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ODRESB-3D USER'S MANUAL A COMPUTER PROGRAM FOR OPTIMUM DESIGN OF REINFORCED CONCRETE AND STEEL BUILDING SYSTEMS SUBJECTED TO 3-D GROUND MOTIONS AND ATC-03 PROVISIONS

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ODRESB-3D

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ABSTRACT

This report has been prepared as a user's guide for the computer program, ODRESB-3D. The program uses the optimality criteria technique of structural optimization to design and analyze elastic building systems subjected to static and multi-component seismic loads.

The building systems may consist of concrete flexural walls, flexural panels and shear walls, as well as steel beams, columns, and braces. The multi-component seismic excitations can be represented through the use of three separate response spectra or through the use of the ATC 3-06 analysis provisions. Second-order effects are considered by using the string-geometric stiffness approach or the ATC 3-06 stability factors.

The computer program has been developed for achieving efficiency in both computations and data preparation. The output of each solution can include: the static and/or dynamic floor displacements, the member forces and stresses, the natural frequencies, and the eigenmodes, as determined from each structural analysis, as well as, the member sizes, the active constraints, the scaling factors, and the objective function value as determined from each cycle of optimization.

The main features within this report are: a general description of the program, instructions for data preparation, lists of typical output solutions, and a guide for program capacity modification.

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I. INTRODUCTION

ODRESB-3D, Optimum Design of 3-Dimensional Reinforced-Concrete and Steel Building Systems, has been developed with the continuous support and encouragement from the University of Missouri-Rolla, Washington University, and the National Science Foundation along with various engineering researchers and designers worldwide. This optimization program is an outgrowth of two computer programs, INRESB-3D (1) and INRESB-3D-II (2). These programs were used to study the elastic and inelastic response of building systems to multi-component seismic excitations. The current program, ODRESB-3D, has removed the inelastic analysis and the time dependent dynamic analysis and replaced them with a structural optimization technique, response spectra analysis, and ATC 3-06 analysis provisions (3). Therefore, this program can be used to produce and study the optimal design of three-dimensional structures subjected to static and dynamic loads.

This manual will be used to provide the information required for the correct use of the computer program ODRESB-3D. It will include a summary of the analytical procedures, a brief description of the computer program subroutines, the instructions for data preparation, the input, results and interpretation of two examples, an outline for program modification, and a listing of the complete program.

II. STRUCTURAL MODEL, ANALYSIS, AND OPTIMIZATION

A. STRUCTURAL MODEL

The program was designed to analyze and optimize three-dimensional systems. Each three-dimensional structure is required to have a plan which can be represented with straight lines, whereas the elevation can be irregular. Each floor must be horizontal, and the columns, panels, and walls must be vertical. The building systems can consist of any combination of steel columns, beams, and braces, and reinforced-concrete flexural walls and panels.

1. Global Degrees of Freedom. Each floor is assumed to be rigid in its own plane, while being flexible in the planes perpendicular to the slab. The rigid slab assumption allows every floor to be represented by two translational and one rotational degree of freedom in the horizontal plane. By allowing the floor to remain flexible with respect to the vertical planes, each structural node is allowed to displace vertically and to rotate about the two horizontal axes. These rotational degrees of freedom are eliminated through static condensation leaving each structure with a vertical degree of freedom at each structural node along with two translational and one rotational degree of freedom for each story as shown in Figure 1. Therefore the total number of global degrees of freedom is given by

$$D.O.F. = NC * NS + 3 * NS = NS * (NC+3) \qquad (2.1)$$

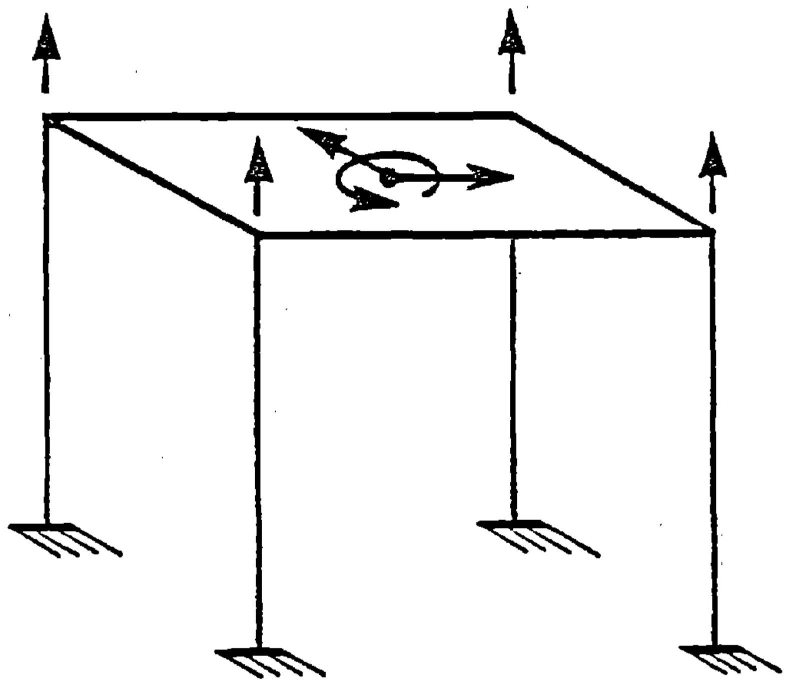


Figure 1.   Global Degrees of Freedom per Floor After Condensation

where NC, is the number of column lines, and NS, is the number of stories. These assumptions along with the condensation cause a large reduction in the amount of computer space needed for the analysis.

2. Second-order Effects. Second-order (P-delta) effects are handled with two different approaches. The static and response spectrum analyses use a separate geometric stiffness matrix, while the ATC 3-06 analysis uses a stability factor in order to adjust the structural response.

The geometric stiffness is based upon the string stiffness technique, as shown in Figure 2. The string stiffness technique assumes that the given column with axial force, P', creates a second-order moment equivalent to the axial force multiplied by the drift, Δ. In order to enforce equilibrium an additional shear of P'/L is required, where L is the length of the flexible portion of the column. This term of P'/L is used to reduce the lateral stiffness of structure, therefore increasing the lateral deflections and increasing the internal moments. Note that D_T and D_B are rigid zones at the top and bottom of the column respectively.

3. External Stiffness. The computer program also has the option of adding external or nonstructural stiffness to the structural stiffness. These externally applied stiffnesses can be added to any one or combination of the floor degrees of freedom which act in the horizontal planes

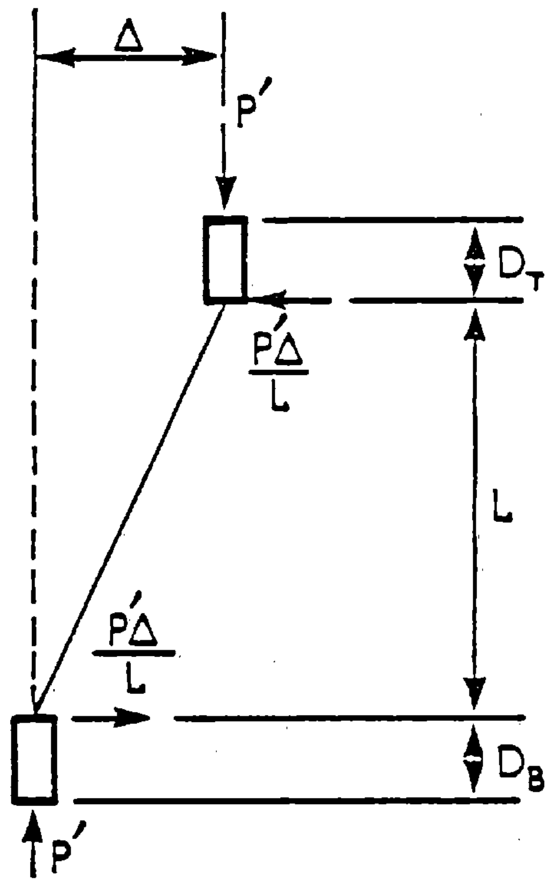


Figure 2. String Stiffness Approach to Second-Order Effects

as shown in Figure 3. Therefore, the three-dimensional structures can be used to simulate two-dimensional structures by eliminating any rotational effects or by eliminating a translational component along with the rotational component of the structural response. These external stiffnesses are used when performing an ATC 3-06 seismic analysis.

4. Structural Mass. When a dynamic analysis is performed the structural mass matrix must be generated. A lumped mass system is used where there is mass associated with each of the global degrees of freedom. The analyses use both structural and nonstructural mass. The non-structural mass must be part of the input data, but the structural mass is generated within the program.

The rotational mass inertia is dependent upon the distribution of the structural and nonstructural masses on each level. The structural mass is assumed to be lumped at each of the structural nodes. Therefore, the structural, rotatory mass inertia is calculated within the program with this formula

$$M_{SRi} = \sum_{k=1}^{q} M_{vk}(x_k^2 + y_k^2) = \sum_{k=1}^{q} M_{vk} r_k^2 \qquad (2.2)$$

where M_{SRi} is the structural, rotatory mass inertia for level i, M_{vk} is the mass associated with node k, x_k and y_k,

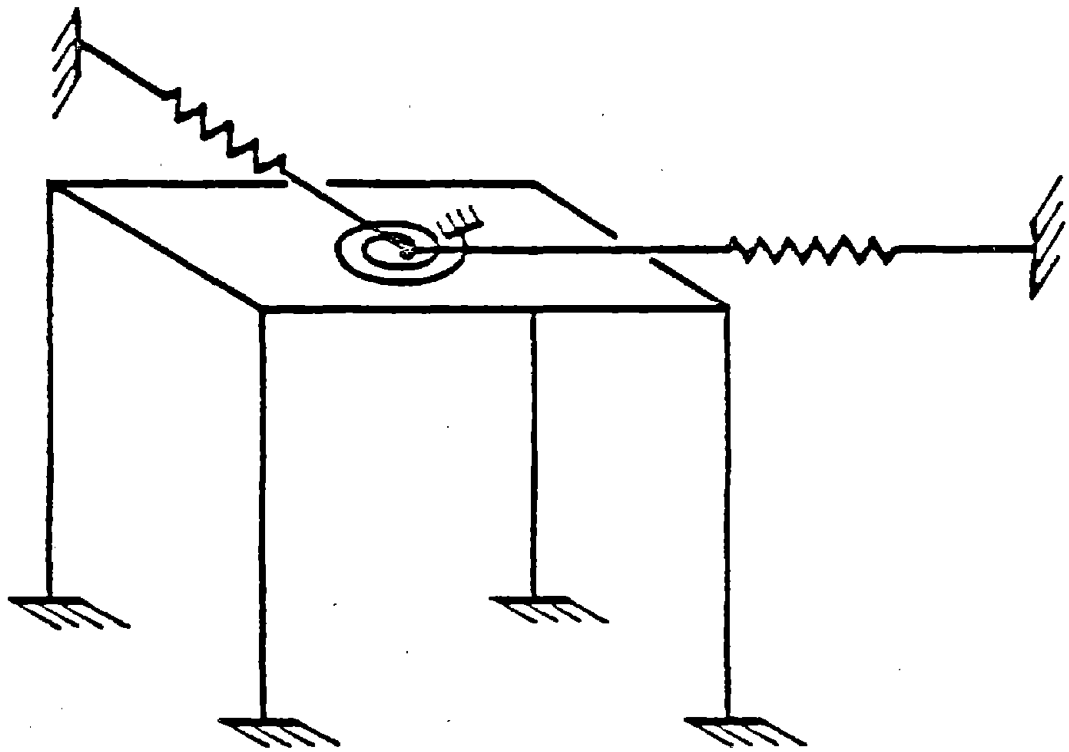


Figure 3. Allowable External Stiffnesses per Floor

are the distances from the global mass center along the global x and y axes for node k, and r_k is the magnitude of the position vector between the global mass center and node k. Therefore, the total rotatory inertia about the global mass center can be given as

$$M_{Ri} = M_{SRi} + M_{NRi} \qquad (2.3)$$

where M_{Ri}, M_{SRi}, and M_{NRi} represent the total, structural, and nonstructural rotatory inertia for level i. There is no mass associated with the condensed rotational degrees of freedom, therefore the mass matrix becomes a diagonal matrix with an associated mass for each global degree of freedom.

5. Steel Elements. The steel element cross-sections can be regular shapes (rectangular, tubular, or circular) or irregular shapes such as I-sections. The wide-flange cross-sections are the most useful in structural design for beams and beam columns, whereas the braces can be considered as single or double angles or rods.

The beam-columns are allowed twelve local degrees of freedom. Each element has three translational and three rotational degrees of freedom at each node as shown in Figure 4. Therefore, the analysis requires each beam-column to be represented by six geometric, cross-sectional properties: the major-axis, minor-axis, and torsional moments of

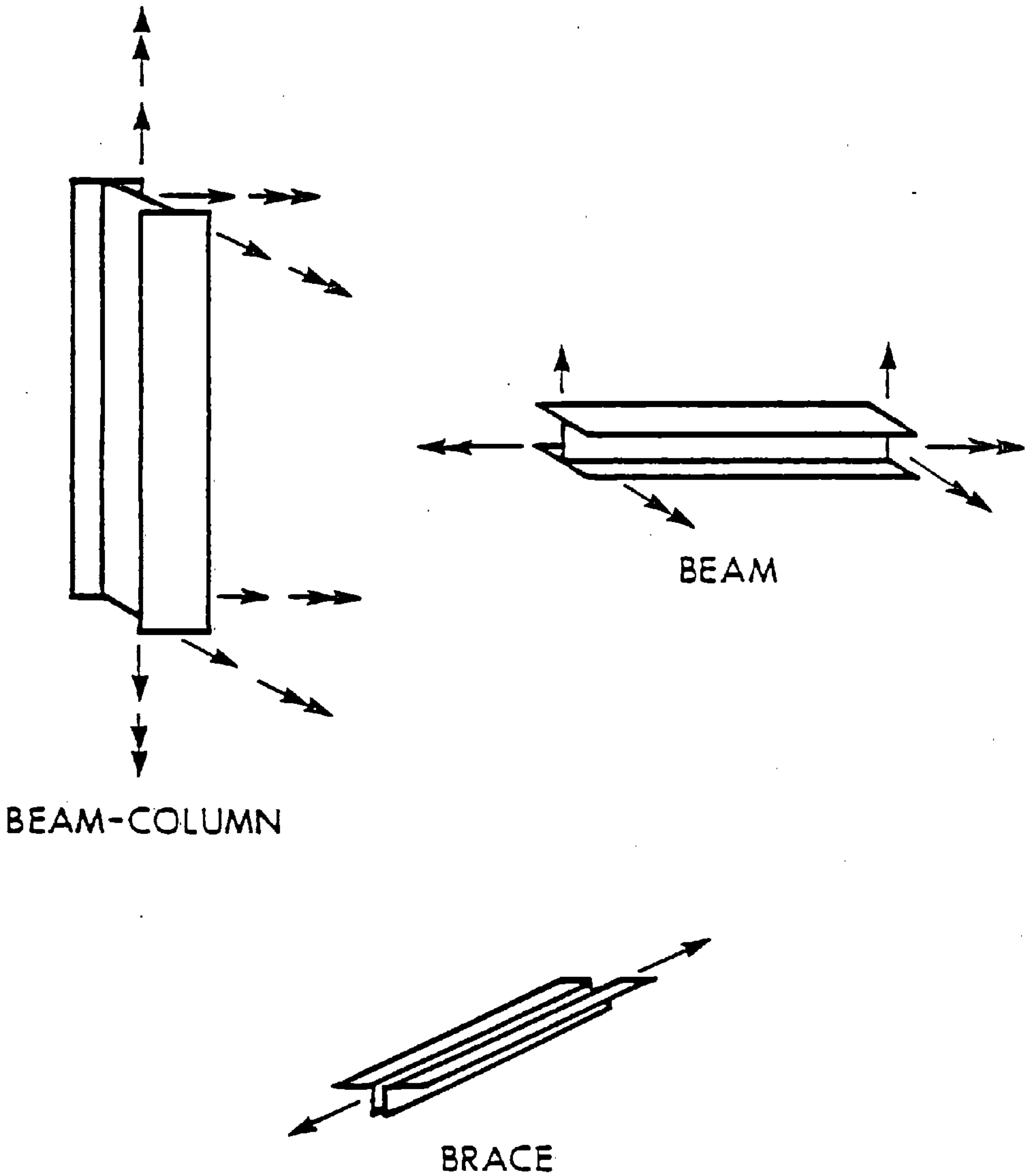


Figure 4. Steel Elements with the Elemental Degrees of Freedom

inertia, major-axis and minor-axis section modulii, and the cross-sectional area.

The beams are allowed six elemental degrees of freedom. Each beam has one degree of translation and two degrees of rotation at each node as shown in Figure 4. Therefore, the analysis requires each beam to be represented by three geometric properties: the major-axis moment of inertia, section modulus, and the torsional moment of inertia.

The steel braces are allowed two degrees of freedom. Each element node is allowed to displace along the axis of the member as shown in Figure 4. Therefore, the cross-sectional area is the only geometric property required to represent a brace.

6. Reinforced-Concrete Elements. The reinforced concrete elements used for the optimization are based upon the following assumptions. The elements must be rectangular (or square) with a fixed depth, h. The steel must be equally distributed along the major and minor axes with the amount of steel based upon the chosen value of ρ, the percentage of steel per the gross cross-sectional area. Also, the cracking depth is based upon the theory of working stress for bending about a single axis.

Both the concrete panels and beam-columns use the same working stress theory in order to determine their cross-sectional properties (4). The panels are allowed six degrees of freedom while the beam-columns are allowed twelve degrees of freedom as shown in Figure 5. Each corner of the panel is allowed to translate in the vertical direction, while the upper and lower faces of the panel are allowed to rigidly displace in the horizontal direction as shown in Figure 5. This requires each panel to be represented by three geometric properties: the major-axis moment of inertia, the major-axis section modulus, and the cross-sectional area. The reinforced-concrete beam-columns have the same degrees of freedom as the steel beam-columns and require the same six geometric properties in order to represent the element.

The working stress model is based upon the transformed cross-sections shown in Figure 6. The transformed cross-sectional properties can be derived as

$$I_x = \frac{1}{3} b(kd)^3 + (n-1)\ A_s(kd-d')^2 + n\ A_s(d-kd)^2 \qquad (2.4)$$

$$I_y = \frac{1}{3} h(kb')^3 + (n-1)\ A_s(kb'-b'')^2 + n\ A_s(b'-kb')^2 \qquad (2.5)$$

$$A_t = b(kd) + (n-1)\ A_s + nA_s \qquad (2.6)$$

where

$$A_s = \rho bd \qquad (2.7)$$

$$d = Ph \qquad (2.8)$$

$$d' = (1-P)h \qquad (2.9)$$

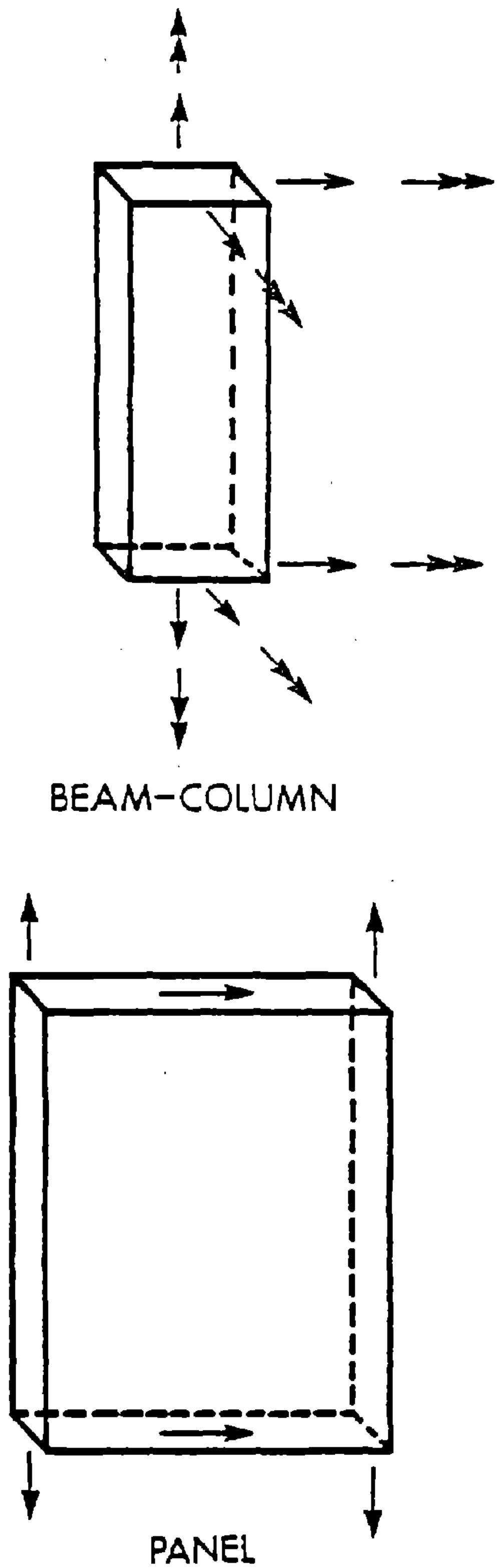
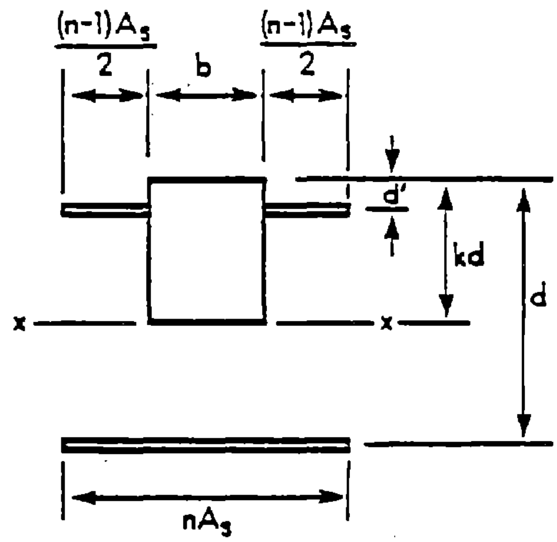
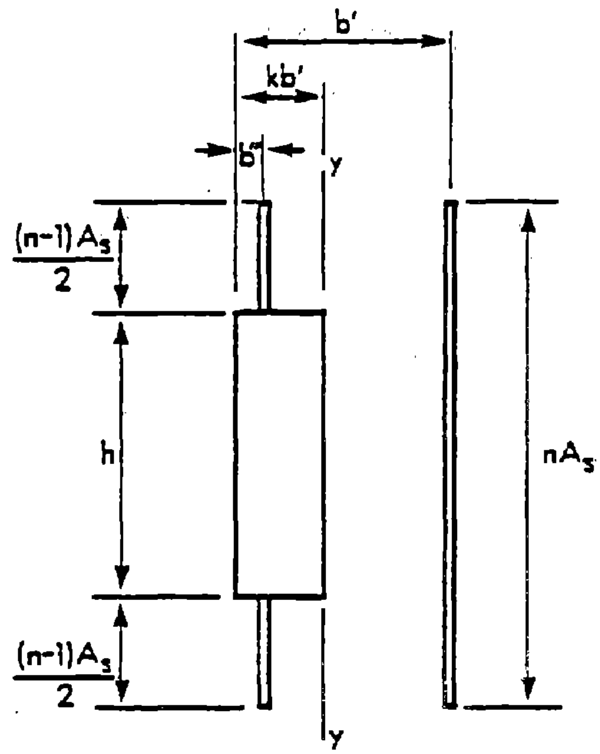


Figure 5. Concrete Elements with the Elemental Degrees of Freedom



(a)



(b)

Figure 6. Transformed Concrete Elements with Respect to a) the Major-Axis and b) the Minor-Axis

$$k = \left(\frac{f_c}{f_c+f_s}\right) \tag{2.10}$$

$$n = E_s/E_c \tag{2.11}$$

in which E_s, is Young's modulus for steel, E_c, is Young's modulus for concrete, f_s, is the yield stress for steel and, f_c, is the yield stress for concrete which provides an equation in terms of ρ, the percentage of steel, P, the percentage of the depth to the lumped steel, k, the percentage of the effective depth for the cracked section based upon the position of the lumped steel, n, the modular ratio, b, the variable width, and h, the fixed depth as

$$I_x = bh^3\left[\frac{1}{3}(kP)^3 + (n-1)\rho P(P(k+1)-1)^2 + n\rho P^3(1-k)^2]\right] \tag{2.12}$$

$$I_y = hb^3\left[\frac{1}{3}(kP)^3 + (n-1)\rho P(P(k+1)-1)^2 + n\rho P^3(1-k)^2]\right] \tag{2.13}$$

$$A_t = Pbh\ [k+2n\rho-\rho] \tag{2.14}$$

Note that the terms in the brackets are independent of the dimensions of the cross-section, therefore greatly simplifying the equations to a constant times the relationship between the depth and width. The assumptions required by this formulation are: 1) uniform distribution of steel with respect to the major and minor axes, 2) no interaction with respect to the bending about both axes, 3) fixed depth with a variable width, and 4) no tensile strength associated with the concrete. These assumptions are somewhat restrictive, but do not hamper the use of the elements within the optimization.

7. Primary vs. Secondary Design Variables. Pure mathematical optimization of a structural system would require each geometric property to be used as a design variable. Although this might be the most efficient system for the given objective function, the set of geometric properties most likely will not represent a cross-section which is realistic. Also, in the optimization process each design variable is an unknown quantity, and just as in a structural problem a slight increase in the number of unknowns (degrees of freedom) can cause a much larger increase in computational efforts. Because of these reasons, a model was developed for both the steel and concrete elements which would allow each element to be represented by one geometric property called the primary design variable. All other geometric properties other than the primary design variable are defined as secondary design variables. The model developed provides a continuous

relationship between the primary and the secondary design variables.

The model developed produces an exact relationship for regular shapes and the reinforced-concrete elements, while providing an approximate relationship for steel wide-flange sections. All element types except the braces use the major-axis moment of inertia as their primary design variables. Whereas, the brace uses its cross-sectional area. Each secondary design variable is represented in this form

$$S_{ij} \cdot = C_{1j} \delta_i^{C_{2j}} + C_{3j} \tag{2.15}$$

where S_{ij} is the j^{th} secondary design variable for the i^{th} element, C_{1j}, C_{2j}, and C_{3j} are the appropriate constants, and δ_i is the i^{th} element primary design variable, (i.e., the major-axis moment of inertia, etc.).

a. Regular Cross-sections. Several different techniques can be used to determine the constants in Equation 2.15. For most regular cross-sections such as pipes, rectangular, and circular shapes these constants can be determined exactly. For example a rectangular cross-section with a fixed ratio of depth to width of R provides a set of equations for the minor-axis moment of inertia and the cross-sectional area as

$$I_y = \frac{1}{R^2} I_x \qquad (2.16)$$

$$A = \left(\frac{12}{R}\right)^{1/2} I_x^{1/2} \qquad (2.17)$$

b. Steel Wide-Flange Sections. The primary and secondary design variables associated with steel wide-flange sections are of the psuedo-discrete variety. The actual values are discrete but are approximated with a continuous spectrum of sizes.

The constants to be used in Equation 2.15 can be determined in any manner which best suits the user. Several possibilities would be to choose the constants to give an upper bound, an average, or a best-fit for each of the secondary design variables. It is important to note that these equations do not provide a one to one correspondence for the primary and secondary design variables with respect to a specific wide-flange cross-section. In other words the final values for these primary and secondary design variables will not yield a specific wide-flange section as found in the American Institute of Steel Construction Manual (AISCM) (5). Reasonable judgement coupled with the optimization information must be used in order to select the appropriate wide-flange cross-section for each element.

c. Reinforced-Concrete Sections. The reinforced-concrete element equations are based upon the working stress model and should be considered as a means of finding reasonable preliminary sizes. The form of the concrete equations is similar to that of Equation 2.15. The equations are based upon the theoretical derivation given in Equations 2.4 to 2.14 and are

$$I_y = \frac{1}{h^8 D^2} I_x^3 \tag{2.18}$$

$$J = \frac{1}{h^8 D^2} I_x^3 + I_x \tag{2.19}$$

$$A = (P(k+2n\rho-\rho)/h^2 D)\ I_x^3 \tag{2.20}$$

$$A_N = \frac{1}{h^2 D} I_x^3 \tag{2.21}$$

where I_x is the major-axis moment of inertia, A_N, is the actual concrete area, h, is the depth of the cross-section, P, is the percentage of depth to the lumped tensile reinforcement, k, is the percentage of depth for the cracked cross-section, n, is the modular ratio, ρ, is the percentage of steel, and D is a constant based on the given properties. The equation for D is

$$D = (Pk)^3 + \rho P(n-1)(P(k+1)-1)^2 + nP^3\rho(1-k)^2 \tag{2.22}$$

Equations 2.18 to 2.21 are derived by replacing the width b with its equivalent representation in terms of I_x as derived from Equation 2.12.

B. ANALYSIS

1. Static Analysis. The elastic, global stiffness is assembled through a sequence of transformations. First the local degrees of freedom are transformed to member-end deformations which include the rigid zones effects. Secondly the member-end deformations are transformed to frame displacements which are located at a reference point which is a specific column line. This column line and frame coordinate system must be located such that the mass center is located in the first quadrant of the frame coordinate system. The last transformation is used to relocate the frame coordinates to a global coordinate system located at the mass center of each floor, as was shown in Figure 1.

The frame to global transformation matrix is element independent and is shown in Figure 7 and is represented as

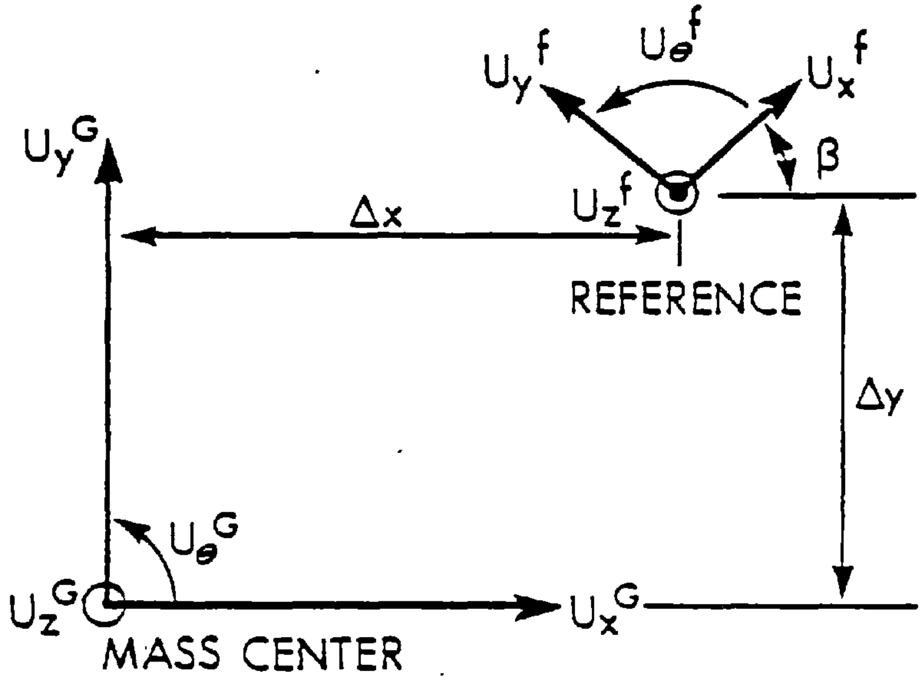


Figure 7. Transformation from Reference to Global Coordinates

$$[T]_G = \begin{bmatrix} I & & & & & \\ & A_1 & & & & \\ & & A_2 & & & \\ & & & \cdot & & \\ & & & & \cdot & \\ & & & & & A_n \end{bmatrix} \tag{2.23}$$

where

$$[A]_n = \begin{bmatrix} \cos\beta & \sin\beta & (-\Delta y \cos\beta + \Delta x \sin\beta) \\ -\sin\beta & \cos\beta & (\Delta x \cos\beta + \Delta y \sin\beta) \\ 0 & 0 & 1 \end{bmatrix}_n \tag{2.24}$$

in which I is the identity matrix corresponding to the vertical displacements of the columns and $[A]_n$ is the n^{th} level transformation with the first two rows corresponding to the x and y displacements, respectively and the third row corresponding to the rotational displacement. All transformations must be considered with respect to displacements, stiffness, loads, and gradients. This transformation was given since the input geometry of each structure is based upon the reference coordinate system.

The rotational degrees of freedom at the structural nodes are condensed for the purpose of increasing computational efficiency and decreasing storage requirements. The condensation is performed using a forward elimination process on a story by story basis from the top to the bottom of the structure. Therefore, the joint rotations and ultimately the member-end forces are obtained by using backward substitution.

The static load combinations are comprised of two sets of independent lateral forces and four sets of vertical forces. The lateral loads consist of two orthogonal, concentrated loads for each level. The four sets of vertical forces are composed of one set of concentrated, vertical nodal loads and three sets of uniformly distributed loads. The vertical nodal loads have independent magnitudes, but must be located at a structural node producing axial loads on the columns. Each uniformly distributed load in a set has its own magnitude and can be applied to any combination of beams within a load combination. These uniformly distributed loads are considered to act along the length of the beams. A variety of load combinations can be formed by applying load factors to the various types of forces. The typical formula would be

$$L_i = \gamma_{1i}V_1 + \gamma_{2i}V_2 + \gamma_{3i}V_3 + \gamma_{4i}V_4 + \gamma_{5i}R_5 + \gamma_{6i}R_6 \quad (2.25)$$

where L_i, is the i^{th} load combination, γ_{1i}, ..., γ_{6i}, are the appropriate load factors, V_1, ..., V_4, are the vertical forces, and R_5 and R_6, are the lateral forces.

2. Natural Frequencies and Mode Shapes. The natural frequencies and mode shapes are needed in order to perform a modal analysis. Several points must be considered when determining which technique is to be used to find the frequencies and eigenmodes. The efficiency, the flexibility, the accuracy, and programmability of the technique need to be considered when choosing an eigenvalue solver.

The natural frequencies and modes of vibration are the eigenvalues and eigenvectors associated with the generalized eigenproblem. It is important to note that the static condensation has no effect on the eigenvalue solutions as long as no mass is associated with the condensed degrees of freedom.

Structural eigenvalue problems generally must be solved through an iterative technique, since the solution involves finding the roots of a polynomial of order equivalent to the order of the stiffness and mass. The iterative techniques can be grouped into five categories: 1) poly-vector iteration methods, 2) transformation methods, 3) polynomial iteration methods, 4) Sturm sequence property methods, and 5) combinations of the other four categories. A transformation method called the generalized Jacobi method was used (6). The advantages of this technique are 1) the eigenproblem need not be transformed to the standard eigenproblem which is advantageous when the matrices are ill-conditioned, 2) all eigenvalues and eigenvectors are determined, and 3) it is simple in theory and easily programmed. The ability to handle ill-conditioned matrices was the primary reason for choosing this technique, since this condition can arise when considering the ATC 3-06 applied loads.

3. Dynamic Analysis.

a. Modal Analysis. Response spectrum or spectral analyses have been used with considerable success with respect to earthquake excitations of structures and structural components (7,8). The advantage is clearly due to the removal of the time dependence of the motion equation. The disadvantage is due to the conservative nature of the solution.

As mentioned previously three separate response spectra can be used in the analysis; one for each direction of horizontal acceleration and one for the vertical acceleration. The rotational degrees of freedom for each floor are assumed to be free of the dynamic excitation.

The computer program requires acceleration spectra to be input as polynomials of the fourth degree or less. These polynomials are of the form

$$S_{a_k}(T)/a_{max} = C_1(T-C_6)^4 + C_2(T-C_6)^3 + C_3(T-C_6)^2 + C_4(T-C_6) + C_5 \qquad (2.26)$$

where $S_{a_k}(T)$, is the acceleration response at period T in the k^{th} direction, a_{max} is the maximum ground acceleration, and $C_1, \ldots, C_6$ are appropriate constants. The equations for the acceleration response spectrum shown in Figure 8 are

$$(S_a/a_{max}) = -26.14T^2 + 13.94T + 0.935 \qquad (2.27)$$

for $T \le 0.4$ sec. and

$$(S_a/a_{max}) = 0.1606(T-0.4)^4 - 1.141(T-0.4)^3$$
$$+ 2.996(T-0.4)^2 - 3.618(T-0.4) + 2.229 \qquad (2.28)$$

for $T > 0.4$ sec. This form was chosen in order to provide an adequate numerical representation of the spectrum and to provide a simple technique for finding the slope of the acceleration spectrum at a given period, the slope is required within the optimization.

<u>b. ATC 3-06 Analysis</u>. The ATC 3-06 tentative provisions provide two options for determining the lateral forces to be used for finding the seismic structural response. The two approaches are called the equivalent lateral force and modal analysis approaches. Both approaches assume the structures to be analyzed as two dimensional structures. This requires two analyses for each three-dimensional structure, one being in each of the two orthogonal directions. In order to simulate a two

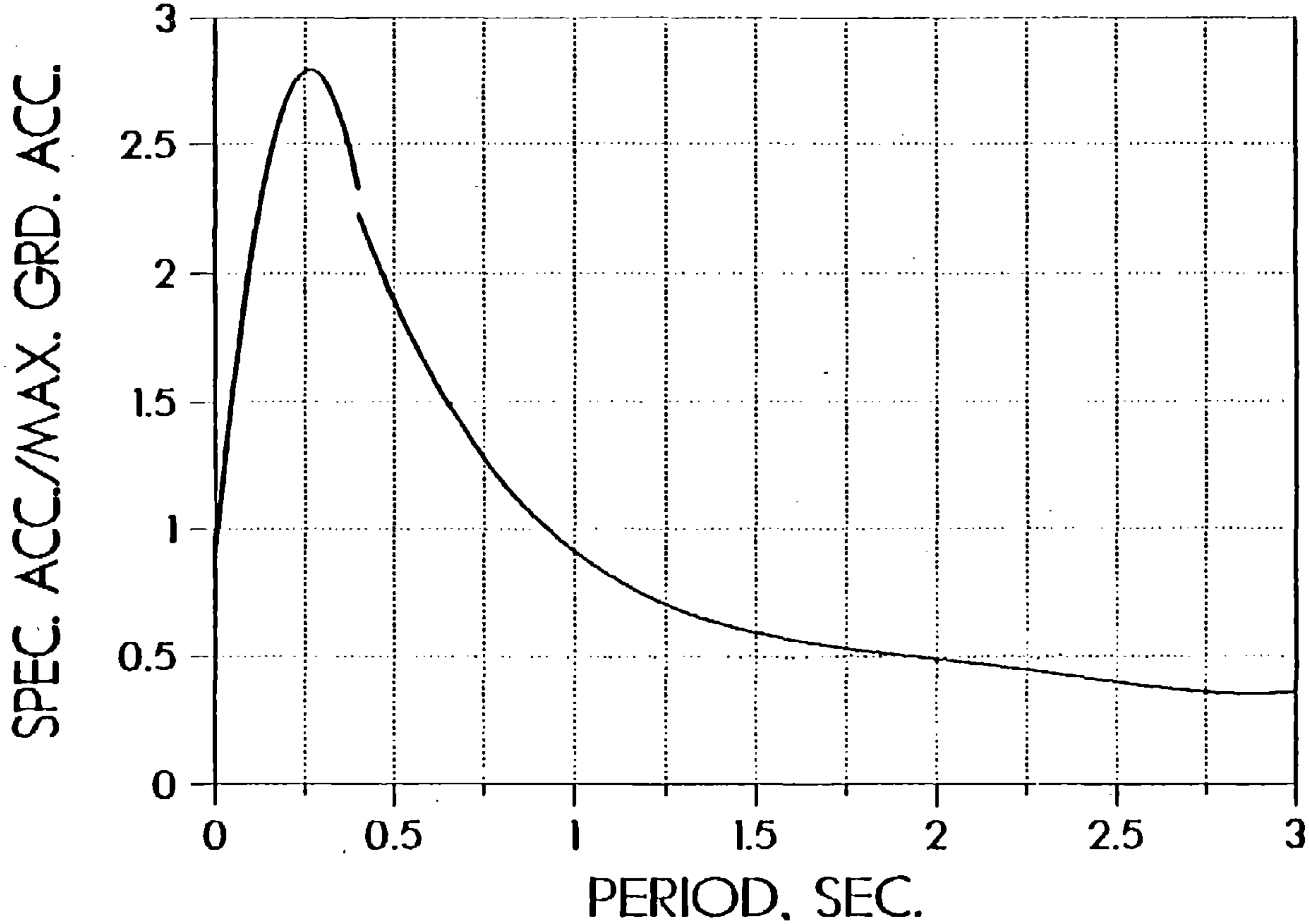


Figure 8. Typical Acceleration Response Spectrum

dimensional system, a "large" external stiffness is applied with respect to the torsional and one translational degree of freedom at each level, while allowing translation in one direction along with the vertical displacements at each node. (This is done automatically within the program.) The ATC 3-06 also requires that the principal direction of excitation have a five percent (of the base dimension) "accidental" eccentricity from the mass center. The final design is based upon the principal direction forces (including the eccentricity) plus thirty percent of the orthogonal direction forces. These exceptions are handled automatically within the program.

The equivalent lateral force technique is based upon the weight distribution coupled with the story height. The base shear, V, and m^{th} level lateral force, F_m, are given as

$$V = C_s W_T \tag{2.29}$$

and

$$F_m = C_{vm} V \tag{2.30}$$

where C_s, is the seismic design coefficient which depends on the soil conditions, building site, fundamental period, and response modification factors as given in the ATC 3-06 provisions, W_T, is the gravity load of the building, and C_{vm}, is the shear distribution factor for the m^{th} level. C_{vm} is given by the formula

$$C_{vm} = \frac{w_m h_m^k}{\sum_{i=1}^{n} w_i h_i^k} \qquad (2.31)$$

where w_m and w_i are the portion of the weight assigned to level m or i, h_m and h_i, are the respective heights above the base to level m or i, and k is an exponent related to the building period ($1 \le k \le 2$). The lateral forces given in Equation 2.30 are used to find the displacements which are used to determine the elastic member forces.

The ATC 3-06 modal analysis procedure is based upon the weight distribution and mode shapes of the system being considered. The base shear for mode j, V_j, and the m^{th} level lateral force for mode j, F_{mj}, are given as

$$V_j = C_{sj}\overline{W}_j \qquad (2.32)$$

and

$$F_{mj} = C_{vmj}V_j \qquad (2.33)$$

where C_{sj}, is the modal seismic design coefficient which depends upon the soil conditions, building site, fundamental period and response modification factor, $\overline{W}_j$, is the effective modal gravity load determined as

$$\overline{W}_j = \frac{\left[\sum_{i=1}^{n} \omega_i \phi_{ij} \right]^2}{\sum_{i=1}^{n} \omega_i \phi_{ij}^2} \tag{2.34}$$

and C_{vmj}, is the j^{th} mode shear distribution factor for the m^{th} level which is given by

$$C_{vmj} = \frac{W_m \phi_{mj}}{\sum_{i=1}^{n} W_i \phi_{ij}} \tag{2.35}$$

where ϕ_{mj} and ϕ_{ij} are the m^{th} and i^{th} level components of the j^{th} eigenvector, and W_m and W_i are the portions of W_T assigned to level m or i. The final design values for base shear, story shears, and deflections are combined by using the square root of the sum of the squares of each modal value.

The ATC 3-06 provisions have their own method for including P-delta effects, called the stability coefficient, which is determined by using the formula

$$\theta = \frac{P_x \Delta}{V_x h_{sx} C_d} \tag{2.36}$$

where P_x, is the total gravity load above level x, Δ, is the story drift, V_x, is the seismic shear force acting between levels x and x-1, h_{sx}, is the story height below level x, and, C_d, is the deflection amplication factor. If the stability coefficient is greater than one-tenth, the story drift is to be multiplied by the factor $(1+a_d)$ in order to take into account the second-order effects. The term a_d is found by using the formula

$$a_d = \theta/(1-\theta) \qquad (2.37)$$

which produces a P-delta factor for the drift of the form

$$f_1 = \left(1 + \frac{\theta}{1-\theta}\right) = 1/(1-\theta) \qquad (2.38)$$

The same factor is to be used for both ATC 3-06 analysis procedures.

The load combinations for seismic excitations include the static effects superimposed with the dynamic effects. The superposition is allowed since the building systems are assumed to remain in the elastic region. ATC 3-06 actually takes into account the inelastic effects through their deflection amplification factors and their response modification factors. The possible load combinations are the same as those for static analysis with the exception that the lateral force responses are replaced with the seismic responses. The only option this precludes is the case where wind or some other lateral force cannot be applied simultaneously with a seismic load. This is a reasonable assumption as evidenced by most seismic codes.

C. STRUCTURAL OPTIMIZATION

1. Objective Function. The objective function is the actual function to be minimized such as cost or weight of the structures. The objective function used in the computer program takes the form

$$O(\delta) = \sum_{i=1}^{n} \gamma_i V_i \tag{2.39}$$

where γ_i, is the appropriate constants of objective value per unit volume for element i, V_i, is the volume of element i which is a function of the primary design variable, and n, is the total number of structural elements. The volume is related to the primary design variables through Equation 2.15 giving the relationship

$$V_i(\delta_i) = \ell_i A_i = \ell_i (C_{1A} \delta_i^{C_{2A}} + C_{3A}) \tag{2.40}$$

where ℓ_i, is the length of element i, C_{1A}, C_{2A}, and C_{3A} are the appropriate constants for the area, A_i, of element i. The constant γ_i is most often used as the specific weight or the cost per unit volume.

2. Constraints. Constraints represent the restrictions that the structural designer would like to impose in

order to produce the optimal structural system. These constraints can be of several different types such as equality, inequality, side or linking constraints. The equality constraints find very little use in building systems since they are generally used to enforce equilibrium and compatibility which are already enforced due to the stiffness formulation. The inequality constraints are used to place limits on structural response such as displacements, frequencies, and stresses. Side constraints are also inequality constraints but are generally not handled in the same mathematical manner as the structural responses. These side constraints are used to limit the size of the structural elements within a practical range. The linking constraints (called linking) are used to force a certain group of structural elements to have the same size. Linking is also handled in a different mathematical fashion than the inequality constraints. In theory any combination of these constraints can be applied to a structure, but numerically this can be difficult. This is one area in which state-of-art research is being applied.

3. Active Constraints. In order to save computational time, it is important to choose a reasonably accurate set of active constraints. The active constraints are considered to be any constraints which are "close" to the constraint surfaces. The algorithm checks these values and compares them to a specific acceptable range as designated

by the user. The choice of active constraints is based upon these equations

$$(1-P_1) \leq \frac{u_j}{\bar{u}_j} \leq (1+P_2) \tag{2.41}$$

for upper bound constraints and

$$(1-P_1) \leq \frac{\underline{u}_j}{u_j} \leq (1+P_2) \tag{2.42}$$

for lower bound constraints, where u_j is the actual structural response, $\bar{u}_j$ is the upper limit, and $\underline{u}_j$ is the lower limit. These equations allow the user the flexibility of establishing a region along the constraint surface which can be as large or as small as desired. The value $(1-P_1)$ provides the proportional thickness of the region on the feasible side of the constraint and the value $(1+P_2)$ provides the acceptable region of constraint violation, if any, for the nonfeasible side of the constraint surface.

4. Scaling of the Design. There must be a set of active constraints before the optimization algorithm can be used. Generally, a preliminary design will be either conservative (no active constraints) or nonconservative (a violation of one or more constraints). Therefore, some technique must be used to adjust these design variables such that a set of active constraints, as justified by Equations

2.41 and 2.42, will be satisfied. In the past, structures which were linear with respect to their design variables used a technique called scaling to adjust the designs. Scaling uses a factor to adjust the design variable which is the maximum value of either of these two values

$$f_j = \frac{u_j}{\bar{u}_j} \qquad j = 1, \ldots, \ell_1 \tag{2.43}$$

for upper limit constraints

$$f_j = \frac{\underline{u}_j}{u_j} \qquad j = 1, \ldots, \ell_2 \tag{2.44}$$

for lower limit constraints where ℓ_1 and ℓ_2 are the numbers of possible upper and lower limit constraints, respectively.

The use of scaling for the nonlinear (in terms of the primary design variable) stiffness and response becomes an iterative procedure. Once the primary design variable is scaled, the secondary design variables are scaled according to Equation 2.15 which gives

$$S_{ij} = C_{1j} \, (f\delta_i)^{C_{2j}} + C_{3j} \tag{2.45}$$

Depending on which constraint is being scaled and the effect of the secondary element on that constraint, the scaling can take several cycles to reach an active value.

The natural frequencies are also affected in a strange manner since both the stiffness and mass change when scaling is used. Thinking of the frequency in terms of the Rayleigh quotient it can be written as

$$\omega^2 = \frac{\{\phi\}^T \, [K]_f \, \{\phi\}}{\{\phi\}^T \, [M]_f \, \{\phi\}} \tag{2.46}$$

where $[K]_f$ and $[M]_f$ represent the nonlinear scaling of the terms in the stiffness and mass. The effect of this is highly problem dependent. Scaling can also become divergent for steel structures if the system which provides an active constraint approaches the point of discontinuity of the secondary design variables with respect to the primary design variable. Despite this possible instability most problems can be adjusted to eliminate this problem by reorienting or resizing certain elements within the problem. Another alternative is to open the range for active constraints in order to force the constraints to become active at an earlier stage. Rarely does the divergent trend occur after the first cycle of optimization.

Scaling can be oscillatory when a combination of frequency and displacement constraints are used. This is due to the fact that the scaling factors become counterproductive. The displacements are affected by the inverse of the factor, whereas the frequencies, in most cases, are affected in a greater sense by the direct multiplication of the factor. Therefore, an oscillation between potentially active constraints can take place where the structural system forces the displacements to become active while violating the frequencies, and this resulting violation causes the frequency to become active while violating the displacements in the next cycle of scaling. Because of this oscillatory effect, frequency and displacement constraint combinations are handled differently. The scaling is only allowed to affect the displacements; and the frequencies are forced to their active values through the use of a correction term applied within the optimization algorithm (Lagrange multiplier determination).

Scaling is important for two different operations during the optimization. The first is to find the initial set of active constraints by using the maximum factor to change the primary design variables which in turn changes the secondary design variables. The second is to force the design back within the region for active constraints as defined by Equations 2.41 and 2.42.

5. Termination Criteria. Due to the iterative techniques used for the nonlinear, structural optimization problem, termination criteria must be developed. The criteria have to be able to handle several distinct conditions. The primary condition is to check for

convergence or divergence of the objective function. Secondary conditions are to limit the amount of allowed computing time and to check for divergent or oscillatory scaling. These criteria must be flexible yet easily handled within the algorithm.

The secondary criteria are important since these are used to terminate an optimization sequence which is either diverging or converging at a very slow rate. Limiting the allowable number of optimization cycles and the allowable number of analyses will stop the procedure from using excessive computing resources due to a slowly converging or slowly diverging solution. (The slowly diverging system usually occurs near the optimal solution where there might be a slight constraint violation.)

Divergent scaling, on the other hand, can occur in two modes, the first being an ever increasing or decreasing set of factors or, most often, a generation of an oscillatory set of factors. These divergent scalings are also handled by limiting the number of optimizations and analyses. These secondary criteria are used to stop an excessive use of the computer resources.

The primary termination criteria are involved with the actual optimization of the structure. In the latter stages of optimization there are very small changes made to the structural elements which provide a very small change in the value of the objective function. Therefore, convergence is considered by comparing the values for the objective function at successive optimization cycles to a specified percentage of change, P_4, which can be written as

$$\frac{|O^{k-1} - O^{k}|}{O^{k}} \leq P_4 \qquad (2.47)$$

If Equation 2.47 is satisfied the algorithm is terminated.

Divergence of the algorithm must also be considered. After several cycles of optimization it is possible that a new set of constraints will be chosen which will cause a divergent trend. The algorithm will allow only two successive iterations in which the objective function increases in value. The algorithm will terminate after the second divergent cycle. The termination criteria must be carefully considered with respect to the condition of computing resources versus the closeness to an optimal solution. A good range for P_4 is 0.5% to 5%. A smaller percentage of change in the objective function requires more computing time but provides a near optimal solution, whereas a larger percentage saves computing time at the expense of optimization.

III. DISCUSSION OF ODRESB-3D

A. NUMERICAL PROCEDURES

ODRESB-3D is composed of a main program and 51 subroutines and is capable of analyzing and optimizing building systems subjected to static loads, multi-component seismic excitations, or a combined loading. The seismic loads can be applied through multiple response spectra or the ATC 3-06 provisions, and are directly superimposed with static loads. The numerical procedures will be explained as a series of steps.

Step 1 - Read and Write Input Data. The main program along with subroutines INFORM and ATCIF read the input data. MAIN amd INFORM read all structural and optimization information while ATCIF reads the information required for an ATC 3-06 analysis. The input data is printed for a check of its correctness.

Step 2 - Clear Arrays and Initializing Input Data. Since the program is capable of solving multiple problems within each input, all numerical arrays must be cleared before each problem is processed. Subroutine INITIL is used to clear arrays and initialize the input data.

Step 3 - Determination of Secondary Design Variables. The user has the option of inputing the secondary design variables if a single analysis is to be performed or having the secondary design variables generated if an optimization is to be performed. Subroutines CONCR and STEEL determine these secondary design variables based upon the user input specified relationships for the steel and the concrete element properties.

<u>Step 4 - Form the Stiffness Matrices</u>. The geometric stiffness is formulated in terms of the lumped masses acting on the vertical members and has to be reformulated after each optimization since the structural mass changes. Subroutine OJBECT is used to find the structural mass for the geometric stiffness, as well as the total weight of the structure.

The structural stiffness formulation starts at the top of the structure and progresses floor-by-floor to the ground level. The subroutines SHRWL1, PANEL, COLUMN, BEAM, and BRAC are used in conjunction with INECOF in order to develop the elemental local stiffnesses. REFCOR is then used to transform the element degrees of freedom to reference degree of freedoms. The individual stiffnesses are combined in FLOSTF to provide a total stiffness for that level. The rotational degrees of freedom are then eliminated by using the subroutine ELIMIN. This elimination process is performed on a floor-by-floor basis until the total reference coordinate stiffness matrix is formulated. At this point subroutine GLOCOR transforms the system stiffness to global coordinates.

<u>Step 5 - Solve for Static and Dynamic Displacements</u>. The static displacements are determined for each of the independent load sets by using Gaussian elimination.

Subroutine GAUSS is used to perform the elimination process. The final load combinations are then found by multiplying the load sets with the appropriate load factors and superimposing the results.

The dynamic displacements are dependent upon the method of analysis chosen. The user has three options: response spectra modal analysis, ATC 3-06 modal analysis approach, or ATC 3-06 equivalent lateral force approach. Each analysis requires the natural frequencies of the structure, and the two modal analysis approaches require the eigenvectors, as well. Subroutine JACOBI is used to find the eigenvectors and eigenvalues for the dynamic analyses. The response spectra modal analysis is performed within subroutine MODAL and its displacements are then assumed to replace the displacements for lateral load case B. The ATC 3-06 equivalent lateral force procedure uses subroutines: ATLINK, ATCCD, LAT1, and LAT2. Subroutine ATLINK and ATCCD compute all the necessary structural information required within the equivalent lateral force analysis; subroutine LAT1 determines the necessary equivalent lateral forces; and subroutine LAT2 provides the 5 percent required eccentricity for the loads and calls GAUSS3 to find the dynamic displacements. It also includes the P-delta effects through the use of ATC 3-06 stability factor, θ. The ATC 3-06 modal analysis procedures uses subroutines: ATCDD, ATLINK, MODALA, LAT2, ROOT1, ROOT2, and ROOT3.

Subroutines ATCDD and ATLINK compute all of the necessary structural data such as story height and mass per story. Subroutine MODALA finds the modal components of the applied forces, displacements and overturning moments. Subroutines ROOT1, ROOT2, and ROOT3 provide the root of the sum of the squares of these quantities, and subroutine LAT2 includes the P-delta effects.

Step 6 - Solve for the Internal Forces and Stresses. Once the displacements are determined the internal forces are determined by using backward substitution from the base of the structure to the top story. These displacements are first transformed into reference coordinates using the subroutine REFDSP. Subroutine FORCES is also used to regenerate the nodal rotational displacements in order to determine the internal forces and stresses from subroutine REFROT. The combinations of the forces are performed after each set of forces corresponding to the independent load sets are found. These combined forces are then used to produce the stresses determined in REFROT.

Step 7 - Determine the Set of Active Constraints. Subroutine SORT is used to check if any of the user defined constraints are within the region of $(1-P_1)$ and $(1+P_2)$ as previously defined. If the constraints are beyond $(1+P_2)$ they are violating one or more of the constraints of displacement, stress or frequency and must be scaled. Subroutine SCALE then resizes the primary design variable by the ratio of actual to acceptable response. At this point the comptuer algorithm goes back to Step 2 and starts a reanalysis of the new structure. This process is continued until all constraints are below $(1+P_2)$.

Once all constraints are below the highest acceptable value of $(1+P_2)$, SORT chooses the set of active constraints. These constraints will be the ones considered within the structural optimization.

Step 8 - Check the Termination Criteria. The MAIN program checks the termination criteria. The program will not terminate if a scaling is required (constraint violation) unless the maximum allowable number of analyses has already been performed. If scaling is not required the main program checks the total number of analyses, the total number of optimization cycles, and the percentage change in weight between optimization cycles. It also checks for a divergent trend between cycles of optimization. If any of the termination criteria are satisfied, the program retrieves the optimal results with the help of subroutines REPLAC, REPORT, and PLOT. These subroutines provide the element stiffnesses, the displacements, the eigenvectors, the natural frequencies and the ATC 3-06 stability factors for the optimal solution. The structural weight and frequencies are also kept on a per optimization cycle basis and retrieved for plotting purposes by these subroutines. These subroutines require file storage space to accumulate this data. At this point the program would terminate. If none of the termination criteria was satisfied the program would continue to Step 9.

Step 9 - Determine the Constraint Gradients. The static response gradients are found by using the virtual load technique (9). Subroutine PSEUDO is used to develop the virtual load vectors for the active static response gradients. The virtual displacements associated with these virtual loads are found using GAUSS4. Subroutine FORCES is then called and uses ROTDIS to find the virtual rotational displacements, and the matrix of the gradient of the stiffness times the actual static displacements. FORCES then calls REFROT to place the virtual displacements in the reference coordinate system and GRAD multiplies the matrix from FORCES with the virtual displacements in order to produce the value for the partial derivative of the static response with respect to a certain element. These last mentioned operations of calling REFROT and GRAD along with the matrix manipulations must be repeated for every element in order to generate the gradient of the response.

The frequency gradients are found through a direct numerical approach derived from the partial derivative of the generalized eigenvalue equation. This numerical approach requires the pre- and postmultiplication of the eigenvectors with the partial derivative of the stiffness and mass. The stiffness manipulations of this procedure are performed in subroutines FORCES and GRAD, whereas, the mass manipulations are performed in subroutines EMAS and GRAD. This procedure must also be performed for each element.

The gradients of the dynamic responses use subroutines PSUEDO, FORCES, REFROT, INVERT, GAUSS2, EMAS, and GRAD. The dynamic response gradients use a pseudo load approach for finding the gradients. The virtual load vectors determined in PSUEDO are multiplied with the dynamic displacement gradients. These gradients are determined through the manipulations of the eigenvectors coupled with the partial derivations of the stiffness, mass, and frequencies and the manipulations of the stiffness, mass, and frequencies coupled with the gradients of the eigenvectors. FORCES, REFROT, and EMAS provide the necessary quantities including the partial derivatives of the stiffness, mass and frequencies, whereas INVERT, GAUSS2, and EMAS are used to find the eigenvector gradients. GRAD is used to manipulate the different matrices and find the final results for the gradients of the dynamic response.

Within these gradient calculations various fictitious loads are generated. Most of these fictitious loads were generated either at the local level or at the global level with respect to the coordinate systems. Therefore within these previously mentioned subroutines several transformations are used. The important transformation subroutines are ROTATE, REFDSP1, REFDSP3, ROTDIS, and GLOCOR. ROTATE and ROTDIS provide the needed rotational displacements in reference coordinates, and REFDSP1 and REFDSP3 are used to transfer the displacements from the mass center to the reference coordinates. GLOCOR is used to transfer the reference coordinates to the mass center coordinates. These different transformations are very important and are used in the different gradient calculations as needed.

Step 10 - Determine the LaGrange Multipliers. The structural optimization is based upon a system which generates a set of simultaneous equations, using the response gradients, to find the LaGrange multipliers. These equations are also used to enforce the side constraints and linking constraints as previously mentioned. The LaGrange multipliers are also used to verify whether the active set of constraints chosen in Step 7 are truly an active set. Each constraint generates one LaGrange multiplier. If the LaGrange multiplier for a constraint is negative, it will be removed from the active set of constraints. This is based upon the Kuhn-Tucker conditions of optimality. Once this constraint is removed, a new set of equations must be generated without this constraint's gradients included. Subroutine LAGMU is used to generate these equations and GAUSS1 solves them by Gaussian elimination.

Step 11 - Determine the New Primary Design Variables. The LaGrange multipliers are then used to find the optimality criteria in subroutine CURSE, and it is used to resize the elements. As the optimal solution is approached, the optimality criteria for each active element should approach unity. If the element is passive (nonactive), this infers that the element is controlled by a side constraint (it wants to become the largest or smallest allowable size for that element). The optimality criteria is used in a linear recurrence relationship which is controlled by a convergence control parameter. A value of 2 for the convergence control parameter is usually sufficient. The larger the number the slower the convergence. If the linear recurrence relationship gives an element size which is smaller or larger than the allowable sizes, the LaGrange multipliers must be recalculated. Therefore, the program goes back to Step 10 and regenerates the equations and solves for the new LaGrange multipliers. This process is repeated until no more side constraints are required. This resizing of the primary design variables occurs in subroutine CURSE. Once the resizing is complete, the program transfers back to Step 2 in order to resize the secondary design variables and the next cycle of optimization begins.

B. REMARKS ON PROGRAM USE.

The following section provides some information which may be useful to the user.

1. The use of multiple constraint types is acceptable and generally performs well. When displacement and frequency constraints are used simultaneously, scaling is performed only with respect to the displacements. The frequency is manipulated through the LaGrange multiplier equations, therefore it is possible for the program to terminate prior to satisfying all of the displacement and frequency constraints simultaneously.

2. A set of extremely restrictive constraints can cause a non-monotonic convergence and in extreme cases can cause a nonconvergent problem. Generally, this situation can be avoided by relaxing or revising the constraints placed on the building system or to increase the acceptable bandwidth for active constraints.

3. A convergence control parameter of 2 is generally adequate for all problems. If excessive scaling is required between cycles of optimization a larger convergence control parameter should be used.

4. The objective function is based upon a per volume of steel and concrete system. Therefore, costs, weights or any other appropriate objective function must provide the coefficients for steel and concrete in a per unit volume fashion.

5. The ATC 3-06 stability and 5 percent eccentricity are considered within the program.

6. All column lines and bays must be represented with a column or beam property. Therefore, if a setback structure is optimized a fictitious set of columns and beams must be used to represent the missing elements.

7. Linking of columns or beams is accomplished by assigning the same property set to those columns or beams that are to maintain the same size.

IV. DESCRIPTION OF SUBROUTINES

Each of the subroutines' functions will be described in this section. The subroutines are presented in the order that they appear within the program.

1. MAIN. The main program is used to read and write the preliminary, non-elemental data of input codes I through VIII and XXI. In addition to providing the general flow by calling the different subroutines, the main program is responsible for checking the termination criteria.

2. Subroutine INFORM. This subroutine is used to read and print all of the input data except for input codes I through VIII, XXI, and XXII.

3. Subroutine GENERA. This subroutine is called from subroutine INFORM to generate the beams and columns for a group of elements having identical properties.

4. Subroutine INITIL. This subroutine is called from the MAIN program to clear arrays and to initialize data. The initialized arrays include member forces, stiffness coefficients, and masses.

5. Subroutine FORM. This subroutine is used to formulate the geometric stiffness and structural stiffness for the analysis procedures. It is also used to arrange the virtual load vectors used in the stress gradient calculations for beams and columns in order to eliminate the local rotational components.

6. Subroutine COLUMN. The subroutine FORM calls COLUMN in order to form the member geometric stiffnesses and

structural stiffnesses in reference coordinates for the steel columns and the concrete flexural walls.

7. Subroutine BEAM. The subroutine FORM calls BEAM in order to form the member stiffnesses in reference coordinates and to generate the fixed-end forces for the steel beams.

8. Subroutine PANEL. The subroutine FORM calls PANEL in order to form the member geometric and structural stiffnesses in reference coordinates for the concrete flexural panels.

9. Subroutine BRAC. The subroutine FORM calls BRAC in order to form the structural stiffnesses in reference coordinates for the bracing elements.

10. Subroutine REFCOR. This subroutine is called from the subroutines COLUMN, BEAM, PANEL, and BRAC in order to transform the matrices encountered from the elemental coordinate systems to the reference coordinate system.

11. Subroutine FLOSTF. This subroutine is called from subroutine FORM in order to place the member stiffnesses and the fixed-end forces (in reference coordinates) in the proper locations within the arrays representing a typical floor within the structural system. These different arrays are used to separate the degrees of freedom to be eliminated and those to be retained.

12. Subroutine ELIMIN. After FLOSTF has been executed for all elements on a specific level, subroutine ELIMIN is called to eliminate the nodal rotational degrees

of freedom and to add the other stiffness coefficients to those of the previous levels. This elimination is performed only on the structural stiffness.

13. Subroutine GLOCOR. This subroutine is used to transfer the geometric and structural stiffnesses from reference coordinates to the global coordinates at the mass center. The transformation of a typical floor includes the lateral and torsional floor stiffnesses which also includes their coupling and sway effects.

14. Subroutine GAUSS. This subroutine is used to perform a Gaussian elimination to find the static displacements.

15. Subroutine GAUSS1. This subroutine is used to perform a Gaussian elimination to find the Lagrange multipliers used within the optimality criteria.

16. Subroutine GAUSS3. This subroutine is used to perform a Gaussian elimination to find the ATC 3-06 pseudo-dynamic displacements.

17. Subroutine GAUSS4. This subroutine is used to perform a Gaussian elimination to find the virtual displacements used to determine the static and ATC 3-06 response gradients.

18. Subroutine GAUSS2. This subroutine is used to perform a Gaussian elimination to find the gradients of the eigenvectors used in a response spectrum modal analysis.

19. Subroutine REFDSP. This subroutine is used to transform the lateral and rotational displacements from

global to reference coordinates. This process is performed for a single level at a time.

20. Subroutine REFDSP1. This subroutine is used to transform the lateral and rotational virtual displacements used within the static gradient calculations from global to reference coordinates.

21. Subroutine REFDSP3. This subroutine is used to transform the lateral and rotational eigenvector gradient terms used within the dynamic gradient calculations from global to reference coordinate.

22. Subroutine FORCES. This subroutine is used to retrieve the correct static, dynamic, and virtual displacements for each level, to generate the elemental transformation matrices to change from floor level reference coordinates to local coordinates, to perform load combinations, and to print the displacements.

23. Subroutine REFROT. This subroutine is used to transform the local static, dynamic, and virtual displacements to local coordinates, to compute and print the member forces and stresses for all load combinations, to compute the gradients of the elemental stiffnesses, and to compute the matrix of stiffness gradients times the actual displacements.

24. Subroutine INECOF. This subroutine generates the stiffness coefficients for the steel members in local coordinates.

25. Subroutine SHRWL1. This subroutine generates the stiffness coefficients for the concrete members in local coordinates.

26. Subroutine SCALE. This subroutine scales each of the primary design variables in order to provide at least one active constraint.

27. Subroutine CONCR. This subroutine finds the values for the secondary design variables related to the concrete elements. The secondary design variables are given in Eqns. 2.18-2.21.

28. Subroutine STEEL. This subroutine determines the secondary design variables for the steel elements based on Eqn. 2.15.

29. Subroutine PSUEDO. This subroutine is used to generate the virtual load vectors for the static gradients and to place the eigenvectors within the virtual load vector for the dynamic gradients.

30. Subroutine ROTDIS. This subroutine is used to recoup the rotational portion of the virtual displacements and the eigenvectors for the gradient calculations.

31. Subroutine GRAD. This subroutine performs the final multiplication of matrices to give the static and dynamic constraint gradients and the eigenvector gradients.

32. Subroutine SORT. This subroutine checks all constraints to see if they are active, passive or violated. If one or more constraints are violated, or if all constraints are passive, a scaling factor is determined. If

there is no violation and one or more active constraints, these constraints are identified and used in the optimization algorithm. This subroutine also keeps the active set of constraints updated for each cycle of the optimization.

33. Subroutine OBJECT. This subroutine is used to calculate the concrete weight, the steel weight, and the objective function value. It is also used to generate the structural mass for each level.

34. Subroutine EMAS. This subroutine is used to calculate the gradient of the structural mass and its related terms for the dynamic displacement and frequency gradients.

35. Subroutine JACOB1. This subroutine uses the Jacobi iteration technique for finding the eigenvectors and eigenvalues.

36. Subroutine MODAL. This subroutine is used to perform the 3-D response spectra modal analysis. It is used to generate the dynamic displacements from the modal spectral accelerations.

37. Subroutine INVERT. This subroutine generates the reduced matrix used to find the eigenvector gradients and stores the inverse of this matrix for later calculations.

38. Subroutine LAGMU. This subroutine formulates and solves the simultaneous equations used to find the Lagrange Multiplers. It also checks for negative Lagrange

multipliers. If there is at least one negative Lagrange multiplier this constraint is removed and the equations are resolved. This subroutine is also used to check for passive elements. If a new passive element is found, the equations have to be regenerated and resolved until there are no negative Lagrange multipliers and no new passive elements.

39. Subroutine CURSE. This subroutine is used to calculate the new primary design variables using a linear recurrence relationship.

40. Subroutine ROTATE. This subroutine is used to calculate the rotational components of the eigenvector gradients.

41. Subroutine ATCCD. This subroutine is used to control the ATC 3-06 analysis. It directs the flow of the ATC 3-06 subroutines according to which method, Equivalent Lateral Force or Modal Analysis, is to be used for analysis.

42. Subroutine LAT1. This subroutine generates the ATC 3-06 Equivalent Lateral Forces. It determines the base shear and distributes this base shear to each of the individual levels.

43. Subroutine LAT2. This subroutine checks for violation of the ATC 3-06 P-Δ criteria. It checks for drift violation and computes the stability coefficient, θ. If the P-Δ criteria is violated, the drifts and displacements are increased.

44. Subroutine MODALA. This subroutine generates the modal forces and displacements for the ATC 3-06 Modal

Analysis Procedure. It also uses root-sum-of-the-squares method to combine the modal effects.

45. Subroutine ROOT1. This subroutine is used to find the root-sum-of-the-squares of the modal base shears.

46. Subroutine ROOT2. This subroutine is used to find the root-sum-of-the-squares of the modal shear, the modal drift, and the modal displacement at each level.

47. Subroutine ROOT3. This subroutine is used to find the root-sum-of-the-squares of the modal overturning moment at the base.

48. Subroutine ATCIF. This subroutine is used to read and print the ATC 3-06 information.

49. Subroutine PERFORM. This subroutine determines the specific seismic data related to the map areas from the ATC 3-06 provisions.

50. Subroutine ATLINK. This subroutine calculates information needed for the ATC 3-06 analysis procedures such as the total gravity load above each level, the height of each level from the base, and the natural periods for the structural system.

51. Subroutine REPLAC. This subroutine catalogues the current optimal design during the optimization process. As a "better design" becomes available, this subroutine replaces the previous optimal design with the new design data.

52. Subroutine REPORT. This subroutine prints the data for the optimal design once the optimization algorithm has terminated.

53. Subroutine PLOT. This subroutine writes the plottable information onto tape or disk. This data can then be supplied to a graphics program which can plot the data.

V. DESCRIPTION OF INPUT DATA

A. GENERAL INFORMATION

The input data consists of 23 input codes (I through (XXIII). Throughout the various input codes, there are various options and omissions which must be followed. The input stream is exactly as outlined within Sections IV.B and C. All input is assumed to be read through Device 5, and the output is assumed to be printed through Device 6. In addition to these devices workspace or work files must be set as device numbers 73, 74, 75, 76, and 77. These workspaces are used to store data during the execution of the program. In addition to these workspaces, several files are used to store data for plotting. These files will be explained in input code XXII for plot control.

B. CONTENTS OF THE INPUT

The input data includes the following major topics of input. These topics will be outlined in this section and described in the next section. The major topics are:

I. TYPE OF ANALYSIS AND OPTIMIZATION

II. OPTIMIZATION INFORMATION

III. STRUCTURAL INFORMATION

IV. STEEL DESIGN VARIABLE RELATIONSHIPS

V. STATIC DISPLACEMENT CONSTRAINT INFORMATION

VI. FREQUENCY CONSTRAINT INFORMATION

VII. DYNAMIC DISPLACEMENT CONSTRAINT INFORMATION

VIII. RESPONSE SPECTRA INFORMATION

IX. STORY DATA AND STATIC LATERAL LOADS

X. STATIC VERTICAL NODAL LOADS

XI. LUMPED MASSES AT NODAL POINTS

XII. COLUMN LINE COORDINATES

XIII. COLUMN PROPERTIES

XIV. BEAM PROPERTIES

XV. FIXED-END BEAM LOADS

XVI. BEAM IDENTIFICATION

XVII. COLUMN IDENTIFICATION

XVIII. FLEXURAL PANEL ELEMENT IDENTIFICATION

XIX. BRACING ELEMENT IDENTIFICATION

XX. STATIC AND DYNAMIC LOAD COMBINATIONS

XXI. ATC 3-06 ANALYSIS INFORMATION

XXII. OUTPUT CONTROL

XXIII. CONTROL OF THE NUMBER OF PROBLEMS

C. PREPARATION OF INPUT DATA

Special instructions:

1. All lengths must be in inches, since the program uses the acceleration due to gravity in in/sec^2.
2. The maximum ground acceleration must be input as in/s^2.
3. All force units must be the same.
4. All X and Y distances in the input are measured in the reference coordinate system, with the correct signs taken into account.

5. The reference point must be chosen such that the mass center of each floor will be located in the first quadrant of the reference system.

6. Floor plans must be horizontal, columns, walls, and panels must be vertical.

7. Concrete columns and panels assume one cross-sectional dimension to be fixed while the other is free to change during the optimization. The user should be sure to choose the correct orientation to optimize the correct direction. The width b is considered as the free variable.

The detailed instructions for data preparation are as follows:

<u>I. TYPE OF ANALYSIS AND OPTIMIZATION</u> (2I5,F5.1,4I5)

COLUMN	ENTRY
1-5	Eq. 0; terminate program
	Eq. 1; continue program
6-10	Eq. 0; analysis only - The user must supply all geometric properties.
	Eq. 1; static optimization with stress constraints
	Eq. 2; static optimization with displacement and stress constraints
	Eq. 3; static optimization with displacement constraints

	Eq. 4; static optimization with frequency constraints
	Eq. 5; dynamic analysis and optimization for all types of constraints
11-15	Optimization Convergence Control Factor; if 6-10 Eq. 0, this will be blank.
16-20	Number of steel column property sets
21-25	Eq. 0; response spectra analysis if 6-10, Eq. 5.
	Eq. 1; ATC 3-06 equivalent lateral force analysis if 6-10 Eq. 5
	Eq. 2; ATC 3-06 modal analysis if 6-10 Eq. 5
26-30	Eq. 1; X is the principle direction for the ATC 3-06 analysis
	Eq. 2; Y is the principle direction for the ATC 3-06 analysis
31-35	Eq. 1; Y is the nonprinciple direction for the ATC 3-06 analysis
	Eq. 2; X is the nonprinciple direction for the ATC 3-06 analysis

II. OPTIMIZATION INFORMATION (2I5,5F10.6)

COLUMN	ENTRY
1-5	Maximum allowable number of optimization cycles

6-10	Maximum number of allowable structural analyses
11-15	Lowest allowable percentage change in the objective function for termination
16-20	Coefficient for the steel elements in the objective function (weight per unit volume of 2.84×10^{-4} kip/in^3 is the default)
21-25	Coefficient for the concrete element in the objective function. (weight per unit volume of 8.68×10^{-5} kip/in^3 is the default)
26-30	Lower limit for the active constraints as the maximum percentage deviation from the limiting constraint limit (i.e., input .05 = 5% below the constraint limit; default = 0.10)
31-35	Upper limit for the active constraints as the maximum percentage deviation from the constraint limit (i.e. input .05 = 5% above the constraint limit; default = 0.05)

III. STRUCTURAL INFORMATION (8I5,10A4)

COLUMN	ENTRY
1-5	Number of stories in the structure (not including the ground level)

6-10	Number of vertical column lines in the structure
11-15	Number of bays in the structure
16-20	Number of sets of different column properties (steel and concrete)
21-25	Number of sets of different beam properties
26-30	Number of sets of different fixed end moments and shears (not supplied by uniformly distributed loads)
31-35	Number of infill flexural panels in the structure
36-40	Number of bracing elements in the structure
41-80	Structure identification information

IV. STEEL DESIGN VARIABLE RELATIONSHIPS

(I5/2F10.3/8F10.0/7F10.0)

$$S_{ij} = C_{ij} I_i^{C_{2j}} + C_{3j} \qquad \text{for } D1 \le I_x < D2$$

where S_{ij} = the j^{th} secondary design variable for the i^{th} element, C_{ij}, C_{2j}, and C_{3j} are the appropriate constants, and I_i is the moment of inertia for the i^{th} steel beam or column

COLUMN	ENTRY
1-5	Number of discontinuous curves to represent the spectrum of secondary design

variables (i.e., 1^{st} curve for $0 \le I_x < 1500\ in^4$, 2^{nd} curve for $1500 \le I < 10{,}000\ in^4$, etc.)

Three cards for each set of discontinuous curves as designated above.

1-10	D1, lower limit for first equation
11-20	D2, upper limit for first equation
1-10	C_1 for the minor-axis moment of inertia, I_y
11-20	C_2 for the minor-axis moment of inertia, I_y
21-30	C_3 for the minor-axis moment of inertia, I_y
31-40	C_1 for the crossectional area, A
41-50	C_2 for the crossectional area, A
51-60	C_3 for the crossectional area, A
61-70	C_1 for the torsional moment of inertia, J
71-80	C_2 for the torsional moment of inertia, J
1-10	C_3 for the torsional moment of inertia, J
11-20	C_1 for the major-axis section moduli, S_x
21-30	C_2 for the major-axis section moduli, S_x
31-40	C_3 for the major-axis section moduli, S_x
41-50	C_1 for the minor-axis section moduli, S_y
51-60	C_2 for the minor-axis section moduli, S_y
61-70	C_3 for the minor-axis section moduli, S_y

V. STATIC DISPLACEMENT CONSTRAINT INFORMATION

(I5/2I5,F10.6)

Skip if static displacements constraints are not involved. See input I.

COLUMN	ENTRY
1-5	Number of displacement constraints. Supply one card for each displacement constraint.

One card for each static displacement constraint. If the previous card Eq. 0, no additional cards are required.

1-5	Level number (roof = number of stories)
6-10	Eq. 1; global X-displacement constraint
	Eq. 2; global Y-displacement constraint
	Eq. 3; global rotational displacement constraint
11-20	Maximum allowable displacement for that direction. (Assumes the same for both the positive and negative direction.)

VI. FREQUENCY CONSTRAINT INFORMATION (I5/2F10.3)

These are to be inserted for both a frequency constraint problem and the dynamic response constraint problems.

COLUMN	ENTRY
1-5	Number of modes to be constrained or to be used within the response spectra or ATC 3-06 analyses

One card for each mode to be constrained or used within the modal analyses. If no frequencies are to be constrained insert blank cards. The cards should be ordered from the lowest natural frequency to the highest.

1-10	Lower limit constraint value for the squared natural frequency considered (limit is the square of the natural frequency)
11-20	Upper limit constraint value for the squared natural frequency considered (limit is the square of the natural frequency)

VII. DYNAMIC DISPLACEMENT CONSTRAINT INFORMATION (2I5/2I5,F10.6)

If option 5 in input I was not used skip this input.

COLUMN	ENTRY
1-5	Number of modes used in the modal analysis
6-10	Number of dynamic displacement constraints to be used.

One card for each dynamic displacement constraint.

1-5	Level number for the constraint (roof = number of stories)
6-10	Eq. 1; global X-displacement constraint Eq. 2; global Y-displacement constraint

Eq. 3; global rotational displacement constraint

11-20	Maximum allowable dynamic displacement constraint. (Assumes the same for both the positive and negative directions.)

VIII. RESPONSE SPECTRA INFORMATION

(3F10.3,I5/(2F10.3/6F10.0)

$$S_a/a_{max} = C_1(T-C_6)^4 + C_2(T-C_4)^3 + C_3(T-C_6)^2 + C_4(T-C_6) + C_5$$

where C_1-C_6 are appropriate constants for the spectral acceleration normalized with respect to the maximum ground acceleration, a_{max}, and T is the period of the structure.

COLUMN	ENTRY
1-10	Maximum vertical ground acceleration
11-20	Maximum X-ground acceleration (global)
21-30	Maximum Y-ground acceleration (global)
31-35	Number of curves needed to represent the spectrum

Two cards for each curve for each direction.

1-10	Lower limit for the first division of the vertical spectra
11-20	Upper limit for the first division of the vertical spectra

1-10 C_1 for the first division of the vertical spectrum

11-20 C_2 for the first division of the vertical spectrum

21-30 C_3 for the first division of the vertical spectrum

31-40 C_4 for the first division of the vertical spectrum

41-50 C_5 for the first division of the vertical spectrum

51-60 C_6 for the first division of the vertical spectrum

Repeat for the number of divisions.

1-10 Lower limit for the first division of the x-spectrum

11-20 Upper limit for the first division of the x-spectrum

1-10 C_1 for the first division of the x-spectrum

11-20 C_2 for the first division of the x-spectrum

21-30 C_3 for the first division of the x-spectrum

31-40 C_4 for the first division of the x-spectrum

41-50 C_5 for the first division of the x-spectrum

51-60 C_6 for the first division of the x-spectrum

Repeat for the number of divisions.

1-10 Lower limit for the first division of the y-spectrum

11-20	Upper limit for the first division of the y-spectrum
1-10	C_1 for the first division of the y-spectrum
11-20	C_2 for the first division of the y-spectrum
21-30	C_3 for the first division of the y-spectrum
31-40	C_4 for the first division of the y-spectrum
41-50	C_5 for the first division of the y-spectrum
51-60	C_6 for the first division of the y-spectrum
	Repeat for the number of divisions.

IX. STORY DATA AND STATIC LATERAL LOADS

(A5,5X,7F10.0/8F10.0/F10.0)

Prepare three cards for each level from top to base of the structure.

COLUMN	ENTRY
1-5	Level identification to be used
6-10	Blank
11-20	Story height
21-30	Nonstructural translational mass
31-40	Nonstructural rotational mass inertia about the vertical axis through the mass of the floor.
41-50	X-distance from the reference point to the mass center
51-60	Y-distance from the reference point to the mass center

61-70	External story stiffness in the X-direction
71-80	External story stiffness in the Y-direction
1-10	Static lateral load case A in the reference X-direction
11-20	Static lateral load case A in the reference Y-direction
21-30	X-distance from the reference point to the static lateral load case A
31-40	Y-distance from the reference point to the static lateral load case A
41-50	Static lateral load case B in the reference X-direction
51-60	Static lateral load case B in the reference Y-direction
61-70	X-distance from the reference point to the static lateral load case B
71-80	Y-distance from the reference point to the static lateral load case B.
1-10	External story stiffness in the θ-direction

X. STATIC VERTICAL LOAD AT NODAL POINTS (8F10.0)

Total number of cards to be supplied at this stage must be equal to the number of stories in the structure times the number of the vertical column lines in the structure and divided by 8. For a structure M columns and N levels, the input data cards should be arranged as follows:

COLUMN	ENTRY
1-10	Static vertical load at column line 1 level N (top floor)
11-20	Static vertical load at column line 2 level N
·	Static vertical load at column line · level N
·	Static vertical load at column line M level N
·	Static vertical load at column line 1 level N-1
·	Static vertical load at column line 2 level N-1
·	Static vertical load at column line · level N-1
·	Static vertical load at column line M level N-1
·	Static vertical load at column line 1 level ·
·	Static vertical load at column line 2 level ·
·	Static vertical load at column line · level ·
·	Static vertical load at column line M level ·
·	Static vertical load at column line 1 level 1
·	Static vertical load at column line 2 level 1
·	Static vertical load at column line · level 1
·	Static vertical load at column line M level 1

Note: Positive indicates the force is acting upward.

XI. NONSTRUCTURAL LUMPED MASSES AT NODAL POINTS

(8F10.0)

Two data sets of lumped masses at the structural nodal points are required. The first set is for the geometric stiffness formulation for which the lumped masses along each column line should be accumulated from the top of the structure to the first floor. The second set is for the mass matrix for which the lumped masses along each column line are based upon the masses distributed on the individual floors.

The input format for each set is the same as input Code X. Thus the total number of cards to be supplied should not exceed twice the total number of cards in input X.

XII. VERTICAL COLUMN LINE COORDINATES (I5,2F10.0)

COLUMN	ENTRY
1-5	Column line identification number, in sequential order (increasing by 1 as 1, 2, 3, ...).
6-15	X-distance from reference point to the column line, (inch)
16-25	Y-distance from reference point to the column line, (inch)

The total number of cards is equal to the total number of vertical column lines in the structure (see input III).

XIII. COLUMN PROPERTIES

(I5,F15.0,2F10.0,F15.0/8F10.0/3F10.0)

The properties of the steel columns must be read before the concrete columns and numbered sequentially from one to the number of steel columns as provided in input I. The properties of the concrete flexural walls are read directly after the steel columns.

a. Sets of Steel Column Property Groups. One set must be supplied for each group of different columns in the structure.

COLUMN	ENTRY
1-5	Identification number (1 to the number of steel column properties, in sequential order) for this column property set.
6-20	Modulus of elasticity
21-30	Axial area
31-40	Blank
41-50	Blank
46-50	Torsional inertia
51-55	Flexural inertia for bending about the major-axis
56-60	Flexural inertia for bending about the minor-axis
61-65	Rigid zone depth at the top of the column
66-80	Rigid zone depth at the bottom of the column
1-10	Depth of the (WF) crossection

11-20	Flange width
21-30	Flange thickness
31-40	Web thickness
41-50	Maximum allowable static tensile stress
51-60	Maximum allowable static compressive stress
61-70	Blank
71-80	Minimum allowable flexural inertia for bending about the major-axis
1-10	Maximum allowable flexural inertia for bending about the major-axis
11-20	Maximum allowable dynamic tensile stress
21-30	Maximum allowable dynamic compressive stress

b. Sets of Flexural Wall Property Groups. One set must be supplied for each group of different elements in the structure. I and J refer to the top and bottom of a member, respectively.

COLUMN	ENTRY
1-5	Identification number (number of steel column properties plus one to the total number of column properties, in sequential order) for this property set
6-20	EI_x - modulus of elasticity times the major-axis moment of inertia
21-30	EA - modulus of elasticity times the cross-sectional arm

31-40	EI_Y - modulus of elasticity times the minor-axis moment of inertia
41-45	K_{II} - stiffness factors (for a prismatic member K_{II} = 4; for a nonprismatic member input the appropriate coefficient).
46-50	K_{JJ} - stiffness factor (same as K_{II} in columns 41-45)
51-55	K_{IJ} - stiffness factor (for a prismatic member K_{IJ} = 2; for a nonprismatic member input the appropriate coefficient)
56-60	Maximum allowable static, reinforcement tensile stress
61-65	Maximum allowable static, concrete compressive stress
66-80	Blank
1-10	Modulus of elasticity of the concrete
11-20	Width perpendicular to the major-axis (depth) (this value remains fixed throughout the optimization process)
21-30	Width perpendicular to the minor-axis (width) (this value changes during the optimization process)
31-40	Modulus of elasticity for the reinforcing steel
41-50	Percentage of steel based upon the gross area (input in decimal form 2.5% = 0.025)

51-60	GJ - shear modulus of elasticity times the torsional moment of inertia
61-70	Shear modulus for the concrete
71-80	Minimum size for the width perpendicular to the minor-axis
1-10	Maximum size for the width perpendicular to the minor-axis
11-20	Maximum allowable dynamic, reinforcement tensile stress
21-30	Maximum allowable dynamic, concrete compressive stress

XIV. BEAM PROPERTIES

(I5,F15.0,F5.0,2F10.0,7F5.0/3F10.0

COLUMN	ENTRY
1-5	Identification number (in sequence) for this beam property set
6-20	Modulus of elasticity
21-25	Blank
26-35	Torsional inertia
36-45	Flexural inertia
46-50	K_{II} - stiffness factor (for a prismatic member $K_{II} = 4$; for a nonprismatic member input the appropriate coefficient)
51-55	K_{JJ} - stiffness factor (same as K_{II} in col. 46-50)

56-60	K_{IJ} - stiffness factor (for a prismatic member K_{IJ} = 2; for a nonprismatic member input the appropriate coefficient)
61-65	Rigid zone at end I
66-70	Rigid zone at end J
71-75	Depth of the member
76-80	Maximum allowable static bending stress
1-10	Minimum allowable flexural inertia
11-20	Maximum allowable flexural inertia
21-30	Maximum allowable dynamic bending stress

XV. FIXED-END BEAM LOADS (2I5,5F10.0)

One card must be supplied for each different type of vertical loads on the beams. Input fixed-end moments and shears for nonuniform vertical loads or for directly applied end-moments or shears. The computer will generate the fixed-end moments and shears for uniform load case. Omit this input, if number of sets of different fixed-end moments equal 0 in column 26-30 of input Code II.

COLUMN	ENTRY
1-5	Identification number for this vertical loading set
6-10	Input code Eq. 0; fixed-end forces are applied at the column faces Eq. 1; fixed-end forces are applied at the column centerlines

11-20	Fixed-end moment at node I
21-30	Fixed-end shear at node I
31-40	Fixed-end moment at node J
41-50	Fixed-end shear at node J
51-60	Uniform load, per unit length, positive acting downward yields fixed-end forces

XVI. BEAM IDENTIFICATION (8I5)

One card per beam must be input from top to bottom and from bay to bay in the structure (unless the data generate option is used).

COLUMN	ENTRY
1-5	Bay identification number (in sequence) for this beam
6-10	Column line number at end I
11-15	Column line number at end J
16-20	Beam property set identification number for this beam (linking is accomplished by using the same beam property set number for each set of linked beams)
21-25	Number of beams in the sequence below to be generated that have the same properties and vertical loading as this beam
26-30	Vertical loading set identification number for vertical load Case 1
31-35	Vertical loading set identification number for vertical load Case 2

36-40	Vertical loading set identification number for vertical load Case 3

XVII. COLUMN IDENTIFICATION (4I5)

One card per column must be input from top to bottom and the column line is used to define the minor axis of the cross section (unless the data generation option is used).

COLUMN	ENTRY
1-5	Column line identification number for this column
6-10	Column property set identification number (linking is accomplished by assigning the same column property set number for each set of linked columns)
11-15	Column line number defining direction of local weak axis (Y-direction) of this column
16-20	Number of columns in sequence below to be generated that have the same properties as this column

XVIII. PANEL ELEMENT IDENTIFICATION

(3I5,F15.0,F10.0,2F5.0,2F15.0/4F5.0,F15.0, F5.0,4F10.0/8F10.0)

Omit this input if no panel elements are in the structure. Three cards per panel; no generation is allowed.

COLUMN	ENTRY
1-5	Level identification number at the top of this panel.
6-10	Column line number at the L side of this panel
11-15	Column line number at the R side of this panel
16-30	EI-modulus of elasticity times the moment of inertia
31-40	EA-modulus of elasticity times the cross-sectional area
41-45	Modulus of elasticity of the element
46-50	Depth of the flexural panel (fixed during the optimization)
51-65	Width of the flexural panel (variable during the optimization)
66-80	Modulus of elasticity of the reinforcement
1-5	Maximum allowable static reinforcement tensile stress
6-10	Maximum allowable static concrete compressive stress
11-15	Blank
16-20	Percentage of reinforcing based upon gross area
21-35	GJ-shear modulus of elasticity times the torsional moment of inertia

36-40	Shear modulus for the concrete
41-50	Blank
51-60	Blank
61-70	Blank
71-80	Blank
1-10	Minimum width of the flexural panel
11-20	Maximum width of the flexural panel
21-30	Maximum allowable dynamic reinforcement tensile stress
31-40	Maximum allowable dynamic compressive stress

XIX. BRACING ELEMENT IDENTIFICATION

(3I5,6F10.0/2F10.0)

Omit this input if no bracing elements are in the structure. Two cards per brace; no generation allowed.

COLUMN	ENTRY
1-5	Floor level identification number at the top of this brace
6-10	Column line number at the upper end of this brace
11-15	Column line number at the lower end of this brace
16-25	Modulus of elasticity
26-35	Crossectional area
36-45	Maximum allowable static tensile stress
46-55	Maximum allowable static compressive stress
56-65	Minimum allowable crossectional area

66-75	Maximum allowable crossectional area
1-10	Maximum allowable dynamic tensile stress
2-10	Maximum allowable dynamic compressive stress

XX. STATIC LOAD COMBINATIONS (2I5/(6F10.0))

COLUMN	ENTRY

a. Types of Loads

1-5	Number of static load combinations
6-10	Total number of load combinations (static plus dynamic)

b. Static Load Combinations

1-10	Multiplier for vertical load case 1
11-20	Multiplier for vertical load case 2
21-30	Multiplier for vertical laod case 3
31-40	Multiplier for lateral load case A
41-50	Multiplier for lateral load case B
51-60	Multiplier for vertical nodal loads

Note lateral load cases A and B are used as dynamic loads for an ATC 3-06 response spectra modal analysis, therefore these cannot be used for static loads if dynamic loads are also being used.

c. Dynamic Load Combinations

1-10	Multiplier for static vertical load case 1
11-20	Multiplier for static vertical load case 2
21-30	Multiplier for static vertical load case 3

31-40	Multiplier for static lateral load case A if response spectra analysis is used or for dynamic ATC 3-06 load with a positive five percent eccentricity
41-50	Multiplier for the dynamic modal load case if response spectra analysis is used or for dynamic ATC 3-06 load with a negative five percent eccentricity
51-60	Multiplier for the static vertical nodal load

XXI. OUTPUT CONTROL (5I5/I5/16I5/I5/16I5)

COLUMN	ENTRY
1-5	Eq. 0. Do not print the elemental forces.
	Eq. 1. Do print the elemental forces.
6-10	Eq. 0. Do not print the elemental stresses.
	Eq. 1. Do print the elemental stresses.
11-15	Eq. 0. Do not print the eigenvalues.
	Eq. 1. Do print the eigenvalues.
16-20	Eq. 0. Do not print the eigenmodes.
	Eq. 1. Do print the eigenmodes.
21-25	Eq. 0. Do not print the displacements.
	Eq. 1. Do print the displacements.

1-5 The number of column line stiffness distributions to be plotted. Each column lines primary design variables are printed in a file from the top to bottom.

1-5 The number of the 1^{st} column line distribution to be plotted.

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75-80 The number of the 16^{th} column line distribution to be plotted.

Use as may cards as needed for the number of column line distribution to be plotted.

1-5 The number of bay stiffness distribution to be plotted. Each bay's primary design variables are printed in a file from the top to bottom.

1-5 The number of the 1^{st} bay distribution to be plotted.

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.

75-80 The number of the 16^{th} bay distribution to be plotted.

Use as many cards as needed for the number of bay distributions to be plotted.

XXII. ATC 3-06 ANALYSIS INFORMATION (11I5/4F10.0)

COLUMN	ENTRY
1-5	Map area for the effective peak acceleration, A_a
6-10	Map area for the effective peak velocity-related acceleration, A_v
11-15	Seismic hazard exposure group
16-20	Eq. 0 for a nonbrittle structure Eq. 1 for a brittle structure
21-25	Eq. 0 if not near an active fault Eq. 1 if near an active fault
26-30	Soil type
31-35	Eq. 0 for an irregular plan Eq. 1 for a regular plan
36-40	Eq. 0 for a vertically irregular structure Eq. 1 for a vertically regular structure
41-45	Eq. 1 at all times (moment-resisting frame)
46-50	Eq. 0 for a concrete frame Eq. 1 for a steel frame
50-55	Eq. 1 for an equivalent lateral force analysis Eq. 2 for a modal analysis
1-10	Response modification factor

11-20	Deflection amplification factor
21-30	Length of the base of the building in the direction of the principal loading
31-40	Length of the base of the building in the direction perpendicular to the direction of the principal loading

XXIII. CONTROL OF THE NUMBER OF PROBLEMS

Stack the problems back to back and place a blank card at the end of the last data set in order to terminate the program. If optimization is to be used, it is advisable to run each problem separately due to the time involved per problem.

D. JOB CONTROL LANGUAGE

JCL FOR RUNNING A BATCH JOB ON AN AMDAHL 470V/7 OR 470V/8

```
//JOBNAME JOB (XXXXRL,PSWD),'NAME',MSGLEVEL=(1,1)
/*JOBPARM L=30,T=10,R=5120
/*ROUTE PRINT UMMVSA.R10
/*ROUTE XEQ IDLE
//S1 EXEC FRTVCLG,PARM.FORT='LANGLVL(66),NOSOURCE,NOSRCFLG,NOMAP',
// FVLNSPC='CYL,(1,1)'
//SYSIN DD *
                .
                .
         source program
                .
                .
//LKED.SYSUT1 DD SPACE=(TRK,(30,20,5),RLSE)
//LKED.SYSLMOD DD SPACE=(TRK,(30,20,5),RLSE)
//GO.FT06F001 DD SYSOUT=(S,,TEXT)
//GO.FT07F001 DD DSN=&&FT07,DISP=(NEW,DELETE),UNIT=SYSDA,
//   DCB=(RECFM=FB,LRECL=80,BLKSIZE=800),SPACE=(TRK,(20,5))
//GO.FT08F001 DD DSN=&&FT08,DISP=(NEW,DELETE),UNIT=SYSDA,
//   DCB=(RECFM=FB,LRECL=80,BLKSIZE=800),SPACE=(TRK,(20,5))
//GO.FT09F001 DD DSN=&&FT09,DISP=(NEW,DELETE),UNIT=SYSDA,
//   DCB=(RECFM=FB,LRECL=80,BLKSIZE=800),SPACE=(TRK,(20,5))
//GO.FT10F001 DD DSN=&&FT10,DISP=(NEW,DELETE),UNIT=SYSDA,
//   DCB=(RECFM=FB,LRECL=80,BLKSIZE=800),SPACE=(TRK,(20,5))
//GO.FT11F001 DD DSN=&&FT11,DISP=(NEW,DELETE),UNIT=SYSDA,
//   DCB=(RECFM=FB,LRECL=80,BLKSIZE=800),SPACE=(TRK,(20,5))
//GO.FT12F001 DD DSN=&&FT12,DISP=(NEW,DELETE),UNIT=SYSDA,
```

```
//    DCB=(RECFM=FB,LRECL=80,BLKSIZE=800),SPACE=(TRK,(20,5))
//GO.FT13F001 DD DSN=&&FT13,DISP=(NEW,DELETE),UNIT=SYSDA,
//    DCB=(RECFM=FB,LRECL=80,BLKSIZE=800),SPACE=(TRK,(20,5))
//GO.FT14F001 DD DSN=&&FT14,DISP=(NEW,DELETE),UNIT=SYSDA,
//    DCB=(RECFM=FB,LRECL=80,BLKSIZE=800),SPACE=(TRK,(20,5))
//GO.FT15F001 DD DSN=&&FT15,DISP=(NEW,DELETE),UNIT=SYSDA,
//    DCB=(RECFM=FB,LRECL=80,BLKSIZE=800),SPACE=(TRK,(20,5))
//GO.FT16F001 DD DSN=&&FT16,DISP=(NEW,DELETE),UNIT=SYSDA,
//    DCB=(RECFM=FB,LRECL=80,BLKSIZE=800),SPACE=(TRK,(20,5))
//GO.FT17F001 DD DSN=&&FT17,DISP=(NEW,DELETE),UNIT=SYSDA,
//    DCB=(RECFM=FB,LRECL=80,BLKSIZE=800),SPACE=(TRK,(20,5))
//GO.FT18F001 DD DSN=&&FT18,DISP=(NEW,DELETE),UNIT=SYSDA,
//    DCB=(RECFM=FB,LRECL=80,BLKSIZE=800),SPACE=(TRK,(20,5))
//GO.FT19F001 DD DSN=&&FT19,DISP=(NEW,DELETE),UNIT=SYSDA,
//    DCB=(RECFM=FB,LRECL=132,BLKSIZE=13200),SPACE=(TRK,(20,5))
//GO.FT73F001 DD DSN=&&FT73,DISP=(NEW,DELETE),UNIT=SYSDA,
//    DCB=(RECFM=FB,LRECL=80,BLKSIZE=800),SPACE=(TRK,(20,5))
//GO.FT74F001 DD DSN=&&FT74,DISP=(NEW,DELETE),UNIT=SYSDA,
//    DCB=(RECFM=FB,LRECL=80,BLKSIZE=800),SPACE=(TRK,(20,5))
//GO.FT75F001 DD DSN=&&FT75,DISP=(NEW,DELETE),UNIT=SYSDA,
//    DCB=(RECFM=FB,LRECL=132,BLKSIZE=13200),SPACE=(TRK,(20,5))
//GO.FT76F001 DD DSN=&&FT76,DISP=(NEW,DELETE),UNIT=SYSDA,
//    DCB=(RECFM=FB,LRECL=132,BLKSIZE=13200),SPACE=(TRK,(20,5))
//GO.FT77F001 DD DSN=&&FT77,DISP=(NEW,DELETE),UNIT=SYSDA,
//    DCB=(RECFM=FB,LRECL=80,BLKSIZE=800),SPACE=(TRK,(20,5))
//GO.SYSIN DD *
```

```
        .
input data
        .
        .
/*
```

E. COMPUTER PROGRAM LISTING

```
C*********************************************************************
C*   DORESD-3D OPTIMAL DESIGN OF REINFORCED CONCRETE AND STEEL      *
C*   BUILDINGS SUBJECTED TO STATIC AND DYNAMIC LOADS                 *
C*   DEVELOPED BY F.Y.CHENG AND K.Z.TRUMAN WITH ASSISTANCE OF D.S.JUANG *
C*   CIVIL ENGINEERING DEPARTMENT,UNIVERSITY OF MISSOURI-ROLLA       *
C*   1985                                                            *
C*********************************************************************
C
      IMPLICIT REAL*8(A-H,O-Z)
      COMMON/DATA1/CLN(14,2),CP(26,45),BP(15,45),FEF(5,10),LD(10,15,3),
     1LDB(10,15,3),LCC(10,14,2),LP(13,20),LEF(10),PP(22,20),LT(13,40),
     2LP(9,40),LIM,ID,GST,GCO,NSTEEL,NSTEE2,NATC,NLDDD,NIOII
      COMMON/DATA2/DD(6,15,10)
      COMMON/DATA5/COCOL(9,14,10),COBM(5,15,10),COPAN(5,20),CODIA(2,40)
      COMMON/DATA7/PLOAD(140),A(10,15),AMA(200),IF,IFC,K1,K1
      COMMON/FORM1/S(406),C(28,28),SB(406),EF(90,54),PF(84,40)
      COMMON/FORM2/KM(246),SD(28),E(28,190),EB(28,190)
      COMMON/FORM3/SL(18,19),NC,NSNC,N,NFR,NF,NL,KLAT,LLAT,MLAT
      COMMON/FD4/SF5(406,10),CF4(28,28,10),EF4(28,190,10),RH4(246,10),
     1RF4(28,3,10),R(3,28,30,10),RF4(28,1,10)
      COMMON/STIF/SS(170,170),SG(30,30),STIFFF(170,170)
      COMMON/TRAN1/D(10,1,2),AA(1,6),RR(10,6),U2(10,6)
      COMMON/GEN/NST,NDF,NTF,NTOT,NAT,NFQ,NSD,IDUM,BHED(10),NSS,JDUM,
     1I(6),RLAB(3),I5,I3
      COMMON/JUNK/JK(3),MMJ,NNJ,JUK(57),SPAC(3)(368)
      COMMON/STIF/ STIF(17596)
      COMMON/MAT/EL,G
      COMMON/NEW/R66(243,10),R(243,16),XM(6,10),FM(8)
      COMMON/STRES/SCOL(10,14,6,6),SBM(10,15,6,2),SPAN(20,6,5),
     1SDIA(40,6),F1,F2,CON(30),P1,P2,DIS(10,3),CCON(5,30),L6,L7,L8,L9,
     2CONCO(8,30)
      COMMON/EIGNV/EIGV(170),EIVEC(170,170),VAL(10),N10,N9,C1(10),
     1L2(10),XMAS(10),XMAS(10),ISMN,L3(10),L4(10),ADDE,PHIN(10),
     2DPHI(10),PHI(170,10),DPHI(10),PHI(10),UVAL(10)
      COMMON/GRAB/T2(10,14,30),T3(10,15,30),T4(10,20,30),T5(10,40,30),
     1RRR
      COMMON/PASS/PPASS(20),IPASS(40),IPASS,IPASS
      COMMON/DYNAM/VMA(170),FMA(170),DDIS(10,3),X2(170,10),PQ(10),
     1ETA(3,10),VM(170),SAA(3,10),PHI(10),VM(170,10)
      COMMON/INV/PHIL(170,10)
      COMMON/JUNK2/MN6,NAD1,NAD2,LSL,ISEC
      COMMON/JUNK3/PDIS2(170,20)
      COMMON/RESP/C11(3),C22(3),C33(3),C44(3),C55(3),C66(3),C77(3)
      COMMON/CODE1/M(10),M(1),WWW(10,1)
      COMMON/ATC1/U(10,10),V(10),DDDIS(10),DELT(10),RM(10),CM(10),
     1SUMMF1(10),SUMMF2(10),WBARM(10),CSN(10),RNORMT(1),CVXN(10,10),
     2FMODAL(10,10),DELXEM(10,10),VMMODE(10,10),RMMODE(1,10),
     3DRIFMO(10,10),VMODAL(10),TETA(10),PP1(10)
      COMMON/ATC2/ACTIV,ISOIL,NR,ISF,NANALS,NNNNN,MMMMM,NDRITL,ISH,
     1MPREGR,NVREGR,ISI,NN,AAI,AV,SBBB,RBBB,CD,RL,AL1,P11,P12,DELA(10),
     2IKE
      COMMON/STEP/C11(15,3),DIX(2,3),NUM22
      COMMON/SPEC/DD1(2,5,3),CC1(6,5,3),NDIV
      COMMON/PLOT1/IPAF,IPAS,IPRE,IPAEA,IPRD
      COMMON/JUN3/ISPA(6),SPA(208)
      DIMENSION RLAB3(11),PDIS(170,30),AMA2(140),AMA4(10),AMA5(10),
     1P6(2,30),RKAPPA(10),T(10),FS(10,2),FFF(10),VAL(10),VM2(170),
     2VM1(170,2),VM12(170,2),FM2(8,16),OBJ(50),OBJS(50),OBJC(50),
     3PERIOD(50,10),VM3(170),NCPL(15),NBPL(15),COLIN(45),BMIN(45),
     4X99(170,10),FINA(170,6)
C     OBJ(NO. OF CYCLES),PERIOD(CYCLES,MODES)
      DATA RLAB3/8H COLUMN_,8H BEAM___,8H PANEL__,8H BRACE__,8H DISP.__
     1,8H FREQ.___,8H D.DIS__,8H D.COL__,8H D.BM___,8H D.PAN__,8H D.BRE__
     2/
      DATA R1/4H  X /,R2/4H  Y /,R3/4HROTN/,R4/4H  Z /
      REWIND 7
      REWIND 8
      REWIND 9
      REWIND 10
      REWIND 11
      REWIND 12
      REWIND 13
      REWIND 14
      REWIND 15
      REWIND 16
      REWIND 17
      REWIND 18
      REWIND 19
      REWIND 73
      REWIND 74
      REWIND 75
      REWIND 76
      REWIND 77
      IKE=0
      RLAB(1)=R1
      RLAB(2)=R2
      RLAB(3)=R3
C
C     READ AND PRINT OF TYPE OF ANALYSIS AND OPTIMIZATION
C
  100 READ(5,1004) IANALY,ID,RRR,NSTEEL,NATC,K122,K133
      NSTEE2=NSTEEL+1
      IF(ID.EQ.0) GO TO 11
      READ(5,1005) NUM,NUM1,PER,GST,GCO,P11,P12
      IF(GST.EQ.0.) GST=.490/1728.
      IF(GCO.EQ.0.) GCO=.150/1728.
   11 IF(IANALY.EQ.0) STOP
      IF(IANALY.EQ.1.AND.ID.NE.5) WRITE(6,2001)
C
      IF(ID.EQ.0) WRITE(6,2002)
      IF(ID.EQ.1) WRITE(6,2003)
      IF(ID.EQ.2) WRITE(6,2004)
      IF(ID.EQ.3) WRITE(6,2005)
      IF(ID.EQ.4) WRITE(6,2010)
      IF(ID.EQ.5) WRITE(6,2011)
C
C     READ AND PRINT OF STRUCTURAL INFORMATION
C
      READ(5,1000) NST,NC,NB,NCP,NBP,NFEF,NPAN,NTRU,BHED
      WRITE(6,2000) BHED,NST,NC,NB,NCP,NBP,NFEF,NPAN,NTRU
     1,NSTEEL,NUM,NUM1,PER,P11,P12,RRR,GST,GCO
C
C     READ AND PRINT OF MEMBER PROPERTY CURVES
C     (PRIMARY AND SECONDARY DESIGN VARIABLE RELATIONSHIP)
C     DIX(2,I) IS THE LOWER BOUND AND DIX(1,I) IS THE UPPER BOUND
C     FOR THE DIFFERENT REGIONS OF THE PRIMARY DESIGN VARIABLE
C
      IF(ID.EQ.0) GO TO 805
      READ(5,1000) NUM22
      DO 805 I=1,NUM22
      READ(5,1003) DIX(2,I),DIX(1,I)
      READ(5,5015) (C11(J,I),J=1,15)
      WRITE(6,5016) DIX(2,I),DIX(1,I)
      WRITE(6,5017) (C11(J,I),J=1,15)
  805 CONTINUE
C
C     READ AND WRITE DISPL. AND FREQ. CONSTRAINTS
C
      DO 103 I=1,NST
      DO 103 J=1,3
      DDIS(I,J)=0.0
  103 DIS(I,J)=0.0
      IF(ID.EQ.0.OR.ID.EQ.1) GO TO 105
      READ(5,5000) N8
      IF(N8.EQ.0) GO TO 973
      WRITE(6,4000)
      DO 104 J=1,N8
      READ(5,5001) N7,K7,DIS(N7,K7)
  104 WRITE(6,5002) N7,RLAB(K7),DIS(N7,K7)
  973 CONTINUE
      IF(ID.GE.5) GO TO 302
      IF(ID.NE.4) GO TO 105
  302 READ(5,5000) N9,ISMN,MODE
      WRITE(6,4001)
      IF(MODE.EQ.1) GO TO 15
      DO 13 J=1,N9
      READ(5,5007) VAL(J),UVAL(J)
   13 WRITE(6,5007) VAL(J),UVAL(J)
      IF(ID.EQ.4) GO TO 105
      GO TO 300
   15 DO 14 J=1,N9
      READ(5,5001) L3(J),L4(J),VAL(J)
      K=L4(J)
      WRITE(6,5002) L3(J),RLAB(K),VAL(J)
   14 CONTINUE
      IF(ID.EQ.4) GO TO 105
  300 WRITE(6,4002)
      READ(5,5000)N9,N11
      DO 310 J=1,N11
      READ(5,5001)N7,K7,DDIS(N7,K7)
  310 WRITE(6,5002)N7,RLAB(K7),DDIS(N7,K7)
C
C     READ COMPONENTS OF ACCELERATION VERTICAL, X, AND Y DIRECTIONS
C
      IF(NATC.NE.0) GO TO 105
      READ(5,1003) (C77(J),J=1,3)
      READ(5,1000) NDIV
      DO 315 J=1,3
      DO 315 K=1,NDIV
      READ(5,1003) DD1(1,K,J),DD1(2,K,J)
      READ(5,5022) (CC1(I,K,J),I=1,6)
      IF(J.NE.1) WRITE(6,5020) RLAB(J-1),DD1(1,K,J),DD1(2,K,J)
      IF(J.EQ.1) WRITE(6,5020) R4,DD1(1,K,J),DD1(2,K,J)
      WRITE(6,5021) C77(J),(CC1(I,K,J),I=1,6)
  315 CONTINUE
  105 NS=NST
```


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```
      IF(P11.EQ.0.0) P11=.1
      IF(P12.EQ.0.0) P12=.05
      P21=1.*P11
      P22=1.*P12
      P1=P11
      P2=P12
      NTF=1
      ISEC=1
      MAT=3
      NOF=NTF
      I3=3
      I3=0
      IP=0
      IOPT=0
      NCTS=NST+NC
      NCMS=NCTS
      NCM=NC
      NCTS2=2*NCTS
      NSS=NST*I3
      NFS=NST*3
      NCP=NCP+1
      NBP=NBP+1
      NSTC=3*NST+NCTS
      NSTM=3*NST+NCMS
      ICT=0
      ICTI=0
      WT=0.0
C
C     READ AND PRINT OF INPUT DATA
C
      CALL INFORM(NST,NCTS2,NTF,NCMS,NCTS,NC,NS,NB,NCP,NBP,NFEF,NPAN,NTR
     1U,JSHER,IANALY,NLD,NTOT)
      READ(5,1000) IPRF,IPRS,IPRE,IPREM,IPRD
      READ(5,1000) NCPL
      IF(NCPL.NE.0) READ(5,1002) (NCPL1(I),I=1,NCPL)
      READ(5,1000) NBPL
      IF(NBPL.NE.0) READ(5,1002) (NBPL1(I),I=1,NBPL)
      IF(NATC.EQ.0) GO TO 900
      CALL ATLINK(NS,A,N9,C1,TT,VAL1,ANA4,0)
      CALL ATC1(FINS,RKAPPA)
  900 CONTINUE
C
C     CLEAR ARRAYS AND INITIALIZE DATA
C
      CALL INITIL(NST,NC,NS,NPAN,NTRU,NB,NSTC,ANA2,ANA4,ANA5)
      MM=2*NC
      MN=2*MM
      NN=MN+NC*NS+3*NS+3*NC
      MN6=MM*MN+6
      LS=(NN*(NN+1))/2
      LC=MN*MM
      NE=NC*NS+3*NS+6*NC
      LE=NE*MM
      NNM=NN-MN
      LSL=(NNM*(NNM+1))/2+NNM*3
      NNL=NN+3
      NAD1=6+2*NC
      NAD2=MM*MN
      ICTT=0
C
C     FORM GEOMETRIC STIFFNESS
C
      ISTAT=0
      CALL FORM(LS,NN,NNM,NE,MN6,NAD1,NAD2,NNL,LSL,NST,NS,NC,NB,NPAN,
     1NTRU,1,NCP,NBP,ISTAT,ISEC,IP,ICTT,POISL,LCON,0)
      CALL GLOCOA(NSS,NSTC,NCTS,1,1)
  101 ISTAT=1
      LMN6=LMN
      ICT=ICT+1
      IP=0
      IDY=0
      IP=0
      NE=NC*NS+3*NS+6*NC
      LE=NE*MM
      NNL=NN+3
C
C     FORM SYSTEM STIFFNESS
C
      IP=0
   10 CALL FORM(LS,NN,NNM,NE,MN6,NAD1,NAD2,NNL,LSL,NST,NS,NC,NB,NPAN,
     1NTRU,2,NCP,NBP,ISTAT,ISEC,IP,ICTT,POISL,LCON,0)
      CALL GLOCOA(NSS,NSTC,NCTS,2,ISTAT)
C
C     CALCULATE STATIC DISPLACEMENTS AND FORCES
C
      CALL REFDSP(6,NFS,NST,NS,NC,NCTS,IS,I3,D,AA,RR)
      IF(ID.GT.4) GO TO 809
      CALL FORCES(6,NC,NS,MM,MN,NN,ISTAT,LS,NNM,NST,NCP,NBP,NB,
     1NPAN,NTRU,NLD,RLAB,IP,POISL,ANA2,ANA4,ANA5,IDY,P6)
C
  809 IF(ID.NE.4.AND.ID.NE.5.AND.ID.NE.6.AND.NATC.EQ.0) GO TO 109
      IF(ISMN.EQ.1) GO TO 110
C
C     DETERMINE NODAL MASSES
C
      CALL OBJECT(1,NST,NC,NB,NPAN,NTRU,WT,ANA2,ANA4,ANA5,WTST,WTCO)
C
C      ADD EXTERNAL STIFFNESS TO SIMULATE 2-D STRUCTURE
C             TO FIND EIGENVALUES AND EIGENVECTORS
C
      REWIND 20
      READ (20,1001) ((SS(I,J),J=1,NSTC),I=1,NSTC)
      DO 80 J=1,2
      IF(ID.EQ.0.AND.J.EQ.2) GO TO 80
      IF(ID.EQ.0) GO TO 110
      IF(NATC.EQ.0.AND.J.EQ.2) GO TO 80
      IF(NATC.EQ.0) GO TO 110
      K12=J
      K13=3-J
      DO 81 I=1,NST
      II=3*(I-1)+NCTS
      SS(II+3,II+3)=SS(II+3,II+3)+9999999999.
      SS(II+K13,II+K13)=SS(II+K13,II+K13)+9999999999.
   81 CONTINUE
C
C     FIND EIGENVALUES AND EIGENVECTORS
C
  110 CALL JACOBI(NST,NSTC,NSS,NCTS,ANA2,ANA4,ANA5,ID,X2)
C
C       CALL ATC-03 ANALYSIS TECHNIQUES
C
      IF(ID.EQ.0.OR.NATC.EQ.0) GO TO 80
      DO 82 I=1,NST
      II=3*(I-1)+NCTS
      SS(II+3,II+3)=SS(II+3,II+3)-9999999999.
      SS(II+K13,II+K13)=SS(II+K13,II+K13)-9999999999.
   82 CONTINUE
      CALL ATLINK(NS,A,N9,C1,TT,VAL1,ANA4,1)
      CALL ATCCO1(IT,NSTC,EIVEC,W1,SIBASE,SS,SC,FS,FFF,RKAPPA,
     1AMP,N9,RM2,ECC,K12,K13,NCTS,NSS,L2,K122)
      TAU=0.0
      IF(J.EQ.K122) TAU=1.0
      DO 905 I=1,NSTC
      VM1(I,J)=FS(I,1)-TAU*FS(I,2)
      VM2(I,J)=FS(I,1)+TAU*FS(I,2)
  905 CONTINUE
   80 CONTINUE
      IF(NATC.EQ.0) GO TO 901
      DO 908 I=1,NSTC
      VM1(I)=VM1(I,K122)+0.30*VM1(I,K133)
      VM2(I)=VM2(I,K122)+0.30*VM2(I,K133)
      U2(I,4)=VM2(I)
      U2(I,5)=VM1(I)
  908 CONTINUE
C
C
      GO TO 906
  901 CONTINUE
      IF(ID.LT.5) GO TO 109
C
C      CALL RESPONSE SPECTRA MODAL ANALYSIS
C
      CALL MODAL(ANA2,ANA4,ANA5,NCTS,NSTC,NST)
      DO 909 I=1,NSTC
      U2(I,5)=VM1(I)
      VM3(I)=VM1(I)
  909 CONTINUE
  906 CONTINUE
      CALL REFDS1(NFS,NST,NS,NC,NCTS,IS,I3,D,AA,VM1)
      IF(NATC.NE.0) CALL REFDS1(NFS,NST,NS,NC,NCTS,IS,I3,D,AA,VM2)
      DO 910 I=1,NSTC
      RR(I,5)=VM1(I)
      IF(NATC.EQ.0) GO TO 910
      RR(I,4)=VM2(I)
  910 CONTINUE
      ISTAT=1
      NTRY=6
      CALL FORCES(NTRY,NC,NS,MM,MN,NN,ISTAT,LS,NNM,NST,NCP,NBP,NB,NPAN,N
     1TRU,NTOT,RLAB,IP,POISL,ANA2,ANA4,ANA5,IDY,P6)
      ISTAT=1
C
C        REMOVE DYNAMIC DISPL FROM LOAD COMBINATIONS FOR GRADIENTS
C
      IF(NATC.NE.0.OR.ID.LT.5) GO TO 959
      DO 949 I=1,NSTC
```

```
      U2(I,5)=0.0
      W2(I,5)=0.0
 949  CONTINUE
 959  CONTINUE
C
C         FIND TOTAL STRUCTURAL WEIGHT
C
 109  CALL OBJECT(2,NST,NC,NB,NPAN,NTRU,WT,AMA2,AMA4,AMA5,WTST,WTCO)
C
      REWIND 76
      IF(F2.LT.(1.-P1).OR.F2.GT.(1.+P2)) GO TO 961
      IOPT=IOPT+1
      IPOT2=IOPT-1
      OBJ(IOPT)=WT
      OBJS(IOPT)=WTST
      OBJC(IOPT)=WTCO
      IF(IO.LT.4) GO TO 961
      DO 960 NNI=1,N9
      PERIOD(IOPT,NNI)=2.0*3.1416/(DSQRT(CL(NNI)))
 960  CONTINUE
 961  CONTINUE
C
      IF(IO.EQ.0) GO TO 108
C
C        CHECK FOR ACTIVE CONSTRAINTS (WHETHER TO SCALE)
C
      IF(F2.LT.(1.-P1).OR.F2.GT.(1.+P2)) GO TO 107
C
C             PRINT ACTIVE CONSTRAINT INFORMATION
C
      WRITE(6,5005)
      DO 106 K=1,LIM
      III=LCON(1,K)
      IF(LCON(4,K).GT.NLDDD.AND.LCON(1,K).LE.4) III=LCON(1,K)+7
      IF(LCON(4,K).GT.NLDDD.AND.LCON(1,K).EQ.5) III=7
      WRITE(6,5003) RLAB3(III),(LCON(J,K),J=2,5),CON(K)
 106  CONTINUE
      WRITE(6,1009)
      WRITE(6,1007) IPOT2
      WRITE(6,1008) IOPT
      WRITE(6,1010)
      IF(WT.LE.WI.OR.WI.EQ.0.0001) CALL REPLAC(NCP,NSTEEL,NSTC,NBP,NPAN
     1,NTRU,NC,NB,IO,N9,NTOT,NS,LP,LT,COLIN,BMIN,K99,FINA,U2,NATC,GN3)
      REWIND 76
      REWIND 75
      REWIND 77
      REWIND 17
      REWIND 18
      PERI=DABS(WI-WT)*100./WT
      IF(PERL.LT.PERI) GO TO 108
      IP=1
      WI=WT
      IJ=0
C
C        PLACE FAKE DYNAMIC CONSTRAINTS FOR MODAL ANALYSIS
C
      IF(NATC.NE.0.OR.IO.LT.5) GO TO 913
      LIM10=LIM
      LIMB=LIM
      DO 912 K=1,LIM
      IF(LCON(4,K).LE.NLDDD) GO TO 912
      LIMB=LIMB+1
      IF(LCON(1,K).LE.4) LCON(1,LIMB)=LCON(1,K)+7
      IF(LCON(1,K).EQ.5) LCON(1,LIMB)=7
      DO 914 KI=2,5
      LCON(KI,LIMB)=LCON(KI,K)
 914  CONTINUE
      CON(LIMB)=CON(K)
      DO 916 KI=1,8
      CONCO(KI,LIMB)=CONCO(KI,K)
 916  CONTINUE
 912  CONTINUE
      LIM=LIMB
 913  CONTINUE
C
C        IF FREQ. CONST. FIND GRADIENT OF MASSES
C
      IF(IO.LT.6) GO TO 17
      DO 12 I=1,LIM
      IF(LCON(1,I).NE.6) GO TO 12
      MI=LCON(5,I)
      IJ=MI
      IF(IJ.GT.10) STOP
      IO=0
      N=0
      M=0
      CALL EMAS(IJ,MI,NCTS,NST,3,LCON,IO,NC,N,M,AMA2,AMA4,AMA5,IDY)
  12  CONTINUE
  17  CONTINUE
      IF(IO.LT.5.OR.NATC.NE.0) GO TO 301
      DO 298 I=1,LIN
      IF(LCON(1,I).LT.7) GO TO 298
      DO 299 J=1,N9
      MI=J
      IJ=MI
      IO=0
      N=0
      M=0
      CALL EMAS(IJ,MI,NCTS,NST,3,LCON,IO,NC,N,M,AMA2,AMA4,AMA5,IDY)
 299  CONTINUE
      GO TO 301
 298  CONTINUE
 301  CONTINUE
C
C         START OPTIMIZATION SUBROUTINES
C
      CALL PSUEDO(NSTC,NCTS,NS,I3,IS,NSS,IP,NST,NFS,MM,MN,NM,
     1ISTAT,LS,NNN,NCP,NBP,NB,NPAN,NTRU,ALAB,NTOT,AMA2,AMA4,AMA5
     2,MAD2,LSL,ISEC,MN6,NADI,IDV,P6,NC)
C
C         ADD DYNAMIC AND STATIC GRADIENTS FOR MODAL ANALYSIS
C
      M40=NCP-1
      M50=NBP-1
      IF(NATC.NE.0.OR.IO.LT.5) GO TO 922
      LIMB=LIM10
      DO 918 K=1,LIM10
      IF(LCON(4,K).LE.NLDDD) GO TO 918
      LIMB=LIMB+1
      DO 919 N=1,NST
      DO 920 M=1,M40
      T2(N,M,K)=T2(N,M,K)+T2(N,M,LIMB)*XM(5,LCON(4,K))
 920  CONTINUE
      DO 921 M=1,M50
      T3(N,M,K)=T3(N,M,K)+T3(N,M,LIMB)*XM(5,LCON(4,K))
 921  CONTINUE
      DO 923 M=1,NPAN
      T4(N,M,K)=T4(N,M,K)+T4(N,M,LIMB)*XM(5,LCON(4,K))
 923  CONTINUE
      DO 924 M=1,NTRU
      T5(N,M,K)=T5(N,M,K)+T5(N,M,LIMB)*XM(5,LCON(4,K))
 924  CONTINUE
 919  CONTINUE
 918  CONTINUE
      LIM=LIM10
 922  CONTINUE
      M40=NCP-1
      M50=NBP-1
C
C        FIND THE REQUIRED LAGRANGE MULTIPLIERS
C
      CALL LAGMU(NST,NC,NB,NPAN,NTRU,M40,M50)
      IF(NATC.NE.0.OR.IO.LT.5) GO TO 77
      DO 76 I=1,NSTC
      U2(I,5)=VA3(I)
  76  CONTINUE
  77  CONTINUE
      IKE=1
      ICT=ICT+1
      IF(ICT.LT.NUM) GO TO 997
      GO TO 108
 107  WRITE(6,5006)
      III=L9
      IF(L8.GT.NLDDD.AND.L9.LE.4) III=L9+7
      IF(L8.GT.NLDDD.AND.L9.EQ.5) III=7
      WRITE(6,5004) L6,RLAB3(III),L7,L8,F2
      IF(III.EQ.6.AND.L7.EQ.1) F2=1.0/F2
      LIM=LIM6
      P1=P11
      P2=P12
C
C        SCALE ALL PRIMARY DESIGN VARIABLES AND PRINT NEW PROPERTIES
C
      CALL SCALE(F2,NBP,NPAN,NTRU,NCP)
 996  IF(ICT.GT.NUM) GO TO 108
 997  L=NCP-1
      DO 201 I=1,L
      IF(CP(6,I).EQ.0.AND.I.LE.NSTEEL) GO TO 201
      IF(I.EQ.1.AND.NSTEEL.NE.0) WRITE(6,2008)
      IF(I.EQ.NSTEE2) WRITE(6,5041)
      IF(I.LE.NSTEEL) WRITE(6,5042) I,CP(1,I),CP(2,I),(CP(J,I),J=5,16)
      IF(I.LE.NSTEEL) WRITE(76,5042) I,CP(1,I),CP(2,I),(CP(J,I),J=5,16)
      IF(I.GT.NSTEEL) CCIX=CP(1,I)/CP(10,I)
      IF(I.GT.NSTEEL) CCA=CP(2,I)/CP(10,I)
      IF(I.GT.NSTEEL) CCIY=CP(3,I)/CP(10,I)
      IF(I.GT.NSTEEL) CCJ=CP(15,I)/CP(16,I)
```

```
      IF(I.GT.NSTEEL) WRITE(6,5043) I,CCIX,CCA,CCIY,(CP(K,I),K=4,14)
     1,CCJ,CP(16,I)
      IF(I.GT.NSTEEL) WRITE(76,5043)         I,CCIX,CCA,CCIY,(CP(K,I),
     1K=4,14),CCJ,CP(16,I)
  201 CONTINUE
  200 L=NBP-1
      IF(L.EQ.0) GO TO 202
      WRITE(6,2009)
      DO 203 I=1,L
      WRITE(76,5070) I,BP(1,I),(BP(J,I),J=3,11)
  203 WRITE(6,5070) I,BP(1,I),(BP(J,I),J=3,11)
  202 IF(NPAN.EQ.0) GO TO 204
      WRITE(6,2006) (LP(1,I),LP(2,I),LP(3,I),(PP(J,I),J=1,12),I=1,NPAN)
      WRITE(76,2020) (LP(1,I),LP(2,I),LP(3,I),(PP(J,I),J=1,12),I=1,NPAN)
  204 IF(NTRU.EQ.0) GO TO 206
      WRITE(6,2007) (LT(1,I),LT(2,I),LT(3,I),TP(1,I),TP(2,I),TP(3,I),TP
     1(4,I),I=1,NTRU)
      WRITE(76,2021) (LT(1,I),LT(2,I),LT(3,I),TP(1,I),TP(2,I),TP(3,I)
     1,TP(4,I),I=1,NTRU)
  206 F2=0.0
  205 GO TO 101
  138 IF(NATC.NE.0.OR.IO.LT.5) GO TO 78
      DO 79 I=1,NSTC
      U2(I,5)=UA3(I)
   79 CONTINUE
   78 CONTINUE
C
C         PLACE DATA IN FILES FOR PLOTTING
C
      CALL REPORT(NCP,NSTEEL,NSTC,NBP,NPAN,NTRU,NC,NB,IO,N9,NTOT1
     1,NS,LP,LT,NSTEE2,NTOT1,NLODD,NATC)
      CALL PLOT(OBJ,PERIOD,L2,XM,IO,N9,NCTS,IOPT,NST,NTOT1
     1,OBJS,OBJC,LCC,LB,NCPL1,NBPL1,COLIN,BMIN,X99,FINA
     2,NCPL,NBPL)
      GO TO 100
C
 1000 FORMAT(8I5,10A4)
 1001 FORMAT(4E17.10)
 1002 FORMAT(16I5)
 1003 FORMAT(3F10.3)
 1004 FORMAT(2I5,F5.1,4I5)
 1005 FORMAT(2I5,5F10.6)
 1006 FORMAT(14F5.5)
 1007 FORMAT(30H0THE END OF OPTIMIZATION CYCLE,I5,' .')
 1008 FORMAT(32H0THE START OF OPTIMIZATION CYCLE,I5,' .')
 1009 FORMAT(///40H0****************************************)
 1010 FORMAT(40H0***************************************)
 2000 FORMAT(1X,10A4/
     127H NUMBER OF STORY LEVELS----,I4/
     127H NUMBER OF COLUMN LINES----,I4/
     127H NUMBER OF BAYS------------,I4/
     127H NUMBER OF DIFF. COL. PROP-,I4/
     127H NUMBER OF DIFF. BEAM PROP-,I4/
     127H NUMBER OF DIFF. FEF-------,I4/
     127H NUMBER OF PANEL ELEMENTS--,I4/
     127H NUMBER OF BRACING ELEMENTS,I4/
     127H NUMBER OF STEEL COL. PROP-,I4/
     127H NUMBER OF OPT. CYCLES-----,I4/
     127H NUMBER OF ANALYSES--------,I4/
     127H PERCENTAGE FOR TERMINATION,F4.1/
     127H PER. OF CONSTRAINT-LOWER--,F4.2/
     127H PER. OF CONSTRAINT-UPPER--,F4.2/
     127H CONVERGENCE CONTROL PARA.-,F4.1/
     127H OBJECTIVE FACTOR-STEEL----,E8.1/
     127H OBJECTIVE FACTOR-CONCRETE-,E8.1/)
 2001 FORMAT('1',21H STATIC ANALYSIS WITH)
 2002 FORMAT('+',21X,15H NO CONSTRAINTS/'+',37H_____________________
     1)
 2003 FORMAT('+',21X,19H STRESS CONSTRAINTS/'+',41H____________________
     1)
 2004 FORMAT('+',21X,36H DISPLACEMENT AND STRESS CONSTRAINTS/'+',58H___
     1_______________________________)
 2005 FORMAT('+',21X,25H DISPLACEMENT CONSTRAINTS/'+',47H______________
     1________________________)
 2010 FORMAT('+',21X,22H FREQUENCY CONSTRAINTS/'+',44H_________________
     1___________________)
 2011 FORMAT('1',47H DYNAMIC ANALYSIS WITH DISPLACEMENT CONSTRAINTS/'+',
     147H________________________________________)
 2020 FORMAT(I4,2I5,F16.1,F11.1,8F7.1,F8.1,F7.1)
 2021 FORMAT(1X,3I5,4F15.5)
 4000 FORMAT(32H0STATIC DISPLACEMENT CONSTRAINTS/'+',32H
     1_______________//,6H LEVEL,3X,9HDIRECTION,6X,5HVALUE/'+',28H___
     2___________________)
 4001 FORMAT(22H0FREQUENCY CONSTRAINTS/'+',22H_____________________)
 4003 FORMAT(33H0DYNAMIC DISPLACEMENT CONSTRAINTS/'+',33H
     1_______________//,6H LEVEL,3X,9HDIRECTION,6X,5HVALUE/'+',28H___
     2_______)
 5000 FORMAT(3I5,F5.1)
 5001 FORMAT(2I5,F10.6)
 5002 FORMAT(I6,5X,A4,5X,F14.6)
 5003 FORMAT(A8,'________',I4,I12,I12,I10,F14.5)
 5004 FORMAT(16H0LEVEL___________,I6/,A4,'__________',I4/,16H LOAD CASE___
     1__,I4/,16H FACTOR__________,F9.5/)
 5005 FORMAT(///19H ACTIVE CONSTRAINTS//,6X,4HTYPE,6X,6H LEVEL,5X,8HLOCA
     1TION,6X,4HLOAD,6X,5HIDENT,6X,5HVALUE)
 5006 FORMAT(23H LARGEST SCALING FACTOR)
 5007 FORMAT(2F10.3)
 5015 FORMAT(8F10.0/7F10.0)
 5016 FORMAT(50H0STEEL MEMBER PROPERTY COEFFICIENTS FOR IX BETWEEN,1X,F7
     1.1,1X,'AND',1X,F7.1/'+',70H_______
     2_____________________//,9H PROPERTY,3X,10HCONSTANT 1,8X,
     35HPOWER,3X,10HCONSTANT 2)
 5017 FORMAT(6X,'IY',1X,3F13.6/,7X,'A',1X,3F13.6/,7X,'J',1X,3F13.6/,6X,'
     1SX',1X,3F13.6/,6X,'SY',1X,3F13.6)
 5020 FORMAT(35H0RESPONSE SPECTRUM COEFFICIENTS FOR,1X,A4,1X,'ACCELERATI
     1ON BETWEEN',1X,F7.3,1X,'AND',1X,F7.3/'+',80H_______________
     2___________________________________________//,10H MA
     3X. ACC.,3X,10HCONSTANT 1,3X,10HCONSTANT 2,3X,10HCONSTANT 3,3X,10H
     4CONSTANT 4,3X,10HCONSTANT 5,3X,10HCONSTANT 6)
 5021 FORMAT(F9.3,3X,6(F10.4,3X))
 5022 FORMAT(6F10.0)
 2008 FORMAT(///10H COLUMN ID,9X,1HE,7X,1HA,3X,6HTORS I,4X,5HMAJ I,3X,5H
     1MIN I,5X,2HDT,6X,2HDB,7X,1HD,6X,2HBF,6X,2HTF,6X,2HTW,6X,2HTS,6X,2H
     2CS,6X,2HSS/'+',9H_________,9X,1H_,7X,1H_,3X,6H______,4X,5H_____,3X
     3,5H_____,5X,2H__,6X,2H__,7X,1H_,6X,2H__,6X,2H__,6X,2H__,6X,2H__,6X
     4,2H__,6X,2H__)
 2009 FORMAT(///10H   BEAM ID,10X,1HE,4X,6HTORS I,2X,6HFLEX I,5X,3HKII,5
     1X,3HKJJ,5X,3HKIJ,5X,2HDI,6X,2HDJ,7X,1HD,6X,2HNS/'+',9H_________,10
     2X,1H_,4X,6H______,2X,6H______,5X,3H___,5X,3H___,5X,3H___,5X,2H__,6
     3X,2H__,7X,1H_,6X,2H__)
 2006 FORMAT(///18H PANEL INFORMATION/'+',17H_________________//14H LEVE
     1L  L     R,13X,3HEIX,9X,2HEA,4X,1HE,6X,1HC,6X,2H B,5X,2HES,5X,2HTS,
     25X,2HCS,5X,2HSS,4X,3HRHO,6X,2HCJ,6X,1HG/'+',13H_____________,13X,3
     3H___,9X,2H__,4X,2H__,5X,2H__,5X,2H__,5X,2H__,5X,2H__,5X,2H__,5X,2H
     4__,6X,3H___,6X,2H__,6X,1H_/(I4,2I5,F16.1,F11.1,8F7.1,F8.1,F7.1))
 2007 FORMAT (///29H BRACING ELEMENT INFORMATION/'+',27H
     1___________//16H    LEVEL  UC   LC,14X,1HE,14X,1HA,13X,2HTS,13X,2HCS
     2/'+',15H_____ __ __,14X,1H_,14X,1H_,13X,2H__,13X,2H__//(1X,3I5,
     34F15.5))
 5041 FORMAT(  1/10H COLUMN ID,9X,3HIX ,9X,2HA ,5X,3HIY ,4X,3HKII,4X,3HK
     1J,4X,3HKIJ,5X,2HTS,5X,2HCS,4X,2HSS,5X,2HEC,5X,2H D,5X,2H W,5X,2HES
     2,5X,3HRO,6X,2HJ ,5X,1HG/'+',9H_________,9X,3H__ ,9X,2H_ ,5X,3H___
     3,4X,3H___,4X,3H___,4X,3H___,5X,2H__,5X,2H__,4X,2H__,5X,2H__,5X,2H__
     4,5X,2H__,5X,2H__,5X,2H__,6X,2H__,5X,1H_)
 5042 FORMAT(I6,4X,F11.2,2F8.2,F9.2,10F8.2)
 5043 FORMAT(I7,3X,F13.0,F11.0,F8.0,F6.1,9F7.1,F7.3,F8.0,F6.0)
 5070 FORMAT(I7,3X,F12.2,F8.2,F9.2,7F8.2)
C
      END
      SUBROUTINE INFORM(NST,NCTS2,NTF,NCNS,NCTS,NC,NS,NB,NCP,NBP,NFEF,
     1NPAN,NTRU,JSHER,IANALY,NLOD,NTOT)
C
C     READ AND PRINT INPUT DATA
C
      IMPLICIT REAL*8(A-H,O-Z)
      COMMON/DATA1/CLN(14,2),CP(26,45),BP(15,45),FEF(5,10),LB(10,15,3),
     1LDB(10,15,3),LC(10,14,2),LP(3,20),IFEF(10),PP(12,20),LT(3,40),
     1TP(4,40),CIN,ID,GS1,GCO,NSTEEL,NSTEE2,NATC,NLODD,NTOT1
      COMMON/DATA7/PLOAD(140),SD(10,15),ANA(200),IF,IFC,X1,Y1
      COMMON/JUNK/NLO,N,ND,MM,MN,LM(12),IDUM,ISPA(5)(64),P(12,30),TT(8)
      COMMON/NEW/R66(24,10),R(263,16),XM(6,10),FR(6)
      DIMENSION PA(10,2),PB(10,2),PJAV(1),AJAV(14)
      DATA VAV/3HCOL/,BVAV/6H______/
      DO 10 I=1,NC
   10 AJAV(I)=BVAV
      PJAV(1)=VAV
C
C     READ AND PRINT OF STORY DATA AND STATIC LATERAL LOAD
C
      NLD=3
      WRITE(6,5009)
      DO 200 N=1,NST
      LN=NST+1-N
      READ(5,5000) (SD(N,I),I=1,10),PA(N,1),PA(N,2),SD(N,12),SD(N,13),
     1PB(N,1),PB(N,2)
      READ(5,5001) SD(N,15)
      WRITE(6,5007) LN,(SD(N,I),I=1,8)
  200 CONTINUE
      WRITE(6,5010)
      DO 310 N=1,NST
      LN=NST+1-N
      SD(N,11)=-SD(N,9)*PA(N,2)+SD(N,10)*PA(N,1)
      SD(N,14)=-SD(N,12)*PB(N,2)+SD(N,13)*PB(N,1)
      WRITE(6,5008)LN,(SD(N,I),I=9,14),PA(N,1),PA(N,2),PB(N,1),PB(N,2)
  310 CONTINUE
      IF=1
```

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      IFC=0
      XI=0.
      VI=0.
C
C     READ AND PRINT OF STATIC VERTICAL LOAD AT NODAL POINTS
C
      READ(5,5003)(PLOAD(I),I=1,NCTS)
      WRITE(6,5030)
      WRITE(6,5031)((PJAY(I,J),J=1,NC)
      WRITE(6,5046)(AJAY(I),I=1,NC)
      DO 311 I=1,NST
      N=NST-I+1
      KSP=NC*I
      KBN=KSP-NC+1
      WRITE(6,5032)N,(PLOAD(K),K=KBN,KSP)
  311 CONTINUE
C
C     READ AND PRINT OF LUMPED MASSES AT NODAL POINTS
C
  509 READ(5,5001)(AMA(I),I=1,NCTS2)
      WRITE(6,5038)
      WRITE(6,5031)((PJAY(I,J),J=1,NC)
      WRITE(6,5046)(AJAY(I),I=1,NC)
      DO 510 I=1,NST
      N=NST-I+1
      KSP=NC*I
      KBN=KSP-NC+1
      WRITE(6,5039)N,(AMA(K),K=KBN,KSP)
  510 CONTINUE
C
C     READ AND PRINT OF COLUMN LINE COORDINATES
C
  512 WRITE(6,1000)
      READ(5,2501) (M,(CLN(J,I),I=1,2),J=1,NC)
      WRITE(6,2000)(J,(CLN(J,I),I=1,2),J=1,NC)
C
C     READ AND PRINT OF COLUMN PROPERTIES
C
  100 L=NCP-1
      IF(L.EQ.0) GO TO 105
      DO 101 I=1,L
      READ(5,1001)M,(CP(J,M),J=1,16),CP(21,M),CP(23,M),CP(24,M),CP(25,M)
     1,CP(26,M)
      IF(M.LE.NSTEEL.AND.ID.NE.0)CALL STEEL(1,M)
      IF(M.LE.NSTEEL)CP(22,M)=CP(6,M)
      IF(M.GT.NSTEEL)CP(22,M)=CP(2,M)/CP(10,M)
      IF(M.EQ.1.AND.NSTEEL.NE.0)WRITE(6,2001)
      IF(M.EQ.NSTEE2)WRITE(6,5041)
      IF(M.LE.NSTEEL)WRITE(6,5042)M,CP(1,M),CP(2,M),(CP(J,M),J=5,16)
      IF(M.LE.NSTEEL)WRITE(76,5042)M,CP(1,M),CP(2,M),(CP(J,M),J=5,16)
      IF(M.LE.NSTEEL) GO TO 101
      IF(ID.NE.0)CALL CONCR(1,M)
      CCIX=CP(1,M)/CP(10,M)
      CCA=CP(2,M)/CP(10,M)
      CCIY=CP(3,M)/CP(10,M)
      CCJ=CP(5,M)/CP(16,M)
      WRITE(6,5043)M,CCIX,CCA,CCIY,(CP(K,M),K=4,14),CCJ,CP(16,M)
      WRITE(76,5043)M,CCIX,CCA,CCIY,(CP(K,M),K=4,14),CCJ,CP(16,M)
  101 CONTINUE
      IF(ID.EQ.0.)GO TO 805
      WRITE(6,5999)
      DO 800 I=1,L
      IF(I.EQ.1.AND.NSTEEL.NE.0)WRITE(6,6001)
      IF(I.LE.NSTEEL)WRITE(6,6002)I,CP(14,I),CP(15,I),CP(24,I),CP(25,I),
     1CP(21,I),CP(23,I)
      IF(I.EQ.NSTEE2)WRITE(6,6003)
      IF(I.GT.NSTEEL)WRITE(6,6002)I,CP(7,I),CP(8,I),CP(24,I),CP(25,I),
     &CP(21,I),CP(23,I)
  800 CONTINUE
  805 CONTINUE
      JSHER=0
      IF(M.GT.NSTEEL)JSHER=M
      IF(JSHER.EQ.0)GO TO 105
      M=JSHER-NSTEEL
C
  105 CONTINUE
C
C     READ AND PRINT OF BEAM PROPERTIES
C
      L=NBP-1
      IF(L.EQ.0)GO TO 115
      READ(5,1002)(M,(BP(J,I),J=1,12),BP(14,I),BP(15,I),I=1,L)
      WRITE(6,2002)
      DO 513 I=1,L
      BP(13,I)=BP(4,I)
      IF(ID.NE.0)CALL STEEL(2,I)
      WRITE(76,5070)I,BP(1,I),(BP(J,I),J=3,11)
      WRITE(6,5070)I,BP(1,I),(BP(J,I),J=3,11)
  513 CONTINUE
      IF(ID.EQ.0) GO TO 806
      WRITE(6,6005)
      DO 801 I=1,L
      WRITE(6,6006)I,BP(11,I),BP(15,I),BP(12,I),BP(14,I)
  801 CONTINUE
  806 CONTINUE
  115 DO 120 I=1,11
  120 BP(I,NBP)=0.
C
C     READ AND PRINT OF FIXED END BEAM LOADS
C
      IF (NFEF.EQ.0) GO TO 208
  205 READ(5,1003)(M,IFEF(I),(FEF(J,I),J=1,5),I=1,NFEF)
      WRITE(6,2003)(I,IFEF(I),(FEF(J,I),J=1,5),I=1,NFEF)
C
C     READ (OR GENERATE) AND PRINT OF BEAM LOCATION CARDS - LB
C
  208 IF (NB.EQ.0) GO TO 300
  210 WRITE(6,2004)
      DO 260 M=1,NB
      K=0
      DO 250 N=1,NS
      IF (K.NE.0) GO TO 220
      LN=NS+1-N
      READ(5,1004) II,(LB(N,M,L),L=1,NLD),K,(LDB(N,M,L),L=1,NLD))
      WRITE(6,1004)II,LN,(LB(N,M,L),L=1,NLD),K,(LDB(N,M,L),L=1,NLD))
      IF (LB(N,M,NLD).EQ.0) LB(N,M,NLD)=NBP
      GO TO 250
  220 K=K-1
      DO 230 L=1,NLD
      LB(N,M,L)=LB(N-1,M,L)
  230 LDB(N,M,L)=LDB(N-1,M,L)
  250 CONTINUE
  260 WRITE(6,3000)
      WRITE(6,3004)
      CALL GENERA(LB,NS,NB,3,3,NBP,10,15,3)
      IF (NFEF.EQ.0) GO TO 300
      DO 270 L=1,NLD
      WRITE(6,4005) L
      CALL GENERA(LDB,NS,NB,3,L,100000,10,15,3)
  270 CONTINUE
C
C     READ (OR GENERATE) AND PRINT COLUMN LOCATIONS - LC
C
  300 WRITE(6,2005)
      DO 360 M=1,NC
      K=0
      DO 350 N=1,NS
      IF (K.NE.0) GO TO 320
      LN=NS+1-N
      READ(5,1005) KK,(LC(N,M,I),I=1,2),K
      WRITE(6,1005)KK,LN,(LC(N,M,I),I=1,2),K
      IF(LC(N,M,1).EQ.0)LC(N,M,1)=NCP
      GO TO 350
  320 K=K-1
      DO 330 I=1,2
  330 LC(N,M,I)=LC(N-1,M,I)
  350 CONTINUE
  360 WRITE(6,3000)
      WRITE(6,3005)
      CALL GENERA(LC,NS,NC,2,1,NCP,10,25,2)
C
C     READ AND PRINT OF PANEL CARDS - LP,PP
C
      IF(NPAN.EQ.0) GO TO 365
      READ(5,1006) (LP(1,I),LP(2,I),LP(3,I),(PP(J,I),J=1,16),PP(18,I)
     1,PP(19,I),PP(20,I),PP(21,I),PP(22,I),I=1,NPAN)
      IF(ID.EQ.0) GO TO 366
      DO 103 I=1,NPAN
      IF(ID.NE.0)CALL CONCR(2,I)
  103 PP(17,I)=PP(1,I)/PP(3,I)
  366 WRITE(76,2020) (LP(1,I),LP(2,I),LP(3,I),(PP(J,I),J=1,12),I=1,NPAN)
      WRITE(6,2006) (LP(1,I),LP(2,I),LP(3,I),(PP(J,I),J=1,12),I=1,NPAN)
      IF(ID.EQ.0) GO TO 365
      WRITE(6,6007) (LP(1,I),LP(2,I),LP(3,I),PP(7,I),PP(8,I),PP(20,I)
     1,PP(21,I),PP(18,I),PP(19,I),I=1,NPAN)
C
C     READ AND PRINT OF BRACES
C
  365 IF (NTRU.EQ.0) GO TO 380
      READ(5,1007) (LT(1,I),LT(2,I),LT(3,I),TP(1,I),TP(2,I),TP(3,I),
     1TP(4,I),TP(5,I),TP(7,I),TP(8,I),TP(9,I),I=1,NTRU)
      WRITE(6,2007) (LT(1,I),LT(2,I),LT(3,I),TP(1,I),TP(2,I),TP(3,I),
     1TP(4,I),I=1,NTRU)
      WRITE(76,2021) (LT(1,I),LT(2,I),LT(3,I),TP(1,I),TP(2,I),TP(3,I),
     1TP(4,I),I=1,NTRU)
      DO 400 I=1,NTRU
```

```
  400 TP(6,I)=TP(2,I)
      IF(ID.EQ.0) GO TO 380
      WRITE(6,6000) (LT(1,I),LT(2,I),LT(3,I),TP(3,I),TP(4,I),TP(8,I),
     1TP(9,I),TP(5,I),TP(7,I),I=1,NTRU)
C
C     PRINT BEAM PROPERTIES AND LOADS
C
  380 IF(NB.EQ.0) GO TO 372
      WRITE(6,2011)
      DO 370 M=1,NB
      WRITE(6,2012) M
      DO 370 N=1,NS
      LN=NS+1-N
      NN=LB(N,M,3)
  370 WRITE(6,2010) LN,BP(1,NN),(BP(J,NN),J=3,11),(LDB(M,N,L),L=1,NLD)
C
C     PRINT COLUMN PROPERTIES
C
  372 WRITE(6,2013)
      DO 375 M=1,NC
      MWR=1
      DO 375 N=1,NS
      LN=NS+1-N
      NN=LC(M,N,1)
      IF(NN.LE.NSTEEL.AND.MWR.EQ.1) WRITE(6,2014) M
      IF(NN.GT.NSTEEL.AND.MWR.EQ.1) WRITE(6,5055) M
      MWR=2
      IF(NN.LE.NSTEEL) WRITE(6,5056) LN,CP(1,NN),CP(2,NN),(CP(J,NN),J=5
     1,16)
      IF(NN.GT.NSTEEL) CCIX=CP(1,NN)/CP(10,NN)
      IF(NN.GT.NSTEEL) CCA=CP(2,NN)/CP(10,NN)
      IF(NN.GT.NSTEEL) CCIY=CP(3,NN)/CP(10,NN)
      IF(NN.GT.NSTEEL) CCJ=CP(15,NN)/CP(16,NN)
      IF(NN.GT.NSTEEL) WRITE(6,5057) LN,CCIX,CCA,CCIY,(CP(J,NN),J=4,14)
     1,CCJ,CP(16,NN)
  375 CONTINUE
C
C
C     READ AND PRINT OF STATIC LOAD COMBINATION MULTIPLIERS
C
      READ(5,6000) NLOD,NTOT,((XM(I,J),I=1,6),J=1,NTOT)
      NLDOD=NLOD
      NTOT1=NTOT
      IF(NLDD.EQ.0) GO TO 517
      WRITE(6,5062)
      WRITE(6,5063) ((XM(I,J),I=1,6),J=1,NLDD)
      IF(NTOT.LE.NLOD) RETURN
C
C         PRINT DYNAMIC LOAD COMBINATIONS
C
  517 NLL=NLOD+1
      WRITE(6,5064)
      WRITE(6,5063) ((XM(I,J),I=1,6),J=NLL,NTOT)
C
C
  516 RETURN
C
 1000 FORMAT(///24H COLUMN LINE COORDINATES/'+',23H_______________________
     1    //5H LINE,14X,1HX,14X,1HY/'+',4H____,14X,1H_,14X,1H_)
 1001 FORMAT(I5,F15.0,2F10.0,3F5.0,F15.0/7F10.0/4F10.0)
 1002 FORMAT(I5,F15.0,F5.0,2F10.0,7F5.0/3F10.0)
 1003 FORMAT (2I5,5F10.0)
 1004 FORMAT (9I5)
 1005 FORMAT(5I5)
 1006 FORMAT (3I5,F15.0,F10.0,2F5.0,2F15.0/4F5.0,F15.0,F5.0,4F10.0/
     15F10.0)
 1007 FORMAT (3I5,6F10.0/2F10.0)
 2000 FORMAT(I4,8X,F10.2,5X,F10.2)
 2001 FORMAT(///10H COLUMN ID,9X,1HE,7X,1HA,3X,6HTORS I,4X,5HMAJ I,3X,5H
     1MIN I,5X,2HDT,6X,2HDB,7X,1HD,6X,2HDF,6X,2HTF,6X,2HTW,6X,2HTS,6X,2H
     2CS,6X,2HSS/'+',9H_________,9X,1H_,7X,1H_,3X,6H______,4X,5H_____,3X
     3,5H_____,5X,2H__,6X,2H__,7X,1H_,6X,2H__,6X,2H__,6X,2H__,6X,2H__,6X
     4,2H__,6X,2H__)
 2002 FORMAT(///10H   BEAM ID,10X,1HE,4X,6HTORS I,2X,6HFLEX I,5X,3HKII,5
     1X,3HKJJ,5X,3HKIJ,5X,2HDI,6X,2HDJ,7X,1HD,6X,2HNS/'+',9H_________,10
     2X,1H_,6X,6H______,2X,6H______,5X,3H___,5X,3H___,5X,3H___,5X,2H__,6
     3X,2H__,7X,1H_,6X,2H__)
 2003 FORMAT (///10H    FEF ID,6X,4HCODE,7X,2HML,10X,2HVL,10X,2HMR,10X,
     1 2HVR,11X,1HW/'+',9H_________,6X,4H____,7X,2H__,10X,2H__,10X,2H__,
     210X,2H__,11X,1H_,/(I7,5X,I7,5F12.3))
 2004 FORMAT(///15H BEAM LOCATIONS/'+',14H______________//47H/  BAY LEVE
     1L IC   JC   BID  GEN  VLC1 VLC2 VLC3 /'+',46H___ _____ __   __
     2)
 2005 FORMAT(///17H COLUMN LOCATIONS/'+',16H________________// 26H  LINE
     1 LEVEL CID WDIR  GEN /'+',25H____ _____ ___ ____ ___)
 2006 FORMAT(///18H PANEL INFORMATION/'+',17H_________________//14H LEVE
     1L   L     R,13X,3HEIX,9X,2HEA,4X,1HE,6X,1HL,6X,2H B,5X,2HES,5X,2HTS,
     25X,2HCS,5X,2HSS,5X,2HRO,6X,2HGJ,6X,1HG/'+',13H____ _    _,13X,3H
     3___,9X,2H__,4X,2H__,5X,2H__,5X,2H__,5X,2H__,5X,2H__,5X,2H__,5X,2H_
     4,5X,2H__,6X,2H__,6X,1H_,7(I4,2I5,F16.1,F11.1,8F7.1,F8.1,F7.1))
 2007 FORMAT (///28H BRACING ELEMENT INFORMATION/'+',27H_______________
     1____________//14H    LEVEL UC    LC,14X,1HE,16X,1HA,13X,2HTS,13X,2HCS
     2/'+',15H______ __    __,14X,1H_,16X,1H_,13X,2H__,13X,2H__/(I1X,3I5,
     34F15.3))
 2010 FORMAT(I6,2X,F12.2,F8.2,F9.2,7F8.2,3I8)
 2011 FORMAT(///37H BEAM PROPERTIES AND LOAD SET NUMBERS/'+',36H_______
     1_____________________________)
 2012 FORMAT (//11H BAY NUMBER,I3/'+',13H_____________/6H LEVEL,10X,1HE,3
     1X,6HTORS I,3X,6HFLEX I,5X,3HKII,5X,3HKJJ,5X,3HKIJ,5X,2HDI,6X,2HDJ,
     27X,1HD,6X,2HNS,7X,4HVLC1,4X,4HVLC2,4X,4HVLC3/'+',5H_____,10X,1H_,3
     3X,6H______,3X,6H______,5X,3H___,5X,3H___,5X,3H___,5X,2H__,6X,2H__,
     47X,1H_,6X,2H__,7X,4H____,4X,4H____,4X,4H____)
 2013 FORMAT(///18H COLUMN PROPERTIES/'+',17H_________________/)
 2014 FORMAT(/16H COLUMN LINE NO.,I3/'+',18H__________________/6H LEVEL,
     113X,1HE,7X,1HA,3X,6HTORS I,4X,5HMAJ I,3X,5HMIN I,5X,2HDT,6X,2HDB,7
     2X,1HD,6X,2HDF,6X,2HTF,6X,2HTW,6X,2HTS,6X,2HCS,6X,2HSS/'+',5H_____,
     313X,1H_,7X,1H_,3X,6H______,4X,5H_____,3X,5H_____,5X,2H__,6X,2H__,7
     4X,1H_,6X,2H__,6X,2H__,6X,2H__,6X,2H__,6X,2H__,6X,2H__)
 2020 FORMAT(I4,2I5,F16.1,F11.1,8F7.1,F8.1,F7.1)
 2021 FORMAT(1X,3I5,4F15.5)
 2501 FORMAT( I5,2F10.0)
 3000 FORMAT (1H1)
 3004 FORMAT (//28H BEAM PROPERTY SET ID NUMBER/'+',27H______________
     1____________//)
 3005 FORMAT (//30H COLUMN PROPERTY SET ID NUMBER/'+',29H_____________
     1________________//)
 4004 FORMAT(///34H GENERATED BEAM LOADS...LOAD CASE ,I2/'+',35H________
     1___________________________//)
 5000 FORMAT (A5,5X,7F10.0/8F10.0)
 5001 FORMAT(8F10.0)
 5003 FORMAT(8F10.0)
 5007 FORMAT (I6,6X,A5,7F13.2)
 5008 FORMAT (I6,2X,6F13.2,3X,4F8.1)
 5009 FORMAT  (///11H STORY DATA/'+',10H__________///  10H LEVEL NO.,3X
     1,2HID,9X,6HHEIGHT,8X,7HMASS(M),5X,5HMR**2,9X,4HX(M),9X,4HY(M),10X,
     23HK-X,10X,3HK-Y/'+',9H_________,3X,2H__,9X,6H______,8X,7H_______,
     35X,5H_____,9X,4H____,9X,4H____,10X,3H___,10X,3H___)
 5010 FORMAT (///37H STATIC LATERAL LOADS...CASES A AND B/'+',36H_______
     1_____________________________//10H LEVEL NO.,7X,4HFX-A,9X,4HFY-A
     2,8X,5HMOM-A,9X,4HFX-B,9X,4HFY-B,8X,5HMOM-B,8X,2HXA,6X,2HYA,6X,2HXB
     3,6X,2HYB/'+',9H_________,7X,4H____,9X,4H____,8X,5H_____,9X,4H____,
     49X,4H____,8X,5H_____,8X,2H__,6X,2H__,6X,2H__,6X,2H__)
 5030 FORMAT(///27H STATIC VERTICAL NODAL LOAD/'+',26H___________________
     1_______//)
 5031 FORMAT(6H STORY,2X,10(4X,A3,I3))
 5032 FORMAT(I4,4X,10F10.2)
 5038 FORMAT(///34H LUMP MASS FOR GEOMETRIC STIFFNESS/'+',33H__________
     1_______________________//)
 5039 FORMAT(I4,6X,10F10.4)
 5041 FORMAT  (/10H COLUMN ID,9X,3HIX ,9X,2HA ,5X,3HIY ,4X,3HKII,4X,3HKJ
     1J,4X,3HKIJ,5X,2HTS,5X,2HCS,4X,2HSS,5X,2HEC,5X,2H D,5X,2H W,5X,2HES
     2,5X,2HRO,6X,2HJ ,5X,1HG/'+',9H_________,9X,3H___,9X,2H__,5X,3H___,
     34X,3H___,4X,3H___,4X,3H___,5X,2H__,5X,2H__,4X,2H__,5X,2H__,5X,2H__
     4,5X,2H__,5X,2H__,5X,2H__,6X,2H__,5X,1H_)
 5042 FORMAT(I6,4X,F11.2,2F8.2,F9.2,10F8.2)
 5043 FORMAT(I7,3X,F13.0,F11.0,F8.0,F6.1,9F7.1,F7.3,F8.0,F6.0)
 5046 FORMAT(/'+',5H_____,2X,10(4X,A6))
 5055 FORMAT(/16H COLUMN LINE NO.,I3/'+',18H__________________/6H LEVEL,
     113X,3HIX ,9X,2HA ,5X,3HIY ,3X,3HKII,4X,3HKJJ,4X,3HKIJ,4X,2HTS,5X,2
     2HCS,5X,2HSS,5X,2HEC,5X,2H D,5X,2H W,5X,2HES,5X,2HRO,6X,2HJ ,4X,1HG
     3/'+',5H_____,13X,3H___,9X,2H__,5X,3H___,3X,3H___,4X,3H___,4X,3H___
     4,4X,2H__,5X,2H__,5X,2H__,5X,2H__,5X,2H__,5X,2H__,5X,2H__,5X,2H__,6
     5X,2H__,4X,1H_)
 5056 FORMAT(I4,F17.2,2F8.2,F9.2,10F8.2)
 5057 FORMAT(I5,F18.0,F11.0,F8.0,F6.1,8F7.1,F7.0,F7.3,F8.0,F7.1)
 5062 FORMAT(///31H STATIC LOAD COMBINATION (MULTIPLIER)/'+',36H_______
     1____________________________//5H VLC1,6X,4HVLC2,6X,4HVLC3,6X,4HLAT
     21,6X,4HLAT2,6X,4HMODI/'+',4H____,6X,4H____,6X,4H____,6X,4H____,6X,
     34H____,6X,4H____)
 5064 FORMAT(///38H DYNAMIC LOAD COMBINATION (MULTIPLIER)/'+',37H_______
     1______________________________//5H VLC1,6X,4HVLC2,6X,4HVLC3,6X,4HL
     2AT1,6X,4HLAT2,6X,4HMODI/'+',4H____,6X,4H____,6X,4H____,6X,4H____,6
     3X,4H____,6X,4H____)
 5063 FORMAT(6(F5.1,5X))
 5070 FORMAT(I7,3X,F12.2,F8.2,F9.2,7F8.2)
 6000 FORMAT(2I5/(8F10.0))
 5999 FORMAT(///46H COLUMN STRESS AND SIDE CONSTRAINT INFORMATION/'+',45
     1H_____________________________________________)
 6001 FORMAT(/10H COLUMN ID,10X,3HSTS,10X,3HSCS,10X,3HDTS,10X,3HDCS,6X,7
     1HMIN. IX,6X,7HMAX. IX/'+',9H_________,10X,3H___,10X,3H___,10X,3H__
     2_,10X,3H___,6X,7H_______,6X,7H_______)
 6002 FORMAT(I6,5X,6F13.2)
 6003 FORMAT(///10H COLUMN ID,10X,3HSTS,10X,3HSCS,10X,3HDTS,10X,3HDCS,7X,
     16HMIN. W,7X,6HMAX. W/'+',9H_________,10X,3H___,10X,3H___,10X,3H___
     2,10X,3H___,7X,6H______,7X,6H______)
 6005 FORMAT(///44H BEAM STRESS AND SIDE CONSTRAINT INFORMATION/'+',43H_
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     1                                                  //10H   BEAM ID,10X,3HSD
     2S,10X,3HDBS,7X,6HMIN. I,7X,6HMAX. I/'+',8H________,10X,3H___,10X,
     33H___,7X,6H______,7X,6H______)
6004 FORMAT(I7,3X,4F13.2)
6007 FORMAT(//45H PANEL STRESS AND SIDE CONSTRAINT INFORMATION/'+',64H
     1                                                  //14H LEVEL  L    B,13
     2X,3HSTS,13X,3HSCS,13X,3HDTS,13X,3HDCS,7X,6HMIN. B,7X,6HMAX. B/'+',
     313H                 ,13X,3H___,13X,3H___,13X,3H___,13X,3H___,7X,6H____
     4__,7X,6H______/(I15,2I5,6F16.1))
6008 FORMAT(//47H BRACING STRESS AND SIDE CONSTRAINT INFORMATION/'+',4
     16H                                                  //16H   LEVEL  UC
     2 LC,12X,3HSTS,12X,3HSCS,12X,3HDTS,12X,3HDCS,9X,6HMIN. A,9X,6HMAX.
     3A/'+',15H              ,12X,3H___,12X,3H___,12X,3H___,12X,3H___,9
     4X,6H______,9X,6H______/(I1X,3I5,6F15.5))
C
      END
      SUBROUTINE GENERA (LOC,NS,NR,NL,L,NPROP,N1,N2,N3)
C
C     PRINT MEMBER LOCATIONS AS GENERATED
C
      IMPLICIT REAL*8(A-H,O-Z)
      COMMON/JUNK/ NLO,LOC(60),III,SPA10(360)
      DIMENSION LOC(N1,N2,N3),BB(1),BJAV(15)
      DATA RM/3HBAY/
      DATA PM/3HCOL/
      DATA CVAV/6H______/
      DO 10 I=1,NR
   10 BJAV(I)=CVAV
C
      IF(N3.EQ.3) BB(1)=RM
      IF(N3.EQ.2) BB(1)=PM
      DO 200 J=1,NR,15
      JJ=J+14
      IF (JJ.GT.NR) JJ=NR
      WRITE(6,2000) (BB(1),I,I=J,JJ)
      WRITE(6,2003) (BJAV(I),I=1,NR)
      DO 200 I=1,NS
      DO 100 K=J,JJ
      LOC(K)=LOC(I,K,L)
      IF (LOC(K).EQ.NPROP) LOC(K)=0
  100 CONTINUE
      M=NS+1-I
  200 WRITE(6,2001) M,(LOC(K),K=J,JJ)
C
      RETURN
C
 2000 FORMAT (6H STORY,15(2X,A3,I3))
 2001 FORMAT (I5,3X,15(I5,3X))
 2003 FORMAT('+',5H_____,15(2X,A6))
C
      END
      SUBROUTINE INITIL(NST,NC,NS,NPAN,NTRU,NB,MSTC,AMA2,AMA4,AMA5)
C
C     CLEAR ARRAYS AND INITIALIZE DATA
C
      IMPLICIT REAL*8(A-H,O-Z)
      COMMON/DATA1/CLN(14,2),CP(26,45),BP(15,45),FEF(5,10),LB(10,15,3),
     1LDB(10,15,3),LCC(10,14,2),LP(3,20),IFEF(10),PP(22,20),LT(3,40),
     2TP(9,40),LIM,ID,GST,GCO,NSTEEL,NSTEE2,NATC,NLDDD,NTOT1
      COMMON/DATA2/DD(6,15,10)
      COMMON/DATA5/COCOL(9,14,10),COBM(5,15,10),COPAN(5,20),CODIA(2,40)
      COMMON/STRES/SCOL(10,14,6,6),SBM(10,15,6,2),SPAN(20,6,5),SDIA(40,6
     1),I1,F2,CON(30),P1,P2,DIS(10,3),LCON(5,30),L6,L7,L8,L9,CONCO(8,30)
      DIMENSION AMA2(140),AMA4(10),AMA5(10)
C
C     CLEAR ARRAYS BEFORE STARTING EACH PROBLEM
C
      DO 41 I=1,NS
      DO 41 J=1,NB
      DO 41 K=1,6
   41 DD(K,J,I)=0.0
      DO 2 I=1,NS
      DO 1 J=1,NC
      DO 1 K=1,9
    1 COCOL(K,J,I)=0.0
      DO 2 J=1,NB
      DO 2 K=1,5
    2 COBM(K,J,I)=0.0
      IF(NPAN.EQ.0) GO TO 4
      DO 3 I=1,NPAN
      DO 3 J=1,5
    3 COPAN(J,I)=0.0
    4 IF(NTRU.EQ.0) GO TO 6
      DO 5 I=1,NTRU
      DO 5 J=1,2
    5 CODIA(J,I)=0.0
    6 LIM=0
      F2=0.0
      NCTS=NC*NST
      DO 7 I=1,NCTS
    7 AMA2(I)=0.0
      DO 8 I=1,NST
      AMA4(I)=0.0
    8 AMA5(I)=0.0
C
      RETURN
      END
      SUBROUTINE FORM(LS,NN,MNN,NE,MN6,NAD1,NAD2,NNL,LSL,NST,NS,NC,NB,
     1NPAN,NTRU,IFORM,NCP,NBP,ISTAT,ISEC,IP,ICTT,PDIS,LCON,IDP)
C
C     FORM GEOMETRIC AND SYSTEM STIFFNESS
C     IFORM EQ. 1 FORM GEOMETRIC STIFFNESS
C     IFORM EQ. 2 FORM SYSTEM STIFFNESS
C
      IMPLICIT REAL*8(A-H,O-Z)
      COMMON/DATA1/CLN(14,2),CP(26,45),BP(15,45),FEF(5,10),LB(10,15,3),
     1LDB(10,15,3),LCC(10,14,2),LP(3,20),IFEF(10),PP(22,20),LT(3,40),
     2TP(9,40),LIM,ID,GST,GCO,NSTEEL,NSTEE2,NATC,NLDDD,NTOT1
      COMMON/DATA5/COCOL(9,14,10),COBM(5,15,10),COPAN(5,20),CODIA(2,40)
      COMMON/DATA7/PLOAD(150),SD(10,15),AMA(280),IF,IFC,XL,T1
      COMMON/FORM1/S(406),C(28,28),SO(406),EF(90,34),PF(84,40)
      COMMON/FORM2/KH(246),SDD(28),EMM(28,190),EB(28,190)
      COMMON/FORM3/SL(18139),NCFD,NSNCFD,NII,NFBFD,NFFD,NLFO,KLAT,LLAT,
     1MLAT
      COMMON/FO4/SF4(406,10),CF4(28,28,10),EF4(28,190,10),KH4(246,10),
     1RF4(28,3,10),RF5(28,30,10),RF6(28,1,10)
      COMMON/JUNK/ NLD,N,ND,MM,NN,LH(12),IDUM,ISPA13(44),P(12,30),TT(8)
      COMMON/MAT/E,G
      DIMENSION PDIS(170,30),LCON(5,30),NTP1(30)
      DATA HI /1HI /
C
C     ZERO ARRAYS AND SHIFT STORAGE
C
      K=NST-NS
      JUT=0
      NCTS=NC*NST
      IF(IP.EQ.1) NLD=ICTT
      IF(IP.EQ.0) NLD=3
      MM=2*NC
      NN=4*NC
      IF(IP.NE.1) GO TO 955
      DO 954 I=1,MM
      DO 954 J=1,LIM
      DO 954 N=1,NS
      RF5(I,J,N)=0.0
  954 CONTINUE
      DO 953 L=1,LIM
      NTP1(L)=0
  953 CONTINUE
  955 CONTINUE
      DO 1 I=1,LS
    1 SB(I)=0.
      DO 3 I=1,MM
      SDD(I)=0.
      DO 3 J=1,NE
      EMM(I,J)=0.
    3 EB(I,J)=0.
      DO 6 I=1,NNL
    6 KH(I)=0.
      DO 7 I=1,LSL
    7 SL(I)=0.
      DO 700 N=1,NS
      DO 8 I=1,LS
      S(I)=SB(I)
    8 SB(I)=0.
      DO 9 I=1,MM
      DO 9 J=1,MM
    9 C(I,J)=0.
      DO 10 I=1,MN6
      DO 10 J=1,NAD1
   10 EF(I,J)=0.
      DO 11 I=1,NAD2
      DO 11 J=1,NLD
   11 PF(I,J)=0.
C
C     FORM COLUMN MATRICES
C
      IF(ISTAT.NE.1) GO TO 12
      DO 390 I=1,12
      DO 390 L=1,NLD
  390 P(I,L)=0.0
   12 NF=6
      ND=12
      DO 500 M=1,NC
      DO 391 I=1,12
      DO 391 L=1,NLD
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      P(I,L)=0.0
  391 CONTINUE
      MC=LC(N,M,1)
      XL=SD(M,2)
      E=CP(1,MC)
      G=E/2.5
      DT=CP(8,MC)
      DB=CP(9,MC)
      XLR=XL-DT-DB
      IF(MC.LE.NSTEEL) GO TO 389
      DT=0.
      DB=0.
      XLR=XL
  389 IF(IFORM.EQ.1) GO TO 401
      IF(MC.GT.NSTEEL) GO TO 810
C
C     FIND STIFFNESS COEFFICIENTS OF STEEL COLUMN ELEMENT
C
      CALL INECOF(1,XLR,CP(6,MC),CP(5,MC),CP(2,MC),
     1SCM1Z,SCM2X,SCM3X,SCM4X,SCMBZ)
      CALL INECOF(1,XLR,CP(7,MC),CP(5,MC),CP(2,MC),
     1SCM1Z,SCM2Y,SCM3Y,SCM4Y,SCMBZ)
C
      GO TO 820
C
C     FIND STIFFNESS COEFFICIENTS OF SHEAR WALL ELEMENT
C
  810 DET=(CP(4,MC)*CP(5,MC)-CP(6,MC)**2)*CP(1,MC)/XL
      BFII=CP(5,MC)/DET
      BFJJ=CP(4,MC)/DET
      BFIJ=-CP(6,MC)/DET
C
      CALL SHRWL1(BFII,BFJJ,BFIJ,SCM2X,SCM4X,SCM3X)
      SCMBZ=CP(15,MC)/XL
      SCM1Z=CP(2,MC)/XL
      SCM2Y=4.*CP(3,MC)/XL
      SCM4Y=SCM2Y/2.0
      SCM3Y=SCM2Y
C
C     TO PREVENT UNDERFLOW IN ELIMINATION PROCESS
C
  820 IF(SCMBZ.LE.0.0)) SCMBZ=0.
      IF(SCM2X.LE.0.0)) SCM2X=0.
      IF(SCM4X.LE.0.0)) SCM4X=0.
      IF(SCM3X.LE.0.0)) SCM3X=0.
      IF(SCM1Z.LE.0.0)) SCM1Z=0.
      IF(SCM2Y.LE.0.0)) SCM2Y=0.
      IF(SCM4Y.LE.0.0)) SCM4Y=0.
      IF(SCM3Y.LE.0.0)) SCM3Y=0.
      COCOL(1,M,N)=SCMBZ
      COCOL(2,M,N)=SCM2X
      COCOL(3,M,N)=SCM4X
      COCOL(4,M,N)=SCM3X
      COCOL(5,M,N)=SCM1Z
      COCOL(6,M,N)=SCM2Y
      COCOL(7,M,N)=SCM4Y
      COCOL(8,M,N)=SCM3Y
C
      IF(IP.NE.1) GO TO 400
      DO 312 L=1,LIM
      IF(LCON(1,L).NE.1.AND.LCON(1,L).NE.8) GO TO 312
      N2=NS-LCON(2,L)+1
      IF(M.NE.LCON(3,L).OR.N.NE.N2) GO TO 312
      IUT=IUT+1
      NTP(L)=IUT
      DO 310 I=1,12
      P(I,IUT)=POIS(I,L)
      POIS(I,L)=0.0
  310 CONTINUE
      DO 311 I=1,6
      NK1=0
      IF(I.GT.3) NK1=3
      NTOP=NCT3+3*(N2-1)+I
      POIS(NTOP,L)=P(I+NK1,IUT)
  311 CONTINUE
  312 CONTINUE
  400 IF(IFORM.EQ.2) GO TO 402
C
  401 MASC=M+NC*(N-1)
      GI=AMA(MASC)
  402 KK=LC(N,M,2)
      B1=CLN(KK,1)-CLN(M,1)
      B2=CLN(KK,2)-CLN(M,2)
      B3=B1*B1+B2*B2
      B3=DSQRT(B3)
      IF(B3.LE.0.) STOP
      CSA=B1/B3
      SNA=B2/B3
      XL1=CLN(M,1)
      YL1=CLN(M,2)
      CALL COLUMN(1,DT,XLR,SNA,CSA,XL1,YL1,DB,GI,IFORM,SCMBZ,SCM2X,
     1SCM4X,SCM3X,SCM1Z,SCM2Y,SCM4Y,SCM3Y,M)
C
C     ADD ELEMENT STIFFNESS TO FLOOR STIFFNESS
C
      LM(6)=4*NC+M+3*(N-1)
      LM(5)=2*M
      LM(4)=LM(5)-1
      LM(11)=LM(5)+2*NC
      LM(10)=LM(4)+2*NC
      LM(12)=LM(6)+NC
      LM(3)=6*NC+3*N
      LM(2)=LM(3)-1
      LM(1)=LM(2)-1
      LM(9)=LM(3)+3
      LM(8)=LM(9)-1
      LM(7)=LM(8)-1
      CALL FLOSTF(NN,MN,ISTAT)
  500 CONTINUE
C
      IF(IFORM.EQ.1) GO TO 601
C
C     FORM BEAM MATRICES
C
      IF (NB.EQ.0) GO TO 610
      NF=3
      ND=6
      DO 600 M=1,NB
      MB=LB(N,M,3)
      IF(MB.EQ.NBP) GO TO 600
      KI=LB(N,M,1)
      KJ=LB(N,M,2)
      B1=CLN(KJ,1)-CLN(KI,1)
      B2=CLN(KJ,2)-CLN(KI,2)
      B3=B1*B1+B2*B2
      B3=DSQRT(B3)
      CSA=B1/B3
      SNA=B2/B3
      XL=B3
      WI=BP(8,MB)
      WJ=BP(9,MB)
      E=BP(1,MB)
      G=E/2.5
      XLR=XL-WI-WJ
      IF(IFORM.EQ.1) GO TO 510
C
C
      CALL INECOF(2,XLR,BP(4,MB),BP(3,MB),0.0,0.0,SCM2,SCM3,SCM4,SCM8)
C
C     TO PREVENT UNDERFLOW IN ELIMINATION PROCESS
C
      IF(SCM8.LE.0.0)) SCM8=0.
      IF(SCM2.LE.0.0)) SCM2=0.
      IF(SCM4.LE.0.0)) SCM4=0.
      IF(SCM3.LE.0.0)) SCM3=0.
      COBM(1,M,N)=SCM8
      COBM(2,M,N)=SCM2
      COBM(3,M,N)=SCM4
      COBM(4,M,N)=SCM3
C
  510 IF(ISTAT.NE.1) GO TO 560
C
      DO 550 L=1,NLD
      DO 520 I=1,6
  520 P(I,L)=0.
      IF(IP.EQ.1) GO TO 551
      J=LDB(N,M,L)
      IF (J) 550,550,530
  530 IF(IFEF(J).EQ.0) XL=XLR
      V=FEF(5,J)*XL/2.
      VM=V*XL/6.
      P(1,L)=-FEF(1,J)-VM
      P(2,L)=-FEF(2,J)-V
      P(3,L)= FEF(3,J)+VM
      P(4,L)=-FEF(4,J)-V
      IF(IFEF(J)) 550,540,550
  540 P(1,L)=P(1,L)+P(2,L)*BP(8,MB)
      P(3,L)=P(3,L)-P(4,L)*BP(9,MB)
  551 CONTINUE
  550 CONTINUE
      IF(IP.NE.1) GO TO 560
  548 DO 552 L=1,LIM
      IF(LCON(1,L).NE.2.AND.LCON(1,L).NE.9) GO TO 552
      N2=NS-LCON(2,L)+1
      IF(M.NE.LCON(3,L).OR.N.NE.N2) GO TO 552
      IUT=IUT+1
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      NTPL(L)=IUT
      DO 549 I=1,6
      P(I,IUT)=POIS(I,L)
      POIS(I,L)=0.0
  549 CONTINUE
  552 CONTINUE
  560 CALL BEAM(L,NI,XLR,SNA,CSA,NJ,SCMB,SCM2,SCM4,SCM3,N,ISTAT,IP)
C
C     ADD ELEMENT STIFFNESS TO FLOOR STIFFNESS
C
      LM(3)=4*NC+KI+3*(N-1)
      LM(2)=2*KI
      LM(1)=LM(2)-1
      LM(6)=4*NC+KJ+3*(N-1)
      LM(5)=2*KJ
      LM(4)=LM(5)-1
      CALL FLOSTF(MM,NN,ISTAT)
  600 CONTINUE
C
C     FORM PANEL STIFFNESS
C
  601 IF(NPAN.EQ.0) GO TO 610
      DO 720 I=1,10
      DO 720 J=1,3
  720 P(I,J)=0.
      NF=3
      ND=10
      DO 800 L=1,NPAN
      NP=NS-LP(1,L)+1
      IF(NP.NE.N) GO TO 800
      XL=SD(N,2)
      KI=LP(2,L)
      KJ=LP(3,L)
      IF(IFORM.EQ.2) GO TO 722
      LOAD1=NC*(NP-1)+KI
      LOAD2=NC*(NP-1)+KJ
      GI=AMA(LOAD1)+AMA(LOAD2)
  722 B1=CLN(KJ,1)-CLN(KI,1)
      B2=CLN(KJ,2)-CLN(KI,2)
      B3=B1*B1+B2*B2
      B3=DSQRT(B3)
      CSA=B1/B3
      SNA=B2/B3
      D=B3
      AR=CLN(KI,1)*CLN(KJ,2)-CLN(KJ,1)*CLN(KI,2)
      DF=AR/B3
      IF(IFORM.EQ.1) GO TO 721
C
C     FIND STIFFNESS COEFFICIENTS OF CONCRETE SHEAR PANEL ELEMENT
C
      DET=12.*PP(1,L)/XL
      BFII=4./DET
      BFJJ=4./DET
      BFIJ=-2./DET
      CALL SHRWL1(BFII,BFJJ,BFIJ,SCM2X,SCM4X,SCM3X)
      SCM12=PP(2,L)/XL
C
C     TO PREVENT UNDERFLOW IN ELEMINATION PROCESS
C
      IF(SCM12.LE.0.01) SCM12=0.
      IF(SCM2X.LE.0.01) SCM2X=0.
      IF(SCM4X.LE.0.01) SCM4X=0.
      IF(SCM3X.LE.0.01) SCM3X=0.
      COPAN(1,L)=SCM2X
      COPAN(2,L)=SCM4X
      COPAN(3,L)=SCM3X
      COPAN(4,L)=SCM12
  721 CALL PANEL(I,L,XL,D,DF,SNA,CSA,NPAN,GI,IFORM,SCM2X,SCM4X,SCM3X,
     1SCM12)
C
C     ADD ELEMENT STIFFNESS TO FLOOR STIFFNESS
C
      LM(3)=6*NC+3*N
      LM(2)=LM(3)-1
      LM(1)=LM(2)-1
      LM(4)=4*NC+KI+3*(N-1)
      LM(5)=4*NC+KJ+3*(N-1)
      LM(8)=6*NC+3*N+3
      LM(7)=LM(8)-1
      LM(6)=LM(7)-1
      LM(9)=LM(4)+NC
      LM(10)=LM(5)+NC
      CALL FLOSTF(MM,NN,ISTAT)
  800 CONTINUE
  610 IF(IFORM.EQ.1) GO TO 710
C
C     FORM BRACE STIFFNESS
C
      IF (NTRU.EQ.0) GO TO 710
      DO 620 I=1,8
      DO 620 J=1,NLD
  620 P(I,J)=0.
      NF=1
      ND=8
      DO 690 L=1,NTRU
      NP=NS-LT(1,L)+1
      IF (NP.NE.N) GO TO 690
      YL=SD(N+K,2)
      KJ=LT(2,L)
      KI=LT(3,L)
      B1=CLN(KJ,1)-CLN(KI,1)
      B2=CLN(KJ,2)-CLN(KI,2)
      B3=B1*B1+B2*B2
      B3=DSQRT(B3)
      CSA=B1/B3
      SNA=B2/B3
      VANG=DATAN(YL/B3)
      DL=DSQRT(B3*B3+YL*YL)
      AR=CLN(KI,1)*CLN(KJ,2)-CLN(KJ,1)*CLN(KI,2)
      D1=AR/B3
      E=TP(1,L)
C
C     FIND STIFFNESS COEFFICIENTS OF STEEL BRACING ELEMENT
C
      CALL INECOF(3,DL,SPACE,SPACE,TP(2,L),
     1SCM12,SCM22,SCM33,SCM44,SCMB8)
C
C     TO PREVENT UNDERFLOW IN ELIMINATION PROCESS
C
      IF(SCM12.LE.0.01) SCM12=0.
      CODTA(1,L)=SCM12
  680 CALL BRACE(I,VANG,DL,SNA,CSA,D1,SCM12,L)
C
C     ADD ELEMENT STIFFNESS TO FLOOR STIFFNESS
C
      LM(3)=6*NC+3*N
      LM(2)=LM(3)-1
      LM(1)=LM(2)-1
      LM(4)=4*NC+KJ+3*(N-1)
      LM(7)=6*NC+3*N+3
      LM(6)=LM(7)-1
      LM(5)=LM(6)-1
      LM(8)=5*NC+KI+3*(N-1)
      CALL FLOSTF(MM,NN,ISTAT)
  690 CONTINUE
  710 CONTINUE
C
C      REDUCE STIFFNESS MATRIX FOR LEVEL N
C
      CALL ELIMIN(MM,NS,NC,NNL,NE,IFORM,LS,NAD2,ISTAT,ICTT,IP,NTPL,LIM)
  700 CONTINUE
C
C     COMPACT STIFFNESS STORAGE (NO DEGREE OF FREEDOM AT BASE)
C
      N=NST-NS+1
      N11=N
      NFRFO=NN-MN-3-NC
      NFFO=1
      NLFO=(NFRFO*(NFRFO+1))/2
      MLAT=LSL-NNM
      LLAT=MLAT-NNM
      LSL=(NNM*(NNM+1))/2+NNM*NLD
      KLAT=LSL-NLD*NNM
      KLAT1=KLAT
      NS3=3*NS
      NSNC=NS*NC
      NSNC1=(NS+1)*NC
      K1=(NSNC*(NSNC+1))/2
      K2=(NSNC1*(NSNC1+1))/2
      K3=LSL-NNM*NLD+NSNC
      K4=K3+NC
      DO 408 J=1,NS3
      DO 406 I=1,NSNC
  406 SL(K1+I)=SL(K2+I)
      DO 407 I=1,J
  407 SL(K1+NSNC+I)=SL(K2+NSNC1+I)
      K1=K1+NSNC+J
  408 K2=K2+NSNC1+J
      DO 405 J=1,NLD
      DO 404 I=1,NS3
  404 SL(K3+I)=SL(K4+I)
      K3=K3+NNM
  405 K4=K4+NNM
      NCFO=NC
      NSNCFO=NSNC
C
```

```
      IF(IP.NE.1) GO TO 881
C
      DO 804 L=1,LIM
      DO 806 N=1,NS
      N3=NS-N+1
      IF(LCON(1,L).NE.1.AND.LCON(1,L).NE.8) GO TO 880
      N2=NS-LCON(2,L)+1
      IF(N3.NE.N2) GO TO 806
      DO 805 M=1,NC
      IF(M.NE.LCON(3,L)) GO TO 805
      IUT=NTPI(L)
      KLAT1=KLAT+(IUT-1)*NNN
      DO 803 I=1,NFRFD
      PDIS(I,L)=SL(KLAT1+I)+PDIS(I,L)
  803 CONTINUE
      GO TO 804
  805 CONTINUE
  880 CONTINUE
      IF(LCON(1,L).NE.2.AND.LCON(1,L).NE.9) GO TO 806
      N2=NS-LCON(2,L)+1
      IF(N3.NE.N2) GO TO 806
      DO 807 M=1,NB
      IF(M.NE.LCON(3,L)) GO TO 807
      IUT=NTPI(L)
      KLAT1=KLAT+(IUT-1)*NNN
      DO 809 I=1,NFRFD
      PDIS(I,L)=SL(KLAT1+I)+PDIS(I,L)
  809 CONTINUE
      GO TO 804
  807 CONTINUE
  806 CONTINUE
  804 CONTINUE
  881 CONTINUE
      RETURN
      END
      SUBROUTINE COLUMN(IO,DT,XLR,SNA,CSA,XL1,YL1,DB,GI,IFORM,S1,S2,S3,
     1S4,S5,S6,S7,S8,M)
C
C     FORM GEOMETRIC AND SYSTEM MEMBER STIFFNESS
C
      IMPLICIT REAL*8(A-H,O-Z)
      COMMON/STIF/ ASA(12,12),SA(8,12),T(8,12),TAC(8,12,14,10),
     1TAB(3,6,15,10),TAD(1,8,40),TAP(4,10,20)
      COMMON/JUNK/ NLD,N,ND,MM,MN,LM(12),IDUM,ISPA13(44),P(12,30),TT(8)
C
      IF(IFORM.EQ.1) GO TO 200
C
C     TRANSFORMATION MATRICES
C
      CALL REFCOR(1,XLR,DT,DB,SNA,CSA,XL1,YL1,0.,0.,M)
C
C     FORCE-FRAME DISPLACEMENT MATRIX
C
      DO 10 I=1,12
      SA(1,I)=S1*TAC(1,I,M,N)
      SA(2,I)=S2*TAC(2,I,M,N)+S3*TAC(3,I,M,N)
      SA(3,I)=S3*TAC(2,I,M,N)+S4*TAC(3,I,M,N)
      SA(4,I)=S5*TAC(4,I,M,N)
      SA(5,I)=S6*TAC(5,I,M,N)+S7*TAC(6,I,M,N)
   10 SA(6,I)=S7*TAC(5,I,M,N)+S8*TAC(6,I,M,N)
C
C     SYSTEM MEMBER STIFFNESS
C
      DO 120 I=1,12
      DO 120 J=I,12
      ASA(I,J)=0.
      DO 110 K=1,6
  110 ASA(I,J)=ASA(I,J)+TAC(K,I,M,N)*SA(K,J)
  120 ASA(J,I)=ASA(I,J)
C
      RETURN
C
C     GEOMETRIC MEMBER STIFFNESS
C
  200 SG1=GI/XLR
      DO 210 I=1,12
      DO 210 J=1,12
  210 ASA(I,J)=0.
      A=-YL1*SNA-XL1*CSA
      B=-YL1*CSA+XL1*SNA
      ASA(1,1)=-SG1
      ASA(1,7)=SG1
      ASA(2,2)=-SG1
      ASA(2,8)=SG1
      ASA(7,1)=SG1
      ASA(7,7)=-SG1
      ASA(8,2)=SG1
      ASA(8,8)=-SG1
      ASA(7,3)=SG1*(A*SNA+B*CSA)
      ASA(3,7)=ASA(7,3)
      ASA(1,9)=ASA(7,3)
      ASA(9,1)=ASA(7,3)
      ASA(1,3)=-ASA(7,3)
      ASA(3,1)=-ASA(7,3)
      ASA(7,9)=-ASA(7,3)
      ASA(9,7)=-ASA(7,3)
      ASA(2,3)=SG1*(A*CSA-B*SNA)
      ASA(3,2)=ASA(2,3)
      ASA(8,9)=ASA(2,3)
      ASA(9,8)=ASA(2,3)
      ASA(8,3)=-ASA(2,3)
      ASA(3,8)=-ASA(2,3)
      ASA(9,2)=-ASA(2,3)
      ASA(2,9)=-ASA(2,3)
      ASA(3,9)=SG1*(A**2+B**2)
      ASA(9,3)=ASA(3,9)
      ASA(3,3)=-ASA(3,9)
      ASA(9,9)=-ASA(3,9)
C
      RETURN
      END
      SUBROUTINE BEAM(IO,WI,XLR,SNA,CSA,WJ,S1,S2,S3,S4,M,ISTAT,IP)
C
C     FORM SYSTEM MEMBER STIFFNESS
C
      IMPLICIT REAL*8(A-H,O-Z)
      COMMON/STIF/ ASA(12,12),SA(8,12),T(8,12),TAC(8,12,14,10),
     1TAB(3,6,15,10),TAD(1,8,40),TAP(4,10,20)
      COMMON/JUNK/ NLD,N,ND,MM,MN,LM(12),IDUM,ISPA13(44),P(12,30),TX(8)
C
C     TRANSFORMATION MATRIX
C
      CALL REFCOR(2,XLR,WI,WJ,SNA,CSA,0.,0.,0.,0.,M)
C
C     FORCE-FRAME DISPLACEMENT MATRIX
C
      DO 10 I=1,6
      SA(1,I)=S1*TAB(1,I,M,N)
      SA(2,I)=S2*TAB(2,I,M,N)+S3*TAB(3,I,M,N)
   10 SA(3,I)=S3*TAB(2,I,M,N)+S4*TAB(3,I,M,N)
C
C     SYSTEM MEMBER STIFFNESS
C
      DO 120 I=1,6
      DO 120 J=I,6
      ASA(I,J)=0.
      DO 110 K=1,3
  110 ASA(I,J)=ASA(I,J)+TAB(K,I,M,N)*SA(K,J)
  120 ASA(J,I)=ASA(I,J)
C
C     FIXED END FORCES
C
      IF(ISTAT.NE.1) RETURN
      IF(IP.EQ.1) GO TO 170
      DO 160 L=1,NLD
      TX(3)= P(2,L)
      TX(1)= SNA*P(1,L)
      TX(2)=-CSA*P(1,L)
      TX(6)= P(4,L)
      TX(4)= SNA*P(3,L)
      TX(5)=-CSA*P(3,L)
      DO 150 I=1,6
  150 P(I,L)=TX(I)
  160 CONTINUE
  170 CONTINUE
C
      RETURN
      END
      SUBROUTINE PANEL (IO,L,XL,D,DF,SNA,CSA,NPAN,G,IFORM,S1,S2,S3,S4)
C
C     FORM GEOMETRIC AND SYSTEM MEMBER STIFFNESS
C
      IMPLICIT REAL*8(A-H,O-Z)
      COMMON/STIF/ ASA(12,12),SA(8,12),T(8,12),TAC(8,12,14,10),
     1TAB(3,6,15,10),TAD(1,8,40),TAP(4,10,20)
C
      IF(IFORM.EQ.1) GO TO 200
C
C     TRANSFORMATION MATRIX
C
      CALL REFCOR(3,XL,D,DF,SNA,CSA,0.,0.,0.,0.,L)
C
C     FORCE-FRAME DISPLACEMENT MATRIX
C
      DO 10 I=1,10
      SA(1,I)=S1*TAP(1,I,L)+S2*TAP(2,I,L)
```

```
      SA(2,I)=S2*TAP(1,I,L)+S3*TAP(2,I,L)
   10 SA(3,I)=S4*TAP(3,I,L)
C
C     SYSTEM MEMBER STIFFNESS
C
   30 DO 120 I=1,10
      DO 120 J=1,10
      ASA(I,J)=0.
      DO 110 K=1,3
  110 ASA(I,J)=ASA(I,J)+TAP(K,I,L)*SA(K,J)
  120 ASA(J,I)=ASA(I,J)
C
      RETURN
C
C     GEOMETRIC MEMBER STIFFNESS
C
  200 SG1=G/XL
      DO 210 I=1,10
      DO 210 J=1,10
  210 ASA(I,J)=0.
      ASA(1,1)=-SG1*CSA*CSA
      ASA(1,2)=-SG1*CSA*SNA
      ASA(1,3)=SG1*CSA*DF
      ASA(1,6)=-ASA(1,1)
      ASA(1,7)=-ASA(1,2)
      ASA(1,8)=-ASA(1,3)
      ASA(2,1)=ASA(1,2)
      ASA(2,2)=-SG1*SNA*SNA
      ASA(2,3)=SG1*SNA*DF
      ASA(2,6)=ASA(1,7)
      ASA(2,7)=-ASA(2,2)
      ASA(2,8)=-ASA(2,3)
      ASA(3,1)=ASA(1,3)
      ASA(3,2)=ASA(2,3)
      ASA(3,3)=-SG1*DF*DF
      ASA(3,6)=ASA(1,8)
      ASA(3,7)=ASA(2,8)
      ASA(3,8)=-ASA(3,3)
      ASA(6,1)=ASA(1,6)
      ASA(6,2)=ASA(2,6)
      ASA(6,3)=ASA(3,6)
      ASA(6,6)=ASA(1,1)
      ASA(6,7)=ASA(1,2)
      ASA(6,8)=ASA(1,3)
      ASA(7,1)=ASA(1,7)
      ASA(7,2)=ASA(2,7)
      ASA(7,3)=ASA(3,7)
      ASA(7,6)=ASA(6,7)
      ASA(7,7)=ASA(2,2)
      ASA(7,8)=ASA(2,3)
      ASA(8,1)=ASA(1,8)
      ASA(8,2)=ASA(2,8)
      ASA(8,3)=ASA(3,8)
      ASA(8,6)=ASA(6,8)
      ASA(8,7)=ASA(7,8)
      ASA(8,8)=ASA(3,3)
C
      RETURN
      END
      SUBROUTINE BRAC(IO,VANG,DL,SNA,CSA,XL1,SL,L)
C
C     FORM SYSTEM MEMBER STIFFNESS
C
      IMPLICIT REAL*8(A-H,O-Z)
      COMMON/STIF/ ASA(12,12),SA(8,12),T(8,12),TAC(8,12,14,10),
     1TAB(3,6,15,10),TAD(1,8,40),TAP(4,10,20)
C
C     TRANSFORMATION MATRIX
C
      CALL REFCOR(4,VANG,0.,DL,SNA,CSA,XL1,0.,0.,0.,L)
C
C     FORCE-FRAME DISPLACEMENT MATRIX
C
      DO 10 I=1,8
   10 SA(1,I)=SL*TAD(1,I,L)
C
C     SYSTEM MEMBER STIFFNESS
C
      DO 120 I=1,8
      DO 120 J=1,8
      ASA(I,J)=TAD(1,I,L)*SA(1,J)
  120 ASA(J,I)=ASA(I,J)
C
      RETURN
      END
      SUBROUTINE REFCOR(KK,XLR,A,B,SNA,CSA,XL1,YL1,XL2,YL2,M)
C
C     FORM TRANSFORMATION MATRICES
C
      IMPLICIT REAL*8(A-H,O-Z)
      COMMON/STIF/ ASA(12,12),SA(8,12),T(8,12),TAC(8,12,14,10),
     1TAB(3,6,15,10),TAD(1,8,40),TAP(4,10,20)
      COMMON/JUNK/ NLD,N,ND,MM,NN,LN(12),IDUM,ISPA(3,44),P(12,30),TT(8)
C
      GO TO (100,200,300,400,300),KK
C
C     COLUMN TRANSFORMATION
C
  100 DO 10 I=1,6,3
      DO 10 J=1,12
   10 TAC(I,J,M,N)=0.
      TAC(1,3,M,N)=1.0
      TAC(1,9,M,N)=-1.0
      TAC(4,6,M,N)=1.0
      TAC(4,12,M,N)=-1.0
      TAC(2,6,M,N)=0.
      TAC(2,12,M,N)=0.
      TAC(3,6,M,N)=0.
      TAC(3,12,M,N)=0.
      TAC(5,6,M,N)=0.
      TAC(5,12,M,N)=0.
      TAC(6,6,M,N)=0.
      TAC(6,12,M,N)=0.
      TAC(2,1,M,N)=CSA/XLR
      TAC(2,7,M,N)=-TAC(2,1,M,N)
      TAC(3,1,M,N)=TAC(2,1,M,N)
      TAC(3,7,M,N)=-TAC(2,1,M,N)
      TAC(5,2,M,N)=TAC(2,1,M,N)
      TAC(5,8,M,N)=-TAC(2,1,M,N)
      TAC(6,2,M,N)=TAC(2,1,M,N)
      TAC(6,8,M,N)=-TAC(2,1,M,N)
      TAC(2,2,M,N)=SNA/XLR
      TAC(2,8,M,N)=-TAC(2,2,M,N)
      TAC(3,2,M,N)=TAC(2,2,M,N)
      TAC(3,8,M,N)=-TAC(2,2,M,N)
      TAC(5,1,M,N)=-TAC(2,2,M,N)
      TAC(5,7,M,N)=TAC(2,2,M,N)
      TAC(6,1,M,N)=-TAC(2,2,M,N)
      TAC(6,7,M,N)=TAC(2,2,M,N)
      TAC(2,3,M,N)=(-YL1*CSA+XL1*SNA)/XLR
      TAC(2,9,M,N)=-TAC(2,3,M,N)
      TAC(3,3,M,N)=TAC(2,3,M,N)
      TAC(3,9,M,N)=-TAC(2,3,M,N)
      TAC(5,3,M,N)=(YL1*SNA+XL1*CSA)/XLR
      TAC(5,9,M,N)=-TAC(5,3,M,N)
      TAC(6,3,M,N)=TAC(5,3,M,N)
      TAC(6,9,M,N)=-TAC(5,3,M,N)
      TAC(2,4,M,N)=SNA*(1.+A/XLR)
      TAC(5,5,M,N)=TAC(2,4,M,N)
      TAC(3,4,M,N)=SNA*A/XLR
      TAC(6,5,M,N)=TAC(3,4,M,N)
      TAC(5,4,M,N)=CSA*(1.+A/XLR)
      TAC(2,5,M,N)=-TAC(5,4,M,N)
      TAC(6,4,M,N)=CSA*A/XLR
      TAC(3,5,M,N)=-TAC(6,4,M,N)
      TAC(2,10,M,N)=SNA*B/XLR
      TAC(5,11,M,N)=TAC(2,10,M,N)
      TAC(3,10,M,N)=SNA*(1.+B/XLR)
      TAC(6,11,M,N)=TAC(3,10,M,N)
      TAC(5,10,M,N)=CSA*B/XLR
      TAC(2,11,M,N)=-TAC(5,10,M,N)
      TAC(6,10,M,N)=CSA*(1.+B/XLR)
      TAC(3,11,M,N)=-TAC(6,10,M,N)
C
      RETURN
C
C     BEAM TRANSFORMATION
C
  200 TAB(1,4,M,N)=CSA
      TAB(1,1,M,N)=-TAB(1,4,M,N)
      TAB(1,5,M,N)=SNA
      TAB(1,2,M,N)=-TAB(1,5,M,N)
      TAB(1,3,M,N)=0.
      TAB(1,6,M,N)=0.
      TAB(2,1,M,N)=SNA*(1.+A/XLR)
      TAB(2,2,M,N)=-CSA*(1.+A/XLR)
      TAB(2,3,M,N)=1./XLR
      TAB(2,6,M,N)=-TAB(2,3,M,N)
      TAB(3,3,M,N)=TAB(2,3,M,N)
      TAB(3,6,M,N)=-TAB(2,3,M,N)
      TAB(2,4,M,N)=SNA*B/XLR
      TAB(2,5,M,N)=-CSA*B/XLR
      TAB(3,1,M,N)=SNA*A/XLR
      TAB(3,2,M,N)=-CSA*A/XLR
      TAB(3,4,M,N)=SNA*(1.+B/XLR)
      TAB(3,5,M,N)=-CSA*(1.+B/XLR)
```

```
C
      RETURN
C
C     PANEL TRANSFORMATION
C
  300 DO 310 I=1,3
      DO 310 J=1,10
  310 TAP(I,J,M)=0.
      TAP(1,1,M)=CSA/XLR
      TAP(1,2,M)=SNA/XLR
      TAP(1,3,M)=B/XLR
      TAP(1,4,M)=-1.D/A
      TAP(1,5,M)=-TAP(1,4,M)
      TAP(1,6,M)=-TAP(1,1,M)
      TAP(1,7,M)=-TAP(1,2,M)
      TAP(1,8,M)=-TAP(1,3,M)
      TAP(2,1,M)=TAP(1,1,M)
      TAP(2,2,M)=TAP(1,2,M)
      TAP(2,3,M)=TAP(1,3,M)
      TAP(2,6,M)=TAP(1,6,M)
      TAP(2,7,M)=TAP(1,7,M)
      TAP(2,8,M)=TAP(1,8,M)
      TAP(2,9,M)=TAP(1,4,M)
      TAP(2,10,M)=TAP(1,5,M)
      TAP(3,4,M)=0.5
      TAP(3,5,M)=0.5
      TAP(3,9,M)=-0.5
      TAP(3,10,M)=-0.5
C
      RETURN
C
C     BRACE TRANSFORMATION
C
  400 TAD(1,1,M)=DCOS(XLR)*CSA
      TAD(1,2,M)=DCOS(XLR)*SNA
      TAD(1,3,M)=DCOS(XLR)*XL1
      TAD(1,4,M)=DSIN(XLR)
      TAD(1,5,M)=-TAD(1,1,M)
      TAD(1,6,M)=-TAD(1,2,M)
      TAD(1,7,M)=-TAD(1,3,M)
      TAD(1,8,M)=-TAD(1,4,M)
C
      RETURN
      END
      SUBROUTINE FLOSTF(MM,MN,ISTAT)
C
C     ADD ELEMENT STIFFNESS TO FLOOR STIFFNESS
C
      IMPLICIT REAL*8(A-H,O-Z)
      COMMON/FORM1/S(406),C(28,28),SB(406),EF(90,34),PF(84,40)
      COMMON/STIF/ ES(12,12),SPAC9(17452)
      COMMON/JUNK/ NLO,N,ND,MD,ID,LM(12),IDUM,ISPA13(44),P(12,30),TT(8)
      DIMENSION KM(12)
C
      DO 100 I=1,ND
      II=LM(I)
      DO 50 J=1,3
      II=II-MN
      IF (II) 20,20,50
   20 KM(I)=J
      GO TO 100
   50 KM(I)=3
  100 CONTINUE
C
      MJ=MN+3*(N-1)
      DO 320 I=1,ND
      II=LM(I)
      IF (II) 320,320,110
  110 KI=KM(I)
      DO 290 J=1,ND
      JJ=LM(J)
      IF (JJ.LT.II) GO TO 290
      KJ=KM(J)
      MI=3*(N-1)
      GO TO (120,150,210) ,KI
  120 GO TO (130,140,200) ,KJ
  130 L=(JJ*(JJ-1))/2+II
      S(L)=S(L)+ES(I,J)
      GO TO 290
  140 C(II,JJ-MM)=C(II,JJ-MM)+ES(I,J)
      GO TO 290
  150 GO TO (290,180,200) ,KJ
  180 JN=JJ-MM
      L=(JN*(JN-1))/2+II-MM
      SB(L)=SB(L)+ES(I,J)
      GO TO 290
C
  200 MI=0
  210 EF(II-MI,JJ-MJ)=EF(II-MI,JJ-MJ)+ES(I,J)
  290 CONTINUE
      IF(ND.NE.6.AND.ND.NE.12) GO TO 320
      IF(ISTAT.NE.1) GO TO 320
      GO TO (300,300,291) ,KI
  291 MII=3*(N-1)
      GO TO 301
  300 MII=0
  301 DO 310 L=1,NLD
  310 PF(II-MII,L)=PF(II-MII,L)+P(I,L)
  320 CONTINUE
C
      RETURN
      END
      SUBROUTINE ELIMIN (MM,NS,NC,NNL,NE,IFORM,LS,NAD2,ISTAT,ICTT,IP
     1,NTP1,LIM)
C
C     ADD FLOOR STIFFNESS TO FRAME STIFFNESS AND ELIMINATE ROTATIONAL
C     DEGREES OF FREEDOM AT JOINTS OF LEVEL N
C
      IMPLICIT REAL*8(A-H,O-Z)
      COMMON/FORM1/S(406),C(28,28),SB(406),EF(90,34),PF(84,40)
      COMMON/FORM2/KH(246),SD(28),E(28,190),ED(28,190)
      COMMON/FORM3/SL1(8139),NCC,NSNC,NL1,NFR,NF,NL,KLAT,LLAT,MLAT
      COMMON/FD4/SF4(406,10),CF4(28,28,10),EF4(28,190,10),KH4(246,10),
     1RF4(28,3,10),RF5(28,30,10),RF6(28,1,10)
      COMMON/JUNK/ NLD,N,ND,MD,ID,LM(12),IDUM,ISPA13(44),P(12,30),TT(8)
      DIMENSION NTP1(30)
C
      NBKS=3
      MN=2*MM
      IF(IP.EQ.1) NLD=ICTT
      IF(IP.EQ.0) NLD=3
      MMP=MM+1
      MNP=MN+1
      NNN=MN+(NS+1)*NC+3*N+3
      NN=NNL-NLD
      NNM=NN-MN
C
      IF(IFORM.EQ.1) GO TO 571
C
      IF(ISTAT.EQ.1) GO TO 30
      DO 20 J=1,NLD
      DO 20 I=1,NAD2
   20 PF(I,J)=0.
C
C     DETERMINE PROFILE OF (S,C,SB)
C
   30 JB=0
      DO 50 J=1,MM
      KH(J)=J
      DO 40 I=1,J
      IF (S(JB+I)) 50,40,50
   40 KH(J)=I+1
   50 JB=JB+J
      DO 70 J=1,MM
      KH(J+MM)=1
      DO 60 I=1,MM
      IF (C(I,J)) 70,60,70
   60 KH(J+MM)=I+1
   70 CONTINUE
C
C     REDUCTION OF S
C
      SD(1)=S(1)
      JB=1
      DO 300 J=2,MM
      SD(J)=0.0
      JM=J-1
      IF (J.EQ.2) GO TO 260
      IB=1
      DO 250 I=2,JM
      IM=I-1
      SS=0.0
      KF=MINO(KH(I),KH(J))
      IF (KF.GT.IM) GO TO 250
C
C     REDUCTION OF S BY S,S
C
      DO 200 K=KF,IM
  200 SS=SS+S(IB+K)*S(JB+K)
      S(JB+I)=S(JB+I)-SS
  250 IB=IB+I
C
C     REDUCTION OF COL BY SELF
C
  260 SS=0.0
      KF=KH(J)
```

```
      IF (KF.GT.JM) GO TO 290
      KD=(KF*(KF+1))/2
      DO 280 K=KF,JM
      IF (S(KD)) 270,280,270
  270 T=S(JB+K)/S(KD)
      SS=SS+T*S(JB+K)
      S(JB+K)=T
  280 KD=KD+K+1
      S(JB+J)=S(JB+J)-SS
  290 SD(J)=S(JB+J)
  300 JB=JB+J
C
C     REDUCTION OF C,SB
C
      JB=0
      DO 500 J=MNP,MN
      JJ=J-MN
      JM=J-1
      IB=1
      DO 450 I=2,JM
      II=I-MN
      IM=I-1
      KL=MINO(IM,MM)
      KF=MINO (KH(I),KH(JJ))
      IF (KF.GT.KL) GO TO 450
      SS=0.0
      IF (I.GT.MM) GO TO 430
C
C     REDUCTION OF C BY S,C
C
      DO 420 K=KF,KL
  420 SS=SS+S(IB+K)*C(K,JJ)
      C(I,JJ)=C(I,JJ)-SS
      GO TO 450
C
C     REDUCTION OF SB BY C,C
C
  430 DO 440 K=KF,KL
  440 SS=SS+C(K,II)*C(K,JJ)
      SB(JB+II)=SB(JB+II)-SS
  450 IB=IB+I
C
C     REDUCTION OF COL BY SELF
C
      SS=0.0
      KF=KH(JJ)
      IF (KF.GT.MM) GO TO 500
      DO 460 K=KF,MM
      IF (SD(K)) 455,460,455
  455 T=C(K,JJ)/SD(K)
      SS=SS+T*C(K,JJ)
      C(K,JJ)=T
  460 CONTINUE
      SB(JB+JJ)=SB(JB+JJ)-SS
  500 JB=JB+JJ
      DO 502 I=1,LS
  502 SF4(I,N)=S(I)
      DO 503 I=1,MM
      DO 503 J=1,MM
  503 CF4(I,J,N)=C(I,J)
C
C     REPLACE E BY EB
C
      DO 501 I=1,MM
      DO 501 J=1,NE
  501 E(I,J)=EB(I,J)
      L1=NC*(N-1)
      L2=3*(N-1)*NC*(NS+1)
      NC2=2*NC
      DO 810 I=1,MM
      DO 800 J=1,NC2
  800 E(I,J+L1)=E(I,J+L1)+EF(I,J)
      DO 801 J=1,6
      JJ=2*NC+J
  801 E(I,J+L2)=E(I,J+L2)+EF(I,JJ)
  810 CONTINUE
      DO 820 I=1,MM
      DO 820 J=1,NLD
  820 E(I,J+NNM)=E(I,J+NNM)+PF(I,J)
C
C     DETERMINE PROFILE OF (E,EB)
C
      DO 90 J=MNP,NNL
      JJ=J-MN
      KH(JJ)=1
      DO 80 I=1,MM
      IF (E(I,JJ)) 90,80,90
   80 KH(JJ)=I+1
   90 CONTINUE
C
C     REDUCTION OF E BY S,E
C
      JB=0
      DO 540 J=MNP,NNL
      JJ=J-MN
      IB=1
      DO 530 I=2,MM
      IM=I-1
      KF=MINO (KH(I),KH(JJ))
      SS=0.0
      IF (KF.GT.IM) GO TO 530
      DO 520 K=KF,IM
  520 SS=SS+S(IB+K)*E(K,JJ)
      E(I,JJ)=E(I,JJ)-SS
  530 IB=IB+I
  540 CONTINUE
      DO 830 I=1,MM
      DO 830 J=1,NE
  830 EB(I,J)=0.0
      DO 840 I=1,MM
      DO 841 J=1,NC2
  841 EB(I,J+L1)=EB(I,J+L1)+EF(I+MM,J)
      DO 842 J=1,6
      JJ=2*NC+J
  842 EB(I,J+L2)=EB(I,J+L2)+EF(I+MM,JJ)
  840 CONTINUE
      DO 845 I=1,MM
      DO 845 J=1,NLD
  845 EB(I,J+NNM)=EB(I,J+NNM)+PF(I+MM,J)
C
C     REDUCTION OF EB BY C,E
C
      DO 570 J=MNP,NNL
      JJ=J-MN
      DO 560 I=MNP,MN
      II=I-MN
      KF=MINO(KH(I),KH(JJ))
      SS=0.0
      IF (KF.GT.MM) GO TO 560
      DO 550 K=KF,MM
  550 SS=SS+C(K,II)*E(K,JJ)
  560 EB(II,JJ)=EB(II,JJ)-SS
  570 CONTINUE
C
  571 L1=NC*(N-1)
      L2=3*(N-1)*NC*(NS+1)
      NC2=2*NC
      NC4=4*NC
      NC6=6*NC
      NCN1=NC*(N-1)
      K1=(L1*(L1+1))/2
      DO 860 J=1,NC2
      DO 850 I=1,J
  850 SL(K1+L1+I)=SL(K1+L1+I)+EF(I+MM,J)
  860 K1=K1+L1+J
      K2=(L2*(L2+1))/2
      DO 863 J=1,6
      DO 861 I=1,NC2
      JJ=2*NC+J
  861 SL(K2+NCN1+I)=SL(K2+NCN1+I)+EF(I+MM,JJ)
      DO 862 I=1,J
  862 SL(K2+L2+I)=SL(K2+L2+I)+EF(I+NC6,JJ)
  863 K2=K2+L2+J
      IF(IFORM.EQ.1) GO TO 701
      NNM1=(NNM*(NNM+1))/2+(N-1)*NC
      DO 865 J=1,NLD
      DO 864 I=1,NC2
  864 SL(NNM1+I)=SL(NNM1+I)+PF(NC4+I,J)
  865 NNM1=NNM1+NNM
C
C     REDUCTION OF SL BY E,E
C
      JB=0
      DO 700 J=MNP,NNL
      JJ=J-MN
      JN=J-1
      JM=MINO(JN,NNM)
      IF (MNP.GT.JM) GO TO 610
      DO 600 I=MNP,JM
      KF=MINO(KH(I),KH(JJ))
      II=I-MN
      SS=0.0
      IF (KF.GT.MM) GO TO 600
      DO 580 K=KF,MM
  580 SS=SS+E(K,II)*E(K,JJ)
  600 SL(JB+II)=SL(JB+II)-SS
```

```
      DO 255 I1=1,I3                                                    GLOC1380
      II=I1+IS                                                          GLOC1390
      DO 255 J1=1,NC                                                    GLOC1400
      JJ=J1+IS                                                          GLOC1410
      S2(I1,JJ)=0.                                                      GLOC1420
      DO 255 KK=1,3                                                     GLOC1430
  255 S2(I1,JJ)=S2(I1,JJ)+AJ(I1,KK)*S(I2+KK,J22+JJ)                     GLOC1440
  256 NN=I3*(NT-1)                                                      GLOC1450
C                                                                       GLOC1460
      DO 300 I=1,I3                                                     GLOC1470
      IIN=I3*(N-NT)+I                                                   GLOC1480
      II=I3*(N-NT)+I+MCTS                                               GLOC1490
      DO 300 J=1,I3                                                     GLOC1500
      JJN=I3*(N-NT)+J                                                   GLOC1510
      JJ=I3*(N-NT)+J+MCTS                                               GLOC1520
      IF(IFORM.EQ.1) SG(NN+IIN,NN+JJN)=SG(NN+IIN,NN+JJN)+AS(I+IS,J+IS)  GLOC1530
      IF(IFORM.EQ.2) SS(NN+II,NN+JJ)=SS(NN+II,NN+JJ)+AS(I+IS,J+IS)      GLOC1540
  300 CONTINUE                                                          GLOC1550
      IF(IFORM.EQ.1) GO TO 400                                          GLOC1560
      DO 310 I=1,NC                                                     GLOC1570
      II=NC*(N-NT)+I                                                    GLOC1580
      DO 310 J=1,I3                                                     GLOC1590
      JJ=I3*(N-NT)+J+MCTS                                               GLOC1600
  310 SS(NN+II,NN+JJ)=SS(NN+II,NN+JJ)+S1(I+IS,J+IS)                     GLOC1610
C                                                                       GLOC1620
      DO 320 I=1,I3                                                     GLOC1630
      II=I3*(N-NT)+I+MCTS                                               GLOC1640
      DO 320 J=1,NC                                                     GLOC1650
      JJ=NC*(N-NT)+J                                                    GLOC1660
  320 SS(NN+II,NN+JJ)=SS(NN+II,NN+JJ)+S2(I+IS,J+IS)                     GLOC1670
  400 CONTINUE                                                          GLOC1680
C                                                                       GLOC1690
      IF(IFORM.EQ.1) RETURN                                             GLOC1700
C                                                                       GLOC1710
      DO 410 I=1,NSNC                                                   GLOC1720
      DO 410 J=1,NSNC                                                   GLOC1730
  410 SS(I,J)=S(I,J)                                                    GLOC1740
      IF(ISTAT.NE.1) GO TO 450                                          GLOC1750
      DO 420 I=1,NSNC                                                   GLOC1760
      DO 420 J=1,3                                                      GLOC1770
  420 RR(I,J)=RR(I,J)+R(I,J)                                            GLOC1780
      DO 440 I=1,NSNC                                                   GLOC1790
  440 RR(I,6)=RR(I,6)+PLOAD(I)                                          GLOC1800
C                                                                       GLOC1810
  450 AA(1,1)=IF                                                        GLOC1820
      AA(1,2)=IFC                                                       GLOC1830
      AA(1,3)=A1(1,1)                                                   GLOC1840
      AA(1,4)=A1(1,2)                                                   GLOC1850
      AA(1,5)=NT                                                        GLOC1860
      AA(1,6)=NC                                                        GLOC1870
      IF(ISTAT.NE.1) RETURN                                             GLOC1880
C                                                                       GLOC1890
C     SOLVE STATIC DISPLACEMENTS                                        GLOC1900
C                                                                       GLOC1910
      DO 460 I=1,MSTC                                                   GLOC1920
      DO 460 J=1,MSTC                                                   GLOC1930
  460 S(I,J)=SS(I,J)                                                    GLOC1940
      DO 470 I=1,NSS                                                    GLOC1950
      DO 470 J=1,NSS                                                    GLOC1960
  470 S(I+MCTS,J+MCTS)=S(I+MCTS,J+MCTS)+386.4*SG(I,J)                   GLOC1970
      CALL GAUSS(S,MSTC,RR,6)                                           GLOC1980
      DO 705 J=1,6                                                      GLOC1990
      DO 705 I=1,MSTC                                                   GLOC2000
  705 U2(I,J)=RR(I,J)                                                   GLOC2010
C                                                                       GLOC2020
      RETURN                                                            GLOC2030
 1000 FORMAT(4E17.10)                                                   GLOC2040
      END                                                               GLOC2050
      SUBROUTINE GAUSS(A,N,B,NL)                                        GAUS0010
C                                                                       GAUS0020
C     SOLVE STATIC DISPLACEMENTS                                        GAUS0030
C                                                                       GAUS0040
      IMPLICIT REAL*8(A-H,O-Z)                                          GAUS0050
      DIMENSION A(170,170),B(170,6)                                     GAUS0060
C                                                                       GAUS0070
      M=0                                                               GAUS0080
C                                                                       GAUS0090
C     REDUCTION OF M TH EQUATION                                        GAUS0100
C                                                                       GAUS0110
   50 M=M+1                                                             GAUS0120
      MM=M+1                                                            GAUS0130
      DO 60 L=1,NL                                                      GAUS0140
   60 B(M,L)=B(M,L)/A(M,M)                                              GAUS0150
      IF (M-N) 70,130,70                                                GAUS0160
   70 DO 80 J=MM,N                                                      GAUS0170
   80 A(M,J)=A(M,J)/A(M,M)                                              GAUS0180
C                                                                       GAUS0190
C     SUBSTITUTION INTO REMAINING EQUATIONS                             GAUS0200
C                                                                       GAUS0210
      DO 120 I=MM,N                                                     GAUS0220
      IF (A(I,M)) 90,120,90                                             GAUS0230
   90 DO 100 J=I,N                                                      GAUS0240
      A(I,J)=A(I,J)-A(I,M)*A(M,J)                                       GAUS0250
  100 A(J,I)=A(I,J)                                                     GAUS0260
      DO 110 L=1,NL                                                     GAUS0270
  110 B(I,L)=B(I,L)-A(I,M)*B(M,L)                                       GAUS0280
  120 CONTINUE                                                          GAUS0290
      GO TO 50                                                          GAUS0300
C                                                                       GAUS0310
C     BACK SUBSTITUTION                                                 GAUS0320
C                                                                       GAUS0330
  130 M=M-1                                                             GAUS0340
      IF (M.EQ.0) GO TO 150                                             GAUS0350
      MM=M+1                                                            GAUS0360
      DO 140 L=1,NL                                                     GAUS0370
      DO 140 J=MM,N                                                     GAUS0380
  140 B(M,L)=B(M,L)-A(M,J)*B(J,L)                                       GAUS0390
      GO TO 130                                                         GAUS0400
C                                                                       GAUS0410
  150 RETURN                                                            GAUS0420
      END                                                               GAUS0430
      SUBROUTINE GAUSS1(A,N,B,NL)                                       GAU10010
C                                                                       GAU10020
C     SOLVE FOR LAGRANGE MULTIPLIERS                                    GAU10030
C                                                                       GAU10040
      IMPLICIT REAL*8(A-H,O-Z)                                          GAU10050
      DIMENSION A(30,30),B(30)                                          GAU10060
C                                                                       GAU10070
      M=0                                                               GAU10080
C                                                                       GAU10090
C     REDUCTION OF M TH EQUATION                                        GAU10100
C                                                                       GAU10110
   50 M=M+1                                                             GAU10120
      MM=M+1                                                            GAU10130
C      PREVENT DIVIDE CHECKS AND UNDERFLOW WHEN FINDING THE             GAU10140
C                        LAGRANGE MULTIPLIERS                           GAU10150
      IF(A(M,M) .GE. 0.0 .AND. A(M,M) .LT. 1.0E-40) A(M,M)=1.0E-40      GAU10160
      IF(A(M,M) .LT. 0.0 .AND. A(M,M) .GT. -1.0E-40) A(M,M)=-1.0E-40    GAU10170
   60 B(M)=B(M)/A(M,M)                                                  GAU10180
      IF (M-N) 70,130,70                                                GAU10190
   70 DO 80 J=MM,N                                                      GAU10200
   80 A(M,J)=A(M,J)/A(M,M)                                              GAU10210
C     SUBSTITUTION INTO REMAINING EQUATIONS                             GAU10220
C                                                                       GAU10230
      DO 120 I=MM,N                                                     GAU10240
      IF (A(I,M)) 90,120,90                                             GAU10250
   90 DO 100 J=I,N                                                      GAU10260
      A(I,J)=A(I,J)-A(I,M)*A(M,J)                                       GAU10270
  100 A(J,I)=A(I,J)                                                     GAU10280
  110 B(I)=B(I)-A(I,M)*B(M)                                             GAU10290
  120 CONTINUE                                                          GAU10300
      GO TO 50                                                          GAU10310
C                                                                       GAU10320
C     BACK SUBSTITUTION                                                 GAU10330
C                                                                       GAU10340
  130 M=M-1                                                             GAU10350
      IF (M.EQ.0) GO TO 150                                             GAU10360
      MM=M+1                                                            GAU10370
      DO 140 J=MM,N                                                     GAU10380
  140 B(M)=B(M)-A(M,J)*B(J)                                             GAU10390
      GO TO 130                                                         GAU10400
C                                                                       GAU10410
  150 RETURN                                                            GAU10420
      END                                                               GAU10430
      SUBROUTINE GAUSS3(A,N,B,NL)                                       GAU30010
C                                                                       GAU30020
C     SOLVE ATC-03 DISPLACEMENTS                                        GAU30030
C                                                                       GAU30040
      IMPLICIT REAL*8(A-H,O-Z)                                          GAU30050
      DIMENSION A(170,170),B(170,2)                                     GAU30060
C                                                                       GAU30070
      M=0                                                               GAU30080
C                                                                       GAU30090
C     REDUCTION OF M TH EQUATION                                        GAU30100
C                                                                       GAU30110
   50 M=M+1                                                             GAU30120
      MM=M+1                                                            GAU30130
      DO 60 L=1,NL                                                      GAU30140
   60 B(M,L)=B(M,L)/A(M,M)                                              GAU30150
      IF (M-N) 70,130,70                                                GAU30160
   70 DO 80 J=MM,N                                                      GAU30170
   80 A(M,J)=A(M,J)/A(M,M)                                              GAU30180
C     SUBSTITUTION INTO REMAINING EQUATIONS                             GAU30190
C                                                                       GAU30200
      DO 120 I=MM,N                                                     GAU30210
      IF (A(I,M)) 90,120,90                                             GAU30220
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   90 DO 100 J=1,N
      A(I,J)=A(I,J)-A(I,M)*A(M,J)
  100 A(J,I)=A(I,J)
      DO 110 L=1,NL
  110 B(I,L)=B(I,L)-A(I,M)*B(M,L)
  120 CONTINUE
      GO TO 50
C
C     BACK SUBSTITUTION
C
  130 M=M-1
      IF (M.EQ.0) GO TO 150
      MM=M+1
      DO 140 L=1,NL
      DO 140 J=MM,N
  140 B(M,L)=B(M,L)-A(M,J)*B(J,L)
      GO TO 130
C
  150 RETURN
      END
      SUBROUTINE GAUSS4(A,N,B,NL)
C
C     SOLVE VIRTUAL DISPLACEMENTS FOR STATIC GRADIENTS
C
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION A(170,170),B(170,30)
C
      M=0
C
C     REDUCTION OF M TH EQUATION
C
   50 M=M+1
      MM=M+1
      DO 60 L=1,NL
   60 B(M,L)=B(M,L)/A(M,M)
      IF (M-N) 70,130,70
   70 DO 80 J=MM,N
   80 A(M,J)=A(M,J)/A(M,M)
C
C     SUBSTITUTION INTO REMAINING EQUATIONS
C
      DO 120 I=MM,N
      IF (A(I,M)) 90,120,90
   90 DO 100 J=I,N
      A(I,J)=A(I,J)-A(I,M)*A(M,J)
  100 A(J,I)=A(I,J)
      DO 110 L=1,NL
  110 B(I,L)=B(I,L)-A(I,M)*B(M,L)
  120 CONTINUE
      GO TO 50
C
C     BACK SUBSTITUTION
C
  130 M=M-1
      IF (M.EQ.0) GO TO 150
      MM=M+1
      DO 140 L=1,NL
      DO 140 J=MM,N
  140 B(M,L)=B(M,L)-A(M,J)*B(J,L)
      GO TO 130
C
  150 RETURN
      END
      SUBROUTINE GAUSS2(A,N,B,NL)
C
C     SOLVE GRADIENTS OF EIGENVECTORS
C
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION A(170,170),B(170,170)
C
      M=0
C
C     REDUCTION OF M TH EQUATION
C
   50 M=M+1
      MM=M+1
      DO 60 L=1,NL
   60 B(M,L)=B(M,L)/A(M,M)
      IF (M-N) 70,130,70
   70 DO 80 J=MM,N
   80 A(M,J)=A(M,J)/A(M,M)
C
C     SUBSTITUTION INTO REMAINING EQUATIONS
C
      DO 120 I=MM,N
      IF (A(I,M)) 90,120,90
   90 DO 100 J=I,N
      A(I,J)=A(I,J)-A(I,M)*A(M,J)
  100 A(J,I)=A(I,J)
      DO 110 L=1,NL
  110 B(I,L)=B(I,L)-A(I,M)*B(M,L)
  120 CONTINUE
      GO TO 50
C
C     BACK SUBSTITUTION
C
  130 M=M-1
      IF (M.EQ.0) GO TO 150
      MM=M+1
      DO 140 L=1,NL
      DO 140 J=MM,N
  140 B(M,L)=B(M,L)-A(M,J)*B(J,L)
      GO TO 130
C
  150 RETURN
      END
      SUBROUTINE REFDSP(MLO,NFS,MST,NS,NC,MCTS,IS,I3,D,A,R)
C
C     TRANSFER DISPLACEMENTS FROM MASS CENTER TO FRAME REF.
C
      IMPLICIT REAL*8(A-H,O-Z)
      COMMON/JUNK/JUK(62),AI(3,3),AJ(3,3),AR(3,3),AS(3,3),RJAV(3,2),SPAI
     1I(326)
      DIMENSION RF(30,30),D(10,1,2),A(1,6),R(170,6)
C
C     SET TRANSFORMATION PARAMETERS
C
      I=1
      DO 25 L=1,3
      DO 25 J=1,3
   25 AI(L,J)=0.
C
      IF=A(I,1)
      IFC=A(I,2)
      AI(1,1)=A(I,3)
      AI(1,2)=A(I,4)
      AI(2,2)=AI(1,1)
      AI(2,1)=-AI(1,2)
      NT=A(I,5)
      MC=A(I,6)
      AI(3,3)=1.
C
C     TRANSFER REF. FLOOR BY FLOOR
C
      NS=MST+1-NT
      NSNC=NS*NC
      NFR=NS*3
      DO 300 N=NT,MST
      NN=(N-NT)*I3+MCTS
      NI=(N- 1)*3
      AI( 1,3)=D(N,1,1)
      AI( 2,3)=D(N,1,2)
      DO 225 II=1,3
      DO 225 L=1,MLO
      RF(NI+II,L)=0.
      DO 225 KK=1,I3
      KI=KK+IS
  225 RF(NI+II,L)=RF(NI+II,L)+AI(II,KI)*R(NN+KK,L)
  300 CONTINUE
C
      DO 310 J=1,MLO
      DO 310 K=1,NFS
  310 R(MCTS+K,J)=RF(K,J)
C
      RETURN
      END
      SUBROUTINE REFDS1(NFS,MST,NS,NC,MCTS,IS,I3,D,A,R)
C
C     TRANSFER DISPLACEMENTS FROM MASS CENTER TO FRAME REF.
C
      IMPLICIT REAL*8(A-H,O-Z)
      COMMON/JUNK/ JUK(62),AI(3,3),AJ(3,3),AR(3,3),AS(3,3),RJAV(3,2),SPA
     1II(326)
      DIMENSION RF(30),D(10,1,2),A(1,6),R(170)
C
C     SET TRANSFORMATION PARAMETERS
C
      I=1
      DO 25 L=1,3
      DO 25 J=1,3
   25 AI(L,J)=0.
C
      IF=A(I,1)
      IFC=A(I,2)
      AI(1,1)=A(I,3)
      AI(1,2)=A(I,4)
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      A(2,2)=A(1,1)                                                     REF10210
      A(2,1)=-A(1,2)                                                    REF10220
      NT=A(1,5)                                                         REF10230
      NC=A(1,6)                                                         REF10240
      AT(3,3)=1.                                                        REF10250
C                                                                       REF10260
C     TRANSFER REF. FLOOR BY FLOOR                                      REF10270
C                                                                       REF10280
      NS=MST+1-NT                                                       REF10290
      NSNC=NS*NC                                                        REF10300
      NFR=NS*3                                                          REF10310
      IS=0                                                              REF10320
      DO 300 N=NT,MST                                                   REF10330
      NN=(N-NT)*I3+NCTS                                                 REF10340
      NI=(N-1)*3                                                        REF10350
      AT( 1,3)=D(N,1,1)                                                 REF10360
      AT( 2,3)=D(N,1,2)                                                 REF10370
      DO 225 II=1,3                                                     REF10380
      RF(NI+II)=0.                                                      REF10390
      DO 225 KK=1,I3                                                    REF10400
      KI=KK+IS                                                          REF10410
  225 RF(NI+II)=RF(NI+II)+AT(II,KI)*R(NN+KK)                            REF10420
  300 CONTINUE                                                          REF10430
C                                                                       REF10440
      DO 310 K=1,NFS                                                    REF10450
  310 R(NCTS+K)=RF(K)                                                   REF10460
C                                                                       REF10470
      RETURN                                                            REF10480
      END                                                               REF10490
      SUBROUTINE REFDS3(MLD,NFS,MST,NS,NC,NCTS,IS,I3,D,A,R)             REF30010
C                                                                       REF30020
C     TRANSFER DISPLACEMENTS FROM MASS CENTER TO FRAME REF.             REF30030
C                                                                       REF30040
      IMPLICIT REAL*8(A-H,O-Z)                                          REF30050
      COMMON/JUNK/JUK(62),AI(3,3),AJ(3,3),AR(3,3),AS(3,3),RJAV(3,2),SPAIREF30060
     1I(326)                                                            REF30070
      DIMENSION RF(30,30),D(10,1,2),A(1,6),R(170,30)                    REF30080
C                                                                       REF30090
C     SET TRANSFORMATION PARAMETERS                                     REF30100
C                                                                       REF30110
      J=1                                                               REF30120
      DO 25 L=1,3                                                       REF30130
      DO 25 J=1,3                                                       REF30140
   25 AT(L,J)=0.                                                        REF30150
C                                                                       REF30160
      IF=A(1,1)                                                         REF30170
      IFC=A(1,2)                                                        REF30180
      AT(1,1)=A(1,3)                                                    REF30190
      AT(1,2)=A(1,4)                                                    REF30200
      AT(2,2)=A(1,1)                                                    REF30210
      AT(2,1)=-A(1,2)                                                   REF30220
      NT=A(1,5)                                                         REF30230
      NC=A(1,6)                                                         REF30240
      AT(3,3)=1.                                                        REF30250
C                                                                       REF30260
C     TRANSFER REF. FLOOR BY FLOOR                                      REF30270
C                                                                       REF30280
      NS=MST+1-NT                                                       REF30290
      NSNC=NS*NC                                                        REF30300
      NFR=NS*3                                                          REF30310
      DO 300 N=NT,MST                                                   REF30320
      NN=(N-NT)*I3+NCTS                                                 REF30330
      NI=(N-1)*3                                                        REF30340
      AT( 1,3)=D(N,1,1)                                                 REF30350
      AT( 2,3)=D(N,1,2)                                                 REF30360
      DO 225 II=1,3                                                     REF30370
      DO 225 L=1,MLD                                                    REF30380
      RF(NI+II,L)=0.                                                    REF30390
      DO 225 KK=1,I3                                                    REF30400
      KI=KK+IS                                                          REF30410
  225 RF(NI+II,L)=RF(NI+II,L)+AT(II,KI)*R(NN+KK,L)                      REF30420
  300 CONTINUE                                                          REF30430
C                                                                       REF30440
      DO 310 J=1,MLD                                                    REF30450
      DO 310 K=1,NFS                                                    REF30460
  310 R(NCTS+K,J)=RF(K,J)                                               REF30470
C                                                                       REF30480
      RETURN                                                            REF30490
      END                                                               REF30500
      SUBROUTINE FORCES(MLD,NC,NS,MM,MN,NN,ISTAT,LS,NNM,NST,NCP,        FORC0010
     1NBP,NB,NPAN,NTRU,NLD,ALAB,IP,PDIS1,AMA2,AMA4,AMA5,IOV,P6)         FORC0020
C                                                                       FORC0030
C     COMPUTE STATIC AND DYNAMIC MEMBER FORCES                          FORC0040
C                                                                       FORC0050
      IMPLICIT REAL*8(A-H,O-Z)                                          FORC0060
      COMMON/DATA1/CLN(14,2),CP(26,45),BP(15,45),FEF(5,10),LB(10,15,3),LFORC0070
     1DB(10,15,3),LC(10,14,2),LP(3,20),IFEF(10),PP(22,20),LT(3,40),IP(9,FORC0080
     240),LIN,ID,GST,GCO,NSTEEL,NSTEE2,NATC,NLDDD,NTOT1                 FORC0090
      COMMON/DATA2/QQ(4,15,10)                                          FORC0100
      COMMON/DATA3/PLOAD(140),SD(10,15),AMA(280),IFFO,IFCFO,XIFO,YIFO   FORC0110
      COMMON/FO4/S(406,10),C(28,28,10),E(28,190,10),XM(246,10),RF4(28,  FORC0120
     13,10),RF5(28,30,10),RF6(28,1,10)                                  FORC0130
      COMMON/TRAN1/OK(7(10,1,2),AAR(T(1,6),U(170,6),U2(170,6)           FORC0140
      COMMON/NEW/A66(243,10),B(243,16),AM(8,10),FM(8)                   FORC0150
      COMMON/JUN3/IF,IFC,ND,NF,LN(12),F(8,16),Q(4,3),P(8),FHED(4),PHIN(8FORC0160
     1),F19(8,6)                                                        FORC0170
      COMMON/STIF/ ASA(12,12),SA(8,12),T(8,12),TAC(8,12,14,10),TAB(3,6, FORC0180
     115,10),TAD(1,8,40),TAP(4,10,20)                                   FORC0190
      COMMON/STRES/SCOL(10,14,6,6),SBM(10,15,6,2),SPAN(20,6,5),SDIA(40,6FORC0200
     1,1),F2,CON(30),P1,P2,DIS(10,3),LCON(5,30),L6,L7,L8,L9,CONCO(8,30) FORC0210
      COMMON/EIGNV/EIGV(170),X(170,170),VAL(10),NIO,N9,C1(10),L2(10)    FORC0220
     1,XMASC(10),XMAS(10),ISNN,L3(10),L4(10),NODE,PHIN(10),OPHI(10),PHILFORC0230
     2(170,10),OPHIM(10),PHI(10),UVAL(10)                               FORC0240
      COMMON/DYNAM/VMAX(170),FMA(170),DDIS(10,3),X2(170,10),PQ(10),ETA(3,FORC0250
     110),VMI(170),SAA(3,10),PH(10),VN(170,10)                          FORC0260
      COMMON/PLOT1/IPRF,IPAS,IPRE,IPAEM,IPAD                            FORC0270
      DIMENSION ALAB(3),PDIS(170,30),FN2(8,16),PDIS1(170,30)            FORC0280
     1,AMA2(140),AMA4(10),AMA5(10),FM4(12,17),P6(12,30)                 FORC0290
C                                                                       FORC0300
C     INDIRECT LOOP SEE LINE 610                                        FORC0310
C                                                                       FORC0320
C     SET FOUNDATION DISPLACEMENTS AND FRAME DISPLACEMENTS              FORC0330
C                                                                       FORC0340
  100 NLD1=NLD                                                          FORC0350
      NBKS=3                                                            FORC0360
      NSNC=NS*NC                                                        FORC0370
      NS3=3*NS                                                          FORC0380
      NSTC=NSNC+NS3                                                     FORC0390
      KL=MM+1                                                           FORC0400
      IF(ISTAT.EQ.2) GO TO 480                                          FORC0410
      DO 475 L=1,MLD                                                    FORC0420
      DO 425 K=1,MN                                                     FORC0430
  425 R(K,L)=0.0                                                        FORC0440
      DO 450 N=1,NSNC                                                   FORC0450
      KK=MN+N                                                           FORC0460
  450 R(KK,L)=U(N,L)                                                    FORC0470
      DO 460 N=1,NC                                                     FORC0480
      KKK=KK+N                                                          FORC0490
  460 R(KKK,L)=0.                                                       FORC0500
      DO 470 N=1,NS3                                                    FORC0510
      KM=KKK+N                                                          FORC0520
  470 R(KM,L)=U(NSNC+N,L)                                               FORC0530
      DO 471 N=1,3                                                      FORC0540
  471 R(KM+N,L)=0.                                                      FORC0550
  475 CONTINUE                                                          FORC0560
      GO TO 295                                                         FORC0570
C                                                                       FORC0580
C     PLACE DYNAMIC DISPLACEMENTS INTO R                                FORC0590
C                                                                       FORC0600
  480 DO 485 K=1,MN                                                     FORC0610
  485 R(K,1)=0.0                                                        FORC0620
      DO 490 N=1,NSNC                                                   FORC0630
      KK=MN+N                                                           FORC0640
  490 R(KK,1)=VMI(N)                                                    FORC0650
      DO 495 N=1,NC                                                     FORC0660
      KKK=KK+N                                                          FORC0670
  495 R(KKK,1)=0.0                                                      FORC0680
      DO 497 N=1,NS3                                                    FORC0690
      KM=KKK+N                                                          FORC0700
  497 R(KM,1)=VMI(NSNC+N)                                               FORC0710
      DO 498 N=1,3                                                      FORC0720
  498 R(KM+N,1)=0.0                                                     FORC0730
C                                                                       FORC0740
C     STORY BY STORY  CALCULATION OF MEMBER FORCES                      FORC0750
C                                                                       FORC0760
  295 N=NS                                                              FORC0770
C                                                                       FORC0780
C     CALCULATE ROTATIONAL DISPLACEMENTS AT LEVEL N                     FORC0790
C                                                                       FORC0800
  300 IF(ISTAT.NE.1) GO TO 303                                          FORC0810
  103 DO 301 I=1,MM                                                     FORC0820
      DO 301 J=1,3                                                      FORC0830
  301 R(I,J)=RF4(I,J,N)                                                 FORC0840
      IF(IP.NE.1) GO TO 303                                             FORC0850
      CALL ROTDIS(PDIS1,LIM,MLD,MN,NSNC,NN,MM,LS,PDIS,N,NS,NC,LCON)     FORC0860
  303 MMP=MM+1                                                          FORC0870
      DO 400 L=1,MLD                                                    FORC0880
      DO 401 J=MMP,NN                                                   FORC0890
      KF=KH(J,N)                                                        FORC0900
      IF (KF.GT.MN) GO TO 401                                           FORC0910
      IF (J.GT.MN) GO TO 402                                            FORC0920
      DO 403 K=KF,MM                                                    FORC0930
  403 R(K,L)=R(K,L)-C(K,J-MM,N)*R(J,L)                                  FORC0940
      GO TO 401                                                         FORC0950
  402 DO 404 K=KF,MM                                                    FORC0960
  404 R(K,L)=R(K,L)-E(K,J-MM,N)*R(J,L)                                  FORC0970
```

```
401 CONTINUE
    IB=LS
    DO 400 II=1,MM
    I=MM+1-II
    KK=I-1
    KF=KH(I,N)
    IB=IB-1
    IF (KF.GT.KK) GO TO 400
    DO 405 K=KF,KK
405 R(K,L)=R(K,L)-S(IB+K,N)*R(I,L)
400 CONTINUE
    IF(ISTAT.NE.2) GO TO 101
    DO 607 I=1,NN
    R46(I,N)=R(I,1)
607 CONTINUE
C
C     CALCULATE COLUMN FORCES
C
101 LV=NS -N+1
    K=NST-NS
    NF=8
    ND=12
    IF(ISTAT.EQ.1.AND.IP.NE.1.AND.IPRF.NE.0) WRITE(6,2009) LV
    IF(ISTAT.EQ.1.AND.IP.NE.1.AND.IPRF.NE.0) WRITE(6,2007)
    IF(ISTAT.EQ.1.AND.IP.NE.1.AND.IPRF.NE.0) WRITE(6,2001)
    DO 300 M=1,NC
    NF=8
    ND=12
    MASC=M+NC*(N-1)
    MC=LC(N,M,1)
    DEL=CP(22,MC)
    XL =SD(N+K,2)
    KK=LC(N,M,2)
    B1=CLN(KK,1)-CLN(M,1)
    B2=CLN(KK,2)-CLN(M,2)
    B3=B1*B1+B2*B2
    B3=DSQRT(B3)
    IF(B3.LE.0.) STOP
    CSA=B1/B3
    SNA=B2/B3
    XL1=CLN(M,1)
    YL1=CLN(M,2)
    DT=CP(8,MC)
    DB=CP(9,MC)
    XLR=XL-DT-DB
    IF(MC.GT.NST(EEL)) XLR=XL
    IF(ISTAT.EQ.1) GI=386.4*AMA(MASC)
    SG1=GI/XLR
    A=-YL1*SNA-XL1*CSA
    B=-YL1*CSA+XL1*SNA
    TAC(7,1,M,N)=-SG1*CSA
    TAC(7,2,M,N)=-SG1*SNA
    TAC(7,3,M,N)=-SG1*B
    TAC(7,4,M,N)=0.
    TAC(7,5,M,N)=0.
    TAC(7,6,M,N)=0.
    TAC(7,7,M,N)=SG1*CSA
    TAC(7,8,M,N)=SG1*SNA
    TAC(7,9,M,N)=SG1*B
    TAC(7,10,M,N)=0.
    TAC(7,11,M,N)=0.
    TAC(7,12,M,N)=0.
    TAC(8,1,M,N)=-SG1*SNA
    TAC(8,2,M,N)=SG1*CSA
    TAC(8,3,M,N)=-SG1*A
    TAC(8,4,M,N)=0.
    TAC(8,5,M,N)=0.
    TAC(8,6,M,N)=0.
    TAC(8,7,M,N)=SG1*SNA
    TAC(8,8,M,N)=-SG1*CSA
    TAC(8,9,M,N)=SG1*A
    TAC(8,10,M,N)=0.
    TAC(8,11,M,N)=0.
    TAC(8,12,M,N)=0.
C
312 LM(6)=4*NC+M+NC*(N-1)
    LM(5)=2*M
    LM(4)=LM(5)-1
    LM(11)=LM(5)+2*NC
    LM(10)=LM(4)+2*NC
    LM(12)=LM(6)+NC
    LM(3)=5*NC+NS*NC+3*N
    LM(2)=LM(3)-1
    LM(1)=LM(2)-1
    LM(9)=LM(3)+3
    LM(8)=LM(9)-1
    LM(7)=LM(8)-1
    CALL REFROT(1,NN,NLD,NLD,M,N,ISTAT,B1,B2,XLR,SNA,CSA,MC,LV,IP,FM2
   1,PDIS,N9,IDY,NSNC,NS,NSTC,NC,LS,NNM,NST,NB,NPAN,NTRU,NCP,NBP,FM4)
    IF(IP.EQ.1) CALL GRAD(PDIS,LM,4,ND,LIM,N,M,1,FM2,CSA,SNA,XM,LCON,
   1B1,B2,NS,NSNC,ID,NC,AMA2,AMA4,AMA5,0.,0.,0.,IDY,DEL,LB,P6,CONCO)
C
    IF(ISTAT.EQ.1.AND.IP.NE.1.AND.IPRS.NE.0) WRITE(6,2005)
500 CONTINUE
    IF(IP.EQ.1)GO TO 900
    IF(IP.NE.1.AND.IPRS.NE.0) WRITE(6,4000)
    IF(IP.NE.1.AND.IPRS.NE.0) WRITE(6,4001)
    DO 200 M=1,NC
    IF(IP.NE.1.AND.IPRS.NE.0) WRITE(6,2005)
    DO 200 I=1,NLD1
    WRITE(76,4002) M,I,(SCOL(N,M,I,J),J=1,6)
    IF(IPRS.NE.0) WRITE(6,4002) M,I,(SCOL(N,M,I,J),J=1,6)
200 CONTINUE
C
C     CALCULATE BEAM FORCES
C
900 IF(NB.EQ.0) GO TO 565
    IF(ISTAT.EQ.1.AND.IP.NE.1.AND.IPRF.NE.0) WRITE(6,2008)
    IF(ISTAT.EQ.1.AND.IP.NE.1.AND.IPRF.NE.0) WRITE(6,2002)
    ND=6
    DO 600 M=1,NB
    NF=3
    ND=6
    MB=LB(N,M,3)
    DEL=BP(13,MB)
    CDEP=BP(10,MB)/2.
    OI=BP(4,MB)
    IF(MB.EQ.NBP) GO TO 600
    KI=LB(N,M,1)
    KJ=LB(N,M,2)
    B1=CLN(KJ,1)-CLN(KI,1)
    B2=CLN(KJ,2)-CLN(KI,2)
    B3=B1*B1+B2*B2
    B3=DSQRT(B3)
    XL=B3
    WI=BP(8,MB)
    WJ=BP(9,MB)
    XLR=XL-WI-WJ
    KK=LC(N,KI,2)
    CSA=(CLN(KK,1)-CLN(KI,1))/XLR
    SNA=(CLN(KK,2)-CLN(KI,2))/XLR
C
    LM(3)=4*NC+KI+NC*(N-1)
    LM(2)=2*KI
    LM(1)=LM(2)-1
    LM( 6)=4*NC+KJ+NC*(N-1)
    LM( 5)=2*KJ
    LM(4)=LM( 5)-1
    IF(ISTAT.NE.1) GO TO 547
    DO 540 L=1,3
    DO 528 I=1,4
528 Q(I,L)=0.
    J=LOB(N,M,L)
    IF (J) 540,540,530
530 IF(IFEF(J).EQ.0) XL=XLR
    V=FEF(5,J)*XL/2.
    YM=V*XL/6.
    Q(1,L)= FEF(1,J)+YM
    Q(2,L)=-FEF(3,J)-YM
    Q(3,L)=Q(1,L)
    Q(4,L)=Q(2,L)
    IF(IFEF(J)) 531,532,531
531 Q(3,L)= Q(3,L) + .5*FEF(5,J)*(BP(8,MB)**2) - V*BP(8,MB)
    Q(4,L)= Q(4,L) - .5*FEF(5,J)*(BP(9,MB)**2) + V*BP(9,MB)
    GO TO 533
532 Q(1,L)= Q(1,L)+V*BP(8,MB)
    Q(2,L)= Q(2,L) - V*BP(9,MB)
533 QQ(1,M,N)=QQ(1,M,N) + Q(1,L)*XM(L,NLD)
    QQ(2,M,N)=QQ(2,M,N) + Q(2,L)*XM(L,NLD)
    QQ(3,M,N)=QQ(3,M,N) + Q(3,L)*XM(L,NLD)
    QQ(4,M,N)=QQ(4,M,N) + Q(4,L)*XM(L,NLD)
540 CONTINUE
547 CALL REFROT(2,NN,NLD,NLD,M,N,ISTAT,WI,WJ,XLR,SNA,CSA,MB,LV,IP,FM2,
   1PDIS,N9,IDY,NSNC,NS,NSTC,NC,LS,NNM,NST,NB,NPAN,NTRU,NCP,NBP,FM4)
    IF(IP.EQ.1) CALL GRAD(PDIS,LM,3,ND,LIM,N,M,2,FM2,CSA,SNA,XM,LCON,
   1B1,B2,NS,NSNC,ID,NC,AMA2,AMA4,AMA5,CDEP,OI,Q,IDY,DEL,LB
   2,P6,CONCO)
    IF(ISTAT.EQ.1.AND.IP.NE.1.AND.IPRS.NE.0) WRITE(6,2005)
600 CONTINUE
    IF(IP.EQ.1) GO TO 901
    IF(IPRS.NE.0) WRITE(6,4003)
    IF(IPRS.NE.0) WRITE(6,4004)
    DO 201 M=1,NB
    IF(IPRS.NE.0) WRITE(6,2005)
    DO 201 I=1,NLD1
    WRITE(76,4002) M,I,(SBM(N,M,I,J),J=1,2)
```

```
      IF(IPRS.NE.0) WRITE(6,4002) M,I,(SBM(N,M,I,J),J=1,2)
  201 CONTINUE
C
C     CALCULATE PANEL FORCES
C
  901 IF(NPAN.EQ.0) GO TO 565
      DO 770 L=1,NPAN
      NP=NS-LP(1,L)+1
      IF (NP.NE.N) GO TO 770
      GO TO 772
  770 CONTINUE
      GO TO 565
  772 IF(ISTAT.EQ.1.AND.IP.NE.1.AND.IPRF.NE.0) WRITE(6,2004)
      IF(ISTAT.EQ.1.AND.IP.NE.1.AND.IPRF.NE.0) WRITE(6,2003)
      LNF=0
      ND=10
      DO 800 L=1,NPAN
      NF=4
      NP=NS-LP(1,L)+1
      IF(NP.NE.N) GO TO 800
      DEL=PP(1,L)
  780 IF(LNF.EQ.NF) GO TO 790
      LNF=NF
  790 XL=SD(N,2)
      KI=LP(2,L)
      N=KI
      KJ=LP(3,L)
      LOAD1=NC*(NP-1)+KI
      LOAD2=NC*(NP-1)+KJ
      B1=CLN(KJ,1)-CLN(KI,1)
      B2=CLN(KJ,2)-CLN(KI,2)
      B3=B1*B1+B2*B2
      B3=DSQRT(B3)
      CSA=B1/B3
      SNA=B2/B3
      AR=CLN(KI,1)*CLN(KJ,2)-CLN(KJ,1)*CLN(KI,2)
      DF=AR/B3
      D=B3
      IF(ISTAT.EQ.1) G1=386.4*(AMA(LOAD1)+AMA(LOAD2))
      SG1=G1/XL
      TAP(4,1,L)=-SG1*CSA
      TAP(4,2,L)=-SG1*SNA
      TAP(4,3,L)=SG1*DF
      TAP(4,4,L)=0.
      TAP(4,5,L)=0.
      TAP(4,6,L)=-TAP(4,1,L)
      TAP(4,7,L)=-TAP(4,2,L)
      TAP(4,8,L)=-TAP(4,3,L)
      TAP(4,9,L)=0.
      TAP(4,10,L)=0.
C
      LM(3)=5*NC+NS*NC+3*N
      LM(2)=LM(3)-1
      LM(1)=LM(2)-1
      LM(4)=4*NC+KI+NC*(N-1)
      LM(5)=4*NC+KJ+NC*(N-1)
      LM(8)=LM(3)+3
      LM(7)=LM(8)-1
      LM(6)=LM(7)-1
      LM(9)=LM(4)+NC
      LM(10)=LM(5)+NC
      CALL REFROT(3,NN,NLD,MLD,L,N,ISTAT,B1,B2,XL,SNA,CSA,D,LV,IP,FM2,
     1PDIS,N9,IDY,NSNC,NS,NSTC,NC,LS,NNM,NST,NB,NPAN,NTRU,NCP,NBP,FM4)
      IF(IP.EQ.1) CALL GRAD(PDIS,LM,3,ND,LIM,N,L,3,FM2,CSA,SNA,XM,LCON,
     1B1,B2,NS,NSNC,ID,NC,AMA2,AMA4,AMA5,0.,0.,0.,IDY,DEL,LB,P6,CONCO)
      IF(ISTAT.EQ.1.AND.IP.NE.1.AND.IPRS.NE.0) WRITE(6,2005)
  800 CONTINUE
      IF(IP.EQ.1) GO TO 565
      IF(IPRS.NE.0) WRITE(6,4005)
      IF(IPRS.NE.0) WRITE(6,4006)
      DO 210 M=1,NPAN
      NP=NS-LP(1,M)+1
      IF(NP.NE.N) GO TO 210
      IF(IPRS.NE.0) WRITE(6,2005)
      DO 202 I=1,NLD1
      IF(IPRS.NE.0) WRITE(6,4002) M,I,(SPAN(M,I,J),J=1,5)
      WRITE(76,4002) M,I,(SPAN(M,I,J),J=1,5)
  202 CONTINUE
  210 CONTINUE
C
C     CALCULATE BRACE FORCES
C
  565 IF (NTRU.EQ.0) GO TO 690
      DO 650 L=1,NTRU
      NP=NS-LT(1,L)+1
      IF(NP.NE.N) GO TO 650
      IF(ISTAT.EQ.1.AND.IP.NE.1.AND.IPRF.NE.0) WRITE(6,2006)
      GO TO 660
  650 CONTINUE
      GO TO 690
  660 NF=1
      ND=8
      DO 680 L=1,NTRU
      NP=NS-LT(1,L)+1
      IF (NP.NE.N) GO TO 680
      DEL=TP(6,L)
      KJ=LT(2,L)
      KI=LT(3,L)
C
      LM(3)=5*NC+NS*NC+3*N
      LM(2)=LM(3)-1
      LM(1)=LM(2)-1
      LM(4)=4*NC+KJ+NC*(N-1)
      LM(7)=LM(3)+3
      LM(6)=LM(7)-1
      LM(5)=LM(6)-1
      LM(8)=5*NC+KI+NC*(N-1)
      CALL REFROT(4,NN,NLD,MLD,L,N,ISTAT,B1,B2,XL,SNA,CSA,D,LV,IP,FM2,
     1PDIS,N9,IDY,NSNC,NS,NSTC,NC,LS,NNM,NST,NB,NPAN,NTRU,NCP,NBP,FM4)
      IF(IP.EQ.1) CALL GRAD(PDIS,LM,1,ND,LIM,N,L,4,FM2,CSA,SNA,XM,LCON,
     1B1,B2,NS,NSNC,ID,NC,AMA2,AMA4,AMA5,0.,0.,0.,IDY,DEL,LB,P6,CONCO)
      IF(ISTAT.EQ.1.AND.IP.NE.1.AND.IPRS.NE.0) WRITE(6,2005)
  680 CONTINUE
      IF(IP.EQ.1) GO TO 690
      IF(IPRS.NE.0) WRITE(6,4007)
      IF(IPRS.NE.0) WRITE(6,4008)
      DO 211 M=1,NTRU
      NP=NS-LT(1,M)+1
      IF(NP.NE.N) GO TO 211
      IF(IPRS.NE.0) WRITE(6,2005)
      DO 203 I=1,NLD1
      IF(IPRS.NE.0) WRITE(6,4002) M,I,SDIA(M,I,1)
      WRITE(76,4002) M,I,SDIA(M,I,1)
  203 CONTINUE
  211 CONTINUE
C
C     SHIFT DISPLACEMENTS
C
  690 DO 212 K=1,NN
      KK=NN+K
      DO 570 L=1,NLD
      R(KK,L)=R(K,L)
  570 R(K,L)=0.0
      IF(IP.NE.1) GO TO 212
      DO 571 L=1,LIM
      PDIS(KK,L)=PDIS(K,L)
      PDIS(K,L)=0.0
  571 CONTINUE
  212 CONTINUE
C
  610 N=N-1
      IF (N.NE.0) GO TO 300
      IF(ISTAT.NE.1) GO TO 614
      IF(IP.EQ.1) GO TO 614
C
C     CALCULATE AND PRINT THE FRAME DISPLACEMENTS
C
      IF(NLD1.EQ.NLDDD.AND.IPRD.NE.0) WRITE(6,3000)
      IF(NLD1.EQ.NTOT1.AND.IPRD.NE.0)                 WRITE(6,3001)
      IF(IPRD.NE.0) WRITE(6,3010) (N,N=1,NLD1)
      DO 613 N=1,NS
      NL=NS+1-N
      DO 612 II=1,3
      NV=(N-1)*3+II+NSNC
      DO 611 L=1,NLD
      F19(L,II)=0.0
      F(L,II)=0.
      DO 611 J=1,6
      F19(L,II)=F19(L,II)+U2(NV,J)*XM(J,L)
  611 F(L,II)=F(L,II)+U(NV,J)*XM(J,L)
      IF(IPRD.NE.0) WRITE(6,2000) NL,RLAB(II),(F19(KD,II),KD=1,NLD1)
      WRITE(76,2000) NL,RLAB(II),(F19(KD,II),KD=1,NLD1)
      IF(II.EQ.3.AND.IPRD.NE.0) WRITE(6,2005)
  612 CONTINUE
      IF(ID.EQ.0.OR.ID.EQ.1.OR.ID.EQ.4) GO TO 613
C
C     CHECK FOR ACTIVE CONSTRAINTS
C
      IF(IP.EQ.1) GO TO 613
      CALL SORT(5,NL,0,NLD,0,NL,FM2,XM)
  613 CONTINUE
  614 CONTINUE
C
  615 RETURN
C
 2000 FORMAT(I6,5X,A4,5X,8F14.7)
```

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2001 FORMAT (128H0  LINE LOAD                  TORSIONAL          MAJOR AXIS
    1                     AXIAL           MINOR AXIS              MAJOR
    2      MINOR /129H                              MOMENT     TOP MOMENT     BOT
    3 MOMENT           FORCE     TOP MOMENT     BOT MOMENT              SHEAR
    4          SHEAR   )
2002 FORMAT(83H                              TORSIONAL     CENTERLINE MOMENTS
    1              BEAM END MOMENTS/87H     BAY    LOAD             MOMENT
    2 I   MOMENT         J   MOMENT       I   MOMENT        J   MOMENT)
2003 FORMAT(12H PANEL   LOAD,6X,13H    TOP-MOMENT,13X,10HBOT-MOMENT,13X,1
    1IHAXIAL-FORCE,12X,11HSHEAR-FORCE )
2004 FORMAT(/13H PANEL FORCES /)
2005 FORMAT (1H )
2006 FORMAT(/17H BRACING ELEMENTS//12H BRACE  LOAD,11X,11HAXIAL-FORCE )
2007 FORMAT(///14H COLUMN FORCES)
2008 FORMAT(/12H BEAM FORCES /)
2009 FORMAT(51H1 LOAD COMBINATIONS------MEMBER FORCES------LEVEL NO.,I3)
3000 FORMAT(///11H STATIC LOAD COMBINATION------LATERAL AND ROTATIONAL M
    1. C. DISPLACEMENTS)
3001 FORMAT(///83H STATIC AND DYNAMIC LOAD COMBINATION------LATERAL AND
    1ROTATIONAL M. C. DISPLACEMENTS)
3010 FORMAT(//6H LEVEL,3X,9HDIRECTION,6X,I2,7(12X,I2))
4000 FORMAT(/16H COLUMN STRESSES/)
4001 FORMAT(12H0  LINE LOAD,12X,7HTOP-MAX,7X,7HTOP-MIN,7X,7HBOT-MAX,7X,
    17HBOT-MIN,6X,9HSHEAR-MAJ,5X,9HSHEAR-MIN)
4002 FORMAT(2I6,5X,6F14.4)
4003 FORMAT(/15H  BEAM STRESSES/)
4004 FORMAT(12H0    BAY LOAD,12X,8HI NORMAL,6X,8HJ NORMAL)
4005 FORMAT(/15H PANEL STRESSES/)
4006 FORMAT(12H0 PANEL LOAD,12X,7HTOP-MAX,7X,7HTOP-MIN,7X,7HBOT-MAX,7X,
    17HBOT-MIN,9X,5HSHEAR)
4007 FORMAT(/15H BRACE STRESSES/)
4008 FORMAT(12H0 BRACE LOAD,14X,5HAXIAL)
C
      END
      SUBROUTINE REFRO(ID,NN,MLD,NLD,M,N,ISTAT,B1,B2,KLR,SNA,CSA,L,LV
     1,IP,FM2,PDIS,N9,IOV,NCYS,NS,NSTL,NC,LS,NNA,NST,NB,NPAN,NTRU,NCP,N
     2BP,FM4)
C
C     COMPUTE STATIC LOAD CASE COMBINATION AND PRINTOUT MEMBER FORCES
C
      IMPLICIT REAL*8(A-H,O-Z)
      COMMON/DATA1/CLN(14,2),CP(26,45),BP(15,45),FEF(5,10),LB(10,15,3),L
     1DB(10,15,3),LCC(10,15,3),LP(3,20),IFEF(10),PP(12,20),LT(5,40),IP(9
     2,40),LIN,ID,GST,GCO,NSTEEL,NSTEE2,NATC,NLODO,NTOT
      COMMON/DATA2/COCOL(9,14,10),COBM(5,15,10),COPAN(5,20),CODIA(2,40)
      COMMON/NEW/R66(72),10),A(24),16),NA(6),10),FM(8)
      COMMON/JUNS/IF,IFC,ND,NF,LM(12),F(8,18),Q(6,3),P(8),FMED(4),PMIN(8
     1),F1(8,8)
      COMMON/SIF/ ASA(12,12),SA(8,12),T(8,12),TAC(8,12,14,10),TAB(3,6,
     115,10),TAD(1,8,40),TAP(4,10,20)
      COMMON/STRES/SCOL(10,14,6,6),SBM(10,15,6,2),SPAN(20,6,5),SDIA(40,6
     1,L1,F2,CON(30),P1,P2,DIS(10,3),LCON(5,30),L6,L7,L8,L9,CONCOL(6,30)
      COMMON/TRAN/DI(10,3,2),A(1,6),AR(170,6),U2(10,6)
      COMMON/DYNAM/VMA(170),FMA(170),DDIS(10,3),X2(170,10),PQ(10),ETA(3,
     110),VM(170),SAA(3,10),PH(10,10),VN(10,10)
      COMMON/JUNK2/NN6,NAD1,NAD2,LSL,ISEC
      COMMON/STEP/C1(15,3),DIX(2,3),NUM22
      COMMON/PLOT/IPAF,IPRS,IPRE,IPAEN,IPRD
      DIMENSION FM1(8,16),FM2(8,16),FM3(8),PDIS(170,30),SCO(4),FM4(12,17
     1),BJ(3,3),LCON(5,10),PDIS3(170,10)
C
      DO 707 I=1,3
      DO 707 J=1,3
  707 BJ(I,J)=0.0
      NLD1=NLD
      P3=.85
      IGN=0
      IF(IP.NE.1) GO TO 2
      IF(ID.LT.4) GO TO 2
      DO 309 I=1,LIN
      IF(LCON(I,1).NE.6) GO TO 309
      IGN=IGN+1
      DO 1 J=1,NN
      R(J,6+IGN)=PDIS(J,I)
    1 CONTINUE
  309 CONTINUE
    2 IGN=IGN+6
      IF(IOV.NE.1) GO TO 5
      LIN6=LIN-N9
      DO 4 J=1,N9
      DO 4 J1=1,NN
      R(J1,IGN+J)=PDIS(J1,LIN6+J)
    4 CONTINUE
      IGN=IGN+N9
      IGN2=IGN
    5 CONTINUE
      DO 6 I=1,LIN
      IF(LCON(I,1).NE.8.AND.LCON(I,1).NE.9) GO TO 6
      IGN=IGN+1
      DO 7 J=1,NN
      R(J,IGN)=R66(J,N)
    7 CONTINUE
      GO TO 8
    6 CONTINUE
    8 IF(ISTAT.EQ.2) IGN=1
C
C     STATIC CASE
C
      DO 100 I=1,NF
      DO 100 J=1,IGN
  100 F(I,J)=0.0
C
  150 DO 200 K=1,ND
      KK=LM(K)
      DO 200 I=1,NF
      DO 200 J=1,IGN
      IF(ID.EQ.1) F(I,J)=F(I,J)+TAC(I,K,M,N)*R(KK,J)
      IF(ID.EQ.2) F(I,J)=F(I,J)+TAB(I,K,M,N)*R(KK,J)
      IF(ID.EQ.3) F(I,J)=F(I,J)+TAP(I,K,N)*R(KK,J)
      IF(ID.EQ.4) F(I,J)=F(I,J)+TAD(I,K,N)*R(KK,J)
  200 CONTINUE
      DO 210 I=1,NF
      FM(I)=0.
      DO 210 J=1,6
  210 FM(I)=FM(I)+F(I,J)*XM(J,NLD)
      DO 211 I=1,NF
      DO 211 J=1,IGN
  211 FM1(I,J)=F(I,J)
C
      IF(ID.EQ.2.OR.ID.EQ.3.OR.ID.EQ.4) GO TO 430
C
C     STATIC COLUMN FORCES
C
      IF(B1.GE.0.AND.B2.GE.0) GO TO 400
      DO 300 I=1,IGN
      FM1(2,I)=-FM1(2,I)
      FM1(3,I)=-FM1(3,I)
      FM1(5,I)=-FM1(5,I)
      FM1(6,I)=-FM1(6,I)
      FM1(7,I)=-FM1(7,I)
  300 FM1(8,I)=-FM1(8,I)
  400 DO 410 I=1,IGN
      FM2(1,I)=COCOL(1,M,N)*FM1(1,I)
      FM2(2,I)=COCOL(2,M,N)*FM1(2,I)+COCOL(3,M,N)*FM1(3,I)
      FM2(3,I)=COCOL(3,M,N)*FM1(2,I)+COCOL(4,M,N)*FM1(3,I)
      FM2(4,I)=COCOL(5,M,N)*FM1(4,I)
      FM2(5,I)=COCOL(6,M,N)*FM1(5,I)+COCOL(7,M,N)*FM1(6,I)
      FM2(6,I)=COCOL(7,M,N)*FM1(5,I)+COCOL(8,M,N)*FM1(6,I)
C
C     DERIVATIVE OF STIFFNESS * TRUE DISPLACEMENT
C
      IF(IP.NE.1) GO TO 408
      IF(L.GT.NSTEEL) GO TO 409
      DO 808 I10=1,NUM22
      IF(CP(6,L).GT.DIX(2,I10).AND.CP(6,L).LT.DIX(1,I10)) I8=I10
  808 CONTINUE
      C1=C1(I8,1,I8)
      P4=C1(I8,2,I8)
      C2=C1(I8,3,I8)
      C3=C1(I8,4,I8)
      P5=C1(I8,5,I8)
      C4=C1(I8,6,I8)
      C5=C1(I8,7,I8)
      P6=C1(I8,8,I8)
      C6=C1(I8,9,I8)
      FM2(1,I)=FM2(1,I)*(C5*P6*CP(6,L)**(P6-1.))/CP(5,L)
      FM2(2,I)=FM2(2,I)/CP(6,L)
      FM2(3,I)=FM2(3,I)/CP(6,L)
      FM2(4,I)=FM2(4,I)*(C3*P5*CP(6,L)**(P5-1.))/CP(2,L)
      FM2(5,I)=FM2(5,I)*(C1*P4*CP(6,L)**(P4-1.))/CP(7,L)
      FM2(6,I)=FM2(6,I)*(C1*P4*CP(6,L)**(P4-1.))/CP(7,L)
      GO TO 408
  409 FM2(1,I)=FM2(1,I)*(1.+3.*(CP(12,L)/CP(11,L))**2.)/CP(15,L)*CP(16,L
     1)
      FM2(2,I)=FM2(2,I)*CP(10,L)/CP(1,L)
      FM2(3,I)=FM2(3,I)*CP(10,L)/CP(1,L)
      FM2(4,I)=FM2(4,I)*(P3*(CP(18,L)+2.*CP(17,L)*CP(14,L)-CP(14,L)))/(C
     1P(1,L)**2.*CP(9,L))*CP(10,L)/CP(2,L)
      FM2(5,I)=FM2(5,I)*CP(10,L)*3.*(CP(12,L)/CP(11,L))**2./CP(3,L)
      FM2(6,I)=FM2(6,I)*CP(10,L)*3.*(CP(12,L)/CP(11,L))**2./CP(3,L)
  408 FM2(7,I)=(FM2(2,I)+FM2(3,I))/XLR+FM1(7,I)
      FM2(8,I)=(FM2(5,I)+FM2(6,I))/XLR-FM1(8,I)
  410 CONTINUE
      GO TO 212
C
  430 IF(ID.EQ.1.OR.ID.EQ.3.OR.ID.EQ.4) GO TO 460
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C
C     STATIC BEAM FORCES
C
      DO 440 I=1,IGN
      FM2(1,I)=COBM(1,M,N)*FM1(1,I)
      FM2(2,I)=COBM(2,M,N)*FM1(2,I)+COBM(3,M,N)*FM1(3,I)
      FM2(3,I)=COBM(3,M,N)*FM1(2,I)+COBM(4,M,N)*FM1(3,I)
C
C     DERIVATIVE OF STIFFNESS * TRUE DISPLACEMENT
C
      IF(IP.NE.1) GO TO 443
      DO 809 I10=1,NUM22
      IF(BP(4,L).GT.DIX(2,I10).AND.BP(4,L).LT.DIX(1,I10)) I8=I10
  809 CONTINUE
      C3=CI(4,I8)
      P5=CI(5,I8)
      C4=CI(6,I8)
      C5=CI(7,I8)
      P6=CI(8,I8)
      C6=CI(9,I8)
      FM2(1,I)=FM2(1,I)+(C5*P6*BP(4,L)**(P6-1.))/BP(3,L)
      FM2(2,I)=FM2(2,I)/BP(4,L)
      FM2(3,I)=FM2(3,I)/BP(4,L)
  443 FM2(4,I)=FM2(2,I)
  440 FM2(5,I)=FM2(3,I)
      DO 445 I=1,3
      FM2(2,I)=FM2(4,I)+((FM2(4,I)+FM2(5,I))/XLR)*B1
  445 FM2(3,I)=FM2(5,I)+((FM2(4,I)+FM2(5,I))/XLR)*B2
      IF(IP.EQ.1) GO TO 446
      DO 441 I=1,3
      FM2(2,I)=FM2(2,I)+Q(1,I)
      FM2(3,I)=FM2(3,I)+Q(2,I)
      FM2(4,I)=FM2(4,I)+Q(3,I)
  441 FM2(5,I)=FM2(5,I)+Q(4,I)
  446 DO 442 I=4,6
      FM2(2,I)=FM2(4,I)+((FM2(4,I)+FM2(5,I))/XLR)*B1
  442 FM2(3,I)=FM2(5,I)+((FM2(4,I)+FM2(5,I))/XLR)*B2
  444 NF=5
      GO TO 212
C
  460 IF(IO.EQ.1.OR.IO.EQ.2.OR.IO.EQ.4) GO TO 464
C
C     STATIC PANEL FORCES
C
      IF(SNA.GE.CSA) GO TO 462
      DO 461 I=1,IGN
  461 FM1(4,I)=-FM1(4,I)
  462 DO 463 I=1,IGN
      FM2(1,I)=COPAN(1,M)*FM1(1,I)+COPAN(2,M)*FM1(2,I)
      FM2(2,I)=COPAN(2,M)*FM1(1,I)+COPAN(3,M)*FM1(2,I)
      FM2(3,I)=COPAN(4,M)*FM1(3,I)
C
C     DERIVATIVE OF STIFFNESS * TRUE DISPLACEMENT
C
      IF(IP.NE.1) GO TO 463
      FM2(1,I)=FM2(1,I)*PP(3,M)/PP(1,M)
      FM2(2,I)=FM2(2,I)*PP(3,M)/PP(1,M)
      FM2(3,I)=FM2(3,I)*PP(3,M)*(P3*(PP(14,M)+2.*PP(13,M)*PP(10,M)-PP(10
     1,M)))/(PP(15,M)*PP(5,M)**2.*PP(2,M))
  463 FM2(4,I)=(FM2(1,I)+FM2(2,I))/XLR*FM1(4,I)
      GO TO 212
C
  464 IF(IO.EQ.1.OR.IO.EQ.2.OR.IO.EQ.3) RETURN
C
C     STATIC BRACE FORCES
C
      DO 470 I=1,IGN
      FM2(1,I)=CODIA(1,M)*FM1(1,I)
C
C     DERIVATIVE OF STIFFNESS * TRUE DISPLACEMENT
C
      IF(IP.NE.1) GO TO 470
      FM2(1,I)=FM2(1,I)/TP(2,M)
  470 CONTINUE
C
C     COMBINATION OF STATIC LOAD CASE
C
  212 CONTINUE
      IF(ISTAT.EQ.2) NLD1=1
      IF(ISTAT.NE.2) GO TO 471
      DO 21 J=1,NF
      FM3(J)=0.0
      FM3(J)=FM2(J,1)
   21 CONTINUE
  471 DO 214 I=1,NLD1
      IF(ISTAT.EQ.2.AND.I.GT.1) GO TO 214
      IF(ISTAT.EQ.2) GO TO 220
      DO 213 J=1,NF
      FM3(J)=0.
      DO 213 K=1,6
      FM3(J)=FM3(J)+FM2(J,K)*XN(K,I)
  213 CONTINUE
  220 CONTINUE
      IF(IO.NE.3) GO TO 501
      IF(IP.NE.1.AND.IPRF.NE.0) WRITE(6,3000) M,I,(FM3(II),II=1,NF)
      IF(IP.NE.1) WRITE(76,3000) M,I,(FM3(II),II=1,NF)
      GO TO 12
  501 IF(IP.NE.1.AND.IPRF.NE.0) WRITE(6,2000) M,I,(FM3(II),II=1,NF)
      IF(IP.NE.1) WRITE(76,2000) M,I,(FM3(II),II=1,NF)
C
C     COLUMN STRESSES
C
      IF(IP.EQ.1) GO TO 214
      IF(IO.EQ.0) GO TO 214
    9 IF(IO.NE.1) GO TO 11
      IF(L.GT.NSTEEL) GO TO 15
      SCO(1)=DABS(FM3(4)/CP(2,L))+DABS(FM3(2)/2.0*CP(10,L)/CP(6,L
     1))+DABS(FM3(5)/2.0*CP(11,L)/CP(7,L))
      SCO(2)=DABS(FM3(4)/CP(2,L))-DABS(FM3(2)/2.0*CP(10,L)/CP(6,L
     1))-DABS(FM3(5)/2.0*CP(11,L)/CP(7,L))
      SCO(3)=DABS(FM3(4)/CP(2,L))+DABS(FM3(3)/2.0*CP(10,L)/CP(6,L
     1))+DABS(FM3(6)/2.0*CP(11,L)/CP(7,L))
      SCO(4)=DABS(FM3(4)/CP(2,L))-DABS(FM3(3)/2.0*CP(10,L)/CP(6,L
     1))-DABS(FM3(6)/2.0*CP(11,L)/CP(7,L))
      IF(FM3(4).GE.0.) GO TO 30
      SCOL(N,M,I,1)=-SCO(2)
      SCOL(N,M,I,2)=-SCO(1)
      SCOL(N,M,I,3)=-SCO(4)
      SCOL(N,M,I,4)=-SCO(3)
      GO TO 10
   30 SCOL(N,M,I,1)=SCO(1)
      SCOL(N,M,I,2)=SCO(2)
      SCOL(N,M,I,3)=SCO(3)
      SCOL(N,M,I,4)=SCO(4)
   10 SCOL(N,M,I,5)=FM3(7)/CP(2,L)
      SCOL(N,M,I,6)=FM3(8)/CP(2,L)
      GO TO 214
   15 DN=CP(13,L)/CP(10,L)
      DK=CP(8,L)/(CP(8,L)+CP(7,L)/DN)
      P3=0.85
      SCOL(N,M,I,2)=-DABS(FM3(2)*P3*CP(11,L)*DK*CP(10,L)/CP(1,L))-DABS(F
     1M3(5)*P3*CP(12,L)*DK*CP(10,L)/CP(3,L))
      SCOL(N,M,I,4)=-DABS(FM3(3)*P3*CP(11,L)*DK*CP(10,L)/CP(1,L))-DABS(F
     1M3(6)*P3*CP(12,L)*DK*CP(10,L)/CP(3,L))
      IF(FM3(4).LT.0.) GO TO 17
      SCOL(N,M,I,1)=(FM3(4)/(P3*CP(11,L)*CP(12,L)*CP(14,L)))+DABS(FM3(2)
     1*DN*P3*CP(11,L)*(1.-DK)*CP(10,L)/CP(1,L))+DABS(FM3(5))*DN*P3*CP(12,
     2L)*(1.-DK)*CP(10,L)/CP(3,L))
      SCOL(N,M,I,3)=(FM3(4)/(P3*CP(11,L)*CP(12,L)*CP(14,L)))+DABS(FM3(3)
     1*DN*P3*CP(11,L)*(1.-DK)*CP(10,L)/CP(1,L))+DABS(FM3(6))*DN*P3*CP(12,
     2L)*(1.-DK)*CP(10,L)/CP(3,L))
      GO TO 16
   17 SCOL(N,M,I,2)=(FM3(4)*CP(10,L)/CP(2,L))+SCOL(N,M,I,1)
      SCOL(N,M,I,1)=DN*(FM3(4)*CP(10,L)/CP(2,L)+DABS(FM3(2))*P3*CP(11,L)*
     1(1.-DK)*CP(10,L)/CP(1,L))+DABS(FM3(5))*P3*CP(12,L)*(1.-DK)*CP(10,L
     2)/CP(3,L)))
      SCOL(N,M,I,4)=(FM3(4)*CP(10,L)/CP(2,L))+SCOL(N,M,I,3)
      SCOL(N,M,I,3)=DN*(FM3(4)*CP(10,L)/CP(2,L)+DABS(FM3(3))*P3*CP(11,L)*
     1(1.-DK)*CP(10,L)/CP(1,L))+DABS(FM3(6))*P3*CP(12,L)*(1.-DK)*CP(10,L
     2)/CP(3,L)))
   16 SCOL(N,M,I,5)=FM3(7)/CP(2,L)*CP(10,L)
      SCOL(N,M,I,6)=FM3(8)/CP(2,L)*CP(10,L)
      GO TO 214
C
C     BEAM STRESSES
C
   11 IF(IO.NE.2) GO TO 12
      SBM(N,M,I,1)=DABS(FM3(4)/BP(4,L)*BP(10,L)/2.0)
      SBM(N,M,I,2)=DABS(FM3(5)/BP(4,L)*BP(10,L)/2.0)
      GO TO 214
C
C     PANEL STRESSES
C
   12 IF(IO.NE.3) GO TO 14
      IF(IO.EQ.0) GO TO 214
      DN=PP(6,M)/PP(3,M)
      DK=PP(8,M)/(PP(8,M)+PP(7,M)/DN)
      P3=0.85
      SPAN(M,I,1)=-DABS(FM3(1)*DK*PP(4,M)*P3*PP(3,M)/PP(1,M))
      SPAN(M,I,3)=-DABS(FM3(2)*DK*PP(4,M)*P3*PP(3,M)/PP(1,M))
      IF(FM3(3).LT.0.) GO TO 18
      SPAN(M,I,2)=(FM3(3)/(PP(10,M)*PP(5,M)*P3*PP(4,M)))+DABS(FM3(1)*PP(
     13,M)*P3*(1.-DK)*PP(4,M)/PP(1,M))*DN
      SPAN(M,I,4)=(FM3(3)/(PP(10,M)*PP(5,M)*P3*PP(4,M)))+DABS(FM3(2)*PP(
     13,M)*P3*(1.-DK)*PP(4,M)/PP(1,M))*DN
      GO TO 13
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```
   18 SPAN(M,1,1)=FM3(3)*PP(3,M)/PP(2,M)+SPAN(M,1,1)
      SPAN(M,1,3)=FM3(3)*PP(3,M)/PP(2,M)+SPAN(M,1,3)
      SPAN(M,1,2)=(FM3(1)*PP(3,M)/PP(2,M))*DN+DABS(FM3(1)*PP(3,M)*P3*(1.
     1-DK)*PP(4,M)/PP(1,M))*DN
      SPAN(M,1,4)=(FM3(1)*PP(3,M)/PP(2,M))*DN+DABS(FM3(2)*PP(3,M)*P3*(1.
     1-DK)*PP(4,M)/PP(1,M))*DN
   13 SPAN(M,1,5)=FM3(4)/PP(2,M)*PP(3,M)
      GO TO 216
C
C     BRACE STRESSES
C
   14 IF(IO.NE.4) GO TO 214
      SDIA(M,1,1)=FM3(1)/PP(2,M)
  214 CONTINUE
C
C
      IF(IDY.NE.1) GO TO 216
      IGN1=IGN2-N9+1
      IF(IO.NE.1) GO TO 555
      IF(B1.GE.0.AND.B2.GE.0.) GO TO 555
      DO 554 J=IGN1,IGN
      FM2(2,J)=-FM2(2,J)
      FM2(3,J)=-FM2(3,J)
      FM2(5,J)=-FM2(5,J)
      FM2(6,J)=-FM2(6,J)
      FM2(7,J)=-FM2(7,J)
      FM2(8,J)=-FM2(8,J)
  554 CONTINUE
  555 CONTINUE
      INI1=IGN+1
      DO 500 I=1,ND
      DO 520 J=IGN1,INI1
      FM4(I,J)=0.0
  520 CONTINUE
      IF(IO.EQ.2) NF=3
      IF(IO.EQ.1) NF=6
      DO 500 K=1,NF
      DO 500 J=IGN1,IGN
      IF(IO.EQ.1) FM4(I,J)=FM4(I,J)+TAC(K,I,M,N)*FM2(K,J)
      IF(IO.EQ.2) FM4(I,J)=FM4(I,J)+TAB(K,I,M,N)*FM2(K,J)
      IF(IO.EQ.3) FM4(I,J)=FM4(I,J)+TAP(K,I,N)*FM2(K,J)
      IF(IO.EQ.4) FM4(I,J)=FM4(I,J)+TAD(K,I,N)*FM2(K,J)
  500 CONTINUE
      IF(IO.NE.1) GO TO 600
      NF=8
      IF(B1.GE.0.AND.B2.GE.0.) GO TO 600
      DO 601 J=IGN1,IGN
      FM2(2,J)=-FM2(2,J)
      FM2(3,J)=-FM2(3,J)
      FM2(5,J)=-FM2(5,J)
      FM2(6,J)=-FM2(6,J)
      FM2(7,J)=-FM2(7,J)
      FM2(8,J)=-FM2(8,J)
  601 CONTINUE
  600 CONTINUE
      IF(IO.NE.2) GO TO 605
      NF=5
  605 CONTINUE
      N9=N9+1
      DO 515 J=1,N9
      DO 515 I=1,NSTC
      X2(I,J)=0.0
  515 CONTINUE
C
      BJ(1,1)=A(1,3)
      BJ(2,1)=A(1,4)
      BJ(2,2)=A(1,3)
      BJ(1,2)=-A(1,4)
      BJ(3,3)=1.0
C
      IF(IO.NE.1.AND.IO.NE.2) GO TO 850
      DO 912 I6=1,NN
      DO 913 J=1,N9
      PDIS3(I6,J)=PDIS(I6,J)
      PDIS(I6,J)=0.0
  913 CONTINUE
  912 CONTINUE
      DO 701 J=1,N9
      DO 700 I=1,ND
      PDIS(I,J)=FM4(I,IGN1+J-1)
  700 CONTINUE
      IF(IO.NE.1) GO TO 857
      PDIS(1,N9)=0.0
      PDIS(2,N9)=0.0
      PDIS(3,N9)=0.0
      PDIS(4,N9)=-PDIS(4,N9)
      PDIS(5,N9)=-PDIS(5,N9)
      PDIS(6,N9)=0.0
      PDIS(7,N9)=0.0
      PDIS(8,N9)=0.0
      PDIS(9,N9)=0.0
      PDIS(10,N9)=-PDIS(10,N9)
      PDIS(11,N9)=-PDIS(11,N9)
      PDIS(12,N9)=0.0
  857 IF(IO.NE.2) GO TO 858
      PDIS(1,N9)=-PDIS(1,N9)
      PDIS(2,N9)=-PDIS(2,N9)
      PDIS(3,N9)=0.0
      PDIS(4,N9)=-PDIS(4,N9)
      PDIS(5,N9)=-PDIS(5,N9)
      PDIS(6,N9)=0.0
  858 CONTINUE
      DO 699 I1=1,5
      LCON1(I1,J)=LCON(I1,J)
  699 CONTINUE
      LCON(1,J)=IO
      LCON(2,J)=LV
      LCON(3,J)=M
  701 CONTINUE
      LIMT=LIM
      LIM=N9
      NET=NC*NS+3*NS+3*NC*N9
      LET=NET*NN
      NNLT=NN*N9
      CALL FORM(LS,NN,NNM,NET,MN6,NAD1,NAD2,NNLT,LSL,NST,NS,NC,NB,NPAN,
     1NTAU,2,NCP,NBP,1,ISEC,1,N9,PDIS,LCON,1)
C
      DO 706 J=1,N9
      DO 705 I1=1,5
      LCON(I1,J)=LCON1(I1,J)
  705 CONTINUE
      DO 706 I2=1,NCTS
      X2(I2,J)=PDIS(I2,J)
  706 CONTINUE
      LIM=LIMT
C
      BJ(1,1)=A(1,3)
      BJ(2,1)=A(1,4)
      BJ(2,2)=A(1,3)
      BJ(1,2)=-A(1,4)
      BJ(3,3)=1.0
C
C
      DO 906 M3=1,NST
      I2=3*(M3-1)+NCTS
      II2=3*(M3-1)+NCTS
      BJ(3,1)=D(M3,1,1)
      BJ(3,2)=D(M3,1,2)
      DO 906 III=1,3
      IS=0
      II=III+IS
      DO 906 L=1,N9
      DO 906 KK=1,3
      X2(III+I12,L)=X2(III+I2,L)+BJ(II,KK)*PDIS(I2+KK,L)
  906 CONTINUE
  850 CONTINUE
C
C     CHANGE THE SIGN FOR COLUMN Y DIRECTION FORCE
C
  910 IF(IO.NE.3) GO TO 540
      KI=LP(2,M)
      KJ=LP(3,M)
      KK=(N-1)*NC+KI
      KK1=(N-1)*NC+KJ
      KK2=KK+NC
      KK3=KK1+NC
      DO 535 J=IGN1,IGN2
      J1=1+J-IGN1
      X2(KK,J1)=FM4(4,J1)
      X2(KK1,J1)=FM4(5,J1)
      IF(KK2.GT.NCTS) GO TO 535
      X2(KK2,J1)=FM4(9,J1)
      X2(KK3,J1)=FM4(10,J1)
  535 CONTINUE
      DO 538 K=1,3
      K1=NCTS+(N-1)*3+K
      DO 538 J=IGN1,IGN2
      J1=1+J-IGN1
      DO 539 I=1,3
      IF(K.EQ.3.AND.I.LT.3) BJ(3,I)=D(N,1,I)
      X2(K1,J1)=X2(K1,J1)+BJ(K,I)*FM4(I,J1)
      IF(N.EQ.NS) GO TO 539
      IF(K.EQ.3.AND.I.LT.3) BJ(3,I)=D(N+1,1,I)
      X2(K1+3,J1)=X2(K1+3,J1)+BJ(K,I)*FM4(I+5,J1)
  539 CONTINUE
  538 CONTINUE
```

```
  540 IF(IO.NE.4) GO TO 550
      KI=LT(2,M)
      KJ=LT(3,M)
      KK=(N-1)*NC+KI
      KK1=(N-1)*NC+KJ+NC
      DO 545 J=IGN1,IGN2
      J1=1+J-IGN1
      X2(KK,J1)=FM4(4,J)
      IF(KK1.GT.NCTS) GO TO 545
      X2(KK1,J1)=FM4(8,J)
  545 CONTINUE
      DO 548 K=1,3
      K1=NCTS+(N-1)*3+K
      DO 548 J=IGN1,IGN2
      J1=1+J-IGN1
      DO 549 I=1,3
      IF(K.EQ.3.AND.I.LT.3) BJ(3,I)=D(N,1,I)
      X2(K1,J1)=X2(K1,J1)+BJ(K,I)*FM4(I,J)
      IF(N.EQ.NS) GO TO 549
      IF(K.EQ.3.AND.I.LT.3) BJ(3,I)=D(N+1,1,I)
      X2(K1+3,J1)=X2(K1+3,J1)+BJ(K,I)*FM4(I+4,J)
  549 CONTINUE
  548 CONTINUE
  550 CONTINUE
      DO 926 J=1,N9
      DO 926 J1=1,NN
      PDIS(J1,J)=PDIS3(J1,J)
  926 CONTINUE
      N9=N9-1
      DO 900 J=1,N9
      DO 900 J1=1,NN
      PDIS(J1,LIM6+J)=A(J1,IGN1+J-1)
  900 CONTINUE
  216 IF(IO.EQ.0.OR.IO.EQ.3.OR.IO.EQ.4) GO TO 215
      IF(IP.EQ.1) GO TO 215
      IF(ISTAT.EQ.2) IO=IO+7
C
C     CHECK FOR ACTIVE CONSTRAINTS
C
      CALL SORT(IO,N,M,NLD,L,LV,FM2,XM)
      IF(ISTAT.EQ.2) IO=IO-7
  215 RETURN
C
 2000 FORMAT(2I6,5X,8F14.4)
 3000 FORMAT(2I6,4(5X,1PE18.11))
C
      END
      SUBROUTINE INECOF(IENTRY,LM,IM,ITOR,AM,SCM1,
     1SCM2,SCM3,SCM4,SCM8)
C
C     FIND STIFFNESS COEFFICIENTS OF STEEL ELEMENT
C
      IMPLICIT REAL*8(A-H,O-Z)
      REAL*8  LM,IM,ITOR
      COMMON/MAT/E,G
C
      GO TO (350,350,380),IENTRY
C
C
C     FLEXURAL STIFFNESS COEFFICIENTS
C
  350 C=(6.0*2.0-3.0**2)*LM/(6.0*E*IM)
      SCM2=2.0/C
      SCM3=2.0/C
      SCM4=1.0/C
C
      IF(IENTRY.EQ.2) GO TO 392
C
C     AXIAL STIFFNESS COEFFICIENTS
C
  380 SCM1=AM*E/LM
C
      IF(IENTRY.EQ.3) RETURN
C
C     TORSIONAL STIFFNESS COEFFICIENTS
C
  392 SCM8=G*ITOR/LM
C
      RETURN
      END
      SUBROUTINE SHRWL1(BFII,BFJJ,BFIJ,SCM2X,SCM4X,SCM3X)
C
C     FIND STIFFNESS COEFFICIENTS OF CONCRETE ELEMENT
C
      IMPLICIT REAL*8(A-H,O-Z)
C
      FII=BFII
      FJJ=BFJJ
      DET=FII*FJJ-BFIJ**2
      SCM2X=FJJ/DET
      SCM3X=FII/DET
      SCM4X=-BFIJ/DET
C
      RETURN
      END
      SUBROUTINE SCALE (F2,NBP,NPAN,NTRU,NCP)
C
C      SCALE THE PRIMARY DESIGN VARIABLES AND RESIZE THE
C                 SECONDARY DESIGN VARIABLES
C
      IMPLICIT REAL*8(A-H,O-Z)
      COMMON/DATA1/CLN(14,2),CP(26,45),BP(15,45),FEF(5,10),LB(10,15,3),L
     1DB(10,15,3),LCC(10,14,3),LP(3,20),IFEF(10),PP(22,20),LT(3,40),TP(9
     2,40),LIM,ID,GST,GCD,NSTEEL,NSTEE2,MATC,NLODD,NIQT1
C
C     STEEL COLUMNS
C
      IF(NSTEEL.EQ.0) GO TO 11
      DO 10 J=1,NSTEEL
      IF(CP(6,J).EQ.0.) GO TO 10
      CP(6,J)=CP(6,J)*F2
      CALL STEEL (1,J)
   10 CONTINUE
C
C     CONCRETE COLUMNS
C
   11 K=NCP-1
      DO 20 J=NSTEE2,K
      IF(CP(12,J).EQ.0.) GO TO 20
      CP(12,J)=CP(12,J)*F2
      CALL CONCR (1,J)
   20 CONTINUE
C
C     BEAMS
C
      IF(NBP.EQ.0) GO TO 31
      K=NBP-1
      DO 30 J=1,K
      BP(4,J)=BP(5,J)*F2
      CALL STEEL (2,J)
   30 CONTINUE
   31 CONTINUE
C
C     PANELS
C
      IF(NPAN.EQ.0) GO TO 51
      DO 50 J=1,NPAN
      PP(5,J)=PP(5,J)*F2
      CALL CONCR (2,J)
   50 CONTINUE
   51 CONTINUE
C
C     BRACES
C
      IF(NTRU.EQ.0) GO TO 61
      DO 60 J=1,NTRU
      TP(2,J)=TP(2,J)*F2
   60 CONTINUE
   61 CONTINUE
      RETURN
      END
      SUBROUTINE CONCR (IT,J)
C
C       FIND THE VALUES OF THE SECONDARY DESIGN VARIABLES
C
      IMPLICIT REAL*8(A-H,O-Z)
      COMMON/DATA1/CLN(14,2),CP(26,45),BP(15,45),FEF(5,10),LB(10,15,3),L
     1DB(10,15,3),LCC(10,14,3),LP(3,20),IFEF(10),PP(22,20),LT(3,40),TP(9
     2,40),LIM,ID,GST,GCD,NSTEEL,NSTEE2,MATC,NLODD,NIQT1
C     P3.EQ.PERCENTAGE OF DEPTH TO LUMPED REINFORCEMENT (DECIMAL #)
      P3=0.85
C
C     IT=1=COLUMNS;IT=2=PANELS
C
      IF(IT.EQ.2) GO TO 15
      DN=CP(13,J)/CP(10,J)
      DK=CP(8,J)/(CP(8,J)+CP(7,J)/DN)
      D=((DK*P3)**3.)/3.+(DN-1.)*CP(14,J)*P3*(P3*(DK+1.)-1.)**2.+DN*P3**
     13.*CP(14,J)*(1.-DK)**2.
      XYZ=CP(11,J)
      CP(11,J)=DABS(CP(11,J))
      YZ=CP(12,J)
      CP(12,J)=DABS(CP(12,J))
      CP(1,J)=CP(12,J)*CP(11,J)**3.*D*CP(10,J)
      CP(3,J)=CP(12,J)**3.*CP(11,J)*D*CP(10,J)
      CP(2,J)=CP(12,J)*CP(11,J)*P3*(DK+2.*DN*CP(14,J)-CP(14,J))*CP(10,J)
```

```
      CP(19,J)=CP(14,J)/CP(10,J)*(CP(1,J)+CP(3,J))
      CP(11,J)=XYZ
      CP(12,J)=YZ
      CP(17,J)=DN
      CP(18,J)=DK
      CP(19,J)=D
      CP(20,J)=P3
      GO TO 16
C
C     PANELS
C
   15 DN=PP(6,J)/PP(3,J)
      DK=PP(8,J)/(PP(6,J)+PP(7,J)/DN)
      D=((DK*P3)**3./3.+(DN-1.)*PP(10,J)*P3*(P3*(DK+1.)-1.)**2.+DN*P3**
     13.*PP(10,J)*(1.-DK)**2.
      XYZ=PP(4,J)
      PP(4,J)=DABS(PP(4,J))
      YZ=PP(5,J)
      PP(5,J)=DABS(PP(5,J))
      PP(1,J)=PP(5,J)*PP(4,J)**3.*D*PP(3,J)
      PP(2,J)=PP(5,J)*PP(4,J)*P3*(DK+2.*DN*PP(10,J)-PP(10,J))*PP(3,J)
      PP(11,J)=PP(12,J)*(PP(1,J)/PP(5,J)+PP(5,J)**3.*PP(4,J)*D)
      PP(4,J)=XYZ
      PP(5,J)=YZ
      PP(13,J)=DN
      PP(14,J)=DK
      PP(15,J)=D
      PP(16,J)=P3
C
   16 RETURN
      END
      SUBROUTINE STEEL (IT,J)
C
C      FIND THE VALUES FOR THE SECONDARY DESIGN VARIABLES
C
      IMPLICIT REAL*8(A-H,O-Z)
      COMMON/DATA1/CLN(14,2),CP(26,45),BP(15,45),FEF(5,10),LB(10,15,3),L
     1DB(10,15,3),LCC(10,14,2),LP(3,20),IFEF(10),PP(22,20),LT(3,40),IP(9
     2,40),LIN,ID,GST,GCO,NSTEEL,NSTEE2,NATC,NLODD,NTOT
      COMMON/STEP/CI1(15,3),DIX(2,3),NUM22
C
C     IT=1=COLUMNS;IT=2=BEAMS
C
      IF(IT.EQ.2) GO TO 15
C
C     COLUMNS
C
      DO 808 I10=1,NUM22
      IF(CP(6,J).GE.DIX(2,I10).AND.CP(6,J).LE.DIX(1,I10)) I8=I10
  808 CONTINUE
      IF(I8.LE.0.OR.I8.GT.NUM22) STOP8
      C1=CI1(1,I8)
      P1=CI1(2,I8)
      C2=CI1(3,I8)
      C3=CI1(4,I8)
      P5=CI1(5,I8)
      C4=CI1(6,I8)
      C5=CI1(7,I8)
      P6=CI1(8,I8)
      C6=CI1(9,I8)
      C7=CI1(10,I8)
      P7=CI1(11,I8)
      C8=CI1(12,I8)
      C9=CI1(13,I8)
      P8=CI1(14,I8)
      C10=CI1(15,I8)
      XYZ=CP(6,J)
      CP(6,J)=DABS(CP(6,J))
      CP(5,J)=C5*(CP(6,J)**P6)+C6
      CP(7,J)=C1*(CP(6,J)**P1)+C2
      CP(2,J)=C3*(CP(6,J)**P5)+C4
      CP(6,J)=XYZ
      SX=C7*(CP(6,J)**P7)+C8
      SY=C9*(CP(6,J)**P8)+C10
      IF(SX.EQ.0.) GO TO 13
      CP(10,J)=2.*CP(6,J)/SX
   13 IF(SY.EQ.0.) GO TO 16
      CP(11,J)=2.*CP(7,J)/SY
      GO TO 16
C
C     BEAMS
C
   15 CONTINUE
      DO 809 I10=1,NUM22
      IF(BP(4,J).GE.DIX(2,I10).AND.BP(4,J).LE.DIX(1,I10)) I8=I10
  809 CONTINUE
      IF(I8.LE.0.OR.I8.GT.NUM22) STOP8
      C3=CI1(4,I8)
      P5=CI1(5,I8)
      C4=CI1(6,I8)
      C5=CI1(7,I8)
      P6=CI1(8,I8)
      C6=CI1(9,I8)
      C7=CI1(10,I8)
      P7=CI1(11,I8)
      C8=CI1(12,I8)
      XYZ=BP(4,J)
      BP(4,J)=DABS(BP(4,J))
      BP(3,J)=C5*(BP(4,J)**P6)+C6
      BP(2,J)=C3*(BP(4,J)**P5)+C4
      BP(4,J)=XYZ
      SX=C7*(BP(4,J)**P7)+C8
      IF(SX.EQ.0.) GO TO 16
      BP(10,J)=2.*BP(4,J)/SX
C
   16 RETURN
      END
      SUBROUTINE PSUEDO(NSTC,MCTS,NS,I3,IS,NSS,IP,NST,NFS,MM,MN,NN,
     1ISTAT,LS,NNM,NCP,NBP,NB,NPAN,NTAU,RLAB,NLD,AMA2,AMA4,AMAS
     2,NAD2,LSC,ISEC,NNS,NAD1,IDY,PA,NC)
      IMPLICIT REAL*8(A-H,O-Z)
C
C     FORM VIRTUAL LOAD VECTORS FOR ACTIVE CONSTRAINTS
C
      COMMON/DATA1/CLN(14,2),CP(26,45),BP(15,45),FEF(5,10),LB(10,15,3),L
     1DB(10,15,3),LCC(10,14,2),LP(3,20),IFEF(10),PP(22,20),LT(3,40),IP(9
     2,40),LIN,ID,GST,GCO,NSTEEL,NSTEE2,NATC,NLODD,NTOT
      COMMON/STIF1/SS(170,170),SG(30,30),SC(170,170)
      COMMON/STIF2/ ASA(12,12),SA(8,12),T(8,12),TAC(8,12,14,10),TAB(3,6,
     115,10),TAD(3,8,40),TAP(3,10,20)
      COMMON/FORM2/RM(246),A1(10,3),S11(10,3),S22(3,10),SPAC1(10098)
      COMMON/TRAN1/D(10,1,2),A(1,6),AR(10,6),U2(170,6)
      COMMON/STRES/SCOL(10,14,6,6),SBM(10,15,6,2),SPAN(20,6,5),SDIA(40,6
     1,1),F2,CON(30),P1,P2,DIS(10,3),LCON(5,30),L6,L7,L8,L9,CONCO(8,30)
      COMMON/DATA7/PLOAD(140),SD(10,15),AMA(200),IF,IFC,X1,Y1
      COMMON/JUNK3/PDIS2(170,20)
      COMMON/EIGNV/EIGV(170),X(170,170),VAL(10),N10,N9,C1(10),L2(10)
     1,XMAS(10),XMAS1(10),ISMN,L3(10),L4(10),MODE,PHIM(10),DPHI(10),PHIL
     2(170,10),OPHIM(10),PHI(10),UVAL(10)
      DIMENSION BJ(3,3),PDIS(170,30),PDIS(170,30),RLAB(3),PF(10,30)
     1,AMA2(140),AMA4(10),AMAS(10),PA(12,30)
      P3=.85
      IF(ID.EQ.0) GO TO 10
      DO 502 I=1,3
      DO 502 J=1,3
  502 BJ(I,J)=0.0
      DO 1 I=1,NSTC
      DO 1 J=1,LIN
      PDIS1(I,J)=0.0
    1 PDIS(I,J)=0.0
      ICT=0
      DO 10 K=1,LIM
      L=NS-LCON(2,K)+1
      M=LCON(3,K)
      J=LCON(5,K)
C
C     STEEL COLUMNS
C
      IF(LCON(1,K).NE.1.AND.LCON(1,K).NE.8) GO TO 2
      ICT=ICT+1
      MC=LCC(L,M,1)
      KK=LCC(L,M,2)
      B1=CLN(KK,1)-CLN(M,1)
      B2=CLN(KK,2)-CLN(M,2)
      IF(MC.GT.NSTEEL) GO TO 700
      XLA=SD(L,2)-CP(8,MC)-CP(9,MC)
      S1=CP(1,MC)*CP(10,MC)/(2.*SD(L,2))
      S2=CP(1,MC)*CP(11,MC)/(2.*SD(L,2))
      S3=CP(1,MC)/SD(L,2)
      IF(B1.GE.0.AND.B2.GE.0.) GO TO 100
      S1=-S1
      S2=-S2
  100 DO 101 I=1,12
      SA(1,I)=4.*S1*TAC(2,I,M,L)+2.*S1*TAC(3,I,M,L)
      SA(2,I)=2.*S1*TAC(2,I,M,L)+4.*S1*TAC(3,I,M,L)
      SA(3,I)=S3*TAC(4,I,M,L)
      SA(4,I)=4.*S2*TAC(5,I,M,L)+2.*S2*TAC(6,I,M,L)
      SA(5,I)=2.*S2*TAC(5,I,M,L)+4.*S2*TAC(6,I,M,L)
      SA(6,I)=(SA(1,I)+SA(2,I))*CP(6,MC)/(SD(L,2)*CP(2,MC))*(
     12./CP(10,MC))
  101 SA(7,I)=(SA(4,I)+SA(5,I))*CP(7,MC)/(SD(L,2)*CP(2,MC))*(
     12./CP(11,MC))
  102 CONTINUE
      IF(J.EQ.5.OR.J.EQ.6) GO TO 127
      IF(J.EQ.3.OR.J.EQ.4) GO TO 115
      IF(CON(K).LT.0.0) GO TO 109
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      IF(CONCO(2,K).GT.0.0) GO TO 105
      DO 104 I=1,12
  104 SA(1,I)=-SA(1,I)
  105 IF(CONCO(5,K).GT.0.0) GO TO 107
      DO 106 I=1,12
  106 SA(4,I)=-SA(4,I)
  107 DO 108 I=1,12
  108 PDIS(I,K)=SA(1,I)+SA(4,I)+SA(3,I)
      GO TO 131
  109 IF(CONCO(2,K).LT.0.0) GO TO 111
      DO 110 I=1,12
  110 SA(1,I)=-SA(1,I)
  111 IF(CONCO(5,K).LT.0.0) GO TO 113
      DO 112 I=1,12
  112 SA(4,I)=-SA(4,I)
  113 DO 114 I=1,12
  114 PDIS(I,K)=SA(1,I)+SA(4,I)+SA(3,I)
      GO TO 131
  115 IF(CON(K).LT.0.0) GO TO 121
      IF(CONCO(3,K).GT.0.0) GO TO 117
      DO 116 I=1,12
  116 SA(2,I)=-SA(2,I)
  117 IF(CONCO(6,K).GT.0.0) GO TO 119
      DO 118 I=1,12
  118 SA(5,I)=-SA(5,I)
  119 DO 120 I=1,12
  120 PDIS(I,K)=SA(2,I)+SA(5,I)+SA(3,I)
      GO TO 131
  121 IF(CONCO(3,K).LT.0.0) GO TO 123
      DO 122 I=1,12
  122 SA(2,I)=-SA(2,I)
  123 IF(CONCO(6,K).LT.0.0) GO TO 125
      DO 124 I=1,12
  124 SA(5,I)=-SA(5,I)
  125 DO 126 I=1,12
  126 PDIS(I,K)=SA(2,I)+SA(5,I)+SA(3,I)
      GO TO 131
  127 IF(J.EQ.6) GO TO 129
      DO 128 I=1,12
  128 PDIS(I,K)=SA(6,I)
      GO TO 131
  129 DO 130 I=1,12
  130 PDIS(I,K)=SA(7,I)
      GO TO 131
C
C     CONCRETE COLUMNS
C
  700 P3=CP(20,MC)
      S1=CP(10,MC)*P3*CP(11,MC)*CP(18,MC)/SD(L,2)
      S2=CP(10,MC)*P3*CP(11,MC)*(1.-CP(18,MC))*CP(17,MC)/SD(L,2)
      S3=CP(10,MC)*P3*CP(12,MC)*CP(18,MC)/SD(L,2)
      S4=CP(10,MC)*P3*CP(12,MC)*(1.-CP(18,MC))*CP(17,MC)/SD(L,2)
      S5=CP(10,MC)/SD(L,2)
      S6=S5*CP(17,MC)
      S7=CP(2,MC)/(CP(11,MC)*CP(12,MC)*P3*CP(14,MC)*SD(L,2))
      DO 702 I=1,12
      SA(1,I)=4.*S1*TAC(2,I,M,L)+2.*S1*TAC(3,I,M,L)
      SA(2,I)=4.*S2*TAC(2,I,M,L)+2.*S2*TAC(3,I,M,L)
      SA(3,I)=2.*S1*TAC(2,I,M,L)+4.*S1*TAC(3,I,M,L)
      SA(4,I)=2.*S2*TAC(2,I,M,L)+4.*S2*TAC(3,I,M,L)
      SA(5,I)=4.*S3*TAC(5,I,M,L)+2.*S3*TAC(6,I,M,L)
      SA(6,I)=4.*S4*TAC(5,I,M,L)+2.*S4*TAC(6,I,M,L)
      SA(7,I)=2.*S3*TAC(5,I,M,L)+4.*S3*TAC(6,I,M,L)
      SA(8,I)=2.*S4*TAC(5,I,M,L)+4.*S4*TAC(6,I,M,L)
      SA(9,I)=S5*TAC(4,I,M,L)
      SA(10,I)=S6*TAC(4,I,M,L)
  702 SA(11,I)=S7*TAC(4,I,M,L)
      IF(J.EQ.5.OR.J.EQ.6) GO TO 2
      IF(CON(K).LT.0.0) GO TO 726
      IF(CONCO(4,K).LT.0.0) GO TO 714
      IF(J.EQ.3) GO TO 708
      IF(CONCO(2,K).GT.0.0) GO TO 704
      DO 703 I=1,12
  703 SA(2,I)=-SA(2,I)
  704 IF(CONCO(5,K).GT.0.0) GO TO 706
      DO 705 I=1,12
  705 SA(6,I)=-SA(6,I)
  706 DO 707 I=1,12
  707 PDIS(I,K)=SA(6,I)+SA(2,I)+SA(11,I)
      GO TO 131
  708 IF(CONCO(3,K).GT.0.0) GO TO 710
      DO 709 I=1,12
  709 SA(4,I)=-SA(4,I)
  710 IF(CONCO(6,K).GT.0.0) GO TO 712
      DO 711 I=1,12
  711 SA(8,I)=-SA(8,I)
  712 DO 713 I=1,12
  713 PDIS(I,K)=SA(4,I)+SA(8,I)+SA(11,I)
      GO TO 131
  714 IF(J.EQ.3) GO TO 720
      IF(CONCO(2,K).GT.0.0) GO TO 716
      DO 715 I=1,12
  715 SA(2,I)=-SA(2,I)
  716 IF(CONCO(5,K).GT.0.0) GO TO 718
      DO 717 I=1,12
  717 SA(6,I)=-SA(6,I)
  718 DO 719 I=1,12
  719 PDIS(I,K)=SA(6,I)+SA(2,I)+SA(10,I)
      GO TO 131
  720 IF(CONCO(3,K).GT.0.0) GO TO 722
      DO 721 I=1,12
  721 SA(4,I)=-SA(4,I)
  722 IF(CONCO(6,K).GT.0.0) GO TO 724
      DO 723 I=1,12
  723 SA(8,I)=-SA(8,I)
  724 DO 725 I=1,12
  725 PDIS(I,K)=SA(4,I)+SA(8,I)+SA(10,I)
      GO TO 131
  726 IF(CONCO(4,K).LT.0.0) GO TO 738
      IF(J.EQ.4) GO TO 732
      IF(CONCO(2,K).LT.0.0) GO TO 728
      DO 727 I=1,12
  727 SA(1,I)=-SA(1,I)
  728 IF(CONCO(5,K).LT.0.0) GO TO 730
      DO 729 I=1,12
  729 SA(5,I)=-SA(5,I)
  730 DO 731 I=1,12
  731 PDIS(I,K)=SA(1,I)+SA(5,I)
      GO TO 131
  732 IF(CONCO(3,K).LT.0.0) GO TO 734
      DO 733 I=1,12
  733 SA(3,I)=-SA(3,I)
  734 IF(CONCO(6,K).LT.0.0) GO TO 736
      DO 735 I=1,12
  735 SA(7,I)=-SA(7,I)
  736 DO 737 I=1,12
  737 PDIS(I,K)=SA(3,I)+SA(7,I)
      GO TO 131
  738 IF(J.NE.2) GO TO 744
      IF(CONCO(2,K).LT.0.0) GO TO 740
      DO 739 I=1,12
  739 SA(1,I)=-SA(1,I)
  740 IF(CONCO(5,K).LT.0.0) GO TO 742
      DO 741 I=1,12
  741 SA(5,I)=-SA(5,I)
  742 DO 743 I=1,12
  743 PDIS(I,K)=SA(1,I)+SA(5,I)+SA(9,I)
      GO TO 131
  744 IF(J.NE.1) GO TO 750
      IF(CONCO(2,K).LT.0.0) GO TO 746
      DO 745 I=1,12
  745 SA(2,I)=-SA(2,I)
  746 IF(CONCO(5,K).LT.0.0) GO TO 748
      DO 747 I=1,12
  747 SA(6,I)=-SA(6,I)
  748 DO 749 I=1,12
  749 PDIS(I,K)=SA(2,I)+SA(6,I)+SA(10,I)
      GO TO 131
  750 IF(J.NE.4) GO TO 756
      IF(CONCO(3,K).LT.0.0) GO TO 752
      DO 751 I=1,12
  751 SA(3,I)=-SA(3,I)
  752 IF(CONCO(6,K).LT.0.0) GO TO 754
      DO 753 I=1,12
  753 SA(7,I)=-SA(7,I)
  754 DO 755 I=1,12
  755 PDIS(I,K)=SA(3,I)+SA(7,I)+SA(9,I)
      GO TO 131
  756 IF(CONCO(3,K).LT.0.0) GO TO 758
      DO 757 I=1,12
  757 SA(4,I)=-SA(4,I)
  758 IF(CONCO(6,K).LT.0.0) GO TO 760
      DO 759 I=1,12
  759 SA(8,I)=-SA(8,I)
  760 DO 761 I=1,12
  761 PDIS(I,K)=SA(4,I)+SA(8,I)+SA(10,I)
  131 CONTINUE
C
C     BEAMS
C
      DO 762 I=1,12
      P6(I,K)=PDIS(I,K)
  762 CONTINUE
    2 IF(LCON(1,K).NE.2.AND.LCON(1,K).NE.9) GO TO 3
      IC(1)=IC(1)+1
      MB=LB(L,N,3)
```

```
      KI=LB(L,M,1)
      KJ=LB(L,M,2)
      B1=CLN(KJ,1)-CLN(KI,1)
      B2=CLN(KJ,2)-CLN(KI,2)
      B3=DSQRT(B1*B1+B2*B2)
      XLR=B3-BP(8,MB)-BP(9,MB)
      S1=BP(1,MB)*BP(10,MB)/(2.*XLR)
      DO 141 I=1,6
      SA(2,I)=(-1.)**I*S1*(4.*TAB(2,I,M,L)+2.*TAB(3,I,M,L))
      SA(3,I)=(-1.)**I*S1*(2.*TAB(2,I,M,L)+4.*TAB(3,I,M,L))
  141 SA(4,I)=(SA(2,I)+SA(3,I))*(2.*BP(10,MB)+BP(4,MB))/BP(2,MB)
      DO 142 J=1,6
      PDIS(J,K)=SA(J+1,1)
  142 CONTINUE
      DO 763 I=1,6
      P6(I,K)=PDIS(I,K)
  763 CONTINUE
C
C     PANELS
C
    3 IF(LCON(1,K).NE.3.AND.LCON(1,K).NE.10) GO TO 4
      S1=PP(3,M)*P3*PP(4,M)*PP(14,M)/SD(L,2)
      S2=PP(3,M)*P3*PP(4,M)*(1.-PP(14,M))*PP(13,M)/SD(L,2)
      S3=PP(1,M)*PP(3,M)/(PP(2,M)*SD(L,2)**2)
      S4=PP(1,M)/SD(L,2)
      S5=S4*PP(5,M)
      S6=PP(2,M)/(SD(L,2)*PP(10,M)*PP(4,M)*PP(5,M)*P3)
      DO 153 I=1,10
      SA(1,I)=4.*S1*TAP(1,I,M)+2.*S1*TAP(2,I,M)
      SA(2,I)=2.*S1*TAP(1,I,M)+4.*S1*TAP(2,I,M)
      SA(3,I)=4.*S2*TAP(1,I,M)+2.*S2*TAP(2,I,M)
      SA(4,I)=2.*S2*TAP(1,I,M)+4.*S2*TAP(2,I,M)
      SA(5,I)=S4*TAP(3,I,M)
      SA(6,I)=S5*TAP(3,I,M)
  153 SA(7,I)=S6*TAP(3,I,M)
      IF(J.EQ.5) GO TO 193
      IF(CON(K).LT.0.0) GO TO 169
      IF(CONCD(3,K).LT.0.0) GO TO 161
      IF(J.EQ.4) GO TO 157
      IF(CONCD(1,K).GT.0.0) GO TO 155
      DO 154 I=1,10
  154 SA(3,I)=-SA(3,I)
  155 DO 156 I=1,10
  156 PF(I,K)=SA(3,I)+SA(7,I)
      GO TO 195
  157 IF(CONCD(2,K).GT.0.0) GO TO 159
      DO 158 I=1,10
  158 SA(4,I)=-SA(4,I)
  159 DO 160 I=1,10
  160 PF(I,K)=SA(4,I)+SA(7,I)
      GO TO 195
  161 IF(J.EQ.4) GO TO 165
      IF(CONCD(1,K).GT.0.0) GO TO 163
      DO 162 I=1,10
  162 SA(3,I)=-SA(3,I)
  163 DO 164 I=1,10
  164 PF(I,K)=SA(3,I)+SA(6,I)
      GO TO 195
  165 IF(CONCD(2,K).GT.0.0) GO TO 167
      DO 166 I=1,10
  166 SA(4,I)=-SA(4,I)
  167 DO 168 I=1,10
  168 PF(I,K)=SA(4,I)+SA(6,I)
      GO TO 195
  169 IF(CONCD(3,K).LT.0.0) GO TO 177
      IF(J.EQ.3) GO TO 173
      IF(CONCD(1,K).LT.0.0) GO TO 171
      DO 170 I=1,10
  170 SA(1,I)=-SA(1,I)
  171 DO 172 I=1,10
  172 PF(I,K)=SA(1,I)
      GO TO 195
  173 IF(CONCD(2,K).LT.0.0) GO TO 175
      DO 174 I=1,10
  174 SA(2,I)=-SA(2,I)
  175 DO 176 I=1,10
  176 PF(I,K)=SA(2,I)
      GO TO 195
  177 IF(J.NE.1) GO TO 181
      IF(CONCD(1,K).LT.0.0) GO TO 179
      DO 178 I=1,10
  178 SA(1,I)=-SA(1,I)
  179 DO 180 I=1,10
  180 PF(I,K)=SA(1,I)+SA(5,I)
      GO TO 195
  181 IF(J.NE.2) GO TO 185
      IF(CONCD(2,K).LT.0.0) GO TO 183
      DO 182 I=1,10
  182 SA(3,I)=-SA(3,I)
  183 DO 184 I=1,10
  184 PF(I,K)=SA(3,I)+SA(6,I)
      GO TO 195
  185 IF(J.NE.3) GO TO 189
      IF(CONCD(2,K).LT.0.0) GO TO 187
      DO 186 I=1,10
  186 SA(2,I)=-SA(2,I)
  187 DO 188 I=1,10
  188 PF(I,K)=SA(2,I)+SA(5,I)
      GO TO 195
  189 IF(J.NE.4) GO TO 195
      IF(CONCD(2,K).GT.0.0) GO TO 191
      DO 190 I=1,10
  190 SA(4,I)=-SA(4,I)
  191 DO 192 I=1,10
  192 PF(I,K)=SA(4,I)+SA(6,I)
  195 II=3*(L-1)*NCTS
      KI=LP(2,M)
      KJ=LP(3,M)
      DO 196 I=1,3
      PDIS(II+I,K)=PF(I,K)
      IF(L.EQ.NST) GO TO 196
      PDIS(II+3+I,K)=PF(I+5,K)
  196 CONTINUE
      KK=(L-1)*NC+KI
      PDIS1(KK,K)=PF(4,K)
      KK=(L-1)*NC+KJ
      PDIS1(KK,K)=PF(5,K)
      IF(L.EQ.NST) GO TO 4
      KK=L*NC+KI
      PDIS1(KK,K)=PF(9,K)
      KK=L*NC+KJ
      PDIS1(KK,K)=PF(10,K)
C
C     BRACES
C
    4 IF(LCON(1,K).NE.4.AND.LCON(1,K).NE.11) GO TO 5
      YL=SD(L,2)
      KJ=LT(2,M)
      KI=LT(3,M)
      B1=CLN(KJ,1)-CLN(KI,1)
      B2=CLN(KJ,2)-CLN(KI,2)
      B3=DSQRT(B1*B1+B2*B2)
      DL=DSQRT(B3*B3+YL*YL)
    9 S1=TP(1,M)/DL
   11 DO 6 I=1,8
    6 SA(1,I)=S1*TAD(1,I,M)
      II=3*(L-1)*NCTS
      DO 7 J=1,3
    7 PDIS(II+J,K)=SA(1,J)
      IF(L.EQ.NST) GO TO 301
      DO 8 J=1,3
      PDIS(II+J+3,K)=SA(1,J+4)
    8 CONTINUE
  301 CONTINUE
      KK=(L-1)*NC+KJ
      PDIS1(KK,K)=SA(1,4)
      IF(L.EQ.NST) GO TO 5
      KK=L*NC+KJ
      PDIS1(KK,K)=SA(1,8)
    5 IF(LCON(1,K).NE.5) GO TO 30
      II=3*(L-1)*NCTS
      PDIS(II+LCON(5,K),K)=1.0
  193 CONTINUE
   30 CONTINUE
C
C     CONDENSE ROTATIONAL DEGREES OF FREEDOM
C
      IF(ICTT.EQ.0) GO TO 144
      IF(ID.GT.2.AND.ID.LT.5) GO TO 144
      NET=NC*NS+3*NS+3*NC+ICTT
      LET=NET*NN
      NNLT=NN*ICTT
      CALL FORM(LS,NN,NNK,NET,NN6,NAD1,NAD2,NNLT,LSL,NST,NS,NC,NB,NPAN,
     1NTRU,2,NCP,NBP,1,ISEC,IP,ICTT,PDIS,LCON,0)
      DO 147 K=1,LIN
      IF(LCON(1,K).GT.2.AND.LCON(1,K).LT.8) GO TO 147
      IF(LCON(1,K).GT.9) GO TO 147
      DO 143 I=1,NCTS
      PDIS1(I,K)=PDIS(I,K)
  143 CONTINUE
  147 CONTINUE
  144 CONTINUE
C
C     TRANSFER INTO GLOBAL LOADING
C
      IF(ID.EQ.3) GO TO 145
```

```
      BJ(1,1)=A(1,3)
      BJ(2,1)=A(1,5)
      BJ(2,2)=A(1,3)
      BJ(1,2)=-A(1,4)
      BJ(3,3)=1.0
      DO 304 N=1,NST
      I2=3*(N-1)+NCTS
      II2=3*(N-1)+NCTS
      BJ(3,1)=DIN(1,1)
      BJ(3,2)=DIN(1,2)
      DO 303 II=1,I3
      II=II+IS
      DO 302 L=1,LIM
      IF(LCON(1,L).EQ.6.OR.LCON(1,L).EQ.7.OR.LCON(1,L).EQ.5) GO TO 302
      DO 400 KK=1,3
      PDIS1(II+II2,L)=PDIS1(II+II2,L)+BJ(I,KK)*PDIS(I2+KK,L)
  400 CONTINUE
  302 CONTINUE
  303 CONTINUE
  304 CONTINUE
  143 CONTINUE
C
      DO 624 J=1,LIM
      IF(LCON(1,J).LT.10) GO TO 624
      DO 625 I=1,NSTC
      PDIS2(I,J)=PDIS1(I,J)
  625 CONTINUE
  624 CONTINUE
C
C     REASSEMBLE GLOBAL STIFFNESS
C
      REWIND 20
      DO 460 I=1,NSTC
      DO 460 J=1,NSTC
  460 S(I,J)=SS(I,J)
      DO 470 I=1,NSS
      DO 470 J=1,NSS
  470 S(I+NCTS,J+NCTS)=S(I+NCTS,J+NCTS)+386.4*SG(I,J)
C
C     CALCULATE VIRTUAL DISPLACEMENTS
C
      CALL GAUSS(4,S,NSTC,PDIS1,LIM)
      DO 630 J=1,LIM
C
C      INSERT EIGENVECTORS IN VIRTUAL DISPLACEMENT VECTOR IN ORDER
C                   TO CALCULATE EIGENVALUE GRADIENT
C
      IF(LCON(1,J).NE.8.AND.LCON(1,J).NE.9) GO TO 630
      DO 631 I=1,NSTC
      PDIS2(I,J)=PDIS1(I,J)
  631 CONTINUE
  630 CONTINUE
      IF(ID.LT.4.OR.MATC.NE.0) GO TO 506
      DO 305 J=1,LIM
      IF(LCON(1,J).NE.6) GO TO 305
      J1=LCON(3,J)
      M1=L2(J1)
      DO 505 I=1,NSTC
      PDIS1(I,J)=X(I,M1)
  505 CONTINUE
  305 CONTINUE
C
C      PLACE EIGENVECTORS IN VIRTUAL DISPLACEMENT VECTOR FOR
C              EIGENVECTOR GRADIENT
C
      IF(ID.LT.5.OR.MATC.NE.0) GO TO 511
      IDUNN=0
      DO 507 J=1,LIM
      IF(LCON(1,J).LT.7) GO TO 507
      IDUNN=IDUNN+1
      DO 508 J1=1,N9
      LCON(5,LIM+J1)=J1
      M1=L2(J1)
      DO 508 I=1,NSTC
      PDIS1(I,J1+LIM)=X(I,M1)
  508 CONTINUE
      GO TO 510
  507 CONTINUE
      IF(IDUNN.EQ.0) GO TO 511
  510 LIM=LIM+N9
      IOY=1
      CALL INVERT(NSTC,NSS,NCTS,NST,3,AMA2,AMA4,AMA5)
  511 CONTINUE
  506 CALL REFOS3(LIM,NFS,NST,NS,NC,NCTS,IS,I3,D,A,PDIS1)
      CALL FORCES(6,NC,NS,NN,KN,NN,ISTAT,LS,NNA,NST,NCP,NBP,NB,NPAN,NI
     1RU,NLD,RLAB,IP,PDIS1,AMA2,AMA4,AMA5,IOY,P6)
      IF(IOY.EQ.1) LIM=LIM-N9
   10 RETURN
 1000 FORMAT(4E17.10)
      END
      SUBROUTINE ROTDIS(PDIS1,LIM,NLD,MN,NSNC,NN,MM,LS,PDIS,NI
     1,NS,NC,LCON)
C
C     CALCULATE ROTATIONAL DISPLACEMENTS
C
      IMPLICIT REAL*8(A-H,O-Z)
      COMMON/FO4/S(406,10),C(28,28,10),E(28,190,10),KH(246,10),RF4(28,
     113,10),RF5(28,30,10),RF6(28,1,10)
      DIMENSION PDIS1(170,30),PDIS(170,30),LCON(5,30)
      IF(NI.NE.NS) GO TO 303
      NS3=3*NS
      DO 475 L=1,LIM
      DO 425 K=1,MN
      PDIS(K,L)=0.0
  425 CONTINUE
      DO 450 N=1,NSNC
      KK=MN+N
  450 PDIS(KK,L)=PDIS1(N,L)
      DO 460 N=1,NC
      KKK=KK+N
  460 PDIS(KKK,L)=0.0
      DO 470 N=1,NS3
      KM=KKK+N
  470 PDIS(KM,L)=PDIS1(NSNC+N,L)
      DO 471 N=1,3
  471 PDIS(KM+N,L)=0.0
  475 CONTINUE
  303 MMP=MM+1
      N=NI
      ICTI=0
  302 DO 301 I=1,MM
      DO 301 J=1,LIM
      IF(LCON(1,J).GT.2.AND.LCON(1,J).LT.8) GO TO 301
      ICTI=ICTI+1
      PDIS(I,J)=RF5(I,J,N)
  301 CONTINUE
      DO 400 L=1,LIM
      DO 401 J=MMP,NN
      KF=KH(J,N)
      IF(KF.GT.MM) GO TO 401
      IF(J.GT.MN) GO TO 402
      DO 403 K=KF,MM
  403 PDIS(K,L)=PDIS(K,L)-C(K,J-MM,N)*PDIS(J,L)
      GO TO 401
  402 DO 404 K=KF,MM
  404 PDIS(K,L)=PDIS(K,L)-E(K,J-MN,N)*PDIS(J,L)
  401 CONTINUE
      IB=LS
      DO 400 II=1,MM
      I=MM+1-II
      KK=I-1
      KF=KH(I,N)
      IB=IB-I
      IF(KF.GT.KK) GO TO 400
      DO 405 K=KF,KK
  405 PDIS(K,L)=PDIS(K,L)-S(IB+K,N)*PDIS(I,L)
  400 CONTINUE
      RETURN
      END
      SUBROUTINE GRAD(PDIS,LM,NF,ND,LIM,N,M,IO,FM2,CSA,SNA,XM,LCON,B1,B2
     1,NST,NCTS,ID,NC,AMA2,AMA4,AMA5,COEP,Q1,Q,IOY,DEL,LB,P6,CONCO)
C
C      CALCULATE THE CONSTRAINT GRADIENTS
C
      IMPLICIT REAL*8(A-H,O-Z)
      COMMON/STIF/ ASA(12,12),SA(8,12),T1(8,12),TAC(8,12,14,10),TAB(3,6,
     115,10),TAD(3,8,40),TAP(4,10,20)
      COMMON/GRAD/T2(10,14,30),T3(10,15,30),T4(10,20,30),T5(10,40,30),RR
     1R
      COMMON/EIGNV/EIGV(170),X(170,170),VAL(10),N10,N9,C1(10),L2(10)
     1,XMAS(10),XMAS1(10),ISMN,L3(10),L4(10),MODE,PHIM(10),DPHI(10),PHIL
     2(170,10),DPHIM(10),PHI(10),UVAL(10)
      COMMON/DYNAM/VMA(170),FMA(170),DOIS(10,3),X2(170,10),PQ(10),ETA(3,
     110),VM(170),SAA(3,10),PHI1(10),VN(170,10)
      COMMON/INV/PHIL1(170,10)
      COMMON/DATA7/PLOAD(140),SO(10,15),AMA(280),IF,IFC,X1,Y1
      COMMON/JUNK3/PDIS2(170,20)
      COMMON/TRAN1/D(10,1,2),AA(1,6),RR(170,6),U2(170,6)
      DIMENSION PDIS(170,30),LM(12),T(8,30),FM2(8,16),FM3(8),XM(6,10)
     1,LCON(5,30),AMA2(140),AMA4(10),AMA5(10),Q(4,3),Q1(10),T6(170)
     2,PPE(170,10),DPHI2(10),DPHIM2(10),T7(170),P6(12,30)
     3,LB(10,15,3),PD(170),CONCO(8,30)
      IJ=0
      NSTC=NST*3+NCTS
      IF(ID.LT.4) GO TO 12
      DO 9 I=1,N9
```

```
    9 XMAS1(I)=0.0
      IF(ISMA.EQ.1) GO TO 12
      DO 10 I=1,LIM
      IF(LCON(1,I).NE.6) GO TO 10
      M2=LCON(5,I)
      M1=L3(M2)
      IJ=M2
      IF(IJ.GT.10) STOP
      CALL EMAS(IJ,M1,MCTS,NST,3,LCON,IO,NC,N,M,AMA2,AMA4,AMA5,IDY)
   10 CONTINUE
   12 IF(IDY.NE.1) GO TO 13
      DO 11 I=1,N9
      IJ=I
      M1=L2(I)
      CALL EMAS(IJ,M1,MCTS,NST,3,LCON,IO,NC,N,M,AMA2,AMA4,AMA5,IDY)
   11 CONTINUE
   13 DO 100 I=1,8
      DO 100 J=1,LIM
  100 T(I,J)=0.0
  150 DO 200 K=1,ND
      KK=LM(K)
      DO 200 I=1,NF
      DO 200 J=1,LIM
      IF(IO.EQ.1) T(I,J)=T(I,J)+TAC(I,K,N,M)*PDIS(KK,J)
      IF(IO.EQ.2) T(I,J)=T(I,J)+TAB(I,K,N,M)*PDIS(KK,J)
      IF(IO.EQ.3) T(I,J)=T(I,J)+TAP(I,K,M)*PDIS(KK,J)
      IF(IO.EQ.4) T(I,J)=T(I,J)+TAD(I,K,M)*PDIS(KK,J)
  200 CONTINUE
      IF(IO.NE.1) GO TO 430
      IF(B1.GE.0.AND.B2.GE.0.) GO TO 400
      DO 300 I=1,LIM
      T(2,I)=-T(2,I)
      T(3,I)=-T(3,I)
      T(5,I)=-T(5,I)
      T(6,I)=-T(6,I)
      T(7,I)=-T(7,I)
  300 T(8,I)=-T(8,I)
  400 IGN=0
C
C     COLUMN COMPONENTS OF THE CONSTRAINT GRADIENTS
C
      DO 410 I=1,LIM
      T2(N,M,I)=0.0
      IF(IDY.EQ.1.AND.I.GT.(LIM-N9)) GO TO 401
      IF(LCON(1,I).EQ.7) GO TO 410
      IF(IDY.EQ.1.AND.I.GT.(LIM-N9)) GO TO 401
      IF(LCON(1,I).EQ.6) GO TO 401
      II=LCON(4,I)
      DO 801 J=1,6
      FM3(J)=0.0
      IF(LCON(1,I).EQ.8.OR.LCON(1,I).EQ.9) GO TO 800
      DO 213 K=1,6
  213 FM3(J)=FM3(J)+FM2(J,K)*XM(K,II)
      GO TO 801
  800 FM3(J)=FM2(J,N9+6+I)
  801 T2(N,M,I)=T2(N,M,I)-T(J,I)*FM3(J)
      GO TO 410
  401 IGN=IGN+1
      M2=LCON(5,I)
      DO 411 J6=1,8
      T2(N,M,I)=T2(N,M,I)+T(J6,I)*FM2(J6,IGN+6)/XMAS(M2)
  411 CONTINUE
      T2(N,M,I)=T2(N,M,I)-C1(M2)*XMAS1(M2)/XMAS(M2)
  410 CONTINUE
      GO TO 212
C
C      BEAM COMPONENTS OF THE CONSTRAINT GRADIENTS
C
  430 IF(IO.NE.2) GO TO 460
      IGN=0
      DO 440 I=1,LIM
      T3(N,M,I)=0.0
      IF(IDY.EQ.1.AND.I.GT.(LIM-N9)) GO TO 431
      IF(LCON(1,I).EQ.7) GO TO 440
      IF(IDY.EQ.1.AND.I.GT.(LIM-N9)) GO TO 431
      IF(LCON(1,I).EQ.6) GO TO 431
      II=LCON(4,I)
      DO 119 J=1,3
      FM3(J)=0.0
      IF(LCON(1,I).EQ.9.OR.LCON(1,I).EQ.8) GO TO 802
      DO 214 K=1,6
  214 FM3(J)=FM3(J)+FM2(J,K)*XM(K,II)
      GO TO 803
  802 FM3(J)=FM2(J,6+N9+I)
  803 T3(N,M,I)=T3(N,M,I)-T(J,I)*FM3(J)
      IF(J.NE.3) GO TO 119
      LTT=NST-LCON(2,I)+1
      IF(LCON(1,I).NE.2.OR.LTT.NE.N.OR.LCON(3,I).NE.M) GO TO 119
      JA=LCON(5,I)
      SIT=1.0
      IF(CONCO(JA+1,I).LT.0.0) SIT=-1.0
      DO 698 L=1,3
      IF(LCON(5,I).EQ.2) GO TO 699
      T3(N,M,I)=T3(N,M,I)-SIT*Q(I,L)*CDEP*XM(L,II)/(DI)**2
      GO TO 698
  699 T3(N,M,I)=T3(N,M,I)+SIT*Q(I,L)*CDEP*XM(L,II)/(DI)**2
  698 CONTINUE
  119 CONTINUE
      GO TO 440
  431 IGN=IGN+1
      M2=LCON(5,I)
      DO 441 J6=1,3
      T3(N,M,I)=T3(N,M,I)+T(J6,I)*FM2(J6,IGN+6)/XMAS(M2)
  441 CONTINUE
      T3(N,M,I)=T3(N,M,I)-C1(M2)*XMAS1(M2)/XMAS(M2)
  440 CONTINUE
C
C      PANEL COMPONENTS OF THE CONSTRAINT GRADIENTS
C
  460 IF(IO.NE.3) GO TO 464
      IF(SNA.GE.CSA) GO TO 462
      DO 461 I=1,LIM
  461 T(4,I)=-T(4,I)
  462 IGN=0
      DO 463 I=1,LIM
      T4(N,M,I)=0.0
      IF(IDY.EQ.1.AND.I.GT.(LIM-N9)) GO TO 465
      IF(LCON(1,I).EQ.7) GO TO 463
      IF(IDY.EQ.1.AND.I.GT.(LIM-N9)) GO TO 465
      IF(LCON(1,I).EQ.6) GO TO 465
      II=LCON(4,I)
      DO 804 J=1,4
      FM3(J)=0.0
      IF(LCON(1,I).EQ.8.OR.LCON(1,I).EQ.9) GO TO 805
      DO 215 K=1,6
  215 FM3(J)=FM3(J)+FM2(J,K)*XM(K,II)
      GO TO 804
  805 FM3(J)=FM2(J,N9+6+I)
  804 T4(N,M,I)=T4(N,M,I)-T(J,I)*FM3(J)
      GO TO 463
  465 IGN=IGN+1
      M2=LCON(5,I)
      DO 442 J6=1,4
      T4(N,M,I)=T4(N,M,I)+T(J6,I)*FM2(J6,IGN+6)/XMAS(M2)
  442 CONTINUE
      T4(N,M,I)=T4(N,M,I)-C1(M2)*XMAS1(M2)/XMAS(M2)
  463 CONTINUE
      GO TO 212
C
C     BRACE COMPONENTS OF THE CONSTRAINT GRADIENTS
C
  464 IF(IO.NE.4) GO TO 212
      IGN=0
      DO 470 I=1,LIM
      T5(N,M,I)=0.0
      IF(IDY.EQ.1.AND.I.GT.(LIM-N9)) GO TO 471
      IF(LCON(1,I).EQ.7) GO TO 470
      IF(IDY.EQ.1.AND.I.GT.(LIM-N9)) GO TO 471
      IF(LCON(1,I).EQ.6) GO TO 471
      II=LCON(4,I)
      FM3(1)=0.0
      IF(LCON(1,I).EQ.8.OR.LCON(1,I).EQ.9) GO TO 806
      DO 216 K=1,6
  216 FM3(1)=FM3(1)+FM2(1,K)*XM(K,II)
      GO TO 807
  806 FM3(1)=FM2(1,N9+6+I)
  807 T5(N,M,I)=(-1.)*T(1,I)*FM3(1)
      GO TO 470
  471 IGN=IGN+1
      M2=LCON(5,I)
      T5(N,M,I)=(1.)*T(1,I)*FM2(1,IGN+6)/XMAS(M2)
      T5(N,M,I)=T5(N,M,I)-C1(M2)*XMAS1(M2)/XMAS(M2)
  470 CONTINUE
  212 IF(IDY.NE.1) RETURN
C
C     EIGENVECTOR GRADIENT CALCULATIONS
C
      DO 650 J=1,N9
      II=LIM-N9+J
      IF(IO.EQ.1) TT=T2(N,M,II)
      IF(IO.EQ.2) TT=T3(N,M,II)
      IF(IO.EQ.3) TT=T4(N,M,II)
      IF(IO.EQ.4) TT=T5(N,M,II)
      DO 650 I=1,NSTC
      X2(I,J)=(-1.)*(X2(I,J)-C1(J)*PHIL1(I,J)-TT*PHIL(I,J))
  650 CONTINUE
```

```
      NSTC1=NSTC-1
      REWIND 19
      DO 661 J=1,N9
      DO 660 I=1,NSTC
      PPE(I,J)=0.0
      DO 660 J1=1,NSTC
      READ (19,1000) XXX
      PPE(I,J)=PPE(I,J)+XXX*X2(J1,J)
  660 CONTINUE
  661 CONTINUE
      DO 590 I=1,NSTC
      T7(I)=0.0
  590 T6(I)=0.0
      DO 600 J2=1,N9
      DPHI(J2)=0.0
      DPHIM(J2)=0.0
      DPHI2(J2)=0.0
      DPHIM2(J2)=0.0
      M1=L2(J2)
      I=LIN-N9+J2
      IF(IO.NE.1) GO TO 601
      TT=T2(N,M,L)
  601 IF(IO.NE.2) GO TO 602
      TT=T3(N,M,L)
  602 IF(IO.NE.3) GO TO 603
      TT=T4(N,M,L)
  603 IF(IO.NE.4) GO TO 604
      TT=T5(N,M,L)
  604 CONTINUE
      DO 497 I=1,NCTS
      DPHI(J2)=DPHI(J2)+PPE(I,J2)*(AMA(NCTS+I)+AMA2(I))*SAA(I,J2)
      DPHIM(J2)=DPHIM(J2)+PPE(I,J2)*(AMA(NCTS+I)+AMA2(I))*X(I,M1)
  497 CONTINUE
      DO 402 N1=1,NST
      I4=3*(N1-1)+NCTS
      DO 402 J=1,3
      IF(J.EQ.3) GO TO 403
      DPHI(J2)=DPHI(J2)+PPE(I4+J,J2)*(SD(N1,3)+AMA4(N1))*SAA(J+1,J2)
      DPHIM(J2)=DPHIM(J2)+PPE(I4+J,J2)*(SD(N1,3)+AMA4(N1))*X(I4+J,M1)
      GO TO 402
  403 DPHI(J2)=DPHI(J2)+PPE(I4+J,J2)*(SD(N1,4)+AMA5(N1))*0.0
      DPHIM(J2)=DPHIM(J2)+PPE(I4+J,J2)*(SD(N1,4)+AMA5(N1))*X(I4+J,M1)
  402 CONTINUE
C
C     CORRECTION TO THE GRADIENT OF THE EIGENVECTOR
C     THIS CORRECTION IS DUE TO NORMALIZATION WITH RESPECT TO
C                   THE MASS-X*M*X-1
C
      DO 615 J7=1,NSTC
      PPE(J7,J2)=PPE(J7,J2)-X(J7,M1)*0.5*(2.*DPHIM(J2)+XMAS1(J2))
  615 CONTINUE
C
C     TERMS WITH CORRECTED GRADIENT FOR THE EIGENVECTOR
C
      DO 616 I=1,NCTS
      DPHI2(J2)=DPHI2(J2)+PPE(I,J2)*(AMA(NCTS+I)+AMA2(I))*SAA(I,J2)
      DPHIM2(J2)=DPHIM2(J2)+PPE(I,J2)*(AMA(NCTS+I)+AMA2(I))*X(I,M1)
  616 CONTINUE
      DO 617 N1=1,NST
      I4=3*(N1-1)+NCTS
      DO 618 J=1,3
      IF(J.EQ.3) GO TO 619
      DPHI2(J2)=DPHI2(J2)+PPE(I4+J,J2)*(SD(N1,3)+AMA4(N1))*SAA(J+1,J2)
      DPHIM2(J2)=DPHIM2(J2)+PPE(I4+J,J2)*(SD(N1,3)+AMA4(N1))*X(I4+J,M1)
      GO TO 618
  619 DPHI2(J2)=DPHI2(J2)+PPE(I4+J,J2)*(SD(N1,4)+AMA5(N1))*0.0
      DPHIM2(J2)=DPHIM2(J2)+PPE(I4+J,J2)*(SD(N1,4)+AMA5(N1))*X(I4+J,M1)
  618 CONTINUE
  617 CONTINUE
      Q1(J2)=(DPHI2(J2)*PHIM(J2))/C1(J2)-PHI(J2)*(2.*DPHIM2(J2)+
     1XMAS1(J2))/C1(J2)-(PHI(J2)/(C1(J2)))**2.*PHI(J2)*3.1416
     2/(C1(J2))**2.5)*TT
      DO 610 I=1,NSTC
  610 T6(I)=VN(I,J2)/VMA(I)*X(I,M1)*Q1(J2)+T6(I)+PPE(I,J2)*PQ(J2)
     1*VN(I,J2)/VMA(I)
      DO 820 I=1,NCTS
      T7(I)=T7(I)+(AMA(NCTS+I)+AMA2(I))*X(I,M1)*(PQ(J2)*TT+
     1C1(J2)*Q1(J2))+C1(J2)*PQ(J2)*(PHIL(I,J2)+(AMA(NCTS+I)+AMA2(I))
     2*PPE(I,J2))
  820 CONTINUE
      DO 821 N1=1,NST
      I4=3*(N1-1)+NCTS
      DO 822 J=1,3
      IF(J.EQ.3) GO TO 823
      T7(I4+J)=T7(I4+J)+(SD(N1,3)+AMA4(N1))*X(I4+J,M1)*(PQ(J2)*TT+
     1C1(J2)*Q1(J2))+C1(J2)*PQ(J2)*(PHIL(I4+J,J2)+(AMA4(N1)+SD(N1,3))*
     2PPE(I4+J,J2))
      GO TO 822
  823 T7(I4+J)=T7(I4+J)+(SD(N1,4)+AMA5(N1))*X(I4+J,M1)*(PQ(J2)*TT+
     1C1(J2)*Q1(J2))+C1(J2)*PQ(J2)*(PHIL(I4+J,J2)+(AMA5(N1)+SD(N1,4))*
     2PPE(I4+J,J2))
  822 CONTINUE
  821 CONTINUE
  600 CONTINUE
      DO 700 L=1,LIN
      IF(LCON(1,L).NE.7) GO TO 700
      NL=NST-LCON(2,L)+1
      NTR=LCON(5,L)
      I4=NCTS+(NL-1)*3+NTR
      IF(IO.NE.1) GO TO 701
      T2(N,M,L)=T6(I4)
  701 IF(IO.NE.2) GO TO 702
      T3(N,M,L)=T6(I4)
  702 IF(IO.NE.3) GO TO 703
      T4(N,M,L)=T6(I4)
  703 IF(IO.NE.4) GO TO 700
      T5(N,M,L)=T6(I4)
  700 CONTINUE
      IREF=0
      DO 710 L=1,LIN
      IF(LCON(1,L).EQ.8.OR.LCON(1,L).EQ.9) GO TO 850
      IF(LCON(1,L).LT.10) GO TO 710
      IF(IO.EQ.1) T2(N,M,L)=0.0
      IF(IO.EQ.2) T3(N,M,L)=0.0
      IF(IO.EQ.3) T4(N,M,L)=0.0
      IF(IO.EQ.4) T5(N,M,L)=0.0
      DO 711 J=1,NSTC
      IF(IO.EQ.1) T2(N,M,L)=T2(N,M,L)+PD(S2(J,L))*T6(J)
      IF(IO.EQ.2) T3(N,M,L)=T3(N,M,L)+PD(S2(J,L))*T6(J)
      IF(IO.EQ.3) T4(N,M,L)=T4(N,M,L)+PD(S2(J,L))*T6(J)
      IF(IO.EQ.4) T5(N,M,L)=T5(N,M,L)+PD(S2(J,L))*T6(J)
  711 CONTINUE
      GO TO 855
  850 NFS=3*NST
      IF(IREF.GT.0) GO TO 857
      IREF=IREF+1
      CALL REFDS1(NFS,NST,0,NC,NCTS,0,3,D,AA,T4)
  857 MM=2*NC
      DO 890 N17=1,NST
      N1=NST-N17+1
      CALL ROTATE(T6,1,1,NCTS,N1,NST,NC,IO,N9,N,M,PD)
      IF(N17.NE.LCON(2,L)) GO TO 867
      IF(LCON(1,L).NE.8) GO TO 861
      LM(6)=4*NC+LCON(3,L)+NC*(N1-1)
      LM(5)=2*LCON(3,L)
      LM(4)=LM(5)-1
      LM(11)=LM(5)+2*NC
      LM(10)=LM(4)+2*NC
      LM(12)=LM(6)+NC
      LM(3)=5*NC+NST*NC+3*N1
      LM(2)=LM(3)-1
      LM(1)=LM(2)-1
      LM(9)=LM(3)+3
      LM(8)=LM(9)-1
      LM(7)=LM(8)-1
  861 IF(LCON(1,L).NE.9) GO TO 862
      N12=LCON(2,L)
      M12=LCON(3,L)
      LM(3)=4*NC+LB(N12,M12,1)+NC*(N1-1)
      LM(2)=2*LB(N12,M12,1)
      LM(1)=LM(2)-1
      LM(6)=4*NC+LB(N12,M12,2)+NC*(N1-1)
      LM(5)=2*LB(N12,M12,2)
      LM(4)=LM(5)-1
  862 CONTINUE
      P78=0.0
      IF(LCON(1,L).EQ.8) NFFF=12
      IF(LCON(1,L).EQ.9) NFFF=6
      DO 860 J=1,NFFF
      KK=LM(J)
      P78=P78+P6(J,L)*PD(KK)
  860 CONTINUE
      IF(IO.EQ.1) T2(N,M,L)=P78
      IF(IO.EQ.2) T3(N,M,L)=P78
      GO TO 855
  867 CONTINUE
      DO 571 K=1,MM
      KK=MM+K
      PD(KK)=PD(K)
      PD(K)=0.0
  571 CONTINUE
  890 CONTINUE
  855 CONTINUE
  710 CONTINUE
 1000 FORMAT(1E25.18)
      RETURN
```

```
C
      END
      SUBROUTINE SORT(IO,N,M,NLD,L,LV,FM2,XM11)
C
C     CHECKS AND DETERMINES ACTIVE CONSTRAINTS
C
      IMPLICIT REAL*8(A-H,O-Z)
      COMMON/DATA1/CLM(16,2),CP(26,45),BP(15,45),FEF(5,10),LB(10,15,3),L
     1DB(10,15,3),LCC(10,14,2),LP(3,20),IFEF(10),PP(22,20),LT(5,40),TP(8
     2,40),LM(10,65),CCO,NSTEEL,NSTEE2,NATC,NLODD,NTOT
      COMMON/STRES/SCOL(10,14,6,6),SBM(10,15,6,2),SPAN(20,6,5),SDIA(40,6
     1,1),F2,CON(30),P1,P2,DIS(10,3),LCON(5,50),L6,L7,L8,L9,CONC0(8,30)
      COMMON/JUN3/IF,IFC,ND,NF,LM(12),F(8,16),Q(4,5),P(8),FMED(4),PMIN(8
     1),F19(8,6)
      COMMON/EIGNV/EIGV(170),X(170,170),VAL(10),N10,N9,C1(10),L2(10)
     1,XMAS(10),XMAS1(10),ISAN,L3(10),L4(10),MODE,PHIM(10),DPHI(10),PHIL
     2(170,10),DPHIM(10),PHI(10),UVAL(10)
      COMMON/DYNAM/VMA(170),FMA(170),DDIS(10,3),X2(170,10),PQ(10),ETA(3,
     110),VM(170),SAA(3,10),PH(10),VN(170,10)
      DIMENSION CS(10),FM2(8,16),XM1(14,10)
C
C      IF I GT. NLODD IT IS A DYNAMIC LOAD COMBINATION
C
      DO 93 J=1,10
      CS(J)=0.0
   93 CONTINUE
      NLD2=NLD
      IF(IO.GE.6) I=1
      IF(IO.GE.6) NLD2=1
      DO [illegible] I=1,NLD2
      IF(IO.EQ.7) GO TO 200
      IF(IO.EQ.6) GO TO 146
      IF(IO.GT.7) GO TO 201
      IF(I.GT.NLODD.AND.IO.EQ.5) GO TO 200
C
C     COLUMN STRESS
C
  201 IF(IO.NE.1.AND.IO.NE.8) GO TO 102
      IF(I.GT.NLODD) IO=IO+7
      IF(L.GT.NSTEEL) GO TO 94
      IF(IO.EQ.1) K=1
      IF(IO.EQ.8) K=24
      GO TO 95
   94 IF(IO.EQ.1) K=7
      IF(IO.EQ.8) K=24
   95 K1=K+1
      K2=K+2
      IF(SCOL(N,M,I,1).LT.0.) GO TO 96
      CS(1)=DABS(SCOL(N,M,I,1)/CP(K,L))
      CS(3)=DABS(SCOL(N,M,I,3)/CP(K,L))
      GO TO 97
   96 CS(1)=DABS(SCOL(N,M,I,1)/CP(K1,L))
      CS(3)=DABS(SCOL(N,M,I,3)/CP(K1,L))
   97 IF(SCOL(N,M,I,2).LT.0.) GO TO 98
      CS(2)=DABS(SCOL(N,M,I,2)/CP(K,L))
      GO TO 99
   98 CS(2)=DABS(SCOL(N,M,I,2)/CP(K1,L))
   99 IF(SCOL(N,M,I,4).LT.0.) GO TO 100
      CS(4)=DABS(SCOL(N,M,I,4)/CP(K,L))
      GO TO 101
  100 CS(4)=DABS(SCOL(N,M,I,4)/CP(K1,L))
  101 CS(5)=DABS(SCOL(N,M,I,5)/CP(K2,L))
      CS(6)=DABS(SCOL(N,M,I,6)/CP(K2,L))
      F1=DMAX1(CS(1),CS(2),CS(3),CS(4),CS(5),CS(6))
      NI=6
      IF(I.GT.NLODD) IO=IO-7
      GO TO 113
C
C     BEAM STRESS
C
  102 IF(IO.NE.2.AND.IO.NE.9) GO TO 103
      IF(I.GT.NLODD) IO=IO+7
      IF(IO.EQ.2) K=1
      IF(IO.EQ.9) K=15
      CS(1)=DABS(SBM(N,M,I,1)/BP(K,L))
      CS(2)=DABS(SBM(N,M,I,2)/BP(K,L))
      F1=DMAX1(CS(1),CS(2))
      NI=2
      IF(I.GT.NLODD) IO=IO-7
      GO TO 113
C
C     PANEL STRESS
C
  103 IF(IO.NE.3.AND.IO.NE.10)  GO TO 110
      IF(I.GT.NLODD) IO=IO+7
      IF(IO.EQ.3) K=7
      IF(IO.EQ.10) K=20
      K1=K+1
      K2=K+2
      IF(SPAN(M,I,1).LT.0.) GO TO 104
      CS(1)=DABS(SPAN(M,I,1)/PP(K,M))
      CS(3)=DABS(SPAN(M,I,3)/PP(K,M))
      GO TO 105
  104 CS(1)=DABS(SPAN(M,I,1)/PP(K1,M))
      CS(3)=DABS(SPAN(M,I,3)/PP(K1,M))
  105 IF(SPAN(M,I,2).LT.0.) GO TO 106
        CS(2)=DABS(SPAN(M,I,2)/PP(K,M))
      GO TO 107
  106 CS(2)=DABS(SPAN(M,I,2)/PP(K1,M))
  107 IF(SPAN(M,I,4).LT.0.) GO TO 108
      CS(4)=DABS(SPAN(M,I,4)/PP(K,M))
      GO TO 109
  108 CS(4)=DABS(SPAN(M,I,4)/PP(K1,M))
  109 CS(5)=DABS(SPAN(M,I,5)/PP(K2,M))
      F1=DMAX1(CS(1),CS(2),CS(3),CS(4),CS(5))
      NI=5
      IF(I.GT.NLODD) IO=IO-7
      GO TO 113
C
C     BRACE STRESS
C
  110 IF(IO.NE.4.AND.IO.NE.11) GO TO 119
      IF(I.GT.NLODD) IO=IO+7
      IF(IO.EQ.4) K=3
      IF(IO.EQ.11) K=8
      K1=K+1
      IF(SDIA(M,I,1).LT.0.) GO TO 111
      F1=DABS(SDIA(M,I,1)/TP(K,M))
      CS(1)=F1
      GO TO 112
  111 F1=DABS(SDIA(M,I,1)/TP(K1,M))
      CS(1)=F1
  112 NI=1
      IF(I.GT.NLODD) IO=IO-7
      GO TO 113
C
C     STATIC DISPLACEMENT
C
  119 IF(IO.NE.5) GO TO 190
      DO 120 II=1,3
      IF(DIS(N,II).EQ.0.) GO TO 120
      CS(II)=DABS(F19(I,II)/DIS(N,II))
  120 CONTINUE
      NI=3
      F1=DMAX1(CS(1),CS(2),CS(3))
      GO TO 113
C
C     FREQUENCY
C
  190 IF(IO.NE.6) GO TO 199
  146 IF(M.EQ.1) GO TO 207
      DO 160 J=1,N9
      IF(VAL(J).EQ.0.) GO TO 160
      CS(J)=DABS(VAL(J)/C1(J))
      IF(IO.GT.4.AND.CS(J).GT.1.0) CS(J)=1.0
  160 CONTINUE
      NI=N9
      F1=DMAX1(CS(1),CS(2),CS(3),CS(4),CS(5),CS(6),CS(7),
     1CS(8),CS(9),CS(10))
      GO TO 113
  207 DO 208 J=1,N9
      IF(UVAL(J).EQ.0.) GO TO 208
      CS(J)=DABS(C1(J)/UVAL(J))
      IF(IO.GT.4.AND.CS(J).GT.1.0) CS(J)=1.0
  208 CONTINUE
      NI=N9
      F1=DMAX1(CS(1),CS(2),CS(3),CS(4),CS(5),CS(6),CS(7),
     1CS(8),CS(9),CS(10))
      GO TO 113
C
C     DYNAMIC DISPLACEMENT
C
  199 IF(IO.NE.7) GO TO 113
  200 NF=1
      DO 210 II=1,3
      IF(DDIS(LV,II).EQ.0.0) GO TO 210
      I5=M+II
      CS(II)=DABS(F19(I,II)/DDIS(LV,II))
  210 CONTINUE
      NI=3
      F1=DMAX1(CS(1),CS(2),CS(3))
  113 IF(F2.GT.F1) GO TO 114
      L6=LV
      L7=M
      L8=I
      L9=IO
```

```
      F2=F1
  114 IF(F2.GT.(1.+P2)) GO TO 127
      IF(F1.LT.(1.-P1).AND.LIM.EQ.0) GO TO 127
      DO 85 J=1,NI
C
C      KEEP CORRECT VALUE FOR ACTIVE CONSTRAINT IF SCALED
C
      DO 129 K3=1,LIM
      IF(LCON(5,K3).NE.J) GO TO 130
      IF(LCON(1,K3).NE.IO) GO TO 130
      IF(LCON(2,K3).NE.LV) GO TO 130
      IF(LCON(3,K3).NE.N) GO TO 130
      IF(IO.EQ.6) GO TO 135
      IF(LCON(4,K3).NE.I) GO TO 130
      IF(IO.EQ.7) GO TO 136
      DO 496 J7=1,NF
      CONCO(J7,K3)=0.0
      IF(LCON(1,K3).GE.8) GO TO 495
      DO 498 K4=1,6
      CONCO(J7,K3)=CONCO(J7,K3)+FM2(J7,K4)*XML1(K4,I)
  498 CONTINUE
      GO TO 496
  495 CONCO(J7,K3)=FM2(J7,I)
  496 CONTINUE
      IF(IO.NE.1.AND.IO.NE.8) GO TO 131
      CON(K3)=SCOL(N,M,I,J)
  131 IF(IO.NE.2.AND.IO.NE.9) GO TO 132
      CON(K3)=SBM(N,M,I,J)
  132 IF(IO.NE.3.AND.IO.NE.10) GO TO 133
      CON(K3)=SPAN(M,I,J)
  133 IF(IO.NE.4.AND.IO.NE.11) GO TO 134
      CON(K3)=SDIA(M,I,J)
  134 IF(IO.NE.5) GO TO 135
      CON(K3)=F19(I,J)
  135 IF(IO.NE.6) GO TO 136
      CON(K3)=C(J)
  136 IF(IO.NE.7) GO TO 130
      I5=M+J
      CON(K3)=VMA(I5)
  130 CONTINUE
  129 CONTINUE
C
C     INSERT NEW ACTIVE CONSTRAINTS AND UPDATE THE OLD CONSTRAINTS
C
      IF(CS(J).LT.(1.-P1).OR.CS(J).GT.(1.+P2)) GO TO 115
      LIM=LIM+1
      IF(LIM.GT.40) WRITE(6,1000)
      IF(LIM.GT.40) STOP
      LCON(1,LIM)=IO
      LCON(2,LIM)=LV
      LCON(3,LIM)=N
      LCON(4,LIM)=I
      LCON(5,LIM)=J
      IF(IO.NE.1.AND.IO.NE.8) GO TO 116
      CON(LIM)=SCOL(N,M,I,J)
  116 IF(IO.NE.2.AND.IO.NE.9) GO TO 117
      CON(LIM)=SBM(N,M,I,J)
  117 IF (IO.NE.3.AND.IO.NE.10) GO TO 118
      CON(LIM)=SPAN(M,I,J)
  118 IF(IO.NE.4.AND.IO.NE.11) GO TO 121
      CON(LIM)=SDIA(M,I,J)
  121 IF(IO.NE.5) GO TO 152
      CON(LIM)=F19(I,J)
  152 IF(IO.NE.6) GO TO 153
      CON(LIM)=C(J)
      GO TO 115
  153 IF(IO.NE.7) GO TO 150
      I5=M+J
      CON(LIM)=VMA(I5)
  150 DO 500 J7=1,NF
      CONCO(J7,LIM)=0.0
      DO 499 K3=1,6
  499 CONCO(J7,LIM)=CONCO(J7,LIM)+FM2(J7,K3)*XML1(K3,I)
  500 CONTINUE
  115 CONTINUE
   85 CONTINUE
  127 CONTINUE
      K7=LIM-1
      LIT=LIM
      IF(LIM.EQ.1) GO TO 590
      DO 501 K3=1,K7
      IF(K3.EQ.LIT) GO TO 501
      K6=K3+1
      DO 502 K4=K6,LIM
      IF(K4.GT.LIT) GO TO 501
      DO 503 K5=1,5
      IF(LCON(K5,K3).NE.LCON(K5,K4)) GO TO 502
  503 CONTINUE
      CON(K3)=CON(K4)
      IF(K4+1.GT.LIT) GO TO 506
      DO 506 K8=K4,LIT
      CON(K8)=CON(K8+1)
      DO 505 K10=1,NF
      CONCO(K10,K8)=CONCO(K10,K8+1)
  505 CONTINUE
      DO 504 K9=1,5
      LCON(K9,K8)=LCON(K9,K8+1)
  504 CONTINUE
  506 CONTINUE
      LIT=LIT-1
  502 CONTINUE
  501 CONTINUE
  590 CONTINUE
      LIM=LIT
      DO 550 K4=1,LIM
  550 CONTINUE
      RETURN
 1000 FORMAT(' TOO MANY ACTIVE CONSTRAINTS')
      END
      SUBROUTINE OBJECT(ITT,NST,NC,NB,NPAN,NTRU,WT,AMA2,AMA4,AMA5
     1,WTST,WTCO)
C
C     CALCULATE STEEL AND CONCRETE WEIGHTS ,THE OBJECTIVE FUNCTION
C               AND THE STRUCTURAL MASS
C
      IMPLICIT REAL*8(A-H,O-Z)
      COMMON/DATA1/CLN(14,2),CP(26,45),BP(15,45),FEF(5,10),LB(10,15,3),L
     1DB(10,15,3),LC(10,14,2),LP(3,20),IFEF(10),PP(22,20),LT(3,40),IP(9
     2,40),LIM,IO,GST,GCO,NSTEEL,NSTEE2,NATC,NLODD,NTOT1
      COMMON/DATA2/PLOAD(140),SD(10,15),AMA(280),IF,IFC,K1,Y1
      DIMENSION AMA2(140),AMA4(10),AMA5(10)
      WT=0.0
      WTST=0.0
      WTCO=0.0
      NS=NST
      IF(ITT.EQ.1) GO TO 195
C
C       WEIGHT AND OBJECTIVE FUNCTION
C
      DO 105 N=1,NST
      DO 100 I=1,NC
      M=LC(N,I,1)
      IF(M.GT.NSTEEL) GO TO 99
      WT=WT+SD(N,2)*CP(2,M)*GST
      WTST=WTST+SD(N,2)*CP(2,M)*.490/1728.
      GO TO 100
   99 WT=WT+SD(N,2)*CP(11,M)*CP(12,M)*GCO
      WTCO=WTCO+SD(N,2)*CP(11,M)*CP(12,M)*.150/1728.
  100 CONTINUE
      IF(NB.EQ.0) GO TO 400
      DO 101 I=1,NB
      M=LB(N,I,3)
      KI=LB(N,I,1)
      KJ=LB(N,I,2)
      B1=CLN(KJ,1)-CLN(KI,1)
      B2=CLN(KJ,2)-CLN(KI,2)
      B3=B1*B1+B2*B2
      B3=DSQRT(B3)
      WI=BP(8,M)
      WJ=BP(9,M)
      XLR=B3-WI-WJ
      WT=WT+XLR*BP(2,M)*GST
      WTST=WTST+XLR*BP(2,M)*.490/1728.
  101 CONTINUE
  400 CONTINUE
      IF(NPAN.EQ.0) GO TO 401
      DO 102 I=1,NPAN
      NP=NS-LP(1,I)+1
      IF(NP.NE.N) GO TO 102
      XL=SD(N,2)
      WT=WT+SD(N,2)*PP(4,I)*PP(5,I)*GCO
      WTCO=WTCO+SD(N,2)*PP(4,I)*PP(5,I)*.150/1728.
  102 CONTINUE
  401 CONTINUE
C
      IF(NTRU.EQ.0) GO TO 402
      DO 103 I=1,NTRU
      NP=NS-LT(1,I)+1
      IF(NP.NE.N) GO TO 103
      KJ=LT(2,I)
      KI=LT(3,I)
      B1=CLN(KJ,1)-CLN(KI,1)
      B2=CLN(KJ,2)-CLN(KI,2)
      B3=B1*B1+B2*B2
      B3=DSQRT(B3)
      YL=SD(N,2)
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```
      DL=DSQRT(B3*B3+YL*YL)
      WT=WT+DL*TP(2,J)*GST
      WTST=WTST+DL*TP(2,J)*.490/1728.
  103 CONTINUE
  402 CONTINUE
  105 CONTINUE
      WRITE(6,1001) WTST
      WRITE(76,1003) WTST
      WRITE(6,1002) WTCO
      WRITE(76,1003) WTCO
      WRITE(6,1000) WT
      WRITE(76,1003) WT
      GO TO 302
C
C     FIND THE STRUCTURAL MASS (NODAL, ROTATIONAL, AND TRANSLATIONAL)
C
  195 NSTCC=NS*NC
      GST1=GST
      GCO1=GCO
      GST=.490/1728.
      GCO=.150/1728.
      DO 305 J=1,NSTCC
  305 ANA2(J)=0.0
      DO 306 J=1,NST
      ANA4(J)=0.0
  306 ANA5(J)=0.0
      DO 205 N=1,NST
      DO 204 I=1,NC
      II=(N-1)*NC+I
      IF(N.EQ.1) GO TO 197
      M=LC(N-1,I,1)
      IF(M.GT.NSTEEL) GO TO 196
      ANA1=0.5*SD(N-1,2)*CP(2,M)*GST/386.4
      ANA2(II)=ANA2(II)+ANA1
      GO TO 197
  196 ANA1=0.5*SD(N-1,2)*CP(11,M)*CP(12,M)*GCO/386.4
      ANA2(II)=ANA2(II)+ANA1
  197 M=LC(N,I,1)
      IF(M.GT.NSTEEL) GO TO 198
      ANA1=0.5*SD(N,2)*CP(2,M)*GST/386.4
      ANA2(II)=ANA2(II)+ANA1
      GO TO 199
  198 ANA1=0.5*SD(N,2)*CP(11,M)*CP(12,M)*GCO/386.4
      ANA2(II)=ANA2(II)+ANA1
  199 IF(NB.EQ.0) GO TO 403
      DO 200 J=1,NB
      KI=LB(N,J,1)
      KJ=LB(N,J,2)
      IF(KI.NE.I.AND.KJ.NE.I) GO TO 200
      M=LB(N,J,3)
      B1=CLN(KJ,1)-CLN(KI,1)
      B2=CLN(KJ,2)-CLN(KI,2)
      B3=DSQRT(B1*B1+B2*B2)
      KLR=B3-BP(8,M)-BP(9,M)
      ANA1=0.5*KLR*BP(2,M)*GST/386.4
      ANA2(II)=ANA2(II)+ANA1
  200 CONTINUE
  403 IF(NPAN.EQ.0) GO TO 404
      DO 201 J=1,NPAN
      NP=NS-LP(1,J)+1
      IF(NP.NE.N.AND.NP.NE.(N-1)) GO TO 201
      IF(LP(2,J).NE.I.AND.LP(3,J).NE.I) GO TO 201
      IF(NP.EQ.N) GO TO 206
      ANA1=0.25*SD(N-1,2)*PP(4,J)*PP(5,J)*GCO/386.4
      ANA2(II)=ANA2(II)+ANA1
      GO TO 201
  206 ANA1=0.25*SD(N,2)*PP(4,J)*PP(5,J)*GCO/386.4
      ANA2(II)=ANA2(II)+ANA1
  201 CONTINUE
  404 IF(NTRU.EQ.0) GO TO 204
      DO 203 J=1,NTRU
      NP=NS-LT(1,J)+1
      IF(NP.NE.N.AND.NP.NE.(N-1)) GO TO 203
      KJ=LT(2,J)
      KI=LT(3,J)
      B1=CLN(KJ,1)-CLN(KI,1)
      B2=CLN(KJ,2)-CLN(KI,2)
      B3=DSQRT(B1*B1+B2*B2)
      IF(NP.EQ.N.AND.LT(2,J).EQ.I) GO TO 202
      IF(NP.EQ.(N-1).AND.LT(3,J).EQ.I) GO TO 207
      GO TO 203
  207 YL=SD(N-1,2)
      DL=DSQRT(B3*B3+YL*YL)
      ANA1=0.5*DL*TP(2,J)*GST/386.4
      ANA2(II)=ANA2(II)+ANA1
      GO TO 203
  202 YL=SD(N,2)
      DL=DSQRT(B3*B3+YL*YL)
      ANA1=0.5*DL*TP(2,J)*GST/386.4
      ANA2(II)=ANA2(II)+ANA1
  203 CONTINUE
  204 CONTINUE
  205 CONTINUE
      DO 300 N=1,NST
      DO 300 I=1,NC
      II=(N-1)*NC+I
      HL=DABS(SD(N,5)-CLN(I,1))
      HM=DABS(SD(N,6)-CLN(I,2))
      ANA4(N)=ANA4(N)+ANA2(II)
      ANA5(N)=ANA5(N)+ANA2(II)*(HL**2.+HM**2.)
  300 CONTINUE
  301 CONTINUE
      GST=GST1
      GCO=GCO1
  302 RETURN
 1000 FORMAT(23H0THE OBJECTIVE VALUE IS,F14.4)
 1001 FORMAT(23H0THE STEEL WEIGHT IS   ,F14.4)
 1002 FORMAT(23H0THE CONCRETE WEIGHT IS,F14.4)
 1003 FORMAT(F14.4)
C
      END
      SUBROUTINE EMAS(IJ,MI,NCTS,NST,I3,LCON,IO,NC,N,M,ANA2,ANA4,ANA5,
     1IDY)
C
C     CALCULATE THE EIGENVECTOR * MASS * EIGENVECTOR
C        AND GRADIENT OF THE STRUCTURAL MASS
C
      IMPLICIT REAL*8(A-H,O-Z)
      COMMON/DATA1/CLN(14,2),CP(26,45),BP(15,45),FEF(5,10),LB(10,15,3),L
     1DB(10,15,3),LC(10,14,2),LP(3,20),IFEF(10),PP(22,20),LT(3,40),TP(5,
     240),LIM,ID,GST,GCO,NSTEEL,NSTEE2,MATC,NLOOD,NTOT1
      COMMON/EIGNV/EIGV(170),X(170,170),VAL(10),NIO,N9,C1(10),L2(10)
     1,XMAS1(10),XMAS(10),ISMN,L3(10),L4(10),MODE,PHIM(10),DPHI(10),PHIL
     2(170,10),DPHIM(10),PHI(10),UVAL(10)
      COMMON/DATA7/PLOAD(40),SD(10,15),ANA(280),IF,IFC,XI,YI
      COMMON/DYNAM/VMA(170),FMA(170),DDIS(10,3),X2(170,10),PO(10),ETA(3,
     110),VN1(170),SAA(3,10),PHI1(10),VN(10,10)
      COMMON/STEP/C1(1(15,3),DIX(2,3),NUM22
      DIMENSION LCON(5,30),ANA6(70),J(8),ANA2(140),ANA4(10),ANA5(10)
C
C     FIND X*MASS*X
C
      IF(IO.NE.0) GO TO 302
      M2=MI
      MI=L2(M2)
      XMAS(IJ)=0.0
      DO 100 I=1,NCTS
      XMAS(IJ)=XMAS(IJ)+X(I,MI)*(ANA(NCTS+I)+ANA2(I))*X(I,MI)
  100 CONTINUE
      DO 102 NB=1,NST
      I4=3*(NB-1)+NCTS
      DO 102 I=1,3
      IF(I.EQ.3) GO TO 101
      XMAS(IJ)=XMAS(IJ)+X(I4+I,MI)*(SD(NB,3)+ANA4(NB))*X(I4+I,MI)
      GO TO 102
  101 XMAS(IJ)=XMAS(IJ)+X(I4+I,MI)*(SD(NB,4)+ANA5(NB))*X(I4+I,MI)
  102 CONTINUE
      MI=M2
      GO TO 221
C
C     MASS GRADIENT CALCULATIONS
C
  302 NSTC=NCTS+NST*3
      GST1=GST
      GCO1=GCO
      GST=.490/1728.
      GCO=.150/1728.
      XMAS1(IJ)=0.0
      PHIM(IJ)=0.0
      DPHI(IJ)=0.0
      DPHIM(IJ)=0.0
      DO 301 I=1,NSTC
      ANA6(I)=0.0
  301 CONTINUE
      IF(IO.NE.1) GO TO 206
      MC=LC(N,M,1)
      DEL=CP(22,MC)
      IF(MC.GT.NSTEEL) GO TO 200
      DO 808 I10=1,NUM22
      IF(CP(6,MC).GE.DIX(2,I10).AND.CP(6,MC).LE.DIX(1,I10)) I8=I10
  808 CONTINUE
      C3=C1(1(4,I8)
      P5=C1(1(5,I8)
      C4=C1(1(6,I8)
      ANA3=(SD(N,2)*GST/386.4)*(C3*P5*CP(6,MC)**(P5-1.))
      GO TO 201
```

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200   AMA3=(SD(N,2)*GCO/386.4)/(CP(1,NC)**2*CP(19,NC))             EMAS0660
201   J1(1)=(N-1)*NC+N                                             EMAS0670
      J1(2)=J1(1)+NC                                               EMAS0680
      DO 202 I=1,6                                                 EMAS0690
202   J1(2+I)=NCTS+(N-1)*3+I                                       EMAS0700
      DO 205 I=1,8                                                 EMAS0710
      K=J1(I)                                                      EMAS0720
      IF(I.EQ.2.AND.K.GT.NCTS) GO TO 205                           EMAS0730
      IF(N.GT.NSTC) GO TO 205                                      EMAS0740
      IF(I.EQ.5) GO TO 203                                         EMAS0750
      IF(I.EQ.8) GO TO 204                                         EMAS0760
      AMA6(K)=0.5*AMA3                                             EMAS0770
      GO TO 205                                                    EMAS0780
203   HL=SD(N,5)-CLN(M,1)                                          EMAS0790
      HM=SD(N,6)-CLN(M,2)                                          EMAS0800
      AMA6(K)=0.5*AMA3*(HL*HL+HM*HM)                               EMAS0810
      GO TO 205                                                    EMAS0820
204   IF(N.EQ.NST) GO TO 205                                       EMAS0830
      HL=SD(N+1,5)-CLN(M,1)                                        EMAS0840
      HM=SD(N+1,6)-CLN(M,2)                                        EMAS0850
      AMA6(K)=0.5*AMA3*(HL*HL+HM*HM)                               EMAS0860
205   CONTINUE                                                     EMAS0870
      GO TO 222                                                    EMAS0880
206   IF(ID.NE.2) GO TO 210                                        EMAS0890
      MB=LB(N,M,3)                                                 EMAS0900
      DO 809 II0=1,NUM22                                           EMAS0910
      IF(BP(4,MB).GE.DIX(2,II0).AND.BP(4,MB).LE.DIX(1,II0)) I8=II0 EMAS0920
809   CONTINUE                                                     EMAS0930
      C3=C1(I1(4,I8))                                              EMAS0940
      P5=C1(I1(5,I8))                                              EMAS0950
      C4=C1(I1(6,I8))                                              EMAS0960
      DEL=BP(13,MB)                                                EMAS0970
      KI=LB(N,M,1)                                                 EMAS0980
      KJ=LB(N,M,2)                                                 EMAS0990
      B1=CLN(KJ,1)-CLN(KI,1)                                       EMAS1000
      B2=CLN(KJ,2)-CLN(KI,2)                                       EMAS1010
      B3=DSQRT(B1*B1+B2*B2)                                        EMAS1020
      XLR=B3-BP(8,MB)-BP(9,MB)                                     EMAS1030
      AMA3=(XLR*GST/386.4)*(C3*P5*BP(4,MB)**(P5-1.))               EMAS1040
      J1(1)=(N-1)*NC+KI                                            EMAS1050
      J1(2)=(N-1)*NC+KJ                                            EMAS1060
      DO 207 I=1,3                                                 EMAS1070
207   J1(2+I)=NCTS+(N-1)*3+I                                       EMAS1080
      DO 209 I=1,5                                                 EMAS1090
      K=J1(I)                                                      EMAS1100
      IF(K.GT.NSTC) GO TO 209                                      EMAS1110
      IF(I.EQ.5) GO TO 208                                         EMAS1120
      AMA6(K)=0.5*AMA3                                             EMAS1130
      IF(I.LT.3) GO TO 209                                         EMAS1140
      AMA6(K)=2.*AMA6(K)                                           EMAS1150
      GO TO 209                                                    EMAS1160
208   HL=SD(N,5)-CLN(KI,1)                                         EMAS1170
      HM=SD(N,6)-CLN(KI,2)                                         EMAS1180
      HL1=SD(N,5)-CLN(KJ,1)                                        EMAS1190
      HM1=SD(N,6)-CLN(KJ,2)                                        EMAS1200
      AMA6(K)=AMA3*0.5*(HL*HL+HM*HM+HL1*HL1+HM1*HM1)               EMAS1210
209   CONTINUE                                                     EMAS1220
      GO TO 222                                                    EMAS1230
210   IF(ID.NE.3) GO TO 216                                        EMAS1240
      DEL=PP(17,M)                                                 EMAS1250
      KI=LP(2,M)                                                   EMAS1260
      KJ=LP(3,M)                                                   EMAS1270
      AMA3=(SD(N,2)*GCO/386.4)/(PP(15,M)*PP(4,M)**2.)              EMAS1280
      J1(1)=LP(2,M)+(N-1)*NC                                       EMAS1290
      J1(2)=LP(3,M)+(N-1)*NC                                       EMAS1300
      J1(3)=LP(2,M)+N*NC                                           EMAS1310
      J1(4)=LP(2,M)+N*NC                                           EMAS1320
      DO 211 I=1,6                                                 EMAS1330
211   J1(4+I)=NCTS+(N-1)*3+I                                       EMAS1340
      DO 215 I=1,10                                                EMAS1350
      K=J1(I)                                                      EMAS1360
      IF(K.GT.NSTC) GO TO 215                                      EMAS1370
      IF(I.GE.5) GO TO 212                                         EMAS1380
      IF(K.GT.NCTS) GO TO 215                                      EMAS1390
      AMA6(K)=0.25*AMA3                                            EMAS1400
      GO TO 215                                                    EMAS1410
212   IF(I.EQ.7) GO TO 213                                         EMAS1420
      IF(I.EQ.10) GO TO 214                                        EMAS1430
      AMA6(K)=0.5*AMA3                                             EMAS1440
      GO TO 215                                                    EMAS1450
213   HL=SD(N,5)-CLN(KI,1)                                         EMAS1460
      HM=SD(N,6)-CLN(KI,2)                                         EMAS1470
      HL1=SD(N,5)-CLN(KJ,1)                                        EMAS1480
      HM1=SD(N,6)-CLN(KJ,2)                                        EMAS1490
      AMA6(K)=AMA3*0.25*(HM*HM+HL*HL+HM1*HM1+HL1*HL1)              EMAS1500
      GO TO 215                                                    EMAS1510
214   IF(N.EQ.NST) GO TO 215                                       EMAS1520
      HL=SD(N+1,5)-CLN(KI,1)                                       EMAS1530
      HM=SD(N+1,6)-CLN(KI,2)                                       EMAS1540
      HL1=SD(N+1,5)-CLN(KJ,1)                                      EMAS1550
      HM1=SD(N+1,6)-CLN(KJ,2)                                      EMAS1560
      AMA6(K)=AMA3*0.25*(HM*HM+HL*HL+HM1*HM1+HL1*HL1)              EMAS1570
215   CONTINUE                                                     EMAS1580
      GO TO 222                                                    EMAS1590
216   IF(ID.NE.4) GO TO 222                                        EMAS1600
      DEL=TP(6,M)                                                  EMAS1610
      KJ=LT(2,M)                                                   EMAS1620
      KI=LT(3,M)                                                   EMAS1630
      B1=CLN(KJ,1)-CLN(KI,1)                                       EMAS1640
      B2=CLN(KJ,2)-CLN(KI,2)                                       EMAS1650
      YL=SD(N,2)                                                   EMAS1660
      DL=DSQRT(B1*B1+B2*B2+YL*YL)                                  EMAS1670
      AMA3=(DL*GST/386.4)                                          EMAS1680
      J1(1)=(N-1)*NC+KJ                                            EMAS1690
      J1(2)=N*NC+KI                                                EMAS1700
      DO 217 I=1,6                                                 EMAS1710
217   J1(2+I)=NCTS+(N-1)*3+I                                       EMAS1720
      DO 220 I=1,8                                                 EMAS1730
      K=J1(I)                                                      EMAS1740
      IF(I.LT.3.AND.K.GT.NCTS) GO TO 220                           EMAS1750
      IF(K.GT.NSTC) GO TO 220                                      EMAS1760
      IF(I.EQ.5) GO TO 218                                         EMAS1770
      IF(I.EQ.8) GO TO 219                                         EMAS1780
      AMA6(K)=0.5*AMA3                                             EMAS1790
      GO TO 220                                                    EMAS1800
218   HL=SD(N,5)-CLN(KJ,1)                                         EMAS1810
      HM=SD(N,6)-CLN(KJ,2)                                         EMAS1820
      AMA6(K)=0.5*AMA3*(HL*HL+HM*HM)                               EMAS1830
      GO TO 220                                                    EMAS1840
219   IF(N.EQ.NST) GO TO 220                                       EMAS1850
      HL=SD(N+1,5)-CLN(KI,1)                                       EMAS1860
      HM=SD(N+1,6)-CLN(KI,2)                                       EMAS1870
      AMA6(K)=0.5*AMA3*(HL*HL+HM*HM)                               EMAS1880
220   CONTINUE                                                     EMAS1890
222   CONTINUE                                                     EMAS1900
C                                                                  EMAS1910
C     QUANTITIES USED IN THE DYNAMIC DISPL. AND FREQ.              EMAS1920
C                 GRADIENT CALCULATIONS                            EMAS1930
C                                                                  EMAS1940
      DO 300 I=1,NSTC                                              EMAS1950
      XMAS1(IJ)=XMAS1(IJ)+X(I,ML)*AMA6(I)*X(I,ML)                  EMAS1960
      PHIL1(I,IJ)=X(I,ML)*AMA6(I)                                  EMAS1970
300   CONTINUE                                                     EMAS1980
      DO 310 I=1,NCTS                                              EMAS1990
      PHIM(IJ)=PHIM(IJ)+X(I,ML)*AMA6(I)*SAA(I,IJ)                  EMAS2000
310   CONTINUE                                                     EMAS2010
      DO 320 N6=1,NST                                              EMAS2020
      DO 321 N7=1,3                                                EMAS2030
      I4=(N6-1)*3+NCTS+N7                                          EMAS2040
      IF(N7.EQ.3) GO TO 330                                        EMAS2050
      PHIM(IJ)=PHIM(IJ)+X(I4,ML)*AMA6(I4)*SAA(N7+1,IJ)             EMAS2060
      GO TO 321                                                    EMAS2070
330   PHIM(IJ)=PHIM(IJ)+X(I4,ML)*AMA6(I4)*0.0                      EMAS2080
321   CONTINUE                                                     EMAS2090
320   CONTINUE                                                     EMAS2100
      GST=GST1                                                     EMAS2110
      GCO=GCO1                                                     EMAS2120
221   RETURN                                                       EMAS2130
C                                                                  EMAS2140
      END                                                          EMAS2150
      SUBROUTINE JACOBI(NST,N,NSS,NCTS,AMA2,AMA4,AMA5,ID,X2)       JACO0010
C                                                                  JACO0020
C      JACOBI ITERATION TECHNIQUE FOR FINDING                      JACO0030
C          EIGENVECTORS AND EIGENVALUES                            JACO0040
C                                                                  JACO0050
      IMPLICIT REAL*8(A-H,O-Z)                                     JACO0060
      COMMON/DATA7/PLOAD(140),SD(10,15),AMA(280),IF,IEC,X1,Y1      JACO0070
      COMMON/STIFF/SS(170,170),SG(30,30),STIFFF(170,170)           JACO0080
      COMMON/EIGNV/EIGV(170),X(170,170),VAL(10),NIO,N9,CS(10),L2(10) JACO0090
     1,XMAS(10),XMAS1(10),ISMN,L3(10),L4(10),MODE,PHIM(10),DPHI(10),PHILJACO0100
     2(170,10),DPHIM(10),PHI(10),UVAL(10)                          JACO0110
      COMMON/PLOTT/IPRF,IPRS,IPRE,IPREM,IPRD                       JACO0120
      DIMENSION A(170,170),B(170,170),D(170),FM2(8,16),XM12(6,10)  JACO0130
     1,AMA2(140),AMA4(10),AMA5(10),K2(170,10)                      JACO0140
C                                                                  JACO0150
C     REASSEMBLE STIFFNESS MATRIX                                  JACO0160
C                                                                  JACO0170
C                                                                  JACO0180
      REWIND 20                                                    JACO0180
      DO 460 I=1,N                                                 JACO0190
      DO 460 J=1,N                                                 JACO0200
      B(I,J)=0.0                                                   JACO0210
460   A(I,J)=SS(I,J)                                               JACO0220
      DO 470 I=1,NSS                                               JACO0230
      DO 470 J=1,NSS                                               JACO0240
470   A(I+NCTS,J+NCTS)=A(I+NCTS,J+NCTS)+386.4*SG(I,J)              JACO0250
C                                                                  JACO0260
```

```
C
C     ASSEMBLE DIAGONAL MASS MATRIX
C
      DO 480 I=1,MCTS
  480 B(I,I)=ANA1(I+MCTS)+ANA2(I)
      DO 490 J=1,MST
      JI=3*(J-1)
      B(MCTS+3+JI,MCTS+3+JI)=SD(J,4)+ANA5(J)
      DO 490 KK=1,2
  490 B(MCTS+JI+KK,MCTS+JI+KK)=SD(J,3)+ANA4(J)
      RTOL=10.**(-I2)
      NSMAX=15
      IFPR=0
C
C     KEEP PREVIOUS EIGENVECTOR
C
      NSTC=MCTS+3*MST
      DO 530 MI=1,N9
      K=L2(MI)
      IF(K.EQ.0) GO TO 530
      DO 520 L=1,NSTC
      XZ(L,MI)=X(L,K)
  520 CONTINUE
  530 CONTINUE
C
C     INITIALIZE EIGENVALUES AND EIGENVECTORS
C
      DO 10 I=1,N
      IF(A(I,I).GT.0..AND.B(I,I).GT.0.) GO TO 4
C
      WRITE(6,2020)
      STOP
    4 D(I)=A(I,I)/B(I,I)
   10 EIGV(I)=D(I)
      DO 30 I=1,N
      DO 20 J=1,N
   20 X(I,J)=0.
   30 X(I,I)=1.
      IF(N.EQ.1) RETURN
C
C     INITIALIZE SWEEP COUNTER AND BEGIN ITERATION
C
      NSWEEP=0
      NR=N-1
   40 NSWEEP=NSWEEP+1
      IF(IFPR.EQ.1)WRITE(6,2000)NSWEEP
C
C     CHECK IF PRESENT OFF-DIAGONAL ELEMENT IS LARGE ENOUGH TO REQUIRE
C
      EPS=(0.01**NSWEEP)**2
      DO 210 J=1,NR
      JJ=J+1
      DO 210 K=JJ,N
      EPTOLA=(A(J,K)*A(J,K))/(A(J,J)*A(K,K))
      EPTOLB=(B(J,K)*B(J,K))/(B(J,J)*B(K,K))
      IF((EPTOLA.LT.EPS).AND.(EPTOLB.LT.EPS)) GO TO 210
C
C     IF ZEROING IS REQUIRED, CALCULATE THE ROTATION MATRIX ELEMENTS CA
C
      AKK=A(K,K)*B(J,K)-B(K,K)*A(J,K)
      AJJ=A(J,J)*B(J,K)-B(J,J)*A(J,K)
      AB=A(J,J)*B(K,K)-A(K,K)*B(J,J)
      CHECK=(AB*AB+4.*AKK*AJJ)/4.
      IF(CHECK)50,60,60
   50 WRITE(6,2020)
      STOP
   60 SQCH=DSQRT(CHECK)
      D1=AB/2.+SQCH
      D2=AB/2.-SQCH
      DEN=D1
      IF(DABS(D2).GT.DABS(D1))DEN=D2
      IF(DEN)80,70,80
   70 CA=0.
      CG=-A(J,K)/A(K,K)
      GO TO 90
   80 CA=AKK/DEN
      CG=-AJJ/DEN
C
C     PERFORM THE GGENERALIZED ROTATION TO ZERO
C
   90 IF(N-2)100,190,100
  100 JP1=J+1
      JM1=J-1
      KP1=K+1
      KM1=K-1
      IF(JM1-1)130,110,110
  110 DO 120 I=1,JM1
      AJ=A(I,J)
      BJ=B(I,J)
      AK=A(I,K)
      BK=B(I,K)
      A(I,J)=AJ+CG*AK
      B(I,J)=BJ+CG*BK
      A(I,K)=AK+CA*AJ
  120 B(I,K)=BK+CA*BJ
  130 IF(KP1-N)140,140,160
  140 DO 150 I=KP1,N
      AJ=A(J,I)
      BJ=B(J,I)
      AK=A(K,I)
      BK=B(K,I)
      A(J,I)=AJ+CG*AK
      B(J,I)=BJ+CG*BK
      A(K,I)=AK+CA*AJ
  150 B(K,I)=BK+CA*BJ
  160 IF(JP1-KM1)170,170,190
  170 DO 180 I=JP1,KM1
      AJ=A(J,I)
      BJ=B(J,I)
      AK=A(I,K)
      BK=B(I,K)
      A(J,I)=AJ+CG*AK
      B(J,I)=BJ+CG*BK
      A(I,K)=AK+CA*AJ
  180 B(I,K)=BK+CA*BJ
  190 AK=A(K,K)
      BK=B(K,K)
      A(K,K)=AK+2.*CA*A(J,K)+CA*CA*A(J,J)
      B(K,K)=BK+2.*CA*B(J,K)+CA*CA*B(J,J)
      A(J,J)=A(J,J)+2.*CG*A(J,K)+CG*CG*AK
      B(J,J)=B(J,J)+2.*CG*B(J,K)+CG*CG*BK
      A(J,K)=0.
      B(J,K)=0.
C
C     UPDATE THE EIGENVECTOR MATRIX AFTER EACH ROTATION
C
      DO 200 I=1,N
      XJ=X(I,J)
      XK=X(I,K)
      X(I,J)=XJ+CG*XK
  200 X(I,K)=XK+CA*XJ
  210 CONTINUE
C
C     UPDATE THE EIGENVALUES AFTER EACH SWEEP
C
      DO 220 I=1,N
      IF(A(I,I).GT.0..AND.B(I,I).GT.0.) GO TO 220
      WRITE(6,2020)
      STOP
  220 EIGV(I)=A(I,I)/B(I,I)
      IF(IFPR.EQ.0) GO TO 230
      WRITE(6,2030)
      WRITE(6,2010) (EIGV(I),I=1,N)
C
C     CHECK FOR CONVERGENCE
C
  230 DO 240 I=1,N
      TOL=RTOL*D(I)
      DIF=DABS(EIGV(I)-D(I))
      IF(DIF.GT.TOL) GO TO 280
  240 CONTINUE
C
C     CHECK ALL OFF-DIAGONAL ELEMENTS
C
      EPS=1.0
      DO 250 J=1,NR
      JJ=J+1
      DO 250 K=JJ,N
      IF(A(J,K) .GE. 0.0 .AND. A(J,K) .LT. 1.0E-35) A(J,K)=1.0E-35
      IF(A(J,K) .LT. 0.0 .AND. A(J,K) .GT. -1.0E-35) A(J,K)=-1.0E-35
  246 TA6=A(J,K)/RTOL**2
      TA7=B(J,K)/RTOL**2
      EPSA=(TA6*A(J,K))/(A(J,J)*A(K,K))
      EPSB=(TA7*B(J,K))/(B(J,J)*B(K,K))
      IF((EPSA.LT.EPS).AND.(EPSB.LT.EPS)) GO TO 250
      GO TO 280
  250 CONTINUE
C
C     FILL OUT BOTTOM TRIANGLE OF RESULTANT MATRICES AND SCALE EIGNVEC
C
  255 DO 260 I=1,N
      DO 260 J=I,N
      A(J,I)=A(I,J)
  260 B(J,I)=B(I,J)
      DO 270 J=1,N
      BB=DSQRT(B(J,J))
```

```
      DO 270 K=1,N
  270 X(K,J)=X(K,J)/BB
      IF(MODE.EQ.1) GO TO 510
      K1=MCTS+MST*3-1
      MSTC=K1+1
  499 DO 500 M1=1,N9
      CS(M1)=0.0
      L2(M1)=0
      ICT=0
      K4=M1-1
      DO 501 J=1,M1
      ICT=0
      IF(M1.EQ.1.AND.J.EQ.1) GO TO 504
      DO 502 J1=1,K4
      IF(J.NE.L2(J1)) GO TO 502
      ICT=ICT+1
      GO TO 501
  502 CONTINUE
      IF(ICT.EQ.0) GO TO 504
  501 CONTINUE
  504 CS(M1)=EIGV(J)
      L2(M1)=J
      IF(M1.EQ.MSTC) GO TO 500
      DO 503 J=1,MSTC
      DO 505 J1=1,M1
      IF(J.EQ.L2(J1)) GO TO 503
  505 CONTINUE
      IF(CS(M1).LE.EIGV(J)) GO TO 503
      CS(M1)=EIGV(J)
      L2(M1)=J
  503 CONTINUE
  500 CONTINUE
      IF(IPRE.NE.0)WRITE(6,1001)
      DO 507 M1=1,N9
      K=L2(M1)
      CSSS=DSQRT(CS(M1))
      IF(IPRE.NE.0)WRITE(6,1000) M1,CSSS
      IF(IPREM.NE.0)WRITE(6,1002)
      IF(IPREM.NE.0)WRITE(6,2010)(X(J,K),J=1,N)
      WRITE(76,2040)CS(M1),(X(J,K),J=1,N)
  507 CONTINUE
C
C     CHECK FOR ACTIVE FREQ. CONSTRAINT
C
      IF(ID.LT.4) GO TO 509
      CALL SORT(6,0,0,0,0,0,FM2,XM12)
      CALL SORT(6,0,1,0,0,0,FM2,XM12)
      GO TO 509
  510 IF(IPRE.NE.0) WRITE(6,1001)
      DO 508 K2=1,N9
      K3=MST-L3(K2)+1
      K4=L4(K2)
      K=MCTS+(K3-1)*3+K4
      CS(K2)=EIGV(K)
      L2(K2)=K
      CSSS=DSQRT(CS(K2))
      IF(IPRE.NE.0)WRITE(6,1000)K2,CSSS
      IF(IPREM.NE.0)WRITE(6,1002)
      IF(IPREM.NE.0)WRITE(6,2010)(X(J,K),J=1,N)
      WRITE(76,2040) CS(K2),(X(J,K),J=1,N)
  508 CONTINUE
      CALL SORT(6,0,0,0,0,0,FM2,XM12)
  509 RETURN
C
C     UPDATE   D  MATRIX AND START NEW SWEEP
C
  280 DO 290 I=1,N
  290 D(I)=EIGV(I)
      IF(NSWEEP.LT.NSMAX) GO TO 40
      GO TO 255
 1000 FORMAT(//6H0FREQ.,I5,'  I5',F10.2)
 1001 FORMAT(24H1THE EIGENSOLUTIONS ARE:)
 1002 FORMAT(//18H0THE EIGENMODE I5:)
 1005 FORMAT(4E17.10)
 2000 FORMAT(27H0SWEEP NUMBER IN *JACOBI* = ,I4)
 2010 FORMAT(1H0,6E20.12)
 2020 FORMAT(25H0*** ERROR  SOLUTION STOP  /
     1       31H MATRICES NOT POSITIVE DEFINITE)
 2030 FORMAT(36H0CURRENT EIGENVALUES IN *JACOBI* ARE,/)
 2040 FORMAT(6E20.12)
C
      END
      SUBROUTINE MODAL(AMA2,AMA4,AMA5,MCTS,MSTC,MST)
C
C      THIS SUBROUTINE CALCULATES THE DYNAMIC DISPLACEMENTS
C          AND LATERAL FORCES FOR A GIVEN ACCELERATION
C              RESPONSE SPECTRUM (POLYNOMIAL FORM)
C
      IMPLICIT REAL*8 (A-H,O-Z)
      COMMON/DATA7/PLOAD(140),SD(10,15),AMA(280),IF,IFC,XI,YI
      COMMON/EIGNV/EIGV(170),X(170,170),VAL(10),N10,N9,L1(10)
     1,L2(10),XMAS(10),ZMAS(10),ESMN,L3(10),L4(10),MODE,PHIN(10),
     2DPHI(10),PHIL(170,10),DPHIM(10),PHI(10),UVAL(10)
      COMMON/DYNAM/VMA(170),FMA(170),DDIS(10,3),X2(170,10),PQ(10),ETA(3,
     110),VN1(170),SAA(3,10),PHI1(10),VN(170,10)
      COMMON/RESP/C11(3),C22(3),C33(3),C44(3),C55(3),C66(3),C77(3)
      COMMON/SPEC/DD1(2,4,3),CC1(6,4,3),NDIY
      DIMENSION B(170),AMA2(140),AMA4(10),AMA5(10),FN(170,10)
C
C     FORMULATE DIAGONAL MASS IN VECTOR FORM
C
      DO 480 I=1,MCTS
  480 B(I)=AMA(I+MCTS)+AMA2(I)
      DO 490 J=1,MST
      J1=3*(J-1)
        B(MCTS+3+J1)=SD(J,4)+AMA5(J)
      DO 490 KK=1,2
  490 B(MCTS+J1+KK)=SD(J,3)+AMA4(J)
C
C     FIND MODAL EARTHQUAKE-EXCITATION FACTORS,GENERALIZED MASS,AND
C                      MODAL SPECTRAL ACCELERATIONS
C
      DO 500 I=1,N9
      M1=L2(I)
      R=0.0
      R1=0.0
      GB=0.0
      TN1=2.*3.1416/(DSQRT(C1(I)))
  403 DO 900 J=1,3
      DO 600 KJ=1,NDIY
      IF(TN1.GE.DD1(1,KJ,J).AND.TN1.LE.DD1(2,KJ,J)) K=KJ
  600 CONTINUE
      C11(J)=CC1(1,K,J)
      C22(J)=CC1(2,K,J)
      C33(J)=CC1(3,K,J)
      C44(J)=CC1(4,K,J)
      C55(J)=CC1(5,K,J)
      C66(J)=CC1(6,K,J)
      TN=TN1-C66(J)
      SAA(J,I)=C77(J)*(C11(J)*(TN)**4+C22(J)*(TN)**3+C33(J)*(TN)**2
     1+C44(J)*(TN)+C55(J))
      ETA(J,I)=C77(J)*(4.*C11(J)*(TN)**3+3.*C22(J)*(TN)**2+2.*C33(J)*(TN
     1)+C44(J))
  900 CONTINUE
  903 CONTINUE
      DO 501 J1=1,MCTS
      R=R+X(J1,M1)*B(J1)*SAA(1,I)
      R1=R1+X(J1,M1)*B(J1)*ETA(1,I)
      GB=GB+X(J1,M1)*B(J1)*X(J1,M1)
  501 CONTINUE
      DO 902 J2=1,MST
      DO 901 J1=1,3
      I4=(J2-1)*3+MCTS+J1
      IF(J1.EQ.3) GO TO 899
      R=R+X(I4,M1)*B(I4)*SAA(J1,I)
      R1=R1+X(I4,M1)*B(I4)*ETA(J1,I)
      GB=GB+X(I4,M1)*B(I4)*X(I4,M1)
      GO TO 901
  899 GB=GB+X(I4,M1)*B(I4)*X(I4,M1)
      R=R+X(I4,M1)*B(I4)*0.0
      R1=R1+X(I4,M1)*B(I4)*0.0
  901 CONTINUE
  902 CONTINUE
C
C     PHI(I)=X(I)*M*SAA
C
      PHI(I)=R
      PHI1(I)=R1
  301 CONTINUE
      PN=R/(GB*C1(I))
      PQ(I)=PN
      DO 502 J1=1,MSTC
      VN(J1,I)=X(J1,M1)*PN
      FN(J1,I)=(C1(I))*B(J1)*VN(J1,I)
  502 CONTINUE
  500 CONTINUE
C
C       ROOT MEAN SQUARE DISPLACEMENTS AND FORCES
C
      DO 511 J=1,MSTC
      VMA(J)=0.0
      FMA(J)=0.0
      DO 510 I=1,N9
      VMA(J)=VMA(J)+VN(J,I)**2
      FMA(J)=FMA(J)+FN(J,I)**2
  510 CONTINUE
```

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      VMA(J)=DSQRT(VMA(J))
      FMA(J)=DSQRT(FMA(J))
      VNI(J)=VMA(J)
  511 CONTINUE
C
C     SORT DYNAMIC DISPLACEMENTS FOR ACTIVE CONSTRAINTS
C
  101 CONTINUE
      RETURN
C
C
      END
      SUBROUTINE INVERT(NSTC,NSS,NCTS,NST,I3,AMA2,AMA4,AMA5)
C
C        FINDS THE INVERSE OF THE REDUCED MATRIX USED
C              TO FIND THE EIGENVALUES
C
      IMPLICIT REAL*8(A-H,O-Z)
      COMMON/ST/F1/SS(170,170),SG(30,30),S(170,170)
      COMMON/DATA7/PLOAD(140),SD(10,15),AMA(280),IF,IFC,X1,Y1
      COMMON/EIGNV/EIGV(170),X(170,170),VAL(10),M10,N9,C1(10)
     1,L2(10),XMAS(10),XMAS1(10),ISMN,L3(10),L4(10),MODE,PHIM(10),
     2DPHI(10),PHIL(170,10),DPHIM(10),PHI(10),UVAL(10)
      COMMON/INV/PHIL(170,10)
      DIMENSION AMA2(140),AMA4(10),AMA5(10),X3(170,170)
      REWIND 19
C     REWIND 20
      DO 500 IJ=1,N9
      MI=L2(IJ)
      KK=MI
      DO 461 I=1,NSTC
      DO 460 J=1,NSTC
      S(I,J)=SS(I,J)
      X3(I,J)=0.0
  460 CONTINUE
      X3(I,I)=1.0
  461 CONTINUE
      DO 470 I=1,NSS
      DO 470 J=1,NSS
  470 S(I+NCTS,J+NCTS)=S(I+NCTS,J+NCTS)+386.4*SG(I,J)
      DO 480 I=1,NCTS
      PHIL(I,IJ)=(AMA(NCTS+I)+AMA2(I))*X(I,MI)
      S(I,I)=S(I,I)-C1(IJ)*(AMA(NCTS+I)+AMA2(I))
  480 CONTINUE
      DO 490 N=1,NST
      I4=3*(N-1)+NCTS
      DO 489 J=1,3
      IF(J.EQ.3) GO TO 488
      PHIL(I4+J,IJ)=(AMA4(N)+SD(N,3))*X(I4+J,MI)
      S(I4+J,I4+J)=S(I4+J,I4+J)-C1(IJ)*(AMA4(N)+SD(N,3))
      GO TO 489
  488 PHIL(I4+J,IJ)=(AMA5(N)+SD(N,4))*X(I4+J,MI)
      S(I4+J,I4+J)=S(I4+J,I4+J)-C1(IJ)*(AMA5(N)+SD(N,4))
  489 CONTINUE
  490 CONTINUE
      NSTC1=NSTC
      IC=0
      DO 809 KI=1,NST
      DO 810 KI1=1,3
      I7=NCTS+(KI-1)*3+KI1
      XX=EIGV(I7)/C1(IJ)
      IF(XX.LT.(.95).OR.XX.GT.(1.05)) GO TO 810
      KK=I7-IC
      IC=IC+1
      NSTC1=NSTC1-1
      DO 808 I=1,NSTC1
      DO 808 J=1,NSTC1
      IF(I.GE.KK.AND.J.GE.KK) GO TO 897
      IF(I.GE.KK.AND.J.LT.KK) GO TO 898
      IF(I.LT.KK.AND.J.GE.KK) GO TO 899
      S(I,J)=S(I,J)
      GO TO 808
  897 S(I,J)=S(I+1,J+1)
      GO TO 808
  898 S(I,J)=S(I+1,J)
      GO TO 808
  899 S(I,J)=S(I,J+1)
  808 CONTINUE
  810 CONTINUE
  809 CONTINUE
      CALL GAUSS2(S,NSTC1,X3,NSTC1)
C
C        STORE THE INVERSE FOR FINDING THE EIGENVECTOR
C              GRADIENTS IN GRAD
C
      DO 811 KI=1,NST
      DO 812 KI1=1,3
      I7=NCTS+(KI-1)*3+KI1
      XX=EIGV(I7)/C1(IJ)
      IF(XX.LT.(.95).OR.XX.GT.(1.05)) GO TO 812
      KK=I7
      DO 510 I=1,NSTC
      DO 509 J=1,NSTC
      IF(I.GT.KK.AND.J.GT.KK) GO TO 530
      IF(I.GT.KK.AND.J.LT.KK) GO TO 531
      IF(I.LT.KK.AND.J.GT.KK) GO TO 532
      IF(I.EQ.KK.OR.J.EQ.KK) GO TO 533
      XXX=X3(I,J)
      GO TO 535
  530 XXX=X3(I-1,J-1)
      GO TO 535
  531 XXX=X3(I-1,J)
      GO TO 535
  532 XXX=X3(I,J-1)
      GO TO 535
  533 XXX=0.0
  535 CONTINUE
      WRITE(19,1000) XXX
  508 CONTINUE
  509 CONTINUE
  510 CONTINUE
  812 CONTINUE
  811 CONTINUE
  500 CONTINUE
 1000 FORMAT(1E25.18)
 1001 FORMAT(4E17.10)
      RETURN
      END
      SUBROUTINE LAGMU(NST,NC,NB,NPAN,NTRU,NCP,NBP)
C
C        FORMULATE THE SIMULTANEOUS EQUATIONS
C           USED TO FIND THE LAGRANGE
C                 MULTIPLIERS
C
      IMPLICIT REAL*8(A-H,O-Z)
      COMMON/DATA1/CLN(14,2),CP(26,45),BP(15,65),FEF(5,10),LB(10,15,3),L
     1DB(10,15,3),LC(10,14,2),LP(3,20),IFEF(10),PP(22,20),LT(3,40),IP(9
     2,40),LIM,IO,GST,GCO,NSTEEL,NSTEE2,NATC,NLODD,NTOT1
      COMMON/DATA7/PLOAD(140),SD(10,15),AMA(280),IF,IFC,X1,Y1
      COMMON/STRES/SCOL(10,14,6,4),SBM(10,15,6,2),SPAN(20,6,3),SDIA(40,6
     1,1),F2,CON(30),P1,P2,DIST(10,1),LCON(5,30),L4,L7,L8,L9,CONCO(8,30)
      COMMON/GRAD/T2(10,14,30),T3(10,15,30),T4(10,20,30),T5(10,40,30),RR
     1R
      COMMON/PASS/PPASS(20),TPASS(40),IPASS,IPASS1
      COMMON/EIGNV/EIGV(170),X(170,170),VAL(10),M10,N9,C1(10),L2(10)
     1,XMAS(10),XMAS1(10),ISMN,L3(10),L4(10),MODE,PHIM(10),DPHI(10),PHIL
     2(170,10),DPHIM(10),PHI(10),UVAL(10)
      COMMON/DYNAM/VMA(170),FMA(170),DDIS(10,3),X2(170,10),PQ(10),ETA(3,
     110),VN(170),SAA(3,10),PHI1(10),VN(170,10)
      COMMON/STEP/C(11)(15,3),DIX(2,3),NUM22
      DIMENSION R(30),R1(30),S(30,30),SS(30,30)
      DIMENSION CPASS1(45),BPASS1(45)
C
      IPASS=0
      IPASS1=0
C     RRR IS THE CONVERGENCE CONTROL PARAMETER
C
      DO 94 N=1,NCP
   94 CPASS1(N)=0.0
      IF(NB.EQ.0) GO TO 92
      DO 93 N=1,NBP
   93 BPASS1(N)=0.0
   92 CONTINUE
      IF(NPAN.EQ.0) GO TO 30
      DO 95 N=1,NPAN
      PPASS(N)=0.0
   95 CONTINUE
   30  IF(NTRU.EQ.0) GO TO 97
      DO 96 N=1,NTRU
      TPASS(N)=0.0
   96 CONTINUE
   97 IGN=0
      DO 99 J=1,LIM
      R1(J)=0.0
      R(J)=0.0
      KA=LCON(5,J)
      IF(IO.EQ.0) GO TO 99
      KI=LCON(1,J)
      IF(LCON(1,J).EQ.6) GO TO 700
      K1=LCON(1,J)
      M1=LCON(3,J)
      N=NST-LCON(2,J)+1
      KKK=LCON(4,J)
      N7=LCON(2,J)
      IF(K1.LE.4.AND.LCON(4,J).GT.NLODD) K1=K1+7
      IF(K1.EQ.5.AND.LCON(4,J).GT.NLODD) K1=7
```

```
      IF(K1.NE.1.AND.K1.NE.8) GO TO 599                               LAGM0590
      MC=LC(N,M,1)                                                    LAGM0600
      IF(MC.GT.NSTEEL) GO TO 598                                      LAGM0610
      IF(K1.EQ.1) K12=14                                              LAGM0620
      IF(K1.EQ.8) K12=24                                              LAGM0630
      K13=K12+1                                                       LAGM0640
      IF(CON(J).LT.0.0) GO TO 597                                     LAGM0650
      R(J)=RRR*(CP(K12,MC)-CON(J))                                    LAGM0660
      GO TO 609                                                       LAGM0670
  597 R(J)=(1.)*RRR*(CON(J)+CP(K13,MC))                               LAGM0680
      GO TO 609                                                       LAGM0690
  598 IF(K1.EQ.1) K12=7                                               LAGM0700
      IF(K1.EQ.8) K12=24                                              LAGM0710
      K13=K12+1                                                       LAGM0720
      IF(CON(J).LT.0.0) GO TO 596                                     LAGM0730
      R(J)=RRR*(CP(K12,MC)-CON(J))                                    LAGM0740
      GO TO 609                                                       LAGM0750
  596 R(J)=(1.)*RRR*(CON(J)+CP(K13,MC))                               LAGM0760
      GO TO 609                                                       LAGM0770
  599 IF(K1.NE.2.AND.K1.NE.9) GO TO 600                               LAGM0780
      IF(K1.EQ.2) K12=11                                              LAGM0790
      IF(K1.EQ.9) K12=15                                              LAGM0800
      MB=LB(N,M,3)                                                    LAGM0810
      R(J)=RRR*(BP(K12,MB)-CON(J))                                    LAGM0820
      GO TO 609                                                       LAGM0830
  600 IF(K1.NE.3.AND.K1.NE.10) GO TO 605                              LAGM0840
      IF(K1.EQ.3) K12=7                                               LAGM0850
      IF(K1.EQ.10) K12=20                                             LAGM0860
      K13=K12+1                                                       LAGM0870
      K14=K12+2                                                       LAGM0880
      IF(J.EQ.5) GO TO 604                                            LAGM0890
      IF(CON(J).LT.0.0) GO TO 606                                     LAGM0900
      R(J)=RRR*(PP(K12,M1)-CON(J))                                    LAGM0910
      GO TO 609                                                       LAGM0920
  606 R(J)=(1.)*RRR*(CON(J)+PP(K13,M1))                               LAGM0930
      GO TO 609                                                       LAGM0940
  604 IF(CON(J).LT.0.0) GO TO 603                                     LAGM0950
      R(J)=RRR*(PP(K14,M1)-CON(J))                                    LAGM0960
      GO TO 609                                                       LAGM0970
  603 R(J)=(1.)*RRR*(CON(J)+PP(K14,M1))                               LAGM0980
      GO TO 609                                                       LAGM0990
  605 IF(K1.NE.4.AND.K1.NE.11) GO TO 608                              LAGM1000
      IF(K1.EQ.4) K12=3                                               LAGM1010
      IF(K1.EQ.11) K12=8                                              LAGM1020
      K13=K12+1                                                       LAGM1030
      IF(CON(J).LT.0.0) GO TO 607                                     LAGM1040
      R(J)=RRR*(TP(K12,M1)-CON(J))                                    LAGM1050
      GO TO 609                                                       LAGM1060
  607 R(J)=(1.)*RRR*(CON(J)+TP(K13,M1))                               LAGM1070
      GO TO 609                                                       LAGM1080
  608 IF(K1.NE.5) GO TO 700                                           LAGM1090
      IF(CON(J).LT.0.0) GO TO 610                                     LAGM1100
      R(J)=RRR*(DIS(N7,KK)-CON(J))                                    LAGM1110
      GO TO 609                                                       LAGM1120
  610 R(J)=(1.)*RRR*(CON(J)+DIS(N7,KK))                               LAGM1130
      GO TO 609                                                       LAGM1140
  700 IF(K1.NE.6) GO TO 701                                           LAGM1150
      IGN=IGN+1                                                       LAGM1160
      IF(LCON(3,J).EQ.1) GO TO 650                                    LAGM1170
      R(J)=RRR*(-VAL(KK)+CON(J))                                      LAGM1180
      GO TO 609                                                       LAGM1190
  650 R(J)=RRR*(-CON(J)+UVAL(KK))                                     LAGM1200
      GO TO 609                                                       LAGM1210
  701 IF(K1.NE.7) GO TO 609                                           LAGM1220
      IF(CON(J).LT.0.0) GO TO 702                                     LAGM1230
      R(J)=RRR*(DDIS(N7,KK)-CON(J))                                   LAGM1240
      GO TO 609                                                       LAGM1250
  702 R(J)=(1.)*RRR*(CON(J)+DDIS(N7,KK))                              LAGM1260
      GO TO 609                                                       LAGM1270
  609 CONTINUE                                                        LAGM1280
      DO 100 N=1,NST                                                  LAGM1290
      DO 101 M=1,NC                                                   LAGM1300
      K=LC(N,M,1)                                                     LAGM1310
      IF(K.GT.NSTEEL) GO TO 102                                       LAGM1320
      IF(CPASS1(K).EQ.1.) GO TO 300                                   LAGM1330
      IF(CPASS1(K).EQ.2.) GO TO 900                                   LAGM1340
      R1(J)=R1(J)+T2(N,M,J)*CP(6,K)                                   LAGM1350
      GO TO 101                                                       LAGM1360
  300 R1(J)=R1(J)-T2(N,M,J)*RRR*(CP(21,K)-CP(6,K))                    LAGM1370
      GO TO 101                                                       LAGM1380
  900 R1(J)=R1(J)-T2(N,M,J)*RRR*(CP(23,K)-CP(6,K))                    LAGM1390
      GO TO 101                                                       LAGM1400
  102 IF(CPASS1(K).EQ.1.) GO TO 301                                   LAGM1410
      IF(CPASS1(K).EQ.2.) GO TO 901                                   LAGM1420
      R1(J)=R1(J)+T2(N,M,J)*CP(1,K)/CP(10,K)                          LAGM1430
      GO TO 101                                                       LAGM1440
  301 R1(J)=R1(J)-T2(N,M,J)*RRR*(CP(21,K)-CP(12,K))*CP(11,K)**3*CP(19,KLAGM1450
      GO TO 101                                                       LAGM1460
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  901 R1(J)=R1(J)-T2(N,M,J)*RRR*(CP(23,K)-CP(12,K))*CP(11,K)**3*CP(19,KLAGM1470
  101 CONTINUE                                                        LAGM1480
      IF(NB.EQ.0) GO TO 32                                            LAGM1490
      DO 103 M=1,NB                                                   LAGM1500
      K=LB(N,M,3)                                                     LAGM1510
      IF(BPASS1(K).EQ.1.) GO TO 302                                   LAGM1520
      IF(BPASS1(K).EQ.2.) GO TO 902                                   LAGM1530
      R1(J)=R1(J)+T3(N,M,J)*BP(4,K)                                   LAGM1540
      GO TO 103                                                       LAGM1550
  302 R1(J)=R1(J)-T3(N,M,J)*RRR*(BP(12,K)-BP(4,K))                    LAGM1560
      GO TO 103                                                       LAGM1570
  902 R1(J)=R1(J)-T3(N,M,J)*RRR*(BP(14,K)-BP(4,K))                    LAGM1580
  103 CONTINUE                                                        LAGM1590
   32 IF(NPAN.EQ.0) GO TO 33                                          LAGM1600
      DO 104 M=1,NPAN                                                 LAGM1610
      NP=NST-LP(1,M)+1                                                LAGM1620
      IF(NP.NE.N) GO TO 104                                           LAGM1630
      IF(PPASS(M).EQ.1.) GO TO 303                                    LAGM1640
      IF(PPASS(M).EQ.2.) GO TO 903                                    LAGM1650
      R1(J)=R1(J)+T4(N,M,J)*PP(1,M)/PP(3,M)                           LAGM1660
      GO TO 104                                                       LAGM1670
  303 R1(J)=R1(J)-T4(N,M,J)*RRR*(PP(18,M)-PP(5,M))*PP(4,M)**3*PP(15,M)  LAGM1680
      GO TO 104                                                       LAGM1690
  903 R1(J)=R1(J)-T4(N,M,J)*RRR*(PP(19,M)-PP(5,M))*PP(4,M)**3*PP(15,M)  LAGM1700
  104 CONTINUE                                                        LAGM1710
   33 IF(NTRU.EQ.0) GO TO 100                                         LAGM1720
      DO 105 M=1,NTRU                                                 LAGM1730
      NP=NST-LT(1,M)+1                                                LAGM1740
      IF(NP.NE.N) GO TO 105                                           LAGM1750
      IF(TPASS(M).EQ.1.) GO TO 304                                    LAGM1760
      IF(TPASS(M).EQ.2.) GO TO 904                                    LAGM1770
      R1(J)=R1(J)+T5(N,M,J)*TP(2,M)                                   LAGM1780
      GO TO 105                                                       LAGM1790
  304 R1(J)=R1(J)-T5(N,M,J)*RRR*(TP(5,M)-TP(2,M))                     LAGM1800
      GO TO 105                                                       LAGM1810
  904 R1(J)=R1(J)-T5(N,M,J)*RRR*(TP(7,M)-TP(2,M))                     LAGM1820
  105 CONTINUE                                                        LAGM1830
  100 CONTINUE                                                        LAGM1840
      IF(LCON(1,J).EQ.6.AND.LCON(3,J).EQ.0) R(J)=R(J)-R1(J)           LAGM1850
      IF(LCON(1,J).EQ.6.AND.LCON(3,J).EQ.1) R(J)=R(J)+R1(J)           LAGM1860
      IF(LCON(1,J).EQ.6) GO TO 696                                    LAGM1870
      IF(CON(J).LT.0.0) R(J)=R(J)-R1(J)                               LAGM1880
      IF(CON(J).GE.0.0) R(J)=R(J)+R1(J)                               LAGM1890
  696 R1(J)=R(J)                                                      LAGM1900
   99 CONTINUE                                                        LAGM1910
      DO 199 K=1,LIN                                                  LAGM1920
      SIT2=-1.0                                                       LAGM1930
      IF(CON(K).GT.0.0) SIT2=1.0                                      LAGM1940
      IF(LCON(1,K).EQ.6.AND.LCON(3,K).EQ.0) SIT2=-1.0                 LAGM1950
      DO 199 I=1,LIN                                                  LAGM1960
      S(K,I)=0.0                                                      LAGM1970
      IF(LCON(1,I).EQ.6.AND.LCON(3,I).EQ.0) GO TO 57                  LAGM1980
      IF(CON(I).GT.0.0) GO TO 50                                      LAGM1990
   57 SIT=-1.0*SIT2                                                   LAGM2000
      GO TO 56                                                        LAGM2010
   50 SIT=1.0*SIT2                                                    LAGM2020
   56 DO 39 N2=1,NCP                                                  LAGM2030
      IF(CPASS1(N2).NE.0.) GO TO 39                                   LAGM2040
      SKY=0.0                                                         LAGM2050
      SKYK=0.0                                                        LAGM2060
      WAIT=0.0                                                        LAGM2070
      DO 200 N=1,NST                                                  LAGM2080
      DO 201 M=1,NC                                                   LAGM2090
      J=LC(N,M,1)                                                     LAGM2100
      IF(J.NE.N2) GO TO 201                                           LAGM2110
      SKY=SKY+T2(N,M,I)                                               LAGM2120
      SKYK=SKYK+T2(N,M,K)                                             LAGM2130
      IF(J.GT.NSTEEL) GO TO 202                                       LAGM2140
      DO 808 II0=1,NUM22                                              LAGM2150
      IF(CP(6,J).GE.DIX(2,II0).AND.CP(6,J).LE.DIX(1,II0)) I8=II0      LAGM2160
  808 CONTINUE                                                        LAGM2170
      C3=C111(4,I8)                                                   LAGM2180
      P5=C111(5,I8)                                                   LAGM2190
      WAIT=WAIT+(GST*SD(N,2)*C3*P5*(CP(6,J)**(P5-1.)))                LAGM2200
      GO TO 201                                                       LAGM2210
  202 DN=CP(17,J)                                                     LAGM2220
      DK=CP(18,J)                                                     LAGM2230
      D=CP(19,J)                                                      LAGM2240
      P3=CP(20,J)                                                     LAGM2250
      WAIT=WAIT+(GCD*SD(N,2)/(CP(11,J)**2.*D))                        LAGM2260
  201 CONTINUE                                                        LAGM2270
  200 CONTINUE                                                        LAGM2280
      IF(N2.LE.NSTEEL) S(K,I)=S(K,I)-CP(6,N2)*SKY*SKYK*SIT/WAIT       LAGM2290
      IF(N2.GT.NSTEEL) S(K,I)=S(K,I)-CP(1,N2)*SKY*SKYK*SIT/(WAIT*CP(10,NLAGM2300
     12))                                                             LAGM2310
   39 CONTINUE                                                        LAGM2320
      IF(NB.EQ.0) GO TO 38                                            LAGM2330
      DO 40 N2=1,NBP                                                  LAGM2340
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      SKY=0.0
      SKYK=0.0
      WAIT=0.0
      IF(BPASS(NZ).NE.0.) GO TO 40
      DO 41 M=1,NST
      DO 204 M=1,NB
      J=LB(N,M,J)
      IF(J.NE.NZ) GO TO 204
      KI=LB(N,M,1)
      KJ=LB(N,M,2)
      B1=CLN(KJ,1)-CLN(KI,1)
      B2=CLN(KJ,2)-CLN(KI,2)
      B3=DSQRT(B1*B1+B2*B2)
      XLR=B3-BP(8,J)-BP(9,J)
      DO 809 IIO=1,NUM22
      IF(BP(4,J).GE.DIX(2,IIO).AND.BP(4,J).LE.DIX(1,IIO)) IB=IIO
  809 CONTINUE
      C3=C(1,IB)
      P5=C(2,IB)
      SKY=SKY+T3(N,M,I)
      SKYK=SKYK+T3(N,M,K)
      WAIT=WAIT+(GST*XLR*C3*P5*(BP(4,J)**(P5-1.)))
  204 CONTINUE
   41 CONTINUE
      S(K,I)=S(K,I)-BP(4,NZ)*SKY*SKYK*SIT/WAIT
   40 CONTINUE
   38 IF(NPAN.EQ.0) GO TO 34
      DO 205 M=1,NPAN
      NP=NST-LP(1,M)+1
      IF(NP.NE.N) GO TO 205
      IF(PPASS(M).NE.0.) GO TO 205
      DN=PP(3,M)
      DK=PP(4,M)
      D=PP(5,M)
      P3=PP(6,M)
      S(K,I)=S(K,I)-PP(1,M)*PP(4,M)**2.*D*T4(N,M,I)*T4(N,M,K)/
     1(PP(3,M)*GCD*SD(N,2))*SIT
  205 CONTINUE
   34 IF(NTRU.EQ.0) GO TO 35
      DO 206 M=1,NTRU
      NP=NST-LT(1,M)+1
      IF(NP.NE.N) GO TO 206
      IF(TPASS(M).NE.0.) GO TO 206
      KJ=LT(2,M)
      KI=LT(3,M)
      B1=CLN(KJ,1)-CLN(KI,1)
      B2=CLN(KJ,2)-CLN(KI,2)
      B3=DSQRT(B1*B1+B2*B2)
      YL=SD(N,2)
      DL=DSQRT(B3*B3+YL*YL)
      S(K,I)=S(K,I)-TP(2,M)/(GST*DL)*T5(N,M,I)*T5(N,M,K)*SIT
  206 CONTINUE
   35 CONTINUE
      SS(K,I)=S(K,I)
  199 CONTINUE
C
C     SOLVE FOR THE LAGRANGE MULTIPLIERS
C
      CALL GAUSS1(S,LIM,R,1)
  805 DO 507 K=1,LIM
      DO 507 I=1,LIM
      S(K,I)=SS(K,I)
  507 CONTINUE
      IF(LIM.EQ.1) GO TO 505
C
C     CHECK FOR NEGATIVE LAGRANGE MULTIPLIERS
C
      NEWI=0
      J=1
  498 CONTINUE
      IF(R(J).GE.0.0) GO TO 502
      LIM=LIM-1
      NEWI=NEWI+1
      IF(J.GT.LIM) GO TO 503
C
C     REFORMULATE THE EQUATIONS AND RESOLVE
C
      DO 499 I=J,LIM
      DO 51 N=1,NST
      IF(NC.EQ.0) GO TO 65
      DO 52 M=1,NC
      T2(N,M,I)=T2(N,M,I+1)
   52 CONTINUE
   65 IF(NB.EQ.0) GO TO 66
      DO 53 M=1,NB
      T3(N,M,I)=T3(N,M,I+1)
   53 CONTINUE
   66 IF(NPAN.EQ.0) GO TO 67
      DO 54 M=1,NPAN
      NP=NST-LP(1,M)+1
      IF(NP.NE.N) GO TO 54
      T4(N,M,I)=T4(N,M,I+1)
   54 CONTINUE
   67 IF(NTRU.EQ.0) GO TO 51
      DO 55 M=1,NTRU
      NP=NST-LT(1,M)+1
      IF(NP.NE.N) GO TO 55
      T5(N,M,I)=T5(N,M,I+1)
   55 CONTINUE
   51 CONTINUE
      RI(I)=RI(I+1)
      R(I)=R(I+1)
      DO 497 K=1,5
      LCON(K,I)=LCON(K,I+1)
  497 CONTINUE
      CON(I)=CON(I+1)
  499 CONTINUE
      IF(J.EQ.1) GO TO 999
      M1=J-1
      DO 500 I=1,M1
      DO 500 K=J,LIM
      S(I,K)=S(I,K+1)
      S(K,I)=S(K+1,I)
  500 CONTINUE
  999 CONTINUE
      DO 501 I=J,LIM
      DO 501 K=J,LIM
      S(I,K)=S(I+1,K+1)
  501 CONTINUE
      IF(J.GT.LIM) GO TO 503
      IF(LIM.EQ.1) GO TO 503
      GO TO 498
  502 J=J+1
      IF(J.LE.LIM) GO TO 498
      IF(NEWI.EQ.0) GO TO 505
  503 DO 504 J=1,LIM
      R(J)=RI(J)
  504 CONTINUE
      DO 800 K=1,LIM
      DO 800 I=1,LIM
      SS(K,I)=S(K,I)
  800 CONTINUE
      CALL GAUSS1(S,LIM,R,1)
      GO TO 805
  505 CONTINUE
C
C     USE THE LAGRANGE MULTIPLIERS TO RESIZE
C           THE PRIMARY DESIGN VARIABLES
C
      CALL CURSE(NST,NC,NB,NPAN,NTRU,R,CON,LCON,NCP,NBP,CPASS1,BPASS1)
      IF(IPASS.GT.0) GO TO 97
C
C     CHECK FOR PASSIVE ELEMENTS
C
      DO 401 K=1,NCP
      IF(K.GT.NSTEEL) GO TO 402
      RT1=CP(6,K)
      IF(CPASS1(K).NE.1.) GO TO 403
      CP(6,K)=CP(21,K)
      GO TO 404
  403 IF(CPASS1(K).NE.2.) GO TO 905
      CP(6,K)=CP(23,K)
      GO TO 404
  905 CP(6,K)=CP(22,K)
  404 CALL STEEL(1,K)
      CP(22,K)=CP(6,K)-RT1
      GO TO 401
  402 RT1=CP(12,K)
      IF(CPASS1(K).NE.1.) GO TO 405
      CP(12,K)=CP(21,K)
      GO TO 406
  405 IF(CPASS1(K).NE.2.) GO TO 906
      CP(12,K)=CP(23,K)
      GO TO 406
  906 CP(12,K)=CP(22,K)
  406 CALL CONC(1,K)
      CP(22,K)=(CP(12,K)-RT1)*CP(11,K)**3.*CP(19,K)
  401 CONTINUE
      IF(NB.EQ.0) GO TO 43
      DO 407 K=1,NBP
      RT1=BP(4,K)
      IF(BPASS1(K).NE.1.) GO TO 408
      BP(4,K)=BP(12,K)
      GO TO 409
  408 IF(BPASS1(K).NE.2.) GO TO 907
      BP(4,K)=BP(14,K)
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      GO TO 409                                                         LAGM4110
  907 BP(4,K)=BP(13,K)                                                  LAGM4120
  409 CALL STEEL(2,K)                                                   LAGM4130
      BP(13,K)=BP(4,K)-RT1                                              LAGM4140
  407 CONTINUE                                                          LAGM4150
   43 CONTINUE                                                          LAGM4160
      DO 400 N=1,NST                                                    LAGM4170
      IF(NPAN.EQ.0) GO TO 44                                            LAGM4180
      DO 410 M=1,NPAN                                                   LAGM4190
      NP=NST-LP(1,M)+1                                                  LAGM4200
      IF(NP.NE.N) GO TO 410                                             LAGM4210
      RT1=PP(5,M)                                                       LAGM4220
      IF(PPASS(M).NE.1.) GO TO 411                                      LAGM4230
      PP(5,M)=PP(18,M)                                                  LAGM4240
      GO TO 412                                                         LAGM4250
  411 IF(PPASS(M).NE.2.) GO TO 908                                      LAGM4260
      PP(5,M)=PP(19,M)                                                  LAGM4270
      GO TO 412                                                         LAGM4280
  908 PP(5,M)=PP(17,M)                                                  LAGM4290
  412 CALL CONCR(2,M)                                                   LAGM4300
      PP(17,M)=(PP(5,M)-RT1)*PP(4,M)**3.*PP(15,M)                       LAGM4310
  410 CONTINUE                                                          LAGM4320
   44 IF(NTRU.EQ.0) GO TO 400                                           LAGM4330
      DO 413 M=1,NTRU                                                   LAGM4340
      NP=NST-LT(1,M)+1                                                  LAGM4350
      IF(NP.NE.N) GO TO 413                                             LAGM4360
      RT1=TP(2,M)                                                       LAGM4370
      IF(TPASS(M).NE.1.) GO TO 414                                      LAGM4380
      TP(2,M)=TP(5,M)                                                   LAGM4390
      GO TO 415                                                         LAGM4400
  414 IF(TPASS(M).NE.2.) GO TO 909                                      LAGM4410
      TP(2,M)=TP(7,M)                                                   LAGM4420
      GO TO 415                                                         LAGM4430
  909 TP(2,M)=TP(6,M)                                                   LAGM4440
  415 TP(6,M)=TP(2,M)-RT1                                               LAGM4450
  413 CONTINUE                                                          LAGM4460
  400 CONTINUE                                                          LAGM4470
      RETURN                                                            LAGM4480
      END                                                               LAGM4490
      SUBROUTINE CURSE(NST,NC,NB,NPAN,NTRU,R,CON,LCON,NCP,NBP,CPASS1,BPACURS0010
     1SS1)                                                              CURS0020
C                                                                       CURS0030
C        RESIZE THE PRIMARY DESIGN VARIABLES                            CURS0040
C           AND CHECK FOR PASSIVE ELEMENTS                              CURS0050
C                                                                       CURS0060
      IMPLICIT REAL*8(A-H,O-Z)                                          CURS0070
      COMMON/DATA1/CLN(14,2),CP(26,45),BP(15,45),FEF(5,10),LB(10,15,3),LCURS0080
     1D8(10,15,3),LC(10,14,2),LP(3,20),IFEF(10),PP(22,20),LT(3,40),TP(6 CURS0090
     2,40),LIM,ID,GST,GCO,NSTEEL,NSTEE2,MAIC,NLODD,NTOTL                CURS0100
      COMMON/DATA7/PLOAD(140),SD(10,15),AMA(280),IF,IFC,X1,Y1           CURS0110
      COMMON/GRAB/T2(10,14,30),T3(10,15,30),T4(10,20,30),T5(10,40,30),ARCURS0120
     1R                                                                 CURS0130
      COMMON/PASS/PPASS(20),TPASS(40),IPASS,IPASS1                      CURS0140
      COMMON/STEP/C111(5,3),DIX(2,3),NUM22                              CURS0150
      DIMENSION R(30),CON(30),LCON(5,30),CPASS1(45),BPASS1(45)          CURS0160
      IPASS=0                                                           CURS0170
      NS=NST                                                            CURS0180
      DO 50 N2=1,NCP                                                    CURS0190
      TR=0.0                                                            CURS0200
      WAIT=0.0                                                          CURS0210
      IF(CPASS1(N2).NE.0.) GO TO 300                                    CURS0220
      DO 100 N=1,NST                                                    CURS0230
      DO 101 M=1,NC                                                     CURS0240
      K=LC(N,M,1)                                                       CURS0250
      IF(K.NE.N2) GO TO 101                                             CURS0260
  299 DO 102 L=1,LIM                                                    CURS0270
      IF(LCON(1,L).EQ.6.AND.LCON(3,L).EQ.0) GO TO 700                   CURS0280
      IF(CON(L).GT.0.0) GO TO 600                                       CURS0290
  700 SIT=-1.0                                                          CURS0300
      GO TO 102                                                         CURS0310
  600 SIT=1.0                                                           CURS0320
  102 TR=-R(L)*SIT*T2(N,M,L)+TR                                         CURS0330
      IF(K.GT.NSTEEL) GO TO 103                                         CURS0340
      DO 808 I10=1,NUM22                                                CURS0350
      IF(CP(6,K).GE.DIX(2,I10).AND.CP(6,K).LE.DIX(1,I10)) I8=I10        CURS0360
  808 CONTINUE                                                          CURS0370
      C3=C111(4,I8)                                                     CURS0380
      P5=C111(5,I8)                                                     CURS0390
      WAIT=WAIT+(GST*SD(N,2)*C3*P5*(CP(6,K)**(P5-1.)))                  CURS0400
      GO TO 101                                                         CURS0410
  103 D=CP(19,K)                                                        CURS0420
      WAIT=WAIT+(GCO*SD(N,2)/(CP(11,K)**2.*D))                          CURS0430
  101 CONTINUE                                                          CURS0440
  100 CONTINUE                                                          CURS0450
      TR=TR/WAIT                                                        CURS0460
      IF(N2.LE.NSTEEL) CP(22,N2)=CP(6,N2)*(1.+(TR-1.)/RRR)              CURS0470
      IF(N2.GT.NSTEEL) CP(1,N2)=CP(1,N2)*(1.+(TR-1.)/RRR)               CURS0480
      IF(N2.GT.NSTEEL) CP(22,N2)=CP(1,N2)/(CP(11,N2)**3.                CURS0490
     1*CP(19,N2)*CP(10,N2))                                             CURS0500
      IF(CP(22,N2).GT.CP(21,N2)) GO TO 200                              CURS0510
      CPASS1(N2)=1.0                                                    CURS0520
      GO TO 303                                                         CURS0530
  200 IF(CP(23,N2).EQ.0.) GO TO 300                                     CURS0540
      IF(CP(22,N2).LT.CP(23,N2)) GO TO 300                              CURS0550
      CPASS1(N2)=2.0                                                    CURS0560
  303 IPASS=IPASS+1                                                     CURS0570
      GO TO 50                                                          CURS0580
  300 CONTINUE                                                          CURS0590
   50 CONTINUE                                                          CURS0600
      IF(NB.EQ.0) GO TO 52                                              CURS0610
      DO 51 N2=1,NBP                                                    CURS0620
      TR=0.0                                                            CURS0630
      WAIT=0.0                                                          CURS0640
      IF(BPASS1(N2).NE.0.) GO TO 305                                    CURS0650
      DO 53 N=1,NST                                                     CURS0660
      DO 104 M=1,NB                                                     CURS0670
  498 K=LB(N,M,3)                                                       CURS0680
      IF(K.NE.N2) GO TO 104                                             CURS0690
      KI=LB(N,M,1)                                                      CURS0700
      KJ=LB(N,M,2)                                                      CURS0710
      B1=CLN(KJ,1)-CLN(KI,1)                                            CURS0720
      B2=CLN(KJ,2)-CLN(KI,2)                                            CURS0730
      B3=DSQRT(B1*B1+B2*B2)                                             CURS0740
      XLR=B3-BP(8,K)-BP(9,K)                                            CURS0750
      DO 105 L=1,LIM                                                    CURS0760
      IF(LCON(1,L).EQ.6.AND.LCON(3,L).EQ.0) GO TO 701                   CURS0770
      IF(CON(L).GT.0.0) GO TO 601                                       CURS0780
  701 SIT=-1.0                                                          CURS0790
      GO TO 105                                                         CURS0800
  601 SIT=1.0                                                           CURS0810
  105 TR=TR-R(L)*SIT*T3(N,M,L)                                          CURS0820
      DO 809 I10=1,NUM22                                                CURS0830
      IF(BP(4,K).GE.DIX(2,I10).AND.BP(4,K).LE.DIX(1,I10)) I8=I10        CURS0840
  809 CONTINUE                                                          CURS0850
      C3=C111(4,I8)                                                     CURS0860
      P5=C111(5,I8)                                                     CURS0870
      WAIT=WAIT+(GST*XLR*C3*P5*(BP(4,K)**(P5-1.)))                      CURS0880
  104 CONTINUE                                                          CURS0890
   53 CONTINUE                                                          CURS0900
      TR=TR/WAIT                                                        CURS0910
      BP(13,N2)=BP(4,N2)*(1.+(TR-1.)/RRR)                               CURS0920
      IF(BP(13,N2).GT.BP(12,N2)) GO TO 202                              CURS0930
      BPASS1(N2)=1.0                                                    CURS0940
      GO TO 304                                                         CURS0950
  202 IF(BP(14,N2).EQ.0.) GO TO 305                                     CURS0960
      IF(BP(13,N2).LT.BP(14,N2)) GO TO 305                              CURS0970
      BPASS1(N2)=2.0                                                    CURS0980
  304 IPASS=IPASS+1                                                     CURS0990
      GO TO 51                                                          CURS1000
  305 CONTINUE                                                          CURS1010
   51 CONTINUE                                                          CURS1020
   52 CONTINUE                                                          CURS1030
      DO 70 N=1,NST                                                     CURS1040
      IF(NPAN.EQ.0) GO TO 30                                            CURS1050
      DO 106 M=1,NPAN                                                   CURS1060
      TR=0.0                                                            CURS1070
      NP=NS-LP(1,M)+1                                                   CURS1080
      IF(NP.NE.N) GO TO 106                                             CURS1090
      IF(PPASS(M).EQ.0.) GO TO 499                                      CURS1100
      GO TO 307                                                         CURS1110
  499 DN=PP(13,M)                                                       CURS1120
      DK=PP(14,M)                                                       CURS1130
      D=PP(15,M)                                                        CURS1140
      P3=PP(16,M)                                                       CURS1150
      DO 107 L=1,LIM                                                    CURS1160
      IF(LCON(1,L).EQ.6.AND.LCON(3,L).EQ.0) GO TO 702                   CURS1170
      IF(CON(L).GT.0.0) GO TO 602                                       CURS1180
  702 SIT=-1.0                                                          CURS1190
      GO TO 107                                                         CURS1200
  602 SIT=1.0                                                           CURS1210
  107 TR=-R(L)*SIT*T4(N,M,L)+TR                                         CURS1220
      TR=TR*PP(4,M)**2.*D/(GCO*SD(N,2))                                 CURS1230
      X=PP(1,M)                                                         CURS1240
      PP(1,M)=PP(1,M)*(1.+(TR-1.)/RRR)                                  CURS1250
      PP(17,M)=PP(1,M)/(PP(4,M)**3.*D*PP(3,M))                          CURS1260
      PP(1,M)=X                                                         CURS1270
      IF(PP(17,M).GT.PP(18,M)) GO TO 203                                CURS1280
      PPASS(M)=1.0                                                      CURS1290
      GO TO 306                                                         CURS1300
  203 IF(PP(19,M).EQ.0.) GO TO 307                                      CURS1310
      IF(PP(17,M).LT.PP(19,M)) GO TO 307                                CURS1320
      PPASS(M)=2.0                                                      CURS1330
  306 IPASS=IPASS+1                                                     CURS1340
      GO TO 106                                                         CURS1350
  307 CONTINUE                                                          CURS1360
  106 CONTINUE                                                          CURS1370
```

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   30 IF(NTRU.EQ.0) GO TO 70
      DO 108 N=1,NTRU
      TR=0.0
      NP=NS-LT(1,N)+1
      IF(NP.NE.NI) GO TO 108
      IF(TPASS(N).EQ.0.) GO TO 500
      GO TO 309
  500 KJ=LT(2,N)
      KI=LT(3,N)
      B1=CLN(KJ,1)-CLN(KI,1)
      B2=CLN(KJ,2)-CLN(KI,2)
      B3=DSQRT(B1*B1+B2*B2)
      YL=SO(N,2)
      DL=DSQRT(B3*B3+YL*YL)
      DO 109 L=1,LIN
      IF(LCON(1,L).EQ.6.AND.LCON(3,L).EQ.0) GO TO 703
      IF(CON(L).GT.0.0) GO TO 603
  703 SIT=-1.0
      GO TO 109
  603 SIT=1.0
  109 TR=-R(L)*SIT*TS(N,M,L)+TR
      TR=TR/(GST*DL)
      TP(6,N)=TP(2,N)*(1.+(TR-1.)/RRR)
      IF(TP(6,N).GT.TP(5,N)) GO TO 204
      TPASS(N)=1.0
      GO TO 308
  204 IF(TP(7,N).EQ.0.) GO TO 309
      IF(TP(6,N).LT.TP(7,N)) GO TO 309
      TPASS(N)=2.0
  308 IPASS=IPASS+1
      GO TO 108
  309 CONTINUE
  108 CONTINUE
   70 CONTINUE
      IPASS1=IPASS1+IPASS
      IPASS2=NCP+NBP+NPAN+NTRU
      IF(IPASS1.EQ.IPASS2) WRITE(6,3000)
      IF(IPASS1.EQ.IPASS2) STOP
      RETURN
 3000 FORMAT(32HALL ELEMENTS HAVE BECOME PASSIVE)
      END
      SUBROUTINE ROTATE(T6,LIN,MLD,NSNC,NI,NS,NC
     1,ID,N9,N2,N,PD)
C
C        FIND ROTATIONAL COMPONENTS OF
C         THE EIGENVECTOR GRADIENTS
C
      IMPLICIT REAL*8(A-H,O-Z)
      COMMON/F04/S(406,10),C(28,28,10),E(28,190,10),KM(246,10),RF(128,
     13,10),RF5(28,30,10),RF6(28,1,10)
      DIMENSION T6(170),PD(170)
      MN=4*NC
      MM=2*NC
      NN=MN+NC+NS+3*NS+3*NC
      LS=(MM*(MM+1))/2
      IF(NI.NE.NS) GO TO 303
      NS3=3*NS
      DO 425 K=1,MN
      PD(K)=0.0
  425 CONTINUE
      DO 450 N=1,NSNC
      KK=MN+N
  450 PD(KK)=T6(N)
      DO 460 N=1,NC
      KKK=KK+N
  460 PD(KKK)=0.0
      DO 470 N=1,NS3
      KM=KKK+N
  470 PD(KM)=T6(NSNC+N)
      DO 471 N=1,3
  471 PD(KM+N)=0.0
  475 CONTINUE
  303 MMP=MM+1
      N=NI
      ICT1=0
  302 DO 301 I=1,MM
      PD(I)=RF6(I,1,N)
  301 CONTINUE
      DO 401 J=MMP,NN
      KF=KM(J,N)
      IF(KF.GT.MM) GO TO 401
      IF(J.GT.MN) GO TO 402
      DO 403 K=KF,MM
  403 PD(K)=PD(K)-C(K,J-MM,N)*PD(J)
      GO TO 401
  402 DO 404 K=KF,MM
  404 PD(K)=PD(K)-E(K,J-MN,N)*PD(J)
  401 CONTINUE
      IB=LS
      DO 400 II=1,MM
      I=MM+1-II
      KK=I-1
      KF=KM(I,N)
      IB=IB-I
      IF(KF.GT.KK) GO TO 400
      DO 405 K=KF,KK
  405 PD(K)=PD(K)-S(IB+K,N)*PD(I)
  400 CONTINUE
      RETURN
      END
      SUBROUTINE ATCC0(IT,MSTC,DM,NSTORY,IIBASE,SS,SG,FS,FFF,RKAPA,
     1AMP,IREQDM,RM2,ECC,K12,K13,MCTS,MSS,L2,K122)
C
C       DETERMINES THE ATC-03 SEISMIC FORCES
C
      IMPLICIT REAL*8(A-H,O-Z)
      COMMON/CODE1/HT(10),WT(1),WWW(10,1)
      COMMON/ATC1/U(10,10),V(10),DIS(10),DELT(10),RM(10),CY(10)
     1,SUMMF1(10),SUMMF2(10),WBARM(10),CSM(10),RMOMN(11),CVXM(10,10)
     2,FMODAL(10,10),DELXEM(10,10),VMMODE(10,10),RNMODE(11,10)
     3,DRIFMO(10,10),VMODAL(10),TETA(10),PP(10)
      COMMON/ATC2/IACTIV,ISOIL,AR,ISF,NANALS,NNNNN,MMMMM,NBRITL,ISH,
     1NPREGR,NVREGR,IS,HN,AA,AV,S,R,CD,RL,RL1,P11,P12,DECA(10),IKE
      DIMENSION DM(170,170),TTT(10),FS(170,2),L2(10)
     1,FFF(10),RKAPA(10),TTT(10),SS(170,170),SG(30,30)
C
C     TO OBTAIN PERIODS AND MODAL MATRIX
C
      IFUNDA=T(1)
      IF(NANALS.EQ.2)GO TO 10
C
C              EQUIV. LAT. FORCE TECHNIQUE
C
      CALL LAT1(TFUNDA,VBASE,CS,RM2,0,0,RKK,NSTORY,IIBASE,FFF,RKAPA,
     1AMP,ECC)
      NP=0
C
C              P-DELTA EFFECTS FOR ELF
C
      CALL LAT2(RM2,VBASE,0,MSTC,NP,RKK,NSTORY
     1,IIBASE,SS,SG,FS,FFF,RKAPA,AMP,ECC,K12,K13,MCTS,MSS,K122)
      GO TO 100
   10 CONTINUE
      DO 110 I=1,IREQDM
  110 TTT(I)=T(I)
      DO 120 I=1,IREQDM
      DO 120 J=1,NSTORY
      JJJJ=MCTS+3*(J-1)+K12
      II8=L2(I)
      U(NSTORY+1-J,I)=DM(JJJJ,II8)
  120 CONTINUE
C
C              MODAL ANALYSIS TECHNIQUE
C
      CALL MODALA(TFUNDA,TTT,NSTORY,IIBASE,SS,SG,FS,FFF
     1,RKAPA,AMP,IREQDM,RM2,MSTC,K12,K13,MCTS,MSS,K122)
  100 CONTINUE
      RETURN
      END
      SUBROUTINE LAT1(T,VBASE,CS,RM2,IFINAL,MODALL,RKK,NSTORY,
     1IIBASE,FFF,RKAPA,AMP,ECC)
C
C        ATC-03 EQUIVALENT LATERAL FORCE METHOD
C
      IMPLICIT REAL*8(A-H,O-Z)
      COMMON/CODE1/HT(10),WT(1),WWW(10,1)
      COMMON/ATC1/U(10,10),V(10),DIS(10),DELT(10),RM(10),CY(10)
     1,SUMMF1(10),SUMMF2(10),WBARM(10),CSM(10),RMOMN(11),CVXM(10,10)
     2,FMODAL(10,10),DELXEM(10,10),VMMODE(10,10),RNMODE(11,10)
     3,DRIFMO(10,10),VMODAL(10),TETA(10),PP(10)
      COMMON/ATC2/IACTIV,ISOIL,AR,ISF,NANALS,NNNNN,MMMMM,NBRITL,ISH,
     1NPREGR,NVREGR,IS,HN,AA,AV,S,R,CD,RL,RL1,P11,P12,DECA(10),IKE
      DIMENSION FFF(10),RKAPA(10)
      IF(IFINAL.EQ.1) GO TO 30
      IF(NN.EQ.0) GO TO 12
      IF(ISF.EQ.1) GO TO 10
C
C              DETERMINE TA COEF.
C
      CT=0.025
      GO TO 11
   10 CT=0.035
   11 TA=CT*HN**(0.75)
      GO TO 13
   12 TA=0.05*HN/(DSQRT(RL))
   13 CONTINUE
```

```
      IF(MODALL.EQ.1) GO TO 14
      IF(T.GT.1.2*TA) T=1.2*TA
      GO TO 15
   14 T=1.5*TA
   15 WRITE(6,1002) T
C
C                 DETERMINE CS COEF.
C
      CS=(1.2*AV*S)/(R*T**(2./3.))
      IF(CS.GT.2.5*AA/R) CS=2.5*AA/R
      IF(ISOIL.EQ.3.AND.AA.GE.0.3) GO TO 16
      GO TO 17
   16 IF(CS.GT.2.0*AA/R)CS=2.0*AA/R
C
C                 DETERMINE BASE SHEAR
C
   17 VBASE=CS*WT(1)
      IF(MODALL.EQ.1) GO TO 100
      IF(T.LE.0.5) GO TO 21
      IF(T.GE.2.5) GO TO 20
C
C                 DETERMINE VERT. DIST. OF LATERAL SEISMIC SHEAR FORCE
C
      RKK=0.75+0.5*T
      GO TO 22
   20 RKK=2.
      GO TO 22
   21 RKK=1.
   22 SUM1=0.
      DO 23 I=1,NSTORY
   23 SUM1=SUM1+WWW(I,1)*(HT(I)**RKK)
      DO 24 I=1,NSTORY
      CV(I)=WWW(I,1)*(HT(I)**RKK)/SUM1
   24 FFF(I)=CV(I)*VBASE
C
C                 DETERMINE HORIZONTAL SHEAR DISTRIBUTION
C
      DO 25 J=1,NSTORY
      V(J)=0.
      DO 25 I=J,NSTORY
   25 V(J)=V(J)+FFF(I)
C
C                 DETERMINE OVERTURNING MOMENT
C
   30 DO 31 J=1,NSTORY
      RM(J)=0.
      DO 31 I=J,NSTORY
   31 RM(J)=RM(J)+FFF(I)*RKAPA(I)*(HT(I)-HT(J))
      RM2=0.
      DO 32 I=1,NSTORY
   32 RM2=RM2+0.75*FFF(I)*HT(I)
      ECC=DABS(RM2/WT(1))
  100 RETURN
 1002 FORMAT(//,'0THE PERIOD USED IN THE CALCULATIONS IS ',F10.5)
      END
      SUBROUTINE LAT2(RM2,VBASE,MODALL,MSTC,NP,RKK,NSTORY,IIBASE,SS,
     1SG,FS,FFF,RKAPA,AMP,ECC,K12,K13,NCTS,NSS,K122)
C
C      DETERMINE THE ATC-03 P-DELTA EFFECT
C
      IMPLICIT REAL*8(A-H,O-Z)
      COMMON/CODE1/H1(10),WT(1),WWW(10,1)
      COMMON/ATC1/U(10,10),V(10),DIS(10),DELT(10),RM(10),CV(10)
     1,SUMWF1(10),SUMWF2(10),WBARM(10),CSM(10),RMOMNT(1),CVXM(10,10)
     2,FMODAL(10,10),DELXEM(10,10),VMMODE(10,10),RMMODE(1,10)
     3,DRIFMO(10,10),VMODAL(10),TETA(10),PP(10)
      COMMON/ATC1/IACTIV,ISOIL,MR,ISF,NANALS,NNNNN,MMMMM,NORITL,ISH,
     1NPREGR,NVREGR,IS,MN,AA,AV,S,R,CD,RL,RL1,P11,P12,DELA(10),IKE
      DIMENSION SK(170,170),SS(170,170),SG(30,30),FS(170,2)
     1,FFF(10),RKAPA(10)
      NCC=NCTS/NSTORY
      IF(MODALL.EQ.1) GO TO 140
      DO 4965 J1=1,2
      DO 4965 I=1,MSTC
      FS(I,J1)=0.
 4965 CONTINUE
      WRITE(6,1010)(I,FFF(I)),I=1,NSTORY)
      DO 110 I=1,NSTORY
      II=NCTS+3*(I-1)+K12
      FS(II,1)=FFF(NSTORY+1-I)
      II=NCTS+3*(I-1)+3
      RLL=RL
      IF(K12.EQ.K122) RLL=RL1
      FS(II,2)=FS(II,1)*.05*RLL
  110 CONTINUE
C
C                 DETERMINE PRELIMINARY DISPLACEMENTS
C
      DO 400 I=1,MSTC
      DO 400 J=1,MSTC
  400 SK(I,J)=SS(I,J)
      DO 410 I=1,NSS
      DO 410 J=1,NSS
  410 SK(I+NCTS,J+NCTS)=SK(I+NCTS,J+NCTS)+386.4*SG(I,J)
      CALL GAUSS3(SK,MSTC,FS,2)
      DO 120 I=1,NSTORY
      II=NCTS+3*(I-1)+K12
  120 DIS(NSTORY+1-I)=FS(II,1)
      DO 130 I=1,NSTORY
  130 DIS(I)=CD*DIS(I)
      IF(NP.EQ.1)GO TO 300
  140 DO 150 I=2,NSTORY
  150 DELT(I)=DABS(DIS(I)-DIS(I-1))
      DELT(1)=DABS(DIS(1))
  160 WRITE(6,1050)(I,DELT(I)),I=1,NSTORY)
      IF(K12.EQ.K122) WRITE(77,1052)((DELT(I),I),I=1,NSTORY)
C
C         CHECK FOR DRIFT VIOLATION
C
      IIBASE=0
      IF(K12.NE.K122) GO TO 182
      IF(IKE.EQ.0) GO TO 182
      AMP=DELT(1)/DELA(1)
      DO 201 I=2,NSTORY
      AMP1=DELT(I)/DELA(I)
      IF(AMP.LT.AMP1) AMP=AMP1
  201 CONTINUE
      IF(AMP.LE.(1*P12)) GO TO 182
      IIBASE=1
  182 CONTINUE
C
      IF(K12.NE.K122) GO TO 270
C                 DETERMINE PX VALUES
C
      DO 220 J=1,NSTORY
      PP(J)=0.
      DO 220 I=J,NSTORY
      PP(J)=PP(J)+WWW(I,1)
  220 CONTINUE
C
C                 DETERMINE THETA COEF.
C
      DO 230 I=1,NSTORY
  230 TETA(I)=(PP(I)*DELT(I))/((V(I)*HI(I)*CD*12.)
      WRITE(6,1051) ((I,TETA(I)),I=1,NSTORY)
      IF(K12.EQ.K122) WRITE(77,1052) ((TETA(I),I),I=1,NSTORY)
      REWIND 77
      DO 240 I=1,NSTORY
      IF(TETA(I).GT.0.1)GO TO 241
  240 CONTINUE
      GO TO 270
C
C                 INCREASE DUE TO P-DELTA
C
  241 DO 250 I=1,NSTORY
      A1=0.9/(1.-TETA(I))
      IF(A1.LT.1.0)A1=1.0
      V(I)=V(I)*A1
C
C               INPUT INCREASE FOR DIS ELF
C
      III=NCTS+3*(NSTORY-I)
      III=(NSTORY-I)*NCC
      DO 251 J=1,NCC
      DO 251 J17=1,2
      FS(III+J,J17)=FS(III+J,J17)*A1
  251 CONTINUE
      DO 252 J=1,3
      DO 252 J17=1,2
      FS(IIII+J,J17)=FS(IIII+J,J17)*A1
  252 CONTINUE
  250 DELT(I)=DELT(I)*A1
 1160 FFF(NSTORY)=V(NSTORY)
      N=NSTORY-1
      DO 260 I=1,N
  260 FFF(I)=V(I)-V(I+1)
      IF(MODALL.EQ.1) GO TO 270
C
C                 REDISTIBUTE SEISMIC FORCES
C
      CALL  LAT1(T,VBASE,CS,RM2,1,0,RKK,NSTORY,IIBASE,FFF,RKAPA,AMP,
     *ECC)
  270 CONTINUE
  300 CONTINUE
 1050 FORMAT(/,5X,' DRIFT:',//,8X,'STORY NO.',5X,
     1'VALUE      ',/,(8X,I5,5X,E15.6))
```

```
 1051 FORMAT(/,5X,' THETA:',//,8X,'STORY NO.',5X,
     1'VALUE',/,(8X,I5,5X,E15.6))
 1052 FORMAT(E15.6,5X,I5)
 1010 FORMAT(//,5X,' LATERAL FORCES:',//,8X,'STORY NO.',5X,'VALUE',/,(8
     1X,I5,5X,E15.6))
      RETURN
      END
      SUBROUTINE MODAL(CT,TT,NSTORY,IIBASE,SS,SG,FS,FFF
     1,RKAPA,AMP,IREQDM,RR3,MSTC,K12,K13,MCTS,MSS,K122)
C
C        ATC-03 MODAL ANALYSIS METHOD
C
      IMPLICIT REAL*8(A-H,O-Z)
      COMMON/CODE1/HT(10),WT(11),WWW(10,1)
      COMMON/ATC1/U(10,10),V(10),DIS(10),DELT(10),AM(10),CV(10)
     1,SUMWF1(10),SUMWF2(10),WBARM(10),CSM(10),RMOMNT(11),CVXM(10,10)
     2,FMODAL(10,10),DELXEM(10,10),VMMODE(10,10),RMMODE(11,10)
     3,DRIFMO(10,10),VMODAL(10),TETA(10),PP(10)
      COMMON/ATC2/IACTIV,ISOIL,RA,ISF,NANALS,NNNNN,MMMMM,NBRITL,ISM,
     1NPREGR,NVREGR,IS,MN,AA,AV,S,R,CD,RL,RLL,P11,P12,DELA(10),IKE
      DIMENSION TT(10),SK(170,170),SS(170,170),SG(30,30),FS(170,2)
     1,FFF(10),RKAPA(10)
C
      CALL LAT1(CT,VBASE,CS,RM2,0,1,RKK,NSTORY,IIBASE,FFF,RKAPA,AMP,ECC)
      DO 35 M=1,IREQDM
      SUMWF1(M)=0.
      SUMWF2(M)=0.
      WBARM(M)=0.
      CSM(M)=0.
      DO 30 I=1,NSTORY
      SUMWF1(M)=SUMWF1(M)+WWW(I,1)*U(I,M)
   30 SUMWF2(M)=SUMWF2(M)+WWW(I,1)*U(I,M)*U(I,M)
      A2=SUMWF1(M)*SUMWF1(M)
      WBARM(M)=A2/SUMWF2(M)
      IF(SUMWF1(M).LE.1.0E-07) WBARM(M)=0.0
   35 CONTINUE
 1000 CONTINUE
      DO 100 M=1,IREQDM
      IF(TT(M).GT.4.) GO TO 40
      CSM(M)=1.2*AV*S/(R*TT(M)**(2./3.))
      IF(ISOIL.NE.3) GO TO 49
      IF(M.NE.1.AND.TT(M).LT.0.3) CSM(M)=AA*(0.8+4.*TT(M))/R
      GO TO 38
   40 CSM(M)=3.*AV*S/(R*TT(M)**(4./3.))
   38 IF(ISOIL.EQ.3.AND.AA.GE.0.3)GO TO 41
   49 IF(CSM(M).GT.(2.5*AA/R)) CSM(M)=2.5*AA/R
      GO TO 37
   41 IF(CSM(M).GT.(2.*AA/R)) CSM(M)=2.*AA/R
   37 IF(CSM(M).LE.0.)STOP
  100 CONTINUE
C
C     FOLLOWING MEANS RETURN TO SOIL-STRUCTURAL INTERACTION AFTER
C     OBTAINING CSM(I).
C
C     VMODAL(M): MODAL BASE SHEAR OF M-TH MODE
      DO 50 M=1,IREQDM
      VMODAL(M)=0.
   50 VMODAL(M)=CSM(M)*WBARM(M)
C
C     OBTAIN CVXM(I,M) TO CALCULATE MODAL FORCES FMODAL(I,MMM)
C     FMODAL(I,M):MODAL FORCE OF I-TH STORY OF M-TH MODE
C
 2000 CONTINUE
      DO 60 M=1,IREQDM
      DO 60 I=1,NSTORY
      CVXM(I,M)=WWW(I,1)*U(I,M)/SUMWF1(M)
      FMODAL(I,M)=CVXM(I,M)*VMODAL(M)
      DELXEM(I,M)=0.81561*CD*FMODAL(I,M)*(TT(M)**2)/WWW(I,1)
   60 CONTINUE
C
C     USING DELXEM(I,M), OBTAIN DELXI(I) WHICH IS DISPLACEMENT OF
C     MODAL ANALYSIS BEFORE MODIFIED
C     DRIFMO(I,M):MODAL DRIFT OF I-TH STORY OF M-TH MODE
C
      DO 62 M=1,IREQDM
      DO 61 I=2,NSTORY
      I2=I-1
   61 DRIFMO(I,M)=DABS(DELXEM(I,M)-DELXEM(I2,M))
   62 DRIFMO(1,M)=DABS(DELXEM(1,M))
C
C
      DO 70 M=1,IREQDM
      DO 70 J=1,NSTORY
      VMMODE(J,M)=0.
      RMMODE(J,M)=0.
      DO 65 I=J,NSTORY
      VMMODE(J,M)=VMMODE(J,M)+FMODAL(I,M)
   65 RMMODE(J,M)=RMMODE(J,M)+FMODAL(I,M)*(HT(I)-HT(J))
   70 CONTINUE
C
C     RMMODE(NSTORY+1,M): OVERTURNING MOMENT AT BASE OF MMM-TH MODE
C
      NSTOR1=NSTORY+1
      DO 75 M=1,IREQDM
      RMMODE(NSTOR1,M)=0.0
      DO 71 I=1,NSTORY
   71 RMMODE(NSTOR1,M)=RMMODE(NSTOR1,M)+FMODAL(I,M)*HT(I)
   75 CONTINUE
C
C     VTMODL :BASE SHEAR OF MODAL ANALYSIS
C     VMODE(I):STORY SHEAR OF I-TH STORY
C     DELT(I): DRIFT OF I-TH FLOOR BEFORE CHECKING
C     DIS(I): DEFLECTION OF I-TH FLOOR
C     RMOMNT(I):OVERTURNING MOMENT OF I-TH STORY OF MODAL ANALYSIS
C
      CALL ROOT1(VMODAL,IREQDM,VTMODL)
      DO 80 I=1,NSTORY
      CALL ROOT2(VMMODE,IREQDM,SSSS,I)
      V(I)=SSSS
      CALL ROOT2(DRIFMO,IREQDM,SSSS,I)
      DELT(I)=SSSS*12.
      CALL ROOT2(DELXEM,IREQDM,SSSS,I)
      DIS(I)=SSSS
   80 CONTINUE
      DO 90 I=1,NSTOR1
      CALL ROOT3(RMMODE,IREQDM,SSSS,I)
      RMOMNT(I)=SSSS
   90 CONTINUE
C
      IF(VTMODL.GE.VBASE) GO TO 110
      DO 109 I=1,NSTORY
      RATIO2=VBASE/VTMODL
      V(I)=V(I)*RATIO2
      DELT(I)=DELT(I)*RATIO2
      DIS(I)=DIS(I)*RATIO2
  109 RMOMNT(I)=RMOMNT(I)*RATIO2
  110 CONTINUE
      N1=NSTORY-1
      FFF(NSTORY)=V(NSTORY)
      DO 111 I=1,N1
  111 FFF(I)=V(I)-V(I+1)
C
C     NEXT SUBROUTINE IS CALLED TO OBTAIN FINAL DESIGN VALUE USING
C     THE INITIAL LATERAL FORCE OBTAINED FROM VMODE(I)  WHICH WILL BE
C     CALCULATED IN SUBROUTINE LAT2
C
      CALL LAT2(RM2,VBASE,1,MSTC,0,AKK,NSTORY
     1,IIBASE,SS,SG,FS,FFF,RKAPA,AMP,ECC,K12,K13,MCTS,MSS,K122)
C
C     OBTAIN FINAL O-V MOMENT USING FINAL LATERAL FORCE FROM LAT2
C
      DO 115 J=1,NSTORY
      RMOMNT(J)=0.
      DO 115 I=J,NSTORY
  115 RMOMNT(J)=RMOMNT(J)+FFF(I)*(HT(I)-HT(J))
      RM3=0.
      DO 117 I=1,NSTORY
  117 RM3=RM3+FFF(I)*HT(I)
      RM3=0.9*RM3
 2500 CONTINUE
C
C      PLACE DISPL. IN FS FOR DETERMINATION OF INTERNAL FORCES
C
      DO 20 J1=1,2
      DO 20 I=1,MSTC
      FS(I,J1)=0.
   20 CONTINUE
      DO 21 I=1,NSTORY
      II=MCTS+3*(I-1)+K12
      FS(II,1)=FFF(NSTORY+1-I)
      IJ=MCTS+3*(I-1)+3
      RLL=RL
      IF(K12.EQ.K122) RLL=RL1
      FS(IJ,2)=FS(II,1)*.05*RLL
   21 CONTINUE
      DO 400 I=1,MSTC
      DO 400 J=1,MSTC
  400 SK(I,J)=SS(I,J)
      DO 410 I=1,MSS
      DO 410 J=1,MSS
  410 SK(I+MCTS,J+MCTS)=SK(I+MCTS,J+MCTS)+386.4*SG(I,J)
      CALL GAUSS3(SK,MSTC,FS,2)
      RETURN
      END
C
C         THE NEXT THREE SUBROUTINES ARE USED IN
```

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C             THE ROOT-MEAN SQUARE METHOD
C                OF MODAL SUPERPOSITION
C
      SUBROUTINE ROOT1(X,N,S)
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION X(10)
      S=0.
      DO 1 I=1,N
    1 S=S+X(I)**2
      S=DSQRT(S)
      RETURN
      END
      SUBROUTINE ROOT2(X,N,S,I)
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION X(10,10)
      S=0.
      DO 1 J=1,N
    1 S=S+X(I,J)**2
      S=DSQRT(S)
      RETURN
      END
C
C
      SUBROUTINE ROOT3(X,N,S,I)
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION X(1,10)
      S=0.
      DO 1 J=1,N
    1 S=S+X(I,J)**2
      S=DSQRT(S)
      RETURN
      END
C
      SUBROUTINE ATCIF(NSTORY,RKAPA)
C
C       READS AND PRINTS ATC-03 INFORMATION
C
      IMPLICIT REAL*8(A-H,O-Z)
      COMMON/CODE1/HT(10),HTT(11),WWW(10,1)
      COMMON/ATC1/IACTIV,ISOIL,MR,ISF,NANALS,NNNNN,MMMMM,NBRITL,ISH,
     1NPREGR,NVREGR,IS,HN,AA,AV,S,R,CD,RL,RL1,P11,P12,DELA(10),IKE
      DIMENSION RKAPA(10)
C
      WRITE(6,2001)
      READ(5,1000) NNNNN,MMMMM,ISH,NBRITL,IACTIV,ISOIL,NPREGR
     1,NVREGR,MR,ISF,NANALS
      READ(5,1001) R,CD,RL,RL1
      CALL PERFOM(IPERFO)
      WRITE(6,2004)R,CD,RL,ISOIL,MR,ISF,NPREGR,NVREGR
      RL=RL/12.
   75 HN=HT(NSTORY)
      GO TO (76,77,78),ISOIL
   76 S=1.0
      GO TO 80
   77 S=1.2
      GO TO 80
   78 S=1.5
   80 WRITE(6,2011)S
      IF(NANALS.GT.0)GO TO 90
      GO TO (82,83,81),IPERFO
   81 IF(NPREGR.EQ.0)GO TO 85
      IF(NVREGR.EQ.1)GO TO 83
      WRITE(6,2006)
      NANALS=2
      GO TO 90
   82 WRITE(6,2007)
      STOP
   83 WRITE(6,2008)
      NANALS=1
      GO TO 90
   85 WRITE(6,2009)
      STOP
   90 GO TO(100,110,120),ISH
  100 IF(NBRITL.EQ.1.OR.NSTORY.GT.3)GO TO 110
      CDELA=0.02
      GO TO 130
  110 CDELA=0.015
      GO TO 130
  120 CDELA=0.01
  130 DELA(1)=CDELA*HT(1)*12.
      DO 140 I=2,NSTORY
      II=I-1
      DELA(I)=(HT(I)-HT(II))*CDELA*12.
  140 CONTINUE
      WRITE(6,2010)((I,DELA(I)),I=1,NSTORY)
      IF(NSTORY.LE.10) GO TO 153
      IF(NSTORY.GE.20) GO TO 155
      N10=NSTORY-9
      DO 151 I=N10,NSTORY
  151 RKAPA(I)=1.
      N101=N10-1
      DO 152 I=1,N101
  152 RKAPA(I)=1.-0.02*(NSTORY-I-9)
      GO TO 170
  153 DO 154 I=1,NSTORY
  154 RKAPA(I)=1.
      GO TO 170
  155 CONTINUE
      N10=NSTORY-9
      N20=NSTORY-19
      DO 156 I=N10,NSTORY
  156 RKAPA(I)=1.
      DO 157 I=1,N20
  157 RKAPA(I)=0.8
      N101=N10-1
      N201=N20+1
      DO 158 I=N201,N101
  158 RKAPA(I)=1.-(N10-I)*0.02
  170 CONTINUE
 1000 FORMAT(12I5)
 1001 FORMAT(4F10.0,2F20.0,2I5)
 2001 FORMAT(//3X,' ATC-3 SEISMIC PROVISIONS',/'+',' ----------------
     1',//5X,' GENERAL INFORMATION :',/)
 2004 FORMAT(5X,' RESPONSE MODIFICATION FACTOR (TABLE 3-B) -------',F10
     1.2,/5X,' DEFLECTION AMPLIFICATION FACTOR (TABLE 3-B) -------',F10.2
     2,5X,' OVERALL LENGTH AT BASE (IN) -------------------',F10.2/
     8,5X,' SOIL TYPE ------------------------------------',5X,I5/
     3,5X,' STRUCTURAL TYPE --------------------------------',5X,I5/
     4,8X,' EQ. 1: MOMENT-RESISTING STRUCTURE',/
     5,8X,' EQ. 0: NON-MOMENT-RESISTING STRUCTURE',/
     6,5X,' MATERIAL OF THE STRUCTURE ----------------------',5X,I5/
     7,8X,' EQ. 1: STEEL FRAME',/8X,' EQ. 0: CONCRETE FRAME',/
     9,5X,' STRUCTURAL CONFIGURATION :',/
     1,7X,' PLAN CONFIGURATION ------------------------',5X,I5/
     1,7X,' VERTICAL CONFIGURATION --------------------',5X,I5/
     2,8X,' EQ. 1: REGULAR',/8X,' EQ. 0: IRREGULAR')
 2011 FORMAT(5X,' SOIL PROFILE COEFFICIENT ---- (TABLE 3-A) -------',
     1F10.3)
 2006 FORMAT(/,5X,' ATC-3  MODAL ANALYSIS METHOD',/)
 2007 FORMAT(/,5X,' NO SEISMIC FORCE',/)
 2008 FORMAT(/,5X,' ATC-3  EQIVALENT LATERAL FORCE METHOD',/)
 2009 FORMAT(/,5X,' GENERAL DYNAMIC ANALYSIS',/)
 2010 FORMAT(//,3X,' ALLOWABLE DRIFT ACCORDING TO TABLE 3-C',/,'+','
     1----------------------------------',//
     1,8X,' FLOOR NO.',5X,' ALLOWABLE VALUE (IN)',/,(10X,I5,10X,F10.5))
      RETURN
      END
C
      SUBROUTINE PERFOM(IPERFO)
C
C        DETERMINES ATC-03 MAP COEFFICIENTS
C
      IMPLICIT REAL*8(A-H,O-Z)
      COMMON/ATC1/IACTIV,ISOIL,MR,ISF,NANALS,NNNNN,MMMMM,NBRITL,ISH,
     1NPREGR,NVREGR,IS,HN,AA,AV,S,R,CD,RL,RL1,P11,P12,DELA(10),IKE
      GO TO (1,1,3,4,5,6,7),NNNNN
    1 AA=0.05
      GO TO 8
    3 AA=0.10
      GO TO 8
    4 AA=0.15
      GO TO 8
    5 AA=0.20
      GO TO 8
    6 AA=0.30
      GO TO 8
    7 AA=0.40
    8 GO TO(11,12,13,14,15,16,17),MMMMM
   11 AV=0.05
      IS=1
      GO TO 18
   12 AV=0.05
      IS=2
      GO TO 18
   13 AV=0.10
      IS=2
      GO TO 18
   14 AV=0.15
      IS=3
      GO TO 18
   15 AV=0.2
      IS=4
      GO TO 18
   16 AV=0.3
      IS=4
      GO TO 18
```

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17 AV=0.4
   IS=4
18 WRITE(6,101)NNNNN,MMMMM,AA,AV,IS,ISH
   GO TO (20,30,40,50),IS
20 WRITE(6,102)
   IPERFO=1
   GO TO 100
30 WRITE(6,103)
   IPERFO=2
   GO TO 100
40 IF(ISH.NE.1)GO TO 30
41 WRITE(6,104)
   IPERFO=3
   GO TO 100
50 IF(ISH.NE.3)GO TO 41
   WRITE(6,105)
   IPERFO=4
100 CONTINUE
101 FORMAT(5X,' AREA MAP NUMBER FOR AA ------------------------',5X
   1,I5/5X,' AREA MAP NUMBER FOR AV ------------------------',5X,I5
   2,5X,' SEISMIC COEFFICIENT AA ------ (TABLE 1-B) -------',F10.3/
   3,5X,' SEISMIC COEFFICIENT AV ------ (TABLE 1-B) -------',F10.3/
   4,5X,' SEISMIC INDEX --------------- (TABLE 1-A) -------',5X,I5/
   5,5X,' SEISMIC HAZARD EXPOSURE GROUP (TABLE 1-A) -------',5X,I5)
102 FORMAT(5X,' SEISMIC PERFORMANCE CATEGORY  (TABLE 1-A) -------',9X
   1,'A')
103 FORMAT(5X,' SEISMIC PERFORMANCE CATEGORY  (TABLE 1-A) -------',9X
   1,'B')
104 FORMAT(5X,' SEISMIC PERFORMANCE CATEGORY  (TABLE 1-A) -------',9X
   1,'C')
105 FORMAT(5X,' SEISMIC PERFORMANCE CATEGORY  (TABLE 1-A) -------',9X
   1,'D')
106 FORMAT(5X,' ANALYSIS PROCEDURE IS EQUIVALENT LATERAL FORCE ')
107 FORMAT(5X,' ANALYSIS PROCEDURE IS MODAL ANALYSIS')
    RETURN
    END
    SUBROUTINE ATLINK(NSTORY,SD,N9,C1,TT,VAL,AMA4,IJACK)
C
C     DETERMINES NEEDED STRUCTURAL DATA FOR THE
C            ATC-03 ANALYSES
C
    IMPLICIT REAL*8(A-H,O-Z)
    COMMON/CODE1/HT(10),WTT(10),WWW(10,1)
    DIMENSION SD(10,15),C1(10),AMA4(10),TT(10),VAL(10)
    IF(IJACK.EQ.1) GO TO 101
C
C                 FIND HEIGHT FROM BASE TO EACH LEVEL
C                 INDEX FROM BASE TO TOP
C                 HEIGHT IN FEET
C
    DO 100 I=1,NSTORY
    HT(NSTORY+1-I)=0.0
    DO 100 J=I,NSTORY
    HT(NSTORY+1-I)=HT(NSTORY+1-I)+SD(J,2)/12.
100 CONTINUE
    GO TO 301
C                 FIND NATURAL FREQ. AND PERIODS
C
101 DO 200 I=1,N9
    VAL(I)=DSQRT(C1(I))
    TT(I)=2.*3.1416/VAL(I)
200 CONTINUE
C
C                 DETERMINE THE TOTAL GRAVITY LOAD AND
C                 THE LOAD PER FLOOR INDEXED FROM BOT TO TOP
C
    WTT(1)=0.0
    DO 300 I=1,NSTORY
    WWW(NSTORY+1-I,1)=(SD(I,3)+AMA4(I))*386.4
    WTT(1)=WWW(NSTORY+1-I,1)+WTT(1)
300 CONTINUE
301 RETURN
    END
    SUBROUTINE REPLAC(NCP,NSTEEL,NSTC,NBP,NPAN,NTRU,NC,NB,ID,N9,NLD1
   1,NS,LP,LT,COLIN,BMIN,X9,FINA,U2,NATC,VM3)
    IMPLICIT REAL*8 (A-H,O-Z)
    DIMENSION CC(16),X(170),LP(3,20),LT(3,40),COLIN(45),BMIN(45)
   1,X9(170,10),FINA(170,6),U2(170,6),VM3(170)
C
C     REPLACE INFORMATION FOR LOWEST OBJECTIVE
C
    L=NCP-1
    DO 201 I=1,L
    IF(I.LE.NSTEEL) READ(76,5042) K,CC(1),CC(2),(CC(J),J=5,16)
    IF(I.LE.NSTEEL) WRITE(75,5042) K,CC(1),CC(2),(CC(J),J=5,16)
    IF(I.LE.NSTEEL) COLIN(I)=CC(6)
    IF(I.GT.NSTEEL) READ(76,5043) K,(CC(J),J=1,16)
    IF(I.GT.NSTEEL) WRITE(75,5043) K,(CC(J),J=1,16)
    IF(I.GT.NSTEEL) COLIN(I)=CC(1)
201 CONTINUE
C
C     REPLACE BEAM PROPERTY SETS
C
    L=NBP-1
    IF(L.EQ.0) GO TO 202
    DO 203 I=1,L
    READ(76,5070) K,CC(1),(CC(J),J=3,11)
    WRITE(75,5070) K,CC(1),(CC(J),J=3,11)
    BMIN(I)=CC(4)
203 CONTINUE
C
C     REPLACE PANEL PROPERTY SETS
C
202 IF(NPAN.EQ.0) GO TO 204
    DO 215 I=1,NPAN
    READ(76,5072) K1,K2,K3,(CC(J),J=1,12)
    WRITE(75,5072) K1,K2,K3,(CC(J),J=1,12)
215 CONTINUE
C
C     REPLACE TRUSS PROPERTY SETS
C
204 IF(NTRU.EQ.0) GO TO 209
    DO 216 I=1,NTRU
    READ(76,5073) K1,K2,K3,CC(1),CC(2),CC(3),CC(4)
    WRITE(75,5073) K1,K2,K3,CC(1),CC(2),CC(3),CC(4)
216 CONTINUE
C
C     REPLACE EIGENVALUES AND EIGENVECTORS
C
209 IF(ID.LT.4) GO TO 205
    K1=N9
    IF(NATC.NE.0) K1=2*N9
    DO 400 M1=1,K1
    READ(76,2010) CC(1),(X(J),J=1,NSTC)
    DO 210 J=1,NSTC
    X9(J,M1)=X(J)
210 CONTINUE
    WRITE(75,2010) CC(1),(X(J),J=1,NSTC)
400 CONTINUE
C
C     REPLACE FORCES AND STRESSES FOR ALL ELEMENTS
C
205 N=NS
900 DO 300 M=1,NC
    DO 300 I=1,NLD1
    READ(76,2000) K1,K2,(CC(J),J=1,8)
    WRITE(75,2000) K1,K2,(CC(J),J=1,8)
300 CONTINUE
    DO 301 M=1,NC
    DO 301 I=1,NLD1
    READ(76,4002) K1,K2,(CC(J),J=1,6)
    WRITE(75,4002) K1,K2,(CC(J),J=1,6)
301 CONTINUE
    IF(NB.EQ.0) GO TO 307
    DO 305 M=1,NB
    DO 305 I=1,NLD1
    READ(76,2000) K1,K2,(CC(J),J=1,3)
    WRITE(75,2000)K1,K2,(CC(J),J=1,3)
305 CONTINUE
    DO 306 M=1,NB
    DO 306 I=1,NLD1
    READ(76,4002) K1,K2,(CC(J),J=1,2)
    WRITE(75,4002) K1,K2,(CC(J),J=1,2)
306 CONTINUE
307 IF(NPAN.EQ.0) GO TO 311
    DO 308 L=1,NPAN
    NP=NS-LP(1,L)+1
    IF(NP.NE.N) GO TO 308
    DO 309 I=1,NLD1
    READ(76,3000) K1,K2,(CC(J),J=1,4)
    WRITE(75,3000) K1,K2,(CC(J),J=1,4)
309 CONTINUE
308 CONTINUE
    DO 310 M=1,NPAN
    NP=NS-LP(1,M)+1
    IF(NP.NE.N) GO TO 310
    DO 315 I=1,NLD1
    READ(76,4002) K1,K2,(CC(J),J=1,5)
    WRITE(75,4002) K1,K2,(CC(J),J=1,5)
315 CONTINUE
310 CONTINUE
311 IF(NTRU.EQ.0) GO TO 317
    DO 316 L=1,NTRU
    NP=NS-LT(1,L)+1
    IF(NP.NE.N) GO TO 316
    DO 312 I=1,NLD1
```

```
      READ(76,2000) K1,K2,CC(I),
      WRITE(75,2000) K1,K2,CC(I),
  312 CONTINUE
  316 CONTINUE
      DO 313 M=1,NTRU
      NP=NS-LT(1,M)+1
      IF(NP.NE.N) GO TO 313
      DO 314 I=1,NLD1
      READ(76,4002) K1,K2,CC(I),
      WRITE(75,4002) K1,K2,CC(I),
  314 CONTINUE
  313 CONTINUE
  317 N=N-1
      IF(N.NE.0) GO TO 900
C
C     REPLACE THE DISPLACEMENTS
C
      DO 320 N=1,NS
      DO 320 II=1,3
      READ(76,2004) NL,RLAB,(CC(J),J=1,NLD1)
      WRITE(75,2004) NL,RLAB,(CC(J),J=1,NLD1)
  320 CONTINUE
      DO 500 J=1,NSTC
      DO 500 K=1,6
      FINA(J,K)=U2(J,K)
  500 CONTINUE
      IF(NATC.NE.0.OR.ID.LT.5) GO TO 502
      DO 501 J=1,NSTC
      FINA(J,5)=UN3(J)
  501 CONTINUE
  502 CONTINUE
C
C     REPLACE WEIGHTS
C
      READ (76,7000) WTST
      WRITE(75,7000) WTST
      READ (76,7000) WTCO
      WRITE(75,7000) WTCO
      READ (76,7000) WT
      WRITE(75,7000) WT
C
C     REPLACE THETA AND DRIFT INFORMATION
C
      IF(NATC.EQ.0) GO TO 600
      DO 599 J=1,NS
      READ(77,1052) DELT,I
      WRITE(19,1053) DELT,I
  599 CONTINUE
      DO 598 J=1,NS
      READ(77,1052) TETA,I
      WRITE(18,1053) TETA,I
  598 CONTINUE
  600 CONTINUE
      RETURN
 1052 FORMAT(E15.6,5X,I5)
 1053 FORMAT(E15.6,' ',I5)
 2000 FORMAT(2I6,5X,8F14.4)
 2004 FORMAT(I6,5X,A4,5X,8F14.7)
 2010 FORMAT(6F20.12)
 3000 FORMAT(2I6,4(5X,1PE18.11))
 4002 FORMAT(2I6,5X,6F14.4)
 5042 FORMAT(I6,4X,F11.2,2F8.2,F9.2,10F8.2)
 5043 FORMAT(I7,3X,F13.0,F11.0,F8.0,F6.1,9F7.1,F7.3,F8.0,F6.0)
 5070 FORMAT(I7,3X,F12.2,F8.2,F9.2,1F8.2)
 5072 FORMAT(I4,2I5,F16.1,F11.1,8F7.1,F8.1,F7.1)
 5073 FORMAT(1X,3I5,4F15.5)
 7000 FORMAT(F14.4)
      END
      SUBROUTINE REPORT(NCP,NSTEEL,NSTC,NBP,NPAN,NTRU,NC,NB,ID,N9,NLD1
     1,NS,LP,LT,NSTEE2,NTOTL,NLDDD,NATC)
      IMPLICIT REAL*8 (A-H,O-Z)
      DIMENSION CC(16),X(170),LP(3,20),LT(3,40)
C
C     REPORT INFORMATION FOR LOWEST OBJECTIVE
C
      WRITE(6,6000)
      L=NCP-1
      DO 201 I=1,L
      IF(I.EQ.1.AND.NSTEEL.NE.0) WRITE(6,2008)
      IF(I.EQ.NSTEE2) WRITE(6,5041)
      IF(I.LE.NSTEEL) READ(75,5042) K,CC(1),CC(2),(CC(J),J=5,16)
      IF(I.LE.NSTEEL) WRITE(6,5042) K,CC(1),CC(2),(CC(J),J=5,16)
      IF(I.GT.NSTEEL) READ(75,5043) K,(CC(J),J=1,16)
      IF(I.GT.NSTEEL) WRITE(6,5043) K,(CC(J),J=1,16)
  201 CONTINUE
C
C     REPORT BEAM PROPRERTY SETS
C
      L=NBP-1
      IF(L.EQ.0) GO TO 202
      WRITE(6,2009)
      DO 203 I=1,L
      READ(75,5070) K,CC(1),(CC(J),J=3,11)
      WRITE(6,5070) K,CC(1),(CC(J),J=3,11)
  203 CONTINUE
C
C     REPORT PANEL PROPERTY SETS
C
  202 IF(NPAN.EQ.0) GO TO 204
      WRITE(6,2006)
      DO 215 I=1,NPAN
      READ(75,5072) K1,K2,K3,(CC(J),J=1,12)
      WRITE(6,5072) K1,K2,K3,(CC(J),J=1,12)
  215 CONTINUE
C
C     REPORT TRUSS PROPERTY SETS
C
  204 IF(NTRU.EQ.0) GO TO 209
      WRITE(6,2007)
      DO 216 I=1,NTRU
      READ(75,5073) K1,K2,K3,CC(1),CC(2),CC(3),CC(4)
      WRITE(6,5073) K1,K2,K3,CC(1),CC(2),CC(3),CC(4)
  216 CONTINUE
C
C     REPORT EIGENVALUES AND EIGENVECTORS
C
  209 IF(ID.LT.6) GO TO 205
      K1=N9
      IF(NATC.NE.0) K1=2*N9
      WRITE(6,2005)
      WRITE(6,1000)
      DO 400 M=1,K1
      WRITE(6,2005)
      READ(75,2010) CC(1),(X(J),J=1,NSTC)
      WRITE(6,2010) CC(1),(X(J),J=1,NSTC)
  400 CONTINUE
C
C     REPORT FORCES AND STRESSES FOR ALL ELEMENTS
C
  205 N=NS
  900 LV=NS-N+1
      WRITE(6,7009) LV
      WRITE(6,7007)
      WRITE(6,2001)
      DO 300 M=1,NC
      WRITE(6,2005)
      DO 300 I=1,NLD1
      READ(75,2000) K1,K2,(CC(J),J=1,8)
      WRITE(6,2000) K1,K2,(CC(J),J=1,8)
  300 CONTINUE
      WRITE(6,4000)
      WRITE(6,4001)
      DO 301 M=1,NC
      WRITE(6,2005)
      DO 301 I=1,NLD1
      READ(75,4002) K1,K2,(CC(J),J=1,6)
      WRITE(6,4002) K1,K2,(CC(J),J=1,6)
  301 CONTINUE
      IF(NB.EQ.0) GO TO 307
      WRITE(6,7008)
      WRITE(6,2002)
      DO 305 M=1,NB
      WRITE(6,2005)
      DO 305 I=1,NLD1
      READ(75,2000) K1,K2,(CC(J),J=1,5)
      WRITE(6,2000)K1,K2,(CC(J),J=1,5)
  305 CONTINUE
      WRITE(6,4003)
      WRITE(6,4004)
      DO 306 M=1,NB
      WRITE(6,2005)
      DO 306 I=1,NLD1
      READ(75,4002) K1,K2,(CC(J),J=1,2)
      WRITE(6,4002) K1,K2,(CC(J),J=1,2)
  306 CONTINUE
  307 IF(NPAN.EQ.0) GO TO 311
      WRITE(6,7004)
      WRITE(6,2003)
      DO 308 L=1,NPAN
      NP=NS-LP(1,L)+1
      IF(NP.NE.N) GO TO 308
      WRITE(6,2005)
      DO 309 I=1,NLD1
      READ(75,3000) K1,K2,(CC(J),J=1,4)
      WRITE(6,3000) K1,K2,(CC(J),J=1,4)
  309 CONTINUE
```

```
  300 CONTINUE
      WRITE(6,4005)
      WRITE(6,4006)
      DO 310 N=1,NPAN
      NP=NS-LP(1,N)+1
      IF(NP.NE.N) GO TO 310
      WRITE(6,2005)
      DO 315 I=1,NLD1
      READ(75,4002) K1,K2,(CC(J),J=1,5)
      WRITE(6,4002) K1,K2,(CC(J),J=1,5)
  315 CONTINUE
  310 CONTINUE
  311 IF(NBRU.EQ.0) GO TO 317
      WRITE(6,7006)
      DO 316 L=1,NBRU
      NP=NS-LT(1,L)+1
      IF(NP.NE.N) GO TO 316
      WRITE(6,2005)
      DO 312 I=1,NLD1
      READ(75,2000) K1,K2,CC(1)
      WRITE(6,2000) K1,K2,CC(1)
  312 CONTINUE
  316 CONTINUE
      WRITE(6,4007)
      WRITE(6,4008)
      DO 313 M=1,MBRU
      NP=NS-LT(1,M)+1
      IF(NP.NE.N) GO TO 313
      WRITE(6,2005)
      DO 314 I=1,NLD1
      READ(75,4002) K1,K2,CC(1)
      WRITE(6,4002) K1,K2,CC(1)
  314 CONTINUE
  313 CONTINUE
  317 N=N-1
      IF(N.NE.0) GO TO 900
C
C        REPORT THE DISPLACEMENTS
C
      IF(NLD1.EQ.NLODD) WRITE(6,7050)
      IF(NLD1.EQ.NTOT1) WRITE(6,3001)
      WRITE(6,3010) (N,N=1,NLD1)
      DO 320 N=1,NS
      WRITE(6,1001)
      DO 320 I=1,3
      READ(75,2004) NL,RLAB,(CC(J),J=1,NLD1)
      WRITE(6,2004) NL,RLAB,(CC(J),J=1,NLD1)
  320 CONTINUE
C
C       REPORT WEIGHTS
C
      READ (75,7000) WTST
      WRITE(6,7001) WTST
      READ (75,7000) WTCO
      WRITE(6,7002) WTCO
      READ (75,7000) WT
      WRITE(6,7003) WT
      RETURN
 1000 FORMAT(//' EIGENVALUES AND EIGENVECTORS')
 1001 FORMAT(1H0)
 2000 FORMAT(2I6,5X,8F14.4)
 2004 FORMAT(I6,5X,A4,5X,8F14.7)
 2010 FORMAT(6E20.12)
 3000 FORMAT(2I6,4(5X,1PE18.11))
 4002 FORMAT(2I6,5X,6F14.4)
 5042 FORMAT(I6,4X,F11.2,2F8.2,F9.2,10F8.2)
 5045 FORMAT(I7,3X,F13.0,F11.0,F8.0,F6.1,9F7.1,F7.3,F8.0,F6.0)
 5070 FORMAT(I7,3X,F12.2,F8.2,F9.2,7F8.2)
 5072 FORMAT(I4,2I5,F16.1,F11.1,8F7.1,F8.1,F7.1)
 5075 FORMAT(1X,3I5,4F15.5)
 6000 FORMAT(31H1THE FINAL OPTIMAL RESULTS ARE:)
 7000 FORMAT(F14.4)
 7001 FORMAT(23H0THE STEEL WEIGHT IS    ,F14.4)
 7002 FORMAT(23H0THE CONCRETE WEIGHT IS,F14.4)
 7003 FORMAT(23H0THE TOTAL WEIGHT IS    ,F14.4)
 2008 FORMAT(///10H COLUMN ID,9X,1HE,7X,1HA,3X,6HTORS I,4X,5HMAJ I,3X,5H
     1MIN I,5X,2HDT,6X,2HDB,7X,1HD,6X,2HBF,6X,2HTF,6X,2HTW,6X,2HTS,6X,2H
     2CS,6X,2HSS/' ',9H_________,9X,1H_,7X,1H_,3X,6H______,4X,5H_____,3X
     3,5H_____,5X,2H__,6X,2H__,7X,1H_,6X,2H__,6X,2H__,6X,2H__,6X,2H__,6X
     4,2H__,6X,2H__)
 2009 FORMAT(///10H   BEAM ID,10X,1HE,4X,6HTORS I,2X,6HFLEX I,5X,3HKII,5
     1X,3HKJJ,5X,3HKIJ,5X,2HDI,6X,2HDJ,7X,1HD,6X,2HNS/' ',9H_________,10
     2X,1H_,4X,6H______,2X,6H______,5X,3H___,5X,3H___,5X,3H___,5X,2H__,6
     3X,2H__,7X,1H_,6X,2H__)
 2006 FORMAT(///18H PANEL INFORMATION/' ',17H_________________//14H LEVE
     1L  L      R,13X,3HEIX,9X,2HEA,6X,1HE,6X,1HL,6X,2H B,5X,2HES,5X,2HTS,
     25X,2HCS,5X,2HSS,4X,3HRHO,6X,2HGJ,6X,1HG/' ',13H_____________,13X,3H
     3H___,9X,2H__,4X,2H__,5X,2H__,5X,2H__,5X,2H__,5X,2H__,5X,2H__,5X,2H
     4__,4X,3H___,6X,2H__,6X,1H_/(I4,2I5,F16.1,F11.1,8F7.1,F8.1,F7.1))
 2007 FORMAT (///28H BRACING ELEMENT INFORMATION/' ',27H________________
     1___________//16H   LEVEL UC    LC,14X,1HE,14X,1HA,13X,2HTS,13X,2HCS
     2/' ',15H_______________,14X,1H_,14X,1H_,13X,2H__,13X,2H__/(1X,3I5,
     34F15.5))
 5041 FORMAT   (/10H COLUMN ID,9X,3HIX ,9X,2HA ,5X,3HIY ,4X,3HKII,4X,3HKJ
     1J,4X,3HKIJ,5X,2HTS,5X,2HCS,4X,2HSS,5X,2HEC,5X,2H D,5X,2H W,5X,2HES
     2,5X,2HRO,6X,2HJ ,5X,1HG/' ',9H_________,9X,3H___,9X,2H__,5X,3H___,
     34X,3H___,4X,3H___,4X,3H___,5X,2H__,5X,2H__,4X,2H__,5X,2H__,5X,2H__
     4,5X,2H__,5X,2H__,6X,2H__,5X,1H_)
 2001 FORMAT (128H0   LINE LOAD                TORSIONAL           MAJOR AXIS
     1                AXIAL           MINOR AXIS                     MAJOR
     2     MINOR /129H                             MOMENT     TOP MOMENT     BOT
     3 MOMENT          FORCE     TOP MOMENT     BOT MOMENT           SHEAR
     4        SHEAR  )
 2002 FORMAT(83H                            TORSIONAL       CENTERLINE MOMENTS
     1              BEAM END MOMENTS/87H     BAY  LOAD            MOMENT
     2 I   MOMENT        J  MOMENT        I   MOMENT      J   MOMENT)
 2003 FORMAT(12H PANEL  LOAD,6X,13H   TOP-MOMENT,13X,10HBOT-MOMENT,13X,1
     11HAXIAL-FORCE,12X,11HSHEAR-FORCE )
 7004 FORMAT(//13H PANEL FORCES /)
 2005 FORMAT (1H )
 7006 FORMAT(/17H BRACING ELEMENTS//12H BRACE  LOAD,11X,11HAXIAL-FORCE )
 7007 FORMAT(///14H COLUMN FORCES)
 7008 FORMAT(//12H BEAM FORCES /)
 7009 FORMAT(56H1STATIC LOAD COMBINATION-----MEMBER FORCES-----LEVEL NO.
     1,I3)
 7050 FORMAT(///71H STATIC LOAD COMBINATION-----LATERAL AND ROTATIONAL M
     1. C. DISPLACEMENTS)
 3001 FORMAT(///83H STATIC AND DYNAMIC LOAD COMBINATION-----LATERAL AND
     1ROTATIONAL M. C. DISPLACEMENTS)
 3010 FORMAT(//6H LEVEL,3X,9HDIRECTION,8X,I2,7(12X,I2))
 4000 FORMAT(//16H COLUMN STRESSES/)
 4001 FORMAT(12HO  LINE LOAD,12X,7HTOP-MAX,7X,7HTOP-MIN,7X,7HBOT-MAX,7X,
     17HBOT-MIN,6X,9HSHEAR-MAJ,5X,9HSHEAR-MIN)
 4003 FORMAT(//15H  BEAM STRESSES/)
 4004 FORMAT(12HO   BAY LOAD,12X,8HI NORMAL,6X,8HJ NORMAL)
 4005 FORMAT(//15H PANEL STRESSES/)
 4006 FORMAT(12HO PANEL LOAD,12X,7HTOP-MAX,7X,7HTOP-MIN,7X,7HBOT-MAX,7X,
     17HBOT-MIN,9X,5HSHEAR)
 4007 FORMAT(//15H BRACE STRESSES/)
 4008 FORMAT(12HO BRACE LOAD,14X,5HAXIAL)
      END
      SUBROUTINE PLOT(OBJ,PERIOD,L2,XM,I0,N9,NCTS,IOPT,NST,
     1NTOT1,OBJS,OBJC,LC,L8,NCPL1,NBPL1,COLIN,BMIN,X99,FINA
     2,NCPL,NBPL)
C
C        PLACE DATA IN A FORM TO BE PLOTTED
C
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION OBJ(50),PERIOD(50,10),L2(10),
     1XM(6,10),OBJS(50),OBJC(50),LC(10,14,2),L8(10,15,3),
     2COLIN(45),BMIN(45),X99(170,10),FINA(170,6),NCPL1(14),NB
     3PL1(15)
C
C PRINT OBJECTIVE FUNCTION VALUE IN FILES 7-9
C
      N10=1
      WRITE(9,3000) N10
      WRITE(7,3000) N10
      WRITE(8,3000) N10
      DO 100 J=1,IOPT
      J2=J-1
      WRITE(9,1000) J2,OBJ(J)
      WRITE(7,1000) J2,OBJS(J)
      WRITE(8,1000) J2,OBJC(J)
  100 CONTINUE
      WRITE(9,4000)
      WRITE(7,4000)
      WRITE(8,4000)
C
C     PRINT DISPL. DATA IN FILES 10-12
C
      DO 400 J=1,NTOT1
      WRITE(10,6000) J,J
      WRITE(11,6000) J,J
      WRITE(12,6000) J,J
      DO 400 N=1,NST
      N2=(N-1)*3*NCTS
      N3=NST-N+1
      DO 400 K=1,3
      IF(N.EQ.1) WRITE(9+K,3000) J
      DP=0.0
      DO 399 M=1,6
      DP=DP+FINA(N2+K,M)*XM(M,J)
  399 CONTINUE
      WRITE(9+K,2000) DP,N3
      IF(N.EQ.NST) WRITE(9+K,5000)
```

```
      IF(N.EQ.NST) WRITE(9+K,4000)
  400 CONTINUE
C
C  PRINT PERIODS IN FILE 13
C
      IF(ID.LT.4) GO TO 500
      DO 199 K=1,N9
      WRITE(13,7000) K,K
      DO 200 J=1,IOPT
      J2=J-1
      IF(J.EQ.1) WRITE(13,3000) K
      WRITE(13,1000) J2,PER(ODIJ,K)
      IF(J.EQ.IOPT) WRITE(13,4000)
  200 CONTINUE
  199 CONTINUE
C
C PRINT EIGENVECTORS IN FILES 14-16
C
      DO 300 J=1,N9
      N=L2(J)
      WRITE(14,7000) J,J
      WRITE(15,7000) J,J
      WRITE(16,7000) J,J
      DO 300 N=1,NST
      N2=(N-1)*3+NCIS
      N3=NST-N+1
      DO 300 K=1,3
      IF(N.EQ.1) WRITE(13+K,3000) J
      WRITE(13+K,2000) X99(N2+K,J),N3
      IF(N.EQ.NST) WRITE(13+K,5000)
      IF(N.EQ.NST) WRITE(13+K,4000)
  300 CONTINUE
C
C       MOMENTS OF INERTIA FOR COLS. AND BEAMS
C
C       COLUMNS IN FILE 74
C
  500 IF(NCPL.EQ.0) GO TO 502
      DO 501 I=1,NCPL
      M=NCPL1(I)
      WRITE(74,8000) I,M
      WRITE(74,3000) I
      DO 503 N=1,NST
      K=LC(N,M,1)
      J=NST-N+1
      WRITE(74,2000) COLMI(K),J
      IF(N.EQ.NST) WRITE(74,5000)
      IF(N.EQ.NST) WRITE(74,4000)
  503 CONTINUE
  501 CONTINUE
  502 CONTINUE
C
C         BEAMS IN FILE 73
C
      IF(NBPL.EQ.0) GO TO 507
      DO 506 I=1,NBPL
      M=NBPL1(I)
      WRITE(73,9000) I,M
      WRITE(73,3000) I
      DO 505 N=1,NST
      K=LB(N,M,3)
      J=NST-N+1
      WRITE(73,2000) BMIN(K),J
      IF(N.EQ.NST) WRITE(73,5000)
      IF(N.EQ.NST) WRITE(73,4000)
  505 CONTINUE
  506 CONTINUE
  507 CONTINUE
      RETURN
 1000 FORMAT(I5,',',F20.7)
 2000 FORMAT(F20.10,',',I5)
 3000 FORMAT(6H CURVE,I3,1X,'DATA VALUES I5')
 4000 FORMAT('-')
 5000 FORMAT(' 0.0, 0.0')
 6000 FORMAT(6H CURVE,I3,1X,21HLEGEND LABEL IS 'LOAD,I3,1X,2H'.)
 7000 FORMAT(6H CURVE,I3,1X,21HLEGEND LABEL IS 'MODE,I3,1X,2H'.)
 8000 FORMAT(6H CURVE,I3,1X,21HLEGEND LABEL IS 'COL.,I3,1X,2H'.)
 9000 FORMAT(6H CURVE,I3,1X,21HLEGEND LABEL IS 'BEAN,I3,1X,2H'.)
      END
```

VI. SAMPLE INPUT DATA AND OUTPUT SOLUTIONS

A. EXAMPLE I: A TWO STORY STEEL STRUCTURE

1. Description. The two story, steel structure shown in Figure 9 is used to illustrate the use of the response spectrum modal analysis coupled with the structural optimization. The response spectrum shown in Figure 8 is used for each of the principle directions with maximum ground accelerations of 0.0g in the vertical direction and 0.3g in both the x and the y directions. The modal analysis is performed using the first four nodes, and a translational mass of 0.77 k-s^2/in (1385.8 kg-s^2/m) and a rotational mass of 745.3 k-s^2 in (8586.7 kg-m-s) for each level. The P-delta effects are not included in this example. No static displacement, frequency or dynamic stress constraints are considered, but dynamic displacement and static stress constraints are considered. The dynamic displacement constraints are 0.60 in (1.52 cm) for the first level and 0.90 in (2.29 cm) for the second level for both the x and y directions. The static stress constraints are 30 ksi (21 kN/cm^2) the columns. The beam static stress was set at 70 ksi (48.3 kN/cm^2). The dynamic stress constraints were set at 9999 ksi (6900 kN/cm^2) in order to keep them from becoming active. The optimization was to be terminated if more than 20 analyses or 15 cycles were required or if the weight changes less than one percent within concurrent cycles. The convergence control parameter was chosen as 2.0. The primary and secondary design variable relationships were

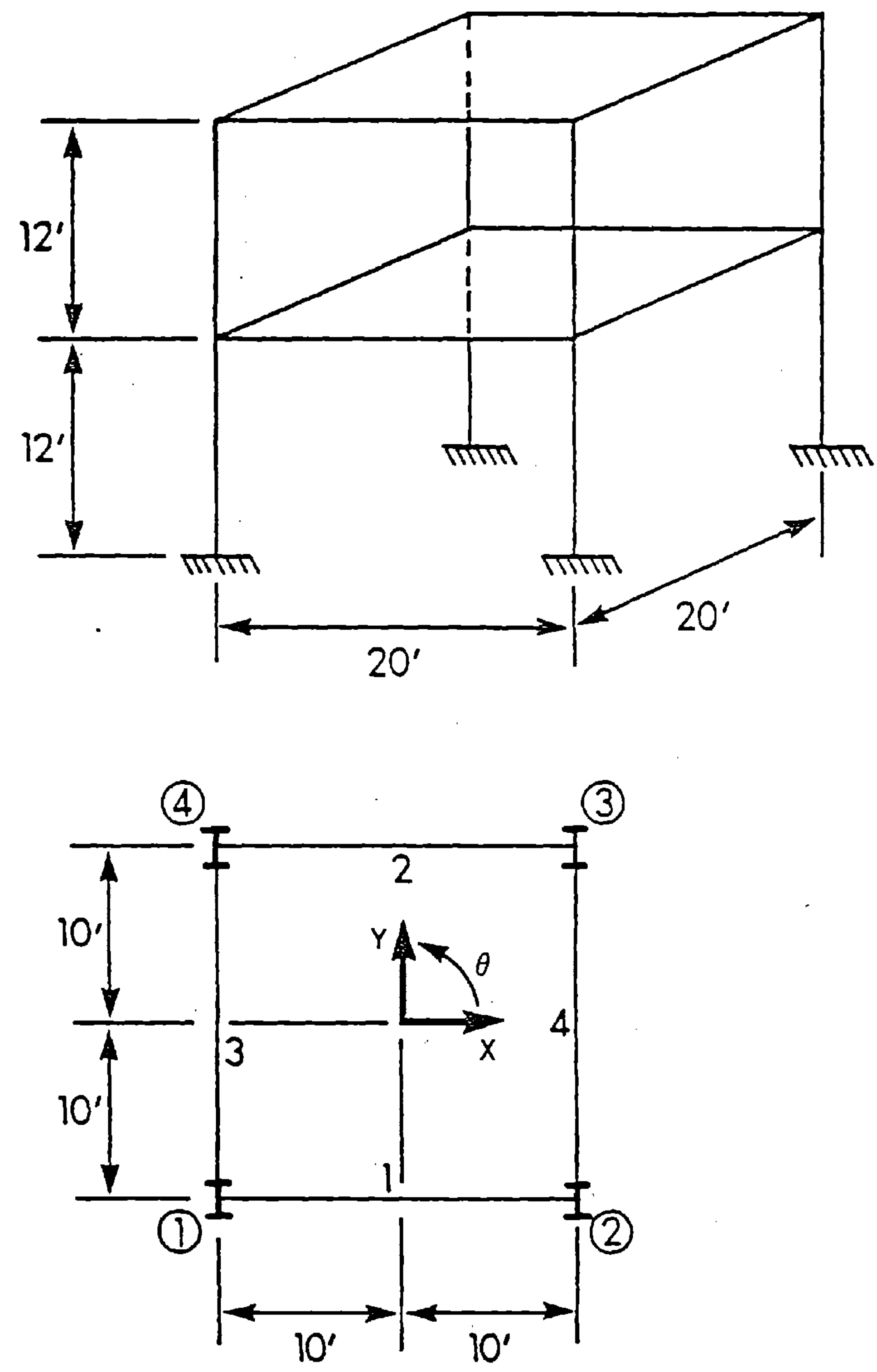

Figure 9. Two Story Steel Structure

determined from the AISCM. One loading condition was considered. This load condition uses a load factor of 1.0 for lateral load Case B since this represents the response from the spectral analysis. The static loads were ignored but could have been included by using other load combinations with the appropriate factors. Therefore, although the static stress constraints were input they were not considered since there was not a purely static load case.

B. EXAMPLE II: A TWO STORY MIXED SETBACK STRUCTURE

1. Description. A two story setback structure, shown in Figure 10, consisting of steel beams, columns, and braces, as well as, concrete columns is analyzed and optimized with respect to the ATC 3-06 provisions. The structure is assumed to be within map area 7 for both the effective peak acceleration, A_a, and the effective peak velocity-related acceleration, A_v. It was considered to be within seismic hazard exposure group 3. The soil condition was chosen as soft or soil condition 3. The ATC 3-06 equivalent lateral force approach was used for the analysis with a response modification factor, R, of 8.0 and a deflection amplification factor of 6.5. The primary direction of excitation was the x-direction. The first level had a translational mass of 0.906 k-s^2/in (159 Mg) and a rotational mass of 40490 k-s^2-in (4.58x10^7 Mg-cm^2). The second level had a translational mass of 0.408 k-s^2/in (71.5 Mg) and a rotational mass of 10390 k-s^2-in (1.17x10^7 Mg-cm^2). The ATC 3-06 provisions require a 5% eccentricity in the load which is included within the program. By calling for 3 modes to be used within the analysis, the first 3 modes with be printed for inspection. The equivalent lateral force method uses only the first natural frequency in its calculations, but in many cases it is useful to see the first few modes. This input of 3 modes would indeed cause 3 modes to be printed and used if the ATC 3-06 modal analysis were specified.

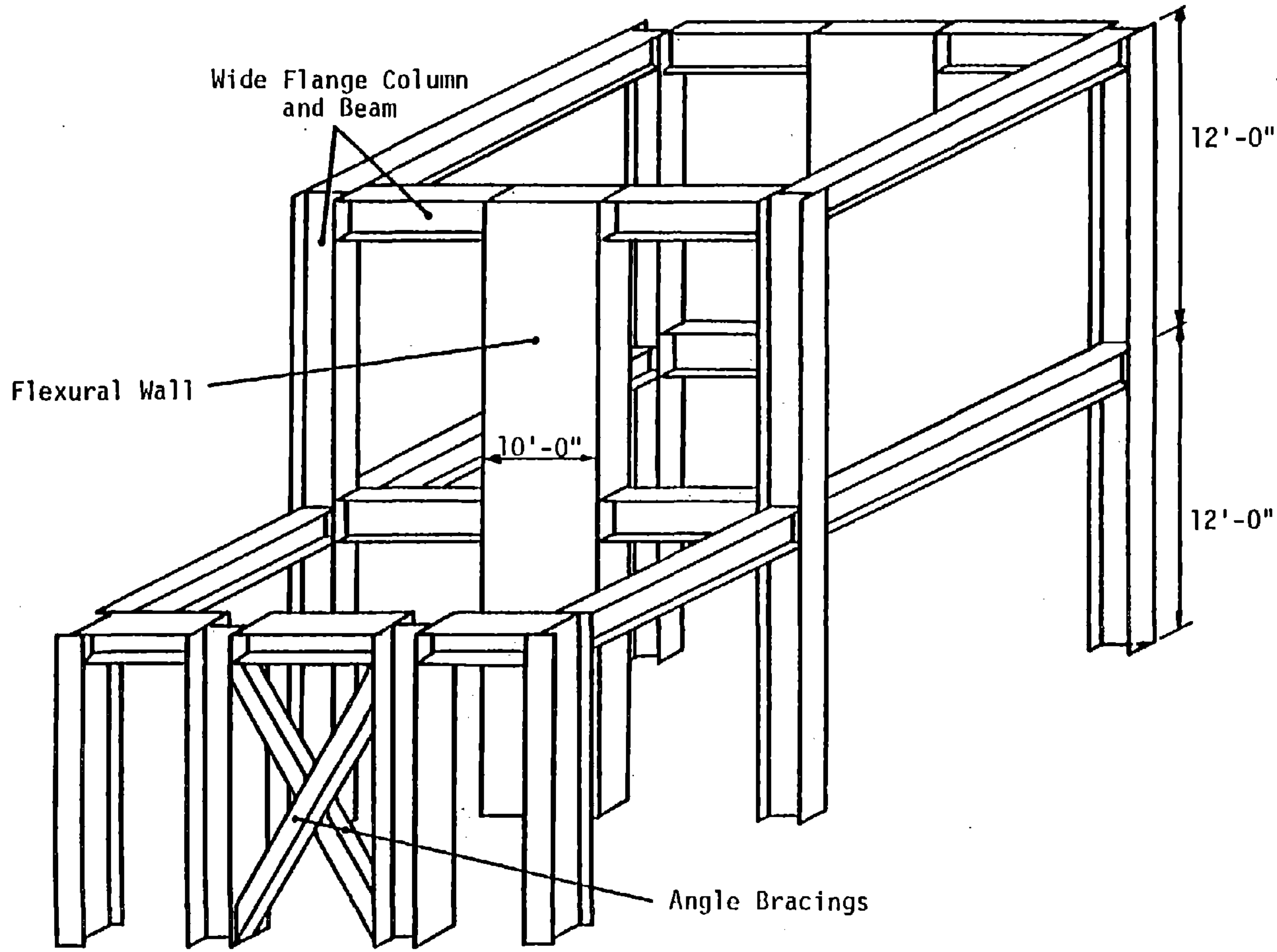

Figure 10. Two Story Mixed Setback Structure

The constraints considered were static and dynamic displacement and stress. The displacement constraints are based upon the ATC 3-06 allowable drift divided by the deflection amplification factor. The constraint limit was 0.22 in (0.56 cm) per level for both the static and dynamic analyses. The static and dynamic stress constraints for the steel elements were 36.0 ksi (24.8 kN/cm^2). The concrete elements had a reinforcement tensile stress constraint of 50 ksi (34.5 kN/cm^2) and a concrete compressive stress of 3.0 ksi (2.1 kN/cm^2). No frequency constraints were considered, therefore three blank lines were inserted in the input data.

All of the steel elements with the exception of the braces are considered as wide flange elements. The primary and secondary design variables are represented by curves which were determined from the AISC Manual. The steel columns have side constraints which require their major-axis moments of inertia to be between 7.00 in^4 (291 cm^4) and 20,000 in^4 (832.400 cm^4). The missing columns and beams on the second level must be represented by "small" fictitious elements. In addition to having "small" geometric properties, the stress constraints values for these fictitious elements have been increased to insure that these elements will not provide any active constraints. In addition the side constraints require these elements to have major-axis moments of inertia between 0.001 in^4 (.042 cm^4) and 1.00 in^4 (41.6 cm^4).

The concrete elements are based upon Equations 2.12 to 2.14. The percentage of steel to gross area was 2.5, and the modular ratio was 10. Each concrete column had a fixed crossectional height of 120 in. (305 cm) and a beginning width of 20 in. (51 cm). The width had side constraints which keep the width between 5.0 in. (12.7 cm) and 20 in. (51 cm).

The analysis considered three loading conditions. The first load case is a static load case. (Notice that the lateral loads are not included in this case since both lateral load cases must be used to represent the ATC 3-06 loads. Lateral load case A has a 5% eccentricity in the positive y-direction, and lateral load case B has a 5% eccentricity in the negative y-direction. Both load cases include 100% of the x-direction load with 30% of the y-direction loads.) Load cases 2 and 3 are seismic load cases including the ATC 3-06 lateral loads. Each of the load cases include vertical nodal loads of 5 kips (22 kN) per node and there are three different uniformly distributed loads to be used to represent the beam loads. These are assigned to each beam's respective vertical load case which is then assigned to the global load cases.

The optimization must be controlled by a set of input parameters, also. The optimization was to be terminated after 10 analyses, 10 optimization cycles, or 2% weight change. The objective function was based upon cost factors of 300 $\$/ft^3$ for steel (.174 $\$/in^3$, 0.010 $\$/cm^3$) and 80 $\$/ft^3$

(0.45 $/in^3, .003 $/cm^3) for concrete. The convergence control parameter was 3.0, and the constraints were considered active if they are within the range of 10% below and 5% above the constraint limit.

C. COMPUTER PRINTS OF EXAMPLES I AND II

I. Input Data of Example I

```
  1    5   2.     8     0     1     2
 15   20   1.         0.0         0.0          .20        .10
  2    4    4     8     8     0     0    0TWO STORY BLDG.
  3
   10.0     1550.0
 0.0389      0.925       0.0    .50080     .48716        0.0     0.0221    .95816
    0.0     0.4530     .7740       0.0     0.0423      .7319
 1550.0    12100.0
0.02651        1.0     20.47    .50080    0.48716        0.0  0.0124215    .90516
    0.0    0.04615       1.0    78.462    0.00412        1.0       7.64
 12100.     20000.
0.05182        1.0    159.08    .50080    0.48716        0.0  0.0124215   0.90516
    0.0    0.05200       1.0      56.0    0.00755        1.0      0.566
  0
  4


  4    4
  2    1      0.90
  2    2      0.90
  1    1      0.60
  1    2      0.60
  000.00    115.92    115.92
  3
     0.0       0.4
     0.0       0.0 -26.14194  13.93676  0.935163        0.0
     0.4       3.0
 .160600  -1.14094   2.99606  -3.61867   2.22972        0.0
     3.0     100.0
     0.0       0.0       0.0       0.0      0.36        0.0
     0.0       0.4
     0.0       0.0 -26.14194  13.93676  0.935163        0.0
     0.4       3.0
 .160600  -1.14094   2.99606  -3.61867   2.22972        0.0
     3.0     100.0
     0.0       0.0       0.0       0.0      0.36        0.0
     0.0       0.4
     0.0       0.0 -26.14194  13.93676  0.935163        0.0
     0.4       3.0
 .160600  -1.14094   2.99606  -3.61867   2.22972        0.0
     3.0     100.0
     0.0       0.0       0.0       0.0      0.36        0.0
FIRST         144.   0.07764     745.3      120.       120.
     20.       20.      120.      120.

SECND         144.   0.07764     745.3      120.       120.
     20.       20.      120.      120.


0.0194099 0.0194099 0.0194099 0.0194099 0.0194099 0.0194099 0.0194099 0.0194099
  1        0.         0.
  2      240.         0.
  3      240.       240.
  4        0.       240.
  1         30000.    5.0112                  .14709000.7.444
     8.         .5        .5         .5         30.        30.        24.        10.
 20000.      9999.     9999.      9999.
  2         30000.    5.0112                  .14709000.7.444
     8.         .5        .5         .5         30.        30.        24.        10.
 20000.      9999.     9999.      9999.
  3         30000.    5.0112                  .14709000.7.444
     8.         .5        .5         .5         30.        30.        24.        10.
 20000.      9999.     9999.      9999.
  4         30000.    5.0112                  .14709000.7.444
     8.         .5        .5         .5         30.        30.        24.        10.
 20000.      9999.     9999.      9999.
  5         30000.    5.0112                  .14709000.7.444
     8.         .5        .5         .5         30.        30.        24.        10.
 20000.      9999.     9999.      9999.
  6         30000.    5.0112                  .14709000.7.444
     8.         .5        .5         .5         30.        30.        24.        10.
 20000.      9999.     9999.      9999.
  7         30000.    5.0112                  .14709000.7.444
     8.         .5        .5         .5         30.        30.        24.        10.
 20000.      9999.     9999.      9999.
  8         30000.    5.0112                  .14709000.7.444
     8.         .5        .5         .5         30.        30.        24.        10.
 20000.      9999.     9999.      9999.
  1         30000.11.80      1.12      9000.    4.    4.    2.                  70.
    10.     20000.     9999.
  2         30000.11.80      1.12      9000.    4.    4.    2.                  70.
    10.     20000.     9999.
  3         30000.11.80      1.12      9000.    4.    4.    2.                  70.
    10.     20000.     9999.
  4         30000.11.80      1.12      9000.    4.    4.    2.                  70.
    10.     20000.     9999.
  5         30000.11.80      1.12      9000.    4.    4.    2.                  70.
    10.     20000.     9999.
  6         30000.11.80      1.12      9000.    4.    4.    2.                  70.
    10.     20000.     9999.
  7         30000.11.80      1.12      9000.    4.    4.    2.                  70.
    10.     20000.     9999.
  8         30000.11.80      1.12      9000.    4.    4.    2.                  70.
    10.     20000.     9999.
  1    1    2    1
  1    1    2    2
  2    4    3    3    0    0
  2    4    3    4    0    0
  3    1    4    5
  3    1    4    6
```

```
4    2    3    7    0
4    2    3    8
1    1    4
1    2    4
2    3    3
2    4    3
3    5    2
3    6    2
4    7    1
4    8    1
0    1
   0.0       0.0       0.0       0.0       1.0        0.0
1    1    1    1    1
4
1    2    3    4
4
1    2    3    4
```

2. Output Solution of Example I

DYNAMIC ANALYSIS WITH DISPLACEMENT CONSTRAINTS

```
TWO STORY BLDG.
NUMBER OF STORY LEVELS----   2
NUMBER OF COLUMN LINES----   4
NUMBER OF BAYS------------   4
NUMBER OF DIFF. COL. PROP-   8
NUMBER OF DIFF. BEAM PROP-   8
NUMBER OF DIFF. FEF-------   0
NUMBER OF PANEL ELEMENTS--   0
NUMBER OF BRACING ELEMENTS   0
NUMBER OF STEEL COL. PROP-   8
NUMBER OF OPT. CYCLES-----  15
NUMBER OF ANALYSES--------  20
PERCENTAGE FOR TERMINATION 1.0
PER. OF CONSTRAINT-LOWER--0.20
PER. OF CONSTRAINT-UPPER--0.10
CONVERGENCE CONTROL PARA.- 2.0
OBJECTIVE FACTOR-STEEL---- 0.3E-03
OBJECTIVE FACTOR-CONCRETE- 0.9E-04
```

STEEL MEMBER PROPERTY COEFFICIENTS FOR IX BETWEEN 10.0 AND 1550.0

PROPERTY	CONSTANT 1	POWER	CONSTANT 2
IY	0.038900	0.925000	0.000000
A	0.500800	0.487160	0.000000
J	0.022100	0.958160	0.000000
SX	0.453000	0.774000	0.000000
SY	0.042300	0.731900	0.000000

STEEL MEMBER PROPERTY COEFFICIENTS FOR IX BETWEEN 1550.0 AND 12100.0

PROPERTY	CONSTANT 1	POWER	CONSTANT 2
IY	0.026510	1.000000	20.470000
A	0.500800	0.487160	0.000000
J	0.012422	0.905160	0.000000
SX	0.046150	1.000000	78.462000
SY	0.004120	1.000000	7.640000

STEEL MEMBER PROPERTY COEFFICIENTS FOR IX BETWEEN 12100.0 AND 20000.0

PROPERTY	CONSTANT 1	POWER	CONSTANT 2
IY	0.051820	1.000000	159.080000
A	0.500800	0.487160	0.000000
J	0.012422	0.905160	0.000000
SX	0.052000	1.000000	56.000000
SY	0.007550	1.000000	0.566000

FREQUENCY CONSTRAINTS

0.000	0.000
0.000	0.000
0.000	0.000
0.000	0.000

DYNAMIC DISPLACEMENT CONSTPAINTS

LEVEL	DIPECTION	VALUE
2	X	0.900000
2	Y	0.900000
1	X	0.600000
1	Y	0.600000

RESPONSE SPECTRUM COEFFICIENTS FOR Z ACCELERATION BETWEEN 0.000 AND 0.400

MAX. ACC.	CONSTANT 1	CONSTANT 2	CONSTANT 3	CONSTANT 4	CONSTANT 5	CONSTANT 6
0.000	0.0000	0.0000	-26.1419	13.9368	0.9352	0.0000

RESPONSE SPECTRUM COEFFICIENTS FOR Z ACCELERATION BETWEEN 0.400 AND 3.000

MAX. ACC.	CONSTANT 1	CONSTANT 2	CONSTANT 3	CONSTANT 4	CONSTANT 5	CONSTANT 6
0.000	0.1606	-1.1409	2.9961	-3.6187	2.2297	0.0000

RESPONSE SPECTRUM COEFFICIENTS FOR Z ACCELERATION BETWEEN 3.000 AND 100.000

MAX. ACC.	CONSTANT 1	CONSTANT 2	CONSTANT 3	CONSTANT 4	CONSTANT 5	CONSTANT 6
0.000	0.0000	0.0000	0.0000	0.0000	0.3600	0.0000

RESPONSE SPECTRUM COEFFICIENTS FOR X ACCELERATION BETWEEN 0.000 AND 0.400

MAX. ACC.	CONSTANT 1	CONSTANT 2	CONSTANT 3	CONSTANT 4	CONSTANT 5	CONSTANT 6
115.920	0.0000	0.0000	-26.1419	13.9368	0.9352	0.0000

RESPONSE SPECTRUM COEFFICIENTS FOR X ACCELERATION BETWEEN 0.400 AND 3.000

MAX. ACC.	CONSTANT 1	CONSTANT 2	CONSTANT 3	CONSTANT 4	CONSTANT 5	CONSTANT 6
115.920	0.1606	-1.1409	2.9961	-3.6187	2.2297	0.0000

RESPONSE SPECTRUM COEFFICIENTS FOR X ACCELERATION BETWEEN 3.000 AND 100.000

MAX. ACC.	CONSTANT 1	CONSTANT 2	CONSTANT 3	CONSTANT 4	CONSTANT 5	CONSTANT 6
115.920	0.0000	0.0000	0.0000	0.0000	0.3600	0.0000

RESPONSE SPECTRUM COEFFICIENTS FOR Y ACCELERATION BETWEEN 0.000 AND 0.400

MAX. ACC.	CONSTANT 1	CONSTANT 2	CONSTANT 3	CONSTANT 4	CONSTANT 5	CONSTANT 6
115.920	0.0000	0.0000	-26.1419	13.9368	0.9352	0.0000

RESPONSE SPECTRUM COEFFICIENTS FOR Y ACCELERATION BETWEEN 0.400 AND 3.000

MAX. ACC.	CONSTANT 1	CONSTANT 2	CONSTANT 3	CONSTANT 4	CONSTANT 5	CONSTANT 6
115.920	0.1606	-1.1409	2.9961	-3.6187	2.2297	0.0000

RESPONSE SPECTRUM COEFFICIENTS FOR Y ACCELERATION BETWEEN 3.000 AND 100.000

MAX. ACC.	CONSTANT 1	CONSTANT 2	CONSTANT 3	CONSTANT 4	CONSTANT 5	CONSTANT 6
115.920	0.0000	0.0000	0.0000	0.0000	0.3600	0.0000

STORY DATA

LEVEL NO.	ID	HEIGHT	MASS(M)	MR**2	X(M)	Y(M)	K-X	K-Y
2	FIRST	144.00	0.08	745.30	120.00	120.00	0.00	0.00
1	SECND	144.00	0.08	745.30	120.00	120.00	0.00	0.00

STATIC LATERAL LOADS...CASES A AND B

LEVEL NO.	FX-A	FY-A	MOM-A	FX-B	FY-B	MOM-B	XA	YA	XB	YB
2	20.00	20.00	0.00	0.00	0.00	0.00	120.0	120.0	0.0	0.0
1	20.00	20.00	0.00	0.00	0.00	0.00	120.0	120.0	0.0	0.0

STATIC VERTICAL NODAL LOAD

STORY	COL 1	COL 2	COL 3	COL 4
2	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00

LUMP MASS FOR GEOMETRIC STIFFNESS

STORY	COL 1	COL 2	COL 3	COL 4
2	0.0000	0.0000	0.0000	0.0000
1	0.0000	0.0000	0.0000	0.0000

COLUMN LINE COORDINATES

LINE	X	Y
1	0.00	0.00
2	240.00	0.00
3	240.00	240.00
4	0.00	240.00

COLUMN ID	E	A	TORS I	MAJ I	MIN I	DT	DB	D	BF	TF	TW	TS	CS	SS
1	30000.00	42.27	47.14	9000.00	259.06	0.00	0.00	36.45	11.59	0.50	0.50	30.00	30.00	24.00
2	30000.00	42.27	47.14	9000.00	259.06	0.00	0.00	36.45	11.59	0.50	0.50	30.00	30.00	24.00
3	30000.00	42.27	47.14	9000.00	259.06	0.00	0.00	36.45	11.59	0.50	0.50	30.00	30.00	24.00
4	30000.00	42.27	47.14	9000.00	259.06	0.00	0.00	36.45	11.59	0.50	0.50	30.00	30.00	24.00
5	30000.00	42.27	47.14	9000.00	259.06	0.00	0.00	36.45	11.59	0.50	0.50	30.00	30.00	24.00
6	30000.00	42.27	47.14	9000.00	259.06	0.00	0.00	36.45	11.59	0.50	0.50	30.00	30.00	24.00
7	30000.00	42.27	47.14	9000.00	259.06	0.00	0.00	36.45	11.59	0.50	0.50	30.00	30.00	24.00
8	30000.00	42.27	47.14	9000.00	259.06	0.00	0.00	36.45	11.59	0.50	0.50	30.00	30.00	24.00

COLUMN STRESS AND SIDE CONSTRAINT INFORMATION

COLUMN ID	STS	SCS	DTS	DCS	MIN. IX	MAX. IX
1	30.00	30.00	9999.00	9999.00	10.00	20000.00
2	30.00	30.00	9999.00	9999.00	10.00	20000.00
3	30.00	30.00	9999.00	9999.00	10.00	20000.00
4	30.00	30.00	9999.00	9999.00	10.00	20000.00
5	30.00	30.00	9999.00	9999.00	10.00	20000.00
6	30.00	30.00	9999.00	9999.00	10.00	20000.00
7	30.00	30.00	9999.00	9999.00	10.00	20000.00
8	30.00	30.00	9999.00	9999.00	10.00	20000.00

BEAM ID	E	TORS I	FLEX I	KII	KJJ	KIJ	DI	DJ	D	NS
1	30000.00	47.14	9000.00	4.00	4.00	2.00	0.00	0.00	36.45	70.00

2	30000.00	47.14	9000.00	4.00	4.00	2.00	0.00	0.00	36.45	70.00
3	30000.00	47.14	9000.00	4.00	4.00	2.00	0.00	0.00	36.45	70.00
4	30000.00	47.14	9000.00	4.00	4.00	2.00	0.00	0.00	36.45	70.00
5	30000.00	47.14	9000.00	4.00	4.00	2.00	0.00	0.00	36.45	70.00
6	30000.00	47.14	9000.00	4.00	4.00	2.00	0.00	0.00	36.45	70.00
7	30000.00	47.14	9000.00	4.00	4.00	2.00	0.00	0.00	36.45	70.00
8	30000.00	47.14	9000.00	4.00	4.00	2.00	0.00	0.00	36.45	70.00

BEAM STRESS AND SIDE CONSTRAINT INFORMATION

BEAM ID	SBS	DBS	MIN. I	MAX. I
1	70.00	9999.00	10.00	20000.00
2	70.00	9999.00	10.00	20000.00
3	70.00	9999.00	10.00	20000.00
4	70.00	9999.00	10.00	20000.00
5	70.00	9999.00	10.00	20000.00
6	70.00	9999.00	10.00	20000.00
7	70.00	9999.00	10.00	20000.00
8	70.00	9999.00	10.00	20000.00

BEAM LOCATIONS

BAY	LEVEL	IC	JC	BID	GEN	VLC1	VLC2	VLC3
1	2	1	2	1	0	0	0	0
1	1	1	2	2	0	0	0	0
2	2	4	3	3	0	0	0	0
2	1	4	3	4	0	0	0	0
3	2	1	4	5	0	0	0	0
3	1	1	4	6	0	0	0	0
4	2	2	3	7	0	0	0	0
4	1	2	3	8	0	0	0	0

BEAM PROPERTY SET ID NUMBER

STORY	BAY 1	BAY 2	BAY 3	BAY 4
2	1	3	5	7
1	2	4	6	8

COLUMN LOCATIONS

LINE	LEVEL	CID	HDIR	GEN
1	2	1	4	0
1	1	2	4	0
2	2	3	3	0
2	1	4	3	0
3	2	5	2	0
3	1	6	2	0
4	2	7	1	0
4	1	8	1	0

COLUMN PROPERTY SET ID NUMBER

STORY	COL 1	COL 2	COL 3	COL 4
2	1	3	5	7
1	2	4	6	8

BEAM PROPERTIES AND LOAD SET NUMBERS

BAY NUMBER 1

LEVEL	E	TORS I	FLEX I	KII	KJJ	KIJ	DI	DJ	D	NS	VLC1	VLC2	VLC3
2	30000.00	47.14	9000.00	4.00	4.00	2.00	0.00	0.00	36.45	70.00	0	0	0
1	30000.00	47.14	9000.00	4.00	4.00	2.00	0.00	0.00	36.45	70.00	0	0	0

BAY NUMBER 2

LEVEL	E	TORS I	FLEX I	KII	KJJ	KIJ	DI	DJ	D	NS	VLC1	VLC2	VLC3
2	30000.00	47.14	9000.00	4.00	4.00	2.00	0.00	0.00	36.45	70.00	0	0	0
1	30000.00	47.14	9000.00	4.00	4.00	2.00	0.00	0.00	36.45	70.00	0	0	0

BAY NUMBER 3

LEVEL	E	TORS I	FLEX I	KII	KJJ	KIJ	DI	DJ	D	NS	VLC1	VLC2	VLC3
2	30000.00	47.14	9000.00	4.00	4.00	2.00	0.00	0.00	36.45	70.00	0	0	0
1	30000.00	47.14	9000.00	4.00	4.00	2.00	0.00	0.00	36.45	70.00	0	0	0

BAY NUMBER 4

LEVEL	E	TORS I	FLEX I	KII	KJJ	KIJ	DI	DJ	D	NS	VLC1	VLC2	VLC3
2	30000.00	47.14	9000.00	4.00	4.00	2.00	0.00	0.00	36.45	70.00	0	0	0
1	30000.00	47.14	9000.00	4.00	4.00	2.00	0.00	0.00	36.45	70.00	0	0	0

COLUMN PROPERTIES

COLUMN LINE NO. 1

LEVEL	E	A	TORS I	MAJ I	MIN I	DT	DB	D	BF	TF	TW	TS	CS	SS
2	30000.00	42.27	47.14	9000.00	259.06	0.00	0.00	36.45	11.59	0.50	0.50	30.00	30.00	24.00
1	30000.00	42.27	47.14	9000.00	259.06	0.00	0.00	36.45	11.59	0.50	0.50	30.00	30.00	24.00

COLUMN LINE NO. 2

LEVEL	E	A	TORS I	MAJ I	MIN I	DT	DB	D	BF	TF	TW	TS	CS	SS
2	30000.00	42.27	47.14	9000.00	259.06	0.00	0.00	36.45	11.59	0.50	0.50	30.00	30.00	24.00
1	30000.00	42.27	47.14	9000.00	259.06	0.00	0.00	36.45	11.59	0.50	0.50	30.00	30.00	24.00

COLUMN LINE NO. 3

LEVEL	E	A	TORS I	MAJ I	MIN I	DT	DB	D	BF	TF	TW	TS	CS	SS
2	30000.00	42.27	47.14	9000.00	259.06	0.00	0.00	36.45	11.59	0.50	0.50	30.00	30.00	24.00
1	30000.00	42.27	47.14	9000.00	259.06	0.00	0.00	36.45	11.59	0.50	0.50	30.00	30.00	24.00

COLUMN LINE NO. 4

LEVEL	E	A	TORS I	MAJ I	MIN I	DT	DB	D	BF	TF	TW	TS	CS	SS
2	30000.00	42.27	47.14	9000.00	259.06	0.00	0.00	36.45	11.59	0.50	0.50	30.00	30.00	24.00
1	30000.00	42.27	47.14	9000.00	259.06	0.00	0.00	36.45	11.59	0.50	0.50	30.00	30.00	24.00

DYNAMIC LOAD COMBINATION (MULTIPLIER)

VLC1	VLC2	VLC3	LAT1	LAT2	MOD1
0.0	0.0	0.0	0.0	1.0	0.0

THE EIGENSOLUTIONS ARE:

FREQ. 1 IS 19.50

THE EIGENMODE IS:

0.870419302828E-02 -0.870419302836E-02 -0.870419302828E-02 0.870419302836E-02 0.680405960618E-02 -0.680405960624E-02
-0.680405960618E-02 0.680405960624E-02 0.247571549358E+01 -0.113106546263E-15 -0.183353747869E-18 0.151312363323E+01
-0.106772678165E-13 -0.872659502477E-19

FREQ. 2 IS 51.07

THE EIGENMODE IS:

-0.195489025862E-01 0.195489025862E-01 0.195489025866E-01 -0.195489025866E-01 -0.113105038006E-01 0.113105038006E-01
0.113105038009E-01 -0.113105038009E-01 -0.157002934562E+01 -0.200987708516E-14 0.249314049756E-15 0.238580770748E+01
-0.908429358984E-15 -0.259769184516E-15

FREQ. 3 IS 72.46

THE EIGENMODE IS:

-0.102992774995E+00 0.102992774995E+00 -0.102992774995E+00 0.102992774995E+00 -0.737127534161E-01 0.737127534162E-01
-0.737127534162E-01 0.737127534161E-01 0.415087456688E-16 -0.390988390826E-13 0.207834873310E-01 -0.163305282336E-16
-0.692148132305E-13 0.958531603752E-02

FREQ. 4 IS 73.56

THE EIGENMODE IS:

0.122676520215E+00 0.122676520215E+00 -0.122676520215E+00 -0.122676520215E+00 0.875900670464E-01 0.875900670464E-01
-0.875900670464E-01 -0.875900670464E-01 0.509500460094E-14 0.265118647121E+01 0.779490712125E-15 0.565060134751E-14
0.119688660478E+01 -0.398318113058E-15

LOAD COMBINATIONS-----MEMBER FORCES-----LEVEL NO. 1

COLUMN FORCES

LINE	LOAD	TORSIONAL MOMENT	MAJOR AXIS TOP MOMENT	MAJOR AXIS BOT MOMENT	AXIAL FORCE	MINOR AXIS TOP MOMENT	MINOR AXIS BOT MOMENT	MAJOR SHEAR	MINOR SHEAR
1	1	0.0000	560.3377	1168.5196	27.8509	-1279.1362	-1311.9867	12.0060	-17.9939

2	1	0.0000	560.3377	1168.5196	27.8509	-1279.1362	-1311.9867	12.0060	-17.9939
3	1	0.0000	560.3377	1168.5196	27.8509	-1279.1362	-1311.9867	12.0060	-17.9939
4	1	0.0000	560.3377	1168.5196	27.8509	-1279.1362	-1311.9867	12.0060	-17.9939

COLUMN STRESSES

LINE	LOAD	TOP-MAX	TOP-MIN	BOT-MAX	BOT-MIN	SHEAR-MAJ	SHEAR-MIN
1	1	30.3969	-29.0790	32.3630	-31.0452	0.2840	-0.4257
2	1	30.3969	-29.0790	32.3630	-31.0452	0.2840	-0.4257
3	1	30.3969	-29.0790	32.3630	-31.0452	0.2840	-0.4257
4	1	30.3969	-29.0790	32.3630	-31.0452	0.2840	-0.4257

BEAM FORCES

		TORSIONAL	CENTERLINE MOMENTS		BEAM END MOMENTS	
BAY	LOAD	MOMENT	I MOMENT	J MOMENT	I MOMENT	J MOMENT
1	1	0.0000	-2054.2607	-2054.2607	-2054.2607	-2054.2607
2	1	0.0000	-2054.2607	-2054.2607	-2054.2607	-2054.2607
3	1	0.0000	-1094.7275	-1094.7275	-1094.7275	-1094.7275
4	1	0.0000	-1094.7275	-1094.7275	-1094.7275	-1094.7275

BEAM STRESSES

BAY	LOAD	I NORMAL	J NORMAL
1	1	4.1600	4.1600
2	1	4.1600	4.1600
3	1	2.2169	2.2169
4	1	2.2169	2.2169

LOAD COMBINATIONS-----MEMBER FORCES-----LEVEL NO. 2

COLUMN FORCES

LINE	LOAD	TORSIONAL	MAJOR AXIS		AXIAL	MINOR AXIS		MAJOR	MINOR
		MOMENT	TOP MOMENT	BOT MOMENT	FORCE	TOP MOMENT	BOT MOMENT	SHEAR	SHEAR
1	1	0.0000	734.5104	534.3898	8.7694	-795.2576	-775.1244	8.8118	-10.9054
2	1	0.0000	734.5104	534.3898	8.7694	-795.2576	-775.1244	8.8118	-10.9054
3	1	0.0000	734.5104	534.3898	8.7694	-795.2576	-775.1244	8.8118	-10.9054
4	1	0.0000	734.5104	534.3898	8.7694	-795.2576	-775.1244	8.8118	-10.9054

COLUMN STRESSES

LINE	LOAD	TOP-MAX	TOP-MIN	BOT-MAX	BOT-MIN	SHEAR-MAJ	SHEAR-MIN
1	1	19.4779	-19.0630	18.6225	-18.2075	0.2085	-0.2580
2	1	19.4779	-19.0630	18.6225	-18.2075	0.2085	-0.2580
3	1	19.4779	-19.0630	18.6225	-18.2075	0.2085	-0.2580
4	1	19.4779	-19.0630	18.6225	-18.2075	0.2085	-0.2580

BEAM FORCES

		TORSIONAL	CENTERLINE MOMENTS		BEAM END MOMENTS	
BAY	LOAD	MOMENT	I MOMENT	J MOMENT	I MOMENT	J MOMENT
1	1	0.0000	-795.2576	-795.2576	-795.2576	-795.2576
2	1	0.0000	-795.2576	-795.2576	-795.2576	-795.2576
3	1	0.0000	-734.5104	-734.5104	-734.5104	-734.5104
4	1	0.0000	-734.5104	-734.5104	-734.5104	-734.5104

BEAM STRESSES

BAY	LOAD	I NORMAL	J NORMAL
1	1	1.6104	1.6104

2	1	1.6104	1.6104
3	1	1.4874	1.4874
4	1	1.4874	1.4874

STATIC AND DYNAMIC LOAD COMBINATION-----LATERAL AND ROTATIONAL M. C. DISPLACEMENTS

LEVEL	DIRECTION	1
2	X	0.9775856
2	Y	0.0503746
2	ROTN	0.0000000
1	X	0.5980284
1	Y	0.0227418
1	ROTN	0.0000000

THE STEEL WEIGHT IS 36.8202

THE CONCRETE WEIGHT IS 0.0000

THE OBJECTIVE VALUE IS 36.8202

ACTIVE CONSTRAINTS

TYPE	LEVEL	LOCATION	LOAD	IDENT	VALUE
D.DIS__________	2	0	1	1	0.97759
D.DIS__________	1	0	1	1	0.59803

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THE END OF OPTIMIZATION CYCLE 0 .

THE START OF OPTIMIZATION CYCLE 1 .

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COLUMN ID	E	A	TORS I	MAJ I	MIN I	DT	DB	D	BF	TF	TW	TS	CS	SS
1	30000.00	39.05	40.69	7648.98	223.24	0.00	0.00	35.46	11.40	0.50	0.50	30.00	30.00	24.00
2	30000.00	45.89	54.92	10653.29	302.89	0.00	0.00	37.37	11.76	0.50	0.50	30.00	30.00	24.00
3	30000.00	39.04	40.66	7644.06	223.11	0.00	0.00	35.45	11.40	0.50	0.50	30.00	30.00	24.00
4	30000.00	45.78	54.69	10604.55	301.60	0.00	0.00	37.35	11.75	0.50	0.50	30.00	30.00	24.00
5	30000.00	39.05	40.69	7648.98	223.24	0.00	0.00	35.46	11.40	0.50	0.50	30.00	30.00	24.00
6	30000.00	45.89	54.92	10653.29	302.89	0.00	0.00	37.37	11.76	0.50	0.50	30.00	30.00	24.00
7	30000.00	39.04	40.66	7644.06	223.11	0.00	0.00	35.45	11.40	0.50	0.50	30.00	30.00	24.00
8	30000.00	45.78	54.69	10604.55	301.60	0.00	0.00	37.35	11.75	0.50	0.50	30.00	30.00	24.00

BEAM ID	E	TORS I	FLEX I	KII	KJJ	KIJ	DI	DJ	D	MS
1	30000.00	23.10	4092.56	4.00	4.00	2.00	0.00	0.00	30.62	70.00
2	30000.00	26.64	4791.36	4.00	4.00	2.00	0.00	0.00	31.99	70.00
3	30000.00	23.10	4092.56	4.00	4.00	2.00	0.00	0.00	30.62	70.00
4	30000.00	26.64	4791.36	4.00	4.00	2.00	0.00	0.00	31.99	70.00
5	30000.00	22.52	3979.23	4.00	4.00	2.00	0.00	0.00	30.36	70.00
6	30000.00	23.64	4198.77	4.00	4.00	2.00	0.00	0.00	30.85	70.00
7	30000.00	22.52	3979.23	4.00	4.00	2.00	0.00	0.00	30.36	70.00
8	30000.00	23.64	4198.77	4.00	4.00	2.00	0.00	0.00	30.85	70.00

THE EIGENSOLUTIONS ARE:

FREQ. 1 IS 20.49

THE EIGENMODE IS:

0.891637384258E-02 -0.893187682823E-02 -0.891637384255E-02 0.893187682820E-02 0.665768873881E-02 -0.667249274348E-02
-0.665768873879E-02 0.667249274346E-02 0.269154945822E+01 -0.109524691125E-04 -0.538285531579E-14 0.140873690117E+01
-0.333092315253E-05 -0.212242934901E-14

FREQ. 2 IS 51.36

THE EIGENMODE IS:

-0.148667286265E-01 0.148864138929E-01 0.148667286265E-01 -0.148864138929E-01 -0.722042908854E-02 0.723728838285E-02
0.722042908856E-02 -0.723728838287E-02 -0.147843456606E+01 0.293819469589E-04 -0.599701436520E-15 0.256455694403E+01
0.102061568314E-04 0.127636420565E-14

FREQ. 3 IS 65.24

THE EIGENMODE IS:

0.774388112126E-01 0.775637490004E-01 -0.774388112126E-01 -0.775637490004E-01 0.506401532383E-01 0.507554082226E-01
-0.506401532383E-01 -0.507554082226E-01 0.260407738320E-04 0.284395526195E+01 -0.214690468296E-15 -0.212390576749E-04
0.110032987374E+01 -0.841725630297E-16

FREQ. 4 IS 67.65

THE EIGENMODE IS:

-0.645751134910E-01 0.646800929398E-01 -0.645751134908E-01 0.646800929396E-01 -0.419342956755E-01 0.420306245481E-01
-0.419342956758E-01 0.420306245485E-01 0.624045719438E-12 0.262775089393E-13 0.232061180657E-01 0.326541266515E-12
0.102101237674E-13 0.917091681091E-02

LOAD COMBINATIONS-----MEMBER FORCES-----LEVEL NO. 1

COLUMN FORCES

LINE	LOAD	TORSIONAL MOMENT	MAJOR AXIS TOP MOMENT	MAJOR AXIS BOT MOMENT	AXIAL FORCE	MINOR AXIS TOP MOMENT	MINOR AXIS BOT MOMENT	MAJOR SHEAR	MINOR SHEAR
1	1	0.0000	248.9221	1337.3682	24.6404	-1137.9263	-1203.5785	11.0159	-16.2604
2	1	0.0000	248.5042	1331.6098	24.6404	-1133.8806	-1198.8484	10.9730	-16.1995
3	1	0.0000	248.8710	1337.3426	24.6404	-1137.9157	-1203.5732	11.0154	-16.2603
4	1	0.0000	248.5552	1331.6353	24.6404	-1133.8701	-1198.8431	10.9735	-16.1994

COLUMN STRESSES

LINE	LOAD	TOP-MAX	TOP-MIN	BOT-MAX	BOT-MIN	SHEAR-MAJ	SHEAR-MIN
1	1	23.0557	-21.9818	26.2389	-25.1650	0.2401	-0.3544
2	1	23.0655	-21.9891	26.2385	-25.1621	0.2397	-0.3538
3	1	23.0554	-21.9815	26.2388	-25.1648	0.2401	-0.3544
4	1	23.0654	-21.9890	26.2384	-25.1621	0.2397	-0.3538

BEAM FORCES

BAY	LOAD	TORSIONAL MOMENT	CENTERLINE MOMENTS I MOMENT	CENTERLINE MOMENTS J MOMENT	BEAM END MOMENTS I MOMENT	BEAM END MOMENTS J MOMENT
1	1	0.0001	-1865.6129	-1861.7582	-1865.6129	-1861.7582
2	1	-0.0001	-1861.7356	-1865.5902	-1861.7356	-1865.5902
3	1	-0.0038	-772.1616	-772.0699	-772.1616	-772.0699
4	1	0.0039	-771.9369	-772.0286	-771.9369	-772.0286

BEAM STRESSES

BAY	LOAD	I NORMAL	J NORMAL
1	1	6.2274	6.2145
2	1	6.2144	6.2273
3	1	2.8364	2.8360
4	1	2.8356	2.8359

LOAD COMBINATIONS-----MEMBER FORCES-----LEVEL NO. 2

COLUMN FORCES

LINE	LOAD	TORSIONAL MOMENT	MAJOR AXIS TOP MOMENT	MAJOR AXIS BOT MOMENT	AXIAL FORCE.	MINOR AXIS TOP MOMENT	MINOR AXIS BOT MOMENT	MAJOR SHEAR	MINOR SHEAR
1	1	0.0000	630.9762	523.2396	8.0631	-753.2510	-727.6904	8.0154	-10.2643
2	1	0.0000	630.8500	523.4325	8.0632	-753.1312	-727.8738	8.0159	-10.2648
3	1	0.0000	630.8674	523.1577	8.0631	-753.2385	-727.6783	8.0141	-10.2641
4	1	0.0000	630.9588	523.5145	8.0632	-753.1187	-727.8617	8.0172	-10.2846

COLUMN STRESSES

LINE	LOAD	TOP-MAX	TOP-MIN	BOT-MAX	BOT-MIN	SHEAR-MAJ	SHEAR-MIN
1	1	20.9072	-20.4942	20.0046	-19.5916	0.2053	-0.2634
2	1	20.9146	-20.5015	20.0201	-19.6070	0.2053	-0.2635
3	1	20.9066	-20.4936	20.0041	-19.5912	0.2052	-0.2634
4	1	20.9146	-20.5014	20.0200	-19.6069	0.2054	-0.2635

BEAM FORCES

		TORSIONAL	CENTERLINE MOMENTS		BEAM END MOMENTS	
BAY	LOAD	MOMENT	I MOMENT	J MOMENT	I MOMENT	J MOMENT
1	1	0.0000	-753.2509	-753.1314	-753.2509	-753.1314
2	1	0.0000	-753.1187	-753.2383	-753.1187	-753.2383
3	1	-0.0001	-630.9762	-630.9589	-630.9762	-630.9589
4	1	0.0002	-630.8500	-630.8673	-630.8500	-630.8673

BEAM STRESSES

BAY	LOAD	I NORMAL	J NORMAL
1	1	2.8176	2.8172
2	1	2.8171	2.8176
3	1	2.4074	2.4073
4	1	2.4069	2.4069

STATIC AND DYNAMIC LOAD COMBINATION-----LATERAL AND ROTATIONAL M. C. DISPLACEMENTS

LEVEL	DIRECTION	1
2	X	0.9199636
2	Y	0.0677994
2	ROTN	0.0000000
1	X	0.4827363
1	Y	0.0262317
1	ROTN	0.0000000

THE STEEL WEIGHT IS 29.8483

THE CONCRETE WEIGHT IS 0.0000

THE OBJECTIVE VALUE IS 29.8483

ACTIVE CONSTRAINTS

TYPE	LEVEL	LOCATION	LOAD	IDENT	VALUE
D.DIS	2	0	1	1	0.91996
D.DIS	1	0	1	1	0.48274

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THE END OF OPTIMIZATION CYCLE 1 .

THE START OF OPTIMIZATION CYCLE 2 .

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THE END OF OPTIMIZATION CYCLE 8 .

THE START OF OPTIMIZATION CYCLE 9 .

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THE FINAL OPTIMAL RESULTS ARE:

COLUMN ID	E	A	TORS I	MAJ I	MIN I	DT	DB	D	BF	TF	TW	TS	CS	SS
1	30000.00	19.06	10.73	1754.63	66.99	0.00	0.00	22.01	9.01	0.50	0.50	30.00	30.00	24.00
2	30000.00	37.42	37.58	7006.95	206.22	0.00	0.00	34.87	11.30	0.50	0.50	30.00	30.00	24.00
3	30000.00	19.85	11.58	1907.85	71.05	0.00	0.00	22.92	9.17	0.50	0.50	30.00	30.00	24.00
4	30000.00	25.95	19.04	3305.33	108.09	0.00	0.00	28.62	10.17	0.50	0.50	30.00	30.00	24.00
5	30000.00	19.40	11.09	1819.12	68.69	0.00	0.00	22.40	9.08	0.50	0.50	30.00	30.00	24.00
6	30000.00	25.52	18.46	3193.68	105.13	0.00	0.00	28.28	10.11	0.50	0.50	30.00	30.00	24.00
7	30000.00	19.31	10.99	1802.12	68.24	0.00	0.00	22.30	9.06	0.50	0.50	30.00	30.00	24.00
8	30000.00	25.45	18.37	3177.61	104.71	0.00	0.00	28.23	10.10	0.50	0.50	30.00	30.00	24.00

BEAM ID	E	TORS I	FLEX I	KII	KJJ	KIJ	DI	DJ	D	MS
1	30000.00	3.61	204.09	4.00	4.00	2.00	0.00	0.00	14.69	70.00
2	30000.00	12.42	741.22	4.00	4.00	2.00	0.00	0.00	19.66	70.00
3	30000.00	3.52	199.01	4.00	4.00	2.00	0.00	0.00	14.60	70.00
4	30000.00	10.57	626.22	4.00	4.00	2.00	0.00	0.00	18.92	70.00
5	30000.00	0.30	15.35	4.00	4.00	2.00	0.00	0.00	8.18	70.00
6	30000.00	0.51	26.26	4.00	4.00	2.00	0.00	0.00	9.24	70.00
7	30000.00	0.31	15.58	4.00	4.00	2.00	0.00	0.00	8.21	70.00
8	30000.00	0.50	26.06	4.00	4.00	2.00	0.00	0.00	9.22	70.00

EIGENVALUES AND EIGENVECTORS

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 0.160489113947E+03  0.447428079880E-02 -0.570604800240E-02 -0.536909596101E-02  0.539579112468E-02  0.290071926717E-02
-0.419089808628E-02 -0.379417561046E-02  0.381008288758E-02  0.317422567347E+01 -0.166022664703E-01 -0.470291366208E-03
 0.125285029271E+01 -0.620183381812E-02 -0.191173934114E-03

 0.577748944478E+03  0.218699319209E-02 -0.534636299199E-03  0.798908975281E-04 -0.229667739362E-02  0.124104114236E-02
-0.470491658327E-03  0.191500401081E-03 -0.153930186596E-02  0.526088755678E-01  0.317444185824E+01  0.797852181680E-02
-0.428167145761E-01  0.906351597348E+00  0.272224391173E-02

 0.100969827649E+04  0.597437469504E-02 -0.763009790920E-02  0.192924929505E-02 -0.133033092984E-02  0.267730853633E-02
-0.420410150184E-02  0.219339741035E-02 -0.185802576540E-02  0.650852291961E+00 -0.810083259345E+00  0.262938966843E-01
-0.139961400635E+01 -0.167518564680E+00  0.752488556357E-02

 0.107135349172E+04 -0.217770524447E-02  0.149574958500E-02  0.812295869640E-02 -0.788147572521E-02  0.674135510432E-03
-0.112348085759E-02  0.381558013830E-02 -0.367388453168E-02 -0.113895120206E+01 -0.362351575624E+00  0.140970888527E-01
 0.268982906760E+01 -0.716034401920E-01  0.385517465293E-02
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STATIC LOAD COMBINATION-----MEMBER FORCES-----LEVEL NO. 1

COLUMN FORCES

LINE	LOAD	TORSIONAL MOMENT	MAJOR AXIS TOP MOMENT	MAJOR AXIS BOT MOMENT	AXIAL FORCE	MINOR AXIS TOP MOMENT	MINOR AXIS BOT MOMENT	MAJOR SHEAR	MINOR SHEAR
1	1	2.0889	-824.1856	2621.6705	6.8810	-531.1919	-676.3302	12.4825	-8.3856
2	1	1.0582	-1315.6553	3069.7034	6.6554	-344.8037	-387.6917	12.1809	-5.0868
3	1	1.0258	-1258.5435	2972.3562	5.8925	-206.3345	-239.5181	11.9015	-3.0962
4	1	1.0211	-704.7716	1023.4085	6.1063	-205.9569	-238.7767	2.2128	-3.0884

COLUMN STRESSES

LINE	LOAD	TOP-MAX	TOP-MIN	BOT-MAX	BOT-MIN	SHEAR-MAJ	SHEAR-MIN
1	1	16.7847	-16.4169	25.2334	-24.8656	0.3336	-0.2241
2	1	22.1719	-21.6589	31.7826	-31.2696	0.4695	-0.1960
3	1	15.7243	-15.2624	24.9081	-24.4462	0.4664	-0.1213
4	1	13.3051	-12.8253	16.3036	-15.8238	0.0869	-0.1213

BEAM FORCES

BAY	LOAD	TORSIONAL MOMENT	CENTERLINE MOMENTS I MOMENT	CENTERLINE MOMENTS J MOMENT	BEAM END MOMENTS I MOMENT	BEAM END MOMENTS J MOMENT
1	1	-1.2449	-803.2554	-666.7121	0.0000	0.0000
2	1	-0.9906	-354.0454	-354.8682	0.0000	0.0000
3	1	-0.0237	-24.0854	-24.9060	0.0000	0.0000
4	1	-0.0049	-62.1952	-62.1641	0.0000	0.0000

BEAM STRESSES

BAY	LOAD	I NORMAL	J NORMAL
1	1	10.6516	8.8410
2	1	5.3493	5.3617
3	1	4.2380	4.3824
4	1	11.0075	11.0020

STATIC LOAD COMBINATION-----MEMBER FORCES-----LEVEL NO. 2

COLUMN FORCES

LINE	LOAD	TORSIONAL MOMENT	MAJOR AXIS TOP MOMENT	MAJOR AXIS BOT MOMENT	AXIAL FORCE	MINOR AXIS TOP MOMENT	MINOR AXIS BOT MOMENT	MAJOR SHEAR	MINOR SHEAR
1	1	1.2750	25.8315	847.0261	2.0343	-272.7681	-272.0872	6.0615	-3.7837
2	1	1.3753	57.0806	1379.0954	1.9091	-290.5239	-321.9133	9.9734	-4.2530
3	1	1.3173	57.0831	1321.6983	1.8901	-142.7534	-148.5289	9.5749	-2.0228
4	1	1.3061	25.5940	728.6870	1.9855	-142.3890	-148.0648	5.2381	-2.0170

COLUMN STRESSES

LINE	LOAD	TOP-MAX	TOP-MIN	BOT-MAX	BOT-MIN	SHEAR-MAJ	SHEAR-MIN
1	1	18.6134	-18.3999	23.7181	-23.5047	0.3180	-0.1985
2	1	19.1820	-18.9897	29.1467	-28.9544	0.5024	-0.2142
3	1	9.8811	-9.6862	18.0490	-17.8541	0.4936	-0.1043
4	1	9.7130	-9.5073	14.4398	-14.2341	0.2713	-0.1045

BEAM FORCES

BAY	LOAD	TORSIONAL MOMENT	CENTERLINE MOMENTS I MOMENT	CENTERLINE MOMENTS J MOMENT	BEAM END MOMENTS I MOMENT	BEAM END MOMENTS J MOMENT
1	1	-0.4592	-272.7573	-290.5077	0.0000	0.0000
2	1	-0.4593	-142.3998	-142.7695	0.0000	0.0000
3	1	-0.0108	-26.2907	-26.0532	0.0000	0.0000
4	1	-0.0162	-56.6214	-56.6239	0.0000	0.0000

BEAM STRESSES

BAY	LOAD	I NORMAL	J NORMAL
1	1	9.8145	10.4532
2	1	5.2249	5.2385
3	1	7.0096	6.9463
4	1	14.9255	14.9261

STATIC AND DYNAMIC LOAD COMBINATION-----LATERAL AND ROTATIONAL M. C. DISPLACEMENTS

LEVEL	DIRECTION	1
2	X	0.9177651
2	Y	0.6303476
2	ROTN	0.0020926
1	X	0.3768472
1	Y	0.1797925
1	ROTN	0.0006670

THE STEEL WEIGHT IS 10.9726

THE CONCRETE WEIGHT IS 0.0000

THE TOTAL WEIGHT IS 10.9726

3. Input Data of Example II

```
 1    5   3.   16    1     1     2
10   10   2.    0.1719   0.0451       .10      .05
 2   10   11   20   22     3     0    ZTWO STORY MIXED STRUCTURE
 3
   00.0     1550.0
 0.0389     0.925      0.0    0.5008    .46716      0.0    0.0221    .95816
    0.0     0.4530    .7740      0.0    0.0423     .7319
```

```
  1550.0   12100.0
 0.02651       1.0     20.47    0.5008   0.48716         0.0 0.0124215    .90516
     0.0   0.04615       1.0    78.462   0.00412         1.0      7.64
  12100.    20000.
 0.05182       1.0    159.08    0.5008   0.48716         0.0 0.0124215   0.90516
     0.0   0.05200       1.0      56.0   0.00755         1.0     0.566
 4
 1    1        .22
 1    2        .22
 2    1        .44
 2    1        .44
 3


 3    4
 1    1        .22
 1    2        .22
 2    1        .44
 2    2        .44
SECND         144.     .4076   10393.8      420.        210.
    400.      400.      000.      000.

FIRST         144.     .9058   40489.3      300.        210.
    450.      450.      000.      000.

      0.        0.        0.        0.        5.        5.        5.        5.
      5.        5.        5.        5.        5.        5.       10.       10.
     10.       10.       10.       10.



 1          0.        0.
 2          0.      120.
 3          0.      300.
 4          0.      420.
 5        240.        0.
 6        240.      210.
 7        240.      420.
 8        600.        0.
 9        600.      210.
10        600.      420.
 1          30000.      5.01            .147 200. 7.44
     8.0      5.25      .308       .23  36.00       36.0     9999.       7.0
  20000.       36.       36.     9999.
 2          30000.      5.01            .147 200. 7.44
     8.0      5.25      .308       .23  36.00       36.0     9999.       7.0
  20000.       36.       36.     9999.
 3          30000.      5.01            .147 200. 7.44
     8.0      5.25      .308       .23  36.00       36.0     9999.       7.0
  20000.       36.       36.     9999.
 4          30000.      5.01            .147 200. 7.44
     8.0      5.25      .308       .23  36.00       36.0     9999.       7.0
  20000.       36.       36.     9999.
 5          30000.      5.01            .147 200. 7.44
     8.0      5.25      .308       .23  36.00       36.0     9999.       7.0
  20000.       36.       36.     9999.
 6          30000.      5.01            .147 200. 7.44
     8.0      5.25      .308       .23  36.00       36.0     9999.       7.0
  20000.       36.       36.     9999.
 7          30000.      5.01            .147 200. 7.44
     8.0      5.25      .308       .23  36.00       36.0     9999.       7.0
  20000.       36.       36.     9999.
 8          30000.      5.01            .147 200. 7.44
     8.0      5.25      .308       .23  36.00       36.0     9999.       7.0
  20000.       36.       36.     9999.
 9          30000.      5.01            .147 200. 7.44
     8.0      5.25      .308       .23  36.00       36.0     9999.       7.0
  20000.       36.       36.     9999.
10          30000.      5.01            .147 200. 7.44
     8.0      5.25      .308       .23  36.00       36.0     9999.       7.0
  20000.       36.       36.     9999.
11          30000.      5.01            .147 200. 7.44
     8.0      5.25      .308       .23  36.00       36.0     9999.       7.0
  20000.       36.       36.     9999.
12          30000.      5.01            .147 200. 7.44
     8.0      5.25      .308       .23  36.00       36.0     9999.       7.0
  20000.       36.       36.     9999.
13          30000.      .005            .001 .002 .002
     1.0        1.        1.        1.  100.       100.      100.0      .001
     1.0     9999.     9999.     9999.
14          30000.      .005            .001 .002 .002
     1.0        1.        1.        1.  100.       100.      100.0      .001
     1.0     9999.     9999.     9999.
15          30000.      .005            .001 .002 .002
     1.0        1.        1.        1.  100.       100.      100.0      .001
     1.0     9999.     9999.     9999.
16          30000.      .005            .001 .002 .002
     1.0        1.        1.        1.  100.       100.      100.0      .001
     1.0     9999.     9999.     9999.
17    3456000000.  2880000.     4000.    4.   4.   2.  50.  3.0           1.0
   3000.      120.       20.    30000.      .025     1600.     1150.       5.0
     20.       50.        3.     9999.
18    3456000000.  2880000.     4000.    4.   4.   2.  50.  3.0           1.0
   3000.      120.       20.    30000.      .025     1600.     1150.       5.0
     20.       50.        3.     9999.
19    3456000000.  2880000.     4000.    4.   4.   2.  50.  3.0           1.0
   3000.      120.       20.    30000.      .025     1600.     1150.       5.0
     20.       50.        3.     9999.
20    3456000000.  2880000.     4000.    4.   4.   2.  50.  3.0           1.0
   3000.      120.       20.    30000.      .025     1600.     1150.       5.0
     20.       50.        3.     9999.
 1          30000. 11.8      1.12      400.    4.    4.   2.          8.2536.00
      5.    20000.      36.0
 2          30000. 11.8      1.12      400.    4.    4.   2.          8.2536.00
      5.    20000.      36.0
```

```
 3             30000. 11.8       1.12       400.   4.    4.    2.              8.2536.00
       5.      20000.      36.0
 4             30000. 11.8       1.12       400.   4.    4.    2.              8.2536.00
       5.      20000.      36.0
 5             30000. 11.8       1.12       400.   4.    4.    2.              8.2536.00
       5.      20000.      36.0
 6             30000. 11.8       1.12       400.   4.    4.    2.              8.2536.00
       5.      20000.      36.0
 7             30000. 11.8       1.12       400.   4.    4.    2.              8.2536.00
       5.      20000.      36.0
 8             30000. 11.8       1.12       400.   4.    4.    2.              8.2536.00
       5.      20000.      36.0
 9             30000. 11.8       1.12       400.   4.    4.    2.              8.2536.00
       5.      20000.      36.0
10             30000. 11.8       1.12       400.   4.    4.    2. 60.0         8.2536.00
       5.      20000.      36.0
11             30000. 11.8       1.12       400.   4.    4.    2. 60.0         8.2536.00
       5.      20000.      36.0
12             30000. 11.8       1.12       400.   4.    4.    2. 60.0         8.2536.00
       5.      20000.      36.0
13             30000. 11.8       1.12       400.   4.    4.    2. 60.0         8.2536.00
       5.      20000.      36.0
14             30000. 11.8       1.12       400.   4.    4.    2. 60.0         8.2536.00
       5.      20000.      36.0
15             30000. 11.8       1.12       400.   4.    4.    2. 60.0         8.2536.00
       5.      20000.      36.0
16             30000. 11.8       1.12       400.   4.    4.    2. 60.0         8.2536.00
       5.      20000.      36.0
17             30000. 11.8       1.12       400.   4.    4.    2. 60.0         8.2536.00
       5.      20000.      36.0
18             30000. 11.8       .001       .004   4.    4.    2.              8.2599.99
     .001         1.0      1000.
19             30000. 11.8       .001       .004   4.    4.    2.              8.2599.99
     .001         1.0      1000.
20             30000. 11.8       .001       .004   4.    4.    2.              8.2599.99
     .001         1.0      1000.
21             30000. 11.8       .001       .004   4.    4.    2.              8.2599.99
     .001         1.0      1000.
22             30000. 11.8       .001       .004   4.    4.    2.              8.2599.99
     .001         1.0      1000.
 1    1           0.         0.         0.         0.        .02
 2    1           0.         0.         0.         0.        .05
 3    1           0.         0.         0.         0.        .02
 1    1    2   18    0
 1    1    2    1    0    1    0    3
 2    6    5   10    0    1    0    3
 2    6    5   11    0    1    2    0
 3    9    8   12    0    1    0    3
 3    9    8   13    0    1    2    0
 4    2    3   19    0
 4    2    3    2    0    1    0    3
 5    3    4   20    0
 5    3    4    3    0    1    0    3
 6    6    7   14    0    1    0    3
 6    6    7   15    0    1    2    0
 7    9   10   16    0    1    0    3
 7    9   10   17    0    1    2    0
 8    1    5   21    0
 8    1    5    4    0    1    0    3
 9    4    7   22    0
 9    4    7    5    0    1    0    3
10    5    8    6    0    1    0    3
10    5    8    7    0    1    2    0
11    7   10    8    0    1    0    3
11    7   10    9    0    1    2    0
 1   13    5    0
 1    1    5    0
 2   14    3    0
 2    2    3    0
 3   15    4    0
 3    3    4    0
 4   16    7    0
 4    4    7    0
 5    5    8    0
 5    6    8    0
 6   17    7    0
 6   18    7    0
 7    7   10    0
 7    8   10    0
 8    9    5    0
 8   10    5    0
 9   19   10    0
 9   20   10    0
10   11    7    0
10   12    7    0
 1    3    2    30000.       9.00       36.0       24.0       1.0        20.
     36.0       24.0
 1    2    3    30000.       9.00       36.0       24.0       1.0        20.
     36.0       24.0
 1    3
      1.0       0.0       0.0       0.0       0.0       1.0
      1.2       1.0       1.0       1.0       0.0       1.0
      1.2       1.0       1.0       0.0       1.0       1.0
 1    1    1    1    1
 2
 5    7
 2
 2    3
 7    7    3    1    1    3    1    0    1    1    1
      8.0       6.5      600.      420.
```

4. Output Solution of Example II

DYNAMIC ANALYSIS WITH DISPLACEMENT CONSTRAINTS

```
TWO STORY MIXED STRUCTURE
NUMBER OF STORY LEVELS----   2
NUMBER OF COLUMN LINES----  10
NUMBER OF BAYS------------  11
NUMBER OF DIFF. COL. PROP-  20
NUMBER OF DIFF. BEAM PROP-  22
NUMBER OF DIFF. FEF-------   3
NUMBER OF PANEL ELEMENTS--   0
NUMBER OF BRACING ELEMENTS   2
NUMBER OF STEEL COL. PROP-  16
NUMBER OF OPT. CYCLES-----  10
NUMBER OF ANALYSES--------  10
PERCENTAGE FOR TERMINATION 2.0
PER. OF CONSTRAINT-LOWER--0.10
PER. OF CONSTRAINT-UPPER--0.05
CONVERGENCE CONTROL PARA.- 3.0
OBJECTIVE FACTOR-STEEL---- 0.2E+00
OBJECTIVE FACTOR-CONCRETE- 0.5E-01
```

STEEL MEMBER PROPERTY COEFFICIENTS FOR IX BETWEEN 0.0 AND 1550.0

PROPERTY	CONSTANT 1	POWER	CONSTANT 2
IY	0.038900	0.925000	0.000000
A	0.500800	0.487160	0.000000
J	0.022100	0.958160	0.000000
SX	0.453000	0.774000	0.000000
SY	0.042300	0.731900	0.000000

STEEL MEMBER PROPERTY COEFFICIENTS FOR IX BETWEEN 1550.0 AND 12100.0

PROPERTY	CONSTANT 1	POWER	CONSTANT 2
IY	0.026510	1.000000	20.470000
A	0.500800	0.487160	0.000000
J	0.012422	0.905160	0.000000
SX	0.046150	1.000000	78.462000
SY	0.004120	1.000000	7.640000

STEEL MEMBER PROPERTY COEFFICIENTS FOR IX BETWEEN 12100.0 AND 20000.0

PROPERTY	CONSTANT 1	POWER	CONSTANT 2
IY	0.051820	1.000000	159.080000
A	0.500800	0.487160	0.000000
J	0.012422	0.905160	0.000000
SX	0.052000	1.000000	56.000000
SY	0.007550	1.000000	0.566000

STATIC DISPLACEMENT CONSTRAINTS

LEVEL	DIRECTION	VALUE
1	X	0.220000
1	Y	0.220000
2	X	0.440000
2	X	0.440000

FREQUENCY CONSTRAINTS

0.000	0.000
0.000	0.000
0.000	0.000

DYNAMIC DISPLACEMENT CONSTRAINTS

LEVEL	DIRECTION	VALUE
1	X	0.220000
1	Y	0.220000
2	X	0.440000
2	Y	0.440000

STORY DATA

LEVEL NO.	ID	HEIGHT	MASS(M)	MR**2	X(M)	Y(M)	K-X	K-Y
2	SECND	144.00	0.41	10393.60	420.00	210.00	0.00	0.00
1	FIRST	144.00	0.91	40489.30	300.00	210.00	0.00	0.00

STATIC LATERAL LOADS...CASES A AND B

LEVEL NO.	FX-A	FY-A	MOM-A	FX-B	FY-B	MOM-B	XA	YA	XB	YB
2	400.00	400.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0
1	450.00	450.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0

STATIC VERTICAL NODAL LOAD

STORY	COL 1	COL 2	COL 3	COL 4	COL 5	COL 6	COL 7	COL 8	COL 9	COL 10
2	0.00	0.00	0.00	0.00	5.00	5.00	5.00	5.00	5.00	5.00
1	5.00	5.00	5.00	5.00	10.00	10.00	10.00	10.00	10.00	10.00

LUMP MASS FOR GEOMETRIC STIFFNESS

STORY	COL 1	COL 2	COL 3	COL 4	COL 5	COL 6	COL 7	COL 8	COL 9	COL 10
2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

COLUMN LINE COORDINATES

LINE	X	Y
1	0.00	0.00
2	0.00	120.00
3	0.00	300.00
4	0.00	420.00
5	240.00	0.00
6	240.00	210.00
7	240.00	420.00
8	600.00	0.00
9	600.00	210.00
10	600.00	420.00

COLUMN ID	E	A	TORS I	MAJ I	MIN I	DT	DB	D	BF	TF	TW	YS	CS	SS
1	30000.00	6.62	3.54	200.00	5.23	0.00	0.00	14.62	5.12	0.31	0.23	36.00	36.00	9999.00
2	30000.00	6.62	3.54	200.00	5.23	0.00	0.00	14.62	5.12	0.31	0.23	36.00	36.00	9999.00
3	30000.00	6.62	3.54	200.00	5.23	0.00	0.00	14.62	5.12	0.31	0.23	36.00	36.00	9999.00
4	30000.00	6.62	3.54	200.00	5.23	0.00	0.00	14.62	5.12	0.31	0.23	36.00	36.00	9999.00
5	30000.00	6.62	3.54	200.00	5.23	0.00	0.00	14.62	5.12	0.31	0.23	36.00	36.00	9999.00
6	30000.00	6.62	3.54	200.00	5.23	0.00	0.00	14.62	5.12	0.31	0.23	36.00	36.00	9999.00
7	30000.00	6.62	3.54	200.00	5.23	0.00	0.00	14.62	5.12	0.31	0.23	36.00	36.00	9999.00
8	30000.00	6.62	3.54	200.00	5.23	0.00	0.00	14.62	5.12	0.31	0.23	36.00	36.00	9999.00
9	30000.00	6.62	3.54	200.00	5.23	0.00	0.00	14.62	5.12	0.31	0.23	36.00	36.00	9999.00
10	30000.00	6.62	3.54	200.00	5.23	0.00	0.00	14.62	5.12	0.31	0.23	36.00	36.00	9999.00
11	30000.00	6.62	3.54	200.00	5.23	0.00	0.00	14.62	5.12	0.31	0.23	36.00	36.00	9999.00
12	30000.00	6.62	3.54	200.00	5.23	0.00	0.00	14.62	5.12	0.31	0.23	36.00	36.00	9999.00
13	30000.00	0.02	0.00	0.00	0.00	0.00	0.00	1.08	0.55	1.00	1.00	100.00	100.00	100.00
14	30000.00	0.02	0.00	0.00	0.00	0.00	0.00	1.08	0.55	1.00	1.00	100.00	100.00	100.00
15	30000.00	0.02	0.00	0.00	0.00	0.00	0.00	1.08	0.55	1.00	1.00	100.00	100.00	100.00
16	30000.00	0.02	0.00	0.00	0.00	0.00	0.00	1.08	0.55	1.00	1.00	100.00	100.00	100.00

COLUMN ID	IX	A	IY	KII	KJJ	KIJ	YS	CS	SS	EC	D	W	ES	PO	J	G
17	2633972.	1734.	73166.	4.0	4.0	2.0	50.0	3.0	1.0	3000.0	120.0	20.030000.0		0.0252707138.		1150.
18	2633972.	1734.	73166.	4.0	4.0	2.0	50.0	3.0	1.0	3000.0	120.0	20.030000.0		0.0252707138.		1150.
19	2633972.	1734.	73166.	4.0	4.0	2.0	50.0	3.0	1.0	3000.0	120.0	20.030000.0		0.0252707138.		1150.
20	2633972.	1734.	73166.	4.0	4.0	2.0	50.0	3.0	1.0	3000.0	120.0	20.030000.0		0.0252707138.		1150.

COLUMN STRESS AND SIDE CONSTRAINT INFORMATION

COLUMN ID	STS	SCS	DTS	DCS	MIN. IX	MAX. IX
1	36.00	36.00	36.00	36.00	7.00	20000.00
2	36.00	36.00	36.00	36.00	7.00	20000.00
3	36.00	36.00	36.00	36.00	7.00	20000.00
4	36.00	36.00	36.00	36.00	7.00	20000.00
5	36.00	36.00	36.00	36.00	7.00	20000.00
6	36.00	36.00	36.00	36.00	7.00	20000.00
7	36.00	36.00	36.00	36.00	7.00	20000.00
8	36.00	36.00	36.00	36.00	7.00	20000.00
9	36.00	36.00	36.00	36.00	7.00	20000.00
10	36.00	36.00	36.00	36.00	7.00	20000.00
11	36.00	36.00	36.00	36.00	7.00	20000.00
12	36.00	36.00	36.00	36.00	7.00	20000.00
13	100.00	100.00	9999.00	9999.00	0.00	1.00
14	100.00	100.00	9999.00	9999.00	0.00	1.00
15	100.00	100.00	9999.00	9999.00	0.00	1.00
16	100.00	100.00	9999.00	9999.00	0.00	1.00

COLUMN ID	STS	SCS	DTS	DCS	MIN. W	MAX. W
17	50.00	3.00	50.00	3.00	5.00	20.00
18	50.00	3.00	50.00	3.00	5.00	20.00
19	50.00	3.00	50.00	3.00	5.00	20.00
20	50.00	3.00	50.00	3.00	5.00	20.00

BEAM ID	E	TORS I	FLEX I	KII	KJJ	KIJ	DI	DJ	D	YS
1	30000.00	6.88	400.00	4.00	4.00	2.00	0.00	0.00	17.10	36.00
2	30000.00	6.88	400.00	4.00	4.00	2.00	0.00	0.00	17.10	36.00
3	30000.00	6.88	400.00	4.00	4.00	2.00	0.00	0.00	17.10	36.00
4	30000.00	6.88	400.00	4.00	4.00	2.00	0.00	0.00	17.10	36.00
5	30000.00	6.88	400.00	4.00	4.00	2.00	0.00	0.00	17.10	36.00
6	30000.00	6.88	400.00	4.00	4.00	2.00	0.00	0.00	17.10	36.00
7	30000.00	6.88	400.00	4.00	4.00	2.00	0.00	0.00	17.10	36.00
8	30000.00	6.88	400.00	4.00	4.00	2.00	0.00	0.00	17.10	36.00
9	30000.00	6.88	400.00	4.00	4.00	2.00	0.00	0.00	17.10	36.00
10	30000.00	6.88	400.00	4.00	4.00	2.00	60.00	0.00	17.10	36.00
11	30000.00	6.88	400.00	4.00	4.00	2.00	60.00	0.00	17.10	36.00
12	30000.00	6.88	400.00	4.00	4.00	2.00	60.00	0.00	17.10	36.00
13	30000.00	6.88	400.00	4.00	4.00	2.00	60.00	0.00	17.10	36.00
14	30000.00	6.88	400.00	4.00	4.00	2.00	60.00	0.00	17.10	36.00
15	30000.00	6.88	400.00	4.00	4.00	2.00	60.00	0.00	17.10	36.00
16	30000.00	6.88	400.00	4.00	4.00	2.00	60.00	0.00	17.10	36.00
17	30000.00	6.88	400.00	4.00	4.00	2.00	60.00	0.00	17.10	36.00
18	30000.00	0.00	0.00	4.00	4.00	2.00	0.00	0.00	1.27	99.99
19	30000.00	0.00	0.00	4.00	4.00	2.00	0.00	0.00	1.27	99.99
20	30000.00	0.00	0.00	4.00	4.00	2.00	0.00	0.00	1.27	99.99
21	30000.00	0.00	0.00	4.00	4.00	2.00	0.00	0.00	1.27	99.99
22	30000.00	0.00	0.00	4.00	4.00	2.00	0.00	0.00	1.27	99.99

BEAM STRESS AND SIDE CONSTRAINT INFORMATION

BEAM ID	SBS	DBS	MIN. I	MAX. I
1	36.00	36.00	5.00	20000.00
2	36.00	36.00	5.00	20000.00
3	36.00	36.00	5.00	20000.00
4	36.00	36.00	5.00	20000.00
5	36.00	36.00	5.00	20000.00
6	36.00	36.00	5.00	20000.00
7	36.00	36.00	5.00	20000.00

8	36.00	36.00	5.00	20000.00
9	36.00	36.00	5.00	20000.00
10	36.00	36.00	5.00	20000.00
11	36.00	36.00	5.00	20000.00
12	36.00	36.00	5.00	20000.00
13	36.00	36.00	5.00	20000.00
14	36.00	36.00	5.00	20000.00
15	36.00	36.00	5.00	20000.00
16	36.00	36.00	5.00	20000.00
17	36.00	36.00	5.00	20000.00
18	99.99	1000.00	0.00	1.00
19	99.99	1000.00	0.00	1.00
20	99.99	1000.00	0.00	1.00
21	99.99	1000.00	0.00	1.00
22	99.99	1000.00	0.00	1.00

FEF ID	CODE	ML	VL	MR	VR	W
1	1	0.000	0.000	0.000	0.000	0.020
2	1	0.000	0.000	0.000	0.000	0.050
3	1	0.000	0.000	0.000	0.000	0.020

BEAM LOCATIONS

BAY	LEVEL	IC	JC	BID	GEN	VLC1	VLC2	VLC3
1	2	1	2	18	0	0	0	0
1	1	1	2	1	0	1	0	3
2	2	6	5	10	0	1	0	3
2	1	6	5	11	0	1	2	0
3	2	9	8	12	0	1	0	3
3	1	9	8	13	0	1	2	0
4	2	2	3	19	0	0	0	0
4	1	2	3	2	0	1	0	3
5	2	3	4	20	0	0	0	0
5	1	3	4	3	0	1	0	3
6	2	6	7	14	0	1	0	3
6	1	6	7	15	0	1	2	0
7	2	9	10	16	0	1	0	3
7	1	9	10	17	0	1	2	0
8	2	1	5	21	0	0	0	0
8	1	1	5	4	0	1	0	3
9	2	4	7	22	0	0	0	0
9	1	4	7	5	0	1	0	3
10	2	5	8	6	0	1	0	3
10	1	5	8	7	0	1	2	0
11	2	7	10	8	0	1	0	3
11	1	7	10	9	0	1	2	0

BEAM PROPERTY SET ID NUMBER

STORY	BAY 1	BAY 2	BAY 3	BAY 4	BAY 5	BAY 6	BAY 7	BAY 8	BAY 9	BAY 10	BAY 11
2	18	10	12	19	20	14	16	21	22	6	8
1	1	11	13	2	3	15	17	4	5	7	9

GENERATED BEAM LOADS...LOAD CASE 1

STORY	BAY 1	BAY 2	BAY 3	BAY 4	BAY 5	BAY 6	BAY 7	BAY 8	BAY 9	BAY 10	BAY 11
2	0	1	1	0	0	1	1	0	0	1	1
1	1	1	1	1	1	1	1	1	1	1	1

GENERATED BEAM LOADS...LOAD CASE 2

STORY	BAY 1	BAY 2	BAY 3	BAY 4	BAY 5	BAY 6	BAY 7	BAY 8	BAY 9	BAY 10	BAY 11
2	0	0	0	0	0	0	0	0	0	0	0
1	0	2	2	0	0	2	2	0	0	2	2

GENERATED BEAM LOADS...LOAD CASE 3

STORY	BAY 1	BAY 2	BAY 3	BAY 4	BAY 5	BAY 6	BAY 7	BAY 8	BAY 9	BAY 10	BAY 11
2	0	3	3	0	0	3	3	0	0	3	3
1	3	0	0	3	3	0	0	3	3	0	0

COLUMN LOCATIONS

LINE	LEVEL	CID	WDIR	GEN
1	2	13	5	0
1	1	1	5	0
2	2	14	3	0
2	1	2	3	0
3	2	15	4	0
3	1	3	4	0

4	2	16	7	0
4	1	4	7	0
5	2	5	8	0
5	1	6	8	0
6	2	17	7	0
6	1	18	7	0
7	2	7	10	0
7	1	8	10	0
8	2	9	5	0
8	1	10	5	0
9	2	19	10	0
9	1	20	10	0
10	2	11	7	0
10	1	12	7	0

COLUMN PROPEPTY SET ID NUMBER

STORY	COL 1	COL 2	COL 3	COL 4	COL 5	COL 6	COL 7	COL 8	COL 9	COL 10
2	13	14	15	16	5	17	7	9	19	11
1	1	2	3	4	6	18	8	10	20	12

BRACING ELEMENT INFORMATION

LEVEL	UC	LC	E	A	TS	CS
1	3	2	30000.00000	9.00000	36.00000	24.00000
1	2	3	30000.00000	9.00000	36.00000	24.00000

BRACING STRESS AND SIDE CONSTRAINT INFORMATION

LEVEL	UC	LC	STS	SCS	DTS	DCS	MIN. A	MAX. A
1	3	2	36.00000	24.00000	36.00000	24.00000	1.00000	20.00000
1	2	3	36.00000	24.00000	36.00000	24.00000	1.00000	20.00000

BEAM PROPERTIES AND LOAD SET NUMBERS

BAY NUMBER 1

LEVEL	E	TORS I	FLEX I	KII	KJJ	KIJ	DI	DJ	D	NS	VLC1	VLC2	VLC3
2	30000.00	0.00	0.00	4.00	4.00	2.00	0.00	0.00	1.27	99.99	0	0	0
1	30000.00	6.88	400.00	4.00	4.00	2.00	0.00	0.00	17.10	36.00	1	0	3

BAY NUMBER 2

LEVEL	E	TORS I	FLEX I	KII	KJJ	KIJ	DI	DJ	D	NS	VLC1	VLC2	VLC3
2	30000.00	6.88	400.00	4.00	4.00	2.00	60.00	0.00	17.10	36.00	1	0	3
1	30000.00	6.88	400.00	4.00	4.00	2.00	60.00	0.00	17.10	36.00	1	2	0

BAY NUMBER 3

LEVEL	E	TORS I	FLEX I	KII	KJJ	KIJ	DI	DJ	D	NS	VLC1	VLC2	VLC3
2	30000.00	6.88	400.00	4.00	4.00	2.00	60.00	0.00	17.10	36.00	1	0	3
1	30000.00	6.88	400.00	4.00	4.00	2.00	60.00	0.00	17.10	36.00	1	2	0

BAY NUMBER 4

LEVEL	E	TORS I	FLEX I	KII	KJJ	KIJ	DI	DJ	D	NS	VLC1	VLC2	VLC3
2	30000.00	0.00	0.00	4.00	4.00	2.00	0.00	0.00	1.27	99.99	0	0	0
1	30000.00	6.88	400.00	4.00	4.00	2.00	0.00	0.00	17.10	36.00	1	0	3

BAY NUMBER 5

LEVEL	E	TORS I	FLEX I	KII	KJJ	KIJ	DI	DJ	D	NS	VLC1	VLC2	VLC3
2	30000.00	0.00	0.00	4.00	4.00	2.00	0.00	0.00	1.27	99.99	0	0	0
1	30000.00	6.88	400.00	4.00	4.00	2.00	0.00	0.00	17.10	36.00	1	0	3

BAY NUMBER 6

LEVEL	E	TORS I	FLEX I	KII	KJJ	KIJ	DI	DJ	D	NS	VLC1	VLC2	VLC3
2	30000.00	6.88	400.00	4.00	4.00	2.00	60.00	0.00	17.10	36.00	1	0	3
1	30000.00	6.88	400.00	4.00	4.00	2.00	60.00	0.00	17.10	36.00	1	2	0

BAY NUMBER 7

LEVEL	E	TORS I	FLEX I	KII	KJJ	KIJ	DI	DJ	D	NS	VLC1	VLC2	VLC3
2	30000.00	6.88	400.00	4.00	4.00	2.00	60.00	0.00	17.10	36.00	1	0	3
1	30000.00	6.88	400.00	4.00	4.00	2.00	60.00	0.00	17.10	36.00	1	2	0

BAY NUMBER 8

LEVEL	E	TORS I	FLEX I	KII	KJJ	KIJ	DI	DJ	D	NS	VLC1	VLC2	VLC3
2	30000.00	0.00	0.00	4.00	4.00	2.00	0.00	0.00	1.27	99.99	0	0	0
1	30000.00	6.88	400.00	4.00	4.00	2.00	0.00	0.00	17.10	36.00	1	0	3

BAY NUMBER 9

LEVEL	E	TORS I	FLEX I	KII	KJJ	KIJ	DI	DJ	D	NS	VLC1	VLC2	VLC3
2	30000.00	0.00	0.00	4.00	4.00	2.00	0.00	0.00	1.27	99.99	0	0	0
1	30000.00	6.88	400.00	4.00	4.00	2.00	0.00	0.00	17.10	36.00	1	0	3

BAY NUMBER 10

LEVEL	E	TORS I	FLEX I	KII	KJJ	KIJ	DI	DJ	D	NS	VLC1	VLC2	VLC3
2	30000.00	6.88	400.00	4.00	4.00	2.00	0.00	0.00	17.10	36.00	1	0	3
1	30000.00	6.88	400.00	4.00	4.00	2.00	0.00	0.00	17.10	36.00	1	2	0

BAY NUMBER 11

LEVEL	E	TORS I	FLEX I	KII	KJJ	KIJ	DI	DJ	D	NS	VLC1	VLC2	VLC3
2	30000.00	6.88	400.00	4.00	4.00	2.00	0.00	0.00	17.10	36.00	1	0	3
1	30000.00	6.88	400.00	4.00	4.00	2.00	0.00	0.00	17.10	36.00	1	2	0

COLUMN PROPERTIES

COLUMN LINE NO. 1

LEVEL	E	A	TORS I	MAJ I	MIN I	DT	DB	D	BF	TF	TW	TS	CS	SS
2	30000.00	0.02	0.00	0.00	0.00	0.00	0.00	1.08	0.55	1.00	1.00	100.00	100.00	100.00
1	30000.00	6.62	3.54	200.00	5.23	0.00	0.00	14.62	5.12	0.31	0.23	36.00	36.00	9999.00

COLUMN LINE NO. 2

LEVEL	E	A	TORS I	MAJ I	MIN I	DT	DB	D	BF	TF	TW	TS	CS	SS
2	30000.00	0.02	0.00	0.00	0.00	0.00	0.00	1.08	0.55	1.00	1.00	100.00	100.00	100.00
1	30000.00	6.62	3.54	200.00	5.23	0.00	0.00	14.62	5.12	0.31	0.23	36.00	36.00	9999.00

COLUMN LINE NO. 3

LEVEL	E	A	TORS I	MAJ I	MIN I	DT	DB	D	BF	TF	TW	TS	CS	SS
2	30000.00	0.02	0.00	0.00	0.00	0.00	0.00	1.08	0.55	1.00	1.00	100.00	100.00	100.00
1	30000.00	6.62	3.54	200.00	5.23	0.00	0.00	14.62	5.12	0.31	0.23	36.00	36.00	9999.00

COLUMN LINE NO. 4

LEVEL	E	A	TORS I	MAJ I	MIN I	DT	DB	D	BF	TF	TW	TS	CS	SS
2	30000.00	0.02	0.00	0.00	0.00	0.00	0.00	1.08	0.55	1.00	1.00	100.00	100.00	100.00
1	30000.00	6.62	3.54	200.00	5.23	0.00	0.00	14.62	5.12	0.31	0.23	36.00	36.00	9999.00

COLUMN LINE NO. 5

LEVEL	E	A	TORS I	MAJ I	MIN I	DT	DB	D	BF	TF	TW	TS	CS	SS
2	30000.00	6.62	3.54	200.00	5.23	0.00	0.00	14.62	5.12	0.31	0.23	36.00	36.00	9999.00
1	30000.00	6.62	3.54	200.00	5.23	0.00	0.00	14.62	5.12	0.31	0.23	36.00	36.00	9999.00

COLUMN LINE NO. 6

LEVEL	IX	A	IY	KII	KJJ	KIJ	TS	CS	SS	EC	D	W	ES	RO	J	G
2	2633972.	1734.	73166.	4.0	4.0	2.0	50.0	3.0	1.0	3000.0	120.0	20.0	30000.	0.0252	707138.	1150.0
1	2633972.	1734.	73166.	4.0	4.0	2.0	50.0	3.0	1.0	3000.0	120.0	20.0	30000.	0.0252	707138.	1150.0

COLUMN LINE NO. 7

LEVEL	E	A	TORS I	MAJ I	MIN I	DT	DB	D	BF	TF	TW	TS	CS	SS
2	30000.00	6.62	3.54	200.00	5.23	0.00	0.00	14.62	5.12	0.31	0.23	36.00	36.00	9999.00
1	30000.00	6.62	3.54	200.00	5.23	0.00	0.00	14.62	5.12	0.31	0.23	36.00	36.00	9999.00

COLUMN LINE NO. 8

LEVEL	E	A	TORS I	MAJ I	MIN I	DT	DB	D	BF	TF	TW	TS	CS	SS
2	30000.00	6.62	3.54	200.00	5.23	0.00	0.00	14.62	5.12	0.31	0.23	36.00	36.00	9999.00
1	30000.00	6.62	3.54	200.00	5.23	0.00	0.00	14.62	5.12	0.31	0.23	36.00	36.00	9999.00

COLUMN LINE NO. 9

LEVEL	IX	A	IY	KII	KJJ	KIJ	TS	CS	SS	EC	D	W	ES	RO	J	G
2	2633972.	1734.	73166.	4.0	4.0	2.0	50.0	3.0	1.0	3000.0	120.0	20.0	30000.	0.0252	707138.	1150.0
1	2633972.	1734.	73166.	4.0	4.0	2.0	50.0	3.0	1.0	3000.0	120.0	20.0	30000.	0.0252	707138.	1150.0

COLUMN LINE NO. 10

LEVEL	E	A	TORS I	MAJ I	MIN I	DT	DB	D	BF	TF	TW	TS	CS	SS
2	30000.00	6.62	3.54	200.00	5.23	0.00	0.00	14.62	5.12	0.31	0.23	36.00	36.00	9999.00
1	30000.00	6.62	3.54	200.00	5.23	0.00	0.00	14.62	5.12	0.31	0.23	36.00	36.00	9999.00

STATIC LOAD COMBINATION (MULTIPLIER)

VLC1	VLC2	VLC3	LAT1	LAT2	MOD1
1.0	0.0	0.0	0.0	0.0	1.0

DYNAMIC LOAD COMBINATION (MULTIPLIER)

VLC1	VLC2	VLC3	LAT1	LAT2	MOD1
1.2	1.0	1.0	1.0	0.0	1.0
1.2	1.0	1.0	0.0	1.0	1.0

ATC-3 SEISMIC PROVISIONS

GENERAL INFORMATION :

```
AREA MAP NUMBER FOR AA --------------------------              7
AREA MAP NUMBER FOR AV --------------------------              7
SEISMIC COEFFICIENT AV ------ (TABLE 1-B) -------          0.400
SEISMIC INDEX --------------- (TABLE 1-A) -------              4
SEISMIC HAZARD EXPOSURE GROUP (TABLE 1-A) -------              3
SEISMIC PERFORMANCE CATEGORY  (TABLE 1-A) -------              D
RESPONSE MODIFICATION FACTOR  (TABLE 3-B) -------           8.00
DEFLECTION AMPLICATION FACTOR (TABLE 3-B) -------           6.50
SOIL TYPE ---------------------------------------              3
STRUCTURAL TYPE ---------------------------------              1
   EQ. 1: MOMENT-RESISTING STRUCTURE
   EQ. 0: NON-MOMENT-RESISTING STRUCTURE
MATERIAL OF THE STRUCTURE -----------------------              1
   EQ. 1: STEEL FRAME
   EQ. 0: CONCRETE FRAME
STRUCTURAL CONFIGURATION :
   PLAN CONFIGURATION ---------------------------              1
   VERTICAL CONFIGURATION -----------------------              0
   EQ. 1: REGULAR
   EQ. 0: IREGULAR
SOIL PROFILE COEFFICIENT ---- (TABLE 3-A) -------          1.500
```

```
SEISMIC COEFFICIENT AA ------ (TABLE 1-B) -------          0.400

OVERALL LENGTH AT BASE (IN) --------------------          600.00
```

ALLOWABLE DRIFT ACCORDING TO TABLE 3-C

FLOOR NO.	ALLOWABLE VALUE (IN)
1	1.44000
2	1.44000

```
THE EIGENSOLUTIONS ARE:

FREQ.    1  IS     11.73

THE EIGENMODE IS:
  0.332853865507E-02  0.196535478373E-04  0.196535478352E-04  0.332853865507E-02  0.432107790980E-02  0.651771222227E-05
  0.432107790979E-02 -0.757991832991E-02 -0.127248646703E-04 -0.757991832978E-02  0.331254190822E-02  0.195623119321E-04
  0.195623119319E-04  0.331254190822E-02  0.171480067575E-02  0.383204570725E-05  0.171480067574E-02 -0.499958467614E-02
 -0.800229703474E-05 -0.499958467606E-02  0.127090797541E+01 -0.104535755622E-21 -0.257113889661E-17  0.429329751777E+00
 -0.265706951226E-21  0.634441821437E-18

FREQ.    2  IS     50.14

THE EIGENMODE IS:
  0.270355459477E-02  0.164624716429E-04  0.164624716411E-04  0.270355459475E-02 -0.144424107574E-01 -0.241543093059E-04
 -0.144424107573E-01  0.117218708276E-01  0.189149839727E-04  0.117218708273E-01  0.272840626420E-02  0.163492508207E-04
  0.163492508202E-04  0.272840626420E-02 -0.902899462815E-02 -0.150944464604E-04 -0.902899462813E-02  0.629649347203E-02
  0.115690324125E-04  0.629649347185E-02 -0.634305318612E+00  0.322670255702E-21 -0.333832434089E-17  0.860211888566E+00
  0.393466276436E-21 -0.112846293756E-17

FREQ.    3  IS    471.99

THE EIGENMODE IS: -
  0.543148601805E-01  0.163212546192E-03  0.163212546460E-03  0.543148601806E-01  0.118470045685E+02  0.113924022530E+00
  0.118470045684E+02  0.435349817478E+00  0.391331543416E-02  0.435349817477E+00  0.402994007202E-01  0.125674719441E-03
  0.125674719340E-03  0.402994007201E-01  0.795634107085E+01  0.786214548046E-01  0.795634107083E+01  0.280360762074E+00
  0.269743258683E-02  0.280360762073E+00 -0.108944009924E-02 -0.140923884983E-18 -0.347558777506E-14  0.869463321653E-03
  0.617075977290E-18 -0.832892104352E-15

THE PERIOD USED IN THE CALCULATIONS IS    0.45542


     LATERAL FORCES:

       STORY NO.      VALUE
           1          0.318106E+02
           2          0.291464E+02

     DRIFT:

       STORY NO.      VALUE
           1          0.104738E+01
           2          0.198009E+01

     THETA:

       STORY NO.      VALUE
           1          0.111899E-01
           2          0.695035E-02


THE EIGENSOLUTIONS ARE:

FREQ.    1  IS     60.00

THE EIGENMODE IS:
  0.422611293640E-02  0.127090214112E+00 -0.127090214112E+00 -0.422611293640E-02  0.308947474118E-01 -0.219823609220E-12
 -0.308947474121E-01  0.309068830838E-01 -0.117687721144E-13 -0.309068830838E-01  0.419107588114E-02  0.126648801144E+00
 -0.126648801144E+00 -0.419107588114E-02  0.199462944500E-01 -0.156802770622E-12 -0.199462944503E-01  0.199630155663E-01
 -0.830962081618E-14 -0.199630155663E-01 -0.175444118874E-21  0.127949327118E+01  0.904509020027E-08  0.302650817049E-21
  0.417394814489E+00  0.130831747830E-06
```

FREQ. 2 IS 274.21

THE EIGENMODE IS:

0.127745137369E-01 0.398602668957E+00 -0.398602668957E+00 -0.127745137369E-01 -0.721945703024E-01 -0.843283134357E-16
0.721945703024E-01 -0.605174496308E-01 -0.170722156724E-17 0.605174496308E-01 0.116746040915E-01 0.368865563895E+00
-0.368865563895E+00 -0.116746040915E-01 -0.383312178244E-01 0.612008236705E-16 0.383312178244E-01 -0.325704101634E-01
-0.509319772762E-18 0.325704101634E-01 -0.352303592748E-23 -0.604234478360E+00 -0.757779053540E-04 0.482308725775E-23
0.848180078024E+00 -0.897387483394E-03

FREQ. 3 IS 471.99

THE EIGENMODE IS:

0.543109521037E-01 0.163181931515E-03 0.163181931349E-03 0.543109521036E-01 0.118470188143E+02 0.113923378741E+00
0.118470188143E+02 0.435192268782E+00 0.391180733566E-02 0.435192268781E+00 0.402964641291E-01 0.125651035224E-03
0.125651035051E-03 0.402964641290E-01 0.795634929315E+01 0.786209986741E-01 0.795634929314E+01 0.280262138750E+00
0.269639354491E-02 0.280262138749E+00 0.119364273366E-07 0.344548531589E-13 -0.171333699344E-15 -0.206893328361E-07
-0.179388901838E-13 -0.726498224967E-15

THE PERIOD USED IN THE CALCULATIONS IS 0.10472

LATERAL FORCES:

STORY NO.	VALUE
1	0.318106E+02
2	0.291464E+02

DRIFT:

STORY NO.	VALUE
1	0.394738E-01
2	0.763741E-01

LOAD COMBINATIONS-----MEMBER FORCES-----LEVEL NO. 1

COLUMN FORCES

LINE	LOAD	TORSIONAL MOMENT	MAJOR AXIS TOP MOMENT	MAJOR AXIS BOT MOMENT	AXIAL FORCE	MINOR AXIS TOP MOMENT	MINOR AXIS BOT MOMENT	MAJOR SHEAR	MINOR SHEAR
1	1	0.0000	-42.7174	-22.7785	2.1317	-0.2238	-0.1119	-0.4548	-0.0023
1	2	0.0006	113.8751	191.5480	0.8774	-0.4507	-0.2033	2.1210	-0.0045
1	3	-0.0008	112.6668	190.0545	0.8926	-0.3230	-0.0960	2.1022	-0.0029
2	1	0.0000	-5.4782	-2.7391	1.2267	0.1523	0.1133	-0.0571	0.0018
2	2	0.0006	-11.1356	-4.7257	-1.3993	-0.4056	-3.7164	-0.1101	-0.0266
2	3	-0.0008	-8.6571	-1.8223	-0.6008	-0.4020	-3.7046	-0.0728	-0.0265
3	1	0.0000	5.4782	2.7391	1.2267	0.1523	0.1133	0.0571	0.0018
3	2	0.0006	13.6359	7.6601	-2.2078	-0.4023	-3.7062	0.1479	-0.0265
3	3	-0.0008	16.1144	10.5635	-3.0062	-0.4059	-3.7180	0.1853	-0.0266
4	1	0.0000	-42.7174	-22.7785	2.1317	0.2238	0.1119	-0.4548	0.0023
4	2	0.0006	112.7710	190.2363	0.8411	0.5793	0.3117	2.1042	0.0062
4	3	-0.0008	113.9792	191.7299	0.8258	0.7070	0.4190	2.1230	0.0078
5	1	0.0000	-11.6926	-7.2661	2.0932	-1.0266	-0.5133	-0.1317	-0.0107
5	2	0.0006	5.7429	137.4819	-20.0966	-2.8528	-1.3930	0.9946	-0.0295
5	3	-0.0008	4.8789	136.1605	-20.0536	-2.7796	-1.3395	0.9794	-0.0286
6	1	0.0000	0.0000	0.0000	3.8046	-37.5741	33.1544	0.0000	-0.0307
6	2	45.0449	-427.3361	1467.0529	-18.9234	1039.1665	-4390.9690	7.2203	-23.2764
6	3	-60.4366	-719.1752	2174.1046	-18.9234	1039.1665	-4390.9690	10.1037	-23.2764
7	1	0.0000	-11.6926	-7.2661	2.0932	1.0266	0.5133	-0.1317	0.0107
7	2	0.0006	5.0067	136.3542	-20.2834	3.1351	1.6009	0.9817	0.0329
7	3	-0.0008	5.8707	137.6756	-20.3264	3.2083	1.6544	0.9968	0.0338
8	1	0.0000	54.6231	25.8917	5.0879	-1.1187	-0.5594	0.5591	-0.0117
8	2	0.0006	301.5478	285.3844	-16.0932	-2.9028	-1.4010	4.0759	-0.0299
8	3	-0.0008	301.3197	284.3809	-16.1382	-3.0002	-1.4726	4.0674	-0.0311
9	1	0.0000	0.0000	0.0000	3.9028	-37.2881	33.2973	0.0000	-0.0277
9	2	45.0449	-735.1920	2170.6191	-18.8391	1039.1277	-4390.9884	9.9682	-23.2768
9	3	-60.4366	-448.7605	1158.8144	-18.8391	1039.1277	-4390.9884	4.9309	-23.2768
10	1	0.0000	54.6231	25.8917	5.0879	1.1187	0.5594	0.5591	0.0117
10	2	0.0006	301.4072	284.5544	-16.3596	3.3331	1.7170	4.0692	0.0331
10	3	-0.0008	301.6352	285.5579	-16.3146	3.2358	1.6453	4.0777	0.0339

COLUMN STRESSES

LINE	LOAD	TOP-MAX	TOP-MIN	BOT-MAX	BOT-MIN	SHEAR-MAJ	SHEAR-MIN
1	1	1.9931	-1.3487	1.2095	-0.5652	-0.0687	-0.0004
1	2	4.5154	-4.2502	7.2334	-6.9682	0.3206	-0.0007
1	3	4.4111	-4.1413	7.1266	-6.8588	0.3177	-0.0004
2	1	0.4601	-0.0893	0.3409	0.0299	-0.0086	0.0003
2	2	0.3940	-0.8170	1.7795	-2.2025	-0.0166	-0.0043
2	3	0.4223	-0.6039	1.7883	-1.9699	-0.0110	-0.0043
3	1	0.4601	-0.0893	0.3409	0.0299	0.0086	0.0003
3	2	0.3616	-1.0289	1.7596	-2.4269	0.0224	-0.0043
3	3	0.3333	-1.2420	1.7508	-2.6595	0.0280	-0.0043
4	1	1.9931	-1.3487	1.2095	-0.5652	-0.0687	0.0004
4	2	4.5325	-4.2783	7.2330	-6.9788	0.3180	0.0009
4	3	4.6368	-4.3872	7.3378	-7.0882	0.3209	0.0012
5	1	1.2460	-0.6133	0.8331	-0.2004	-0.0199	-0.0016
5	2	-1.4317	-4.6430	2.6694	-8.7440	0.1503	-0.0045
5	3	-1.4926	-4.5691	2.6014	-8.6630	0.1480	-0.0043
6	1	0.1292	-0.0033	0.1227	-0.0029	0.0000	0.0000
6	2	1.5034	-0.0109	6.6224	-0.0109	0.0042	-0.0134
6	3	1.5740	-0.0109	6.7935	-0.0109	0.0058	-0.0134
7	1	1.2460	-0.6133	0.8331	-0.2004	-0.0199	0.0016
7	2	-1.3487	-4.7824	2.7016	-8.8327	0.1484	0.0050
7	3	-1.2878	-4.8563	2.7596	-8.9137	0.1507	0.0051
8	1	3.3129	-1.7749	1.9890	-0.4511	0.0845	-0.0018
8	2	10.0100	-14.8744	8.6844	-13.5489	0.6160	-0.0045
8	3	10.0425	-14.9206	8.6760	-13.5541	0.6147	-0.0047
9	1	0.1307	-0.0032	0.1249	-0.0029	0.0000	0.0000
9	2	1.5783	-0.0109	6.7932	-0.0109	0.0057	-0.0134
9	3	1.5090	-0.0109	6.5483	-0.0109	0.0028	-0.0134
10	1	3.3129	-1.7749	1.9890	-0.4511	0.0845	0.0018
10	2	10.1751	-15.1201	8.7684	-13.7134	0.6150	0.0053
10	3	10.1426	-15.0740	8.7768	-13.7083	0.6163	0.0051

BEAM FORCES

		TORSIONAL	CENTERLINE MOMENTS		BEAM END MOMENTS	
BAY	LOAD	MOMENT	I MOMENT	J MOMENT	I MOMENT	J MOMENT
1	1	-0.1823	0.1605	-44.1392	0.1605	-44.1392
1	2	0.4042	0.2593	-98.0172	0.2593	-98.0172
1	3	0.4040	0.1315	-101.0309	0.1315	-101.0309
2	1	-0.0420	148.2883	-2.6329	16.6725	-2.6329
2	2	0.1103	603.5584	-6.4909	99.9677	-6.4909
2	3	0.1133	608.0060	-6.2763	103.0832	-6.2763
3	1	0.1770	143.2342	-2.8089	13.1127	-2.8089
3	2	1.0871	601.5349	-6.3620	98.4855	-6.3620
3	3	1.0922	595.7414	-6.6368	94.4258	-6.6368
4	1	0.0000	49.6175	-49.6175	49.6175	-49.6175
4	2	-0.0014	109.1529	-108.6299	109.1529	-108.6299
4	3	0.0020	109.6881	-108.0947	109.6881	-108.0947
5	1	0.1523	44.1392	-0.1605	44.1392	-0.1605
5	2	-0.4038	94.9939	-0.3793	94.9939	-0.3793
5	3	-0.4040	91.9801	-0.5071	91.9801	-0.5071
6	1	0.0420	148.2883	-2.6329	16.6725	-2.6329
6	2	-0.1128	586.7552	-7.2796	88.1907	-7.2796
6	3	-0.1098	582.3075	-7.4942	85.0751	-7.4942
7	1	-0.1770	143.2342	-2.8089	13.1127	-2.8089
7	2	-1.0917	575.7214	-7.5776	80.3946	-7.5774
7	3	-1.0865	581.5150	-7.3026	84.4543	-7.3026
8	1	-0.0634	42.8699	-130.5152	42.8699	-130.5152
8	2	-0.1914	-114.2824	-601.5617	-114.2824	-601.5617
8	3	-0.1915	-113.0740	-600.1467	-113.0740	-600.1467
9	1	0.0634	42.8699	-130.5152	42.8699	-130.5152
9	2	0.2000	-113.1779	-600.2365	-113.1779	-600.2365
9	3	0.1999	-114.3863	-601.6514	-114.3863	-601.6514
10	1	-0.0048	230.6958	-174.7779	230.6958	-174.7779
10	2	-0.0044	599.7349	-880.3432	599.7349	-880.3432
10	3	-0.0092	601.1224	-878.7012	601.1224	-878.7012
11	1	0.0048	230.6958	-174.7779	230.6958	-174.7779
11	2	0.0086	600.9448	-878.8950	600.9448	-878.8950
11	3	0.0039	599.5572	-880.5370	599.5572	-880.5370

BEAM STRESSES

BAY	LOAD	I NORMAL	J NORMAL
1	1	0.0034	0.9435
1	2	0.0035	2.0951
1	3	0.0028	2.1595
2	1	0.3564	0.0563
2	2	2.1368	0.1387
2	3	2.2034	0.1342

3	1	0.2803	0.0600
3	2	2.1051	0.1360
3	3	2.0184	0.1419
4	1	1.0606	1.0606
4	2	2.3331	2.3220
4	3	2.3446	2.3105
5	1	0.9435	0.0034
5	2	2.0305	0.0081
5	3	1.9661	0.0108
6	1	0.3564	0.0563
6	2	1.8851	0.1556
6	3	1.8185	0.1602
7	1	0.2803	0.0600
7	2	1.7184	0.1620
7	3	1.8052	0.1561
8	1	0.9163	2.7898
8	2	2.4428	12.8584
8	3	2.4170	12.8282
9	1	0.9163	2.7898
9	2	2.4192	12.8301
9	3	2.4450	12.8603
10	1	4.9311	3.7359
10	2	12.8194	18.8174
10	3	12.8490	18.7823
11	1	4.9311	3.7359
11	2	12.8452	18.7864
11	3	12.8156	18.8215

BRACING ELEMENTS

BRACE	LOAD	AXIAL-FORCE
1	1	0.6512
1	2	-0.2846
1	3	1.0450
2	1	0.6512
2	2	-1.6301
2	3	-2.9596

BRACE STRESSES

BRACE	LOAD	AXIAL
1	1	0.0724
1	2	-0.0316
1	3	0.1161
2	1	0.0724
2	2	-0.1811
2	3	-0.3288

LOAD COMBINATIONS-----MEMBER FORCES-----LEVEL NO. 2

COLUMN FORCES

LINE	LOAD	TORSIONAL	MAJOR AXIS		AXIAL	MINOR AXIS		MAJOR	MINOR
		MOMENT	TOP MOMENT	BOT MOMENT	FORCE	TOP MOMENT	BOT MOMENT	SHEAR	SHEAR
1	1	0.0000	0.0002	-0.0002	0.0000	0.0000	0.0000	0.0000	0.0000
1	2	0.0000	0.0035	0.0031	0.0000	0.0000	0.0000	0.0000	0.0000
1	3	0.0000	0.0035	0.0031	0.0000	0.0000	0.0000	0.0000	0.0000
2	1	0.0000	0.0000	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
2	2	0.0000	0.0000	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
2	3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3	1	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
3	2	0.0000	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
3	3	0.0000	0.0001	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000
4	1	0.0000	0.0002	-0.0002	0.0000	0.0000	0.0000	0.0000	0.0000
4	2	0.0000	0.0035	0.0031	0.0000	0.0000	0.0000	0.0000	0.0000
4	3	0.0000	0.0035	0.0031	0.0000	0.0000	0.0000	0.0000	0.0000
5	1	0.0000	-155.7806	-88.4460	0.0201	-1.5559	-1.5479	-1.6960	-0.0216
5	2	0.0013	-116.6038	-4.0263	-4.3665	-2.6530	-3.4511	-0.8377	-0.0424
5	3	-0.0016	-118.2875	-5.9680	-4.3483	-2.5099	-3.3144	-0.8629	-0.0404
6	1	0.0000	0.0000	0.0000	-0.6082	0.9867	37.6581	0.0000	0.2684
6	2	96.0414	19.9665	444.1393	-7.7809	0.8866	-1039.3896	3.2230	-7.2118
6	3	-115.7622	31.1411	744.8737	-7.7809	0.8866	-1039.3896	5.3890	-7.2118
7	1	0.0000	-155.7806	-88.4460	0.0201	1.5559	1.5479	-1.6960	0.0216
7	2	0.0013	-118.1423	-5.8279	-4.4724	3.1738	3.9532	-0.8609	0.0495
7	3	-0.0016	-116.4586	-3.8863	-4.4906	3.3170	4.0899	-0.8357	0.0514
8	1	0.0000	161.5932	119.9777	-0.0361	-1.6927	-1.6854	1.9554	-0.0235
8	2	0.0013	603.1581	577.7083	-7.0579	-2.6070	-3.4548	8.2005	-0.0421
8	3	-0.0016	601.5659	576.2893	-7.0824	-2.7860	-3.6274	8.1795	-0.0445
9	1	0.0000	0.0000	0.0000	-0.5598	-0.8901	36.9341	0.0000	0.2503
9	2	96.0414	31.3957	761.0055	-7.7595	-2.8890	-1041.3065	5.5028	-7.2514
9	3	-115.7622	17.6487	462.9869	-7.7595	-2.8890	-1041.3065	3.3377	-7.2514

10	1	0.0000	161.5932	119.9777	-0.0361	1.6927	1.6854	1.9554	0.0235
10	2	0.0013	601.7053	576.3962	-7.2030	3.4200	4.2356	8.1813	0.0532
10	3	-0.0016	603.2975	577.8152	-7.1784	3.2410	4.0630	8.2022	0.0507

COLUMN STRESSES

LINE	LOAD	TOP-MAX	TOP-MIN	BOT-MAX	BOT-MIN	SHEAR-MAJ	SHEAR-MIN
1	1	0.0728	-0.0722	0.0724	-0.0718	0.0000	0.0000
1	2	0.9749	-0.9716	0.8726	-0.8693	0.0019	0.0000
1	3	0.9562	-0.9529	0.8532	-0.8499	0.0019	0.0000
2	1	0.0124	-0.0124	0.0202	-0.0202	0.0000	0.0000
2	2	0.0510	-0.0510	0.1325	-0.1324	0.0000	0.0000
2	3	0.0446	-0.0446	0.1178	-0.1178	0.0000	0.0000
3	1	0.0124	-0.0124	0.0202	-0.0202	0.0000	0.0000
3	2	0.0632	-0.0632	0.1449	-0.1448	0.0001	0.0000
3	3	0.0768	-0.0767	0.1595	-0.1595	0.0001	0.0000
4	1	0.0728	-0.0722	0.0724	-0.0718	0.0000	0.0000
4	2	0.9810	-0.9778	0.8780	-0.8748	0.0019	0.0000
4	3	0.9997	-0.9965	0.8973	-0.8941	0.0019	0.0000
5	1	6.4583	-6.4522	3.9932	-3.9871	-0.2563	-0.0033
5	2	4.9001	-6.2200	1.1757	-2.4956	-0.1266	-0.0064
5	3	4.8944	-6.2087	1.1826	-2.4969	-0.1304	-0.0061
6	1	-0.0021	-0.0004	0.0512	-0.0004	0.0000	0.0002
6	2	-0.0388	-0.0045	1.5720	-0.0045	0.0019	-0.0042
6	3	-0.0360	-0.0045	1.6448	-0.0045	0.0031	-0.0042
7	1	6.4583	-6.4522	3.9932	-3.9871	-0.2563	0.0033
7	2	5.1951	-6.5470	1.4712	-2.8231	-0.1301	0.0075
7	3	5.2009	-6.5583	1.4644	-2.8217	-0.1263	0.0078
8	1	6.7292	-6.7401	5.2045	-5.2154	0.2955	-0.0035
8	2	22.2551	-24.3885	21.7397	-23.8730	1.2394	-0.0064
8	3	22.2808	-24.4216	21.7685	-23.9093	1.2362	-0.0067
9	1	-0.0019	-0.0003	0.0504	-0.0003	0.0000	0.0001
9	2	-0.0330	-0.0045	1.6516	-0.0045	0.0032	-0.0042
9	3	-0.0363	-0.0045	1.5795	-0.0045	0.0019	-0.0042
10	1	6.7292	-6.7401	5.2045	-5.2154	0.2955	0.0035
10	2	22.5779	-24.7551	22.0518	-24.2290	1.2365	0.0080
10	3	22.5522	-24.7220	22.0229	-24.1928	1.2396	0.0077

BEAM FORCES

		TORSIONAL	CENTERLINE MOMENTS		BEAM END MOMENTS	
BAY	LOAD	MOMENT	I MOMENT	J MOMENT	I MOMENT	J MOMENT
1	1	0.0000	0.0000	0.0000	0.0000	0.0000
1	2	0.0000	0.0000	0.0000	0.0000	0.0000
1	3	0.0000	0.0000	0.0000	0.0000	0.0000
2	1	-0.4934	149.4079	-1.5511	17.1631	-1.5511
2	2	-0.4455	384.6854	-2.6539	77.5335	-2.6539
2	3	-0.4407	390.2727	-2.5045	81.4818	-2.5045
3	1	0.4450	144.4808	-1.6975	13.6855	-1.6975
3	2	1.4427	388.2565	-2.6061	80.0707	-2.6061
3	3	1.4467	381.3830	-2.7913	75.2139	-2.7913
4	1	0.0000	0.0000	0.0000	0.0000	0.0000
4	2	0.0000	0.0000	0.0000	0.0000	0.0000
4	3	0.0000	0.0000	0.0000	0.0000	0.0000
5	1	0.0000	0.0000	0.0000	0.0000	0.0000
5	2	0.0000	-0.0001	0.0000	-0.0001	0.0000
5	3	0.0000	-0.0001	0.0000	-0.0001	0.0000
6	1	0.4934	149.4079	-1.5511	17.1631	-1.5511
6	2	0.4411	364.7189	-3.1690	63.4189	-3.1690
6	3	0.4459	359.1316	-3.3183	59.4707	-3.3183
7	1	-0.4450	144.4808	-1.6975	13.6855	-1.6975
7	2	-1.4463	356.8608	-3.4249	57.8791	-3.4249
7	3	-1.4423	363.7343	-3.2397	62.7358	-3.2397
8	1	0.0000	-0.0002	-0.0014	-0.0002	-0.0014
8	2	0.0000	-0.0036	-0.0061	-0.0036	-0.0061
8	3	0.0000	-0.0035	-0.0060	-0.0035	-0.0060
9	1	0.0000	-0.0002	-0.0014	-0.0002	-0.0014
9	2	0.0000	-0.0035	-0.0060	-0.0035	-0.0060
9	3	0.0000	-0.0036	-0.0061	-0.0036	-0.0061
10	1	-0.0048	156.2754	-162.0382	156.2754	-162.0382
10	2	0.0008	117.0554	-604.6008	117.0554	-604.6008
10	3	-0.0053	118.7343	-603.0125	118.7343	-603.0125
11	1	0.0048	156.2754	-162.0382	156.2754	-162.0382
11	2	0.0048	118.5895	-603.1516	118.5895	-603.1516
11	3	-0.0013	116.9106	-604.7399	116.9106	-604.7399

BEAM STRESSES

BAY	LOAD	I NORMAL	J NORMAL
1	1	0.0006	0.0036
1	2	0.0009	0.0059
1	3	0.0000	0.0008

2	1	0.3669	0.0332
2	2	1.6573	0.0567
2	3	1.7417	0.0535
3	1	0.2925	0.0363
3	2	1.7115	0.0557
3	3	1.6077	0.0597
4	1	0.0003	0.0003
4	2	0.0001	0.0007
4	3	0.0013	0.0020
5	1	0.0036	0.0006
5	2	0.0123	0.0018
5	3	0.0189	0.0027
6	1	0.3669	0.0332
6	2	1.3556	0.0677
6	3	1.2712	0.0709
7	1	0.2925	0.0363
7	2	1.2372	0.0732
7	3	1.3410	0.0692
8	1	0.0382	0.2238
8	2	0.5645	0.9609
8	3	0.5610	0.9571
9	1	0.0382	0.2238
9	2	0.5611	0.9571
9	3	0.5645	0.9609
10	1	3.3404	3.4636
10	2	2.5021	12.9234
10	3	2.5380	12.8894
11	1	3.3404	3.4636
11	2	2.5349	12.8924
11	3	2.4990	12.9264

STATIC AND DYNAMIC LOAD COMBINATION-----LATERAL AND ROTATIONAL M. C. DISPLACEMENTS

LEVEL	DIRECTION	1	2	3
2	X	-0.0061468	0.4438713	0.4438713
2	Y	0.0000000	0.0055102	0.0051835
2	ROTN	0.0000000	0.0000065	-0.0000081
1	X	-0.0016356	0.1546337	0.1546337
1	Y	0.0000000	0.0015952	0.0020486
1	ROTN	0.0000000	0.0000021	-0.0000028

THE STEEL WEIGHT IS 13.7411

THE CONCRETE WEIGHT IS 120.0000

THE OBJECTIVE VALUE IS 70676.2542

ACTIVE CONSTRAINTS

TYPE	LEVEL	LOCATION	LOAD	IDENT	VALUE
D.DIS________	2	0	2	1	0.44387
D.DIS________	2	0	3	1	0.44387

****

THE END OF OPTIMIZATION CYCLE 0 .

THE START OF OPTIMIZATION CYCLE 1 .

****

COLUMN ID	E	A	TORS I	MAJ I	MIN I	DT	DB	D	BF	TF	TW	TS	CS	SS
1	30000.00	7.44	4.45	254.14	6.53	0.00	0.00	15.43	5.36	0.31	0.23	36.00	36.00	9999.00
2	30000.00	5.46	2.43	134.93	3.63	0.00	0.00	13.38	4.74	0.31	0.23	36.00	36.00	9999.00
3	30000.00	5.46	2.43	134.94	3.63	0.00	0.00	13.38	4.74	0.31	0.23	36.00	36.00	9999.00
4	30000.00	7.44	4.46	254.15	6.53	0.00	0.00	15.43	5.36	0.31	0.23	36.00	36.00	9999.00
5	30000.00	4.30	1.51	82.38	2.30	0.00	0.00	11.96	4.31	0.31	0.23	36.00	36.00	9999.00
6	30000.00	6.55	3.47	196.08	5.13	0.00	0.00	14.56	5.10	0.31	0.23	36.00	36.00	9999.00
7	30000.00	4.29	1.51	82.33	2.30	0.00	0.00	11.96	4.31	0.31	0.23	36.00	36.00	9999.00
8	30000.00	6.55	3.47	196.08	5.13	0.00	0.00	14.56	5.10	0.31	0.23	36.00	36.00	9999.00
9	30000.00	11.76	10.98	651.60	15.59	0.00	0.00	19.09	6.43	0.31	0.23	36.00	36.00	9999.00
10	30000.00	6.95	3.90	221.25	5.74	0.00	0.00	14.96	5.22	0.31	0.23	36.00	36.00	9999.00
11	30000.00	11.76	10.98	651.60	15.59	0.00	0.00	19.09	6.43	0.31	0.23	36.00	36.00	9999.00
12	30000.00	6.95	3.90	221.38	5.74	0.00	0.00	14.96	5.22	0.31	0.23	36.00	36.00	9999.00
13	30000.00	0.02	0.00	0.00	0.00	0.00	0.00	0.99	0.51	1.00	1.00	100.00	100.00	100.00
14	30000.00	0.02	0.00	0.00	0.00	0.00	0.00	0.99	0.51	1.00	1.00	100.00	100.00	100.00
15	30000.00	0.02	0.00	0.00	0.00	0.00	0.00	0.99	0.51	1.00	1.00	100.00	100.00	100.00
16	30000.00	0.02	0.00	0.00	0.00	0.00	0.00	0.99	0.51	1.00	1.00	100.00	100.00	100.00

COLUMN ID	IX	A	IY	KII	KJJ	KIJ	TS	CS	SS	EC	D	H ES	RO J	G
17	1794783.	1182.	23148.	4.0	4.0	2.0	50.0	3.0	1.0	3000.0	120.0	13.630000.0	0.0251817931.	1150.
18	2260469.	1488.	46246.	4.0	4.0	2.0	50.0	3.0	1.0	3000.0	120.0	17.230000.0	0.0252306715.	1150.
19	1794778.	1182.	23148.	4.0	4.0	2.0	50.0	3.0	1.0	3000.0	120.0	13.630000.0	0.0251817925.	1150.
20	2260478.	1488.	46246.	4.0	4.0	2.0	50.0	3.0	1.0	3000.0	120.0	17.230000.0	0.0252306724.	1150.

BEAM ID	E	TORS I	FLEX I	KII	KJJ	KIJ	DI	DJ	D	NS
1	30000.00	4.67	266.87	4.00	4.00	2.00	0.00	0.00	15.61	36.00
2	30000.00	4.67	266.72	4.00	4.00	2.00	0.00	0.00	15.60	36.00
3	30000.00	4.67	266.89	4.00	4.00	2.00	0.00	0.00	15.61	36.00
4	30000.00	7.84	458.38	4.00	4.00	2.00	0.00	0.00	17.63	36.00
5	30000.00	7.84	458.37	4.00	4.00	2.00	0.00	0.00	17.63	36.00
6	30000.00	7.47	436.06	4.00	4.00	2.00	0.00	0.00	17.44	36.00
7	30000.00	5.90	341.00	4.00	4.00	2.00	0.00	0.00	16.49	36.00
8	30000.00	7.47	436.06	4.00	4.00	2.00	0.00	0.00	17.44	36.00
9	30000.00	5.90	341.03	4.00	4.00	2.00	0.00	0.00	16.49	36.00
10	30000.00	4.64	265.29	4.00	4.00	2.00	60.00	0.00	15.58	36.00
11	30000.00	4.66	266.07	4.00	4.00	2.00	60.00	0.00	15.59	36.00
12	30000.00	4.71	269.59	4.00	4.00	2.00	60.00	0.00	15.64	36.00
13	30000.00	4.70	268.62	4.00	4.00	2.00	60.00	0.00	15.63	36.00
14	30000.00	4.64	265.47	4.00	4.00	2.00	60.00	0.00	15.59	36.00
15	30000.00	4.66	266.14	4.00	4.00	2.00	60.00	0.00	15.60	36.00
16	30000.00	4.71	269.29	4.00	4.00	2.00	60.00	0.00	15.64	36.00
17	30000.00	4.70	268.46	4.00	4.00	2.00	60.00	0.00	15.63	36.00
18	30000.00	0.00	0.00	4.00	4.00	2.00	0.00	0.00	1.16	99.99
19	30000.00	0.00	0.00	4.00	4.00	2.00	0.00	0.00	1.16	99.99
20	30000.00	0.00	0.00	4.00	4.00	2.00	0.00	0.00	1.16	99.99
21	30000.00	0.00	0.00	4.00	4.00	2.00	0.00	0.00	1.16	99.99
22	30000.00	0.00	0.00	4.00	4.00	2.00	0.00	0.00	1.16	99.99

BRACING ELEMENT INFORMATION

LEVEL	UC	LC	E	A	TS	CS
1	3	2	30000.00000	6.00001	36.00000	24.00000
1	2	3	30000.00000	5.99995	36.00000	24.00000

THE EIGENSOLUTIONS ARE:

FREQ. 1 IS 10.23

THE EIGENMODE IS:

```
 0.291800497854E-02  0.152349276885E-04  0.152429497586E-04  0.291764963375E-02  0.584832301302E-02  0.713199630432E-05
 0.584843746898E-02 -0.620753302102E-02 -0.109010794269E-04 -0.620563445906E-02  0.290830285476E-02  0.151699256626E-04
 0.151779643984E-04  0.290802952338E-02  0.169607486265E-02  0.364687486122E-05  0.169587334694E-02 -0.469621221930E-02
-0.643665305272E-05 -0.469455938087E-02  0.131751853974E+01 -0.503519320477E-14 -0.500231768520E-10  0.418501937463E+00
-0.264937431632E-13  0.746731169815E-10
```

FREQ. 2 IS 36.05

THE EIGENMODE IS:

```
 0.432125913330E-02  0.231190575736E-04  0.231632686609E-04  0.432172142476E-02 -0.195214674995E-01 -0.269272311694E-04
-0.195212279514E-01  0.921337111432E-02  0.158463819708E-04  0.920998136174E-02  0.433407467350E-02  0.229951932828E-04
 0.230393206582E-04  0.433453239078E-02 -0.115790365778E-01 -0.152371806528E-04 -0.115779088824E-01  0.629665634940E-02
 0.921010873163E-05  0.629363210495E-02 -0.623443084970E+00  0.901898551682E-13  0.523987880719E-11  0.884414111421E+00
-0.202786253057E-12  0.240365903953E-09
```

FREQ. 3 IS 463.29

THE EIGENMODE IS:

```
 0.536595807619E-02 -0.142138118693E-02  0.139795745393E-02  0.650874674935E-01  0.153587053475E+01  0.438255899447E-01
 0.187466904652E+02  0.228466843019E-01  0.740676049918E-03  0.279522674982E+00  0.403084324265E-02 -0.111758968120E-02
 0.109769540565E-02  0.468918509012E-01  0.841537243505E+00  0.273732039719E-01  0.102703911918E+02  0.174360898201E-01
 0.475096458798E-03  0.213186576886E+00 -0.107550355298E-02 -0.266506670083E-07  0.478603067917E-05  0.889700036204E-03
 0.206632896706E-07  0.940018913104E-05
```

THE PERIOD USED IN THE CALCULATIONS IS 0.45542

```
LATERAL FORCES:

  STORY NO.      VALUE
      1          0.307959E+02
      2          0.277537E+02

DRIFT:

  STORY NO.      VALUE
      1          0.132904E+01
      2          0.268569E+01

THETA:

  STORY NO.      VALUE
      1          0.141991E-01
      2          0.940158E-02


THE EIGENSOLUTIONS ARE:

FREQ.    1  IS     55.92

THE EIGENMODE IS:

  0.242530355904E-02  0.108712627483E+00 -0.108710520877E+00 -0.242542924721E-02  0.253596779482E-01  0.524589225934E-06
 -0.253756301198E-01  0.208477737732E-01 -0.976499652141E-06 -0.208279071877E-01  0.240275081695E-02  0.108383589452E+00
 -0.108381489440E+00 -0.240287575716E-02  0.137021076114E-01  0.260635979959E-06 -0.137077780287E-01  0.157209003766E-01
 -0.511378908763E-06 -0.157057423021E-01 -0.211659920528E-13  0.131708518005E+01 -0.310895249704E-06  0.236645016631E-13
  0.419064576240E+00 -0.208796492922E-05

FREQ.    2  IS    247.12

THE EIGENMODE IS:

  0.628172571477E-02  0.318898904133E+00 -0.318892481305E+00 -0.628188787224E-02 -0.573210224628E-01 -0.137563444902E-05
  0.573724475782E-01 -0.352991619099E-01  0.200052405203E-05  0.352583001238E-01  0.584695209291E-02  0.299578871949E+00
 -0.299572843755E+00 -0.584710393603E-02 -0.224396804403E-01 -0.631142153912E-06  0.224571580219E-01 -0.232034804990E-01
  0.931230374232E-06  0.231746092923E-01  0.757517053554E-13 -0.616850357576E+00 -0.435467315171E-04 -0.294734463488E-12
  0.873220684544E+00 -0.708865273190E-03

FREQ.    3  IS    463.29

THE EIGENMODE IS:

  0.100655468871E-01 -0.250230998665E-02  0.247737649569E-02  0.645418149231E-01  0.289783413738E+01  0.464172685755E-01
  0.185867355178E+02  0.434258266498E-01  0.784237354182E-03  0.276727191766E+00  0.756090340760E-02 -0.196815146625E-02
  0.194698306258E-02  0.484819506778E-01  0.156770640391E+01  0.289920207417E-01  0.101817032959E+02  0.331284747652E-01
  0.503039283561E-03  0.211061485142E+00  0.114606380068E-07  0.267870962300E-02  0.478461712170E-05 -0.209846252223E-07
 -0.118855057395E-02  0.139801564633E-04

THE PERIOD USED IN THE CALCULATIONS IS    0.11236

LATERAL FORCES:

  STORY NO.      VALUE
      1          0.307959E+02
      2          0.277537E+02

DRIFT:

  STORY NO.      VALUE
      1          0.453284E-01
      2          0.886930E-01
```

LOAD COMBINATIONS-----MEMBER FORCES-----LEVEL NO. 1

COLUMN FORCES

LINE	LOAD	TORSIONAL MOMENT	MAJOR AXIS TOP MOMENT	MAJOR AXIS BOT MOMENT	AXIAL FORCE	MINOR AXIS TOP MOMENT	MINOR AXIS BOT MOMENT	MAJOR SHEAR	MINOR SHEAR
1	1	0.0000	-52.1198	-36.0266	2.0974	-0.3736	-0.1868	-0.6121	-0.0039
1	2	0.0008	175.1212	284.0729	1.3399	-0.8474	-0.3916	3.1888	-0.0086
1	3	-0.0013	173.5069	281.9187	1.3472	-0.6639	-0.2343	3.1627	-0.0062
2	1	0.0000	-5.1829	-2.5915	1.2853	0.0995	0.1923	-0.0540	0.0020
2	2	0.0005	-11.3453	-5.0087	-1.5617	-0.3343	-2.9724	-0.1136	-0.0230
2	3	-0.0007	-9.2936	-2.6270	-0.8839	-0.3316	-2.9629	-0.0828	-0.0229
3	1	0.0000	5.1829	2.5914	1.2854	0.0995	0.1923	0.0540	0.0020
3	2	0.0005	13.3493	7.3387	-2.2260	-0.3321	-2.9652	0.1437	-0.0229
3	3	-0.0007	15.4012	9.7206	-2.9038	-0.3348	-2.9747	0.1745	-0.0230
4	1	0.0000	-52.1189	-36.0266	2.0974	0.3736	0.1868	-0.6121	0.0039
4	2	0.0008	173.8051	282.3838	1.3095	1.0265	0.5454	3.1680	0.0109
4	3	-0.0013	175.4193	284.5380	1.3022	1.2101	0.7027	3.1941	0.0133
5	1	0.0000	-27.2425	-21.3109	2.4471	-1.4959	-0.7480	-0.3372	-0.0156
5	2	0.0006	57.4643	180.3486	-19.3334	-4.5688	-2.2471	1.6515	-0.0473
5	3	-0.0010	56.0629	178.6086	-19.2990	-4.4798	-2.1821	1.6297	-0.0463
6	1	0.0026	0.0264	-0.0147	3.7856	-172.8517	94.9403	0.0001	-0.5411
6	2	41.3269	-401.4163	1439.8769	-18.6913	294.0124	-3419.5101	7.2115	-21.7048
6	3	-65.8005	-700.9462	2192.1532	-18.6913	294.0127	-3419.5101	10.3556	-21.7048
7	1	0.0000	-27.2512	-21.3155	2.4472	1.4957	0.7478	-0.3373	0.0156
7	2	0.0006	56.3834	179.0105	-19.4775	4.8845	2.4795	1.6347	0.0511
7	3	-0.0010	57.7850	180.7507	-19.5119	4.9736	2.5445	1.6565	0.0522
8	1	0.0000	45.2839	13.9648	4.7116	-1.6039	-0.8019	0.4114	-0.0167
8	2	0.0007	147.6544	244.9131	-17.8304	-4.7561	-2.3163	2.7262	-0.0491
8	3	-0.0012	148.0434	243.9349	-17.8706	-4.8703	-2.4026	2.7221	-0.0505
9	1	0.0026	-0.0178	0.0124	4.0432	-172.6232	95.0566	0.0000	-0.5387
9	2	41.3271	-714.4028	2075.7530	-18.1195	294.1628	-3419.4753	9.4538	-21.7036
9	3	-65.8007	-422.6753	1069.7033	-18.1195	294.1631	-3419.4752	4.4933	-21.7036
10	1	0.0000	45.3005	13.9683	4.7114	1.6054	0.8027	0.4116	0.0167
10	2	0.0007	148.1920	244.3708	-18.0753	5.2459	2.6848	2.7261	0.0551
10	3	-0.0012	147.8027	245.3496	-18.0352	5.1316	2.5984	2.7302	0.0537

COLUMN STRESSES

LINE	LOAD	TOP-MAX	TOP-MIN	BOT-MAX	BOT-MIN	SHEAR-MAJ	SHEAR-MIN
1	1	2.0181	-1.4540	1.4527	-0.8886	-0.0823	-0.0005
1	2	5.8458	-5.4854	8.9670	-8.6066	0.4289	-0.0012
1	3	5.7224	-5.3600	8.8380	-8.4756	0.4253	-0.0008
2	1	0.5572	-0.0865	0.4892	-0.0186	-0.0099	0.0004
2	2	0.4946	-1.0664	1.9020	-2.4739	-0.0208	-0.0042
2	3	0.5152	-0.8389	1.9018	-2.2255	-0.0152	-0.0042
3	1	0.5571	-0.0865	0.4892	-0.0186	0.0099	0.0004
3	2	0.4709	-1.2859	1.8911	-2.7061	0.0263	-0.0042
3	3	0.4502	-1.5134	1.8913	-2.9545	0.0319	-0.0042
4	1	2.0180	-1.4539	1.4527	-0.8885	-0.0823	0.0005
4	2	5.8751	-5.5229	8.9745	-8.6223	0.4260	0.0015
4	3	5.9985	-5.6482	9.1035	-8.7532	0.4296	0.0018
5	1	2.1272	-1.3803	1.5357	-0.7889	-0.0515	-0.0024
5	2	1.4505	-7.3511	4.8591	-10.7597	0.2520	-0.0072
5	3	1.3596	-7.2497	4.7675	-10.6576	0.2487	-0.0071
6	1	0.4273	-0.0204	0.2737	-0.0112	0.0000	-0.0004
6	2	0.5673	1.4908	7.0228	6.6099	0.0048	-0.0146
6	3	0.6518	1.5614	7.2349	6.7810	0.0070	-0.0146
7	1	2.1273	-1.3804	1.5358	-0.7889	-0.0515	0.0024
7	2	1.5451	-7.4896	4.9027	-10.8472	0.2495	0.0078
7	3	1.6361	-7.5911	4.9943	-10.9493	0.2528	0.0080
8	1	2.9374	-1.5816	1.5143	-0.1586	0.0592	-0.0024
8	2	4.5869	-9.7177	6.7659	-11.8967	0.3922	-0.0071
8	3	4.6462	-9.7886	6.7663	-11.9087	0.3916	-0.0073
9	1	0.4327	-0.0204	0.2798	-0.0112	0.0000	-0.0004
9	2	0.6597	1.5661	7.2058	6.7810	0.0064	-0.0146
9	3	0.5774	1.4968	6.9221	6.5362	0.0030	-0.0146
10	1	2.9375	-1.5821	1.5143	-0.1589	0.0592	0.0024
10	2	4.7900	-9.9899	6.8764	-12.0764	0.3921	0.0079
10	3	4.7307	-9.9191	6.8760	-12.0644	0.3927	0.0077

BEAM FORCES

BAY	LOAD	TORSIONAL MOMENT	CENTERLINE MOMENTS I MOMENT	CENTERLINE MOMENTS J MOMENT	BEAM END MOMENTS I MOMENT	BEAM END MOMENTS J MOMENT
1	1	-0.0995	0.2635	-44.7191	0.2635	-44.7191
1	2	0.3332	0.4877	-97.7828	0.4877	-97.7828
1	3	0.3334	0.3048	-100.0345	0.3048	-100.0345
2	1	-0.0788	148.9718	-2.6266	17.1589	-2.6266
2	2	0.1576	589.1785	-7.4872	89.9810	-7.4872
2	3	0.1591	592.8231	-7.3165	92.5355	-7.3165

3	1	0.0755	140.6675	-8.1674	12.8103	-8.1674
3	2	0.3278	575.4915	-20.5507	83.9370	-20.5507
3	3	0.3334	570.4159	-21.2459	80.5102	-21.2459
4	1	0.0000	49.9020	-49.9024	49.9020	-49.9024
4	2	-0.0011	109.1283	-108.9472	109.1283	-108.9472
4	3	0.0018	109.3282	-108.7473	109.3282	-108.7473
5	1	0.0995	44.7195	-0.2635	44.7195	-0.2635
5	2	-0.3332	95.5977	-0.6552	95.5977	-0.6552
5	3	-0.3330	93.3458	-0.8382	93.3458	-0.8382
6	1	0.0788	148.9727	-2.6254	17.1592	-2.6254
6	2	-0.1588	576.4659	-8.0679	81.0665	-8.0679
6	3	-0.1572	572.8206	-8.2387	78.5114	-8.2387
7	1	-0.0754	140.6655	-8.1730	12.8105	-8.1730
7	2	-0.3322	553.6994	-23.5693	69.2337	-23.5693
7	3	-0.3267	558.7726	-22.8741	72.6587	-22.8741
8	1	-0.1101	52.2196	-130.6842	52.2196	-130.6842
8	2	-0.3597	-175.4565	-652.3134	-175.4565	-652.3134
8	3	-0.3591	-173.8424	-650.8087	-173.8424	-650.8087
9	1	0.1101	52.2187	-130.6927	52.2187	-130.6927
9	2	0.3713	-174.1404	-651.0390	-174.1404	-651.0390
9	3	0.3719	-175.7545	-652.5434	-175.7545	-652.5434
10	1	0.0028	226.3630	-182.2028	226.3630	-182.2028
10	2	0.0129	567.3961	-1005.4779	567.3961	-1005.4779
10	3	0.0084	568.7351	-1003.5315	568.7351	-1003.5315
11	1	-0.0028	226.3565	-182.2071	226.3565	-182.2071
11	2	-0.0107	568.4651	-1003.8895	568.4651	-1003.8895
11	3	-0.0152	567.1261	-1005.8359	567.1261	-1005.8359

BEAM STRESSES

BAY	LOAD	I NORMAL	J NORMAL
1	1	0.0077	1.3075
1	2	0.0143	2.8590
1	3	0.0089	2.9248
2	1	0.5029	0.0770
2	2	2.6369	0.2194
2	3	2.7118	0.2144
3	1	0.3727	0.2376
3	2	2.4418	0.5978
3	3	2.3421	0.6181
4	1	1.4597	1.4597
4	2	3.1921	3.1868
4	3	3.1979	3.1809
5	1	1.3074	0.0077
5	2	2.7949	0.0192
5	3	2.7291	0.0245
6	1	0.5028	0.0769
6	2	2.3753	0.2364
6	3	2.3004	0.2414
7	1	0.3728	0.2379
7	2	2.0150	0.6860
7	3	2.1147	0.6657
8	1	1.0045	2.5138
8	2	3.3751	12.5479
8	3	3.3440	12.5189
9	1	1.0045	2.5141
9	2	3.3498	12.5236
9	3	3.3809	12.5526
10	1	5.4746	4.4066
10	2	13.7225	24.3176
10	3	13.7549	24.2705
11	1	5.4741	4.4064
11	2	13.7474	24.2775
11	3	13.7151	24.3246

BRACING ELEMENTS

BRACE	LOAD	AXIAL-FORCE
1	1	0.5509
1	2	-0.2628
1	3	0.8582
2	1	0.5510
2	2	-1.3608
2	3	-2.4818

BRACE STRESSES

BRACE	LOAD	AXIAL
1	1	0.0918
1	2	-0.0438
1	3	0.1430

2	1	0.0918
2	2	-0.2268
2	3	-0.4136

LOAD COMBINATIONS-----MEMBER FORCES-----LEVEL NO. 2

COLUMN FORCES

LINE	LOAD	TORSIONAL MOMENT	MAJOR AXIS TOP MOMENT	MAJOR AXIS BOT MOMENT	AXIAL FORCE	MINOR AXIS TOP MOMENT	MINOR AXIS BOT MOMENT	MAJOR SHEAR	MINOR SHEAR
1	1	0.0000	0.0000	-0.0003	0.0000	0.0000	0.0000	0.0000	0.0000
1	2	0.0000	0.0024	0.0021	0.0000	0.0000	0.0000	0.0000	0.0000
1	3	0.0000	0.0024	0.0021	0.0000	0.0000	0.0000	0.0000	0.0000
2	1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	2	0.0000	0.0000	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
2	3	0.0000	0.0000	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
3	1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3	2	0.0000	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
3	3	0.0000	0.0001	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000
4	1	0.0000	0.0000	-0.0003	0.0000	0.0000	0.0000	0.0000	0.0000
4	2	0.0000	0.0024	0.0021	0.0000	0.0000	0.0000	0.0000	0.0000
4	3	0.0000	0.0024	0.0021	0.0000	0.0000	0.0000	0.0000	0.0000
5	1	0.0000	-102.6514	-68.3575	0.2998	-1.0293	-1.0177	-1.1876	-0.0142
5	2	0.0007	-10.7061	27.2955	-3.5012	-2.0356	-2.5459	0.1152	-0.0318
5	3	-0.0009	-12.2022	25.8516	-3.4888	-1.9545	-2.4693	0.0948	-0.0307
6	1	0.0069	0.0007	-0.0273	-0.6206	1.0321	173.0093	-0.0002	1.2086
6	2	74.8690	15.5020	414.1289	-7.6747	0.2804	-294.3287	2.9835	-2.0420
6	3	-100.9440	25.0333	720.9487	-7.6747	0.2804	-294.3290	5.1804	-2.0420
7	1	0.0000	-102.6169	-68.3338	0.2999	1.0283	1.0168	-1.1872	0.0142
7	2	0.0007	-11.9795	26.0317	-3.5854	2.3030	2.8014	0.0976	0.0354
7	3	-0.0009	-10.4838	27.4751	-3.5978	2.3840	2.8780	0.1180	0.0355
8	1	0.0000	207.2874	136.8435	-0.3420	-6.5988	-6.5663	2.3898	-0.0914
8	2	0.0047	832.6769	857.4957	-8.1661	-12.4392	-15.8075	11.7373	-0.1962
8	3	-0.0064	830.2990	855.1547	-8.1879	-13.0453	-16.3840	11.7045	-0.2044
9	1	0.0069	-0.0006	0.0199	-0.4949	-0.2120	172.4723	0.0001	1.1963
9	2	74.8687	27.4147	736.1948	-7.4125	-0.8232	-294.8228	5.3028	-2.0531
9	3	-100.9438	14.9893	434.3186	-7.4125	-0.8232	-294.8232	3.1202	-2.0531
10	1	0.0000	207.2997	136.8312	-0.3422	6.6039	6.5704	2.3898	0.0915
10	2	0.0047	830.6489	855.3653	-8.3002	15.1088	18.3341	11.7084	0.2322
10	3	-0.0064	833.0268	857.7066	-8.2785	14.5028	17.7576	11.7412	0.2240

COLUMN STRESSES

LINE	LOAD	TOP-MAX	TOP-MIN	BOT-MAX	BOT-MIN	SHEAR-MAJ	SHEAR-MIN
1	1	0.0259	-0.0254	0.1337	-0.1333	-0.0001	0.0000
1	2	0.8921	-0.8896	0.8148	-0.8123	0.0016	0.0000
1	3	0.8723	-0.8697	0.7940	-0.7914	0.0015	0.0000
2	1	0.0074	-0.0074	0.0495	-0.0495	0.0000	0.0000
2	2	0.0145	-0.0145	0.1002	-0.1002	0.0000	0.0000
2	3	0.0011	-0.0011	0.0832	-0.0832	0.0000	0.0000
3	1	0.0074	-0.0074	0.0495	-0.0495	0.0000	0.0000
3	2	0.0277	-0.0277	0.1136	-0.1135	0.0001	0.0000
3	3	0.0434	-0.0433	0.1306	-0.1305	0.0001	0.0000
4	1	0.0259	-0.0255	0.1337	-0.1332	-0.0001	0.0000
4	2	0.8994	-0.8969	0.8210	-0.8185	0.0015	0.0000
4	3	0.9192	-0.9168	0.8418	-0.8394	0.0016	0.0000
5	1	8.4884	-8.3488	5.9871	-5.8475	-0.2765	-0.0033
5	2	1.8686	-3.4989	3.5512	-5.1815	0.0268	-0.0074
5	3	1.9042	-3.5288	3.3774	-5.0020	0.0221	-0.0072
6	1	-0.0020	-0.0026	0.5359	0.0507	0.0000	0.0010
6	2	-0.0586	-0.0452	1.0027	1.5655	0.0025	-0.0017
6	3	-0.0552	-0.0425	1.1117	1.6383	0.0044	-0.0017
7	1	8.4884	-8.3487	5.9870	-5.8473	-0.2765	0.0033
7	2	2.1928	-3.8627	3.6807	-5.3506	0.0227	0.0083
7	3	2.1571	-3.8329	3.8544	-5.5301	0.0275	0.0085
8	1	4.3681	-4.4263	3.3293	-3.3875	0.2032	-0.0078
8	2	14.0697	-15.4581	15.1276	-16.5160	0.9978	-0.0167
8	3	14.1579	-15.5500	15.2102	-16.6024	0.9950	-0.0174
9	1	-0.0035	-0.0024	0.5353	0.0500	0.0000	0.0010
9	2	-0.0504	-0.0392	1.1209	1.6453	0.0045	-0.0017
9	3	-0.0546	-0.0426	1.0136	1.5732	0.0026	-0.0017
10	1	4.3693	-4.4275	3.3299	-3.3881	0.2032	0.0078
10	2	14.5787	-15.9899	15.6056	-17.0168	0.9953	0.0197
10	3	14.4905	-15.8980	15.5229	-16.9305	0.9981	0.0190

BEAM FORCES

BAY	LOAD	TORSIONAL MOMENT	CENTERLINE MOMENTS I MOMENT	CENTERLINE MOMENTS J MOMENT	BEAM END MOMENTS I MOMENT	BEAM END MOMENTS J MOMENT
1	1	0.0000	0.0000	0.0000	0.0000	0.0000
1	2	0.0000	0.0000	0.0000	0.0000	0.0000
1	3	0.0000	0.0000	0.0000	0.0000	0.0000
2	1	-0.5158	150.1950	-1.0346	17.5778	-1.0346
2	2	-0.1406	370.5708	-2.0485	67.2787	-2.0485
2	3	-0.1396	375.3349	-1.9595	70.6562	-1.9595
3	1	0.1061	142.5621	-6.5934	13.7139	-6.5934
3	2	0.4094	360.5825	-12.4263	63.1093	-12.4263
3	3	0.4150	354.3667	-13.0404	58.8449	-13.0404
4	1	0.0000	0.0000	0.0000	0.0000	0.0000
4	2	0.0000	0.0000	0.0000	0.0000	0.0000
4	3	0.0000	0.0000	0.0000	0.0000	0.0000
5	1	0.0000	0.0000	0.0000	0.0000	0.0000
5	2	0.0000	-0.0001	0.0000	-0.0001	0.0000
5	3	0.0000	-0.0001	0.0000	-0.0001	0.0000
6	1	0.5163	150.1943	-1.0335	17.5769	-1.0335
6	2	0.1398	355.0688	-2.3106	56.2807	-2.3106
6	3	0.1408	350.3016	-2.3996	52.9010	-2.3996
7	1	-0.1060	142.5627	-6.5987	13.7158	-6.5987
7	2	-0.4138	333.1678	-15.1012	44.2916	-15.1012
7	3	-0.4082	339.3774	-14.4872	48.5516	-14.4872
8	1	0.0000	0.0000	-0.0011	0.0000	-0.0011
8	2	0.0000	-0.0024	-0.0037	-0.0024	-0.0037
8	3	0.0000	-0.0024	-0.0037	-0.0024	-0.0037
9	1	0.0000	0.0000	-0.0011	0.0000	-0.0011
9	2	0.0000	-0.0024	-0.0037	-0.0024	-0.0037
9	3	0.0000	-0.0024	-0.0037	-0.0024	-0.0037
10	1	0.0054	103.1683	-207.3935	103.1683	-207.3935
10	2	0.0129	10.8505	-833.0864	10.8505	-833.0864
10	3	0.0049	12.3456	-830.7139	12.3456	-830.7139
11	1	-0.0052	103.1343	-207.4057	103.1343	-207.4057
11	2	-0.0076	12.1231	-831.0626	12.1231	-831.0626
11	3	-0.0156	10.6284	-833.4350	10.6284	-833.4350

BEAM STRESSES

BAY	LOAD	I NORMAL	J NORMAL
1	1	0.0006	0.0033
1	2	0.0014	0.0085
1	3	0.0003	0.0014
2	1	0.5163	0.0304
2	2	1.9762	0.0602
2	3	2.0754	0.0576
3	1	0.3978	0.1913
3	2	1.8307	0.3605
3	3	1.7070	0.3783
4	1	0.0010	0.0010
4	2	0.0000	0.0014
4	3	0.0020	0.0035
5	1	0.0033	0.0006
5	2	0.0148	0.0023
5	3	0.0219	0.0033
6	1	0.5160	0.0303
6	2	1.6523	0.0678
6	3	1.5530	0.0704
7	1	0.3982	0.1916
7	2	1.2860	0.4385
7	3	1.4097	0.4206
8	1	0.0102	0.2385
8	2	0.5118	0.8057
8	3	0.5085	0.8035
9	1	0.0102	0.2386
9	2	0.5087	0.8035
9	3	0.5120	0.8057
10	1	2.0627	4.1465
10	2	0.2169	16.6564
10	3	0.2468	16.6089
11	1	2.0620	4.1468
11	2	0.2424	16.6160
11	3	0.2125	16.6634

STATIC AND DYNAMIC LOAD COMBINATION-----LATERAL AND ROTATIONAL M. C. DISPLACEMENTS

LEVEL	DIRECTION	1	2	3
2	X	-0.0462172	0.4845132	0.4845133
2	Y	0.0000000	0.0063410	0.0060298
2	ROTN	0.0000000	0.0000074	-0.0000105

1	X	-0.0090358	0.1776870	0.1776870
1	Y	0.0000000	0.0018068	0.0023773
1	ROTN	0.0000000	0.0000022	-0.0000036

THE STEEL WEIGHT IS 12.8383

THE CONCRETE WEIGHT IS 92.3758

THE OBJECTIVE VALUE IS 55776.7649
LARGEST SCALING FACTOR

LEVEL__________ 2
D.DIS__________ 0
LOAD CASE______ 3
FACTOR_________ 1.1012

COLUMN ID	E	A	TORS I	MAJ I	MIN I	DT	DB	D	BF	TF	TW	TS	CS	SS
1	30000.00	7.79	4.89	279.85	7.13	0.00	0.00	15.77	5.46	0.31	0.23	36.00	36.00	9999.00
2	30000.00	5.72	2.66	148.58	3.97	0.00	0.00	13.67	4.83	0.31	0.23	36.00	36.00	9999.00
3	30000.00	5.73	2.66	148.59	3.97	0.00	0.00	13.67	4.83	0.31	0.23	36.00	36.00	9999.00
4	30000.00	7.79	4.89	279.86	7.13	0.00	0.00	15.77	5.46	0.31	0.23	36.00	36.00	9999.00
5	30000.00	4.50	1.66	90.71	2.52	0.00	0.00	12.23	4.39	0.31	0.23	36.00	36.00	9999.00
6	30000.00	6.87	3.81	215.91	5.61	0.00	0.00	14.88	5.19	0.31	0.23	36.00	36.00	9999.00
7	30000.00	4.50	1.66	90.66	2.52	0.00	0.00	12.23	4.39	0.31	0.23	36.00	36.00	9999.00
8	30000.00	6.87	3.81	215.92	5.61	0.00	0.00	14.88	5.19	0.31	0.23	36.00	36.00	9999.00
9	30000.00	12.33	12.04	717.52	17.04	0.00	0.00	19.51	6.55	0.31	0.23	36.00	36.00	9999.00
10	30000.00	7.28	4.28	243.64	6.28	0.00	0.00	15.29	5.32	0.31	0.23	36.00	36.00	9999.00
11	30000.00	12.33	12.04	717.52	17.05	0.00	0.00	19.51	6.55	0.31	0.23	36.00	36.00	9999.00
12	30000.00	7.29	4.28	243.77	6.28	0.00	0.00	15.29	5.32	0.31	0.23	36.00	36.00	9999.00
13	30000.00	0.02	0.00	0.00	0.00	0.00	0.00	1.01	0.52	1.00	1.00	100.00	100.00	100.00
14	30000.00	0.02	0.00	0.00	0.00	0.00	0.00	1.01	0.52	1.00	1.00	100.00	100.00	100.00
15	30000.00	0.02	0.00	0.00	0.00	0.00	0.00	1.01	0.52	1.00	1.00	100.00	100.00	100.00
16	30000.00	0.02	0.00	0.00	0.00	0.00	0.00	1.01	0.52	1.00	1.00	100.00	100.00	100.00

COLUMN ID	IX	A	IY	KII	KJJ	KIJ	TS	CS	SS	FC	D	W	ES	RO	J	G
17	1976355.	1301.	30908.	4.0	4.0	2.0	50.0	3.0	1.0	3000.0	120.0	15.0	30000.0	0.025	2007263.	1150.
18	2489153.	1639.	61749.	4.0	4.0	2.0	50.0	3.0	1.0	3000.0	120.0	18.9	30000.0	0.025	2550902.	1150.
19	1976349.	1301.	30908.	4.0	4.0	2.0	50.0	3.0	1.0	3000.0	120.0	15.0	30000.0	0.025	2007257.	1150.
20	2489162.	1639.	61750.	4.0	4.0	2.0	50.0	3.0	1.0	3000.0	120.0	18.9	30000.0	0.025	2550912.	1150.

BEAM ID	E	TORS I	FLEX I	KII	KJJ	KIJ	DI	DJ	D	WS
1	30000.00	5.12	293.87	4.00	4.00	2.00	0.00	0.00	15.95	36.00
2	30000.00	5.12	293.70	4.00	4.00	2.00	0.00	0.00	15.95	36.00
3	30000.00	5.12	293.89	4.00	4.00	2.00	0.00	0.00	15.95	36.00
4	30000.00	8.60	504.75	4.00	4.00	2.00	0.00	0.00	18.02	36.00
5	30000.00	8.60	504.74	4.00	4.00	2.00	0.00	0.00	18.02	36.00
6	30000.00	8.20	480.18	4.00	4.00	2.00	0.00	0.00	17.82	36.00
7	30000.00	6.48	375.50	4.00	4.00	2.00	0.00	0.00	16.86	36.00
8	30000.00	8.20	480.18	4.00	4.00	2.00	0.00	0.00	17.82	36.00
9	30000.00	6.48	375.53	4.00	4.00	2.00	0.00	0.00	16.86	36.00
10	30000.00	5.09	292.12	4.00	4.00	2.00	60.00	0.00	15.93	36.00
11	30000.00	5.11	292.99	4.00	4.00	2.00	60.00	0.00	15.94	36.00
12	30000.00	5.17	296.87	4.00	4.00	2.00	60.00	0.00	15.99	36.00
13	30000.00	5.15	295.79	4.00	4.00	2.00	60.00	0.00	15.97	36.00
14	30000.00	5.09	292.32	4.00	4.00	2.00	60.00	0.00	15.93	36.00
15	30000.00	5.11	293.06	4.00	4.00	2.00	60.00	0.00	15.94	36.00
16	30000.00	5.16	296.53	4.00	4.00	2.00	60.00	0.00	15.98	36.00
17	30000.00	5.15	295.62	4.00	4.00	2.00	60.00	0.00	15.97	36.00
18	30000.00	0.00	0.00	4.00	4.00	2.00	0.00	0.00	1.18	99.99
19	30000.00	0.00	0.00	4.00	4.00	2.00	0.00	0.00	1.18	99.99
20	30000.00	0.00	0.00	4.00	4.00	2.00	0.00	0.00	1.18	99.99
21	30000.00	0.00	0.00	4.00	4.00	2.00	0.00	0.00	1.18	99.99
22	30000.00	0.00	0.00	4.00	4.00	2.00	0.00	0.00	1.18	99.99

BRACING ELEMENT INFORMATION

LEVEL	UC	LC	E	A	TS	CS
1	3	2	30000.00000	6.60701	36.00000	24.00000
1	2	3	30000.00000	6.60695	36.00000	24.00000

THE EIGENSOLUTIONS ARE:

FREQ. 1 IS 11.26

THE EIGENMODE IS:

0.302907076085E-02 0.164265855784E-04 0.164354095413E-04 0.302869798105E-02 0.617790419623E-02 0.754350829698E-05
0.617801979355E-02 -0.651279215666E-02 -0.114211409892E-04 -0.651080259171E-02 0.301887192733E-02 0.163554246554E-04
0.163642667891E-04 0.301850127415E-02 0.181397287599E-02 0.386258135610E-05 0.181375721758E-02 -0.492449314653E-02
-0.674270656267E-05 -0.492276016014E-02 0.131176291467E+01 -0.571185358794E-14 -0.543391675304E-10 0.412565048663E+00
-0.309434655522E-13 0.789053094015E-10

FREQ. 2 IS 40.65

THE EIGENMODE IS:

```
 0.452272581178E-02  0.251420639903E-04  0.251911269684E-04  0.452320752066E-02 -0.203678288441E-01 -0.281182360460E-04
-0.203675715710E-01  0.959712116448E-02  0.165015759396E-04  0.959359214338E-02  0.453426148436E-02  0.249975224168E-04
 0.250464883514E-04  0.453473822730E-02 -0.120866251083E-01 -0.159134856594E-04 -0.120854447813E-01  0.655702024731E-02
 0.959089673274E-05  0.655387082984E-02 -0.614629729226E+00  0.105162461632E-12  0.670158822473E-11  0.880505810031E+00
-0.238114538256E-12  0.257931500925E-09
```

FREQ. 3 IS 463.55

THE EIGENMODE IS:

```
 0.559035217175E-02 -0.153340593305E-02  0.153499210766E-02  0.667881198059E-01  0.152278772847E+01  0.428388729731E-01
 0.183118923146E+02  0.238097300132E-01  0.766670526873E-03  0.286952293583E+00  0.419787616129E-02 -0.120531467557E-02
 0.120497757632E-02  0.501509703562E-01  0.834315672402E+00  0.267598580058E-01  0.100304570328E+02  0.181712512722E-01
 0.491628604886E-03  0.218850239591E+00 -0.114274056998E-02 -0.285099825694E-07  0.520015593069E-05  0.946278408831E-03
 0.217814525203E-07  0.976269054836E-05
```

THE PERIOD USED IN THE CALCULATIONS IS 0.45542

LATERAL FORCES:

STORY NO.	VALUE
1	0.311817E+02
2	0.280986E+02

DRIFT:

STORY NO.	VALUE
1	0.108652E+01
2	0.223128E+01

THETA:

STORY NO.	VALUE
1	0.116081E-01
2	0.781073E-02

THE EIGENSOLUTIONS ARE:

FREQ. 1 IS 58.31

THE EIGENMODE IS:

```
 0.258625522705E-02  0.112292404357E+00 -0.112290248979E+00 -0.258638831280E-02  0.264774973354E-01  0.520822325892E-06
-0.264941413536E-01  0.217459933187E-01 -0.969455349484E-06 -0.217252664515E-01  0.256151905578E-02  0.111922685718E+00
-0.111920537677E+00 -0.256165129603E-02  0.143056693710E-01  0.258829388808E-06 -0.143115842872E-01  0.163975068015E-01
-0.507713590576E-06 -0.163816928295E-01 -0.243038654906E-13  0.130892359025E+01 -0.356829956497E-06  0.271103295803E-13
 0.416550134925E+00 -0.237038425335E-05
```

FREQ. 2 IS 256.60

THE EIGENMODE IS:

```
 0.684824360360E-02  0.338432632344E+00 -0.338425856722E+00 -0.684840873096E-02 -0.611676241259E-01 -0.138484471144E-05
 0.612230231933E-01 -0.371292018565E-01  0.197702394444E-05  0.370860866564E-01  0.633585869217E-02  0.316322950836E+00
-0.316316624143E+00 -0.633601250143E-02 -0.240734925673E-01 -0.638794134425E-06  0.240925117436E-01 -0.245132025736E-01
 0.926178087913E-06  0.244826207764E-01  0.898267026378E-13 -0.611625334446E+00 -0.526730250285E-04 -0.352727945218E-12
 0.865488618440E+00 -0.773970727120E-03
```

FREQ. 3 IS 463.55

THE EIGENMODE IS:

```
 0.110610406141E-01 -0.273444346758E-02  0.273599204312E-02  0.661189458561E-01  0.303179099773E+01  0.456889651131E-01
 0.181230104597E+02  0.477521054184E-01  0.817415406028E-03  0.283577050538E+00  0.830564296742E-02 -0.215012267428E-02
 0.214965094987E-02  0.496484658422E-01  0.166098775161E+01  0.285402819277E-01  0.992702918797E+01  0.364285982760E-01
 0.524169811929E-03  0.216283478941E+00  0.124150297795E-07  0.280918564233E-02  0.518940333743E-05 -0.227398491584E-07
-0.124979141184E-02  0.147517237351E-04
```

THE PERIOD USED IN THE CALCULATIONS IS 0.10776

LATERAL FORCES:

STORY NO.	VALUE
1	0.311817E+02
2	0.280986E+02

DRIFT:

STORY NO.	VALUE
1	0.417214E-01
2	0.815575E-01

LOAD COMBINATIONS-----MEMBER FORCES-----LEVEL NO. 1

COLUMN FORCES

LINE	LOAD	TORSIONAL	MAJOR AXIS		AXIAL	MINOR AXIS		MAJOR	MINOR
		MOMENT	TOP MOMENT	BOT MOMENT	FORCE	TOP MOMENT	BOT MOMENT	SHEAR	SHEAR
1	1	0.0000	-51.0334	-34.6736	2.1070	-0.3727	-0.1863	-0.5952	-0.0039
1	2	0.0008	151.1494	252.0783	1.1524	-0.8382	-0.3867	2.8002	-0.0085
1	3	-0.0013	149.5135	249.8949	1.1602	-0.6517	-0.2275	2.7737	-0.0061
2	1	0.0000	-5.1969	-2.5985	1.2719	0.0970	0.1785	-0.0541	0.0019
2	2	0.0005	-11.3241	-4.9879	-1.5407	-0.2872	-2.6446	-0.1133	-0.0204
2	3	-0.0007	-9.2491	-2.5753	-0.8613	-0.2845	-2.6350	-0.0821	-0.0203
3	1	0.0000	5.1969	2.5984	1.2719	0.0970	0.1785	0.0541	0.0019
3	2	0.0005	13.3526	7.3505	-2.2072	-0.2850	-2.6373	0.1438	-0.0203
3	3	-0.0007	15.4278	9.7638	-2.8866	-0.2877	-2.6470	0.1749	-0.0204
4	1	0.0000	-51.0326	-34.6737	2.1071	0.3726	0.1863	-0.5952	0.0039
4	2	0.0008	149.8186	250.3710	1.1212	1.0204	0.5425	2.7791	0.0109
4	3	-0.0013	151.4544	252.5545	1.1134	1.2068	0.7018	2.8056	0.0133
5	1	0.0000	-26.6652	-20.3975	2.4634	-1.4898	-0.7449	-0.3268	-0.0155
5	2	0.0007	34.7932	153.5756	-19.3266	-4.5056	-2.2153	1.3081	-0.0467
5	3	-0.0010	33.3723	151.8116	-19.2917	-4.4160	-2.1499	1.2860	-0.0456
6	1	0.0025	0.0260	-0.0143	3.7888	-185.7138	109.1942	0.0001	-0.5314
6	2	41.9040	-406.4588	1459.4555	-18.7189	382.1382	-3691.9641	7.3125	-22.9649
6	3	-67.1560	-709.2381	2223.6444	-18.7189	382.1386	-3691.9641	10.5167	-22.9849
7	1	0.0000	-26.6736	-20.4020	2.4636	1.4895	0.7447	-0.3269	0.0155
7	2	0.0007	33.6976	152.2220	-19.4724	4.8232	2.4491	1.2911	0.0505
7	3	-0.0010	35.1188	153.9862	-19.5073	4.9129	2.5146	1.3132	0.0516
8	1	0.0000	43.1123	13.5841	4.6823	-1.5996	-0.7998	0.3937	-0.0167
8	2	0.0007	141.9929	224.6626	-17.6211	-4.7019	-2.2888	2.5462	-0.0485
8	3	-0.0012	142.3854	223.6700	-17.6616	-4.8167	-2.3757	2.5421	-0.0499
9	1	0.0025	-0.0178	0.0123	4.0463	-185.4829	109.3119	0.0000	-0.5290
9	2	41.9042	-723.3564	2101.0314	-18.1438	382.2580	-3691.9482	9.5672	-22.9840
9	3	-67.1562	-428.4193	1081.9432	-18.1438	382.2584	-3691.9481	4.5384	-22.9840
10	1	0.0000	43.1281	13.5875	4.6821	1.6012	0.8006	0.3939	0.0167
10	2	0.0007	142.5338	224.1036	-17.8685	5.1941	2.6592	2.5461	0.05-5
10	3	-0.0012	142.1411	225.0967	-17.8281	5.0792	2.5723	2.5503	0.0531

COLUMN STRESSES

LINE	LOAD	TOP-MAX	TOP-MIN	BOT-MAX	BOT-MIN	SHEAR-MAJ	SHEAR-MIN
1	1	1.8512	-1.3105	1.3189	-0.7781	-0.0764	-0.0005
1	2	4.7284	-4.4327	7.4002	-7.1044	0.3593	-0.0011
1	3	4.6120	-4.3142	7.2787	-6.9809	0.3559	-0.0008
2	1	0.5203	-0.0759	0.4503	-0.0059	-0.0095	0.0003
2	2	0.4265	-0.9647	1.5686	-2.1069	-0.0198	-0.0036
2	3	0.4481	-0.7490	1.5704	-1.8713	-0.0143	-0.0035
3	1	0.5202	-0.0759	0.4502	-0.0059	0.0095	0.0003
3	2	0.4020	-1.1731	1.5563	-2.3274	0.0251	-0.0035
3	3	0.3804	-1.3888	1.5545	-2.5629	0.0306	-0.0036

4	1	1.8511	-1.3104	1.3188	-0.7781	-0.0764	0.0005
4	2	4.7564	-4.4687	7.4074	-7.1197	0.3566	0.0014
4	3	4.8729	-4.5872	7.5289	-7.2431	0.3600	0.0017
5	1	1.9664	-1.2491	1.4059	-0.6886	-0.0476	-0.0023
5	2	0.4689	-6.0969	3.5013	-9.1293	0.1905	-0.0068
5	3	0.3835	-6.0014	3.4153	-9.0332	0.1872	-0.0066
6	1	0.3806	-0.0181	0.2562	-0.0107	0.0000	-0.0003
6	2	0.6112	0.5559	6.2629	7.0114	0.0045	-0.0140
6	3	0.6888	0.6404	6.4587	7.2235	0.0064	-0.0140
7	1	1.9666	-1.2492	1.4060	-0.6886	-0.0476	0.0023
7	2	0.5568	-6.2272	3.5415	-9.2118	0.1880	0.0074
7	3	0.6421	-6.3227	3.6274	-9.3080	0.1912	0.0075
8	1	2.6727	-1.3872	1.4076	-0.1221	0.0541	-0.0023
8	2	4.0268	-8.8648	5.5986	-10.4367	0.3495	-0.0067
8	3	4.0822	-8.9314	5.5987	-10.4479	0.3490	-0.0069
9	1	0.3856	-0.0181	0.2617	-0.0107	0.0000	-0.0003
9	2	0.6961	0.6486	6.4307	7.1948	0.0058	-0.0140
9	3	0.6206	0.5664	6.1697	6.9110	0.0028	-0.0140
10	1	2.6728	-1.3876	1.4076	-0.1224	0.0541	0.0023
10	2	4.2161	-9.1208	5.7011	-10.6058	0.3494	0.0075
10	3	4.1607	-9.0543	5.7010	-10.5946	0.3500	0.0073

BEAM FORCES

		TORSIONAL	CENTERLINE MOMENTS		BEAM END MOMENTS	
BAY	LOAD	MOMENT	I MOMENT	J MOMENT	I MOMENT	J MOMENT
1	1	-0.0970	0.2627	-44.6940	0.2627	-44.6940
1	2	0.2861	0.4825	-97.8391	0.4825	-97.8391
1	3	0.2664	0.2965	-100.1714	0.2965	-100.1714
2	1	-0.0753	148.8293	-2.6162	17.0541	-2.6162
2	2	0.1075	590.4411	-7.3773	90.8515	-7.3773
2	3	0.1090	594.1348	-7.2055	93.4407	-7.2055
3	1	0.0727	140.4765	-8.1447	12.6674	-8.1447
3	2	0.3170	576.6036	-20.2885	84.6564	-20.2885
3	3	0.3226	571.4718	-20.9874	81.1906	-20.9874
4	1	0.0000	49.8909	-49.8913	49.8909	-49.8913
4	2	-0.0011	109.1633	-108.9264	109.1633	-108.9264
4	3	0.0018	109.4205	-108.6692	109.4205	-108.6692
5	1	0.0970	44.6944	-0.2627	44.6944	-0.2627
5	2	-0.2862	95.5737	-0.6531	95.5737	-0.6531
5	3	-0.2859	93.2412	-0.8390	93.2412	-0.8390
6	1	0.0753	148.8302	-2.6150	17.0544	-2.6150
6	2	-0.1087	577.5715	-7.9612	81.8257	-7.9612
6	3	-0.1071	573.8771	-8.1330	79.2359	-8.1330
7	1	-0.0726	140.4747	-8.1503	12.6677	-8.1503
7	2	-0.3215	554.5804	-23.3222	69.7923	-23.3222
7	3	-0.3159	559.7096	-22.6233	73.2563	-22.6233
8	1	-0.1100	51.1307	-131.9561	51.1307	-131.9561
8	2	-0.3557	-151.4375	-631.2232	-151.4375	-631.2232
8	3	-0.3552	-149.8018	-629.6989	-149.8018	-629.6989
9	1	0.1100	51.1299	-131.9642	51.1299	-131.9642
9	2	0.3673	-150.1067	-629.9363	-150.1067	-629.9363
9	3	0.3678	-151.7423	-631.4604	-151.7423	-631.4604
10	1	0.0027	224.7724	-184.6636	224.7724	-184.6636
10	2	0.0122	581.9832	-984.7502	581.9832	-984.7502
10	3	0.0077	583.3411	-982.7772	583.3411	-982.7772
11	1	-0.0027	224.7660	-184.6678	224.7660	-184.6678
11	2	-0.0100	583.0637	-983.1429	583.0637	-983.1429
11	3	-0.0145	581.7059	-985.1161	581.7059	-985.1161

BEAM STRESSES

BAY	LOAD	I NORMAL	J NORMAL
1	1	0.0071	1.2128
1	2	0.0131	2.6550
1	3	0.0080	2.7183
2	1	0.4639	0.0712
2	2	2.4711	0.2007
2	3	2.5415	0.1960
3	1	0.3420	0.2199
3	2	2.2857	0.5478
3	3	2.1921	0.5667
4	1	1.3545	1.3545
4	2	2.9636	2.9572
4	3	2.9706	2.9502
5	1	1.2128	0.0071
5	2	2.5934	0.0177
5	3	2.5301	0.0228
6	1	0.4638	0.0711
6	2	2.2252	0.2165
6	3	2.1548	0.2212

7	1	0.3422	0.2202
7	2	1.8852	0.6300
7	3	1.9788	0.6111
8	1	0.9129	2.3559
8	2	2.7037	11.2695
8	3	2.6745	11.2422
9	1	0.9129	2.3561
9	2	2.6800	11.2467
9	3	2.7092	11.2739
10	1	5.0454	4.1451
10	2	13.0636	22.1045
10	3	13.0941	22.0602
11	1	5.0449	4.1449
11	2	13.0870	22.0669
11	3	13.0565	22.1112

BRACING ELEMENTS

BRACE	LOAD	AXIAL-FORCE
1	1	0.5728
1	2	-0.2922
1	3	0.8336
2	1	0.5729
2	2	-1.3958
2	3	-2.5215

BRACE STRESSES

BRACE	LOAD	AXIAL
1	1	0.0867
1	2	-0.0442
1	3	0.1262
2	1	0.0867
2	2	-0.2113
2	3	-0.3816

LOAD COMBINATIONS-----MEMBER FORCES-----LEVEL NO. 2

COLUMN FORCES

LINE	LOAD	TORSIONAL	MAJOR AXIS		AXIAL	MINOR AXIS		MAJOR	MINOR
		MOMENT	TOP MOMENT	BOT MOMENT	FORCE	TOP MOMENT	BOT MOMENT	SHEAR	SHEAR
1	1	0.0000	0.0001	-0.0003	0.0000	0.0000	0.0000	0.0000	0.0000
1	2	0.0000	0.0022	0.0020	0.0000	0.0000	0.0000	0.0000	0.0000
1	3	0.0000	0.0022	0.0019	0.0000	0.0000	0.0000	0.0000	0.0000
2	1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	2	0.0000	0.0000	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
2	3	0.0000	0.0000	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
3	1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3	2	0.0000	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
3	3	0.0000	0.0001	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000
4	1	0.0000	0.0001	-0.0003	0.0000	0.0000	0.0000	0.0000	0.0000
4	2	0.0000	0.0022	0.0020	0.0000	0.0000	0.0000	0.0000	0.0000
4	3	0.0000	0.0022	0.0020	0.0000	0.0000	0.0000	0.0000	0.0000
5	1	0.0000	-100.3746	-66.0757	0.3154	-1.0256	-1.0137	-1.1559	-0.0142
5	2	0.0007	-24.3950	14.3393	-3.5908	-1.9939	-2.5037	-0.0698	-0.0312
5	3	-0.0009	-25.9111	12.8765	-3.5783	-1.9124	-2.4266	-0.0905	-0.0301
6	1	0.0068	0.0009	-0.0269	-0.6187	1.0066	185.8644	-0.0002	1.2977
6	2	75.8697	15.6887	419.3285	-7.6900	0.3776	-382.3544	3.0210	-2.6526
6	3	-102.7006	25.3412	729.4959	-7.6899	0.3776	-382.3547	5.2419	-2.6526
7	1	0.0000	-100.3411	-66.0529	0.3155	1.0246	1.0129	-1.1555	0.0141
7	2	0.0007	-25.6778	13.0663	-3.6760	2.2627	2.7607	-0.0876	0.0349
7	3	-0.0009	-24.1621	14.5286	-3.6885	2.3442	2.8378	-0.0669	0.0360
8	1	0.0000	210.9386	141.4786	-0.3593	-6.5790	-6.5478	2.4473	-0.0912
8	2	0.0047	811.2526	842.4404	-8.0615	-12.2440	-15.5989	11.4840	-0.1934
8	3	-0.0064	808.8427	840.0691	-8.0834	-12.8532	-16.1784	11.4508	-0.2016
9	1	0.0068	-0.0009	0.0196	-0.4935	-0.2187	185.3376	0.0001	1.2855
9	2	75.8695	27.7153	745.3797	-7.4249	-0.7998	-382.8965	5.3687	-2.6646
9	3	-102.7003	15.1532	440.1816	-7.4249	-0.7998	-382.8969	3.1620	-2.6646
10	1	0.0000	210.9506	141.4671	-0.3594	6.5841	6.5518	2.4473	0.0912
10	2	0.0047	809.2045	840.2876	-8.1970	14.9267	18.1381	11.4548	0.2296
10	3	-0.0064	811.6142	842.6592	-8.1750	14.3176	17.5586	11.4880	0.2214

COLUMN STRESSES

LINE	LOAD	TOP-MAX	TOP-MIN	BOT-MAX	BOT-MIN	SHEAR-MAJ	SHEAR-MIN
1	1	0.0326	-0.0322	0.1131	-0.1126	-0.0001	0.0000
1	2	0.7786	-0.7763	0.7046	-0.7023	0.0014	0.0000
1	3	0.7598	-0.7575	0.6849	-0.6826	0.0014	0.0000
2	1	0.0069	-0.0069	0.0430	-0.0430	0.0000	0.0000
2	2	0.0134	-0.0133	0.0935	-0.0935	0.0000	0.0000
2	3	0.0013	-0.0013	0.0775	-0.0775	0.0000	0.0000
3	1	0.0069	-0.0069	0.0430	-0.0430	0.0000	0.0000
3	2	0.0258	-0.0257	0.1060	-0.1060	0.0001	0.0000
3	3	0.0404	-0.0404	0.1220	-0.1219	0.0001	0.0000
4	1	0.0327	-0.0322	0.1131	-0.1126	-0.0001	0.0000
4	2	0.7855	-0.7832	0.7105	-0.7082	0.0014	0.0000
4	3	0.8042	-0.8019	0.7301	-0.7279	0.0014	0.0000
5	1	7.7305	-7.5904	5.4084	-5.2683	-0.2568	-0.0031
5	2	2.5866	-4.1820	2.3538	-3.9491	-0.0155	-0.0069
5	3	2.6204	-4.2102	2.1907	-3.7805	-0.0201	-0.0067
6	1	-0.0022	-0.0025	0.4747	0.5354	0.0000	0.0010
6	2	-0.0531	-0.0645	1.0624	0.9968	0.0023	-0.0020
6	3	-0.0500	-0.0611	1.1624	1.1058	0.0040	-0.0020
7	1	7.7305	-7.5903	5.4083	-5.2681	-0.2568	0.0031
7	2	2.8900	-4.5236	2.4744	-4.1080	-0.0195	0.0078
7	3	2.8561	-4.4953	2.6375	-4.2767	-0.0149	0.0080
8	1	4.1030	-4.1613	3.1524	-3.2107	0.1985	-0.0074
8	2	12.7297	-14.0374	13.7982	-15.1060	0.9315	-0.0157
8	3	12.8121	-14.1235	13.8755	-15.1868	0.9288	-0.0164
9	1	-0.0032	-0.0039	0.4743	0.5349	0.0000	0.0010
9	2	-0.0461	-0.0561	1.1710	1.1152	0.0041	-0.0020
9	3	-0.0501	-0.0605	1.0726	1.0079	0.0024	-0.0020
10	1	4.1041	-4.1624	3.1530	-3.2113	0.1985	0.0074
10	2	13.2060	-14.5358	14.2455	-15.5753	0.9291	0.0186
10	3	13.1236	-14.4498	14.1662	-15.4944	0.9318	0.0180

BEAM FORCES

BAY	LOAD	TORSIONAL MOMENT	CENTERLINE MOMENTS I MOMENT	CENTERLINE MOMENTS J MOMENT	BEAM END MOMENTS I MOMENT	BEAM END MOMENTS J MOMENT
1	1	0.0000	0.0000	0.0000	0.0000	0.0000
1	2	0.0000	0.0000	0.0000	0.0000	0.0000
1	3	0.0000	0.0000	0.0000	0.0000	0.0000
2	1	-0.5031	149.9934	-1.0309	17.4327	-1.0309
2	2	-0.1892	372.2271	-2.0056	68.4495	-2.0056
2	3	-0.1882	377.0518	-1.9160	71.8702	-1.9160
3	1	0.1094	142.3891	-6.5737	13.5847	-6.5737
3	2	0.3977	361.8466	-12.2323	63.9568	-12.2323
3	3	0.4033	355.5625	-12.8495	59.6445	-12.8495
4	1	0.0000	0.0000	0.0000	0.0000	0.0000
4	2	0.0000	0.0000	0.0000	0.0000	0.0000
4	3	0.0000	0.0000	0.0000	0.0000	0.0000
5	1	0.0000	0.0000	0.0000	0.0000	0.0000
5	2	0.0000	-0.0001	0.0000	-0.0001	0.0000
5	3	0.0000	-0.0001	0.0000	-0.0001	0.0000
6	1	0.5035	149.9925	-1.0298	17.4317	-1.0298
6	2	0.1884	356.5385	-2.2690	57.3186	-2.2690
6	3	0.1894	351.7106	-2.3586	53.8958	-2.3586
7	1	-0.1093	142.3900	-6.5789	13.5869	-6.5789
7	2	-0.4021	334.1313	-14.9204	44.9282	-14.9204
7	3	-0.3965	340.4092	-14.3032	49.2361	-14.3032
8	1	0.0000	-0.0001	-0.0011	-0.0001	-0.0011
8	2	0.0000	-0.0022	-0.0036	-0.0022	-0.0036
8	3	0.0000	-0.0022	-0.0036	-0.0022	-0.0036
9	1	0.0000	-0.0001	-0.0011	-0.0001	-0.0011
9	2	0.0000	-0.0022	-0.0036	-0.0022	-0.0036
9	3	0.0000	-0.0022	-0.0036	-0.0022	-0.0036
10	1	0.0053	100.8790	-211.0480	100.8790	-211.0480
10	2	0.0117	24.5878	-811.6503	24.5878	-811.6503
10	3	0.0036	26.1029	-809.2460	26.1029	-809.2460
11	1	-0.0052	100.8457	-211.0599	100.8457	-211.0599
11	2	-0.0064	25.8698	-809.6065	25.8698	-809.6065
11	3	-0.0144	24.3552	-812.0107	24.3552	-812.0107

BEAM STRESSES

BAY	LOAD	I NORMAL	J NORMAL
1	1	0.0006	0.0032
1	2	0.0012	0.0077
1	3	0.0003	0.0010
2	1	0.4752	0.0281
2	2	1.8661	0.0547
2	3	1.9593	0.0522

3	1	0.3658	0.1770
3	2	1.7220	0.3293
3	3	1.6059	0.3460
4	1	0.0009	0.0009
4	2	0.0001	0.0013
4	3	0.0017	0.0031
5	1	0.0032	0.0006
5	2	0.0136	0.0021
5	3	0.0205	0.0031
6	1	0.4750	0.0281
6	2	1.5618	0.0618
6	3	1.4685	0.0643
7	1	0.3661	0.1773
7	2	1.2107	0.4021
7	3	1.3268	0.3854
8	1	0.0145	0.2248
8	2	0.4461	0.7267
8	3	0.4430	0.7247
9	1	0.0145	0.2248
9	2	0.4433	0.7247
9	3	0.4464	0.7267
10	1	1.8720	3.9163
10	2	0.4563	15.0614
10	3	0.4844	15.0168
11	1	1.8714	3.9165
11	2	0.4801	15.0235
11	3	0.4519	15.0681

STATIC AND DYNAMIC LOAD COMBINATION-----LATERAL AND ROTATIONAL M. C. DISPLACEMENTS

LEVEL	DIRECTION	1	2	3
2	X	-0.0378621	0.4014228	0.4014229
2	Y	0.0000000	0.0058316	0.0055477
2	ROTN	0.0000000	0.0000068	-0.0000097
1	X	-0.0075390	0.1448851	0.1448851
1	Y	0.0000000	0.0016624	0.0021887
1	ROTN	0.0000000	0.0000021	-0.0000033

THE STEEL WEIGHT IS 13.4971

THE CONCRETE WEIGHT IS 101.7211

THE OBJECTIVE VALUE IS 61031.4946

ACTIVE CONSTRAINTS

TYPE	LEVEL	LOCATION	LOAD	IDENT	VALUE
D.DIS_________	2	0	2	1	0.40142
D.DIS_________	2	0	3	1	0.40142

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THE END OF OPTIMIZATION CYCLE 1 .

THE START OF OPTIMIZATION CYCLE 2 .

****

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THE END OF OPTIMIZATION CYCLE 6 .

THE START OF OPTIMIZATION CYCLE 7 .

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THE FINAL OPTIMAL RESULTS ARE:

COLUMN ID	E	A	TORS I	MAJ I	MIN I	DT	DB	Q	BF	TF	TW	TS	CS	SS
1	30000.00	17.05	22.79	1396.00	31.55	0.00	0.00	22.68	7.45	0.31	0.23	36.00	36.00	9999.00
2	30000.00	2.68	0.60	31.31	0.94	0.00	0.00	9.62	3.58	0.31	0.23	36.00	36.00	9999.00
3	30000.00	2.68	0.60	31.32	0.94	0.00	0.00	9.62	3.58	0.31	0.23	36.00	36.00	9999.00
4	30000.00	17.05	22.78	1395.41	31.54	0.00	0.00	22.68	7.45	0.31	0.23	36.00	36.00	9999.00
5	30000.00	3.64	1.10	58.76	1.68	0.00	0.00	11.09	4.04	0.31	0.23	36.00	36.00	9999.00
6	30000.00	12.78	12.92	772.18	18.24	0.00	0.00	19.84	6.64	0.31	0.23	36.00	36.00	9999.00
7	30000.00	3.64	1.10	58.76	1.68	0.00	0.00	11.09	4.04	0.31	0.23	36.00	36.00	9999.00
8	30000.00	12.78	12.92	771.88	18.24	0.00	0.00	19.84	6.64	0.31	0.23	36.00	36.00	9999.00
9	30000.00	16.61	21.64	1322.89	30.02	0.00	0.00	22.41	7.37	0.31	0.23	36.00	36.00	9999.00
10	30000.00	4.80	1.88	103.55	2.84	0.00	0.00	12.60	4.51	0.31	0.23	36.00	36.00	9999.00
11	30000.00	16.61	21.64	1322.78	30.01	0.00	0.00	22.41	7.37	0.31	0.23	36.00	36.00	9999.00
12	30000.00	4.81	1.89	104.03	2.86	0.00	0.00	12.61	4.51	0.31	0.23	36.00	36.00	9999.00
13	30000.00	0.02	0.00	0.00	0.00	0.00	0.00	0.93	0.48	1.00	1.00	100.00	100.00	100.00
14	30000.00	0.02	0.00	0.00	0.00	0.00	0.00	0.93	0.48	1.00	1.00	100.00	100.00	100.00
15	30000.00	0.02	0.00	0.00	0.00	0.00	0.00	0.93	0.48	1.00	1.00	100.00	100.00	100.00
16	30000.00	0.02	0.00	0.00	0.00	0.00	0.00	0.93	0.48	1.00	1.00	100.00	100.00	100.00

COLUMN ID	IX	A	II	KII	KJJ	KIJ	TS	CS	SS	EC	D	H	ES	RO	J	G
17	658493.	434.	1143.	4.0	4.0	2.0	50.0	3.0	1.0	3000.0	120.0	5.0	30000.0	0.025	659636.	1150.
18	658493.	434.	1143.	4.0	4.0	2.0	50.0	3.0	1.0	3000.0	120.0	5.0	30000.0	0.025	659636.	1150.
19	658493.	434.	1143.	4.0	4.0	2.0	50.0	3.0	1.0	3000.0	120.0	5.0	30000.0	0.025	659636.	1150.
20	658493.	434.	1143.	4.0	4.0	2.0	50.0	3.0	1.0	3000.0	120.0	5.0	30000.0	0.025	659636.	1150.

BEAM ID	E	TORS I	FLEX I	KII	KJJ	KIJ	DI	DJ	Q	NS
1	30000.00	1.12	60.00	4.00	4.00	2.00	0.00	0.00	11.14	36.00
2	30000.00	1.12	60.01	4.00	4.00	2.00	0.00	0.00	11.14	36.00
3	30000.00	1.12	60.02	4.00	4.00	2.00	0.00	0.00	11.14	36.00
4	30000.00	13.54	810.83	4.00	4.00	2.00	0.00	0.00	20.06	36.00
5	30000.00	13.54	810.54	4.00	4.00	2.00	0.00	0.00	20.06	36.00
6	30000.00	10.82	641.50	4.00	4.00	2.00	0.00	0.00	19.03	36.00
7	30000.00	7.09	413.05	4.00	4.00	2.00	0.00	0.00	17.22	36.00
8	30000.00	10.82	641.55	4.00	4.00	2.00	0.00	0.00	19.03	36.00
9	30000.00	7.10	413.18	4.00	4.00	2.00	0.00	0.00	17.23	36.00
10	30000.00	1.08	57.83	4.00	4.00	2.00	60.00	0.00	11.05	36.00
11	30000.00	1.10	59.29	4.00	4.00	2.00	60.00	0.00	11.11	36.00
12	30000.00	1.17	62.71	4.00	4.00	2.00	60.00	0.00	11.25	36.00
13	30000.00	1.17	63.10	4.00	4.00	2.00	60.00	0.00	11.26	36.00
14	30000.00	1.08	58.16	4.00	4.00	2.00	60.00	0.00	11.06	36.00
15	30000.00	1.11	59.36	4.00	4.00	2.00	60.00	0.00	11.11	36.00
16	30000.00	1.16	62.20	4.00	4.00	2.00	60.00	0.00	11.23	36.00
17	30000.00	1.17	62.76	4.00	4.00	2.00	60.00	0.00	11.25	36.00
18	30000.00	0.00	0.00	4.00	4.00	2.00	0.00	0.00	0.93	99.99
19	30000.00	0.00	0.00	4.00	4.00	2.00	0.00	0.00	0.93	99.99
20	30000.00	0.00	0.00	4.00	4.00	2.00	0.00	0.00	0.93	99.99
21	30000.00	0.00	0.00	4.00	4.00	2.00	0.00	0.00	0.93	99.99
22	30000.00	0.00	0.00	4.00	4.00	2.00	0.00	0.00	0.93	99.99

BRACING ELEMENT INFORMATION

LEVEL	UC	LC	E	A	TS	CS
1	3	2	30000.00000	1.34878	36.00000	24.00000
1	2	3	30000.00000	1.34870	36.00000	24.00000

EIGENVALUES AND EIGENVECTORS

0.897584325605E+02	0.259922666521E-02	0.144935315112E-04	0.144298070324E-04	0.259869849458E-02	0.760558912775E-02
0.622491939770E-05	0.760822467698E-02	-0.117787046901E-01	-0.285325244416E-04	-0.117579793397E-01	0.259376961037E-02
0.144588679612E-04	0.143951534638E-04	0.259324175450E-02	0.395783718857E-03	0.327946531640E-05	0.397674269848E-03
-0.102057503260E-01	-0.187809440289E-04	-0.101846861205E-01	0.144001941253E+01	-0.138559174227E-12	0.217791018540E-09
0.312215558753E+00	0.238133564955E-12	-0.715461376673E-09			
0.473267280166E+03	0.771242069689E-02	0.437980770616E-04	0.438861844493E-04	0.771061244643E-02	-0.239695976099E-01
-0.278546947451E-04	-0.239694873497E-01	0.120160139817E-01	0.287535114106E-04	0.119943910805E-01	0.771912389035E-02
0.436819437906E-04	0.437700611843E-04	0.771731529429E-02	-0.140103821617E-01	-0.185376873146E-04	-0.140080904738E-01
0.983441515684E-02	0.187848246267E-04	0.981207835002E-02	-0.463565118886E+00	0.217954438342E-12	-0.926870390360E-09
0.969858253068E+00	-0.429421502437E-12	0.144648196528E-08			
0.180301242691E+06	-0.378429057610E-02	0.269026358351E-03	-0.302052334029E-03	-0.271601220724E-04	0.188909602877E+00
0.528984419280E-04	0.157446025308E-02	0.148098716024E+02	0.555525984358E-01	0.123283247304E+00	-0.314630386694E-02
0.231173233890E-03	-0.259494821615E-03	-0.225534603022E-04	0.676164382313E-01	0.390655565150E-04	0.557840597495E-03
0.128064036795E+02	0.381868576853E-01	0.106577737974E+00	0.151635319122E-02	0.135466585119E-07	-0.102271226860E-06
-0.513824910422E-03	-0.104761647785E-07	-0.559992559228E-05			
0.100674630589E+04	0.492823933601E-03	0.582869683181E-01	-0.582818023764E-01	-0.492965523669E-03	0.542608933583E-02
0.307250942133E-05	-0.544860293732E-02	0.114075952658E-01	-0.810556025904E-05	-0.113326154476E-01	0.484357197018E-03
0.582419564855E-01	-0.582367945220E-01	-0.484498420453E-03	0.213989833443E-02	0.165336995801E-05	-0.214572845261E-02
0.989637936921E-02	-0.500572186087E-05	-0.982941398583E-02	-0.735401018323E-13	0.136043393647E+01	-0.265844412834E-06
0.736421310467E-13	0.445614330692E+00	-0.100048271512E-05			
0.228167345220E+05	0.681432480320E-03	0.134316961074E+00	-0.134304841409E+00	-0.681699057803E-03	-0.943733236125E-02
-0.753784649170E-05	0.949521757707E-02	-0.188515628859E-01	0.151399086652E-04	0.187162117223E-01	0.677973458534E-03
0.131930702607E+00	-0.131918798963E+00	-0.678235658903E-03	-0.134640721565E-02	-0.385295635912E-05	0.135973345002E-02
-0.154229186996E-01	0.827723312203E-05	0.153066490246E-01	0.341789095238E-12	-0.660796063787E+00	-0.446626464789E-05
-0.455240909208E-12	0.915052112804E+00	-0.242445735962E-03			
0.180301337764E+06	-0.377959904858E-02	0.457502576609E-03	-0.490479969832E-03	-0.266348848612E-04	0.185799263673E+00
0.527143309686E-04	0.180030384676E-02	0.148096711643E+02	0.556301728444E-01	0.144405462530E+00	-0.314233347287E-02
0.393090465439E-03	-0.421370401876E-03	-0.220712679753E-04	0.675810523627E-01	0.369479495789E-04	0.633653480356E-03
0.128062308794E+02	0.382401851955E-01	0.124835600153E+00	-0.119512007921E-07	-0.181469449608E-02	-0.124844434124E-06
0.890434167809E-08	0.727525455257E-03	-0.653853557037E-05			

STATIC LOAD COMBINATION-----MEMBER FORCES-----LEVEL NO. 1

COLUMN FORCES

LINE	LOAD	TORSIONAL MOMENT	MAJOR AXIS TOP MOMENT	MAJOR AXIS BOT MOMENT	AXIAL FORCE	MINOR AXIS TOP MOMENT	MINOR AXIS BOT MOMENT	MAJOR SHEAR	MINOR SHEAR
1	1	0.0000	-58.0058	-23.8248	2.0556	-5.0770	-2.5384	-0.5683	-0.0529
1	2	0.0116	653.4818	1540.1466	4.8513	-12.3410	-5.6270	15.2335	-0.1248
1	3	-0.0207	640.0168	1511.7802	4.7738	-10.7351	-3.8891	14.9430	-0.1016
2	1	0.0000	-5.5686	-2.7842	1.4868	0.0048	-0.0011	-0.0580	0.0000
2	2	0.0003	-12.5098	-5.7151	-1.7611	-0.0549	-0.8421	-0.1266	-0.0062
2	3	-0.0005	-10.9147	-3.9900	-1.2638	-0.0539	-0.8354	-0.1035	-0.0062
3	1	0.0000	5.5696	2.7849	1.4866	0.0049	-0.0011	0.0580	0.0000
3	2	0.0003	14.3571	7.7182	-2.3401	-0.0542	-0.8375	0.1533	-0.0062
3	3	-0.0005	15.9518	9.4437	-2.8374	-0.0552	-0.8442	0.1764	-0.0062
4	1	0.0000	-57.9997	-23.8126	2.0556	5.0745	2.5374	-0.5681	0.0529
4	2	0.0116	643.4147	1519.0317	4.7433	14.2005	7.6436	15.0170	0.1517
4	3	-0.0207	656.8780	1547.3941	4.8207	15.8062	9.3810	15.3074	0.1749
5	1	0.0000	-38.2235	-16.2476	1.8758	-17.0565	-8.5283	-0.3783	-0.1777
5	2	0.0066	477.2589	909.8098	-23.4529	-61.2186	-30.1787	9.6324	-0.6347
5	3	-0.0117	463.4832	890.9555	-23.3828	-60.5115	-29.6076	9.4058	-0.6258
6	1	-0.0235	-0.1461	-0.1238	4.1331	-29.1745	-15.0118	-0.0019	-0.3068
6	2	32.2443	-383.0395	1362.8360	-16.8826	-16.1193	-106.7905	6.8041	-0.8535
6	3	-57.3357	-632.6366	2023.1490	-16.8825	-16.1196	-106.7909	9.6563	-0.8535
7	1	0.0000	-38.2135	-16.2374	1.8761	17.0396	8.5198	-0.3781	0.1775
7	2	0.0066	467.0767	895.8431	-23.5602	63.9236	32.3923	9.4647	0.6689
7	3	-0.0117	480.8521	914.6959	-23.6304	64.6307	32.9632	9.6913	0.6777
8	1	0.0000	61.0202	30.8942	4.6345	-1.9715	-0.9858	0.6383	-0.0205
8	2	0.0010	85.5176	132.7680	-19.7633	-7.2315	-3.5214	1.5159	-0.0747
8	3	-0.0017	86.1862	131.4975	-19.7658	-7.3226	-3.6086	1.5117	-0.0759
9	1	-0.0235	0.5112	-0.2536	4.9987	-29.1666	-15.0078	0.0018	-0.3068
9	2	32.2443	-633.1172	1667.5708	-14.9625	-16.1222	-106.7919	8.5726	-0.8536
9	3	-57.3357	-399.9582	1019.6462	-14.9621	-16.1225	-106.7924	4.3034	-0.8536
10	1	0.0000	61.2737	31.0236	4.6324	1.9845	0.9922	0.6410	0.0207
10	2	0.0010	86.6537	132.5884	-20.0490	7.6920	3.9407	1.5225	0.0803
10	3	-0.0017	85.9838	133.8661	-20.0469	7.6007	3.8533	1.5267	0.0795

COLUMN STRESSES

LINE	LOAD	TOP-MAX	TOP-MIN	BOT-MAX	BOT-MIN	SHEAR-MAJ	SHEAR-MIN
1	1	1.1909	-0.9498	0.6137	-0.3725	-0.0333	-0.0031
1	2	7.0497	-6.4806	13.4605	-12.8914	0.8935	-0.0073
1	3	6.7462	-6.1862	13.0204	-12.4604	0.8764	-0.0060
2	1	1.4188	-0.3097	0.9841	0.1250	-0.0216	0.0000
2	2	1.3682	-2.6819	1.8215	-3.1352	-0.0472	-0.0023
2	3	1.3870	-2.2498	1.7293	-2.6720	-0.0386	-0.0023
3	1	1.4186	-0.3098	0.9840	0.1249	0.0216	0.0000
3	2	1.4343	-3.1796	1.9038	-3.6492	0.0572	-0.0023
3	3	1.4954	-3.6118	1.9960	-4.1124	0.0658	-0.0023
4	1	1.1909	-0.9498	0.6136	-0.3725	-0.0333	0.0031
4	2	7.1833	-6.6268	13.5249	-12.9684	0.8809	0.0089
4	3	7.4868	-6.9212	13.9651	-13.3995	0.8980	0.0103
5	1	3.7426	-3.4490	1.9079	-1.6143	-0.0296	-0.0139
5	2	15.4395	-19.1104	15.3464	-19.0173	0.7539	-0.0497
5	3	15.1392	-18.7993	15.0057	-18.6657	0.7361	-0.0490
6	1	1.0022	-0.0407	0.6731	-0.0209	0.0000	-0.0007
6	2	0.3559	0.4043	3.4112	3.4312	0.0157	-0.0020
6	3	0.5976	0.6476	4.0505	3.9847	0.0223	-0.0020
7	1	3.7405	-3.4468	1.9068	-1.6131	-0.0296	0.0139
7	2	15.7974	-19.4859	15.5663	-19.2548	0.7409	0.0524
7	3	16.0977	-19.7972	15.9071	-19.6065	0.7586	0.0531
8	1	6.2391	-4.3086	3.6255	-1.6951	0.1329	-0.0043
8	2	6.8143	-15.0465	6.7502	-14.9824	0.3157	-0.0156
8	3	6.9266	-15.1598	6.7415	-14.9747	0.3148	-0.0158
9	1	1.0702	-0.0407	0.7410	-0.0209	0.0000	-0.0007
9	2	0.6424	0.6733	3.9442	4.0265	0.0198	-0.0020
9	3	0.4167	0.4508	3.1233	3.2334	0.0099	-0.0020
10	1	6.2437	-4.3184	3.6266	-1.7013	0.1332	0.0043
10	2	7.1589	-15.4915	6.9822	-15.3148	0.3164	0.0168
10	3	7.0467	-15.3784	6.9911	-15.3228	0.3173	0.0165

BEAM FORCES

BAY	LOAD	TORSIONAL MOMENT	CENTERLINE MOMENTS I MOMENT	CENTERLINE MOMENTS J MOMENT	BEAM END MOMENTS I MOMENT	BEAM END MOMENTS J MOMENT
1	1	-0.0049	4.4482	-44.1610	0.0000	0.0000
1	2	0.0541	9.9223	-95.9779	0.0000	0.0000
1	3	0.0553	8.3352	-97.5644	0.0000	0.0000

2	1	-0.0323	131.8296	-20.3986	0.0000	0.0000
2	2	0.0494	499.0320	-71.6404	0.0000	0.0000
2	3	0.0508	502.2914	-70.7715	0.0000	0.0000
3	1	0.0376	115.9720	-33.5768	0.0000	0.0000
3	2	0.0758	474.5430	-99.7366	0.0000	0.0000
3	3	0.0800	469.3979	-101.7570	0.0000	0.0000
4	1	0.0000	49.7298	-49.7324	0.0000	0.0000
4	2	-0.0008	108.4872	-108.5193	0.0000	0.0000
4	3	0.0014	108.4794	-108.5273	0.0000	0.0000
5	1	0.0049	44.1627	-4.4464	0.0000	0.0000
5	2	-0.0550	94.1617	-11.7299	0.0000	0.0000
5	3	-0.0537	92.5749	-13.3167	0.0000	0.0000
6	1	0.0323	131.8569	-20.3735	0.0000	0.0000
6	2	-0.0505	486.5787	-74.9052	0.0000	0.0000
6	3	-0.0491	483.3167	-75.7742	0.0000	0.0000
7	1	-0.0374	115.8706	-33.6837	0.0000	0.0000
7	2	-0.0787	450.3279	-109.5332	0.0000	0.0000
7	3	-0.0745	455.4519	-107.5180	0.0000	0.0000
8	1	-0.6288	58.0113	-135.9224	0.0000	0.0000
8	2	-2.4188	-653.5364	-1039.4594	0.0000	0.0000
8	3	-2.3999	-640.0726	-1027.9889	0.0000	0.0000
9	1	0.6282	58.0052	-135.9262	0.0000	0.0000
9	2	2.4707	-643.4701	-1030.8490	0.0000	0.0000
9	3	2.4896	-656.9323	-1042.3176	0.0000	0.0000
10	1	0.0686	252.4085	-126.8227	0.0000	0.0000
10	2	0.2254	544.9870	-1036.2497	0.0000	0.0000
10	3	0.2204	550.2707	-1028.9588	0.0000	0.0000
11	1	-0.0680	252.4010	-126.8344	0.0000	0.0000
11	2	-0.2361	549.0049	-1030.5657	0.0000	0.0000
11	3	-0.2411	543.7200	-1037.8575	0.0000	0.0000

BEAM STRESSES

BAY	LOAD	I NORMAL	J NORMAL
1	1	0.4129	4.0990
1	2	0.9210	8.9085
1	3	0.7737	9.0558
2	1	0.9360	1.9108
2	2	4.1141	6.7107
2	3	4.3089	6.6293
3	1	0.2170	2.9974
3	2	3.0758	8.9035
3	3	2.7993	9.0838
4	1	4.6151	4.6153
4	2	10.0679	10.0709
4	3	10.0672	10.0716
5	1	4.0981	0.4126
5	2	8.7378	1.0885
5	3	8.5905	1.2357
6	1	0.9363	1.9068
6	2	3.3653	7.0105
6	3	3.1705	7.0918
7	1	0.2141	3.0195
7	2	1.7891	9.8188
7	3	2.0655	9.6381
8	1	0.7176	1.6814
8	2	8.0846	12.8587
8	3	7.9180	12.7168
9	1	0.7178	1.6820
9	2	7.9623	12.7558
9	3	8.1289	12.8977
10	1	5.2628	2.6443
10	2	11.3631	21.6061
10	3	11.4733	21.4541
11	1	5.2614	2.6439
11	2	11.4441	21.4824
11	3	11.3340	21.6344

BRACING ELEMENTS

BRACE	LOAD	AXIAL-FORCE
1	1	0.2919
1	2	0.0848
1	3	0.9231
2	1	0.2918
2	2	-0.8898
2	3	-1.7281

BRACE STRESSES

BRACE	LOAD	AXIAL
1	1	0.2164
1	2	0.0628
1	3	0.6844
2	1	0.2163
2	2	-0.6597
2	3	-1.2813

STATIC LOAD COMBINATION-----MEMBER FORCES-----LEVEL NO. 2

COLUMN FORCES

LINE	LOAD	TORSIONAL	MAJOR AXIS		AXIAL	MINOR AXIS		MAJOR	MINOR
		MOMENT	TOP MOMENT	BOT MOMENT	FORCE	TOP MOMENT	BOT MOMENT	SHEAR	SHEAR
1	1	0.0000	-0.0002	-0.0006	0.0000	0.0000	0.0000	0.0000	0.0000
1	2	0.0000	0.0008	0.0005	0.0000	0.0000	0.0000	0.0000	0.0000
1	3	0.0000	0.0008	0.0005	0.0000	0.0000	0.0000	0.0000	0.0000
2	1	0.0000	0.0000	-0.0002	0.0000	0.0000	0.0000	0.0000	0.0000
2	2	0.0000	-0.0001	-0.0003	0.0000	0.0000	0.0000	0.0000	0.0000
2	3	0.0000	0.0000	-0.0003	0.0000	0.0000	0.0000	0.0000	0.0000
3	1	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000
3	2	0.0000	0.0002	0.0004	0.0000	0.0000	0.0000	0.0000	0.0000
3	3	0.0000	0.0003	0.0005	0.0000	0.0000	0.0000	0.0000	0.0000
4	1	0.0000	-0.0002	-0.0006	0.0000	0.0000	0.0000	0.0000	0.0000
4	2	0.0000	0.0008	0.0005	0.0000	0.0000	0.0000	0.0000	0.0000
4	3	0.0000	0.0008	0.0005	0.0000	0.0000	0.0000	0.0000	0.0000
5	1	0.0000	-99.7130	-78.2303	0.1187	-2.9274	-2.6445	-1.2357	-0.0387
5	2	0.0012	8.2760	17.1641	-3.4286	-7.1132	-7.7776	0.1767	-0.1034
5	3	-0.0019	4.7769	14.1841	-3.4471	-6.9580	-7.6397	0.1317	-0.1014
6	1	-0.0908	-0.0165	0.1189	-0.6054	0.3201	29.2391	0.0007	0.2053
6	2	70.9553	11.1525	395.4929	-7.3470	0.0246	16.0194	2.8239	0.1114
6	3	-107.0766	17.3021	651.6113	-7.3469	0.0246	16.0197	4.6452	0.1114
7	1	0.0000	-99.7122	-78.2290	0.1187	2.9152	2.6377	-1.2357	0.0386
7	2	0.0012	5.4418	14.7170	-3.5119	7.6609	8.2749	0.1400	0.1107
7	3	-0.0019	8.9405	17.6964	-3.4935	7.8162	8.4128	0.1850	0.1127
8	1	0.0000	141.6451	65.7649	-0.4067	-32.1381	-31.6739	1.4403	-0.4431
8	2	0.0243	902.4978	950.6563	-9.0935	-72.0083	-92.7305	12.8691	-1.1440
8	3	-0.0367	893.7596	942.6926	-9.0968	-74.0383	-94.6548	12.7531	-1.1715
9	1	-0.0908	0.1136	-0.4097	-0.0179	0.0133	29.0916	-0.0021	0.2021
9	2	70.9553	27.5669	657.3323	-6.0148	-0.0746	15.9676	4.7562	0.1104
9	3	-107.0766	16.0373	413.9042	-6.0146	-0.0746	15.9679	2.9857	0.1104
10	1	0.0000	141.6169	65.5234	-0.4077	32.2574	31.7673	1.4385	0.4446
10	2	0.0243	895.4337	943.8333	-9.2442	81.8973	102.0773	12.7727	1.2770
10	3	-0.0367	904.1716	951.7992	-9.2411	79.8737	100.1583	12.8887	1.2502

COLUMN STRESSES

LINE	LOAD	TOP-MAX	TOP-MIN	BOT-MAX	- BOT-MIN	SHEAR-MAJ	SHEAR-MIN
1	1	0.1070	-0.1070	0.3037	-0.3037	-0.0003	0.0000
1	2	0.4210	-0.4202	0.3310	-0.3302	0.0005	0.0000
1	3	0.3796	-0.3788	0.2905	-0.2896	0.0005	0.0000
2	1	0.0212	-0.0211	0.1813	-0.1813	-0.0001	0.0000
2	2	0.0454	-0.0453	0.2074	-0.2073	-0.0002	0.0000
2	3	0.0091	-0.0090	0.1655	-0.1653	-0.0001	0.0000
3	1	0.0212	-0.0212	0.1813	-0.1813	0.0001	0.0000
3	2	0.0835	-0.0834	0.2533	-0.2531	0.0002	0.0000
3	3	0.1197	-0.1196	0.2952	-0.2951	0.0003	0.0000
4	1	0.1070	-0.1070	0.3037	-0.3037	-0.0003	0.0000
4	2	0.4489	-0.4481	0.3524	-0.3517	0.0005	0.0000
4	3	0.4902	-0.4896	0.3929	-0.3922	0.0005	0.0000
5	1	12.9489	-12.8837	10.5832	-10.5181	-0.3392	-0.0106
5	2	8.3695	-10.2517	10.0046	-11.8868	0.0485	-0.0284
5	3	7.8482	-9.7406	9.5531	-11.4455	0.0361	-0.0278
6	1	-0.0065	-0.0062	0.6655	0.5362	0.0000	0.0005
6	2	-0.1581	-0.1718	0.5856	0.6693	0.0065	0.0003
6	3	-0.1522	-0.1636	0.8336	0.9204	0.0107	0.0003

7	1	12.9342	-12.8691	10.5750	-10.5098	-0.3392	0.0106
7	2	8.7361	-10.6641	10.3474	-12.2753	0.0384	0.0304
7	3	9.2574	-11.1752	10.7988	-12.7166	0.0508	0.0309
8	1	5.1200	-5.1690	4.4204	-4.4694	0.0867	-0.0267
8	2	15.9348	-17.0298	18.8863	-19.9813	0.7748	-0.0689
8	3	16.1098	-17.2052	19.0549	-20.1503	0.7678	-0.0705
9	1	0.0000	-0.0028	0.6759	0.5447	0.0000	0.0005
9	2	-0.1103	-0.1207	0.8686	0.9351	0.0110	0.0003
9	3	-0.1215	-0.1357	0.6330	0.6992	0.0069	0.0003
10	1	5.1347	-5.1838	4.4300	-4.4791	0.0866	0.0268
10	2	17.0809	-18.1941	19.9680	-21.0812	0.7690	0.0769
10	3	16.9067	-18.0195	19.8001	-20.9130	0.7760	0.0753

BEAM FORCES

		TORSIONAL	CENTERLINE MOMENTS		BEAM END MOMENTS	
BAY	LOAD	MOMENT	I MOMENT	J MOMENT	I MOMENT	J MOMENT
1	1	0.0000	0.0000	0.0000	0.0000	0.0000
1	2	0.0000	0.0000	0.0001	0.0000	0.0000
1	3	0.0000	0.0000	0.0000	0.0000	0.0000
2	1	-0.1596	150.7176	-3.1640	0.0000	0.0000
2	2	-0.0121	339.8120	-7.7129	0.0000	0.0000
2	3	-0.0125	342.8794	-7.5380	0.0000	0.0000
3	1	-0.0067	117.8628	-31.9015	0.0000	0.0000
3	2	0.0358	276.4802	-71.4086	0.0000	0.0000
3	3	0.0399	278.6977	-73.4583	0.0000	0.0000
4	1	0.0000	0.0000	0.0000	0.0000	0.0000
4	2	0.0000	0.0000	0.0000	0.0000	0.0000
4	3	0.0000	0.0000	-0.0001	0.0000	0.0000
5	1	0.0000	0.0000	0.0000	0.0000	0.0000
5	2	0.0000	-0.0001	0.0000	0.0000	0.0000
5	3	0.0000	-0.0002	0.0000	0.0000	0.0000
6	1	0.1605	150.7341	-3.1474	0.0000	0.0000
6	2	0.0125	328.6603	-8.2871	0.0000	0.0000
6	3	0.0120	325.5773	-8.4620	0.0000	0.0000
7	1	0.0066	117.7493	-32.0252	0.0000	0.0000
7	2	-0.0385	248.9132	-81.2711	0.0000	0.0000
7	3	-0.0348	254.6604	-79.2279	0.0000	0.0000
8	1	0.0000	0.0002	-0.0003	0.0000	0.0000
8	2	0.0000	-0.0008	-0.0010	0.0000	0.0000
8	3	0.0000	-0.0008	-0.0010	0.0000	0.0000
9	1	0.0000	0.0002	-0.0003	0.0000	0.0000
9	2	0.0000	-0.0008	-0.0010	0.0000	0.0000
9	3	0.0000	-0.0008	-0.0010	0.0000	0.0000
10	1	0.2366	99.8729	-141.6384	0.0000	0.0000
10	2	0.5997	-8.2630	-902.5337	0.0000	0.0000
10	3	0.5801	-4.7633	-893.7995	0.0000	0.0000
11	1	-0.2322	99.8730	-141.6103	0.0000	0.0000
11	2	-0.6262	-5.4283	-895.4725	0.0000	0.0000
11	3	-0.6458	-8.9275	-904.2062	0.0000	0.0000

BEAM STRESSES

BAY	LOAD	I NORMAL	J NORMAL
1	1	0.0023	0.0131
1	2	0.0064	0.0396
1	3	0.0023	0.0194
2	1	1.7725	0.3022
2	2	4.4816	0.7366
2	3	4.6860	0.7199
3	1	0.2962	2.8614
3	2	1.7839	6.4049
3	3	1.4659	6.5888
4	1	0.0080	0.0080
4	2	0.0057	0.0223
4	3	0.0103	0.0384
5	1	0.0132	0.0023
5	2	0.0611	0.0108
5	3	0.0813	0.0149
6	1	1.7653	0.2993
6	2	3.7200	0.7879
6	3	3.5153	0.8046
7	1	0.2939	2.8905
7	2	0.2722	7.3353
7	3	0.5900	7.1509
8	1	0.0885	0.1203
8	2	0.3690	0.4705
8	3	0.3606	0.4673

9	1	0.0885	0.1203
9	2	0.3620	0.4677
9	3	0.3704	0.4710
10	1	1.4811	2.1005
10	2	0.1225	13.3843
10	3	0.0706	13.2548
11	1	1.4810	2.0999
11	2	0.0805	13.2787
11	3	0.1324	13.4083

BRACING ELEMENTS

BRACE LOAD AXIAL-FORCE

BRACE STRESSES

BRACE LOAD AXIAL

STATIC AND DYNAMIC LOAD COMBINATION-----LATERAL AND ROTATIONAL M. C. DISPLACEMENTS

LEVEL	DIRECTION	1	2	3
2	X	-0.1005641	0.4408221	0.4408222
2	Y	-0.0000035	0.0194920	0.0187559
2	ROTN	0.0000000	0.0000196	-0.0000312
1	X	0.0008555	0.1989788	0.1989793
1	Y	-0.0000009	0.0058058	0.0075325
1	ROTN	0.0000000	0.0000061	-0.0000109

THE STEEL WEIGHT IS 12.6700

THE CONCRETE WEIGHT IS 30.0000

THE TOTAL WEIGHT IS 23267.2318

D. IDENTIFICATION OF POSITIVE MEMBER FORCES

The positive direction of moments is in the same direction as the local axes of the members. The positive local axes can be identified by using the following methods:

1. Start from the column at the origin of the reference coordinates. The positive weak axis of this column must coincide with one of the positive reference coordinates. The positive strong axis of the member can be located by using the right-hand-screw rule, which states that the index finger points at the weak axis and the thumb to the strong axis.

2. The positive local axes of the other columns, flexural walls, and panels can be located by rotating the column at the origin of the reference coordinates in a counterclockwise direction, if necessary, such that the positive weak axis of the member being studied.

3. The positive major axes of a beam are always oriented such that when facing the beam with end i to your left and end j to your right, the positive major axis at each end points out toward you.

4. The positive axial force is assumed to be in tension, and the positive torsion is based on the right-hand-rule, which states that the thumb in representing the torsional vector points away from the member axis.

As an illustration, the positive axes of the vertical members of Example II are shown in Figure 11. The origin of the reference coordinates is located at column 1 whose

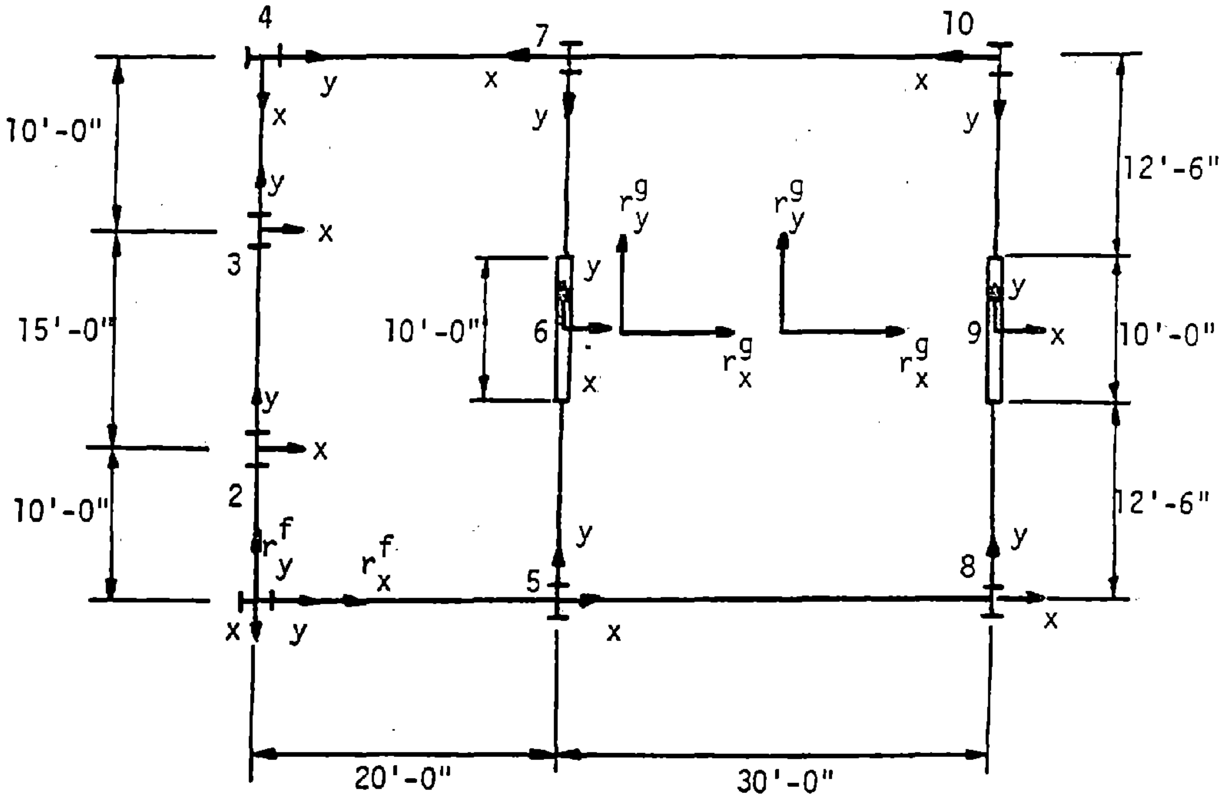

Figure 11. Positive Axes for the Vertical Members of Example II

positive weak axis coincides with the x-axis of the reference coordinates. Use of the right-hand-screw rule yields the strong axis as sketched in the figure. For the shear wall, which is identified as column 6, the positive weak axis must be in the direction shown, because the counterclockwise rotation of column 1 sets the weak axis of the column in that direction. The positive major axes of the beam in bay 1 are in the y-direction at column 1 and in the x-direction at column 2. The internal forces of a few typical members in Example II for load case 2 are shown in Figure 12, in which the arrows signify the positive load directions.

E. OUTPUT NOMENCLATURE

This section will be used to define different terms found within the output:

STS = static tensile stress

SCS = static compressive stress

DTS = dynamic tensile stress

DCS = dynamic compressive stress

TS = tensile stress

CS = compressive stress

SBS = static bending stress

DBS = dynamic bending stress

In the sections defined as active constraints and the largest scaling factor, there are several types, locations, and identifiers.

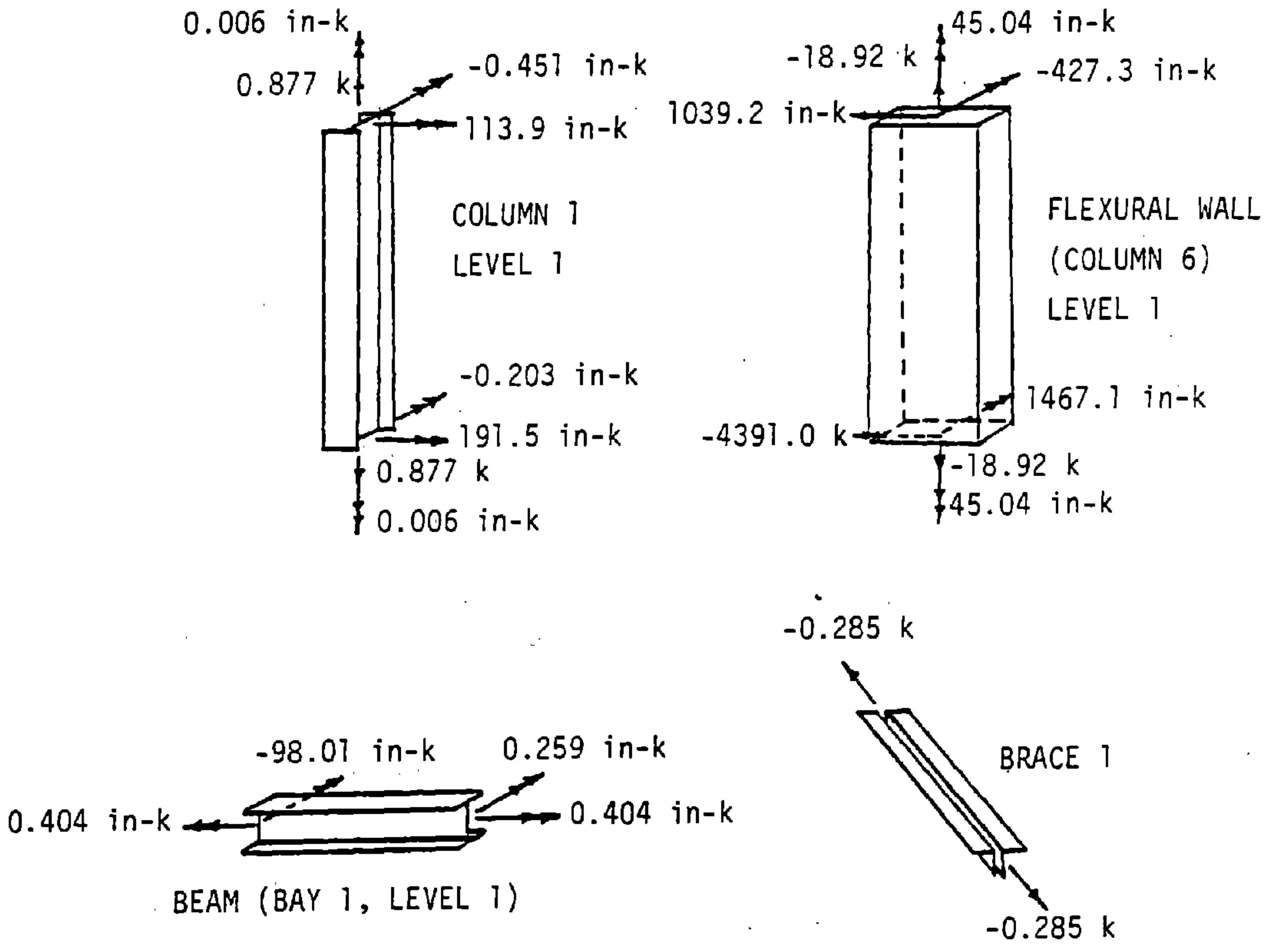

Figure 12. Internal Forces of Typical Members of Example II

Types:

COLUMN = static column stress

BEAM = static beam stress

PANEL = static panel stress

BRACE = static brace stress

DISP. = static displacement

FREQ. = natural frequency

D.DIS = dynamic displacement

D.COL = dynamic column stress

D.BM = dynamic beam stress

D.PAN = dynamic panel stress

D.BRE = dynamic brace stress

Locations:

COLUMNS = column line

BEAMS = bay

PANELS = panel number

BRACE = brace number

Ident:

DISPLACEMENTS

x = 1

y = 2

z = 3

COLUMN STRESS

TOP-MAX = 1

TOP-MIN = 2

BOT-MAX = 3

BOT-MIN = 4

BEAM STRESS

I NORMAL = 1

J NORMAL = 2

PANEL STRESSES

TOP-MAX = 1

TOP-MIN = 2

BOT-MAX = 3

BOT-MIN = 4

FREQUENCY

1ST FREQ = 1

2ND FREQ = 2

All other terms are explained within the input procedures.

VII. PROGRAM CAPACITY AND GUIDE FOR MODIFICATION

A. PROGRAM CAPACITY

The computer program is written in FORTRAN IV with fixed commons and dimensions. The capacity of the program is limited by the following constraints:

- The number of floor levels in the structure is not more than 10.
- The number of bays in the structure is not more than 15.
- The number of column lines in the structure is not more than 14.
- The number of panel elements in the structure is not more than 20.
- The number of braced elements in the structure is not more than 40.
- The number of sets of different fixed-end moments and shears for the beams is not more than 10.
- The different column properties are not more than 45.
- The different beam properties are not more than 45.
- The total number of load combinations is not more than 10.
- The total number of active constraints is not more than 30.

- The total number of modes to be used for a modal analysis is not more than 5. The dimensions are set for 10 modes, but COMMON/INV/ along with subroutine INVERT allow only 5 modes in the optimization.

B. GUIDE FOR MODIFICATION

The modification of the program capacity can be achieved by changing the numbers for appropriate variables in the following common and dimension statements:

```
COMMON/DATA1/CLN(NC,2), CP(26,NCP), BP(15,NBP),
     FEF(5,NFEF), LB(NST,NB,3), LDB(NST,NB,3),
     LCC(NST,NC,2), LP(3,NPAN), IFEF(NFEF), PP(22,NPAN),
     LT(3,NTRU), TP(9,NTRU), LIM, ID, GST, GCO, NSTEEL,
     NSTEE2, NATC, NLDDD, NTOT1

COMMON/DATA2/QQ(4,NB,NST)

COMMON/DATA5/COCOL(9,NC,NST), COBM(5,NB,NST),
     COPAN(5,NPAN), CODIA(2,NTRU)

COMMON/DATA7/PLOAD(NST*NC), A(NST,15), AMA(2*NST*NC), IF,
     IFC, X1, Y1

COMMON/FORM1/S(LS), C(MM,MM), SB(LS), EF(MN6,NAD1),
     PF(NAD2,LIM+N9)

COMMON/FORM2/KH(NNL), SD(MM), E(MM,NE), EB(MM,NE)
```

```
COMMON/FORM3/SL(LSL), NC, NSNC, N, NFR, NF, NL, KLAT,
     LLAT, MLAT

COMMON/F04/SF4(LS,NST), CF4(MM,MM,NST), EF4(MM,NE,NST),
     KH4(NNL,NST), RF4(MM,3,NST), RF5(MM,LIM,NST),
     RF6(MM,1,NST)

COMMON/STIF1/SS(NSTC,NSTC), SG(NSS,NSS), STIFFF(NSTC,NSTC)

COMMON/TRAN1/D(NST,1,2),AA(1,6),RR(NSTC,6),U2(NSTC,6)

COMMON/GEN/NST, NDF, NTF, NTOT, NAT, NFQ, NSD, IDUM,
     BHED(NST), NSS, JDUM, T(6), RLAB(3), IS, I3

COMMON/JUNK/JK(3), MMJ, MNJ, JUK(57), SPAC13(368)

COMMON/STIF/STF(N2)

COMMON/MAT/E1, G

COMMON/NEW/R66(NN,NLD), R(NN,N9+6), XM(6,NLD), FM(8)

COMMON/STRES/SCOL(NST,NC,6,6), SBM(NST,NB,6,2),
     SPAN(NPAN,6,5), SDIA(NTRU,6,1),F2, CON(LIM), P1, P2,
     DIS(NST,3), LCON(5,LIM), L6, L7, L8, L9,CONCO(8,LIM)

COMMON/EIGNV/EIGV(NSTC), EIVEC(NSTC,NSTC), VAL(N9), N10,
     N9, C1(N9), L2(N9), XMAS(N9), XMAS1(N9), ISMN,
     L3(N9), L4(N9), MODE, PHIM(N9), DPHI(N9),
     PHIL1(NSTC,N9), DPHIM(N9), PHI(N9), UVAL(N9)
```

```
COMMON/GRAB/T2(NST,NC,LIM), T3(NST,NB,LIM),
     T4(NST,NPAN,LIM), T5(NST,NTRU,LIM), RRR

COMMON/PASS/PPASS(NPAN), TPASS(NTRU), IPASS, IPASS1

COMMON/DYNAM/VMA(NSTC), FMA(NSTC), DDIS(NST,3),
     X2(NSTC,N9), PQ(N9), ETA(3,N9), VM1(NSTC), SAA(3,N9),
     PHII(N9), VN(NSTC,N9)

COMMON/INV/PHIL(NSTC,N9)

COMMON/JUNK2/MN6, NAD1, NAD2, LSL, ISEC

COMMON/JUNK3/PSID2(NSTC,LDLIM)

COMMON/RESP/C11(3), C22(3), C33,(3), C44(3), C55(3),
     C66(3), C77(3)

COMMON/CODE1/HT(NST), WTT(1), WWW(NST,1)

COMMON/ATC1/U(NST,N9), V(NST), DDDIS(NST), DELT(NST),
     RM(NST), CV(NST), SUMWF1(N9), SUMWF2(N9), WBARM(N9),
     CSM(N9), RMOMNT(NST+1), CVXM(NST,N9), FMODAL(NST,N9),
     DELXEM(NST,N9), VMMODE(NST,N9), RMMODE(NST+1,N9),
     DRIFMO(NST,N9), VMODAL(N9), TETA(NST), PP1(NST)

COMMON/ATCI/IACTIV, ISOIL, MR, ISF, NANALS, NNNNN, MMMMM,
     NBRITL, ISH, NPREGR, NVREGR, IS1, NH, AA1, AV, S888,
     R888, CD, RL, RL1, P11, P12, DELA(NST), IKE

COMMON/STEP/C111(15,NUM22), DIX(2,NUM22), NUM22
```

```
COMMON/SPEC/ DD11(2,NDIV,3), CC11(6,NDIV,3), NDIV

COMMON/PLOTT/IPRF, IPRS, IPRE, IPREM, IPRD

COMMON/JUN3/ISPA(16), SPA(208)

DIMENSION RLAB3(11), PDIS1(NSTC,LIM), AMA2(NST*NC),
     AMA4(NST), AMA5(NST), P6(12,LIM), RKAPPA(NST),
     TT(N9), FS(NSTC,2), FFF(NST), VAL1(N9), VM2(NSTC),
     VM11(NSTC,2), VM12(NSTC,2), FM2(8,N9+6), OBJ(NOC),
     OBJS(NOC), OBJC(NOC), PERIOD(NOC,N9), VM3(NSTC),
     NCPL1(NC), NBPL1(NB), COLIN(NCP), BMIN(NBP),
     X99(NSTC,N9), FINA(NSTC,6), ... in MAIN

DIMENSION PA(NST,2), PB(NST,2), AJAV(NC) ... in subroutine
     INFORM

DIMENSION BJAV(NC OR NB, whichever is larger), ... in
     subroutine GENERA

DIMENSION AMA2(NST*NC), AMA4(NST), AMA5(NST), ... in
     subroutine INITIL

DIMENSION PDIS(NSTC,LIM), LCON(5,LIM), NTP1(LIM) ... in
     subroutine FORM

DIMENSION NTP1(LIM) ... in subroutine ELIMIN

DIMENSION A(NSTC,NSTC), B(NSTC,6) ... in subroutine GAUSS

DIMENSION A(LIM,LIM), B(LIM) ... in subroutine GAUSS1
```

DIMENSION A(NSTC,NSTC), B(NSTC,2) ... in subroutine GAUSS3

DIMENSION A(NSTC,NSTC), B(NSTC,LIM) ... in subroutine GAUSS4

DIMENSION A(NSTC,NSTC), B(NSTC,NSTC) ... in subroutine GAUSS2

DIMENSION RF(NSS,LIM), D(NST,1,2), R(NSTC,6) ... in subroutine REFDSP

DIMENSION RF(NSS), D(NST,1,2), R(NSTC) in subroutine REFDSP1

DIMENSION RF(NSS,LIM), D(NST,1,2), R(NSTC,LIM) ... in subroutine REFDSP3

DIMENSION PDIS(NSTC,LIM), FM2(8,N9+6), PDIS1(NSTC,LIM), AMA2(NST*NC), AMA4(NST), AMA5(NST), FM4(12,N9), P6(12,LIM) ... in subroutine FORCES

DIMENSION FM1(8,N9+6), FM2(8,N9+6), PDIS(NSTC,LIM), FM4(12,N9), LCON1(5,N9), PDIS3(NSTC,N9) ... in subroutine REFROT

DIMENSION PDIS(NSTC,LIM), PDIS1(NSTC,LIM), PF(NAD2,LIM), AMA2(NST*NC), AMA4(NST), AMA5(NST), P6(12,LIM) ... in subroutine PSEUDO

DIMENSION PDIS1(NSTC,LIM), PDIS(NSTC,LIM), LCON(5,LIM) ... in subroutine ROTDIS

DIMENSION PDIS(NSTC,LIM), T(8,LIM), FM2(8,N9+6), XM(6,NLD), LCON(5,LIM), AMA2(NST*NC), AMA4(NST), AMA5(NST), Q1(N9), T6(NSTC), PPE(NSTC,N9), DPHI2(N9), DPHIM2(N9), T7(NSTC), P6(12,LIM), LB(NST,NB,3), PD(NSTC), CONCO(8,LIM) ... in subroutine GRAD

DIMENSION CS(N9), FM2(8,N9+6), XM11(6,NLD) ... in subroutine SORT

DIMENSION AMA2(NST*NC), AMA4(NST), AMA5(NST) ... in subroutine OBJECT

DIMENSION LCON(5,LIM), AMA6(NSTC), AMA2(NST*NC), AMA4(NST), AMA5(NST), ... in subroutine EMAS

DIMENSION A(NSTC,NSTC), B(NSTC,NSTC), D(NSTC), FM2(8,N9+6), XM12(6,NLD), AMA2(NST*NC), AMA4(NST), AMA5(NST), X2L(NSTC,N9) ... in subroutine JACOBI

DIMENSION B(NSTC), AMA2(NST*NC), AMA4(NST), AMA5(NST), FN(NSTC,N9), ... in subroutine MODAL

DIMENSION AMA2(NST*NC), AMA4(NST), AMA5(NST), X3(NSTC,NSTC) ... in subroutine INVERT

DIMENSION R(LIM), R1(LIM), S(LIM,LIM), S5(LIM,LIM), CPASS1(NCP), BPASS1(NBP) ... in subroutine LAGMU

DIMENSION R(LIM), CON(LIM), LCON(5,LIM), CPASS1(NCP), BPASS1(NBP) ... in subroutine CURSE

DIMENSION T6(NSTC), PD(NSTC), ... in subroutine ROTATE

DIMENSION DM(NSTC,NSTC), TT(N9), FS(NSTC,2) L2(N9), FFF(NST), RKAPPA(NST), TTT(N9), SS(NSTC,NSTC), SG(NSS,NSS) ... in subroutine ATCCD

DIMENSION FFF(NST), RKAPPA(NST) ... in subroutine LAT1

DIMENSION SK(NSTC,NSTC), SS(NSTC,NSTC), SG(NSS,NSS), FS(NSTC,2), FFF(NST), RKAPPA(NST) ... in subroutine LAT2

DIMENSION TT(N9), SK(NSTC,NSTC), SS(NSTC,NSTC), SG(NSS,NSS), FS(NSTC,2), FFF(NST), RKAPPA(NST) ... in subroutine MODALA

DIMENSION X(N9) ... in subroutine ROOT1

DIMENSION X(NST,N9) ... in subroutine ROOT2

DIMENSION X(NST+1,N9) ... in subroutine ROOT3

DIMENSION RKAPA(NST) ... in subroutine ATCIF

DIMENSION SD(NST,15), C1(N9), AMA4(NST), TT(N9), VAL(N9) ... in subroutine ATLINK

DIMENSION X(NSTC), LP(3,NPAN), LT(3,NTRU), COLIN(NCP), BMIN(NBP), X9(NSTC,N9), FINA(NSTC,6), U2(NSTC,6), VM3(NSTC) ... in subroutine REPLAC

DIMENSION CC(16), X(NSTC), LP(3,NPAN), LT(3,NTRU) ... in subroutine REPORT

DIMENSION OBJ(NOC), PERIOD(NOC,N9), L2(N9), XM(6,NLD), OBJS(NOC), OBJC(NOC), LC(NST,NC,2), LB(NST,NB,3), COLIN(NCP), BMIN(NBP), X99(NSTC,N9), FINA(NSTC,6), NCPL1(NC), NBPL1(NB) ... in subroutine PLOT

The following commons serve several purposes throughout the program and should be modified accordingly in the various subroutines: FORM2, JUNK, STIF, and JUN3.

The variables in the COMMON and DIMENSION statements are listed as follows in which the numbers in parentheses represent the program capacity in the present form:

NC = Number of vertical column lines in the structure (14).

NCP = Number of sets of different column properties (45).

NBP = Number of sets of different beam properties (45).

NFEF = Number of sets of different fixed-end moments and shears due to vertical loads acting on the beams (10).

NST = Number of stories in the structure (10).

NB = Number of bays in the structure (15).

NPAN = Number of flexural panels in the structure (20).

NTRU = Number of bracing elements in the structure (40).

NLD = Total of static and/or dynamic load combinations (10).

N9 = Number of modes used in a modal analysis and/or frequency constraint problem (10). (Optimization during a response spectra analysis allows only 5 modes.)

NUM22 = Number of subdivisions for steel element secondary to primary design variable relationships (3).

NDIV = Number of subdivisions for the polynomial representation of the acceleration response spectra (4).

NOC = Number of optimization cycles (50).

LIM = Number of constraints (30).

LDLIM = Number of allowable dynamic displacement constraints (20).

MM = 2 * NC

MN = 2 * MM

NN = MN + NC * NST + 3 * NST + 3 + NC

MN6 = MM + MN + 6

LS = (MM * (MM+1))/2

LC = MM * MM

NE = NC * NST + 3 * NST + 6 + NC

NNM = NN - MN

LSL = (NNM * (NNM + 1))/2 + NNM * 3

NNL = NN + 3

NAD1 = MM + 6

NAD2 = MM + MN

NSTC = NST * NC + NST * 3

NSS = NST * 3

N2 = 96 * NC * NST + 18 * NB * NST + 8 * NTRU + 40 * NPAN + 336

As mentioned previously the number of modes allowed during the optimization of a response spectra modal analysis problem is limited to 5 due to both program statements and commons. Therefore, if more modes are required, these changes must be made:

1. A new two dimensional array must be added to COMMON/INV/ for each additional mode (i.e., X9(NSTC,NSTC), X10(NSTC,NSTC) for modes 6 and 7, respectively).
2. A new line for each new mode must be added to subroutine GRAD after line 4912. These lines would be similar to lines 4908 to 4912, with the new arrays being substituted for the correct mode.
3. Three new lines for each new mode must be added to subroutine INVERT after line 6284. These lines would be similar to lines 6273 to 6275 with

the new arrays and mode numbers being substituted within the new lines.

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