. The original computer program provided a very flexible tool for the analysis of these natural forces and their effect on specific buildings. Multiple options for modeling the earthquake and wind environment, site modifications, structural configurations and types of damage were offered by this program. Understandably, this flexibility has proved to be somewhat of a deterrent to practical use, because of the large amount of input required to exercise the various options. This is especially true for local building and safety departments where the needs tend to be more utilitarian. The objectives of the present study were to investigate the tradeoffs between modeling detail and flexibility on one hand, and utility on the other, as they affected the primary output of the program which was structural response and corresponding measures of "damageability." Damageability is herein considered to be the potential of a building to suffer damage from the natural hazards (or forces) under consideration.

The present computer program incorporates several major changes. First, the text of the computer manual has been simplified so as to require only a minimal amount of previous computer experience. Second, as a result of a sensitivity study, many of the original input parameters in the previous program are now internally set. This does include, for example, ground motion attenuation constants which are used to transform Richter magnitudes to site ground motions (i.e., peak ground accelerations, velocities and displacements). Third, several options present in the original computer program have since been eliminated. One set of options eliminated was the soil amplification routines. Finally, the program utilizes a different damage estimation routine. The present damage subroutine is based on semi-empirical relationships between percent damage and interstory drift for different categories of buildings and systems. The reader is referred to the first volume of this report for discussion on the development of these damage relationships.

1.2 Schematic Flow Chart of Damageability Assessment Procedure

This section provides a general overview of the damageability assessment procedure used in the present computer program. Figure A shows a schematic of the program data deck. The input is organized such that most of the data is input in data blocks consistent with the computational organization of the program. Figure B shows a macro flowchart of the DAMAGE computer program.

The circled numbers noted in Figure B denote, for reference, the basic modules of the program. The building's site location, and the desired program options are read in as input to the program in ① . The user has the option of selecting any combination of hazard loads he desires. The hazards which are addressed in the program are earthquake, wind and tornado. The user must also select, at this point, the structural modeling option that will be exercised in the program. Three options are provided: Detailed Frame model; Story Stiffness model; and an Empirical model. The Detailed Frame model generates a stiffness matrix and computes modal deflections from a detailed multi-degree of freedom structural model incorporating beam and column framing elements, rigid diaphragms and concrete or masonary shear walls. The Story Stiffness model generates the same information as the Detailed Frame model but from user input story stiffness data. The Empirical model simply computes modal deflections from a linear mode shape model and a user input fundamental period. These three options provide enough program flexibility to allow the user to select the level of detail necessary to his problem.

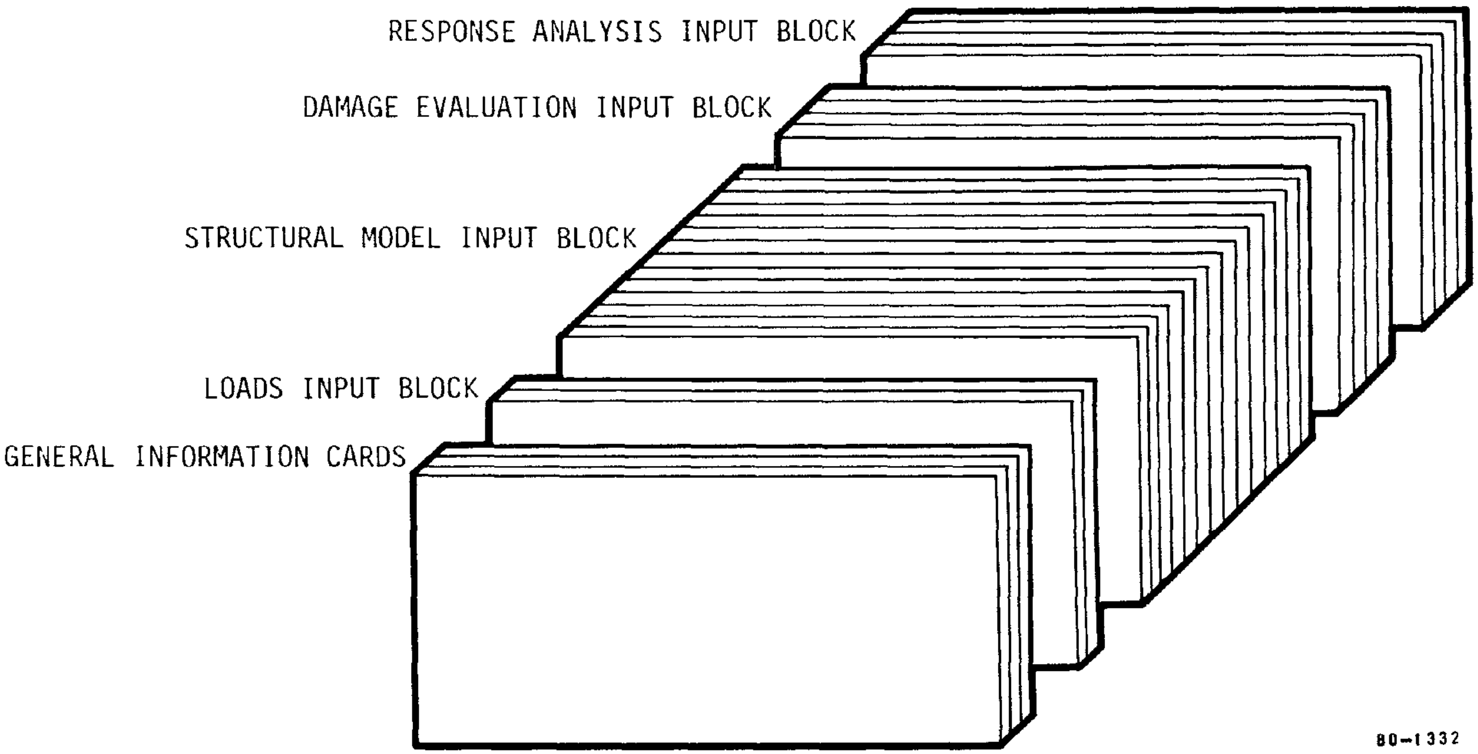


Figure A. DAMAGE Program Data Deck Set-up

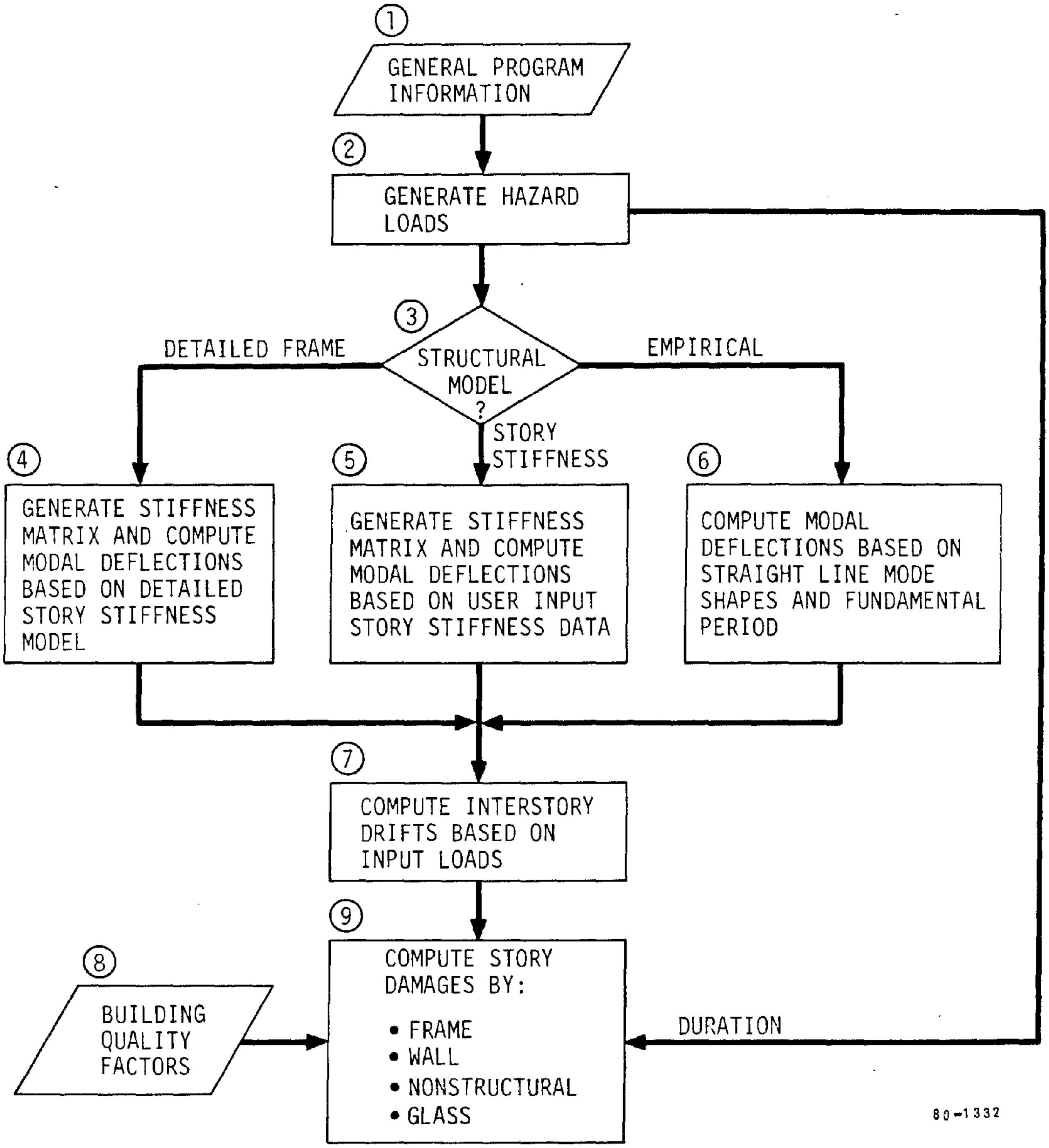


Figure B. Macro Flowchart of DAMAGE Computer Program

Depending upon which hazards are considered in the analysis, hazard input loads are generated in ② . For earthquake, a Richter magnitude and effective hypocentral distance must be provided. In addition, the user has the option of specifying peak ground acceleration, velocity and displacement which overrides those computed automatically from Richter magnitude and distance. For wind, a code describing the terrain surrounding the site, and an estimate of the fastest-mile wind velocity which can be expected to effect the site (and it's associated return period) must be input. For tornado, an estimate of the maximum wind velocity (and it's associated return period) must be determined.

Once these loads are generated, we then check in ③ to see which structural modeling option is to be exercised.If the Detailed Frame model in ④ is selected, the stiffness matrix and modal deflections are generated using a detailed finite element model. The stiffness matrix is constructed frame by frame, story by story, from top to bottom. Stiffness and mass contributions from each frame are superimposed in formulating a two-dimensional model of the building. The user may choose between two frame modeling options: steel frame, general frame. The general frame model is intended to be used primarily for concrete frame and shear wall type structures, although it could be used for steel frame structures as well. If the story stiffness model in ⑤ is selected, the stiffness matrix and modal deflections are generated based on user input story stiffness data, e.g., story stiffness, floor heights and floor weights. If the Empirical model in ⑥ is selected, modal deflections are simply computed using a linear mode shape model and a user input fundamental period for the building.

Depending upon the type of response analysis desired (i.e., dynamic for earthquake and static for wind), the computer program then computes interstory drifts in ⑦ based on the input hazard loads. For earthquake, if the computed response indicates that the ductility is greater than one, i.e., computed interstory drift exceeds the specified "drift-to-yield," then the response of the structure is altered so that the effects of yielding are reflected. For wind, an estimate of building damping and shape, wind direction and ratio of open surface area to solid area is required to evaluate the static response of the structure to wind loads.

Once the interstory drifts are computed for the subject building, damageability is evaluated. Damageability is determined in three parts:

I. Total damage to the building as a percent of estimated repair cost to replacement cost of the building. This damage category includes structural as well as nonstructural damage.

II. Damage to structural components. Damage to lateral load carrying components including frames and shear walls is estimated as a percent of their repair cost to replacement cost.

III. Damage to selected nonstructural components. Two primary categories of nonstructural damage are considered for both earthquake and wind. Glass damage is one of the categories in each case. For earthquake, the second category is damage to nonstructural components which are sensitive to floor motion. For wind, the second category includes partitions and ceilings which are sensitive to interstory drift.

In ⑧ Building quality factors reflecting the relative strengths, physical condition, integrity, and workmanship of the various systems are determined to help select the appropriate damage model to be used in ⑨. The relationships allow the estimation of damages on a floor by floor level, and a single estimate of total building damage.

1.3 Organization of the Manual

Chapter 2 of this manual contains the input instructions for the DAMAGE computer program. That chapter contains six major sub-sections. The first five deal with how to input specific data blocks. The sixth section contains all the Figures and Tables for Section 2. Appendix A contains a sample input data form. Appendix B presents an input/output example using the program. Appendix C presents a FORTRAN computer listing of the DAMAGE program.

2. INPUT INSTRUCTIONS

All of the input data for the computer program must be entered in fields of eight (8) columns each, with the exception of the first card (General ID card) where the first 72 columns are used. There may be as many as ten fields on any one card. Data will be either of the integer type (i.e., no decimal point specified) or of the floating-point type (i.e., a decimal point must be specified). The following provides examples of the above:

INTEGER (I):	999
FLOATING POINT (F):	999.0

The data type for each parameter can be determined by examining the code in the "Format Type" column. An 'I' signifies INTEGER form; and 'F' signifies FLOATING POINT form. One final note: all INTEGER values must be right justified in their particular fields. That is, no space must appear on the right side of the field. FLOATING POINT values may be punched anywhere in the field. All tables and figures for this section appear at the end of the report.

The data for a computer run must be organized in the sequence described below:

2.1 General Information

A. General ID Card

Column	Format Type	Entry
1-72	A*	Title or identification of computer run.

* "A" format type allows the input of alphanumeric characters (i.e., a mix of alphabetic letters and numbers)

B. Hazards Option Card

Column	Format Type	Entry
8	I	=1 consider earthquake
		=0 do not consider earthquake
16	I	=1 consider wind
		=0 do not consider wind
24	I	=1 consider tornado
		=0 do not consider tornado

C. Site Location Card

Column	Format Type	Entry
1-8	F	North latitude (degrees)
9-16	F	West longitude (degrees)

D. Structural Modeling Option Card

(see Section 2.3 for an explanation of the different options)

Column	Format Type	Entry
8	I	=1 Detailed frame
		=2 Story stiffness
		=3 Empirical

2.2 Loads

2.2.1 Earthquake Input: (Only entered if earthquake hazard is considered, i.e., if entry in column 8 of card B of Section 2.1 is equal to 1)

A. Earthquake Hazard Data Card

Column	Format Type	Entry
1-8	F	Richter Magnitude of earthquake being considered
9-16	F	Effective hypocentral distance between site and specified earthquake (miles)

If user-determined site ground motions are to override those computed internally from magnitude and distance, the following data fields should be entered on the same card.

Column	Format Type	Entry
17-24	F	Peak Ground Acceleration (g)
25-32	F	Peak Ground Velocity (in/sec)
33-40	F	Peak Ground Displacement (in)

2.2.2 Wind Input: (Entered only if wind hazard is considered, i.e.,if entry in column 16 of card B of Section 2.1 is equal to 1)

A: Wind Hazard Data Card

Column	Format Type	Entry
8	I	Code that describes terrain surrounding the structure (see Table 1)
9-16	F	Fastest-mile wind velocity for the site (in mph), as determined from Figures 1 through 5 or from Table 2 (select only one velocity, i.e., that velocity corresponding to

		your desired return period)
17-24	F	Specified return period associated with above wind velocity (years)

2.2.3 Tornado Input: (Entered only if tornado hazard is considered, i.e., if entry in Column 24 of card B of Section 2.1 is equal to 1)

A: Tornado Hazard Card

Column	Format Type	Entry
1-8	F	Tornado wind velocity (in mph).
9-16	F	Specified return period associated with above wind velocity (years) (See Figure 6 for explanation).

2.3 Structural Model

A: Structural Configuration Card

Column	Format Type	Entry
1-8	I	Number of stories
9-16	F	Total width of building (inches)
17-24	F	Total length of building (inches)
25-32	F	Parapet height (inches)

2.3.1 Detailed Frame Model: (Entered only if structural modeling option in card D of Section 2.1 is 1)

A: Number of Frames Card

Any number of frames may be used to model a building. Since the model is two-dimensional, stiffness matrices for the various frames are superimposed (summed). Each frame is assumed to lie in a vertical plane parallel to the direction of motion. Thus, for example, if the outside frames contain concrete shearwalls while the inner frames are constructed primarily of steel beams and columns, each may be modeled separately and their contributions to the overall stiffness of the structure will be additive, analogous to springs acting in parallel.

The framing options presented herein offer the user considerable latitude in types of building framing options. However, it should be noted that the user may, be placing "near zero" virtual members (properties down to 10^{-4} magnitude levels may be used without numerical ill-conditioning), extend the range of framing types. K bracing and other bracing systems may be handled in this manner.

The following restrictions apply to each two-dimensional frame generated; none of the restrictions may be exceeded:

Number of stories	30
Number of bays	9
Beam section types	99
Column section types	99
Total number of beams	200
Total number of columns	200

There is no limit to the number of frames which may be generated.

Column	Format Type	Entry
1-8	I	Number of frames to be analyzed using detailed model

B: Frame Option Card

Individual frames for a particular building may be modeled as either steel frames or general frames (See Figure 7). Cards B through K of this section must be completed for each individual frame. If more than one frame is specified, the sequence of cards B through K must be repeated using the appropriate data. Within each frame model (card sequence B through K) cards G through K must be repeated until all bays and all stories are defined. The only restriction that must be observed is that the story heights for all frames be the same.

Column	Format Type	Entry
8	I	=1 Steel frame (may have non-rigid joints) =2 General frames (used for concrete structures)

C: Frame Description Card

Only one frame description card is needed per frame. If steel frame is considered, the card contains:

Column	Format Type	Entry
1-8	F	Young's modulus (ksi)
16	I	Number of bays
17-24	I	Number of beam sections
25-32	I	Number of column sections
33-40	I	Number of braced bays
41-48	I	Number of bracing types
56	I	=0 Frame joints are simple moment resisting joints =1 Frame joints are complex (with or without rigid zone at end, see Figure 13)

If general frame is considered, the card contains:

Column	Format Type	Entry
8	I	Number of bays
9-16	I	Number of beam sections
17-24	I	Number of column sections
25-32	F	Young's modulus for columns (ksi)
33-40	F	Shear modulus for columns (ksi)
41-48	F	Young's modulus for beams (ksi)
49-56	F	Shear modulus for beams (ksi)
57-64	F	Weight of beam (lbs/cu. ft.)
65-72	F	Weight of column (lbs/cu. ft.)

D: Beam Properties Card(s)

If steel frame is considered, the beam properties card is used to select beam properties in Table 3 or to add additional beam properties which are not included in Table 3. If additional beam properties are to be input, beam numbering should begin with the number 82. No more than a total of 18 additional beams may be input. A separate card is prepared for each different beam section specified. The total number of input cards must be equal to the number of beam sections specified in the Frame Description card.

Column	Format Type	Entry
1-8	I	Beam number, if it is between 1 and 81, the corresponding beam type in Table 3 is used; if it is between 82 and 99, it adds additional properties to the data base. For the latter case, data for the following three fields must be entered.

9-16	F	Area (in.^{2})
17-24	F	Moment of inertia (in.^{4})
25-32	F	Weight (lb/ft)

If general frame is considered, the beam properties card is used to select a beam type from Figure 11 and to specify beam dimensions. A separate card is prepared for each different beam section specified. The total number of input cards must be equal to the number of beam sections specified in the Frame Description card.

Column	Format Type	Entry
1-8	I	Beam identification number (This number is used to identify different beam types. Beam numbering should begin with the number 1.)
9-16	F	Beam dimension*, defined by B1 in Figure 11
17-24	F	Beam dimension, defined by D1 in Figure 11
32	I	Beam section code, defined in Figure 11

If the beam section code > 2, enter the additional beam dimensions.

Column	Format Type	Entry
33-40	F	Beam dimension defined by T1 in Figure 11
41-48	F	Beam dimension defined by T2 in Figure 11

* If circular beam is selected (i.e., beam section code equal to two), then B1 and D1 are equal.

E: Column Properties Cards

If steel frame is considered, the column properties card is used to select column properties in Table 4 or to add additional column properties which are not included in Table 4. If additional column properties are to be input, column numbering should begin with the number 39 and end with the number 50 for columns with the strong axis bending, or begin with the number 89 and end with the number 99 for columns with the weak axis bending. A separate card is prepared for each different column section specified. The total number of input cards must be equal to the number of column sections specified in the Frame Description card.

Column	Format Type	Entry
1-8	I	Column number, if it is between 1 and 38 or 51 and 88, the corresponding column type in Table 4 is used; if it is between 39 and 50, and 89 or 99, it adds additional properties to the data base. For the latter case, data for the following three fields must be entered.
9-16	F	Area (in.^{2})
17-24	F	Moment of inertia (in.^{4})
25-32	F	Weight (lb/ft)

If general frame is considered, the column properties card is used to select a column type from Figure 11 and to specify column dimensions. A separate card is prepared for each different column section specified. The total number of input cards must be equal to the number of column sections specified in the Frame Description card.

Column	Format Type	Entry
1-8	I	Column identification number (This number is used to identify different column types. Column numbering should begin with the number 1)
9-16	F	Column dimension*, defined by B1 in Figure 11
17-24	F	Column dimension, defined by D1 in Figure 11
32	I	Column section code, defined in Figure 11

If the column section code > 2, enter the additional column dimensions.

Column	Format Type	Entry
33-40	F	Column dimension defined by T1 in Figure 11
41-48	F	Column dimension defined by T2 in Figure 11

F: <u>Bracing Properties Card(s)</u>

(Entered only if braced bays are considered, i.e., if the entry in columns 33-40 of card C of section 2.3.1 is greater than 0.) A bracing type is associated with a diagonal bay member of a particular cross-sectional area. Any one bracing type may be used repeatedly throughout the frame and is specified by either of the variables BT1 or BT2 which are defined in the Brace Card in card I of this Section. A separate card is prepared for each different bracing type specified. The total

* If circular column is selected (i.e., column section code equal to two), then B1 and D1 are equal.

number of input cards must be equal to the number of bracing types specified in the Frame Description card for steel frames.

Column	Format Type	Entry
1-8	I	Bracing number identification (This number is used to identify different bracing types. Brace numbering should begin with the number 1.)
9-16	F	Cross-sectional area of above bracing type member (in.^{2})

G: Bay Description Card(s)

One bay description card is required for each set of consecutive bays with identical widths. The total number of cards is always less than or equal to the number of bays in the Frame Description card.

Column	Format Type	Entry
8	I	Number of consecutive bays of identical width
9-16	F	Bay width defined by BW in Figure 12

If a general frame is being considered, enter the appropriate data in the following two fields.

Column	Format Type	Entry
17-24	F	Distance from column center line to face of column, left end of span defined by BL in Figure 12
25-32	F	Distance from column center line

to face of column, right end of span defined by AL in Figure 12

H: Story Description Card(s)

One story description card is required for each set of consecutive stories of identical configuration (dimensions and structural member properties) beginning from the top. The total number of cards is always less than or equal to the number of stories indicated in the Structure Configuration card (Card A of Section 2.3).

Column	Format Type	Entry
1-8	I	Number of consecutive stories of identical height, beam, column and bracing properties
9-16	F	Story height (in.)

Prepare two (2) or three (3) sets of cards per story level; the third set is required if braced bays are considered, i.e., if entry in columns 33-40 of Card C of Section 2.3 is greater than 0. Data are entered in sequence starting from the top story down to the bottom story of the building.

I: Beam Card(s)

One beam card is required for each set of consecutively identical beams for each story. The total number of cards per story is always less than or equal to the number of bays. If the steel frame option has been selected and frame joints are simple moment resisting joints, enter values only for fields 1 (i.e., columns 1-8) and 2 (i.e., columns 9-16). If the general frame option has been selected, enter values only for fields 1 (i.e., columns 1-8) and 2 (i.e., columns 9-16).

Column	Format Type	Entry
1-8	I	Number of consecutively identical beams, starting from the left
9-16	I	Type of beam from data base (Table 4) or input (beam properties card)
24	I	=0 joints are assumed rigid and the values for SCJ and SCK, Figure 13, that are read in are ignored =1 joints are not rigid with specified SCJ and SCK as read in
25-32	F	Dimension of rigid joint, A, at left end (see Figure 13)
33-40	F	Dimension of rigid joint, B, at right end (see Figure 13)
41-48	F	Spring constant left end, SCJ, (see Figure 13)
49-56	F	Spring constant right end, SCK, (see Figure 13)

J: Column Card(s)

One column card is required for each set of consecutively identical columns. For each story the total number of column cards per story is always less than or equal to the number of bays plus 1. If the steel frame option has been selected and frame joints are simple moment resisting joints, enter values only for fields 1 (i.e., columns 1-8) and 2 (i.e., columns 9-16). If the general frame has been selected, enter values only for fields 1 (i.e., columns 1-8) and 2 (i.e., columns 9-16).

Column	Format Type	Entry
1-8	I	Number of consecutively identical columns, starting from the left

9-16	I	Type of column from data base (Table 4) or input (column properties card)
24	I	=0 joints are assumed rigid and values for SCJ and SCK, Figure 13, that are read in are ignored =1 joints are not rigid with specified SCJ and SCK as read in
25-32	F	Dimension of rigid joint, A, at top end (see Figure 13)
33-40	F	Dimension of rigid joint, B, at to end (see Figure 13)
41-48	F	Spring constant top end, SCJ, (see Figure 13)
49-56	F	Spring constant bottom end, SCK, (see Figure 13)

K: Brace Card(s)

(Entered only if braced bays are considered, i.e., if entry in columns 33-40 of card C of Section 2.3.1 is greater than 0). The number of brace cards is always equal to the number of braced bays in the Frame Description card. Refer to Figure 14 for the orientation of pairs of braces.

Column	Format Type	Entry
1-8	I	Beam number (refer to numbering conventions in Figure 10)
9-16	I	Brace type for first brace, (BT1 in Figure 14)
17-24	I	Brace type for second brace, (BT2 in Figure 14)

2.3.2 Story Stiffness Model: (Entered only if structural modeling option in card D of Section 2.1 is 2)

A: Story Stiffness Card(s)

Prepare one (1) card per story level; data are entered in sequence starting from the top story down to the bottom story of the building. These stiffnesses correspond to the springs shown in Figure 8. They need not represent translational stiffnesses of column type structures where both ends of the column are constrained against rotation. Although this is one interpretation, resulting model frequencies may be too high so that somewhat smaller stiffness coefficients should be used.

Column	Format Type	Entry
1-8	F	Story stiffness coefficient
9-16	F	Story height (in.)

2.3.3 Empirical Model: (Entered only if structural modeling option in card D of Section 2.1 is 3, see Figure 9)

A: Fundamental Period Card

Column	Format Type	Entry
1-8	F	Fundamental period of the building (sec)

B: Story Height Card

Prepare one (1) card per story level; data are entered in sequence from top to bottom.

Column	Format Type	Entry
1-8	F	Story height (in.)

2.3.4 Floor Weight and Effective Story Drift to Yield

A: Floor Weight and Effective Story Drift to Yield Card

Prepared one (1) card per story level; data are entered in sequence from top to bottom.

Column	Format Type	Entry
1-8	F	Floor weight (kips)
9-16	F	Effective Drift to Yield (See Figure 15 for explanation)

2.4 Response

2.4.1 Dynamic Analysis: (Entered only if earthquake hazard is considered, i.e., if entry in column 8 of card B of Section 2.1 is equal to 1.)

A: Damping Option Card

Column	Format Type	Entry
8	I	=1 Damping for steel and reinforced concrete frame structures =2 Damping for bolted steel frame on timber structures

2.4.2 Static Analysis: (Entered only if wind hazard or tornado is considered, i.e., if entry in column 16 of card B of Section 2.1 is equal to 1.)

A: Ambient Damping Card

Column	Format Type	Entry
1-8	F	Building damping under wind conditions as a fraction of critical. This value should be less than the damping of the building under strong earthquake conditions.

B: External Pressure Coefficients Card

Column	Format Type	Entry
1-8	I	Code from Table 5 for specification of building's shape
16	I	Code from Table 6 for specification wind direction.

C: Window Damage Due to Wind Card

Column	Format Type	Entry
1-8	F	Ratio of open area to solid area $0. \leqslant \text{ratio} \leqslant 1.$
16	I	Wall code specifying which exterior wall has the majority of openings: =1 Windward wall 1 see Figure 16 =2 Leeward wall 2 see Figure 16 =3 Side wall 3 see Figure 16 =4 Side wall 4 see Figure 16 =5 Openings uniformly distributed

2.5 Damageability: (Entered only if earthquake hazard or wind hazard is considered, i.e., if either entries in columns 8 or 16 on card B of Section 2.1 are 1).

A: Building Damage Information Card

(For categories not appropriate to subject building, leave blanks)

Column	Format Type	Entry
8	I	Building quality factors for Framing System =1 poor quality =2 average quality =3 good quality (see Table 7 for definition of quality types)
16	I	Frame material type =1 structural steel =2 concrete - poured in place =3 precast prestressed
24	I	Building quality factors for shear wall systems =1 poor quality =2 average quality =3 good quality (see Table 7 for definition of quality types)
32	I	Wall material type =1 concrete - poured in place =2 precast prestressed =3 masonry
40	I	Quality factor for nonstructural materials

=1 poor quality
=2 average quality
=3 good quality
(see Table 8 for definition of quality types)

If the lateral resisting system is made up of a combination of two material types, the following card should be input. Otherwise, proceed to Card C.

B: Overall Building Classification Card

Column	Format Type	Entry
8	I	=1 the predominant lateral resisting system is a frame system
		=2 the predominant lateral resisting system is a shear wall
		=3 the predominant lateral resisting system is a combination of frames and shear walls.

C: Window Information Card

Column	Format Type	Entry
1-8	F	Nominal window height* (inches)
9-16	F	Nominal window width* (inches)
17-24	F	Thickness of glass used in nominal windows (in.)

*The parameters should reflect the width and height of an average pane of glass.

2.6 Tables and Figures for Section 2

Table 1. Input Code for Various Wind Terrains [6]

Code	Description of the Terrain
1	For centers of large cities
2	For wooden countryside, parkland, towns, outskirts of large cities, rough coastal belts
3	For open country, flat coastal belts, small islands situated in large bodies of water, prairie grassland, tundra, etc.

Table 2. Hawaii Fastest Mile Data (mph) at Sea Level* [4]

Exposure	Return Period in Years				
	2	10	25	50	100
Leeward (Westerly)	38	51	60	67	75
Windward (Easterly)	42	59	70	80	91

* The following footnote applies only to Hawaii.

Since the data of Table 2 is taken at sea level stations, it must be converted to an equivalent fastest mile wind velocity at 30 feet above the ground for a site at an elevation Z feet above sea level. The user must do the following conversion before entering the data into the wind program:

$$V_{Z30} = V_{30} \left(\frac{Z + 30}{30}\right)^{1/7}$$

where

V_{30} = a velocity from Table 2.

Z = elevation of site above sea level in feet.

V_{Z30} = new fastest mile wind velocity at 30 feet above ground for the site.

Table 3. Beam Sections Included in Stored Data Base

Beam No.	Section	Beam No.	Section
1	W16X 26	42	94
2	31	43	100
3	36	44	110
4	40	45	120
5	45	46	130
6	50	47	145
7	58	48	160
8	64	49	W27X 84
9	71	50	94
10	78	51	102
11	88	52	114
12	96	53	145
13	W18X 35	54	160
14	40	55	177
15	45	56	W30X 99
16	50	57	108
17	55	58	116
18	60	59	124
19	64	60	132
20	70	61	172
21	77	62	190
22	85	63	210
23	96	64	W33X 118
24	105	65	130
25	114	66	141
26	W21X 44	67	152
27	49	68	200
28	55	69	220
29	62	70	240
30	68	71	W36X 135
31	73	72	150
32	82	73	160
33	96	74	170
34	112	75	182
35	127	76	194
36	142	77	230
37	W24X 55	78	245
38	61	79	260
39	68	80	280
40	76	81	300
41	84		

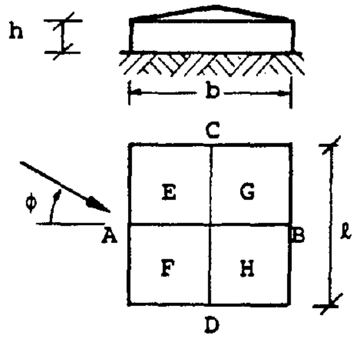
Table 4. Column Sections Included in Stored Data Base

Column Number		Section
Strong Axis Bending	Weak Axis Bending	
1	51	W14X 61
2	52	68
3	53	74
4	54	W14X 78
5	55	84
6	56	W14X 87
7	57	95
8	58	103
9	59	111
10	60	119
11	61	127
12	62	136
13	63	W14X 142
14	64	150
15	65	158
16	66	167
17	67	176
18	68	184
19	69	193
20	70	202
21	71	211
22	72	219
23	73	228
24	74	237
25	75	W14X 246
26	76	264
27	77	287
28	78	314
29	79	342
30	80	370
31	81	398
32	82	426
33	83	W14X 455
34	84	500
35	85	550
36	86	605
37	87	665
38	88	730

Table 5. Building Identification by Code ITYPE Using Swiss and ANSI A58.1 - 1972 Data, External Pressure Coefficients. All Data Are Swiss Unless Otherwise Noted [1,3]

ITYPE

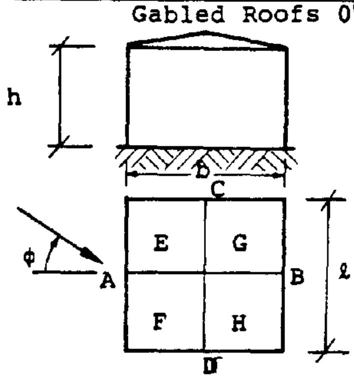
1 Gabled Roofs 0°-3°



$h:b:\ell = 1:4:4$

ϕ	A	B	C	D	E	F	G	H
0°	.9	-.3	-.4	-.4	-.8	-.8	-.3	-.3
45°	.5	-.4	.5	-.4	-.9	-.6	-.6	-.3
90°	-.4	-.4	.9	-.3	-.8	-.3	-.8	-.3

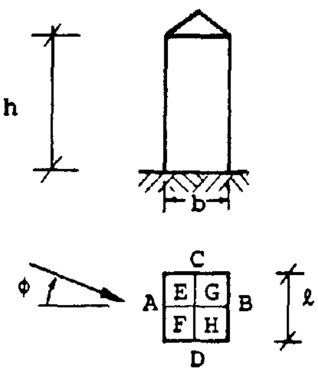
2 Gabled Roofs 0°-10°



$h:b:\ell = 1:1:1$

ϕ	A	B	C	D	E	F	G	H
0°	.9	-.5	-.6	-.6	-.7	-.7	-.5	-.5
45°	.5	-.5	.5	-.5	-.8	-.5	-.5	-.4
90°	-.6	-.6	.9	-.5	-.7	-.5	-.7	-.5

3 Gabled Roofs 0°-15°



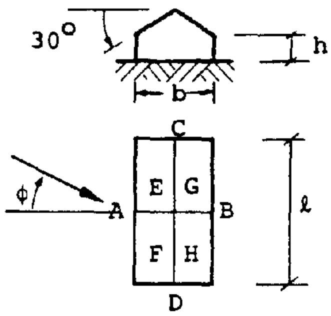
$h:b:\ell = 2.5:1:1$

ϕ	A	B	C	D	E	F	G	H
0°	.9	-.6	-.7	-.7	-.8	-.8	-.8	-.8
45°	.5	-.5	-.5	-.5	-.8	-.7	-.7	-.5
90°	-.7	-.7	.9	-.6	-.8	-.8	-.8	-.8

Table 5. Building Identification (Continued)

I TYPE

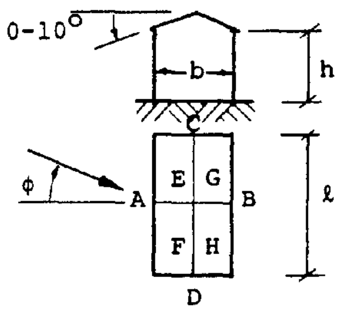
4



h:b:ℓ = 1:8:16

φ	A	B	C	D	E	F	G	H
0°	.8	-.5	-.5	-.5	.2	.2	-.6	-.6
45°	.5	-.5	.4	-.3	.1	-.1	-.8	-.5
90°	-.3	-.3	.9	-.3	-.5	-.1	-.5	-.1

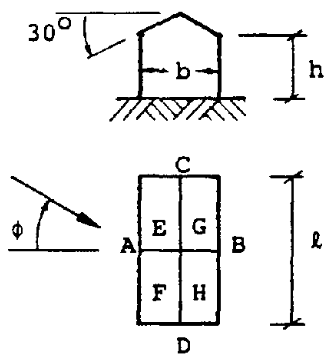
5



h:b:ℓ = 2.5:2:5

φ	A	B	C	D	E	F	G	H
0°	.9	-.5	-.7	-.7	-.6	-.6	-.5	-.5
45°	.6	-.5	.4	-.5	-.9	-.7	-.6	-.7
90°	-.5	-.5	.9	-.4	-.8	-.2	-.8	-.2

6



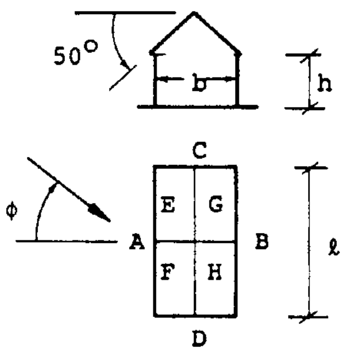
h:b:ℓ = 2.5:2:5

φ	A	B	C	D	E	F	G	H
0°	.9	-.5	-.7	-.7	-.6	-.6	-.5	-.5
45°	.6	-.5	.4	-.4	-.4	-.5	-.6	-.7
90°	-.5	-.5	.9	-.4	-.7	-.2	-.7	-.2

Table 5. Building Identification (Continued)

I TYPE

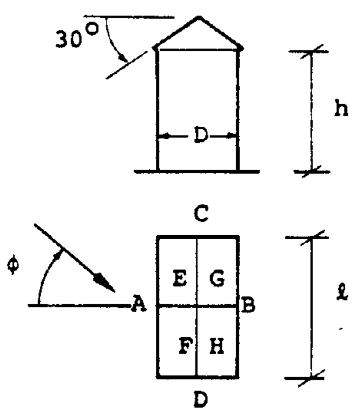
7



h:b:ℓ = 2.5:2:2.5

φ	A	B	C	D	E	F	G	H
0°	.9	-.5	-.7	-.8	.3	.3	-.6	-.6
45°	.6	-.5	.4	-.4	.3	-.1	-.5	-.6
90°	-.5	-.5	.9	-.4	-.8	-.2	-.8	-.2

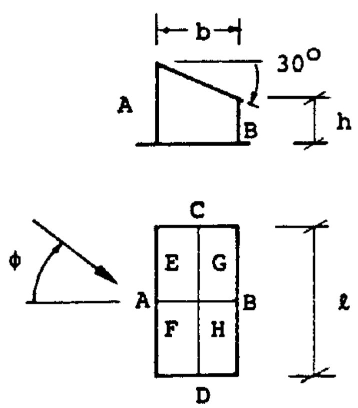
8



h:b:ℓ = 2:1:2

φ	A	B	C	D	E	F	G	H
0°	.9	-.5	-.8	-.8	-1.0	-1.0	-.5	-.5
45°	.6	-.5	.4	-.4	-.3	-.4	-.5	-.6
90°	-.6	-.6	.9	-.4	-.7	-.5	-.7	-.5

9



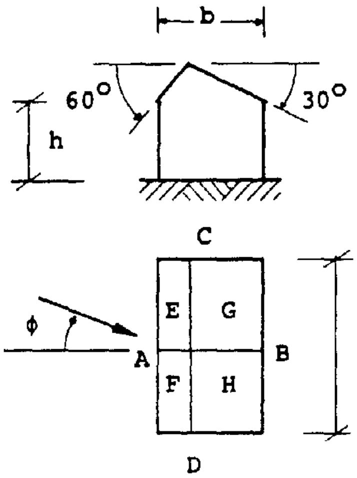
h:b:ℓ = 1:2.4:12

φ	A	B	C	D	E	F	G	H
0°	.9	-.5	-.6	-.6	-.5	-.5	-.5	-.5
45°	.5	-.6	.4	-.4	-1.2	-.7	-1.1	-.7
90°	-.4	-.3	.9	-.2	-.3	0	-.3	0

Table 5. Building Identification (Continued)

I TYPE

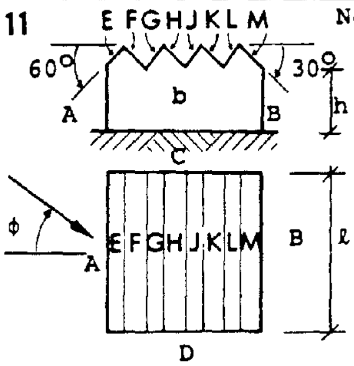
10



h:b:ℓ = 1:1:5

ϕ	A	B	C	D	E	F	G	H
0°	.9	-.5	-.6	-.6	.6	.6	-.5	-.5
45°	.5	-.8	.4	-.5	.2	-.1	-1.0	-.8
90°	-.4	-.4	.9	-.3	-.4	0	-.4	0

11

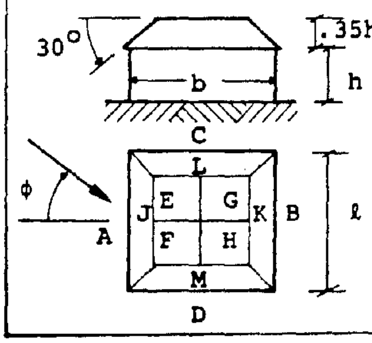


Neglect Wind Friction

h:b:ℓ = 1:4:5

ϕ	A	B	C	D	E	F	G	H	J	K	L	M
0°	.9	-.3	-.4	-.4	.6	-.6	-.6	-.5	-.5	-.4	-.3	-.3
45°	.5	-.4	.5	-.3	.2	-.8	-.5	-.4	-.2	-.4	-.2	-.5
90°	-.4	-.4	.9	-.3	-.3	-.4	-.4	-.4	-.4	-.4	-.4	-.3

12



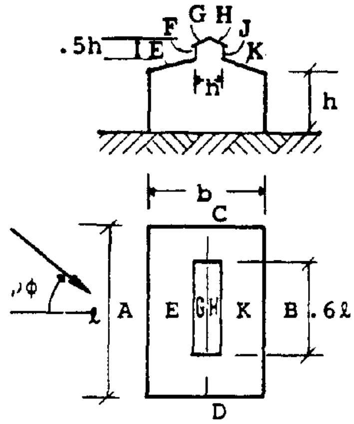
h:b:ℓ = 1:3:4

ϕ	A	B	C	D	E	F	G	H	J	K	L	M
0°	.9	-.5	-.6	-.6	-.8	-.8	-.4	-.4	-1.0	-.4	.5	-.5
45°	.5	-.5	.5	-.4	-.6	-.5	-.5	-.5	-.5	-.5	-.5	-.5
90°	-.5	-.5	.9	-.4	-.8	-.4	-.8	-.4	-.4	-.4	-1.0	-.4

Table 5. Building Identification (Continued)

I TYPE

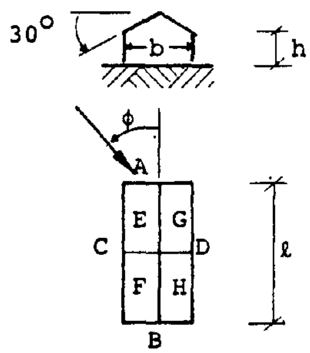
13



h:b:ℓ = 1:4:8

ϕ	A	B	C	D	E	F	G	H	J	K
0°	.8	-.5	-.7	-.7	.2	.6	-1.0	-.6	-.5	-.6
45°	.4	-.5	.4	-.5	-.3	.2	-1.3	-1.4	-1.0	-.7
90°	-.4	-.4	.8	-.3	-.4	-.2	-.3	-.3	-.2	-.4

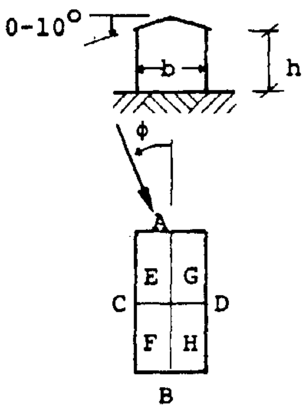
14



h:b:ℓ = 1:8:16

ϕ	A	B	C	D	E	F	G	H
0°	.9	-.3	-.3	-.3	-.5	-.1	-.5	-.1
45°	.4	-.3	.5	-.5	.1	-.1	-.8	-.5
90°	-.5	-.5	.8	-.5	.2	.2	-.6	-.6

15



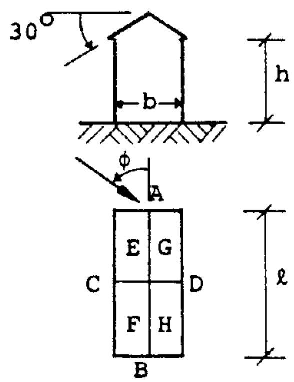
h:b:ℓ = 2.5:2:5

ϕ	A	B	C	D	E	F	G	H
0°	.9	-.4	-.5	-.5	-.8	-.2	-.8	-.2
45°	.4	-.5	.6	-.5	-.9	-.7	-.6	-.7
90°	-.7	-.7	.9	-.5	-.8	-.6	-.5	-.5

Table 5. Building Identification (Continued)

I TYPE

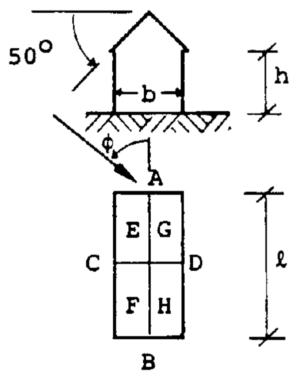
16



h:b:ℓ = 2.5:2:5

ϕ	A	B	C	D	E	F	G	H
0°	.9	-.4	-.5	-.5	-.7	-.2	-.7	-.2
45°	.4	-.4	.6	-.5	-.4	-.5	-.6	-.7
90°	-.7	-.7	.9	-.5	-.6	-.6	-.5	-.5

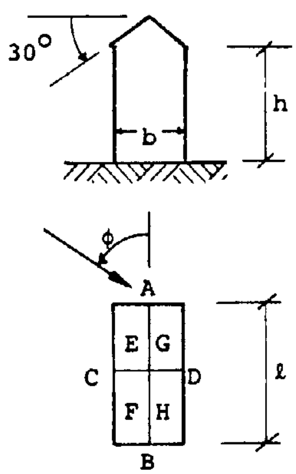
17



h:b:ℓ = 2.5:2:5

ϕ	A	B	C	D	E	F	G	H
0°	.9	-.4	-.5	-.5	-.8	-.2	-.8	-.2
45°	.4	-.4	.6	-.5	.3	-.1	-.5	-.6
90°	-.8	-.8	.9	-.5	.3	.3	-.6	-.6

18



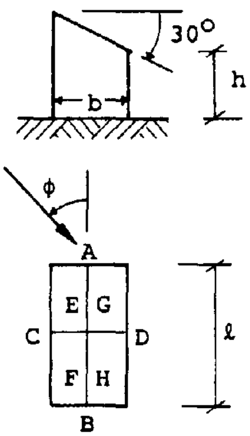
h:b:ℓ = 2:1:2

ϕ	A	B	C	D	E	F	G	H
0°	.9	-.4	-.6	-.6	-.7	-.5	-.7	-.5
45°	.4	-.4	.6	-.5	-.3	-.4	-.5	-.6
90°	-.8	-.8	.9	-.5	-1.0	-1.0	-.5	-.5

Table 5. Building Identification (Continued)

I TYPE

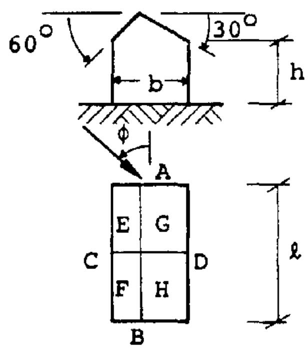
19



h:b:ℓ = 1:2.4:12

φ	A	B	C	D	E	F	G	H
0°	.9	-.2	-.4	-.3	-.3	0	-.3	0
45°	.4	-.4	.5	-.6	-1.2	-.7	-1.1	-.7
90°	-.6	-.6	.9	-.5	-.5	-.5	-.5	-.5

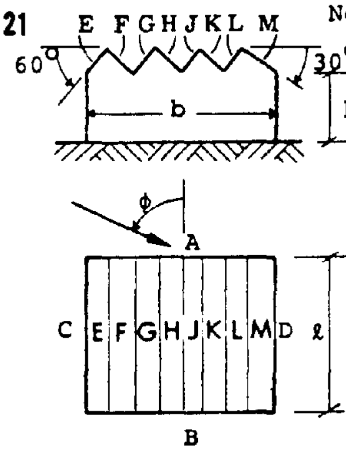
20



h:b:ℓ = 1:1:5

φ	A	B	C	D	E	F	G	H
0°	.9	-.3	-.4	-.4	-.4	0	-.4	0
45°	.4	-.5	.5	-.8	.2	-.1	-1.0	-.8
90°	-.6	-.6	.9	-.5	.6	.6	-.5	-.5

21



Neglect Wind Friction

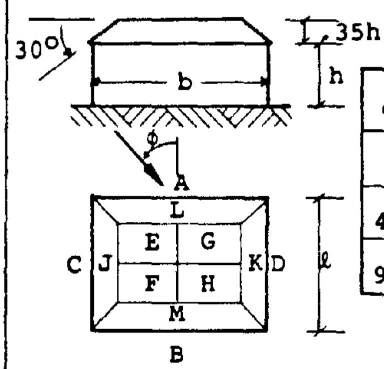
h:b:ℓ = 1:4:5

φ	A	B	C	D	E	F	G	H	J	K	L	M
0°	.9	-.3	-.4	-.4	-.3	-.4	-.4	-.4	-.4	-.4	-.4	-.3
45°	.5	-.3	.5	-.4	.2	-.8	-.5	-.4	-.2	-.4	-.2	-.5
90°	-.4	-.4	.9	-.3	.6	-.6	-.6	-.5	-.5	-.4	-.3	-.3

Table 5. Building Identification (Continued)

I TYPE

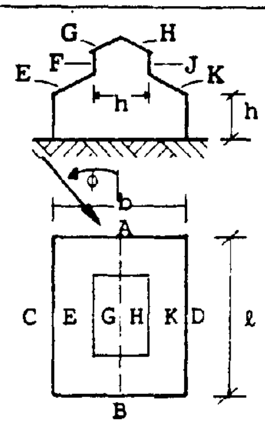
22



h:b:ℓ = 1:3:4

φ	A	B	C	D	E	F	G	H	J	K	L	M
0°	.9	-.4	-.5	-.5	-.8	-.4	-.8	-.4	-.4	-.4	-1.0	-.4
45°	.5	-.4	.5	-.5	-.6	-.5	-.5	-.5	-.5	-.5	- .5	-.5
90°	-.6	-.6	.9	-.5	-.8	-.8	-.4	-.4	-1.0	-.4	-.5	-.5

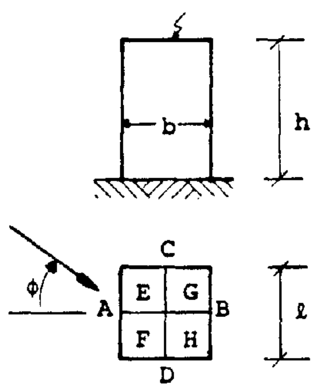
23



h:b:ℓ = 1:4:8

φ	A	B	C	D	E	F	G	H	J	K
0°	.8	-.3	-.4	-.4	-.4	-.2	- .3	- .3	- .2	-.4
45°	.4	-.5	.4	-.5	-.3	.2	-1.3	-1.4	-1.0	-.7
90°	-.7	-.7	.8	-.5	-.2	.6	-1.0	-.6	-.5	-.6

24 Essentially Flat



h:b:ℓ = 1:≥2.5:≥2.5

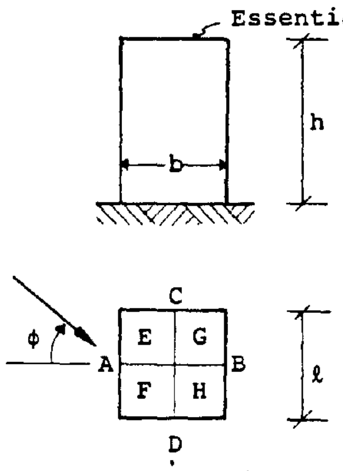
φ	A	B	C	D	E	F	G	H
0°	.8	-.6	-.7	-.7	-.8	-.8	-.8	-.8
90°	-.7	-.7	.8	-.6	-.8	-.8	-.8	-.8

ANSI A58.1 - 1972
(No Specifications for φ = 45°)

Table 5. Building Identification (Continued)

I TYPE

25



h:b:ℓ = 1:<2.5:<2.5

φ	A	B	C	D	E	F	G	H
0°	.8	-.5	-.7	-.7	-.7	-.7	-.7	-.7
90°	-.7	-.7	.8	-.5	-.7	-.7	-.7	-.7

ANSI A58.1 - 1972
(No Specification for φ = 45°)

Table 6. Codes for Specification of Wind Direction with Respect to Line of Frame Action

ANGLE	Direction
1	0°
2	45°
3	90°

Table 7. Quality Rating of Materials in Structural System (a. Strength)

Material	Quality		
	Good Q = 3	Average Q = 2	Poor Q = 1
Structural Steel & Metal Decking	$f_y \geq 40$ ksi Double sheet metal decking	$f_y \geq 30$ ksi Single sheet metal decking	$f_y < 30$ ksi Cast iron Corrugated Iron
Concrete: Including Precast & Prestressed	$f'_c \geq 3$ ksi	$f'_c \geq 2$ ksi	$f'_c < 2$ ksi
Masonry (Based on core tests or specified strengths)	$f'_m \geq 2.0$ ksi Mortar $f'_c \geq 2.0$ ksi Grout $f'_c \geq 2.0$ ksi Continuous Inspection	$f'_m \geq 1.2$ ksi Mortar $f'_c \geq 1.0$ ksi Grout $f'_c \geq 1.0$ ksi Called Inspection	$f'_m < 1.2$ ksi Mortar $f'_c < 1.0$ ksi Old sand-lime mortar Grout $f'_c < 1.0$ ksi No Inspection
Timber Plywood	$f_b \geq 1.9$ ksi Select Structural Structural I Plywood	$f_b \geq 1.5$ ksi Construction Industrial Structural II Plywood	$f_b < 1.5$ ksi Not Grade Marked Plywood not grade marked
Gypsum	$f'_g \geq 1.0$ ksi	$f'_g \geq 0.5$ ksi	$f'_g < 0.5$ ksi

Table 7. Quality Rating of Materials in Structural System (b. Physical Condition)

Material	Physical Condition: Good Q = 3	Average Q = 2	Poor Q = 1
Structural Steel and Metal Decking	No weld cracks. No cracks at holes. No corrosion.	Few cracked welds (none critical). Few cracks at holes (none critical). Slight corrosion. Machine bolts.	Many cracked welds. Many cracks at holes. Moderate corrosion.
Concrete: Including Precast & Prestressed	Few minor shrinkage cracks. No shear or flexure cracks. No excessive deflection, (i.e., drift < story height divided by 240).	Few shear and/or flexure cracks (none critical). Few shrinkage cracks. Few cracked welds at precast connections.	Many shrinkage cracks. Many shear and flexure cracks. Deteriorated concrete. Exposed reinforcing. Excessive deflections in beams and slabs. Many cracked welds.
Masonry	Few minor shrinkage cracks. No shear or flexure cracks. Plumb walls.	Few moderate shrinkage cracks. Few shear or flexure cracks.	Many shrinkage cracks. Many shear and flexure cracks. Deteriorated, soft mortar. Exposed reinforcing. Bowed and out of plumb walls.
Timber and Plywood	No splits or twisted members. No loose bolts or screws. No loose knots. No projecting nails on bottom side. Grade worked lumber.	Few knots and splits, twisted members. Few loose bolts & screws. Minor-moderate deflections. Few loose nails. Fair nailing pattern. Fair connections.	Many splits and twisted members. Many loose bolts & screws. Rotting. Excessive deflections. Many loose nails.
Gypsum	No cracks in formboard. Good connection details. Smooth hand surface.	Few cracks in formboard. Crack pattern over T-supports.	Many cracks and excessive deflection of formboard.

Table 7. Quality Rating of Materials in Structural System (c. Integrity)

Material	Workmanship		
	Good Q = 3	Average (Note A) Q = 2	Poor (Note A) Q = 1
Structural Steel	All parts of joints in full contact. Members straight. Structure plumb. Bolts tight. Structural welds all OK. Deck welds all OK. Continuous Inspection.	Few joints with members not in full contact. Few bent members. Few loose bolts. Few poor welds. Selective Inspection.	Many joints with members not in full contact. Many bent members. Many loose bolts. Many poor welds. No Inspection.
Concrete (Including Precast and Prestressed)	Clean construction joints. No rock pockets. Construction straight and plumb. All tendons grouted. Continuous inspection.	Few poor construction joints. Few small rock pockets. Few members show evidence of form failure. Few poor welds at precast joints. Tendons not grouted. Called inspection.	Many poor construction joints. Many rock pockets. Many evidences of form failure. Mixture of hardrock and lightweight concrete at joints. Many poor welds. No inspection.
Masonry	All grout and mortar spaces filled. Construction straight and plumb. Running bond. Continuous inspection.	Few grout and mortar spaces not filled. Running bond. Called inspection.	Many grout and mortar spaces not filled. Construction bowed and out of plumb. Stacked bond. No inspection.
Timber and Plywood	All members in full bearing contact at joints. Bolts & screws tight. Members straight & plumb. All plywood edges blocked with members 3"+ in width. Continuous inspection.	Few members not in full contact. Few loose bolts & screws. Few twisted or bowed members. Diagonal sheathing well nailed. Blocking by cleats and members 2"+ in width. Called inspection.	Many members not in full contact. Many loose bolts & screws. Many twisted and/or bowed members. Straight sheathing. Unblocked plywood. Irregular nail spacing & edge distance. No inspection.
Gypsum	Smooth hard surface. Continuous inspection.	Fair surface. Called inspection.	Rough, uneven surface. Soft material. No inspection.

Table 7. Quality Rating of Materials in Structural System (d. Workmanship)

Material	Quality		
	Good Q = 3	Average Q = 2	Poor Q = 1
Structural Steel and Metal Decking	Ductile framing details. High strength bolts or good weld details to member. Approved tested deck systems properly welded and connected. Members well braced laterally. Decking welded for ≥ 1.0 K/LF in. shear.	Main connections are riveted or welded. Minor connections with unfinished bolts. Some members not adequately braced laterally. Decking welded for ≥ 0.5 K/LF in. shear.	Machine bolted connections. No lateral bracing of members. Deck diaphragm. <0.5 K/LF
Concrete: a. Poured in place	Close spacing of ties and stirrups.		Deficient framing details.
b. Precast c. Pre-stressed	Ductile reinforced details. Spiral type columns. No precast or prestressed members.	Ordinary reinforced details tied columns. (#3 and over). Poured precast joinery well detailed w/welded reinforced precast & prestressed members.	No mild steel Deficient reinforced details tied columns (#2 & smaller). Welded precast joinery.
Masonry	Fully grouted members. Embedded anchors, bolts, & strap ties. Adequate reinforced, uniformly spaced in two directions. All columns filled. Adequate laps at corners and intersections. Adequate bars at openings.	Bolted connections. Adequate reinforced, concentrated at tops & bottoms of walls. Columns filled at reinforcing only. Horizontal mesh reinforced.	Non-grouted wall, nailed connection. No or partial reinforcement. Poor tie and lap details. Filler walls not anchored to framing.
Timber	Strap anchors to masonry walls plus shear transfer connections.	Melar hardware at some connections. Few steel strap ties at joints.	No connections to masonry walls. No strap at connections.
Plywood	Bolts at critical joints well anchored to footings. Steel strap ties to walls spaced 4 ft. or less.	Bolted & nailed joints anchored to footings. No strap ties or straps over 4 ft. o.c.	Not anchored to footings. No strap ties.
Gypsum	Trussed purlins. Adequate connection to walls. Mesh reinforced.	Solid purlins. Poor connections to walls.	No reinforcement. No connections to walls.

Table 8. Quality Ratings for Nonstructural Components

Component	Quality: Good Q = 3	Average Q = 2	Poor Q = 1
Ceilings	Gypsum Board and MLP attached directly to structural framing (not suspended)	Suspended wood framing with Gypsum Board nailed Suspended Metal Lath and Plaster. Suspended Plywood nailed to wood framing.	Suspended "T" Bar with lay-in or splined acoustical tiles.
Partitions	Wood Panel, well anchored and braced to structure	Gypsum Board and Metal Studs and Plaster, anchored and braced to structure	Unreinforced masonry and Gypsum block. Ceiling height partitions, braced by suspended "T" bar ceilings.
Trim and Veneer	Not Applicable	Masonry Veneer and facings, well anchored and with cement mortar	Masonry Veneer on facings, not anchored and with poor mortar. Heavy ornamentation such as statues, steeples, and cornices.
Glass	Full elastomeric mounting with at least 1/2" clearance all around. Glass set outside of framing.	Elastomeric Mounting, 1/4" Clearance, set between framing.	Fixed sash with putty - negligible clearance
Filler Walls Between Framing Members	Reinforced Concrete or masonry wall anchored to frame. Metal and wood studs and plaster anchored to structure.	Unreinforced masonry cement mortar anchored to structural framing.	Unreinforced masonry, poor mortar. No anchorage to structural framing.

Table 8. Quality Ratings for Nonstructural Components (Continued)

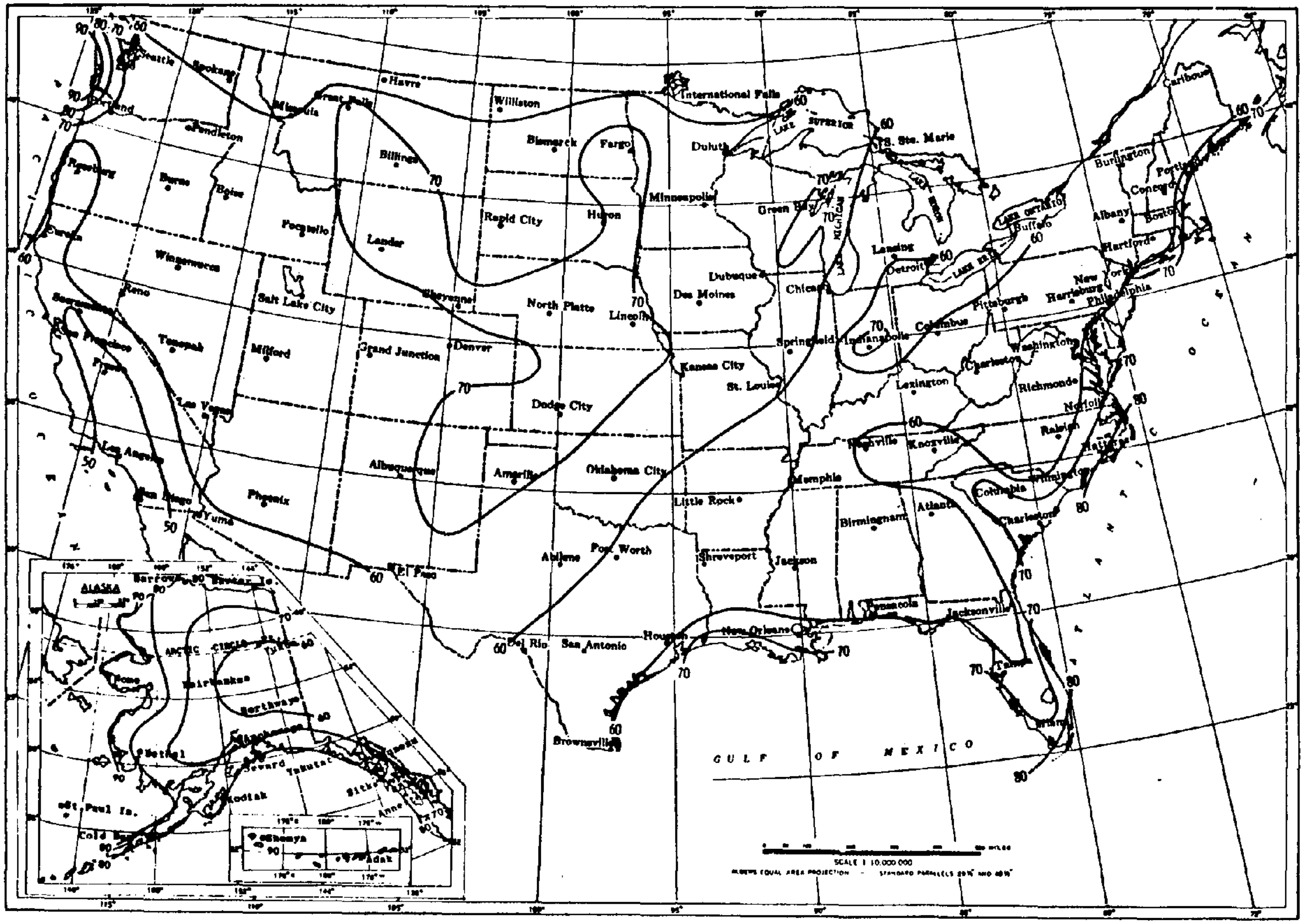
Component	Quality: Good Q = 3	Average Q = 2	Poor Q = 1
Curtain walls set outside of framing line	Reinforced concrete and masonry well anchored to structure. Metal frame and siding well anchored. Struss well anchored.	Unreinforced masonry with good cement mortar. Anchored to structure. Precast concrete units - well anchored to structure.	Unreinforced masonry, poor mortar, not anchored to structure. Precast concrete units, welded anchorage.
Fire Escapes	Not Applicable.	Metal Framing attached to building.	Free standing concrete and masonry.
Overhangs and Gargoyles	Not Applicable.	Reinforced and anchored.	Unreinforced masonry, poorly anchored.
Signs and Marquees	Not Applicable.	Steel Frames. Signs on roof and walls.	Heavy marquees.
Antennae	Steel Towers Guyed.	Steel towers on roof not guyed.	Not Applicable.

Table 9. Drift to Yield by Type of Building and Quality Rating

FUNCTION	MATERIAL	GOOD	AVERAGE	POOR
		Δ_y	Δ_y	Δ_y
FRAME	STRUCTURAL STEEL	.0125	.0077	.0036
	CONCRETE POURED IN PLACE	.0084	.0052	.0029
	PRECAST CONCRETE	.0049	.0027	.0013
SHEAR WALL	CONCRETE POURED IN PLACE	.0045	.0026	.0017
	PRECAST CONCRETE	.0029	.0016	.0010
	MASONRY	.0059	.0041	.0021

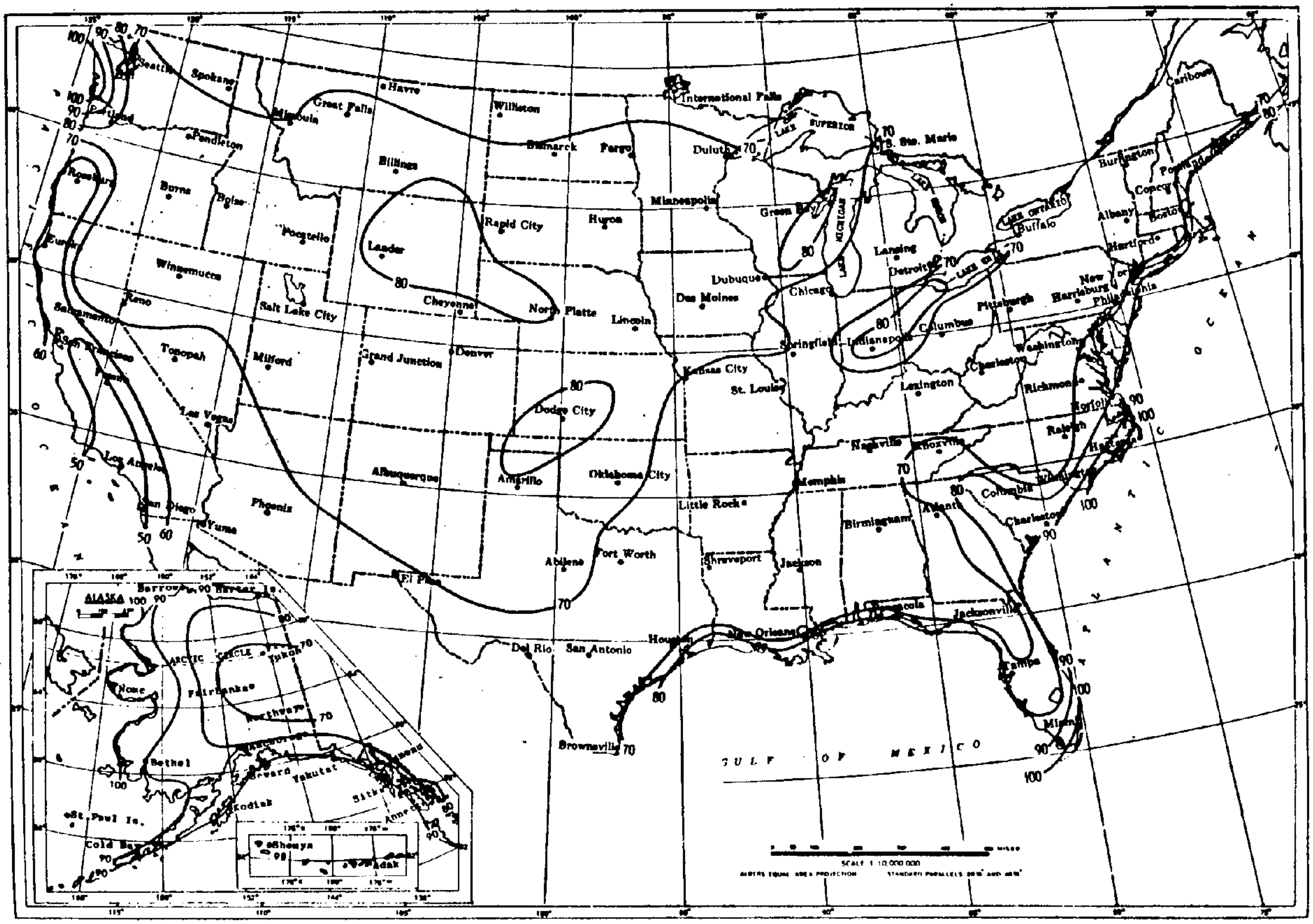
80-1332

Figure 1. Mean Return Wind Velocity in Miles Per Hour - 2 Year Return Period [4]



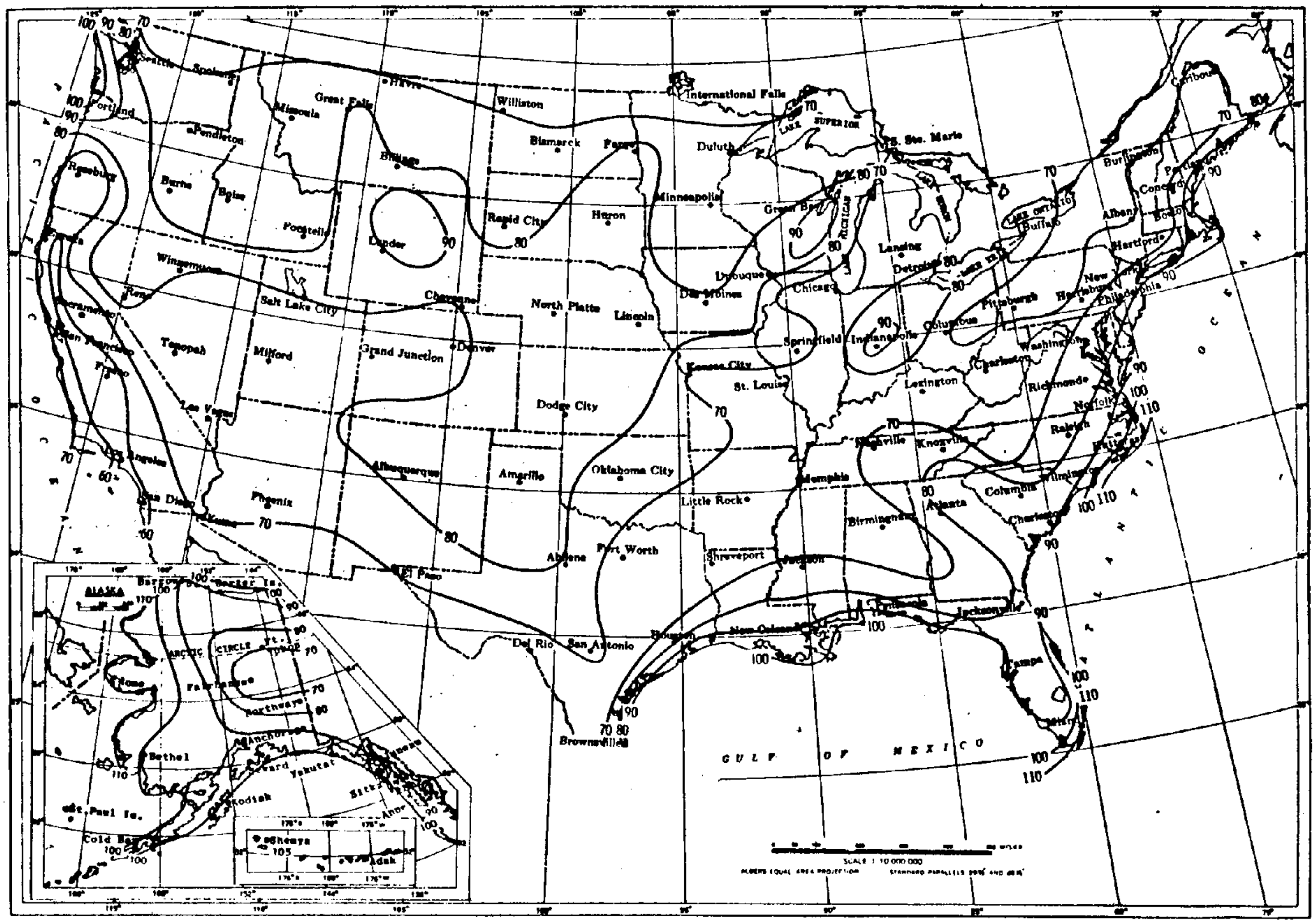
80-1332

Figure 2. Mean Return Wind Velocity in Miles Per Hour - 10 Year Period [4]



80-1332

Figure 3. Mean Return Wind Velocity in Miles Per Hour - 25 Year Return Period [4]



80-1332

Figure 4. Mean Return Wind Velocity in Miles Per Hour - 50 Year Return Period [4]

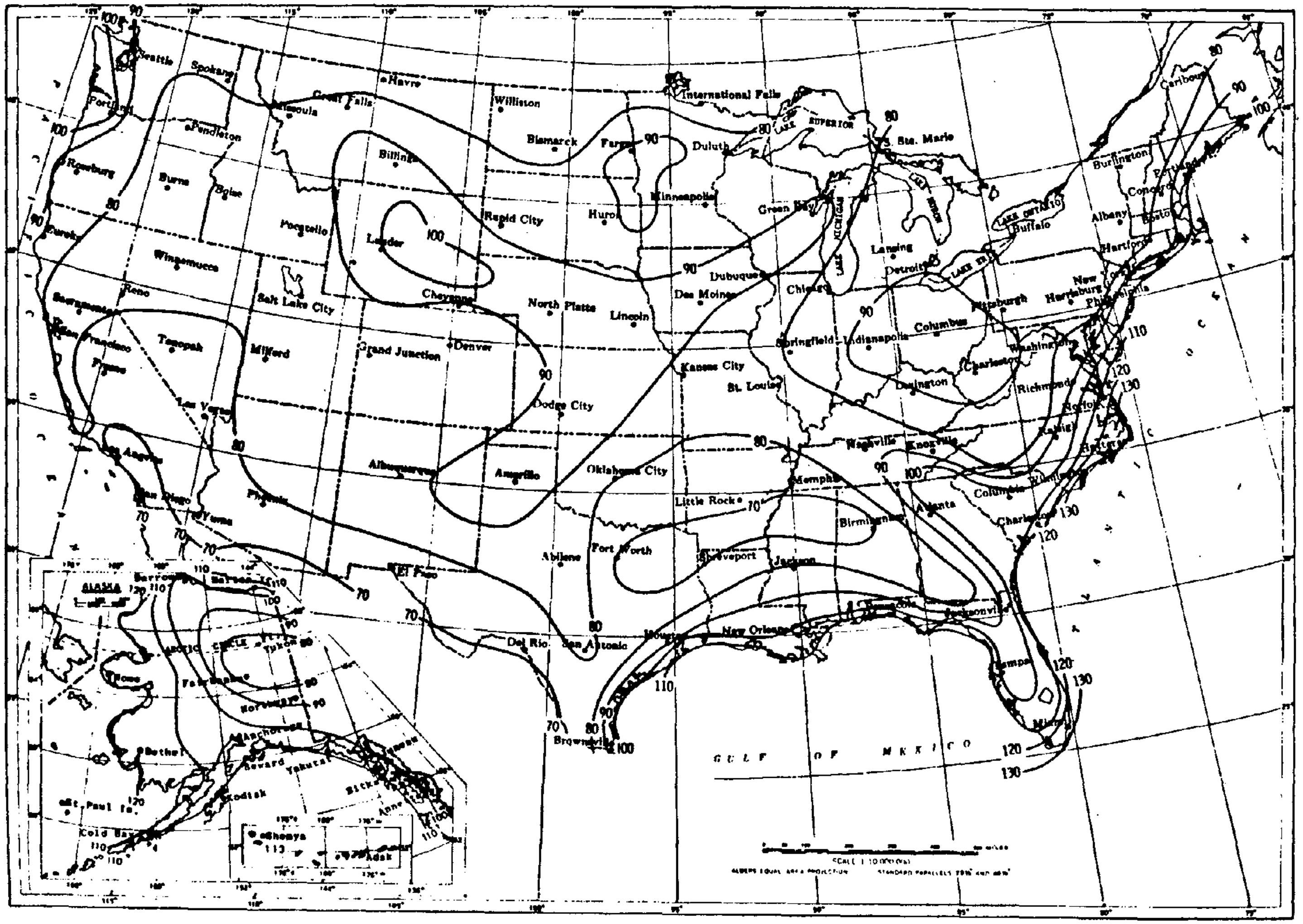
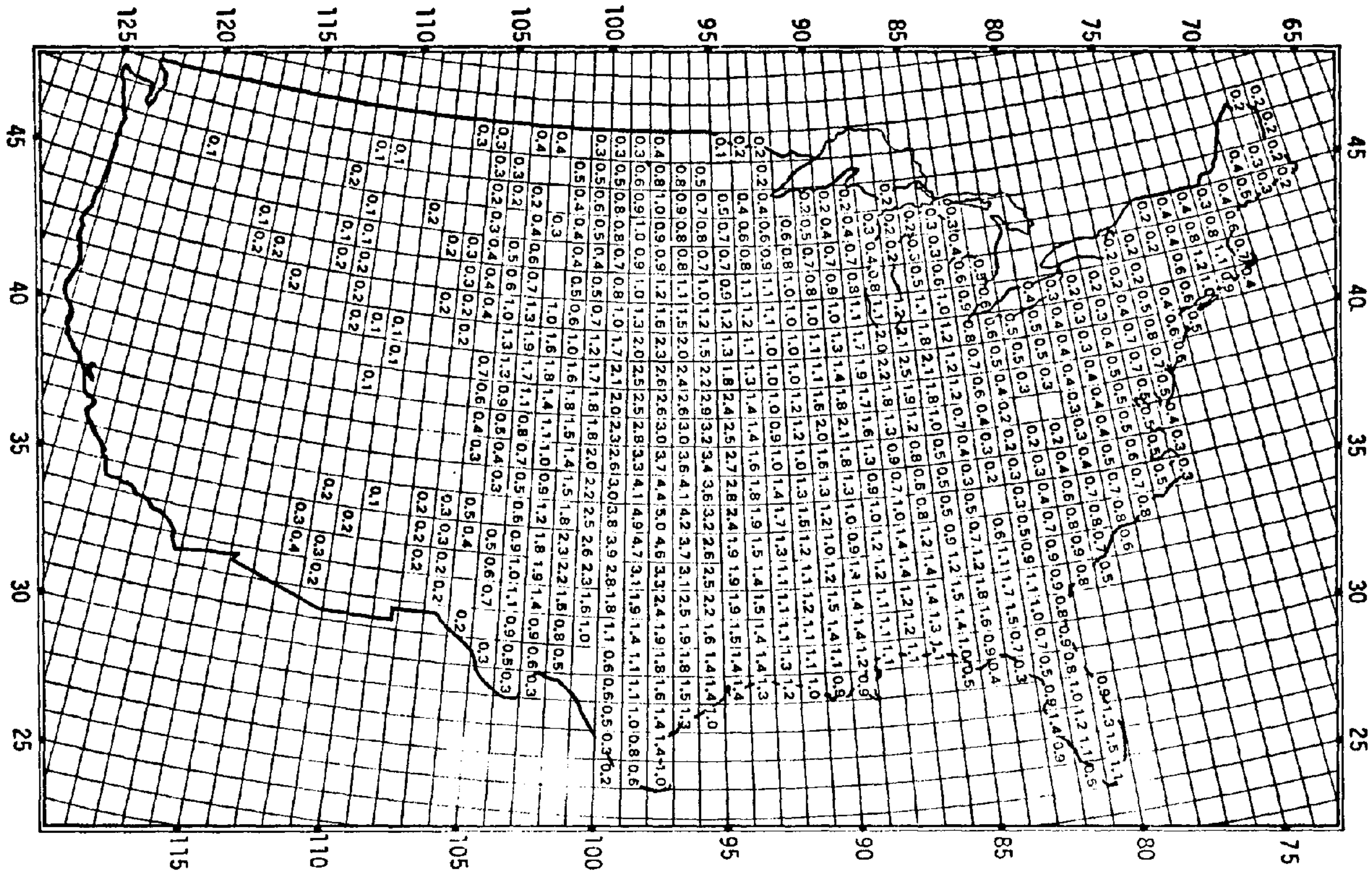
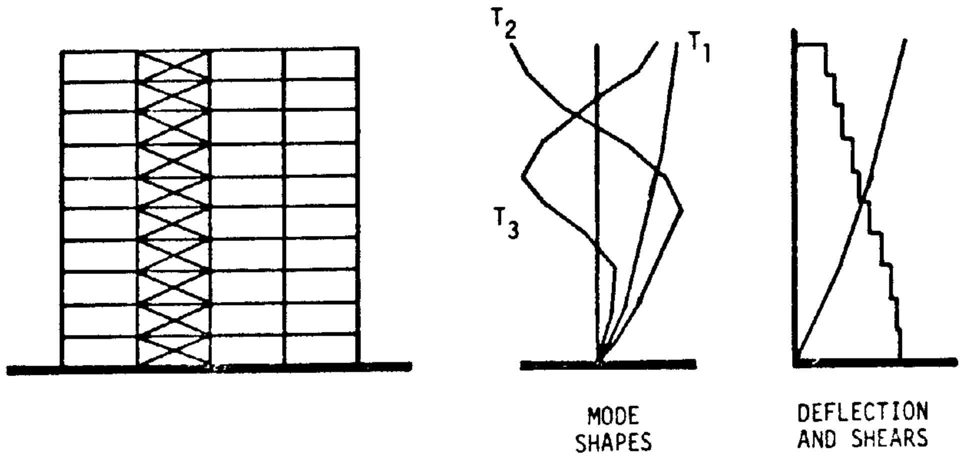


Figure 5. Mean Return Wind Velocity in Miles Per Hour - 100 Year Return Period [4]

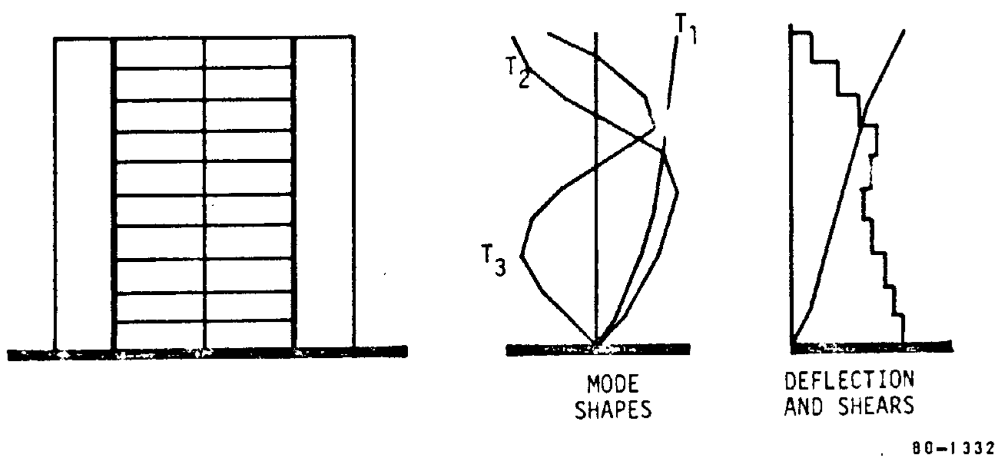


Note: The return period for a one degree by one degree grid may be obtained by inverting the mean annual frequency of tornadoes observed for that grid.

Figure 6. Mean Annual Frequency of Tornadoes 1953-1962, [5]



(Steel Frame Model)



(General Frame Model)

Figure 7. Detailed Frame Model Options

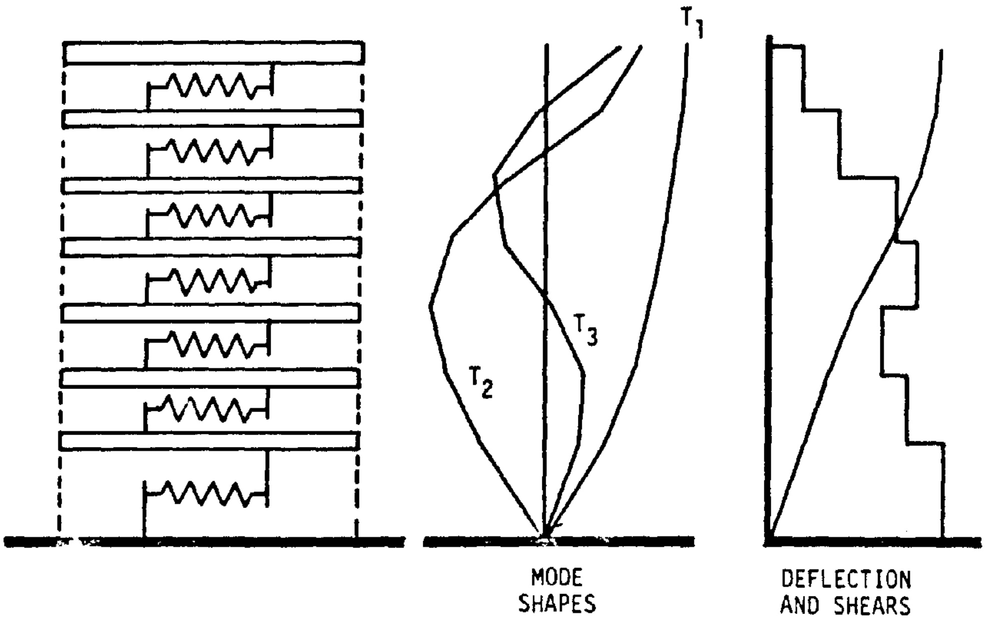


Figure 8. Story Stiffness Model

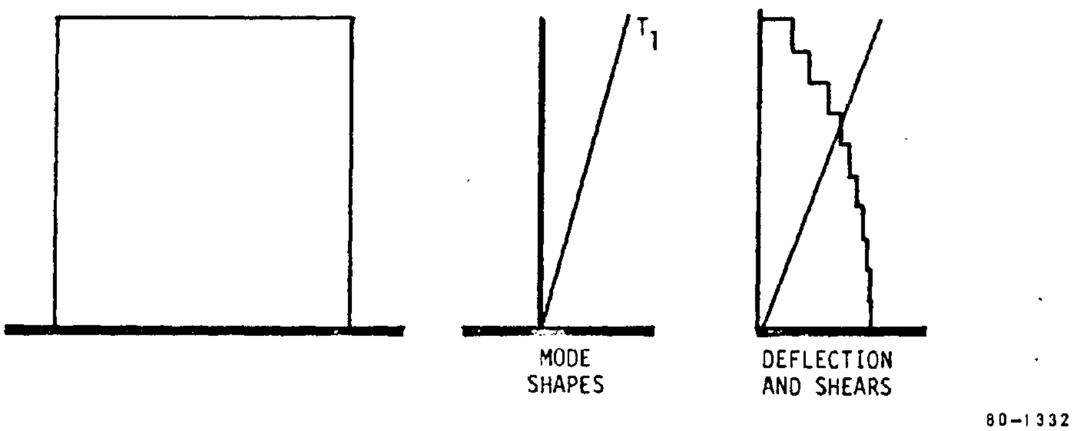


Figure 9. Empirical Model

REMARKS:
1. BEAMS, COLUMNS, AND JOINT LOCATIONS AT EACH FLOOR ARE NUMBERED FROM LEFT TO RIGHT, STARTING WITH 1.
2. STORIES ARE NUMBERED FROM BOTTOM TO TOP.

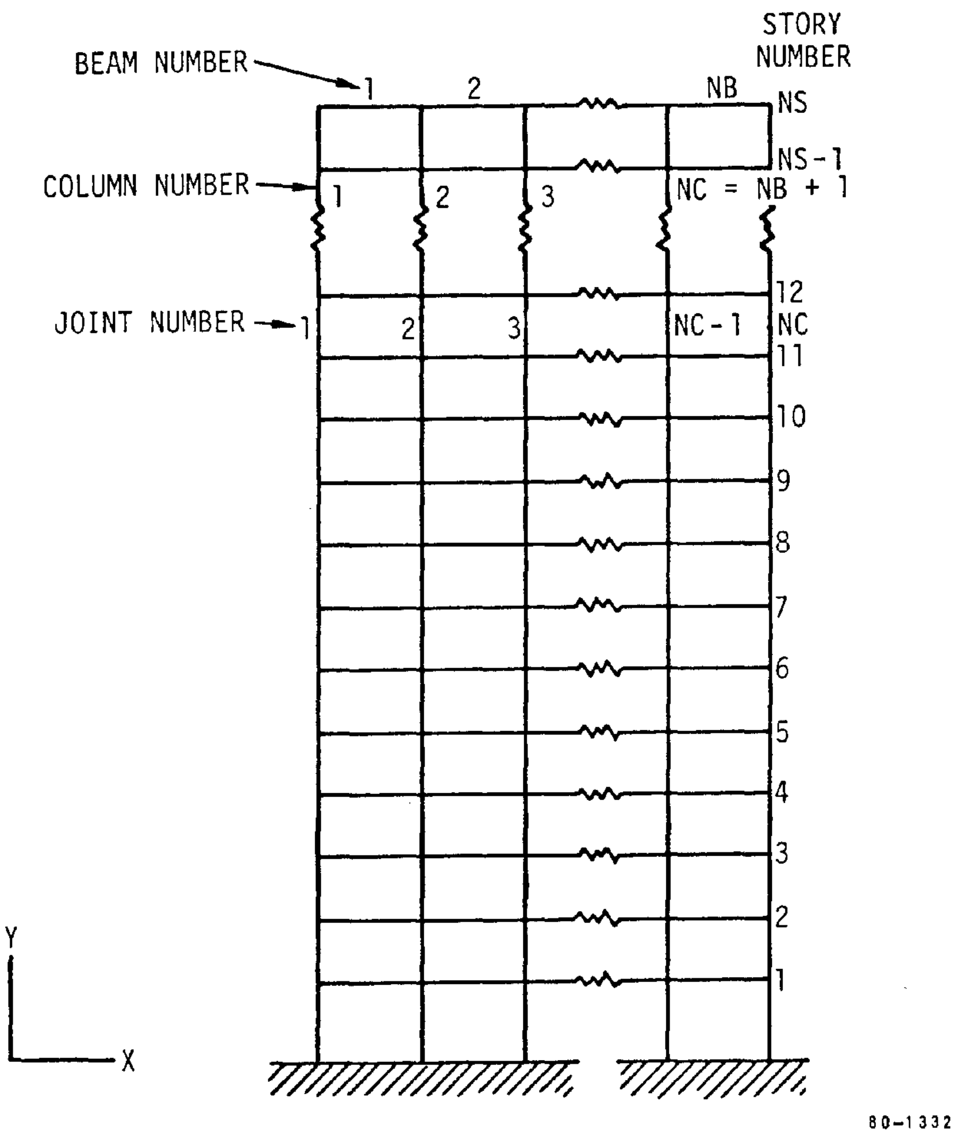


Figure 10. Numbering Conventions

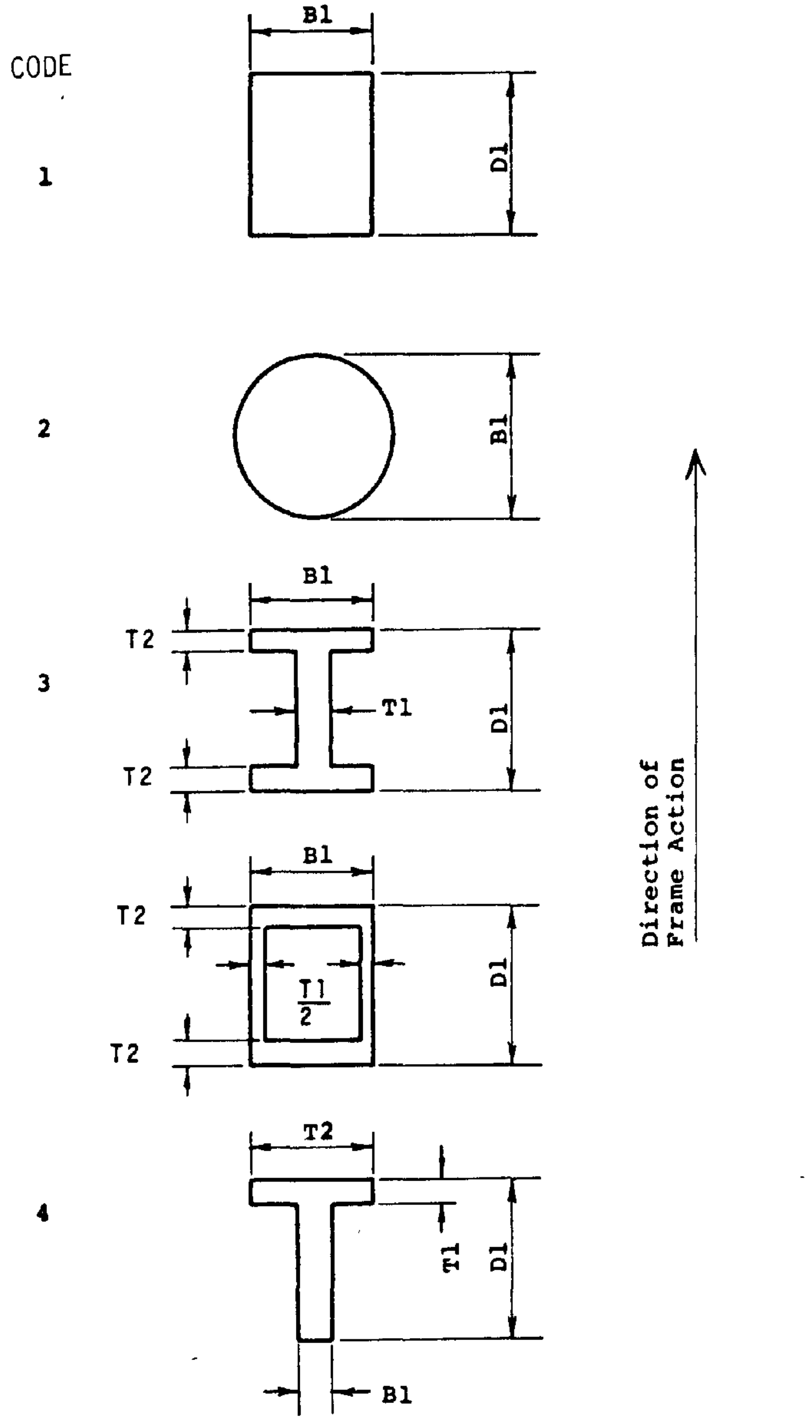


Figure 11. Beam and Column Sections

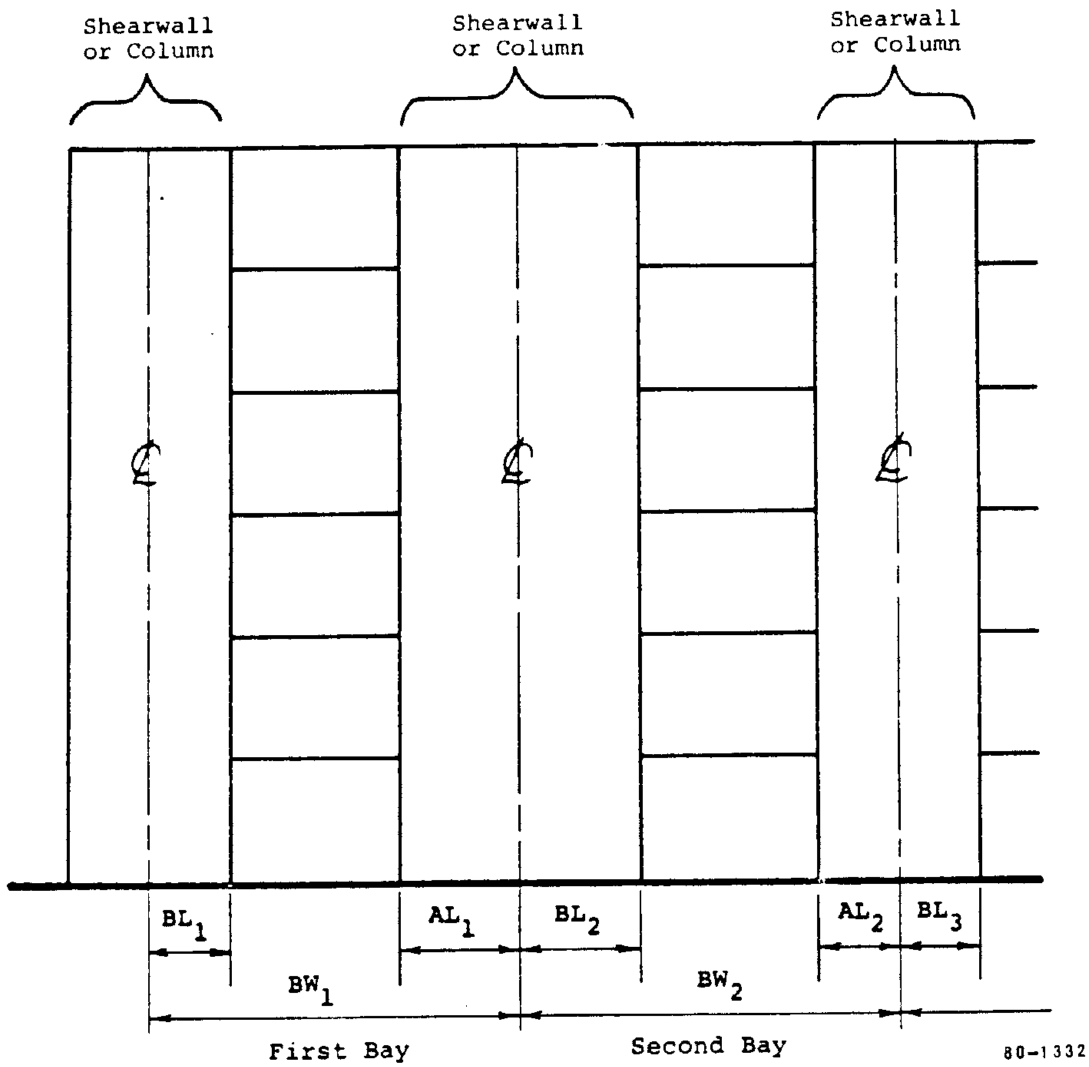


Figure 12. Bay Dimensions for General Frame Option

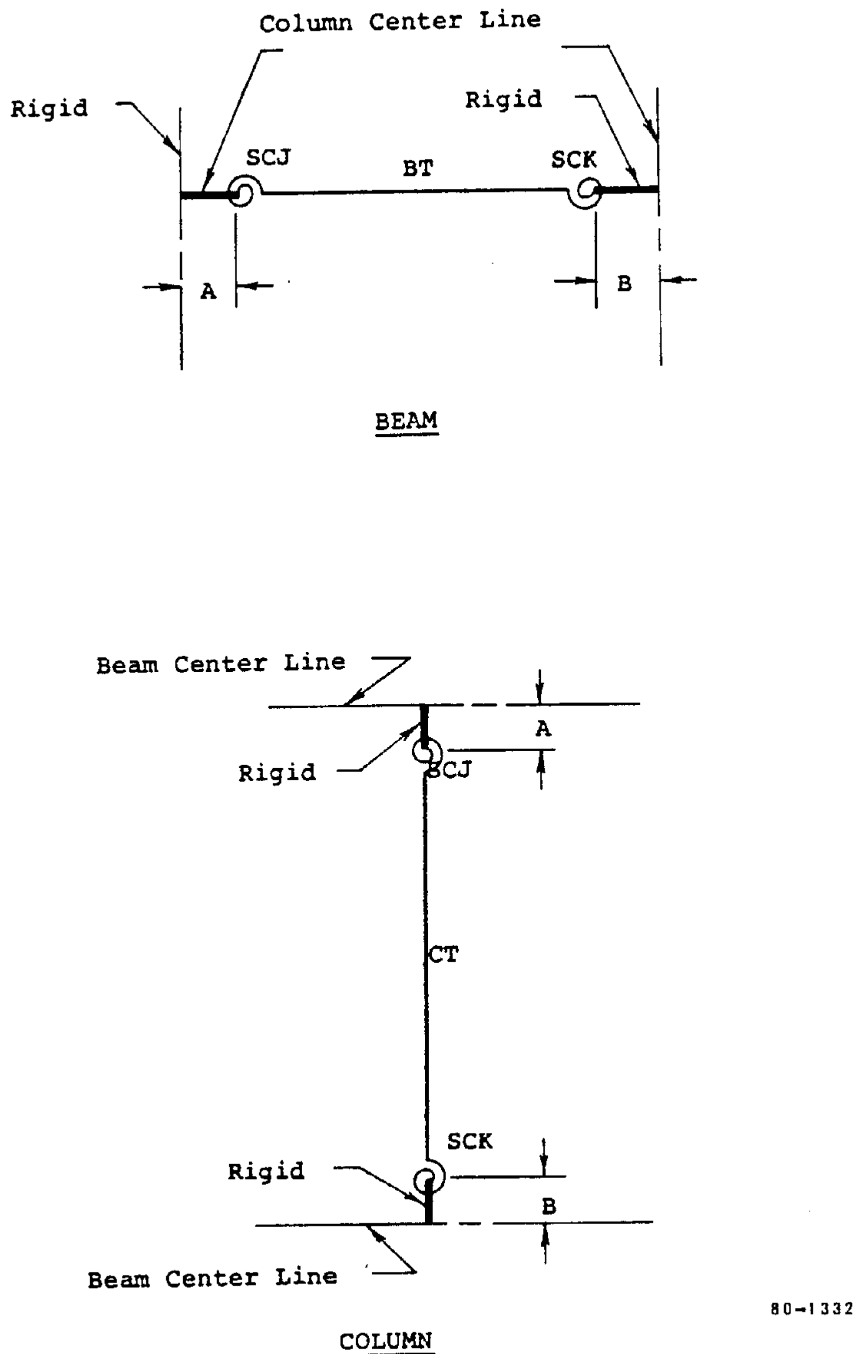
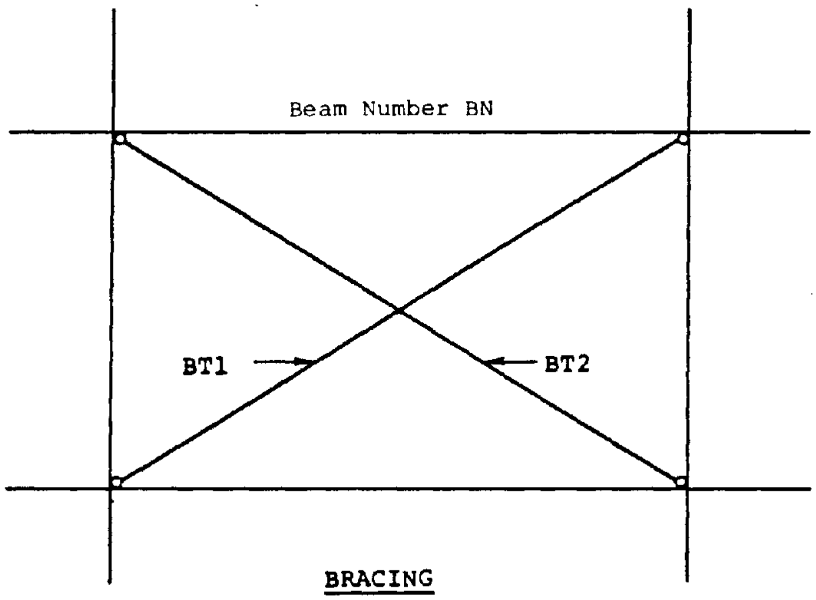


Figure 13. Complex Joint Model for Beams and Columns Used in Steel Frame Option



Note - K bracing and other bracing systems may be handled by inserting "ficticious" members or members with near zero stiffness.

80-1332

Figure 14. Braces for Steel Frame Option

In cases where only a single bracing system is used in a building, the effective drift to yield should correspond to that selected from information supplied in the "Building Damage Information Card," Card A of Section 2.5. A summary of these values is shown in Table 9. In cases where a dual bracing system is used, e.g., ductile moment resisting space frame and shear walls, the following guidelines are offered.

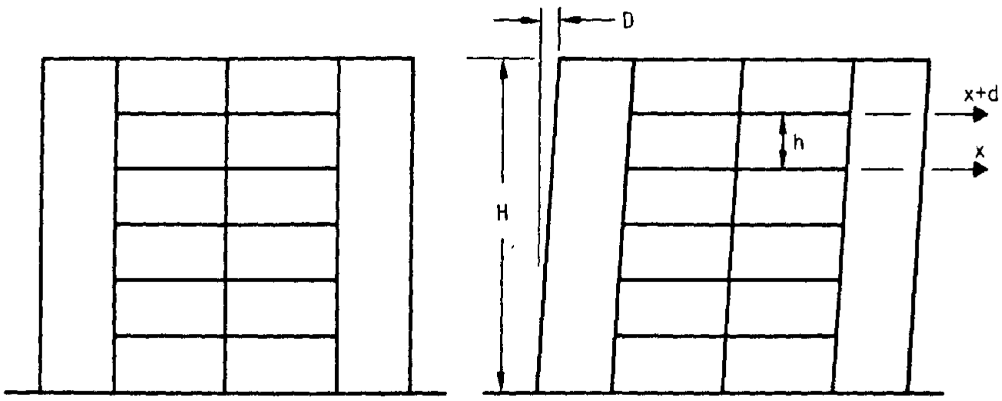


ILLUSTRATION OF A DUAL BRACING SYSTEM

$\Delta = \frac{d}{h}$ = Interstory Drift

$(\Delta)_{avg} = \frac{D}{H}$ = Average Interstory Drift

Δ_y = Drift to Yield

Δ_y^F = Drift to Yield of Space Frame Elements

Δ_y^W = Drift to Yield of Shear Wall Elements

$(\Delta_y)_{eff}$ = Effective Drift to Yield

$$(\Delta_y)_{eff} = C_F\Delta_y^F + C_W\Delta_y^W$$

$$C_F + C_W = 1$$

C_F and C_W may be interpreted as the relative rigidities of space frame and shear wall elements, respectively.

The effective drift to yield $(\Delta_y)_{eff}$, for each story is used in computing the overall response ductility of the building (See Volume I). When the dynamic response of the building is such that this ductility exceeds unity, an approximate nonlinear response analysis is made. This generally results in larger displacements and a lengthening of the fundamental period of the building accompanied by higher damping. The effective drift-to-yield is used only in the response analysis. It does not affect the damageability models themselves. However, the user should understand that once the response enters the nonlinear range, higher levels of damage may be expected as a result of increasing interstory drift.

80-1332

Figure 15. Evaluation of Effective Drift to Yield

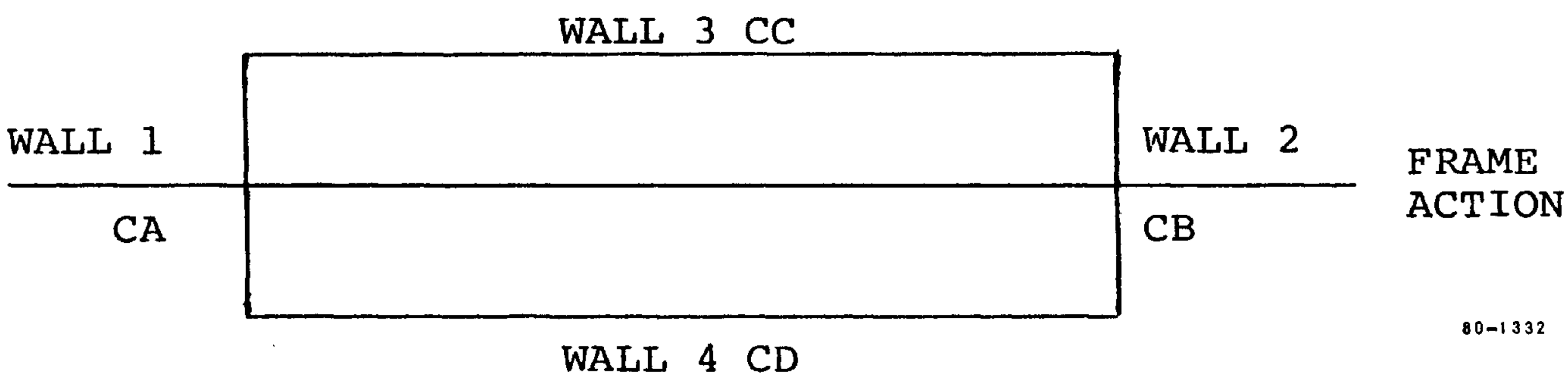


Figure 16. Wall Numbering Convention With Respect to Line of Frame Action

3. REFERENCES

1. American National Standards Institute, "Building Code Requirements for Minimum Design Loads in Buildings and Other Structures," ANSI A58.1-1972, 1430 Broadway, New York, New York 10018, 1972.

2. Culver, C.G., Lew, H.S., Hart, G.C., and C.W. Pinkham, "Natural Hazards Evaluation of Existing Buildings," Building Science Series 61, National Bureau of Standards, U.S. Department of Commerce, 1975.

3. Scheizerischer Ingenieur and Architekten Vasein, "Standards of the Swiss Association of Engineers and Architects on Load Assumptions, Acceptance and Supervision of Buildings," Technische Normen. No. 160, 1956.

4. Thom, H.C.S., "New Distributions of Extreme Winds in the United States," Journal of the Structural Division of ASCE, 1968.

5. Thom, H.C.S., "Tornado Probabilities," Monthly Weather Review, 1963.

6. Vellozzi, J.W. and E. Cohen, "GUST Response Factors," Journal of the Structural Division of ASCE, Vol. 94, 1968.

APPENDIX A

Input Data Form

j.h.wiggins company 1650 S. PACIFIC COAST HIGHWAY REDONDO BEACH, CALIFORNIA 90277

FORTRAN

PROGRAM

PROGRAMMER

DATE

PUNCHING INSTRUCTIONS

GRAPHIC

PUNCH

PAGE OF

CARD ELECTO NO.

STATEMENT NUMBER

A B

ID-SEQUENCE

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

JHW Form 72-76

APPENDIX B

Example Input and Output

INPUT

```
 VENTURA BLVD BANK CF CA   TRANSVERSE
       1        1       0
34.02   118.5
       1
 6.5      22.5  0.0372  2.313   1.01378
       1  125.    25.
      12   720.   1932.   183.96
       7
       2
       5          2         2  3900.   1560.   2100.    840.    110.    150.
       1     12.       40.       1
       2     10.       40.       1
       1     18.       36.       4  18.     36.
       2     36.       18.       1
       1    144.       18.     9.
       3    144.        9.     9.
       1    144.        9.    18.
      11    156.
       1    192.
       5          1
       1          1
       4          2
       1          1
       5          1
       1          1
       4          2
       1          1
       5          1
       1          1
       4          2
       1          1
       5          1
       1          1
       4          2
       1          1
       5          1
       1          1
       4          2
       1          1
       5          1
       1          1
       4          2
       1          1
       5          1
       1          1
       4          2
       1          1
       5          1
       1          1
       4          2
       1          1
       5          1
       1          1
       4          2
       1          1
       5          1
       1          1
       4          2
       1          1
       5          1
       1          1
       4          2
```

1	1							
5	2							
1	1							
4	2							
1	1							
2								
5	2	2	3900.	1560.	2100.	840.	110.	150.
1	12.	40.	1					
2	10.	40.	1					
1	18.	36.	4	18.	36.			
2	36.	18.	1					
1	144.	18.	9.					
3	144.	9.	9.					
1	144.	9.	18.					
11	156.							
1	192.							
5	1							
1	1							
4	2							
1	1							
5	1							
1	1							
4	2							
1	1							
5	1							
1	1							
4	2							
1	1							
5	1							
1	1							
4	2							
1	1							
5	1							
1	1							
4	2							
1	1							
5	1							
1	1							
4	2							
1	1							
5	1							
1	1							
4	2							
1	1							
5	1							
1	1							
4	2							
1	1							
5	1							
1	1							
4	2							
1	1							
5	1							
1	1							
4	2							
1	1							
5	1							
1	1							
4	2							
1	1							

B-3

B-4

```
  1       1
  5       2
  1       1
  4       2
  1       1
  2
  2       3       5    3900.    1560.    2100.    840.    110.    150.
  1      .1      .1       1
  2  27.     27.          1
  3  18.     27.          1
  1      .1      .1       1
  2  18.     36.          1
  3  40.     24.          1
  4  24.     36.          1
  5  44.     24.          1
  1 432.     18.     12.
  1 288.     12.     18.
 11 156.
  1 192.
  2       1
  3       1
  2       1
  3       1
  2       1
  3       1
  2       1
  3       1
  2       1
  3       1
  2       1
  3       1
  2       1
  3       1
  2       1
  3       1
  2       1
  3       1
  2       1
  3       1
  1       2
  1       3
  1       2
  1       3
  1       2
  1       2
  1       3
  1       4
  1       5
  1       2
  2
  2       3       5    3900.    1560.    2100.    840.    110.    150.
  1      .1      .1       1
  2  27.     27.          1
  3  18.     27.          1
  1      .1      .1       1
  2  18.     36.          1
  3  40.     24.          1
  4  24.     36.          1
  5  44.     24.          1
```

```
 1    432.        18.       12.
 1    288.        12.       18.
11    156.
 1    192.
 2          1
 3          1
 2          1
 3          1
 2          1
 3          1
 2          1
 3          1
 2          1
 3          1
 2          1
 3          1
 2          1
 3          1
 2          1
 3          1
 2          1
 3          1
 2          1
 3          1
 1          2
 1          3
 1          2
 1          3
 1          2
 1          2
 1          3
 1          4
 1          5
 1          2
 2
 2          3        5   3900.     1560.     2100.       840.       110.       150.
 1         .1       .1          1
 2     27.        27.           1
 3     18.        27.           1
 1         .1       .1          1
 2     18.        36.           1
 3     40.        24.           1
 4     24.        36.           1
 5     44.        24.           1
 1    432.        18.       12.
 1    288.        12.       18.
11    156.
 1    192.
 2          1
 3          1
 2          1
 3          1
 2          1
 3          1
```

```
 2        1
 3        1
 2        1
 3        1
 2        1
 3        1
 2        1
 3        1
 2        1
 3        1
 2        1
 3        1
 2        1
 3        1
 1        2
 1        3
 1        2
 1        3
 1        2
 1        2
 1        3
 1        4
 1        5
 1        2
 2
 2        3      5  3900.    1560.    2100.     840.     110.     150.
 1       .1     .1          1
 2     27.    27.           1
 3     18.    27.           1
 1       .1     .1          1
 2     18.    36.           1
 3     40.    24.           1
 4     24.    36.           1
 5     44.    24.           1
 1    432.    18.       12.
 1    288.    12.       18.
11    156.
 1    192.
 2        1
 3        1
 2        1
 3        1
 2        1
 3        1
 2        1
 3        1
 2        1
 3        1
 2        1
 3        1
 2        1
 3        1
 2        1
 3        1
 2        1
 3        1
 2        1
 3        1
```

B-6

```
          1         2
          1         3
          1         2
          1         3
          1         2
          1         2
          1         3
          1         4
          1         5
          1         2
 1849.       .0052
 1352.       .0052
 1356.       .0052
 1360.       .0052
 1365.       .0052
 1370.       .0052
 1375.       .0052
 1381.       .0052
 1387.       .0052
 1391.       .0052
 1428.       .0052
 1831.       .0052
          1
   0.2
         25         1
   0.5              1
          2         2                      2
 78.       40.          0.2
```

OUTPUT

```
 RUN IDENTIFICATION:

              VENTURA BLVD BANK OF CA    TRANSVERSE
EARTHQUAKE HAZARD IS INCLUDED
WIND HAZARD IS INCLUDED
SITE LOCATION: LATITUDE   34.02  DEGREES, LONGITUDE  118.50  DEGREES
BUILDING MODELING OPTION: DETAILED FRAME
```

E A R T H Q U A K E   L O A D   A N A L Y S I S

SITE GROUND MOTION CHARACTERISTICS

```
RICHTER MAGNITUDE              =  6.50E+00
HYPOCENTRAL DISTANCE (MILES)   =  2.25E+01
     SITE ACCELERATION (G)     =  1.49E-01
     SITE VELOCITY (IN/SEC)    =  9.25E+00
     SITE DISPLACEMENT (IN)    =  4.06E+00
```

SITE GROUND MOTION SPECTRUM

PERIOD (SEC)	.10	.20	.30	.40	.50	.60	.70	.80	.90	1.00
VEL (IN/SEC)	.91	1.83	2.74	3.66	4.57	5.48	6.40	7.31	8.23	9.14
PERIOD (SEC)	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00
VEL (IN/SEC)	9.25	9.25	9.25	9.25	9.25	9.25	9.25	9.25	9.25	9.25
PERIOD (SEC)	2.10	2.20	2.30	2.40	2.50	2.60	2.70	2.80	2.90	3.00
VEL (IN/SEC)	9.25	9.25	9.25	9.25	9.25	9.25	9.25	9.10	8.79	8.49
PERIOD (SEC)	3.10	3.20	3.30	3.40	3.50	3.60	3.70	3.80	3.90	4.00
VEL (IN/SEC)	8.22	7.96	7.72	7.49	7.28	7.08	6.89	6.71	6.53	6.37
PERIOD (SEC)	4.10	4.20	4.30	4.40	4.50	4.60	4.70	4.80	4.90	5.00
VEL (IN/SEC)	6.21	6.07	5.93	5.79	5.66	5.54	5.42	5.31	5.20	5.10
PERIOD (SEC)	5.10	5.20	5.30	5.40	5.50	5.60	5.70	5.80	5.90	6.00
VEL (IN/SEC)	5.00	4.90	4.81	4.72	4.63	4.55	4.47	4.39	4.32	4.25
PERIOD (SEC)	6.10	6.20	6.30	6.40	6.50	6.60	6.70	6.80	6.90	7.00
VEL (IN/SEC)	4.18	4.11	4.04	3.98	3.92	3.86	3.80	3.75	3.69	3.64
PERIOD (SEC)	7.10	7.20	7.30	7.40	7.50	7.60	7.70	7.80	7.90	8.00
VEL (IN/SEC)	3.59	3.54	3.49	3.44	3.40	3.35	3.31	3.27	3.23	3.18
PERIOD (SEC)	8.10	8.20	8.30	8.40	8.50	8.60	8.70	8.80	8.90	9.00
VEL (IN/SEC)	3.15	3.11	3.07	3.03	3.00	2.96	2.93	2.90	2.86	2.83
PERIOD (SEC)	9.10	9.20	9.30	9.40	9.50	9.60	9.70	9.80	9.90	10.00
VEL (IN/SEC)	2.80	2.77	2.74	2.71	2.68	2.65	2.63	2.60	2.57	2.55

```
W I N D   L O A D   A N A L Y S I S

ISITE=     1     ITEST=     2     ITY=     1     JSHAPE=     1

 USERS VALUE OF WIND VELOCITY -FASTEST MILE AT 30 FT ABOVE GROUND - FREE FIELD IN MPH = 125.00
 RETURN PERIOD IN YEARS=   25.0
```

S T R U C T U R A L   A N A L Y S I S

NUMBER OF STORIES =   12

TOTAL BUILDING WIDTH (INCHES) =   720.0

TOTAL BUILDING LENGTH (INCHES) = 1932.0

HEIGHT OF PARAPET (INCHES)   =   184.0

NUMBER OF FRAMES =   7

-- FRAME NO. 1 -- FRAME MODELING OPTION= 2

```
NUMBER OF BAYS  =     5
BEAMS:     E=   2100.0  G=    840.0  W(LBS/CU.FT)=   110.00
COLUMNS:   E=   3900.0  G=   1560.0  W(LBS/CU.FT)=   150.00
```

BEAM TYPE	AB	IB	FB
1	480.0	64000.0	1.20
2	400.0	53333.3	1.20

COLUMN TYPE	AC	IC	FC
1	972.0	96228.0	1.50
2	648.0	17496.0	1.20

BAY WIDTHS ------

```
 1 BAYS AT   144.000 INCHES
 3 BAYS AT   144.000 INCHES
 1 BAYS AT   144.000 INCHES
```

STORY HEIGHTS -------

```
11 STORIES AT   156.000 INCHES
 1 STORIES AT   192.000 INCHES
```

-- FRAME NO. 2 -- FRAME MODELING OPTION= 2

NUMBER OF BAYS = 5

BEAMS: E= 2100.0 G= 840.0 W(LBS/CU.FT)= 110.00

COLUMNS: E= 3900.0 G= 1560.0 W(LBS/CU.FT)= 150.00

BEAM TYPE	AB	IB	FB
1	480.0	64000.0	1.20
2	400.0	53333.3	1.20

COLUMN TYPE	AC	IC	FC
1	972.0	96228.0	1.50
2	648.0	17496.0	1.20

BAY WIDTHS ------

1 BAYS AT 144.000 INCHES
3 BAYS AT 144.000 INCHES
1 BAYS AT 144.000 INCHES

STORY HEIGHTS -------

11 STORIES AT 156.000 INCHES
1 STORIES AT 192.000 INCHES

-- FRAME NO. 3 -- FRAME MODELING OPTION= 2

NUMBER OF BAYS = 2

BEAMS: E= 2100.0 G= 840.0 W(LBS/CU.FT)= 110.00

COLUMNS: E= 3900.0 G= 1560.0 W(LBS/CU.FT)= 150.00

BEAM TYPE	AB	IB	FB
1	.0	.0	1.20
2	729.0	44286.8	1.20
3	486.0	29524.5	1.20

COLUMN TYPE	AC	IC	FC
1	.0	.0	1.20
2	648.0	69984.0	1.20
3	960.0	46080.0	1.20
4	864.0	93312.0	1.20
5	1056.0	50688.0	1.20

BAY WIDTHS ------

1 BAYS AT 432.000 INCHES
1 BAYS AT 288.000 INCHES

STORY HEIGHTS -------

11 STORIES AT 156.000 INCHES
1 STORIES AT 192.000 INCHES

-- FRAME NO. 4 -- FRAME MODELING OPTION= 2

NUMBER OF BAYS = 2

BEAMS: E= 2100.0 G= 840.0 W(LBS/CU.FT)= 110.00

COLUMNS: E= 3900.0 G= 1560.0 W(LBS/CU.FT)= 150.00

BEAM TYPE	AB	IB	FB
1	.0	.0	1.20
2	729.0	44286.8	1.20
3	486.0	29524.5	1.20

COLUMN TYPE	AC	IC	FC
1	.0	.0	1.20
2	648.0	69984.0	1.20
3	960.0	46080.0	1.20
4	864.0	93312.0	1.20
5	1056.0	50688.0	1.20

BAY WIDTHS ------

1 BAYS AT 432.000 INCHES
1 BAYS AT 288.000 INCHES

STORY HEIGHTS -------

11 STORIES AT 156.000 INCHES
1 STORIES AT 192.000 INCHES

-- FRAME NO. 5 -- FRAME MODELING OPTION= 2

NUMBER OF BAYS = 2

BEAMS: E= 2100.C G= 840.0 W(LBS/CU.FT)= 110.00

COLUMNS: E= 3900.C G= 1560.0 W(LBS/CU.FT)= 150.00

BEAM TYPE	AB	IB	FB
1	.0	.0	1.20
2	729.0	44286.8	1.20
3	486.0	29524.5	1.20

COLUMN TYPE	AC	IC	FC
1	.0	.0	1.20
2	648.0	69984.0	1.20
3	960.C	46080.0	1.20
4	864.0	93312.0	1.20
5	1056.0	50688.0	1.20

BAY WIDTHS ------

1 BAYS AT 432.000 INCHES
1 BAYS AT 288.000 INCHES

STORY HEIGHTS -------

11 STORIES AT 156.000 INCHES
1 STORIES AT 192.000 INCHES

-- FRAME NO. 6 -- FRAME MODELING OPTION= 2

NUMBER OF BAYS = 2

BEAMS: E= 2100.0 G= 840.0 W(LBS/CU.FT)= 110.00

COLUMNS: E= 3900.0 G= 1560.0 W(LBS/CU.FT)= 150.00

BEAM TYPE	AB	IB	FB
1	.0	.0	1.20
2	729.0	44286.8	1.20
3	486.0	29524.5	1.20

COLUMN TYPE	AC	IC	FC
1	.0	.0	1.20
2	648.0	69984.0	1.20
3	960.0	46080.0	1.20
4	864.0	93312.0	1.20
5	1056.0	50688.0	1.20

BAY WIDTHS ------

1 BAYS AT 432.000 INCHES
1 BAYS AT 288.000 INCHES

STORY HEIGHTS -------

11 STORIES AT 156.000 INCHES
1 STORIES AT 192.000 INCHES

-- FRAME NO. 7 -- FRAME MODELING OPTION= 2

NUMBER OF BAYS = 2

BEAMS: E= 2100.0 G= 840.0 W(LBS/CU.FT)= 110.00

COLUMNS: E= 3900.0 G= 1560.0 W(LBS/CU.FT)= 150.00

BEAM TYPE	AB	IB	FB
1	.0	.0	1.20
2	729.0	44286.8	1.20
3	486.0	29524.5	1.20

COLUMN TYPE	AC	IC	FC
1	.0	.0	1.20
2	618.0	69984.0	1.20
3	980.0	46080.0	1.20
4	864.0	93312.0	1.20
5	1056.0	50688.0	1.20

BAY WIDTHS ------

1 BAYS AT 432.000 INCHES
1 BAYS AT 288.000 INCHES

STORY HEIGHTS -------

11 STORIES AT 156.000 INCHES
1 STORIES AT 192.000 INCHES

STIFFNESS MATRIX (KIPS/IN)

STORY NO.										
12	2.87E+03	-3.63E+03	7.08E+02	-3.90E+01	2.10E+01	1.27E+01	1.14E+01	9.94E+00	8.91E+00	8.12E+00
11	-3.63E+03	7.30E+03	-4.27E+03	6.77E+02	-6.35E+01	1.10E+00	-4.11E+00	-3.04E+00	-2.72E+00	-2.43E+00
10	7.08E+02	-4.27E+03	7.09E+03	-4.16E+03	6.77E+02	-5.57E+01	6.73E+00	6.52E-01	1.01E+00	8.11E-01
9	-3.90E+01	6.77E+02	-4.16E+03	7.06E+03	-4.16E+03	6.76E+02	-5.64E+01	6.13E+00	1.56E-01	5.91E-01
8	2.10E+01	-6.35E+01	6.77E+02	-4.16E+03	7.06E+03	-4.16E+03	6.76E+02	-5.62E+01	6.30E+00	3.13E-01
7	1.27E+01	1.10E+00	-5.57E+01	6.76E+02	-4.16E+03	7.06E+03	-4.16E+03	6.76E+02	-5.61E+01	6.40E+00
6	1.14E+01	-4.11E+00	6.73E+00	-5.64E+01	6.76E+02	-4.16E+03	7.06E+03	-4.16E+03	6.77E+02	-5.60E+01
5	9.94E+00	-3.04E+00	6.52E-01	6.13E+00	-5.62E+01	6.76E+02	-4.16E+03	7.06E+03	-4.16E+03	6.77E+02
4	8.91E+00	-2.72E+00	1.01E+00	1.56E-01	6.30E+00	-5.61E+01	6.77E+02	-4.16E+03	7.06E+03	-4.16E+03
3	8.12E+00	-2.43E+00	8.11E-01	5.91E-01	3.13E-01	6.40E+00	-5.60E+01	6.77E+02	-4.16E+03	7.06E+03
2	7.93E+00	-2.35E+00	7.60E-01	4.83E-01	7.90E-01	4.92E-01	6.62E+00	-5.57E+01	6.77E+02	-4.15E+03
1	9.28E+00	-2.70E+00	8.35E-01	5.17E-01	7.79E-01	1.10E+00	9.03E-01	7.08E+00	-5.43E+01	6.69E+02

STORY NO.		
12	7.93E+00	9.28E+00
11	-2.35E+00	-2.70E+00
10	7.60E-01	8.35E-01
9	4.83E-01	5.17E-01
8	7.90E-01	7.79E-01
7	4.92E-01	1.10E+00
6	6.62E+00	9.03E-01
5	-5.57E+01	7.08E+00
4	6.77E+02	-5.43E+01
3	-4.15E+03	6.69E+02
2	9.82E+03	-8.23E+03
1	-8.23E+03	1.53E+04

TOTAL WEIGHT VECTOR & DRIFT TO YIELD

STORY NO.	STORY WT. (KIPS)	DRIFT TO YIELD
12	1954.43	.0052
11	1518.85	.0052
10	1522.85	.0052
9	1526.85	.0052
8	1531.85	.0052
7	1536.85	.0052
6	1541.85	.0052
5	1547.85	.0052
4	1553.85	.0052
3	1557.65	.0052
2	1892.39	.0052
1	2343.42	.0052

CHARACTERISTIC VECTORS

STORY NO.	MODE NO. 1	2	3	4	5	6
12	1.00E+00	-9.67E-01	8.56E-01	-7.71E-01	6.77E-01	5.84E-01
11	9.59E-01	-7.36E-01	3.97E-01	-4.11E-02	-2.99E-01	-6.10E-01
10	9.05E-01	-4.02E-01	-2.28E-01	7.49E-01	-9.90E-01	-8.87E-01
9	8.37E-01	-1.66E-02	-7.56E-01	9.89E-01	-5.44E-01	2.99E-01
8	7.56E-01	3.66E-01	-9.78E-01	5.07E-01	5.27E-01	1.00E+00
7	6.65E-01	6.92E-01	-8.08E-01	-3.46E-01	1.00E+00	6.33E-02
6	5.65E-01	9.14E-01	-3.12E-01	-9.51E-01	3.32E-01	-9.73E-01
5	4.57E-01	1.00E+00	3.12E-01	-8.64E-01	-7.12E-01	-4.01E-01
4	3.44E-01	9.38E-01	8.16E-01	-1.48E-01	-9.33E-01	8.36E-01
3	2.30E-01	7.41E-01	1.00E+00	6.75E-01	-7.53E-02	6.91E-01
2	1.23E-01	4.56E-01	8.10E-01	1.00E+00	8.39E-01	-5.44E-01
1	5.67E-02	2.22E-01	4.29E-01	6.06E-01	6.23E-01	-5.70E-01

E A R T H Q U A K E   R E S P O N S E   A N A L Y S I S

DAMPING CURVE OPTION FOR STEEL AND RC FRAME STRUCTURES

MAXIMUM NUMBER ITERATIONS= 6
MODIFY RESPONSE FOR DUCTILITY
MODAL COMBINATION OPTION = RSS

EFFECTIVE INTERSTORY DRIFT TO YIELD BY STORY (IN/IN)

5.20E-03 5.20E-03 5.20E-03 5.20E-03 5.20E-03 5.20E-03 5.20E-03 5.20E-03 5.20E-03 5.20E-03
5.20E-03 5.20E-03

CRITICAL DAMPING (PERCENT) =   6.62

MODAL RESPONSE

MODE NO.	FREQUENCY (CPS)	PERIOD (SEC.)	MASS RATIO	PSUDO-SPECTRAL VELOCITY	MAXIMUM BASE SHEAR	AMPLITUDE RATIO	PS.SPECT.VEL. MODIFIED FOR DUCTILITY (ACCEL)	(DISPL)
1	.4241	2.358	.735	14.855	1508.652	.753	14.855	14.855
2	1.3057	.766	.129	11.744	645.107	1.907	11.744	11.744
3	2.2607	.442	.060	6.925	304.568	2.841	6.925	6.925
4	3.1874	.314	.035	4.974	179.626	3.814	4.974	4.974
5	4.1853	.239	.016	3.826	85.569	5.375	3.826	3.826
6	5.2830	.189	.007	2.883	36.991	-7.747	2.883	2.883

TOTAL RESPONSE

STORY NO.	I.S. DEFL (IN)	VELOCITY (IN/SEC)	ACCELERATION (G)	I.S. DRIFT (IN/IN)
12	3.6087E-01	2.0755E+01	2.1102E-01	2.1133E-03
11	4.9034E-01	1.9498E+01	1.6785E-01	3.1435E-03
10	5.8873E-01	1.8083E+01	1.5497E-01	3.7739E-03
9	6.6377E-01	1.6675E+01	1.5104E-01	4.2549E-03
8	7.2218E-01	1.5311E+01	1.5306E-01	4.6294E-03
7	7.6905E-01	1.3968E+01	1.5660E-01	4.9298E-03
6	8.0635E-01	1.2577E+01	1.6225E-01	5.1818E-03
5	8.4166E-01	1.1018E+01	1.6286E-01	5.3953E-03
4	8.6299E-01	9.1708E+00	1.5956E-01	5.5320E-03
3	8.2180E-01	6.9401E+00	1.4480E-01	5.2679E-03
2	5.2566E-01	4.4462E+00	1.2500E-01	3.3697E-03
1	4.5987E-01	2.2560E+00	7.2838E-02	2.3951E-03

DUCTILITY BY STORY

4.45E-01 6.05E-01 7.26E-01 8.16E-01 8.90E-01 9.48E-01 9.96E-01 1.04E+00 1.06E+00 1.01E+00
6.48E-01 4.61E-01

EFFECTIVE DUCTILITY FOR BUILDING = .77

CRITICAL DAMPING (PERCENT) = 5.73

MODAL RESPONSE

MODE NO.	FREQUENCY (CPS)	PERIOD (SEC.)	MASS RATIO	PSUDO-SPECTRAL VELOCITY	MAXIMUM BASE SHEAR	AMPLITUDE RATIO	PS.SPECT.VEL. MODIFIED FOR DUCTILITY (ACCEL)	(DISPL)
1	.4241	2.358	.735	15.221	1545.652	.753	15.221	15.221
2	1.3057	.766	.129	12.021	660.328	1.907	12.021	12.021
3	2.2607	.442	.060	7.085	311.628	2.841	7.085	7.085
4	3.1874	.314	.035	5.088	183.725	3.614	5.088	5.088
5	4.1854	.239	.016	3.913	87.502	5.375	3.913	3.913
6	5.2831	.189	.007	2.948	37.822	-7.747	2.948	2.948

TOTAL RESPONSE

STORY NO.	I.S. DEFL (IN)	VELOCITY (IN/SEC)	ACCELERATION (G)	I.S. DRIFT (IN/IN)
12	3.6963E-01	2.1264E+01	2.1606E-01	2.3694E-03
11	5.0229E-01	1.9977E+01	1.7191E-01	3.2198E-03
10	6.0366E-01	1.8528E+01	1.5870E-01	3.8658E-03
9	6.7999E-01	1.7085E+01	1.5466E-01	4.3589E-03
8	7.3988E-01	1.5687E+01	1.5671E-01	4.7428E-03
7	7.8794E-01	1.4310E+01	1.6032E-01	5.0509E-03
6	8.2824E-01	1.2884E+01	1.6609E-01	5.3093E-03
5	8.6238E-01	1.1285E+01	1.6670E-01	5.5281E-03
4	8.8422E-01	9.3922E+00	1.6331E-01	5.6680E-03
3	6.4198E-01	7.1065E+00	1.4818E-01	5.3973E-03
2	5.3856E-01	4.5517E+00	1.2788E-01	3.4523E-03
1	4.7111E-01	2.3093E+00	7.4512E-02	2.4537E-03

DUCTILITY BY STORY

4.56E-01 6.19E-01 7.43E-01 8.38E-01 9.12E-01 9.71E-01 1.02E+00 1.06E+00 1.09E+00 1.04E+00
6.64E-01 4.72E-01

EFFECTIVE DUCTILITY FOR BUILDING = .79

CRITICAL DAMPING (PERCENT) = 5.81

COMBINED FORCE FOR ALL MODES (METHOD RSS)

STORY	FORCE(KIPS)	SHEAR(KIPS)
12	422.281	422.281
11	245.264	667.545
10	176.289	845.834
9	139.289	985.123
8	114.332	1099.455
7	100.624	1200.079
6	95.893	1295.972
5	96.207	1392.179
4	95.110	1487.290
3	65.674	1572.964
2	81.486	1654.450
1	67.656	1722.105

W I N D   R E S P O N S E   A N A L Y S I S

BUILDING SHAPE CODE = 25   WIND DIRECTION CODE = 1

```
EXTERNAL PRESSURE COEFFICIENT FOR WALL 1 . . .=    .800
EXTERNAL PRESSURE COEFFICIENT FOR WALL 2 . . .=   -.500
SHAPE FACTOR FOR WIND DIRECTION . . .=   1.300

WIND DIRECTION WITH RESPECT TO
NORMAL OF WALL 1 . . . . . . . . . . . . =   0.0 DEGREES


  OPEN AREA RATIO =     .500     WALL CODE =     1
```

WIND ANALYSIS

STORY NO.	DEFLECTION (INCHES)	DRIFT (IN/IN)	STORY SHEAR (KIPS)
1	.922	.0007	13.89
2	.895	.0003	10.79
3	.855	.0003	66.48
4	.801	.0004	90.91
5	.734	.0005	114.00
6	.656	.0006	135.68
7	.566	.0006	155.87
8	.466	.0007	174.43
9	.358	.0007	191.22
10	.244	.0007	206.01
11	.134	.0005	218.46
12	.063	.0003	228.07

D A M A G E   A N A L Y S I S

DAMAGEABILITY INPUTS FOR EARTHQUAKE WIND, OR TORNADO

STORY NO.	DRIFT TO YIELD(IN/IN) FRAME	WALL	DRIFT TO FAILURE(IN/IN) FRAME	WALL	QUALITY FACTOR FOR NONSTRUCT. DAMAGE	WINDOW HT.(IN)	WINDOW WIDTH(IN)	THICKNESS OF WINDOW GLASS(IN)
12	.0052	0.0000	.0500	0.0000	2.00	78.00	40.00	.20
11	.0052	0.0000	.0500	0.0000	2.00	78.00	40.00	.20
10	.0052	0.0000	.0500	0.0000	2.00	78.00	40.00	.20
9	.0052	0.0000	.0500	0.0000	2.00	78.00	40.00	.20
8	.0052	0.0000	.0500	0.0000	2.00	78.00	40.00	.20
7	.0052	0.0000	.0500	0.0000	2.00	78.00	40.00	.20
6	.0052	0.0000	.0500	0.0000	2.00	78.00	40.00	.20
5	.0052	0.0000	.0500	0.0000	2.00	78.00	40.00	.20
4	.0052	0.0000	.0500	0.0000	2.00	78.00	40.00	.20
3	.0052	0.0000	.0500	0.0000	2.00	78.00	40.00	.20
2	.0052	0.0000	.0500	0.0000	2.00	78.00	40.00	.20
1	.0052	0.0000	.0500	0.0000	2.00	78.00	40.00	.20

TOTAL EARTHQUAKE DAMAGE TO BUILDING (PERCENT OF REPAIR COST/ REPLACEMENT COST)

BUILDING CLASSIFICATION: REINFORCED CONCRETE FRAME

OVERALL QUALITY RATING: AVERAGE

TOTAL NO. STY.	AVERAGE INTERSTY. DRIFT	BUILDING PERCENT DAMAGE
12	.0043	3.14

EARTHQUAKE DAMAGE TO STRUCTURAL COMPONENTS (PERCENT OF REPAIR COST/ REPLACEMENT COST)

STORY NO.	FRAME TYPE: 2 INTERSTY. DRIFT	PERCENT DAMAGE BY QUALITY GOOD	AVERAGE	POOR	SHEARWALL TYPE: 0 INTERSTY. DRIFT	PERCENT DAMAGE BY QUALITY GOOD	AVERAGE	POOR
12	.0024	.77	1.48	5.25	.0024	0.00	0.00	0.00
11	.0032	1.07	2.19	8.60	.0032	0.00	0.00	0.00
10	.0039	1.30	2.75	11.54	.0039	0.00	0.00	0.00
9	.0044	1.48	3.20	14.00	.0044	0.00	0.00	0.00
8	.0047	1.63	3.56	16.04	.0047	0.00	0.00	0.00
7	.0051	1.74	3.86	17.75	.0051	0.00	0.00	0.00
6	.0053	1.84	4.11	19.24	.0053	0.00	0.00	0.00
5	.0055	1.92	4.32	20.53	.0055	0.00	0.00	0.00
4	.0057	1.97	4.46	21.37	.0057	0.00	0.00	0.00
3	.0054	1.87	4.20	19.75	.0054	0.00	0.00	0.00
2	.0035	1.15	2.39	9.62	.0035	0.00	0.00	0.00
1	.0025	.80	1.55	5.55	.0025	0.00	0.00	0.00

EARTHQUAKE DAMAGE TO NONSTRUCTURAL COMPONENTS (PERCENT OF COMPONENTS DAMAGED)

STORY NO.	COMPONENTS SENSITIVE TO FLOOR MOTION FLOOR ACCL.(G)	PERCENT DAMAGE BY QUALITY GOOD	AVERAGE	POOR	GLASS INTERSTY. DRIFT	PERCENT DAMAGE BY QUALITY GOOD	AVERAGE	POOR
12	.22	1.69	10.89	70.04	.0024	1.04	2.51	7.13
11	.17	1.54	9.76	61.79	.0032	2.11	4.45	11.74
10	.16	1.38	8.55	53.11	.0039	3.22	6.27	15.82
9	.15	1.22	7.42	45.13	.0044	4.26	7.85	19.23
8	.16	1.07	6.38	38.01	.0047	5.18	9.19	22.06
7	.16	.93	5.43	31.61	.0051	5.99	10.34	24.44
6	.17	.80	4.51	25.60	.0053	6.73	11.35	26.51
5	.17	.65	3.58	19.61	.0055	7.39	12.24	28.31
4	.16	.49	2.59	13.56	.0057	7.83	12.82	29.49
3	.15	.32	1.59	7.74	.0054	6.99	11.70	27.23
2	.13	.21	.97	4.42	.0035	2.48	5.07	13.16
1	.07	.08	.29	1.10	.0025	1.12	2.68	7.55

FRAME TYPES:

0: NOT APPLICABLE
1: STEEL
2: REINFORCED CONCRETE
3: PRECAST CONCRETE

SHEARWALL TYPES:

0: NOT APPLICABLE
1: REINFORCED CONCRETE
2: PRECAST CONCRETE
3: BRICK MASONRY

TOTAL WIND DAMAGE TO BUILDING (PERCENT OF REPAIR COST/ REPLACEMENT COST)

BUILDING CLASSIFICATION: REINFORCED CONCRETE FRAME

OVERALL QUALITY RATING: AVERAGE

TOTAL NO. STY.	AVERAGE INTERSTY. DRIFT	BUILDING PERCENT DAMAGE
12	.0005	.07

WIND DAMAGE TO STRUCTURAL COMPONENTS (PERCENT OF REPAIR COST/REPLACEMENT COST)

	FRAME TYPE: 2				SHEARWALL TYPE: 0			
STORY NO.	INTERSTY. DRIFT	PERCENT GOOD	DAMAGE BY AVERAGE	QUALITY POOR	INTERSTY. DRIFT	PERCENT GOOD	DAMAGE BY AVERAGE	QUALITY POOR
12	.0002	0.00	0.00	0.00	.0002	0.00	0.00	0.00
11	.0003	0.00	0.00	0.00	.0003	0.00	0.00	0.00
10	.0003	0.00	0.00	0.00	.0003	0.00	0.00	0.00
9	.0004	0.00	0.00	0.00	.0004	0.00	0.00	0.00
8	.0005	0.00	0.00	0.00	.0005	0.00	0.00	0.00
7	.0006	0.00	0.00	.57	.0006	0.00	0.00	0.00
6	.0006	0.00	0.00	.76	.0006	0.00	0.00	0.00
5	.0007	0.00	0.00	.95	.0007	0.00	0.00	0.00
4	.0007	0.00	0.00	1.09	.0007	0.00	0.00	0.00
3	.0007	0.00	0.00	1.00	.0007	0.00	0.00	0.00
2	.0005	0.00	0.00	0.00	.0005	0.00	0.00	0.00
1	.0003	0.00	0.00	0.00	.0003	0.00	0.00	0.00

WIND DAMAGE TO NONSTRUCTURAL COMPONENTS (PERCENT OF COMPONENTS DAMAGED)

	CEILINGS AND PARTITIONS				GLASS (PERCENT DAMAGE BY WALL)					
STORY NO.	INTERSTY. DRIFT	PERCENT GOOD	DAMAGE BY AVERAGE	QUALITY POOR	WIND PRESS PSF	WALL 1	WALL 2	WALL 3	WALL 4	CORNERS
12	.0002	.13	.22	1.78	27.68	16.67	1.77	8.91	8.91	99.98
11	.0003	.22	.36	2.56	26.54	13.72	1.45	7.27	7.27	99.95
10	.0003	.34	.55	3.44	25.34	11.05	1.18	5.81	5.81	99.84
9	.0004	.46	.75	4.27	24.09	8.68	.94	4.55	4.55	99.53
8	.0005	.58	.95	5.05	22.78	6.63	.73	3.47	3.47	98.74
7	.0006	.69	1.15	5.76	21.40	4.89	.56	2.56	2.56	96.85
6	.0006	.80	1.33	6.39	19.92	3.45	.42	1.83	1.83	92.72
5	.0007	.90	1.48	6.92	18.33	2.32	.30	1.24	1.24	84.58
4	.0007	.96	1.60	7.29	16.58	1.45	.21	.80	.80	70.58
3	.0007	.92	1.53	7.07	14.63	.83	.14	.47	.47	50.25
2	.0005	.50	.82	4.57	12.35	.41	.08	.24	.24	26.87
1	.0003	.31	.51	3.26	9.49	.15	.04	.10	.10	8.04

FRAME TYPES:

0: NOT APPLICABLE
1: STEEL
2: REINFORCED CONCRETE
3: PRECAST CONCRETE

SHEARWALL TYPES:

0: NOT APPLICABLE
1: REINFORCED CONCRETE
2: PRECAST CONCRETE
3: BRICK MASONRY

END OF JOB.

APPENDIX C

FORTRAN Listing of Computer Program

```
      PROGRAM DAMAGE (INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT)
C     C=============================================================C
C     C   D A M A G E                                 JJJ   HHH     C
C     C                                               JJJ   HHH     C
C     C   A PROGRAM FOR ASSESSING THE DAMAGEABILITY         HHH     C
C     C   OF EXISTING BUILDINGS IN A NATURAL          JJJ   HHH     C
C     C   HAZARDS ENVIRONMENT                         JJJ   HHH     C
C     C                                           JJJ JJJ   HHHHHHH C
C     C   REVISED SEPT 1980, CHEN + HASSELMAN     JJJ JJJ   HHHHHHH C
C     C   DEVELOPED JULY 1973, HASSELMAN          JJJJJJJ   HHH HHH C
C     C                                           JJJJJJJ   HHH HHH C
C     C                                                             C
C     C                                           WWWW  WWWW  WWWW  C
C     C                                           WWWW  WWWW  WWWW  C
C     C   J. H.  W I G G I N S   C O M P A N Y    WWWW  WWWW  WWWW  C
C     C                                           WWWW  WWWW  WWWW  C
C     C   1650 SOUTH PACIFIC COAST HIGHWAY        WWWW  WWWW  WWWW  C
C     C                                           WWWW  WWWW  WWWW  C
C     C   REDONDO BEACH, CA 90277                 WWWWWWWWWWWWWWWW  C
C     C                                           WWWWWWWWWWWWWWWW  C
C     C   (213) 378-0257                          WWWWWWWWWWWWWWWW  C
C     C=============================================================C
      REAL M,LC(30),S(70,70),EDEFL(30),DFT(30)
      REAL CEC(10),CIC(10),QMS(30),VMM(30)
      DIMENSION NHAZ(3),T(100),F(100),C(70),D(70,70),M(30),
     1E(30,30),FA(30),FV(30),DRFT(30),TITLE(18)
      READ(5,588) (TITLE(I),I=1,18)
  588 FORMAT(18A4)
      WRITE(6,688) (TITLE(I),I=1,18)
  688 FORMAT('1',' RUN IDENTIFICATION:',//,10X,18A4)
      READ(5,9001) (NHAZ(I),I=1,3)
 9001 FORMAT(10I8)
      IF(NHAZ(1).EQ.1) WRITE(6,601)
      IF(NHAZ(2).EQ.1) WRITE(6,602)
      IF(NHAZ(3).EQ.1) WRITE(6,603)
  601 FORMAT(' EARTHQUAKE HAZARD IS INCLUDED')
  602 FORMAT(' WIND HAZARD IS INCLUDED')
  603 FORMAT(' TORNADO HAZARD IS INCLUDED')
      READ(5,9002) DLAT,DLONG
 9002 FORMAT(10E8.3)
      WRITE(6,620) DLAT,DLONG
  620 FORMAT(' SITE LOCATION: LATITUDE',F8.2,2X,                        SCHEN
     1'DEGREES, LONGITUDE',F8.2,2X,'DEGREES')                           SCHEN
C     READ(5,9001) LRISK,NMOD,LSROPT                                    SCHEN
      LRISK=1
      LSROPT=0                                                          SCHEN
      READ(5,9001) NMOD                                                 SCHEN
      IF(NMOD.EQ.1) WRITE(6,611)
      IF(NMOD.EQ.2) WRITE(6,612)
      IF(NMOD.EQ.3) WRITE(6,613)
  611 FORMAT(' BUILDING MODELING OPTION: DETAILED FRAME')
  612 FORMAT(' BUILDING MODELING OPTION: STORY STIFFNESS')
  613 FORMAT(' BUILDING MODELING OPTION: EMPIRICAL')
      CALL LOADS(DLAT,DLONG,LRISK,NHAZ,T,F,VF,ISITE,ISHAPE,VT,BL,ITOR,F1
     1,EM,AR,VR)                                                        CHEN79
      IF((NHAZ(1).EQ.0).AND.(NHAZ(2).EQ.0).AND.(ITOR.NE.1)) GO TO 99
      CALL STRUCT(NMOD,NS,LC,TWB,TLB,PHR,NOPRT,LRT,M,S,E,C,D,NOPT)
      IF(LRT.GT.0) GO TO 99
      T1=6.283/SQRT(C(1))
      IF(NHAZ(1).EQ.0) GO TO 10
      CALL DYNAMC(NS,LC,S,C,D,M,AR,VR,T,F,E,LD,NOPRT,NMOD,DFT)
      DO 30 I=1,NS
      FA(I)=E(I,6)
      FV(I)=E(I,5)
      EDEFL(I)=E(I,4)
   30 CONTINUE
   10 IF(NHAZ(2).EQ.0) GO TO 20
```

```
  100 CONTINUE
      CALL STATIC(NHAZ,NS,S,LC,TWB,PHR,T1,DRFT,VT,
     1D,VF,M,CEC,CIC,QMS,VMM,ISHAPE,ISITE,NMOD,ITOR,ITYPE,LRT)
      IF(LRT.GT.0) GCTO 99
   20 CONTINUE
      IF(LSROPT.EQ.0) GO TO 40
      IF(ITOR.EQ.-1) GO TO 36
      THB=0.
      DO 35 I=1,NS
   35 THB=THB+LC(I)
   36 P1=QMS(1)
      PI=VMM(1)
C     CALL LSROOF(ITYPE,TLR,TWB,THB,P1,PI,IFLY,IW)                SCHEN
   40 CONTINUE
      CALL DAMAG(NHAZ,EM,AR,VR,NS,FA,FV,EDEFL,DFT,LC,T1,DRFT,
     :CEC,CIC,QMS,VMM,ITOR,LSROPT,IFLY,IW,NOPT)
      IF((NHAZ(3).NE.0).AND.(ITOR.GT.0)) GO TO 98
      GO TO 99
   98 ITOR=-1
      GO TO 100
   99 CONTINUE
      WRITE(6,700)
  700 FORMAT('OEND OF JOB.')
      STOP
      END
      SUBROUTINE LOADS(DLAT,DLONG,LRISK,NHAZ,T,F,VF,ISITE,ISHAPE,VT,
     :BL,ITOR,F1,EM,AR,VR)                                         CHEN79
C
C  THIS SUBROUTINE GENERATES SITE LOADS FOR THREE NATURAL HAZARDS.
C
C     EARTHQUAKE'  SITE LOAD IS DEFINED TO BE THE GROUND
C                  PSEUDO-VELOCITY SPECTRUM COMPUTED FROM
C                  A BASE-ROCK SPECTRUM AND MODIFIED BY SITE SOIL
C                  CHARACTERISTICS.
C
C     WIND'        SITE LOAD IS DEFINED TO BE THE FASTEST MILE OF WIND
C                  AT 30 FEET FOR OPEN EXPOSURE.
C
C     TORNADO'     SITE LOAD IS DEFINED IN TERMS OF PROBABILITY OF HIT
C                  AND, IF DESIRED, A NOMINAL TORNADO WIND VELOCITY
C                  SPECIFIED BY THE USER.
C
      INTEGER NHAZ(3)
      REAL T(100),F(100)
      IF(NHAZ(1).EQ.0) GO TO 10
      CALL SEISMC(LRISK,DLAT,DLONG,EM,AR,VR,DR)
      CALL SOILOD(AR,VR,DR,F,T)
   10 IF(NHAZ(2).EQ.0) GO TO 20
      CALL WNDLOD(ISITE,ISHAPE,VF)
   20 IF(NHAZ(3).EQ.0) GO TO 30
      CALL TRNLOD(DLAT,DLONG,VT,ITOR)
   30 CONTINUE
      RETURN
      END
      SUBROUTINE SEISMC(LRISK,DLAT,DLONG,EM,AR,VR,DR)
```

```
C
C   THIS SUBROUTINE READS SEISMICITY DATA OBTAINED FROM
C   TABLES AND COMPUTES HARD ROCK ACCELERATION, VELOCITY AND
C   DISPLACEMENT CHARACTERISTICS.
C
      WRITE(6,700)
  700 FORMAT(1H1,20X,'E A R T H Q U A K E   L O A D   A N A L Y S I S',///
     :)
      IF(LRISK.NE.0) GO TO 10
C     READ(5,9002) EM,RBAR                                             SCHEN
 9002 FORMAT(10F8.3)
      GO TO 100
   10 CONTINUE
      LP=0                                                             SCHEN
C     READ(5,9001) LP                                                  SCHEN
 9001 FORMAT(10I8)
C     IF(LP.NE.0) GO TO 20
      READ(5,9002) EM,RBAR,RAR,RVR,RDR
C     RN=1./RNI
C     GO TO 30
C  20 CONTINUE
C     READ(5,9002) BLIFE,PNOC
C     RN=ALOG(1./PNOC)/BLIFE
C  30 CONTINUE
C     READ(5,9002) A,ASIG,RBAR                                         SCHEN
C     WRITE(6,610) A,ASIG                                              SCHEN
C 610 FORMAT('0MEAN SEISMICITY     =',1PE10.3,5X,
C    :'STANDARD DEVIATION =',1PE10.3)
C     READ(5,9002) A,RBAR                                              SCHEN
C     EM=(A-ALOG10(RN))/.9
C     IF(LP.EQ.0) WRITE(6,621) EM,RNI
C 621 FORMAT('0RETURN PERIOD FOR EARTHQUAKE OF MAGNITUDE',F6.2,
C    :2X,' = ',F8.1,2X,'YEARS')
C     IF(LP.NE.0) WRITE(6,620)EM,BLIFE,PNOC
C 620 FORMAT('0PROBABILITY THAT EARTHQUAKE OF MAGNITUDE',F5.1,2X,/,
C    :1X,'OR LARGER WILL NOT OCCUR DURING A PERIOD OF',F7.1,2X,
C    :'YEARS =',F6.3)
      EMMAX=8.5                                                        SCHEN
C     READ(5,9002) ENSIG,EMMAX                                         SCHEN
C     A=A+ENSIG*ASIG                                                   SCHEN
C     WRITE(6,630) ENSIG,A                                             SCHEN
C 630 FORMAT(' SELECTED SEISMICITY:  MEAN PLUS',F5.1,2X,               SCHEN
C    1'SIGMA =',F5.1)                                                  SCHEN
C     EM=(A-ALOG10(RN))/.9
      IF(EM.GT.EMMAX) EM=EMMAX
      IF(RAR.EQ.0.) GO TO 100
      AR=RAR
      VR=RVR
      DR=RDR
      GO TO 121
  100 CONTINUE
```

```
C
C  COMPUTE HARD ROCK GROUND MOTION
C
      LCOP=0                                                            SCHEN
C     READ(5,9001) LCOP                                                 SCHEN
      IF(LCOP.EQ.0) GO TO 110
      WRITE(6,640)
  640 FORMAT('0USER INPUT CONSTANTS FOR COMPUTING HARD ROCK GROUND MOTIO
     :N',//)
      READ(5,9002) C1,C2,C3
      READ(5,9002) CA1,CA2
      READ(5,9002) CD1,CD2
      WRITE(6,650) C1,C2,C3,CA1,CA2,CD1,CD2
  650 FORMAT(1X,1P10E10.2)
      GO TO 120
  110 CONTINUE
      IF(DLONG.GT.105.)GO TO 115
      C1=.00867
      C2=.563
      C3=.979
      GO TO 116
  115 C1=.0237
      C2=.563
      C3=1.403
  116 CONTINUE
      CA1=-1.5675
      CA2=0.7718
      CD1=-0.6144
      CD2=1.1438
  120 VR=C1*10.**(C2*EM)*RBAR**(-C3)
      AA=CA1+CA2*ALOG10(VR)
      DD=CD1+CD2*ALOG10(VR)
      AR=10.**AA
      DR=10.**DD
121   CONTINUE
C FIND SITE GROUND MOTION
      SAR=AR*4.
      SVR=VR*4.
      SDR=DR*4.
      WRITE(6,660) EM,RBAR,SAR,SVR,SDR
  660 FORMAT(15X,'SITE GROUND MOTION CHARACTERISTICS',//,
     :10X,'RICHTER MAGNITUDE              =',1PE10.2,/,
     :10X,'HYPOCENTRAL DISTANCE (MILES)   =',1PE10.2,/,
     :10X,'      SITE ACCELERATION (G)    =',1PE10.2,/,
     :10X,'      SITE VELOCITY (IN/SEC)   =',1PE10.2,/,
     :10X,'      SITE DISPLACEMENT (IN)   =',1PE10.2)
      RETURN
      END
      SUBROUTINE PRSPEC(BASE,SIG)
      REAL BASE(100),PER(100)
      PER(1)=0.1
      DO 1 I=2,100
    1 PER(I)=PER(I-1)+0.1
```

```
      WRITE(6,100)
  100 FORMAT('1',15X,'SITE GROUND MOTION SPECTRUM',///)
      DO 200 I=1,10
      N1=10*(I-1)+1
      N2=10*I
      WRITE(6,101)(PER(K),K=N1,N2)
  101 FORMAT(10X,'PERIOD (SEC)',10(2X,F7.2))
      WRITE(6,102)(BASE(K),K=N1,N2)
  102 FORMAT(10X,'VEL (IN/SEC)',10(2X,F7.2),//)
  200 CONTINUE
      RETURN
      END
      SUBROUTINE WNDLCD(ISITE,ISHAPE,VF)
C     READ(5,9001) ISITE,ITEST,ITY,ISHAPE                                SCHEN
 9001 FORMAT(10I8)
      ITEST=2                                                            SCHEN
      ISHAPE=1                                                           SCHEN
      ITY=1                                                              SCHEN
      WRITE(6,20)
   20 FORMAT('1',10X,'W I N D  L O A D  A N A L Y S I S',//)
      SIG=0.0
      IF(ITEST.EQ.1) READ(5,9002) SIG
      IF(ITEST.EQ.1) WRITE(6,50) SIG
   50 FORMAT('0',10X,'ANALYSIS TO BE BASED ON A MEAN WIND VELOCITY AND '
     1,F5.1,' SIGMA',//)
      GO TO(71,78),ITEST
C  71 CALL REG1(A1,B1,DIFF)
   71 CONTINUE                                                           SCHEN
      GO TO (73,74),ITY
   73 READ(5,9002) PERIOD
 9002 FORMAT(10F8.3)
      WRITE(6,11) PERIOD
   11 FORMAT('/',11X,'RETURN PERIOD IN YRS = ',F10.2,//)
      XX=1./PERIOD
      GO TO 75
   74 READ(5,9002) BLIFE,PROB
      WRITE(6,21) BLIFE,PROB
   21 FORMAT('0',11X,'LIFE OF BUILDING IN YRS = ',F8.2,5X,'PROBABILITY O
     1F NON OCCURRENCE = ',F8.3,//)
      XX=ALOG(1./PROB)/BLIFE
   75 VF = (ALOG10(XX)-A1*(1.+SIG*DIFF))/B1
      WRITE(6,51) VF
   51 FORMAT('0',10X,'FASTEST MILE WIND VELOCITY AT 30 FT - FREE FIELD',
     1              /,11X,' (NO GUST) FOR THE STATISTICAL PARAMETERS CHOSE
     2N = ',F8.2,' MPH',//)
      GO TO 72
C  78 READ(5,9002) VF                                                    SCHEN
   78 READ(5,9009) ISITE,VF,PERIOD                                       SCHEN
 9009 FORMAT(I8,2F8.3)                                                   SCHEN
      WRITE(6,10)ISITE,ITEST,ITY,ISHAPE
   10 FORMAT('0',10X,'ISITE= ',I5,5X,'ITEST= ',I5,5X,'ITY= ',I5,5X,'ISHA
     1PE= ',I5,//)
      WRITE(6,13) VF,PERIOD                                              SCHEN
   13 FORMAT('0',11X,'USERS VALUE OF WIND VELOCITY -FASTEST MILE AT 30 F
     1T ABOVE GROUND - FREE FIELD IN MPH =',F7.2,//,11X,' RETURN PERIOD
     1IN YEARS=',F7.1,//)
   72 CONTINUE
      RETURN
      END
      SUBROUTINE SOILCD(AR,VR,DR,Y,T)
      REAL AMP(100),Y(100),HR(100),T(100)
      DO 110 I=1,100
      Y(I)=0.0
      HR(I)=0.0
      T(I)=0.0
      AMP(I)=0.0
```

```
  110 CONTINUE
C     READ(5,9003) IPROC,SIG                                           SCHEN
C9003 FORMAT(I8,E8.3)                                                   SCHEN
      IPROC=5                                                           SCHEN
      SIG=0.0                                                           SCHEN
      GO TO (1,1,2,3,5),IPROC                                           SCHEN
C     GO TO (1,1,2,3),IPROC                                             SCHEN
C   1 CALL SDYN(AMP,SIG)
    1 CONTINUE                                                          SCHEN
      GO TO 5
C   2 CALL SSTATA(AMP,SIG)
    2 CONTINUE                                                          SCHEN
      GO TO 5
C   3 CALL SSTATB(AMP,SIG)
    3 CONTINUE                                                          SCHEN
    5 CONTINUE
      PI=2.*3.1415926
      TA=PI*VR/(AR*386.)
      TD=PI*DR/VR
C
C     FORM PERIOD ARRAY
C
      DO 10 I=1,100
      AMP(I)=4.0
   10 T(I)=0.1*I
C
C     FORM HARD ROCK SPECTRUM
C
      DO 11 I=1,100
      IF(T(I).LT.TA) HR(I)=(T(I)*AR*386./PI)
      IF (T(I).GE.TA.AND.T(I).LT.TD) HR(I)=VR
      IF (T(I).GE.TD) HR(I)=DR*PI/T(I)
   11 CONTINUE
C
C     FORM BASE SPECTRUM
C
      DO 12 I=1,100
   12 Y(I)=HR(I)*AMP(I)
      CALL PRSPEC(Y,SIG)
      RETURN
      END
      SUBROUTINE TRNLCD(NLAT,WLONG,VT,ITOR)
      REAL BL,F1,VT,NLAT                                                SCHEN
      WRITE(6,51)
   51 FORMAT('1',///,15X,'T O R N A D O   L O A D   A N A L Y S I S',//)
C     READ(5,9003) BL,F1,ITOR                                           SCHEN
C9003 FORMAT(2E8.3,I8)                                                  SCHEN
      ITOR=1
      READ(5,9002) VT,BL
 9002 FORMAT(10E8.3)
C     IF(ITOR.NE.0) READ(5,9002) VT                                     SCHEN
      IF(ITOR.NE.0) WRITE(6,600) VT,BL
  600 FORMAT(1H0,10X,'TORNADO WIND VELOCITY =',F8.2,2X,'MILES PER HOUR',
     1//,18X,'RETURN PERIOD =',F8.2,2X,'YEARS')
C
C BYPASS PROBABILITY COMPUTATIONS                                      SC
C
      GO TO 99
```

```
   10 IF (NMOD.NE.2) GO TO 20
      CALL STIFF2 (NS,S,LC)
      GO TO 30
   20 IF (NMOD.NE.1) GO TO 40
      CALL STIFF1 (NCFT,NS,LC,S,M,LRT,NOPRT)
      IF(LRT.GT.0) GO TO 99
   30 DO 25 I=1,NS
      DO 25 J=1,NS
      JK(J)=NS+1-J
   25 E(I,J)=S(I,J)
      WRITE(6,603)
  603 FORMAT('1STIFFNESS MATRIX (KIPS/IN)',/)
      WRITE(6,601)
  601 FORMAT(/,' STORY',/,'  NO.')
      CALL MATPRT(NS,NS,S)
      CALL FLMASS (NS,M)
      WRITE(6,604)
  604 FORMAT(////,' TOTAL WEIGHT VECTOR + DRIFT TO YIELD',//,
     :              ' STORY    STORY WT.    DRIFT TO',/,
     :              '  NO.      (KIPS)       YIELD',//)
  606 FORMAT(I5,F11.2,F10.4)
      DO 60 I=1,NS
      LK=NS+1-I
      C(I)=M(I)*386.4
   60 WRITE(6,606) LK,C(I),DRFTY(I)
      CALL EIGENS (S,MT,M,C,D,NS,A,B,PP)
      DO 35 I=1,NS
      DO 35 J=1,NS
   35 S(I,J)=E(I,J)
      GO TO 50
  150 CONTINUE
      CALL FLMASS(NS,M)
      WRITE(6,604)
      DO 151 I=1,NS
      LK=NS+1-I
      A(I)=M(I)*386.4
  151 WRITE(6,606) LK,A(I),DRFTY(I)
      GO TO 50
   40 WRITE (6,600)
  600 FORMAT ('1STRUCTURAL MODELING OPTION IMPROPERLY SPECIFIED.
     1                EXECUTION TERMINATED.')
   99 CONTINUE
   50 RETURN
      END
      SUBROUTINE STIFF3(NS,LC,TI,CV,DN)
C
C  THIS SUBROUTINE READS THE NUMBER OF STORIES AND STORY HEIGHTS
C  OF A BUILDING AND ITS FUNDAMENTAL PERIOD, TI. IT THEN COMPUTES MODAL
C  DEFLECTIONS ASSUMING A STRAIGHT-LINE MODE SHAPE FOR THE FUNDAMENTAL
C  MODE AND EVALUATES THE FUNDAMENTAL EIGENVALUE BASED ON THE PERIOD
C  SPECIFIED.
C
      DIMENSION CV(70),DN(70,70)
      REAL LC(30)
  600 FORMAT('0NUMBER OF STORIES = ',I5)
 9002 FORMAT(10E8.3)
      READ(5,9002) TI
      WRITE(6,620) TI
  620 FORMAT('0FUNDAMENTAL PERIOD (SEC) =',F8.3)
C     READ(5,9002) (LC(I),I=1,NS)
      DO 55 I=1,NS
   55 READ(5,9002) LC(I)                                          SCHEN
      WRITE(6,610) (LC(I),I=1,NS)                                 SCHEN
  610 FORMAT('0STORY HEIGHTS, TOP TO BOTTOM',//,
     :3(1X,1P10E10.2,/))
```

```
4     SUM1=0.0
      DO 200 I=1,NS
200   SUM1=SUM1+LC(I)
      DN(1,1)=1.00
      SUM2=0.0
      DO 201 I=2,NS
      SUM2=SUM2+LC(I-1)
201   DN(I,1)=1.0*(SUM1-SUM2)/SUM1
      CV(1)=(6.2831853/TI)**2
      RETURN
      END
      SUBROUTINE STIFF2(NS,S,LC)
C
C     THIS SUBROUTINE READS CARD INPUT FOR GENERATING THE STIFFNESS
C     MATRIX OF A STORY MODEL OF A BUILDING AND PRODUCES AN NXN
C     STIFFNESS MATRIX WHERE N = NUMBER OF STORIES.
C
      REAL S(70,70),SK(30),LC(30)
      WRITE(6,10)
   10 FORMAT('0STIFFNESS INPUT FOR STORY MODEL - NBOPT = 2')
C     READ(5,9002) (LC(I),I=1,NS)
C     READ(5,9002)(SK(I),I=1,NS)
      DO 55 I=1,NS                                                      SCHEN
   55 READ(5,9002) SK(I),LC(I)                                          SCHEN
 9002 FORMAT(10E8.3)
      WRITE(6,30)
   30 FORMAT('0STORY',' STIFFNESS(KIPS/IN)')
      DO 40 I=1,NS
   40 WRITE(6,50)NS,SK(I)
   50 FORMAT(1H ,I5,E20.4)
      WRITE(6,600) (LC(I),I=1,NS)
  600 FORMAT('0STORY HEIGHTS, TOP TC BOTTOM (INCHES)',//,3(1X,1P10E10.2,
     */))
C
C     COMPUTE STIFFNESS MATRIX S
C
      S(1,1)=SK(1)
      IF(NS.EQ.1) GO TO 62
      S(2,1)=-SK(1)
      NSM1=NS-1
      DO 60 I=2,NSM1
      S(I-1,I)=-SK(I-1)
      S(I,I)=SK(I-1)+SK(I)
      S(I+1,I)=-SK(I)
   60 CONTINUE
      S(NS-1,NS)=S(NS,NS-1)
      S(NS,NS)=SK(NS)+SK(NS-1)
   62 CONTINUE
      RETURN
      END
      SUBROUTINE STIFF1(NOPT,NS,LC,S,M,LRT,NOPRT)
```

```
C
C     THIS SUBROUTINE READS DETAILED STRUCTURAL DATA AND COMPUTES
C     A REDUCED STIFFNESS MATRIX CORRESPONDING TO FLOOR
C     TRANSLATIONS. WHEN NDLC .NE. 1, A MASS VECTOR IS COMPUTED TO
C     ACCOUNT FOR THE MASS OF STEEL FRAMING ONLY.
C
      REAL ST(30,30),D(30,30)
      REAL LB(10),LC(30),AB(99),AC(99),IB(99),IC(99),WB(99),WC(99)
      REAL S(70,70),M(30),
     1     AL(10),BL(10),FB(99),FC(99)
      INTEGER SN,FRN
      INTEGER BTP(200),CTP(220),BBTP1(200),BBTP2(200)
      REAL ALB(200),BLB(200),SCJB(200),SCKB(200),ALC(220),BLC(220),
     1 SCJC(220),SCKC(220)
      COMMON /DATA/ BTP,CTP,LB,AB,AC,IB,IC,E,WB,WC,ALB,BLB,SCJB,
     1 SCKB,ALC,BLC,SCJC,SCKC,BBTP1,BBTP2,ABR(20)
     1 ,AL,BL,FB,FC,G,EB,GB
C*******************************************************************
C   INPUT PARAMETERS
C********************************************************************
      CALL SDATA
      NDIM=70
9001  FORMAT (10I8)
      FRN=0
      DO 22 I=1,30
      M(I)=0.0
      DO 22 J=1,30
      ST(I,J)=0.0
22    D(I,J)=0.0
      READ(5,9001) NFRMS
      WRITE(6,687) NFRMS
      IF(NFRMS.GT.5.AND.NS.GT.10) NOPRT=1
687   FORMAT('0NUMBER OF FRAMES  = ',I5,/)
2     FRN=FRN+1
      READ(5,9001) NOPT
      WRITE(6,686) FRN,NOPT
686   FORMAT('1',' -- FRAME NO.',I3,' --',' FRAME MODELING OPTION=',I5,
     1//)
      DO 3 I=1,NDIM
      DO 3 J=1,NDIM
3     S(I,J)=0.0
C************************************************************
C   DEFINE STRUCTURE PARAMETERS
C************************************************************
      IF(NOPT.EQ.1) CALL READ1(NB,NS,LC,NBB,NRFJ,NDLC )
      IF(NOPT.EQ.2) CALL READ2(NB,NS,LC,NDLC ,NOPT)
C************************************************************
C   GENERATE STIFFNESS MATRIX AND FRAMING MASS MATRIX.
C   ELIMINATE VERT. TRANS. AND ROTAT. BY STATIC CONDENSATION
C************************************************************
      SN=0
6     SN=SN+1
      IF(NOPT.EQ.1) CALL SFRAME(NB,NS,LC,SN,S,NOPRT,NRFJ,NBB)
      IF(NOPT.EQ.2) CALL GFRAME(NB,NS,LC,SN,S,NOPRT)
      IF(NDLC.EQ.1) GO TO 10
      CALL FRMASS(M,SN,LC,NB,NOPRT)
   10 CONTINUE
      CALL CONDEN(NB,NS,SN,S,LRT)
      IF(LRT.GT.0) GO TO 99
      IF(SN.LT.NS) GOTO 6
      NB2N=(2*NB+2)*2
      DO 5 I=1,NS
      DO 5 J=1,NS
5     S(I,J)=S(I+NB2N,J+NB2N)
```

```
C*************************************************************
C  SUPERIMPOSE PLANE FRAME STIFFNESS MATRICES
C*************************************************************
      IF(FRN.EQ.1) GOTO 7
      DO 8 I=1,NS
      DO 8 J=1,NS
      TEMP=ST(I,J)
8     S(I,J)=S(I,J)+TEMP
7     CONTINUE
      DO 9 I=1,NS
      DO 9 J=1,NS
9     ST(I,J)=S(I,J)
      IF(FRN.LT.NFRMS) GOTO 2
      GO TO 100
   99 WRITE(6,700)
  700 FORMAT('1STIFFNESS MATRIX CONDENSATION ERROR. EXECUTION TERMINATED
     1.')
  100 RETURN
      END
      SUBROUTINE SDATA
      REAL LB(10),AB(99),AC(99),IB(99),IC(99),WB(99),WC(99)
     $        ,AL(10),BL(10),FB(99),FC(99)
      INTEGER BTP(200),CTP(220),BBTP1(200),BBTP2(200)
      REAL ALB(200),BLB(200),SCJB(200),SCKB(200),ALC(220),BLC(220),
     $ SCJC(220),SCKC(220)
      COMMON /DATA/ BTP,CTP,LB,AB,AC,IB,IC,E,WB,WC,ALB,BLB,SCJB,
     $ SCKB,ALC,BLC,SCJC,SCKC ,BBTP1,BBTP2,ABR(20)
     $ ,AL,BL,FB,FC,G,EB,GB
      DATA ((AB(I),I=1,83)=
     1  7.67,9.13,10.6,11.8,13.3,14.7,17.1,18.8,20.9,23.0,25.9,28.2,
     2  10.3,11.8,13.2,14.7,16.2,17.7,18.9,20.6,22.7,25.0,28.2,30.9,
     3  33.5,13.0,14.4,16.2,18.3,20.0,21.5,24.2,28.3,33.0,37.4,41.8,
     4  16.2,18.0,20.0,22.4,24.7,27.7,29.5,32.5,35.4,38.3,42.7,47.1,
     5  24.8,27.7,30.0,33.6,42.7,47.1,52.2,29.1,31.8,34.2,36.5,38.9,
     6  50.7,56.0,61.9,34.8,38.3,41.6,44.8,58.9,64.8,70.6,39.8,44.2,
     7  47.1,50.0,53.6,57.2,67.7,72.1,76.5,82.4,88.3,100.,0.00)
      DATA ((IB(I),I=1,83)=
     1  300.,374.,447.,517.,584.,657.,748.,836.,941.,1050.,1220.,
     2  1360.,513.,612.,706.,802.,891.,986.,1050.,1160.,1290.,1440.,
     3  1680.,1850.,2040.,843.,971.,1140.,1330.,1480.,1600.,1760.,
     4  2100.,2620.,3020.,3410.,1340.,1540.,1820.,2100.,2370.,2690.,
     5  3000.,3330.,3650.,4020.,4570.,5120.,2830.,3270.,3610.,4090.,
     6  5430.,6030.,6740.,4000.,4470.,4930.,5360.,5760.,7910.,8850.,
     7  9890.,5900.,6710.,7460.,8160.,11100.,12300.,13600.,7820.,
     8  9030.,9760.,10500.,11300.,12100.,15000.,16100.,17300.,
     9  18900.,20300.,1.,1.)
      DATA ((WB(I),I=1,83)=
     1  26.,31.,36.,40.,45.,50.,58.,64.,71.,78.,88.,96.,35.,40.,45.,
     2  50.,55.,60.,64.,70.,77.,85.,96.,105.,114.,44.,49.,55.,62.,68.,
     3  73.,82.,96.,112.,127.,142.,55.,61.,68.,76.,84.,94.,100.,110.,
     4  120.,130.,145.,160.,84.,94.,102.,114.,145.,160.,177.,99.,108.,
     5  116.,124.,132.,172.,190.,210.,118.,130.,141.,152.,200.,220.,
     6  240.,135.,150.,160.,170.,182.,194.,230.,245.,260.,280.,300.,
     7  0.,0.)
      DATA ((AC(I),I=1,39)=
     1  17.9,20.0,21.8,22.9,24.7,25.6,27.9,30.3,32.7,35.0,37.3,
     2  40.0,41.8,44.1,46.5,49.1,51.7,54.1,56.7,59.4,62.1,64.4,
     3  67.1,69.7,72.3,77.6,84.4,92.3,101.,109.,117.,125.,134.,
     4  147.,162.,178.,196.,215.,1.00)
      DATA ((IC(I),I=1,89)=
     1  641.0,724.0,797.0,851.0,928.0,967.0,1060.,1170.,1270.,1370.,
     2  1480.,1590.,1670.,1790.,1900.,2020.,2150.,2270.,2400.,2540.,
     3  2670.,2800.,2940.,3080.,3230.,3530.,3910.,4400.,4910.,5450.,
     4  6010.,6610.,7220.,8250.,9450.,10900.,12500.,14400.,1.00,11*0.0,
     5  107.0,121.0,133.0,207.0,225.0,350.0,384.0,420.0,455.0,492.0,
     6  528.0,568.0,660.0,703.0,745.0,790.0,838.0,883.0,930.0,980.0,
     7  1030.,1070.,1120.,1170.,1230.,1330.,1470.,1630.,1810.,1990.,
     8  2170.,2360.,2560.,2880.,3260.,3680.,4170.,4720.,1.000)
      DATA ((WC(I),I=1,39)=
```

```
     1  61.0,68.0,74.0,78.0,84.0,87.0,95.0,103.,111.,119.,127.,
     2  136.,142.,150.,158.,167.,176.,184.,193.,202.,211.,219.,
     3  228.,237.,246.,264.,287.,314.,342.,370.,398.,426.,455.,
     4  500.,550.,605.,665.,730.,0.00)
      DO 10 I=1,38
      I2=50+I
      WC(I)=WC(I)/1000.0/12.0
      AC(I2)=AC(I)
      WC(I2)=WC(I)
   10 CONTINUE
      DO 20 I=1,81
   20 WB(I)=WB(I)/1000.0/12.0
      DO 21 I=1,99
      FB(I)=0.0
   21 FC(I)=0.0
      RETURN
      END
      SUBROUTINE READ1(NB,NS,LC,NBB,NRFJ,NDLC )
      REAL RAB(99),RAC(99),RIB(99),RIC(99),RWB(99),RWC(99)
      REAL LB(10),LC(30),AB(99),AC(99),IB(99),IC(99),WB(99),WC(99)          14.
      REAL  AL(10),BL(10),FB(99),FC(99)
      INTEGER SUM
      INTEGER BTP(200),CTP(220),BBTP1(200),BBTP2(200)
      REAL ALB(200),BLB(200),SCJB(200),SCKB(200),ALC(220),BLC(220),
     $ SCJC(220),SCKC(220)
      COMMON /DATA/ BTP,CTP,LB,AB,AC,IB,IC,E,WB,WC,ALB,BLB,SCJB,
     $ SCKB,ALC,BLC,SCJC,SCKC,BBTP1,BBTP2,ABP(20)
     $ ,AL,BL,FB,FC,G,EB,GH
C     READ(5,9003) E,NB,NBT,NCT,NBB,NBRT,NRFJ,NDLC                          SCHEN
      NDLC=0                                                                SCHEN
      READ(5,9003) E,NB,NBT,NCT,NBB,NBRT,NRFJ                               SCHEN
 9003 FORMAT(E8.3,7I8)
 9004 FORMAT(I8,3E8.3)
      WRITE(6,673)NB,NBB,E
  673 FORMAT('ONUMBER OF BAYS         =',I5,/
     $        'ONUMBER OF BRACED BAYS =',I5,/,
     $        'OYOUNGS MODULUS        =',F9.1,3X,'(KIPS/SQ IN)',/)
      IF(NBT.LE.0) GOTO 73
      WRITE(6,601)                                                          45.
  601 FORMAT('OBEAM TYPE          AB          IB          WB',/)            46.
      DO 2 I=1,NBT                                                          47.
      READ(5,9004)J,RAB(J),RIB(J),RWB(J)
      IF(J.GE.82)GO TO 11
      GO TO 15
   11 AB(J)=RAB(J)
      IB(J)=RIB(J)
      WB(J) =RWB(J)/1000.0/12.0
   15 WRITE(6,602)J,AB(J),IB(J),WB(J)
  602 FORMAT(I10,F13.1,F10.1,F8.3)
    2 CONTINUE                                                              53.
   73 IF(NCT.LE.0) GOTO 74
      WRITE(6,603)                                                          54.
  603 FORMAT('OCOLUMN TYPE        AC          IC          WC',/)            55.
      DO 3 I=1,NCT                                                          56.
      READ(5,9004)J,RAC(J),RIC(J),RWC(J)
      IF(J.GE.39.AND.J.LE.50) GO TO 12
      IF(J.GE.90) GO TO 12
      GO TO 16
   12 AC(J)=RAC(J)
      IC(J)=RIC(J)
      WC(J) =RWC(J)/1000.0/12.0
   16 WRITE(6,602)J,AC(J),IC(J),WC(J)                                       58.
    3 CONTINUE                                                              60.
   74 CONTINUE
```

```
      IF(NBRT.EQ.0) GCTO 77
      DO 75 I=1,200
      BBTP1(I)=0
   75 BBTP2(I)=0
      WRITE(6,609)
      DO 76 I=1,NBRT
      READ(5,9004) J,ABR(J)
   76 WRITE(6,602) J,ABR(J)
  609 FORMAT ('OBRACE TYPF      ABR',/)
   77 CONTINUE
      WRITE(6,604)
604   FORMAT('OBAY WIDTHS -------',/)
      SUM=0
    4 READ(5,9004)NUM,BW
      WRITE(6,605)NUM,BW
  605 FORMAT(I6,' BAYS AT',F10.3,' INCHES')
      J1=SUM+1
      J2=SUM+NUM
      DO 102 J=J1,J2
  102 LB(J)=BW
      SUM=SUM+NUM
      IF(SUM.LT.NB) GCTO 4
      WRITE(6,606)
  606 FORMAT('OSTCRY HEIGHTS --------',/)
      SUM=0
    5 READ(5,9004) NUM,SH
      WRITE(6,607)NUM,SH
  607 FORMAT(I6,' STCRIES AT',F10.3,' INCHES')
      J1=SUM+1
      J2=SUM+NUM
      DO 101 J=J1,J2
  101 LC(J)=SH
      SUM=SUM+NUM
      IF(SUM.LT.NS) GCTO 5
      RETURN
      END
      SUBROUTINE SFRAME(NB,NS,LC,SN,S,NOPRT,NRFJ,NBB)
      REAL S(70,70),L
      REAL LB(10),LC(30),AB(99),AC(99),IB(99),IC(99),WB(99),WC(99)
      INTEGER BTP(200),CTP(220),BBTP1(200),BBTP2(200)
      REAL ALB(200),BLB(200),SCJB(200),SCKB(200),ALC(220),BLC(220),
     $ SCJC(220),SCKC(220)
     $ ,AL(10),BL(10),FB(99),FC(99)
      COMMON /DATA/ BTP,CTP,LB,AB,AC,IB,IC,E,WB,WC,ALB,BLB,SCJB,
     $ SCKB,ALC,BLC,SCJC,SCKC,BBTP1,BBTP2,ABR(20)
     $ ,AL,BL,FB,FC,G,EB,GB
      INTEGER B1,B2,BN,C1,C2,CN,BT,CT,SUM,SN,F1,F2
      SUM=0
      IFR=0
      A=0.0
      B=0.0
      SCJ=0.0
      SCK=0.0
      NC=NB+1
      R9=1.0
      IF(SN.EQ.NS) R9=0.0
      LS=NS+1-SN
      IF(NOPRT.NE.1)WRITE(6,600)LS
      IBTP=(SN-1)*NB
       ICTP=(SN-1)*(NB+1)
  600 FORMAT('OSTORY NO.',I5,' --------STRUCTURE DATA',/,'OBEAM     AREA
     *          IZ      W(DL) ',5X,'A',7X,'B',3X,'SCJ',5X,'SCK',/)
    1 IF(NRFJ.EQ.1) GCTO 80
      READ(5,9001)NUM,BT
```

```
9001 FORMAT(10I8)
9002 FORMAT(10E8.3)
9003 FORMAT(3I8,4E8.3)
     GOTO 81
  80 READ(5,9003)NUM,BT,IFR,A,B,SCJ,SCK
  81 CONTINUE
     B1=SUM+1
     B2=SUM+NUM
     DO 2 BN=B1,B2
     L=LB(BN)-A-B
     SCM2=4.0*E*IB(BT)/L
     SCM3=1.5*SCM2/L
     SCM4=2.0*SCM3/L
     ALB(IBTP+BN)=A
     BLB(IBTP+BN)=B
     SCJB(IBTP+BN)=SCJ
     SCKB(IBTP+BN)=SCK
     BTP(IBTP+BN)=BT
     IF(IFR.EQ.1)GOTO 59
     EJ=0.0
     EK=0.0
     GOTO 60
  59 EJ=SCM2/4.0/SCJ
     EK=SCM2/4.0/SCK
  60 ES=12.0*EJ*EK+4.0*(EJ+EK)+1.0
     E1=EJ+EK+1.0
     E2J=2.0*EJ+1.0
     E2K=2.0*EK+1.0
     E3J=3.0*EJ+1.0
     E3K=3.0*EK+1.0
     IF(NOPRT.NE.1)WRITE(6,601)BN,AB(BT),IB(BT),WB(BT),A,B,SCJ,SCK
 601 FORMAT(I5,F9.1,F10.1,F9.5,2F8.2,1X,1P2E9.2)
     J1=(BN-1)*2+1
     J2=J1+1
     K1=J2+1
     K2=K1+1
     S(J1,J1)=S(J1,J1)+SCM4*E1/ES
     S(J1,J2)=S(J1,J2)+SCM3*(E2K+2.0*(A/L)*E1)/ES
     S(J1,K1)=S(J1,K1)-SCM4*E1/ES
     S(J1,K2)=S(J1,K2)+SCM3*(E2J+2.0*B*E1/L)/ES
     S(J2,J2)=S(J2,J2)+SCM2*(E3K+3.0*(A/L)*(E2K+(A/L)*E1))/ES
     S(J2,K1)=S(J2,K1)-SCM3*(E2K+2.0*A*E1/L)/ES
     S(J2,K2)=S(J2,K2)+SCM2/2.0*(1.0+3.0*(A/L)*E2J+3.0*B/L*
    $E2K+6.0*A*B*E1/L/L)/ES
     S(K1,K1)=S(K1,K1)+SCM4*E1/ES
     S(K1,K2)=S(K1,K2)-SCM3*(E2J+2.0*B*E1/L)/ES
     S(K2,K2)=S(K2,K2)+SCM2*(E3J+3.0*B*(E2J+B*E1/L)/L)/ES
   2 CONTINUE
     SUM=SUM+NUM
     IF(SUM.LT.NB)GOTO 1
     SUM=0
     F1=NC*4+SN
     F2=F1+1
     IF(SN.EQ.NS) F2=F1
     IF(NOPRT.NE.1)WRITE(6,602)
 602 FORMAT('0COLUMN          ',/)
   3 IF(NREJ.EQ.1) GOTO 82
     READ(5,9001)NUM,CT
     GOTO 83
  82 READ(5,9003)NUM,CT,IFR,A,B,SCJ,SCK
  83 CONTINUE
     C1=SUM+1
     C2=SUM+NUM
     DO 4 CN=C1,C2
     L=LC(SN)-A-B
     SCM2=4.0*E*IC(CT)/L
     SCM3=1.5*SCM2/L
     SCM4=2.0*SCM3/L
```

```
      ALB(IBTP+BN)=A
      BLB(IBTP+BN)=B
      SCJB(IBTP+BN)=SCJ
      SCKB(IBTP+BN)=SCK
      BTP(IBTP+BN)=BT
      IF(IFR.EQ.1)GOTO 59
      EJ=0.0
      EK=0.0
      GOTO 60
   59 EJ=SCM2/4.0/SCJ
      EK=SCM2/4.0/SCK
   60 ES=12.0*EJ*EK+4.0*(EJ+EK)+1.0
      E1=EJ+EK+1.0
      E2J=2.0*EJ+1.0
      E2K=2.0*EK+1.0
      E3J=3.0*EJ+1.0
      E3K=3.0*EK+1.0
      IF(NOPRT.NE.1)WRITE(6,601)BN,AB(BT),IB(BT),WB(BT),A,B,SCJ,SCK
  601 FORMAT(I5,F9.1,F10.1,F9.5,2F8.2,1X,1P2E9.2)
      J1=(BN-1)*2+1
      J2=J1+1
      K1=J2+1
      K2=K1+1
      S(J1,J1)=S(J1,J1)+SCM4*E1/ES
      S(J1,J2)=S(J1,J2)+SCM3*(E2K+2.0*(A/L)*E1)/ES
      S(J1,K1)=S(J1,K1)-SCM4*E1/ES
      S(J1,K2)=S(J1,K2)+SCM3*(E2J+2.0*B*E1/L)/ES
      S(J2,J2)=S(J2,J2)+SCM2*(E3K+3.0*(A/L)*(E2K+(A/L)*E1))/ES
      S(J2,K1)=S(J2,K1)-SCM3*(E2K+2.0*A*E1/L)/ES
      S(J2,K2)=S(J2,K2)+SCM2/2.0*(1.0+3.0*(A/L)*E2J+3.0*B/L*
     $E2K+6.0*A*B*E1/L/L)/ES
      S(K1,K1)=S(K1,K1)+SCM4*E1/ES
      S(K1,K2)=S(K1,K2)-SCM3*(E2J+2.0*B*E1/L)/ES
      S(K2,K2)=S(K2,K2)+SCM2*(E3J+3.0*B*(E2J+B*E1/L)/L)/ES
    2 CONTINUE
      SUM=SUM+NUM
      IF(SUM.LT.NB)GOTO 1
      SUM=0
      F1=NC*4+SN
      F2=F1+1
      IF(SN.EQ.NS) F2=F1
      IF(NOPRT.NE.1)WRITE(6,602)
  602 FORMAT('0COLUMN                ',/)
    3 IF(NRFJ.EQ.1) GOTO 82
      READ(5,9001)NUM,CT
      GOTO 83
   82 READ(5,9003)NUM,CT,IFR,A,B,SCJ,SCK
   83 CONTINUE
      C1=SUM+1
      C2=SUM+NUM
      DO 4 CN=C1,C2
      L=LC(SN)-A-B
      SCM2=4.0*E*IC(CT)/L
      SCM3=1.5*SCM2/L
      SCM4=2.0*SCM3/L
      ALC(ICTP+CN)=A
      BLC(ICTP+CN)=B
      SCJC(ICTP+CN)=SCJ
      SCKC(ICTP+CN)=SCK
      CTP(ICTP+CN)=CT
      IF(IFR.EQ.1)GOTO 69
      EJ=0.0
      EK=0.0
      GOTO 70
```

```
 69 EJ=SCM2/4.0/SCJ
    EK=SCM2/4.0/SCK
 70 ES=12.0*EJ*EK+4.0*(EJ+EK)+1.0
    E1=EJ+EK+1.0
    E2J=2.0*EJ+1.0
    E2K=2.0*EK+1.0
    E3J=3.0*EJ+1.0
    E3K=3.0*EK+1.0
    IF(NOPRT.NE.1)WRITE(6,601)CN,AC(CT),IC(CT),WC(CT),A,B,SCJ,SCK
    J1=CN*2-1                                                      298.
    J2=J1+1                                                        299.
    K1=J1+NC*2                                                     300.
    K2=K1+1                                                        301.
    SCM1=E*AC(CT)/LC(SN)                                           304.
    S(F1,F1)=S(F1,F1)+SCM4*E1/ES
    S(J2,F1)=S(J2,F1)+SCM3*(E2K+2.0*A*E1/L)/ES
    S(J1,J1)=S(J1,J1)+SCM1                                         310.
    S(J2,J2)=S(J2,J2)+SCM2*(E3K+3.0*(A/L)*(E2K+(A/L)*E1))/ES
    IF(SN.EQ.NS) GOTO 4                                            312.
    S(K2,F1)=S(K2,F1)+SCM3*(E2J+2.0*B*E1/L)/ES
    S(J1,K1)=-SCM1                                                 314.
    S(J2,K2)=SCM2/2.0*(1.0+3.0*(A/L)*E2J+3.0*B/L*
   $E2K+6.0*A*B*E1/L/L)/ES
    S(K1,K1)=SCM1                                                  316.
    S(K2,K2)=SCM2*(E3J+3.0*B*(E2J+B*E1/L)/L)/ES
    S(F1,F2)=S(F1,F2)-SCM4*E1/ES
    S(F2,F1)=S(F1,F2)
    S(J2,F2)=-SCM3*(E2K+2.0*A*E1/L)/ES
    S(K2,F2)=-SCM3*(E2J+2.0*B*E1/L)/ES
    S(F2,F2)=S(F2,F2)+SCM4*E1/ES
  4 CONTINUE                                                       323.
    SUM=SUM+NUM
    IF(SUM.LT.NB+1) GOTO 3
    IF(NBB.EQ.0) GOTO 91
    IF(NOPRT .NE. 1) WRITE(6,603)
603 FORMAT('0BRACE    AREA       AREA',/)
    DO 9 I=1,NBB
    READ(5,9001) BN,BT,CT
    BBTP1(IBTP+BN)=BT
    BBTP2(IBTP+BN)=CT
    L=SQRT(LB(BN)**2+LC(SN)**2)
    J1=BN*2-1
    J2=(BN+1)*2-1
     K1=J1+NC*2
    K2=J2+NC*2
    CX=LB(BN)/L
    CY=LC(SN)/L
    SCM1=E*ABR(BT)/L
    SCM2=E*ABR(CT)/L
    S(F2,F2)=S(F2,F2) + CX*CX*R9*(SCM1+SCM2)
    S(F2,F1)=S(F2,F1) - CX*CX*R9*(SCM1+SCM2)
    S(K1,F2)=S(K1,F2) + CX*CY*R9*SCM1
    S(K1,K1)=S(K1,K1) + CY*CY*R9*SCM1
    S(K1,F1)=S(K1,F1) - CX*CY*R9*SCM1
    S(F1,F2)=S(F1,F2) - CX*CX*R9*(SCM1+SCM2)
    S(F1,F1)=S(F1,F1) + CX*CX*(SCM1+SCM2)
    S(J2,F2)=S(J2,F2) - CX*CY*R9*SCM1
    S(J2,K1)=S(J2,K1) - CY*CY*R9*SCM1
    S(J2,F1)=S(J2,F1) + CX*CY*SCM1
    S(J2,J2)=S(J2,J2) + CY*CY*SCM1
    CY=-CY
    S(J1,F1)=S(J1,F1) + CX*CY*SCM2
    S(J1,J1)=S(J1,J1) + CY*CY*SCM2
    S(J1,F2)=S(J1,F2) - CX*CY*R9*SCM2
    S(J1,K2)=S(J1,K2) - CY*CY*R9*SCM2
    S(K2,F1)=S(K2,F1) - CX*CY*R9*SCM2
    S(K2,F2)=S(K2,F2) + CX*CY*R9*SCM2
    S(K2,K2)=S(K2,K2) + CY*CY*R9*SCM2
    IF(NOPRT.NE.1) WRITE(6,601) BN,ABR(BT),ABR(CT)
```

```
    9 CONTINUE
   91 CONTINUE
      RETURN
      END                                                                 327.
      SUBROUTINE READ2(NB,NS,LC,NDLC ,NOPT)
      REAL LB(10),LC(30),AB(99),AC(99),IB(99),IC(99),WB(99),WC(99)         10.
      REAL  AL(10),BL(10),FB(99),FC(99),
     $       ALB(200),BLB(200),SCJB(200),
     $     SCKB(200),ALC(220),BLC(220),SCJC(220),SCKC(220)
      INTEGER SUM
      INTEGER BTP(200),CTP(220),BBTP1(200),BBTP2(200)
      COMMON /DATA/ BTP,CTP,LB,AB,AC,IB,IC,E,WB,WC,ALB,BLB,SCJB,
     $ SCKB,ALC,BLC,SCJC,SCKC,BBTP1,BBTP2,ABR(20)
     $ ,AL,BL,FB,FC,G,EB,GB
      IF(NOPT.EQ.3) GOTO 105
C     READ(5,9003) NB,NBT,NCT,E,G,EB,GB,WTB,WTC,NDLC                        SCHEN
      NDLC=0                                                                SCHEN
      READ(5,9003) NB,NBT,NCT,E,G,EB,GB,WTB,WTC                             SCHEN
 9002 FORMAT(10E8.3)
 9003 FORMAT(3I8,6E8.3,I8)
 9004 FORMAT(I8,2E8.3,I8,2E8.3)
 9005 FORMAT(I8,3E8.3)
      IF(EB .EQ. 0.0) EB=E
      IF(GB .EQ. 0.0) GB=G
      WRITE(6,501) NB,EB,GB,WTB,E,G,WTC
  501 FORMAT('0 NUMBER OF BAYS  =',I5,/,
     $ '0 BEAMS:   E=',F9.1,'  G=',F9.1,'  W(LBS/CU.FT)=',F9.2,/,
     $ '0 COLUMNS:  E=',F9.1,'  G=',F9.1,'  W(LBS/CU.FT)=',F9.2,/)
      IF(NBT.EQ.0) GOTO 73
      WRITE(6,601)                                                         45.
  601 FORMAT('0BEAM TYPE          AB          IB         FB',/)
      DO 2 I=1,NBT
      READ(5,9004) J,B1,D1,ISECT,RT1,RT2
      IF(ISECT.GT.2) GO TO 502
      GO TO 503
  502 T1=RT1
      T2=RT2
  503 CONTINUE
      GOTO(2001,2002,2003,2004),ISECT
 2001 AB(J)=B1*D1
      IB(J)=B1*D1**3/12.0
      FB(J)=1.20
      GOTO 2005
 2002 B1=B1/2.0
      AB(J)=3.1416*B1*B1
      IB(J)=3.1416*B1**4/4.0
      FB(J)=1.111111
      GOTO 2005
 2003 AB(J)=T1*(D1-2.*T2)+T2*2.*B1
      IB(J)=B1*D1**3/12.0-(B1-T1)*(D1-2.*T2)**3/12.0
      FB(J)=AB(J)/D1/T1
      GOTO 2005
 2004 AB(J)=T2*T1+B1*(D1-T1)
      Y=(B1*(D1-T1)**2/2.0+T2*T1*(D1-T1/2.0))/AB(J)
      IB(J)=B1*D1**3/12.0+(T2-B1)*T1**3/12.0+
     $      B1*D1*(D1/2.0-Y)**2+(T2-B1)*T1*(D1-T1/2.0-Y)**2
      FB(J)=AB(J)/(B1*D1)
 2005 WB(J)=AB(J)*WTB/1728./1000.
      WRITE(6,602)J,AB(J),IB(J),FB(J)
  602 FORMAT (I10,F12.1,F11.1,F9.2,F11.1,F10.3)
    2 CONTINUE
   73 IF(NCT.EQ.0) GOTO 74
      WRITE(6,603)
  603 FORMAT('0COLUMN TYPE        AC          IC         FC',/)
      DO 3 I=1,NCT
      READ(5,9004) J,B1,D1,ISECT,RT1,RT2
```

```
      IF(ISECT.GT.2)GC TO 504
      GO TO 505
  504 T1=RT1
      T2=RT2
  505 CONTINUE
      GOTO (3001,3002,3003,3004),ISECT
 3001 AC(J)=B1*D1
      IC(J)=B1*D1**3/12.0
      FC(J)=1.20
      GOTO 3005
 3002 B1=B1/2.0
      AC(J)=3.1416*B1*B1
      IC(J)=3.1416*B1**4/4.0
      FC(J)=1.111111
      GOTO 3005
 3003 AC(J)=T1*(D1-2.*T2)+T2*2.*B1
      IC(J)=B1*D1**3/12.0-(B1-T1)*(D1-2.*T2)**3/12.0
      FC(J)=AC(J)/D1/T1
      GOTO 3005
 3004 AC(J)=T2*T1+B1*(D1-T1)
      Y=(B1*(D1-T1)**2/2.0+T2*T1*(D1-T1/2.0))/AC(J)
      IC(J)=B1*D1**3/12.0+(T2-B1)*T1**3/12.0+
     $        B1*D1*(D1/2.0-Y)**2+(T2-B1)*T1*(D1-T1/2.0-Y)**2
      FC(J)=AC(J)/(B1*D1)
 3005 WC(J)=AC(J)*W1C/1728./1000.
      WRITE(6,612)J,AC(J),IC(J),FC(J)
  612 FORMAT(I10,F12.1,F11.1,F9.2,2F11.1,F10.3)
    3 CONTINUE
   74 CONTINUE
      WRITE(6,604)
  604 FORMAT('0BAY WIDTHS -------',/)
      SUM=0
    4 READ(5,9005)NUM,BW,BL1,AL2
      WRITE(6,605) NUM,BW
  605 FORMAT(I6,' BAYS AT',F10.3,' INCHES')
      J1=SUM+1
      J2=SUM+NUM
      DO 102 J=J1,J2
      BL(J)=BL1
      AL(J+1)=AL2
  102 LB(J)=BW
      SUM=SUM+NUM
      IF(SUM.LT.NB) GCTO 4
  105 CONTINUE
      WRITE(6,606)
  606 FORMAT('0STORY HEIGHTS --------',/)
      SUM=0
    5 READ(5,9004) NUM,SH
      WRITE(6,607)NUM,SH
  607 FORMAT(I6,' STORIES AT',F10.3,' INCHES')
      J1=SUM+1
      J2=SUM+NUM
      DO 101 J=J1,J2
  101 LC(J)=SH
      SUM=SUM+NUM
      IF(SUM.LT.NS) GCTO 5
      RETURN
      END
      SUBROUTINE GFRAME(NB,NS,LC,SN,S,NOPRT)
      REAL S(70,70),L,AL(10),BL(10),FB(99),FC(99)
      REAL LB(10),LC(30),AB(99),AC(99),IB(99),IC(99),WB(99),WC(99)
     $ ,ALB(200),BLB(200),SCJB(200),SCKB(200),
     $ ALC(220),BLC(220),SCJC(220),SCKC(220)
      INTEGER BTP(200),CTP(220),BBTP1(200),BBTP2(200)
      COMMON /DATA/ BTP,CTP,LB,AB,AC,IB,IC,F,WB,WC,ALB,BLB,SCJB,
     $ SCKB,ALC,BLC,SCJC,SCKC,BBTP1,BBTP2,AHR(20)
     $ ,AL,BL,FB,FC,G,EB,GB
      INTEGER B1,B2,BN,C1,C2,CN,BT,CT,SUM,SN,F1,F2
      SUM=0
```

```
      NC=NB+1
      LS=NS+1-SN
      IF(NOPRT.NE.1)WRITE(6,600)LS
      IBTP=(SN-1)*NB
       ICTP=(SN-1)*(NB+1)
  600 FORMAT('OSTORY NO.',I5,' -------STRUCTURE DATA',/,'OBEAM     AREA
     *       IZ        W(DL)  ',5X,'BL1',7X,'AL1',/)
    1 READ(5,9001) NUM,BT
 9001  FORMAT (10I8)
      B1=SUM+1
      B2=SUM+NUM
      DO 2 BN=B1,B2
      L=LB(BN)-BL(BN)-AL(BN+1)
      BTP(IBTP+BN)=BT
      IF(NOPRT.NE.1)WRITE(6,601)BN,AB(BT),IB(BT),WB(BT),BL(BN),AL(BN+1)
  601 FORMAT(I5,2F10.1,F10.5,2F10.2)
      G1=6.0*FB(BT)*EB*IB(BT)/GB/AB(BT)/L/L
      SCM2=4.0*EB*IB(BT)/L/(1.0+2.0*G1)
      SCM3=1.5*SCM2/L
      SCM4=2.0*SCM3/L
      J1=(BN-1)*2+1
      J2=J1+1
      K1=J2+1
      K2=K1+1
      B=AL(BN+1)
      A=BL(BN)
      S(J1,J1)=S(J1,J1)+SCM4
      S(J1,J2)=S(J1,J2)+SCM3*(1.0+2.0*A/L)
      S(J1,K1)=S(J1,K1)-SCM4
      S(J1,K2)=S(J1,K2)+SCM3*(1.0+2.0*B/L)
      S(J2,J2)=S(J2,J2)+SCM2*(1.0+3.0*(A/L)*(1.0+A/L))*(1.0+G1/2.0)
      S(J2,K1)=S(J2,K1)-SCM3*(1.0+2.0*A/L)
      S(J2,K2)=S(J2,K2)+SCM2/2.0*(1.0+3.0*(A/L)+3.0*(B/L)+
     $                  6.0*A*B/L/L)*(1.0-G1)
      S(K1,K1)=S(K1,K1)+SCM4
      S(K1,K2)=S(K1,K2)-SCM3*(1.0+2.0*B/L)
      S(K2,K2)=S(K2,K2)+SCM2*(1.0+3.0*(B/L)*(1.0+B/L))*(1.0+G1/2.0)
    2 CONTINUE
      SUM=SUM+NUM
      IF(SUM.LT.NB)GOTO 1
      SUM=0
      IF(NOPRT.NE.1)WRITE(6,602)
  602 FORMAT('OCOLUMN  AREA          IZ       W(DL)',/)
    3 READ(5,9001) NUM,CT
      C1=SUM+1
      C2=SUM+NUM
      DO 4 CN=C1,C2
      CTP(ICTP+CN)=CT
      IF(NOPRT.NE.1)WRITE(6,601)CN,AC(CT),IC(CT),WC(CT)
      J1=CN*2-1
      J2=J1+1
      K1=J1+NC*2
      K2=K1+1
      F1=NC*4+SN
      F2=F1+1
      SCM1=E*AC(CT)/LC(SN)
      G1=6.0*FC(CT)*E*IC(CT)/G/AC(CT)/LC(SN)/LC(SN)
      SCM2=4.0*E*IC(CT)/LC(SN)/(1.0+2.0*G1)
      SCM3=1.5*SCM2/LC(SN)
      SCM4=2.0*SCM3/LC(SN)
      S(F1,F1)=S(F1,F1)+SCM4
      S(J2,F1)=S(J2,F1)+SCM3
      S(J1,J1)=S(J1,J1)+SCM1
      S(J2,J2)=S(J2,J2)+SCM2*(1.0+G1/2.0)
      IF(SN.EQ.NS) GOTO 4
      S(K2,F1)=S(K2,F1)+SCM3
      S(J1,K1)=-SCM1
      S(J2,K2)=SCM2/2.0*(1.0-G1)
      S(K1,K1)=SCM1
      S(K2,K2)=SCM2*(1.0+G1/2.0)
      S(F1,F2)=S(F1,F2)-SCM4
```

```
      S(F2,F1)=S(F2,F1)-SCM4
      S(J2,F2)=-SCM3
      S(K2,F2)=-SCM3
      S(F2,F2)=S(F2,F2)+SCM4
    4 CONTINUE
      SUM=SUM+NUM
      IF(SUM.LT.NB+1) GOTO 3
      RETURN
      END
      SUBROUTINE FRMASS(M,SN,LC,NB,NOPRT)
      REAL LB(10),LC(30),AB(99),AC(99),IB(99),IC(99),WB(99),WC(99)
      INTEGER BTP(200),CTP(220),BBTP1(200),BBTP2(200)
      REAL ALB(200),BLB(200),SCJB(200),SCKB(200),ALC(220),BLC(220),
     : SCJC(220),SCKC(220)
     : ,AL(10),BL(10),FB(99),FC(99)
      REAL M(30)
      COMMON /DATA/ BTP,CTP,LB,AB,AC,IB,IC,E,WB,WC,ALB,BLB,SCJB,
     : SCKB,ALC,BLC,SCJC,SCKC,BBTP1,BBTP2,ABR(20)
     : ,AL,BL,FB,FC,G,EB,GB
      INTEGER SN,BN,CN,BT,CT
      NC=NB+1
      G=386.4
  601 FORMAT('OTOTAL WEIGHT OF STORY FRAMING =',F15.3,' KIPS')
      IBTP=(SN-1)*NB
      DO 1 BN=1,NB
      BT=BTP(IBTP+BN)
    1 M(SN)=M(SN)+WB(BT)*LB(BN)/G
      ICTP=(SN-1)*NC
      DO 2 CN=1,NC
      CT=CTP(ICTP+CN)
      M(SN)=M(SN)+WC(CT)*LC(SN)/2.0/G
      IF(SN.EQ.1) GOTO 2
      CT=CTP(ICTP+CN)
      M(SN)=M(SN)+WC(CT)*LC(SN-1)/2.0/G
    2 CONTINUE
      WTL = M(SN)*G
      IF(NOPRT.NE.1)WRITE(6,601) WTL
      RETURN
      END
      SUBROUTINE FLMASS(NS,M)
C
C  THIS SUBROUTINE READS FLOOR WEIGHT DATA FOR THE BUILDING,
C  CONVERTS TO MASS, AND ADDS IT TO THE FRAMING MASS (IF ANY) FOR EACH
C  STORY.
C
      REAL M(30),FWT(30)
      REAL DRFTY(30)
C PASS TO SUBROUTINE DYNAMC
      COMMON/DAT/DRFTY                                                  SCHEN
C     READ(5,9002) (FWT(I),I=1,NS)
      DO 55 I=1,NS                                                      SCHEN
   55 READ(5,9002)  FWT(I),DRFTY(I)
 9002 FORMAT(10E8.3)
      DO 10 I=1,NS
   10 M(I)=M(I)+FWT(I)/386.4
      RETURN
      END
      SUBROUTINE EIGENS(S,MT,M,CV,DN,N,A,H,PP)
      DIMENSION MN(6)
      REAL S(70,70),MT(30),M(30),CV(70),DN(70,70)
      REAL A(100),B(100),PP(100)
      DO 2 I=1,N
    2 MT(I)=1.0/SQRT(M(I))
      DO 3 J=1,N
      DO 3 K=1,N
```

```
   3 S(J,K)=S(J,K)*MT(J)*MT(K)
     CALL HOUSQR (N,S,CV,DN,A,B,PP)
     DO 4 J=1,N
     DO 4 K=1,N
     MN(K)=K
   4 DN(J,K)=DN(J,K)*MT(J)
     CALL NORMAL(N,DN)
     WRITE(6,608)
 608 FORMAT('1CHARACTERISTIC VECTORS',//)
     WRITE (6,609)(MN(I),I=1,6)
 609 FORMAT(' STORY',20X,'MODE NO.',/,'  NO.',6(I7,3X))
     CALL MATPRT(N,6,DN)
     RETURN
     END
     SUBROUTINE HOUSQR(N,G,E,X,A,B,PP)
           INTEGER N
           REAL E(70),G(70,70),X(70,70)
     INTEGER I,J,K,M,NQR,I1,K1,N1
     REAL T,ALFA,BETA,GAMMA,ABSB,R,S,C,W,H,PK,AINEW,P,Q,F,
    1      A(100),B(100),PP(100)
     DOUBLE PRECISICN SUM,SIGMA,DPRS
     DO 29 I=1,100
     A(I)=0.0
     B(I)=0.0
  29 PP(I)=0.0
     DO 1  I = 1,N
           I1 = I+1
           X(I,I) = 1
           DO 1  J = I1,N
                 X(I,J) = 0.0
   1 X(J,I) = 0.0
     IF (N .GT. 1) GC TO 3
     IF(N.NE.1) GOTC 2
                 E(1) = G(1,1)
                 X(1,1) = 1.0
   2       RETURN
   3 N1 = N-2
     IF (N .EQ. 2) GC TO 165
     DO 16  K = 1,N1
           K1 = K+1
           A(K) = G(K,K)
           SIGMA = 0
           DO 4  I = K1,N
   4       SIGMA=SIGMA+G(I,K)**2
           IF (SIGMA .EQ. 0.0) GO TO 16
           ABSB = DSQRT(SIGMA)
           ALFA = G(K1,K)
           IF (ALFA .GE. 0) GO TO 5
                 BETA = ABSB
                 GO TO 6
   5       BETA = -ABSB
   6       B(K) = BETA
           GAMMA = 1.0/(SIGMA - ALFA * BETA)
           G(K1,K) = ALFA - BETA
           DO 9  I = K1,N
                 SUM = 0
                 IF (I .EQ. K) GO TO 75
                 DO 7  J = K1,I
                 DPRS = G(J,K)
   7             SUM = SUM + G(I,J) *    DPPS
  75             I1 = I+1
                 IF (I .EQ. N) GO TO 9
                 DO 8  J = I1,N
                 DPRS = G(J,K)
   8             SUM = SUM + G(J,I) * DPRS
   9       PP(I) = GAMMA * SUM
           SUM = 0
           DO 10  I = K1,N
           DPRS = G(I,K)
  10       SUM = SUM + DPRS * PP(I)
           T = 0.5 * GAMMA * SUM
```

```
      DO 11  I = K1,N
11    PP(I) = PP(I) - T * G(I,K)
      DO 12  I = K1,N
      DO 12  J = K1,N
12    G(I,J) = G(I,J) - G(I,K) * PP(J) - PP(I) * G(J,K)
      DO 14  I = 2,N
            SUM = 0
            DO 13  J = K1,N
            DPRS = G(J,K)
13          SUM = SUM + X(I,J) * DPRS
14    PP(I) = GAMMA * SUM
      DO 15  I = 2,N
      DO 15  J = K1,N
15    X(I,J) = X(I,J) - PP(I) * G(J,K)
16 CONTINUE
165 N1 = N-1
   A(N1) = G(N1,N1)
   B(N1) = G(N,N1)
   A(N)  = G(N,N)
   NQR = 0
   R = ABS(A(N))
   DO 17  I = 1,N1
      S = ABS(A(I))
      IF (S .GT. R) R = S
      S = ABS(B(I))
17 IF (S .GT. R) R = S
   IF (R .NE. 0.0) GO TO 19
      DO 18  I = 1,N
18    E(I) = 0
      RETURN
19 E(N) = A(N)
   DO 20  I = 1,N1
20 E(I) = A(I)
   K = N
21 M = K
   IF (M .LE. 1) GO TO 28
   T = ABS(E(K))
   B(M) = 0
22 K = K-1
      IF (K .LE. 0) GO TO 23
      S = B(K)
      IF (T+S .EQ. T) GO TO 23
      T = ABS(E(K))
      IF (T+S .EQ. T) GO TO 23
      GO TO 22
23 IF (K .EQ. M-1) GO TO 21
   K1 = K+1
   T = 1
   S = E(M) - E(M-1)
   R = B(M-1)
   IF (ABS(R)+ABS(S) .EQ. ABS(R)) GO TO 24
      W = 2.0 * R / S
      T = W / (SQRT(W**2 + 1.0 ) + 1.0)
24 NQR = NQR + M-K
   H = E(K1) - (E(M) + T * R)
   W = B(K1)
   BK = W
   T = SQRT(H ** 2 + W ** 2)
   GO TO 26
25    T = SQRT(H ** 2 + W ** 2)
      B(K) = T
```

```
 26      K = K+1
         C = H / T
         S = W / T
         P = E(K)
         F = C * P + S * BK
         T = E(K+1)
         Q = C * BK + S * T
         BK = B(K+1)
         W = S * BK
         BK = C * BK
         AINEW = F * C + Q * S
         H = Q * C - F * S
         E(K+1) = (P+T) - AINEW
         E(K) = AINEW
         DO 27  J = 1,N
              P = X(J,K)
              Q = X(J,K+1)
              X(J,K) = C * P + S * Q
 27      X(J,K+1)=C*Q - S*P
         IF (K .LT . M-1) GO TO 25
      B(M-1) = H
      K = K+1
      GO TO 21
 28   NQR = NQR/N
      I=1
201        Q=10.0**8
           DO 200 J=I,N
                IF(E(J).GT.Q) GOTO 200
                Q=E(J)
                K=J
200        CONTINUE
           IF(K.EQ.I) GOTO 203
           SUM=E(I)
           E(I)=E(K)
           E(K)=SUM
           DO 202 J=1,N
                A(J)=X(J,I)
                X(J,I)=X(J,K)
                X(J,K)=A(J)
202        CONTINUE
203        I=I+1
      IF(I.LT.N) GOTO 201
      RETURN
      END
      SUBROUTINE NORMAL(N,DN)
      REAL LARGE,DN(70,70)
      DO 7 I=1,N
      LARGE = 0.0
      DO 5 J=1,N
    5 IF(ABS(DN(J,I)).GT.ABS(LARGE)) LARGE=DN(J,I)
      DO 6 J=1,N
    6 DN(J,I)=DN(J,I)/LARGE
    7 CONTINUE
      RETURN
      END
      SUBROUTINE DECOMP(N,A,LRT)
      DIMENSION A(70,70)
      DOUBLE PRECISION SUM,DA
      DO 3 I=1,N
      DO 3 J=I,N
      SUM=A(I,J)
      K1=I-1
      IF(I.EQ.1)GOTO 1
      DO 4 K=1,K1
      DA = A(K,J)
```

```
    4 SUM=SUM-A(K,I)*DA                                                456.
    1 IF(J.NE.I)GOTO 2                                                 457.
      LRT=0
      IF (SUM.LE.0.0) LRT=1
      IF (SUM.LE.0.0) GO TO 13                                          CHEN
      TEMP=1.0/DSQRT(SUM)                                              459.
      A(I,J)=TEMP                                                      460.
      GOTO 3                                                           461.
    2 A(I,J)=SUM*TEMP                                                  462.
    3 CONTINUE                                                         463.
   13 CONTINUE                                                          CHEN
      RETURN                                                           464.
      END                                                              465.
      SUBROUTINE INVERS(N,U)
      DIMENSION U(70,70)                                               467.
      DOUBLE PRECISION SUM,DU
      I1=N-1                                                           469.
      DO 2 I=1,I1                                                      470.
      J1=I+1                                                           471.
      DO 2 J=J1,N                                                      472.
      SUM=0.0                                                          473.
      K1=J-1                                                           474.
      DO 1 K=I,K1
      DU = U(K,J)                                                      476.
    1 SUM=SUM-U(K,I)*DU                                                477.
    2 U(J,I)=SUM*U(J,J)                                                478.
      DO 4 I=1,N                                                       479.
      DO 4 J=I,N                                                       480.
      SUM=0.0                                                          481.
      DO 3 K=J,N                                                       482.
      DU = U(K,J)                                                      483.
    3 SUM=SUM+U(K,I)*DU                                                484.
      U(I,J)=SUM
    4 U(J,I)=SUM                                                       486.
      RETURN                                                           487.
      END                                                              488.
      SUBROUTINE CONDEN(NB,NS,SN,S,LRT)
      INTEGER SN,NB2,NB22,NBSN,NB2N,NB21                               329.
      REAL SAB(20,20),S(70,70)
      DOUBLE PRECISION TEMP,DS
      NB2=2*NB+2                                                       334.
C                                                                      335.
C     INVERT S(AA)                                                     336.
C                                                                      337.
      CALL DECOMP(NB2,S,LRT)
      IF(LRT.GT.0) GO TO 99
      CALL INVERS (NB2,S)
C                                                                      340.
      IF(SN.EQ.NS) GOTO 20                                             341.
      DO 1 I=1,NB2                                                     342.
      DO 1 J=1,NB2
    1 SAB(I,J)=S(I,J+NB2)
C                                                                      344.
C     S(AA)-1 * S(AB) STORED IN S(AB), S(AA)-1 * S(AF) STORED IN S(FA)
C                                                                      346.
      DO 2 I=1,NB2                                                     347.
      DO 2 J=1,NB2                                                     348.
      TEMP=0.0
      DO 22 K=1,NB2
      DS=SAB(K,J)
   22 TEMP=TEMP+S(I,K)*DS
    2 S(I,J+NB2)=TEMP
   20 CONTINUE                                                         350.
      NB22=2*NB2+1                                                     351.
      NBSN=2*NB2+SN+1                                                  352.
      IF(SN.EQ.NS) NBSN=2*NB2+SN
      DO 4 I=1,NB2                                                     354.
      DO 4 J=NB22,NBSN                                                 355.
```

```
      TEMP=0.0
      DO 3 K=1,NB2
      DS = S(K,J)
    3 TEMP=TEMP+S(I,K)*DS
    4 S(J,I)=TEMP
      IF(SN.EQ.NS) GOTO 21
C
C     S(BB)* = S(BB) - S(AB)T * S(AA)-1 * S(AB)
C
      NB21=NB2+1
      NB2N=2*NB2
      DO 5 I=NB21,NB2N
      DO 5 J=NB21,NB2N
      TEMP=0.0
      DO 51 K=1,NB2
      DS=S(K,J)
   51 TEMP=TEMP+SAB(K,I-NB2)*DS
    5 S(I,J)=S(I,J)-TEMP
C
C     S(BF)* = S(BF) - S(AB)T * S(AA)-1 * S(AF)
C
      DO 6 I=NB21,NB2N
      DO 6 J=NB22,NBSN
      TEMP=0.0
      DO 61 K=1,NB2
      DS=S(J,K)
   61 TEMP=TEMP+SAB(K,I-NB2)*DS
    6 S(I,J)=S(I,J)-TEMP
   21 CONTINUE
C
C     S(FF)* = S(FF) - S(AF)T * S(AA)-1 * S(AF)
C
      DO 8 I=NB22,NBSN
      DO 8 J=NB22,NBSN
      TEMP =00.0
      DO 7 K=1,NB2
      DS = S(J,K)
    7 TEMP = TEMP + S(K,I)*DS
    8 S(I,J)=S(I,J)-TEMP
      IF(SN.EQ.NS) GOTO 111
C
C     MOVE S(BB)* TO S(AA)  AND  S(BF)* TO S(AF)
C
      DO 9 I=1,NB2
      DO 9 J=1,NB2
      S(I,J)=S(I+NB2,J+NB2)
    9 S(I+NB2,J+NB2)=0.0
      DO 10 I=1,NB2
      DO 10 J=NB22,NBSN
      S(I,J)=S(I+NB2,J)
   10 S(I+NB2,J)=0.0
  111 CONTINUE
      DO 12 I=1,NB2
      DO 12 J=NB21,NB2N
   12 S(I,J)=0.0
      GOTO 11
   99 CONTINUE
   11 CONTINUE
      RETURN
      END
      SUBROUTINE MATPRT (M,N,A)
      INTEGER RTCCL
      DIMENSION A(70,70)
```

```
  602 FORMAT (' ',I3,2X,1P10E10.2)
      NPAGES = (N-1)/10+ 1
      DO 101 I=1,NPAGES                                                    681.
      WRITE(6,601)
  601 FORMAT('0')
      LTCOL =10*(I-1) + 1
      RTCOL =10*I
      IF (RTCOL.GT.N) RTCOL=N                                              684.
      DO 101 J=1,M                                                         685.
      JK=M+1-J
  101 WRITE (6,602)JK, (A(J,K),K=LTCOL,RTCOL)
      RETURN                                                               687.
      END                                                                  688.
      SUBROUTINE DAMPR(NDAMP,EMU,ZETA)
      ZETA=2.16+5.2*EMU-.74*EMU**2
      EMUM=5.2/1.44
      ZETAM=2.16+5.2*EMUM-.74*EMUM**2
      IF (EMU.GT.EMUM) ZETA=ZETAM
      IF(NDAMP.EQ.2) ZETA=2.*ZETA
      RETURN
      END
      SUBROUTINE SPECTR(TI,EMU,T,F,BETA,ASR,VSR,SV,SVF,SVD,LD)
C
C  THIS SUBROUTINE INTERPOLATES LINEARLY BETWEEN POINTS DEFINED ON THE
C  GROUND SITE VELOCITY SPECTRUM AND THEN MULTIPLIES RESULT-
C  ING SPECTRAL VELOCITY BY A DYNAMIC AMPLIFICATION FACTOR.
C  IF SPECTRAL VELOCITY IS TO BE MODIFIED TO ACCOUNT FOR DUCTILITY,
C  LD .NE. ZERO, THEN THE MODAL PERIOD IS CHANGED AND TWO SEPARATE
C  SPECTRAL VELOCITIES ARE COMPUTED. SVF IS TO BE USED TO COMPUTE ACCELERATION
C  DEPENDENT QUANTITIES INCLUDING FORCE, AND SVD IS TO BE USED TO COMPUTE DIS-
C  PLACEMENT DEPENDENT QUANTITIES INCLUDING DEFLECTION AND PSEUDO VELOCITY.
C
      REAL T(100),F(100)
      IF(LD.EQ.0) GO TO 11
      IF(EMU.LT.1.) GO TO 11
      TI=TI*(.75+ASIN(1./SQRT(2.*EMU-1.))/6.283+SQRT(2.*(EMU-1.))/6.283)
   11 CONTINUE
      IF(TI.LT.T(1)) TI=T(1)
      DO 10 I=1,500
      K=I+1
      IF ((TI.LE.T(K)) .AND. (TI.GE.T(I))) GO TO 15
   10 CONTINUE
   15 Y=F(K)-F(I)
      X=T(K)-T(I)
      IF(X.LT..001) X=0.001
      Z=TI-T(I)
      SLOPE=Y/X
      SV=F(I)+Z*SLOPE
C
C  MODIFY SPECTRAL VELOCITY FOR ELASTIC STRUCTURAL AMPLIFICATION
C
      TA=ALOG10(TI)
      TB=ALOG10(BETA)
  600 FORMAT('0TA = ',E12.4,5X,'TB = 'E12.4)
      IF(TI.LT.0.2) GO TO 20
      AFB=2.18-.147*TA-.633*TB
      GO TO 25
   20 AFB=(2.28-.633*TB)*TI/.2
   25 CONTINUE
      IF(AFB.LT.1.0) AFB=1.0
   23 FORMAT(1H0,2X,'AFB =',E12.4)
   21 FORMAT(1H0,2X,'SV =',E12.4)
      SV=SV*AFB
      IF (LD.EQ.0) GO TO 140
      IF(EMU.LT.1.) GO TO 140
```

```
C
C  MODIFY SPECTRAL VELOCITY FOR DUCTILITY
C
      TA1=6.283*VSR/ASR/386.4
      SREMU=SQRT(EMU)
      TA2=TA1/SREMU
      IF(TI.GT.TA2) GC TO 120
      SVF=SV/SREMU
      SVD=SV*SREMU
      GO TO 150
  120 IF(TI.GT.TA1) GC TO 130
      SVF=SV*(1.-(TI-TA2)/TA1)/SREMU
      SVD=SV*(1.-(TI-TA2)/TA1)*SREMU
      GO TO 150
  130 SVF=SV/EMU
      SVD=SV
      GO TO 150
  140 CONTINUE
      SVF=SV
      SVD=SV
  150 RETURN
      END
      SUBROUTINE DYNAMC(N,LC,S,C,D,M,ASR,VSR,T,F,E,LD,NOPRT,NMOD,DFT)
C
C
C  THIS SUBROUTINE CCMPUTES THE DYNAMIC RESPONSF OF A BUILDING
C  TO A SEISMIC LOAC ENVIRONMENT CHARACTERIZED BY THE GROUND
C  SITE RESPONSE SPECTRUM. AN INITIAL VALUE OF STRUCTURAL DAMPING
C  IS COMPUTED, AND SUBSEQUENTLY UPDATED BY SUBROUTINE DAMPR
C  IN AN ITERATIVE MANNER UNTIL THE AMOUNT OF DAMPING IS CONSISTENT
C  WITH THE AMPLITUCE OF MOTION FOR THE TYPE OF STRUCTURE SPECIFIED.
C
      REAL T(100),F(100),C(70),D(70,70),S(70,70),DEFLY(30),DMU(30),
     1     M(30),W(30),V(30),E(30,30),MR,EE(30,24),DRFTY(30),DFT(30),
     1     LC(30),DISF(30)
      REAL CT(70)
      COMMON/DAT/DRFTY                                                  SCHEN
      WRITE(6,700)
  700 FORMAT(1H1,20X,'E A R T H Q U A K E   R E S P O N S E   A N A L Y
     1S I S',///)
      DO 500 I=1,30
      DO 500 J=1,24
  500 EE(I,J)=0.0
C
C  READ CONTL. VARS., STORY DRIFT TC YIELD, AND COMPUTE MODAL PARAMETERS.
C
      READ(5,9001) NCAMP,ITERMX,LD,MCOP                                 SCHEN
      NOPRT = 1
      ITERMX=6                                                          SCHEN
      LD=1                                                              SCHEN
      MCOP=2                                                            SCHEN
      READ(5,9001) NDAMP
 9001 FORMAT(10I8)
  611 FORMAT(' DAMPING CURVE OPTION FOR STEEL AND RC FRAME STRUCTURES'/)
  612 FORMAT(' DAMPING CURVE OPTION FOR BOLTED STEEL OR TIMBER STRUCTURE
     1S',/)
      IF(NDAMP.EQ.1) WRITE(6,611)
      IF(NDAMP.EQ.2) WRITE(6,612)
      WRITE(6,607)
  607 FORMAT(' MAXIMUM NUMBER ITERATIONS= 6',/,
     1' MODIFY RESPONSE FOR DUCTILITY',/,
     1 ' MODAL COMBINATION OPTION = RSS')
      EBETA=.05
      EEMU=.05
 9002 FORMAT(10E8.3)
```

SCHEN

```
C     READ(5,9002) (DRFTY(I),I=1,N)
      DO 616 I=1,5
  616 WRITE(6,615)
  615 FORMAT(///)
      WRITE(6,650) (DRFTY(I),I=1,N)
  650 FORMAT('0EFFECTIVE INTERSTORY DRIFT TO YIELD BY STORY (IN/IN)',//,
     13(1X,1P10E10.2,/))
      EMU=1.0
      CALL DAMPR(NDAMP,EMU,BETA)
      WRITE (6,606) BETA
      NR=3
      N9=N
      IF(N.GT.6) N9=6
      IF(NMOD.EQ.3) N9=1
      ITER=0
   20 CONTINUE
      WRITE(6,600)
      TM=0.0
      ITER=ITER+1
      DO 8 I=1,N
    8 TM=TM+M(I)
      DO 2 I=1,N9
      SUM1=0.0
      SUM2=0.0
      SUM3=0.0
      DO 1 J=1,N
      SUM2=SUM2+D(J,I)**2*M(J)
    1 SUM3=SUM3+D(J,I)*M(J)
      SUM1=SUM3**2
      W(I)=SUM1/SUM2
      TI=6.2831853/SQRT(C(I))
      CALL SPECTR(TI,EMU,T,F,BETA,ASR,VSR,SV,SVF,SVD,LD)
      CT(I)=(6.2831853/TI)**2
      FI=1.0/TI
      V(I)=W(I)*2.0*3.1416*SVF/TI
      AR=SUM2/SUM3
      MR=W(I)/TM
      WRITE(6,601) I,FI,TI,MR,SV,V(1),AR,SVF,SVD
      W(I)=SVD*TI/6.283185/AR
    2 E(N,I)=SUM3
  606 FORMAT('0CRITICAL DAMPING (PERCENT) =',F8.2)
C
C  COMPUTE MODAL RESPONSE
C
      DO 7 I=1,N9
      DO 7 J=1,N
    7 E(J,I)=V(I)*D(J,I)*M(J)/E(N,I)
      DO 5 I=1,N9
      IF(NOPRT.NE.1) WRITE(6,602) I
      SUM1=0
      DO 3 J=1,N
      JK= N+1-J
      SUM1=SUM1+E(J,I)
      SUM2=D(J,I)*W(I)
      IF(J.EQ.N) SUM3=SUM2
      IF(J.NE.N) SUM3=SUM2-D(J+1,I)*W(I)
      SUM3=ABS(SUM3)
      IF(I.GT.6) GOTC 31
      II=I+6
      EE(J,II)=SUM3
      II=I+12
      EE(J,II)=SUM2*SQRT(CT(I))
      II=I+18
      EE(J,II)=E(J,I)/M(J)/386.4
      IF (NOPRT.EQ.1) GO TO 3
   31 WRITE(6,603)JK,E(J,I),SUM1,SUM2,SUM3,EE(J,I+12),EE(J,I+18)
    3 E(J,I)=SUM1
    5 CONTINUE
```

```
C
C  COMPUTE TOTAL RESPONSE
C
      GO TO (110,120,130), MCOP
  110 DO 111 I=1,N
      EE(I,4)=EE(I,7)
      DFT(I)=EE(I,4)/LC(I)
      EE(I,5)=EE(I,13)
  111 EE(I,6)=EE(I,19)
      GO TO 140
  120 DO 121 I=1,N
      SUM1=0.
      SUM2=0.
      SUM3=0.
      DO 122 J=1,N9
      SUM1=SUM1+EE(I,J+6)**2
      SUM2=SUM2+EE(I,J+12)**2
  122 SUM3=SUM3+EE(I,J+18)**2
      EE(I,4)=SQRT(SUM1)
      DFT(I)=EE(I,4)/LC(I)
      EE(I,5)=SQRT(SUM2)
  121 EE(I,6)=SQRT(SUM3)
      GO TO 140
  130 DO 131 I=1,N
      SUM1=0.
      SUM2=0.
      SUM3=0.
      DO 132 J=1,N9
      SUM1=SUM1+ABS(EE(I,J+6))
      SUM2=SUM2+ABS(EE(I,J+12))
  132 SUM3=SUM3+ABS(EE(I,J+18))
      EE(I,4)=SUM1
      DFT(I)=EE(I,4)/LC(I)
      EE(I,5)=SUM2
  131 EE(I,6)=SUM3
  140 CONTINUE
      WRITE(6,199)
  199 FORMAT('1',' TOTAL RESPONSE',/,
     1' STORY              I.S. DEFL            VELOCITY          ACCELERATION
     1           I.S. DRIFT',/,
     1'    NO.               (IN)                (IN/SEC)                 (G)
     1              (IN/IN)',/)
      DO 200 I=1,N
      JK= N+1-I
  200 WRITE(6,665)JK,EE(I,4),EE(I,5),EE(I,6),DFT(I)
  665 FORMAT(I5,1P4F20.4)
C
C  COMPUTE DUCTILITY BY STORY AND EFFECTIVE DUCTILITY FOR BUILDING
C
      EMU1=EMU
      DO 150 I=1,N
  150 DMU(I)=EE(I,4)/LC(I)/DRFTY(I)
      WRITE(6,670) (DMU(I),I=1,N)
  670 FORMAT('0DUCTILITY BY STORY',//,3(1X,1P10E10.2,/))
      DISP(N)=EE(N,4)
      DEFLY(N)=DRFTY(N)*LC(N)
      DO 210 I=2,N
      II=N+1-I
      DISP(II)=DISP(II+1)+EE(II,4)
  210 DEFLY(II)=DEFLY(II+1)+DRFTY(II)*LC(II)
      IF(NMOD.EQ.3) GO TO 180
      DO 160 I=1,N
      V(I)=0.
      W(I)=0.
      DO 160 J=1,N
      V(I)=V(I)+S(I,J)*DISP(J)
```

```
160 W(I)=W(I)+S(I,J)*DEFLY(J)
    SUM1=0.
    SUM2=0.
    DO 170 I=1,N
    SUM1=SUM1+DISP(I)*V(I)
170 SUM2=SUM2+DEFLY(I)*W(I)
    EMU=SQRT(SUM1/SUM2)
    GO TO 190
180 CONTINUE
    SUM1=0.
    DO 181 I=1,N
181 SUM1=SUM1+DMU(I)
    EMU=SUM1/N
190 WRITE(6,680) EMU
680 FORMAT('0EFFECTIVE DUCTILITY FOR BUILDING = ',F6.2)
    IF(ITER.GE.ITERMX) GO TO 11
    BETA1=BETA
    CALL DAMPR(NDAMP,EMU,BETA)
    WRITE(6,606) BETA
C
C  TEST FOR CONVERGENCE OF DUCTILITY AND DAMPING
C
    IF(LD.EQ.0) GO TO 10
    IF(ABS(1.-EMU/EMU1).GT.EEMU) GO TO 20
 10 CONTINUE
    IF (ABS(1.0-BETA/BETA1).GT.EBETA) GO TO 20
 11 CONTINUE
C
C  PRINT FINAL RESPONSE CALCULATIONS.
C
    DO 51 I=1,N
    IF(NMOD.EQ.3) GOTO 91
    SUM=0.0
    SUM1=0.0
    SUM2=0.0
    DO 4 J=1,N9
    SUM2=SUM2+ABS(E(I,J))
    SUM1=SUM1+E(I,J)**2
  4 CONTINUE
    EE(I,2)=SQRT(SUM1)
    EE(I,3)=SUM2
 51 EE(I,1)=E(1,1)
    K=2
    WRITE(6,604)
    DO 30 I=1,N
    JK= N+1-I
    IF (I.EQ.1) SUM1=EE(1,K)
    IF (I.GT.1) SUM1=EE(I,K)-EE(I-1,K)
 30 WRITE(6,605)JK,SUM1,EE(I,K)
600 FORMAT('1',/,' MODAL RESPONSE',///,
   *'  MODE  FREQUENCY PERIOD  MASS  PSUDO-SPECTRAL   MAXIMUM',
   *'  AMPLITUDE     PS.SPECT.VEL. MODIFIED FOR DUCTILITY',/,
   *'   NO.     (CPS)    (SEC.)  RATIO    VELOCITY      BASE SHEAR',
   *'   RATIO       (ACCEL)        (DISPL)',/)
601 FORMAT(I4,F12.4,2F7.3,F11.3,F15.3,F11.3,2F11.3)
602 FORMAT (///,
   *'    EFFECTIVE FORCE FOR MODE NO.',I4,//,
   *' STORY    FORCE(KIPS)    SHEAR(KIPS)    DEFLECTION  STORY DEFL.',
   1'   VELOCITY   ACCELERATION',/)
603 FORMAT(I5,F12.3,F14.3,4F14.4)
604 FORMAT (///,
   *'    COMBINED FORCE FOR ALL MODES (METHOD RSS ) ',/,/,
   *' STORY    FORCE(KIPS)    SHEAR(KIPS)',/)
605 FORMAT(I5,F12.3,F14.3)
```

```
   91 CONTINUE
      DO 9 I=1,N
      DO 9 J=1,24
    9 E(I,J)=EE(I,J)
      RETURN
      END
      SUBROUTINE STATIC(NHAZ,NS,S,LC,TWB,PHR,TI,DRFT,VT,
     :DN,VF,M,CEC,CIC,QMS,VMM,ISHAPE,ISITE,NMOD,ITOR,ITYPE,LRT)
C
C  THIS SUBROUTINE COMPUTES THE STATIC RESPONSE OF A BUILDING
C  TO WIND PRESSURE DISTRIBUTIONS.
C
      REAL S(70,70),LC(30),DRFT(30),DF(30),WF(30),M(30),DN(70,70)
      REAL CEC(10),CIC(10),QMS(30),VMM(30)
      INTEGER NHAZ(3)
      WRITE(6,700)
  700 FORMAT(1H1,20X,'W I N D   R E S P O N S E   A N A L Y S I S',
     :///)
      IF((ITOR.EQ.-1).AND.(NHAZ(2).NE.0)) GO TO 23
      IF(NMOD.EQ.3) GOTO 23
C
C  INVERT STIFFNESS MATRIX
C
      CALL DECOMP(NS,S,LRT)
      IF(LRT.GT.0) GO TO 99
      CALL INVERS(NS,S)
   23 CONTINUE
      TM=0.
      DO 10 I=1,NS
   10 TM=TM+M(I)
C
C  COMPUTE PRESSURE FORCES FOR EACH STORY
C
      IF(ITOR.EQ.-1) GO TO 16
      CALL WIND(LC,NS,TWB,TM,TI,CEC,CIC,QMS,VMM,WF,ISHAPE,ISITE,VF,ITYPE
     :)
      GO TO 17
   16 CONTINUE
      WRITE(6,750)
  750 FORMAT(1H0,20X,'W I N D   D U E   T O   T O R N A D O',///)
      CALL TRNADO(VT,LC,NS,WF,TWB,CEC,CIC,QMS,VMM)
  900 FORMAT(1P10E10.2)
   17 IF(NMOD.EQ.3) GOTO 24
      GOTO 25
C
C  COMPUTE WIND DEFLECTIONS FOR EMPERICAL MODEL
C
24    SUM1=0.0
      SUM2=0.0
      DO 26 I=1,NS
      SUM1=SUM1+M(I)*386.4
26    SUM2=SUM2+WF(I)
      DO 27 I=1,NS
27    DF(I)=DN(I,1)*(3.89*TI)**2*(SUM2/SUM1)
      GOTO 28
C
```

```
C  COMPUTE WIND DEFLECTIONS FOR OTHER MODELS
C
25     DO 34 I=1,NS
       TEMP=0.0
       DO 35 J=1,NS
35     TEMP=TEMP+S(I,J)*WF(J)
34     DF(I)=TEMP
28     SUM2=0.0
C
C  COMPUTE STORY DRIFT AND SHEAR
C
       WRITE(6,657)
657    FORMAT('1WIND ANALYSIS',/,
     :        '0STORY  DEFLECTION  DRIFT   STORY SHEAR',/,
     :        '  NO.    (INCHES)  (IN/IN)    (KIPS)',/)
       DO 36 I=1,NS
       SUM2=SUM2+WF(I)
       IF(I.EQ.NS)GOTO 37
       DRFT(I)=ABS(DF(I)-DF(I+1))
       GOTO 38
37     DRFT(NS)=ABS(DF(NS))
38     DRFT(I)=DRFT(I)/LC(I)
       WRITE(6,658) I,DF(I),DRFT(I),SUM2
658    FORMAT(I4,F12.3,F9.4,F11.2)
36     CONTINUE
       RETURN
   99  WRITE(6,660)
  660  FORMAT('0STIFFNESS MATRIX IS SINGULAR')
       RETURN
       END
       SUBROUTINE WIND(SH,NS,B,MASS,TN,CEC,CIC,QMS,VMH,FC,ISHAPE,ISITE,VF
     1,ITYPE)
       REAL MASS,SH(30),H(30),GUST(30),QMS(30),VMH(30),C(3)
       REAL FC(30),CEC(10),CIC(10)
       INTEGER ANGLE
       MASS=MASS*12000.
       DO 70 I=1,30
       H(I)=0.0
       GUST(I)=0.0
       QMS(I)=0.0
       VMH(I)=0.0
   70  CONTINUE
       B=B/12.
       READ(5,9002) BS
 9002  FORMAT(10E8.3)
 9003  FORMAT(2E8.3,I8)
       FN=1./TN
       H(1)=SH(NS)/12.
       IF(NS.EQ.1) GO TO 9
       DO 19 I=2,NS
   19  H(I)=(SH(NS-I+1)/12.)+H(I-1)
    9  HT=H(NS)
       GO TO (2,3,4),ISITE
    2  ALFA=1./3.
       RK=.025
       ZG=1500.
       GO TO 5
    3  ALFA=1./4.5
       RK=.01
       ZG=1300.
       GO TO 5
```

```
    4 ALFA=1./7.
      RK=.005
      ZG=900.
    5 T=3600./VF
      IF(T.LT.30.) GC TO 6
      IF((T.LT.4000.).AND.(T.GE.30.)) GO TO 7
      IF(T.GE.4000.) GO TO 8
    6 F=1.56-0.0618*(ALOG10(T)**2)-0.0733*ALOG10(T)
      GO TO 16
    7 F=1.317+.06*(ALCG10(T/30.)**2)-0.277*ALOG10(T/30.)
      GO TO 16
    8 F=1.0
   16 VMS=(1.63*VF/F)*((30./ZG)**ALFA)
      VM30=VF/F
      W1=4.*B
      W2=4.*HT
      IF(W1.LT.W2) GO TO 20
      W3=W2
      GO TO 41
   20 W3=W1
   41 VH=VMS*1.46667*((HT/30.)**ALFA)/(ALFA+1.0)
      C(1)=3.85*FN*W3/VH
      C(2)=11.5*FN*B/VH
      C(3)=3.85*FN*HT/VH
      CSQ=1.0
      DO 15 I=1,3
   15 CSQ=CSQ*((1./C(I))-(1.-EXP(-2.*C(I)))/(2.*C(I)**2))
      XN=4000.*FN/VMS
      SP2=(XN**2)*(1.+XN**2)**(-4./3.)
      GO TO (21,22,23),ISITE
   21 SB=1.30-0.035*(ALOG10(HT/10.)**2)-0.205*ALOG10(HT/10.)
      GO TO 29
   22 IF(HT.LT.100.) GO TO 30
      IF(HT.GE.100.) GO TO 31
   30 SB=1.3-0.05*(ALCG10(HT/10.)**2)-.21*ALOG10(HT/10.)
      GO TO 29
   31 SB=1.04-.142*(ALOG10(HT/100.)**2)-.23*ALOG10(HT/100.)
      GO TO 29
   23 IF(HT.LT.100.) GO TO 32
      IF(HT.GE.100.) GO TO 33
   32 SB=1.3-.00746*(ALOG10(HT/10.)**2)-.277*ALOG10(HT/10.)
      GO TO 29
   33 SB=1.02-.161*(ALOG10(HT/100.)**2)-.252*ALOG10(HT/100.)
   29 S=SB/(1.0 + 0.002*B)
      AA=2.0*ALFA + 1.0
      PI=3.14
      GO TO (86,87),ISHAPE
   86 CALL SHAPEX(CA,CB,ANGLE,ITYPE,0)
      GO TO 88
   87 READ(5,9003) CA,CB,ANGLE
   88 DC=CA-CB
      PBAR=0.00256*(VMS**2)*B*(HT**AA)/(AA*(30.**(2.*ALFA)))*DC
      BA=PBAR/(2.*PI*FN*MASS*VH)
      R=((PI*CSQ*SP2)/(4.*(BA+BS)))+S
      R=SQRT(R)
      DO 35 I=1,NS
      TZ=2.35*SQRT(RK)/((H(I)/30.)**ALFA)
      GUST(I) = 1.0 +(5.1)*R*TZ
      VMH(I)=VMS*(H(I)/30.)**ALFA
      QMS(I)=0.00256*GUST(I)*(VMH(I)**2)
   35 CONTINUE
      B=B*12.
      CALL WNDFOR(QMS,SH,NS,B,CA,CB,ANGLE,FC,1)
      CALL INTPRS(QMS,GUST,VMH,CA,CB,CIC,CEC,ANGLE,ITYPE,NS,ISHAPE)
      RETURN
      END
      SUBROUTINE TRNADO(VT,SH,NS,FC,B,CE,CI,QMS,V)
      REAL CE(10),CI(10),V(30)
      REAL QMS(30),SH(30),FC(30)
```

```
C
C     CALCULATE A UNIFORM PRESSURE DISTRIBUTION - NO GUSTING
C     NO VARIATION WITH HEIGHT - ASSUME DIRECT HIT BY TORNADO
C
      DO 2 J=1,5
      CE(J)=1.0
    2 CI(J)=0.0
      DO 1 I=1,NS
      V(I)=0.0
    1 QMS(I)=0.00256*(VT**2)
      CALL WNDFOR(QMS,SH,NS,B,.9,-.3,1,FC,0)
   54 CONTINUE
      RETURN
      END
      SUBROUTINE SHAPEX(CA,CB,ANGLE,ITYPE,ICON)
      INTEGER ANGLE
      IF(ICON.NE.0) GC TO 500
      READ(5,9001) ITYPE,ANGLE
 9001 FORMAT(10I8)
      WRITE(6,400)ITYPE,ANGLE
  400 FORMAT('0',11X,'BUILDING SHAPE CODE = ',I5,5X,'WIND DIRECTION CODE
     1 = ',I5,/)
  500 CONTINUE
      GO TO (1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23
     *,24,25),ITYPE
    1 GO TO (66,67,68),ANGLE
   66 CA=0.9
      CB=-0.3
      GO TO 200
   67 CA=0.5
      CB=-0.4
      GO TO 200
   68 CA=-0.4
      CB=CA
      GO TO 200
    2 GO TO (69,70,71),ANGLE
   69 CA=0.9
      CB=-0.5
      GO TO 200
   70 CA=0.5
      CB=-CA
      GO TO 200
   71 CA=-0.6
      CB=CA
      GO TO 200
    3 GO TO (72,70,73),ANGLE
   72 CA=0.9
      CB=-0.6
      GO TO 200
   73 CA=-0.7
      CB=CA
      GO TO 200
    4 GO TO (74,70,75),ANGLE
   74 CA=0.8
      CB=-0.5
      GO TO 200
   75 CA=-0.3
      CB=CA
      GO TO 200
    5 GO TO (69,76,77),ANGLE
   76 CA=0.6
      CB=-0.5
      GO TO 200
   77 CA=-0.5
```

```
      CB=CA
      GO TO 200
    6 GO TO (69,76,77),ANGLE
    7 GO TO (69,76,77),ANGLE
    8 GO TO (69,76,71),ANGLE
    9 GO TO (69,78,79),ANGLE
   78 CA=0.5
      CB=-0.6
      GO TO 200
   79 CA=-0.4
      CB=-0.3
      GO TO 200
   10 GO TO (69,80,68),ANGLE
   80 CA=0.5
      CB=-0.8
      GO TO 200
   11 GO TO (66,67,68),ANGLE
   12 GO TO (69,70,77),ANGLE
   13 GO TO (74,81,68),ANGLE
   81 CA=0.4
      CB=-0.5
      GO TO 200
   14 GO TO (66,90,77),ANGLE
   15 GO TO (82,81,73),ANGLE
   82 CA=.9
      CB=-.4
      GO TO 200
   16 GO TO (82,91,73),ANGLE
   17 GO TO (82,91,84),ANGLE
   84 CA=-.8
      CB=CA
      GO TO 200
   18 GO TO (82,91,84),ANGLE
   19 GO TO (85,91,71),ANGLE
   85 CA=+.9
      CB=-.2
      GO TO 200
   20 GO TO (66,81,71),ANGLE
   21 GO TO (66,86,71),ANGLE
   86 CA=.5
      CB=-.3
      GO TO 200
   22 GO TO (82,87,71),ANGLE
   87 CA=.5
      CB=-.4
      GO TO 200
   23 GO TO (88,81,73),ANGLE
   88 CA=.8
      CB=-.3
      GO TO 200
   24 GO TO (89,201,73),ANGLE
   89 CA=.8
      CB=-.6
      GO TO 200
   90 CA=0.4
      CB=-0.3
      GO TO 200
   91 CA=0.4
      CB=-CA
      GO TO 200
   25 GO TO (74,202,73),ANGLE
  201 WRITE(6,300)
  300 FORMAT('1    THERE IS NO A.N.S.I. CODE SPECIFICATION FOR A WIND DIR
     *ECTION EQUAL TO 45 DEGREES',/,'      ANALYSIS WILL THEREFORE BE BASE
     *D ON THE ASSUMPTION OF A ZERO (0) WIND ANGLE',///)
      ANGLE=1
      GO TO 89
```

```
  202 WRITE(6,300)
      ANGLE=1
      GO TO 74
  200 CONTINUE
      RETURN
      END
      SUBROUTINE WNDFCR(QMS,SH,NS,B,CA,CB,ANGLF,FC,IFL)
      REAL FC(30),QMS(30),SH(30)
      INTEGER ANGLF
      DO 1 I=1,NS
    1 FC(I)=QMS(I)
      DO 3 I=1,NS
      IJ=NS-I+1
    3 QMS(I)=FC(IJ)
      DO 4 I=1,30
      FC(I)=0.0
    4 CONTINUE
      FC(1)=B*SH(1)*(3.*QMS(1)+QMS(2))/8.
      DO 60 I=2,NS
      FC(I)=(3.*(SH(I)+SH(I-1))*QMS(I)+QMS(I-1)*SH(I-1)+QMS(I+1)*SH(I))*
     1B/8.
   60 CONTINUE
      SF=CA-CB
      DO 61 I=1,NS
   61 FC(I)=(CA-CB)*FC(I)/144000.
      IF(IFL.EQ.0) RETURN
      WRITE(6,70) CA,CB,SF
   70 FORMAT('1',9X,'EXTERNAL PRESSURE COEFFICIENT FOR WALL 1 . . .=',F8
     *       .3,/,10X,'EXTERNAL PRESSURE COEFFICIENT FOR WALL 2 . . .=',F
     *       8.3,/,10X,'SHAPE FACTOR FOR WIND DIRECTION . . .=',F8.3,/)
      GO TO (50,51,52),ANGLE
   50 ANGL= 0.0
      GO TO 55
   51 ANGL=45.0
      GO TO 55
   52 ANGL=90.0
   55 CONTINUE
      WRITE(6,71) ANGL
   71 FORMAT(10X,'WIND DIRECTION WITH RESPECT TO',/,
     *       10X,'NORMAL OF WALL 1 . . . . . . . . . . . . . =',F6.1,' DE
     *GREES',//)
      RETURN
      END
      SUBROUTINE INTPRS(Q,G,V,CA,CB,CIC,CEC,ANG,ITYPE,NS,ISHAPE)
      REAL Q(30),G(30),V(30),CIC(10),CEC(10)
      INTEGER ANG
C
C     INVERT THE ORDERING OF THE GUST FACTOR ARRAY
C
      IF(ISHAPE.EQ.1) GO TO 15
      READ(5,9002) CC,CD
 9002 FORMAT(10F8.3)
 9003 FORMAT(F8.3,I8)
      WRITE(6,501) CC,CD
  501 FORMAT('0',11X,'USER INPUT - PRESSURE COEFFICIENTS = ',2X,2(F8.2,3
     2X),//)
   15 DO 1 I=1,NS
    1 V(I)=G(I)
      DO 2 I=1,NS
      J=NS-I+1
    2 G(I)=V(J)
C
C     COMPUT THE APPRCACH PRESSURE WITHOUT GUST FACTOR
C     FOR INTERNAL PRESSURE CALCULATIONS
C
```

```
      DO 3 I=1,NS
    3 V(I)=Q(I)/G(I)
C
C     PRESSURE COEFFICIENT FOR BUILDING CORNERS PER ANSI A58.1-1972
C
      CK=-2.0
C
C     DETERMINE INTERNAL PRESSURE COEFFICIENT PER ANSI A58.1-1972
C
      READ(5,9003) RATIO,IWALL
      WRITE(6,500) RATIO,IWALL
  500 FORMAT('0',11X,'OPEN AREA RATIO = ',F8.3,5X,'WALL CODE = ',I5,/)
      IF(RATIO.GT.0.3) GO TO 71
C
C     IWALL =1,4 CORRESPONDS TO THE  WALL NUMBERING CONVENTION
C     IWALL = 5 IS THE CODE FOR A UNIFORM DISTRIBUTION OF WINDOWS
C
      GO TO (62,63,64,65,41),IWALL
   62 GO TO (40,41,42),ANG
   63 GO TO (42,42,42),ANG
   64 GO TO (42,41,40),ANG
   65 GO TO (42,42,42),ANG
   40 CI=0.3 + (RATIO*5.)/3.
      GO TO 80
   41 CI=0.3
      GO TO 80
   42 CI=-0.3-RATIO
      GO TO 80
   71 GO TO (51,52,53,54,41),IWALL
   51 GO TO (43,44,45),ANG
   52 GO TO (45,45,45),ANG
   53 GO TO (45,44,43),ANG
   54 GO TO (45,45,45),ANG
   43 CI=0.8
      GO TO 80
   44 CI=0.4
      GO TO 80
   45 CI=-0.6
   80 CONTINUE
      IF(ISHAPE.EQ.2) GO TO 50
C
C     DETERMINE THE EXTERNAL PRESSUR COEFFICIENTS OF SIDE
C     WALLS PARALLEL TO GET LINE OF FRAME ACTION
C
      IF(ITYPE.LE.3) GO TO 10
      IF(ITYPE.GT.3.AND.ITYPE.LE.13) GO TO 11
      IF(ITYPE.GT.13.AND.ITYPE.LE.23) GO TO 12
      IF(ITYPE.EQ.24.OR.ITYPE.EQ.25) GO TO 13
   10 GO TO (20,21,22),ANG
   20 ANG=3
      GO TO 21
   22 ANG=1
      GO TO 21
   11 ITYPE=ITYPE+10
      GO TO (20,21,22),ANG
   12 ITYPE=ITYPE-10
      GO TO (20,21,22),ANG
   13 GO TO (23,23,24),ANG
   23 ANG=3
      GO TO 21
   24 ANG=1
   21 CALL SHAPEX(CC,CD,ANG,ITYPE,1)
   50 CONTINUE
C
```

```
C     DO A FREE BODY ANALYSIS OF EACH WALL FOR MAXIMUM WINDOW PRESSURE
C
      CEC(1)=CA
      CEC(2)=CB
      CEC(3)=CC
      CEC(4)=CD
      CEC(5)=CK
      DO 67 I=1,5
   67 CIC(I)=CI
      IF(IWALL.NE.5) GO TO 66
      C1=CA-CI
      C2=CB-CI
      C3=CC-CI
      C4=CD-CI
      C5=CK-CI
      IF(ABS(C1).GE.ABS(CA)) GO TO 90
      CIC(1)=-CI
   90 IF(ABS(C2).GE.ABS(CB)) GO TO 91
      CIC(2)=-CI
   91 IF(ABS(C3).GE.ABS(CC)) GO TO 92
      CIC(3)=-CI
   92 IF(ABS(C4).GE.ABS(CD)) GO TO 93
      CIC(4)=-CI
   93 IF(ABS(C5).GE.ABS(CK)) GO TO 66
      CIC(5)=-CI
   66 CONTINUE
C
C     AT THIS POINT ALL DATA IS READY FOR WINDOW PRESSURE CALCULATIONS
C
  900 FORMAT(1P10E10.2)
      RETURN
      END
      SUBROUTINE DAMAG(NHAZ,EM,AR,VR,NS,A,V,EDEFL,DFT,LC,T1,DRFT,
     1CEC,CIC,QMS,VMH,ITOR,LSROPT,IFLY,IW,NOPT)
C
C  THIS SUBROUTINE COMPUTES THE PERCENT DAMAGE TO BUILDINGS
C  DUE TO EARTHQUAKE AND WIND ENVIRONMENTS. DAMAGE CATEGORIES
C  INCLUDE STRUCTURAL, NONSTRUCTURAL AND GLASS.
C
      INTEGER NHAZ(3),QT
      REAL DFT(30),EDEFL(30),LC(30)
      REAL FDRY(3,3),FDRT(3,3),FDRF(3,3),FQRY(3,3),FQRF(3,3),FDMUF(3,3),
     :     WDRY(3,3),WDRT(3,3),WDRF(3,3),WQRY(3,3),WQRF(3,3),WDMUF(3,3)
     :    ,FDRC(3,3),WDRC(3,3)
      REAL HW(30),BW(30),Q(30),THG(30)
      REAL CVPZR(30)
      REAL CEC(10),CIC(10),QMS(30),VMH(30)
      REAL A(30),V(30),DRFT(30),FDST(3),WDST(3),DNST(3),DG(5)
C
C  LIST DATA FOR DRY,DRT,DRF,QRY,QRF,DMUF VS. 3-QTY. 3-TYPE OF MATERIAL
C   THE PRIOR ESTIMATES OF STEEL AND RC HAVE BEEN REPLACED BY BAYESIAN
C   ESTIMATES
C
C    FRAME
      DATA FDRY/.0036,.0077,.0125,.0029,.0052,.0084,.0013,.0027,.0049/
      DATA FDRT/.0014,.003,.0049,.00055,.001,.0016,.00025,.00053,.00093/
      DATA FDRF/.016,.089,.262,.0125,.05,.144,.0033,.01,.025/
      DATA FQRY/.51,1.,1.6,.56,1.,1.6,.48,1.,1.8/
      DATA FQRF/.18,1.,3.,.24,1.,2.8,.33,1.,2.5/
      DATA FDMUF/4.4,11.5,21.,4.3,9.6,17.2,2.5,3.8,5.1/
C    SHEARWALL
      DATA WDRY/.0017,.0026,.0045,.001,.0016,.0029,.0021,.0041,.0059/
      DATA WDRT/.00032,.00049,.00086,.00019,.0003,.00055,.0004,.00078,.0
     ;0011/
      DATA WDRF/.0058,.017,.046,.0016,.0037,.0093,.0042,.018,.041/
      DATA WQRY/.65,1.,1.7,.63,1.,1.8,.51,1.,1.4/
      DATA WQRF/.28,1.,2.3,.44,1.,2.5,.23,1.,2.3/
      DATA WDMUF/3.4,6.7,10.3,1.6,2.3,3.2,2.,4.4,6.9/
C
C READ DAMAGEABILITY INPUTS FOR EQUAKE, WIND, OR TORNADO
C
```

```
      READ(5,9001) L1,M1,L2,M2,QT
      INDEX=0
      IF(M1.GT.0) INDEX=1
      IF(M2.GT.0) INDEX=INDEX+1
      IF(INDEX.GT.2) READ(5,9001) MCPT
 9001 FORMAT(10I8)                                                      SCHEN
C
C FIND DMUC FROM DMUF, TI, AND EM
      CTM=T1/.0046/EXP(EM)
      DO 666 M=1,3
      DO 666 L=1,3
      FDRC(L,M)=FDRY(L,M)*FDMUF(L,M)*CTM
      WDRC(L,M)=WDRY(L,M)*WDMUF(L,M)*CTM
  666 CONTINUE
C
       IF(NHAZ(2).EQ.0.AND.NHAZ(3).EQ.0) GO TO 588
      READ(5,9002) WH,WB,THK
 9002 FORMAT(10E8.3)
      DO 58 I=1,NS
      HW(I)=WH                                                          SCHEN
      BW(I)=WB                                                          SCHEN
      THG(I)=THK                                                        SCHEN
  58  CONTINUE
C
  588 CONTINUE
      WRITE(6,8000)
 8000 FORMAT(1H1,20X,'D A M A G E   A N A L Y S I S',///)
      IF(ITOR.EQ.-1) GO TO 41
C
C WRITE DAMAGEABILITY INPUTS FOR EQUAKE, WIND, OR TORNADO
C
      WRITE(6,622)
  622 FORMAT(' DAMAGEABILITY INPUTS FOR EARTHQUAKE WIND, OR TORNADO',//,
     1' STORY  DRIFT TO YIELD(IN/IN)   DRIFT TO FAILURE(IN/IN)  QUALITY
     1FACTOR FOR  WINDOW   WINDOW   THICKNESS OF',/,
     1'  NO.    FRAME    WALL              FRAME    WALL           NONSTRU
     1CT. DAMAGE  HT.(IN) WIDTH(IN)  WINDOW GLASS(IN)',/)
      DO 642 I=1,NS
      JK=NS+1-I
      Q(I)=FLOAT(QT)
      IF(M1.GT.0) GO TO 121
      AY=B=0.
      GO TO 122
  121 AY=FDRY(L1,M1)
       B=FDRF(L1,M1)
  122 IF(M2.GT.0) GO TO 123
      C=D=0.
      GO TO 642
  123  C=WDRY(L2,M2)
       D=WDRF(L2,M2)
  642 WRITE(6,632)JK,AY,C,B,D,Q(I
     :),HW(I),BW(I),THG(I)
  632 FORMAT(I4,2F10.4,4X,2F10.4,F20.2,2F14.2,F12.2)
C
```

```
C COMPUTE TOTAL EARTHQUAKE DAMAGE TO BUILDING
C
      IF(NHAZ(1).EQ.0)GO TO 42
      WRITE(6,653)
  653 FORMAT(1H1,//)
      WRITE(6,654)
  654 FORMAT(' TOTAL EARTHQUAKE DAMAGE TO BUILDING (PERCENT OF REPAIR CO
     :ST/ REPLACEMENT COST)',//)
C COMPUTE AVERAGE INTERSTORY DRIFT DUE TO EARTHQUAKE
      SMDFT=0.
      DO 89 I=1,NS
   89 SMDFT=SMDFT+DFT(I)
      AVDFT=SMDFT/FLOAT(NS)
C TOTAL DAMAGE: EITHER FRAME, SHEARWALL, OR THE COMBINATION WHICH IS
C PREDOMINANT
      A05=ALOG10(.5)
      A50=ALOG10(50.)
      IF(AVDFT.NE.0.) GO TO 671
      TDST=0.
      GO TO 670
  671 CONTINUE
      IF(M1.NE.0.OR.MPDT.EQ.1) GO TO 675
      IF(M2.NE.0.OR.MPDT.EQ.2) GO TO 676
      WRITE(6,6741)
      IF(L1.EQ.1.AND.L2.EQ.1) WRITE(6,6771)
      IF(L1.EQ.2.AND.L2.EQ.2) WRITE(6,6772)
      IF(L1.EQ.3.AND.L2.EQ.3) WRITE(6,6773)
      IF((L1.EQ.1.AND.L2.EQ.3.).OR.(L1.EQ.3.AND.L2.EQ.1))WRITE(6,6774)
      IF((L1.EQ.1.AND.L2.EQ.2.).OR.(L1.EQ.2.AND.L2.EQ.1))WRITE(6,6775)
      IF((L1.EQ.3.AND.L2.EQ.2.).OR.(L1.EQ.2.AND.L2.EQ.3))WRITE(6,6776)
      DRT05=SQRT(FDRT(L1,M1)*WDRT(L2,M2))
      DRC50=SQRT(FDRC(L1,M1)*WDRC(L2,M2))
      GO TO 678
  675 IF(M1.EQ.1) WRITE(6,6551)
      IF(M1.EQ.2) WRITE(6,6552)
      IF(M1.EQ.3) WRITE(6,6553)
      DRT05=FDRT(L1,M1)
      DRC50=FDRC(L1,M1)
      GO TO 677
  676 IF(M2.EQ.1) WRITE(6,6561)
      IF(M2.EQ.2) WRITE(6,6562)
      IF(M2.EQ.3) WRITE(6,6563)
      DRT05=WDRT(L2,M2)
      DRC50=WDRC(L2,M2)
  677 IF(L1.EQ.1.OR.L2.EQ.1)WRITE(6,6771)
      IF(L1.EQ.2.OR.L2.EQ.2)WRITE(6,6772)
      IF(L1.EQ.3.OR.L2.EQ.3)WRITE(6,6773)
  678 ADRT=ALOG10(DRT05)
      ADRC=ALOG10(DRC50)
      C1=(A05*ADRC-A50*ADRT)/(ADRC-ADRT)
      C2=(A50-A05)/(ADRC-ADRT)
      TDST=EXP(2.30258*(C1+C2*ALOG10(AVDFT)))
      IF (TDST.GT.100.) TDST=100.
  670 CONTINUE
      WRITE(6,698) NS,AVDFT,TDST
  698 FORMAT('          TOTAL     AVERAGE            BUILDING',/,
     :'       NO.       INTERSTY.           PERCENT',/,
     :'       STY.       DRIFT              DAMAGE',//,5X,I3,6X,F6.4,10X,F6.2)
 6741 FORMAT('        BUILDING CLASSIFICATION: COMBINATION',//)
 6551 FORMAT('        BUILDING CLASSIFICATION: STEEL FRAME',//)
 6552 FORMAT('        BUILDING CLASSIFICATION: REINFORCED CONCRETE FRAME',/
     :/)
 6553 FORMAT('        BUILDING CLASSIFICATION: PRECAST CONCRETE FRAME',//)
 6561 FORMAT('        BUILDING CLASSIFICATION: REINFORCED CONCRETE SHEARWAL
     :L',//)
 6562 FORMAT('        BUILDING CLASSIFICATION: PRECAST CONCRETE SHEARWALL',
     ://)
 6563 FORMAT('        BUILDING CLASSIFICATION: BRICK MASONRY SHEARWALL',//)
 6771 FORMAT('        OVERALL QUALITY RATING: POOR',//)
 6772 FORMAT('        OVERALL QUALITY RATING: AVERAGE',//)
 6773 FORMAT('        OVERALL QUALITY RATING: GOOD',//)
```

```
 6774 FORMAT('      OVERALL QUALITY RATING: POOR TO GOOD',//)
 6775 FORMAT('      OVERALL QUALITY RATING: POOR TO AVERAGE',//)
 6776 FORMAT('      OVERALL QUALITY RATING: AVERAGE TO GOOD',//)
C
C   COMPUTE EARTHQUAKE DAMAGE FOR EACH FLOOR
C
C   STRUCTURAL DAMAGE
C
      WRITE(6,653)
      WRITE(6,699) M1,M2
  699 FORMAT(' EARTHQUAKE DAMAGE TO STRUCTURAL COMPONENTS (PERCENT OF RE
     :PAIR COST/ REPLACEMENT COST)',//,
     :16X,'FRAME TYPE:',I2,29X,'SHEARWALL TYPE:',I2,//,
     :' STORY    INTERSTY.   PERCENT DAMAGE BY QUALITY      INTERSTY.
     :PERCENT DAMAGE BY QUALITY',/,
     :'  NO.     DRIFT       GOOD     AVERAGE    POOR          DRIFT
     :GOOD     AVERAGE    POOR',//,)
      DO 20 I=1,NS
      JK=NS+1-I
      DO 30 L=1,3
C FIND DAMAGE FOR FRAME
      IF(M1.EQ.0.) GO TO 31
      IF (DFT(I).EQ.0.) GO TO 31
      DRT05=FDRT(L,M1)
      DRC50=FDRC(L,M1)
      ADRT=ALOG10(DRT05)
      ADRC=ALOG10(DRC50)
      C1=(A05*ADRC-A50*ADRT)/(ADRC-ADRT)
      C2=(A50-A05)/(ADRC-ADRT)
      FDST(L)=EXP(2.30258*(C1+C2*ALOG10(DFT(I))))
      IF(FDST(L).LT.0.5) FDST(L)=0.
      IF(FDST(L).GT.100.) FDST(L)=100.
      GO TO 33
   31 FDST(L)=0.
C FIND DAMAGE FOR SHEARWALL
   33 IF(M2.EQ.0.) GO TO 32
      IF (DFT(I).EQ.0.) GO TO 32
      DRT05=WDRT(L,M2)
      DRC50=WDRC(L,M2)
      ADRT=ALOG10(DRT05)
      ADRC=ALOG10(DRC50)
      C1=(A05*ADRC-A50*ADRT)/(ADRC-ADRT)
      C2=(A50-A05)/(ADRC-ADRT)
      WDST(L)=EXP(2.30258*(C1+C2*ALOG10(DFT(I))))
      IF(WDST(L).LT.0.5) WDST(L)=0.
      IF(WDST(L).GT.100.) WDST(L)=100.
      GO TO 30
   32 WDST(L)=0.
   30 CONTINUE
      WRITE(6,700)JK,DFT(I),FDST(3),FDST(2),FDST(1),DFT(I),WDST(3),WDST(
     :2),WDST(1)
  700 FORMAT(I4,4X,F9.4,1X,3F9.2,4X,F9.4,3X,3F9.2)
   20 CONTINUE
C
C   NONSTRUCTURAL DAMAGE INCLUDING GLASS
C
      WRITE(6,709)
  709 FORMAT(///,' EARTHQUAKE DAMAGE TO NONSTRUCTURAL COMPONENTS (PERCEN
     :T OF COMPONENTS DAMAGED)',//,
     :10X,'COMPONENTS SENSITIVE TO FLOOR MOTION              GLASS',//,
     :' STORY    FLOOR       PERCENT DAMAGE BY QUALITY      INTERSTY.
     :PERCENT DAMAGE BY QUALITY',/,
     :'  NO.     ACCL.(G)    GOOD     AVERAGE    POOR          DRIFT
     :GOOD     AVERAGE    POOR',//)
```

```
      A100=ALOG10(100.)
      A175=ALOG10(1.75)
      A014=ALOG10(0.14)
      DO 40 I=1,NS
      JK=NS+1-I
      AMMI = 3.5*ALOG10(A(I))+10.28
      BMMI = 2.73*ALCG10(V(I))+5.16
      EMMI = AMAX1(AMMI , BMMI)
      DO 708 L=1,3
      Q(I)=FLOAT(L)
      X = -4.62 + .552*EMMI*(1.-(Q(I)-3.)/6.)
      DNST(L)=10.**X
      IF(DNST(L).GT.100.) DNST(L)=100.
  708 CONTINUE
C GLASS DAMAGE
      Y=EDEFL(I)/LC(I)
      IF (Y.NE.0.) GC TO 422
      DG(1)=DG(2)=CG(3)=0.
      GO TO 446
  422 IF(M1.EQ.0.OR.MCPT.EQ.2) GO TO 401
      IF(M1.NE.1) GO TO 402
      DR100=.012
      DRTT=.003
      ADRC=ALOG10(DR100)
      ADRT=ALOG10(DRTT)
      C1=(A175*ADRC-A100*ADRT)/(ADRC-ADRT)
      C2=(A100-A175)/(ADRC-ADRT)
      DG(1)=EXP(2.30258*(C1+C2*ALOG10(Y)))
      DR100=.017
      ADRC=ALOG10(DR100)
      C1=( A05*ADRC-A100*ADRT)/(ADRC-ADRT)
      C2=(A100-A05)/(ADRC-ADRT)
      DG(2)=EXP(2.30258*(C1+C2*ALOG10(Y)))
      C1=(A014*ADRC-A100*ADRT)/(ADRC-ADRT)
      C2=(A100-A014)/(ADRC-ADRT)
      DG(3)=EXP(2.30258*(C1+C2*ALOG10(Y)))
      GO TO 444
  402 DR100=.012
      DRTT=.001
      ADRT=ALOG10(DRTT)
      ADRC=ALOG10(DR100)
      C1=(A175*ADRC-A100*ADRT)/(ADRC-ADRT)
      C2=(A100-A175)/(ADRC-ADRT)
      DG(1)=EXP(2.30258*(C1+C2*ALOG10(Y)))
      DR100=.017
      ADRC=ALOG10(DR100)
      C1=( A05*ADRC-A100*ADRT)/(ADRC-ADRT)
      C2=(A100-A05)/(ADRC-ADRT)
      DG(2)=EXP(2.30258*(C1+C2*ALOG10(Y)))
      C1=(A014*ADRC-A100*ADRT)/(ADRC-ADRT)
      C2=(A100-A014)/(ADRC-ADRT)
      DG(3)=EXP(2.30258*(C1+C2*ALOG10(Y)))
      GO TO 444
  401 DR100=.012
      DRTT=.0005
      ADRT=ALOG10(DRTT)
      ADRC=ALOG10(DR100)
      C1=(A175*ADRC-A100*ADRT)/(ADRC-ADRT)
      C2=(A100-A175)/(ADRC-ADRT)
      DG(1)=EXP(2.30258*(C1+C2*ALOG10(Y)))
      DR100=.017
      ADRC=ALOG10(DR100)
      C1=( A05*ADRC-A100*ADRT)/(ADRC-ADRT)
      C2=(A100-A05)/(ADRC-ADRT)
      DG(2)=EXP(2.30258*(C1+C2*ALOG10(Y)))
      C1=(A014*ADRC-A100*ADRT)/(ADRC-ADRT)
      C2=(A100-A014)/(ADRC-ADRT)
      DG(3)=EXP(2.30258*(C1+C2*ALOG10(Y)))
```

```
444 DO 445 L=1,3
445 IF(DG(L).GT.100.) DG(L)=100.
446 WRITE(6,710)JK,A(I),DNST(3),DNST(2),DNST(1),Y,DG(3),DG(2),DG(1)
710 FORMAT(I4,F10.2,4X,3F9.2,F14.4,2X,3F9.2)
 40 CONTINUE
    WRITE(6,987)
987 FORMAT(///,' FRAME TYPES:                     SHEARWALL TYPES:',//,
   :'   0: NOT APPLICABLE              0: NOT APPLICABLE',/,
   :'   1: STEEL                       1: REINFORCED CONCRETE',/,
   :'   2: REINFORCED CONCRETE         2: PRECAST CONCRETE',/,
   :'   3: PRECAST CONCRETE            3: BRICK MASONRY')
 42 CONTINUE
C
C COMPUTE TOTAL WIND DAMAGE TO BUILDING
C
    IF(NHAZ(2).EQ.0) GO TO 125
 41 CONTINUE
    WRITE(6,653)
    WRITE(6,711)
711 FORMAT(' TOTAL WIND DAMAGE TO BUILDING (PERCENT OF REPAIR COST/ RE
   :PLACEMENT COST)',//)
C COMPUTE AVERAGE INTERSTORY DRIFT DUE TO WIND
    DO 718 I=1,NS
718 SMDRFT=SMDRFT+DRFT(I)
    AVDFT=SMDRFT/FLOAT(NS)
C TOTAL DAMAGE: EITHER FRAME, SHEARWALL, OR THE COMBINATION WHICH IS
C PREDOMINANT
    IF(AVDFT.NE.0.) GO TO 674
    TDST=0.
    GO TO 679
674 CONTINUE
    IF(M1.NE.0.OR.MFDT.EQ.1) GO TO 201
    IF(M2.NE.0.OR.MFDT.EQ.2) GO TO 202
    WRITE(6,6741)
    IF(L1.EQ.1.AND.L2.EQ.1) WRITE(6,6771)
    IF(L1.EQ.2.AND.L2.EQ.2) WRITE(6,6772)
    IF(L1.EQ.3.AND.L2.EQ.3) WRITE(6,6773)
    IF((L1.EQ.1.AND.L2.EQ.3.).OR.(L1.EQ.3.AND.L2.EQ.1))WRITE(6,6774)
    IF((L1.EQ.1.AND.L2.EQ.2.).OR.(L1.EQ.2.AND.L2.EQ.1))WRITE(6,6775)
    IF((L1.EQ.3.AND.L2.EQ.2.).OR.(L1.EQ.2.AND.L2.EQ.3))WRITE(6,6776)
    DRT05=SQRT(FDRT(L1,M1)*WDRT(L2,M2))
    DRC50=SQRT(FDRY(L1,M1)*WDRY(L2,M2))
    GO TO 214
201 IF(M1.EQ.1) WRITE(6,6551)
    IF(M1.EQ.2) WRITE(6,6552)
    IF(M1.EQ.3) WRITE(6,6553)
    DRT05=FDRT(L1,M1)
    DRC50=FDRY(L1,M1)
    GO TO 213
202 IF(M2.EQ.1) WRITE(6,6561)
    IF(M2.EQ.2) WRITE(6,6562)
    IF(M2.EQ.3) WRITE(6,6563)
    DRT05=WDRT(L2,M2)
    DRC50=WDRY(L2,M2)
213 IF(L1.EQ.1.OR.L2.EQ.1)WRITE(6,6771)
    IF(L1.EQ.2.OR.L2.EQ.2)WRITE(6,6772)
    IF(L1.EQ.3.OR.L2.EQ.3)WRITE(6,6773)
214 ADRT=ALOG10(DRT05)
    ADRC=ALOG10(DRC50)
    C1=(A05*ADRC-A50*ADRT)/(ADRC-ADRT)
    C2=(A50-A05)/(ADRC-ADRT)
    TDST=EXP(2.302585*(C1+C2*ALOG10(AVDFT)))
    IF (TDST.GT.100.) TDST=100.
679 CONTINUE
    WRITE(6,698) NS,AVDFT,TDST
```

```
C
C   COMPUTE WIND DAMAGE FOR EACH FLOOR
C
C   STRUCTURAL DAMAGE
C
      WRITE(6,653)
      WRITE(6,719) M1,M2
  719 FORMAT(' WIND DAMAGE TO STRUCTURAL COMPONENTS (PERCENT OF REPAIR C
     :OST/ REPLACEMENT COST)',//,
     :16X,'FRAME TYPE:',I2,29X,'SHEARWALL TYPE:',I2,//,
     :' STORY     INTERSTY.    PERCENT DAMAGE BY QUALITY        INTERSTY.
     :PERCENT DAMAGE BY QUALITY',/,
     :'   NO.      DRIFT         GOOD      AVERAGE    POOR          DRIFT
     :GOOD      AVERAGE    POOR',//,)
      DO 100 I=1, NS
      JK=NS+1-I
      DO 110 L=1,3
C FIND DAMAGE FOR FRAME
      IF(M1.EQ.0.) GO TO 331
      IF(DRFT(I).EQ.0.) GO TO 331
      DRT05=FDRT(L,M1)
      DRC50=FDRY(L,M1)*1.0
      ADRT=ALOG10(DRT05)
      ADRC=ALOG10(DRC50)
      C1=(A05*ADRC-A50*ADRT)/(ADRC-ADRT)
      C2=(A50-A05)/(ADRC-ADRT)
      FDST(L)=EXP(2.30258*(C1+C2*ALOG10(DRFT(I))))
      IF(FDST(L).LT.0.5) FDST(L)=0.
      IF(FDST(L).GT.100.) FDST(L)=100.
      GO TO 333
  331 FDST(L)=0.
C FIND DAMAGE FOR SHEARWALL
  333 IF(M2.EQ.0.) GO TO 332
      IF(DRFT(I).EQ.0.) GO TO 332
      DRT05=WDRT(L,M2)
      DRC50=WDRY(L,M2)*1.0
      ADRT=ALOG10(DRT05)
      ADRC=ALOG10(DRC50)
      C1=(A05*ADRC-A50*ADRT)/(ADRC-ADRT)
      C2=(A50-A05)/(ADRC-ADRT)
      WDST(L)=EXP(2.30258*(C1+C2*ALOG10(DRFT(I))))
      IF(WDST(L).LT.0.5) WDST(L)=0.
      IF(WDST(L).GT.100.) WDST(L)=100.
      GO TO 110
  332 WDST(L)=0.
  110 CONTINUE
      WRITE(6,700)JK,DRFT(I),FDST(3),FDST(2),FDST(1),DRFT(I),WDST(3),WDS
     :T(2),WDST(1)
  100 CONTINUE
C
C   NONSTRUCTURAL DAMAGE - PARTITIONS AND GLASS
C
      WRITE(6,729)
  729 FORMAT(///,' WIND DAMAGE TO NONSTRUCTURAL COMPONENTS (PERCENT OF C
     :OMPONENTS DAMAGED)',//,
     :10X,'CEILINGS AND PARTITIONS                                 GLASS',
     -' (PERCENT DAMAGE BY WALL)',//,
     :' STORY     INTERSTY.    PERCENT DAMAGE BY QUALITY        WIND PRESS
     :WALL 1   WALL 2   WALL 3   WALL 4   CORNERS',/,
     :'   NO.      DRIFT         GOOD      AVERAGE    POOR          (PSF)',//)
      A10=ALOG10(10.)
      A25=ALOG10(2.5)
      A15=ALOG10(1.5)
      DO 120 I=1,NS
      JK=NS+1-I
      CVPZR(I)=.25
      IF(DRFT(I).NE.0.) GO TO 554
      DNST(1)=DNST(2)=DNST(3)=0.
      GO TO 557
```

```
554 DR100=.01
    DRTT=.001
    ADRT=ALOG10(DRTT)
    ADRC=ALOG10(DR100)
    C1=(A10*ADRC-A100*ADRT)/(ADRC-ADRT)
    C2=(A100-A10)/(ADRC-ADRT)
    DNST(1)=EXP(2.30258*(C1+C2*ALOG10(DRFT(I))))
    IF(M1.EQ.0.OR.MCPT.EQ.2) GO TO 553
    IF(M1.NE.1) GO TO 551
    DR100=.0135
    DRTT=.003
    ADRC=ALOG10(DR100)
    ADRT=ALOG10(DRTT)
    C1=(A25*ADRC-A100*ADRT)/(ADRC-ADRT)
    C2=(A100-A25)/(ADRC-ADRT)
    DNST(2)=EXP(2.30258*(C1+C2*ALOG10(DRFT(I))))
    DR100=.02
    ADRC=ALOG10(DR100)
    C1=(A15*ADRC-A100*ADRT)/(ADRC-ADRT)
    C2=(A100-A15)/(ADRC-ADRT)
    DNST(3)=EXP(2.30258*(C1+C2*ALOG10(DRFT(I))))
    GO TO 552
551 DR100=.0135
    DRTT=.001
    ADRC=ALOG10(DR100)
    ADRT=ALOG10(DRTT)
    C1=(A25*ADRC-A100*ADRT)/(ADRC-ADRT)
    C2=(A100-A25)/(ADRC-ADRT)
    DNST(2)=EXP(2.30258*(C1+C2*ALOG10(DRFT(I))))
    DR100=.02
    ADRC=ALOG10(DR100)
    C1=(A15*ADRC-A100*ADRT)/(ADRC-ADRT)
    C2=(A100-A15)/(ADRC-ADRT)
    DNST(3)=EXP(2.30258*(C1+C2*ALOG10(DRFT(I))))
    GO TO 552
553 DR100=.0135
    DRTT=.0005
    ADRT=ALOG10(DRTT)
    ADRC=ALOG10(DR100)
    C1=(A25*ADRC-A100*ADRT)/(ADRC-ADRT)
    C2=(A100-A25)/(ADRC-ADRT)
    DNST(2)=EXP(2.30258*(C1+C2*ALOG10(DRFT(I))))
    DR100=.02
    ADRC=ALOG10(DR100)
    C1=(A15*ADRC-A100*ADRT)/(ADRC-ADRT)
    C2=(A100-A15)/(ADRC-ADRT)
    DNST(3)=EXP(2.30258*(C1+C2*ALOG10(DRFT(I))))
552 DO 555 L=1,3
    IF(DNST(L).GT.100.) DNST(L)=100.
555 CONTINUE
557 AA = AMIN1(HW(I),BW(I))
    BB = AMAX1(HW(I),BW(I))
    SGB=5000.
    PZR = SGB*THG(I)**2*(1.+1.61*(AA**3/BB**3))/.75/AA**2
    DO 119 J=1,5
    P=CEC(J)*QMS(I)-CIC(J)*VMH(I)
    P=ABS(P)/144.
    X=(P/PZR-1.)/CVPZR(I)
    IF(X.LT.-5.) X=-5.
119 DG(J)=100.*RNORM(X)
    WRITE(6,730)JK,DRFT(I),DNST(3),DNST(2),DNST(1),QMS(I),(DG(J),J=1,5
   :)
730 FORMAT(I4,F12.4,2X,3F9.2,F12.2,4X,5F9.2)
120 CONTINUE
    WRITE(6,987)
125 CONTINUE
    IF(LSROPT.EQ.0) GO TO 500
```

```
C
C  LONG SPAN ROOF DAMAGE
C
      WRITE(6,800)
      IF(IFLY.NE.0)WRITE(6,810)
      IF(IW.NE.0) WRITE(6,820)
      IF((IFLY.EQ.0).AND.(IW.EQ.0)) WRITE(6,830)
  800 FORMAT('0DAMAGE TO LONG-SPAN ROOF',//)
  810 FORMAT(10X,'ROOF TIE-DOWN SUPPORTS ARE INADEQUATE TO RESIST ',/,
     :10X,'NET UPLIFT PRESSURE DUE TO WIND. PREDICT ROOF SEPARATION.',/)
  820 FORMAT(10X,'ROOF DESIGN IS INADEQUATE TO SUPPORT DEAD WEIGHT',/,
     :10X,'DUE TO PONDING. PREDICT COLLAPSE.',/)
  830 FORMAT(10X,'TIE-DOWN CAPACITY AND DEAD WEIGHT CAPACITY ARE',/,
     :10X,'ADEQUATE TO RESIST PREDICTED LEVELS OF NET UPLIFT',/,
     :10X,'DUE TO WIND, AND COLLAPSE DUE TO PONDING (IF ANY).',/,
     :10X,'NO DAMAGE IS PREDICTED.')
  500 RETURN
      END
      FUNCTION RNORM(Z)
      Z=Z/SQRT(2.)
      X=ABS(Z)
      X2=-(X**2)
      E=1./(1.+.3275911*X)
      Q=E*(.225836846+E*(-.252128668+E*(1.25969513+E*(-1.287822453+
     1E*.94064607))))
      ERF=1.-Q*EXP(X2)*2./1.77245385
      IF(Z.LT.0.) ERF=-ERF
      RNORM=.5*(1.+ERF)
      RETURN
      END
```

U.S. DEPARTMENT OF COMMERCE
Technology Administration
National Technical Information Service
Springfield, VA 22161 (703) 487-4650