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CORPS-WIDE CONFERENCE ON COMPUTER AIDED DESIGN IN STRUCTURAL ENGINEERING

22-26 September 1975

VOLUME X
STIFFNESS METHODS, FRAMES, and MILITARY ENGINEERING

Edited by N. RADHAKRISHNAN

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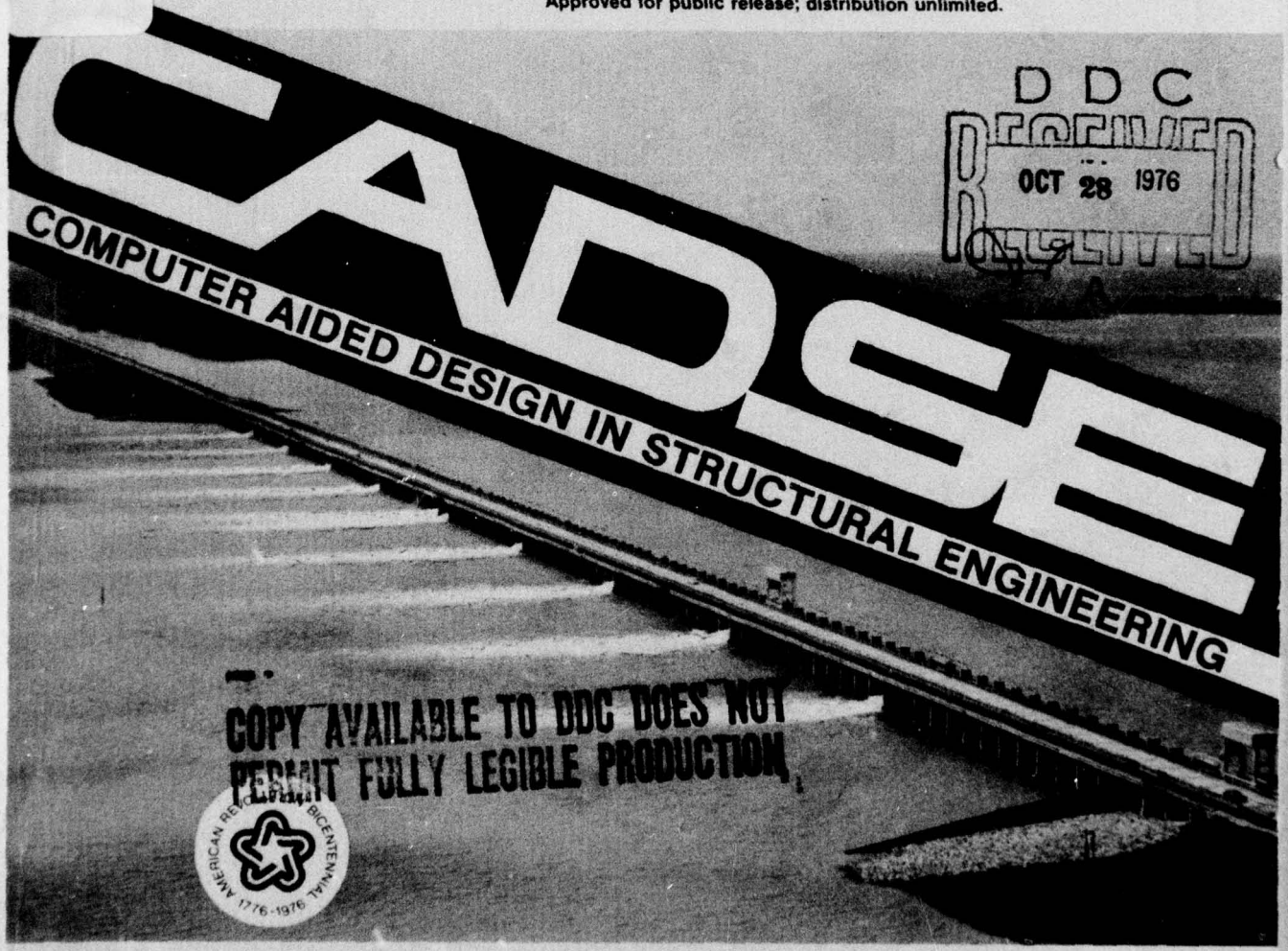

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ASHTON - Matrix analysis, which employs the finite element method, is the accepted Corps technique for analyzing structures. It is a powerful tool for the analysis of two-dimensional continuums, as well as for the design of beams, trusses, and frames. Recent advances in interactive graphics will make these analyses even more useful to the designer. This paper briefly summarizes the basic concepts and coding procedures common to all program packages. The direct stiffness method of structural analysis, involving simultaneous equations

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in matrix form, is surveyed. The input data required for all direct stiffness programs (identification data, control data, material properties, nodal point description, and element definition) are discussed.

REYNOLDS - This report deals with computer-aided design for building frames, specifically in the area of analysis programs. Three examples of the work done in the Sacramento District are provided. The first, the Post Chapel at the Presidio in San Francisco, California, required repairs to a deflected building frame. A computer model was used to match the shape of the deflected frame and then to determine the forces necessary to correct the problem. The second example is the Weapons Evaluation Facility at Yuma, Arizona. The facility was designed with the help of computer analysis. One particular problem was to construct a door between two bays of the facility that could support a building frame at its center as well as unsymmetrical crane loads perpendicular to the plane of the truss on its sides. Computer three-dimensional analysis aided in solving this problem. The third problem dealt with the adaptation of a roof frame plan for the dental clinic at Fort Ord, California, so that adequate space was provided for mechanical ducts. The computer model not only provided adequate space but also represented an $18,800 savings from the original roof frame plan. This report also lists problems encountered by engineers in computer analysis, suggests ways to improve computer usage, and recommends the development of programs on a common data basis with subprograms that can be linked together and tailored to a systems approach. Also included is a two-dimensional steel-frame problem sent to various Districts and the computer programs used to solve it.

BALDWIN - In recent years, architectural and engineering design for mili-rary construction has been complicated by new regulations and technical factors. Environmental and energy conservation considerations, the effects of rapid inflation on material and construction costs, and the effect of energy shortages have all added to the problem. With all the complex factors facing Corps designers, more effective use of the computer is required. The Military Construction Directorate is developing a computer system for the coordinated integration of engineering and architectural components of the MCA design process. This is the Automated Engineering and Architectural Design System, AEADS, an optimum mix of software and hardware to aid the professional in making design decisions. This paper discusses objectives and development strategy for AEADS and evaluates SEARCH and the DD 1391 Checker.

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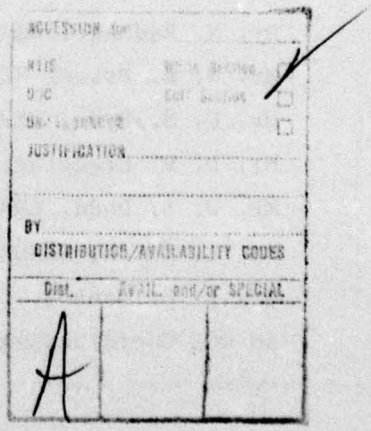

PREFACE

In December 1974, the Automatic Data Processing (ADP) Center, U. S. Army Engineer Waterways Experiment Station (WES), submitted a proposal to conduct a Corps-wide Conference on Computer-Aided Design in Structural Engineering (CADSE) to the Office, Chief of Engineers (OCE). OCE approved the proposal and efforts were started in February 1975 to conduct this Conference. The Conference was conducted in New Orleans, Louisiana, 22-26 September 1975 and was attended by 175 engineers from 48 Corps field offices, OCE, Construction Engineering Research Laboratory (CERL), and WES.

This volume contains the papers from Specialty Session F, State-of-the-Corps-Art on Stiffness Methods, Frames, and Military Construction. Mr. Donald B. Baldwin, General Engineer, DAEN-MCE-D, OCE, was session chairman and presented a paper. Other papers were presented by Mr. William D. Ashton, Chief, Structures Section, NCRED-D, Rock Island District; and Mr. Daniel Reynolds, Structural Engineer, SPKED-M, Sacramento District.

The Conference was successful due to the efforts of a multitude of people. The roles they played were different but they were all directed towards making a concept on "instant dissemination" work. The Organizing Committee for the Conference consisted of:

COL G. H. Hilt, WES
Mr. F. R. Brown, WES
Mr. D. L. Neumann, WES
Mr. J. B. Cheek, Jr., WES
Dr. N. Radhakrishnan, WES--Conference Coordinator
Mr. W. A. Price, WES
Mr. G. S. Hyde, WES
Mr. D. R. Dressler, LMVD
Mr. W. B. Dodd, LMNDE
Ms. E. Smith, LMNDE
Mr. L. H. Manson, LMNDE

An OCE Coordinating Committee also worked enthusiastically to

ensure the success of the Conference. This Committee consisted of:

Mr. C. F. Corns

Mr. R. L. Delyea

Mr. R. F. Malm, OCE Coordinator

Mr. L. G. Guthrie

Mr. D. B. Baldwin

Mr. R. A. McMurrer

The New Orleans District did a remarkable job in playing hosts to the Conference.

There were 13 division speakers, 25 moderators, two invited speakers, four technical speakers, and ten session chairmen, who shared the technical load of the Conference. Also, eight computer vendors showed their wares to the participants.

The editor would like to thank all the individuals who served on the committees and the speakers and the moderators for sharing their time and thoughts. Without them the Conference would not have been the success it was. Mr. Dressler, LMVD, and Mr. Price, WES, are specially thanked for their technical guidance and assistance.

This report was edited by Dr. N. Radhakrishnan, Research Civil Engineer, Computer Analysis Branch (CAB) and Special Technical Assistant, ADP Center, under the direct supervision of Mr. J. B. Cheek, Jr., Chief, CAB, ADP Center, and the general supervision of Mr. D. L. Neumann, Chief, ADP Center.

The Director of WES during the Conference and the preparation of this report was COL G. H. Hilt, CE. Mr. F. R. Brown was Technical Director.

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STIFFNESS ANALYSIS OF STRUCTURES

by

William D. Ashton*

Matrix analysis is an accepted method of analyzing structures in the Corps of Engineers. The application of matrix techniques in the solution of conventional design problems is increasing rapidly. Design staffs are using automated matrix design systems to produce superior designs in reduced time and at lower project costs.

The Corps of Engineers' designers first became involved in matrix analysis when the University of California made significant advancements in the analysis of two-dimensional continuums, commonly known as finite element analysis. The finite element methods are equally powerful analysis tools in the design of beams, trusses, and frames. These conventional structural systems are being analyzed with matrix analysis programs by numerous district design staffs. Recent advances in interactive graphics will make matrix analysis of 2-D continuums an accepted practice in the Corps of Engineers. This paper briefly summarizes the basic concepts and the coding procedures similar to all program packages. Much of the material presented has been obtained from the manuscript by W. D. Ashton and Dr. B. L. Meyers (Bechtel Corp.), "Stiffness Analysis of Structural Systems."

Available to the structural designer is a wide assortment of generalized matrix solution programs, such as STRESS, STRUDL, GENSAP, etc. Also available are many programs developed by various District offices, such as PTRUSS, GFRAME, BEAM, TRUSS, FRAME, GRID, STRUSS, etc. The available matrix programs make possible the analysis of continuous beams, plane pin-jointed trusses, plane frames, grid structures, and space trusses. The programs are based on the stiffness method of matrix analysis and the majority use direct stiffness techniques for solving the systems of equations for the displacements. In all the programs,

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* Chief, Structures Section, Rock Island District.

the designer prepares an idealization of the structure to be analyzed and describes the engineering properties of each member along with the location of each nodal point in the structural system. The computer assembles the required properties of the total system into a representative matrix. The matrix is solved, and the engineer is provided with the displacements of each joint and the requested stresses in each member.

A designer requires time to gain confidence and to understand the computer program and its inherent assumptions and coding routines. Once a designer is familiar with a particular program package and is comfortable using it, he should continue to use it. Confidence, gained through repeated application, usually results in reduced design time and consequently realizes lower design costs. Each program has advantages and disadvantages, but each results in output consisting of displacements and stresses. Interactive graphics routines will soon be provided to simplify input and display output. Programs with interactive graphics capability will be favored by designers, and their use should be encouraged.

Simultaneous equations have been used for many years to express the relationships between forces applied to a structural system and the resulting displacements. Functional relationships can be written for any structure subjected to a set of forces. In the stiffness method the equations take the following matrix form:

$$[F] = [K]\{\delta\}$$

where

$[F]$ is a column matrix representing the force system
$[K]$ is a square matrix of the stiffness coefficients
$\{\delta\}$ is a column matrix representing the displacements

A structure can be considered a collection of elements of known stiffness behavior. The stiffness coefficients describing this behavior must be evaluated for a specific structural configuration (i.e. beam, truss, etc.) being analyzed, by satisfying the condition of equilibrium and strain compatibility, and the stress-strain law of the material. A single stiffness matrix can be constructed that will completely describe

the behavior of the structure. The equations represented by the stiffness matrix can be assembled in an efficient manner on the computer. The solution of the structural stiffness problem reduces to solving the matrix equation for the unknown displacements.

The stiffness matrix is square, positive definite, and symmetrical about the principal diagonal. The direct stiffness procedures permit solution for the unknown displacements directly, using the general stiffness equations. Modification and conditioning of the structural stiffness matrix are accomplished without destroying the banded symmetrical properties of the matrix. The direct stiffness method requires storage of only one-half of the symmetrical band of the structure stiffness coefficients, which results in a significant reduction in computer memory. This reduction in computer hardware requirements, combined with the application of direct matrix solution techniques, makes the direct stiffness method ideal for the analysis of large structural systems.

The advantages of the stiffness method become obvious as the engineer applies the procedures to increasingly complex structures. The simplicity, compactness, and generality in analyzing diversified structural behavior make the method ideal for the straightforward development of computer-aided design systems. The direct stiffness method permits realization of the advantages of computer-aided design from its initial introduction into the design system, and permits continuous growth to more sophisticated systems as the users develop and analyze more complex applications. Identical programming procedures, with slight modifications for structural type, are used in all direct stiffness applications, greatly reducing programming time and effort in the initial development and the learning time required by new users. Consequently, conversion of the programs developed within the Corps to available hardware involves routine programming procedures and a minimal engineering effort.

The input data required in all programs represent a numerical characterization of the idealization of the structural system. The input data for the majority of applications can be divided into the following categories:

Identification Data

Control Data

Material Properties

Nodal Point Description

Element Definition

The identification data should describe the problem being analyzed. Space is usually allocated for the engineer's name, project number, and structure identifiers. The responsible engineer should sign a listing of the computer input after review for correctness.

The control data are usually a single card transmitting the number of material cards, nodal point cards, and element cards which will be used to describe the structure. Using the data provided, values are inserted into computer memory establishing iterative limits in the computer routines.

In large structural systems consisting of more than one material, or in large framed structures where identical section properties are used for many members, separate blocks of material data are being used to advantage. Each material or structural shape is given a numerical code. These numerical codes index an area in the computer where data describing the particular material or section are retained. Each element is assigned the appropriate material code that matches its characteristics with those indexed on the material cards and in computer memory. In subsequent computer routines the program sequence seeks the index number for a particular element and uses the matching values in evaluating the stiffness characteristics.

An alternate method sometimes found is to specify the material description with the definition of each element. This procedure allows an unlimited number of materials to be used, but substantially increases the volume of input data to be prepared.

The required nodal point information is similar to the information necessary to accurately sketch the geometry, loading, and boundary restraints of the structural system. The geometric locations of each nodal point, in structure coordinates, must be determined along with the known loads or boundary restraints at each node. One card or line is

usually used to input these data for each nodal point. This input medium contains the list of coordinates, the load or displacements appropriate to each node, and a nodal point code number unique to the class of structure under consideration.

The nodal point code defines to the computer the type of boundary restraints or applied loads, if any, which are located at each node. The nodal point code is used in the computer routines which assemble the load vector and modify the appropriate equations in the stiffness matrix for boundary restraint.

Two basic nodal point codes are commonly used. The first is identical to the type code used on the material cards. The code assigns a number to each possible arrangement of restrained or unrestrained actions at a node.

When the number of permissible degrees of freedom permit numerous combinations, a digital nodal point code is more convenient. A code number containing a digit location for each permissible displacement action is used. If the displacement is restrained at the node being described as 1, it is entered in the corresponding digit location and the value of the restraint becomes an input value. If the particular displacement is permitted, a 0 is entered in the corresponding digit location and a force value becomes an input value.

Each element is defined to the computer using one input line or card containing the nodal point numbers of the element and a material index code or a listing of the material properties. Knowing the nodal numbers which define the element boundary, the computer can retrieve the associated nodal coordinates from the nodal point description. The order of specifying the node numbers is immaterial to the analysis except in describing the finite element, which is usually specified in a counterclockwise manner.

The first step in the computer program must allocate appropriate sized blocks of storage in computer memory for retention of various subscripted variables, such as stiffness coefficients, used throughout the program. The size of each block depends primarily on the following characteristics of the system: (a) number of degrees of freedom,

(b) number of nodal points permissible, (c) number of elements permissible, and (d) solution technique.

The number of degrees of freedom is established by the class of structure. The number of nodal points and number of elements is different for each structural application. The initial programmer must select a combination of nodal points and elements representative of the type of problems to be analyzed. The engineer must be aware of this arbitrary decision and modify the appropriate storage specifications as required for special element-nodal point connectivity. In large packages the storage specifications are made very large, so that only very infrequently will an application arise that the system cannot handle without modification. Unfortunately, such liberal assignment of storage specifications must also be paid for in the solution of the small frequently encountered problems.

Continued and more intensive training is required to insure the correct use of matrix analysis programs. Training disseminates information regarding program application and aids in overcoming the natural reluctance to use automated design techniques. Management should encourage the evolution of computer-aided design with training. In-house programs frequently are more easily understood, operate at greatly reduced costs, and provide the basis to develop a thorough understanding of more sophisticated techniques.

COMPUTER-AIDED DESIGN FOR BUILDING FRAMES

by

Daniel W. Reynolds*

Present State of the Art

Computers have failed, thus far, to satisfy some of the pressing needs of the structural engineer, because the state of the art within the Corps of Engineers consists of using and developing "analysis" type programs, which means we have succeeded in computerizing one-fifth of the design engineer's work. Responses to the written questionnaire and follow-up telephone canvases revealed that structural design engineers within the Corps are using a varied assortment of computer equipment and programs. These programs, listed in Appendix A of this paper, are mainly analysis type programs. They consist of in-house developed, documented, and undocumented programs, university research sponsored, single and general purpose programs and programs available through contracted computer services. For analysis type programs, the engineer describes structure geometry, loads and assumed member sizes, and uses the computer to perform indeterminate frame analysis. The analysis represents about 20 percent of the total design procedure.

An example two-story, two-dimensional steel-frame problem, Figure 1, was sent to different districts for solution by engineers experienced with using the various programs available. The results are included as Appendix B of this paper for your comparison of the different programs, and as an example of the present computer-aided design art within the Corps of Engineers.

How I Use the Computer

In my district, the designing of 2-D and 3-D frames is now limited to the use of analysis type programs, such as Wilson 2-D Frame, SAP IV,

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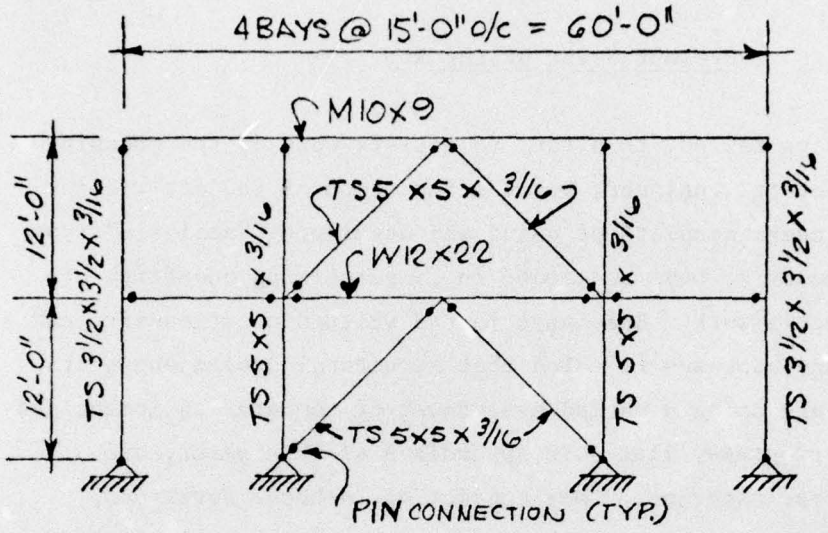
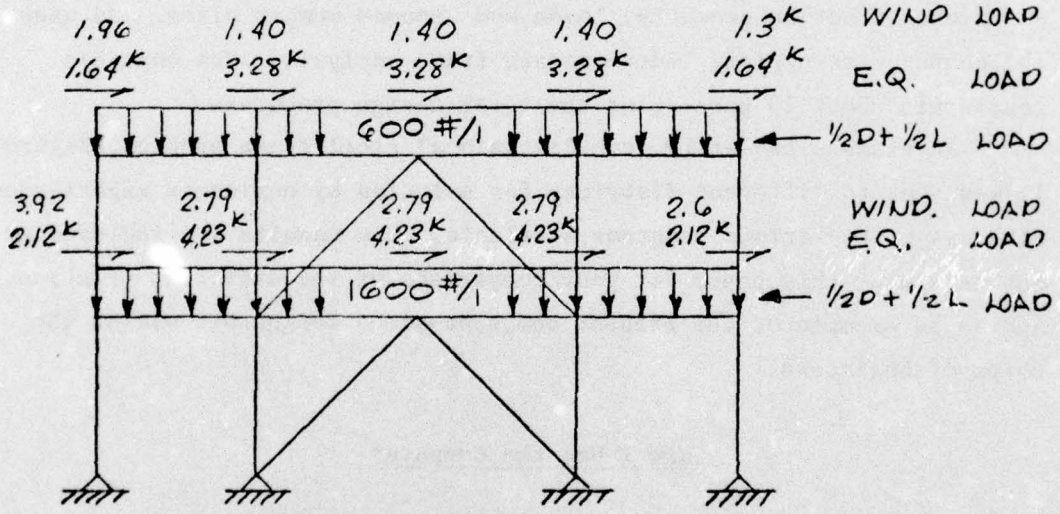
* Structural Engineer, Military Design Branch, Sacramento District.



FRAME ELEVATION



FRAME LOADS

Figure 1. Steel frame problem used in solution programs of Appendix B

and GENSAP. Most of the work is being done with SAP IV; we feel that using SAP IV, even on small structures, is warranted in order to stay confident and efficient using the program. All programs are run in the remote batch mode. All preanalysis processing for input data and post-analysis processing for design is done by hand calculator and the Wang 700B programmable calculator. The three example structures done in my district on the computer are: (a) the Post Chapel Addition at the Presidio of San Francisco, California, (b) the Weapon Evaluation Facility at Yuma Proving Grounds in Arizona, and (c) the Dental Clinic at Fort Ord, Monterey, California.

Figure 2 shows the interior of the Post Chapel at the Presidio of San Francisco. It was built around 1889 and went through the 1906 San Francisco Earthquake. We extended the Chapel and added one new frame to match the existing ones, which were made of 4 by 8 timber beams. This is an indeterminate frame; there is no tension rod between the center (of the) top and bottom chords and every member is bending. A year after the building was completed the new frame had deflected noticeably and repairs were required.

Figure 2. Interior of Post Chapel

Figure 3 shows part of the contract drawing of the process we used to repair the deflected frame. We jacked the frame up, using 370-lb force at five panel points simultaneously, thus restoring it to its original undeflected shape. Then we added a chain between the top and bottom chord panel center points to take tension (Figure 4) thus making the frame a truss, which was stronger and deflected less. Chain was used as the tension member to match the existing chapel decor.

Figure 5 is a computer model used to determine the forces and match the deflected shape of the frame. Four such models were tried before the deflected frame was matched. The input model (straight lines) used continuous members with pinned joints except for the half-lapped joint at the center bottom chord connection. The forces were input using fixed-end forces through the top chords. The deflected frame (curved lines) and the member end forces were now used as input for the next computer model. Note the direction of the member end moments.

Figure 6 is the final computer model showing the five jacking forces used to restore the frame to its original position (straight lines). Note that the member end-moments have reversed, thus relieving the member forces induced by the deflection. The Wilson 2-D Frame program was used. Note that pinned ends were required in order to match the existing deflected truss and two materials (steel chains and timber beams) were required to solve the problem.

Figure 7 illustrates the end elevation of the Weapons Evaluation Facility at Yuma, Arizona. The building is 300 ft square and 50 ft high.

Figure 8 shows the building in cross section with three spans of 55 ft and one of 90 ft. There is a 40-ton bridge crane in the high bay and 10-ton bridge cranes in one of the 55- and the 90-ft bays. This building would be very difficult to analyze without the aid of the computer.

Figure 9 shows one 55-ft bay. The high bay is to the right of the figure. Note the cars in the lower right-hand side of the figure in relationship to the building size.

Truss T-5, which is symmetrical about its center line, is shown in

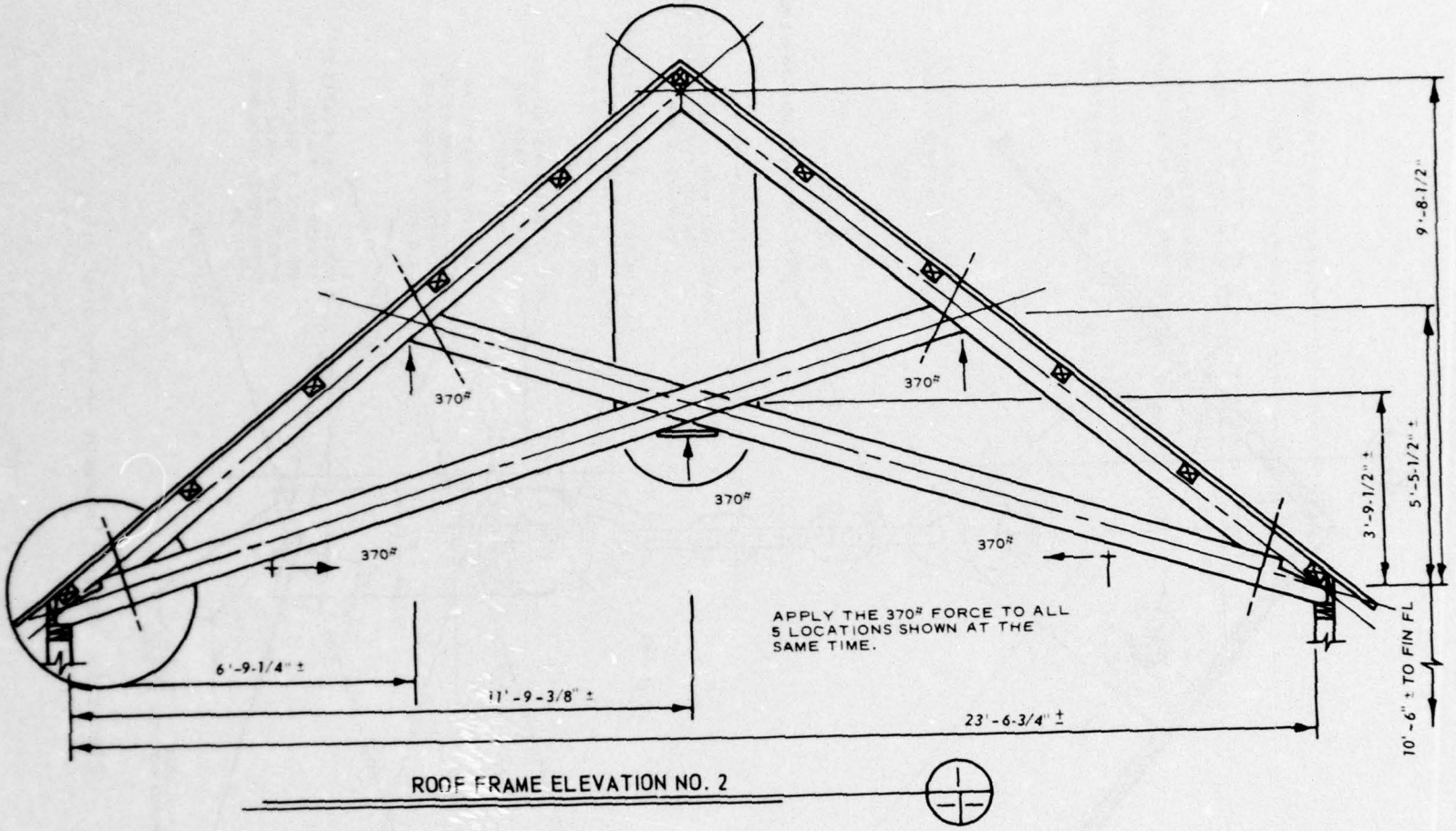


Figure 3. Contract drawing of process used in frame reparation

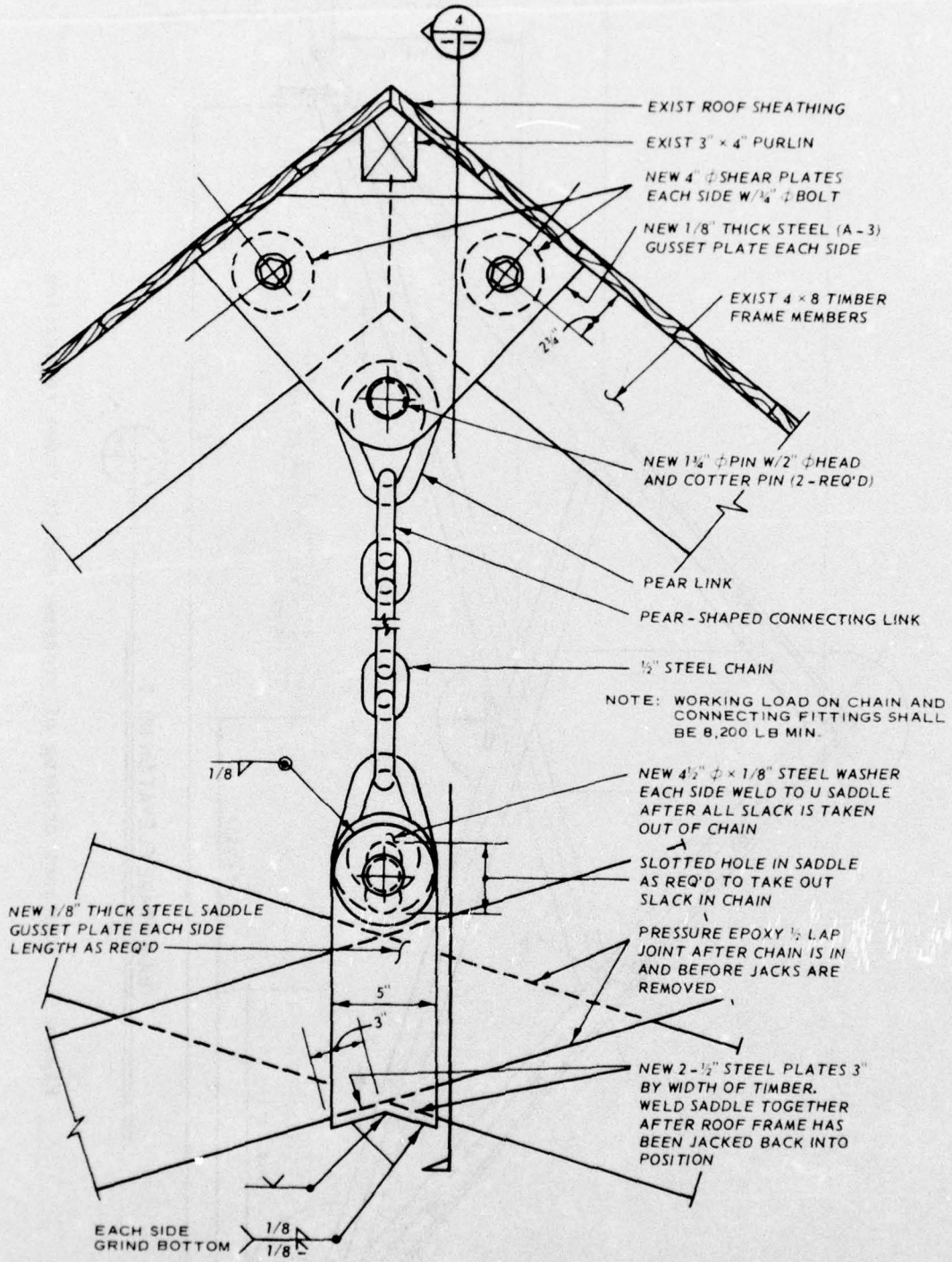


Figure 4. Chain placement on restored frame

MEMBER END FORCES

ELEMENT	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	1.066	0.365	0.000	-1.404	0.139	14.773
2	0.622	-.081	-14.773	-.378	0.347	0.000
3	-1.176	0.135	0.000	1.216	-.045	14.078
4	0.362	0.694	0.000	-.374	-.666	34.268
5	0.374	-.666	-34.268	-.362	0.694	0.000
6	0.378	0.347	0.000	-.622	-.081	14.773
7	1.404	0.139	-14.773	-1.066	0.365	0.000
8	-1.216	-.045	-14.078	1.176	0.135	-.000
9	-1.217	0.004	-14.078	1.217	-.004	14.097
10	0.399	0.652	-34.268	-.399	-.652	37.823
11	0.399	-.652	-37.823	-.399	0.652	34.268
12	-1.217	-.004	-14.097	1.217	0.004	14.078

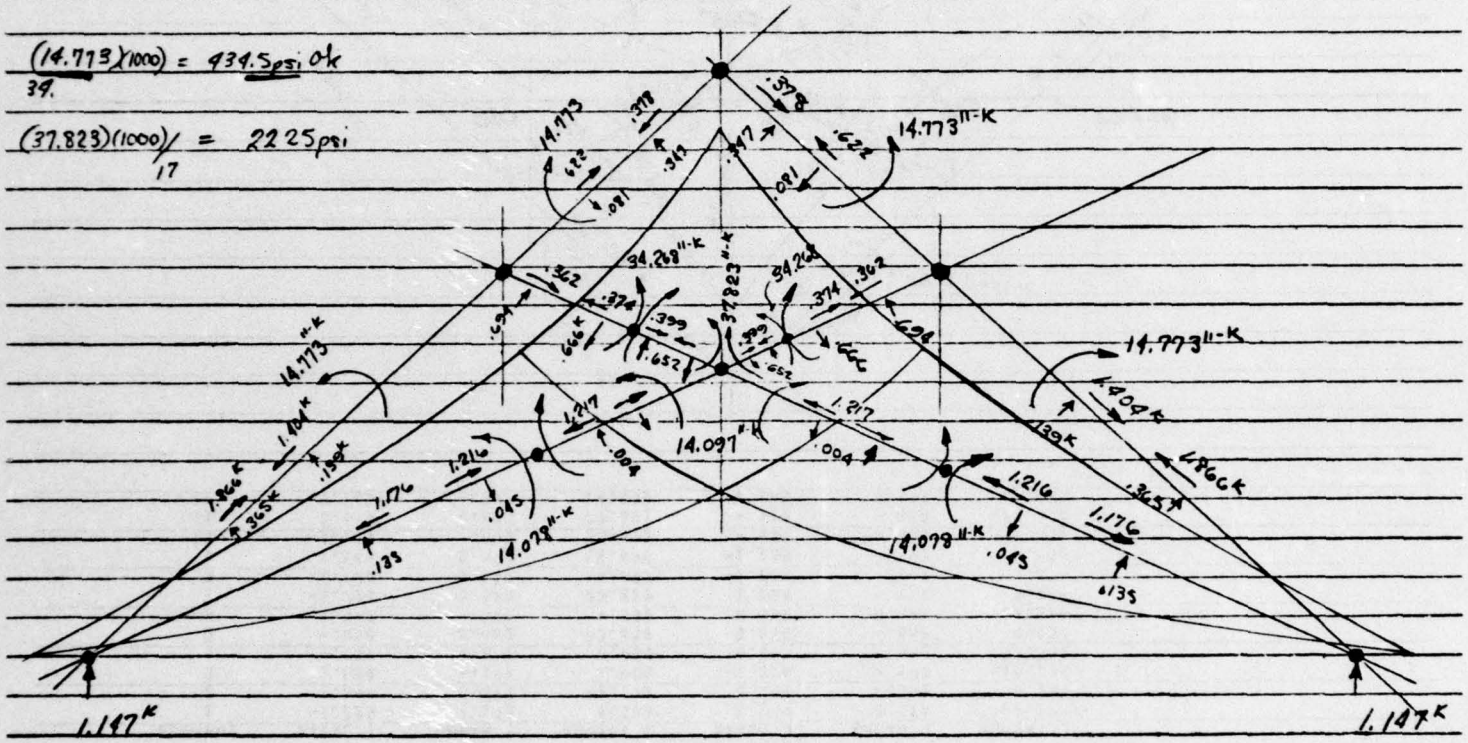


Figure 5. Trial computer model of deflected frame

MEMBER END FORCES

ELEMENT	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	-1.229	-.170	0.000	1.229	0.170	-22.227
2	-.349	0.321	22.227	0.349	-.321	0.000
3	1.226	-.107	-.000	-1.226	0.107	-16.695
4	-.050	-.662	0.000	0.050	0.662	-33.352
5	-.050	0.662	33.350	0.050	-.662	0.000
6	-.349	-.321	-.000	0.349	0.321	-22.229
7	-1.228	0.170	22.229	1.228	-.170	0.000
8	1.226	0.107	16.697	-1.226	-.107	0.000
9	1.165	0.397	16.695	-1.165	-.397	-14.688
10	0.119	-.653	33.352	-.119	0.653	-37.603
11	0.119	0.653	37.601	-.119	-.653	-33.350
12	1.165	-.397	14.689	-1.165	0.397	-16.697

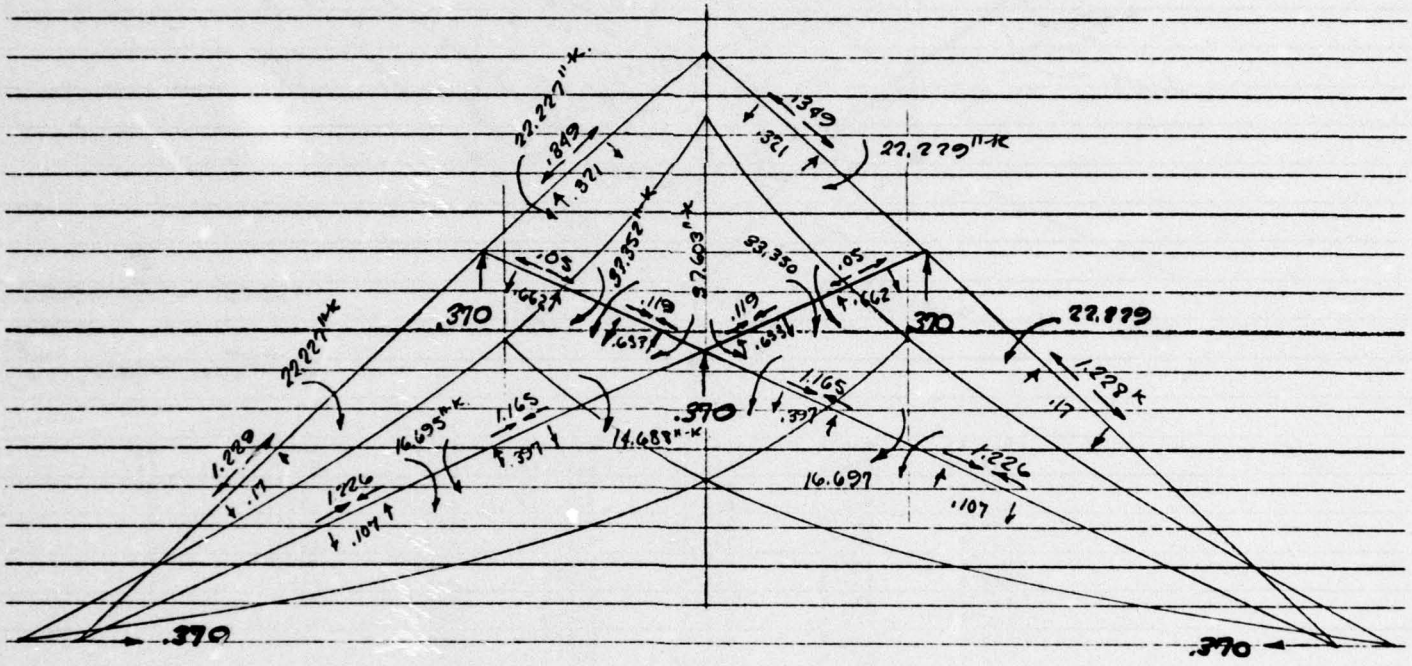


Figure 6. Final computer model of frame restored by jacking forces

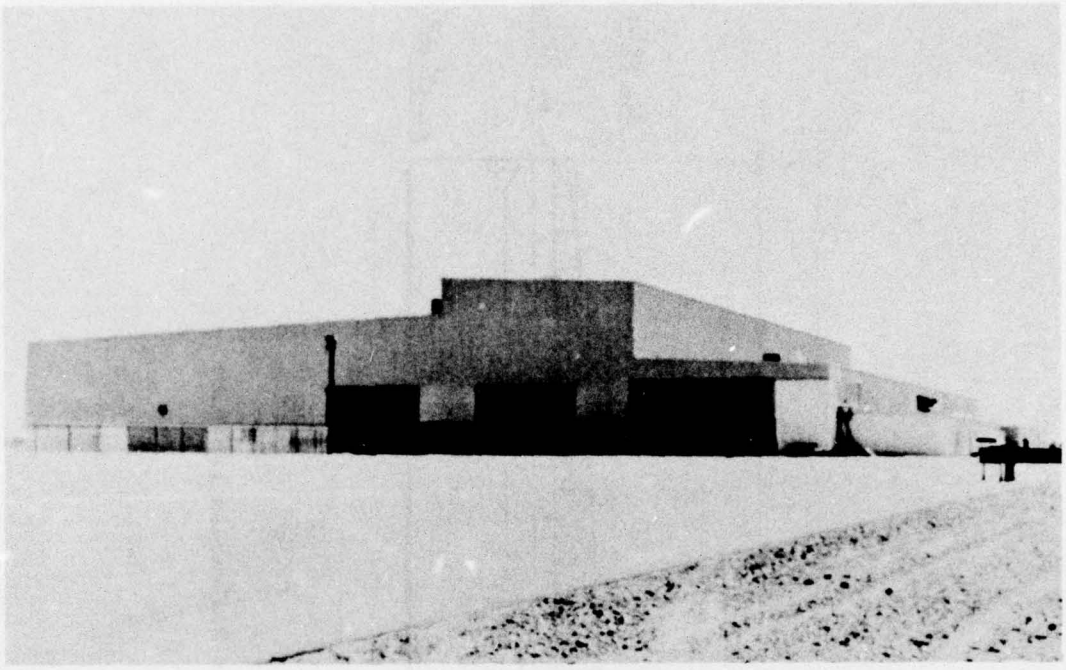
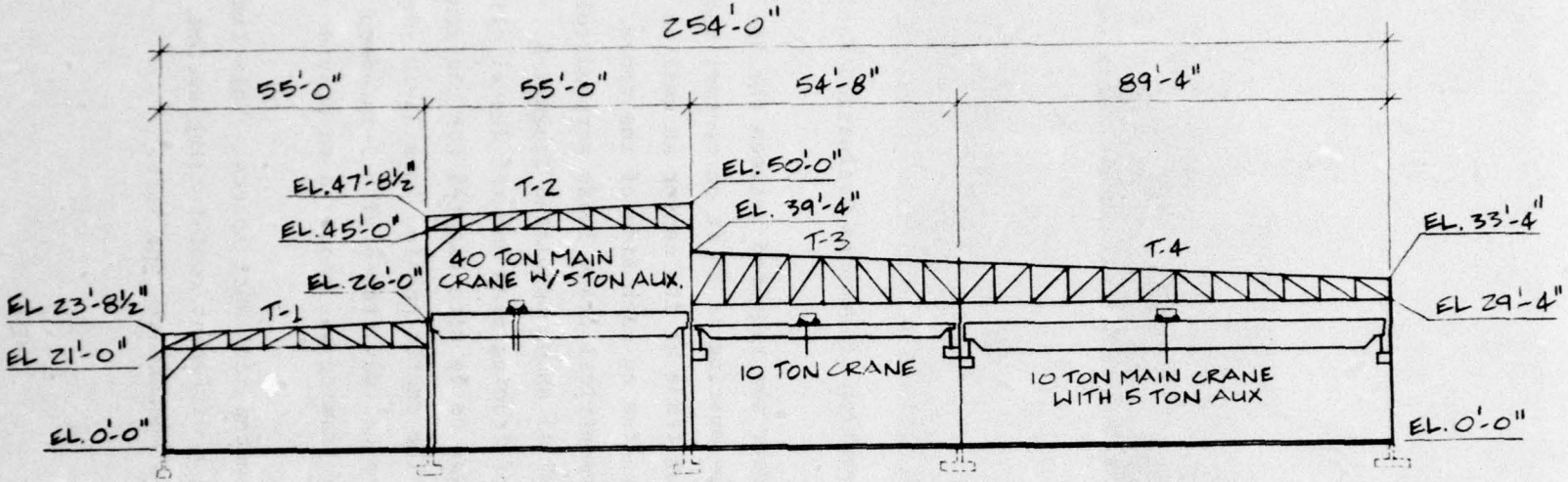


Figure 7. End elevation of Weapons Evaluation Facility

Figure 10. A 40-ft-wide door was required between the 55- and 90-ft bays. The regular building column spacing is 25 ft on center; therefore Truss T-5 must support a building frame at its center as well as a 10-ton bridge crane of different span lengths on each side of the truss. This required a 3-D analysis due to unsymmetrical crane loads perpendicular to the plane of the truss. Figure 11 shows completed Truss T-5.

Figure 12 is the roof framing plan for the dental clinic at Fort Lewis, Washington, which was to be site adapted for the dental clinic at Fort Ord, California. The center portion is a 36-in.-deep open web joist. Down each side is a hallway framed with 3-in.-deep channel sections. The change in roof framing was required to provide a mechanical duct space.

Figure 13 shows the mechanical duct spaces. This limited space prompted me to investigate a different roof-framing system, one which was deep enough to act as a mechanical-type loft.



TRUSS ELEVATION

Figure 8. Cross section of Weapons Evaluation Facility

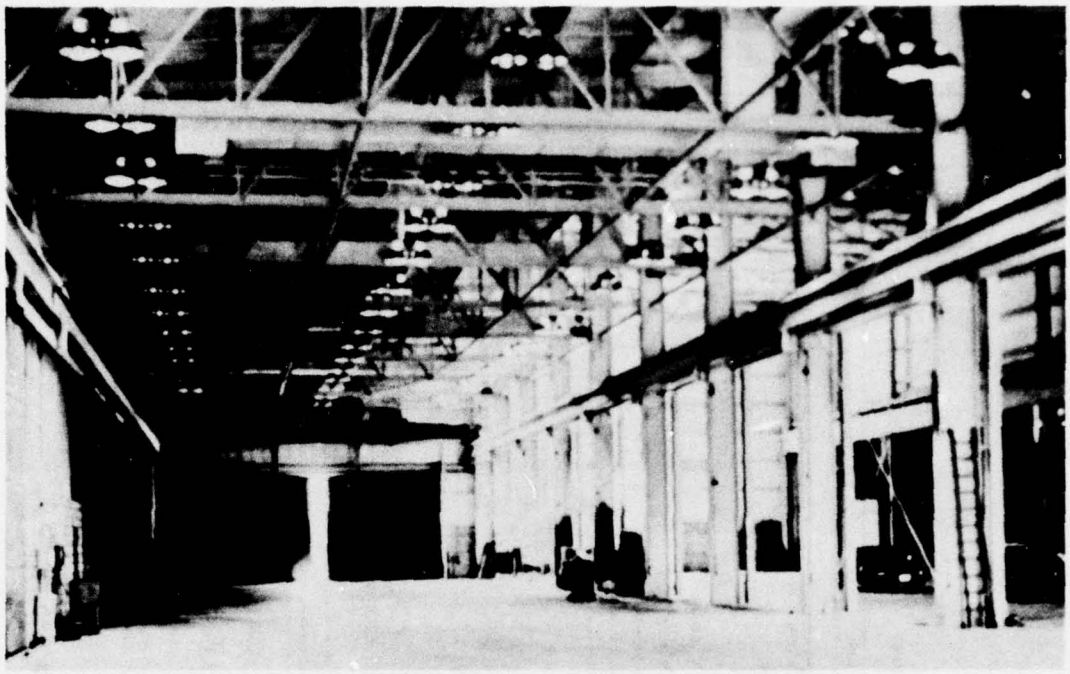


Figure 9. 55-ft bay of Weapons Evaluation Facility

Figure 14 is a cross section of the new roof framing system and the mechanical duct space provided.

Figure 15 is a picture of a section of the new roof framing system, a 3-dimensional space truss.

Figure 16 illustrates a 3-dimensional space truss made of double angle top and bottom chords and bent pipes for diagonals; 2-in. square tubes were used as transverse top and bottom chords.

Figure 17 shows the uniform 4-ft by 8-in. depth of the 3-D space truss, which provides for the mechanical loft. This roof framing system would not have been considered if it were not for the computer program SAP IV. The roof system is symmetrical about both center lines. Therefore, only one fourth of the structure was modeled.

The computer model contained 252 modal points and 647 members. Therefore, in order to verify the input data, it was plotted by a Cal Comp Plotter using a plotting subroutine in the program GENSAP.

The estimated cost of the original roof framing system was $96,000.

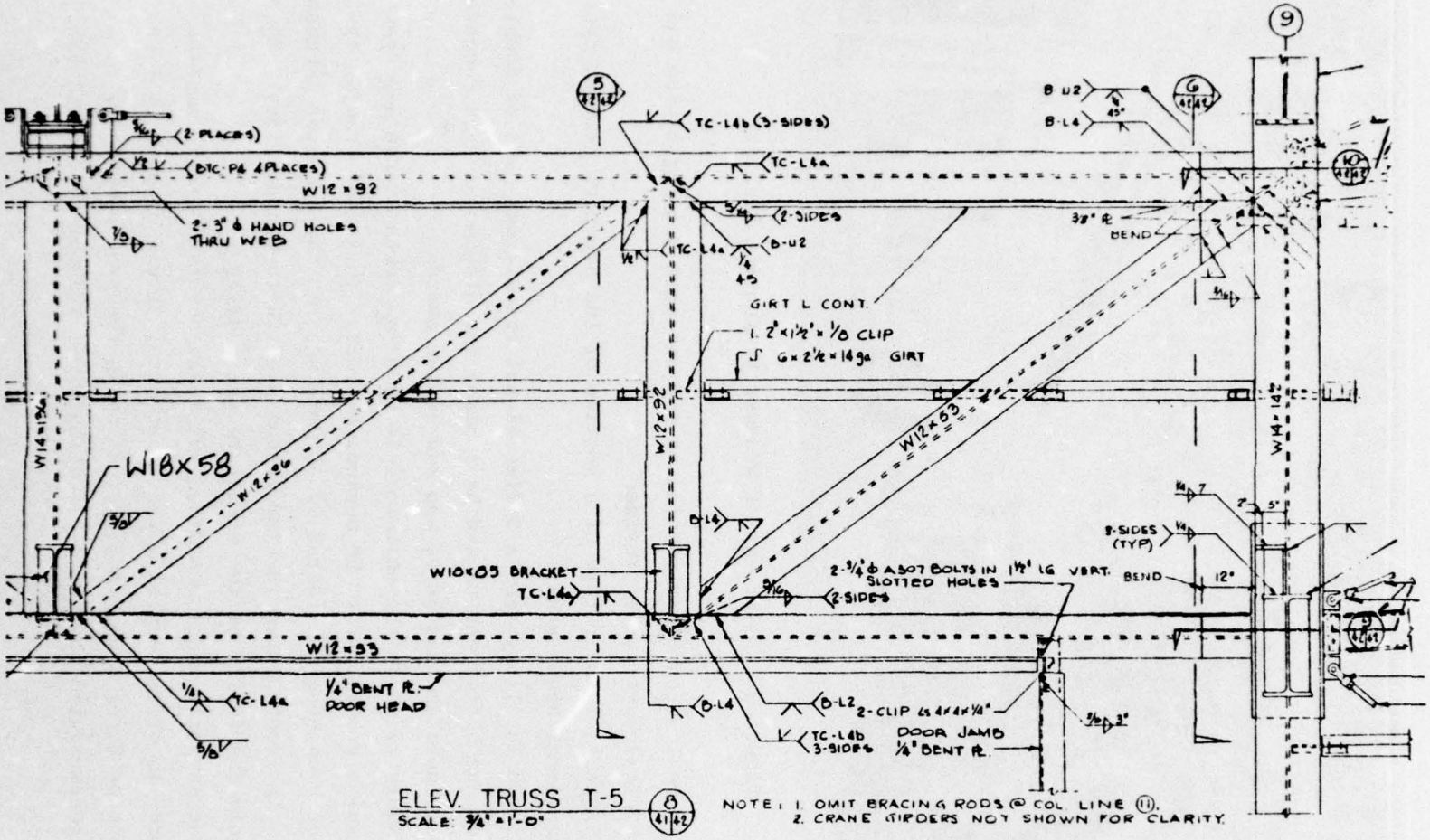


Figure 10. Truss T-5

Figure 11. Truss T-5 completed

The estimated cost of the 3-D space truss system was $71,200; this represented a $24,800 savings. After deducting the value engineering study cost of $3000 and the $3000 redesign cost, the net savings is $18,800.

These three examples have shown the change in design philosophy within my district, from the use of the computer to solve a difficult repair job, to the design of a complicated conventional 2-D frame, to a unique structural solution for meeting a functional requirement without regard for limitations set by analytical methods.

The computer-aided design procedure just illustrated is adequate in concept, but contains deficiencies in practice. For example, as stated before, the GENSAP program is used for plotting because SAP IV does not have a plot subroutine. Therefore, input data must be changed to run on GENSAP; at this time the job card deck is transmitted through a COPE 1200 terminal from the District ADP Center to Lawrence Berkeley Lab (LBL) at Berkeley, California. There it is run on a CDC 7600 Computer, which generates a plot tape. The plot tape is taken by courier to the division

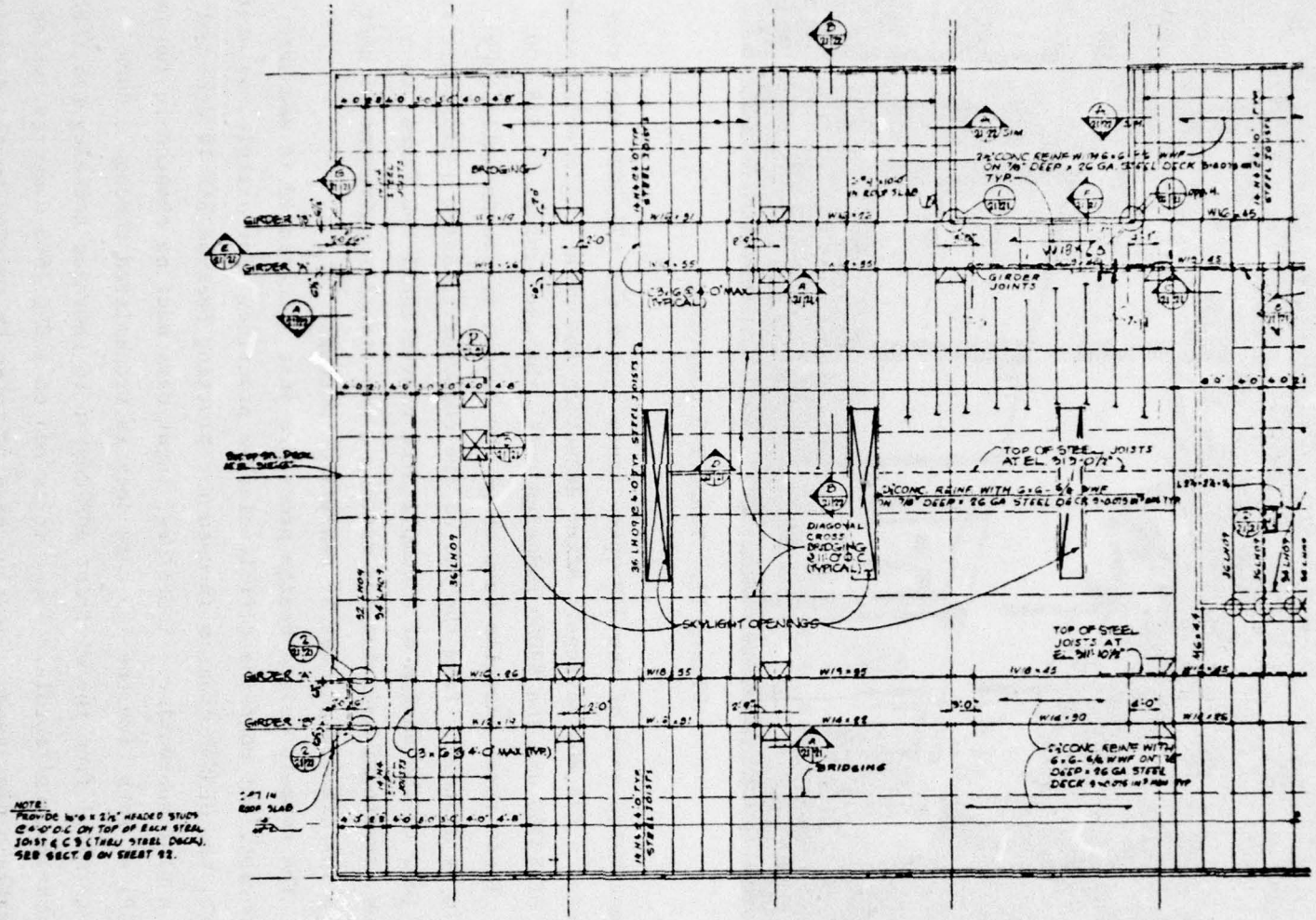


Figure 12. Original roof frame plan for dental clinic

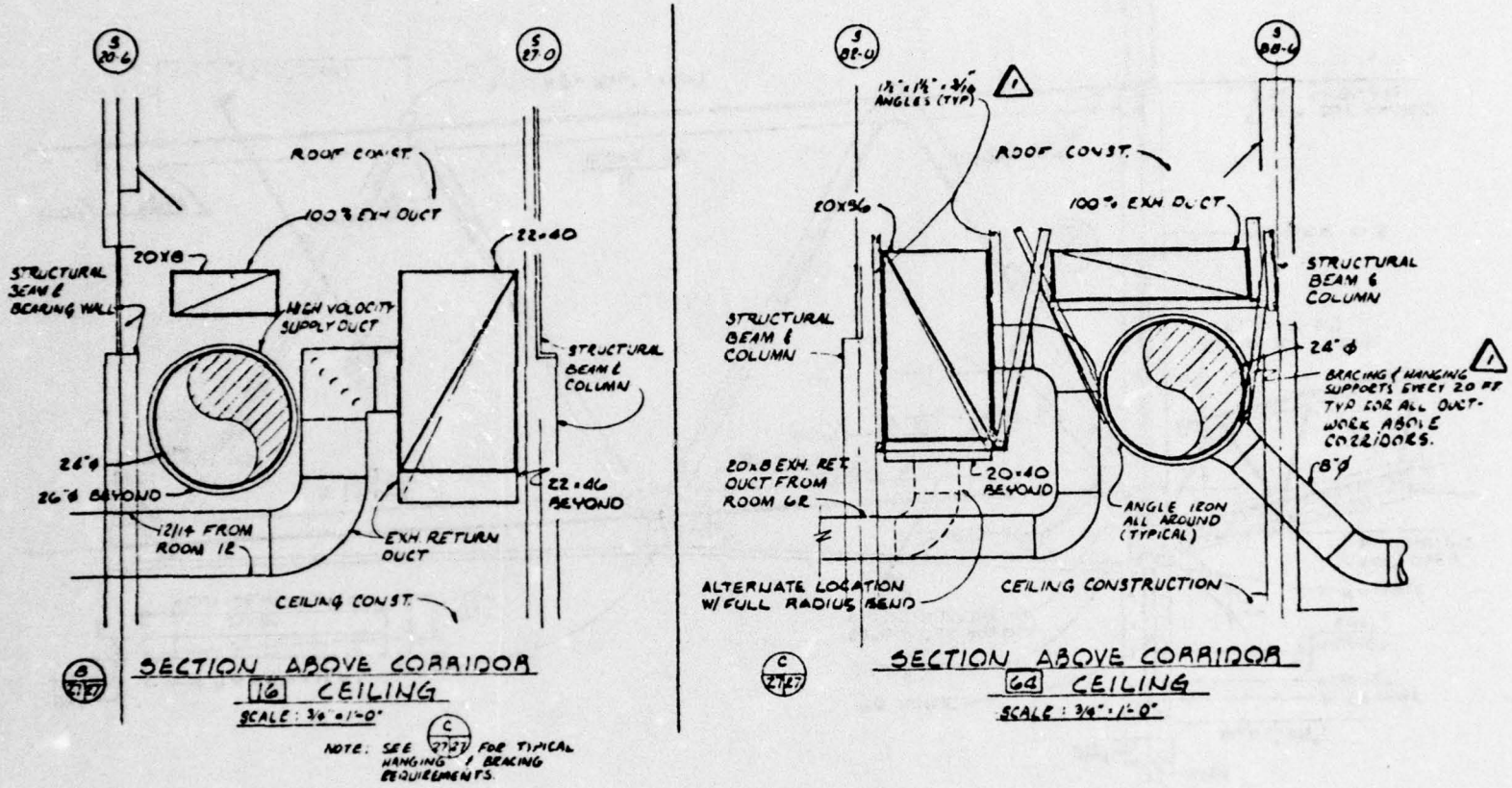


Figure 13. Original mechanical duct spaces for dental clinic

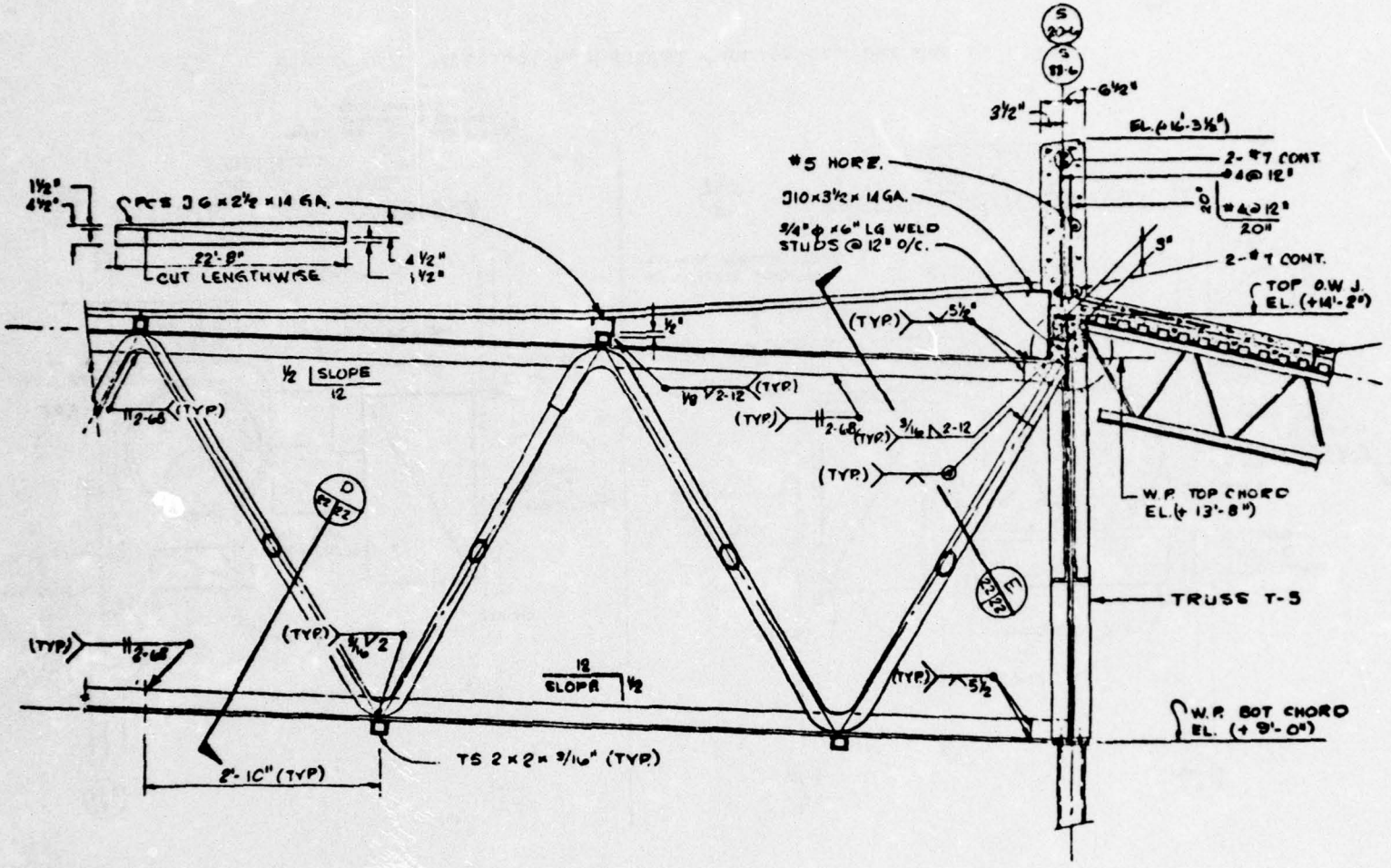


Figure 14. Cross section of new roof frame and mechanical duct space for dental clinic

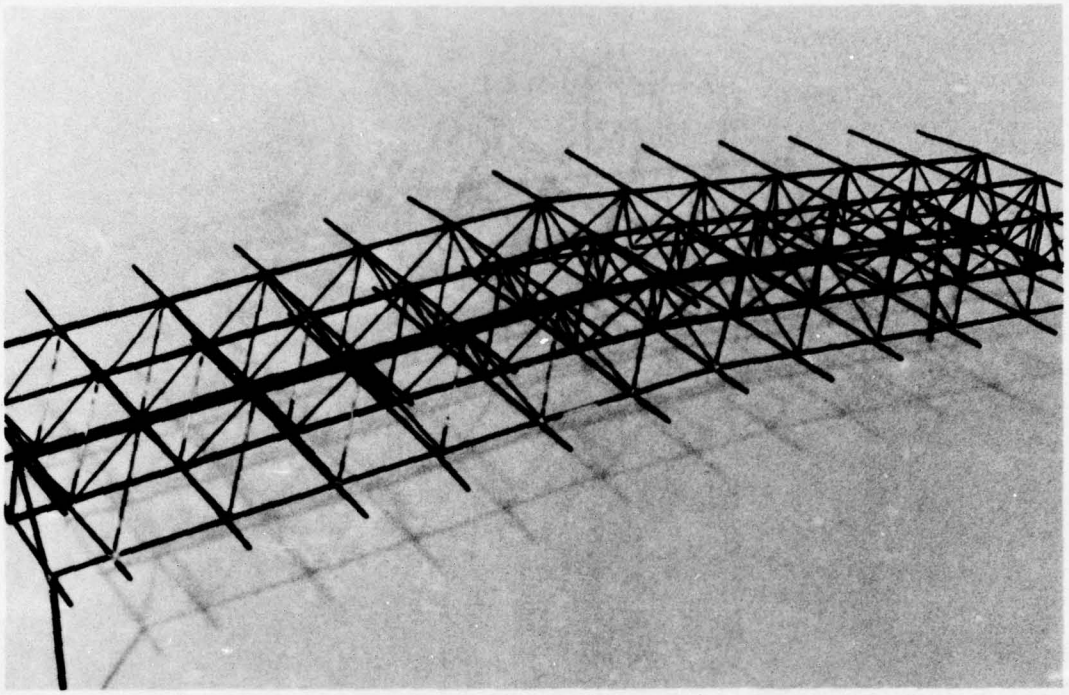


Figure 15. 3-D space truss model for dental clinic

ADP Center to be plotted on a Cal Comp Plotter. The plot is then sent by courier to our district. This plotting procedure takes a minimum of two complete working days; if there are any errors in the input data, the procedure is repeated until the input data are verified.

We have informed our ADP Center of this inconvenience and have requested that they install a plotter in the district. We have also informed them that a plot program is available for SAP IV from an outside vendor, but nothing has been done to improve the situation. I feel that this example of inadequate program and equipment support, resulting in lost effort and time, and generating ill will between designer and supervisor, is typical of the problems other districts are having with computer-aided design.

Restraints Placed on Computer Usage

The inefficient and slow progress of computer-aided design within

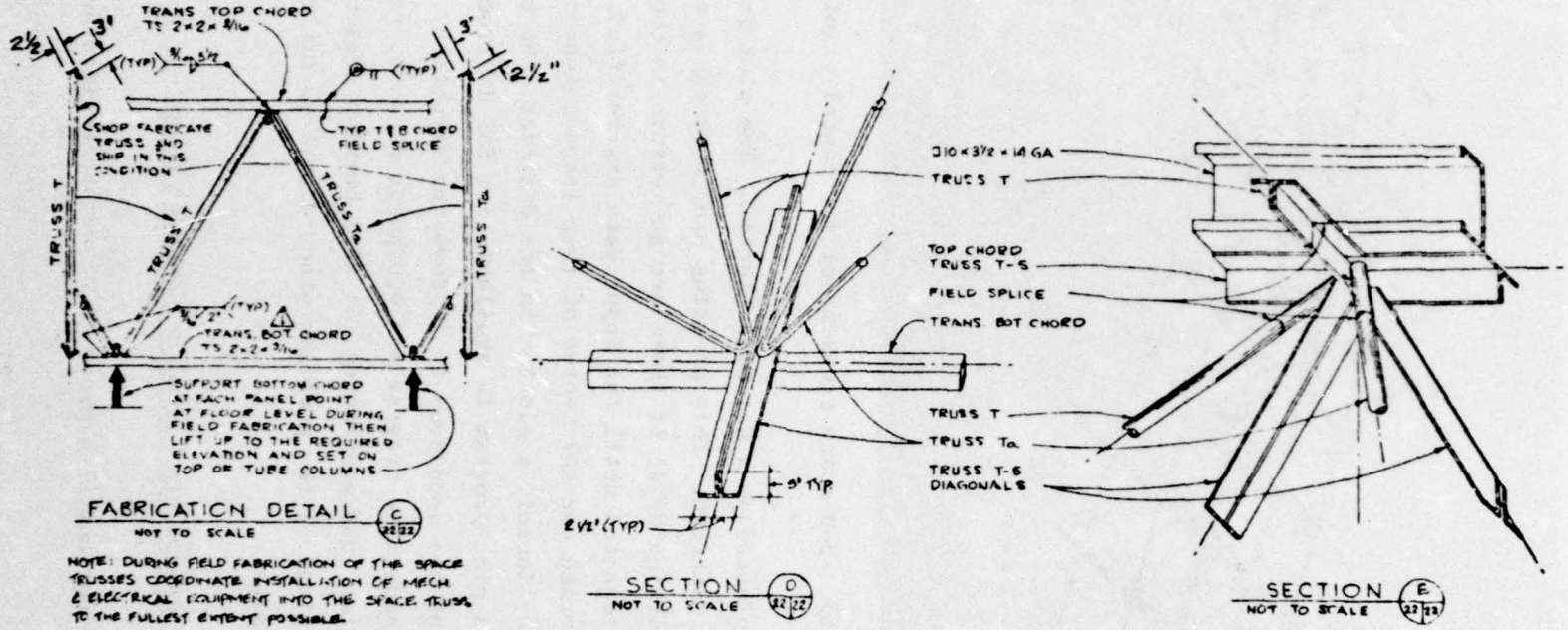


Figure 16. Fabrication detail of 3-D space truss

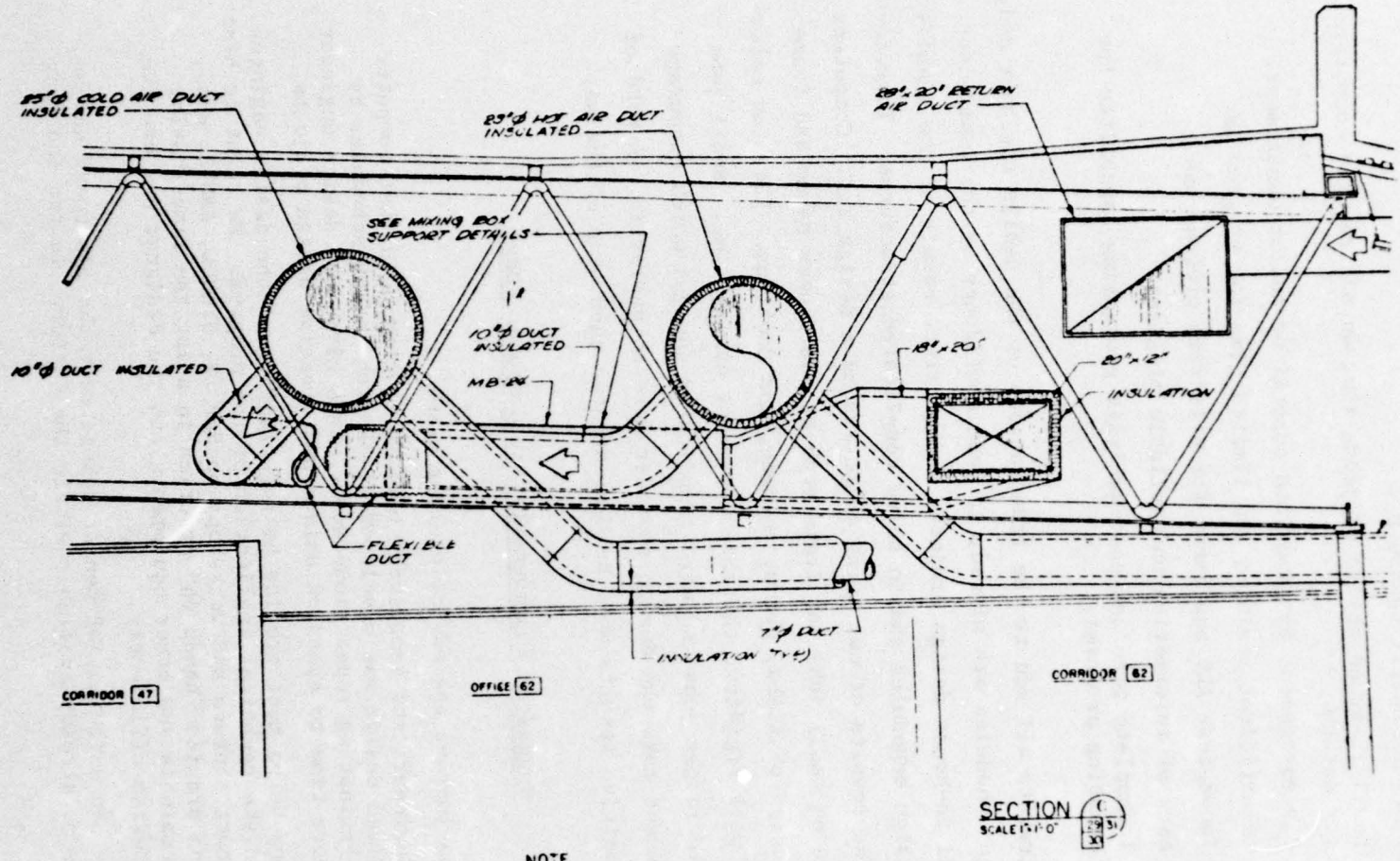


Figure 17. Cross section of dental clinic roof framing with ductwork installed

the Corps has been partly caused by:

a. Small in-house design projects that do not require computers for design.

b. Discouragement by immediate supervisor and/or management.

c. Insufficient training and limited time for program use.

d. Incomplete ADP equipment for effective program use.

e. Lack of information on available programs.

f. Incomplete pre- and post-analysis processing capability for existing programs.

These restraints all add to the frustrations of the design engineer and, when design schedules are missed, to lost confidence by the supervisor.

Small in-house design projects are a direct result of the inability to meet design schedules and to solve complicated structures. Therefore, they are the results of not using computers as a design aid. Computers can be used on small jobs for items such as continuous beams and frame moments, design of slabs, beams, columns, and footings. They can calculate shear wall rigidity, thereby shortening design time. Small jobs then lead to larger jobs and more complicated designs which encourage better work and make the design engineer more enthusiastic. A word of caution, positive results must be demonstrated each step of the way.

Suggested Improvements for Computer Usage

We can improve the educational programs.

a. Engineers and management have to be convinced that computer-aided design was developed to shorten design schedules by eliminating repetitious work. This gives the design engineer more time to spend on unique and creative design projects.

b. The Corps must provide better training of the design engineer in the technical application of the program. We ought to have short courses and workshops on SAP IV, STRUDL, ANSYS, etc., and provide "hands on" practice in using the time-sharing terminals and other equipments, so the designer can use the program efficiently.

c. We can have the ADP Center demonstrate the equipment and programs already available within the Center. In far too many

cases, the districts already have capabilities which the designers are not using.

d. We need to have demonstrations by vendors and in-house organizations to expose management and supervisors to available computer-aided design techniques and equipment and to present an overview of new approaches to existing engineering problems.

We can evaluate what ADP equipment and services are needed by the district for effective program usage and take action for their procurement. We need:

a. Graphic terminals or Cathode Ray Tube Terminals (CRT), which are television type screen units used for input and output in time-sharing program usage.

b. Graphic input devices for generating input data. A graphical device is generally an electronic light table with an electronic pencil or mouse for tracing a drawing and converting its information into numbers for use by the computer. Its use can accelerate the input of frames and finite element grids.

c. Flat bed or drum plotters for plotting input and output for such items as deflected shapes, principal stresses, stress contours, schedules of member sizes, and reinforcing steel bars, etc.

d. Contracts with outside vendors' services such as MCAUTO (McDonald Douglas Automation Company), BCS (Boeing Computer Services, Inc.), SDRC (Structural Dynamics Research Corporation), CDC (Control Data Corporation), etc.

We can expand the Engineering Computer Program Library (ECPL) and their listing of accepted programs.

a. The library should maintain a listing of programs which are currently under development, because many programs are being written and not documented due to lack of time and funds.

b. The library should promote official and unofficial channels of communication between designers and districts for sharing ideas and programs. The "Engineering Computer Notes" published by WES is one method of communication. Another method is to designate computer-oriented design engineers as ADP design coordinators in each district (similar to present coordinators in ADP Section).

We can determine programs needed within the district's set priorities and start developing or procuring them.

Although many programs are available to structural engineers, their usefulness is diminished by the varying standards to which they are

written, the many different forms of input data, and the machine-dependent nature of the programs. Each program should be designed with a common data basis and as a subprogram so that they can be linked together and tailored by the engineer developing a systems approach to meet the requirements of the particular structure under design. A list of such subprograms is as follows:

a. Preanalysis programs.

(1) Graphic package to generate input data and plots.

(2) Programs to generate fixed-end force data for input into the analysis programs.

(3) Programs which calculate assumed member sizes for input data.

b. Analysis programs. What should a good 2-D frame analysis program have?

(1) Option for prismatic and/or nonprismatic cross section.

(2) Option for variable stiffness, rigid, or pinned joints.

(3) Option for rigid or yielding supports.

(4) Option for combining members with different moduli of elasticity.

(5) Method for generating loading combinations including: dead loads, live loads, wind loads, earthquake loads, and temperature loads.

(6) Method for generating input data such as nodal points, members, loadings, etc.

(7) Option for shear and axial force deformations.

(8) Output that echoes print input data for verification.

(9) Output that includes deflections, axial forces, shear forces, moments, and reactions, printed out under nonsymbolic heading.

(10) Generation of a stored data file for data recall for use by postanalysis processing programs.

(11) Output format easily reproduced and used as the design analysis.

c. Postanalysis processing programs.

(1) Programs to produce graphic output including such items as:

(a) Deflected structure.

(b) Principal stress for plate and shell elements.

(c) Mode shapes.

(2) Programs to convert distributed moments, shear forces, and results of the analysis program, and to calculate the positive moments, shear forces, points of inflection and deflections.

d. Design programs.

(1) Design programs should take the analysis and postanalysis program results and design the beams, columns, connections, and footings according to building code requirements. Output for these programs should be as complete as possible, including schedules for all types of members and a complete tabulation of material quantities for estimating. The format should allow these schedules to be copied directly onto contract documents by draftsmen or transferred by other means. Many of these programs are already developed; however, they have to be linked with each other in order to obtain the complete analysis and design program.

(2) The ICES-STRUDL system is the only complete analysis and design program available for designing frames within the Corps of Engineers library. This program is available to the districts within the North Pacific Division and through a vendor contract at the Waterways Experiment Station (WES) to a limited number of other districts.

(3) The long-range approach to design programs must consider construction economy. Construction cost is of utmost importance in both civil and military construction; therefore, construction cost should be one of the controlling design factors. All programs we have discussed are for analyzing and designing structures to conform to allowable stresses and design codes with no references to cost except for a tabulation of material quantities for estimating. The computer-aided design approach must have an optimization procedure for determining the most economical combination of materials for construction. For example, to produce the lowest cost reinforced concrete members, the optimum relationship between the member capacity and the combination of two materials having different relative costs and strengths must be determined.

In conclusion, the state of the art within the Corps of Engineers consists of using and developing analysis programs, which represent about 20 percent of the design engineer's work. In order to realize the full potential of the computer it is imperative that we develop economical methods for using the computer in solving the full range of structural problems. It is felt by many that we are at a turning point in computer

usage for structural engineers within the Corps. The next few years will see substantial progress in developing a unified and positive approach to computer-aided design.

Appendix A: List of Computer Programs

TRUSS ANALYSIS PROGRAMS

PROGRAM NAME	AUTHOR/CONTACT OFFICE	LIBRARY	PROGRAM NUMBER--OCE CATEGORY	COMPUTER/ MODE	DOCUMENTED YES	DOCUMENTED NO	DESCRIPTION
PTRUSS (Program in progress)	Memphis District		713-G9-A1050	G-635	X		Solution of joint displacements and member axial load for planar pinned trusses.
X0002 (TRUSS)	Rock Island District	WESLIB	713-F3-F401B	G-635	X		Plane pin-jointed truss analysis by direct stiffness. Total truss structure stiffness is assembled from individual truss bar stiffness matrices. Then equation and terms related to known boundary conditions are modified. Data can be entered interactively or from a data file.
X0005 (STRUSS)	Rock Island District	WESLIB	713-F3-F401E	G-635	X		Pin-jointed space truss by direct stiffness. Space structures composed of members which are assumed straight between joints with loads applied at joint only and whose ends are free to rotate are considered. Individual bar stiffness matrices are determined by a modified gaussian elimination procedure.
Determinate Truss	David Heindel, USAE District, Norfolk, Baltimore	ECPL	713-F7-E4580 B	G-225 Batch	X		"Determinate Truss Analysis" of a simple statically determinate pin-connected truss for the support reactions and axial stress in up to 425 members. Loads are applied at joints.
Pin-Jointed Truss Analysis	Ploudre, Seattle District E. Wilson U.C. Berkeley	NPD	713-K5-G3150 A	IBM 360	X		2-D truss using direct stiffness method including support settlement.
Truss Influence Lines Plot	Ploudre, Seattle District	NPD	713-K5-G327 A	IBM 360	X		Modified pin-jointed truss analysis. Program 713-K5-G3150 is used for plotting influence lines.

CONTINUOUS BEAMS - ANALYSIS PROGRAMS

PROGRAM NAME	AUTHOR/CONTACT OFFICE	LIBRARY	PROGRAM NUMBER--OCE CATEGORY	COMPUTER/ MODE	DOCUMENTED YES	DOCUMENTED NO	DESCRIPTION
MDCF	W.A. Price, WESKA	WESLIB	713-F3-M3500	600TSS	X		Moment distribution for prismatic members. The program computes fixed-end moments, fixed-end shears, simple-span shears, and equivalent-FEM trapezoidal load for any superimposed combination of point loads and trapezoidal loads, over any portion of the span.
X0001 (BEAM 1)	Rock Island District	WESLIB	713-F3-F401A	G-635	X		Analysis of beams by direct stiffness method. The computer program analyzes beams of variable cross sections subjected to arbitrary loading. It uses the principle of matrix structure analysis, using the displacement method. Data can be entered interactively or from a data file.
BEAMHBW	H. B. Wilson, University of Alabama			G-635	X		General purpose continuous beam analysis. Multiple span, variable section properties, point and trapezoidal loads are computed. Plots shear, moment, slope, and deflection are given on terminal printer.
GIRDER	Paul Senter, WESKA	WESLIB		600TSS	X		Load Analysis Program. GIRDER provides an analysis of the loading (reactions, shears, and bending moments) in continuous girder in up to five spans using the principle of least work.
BMCOL	Professor Matlock, University of Texas Dr. N. Radhakrishnan, WESKA	LMVD		600 Card-in	X		Finite difference program to solve a variety of simple and complex beam-column structural problems accounting for movable loads.
BMCOL 4	Professor Matlock, University of Texas Fleming, Vicksburg District			GE-225 Batch	X		Linear finite difference program to solve a variety of single and complex beam-column structure problems.
/Mudd/BMCOL	Larry Farmer, Thomas Mudd, Saint Louis District	WESLIB	713-F3-A350	600TSS	X		Matlock's solution for BM-COL. The program is a finite element model solution for beam columns consisting of interacting bars and springs. It can model beam columns of varying cross section, applied lateral and axial loads, specified deflection and slopes, and lateral and rotational spring restraint.

CONTINUOUS BEAMS - ANALYSIS PROGRAMS

PROGRAM NAME	AUTHOR/CONTACT OFFICE	LIBRARY	PROGRAM NUMBER--OCE CATEGORY	COMPUTER/ MODE	DOCUMENTED YES	DOCUMENTED NO	DESCRIPTION
A71350	Larry Farmer, Joe Vennari, Saint Louis District	WESLIB	713-F3-A350	600TSS	X		Matlock's recursive solution for beam columns. This program solves beam-column problems with Matlock's recursive solution.
MATLOCKM	Forms-Hartman, Joseph P. Hartman, Saint Louis District			600 Batch	X		Determines maximum positive and negative moments, shear displacements, and reactions at each location on a beam for any set of vertical load moved incrementally along the length of a beam. This is a modified version of BMCDL for moving loads.
BEAM	Dr. N. Radhakrishnan, WESKA	WESLIB		600TSS	X		Program to compute beam moments and deflections. This program computes moments and deflections in a single-span variable-depth beam carrying concentrated and distributed loads. The end deflections are zero. The remaining conditions can involve zero slope or zero moment.
BEAMNOD (Program in progress)	New Orleans District		713-F3-A2580	G-635	X		Analyze a symmetrical straight member for any statically determinant one-dimensional load which consists of transverse point loads, transverse continuous loads, or couples.
Beams (Shear, Moment, Deflection)	Beer, New Orleans District		713-F3-A2-580 C	600TSS		X	Determines for small deflections the shear force, bending moment, and deflection at selected positions for any statically determinant beam and coplanar loading perpendicular to the neutral axis. The program accepts a load system from 741-F3-A2-370 of WESLIB.
Finite Difference Analysis of Beam-Column on Elastic Foundation	Weller, Portland District	NPD	713-K5-G4130 A	IBM 360	X		
Beam Column Analysis w/ Printer Plot	Mueller, Dickenson, University of Missouri	NPD	713-K5-G2160 A	IBM 360	X		
Analysis of Curved Continuous Beams	Gniewosz Portland District	NPD	713-K5-G2210 A	IBM 360	X		

2-D FRAME ANALYSIS PROGRAMS

PROGRAM NAME	AUTHOR/CONTACT OFFICE	LIBRARY	PROGRAM NUMBER--OCE CATEGORY	COMPUTER/ MODE	DOCUMENTED YES	DOCUMENTED NO	DESCRIPTION
WILSON 2-D	Ed Wilson, J. D. Rafferty, University of California, Berkeley, San Francisco District	ECPL	713-G2-L3002 B	IBM 360 Batch	X		Analysis of two-dimensional frame structures. Joint deflection, member-end forces, and joint reactions are determined for plane frames which may be subjected to joint loads, joint displacements, and member loads. Supports may be rigid or linear. Elastic members may be nonprismatic. Member to joint connections may be flexible (partially rigid). Different material may be used for different members in frame.
	D. Reynolds, Sacramento District Omaha District		713-G2-L2-17C 713-X6-L2-17C	GE-415 CDC 7600 LBL Batch			
GFRAME	Robert Brittain, Memphis District	WESLIB	713-F3-A104	600TSS	X		Analysis of Planar Rigid Frames. The program analyzes planar rigid frames taking into account axial deformations.
GFRAME	Galveston District	ECPL	713-G1-A1040	G-225 G-437	X		Same program as GFRAME in system WESLIB, except links to program POSMO (713-G1-M3180) to compute shears, moments and axial forces at 1/10 points along each member of the frame for each load condition. The program uses rigid frame analysis with 60 members and 40 joints maximum.
X0003 (FRAME)	Rock Island District	WESLIB	713-F3-F401C	G-635	X		Analysis of frames by direct stiffness method. Computer program analyzes frames of variable cross section subjected to arbitrary loading. It uses the principle of matrix structure analysis, using the displacement method. Data can be entered interactively or from a data file.
X0004 (GRID)	Rock Island District	WESLIB	713-F3-F401D	G-635	X		Grid analysis by direct stiffness. The individual grid element stiffness matrix is transferred to the grid structure coordinate system and modified for specified boundary restraints. These restraints are added to form total structure stiffness matrix. Data can be entered interactively or from a data file.

2-D FRAME ANALYSIS PROGRAMS

PROGRAM NAME	AUTHOR/CONTACT OFFICE	LIBRARY	PROGRAM NUMBER--OCE CATEGORY	COMPUTER/ MODE	DOCUMENTED YES	DOCUMENTED NO	DESCRIPTION
Grid Analysis	Portland District	NPD	713-K5-G2130 A	IBM 360	X		
FRAME (Program in progress)	Robert Hall, WESKA	WESLIB		G-635TSS Interactive Graphics	X		An interactive graphics program that builds frame cases and analyzes with GFRAME and displays shear, moment, and displacement diagrams.
	Vicksburg District		713-F3-A4140				Two-dimensional frame analysis program.
SM 468	Fleming, Vicksburg District		713-G9-A4020	400 Batch	X		Plane Frame - Beam element finite element code.
OFRAME	Robert Brittain, Memphis District	ECPL	713-G9-A1030 B	GE-400TSS	X		Analyzes planar orthogonal frames.
STRESS	Dr. N. Radhakrishnan	Honeywell		BATCH	X		Structural Engineering System Solver. Performs linear analysis of elastic statically loaded framed structures.
Indeterminate Frame	Brammer, Portland District	NPD	713-K5-G4100 B	IBM 360	X		
2-D Frame Analysis	McDonald, Portland District	NPD	713-K5-G4110 A	IBM 360	X		
Truss, Frame, & Beam Element Analysis	Mueller, Portland District	NPD	713-K5-G204A A	IBM 360	X		
Stiffness Analysis	Raisanen, Portland District	NPD	713-K5-G0030 B	IBM 360	X		
Lateral Force Distribution for Shear Walls	Lonberg, Portland District	NPD	713-K5-G2180 A	IBM 360	X		
Lateral Load Analysis of Multistory Frames with Shear Walls	Ploudre, Portland Cement Association program	NPD	713-K5-G332 A	IBM 360	X		

3-D FRAME ANALYSIS PROGRAMS

PROGRAM NAME	AUTHOR/CONTACT OFFICE	LIBRARY	PROGRAM NUMBER--OCE CATEGORY	COMPUTER/ MODE	DOCUMENTED YES	DOCUMENTED NO	DESCRIPTION
SAP IV	B. Haavisto, D. Reynolds, University of California Sacramento District	Sacramento District	713X6L221A	Batch/CDC7600 @ LBL	X		General finite element program for static and dynamic analysis of linear elastic structural systems. Element library includes 3-D truss, 3-D beam, isoparametric plane strain/ stress, isoparametric 21 node, 3-D solid/thick shell, isoparametric thin shell, axisymmetric solid, 3-D pipe, boundary spring. Program time-history and spectral analysis capability. There are currently no graphics.
SAP 4	Ed Wilson, University of California Bill Boyt, WESKA			600 Batch	X		3-D structural analysis program for linear systems. The program uses finite elements for static and dynamic problems with approximate mode shapes for the dynamic option.
SAPBEAM	H. W. Jones, WESKA	LMVD		G-635 Batch CARDIN	X		A modified general purpose structural analysis program (SAP4) that can automatically compute fixed end moments and shears on beam elements for in-span beam loads.
SAPPILE	H. W. Jones, WESKA	LMVD		G-635 Batch CARDIN	X		A modified general purpose structural analysis program (SAP4) with a three-dimensional pile element added. It is good for analysis of 3-D flexible cap pile foundations.
GENSAP	Agbabian Associates, Huntsville Division	ECPL	713-C8-7006F B	CDC 6400 Batch	X		"General Elastic and Non-linear Structural Analysis Program." This is a general purpose system for 3-D analysis of structural systems using the finite element method.
GENSAP	Agbabian-Jacobsen Associates, Los Angeles, California B. Haavisto, D. Reynolds, Sacramento District	Sacramento District	713X6L231A	BATCH/ CDC 7600 @ LBL	X		General elastic and nonlinear finite element structural analysis program. Elememt library includes 3-D truss, 3-D beam, plane strain, plane stress, axisymmetric solid, 3-D solid, thin plate/shell, and boundary spring. The program offers static and dynamic analysis, including time-history and spectral analyses. There are limited graphics in pre- and post-processors.
GENSAP	Adams, Portland District	NPD	713-K5-7006F A	IBM 360	X		General purpose 3-dimensional, static and dynamic analysis.
NASTRAN	Coell, Portland District	NPD	713-K5-00060 B	IBM 360	X		General purpose program.

3-D FRAME ANALYSIS PROGRAMS

PROGRAM NAME	AUTHOR/CONTACT OFFICE	LIBRARY	PROGRAM NUMBER--OCE CATEGORY	COMPUTER/ MODE	DOCUMENTED YES	DOCUMENTED NO	DESCRIPTION
NASTRAN	Joe Hartman, St. Louis District MCAUTO						General purpose program.
TABS	University of California, Berkeley D. Reynolds, Sacramento District	Sacramento District	713-X6-L2-240	CDC 7600 @ LBL BATCH	X		Static and earthquake analyses of 3-D frame and shear wall buildings. Program gives linear structural analysis of frame and shear wall buildings subject to static and earthquake loadings. Beams and girders may be nonprismatic; bending and shearing deformation are included. Nonsymmetric, nonrectangular buildings having frames and shear walls in plan can be considered. Earthquake input is specified as an acceleration spectrum response.
NONSAP	University of California, Berkeley B. Haavisto, D. Reynolds, Sacramento District	Sacramento District	713X6L2	CDC 7600 @ LBL BATCH	X		Finite element program for static and dynamic analysis of nonlinear structural systems. Element library consists of 3-D truss, 3-8 node isoparametric plane strain/stress, 3-8 node isoparametric axisymmetric solid, 8-21 node isoparametric 3-D solid/thick shell. Available analysis procedures are: 1) Linear Elastic: assumes small displacements, infinitesimal strains, isotropic or orthotropic linear elastic material. 2) Materially Nonlinear: assumes small displacements, infinitesimal strains, nonlinear material stress-strain description. 3) Total Lagrangian Formulation: element may experience large displacements and strains, stress-strain relation is linear or nonlinear. 4) Updated Lagrangian Formulation: element may experience large displacements and strains; stress-strain relation is linear or nonlinear. Program designed for general incremental solution of nonlinear problems; linear analyses are possible also.
SAGS	Chicago District	INFONET					Static Analysis of General Structures including two- and three-dimensional frame structures.
SUPERB		INFONET					General purpose, structural analysis programs.
ECI STRUDL	Seattle District	Seattle District					General purpose, structural analysis and design programs.
ECI STRUDL	MCAUTO, New England Division Saint Louis District	WES Contract					General purpose, structural analysis and design programs.

DESIGN PROGRAMS

PROGRAM NAME	AUTHOR/CONTACT OFFICE	LIBRARY	PROGRAM NUMBER--OCE CATEGORY	COMPUTER/ MODE	DOCUMENTED YES	DOCUMENTED NO	DESCRIPTION
Analysis and Design of Flat Plates, Waffle Slabs and Continuous Frames	Portland Cement Association program Sacramento	SPK	713-58-L2-20C INFONET	UNV 1108 BATCH	X		1971 ACI-318 Bldg. Code analysis and design for flat plates, flat slabs (with drop panels), waffle slabs, and continuous concrete frames.
Analysis and Design, Flat Plates and Continuous Frames	Portland Cement Association program Ploudre, Seattle District	NPD	713-K5-G3280 A	IBM 360	X		
Composite Section Properties	Ploudre, Seattle District	NPD	713-K5-G3410 A	IBM 360	X		Computes section properties of any structural composite section.
AISCB (Program in progress)	American Institute of Steel Construction	WESLIB		G-635TSS	X		Computer program for steel beam, girder, and floor framing design.
AISCC (Program in progress)	American Institute of Steel Construction	WESLIB		G-635TSS	X		Computer program for steel column design.
GVSCAT 2 GVSCAT 3	G. V. Schwalbe, Thomas J. Mudd, St. Louis District			600TSS	X		Computes actual and allowable axial and bending stresses and the combined stress ratios for steam beam columns in accordance with 1969 AIS specifications.
PCABR	Portland Cement Association program	WESLIB		G-635TSS	X		Analysis and design of simple-span, precast, prestressed highway or railway bridges. The program uses 1968 AASHO or AREA specifications.
PCAUC	Portland Cement Association program	WESLIB		G-635TSS	X		Ultimate strength design of reinforced concrete columns.
PCAUC	Ploudre, Portland Cement Association program	NPD	713-K5-G3300 A	IBM 360	X		Ultimate strength design of reinforced concrete columns.
Strength Design of Reinforced Concrete Column Sections	Portland Cement Association program, Sacramento	SPK	713-58-L2-20B	UNV 1108 BATCH	X		Capacity to design or investigate reinforced concrete compression members. AASHTO, 1973 Interior Spec. Sec. 5, Part 6, Load Factor Design, and ACI 318-71 Bldg. Code.
Concrete General Flexure Analysis	Ploudre, Seattle District	NPD	713-K5-G3010 A	IBM 360	X		
Reinforced Concrete Design for Flexure and Axial Load	Monroe, Portland District	NPD	713-K5-G0050	IBM 360	X		
DRCB	Robert Hall, WESKA			600TSS		X	Computes stresses for double reinforced concrete member by inputting strain of rebars.

POSTPROCESSOR PROGRAMS

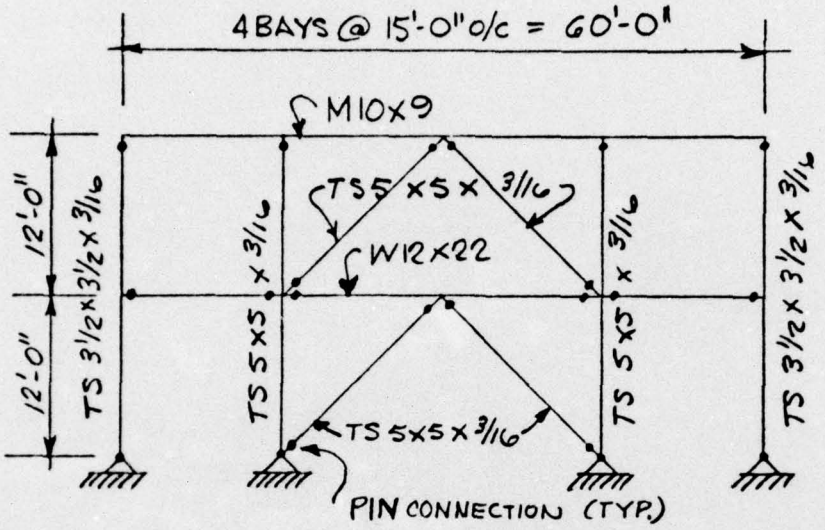
PROGRAM NAME	AUTHOR/CONTACT OFFICE	LIBRARY	PROGRAM NUMBER--OCE CATEGORY	COMPUTER/ MODE	DOCUMENTED YES	DOCUMENTED NO	DESCRIPTION
PCA-BM	Sefton Lucas, Memphis District	A1B400		600TSS		X	Post-processor for GFRAME computes resisting moment for concrete beam. The program checks shear at face of support, computes moment at fixed increments, and designs reinforcement for axial load plus bending.
POSMO	Galveston District	ECPL	713-G1-M3180	G-225 G-437	X		Links from program GFRAME (713-G1-A1040) and calculates shears, moments and axial forces at 1/10 point of each member for each load case. Call Wm. A. Price, FTS 601-636-3645 for information.
Beam Analysis One Span	Portland District	NPD	713-K5-G3110 A	IBM 360	X		

PRE-PROCESSOR PROGRAMS

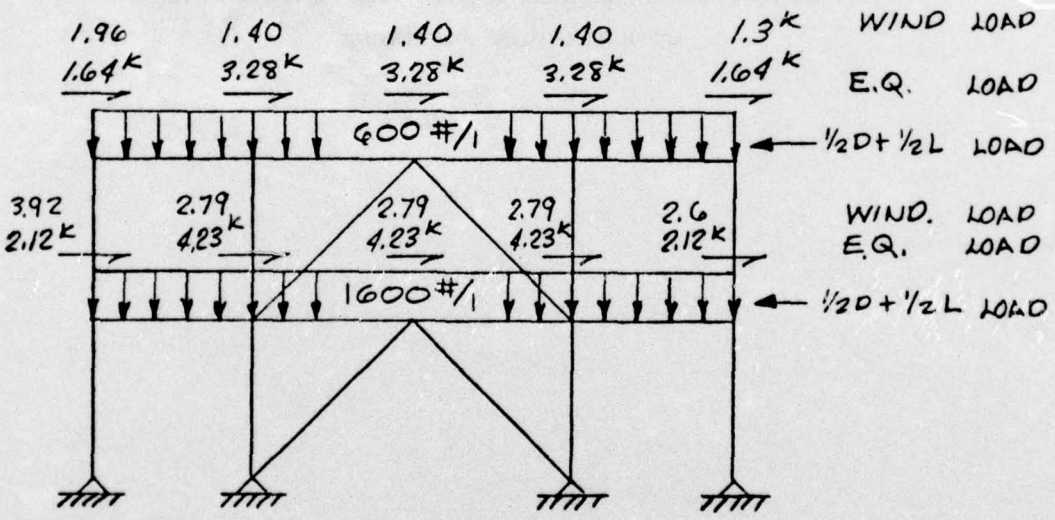
PROGRAM NAME	AUTHOR/CONTACT OFFICE	LIBRARY	PROGRAM NUMBER--OCE CATEGORY	COMPUTER/ MODE	DOCUMENTED YES	DOCUMENTED NO	DESCRIPTION
PREFEM	Fred Tracy, WESKA	WESLIB		G-635TSS Interactive Graphics	X		An interactive graphics program for automatically generating finite element grids and on-line data editing and numberings. It is a preprocessor finite element program.
POSTFEM	Fred Tracy, WESKA	WESLIB		G-635TSS Interactive Graphics	X		An interactive graphics program for proof-processing finite element data. Programs can generate contour plots, vector plots, isometric and perspective plots.
3-D EDIT	Fred Tracy, WESKA	WESLIB		G-635 Batch	X		3-D edit program for the finite element program.
PRESAP	H. W. Jones, WESKA	LMVD		G-635TSS	X		An interactive time-sharing program to generate data for the General Purpose Structure Analysis Program (SAP4).

Appendix B

Two-Story, Two-Dimensional Steel Frame Sample Problem
with District Solutions



FRAME ELEVATION



FRAME LOADS.

PROJECT 2-D FRAME SAMPLE PROBLEM

ITEM _____

_____

COMPUTED BY _____ CHECKED BY _____

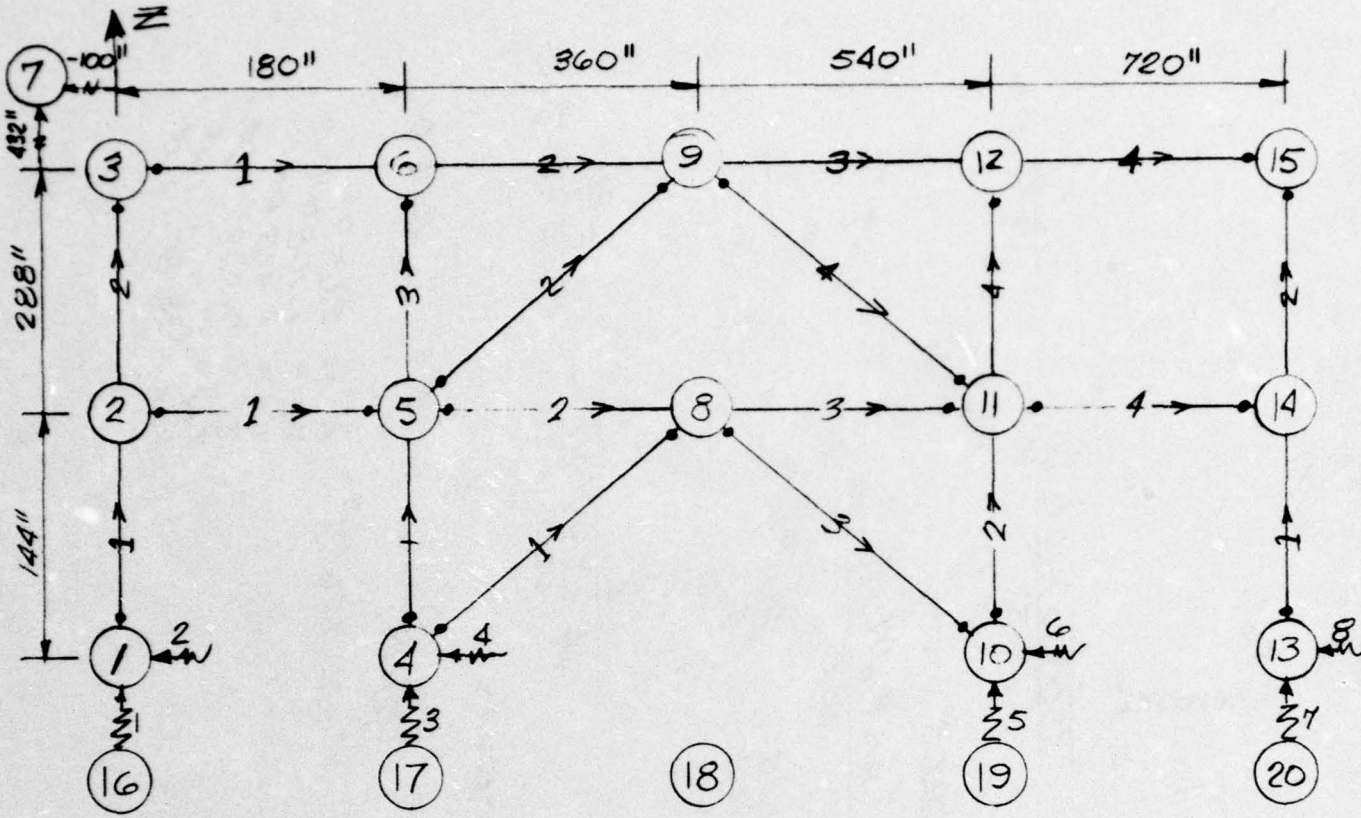
LOADING CASES

1	D.L.
2	L.L.
3	W.L.
4	E.Q.
5	D + L
6	D + L + W
7	D + ½L + W
8	D + L + ½W
9	.9D + W
10	D + L + E
11	D + ½L + E
12	D + L + ½E
13	.9D + E

← RUN THIS LOAD CASE IF PROGRAM REQUIRE MORE THAN ONE RUN.

DISTRICT SOLUTIONS

PROGRAM	DIV. OR DISTRICT CONTACT
SAP IV	SACRAMENTO REYNOLDS
WILSON 2-D	SACRAMENTO REYNOLDS
SAGS	NORTH CENTRAL DIVISION SOUPOS
STRUDL	ST. LOUIS HARTMAN
NASTRAN	ST. LOUIS HARTMAN



COMUTER MODEL SAMPLE PROBLEM.
2-STORY, 2-D FRAME,

ALL UNITS ARE KIPS AND INCHES.

BM. ELEMENT GROUPS

1. COL. 1-2, 2-3,
2. COL. 4-5, 5-6, 10-11 & 11-12
3. COL. 13-14, & 14-15.
4. RF. BMS
5. 2ND FLR BMS
6. DIAGONAL "K" BRACE (TRUSS ELEMENT
7. BOUNDRY SPRINGS. 1-8

PROJECT 2-D FRAME SAMPLE PROBLEM.
ITEM SAP III
SACRAMENTO
COMPUTED BY REYNOLDS CHECKED BY
SHEET NO. ___ OF ___ SHEETS
DATE ___, 19___
FILE
REF. DRWG. NO.

PROJECT 2-D FRAME SAMPLE PROBLEM1 SHEET NO. ___ OF ___ SHEETS

ITEM SAP IV DATE _____, 19___

FILE _____

COMPUTED BY DWR CHECKED BY _____ REF. DRWG. NO. _____

ROOF LOADS. $L.L. = \frac{(30\#/\square')(10')}{1000} = .3\ K/'$

D.L.	ROOFING	6 #/□'
	INSUL.	3
	ROOF DECKING	2
	O.W.J.	2
	M.&E.	15
	CEILING	2

$\frac{(30\#/\square')(10')}{1000} = .3\ K/'$ L.L.

$.6\ K/'$ D+L.

2ND FLOOR LOADS

$L.L. = \frac{(80\#/\square')(10)}{1000} = .8\ K/'$

D.L.	PARTITIONS	20 #/□'
	4" CONC. DECK	40
	STL. DECK	2
	CEILING	2
	M.&E.	12
	O.W.J.	4

$\frac{(80\#/\square')(10)'}{1000} = .8\ K/'$ L.L.

$1.6\ K/'$ D+L.

SIZE ROOF BEAMS.

$S_x = \frac{WL^2}{8f_b} = \frac{(.6)(15)^2(12)}{(8)(24)} = 8.44\ IN^3$ REQ'D

TRY M10 x 9 $S_x = 7.76\ IN^3$

$A = 2.65\ \square''$
$V_y = 1.108\ \square''$
$V_x = 1.413\ \square''$
$J = 0.033\ IN^4$
$I_{yy} = 0.609\ IN^4$
$I_{xx} = 38.80\ IN^4$

PROJECT 2-D FRAME SAMPLE PROBLEM. SHEET NO. ___ OF ___ SHEETS

ITEM SAP IV DATE ___ 19 ___

FILE ___

COMPUTED BY DWR CHECKED BY ___ REF. DWG. NO. ___

2ND FLOOR BEAM.

$$S_x = \frac{WL^2}{8f_b} = \frac{(1.6)(15)^2(12)}{(8)(24)} = 22.5\ IN^3\ REQ'D$$

TRY W12 x 22 BM. $S_x = 25.3\ IN^3$

$A = 6.47\ \square''$
$V_y = 3.417\ \square''$
$V_x = 2.69\ \square''$
$J = 0.292\ IN^4$
$I_{yy} = 4.69\ IN^4$
$I_{xx} = 156.0\ IN^4$

COLUMNS EXTERIOR COLS. GR 1 & 3.

		D.L.	L.L
ROOF LOADS	(7.5)(.30) =	2.25	2.25
2ND FLR	(7.5)(.8) =	6.00	6.00
		8.25	8.25

BRACED FRAME D+L. = 16.5K

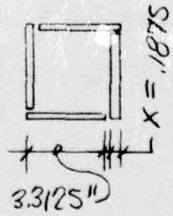
$$\frac{Kl}{r} = (1.0)(l) = 12.0'$$

TS 3½ x 3½ x 3/16 $P = 31.0^K$ @ $L = 12'$ $F_y = 46\ ksi$

$A = 2.39\ \square''$
$V_y = V_x = 1.195\ \square''$
$I_{xx} = I_{yy} = 4.29\ IN^4$

$$J = \Sigma\left(1 - .63\frac{x}{y}\right)\left(\frac{x^3 y}{3}\right)$$

$$J = 4\left[\left[1 - (.63)\left(\frac{.1875}{3.3125}\right)\right]\left[\frac{(.1875)^3(3.3125)}{3}\right]\right] = 0.028$$

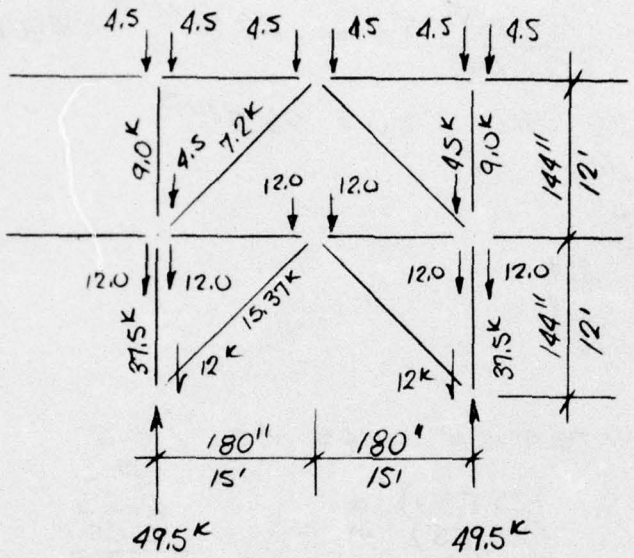


PROJECT 2-D FRAME SAMPLE PROGRAM
ITEM SAP IV
COMPUTED BY DWR CHECKED BY

SHEET NO. ___ OF ___ SHEETS
DATE ___, 19___
FILE
REF. DRWG. NO.

COLUMNS. ROOF.

ROOF $\frac{(15)(.3)}{2}$ = 2.25 D.L
2.25 LL
4.50 D+L.



2ND FLOOR

$\frac{(15)(.8)}{2}$ = 6.0 D.L
6.0 L.L
12.0 D+L.

TRY TS 5x5x 3/16 P = 67K @ L = 12'
P = 38K @ L = 19'

A = 3.49 □"
$V_x = V_y$ = 1.745 □"
$I_{xx} = I_{yy}$ = 13.2 IN^4

$$J = 4\left[\left[1-(.63)\left(\frac{.1875}{4.8125}\right)\right]\left[\frac{(.1875)^3(4.8125)}{3}\right]\right] = .0041 \text{ IN}^4$$

PROJECT 2-D FRAME SAMPLE PROBLEM. SHEET NO. ___ OF ___ SHEETS
ITEM SAP III DATE ___ 19___
FILE ___
COMPUTED BY DWR. CHECKED BY ___ REF. DRWG. NO. ___

WIND LOAD. 31 #/ft'

.9 PRESSURE ON WINDWARD WALL
.4 SUCTION ON LEEWARD WALL
1.3

(.9)(31) = 21 #/ft'
(.4)(31) = 10
31

ASSUME BUILDING IS 80' LONG.

TOTAL WIND LOAD. ROOF (6'X80/2)(.031) = 7.44 K
2ND FLR. (12')(80/2)(.031) = 14.88 K
22.32 K

WIND FORCE ON NODE (1) (10')(6')(.021) = 1.26
NODE (13) (10')(6')(.010) = .60

TOTAL WIND LOAD = 24.18 K

DIAPHRAGM SHEAR TO END WALL.

ROOF = 7.44 K
(3) - 1.26
(15) - .60
5.58 K / 720" = .00775 K/"

TOTAL LOAD TO EACH NODE ON ROOF.

(3) = 1.26 K + (.00775)(90") = 1.9575 K
(6), (9), (12), (.00775)(180") = (1.395)(3) = 4.1850 K
(15) .6 K + (.00775)(90) = 1.2957
7.4382 K

2ND FLOOR. LOAD. = 14.88 K
(2) (10)(12)(.021) = -2.52
(14) (10)(12)(.010) = -1.20
11.16 K / 720" = .0155 K/"

PROJECT _____ SHEET NO. ___ OF ___ SHEETS

ITEM _____ DATE _____, 19___

_____ FILE _____

COMPUTED BY _____ CHECKED BY _____ REF. DRWG. NO. _____

TOTAL LOAD TO EACH NODES ON 2ND FLR.

(2) 2.52 + (.0155)(90) = 3.915 k

(5), (8), (11) (.0155)(180) = (2.79)(3) = 8.37 k

(14) 1.2 k + (.0155)(90) = 2.595 k

14.88 k

LOAD CASE MULTIPLIERS.

WINDWARD COLUMN @ NODES (2) & (3)

(3) = 1.26 k = (M.)(A 2.39)(ℓ 72)(Wt. Density .000283) M = 25.874

LEE WARD COLUMN. @ NODES (14) & (15)

(15) = 0.6 k = (M)(2.39)(72)(.000283) M = 12.321

ROOF DIAPHRAGM. NODE LOADS

(6) = 1.395 k = (M)(2.65)(180)(.000283) M = 10.335

2ND FLOOR DIAPHRAGM NODE LOADS.

(5) = 2.79 k = (M)(6.47)(180)(.000283) M = 8.47

PROJECT 2-D FRAME SAMPLE PROBLEM
ITEM SAP III
COMPUTED BY DWR. CHECKED BY

SHEET NO. ___ OF ___ SHEETS
DATE ___, 19___
FILE
REF. DRWG. NO.

SEISMIC ZONE III

$V = ZKCW$

$Z = 1.0$
$K = 1.0$
$C = 0.1$

$V = (1.0)(1.0)(0.1)(W) = .1W.$

APPROX. INTERIOR FRAMES,

RF. BMS $S_x = \frac{WL^2}{8f_b} = \frac{(1.2)(15)^2(12)}{(8)(24)} = 16.88\ IN^3$

TRY W12×16.5 BM.

2ND FLR. $S = \frac{(3.2)(15)^2(12)}{(8)(24)} = 45\ IN^3$

TRY W16×31 BM.

COLUMNS EXTERIOR WALLS

ROOF $(1.2)(7.5') = 9^K$
2ND FLR. $(3.2)(7.5) = 24$
33^K

TRY TS 3½×3½×¼
$P = 38^K$ @ $L = 12'$
$Wt = 10.5\#/l$

INTERIOR COLUMN.

RF $(1.2\ K/l)(15) = 18^K$
2ND FLR $(3.2\ K/l)(15) = 48^K$
66^K

TS 5×5×3/16 COL.
$Wt = 12\#/l$ $P = 64^K$

PROJECT 2-D FRAME SAMPLE PROBLEM
ITEM SAP IV
COMPUTED BY DWR CHECKED BY
SHEET NO. ___ OF ___ SHEETS
DATE ___, 19___
FILE
REF. DRWG. NO.

SEISMIC

ROOF

WT ROOF D.L.	(.03)(60)(80) =	144 K
Wt. WALLS	(.01)(6')(280') =	16.8 K
Wt. STRUCTURAL FRAME	(.011)(60') + (2)(6)(.008) + (2)(6)(.012) + (19)(.012) =	1.07 K
		1.07 K
Wt. INT. STRUCT. FRAME.	[(.0165)(60) + (2)(6)(.01) + (3)(6)(.012)] (3) =	3.978 K
		166.918
	RF. =	167 K

2ND FLOOR

2ND FLR.	(.08)(60)(80') =	384 K
WALLS	(.01)(12)(280)' =	33.6 K
END FRAME	[(.022)(60) + (2)(12)(.008) + (2)(12)(.012) + (2)(19)(.012)](2) =	4.512 K
INT. FRAME.	[(.031)(60) + (2)(12)(.01) + (3)(12)(.012)](3) =	2.596 K
		429.708 K
	2ND FLR =	430 K

$V = (.1)(W) = (.1)(167 + 430) = 59.7^K$

EACH END FRAME $V = 59.7/2 = 29.85^K$

	hx	Wx	Wx hx	$\frac{Wx\,hx}{\sum Wx\,hx}$	Fx	Vx	
RF	24	167 K	4008	.437	13.11	13.11 K	$13.11/720 = .0182^K/_{11}$
2ND	12	430 K	5160	.563	16.89	30.0 K	$16.89/720 = .0235^K/_{11}$
	-	597 K	9168	1.000	30.0 K		

RF. (3), (15) = (90)(.0182) = 1.638 K
(6), (9), (12) = (180)(.0182) = 3.276 K
MULTIPLIER = (24.27)

2ND FLR (2), (14) = (90)(.0235) = 2.115 K
(5), (8), (11) = (180)(.0235) = 4.23 K
MULTIPLIER = (12.84)

PROGRAM SAP IV SAMPLE PROBLEM. 2-STORY BLDG. 2-D FRAME DATE 23AUG

REQUESTED BY REYNOLDS PREPARED BY CHECKED BY PAGE 1 OF 4

```
SAMPLE PROBLEM  2 STORY BLDG, 2-D FRLME
21    1   13
 1    1    0    0    0    1    1        0.00        0.00        0.00
 4    1    0    0    0    1    1                  180.00        0.00
10    1    0    0    0    1    1                  540.00        0.00
13    1    0    0    0    1    1                  720.00        0.00
 2    1    0    0    0    1    1                    0.00      144.00
14    1    0    0    0    1    1                  720.00      144.00    3
 3    1    0    0    0    1    1                    0.00      288.00
15    1    0    0    0    1    1                  720.00      288.00    3
 7    1    1    1    1    1    1                 -100.00      432.00
16    1    1    1    1    1    1                    0.00      -10.00
20    1    1    1    1    1    1                  720.00      -10.00    1
21    1    1    1    1    1    1        0.00      730.00        0.00
 2    2    1    1
 1  30000.00         0.27      2.17-7      2.83-4
 1      2.39         1.19        1.19       0.028        4.29        4.29
blank card
                    25.874
-1.00
 1    1    2    7    1    1                                1
 2    2    3    7    1    1                                          1
 2    4    1         1
 1  30000.00         0.27      2.17-7      2.83-4
 1      3.49         1.75        1.75       0.041       13.20       13.20
blank card
blank card
-1.00
 1    4    5         1    1                                1
 2   10   11         1    1                                1
```

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PERMIT FULLY LEGIBLE PRODUCTI

PROGRAM SAP III SAMPLE PROBLEM 2-STORY BLDG 2-D FRAME DATE 2-LUG 75

REQUESTED BY REYNOLDS PREPARED BY CHECKED BY PAGE 2 of 4

```
3    5    6    7                                                                    1
4   11   12    7                                                                    1
2    2    1
1 30000.00          0.27        2.17-7      2.83-4
1         2.39      1.19        1.19        0.028          4.29          4.29
Blank card
                              12.321
-1.00
1   13   14    7                                                          1
2   14   15    7                                                                    1
2    4    1    2
1 30000.00          0.27        2.17-7      2.83-4
1         2.65      1.11        1.413       0.033          0.609         38.80
Blank card
                              10.335      24.270
Blank card.
1         0.00      2.25        0.00        0.00           0.00          67.50
          0.00      2.25        0.00        0.00           0.00         -67.50
2         0.00      2.25        0.00        0.00           0.00          67.50
          0.00      2.25        0.00        0.00           0.00         -67.50
1    3    6    7                   1       2                      1
2    6    0    7                   1       2
3    9   12    7                   1       2
4   12   15    7                   1       2                                   1
2    4    1    2
1 30000.00          0.27        2.17-7      2.83-4
1         6.47      3.42        2.69        0.292          4.64         156.00
Blank card
                              8.47        12.84
Blank card.
1         0.00      6.00        0.00        0.00           0.00         180.00
          0.00      6.00        0.00        0.00           0.00        -180.00
```

PROGRAM SAP III SAMPLE PROBLEM 2-STORY BLDG. 2-D FRAME DATE 23 AUG 75

REQUESTED BY REYNOLDS PREPARED BY CHECKED BY PAGE 3 OF 4

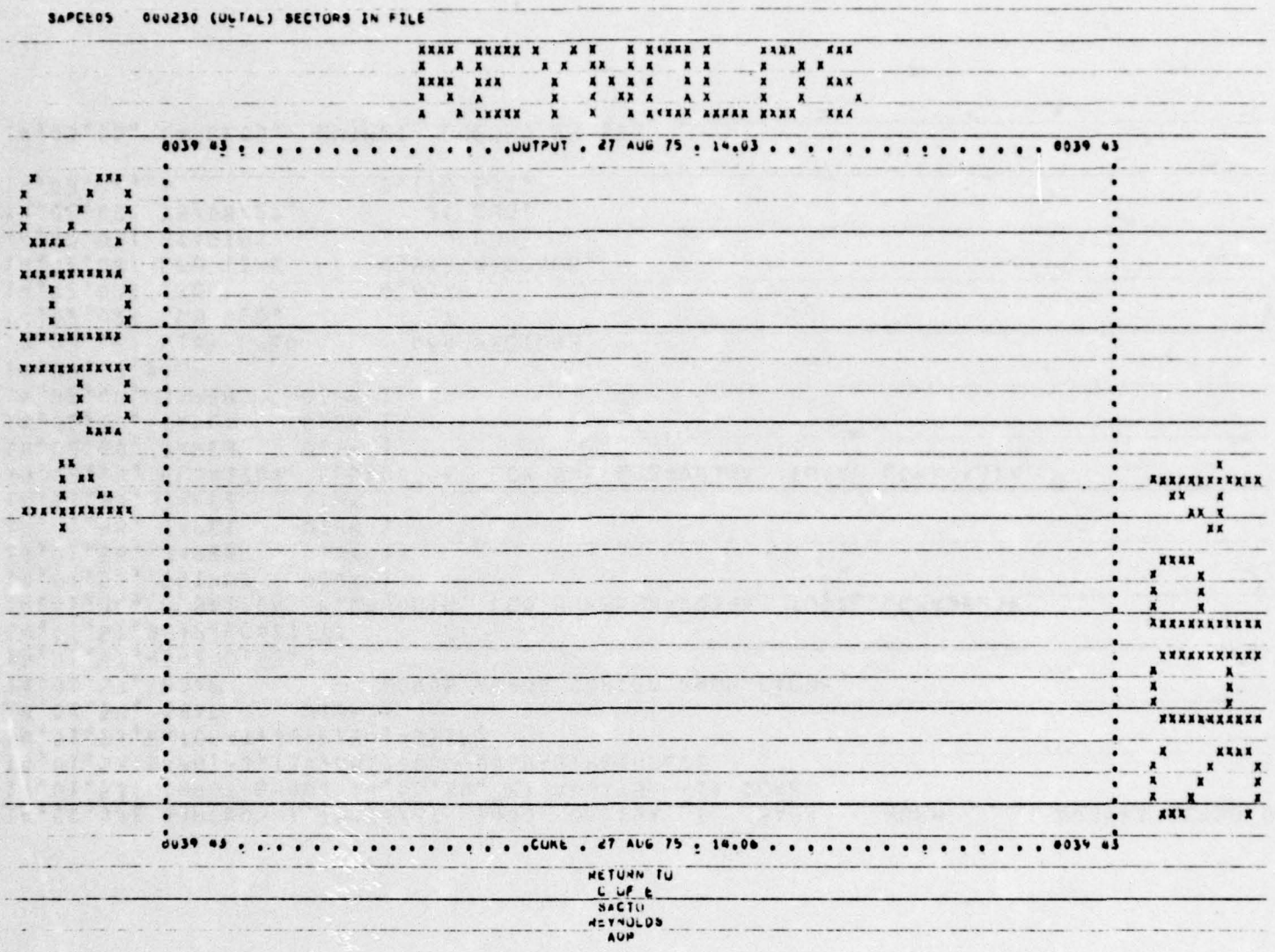
1	2	3	4	5	6	7	8	9	10
2	0.00	6.0.0	0.00	0.00	0.00	180.0.0			
	0.00	6.0.0	0.00	0.00	0.00	-180.00			
1	2 5 7	1	1	1 2		1	1		
2	5 8 7	1	1	1 2		1			
3	8 11 7	1	1	1 2			1		
4	11 14 7	1	1	1 2		1	1		
1	4 1								
1	3.0000.00	0.0.0	7.34-7		3.49	2.83-4			
Blank card									
Blank card									
-1.00									
Blank Card									
1	4 8 1								
2	5 9 1								
3	8 10 1								
4	9 11 1								
7	8								
1.00	1.00	1.00	1.00						
1	16		1						
1	21		1						
4	17		1						
4	21		1						
10	19		1						
10	21		1						
13	20		1						
13	21		1						
Blank card									
1.00									
	1.00								
		1.00							

PROGRAM SAP II SAMPLE PROBLEM 2-STORY BLDG. 2-D FRAME DATE 23 AUG 75

REQUESTED BY REYNOLDS PREPARED BY CHECKED BY PAGE 4 of 4

1	2	3	4	5	6	7	8	9	10
				1.00,					
1.00	1.00								
1.00	1.00		1.00						
1.00	0.50		1.00						
1.00	1.00		0.50						
0.90			1.00						
1.00	1.00			1.00,					
1.00	0.50			1.00,					
1.00	1.00			0.50,					
0.90				1.00,					
Blank card									

60


SAPCL05 000230 (OCTAL) SECTORS IN FILE
0039 43 . . . . . OUTPUT . 27 AUG 75 . 14.03 . . . . . 0039 43
0039 43 . . . . . CORE . 27 AUG 75 . 14.06 . . . . . 0039 43
RETURN TO
C UP E
SACTO
REYNOLDS
AUP

```
14.01.55| SAPCE05 | 75/08/27  7600  HKY15A  3   SAP4     NORM        803943 REYNOLDS
14.01.55| INPUT 66000 14.00.30, 27 AUG 75  VIA COKE
14.01.53|SAP4,P3,T30,CM170000,803943,REYNOLDS
14.01.53,FETCHMT,SSAP,26143,1F.
14.01.54, SSAP      DISK 1
14.01.57, SSAP           66905 WORDS COPIED FROM CACHE.
14.01.57,REWIND,SSAP.
14.01.57,SSAP,LC=77777
14.01.56, FLS=170K  FLL=0001K  LCM BUFFERS=0034K  TOTAL LCM=0225K
14.01.56, OUTPUT    DISK 1
14.01.56, TAPE6     DISK 1
14.01.56, TAPE1     DISK 1
14.01.55, TAPE2     DISK 1
14.02.00, FLS=170K  FLL=0005K  LCM BUFFERS=0234K  TOTAL LCM=0431K
14.02.00, TAPE3     DISK 1
14.02.00, TAPE4     DISK 1
14.02.00, TAPE9     DISK 1
14.02.02,STOP
14.02.02| DISK USED        480 SECTORS
14.02.02| LCM BLD.          27
14.02.02| ITO            4.617
14.02.02| CPU TIME        0.582 SECONDS.
14.02.02| STAGING             0 CUS.
14.02.02| 75/08/27.          21 CUS.
14.02.02, *               2.170 EST.

14.03.05, SAPCE05.  OUTPUT  QUEUED PR 152
```

SAMPLE PROBLEM 2 STORY BLDG 2-D FRAME

C O N T R O L I N F O R M A T I O N

NUMBER OF NODAL POINTS	=	21
NUMBER OF ELEMENT TYPES	=	7
NUMBER OF LOAD CASES	=	13
NUMBER OF FREQUENCIES	=	0
ANALYSIS CODE (NDYN)	=	0
EQ.0, STATIC		
EQ.1, MODAL EXTRACTION		
EQ.2, FORCED RESPONSE		
EQ.3, RESPONSE SPECTRUM		
EQ.4, DIRECT INTEGRATION		
SOLUTION MODE (MODEX)	=	0
EQ.0, EXECUTION		
EQ.1, DATA CHECK		
NUMBER OF SUBSPACE ITERATION VECTORS (NAD)	=	0
EQUATIONS PER BLOCK	=	0
TAPE10 SAVE FLAG (N10SV)	=	0

NODAL POINT INPUT DATA

NODE NUMBER	BOUNDARY CONDITION CODES X	Y	Z	XX	YY	ZZ	NODAL POINT COORDINATES X	Y	Z		T
1	1	0	0	0	1	1	0.000	0.000	0.000	-0	-0.000
4	1	0	0	0	1	1	0.000	180.000	0.000	-0	-0.000
10	1	0	0	0	1	1	0.000	540.000	0.000	-0	-0.000
13	1	0	0	0	1	1	0.000	720.000	0.000	-0	-0.000
2	1	0	0	0	1	1	0.000	0.000	144.000	-0	-0.000
14	1	0	0	0	1	1	0.000	720.000	144.000	5	-0.000
3	1	0	0	0	1	1	0.000	0.000	288.000	-0	-0.000
15	1	0	0	0	1	1	0.000	720.000	288.000	5	-0.000
7	1	1	1	1	1	1	0.000	-100.000	432.000	-0	-0.000
16	1	1	1	1	1	1	0.000	0.000	-10.000	-0	-0.000
20	1	1	1	1	1	1	0.000	720.000	-10.000	1	-0.000
21	1	1	1	1	1	1	0.000	730.000	0.000	-0	-0.000

GENERATED NODAL DATA

NODE NUMBER	BOUNDARY CONDITION CODES X	Y	Z	XX	YY	ZZ	NODAL POINT COORDINATES X	Y	Z	T
1	1	0	0	0	1	1	0.000	0.000	0.000	-0.000
2	1	0	0	0	1	1	0.000	0.000	144.000	-0.000
3	1	0	0	0	1	1	0.000	0.000	288.000	-0.000
4	1	0	0	0	1	1	0.000	180.000	0.000	-0.000
5	1	0	0	0	1	1	0.000	180.000	144.000	0.000
6	1	0	0	0	1	1	0.000	180.000	288.000	0.000
7	1	1	1	1	1	1	0.000	-100.000	432.000	-0.000
8	1	0	0	0	1	1	0.000	360.000	144.000	0.000
9	1	0	0	0	1	1	0.000	360.000	288.000	0.000
10	1	0	0	0	1	1	0.000	540.000	0.000	-0.000
11	1	0	0	0	1	1	0.000	540.000	144.000	0.000
12	1	0	0	0	1	1	0.000	540.000	288.000	0.000
13	1	0	0	0	1	1	0.000	720.000	0.000	-0.000
14	1	0	0	0	1	1	0.000	720.000	144.000	-0.000
15	1	0	0	0	1	1	0.000	720.000	288.000	-0.000
16	1	1	1	1	1	1	0.000	0.000	-10.000	-0.000
17	1	1	1	1	1	1	0.000	180.000	-10.000	0.000
18	1	1	1	1	1	1	0.000	360.000	-10.000	0.000
19	1	1	1	1	1	1	0.000	540.000	-10.000	0.000
20	1	1	1	1	1	1	0.000	720.000	-10.000	-0.000
21	1	1	1	1	1	1	0.000	730.000	0.000	-0.000

EQUATION NUMBERS

N	X	Y	Z	XX	YY	ZZ
1	0	1	2	3	0	0
2	0	4	5	6	0	0
3	0	7	8	9	0	0
4	0	10	11	12	0	0
5	0	13	14	15	0	0
6	0	16	17	18	0	0
7	0	0	0	0	0	0
8	0	19	20	21	0	0
9	0	22	23	24	0	0
10	0	25	26	27	0	0
11	0	28	29	30	0	0
12	0	31	32	33	0	0
13	0	34	35	36	0	0
14	0	37	38	39	0	0
15	0	40	41	42	0	0
16	0	0	0	0	0	0
17	0	0	0	0	0	0
18	0	0	0	0	0	0
19	0	0	0	0	0	0
20	0	0	0	0	0	0
21	0	0	0	0	0	0

3 / D B E A M E L E M E N T S

GP - #1

COLUMNS

NUMBER OF BEAMS = 2
NUMBER OF GEOMETRIC PROPERTY SETS= 1
NUMBER OF FIXED END FORCE SETS = 0
NUMBER OF MATERIALS = 1

MATERIAL PROPERTIES

MATERIAL NUMBER	YOUNG'S MODULUS	POISSON'S RATIO	MASS DENSITY	WEIGHT DENSITY
1	3.0000E+04	.2700	2.1700E-07	2.6300E-04

BEAM GEOMETRIC PROPERTIES

SECTION NUMBER	AXIAL AREA A(1)	SHEAR AREA A(2)	SHEAR AREA A(3)	TORSION J(1)	INERTIA I(2)	INERTIA I(3)
1	2.3900E+00	1.1900E+00	1.1900E+00	2.8000E-02	4.2900E+00	4.2900E+00

ELEMENT LOAD MULTIPLIERS

	A	B	C	D
X-DIR	0.	0.	0.	0.
Y-DIR	0.	0.	2.587400E+01	0.
Z-DIR	1.000000E+00	0.	0.	0.

3/D BEAM ELEMENT DATA

BEAM NUMBER	NODE I	NODE J	NODE K	MATERIAL NUMBER	SECTION NUMBER	ELEMENT END LOADS A	B	C	D	END CODES I	J
1	1	2	7	1	1	0	0	0	0	1	0
2	2	3	7	1	1	0	0	0	0	0	1

3 / D B E A M E L E M E N T S

GP-2
COLUMNS

NUMBER OF BEAMS = 4
NUMBER OF GEOMETRIC PROPERTY SETS = 1
NUMBER OF FIXED END FORCE SETS = 0
NUMBER OF MATERIALS = 1

MATERIAL PROPERTIES

MATERIAL NUMBER	YOUNG'S MODULUS	POISSON'S RATIO	MASS DENSITY	WEIGHT DENSITY
1	3.0000E+04	.2700	2.1700E-07	2.8300E-04

BEAM GEOMETRIC PROPERTIES

SECTION NUMBER	AXIAL AREA A(1)	SHEAR AREA A(2)	SHEAR AREA A(3)	TORSION J(1)	INERTIA I(2)	INERTIA I(3)
1	3.4900E+00	1.7500E+00	1.7500E+00	4.1000E-02	1.3200E+01	1.3200E+01

ELEMENT LOAD MULTIPLIERS

	A	B	C	D
X-DIR	=0.	=0.	=0.	=0.
Y-DIR	=0.	=0.	=0.	=0.
Z-DIR	=1.000000E+00	=0.	=0.	=0.

3/D BEAM ELEMENT DATA

BEAM NUMBER	NODE =I	NODE =J	NODE =K	MATERIAL NUMBER	SECTION NUMBER	ELEMENT END LOADS A	B	C	D	END CODES =I	=J
1	4	5	7	1	1	=0	=0	=0	=0	1	=0
2	10	11	7	1	1	=0	=0	=0	=0	1	=0
3	5	6	7	1	1	=0	=0	=0	=0	=0	1
4	11	12	7	1	1	=0	=0	=0	=0	=0	1

3 / D B E A M E L E M E N T S

GROUP - 3
COLUMNS

NUMBER OF BEAMS = 2
NUMBER OF GEOMETRIC PROPERTY SETS = 1
NUMBER OF FIXED END FORCE SETS = 0
NUMBER OF MATERIALS = 1

MATERIAL PROPERTIES

MATERIAL NUMBER	YOUNG'S MODULUS	POISSON'S RATIO	MASS DENSITY	WEIGHT DENSITY
1	3.0000E+04	.2700	2.1700E-07	2.6300E-04

BEAM GEOMETRIC PROPERTIES

SECTION NUMBER	AXIAL AREA A(1)	SHEAR AREA A(2)	SHEAR AREA A(3)	TORSION J(1)	INERTIA I(2)	INERTIA I(3)
1	2.3900E+00	1.1900E+00	1.1900E+00	2.8000E-02	4.2900E+00	4.2900E+00

ELEMENT LOAD MULTIPLIERS

	A	B	C	D
X-DIR	-0.	-0.	-0.	-0.
Y-DIR	-0.	-0.	1.232100E+01	-0.
Z-DIR	-1.000000E+00	-0.	-0.	-0.

3/D BEAM ELEMENT DATA

BEAM NUMBER	NODE -I	NODE -J	NODE -K	MATERIAL NUMBER	SECTION NUMBER	ELEMENT END LOADS A	B	C	D	END CODES -I	-J
1	13	14	7	1	1	-0	-0	-0	-0	1	-0
2	14	15	7	1	1	-0	-0	-0	-0	-0	1

3 / D B E A M E L E M E N T S

GP-4 ROOF BEAMS

NUMBER OF BEAMS = 4
NUMBER OF GEOMETRIC PROPERTY SETS = 1
NUMBER OF FIXED END FORCE SETS = 2
NUMBER OF MATERIALS = 1

MATERIAL PROPERTIES

MATERIAL NUMBER	YOUNG'S MODULUS	POISSON'S RATIO	MASS DENSITY	WEIGHT DENSITY
1	3.0000E+04	.2700	2.1700E-07	2.8300E-04

BEAM GEOMETRIC PROPERTIES

SECTION NUMBER	AXIAL AREA A(1)	SHEAR AREA A(2)	SHEAR AREA A(3)	TORSION J(1)	INERTIA I(2)	INERTIA I(3)
1	2.6500E+00	1.1100E+00	1.4130E+00	3.3000E-02	6.0900E-01	3.8800E+01

ELEMENT LOAD MULTIPLIERS

	A	B	C	D
X-DIR	-0.	-0.	-0.	-0.
Y-DIR	-0.	-0.	1.033500E+01	2.427000E+01
Z-DIR	-0.	-0.	-0.	-0.

FIXED END FORCES IN LOCAL COORDINATES

TYPE	NODE	FORCE X	FORCE Y	FORCE Z	MOMENT X	MOMENT Y	MOMENT Z
1	I	0.000	2.250	0.000	0.000	0.000	67.500
	J	0.000	2.250	0.000	0.000	0.000	-67.500
2	I	0.000	2.250	0.000	0.000	0.000	67.500
	J	0.000	2.250	0.000	0.000	0.000	-67.500

3/D BEAM ELEMENT DATA

BEAM NUMBER	NODE -I	NODE -J	NODE -K	MATERIAL NUMBER	SECTION NUMBER	ELEMENT END LOADS A	B	C	D	END CODES -I	-J
1	3	6	7	1	1	1	2	-0	-0	1	-0
2	6	9	7	1	1	1	2	-0	-0	-0	-0
3	9	12	7	1	1	1	2	-0	-0	-0	-0
4	12	15	7	1	1	1	2	-0	-0	-0	1

3/D BEAM ELEMENTS

GROUP 5
2ND FLOOR BMS

NUMBER OF BEAMS	=	4
NUMBER OF GEOMETRIC PROPERTY SETS	=	1
NUMBER OF FIXED END FORCE SETS	=	2
NUMBER OF MATERIALS	=	1

MATERIAL PROPERTIES

MATERIAL NUMBER	YOUNG'S MODULUS	POISSON'S RATIO	MASS DENSITY	WEIGHT DENSITY
1	3.0000E+04	.2700	2.1700E-07	2.8300E-04

BEAM GEOMETRIC PROPERTIES

SECTION NUMBER	AXIAL AREA A(1)	SHEAR AREA A(2)	SHEAR AREA A(3)	TORSION J(1)	INERTIA I(2)	INERTIA I(3)
1	6.4700E+00	3.4200E+00	2.0900E+00	2.9200E-01	4.0400E+00	1.5500E+02

ELEMENT LOAD MULTIPLIERS

	A	B	C	D
X-DIR	-0.	-0.	-0.	-0.
Y-DIR	-0.	-0.	8.470000E+00	1.284000E+01
Z-DIR	-0.	-0.	-0.	-0.

FIXED END FORCES IN LOCAL COORDINATES

TYPE	NODE	FORCE X	FORCE Y	FORCE Z	MOMENT X	MOMENT Y	MOMENT Z
1	I	0.000	0.000	0.000	0.000	0.000	180.000
	J	0.000	0.000	0.000	0.000	0.000	-180.000
2	I	0.000	0.000	0.000	0.000	0.000	180.000
	J	0.000	0.000	0.000	0.000	0.000	-180.000

3/D BEAM ELEMENT DATA

BEAM NUMBER	NODE -I	NODE -J	NODE -K	MATERIAL NUMBER	SECTION NUMBER	ELEMENT END LOADS A	B	C	D	END CODES -I	-J
1	2	5	7	1	1	1	2	-0	-0	1	1
2	5	8	7	1	1	1	2	-0	-0	1	-0
3	8	11	7	1	1	1	2	-0	-0	-0	1
4	11	14	7	1	1	1	2	-0	-0	1	1

GROUP - 6

DIAGONAL "K" BRACES.

NUMBER OF TRUSS MEMBERS= 4
NUMBER OF DIFF. MEMBERS= 1

TYPE	E	ALPHA	DEN	AREA	WT
1	3.0000000E+04	0.	7.3400000E-07	3.4900000E+00	2.8300000E-04

ELEMENT LOAD MULTIPLIERS

	A	B	C	D
X-DIR	=0.	=0.	=0.	=0.
Y-DIR	=0.	=0.	=0.	=0.
Z-DIR	=1.0000000E+00	=0.	=0.	=0.
TEMP	=0.	=0.	=0.	=0.

N	I	J	TYPE	TEMP	BAND
1	4	8	1	=0.00	11
2	5	9	1	=0.00	11
3	8	10	1	=0.00	8
4	9	11	1	=0.00	8

BOUNDARY ELEMENTS GROUP 7

ELEMENT TYPE = 7
NUMBER OF ELEMENTS = 8

ELEMENT LOAD CASE MULTIPLIERS

CASE(A)	CASE(B)	CASE(C)	CASE(D)
1.0000	1.0000	1.0000	1.0000

ELEMENT NUMBER	NODE (N)	NODES DEFINING (NI)	CONSTRAINT DIRECTION (NJ)	(NK)	(NL)	CODE RD	CODE RR	GENERATION CODE (NN)	SPECIFIED DISPLACEMENT	SPECIFIED ROTATION	SPRING RATE
1	1	16	=0	=0	=0	1	=0	=0	=0.	=0.	1.0000E+10
2	1	21	=0	=0	=0	1	=0	=0	=0.	=0.	1.0000E+10
3	4	17	=0	=0	=0	1	=0	=0	=0.	=0.	1.0000E+10
4	4	21	=0	=0	=0	1	=0	=0	=0.	=0.	1.0000E+10
5	10	19	=0	=0	=0	1	=0	=0	=0.	=0.	1.0000E+10
6	10	21	=0	=0	=0	1	=0	=0	=0.	=0.	1.0000E+10
7	13	20	=0	=0	=0	1	=0	=0	=0.	=0.	1.0000E+10
8	13	21	=0	=0	=0	1	=0	=0	=0.	=0.	1.0000E+10

EQUATION PARAMETERS

TOTAL NUMBER OF EQUATIONS	= 42
BANDWIDTH	= 12
NUMBER OF EQUATIONS IN A BLOCK	= 40
NUMBER OF BLOCKS	= 2

NODAL LOADS (STATIC) OR MASSES (DYNAMIC)

NODE NUMBER	LOAD CASE	X-AXIS FORCE	Y-AXIS FORCE	Z-AXIS FORCE	X-AXIS MOMENT	Y-AXIS MOMENT	Z-AXIS MOMENT

STRUCTURE LOAD CASE	ELEMENT LOAD MULTIPLIERS A	B	C	D
1	1.000	-0.000	-0.000	-0.000
2	-0.000	1.000	-0.000	-0.000
3	-0.000	-0.000	1.000	-0.000
4	-0.000	-0.000	-0.000	1.000
5	1.000	1.000	-0.000	-0.000
6	1.000	1.000	1.000	-0.000
7	1.000	.500	1.000	-0.000
8	1.000	1.000	.500	-0.000
9	.500	-0.000	1.000	-0.000
10	1.000	1.000	-0.000	1.000
11	1.000	.500	-0.000	1.000
12	1.000	1.000	-0.000	.500
13	.500	-0.000	-0.000	1.000

NODE DISPLACEMENTS/ROTATIONS

NODE NUMBER	LOAD CASE	X= TRANSLATION	Y= TRANSLATION	Z= TRANSLATION	X= ROTATION	Y= ROTATION	Z= ROTATION
21	1	0.	0.	0.	0.	0.	0.
	2	0.	0.	0.	0.	0.	0.
	3	0.	0.	0.	0.	0.	0.
	4	0.	0.	0.	0.	0.	0.
	5	0.	0.	0.	0.	0.	0.
	6	0.	0.	0.	0.	0.	0.
	7	0.	0.	0.	0.	0.	0.
	8	0.	0.	0.	0.	0.	0.
	9	0.	0.	0.	0.	0.	0.
	10	0.	0.	0.	0.	0.	0.
	11	0.	0.	0.	0.	0.	0.
	12	0.	0.	0.	0.	0.	0.
	13	0.	0.	0.	0.	0.	0.
20	1	0.	0.	0.	0.	0.	0.
	2	0.	0.	0.	0.	0.	0.
	3	0.	0.	0.	0.	0.	0.
	4	0.	0.	0.	0.	0.	0.
	5	0.	0.	0.	0.	0.	0.
	6	0.	0.	0.	0.	0.	0.
	7	0.	0.	0.	0.	0.	0.
	8	0.	0.	0.	0.	0.	0.
	9	0.	0.	0.	0.	0.	0.
	10	0.	0.	0.	0.	0.	0.
	11	0.	0.	0.	0.	0.	0.
	12	0.	0.	0.	0.	0.	0.
	13	0.	0.	0.	0.	0.	0.
19	1	0.	0.	0.	0.	0.	0.
	2	0.	0.	0.	0.	0.	0.
	3	0.	0.	0.	0.	0.	0.
	4	0.	0.	0.	0.	0.	0.
	5	0.	0.	0.	0.	0.	0.
	6	0.	0.	0.	0.	0.	0.
	7	0.	0.	0.	0.	0.	0.
	8	0.	0.	0.	0.	0.	0.
	9	0.	0.	0.	0.	0.	0.
	10	0.	0.	0.	0.	0.	0.
	11	0.	0.	0.	0.	0.	0.
	12	0.	0.	0.	0.	0.	0.
	13	0.	0.	0.	0.	0.	0.
18	1	0.	0.	0.	0.	0.	0.
	2	0.	0.	0.	0.	0.	0.
	3	0.	0.	0.	0.	0.	0.
	4	0.	0.	0.	0.	0.	0.
	5	0.	0.	0.	0.	0.	0.
	6	0.	0.	0.	0.	0.	0.
	7	0.	0.	0.	0.	0.	0.
	8	0.	0.	0.	0.	0.	0.
	9	0.	0.	0.	0.	0.	0.
	10	0.	0.	0.	0.	0.	0.
	11	0.	0.	0.	0.	0.	0.
	12	0.	0.	0.	0.	0.	0.
	13	0.	0.	0.	0.	0.	0.
17	1	0.	0.	0.	0.	0.	0.
	2	0.	0.	0.	0.	0.	0.
	3	0.	0.	0.	0.	0.	0.
	4	0.	0.	0.	0.	0.	0.
	5	0.	0.	0.	0.	0.	0.
	6	0.	0.	0.	0.	0.	0.
	7	0.	0.	0.	0.	0.	0.
	8	0.	0.	0.	0.	0.	0.
	9	0.	0.	0.	0.	0.	0.
	10	0.	0.	0.	0.	0.	0.
	11	0.	0.	0.	0.	0.	0.
	12	0.	0.	0.	0.	0.	0.
	13	0.	0.	0.	0.	0.	0.

10	1	0.	0.	0.	0.	0.	0.
	2	0.	0.	0.	0.	0.	0.
	3	0.	0.	0.	0.	0.	0.
	4	0.	0.	0.	0.	0.	0.
	5	0.	0.	0.	0.	0.	0.
	6	0.	0.	0.	0.	0.	0.
	7	0.	0.	0.	0.	0.	0.
	8	0.	0.	0.	0.	0.	0.
	9	0.	0.	0.	0.	0.	0.
	10	0.	0.	0.	0.	0.	0.
	11	0.	0.	0.	0.	0.	0.
	12	0.	0.	0.	0.	0.	0.
	13	0.	0.	0.	0.	0.	0.
15	1	0.	3,78320E-06	-1,95500E-02	5,11015E-34	0.	0.
	2	0.	3,58923E-06	-1,91657E-02	5,10203E-34	0.	0.
	3	0.	7,51218E-02	-1,12500E-05	3,55997E-36	0.	0.
	4	0.	1,10454E-01	-1,71395E-05	-3,07597E-36	0.	0.
	5	0.	7,37249E-06	-3,87217E-02	1,02122E-33	0.	0.
	6	0.	7,51292E-02	-3,87350E-02	1,02479E-33	0.	0.
	7	0.	7,51274E-02	-2,91501E-02	7,69679E-34	0.	0.
	8	0.	3,75063E-02	-3,87273E-02	1,02300E-33	0.	0.
	9	0.	7,51252E-02	-1,76116E-02	4,63474E-34	0.	0.
	10	0.	1,10461E-01	-3,87366E-02	1,01819E-33	0.	0.
	11	0.	1,10459E-01	-2,91500E-02	7,63042E-34	0.	0.
	12	0.	5,52342E-02	-3,87303E-02	1,01969E-33	0.	0.
	13	0.	1,10457E-01	-1,76175E-02	4,50438E-34	0.	0.
14	1	0.	2,55265E-03	-1,59009E-02	-1,51563E-08	0.	0.
	2	0.	2,42136E-03	-1,56086E-02	-1,44626E-08	0.	0.
	3	0.	5,11280E-02	-5,62800E-06	-2,60840E-04	0.	0.
	4	0.	6,81104E-02	-4,56975E-06	-3,05519E-04	0.	0.
	5	0.	4,97301E-03	-5,15089E-02	-2,55969E-06	0.	0.
	6	0.	5,91016E-02	-3,15145E-02	-2,60865E-04	0.	0.
	7	0.	5,48909E-02	-2,37105E-02	-2,60859E-04	0.	0.
	8	0.	3,05376E-02	-3,15117E-02	-1,30445E-04	0.	0.
	9	0.	5,34250E-02	-1,43164E-02	-2,60851E-04	0.	0.
	10	0.	7,30840E-02	-3,15174E-02	-3,83545E-04	0.	0.
	11	0.	7,16733E-02	-2,37135E-02	-3,83539E-04	0.	0.
	12	0.	3,90288E-02	-3,15132E-02	-1,91785E-04	0.	0.
	13	0.	7,04074E-02	-1,43194E-02	-3,83531E-04	0.	0.
13	1	0.	3,29335E-14	-7,98602E-10	7,48822E-47	0.	0.
	2	0.	3,12444E-14	-7,77147E-10	7,10419E-47	0.	0.
	3	0.	6,01708E-11	-2,60228E-13	1,30826E-43	0.	0.
	4	0.	1,00370E-13	-4,26702E-13	3,78282E-46	0.	0.
	5	0.	6,41701E-14	-1,57375E-09	1,45924E-46	0.	0.
	6	0.	6,02410E-11	-1,57403E-09	1,36472E-43	0.	0.
	7	0.	6,02253E-11	-1,18548E-09	1,36937E-43	0.	0.
	8	0.	3,01520E-11	-1,57384E-09	6,85591E-44	0.	0.
	9	0.	6,02064E-11	-7,17222E-10	1,36894E-43	0.	0.
	10	0.	2,30548E-13	-1,57416E-09	5,24206E-46	0.	0.
	11	0.	2,14926E-13	-1,18560E-09	4,88009E-46	0.	0.
	12	0.	1,47303E-13	-1,57396E-09	3,35065E-46	0.	0.
	13	0.	1,96010E-13	-7,17388E-10	4,45676E-46	0.	0.
12	1	0.	3,03759E-06	-3,22340E-02	-6,69867E-04	0.	0.
	2	0.	2,88181E-06	-3,15270E-02	-6,73920E-04	0.	0.
	3	0.	7,21799E-02	-4,08523E-03	-3,58105E-06	0.	0.
	4	0.	1,06741E-01	-7,14352E-03	-4,76097E-08	0.	0.
	5	0.	5,91940E-06	-6,37614E-02	-1,34574E-03	0.	0.
	6	0.	7,21858E-02	-6,78471E-02	-1,34737E-03	0.	0.
	7	0.	7,21844E-02	-5,20832E-02	-1,34704E-03	0.	0.
	8	0.	3,60959E-02	-6,36045E-02	-1,34753E-03	0.	0.
	9	0.	7,21820E-02	-3,30954E-02	-6,70401E-04	0.	0.
	10	0.	1,06747E-01	-7,09554E-02	-1,34384E-03	0.	0.
	11	0.	1,06745E-01	-5,51915E-02	-1,34387E-03	0.	0.
	12	0.	5,33704E-02	-6,73586E-02	-1,34381E-03	0.	0.
	13	0.	1,06744E-01	-3,42042E-02	-6,82426E-04	0.	0.

11	1	0.	2,552066E-03	-2,506944E-02	-1,058439E-08	0.	0.
	2	0.	2,422194E-03	-2,446246E-02	-1,000316E-08	0.	0.
	3	0.	4,872407E-02	-4,095816E-03	-2,506295E-04	0.	0.
	4	0.	6,615136E-02	-7,205296E-03	-3,706216E-04	0.	0.
	5	0.	4,974806E-03	-4,953186E-02	-2,054706E-08	0.	0.
	6	0.	5,309886E-02	-5,362566E-02	-2,506486E-04	0.	0.
	7	0.	5,248786E-02	-4,139946E-02	-2,506046E-04	0.	0.
	8	0.	2,933686E-02	-5,157876E-02	-1,253536E-04	0.	0.
	9	0.	5,102166E-02	-2,665636E-02	-2,506346E-04	0.	0.
	10	0.	7,112916E-02	-5,673706E-02	-3,706496E-04	0.	0.
	11	0.	6,991516E-02	-4,450586E-02	-3,706446E-04	0.	0.
	12	0.	3,805046E-02	-5,313446E-02	-1,853356E-04	0.	0.
	13	0.	6,844896E-02	-2,976776E-02	-3,706356E-04	0.	0.
10	1	0.	9,446126E-10	-2,594666E-09	8,594206E-42	0.	0.
	2	0.	9,303066E-10	-2,522656E-09	8,461636E-42	0.	0.
	3	0.	1,116156E-09	-1,190186E-09	1,015146E-41	0.	0.
	4	0.	1,501456E-09	-1,724636E-09	1,365566E-41	0.	0.
	5	0.	1,875006E-09	-5,119716E-09	1,705306E-41	0.	0.
	6	0.	2,991156E-09	-6,390946E-09	2,720446E-41	0.	0.
	7	0.	2,525966E-09	-5,048406E-09	2,297356E-41	0.	0.
	8	0.	2,433006E-09	-5,711606E-09	2,212876E-41	0.	0.
	9	0.	1,906306E-09	-3,527356E-09	1,733436E-41	0.	0.
	10	0.	3,376456E-09	-6,844546E-09	3,070066E-41	0.	0.
	11	0.	2,911256E-09	-5,582926E-09	2,647776E-41	0.	0.
	12	0.	2,862726E-09	-5,982036E-09	2,603606E-41	0.	0.
	13	0.	2,351606E-09	-4,061806E-09	2,138776E-41	0.	0.
9	1	0.	-4,996006E-16	-4,069716E-02	4,725756E-18	0.	0.
	2	0.	-3,604226E-16	-3,928676E-02	-9,813676E-20	0.	0.
	3	0.	6,606796E-02	7,580706E-04	-3,377296E-05	0.	0.
	4	0.	9,559886E-02	-3,651596E-16	-5,943406E-05	0.	0.
	5	0.	-9,992016E-16	-7,998506E-02	7,245256E-18	0.	0.
	6	0.	6,606796E-02	-7,922786E-02	-3,377296E-05	0.	0.
	7	0.	6,606796E-02	-5,958346E-02	-3,377246E-05	0.	0.
	8	0.	3,303396E-02	-7,990086E-02	-1,688646E-05	0.	0.
	9	0.	6,606796E-02	-3,586946E-02	-3,377296E-05	0.	0.
	10	0.	9,559886E-02	-7,998506E-02	-5,943406E-05	0.	0.
	11	0.	9,559886E-02	-6,034156E-02	-5,943406E-05	0.	0.
	12	0.	4,779946E-02	-7,998506E-02	-2,971706E-05	0.	0.
	13	0.	9,559886E-02	-3,002746E-02	-5,943406E-05	0.	0.
8	1	0.	-9,253076E-17	-4,262946E-02	2,854036E-18	0.	0.
	2	0.	-4,195866E-17	-4,198706E-02	2,567416E-18	0.	0.
	3	0.	4,028246E-02	6,663016E-04	-2,274636E-05	0.	0.
	4	0.	5,419446E-02	7,795246E-18	-4,002926E-05	0.	0.
	5	0.	-2,595586E-16	-8,481096E-02	5,708076E-18	0.	0.
	6	0.	4,028296E-02	-8,481096E-02	-2,274636E-05	0.	0.
	7	0.	4,028296E-02	-6,302316E-02	-2,274636E-05	0.	0.
	8	0.	2,014146E-02	-8,481096E-02	-1,137316E-05	0.	0.
	9	0.	4,028296E-02	-3,036046E-02	-2,274636E-05	0.	0.
	10	0.	5,419446E-02	-8,481096E-02	-4,002926E-05	0.	0.
	11	0.	5,419446E-02	-6,302316E-02	-4,002926E-05	0.	0.
	12	0.	2,709726E-02	-8,481096E-02	-2,001466E-05	0.	0.
	13	0.	5,419446E-02	-3,036046E-02	-4,002926E-05	0.	0.
7	1	0.	0.	0.	0.	0.	0.
	2	0.	0.	0.	0.	0.	0.
	3	0.	0.	0.	0.	0.	0.
	4	0.	0.	0.	0.	0.	0.
	5	0.	0.	0.	0.	0.	0.
	6	0.	0.	0.	0.	0.	0.
	7	0.	0.	0.	0.	0.	0.
	8	0.	0.	0.	0.	0.	0.
	9	0.	0.	0.	0.	0.	0.
	10	0.	0.	0.	0.	0.	0.
	11	0.	0.	0.	0.	0.	0.
	12	0.	0.	0.	0.	0.	0.
	13	0.	0.	0.	0.	0.	0.

6	1	0.	-3.03759E-06	-3.22340E-02	6.69867E-04	0.	0.
	2	0.	-2.88181E-06	-3.15278E-02	6.73920E-04	0.	0.
	3	0.	7.30750E-02	4.09008E-03	3.52694E-06	0.	0.
	4	0.	1.06741E-01	7.14352E-03	-4.76097E-06	0.	0.
	5	0.	-5.91940E-06	-6.37614E-02	1.54379E-03	0.	0.
	6	0.	7.30691E-02	-5.96718E-02	1.54751E-03	0.	0.
	7	0.	7.30705E-02	-4.59079E-02	1.01055E-03	0.	0.
	8	0.	3.68316E-02	-6.17168E-02	1.34555E-03	0.	0.
	9	0.	7.36722E-02	-2.49206E-02	6.06407E-04	0.	0.
	10	0.	1.06735E-01	-5.05654E-02	1.34374E-03	0.	0.
	11	0.	1.06736E-01	-4.08044E-02	1.00678E-03	0.	0.
	12	0.	5.33545E-02	-6.01651E-02	1.34375E-03	0.	0.
	13	0.	1.06736E-01	-2.18171E-02	6.02853E-04	0.	0.
5	1	0.	-2.55286E-03	-2.50694E-02	1.05439E-06	0.	0.
	2	0.	-2.42194E-03	-2.44624E-02	1.00051E-06	0.	0.
	3	0.	4.99452E-02	4.09484E-03	-2.55015E-04	0.	0.
	4	0.	6.61513E-02	7.20520E-03	-3.73625E-04	0.	0.
	5	0.	-4.97030E-03	-4.95318E-02	2.05470E-06	0.	0.
	6	0.	4.49704E-02	-4.54369E-02	-2.55795E-04	0.	0.
	7	0.	4.61814E-02	-3.52057E-02	-2.55600E-04	0.	0.
	8	0.	1.99978E-02	-4.74844E-02	-1.27867E-04	0.	0.
	9	0.	4.76476E-02	-1.64670E-02	-2.55800E-04	0.	0.
	10	0.	6.11765E-02	-4.23265E-02	-3.70607E-04	0.	0.
	11	0.	6.23875E-02	-3.00953E-02	-3.70612E-04	0.	0.
	12	0.	2.81008E-02	-4.59241E-02	-1.85243E-04	0.	0.
	13	0.	6.38537E-02	-1.53572E-02	-3.70619E-04	0.	0.
4	1	0.	-9.44612E-10	-2.59666E-09	-8.59120E-42	0.	0.
	2	0.	-9.30388E-10	-2.52285E-09	-8.46183E-42	0.	0.
	3	0.	1.11617E-09	1.19025E-09	1.01515E-41	0.	0.
	4	0.	1.30145E-09	1.72403E-09	1.39550E-41	0.	0.
	5	0.	-1.87500E-09	-5.11971E-09	-1.70530E-41	0.	0.
	6	0.	-7.58828E-10	-3.92940E-09	-6.90150E-42	0.	0.
	7	0.	-2.93634E-10	-2.06803E-09	-2.67056E-42	0.	0.
	8	0.	-1.31691E-09	-4.52458E-09	-1.19773E-41	0.	0.
	9	0.	2.66022E-10	-1.14692E-09	2.41945E-42	0.	0.
	10	0.	-3.73554E-10	-3.59508E-09	-3.39746E-42	0.	0.
	11	0.	9.16396E-11	-2.13305E-09	8.33457E-43	0.	0.
	12	0.	-1.12428E-09	-4.25749E-09	-1.02252E-41	0.	0.
	13	0.	6.51295E-10	-6.12537E-10	5.92549E-42	0.	0.
3	1	0.	-5.78326E-06	-1.95560E-02	1.72065E-34	0.	0.
	2	0.	-3.58923E-06	-1.91657E-02	1.68813E-34	0.	0.
	3	0.	7.61115E-02	8.22275E-06	-3.61348E-35	0.	0.
	4	0.	1.10054E-01	1.71395E-05	-6.05284E-35	0.	0.
	5	0.	-7.37249E-06	-3.87217E-02	3.40878E-34	0.	0.
	6	0.	7.81041E-02	-3.87155E-02	3.40743E-34	0.	0.
	7	0.	7.81059E-02	-2.91306E-02	2.20337E-34	0.	0.
	8	0.	3.90484E-02	-3.87170E-02	3.42611E-34	0.	0.
	9	0.	7.81081E-02	-1.75921E-02	1.18724E-34	0.	0.
	10	0.	1.10446E-01	-3.87046E-02	2.72350E-34	0.	0.
	11	0.	1.10446E-01	-2.91217E-02	1.87945E-34	0.	0.
	12	0.	5.52194E-02	-3.87131E-02	3.06014E-34	0.	0.
	13	0.	1.10450E-01	-1.75852E-02	8.63501E-35	0.	0.
2	1	0.	-2.55225E-03	-1.59009E-02	1.31305E-08	0.	0.
	2	0.	-2.42136E-03	-1.56080E-02	1.24026E-08	0.	0.
	3	0.	5.35731E-02	4.11137E-06	-2.71221E-04	0.	0.
	4	0.	6.81104E-02	6.56975E-06	-3.63519E-04	0.	0.
	5	0.	-4.97301E-03	-3.15089E-02	2.55969E-08	0.	0.
	6	0.	4.85995E-02	-3.15046E-02	-2.71195E-04	0.	0.
	7	0.	4.96102E-02	-2.37009E-02	-2.71201E-04	0.	0.
	8	0.	2.19129E-02	-3.15088E-02	-1.35585E-04	0.	0.
	9	0.	5.12701E-02	-1.43087E-02	-2.71204E-04	0.	0.
	10	0.	6.31308E-02	-3.15003E-02	-3.83494E-04	0.	0.
	11	0.	6.43475E-02	-2.36963E-02	-3.83500E-04	0.	0.
	12	0.	2.90816E-02	-3.15048E-02	-1.91754E-04	0.	0.
	13	0.	6.55134E-02	-1.43022E-02	-3.83508E-04	0.	0.

1	1	0.	-5.29335E-14	-7.96602E-10	-7.48822E-47	0.	0.
	2	0.	-3.12446E-14	-7.77147E-10	-7.10419E-47	0.	0.
	3	0.	1.20190E-10	2.04712E-13	2.88924E-43	0.	0.
	4	0.	1.66370E-13	4.20702E-13	3.78202E-46	0.	0.
	5	0.	-6.41701E-14	-1.57375E-09	-1.45924E-46	0.	0.
	6	0.	1.20120E-10	-1.57354E-09	2.86778E-43	0.	0.
	7	0.	1.20142E-10	-1.18497E-09	2.86815E-43	0.	0.
	8	0.	6.30510E-11	-1.57365E-09	1.43310E-43	0.	0.
	9	0.	1.20161E-10	-7.16737E-10	2.86855E-43	0.	0.
	10	0.	1.02192E-13	-1.57332E-09	2.32353E-46	0.	0.
	11	0.	1.17814E-13	-1.18475E-09	2.67079E-46	0.	0.
	12	0.	1.90069E-14	-1.57354E-09	4.32167E-47	0.	0.
	13	0.	1.36730E-13	-7.16515E-10	3.10883E-46	0.	0.

*****BEAM FORCES AND MOMENTS GROUP I COLUMNS

BEAM NO.	LOAD NO.	AXIAL M1	SHEAR M2	SHEAR M3	TORSION M1	BENDING M2	BENDING M3
1	1	79.173E-01	-32.934E-05	0.	0.	0.	0.
		-79.173E-01	32.934E-05	0.	0.	0.	-47.424E-03
1	2	77.715E-01	-31.245E-05	0.	0.	0.	0.
		-77.715E-01	31.245E-05	0.	0.	0.	-44.992E-03
1	3	-20.471E-04	18.747E-04	0.	0.	0.	0.
		20.471E-04	-18.747E-04	0.	0.	0.	26.995E-02
1	4	-42.670E-04	16.637E-04	0.	0.	0.	0.
		42.670E-04	-16.637E-04	0.	0.	0.	23.957E-02
1	5	15.884E+00	-64.178E-05	0.	0.	0.	0.
		-15.884E+00	64.178E-05	0.	0.	0.	-92.410E-03
1	6	15.887E+00	12.329E-04	0.	0.	0.	0.
		-15.887E+00	-12.329E-04	0.	0.	0.	17.754E-02
1	7	11.801E+00	13.891E-04	0.	0.	0.	0.
		-11.801E+00	-13.891E-04	0.	0.	0.	20.003E-02
1	8	15.888E+00	29.555E-05	0.	0.	0.	0.
		-15.888E+00	-29.555E-05	0.	0.	0.	42.560E-03
1	9	71.235E-01	15.783E-04	0.	0.	0.	0.
		-71.235E-01	-15.783E-04	0.	0.	0.	22.727E-02
1	10	15.885E+00	10.219E-04	0.	0.	0.	0.
		-15.885E+00	-10.219E-04	0.	0.	0.	14.710E-02
1	11	11.799E+00	11.781E-04	0.	0.	0.	0.
		-11.799E+00	-11.781E-04	0.	0.	0.	16.965E-02
1	12	15.887E+00	19.007E-05	0.	0.	0.	0.
		-15.887E+00	-19.007E-05	0.	0.	0.	27.370E-03
1	13	71.213E-01	13.673E-04	0.	0.	0.	0.
		-71.213E-01	-13.673E-04	0.	0.	0.	19.689E-02
2	1	16.199E-01	32.934E-05	0.	0.	0.	47.424E-03
		-16.199E-01	-32.934E-05	0.	0.	0.	0.
2	2	17.715E-01	31.245E-05	0.	0.	0.	44.992E-03
		-17.715E-01	-31.245E-05	0.	0.	0.	0.
2	3	-20.471E-04	-18.747E-04	0.	0.	0.	-26.995E-02
		20.471E-04	18.747E-04	0.	0.	0.	0.
2	4	-42.670E-04	-16.637E-04	0.	0.	0.	-23.957E-02
		42.670E-04	16.637E-04	0.	0.	0.	0.
2	5	35.914E-01	64.178E-05	0.	0.	0.	92.410E-03
		-35.914E-01	-64.178E-05	0.	0.	0.	0.

2	6	35.893E-01	-12.329E-04	0.	0.	0.	-17.754E-02
		-35.893E-01	12.329E-04	0.	0.	0.	0.
2	7	27.036E-01	-13.691E-04	0.	0.	0.	-20.003E-02
		-27.036E-01	13.691E-04	0.	0.	0.	0.
2	8	35.904E-01	-29.555E-05	0.	0.	0.	-42.560E-03
		-35.904E-01	29.555E-05	0.	0.	0.	0.
2	9	16.359E-01	-15.783E-04	0.	0.	0.	-22.727E-02
		-16.359E-01	15.783E-04	0.	0.	0.	0.
2	10	35.871E-01	-10.219E-04	0.	0.	0.	-14.710E-02
		-35.871E-01	10.219E-04	0.	0.	0.	0.
2	11	27.014E-01	-11.781E-04	0.	0.	0.	-16.965E-02
		-27.014E-01	11.781E-04	0.	0.	0.	0.
2	12	35.893E-01	-19.007E-05	0.	0.	0.	-27.370E-03
		-35.893E-01	19.007E-05	0.	0.	0.	0.
2	13	16.357E-01	-13.673E-04	0.	0.	0.	-19.689E-02
		-16.357E-01	13.673E-04	0.	0.	0.	0.

....BEAM FORCES AND MOMENTS GROUP 2 COLUMNS

BEAM NO.	LOAD NO.	AXIAL R1	SHEAR R2	SHEAR R3	TORSION M1	BENDING M2	BENDING M3
1	1	16.228E+00	-10.123E-04	0.	0.	0.	0.
		-16.228E+00	10.123E-04	0.	0.	0.	-14.577E-02
1	2	17.786E+00	-46.035E-05	0.	0.	0.	0.
		-17.786E+00	46.035E-05	0.	0.	0.	-13.829E-02
1	3	-29.773E-01	52.006E-04	0.	0.	0.	0.
		29.773E-01	-52.006E-04	0.	0.	0.	74.889E-02
1	4	-52.388E-01	50.709E-04	0.	0.	0.	0.
		52.388E-01	-50.709E-04	0.	0.	0.	73.021E-02
1	5	36.014E+00	-19.726E-04	0.	0.	0.	0.
		-36.014E+00	19.726E-04	0.	0.	0.	-28.406E-02
1	6	33.036E+00	32.280E-04	0.	0.	0.	0.
		-33.036E+00	-32.280E-04	0.	0.	0.	46.485E-02
1	7	24.143E+00	37.082E-04	0.	0.	0.	0.
		-24.143E+00	-37.082E-04	0.	0.	0.	53.397E-02
1	8	34.525E+00	62.780E-05	0.	0.	0.	0.
		-34.525E+00	-62.780E-05	0.	0.	0.	90.388E-03
1	9	13.427E+00	42.890E-04	0.	0.	0.	0.
		-13.427E+00	-42.890E-04	0.	0.	0.	61.770E-02
1	10	30.775E+00	30.983E-04	0.	0.	0.	0.
		-30.775E+00	-30.983E-04	0.	0.	0.	44.615E-02
1	11	21.882E+00	35.785E-04	0.	0.	0.	0.
		-21.882E+00	-35.785E-04	0.	0.	0.	51.534E-02
1	12	33.394E+00	56.284E-05	0.	0.	0.	0.
		-33.394E+00	-56.284E-05	0.	0.	0.	81.046E-03
1	13	11.100E+00	41.599E-04	0.	0.	0.	0.
		-11.100E+00	-41.599E-04	0.	0.	0.	59.902E-02
2	1	16.228E+00	10.123E-04	0.	0.	0.	0.
		-16.228E+00	-10.123E-04	0.	0.	0.	14.577E-02

2	2	17.786E+00	90.035E-05	0.	0.	0.	0.
		-17.786E+00	-90.035E-05	0.	0.	0.	13.829E-02
2	3	29.765E-01	50.127E-04	0.	0.	0.	0.
		-29.765E-01	-50.127E-04	0.	0.	0.	72.182E-02
2	4	52.388E-01	50.709E-04	0.	0.	0.	0.
		-52.388E-01	-50.709E-04	0.	0.	0.	73.021E-02
2	5	36.014E+00	19.726E-04	0.	0.	0.	0.
		-36.014E+00	-19.726E-04	0.	0.	0.	28.406E-02
2	6	36.990E+00	64.853E-04	0.	0.	0.	0.
		-36.990E+00	-64.853E-04	0.	0.	0.	10.059E-01
2	7	30.097E+00	65.051E-04	0.	0.	0.	0.
		-30.097E+00	-65.051E-04	0.	0.	0.	93.674E-02
2	8	37.502E+00	44.790E-04	0.	0.	0.	0.
		-37.502E+00	-44.790E-04	0.	0.	0.	64.497E-02
2	9	19.381E+00	59.237E-04	0.	0.	0.	0.
		-19.381E+00	-59.237E-04	0.	0.	0.	85.301E-02
2	10	41.253E+00	70.435E-04	0.	0.	0.	0.
		-41.253E+00	-70.435E-04	0.	0.	0.	10.143E-01
2	11	32.359E+00	65.634E-04	0.	0.	0.	0.
		-32.359E+00	-65.634E-04	0.	0.	0.	94.512E-02
2	12	38.633E+00	45.081E-04	0.	0.	0.	0.
		-38.633E+00	-45.081E-04	0.	0.	0.	64.910E-02
2	13	21.644E+00	59.820E-04	0.	0.	0.	0.
		-21.644E+00	-59.820E-04	0.	0.	0.	86.140E-02
3	1	52.093E-01	10.123E-04	0.	0.	0.	14.577E-02
		-52.093E-01	-10.123E-04	0.	0.	0.	0.
3	2	51.372E-01	90.035E-05	0.	0.	0.	13.829E-02
		-51.372E-01	-90.035E-05	0.	0.	0.	0.
3	3	34.613E-04	-52.006E-04	0.	0.	0.	-74.889E-02
		-34.613E-04	52.006E-04	0.	0.	0.	0.
3	4	85.340E-04	-50.709E-04	0.	0.	0.	-73.021E-02
		-85.340E-04	50.709E-04	0.	0.	0.	0.
3	5	10.340E+00	19.726E-04	0.	0.	0.	28.406E-02
		-10.340E+00	-19.726E-04	0.	0.	0.	0.
3	6	10.350E+00	-32.280E-04	0.	0.	0.	-46.483E-02
		-10.350E+00	32.280E-04	0.	0.	0.	0.
3	7	77.614E-01	-37.082E-04	0.	0.	0.	-53.397E-02
		-77.614E-01	37.082E-04	0.	0.	0.	0.
3	8	10.340E+00	-62.760E-05	0.	0.	0.	-90.386E-03
		-10.340E+00	62.760E-05	0.	0.	0.	0.
3	9	46.918E-01	-42.896E-04	0.	0.	0.	-61.770E-02
		-46.918E-01	42.896E-04	0.	0.	0.	0.
3	10	10.355E+00	-30.983E-04	0.	0.	0.	-44.615E-02
		-10.355E+00	30.983E-04	0.	0.	0.	0.
3	11	77.664E-01	-35.785E-04	0.	0.	0.	-51.53VE-02
		-77.664E-01	35.785E-04	0.	0.	0.	0.
3	12	10.351E+00	-56.284E-05	0.	0.	0.	-81.048E-03
		-10.351E+00	56.284E-05	0.	0.	0.	0.
3	13	46.969E-01	-41.594E-04	0.	0.	0.	-59.902E-02
		-46.969E-01	41.594E-04	0.	0.	0.	0.

4	1	52.093E-01	-10.123E-04	0.	0.	0.	-14.577E-02
		-52.093E-01	10.123E-04	0.	0.	0.	0.
4	2	51.372E-01	-40.035E-05	0.	0.	0.	-13.829E-02
		-51.372E-01	40.035E-05	0.	0.	0.	0.
4	3	-62.375E-04	-50.127E-04	0.	0.	0.	-72.182E-02
		62.375E-04	50.127E-04	0.	0.	0.	0.
4	4	-85.340E-04	-50.709E-04	0.	0.	0.	-73.021E-02
		85.340E-04	50.709E-04	0.	0.	0.	0.
4	5	10.340E+00	-14.726E-04	0.	0.	0.	-26.400E-02
		-10.340E+00	14.726E-04	0.	0.	0.	0.
4	6	10.340E+00	-04.853E-04	0.	0.	0.	-10.059E-01
		-10.340E+00	04.853E-04	0.	0.	0.	0.
4	7	77.717E-01	-05.051E-04	0.	0.	0.	-93.674E-02
		-77.717E-01	05.051E-04	0.	0.	0.	0.
4	8	10.343E+00	-44.790E-04	0.	0.	0.	-64.497E-02
		-10.343E+00	44.790E-04	0.	0.	0.	0.
4	9	46.821E-01	-54.237E-04	0.	0.	0.	-85.301E-02
		-46.821E-01	54.237E-04	0.	0.	0.	0.
4	10	10.350E+00	-70.435E-04	0.	0.	0.	-10.145E-01
		-10.350E+00	70.435E-04	0.	0.	0.	0.
4	11	77.694E-01	-05.034E-04	0.	0.	0.	-94.512E-02
		-77.694E-01	05.034E-04	0.	0.	0.	0.
4	12	10.342E+00	-45.081E-04	0.	0.	0.	-64.916E-02
		-10.342E+00	45.081E-04	0.	0.	0.	0.
4	13	46.798E-01	-54.820E-04	0.	0.	0.	-80.140E-02
		-46.798E-01	54.820E-04	0.	0.	0.	0.

.....BEAM FORCES AND MOMENTS GROUP 3 COLUMNS

BEAM NO.	LOAD NO.	AXIAL R1	SHEAR R2	SHEAR R3	TORSION M1	BENDING M2	BENDING M3
1	1	79.173E-01	32.934E-05	0.	0.	0.	0.
		-79.173E-01	-32.934E-05	0.	0.	0.	47.424E-03
1	2	77.715E-01	31.245E-05	0.	0.	0.	0.
		-77.715E-01	-31.245E-05	0.	0.	0.	44.992E-03
1	3	28.023E-04	17.520E-04	0.	0.	0.	0.
		-28.023E-04	-17.520E-04	0.	0.	0.	25.228E-02
1	4	42.670E-04	10.637E-04	0.	0.	0.	0.
		-42.670E-04	-10.637E-04	0.	0.	0.	23.957E-02
1	5	15.689E+00	04.176E-05	0.	0.	0.	0.
		-15.689E+00	-04.176E-05	0.	0.	0.	92.410E-03
1	6	15.692E+00	23.937E-04	0.	0.	0.	0.
		-15.692E+00	-23.937E-04	0.	0.	0.	34.470E-02
1	7	11.606E+00	22.375E-04	0.	0.	0.	0.
		-11.606E+00	-22.375E-04	0.	0.	0.	32.220E-02
1	8	15.690E+00	15.178E-04	0.	0.	0.	0.
		-15.690E+00	-15.178E-04	0.	0.	0.	21.856E-02
1	9	71.284E-01	20.484E-04	0.	0.	0.	0.
		-71.284E-01	-20.484E-04	0.	0.	0.	29.490E-02
1	10	15.693E+00	23.055E-04	0.	0.	0.	0.
		-15.693E+00	-23.055E-04	0.	0.	0.	33.199E-02

1	11	11.807E+00	21.493E-04	0.	0.	0.	0.
		-11.807E+00	-21.493E-04	0.	0.	0.	30.949E-02
1	12	15.691E+00	14.736E-04	0.	0.	0.	0.
		-15.691E+00	-14.736E-04	0.	0.	0.	21.220E-02
1	13	71.299E-01	19.601E-04	0.	0.	0.	0.
		-71.299E-01	-19.601E-04	0.	0.	0.	28.225E-02
2	1	18.199E-01	-32.934E-05	0.	0.	0.	-47.424E-03
		-18.199E-01	32.934E-05	0.	0.	0.	0.
2	2	17.715E-01	-31.245E-05	0.	0.	0.	-44.992E-03
		-17.715E-01	31.245E-05	0.	0.	0.	0.
2	3	26.023E-04	-17.520E-04	0.	0.	0.	-25.226E-02
		-26.023E-04	17.520E-04	0.	0.	0.	0.
2	4	42.670E-04	-10.637E-04	0.	0.	0.	-23.957E-02
		-42.670E-04	10.637E-04	0.	0.	0.	0.
2	5	35.914E-01	-64.178E-05	0.	0.	0.	-92.416E-03
		-35.914E-01	64.178E-05	0.	0.	0.	0.
2	6	35.942E-01	-23.937E-04	0.	0.	0.	-34.470E-02
		-35.942E-01	23.937E-04	0.	0.	0.	0.
2	7	27.085E-01	-22.375E-04	0.	0.	0.	-32.220E-02
		-27.085E-01	22.375E-04	0.	0.	0.	0.
2	8	35.928E-01	-15.178E-04	0.	0.	0.	-21.850E-02
		-35.928E-01	15.178E-04	0.	0.	0.	0.
2	9	16.407E-01	-20.484E-04	0.	0.	0.	-29.496E-02
		-16.407E-01	20.484E-04	0.	0.	0.	0.
2	10	35.957E-01	-23.055E-04	0.	0.	0.	-33.199E-02
		-35.957E-01	23.055E-04	0.	0.	0.	0.
2	11	27.099E-01	-21.493E-04	0.	0.	0.	-30.949E-02
		-27.099E-01	21.493E-04	0.	0.	0.	0.
2	12	35.935E-01	-14.736E-04	0.	0.	0.	-21.22VE-02
		-35.935E-01	14.736E-04	0.	0.	0.	0.
2	13	16.422E-01	-19.601E-04	0.	0.	0.	-28.225E-02
		-16.422E-01	19.601E-04	0.	0.	0.	0.

.....BEAM FORCES AND MOMENTS — GROUP 4 ROOF BEAMS

BEAM NO.	LOAD NO.	AXIAL R1	SHEAR R2	SHEAR R3	TORSION M1	BENDING M2	BENDING M3
1	1	-32.934E-05	17.712E-01	0.	0.	0.	0.
		32.934E-05	27.288E-01	0.	0.	0.	-86.180E+00
1	2	-31.245E-05	17.715E-01	0.	0.	0.	0.
		31.245E-05	27.285E-01	0.	0.	0.	-86.139E+00
1	3	19.595E-01	-20.471E-04	0.	0.	0.	0.
		-19.595E-01	20.471E-04	0.	0.	0.	-30.648E-02
1	4	16.398E-01	-42.670E-04	0.	0.	0.	0.
		-16.398E-01	42.670E-04	0.	0.	0.	-76.800E-02
1	5	-64.178E-05	55.427E-01	0.	0.	0.	0.
		64.178E-05	54.573E-01	0.	0.	0.	-17.232E+01
1	6	19.588E-01	35.406E-01	0.	0.	0.	0.
		-19.588E-01	54.594E-01	0.	0.	0.	-17.280E+01

1	7	19.590E-01	20.549E-01	0.	0.	0.	0.
		-19.590E-01	40.951E-01	0.	0.	0.	-12.962E+01
1	8	97.409E-02	55.417E-01	0.	0.	0.	0.
		-97.409E-02	54.583E-01	0.	0.	0.	-17.250E+01
1	9	19.592E-01	15.921E-01	0.	0.	0.	0.
		-19.592E-01	24.579E-01	0.	0.	0.	-77.950E+00
1	10	18.391E-01	55.384E-01	0.	0.	0.	0.
		-18.391E-01	54.616E-01	0.	0.	0.	-17.306E+01
1	11	18.393E-01	20.527E-01	0.	0.	0.	0.
		-18.393E-01	40.973E-01	0.	0.	0.	-13.002E+01
1	12	81.925E-02	55.406E-01	0.	0.	0.	0.
		-81.925E-02	54.594E-01	0.	0.	0.	-17.270E+01
1	13	16.395E-01	15.698E-01	0.	0.	0.	0.
		-16.395E-01	24.302E-01	0.	0.	0.	-76.330E+00
2	1	-13.410E-04	24.094E-01	0.	0.	0.	80.180E+00
		13.410E-04	20.906E-01	0.	0.	0.	-57.484E+00
2	2	-12.728E-04	24.086E-01	0.	0.	0.	80.135E+00
		12.728E-04	20.914E-01	0.	0.	0.	-57.581E+00
2	3	33.598E-01	14.142E-04	0.	0.	0.	30.840E-02
		-33.598E-01	-14.142E-04	0.	0.	0.	-11.393E-02
2	4	49.211E-01	42.670E-04	0.	0.	0.	70.806E-02
		-49.211E-01	-42.670E-04	0.	0.	0.	63.949E-15
2	5	-20.144E-04	48.181E-01	0.	0.	0.	17.232E+01
		20.144E-04	41.819E-01	0.	0.	0.	-11.506E+01
2	6	53.572E-01	48.195E-01	0.	0.	0.	17.268E+01
		-53.572E-01	41.805E-01	0.	0.	0.	-11.518E+01
2	7	33.578E-01	38.152E-01	0.	0.	0.	12.962E+01
		-33.578E-01	31.348E-01	0.	0.	0.	-80.388E+00
2	8	16.773E-01	48.188E-01	0.	0.	0.	17.250E+01
		-16.773E-01	41.812E-01	0.	0.	0.	-11.512E+01
2	9	33.586E-01	21.099E-01	0.	0.	0.	77.950E+00
		-33.586E-01	18.801E-01	0.	0.	0.	-51.849E+00
2	10	49.185E-01	48.223E-01	0.	0.	0.	17.308E+01
		-49.185E-01	41.777E-01	0.	0.	0.	-11.500E+01
2	11	49.191E-01	38.180E-01	0.	0.	0.	13.002E+01
		-49.191E-01	31.320E-01	0.	0.	0.	-80.274E+00
2	12	24.579E-01	48.202E-01	0.	0.	0.	17.270E+01
		-24.579E-01	41.798E-01	0.	0.	0.	-11.506E+01
2	13	49.199E-01	21.727E-01	0.	0.	0.	76.330E+00
		-49.199E-01	18.773E-01	0.	0.	0.	-51.730E+00
3	1	-13.410E-04	20.906E-01	0.	0.	0.	57.484E+00
		13.410E-04	24.094E-01	0.	0.	0.	-80.180E+00
3	2	-12.728E-04	20.914E-01	0.	0.	0.	57.581E+00
		12.728E-04	24.086E-01	0.	0.	0.	-80.135E+00
3	3	-20.995E-01	34.352E-04	0.	0.	0.	11.393E-02
		20.995E-01	-34.352E-04	0.	0.	0.	50.441E-02
3	4	-49.211E-01	42.670E-04	0.	0.	0.	-54.717E-15
		49.211E-01	-42.670E-04	0.	0.	0.	70.806E-02

3	5	-26.144E-04	41.919E-01	0.	0.	0.	11.506E+01
		26.144E-04	40.181E-01	0.	0.	0.	-17.232E+01
3	6	-27.021E-01	41.854E-01	0.	0.	0.	11.518E+01
		27.021E-01	40.146E-01	0.	0.	0.	-17.181E+01
3	7	-27.015E-01	31.397E-01	0.	0.	0.	80.388E+00
		27.015E-01	30.103E-01	0.	0.	0.	-12.874E+01
3	8	-13.524E-01	41.837E-01	0.	0.	0.	11.512E+01
		13.524E-01	40.163E-01	0.	0.	0.	-17.206E+01
3	9	-27.007E-01	18.850E-01	0.	0.	0.	51.849E+00
		27.007E-01	21.650E-01	0.	0.	0.	-77.057E+00
3	10	-49.237E-01	41.862E-01	0.	0.	0.	11.506E+01
		49.237E-01	40.138E-01	0.	0.	0.	-17.155E+01
3	11	-49.231E-01	31.405E-01	0.	0.	0.	80.274E+00
		49.231E-01	30.095E-01	0.	0.	0.	-12.848E+01
3	12	-24.632E-01	41.841E-01	0.	0.	0.	11.506E+01
		24.632E-01	40.159E-01	0.	0.	0.	-17.193E+01
3	13	-49.223E-01	18.858E-01	0.	0.	0.	51.730E+00
		49.223E-01	21.642E-01	0.	0.	0.	-76.794E+00
4	1	-32.934E-05	27.288E-01	0.	0.	0.	80.189E+00
		32.934E-05	17.712E-01	0.	0.	0.	0.
4	2	-31.245E-05	27.285E-01	0.	0.	0.	80.135E+00
		31.245E-05	17.715E-01	0.	0.	0.	0.
4	3	-12.993E-01	-20.023E-04	0.	0.	0.	-50.441E-02
		12.993E-01	20.023E-04	0.	0.	0.	0.
4	4	-16.398E-01	-42.670E-04	0.	0.	0.	-70.804E-02
		16.398E-01	42.670E-04	0.	0.	0.	0.
4	5	-64.178E-05	54.573E-01	0.	0.	0.	17.232E+01
		64.178E-05	35.427E-01	0.	0.	0.	0.
4	6	-13.000E-01	54.545E-01	0.	0.	0.	17.181E+01
		13.000E-01	35.455E-01	0.	0.	0.	0.
4	7	-12.990E-01	40.902E-01	0.	0.	0.	12.874E+01
		12.990E-01	20.598E-01	0.	0.	0.	0.
4	8	-65.031E-02	54.559E-01	0.	0.	0.	17.206E+01
		65.031E-02	35.441E-01	0.	0.	0.	0.
4	9	-12.990E-01	24.531E-01	0.	0.	0.	77.057E+00
		12.990E-01	15.969E-01	0.	0.	0.	0.
4	10	-16.404E-01	54.530E-01	0.	0.	0.	17.155E+01
		16.404E-01	35.470E-01	0.	0.	0.	0.
4	11	-16.403E-01	40.888E-01	0.	0.	0.	12.848E+01
		16.403E-01	20.612E-01	0.	0.	0.	0.
4	12	-82.053E-02	54.552E-01	0.	0.	0.	17.193E+01
		82.053E-02	35.448E-01	0.	0.	0.	0.
4	13	-16.401E-01	24.510E-01	0.	0.	0.	76.794E+00
		16.401E-01	15.964E-01	0.	0.	0.	0.

.....BEAM FORCES AND MOMENTS GROUP 5 2ND FLOOR BEAMS

BEAM NO.	LOAD NO.	AXIAL P1	SHEAR P2	SHEAR P3	TORSION M1	BENDING M2	BENDING M3
1	1	65.867E-05	60.000E-01	0.	0.	0.	0.
		-65.867E-05	60.000E-01	0.	0.	0.	0.
1	2	62.489E-05	60.000E-01	0.	0.	0.	0.
		-62.489E-05	60.000E-01	0.	0.	0.	0.
1	3	39.121E-01	-10.554E-16	0.	0.	0.	0.
		-39.121E-01	10.554E-16	0.	0.	0.	0.
1	4	21.126E-01	-25.595E-16	0.	0.	0.	0.
		-21.126E-01	25.595E-16	0.	0.	0.	0.
1	5	12.836E-04	12.000E+00	0.	0.	0.	0.
		-12.836E-04	12.000E+00	0.	0.	0.	0.
1	6	39.134E-01	12.000E+00	0.	0.	0.	0.
		-39.134E-01	12.000E+00	0.	0.	0.	0.
1	7	39.131E-01	90.000E-01	0.	0.	0.	0.
		-39.131E-01	90.000E-01	0.	0.	0.	0.
1	8	19.573E-01	12.000E+00	0.	0.	0.	0.
		-19.573E-01	12.000E+00	0.	0.	0.	0.
1	9	39.127E-01	54.000E-01	0.	0.	0.	0.
		-39.127E-01	54.000E-01	0.	0.	0.	0.
1	10	21.139E-01	12.000E+00	0.	0.	0.	0.
		-21.139E-01	12.000E+00	0.	0.	0.	0.
1	11	21.130E-01	90.000E-01	0.	0.	0.	0.
		-21.130E-01	90.000E-01	0.	0.	0.	0.
1	12	10.576E-01	12.000E+00	0.	0.	0.	0.
		-10.576E-01	12.000E+00	0.	0.	0.	0.
1	13	21.132E-01	54.000E-01	0.	0.	0.	0.
		-21.132E-01	54.000E-01	0.	0.	0.	0.
2	1	-27.528E-01	45.577E-01	0.	0.	0.	0.
		27.528E-01	74.423E-01	0.	0.	0.	-25.961E+01
2	2	-26.117E-01	45.577E-01	0.	0.	0.	0.
		26.117E-01	74.423E-01	0.	0.	0.	-25.962E+01
2	3	10.419E+00	12.166E-07	0.	0.	0.	0.
		-10.419E+00	-12.166E-07	0.	0.	0.	21.648E-05
2	4	12.893E+00	-32.196E-16	0.	0.	0.	0.
		-12.893E+00	32.196E-16	0.	0.	0.	-85.265E-15
2	5	-53.045E-01	91.154E-01	0.	0.	0.	0.
		53.045E-01	14.885E+00	0.	0.	0.	-51.923E+01
2	6	50.547E-01	91.154E-01	0.	0.	0.	0.
		-50.547E-01	14.885E+00	0.	0.	0.	-51.923E+01
2	7	63.005E-01	88.356E-01	0.	0.	0.	0.
		-63.005E-01	11.193E+00	0.	0.	0.	-38.942E+01
2	8	-15.490E-02	91.154E-01	0.	0.	0.	0.
		15.490E-02	14.885E+00	0.	0.	0.	-51.923E+01
2	9	79.410E-01	81.020E-01	0.	0.	0.	0.
		-79.410E-01	99.980E-01	0.	0.	0.	-23.364E+01

2	10	75.290E-01	91.154E-01	0.	0.	0.	0.
		-75.290E-01	14.885E+00	0.	0.	0.	-51.923E+01
2	11	88.346E-01	00.366E-01	0.	0.	0.	0.
		-88.346E-01	11.163E+00	0.	0.	0.	-38.942E+01
2	12	10.822E-01	91.154E-01	0.	0.	0.	0.
		-10.822E-01	14.885E+00	0.	0.	0.	-51.923E+01
2	13	10.410E+00	41.020E-01	0.	0.	0.	0.
		-10.410E+00	00.980E-01	0.	0.	0.	-23.365E+01
3	1	-27.526E-01	74.423E-01	0.	0.	0.	25.961E+01
		27.526E-01	45.577E-01	0.	0.	0.	0.
3	2	-26.117E-01	74.423E-01	0.	0.	0.	25.962E+01
		26.117E-01	45.577E-01	0.	0.	0.	0.
3	3	-91.023E-01	-12.166E-07	0.	0.	0.	-21.890E-05
		91.023E-01	12.166E-07	0.	0.	0.	0.
3	4	-12.893E+00	-20.967E-16	0.	0.	0.	-10.284E-16
		12.893E+00	20.967E-16	0.	0.	0.	0.
3	5	-53.645E-01	14.885E+00	0.	0.	0.	51.923E+01
		53.645E-01	91.154E-01	0.	0.	0.	0.
3	6	-14.467E+00	14.885E+00	0.	0.	0.	51.923E+01
		14.467E+00	91.154E-01	0.	0.	0.	0.
3	7	-13.161E+00	11.163E+00	0.	0.	0.	38.942E+01
		13.161E+00	00.366E-01	0.	0.	0.	0.
3	8	-99.156E-01	14.885E+00	0.	0.	0.	51.923E+01
		99.156E-01	91.154E-01	0.	0.	0.	0.
3	9	-11.580E+00	00.980E-01	0.	0.	0.	23.364E+01
		11.580E+00	41.020E-01	0.	0.	0.	0.
3	10	-18.256E+00	14.885E+00	0.	0.	0.	51.923E+01
		18.256E+00	91.154E-01	0.	0.	0.	0.
3	11	-10.952E+00	11.163E+00	0.	0.	0.	38.942E+01
		10.952E+00	00.366E-01	0.	0.	0.	0.
3	12	-11.811E+00	14.885E+00	0.	0.	0.	51.923E+01
		11.811E+00	91.154E-01	0.	0.	0.	0.
3	13	-15.371E+00	00.980E-01	0.	0.	0.	23.365E+01
		15.371E+00	41.020E-01	0.	0.	0.	0.
4	1	65.867E-05	00.000E+01	0.	0.	0.	0.
		-65.867E-05	00.000E+01	0.	0.	0.	0.
4	2	62.489E-05	00.000E+01	0.	0.	0.	0.
		-62.489E-05	00.000E+01	0.	0.	0.	0.
4	3	-25.923E-01	-17.414E-16	0.	0.	0.	0.
		25.923E-01	17.414E-16	0.	0.	0.	0.
4	4	-21.120E-01	-25.058E-16	0.	0.	0.	0.
		21.120E-01	25.058E-16	0.	0.	0.	0.
4	5	12.836E-04	12.000E+00	0.	0.	0.	0.
		-12.836E-04	12.000E+00	0.	0.	0.	0.
4	6	-25.910E-01	12.000E+00	0.	0.	0.	0.
		25.910E-01	12.000E+00	0.	0.	0.	0.
4	7	-25.913E-01	00.000E+01	0.	0.	0.	0.
		25.913E-01	00.000E+01	0.	0.	0.	0.

4	8-12.949E-01	12.000E+00	0.	0.	0.	0.
	12.949E-01	12.000E+00	0.	0.	0.	0.
4	9-25.917E-01	54.000E-01	0.	0.	0.	0.
	25.917E-01	54.000E-01	0.	0.	0.	0.
4	10-21.113E-01	12.000E+00	0.	0.	0.	0.
	21.113E-01	12.000E+00	0.	0.	0.	0.
4	11-21.116E-01	90.000E-01	0.	0.	0.	0.
	21.116E-01	90.000E-01	0.	0.	0.	0.
4	12-10.550E-01	12.000E+00	0.	0.	0.	0.
	10.550E-01	12.000E+00	0.	0.	0.	0.
4	13-21.120E-01	54.000E-01	0.	0.	0.	0.
	21.120E-01	54.000E-01	0.	0.	0.	0.

GROUP #6 "K" BRACE

TRUSS MEMBER ACTIONS

MEMBER	LOAD	STRESS	FORCE
1	1	-5.46580	-12.096
1	2	-3.41363	-11.914
1	3	4.09379	14.287
1	4	5.50756	19.221
1	5	-6.87943	-24.009
1	6	-2.78564	-9.722
1	7	-1.07882	-3.765
1	8	-4.83253	-16.866
1	9	.97457	3.401
1	10	-1.37186	-4.788
1	11	.33495	1.169
1	12	-4.12564	-14.398
1	13	2.38634	8.335
2	1	-1.01111	-3.529
2	2	-.95926	-3.348
2	3	1.36720	4.772
2	4	2.40684	8.400
2	5	-1.97037	-6.877
2	6	-.60317	-2.105
2	7	-.12354	-.431
2	8	-1.28577	-4.491
2	9	.45720	1.596
2	10	.43647	1.523
2	11	.91610	3.197
2	12	-.76695	-2.077
2	13	1.49684	5.224

3	1	-5.46580	-12.096
3	2	-5.41303	-11.914
3	3	-4.09379	-14.287
3	4	-5.50756	-19.221
3	5	-6.87943	-24.009
3	6	-10.97321	-38.297
3	7	-9.26640	-32.340
3	8	-8.92632	-31.153
3	9	-7.21501	-25.173
3	10	-12.38699	-43.231
3	11	-10.68018	-37.274
3	12	-9.63321	-33.620
3	13	-8.62678	-30.107
4	1	-1.01111	-3.529
4	2	-.95926	-3.348
4	3	-1.36813	-4.775
4	4	-2.40684	-8.400
4	5	-1.97037	-6.877
4	6	-3.33850	-11.651
4	7	-2.85887	-9.977
4	8	-2.65444	-9.264
4	9	-2.27813	-7.951
4	10	-4.37721	-15.276
4	11	-3.89758	-13.603
4	12	-3.17379	-11.077
4	13	-3.31684	-11.576

BOUNDARY ELEMENT
FORCES/MOMENTS

ELEMENT NUMBER	LOAD CASE	FORCE	MOMENT
1	1	7.96602E+00	0.
1	2	7.77147E+00	0.
1	3	-2.04712E-03	0.
1	4	-4.26702E-03	0.
1	5	1.57375E+01	0.
1	6	1.57354E+01	0.
1	7	1.18497E+01	0.
1	8	1.57365E+01	0.
1	9	7.16737E+00	0.
1	10	1.57332E+01	0.

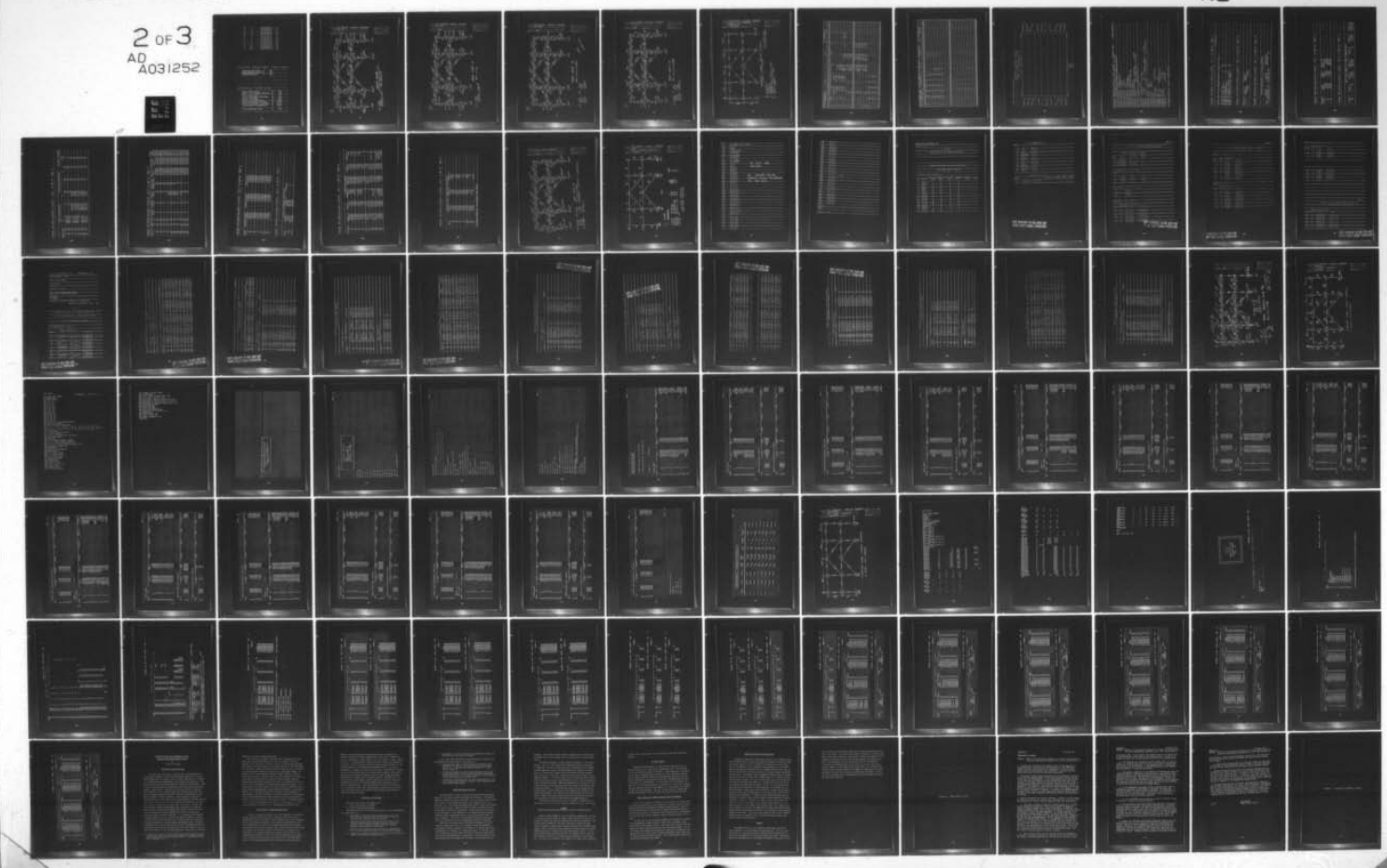
1	11	1.18475E+01	0.
1	12	1.57354E+01	0.
1	13	7.16515E+00	0.
2	1	-3.29335E-04	0.
2	2	-3.12446E-04	0.
2	3	1.26190E+00	0.
2	4	1.66370E-03	0.
2	5	-0.41781E-04	0.
2	6	1.26120E+00	0.
2	7	1.26142E+00	0.
2	8	0.30310E-01	0.
2	9	1.26161E+00	0.
2	10	1.02192E-03	0.
2	11	1.17614E-03	0.
2	12	1.90069E-04	0.
2	13	1.36730E-03	0.
3	1	2.59686E+01	0.
3	2	2.52285E+01	0.
3	3	-1.19025E+01	0.
3	4	-1.72463E+01	0.
3	5	5.11971E+01	0.
3	6	5.92940E+01	0.
3	7	2.66803E+01	0.
3	8	4.52458E+01	0.
3	9	1.14692E+01	0.
3	10	3.39508E+01	0.
3	11	2.13365E+01	0.
3	12	4.25739E+01	0.
3	13	6.12537E+00	0.
4	1	-9.44612E+00	0.
4	2	-9.30388E+00	0.
4	3	1.11617E+01	0.
4	4	1.50145E+01	0.
4	5	-1.87500E+01	0.
4	6	-7.58828E+00	0.
4	7	-2.93634E+00	0.
4	8	-1.31691E+01	0.
4	9	2.66022E+00	0.
4	10	-5.73554E+00	0.
4	11	9.16396E-01	0.
4	12	-1.12428E+01	0.
4	13	6.51295E+00	0.

5	1	2.59686E+01	0.
5	2	2.52285E+01	0.
5	3	1.19018E+01	0.
5	4	1.72463E+01	0.
5	5	5.11971E+01	0.
5	6	6.30989E+01	0.
5	7	5.04846E+01	0.
5	8	5.71480E+01	0.
5	9	5.52735E+01	0.
5	10	6.84434E+01	0.
5	11	5.58292E+01	0.
5	12	5.98203E+01	0.
5	13	4.06180E+01	0.
6	1	9.44612E+00	0.
6	2	9.30388E+00	0.
6	3	1.11615E+01	0.
6	4	1.50145E+01	0.
6	5	1.87500E+01	0.
6	6	2.99115E+01	0.
6	7	2.52596E+01	0.
6	8	2.43308E+01	0.
6	9	1.96630E+01	0.
6	10	3.37645E+01	0.
6	11	2.91125E+01	0.
6	12	2.62572E+01	0.
6	13	2.35160E+01	0.
7	1	7.96602E+00	0.
7	2	7.77147E+00	0.
7	3	2.80228E-03	0.
7	4	4.26702E-03	0.
7	5	1.57375E+01	0.
7	6	1.57403E+01	0.
7	7	1.18546E+01	0.
7	8	1.57389E+01	0.
7	9	7.17222E+00	0.
7	10	1.57418E+01	0.
7	11	1.18560E+01	0.
7	12	1.57396E+01	0.
7	13	7.17368E+00	0.

AD-A031 252 ARMY ENGINEER WATERWAYS EXPERIMENT STATION VICKSBURG MISS F/G 9/2
CORPS-WIDE CONFERENCE ON COMPUTER-AIDED DESIGN IN STRUCTURAL EN--ETC(U)
AUG 76 W D ASHTON, D REYNOLDS, D B BALDWIN

UNCLASSIFIED NL

2 OF 3
AD A031252



8	1	5.29335E-04	0.
8	2	5.12446E-04	0.
8	3	6.01768E-01	0.
8	4	1.06370E-03	0.
8	5	6.41781E-04	0.
8	6	6.02410E-01	0.
8	7	6.02253E-01	0.
8	8	5.01526E-01	0.
8	9	6.02064E-01	0.
8	10	2.30546E-03	0.
8	11	2.14926E-03	0.
8	12	1.47363E-03	0.
8	13	1.96010E-03	0.

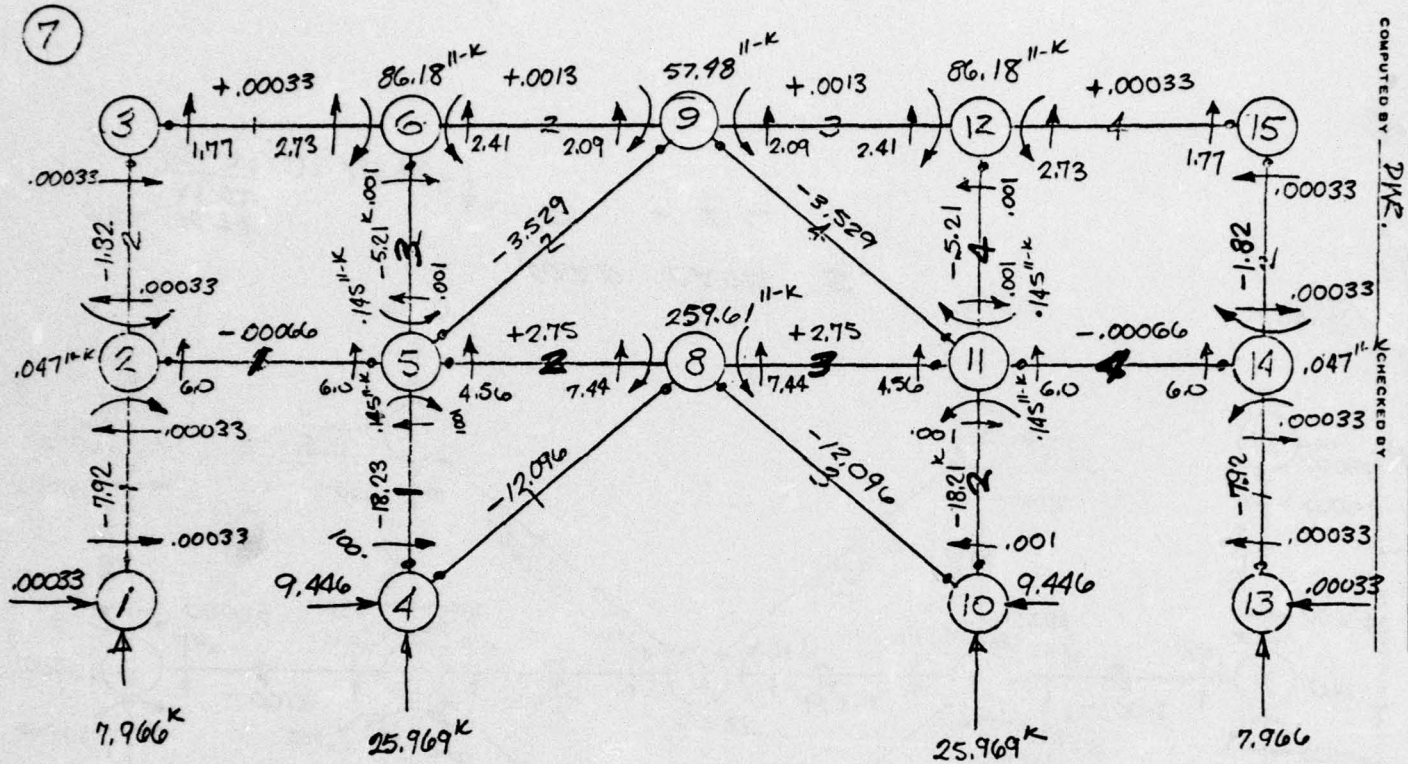
STATIC SOLUTION TIME LOG

EQUATION SOLUTION	=	.03
DISPLACEMENT OUTPUT	=	.07
STRESS RECOVERY	=	.18

OVERALL TIME LOG

NODAL POINT INPUT	=	.02
ELEMENT STIFFNESS FORMATION	=	.14
NODAL LOAD INPUT	=	.00
TOTAL STIFFNESS FORMATION	=	.04
STATIC ANALYSIS	=	.29
EIGENVALUE EXTRACTION	=	0.00
FORCED RESPONSE ANALYSIS	=	0.00
RESPONSE SPECTRUM ANALYSIS	=	0.00
STEP-BY-STEP INTEGRATION	=	0.00
TOTAL SOLUTION TIME	=	.50

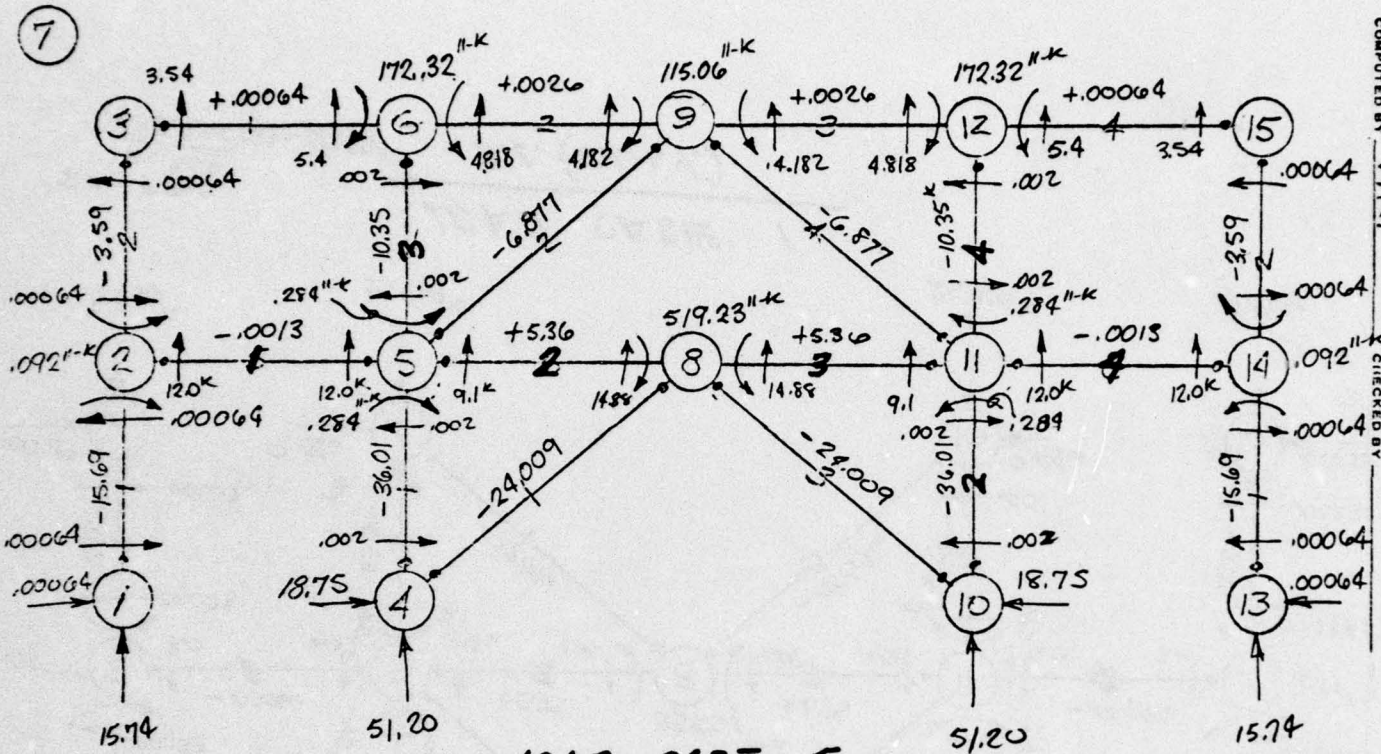
PROJECT 2-D FRAME SAMPLE PROBLEM
ITEM SAP II
COMPUTED BY PMK. CHECKED BY
SHEET NO. ___ OF ___ SHEETS
DATE ___ 19 ___
FILE
REF. DRWG. NO.



LOAD CASE 1

D.L. (ONLY.)

$\Sigma V = 7.966 + 25.969 = (33.935)(2) = 67.87^{K}$



LOAD CASE 5

D.L. + L.L.

$\Sigma V = 15.74 + 51.20$

$(66.94)(2) = 133.88^{K} \uparrow$

PROJECT 2-D FRAME SAMPLE FRAME

ITEM SAP IV

COMPUTED BY PKR CHECKED BY

DATE 19

FILE

REF. DRWG. NO.

SHEET NO. OF SHEETS

PROJECT 2-D FRAME SAMPLE FRAME

ITEM SAP IV

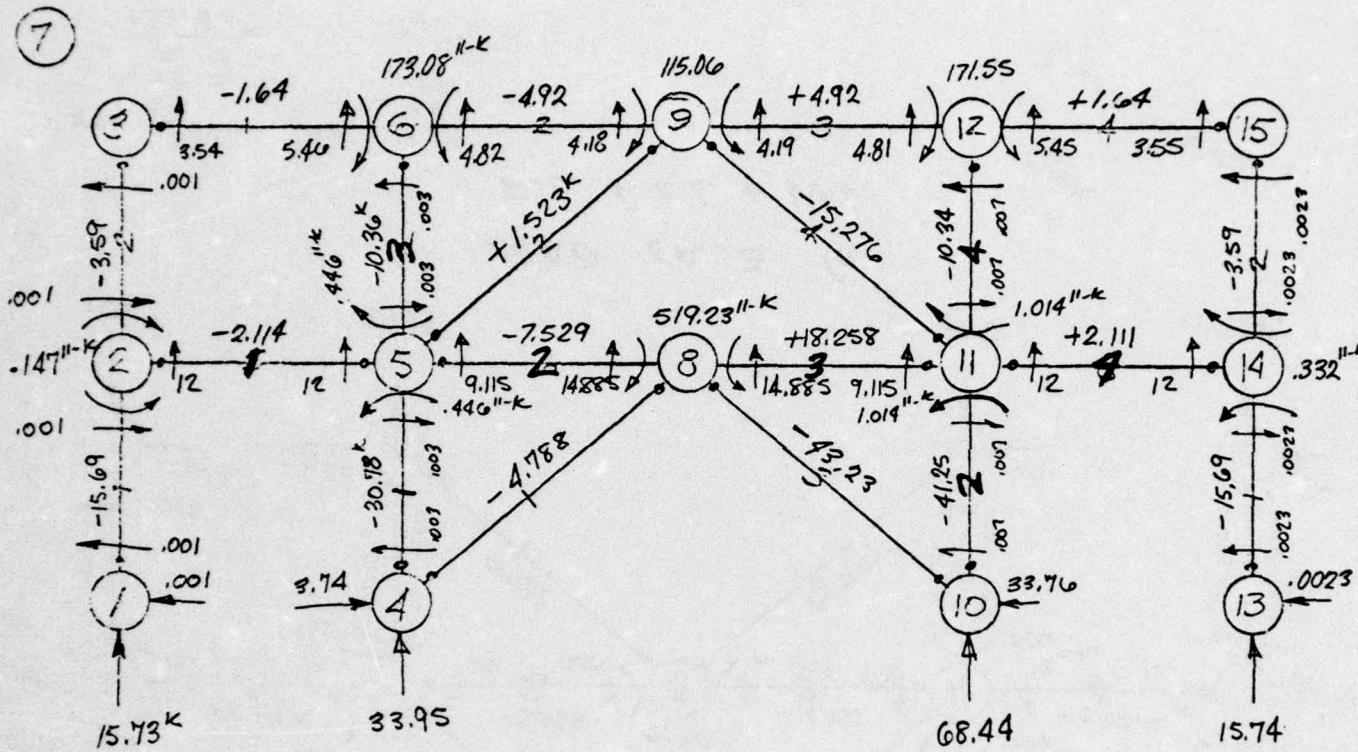
COMPUTED BY DWR. CHECKED BY

SHEET NO. ___ OF ___ SHEETS

DATE ___ 19___

FILE ___

REF. DRWG. NO. ___



LOAD CASE 10

D.L. + L.L. + E.Q.

$\Sigma V = 15.73 + 33.95 + 68.44 + 15.74 = 133.86^{K} \uparrow$

$\Sigma H = .001 - 3.740 + 33.76 + .002 = 30.023^{K} \leftarrow$

PROJECT 2-D FRAME SAMPLE PROBLEM
ITEM SAP IV
COMPUTED BY DWR. CHECKED BY
SHEET NO. ___ OF ___ SHEETS
DATE ___ 19___
FILE
REF. DWG. NO.

PROJECT 2-D FRAME SAMPLE PROBLEM.
ITEM WILSON 2-D FRAME
SACRAMENTO
COMPUTED BY REYNOLDS CHECKED BY

SHEET NO. ___ OF ___ SHEETS
DATE ___ 19 ___
FILE ___
REF. DRWG. NO. ___

COMPUTER MODEL SAMPLE PROGRAM
2-STORY, 2-D FRAME

ALL UNITS ARE
KIPS AND INCHES.

20 ELEMENTS
14 NODES
1 MATERIAL
4 GEOMETRIC PROPERTY CARDS.
1 ELASTIC SUPPORT CARD
2 F.E.F CARDS

PROGRAM WILSON 2-D. DATE 23AUG 75

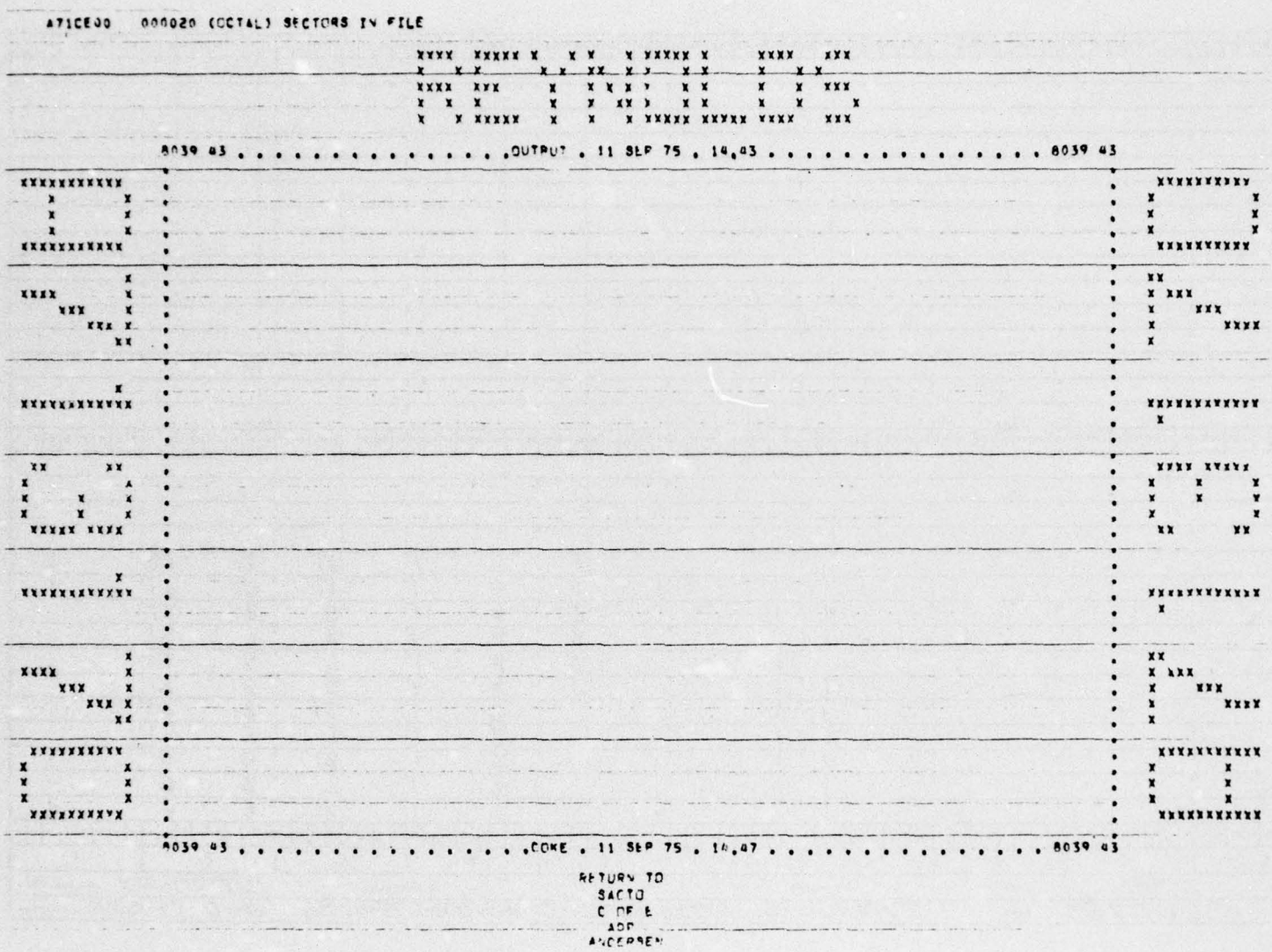
REQUESTED BY REYNOLDS PREPARED BY CHECKED BY PAGE 1 OF 2

	1	2	3	4	5	6	7	8	9	10
A	WILSON 2-D SAMPLE PROBLEM 2-STORY BLDG 2-D FRAME									
B	20	14	1	4	1	2				
C	1	30000.00	0.27							
D	1	1.0+10	1.0+10							
E	1	2.39	1.195	4.29						
C	2	3.49	1.745	13.20						
1	3	2.65	1.413	38.80						
E	4	6.47	2.690	156.00						
F	1	0.00	4.500	135.00	0.00	4.50	-135.00			
F	2	0.00	12.000	360.00	0.00	12.00	-360.00			
G	1		1	0.00	0.00					
C	2		1	180.00	0.00					
	3		1	540.00	0.00					
	4		1	720.00	0.00					
I	5			0.00	144.00	2.12				
	6			180.00	144.00	4.23				
	8			540.00	144.00	4.23				
	9			720.00	144.00	2.12				
	10			0.00	288.00	1.64				
I	11		1	180.00	288.00	3.28				
I	13			540.00	288.00	3.28				
G	14			720.00	288.00	1.64				
H	1	1 5	1	1						
C	2	5 10	1	1			1			
	3	2 6	1	2						
	4	6 11	1	2			1			
	5	3 8	1	2						
I	6	8 13	1	2			1			
H	7	4 9	1	1						

PROGRAM WILSON 2-D SAMPLE PROBLEM 2-STORY BLDG 2-D FRAME DATE 23AUG75

REQUESTED BY REYNOLDS PREPARED BY CHECKED BY PAGE 2 OF 2

H	8	9	14	1	1			1	
	9	2	7	1	2			1	
	10	6	12	1	2			1	
	11	3	7	1	2			1	
	12	8	12	1	2			1	
	13	5	6	1	4	2		1	
	14	6	7	1	4	2		1	
	15	7	8	1	4	2			1
	16	8	9	1	4	2		1	1
F	17	10	11	1	3	1	1		
H	20	13	14	1	3	1			


A71CE00 000020 (OCTAL) SECTORS IN FILE
8039 43 . . . . . .OUTPUT . 11 SEP 75 . 14,43 . . . . . 8039 43
8039 43 . . . . . .CORE . 11 SEP 75 . 14,47 . . . . . 8039 43
RETURN TO
SACTO
C OF E
ADP
ANDERSEN

```
14.18.41| A71CE00 | 75/09/11  7600  BKY158  1   A713170 NORM        803943 REYNOLDS
14.18.41| INPUT 66008 14.15.57, 11 SEP 75  VIA COKE
14.18.41|A713170,P3,T100,CM45000,803943,REYNOLDS.
14.18.41,COMMENT,  ,ID=.........
14.18.41,COMMENT,  ( RETURN TO
14.18.41,COMMENT,  ( SACTO,
14.18.41,COMMENT,  ( C OF E
14.18.41,COMMENT,  ( ADP
14.18.41,COMMENT,  ( ANDERSEN
14.18.41,COMMENT,  *PSS,NOTAPES
14.18.41,FETCHPS,STRUT,KC1708,KC170B,
14.18.42, TAPEPAC  DISK 1
14.42.51, "STAGING COMPLETE   14.42.23,        2 CUS,
14.42.51, KC1708          2962 WORDS STORED IN CACHE,
14.42.52,LINK,F=KC171P,CS=ZERO,LO=0,X,
14.42.54, DSGMAP   DISK 1
14.42.54, LOAD COMPLETE, LINK 73,
14.42.54,   TIME---          24 MSEC,
14.42.54,   MEMORY=      LOAD      25000,  EXECUTE      44000,
14.42.54, FLS=048K  FLL=0000K  LCM BUFFERS=0034K  TOTAL LCM=0100K
14.42.54, OUTPUT   DISK 1
14.42.54, TAPE1    DISK 1
14.42.54, TAPE2    DISK 1
14.42.54,EXIT
14.42.54| DISK USED         360 SECTORS
14.42.54| LCM BLD.           17
14.42.54| ITC             2,141
14.42.54| CPU TIME         0,133 SECONDS,
14.42.54| STAGING             2 CUS,
14.42.54| 75/09/11,           14 CUS,
14.42.54, $               1,680 EST,

14.43.20, A71CE00,  OUTPUT  QUEUED PR 20
```

713-002 2-D FRAME ANALYSIS - V.12/70. RUN - 11 SEP 75 PAGE 1

14.42.54

ILSON 2-D SAMPLE PROBLEM 2-STORY BLDG 2-D FRAME

NUMBER OF ELEMENTS	=	20
NUMBER OF NODAL POINTS	=	14
NUMBER OF MATERIALS	=	1
NUMBER OF ELEMENT TYPES	=	4
NUMBER OF ELASTIC SUPPORT TYPES	=	1
NUMBER OF FIXED END FORCE TYPES	=	2

713-002 2-D FRAME ANALYSIS - V.12/70. RUN - 11 SEP 75 PAGE 2

MATERIAL	YOUNG S MODULUS	POISSON S RATIO
1	30000.	.27000

713-002 2-D FRAME ANALYSIS - V.12/70. RUN - 11 SEP 75 PAGE 3

SPRING CONSTANTS OF ELASTIC SUPPORTS

TYPE	LINEAR STIFFNESS X	LINEAR STIFFNESS Y	ROTATIONAL STIFFNESS Z
1	10000000000.000	10000000000.000	.0

ELEMENT TYPE	AXIAL AREA	SHEAR AREA	MOMENT OF INERTIA
1	2.390	1.195	4.290
2	3.490	1.745	13.200
3	2.650	1.413	38.800
4	6.470	2.690	156.000

FIXED END FORCES IN LOCAL COORDINATES

TYPE	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0	4.500	135.000	0	4.500	-135.000
2	0	12.000	360.000	0	12.000	-360.000

		NODAL COORDINATES		BOUNDARY CONDITIONS			ELASTIC SUPPORT
NODE	CODE	X	Y	X	Y	Z	TYPE
1	-0	0	0	-0	-0	-0	1
2	-0	180.000	0	-0	-0	-0	1
3	-0	540.000	0	-0	-0	-0	1
4	-0	720.000	0	-0	-0	-0	1
5	-0	0	144.000	2.120	-0	-0	-0
6	-0	180.000	144.000	4.230	-0	-0	-0
7	-0	360.000	144.000	4.230	-0	-0	-0
8	-0	540.000	144.000	4.230	-0	-0	-0
9	-0	720.000	144.000	2.120	-0	-0	-0
10	-0	0	288.000	1.640	-0	-0	-0
11	-0	180.000	288.000	3.280	-0	-0	-0
12	-0	360.000	288.000	3.280	-0	-0	-0
13	-0	540.000	288.000	3.280	-0	-0	-0
14	-0	720.000	288.000	1.640	-0	-0	-0

713-002 2-D FRAME ANALYSIS - V.12/70. RUN - 11 SEP 75 PAGE 7

ELEMENT	NODE I	NODE J	MATERIAL TYPE	ELEMENT TYPE	ELEMENT CODE	FIXED END FORCE TYPE	RELATIVE STIFFNESS KIJ	RELATIVE STIFFNESS KJI	CARRY OVER FACTOR
1	1	5	1	1	-0	-0	4.00000	4.00000	.50000
2	5	10	1	1	1	-0	4.00000	4.00000	.50000
3	2	6	1	2	-0	-0	4.00000	4.00000	.50000
4	6	11	1	2	1	-0	4.00000	4.00000	.50000
5	3	8	1	2	-0	-0	4.00000	4.00000	.50000
6	8	13	1	2	1	-0	4.00000	4.00000	.50000
7	4	9	1	1	-0	-0	4.00000	4.00000	.50000
8	9	14	1	1	1	-0	4.00000	4.00000	.50000
9	2	7	1	2	1001	-0	4.00000	4.00000	.50000
10	6	12	1	2	1001	-0	4.00000	4.00000	.50000
11	3	7	1	2	1001	-0	4.00000	4.00000	.50000
12	8	12	1	2	1001	-0	4.00000	4.00000	.50000
13	5	6	1	4	1001	2	4.00000	4.00000	.50000
14	6	7	1	4	1000	2	4.00000	4.00000	.50000
15	7	8	1	4	1	2	4.00000	4.00000	.50000
16	8	9	1	4	1001	2	4.00000	4.00000	.50000
17	10	11	1	3	-0	1	4.00000	4.00000	.50000
18	11	12	1	3	-0	1	4.00000	4.00000	.50000
19	12	13	1	3	-0	1	4.00000	4.00000	.50000
20	13	14	1	3	-0	1	4.00000	4.00000	.50000

JOINT	X-DISPLACEMENT	Y-DISPLACEMENT	Z-ROTATION
1	.00000	-.00000	-.00047
2	-.00000	-.00000	-.00045
3	.00000	-.00000	-.00055
4	.00000	-.00000	-.00057
5	.06332	-.03120	-.00038
6	.06135	-.04172	-.00037
7	.05423	-.08393	-.00004
8	.07103	-.05615	-.00037
9	.07299	-.03122	-.00038
10	.11054	-.03831	-.00613
11	.10682	-.05587	.00135
12	.09567	-.07857	-.00006
13	.10683	-.07028	-.00135
14	.11055	-.03834	.00625

ELASTIC FOUNDATION REACTIONS

NODE	FORCE X	FORCE Y	MOMENT Z
1	-.001	15.537	0
2	3.574	33.199	0
3	-33.621	67.718	0
4	-.002	15.546	0

MEMBER END FORCES

ELEMENT	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	15.537	.001	-.000	-15.537	-.001	.150
2	3.537	-.001	-.150	-3.537	.001	0
3	30.337	.003	.000	-30.337	-.003	.454
4	10.287	-.003	-.454	-10.287	.003	0
5	40.827	.007	0	-40.827	-.007	1.006
6	10.270	-.007	-1.006	-10.270	.007	0
7	15.546	.002	-.000	-15.546	-.002	.329
8	3.546	-.002	-.329	-3.546	.002	0
9	4.581	.000	0	-4.581	-.000	0
10	-1.718	.000	0	1.718	-.000	0
11	43.047	-.000	0	-43.047	.000	0
12	15.101	-.000	0	-15.101	.000	0
13	2.118	12.000	0	-2.118	12.000	0
14	7.683	9.123	0	-7.683	10.877	-517.775
15	-18.123	10.877	517.775	18.123	9.123	0
16	-2.115	12.000	0	2.115	12.000	0
17	1.641	3.537	.000	-1.641	5.463	-173.294
18	4.924	4.824	173.294	-4.924	4.176	-114.940
19	-4.929	4.184	114.940	4.929	4.816	-171.753
20	-1.642	5.454	171.753	1.642	3.546	-.000

APPLIED JOINT LOADS AND REACTIONS

NODE	FORCE X	FORCE Y	MOMENT Z
1	.000	.000	-.000
2	-.000	.000	.000
3	-.000	.000	0
4	-.000	.000	.000
5	2.120	-.000	.000
6	4.230	.000	.000
7	4.230	.000	0
8	4.230	-.000	.000
9	2.120	-.000	0
10	1.640	.000	.000
11	3.280	.000	.000
12	3.280	0	0
13	3.280	-.000	0
14	1.640	0	-.000

PROBLEMS COMPLETED OR CONTROL CARD ERROR

PROJECT

ITEM WILSON 2-D FRAME

COMPUTED BY DWR CHECKED BY

SHEET NO. ___ OF ___ SHEETS

DATE ___ 19 ___

FILE

REF. DRWG. NO.

PROJECT 2-D FRAME SAMPLE PROBLEM
ITEM SAGS
NORTH CENTRAL DIVISION
COMPUTED BY SOUPOS CHECKED BY

SHEET NO. ___ OF ___ SHEETS
DATE _____ 19 ___
FILE _____
REF. DRWG. NO. _____

(1) - JOINTS

[1] - MEMBERS

		A	I
1,2,3,4	M 10 x 9	2.65	38.8
5,6,7,8	W 12 x 22	6.47	156.0
9,14,15,20	TS 3½ x 3½ x 3/16	2.39	4.29
10,13,16,19	TS 5 x 5 x 3/16	3.49	13.2
11,12,17,18			

NODE
1
2
3
4
4

600 #/in. = 0.05 K/in.
1600 #/in. = 0.133 K/in.

```
LIST
  100     2-D FRAME SAMPLE PROBLEM
  110     3,0,2,0,1
  120     14,20
  130     1,4,4
  140     1,29E6,11.5E6
  150     1,2.65,38.8
  160     2,6.47,155
  170     3,2.39,4.29
  180     4,3.49,13.2
  190     3,"SOCKET"
  200     6,"SOCKET"
  210     11,"SOCKET"
  220     14,"SOCKET"
  230     1,0,28
  240     2,0,144
  250     3,0,0
  260     4,180,288
  270     5,180,144
  280     6,180,0
  290     7,360,288
  300     8,360,144
  310     9,540,288
  320     10,540,144
  330     11,540,0
  340     12,720,288
  350     13,720,144
  360     14,720,0
  370     1,1,4,1,1
  380     2,4,7,1,1
  390     3,7,9,1,1
  400     4,9,12,1,1
  410     5,2,5,1,2
  420     6,5,8,1,2
  430     7,8,10,1,2
  440     8,10,13,1,2
  450     9,1,2,1,3
  460     10,4,5,1,4
  470     11,7,5,1,4
  480     12,7,10,1,4
  490     13,9,10,1,4
  500     14,12,13,1,3
  510     15,2,3,1,3
  520     15,5,6,1,4
  530     17,4,6,1,4
  540     18,8,11,1,4
  550     19,10,11,1,4
  560     20,13,14,1,3
  570     0,"DL OR LL"
  580     3
  590     1,2,-.025
  600     2,2,-.025
  610     3,2,-.025
  620     4,2,-.025
  630     5,2,-.057
  640     6,2,-.057
  650     7,2,-.057
  660     8,2,-.057
  670     10,"WL"
```

ALL UNITS ARE INCH/KIPS.

ALL LOADINGS CAN BE COMPUTED WITHOUT RE-ENTERING THE INPUT DATA.

```
680         1,1,1.96
690         4,1,1.4
700         7,1,1.4
710         9,1,1.4
720         12,1,1.3
730         2,1,3.92
740         5,1,2.79
750         8,1,2.79
760         10,1,2.79
770         13,1,2.5
780         0
790         10,"EQ"
800         1,1,1.64
810         4,1,3.28
820         7,1,3.28
830         9,1,3.28
840         12,1,1.64
850         2,1,2.12
860         5,1,4.23
870         8,1,4.23
880         10,1,4.23
890         13,1,2.12
900         0
910         10,"DL + LL + EQ"
920         1,1,1.64
930         4,1,3.28
940         7,1,3.28
950         9,1,3.28
960         12,1,1.64
970         2,1,2.12
980         5,1,4.23
990         8,1,4.23
1000        10,1,4.23
1010        13,1,2.12
1020        0
1030        1,2,-.05
1040        2,2,-.05
1050        3,2,-.05
1060        4,2,-.05
1070        5,2,-.133
1080        6,2,-.133
1090        7,2,-.133
1100        8,2,-.133
-QUIT

SAVE:1.0
!SAGS

VERSION 11-1-72
```

ENTER DATA FILE NAME? SACD

PRINT INPUT DATA? YES

S A G S

STATIC ANALYSIS OF GENERAL STRUCTURES

STRUCTURAL DYNAMICS RESEARCH CORPORATION

2-D FRAME SAMPLE PROBLEM

* * PLANAR FRAME ANALYSIS * *

SPAN	LENGTH	FORE END JOINT	AFT END JOINT	MATERIAL CODE	SECTION CODE	ROTATION ANGLE	TEMP.
1	180.00	1	4	1	1		
2	180.00	4	7	1	1		
3	180.00	7	9	1	1		
4	180.00	9	12	1	1		
5	180.00	2	5	1	2		
6	180.00	5	8	1	2		
7	180.00	8	10	1	2		
8	180.00	10	13	1	2		
9	144.00	1	2	1	3		
10	144.00	4	5	1	4		
11	230.51	7	5	1	4		
12	230.51	7	10	1	4		
13	144.00	9	10	1	4		
14	144.00	12	13	1	3		
15	144.00	2	3	1	3		
16	144.00	5	6	1	4		
17	230.51	8	6	1	4		
18	230.51	8	11	1	4		
19	144.00	10	11	1	4		
20	144.00	13	14	1	4		

JOINT COORDINATES

JOINT	X	Y	Z
1	0.	288.000	
2	0.	144.000	
3	0.	0.	
4	180.000	288.000	
5	180.000	144.000	
6	180.000	0.	
7	360.000	288.000	
8	360.000	144.000	
9	540.000	288.000	
10	540.000	144.000	
11	540.000	0.	
12	720.000	288.000	
13	720.000	144.000	
14	720.000	0.	

MATERIAL PROPERTIES

CODE	E	G	DENSITY	THERMAL COEFFICIENT
1	29.0E+06	11.5E+06		

COPY AVAILABLE TO DDC DOES NOT
PERMIT FULLY LEGIBLE PRODUCTION

STATIC ANALYSIS OF GENERAL STRUCTURES
2-D FRAME SAMPLE PROBLEM

CROSS-SECTION PROPERTIES

CODE	AREA	MOMENT OF INERTIA	SHEAR RATIO
1	2.65E+00	3.85E+01	0.
2	5.47E+00	1.55E+02	0.
3	2.39E+00	4.29E+00	0.
4	3.40E+00	1.32E+01	0.

DISTANCE TO OUTER FIBER

CODE	Y	Z	R
1	1.000	1.000	1.000
2	1.000	1.000	1.000
3	1.000	1.000	1.000
4	1.000	1.000	1.000

SPECIFIED RESTRAINTS

JOINT	DIR	TYPE	VALUE
3		SOCKET	
5		SOCKET	
11		SOCKET	
14		SOCKET	

LOADING NO. 1: DL OR LL

DISTRIBUTED LOADING

SPAN	DIR	COORDINATE	VALUE
1	Y	ABSOLUTE	-2.50E-02
2	Y	ABSOLUTE	-2.50E-02
3	Y	ABSOLUTE	-2.50E-02
4	Y	ABSOLUTE	-2.50E-02
5	Y	ABSOLUTE	-5.70E-02
6	Y	ABSOLUTE	-5.70E-02
7	Y	ABSOLUTE	-5.70E-02
8	Y	ABSOLUTE	-5.70E-02

COPY AVAILABLE TO DDC DOES NOT PERMIT FULLY LEGIBLE PRODUCTION

STATIC ANALYSIS OF GENERAL STRUCTURES
2-D FRAME STATIC PROBLEM

LOADING NO. 2: W

APPLIED FORCES

JOINT	DIR	TYPE	VALUE
1	X	FORCE	1.96E+00
4	X	FORCE	1.40E+00
7	X	FORCE	1.40E+00
9	X	FORCE	1.40E+00
12	X	FORCE	1.30E+00
2	X	FORCE	3.42E+00
5	X	FORCE	2.79E+00
8	X	FORCE	2.79E+00
10	X	FORCE	2.79E+00
13	X	FORCE	2.60E+00

LOADING NO. 3: EQ

APPLIED FORCES

JOINT	DIR	TYPE	VALUE
1	X	FORCE	1.64E+00
4	X	FORCE	3.28E+00
7	X	FORCE	3.28E+00
9	X	FORCE	3.28E+00
12	X	FORCE	1.64E+00
2	X	FORCE	2.12E+00
5	X	FORCE	4.23E+00
8	X	FORCE	4.23E+00
10	X	FORCE	4.23E+00
13	X	FORCE	2.12E+00

Y AVAILABLE TO DDC DOES NOT
MIT FULLY LEGIBLE PRODUCTION

LOADING NO. 4: DL + L + EQ

APPLIED FORCES

JOINT	DIR	TYPE	VALUE
1	X	FORCE	1.64E+00
4	X	FORCE	3.28E+00
7	X	FORCE	3.28E+00
9	X	FORCE	3.28E+00
12	X	FORCE	1.64E+00
2	X	FORCE	2.12E+00
5	X	FORCE	4.23E+00
8	X	FORCE	4.23E+00
10	X	FORCE	4.23E+00
13	X	FORCE	2.12E+00

STATIC ANALYSIS OF GENERAL STRUCTURES
2-D FRAME SAMPLE PROBLEM

DISTRIBUTED LOADING

SPAN	DIR	COORDINATE	VALUE
1	Y	ABSOLUTE	-5.00E-02
2	Y	ABSOLUTE	-5.00E-02
3	Y	ABSOLUTE	-5.00E-02
4	Y	ABSOLUTE	-5.00E-02
5	Y	ABSOLUTE	-1.35E-01
6	Y	ABSOLUTE	-1.35E-01
7	Y	ABSOLUTE	-1.35E-01
8	Y	ABSOLUTE	-1.35E-01

COPY AVAILABLE TO DDC DOES NOT PERMIT FULLY LEGIBLE PRODUCTION

NO. OF EQUATIONS = 34 BANDWIDTH = 12

SIZE FACTOR = 342

RUN PROGRAM SAS1

SRU'S:37.8

!SAS1

VERSION 11-1-72

ENTER DATA FILE NAME? SACD
ENTER OUTPUT FILE NAME?NONE

IN BEAM
IN SETUP
IN DCPBD

DIAGONAL ELEMENTS: AVERAGE = 3.203+007

SMALLEST = 1.279+005 ROW 28

S A S 5

STATIC ANALYSIS OF GENERAL STRUCTURES

STRUCTURAL DYNAMICS RESEARCH CORPORATION

2-D FRAME SAMPLE PROBLEM

*** LOADING NO. 1: DL OR LL

JOINT DISPLACEMENTS

JOINT	X	Y	ROTATION
1	5.554-007	-1.779-004	-2.539-006
2	-2.721-006	-1.389-005	-1.964-006
3	0.	0.	1.008-006
4	1.775-007	-3.450-005	3.985-007
5	-2.600-006	-2.948-005	3.441-007
6	0.	0.	-1.539-007
7	-1.016-022	-4.518-005	2.585-025
8	-1.234-024	-3.[illegible]-005	5.[illegible]-025
9	-1.775-007	-3.560-005	-3.985-007
10	2.005-006	-2.208-005	-3.401-007
11	0.	0.	1.539-007
12	-5.564-007	-1.772-005	2.589-006
13	2.721-006	-1.389-005	1.964-006
14	0.	0.	-1.008-006

COPY AVAILABLE TO DDC DOES NOT
PERMIT FULLY LEGIBLE PRODUCTION

JOINT REACTIONS

JOINT	F(X)	F(Y)	M(Z) END
3	3.55[illegible]-002	[illegible]	[illegible]
6	7.119+00[illegible]	2.543+001	0.
[illegible]	[illegible]	[illegible]	[illegible]
14	-3.55[illegible]-002	[illegible]	0.

SPAN	JT.	FORE END FORCES AXIAL	SHEAR	MOMENT	JT.	AFT END FORCES AXIAL	SHEAR	MOMENT
1	1	1.62-001	1.84+000	1.22+001	4	-1.62-001	2.63+000	-8.56+001
2	4	7.58-002	2.35+000	7.91+001	7	-7.58-002	2.15+000	-5.03+001
3	7	7.58-002	2.15+000	6.09+001	9	-7.58-002	2.35+000	-7.91+001
4	9	1.62-001	2.63+000	8.56+001	12	-1.62-001	1.84+000	-1.22+001
5	2	-1.26-001	4.84+000	1.62+001	5	1.26-001	7.22+000	-2.30+002
6	5	-2.71+000	5.35+000	2.13+002	8	2.71+000	2.71+000	-1.35+002
7	8	-2.71+000	5.71+000	1.61+002	10	2.71+000	6.35+000	-2.18+002
8	10	-1.26-001	7.22+000	2.30+002	13	1.26-001	4.84+000	-1.62+001
9	1	1.84+000	-1.62-001	-1.22+001	2	-1.84+000	1.62-001	-1.[illegible]+001
10	4	5.01+000	-8.60-002	-6.34+001	5	-5.01+000	8.60-002	-6.05+001
11	7	3.41+000	2.00-002	1.74+000	5	-3.41+000	-2.00-002	2.98+000
12	7	3.41+000	-2.00-002	-1.74+000	10	-3.41+000	2.00-002	-2.98+000
13	9	5.01+000	-8.60-002	-6.34+001	10	-5.01+000	8.60-002	-6.05+001
14	12	1.84+000	1.62-001	1.22+001	13	-1.84+000	-1.62-001	1.[illegible]+001
15	2	6.69+000	-3.57-002	-5.14+000	3	-6.69+000	3.57-002	-1.39-017
16	5	2.07+001	1.70-002	2.56+001	6	-2.07+001	-1.70-002	-1.02-001
17	8	9.14+000	3.10-003	6.13-001	6	-9.14+000	-3.10-003	1.02-001

COPY AVAILABLE TO DDC DOES NOT PERMIT FULLY LEGIBLE PRODUCTION

COPY AVAILABLE TO DDC DOES NOT
PERMIT FULLY LEGIBLE PRODUCTION

STATIC ANALYSIS OF GENERAL STRUCTURES
2-D FRAME SAMPLE PROBLEM

SPAN	JT.	FORE END FORCES AXIAL	SHEAR	MOMENT	JT.	AFT END FORCES, AXIAL	SHEAR	MOMENT
18	9	9.14+00	-3.10-003	-6.13-001	1	-9.14+000	3.10-003	1.02-001
19	10	2.07+001	-1.70-002	-2.5 +000	11	-2.07+001	1.70-002	1.02-001
20	13	6.59+00	3.57-002	5.14+00	14	-6.59+000	-3.57-002	3.47-018

SPAN	END	STRESS CALCULATIONS MZ/SM	MY/SM	P/A	SHEAR
1	AFT	-2.203+00	0.	-5.10 -002	0.
2	FORE	2.039+0	0.	-2.859-002	0.
3	AFT	-2.039+0	0.	-2.859-002	0.
4	FORE	2.203+00	0.	-5.106-002	0.
5	AFT	-1.471+00	0.	1.350- 2	0.
6	FORE	1.393+00	0.	4.190-001	0.
7	AFT	-1.398+0	0.	4.190-001	0.
8	FORE	1.471+00	0.	1.350-002	0.
9	FORE	-2.842+00	0.	-7.711-001	0.
10	FORE	4.803-001	0.	-1.435+000	0.
11	AFT	2.182-001	0.	-9.783-001	0.
12	AFT	-2.182-001	0.	-9.783-001	0.
13	FORE	-4.803-001	0.	-1.435+00	0.
14	FORE	2.842+00	0.	-7.711-001	0.
15	FORE	-1.197+00	0.	-2.798+00	0.
16	FORE	1.929-001	0.	-5.937+000	0.
17	FORE	4.64 -002	0.	-2.619+00	0.
18	FORE	-4.64 -002	0.	-2.619+00	0.
19	FORE	-1.92 -001	0.	-5.937+00	0.
20	FORE	1.197+00	0.	-2.798+00	0.

STATIC ANALYSIS OF GENERAL STRUCTURES
2-D FRAME SAMPLE PROBLEM

** LOADING NO. 2: WL

JOINT DISPLACEMENTS

JOINT	X	Y	ROTATION
1	8.034-005	1.421-007	1.103-008
2	5.533-005	1.126-007	2.803-008
3	0.	0.	-5.902-007
4	7.579-005	8.111-006	-3.591-008
5	5.158-005	4.124-006	-3.231-008
6	0.	0.	-3.821-007
7	6.802-005	7.806-007	-2.748-008
8	4.161-005	-1.237-009	-1.594-008
9	7.424-005	-4.107-006	-4.145-008
10	5.032-005	-1.124-006	-3.211-008
11	0.	0.	-3.741-007
12	7.726-005	1.429-007	1.485-008
13	5.282-005	-1.124-007	2.855-008
14	0.	0.	-5.641-007

JOINT REACTIONS

JOINT	F(X)	F(Y)	MOMENT
3	-7.419-003	-5.414-002	0.
6	-1.117+001	-1.182+001	0.
11	-1.117+001	-1.182+001	0.
14	-7.112-003	5.412-002	0.

COPY AVAILABLE TO DDC DOES NOT PERMIT FULLY LEGIBLE PRODUCTION

COPY AVAILABLE TO DDC DOES NOT
PERMIT FULLY LEGIBLE PRODUCTION

SPAN	JT.	FORE END FORCES, AXIAL	SHEAR	MOMENT	JT.	AFT END FORCES, AXIAL	SHEAR	MOMENT
1	1	1.95+00	-1.42-002	-9.84-001	4	-1.95+00	1.42-002	-1.57+00
2	4	3.32+00	-5.41-003	-5.43-001	7	-3.32+00	5.41-003	-4.36-001
3	7	-2.65+00	-3.01-003	-1.85-001	9	2.65+00	3.01-003	-3.58-001
4	9	-1.29+00	-1.47-002	-1.67+00	12	1.29+00	1.47-002	-9.75-001
5	2	3.93+00	-4.00-002	-2.38+00	5	-3.93+00	4.00-002	-5.12+00
6	5	1.04+001	-2.00-003	-5.91-001	8	-1.04+001	2.00-003	-2.32-001
7	8	-9.08+00	-1.84-003	2.41-001	10	9.08+00	1.84-003	-5.72-001
8	10	-2.61+00	-3.04-002	-5.07+00	13	2.61+00	3.04-002	-2.02+00
9	1	-1.42-002	1.39-002	9.84-001	2	1.42-002	-1.39-002	1.01+00
10	4	8.76-003	2.95-002	2.11+00	5	-8.76-003	-2.95-002	2.13+00
11	7	-4.72+00	2.24-003	2.65-001	5	4.72+00	-2.24-003	2.50-001
12	7	4.72+00	3.00-003	3.53-001	10	-4.72+00	-3.00-003	3.33-001
13	9	-1.17-002	2.85-002	2.03+00	10	1.17-002	-2.85-002	2.08+00
14	12	1.47-002	1.37-002	9.75-001	13	-1.47-002	-1.37-002	1.01+00
15	2	-5.42-002	7.42-003	1.07+00	3	5.42-002	-7.42-003	1.04-017
16	5	-2.90+00	3.33-002	3.33+00	6	2.90+00	-3.33-002	1.47+00
17	8	-1.43+001	-7.41-003	-2.60-001	6	1.43+001	7.41-003	-1.47+00
18	3	1.43+001	-7.10-003	-2.53-001	14	-1.43+001	7.10-003	-1.41+00
19	10	2.90+00	3.23-002	3.23+00	11	-2.90+00	-3.23-002	1.41+00
20	13	5.41-002	7.11-003	1.02+00	14	-5.41-002	-7.11-003	5.30-018

STATIC ANALYSIS OF GENERAL STRUCTURES

2-D FRAME SAMPLE PROBLEM

STRES CALCULATIONS

SPAN	END	MZ/S	MY/S	P/A	SHEAR
1	AFT	-4.051-002	0.	-7.34 -001	0.
2	FORE	-1.39 -002	0.	-1.252+000	0.
3	AFT	-9.228-003	0.	-1.003+000	0.
4	FORE	-4.301-002	0.	4.854-001	0.
5	AFT	-3.231-002	0.	-6.0 -001	0.
6	FORE	-3.791-003	0.	-1.607+000	0.
7	AFT	-3.6 -003	0.	1.40 +000	0.
8	FORE	-3.252-002	0.	4.029-001	0.
9	AFT	-2.362-001	0.	5.940- 03	0.
10	AFT	1.617-001	0.	-2.510-003	0.
11	FORE	2.016- 2	0.	1.352+000	0.
12	FORE	2.578-002	0.	-1.353+000	0.
13	AFT	1.573-001	0.	3. 7-003	0.
14	AFT	2.3 1-001	0.	-6.145-003	0.
15	FORE	2.490- 1	0.	2.268-002	0.
16	FORE	2.519-001	0.	8.305-001	0.
17	AFT	-1. -001	0.	4.087+000	0.
18	AFT	-1.07 -001	0.	-4.085+000	0.
19	FORE	-2.4 7-001	0.	-8.305- 1	0.
20	FORE	2.337-001	0.	-2.264-002	0.

COPY AVAILABLE TO DDC DOES NOT PERMIT FULLY LEGIBLE PRODUCTION

2-D FRAME SAMPLE PROBLEM

JOINT DISPLACEMENTS

JOINT	X	Y	ROTATION
1	1.134-004	2.352-007	2.201-008
2	7.053-005	1.829-007	5.069-008
3	0.	0.	-7.574-007
4	1.096-004	7.234-006	-5.570-008
5	6.323-005	7.259-006	-4.877-008
6	0.	0.	-5.031-007
7	9.830-005	-7.613-023	-4.976-008
8	5.441-005	0.	-3.240-008
9	1.096-004	-7.234-006	-5.570-008
10	6.323-005	7.259-006	-4.877-008
11	0.	0.	-5.031-007
12	1.134-004	-2.352-007	2.201-008
13	7.053-005	-1.829-007	5.069-008
14	0.	0.	-7.574-007

JOINT REACTIONS

JOINT	F(X)	F(Y)	MOMENT
1	-9.636-003	8.402-002	0.
5	-1.502+001	-1.709+001	0.
11	-1.502+001	1.709+001	0.
14	-9.636-003	8.402-002	0.

COPY AVAILABLE TO DDC DOES NOT PERMIT FULLY LEGIBLE PRODUCTION

SPAN	FORE END FORCES JT.	AXIAL	SHEAR	MOMENT	AFT END FORCES JT.	AXIAL	SHEAR	MOMENT
1	1	1.62+000	-2.52-002	-1.71+000	4	-1.62+000	2.52-002	-2.82+000
2	4	4.85+000	-7.42-003	-7.74-001	7	-4.85+000	7.42-003	-5.62-001
3	7	-4.85+000	-7.42-003	-5.62-001	9	4.85+000	7.42-003	-7.74-001
4	9	1.62+000	-2.52-002	-2.82+000	12	1.62+000	2.52-002	-1.71+000
5	2	2.13+000	-6.28-002	-3.16+000	5	-2.13+000	6.28-002	-3.16+000
6	5	1.29+001	-4.27-004	-4.50-001	8	-1.29+001	4.27-004	-3.73-001
7	8	-1.29+001	-4.27-004	-3.73-001	10	1.29+001	4.27-004	-4.50-001
8	10	-2.13+000	-6.28-002	-1.16+000	13	2.13+000	6.28-002	-3.16+000
9	1	-2.52-002	2.41-002	1.71+000	2	2.52-002	-2.41-002	1.76+000
10	4	1.78-002	5.06-002	3.59+000	5	-1.78-002	-5.06-002	3.69+000
11	7	-3.30+000	4.89-003	5.62-001	5	3.30+000	-4.89-003	5.65-001
12	7	8.30+000	4.89-003	5.62-001	10	-8.30+000	-4.89-003	5.65-001
13	9	-1.78-002	5.06-002	3.59+000	10	1.78-002	-5.06-002	3.69+000
14	12	2.52-002	2.41-002	1.71+000	13	-2.52-002	-2.41-002	1.76+000
15	2	-8.80-002	9.70-003	1.40+000	3	8.80-002	-9.70-003	1.04-017
16	5	-5.10+000	4.37-002	4.35+000	6	5.10+000	-4.37-002	1.94+000
17	8	-1.92+001	-1.00-002	-3.73-001	6	1.92+001	1.00-002	-1.94+000
18	8	1.92+001	-1.00-002	-3.73-001	11	-1.92+001	1.00-002	-1.94+000
19	10	5.10+000	4.37-002	4.35+000	11	-5.10+000	-4.37-002	1.94+000
20	13	8.80-002	9.70-003	1.40+000	14	-8.80-002	-9.70-003	1.04-017

COPY AVAILABLE TO DDC DOES NOT PERMIT FULLY LEGIBLE PRODUCTION

STATIC ANALYSIS OF GENERAL STRUCTURES

2-D FRAME SAMPLE PROBLEM

STRESS CALCULATIONS

SPAN	E-D	AXIAL	AXIAL	P/A	SHEAR
1	AFT	-7.268-002	0.	-6.098-001	0.
2	FORE	-1.994-002	0.	-1.828+000	0.
3	AFT	-1.994-002	0.	1.828+000	0.
4	FORE	-7.268-002	0.	6.098-001	0.
5	AFT	-5.224-002	0.	3.294-001	0.
6	FORE	-2.834-003	0.	-1.987+000	0.
7	AFT	-2.834-003	0.	1.987+000	0.
8	FORE	-5.228-002	0.	3.299-001	0.
9	AFT	4.103-001	0.	1.053-002	0.
10	AFT	2.795-001	0.	-5.086-003	0.
11	AFT	4.281-002	0.	2.379+000	0.
12	AFT	4.281-002	0.	-2.379+000	0.
13	AFT	2.795-001	0.	5.086-003	0.
14	AFT	4.103-001	0.	-1.053-002	0.
15	FORE	3.255-001	0.	3.583-002	0.
16	FORE	3.297-001	0.	1.462+000	0.
17	AFT	-1.467-001	0.	5.496+000	0.
18	AFT	-1.467-001	0.	-5.496+000	0.
19	FORE	3.297-001	0.	-1.462+000	0.
20	FORE	3.255-001	0.	-3.683-002	0.

COPY AVAILABLE TO DDC DOES NOT PERMIT FULLY LEGIBLE PRODUCTION

STATIC ANALYSIS OF GENERAL STRUCTURES
2-D FRAME SAMPLE PROBLEM

LOADING NO. 4: OLD TYPES

JOINT DISPLACEMENTS

JOINT	X	Y	ROTATION
1	1.145-004	-3.506-005	-5.156-006
2	6.488-005	-2.745-005	-3.947-006
3	0.	0.	1.248-006
4	1.100-004	-6.569-005	7.314-007
5	6.308-005	-5.141-005	6.343-007
6	0.	0.	-8.034-007
7	9.830-005	-9.016-005	-4.976-006
8	5.594-005	-6.617-005	-3.240-006
9	1.093-004	-8.015-005	-8.648-007
10	7.348-005	-6.593-005	-7.314-007
11	0.	0.	-1.978-007
12	1.123-004	-3.553-005	3.201-006
13	7.577-005	-2.782-005	3.944-006
14	0.	0.	2.759-006

JOINT REACTIONS

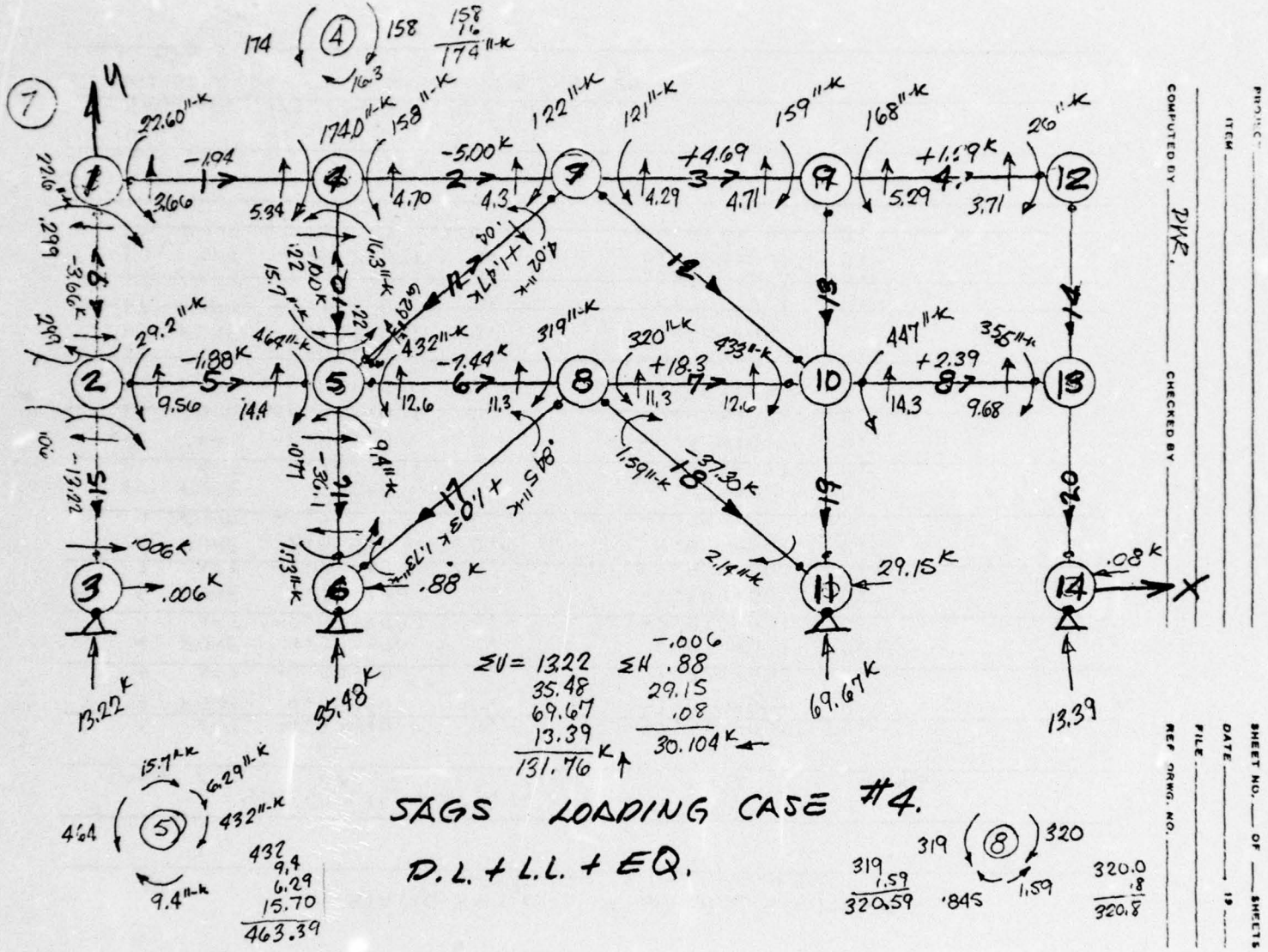
JOINT	F(X)	F(Y)	MOMENT
3	6.110-002	1.324+001	0.
6	-8.812-001	3.548+001	0.
11	-2.915+001	6.957+001	0.
14	8.049-002	1.349+001	0.

		FORE END FORCES				AFT END FORCES		
SPAN	JT.	AXIAL	SHEAR	MOMENT	JT.	AXIAL	SHEAR	MOMENT
1	1	1.88+000	3.6 +00	2.2e+001	4	-1.9 +00	3.3 +00	-1.7 +0 2
2	4	5.00+00	4.70+0	1.58+002	7	-5.00+00	4.30+	-1.2 +002
3	7	-4.62+00	4.23+0	1.21+002	1	4.62+0	4.71+0	-1.5 +002
4	9	-1.29+00	5.29+0	1.58+002	12	1.29+000	3.71+00	-2.3 +001
5	2	1.83+00	9.52+0	2.92+001	5	-1.8 +0	1.49+001	-4.5 +002
6	5	7.44+000	1.26+001	4.32+002	8	-7.4 +00	1.13+001	-3.19+002
7	3	-1.43+001	1.43+0 1	3.20+ 2	13	1.43+0 1	1.2 +0 1	-4.1 +0 2
8	10	-2.39+00	1.43+001	4.47+002	13	2.39+00	9.63+0	-3.5 +001
9	1	3.6 +0	-2.9 -0 1	-2.5 +0 1	2	-3.5 +0	2.9 +0 1	-2.4 +0 1
10	4	1.0 +0 1	2.22-001	1.53+00	5	-1.0 +0 1	-2. -00	1.57+001
11	7	-1.47+0	4.47-002	4.02+0	9	1.47+0	-4. 7-0 2	5.2 +001
12	7	1.51+001	-3.50-002	-2.90+	10	-1.51+001	3.50-0 2	-5.15+000
13	9	1.0 +0 1	-1.2 -001	-9.07+0	10	-1.0 +0 1	1.2 -0 1	-3.35+0
14	12	3.71+0	3.47-001	2.50+001	13	-3.71+0 1	-3.47-0 1	2.3 +001
15	2	1.32+0 1	6.1 -0 2	4.3 +0	3	-1.32+0 1	6.1 -0 2	5.4 -004
15	5	3.61+001	7.73-002	9.40+00	6	-3.61+001	-7.73-002	1.73+001
17	8	-1.03+0	-3.45-003	1.49-001	6	1.03+0	3.45-003	-1.7 +00
18	8	3.73+001	-1.62-002	-1.5 +000	11	-3.73+001	1.62-002	-2.1 +00
19	10	4.63+0 1	1.0 -1 2	-5.3 -0 1	11	-4.63+01	-1.0 -2	2.1 +00
20	13	1.34+001	8.05-002	1.56+001	14	-1.34+001	-8.05-002	1.39-017

STRESS CALCULATIONS

SPAN	END	MZ/SM	MY/SM	P/A	SHEAR
1	AFT	-4.473+000	0.	-7.315-001	0.
2	FORE	4.059+00[illegible]	0.	-1.8[illegible]5+00[illegible]	0.
3	AFT	-4.09[illegible]+00[illegible]	0.	1.721+000	0.
4	FORE	4.3[illegible]+00[illegible]	0.	4.830-001	0.
5	AFT	-2.973+00[illegible]	0.	-2.910-0[illegible]1	0.
6	FORE	2.771+00[illegible]	0.	-1.149+00[illegible]	0.
7	AFT	-2.7[illegible]+00[illegible]	0.	2.825+000	0.
8	FORE	2.863+00[illegible]	0.	3.68[illegible]-001	0.
9	FORE	-5.274+00[illegible]	0.	-1.532+00[illegible]	0.
10	FORE	1.232+00[illegible]	0.	-2.875+00[illegible]	0.
11	AFT	4.76[illegible]-001	0.	4.221-001	0.
12	AFT	-3.91[illegible]-001	0.	-4.3[illegible]5+00[illegible]	0.
13	FORE	-6.873-001	0.	-2.[illegible]45+00[illegible]	0.
14	FORE	6.071+00[illegible]	0.	-1.553+00[illegible]	0.
15	FORE	-2.051+00[illegible]	0.	-5.[illegible]30+00[illegible]	0.
16	FORE	7.123-001	0.	-1.035+001	0.
17	AFT	-1.312-00[illegible]	0.	2.95[illegible]-001	0.
18	AFT	-1.52[illegible]-001	0.	-1.07[illegible]+001	0.
19	AFT	1.622-001	0.	-1.328+001	0.
20	FORE	2.702+0[illegible]	0.	-5.603+00[illegible]	0.

STOP
SRU'S:263.4
!OFF
USAGE ON 09/12/75 AT 13:31:04
SRU'S:304.4 ELAPSED TIME: 00:29:27
GOOD BYE.


SAGS LOADING CASE #4.
D.L. + L.L. + EQ.
ΣV = 13.22 + 35.48 + 69.67 + 13.39 = 131.76 K
ΣH = .006 + .88 + 29.15 + .08 = 30.104 K
13.22 K
35.48 K
69.67 K
13.39
COMPUTED BY PWR.
CHECKED BY
SHEET NO. ___ OF ___ SHEETS
DATE
FILE
REF. DRWG. NO.

PROJECT 2-D FRAME SAMPLE PROBLEM

ITEM STRUDL

ST. LOUIS, DISTRICT

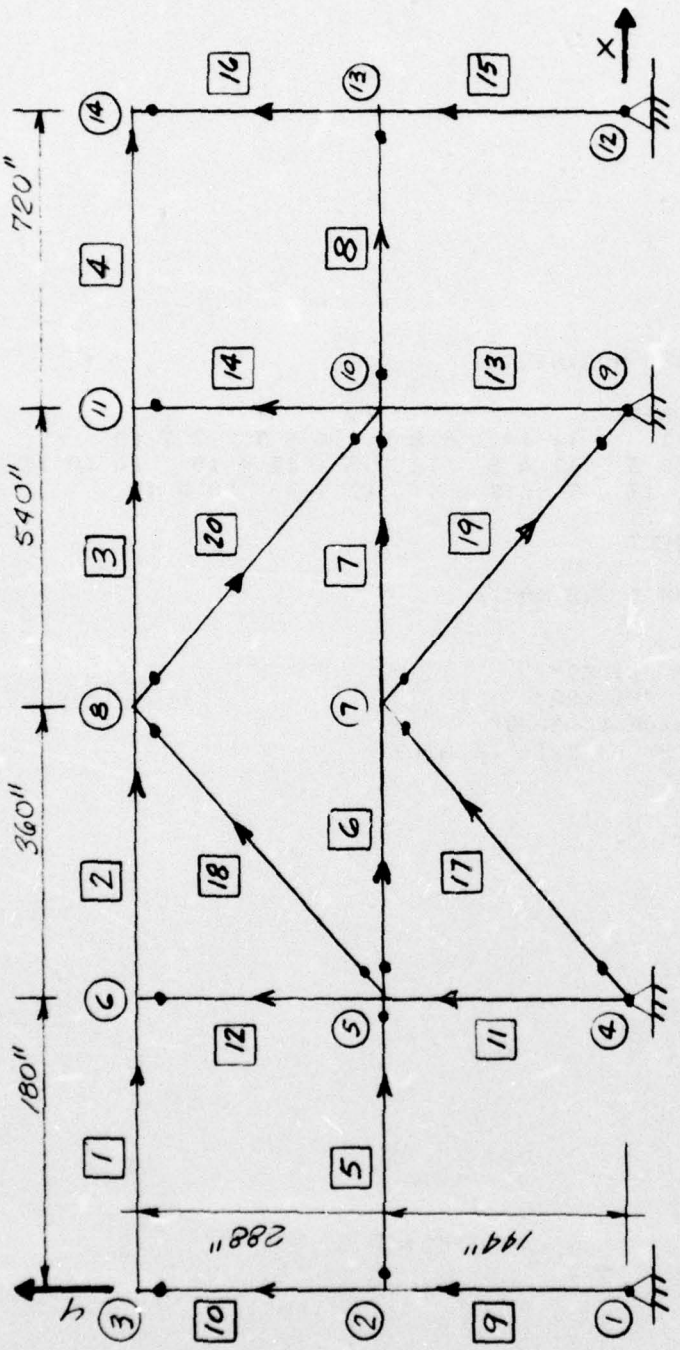
COMPUTED BY HARTMAN CHECKED BY

SHEET NO. ___ OF ___ SHEETS

DATE _____ 19 ____

FILE _____

REF. DRWG. NO. _____



COMPUTER MODEL SAMPLE PROGRAM.

2-STORY, 2-0 FRAME

STRUDL INPUT FILE

```
#LNH JPHSTR
100 STRUDL '2D FRAME'
110 UNITS FEET
120 JOINT COORD
130 1 0. 0. S
140 2 0. 12.
150 3 0. 24.
160 4 15. 0. S
170 5 15. 12.
180 6 15. 24.
190 7 30. 12.
200 8 30. 24.
210 9 45. 0. S
220 10 45. 12.
230 11 45. 24.
240 12 60. 0. S
250 13 60. 12.
260 14 60. 24.
270 JOINT 1 4 9 12 RELEASES MOMENT Z
280 TYPE PLANE FRAME
290 MULTIPLE MEMBER INCIDENCES
300 1 3 6   2 6 8   3 8 11   4 11 14   5 2 5   6 5 7   7 7 10
310 8 10 13   9 1 2   10 2 3   11 4 5   12 5 6   13 9 10   14 10 11
320 15 12 13   16 13 14   17 4 7   18 5 8   19 7 9   20 8 10
330 MEM RELEASES
340 7 10 12 14 16 END MOMENT Z
350 6 START MOMENT Z
360 5 8 17 TO 20 START MOM Z END MOM Z
370 UNITS INCH KIPS
380 MEM PROP
390 1 TO 4 TABLE 'STEELM' 'M10X9'
400 5 TO 8 TABLE 'STEELW' 'W12X22'
410 9 10 15 16 PRISM AX 3.09 IZ 5.29
420 11 TO 14 17 TO 20 PRISM AX 8.14 IZ 25.7
430 CONSTANTS E 30000. ALL
440 UNITS FEET
450 LOADING 4 'EARTHQUAKE'
460 JOINT LOADS
470 3 14 FORCE X 1.64
480 6 8 11 FOR X 3.28
490 2 13 FORCE X 2.12
500 5 7 10 FOR X 4.23
510 LOADING 3 'WIND'
520 JOINT LOADS
530 3 FOR X 1.96
540 14 FOR X 1.30
550 6 8 11 FOR X 1.40
560 2 FOR X 3.92
570 13 FOR X 2.60
580 5 7 10 FOR X 2.79
```

```
590 LOADING 5 'LIVE + DEAD'
600 MEMBER LOADS
610 1 TO 4 FORCE Y GLOBAL UNI -.600
620 5 TO 8 FOR Y GLO UNI -1.6
630 LOAD COMB 6 'D+L+W' COMB 3 1.0 5 1.0
640 LOAD COMB 8 'D+L+W/2' COMB 3 0.5 5 1.0
650 LOAD COMB 10 'D+L+E' COMB 4 1.0 5 1.0
660 LOAD COMB 12 'D+L+E/2' COMB 4 0.5 5 1.0
670 STIFFNESS ANALYSIS
680 UNITS INCH LB
690 OUTPUT DECIMAL 4
700 LIST DISPL FORCES REAC
710 SECTION FR NS 3 0.0 0.5 1.0
720 PARAMETERS
730 'FYLD' 50000. ALL
740 'CODE' 'SP69' ALL
750 CHECK CODE MEM 1 TO 8
760FINISH
```

```
*****************************************
*                                       *
*     MCDONNELL-ECI ICES EXECUTIVE SYSTEM *
*                                       *
*        MAC REL. 2.3 - RELEASED  2/5/73 *
*          TIME=11.0A.32,  9/10/75      *
*                                       *
*****************************************
```

```
STRUDL '20 FRAME'

      ********************************************
      *                                          *
      *          MCDONNELL-ECI ICES STRUDL       *
      *                                          *
      *           STRUDL       REL 2.7           *
      *           STRUDL DYNAL REL 4.1           *
      *           STRUDL PLOTS REL 1.12          *
      *           11.08.55        9/10/75        *
      *          SIZE OF PDDL 30640 BYTES        *
      *                                          *
      ********************************************

UNITS FEET
JOINT COORD
1 0. 0. 8
2 0. 12.
3 0. 24.
4 15. 0. 8
5 15. 12.
6 15. 24.
7 30. 12.
8 30. 24.
9 45. 0. 8
10 45. 12.
11 45. 24.
12 60. 0. 8
13 60. 12.
14 60. 24.
JOINT 1 4 9 12 RELEASES MOMENT Z
```

```
TYPE PLANE FRAME
MULTIPLE MEMBER INCIDENCES
1 3 6   2 6 8   3 8 11   4 11 14   5 2 5   6 5 7   7 7 10
8 10 13   9 1 2   10 2 3   11 4 5   12 5 6   13 9 10   14 10 11
15 12 13   16 13 14   17 4 7   18 5 8   19 7 9   20 8 10
MEM RELEASES
7 10 12 14 16 END MOMENT Z
6 START MOMENT Z
5 8 17 TO 20 START MOM Z END MOM Z
UNITS INCH KIPS
MEM PROP
1 TO 4 TABLE 'STEELW' 'W10X9'
5 TO 8 TABLE 'STEELW' 'W12X22'
9 10 15 16 PRISM AX 3.09 IZ 5.29
11 TO 14 17 TO 20 PRISM AX 8.14 IZ 25.7
CONSTANTS E 30000. ALL
UNITS FEET
LOADING 4 'EARTHQUAKE'
JOINT LOADS
3 14 FORCE X 1.64
6 8 11 FOR X 3.28
2 13 FORCE X 2.12
5 7 10 FOR X 4.23
LOADING 3 'WIND'
JOINT LOADS
```

```
3 FOR X 1.96

14 FOR X 1.30

6 C 11 FOR X 1.40

2 FOR X 3.92

13 FOR X 2.60

5 7 10 FOR X 2.79

LOADING 5 'LIVE + DEAD'

MEMBER LOADS

1 TO 4 FORCE Y GLOBAL UNI -.600

5 TO 8 FOR Y GLO UNI -1.6

LOAD COMB 6 'D+L+W' COMB 3 1.0 5 1.0

LOAD COMB 8 'D+L+W/2' COMB 3 0.5 5 1.0

LOAD COMB 10 'D+L+E' COMB 4 1.0 5 1.0

LOAD COMB 12 'D+L+E/2' COMB 4 0.5 5 1.0

STIFFNESS ANALYSIS
**** WARNING - DEFAULT CHANGED TO "WITH REACTIONS"
               SPECIFY "WITHOUT REACTIONS" IF REACTIONS NOT DESIRED

UNITS INCH LB

OUTPUT DECIMAL 4

LIST DISPL FORCES REAC
```

****
RESULTS OF LATEST ANALYSES
****

PROBLEM = 2D FRAME TITLE = NONE GIVEN

ACTIVE UNITS INCH LB RAD FAHR SEC LBM

LOADING = 4 EARTHQUAKE

MEMBER FORCES

MEMBER	JOINT	FORCE AXIAL	FORCE SHEAR Y	FORCE SHEAR Z	MOMENT TORSIONAL	MOMENT BENDING Y	MOMENT BENDING Z
1	3	1640.9272	-1.8344				-0.0000
1	6	-1640.9272	1.8344				-330.1997
2	6	4925.3516	1.8344				330.1997
2	8	-4925.3516	-1.8344				-0.0000
3	8	-4925.3516	1.8344				-0.0000
3	11	4925.3516	-1.8344				330.1997
4	11	-1640.9272	-1.8344				-330.1997
4	14	1640.9272	1.8344				-0.0000
5	2	2118.1436	-0.0000				0.0
5	5	-2118.1436	0.0000				-0.0000
6	5	12904.6367	-0.0000				-0.0000
6	7	-12904.6367	0.0000				-0.0000
7	7	-12904.6367	-0.0000				-0.0000
7	10	12904.6367	0.0000				0.0
8	10	-2118.1436	-0.0000				0.0
8	13	2118.1436	0.0000				-0.0000
9	1	-1.8344	0.9280				0.0000
9	2	1.8344	-0.9280				133.6346
10	2	-1.8344	-0.9280				-133.6346
10	3	1.8344	0.9280				0.0
11	4	-5248.6094	4.4259				0.0000
11	5	5248.6094	-4.4259				637.3523
12	5	3.6689	-4.4259				-637.3523

MEMBER FORCES

MEMBER	JOINT	FORCE			MOMENT		
		AXIAL	SHEAR Y	SHEAR Z	TORSIONAL	BENDING Y	BENDING Z
12	6	-3.6689	4.4259				0.0
13	9	5248.6094	4.4259				0.0000
13	10	-5248.6094	-4.4259				637.3323
14	10	-3.6689	-4.4259				-637.3323
14	11	3.6689	4.4259				0.0
15	12	1.8344	0.9280				0.0000
15	13	-1.8344	-0.9280				133.6346
16	13	1.8344	-0.9280				-133.6346
16	14	-1.8344	0.9280				0.0
17	4	-19234.5195	0.0000				-0.0000
17	7	19234.5195	-0.0000				0.0000
18	5	-8407.7500	0.0000				0.0000
18	8	8407.7500	-0.0000				0.0000
19	7	19234.5195	-0.0000				0.0
19	9	-19234.5195	0.0000				-0.0000
20	8	8407.7500	-0.0000				0.0000
20	10	-8407.7500	0.0000				-0.0000

RESULTANT JOINT LOADS - SUPPORTS

JOINT		FORCE			MOMENT		
		X FORCE	Y FORCE	Z FORCE	X MOMENT	Y MOMENT	Z MOMENT
1	GLOBAL	-0.9280	-1.8344				0.0000
4	GLOBAL	-15024.0625	-17264.3203				0.0000
9	GLOBAL	-15024.0625	17264.3203				0.0000
12	GLOBAL	-0.9280	1.8344				0.0000

RESULTANT JOINT DISPLACEMENTS - SUPPORTS

JOINT		DISPLACEMENT			ROTATION		
		X DISP	Y DISP	Z DISP	X ROT	Y ROT	Z ROT
1	GLOBAL	0.0	0.0				-0.0003
4	GLOBAL	0.0	0.0				-0.0003
9	GLOBAL	0.0	0.0				-0.0003
12	GLOBAL	0.0	0.0				-0.0003

RESULTANT JOINT DISPLACEMENTS - FREE JOINTS

JOINT		DISPLACEMENT			ROTATION		
		X DISP	Y DISP	Z DISP	X ROT	Y ROT	Z ROT
2	GLOBAL	0.0372	0.0000				-0.0002
3	GLOBAL	0.0627	0.0000				0.0000
5	GLOBAL	0.0352	0.0031				-0.0002
6	GLOBAL	0.0590	0.0031				-0.0000
7	GLOBAL	0.0233	0.0000				-0.0000
8	GLOBAL	0.0479	0.0000				-0.0000
10	GLOBAL	0.0352	-0.0031				-0.0002
11	GLOBAL	0.0590	-0.0031				-0.0000
13	GLOBAL	0.0372	-0.0000				-0.0002
14	GLOBAL	0.0627	-0.0000				0.0000

LOADING = 3 WIND

MEMBER FORCES

MEMBER	JOINT	FORCE			MOMENT		
		AXIAL	SHEAR Y	SHEAR Z	TORSIONAL	BENDING Y	BENDING Z
1	3	1961.2415	-0.6641				-0.0000
1	6	-1961.2415	0.6641				-119.5292
2	6	3366.1836	0.0280				119.5292
2	8	-3366.1836	-0.0280				-114.4953
3	8	-2705.6658	2.0598				114.4953
3	11	2705.6658	-2.0598				256.2622
4	11	-1301.0901	-1.4237				-256.2622
4	14	1301.0901	1.4237				-0.0000
5	2	3917.5137	-0.0000				0.0
5	5	-3917.5137	0.0000				-0.0000
6	5	10432.2813	0.0005				-0.0000
6	7	-10432.2813	-0.0005				0.0953
7	7	-9115.8555	-0.0005				-0.0953
7	10	9115.8555	0.0005				0.0
8	10	-2597.8167	-0.0000				0.0
8	13	2597.8167	0.0000				-0.0000
9	1	-0.6641	1.2426				0.0000
9	2	0.6641	-1.2426				178.9369
10	2	-0.6641	-1.2426				-178.9369
10	3	0.6641	1.2426				0.0
11	4	-2987.0313	4.9426				0.0000
11	5	2987.0313	-4.9426				711.7383

MEMBER FORCES

MEMBER	JOINT	FORCE			MOMENT		
		AXIAL	SHEAR Y	SHEAR Z	TORSIONAL	BENDING Y	BENDING Z
12	5	0.6920	-4.9426				-711.7383
12	6	-0.6920	4.9426				0.0
13	9	2986.2725	4.5762				0.0000
13	10	-2986.2725	-4.5762				658.9731
14	10	-3.4834	-4.5762				-658.9731
14	11	3.4834	4.5762				0.0
15	12	1.4237	1.0912				0.0000
15	13	-1.4237	-1.0912				157.1356
16	13	1.4237	-1.0912				-157.1356
16	14	-1.4237	1.0912				0.0
17	4	-14303.3867	0.0000				0.0
17	7	14303.3867	-0.0000				0.0000
18	5	-4782.6914	0.0000				-0.0000
18	8	4782.6914	-0.0000				0.0000
19	7	14303.3867	-0.0000				0.0
19	9	-14303.3867	0.0000				-0.0000
20	8	4785.9414	-0.0000				0.0000
20	10	-4785.9414	0.0000				-0.0000

RESULTANT JOINT LOADS = SUPPORTS

JOINT		FORCE			MOMENT		
		X FORCE	Y FORCE	Z FORCE	X MOMENT	Y MOMENT	Z MOMENT
1	GLOBAL	-1.2426	-0.6641				0.0000
4	GLOBAL	-11174.0117	-11922.2852				0.0000
9	GLOBAL	-11173.6445	11921.5273				0.0000
12	GLOBAL	-1.0912	1.4237				0.0000

RESULTANT JOINT DISPLACEMENTS = SUPPORTS

JOINT		DISPLACEMENT			ROTATION		
		X DISP	Y DISP	Z DISP	X ROT	Y ROT	Z ROT
1	GLOBAL	0.0	0.0				-0.0002
4	GLOBAL	0.0	0.0				-0.0002
9	GLOBAL	0.0	0.0				-0.0002
12	GLOBAL	0.0	0.0				-0.0002

RESULTANT JOINT DISPLACEMENTS • FREE JOINTS

JOINT		DISPLACEMENT			ROTATION		
		X DISP	Y DISP	Z DISP	X ROT	Y ROT	Z ROT
2	GLOBAL	0.0306	0.0000				-0.0002
3	GLOBAL	0.0456	0.0000				0.0000
5	GLOBAL	0.0270	0.0018				-0.0001
6	GLOBAL	0.0412	0.0018				0.0000
7	GLOBAL	0.0173	0.0000				-0.0000
8	GLOBAL	0.0335	0.0008				-0.0000
10	GLOBAL	0.0257	-0.0018				-0.0001
11	GLOBAL	0.0397	-0.0018				-0.0000
13	GLOBAL	0.0282	-0.0000				-0.0001
14	GLOBAL	0.0426	-0.0000				0.0000

LOADING • 5 LIVE + DEAD

MEMBER FORCES

MEMBER	JOINT	FORCE			MOMENT		
		AXIAL	SHEAR Y	SHEAR Z	TORSIONAL	BENDING Y	BENDING Z
1	3	-0.7695	3536.7439				0.0000
1	6	0.7695	5463.2500				-173385.8750
2	6	-4.5096	4823.1406				173385.8750
2	8	4.5096	4176.8516				-115219.8125
3	8	-4.5096	4176.8516				115219.8125
3	11	4.5096	4823.1406				-173385.8750
4	11	-0.7695	5463.2500				173385.8750
4	14	0.7695	3536.7422				-0.0000
5	2	1.5390	11999.9922				0.0000
5	5	-1.5390	11999.9883				0.0000
6	5	-5212.0469	9069.5547				0.0000
6	7	5212.0469	14930.4258				-527478.8125
7	7	-5212.0469	14930.4297				527478.8125
7	10	5212.0469	9069.5508				0.0
8	10	1.5390	11999.9922				0.0000
8	13	-1.5390	11999.9883				0.0000
9	1	15536.7383	-0.7695				-0.0000
9	2	-15536.7383	0.7695				-110.8060
10	2	3536.7439	0.7695				110.8060
10	3	-3536.7439	-0.7695				0.0
11	4	35532.7930	-3.7401				-0.0000
11	5	-35532.7930	3.7401				-536.5757

MEMBER FORCES

MEMBER	JOINT	FORCE			MOMENT		
		AXIAL	SHEAR Y	SHEAR Z	TORSIONAL	BENDING Y	BENDING Z
12	5	10286.3945	3.7401				538.5757
12	6	-10286.3945	-3.7401				0.0
13	9	35532.7930	3.7401				0.0000
13	10	-35532.7930	-3.7401				538.5757
14	10	10286.3945	-3.7401				-538.5757
14	11	-10286.3945	3.7401				0.0
15	12	15536.7305	0.7695				0.0000
15	13	-15536.7305	-0.7695				110.8060
16	13	3536.7422	-0.7695				-110.8060
16	14	-3536.7422	0.7695				0.0
17	4	23900.3477	0.0000				0.0
17	7	-23900.3477	-0.0000				0.0000
18	5	6686.2266	0.0000				0.0
18	8	-6686.2266	-0.0000				0.0000
19	7	23900.3477	-0.0000				0.0
19	9	-23900.3477	0.0000				-0.0000
20	8	6686.2266	-0.0000				0.0000
20	10	-6686.2266	0.0000				-0.0000

RESULTANT JOINT LOADS - SUPPORTS

JOINT		FORCE			MOMENT		
		X FORCE	Y FORCE	Z FORCE	X MOMENT	Y MOMENT	Z MOMENT
1	GLOBAL	0.7695	15536.7383				-0.0000
4	GLOBAL	18666.7773	50463.2227				-0.0000
9	GLOBAL	-18666.7773	50463.2227				0.0000
12	GLOBAL	-0.7695	15536.7305				0.0000

RESULTANT JOINT DISPLACEMENTS - SUPPORTS

JOINT		DISPLACEMENT			ROTATION		
		X DISP	Y DISP	Z DISP	X ROT	Y ROT	Z ROT
1	GLOBAL	0.0	0.0				0.0001
4	GLOBAL	0.0	0.0				0.0001
9	GLOBAL	0.0	0.0				-0.0001
12	GLOBAL	0.0	0.0				-0.0001

RESULTANT JOINT DISPLACEMENTS - FREE JOINTS

JOINT		DISPLACEMENT			ROTATION		
		X DISP	Y DISP	Z DISP	X ROT	Y ROT	Z ROT
2	GLOBAL	-0.0048	-0.0241				0.0000
3	GLOBAL	-0.0000	-0.0296				-0.0060
5	GLOBAL	-0.0048	-0.0210				0.0000
6	GLOBAL	-0.0000	-0.0270				0.0014
7	GLOBAL	-0.0000	-0.0361				0.0000
8	GLOBAL	-0.0000	-0.0371				0.0000
10	GLOBAL	0.0048	-0.0210				-0.0000
11	GLOBAL	0.0000	-0.0270				-0.0014
13	GLOBAL	0.0048	-0.0241				-0.0000
14	GLOBAL	0.0000	-0.0296				0.0060

LOADING - 6 D+L+W

MEMBER FORCES

MEMBER	JOINT	FORCE			MOMENT		
		AXIAL	SHEAR Y	SHEAR Z	TORSIONAL	BENDING Y	BENDING Z
1	3	1960.4719	3536.0798				0.0000
1	6	-1960.4719	5463.9102				-173509.3750
2	6	3361.6738	4823.1680				173505.3750
2	8	-3361.6738	4176.8203				-115334.2500
3	8	-2710.1753	4178.9102				115334.2500
3	11	2710.1753	4821.0781				-173129.5625
4	11	-1301.8594	5461.8242				173129.5625
4	14	1301.8594	3538.1658				-0.0000
5	2	3919.0525	11999.9922				0.0000
5	5	-3919.0525	11999.9883				0.0000
6	5	5220.2344	9069.5547				0.0000
6	7	-5220.2344	14930.4219				-527478.6875
7	7	-14327.9023	14930.4258				527478.6875
7	10	14327.9023	9069.5508				0.0
8	10	-2590.2776	11999.9922				0.0000
8	13	2590.2776	11999.9883				0.0000
9	1	15536.0742	0.4731				0.0000
9	2	-15536.0742	-0.4731				68.1309
10	2	3536.0798	-0.4731				-68.1309
10	3	-3536.0798	0.4731				0.0
11	4	32545.7617	1.2025				0.0000
11	5	-32545.7617	-1.2025				173.1626

MEMBER FORCES

MEMBER	JOINT	FORCE			MOMENT		
		AXIAL	SHEAR Y	SHEAR Z	TORSIONAL	BENDING Y	BENDING Z
12	5	10287.0859	-1.2025				-173.1626
12	6	-10287.0859	1.2025				0.0
13	9	38519.0625	8.3163				0.0000
13	10	-38519.0625	-8.3163				1197.5488
14	10	10282.9102	-8.3163				-1197.5488
14	11	-10282.9102	8.3163				0.0
15	12	15538.1523	1.8607				0.0000
15	13	-15538.1523	-1.8607				267.9414
16	13	3538.1658	-1.8607				-267.9414
16	14	-3538.1658	1.8607				0.0
17	4	9596.9609	0.0000				0.0
17	7	-9596.9609	-0.0000				0.0000
18	5	1903.5352	0.0000				-0.0000
18	8	-1903.5352	-0.0000				0.0000
19	7	38203.7344	-0.0000				0.0
19	9	-38203.7344	0.0000				-0.0000
20	8	11472.1680	-0.0000				0.0000
20	10	-11472.1680	0.0000				-0.0000

RESULTANT JOINT LOADS = SUPPORTS

JOINT		FORCE			MOMENT		
		X FORCE	Y FORCE	Z FORCE	X MOMENT	Y MOMENT	Z MOMENT
1	GLOBAL	-0.4731	15536.0742				0.0000
4	GLOBAL	7492.7656	38540.9375				0.0000
9	GLOBAL	-29840.4219	62384.7500				0.0000
12	GLOBAL	-1.8607	15538.1523				0.0000

RESULTANT JOINT DISPLACEMENTS = SUPPORTS

JOINT		DISPLACEMENT			ROTATION		
		X DISP	Y DISP	Z DISP	X ROT	Y ROT	Z ROT
1	GLOBAL	0.0	0.0				-0.0002
4	GLOBAL	0.0	0.0				-0.0002
9	GLOBAL	0.0	0.0				-0.0002
12	GLOBAL	0.0	0.0				-0.0003

RESULTANT JOINT DISPLACEMENTS = FREE JOINTS

JOINT		DISPLACEMENT			ROTATION		
		X DISP	Y DISP	Z DISP	X ROT	Y ROT	Z ROT
2	GLOBAL	0.0258	-0.0241				-0.0002
3	GLOBAL	0.0456	-0.0296				-0.0060
5	GLOBAL	0.0221	-0.0192				-0.0001
6	GLOBAL	0.0412	-0.0253				0.0014
7	GLOBAL	0.0173	-0.0361				-0.0000
8	GLOBAL	0.0335	-0.0363				-0.0000
10	GLOBAL	0.0306	-0.0227				-0.0001
11	GLOBAL	0.0397	-0.0288				-0.0014
13	GLOBAL	0.0330	-0.0241				-0.0001
14	GLOBAL	0.0426	-0.0296				0.0060

LOADING = 8 D+L+W/2

MEMBER FORCES

MEMBER	JOINT	FORCE			MOMENT		
		AXIAL	SHEAR Y	SHEAR Z	TORSIONAL	BENDING Y	BENDING Z
1	3	979.8511	3536.4119				0.0000
1	6	-979.8511	5463.5781				-173445.6250
2	6	1678.5820	4823.1523				173445.6250
2	8	-1678.5820	4176.8359				-115277.0000
3	8	-1357.3423	4177.8789				115277.0000
3	11	1357.3423	4822.1094				-173257.6875
4	11	-651.3142	5462.5352				173257.6875
4	14	651.3142	3537.4539				-0.0000
5	2	1960.2957	11999.9922				0.0000
5	5	-1960.2957	11999.9883				0.0000
6	5	4.0938	9069.5547				0.0000
6	7	-4.0938	14930.4219				-527478.7500
7	7	-9769.9727	14930.4258				527478.7500
7	10	9769.9727	9069.5508				0.0
8	10	-1297.3691	11999.9922				0.0000
8	13	1297.3691	11999.9883				0.0000
9	1	15530.4063	-0.1482				0.0000
9	2	-15530.4063	0.1482				-21.3376
10	2	3530.4119	0.1482				21.3376
10	3	-3530.4119	-0.1482				0.0
11	4	34039.2773	-1.2688				-0.0000
11	5	-34039.2773	1.2688				-182.7065

MEMBER FORCES

MEMBER	JOINT	FORCE			MOMENT		
		AXIAL	SHEAR Y	SHEAR Z	TORSIONAL	BENDING Y	BENDING Z
12	5	10286.7383	1.2688				182.7065
12	6	-10286.7383	-1.2688				0.0
13	9	37025.9258	6.0282				0.0000
13	10	-37025.9258	-6.0282				868.0623
14	10	10284.6523	-6.0282				-868.0623
14	11	-10284.6523	6.0282				0.0
15	12	15537.4414	1.3151				0.0000
15	13	-15537.4414	-1.3151				189.3738
16	13	3537.4539	-1.3151				-189.3738
16	14	-3537.4539	1.3151				0.0
17	4	16748.6563	0.0000				0.0
17	7	-16748.6563	-0.0000				0.0000
18	5	4294.8789	0.0000				-0.0000
18	8	-4294.8789	-0.0000				0.0000
19	7	31052.0391	-0.0000				0.0
19	9	-31052.0391	0.0000				-0.0000
20	8	9079.1953	-0.0000				0.0000
20	10	-9079.1953	0.0000				-0.0000

RESULTANT JOINT LOADS • SUPPORTS

JOINT		FORCE			MOMENT		
		X FORCE	Y FORCE	Z FORCE	X MOMENT	Y MOMENT	Z MOMENT
1	GLOBAL	0.1482	15536.4063				0.0000
4	GLOBAL	13079.7734	44502.0820				-0.0000
9	GLOBAL	-24253.5977	56423.9844				0.0000
12	GLOBAL	-1.3151	15537.4414				0.0000

RESULTANT JOINT DISPLACEMENTS • SUPPORTS

JOINT		DISPLACEMENT			ROTATION		
		X DISP	Y DISP	Z DISP	X ROT	Y ROT	Z ROT
1	GLOBAL	0.0	0.0				-0.0001
4	GLOBAL	0.0	0.0				-0.0001
9	GLOBAL	0.0	0.0				-0.0001
12	GLOBAL	0.0	0.0				-0.0002

RESULTANT JOINT DISPLACEMENTS = FREE JOINTS

JOINT		DISPLACEMENT			ROTATION		
		X DISP	Y DISP	Z DISP	X ROT	Y ROT	Z ROT
2	GLOBAL	0.0105	-0.0241				-0.0001
3	GLOBAL	0.0228	-0.0296				-0.0060
5	GLOBAL	0.0086	-0.0201				-0.0001
6	GLOBAL	0.0206	-0.0261				0.0014
7	GLOBAL	0.0086	-0.0301				-0.0000
8	GLOBAL	0.0168	-0.0367				-0.0000
10	GLOBAL	0.0177	-0.0218				-0.0001
11	GLOBAL	0.0198	-0.0279				-0.0014
13	GLOBAL	0.0189	-0.0241				-0.0001
14	GLOBAL	0.0213	-0.0296				0.0060

LOADING = 10 D+L+E

MEMBER FORCES

MEMBER	JOINT	FORCE			MOMENT		
		AXIAL	SHEAR Y	SHEAR Z	TORSIONAL	BENDING Y	BENDING Z
1	3	1640.1577	3534.9094				0.0000
1	6	-1640.1577	5465.0820				-173716.0625
2	6	4920.8398	4824.9727				173716.0625
2	8	-4920.8398	4175.0156				-115219.8125
3	8	-4929.8594	4178.6836				115219.8125
3	11	4929.8594	4821.3047				-173055.6250
4	11	-1641.6965	5461.4141				173055.6250
4	14	1641.6965	3538.5764				-0.0000
5	2	2119.6824	11999.9922				0.0000
5	5	-2119.6824	11999.9883				0.0000
6	5	7692.5898	9069.5547				0.0000
6	7	-7692.5898	14930.4258				-527478.8125
7	7	-18110.6836	14930.4297				527478.8125
7	10	18110.6836	9069.5508				0.0
8	10	-2110.6045	11999.9922				0.0000
8	13	2110.6045	11999.9883				0.0000
9	1	15534.9023	0.1585				0.0000
9	2	-15534.9023	-0.1585				22.8286
10	2	3534.9094	-0.1585				-22.8286
10	3	-3534.9094	0.1585				0.0
11	4	30284.1836	0.6858				0.0000
11	5	-30284.1836	-0.6858				98.7566

MEMBER FORCES

MEMBER	JOINT	FORCE			MOMENT		
		AXIAL	SHEAR Y	SHEAR Z	TORSIONAL	BENDING Y	BENDING Z
12	5	10290.0625	-0.6858				-98.7566
12	6	-10290.0625	0.6858				0.0
13	9	40781.4023	8.1660				0.0000
13	10	-40781.4023	-8.1660				1175.9080
14	10	10282.7227	-8.1660				-1175.9080
14	11	-10282.7227	8.1660				0.0
15	12	15538.5625	1.6975				0.0000
15	13	-15538.5625	-1.6975				244.4406
16	13	3538.5764	-1.6975				-244.4406
16	14	-3538.5764	1.6975				0.0
17	4	4665.8281	0.0000				-0.0000
17	7	-4665.8281	-0.0000				0.0000
18	5	-1721.5234	0.0000				0.0000
18	8	1721.5234	-0.0000				0.0000
19	7	43134.8672	-0.0000				0.0
19	9	-43134.8672	0.0000				-0.0000
20	8	15093.9766	-0.0000				0.0000
20	10	-15093.9766	0.0000				-0.0000

RESULTANT JOINT LOADS - SUPPORTS

JOINT		FORCE			MOMENT		
		X FORCE	Y FORCE	Z FORCE	X MOMENT	Y MOMENT	Z MOMENT
1	GLOBAL	-0.1585	15534.9023				0.0000
4	GLOBAL	3642.7148	33198.9023				0.0000
9	GLOBAL	-33690.8398	67727.5000				0.0000
12	GLOBAL	-1.6975	15538.5625				0.0000

RESULTANT JOINT DISPLACEMENTS - SUPPORTS

JOINT		DISPLACEMENT			ROTATION		
		X DISP	Y DISP	Z DISP	X ROT	Y ROT	Z ROT
1	GLOBAL	0.0	0.0				-0.0002
4	GLOBAL	0.0	0.0				-0.0002
9	GLOBAL	0.0	0.0				-0.0003
12	GLOBAL	0.0	0.0				-0.0003

RESULTANT JOINT DISPLACEMENTS = FREE JOINTS

JOINT		DISPLACEMENT			ROTATION		
		X DISP	Y DISP	Z DISP	X ROT	Y ROT	Z ROT
2	GLOBAL	0.0324	-0.0241				-0.0002
3	GLOBAL	0.0027	-0.0296				-0.0060
5	GLOBAL	0.0304	-0.0179				-0.0002
6	GLOBAL	0.0590	-0.0239				0.0014
7	GLOBAL	0.0233	-0.0361				-0.0000
8	GLOBAL	0.0479	-0.0371				-0.0000
10	GLOBAL	0.0401	-0.0240				-0.0002
11	GLOBAL	0.0590	-0.0301				-0.0014
13	GLOBAL	0.0420	-0.0241				-0.0002
14	GLOBAL	0.0627	-0.0296				0.0061

LOADING = 12 D+L+E/2

MEMBER FORCES

MEMBER	JUINT	FORCE			MOMENT		
		AXIAL	SHEAR Y	SHEAR Z	TORSIONAL	BENDING Y	BENDING Z
1	3	819.6941	3535.8267				0.0000
1	6	-819.6941	5464.1641				-173550.9375
2	6	2458.1660	4824.0547				173550.9375
2	8	-2458.1660	4175.9336				-115219.8125
3	8	-2467.1853	4177.7656				115219.8125
3	11	2467.1853	4822.2227				-173220.7500
4	11	-821.2329	5462.3320				173220.7500
4	14	821.2329	3537.6592				-0.0000
5	2	1060.6106	11999.9922				0.0000
5	5	-1060.6106	11999.9883				0.0000
6	5	1240.2695	9069.5547				0.0000
6	7	-1240.2695	14930.4258				-527478.8125
7	7	-11664.3633	14930.4297				527478.8125
7	10	11664.3633	9069.5508				0.0
8	10	-1057.5327	11999.9922				0.0000
8	13	1057.5327	11999.9883				0.0000
9	1	15535.8203	-0.3055				0.0000
9	2	-15535.8203	0.3055				-43.9887
10	2	3535.8267	0.3055				43.9887
10	5	-3535.8267	-0.3055				0.0
11	4	32908.4883	-1.5272				0.0000
11	5	-32908.4883	1.5272				-219.9097

MEMBER FORCES

MEMBER	JOINT	FORCE			MOMENT		
		AXIAL	SHEAR Y	SHEAR Z	TORSIONAL	BENDING Y	BENDING Z
12	5	10288.2266	1.5272				219.9097
12	6	-10288.2266	-1.5272				0.0
13	9	38157.0977	5.9531				0.0000
13	10	-38157.0977	-5.9531				857.2417
14	10	10284.5586	-5.9531				-857.2417
14	11	-10284.5586	5.9531				0.0
15	12	15537.6445	1.2335				0.0000
15	13	-15537.6445	-1.2335				177.6233
16	13	3537.6592	-1.2335				-177.6233
16	14	-3537.6592	1.2335				0.0
17	6	14283.0898	0.0000				-0.0000
17	7	-14283.0898	-0.0000				0.0000
18	5	2482.3516	0.0000				0.0000
18	8	-2482.3516	-0.0000				0.0000
19	7	33517.6055	-0.0000				0.0
19	9	-33517.6055	0.0000				-0.0000
20	8	10890.1016	-0.0000				0.0000
20	10	-10890.1016	0.0000				-0.0000

RESULTANT JOINT LOADS - SUPPORTS

JOINT		FORCE			MOMENT		
		X FORCE	Y FORCE	Z FORCE	X MOMENT	Y MOMENT	Z MOMENT
1	GLOBAL	0.3055	15535.8203				0.0000
6	GLOBAL	11154.7461	41831.0625				0.0000
9	GLOBAL	-26178.8086	59095.3828				0.0000
12	GLOBAL	-1.2335	15537.6445				0.0000

RESULTANT JOINT DISPLACEMENTS - SUPPORTS

JOINT		DISPLACEMENT			ROTATION		
		X DISP	Y DISP	Z DISP	X ROT	Y ROT	Z ROT
1	GLOBAL	0.0	0.0				-0.0001
6	GLOBAL	0.0	0.0				-0.0001
9	GLOBAL	0.0	0.0				-0.0002
12	GLOBAL	0.0	0.0				-0.0002

RESULTANT JOINT DISPLACEMENTS - FREE JOINTS

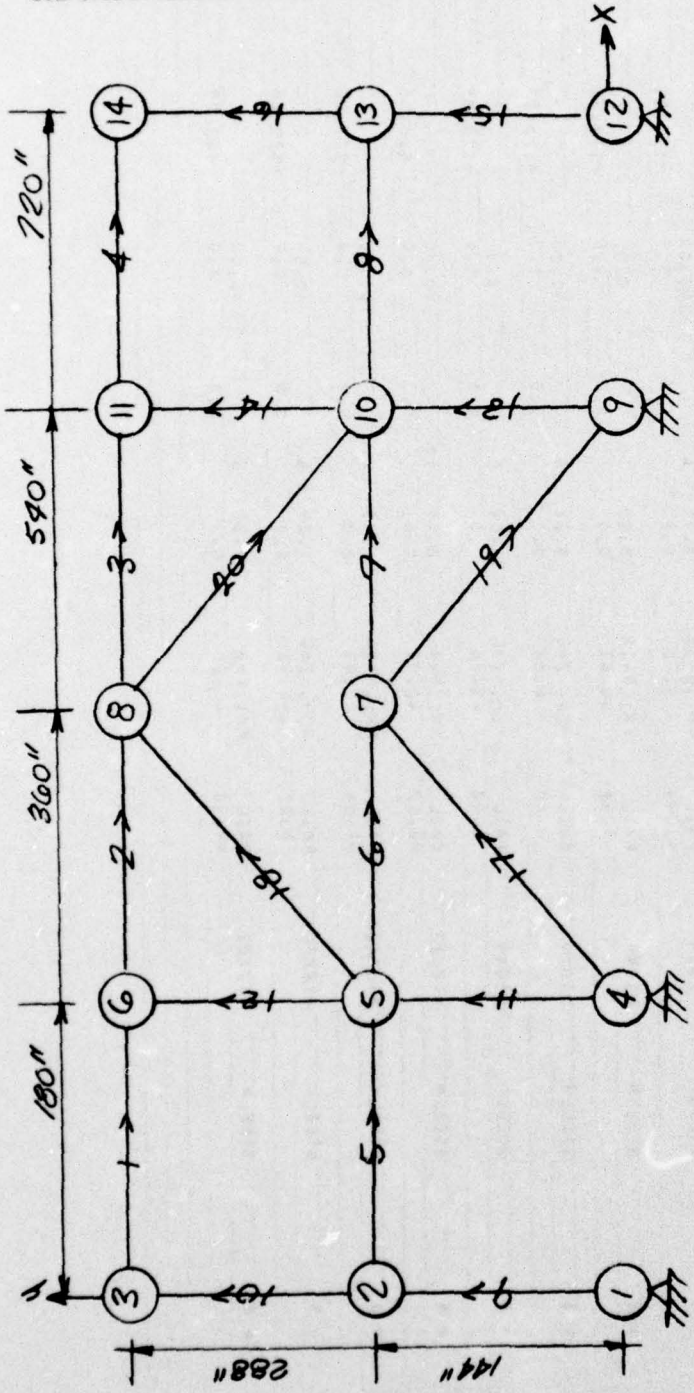
JOINT		DISPLACEMENT			ROTATION		
		X DISP	Y DISP	Z DISP	X ROT	Y ROT	Z ROT
2	GLOBAL	0.0138	-0.0241				-0.0001
3	GLOBAL	0.0314	-0.0296				-0.0060
5	GLOBAL	0.0128	-0.0194				-0.0001
6	GLOBAL	0.0295	-0.0255				0.0014
7	GLOBAL	0.0116	-0.0361				-0.0000
8	GLOBAL	0.0239	-0.0371				-0.0000
10	GLOBAL	0.0224	-0.0225				-0.0001
11	GLOBAL	0.0295	-0.0286				-0.0014
13	GLOBAL	0.0234	-0.0241				-0.0001
14	GLOBAL	0.0314	-0.0296				0.0060


```
SECTION FR NS 3 0.0 0.5 1.0
PARAMETERS
'FYLD' 50000. ALL
'CODE' 'SP69' ALL
CHECK CODE MEM 1 TO 8
```

***

PROJECT 2-D FRAME SAMPLE PROBLEM
ITEM NASTRAN
ST. LOUIS DISTRICT
COMPUTED BY HARTMAN. CHECKED BY

SHEET NO. ___ OF ___ SHEETS
DATE _____, 19___
FILE _____
REF. DRWG. NO. _____



COMPUTER MODEL SAMPLE PROGRAM
2-STORY, 2-D FRAME.

```
$LNH JPHNAS

100ID FRAME NASTRAN
110SOL 1,0
120TIME 3
130CEND
1400UTPUT
150SET  1 = 1,4,9,12
160DISPLACEMENT=ALL
170ELFORCE=ALL
180SPCFORCE  = 1
190SUBCASE  1
200     LOAD=3
210SUBCASE  2
220     LOAD=4
230SUBCASE  3
240     LOAD=5
250SUBCOM  6
260    SUBSEQ=1.0,0.0,1.0
270SUBCOM  8
280    SUBSEQ=0.5,0.0,1.0
290SUBCOM  10
300    SUBSEQ=0.0,1.0,1.0
310SUBCOM  12
320    SUBSEQ=0.0,0.5,1.0
330BEGIN BULK
340GRDSET                                                       345
350GRID          1              0.      0.      0.             12345
360GRID          2              0.    144.      0.
370GRID          3              0.    288.      0.
380GRID          4            180.      0.      0.             12345
390GRID          5            180.    144.      0.
400GRID          6            180.    288.      0.
410GRID          7            360.    144.      0.
420GRID          8            360.    288.      0.
430GRID          9            540.      0.      0.             12345
440GRID         10            540.    144.      0.
450GRID         11            540.    288.      0.
460GRID         12            720.      0.      0.             12345
470GRID         13            720.    144.      0.
480GRID         14            720.    288.      0.
490BAROR                                       -1.     1.      0.
  1
500CBAR          1       1       3       6
510CBAR          2       1       6       8
520CBAR          3       1       8      11
530CBAR          4       1      11      14
540CBAR          5       2       2       5
   C1
550+1       6       6
560CBAR          6       2       5       7
   C2
570+2       6
580CBAR          7       2       7      10
   C3
590+3             6
600CBAR          8       2      10      13
   C4
```

```
610+4       6       6
620CBAR             9       3       1       2
630CBAR            10       3       2       3
    C5
640+5               6
650CBAR            11       4       4       5
660CBAR            12       4       5       6
    C6
670+6               6
680CBAR            13       4       9      10
690CBAR            14       4      10      11
    C7
700+7               6
710CBAR            15       3      12      13
720CBAR            16       3      13      14
    C8
730+8               6
740CROD            17       1       4       7      18       1       5
  8
750CROD            19       1       7       9      20       1       8
 10
760PBAR             1       1   2.65    38.8
770PBAR             2       1   6.47    25.3
780PBAR             3       1   3.09    5.29
790PBAR             4       1   8.14    25.7
800PROD             1       1   8.14
810MAT1             1  3.E+07
830FORCE            3       3           1960.      1.      0.      0.
840FORCE            3       6           1400.      1.      0.      0.
850FORCE            3       8           1400.      1.      0.      0.
860FORCE            3      11           1400.      1.      0.      0.
870FORCE            3      14           1300.      1.      0.      0.
880FORCE            3       2           3920.      1.      0.      0.
890FORCE            3       5           2790.      1.      0.      0.
900FORCE            3       7           2790.      1.      0.      0.
910FORCE            3      10           2790.      1.      0.      0.
920FORCE            3      13           2600.      1.      0.      0.
930FORCE            4       3           1640.      1.      0.      0.
940FORCE            4       6           3280.      1.      0.      0.
950FORCE            4       8           3280.      1.      0.      0.
960FORCE            4      11           3280.      1.      0.      0.
970FORCE            4      14           1640.      1.      0.      0.
980FORCE            4       2           2120.      1.      0.      0.
990FORCE            4       5           4230.      1.      0.      0.
1000FORCE           4       7           4230.      1.      0.      0.
1010FORCE           4      10           4230.      1.      0.      0.
1020FORCE           4      13           2120.      1.      0.      0.
1030PLOAD1          5       1      FY       LE      0.    -50.    180.
-50.
```

```
1040PLOAD1          5       2       FY      LE      0.      -50.    180.
-50.
1050PLOAD1          5       3       FY      LE      0.      -50.    180.
-50.
1060PLOAD1          5       4       FY      LE      0.      -50.    180.
-50.
1070PLOAD1          5       5       FY      LE      0.    -133.3    180.   -1
33.3
1080PLOAD1          5       6       FY      LE      0.    -133.3    180.   -1
33.3
1090PLOAD1          5       7       FY      LE      0.    -333.3    180.   -1
33.3
1100PLOAD1          5       8       FY      LE      0.    -133.3    180.   -1
33.3
1110ENDDATA

$BYE

MRU = .713 CON= :22
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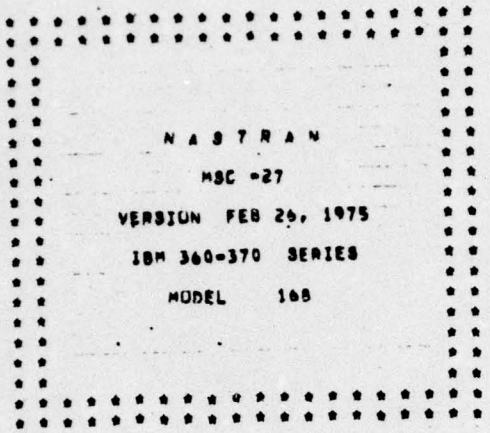

N A S T R A N E X E C U T I V E C O N T R O L D E C K E C H O

```
ID FRAME NASTRAN
SOL 1,0
TIME 3
CEND
```

C A S E C O N T R O L D E C K E C H O

```
CARD
COUNT
  1     OUTPUT
  2     SET  1 = 1,4,9,12
  3     DISPLACEMENT=ALL
  4     ELFORCE=ALL
  5     SPCFORCE  = 1
  6     SUBCASE  1
  7        LOAD=3
  8     SUBCASE  2
  9        LOAD=4
 10     SUBCASE  3
 11        LOAD=5
 12     SUBCUM  6
 13        SUBSEQ=1.0,0.0,1.0
 14     SUBCUM  8
 15        SUBSEQ=0.5,0.0,1.0
 16     SUBCUM  10
 17        SUBSEQ=0.0,1.0,1.0
 18     SUBCUM  12
 19        SUBSEQ=0.0,0.5,1.0
 20     BEGIN BULK
```

*** USER INFORMATION MESSAGE 207, BULK DATA NOT SORTED, ASORT WILL RE-ORDER DECK.

SORTED BULK DATA ECHO

CARD COUNT	1	2	3	4	5	6	7	8	9	10
1-	BARDR					-1.	1.	0.0	1	
2-	CBAR	1	1	3	6					
3-	CBAR	2	1	6	8					
4-	CBAR	3	1	8	11					
5-	CBAR	4	1	11	14					
6-	CBAR	5	2	2	5					C1
7-	&1	6	6							
8-	CBAR	6	2	5	7					C2
9-	&2	6								
10-	CBAR	7	2	7	10					C3
11-	&3		6							
12-	CBAR	8	2	10	13					C4
13-	&4	6	6							
14-	CBAR	9	3	1	2					
15-	CBAR	10	3	2	3					C5
16-	&5		6							
17-	CBAR	11	4	4	5					
18-	CBAR	12	4	5	6					C6
19-	&6		6							
20-	CBAR	13	4	9	10					
21-	CBAR	14	4	10	11					C7
22-	&7		6							
23-	CBAR	15	3	12	13					
24-	CBAR	16	3	13	14					C8
25-	&8		6							
26-	CROD	17	1	4	7	18	1	5	9	
27-	CROD	19	1	7	9	20	1	8	10	
28-	FORCE	3	2		3920.	1.	0.0	0.0		
29-	FORCE	3	3		1960.	1.	0.0	0.0		
30-	FORCE	3	5		2790.	1.	0.0	0.0		
31-	FORCE	3	6		1400.	1.	0.0	0.0		
32-	FORCE	3	7		2790.	1.	0.0	0.0		
33-	FORCE	3	8		1400.	1.	0.0	0.0		
34-	FORCE	3	10		2790.	1.	0.0	0.0		
35-	FORCE	3	11		1400.	1.	0.0	0.0		
36-	FORCE	3	13		2600.	1.	0.0	0.0		
37-	FORCE	3	14		1300.	1.	0.0	0.0		
38-	FORCE	4	2		2120.	1.	0.0	0.0		
39-	FORCE	4	3		1640.	1.	0.0	0.0		
40-	FORCE	4	5		4230.	1.	0.0	0.0		
41-	FORCE	4	6		3280.	1.	0.0	0.0		
42-	FORCE	4	7		4230.	1.	0.0	0.0		
43-	FORCE	4	8		3280.	1.	0.0	0.0		
44-	FORCE	4	10		4230.	1.	0.0	0.0		
45-	FORCE	4	11		3280.	1.	0.0	0.0		
46-	FORCE	4	13		2120.	1.	0.0	0.0		
47-	FORCE	4	14		1640.	1.	0.0	0.0		
48-	GRDSET							345		
49-	GRID	1		0.0	0.0	0.0		12345		
50-	GRID	2		0.0	144.	0.0				

SORTED BULK DATA ECHO

CARD COUNT	1	2	3	4	5	6	7	8	9	10
51*	GRID	3		0.0	288.	0.0				
52*	GRID	4		180.	0.0	0.0		12345		
53*	GRID	5		180.	144.	0.0				
54*	GRID	6		180.	288.	0.0				
55*	GRID	7		360.	144.	0.0				
56*	GRID	8		360.	288.	0.0				
57*	GRID	9		540.	0.0	0.0		12345		
58*	GRID	10		540.	144.	0.0				
59*	GRID	11		540.	288.	0.0				
60*	GRID	12		720.	0.0	0.0		12345		
61*	GRID	13		720.	144.	0.0				
62*	GRID	14		720.	288.	0.0				
63*	MAT1	1	3.E+07							
64*	PBAR	1	1	2.65	38.8					
65*	PBAR	2	1	6.47	25.3					
66*	PBAR	3	1	3.09	5.29					
67*	PBAR	4	1	8.14	25.7					
68*	PLOAD1	5	1	FY	LE	0.0	-50.	180.	-50.	
69*	PLOAD1	5	2	FY	LE	0.0	-50.	180.	-50.	
70*	PLOAD1	5	3	FY	LE	0.0	-50.	180.	-50.	
71*	PLOAD1	5	4	FY	LE	0.0	-50.	180.	-50.	
72*	PLOAD1	5	5	FY	LE	0.0	-133.3	180.	-133.3	
73*	PLOAD1	5	6	FY	LE	0.0	-133.3	180.	-133.3	
74*	PLOAD1	5	7	FY	LE	0.0	-133.3	180.	-133.3	
75*	PLOAD1	5	8	FY	LE	0.0	-133.3	180.	-133.3	
76*	PROD	1	1	8.14						
	ENDDATA									

NO ERRORS FOUND - EXECUTE NASTRAN PROGRAM

***USER INFORMATION MESSAGE--PARAMETERS FOR SYMMETRIC DECOMPOSITION OF DATA BLOCK KLL % TYPE=RDP < FOLLOW

MATRIX SIZE =	34 ROWS	TIME ESTIMATE =	1 SEC
ADDITIONAL MEMORY =	-22289 WORDS	PASSIVE COLUMNS =	0 GROUPS
ACTIVE COLUMNS =	10 MAX	PASSIVE COLUMNS =	0 MAX
ACTIVE COLUMNS =	6 RMS	PASSIVE COLUMNS =	0 RMS
SPILL =	0 GROUPS	PREFACE =	1 LOOPS
SPILL ROWS =	0 AVG	NZ NBR IN FACTOR=	207 TERMS

***USER INFORMATION MESSAGE--STATISTICS FOR SYMMETRIC DECOMPOSITION OF DATA BLOCK KLL FOLLOW

NUMBER OF NEGATIVE TERMS ON FACTOR DIAGONAL = 0

MAXIMUM RATIO OF MATRIX DIAGONAL TO FACTOR DIAGONAL = 3.0E 00 AT RUN NUMBER 32

SUBCASE 1

D I S P L A C E M E N T V E C T O R

POINT ID.	TYPE	T1	T2	T3	R1	R2	R3
1	G	0.0	0.0	0.0	0.0	0.0	-2.395461E-04
2	G	3.059795E-02	1.031030E-06	0.0	0.0	0.0	-1.583652E-04
3	G	4.560918E-02	2.062062E-06	0.0	0.0	0.0	1.285097E-05
4	G	0.0	0.0	0.0	0.0	0.0	-2.094123E-04
5	G	2.696502E-02	1.761390E-03	0.0	0.0	0.0	-1.429466E-04
6	G	4.116863E-02	1.760991E-03	0.0	0.0	0.0	3.013538E-06
7	G	1.729059E-02	2.164194E-10	0.0	0.0	0.0	-9.784228E-06
8	G	3.354708E-02	7.606822E-04	0.0	0.0	0.0	-1.466145E-05
9	G	0.0	0.0	0.0	0.0	0.0	-1.992926E-04
10	G	2.574427E-02	-1.760932E-03	0.0	0.0	0.0	-1.377539E-04
11	G	3.967312E-02	-1.758848E-03	0.0	0.0	0.0	-3.031710E-06
12	G	0.0	0.0	0.0	0.0	0.0	-2.192731E-04
13	G	2.815336E-02	-2.239802E-06	0.0	0.0	0.0	-1.479026E-04
14	G	4.261898E-02	-4.479604E-06	0.0	0.0	0.0	1.643559E-05

***USER INFORMATION MESSAGE--FBS TIME ESTIMATE TO FORM DATA BLOCK ULV % TYPE=RDP < IS 1 SEC, NUMBER OF PASSES = 1

*** USER INFORMATION MESSAGE 3035

FOR LOAD 1 EPSILON SUB E = -2.7152223E-15

*** USER INFORMATION MESSAGE 3035

FOR LOAD 2 EPSILON SUB E = -2.3636507E-15

*** USER INFORMATION MESSAGE 3035

FOR LOAD 3 EPSILON SUB E = -3.1959188E-16

SUBCASE 2

D I S P L A C E M E N T V E C T O R

POINT ID.	TYPE	T1	T2	T3	R1	R2	R3
1	G	0.0	0.0	0.0	0.0	0.0	-2.784249E-04
2	G	3.718306E-02	2.874010E-06	0.0	0.0	0.0	-2.177969E-04
3	G	6.272548E-02	5.748020E-06	0.0	0.0	0.0	2.573346E-05
4	G	0.0	0.0	0.0	0.0	0.0	-2.644139E-04
5	G	3.521879E-02	3.094987E-03	0.0	0.0	0.0	-2.048965E-04
6	G	5.901020E-02	3.092806E-03	0.0	0.0	0.0	-1.596672E-04
7	G	2.325157E-02	-3.441220E-23	0.0	0.0	0.0	-1.719437E-05
8	G	3.785845E-02	-1.632338E-17	0.0	0.0	0.0	-2.576539E-05
9	G	0.0	0.0	0.0	0.0	0.0	-2.644139E-04
10	G	3.521879E-02	-3.094987E-03	0.0	0.0	0.0	-2.048965E-04
11	G	5.901020E-02	-3.092806E-03	0.0	0.0	0.0	-1.596672E-04
12	G	0.0	0.0	0.0	0.0	0.0	-2.784249E-04
13	G	3.718306E-02	-2.874010E-06	0.0	0.0	0.0	-2.177969E-04
14	G	6.272548E-02	-5.748020E-06	0.0	0.0	0.0	2.573346E-05

SUBCASE 3

D I S P L A C E M E N T V E C T O R

POINT ID.	TYPE	T1	T2	T3	R1	R2	R3
1	G	0.0	0.0	0.0	0.0	0.0	5.015203E-05
2	G	-4.816581E-03	-2.411911E-02	0.0	0.0	0.0	4.136978E-08
3	G	-1.191450E-05	-2.960211E-02	0.0	0.0	0.0	-5.922180E-03
4	G	0.0	0.0	0.0	0.0	0.0	5.016987E-05
5	G	-4.818004E-03	-2.091658E-02	0.0	0.0	0.0	3.533967E-08
6	G	-1.017783E-05	-2.699430E-02	0.0	0.0	0.0	1.449079E-03
7	G	-1.010371E-15	-3.625048E-02	0.0	0.0	0.0	9.762034E-15
8	G	-1.406335E-12	-3.701011E-02	0.0	0.0	0.0	-8.123062E-10
9	G	0.0	0.0	0.0	0.0	0.0	-5.016987E-05
10	G	4.818004E-03	-2.091658E-02	0.0	0.0	0.0	-3.533966E-08
11	G	1.017782E-05	-2.699430E-02	0.0	0.0	0.0	-1.449079E-03
12	G	0.0	0.0	0.0	0.0	0.0	-5.015203E-05
13	G	4.816581E-03	-2.411911E-02	0.0	0.0	0.0	-4.136977E-08
14	G	1.191449E-05	-2.960210E-02	0.0	0.0	0.0	5.922176E-03

SUBCOM 6

D I S P L A C E M E N T V E C T O R

POINT ID.	TYPE	T1	T2	T3	R1	R2	R3
1	G	0.0	0.0	0.0	0.0	0.0	-1.893940E-04
2	G	2.578137E-02	-2.411807E-02	0.0	0.0	0.0	-1.583238E-04
3	G	4.559726E-02	-2.960004E-02	0.0	0.0	0.0	-5.909324E-03
4	G	0.0	0.0	0.0	0.0	0.0	-1.592424E-04
5	G	2.214701E-02	-1.915519E-02	0.0	0.0	0.0	-1.429113E-04
6	G	4.115845E-02	-2.523330E-02	0.0	0.0	0.0	1.453291E-03
7	G	1.729058E-02	-3.625948E-02	0.0	0.0	0.0	-9.784227E-06
8	G	3.354707E-02	-3.624943E-02	0.0	0.0	0.0	-1.466226E-05
9	G	0.0	0.0	0.0	0.0	0.0	-2.494622E-04
10	G	3.056227E-02	-2.267751E-02	0.0	0.0	0.0	-1.377892E-04
11	G	3.968329E-02	-2.675314E-02	0.0	0.0	0.0	-1.453310E-03
12	G	0.0	0.0	0.0	0.0	0.0	-2.694249E-04
13	G	3.296995E-02	-2.412134E-02	0.0	0.0	0.0	-1.480239E-04
14	G	4.263089E-02	-2.960657E-02	0.0	0.0	0.0	5.938604E-03

SUBCOM 8

D I S P L A C E M E N T V E C T O R

POINT ID.	TYPE	T1	T2	T3	R1	R2	R3
1	G	0.0	0.0	0.0	0.0	0.0	-6.962100E-05
2	G	1.048240E-02	-2.411859E-02	0.0	0.0	0.0	-7.914122E-05
3	G	2.279267E-02	-2.960107E-02	0.0	0.0	0.0	-5.915750E-03
4	G	0.0	0.0	0.0	0.0	0.0	-5.453027E-05
5	G	8.864507E-03	-2.003589E-02	0.0	0.0	0.0	-7.143794E-05
6	G	2.057413E-02	-2.611380E-02	0.0	0.0	0.0	1.451464E-03
7	G	8.645292E-03	-3.625948E-02	0.0	0.0	0.0	-4.892115E-06
8	G	1.677353E-02	-3.662977E-02	0.0	0.0	0.0	-7.331537E-06
9	G	0.0	0.0	0.0	0.0	0.0	-1.498161E-04
10	G	1.769013E-02	-2.179705E-02	0.0	0.0	0.0	-6.891225E-05
11	G	1.984673E-02	-2.787372E-02	0.0	0.0	0.0	-1.451495E-03
12	G	0.0	0.0	0.0	0.0	0.0	-1.597885E-04
13	G	1.889326E-02	-2.412022E-02	0.0	0.0	0.0	-7.403264E-05
14	G	2.132140E-02	-2.960433E-02	0.0	0.0	0.0	5.930386E-03

SUBCOM 10

D I S P L A C E M E N T V E C T O R

POINT ID.	TYPE	T1	T2	T3	R1	R2	R3
1	G	0.0	0.0	0.0	0.0	0.0	-2.282727E-04
2	G	3.236648E-02	-2.411623E-02	0.0	0.0	0.0	-2.177555E-04
3	G	6.271350E-02	-2.959636E-02	0.0	0.0	0.0	-5.896442E-03
4	G	0.0	0.0	0.0	0.0	0.0	-2.142438E-04
5	G	3.040078E-02	-1.782159E-02	0.0	0.0	0.0	-2.048012E-04
6	G	5.900002E-02	-2.390149E-02	0.0	0.0	0.0	1.449661E-03
7	G	2.325157E-02	-3.625048E-02	0.0	0.0	0.0	-1.719435E-05
8	G	4.785845E-02	-3.701011E-02	0.0	0.0	0.0	-2.576617E-05
9	G	0.0	0.0	0.0	0.0	0.0	-3.145833E-04
10	G	4.003678E-02	-2.801157E-02	0.0	0.0	0.0	-2.049316E-04
11	G	5.902037E-02	-3.008710E-02	0.0	0.0	0.0	-1.449695E-03
12	G	0.0	0.0	0.0	0.0	0.0	-3.285767E-04
13	G	4.199963E-02	-2.412197E-02	0.0	0.0	0.0	-2.178382E-04
14	G	6.273729E-02	-2.960784E-02	0.0	0.0	0.0	5.947903E-03

SUBCOM 12

D I S P L A C E M E N T V E C T O R

POINT ID.	TYPE	T1	T2	T3	R1	R2	R3
1	G	0.0	0.0	0.0	0.0	0.0	-8.906043E-05
2	G	1.377495E-02	-2.411767E-02	0.0	0.0	0.0	-1.088571E-04
3	G	3.135082E-02	-2.959923E-02	0.0	0.0	0.0	-5.909309E-03
4	G	0.0	0.0	0.0	0.0	0.0	-8.203706E-05
5	G	1.279139E-02	-1.936908E-02	0.0	0.0	0.0	-1.024129E-04
6	G	2.949402E-02	-2.564769E-02	0.0	0.0	0.0	1.449669E-03
7	G	1.162578E-02	-3.625048E-02	0.0	0.0	0.0	-8.597182E-06
8	G	2.392922E-02	-3.701011E-02	0.0	0.0	0.0	-1.288350E-05
9	G	0.0	0.0	0.0	0.0	0.0	-1.823768E-04
10	G	2.242739E-02	-2.246407E-02	0.0	0.0	0.0	-1.024836E-04
11	G	2.951527E-02	-2.854070E-02	0.0	0.0	0.0	-1.449687E-03
12	G	0.0	0.0	0.0	0.0	0.0	-1.893645E-04
13	G	2.340810E-02	-2.412054E-02	0.0	0.0	0.0	-1.089398E-04
14	G	3.137465E-02	-2.960497E-02	0.0	0.0	0.0	5.935036E-03

SUBCASE 1

F O R C E S O F S I N G L E - P O I N T C O N S T R A I N T

POINT ID.	TYPE	T1	T2	T3	R1	R2	R3
1	G	-1.242612E 00	-6.637262E-01	0.0	0.0	0.0	0.0
4	G	-1.117402E 04	-1.192228E 04	0.0	0.0	0.0	0.0
9	G	-1.117365E 04	1.192150E 04	0.0	0.0	0.0	0.0
12	G	-1.091223E 00	1.441872E 00	0.0	0.0	0.0	0.0

SUBCASE 2

F O R C E S O F S I N G L E - P O I N T C O N S T R A I N T

POINT ID.	TYPE	T1	T2	T3	R1	R2	R3
1	G	-9.280188E-01	-1.850143E 00	0.0	0.0	0.0	0.0
4	G	-1.502407E 04	-1.726430E 04	0.0	0.0	0.0	0.0
9	G	-1.502407E 04	1.726430E 04	0.0	0.0	0.0	0.0
12	G	-9.280188E-01	1.850143E 00	0.0	0.0	0.0	0.0

SUBCASE 3

F O R C E S O F S I N G L E - P O I N T C O N S T R A I N T

POINT ID.	TYPE	T1	T2	T3	R1	R2	R3
1	G	7.670296E-01	1.552667E 04	0.0	0.0	0.0	0.0
4	G	1.874154E 04	5.046129E 04	0.0	0.0	0.0	0.0
9	G	-1.874154E 04	5.046129E 04	0.0	0.0	0.0	0.0
12	G	-7.670296E-01	1.552667E 04	0.0	0.0	0.0	0.0

SUBCOM 6

FORCES OF SINGLE-POINT CONSTRAINT

POINT ID.	TYPE	T1	T2	T3	R1	R2	R3
1	G	-4.755816E-01	1.552600E 04	0.0	0.0	0.0	0.0
4	G	7.567523E 03	3.853901E 04	0.0	0.0	0.0	0.0
9	G	-2.991518E 04	6.236279E 04	0.0	0.0	0.0	0.0
12	G	-1.858251E 00	1.552811E 04	0.0	0.0	0.0	0.0

SUBCOM 8

FORCES OF SINGLE-POINT CONSTRAINT

POINT ID.	TYPE	T1	T2	T3	R1	R2	R3
1	G	1.457237E-01	1.552634E 04	0.0	0.0	0.0	0.0
4	G	1.315453E 04	4.450015E 04	0.0	0.0	0.0	0.0
9	G	-2.432836E 04	5.642204E 04	0.0	0.0	0.0	0.0
12	G	-1.312640E 00	1.552738E 04	0.0	0.0	0.0	0.0

SUBCOM 10

FORCES OF SINGLE-POINT CONSTRAINT

POINT ID.	TYPE	T1	T2	T3	R1	R2	R3
1	G	-1.609802E-01	1.552482E 04	0.0	0.0	0.0	0.0
4	G	3.717469E 03	3.319699E 04	0.0	0.0	0.0	0.0
9	G	-3.376560E 04	6.772556E 04	0.0	0.0	0.0	0.0
12	G	-1.695047E 00	1.552851E 04	0.0	0.0	0.0	0.0

SUBCOM 12

F O R C E S O F S I N G L E - P O I N T C O N S T R A I N T

POINT ID.	TYPE	T1	T2	T3	R1	R2	R3
1	G	3.030202E-01	1.552574E 04	0.0	0.0	0.0	0.0
4	G	1.122950E 04	4.182914E 04	0.0	0.0	0.0	0.0
9	G	-2.625357E 04	5.909343E 04	0.0	0.0	0.0	0.0
12	G	-1.231038E 00	1.552759E 04	0.0	0.0	0.0	0.0

SUBCASE 1

F O R C E S I N B A R E L E M E N T S (C B A R)

ELEMENT ID.	BEND-MOMENT END-A PLANE 1	BEND-MOMENT END-A PLANE 2	BEND-MOMENT END-B PLANE 1	BEND-MOMENT END-B PLANE 2	SHEAR PLANE 1	SHEAR PLANE 2	AXIAL FORCE	TORQUE
1	2.441406E-04	0.0	-1.194706E 02	0.0	6.637268E-01	0.0	-1.961242E 03	0.0
2	-1.194707E 02	0.0	-1.166857E 02	0.0	-1.430138E-02	0.0	-3.300184E 03	0.0
3	-1.168859E 02	0.0	2.595364E 02	0.0	-2.091230E 00	0.0	2.705664E 03	0.0
4	2.595369E 02	0.0	0.0	0.0	1.441873E 00	0.0	1.301094E 03	0.0
5	-6.443940E-08	0.0	-2.321428E-04	0.0	1.289324E-06	0.0	-3.917512E 03	0.0
6	-1.100869E-04	0.0	1.625139E-02	0.0	-9.089708E-05	0.0	-1.043225E 04	0.0
7	1.590069E-02	0.0	1.249313E-04	0.0	8.797646E-05	0.0	9.115887E 03	0.0
8	1.100582E-04	0.0	-1.218004E-04	0.0	1.288104E-06	0.0	2.597616E 03	0.0
9	0.0	0.0	1.789352E 02	0.0	-1.242605E 00	0.0	6.637250E-01	0.0
10	1.789358E 02	0.0	3.662109E-04	0.0	1.242607E 00	0.0	6.637262E-01	0.0
11	3.906250E-03	0.0	7.117444E 02	0.0	-4.942642E 00	0.0	2.987024E 03	0.0
12	7.117383E 02	0.0	4.394531E-03	0.0	4.942596E 00	0.0	-6.777344E-01	0.0
13	0.0	0.0	6.589797E 02	0.0	-4.576248E 00	0.0	-2.986246E 03	0.0
14	6.589766E 02	0.0	3.417969E-03	0.0	4.576202E 00	0.0	3.533447E 00	0.0
15	-2.441406E-04	0.0	1.571351E 02	0.0	-1.091218E 00	0.0	-1.441872E 00	0.0
16	1.571357E 02	0.0	7.629395E-05	0.0	1.091220E 00	0.0	-1.441872E 00	0.0

SUBCASE 1

F O R C E S I N R O D E L E M E N T S (C R O D)

ELEMENT ID.	AXIAL FORCE	TORQUE	ELEMENT ID.	AXIAL FORCE	TORQUE
17	1.430338E 04	0.0	18	4.782052E 03	0.0
19	-1.430338E 04	0.0	20	-4.785977E 03	0.0

SUBCASE 2

FORCES IN BAR ELEMENTS (CBAR)

ELEMENT ID.	BEND-MOMENT END-A PLANE 1	PLANE 2	BEND-MOMENT END-B PLANE 1	PLANE 2	- SHEAR - PLANE 1	PLANE 2	AXIAL FORCE	TORQUE
1	2.441406E-04	0.0	-3.330254E 02	0.0	1.850143E 00	0.0	-1.640914E 03	0.0
2	-3.330261E 02	0.0	0.0	0.0	-1.850145E 00	0.0	-4.925355E 03	0.0
3	-7.324219E-04	0.0	3.330254E 02	0.0	-1.850145E 00	0.0	4.925355E 03	0.0
4	3.330259E 02	0.0	2.441406E-04	0.0	1.850143E 00	0.0	1.640914E 03	0.0
5	-1.796256E-07	0.0	-4.078310E-04	0.0	2.264731E-06	0.0	-2.118141E 03	0.0
6	-1.934367E-04	0.0	3.215473E-04	0.0	-2.861023E-06	0.0	-1.290464E 04	0.0
7	-3.356934E-04	0.0	1.792908E-04	0.0	-2.861023E-06	0.0	1.290464E 04	0.0
8	1.934367E-04	0.0	-2.142148E-04	0.0	2.264731E-06	0.0	2.118141E 03	0.0
9	-9.765625E-04	0.0	1.336333E 02	0.0	-9.280157E-01	0.0	1.850142E 00	0.0
10	1.336348E 02	0.0	2.288818E-04	0.0	9.280176E-01	0.0	1.850143E 00	0.0
11	0.0	0.0	6.373455E 02	0.0	-4.426010E 00	0.0	5.248578E 03	0.0
12	6.373359E 02	0.0	8.056641E-03	0.0	4.425888E 00	0.0	-3.099219E 00	0.0
13	0.0	0.0	6.373455E 02	0.0	-4.426010E 00	0.0	-5.248578E 03	0.0
14	6.373359E 02	0.0	8.056641E-03	0.0	4.425888E 00	0.0	3.099219E 00	0.0
15	-9.765625E-04	0.0	1.336333E 02	0.0	-9.280157E-01	0.0	-1.850142E 00	0.0
16	1.336348E 02	0.0	2.288818E-04	0.0	9.280176E-01	0.0	-1.850143E 00	0.0

SUBCASE 2

FORCES IN ROD ELEMENTS (CROD)

ELEMENT ID.	AXIAL FORCE	TORQUE	ELEMENT ID.	AXIAL FORCE	TORQUE
17	1.923451E 04	0.0	18	8.407750E 03	0.0
19	-1.923451E 04	0.0	20	-8.407750E 03	0.0

SUBCASE 3

FORCES IN BAR ELEMENTS (CBAR)

ELEMENT ID.	BEND-MOMENT END-A PLANE 1	PLANE 2	BEND-MOMENT END-B PLANE 1	PLANE 2	- SHEAR - PLANE 1	PLANE 2	AXIAL FORCE	TORQUE
1	1.340997E 05	0.0	-3.965750E 04	0.0	9.703179E 02	0.0	7.670288E-01	0.0
2	-3.965721E 04	0.0	2.090809E 04	0.0	-3.364739E 02	0.0	4.495204E 00	0.0
3	2.090812E 04	0.0	-3.965731E 04	0.0	3.364746E 02	0.0	4.495203E 00	0.0
4	-3.965706E 04	0.0	1.340999E 05	0.0	-9.703164E 02	0.0	7.670298E-01	0.0
5	1.507444E-03	0.0	1.085237E-03	0.0	2.345594E-06	0.0	-1.535150E 00	0.0
6	1.307287E-03	0.0	1.078206E 03	0.0	-5.990363E 00	0.0	5.195410E 03	0.0
7	1.078264E 03	0.0	-9.765625E-04	0.0	5.990363E 00	0.0	5.195410E 03	0.0
8	1.307287E-03	0.0	1.720493E-03	0.0	-2.345594E-06	0.0	-1.535150E 00	0.0
9	1.525879E-05	0.0	-1.104521E 02	0.0	7.670288E-01	0.0	-1.552667E 04	0.0
10	-1.104522E 02	0.0	9.155273E-05	0.0	-7.670301E-01	0.0	-3.529680E 03	0.0
11	-2.441406E-04	0.0	-5.368574E 02	0.0	3.728170E 00	0.0	-3.547103E 04	0.0
12	-5.368569E 02	0.0	4.882813E-04	0.0	-3.728170E 00	0.0	-1.030679E 04	0.0
13	2.441406E-04	0.0	5.368574E 02	0.0	-3.728170E 00	0.0	-3.547103E 04	0.0
14	5.368569E 02	0.0	-4.882813E-04	0.0	3.728170E 00	0.0	-1.030679E 04	0.0
15	-1.525879E-05	0.0	1.104521E 02	0.0	-7.670288E-01	0.0	-1.552666E 04	0.0
16	1.104522E 02	0.0	-9.155273E-05	0.0	7.670301E-01	0.0	-3.529680E 03	0.0

SUBCASE 3

FORCES IN ROD ELEMENTS (CROD)

ELEMENT ID.	AXIAL FORCE	TORQUE	ELEMENT ID.	AXIAL FORCE	TORQUE
17	-2.399609E 04	0.0	18	-6.644883E 03	0.0
19	-2.399609E 04	0.0	20	-6.644883E 03	0.0

SUBCOM 6

F O R C E S I N B A R E L E M E N T S (C B A R)

ELEMENT ID.	BEND-MOMENT END-A PLANE 1	PLANE 2	BEND-MOMENT END-B PLANE 1	PLANE 2	- SHEAR - PLANE 1	PLANE 2	AXIAL FORCE	TORQUE
1	1.349996E 05	0.0	-3.977688E 04	0.0	9.709807E 02	0.0	-1.960473E 03	0.0
2	-3.977668E 04	0.0	2.079117E 04	0.0	-3.364880E 02	0.0	-3.361691E 03	0.0
3	2.079123E 04	0.0	-3.939776E 04	0.0	3.343833E 02	0.0	2.710164E 03	0.0
4	-3.939744E 04	0.0	1.349997E 05	0.0	-9.688730E 02	0.0	1.301855E 03	0.0
5	1.507380E-03	0.0	8.530943E-04	0.0	3.634919E-06	0.0	-3.919047E 03	0.0
6	1.197199E-03	0.0	1.078282E 03	0.0	-5.990454E 00	0.0	-5.236848E 03	0.0
7	1.078280E 03	0.0	-7.324219E-04	0.0	5.990451E 00	0.0	1.431130E 04	0.0
8	1.417344E-03	0.0	1.007692E-03	0.0	-1.057488E-06	0.0	2.596281E 03	0.0
9	0.0	0.0	6.848326E 01	0.0	-4.755783E-01	0.0	-1.552600E 04	0.0
10	6.848340E 01	0.0	1.220703E-04	0.0	4.755783E-01	0.0	-3.529020E 03	0.0
11	3.173828E-03	0.0	1.748857E 02	0.0	-1.214462E 00	0.0	-3.248400E 04	0.0
12	1.748789E 02	0.0	2.929688E-03	0.0	1.214417E 00	0.0	-1.030746E 04	0.0
13	-3.906250E-03	0.0	1.195840E 03	0.0	-8.304474E 00	0.0	-3.845727E 04	0.0
14	1.195832E 03	0.0	9.765625E-04	0.0	8.304382E 00	0.0	-1.030326E 04	0.0
15	-7.324219E-04	0.0	2.675881E 02	0.0	-1.858257E 00	0.0	-1.552811E 04	0.0
16	2.675879E 02	0.0	2.441406E-04	0.0	1.858249E 00	0.0	-3.531117E 03	0.0

SUBCOM 6

F O R C E S I N R O D E L E M E N T S (C R O D)

ELEMENT ID.	AXIAL FORCE	TORQUE	ELEMENT ID.	AXIAL FORCE	TORQUE
17	-9.692707E 03	0.0	18	-1.882236E 03	0.0
19	-3.829946E 04	0.0	20	-1.145085E 04	0.0

SUBCOM 8

F O R C E S I N B A R E L E M E N T S (C B A R)

ELEMENT ID.	BEND-MOMENT END-A PLANE 1	PLANE 2	BEND-MOMENT END-B PLANE 1	PLANE 2	- SHEAR - PLANE 1	PLANE 2	AXIAL FORCE	TORQUE
1	1.349906E 05	0.0	-3.971719E 04	0.0	9.706489E 02	0.0	-9.798555E 02	0.0
2	-3.971694E 04	0.0	2.084963E 04	0.0	-3.364810E 02	0.0	-1.678594E 03	0.0
3	2.084968E 04	0.0	-3.952754E 04	0.0	3.354290E 02	0.0	1.357328E 03	0.0
4	-3.952716E 04	0.0	1.349998E 05	0.0	-9.695942E 02	0.0	6.513125E 02	0.0
5	1.507412E-03	0.0	9.691657E-04	0.0	2.990257E-06	0.0	-1.960289E 03	0.0
6	1.252243E-03	0.0	1.078274E 03	0.0	-5.990408E 00	0.0	-2.071875E 01	0.0
7	1.078272E 03	0.0	-9.765625E-04	0.0	5.990407E 00	0.0	9.753348E 03	0.0
8	1.362315E-03	0.0	1.668593E-03	0.0	-1.701541E-06	0.0	1.297375E 03	0.0
9	0.0	0.0	-2.098375E 01	0.0	1.457205E-01	0.0	-1.552633E 04	0.0
10	-2.098413E 01	0.0	3.051758E-04	0.0	-1.457253E-01	0.0	-3.529352E 03	0.0
11	-7.324219E-04	0.0	-1.809865E 02	0.0	1.258845E 00	0.0	-3.397751E 04	0.0
12	-1.809890E 02	0.0	1.266479E-03	0.0	-1.258877E 00	0.0	-1.030713E 04	0.0
13	1.220703E-03	0.0	8.663457E 02	0.0	-6.010281E 00	0.0	-3.696415E 04	0.0
14	8.663447E 02	0.0	0.0	0.0	6.010283E 00	0.0	-1.030502E 04	0.0
15	2.441406E-04	0.0	1.890204E 02	0.0	-1.312640E 00	0.0	-1.552738E 04	0.0
16	1.890200E 02	0.0	-3.051758E-05	0.0	1.312639E 00	0.0	-3.530398E 03	0.0

SUBCOM 8

F O R C E S I N R O D E L E M E N T S (C R O D)

ELEMENT ID.	AXIAL FORCE	TORQUE	ELEMENT ID.	AXIAL FORCE	TORQUE
17	-1.684439E 04	0.0	18	-4.273563E 03	0.0
19	-3.114777E 04	0.0	20	-9.057863E 03	0.0

SUBCOM 10

F O R C E S I N B A R E L E M E N T S (C B A R)

ELEMENT ID.	BEND-MOMENT END-A PLANE 1	PLANE 2	BEND-MOMENT END-B PLANE 1	PLANE 2	- SHEAR - PLANE 1	PLANE 2	AXIAL FORCE	TORQUE
1	1.349996E 05	0.0	-3.999038E 04	0.0	9.721670E 02	0.0	-1.640125E 03	0.0
2	-3.999023E 04	0.0	2.090809E 04	0.0	-3.383240E 02	0.0	-4.920855E 03	0.0
3	2.090811E 04	0.0	-3.932425E 04	0.0	3.346243E 02	0.0	4.929848E 03	0.0
4	-3.932399E 04	0.0	1.349997E 05	0.0	-9.684651E 02	0.0	1.641637E 03	0.0
5	1.507264E-03	0.0	6.774053E-04	0.0	4.610322E-06	0.0	-2.119680E 03	0.0
6	1.113449E-03	0.0	1.078267E 03	0.0	-5.990368E 00	0.0	-7.709234E 03	0.0
7	1.078264E 03	0.0	-9.765625E-04	0.0	5.990359E 00	0.0	1.810005E 04	0.0
8	1.500723E-03	0.0	1.515279E-03	0.0	-8.086499E-08	0.0	2.116609E 03	0.0
9	-1.708984E-03	0.0	2.318219E 01	0.0	-1.609993E-01	0.0	-1.552482E 04	0.0
10	2.318408E 01	0.0	5.950928E-04	0.0	1.609964E-01	0.0	-3.527828E 03	0.0
11	-7.812500E-03	0.0	1.004883E 02	0.0	-6.978760E-01	0.0	-3.022244E 04	0.0
12	1.004727E 02	0.0	4.882813E-04	0.0	6.977234E-01	0.0	-1.031049E 04	0.0
13	-7.812500E-03	0.0	1.174207E 03	0.0	-8.154266E 00	0.0	-4.071961E 04	0.0
14	1.174158E 03	0.0	1.708984E-03	0.0	8.154068E 00	0.0	-1.030309E 04	0.0
15	-1.953125E-03	0.0	2.440867E 02	0.0	-1.695060E 00	0.0	-1.552851E 04	0.0
16	2.440894E 02	0.0	1.983643E-04	0.0	1.695064E 00	0.0	-3.531527E 03	0.0

SUBCOM 10

F O R C E S I N R O D E L E M E N T S (C R O D)

ELEMENT ID.	AXIAL FORCE	TORQUE	ELEMENT ID.	AXIAL FORCE	TORQUE
17	-4.761574E 03	0.0	18	1.742834E 03	0.0
19	-4.323058E 04	0.0	20	-1.507261E 04	0.0

SUBCOM 12

F O R C E S I N B A R E L E M E N T S (C B A R)

ELEMENT ID.	BEND-MOMENT END-A PLANE 1	PLANE 2	BEND-MOMENT END-B PLANE 1	PLANE 2	- SHEAR - PLANE 1	PLANE 2	AXIAL FORCE	TORQUE
1	1.599996E 05	0.0	-3.982388E 04	0.0	9.712419E 02	0.0	-8.196914E 02	0.0
2	-3.982371E 04	0.0	2.090809E 04	0.0	-3.373989E 02	0.0	-2.458180E 03	0.0
3	2.090812E 04	0.0	-3.949076E 04	0.0	3.355493E 02	0.0	2.467172E 03	0.0
4	-3.949053E 04	0.0	1.349996E 05	0.0	-9.693901E 02	0.0	8.212266E 02	0.0
5	1.507354E-03	0.0	8.813229E-04	0.0	3.477952E-06	0.0	-1.060605E 03	0.0
6	1.210568E-03	0.0	1.078267E 03	0.0	-5.990365E 00	0.0	-1.256914E 03	0.0
7	1.078244E 03	0.0	-7.324219E-04	0.0	5.990361E 00	0.0	1.164773E 04	0.0
8	1.404005E-03	0.0	1.622387E-03	0.0	-1.213237E-06	0.0	1.057539E 03	0.0
9	-2.441406E-04	0.0	-4.363409E 01	0.0	3.030128E-01	0.0	-1.552574E 04	0.0
10	-4.363477E 01	0.0	3.204346E-04	0.0	-3.030214E-01	0.0	-3.528754E 03	0.0
11	-1.953125E-03	0.0	-2.181860E 02	0.0	1.515167E 00	0.0	-3.284673E 04	0.0
12	-2.181904E 02	0.0	2.441406E-03	0.0	-1.515228E 00	0.0	-1.030864E 04	0.0
13	-2.441406E-04	0.0	8.555271E 02	0.0	-5.941162E 00	0.0	-3.809532E 04	0.0
14	8.555198E 02	0.0	-9.765625E-04	0.0	5.941116E 00	0.0	-1.030494E 04	0.0
15	0.0	0.0	1.772700E 02	0.0	-1.231042E 00	0.0	-1.552759E 04	0.0
16	1.772695E 02	0.0	4.577637E-05	0.0	1.231038E 00	0.0	-3.530602E 03	0.0

SUBCOM 12

F O R C E S I N R O D E L E M E N T S (C R O D)

ELEMENT ID.	AXIAL FORCE	TORQUE	ELEMENT ID.	AXIAL FORCE	TORQUE
17	-1.437883E 04	0.0	18	-2.461014E 03	0.0
19	-3.361333E 04	0.0	20	-1.086877E 04	0.0

OUTLOOK FOR THE USE OF COMPUTERS IN THE MILITARY CONSTRUCTION DESIGN PROCESS

by

Donald B. Baldwin*

The Present and Recent Past

In recent years, the scope of architectural and engineering design has been expanded to include more detailed examination of factors. Stated another way, the design process has been complicated by a variety of new constraints and requirements, both technical and statutory. The facility design process has been made more complex by many factors. Some of them are environmental considerations, both health and economics motivated. Rapid rates of inflation and the direct effect on material and construction costs, energy conservation considerations, and the effects of energy shortages on facility operation and maintenance costs have also added to design complexity. Being required to take all of these factors into account when planning and designing a military facility has made it difficult for the Corps' professional designers to do their job. Design accountability is much harder to maintain. Without some form of rapid, computer-aided design tool, the capacity of engineers and architects to objectively examine and evaluate a variety of alternates to determine the best compatible set to use in a particular facility design is severely restrained. It is important for designers to respond rapidly, and in a rational and objective manner, to budget cuts and other factors, which can have a strong impact on a chosen set of design alternates at any time during the design process. Designers frequently lack a clearly defined audit trail of the design decisions, which have been made up to any given time, and their effect on cost, as well as the effect of cost on design decisions. This lack is a serious

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* AEADS Project Monitor, Advanced Technology Branch, Engineering Division Military Construction Directorate, Office of the Chief of Engineers, Washington, D. C.

drawback in the Corps' design environment.

Until recently, the Corps, like many other organizations in the design and construction business, has used the computer to aid the engineer in the execution of relatively single purpose design functions. For example, structural engineers are using programs such as ICES-STRUDL, SAP, and EASE to analyze or design structural frames for large facilities. In a similar manner, mechanical engineers are using TRACE, ECUBE, and ACCESS to aid in the design and analysis of HVAC systems for some of these same structures. However, only a very few engineers are trying to interconnect and interface the functions of these various different programs and engineering disciplines in such a coordinated way as to be able to perform integrated, cross-discipline analysis and design. Although there are time and money to be saved through the effective use of these various single-purpose, single-discipline programs, a much greater benefit can be realized through their organized and coordinated use. The tendency in the past has been to focus our attention on the examination of each individual tree rather than step back and try to take an overall view of the collection of trees as a forest. A building facility is not so unlike this forest, with each of its subsystems, i.e., structural, mechanical, electrical, etc., representing a different tree.

The Outlook in Computer-Aided Design

A look at our past and present use of the computer in engineering design, together with the multitude of complex factors that today's designer must take into account, clearly indicates that a more effective use of the computer is required. The technology advancements in computer hardware are far ahead of the engineering applications programs and systems that the Corps currently uses. The realization of this need has prompted the Military Construction Directorate to embark on the development of a computer system whose primary function will be the coordinated integration of all of the various engineering and architectural functions and disciplines that normally make up the MCA design process. The Automated Engineering and Architectural Design System,

AEADS, is being designed and developed specifically to support the military construction design responsibility of the Corps. AEADS will not be an "automatic" design system, as its name implies to some. Rather, it will be a "computer-aided" design system that employs an optimum mix of state-of-the-art software and state-of-the-technology hardware to aid the professional in the design decision-making process. We are not attempting to automate the process in the sense of "push-button" design; we do not believe that either the design process itself or the state-of-the-art and technology in computer science are well enough understood and advanced to produce such an automatic system. The AEADS will provide an on-line, man-machine interface which will directly involve the professional in all of the decision making that takes place in the facility design process. The professional will be able to focus more of his attention on the vital decision-making aspects of design and become less bogged down in the technical level details which consume so much of his time at present.

Objectives of the AEADS

The basic objectives of the AEADS are to:

a. Improve the quality of design.

b. Improve design responsiveness.

Improving the quality of the MCA design product can be accomplished by consideration of:

a. Development of structured relationships between decisions made during the design process and the impact of these decisions on the quality of the final product.

b. Improvement of the process whereby facility design is continually reviewed during the design process to ascertain compliance with criteria including functional adequacy, budgetary restrictions, and user needs.

c. Ability to derive facility criteria from user requirements and to include innovative design and construction techniques.

d. Capability to examine and minimize life cycle costs within the limits of the desired functional criteria.

e. Development of facility design which minimizes the impact of the facility on the total environment.

On the other hand, improving the responsiveness of design can be accomplished by consideration of such things as:

a. Maximizing the number of design alternates examined while minimizing the impact on the time span of the total design process, i.e., consider more design alternates in a much shorter time span.

b. Increasing the level of capacity and readiness of the Corps' professional design staff in architectural and engineering design activities, i.e., increase and improve the productivity of the Corps' professional design staff.

c. Providing an organized format for the standardization of computer software and hardware to support a more systematic and accountable design process.

AEADS Development Strategy

The development of such a large and integrated software/hardware system is very complex and must be approached in phases. Although the AEADS will address the entire spectrum of facility design, first priority will be given to developing the system at the opposite ends of the spectrum, i.e., the concept development phase and the final review phase of the design process. These two areas are where the bulk of the in-house effort is currently concentrated. Second priority will be given to the development of the remainder of the design process, including technical design computations and the actual production of final contract documents. In any case, the high payoff areas that are identifiable in the MCA cycle will be implemented as quickly as possible.

While the overriding goal of the AEADS development will be the eventual integration of all of its component parts and subsystems, nevertheless, whenever possible, the product(s) of any one phase will be designed to be operable on a stand-alone basis. In this way, parts of the system may be field tested and used for productive work before the final system integration is accomplished. The best available technical design software packages will be used by the system as much as

possible. New technical design software packages will be developed for the AEADS only if such software does not already exist from some other source.

The AEADS development is being treated by MC/OCE as a full-scale project. The U. S. Army Construction Engineering Research Laboratory at Champaign, Illinois, has been given the responsibility for planning and developing the system. The CERL AEADS Project Manager, Mr. David Sides, is formulating an AEADS Project Development Plan and Schedule. Over the next 5 yr, from 10 to 20 million dollars will be spent on the AEADS development. The Project Manager will be using the best available people from both the private and Government sectors of the profession to design and build the AEADS. AEADS development will be carried out with close consultation and cooperation with Corps district and division professional personnel. A project Monitor Team at OCE is monitoring and giving general technical direction to the AEADS Project Manager in the system's development. This Monitor Team will also serve as the focal point of AEADS coordination between Civil Works and Military Construction Directorates as well as other DOD and Government agencies.

The phased development strategy of the AEADS is perhaps best illustrated by two of its current products, SEARCH and the DD 1391 Checker.

SEARCH
(Systematic Evaluation and Review of Criteria for Habitability)

Briefly stated, SEARCH is a set of computer programs that are used in conjunction with two special graphic input devices by architects to evaluate concept plans that are submitted to the Army for approval. The system accepts information from Space Utilization Guides and other criteria documents together with a graphic description of building floor plans; it then evaluates the plans submitted by these specified criteria. SEARCH functions as a geometrical space relationship checker. It not only performs these criteria checks but also informs the user when and where criteria conflicts occur and gives an indication of their severity. The user is in control of the system at all times, and it produces

an audit trail of the source of all criteria; it uses this during the analysis.

DD 1391 Checker

Although the 1391 Checker is only partially operational, it is already proving to be a very useful, time-saving tool in the checking of the cost estimate portion of DD 1391's. When completed, the Checker will provide a computer-aided procedure for assisting master planners and all others normally involved in verifying that applicable DOD, DA, and CE requirements and regulations have been considered when a project is submitted for authorization. In its present form, the Checker is used in an on-line interactive mode by estimators to price out a project with the assurance that the cost computed is within statute and criteria of DOD, AR, and ER guidance. The cost checker portion of the DD 1391 Checker can generate as well as check the cost data for any DD 1391.

Other Features of AEADS Currently Under Development

One of the functions of AEADS will be its ability to produce project specifications based on the automatically recorded design decisions made by architects and engineers during the design process. Part of this process involves the tailoring of standard guide specifications to particular projects. Initially, this tailoring will be accomplished by an on-line text editor, EDITSPEC, which is currently under development.

In the area of cost estimating, AEADS will be designed to provide cost breakdowns at various levels of detail and at different times during the facility design process. The costs will be keyed to specific design decisions through an intricate data structuring scheme. At concept stage, costs given would be based in large part on historical and empirical data; at later times in design development, these costs will be based on actual material takeoffs. Life cycle as well as first cost values will be given by the system.

AEADS Coordination and Integration

Although the early-on, stand-alone products such as SEARCH and the DD 1391 Checker serve a useful and productive purpose in their own right, the greater benefit is to be achieved by providing the overall framework of the AEADS for their systematic and integrated use. The system must provide design accountability via a design decision audit trail as well as the ability to directly interface the various design disciplines and functions. For example, when a mechanical engineer makes the design decision to use a particular type of HVAC system or to consider several such alternate systems, all other functions and parts of the design process must be checked by the AEADS to: (a) make sure that criteria are not violated, (b) determine the impact, if any, on the other decisions that have already been made by other engineers, (c) determine the required sections of guide specifications that are needed, and (d) determine the initial and, in some cases, the life cycle cost of the alternate(s) to be considered. In addition, some design decisions must be analyzed in regard to their possible impact on environmental and energy conservation aspects. The ability to make, review, and evaluate such design decisions at any stage of the facility design process in a dynamic way can be a very powerful and effective use of the computer as a tool in design. Eventually the AEADS will be linked with other software systems being developed that will monitor the construction and operation phases of facilities. This linkup will provide a vital direct feedback mechanism which the AEADS can use to modify the design criteria that will be used in future projects.

Summary

The AEADS Project is a very ambitious undertaking, and OCE is fully committed to its development and implementation. The best qualified experts in engineering software design and data handling both in and out of Government will be used in building the system. Successful design and implementation of the AEADS will depend in large part on the

joint cooperation and the concerted effort of Corps professional personnel at all levels. It will be field tested in districts, divisions, and OCE at every step of the way. The system's software and hardware will be designed with the end user, the practicing engineer and architect, in mind. The expenditure in time and resources will be considerable; we believe the commitment will be well worth the effort. Within the next few months, a joint CW/MC letter will be sent to all district and division offices giving information on AEADS and requesting their input and support as users in the system's planning and development. Due to its size, the AEADS Project development is being coordinated with other DOD and Federal agencies.

Appendix A: Memorandum For Record

DAEN-MCE-D 6 October 1975

MEMORANDUM FOR RECORD

SUBJECT: Report on the Corps-Wide Conference on Computer-Aided Design in Structural Engineering, September 22-26, 1975, New Orleans, LA

1. Although the conference was started in style by the near miss of hurricane Eloise, there were over 180 participants, with EURDIV and MEDDIV being the only divisions not represented. A total of eight people from OCE participated in the conference, seven from the Civil Works Directorate, and one from Military Construction.

2. The general session papers presented by the CW Directorate representative and the representatives of the various division offices were excellent and very enlightening. It was encouraging to know that so many of the divisions and districts are now pursuing effective use of the computer in structural design and analysis as well as in other areas of the engineering profession. The specialty sessions proved to be very productive. The session I chaired (Matrix Analysis Methods, Frames, and Military Construction) was given twice to a total of 81 persons. A list of the session attendees is inclosed. In addition, the SEARCH demonstration was given a total of fifteen times by Dale Bryant and Bruce Dains of CERL, so that every conference participant received close exposure to the system.

3. During the general and specialty sessions, a number of serious issues and important problems were surfaced and discussed--some in great detail. The following are a few of the more important items that were raised.

a. The Corps is rapidly losing its in-house capability to do engineering design and review work. The Corps is rapidly becoming the "Corps of Clerks" instead of the Corps of Engineers. In addition, not enough challenging design work is being done in-house to adequately train and attract or hold on to young engineers. In the MC area, work loads are scheduled without apparent regard for the in-house capability to perform the work. More often than not, the short time span allowed for MC work does not allow engineers to become familiar with the potential benefits of computer-aided design. It was suggested by some division speakers that if the Corps is going to continue with its current work load level and manpower level, then OCE should seriously consider farming out to A&E consultants the preparation of project specifications and estimates, and performing more actual design work in-house. The consensus of the division speakers, as well as the participants, was that unless engineers are kept actively involved in actual design work, they will soon be virtually useless as design reviewers.

b. Many of those present who are involved in MC work expressed a real need to find ways to involve the computer more in all of the various phases of the MCA design process, not just in the technical design

calculation stage. In particular, the computer needs to be applied more at the concept and review stages of the design process. We need to be using the computer to do better design very early in the concept phase.

c. The reluctance of supervisors to allow their people to use the computer in design is due in part to lack of confidence in the computer on the part of the supervisors. It was suggested that a training program be instituted by the Corps to educate supervisors in the capabilities and benefits of computer-aided design.

d. The general consensus of all conference participants was that the conference should be repeated on a periodic basis. One division representative suggested that consideration be given to dividing future conferences into two parts. One part would be specifically aimed at the supervisors and the other part devoted to the designers. In this way, the short time constraints revealed in this conference would be corrected. The consensus was that there was not enough time in any of the sessions to discuss the problems surfaced in adequate detail.

e. It was suggested that either an OCE or division-wide panel of professional engineers be established to determine the long-range computer hardware and software needs of the Corps. In particular, it was suggested that this high level, professional panel should be recommending new software development, procurement, and use throughout the Corps based on projected Corps workloads.

f. It was recommended that greater use be made of currently available computer programs from private industry.

g. It was requested that OCE provide funds and take a strong position with regard to the proper and adequate documentation of in-house developed computer programs. Too many of these existing programs are virtually useless to people other than the originator without good user documentation. In nearly every case, the author of an in-house program is either too busy to properly document his work or else his supervisors discourage him from taking the time to do this very vital task. OCE needs to recognize this need and take positive steps to correct the problem.

h. Nearly all conference participants expressed a need to use computer graphics more for pre- and post-processing of program data and results. One of the major drawbacks to using the larger design and analysis programs is the inordinate amount of time it takes the professional to express his problem to the computer and the often very complicated and time-consuming problem of correctly reading and interpreting the results. Computer graphics appears to have great potential

in both areas. The use of conversational, easy to use, and understand man-machine interface software is another area that should be pursued more strongly.

3. While there were many other very important issues that were made and discussed by the participants, these are some of the most important and were, by far, the points on which nearly every participant agreed.

4. Although the material presented at the specialty sessions was predominantly civil works oriented, the division papers and specialty session discussions indicated about a 60 percent to 40 percent (CW vs. MC) division in participant interest. In addition, there was a general expression on the part of nearly all of the participants for the desire to have OCE state clearly and definitively its policy and support regarding the use of computers in the engineering design process.

5. Sometime within the next two months, representatives of WES will make a formal presentation to the Civil Works and Military Construction Directorates on the results and outcome of the conference. All invited OCE, division, and specialty session speakers are due to submit the final drafts of their presentations as written papers, to be included in the conference proceedings, to WES by 24 October 1975. The proceedings will be published during the first calendar quarter of 1976.

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DON BALDWIN
AEADS Project Monitor

APPENDIX A: BIOGRAPHICAL SKETCHES OF AUTHORS

AD-A031 252 ARMY ENGINEER WATERWAYS EXPERIMENT STATION VICKSBURG MISS F/G 9/2
CORPS-WIDE CONFERENCE ON COMPUTER-AIDED DESIGN IN STRUCTURAL EN--ETC(U)
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Mr. William D. Ashton is a Structural Design Engineer working with the Rock Island District, Corps of Engineers, Illinois. He has his BS and MS degrees in Civil Engineering from the University of Iowa. His experience in the design area include the structural inspection and evaluation of numerous navigation structures and highway and railroad bridges, design of several highway and railroad bridges, and other typical Corps of Engineers application areas. He has been very active in developing computer programs for design-analysis and has taught several short courses on the "Stiffness Method of Structural Analysis." He is the author of numerous publications and is the joint author (with Dr. B. L. Meyers) of a book (to be published) on "Stiffness Method of Structural Analysis."

Mr. Donald B. Baldwin graduated in 1957 from the University of Louisville, in Kentucky, with a Bachelor of Civil Engineering degree. He received an M.S. in Engineering from George Washington University in 1969, and, in 1972, a Master of Civil Engineering degree from the University of Louisville. He has worked as a Civil Engineer, General Engineer, and as a Specialist in Structural Dynamics. Currently, he is employed as a General Engineer, Advanced Technology Branch, OCE, and is primarily responsible for the planning and design of AEADS. In Kentucky he is registered as a Professional Civil Engineer; he is also a Certified Fallout Shelter Analyst. Mr. Baldwin is a member of ASCE's Technical Council on Computer Practices, the Federal Construction Council of the National Academy of Sciences, the Standing Committee on Computer Technology for the Building Research Advisory Board, and the Reinforced Concrete Research Council. His publications include: "Professional Recognition Through Registration," Civil Engineering Magazine; a technical report, Soil Thermal Conductivity Investigation for Underground Shelters; and co-authorship on Design and Evaluation of a 480-Person Austere Community Fallout Shelter.

Daniel W. Reynolds received a B.S. degree in Civil Engineering from the University of Wyoming at Laramie in 1959, and holds an Engineering-in-Training Certificate issued by Wyoming. He has served with the Corps as a Civil Engineer, Missouri River Division; and Construction Engineer

Ballistic Missile Construction Office, in Denver, Colorado, and Roswell, New Mexico. While working as a Structural Engineer, Military Design Branch, Alaska District, he helped with reconstruction after the Prince William Sound, Alaska, earthquake of 1964. In the 10 yr since joining the Military Design Branch, Sacramento District, he has worked in General and Civil Engineering, and is now serving as a Structural Engineer.

In accordance with ER 70-2-3, paragraph 6c(1)(b), dated 15 February 1973, a facsimile catalog card in Library of Congress format is reproduced below.

Corps-Wide Conference on Computer-Aided Design in Structural Engineering, New Orleans, La., 1975.
[Proceedings ... held in New Orleans, Louisiana, 22-26 September 1975, Vicksburg, Miss., Automatic Data Processing Center, U. S. Army Engineer Waterways Experiment Station, 1976-
12 v. illus. 27 cm.
Contents.-v.1. Management report.-v.2. List of computer programs for CADSE.-v.3. Invited speeches and technical presentations.-v.4. Division presentations.-v.5. State-of-the-Corps-Art (SOCA) reports on gravity monoliths, U-frame locks, and channels.-v.6. SOCA reports on gates, stoplogs, and trashracks.-v.7. SOCA reports on single- and multiple-cell conduits and tunnels.-v.8. SOCA reports on pile foundations and sheet pile cells.-v.9. SOCA reports on sheet pile walls and T-walls.-v.10. SOCA reports on stiffness methods, frames, and military construction.-v.11. SOCA reports on earthquake and dynamic analyses.-v.12. Interactive graphics, SEARCH and CORPS systems.

(Continued on next card)

Corps-Wide Conference on Computer-Aided Design in Structural Engineering, New Orleans, La., 1975.
[Proceedings ...] 1976-
(Card 2)

1. Computer-aided design -- Congresses. 2. Design -- Congresses. 3. Structural engineering -- Congresses. I. U. S. Army. Corps of Engineers. II. U. S. Waterways Experiment Station, Vicksburg, Miss.
TA641.C67 1975